ENGINEERING ABSTRACTS

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Effect of Freezing on Manila Rope

In this investigation of the effects of freezing on manila rope a large number of pieces of 1-inch-diameter manila rope manufactured by the author's company were made up into test lengths. After conditioning at 65 per cent relative humidity and 70 deg. F., six of these ropes were broken to provide a control for evaluating the other tests. The balance of the lot were subjected to freezing under various conditions. All freezing was done in a food-processing plant at 0 deg. F. with a minimum exposure of five hours at this temperature. The frozen ropes were insulated carefully and brought to the physical testing laboratory where tensile tests were made. There was very little increase in the temperature of the rope during the period of transportation and before testing. From the experiments and data obtained in an earlier investigation, the following conclusions are drawn: (1) The strength of dry manila rope is not seriously affected when loaded at temperatures below freezing. (2) A thoroughly soaked manila rope is considerably weaker in tension if stressed while in a frozen condition; this loss of strength can be as high as 30 per cent. However, there is no further loss in strength by repeated freezing and thawing. (3) Contrary to previous evidence, this investigation indicates that a rope is not permanently damaged by being frozen while wet, if it is not loaded in that condition. If allowed to thaw out, the rope is not harmed. This applies to repeated freezing and thawing, as well as to the first incident. (4) Manila rope is not harmed by being subjected to low temperatures in a dry condition. (5) From the standpoint of safety, the thing to watch is the use of manila rope in subfreezing weather. Don't overload it, as it is weaker. Experiments indicate that the more water is in the rope, the greater the loss in strength. Therefore, a rope which is treated to repel moisture gives a better chance of operating safely, than a rope which readily soaks up water. Occasional brief immersion will not put a large amount of water in a well waterproofed manila rope. For example, the first quality rope used in these tests will absorb less than a third as much water on immersion for a half hour as on untreated rope. This is another argument for using high-quality manila rope which has been treated especially to make it water repellent. *—R. T. Starr, Marine Engineering and Shipping Review, Vol. 56, November 1951, pp. 65-66.*

Possibilities of Hydrofoils

In this paper the author describes the applications of hydrofins and hydrofoils along with a fairly complete history of their development. A generalization on the theory of hydrofoils is given by the application of Bernoulli's law. The performance characteristics are shown in curves in which the ratio of lifting force to drag force is plotted against the angle of attack and velocity. In discussing the type of hydrofoil elements, the author draws upon the early German work (1891) and explains the development of the step type, V-type, Tietjens type (closed loop or U), and Hook type. A comparison of the hydrofoil boat and the planing boat is presented by two figures which make a comparison of the lift to drag ratio plotted against speed in knots. A destroyer and a modern cargo carrier are also plotted on this chart. The conclusion is drawn that beyond 45 knots only the planing hull appears to be practicable. The author gives his own conclusions and analysis of a chart drawn by Tietjens of the horsepower requirements of the planing hull and the hydrofoil as plotted against Froude's number. In discussing the design problem, particular mention is made of the problem of air entrainment and cavitation. In conclusion, the author gives several interesting applications for the hydrofoil boat; for example, rapid transportation in harbours, coastal service, air-sea rescue, torpedo boat, noiseless submarine chasers, and racing boats. A brief description of a proposed passenger hydrofoil boat is given.—*Paper by J. J. Oetling, read at a meeting of the Northern California Section of the Society of Naval Architects and Marine Engineers, 11th May 1951.*

New Swedish Ferry

The motor ferry *Kalmarsund VI,* which recently entered service between the Swedish mainland and the island of Oland off the east coast of Southern Sweden, is a valuable addition to that service. The new ferry is double ended with a propeller and rudder at each end. She was built by the Kalmar Shipyard to designs of Mr. Gunnar Byfors, chief engineer of the shipyard. The principal particulars are:—

Length overall	137ft. 10in.
Breadth moulded...	35ft. 1in.
Depth moulded	14ft. 9in.
Draught	11ft. 0in.
Freeboard amidships	4ft. 7in.
Gross tonnage	493 tons
Speed on trials	11·2 knots

After a number of alternative machinery proposals had been considered, a 7-cylinder, direct reversible Nohab Diesel engine, manufactured by Nydqvist and Holm A/B Trollhättan, Sweden, was finally chosen. The engine is of the ML-7 type with an output of 1,050 s.h.p. at 250 r.p.m. and is erected in line with the two propeller shafts so that one or both propellers can be driven simultaneously. This has been rendered possible by fitting an Airflex clutch coupling at each end of the engine. The couplings serve a double purpose, as they increase the manœuvring qualities of the ferry and also make it possible to utilize the total output of the engine during service in severe ice. Extensive tests carried out at the Government Experiment Tank at Gothenburg show among other things, that if both propellers are connected, the vessel will have a tendency to sheer to starboard. On the other hand, if the rear propeller is connected, the tendency will be to sheer to port. This peculiarity is of great importance when entering and leaving the ferry stations. So far as service in ice is concerned, it is a well known fact that increased resistance (ice) and propellers with fixed blades will cause a rather considerable reduction of the speed of the engine below the normal r.p.m., resulting in a corresponding reduction of the output. If no couplings were fitted, the engine would have to drive both propellers simultaneously, and when running through ice, the speed of the engine would be reduced below the normal speed. With the couplings, however, the front propeller can, under such conditions, be disconnected and the whole output of the engine applied to the rear propeller. The speed can be maintained and a considerable increase of the propeller capacity can be obtained.—*Shipbuilding and Shipping Record, Vol. 78, 25th October 1951, pp. 525-526.*

Stud Welding on Aluminium Alloys

Stud welding, a form of arc welding in which studs are jointed to plates without the need for drilling and tapping, has made much progress in shipbuilding during recent years. It was first applied nearly thirty years ago to fix certain brass studs to steel plates, but was further developed during the later war for high-grade steel-to-steel welding. More recently the process has been demanded for work on aluminium, and the present article describes tests made on some of the aluminium-magnesium alloys of particular interest in marine construction. These materials were tested because of their shipbuilding applications, but, like other forms of arc welding, the process may also be suitable for most alloys of aluminium.—*D. C. G. Lees, Welding and Metal Fabrication, Vol. 19, October 1951, pp. 390-391.*

Residual Stresses in Welded Mild-steel Pipe

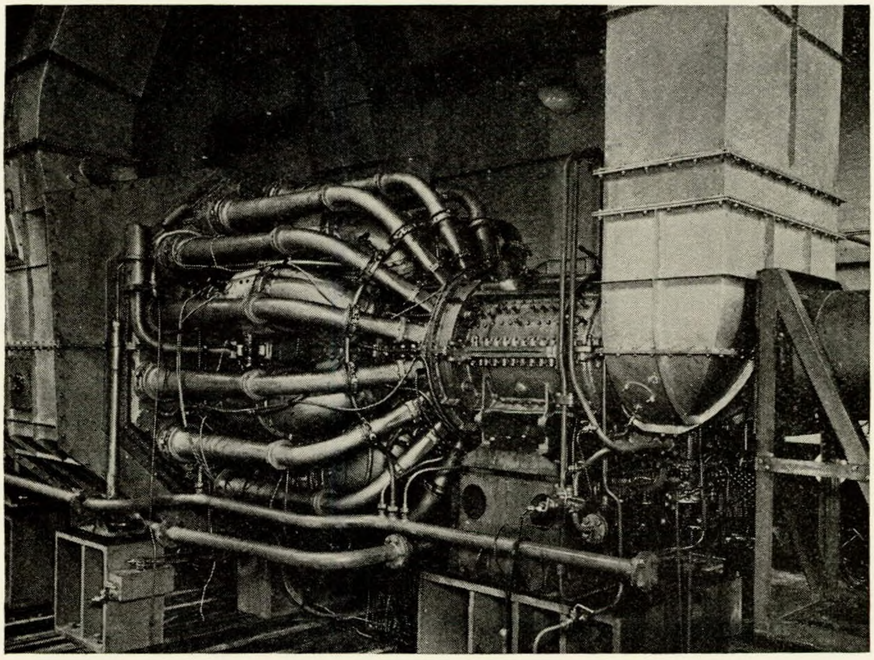
The study of the distribution and magnitude of stresses due to circumferential butt welds in 5½-inch o.d., ½-in. wall thickness mild-steel pipe as determined by Sachs' boring-out method, and of the effects of stress relief postheating of the weld and annealing of the pipe prior to welding, has led to the following conclusions: (1) The pipe as received, welded without preheat or postheat (stress relief), had high tensile transverse stresses (25,000 to 30,000lb. per sq. in.) at the inner surface of the weld changing in a roughly linear manner to high compressive stresses (27,000 to 31,000lb. per sq. in.) a distance approximately ⅛-inch from the outer surface and then dropping sharply in magnitude (less than 5,000lb. per sq. in.), compressive at or near the inner surface and tensile at or near the outer surface. (2) Stress relieving at 1,200 deg. F. for 1 hr. was effective in reducing the magnitude of the transverse stresses (from 30,000 to 10,000lb. per sq. in.) but had no effect upon the magnitude of the circumferential stresses. (3) The high transverse tensile stresses at the inner wall of as-welded pipe might be of a favourable nature since they would tend to oppose expansion forces caused by pressure within the pipe. Since stress-relieving considerably lowers these transverse tensile stresses, postheating circumferential welds in mild-steel pipe, from the viewpoint of these stresses alone, might be a harmful rather than a favourable treatment. (4) The transverse stresses in as-welded pipe can be explained as resulting primarily from bending moments caused by shrinkage of the band of weld metal around the circumference, and the circumferential stresses as resulting primarily from the restraint opposing the shrinkage of the band of weld metal. (5) Annealing the pipe prior to welding did not change the stress distributions, but it did result in lower transverse stresses and higher circumferential stresses in the weld after welding than were found in the pipe welded as received. (6) Both transverse and circumferential stresses, in a band of the base metal 1¼-inch away from the weld centre, were low (less than 5,000lb. per sq. in.) regardless of the welding procedure used. No definite pattern of stress distribution could be established in this zone. (7) Transverse and circumferential stresses in the unwelded pipe as received were zero or of a very low magnitude at the inner and outer surfaces and reached a maximum compressive magnitude (21,000lb. per sq. in. transverse and 25,000lb. per sq. in. in circumferential) approximately one-third of the thickness below the inner surface and a maximum tensile magnitude (25,000lb. per sq. in. transverse and 4,000lb. per sq. in. circumferential) just below the outer surface. (8) Radial stresses were negligible in all pipes and welds.—*L. J. Privoznik, The Welding Journal (New York), Vol. 30, September 1951, pp. 422-s-428-s.*

Allen Gas Turbine

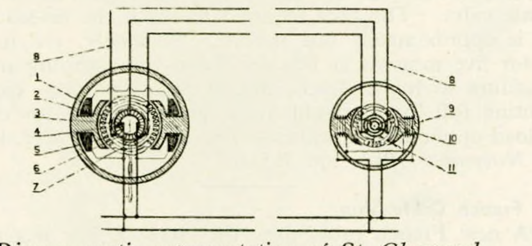
The gas-turbine alternator supplied by W. H. Allen and Co., Ltd., to the Admiralty for Naval service is a simple open-cycle set having an axial-flow compressor with a compression ratio of 4¼:1, driven by a two-stage turbine, with an annular two-pass cross-flow heat exchanger, a multi-chamber combustion system disposed symmetrically round the engine, and a separate single-stage power turbine driving the Allen alternator through Allen-Stoeckicht epicyclic gearing. The Admiralty specification called for a set of 1,000 kW maximum continuous rating with a 20 per cent overload for ten minutes, to be suitable for operation at all loads up to overload under temperate (60 deg. F.) or tropical (100 deg. F.) conditions, and capable of running satisfactorily in parallel with other steam turbo-alternators, the governing requirements being 2½ per cent speed change for 50 per cent load change and the ability to accept or shed 100 per cent load without the emergency gear operating. The fuel was to be Diesel oil, Admiralty reference Fuel B.310, and a maximum fuel consumption of 1·27lb./kW/hr. under tropical conditions in the zone 60 per cent to 100 per cent power was specified. Total head pressures of 14·1lb. per sq. in. abs. at the compressor intake and 15·1lb. per sq. in. abs. at the power turbine outlet were called for, thus allowing for very high inlet and exhaust trunking losses. The engine was to be entirely self-contained and to be as small as consistent with reasonable accessibility, the maximum height available being 7ft., and every reasonable opportunity was to be taken to reduce weight without sacrificing reliability. Shock loading of 40 g. upwards, 25 g. downwards and 15 g. athwartships were specified. Finally, a life of 100,000 hours was to be aimed at, this period being made up of 65,000 hours at 80 per cent power under temperate conditions, 33,000 hours at 80 per cent power under tropical conditions, and 2,000 hours at full power under tropical conditions. The compressor is of the axial-flow, multi-stage type. The rotor is of a special built-up design to reduce its moment of inertia to as small a value as possible in order to assist the speed governor during sudden large load changes. The heat exchanger is of the tubular, cross-flow, recuperative type arranged with a single pass on the hot exhaust gas side and two passes on the cold inlet air side. It is built of eight similar segments each containing just over 2,000 tubes, the total number being 16,500. The shell is of fabricated aluminized mild steel fitted with tubes of Yorkshire Copper Company's "Yorcalnic", 5/16-in. outside diameter, ·020-in. thick, which are secured to the mild steel tube plates by expanded ferrules. The compressor turbine is of the axial flow type consisting of two stages. The two "G. 18 B" steel rotor wheels and the stub shafts are bolted together by means of a pre-stressed manganese molybdenum bolt passing through the centrally-bored wheels, and specially designed to withstand the high expansion which occurs in the wheels themselves. The power turbine is of the axial-flow type, consisting of a single-stage, mechanically independent of the compressor turbine. The turbine is provided with a simple fuel-oil system employing Lucas Simplex-type burners. The quantity of fuel delivered to the combustion chambers is varied by the opening of a throttle valve fitted in the fuel-supply pipe to the burners and controlled by the speed governor through an oil relay. The starting procedure is briefly as follows: The compressor is run by an electric motor to approximately 1,500 r.p.m. (taking approximately 16 h.p.). The torch igniters are then lighted by means of an ordinary sparking plug and when the thermocouples indicate that they are operating satisfactorily, the main fuel supply is switched on to the burners. Further thermocouples indicate when each combustion chamber is alight and, upon verification that all chambers are functioning satisfactorily, the turbine is accelerated on the hand throttle valve. The starter motor continues to assist the turbine up to a speed of about 2,500 r.p.m. when the turbine becomes self-sustaining and its speed overtakes the starter motor, which disengages by means of a free-wheel clutch. As the turbine speed approaches no-load speed, the automatic speed control governor takes over control of the fuel supply through the oil-operated throttle valve. The time required to reach the no-load condition is approximately one minute. Normally, the turbine is run for five minutes at this condition for warming up before proceeding to higher loads, but, if necessary, it is capable of accepting full load straight away, giving a time for obtaining full load of about 1½ minutes.—*The Shipping World, Vol. 125, 21st November 1951, pp. 365-367.*

New French Cable Ship

A new French cable ship, the *Ampere*, has recently been completed for the French Department of Communications by Soc. de Chantiers et Ateliers de St. Nazaire (Penhoet). The most interesting part of the ship is perhaps her propelling machinery, which consists of steam turbines driving variable pitch propellers. The two turbines are geared to the propeller shafts. Steam is supplied by two Penhoet boilers, working at 240lb. per sq. in. with an output of 20 tons per hr. The designed speed of 14 knots requires 2,500 h.p., with a propeller speed of 129 r.p.m. The variable pitch propellers are of the Escher-Wyss type, constructed by Penhoet. They are 10ft. 10in. in diameter. They can be controlled from any one of three control positions, situated respectively on the bridge, in the engine room, and on a special platform alongside the cable laying machinery. The control gear for the propellers has been supplied by Etablissements St.-Chamond-Granat, of Paris. The actual propellers are hydraulically operated, and the hydraulic servo motor is controlled by an electrical system from the three controllers. These controllers have dials showing the inclination of the blades of each of the propellers, together with handles



The 1,000-kW. Allen gas turbine-driven alternator erected for testing. The lagged outer covers are removed to expose the compressor, turbines, air pipes, heat exchanger, combustion chambers, and instrumentation piping. The air intake trunking is shown on the right, and the exhaust outlets are arranged on each side of the heat exchanger for controlling their movement. The electrical connexions from all three are led to a change-over switch on the bridge, by means of which the position to control the propellers may be selected. The indicator transmission system is shown diagrammatically below. The transmitter consists essentially of a shunt motor, with stator (1), rotor (2) and commutator (3). In addition to the normal supply brushes (4), carrying the normal rotor current, three rotating brushes bear on the commutator. These are mounted 120 deg. apart on a ring, and this ring is given the motion which it is desired to transmit. When the system

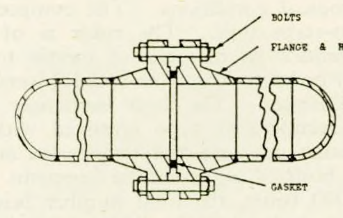


Diagrammatic representation of St. Chamand-Granat transmission circuit

is in operation, although the commutator is rotating and the voltage on any individual segment is alternating as it rotates, the voltage that will be picked up by a stationary brush will be constant, as each segment will instantaneously have the same voltage as it passes beneath the brush. If the brush is now slowly rotated, it will pick up a voltage that will alternate with the frequency of rotation of the brush. It will be seen, therefore, that the three movable brushes, being spaced 120 deg. apart, will transmit a three-phase current, the frequency of rotation of the mounting ring. The receiver consists of a stator carrying direct current, and a three-phase rotor. This rotor is fed through slip rings with the current picked up by the transmitter brushes. The resultant field induced in the rotor will rotate at the same frequency as the current. As this field will always endeavour to set itself in exact opposition to the stator field, which, of course, is stationary, the effect will be that the rotor of the receiver will move at the same speed and in the same direction (electrically) as the transmitter brush ring. If the latter is stationary, the former will be held in the corresponding position. When geared in a 1 : 1 ratio to its indicator, this system is thus self-aligning. It also has sufficient power to operate a servo motor itself, and may be used for power transmission instead of for indicating purposes.—*World Shipbuilding, Vol. 1, November 1951, pp. 118-119.*

Pipe Flange Jointings

It has been found that the pressure on gasket faces required to avoid leakage must bear a minimum ratio called *m* to the hydrostatic pressure expected to be confined. The value of *m* depends on the type of gasket material and the initial pressure to which the gasket is installed. It also depends on the type of flange facing used, but the methods of design usually account for this by choosing an "effective" gasket width.



Conventional flanged assembly

This term *m* is linked to the way the "total hydrostatic end load" (which is the pressure load tending to pull the assembly apart) is computed. Narrow gaskets make the exact choice of *m* values less important. Narrow gaskets tend to make more efficient pressure seals, from the point of view that a smaller percentage of the total area is involved. The fundamental problems encountered in gasket design therefore reduce to determining (1) a good criterion for gasket crushing, (2) good criteria for gasket "blowout", and (3) for wide gaskets used with flexible flanges, effective *m* values taking account of non uniform gasket pressure distribution across the gasket width.—*Paper by R. G. Blick, abstracted in Mechanical Engineering, Vol. 73, December 1951; p. 1015.*

Opposed-piston Engine

In view of the present design of Harland and Wolff engines using eccentrics for driving exhaust piston valves, the diagrams shown in Fig. 1 are of particular interest, inasmuch as they indicate the use of three cranks per cylinder. The left-hand front and side elevations refer to a trunk piston engine, while those on the right are of a crosshead type. In the case of the trunk-piston design, the main piston (1) controls the scavenging air ports (21). The exhaust piston (6) opens and closes the ports (22), and the main piston drives the crankshaft (3) through the connecting rod (2). The exhaust piston (6) is

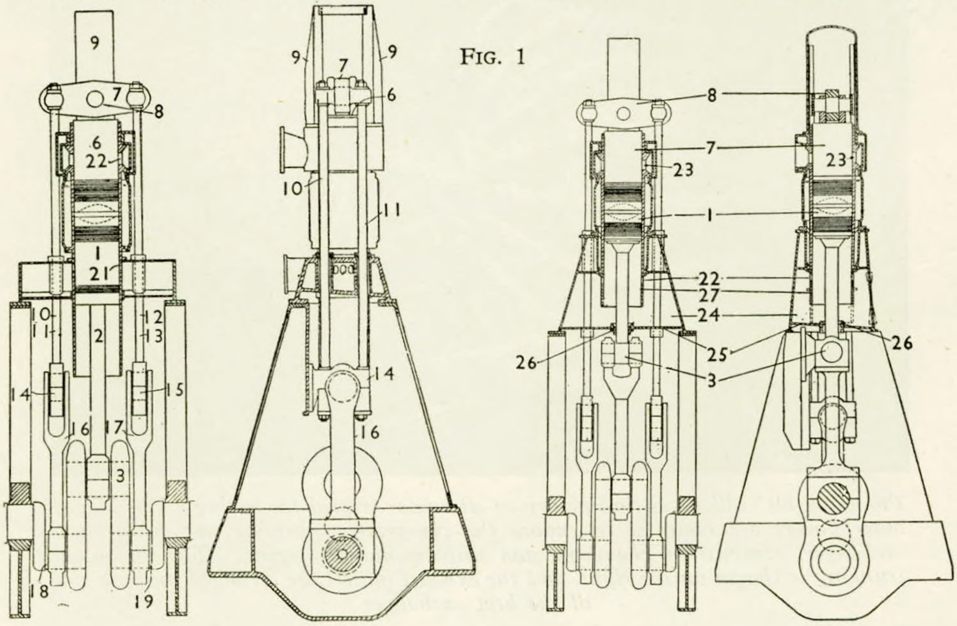


Fig. 1

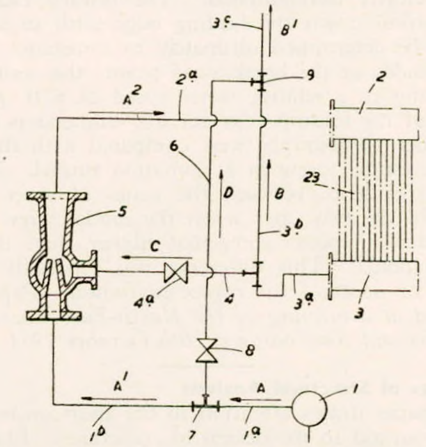
attached to a yoke (7), and the gudgeon (8) runs in guides (9). Four side rods (10, 11, 12, 13) are attached to the yoke (7), two of the rods being secured to a crosshead (15). These crossheads run in guides and operate the connecting rods (16, 17) connected to the side cranks (18, 19). Referring to the crosshead-type engine, the main piston (1) controls the scavenging air ports (22), and the exhaust piston (7) opens and closes the ports (23). A diaphragm (25) forms the top of the engine crankcase, and a stuffing box (26) is provided. The arrangement of a yoke with a gudgeon (8), four side rods and two crossheads corresponds with the trunk-piston engine design. The piston rod is connected to a centre crosshead (3) running in its own guide. The lower end of the cylinder liner is provided with a detachable skirt (27), which can be lowered to rest on the diaphragm (25). This enables the rings of the piston (1) to be inspected, while the piston can be withdrawn through the scavenging air belt (24) complete with the liner skirt (27).—*Brit. Pat. Nos. 657,998 and 657,999. C. C. Pounder and Sir F. E. Rebbeck, Harland and Wolff, Ltd., Belfast. The Motor Ship, Vol. 32, November 1951; p. 328.*

Tests of Werkspoor-Lugt Engine

Shop trials were recently run at the Amsterdam works of Werkspoor, N.V. of the first Werskpoor-Lugt turbo pressure-charged two-stroke engine to be fitted in a ship. Eight engines of this class are being built in powers up to 9,600 b.h.p. The first engine of this type, which was non-pressure-charged, was installed to the Oranje Line's *Prins Frederik Willem,* now operating on boiler oil on the company's Atlantic and Great Lakes service. The pressure-charged engine on test is of the "low-built" type, originally ordered by Empresa Nacional Elcano to run on Diesel oil as a normally aspirated unit. The cylinders have a diameter of 600 mm., and the stroke is 900 mm. Modifications have been made to the engine to facilitate pressure-charging, and thus give an increase in power of about 33 per cent. In the ship, however, this engine will be operated without the supercharging equipment, but all future engines will be pressure-charged. The normal brake horsepower for the four-cylinder, non-pressure-charged engine is 1,800 at 165 r.p.m., the b.m.e.p. being 70-71lb. per sq. in.; with turbo pressure-charging this is increased to 2,400 b.h.p., the b.m.e.p. being 95 lb. per sq. in. This is considered a safe service power. It is understood, however, that subsequent development will enable this figure to be exceeded. The pressure-charging system incorporates a Brown-Boveri exhaust-gas turbo-charger operating in parallel with the main engine-driven, double-acting pumps. As the output of the turbo-blower increases after the engine is started, the output of the double-acting pumps is automatically reduced, until nearly all combustion and scavenging air is delivered from the blower. Such an arrangement has resulted in an appreciable increase in the mechanical efficiency of the engine. The blower delivers air, through an air cooler, into the scavenging air receiver at a pressure of 7lb. per sq. in. The weight of the normally aspirated engine is about 95 tons, or about 118lb. per b.h.p., for a rating of 1,800 b.h.p.; when supercharged to give an output of 2,400 b.h.p., the total weight is increased by approximately 2 tons, giving a weight per b.h.p. of about 90lb.—*The Motor Ship, Vol. 32, December 1951; p. 346.*

Economizer Circuit

The inventor proposes an improved method of feeding an economizer with water so that reduction of the gas temperature below the dew point can be prevented. As shown in Fig. 2, a pump (1) delivers water through the pipes (1a, 1b, ejector 5 and pipe 2a), in the direction of the arrows A, A^1, A^2, into the inlet header (2) and tubes (23) of the economizer. The water heated in the economizer tubes (23) passes out through the outlet header (3) by means of pipes (3a, 3b, 3c), in the direction of the arrows B, B^1, and is delivered toward the point of utilization. Part of the water leaving the outlet header (3) is returned in the direction of the arrow (C) to the fresh water feed-line to the economizer. The heated water flows from pipe (3a) through the pipe (4), controlled by valve (4a) into the ejector (5), where it mixes with the fresh water from pump (1). There is a bypass (6) branched off at (7) from the pump delivery line (1a, 1b) and provided with a valve (8), which enables part of the water delivered by the pump (1) to be diverted, in the direction of the arrow (D), directly toward the point of utilization of water heated by the economizer. The bypass (6) joins



the economizer delivery line (3b, 3c) at the junction fittings (9). The provision of the valve controlled bypass (6) enables the water which is fed into the inlet header (2) of the economizer to be at a higher temperature than would otherwise be the case. The quantity of cold water which enters into the economizer is therefore reduced, and the fall in temperature of the tubes of the latter is thus avoided and condensation does not form on the tubes.—*Brit. Pat. No. 658,408, issued to A. Huet. Complete specification published 10th October 1951. Engineering and Boiler House Review, Vol. 66, December 1951; pp. 385-386.*

Photography at Sea of Propeller Cavitation

In this paper a brief account is given of what is believed to be the first successful attempt at direct-observation and short-duration flash photography of the cavitation on the blades of a ship's propeller at sea. Hitherto the state of cavitation of ships' propellers could be inferred only from cavitation-tunnel tests of scale-model propellers. Tunnel conditions, however, do not exactly simulate the full-scale conditions at sea, for the following principal reasons: (a) The tunnel usually operates with well de-aerated fresh water, while sea-water is approximately air saturated. (b) The flow into a model screw is free of the turbulence and wake velocity variations to which the ship screw is subjected, together with further disturbance due to pitch and roll. (c) The Reynolds' number is as a rule much less (1/10 to 1/20) for the model than for the ship screw. (d) The model, unlike the real propeller, has a high degree of surface finish and is free of the wear-and-tear imperfections of the average ship propeller. Some allowances and corrections, of course, can be made in interpreting more realistically the model data; in particular any loss in thrust or efficiency of the model attributable to cavitation can be compared with corresponding losses determined during ship trials, thus establishing an indirect check on the correlation of model and full-scale propulsive effects. Indeed for a long time the term "cavitation", as understood by marine engineers, appeared to be almost synonymous with a degree of blade cavitation sufficient to cause loss of thrust and efficiency, or to result in harmful erosion effects. In this connexion, therefore, it is clearly desirable to discover by direct observation the reliability or otherwise of model predictions, including those concerning the onset and development of cavitation in its incipient and early stages. The only way to do this is to provide the hull with transparent viewing ports which will permit stroboscopic observation and short-duration flash photography of the propellers while the ship is operating normally at sea. For this purpose the hull was provided with two adjacent submerged 8-in. diameter glass ports, so situated that visual observations and photographs of the propeller blade cavitation could be made through one, while a high-intensity short-duration electronic flash provided illumination through the other. By working at night, under clear-water conditions, the growth of blade cavitation on the 8-ft. diameter propeller could be studied in detail, as the revolution rate was increased. The zones of sheet and bubble cavitation were clearly differentiated. The inward radial creep of sheet cavitation down the leading edge with increasing speed appears to be determined ultimately by constancy of the local cavitation index at the break-away point; this value was 0·65, corresponding to a relative water speed of 67ft. per sec. past this point of the leading edge for 8ft. immersion depth. The ship propeller photographs were compared with those taken of a 1/8 scale model screw in a cavitation tunnel. There was a close correspondence between the zones of sheet and bubble cavitation in the two cases when the model screw was run in aerated water at speeds somewhat higher than the estimated equivalent speeds. This difference was especially marked for the speeds of onset of tip vortex cavitation.—*Paper by J. W. Fisher, read at a meeting of the North-East Coast Institution of Engineers and Shipbuilders, 26th October 1951.*

Shortcomings of Structural Analysis

This paper draws attention to the shortcomings of elastic analysis as an aid to the design of structures. Elastic analysis can be depended upon to give sufficiently accurate values of the stresses in any structure where the characteristics of connexions are known, and the members and foundations are without imperfections. These conditions are not satisfied where real structures are concerned, and examples are quoted from framed structures to ships to show how far the real stresses are from those calculated. The conclusion drawn is that the elastic behaviour of real structures is too complex and variable to enable the designer to make any practical advances by the use of elastic analysis. This conclusion would be depressing if the engineer had no other means of determining the strength of his structure. Fortunately, it is possible in the case of structures made of a ductile material to determine with surprising accuracy the load at which a structure will fail or develop embarrassingly large deflexions. This is possible by admitting and taking full account of the plastic behaviour of the material. Examples are given demonstrating this and showing that the collapse load is independent of imperfections at joints, sinking and spread of supports, and residual stress systems such as those set up by welding.—*Paper by Prof. J. F. Baker, O.B.E., given as the Twentieth Andrew Laing Lecture, read at a meeting of the North-East Coast Institution of Engineers and Shipbuilders, 9th November 1951.*

Gear-oil Additives

Gear teeth, regardless of their design or the accuracy with which they are made, develop a combination of sliding and rolling motion as they pass into and out of mesh. Since sliding always prevails between gear teeth, accompanied so often by very high pressures which are comparable to those encountered in rolling contact bearings, maintenance of the lubricating film is an important requirement. In order to understand where film-strength fitted into the programme of developing the modern gear lubricants, the types of lubrication which can exist must be discussed. They involve: (1) Thick-film or hydrodynamic lubrication. (2) Boundary lubrication. In thick-film lubrication the parts are completely separated by a film of oil, so when one tooth surface slides over another the oil film will be sheared continuously. The term "film-strength" as applied to thick-film lubrication, therefore, has no significance. The oil film cannot be considered in terms of some material having resistance to puncture or which supports the load entirely by hydraulic action, and the oil characteristic which controls this action is viscosity. As a result, the presence of film strength additives of phosphorus, chlorine, or sulphur compounds in the oil can serve little useful purpose during thick film lubrication. If the viscosity is increased, the oil film becomes thicker and more work is required to turn the gears in and out of mesh. In other words, the friction is increased. However, if the oil viscosity is decreased, the film becomes thinner, and although the work required then is less, the high spots on the tooth surfaces approach nearer to each other and the transition from thick-film to boundary lubrication is approached. Similarly, if the load is increased or the speed is decreased, the tooth surfaces approach each other and again the action approaches boundary lubrication. When conditions of load, speed and oil viscosity are such that the oil film is too thin to separate the gear teeth completely, then the high spots may begin to touch each other. Thick-film lubrication no longer exists and the condition termed boundary lubrication is approached. As the load is increased or the speed is decreased, more and more of the high spots tend to come in contact and the force required to turn the gears increases. What actually happens at the high spots and also what happens to the contacting surfaces involves both chemical and physical phenomena. The theory is that extreme pressure additives support the load by forming a chemical film or by forming an easily sheared film such as lead sulphide, lead chloride, etc. Research has shown that certain materials termed oiliness or polar agents are effective in reducing friction under boundary lubrication conditions. These materials are high molecular weight organic compounds containing carbon, hydrogen and oxygen as compared to lubricating oils which contain only carbon and hydrogen. When one end of the lubricant molecule is highly reactive, it has the property of forming a powerful bond with a steel surface or may actually form soaps and enhance load carrying capacity.—*Lubrication, Vol. 6, October 1951; pp. 109-120.*

Venting Cargo Oil Tanks

A special form of valve is used in connexion with the venting arrangement for cargo tanks shown in Fig. 2. The top left-hand diagram shows a relief and pressure valve in its open position, and the right-hand view represents the valve when it is closed. The lower diagram illustrates the application of the device with three valves combined in one body. The valves (5, 9) are automatically lifted by pressure or vacuum in the cargo tank connected with the lower valve compartment. If it is desired to provide an open connexion between the tank and the atmosphere during loading or discharging, the valve

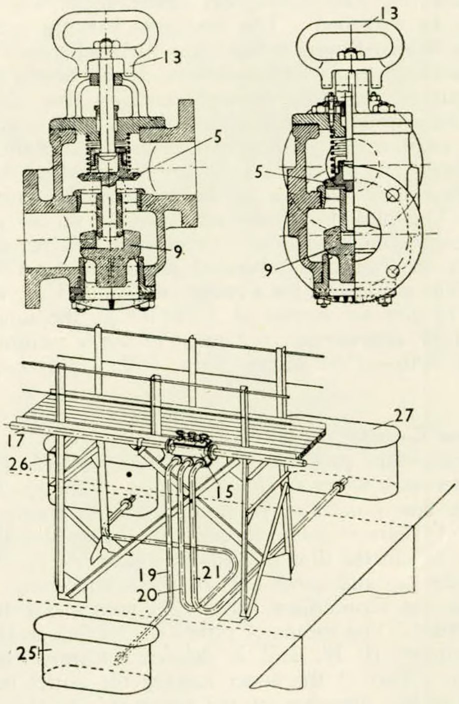


FIG. 2

(5) is lifted to its open position by a handle (13). When this is turned it locks the valve open. In order to avoid the use of spring exposed to corrosion, the valve (9) is of heavy construction and is lifted against gravity in the event of a vacuum in the cargo tank. With the system shown in the lower view, the valves indicated are connected to a vent header (17). The lower compartments of the valve casing (15) are separate, and are connected with the ullage hatches (25, 26, 27) by branch pipes (19, 20, 21).—*Brit. Pat. No. 656,513. F. B. Larsen and A. C. Larsen, Odense. The Motor Ship, Vol. 32, November 1951; p. 328.*

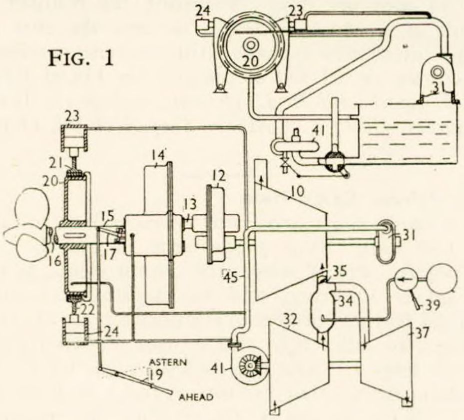
Fluids for Hydraulic Power Transmission

The connexion between aircraft, land, and marine hydraulics is emphasized, epecially regarding the working fluid and the sealing problems. The ideal fluid which would suit all cases does not exist as yet. The properties, advantages, and disadvantages of a number of well known, and a few lesser known, fluids are discussed. The fluids include those based on petroleum, castor, water-glycol, halogenated, and synthetic compounds. The properties covered include viscosity and density, and their variation with temperature and pressure; chemical and toxic effects; bulk modulus or compressibility; water miscibility, and the significance of cloud, pour, and boiling points. The fire hazard, and its difficulties of assessment in relation to the usual recorded properties and conditions, is noted. Thermal conductivity, dielectric strength and storage conditions are also considered. Some of the information, of which much hitherto has been widely scattered, has been derived from recent research, and an attempt has been made to arrange the data in rational form.—*Paper by A. E. Bingham, read at a meeting of The Institution of Mechanical Engineers, 14th December 1951.*

Gas and Hydraulic Turbine Drive

Fig. 1 illustrates an arrangement of mechanism embodying gas and hydraulic turbines. The main gas turbine (10) is coupled through reduction gearing (12) to a reversing gear (14) which drives the propeller shaft (16). The lever (17) preselects the ahead and astern clutches, the engagement taking place only when the speeds of the shafts (13, 15) have been brought into the required relationship. A brake (21, 22) is engaged by hydraulic pistons (23, 24). An auxiliary hydraulic turbine (31) is connected to the main gas turbine (10). The air compressor (32) communicates with the combustion chamber (34), which is connected to the main gas turbine (10) and to a primary gas turbine (37). The hydraulic turbine (31) is supplied, when required, with fluid from a pump (41) connected to the shaft of the turbo-compressor set (37, 32). When reversing, the control handle (39) of the fuel pump is operated to reduce the supply to the combustion chamber and the valve (35) restricts the volume of gas passing to the main turbine. The lever (19) is moved to preselect the astern gear, and the hydraulic main (45) is charged by the pump (41), so that the hydraulic turbine (31) generates a torque which tends to reverse the rotation of the main turbine and disengages the ahead selecting clutch in the gear (14). At the same time, the hydraulic pistons (23, 24) engage the propeller shaft brake (20). The main turbine is accelerated in the reverse direction by the hydraulic turbine (31) until the astern selecting clutch in the gear (14) is synchronized.—*Brit. Pat. No. 655,476. H. Sinclair, London. The Motor Ship, Vol. 32, December 1951; p. 368.*

FIG. 1



Rotating Disks in Pure Sliding

While there is a reasonably large amount of agreemnt between theory and practice in the lubrication of bearings, gearing results have so far defied theoretical attack. The work described here is part of a programme designed to apply theory to practical results, and at the outset of this programme of work the phenomenon described here was observed. Briefly, the lubrication of gears—or disks to which they are kinematically similar—should depend only on their rolling velocity, and not at all on their sliding velocities. In fact, Reynolds' classical hydrodynamic lubrication theory leads to equations which show that the formation of an oil film between disks is dependent on the rolling velocity only. Experiments have been carried out by the author which show that it is possible to get an oil film under conditions of pure sliding with no rolling at all. Classical lubrication theory will not explain this new effect. The explanation advanced for it is that the variation of viscosity across the thickness of the film introduces an extra term into the standard equation of film lubrication. Making two simplifying assumptions for the temperature of the surfaces in contact and the temperature distribution in the oil film, the theory is tested numerically.—*A. Cameron, Journal of The Institute of Peroleum, Vol. 37, No. 332, August 1951; pp. 471-486.*

Forced Draught Blowers

This article includes reference to an accident in which a vertical type centrifugal blower had disintegrated and wrecked the fireroom. A steel pipe deck support near the blower was cut in two. The exhaust line was broken, the bulkhead behind the boiler had a 6-ft. hole in it, one could stand on the upper grating and look out over the water through the holes in the side of the ship. The main steam line on the opposite side of the ship was badly dented. Pieces of the blower fan had been thrown across the top of the boiler, barely missing the four safety valves. The explanation of the accident is given as follows: Prior to receiving orders for an increase in speed, the fireroom force had the standby blower warmed up for just such an eventuality. The intake flaps of the stand-by blower were closed. When the increased speed signal was rceived, a fireman was sent up on deck to open the flaps of the stand-by boiler. By mistake, he opened the wrong flaps and when the stand-by blower was started it had no air supply. The blower over-speed trip failed to function and, as it had no governor control, it continued to speed up. As the speed of the blower fan increased, it created a low-pressure area on the suction side and was raised off its pedestal bearing. When the fan struck the blower casing, it flew apart.—*F. G. Corneau, Marine Engineering and Shipping Review, Vol. 56, December 1951; pp. 69-70.*

Safe Practice in Oxyacetylene Welding

Safety in welding and cutting operations has been achieved through the co-operative efforts of management, employees, equipment manufacturers and all others interested in good welding practices. In the U.S.A., organizations such as the American Welding Society and the International Acetylene Association provide the means for bringing these different interests together and promoting the general use of good practices. Safety in welding and cutting has become an accomplished fact through a recognition of the hazards involved in dealing with fire, compressed gases, hot metal, sparks, fumes and other such sources of hazard, and through the establishment of proper precautions to control the hazards involved. A review of the requirements of the new American standard safety code, "Safety in Electric and Gas Welding and Cutting Operations", shows that safe practicees in welding and cutting are the same as *efficient* practices for these operations. For example, use of excessive pressure in gas welding or cutting not only may cause flying sparks, but may waste fuel gas. Fig. 1 shows how excessive oxygen-cutting pressure increases the distance that sparks will fly. Strewn scrap and dirt are a fire hazard; they also hamper movement of the welder or cutter, thereby making welding or cutting more difficult. Poor ventilation may be not only a source of toxic fumes, but may make visibility difficult,

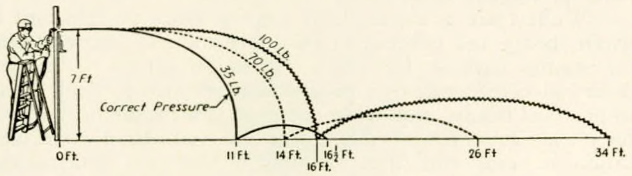


FIG. 1—*Relation of cutting-oxygen pressures to distances resulting sparks will fly*

causing poor welding. Welding can be done safely in confined spaces, as in tanks or the holds of ships. In such cases it is mandatory that proper ventilation be provided either to completely ventilate the space, or by providing individual respiratory equipment to each welder. This is necessary even where there is no likelihood of the accumulation of toxic fumes, in order to prevent oxygen deficiency. The gas cylinders should be left on the outside of the confined space, and, where possible, an attendant stationed on the outside to shut off the gas supply in an emergency. When the welder must enter such confined spaces through a manhole or other small opening, some means must be provided for quickly removing him in case of emergency. Safety belts or life lines are convenient means for such purposes. When it is necessary to stop work, the welder should not leave the confined space without shutting off his equipment at a point outside the confined area. It is preferable that he should remove his torch, although this is not mandatory if the work is to be resumed shortly. Drums, barrels, tanks and other containers that have held combustible gases or liquids should be completely cleaned and purged before any welding or cutting operations. Pipe lines should be disconnected or blanked to prevent the flow of any gas or liquid through the area to be welded or cut. All hollow cavities and containers should be vented to permit the escape of air or gases. If it is possible, the previous contents of the container should be determined. This is not always possible, and in such cases all

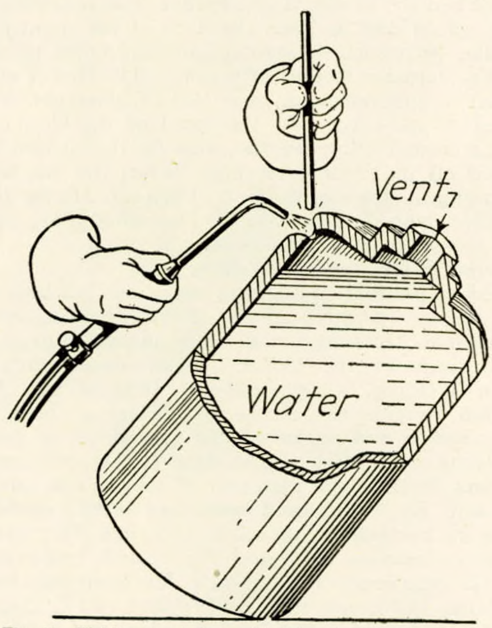


Fig. 12 Welding container which has held combustibles

precautions should be taken. All containers, whether they contained grease, oil, gas, acid, tar or any other similar substance, should be thoroughly cleaned. For very volatile substances steam or very hot water may be used. For other substances, such as heavy oils, a strong solution of caustic soda may be used. For other substances it is necessary to use a solvent. Even though the container has been cleaned, the welding or cutting operation should be further safeguarded by filling the container with water, as shown in Fig. 12, to within a few inches of the point of welding or cutting. If filling with water is not practical, an inert gas may be used.—*S. A. Greenberg, The Welding Journal, Vol. 30, November 1951; pp. 1020-1025.*

Size and Speed of Tankers

Apart from the introduction of welding, improved living quarters for officers and crew and the provision of aids to navigation and labour-saving appliances, tankers building today are not so very different from what they were twenty years ago, excepting that they are larger and faster. Deadweights of the largest tankers have gone up from 12,000 to 30,000 tons and speeds have increased from 12 knots to 16 knots. In some instances, speeds in excess of 16 knots have been adopted, but such ships were designed for special purposes. The Shell Group, for example, own two 18,000-ton d.w. tankers capable of a sustained speed of 18 knots when fully loaded. The economical average speeds for ships of 10,000, 20,000 and 30,000 tons deadweight are in the region of 11½, 13½ and 15 knots respectively, and taking the operating cost of the smallest ship as 100, the operating costs of the others are 64 for the 20,000-ton ship and 49 for the 30,000-ton ship. Thus, by increasing the speed of the 20,000-ton ship to 13½ knots, a gain of two points is made, and three points when the speed of the 30,000-ton ship is increased to 15 knots. An argument sometimes put forward in favour of ample power in a ship is that a ship so provided can on occasions avoid missing a tide when making port. Such a ship may once or twice a year save twelve hours' delay in entering port, but if feats of this kind are to be accomplished the reserve power must be of an order that will give the ship a speed increase of at least one knot. A smaller proportion of reserve power by chance may cause a ship to catch a tide that would be missed otherwise, but the circumstances from which such a benefit would accru are so rare and unforeseeable that there is no sound basis on which to calculate. The usual practice is to operate machinery in service at from 5 to 10 per cent below the engine builders' rated power output in order to keep wear and tear and, consequently, maintenance costs, within reasonable limits. If, in addition to this, a ship is given sufficient reserve power to travel occasionally at one knot greater than the normal maximum speed, the machinery will, except on such rare occasions, be operating at not more than three-quarters the rated power. If the machinery is of the Diesel type, this means that the fuel consumption will be 0·370lb. per b.h.p. per hour instead of 0·357lb., which in an installation rated at 5,000 i.h.p. represents a difference of 0·46 tons per day. Assuming the number of days a ship spends at sea to be 320 per annum, the cost to catch a tide on the few occasions when this becomes necessary is 147 tons per annum or £1,300 at present-day Diesel fuel prices.—*Paper by J. Lamb and R. L. Brown, read at the World Petroleum Congress, 1951; The Motor Ship, Vol. 32, October 1951; pp. 264-266.*

Adjustable Voltage Cargo Hoist

A new cargo hoist drive was developed in connexion with the new C-4 cargo ship programme of the U.S. Maritime Administration. Fig. 4 shows the circuit elements involved in hoisting, power lowering, and overhauling lowering. Three new electrical features of special significance are (1) the rectifier; (2) the generator killer field and dynamic breaking resistor R_1; and (3) load relay LR and timing load relay LRT. The rectifier is a static device that permits current to flow through its series field. With the use of the rectifier, the motor is able to

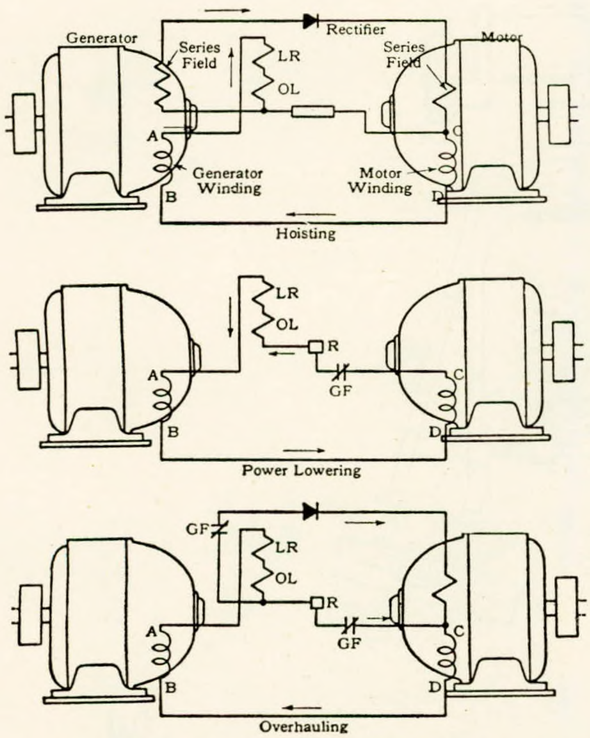


FIG. 4—*Circuit elements involved in hoisting, power lowering, and overhauling lowering*

produce a torque in the lowering direction approximately equal to 50 per cent full load hoisting torque. The rectifier also is used in stopping an overhauling load. Here, it prevents the flow of regenerative current through the winch-motor series field. This, in conjunction with the regenerative current flowing in the main circuit, ensures a positive braking torque, sufficient to stop the load without the mechanical brake. The mechanical brake is required essentially only for holding the load. The generator killer field and dynamic braking resistor R_1 are used to increase safety to personnel and load. They also help to brake the load and reduce wear on the mechanical brake lining, lowering maintenance and increasing the reliability of the equipment. In addition, the generator killer field reduces the regenerative current flowing in the main circuit to such a point that no extra heavy contactors are needed to open the main circuit. Load relay LR and timing load relay LRT are used only on the last position of the master switch in the lowering direction (see Fig. 5). They operate in conjunction with a current coil in the main circuit to measure the load on the hook. This provides a high light-hook lowering speed and limits full-load overhauling speed. Light-hook lowering speed can be made as high as 2·5 times full-load hoisting speed (which for the rated load of 3 long tons is 225ft. per min.). Full-load overhauling speed is limited to about 1·5 times full-load hoisting speed.—*W. Schaelchlin and H. C. Lindstrom, Marine Engineering and Shipping Review, Vol. 56, November 1951; pp. 43-45.*

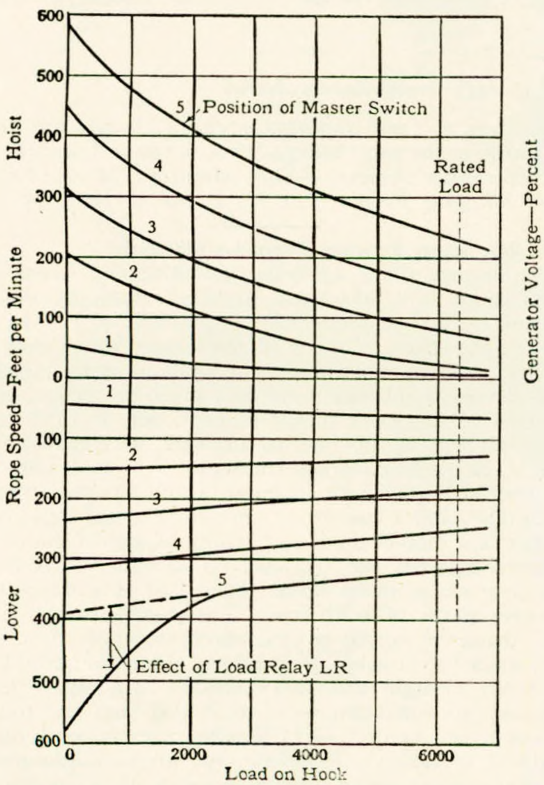


FIG. 5—*Winch performance—speed torque characteristics for hoisting and overhauling lowering*

Petroleum Barge

In the 500-ton all-welded power barge *Esso Abingdon*, 500 tons of petroleum spirit, which is the maximum allowed under Port of London Authority regulations, are carried in seven tanks, four of which can accommodate 70 tons, two about 63 tons and the remaining tank 74 tons. The cargo space is separated by cofferdams forward and aft and by spaces at the sides and beneath the tanks—a feature which prevents the possibility of oil leakage into the river in the event of damage to the shell. The principal characteristics of the vessel are as follows: —

Length overall	168ft.
Breadth	32ft. 6in.
Draught	8ft. 6in.
Deadweight	518 tons
Cargo capacity	500 tons of petroleum spirit ·72 sp. gr.
Estimated speed on trial ...	9½ knots
Service speed	8½ knots

For main propulsion there is a four-cylinder Crossley engine developing 400 b.h.p. at 500 r.p.m. and driving a propeller through an S.L.M. 2:1 reverse-reduction hydraulic gearbox. There are three 45 b.h.p. Crossley Diesel engines for auxiliary purposes, two of which are clutch-coupled to the two cargo pumps in the after cofferdam, or pump room. Each of these pumps has a capacity of 175 tons per hour, enabling the ship to be completely discharged in 90 minutes. The third engine is coupled to a 20-kW. 110 volt flame-proof generator, but also drives the ballast pump in the pump room through the bulkhead. This pump can fill the forward ballast tanks in the same time as is taken for discharging the vessel, thus enabling the vessel to maintain an even trim.—*The Motor Ship, Vol. 32, December 1951; p. 345.*

Marine Boiler Design

Increased propulsion plant efficiency is achieved by increasing the operating pressure, steam temperature and feedwater temperature. As the feedwater and steam temperatures are increased, a greater portion of the heat absorbed by the complete boiler unit is absorbed in the superheater. The heat absorption in the superheater is approximately 15 per cent of the total heat absorbed with steam conditions of 450lb. per sq. in., 750 deg. F. With boilers designed for the highest steam temperature, 1,020 deg. F., in use in marine service today, over 26 per cent of the total heat absorbed is adsorbed in the superheater. In order to have an economical temperature difference between the combustion gas passing over the superheater surface and the high-temperature steam within the surface, it is essential that the superheater be located in a zone of high gas tem-

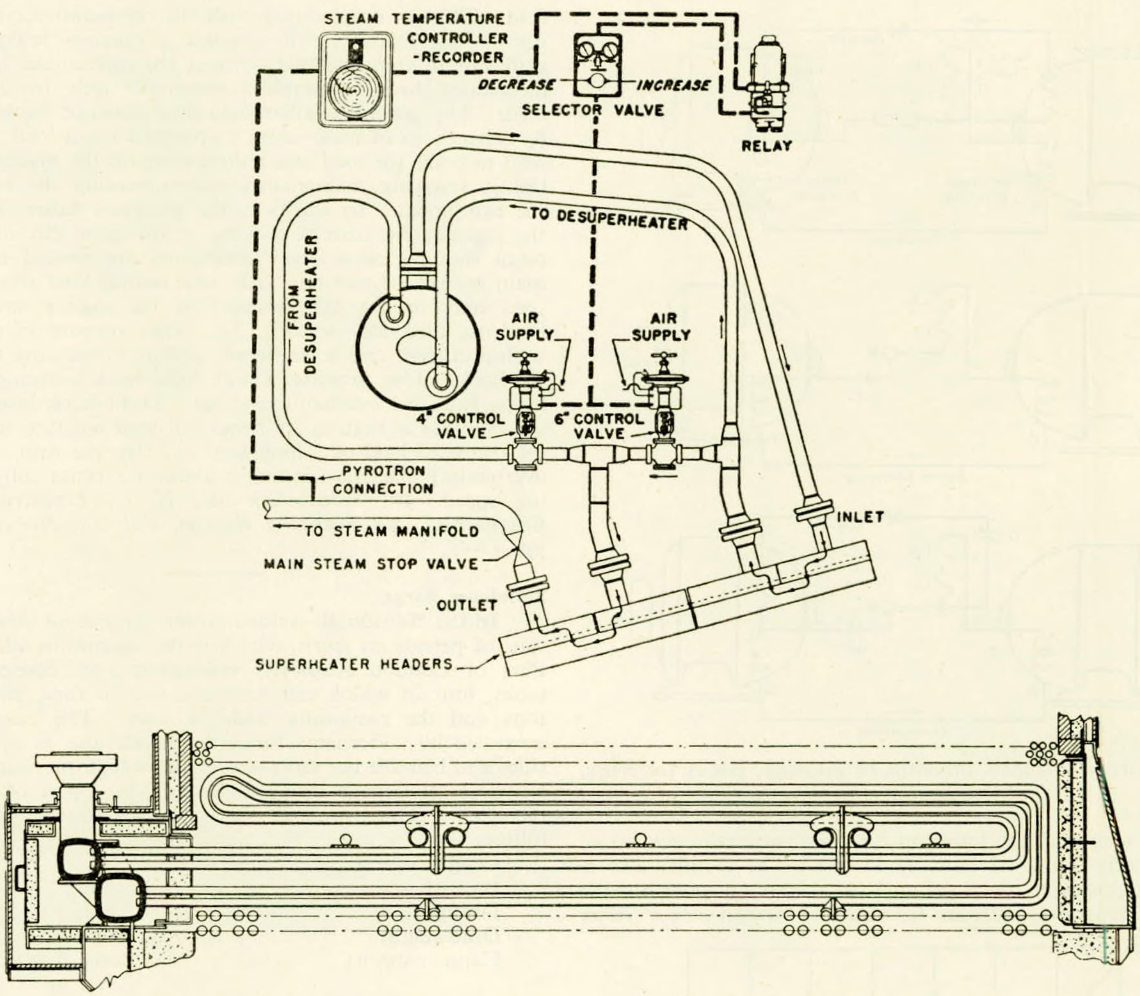


FIG. 10—*Arrangement of superheat control and of high-temperature superheater*

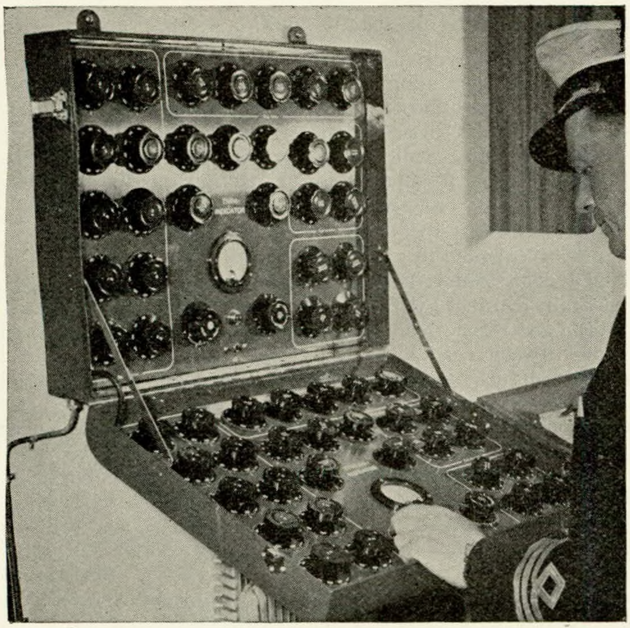
perature. This limits the amount of convection boiler surface used as a screen between the furnace and the superheater. With a steam temperature of this magnitude, 1,020 deg. F., the rest of the boiler components are in effect built around the superheater. Superheater materials must of course be satisfactory for the temperature and stress encountered and in this particular superheater four different alloy materials were used in addition to carbon steel. To maintain a high plant efficiency over a wide load range the boilers are designed for a steam temperature of 1,020 deg. F. from 50 to 120 per cent of normal boiler load. The steam temperature control which accomplished this and by so doing protects the turbine and the last two passes of the superheater is shown in Fig. 10. Air-operated control valves are actuated by the steam temperature at the superheater outlet. Below the set temperature all the steam generated passes through the 6-in. control valve, the 4-in. valve being closed. If the temperature tends to rise above the set temperature, the 4-in. valve opens to permit a portion of the steam to flow and to have its temperature reduced in the submerged desuperheater located in the steam drum. If the temperature continues to rise, as is expected at overload or during manœuvring, the 4-in. valve opens wide and, as it does, the 6-in. valve tends to close, reducing the temperature to the set value. On air failure both valves open wide. Valves are provided with hand jacks for manual operation. Multiloop superheater elements which require fewer header joints and which improve steam distribution are used for this very high-temperature superheater. This type of element is ideally suited for this application because space for installation was limited. Also, since the terminal ends of the elements are seal welded to the headers, minimizing the number of joints was of great importance. Soot blowers are installed in the centre of the superheater surface positioned at right angles to the superheater elements.—*S. F. Mumford, Marine Engineering and Shipping Review, Vol. 56, December 1951; pp. 56–61.*

Welded Pipe Joints Between Dissimilar Materials

The joining of the dissimilar austenitic and ferritic alloys presents design and fabrication problems, many of which are important factors in production of welded joints. In order to explore the effects of some of the factors which may affect the safety of ferritic-austenitic weld joints in steam piping, the authors devised a full-size proof test, involving maintenance of a specimen of composite piping at 1,100 deg. F. (593 deg. C.) and 1,500lb. per sq. in. internal pressure, with periodic shutdowns. The three materials employed were 18-8 chromium-nickel steel stabilized with niobium, a chromium-molybdenum steel ($2\frac{1}{4}$-1%), and a cast 16-13 chromium-nickel steel containing 2 per cent molybdenum and stabilized with niobium. The last-named material was included on account of its frequent use in large steam valves. Electrodes used in making the test welds were of the 19-9-Nb type. The specimen consisted of a $10\frac{3}{4}$-in. diameter section of the chromium-molybdenum steel piping, welded to suitably designed and dimensioned end pieces of 18-8-Nb wrought and 16-13-Mo-Nb cast steels. From a preliminary consideration it is concluded that the following stress conditions existed:—(1) Residual stresses resulting from the welding operation. (2) Operational stresses (circumferential and longitudinal), due to internal pressure, these stresses varying with pressure changes. (3) Stresses resulting from differential expansion of the ferritic and austenitic materials. Such stresses vary in magnitude with changes in temperature and are at a maximum immediately after a major alteration in temperature. (4) Stresses resulting from differences in the thermal conductivities of the two types of material. These stresses exist only during the heating and cooling cycles, and disappear at stable operating temperatures and in atmospheric conditions. It is believed that the combined stresses may span a range larger than the yield point stress at room temperature plus the limiting creep stress at operating temperature. Plastic deformation can therefore occur both at the room-temperature and the service-temperature ends of the cycle. The destructive action is aggravated by the fact that the two types of plastic deformation take place in opposite directions, and occur in the weakest part of the joint, i.e., in the narrow carbon-depleted zone next to the weld junction. Stress concentration at the weld metal/pipe metal interface promotes formation and inward propagation of an oxide notch in the less-oxidation-resistant chromium-molybdenum steel piping, and facilitates intergranular oxygen penetration, grain-boundary oxidation, and subsequent cracking. Tests are being made to evaluate the relative potency of the respective factors. Radiographic examination of the welds showed cracks in the chromium-molybdenum steel piping, at the edge of the weld joint, after 4,631 hours at 1,100 deg. F. (593 deg. C.), a period involving 47 week-end shutdowns to atmospheric temperature.—*Paper by R. U. Blaser, F. Eberle and J. T. Tucker; Proc. Amer. Soc. Testing Materials, Vol. 50, 1950; pp. 789-808. Abstracted in The Nickel Bulletin, Vol. 24, September-October 1951; Nos. 9-10; pp. 200-207.*

Götaverken Tanker Load Calculator

An electrically operated load distribution calculator has been produced by Götaverken A/B, Gothenburg, under the trade name of "Lodicator". The Lodicator is in effect an electric calculating machine. It is fitted with a number of knobs, each corresponding to one of the cargo spaces on board, and graduated in tons. The machine is set by turning each knob to correspond with the number of tons of cargo in, or intended to be in, each cargo space. It is then possible to read on a dial if the distribution stands within the limits of safe trim which have been set, or not. The instrument must, of course, be adapted initially to suit the strength requirements of every individual ship. It enables officers to calculate in a few minutes how the cargo should be distributed in the different tanks in order to avoid excessive longitudinal stresses. This operation can take place before the cargo is loaded. The use of the Lodicator will also be beneficial when judging the new load distribution situation when a tanker has unloaded part of its cargo before proceeding to another port. Calculations of this kind previously have required much time and study, and it is the common practice of officers to rely mainly on their own experience and general rules when the cargo is distributed in the ship. The dimensions of tankers are increasing steadily, as is the number of tanks in the ship, factors which have increased the complication of load distribution calculations. The new Lodicator was first installed in the motor tanker *Margaret Onstad,* completed in July for Skibs A/S Alse, of Oslo. Three other tankers have already been supplied with the new instrument, and it is intended that all tankers delivered by Götaverken in future will be similarly equipped.—*The Shipping World, 12th December 1951; p. 428.*



The Lodicator

Improved Ship's Funnel

This patent describes a new version of the FCM/Valensi funnel. The patentees envisage a funnel designed to create, in the vicinity of the outlet from the funnel, a concentrated eddy known as the marginal vortex which will guide the smoke at its exit from the smoke duct. Fig. 1 shows an elevation of

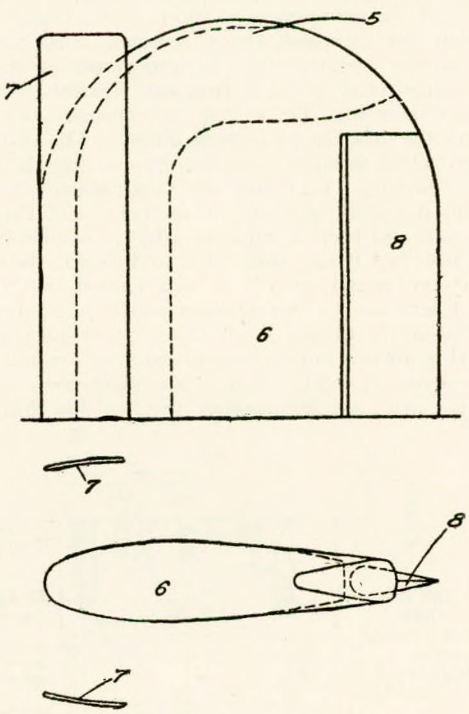


FIG. 1

the funnel, with two slots at the front and a slotted aileron at the rear, and a plain view. The smoke outlet is shown at 5, the fairing or streamlining at 6, the fins used to create the fore slots at 7 and the rear slotted aileron at 8. The fairing (6) has the form of an aerofoil of symmetrical biconvex cross section. The rear aileron (8) is about three-quarters as high as the fairing (6) and has a length of about one-quarter of its height. Its axis of rotation is set so that when it turns the aileron opens a slot in the aerofoil. When trimmed, the slotted aileron, together with the fore slots, will improve the coefficient of aerodynamic force of the fairing. The aileron is set at an angle to the plane of symmetry of the fairing, so as to suit the angle of incidence of the relative wind. The effect of this is to ensure that the marginal vortex formed at the rear of the fairing is maintained when the incidence angle of the relative wind exceeds the value (about 25 per cent) at which the marginal vortex normally ceases to be produced.—*Patentees: Soc. des*

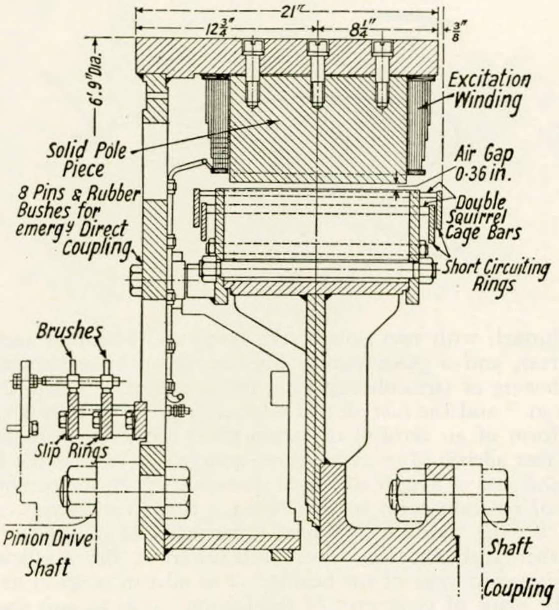
Forges et Chantiers de la Mediterranée and J. Valensi, Brit. Pat. No. 657,365. World Shipbuilding, Vol. 1, November 1951; p. 124.

Geared Motorship *Waimate*

The geared motorship *Waimate* was built by Henry Robb, Ltd., for the Union Steamship Company of New Zealand. The new ship is a cargo vessel of combined bridge and poop deck pattern, with two large holds and 'tween deck aft of the machinery space. The principal particulars are as follows:—

Length between perpendiculars ...	325ft. 0in.
Moulded breadth	50ft. 0in.
Moulded depth to upper deck ...	26ft. 0in.
Cargo capacity...	239,000 cu. ft.
Deadweight capacity on 22ft. draught	5,170 tons
Service speed	12 knots

The propelling machinery consists of two eight-cylinder British Polar type M58M engines, each developing approximately 1,375 b.h.p. at 300 r.p.m. and coupled through B.T.H. electro-magnetic couplings and a twin-pinion single-reduction gearbox to the main shaft. This rotates at 150 r.p.m. at full power and carries a four-bladed solid bronze propeller supplied by J. Stone and Co., Ltd. The principal reason for the use of electro-magnetic couplings is that their elastic properties reduce the effects of the torsional oscillations of the Diesel engine to a value below that at which torque reversal at the gears can take place. Another consideration of importance is that the ship can be manœuvred without frequent reversals of the Diesel engines, by running one engine at approximately half-speed ahead and the other at half-speed astern. The ship, therefore, can be propelled in either direction by exciting the appropriate magnetic coupling. Each time the ship manœuvres into or out of harbour it is only necessary to reverse one of the two Diesel engines once and keep it running astern. Manœuvring in the manner described is easy and rapid and avoids the expenditure of much compressed air. It is well known that the wear of cylinder liners can be heavy when much manœuvring of the engines has to be effected, while the frequent admission of cold manœuvring air is a not infrequent cause of cracked covers and piston crowns. A reduction in replacement costs can therefore be expected, with the arrangement used in this ship. The fact that the engines can be started and "run light" by leaving the couplings de-energized is in itself an important practical feature. The electro-magneto couplings consist essentially of two concentric members, the outer one carrying a number of wound salient poles and the inner member comprising a laminated core with a double squirrel-cage winding. The coupling itself has no bearings; the outer and heavier member is overhung on the pinion drive shaft, while the inner member is bolted to the crankshaft coupling face. The radial air gap between the coupling members is 0·36 inch. The outer member of the coupling consists of a welded steel ring carrying 28 solid high-permeability steel poles spaced around the inner periphery. The field windings, of rectangular asbestos-covered wire, are wound directly on the pole pieces and insulated to conform with Class "B" requirements of Lloyd's Register of Shipping. A steel disc spigoted and bolted to the outer coupling carries phosphor-bronze slip rings on insulated studs. Two brushes per slip ring are employed The inner member of the coupling consists of a segmental rotor core built up of low-hysteresis steel punchings, clamped between steel end flanges and mounted on a fabricated steel spider. The outer and inner cages of the double-squirrel cage windings are formed respectively of bars of high resistance alloy and copper. Each cage has its own copper short-circuiting rings soldered to the bars. No insulation is used between the bars and the punchings to ensure effective heat conductivity. The excitation current for the magnetic couplings is approximately 15 kW. each and is supplied at 220 volts through the ship's main switchboard to the coupling control cabinet.—*The Marine Engineer and Naval Architect, Vol. 74, December 1951; pp. 543-547.*



Sectional drawing showing details of the B.T.H. magnetic coupling. Note particularly the double squirrel-cage windings on the input element attached to the engine and the brushes and slip rings through which the excitation is applied to the secondary windings

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Bureau Veritas Rules

In the new edition of the Rules and Regulations of the Bureau Veritas for the Building and Classification of Steel Vessels, many important revisions and improvements are made including several additions which take into account the evolution and progress in shipbuilding. Among the main modifications, adjustments and additions introduced are the following: On the whole the symbols designating the service and construction of vessels remain unchanged, but, for the purpose of attesting that the relevant national and international legislation has been fulfilled, special designations will appear in the Register, with the classification symbols. Passenger ships whose arrangements comply with the regulations of the 1948 International Convention for the Safety of Life at Sea, will be entered in the Register with the special mark $\begin{smallmatrix}1\wedge 9\\4\vee 8\end{smallmatrix}$ framing the division numeral and a symbol indicating the standard of subdivision. The society have adopted new methods to be applied to the calculation of subdivision and stability in the flooded condition. Vessels which are in accordance with the Convention in regard to fire-protection will be entered in the Register with the symbol: F. If permanent fire-protection measures have been surveyed during construction, the vessel will be entered in the Register with the special symbol: *F*. The code of letters has been supplemented by the letter "S" applying to tugboats. This letter will be followed by an indication of the service for which the ship is intended, e.g., "deep-sea trade", "short coasting trade", and "roadstead and estuaries". A distinction is now made between deep tanks and peak tanks kept empty or full at sea and fuel bunkers and deep tanks liable to be emptied at sea. The corresponding scantlings are specified in two articles, and sketches of the stringer arrangement make for easy interpretation of the Rules. A separate article deals with the rudder, steering gear, etc. The formulæ applicable to different types of rudder are included and sketches facilitate the selection of the formula to be adopted in a given case. A new article lays down the requirements for the use of light alloys in shipbuilding; the increase in scantlings required by the substitution of light alloys for steel are indicated. The sections dealing with arc welding have been considerably modified and improved to take account of recent technical progress, including the use of radiographic control. Special provisions govern the welding of butt welds, right-angle welds, lap welds, plug welds, welding of heavy parts and special steels, and automatic or semi-automatic welding. The types and sizes of welds to be used have been revised; a new table gives particulars of the welds in tank ships. Many tank ships now have two watertight longitudinal bulkheads and the regulations have been amplified to cover the various types of construction, including ships which are longitudinally framed in the centre tank and transversely framed in the wing tanks. For many years, the regulations dealt more especially with ships built on the transverse system, where beams and frames are in the same transverse section. As both transverse and longitudinal systems have been adopted in recent passenger ships, rules have been introduced regarding the construction of ships having transverse frames at the sides and longitudinal elements at the deck and bottom. The calculation of the scantlings of derrick posts and masts supporting derricks has been modified and now follows a more accurate and rational procedure. Tables and formulæ facilitate the determination of mast scantlings, taking into account their length and the span of the stays and shrouds provided in the most usual cases. The rules also apply to masts supporting heavy-lift derricks of up to 100 tons capacity. Other sections of the rules deal with piping systems, boiler and pressure vessels, and engine and electrical equipment.—*The Shipbuilder and Marine Engine-Builder, Vol. 58, December 1951; p. 753.*

Two 1,660 b.h.p. Auxiliary Engines for Liner

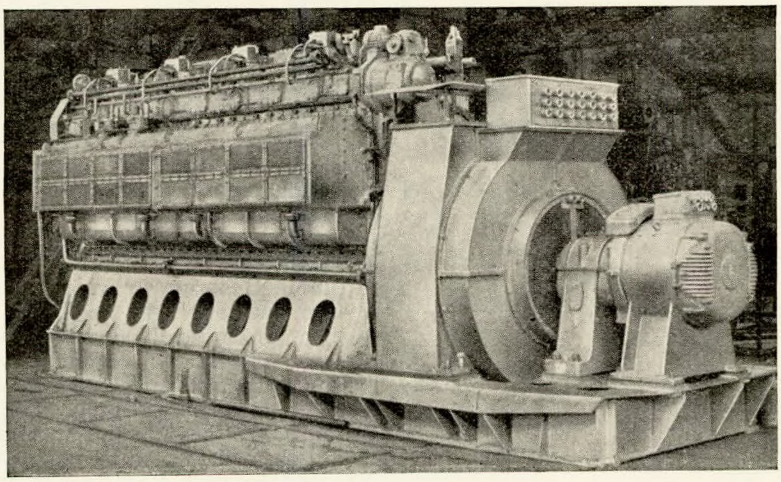
In the turbine-driven liner *Flandre,* which was launched recently at the Ateliers et Chantiers de France yard, Dunkerque, current for lighting and power is provided by two 2,000 kW. turbo alternators installed in the engine room. In addition to these, a separate compartment between the main engine room and the boiler room houses two 750 kW. alternators, driven by Sulzer-type engines built by the Forges et Chantiers de la Mediterranée, Havre. Each set, one of which is illustrated, comprises an eight-cylinder two-stroke single-acting engine rated at 1,660 b.h.p., the speed being 500 r.p.m. The maximum output is 1,800 b.h.p. The engines, of which two more are under construction for the liner *Antilles,* have a cylinder diameter of 320 mm., corresponding to 12·6in., the piston stroke being 380 mm. or 14·96in. The fuel consumption is 171 gr. per b.h.p. per hr. or about 0·37lb. per b.h.p. per hr. The alternators are of the Alsthom type supplying current at 400 volts, 50 cycles and have a maximum output of 1,420 kVA. It was a requirement of the shipbuilders that the auxiliary Diesel engines should occupy the smallest possible amount of space and the total length of each set, which includes the necessary exciter, is 7·1m. or about 23 feet, the height above the shaft centre line being approximately 5·6 feet. Scavenging air is drawn through a special type of filter and supplied to the cylinders by eight separate double-acting pumps arranged at one side of the engine. These pumps are driven by levers and links attached to the connecting rods.—*The Motor Ship, Vol. 32, December 1951; p. 344.*

Compound to Improve Diesel Fuel

The U.S. Navy is testing a new chemical compound designed to raise the quality of Diesel fuel to navy requirements without the refining now necessary. If successful, the compound will increase greatly the amount of fuel oil available for submarines and other Diesel vessels without added strain on the nation's oil refineries. The compound is a blend of several amyl nitrates found to be the most economical and practical as a quality booster of Diesel fuel. Small amounts of the blend added to Diesel fuel will improve its quality, causing it to ignite more readily in the combustion chamber of an engine. Diesel fuel quality is now raised to navy specifications by refining, which reduces the amount of usable fuel that can be obtained from a given quantity of crude oil. With use of the new blend, much of this refining might be eliminated, which would permit refiners to meet enlarged wartime demands. It would also permit them to devote more of their facilities to production of other critically needed fuels.—*Marine Engineering and Shipping Review, Vol. 56, December 1951; p. 37.*

Joining of Dissimilar Metals for High-temperature High-pressure Service

This paper summarizes some results obtained in a study, by Babcock and Wilcox, Ltd., of conditions involved in, and effects resulting from, service in boiler units of a type permitting use of ferritic materials for a large part of the superheater section, but requiring austenitic materials at the outlet side. The work on which it is based comprised examination of dissimilar metal welds at the junction of austenitic to ferritic tubing, at metal temperatures to be expected in units operating in the gas-temperature range of 1,900 deg. F. to 2,500 deg. F. (1,035 deg. C. to 1,370 deg. C.). Practical recommendations are made on procedure designed to give improved life expectancy in dissimilar-metal joints. These are briefly summarized below:—(1) The weld metal used may be either austenitic or ferritic, but each should demand an exacting control of the electrode itself and of the technique employed. This control should include careful shop tests of the electrodes, to ensure absence of fissuring. Careful procedures and welding details must be established. Welding techniques in production should be controlled to assure removal of crater cracking or other mechanical defects. The cover beads should be removed flush to the surface and all other stress raisers, such as notches and undercuts, carefully removed when they are near the fusion line.



One of four 1,660 b.h.p. F.C.M. Sulzer engined alternator sets for two passenger liners

(2) No post-welding heat treatment need be given to welds joining ferritic to austenitic materials when the ferritic material does not show as-welded hardnesses over 350 Brinell, and when service temperatures exceed 950 deg. F. (510 deg. C.). This will reduce carbon depletion on the ferritic side and will lessen the rate of sigma formation in the austenitic weld metal. (3) The choice of welding composition seems to be a 19-9-Nb electrode for most applications. (4) The safe operating temperature limits to be expected of a dissimilar-metal weld appear to be a function of the operating temperature. (5) Where temperature and stress conditions are such as to indicate possible failure during the normal life of the assembly, it is recommended that all cyclic temperatures be prevented at dissimilar joints. This may be accomplished by separate heating applied to the outside of the joint; this procedure refers particularly to piping. On small tubing, such as superheaters, the work reported would indicate that this precaution is not necessary under normal operating conditions.—*Paper by O. R. Carpenter, N. C. Jensen, J. L. Oberg and R. D. Wyllie; Proc. Amer. Soc. Testing Materials, Vol. 50, 1950; pp. 809-857. Abstract: The Nickel Bulletin, Vol. 24, Sept.-Oct. 1951, Nos. 9-10; p. 207.*

Evershed-Straub Degassing Condenser

The principle employed by Evershed and Vignoles, Ltd., in their "Dionic" water purity meter is known as the electrical conductivity method and is based on the phenomenon that the electrical conductivity of a dilute aqueous solution varies in proportion to the quantity of inorganic salts in solution. However, the conductivity is also affected by dissolved gases such as carbon-dioxide, ammonia and hydrogen-sulphide, and in steam samples the influence of these dissolved gases is often many times greater than that of the inorganic salts, whereas it is the inorganic salts which cause so much of the trouble in superheater tubes, turbines, etc. The Evershed-Straub condenser, it is claimed, removes all traces of non-condensable gases such as carbon-dioxide, ammonia and hydrogen sulphide and passes a gas-free sample of condensate to the "Dionic" water purity meter for conductivity measurement. Operation of the condenser may be observed by reference to Fig. 1, and is as follows: Saturated steam from the boiler passes through a special quantity and pressure regulator which reduces the pressure to about 100lb. per sq. in. The steam then enters the apparatus through the stainless steel tube (1) and flows through the stainless steel heating or reboiling coil (2) where much of the available heat is removed in reboiling the condensate which collects in the reboiling chamber at the bottom of the column. The steam then passes through the inner tube of the condensing coil (3) where it is condensed by cooling water flowing in the outer surrounding tube. The majority of the condensate then passes through the orifice (5), but a small portion flows through line (4), which is open to the atmosphere, to the overflow pipe (6), thus maintaining constant head above the orifice (5). The condensate discharged through the orifice next passes down through the scrubbing or stripping column (7) which is made up of a series of stainless steel plates as shown in section BB. In doing so, it is heated and degassed by the gas-free steam rising from the reboiling chamber at the bottom of the column, and the rising steam is subsequently condensed in the condenser (10), the resulting condensate falling back to the bottom of the column. The undesirable gases aided by a small amount of scavenging steam pass out through the vent (11). The condensate which is now gas-free, flows out through the inner tube of the cooling coil (8) and through the pipe (9) to the conductivity tube of the "Dionic" steam purity meter.—*Engineering and Boiler House Review, Vol. 66, December 1951; pp. 380-381.*

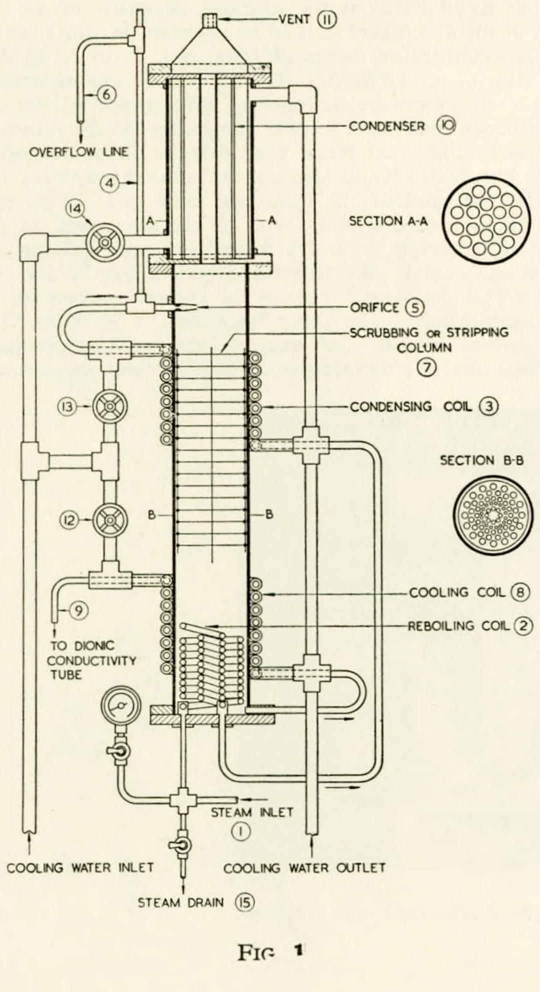


FIG. 1

Steering Engine Accident

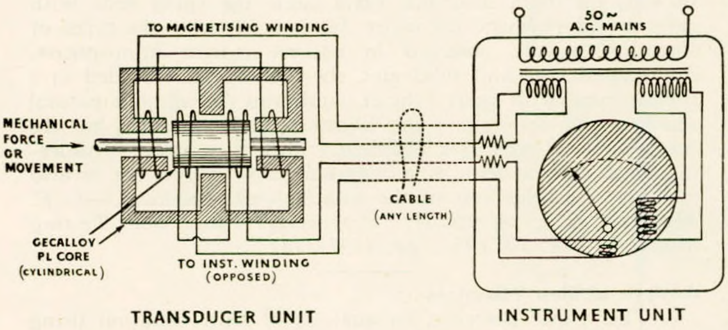
On one of the vessels of the line with which the author is associated, a first assistant engineer, desirous of having the ship arrive in port neat, clean and in good order in the engine department, assigned two men to paint out the overhead, bulkheads and deck of the steering-engine room and, possibly, although always a disputed point, the steering engine itself. This has always been a disputed point as it has been denied vigorously that orders to paint the steering engine were given; nevertheless, having completed the bulkheads and the overhead of the steering-engine room and prior to painting the deck, the men involved undertook to paint the steering engine while the vessel was under way. One of the men involved had his hand caught in moving parts of the engine, ripping away the flesh on the back of the hand and seriously fracturing it. The hand eventually had to be amputated. Obviously, it was not necessary to paint the steering engine at sea and to do so was a hazardous operation. It is also obvious that it is nearly equally unnecessary to paint in the steering-engine room, let alone the steering engine while at sea.—*L. H. Quackenbush, Marine Engineering and Shipping Review, Vol. 56, December 1951; pp. 42-43, 55.*

Cadmium Fume Hazard

Cadmium is now recognized as an excellent plating material in many industrial applications. Its wide use requires that users be constantly alert to the hazard in welding or cutting cadmium-bearing materials. No opportunity should be lost to educate those who may conceivably at any time be exposed to cadmium fumes. In the United States two industrial deaths were reported recently to have been caused by the inhalation of cadmium fumes. Cadmium is widely used for electroplating other metals. It produces a silver-white coating that takes a high polish and protects the base metal from corrosion. Plating with cadmium does not create any more of a health hazard than plating with many other commonly used metals. The trouble starts when heat is applied to metallic cadmium or its salts, either with a welding torch or by some other means. In one of the cases reported, an employee was engaged in spot welding cadmium-plated steel. He died in hospital six days after his exposure to the fumes, which resulted from this application of heat to cadmium. Cadmium-plated metals can be confused easily with electroplated zinc-coated metals; unlike zinc, the oxide of cadmium formed when the metal is heated in air is brown, while the similar oxide of zinc is white. Thus, cadmium provides its own mark of identification. Should there be any doubt in anyone's mind whether a metal is cadmium- or zinc-plated, a sample of the metal in question should be submitted to a competent chemical laboratory for analysis. Welding should never be performed on a metal or plated metal of an unknown identity.—*The Welding Journal, Vol. 30, November 1951; pp. 1029-1030.*

Remote Reading Mechanical Meter

An instrument for the measurement of mechanical quantities by electrical means, capable of presenting the readings at a distance, has been developed by the research laboratories of The General Electric Co., Ltd., and Salford Electrical Instruments, Ltd. Basically, the system measures lengths or alterations in length of up to 0·1 inch, but naturally it can be employed for the measurement of other mechanical quantities, such as pressures and temperatures, and it would appear to have a wide range of potential applications in industry. The instrument operates from ordinary a.c. mains, and the readings can be transmitted over a distance of several miles. The basic principle employed in the system is the change of inductance in a circuit, and the accompanying diagram shows how this is effected. The troubles of some earlier systems using this principle, due to magnetic leakage, temperature errors, and poor electro-mechanical efficiency, have been overcome by the use of an entirely new magnetic-powder material known as Gecalloy PL. The accuracy of the system is claimed to be high, and unaffected by changes of mains voltage and frequency of as much as 30 per cent and 10 per cent respectively. The accuracy is also unaffected by changes of ambient temperature. The transducer unit is about 5 inch long, and the indicator is similar in size and appearance to a normal moving coil switchboard instrument.—*The Shipping World, Vol. 125, 19th December 1951; p. 447.*



Metastable Flow of Saturated Water

This paper discusses the nature of the flow of saturated and nearly saturated water into regions where the pressure is less than the saturation pressure. It is shown that complete metastability (the entire stream being a superheated liquid) occurs within an orifice and may occur in a well-shaped nozzle. In an orifice the flow is effectively that of a completely metastable liquid because the length of the orifice is zero. Actually, it is not practical to make orifices of zero length. However, if the length is not too great, the contraction of the liquid jet is sufficient to permit vapour to form within an orifice of finite length without restricting the flow. In the case of a well-designed nozzle the completely metastable state persists for only a relatively few degrees of superheat. For discharge pressures appreciably below the saturation pressure, complete metastability does not exist in a nozzle, and the fluid consists of a metastable liquid core surrounded by a ring of vapour. A method of computing the mass flow rate of saturated or nearly saturated water through nozzles is given in the form of equations. This method is based on the rate of evaporation from the liquid core into the ring of vapour, and it gives results which agree well with existing experimental data.—*J. F. Bailey, Trans. A.S.M.E., Vol. 73, November 1951; pp. 1109-1611.*

Creep as a Surface-dependent Phenomenon

The paper is concerned especially with the influence of surface condition of metallic materials on creep-resistance during the secondary stage, which is generally considered to be associated with atomic rearrangements due primarily to thermal agitation, the external stress having mainly a directing influence. Tests at 750 deg. C., on nickel under a stress of 3,650lb. per sq. in., in hydrogen, helium, and air, showed a creep rate in hydrogen more than double that occurring in air, and further tests confirmed the strengthening influence of the oxide layer formed on the air-tested specimens. It is suggested that if the presence of a thin layer of nickel oxide produces such a substantial increase in creep-resistance, the effect might be even more potent in the case of the oxides of other metals, such as aluminium or chromium. This possibility is to be explored in later stages of the same research, which is being carried out under the auspices of the U.S. Office of Naval Research.—*Paper by M. R. Pickus and E. R. Parker, A.S.T.M. Special Techn. Publn. 108, 1951. The Nickel Bulletin, Vol. 24, 1951, Nos. 9-10; p. 208.*

Single-pole Electric Circuits on Passenger Vessels

While the early steamers were equipped with 110-v. d.c. generators and single-pole circuits for the new electrical installations they carried, the increase in the use of electrical deck auxiliaries that has followed the introduction of motor ships caused this voltage to be raised to 220v. At the same time, bi-polar circuits were introduced to reduce the dangers resulting from accidental contact with a live conductor, and also because it would then be possible to supervise the insulation of both conductors with respect to the ship's hull at all times. This did not prove satisfactory in practice, however, as even when the insulation was in good condition the leakage currents were considerable. It was found that when a d.c. current flows in a damp atmosphere, a form of electrical osmosis causes the insulation of the negative conductor to become impaired. Since the leakage current is in any event large, a further current, sufficient to cause local overheating and even a fire, may flow as the result of the reduced insulation, without the overall insulation of the circuit being markedly reduced, so that the fault is not apparent on the instruments. With single-pole installations, on the other hand, any fault in the insulation results in a dead short circuit, and the fuse will blow immediately. Other advantages of this type of installation are that the weight of the copper conductors is reduced, firstly because one conductor is no longer required, and secondly because the conductor that remains can be reduced in size, as the voltage drop in the return circuit via the ship's hull can be neglected. The room required for the installation is also less, and holes to pass the cables through water and fireproof bulkheads are also smaller. The author also considers that corrosion due to leakage currents is less with the single-pole arrangement. Since 1928 no German ship has been built with a bi-pole installation, and no fires attributable to a faulty electric circuit have occurred.—*W. Kress, Schiffbautechnik, Vol. 1, July 1951; p. 27. Journal, The British Shipbuilding Research Association, Vol. 6, November 1951; Abstract No. 5,440.*

Design and Manufacture of Ships' Propellers

In a paper read at a meeting of the Koninklijk Instituut van Ingenieurs, W. P. A. van Lammeren considers the results of some recent tests performed at the Dutch Shipbuilding Experiment Station. The first investigation concerned the effect of blade thickness on the efficiency, the number of revolutions, and the cavitation properties of the propeller. The second investigation consisted of an analysis of the dimensions of propellers and of their effect on the cavitation properties and efficiency.

Both investigations are connected with the conditions to be satisfied in the design and manufacture of propellers, which are that the efficiency must be as high as possible, that the propeller must make the correct number of revolutions, that the propeller must be free from cavitation or, where this is not possible, the cavitation must not affect the propulsive force, and that the propeller must be made sufficiently strong to withstand the stresses arising. The author considers these points in some detail, and then remarks on the advantages of employing a standard propeller chart for the design of propellers. An extension of the diagrams of the systematic propeller series of the Wageningen Ship Model Basin is given for blade-thickness ratios which differ from the standard thickness ratio of the 4-bladed B-series propellers. The effect of the accuracy of manufacture and finish of full-scale propellers on their efficiency and cavitation properties is briefly discussed. Finally, the author considers in detail a standardization sheet for the allowable deviations from the design value of the dimensions of propellers.—*Journal, The British Shipbuilding Research Association, Vol. 6, November 1951; Abstract No. 5,351.*

Automatic Combustion Control for Marine Boilers

The more widespread use of automatic controls for the regulation of the air and fuel supplies to a boiler being of fairly recent date in the British merchant service, this paper has been prepared with the object of providing a comprehensive survey of the subject for the use of marine engineers. Although details of control equipment and descriptions of typical recent installations which are included have had to be limited to the more commonly used systems, an attempt has been made to deal generally with the subject. The possible advantages which may result from the use of automatic equipment are discussed in some detail and, although the reduction in fuel consumption compared with an efficiently run manually controlled installation may be small, it appears that other advantages might justify the wider adoption of such equipment. Consideration is given to the principal elements of control systems, and the various ways in which they may be arranged are discussed. In view of the importance of the methods adopted for measuring and controlling the flow of air and fuel, separate sections are devoted to these points. The paper concludes by summarizing some of the main factors which might prevent the best use being made of combustion control equipment.—*Paper by B. Taylor, read at a meeting of the Institute of Marine Engineers, 27th November 1951.*

Reconditioning Lubricating Oil

The increasing cost in recent years of high grade lubricating oil suitable for marine Diesel engines has led to more attention being given to the possibility of reconditioning these oils. It is the usual practice on board ship for the crankcase lubricating oil to be continuously passed through centrifugal separators and filters during voyages. After some time this process fails to extract the accumulation of fuel soot (colloidal carbon), which is continuously building up, and the oil has to be ultimately discarded. Recently a British firm, which has been handling and treating oils for many years, has evolved a process by which treatment of contaminated oil can be carried out at a reasonable cost to the shipowner. The oil is delivered to the company, which processes it, removing all the colloidal carbon, the fresh or salt water which may also be contained in the oil, and also any Diesel fuel oil, which from time to time has been found in used oil. The average loss in bulk in decontamination amounts to about 25 per cent, and the time required to carry out the process is about seven to ten days. Results obtained by this process appear to show that the reconditioned oil compares very favourably with the original oil.—*The Shipping World, Vol. 125, 14th November 1951; p. 343.*

Sea Water Spray Testing of Metals

In connexion with corrosion experiments which were to be conducted in synthetic sea water, the U.S. Naval Research Laboratory some years ago made an examination of existing formulæ for such solutions. The results indicated serious discrepancies. A literature survey was therefore conducted, to establish a summary of existing knowledge on the compositions of sea water from various parts of the world. This permitted development of a formula which would provide an exact duplicate of the organic components of natural ocean water, and during 1948-50 many corrosion tests were carried out with this solution, in order to evaluate it as a corrosive medium. This paper presents a correlated account of the nature of sea waters from various sources, and gives results of comparative tests made (1) in spray cabinets, using 3 and 20 per cent sodium-chloride solutions, (2) in natural sea water, and (3) in the proposed solution, which shows ion concentrations closely similar to those of natural sea water. The following materials were exposed for test: ingot iron containing 0·4 per cent copper, steels containing 0·05 and 0·27 per cent copper, rolled zinc, zinc plating electrodeposited on low-copper steel titanium. Specimens of the same materials were also exposed in a marine atmosphere and in sea water at Kure Beach, N.C. The test results revealed little similarity of performance between specimens exposed in the natural environments and those tested in the spray cabinets using sodium-chloride solutions. One exception was the nickel-plated steel immersed in sea water, in which case all the spray tests caused a similar type of failure. In tests on ingot iron and plain steels the spray tests with natural and synthetic sea water did not duplicate the types of corrosion usually observed in natural marine atmospheres. Zinc-plated steel and solid zinc sheet, however, corroded in a similar manner in spray cabinet conditions (using both natural and synthetic sea waters) and in atmospheric exposure, but the corrosion rates were not sufficiently high to warrant considering such cabinet tests as accelerated tests. Comment is also made on the behaviour of the nickel-plated specimens.—*T. P. May and A. L. Alexander. Proceedings Amer. Soc. Testing Materials, Vol. 50, 1950; pp. 1131-1141.*

Analysis of Ship Vibrations

This paper describes an analysis of ship vibration using basic functions developed by the author in the course of his duties with the British Shipbuilding Research Association. The object of this work was to investigate whether the results of the exciter tests being carried out by B.S.R.A. could be used to obtain information as to the engine unbalance which can be permitted without causing unpleasant vibration. Only a skeleton of the mathematical analysis is given, as this is not of general interest. The analysis is applied to the vertical vibration of the s.s. *Ocean Vulcan,* a ship which has been the subject of comprehensive exciter tests, reported by Johnson. A comparison is made between the calculated and measured frequencies and profiles of vertical vibration for five conditions of loading. Fair agreement is obtained between the calculated and measured vibration profiles and two-node vertical frequencies, but discrepancies are found between the calculated and measured frequencies of the three- and four-node modes of vibration. These discrepancies are much too large to be explained by lack of refinement of the calculations and throw doubt on the validity of the fundamental assumptions made as a basis for ship vibration calculations. It is suggested that these discrepancies may arise mainly from the superimposed vibration of the double-bottom structure of the ship, which is loaded with the entrained water, and further vibration tests carried out on this ship substantiate this explanation.—*Paper by J. E. Richards, read at a meeting of the North-East Coast Institution of Engineers and Shipbuilders, 23rd November 1951.*

Unusual Tugboat

An unusual tugboat, the *Salutation,* has just made her appearance in New York waters. For the first time in local shipping history a tugboat has been especially built with a pilot house that drops and rises again by means of a pneumatic-controlled hydraulic lift when the craft has to pass under a bridge along the New York State canal. This is a new 89-ft. 1,200 h.p. General Motors Diesel-driven tug constructed for the James McWilliams Blue Line of New York.—*Marine Engineering and Shipping Review, Vol. 56, November 1951; p. 51.*

ENGINEERING ABSTRACTS

Section 3. Shipbuilding and Marine Engineering

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Vessel Unloading with Air-activated Gravity Conveyors

Increased cargo capacity, elimination of hold cleanup, and nearly automatic control of the unloading operation for a vessel carrying portland cement in bulk were obtained by the use of airslides when the steamer *Samuel Mitchell* was reconverted upon her return from the War Shipping Administration in 1947. In 1946, the *Mitchell* was converted to a bulk cement carrier, and hoppers with 40 deg. slopes were installed. The recent conversion increased the cubic capacity almost 30 per cent by using a hopper slope of 9 degrees. A false floor above the tank top was constructed, which consisted of small parallel hoppers, sloped to a central, longitudinal tunnel. Airslides, consisting of 8-in. wide by 3-in. deep ducts covered with porous fabric, were installed, spaced on centres of 2ft. Cargo is discharged from the holds through 4-in. × 8-in. openings into two longitudinal screw conveyors. The screw conveyors carry the cement forward to two bucket elevators which discharge into short airslides, which in turn discharge into a 10-in. Fuller-Kinyon pump. The pump elevates the cement through a pipe line to shore bins. To make the cement flow, air at one lb. per sq. in. is introduced to the airslides. The cement then becomes aerated, reducing the friction between the particles and flows much as a liquid. Airslides have been used to convey alumina, carbon, pulverized coal, flour, lime, fly ash, soda ash, iron ore, and in general are adaptable to the conveying of any dry, pulverized material. Considerable attention was directed to stability, both from the standpoint of the physical properties of cement and the characteristics of the vessel. Cement particles may be separated in the vessel's hold and made to flow by air picked up through a vessel's roll. Large model experiments were conducted to determine the extent of permanent list if the cargo shifted. From these experiments it was found to be advisable to trim the cargo, and airslides were installed for this purpose. Inclining experiments have been made each year to give warning of a creep upward of the centre of gravity.—*Paper by C. M. Adams and H. C. Adams, read at the Autumn Meeting of the Great Lakes Section of The Society of Naval Architects and Marine Engineers, 21st September 1951.*

Large Fatigue Testing Installation

The Association des Industriels de Belgique have increased the scope of their laboratories by the installation of a large fatigue-testing equipment designed to perform fatigue and static-load tests on large or small components of metal, concrete, or wood. The loads, either static or pulsating, can be applied in various directions. The maximum alternating load that can be applied is 50 tons, in any direction; the maximum static forces are 400 tons horizontally and 200 tons vertically. The frequency of the alternating loads is one million cycles in 34 hours. The bedplate of the equipment consists of a reinforced concrete slab, some 65ft. by 43ft. The loading is performed by 23 vibrators, of capacities from 1 ton to 50 tons, two large Amsler pulsators, two 25-ton impact pendulums, and a testing machine capable of applying repeated loads of 0 to 50 tons or alternating loads of −25 to +25 tons.—*Journal, The British Shipbuilding Research Association, Vol. 6, November 1951; Abstract No. 5405.*

Behaviour of Light Alloys in Marine Atmosphere

The tests described were carried out at the marine corrosion stations of the Compagnie Péchiney, and have led to certain general conclusions regarding the behaviour of light alloys in a marine atmosphere. Generally speaking, corrosion develops during the first few months of exposure, later becoming stable, provided, of course, the thickness of the material is adequate. The thickness of the metal or alloy exposed to marine conditions is therefore of importance to the performance of the material, the relative deterioration being less the greater the thickness of the material. Thus, it is possible to envisage the favourable behaviour in sea water of A-G5 (Al-5% Mg) alloy which in thicknesses of 2 mm. and greater after four years in sea water would suffer a loss in tensile strength of not more than 4 per cent and a loss in elongation of 16 per cent. In the case of alloys of low corrosion resistance of the Duralumin type, no losses in tensile strength greater than 6 per cent were observed after four years' exposure to marine conditions of sheet having a thickness of 4 mm. Losses in elongation were zero. These observations show that it is not necessary to resort to surface protection in order to preserve good mechanical properties. However, the more or less rapid tarnishing of the surfaces may detract from their decorative value. Anodic oxidation is indicated if it is desired to retain in a marine atmosphere the appearance of a surface without frequent maintenance. Generally speaking, anodic coatings resist marine conditions very well even on alloys of the Al-Cu-Mg type and on secondary alloys. Sheets of A-U4G (Al-4% Cu-Mg) alloy anodized and sealed in potassium dichromate solution have remained without any deterioration after five years on the sea shore. Bolted light alloy joints protected by anodic oxidation and coated with lanolin also show a remarkable resistance to marine corrosion. There are no bimetallic contacts and, moreover, screwing and unscrewing are easy even after several years' immersion in sea water or exposure on the shore. This latter fact is of undoubted importance in connexion with structures it might be necessary to disassemble for maintenance purposes. In this respect light alloy steel bolts anodized and coated with lanolin are definitely superior to steel bolts whether or not the latter are protected by chromium, nickel or cadmium plating. Light alloy bolts anodized and coated with lanolin may likewise be recommended for joints between light alloy and carbon or stainless steel parts. Bimetallic light alloy/steel assemblies are effectively protected against corrosion in a marine atmosphere by spraying the areas of the joints with aluminium, cadmium or zinc or by applying a layer of zinc chromate paint. A top coat of oil-glycerophthalate base paint has proved particularly effective.—*Paper by R. Guilhaudis, read at the Autumn Meeting of the Société Française de Metallurgie, Paris. Light Metals Bulletin, Vol. 13, No. 21, 1951; pp. 731-732.*

Plastic Theory Applied to Strain Hardening

In the simple plastic theory commonly used for mild steel, it is assumed that after yielding has occurred in either tension or compression, straining can continue indefinitely at constant stress. Such an assumption has been found satisfactory for low carbon steels having a plastic range corresponding to eight to ten times the strain at yield, but for steels of greater strength this range is often considerably shorter, and it becomes necessary to take into account the strain-hardening range beyond. To obtain experimental data, four steels were selected, varying in carbon content from 0·28 to 0·89 per cent, and having widely different stress-strain relationships. For each steel, a number of simply supported beams of square section were subjected to a symmetrical two-point loading; tension specimens were prepared from the unyielded ends of these beams and tested in spring-loaded autographic testing machine to determine upper and lower yield stresses. In addition, two tension specimens from each steel were tested in a lever type of machine, and the stress-strain relationships through the plastic range and the initial stages of the strain-hardening range were obtained with the aid of a "Gerard" extensometer. This information gave good support to the theoretical work, whereby the behaviour of these steels in flexure can be correlated with the tensile properties.—*Paper by J. W. Roderick and J. Heyman, submitted to The Institution of Mechanical Engineers for written discussion, 1951.*

German Steam Turbine Propulsion Plant

Modern German turbine propulsion plant is preponderantly of the two-cylinder design with steam conditions of 45 kg. per sq. cm. g. and 450 deg. C. The accompanying illustration Fig. 2 shows the low pressure turbine of the 17,500 s.h.p. plant now being constructed by the Howaldtswerke, Hamburg, for the 40,000-ton tankers which are being built at this yard. Throttle conditions are 42 kg. per sq. cm. g. and 443 deg. C.; the high pressure turbine speed is 5,450 r.p.m. and that of the

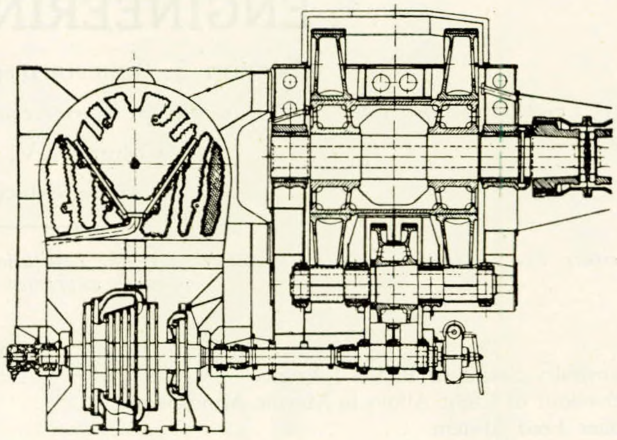


Fig. 2

low pressure turbine is 2,840 r.p.m. There is only one astern turbine, located at the forward end of the low pressure turbine which is seen to be driving the propeller shaft turning at 110 r.p.m. A double reduction gear for 10,000 s.h.p., in which the first stage is a Stoeckicht epicyclic gear, is in the design stage. Its weight of 85 tons compares with a weight of 135 tons for a conventional double reduction gear.—*H. Schepler, Schiff und Hafen, Vol. 3, December 1951; pp. 441-442.*

Plastic Flexure of Steel Beams

The paper describes tests on a 0·28 per cent carbon steel in tension and compression, and in flexure of beams of rectangular cross-section, to a maximum strain about three times that at the initial yield. The object of these tests was to investigate the shape of the stress-strain curve immediately after the initial yielding, and to determine whether in such a case as flexure the upper yield stress could be relied upon as a criterion of design. The results from this material indicate that the stress-strain curve falls rapidly but not immediately from the upper to the lower yield value, and that a beam is capable of withstanding a slightly greater bending moment than would be predicted by calculations based on the direct stress tests, including the upper yield stress.—*Paper by K. K. Shackell and J. H. Welsh, submitted to The Institution of Mechanical Engineers for written discussion, 1951.*

Plasticity Research

One of the most difficult problems which has confronted the Welding Research Council, New York, is that associated with the failures which have occurred in some large welded structures, such as ships and bridges. These failures are described by engineers as brittle and they are perplexing because they have occurred under loading conditions which would normally be considered safe. The ship failures during the war necessitated a great deal of research covering many phases of the problem in order that quick answers could be found. Enough was soon learned regarding the problem that naval architects and engineers were able to get out compromise designs, involving some riveted joints, which were a great improvement. After the emergency, the Welding Research Council appreciated the need for sound design information if a repetition of the ship and structural failures were to be prevented and if efficient economical designs were to be produced. It appointed a Plasticity Committee of eminent engineers and scientists to tackle this problem. It was hoped that the needed information could be sifted from the mass of government sponsored research here and abroad. After eight meetings extending over a period of more than a year, agreement was reached between the scientists and engineers on a three-pronged attack on this problem. A considerable amount of scientific information has been accumulated on the flow and fracture of metals, some of which can be translated now in terms which the engineer can use. It was also agreed that two parameters of behaviour (strain rates and gradients) need further investigation. Possibilities of new approaches to the problem were not overlooked and have been provided for in the programme.—*The Welding Journal, New York, Vol. 30, October 1951; p. 528-s.*

Testing Welds by Bulge Explosion Test

A pressing need exists in the welding field for a relatively inexpensive, semiworks-scale, structural test of full weld joints featuring simple geometry and controlled loading. Such a test has been developed at the U.S. Naval Research Laboratory by extension of established bulge test techniques long used for evaluating the behaviour of metals under combined loads. The test features the bulging of welded plate in full thickness by means of an air blast produced by the detonation of an explosive. By modification of bulge geometry it is possible to obtain a wide range of stress conditions. The theory and development of the test have been reported previously, together with a detailed analysis of the plastic deformation characteristics of various weld combinations. It was demonstrated that the stress and strain states imposed by the loading conditions are not always accepted as such by the weld joint. Depending on the relative flow strengths of weld and base metal, a system of stress and strain entirely foreign to the remainder of the structure may be developed in the weld and near-weld regions. The present report deals with the fracture characteristics of various weld and base metal combinations. In addition, the nature of the weld-deformation characteristics have been studied in relation to the intrinsic properties of the welds and base metal in an attempt to arrive at a basic understanding of the factors controlling weld performance. Two steels representative of high-tensile and mild-steel grades were investigated. In conjunction with the bulge fracture study, the deformation characteristics of the various weld and base metal combinations were investigated, together with their flow strengths and Charpy V-notch transitions in an attempt to determine the basic factors controlling weld performance. It is indicated that the performance of pearlitic steel weldments is determined by the weld rather than by the heat-affected zone. The notch toughness and flow strength of the weld appear to be the major controlling factors. The significance of explosion bulge test evaluations in terms of structural performance is discussed.—*C. E. Hartbower and W. S. Pellini, The Welding Journal (New York), Vol. 30, October 1951; pp. 499-s-511-s.*

New French Passenger Liner

The new French passenger liner *Flandre,* which was recently launched from the Dunkirk yard of the Société des Ateliers et Chantiers de France, is a 20,500 tons gross twin-screw steamship built for the Compagnie Générale Transatlantique. After careful model experiments in the Paris Testing Tank, it was decided to adopt a bubble-shaped stem which extends beyond the forward waterline perpendicular. The stern lines of the hull are equally unusual, owing to the fact that the skeg of the keel is placed some 82 feet in front of the after perpendicular, providing a flat bottom sternway clear from the propellers. The propeller shaft stays have been designed with special A-brackets, incorporating athwartship fins designed to direct the water stream against the propellers in order to achieve maximum efficiency. The principal particulars of the *Flandre* are as follows:

Length overall	597ft.
Length b.p.	569ft.
Breadth moulded	80ft.
Depth to promenade deck ...	56ft.
Draught	26ft.
Total complement	1,146
Cargo capacity	2,800 tons
Displacement	20,300 „
Gross tonnage (about) ...	20,500 „
Normal horsepower ...	36,000 s.h.p. at 180 r.p.m.
Normal speed	23 knots

The main machinery of the *Flandre* comprises two sets of Rateau-type turbines by Chantiers de Bretagne. Each of these groups consists of a h.p., m.p. and two l.p. turbines controlling the corresponding shafting through double reduction gearing. The machinery is capable of developing in normal service a total of 36,000 h.p. at 180 r.p.m., the maximum output being 44,000 h.p. Steam is supplied from four boilers of the La Mont type, one of which is a standby unit. These boilers are capable of evaporating 50 tons of steam per hour in normal service.—*The Shipping World, Vol. 125, 7th November 1951; pp. 328-329, 333.*

Shaft Drive for Generators

An arrangement giving a damping effect to the drive for an engine shaft operating an electric generator is shown in Fig. 3. The propeller shaft (1) carries a gear wheel having an inner part with pockets (9), which contain pairs of springs (7, 8). These springs are separated by a sleeve (10) measuring

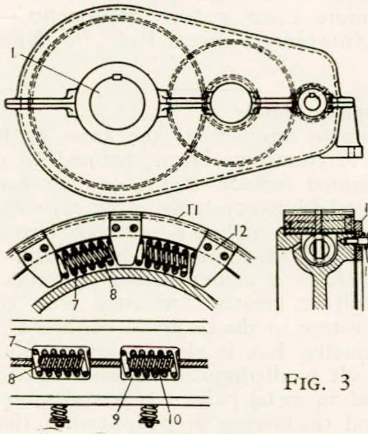


FIG. 3

less in length than the inner compressed spring (8). The load is transmitted from the toothed ring (11) to the springs through cheeks (12). When the gear is being assembled the springs are first inserted in their pockets (9) and the toothed ring (11) is moved over the centre. The cheeks (12) are screwed into a loose guiding flange (13) and then placed over the bolts (14). Springs (16) on the bolts are regulated by means of nuts (15), so that a suitable friction damping is achieved. Up to a certain limit of the load the cheeks (12) act only on the outer springs (7) and the spring coefficient is constant. When the load is increased to such an extent that the cheeks act also on the inner springs (8), the total spring coefficient is varied.—*British Patent No. 659,262, A.S.E.A., Vasteras, Sweden. The Motor Ship, Vol. 32, January 1952; p. 433.*

New Steering Control System

The new Gyro-Pilot system, which incorporates electronic rate control, can now direct a vessel automatically to its proper heading—from the smallest deviation or largest course change alike—rapidly, positively, and with no overshoot whatsoever. In short, the new Gyro-Pilot takes care of such variables as speed, ship's turning momentum, wind and sea conditions, and calls for just the right amount of rudder to meet these forces. In simplest terms, the rate signal in the new Gyro-Pilot functions so that the faster the vessel is forced from the heading, the greater the rudder angle applied to hold her. Conversely, the faster the vessel is turning into the desired heading, the greater the opposite or "meeting" rudder applied to stop the turn. Setting a new course through the new Gyro-Pilot is a simple operation. In the steering stand, there is a gyro-compass repeater on which a course-setting pointer is superimposed. When the ship is in automatic steering, the helmsman can select a new course by moving the steering wheel to set the pointer on the exact header desired. Smoothly, the ship automatically turns to the course. The Sperry Gyro-Pilot combines both rate and displacement signals to attain its precise steering control. Rate control is applied as a direct-current voltage—proportional to the rate or speed of turning of the vessel—and is obtained from the generator geared to the Sperry Gyro-Compass. These signals are combined with displacement signals to obtain optimum rudder control. To adapt this steering-control system to the highly variable characteristics of different hulls, the proportion between the two signals is changed to suit a particular vessel. Once the proportion is established by trial, it will suffice for all speeds, turns and sea conditions. Further improvement in the quality of steering control afforded by the electronic "Metal Mike" has been made possible through the use of a hydraulic rather than an electric power unit for controlling a vessel's steering engines. Located in the steering gear room, the power unit is a hydraulic cylinder with associated pump and valving mechanism which receives steering intelligence in the form of electric signals from the Gyro-Pilot. The resulting linear piston motion is used to stroke the valves of the main steering gear which moves the ship's rudder. These hydraulic cylinders avoid high inertia of moving parts and make possible more exact rudder movements.—*Marine Engineering and Shipping Review, Vol. 56, November 1951; pp. 60-62.*

Protective Coatings on Metals

An approximate estimate of the areas of breakdown of paint on a pair of metal specimens, painted on one side only and with the painted surfaces facing one another, can, nevertheless, be obtained from conductance or capacitance measurements, provided that the surface is relatively free from rust and that "fringing" effects are minimized by making measurements with the two surfaces a certain critical distance apart. The relative errors will be greatest for small areas of breakdown. There is no advantage in the electrical method if the areas can be measured visually, but it should prove valuable in cases where it is difficult to distinguish between areas of breakdown and the surrounding metal paint. It has also been established, for the types and thicknesses of paint tested, that the rate of penetration of corrosion at exposed areas in the paint film is independent of the relative areas of the exposed metal and of the intact paint film; hence it appears that the whole surface of the paint film is not functioning as an efficient cathode.—*F. Wormwell and D. M. Brasher, Journal of the Iron and Steel Institute, Vol. 169, November 1951; pp. 228-234.*

Damage Due to Vibration

A casualty report was received recently relating an unusual accident to a Liberty-type tanker. The tanker in question was discharging a cargo of crude oil at the time of the accident. The forward pump room was in operation. Cargo valves had been set and pumps started. The pumpman, after watching to see that the discharge rate had steadied down, departed, only to return at various intervals to examine their operation and oil them. It was during one of these periodic visits to the pump room that he observed an overflow of oil from the pump room escape hatch. The pumps were stopped and assistance was obtained in pumping out the flooded pump room. After the gas-freeing operation was completed, the pump room was examined by the chief and port engineer. From their examination it was learned that a 3-in. gate valve in the bilge had come completely adrift at its junction with an 8-in. cargo discharge line. The valve was replaced in the line, flanged bolts secured with jamb nuts and discharging was resumed. During this second attempt to discharge the cargo, 30-minute inspection rounds of the pump room were made. About six hours after the second start, it was discovered that 5ft. of oil had flooded the pump room between two of the inspection rounds. The pump room was again emptied and again gas-freed. Upon examination it was discovered that another joint in a 3-in. bilge discharge line had opened up due to the slackening off of the nuts on the flanged bolts and that this spread joint had caused the second flooding. The bilge line was isolated by shutting the intermediate valve in the discharge line near the pump and discharging was resumed. Shortly thereafter it was discovered that the weld in the flange between the intermediate valve in the discharge line and its junction with the 8-in. cargo oil line was cracked. At this point the starboard cargo pump was secured and the remainder of the cargo discharged by means of the port pump. No injuries to personnel occurred as a result of this extraordinary accident and no damage to material occurred other than that detailed above. The cargo pumps in the forward pump room of the vessel in question were steam-driven vertical pumps with a capacity of approximately 1,000 barrels per hr. each. Apparently, excessive vibration in these pumps during operation had been noted by the chief engineer and pumpman and shoring of the cargo pumps had been contemplated. During the repair operations it was found that the pumps were secured at the bottom only with four bolts. These four holding-down bolts were smaller in diameter than the holes in the base of the pump. Repairs consisted of measures to reduce the vibration. Among the measures taken were the insertion of body bound bolts in the holes in the base of the pump and the nuts thereon were tack welded. The steam ends of the pump were reinforced by means of straps around the pump welded to the bulkhead. The tie rods between the steam and liquid ends of the pumps, being loose in the threads, were permanently secured by tack welding. The cracked weld and other damage to the 3-in. bilge discharge line was of course repaired in the usual manner.—*Proceedings of the Merchant Marine Council United States Coast Guard, Vol. 8, August 1951; pp. 174-175.*

Large Tankers

The largest tankers in the world now under construction at the Howaldtswerke yard in Hamburg will have the following principal particulars:

Length overall	756ft. 0in.
Length between perpendiculars	722ft. 0in.
Breadth	95ft. 0in.
Depth	51ft. 6in.
Loaded draught	34ft. 6in.
Deadweight capacity	40,000 tons
Gross tonnage	29,000 „

There will be twelve sets of tanks divided by three longitudinal bulkheads, making forty-eight separate compartments. The bulkheads will be of corrugated type and there will be one main pump room aft and a stripping pump room forward. The ships are being constructed under the survey of the American Bureau of Ships and delivery of the first vessel is expected in April 1953. The machinery will consist of a single-screw set of cross-compound turbines with double-reduction nested-type gearing designed to develop 17,500 s.h.p. on trials and 16,000 s.h.p. in service. These will take steam at 610lb. per sq. in. and 840 deg. F. from two two-drum water-tube boilers of Howaldtswerke design which will be built at their Kiel establishment. Certain of the auxiliaries will be driven by high-speed geared turbines of Röder design; these include the cargo pumps, main feed pumps and two 600 kW 450-volt alternators. The boilers will be installed forward of and slightly above the level of the turbines, while the principal auxiliaries will be installed below.—*The Marine Engineer and Naval Architect, Vol. 74, November 1951; p. 500.*

Cargo Motorship *Ciudad de Medellin*

The cargo motorship *Ciudad de Medellin* is the first of four similar vessels ordered by the Flota Mercante Grancolumbiano of Bogota, Colombia, from the Govan yard of Fairfield Shipbuilding and Engineering Co., Ltd. This class of ship has been designed for the carriage of bananas, coffee and general cargo on a regular service from Venezuela, Colombia and Ecuador to New York via New Orleans. The ship is a shelter decker with a well-raked fashioned-plate stem, a cruiser stern, two masts and a streamlined funnel. The principal dimensions are:

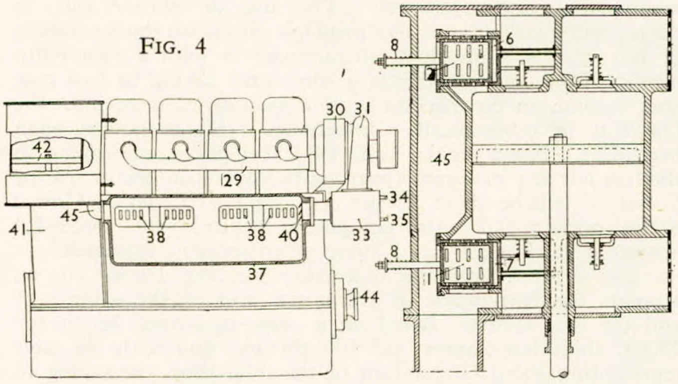
Length overall	423ft. 6in.
Length between perpendiculars	395ft. 0in.
Breadth moulded	55ft. 0in.
Depth moulded to main deck	24ft. 6in.
Gross tonnage	4,129 tons
Speed	14½ knots

The vessel is propelled by a four-cylinder Fairfield-Doxford engine having cylinders 670 mm. diameter with a combined stroke of 2,320 mm. and developing 4,600 b.h.p. at about 118 r.p.m. on trials. There is no steam service on board the vessel and all auxiliary machinery and the ship's services are electrically powered. The necessary electric current is supplied by three 340 kW Diesel generators installed on the starboard side of the engine room. Distilled water for main engine cooling water make-up is provided by a distiller which takes vapour from a small electrically heated evaporator.—*The Marine Engineer and Naval Architect, Vol. 74, November 1951; pp. 497-500.*

Werkspoor Engine with Scavenging Pump and Turbo Blower

A four-cylinder engine embodying a reciprocating scavenging-air pump as well as an exhaust-gas turbo blower is illustrated in Fig. 4. The exhaust pipe (29) communicates with the gas turbine (30), which is coupled to the scavenging blower

Fig. 4



(31). The discharge from the blower passes through an air cooler (33), circulating-water cooling pipes (34, 35) being provided. The air supplied from the cooler is delivered to the supercharging trunk (37) which surrounds the air inlet ports (38). A non-return valve (40) is fitted. The scavenging-air pump plunger (42) is driven by the crankshaft (44) and the air discharge pipe (45) from the pump opens freely into the air chamber (37). The pump and the blower, accordingly, are always in parallel. The air space (37), at low revolutions, receives sufficient pressure from the pump (41). At heavy loads the air supplied from the rotary blower (31) may be decreased. The slide valves (1, 2) are influenced by the pressure in the trunk (45). This pressure is built up by the compressor (31) and the pump (41) jointly. The valves are also influenced by atmospheric air in the spaces (6, 7). The force which is created by the pressure difference is counteracted by an adjustable spring (8).—*British Patent No. 660,294. Werkspoor, N.V., Amsterdam. The Motor Ship, Vol. 32, January 1952; p. 433.*

Gerritsen Gear

The Gerritsen transmission provides a new solution to infinitely variable speed problems for light loads. It can be used for ratios in the 1 to 1 range, or for very high reductions. In addition, it can provide a constant output speed for a variable input speed without an additional governor. The gear is of the mechanical friction type. Basically, it is similar to a ball bearing, using a number of steel balls, and four cones, two male and two female. These four cones are preloaded into contact with the balls and control their movement about the central axis of the unit. One or two of these cones form the input member, and one or two the output member. At least one of the cones does not rotate but constitutes a reaction member. For what duty any particular surface is used depends on the performance required from the gear. Apart from the configuration, the gear ratio depends mainly upon the distance of the ball centres to the centre of the complete unit, and upon the angles of contact of the balls with the cones. The balls are allowed radial movement, and if curved surfaces are employed in the gear, new angles of contact will be obtained as the balls move in or out. This movement is obtained by axial squeezing together of either the two inner or the two outer cones. The axial movement can be under external control. For self-governing gears, however, the outer cones are spring-loaded together, the cones being forced apart by the centrifugal force on the balls. The unit is calculated such that for a given percentage increase in speed, the resultant axial movement causes the gear ratio to drop by the same percentage and, hence, constant speed is achieved.—*Paper by J. J. Gerritsen, read at a meeting of The Liverpool Engineering Society on 24th October 1951.*

Propeller Milling Machine

A recent Norwegian patent by A. Tveitan and L. Myrolt of Trondheim describes an apparatus which machines with theoretically unlimited accuracy, the whole surface of conventional screw propellers, i.e. the pressure and suction surfaces, the blade outline and the hub exterior. The machining consists of cutting out the lines representing the intersection of the propeller surface with a series of meridian planes (planes having the propeller axis as their common intersection line). The cutting edge of an end-milling cutter rotates in the meridian plane concerned, and its movement in relation to the propeller is regulated by a transparent disk which is made to describe the meridian curve in question on a drawing of such curves fastened to a movable table. The disk is cut in the shape of a circle or an ellipse, representing the cutter, and is mechanically connected to the cutter holder. Most propeller milling machines are able to cut cylinder sections only, i.e. the intersection of the propeller surface and a series of cylinder surfaces with their common axis identical to that of the propeller. As it is not practicable to make the milling cutter with an infinitely small diameter, it is generally not possible by simple mechanical means to cut cylinder sections with mathematical accuracy without modifying the drawing in a rather complicated way. A feature of the patentee's milling machine is the simple mechanical means required for cutting in meridian sections compared to cylindrical ones, if the drawing of the section is not permitted to be modified otherwise than possibly by using different scales in the two principal sections of the drawing. Cutting in meridian sections also causes no difficulties for normal screw propellers in passing from the blade to the hub, or machining the hub between the blades of the propellers. —*The Shipping World, Vol. 125, 19th December 1951, p. 447.*

Small Gas Turbine

The U.S. Navy is now testing a 24-ft. boat fitted with a 175-h.p. gas turbine at the U.S. Naval Engineering Experiment Station, Annapolis, Md. A boat of this type could be used for seaplane operations. Its high speed would permit efficient and speedy rescues in cases of plane crash. The engine consists of a single-stage centrifugal compressor with two outlets, two constant-pressure burners, and a compressor-driving turbine having a rated speed of 36,000 r.p.m. The power-output stage consists of another turbine with a rated speed of 24,000 r.p.m. and 9·6:1 reduction gear. To keep weights to a minimum, aluminium is used for a number of major components. Weighing only 150lb., the engine is light enough for two men to lift and occupies less space than a household washing machine. Maintenance is simple, as there are about one-tenth as many parts as in a conventional gasoline or oil engine of comparable horsepower. Output will vary between 100 and 200 b.h.p., depending on the endurance life expected. The turbine can drive the boat at speeds up to 21·7 knots with much less vibration than a Diesel or gasoline engine of comparable horsepower. Smooth starting is an outstanding characteristic of the gas turbine. The engine in the experimental boat will start and attain full speed in about seven seconds. It runs equally well on gasoline, kerosene, and light or heavy fuel oil. It is considerably quieter in operation than a conventional piston-type engine. The turbine is still in the development stage and is not yet ready for production. Although emphasis has been placed on reliability, other phases of the turbine's proving have not been neglected. Design changes already made to improve operation of the unit are a more rigid but lighter-weight cast frame, replacing the original fabricated frame; a new accessory drive unit; cast aluminium burner elbows, replacing the steel fabricated elbows formerly used; development of a new type ignition plug, and addition of a cross-over tube between burners to ensure quick, dependable two-burner starts; and circular exhaust outlets which permit the small-volume turbine to be installed in an even smaller space than previously.—*Mechanical Engineering, Vol. 73, December 1951; p. 1010.*

Graphite Impregnated Rubber Packing for Pumps

This paper explores the use of graphite-impregnated rubber as possible material for making rubber goods subjected to abrasive wear, e.g. gland packing for slush pumps. The value of graphite as a lubricant has been known for a considerable period of time. It works well as a lubricant by itself as well as in oil. If the graphite could be mixed in sufficient quantities into the rubber packing used to prevent a fluid leak around a moving part, it is possible that a considerable power saving and a longer life for the packing could be realized. It might also provide for a graphite-coated metal part which should reduce, at least to some extent, the tendency of the metal to corrode. Tests were made on rubber packing used on oil-well stuffing boxes and slushpump packing glands under field conditions. When the rubber packing is properly made, considerable longer packing life is obtained in field tests. It was found that graphite, flake or amorphous, can be used as a rubber additive in mechanical rubber goods provided that the amount of graphite added gives sufficient lubrication without detracting too much from physical properties of the rubber. The optimum quantity of graphite to be used will apparently have to be worked out for each application.—*Paper by E. T. Skinner, abstracted in Mechanical Engineering, Vol. 73, December 1951, pp. 1016-1017.*

Heat Transfer Inside Tubes

The separate contributions of convection and radiation heat transfer from non-luminous gases flowing in a 3-in. tube have been studied at temperatures up to 2,000 deg. F. and at values of Reynolds' numbers of 690 to 15,100. Importance has been attached to the accurate determination of gas temperature from temperature and velocity distributions across the tube. The influence of turbulence on the heat transfer and pressure drop has been examined and a quantitative assessment made of the effect of introducing spiral turbulence promoters. For the same pressure drop in an empty tube, it has been shown that, although there is an increase in the convection coefficient with the promoter, the total heat transfer to the tube is less, the implication being that disturbed turbulence admits of shortening the tube length for the same heat flux. For conditions in the empty tube, existing formulæ developed for temperatures below 600 deg. F. for calculating the convection coefficient are shown to be applicable for gas temperatures up to 2,000 deg. F. The work indicates that the values of the thermal conductivity and viscosity of gases recommended by Fishenden and Saunders and by Spiers are most suitable for use in the pertinent equations. In the study of radiative heat transfer, it is shown that a more accurate value is obtained by the use of the logarithmic mean temperature of the gas in the computation.—*S. I. Evans and R. J. Sarjant, Journal of the Institute of Fuel, Vol. 24, September 1951, pp. 216-227.*

Twofold Use of Magnetic Couplings

An interesting application of the use of magnetic couplings is represented by the equipment which the British Thomson-Houston Co., Ltd., is to supply for a cement carrier being built by Henry Robb, Ltd. This is a twin-screw ship which will be powered by two British Polar Diesel engines, each developing 640 h.p. at 250 r.p.m., and has special requirements in that about 600 kW. of electric power is needed for cargo handling in harbour. To avoid the necessity of installing special generators to carry this load, an ingenious arrangement of the main propulsion equipment has been adopted. Each shaft carries an electro-magnetic coupling, the d.c. portion of which is connected to the engine, and the a.c. portion of which carries a three-phase winding and is coupled to the propeller shaft. When the ship is at sea the three-phase windings are short circuited and the couplings transmit power to the propeller in the normal way, but on returning to harbour the propeller shafts are locked, the short circuiting bars are removed from the a.c. portion of the couplings, and normal three-phase connexions made. The couplings can then be used as alternators and, with the engines running at 300 r.p.m., are each capable of generating 400 kW. of electric power. A total of 800 kW. is thus available in harbour for cargo handling purposes.—*The Shipping World, Vol. 126, 30th January 1952; p. 142.*

Burning Bunker Oils in American Diesels

The operation of the Diesel engine on bunker fuel is not difficult, but simply entails care in the proper processing and preparation of the fuel, together with standard Diesel engine maintenance and operation. The use of bunker oils in American motorships has two principal effects on the economics of this type of ship; first, in comparison with a motorship burning Diesel oil, it permits a substantial saving in fuel cost and, second, in comparison with a steamship, it permits the Diesel to be economically competitive at higher powers than heretofore. Based on the June 1951 fuel prices, the saving in the fuel bill of a motorship burning bunker oil in lieu of marine Diesel oil will be about 35 per cent for East Coast of United States ports. Since the equipment required for successful operation on bunker oil is more extensive and represents an increase in cost over the motorship burning Diesel oil, an estimate has been made of the initial cost of the equipment and the fuel saving. Based on a cargo-passenger design for 13,500 shaft horsepower and 500 persons, and with sea days representing about 60 per cent of the total time, the saving in fuel cost will pay for the increased initial cost in less than one year. Therefore, the percentage saving previously noted can be effected after the first year. The size of the installation and the load factor should also be considered. Small installations with low load factors would not justify the installation of equipment necessary to burn bunker fuels. It is well known that American owners, in general, have preferred steam machinery, whereas a large majority of new construction abroad, of comparable size, has been fitted with Diesel machinery. Economic considerations generally support this

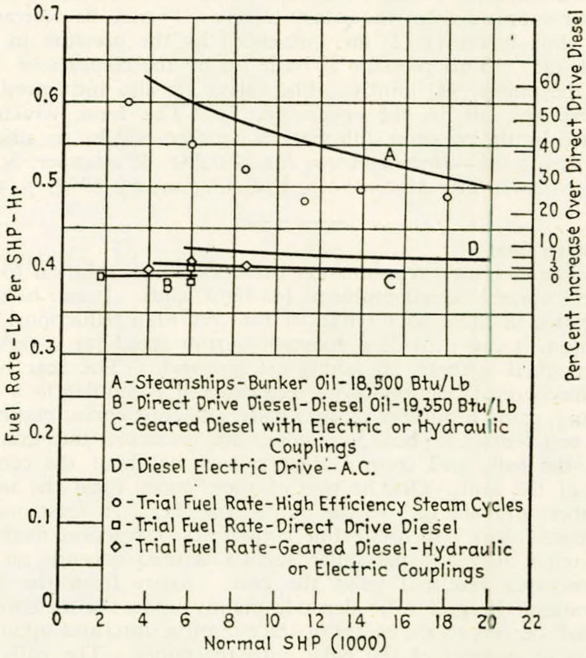


FIG. 7—*Cargo ship fuel rates (all purposes)*

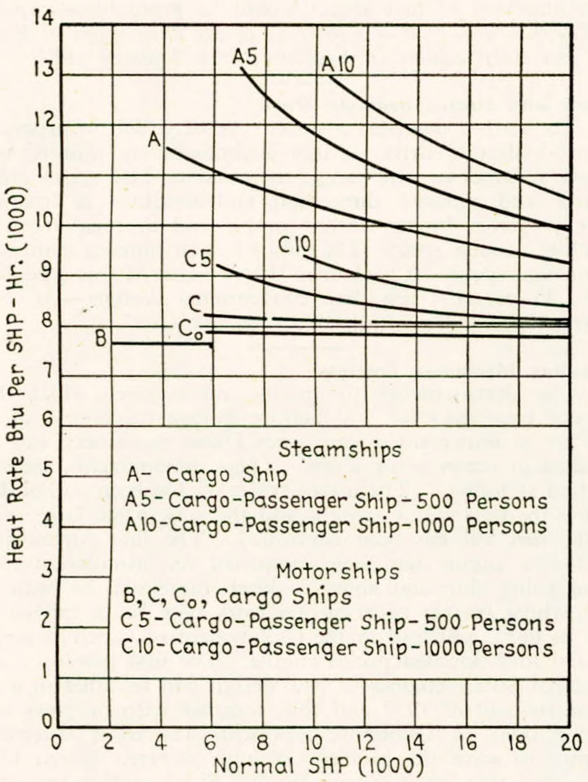


FIG. 8—*All-purpose heat rates*

fact; i.e. in spite of the low specific fuel consumption of the Diesel, the fuel cost of the motorship using marine Diesel oil and bunkering in the U.S.A. has been greater than for the comparative steamship. The ability of the modern American Diesels to burn bunker oils successfully should have an appreciable effect upon this condition. Fig. 7 has been prepared to indicate the all-purpose fuel rates of geared-steam-turbine and Diesel-driven cargo ships over a range of power from 2,000 to 20,000 shaft horsepower (without cargo refrigeration). Curve A represents average estimated performance for steamships, and the circled points indicate the trial results of certain ships having high efficiency steam cycles. Curves B, C, and D represent average estimated performance for motorships with various types of drive, and the boxed points show trial fuel rates for comparative purposes. Fig. 8 indicates the all-purpose heat rates for cargo and cargo-passenger ships and is based on Fig. 7. For the steamship, fuel rate curve A of Fig. 7 has been converted to heat rate curve A of Fig. 8, and then this curve has been corrected to provide hotel service for a total of 500 and 1,000 persons, to give the cargo-passenger heat rate curves A5 and A10, respectively. For the motorship, curves B and D of Fig. 7 have been converted to heat rate curves B and C of Fig. 8. Curve C_0 is a modification of curve C and indicates the heat rate of a Diesel-electric (alternating-current) motorship, utilizing a low-pressure turbine-driven generator set to produce electric power for auxiliary purposes. The steam used in this set is obtained from a waste heat boiler, and represents the surplus steam after satisfying the other steam requirements. Curve C_0 has been corrected to provide hotel services for a total of 500 and 1,000 persons, to give the cargo-passenger heat rates C5 and C10, respectively. —*Paper by E. B. Rawlins, E. D. Newell, and D. C. MacMillan, read at the annual meeting of The Society of Naval Architects and Marine Engineers, New York, 15-16th November 1951.*

Manufacture of Ship Propellers

This article gives a description of the manufacture of ship propellers at the Yoker works of Bull's Metal and Melloid Co., Ltd. The first operation is to set up a heavy iron spindle in the centre of the pit, and to make around it three, four or five beds, depending on the number of blades required. In the case of a propeller of uniform pitch, the top surface of the loam is formed by swinging a heavy striking board round the centre spindle while raising it uniformly by causing its outer end to slide up an inclined rail. If a non-uniform pitch is required, an articulated striking board is employed. Subsequently, thin wooden sections having the shape of the blades at various radial distances from the propeller axis are placed on the bed at their correct radial positions, and are bent circumferentially into their appropriate shapes. After they have been fixed in position, the intervening spaces are filled with soft sand until a replica of the blade is formed. Construction of the reinforced cope, or cover, follows. When the latter is lifted subsequently, the soft sand and wooden sections are removed, the cope is lowered again on to the bed and the two are fastened rigidly together. The metal ingots required for casting are melted in adjoining furnaces and raised to the correct temperature. After the furnaces have been tapped, the molten metal, conveyed to the pit in ladles, is poured into the runner-box which controls the flow of metal into the bottom of the mould. When the metal has solidified and cooled, the casting is removed. In its rough state, it is 50 per cent to 70 per cent in excess of its finished weight. After casting, a propeller is removed to the machine shop. There the head is removed on a horizontal boring machine and the fore and aft faces of the boss are finished to their required dimensions. The tapered bore for the tail shaft is then completed and the keyway cut. Still with its blades in the rough condition, the propeller is passed on to the finishing shop. The usual method of finishing involves chipping away most of the unwanted metal from the blades by means of pneumatic tools and, when the dimensions are nearly those required, grinding and polishing the blades to their final shape. Static balancing is then all that is normally necessary.—*Engineering, Vol. 172, 7th December 1951; p. 717.*

Estimation of Ship's Engine Power from Model Results

During ship acceptance trials the instruments used to measure cylinder pressures or shaft torques can usually be relied upon to give repeat readings only within 3 or 4 per cent in the conditions under which such trials have to be made, and errors in the engine and transmission efficiencies are probable. Errors in the measurement of the ship's speed due to inaccuracies in observation, tide, steering, etc., add to the possible error of the trial data, and the weather is rarely ideal. Furthermore, the model experiments, which are usually made before the ship is built, are not usually carried out at exactly the same draught and trim as that of the ship on trial. For all these reasons, accurate comparisons between model predictions and ship performances are not usually possible within an accuracy of six or seven per cent. Model predictions of engine power and propeller revolutions are made by assuming the model quasi-propulsive coefficient (either with the model self-propelled or with its resistance reduced by a skin friction correction) by dividing the tow rope power (deduced from model resistance tests) by this coefficient and also by the engine and transmission efficiencies. To make this predicted power agree with that of the ship, it is multiplied by an ignorance factor of 1·08. The propeller revolutions are found from the apparent slip ratio at which the predicted power equals that of the model when underpropelled. A new method of predicting a ship's performance from the model experiment data is proposed, which consists of first correcting the model torque/slip diagram for differences in the wake velocities in which the ship and model screws work and then making a correction for the "scale effect" of the model screw. The method used to make these approximate corrections is described in appendices. From the ship torque/slip diagram so obtained, the ship's engine power and propeller revolutions are determined by assuming the augmented resistance of the ship to be the same as that of the model when self-propelled. A comparison is made between the propulsion data obtained during the acceptance trials of eighteen single-screw vessels and the predictions from experiments with their models, made by the quasi-propulsive coefficient method and also by that suggested in the paper. These comparisons show that the predictions by the new method are reasonably good and it is suggested that they would be improved by further research described at the end of the paper. The effect of wind and of ordinary "fine" weather upon the resistances of full ships have been deduced from the trial results, with the assistance of the model experiment data.—*Paper by J. L. Kent, read at a meeting of the North-East Coast Institution of Engineers and Shipbuilders, 25th January 1952.*

Influence of Support upon Critical Speed of Rotor

Specifications on marine propulsion sets usually require that the calculated first critical speed be at least 20 per cent above running speed. The reason undoubtedly is to have propulsion units with rotors which will not pass through speeds of peak vibration; that is, critical speeds within the running speed range. The actual results obtained in operation defeat the intent of such a requirement and hence it becomes meaningless. Furthermore, the vibration of a rotor at the actual critical speed is well within proper operating limits when the turbine is designed properly and balanced. Observations taken on units having the calculated critical speed in accordance with these specifications show that the actual critical speed occurs materially below the calculated value and that the actual critical speed occurs within the running speed range on most units where the maximum operating speed is above 3,000 revolutions per minute. This discrepancy is due to the fact that the bearing supports, which consist of the oil film, pedestals and foundation, are elastic bodies. Although the pedestals and foundations may be of rugged design, they deflect under the loads imposed upon them. The flexibility associated with the deflexion of the supports lowers the "actual or operating critical speed" below the calculated value on rigid supports. By eliminating the requirement of having the calculated critical speed 20 per cent above running speed and allowing the engineer to place the critical speed above or below running speed, sets can be designed to give the customer a unit of higher efficiency, simpler design, and equivalent operational performance.—*Paper by F. C. Linn and M. A. Prohl, read at the annual meeting of the Society of Naval Architects and Marine Engineers, New York, 15th-16th November 1951.*

Vibrations in Marine Engineering

A survey of the vibrations, affecting main machinery and hull in practice, is followed by a historical survey of the subject. Various aspects of the problems are then discussed—hull vibration periods, torsional vibrations in the machinery, hull vibration excited by the engines, longitudinal vibration of the shafting system and noise and vibration sensation. As the author points out, modern requirements in connexion with engineering products have become so exacting that it is surprising to find little or no reference to vibration characteristics in contract specifications. The fact of the matter is that this cannot be done in a definite manner unless and until proper standards of measurement are available. Another point is that usually no attempt is made to decide the onus of responsibility as lying with the engineers or the shipbuilders, which could in some circumstances create an awkward situation. The subject is one which demands the closest possible collaboration between naval architects and engine designers and there is a tendency for this to be neglected, particularly when another firm supplies the engines to a shipbuilder. A great amount of research has been carried out recently, and is continuing, on ship vibration problems, particularly in regard to frequencies. Possibly too much emphasis has been laid on engine effects, because if the position of nodes is known approximately, engines could be so designed that at synchronous speed no appreciable vibration resulted and consequently the exact value of the frequency would be immaterial. This would simplify matters, provided that effects arising at the propeller end could be rendered insignificant, and more attention to that aspect would be profitable.—*Paper by A. E. Fothergill, read at a meeting of the Institution of Engineers and Shipbuilders in Scotland, 29th January 1952.*

Winch with Electric-hydraulic Drive

The author describes a novel type of winch incorporating electric-hydraulic drive. Main advantages are infinite speed variation, larger control range, increased no-load speed, simple control and reduced dimension and weight. A hydraulic drive is driven by an electric motor and in turn drives the winch at variable speed. The motor is kept running continually at constant speed. It is claimed that winches of this type weigh 40 to 45 per cent less than conventional designs.—*M. Pape, Hansa, Vol. 88, November 1951; pp. 1686-1687.*

Propelling Machinery Progress

The developments in marine oil engines which have recently been made or will mature during the course of this year are as important as any since Diesel machinery was first installed in ocean going ships. These developments are summarized as follows: The use of boiler oil has been consolidated during the past twelve months and the anticipated large saving in the fuel bill has been confirmed. The first supercharged two-stroke engine has been completed for installation in an ocean going ship and about a dozen more will be built this year, whilst further experimental work now being carried out, it is thought, will lead to the employment of supercharging in the Doxford opposed piston engine. The first pair of a series of geared Sulzer engines of new design will be fitted in a ship before the end of 1952 and this, together with progress along similar lines in Germany, represents the most determined attempt to solve the problem of high powered geared Diesel machinery that has yet been made. Single acting two-stroke units of 10,000 b.h.p. are now within the range of Diesel engine builders and before the end of the year there will be at least three types capable of developing this output on a single screw with direct drive, in addition to geared installations with two engines coupled to a single shaft. Much work is now being carried out on highly supercharged four-stroke engines, which, in addition to being of immediate application to auxiliary sets (giving an output 100 per cent above the unsupercharged plant) is likely to influence marine propulsion. The claim made for a development with which the M.A.N. are concerned is that a 10,000 b.h.p. highly supercharged four-stroke geared installation driving a single screw can be built weighing 77lb. per b.h.p. (including the gearing) and having a consumption of no more than 140 grams or ·31lb. per b.h.p.-hr. Following experimental investigation an engine of this design is now being manufactured with six cylinders developing 3,000 b.h.p. at 275 r.p.m. to operate on boiler oil.—*The Motor Ship, Vol. 32, January 1952; p. 375.*

Diesel Engines for Large Tankers

There is today an increasing tendency towards the adoption of multi-engine propulsion and many ships are in service with two engines coupled through reverse-reduction gear to one propeller shaft. There are also examples of four engines coupled to one shaft, although, in such cases, reverse-reduction gear has not been used. In view of the many advantages of this type of installation, it is felt that careful consideration should be given to a multi-engine installation when considering the propelling machinery for tankers of 26,000 tons d.w.c. and above. A survey of present power requirements for tankers of this size suggests that a total of 12,000 to 14,000 s.h.p. is needed. Fig. 1 gives a comparison of installations for a twin-screw motor vessel having 7,000 s.h.p. per shaft at 120 r.p.m., developing for propulsion purposes, therefore, a total of 14,000 s.h.p. In this case, the overall dimensions of a multi-engine medium-speed, uni-directional, installation are compared with one direct-reversing, direct-coupled, slow-speed engine per shaft. As shown, there would be one five-cylinder and three nine-cylinder medium-speed units per shaft, instead of one large six-cylinder slow-speed engine, but one engine can be cut

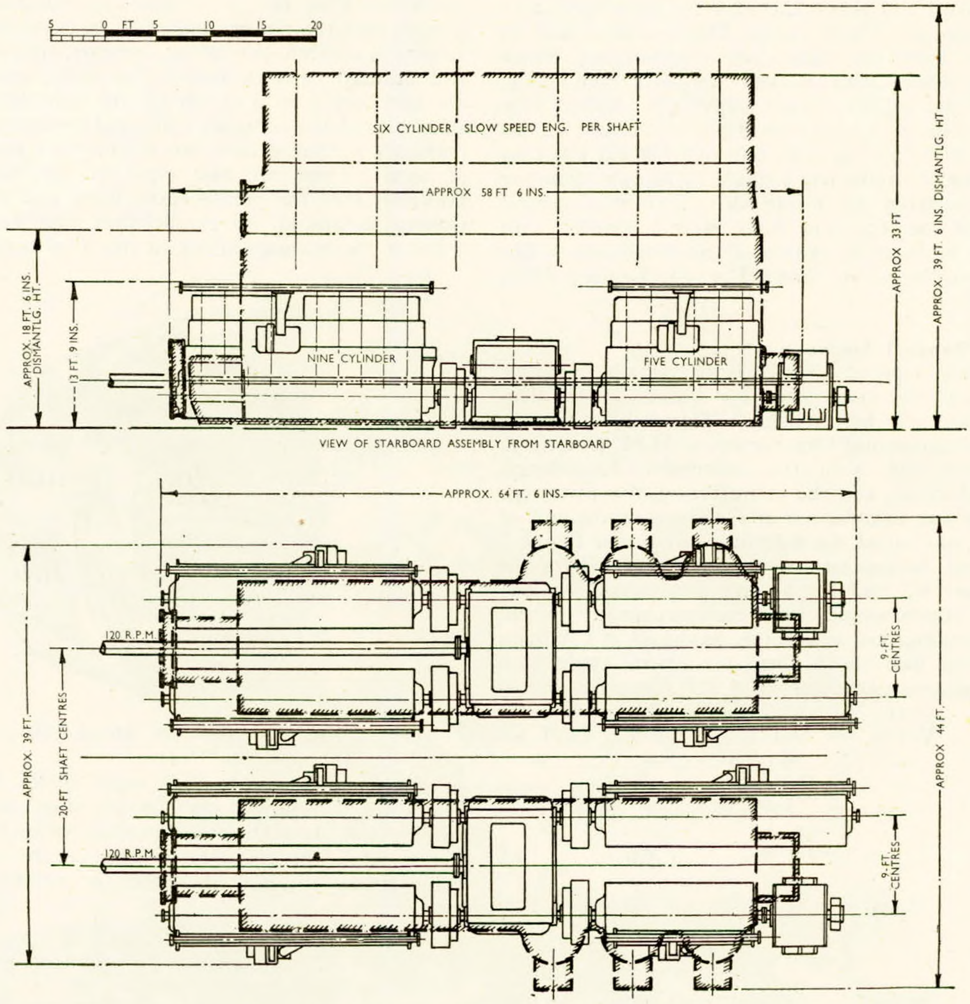


FIG. 1—*Comparison of overall dimensions for one slow speed engine or a multi-engine installation for each shaft*

out, thus allowing the full power to be obtained from the three remaining engines. The five-cylinder engine can be used as a generating unit, when not required for propulsion duties, and it is estimated that, for a tanker of this class, a generator of about 800 kW. would be required. Should a stand-by generator also be needed, this could be coupled direct to the five-cylinder engine on the other propeller shaft. It is estimated that the saving in weight by the adoption of a medium-speed multi-engine installation, instead of a large, slow-speed, direct-reversing engine of the same power, is about 40 per cent. This includes the weight of the reverse-reduction gear-box, flywheels and couplings necessary for the multi-engine installation. Assuming that, for a tanker of this class, the propeller shaft centres are 20 feet, the estimated space savings would be some 5 feet athwartships and some 21 feet in height. The multi-engine installation would, however, be about 6 feet longer. On the other hand, this extra length includes the length occupied by the 800-kW. auxiliaries for the cargo pumps. It is believed that if similar auxiliary machinery were included for comparative purposes in the overall length of the slow-speed engine, its length would be even greater than that for a multi-engine installation. Each engine would be a four-stroke, pressure-charged, uni-directional unit with a cylinder diameter of 17 inch and a speed of 435 r.p.m. Under these conditions the rating would be conservatively fixed at a b.m.e.p. of 108lb. per sq. in., giving a power of 244 h.p. per cylinder. The coupling between the engine and gearbox would be of the hydraulic type with scoop control, while the gearbox would be of the oil-operated, reverse-reduction type, incorporating the propeller thrust in its construction. Control of the machinery would be from a single control station from which the engines could be started and controlled in speed, either separately or in any combination of one or more.—*I. Wans, The Motor Ship, Vol. 32, January 1952; p. 387.*

First Australian-built Doxford Engine

At a recent Melbourne ceremony, the first Australian-built Doxford type marine oil engine, a four-cylinder unit developing 2,800 b.h.p., and the largest Diesel engine ever built in the southern hemisphere, was handed over by Mr. Harrison, Australian Minister for Defence Production, to a representative of the Minister of Shipping and Transport. It is the first of six under construction for a series of 6,000 tons "B" class standard cargo motorships building at Mort's Dock and Engineering Co., Ltd., Sydney, and Evans, Deakin and Co., Ltd., Brisbane. The Commonwealth Government Marine Engine Works at Port Melbourne was established during 1942-43 under the control of the Australian Shipbuilding Board for the manufacture of marine main engines and auxiliaries for Australian-built ships. In 1947 control passed to the Government's ordnance group of establishments. Until 1948 production was confined to steam machinery, including triple-expansion engines with Bauer-Wach exhaust turbines in sizes developing 3,100 and 3,750 s.h.p., and Lentz type double compound 1,800 s.h.p. engines. Steering engines, cargo winches, and other deck machinery were also built. In 1948 a licence was taken out from William Doxford and Sons, Ltd., for the construction of their well-known opposed piston marine Diesel engine, and an order was received from the Australian Shipbuilding Board for six engines to power their B-class standard motorships. The engines are of the 56LB4 welded frame type, having four 560 mm. bore cylinders with a combined piston stroke of 2,160 mm. (1,250 mm.+ 910 mm.) and an output of 2,800 b.h.p. at 110 r.p.m. This type of engine has a single 1,410 mm. diameter by 1,100 mm. scavenging air pump driven from a central crank and is not of the type now built in this country with dual pumps driven by beam from two of the crossheads.—*The Marine Engineer and Naval Architect, Vol. 75, January 1952; pp. 5-8.*

Admiralty Standard Range 1 Engine

Details of a new type of Diesel engine, which is exceptionally compact and gives more power for a given weight than previous designs, can now be published. Detailed design was undertaken by the Engineering Department of H.M. Dockyard, Chatham, in conjunction with the Admiralty Engineering Laboratory, West Drayton, and the manufacture of a prototype 16-cylinder version was commenced at Chatham at the end of 1948. The engine was called the Admiralty Standard Range 1 (A.S.R.I.) engine and designs have now been completed for the 16- and 12-cylinder "V" and the 8- and 6-cylinder "in line" versions in both supercharged and unsupercharged forms. Numbers of these engines are now being produced at Chatham Dockyard and various well known firms for general application in the Navy. The general particulars of A.S.R.I. engines are:—

	16 V.T.S.	12 V.T.S.	8 L.T.S.	6 L.T.S.
Bore	—	9¾ inch	—	—
Stroke	—	10½ inch	—	—
Maximum r.p.m.	—	1,000	—	—
Maximum b.h.p. supercharged ...	2,000	1,500	1,000	750
Maximum b.h.p. unsupercharged...	1,400	1,050	700	525
Dry weight (lb.) including engine mounted auxiliaries	36,000	29,000	24,000	19,000
Length	16ft. 10in.	14ft. 0in.	16ft. 6in.	14ft. 0in.
Breadth	5ft. 4in.	5ft. 4in.	4ft. 3in.	4ft. 3in.
Height	8ft. 7½in.	8ft. 6in.	8ft. 7in.	8ft. 6in.

The design incorporates: (a) direct injection, 4 valve cylinder heads; (b) all welded steel frame; (c) chromium plated cylinder liners; (d) copper-lead main and large end prefinished thin shell bearings, the latter being of fork and blade type; (e) engine driven and engine mounted lubricating oil scavenge and pressure pumps and sea and fresh water cooling pumps; and (f) hydraulic governors on both propulsion and generator engines. Particular attention has been paid to complete interchangeability of all replaceable parts, including identical crankshafts and bedplates for "in line" and "V" versions of equivalent number of crank throws, and to accessibility and ease of maintenance.—*The Engineers' Digest, Vol. 13, January 1952; p. 32.*

Combined Fan and Air Heater

The basic idea of the Motala fan-preheater is to utilize the properties of the rapidly rotating disk to give, on the one hand a high coefficient of heat transfer on account of the great difference of speed between disk and air or gas respectively, and on the other hand to achieve a certain fan action. For this reason the fan-preheater functions not only as an air-preheater but also as an induced and forced draught fan, since it can give the air and the flue gases the static pressure required for stokers, furnaces, boilers and economizers. The Swedish Boiler Association has carried out extensive tests on a fan-preheater, and obtained heat transfer coefficients k ranging from 6 to 10 B.Th.U's per sq. ft. of heating surface per deg. F. per hour. With a fan-preheater of special design, Professor L. Malm of the Royal Swedish Technical University obtained an average coefficient k of 16. It is also claimed that its fan efficiency is such that the power consumption is approximately the same as with a combination of an ordinary air-preheater plus forced and induced draught fans. The heat losses due to radiation are very small as a result of the compact construction and small size of the complete unit, and another feature of this fan-preheater is that it does not require any regular daily removal of soot. There are two types of the Motala fan-preheater available, viz., the parallel-flow type, and the cross-flow type. General details of the parallel-flow type are outlined in Figs. 5 and 6, the heating surface of this type consisting of a number

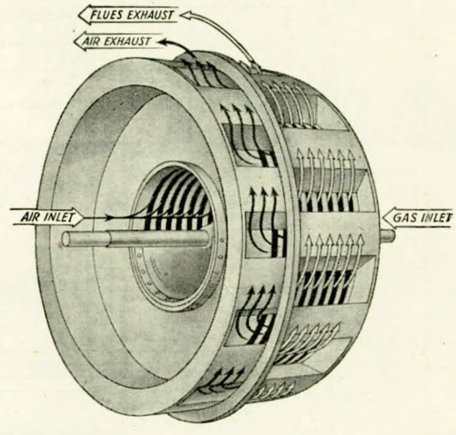


FIG. 5—*Rotor for Motala fan-preheater*

of annular plates placed at right angles to the shaft. The plates are so arranged that the air entering at one end of the rotor passes through every alternate space between the annular plates, while the gas, which enters at the opposite end of the rotor passes through the other or remaining spaces. Thus

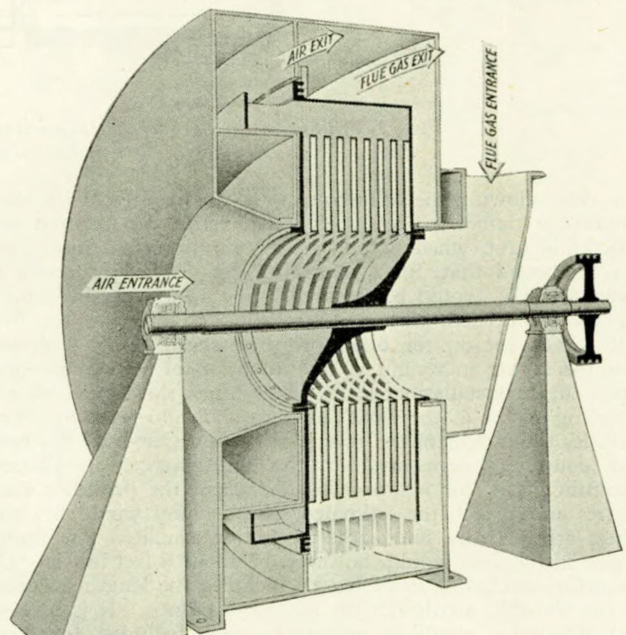


FIG. 6—*Sectional view of fan-preheater*

each annular plate encounters the incoming air on the one side, and the outgoing flue gas on the other. The rotor itself is surrounded by a spiral-shaped housing which, by means of an intermediate partition, is divided into an "air-side" and a "flue-gas side".—*Engineering and Boiler House Review, Vol. 67, January 1952; pp. 13-15, 20.*

Flame Radiation Research

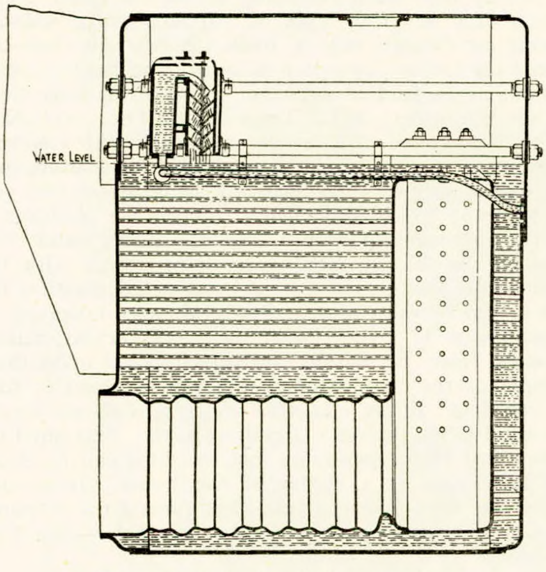
The following conclusions are drawn from the 1949 Flame Radiation experiments at Ijmuiden, Holland: Experiments on a 6-ft.× 6-ft.×24-ft. experimental furnace have shown the following relative effects of the five variables tested at each of the two levels:—(i) Oil gave a flame with a peak radiation 17 per cent lower than that in the flame from 50:50 creosote-pitch, and the peak radiation in the former case was farther from the burner. The creosote-pitch flame has a higher emissivity than the oil flame. (ii) An increase of 39 per cent in the fuel quantity gave a flame which was both longer and more intense (peak radiation 7 per cent greater; distance to peak 16 per cent greater; heat input rates 2 to $2{\cdot}7 \times 10^6$ k. cal./hr.). (iii) The use of steam as atomizing agent gave a peak radiation 10 per cent lower than when air was used and the peak was 10 per cent farther from the burner, owing to the peak flame-temperature being developed later and being 11 per cent lower. (iv) An increase of 20 per cent in the quantity of atomizing agent gave a lower radiation at the tail of the flame (11 per cent lower 3 metres from the burner), this lower radiation being due rather to lower flame emissivity than to lower temperature. This suggests that the increased quantity completes combustion more rapidly, i.e. shortens the flame. (v) An increase of 25 per cent in the combustion-air quantity gave a lower radiation at the tail of the flame (14 per cent lower 3 metres from the burner). These effects suggest that the radiation from the early part of the flame, where the flame is black, depends mainly on the quality variables, namely the type of fuel and atomizing agent (which control rapidity of ignition and theoretical combustion temperature), but not on the quantity variables, namely mixing rates and fuel rate. Tail radiation, on the other hand, varies with both emissivity (which depends mainly on the fraction of the combustion heat lost to the walls). These effects are given as ratios rather than absolute values because of the effects of false air, recirculation of burnt gases and possible calibration errors. In the ratio form the results can be applied to actual systems.—*J. E. de Graaf and M. W. Thring, Journal of The Institute of Fuel, Vol. 25, January 1952; pp. S. 31-S. 36.*

Boiler Feed System

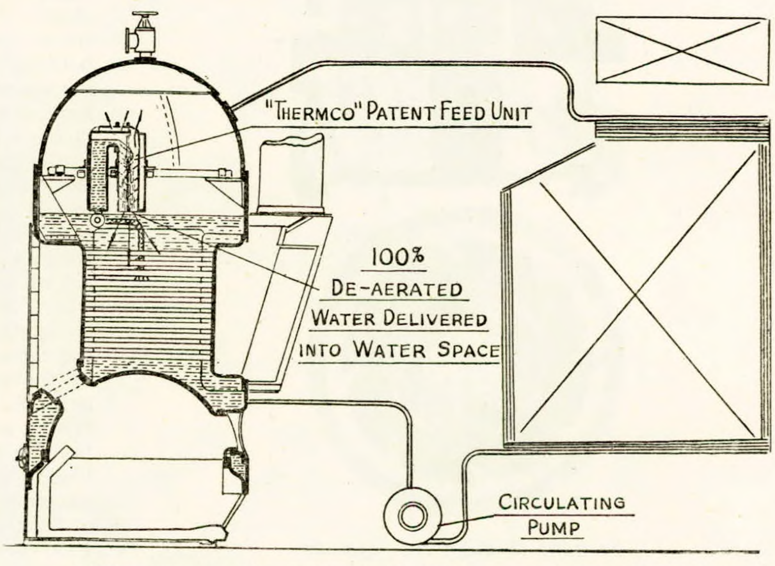
In the Thermco system, the feedwater is not pumped into the water space of the boiler but into the steam space, by passing it through the Thermco unit. This is made possible by incorporating in the unit a receiver which provides the solid body of water required to prevent concussion. The feed water entering the boiler passes through the internal feed pipe (either main or auxiliary feed) connected to the receiver of the Thermco unit and it rises slowly up the receiver, because the ratio of area of the receiver to the feed pipe is approximately 50 sq. in. to 3½ sq. in. When the feed water reaches the outlet of the receiver it overflows into the tray chamber and in descending in the tray chamber it is broken up into a spray, instantly heated up to the evaporation temperature in the tray chamber. All the dissolved oxygen and carbon dioxide leave the feed water, which is then discharged on to the level of the water in the water space of the boiler. The dissolved oxygen and carbon dioxide rise in the tray chamber and escape into the steam space through suitable vents. The dissolved oxygen and carbon dioxide are absolutely harmless in the steam space of the boiler and pass out of the boiler with the steam. This patented system has now been fitted to ships with boilers of several different types and it is reported that not only were corrosion and pitting completely eliminated but already affected parts were cleaned up. Instead of a hard scale developing on the heating surfaces, it has been found that minerals in the feed water are deposited in the bottom of the boiler in the form of sludge, while existing hard scale broke off and also collected at the bottom of the boiler. Unequal expansion and corresponding stresses in the boiler are avoided by the introduction of water at the temperature of evaporation. Any oil passed through with the feed water can be removed by using the scum cock. It is claimed that the cost of repairs inside the boiler is reduced by 75 per cent when using the Thermco system.—*The Shipping World, Vol. 125, 26th December 1951; pp. 461-462.*

Cargo Handling in Wet Weather

A recent Italian invention consists of a temporary roof which is placed over the opened portion of the hatchway. In the centre of this roof is a hole, closed by sliding doors, sufficiently large to permit a pallett or a sling of cargo to pass. The hole is surrounded by a circular frame which supports a bell shaped cover. This cover is free to slide on the winch wire but is retained by the hook. The method of operating the system is as follows. The bell shaped cover rests on the frame on the roof over the hatch. The hook is in the hold, and a load is attached. The hook is then hauled up and as it passes clear of the hatch it carries with it the bell shaped cover, which protects the load for the remainder of its journey. As the load is hoisted clear, so the sliding doors in the roof over the hatch are shut to protect the hold while the cover is absent. A similar temporary roof with a frame to support the cover is erected on shore, either to protect a truck or lorry, or to provide a covered handling space. The load is then lowered over this roof, the sliding doors are opened, and the load passes through while the bell shaped cover is supported on the frame and thu



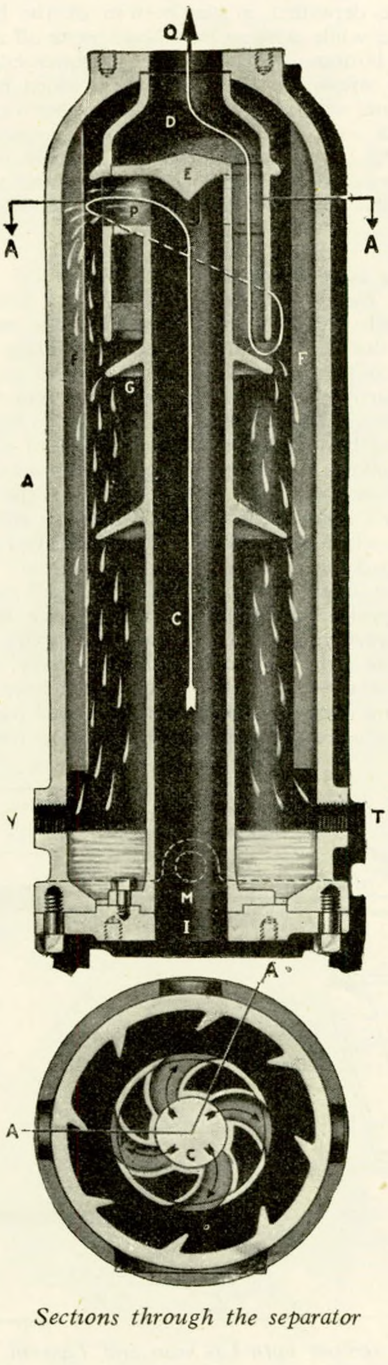
The patent feed unit in operation



A "Thermco" unit serving both Cochran and Lamont boilers covers the hole in the roof and at the same time is lifted clear of the pallett or sling to permit the cargo to be handled. When the sling is empty, the hook is hauled up again, carrying the cover with it. Thus, by judicious manœuvring of the sliding doors in the two temporary roofs, one on shore, the other over the hatch, it is possible to provide complete protection against the weather since, when it is in the air, the load is completely surrounded and protected by the cover.—*Journal de la Marine Marchande, Vol. 33, 15th November 1951; p. 2523. The British Shipbuilding Research Association, Vol. 6, December 1951; Abstract No. 5575.*

Steam Separators for Ships' Whistles

A British firm has introduced a new design of separator specially intended for ships' whistle and siren steam lines. The new design employs the accepted method of separation, namely centrifugal force combined with abrupt change of direction, and is also provided with a large reservoir. The separator is installed in a vertical position for upward flow, and it is desirable that it should be placed as near to the whistle as possible. There is no difficulty about this with the separators for the 2 inch and 1½ inch diameter pipe lines, but the 3 inch and 2½ inch diameter models are fairly heavy and if suitable attachments are not available they should be placed at the base of the funnel. This was done in the case of the Royal Mail liner *Andes*. Referring to the illustration, it will be seen that steam enters at the bottom, flows up a central tube and is diverted at the top to pass through radially-curved passages. These cause the steam to whirl and the water is thrown to the outside of the vessel and trapped behind a series of vanes. The still-whirling steam then flows in a downward direction until it reaches the lower edge of a cowl where an abrupt change of direction to upward flow takes place. Here again, entrained water is thrown into the bottom of the well, while the dry steam proceeds upwards between the radial passages to the whistle or siren; any condensate forming in the pipe above the separator falls freely through the apertures between the radial vanes into the well. Provision is also made for connexion to a magnetic water-dumping valve. This is only fitted in cases where even the large well provided is insufficient to accommodate the condensate. In these circumstances a magnetic valve, electrically-operated simultaneously with the siren, allows the receiver to discharge through the large area of this valve and enables the separator to handle large quantities of water without materially affecting the steam supply to the siren.—*The Marine Engineer and Naval Architect, Vol. 75, January 1952; pp. 22-23.*



Sections through the separator

New Seatrain Vessels

The *Seatrain Georgia* and *Seatrain Louisiana* are the latest additions to the Seatrain Lines' growing fleet of unique type vessels, which are specially designed to carry loaded railroad freight cars as seagoing cargo. All-welded ships of 8,300 gross tons each, with lengths of 503 feet, beams of 63·5 feet, and drafts of 27 feet, the two new Seatrains are single screw vessels propelled by General Electric turbine machinery developing 8,000 horsepower. They will maintain an average speed of 16 knots, with lower fuel consumption than others of the fleet. Their reserve power has been stepped up from the previous 10 per cent to 20 per cent. The new Seatrains have a capacity of 100 loaded railroad freight cars and are equipped with side tanks, which can hold 12,000 barrels of liquid cargo. Like the other vessels the new ships have four decks, served by one hatch extending across the beam amidships. Each deck has four rows of standard gauge railroad tracks, giving each ship a mile of track. A Seatrain shore-to-hold railroad car loading operation is among the most interesting operations in the field of shipping. Each of the company's terminals at Edgewater, N.J., Texas City, Tex., and New Orleans, La., is equipped with car elevators, each with a normal lifting capacity of 125 tons. A car scheduled for loading into the vessel is first spotted on a platform by a locomotive and locked in place by strong rail clamps. Then the platform is lifted by the elevator and moved over the ship's hatch and lowered on to the desired deck, where it is stowed with the aid of steam gear hauling. Once in its assigned position the wheels are locked by rail clamps. Powerful jacks, operating at an angle of about 45 degrees with the perpendicular, relieve the car springs from the tension normally imposed upon them by the weight of the car. Four chains and turnbuckles then draw the car down firmly. In this position, with its weight resting on solid jacks, the car is rigidly secured. Seatrain Line have so perfected these operations that its ships can be either loaded or discharged in a matter of five hours. It is such efficiency as this that, over the years, has proved the economy of freight-car-water movement on regular timetable.—*The Log, Vol. 46, October 1951; pp. 60-61.*

ENGINEERING ABSTRACTS

Section 3. Shipbuilding and Marine Engineering

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Relation of Notch Bar Testing to Welded Construction

A symposium on notch bar testing and its relation to welded construction, organized by The Institute of Welding in association with the Joint Committee on Materials and Their Testing, was held at the Institution of Civil Engineers in London on 5th December 1951. The first paper, entitled "Notch Bar Testing and the Selection of Steel for Welded Construction", was presented by Mr. W. Barr and Mr. I. M. Mackenzie. The authors pointed out that notch ductility is not a simple property of steel comparable to tensile strength, general elongation, etc., but is a complex result of many factors, the individual effects of which are still unknown, and the relative importance of which depends upon a given set of conditions. Notch ductility is a shorthand term for expressing the relative capacity of steel for plastic deformation under certain adverse conditions of stress concentration, temperature and loading. It cannot be determined by a single test and the relative notch ductility of two steels cannot be determined except for an arbitrary set of testing conditions. In the design of welded structures, it should be appreciated that mild steel is liable to fail in a brittle manner but that by proper design and careful selection of steel the chance of failure can be reduced to its economic minimum. To use a material with excessive resistance to brittle fracture would be wasteful, as notch ductility, like any other property, must be paid for. It would be possible to select a steel solely on the basis of previous experience of the behaviour of comparable structures, without employing any laboratory test whatever, but such a procedure would cause an excessive delay and the authors believe that any test that effectively imitates actual conditions will provide a good guide. The authors contend that notched-bar impact tests correlate sufficiently well with service results and quote examples in support of this view. They make the point that a test is the more severe the lower the temperature, the higher the speed of deformation, and the sharper the notch. In practice, either the lowering of the temperature or the degree of sharpness of the notch necessary to produce a cleavage fracture may be used as a criterion. The authors propose to employ the lowering of temperature. Where a steel has been chosen by means of a test of this nature, a second test for specification purposes is required. This must be simple and definite. But the standard of quality needed in terms of transition temperature as shown by notch impact tests must first be decided upon. Experience shows that a lower transition temperature is associated with greater resistance to brittle fracture. If the transition range includes room temperature, a single notch impact test at room temperature will therefore be sufficient. If the transition range does not include atmospheric temperature, a test should be carried out at a temperature about the middle of the transition range and an energy absorption value not less than a chosen figure must be attained if the material is to be considered acceptable. Acceptance tests for notch ductility are relatively expensive to carry out and should therefore be employed with discretion. From a national viewpoint, the authors consider it more desirable that the steelmakers should carry out periodic tests on their products. The second paper, entitled "The Assessment of Notch Ductility by a Variety of Notch Tests", was read by Mr. G. M. Boyd, who compared the available results from eight of the most common tests in order to determine whether valid relationships between the results of different small notch tests as applied to structural mild steel can be established. In view of the wide divergence of views on the definitions of brittleness and toughness, the author defines brittleness as the converse of toughness, which is measured by the amount of work required to produce or extend a fracture. Thus, if two geometrically identical, notched specimens are broken under identical conditions, the specimen which requires the greater amount of work to fracture it completely will be the "tougher", and therefore preferable to the other. The test methods surveyed were the Izod test, the Charpy Vee-notch test, the Standard Charpy Keyhole tests, the Mesnager test, the DMVr (Austrian) test, the Schnadt test, the Tipper test, and the Navy tear test. The author comes to the conclusion that the evidence given does not permit any clear relationship to be established between different notched tests, even when performed on the same material. This is considered a disappointingly negative result which, however, must be accepted as being consistent with the present state of thought on the subject. The position is not, however, entirely hopeless, since there appears to be a consensus of evidence pointing to the conclusion that any of the common notch tests may be used comparatively, in the sense that if one steel is tougher than another in a given notch test, it will probably be tougher in service, i.e. less liable to brittle fracture. It is necessary, however, to regard with some caution an impression to be gained from some recent American work that "all notch tests place steels in approximately the same order of merit". Very broadly speaking, this impression seems to be true; but it contains some inherent looseness, since the choice of criteria of merit may considerably affect the order, even when a single test is considered. For this reason the quest for a criterion which bears a fixed relation to service performance must continue to be pursued. Such a criterion, if and when it is discovered, would be a measure of the notch toughness of steels, but no such measure can be said to exist at present. The author makes the point that brittleness in extensive failures which have been experienced in ships and other structures appears to be a characteristic of the manner in which a fracture propagates, rather than of the manner in which it begins or ends. Once a fracture has progressed a distance equal to a few times the thickness of the plate, it assumes a "natural" form, which is independent of the form of the originating notch. This "natural" mode of fracture should be governed only by the properties of the material, the plate thickness and the general stress system. Attention should therefore be focused on the "natural" type of fracture, i.e. on the part of the fracture remote from "end effects" such as the originating notch and the stage where the fracture is nearly completed. The paper on "The State of Stress and Brittle Fracture", read by Professor Ing. W. Soete, was summarized by the rapporteur Dr. N. P. Allen to the effect that the author had set out to measure the degree of triaxiality of stress induced by notches of varying degrees of sharpness when the steel is undergoing plastic deformation at various temperatures, and to compare it with the triaxiality induced by similar notches when the stresses are entirely within the elastic range. Two steels were used for the test, a coarse-grained steel of low carbon content (0·06 per cent) and rather high nitrogen content (0·011 per cent), and a fine grained, aluminium treated steel with a rather higher carbon content (0·14 per cent) and a lower—but not negligible—nitrogen content (0·007 per cent). Two series of tests were conducted. In the first series, one of the steels was tested at room temperature with notches of varying sharpness. It was found from the stress-strain curves that whereas, in the elastic range, the triaxiality ratios for the notches studied varied from 0·80 for the sharpest notch to 0·36 for the bluntest notch, the triaxiality ratios in the plastic range were much lower, varying from 0·30 to 0·25, and did not change much as the deformation increased. This change was associated with the effective increase of Poisson's ratio when plastic deformation set in. The elongation of the steel decreased very markedly with increasing triaxiality ratio. In the second series of tests, both steels were tested over a range of temperature from − 60 deg. C. to + 400 deg. C., using an unnotched bar and a bar with a very sharp notch of 0·1 mm. radius. It was concluded from the results on the plain bars, that temperature did not appreciably affect the ductility and consequently it was expected that temperature would not affect the ductility of the notched bars; but this was found to be not quite true, particularly of one steel. It was noticed, however, that temperature did affect the triaxiality of stress, in the sense that raising the temperature raised the triaxiality ratio, in one case from 0·25 at − 60 deg. C. to 0·42 at + 200 deg. C. The greatest strain at fracture in both steels was associated with an intermediate triaxiality ratio of 0·31. Specimens tested below 0 deg. C. showed cleavage fractures but not those tested above that temperature. Dr. Allen pointed out that the relationship between triaxiality ratio and temperature was rather unexpected and he drew attention to the fact that one of the steels had a high nitrogen content and showed exceptional notch sensitivity at 200 to 300 deg. C., where strain age-hardening phenomena might have been expected. The fourth paper was read by Dr. C. F. Tipper and dealt with "Notch Bar Tests in Relation to Service Performance". In the first part of the paper, the author dealt with the characteristics of the fractures of plates in service and pointed out that service fractures which have caused so much concern, are unlike the normal fracture in tension of a mild steel, in that they are not preceded by a large amount of plastic deformation which is distributed throughout a considerable volume of the metal adjacent to fracture. In the typically brittle fracture, the deformation is severely localized to a zone of one or two millimetres on either side of the path of separation and the two parts remain in close contact. Within this zone, the deformation of individual grains may be high. It differs from a fatigue fracture in that it propagates at a very high velocity by the cleavage of a large proportion of the crystals, rather than at a rate depending upon rate of straining or upon rate of redistribution of load. Hence the crystalline, granular appearance as opposed to the silky or fibrous structure associated with plastic deformation. These observations are confirmed as a result of the study of the microstructure of both service and laboratory fractures. Low ductility, low energy absorption, and often low strength, accompany the appearance of a crystalline fracture since, as a proportion of the crystals break prematurely, all the mechanical properties are affected. The significance of dimensions of test pieces and the choice of a test for brittleness are discussed. The author then presents the gist of the findings of an investigation of samples of fractured ship plates from two casualties obtained through Lloyd's Register of Shipping and investigated at the engineering department of Cambridge University. This is followed by a brief account of the results of tests made on a steel treated to give two types of very different energy/temperature curves. In her conclusion, Dr. Tipper points out that the criterion for defining brittleness and the effect of dimension are among the most important factors that must receive attention in relating small scale tests to the full scale structure. The ability of a steel to absorb energy in a notch test is an indication of notch ductility but in small impact bend tests the energy absorbed in initiating fracture is too high a proportion of the total, and does not always indicate whether the fracture is crystalline. An impact energy figure as a criterion may be misleading and there are obvious objections to assigning any figure to such a test, without also taking the fracture appearance into consideration. A lower figure coupled with a fully fibrous fracture appears to be preferable to, or at least as good as, a higher figure with a crystalline fracture. The relation which must exist between energy absorption and extent of fracture depends upon the post-crack properties of the material as well as upon the stress distribution of the structure. An alternative method of approach in the prediction of service performance is to make up parts or models, as near full-scale as possible, and to subject them to tests under controlled conditions, similar to those which might be expected in service. The fifth and last paper is entitled "Development of a Testing Method on Brittle Fracture of Mild Steel Plates" and was read by Dr. J. H. van der Veen, who described a notched slow bend test for the determination of the tendency to brittle fracture of steel plates. Although this test shows much resemblance to Bagsar's DX

Test, it was developed independently during a period before Bagsar's paper came to the knowledge of the author. Beside this, there are certain differences with regard to notch-depth, procedure, interpretation and criteria which are discussed by the author. The dimensions of the test specimen, which is presented schematically in Fig. 1, are $t \times 70 \times 225$ mm., where t is the plate thickness. The longitudinal axis of the bar is

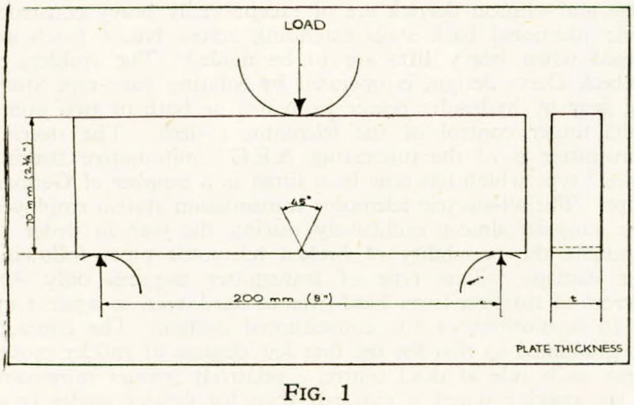
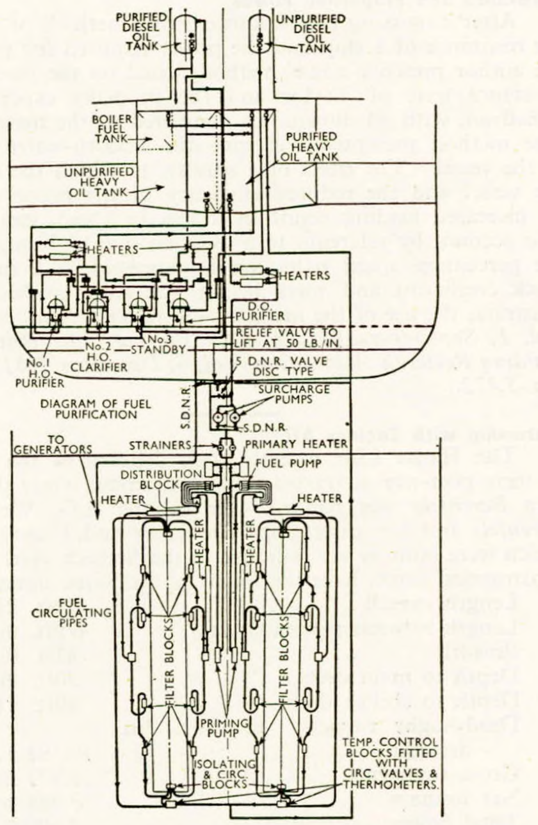


Fig. 1

generally taken perpendicular to the direction of rolling. In the middle of one of the machined sides (dimensions $t \times 225$ mm.) a sharp 3 mm. deep notch is pressed with an included angle of 45 deg. and a fairly constant root-radius of about 0·04 mm. The axis of the notch is perpendicular to the plate surface. Mill scale is removed. In the test, roughly speaking, the steel may be considered to undergo three successive examinations, taking place respectively at the root of the notch, in the tension zone, and finally in the compression zone of the bar. Usually, two transition temperatures are determined ("ductility" and "fracture appearance"). The determination of the latter is facilitated by the minimum tendency to start cleavage appearing to exist at the neutral axis of the bar. Both temperatures may be determined without the recording of a load deflexion diagram. The evaluation of brittleness is based only on types of diagrams and fractures and not on absolute values of certain criteria, such as energy to fracture. The possibility of doing this is considered an advantage of this test because the tendency to start cleavage, determined in this way, is not confused with other properties of the steel, such as the tendency to start and propagate fibrous fractures. Comparison with other tests shows that, with the notched slow bend test, at least the same degree of differentiation between different plates and at least the same steepness of transition curves is obtained as with the Kommerell and the Kinzel tests. With impact tests, however, such as Charpy impact test with Izod notch, keyhole impact tests, and two types of Schnadt tests, less differentiation was obtained and the width of the temperature interval in which the transition takes place was found to be more than twice as large. The author points out that the Schnadt test does not appear to furnish a better differentiation than the normal impact tests.—*Papers read before the Institute of Welding and the Joint Committee on Materials and Their Testing at the Institution of Civil Engineers, 5th December 1951.*

Boiler-oil Fuel System for the *Aureol*

An interesting feature of the 14,000 gross tons Elder Dempster Lines' new twin-screw passenger liner *Aureol*, is the "ring main" arrangement for the boiler fuel-burning system for the main engines. The propelling machinery comprises two Stephen-Doxford opposed-piston, four-cylinder engines, and these develop a total of 9,400 b.h.p. at 119 r.p.m. As the accompanying diagram shows, this fuel system differs appreciably from that usually adopted for Doxford engines burning residual fuels. Although, undoubtedly, more expensive in first cost, this installation, which is an effort to maintain a uniform



Diagrammatic arrangement of the Aureol's *fuel oil system*

temperature at all fuel valves, does allow for rapid displacement of cold fuel from the fuel system. Heavy fuel oil, after having been centrifuged in a De Laval purifier and clarifier, is drawn from the clean oil tank to two Stothert and Pitt surcharge pumps, whence it is delivered through Clinsol strainers and the primary heaters. From the fuel pumps the oil is fed to a distributor with two outlets leading to a distribution block at the centre of the ring main on both sides of each engine. Fuel is then delivered to the two filter blocks serving each cylinder, then to the fuel valves. It will be noted that there is an isolating block by which the port and starboard sides of the ring main may be made independent. In addition, there is a connexion to a circulating valve which can spill fuel back to the purified heavy oil tank. A special feature, although not shown, is the spring-loaded discharge valve placed between the filter block and the fuel valves to obviate the possibility of any fuel leakage to the cylinders during the hot oil-circulating period.—*The Motor Ship, Vol. 32, February 1952; p. 444.*

Minimum Weight of Structural Parts

One of the objects of strength calculations is to save weight. The author gives a number of examples from parts of ships' hulls, with the suggestion that the methods used should be of interest also for other types of structure. A symmetrical arrangement of hatch end beams and hatch side girders is discussed as an example of a redundant system of beams and girders subjected to lateral loading. For the combination of an ordinary beam with adjacent frames, it is shown that the minimum weight is obtained when beam as well as frames are designed for maximum allowable stress. A deck panel with lateral load, and a deck panel under compression in the longitudinal direction are considered, and the procedure for obtaining minimum weight is reviewed.—*G. Vedeler, Det Kgl. Norske Videnskabers Selskabs Skrifter, 1951, No. 1. Journal, The British Shipbuilding Research Association, Vol. 6, December 1951; Abstract No. 5,489.*

Resistance and Propulsive Power

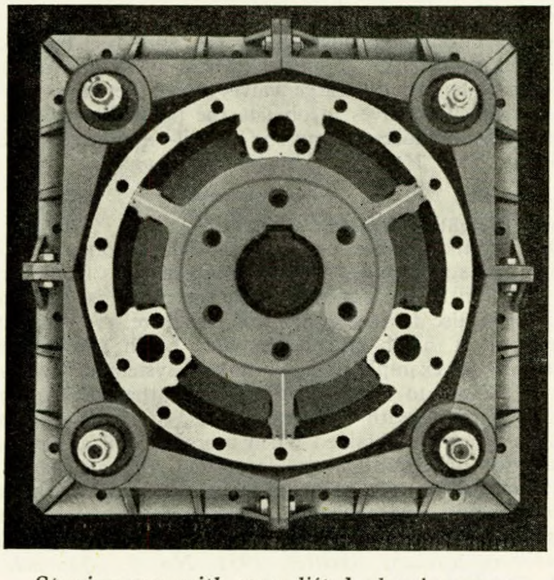
After discussing the various existing methods of estimating the resistance of a ship and the power required for propulsion, the author presents a new method, based on the results of the resistance tests of Taylor and the propeller experiments of Schaffran, with all dimensions converted to the metric system. The method presented will give the smooth-water resistance of the vessel. The effect of a seaway, in which the motion of the vessel and the reduced efficiency of the propeller due to its increased loading result in a loss in speed, can be taken into account by referring to a diagram due to Kent, in which the percentage speed reduction is expressed as a function of block coefficient and wave height. A fully worked example illustrates the use of the method.—*A. Krause, Schiffbautechnik, Vol. 1, September 1951; p. 68. Journal, The British Shipbuilding Research Association, Vol. 6, December 1951; Abstract No. 5,472.*

Motorship with Engines Aft

The Hansa Line recently took delivery of the first unit of their post-war reconstruction programme when the motorship *Barenfels* was handed over by the A.G. Weser. The *Barenfels* and her sister ships *Birkenfels* and *Braunfels*, all of which were built or are building in the Seebeck yard's drydock construction berth, have the following principal dimensions:—

Length overall	510ft. 2¾in.
Length between perpendiculars ...	479ft. 0in.
Breadth	61ft. 0in.
Depth to main deck	30ft. 2in.
Depth to shelter deck...	39ft. 4½in.
Deadweight capacity on 26ft. 3in. draught	10,698 tons
Gross tonnage...	6,973 tons
Net tonnage	3,988 tons
Total power	3,600 s.h.p.
Service speed	12 knots
Total cargo capacity	685,000 cu. ft.
Insulated space, including domestic stores	17,000 cu. ft.

The vessel has been built to receive the highest classification of the Germanischer Lloyd, +100 A/4, but in many places the scantlings are considerably in excess of class requirements. The sheer strake amidships, for instance, is as much as 21 mm. thick and deep beams are worked every six or seven frames in this area. On each side four longitudinal girders between the knee brackets and the hatch coamings support the shelter deck, and the coamings are extended below this deck to give a total depth of some 6 feet. The decks and double-bottoms are all-welded, while the frames are riveted to the shell plating. Heavy doubling plates are fitted to the deck abreast No. 2 hatch to compensate for the additional access hatches on each side of it. The *Barenfels* has two masts and four pairs of samson posts. The most striking feature of the ship's outfit of lifting tackle is the 165-ton samson derrick. This serves No. 3 hatch and is swung from the forward side of the mainmast. (The mainmast and samson derrick are of exceptionally heavy construction; additional back stays extending across No. 4 hatch are rigged when heavy lifts are to be made.) The rudder, of Seebeck Oertz design, is operated by rotating vane-type steering gear by hydraulic power from one or both of two pump units under control of the telemotor system. The steering transmitter is of the interesting A.E.G. "automotive steering wheel" type which has now been fitted in a number of German ships. The all-electric telemotor transmission system employed was adopted almost exclusively during the war in order to eliminate the possibility of broken telemotor pipes following war damage. This type of transmitter requires only 420 degrees of rotation from hard-over to hard-over, as against up to 16 revolutions of the conventional design. The contacts are graduated so that for the first few degrees of rudder movement, each side of dead centre, a relatively greater movement of the steering wheel is required than for greater angles from the centre position; improved sensitivity is thereby provided. A helm indicator and a rudder angle repeater are in full view of the helmsman while, incorporated in the base of the pedestal, is a large scale helm indicator, visible from either side of the bridge. The *Barenfels* is propelled by two six-cylinder single-acting two-stroke trunk-piston engines connected to a single propeller shaft through Vulcan hydraulic couplings and single-reduction gearing. The engines are the first two of an improved M.A.N. design to leave the Augsburg works. The cylinder bore is 520 mm., the stroke is 700 mm., and the rated output of each engine at service power is 1,910 b.h.p. at 220 r.p.m.—*The Marine Engineer and Naval Architect, Vol. 74, December 1951; pp. 527-535.*



Steering gear with cover lifted, showing vanes

Effective Breadth of Stiffened Plating Under Bending Loads

The phrases "effective width", "effective breadth", "mittragende Breite", have been used variously in structural engineering and particularly in naval architecture, to describe sections of stiffened plating in which, for design purposes, stresses are reckoned as uniform as a matter of convenience, in situations where it is known that the stress distribution across the plate is, in fact, not uniform. There are two entirely distinct types of loading to which this concept has been applied. First, the plate panel subjected to a compressive load in its own plane parallel to its stiffening members is said to exhibit an "effective" width, or breadth. Here the inference usually is that the load produces buckling of the plate between stiffeners with consequent non-uniform stressing, but as a convenience in design the total load is thought of as uniformly distributed across an "effective" width which is, of course, less than the actual width. This use of "effectiveness" is limited clearly to compressive loading, since the departure from uniform stress distribution occurs only because of plate buckling. A second, and entirely different, situation occurs when a stiffened plate panel is designed to resist lateral loads, which cause the panel to bend out of its original plane. Under these circumstances the plate behaves as the flange of a beam, but the distribution of stress across the plate is again uniform. The plate is loaded only by virtue of the transmission of shear through the plate from the web of the stiffener, and therefore the direct stress diminishes as distance from the web increases. Here, the "effective" part of the plate is reckoned as that part which, if computed as uniformly stressed, would be compatible with the actual flexure of the assembly. Then this concept of effectiveness is one which enables the designer to compute the behaviour of the assembly under bending loads by use of simple beam theory, and clearly it is applicable equally to plates stressed either in compression or tension. Failure to distinguish between these two cases leads to design practices which are difficult to rationalize, and confusion has been encouraged by the use of common terminology to describe either situation. In this discussion, the term "effective width" is used to mean effectiveness in the first situation; i.e. instability under compressive stressing; and the term "effective breadth" is limited to effectiveness of plate as a component of a beam, where sheer transmission, not instability, produces non-uniformity. A survey of important ship design agencies indicates that in most cases an effective width criterion is used exclusively, even though the loading may be one to produce bending, not instability. For any given structure, effective width varies with the load placed on the structure after buckling has begun, and effective width criteria expressed simply as a multiple of plate thickness imply a certain load or a certain stress; usually, they give the effective width at the load which produces a maximum stress in the assembly equal to the yield stress. Much less attention has been paid to the effective breadth question in the literature, and some of the work that has been done is not readily accessible, or involves mathematical procedures much too cumbersome for practical design use. Analytical treatment leads the author to a general equation for the effective breadth. This shows that *for uniform loading, the effective breadth is independent of the geometry of the section*; i.e. independent of plate thickness, web thickness and web depth. The graphs given in the paper include curves for concentrated loading. The author states that an actual concentrated load in practice occurs very rarely, if at all. All loads (including supports) are subject to some distribution by connecting structure. Further, it must be noted that the effective breadths computed and plotted are at the points of maximum bending moment; i.e. at the concentrated load. Effective breadth varies along the length of a member, dropping sharply at the points of load application. If, as is the actual case, these loads cannot exist as sharp concentrations but instead are, in fact, somewhat spread or distributed, by structure, the reduction in effective breadth at such points will be lessened, and the actual effective breadth will approach that for a uniform load. It therefore seems probable that in most circumstances the design estimate of effective breadth should be based on a uniform load rather than a concentrated load. In particular, if deflexion estimates are important, the effective breadth which enters into the moment of inertia computation should be based on uniform load distribution.—*Paper by H. A. Schade, read at the annual meeting of the Society of Naval Architects and Marine Engineers, New York, 15-16th November 1952.*

Self-sealing One-way Bolt

The illustration reproduced in Fig. 3 shows a special self-sealing one-way bolt, designed and manufactured by Oddie, Bradbury and Cull, Ltd., of Southampton. It is an ingenious and effective device for replacing faulty rivets at sea, and is ideal for use where a repair is accessible from one side only.

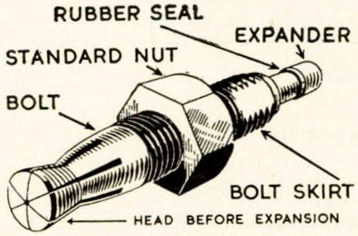


FIG. 3—*Oddie one-way bolt*

Its operation is extremely simple. The faulty rivet is driven out and the bolt is pushed through the hole left by the displaced rivet. The expander is driven through the bolt head by hammer blows, causing the bolt head to splay out and so seal the hole. When it is inconvenient or inadvisable to use a hammer, a special tool may be employed. This engages the bolt threads and forces the expander into place, after which it is only necessary to tighten the nut.—*The Shipbuilder and Marine Engine-Builder, Vol. 59, January 1952; p. 57.*

Use of Detergent Lubricants

As the burning of boiler oil in heavy marine Diesel engines advances rapidly towards general adoption, at least for new tonnage, much thought and attention are being devoted to the provision of the best possible tools with which the marine engineer can ensure the success of this progressive operation, and to this end high-performance fuel purification equipment, efficient fuel temperature control devices, improved piston rings and, in recent cases, chrome-hardened cylinder liners, have been provided. Not quite the same early interest has been extended to that all-important consideration, the lubricant, as it has been asserted and, indeed, demonstrated in two tanker fleets that with boiler oils of fairly consistent quality the conventional pure mineral cylinder lubricant appeared adequately to fulfil its designed function. One British owner, however, for a series of ships with double-acting engines running on boiler oil, ordered detergent cylinder oils, which, applied to four of the eight main engine cylinders in each ship (with the remaining cylinders continuing to use pure mineral oil), demonstrated by fair comparative service tests the advantages to be gained from the adoption of the new lubricants. Where detergent oil had been used there were fewer seized or fractured rings in the main and exhaust pistons, deposits in the exhaust and scavenge ports were of a more pliable nature, and close inspection revealed an improved and more effectively oil-wetted surface finish, all achieved with a slightly reduced oil feed. The indirect operational economies to be secured from these improvements alone justified the discontinuance of the use of the straight mineral cylinder oil, but further time must elapse before additional benefits, if any, in the shape of reduced liner wear can be fairly assessed.—*F. T. Brown, The Motor Ship, Vol. 32, January 1952; p. 414.*

Boiler-oil as Standard Fuel

The results of the performance of large numbers of motor ships with machinery operating on boiler oil have been so favourable during the past year that the time is approaching when all shipowners will wish to gain the advantage of a 20 to 30 per cent saving in the fuel bill and will generally specify that engines of their ships shall operate on this fuel. At the present time there are over 100 motor ships running exclusively on boiler oil and at least 600 further installations are under contract. So much experience has now been gained with various classes of two-stroke and four-stroke engines that there is no longer any serious technical problem involved in arranging for marine propelling engines to operate continuously on boiler oil with a viscosity up to 3,000 seconds Redwood No. I. As the general policy of oil suppliers is not to market fuel with a viscosity exceeding this figure, it may be said that Diesel machinery can operate on the boiler oil available throughout the whole world. The consumption when using the heavier fuel is higher by the difference in calorific value, there is a slightly increased liner wear in most cases, and the necessary installation, including heating coils, for satisfactory operation on boiler oil, involves a substantial capital expenditure ranging from £7,000 to £10,000, according to the size of machinery. Allowing, however, for these factors, no owner can ignore the financial advantage to be gained, an advantage that will have greater importance when competition becomes more acute. It has been suggested that if all motor ships operate on boiler oil, there is likely to be a surplus of distillate and a shortage of residual fuel. If this circumstance arises, it will not be because of the use of boiler oil in motor ships but for other causes, since the total consumption in all the motor ships of the world is small compared with the requirements for other purposes. It is true that the percentage increase in the cost of marine fuel oil, during the past year, has been slightly more than that of Diesel fuel (33 per cent and 30 per cent respectively for sterling ports), but the actual increase in shillings per ton was greater with Diesel fuel than residual oil. The result is that there is a wider differential between the cost of Diesel fuel and boiler oil than was the case a year ago.—*The Motor Ship, Vol. 32, January 1952; p. 372.*

Gas Turbine for Cargo Vessel

The objective of this paper is to discuss a conservative gas-turbine plant for a cargo vessel operating under present day temperature and pressure limitations, and designed for long life. The vessel selected is a cargo vessel of the C-3 type having the following principal characteristics:—

Length overall	492 feet
Breadth moulded	71·2 feet
Mean draft	27·3 feet
Shaft horsepower, normal	8,500
Shaft horsepower, maximum	9,350
Speed at 8,500 horsepower	17·8 knots
Gross tonnage	7,940
Cruising radius at 16·5 knots	10,000 miles
Fuel oil capacity...	1,464 tons
Diesel oil capacity	105 tons

The vessel will be single screw and the normal shaft horsepower (specified) shall be adequate to maintain a sea speed of at least 16·5 knots when loaded to a mean draft of 27·3 feet. A controllable pitch propeller has been chosen because, as a result of a great deal of experimental work and actual operation, it is felt that such a propeller is the most logical solution to the reversal problem. On a mean draft of 29·1 feet in salt water, the ship in loaded condition with all equipment, outfit, and spare parts is designed to have a total displacement of 17,615 tons of 1,000 kilograms per ton, made up as follows:—

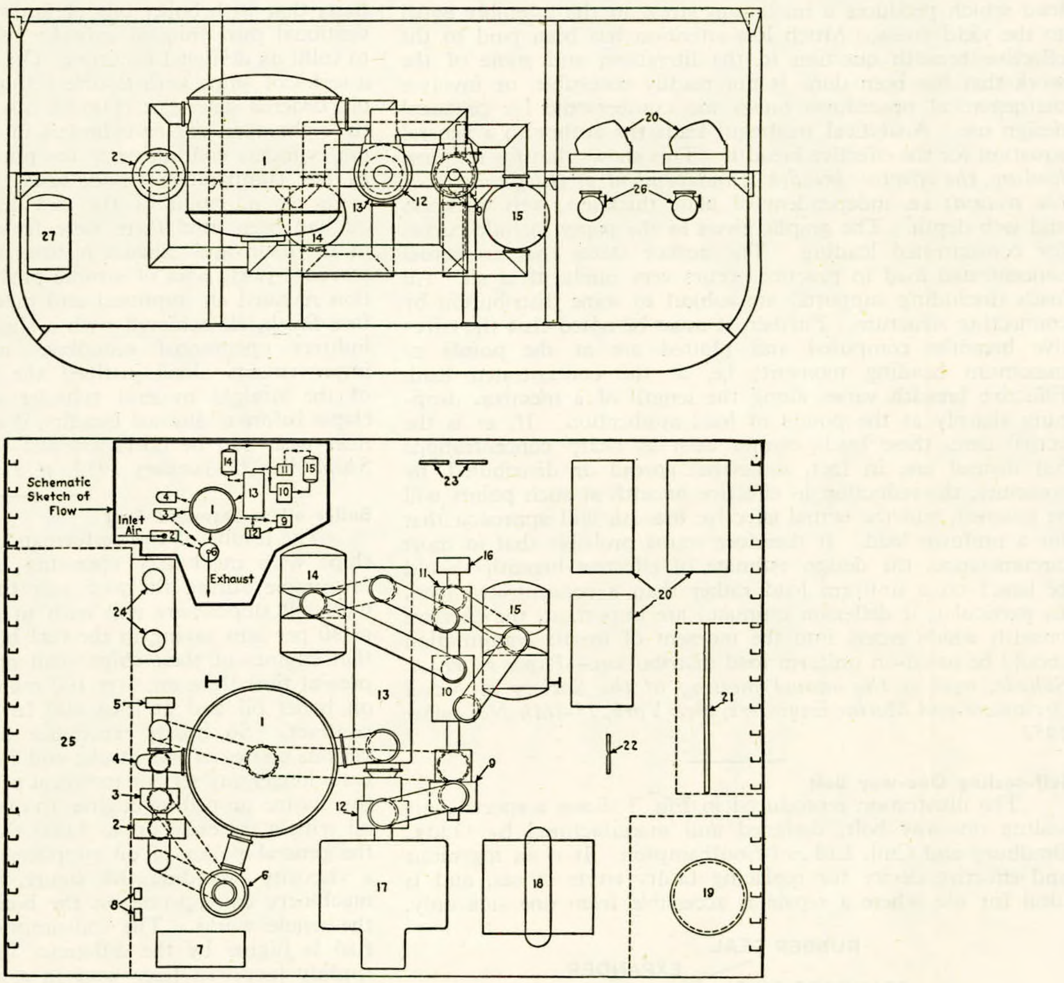


FIG. 11—*Machinery arrangement in C-3 cargo vessel*

1—Air heater
2—Combustion air compressor
3—Exhaust gas turbine
4—Recirculating gas fan
5—Starting turbine for charging set
6—Air preheater
7—Air accumulator
8—Makeup air compressors
9—H.P. turbine
10—L.P. compressor
11—H.P. compressor
12—L.P. turbine
13—Heat exchanger (recuperator)
14—Precooler
15—Intercooler
16—Starting turbine for compressor set
17—Reduction gears
18—Auxiliary boiler
19—Oil and water separator
20—Main turbo-generators
21—Main electrical switchboard
22—Boiler control board
23—Turbine control board
24—Fuel oil heaters
25—Workshop
26—Turbo-generator condensers
27—Distilling plant

Light weight		5,088
Fuel oil in double bottom and settling tanks in engine room, taken at 98 per cent capacity and 37 cu. ft. per ton	1,635	
Drinking water and culinary water...	69	
Distilled water	17	
Boiler feedwater	227	
Crew and effects and stores... ...	50	
General cargo	10,529	
Deadweight		12,527
Total displacement		17,615

A basic comparison between an open and closed cycle plant is made and both cycles are compared to the presently installed steam plant. This comparison indicates that it is possible to design and install a long life gas turbine plant which will fit the space and weight requirements of a C-3 cargo vessel. A disadvantage of the open cycle plant is the large required smokepipe and inlet area. Even so, it is still within acceptable limits, and in cargo vessels it is not a severe disadvantage when the smokepipe diameter is 20 per cent of the vessel's beam. The engine room layout is shown in Fig. 11. The plant weights of both the open and closed cycles are about the same and can be 30 per cent more or less than that of a comparable steam plant. The open process has an average weight of 43·2lb. per s.h.p.; the closed 40lb. per s.h.p.; and the steam plant 77lb. per s.h.p. Space requirement is one of the most controversial questions yet to be considered, but nevertheless it can be stated that the open cycle, using reheat, intercooling and recuperation, and the closed cycle will require approximately the same volume, and in both cases this volume can be 25 per cent less than that of a comparable steam plant. The closed cycle has been selected as the more practical for this particular use at the present time, i.e. a C-3 cargo vessel with a shaft horsepower of 8,500 and designed for long life. The reasons for the selection of a closed cycle are: (a) smaller stack area; (b) clean operating air; (c) better part load efficiency; (d) better regulation; (e) possibility of using a medium other than air; (f) greater potential. The closed cycle can be compared best with the steam cycle with the added advantage that it possesses an additional phase of freedom, namely, the pressure. The disadvantages of the closed cycle plant are all related to the air heater and, although mentioned in the various sections, may be summarized as follows: (a) This one unit (i.e. the air heater) can represent one-third of the total weight, space, and cost of the closed cycle plant. (b) Its relatively low efficiency of 86-91 per cent as compared to the 98 per cent efficiency of the open-cycle combustion chamber may, in the future, permit the theoretical open cycle plant efficiency to exceed that of the closed cycle plant when turbine inlet temperatures of more than approximately 1,650 deg. F. are possible. (c) The maximum closed cycle temperature may be limited eventually by the allowable air heater tube wall temperatures because, if and when blade cooling is perfected, it will be much simpler to cool the first few rows of turbine blades than the tube walls. Also, as better heat resisting materials are developed, it will be possible to use a smaller amount of such a strategic material in the combustion chamber and initial turbine blading of the open-cycle than in the many tubes of the closed cycle air heater. (d) The necessity of an air heater charging group. However, the development of a high efficiency radiation type air heater will not only eliminate the charging group but also reduce the size of the air heater. (e) The large thermal capacity of the air heater causes a longer warm-up period compared to the open cycle plant.—*Paper by J. J. McMullen, read at the annual meeting of the Society of Naval Architects and Marine Engineers, New York, 15th-16th November 1951.*

Polyamide-clad Wire Rope

It is claimed that application of a coating of polyamide plastic considerably improves the wearing properties of steel wire rope. In the industrial application of this process the polyamide is applied in a liquid state to the wire rope by means of a spraying process. After cooling down, the solidified polyamide coating encloses the wire rope in the form of a tight covering. It is also possible to cover individual wire rope strands with polyamide and to twist them subsequently into wire rope. The great advantage of polyamide-clad wire rope is claimed to be its long life, the polyamide itself being very resistant to wear so that the wire rope proper is less exposed to wear and tear. Moreover, owing to the application of the protective skin, the wire rope is protected against corrosion. The coating must, of course, be removed when splicing, and in this case a new coating must afterwards be provided. Polyamide is a good electrical insulator, which is of importance in applications where accidental contact of the rope with bare electrical conductors would otherwise have serious consequences. Polyamide-clad steel wire rope is claimed to be easily handled, as it is less subject to kinking and is smooth to the touch. Damage owing to the presence of projecting wires should therefore also be precluded. The manufacturers state that the new wire rope is more expensive than ordinary steel wire rope, but that it is cheaper than the stainless steel material. The new product would appear to be particularly suitable for cases where operating conditions are not unduly arduous and where corrosion is the main factor in determining service life.—*The Engineers' Digest, Vol. 13, January 1952; p. 1.*

Sigma Welding of Carbon Steels

Some twenty years ago attempts were made to weld carbon steel with bare wire electrodes in an inert atmosphere. Due to the high cost of, and impurities in, the inert gas and lack of knowledge regarding current density, commercial application of the process was not established. In recent years, however, the process has proved commercially feasible using a tungsten electrode and an inert gas shield. It is known as inert gas-shielded arc welding. Experience of several years using an inert atmosphere for welding with a tungsten electrode led to the development of the consumed metal electrode welding method, called "shielded inert gas metal arc" welding. This name has been shortened to "sigma", using the initial letters of the five descriptive words. The first practical application of sigma welding was to aluminium. This proved to be commercially feasible. However, it was clearly desirable to apply this process to the welding of other metals. Although stainless steel, copper and copper alloys could be successfully welded, initial trials of sigma welding of carbon steel with commonly used inert atmospheres were unsuccessful. Metal transfer and weld bead contour were poor, porosity and undercutting were prevalent, and costs were high due to slow welding speeds and the expense of the very small diameter welding rods that were found necessary. Earlier experiments on adding various liquid and gaseous components to the inert atmosphere in welding with a tungsten electrode indicated that the same line of research should be followed with the consumable electrode. When this was continued for sigma welding of carbon steels, it was found that excellent results were achieved through the addition of small percentages of oxygen to argon. The most effective mixture contains approximately 5 per cent oxygen and 95 per cent argon, and is available in standard size compressed gas cylinders.—*H. T. Herbst and T. McElrath, The Welding Journal, Vol. 30, December 1951; pp. 1084-1091.*

Stud Welding Cast Iron

As the result of experiments by the Nelson stud welding engineers at Crompton Parkinson, Ltd., it is now practicable to stud weld effectively on iron castings. In the past, although it has been possible to end-weld studs on to castings with a Nelson gun, the attachment was of little practical value because, as the inherent strength of the casting localized round the site of the weld is so much weaker than the steel attachment, if the latter is subject to loading of any sort, fracture of the casting occurs, usually bringing a portion of this away with the attachment. It has been found that by spreading the area over which the attachment is made to the casting, strength results can be obtained which may be adequate for some structural purposes. This can be achieved as described below. On the site where the stud welded attachment is required to be made on the casting, a deposit of steel weld filler rod is made by arc welding, or other suitable process, to form a pad. Optimum results are obtained with a pad of a diameter not less than one and a half times the diameter of the stud or attachment to be welded thereto, and of a thickness not less than the minimum plate thickness when welding that attachment to steel. This deposited pad is best made by starting on a centre pop mark and depositing filler rod in a gradually increasing spiral from the centre outwards to the required depth and diameter. On completion of the pad, the stud or attachment is end-welded on the top of it. Tests have proved that a stud or attachment so welded, when subjected to tension and hammer tests, will itself break or bend before there is any sign of the casting breaking.—*Welding and Metal Fabrication, Vol. 20, January 1952; p. 38.*

Marine Gas Turbine from the Viewpoint of an Aeronautical Engineer

In view of the intensive development of gas turbines for aeronautical purposes, the author advocates the adoption of aero-design techniques for the production of gas turbines for marine and stationary purposes. A review is made of the more obvious features of various typical aircraft turbines and the conclusions are drawn that multiple combustion systems and single- or two-stage turbines should be employed with a considerable reduction in the mass of metal in the assembly as compared with extant stationary designs, in order to reduce transient temperature stressing. A description is given of an experimental heat exchanger embodying the principles of light scantlings, symmetry of design and purity of suspension. A brief excursion into the performance calculations for a marine turbine leads to a recommendation to use a compound cycle of 8 : 1 overall compression ratio, with centrifugal compressors for robustness and with a high combustion temperature involving the use of air-cooled blading. A life of 10,000 hours appears within reach, which figure is considered to be adequate for merchant ship service. A compact arrangement is suggested for a turbine of this type giving 4,000 s.h.p. at an overall thermal efficiency of 30 per cent. The manœuvring and reversing problems are to be overcome by the fitting of a variable pitch propeller, but development work on this device is required to reduce its alleged tendency to greater losses as compared with the fixed-pitch type.—*Paper by A. H. Fletcher read at a general meeting of the Institution of Mechanical Engineers on 25th January 1952.*

Non-magnetic Ship Model Laboratory

A non-magnetic ship model laboratory is now nearing completion at the U.S. Naval Ordnance Laboratory, White Oak, Md. The building is constructed on non-ferrous materials, a permanent installation of modified Helmholtz coils compensates for the earth's magnetic field in the area and automobile parking is prohibited in the vicinity. Within the building, magnetic fields can be duplicated to simulate any which might be encountered by a ship under test, or ship models can be studied in an area completely free of magnetic influence; the results of tests will help in protecting ships against influence mines and torpedoes. Equipment operation is handled by a master console with 357 controls.—*Marine Engineering and Shipping Review, Vol. 57, January 1952; p. 48.*

Swiss Lake Motorship

The new motorship *Rothorn,* operating on the Lake of Brienz, is 131-ft. long and 18-ft. broad and can accommodate 400 passengers. Of this number the second class accounts for 280 and has the whole main deck at its disposal. The vessel is propelled by a four-cylinder Sulzer two-stroke engine with an output of 300 b.h.p. at 400 r.p.m. The engine drives the propeller shaft direct and gives the vessel a maximum speed of 15·3 miles per hour. The propeller can be reversed by means of a planetary gear with a hydraulically operated multi-plate coupling of Sulzer make, which is remote controlled from a lever located in the wheelhouse. The speed of the Diesel engine and with it the velocity of the ship, can also be set from the wheelhouse by means of a remote control system.—*Sulzer Technical Review, No. 2, 1951; pp. 30-31.*

Features of 250-kW. Marine Gas Turbine

A description is given of the first gas turbine emergency generator set installed in a Naval ship. The shafts of the principal components are connected by splined couplings. Inlet air is inducted through a combined silencer and oil-cooler assembly located near the centre of the engine, flows forward through the compressor, is diffused, reversed 180 degrees in direction, and passes into a single combustion chamber parallel to the compressor. The hot gas produced in the combustor enters a turbine scroll which conducts and distributes it to the first stage turbine nozzle. At the exit of the turbine the gas is diffused and then enters an exhaust collector which discharges

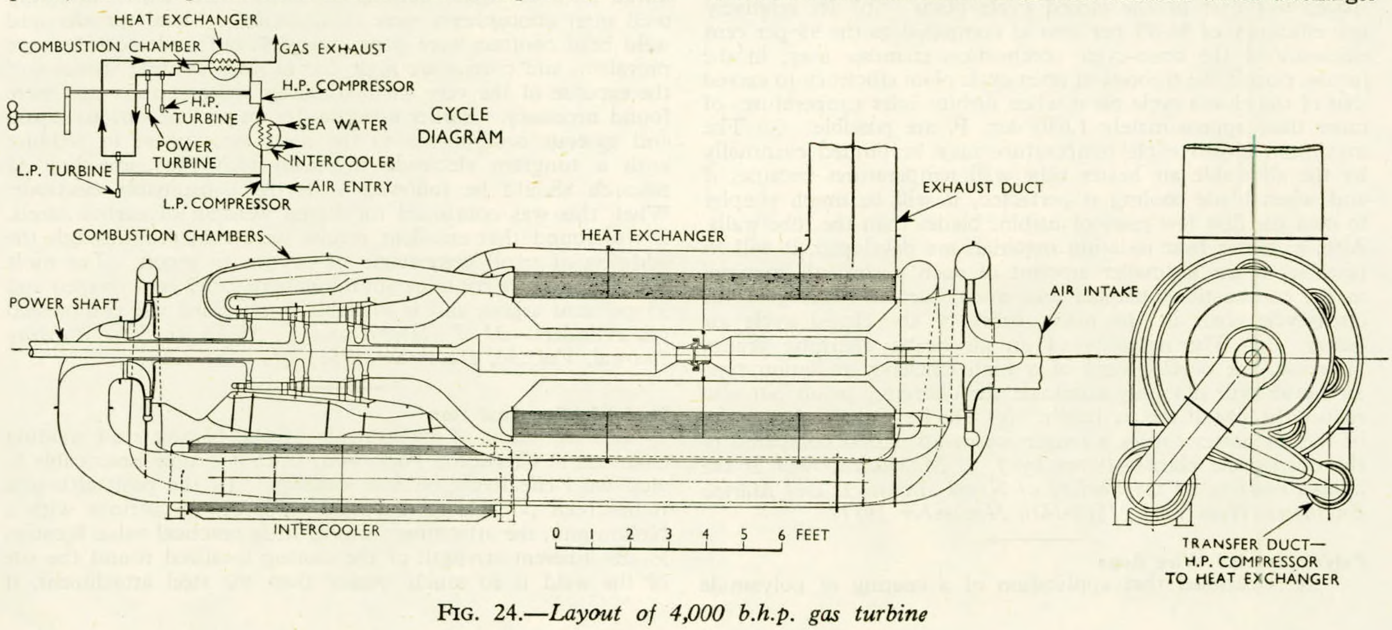


FIG. 24.—*Layout of 4,000 b.h.p. gas turbine*

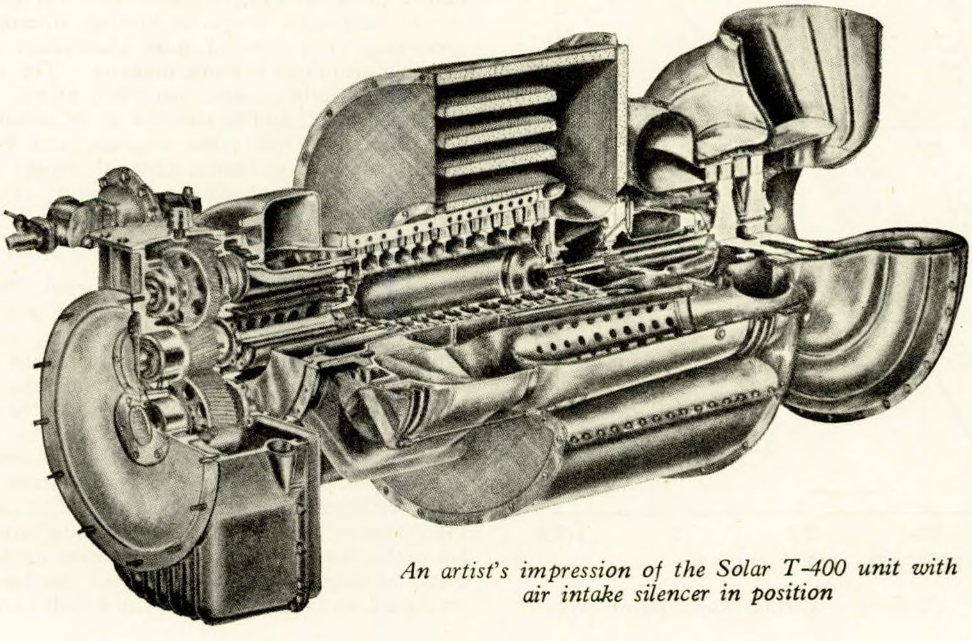
vertically upwards. An exhaust muffler is located in the exhaust stack. Accessories mounted on and driven from the gear box include the governor, lubricating oil pump, fuel pump, speed-sequencing switch assembly, and tachometer generator. The power plant mounts, consisting of a trunnion on each side of the generator and a third support under the turbine, flexible in the fore-and-aft direction, do not incorporate isolating media. The compressor, combustor, turbine, reduction gear, lubrication system, starting system, fuel and control system, and silencers are described. The engine has successfully completed ninety hours of shore test operation and is now awaiting shipboard trials. In its present form, the prime mover is suitable for substantially fixed-speed applications, such as generator, pump, and compressor or blower drives. By adding a third turbine stage not mechanically connected to the first two, and taking the power output from a reduction gear coupled to the third stage, it could be used for propulsion of land vehicles or small boats and other variable speed applications.—*Paper by R. R. Peterson and P. G. Carlson, read at the A.S.M.E. Annual Meeting 1951. Journal, The British Shipbuilding Research Association, Vol. 7, January 1952; Abstract No. 5661.*

Simple 400-horsepower Gas Turbine

In applications where compactness, light weight and quick starting are of more significance than low fuel consumption, the gas turbine holds commanding advantages. One such application is the emergency generation of electricity in warships, which accounts for a specification issued in 1947 by the Department of the U.S. Navy, Bureau of Ships; this called for a gas turbine capable of driving a 250-kW. high speed generator and having a starting time of 10 seconds maximum from standstill to full load. A prototype engine meeting this specification was ordered from the Solar Aircraft Company, of San Diego, California, in June 1947, and has recently been installed in a U.S. Naval vessel. First trials of the engine took place in September 1949, after which a development programme revealed the need for various design changes. Acceptance testing at the Annapolis experimental station began in June 1950 and the unit was delivered to a shipyard for installation early in 1951. This gas turbine is a single-shaft design with a rated speed of 20,138 r.p.m. and a maximum output of some 400 b.h.p. A 10-stage axial compressor of 4·8 to 1 pressure ratio supplies 6·6lb. of air per second to a single all-metal aircraft-type combustion chamber situated parallel to and alongside the turbine shaft. Gas is supplied to the two-stage turbine at an inlet temperature of 838 deg. C. (1,540 deg. F.). When the air inlet silencer and exhaust muffler are fitted, the best specific fuel consumption achieved is some 1·07lb. per b.h.p. hr. at full output; this deteriorates to about 2·4lb. per b.h.p. hr. at one-quarter load (100 b.h.p.). Heat-resisting alloys of high quality are used for the turbine discs and blades, so as to reduce the need for air cooling. Both discs are in N-155 material, the rear disc being attached to the front disc by three ½-in. bolts. Stator blades are in Hastelloy C and rotor blades in S-816, the latter being attached to the discs by the British loose-fit fir-tree method. A small fan integral with the front face of the first disc circulates cooling air over the turbine hub and front face of the disc; this air passes round the turbine inlet scroll, through its shrouding, round the turbine casing, and finally discharges into the turbine exhaust. A second fan mounted on the rear face of the second disc circulates cooling air in that region. Design of the turbine blading is on the vortex principle, using 20 per cent and 11 per cent reaction at the roots and 49 and 48 per cent at the tips of the first and second stages respectively. Under rated conditions, turbine tip speed is 1,054ft. per sec. The combustion chamber is a conventional unit, having a specific heat release at full load of approximately 5×10^6 B.Th.U.s per hr. per cu. ft. per atmosphere. For good atomization at all loads, a variable area fuel nozzle is employed. Ignition is provided by a spark plug energized by a storage battery and vibrator coil. Removal of the combustion chamber is readily effected without dismantling any other part of the power plant.—*The Oil Engine and Gas Turbine, Vol. 19, January 1952; pp. 377-379.*

Marine Fans

The motorship *Atreus*, built by Vickers-Armstrongs, Ltd., is the first of a number of new vessels for the Blue Funnel Line to be equipped with "Aerofoil" fans manufactured by Woods of Colchester, Ltd. These fans are so designed that, with the assistance of a patent adjustable impeller, precise requirements in air delivery, pressure, sound level and dimensions can be met economically from standardized and interchangeable parts. It is claimed that with the development of these fans, a limiting factor in the use of axial-flow fans on ships has been successfully overcome. Hitherto, this type has been generally confined to static pressures up to about 1½ inch water gauge on account of the sound level produced by high tip speeds. The problem has been solved by Aerofoil contra-rotating two-stage fans. These have two opposite-handed impellers driven in opposite directions by two independent motors. A contra-rotating fan develops 2¾ times the pressure of a single-stage unit of equal size and speed without proportionate increase in sound level. Alternatively, it will provide a required volume and pressure at about two-thirds the tip



An artist's impression of the Solar T-400 unit with air intake silencer in position speed of a single-stage fan, and is thus appreciably quieter. This system prevents losses due to air rotation. Air leaving a single-stage impeller rotates in a helix. Its rotational movement absorbs part of the energy imparted to the air and that proportion of the energy normally serves no useful purpose. The contra-rotating Aerofoil makes use of this air rotation by feeding the delivery from one impeller into a second stage with blades designed to accept rotating air and discharge it axially. As the air enters and leaves in an axial direction, two or more contra-rotating units may be connected together in series. Two contra-rotating fans will develop twice the pressure of one, and so on up to a limit of about 20 inch W.G. The *Atreus* is equipped with four 38 inch contra-rotating Aerofoils for ventilating the machinery spaces. Each moves 13,500 cu. ft. per minute against a static pressure of 1-in. W.G., absorbing 3·5 b.h.p. The total efficiency of these fans is 73 per cent. They run at 680 r.p.m.—*The Shipping World, Vol. 126, 16th January 1951; p. 109.*

Marine Gas Turbine Plant in 1951

Four gas turbine engines have seen service afloat to date in six installations. A light, simple, medium-life engine of 2,500 horsepower first went to sea in 1947 in a British Naval motor gunboat. Two British 120-h.p. simple engines provided the major propulsive power for the yacht *Torquil* in May 1950; one of these engines now powers a British Naval harbour launch. A 160-h.p. simple engine developed by Boeing for the United States Navy powered a naval personnel boat in May 1950 and became the first gas turbine engine to which vessel propulsion was wholly entrusted; its later version powers a small landing craft undergoing extensive tests for the U.S. Navy. Lastly, but of greatest general significance, a 1,200-h.p. British long-life recuperative engine has just been installed as part of the propulsion plant of the British tanker *Auris*, providing first extensive experience afloat for merchant type plants. Ten further marine units have been completed but not installed. Seven are for propulsion and three for auxiliary use. Five of the propulsion and two of the auxiliary units were built for the United States Navy. One propulsion and one auxiliary engine were built in England and the final propulsion engine in Switzerland. Six additional engines are under construction for propulsion in this country, England and France. Due to its unparalleled versatility, the gas turbine engine must be further defined as to long or short life, simple cycle or recuperative, intercooled or reheat cycle, before its qualifications for marine use can be assessed. At present, only the long-life complex recuperative type appears qualified for merchant propulsion in general, and here its probably superior characteristics of reduced maintenance and operating personnel requirements plus improved manœuvrability require demonstration in actual service afloat. The highest power gas turbine plant suitable for marine use now available delivers 5,000 h.p. The ability of high temperature gas turbine plants to burn successfully residual fuel oils unrestricted as to source remains to be proved, and has a strong bearing upon their merchant use. The high powered complex recuperative gas turbine engine cannot today compete with steam in general Naval propulsion. For powers below 10,000 h.p., it competes fairly well with steam, but lacks the clear superiority needed to supplant that time tested prime mover. For very low powers, its situation is about the same in relation to the Diesel engine. Only in the case of the medium and short life simple gas turbine engine type below about 6,000 horsepower is there a present claim of clear superiority, and that superiority is based upon reduced maintenance, compactness, and light weight. Applications embraced by this power range include boats, certain landing craft, high speed rescue craft, and the peak load or "burst" power of PT boats, destroyer escorts and destroyers. Existing equipment has established a definite place for simple marine auxiliary gas turbine engines in performing any intermittent or emergency service where premiums will accrue from their light weight, low maintenance, independence of other systems and quick starting.—*Paper by W. T. Sawyer read at the annual meeting of the Society of Naval Architects and Marine Engineers, New York, 15th-16th November 1951.*

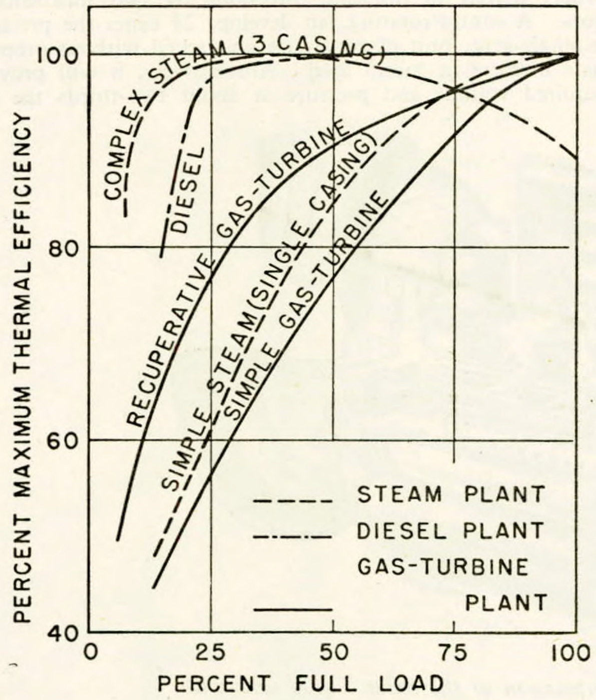


FIG. 3—*Part-load efficiency of various naval prime movers*

Brazed Aluminium Heat Exchangers

A recent article in the American journal "Steel" describes the brazed aluminium heat exchangers built by the Trane Company of America. These effect big savings in space, weight and cost. The units are built up of alternate layers of corrugated fins and flat aluminium sheets. Some of the units provide up to 450 sq. ft. of heat-transfer surface in one cubic foot of space, which is nine times the surface in a conventional shell-and-tube exchanger with ¾-in. tubes. Heat can be transferred from gas to gas, liquid to liquid, or liquid to gas. Up to five different streams of fluid can flow at any point along the length of the exchanger. The fundamental flexibility of the core construction permits wide variation in the combination of circuits, temperature drop, and pressure drop for particular processes to be worked out. For successful fabrication of the exchanger, a special brazing aluminium sheet is used, consisting of a core of pure aluminium with a coating of silicon-aluminium brazing material. The exchanger has been used successfully in air-liquefaction plants, in chemical plants, and in aircraft, and is thought to be suitable for radiators in Diesel engines and other engines, and for air-conditioning plant, particularly during time of copper shortage.—*Journal, The British Shipbuilding Research Association, Vol. 6, December 1951. Abstract No. 5,565.*

New Method of Rust Protection

An article in the German journal "Werkstoff und Korrosion" describes a method of forming a permanent protective layer on structural steel. The process, which is still in the experimental stage, consists of covering the steelwork with two layers, the inner layer containing all the minerals, solvents, etc., for enamelling or burnishing, and the outer consisting of rapidly combustible material. When the latter is ignited it produces an instantaneous very high temperature and a gas pressure which jointly heat the substances in the lower layer and force them on to the structure. The careful surface cleaning necessary with a normal enamelling process is not essential, since the heat is sufficient to reduce oxides adhering to the metal surface. For practical use, the two layers should be combined to form a plastic skin which can be applied in any position.—*Journal, The British Shipbuilding Research Association, Vol. 6, December 1951; Abstract No. 5,591.*

Lifts in Ships

Special difficulties confront the lift engineer in connexion with the design of lift installations in ships. Among the points he has to bear in mind are that the centre of gravity of the ship must be kept as low as possible; that the electric supply is normally on the direct-current system; that the doors or gates of the lift must be designed in such a way that the motion of the ship does not cause them to move erratically; that the counterweight does not travel down to solid ground; and that the trailing cables must not swing so that they foul projections in the elevator shaft. It is meeting the first of these requirements—that of keeping the centre of gravity as low as possible—that the lift engineer is faced with his greatest problem. The ship designer would prefer the machinery to be arranged below the lift, at the bottom of the shaft; on the other hand, the lift engineer has substantial reasons for desiring to locate the hauling and control equipment above the lift, at the top of the shaft. Among these reasons are the following:—(1) The smaller amount of equipment required and the lower installation charges reduce the capital cost of the installation. (2) For a given size of lift car, the lift trunk is smaller—an important consideration, as space in a ship is usually very valuable. (3) Owing to the reduced number of guide pulleys required, friction is decreased, and this results in economy of power consumption. (4) The quantity of rope required is reduced by about 60 per cent. (5) Replacements of the ropes are necessary at less frequent intervals, in this way minimizing the cost of maintenance. As a compromise, it may be convenient to arrange the equipment in a machine room, adjacent to the uppermost deck served. While this does not materially alter the arrangement of guide pulleys at the top of the trunk, it does obviate the presence of additional lengths of rope in the trunk. On the other hand, with this arrangement the ropes operate under more severe conditions of reverse bending, for they must pass over the several guide pulleys. One advantage incidental to the compromise is that it allows adequate ventilation of the machine room to be more easily provided. Because the counterweight does not travel down to solid ground—as it would in a shore installation—safety gear has to be fitted to the counterweight, as well as to the car. Another important factor in marine lift installations is the need to eliminate radio interference; suppression equipment must, therefore, be embodied in all the associated motors and control equipment.—*The Shipbuilder and Marine Engine-Builder, Vol. 59, February 1952; pp. 126-128.*

Dredger

The dredging system illustrated in Fig. 2 enables the dredged soil to be discharged directly on to the banks and any mixture of the soil with water is unnecessary. Also, separate elevators for depositing are not required. The dredger (5) is connected by a lattice girder to a main pontoon (6), allowing a pivotal action to take place. A lateral auxiliary pontoon (9) is connected to the pontoon (6) by a bridge (10). The soil is collected by a bucket chain of the dredge (5), falls into a hopper and is discharged to a conveyor belt (12), whence it falls on a second belt (13) which discharges the soil into a hopper mounted on the pontoon (6). The dredged earth slides down on to a third belt elevator (14) mounted on the bridge (10) and it is finally transferred to a conveyor (15), guided by a boom (16), supported by the mast (11). At the upper extremity of the conveyor (15) the soil is discharged and forms an embankment (17).—*Brit. Pat. No. 659,845. Verschure and Co., Amsterdam, The Motor Ship, Vol. 32, February 1952; p. 468.*

Fracture of Marine Shafting

The author considers the fracture not only of propeller shafts, but also of intermediate shafts, excluding shafts for reduction gears, crankshafts, etc. Fractures in these shafts are due to fatigue. There are three types of stress on a shaft, due to longitudinal loading, torsion, and bending. Longitudinal loading, which is normally compressive, is of minor importance. The stresses arising in the other two cases are considered in somewhat greater detail. Torsional stresses may be induced by the propeller or by irregular running of the engine. Unless the frequency of these applied stresses corresponds to that of a critical torsional speed of the shaft, there will be little danger. A fracture due to torsional stress alone will follow a helix with an angle of 45 degrees. Torsional stress can also cause fractures originating in the keyways in the tapered portion of the shaft. A bending stress always results from a geometrical fault in the shaft, and may be aggravated by corrosion or by a notch effect. In this type of failure, the fracture is perpendicular to the shaft. In many practical cases, the fracture is due to a combination of bending and torsion, and is of an intermediate type.—*H. de Leiris, Nav. Ports. Chant., Vol. 2, December 1951; p. 636. Journal, The British Shipbuilding Research Association, Vol. 7, January 1952; Abstract No. 5,670.*

Stack Design to Avoid Smoke Nuisance

This paper describes wind tunnel tests conducted at the Quincy Yard of the Bethlehem Steel Company to investigate various methods of minimizing smoke nuisance on ships. In particular, it describes the development of the stack design for the two new American Export liners *Independence* and *Constitution.* The most important factor in the smoke nuisance picture is the location of the upper boundary of turbulent air surrounding the superstructure. A method is given for estimating the height of the turbulent boundary for cargo and passenger ships with superstructures of normal proportions.

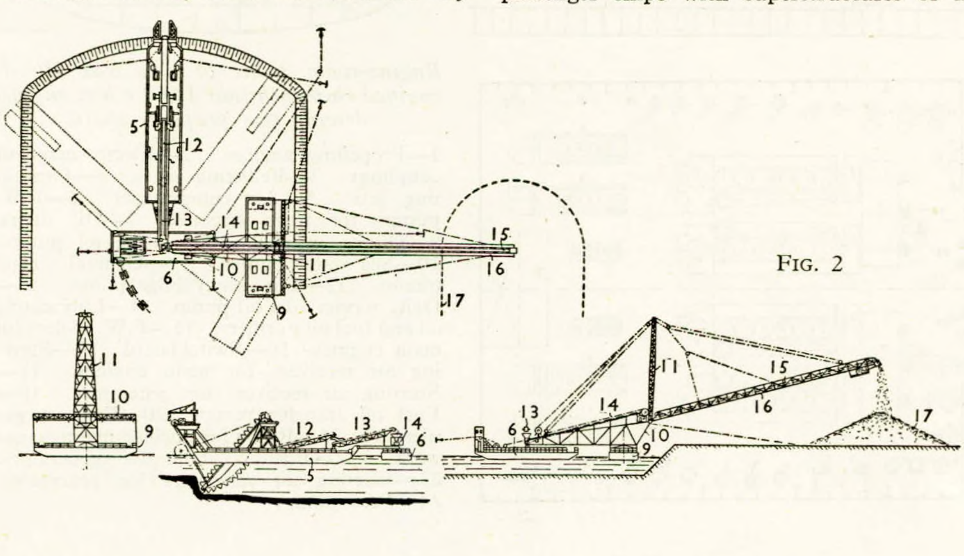
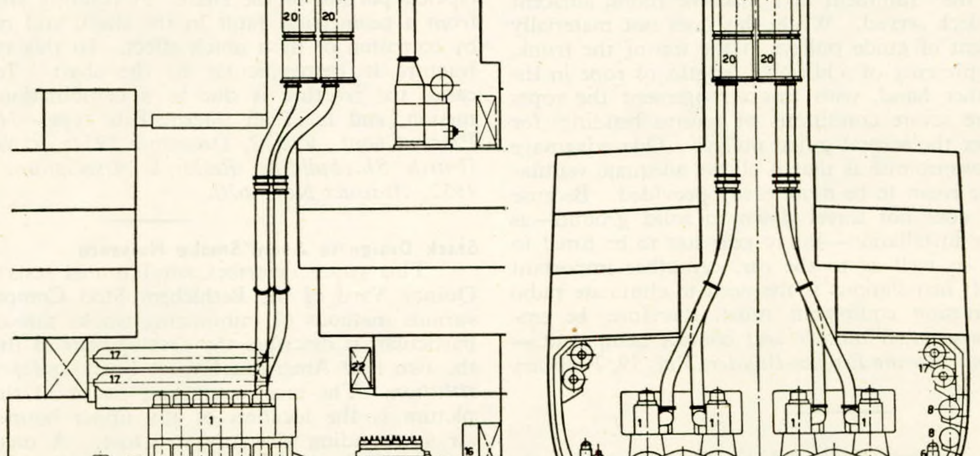


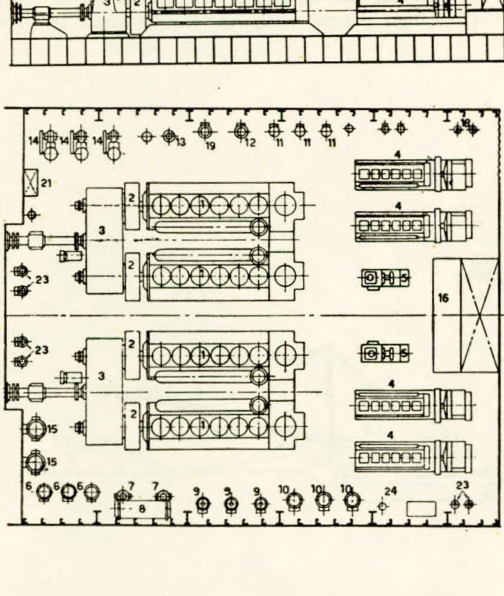
FIG. 2

The effects of varying the shape of the house front and of turning the model in the wind tunnel (to various yaw angles) were investigated. Rounding or streamlining the house front substantially reduced the height of turbulence. Up to yaw angles of about 60 degrees the turbulent zone changed very little, but when the wind approached broadside (90 degrees yaw) there was a distinct upsweep over the superstructure and this generally caused an improvement in the smoke pattern. As a rule, the ordinary stack should extend above the turbulent zone at least one-half the stack diameter, or stack width, to prevent the downwash of smoke from extending into the turbulent zone. However, with the customary oval or streamlined stacks the downwash of smoke becomes worse at yaw angles from 15 to 60 degrees and then, as mentioned above, improves somewhat as the yaw angle approaches 90 degrees. The extent of downwash is a function of both the smoke velocity and the shape of the stack top. Both of these are interrelated and must be considered together. It was found that design features that minimize the amount of downwash or that allow the surrounding air to flow smoothly around the stack top are effective only up to yaw angles of 20 or 30 degrees. Locating the uptake at the aft end of the stack was beneficial for all conditions except for following winds; in addition, sloping the uptake aft resulted in further improvement even at large yaw angles. A small stack top cross section and rounded edges are always desirable. However, neither free flowing air through slots in the front of the stack nor the engine room exhaust can be counted on to reduce the amount of downwash. Tests showed that maintaining a high gas velocity is the best way to improve the all-around performance of a stack. In addition to minimizing downwash, increasing the gas velocity has the desirable feature of blowing the hard soot particles high in the air, particularly when blowing tubes, so that they have a better chance to clear the ship. Observations of smoke patterns during ship trials and at dock showed that model tests generally predict a somewhat less favourable smoke pattern than is actually produced on the full-size ship. The stack performance predicted by the models is fairly reliable for strong wind conditions but is decidedly on the pessimistic side for light wind conditions.—*Paper by H. G. Acker, S.N.A.M.E. Bulletin, Vol. 7, January 1952; pp. 20-21.*

Geared Diesel Passenger Ships

For service between Italy, Sicily and Sardinia, five passenger ships were ordered some time ago by the Tirrenia Line and in each of these the installation consists of four 1,800 b.h.p. Fiat engines, each pair of which drives a propeller through an Asea electric coupling and reducing gear. They are vessels of 5,200 gross tons. Of the twenty engines required for these ships, twelve will be built at the Fiat Works at Turin and eight by the S/A Ansaldo under licence. Most of the machinery is now completed. The engines have six cylinders, 480 mm. in diameter with a piston stroke of 640 mm., and are of the two-stroke single-acting type. The object of the employment of four high-speed engines was to enable the machinery to be installed in an engine-room of low height, in order to utilize the space above. They are, however, of the crosshead-type with a cover between the bottom of the liner and the crankchamber.





Engine-room plans of a geared Diesel-engined ship with four 1,800 b.h.p. engines driving two propeller shafts

1—Propelling engines. 2—Electro-magnetic couplings. 3—Reducing gears. 4—Generating sets. 5—Air compressors. 6—F.W. pumps for main engines. 7—Oil filters. 8—Oil coolers. 9—Lubricating oil pumps. 10—Sea water pumps. 11—General service pumps. 12—Emergency bilge pump. 13—Daily service fuel oil pump. 14—Lubricating oil and fuel oil purifiers. 15—F.W. coolers for main engines. 16—Switchboard. 17—Starting air receivers for main engines. 18—Starting air receivers for generators. 19—Fuel oil transfer pump. 20—Exhaust gas silencers. 21—Bench for purifier maintenance work. 22—Fuel oil tank for generators. 23—Starting air reservoirs for generators. 24—Feed pump.

This is a desirable feature of the design, in view of the fact that the engines operate on boiler oil. The liner wear with this class of engine using boiler oil is stated to be from 0·10-0·15 mm. per 1,000 hours' running. The Asea electric couplings were built in Italy by the Officine di Savigliano. The general arrangement of the machinery is shown in the accompanying illustration.—*The Motor Ship, Vol. 32, February 1952; p. 463.*

Shaft Materials in Torsion

The term "elastic hysteresis" is used to describe inelastic effects at stresses below the conventional elastic limit. A series of hysteresis and room temperature creep tests was carried out on several typical high strength shafting materials, using apparatus designed to measure displacement changes of 0·002 per cent of the full load deflexion. The results showed that for unidirectional stresses up to 24,000lb. per sq. in. in chrome-molybdenum steel, hysteresis and creep are low in magnitude—0·03 per cent of full load deflexion. For reversed loading, the hysteresis is many times greater, being 0·12 per cent for 12,000lb. per sq. in. stress amplitude, and 0·42 per cent for 24,000lb. per sq. in. The hysteresis values in torsion for a thin-walled tubular specimen proved to be large compared with the values for a similar solid specimen. Low carbon steel showed large hysteresis for all the test conditions imposed. The smallest observed values were 0·25 per cent, and some cycles showed almost ten times this amount. For the two steels tested, strain history was an important factor in the results. In all cases, however, the hysteresis had apparently reached a stable value in from three to four cycles of loading. On the first cycle the hysteresis was as much as five times the stabilized value obtained after several cycles of loading. Two non-magnetic alloys, K Monel and Inconel X, proved to have exceptionally low hysteresis and creep for shearing stresses up to 24,000lb. per sq. in. Both hysteresis and creep values were only 0·01 per cent, even for reversed loading.—*Paper by W. P. Welch and B. Cametti, read at the A.S.M.E. Annual Meeting, 1951. Journal, The British Shipbuilding Research Association, Vol. 7, January 1952; Abstract No. 5638.*

New Uses of Metal Spraying Process

A by-product of Navy Bureau of Ordnance Research into the nature of the metal-spraying process is a new spray-forming technique for fabricating large, complex parts of high melting point metals, according to an announcement by the Office of Technical Services of the U.S. Department of Commerce. In a research project for the Navy Bureau of Ordnance, scientists at the Massachusetts Institute of Technology first uncovered the exact process by which a sprayed-metal deposit is built up. Using this knowledge they evolved a new process for forming high melting point metal parts by first spraying the metal on to a core of the desired shape, then sintering the sprayed deposit to form a dense, strong, metal part. This new method is considered to provide a simple, inexpensive process for forming high melting point metal parts, especially large, complex shapes that are difficult to fabricate by the conventional processes of powder metallurgy, precision casting, or die forging. High melting point alloys as well as elementary metals can be formed by the new process. The report describes the new spray-forming technique and the properties of the deposits, and explains how sintering produces the densification or strengthening of the metal. Also described in this report is the investigation which uncovered the exact process by which sprayed metal deposits are built up.—*Marine Engineering and Shipping Review, Vol. 57, February 1952; p. 84.*

Controlled Density Steel

A new and revolutionary method for producing finished and semi-finished steel articles, which is expected to yield considerable economies, has been developed by the Ontario Research Foundation. According to a contemporary, by this method, as compared with the normal steel density 7·8, controlled density steel can be produced with any desired density from 1·0 to 7·2 directly from the furnace. The process—which is described as being extremely simple—enables fine iron ore to be made directly into the desired steel shape without melting or any other intermediate step. The dry, fine prepared ore, generally finer than 60 mesh, is poured directly into suitable moulds, reduced at a temperature of about 2,000 deg. F., and finally held for a longer treatment time of several hours at the same temperature. The resulting article has, it is claimed, the composition and structure of normal steel except that it contains a predetermined amount of spherical voids which are not interconnected. This last point is most important since the cellular structure of the steel allows it to be heated and hot-worked without any great precautions being necessary to prevent excessive oxidation and scaling. The future applications of this new engineering material have been divided into three classes according to the density, viz. hot-worked material for densities over 3·0 and preferably over 4·0 and, as a substitute for iron powder, in the density range 4·0 to 6·5.—*Shipbuilding and Shipping Record, Vol. 79, January 1952; p. 67.*

Improved Safety Valve

The leakage of steam through safety valves has long been recognized as one of the most difficult problems required to be solved in the design of such valves. Many previous attempts to solve the problem have met with little success. Extended experiments have shown that even the slightest leak, once initiated, rapidly develops into a very serious leak, not in the first instance by reason of the scoring or erosion of the opposed surfaces, but because the outwardly flowing and rapidly expanding fluid produces a temperature drop in the region of the leak with the result that the metal parts contract locally. In this way the dimensions of the leak orifice are immediately increased so that the leak almost instantly becomes larger. According to the proposals of the inventors the contacting surfaces of the seat and the head are so designed that rapid heat conduction is ensured, and the location of these surfaces is arranged in such relation to the steam that the metal in the vicinity of the leaks will be kept at all times substantially at the temperature of the steam. This aim is realized by providing at least one of the contact surfaces on a thin flange, precautions being taken to prevent welding together of the seat and head. Referring to Figs. 2 and 3, when the valve head is seated, the contact surface

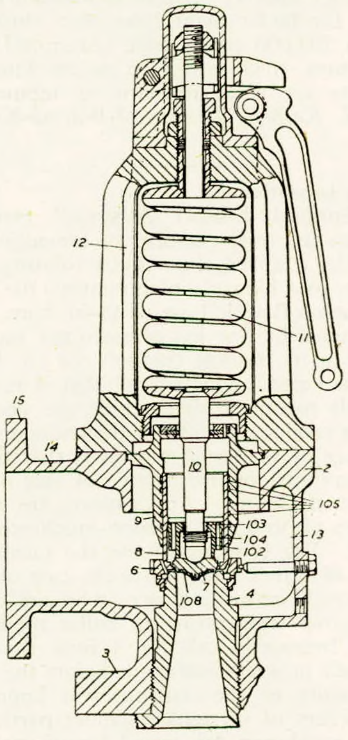


FIG. 2

(19) engages the bevelled seat surface (5) and the fluid pressure acts against the inner surface (20) of the flange in a direction nearly normal to the surface (19). But the flange, owing to its thinness, possesses a degree of flexibility, and the pressure urging the surface (19) against the seat (5) will therefore mould this surface to the seat surface, and as a result compensate for any very slight surface irregularities. On the other hand, if a microscopic leak does develop, the rapid transfer of heat through the mass of the flange (16) substantially compensates for the decrease in temperature due to the sudden expansion of the

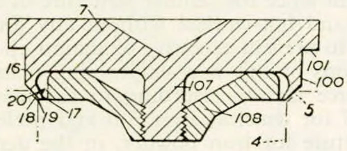


FIG. 3

escaping steam. The tendency for the leak to increase by contraction of the adjacent metal is thus practically avoided. The danger of the valve and seat surfaces coming into molecular contact so that they weld together is overcome by making the surfaces of different materials with non-welding characteristics. Thus, for instance, the seat bushing may be made of 13 per cent chrome steel and the contacting bevel surface may be provided with a deposit of chromium, while the disc member is made of 13 per cent chrome steel or of nitrided steel. Similarly, invar or stellite may be used.—*Brit. Pat. No. 663,333, issued to Dewrance and Co., Ltd. Complete specification published 19th December 1951. Engineering and Boiler House Review, Vol. 67, February 1952; pp. 61-62.*

Chromizing

Chromized tubes installed in steam condensers have given satisfactory results in cases where difficulties with the expanding of the tubes have been experienced. It was found that these tubes remain practically free from scale encrustation; and this may be due to an influence of the chromium content in the surface of the tube upon the crystallization process of the scale forming constituents. Chromized condenser tubes show a better corrosion resistance than 17 per cent chromium iron tubes. Air preheater tubes for boiler plant have been chromized. These tubes, of which 300,000 pieces were chromized, were 47 mm. in diameter, 1 mm. thick and 1·86 metres long. Chromized component parts are scale resistant at temperatures up to 850 deg. C.—*H. Kalpers, Brennstoff-Warme-Kraft, December 1951; p. 416.*

Sprayed Asbestos Insulation

In the "Sprayed Limpet Asbestos" process, prepared asbestos fibres are fed to the hopper of a machine, from which they are carried by a spiked sheet under rotating brushes which control quantity, to a blower which conveys the dry fibre in an air stream through a flexible hose of 1¾-in. bore, to a spray gun which is surrounded by fine jets of atomized water, so that the fibre is damped in its passage through the air, before reaching the surface to be coated, which is all that is required to cause the fibres to felt together, after which the coating is lightly pressed down to produce a uniform thickness and density. An obvious advantage of the spray process is that the material can be applied to any surface irrespective of size or contour, and in any required thickness. Applications are normally made from 3/16th inch up to 6 inch, though much greater thicknesses have been used. For economical use the maximum thickness is in the region of 2 inch, such as in the case of high temperature boilers, though many engineers who are concerned with keeping the internal temperature in boiler rooms and the like to a minimum frequently call for 4 inch thickness. In the marine field much progress was made before the last war, when the fireproof nature of the coatings was appreciated by the builders and owners of oil tankers, more particularly in providing comfort insulation for crews' living spaces, so that by early 1940 the shortage of deck timber had resulted in the almost universal employment of these coatings for underdrawing decks over crews' accommodation. An interesting repercussion of the false airspace theory arose in acute form when our Naval escort vessels were engaged in convoying ships to North Russia, as it was found that the subdivided airspace merely acted as a collector of solid ice inside the ship, which made living conditions almost impossible. The success of early trials carried out for the Director of Naval Construction, Admiralty, soon led to the general adoption of the process for the insulation of living spaces on British Naval vessels and those of many of the allied navies, the complete absence of smoke from these coatings in the event of fire being an obvious advantage. Since the war, certain improvements have been carried out to meet weight requirements on latest type war craft, and the process has also been largely used on all forms of merchant ship construction, including such luxury liners as the R.M.S. *Caronia,* where the purpose is not only to provide maximum comfort but, as part of this, to reduce the noise level on board to a minimum.—*Fuel Economy Review, Vol. 30, December 1951; pp. 20-23.*

Aluminium Paint in Marine Use

Due to the leaf-like pigment, aluminium provides remarkable excluding properties, both to moisture and vapour, as well as chemical fumes and gases. At the same time aluminium reflects a high percentage of the sun's heat and light rays, thus giving definite protection against actinic film disintegration of the paint binder itself, and holding evaporation losses to a minimum because of reduced surface temperatures. This makes aluminium paint particularly suited for the painting of tankers and oil storage facilities, inasmuch as it is neither softened nor dissolved by lubricating oils, nor discoloured by high heat. These facts also suggest it as the logical protection of boiler fronts, engine rooms, turbine casings, pipe lines and condensers. Some confusion prevails, however, in some engineering and painting quarters as to the anticorrosiveness and rust protection of aluminium paint. It is well to recapitulate that there are: (1) so-called inhibiting pigments; (2) indeterminate or neutral pigments and (3) corrosion stimulating pigments in the presence of an electrolyte (salt water), when in contact with iron or steel. Chromates belong to the former; iron oxides to the neutral, and lampblack and graphite to the rust-stimulators. Corrosion is generally accelerated by pigments strongly cathodic to iron, whereas pigments anodic to iron afford protection by sacrifice. Aluminium, while slightly anodic to iron, may be considered *neutral,* or indeterminate, only. Definite protection towards moisture and vapour transmission, therefore, is due mainly to the leaf-like orientation of the pigment, forming a multiple layer of protective aluminium and binder as an effective barrier; i.e., a protection by *exclusion* and not by any electrolytic action. It is therefore apparent that for best results a chromate or red lead coating should be used as a primer, before applying at least two coats of good aluminium paint (unless the aluminium is to protect hot surfaces. Obviously, in such case a primer would defeat the purpose). A recent important development in the aluminium paint field has been the successful addition of special chromates of low hiding and tinting power, so that as high as one pound of chromate could be added to the aluminium without any change in the metallic silver-lustre. This addition makes a true anti-corrosive out of the aluminium paint, often doing away with undercoats and primers and permitting the aluminium to become its own rust inhibitor.—*H. L. Warnecke, Marine News, Vol. 38, January 1952; pp. 32, 53, 54.*

Corrosion Testing

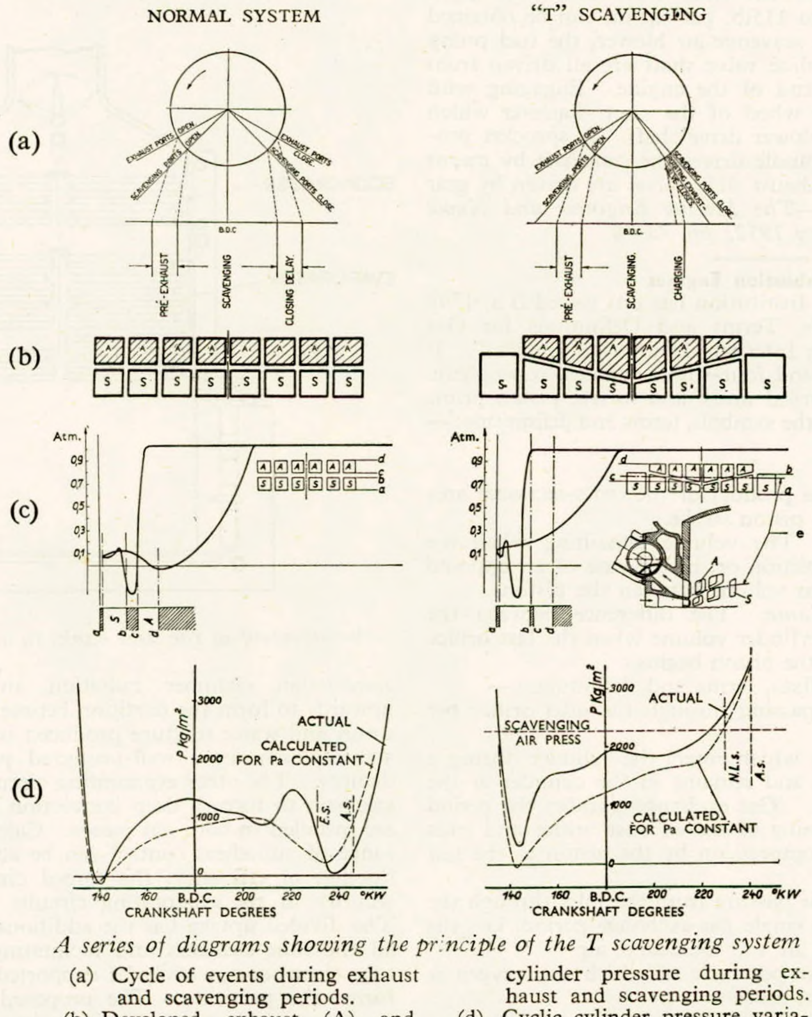
Further facilities for the study of sea water corrosion are being added to the Harbour Island Station of the Kure Beach project, near Willington, N.C., it was announced by F. L. LaQue, in charge of International Nickel Company's corrosion engineering section, under whose supervision the project is operated. Included in the new facilities will be a full sized salt water evaporator and distillation unit to study the effects of water treatment and design on corrosion and scaling of such units, especially as used on board ship. The equipment will include a boiler plant with a capacity of 4,000lb. of steam per hr. The new unit will be housed in the present laboratory building at Harbour Island and, to replace the space thus used, a new two-storey concrete structure will be erected on the site. The first floor will be used by machine and carpenter shops and for the new boiler. The second floor will provide for a meeting room to accommodate up to seventy-five people as well as a marine museum where specimens of wood, metals and other materials removed from test will be displayed. Additional facilities will be provided for laboratory studies of marine organisms and other biological studies. An enlarged photographic darkroom also will be provided. Concurrent with the erection of the new building at Harbour Island, the facilities for exposure of specimens to sea spray near the ocean at Kure Beach are being extended by a new test lot located about 80 feet from the ocean. This will increase the capacity of existing sea spray facilities approximately three times. During the sixteen years of its existence, the Harbour Island project has tested more than 20,000 specimens in sea water, 25,000 in sea atmosphere and a somewhat smaller number in sea spray. The atmospheric and spray tests are still located at Kure Beach. Specimens studied include metals, wood, rope, and even protective coatings such as paint.—*Mechanical Engineering, Vol. 74, January 1952; p. 30.*

Six-bladed Propeller

What is believed to be the first six-bladed propeller to be installed on an ocean going vessel was recently fitted to the tail shaft of the Liberty-type Greek freighter *Megalohari.* Designed by Dr. Frederick H. Todd, chief naval architect of the U.S. Navy's David Taylor Model Basin in Washington from designs developed from data prepared by Eugene P. Panagopulos, the solid manganese bronze propeller is approximately 18 feet in diameter and weighs over 18,000 pounds. The designer expects the overall performance of the new six-bladed propeller to be superior to the present four-bladed modified designs now in service on Liberty ships. The calculations on which the six-bladed design is based indicate that the new propeller will go far toward eliminating tailshaft failures on this class of ships. It is expected that similar installations will be made shortly on Liberty and other types of ships.—*The Log, Vol. 47, January 1952; pp. 94-96.*

Improved Medium Speed Diesel Engine

The redesigned GZ 52/70 M.A.N. engine is fitted with Roots-type scavenging air blowers which are driven from the crankshaft at about 3¾-times engine speed by means of a gear train incorporating a spring-type flexible coupling. Changeover valves controlled automatically by the reversing lever from the starting platform shift the position of the inlet and outlet ports of the blower when the engine is reversed. The most important modification is the fitting of rotary slide valves in the exhaust passages between the ports and the manifolds. As will be appreciated, with ordinary port scavenging the sequence of events when the piston descends is: exhaust ports open,



A series of diagrams showing the principle of the T scavenging system

(a) Cycle of events during exhaust and scavenging periods.
(b) Developed exhaust (A) and scavenge air ports (S).
(c) Light spring diagrams showing cylinder pressure during exhaust and scavenging periods.
(d) Cyclic cylinder pressure variations referred to crankshaft degrees.

scavenging ports open, and then symmetrically, on the side of bottom dead-centre, the scavenging ports close, exhaust ports close. Clearly, no scavenging air pressure in excess of the exhaust back pressure can be retained in the cylinder under these circumstances. If, however, a valve in the exhaust passage can be timed to close before the scavenge ports close, then an appreciable extra charge of air can be applied. The slide valves take the form of rotary part-cylinders, all connected together in the form of a shaft at the back of the engine and supported by water cooled roller bearings. The part-cylinders are recessed into the cylinder block and the running clearance of 1 mm. is sufficient to serve as a gas seal without danger of interference due to expansion. The valve timing is altered for astern running by means of a simple lost-motion device embodied in the drive mechanism. The scavenging air and exhaust ports have been rearranged (b) the new disposition providing a considerable degree of overlap. This modification alone results in a 10 per cent increase in output before smoke is perceptible in the exhaust. Light spring indicator diagrams (c) show that, whereas with the former method of scavenging, compression only begins after the exhaust ports close, with the new system an appreciable initial pressure already exists. The cylinder pressure using the normal system does not rise above atmospheric pressure until some 60 degrees after bottom dead centre, whereas with the rotary slide valve the pressure begins to rise some 20 degrees before bottom dead centre. Experiments carried out on a single-cylinder engine have shown that the cylinder pressure before the exhaust ports close can be raised from 1·1 to 1·35 or even 1·4 atmospheres by the use of the slide valve and that mean indicated pressures of up to 115lb. per sq. in. can be obtained with a clear exhaust. The scavenge air blower, the fuel pump camshaft and the exhaust slide valve shaft are all driven from a gear wheel at the after end of the engine. Engaging with this gear wheel is an idler wheel of the same diameter which engages in turn with the blower drive shaft. A sprocket provided on the idler wheel spindle drives the camshaft by means of a roller chain and the exhaust slide valves are driven by gear train from the camshaft.—*The Marine Engineer and Naval Architect, Vol. 75, February 1952; pp. 73-78.*

Definitions for Internal Combustion Engines

The British Standards Institution has just issued B.S. 1798 of 1951 entitled "Symbols, Terms and Definitions for Gas Quantities in Reciprocating Internal Combustion Engines". It applies alike to two-stroke and four-stroke engines, atmospheric induction and pressure charged units, and to free piston prime movers. The following are the symbols, terms and definitions: —

V Volume.

W Weight.

S Swept volume. The product of the cross-sectional area of the cylinder and the full piston stroke.

C Clearance volume. The volume remaining when the piston is at its top dead position or, in the case of an opposed piston engine, the minimum volume between the pistons.

E Effective swept volume. The difference between the clearance volume and the cylinder volume when the last orifice closes and compression by the piston begins.

The following are suffixes, terms and definitions: —

t Total air. The air passing through the inlet orifice per cycle.

c Charge air. The air which enters the cylinder during a single gas exchange period and remains in the cylinder at the end of the exchange period. (Gas exchange signifies the period which begins with the opening of the exhaust orifice and ends at the commencement of compression by the piston as the last orifice closes.)

s Scavenge air. The air passing from the inlet through the engine to exhaust during a single gas exchange period, i.e., the difference between the total air and the charge air.

b Burned air. The air per cycle of which the oxygen is consumed in the combustion process.

r Residual gas. The gas remaining in the cylinder from the previous cycle which, together with the charge air, makes up the cylinder content during the compression stroke.

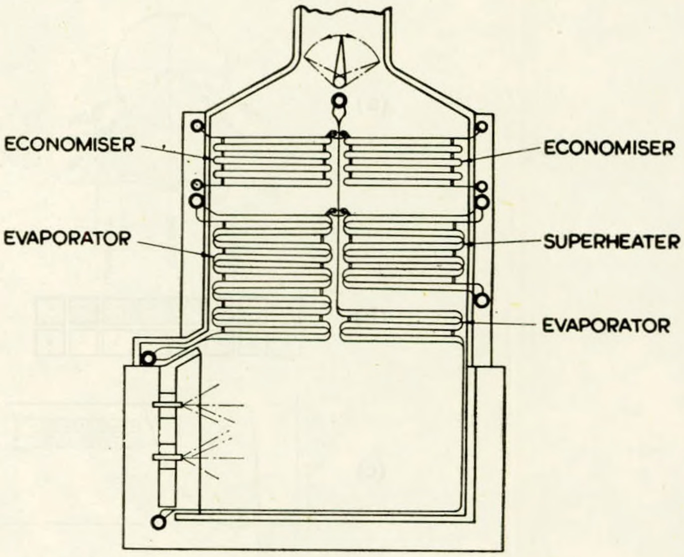
n Net exhaust gas. The gas present during an expansion stroke which passes to the exhaust during the gas exchange period.

g Gross exhaust gas. The total quantity of gases passing to the exhaust per cycle, i.e., the sum of the net exhaust gas and scavenge air.

The symbol *V* or *W* is used, together with one of the suffixes, to denote the volume or weight of any of the seven gas quantities. When specifying the volume of a quantity of gas, its temperature and pressure (or an indication of them) are given in brackets, unless the prevailing atmospheric temperature and pressure are intended. The symbols *S*, *C* and *E* represent constant quantities for a given engine with which any gas volume may be compared. For a free piston engine these three quantities are constant for any given working condition.—*The Oil Engine and Gas Turbine, Vol. 19, January 1952; p. 371.*

Superheat Control

For superheat control in La Mont boilers under varying load conditions, damper control of the gas flow is the simplest method. Forced circulation boilers can be favourably adapted to this system of superheat control. The accompanying illustration shows a boiler with divided uptake. The evaporative part of the boiler consists of two main circuits. The first of these consists of a series of tubes emanating from a header at the bottom of the furnace and covering the floor and rear wall. The tubes continue to form a small convection bank deep enough to protect the superheater tube elements from direct



Arrangement of the tube banks in a modern La Mont boiler

combustion chamber radiation and finally run vertically upwards to form the partition between the two gas passes. The steam and water mixture produced is discharged into a header, above which, in a well-protected position, is the regulating damper. The other evaporating circuit is arranged in the other gas pass to form a deep convection bank. Economizer banks are installed in both gas passes. Calculations show that a wide range of superheat control can be achieved without undue reduction of efficiency, the forced circulation providing ample security in the evaporating circuits for all damper positions. The divided uptake has the additional advantage of shortening all the tube elements and facilitating their withdrawal. The tube elements can easily be supported on the water wall which forms the partition. The proposed arrangement lends itself most favourably to the construction of light-weight boilers.—*H. Reppel, The Marine Engineer and Naval Architect, Vol. 75, February 1952; pp. 79-80.*

ENGINEERING ABSTRACTS

Section 3. Shipbuilding and Marine Engineering

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Nozzle-type Boiler Air Register

The nozzle-type air register was designed in an attempt to decrease the amount of excess air required for complete combustion. The specific features of design which the author believes will accomplish this end are the arrangement of the vanes and the position of the throats. If the velocity of the incoming air is too great, the flame shape will be destroyed; however, if the velocity of the air is not great enough, thorough mixing of fuel and air will not be obtained. Unlike most designs, the major throat was placed forward of the burner tip, therefore the velocity with which the air strikes the oil cone will be a function of throat diameter, which in turn can be calculated for any specific application. In this manner the design permits control of the velocity with which the air strikes the oil cone and ensures the maximum amount of turbulence. The direction vanes also have a unique arrangement. They are placed between the major throat and the burner tip instead of in the windbox as is done in most other designs. The vanes follow a helix about the burner receiver tube and change the direction of air flow 120 degrees in the vertical plane, that is, the inlet edge of the vanes is 120 degrees from the discharge edge in the vertical plane. The after edges of the vanes generate a cone which has the same included angle as the diffuser plate. Another feature of design which aids in the mixing of the fuel and air is the minor throat. The diameter of this throat is just large enough to allow passage of the oil cone without impingement. Thus the air is held around the oil cone and prevented from escaping into the furnace without mixing with the fuel. Also, since the air pressure in the furnace is slightly below the pressure in this throat, the air will expand as it leaves the minor throat, thus creating more turbulence and completing the mixing process. The design eliminates the necessity of making the burner throat in the furnace refractory, which will aid in the installation of such refractory. To the author's knowledge there is no other forced draft air register which provides a vertical closure. This type of closure is permitted by the arrangement of the vanes and reduces the frictional resistance to the flow of air by removing the vanes from their former position in the windbox. Another advantage which stems from the design of this register is the reduction of forced draft fan motor horsepower which is made possible by the reduction of the amount of air that must be supplied to the boiler. Also coincidental with the reduction of the volume of air supplied to the boiler is the reduction in volume of the air heater tube bank; that is, if a smaller volume of air is to be supplied to the boiler, the volume of the air heater may be reduced. The one probable, serious disadvantage to this design is the overheating of the register in that area where initial combustion takes place.—*Paper by J. E. Bradshaw, S.N.A.M.E. Bulletin, Vol. 7, January 1952; p. 21.*

Steam Safety Valve

The design of a "full-lift" type of safety valve, manufactured by Dewrance and Co., Ltd., of London, and which has been approved by the Ministry of Transport and Lloyd's Register of Shipping, is illustrated in Fig. 2. The valve, which has been specially constructed for marine service, has a high discharge capacity and, by means of an adjusting screw on the bush seating, the blow-down may be controlled to within from 1 to 4 per cent of the set pressure. A padlocked pin holds the adjusting ring in its correct setting. Positive and precise closing is obtained by a booster reseating feature. When the valve discharges, the escaping steam has access to the chamber (F) passing the spindle overlap (G) which takes up a position above the plate (H) while the valve head (A) is in the open position. When the valve closes, the spindle overlap (G) moves down below the opening in the plate (H) and the momentary pressure built up in the chamber (F) assists the downward spring thrust, ensuring tight and positive closure. The valve head (A) is a separate, replaceable component, secured in the valve-head guide (B) by the retaining nut (C). The safety valve is fitted with an easing lever, and unauthorized interference with the spring adjustment

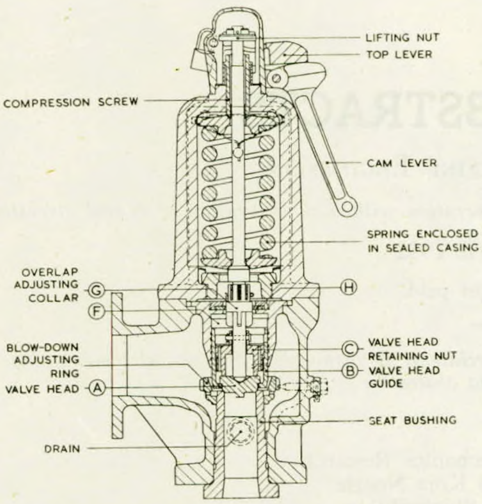


FIG. 2—*Sectional elevation of Dewrance-Consolidated steam safety valve*

is prevented by a padlocked cap. The spring is enclosed in a sealed case and the body is provided with a boss for draining the exhaust side of the valve. The Dewrance-Consolidated safety valve is supplied with a cast-steel body and cover, stainless-steel valve-head assembly and seat, and Dewrancalloy non-corrodible blow-down adjusting ring. It is suitable for pressures of up to 600lb. per sq. in. and temperatures of up to 900 deg. F. The flanged connexions conform to the appropriate British Standard tables. At a pressure of 575lb. per sq. in. of saturated steam, the valve discharges 33,500lb. per hr.—*The Shipbuilder and Marine Engine-Builder, Vol. 59, February 1952; p. 132.*

Reclaiming Used Diesel Parts

According to an article in a recent issue of Diesel Power and Diesel Transportation, the Van der Horst Corporation of America has developed a method of rebuilding the worn parts of Diesel engines by the electro-deposition of iron. When this new electrolytic iron is examined microscopically, it is found to have a fine columnar structure with the closely packed grains perpendicular to the bond surface, which should make for good wear resistance. It is stated that there is a notable absence of any graphite in the deposited iron, but further research is under way with a view to perfecting a method of controlled graphite placing so as to produce deposits with the desired graphitic distribution in colloidal or spheroidal forms. The process as now being used can be controlled so that deposits can be produced with tensile strengths in a fairly wide range. The average physical characteristics of the deposit are: tensile strength, 75,000lb. per sq. in.; yield point, 60,000lb. per sq. in.; Brinell hardness, 200-210. The deposited alloy is said to have machining characteristics somewhat similar to those of alloy steels, with a tendency towards toughness. Inside bores are more difficult to machine but are said to respond readily to grinding and honing. Fatigue tests to determine the endurance limit of the deposited material and its effect on base metal are being conducted, but no precise data are available. The strength of bond is said to be excellent. Deposits of $\frac{1}{4}$-in. radial thickness or more can be made, the economics of the job and the design characteristics being the limiting factors. Concerning the process, after degreasing and alkaline cleaning, the areas to be iron-plated are suitably covered with wax and, just prior to plating, the surface for treatment is given an anodic etching in a sulphuric acid bath. It is desirable first to machine the worn surfaces to be treated so as to make them geometrically accurate, while liners and pistons call for preliminary baking so as to carbonize out the impregnated oil which is in the material after a long period of operation. The actual plating is carried out in a bath something after the fashion of the Van der Horst chromium plating process.—*Gas and Oil Power, Vol. 27, March 1952; p. 71.*

Moisture Damage to Cargoes

This paper examines the extent and prevalence of moisture damage to cargoes and indicates that damage is either insignificant or of very small value in relation to the value of the cargoes. It seems probable that considerations of goodwill and prestige, however, may increase the use of mechanical ventilation and drying systems. The provision of general all-embracing standards of ventilation is not feasible since the standard of ventilation to be installed must be related to the trade on which the particular ship is to be engaged. Data are presented on the properties of a number of representative commodities of a hygroscopic nature with particular reference to the requirements necessary for efficient sea carriage. The use of data of this type should be helpful in tackling moisture damage in cases where it is considered to be of significant magnitude. The outstanding conclusion is that the standard of cargo out-turns appears to be in direct proportion to the care and knowledge shown by the ships' officers of the factors involved in ventilation.—*Paper by W. McClimont, read at a Meeting of the North-East Coast Institution of Engineers and Shipbuilders, 7th March 1952.*

Anti-corrosion Paints

The author reviews the present position regarding the inhibition of the corrosion of iron and steel by paints. He first briefly reviews the theory of corrosion and certain general properties of unpigmented paint films. He then divides pigments into three classes: (1) inert pigments, which do not react with the vehicle; (2) basic pigments, which form soaps by reacting with certain vehicles; and (3) soluble pigments, which pass directly into solution with the production of inhibitive ions. The pigment-vehicle relationship is discussed in each case. (1) Paints made with inert pigments, e.g. titanium oxide, Indian red, etc., should be based on vehicles that are as impermeable as possible to water and salts. (2) Lead, zinc, barium, calcium, and strontium linoleates are basic pigments which render water non-corrosive. When basic pigments are used for protection against atmospheric exposure, soap formation should be encouraged by the use of linseed oil or linseed stand oil, and should be controlled by means of a suitable pigment mixture. In the presence of salt the vehicle should be alkali-resistant. (3) Zinc chromate and zinc tetroxychromate are soluble pigments which render water non-corrosive, probably owing to the formation of chromate ions; when ground in drying oils they may function as basic pigments to form soaps. This dual function of chromates may explain some of the conflicting results that have been obtained in different attempts to assess the relative merits of zinc chromate and zinc tetroxychromate. Further work is necessary to explain the mechanism of protection by chromate paints.—*J. E. O. Mayne, Oil and Colour Chemists' Association, Vol. 34, 1951; p. 473. Journal, The British Shipbuilding Research Association, Vol. 7, February 1952; Abstract No. 5,826.*

Heavy Fuels for Medium-sized Marine Engines

Problems are discussed associated with the burning of heavy fuels in medium-speed, two-cycle, trunk-piston types of engine. Tests with a stationary engine are described, and performances, rates of cylinder-bore wear, and degrees of fouling are compared, when five classes of fuel are burnt. Pretreatment of fuels in the centrifuge is considered, and the results from practical experience show how certain fuels with high ash content, probably in an oil-soluble form, promote rapid cylinder-bore wear, even after being subjected to thorough treatment. Comparative rates of deterioration of the lubricating oil are recorded when different classes of fuel are burnt, and figures are given which show how fuels with a high sulphur content promote the formation of sulphuric acid in the crank chamber. Findings with the stationary engine are correlated to marine requirements, and the economy aspect of bunkering a lower grade of fuel in a coast-wise vessel of 2,500 tons dead weight is presented. The conclusion is reached that a marine Diesel fuel, preferably a distillate, instead of gas oil could be bunkered with financial advantage, but that in the light of present knowledge the use of a boiler-grade fuel could not be recommended. —*Paper by J. R. P. Smith, read at a Meeting of The Institute of Mechanical Engineers, 7th March 1952.*

Deep Sea Salvage Tug

The motor tug *Oceaan,* recently completed by J. and K. Smit's Scheepswerven, Kinderdjik, for L. Smit and Company's Internationale Sleepsdienst, Rotterdam, is a sister ship of the *Rode Zee,* built by the same firm in 1949. In the case of the *Oceaan,* however, the propelling machinery consists of a 6-cylinder Smit-M.A.N. single acting four-stroke engine, whereas the *Rode Zee* has a 6-cylinder, single acting two-stroke Smit-B. and W. engine. Built under the special survey of Lloyd's Register of Shipping to the highest classification for towing services and to the rules of the Netherlands Shipping Inspection, the new vessel has special strengthening specified by the owners. The principal particulars are:—

Length	160ft. 0in.
Breadth	29ft. 0in.
Depth	15ft. 0in.
Gross tonnage	497 tons
Net tonnage	75 tons
Endurance	17,000 miles
Speed	14 knots

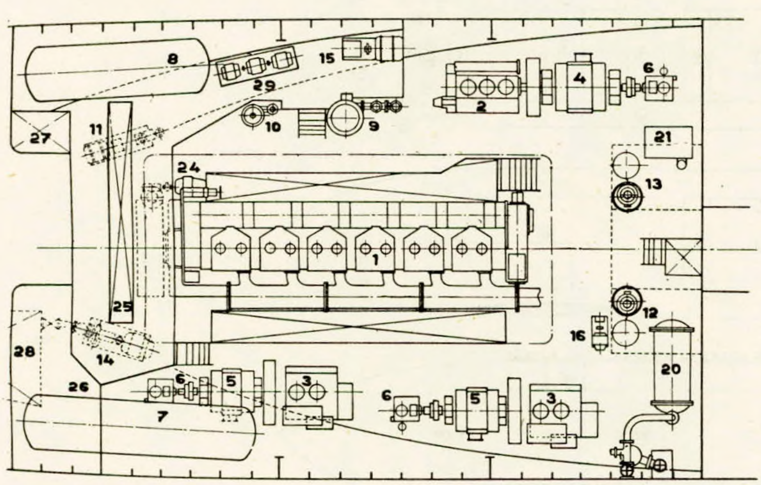
The main fuel bunkers are arranged in a number of separate compartments, entirely independent of each other. In addition, ample capacity for ballast and fresh water is provided in order to maintain a good draught for propeller immersion and for the supply of cooling water in shallow muddy water. A refrigerator of ample capacity with ice water supply has been installed. The towing winch is of a special design and of the self-spooling type. Duplicate control positions are provided. About 1,700 feet of 5½-in. steel wire rope with a breaking load of 175,000lb., are reeled on the drum. The propelling machinery consists of a 6-cylinder Smit-M.A.N., single acting four-stroke direct-reversible Diesel engine capable of developing 2,000 i.h.p. The engine is fresh water cooled and has oil cooled pistons. Auxiliary machinery consists of a 3-cylinder Smit-M.A.N., four-stroke Diesel engine, driving a 65-kW. generator and compressor, and two sets of 2-cylinder B. and W. four-stroke Diesel engines, each with a 30 kW. generator and a large compressor.—*Shipbuilding and Shipping Record, Vol. 79, 10th January 1952; pp. 41-42.*

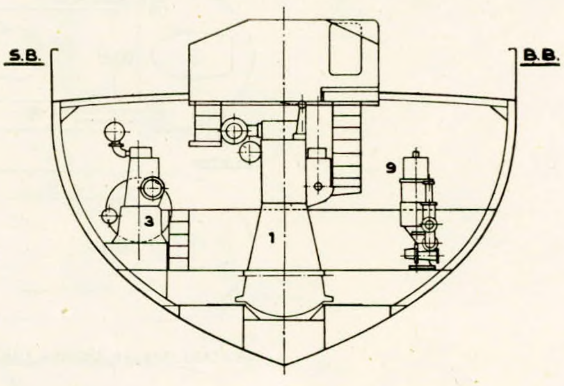
Glass Insulation

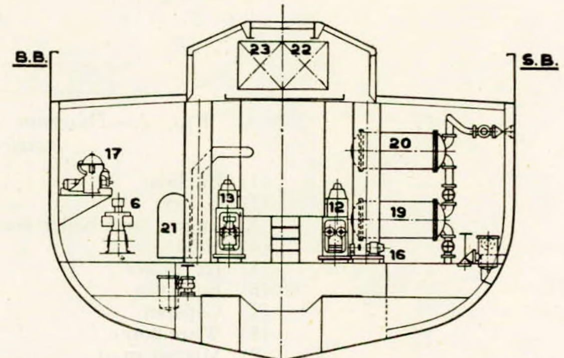
Foamglass is true pyrex glass to which carbon is added to form what is known in the trade as cellular glass. The manufacturing process is one of baking the component parts like bread, with a leavening action occurring comparable to the action of yeast in dough, and results in a rigid light-weight composition of glass containing countless separate hermetically sealed cells, each filled with dead air. The material has a crushing strength of 20,000lb. per sq. ft., which accounts for its use on floors of ice houses. Foamglass is non-combustible, water and acid resistant, non-absorbent, non-organic vermin- and rat-proof, easily worked and fabricated on the job, and a preventive against rust and fungus growth. The product is marketed in shapes and sizes to fit standard pipe ranging up to 36-inch pipe, and in blocks of 18 inch long, 3, 6, and 12 inch wide; 1½ to 5 inch in thickness.—*The Log, Vol. 47, February 1952; pp. 76, 104.*

Dilastrain Method

Two scientists at Rensselaer Polytechnic Institute, Troy, New York, have found a rapid and accurate way for testing steel alloys, other metals and plastics to find out how long they will stand up under normal loads when they are used for making moving parts of machines. A research authority in a national industry has declared it "impossible to exaggerate the importance" of this invention. The apparatus which Dr. Joseph L. Rosenholtz and Professor Dudley T. Smith have assembled in their laboratory makes possible the completion in ten hours or less of a testing job which has been requiring three months or longer on costly machines under expert supervision. The importance of the Rensselaer discovery to industry







1—Main engine. 2—Auxiliary engine (M.A.N.). 3—Auxiliary engine (B. and W.). 4—65-kW. generator. 5—30-kW. generator. 6—Compressor. 7—Main air receiver. 8—Auxiliary air receiver. 9—Salvage and fire pump. 10—Wash deck and bilge pump. 11—Auxiliary bilge pump. 12—Standby lubricating oil pump. 13—Fuel oil transfer pump. 14—Fresh water cooling pump. 15—Steering gear pump. 16—L.P. fuel oil pump. 17—Fuel oil purifier. 18—Lubricating oil purifier. 19—Lubricating oil cooler. 20—Heat exchanger. 21—Central heating boiler. 22—Gas oil tank. 23—Fuel oil supply tank. 24—Turning gear. 25—Main switchboard. 26—Store room. 27—Lubricating oil tank. 28—Fresh water cooling tank. 29—W.T. generator.

Machinery arrangement of the Oceaan

of almost every kind, but especially to defence production, rests in the fact that government and industrial laboratories, the world over, are searching constantly for materials and alloys to meet new and demanding standards. Thousands of tests are run annually to determine if a new material will permit faster and cheaper production, will prevent breakdowns and will save lives in both industry and the armed forces. The Rosenholtz-Smith apparatus permits the rapid and inexpensive testing of materials for tank engines and jet motors, as well as for propellers, turbine blades, revolving shafts and a myriad of other dynamic parts. The inventors call their discovery the Dilastrain Method. It is based on precise measurements of the extent to which specimens of a given material will expand under controlled temperatures. Industrial researchers want to know the endurance limit of each new material used for dynamic moving parts. They want to know the load it will bear without giving way as it goes through an infinite number of its movements. The endurance limit, under the slow and costly testing methods which are employed at present, has been found by subjecting test bars to varying loads or stresses and vibrating them until they either give way or prove sufficiently enduring. This ordinarily takes three months or longer, since a half-billion cycles, or complete vibrations, may be set as a practical limit for testing materials which have been designed for moving parts of machines. The method evolved requires the selection of identical specimens of the material and the putting of them under stress in a definite range. They are then put through an equal number of cycles of vibration so that all will be on an even level of fatigue. This takes a few hours. The specimens are then placed in the apparatus and subjected to controlled temperatures ranging from 20 deg. C., the ordinary room heat, to 100 deg. C., the boiling point of water. The specimens all have the same length, about 2 inch to start with, but the inventors have found that as temperatures are stepped up each specimen changes in length in proportion to the amount of stress to which it has been previously subjected. The apparatus automatically magnifies 3,500 times the amount of each expansion and records it. In approximately two hours the total linear expansion of all test specimens has been recorded. When these values are plotted against the stresses previously applied to the specimens, it is found that a sharp dip in the resulting curve appears at the point where the test material reaches its endurance limit. Tests have already been run on a chemically complex steel alloy supplied by the Allegheny Ludlum Steel Corporation, and the endurance limit which was found is admittedly more accurate than that found by ordinary methods.—*The Welding Journal, Vol. 31, January 1952; p. 36-s; 64-s.*

Drifter Trawlers

Drifters would not be earning to their full capacity if they confined themselves to herring fishing and other drift catches and so, when the season is fully over, many undergo structural alterations which allow them to take part in trawl-net fishing. The reasons for having to change the deck arrangement of the drifter which has to go trawling is that drift-net fishing and trawl-net fishing involve entirely different layout and techniques. The drifter requires a capstan which is used for hauling in the fleet of nets when a catch has been made and for unloading the catch when in port, a jenny which consists of rollers over which the ground rope to which the nets are attached pass when hauling in, and a rail roller over which the nets themselves are hauled after detachment from the ground rope. The hold of the drifter is completely open when fishing and the fish are shaken out of each net in turn as it is hauled over the rail roller and over the hold. In the trawler the capstan is not used. The hold of the trawler is fitted with shelves and lockers for the storage of the fish caught, the lockers being in the wings. Prime or best quality fish are put in the lockers and rough fish under the floor of the main hold. In addition, where the drifter is being used for trawling a steel bulkhead is usually fitted in the first wing of the hold to provide extra space for

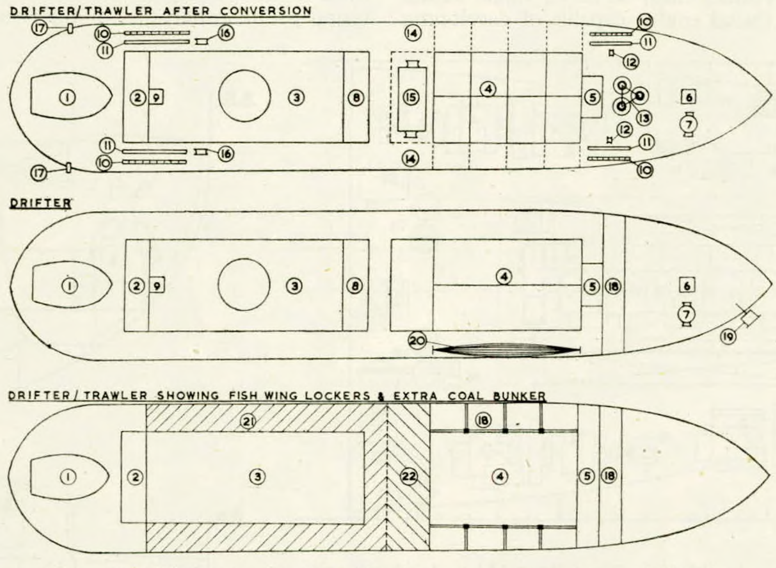


FIG. 2.—*Diagram showing the layout of gear on a drifter/trawler before and after conversion*

(1) Lifeboat.
(2) Galley.
(3) Engine and boiler room.
(4) Hold.
(5) Ice locker.
(6) Foremast.
(7) Capstan.
(8) Wheelhouse.
(9) Mizzen mast.
(10) Trawl boards stowed.
(11) Gallows.
(12) Deck fairleads.
(13) Centre fairleads.
(14) Side bollards.
(15) Winch.
(16) Foot sheaves in gallows legs.
(17) Tow blocks.
(18) Rope store.
(19) Jenny.
(20) Rail roller.
(21) Bunker.
(22) Extra bunker.

storage of coal—this is removed during herring time. The shelves and lockers are removed when drifting and the fish stowed in the wings and on the floor of the hold with squash boards in the wings to prevent movement of the cargo at the top. The job of conversion usually takes place in mid-December. First of all each ship is stripped of all drift gear, nets, ropes, and pallets, then alterations are made to the deck equipment such as blanking off the capstan, fitting up the fish hold for storage of white fish and ice, and installing a false bulkhead to form an extra bunker for coal (since a trawler has to spend much more time at sea than a drifter). Having taken care of these preliminaries and structural alterations, the trawl gear itself is fitted. The sketch in Fig. 2 illustrates diagrammatically the layout of the gear. The first item is the winch which is specially constructed for drifter/trawlers having due regard to deck space and the power required. It is built on the same lines as those used on the larger trawlers with separate drums supported in individual bearings and independent of the shaft. The gearing is of cast steel with helical toothed wheels, cylinders 6½in. by 11in., all engine parts being of extra strength with large adjustable bearings. The unit is designed so that all parts are readily accessible. This winch is fitted to a bedplate over the hatch or on deck on a hardwood seating securely bedded and bolted down and with a suitable grating fitted abaft. Each drum carries about 200 fathoms of warps and the fitting of this involves the use of about 400 yards of quayside while it is being run on to the drums. It will be seen from Fig. 2 that the winch is positioned forward of the wheelhouse. Steam has to be taken from the boiler with a Tee piece inserted in one of the existing pipes and a G.M. stop valve attached. A 1½in. copper tube connects this pipe to the valve on the winch and a 2in. exhaust pipe is led back through the casing to the waste steam pipe. The winch weighs in the region of 6 tons and once the initial fitting out of the boat is completed, it is only necessary to lift the winch aboard, position it and bed it down, connect up the pipes and joint. It is then ready for the warps to be run on. All overhauling of the working parts found to be necessary is carried out whilst in store between the fishing periods. From the winch the warps are led through two strong centre bollards on a deep base situated amidships and carried through to the gallows through a footsheave arranged to give a fairlead, and finally up to the hanging sheave at the highest point of the gallows bow. One warp is led to the forward gallows and the other through a side bollard on the deck and fairleads, attached to the casing in suitable positions, to the after gallows while tow cast iron fairleads with sheaves are fitted and fixed on the rail abaft the gallows. All bollards are bedded on hardwood and secured and bolted in fairlead positions and the shelves are of specially hardened metals. The gear is used on either side of the ship. All are fitted at this time. Gallows and galliasses are fitted forward and aft as shown in the accompanying diagram and there is one pair to each side. They are constructed of 6in. by 5in. H iron and their essential features are strength and angle of set. They must be set so that the hanging sheave is slightly outboard of the rail in order that the otter board may be shipped between the gallows and the rail when not in use and in order that the warp chafes as little as possible. The bow is formed and the legs drilled and countersunk and riveted to take the feet which are of ⅝in. plate, and include a sheave fitted in one foot of each. The warps are led through this, giving a fairlead to the hanging block. Occasionally this sheave is dispensed with and a separate sheave fitted on deck between the gallows legs for the same purpose. The whole is riveted up and the base formed of 3in. by 3in. angle irons which are bolted to hardwood blocks on the deck. The position of the feet must be precise and a template made to ensure that they come to the bolts correctly especially when renewing gallows which have been broken. Two-inch stays are fitted between the top of the gallows and the mast for additional stiffness. The gallows are removed annually for drifting purposes and replaced for trawling. They must be exceptionally stout to stand the strain of encountering obstacles on the sea bed when towing.—*E. P. Neal, Ship and Boat Builder, Vol. 5, February 1952; pp. 281-284.*

Gear-tooth Stress and Rating Formulæ

The state of knowledge about stress conditions in gear teeth is briefly reviewed, and directions in which further research is required are indicated. The assumptions underlying methods of stress-comparison, and the chosen load-points, are considered in relation to profile-modification, leading to revised conceptions of "precision" and "commercial" classes of gear. The present (British Standard) basis for the design of "commercial" teeth is stated and a new basis for the design of precision, high-duty gears is offered. Criteria of surface stress are re-examined and current British Standard rating formulæ for wear are shown to be equivalent to the use of an unmodified criterion $S_c = F_c/R_r$ in conjunction with a speed factor which is function of pitch circle velocity and gear ratio. New values for zone factors and strength factors for spur gears have been determined on the revised assumptions, and it is shown how the factors for helical teeth may be derived from those for the virtual spur gears. The assumptions underlying rating formulæ for variable load-cycles are also examined, and a revised formula is suggested whereby present inconsistencies are removed.—*Paper by H. E. Merritt, read at a meeting of the Institution of Mechanical Engineers, 29th February 1952.*

Fused Metallized Coatings

During the past few years the increased use of hard facing and corrosion-protective coatings has contributed greatly towards lengthening the life and reducing the number of failures in machine parts, structures and welded assemblies subject to wearing corrosive or erosive influences. The application of overlays has become an important item in the armed services as well as in industry. The U.S. Naval Engineering Experiment Station has played an important part in the development of hard facing applications for use in the U.S. Naval service. The U.S. Navy has conducted extensive investigations in the search for a suitable coating for low-alloy steels to allow their use in salt water. Two applications in particular have created considerable interest along this line. These are the desire to use steel propellers and the improved protection of outboard propeller shafting. Both of these applications require complete protection of the base metal as a means of preventing corrosion fatigue. In the case of propellers a considerable saving in cost and in strategic materials would be realized by the use of steel in the place of the usual manganese bronze. The design trend toward thinner blades and higher operational speeds has required that materials stronger and more resistant to cavitation be used. The coating of a steel propeller has been a problem on which the Navy has been working for a number of years. The present method of protecting outboard portions of propulsion shafting is to cover the bearing areas of the steel shaft with bronze sleeves and the balance of the shaft with a neoprene coating so as to prevent sea water from coming in contact with the shaft. There is, however, a possibility of incomplete protection at the joints in the sleeves or where damage occurs to the neoprene coating. This is one reason for operating U.S. Naval vessels with relatively low shaft stresses and correspondingly large shaft diameters. Advanced design practices are now employing lighter weight, higher stressed shafting. With these conditions the reliability of the protective covering becomes extremely important. With the higher stresses and increased twisting of the shaft the bronze sleeves and neoprene coating may not function so satisfactorily. It is for these reasons that the U.S. Navy has been interested in developing the use of metallizing and remelting as a means of applying a protective coating to shafting. The use of hard surface and corrosion protective overlays is not by any means limited to the above two applications. There are literally hundreds of machine parts and assemblies in use throughout the U.S. Naval Service where the application of a protective coating contributes greatly toward increasing the life of the part and affects appreciable savings in cost through the reclaiming of damaged or worn equipment. The initial phases of the investigation to develop a suitable corrosion and cavitation-resistant coating for steel propellers were started in 1942. The metallizing and remelting procedure was first applied using phosphor bronze as the overlay material. The optimum cladding technique was developed and this procedure was applied experimentally to two small propellers. One of these, fabricated of mild-steel plates and cladded with phosphor bronze, was operated in Severn River water for approximately 1,200 hours. During this period no defects or failures developed. However, cladding steel with phosphor bronze was found to entail certain disadvantages which would render the application difficult and impracticable from a production standpoint. In the continued search for a satisfactory protective coating to be applied by metallizing and remelting, many metals and alloys were tried. These included nickel, brass, monel, stainless steel and nickel-chrome-tungsten alloys of various types. None of these materials was found suitable for use in fused metallized coating procedure. Recently a chrome-nickel-boron surfacing alloy was developed. This material, available in either powder or wire form, is particularly suited for application by metallizing and remelting and has the desired properties of resistance to corrosion and cavitation. This alloy has a nominal composition of 65-75 per cent nickel, 13-20 per cent chrome, 3-5 per cent boron with a combined maximum of 10 per cent iron, silicon and carbon. In the coating of a steel propeller various problems are present which required the development of special techniques. Extreme care must be taken to eliminate warpage of the blades during the cladding procedure. In order to control distortion, a technique was developed wherein the blade is held in a vertical position and two welders are employed simultaneously to remelt both sides of the blade. This procedure has many applications other than on propellers and shafting. Recent reports received from various manufacturing firms have revealed some startling results on the savings effected through the salvage of worn parts by the use of fused metallized coatings. In one example, mandrels were salvaged. The mandrels made of the best tool steels and chrome plated lasted only about seventy-five operations. Mandrels coated with a fused metallized hard-surface alloy have been in use for more than 35,000 operations with no visible signs of wear.—*H. S. Sayre, The Welding Journal, Vol. 31, January 1952; pp. 35-39.*

Japanese Shipbuilding

This is an abstract of an article originally published in a recent issue of *Schip en Werf*. After a brief introduction outlining the historical development of the Japanese shipbuilding industry, and the basis on which the construction of post-war tonnage has been permitted, the author describes the facilities at present available. Since the war, there has been a tendency to concentrate the industry on the larger yards. Of the eighty pre-war yards, some fifty-five are still in operation; ocean-going vessels are built at about eleven large yards, two medium yards and seven smaller yards with a total capacity of approximately 650,000 gross tons, while the remainder deal only with repair work and the construction of coasters and fishing vessels. A brief description of the facilities available at each of these major yards is given. The author then considers the financial aspect. The manner in which the post-war shipbuilding programmes have been financed is described, and a brief indication of the way in which Japanese prices compare with those prevailing in Europe is given. In general, it appears that Japanese prices are somewhat the higher, mainly because of the high costs of steel and iron, which must be imported from the United States. A description of the vessels constructed since the war, both under the shipbuilding programme and for foreign owners, is given. In considering the quality of the works performed, the author is of the opinion that, while at the end of the war Japanese methods were less advanced than European and American, this difference has now been overcome, and in some cases improvements over Western methods have been introduced; thus more care is exercised in electric welding, and better results are obtained. In addition to the fact that Japan is capable of building good, and under certain circumstances very good, ships there is the advantage that Japanese yards are not booked up to anything like the same extent as are the majority of European and American yards, so that good delivery times can be quoted. A further advantage lies in the fact that the larger yards have their own engine shops and can provide the entire equipment for a ship. Disadvantages include the occasional lack of adequate inspection during the building process, so that substandard work may occur; the equipment of many of the yards is obsolescent and, although replacement has commenced, this will take a considerable time; the prices quoted are high which, as has been shown, is due to the high costs of iron and steel.—*Journal, The British Shipbuilding Research Association, Vol. 7, January 1952; Abstract No. 5626.*

Denmark and Holland to Build Ships for Russia

The U.S.S.R. has placed orders for a considerable number of cargo ships in Denmark and Holland, and three, which are being constructed at the De Schelde yard in Holland, will be 10,000-ton vessels with 8,000 b.h.p. Diesel-electric machinery and a speed of 14 knots. They are for service in the Arctic and are strengthened for operation in ice, the propeller of each ship weighing over 100 tons. There will be four De Schelde-Sulzer high-speed engines, each rated at 2,000 b.h.p. at 360 r.p.m. and driving a Diesel generator. The current is supplied to a single propelling motor. All electrical machinery, including the Diesel-engined generators, is of the B.T.H. type.—*The Motor Ship, Vol. 32, February 1952; p. 449.*

Minesweepers with Pescara Free-piston Engines

Several warships for the French Navy are being built by French private shipyards; they include destroyers, escort vessels and minesweepers. Fourteen minesweepers had already been allocated to French shipyards by the end of 1951. The hulls will be built of wood and light alloy, and the plans are similar to those of minesweepers being built in Great Britain, Canada and the United States. Four were allocated to the Chantiers Augustin Normand (Le Havre), four to Penhoet (Chantier de Normandie) and two to the Ateliers et Chantiers de la Seine Maritime, to the Chantiers Navals de Caen and to the Chantiers Amiot (Cherbourg). The displacement of these vessels will be 350 tons and their length 142 feet. An interesting feature of the French-built minesweepers will be their machinery, as they will be propelled by Pescara Diesel generators and gas turbines. The Pescara free-piston engine, working on the two-stroke cycle, consists essentially of a gas generator, in which gas under pressure is produced by pistons operating compressors at either end of a cylinder. This Pescara generator occupies the same relative position as does the boiler in a geared turbine set. The hot combustion gas so generated, mixed with excess scavenge air, exhausts into a receiver and then flows through a gas turbine. The advantages of this type of installation may be summarized as follows: reduction in weight and volume; flexibility of operation; parts fairly light and therefore easy to handle; lack of vibration; ease of manufacture as there is no crankshaft; low starting air consumption. The fuel consumption is of the same order as that of a corresponding Diesel engine but residual fuel oil can be used. These propulsion sets are being built in France either by the Société Industrielle Générale de Mecanique (S.I.G.M.A.), near Lyons, or by the Chantiers Augustin Normand. The latter have also under construction two 850-tons d.w. coasters (195 feet in length; 1,100 h.p.) which will be propelled by free-piston Pescara generators and a gas turbine.—*The Shipping World, Vol. 126, 13th February 1952; p. 179.*

Design of Wheelhouses and Bridges

The author's aim is to point out some of the defects in design or planning of vessels' bridges and to make suggestions for bettering them. From its early position aft the bridge has been gradually moved forward to midships or farther where the helmsman has better visibility. For the average cargo ship the height of eye for the bridge is 45 to 50 feet, when the ship is loaded. The width of the bridge athwartships should bring the structure flush with the ship's side and the fore and aft dimension should be 12 to 15 feet from the front of the bridge to the rear of the wheelhouse bulkhead. For ease in fitting windows, the front of the wheelhouse can be three-sided and the wings of the bridge should extend outward from the wheelhouse, set back 4 to 5 feet from the wheelhouse front to afford increased visibility to port and starboard from the wheelhouse. Also there should be a catwalk in front of the wheelhouse for a clear walkway from the port to the starboard wing. For the wheelhouse proper, the width should be approximately one-half the width of the bridge deck, the fore and aft length should be 12 to 15 feet and the height from deck to overhead need not exceed 7½ feet. The maximum number of windows for proper visibility is of primary importance and these windows should be of the crank operated type with upper and lower sections of safety glass. In locating instruments the telemotor should be placed on the centreline of the vessel in the middle of the wheelhouse with adequate room for walking around the telemotor. The electric steering wheel should be close by. All other navigational gear should be placed aft in the wheelhouse and painted with appropriate markings in luminous paint.—*Paper by J. B. Platt, S.N.A.M.E. Bulletin, Vol. 7, January 1952; p. 22.*

New Davit for Merchant Ships

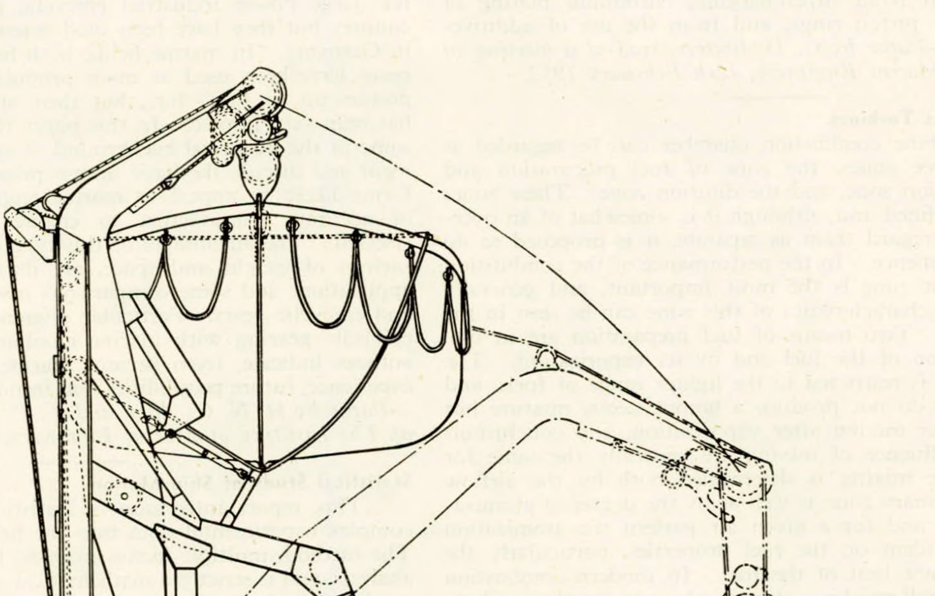
A gravity type luffing davit has been designed for lifeboats of over four tons turned out weight and for tankers' lifeboats of less weight, which require more prompt launching arrangements than can be obtained from mechanically operated davits. This davit has been shown to be capable of smoothly turning out a boat, by gravitational force only, at any angle of list up to 25 degrees inboard or outboard, relative to the boat. The boat chocking and griping arrangements provide effective stowage but give immediate release for turning out when the slip hooks on the griping wires are operated and the chocks fall clear on the release of the griping wires. Control of the boats and davits is exercised by wire falls. These operate on a purchase system, one half of the system which controls the lowering of the boat from the davit head. This means that where the lowering purchase is two-fold, the turning out is controlled by the same falls in single purchase, and where lowering is by four-fold purchase, turning out is by the same falls in double purchase. While this arrangement enables the boat to be turned out without imposing a load on the falls exceeding that imposed when lowering the fully laden boat, it also maintains a pull on the falls and the boat winch sufficient to ensure the turning out of the boat under gravitational forces when there is heavy adverse listing of the ship. This arrangement also ensures that the boat cannot leave its position at the davit heads until the davits have come to rest at their extreme outboard position. Turning out is done by the davit being tracked and luffed simultaneously until the outboard position is reached. The loading of the parts is thereby at a minimum commensurable with the stability and smooth operation of the davit. The company have also designed, for the approval of the Ministry of Transport, a type of mechanically operated luffing davit to turn out lifeboats which have a weight not exceeding four tons when fully equipped and manned. A winch suitable for operating with the davits has been designed to Ministry of Transport requirements and is in production.—*Shipbuilding and Shipping Record, Vol. 79, 24th January 1952; pp. 109-110.*

Motorships for Egypt

The motorships *Star of Luxor, Star of Suez* and *Port Said* of the Alexandria Navigation Company and the Misr Navigation Company, Alexandria, are passenger and cargo vessels built in the yards of the Cantieri Riuniti dell'Adriatico under the supervision of Lloyd's Register of Shipping for the highest class of vessel. Their principal dimensions are as follows:

Length on waterline... ...	390ft.
Moulded breadth	56ft. 6in.
Deck height	34ft. 6in.
Register tonnage	6,433 tons
First class and luxury class passengers	40
Capacity of holds and 'tween decks for grain	350,000 cu. ft.
Speed	14·8 knots

These single screw vessels are each propelled by a single-acting



The new Mechan davit for merchant ships

Sulzer two-stroke Diesel engine built under licence in the Sant' Andrea works of the Cantieri Riuniti dell'Adriatico and have a rating of 4,200 b.h.p. at approximately 130 r.p.m. The electricity required for lighting and general purposes is generated by three Diesel-electric sets of 150 kW. each. Cargo winches, windlasses and capstans are electrically operated and the steering gear is of the electro-hydraulic type.—*Sulzer Technical Review, No. 2, 1951; pp. 29-30.*

Fuels for Marine Auxiliary Oil Engines

The steady rise in operating costs of motor ships in the post-war period has focused attention upon the possibility of effecting worthwhile economies by the use of heavier and usually cheaper grades of fuel in the main engines. However, when the ship's auxiliaries are also of the compression ignition type, the use of the main engine fuel in these smaller, and sometimes therefore more fuel-sensitive engines, poses several problems, whilst being attractive because it avoids the inconveniences of bunkering and handling two separate fuels. A compromise, therefore, may have to be made in the choice of alternative main engine fuel if it is to be suitable for the auxiliaries also, and the paper reviews the more important factors which must be taken into account in deciding upon the suitability of a fuel for this dual service. After outlining the limitations imposed by the specifications against which the various categories of normally available fuels are usually marketed, the influence is discussed of variations, within these limitations, of the individual characteristics of the fuel on the performance and durability of engines in the various size groups found in marine auxiliary service. The data presented were derived from observations made in the laboratory and in actual service and show that whilst in any engine these characteristics may have little influence on performance, the size of engine is an important factor in their effect on durability and maintenance costs. The importance of fuel cleanliness and of the proper maintenance of injection equipment is stressed and reference is made to the benefits, by way of the widening choice of fuels, which may result from supercharging, chromium plating of cylinder bores or piston rings, and from the use of additive-type lubricants.—*Paper by C. D. Brewer, read at a meeting of the Institute of Marine Engineers, 12th February 1952.*

Combustion in Gas Turbines

The gas-turbine combustion chamber can be regarded as divided into three zones, the zone of fuel preparation and mixing, the reaction zone, and the dilution zone. These zones are not clearly defined and, although it is somewhat of an over-simplification to regard them as separate, it is proposed to do so here for convenience. In the performance of the combustion chamber, the first zone is the most important, and generally the effects of the characteristics of this zone can be seen in the other two zones. Two means of fuel preparation are in use, by the atomization of the fuel and by its vaporization. The use of vaporizers is restricted to the lighter range of fuels, and as the vaporizers do not produce a homogeneous mixture but depend on further mixing after vaporization, any conclusions regarding the influence of mixing are generally the same for both types. The mixing is determined both by the airflow pattern in the primary zone as well as by the degree of atomization of the fuel, and for a given air pattern the atomization required is dependent on the fuel properties, particularly the volatility and latent heat of the fuel. In modern combustion chambers the overall residence time is adequate for the combustion of relatively large droplets of 200 microns diameter and above. This, however, does not necessarily mean satisfactory combustion, as even with adequate mixing quenching can be experienced from wall-cooling air or an excess of combustion air, as well as from the air introduced for dilution. Where such effects are present, differences are shown between fuels, but it should be possible to reduce these as our knowledge of the mechanism of flame control is increased. The main fuel characteristic affecting the rate of combustion of a droplet is the latent heat and not the vapour pressure. The reason for this is that the rate of combustion is controlled by the rate of heat transfer to the droplet. The variation of latent heat with practical hydrocarbon fuels is not much, there being a range of about $1\frac{1}{2}:1$ between the heaviest and lightest fuels. As the heaviest fuels have the lowest latent heat, there is some degree of compensation for any effect of vapour pressure in practice. The vapour pressure still has some effect, but this is small in comparison with the possible range of vapour pressure of fuels. A further factor controlling droplet life is the formation of carbon, either directly from the droplet as in the case of residual fuels or in the flame. The time of combustion of a carbon particle is over ten times that of the corresponding fuel particle and, although the residence time may be sufficient for the complete combustion of the fuel, a carbon particle may be quenched before burning out, with a corresponding combustion loss and the formation of smoke. Two mechanisms of carbon deposition can be postulated. First, the quenching of burning carbon in the flame and, secondly, the cracking of fuel deposited on hot surfaces with the formation of a carbon residue. It is thought that both mechanisms are present in both types of carbon deposition, but that the first is preponderant in the case of downstream carbon and the second in the case of upstream carbon. Downstream carbon usually occurs in the dilution zone and at the entry of wall-cooling air, but is accelerated by bad atomization and flame impingement. Carbon on the burner and swirler is probably due to eddies carrying fuel from the spray on to these parts, but the eddies may also recirculate burning particles. The cure for downstream carbon is the control of admission of cooling and dilution air and the elimination of flame impingement.—*J. G. Dawson, Journal of The Institute of Petroleum, Vol. 37, No. 333, 1951; pp. 509-516.*

Epicyclic Gears

Epicyclic gears in various forms have been used in a wide field of engineering for many years. There are many successful applications in automotive engineering, whilst more recently epicyclic gears of considerable horsepower have been used for straight speed reduction, particularly in aircraft. Until recently, few large power industrial epicyclic gears were built in this country but they have been used extensively elsewhere, notably in Germany. In marine fields, both here and abroad, epicyclic gears have been used as main propulsion reduction gears for powers up to 1,000 h.p., but their application for auxiliaries has been very limited. In this paper the authors briefly survey some of the historical background of epicyclic gearing development and discuss the basic design principles of some well tried forms likely to appeal to marine engineers. The importance of accurate manufacture to ensure successful operation is stressed. The advantages of this type of gearing, including the savings of weight and space, are illustrated for a number of applications and some comparisons made between parallel shaft and epicyclic gears. Particular reference is made to the use of epicyclic gearing with marine auxiliaries. In conclusion, the authors indicate, from present marine, industrial and aircraft experience, future possibilities and trends in marine applications. —*Paper by H. N. G. Allen and T. P. Jones, read at a meeting of The Institute of Marine Engineers, 11th March 1952.*

Statistical Study of Ship Motion

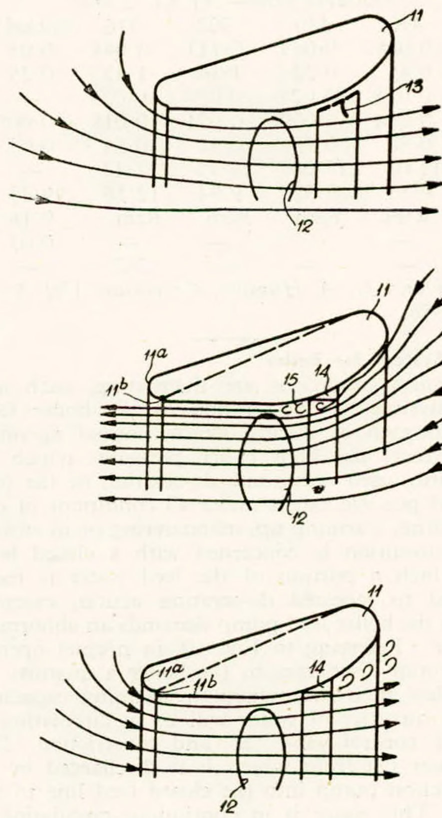
This report introduces a statistical method of handling complex experimental data into the field of naval architecture. The method, multiple factor analysis, is a form of dimensional analysis, and is strictly a mathematical study of the experimental results to find overall relationships between groups of variables. It is a logical tool that can present very complex information in such a form that interpretation of the information is appreciably assisted. This report uses data obtained in seaway simulation tests performed by a self-propelled oil tanker model (TMB No. 4057) at the U.S. Naval Experimental Model Basin. The three objects of the report are as follows: (a) To present the method, together with its major objects, assumptions, and limitations; (b) To present a few results of attack of the seaway simulation test data as examples of the method's use. It should be noted that the intent was to illustrate the method. For this reason, the factor analysis was not carried to completion beyond these aims; (c) To describe procedures used in obtaining these results in sufficient detail to provide an insight into the mechanics of its operation. In view of the nature of the method, a brief mathematical text is included to assist in its understanding. The illustrative uses of the method are as follows: (a) Resonant pitch oscillation of the model was confirmed in a large number of test runs; (b) For resonant pitching, the period of the pitch divided by the period of wave encounter tended to be one of the simple ratios 1/2, 1/1, 3/2; (c) After accounting for the effects of displacement on pitch and heave behaviour from still water standardizing runs; the effects of displacement under simulated seaway conditions were almost entirely accounted for by a simple relation found to exist between displacement, average pitch angle and velocity of encounter; (d) The maximum observed angular velocities of pitching are associated with thrust values a little higher than those required for corresponding model velocities in still water. Very high thrust values are associated with somewhat lower maximum pitching angular velocities; (e) Measurement of the several time periods used in this (periods of wave oscillation, of wave encounter, of pitching or of heaving) is relatively difficult. A measure of the relative unreliability of these values has been obtained from this preliminary analysis, subject to a few simplifying assumptions; (f) Still water test runs were used for calibration of the model for pitch, heave and thrust. It has been found that the model velocity has very little relation to the other experimental variables after accounting for these still water effects. The velocity of wave encounter is the effective measure of seaway response after such calibration. This result is in accordance with the intuitive concept of the independence of wave and overall water motions relative to the model in production of pitching and heaving.—*H. S. Youngs, Journal of the American Society of Naval Engineers, Vol. 63, November 1951; pp. 805-830.*

Tanker Built in Japan

The turbine steamship *Tini*, a tanker of 19,000 tons d.w., is the first turbine steamship to be built in Japan for export since before the war. She was launched from the Sakurajima shipyard of the Hitachi Shipbuilding and Engineering Co., Ltd., and is the first of a series of four similar vessels ordered. The vessel is built to the highest class of the American Bureau of Shipping and to comply with the requirements of the U.S. Coastguard and other regulations. The hull is electrically welded to the extent of 95 per cent, transverse and longitudinal bulkheads being of corrugated type. The cargo pumproom is situated immediately in front of the engine room. The nine cargo tanks are subdivided into twenty-seven compartments by two longitudinal bulkheads. The main cargo pumps comprise three turbine-driven centrifugal pumps with a capacity of 500 cu. m. per hour against a head of 70 m., and one with a capacity of 160 cu. m. per hour against a head of 60 m. The cargo pipeline system follows the latest American fashion, comprising three independent lines with suitable crossover lines. The Butterworth system is incorporated for tank cleaning, and steam and foamite fire extinguishing systems are provided. The main propelling machinery consists of one set of steam turbines, manufactured by the builders, geared to a four-bladed manganese brass propeller having a diameter of 6,000 mm. and a pitch of 4,650 mm. The turbines have a normal output of 8,000 s.h.p. at a propeller speed of 102 r.p.m. Steam is supplied at a pressure of 426lb. per sq. in. and a temperature of 750 deg. F. by two Babcock and Wilcox watertube boilers, which are fitted with an air-operated combustion control system. The latest type closed feedwater system is adopted, with deaerator and condenser. Electric current is supplied at 450 volts a.c. by two main turbo-generators of 500 kVA capacity, and an auxiliary Diesel generator of 80 kVA capacity is also provided.—*The Shipping World, Vol. 126, 27th February 1952; p. 215.*

Improved Kort Nozzle

In this invention a nozzle for shrouding a ship's screw is fitted with a protruding member which detaches the flow of the water from the wall of the nozzle after passing through the screw when the ship is going astern. Thus the water escapes at greater velocity, and the astern thrust is considerably increased. The swinging of the stern to one side or the other is also avoided. In Fig. 4 a nozzle (11) surrounds a propeller (12) and a leather or rubber strip (13) is so fastened in the inlet opening of the nozzle wall when the engines are going ahead and produces negligible flow resistance. When the direction of rotation of the screw is reversed this strip is swung away from the nozzle wall by the flow of water, taking up the position shown in full lines. Figs. 5 and 6 show an alternative



FIGS. 4, 5 and 6.

version with a solid ring (14) on the nozzle, and indicate respectively the streamlines for ahead and astern motion. The edge is so formed that on going ahead only small loosening eddies (15) are formed, while on reversal of the screw the action of the ring has full effect in the rapidly divergent nozzle mouth. Figs. 5 and 6 also show a rounded outlet (11a) from the nozzle with a loosening edge (11b). The form of outlet from the nozzles previously employed is shown in dotted lines. —*Patentee: L. Kort, Hanover (Brit. Pat. No. 661,837). World Shipbuilding, Vol. 2, February 1952; p. 32.*

Reducing Corrosion by Cathodic Currents

Crevice corrosion and pitting occur when chromium bearing stainless steels, chromium-nickel stainless steels and nickel are immersed in quiet sea water. The crevice corrosion on these materials is of the oxygen concentration cell type of attack. The pitting of these materials is usually severe in sea water. Monel in quiet sea water suffers slight, shallow pitting attack which usually is arrested before deep penetration occurs. Experiments were conducted in sea water at Kure Beach, N.C., to determine the effectiveness of cathodic current in reducing these forms of corrosion. Test specimens were coupled to magnesium anodes with appropriate resistors in each circuit to control the currents. Potential measurements were made during the course of two runs of four and six months, respectively. Cathodic current in quiet sea water reduces pitting and crevice corrosion on Types 410 and 430 stainless steels, but its use is impractical because it causes severe blistering when the current is sufficient to eliminate the corrosion. This blistering is due to hydrogen which is formed on the cathode surfaces by the current. Hydrogen is also generated on mild steel surfaces, but does not ordinarily produce blistering. Cathodic currents effectively reduced these forms of corrosion on nickel, Monel and Types 302 and 316 stainless steels without the development of blisters even at 30 ma per sq. ft. The composition of the materials referred to is as follows:

Stainless Steel—A.I.S.I. Type

Element	410	430	302	316	Nickel	Monel
C ...	0·088	0·069	0·111	0·048	0·03	0·12
Mn ...	0·45	0·22	1·16	1·85	0·25	1·06
P ...	0·015	0·021	0·026	0·028	—	—
S ...	0·016	0·009	0·021	0·018	0·005	0·005
Si ...	0·36	0·50	0·52	0·54	0·05	0·17
Cr ...	13·01	17·00	18·55	17·41	—	—
Ni ...	0·33	0·32	9·94	12·56	99·43	65·62
Fe ...	Rem.	Rem.	Rem.	Rem.	0·16	1·53
Cu ...	—	—	—	—	0·05	31·47
Mo ...	—	—	—	2·27	—	—

—*T. P. May and H. A. Humble, Corrosion, Vol. 8, February 1952; pp. 50-56.*

Closed Feed System for Boiler

When boiler conditions are fluctuating, such as during rapid manœuvring, the de-aeration of the boiler feed water is not as thorough as during steady normal operating conditions. Further, the high boiler pressures which are now more commonly used necessitate de-aeration of the feed water to the greatest possible extent under all conditions of operation, whether standing, warming up, manœuvring or in steady operation. This invention is concerned with a closed boiler feed system in which a portion of the feed water is recirculated and subjected to repeated de-aerating action, except during periods when the boiler feed pump demands an abnormal supply of feed water. Referring to Fig. 10, in normal operation the boiler feed pump discharges to the boiler a quantity of water equal to or less than the maximum steaming capacity of the boiler, and a quantity of water will be in circulation through the pipe (21), control valve (22) and constriction (23) to the main condenser (2) from which it is discharged by the condensate extraction pump into the closed feed line to the boiler feed pump. This water is in continuous circulation, so that the water in the base of the condenser will be subjected to a repeated de-aeration action as it is sprayed into the condenser through the recirculating system. In the event of an emergency and of the boiler requiring more water than its steaming capacity, which may occur with manœuvring conditions, the pressure in the closed feed line will fall and the valve (22), which is preferably spring loaded, is closed automatically when the pressure in the closed feed system falls to a predetermined pressure, at which point the full capacity of the condensate extraction pump (6) will be available for supplying the boiler feed pump (9).—*Patentees: G. and J. Weir, Ltd. (Brit. Pat. No. 657,170). World Shipbuilding, Vol. 2, February 1952; p. 33.*

New Device for Fish Detection

The "Fischlupe", developed by the German firm Electroacustic G.m.b.H., is a new departure in echo-fishing, and several instruments have already been installed by the Marconi Marine Company in British fishing vessels. It employs a basic principle similar to that of the echometer, sending out sound impulses and receiving them after reflexion from the sea-bed and from intervening fish shoals. Instead, however, of presenting soundings on a paper record or by a light flash against a graduated scale, the Fischlupe employs a cathode-ray tube, similar to those used in radar and television. The employment of a cathode-ray tube, however, is the only point of similarity between the Fischlupe and television. The Fischlupe is an instrument designed specially for the indication of fish by means of reflected sound impulses. It does not "see" the fish as a camera would, but records their presence in the form of a horizontal light trace upon the face of the tube. This light trace shows at a position corresponding on the scale to the depth at which the fish are lying, and it is then that the Fischlupe really lives up to its name, which in English means "Fish-Lens", for once the presence of fish beneath the vessel has been established, the instrument can be focused upon a horizontal stratum of water 45ft. in depth, ignoring the empty water above and below the shoal. This greatly magnifies the echo signals from the shoal, to such an extent that a distinction can be made between the dense fine horizontal traces made by herring and the more widely-spaced bolder traces attributable to larger fish such as cod. More, when a 45-ft. layer of water is under observation, single traces from individual fish can be seen, and the density of the shoal accurately gauged. The advantage of this facility of close scrutiny is self-evident. With a little experience in interpreting the scan the size of an impending haul can be estimated, as well as the direction of the centre of the shoal,

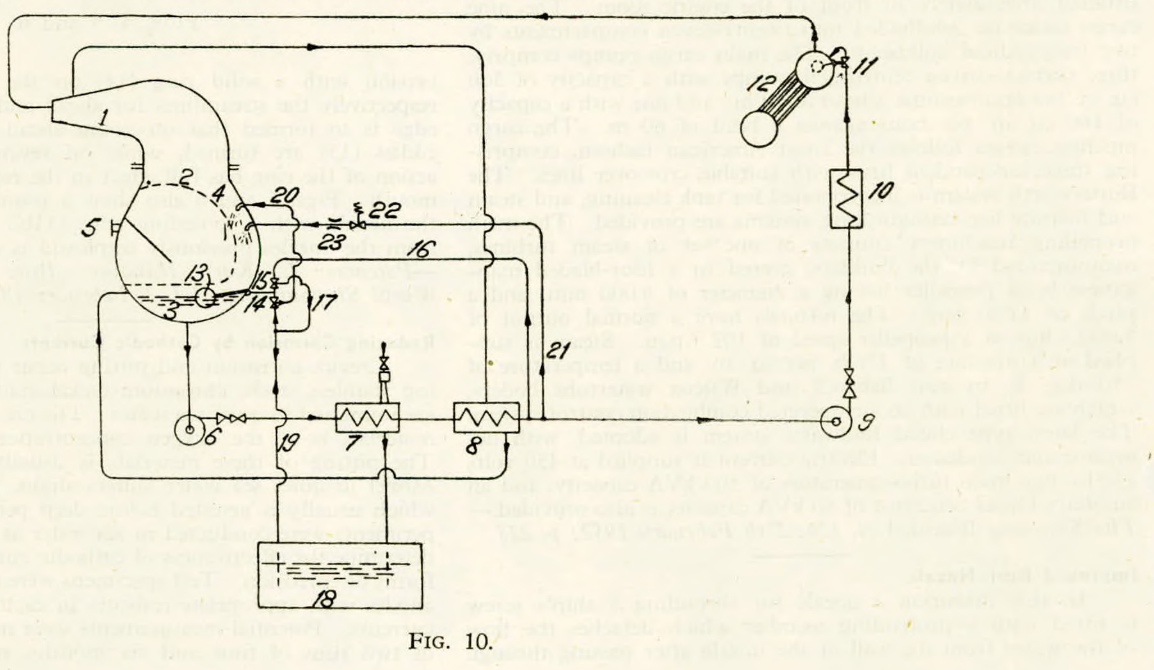


FIG. 10.

where fish are usually thickest. By watching the screen, an experienced skipper can fish spirally inwards from the thin perimeter of a shoal towards the centre.—*Shipbuilding and Shipping Record, Vol. 79, 13th March 1952; p. 337.*

Hydromechanics Research

Hydromechanics is becoming of increasing importance to the marine engineer as, for example, in improved designs of pumps, fluid coupling, servo mechanisms and so on. Considerable interest therefore attaches to the fourth annual report of the British Hydromechanics Research Association, not only because it reveals the scope of the work being undertaken by the Association but also because it covers the opening of the Association's new 14,000 sq. ft. research laboratory, the first industrial building in the new town of Harlow, Essex. Among the fundamental researches now being undertaken, pride of place is given to the work on cavitation which, it is suggested, is the limiting factor in the use of higher speeds with its reduction in weight and cost of many hydraulic machines. A considerable amount of work is also being carried out on various designs of pumps and, as a part of the long term scheme to study the performance of pumps of the centrifugal type, a transparent test rig is now under construction, the casing being of glass with the impeller and suction pipe in clear "Perspex" sheet. This is to be run in conjunction with a piece of apparatus giving high intensity flashes at a frequency of 2,000 cycles per second with which photographs will be obtained of the passage of tracer particles through the impeller. Of considerable interest too is the work on seals, packing and joints for which an experimental rig has been completed whereby tests can be carried out at any speed up to 3,000 r.p.m.—*Shipbuilding and Shipping Record, 13th March 1952; Vol. 79, p. 324.*

Nodal Pattern Analysis

The paper elucidates the manner in which impeller blades, turbine and axial compressor blades, aircraft and marine propeller blades or similar bodies, vibrate in their higher nodes. It is demonstrated that complex nodal patterns derive from consistent series of simpler modes and that the frequencies of the latter may be plotted in families of curves. Classical work of Chladni, together with more recent investigations on free square and circular plates, is first reviewed. The similarity of the manner of vibration of the cantilevered plate is then described with a note on the relation of the torsional series of modes to the simple flexural "bar" type modes. The vibration nodal patterns of impeller blades are discussed and diagrams illustrate how "complex" modes were resolved into their constituent "basic" modes, each having an ordered place in the families of nodes and frequencies. Similar analysis, with examples, is shown to be applicable to turbine blades, and aircraft and marine propeller blades.—*Paper by B. Grinsted, submitted to The Institution of Mechanical Engineers for written discussion, 1952.*

Flow of Evaporating Fluids in Pipes

This paper presents a theoretical investigation of the adiabatic flow of evaporating fluids in pipes, supported by experiments with water. It is postulated, on the basis of published data, that an evaporating fluid flow will conform to one of three modes: (1) annular (2) separated, and (3) frothing. In types (1) and (2) the liquid and vapour phases flow with different velocities. Starting from assumptions usually made in the subject of fluid flow, theory is developed which enables the mean liquid and vapour velocities and also the associated critical outlet conditions to be calculated. In type (3) a network of liquid maintained by surface tension operates to prevent relative motion, and standard thermodynamic is applicable. In experiments with water the flow was found to be annular. By measuring the fluid momentum at the tube outlet an experimental determination of the relative velocity factor (the ratio of mean vapour velocity to mean liquid velocity) was obtained. Data given by Burnell are also analysed. Measured values of critical outlet pressures and relative velocity factors are in good agreement with those predicted by theory. A chart is provided relating initial pressure, critical outlet pressure, and mass flow per unit area, over a range of initial pressures from 8 to 100lb. per sq. in. abs. for water.—*Paper by D. L. Linning, submitted to The Institution of Mechanical Engineers for written discussion, 1952.*

Nozzle Propeller

In the design, shown on Fig. 3, stationary nozzles are arranged forward of and abaft the propeller, which is itself fitted with an integral nozzle ring. The shapes of the stationary

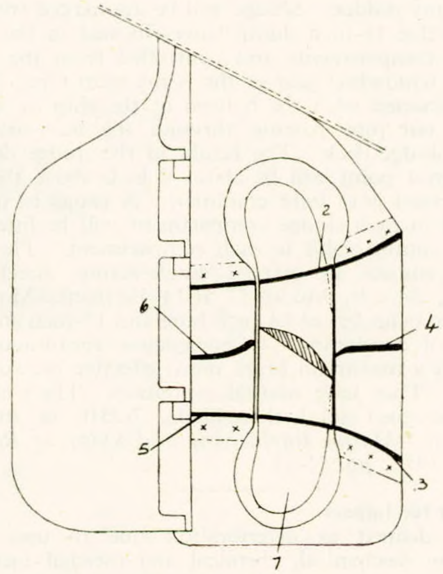


FIG. 3.

and the rotating nozzles are so designed that the water supplied to the propeller and discharged by it is increasingly accelerated. Contra-propellers may be provided. In Fig. 3, the propeller (1) is fitted with an integral nozzle ring (2). The stationary nozzle (3) in front of the propeller has a contra-propeller (4) and the nozzle (5) has a contra-propeller (6).—*L. Schnitger, Bremen (German Patent No. 806,766). World Shipbuilding Vol. 2, February 1952; pp. 31-32.*

New Sludge Vessel

As a component part of New York City's expanding programme of sewage disposal and its plans to eradicate pollution of Class A or recreational waters around the city, the construction of an additional sludge vessel is in progress. Whereas the existing vessels are riveted, the new vessel will be electrically welded throughout, resulting in a considerable saving in weight and, consequently, an increase in cargo-carrying capacity. Welding also produces a smoother hull and one that can stand more rigorous service, with less frequent docking. The new vessel, with its capacity of 1,900 tons, will haul as much in three trips as an existing vessel of 1,430 tons will haul in four trips, and at the same operating cost per trip. An air space, forming buoyancy compartments, will extend fore and aft below the sludge compartments. A centreline bulkhead, non-tight in buoyancy spaces and watertight in way of sludge compartments, extends throughout the length of sludge compartments. Transverse swash (structural) bulkheads will be fitted at mid-length of each sludge compartment. Web frames will be fitted in the engine room and sludge compartments. The hull framing is of the longitudinal system throughout the sludge compartments and of the transverse system forward and aft. Access trunks with watertight doors are to be provided for the sludge compartments and buoyancy spaces. The moisture content of the sludge as delivered to the vessel will be approximately 90-96 per cent. It will be taken on board the vessel by the gravity method through flexible hose connexions attached to the pipe line from the storage tanks. Sludge will be distributed into the six sludge compartments of the ship through a 14-inch filling line on the main deck, controlled by gate valves, thereby permitting loading of the vessel to suit required conditions of draught and trim. The two 10-inch diameter flexible hose connexions are arranged so that the vessel may be loaded from either side and are supported and handled by booms on king-posts, permitting the vessel to rise or fall with the tide without interruptions of the filling process. Any compartment filled with sludge may be allowed to overflow into adjoining compartments through openings in bulkheads between access trunks. By overflowing from one compartment to another, a compartment may serve as a settler for any residue. Sludge will be discharged from the ship through twelve 18-inch dump valves located in the bottom of the sludge compartments and controlled from the main deck by suitable handwheel gear of the rising stem type. Each valve will be connected with the bottom of the ship by means of a watertight tail pipe passing through the buoyance chamber below the sludge deck. The height of the sludge deck is such that its lowest point will be about 9 inch above the waterline when the vessel is in light condition. A gauge to indicate the liquid level in each sludge compartment will be fitted near the filling line control valve to each compartment. The two main propulsion engines are vertical, single-acting, direct reversing, air-starting, 2-cycle, Model 37 E-14 Fairbanks-Morse Diesels having seven cylinders of 14-inch bore and 17-inch stroke. Each is capable of developing 740 horsepower continuously at 275 r.p.m., with a maximum brake mean effective pressure of 85lb. per sq. in. They have natural aspiration. The propellers are specially designed solid three-blade, 7·25ft. in diameter by 5·12ft. pitch.—*Marine Engineering and Shipping Review, Vol. 57, March 1952; pp. 51-53.*

Hard Facing for Impact

Wear, defined as deterioration due to use, is caused primarily by mechanical, chemical and thermal factors. The mechanical factors operate through stress and impact is one of the important stress producers. Hard facing, which is one of the important techniques for combating wear, can provide effective protection against deterioration from impact provided the alloys are properly selected and used. The most appropriate hard-facing materials for such service are martensitic irons, martensitic steels, and austenitic steels; which are considered suitable for light, medium and heavy impact respectively. Static and dynamic compression testing are described, together with data for important hard-facing alloys, while the importance of engineering to avoid tension is stressed. Critical limitations of impact energy and velocity are suggested to minimize structural damage and to help in alloy selection. The three hard-facing alloy types are described in some detail to guide the engineer in their selection. This paper is intended to help engineers cope with the problems of industrial wear and includes some pertinent data on abrasion.—*H. S. Avery, The Welding Journal, Vol. 31, February 1952; pp. 116-145.*

Microstructure of Ship Plate Steel

Microstructure is an important element in the transition temperature of ship plates subjected to the heat of the welding cycle. In this connexion, it has become apparent, from the work done in the last few years on the causes of brittle failure in ship plate, that a more precise means of determining ferrite grain size is needed. The ferrite grain size of ¾-in. ship plate steels usually falls within the range of 40 to 120 grains per sq. in. at 100 diameters. This range in grain size approximately covers the range for ASTM Grain Sizes Nos. 7 and 8. Therefore, the use of ASTM numbers for designating grain size is not accurate enough to show the relationship between grain size and transition temperature. Methods which have been tried for determining ferrite grain size in ship steel are described and compared in this report. The grain sizes of specially heat-treated ship plate steel were determined by use of the intercept method, by counting, by comparison with a special series of photomicrographs, and by fracturing after cooling in liquid nitrogen. The results suggest that the counting method gives the most reproducible results and the best agreement among investigators. However, it is somewhat deficient in that it does not describe the degree of banding or degree of Widmanstätten structure that may be present. Comparison of photomicrographs gave somewhat poorer agreement among different investigators in rating grain size, but such a procedure does permit a partial description of the degree of banding or the presence of Widmanstätten structure. The agreement among investigators using the comparison chart appears to improve as the investigators become more experienced. In other words, some degree of skill is required in using the comparison chart. In the investigation referred to, ferrite grain sizes were determined in Class A ship plate in the as-rolled condition and after austenitizing at various temperatures followed by cooling various cooling rates. The average ferrite grain size was found to be dependent on the cooling rate as well as on the austenitizing temperature. When the ferrite grain size was rated by intercept methods, grain counts, comparison with special photomicrographs and fracture methods, the counting method was the most reliable. The comparison method is less accurate than the counting method, but it is quicker and the type of structure may also be rated. The fracture method was not suitable for determining ferrite grain size in ship plate.—*J. E. Campbell, R. H. Frazier, and H. O. McIntire, The Welding Journal, Vol. 31, February 1952; pp. 78-s-90-s.*

Demineralizing Boiler Makeup

The first installation of silica-removing demineralizing equipment on board ship for treating boiler makeup was made early in the year on the steamships *Ishpeming* and *LaSalle,* operated by the Cleveland Cliffs Steamship Company. The boiler steam conditions are 450lb. per sq. in. and 750 deg. F. The use of such equipment for treating makeup for high pressure boilers instead of using evaporators has been making rapid strides in the past few years in central power stations and industrial plants. The cation exchanger contains hydrogen zeolite which exchanges hydrogen for the cations (metallic ions), calcium, magnesium, and sodium which are in the raw water, as the water flows through the unit. This results in converting the salts of these cations, namely, calcium, magnesium, sodium bicarbonate, sulphate and chloride into the corresponding acids, carbonic, sulphuric and hydrochloric acids. The effluent from the cation exchanger flows through the anion exchanger which contains a strong base anion exchange resin. This resin adsorbs not only the strong acids produced by the cation unit, such as sulphuric and hydrochloric, but also adsorbs the weak acids, such as silicic acid formed from the silica, and carbonic acid from the bicarbonates present in the raw water. In removing the dissolved minerals by demineralization, no chemicals are added to the water; the entire process takes place inside of the units. The zeolite or resin remains insoluble throughout the process and is not lost. After a given number of gallons has passed through the units, the zeolite or resin loses its capacity for removing the cations and anions from the water and must be regenerated. The cation exchanger is regenerated with dilute sulphuric acid and the anion exchanger with dilute caustic soda. The regeneration consists of three steps as follows: (1) Backwashing to remove any dirt that may have been caught by the resin bed. In this step the water is passed upward through the resin bed to expand it and float the dirt out. The backwash effluent is discharged to waste. (2) Introduction of regenerant by means of an hydraulic ejector to remove the cations and anions adsorbed during the previous service run. In this step the regenerant solution is drawn from a tank, in which it has been prepared in advance, by the ejector and passed downward through the resin bed to waste. An excess of regenerant is employed to ensure that all the cations and anions previously adsorbed are removed. (3) Rinsing of the excess regenerant by passing water downward through the resin bed to waste. This step is continued until the rinse effluent is free from regenerant, at which time the unit is placed back in service.—*K. C. Smith and G. Crits, Marine Engineering and Shipping Review, Vol. 57, March 1952; pp. 73-75.*

ENGINEERING ABSTRACTS

Section 3. SHIPBUILDING AND MARINE ENGINEERING

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Cooled Rotor for Gas Turbine

With the gas turbine rotor, partly shown in Fig. 6, each disc in that part of the rotor which deals with gas at a temperature above 550 deg. C. is provided with narrow bores in an annular zone of which the greater radius is less than 0·95 times and the smaller radius is greater than 0·25 times that of the rotor disc. The number of bores (19) is such that the total area of the surface in each section is equal to $(t - 400) \times (0{\cdot}0005) \times A$, where A is the total area of the rotor disc periphery and of the blades, t being the gas temperature over 550 deg. C. Cooling air is admitted through a branch (7) and passes through an opening (9) through the group of bores (19) in the first turbine disc (1) to the cavity (11), and so on. At each stage, air escapes through slots (20, 21, 22). With a decrease in the temperature the bores (19) are omitted, as in the case of the last rotor disc (5). Some of the bores open into hollow moving blades (25).—*Brit. Pat. No. 664,628, Burmeister and Wain, Copenhagen. The Motor Ship, Vol. 33, April 1952; p. 39.*

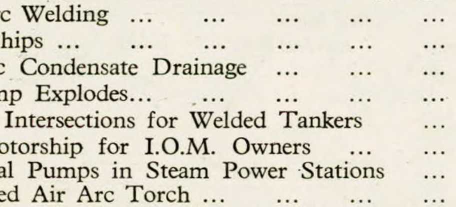


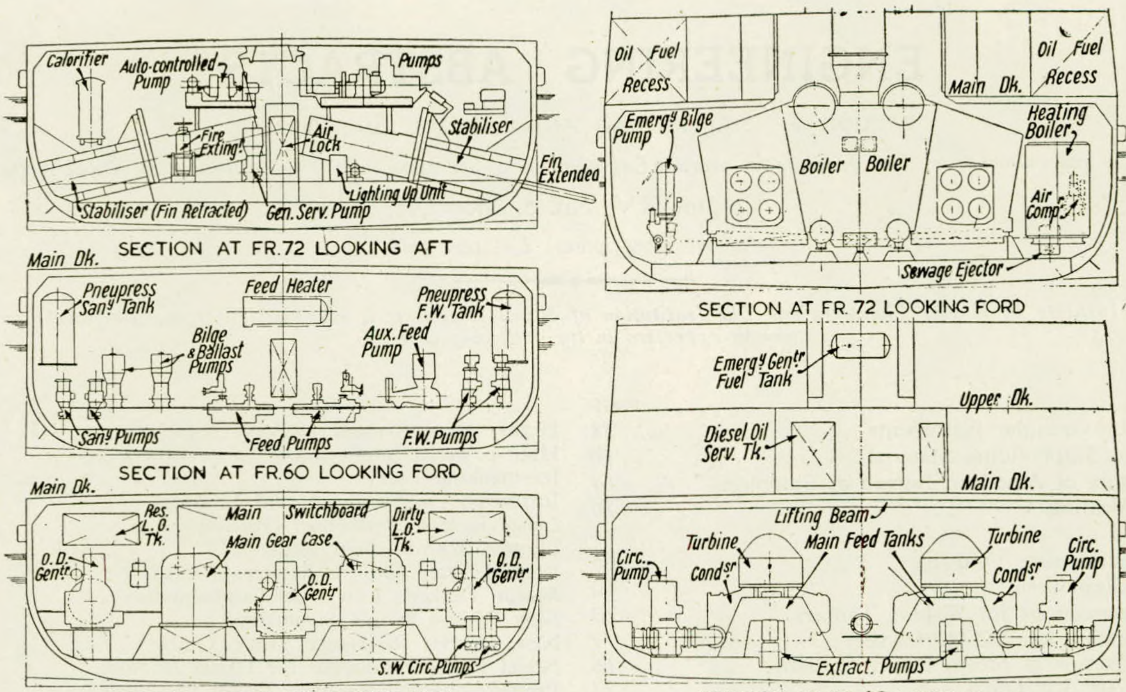
FIG. 6

New Cross-Channel Steamship

The Southern Region of British Railways have recently taken delivery of the new cross-Channel steamship *Normannia.* She has been built and equipped to comply with the requirements of Lloyd's Register of Shipping for a class "A" certificate for channel service, the Merchant Shipping Acts, the Ministry of Transport requirements, and the Merchant Shipping (Safety and Load Line Convention) Act. Her principal particulars are as follows:—

Length overall	309ft. 0in.
Length between perpendiculars ...	291ft. 0in.
Moulded breadth	48ft. 0in.
Moulded depth to upper deck at side ...	25ft. 6in.
Gross tonnage	3,543 tons
Total power	8,000 s.h.p.
Service speed	19½ knots
Passenger accommodation	1,400
Passenger berths	325
Crew	71

Welding has been extensively employed in the construction of bulkheads and for the vertical butts of the shell. The plating is heavily flared and has a distinct chine forward and aft in order to provide the maximum space for cars and cargo. To prevent slamming in head seas and damage to other ships when coming alongside, the anchors are stowed in recesses incorporated in the bow plating. The large balanced main rudder and the bow rudder are both powered by twin-motor electro-hydraulic two-ram trunk piston-type steering gears supplied by Brown Bros., Ltd., of Edinburgh. The bow rudder was fitted to assist the ship when entering ports stern first but also enabled a lengthy full-astern trial of half an hour's duration to be achieved. A speed of 15·6 knots was obtained under these conditions. The steering telemotor for the after rudder is fitted in the wheelhouse, where there is a Siemens rudder angle indicator. An important item of the hull equipment is the Denny-Brown ship stabilizer, which has been installed following the successful operation of similar plants in a number of cross channel and Irish sea vessels. Rolling has been almost



Sections through the machinery spaces showing the stabilizer fins extended and retracted

eliminated, thus adding greatly to the comfort of passengers in bad weather, while steering is greatly facilitated. The *Normannia's* equipment is of the latest type as fitted in the P. and O. liner *Chusan,* but is, of course, smaller. The single-casing impulse turbines are of the Pametrada design which William Denny and Brothers built and installed in the 18,500 s.h.p. 24-knot steamship *Brighton.* A similar but higher speed and lower powered arrangement has been adopted in the *Normannia,* where the combined output at the two propellers is 8,000 s.h.p. at 270 r.p.m., with steam conditions of 350lb. per sq. in. and 650 deg. F. The ahead blading consists of a compounded-velocity stage followed by eight impulse stages, the steam flow being towards the after end of the casing. The astern elements comprise a compounded-velocity and one impulse stage, with a forward steam flow, to give 85 per cent of the full power ahead revolutions. The nozzles and diaphragms of each turbine (both ahead and astern elements) are carried in a single cast steel pressure casing, supported within an outer fabricated shell. The pressure casing is secured only at the line of the steam admission belts and is able to expand freely forward and aft from this point on the supporting palms which can be seen in the illustration. The space between the outer shell and pressure casing is in communication with the steam space of the condenser; uniform temperature conditions thus prevail all round the pressure casing and obviate the necessity for any insulation of the outer shell. A light metal shield prevents loss of heat from the higher temperature parts of the inner casing to the steam space, and a flexible diaphragm plate closes the annulus between the casing and shell in way of the ahead steam branch. The after end of the shell is rigidly bolted to the gear case, and the forward end is carried on a suitable seating. The turbine rotors are machined from single forgings and are of such stiffness that the first critical speed is at least 30 per cent above the maximum running speed. The rotors are only 6ft. in length, between bearing centres. The blading, shrouding and nozzle segments are of stainless iron. The nozzles are of the built-up type having separate segments secured by rivets and interlocked joints to a steel centre. The *Normannia* is the first British merchant vessel to employ locked train double-reduction gearing, or to use the nomenclature of the recently-published B.S.S. 1807: 1952, dual tandem articulated gear trains. This design was used in two of the wartime-built turbine-engine frigates and is also employed in certain of the *Daring* class destroyers.—*The Marine Engineer and Naval Architect, Vol. 75, March 1952; pp. 96-105.*

Air Drying by Granular Adsorbents

Adsorption is defined briefly as a selective surface attraction exerted by the adsorbent for the adsorbate, but the physical mechanism is not fully understood at present. For some years the process has been used on a laboratory scale for very low humidity work and on a commercial scale for higher humidities, but developments of supersonic wind tunnels and other research plant revealed an intermediate field where information was scanty. To reduce this gap in knowledge, tests were made at the Royal Aircraft Establishment of a pilot plant with an uncooled bed. The investigation covered two adsorbents, silica gel and activated alumina, and a range of inlet humidity, air velocity, bed depth and adsorbent grain size. A design method based on the results is given but, owing to the limited data, portions of the method are extremely tentative. For drying air supplied at atmospheric humidity uncooled beds are not economic, but may be advantageously combined with a refrigerated precooler. Regeneration, i.e. removal of the adsorbed water, is discussed and some methods of reducing the high rate of heat consumption per pound of water adsorbed are given. Examples of large low-humidity driers are described, in two of which advantage is taken of specialized usage to reduce the mass of adsorbent and the heat consumption. Finally, the application of adsorption to air conditioning for relative humidities around 30 per cent is discussed.—*B. L. Rathmell and P. J. Bateman, Journal of the Institution of Heating and Ventilating Engineers, Vol. 19, February 1952; pp. 471-523.*

Highly Supercharged M.A.N. Diesel Engine—(1)

Some years ago the M.A.N. began the construction of a trial engine, which was to have a mean effective working pressure of 15-16 at. (210-225lb./in.) with the aid of exhaust gas turbo-charging and with the lowest possible fuel consumption. Beside the basic thermo-dynamic considerations which had to be taken into account when the engine was designed, constructional questions, such as the cycle of operations, the

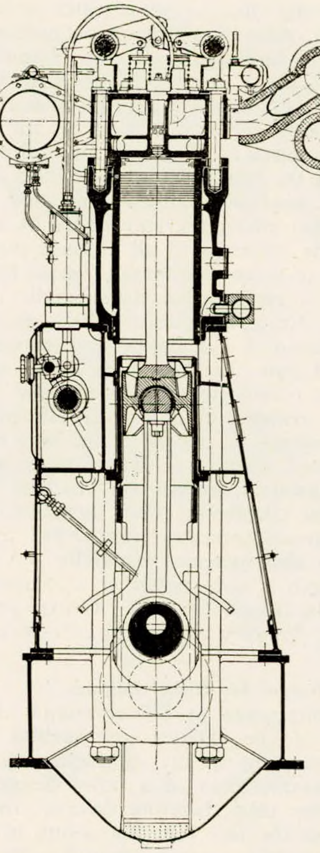


FIG. 2.—*Cross-section through experimental welded-type M.A.N. engine, 300 mm. bore and 450 mm. stroke*

number of valves, the advisability of using a crosshead, etc., had to be answered. At the same time this engine, with its high efficiency, had to be suitable for continuous service. All this meant that the stress on the bedplate and the crankcase could not be allowed to exceed the usual figures. For the high charging-pressure adopted, also, an exhaust-gas turbo-blower of several stages had to be built. On account of the charging pressure and the limit placed on the fuel consumption, the output of the engine was set above a certain limit, in order that the degree of efficiency of the blower could be satisfactory. The result of these considerations was a six-cylinder engine with a bore of 300 mm. (11·81in.) and a stroke of 450 mm. (17·72in.)

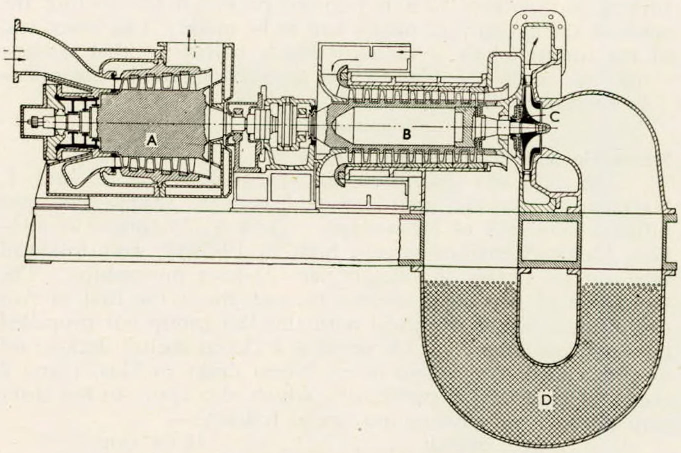


FIG. 13—*Section through exhaust-gas turbo-blower*

A.—Five-stage turbine. B.—Nine-stage axial part of blower. C.—Single-stage radial part of blower. D.—Intercooler.

It was decided to employ crossheads. A cross-sectional elevation of the engine is shown in Fig. 2. By adopting this design, a low lubricating oil consumption was obtained and favourable starting conditions were created to run the engine on heavy oil. The base and frame are welded, as this method of manufacture was the quickest and least expensive for a trial engine. The cylinders are cast and fitted together in block form, connected by a top-plate. The crankcase and the cylinders are separated by a round crosshead working in a corresponding cylindrical slide. The base, frame and cylinders are bolted together with steel tie-rods. The multi-stage design of the turbine and blower is shown in Fig. 13. It has been indicated that this design was adopted as the pressures of the exhaust gas and the charging air were to reach higher values than usual and the greatest efficiency was required of the charging assembly. The blower is distinctive by reason of its subdivision into an axial and radial part. A mean effective pressure of 15 at. (210-215lb./in.^{2}) was the designed normal load. The specific fuel consumption reached its lower value at 16 at. (225-230lb./in.^{2}) and this was quite clearly below 140 gr./b.h.p./hr. (0·31lb./b.h.p./hr.). The fuel used had a net calorific value of 10,170 K.cal./kg. (18,200 B.T.U./lb.). The thermal efficiency, therefore, reached the remarkable value of 44·6 per cent. The fuel consumption curve is particularly flat even at relatively high loads, being at 20 at. (285lb./in.^{2}), scarcely 142 gr./b.h.p./hr. (0·3125lb./in.^{2}). The exhaust gas temperature at about 16 at. working pressure amounts to only 500 deg. C. (932 deg. F.). It rises with the increasing charging air temperature to about 560 deg. C. (1,040 deg. F.), but still remains below the value reached with a normal pressure-charged engine, running at 600 deg. C. (1,112 deg. F.), with half as great mean pressures. This temperature of 600 deg. C. is still the limit for continuous service that can be permitted without endangering the uncooled rotor of the exhaust-gas turbine. The trials relating to the influence of the charging air temperature with constant load have shown that with an increase in this temperature the fuel consumption rises accordingly. The figure for full load is about 2·4 gr./b.h.p./hr. for a rise in temperature of 35·7 deg. C. (96 deg. F.), or, in other words, with an additional fuel consumption of 1·7 per cent.—*G. Eichelberg and W. Pflaum, The Motor Ship, Vol. 33, April 1952; pp. 18-20.*

Evaporator Plants

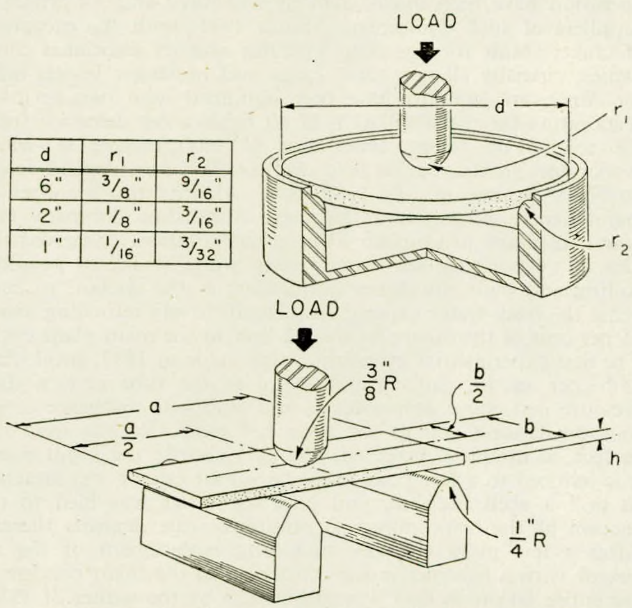
The United States Navy has employed multiple-effect vacuum-type evaporator plants aboard virtually all steam-turbine-driven Naval vessels since 1922. Since that time a great many improvements in design, construction and simplicity of operation have been made, both by the Navy and its principal suppliers of such equipment. Since 1945, with the exception of tankers built for one large operator and its associated companies, virtually all new tank, cargo and passenger vessels built for American accounts have been equipped with two or more evaporators for the distillation of all fresh-water demands from the sea. The recent acceptance of low-pressure sea-water evaporators in the marine field did not, however, depend solely on Navy pioneering. In 1937, B. E. Meurk, then manager of maintenance and repair at Isthmian Steamship Company and now consultant to Orinoco Mining Corporation, conceived the idea of evaporating sea water, using waste steam to promote boiling and main condenser condensate as the coolant to condense the fresh water vapour, thereby effectively returning about 75 per cent of the otherwise wasted heat to the main plant cycle. The first experimental installation was made in 1937, employing 35lb. per sq. in. gauge input steam to the tube nest, a shell pressure just above atmospheric, and a vapour discharge direct to a condensing coil in the open hot well. Results were not perfect, as might be expected, and very shortly the input steam was reduced to a few pounds gauge, an air ejector was attached to pull a shell vacuum, and cold sea water was bled to the suction of the brine pump to minimize scale deposits therein. After a few more changes, including replacement of the air ejector with a barometric leg connexion to the main condenser, the entire Isthmian fleet was in business by the winter of 1938-1939, producing all of its fresh water from the sea and, consequently, carrying up to 300 tons of extra, paying cargo per passage.—*Marine Engineering and Shipping Review, Vol. 57, March 1952; pp. 70-72.*

Bilge Pump Explodes

The following is another case which shows the value of checking parts and equipment before it is too late. The first assistant engineer on a dry cargo Liberty type vessel was engaged in adjusting the forward suction valve of the bilge piping system. The discharge assembly and air vessel on the attached bilge pump burst with such force that he was thrown on the fireroom floor plates. Fortunately, he was only knocked unconscious and suffered minor bruises and contusions. This bilge pump was standard equipment on the Liberty type cargo vessel when built, but because of "mothballing" the ship had not been in use for some time. However, the fact remains that upon "de-mothballing", all equipment and accessories should have been checked and rechecked to ensure against any recurrence of accidents such as this engineer suffered. Upon investigation it was learned that the following parts of the forward bilge pump discharge assembly were found to have been disabled and needed renewals: 3½-in. discharge assembly, air vessel, section of discharge piping and fittings. It is believed that the discharge end of the air chamber had become plugged by scale or other accumulation during the inactive period; however, no immediate cause for the accident was determined. In the investigations of similar casualties, it has been brought out that even death has resulted in numerous instances of this type.—*Proceedings of the Merchant Marine Counsel, U.S. Coast Guard, Vol. 9, February 1952; p. 41.*

Dimensional Effects in Fracture

Three phases of the general problem of the effects of dimensional changes of test specimens on fracture characteristics are reported. These are (1) the influence of size on the transition temperature from ductile to brittle fracture, (2) the effect of various ratios of combined stresses on the brittle transition temperature and (3) the effect of combined stresses on fracture strength. In the first problem, flat circular disks of 0·95 C. steel, simply supported around the circumference and loaded by a concentrated force at the centre, were tested at constant deflexion rates and at various constant temperatures in the M.I.T. slow-bend testing device described previously. Sizes were changed in the ratios 6, 2, 1. When the sizes were altered, all dimensions including the disks, supports and loading members were changed in the same proportions. Comparisons were made of the transition temperatures for brittle



d	r1	r2
6"	3/8"	9/16"
2"	1/8"	3/16"
1"	1/16"	3/32"

FIG. 3—*Specimen supports and loading devices*

fracture at the same effective strain rates rather than at equal deflexion rates in order to maintain mechanical similitude. It was found that the largest disk of 6-in. diameter had a transition temperature only 8 deg. F. higher than the disk of 1-in. diameter. Thus the size effect for this material is of a trivial nature in ratio ranges of 6 to 1 as far as the brittle transition temperature is concerned. To study the influence of biaxiality of the stresses on the brittle transition temperature, rectangular plates of 0·95 C. steel were simply supported along two sides, free along the other two sides, and loaded by a central concentrated force. The thickness of all of these plates was equal to ⅛-in. The ratios of supported lengths varied from 0·5 to 2·667, which produced a variation of the biaxiality of stresses from 0·483 to 0·855. Since the circular disks described previously had a biaxiality ratio of 1·0, the present tests studied the effect of this combined stress ratio between 0·483 and 1·0. It was found that if the biaxiality ratio varied from 0·483 to 1·0 the brittle transition temperature at a given effective strain rate increased on the average 62 deg. F. The data obtained in these tests also permitted some conclusions to be drawn regarding the effect of combined stresses on fracture strength. It is shown that as the constraint effect increases, i.e., as the ratio of the biaxial stresses increases from 0·483 to 1·0, the brittle fracture strength also increases markedly. A definite increase in fracture strength is also shown to accompany a decrease in size.—*C. W. MacGregor and N. Grossman, The Welding Journal, Vol. 31, January 1952; pp. 20-s-26-s.*

Novel Pressure Charger for Diesel Engines

Recent developments in Diesel engine design emphasize the importance of the exhaust gas turbine driven pressure charger as outstanding means of increasing specific engine power. The announcement of a novel design of exhaust gas turbine and blower unit therefore deserves the greatest attention. Apart from the fact that the design of the exhaust gas turbine is based upon experiences gained with the operation of explosion type gas turbines, the arrangement of the exhaust gas supply to the turbine nozzles is of outstanding interest. It was found that the size and length of the connexions between the engine exhaust valves and the nozzles chest, and also the size of the latter, exert an important influence upon pressure drop and heat drop and should therefore be kept to a minimum in order to utilize the impulse energy of the discharged exhaust gases. In order to meet this requirement, the new exhaust gas turbine was so designed that the exhaust gases from each cylinder are led through short connecting pipes to individual nozzles chambers. For this purpose, a gas turbine of the vertical shaft type is placed directly above the engine cylinder heads, and in the case of a V-type engine, between the two rows of exhaust valves, the turbo-blower forming the upper part of the unit. As gas temperature drop between engine and turbine is thus kept to a minimum, provision for cooling the roots of the gas turbine blades had to be made. The lower end of the turbine shaft is therefore made hollow so that cooling water can reach the blade roots through internal passages.—*The Engineers' Digest, Vol. 13, April 1952; p. 102.*

Steamship with Bauer-Wach Turbine

The post-war reconstruction programme of T. and J. Harrison, Ltd., the well-known Liverpool shipowners, has hitherto consisted of motorships. Three 9,270 tons d.w. 14½-knot Doxford engined vessels, built in 1947-48, were followed last year by a class of four similar 12½-knot motorships. The *Crofter* is of particular interest because she is the first of two cargo liners, almost identical with this last group but propelled by steam machinery. This vessel is a closed shelter deck vessel with extended fo'c'sle and lower 'tween decks in Nos. 1 and 2 holds. Her principal particulars, which also apply to her sister ship *Forester*, now fitting out, are as follows:—

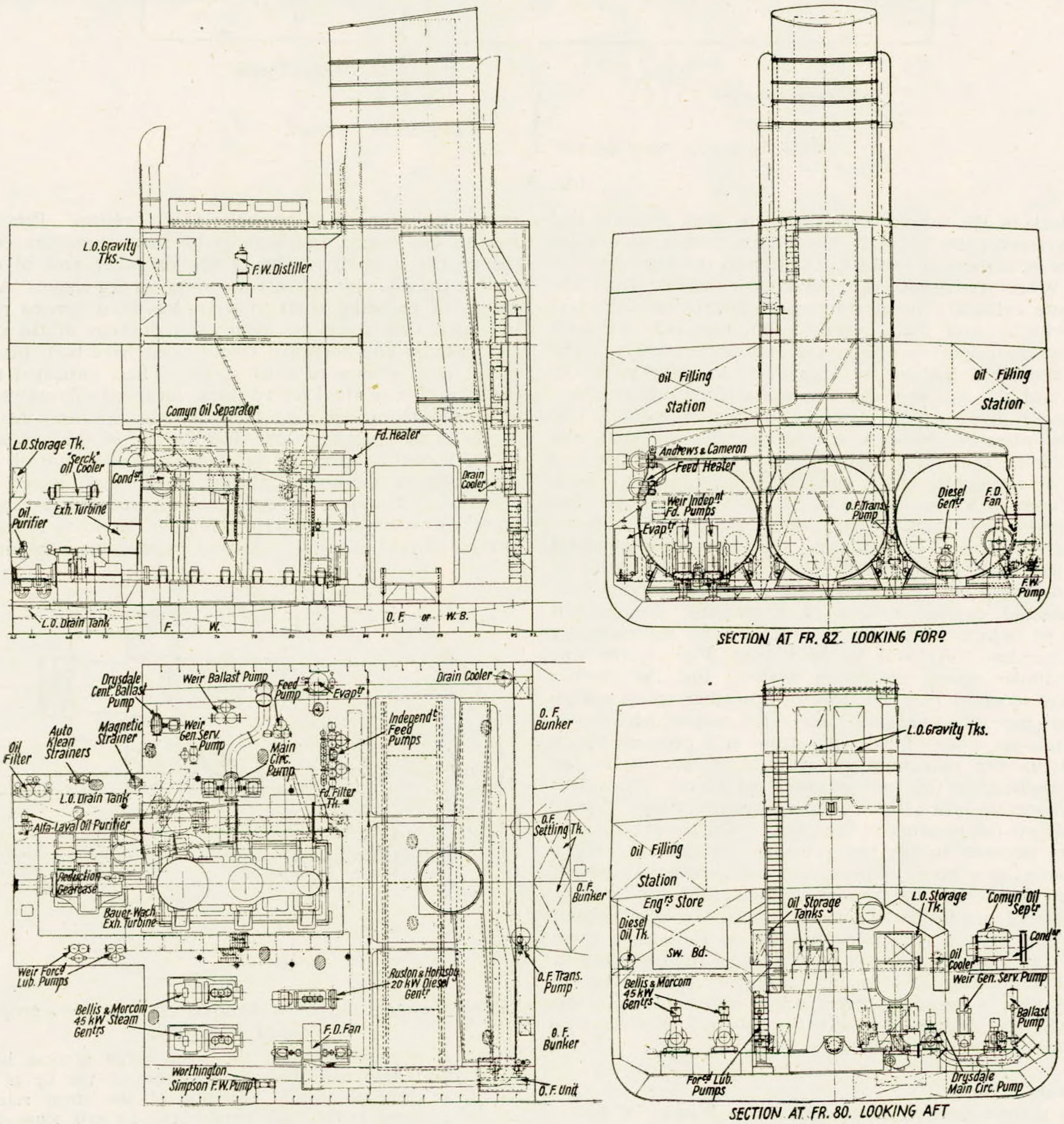
Length overall	460ft. 0in.
Length between perpendiculars	442ft. 0in.
Breadth	59ft. 8in.
Loaded draught	26ft. 10in.

Gross tonnage	8,377 tons
Deadweight capacity	10,400 tons
Loaded service speed	12 knots

The main engines and boilers were constructed by the shipbuilder's engine department. The three multitubular boilers are 16ft. 3in. in diameter and 12-ft. long; each has four Deighton-type furnaces, oil-fired on the Wallsend-Howden system. A MeLeSco smoke-tube superheater, designed to give a final steam temperature of 560 deg. F., with each boiler evaporating 14,000lb. of steam per hour, is fitted in the tubes over each furnace. The superheater headers are machined from solid-drawn double-bored billets. All the branches are welded, the headers and branches being subsequently normalized. Forced draught is supplied by a 72-in. diameter Howden steam-engine-driven fan arranged in the starboard forward corner of the engine room. The main engine and exhaust turbine combination is designed to develop the equivalent of 3,750 i.h.p. at 85 r.p.m. in normal service and 4,200 equivalent i.h.p. at 88 r.p.m. on trials, when supplied with steam at 220lb. per sq. in. and 580 deg. F. temperature. The cylinders are 26½ inch, 44 inch and 74 inch in diameter with a stroke of 48 inch, the l.p. cylinder exhausting to a Bauer-Wach turbine built by the Neptune Engine Works of Swan, Hunter and Wigham Richardson, Ltd. At normal service rating the output of the exhaust turbine is equivalent to 1,050 i.h.p. at 3,342 r.p.m. and under trial conditions the corresponding turbine speed is 3,473 r.p.m. with increased power due to the greater steam flow and higher vacuum then maintained.—*The Marine Engineer and Naval Architect, Vol. 75, February 1952; pp. 55-60.*

Improved Double-compound Engines

Considerable advances have been made in recent years in the field of double-compound marine steam engines, in which the low pressure cylinder is of the uniflow type. An outstanding example is the Fredriksstad Steam Motor, which is built under licence by Rankin and Blackmore, Ltd., Greenock. The engine is built on the Woolf principle, each of the four pistons acting upon its own crank and taking superheated steam of 220 lb. per sq. in. pressure and about 600 deg. F. steam temperature. Each of the two castings comprising the



General arrangement of the machinery space of the Crofter

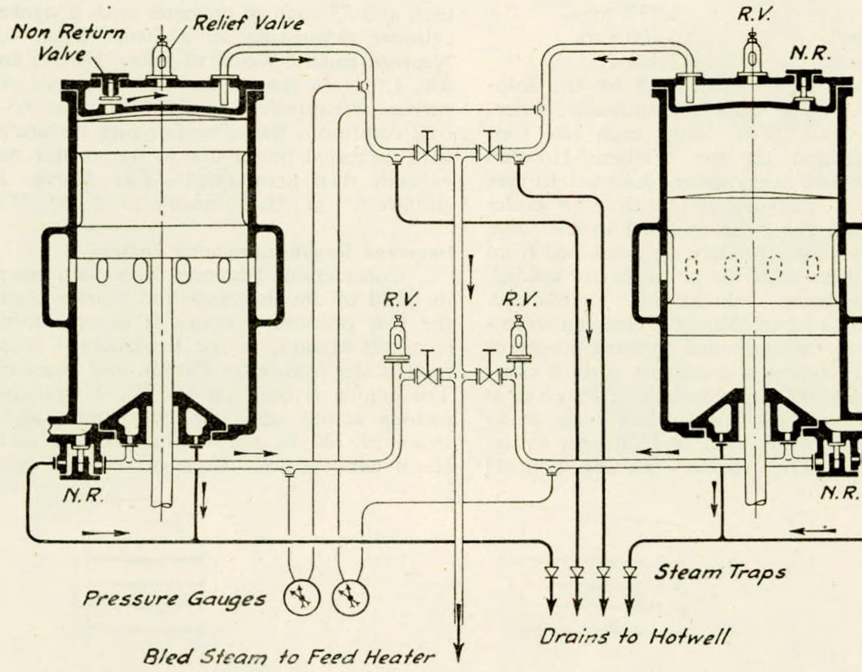
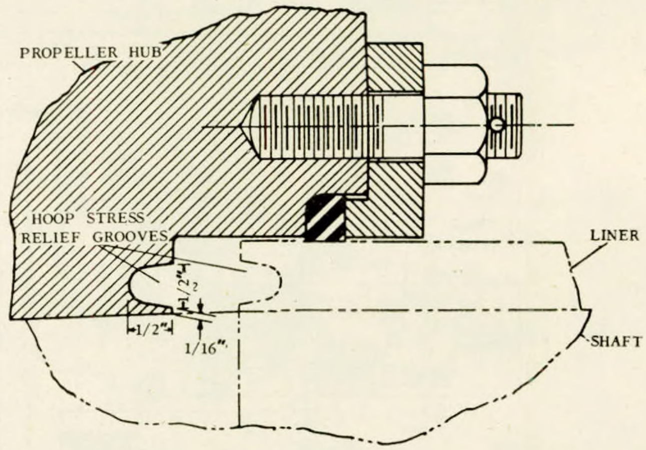


FIG. 3

cylinder block of the engine consists of one high pressure and one low pressure cylinder, with a common piston slide valve which controls admission to the exhaust from the high pressure cylinder. When the piston valve opens for exhaust from the high pressure cylinder, the steam passes directly into the low pressure cylinder and then expands simultaneously in both cylinders, as the respective cranks are 180 degrees apart. The cranks of the other half of the engine are at right angles to these two, and the fact that the engine has four cranks about equally spaced gives a very smooth turning moment. The uniflow low pressure cylinders are ported, and the port area is made so large that the pressure drop between cylinder and condenser is negligible, the engine being designed to work with a vacuum of 95 per cent. In the low pressure cylinders the compression extends to 90 per cent of the stroke, due to the uniflow principle. The resulting high compression would rise to a dangerous level if the vacuum for some reason or other should drop or fail. The safety-feature embodied in the Fredriksstad engine consists of a bleeding arrangement (patented) by which any drop in vacuum is automatically rendered harmless. As will be seen from Fig. 3, the low pressure cylinder covers are made hollow, and the cavities thus formed serve as receivers for low pressure steam which is admitted through unloaded, low lift, non-return valves. These cavities are always filled with steam at a pressure which corresponds to the maximum pressure of 50 to 60 lb. per sq. in., prevailing in the low pressure cylinder. The valves close automatically when the cylinder pressure drops during expansion below the pressure in the cavity. On the other hand, if the steam pressure in the low pressure cylinder rises above normal, owing to a poor vacuum, the non-return valves will admit steam from the compression volume into the cavities, thereby effecting a considerable reduction in the compression pressure. The cavities are also connected to the steam space in the feed water heater, whereby an additional receiver space is created. This heating of the low pressure cylinder covers should also have a beneficial effect upon engine economy by reducing cylinder condensation.—*D. W. Rudorff, World Shipbuilding, Vol. 2, February 1952; pp. 25-27.*

Reducing Shaft Failures

At the annual meeting of the American Bureau of Shipping's committee on engineering there was considerable discussion as to what further steps might be taken in an effort to reduce the number of propeller shaft failures. Previously the Bureau has issued instructions to their surveyors concerning the proper method of fitting the propeller and of effectively sealing the assembly against the access of sea water. An investigation of propeller shaft material has been carried out which indicated that there has been no reduction in the quality of the material and torsional calculations have been made for all of the large groups of sister ships. These indicated that, with the exception of the Liberty ships, torsional vibrations were not a significant contributing factor to the failures. Most of the cracks in the shafting occur near the end of the keyway, in way of the forward end at the fit of the propeller hub on the shaft, or in way of the end of the fit of the shaft liner. The discussions at this year's meeting of the committee dealt mainly with practicable methods for reducing the stress concentrations at these critical locations. Several suggestions were made which



Sketch showing suggested hoop stress relief for propeller hub and shaft liner

NOTE: It is important that the stress relief grooves be at least ½in. deep and that the thickness of the lip at the edge be held at $\frac{1}{16}$in. The side of the stress relief groove adjacent to the shaft should have an easy slope, as shown, to provide effective relief over a distance of at least ½in. from the edge of the fit.

the committee felt could do no harm and might prove effective in helping to alleviate this condition should any owners wish to incorporate them in their ships. A letter was addressed to all owners of vessels classed with the Bureau. This contained the suggestions given below and indicated on the attached sketch. (1) In most assemblies the keyway in the shaft runs out approximately at the bottom of the counterbore of the propeller hub. Since both the keyway itself and the edge of a press fit cause stress concentrations, it is suggested that the stress concentration at this location might be reduced by stopping the keyway several inches short of the bottom of the hub counterbore. (2) In order to reduce further the stress concentration at the end of the keyway it is suggested not only that generous fillets be provided at the bottom corners of the keyway but that at the forward end, reverse fillets be used at the top of the keyway to blend it gradually into the contour of the shaft; this will make a "spoon shaped" ending to the keyway. It is also suggested that two saw slots or a "fish tail" slot be provided in the end of the key itself in order to avoid a sudden change in loading at the end of the key. (3) A considerable amount of research has been carried out during the past fifteen years on the problem of fatigue of shafts at fitted members, most of which has been reported in the Transactions of the American Society of Mechanical Engineers. One simple and practicable method found for reducing the stress concentration in such locations as the end of the shaft liner and the edge of the propeller hub fit is to provide grooves in the end of the liner and at the bottom of the propeller hub counterbore as shown in the accompanying sketch.—*The Marine Engineer and Naval Architect, Vol. 75, March 1952; pp. 111-112.*

Bulkhead Intersections for Welded Tankers

Four large bulkhead intersection specimens were tested in tension in the Engineering Mechanics Section of the National Bureau of Standards for the Ship Structure Committee. The tests are part of a study of the typical structural discontinuities in ships to determine the magnitude of stress concentrations and areas affected by discontinuities, and to furnish data necessary for improving current designs. Each specimen represents the intersection of a longitudinal bulkhead and a transverse bulkhead as found in welded tanker design. Isomeric representations of the four specimens, numbered 5 to 8, are shown in Fig. 1. The specimens were fabricated from steel ship plates joined by welding. Specimen 5 represented the basic structure, modifications of which were used in fabricating specimens 6, 7 and 8. Full penetration welds at the longitudinal bulkhead

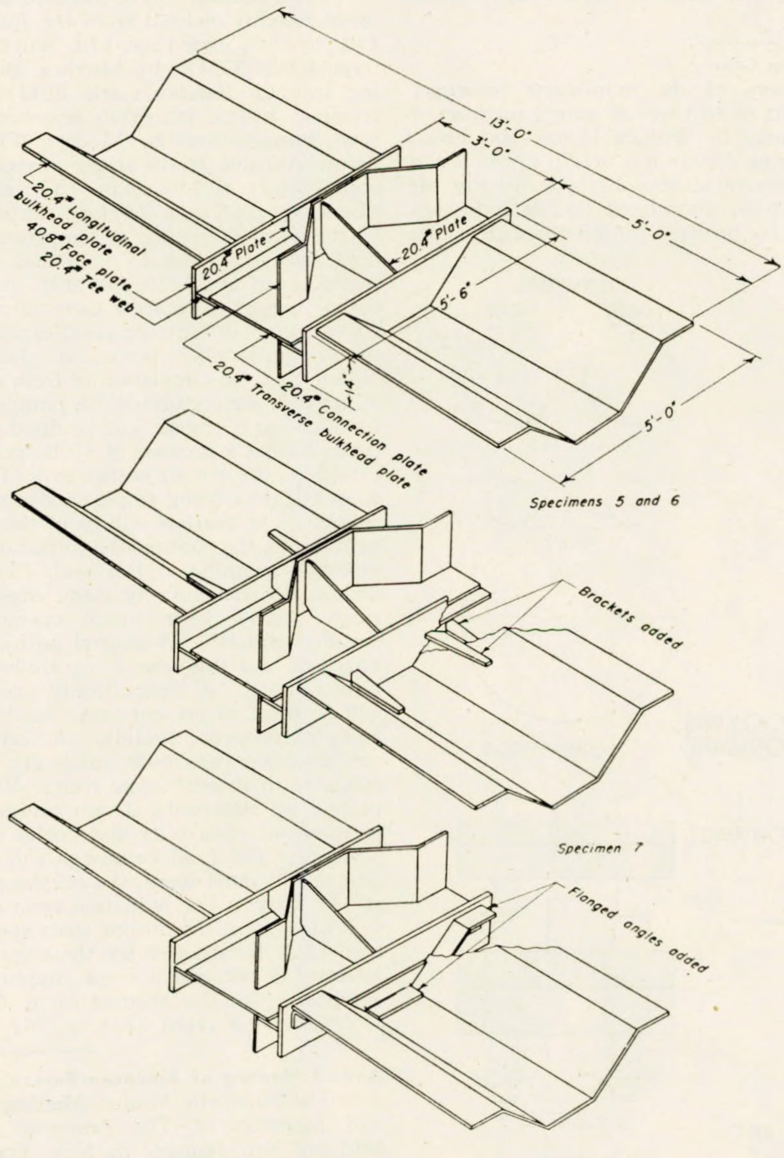
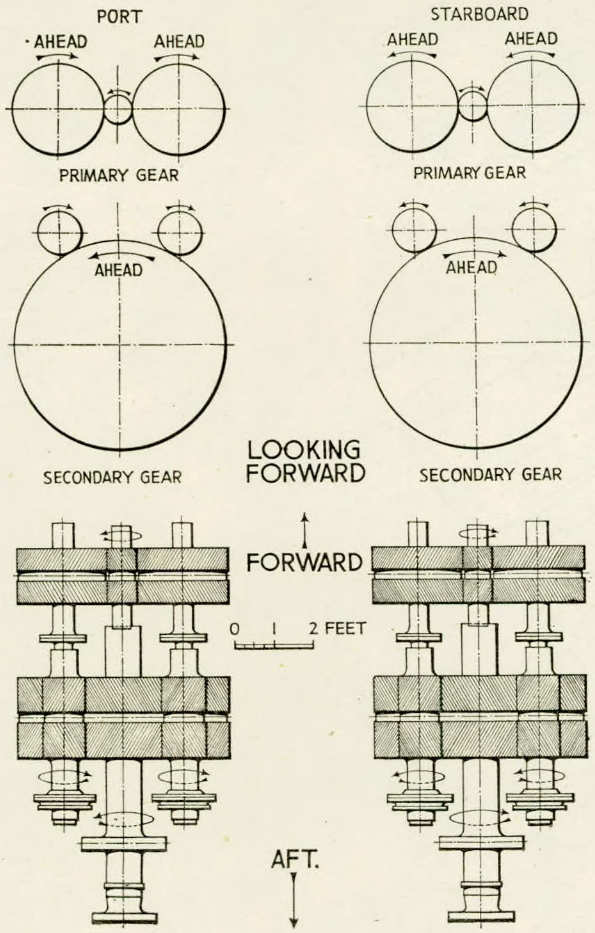


FIG. 1

connexion on specimen 6 replaced the fillet welds used on specimen 5. At the longitudinal bulkhead connexion and in line with the tee web, brackets were introduced on both sides of the sloping corrugated section on specimen 7. Specimen 8 was obtained by adding a formed angle at the longitudinal bulkhead connexion. The elastic stress distribution at room temperature, strain distribution prior to failure at 0 deg. F., and energy to failure at 0 deg. F. were determined, and the maximum loads were measured. Stresses in the axial direction ranging from 2·1 to 3·4 times the average stress in the longitudinal bulkhead were measured at the intersection of the tee web and the sloping sides of the longitudinal bulkhead. The strain distributions for high loads did not differ appreciably from the elastic stress distributions. The four specimens sustained considerable elongation before failure but all specimens ultimately developed brittle fractures in the area of the intersection. Based on the energy for failure, maximum load and reduction of stress concentrations at high loads, specimen 8, for which the basic structure was modified by the addition of angles at the bulkhead connexion, showed the most promising performance of the four designs studied. Based on reduction of stress concentrations under elastic conditions, specimen 7 showed the best performance.—*W. R. Campbell, K. Irwin, and R. C. Duncan, The Welding Journal, Vol. 31, February 1952; pp. 68-s-76-s.*

Locked Train Double Reduction Gear

The propelling machinery of the twin-screw passenger steamship *Normannia* consists of two sets of geared turbines of Pametrada design manufactured by William Denny and Bros., Ltd., the combined output being 8,000 s.h.p. at 270 r.p.m. Each set consists of a single turbine of all-impulse type driving the shafting through a locked train articulated double reduction gearing. Each rotor drives its primary pinion through a fine tooth type flexible coupling. This pinion engages with two primary wheels coupled to secondary pinions through quill shafts having flexible couplings at their after ends. The secondary pinions engage with the main wheel. Primary gear teeth are of "all addendum" form and secondary gear teeth are of "deep tooth" form. The primary gear case is of cast iron and the secondary gear case is of fabricated steel plate. It is of interest to note that this is the first time a locked train double-reduction gearing has been fitted in a British merchant ship. The old *Normannia* and her sister, the *Hantonia,* were also pioneers in their day, as they were fitted with the first sets of reduction gearing to be installed in a passenger ship. Thrust blocks, which are of the Michell line contact type, are incorporated in the gear cases. The shafting is supported in Cooper split roller bearings. The tail shafts, which are without liners, run in oil-filled stern tubes and have normal packed glands at their inboard ends and Newark patent oil glands supplied by Ferguson Brothers (Port Glasgow) at their outboard ends. The stern tube bushes are of brass lined with white metal.—*Shipbuilding and Shipping Record, Vol. 79, 10th April 1952; pp. 467–468.*



Large Reverse Reduction Gearing

The machinery to be installed in the 11,000 tons d.w. cargo vessel recently ordered from the Burntisland Shipbuilding Co., Ltd., by the Currie Line, Ltd., will consist of two Diesel engines (type KVS12GMR) by Mirrlees, Bickerton & Day, Ltd., driving through Barclay Curle fluid couplings and thence to a common reverse reduction gear-box of the SLM oil-operated type, manufactured by Modern Wheel Drive, Ltd. The final power available at the single propeller shaft will be 3,565 h.p. continuously at 116 r.p.m. The engines are of the unidirectional type and each develops continuously 1,955 b.h.p. at 375 r.p.m. when operating in temperate climatic conditions. The bore and stroke are 15 inch and 18 inch respectively. The piston speed is 1,125ft. per min. at 375 r.p.m. The units are turbo-charged to increase their output by 50 per cent over and above their naturally-aspirated capacity and the b.m.e.p. for the installation is 108lb. per sq. in. Jacket cooling is of the closed circuit type, the circulation of fresh and salt water being effected by separate electrically-driven pumps. Separate heat exchangers for each main engine will be fitted. Starting will be by compressed air at a pressure of 300lb. per sq. in. direct to the engine cylinders and two air bottles each of 44½ cu. ft. capacity will be supplied, these being ample to give twelve consecutive starts per engine. The gearbox will be of the twin engine type and rated to transmit the continuous output of both engines when simultaneously running at full load. The box will be of standard design, the manœuvring being effected by the movement of a single control lever which operates either the "ahead" or "astern" clutches. A neutral position is provided for isolation purposes and this also is controlled by the single cock mentioned above. A hydraulically operated propeller shaft brake will be fitted to prevent "over-run" with the consequent possibility of propeller fouling. A feature of the gearing is that the couplings are built integrally, the gearbox casing being extended to accommodate them. Wet sump lubrication is employed, an electrically-driven pump being provided to supply pressure oil via a filter and cooler to all the principal bearing surfaces. The fluid couplings will have a slip of about 3 per cent at full rated speed, the coupling secondary halves revolving at 364 r.p.m. The reduction ratio incorporated in the gearing is 3·125 : 1 and the output shaft speed will be 116 r.p.m. The final shaft horsepower for the engines takes into consideration losses of 3 per cent for the couplings and 6 per cent for the gearbox. (See also abstract on p. 65.)—*The Shipping World, Vol. 126, 16th April 1952; p. 362.*

Annual Meeting of American Bureau of Shipping

The Ninetieth Annual Meeting of the Board of Managers and Members of The American Bureau of Shipping was held on 29th January in New York City. During the past year, meetings of the several Bureau Technical Committees and Special Sub-Committees have been held for the purpose of reviewing the Rules of the Bureau and to consider modifications indicated as being desirable, based upon the service records of vessels and their machinery and equipment in class with the Bureau, and also, to bring the Rules up to date with latest developments. As a result of these activities, several changes to the 1951 Rules have been adopted for inclusion in the 1952 edition, which will soon be available for distribution. Only very minor changes have been considered desirable to be made to the Rules relating to hull construction, materials and welding. In the Machinery Rules, the most important changes deal with stress concentrations in shafting. A new formula has been added to take care of the special case of quill shafts, particularly in association with nodal drives for geared turbine installations. The requirements for propeller shafts have been rewritten to emphasize the necessity for reducing stress concentrations to a minimum in the design of propeller assemblies. Service records of the vessels which have been built since the adoption in 1947 of the present requirements for improving the notch toughness of hull steel plates and in which the improved steel has been used, as well as continued research activities on ship steel problems, have continued to support the action which was taken. There has been growing recognition of the Bureau specifications in steel producing and shipbuilding areas throughout the world, but in connexion with some of the very large amount of foreign construction to Bureau classification, there have been some difficulties in obtaining literal adherence to the Bureau's specifications on account of limitations in available materials and production capacities. With regard to the procedure for repairing shafting by welding, which was mentioned at last year's Annual Meeting, three of the major American repair yards have received Bureau approval to carry out this type of repair. Several yards in other parts of the world have expressed a desire to qualify.—*The Welding Journal, Vol. 31, March 1952; pp. 252-254.*

Pressure-charged Vee-type Diesel Machinery

The contract placed with the Burntisland Shipbuilding Co., Ltd., by the Currie Line, Ltd., for a motor ship of 11,000 tons d.w.c. is noteworthy in that it is for the first British-built ship of this size to be propelled by two turbo-pressure-charged vee-type engines, driving a single propeller shaft. This installation will deliver a total of 3,565 b.h.p. to drive the propeller shaft at 116 r.p.m., and give the vessel a service speed of about 12 knots. These units will be supplied by Mirrlees, Bickerton and Day, Ltd., who supplied a rather similar but smaller machinery installation for the London collier *Fulham VIII* which has also two vee-type pressure-charged engines transmitting to a single shaft a total of 1,640 b.h.p. through fluid couplings and reverse reduction gearing. In the new vessel, the two engines will be unidirectional units, each with two banks of six cylinders, having a bore of 15 inch and a stroke of 18 inch. Each engine develops 1,955 b.h.p. continuously at 375 r.p.m., at which the piston speed is 1,125ft. per minute. The normally aspirated b.m.e.p. has been increased by turbo pressure-charging on the Büchi system from 80lb. per sq. in. to 108lb. per sq. in. Each engine weighs about 60 tons and, with the 26-ton gearbox, the total weight of the propelling unit will be about 146 tons. The hydraulic couplings, built integral with the gearing, will be of the Barclay, Curle rapid-emptying type, the oil being fed by electrically driven pumps from the coupling sumps which are integral with the gear casing. The rapid-emptying rings will be operated from the main control position and used for clutching-in the main engines as required. These couplings have a slip of about three per cent at fully rated speed, the coupling secondary halves revolving at 364 r.p.m. Generally, the gearbox is to be of standard S.L.M. design, manœuvring being effected by a single control lever operating either the ahead or astern clutches. The reduction ratio of the gearing will be 3·125:1, the output shaft speed being, as stated, 116 r.p.m. The final shaft horsepower for the engines gives an allowance for losses of three per cent for the couplings and six per cent for the gearing. A single handwheel will control the starting, stopping and speed variation of each engine, the speed being closely determined by mechanical/hydraulic governor. It is proposed that, for manœuvring, the engine controls should be interconnected by rods and gears or, alternatively, by chains and chain wheels, so that the handwheel of either can give complete control of the entire installation. An isolating clutch will be fitted to ensure that each engine can be controlled independent of the other, but provision is to be made to ensure that both engines are synchronized when running as a single unit. Manœuvring will be carried out without operation of the couplings. To change from ahead to astern will require the engines to be throttled down to about one-third of their normal running speed. If required, the engines may be fully isolated from the gearbox.—*The Motor Ship, Vol. 33, May 1952; p. 64.*

Motor Tanker's Low Fuel Consumption

With the tendency towards higher speeds and powers for tankers, it is interesting to quote performance figures for the 17,720-ton 12-knot motor tanker *Hollywood* which tend to support the contention that this class of vessel is one of the most economical in service. Owned by John I. Jacobs and Co., Ltd., and equipped with an N.E.M.-Doxford four-cylinder engine of 4,250 b.h.p. at 110 r.p.m., and with engine-driven pumps for lubricating oil, jacket water cooling and sea water circulating services, this vessel, in loaded service, has a total daily fuel consumption of about 12¼ tons. On a recent voyage, fully loaded, from Mena al Ahmadi to Antwerp, with the engines running at 99·73 r.p.m. with 4·71 per cent slip, the average speed was 11·96 knots, and the daily main engine fuel consumption was 11·96 tons. An average of 11 gallons of lubricating oil per day was used for the main engines. With one boiler on exhaust gases, the daily boiler oil consumption was 0·911 tons. One of the 54 b.h.p. 23 kW generators is steam driven, the other being driven by a Ruston Diesel engine, and this has a daily fuel consumption of 0·30 tons. Built by Sir James Laing and Sons, Ltd., the *Hollywood* is, therefore, carrying her 17,720 deadweight tons at 12 knots on a total of 12·26 tons of Diesel oil and 0·911 tons of boiler oil per day. The total daily fuel cost at current bunker spot prices will be £151 13s.—*The Motor Ship, Vol. 33, May 1952, p. 69.*

Two-furnace Boiler

The boiler forming the substance of this invention has two separately fired furnaces, two banks of evaporating tubes, and a superheater for the steam produced by the two banks. It also has three separate passages, through which the gases from the furnaces flow in parallel. In one of these passages, one of the banks is heated by gases from one of the furnaces; in another, the other bank is heated by gases from both furnaces. Thus, two of the three passages are associated with one furnace and two with the other and, in order to enable the final steam temperature to be varied, means are provided for controlling the transfer of heat in the superheater and in the other passages. This invention is most usefully applied to boilers in which the combustion air is supplied to the furnaces under pressure and serves to protect the casing of the boiler from being overheated by the furnace gases. The installation indicated in Fig. 4 comprises a horizontal cylindrical boiler (10) supplied with air through an inlet conduit (11) by an air compressor (12), driven during normal operation by a gas turbine (13). The latter is

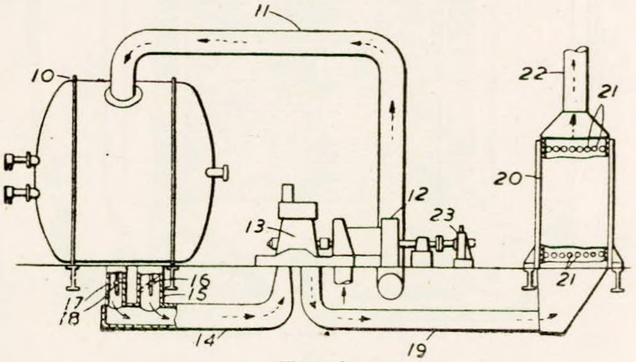


FIG. 4

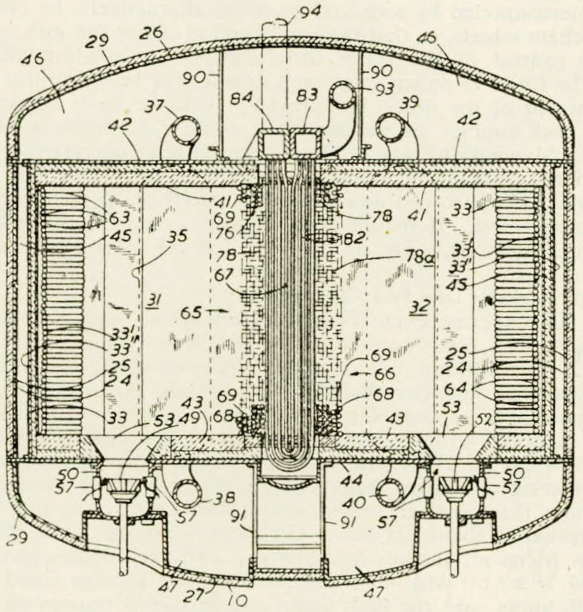


FIG. 5

actuated by gases supplied to it from the boiler through a conduit (14) communicating with the boiler through outlets (15) and (17) controlled respectively by dampers (16) and (18). Exhaust gases from the turbine (13) pass through a conduit (19) into an economizer (20) in which they impart heat to the tubes (21) through which feedwater for the boilers flows. The gases then flow into the flue (22) and thence to the stack. During the starting up period of the boiler, the air compressor (12) is driven by an auxiliary steam turbine (23) or an electric motor. A bank of horizontal superheater tubes (82) is disposed in the central passage (67), Fig. 5. The superheater tubes (82) are connected at one end to a substantially vertical inlet header (83) in the space which is connected to a "dry pipe" (92) by a steam pipe (93), as shown in Figs. 5 and 6. The tubes (82) extend horizontally through the rear wall (43), and then return through the wall (43), passage (67) and wall (42) to an outlet

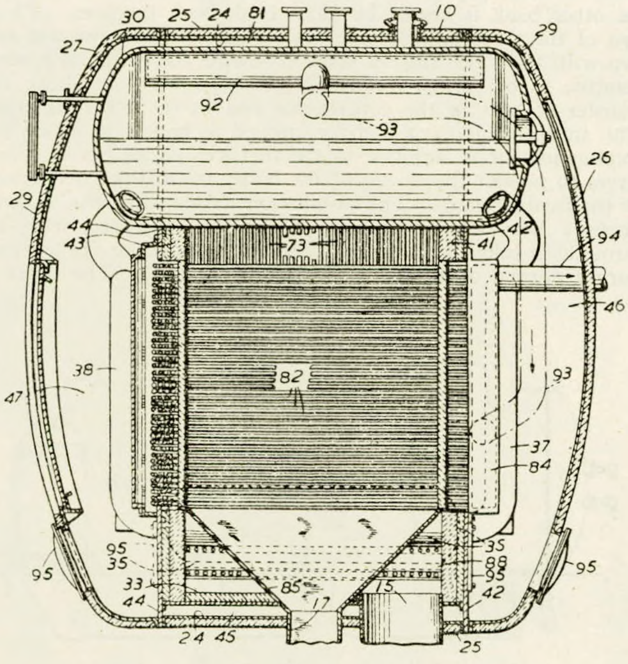


FIG. 6

header (84) which extends parallel to and near the inlet header (83). The tubes (82) are therefore supported in the front wall (43) and rear wall (41). The outlet header (84) is in communication with an outlet line (94). The superheater passage (67) communicates at the bottom through a hopper-shaped conduit with the gas outlet conduit (17), while the gas space communicates with the combustion gas outlet conduit (15).—*Brit. Pat. No. 667,267, issued to Foster Wheeler, Ltd. Application made in the U.S.A., 19th February 1947. Complete specification published 27th February 1952. Engineering and Boiler House Review, Vol. 67, April 1952; pp. 121-122.*

Centrifugal Pumps in Steam Power Stations

Some fundamental and specific hydraulic considerations associated with the operation of centrifugal pumps on condenser cooling-water circulation, condensate extraction and boiler feeding services are discussed and illustrated by simple empirical formulæ and practical diagrams. Attention is drawn to the importance of selecting the correct speed for reliable operation. The hydraulic gradient through a pump is represented diagrammatically to illustrate the meaning of the term "depression head" and to show how this is related to the throttling condition. It is claimed that in certain circumstances a pump can operate advantageously and safely on the throttling point, but otherwise it is essential to avoid what is described as the "cavitation area". A relation is established between pump output, "depression head", and maximum permissible speed. The "speed coefficient" used in the formula is shown to depend on several factors. For circulating water pumps the relation between "depression head" and suction lift is illustrated. Maximum speed in relation to output and variation of pump type with specific speed and net head are presented graphically. Diagrams and curves show the fundamental difference in operating methods of extraction pumps on the two main types of surface condenser and on de-aerators. Factors influencing the choice of speed are outlined. A typical build-up of the pressure characteristics of a boiler feed system is illustrated and the requirements of the system are compared with the characteristics provided by the feed-pumps, both constant and variable speed. Reference is made to the importance of providing suitable pressure-characteristics to ensure satisfactory parallel operation, load sharing and freedom from pressure surge. A formula is developed for calculation of the temperature rise across a feed-pump at any load, and proposals are outlined for keeping this rise within safe limits. Special reference is made to the feed-pump drawing direct from a de-aerator and the problem of avoiding vapour locking with sudden fall in pressure. The main factors which determine the operating speed of a feed-pump are enumerated. Attention is drawn to the importance of, and means of constructing, the pump to withstand a sudden reduction in temperature without incurring casing joint leakages. The relative merits of placing the feed pumps before or after the heaters are discussed, and it is claimed that considerable thermal economy is achieved by using high-pressure heaters.—*Paper by R. Pennington, read at a meeting of the Institution of Mechanical Engineers, 21st March 1952.*

Automatic Condensate Drainage

A new type of steam trap described by H. Richter in a recent issue of Brennstoff-Waerme-Kraft incorporates a nozzle as its discharge element. In order to minimize the loss of steam through the nozzle when no condensate is being discharged, the nozzle has been made of a special form which is outlined in the accompanying illustrations. It is stated that theoretically a nozzle of this type will pass a weight of water which is approximately twenty times the weight of the steam which will pass through the nozzle when operating at 210lb. per sq. in. steam pressure. Or, in other words, the loss of steam through the nozzle when no condensate is being discharged will take place at the rate of five per cent of the rate of discharge of condensate. The special shape of the nozzle, as indicated in Fig. 2, is largely responsible for the low rate of steam discharge on account of the throttling action it produces at the nozzle outlet. It is possible to resort to multi-stage expansion by placing several nozzles in series and thereby reducing the steam loss but, in order to be effective, more than four expansion stages are required. The nozzle described has the advantage

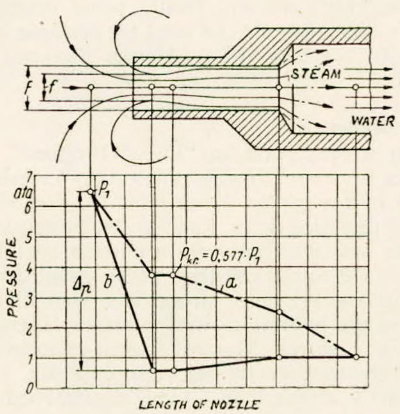


FIG. 2—*Sectional arrangement of nozzle and curves showing pressure-drop through nozzle*

that it is easily manufactured and this is especially important as it must be made of wear resisting material having a high degree of hardness. In the trap outlined in Fig. 3, the nozzle is incorporated in the body of a stop valve *g* which makes possible shutting off the condensate and/or steam supply to

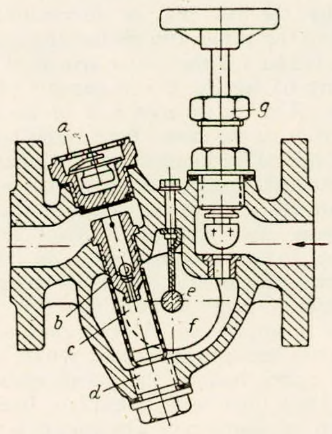


FIG. 3—*Outline of steam-trap of the single nozzle type*

Key:—
(*a*) Bi-metal thermometer.
(*b*) Non-return valve.
(*c*) Strainer.
(*d*) Drain plug.
(*e*) Baffle.
(*f*) Inspection window.
(*g*) Stop valve.

the nozzle whenever this is desirable, for the removal or cleaning of the nozzle body *b*. A steel ball is placed above the nozzle orifice proper and acts as a non-return valve. In order to make it possible to ascertain the flow of water through the trap, inspection windows *f* are provided at opposite sides of the body of the trap, the water being forced to flow round the deflector *e*. A strainer *c* of the cartridge type is provided below and partly around the nozzle body. A clean-out plug *d* at the bottom of the body of the trap allows removal of the strainer for cleaning and, if required, replacement of the nozzle body.—*Engineering and Boiler House Review, Vol. 67, April 1952; pp. 117-118.*

Form Variations of Fast Coasters

The author describes tests carried out at the Norwegian Ship Model Experiment Tank with models of a particular type of vessel used to carry mails, passengers, and cargo on the Norwegian fjords. From the parent form, with its good resistance qualities, other forms were developed with the object of examining the effect of the longitudinal position of centre of buoyancy (Series A); the breadth-draught ratio (Series B); the prismatic coefficient (Series C); and the displacement-length ratio (Series D). In Series E five models were used, two made from the same set of lines used by Taylor in his Standard Series, two in which the lines were changed to a more useful form, and a fifth which was a model tested for a shipyard. The models were fitted with rudder and dummy bossing, but no keel; and the resistance tests were carried out over a speed range corresponding to 8-16 knots for the ship. The results of these tests are shown as Ⓒ-values for a ship having a waterline length of 162 feet, and a method of transferring the results from a ship of this length to ships of the same shape but other dimensions is given. Propulsive tests were carried out only with models of the first four series, the speed range corresponding to 8-15 knots. A propeller corresponding to a ship propeller of diameter 7·52 feet and pitch 6·16 feet was fitted on all models except one, on which a variable-pitch propeller was used. The results are given as wake fractions according to Froude, thrust-deduction fraction, and relative rotative efficiency. The same quantities are plotted against the particular variation corresponding to each series.—*A. Haaland, Norges Tekniske Hogskolè, Trondheim; Skipsmodelltankens Meddelelse, No. 4, January 1951. Journal, The British Shipbuilding Research Association, Vol. 7, March 1952; Abstract No. 5,843.*

Towboat with Nine Rudders

An interesting river towboat, the first of two, was completed recently for the Ashland Oil and Refining Company, of Kentucky, by the Calumet Shipyard and Dry Dock Company, Chicago. The vessel, the *Aetna-Louisville*, is intended to handle an integrated tow of eight oil barges with a total deadweight capacity at deep draught of 26,000 tons. She is powered by three General Motors Diesel engines, of 16-cylinder two-stroke type. These develop 1,600 b.h.p. each, giving a total power of 4,800 b.h.p., and drive triple screws. The screws are fitted with Kort nozzles, and are 8 feet in diameter. There are in all nine rudders, of which three lie immediately abaft the Kort nozzles, the two on the outside being of contraguide design. The other six rudders are used for flanking and for going astern. The three main Diesel engines develop their power at 750 r.p.m., and drive the propellers through reduction gearing at about 225 r.p.m. Electric power is provided by three General Motors auxiliary generators, driving alternators and d.c. generators on the same shaft. The appearance of the ship is also unusual, as she has three funnels in line abreast.—*The Shipping World, Vol. 126, 26th March 1952; p. 294.*

Ice-breaking Ferry

The Michigan State Highway Department's double-ended ice-breaking ferry, the *Vacationland*, with a capacity for 150 vehicles and 650 passengers, is stated to be the largest ship of its type. She was recently completed by the Great Lakes Engineering Works, Michigan, for operating an all-the-year service, between St. Ignace and Mackinaw City, Michigan. The new ferry, which is wholly welded, is 360 feet in length with a moulded beam of 73ft. 6in. and a depth of 43ft. 4in. Special features are incorporated both in regard to the hull and machinery, in view of the fact that the ship will operate in heavy ice, and there are twelve watertight bulkheads arranged so that the vessel will remain afloat if two compartments are flooded. Similarly equipped wheelhouses are arranged at each end of the vessel and, below, are observation rooms and the passenger accommodation. The employment of direct-reversing Diesel engines driving the propellers through Westinghouse electric slip couplings was decided upon after an examination of the Diesel-electric drive and reciprocating steam-engined propulsion. There are two engine rooms with a watertight bulkhead between them and in each is a pair of propelling engines driving three-bladed propellers 12ft. 3in. in diameter with a pitch of 9ft. 2in., the speed being 165 r.p.m. for full output. The slip couplings can be disconnected when required, so that the two bow propellers may revolve freely when the ship is being propelled by the two after engines. Rapid starting and reversal of the engines is possible by disconnecting the couplings, and during these operations reduced excitation is applied to the couplings for a short period, thus reducing the torque and the possibility of the engines stopping. After a predetermined interval the couplings become fully excited and transmit the normal load with a slip of 1·15 per cent. Each coupling will carry 175 per cent of full load torque so that the engine stalls if the propeller is jammed in the ice. Another feature of the employment of slip couplings is that if a propeller is stopped by the ice the engines are brought up to about two-thirds speed with the couplings disengaged, after which maximum excitation is applied, by pushing a control button, thus giving immediate high torque and enabling the propeller to be freed. A second and greater reduction in excitation is applied manually, allowing the coupling to operate at high slip for indefinite periods with very low torque transmission and low propeller speed. If the main engines are running at 100 r.p.m., the propeller speed can be varied in this way down to 20 r.p.m. The four Nordberg engines are eight-cylinder units with a cylinder diameter of 21½ inch and a piston stroke of 31 inch and have a total output of 9,300 s.h.p. They are of the trunk piston design and each drives an attached Roots-Connersville scavenging air blower. It is only in severe ice conditions that the full power of all the engines will be employed but in open water two are sufficient to give the required speed.—*The Motor Ship, Vol. 33, April 1952; pp. 22-23.*

Refrigerated French Cargo Boat

The twin-screw refrigerated cargo motor ship *Kadoura* has been built to the order of the Compagnie Maritime des Chargeurs Reunis, Paris, for their banana trade between Le Havre, Marseilles, the West Coast of Africa and the Canary Islands. She is generally similar to the *Kiffa* and *Koba*, completed for these owners by the Chantiers de Provence last year, and has the following principal dimensions:—

Length overall...	359ft. 3in.
Length b.p.	328ft. 0in.
Moulded breadth	50ft. 6in.
Depth, moulded to upper deck	32ft. 9¼in.
Loaded draught	20ft. 8in.
Deadweight capacity	2,520 tons
Gross tonnage	4,143 tons
Insulated cargo space (approx.)	190,000 cu. ft.
Total power	6,500 b.h.p.
Speed	17 knots

The propelling machinery consists of two sets of eight cylinder Copenhagen-built Burmeister and Wain 850-VTF-110 single-acting two-stroke crosshead-type engines installed by the shipbuilders. The cylinder bore is 500 mm.; the stroke is 1,100 mm., and the total output is 6,500 b.h.p. at 165 r.p.m. All the auxiliary machinery is electrically driven, power being supplied by three 240 kW., 220-volt Burmeister and Wain Diesel generators. Most of the essential pumps, such as those for fresh and salt water, lubricating oil, and also the air compressors, were supplied by the Danish engine builders. De Laval purifiers are installed for treating the fuel and lubricating oil. The ballast, bilge, fresh water and sanitary pumps are of Worthington Simpson make. A novel feature in the engine room is the provision of a Basol degreasing unit. The system comprises two lagged water tanks fitted with portable filter trays and thermostatically-controlled electric heating elements whereby the Basol solution is raised to a temperature of about 190 deg. F. A pump draws from the lowest part of each tank and discharges the degreasing mixture through the lubricating oil coolers. The mixture, together with the removed grease, flows back to the upper portion of the tank and through the filter tray. After repeated cleaning in this manner, the connexions from the tanks are shut off and coolers are rinsed by fresh water from the ship's system, finally being drained to bilge. The plant, of course, can also be used for cleaning engine components prior to overhaul.—*The Marine Engineer and Naval Architect, Vol. 75, April 1952; pp. 169-170.*

Diesel Electric Dredger

According to an article in "Diesel Progress", the Diesel-electric dredger *Western Chief* is noteworthy in being the most powerful craft of her type. A vessel of 175 feet by 46 feet by 11 feet, she is provided with four double longitudinal watertight bulkheads and six transverse watertight bulkheads. The hull is thus divided into more than thirty small compartments, which make her exceptionally strong and virtually unsinkable. She operates on the hydraulic suction principle, there being no fewer than six General Motors sixteen-cylinder two-stroke engines and three broadly similar eight-cylinder, in-line G.M. engines, compactly arranged in a main engine room where they drive a.c. generators which supply current for the dredge pumps. The Vee-type engines are of the 278A type, each being rated at 1,600 b.h.p. The vertical engines are of the 268 type and each is rated at 450 b.h.p. There is thus a total of almost 11,000 b.h.p. of comparatively high-speed Diesel engines housed in a small engine room in this 170-ft. vessel. The six large engines drive 1,200 kW. Allis-Chalmers d.c. generators. The various auxiliary pumps, etc., are driven by alternating current motors, there being two 200 kW. motor-generator sets on board which supply through a separate a.c. switchboard. All the main sets are connected to a common bus on the control switchboard so that the load may be distributed as required to pumping, operating the cutter arm motor or supplying auxiliary equipment. The ladder for the cutter arm is of built-up girder construction, being 65 feet long and capable of dredging to a depth of 48 feet. The cutter motor is of no less than 1,500 horsepower, the drive to the cutter head being taken through an 18 to 1 double-helical reduction gear. There are separate cutters for soft material and for dealing with rock and similar hard dredged material, the wearing edges of the blades in each case being of special alloy material and, of course, renewable when worn. The dredging pump has a 36 inch suction and 30 inch discharge, and either a three- or four-blade impeller of 72 inch diameter, capable of passing solids no less than 18 inch in diameter, is employed. A split casing is used for the pump, the shell liner being in one piece, which can be detached by removing the upper half of the pump casing. Alloy steel is used for the shell liner and face plate liner. The pump spindle is 14 inch in diameter. The pump is driven by four 1,500 h.p. at 600 r.p.m. Westinghouse motors through two shafts and suitable reduction gearing with flexible couplings. Kingsbury thrust and steady bearings are used and the pump's speed can be varied by means of Ward Leonard control. All controls for pump, cutter, etc., are centralized and electrically operated. All operations on board the vessel are directed from the control room by means of radio, telephone or signals, the control room being so placed that those in charge have a good view fore and aft. Close attention has been given to lighting, including flood lighting, to enable operations to be carried on at night.—*The Marine Engineer and Naval Architect, Vol. 75, April 1952; p. 176.*

High-powered Single-screw Cargo Liners

Early in 1945 the managers of the Blue Funnel Line embarked upon an extensive building programme which included a number of fast single-screw cargo liners of two classes, recognized by the letters "P" and "H". Four of each class entered service, the "P's" serving the Far East and the "H's" Australia, and each is propelled by double reduction geared turbines of comparatively high power on a single screw. This feature is the subject of the present paper, which attempts to amplify information, and record in greater detail than already published, particulars relating to the design, construction, and performance of ships which at the time of their design marked an exceptional advance in single-screw propulsion.—*Paper by W. H. Dickie, read at a joint meeting of The Institution of Naval Architects and the Institute of Marine Engineers, 3rd April 1952.*

Atomic Ships

Ships in which the power is derived from atomic reactors are today "within the range of the possible", according to Mr. Odd Dahl, who designed the uranium reactor at Kjeller, near Oslo. There is, however, a vast difference between a system of propulsion which is theoretically possible and one which is commercially practicable and desirable. The only advantage of "atomic" propulsion for merchant ships, so far as present-day knowledge indicates, is the saving in the weight of fuel, and there seems no likelihood, within measurable time, of any economy of operation. Moreover, the low fuel weight may be counterbalanced by heavy machinery weight. The prospects for Naval ships are more promising and when, in the course of a few years, the results are available of the operation of the submarine to be built in America, with atomic propulsion, we shall know a little more clearly how we stand. It would be a pure guess to say when the first merchant ship with atomic machinery will be built, but there seems no hope for the next twenty years. Mr. Dahl mentioned that Norway is one of the countries possessing relatively rich deposits of medium- or low-content uranium ore, and that these would become important when the rich deposits elsewhere are exhausted. It is believed that the world has atomic fuel reserves 600 times as large as those of coal and oil.—*The Motor Ship, Vol. 32, March 1952; p. 481.*

Tanker Trial

The 18,100-ton d.w.c. motor tanker *London Victory*, the first of a series of four standard tankers which the Furness Shipbuilding Co., Ltd., are building for London and Overseas Freighters, Ltd., completed her trials off the Newbiggin Mile and has entered service on a five year charter to the Anglo-Iranian Oil Co. In addition to these four 18,000-ton vessels, the company have two 24,000-ton tankers on order with the same builders, one of which will be delivered this year. All will be propelled by N.E.M.-Doxford engines. The trials of the *London Victory* proved to be of particular interest as, although all the main engine fuel pump deliveries are connected to a "common rail", the entire trials—on the measured mile and the endurance trials—were run with each delivery isolated to its own cylinder. This is the first occasion on which the North Eastern Marine Engineering Co. have run the trials of one of their Doxford engines in this manner. They consider that this obviates the danger of an excess of fuel being admitted to one cylinder in the event of its fuel valve sticking in an open position. The ship, however, will operate in the normal manner with the fuel pumps delivering to the common rail, pending the analysis of the results by the engine builders. The vessel is designed to carry its 18,100 deadweight tons at a mean draught of 30ft. 6in. Built on the combined system of transverse side framing and longitudinal bottom and decks, the hull is extensively welded. The bottom shell and decks are completely welded, and the corrugated longitudinal and transverse bulkheads are welded on the Union-melt system. The main propelling machinery comprises an N.E.M.-Doxford oil engine with six cylinders, having a bore of 670 mm. and a combined stroke of 2,320 mm. The engine, which develops 6,800 b.h.p. at 119 r.p.m., conforms to normal Doxford design and construction and, although it is not intended that it will burn boiler fuel at this stage, the owners have made provision in the installation for the subsequent use of this fuel, if required.—*The Motor Ship, Vol. 32, March 1952; p. 485.*

French Passenger Liner

A maximum average speed of 24·55 knots was obtained on the trials of the new French passenger liner *Lyautey*, built by the Forges et Chantiers de la Mediterranée for the Compagnie de Navigation Paquet. This compares with a designed speed of 22·5 knots. An average of 24 knots was attained on trials for a period of six hours with only two of the three boilers in operation. Fuel consumption acceptance trials showed that at 17 knots 117 kg. of fuel per mile were consumed instead of the designed 135 kg., and at 22 knots 167 kg. per mile instead of 220 kg. The *Lyautey* is fitted with the new FCM/47 boiler, working at a pressure of 885lb. per sq. in. and a temperature of 865 deg. F.—*The Shipping World, Vol. 126, 2nd April 1952; p. 322.*

Largest Scandinavian Ship

The *Brita Onstad*, the first of a series of big tankers to be built at Götaverken, and the largest ship yet constructed in Scandinavia, has a deadweight capacity of 29,000 tons and is to be equipped with a Götaverken Diesel engine, the speed of the ship in service being 14½ knots. The main details are:—

Length overall...	649ft. 8in.,
Breadth moulded	80ft. 6in.
Depth moulded	44ft. 9in.
Mean draught on summer free-board	33ft. 0in.
Deadweight capacity ...	29,000 tons
Machinery	10,000 i.h.p.

There are eleven centre and twelve wing tanks, the total capacity being 1,337,000 cu. ft. The steam-driven cargo pumps, installed in two compartments, have a total output of 1,550 tons per hour. The propelling engine is a nine-cylinder single-acting two-stroke unit, having cylinders 760 mm. in diameter with a piston stroke of 1,500 mm. The speed for full output is 112 r.p.m. Two 200-kW. generators are installed, each driven by a 300 h.p. Götaverken engine. A steam-driven 110-kW. generator is also provided. The nautical equipment includes a Sal log., an echo sounding apparatus, a gyro compass with automatic pilot, a radar installation and an indicator of load distribution named the Lodicator, which has been developed by Götaverken. All cabins are of the single-berth type.—*The Motor Ship, Vol. 33, May 1952; p. 64.*

Desuperheater for Stage-type Boilers

In the boiler of the two-stage type, shown in Fig. 7, the water and steam drum (1) is divided between its ends by a transverse baffle or weir plate (2) into two sections (3) and (4) to which banks of water tubes (5) and (6) respectively are connected. Numerals (7) and (8) indicate the primary and secondary sections of the superheater, and (9) is a tubular desuper-

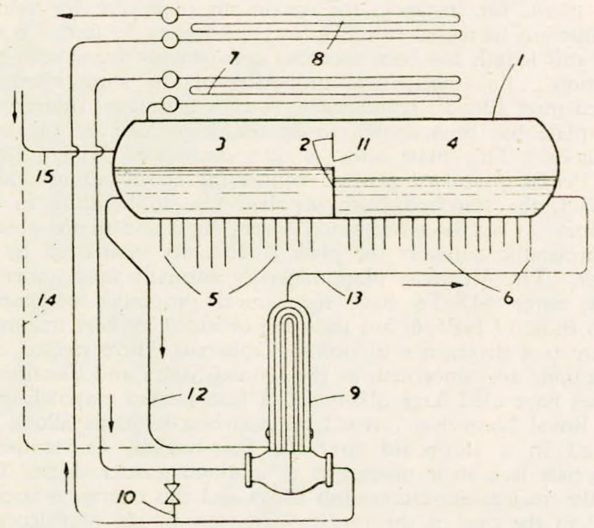


FIG. 7

heater of conventional construction connected between the primary and secondary sections of the superheater. The desuperheater by-pass is controlled by the valve (10). The section (3) of the drum (1) and the water tubes (5) are included in the first evaporative circuit of the boiler and the other section (4) of the drum (1) and the water tubes (6) in the second of such circuits. The weir or baffle plate (2) is such that a higher water level will be maintained in the section (3) of the drum than in the section (4), and water from the section (3) will flow through an aperture or apertures (11) in the plate (2) into the second section (4). If desired, the plate (2) may be such that water flows over it instead of through apertures. The desuperheater (9) is placed in the installation at a lower level than the boiler drum (1), with its water intake connected by the pipe (12) to the higher water level of first evaporative circuit (3) of the drum (1) at a point above the minimum water level which may obtain when there is no load on the boiler. The water outlet from the desuperheater (9) is connected by a pipe (13) to the lower level of second evaporative circuit (4). When the installation is on load, an active circulation of water will obtain in the desuperheater (9), due mainly to thermosyphonic action set up by the transfer of heat to the water from the superheated steam flowing through the desuperheater, but in part resulting from the difference in level of the water in the two sections (3) and (4) of the drum (1). During off load periods the differential water level in the drum maintains a natural circulation of water through the desuperheater, so that settlement of sludge in the desuperheater is avoided. Instead of taking the supply of cooling water for the desuperheater (9) from the section (3) of the boiler drum (1), it may be taken from the economizer. Due to evaporation, the percentage of concentrates in the water leaving the desuperheater (9) will have become increased, and delivery of this water with increased concentration into the first evaporative circuit of the boiler exposed to the highest temperature must be avoided. Therefore a proportion of the feedwater which flows through the desuperheater is arranged to enter the second evaporative circuit of the boiler either at the section (4), or at a water drum or other appropriate point of the second circuit.—*British Patent No. 667,398 issued to The Superheater Co., Ltd. and L. C. Southcott and D. W. Rudorff. Complete Specification published 27th February 1952. Engineering and Boiler House Review, Vol. 67, April 1952; p. 122.*

Aluminium as Shipbuilding Material

The search for an aluminium alloy suitable for shipbuilding plate has produced an alloy containing 4 per cent magnesium and a certain amount of manganese, and this proved to be a practical and economic material. On one plant, for instance, the maximum plate size for normal production increased from 18 feet × 6 feet to 30 feet × 6 feet, and this length has been exceeded considerably for special production. The mechanical properties of the alloy when hot rolled meet Lloyd's requirements with a handsome margin and the plate has been shown to be readily welded by the latest methods. This plate alloy is now designated NP5/6 under the British Standard general engineering specifications and is, in fact, the standard plate supplied for shipbuilding in this country. Corrosion resistance is very high and in the absence of bimetallic contacts the plate is virtually unaffected by sea water. The American plate materials normally used under the alloy name 61S-T6 have mechanical properties comparable with those of NP5/6, but these are obtained by heat treatment. There is a divergence of opinion apparent where riveted constructions are concerned, as the United States and Continental navies have used large quantities of heat-treated material, while the Royal Navy has insisted on non-heat-treatable alloys. If heated in a shipboard fire, the heat-treated, i.e. tempered, materials lose their properties to a much greater degree than do the magnesium-aluminium alloys and this change is irreversible in the case of the former. In view of the prevalence of small fires in action there is much to be said for the British point of view which has been reinforced forcibly by the twin American inventions of Argon Arc and Aircomatic Welding. The magnesium-silicide materials are not suitable for welding unless subsequent heat treatment can be applied, as welds of poor efficiency and of extremely low weld-metal elongation are obtained. In the magnesium alloys, however, welds can be produced virtually equal to the parent metal in strength and elongation and this, of course, applies to NP5/6. It is believed that, as a result of this situation, there is considerable pressure in the United States in favour of a change to the British material in the form of an alloy designated 54S, which is very similar in composition to NP5/6.—*Paper by E. C. B. Corlett, read at a meeting of the North-East Coast Institution of Engineers and Shipbuilders, 22nd February 1952.*

Argon Arc Welding

In the argon arc welding process as applied to the welding of aluminium, the source of heat used to bring about fusion is an arc between a tungsten electrode and the material to be welded. The molten pool of metal created by this arc is protected from oxidation by a stream of argon from a nozzle through which the electrode protrudes. Where filler rod material is required it is applied as flux-free, clean wires or rods which are presented in such a manner that they melt at the edge of the weld pool. The process involves two essential problems, namely (a) to develop the heat required in the material to be welded, and (b) to maintain an oxide-free surface of the materials to be welded. In the normal type of arc welding of metals, with electrodes of the same composition as the material being welded, direct current is used. The substitution of tungsten electrodes introduces electrical difficulties. For the welding of aluminium alloys it is essential that the electrode shall be positive to ensure that the current flow will break up the oxide skin on the surface of the aluminium. Unfortunately, two-thirds of the heat then generated in the arc collects at the tip of the electrode, while the work remains relatively cool. It would be possible to increase the temperature of the work by raising the welding current, but only at the risk of melting the electrode and contaminating the weld with globules of tungsten. The practical solution of this problem is to use a.c. instead of d.c. By so doing, better heat distribution is obtained and the requisite scouring action of the current flow is maintained. For the main power units standard types of a.c. welding transformers are used. For general purposes their open circuit voltage should preferably be not less than 100 v. Lower voltage—70/80 v.—may be used if only thin materials are to be welded, but this does not help with regard to arc stability. As a general rule it may be taken that the welding of aluminium alloys requires approximately 1 amp. for each one-thousandth of an inch of thickness. Capacity can be built up by using two or more transformers in parallel, e.g. two 300 amp. transformers may be used to serve a 500/600 amp. torch. Owing to the large currents which are required to weld thick aluminium stock, there is an increasing demand for transformers of the order of 1,000 amp.—*J. R. Handforth, The Shipping World, Vol. 126, 6th February 1952; pp. 160-161.*

Stainless Clad Steels

A stainless clad steel is a composite steel made up of a mild or low-alloy "backing" steel to which a stainless-steel cladding is continuously bonded over the entire contact area. The stainless steel cladding generally amounts to about 10 to 20 per cent of the total sheet or plate thickness. Stainless clad steels are generally commercially produced by (1) roll welding; (2) casting; (3) intermelting; (4) arc and gas welding, and other processes in which combinations of these are used. In these methods the final steel-mill operation usually consists of soaking a composite assembly at about 2,100 to 2,350 deg. F. (1,150 to 1,290 deg. C.) followed by hot rolling to the desired plate or sheet gauge. In stainless clad steels, noticeable carbon diffusion may occur across the bond from the backing steel into the stainless cladding when the material is exposed to temperatures at which the diffusion rates of carbon in steel are appreciable. The use of intermediate layers of nickel or certain other alloy materials at the bond between the backing steel and the cladding may considerably inhibit such carbon diffusion, which only in very severe cases has occasionally affected detrimentally the fabrication and service behaviour of clad materials. A.S.T.M. Specifications require that the tensile properties of the stainless clad plate (cladding along one side of the test bar) be equal to or greater than the minimum requirements prescribed for the base plate material alone. Moreover, two bend tests of the composite plate should also be made, one with the alloy cladding in tension and the other with the alloy cladding in compression. On steels and strips less than $\frac{3}{16}$-in. thick the bend-test specimens must stand being bent cold with the clad side in tension through an angle of 180 deg. without cracking on the outside of the bent portion. On plates more than $\frac{3}{16}$-in. thick the purchaser may also require shear tests to show a minimum shear strength at the bond of 20,000lb. per sq. in. Stainless clad steels and applied liners generally are readily weldable. Certain factors, however, should be considered: (1) welding procedure; (2) welding position; (3) positioning and fit-up; (4) groove preparation; (5) plate thickness; (6) dilution and (7) selection of stainless electrodes. Thin plates $\frac{1}{8}$ to $\frac{1}{4}$ inch in thickness are generally welded from both sides with stainless steel electrodes. Moreover, 80 deg. V-joints are most commonly employed on the mild steel side. Plates between $\frac{1}{4}$ and $\frac{1}{2}$ inch generally are welded by (1) tacking plates from base steel side with steel welding electrodes; (2) completing weld on base steel side with steel electrodes; (3) chipping at clad side of joint to remove any unfused area and (4) depositing on chipped groove the necessary number of weld beads or layers with a suitable stainless-steel electrode. Plates heavier than $\frac{1}{2}$ inch generally are welded in a manner similar to the $\frac{1}{4}$ to $\frac{1}{2}$ inch plates. However, because the heavier plates are more susceptible to cracking as a result of high restraint, special joints and welding procedures are sometimes necessary.—*The Welding Journal, Vol. 31, March 1952; pp. 142s-160s.*

Cargo Motorship for I.O.M. Owners

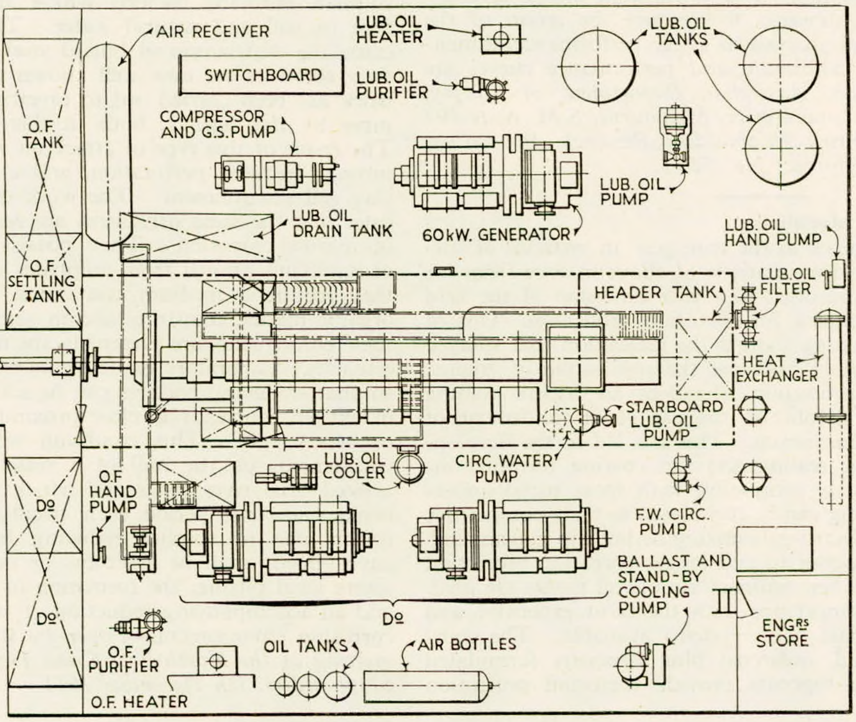
After successful trials on the Firth of Clyde, the cargo motorship *Fenella*, built by the Ailsa Shipbuilding Company, Troon, for the Isle of Man Steam Packet Company, Douglas, has been handed over to her owners. The new vessel is the first motorship to be owned by the company in its long career as carriers between the mainland and the Isle of Man. Intended for the carriage of general cargo, in addition to horses and cattle, the *Fenella* is of modern appearance with raked stem and cruiser stern. An important feature of her design is the large clear between deck space with more than normal headroom, provided for the carriage of motor cars and modern containers. The principal particulars are:—

Length b.p.	210ft. 0in.
Breadth moulded	37ft. 0in.
Depth moulded to main deck	16ft. 6in.
Depth moulded to bridge deck	25ft. 9in.
Gross tonnage	1,019 tons
Net tonnage	438 tons
Speed on service	$12\frac{1}{2}$ knots

The propelling machinery consists of a British Polar engine type M.47 M developing 1,210 b.h.p. at 270 r.p.m. Electrical requirements are supplied by three 60 kW. Diesel-driven generating sets, comprising Sunderland Forge dynamos driven by National M.A. type engines. The main and generator engines are fresh water cooled, each engine having its own heat exchanger. The fresh water cooling pump for the main engine is an independent electric pump, supplied by Worthington Simpson, which draws from the header tank discharging to the engine and thence to the heat exchanger. The sea water supply to the heat exchanger is from an engine-driven pump. An independent electric ballast and stand-by cooling pump of Worthington Simpson make is provided. This pump draws from the sea, the fore and aft peaks and bilges, and discharges to the fore and aft peaks, the cooling system, and overboard. The fresh and salt water pumps for the generator engine cooling systems are driven from their respective engines.—*Shipbuilding and Shipping Record, Vol. 79, 3rd April 1952; pp. 431-433.*

Compressed Air Arc Torch

A compact electric arc and compressed air gouging and cutting torch is claimed to be capable of cutting austenitic chrome-nickel weld metal at speeds comparable to the oxygen-acetylene torch and at a fraction of the cost. The torch uses



Machinery arrangement in the Fenella

a ⅜ × 12-in. carbon electrode requiring a current of 300 to 400 amps. In the rotating nozzle which holds the electrode, two ⅛-in. holes are provided which constitute the compressed air outlets. The escaping air stream therefore passes parallel with the carbon electrode. The new torch is the outcome of efforts to speed up the gouging of austenitic chrome-nickel weld metal seams in naval armour plate. Gouging or cutting with ordinary methods is out of the question and the removal of such welds is slow and costly. Chipping is difficult because of the work-hardened properties of the metal. This led to melting it out with the electric arc. At first gravity was depended upon to remove the molten metal. As a next step an intermittent air jet was used to blow out the molten metal. Later, it was found possible to maintain the arc in a continuous stream of air parallel with the plate. The first combined air-arc torch removed 2,400 feet of ⅜-in. austenitic fillet weld in twenty man-days, while removal by chipping would have taken at least 120 man-days. The torch is finding wide application in structural fabrication, foundries, and steel mills. Although originally developed for stainless steel, it is equally useful for similar work on mild steel.—*The Engineers' Digest, Vol. 13, April 1952; p. 102.*

New Electric Resistance Strain Gauge

The author describes the construction and operation of a new type of unbonded, electric-resistance strain gauge capable of measuring strains up to 8 or 10 per cent. The final design consists of a small bridge-like frame made of aluminium alloy, with two bakelite end pieces firmly attached. Two pairs of nichrome resistance wires 0·001 inch in diameter are strung between the end pieces and fixed to them with a cellulose-base adhesive. A small portion of the frame is thinned out near one end; thus a pivot is formed enabling the frame to bend easily. The gauge has two "feet", consisting of two gramophone needles 2 inch apart, which are inserted into cups attached to the specimen to be tested, and held in position by a pair of spring clips bearing on the frame above the pins. When the specimen is strained, the distance between the needles alters and the frame bends. This action produces a difference in strains in the lower and upper pairs of gauge wires, thereby changing their electrical resistance. This difference produces a deflexion of a galvanometer in a Wheatstone-bridge arrangement, which can be calibrated to measure the strain of the specimen. A theoretical analysis of gauge performance, dimensioned drawings, and calibration and performance curves are given.—*N. L. Svensson, Australian Department of Supply, Aeronautical Research Laboratories, Melbourne, S.M. Note 193 (Sept. 1951). The British Shipbuilding Research Association, Vol. 7, March 1952; Abstract No. 5,931.*

Corrosion Protection by Metallizing

Modern improvements in the wire gun, in methods of surface preparation and in formulations of alloys in wire form for use in wire guns have resulted in a vast extension of the field of application of metallizing for corrosion protection. One of the greatest forward-looking steps is the realization that sprayed metal surfaces are excellent bases for the application of organic coatings and that the protection offered by an organic coating can be extended several-fold by the use of an undercoat of metallized zinc or of aluminium. This has led to the development of special organic sealing and top coating formulations particularly and peculiarly compatible with spray metal undercoats. Today metallizing can be considered as truly competitive to galvanizing, either electro-galvanizing or hot dip galvanizing. Metallizing alone is superior to and longer corrosion protection is provided by it than when ordinary simple oil paints are used. Metallizing alone is competitive with the most expensive and complicated multiple-coat paint systems available. The combination of a metallized undercoat plus especially formulated seal and organic resin topcoats provide corrosion protection superior to anything obtainable to date by organic systems applied directly to steel. It is common to consider the protection offered to iron and steel by various paint systems in terms of two, three, five or seven years maximum period between repaintings. The protection offered by metallizing is considered in terms of five, ten, twenty or more years. These differences in expected life are so phenomenal as to be looked upon with great scepticism. Although this order of protection against corrosion is confirmed by many case histories both in this country and Europe, there is need for more authentic information. This need for authentic information regarding the corrosion protection offered by various thicknesses of sprayed zinc, by various thicknesses of sprayed aluminium, and by these same thicknesses combined with sealing coats of organic materials plus topcoats of organic materials has been recognized by the Metallizing Committee of the American Welding Society. Its Subcommittee III on Corrosion Applications has formulated an extensive programme of testing which is calculated to yield the authentic unbiased information needed in this field. The programme involves the preparation of over 4,500 panels of steel to be exposed at many different locations.—*The Welding Journal, Vol. 31, March 1952; pp. 199-207.*

Ship Corrosion Due to Bacterial Action

Bacterial corrosion due to sulphate-reducing bacteria occurs essentially under anærobic conditions, i.e. in the absence of oxygen. The corrosion product is not rust but contains black sulphide of iron. It is somewhat paradoxical to find corrosion of a most severe character occurring in an environment from which oxygen is virtually excluded. In the case of the ship corrosion which forms the basis of this paper, such anærobic conditions would be attained due to the fact that the hull of the vessel below the water line was encased for several weeks in a thick deposit of mud which is attributable to the location of the vessel and its movement while it rested on the mud bank and to the flow of water carrying suspended mud. This coating of mud was likely to be attached most easily to projecting surfaces on the plates and on rivet points and in view of its viscous and adhesive nature would exclude oxygen from the encased metal surfaces. The explanation of metallic corrosion under anærobic conditions is to be found in the activity of certain micro-organisms. These are the sulphate reducing bacteria which are found in almost every type of soil and natural water. These organisms frequently cause the destruction of buried steel and iron water-pipes and their activities are now well known to water engineers. Much work has been carried out to investigate the corrosion of such pipes by this agency, both in this country and in America. The result of this type of attack on water pipes has been severe pitting, frequent perforation, and always a blackening of the clay soil environment. The work of Veillon in France indicates that the same organisms are responsible for certain types of marine corrosion. They possess the destructive property of removing oxygen from sulphates and for their development they require a medium containing in addition to sulphates, organic matter, moisture, and in some cases iron salts. All of these constituents are present in the mud banks of most marine estuaries. Laboratory experiments by Bunker have shown that sulphate-reducing bacteria can be active in very restricted areas of oxygen deficiency in close proximity to regions of abundant oxygen supply. This condition would pertain in the mud encasements on the hull of a vessel which was immersed in aerated tidal river water and which was in contact with mud banks for some period each twenty-four hours. Thus corrosion due to sulphate-reducing bacteria requires that the environment shall be anærobic or nearly so, and it results in severe local pitting, the formation of black corrosion products, and an accompanying reduction of sulphate to sulphide in the corrosion environment.—*Paper by W. S. Patterson, read at a meeting of the North-East Coast Institution of Engineers and Shipbuilders, 7th December 1951.*

ENGINEERING ABSTRACTS

Section 3. Shipbuilding and Marine Engineering

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Coupon Technique in Corrosion Testing

The "coupon technique" has often been referred to as a method of assessing corrosion. Little discussion, however, has been devoted to important details of procedure. As a result, those inexperienced in the art often draw misleading conclusions from reported data. The paper presents a comprehensive discussion of its application, procedure, and limitations. The "coupon technique" is the only approach which embraces both physical and chemical concepts of a corrosion environment. Small metal plates, commonly called coupons, are weighed and otherwise prepared for exposure, exposed to the well fluids for a number of days, examined, cleaned of corrosion products, and reweighed. Both qualitative and quantitative data are obtained. Careful examination and interpretation of the appearance of corrosion products adhering to the exposed coupons affords valuable characterization of the type of attack which may be anticipated in the well. The difference in weight before and after exposure places a numerical value on the corrosiveness. This paper describes the coupon study procedure of one oil and gas producing company. Selection of coupon material, preparation of specimen, shipment and handling of coupons and methods of exposing coupons under various conditions are discussed in detail. In addition techniques of evaluating and processing exposed coupons are considered. The construction of special equipment for processing and storage of coupons is described. An analysis of the cost of conducting coupon studies on a widespread scale is given. The coupon technique has been used to study corrosion under many conditions. A list of environments which have been investigated through the use of this method include gas lift and gas injection systems, water injection wells, gasoline plants, condensate wells, oil wells of all types, tanks, cooling systems, etc. In general, the results of studies of gaseous system can be interpreted most literally. Studies of liquid systems have been very valuable but occasionally variables not related to the corrosion process have influenced results. A résumé of these and other pertinent factors concerned with the use and limitations of the coupon technique is given.—*Paper by H. L. Bilhartz and H. E. Greenwell, read at the 1952 Conference of the National Association of Corrosion Engineers, Galveston, Texas, 10th-14th March 1952.*

Protection of Inactivated Ship Bottoms

Tests conducted at several reserve fleet sites of the U.S. Maritime Administration show that magnesium anodes can provide adequate and economical protection for the continuously submerged surfaces on the ship hulls. This paper describes the results obtained in a test programme carried out in co-operation with the Maritime Administration personnel on a Liberty ship at their James River Reserve Fleet Site. Two hundred 17-lb. magnesium anodes were used. Total anode current output varied widely with the salinity of the water, ranging from 13 to 81 amperes, with a first year average of 40 amperes. This represents a current density of approximately 2 milliamperes per sq. ft. of submerged hull surface. The estimated life of the anode installation is four to five years. Both steel test coupons and potential meaurements were used as criteria of protection.—*Paper by H. A. Humbie and R. L. Featherly, read at the 1952 Conference of the National Association of Corrosion Engineers, Galveston, Texas, 10th-14th March 1952.*

Gasolene Resistant Tank Coatings.

Rapid corrosion of steel occurs in cargo tanks of Navy tankers when successive cargoes of gasolene are carried. The corrosion results from salt water ballast, hot salt water jets used for gas-freeing, and moisture, in conjunction with the gasolene. The nature of the structures is such that only air drying paints are practicable. Search for such coatings began about 1943. Certain coatings were applied to several ships about 1947. Service under operating conditions resulted in selection of a vinyldene chloride-acrylonitrile copolymer as most promising. General use of this coating on certain tanks of submarines began in 1948. Active use on tankers began in 1951. Trial on tank cars was started in 1950, and two hundred cars are now in use transporting aviation gasolene and jet fuel. Many materials, including many proprietary coating systems, have been tested. Laboratory tests are still continuing. As warranted, service trials are contemplated on additional materials, some of which are sufficiently promising to warrant direct comparison to the present standard under operating conditions. A discussion of the problem of coating underground concrete gasolene storage tanks is included, using data furnished by the Naval Research Laboratory. The paper also includes a discussion of surface preparation, ventilation, safety precautions and costs. Likewise, a discussion of methods other than coatings, which have been investigated to reduce this corrosion problem, is included.—*Paper by W. W. Cranmer, read at the 1952 Conference of the National Association of Corrosion Engineers, Galveston, Texas, 10th-14th March 1952.*

Swedish Ice-breaker

The ice-breaker *Thule* is the third ice-breaker in Sweden owned by the Government and will carry out ice-breaking operations in Swedish waters. The details are: —

Length overall...	204ft. 3in.
Breadth moulded	52ft. 9in.
Displacement	1,950 tons
Machinery	4,500 b.h.p.

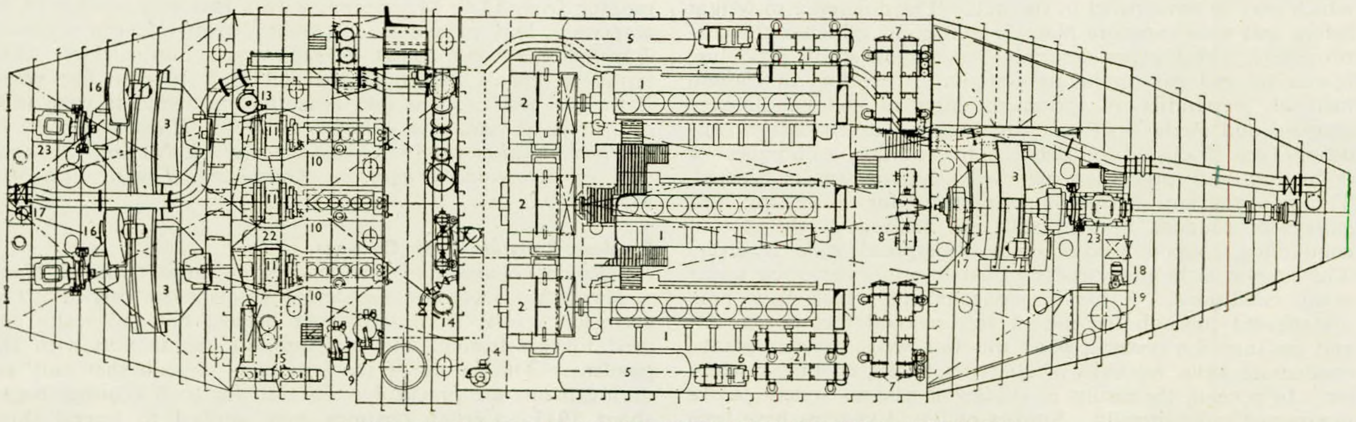
The *Thule*, which will carry a crew of fifty-eight, is to be provided with all the necessary equipment for a modern ice-breaker, including two heeling tanks, each with a capacity of 130 tons. The water in these tanks can be transferred by a propeller type heeling pump in about one minute. Large trimming pumps are also provided. Water, oil and food, if necessary, can be supplied from the m.s. *Thule* to other ships in case of need. There are two propellers at the after end and one forward, each driven by an electric motor of 1,500 b.h.p. Current is supplied to these motors by three generators driven by engines of the Nohab Polar type, built by Nydqvist and Holm, A/B. They are two-stroke eight-cylinder non-reversible units, normally to be run on Diesel fuel, although capable of operating on Swedish shale oil without modifications, when desired. Each is rated at 1,600 b.h.p. at a speed of 335 r.p.m., but when the ship is proceeding against heavy ice, each engine can develop 2,000 b.h.p. at 400 r.p.m. for a period of six hours. For a quarter of an hour the engine may have an output of 2,300 b.h.p. at 400 r.p.m., and for one minute 2,400 b.h.p. at the same maximum speed. The governor is of special design. It controls the momentary load variations, as is the case with a normal pendulum governor, but the speed is automatically increased in a definite relation to the load. With changes in load of 25 per cent and 100 per cent, the momentary speed drop must not exceed 4 per cent and 10 per cent respectively. Automatic regulation of speed change in direct relation to power variation follows from 280 r.p.m. when running idle, up to 335 r.p.m. at 1,680 b.h.p. Above 335 r.p.m. the speed is manually controlled to speeds of about 357 r.p.m., 378 r.p.m. and 400 r.p.m.—*The Motor Ship, Vol. 32, March 1952; pp. 510-511.*

Motion Due to Slow Precession of a Gyroscope

The movements of a special gyroscopic system due to precession are considered. The system consists of a rotor driven through a directionally-free coupling, an arrangement which has found use in certain control instruments. When the system is processed at uniform velocity about an axis perpendicular to the driving axis, relative angular deflexion of the rotor takes place. In general, the rotor axis follows a spiral path, ultimately attaining an equilibrium position relative to the driving axis. When precession is stopped the rotor axis returns by a separate path to its zero position. These motions depend on the properties of the system, in particular: (1) rotor spin; (2) rotor windage torque; (3) friction at coupling joints; (4) inertia of driving system; (5) precessional velocity; (6) rotor inertia. The paths resulting from changes in each of these variables are studied experimentally, and theoretical methods are developed for predicting the equilibrium positions and form of rotor paths for such a system.—*Paper by R. N. Arnold and L. Maunder, submitted to the Institution of Mechanical Engineers for written discussion, 1952.*

Studies of Human Stress from a Marine and Naval Viewpoint

Recent laboratory researches in experimental psychology have analysed the effects of the general surroundings on the working ability of human subjects. The paper deals first with some of the results from research studies aimed at discovering the effects of high atmospheric temperatures. Secondly, the effects of very low atmospheric temperatures on human performance are considered. Thirdly, the influence of prolonged general noise on watchkeeping ability is discussed. The rest of the paper considers the changes in accuracy and speed of work that arise from various local arrangements of the working task in contrast to these influences arising from the general surroundings. It is believed that very much can still be done to improve work design. Instances of such possibilities open to experimental proof have been taken from ways in which manual actions can best be utilized. But designing the task need not stop at sensory and motor considerations, and the paper ends with some points taken from researches on decision taking, with some indications on how activities of this kind can be helped or hindered. Throughout the paper an attempt has been made to illustrate the approach used in considering such problems rather than to try to give any complete survey of the knowledge at present available. This information is now



ENGINE ROOM PLAN OF THE ICEBREAKER "THULE"

1.—Main Engine. 2.—Generator. 3.—Propelling motor. 4.—Starting air compressor. 5.—Compressed air reservoir. 6.—Lubricating oil pump. 7.—Lubricating oil cooler. 8.—Cooling water pump. 9.—Lubricating oil seperator. 10.—Auxiliary Diesel engine. 11.—Auxiliary generator. 13.—Ballast pump. 14.—Fire and bilge pump. 15.—Fuel oil transfer pump. 16.—Propelling motor fan. 17.—Bilge pump. 18.—Fresh water pump. 19.—Fresh water tank. 21.—Heat exchanger. 22.—Lubricating oil tank. 23.—Thrust bearing.

extensive—although it is scattered, rather specific and very incomplete, largely owing to the great complexities of human behaviour.—*Paper by N. H. Mackworth, read at a joint meeting of The Institute of Marine Engineers and The Institution of Naval Architects, 8th April 1952.*

Fishery Research Trawler

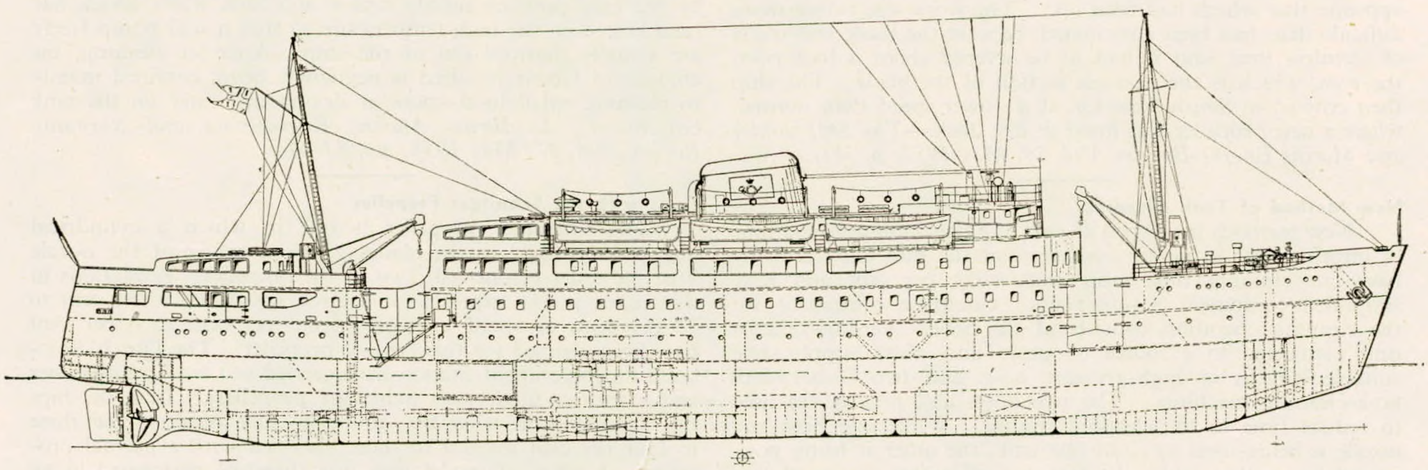
The Admiralty, on behalf of the Department of Scientific and Industrial Research, has placed an order with Hall, Russell and Co., Ltd., Aberdeen, for a fishery research trawler of 125 feet length b.p., with Diesel-electric propelling machinery supplied by the Metropolitan Vickers Electrical Co., Ltd. Designed to assist the work of the Torry Research Station, Aberdeen, the new research trawler will permit, among other things, practical investigations in the fishing grounds of various aspects of the radical change of technique, particularly in the freezing of fish on board, necessitated by the overfishing of near waters and the longer distances from the fishing grounds. The new research trawler will be equipped for trawling on a commercial scale and the fish hold will have a capacity for the testing of fish processing plants, and a laboratory for chemical and bacteriological investigations of fish preservation and by-products. The fuel endurance will be over twenty days enabling the ship to visit all the North Atlantic fishing grounds. There will be accommodation for six scientists and a crew of up to fifteen. The propeller can be controlled direct from the wheelhouse and provision is made for fine speed control from a few revolutions per minute upwards. The vessel will thus be able to employ most commercial methods of fishing. Power for both the propulsion and the trawl winch motors is to be supplied by four main generators on the constant-current system. The maximum shaft horsepower will be 600 at 200 r.p.m., and the maximum output of the winch motors will be 150 b.h.p. Two auxiliary generators will each have an output of 135 kW., which will allow the fitting of large-scale quick-freezing plant. Main and auxiliary generators will be driven by Meadows high speed 6-cylinder four-stroke turbo-charged engines developing 200 b.h.p. at 1,400 r.p.m. The six engines will be identical and it will be possible to remove them for overhaul.—*The Shipping World, Vol. 126, 7th May 1952; p. 417.*

New Danish Motor Ship

The motor ship *Kongedybet*, which has been placed in service between Copenhagen and Rönne on the Island of Bornholm for the A/S Dampskibsselskabet Bornholm of 1866, and which was built by Burmeister and Wain, has berth accommodation for 259 in the first class, besides a number in the third class. She is 292 feet overall with a beam of 43ft 6in. and a mean draught loaded of 14ft. 4½in., the gross register being 2,313·8 tons and the speed 15¾ knots. The first class dining room has seats for eighty-eight persons and in the third class dining room are fifty-six seats. The doorways of all passenger cabins have a door fitted in a rubber frame, which may be kicked or pressed, thus leaving a big hole large enough for a person to pass through. In all, 1,500 passengers can be carried, either by day or on the night service. A seven-cylinder two-stroke B. and W. engine of 3,400 i.h.p. or 2,700 b.h.p. is installed. It runs at 155 r.p.m. Current for lighting and power is supplied by four 160-kW. Diesel-engined dynamos.—*The Motor Ship, Vol. 33, May 1952; p. 61.*

Failure of a High Pressure Turbine Shaft

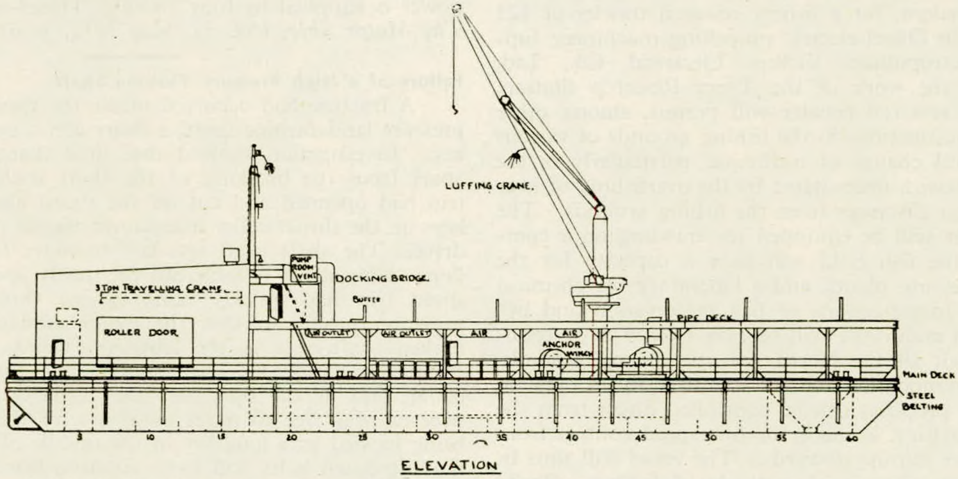
A fracture had occurred under the thrust collar of a high pressure land turbine shaft, a short way along the thrust collar key. Investigation showed that little damage had been done apart from the breaking of the shaft itself. The over-speed trip had operated and cut off the steam almost at once. The keys on the thrust collar maintained the oil pump and governor drive. The shaft itself was free to move forward and it had done so for about $\frac{3}{16}$ inch, but the timely operation of the over-speed trip had quickly removed the thrust from the high pressure turbine so that the major damage, apart from the broken shaft, was to the labyrinth glands, which had to be completely removed. There was a single thrust bearing on the collar, and at the back was the thrust-adjusting gear. The pedestal was free to move parallel with the axis of the shaft, being located by a long key in the middle of the pedestal. The holding-down bolts had loose washers, fitted with about 0·020 inch clearance. Part of the trouble had been due to "cocking-up" of the pedestal under temperature conditions, and a mistaken attempt had been made to cure or mitigate it by bedding the bearings (a parallel-house bearing with no self-alignment features) on the after-portion only. There was a fracture of the metal in the bearing and also excessive wear on the thrust pads and trouble with the over-speed trip operating because the vibration was so bad. There had also been trouble in the oil pump itself. The failure of the shaft was a simple fatigue fracture, and the analysis of the metal afterwards had shown no fault in the material itself. The fracture was doubtless largely due to the reversal of stress (3,000 times per minute) caused by the peculiar thrust arrangement and tipping of the bearing. A new stub end had been made and screwed into the old shaft; it lasted a month. A final satisfactory repair had subsequently been made by again making a stub end for screwing into the shaft, but arranged to be a shrink fit in the collar and welded right round. The machine had since run for over 8,000 hours and had functioned satisfactorily. The manufacturers had made improvements in subsequent machines by fitting a spherical bearing as No. 1 bearing and a spherical housing to the thrust bearing.—*Vulcan, Vol. 12, April 1952, p. 15.*



Profile of the m.s. Kongedybet

Diesel-electric Barge

At the yard of Ferguson Bros. (Port Glasgow), Ltd., a Diesel-electric power barge for drilling operations in Lake Maracaibo, Venezuela, is under construction for the Shell Petroleum Co., Ltd. It is stated to be the first of its type built in this country. The length is 158 feet, the breadth 80 feet and the designed draught 7ft. 6in. Four 12-cylinder V-type Mirrlees pressure-charged four-stroke engines are installed; they run at 650 r.p.m. and each is coupled to a 450-kW. d.c. generator. The 12-hr. rating is 910 b.h.p. and the continuous rating 698 b.h.p., allowing for site temperature and humidity. There are two 800 h.p. electric motors independently connected through a chain drive to the two main mud pumps. A 300 h.p. motor is directly coupled to a high-pressure multi-cylinder pump providing for cementing operations, and a 150 h.p. motor drives an auxiliary mud pump. A second 150 h.p. motor drives the coring reel. Further, there is a draw-works motor of 800 h.p., a rotary table motor of 300 h.p. and various other auxiliaries. These two motors are forced ventilated by electric motor-driven blowers giving full and constant ventilation.—*The Motor Ship, Vol. 33, May 1952; p. 65.*



A Diesel-electric power barge, with four Mirrlees Diesel-engined 450-kW. generators

Removal of Propeller Blade

An interesting underwater contract was recently completed by the Durban firm of James Brown, Ltd., on the Norwegian tank ship *Fenheim.* When the vessel was several hundred miles north-east of Durban, she lost one of the blades of her propeller; the remaining three blades set up heavy vibration and, when the ship docked, it was decided to remove the blade opposite that which had been lost. The work was rather more difficult than had been anticipated, because the blade was made of stainless steel, and it had to be severed about a foot from the root, which is the heaviest section of the blade. The ship then crossed to South America, at a slower speed than normal, where a new propeller was fitted in dry dock.—*The Shipbuilder and Marine Engine-Builder, Vol. 59, May 1952; p. 381.*

New Method of Tank Cleaning

New methods developed as part of a continuing programme of improvement in tanker operations at the Sun Oil Company have cut cleaning time more than sixty per cent and have simplified equipment requirements. Complete equipment for the cleaning operation consists of the Sellers Venturi-injector unit connected to a source of steam and water supply, two suitable lengths of high-pressure hose, and two Butterworth tank-cleaning machines. The two hoses and nozzles are used to reduce time in the cleaning routine. While one hose and nozzle is being used to clean one tank, the other is being positioned in another tank. In this way, cleaning can be shifted from tank to tank without loss of time. If the steam supply is sufficient, then the Venturi-injector unit can supply two cleaning machines simultaneously. All tank shifts fit a cleaning pattern. The heat developed cleaning one tank is utilized to heat the bulkheads of adjoining tanks to an efficient cleaning temperature. A standard system of cleaning levels has been developed, depending upon the type of recent cargo. Under this system, the hose and nozzle are lowered to a new position after a predetermined cleaning time. Thus, the cleaning of each tanker is in accordance with a set programme that gets the job done with very little arbitrary judgement. Typical cleaning conditions established by the Venturi-injector unit in conjunction with a Butterworth rotary nozzle (⅝-in. bore) are as follows:—

Steam supply pressure	74lb. per sq. in.
Water supply pressure	72lb. per sq. in.
Jet discharge pressure	185lb. per sq. in.
Jet discharge temperature ...	190 deg. F.

With these new facilities, the reduction in tanker cleaning time has been in excess of 60 per cent. This time varies, of course, with the cargo that has been last carried and the grade of cargo to be carried on the next voyage. After the most difficult cargoes, cleaning time may be as long as 2½ hours per tank. This would range down to as low as ½ hour per tank if the previous cargo were light oil or gasoline. In all cases, routine cleaning can be completed in approximately half the time required by the previous fixed system of pump, heater, and reheater. During cleaning, stripping pumps must be in constant operation, conveying waste from the tanker to shore slop facilities. In this way, most scale which has been pulverized by the high-pressure nozzle stream and tank waste which has been heated by the high temperature so that it will pump freely are actually pumped out of the ship. After jet cleaning, the amount of labour required is negligible, being confined mainly to cleaning small local spots or drying up water on the tank bottom.—*C. L. Boyle, Marine Engineering and Shipping Review, Vol. 57, May 1952; pp. 83-84.*

Tests with the Schnitger Propeller

The Schnitger propeller is one in which a cylindrical nozzle is attached to the blades. The diameter of the nozzle is of the order of one-half that of the propeller. Reductions in the engine power required for a given speed of 7·5 per cent to 12 per cent, or speed increases of 2·5 per cent to 8 per cent have been claimed for this type of propeller. The Dutch Shipbuilding Experiment Station have carried out tests on a coaster and a trawler fitted with Schnitger propellers. In both ships the Schnitger propeller was found to give results some three to four per cent inferior to those obtained with a normal propeller. A series of model tests was therefore performed in an attempt to clarify this discrepancy. The propeller tested was basically a model of that fitted to the trawler but only the central portion of the nozzle was rigidly attached to the blades, and a series of different leading and trailing edges was used to give different angles of attack. It was found that the efficiency of the Schnitger propeller increases with increasing angles of attack, up to a maximum of some nine or ten degrees, but that it remained below that of the standard B-series propellers.—*J. D. van Manen, Schip en Werf, 19 (1952), p. 69 (15th Feb.). Publication No. 101 of the Dutch Shipbuilding Experiment Station, Wageningen. Journal, The British Shipbuilding Research Association, Vol. 7, April 1952; Abstract No. 5,956.*

Compression Work in Root's Blower

The paper contains the derivation of an expression for the ideal work of compression in a Root's blower, which takes into account the inherent irreversibility of the process. Moreover, the expression takes into account the finite delivery volume, and it is shown that the conventional formula is contained in the more accurate formula as a limiting case for infinite delivery volume. Formulæ are derived which enable the delivery temperature to be calculated for given values of overall pressure ratio and for several values of the pocket to delivery-volume ratio. Graphs of power coefficients are given, so that the calculation of horsepower is facilitated. The horsepower can be calculated either for a given volume of free air delivered or for the volume of discharge required.—*Paper by J. Kestin and J. A. Owczarek, submitted to the Institution of Mechanical Engineers for written discussion, 1952.*

Prefabricated Propeller

A propeller made of welded plates and sections is shown in Fig. 5. The boss (10) comprises flame-cut plates (18), each with a projection (22) for the blades. The plates are spaced by sections (24) forming the propeller shaft bearing surface.

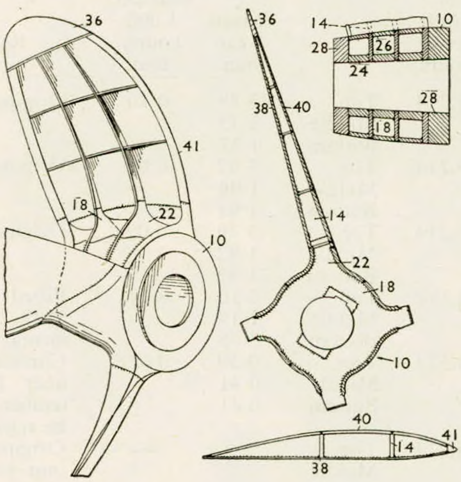


FIG. 5

At the periphery the plates are spaced by further sections (26) and the boss is completed by portions (28). The ribs (14) are set at the correct pitch and are connected by welds to the projections (22) on the boss plates (18), the plates and ribs extending from the boss, through the roots of the blades, to the tips (36), which are also welded in position. The front and back of the blades are completed by face plates (38, 40) and leading blade edge pieces (41). This type of construction is stated to be particularly suitable for large propellers not required in great quantities. For small propellers the boss construction may include pressings or castings.—*(Brit. Pat. No. 664,153. Richardsons, Westgarth and Co., Ltd. Harry Hunter and J. A. Dorrat, Newcastle-on-Tyne.) The Motor Ship, Vol. 33; April 1952; p. 39.*

Shepers Davits

This article describes a new type of davit developed specially for small lifeboats used by the Dutch Coaster Fleet, and recently patented by Shepers. It is said to be an improvement on older types, enabling the boat to be swung out and in rapidly and easily. The novelty of the idea is that the initial lifting of the boat is assisted by the boat's own weight. This is achieved by a simple lever system linking the davit post with the davit arm. The system consists of two levers of unequal length hinged together at their ends. The pin of the hinge is extended and carries a sheave, round which the hauling rope of the boat tackle is passed, forming a kind of loop. Under the weight of the boat this loop pulls the hinge upward and forces the davit arm outward. The arrangement may be so adjusted that the path of the boat when swinging out is practically horizontal at the beginning, gradually changing into a downward arc. Hence no labour is necessary to move the boat against gravity, and only frictional forces and the weight of the mechanism itself have to be overcome. This can be easily done by one man, who can swing the boat out well within ten seconds. Swinging-in is slightly more difficult and requires two men.—*Holland Shipb. Vol. 1, February 1952; p. 12. Journal, The British Shipbuilding Research Association, Vol. 7, April 1952; Abstract No. 6,051.*

Ports for Double-acting Engines

A special design of ports for double-acting engines is illustrated in Fig. 3. Those for the inlet of scavenging air (1, 2, 3, 4) for the top and bottom of the cylinder increase in length from the centre of the row to the sides, while the length of the exhaust ports (11, 12, 13, 14) decreases in the same direction. Thus, the bridge portions (6) between the ports are oblique to the axis of the cylinder. The direction of the

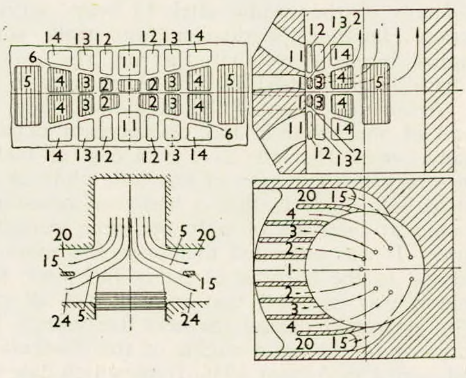
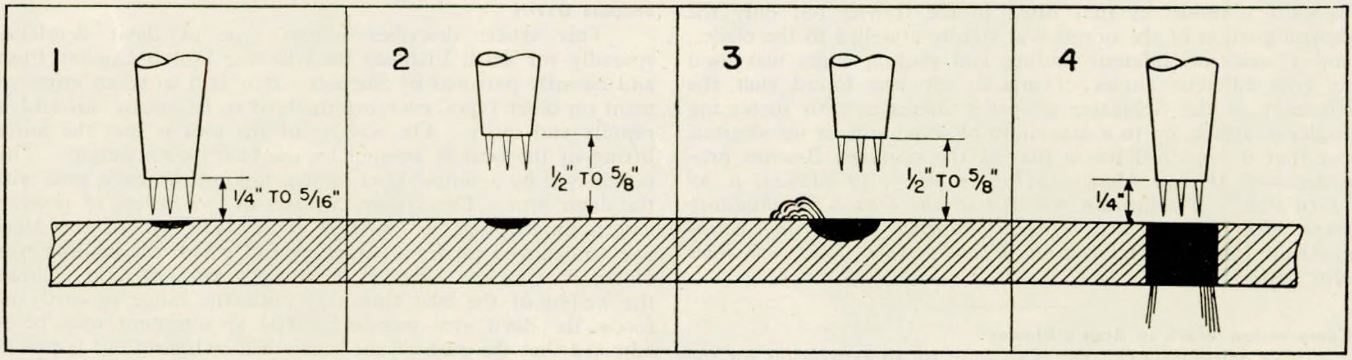


FIG. 3

scavenging-air streams is shown in the diagrams. Those from the outer inlet ports (5) penetrate to the right of the cylinder and are upwardly deflected, one against the other. The air streams from the smaller inlet ports are also deflected upwards and sweep along the centre zone of the cylinder. The co-operation of the two supply (20, 24) for the top and bottom of the cylinder enables a greater charge to be obtained, as the partition (15) is not extended to the cylinder wall. These ducts (20, 24) lead to the common inlet port (5) and the charge can flow into the same part of the cylinder, top or bottom, from both passages.—*Patent No. 661,141, Maschinenfabrik Augsburg-Nürnberg A.G. Augsburg. The Motor Ship, Vol. 32, March 1952; p. 517.*

Use of Welding Torch as Drill

The accompanying diagrams show how to use the oxy-acetylene blowpipe to cut holes in steel plate. Flame adjustment is the same as for ordinary oxyacetylene cutting. Holes for rivets, bolts and anchors are easy to make by following this technique: *Fig. 1.* Hold the blowpipe steady and preheat a spot until it turns light red. Keep the end of the nozzle about



FIGS. 1-4

¼ inch from the plate so that the inner cones almost touch it. *Fig. 2.* As soon as the spot turns light red, raise the blowpipe a little as shown. The surface will start to melt. If you do not raise the blowpipe, the slag may blow up and clog the nozzle orifices. *Fig. 3.* Depress the cutting oxygen lever slowly so that the slag does not blow and scatter. At the same time begin moving the blowpipe in a small circle. This helps to control the slag by washing it to the opposite side of the puddle. *Fig. 4.* Keep the end of the nozzle about ½ to ⅝ inch away from the plate and continue the circling motion until the cut is through the plate. Then lower the blowpipe as shown here. Continue the same circling motion until the hole is of the desired diameter.—*The Welding Journal, Vol. 31, March 1952; pp. 242-243.*

The *Auricula* in Service

Full details of the results after 5½ years' service with a solid-injection Hawthorn-Werkspoor four-stroke single-acting Diesel engine burning residual fuel in the motor tanker *Auricula* have been released by the Anglo-Saxon Petroleum Co., Ltd. At an inspection of the engine and ship, Mr. John Lamb, head of the research and development department of the company, stated that the saving in cost of fuel over the 5½ years has been in the region of £61,000, while an additional economy had been made in that it had been necessary to dry-dock the ship at intervals of only one year instead of every nine months. It was estimated that some 500 motorships had been converted to the burning of boiler fuel since the end of 1948, while it was expected that most if not all motorships would be so converted during the next five years. There had been no nursing of the main engine of the *Auricula* since she was commissioned in August 1946, from which date the engine had been throughout on various commercial grades of boiler fuel shipped at fifty-six different ports in both the eastern and western hemispheres. During the first three years, fuels having viscosity ranging between 1,200 and 1,500 sec. Redwood I at 100 deg. F. were used, while during the past 2½ years the engine had operated on fuels having viscosity range of 2,000 to 3,500 sec. The ship is provided with two different sets of fuel valve nozzles, one set for fuels between 40 and 1,500 sec. and the other set for fuels between 1,500 and 3,500 sec. viscosity; both sets have eight holes, the former being holes of 0·85 mm. diameter and the other 0·75 mm. diameter. The practice of sending nozzles and their needle valves to the makers to be reconditioned after about 2,000 hours' service had been instituted, as it was found that the work could not be done satisfactorily on board. Faults in this part were responsible for poor combustion and increased wear of cylinder liners and piston rings, particularly when using viscous fuels. The fuel injection pressures for the entire range of boiler fuels varied between 5,000 and 7,200lb. per sq. in., the pressure with Diesel fuel being 4,000lb. per sq. in. All fuel consumed by the main engine during the 5½ years in service had been purified by centrifugal separators at half the rated throughput. No alterations had been made to the purifying system since commissioning. The purifying temperature was still 180 deg. F. No corrosion of the separator bowls had been observed. In September 1949, two of the original main engine cylinder liners, Nos. 4 and 5, were replaced by one new standard liner and one chromium plated liner in order to obtain a true measure of the advantages of plating the bore. The wear rates of these two liners, which had been subjected to exactly the same conditions as regards power output and lubricating oil consumed for the same length of time, are given in the accompanying table. Piston rings made by six different manufacturers had been tried out, the material of the rings varying in Brinell Hardness from 160 to 230. The results obtained in the *Auricula* and forty-six other motorships of the Shell fleet which were now burning high viscosity fuels proved that commercial boiler fuel could be burned satisfactorily. The remainder of the fleet would be equipped as the opportunity occurred.

Liner No.	Total full power hours		Mean wear, mm.	Maximum wear per 1,000 hours, mm.	Remarks
1	33,214	Top	3·39	0·10	Original liner
		Middle	1·75		
		Bottom	1·37		
2	33,214	Top	3·02	0·09	Original liner
		Middle	1·96		
		Bottom	1·95		
3	33,214	Top	3·29	0·09	Original liner
		Middle	1·92		
		Bottom	1·92		
4	14,522	Top	2·10	0·14	Fitted September
		Middle	1·19		1949, for experi-
		Bottom	2·25		mental purposes
5	14,522	Top	0·39	0·026	Chrome-plated
		Middle	0·41		liner fitted Sep-
		Bottom	0·41		tember 1949 (to be regauged)
6	33,214	Top	—	—	Original liner
		Middle			(not yet gauged)
		Bottom			
7	33,214	Top	3·59	0·10	Original liner
		Middle	1·78		
		Bottom	1·63		
8	33,214	Top	3·49	0·10	Original liner
		Middle	1·93		
		Bottom	1·75		

In assessing the cylinder liner wear results, it must be remembered that until knowledge of the adjustments necessary to burn boiler fuel to the best advantage was ascertained the engine operated under conditions which were not conducive to minimum wear. The wear rates per 1,000 hours did not include harbour steaming. The wear rate per million revolutions in the case of Nos. 1, 2, 3, 6, 7 and 8 liners averaged 6/10,000 of an inch. The main engine had operated for 33,214 hours at an average i.h.p. of 4,120. The normal practice in similar ships of the Shell fleet was to run these Hawthorn-Werkspoor engines in service at 3,900 i.h.p.—*The Shipping World, Vol. 126, 23rd April 1952; p. 377.*

Chilling of Diesel Engines

For many years marine Diesel operators were instructed to continue circulating cooling water through the jackets after a Diesel was stopped until it was "nice and cool". This practice was once universally followed and is still continued on some vessels today. The reason given for using this technique was that it prevented gumming and sticking of rings as the result of latent heat in the pistons spreading to the ring area and badly burning the oil. It was said that the engine actually heats up after it is stopped if the cooling water is not circulated long enough to draw the heat from the parts that were directly exposed to combustion. With direct sea water cooling an engine could be chilled very quickly. With present day closed cooling systems the induced cool-off period is greater. Yet in no instance should it be practised. Some of the Sun-Doxford Diesels were never permitted to fall below operating temperature and their records of trouble-free operations were outstanding. A two and a half year record of the operation of the engines in the motorship *City of New York* revealed that the jackets had never been drained nor permitted to cool. There had been no fractures of castings, and phenomenally low rate of cylinder and ring wear was revealed in a report in 1932. On a contemporary motorship with an engine of Werkspoor design the cooling-down practice had been followed and rather more than normal cylinder liner wear was observed. This was a crosshead engine remarkably accessible in which a piston could be exposed for inspections in a matter of minutes and it was therefore common practice to open up and take a look at one or two cylinders each voyage. It was noted that a thin coat of rust appeared on the cylinder walls and it was decided that excessive wear was connected with the rust and thus with the condition causing it. Further observation revealed rust only in cylinders in which an exhaust or inlet valve stood open while the engine was shut down. This led to the belief that in the cooling or chilling process the metal temperature fell below the dewpoint and condensate had formed in the cylinders directly open to the atmosphere in the engineroom or to the outside via the exhaust pipe. It was further decided that a trace of sulphur in the fuel may have left some weak sulphur fumes in the exhaust system to be absorbed by the condensate, making a weak solution of sulphuric acid tending to hasten the rusting process. The practice of chilling the engine was discontinued; the reversing mechanism was placed in neutral position, closing all valves on all cylinders while in port, and no further rust was observed. The rate of liner wear was reduced slightly. In view of what has been learned about the control of cooling water temperature, it appears quite probable that many of the so-called heat fractures in cylinder heads were due to cold and not to heat. Apparently, when the engine stops generating heat in the combustion space and the normal dissipation of such heat through the castings stops, some places in the casting will cool more quickly than others, tending to prevent uniform shrinkage and thus setting up stresses until the entire casting takes on uniform temperature.—*A. B. Newell, Motorship (New York), Vol. 37, March 1952; p. 34.*

Explosions in Enclosed Crankcases

The author treats the important problem of crankcase explosion prevention in practice. After dealing with the cause of such explosions, the author concludes that, whilst much can be done to minimize explosions, to prevent them altogether is not practicable. The merits of ventilation of crankcases are discussed and ways are suggested to prevent bearings running hot, while means to detect a temperature rise in inaccessible bearings and pistons are described. Tests carried out with the object of preventing injury to personnel and damage to property in the event of an explosion are described. A relief valve which opens and closes instantly is described and illustrated. The danger of burning gases issuing from relief valves is discussed, and the experiments are described which resulted in the evolution of a simple but effective flame trap. The author's most recent experience of a crankcase explosion occurred in an engine crankcase, the construction of which is shown in Fig. 4. This follows normal practice. The only communication with the atmosphere was through a vent pipe of 2-in. diameter at the forward end of the engine. The first explosion was caused by the overheating of No. 2 piston. The cover, indicated at the opposite end of the engine, was broken into several pieces and projected with great force about the engine room. The camshaft-drive gear-wheels situated immediately inside the broken cover were unaffected, and the engine continued until the fuel was shut off. The engine had been running continuously for several days when the explosion occurred. An interesting feature of this explosion is that other parts of the crankcase, nearer to No. 2 piston, showed no sign of strain. This supports the theory that the pressure produced at the seat of the explosion is relatively small, and that the farther the pressure-waves travel through oily mist the greater will be the accumulated pressure. The steps taken to prevent a repetition of this damage included the fitting of a spring-loaded hinged-valve in the position indicated in Fig. 4. This position is not at the end where the cover was broken, because release of burning gases at the opposite end would have severely damaged a vital part of the propelling installation. About two years later a second explosion occurred. This was caused by the running hot of

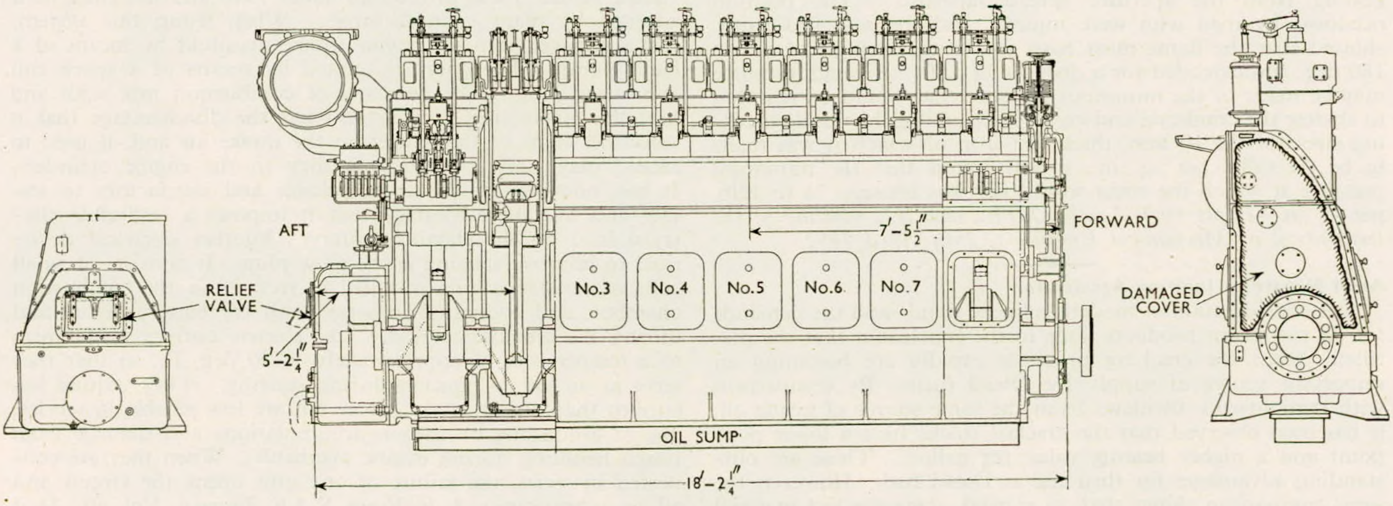


FIG. 4

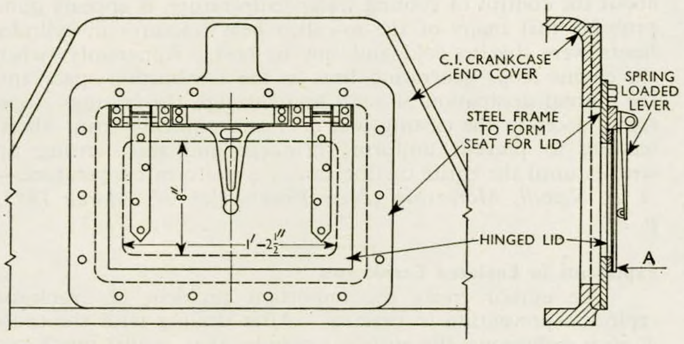


FIG. 5

No. 5 piston, which is situated about mid-length. Both ends of the crankcase would, therefore, have been subjected to approximately the same pressure. It is possible, however, that as the pressure waves did not travel quite so far during the second explosion, the cover at the after end of the crankcase was not subjected to as high a pressure as on the first occasion, when the seat of the explosion was at No. 2 piston, or that the presence of the excess pressure escape on the forward end reduced the pressure on the opposite end. As the engine had been running continuously for about the same length of time as on the previous occasion, the density of the oil mist would have been the same. This eight-cylinder engine has a total crankcase volume of 220 cu. ft. The area of the pressure release opening is 118 sq. in., so that the ratio of release area to total crankcase volume is 1 sq. in. per 1·8 cu. ft., which in this particular instance proved sufficient to prevent damage to the engine under the conditions resulting from an explosion starting from No. 5 piston. The advantages of the form of relief valve shown in Fig. 5 are that it is simple in construction, and that when fully open it offers minimum resistance to the flow of excess gases. The disadvantages are that if the spring load is sufficient to ensure the closing of the door with the speed necessary to prevent air entering the crankcase, the load may be too great to ensure its opening with the speed necessary to prevent a serious build-up of pressure. In the case just quoted the spring load holding the relief valve in closed position was just sufficient to avoid movement and leakages of mist resulting from the pulsation of the eight trunk pistons. When it was tested by means of a sensitive spring-balance, a pressure of 4lb., applied to the point indicated by A (Fig. 5), was found to be required to "crack" the valve, and 13¾lb. to hold it fully open. When this relief valve was called upon to function, the pressure produced in the crankcase was such that the burning gases issuing from the aperture spread fan-wise. The position occupied by men who were injured, and the scorched paint, showed that the flame must have spread to an angle of nearly 180 deg. and extended for a distance of 15ft. A rough estimate may be made of the minimum pressure that would be required to shatter the crankcase end-cover. Assuming the tensile breaking stress of the 10 mm. thick cast iron of which it was made to be 20,000lb. per sq. in., it was found that the minimum pressure at which the cover would fail was between 7½ to 12lb. per sq. in.—*Paper by J. Lamb, O.B.E., read at a meeting of the Institution of Mechanical Engineers, 25th April 1952.*

Amyl Nitrate as Ignition Accelerator

A consideration of modern refinery trends and the demands for all petroleum products leads to the conclusion that the distillates from the cracking processes rapidly are becoming an important source of supply for Diesel fuels. By comparison with straight-run distillates from the same source of crude oil, it has been observed that the cracked stocks have a lower pour point and a higher heating value per gallon. These are outstanding advantages for their use as Diesel fuel. However, the same comparison shows that, in general, some cracked material is lacking in ignition quality. This quality can be supplied by the addition of a small amount of ignition accelerator. In this way the supply of Diesel fuels can be increased appreciably, better uniformity of fuels can be achieved, and blending can be done with a consideration for other important fuel properties. In addition to its main function, that of improving the combustion of low-cetane stocks in full-scale engines, for a wide range of operating conditions, a good ignition accelerator must not damage the engine or increase maintenance problems in any way. There is information available to support a belief that engines will operate satisfactorily on fuels containing amyl nitrate. However, laboratory and service tests are now under way to determine how well amyl nitrate meets all the requirements for a good ignition accelerator. To become commercial, an ignition accelerator must have a low cost for a given gain in cetane number because it must compete with other methods for improving ignition quality which are presently in use. Of the nearly 300 compounds that were investigated, the cost per cetane number gain was so high for almost all of them that they were excluded from further consideration. One of the greatest advantages for amyl nitrate is its effectiveness when used in small quantities, such that one-eighth to one-quarter volume per cent is sufficient for cetane number gains of 4 to 7 units. From the investigations conducted it was found that amyl nitrate provides ignition quality which compares favourably with that inherent in a clear fuel of the same cetane number for a wide range of operating conditions. The overall cetane number requirement for the test engine was determined by the requirement for low-load, low-speed operation, this being greater than the requirement for high-load, high-speed operation. Amyl nitrate was found to provide ignition quality that is effective at the low temperatures resulting from low-speed, low-load operation.—*M. J. Anderson and G. C. Wilson, S.A.E. Quarterly Transactions, Vol. 6, April 1952, pp. 230-251.*

Diesel Engine Starting

The Internal Combustion Engine Laboratory of the U.S. Naval Engineering Experiment Station, Annapolis, Md., has conducted a number of cold starting tests on various makes of high speed Diesel engines. It was found that many engines now on the market cannot be started at temperatures below 32 deg. F. without the assistance of special starting aids. These most frequently take the form of heaters for the intake air. A common type consists of an electric resistance grid in the air intake manifold, which is heated from the engine starting battery before and during the cranking period. These heaters have the fault that they impose an extra load on the starting battery at a time when the cranking load may already be excessive. A different type of intake air heater, called a "flame primer", was introduced about 1940 and has since been adopted by many manufacturers. When using this system, fuel is sprayed into the engine intake manifold by means of a hand pump. The spray is ignited by means of a spark coil and spark plug. The products of combustion mix with and heat the intake air. This system has the disadvantage that it consumes some of the oxygen in the intake air and, if used to excess, may cause oxygen deficiency in the engine cylinders. It has, however, proved to be reliable and satisfactory in service and has the advantage that it imposes a negligible electrical load on the starting battery. Another electrical device used to improve starting is the glow plug. It consists of small coils of resistance wire installed in recesses in the combustion chambers and connected in series with the battery before and during the cranking period. The electric current heats them to a temperature of approximately 1,700 deg. F., so that they serve as an aid to ignition during starting. They require less current than an air intake heater but are less reliable in service, due to grounding by carbon accumulations and damage from rough handling during engine overhauls. When they are connected in series, the failure of one unit opens the circuit and all are inoperative.—*J. F. Blose, S.A.E. Journal, Vol. 60, April 1952; pp. 40-44.*

Reheated Engine in Norwegian Freighter

Although only a small freighter of 3,600 deadweight tons and rated at 2,000 indicated horsepower, the Norwegian single-screw shelter-deck type freighter *Mim* should be of special interest to marine engineers, operators and others because of her unusual power plant which employs a steam reheat cycle. The main propulsion unit of the *Mim* is a five cylinder triple expansion reciprocating engine designed and fabricated by the Trondhjems Mek Verksted A/S, Trondheim, Norway. It is rated at 2,000 i.h.p. and gives the ship a speed of 13 knots when loaded. An interesting feature of the engine room layout is the fact that the engine and auxiliary equipment are located forward of the two steam generating units. Thus, the main driving shaft runs between the steam generating units at deck level before entering the shaft alley. The firing walls of the steam generating units are separated from the after engine room bulkhead only by the firing aisle. Steam from the superheater enters the steam reheater (Fig. 2) at 724 deg. F., passes through the tube bundle where it is cooled to 572 deg. F., and is routed to the high pressure cylinder of the engine. Steam enters the high pressure cylinder at 572 deg. F. and is passed back to the steam reheater, which it enters at 419 deg. F. By heat transfer from the superheated steam in the tube bundle, the temperature of the steam from the high pressure cylinder is now raised back to 572 deg. F. for use in the intermediate and low pressure cylinders of the engine.—*The Log, Vol. 47, April 1952; pp. 51-52, 87.*

U.S. Navy Expands Boiler Test Plant

Full-scale testing there of the largest marine boilers will be made possible by a $3,500,000 expansion to the Naval Boiler and Turbine Laboratory at the Philadelphia Naval Shipyard, according to a recent announcement. The addition to the present laboratory will include a 120 by 250-ft. one-storey section with heavy cranes where three or more boilers, including those for large carriers, may be tested simultaneously. An attached three-storey building will house machine and electrical shops, a laboratory and engineering and administrative offices as well. Since the boiler laboratory was established, working pressures, temperatures, sizes, and capacities in Navy boilers

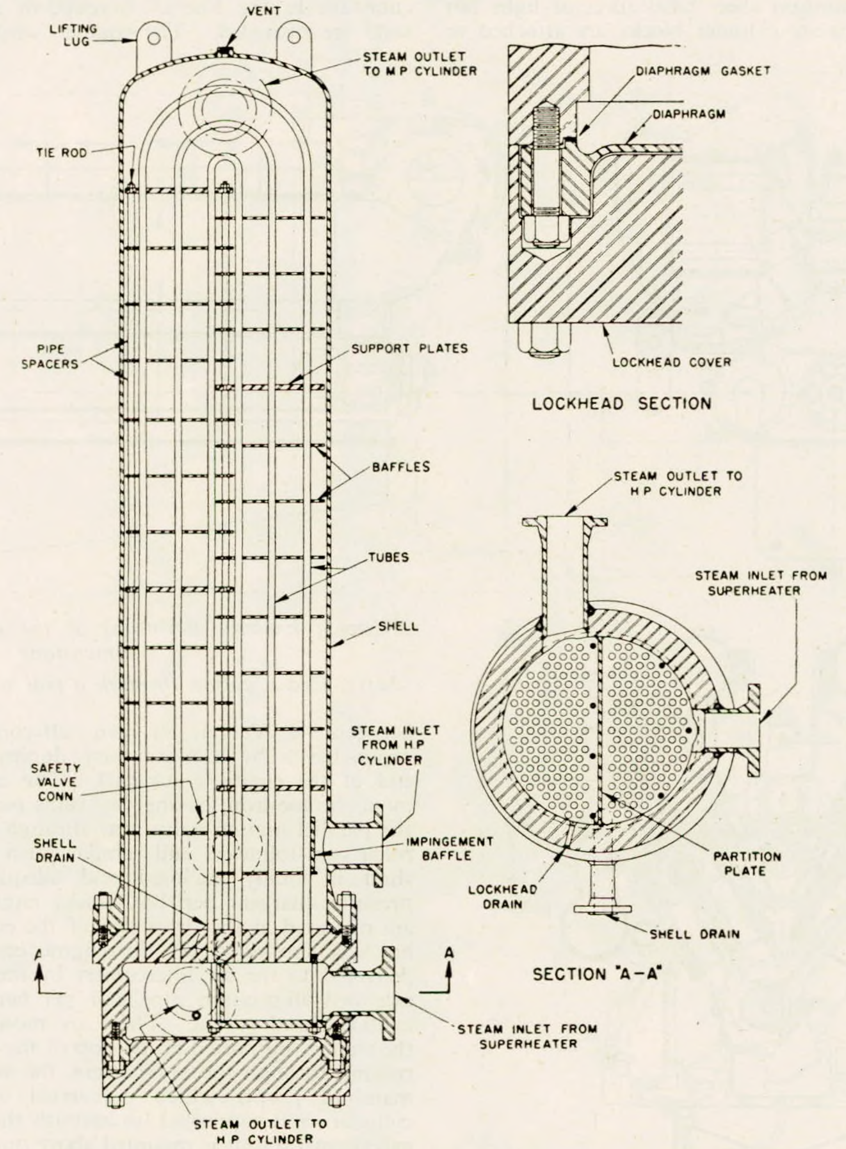
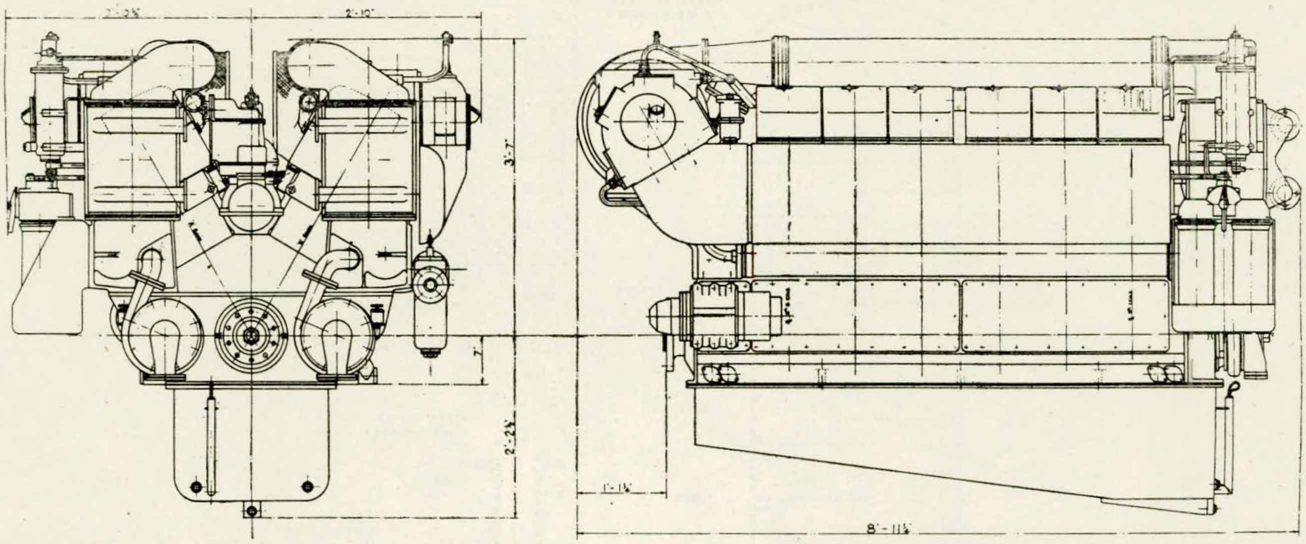


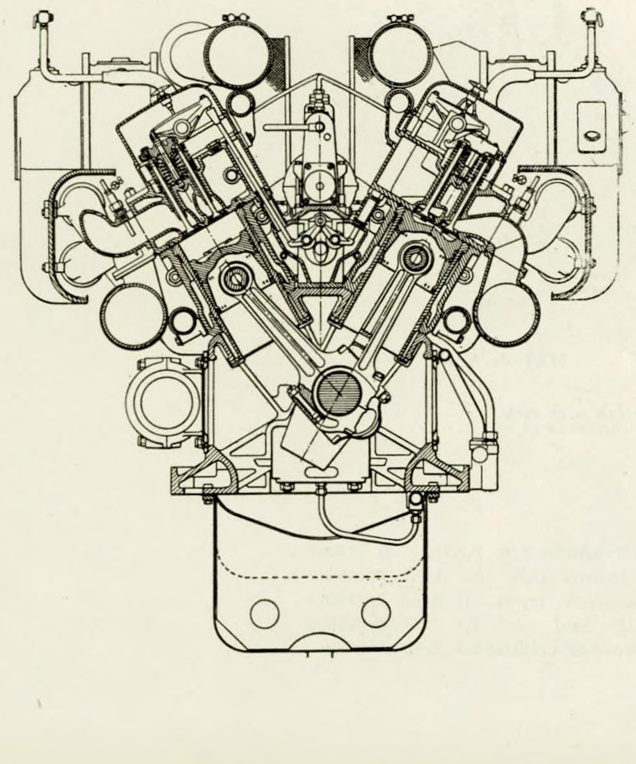
FIG. 2.—*The cross section of the reheater shows the passage of steam from the superheater through the tube bundle into the high pressure cylinder of the reciprocating engine. The steam from the high pressure cylinder flows around the tube bundle and out to the medium pressure cylinder after it has absorbed additional heat*

have increased to make existing facilities inadequate for testing boilers of the present and future.—*Marine Engineering and Shipping Review, Vol. 57, May 1952; p. 76.*

Admiralty Range II Diesel Engine

Details have been released of the A.S.R. II Diesel engine, which has been designed for the Admiralty by Davey, Paxman and Co., Ltd. It is at present being constructed by the designers, and also under licence by Ruston and Hornsby, Ltd., and Ransomes, Sims and Jefferies, Ltd. The engine is a 7in. by 7¾in. Vee-type engine, and is notable for the extent to which light alloy has been used, some of the major components, including crankcase, cylinder blocks and cylinder heads being of this material. Despite the efforts that have been made to save weight in the A.S.R.II engine, it has been designed with the aim of maintaining long periods in service. The crankcase is a one-piece casting in aluminium alloy, fully heat treated, supporting the underslung crankshaft in forged aluminium bearing caps, and providing also the mounting supports for the entire engine. The sump is attached to the underface of the crankcase, and is an aluminium sheet fabrication of light but robust construction. Separate cylinder blocks are attached to the upper faces of the crankcase casting by means of high expansion austenitic steel studs. These cylinder blocks carry the wet type prefinished cylinder liners. The crankshaft is of heat treated alloy steel with solid pins and journals, and having a forged flange of substantial proportions at the drive end. All main and large end bearings are steel-backed copper lead-lined shells, lead plated initially to assist running in. The big end bearings are of the blade and forked pattern. The pistons are of aluminium alloy and carry three compression and two oil control rings. These are of such proportions as to permit them to be removed through the crankcase door without removing the cylinder heads, eliminating the necessity of draining the water system. The connecting rods are H section steel stampings. The unit cylinder heads are cast in heat treated aluminium alloy and carry two exhaust and two inlet valves. To provide efficient cooling of the valve seats and injector, cooling water is passed downwards round the injector and sprays out at high velocity over the bottom deck of the cylinder head. The water leaves the cylinder head at its uppermost point. The valves are not masked and there are no cutaways in the liners. Screwed-in aluminium-bronze valve seats are provided. The engine camshaft is carried centrally





(Above): Exterior elevations of the engine, showing leading dimensions

(Left): Cross section through a pair of cylinders

between the Vee in its own self-contained cambox, and is chain-driven by a heavy-duty duplex chain from the drive end of the engine crankshaft. The camshaft is in chill-cast monochrome iron, having two cams per cylinder which operate the parallel motion valve gear through swinging hardened steel roller cam-followers and tubular push rods. The whole camshaft is totally enclosed and adequately lubricated. Two pressure chargers per 12-cylinder engine are fitted and these are mounted at the drive end of the engine in cast aluminium brackets supported on the engine crankcase. Charge air is delivered to the air intercoolers by means of a large diameter extruded aluminium pipe, one per bank, supported above the cylinder head covers. These are mounted at the free end of the engine, supported on the top of the free end gearcase. After passing through the intercoolers, the air is taken into the inlet manifold proper which is carried outboard of the engine cylinders and supported underneath the exhaust manifolds. A galvanometer unit is mounted above one intercooler and records the temperatures of each cylinder exhaust outlet by means of thermocouples. Exhaust pipes with expansion sections are cast in austenitic iron and lagged with sprayed asbestos. They are still further protected by means of a wire mesh guard lagged with asbestos, completely covering the exhaust system and entry to the supercharger turbine.—*The Shipping World, Vol. 126, 21st May 1952; pp. 452-453.*

Steam Pipe Materials for Advanced Steam Conditions

The trend towards higher steam temperatures and pressures for ships' machinery introduces new problems regarding the choice of suitable materials and the present paper has been prepared in order to provide a survey of suitable materials for steam pipes working at these advanced steam conditions. The choice of a material depends upon the working temperature, but four available steels are described which cover a range of temperatures up to 1,050 deg. F. These are plain carbon steel and three low alloy steels containing molybdenum, chromium and vanadium; they have all been used for steam pipes and represent British practice. The main requirements of a steel for high temperatures are resistance to creep and corrosion, stability of the microstructure and suitability for manufacture and welding. All these points are discussed in the paper and recommendations are given, based upon these properties, for the appropriate temperature range for each steel. There is an appendix giving notes on the creep of metals and creep testing.—*Paper by D. W. Crancher, read at a meeting of The Institute of Marine Engineers, 13th May 1952.*

Acceleration of Ships

Experience on measured-mile trials has shown that during runs on the mile the speed of revolution of the propeller shafts tends to increase slowly, and that when runs are made over two consecutive miles the mean speed over the second mile is sometimes slightly greater than over the first. This suggests that in such instances conditions were not steady, and that the length of run made in approaching the measured course was probably not sufficient to allow the ship to attain its maximum speed or develop the maximum power and r.p.m. Calculations show that when a ship is working up to full speed, the acceleration falls off rapidly as speed increases and that maximum speed is approached very slowly indeed. In carrying out measured-mile trials it is therefore of the utmost importance to have a knowledge of the length of approach required to ensure that the ship will attain a speed sufficiently near its maximum for all practical purposes and at least within the accuracy to which the speeds are being measured. Part I of the paper deals with theoretical considerations, and results of detailed calculations of time and distance required to attain various fractions of full speed are given for several typical ships. In Part II an account is given of full-scale acceleration trials carried out on a cross-channel vessel by courtesy of Wm. Denny and Bros., Ltd. The trial results are compared with calculations made on the lines described in Part I, and the agreement appears to be sufficiently close to justify the underlying assumptions in the latter. Part III deals with the accuracy of speed measurement on measured-mile trials based on times recorded by observers with stop watches. On some recent trials it has been possible to assess the actual stop-watch errors using times recorded by a ciné-theodolite. These results are presented and discussed and appear to support the standard of speed comparison used in the acceleration calculations. These results have also shown that it is possible to obtain a high standard of accuracy in the usual method of timing with stop watches.—*Paper by H. Lackenby, read at a meeting of The Institution of Engineers and Shipbuilders in Scotland on 26th February 1952.*

Modern Cargo Handling Methods

During recent years many owners have become more acutely aware of the apparent inconsistency of installing the ship's engine amidships. Port records invariably show that the best loading and discharging performances are obtained amidships, where the holds are more nearly cube-shaped. The sharp fore and aft cargo holds and the propeller shaft tunnels impede the efficiency of stowage and handling of the cargo. Yet, in the conventional cargo liner the engine-room is located in what is the most desirable part of the vessel from the cargo-carrying point of view, amidships. If the engine-room is moved to the after part, the loss of cubic space occasioned by the propeller shaft tunnels is partly eliminated. When operating under ballast conditions the propeller will be under water, while ballast tanks will make it possible to trim the vessel practically on an even keel, if desired. With the engine-room amidships a considerable portion of the cargo is banished to other parts of the vessel where working and handling conditions are generally less favourable. But, when the engine-room is located in the after part of the vessel, all the cargo holds with the exception of No. 1 hold will be approximately rectangular with the ship's sides running practically perpendicular to the decks. During recent years there has consequently been a stronger tendency towards placing the engines aft, whereby a larger proportion of the ship's usable cubic space can be located amidships. Although this design for dry-cargo vessels was adopted many years ago for coasters, the author believes that it was the U.S. Maritime Commission which was the first to introduce this design for larger ships. During the Second World War a considerable number of 6,000-ton ships were constructed and at present many of these are employed in commercial operation. As another example where the ship's design will have to be adapted to the growing demands for modern cargo-handling methods, the author mentions the desirability of providing as much space as possible for mechanical handling underdeck. The 'tween-deck hatch coaming in open shelterdeck ships form an obstacle, and it may well be that in the near future the open shelterdeck ship will have to give way to the full scantling vessel.—*W. H. Kruyff, The Shipping World, Vol. 126, 14th May 1952; pp. 427-428.*

Performance of S.S. *Schuyler Otis Bland*

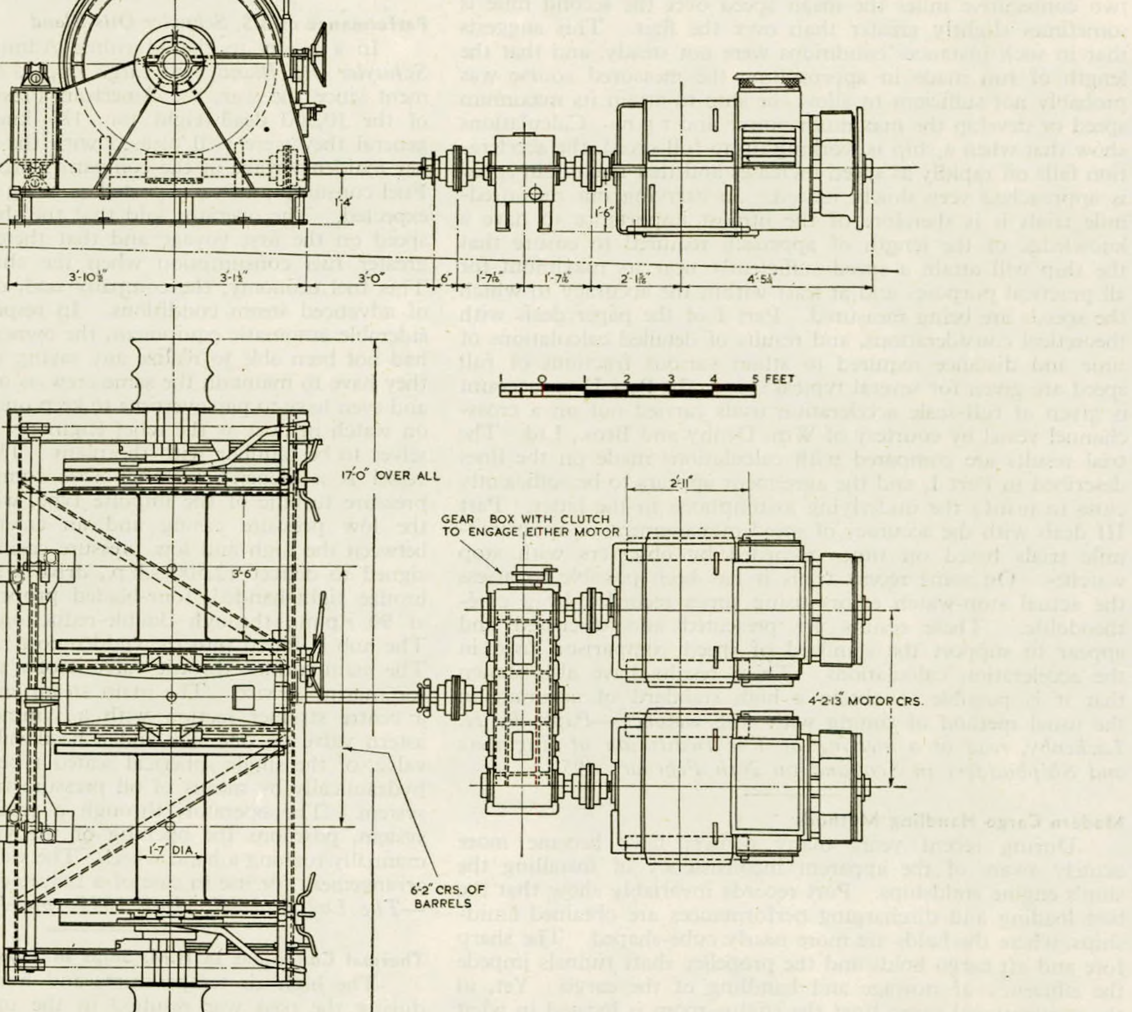
In a report to the Maritime Administration on the S.S. *Schuyler Otis Bland,* first cargo ship to be built by the government since the war, the American President Lines, charterers of the 10,500 deadweight ton, 18½ knot vessel, said that in general they were well pleased with the ship's performance on her maiden voyage in the company's around the world service. Fuel consumption was reported as being a little better than was expected. The operator said that the ship was not pushed for speed on the first voyage and that there would probably be a greater fuel consumption when the ship was deeper loaded. This fuel economy, the company said, demonstrated the value of advanced steam conditions. In respect to the use of considerable automatic equipment, the owners said that as yet they had not been able to realize any saving in labour expense since they have to maintain the same crew as on a conventional vessel and even have to pay overtime to keep one of the ship's engineers on watch in port as the relief engineers have not shown themselves to be familiar with the plant. The main turbine of the vessel is a General Electric cross compound, high and low pressure turbine of the impulse type, with an astern wheel in the low pressure casing and an emergency connexion line between the high and low pressure casings. The turbines, designed to deliver 12,500 s.h.p., drive a single solid manganese bronze right-handed, four-bladed propeller of 22-ft. diameter at 90 r.p.m., through double-reduction, double-helical gears. The hub is faired into the rudder post to minimize turbulence. The main turbine throttle valve is of a new and unique design for marine service. The main steam enters the valve through a centre strainer section with a symmetrical arrangement of astern valve on one side and a head valve on the other. The valve, of the single spherical seated type, is opened and closed hydraulically by means of oil pressure from the lubricating oil system. The operator, through a regular throttle and lever system, positions the opening of the valve desired instead of manually turning a hand wheel. The valve is fitted with a hand arrangement for use in case of a failure of the hydraulic system. —*The Log, Vol. 47, April 1952; pp. 41-42, 57.*

Thermal Conditions in H.M. Ships in Tropical Waters

The high air temperatures and humidities in H.M. ships during the past war resulted in the upper permissible limits of the thermal environment being defined. Practical application demands a method of predicting, before the ship leaves home waters, the thermal conditions which are to be expected within compartments under tropical conditions. The difference between the total heat content of the air within a compartment and that of the external air (heat gain) is shown to be independent of the temperature and humidity of the outside air provided the ventilation is unchanged. The distribution of the heat gains is shown to approach normality. Compartment wet-bulb temperature can be predicted by adding heat gain to a given external total heat content and converting the answer to wet-bulb temperature. For messdecks a technique is used for converting the predicted wet-bulb temperature into effective temperature for air speeds between 20 and 300ft. per minute. A nomogram is presented for easy prediction of effective temperature on messdecks. It also indicates the rate of change of effective temperature in respect of the total heat content of the air and the speed of air movement.—*Paper by J. A. B. Gray and F. E. Smith, read at a meeting of the Institution of Naval Architects, 4th April 1952.*

Trawl Winch

An electrically driven trawl winch, of the type specially designed by Clarke, Chapman and Co., Ltd., for motor trawlers, is to be fitted on the quick-freeze trawler-factory ship which John Lewis and Sons, Ltd., Aberdeen, are to build for Chr. Salvesen and Co., Leith. Power for the trawl winch is supplied by four 220-kW. generators, each driven at 500 r.p.m. by a 360 h.p. Diesel engine. Any of these generators can be switched on to either of the two driving motors on the trawl winch and, when connected, will give variable voltage (Ward-Leonard) control. In addition, either or all of the generators may be switched on to the trawler's main bus-bars to give a constant 220-volt supply, when the maximum output of each generator will be 245 kW., giving a total of 980 kW. for general shipboard requirements. The general arrangement of the trawl winch with its twin motor drive is shown; each motor is complete with its own control gear, so that, in effect, there is a spare or stand-by set of electrical equipment. An interlock ensures that only one motor is coupled to the trawl winch at a time. Each of the motors will transmit 270 b.h.p. The winch is designed for a maximum rope length of 1,200 fathoms and a mean speed of 320 feet per minute. It is claimed that the power consumption, when hauling in 1,200 fathoms with an average load of seven tons, is 63 B.o.T. units. Each barrel is equipped with a screw brake, and a magnetic brake is fitted to each motor.—*The Motor Ship, Vol. 33, June 1952; p. 103.*



General arrangement plans of a special design of winch for a new trawler-factory ship

ENGINEERING ABSTRACTS

Section 3. Shipbuilding and Marine Eningeering

Compiled and published by The Institute of Marine Engineers in co-operation with The Institution of Naval Architects.

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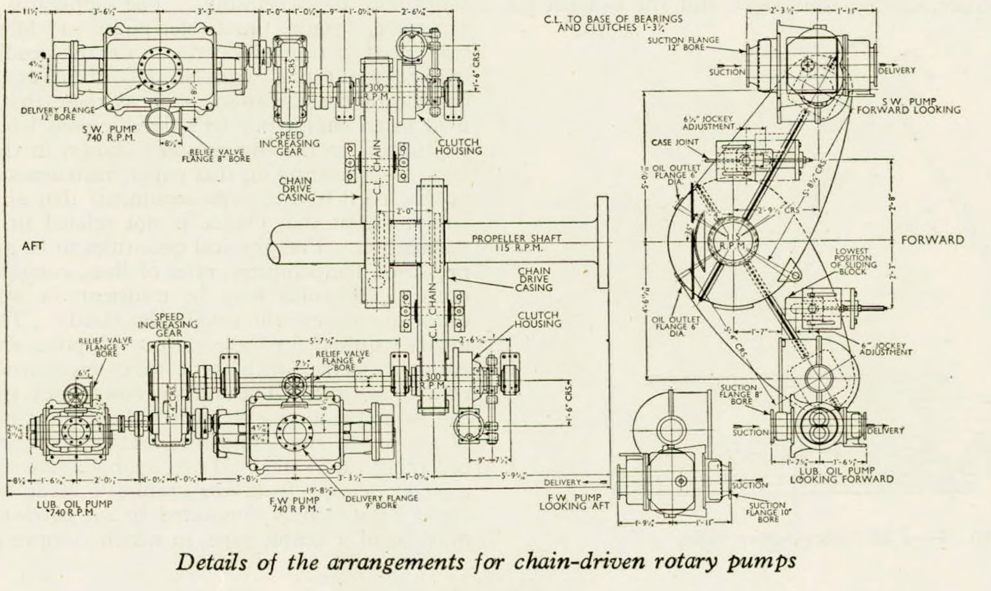
Chain Driven Pumps for Doxford Engines

An arrangement by which rotary pumps for the main engine forced lubrication, fresh water cooling and salt water circulating pumps will be chain-driven off the propeller shafting has been developed by the Furness Shipbuilding Company and Trewent and Proctor, consulting engineers and marine surveyors, in conjunction with Stothert and Pitt, Ltd. It is thought that this will result in economies in fuel and maintenance costs. The installation, shown in the accompanying plans, will first be adopted in the tanker *London Splendour*, of 24,750 tons d.w.c., for London and Overseas Freighters, Ltd. This ship will be propelled by a 6,800 b.h.p. Wallsend-Doxford engine. At least four vessels will be similarly equipped. Such an arrangement is designed to dispense with the use at sea of electrically driven pumps, which demand greater generator capacity, or the employment of steam-driven reciprocating pumps for these services. The total amount of oil and water to be pumped per hour is about 700-800 tons. The plans show that the pumps, which are of the Stothert and Pitt positive screw-displacement type, are chain-driven through clutches and increasing gear from the propeller shaft, which runs normally at 115 r.p.m. The speed is increased to 740 r.p.m. for all pumps. The power absorbed by each pump is approximately as follows: lubricating oil pump, 28 h.p.; fresh water cooling pump, 51 h.p.; salt water circulating pump, 57 h.p.—a total for all of the pumps of about 140 b.h.p. at full load. As the



Details of the arrangements for chain-driven rotary pumps main engine will not, in any case, be run at its full load, the power required for these pumps will be supplied by the most efficient means. Steam to the generator engine for lighting and other services, and certain engine-room pumps, will be raised by the exhaust gas boiler, so that with the machinery running under normal conditions the only fuel consumed will be that in the main engines. Steam-driven standby pumps are, of course, provided.—*The Motor Ship, Vol. 33, June 1952; p. 105.*

New Exhaust for Gas Boiler

A marine exhaust-gas boiler has recently been developed by A/S Akers Mek. Verk., Oslo, and has now been installed in several of the motor ships constructed by these builders.

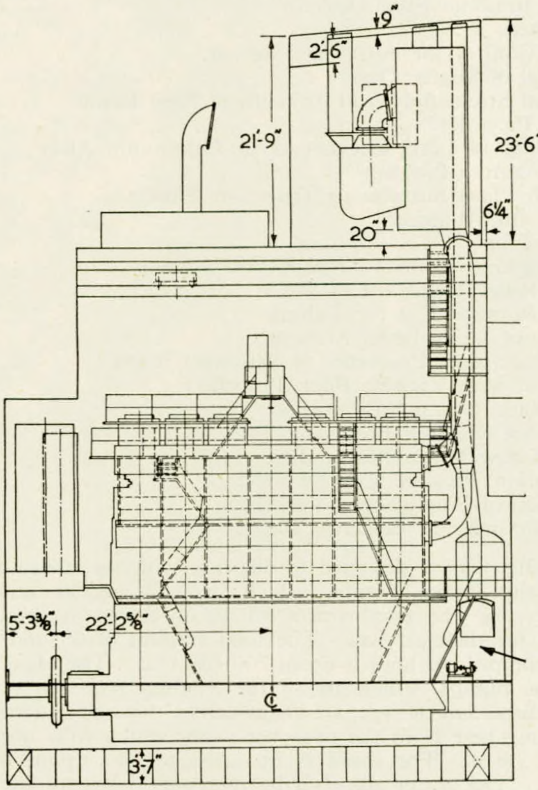


FIG. 3

Fig. 3 illustrates the arrangement of the main engine, with the exhaust pipes, silencer, change-over valve and the exhaust-gas boiler. An oil-fired boiler is seen forward of the main engine and may be used as a steam accumulator when the exhaust-gas boiler is in use. Fig. 4 shows the change-over valve. It is of the duplex type and the valve face not in use acts as a direction screen for the gas. The valve casing is welded to the silencer.—*The Motor Ship, Vol. 33, June 1952; p. 112.*

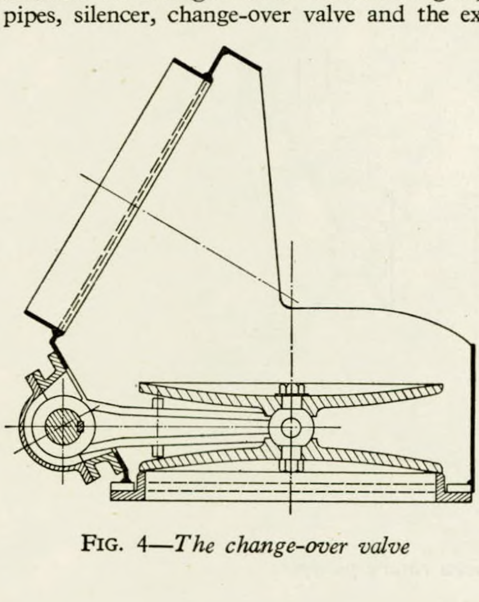


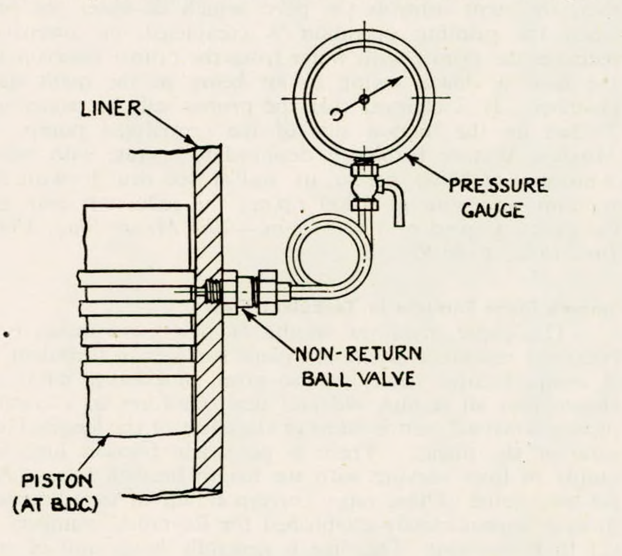
FIG. 4—*The change-over valve*

Testing of Steam Boiler Materials

This paper points out the necessity of having adequate data on the high temperature properties of metals used in steam boiler construction. The significance of the time factor in testing in relationship to long-life high-performance steam generating equipment is discussed, as are the general effects of metal oxidation from steam and combustion atmospheres. Metallurgical stability of steels is important in maintaining creep strength and is necessary to prevent severe modification of mechanical properties through effects such as spheroidization of carbide phase, graphitization or formation of sigma phase in highly alloyed steels. The relative merits of long-time creep tests and stress rupture tests are considered, and typical test data are cited for each form of test. These data are necessary for design of superheater tubes and headers, alloy baffles, hangers and fittings, and are an aid to the Boiler Code Committee of the American Society of Mechanical Engineers in assigning suitable stress allowances for materials. The paper gives suggestions for temperature limits for superheater tube materials and a résumé of field experience on carbon and alloy steels. Conclusions are drawn that high temperature creep and rupture testing have been very useful in evaluating the relative strength of steels for high temperature use, in aiding in the development of superior materials, and in permitting the increases in steam temperature and pressure which have led to much greater economy in power production. Further advances are forecast for the future through a well co-ordinated programme of metal testing now in progress.—*Paper by J. B. Romer and H. D. Newell, Trans.A.S.M.E., Vol. 74, February 1952; pp. 157-174.*

Instrumentation for Diesel Engines in Service

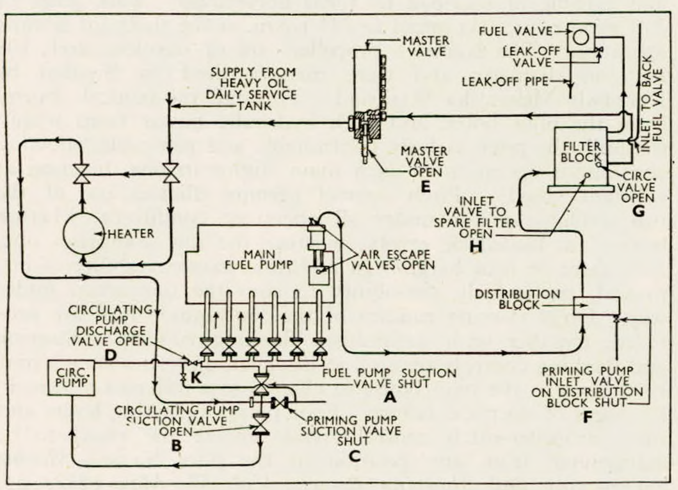
Instruments can be of great value to the engine operator. They enable him to make precise observations, and by relating these to existing knowledge he can determine a course of action with some certainty. At the same time, he can make records which add to the knowledge available for his own use and for communication. Finally, when suitable action can be predetermined, the instruments can be arranged to act upon their own information. It is not always easy to decide what instruments to install. Because a particular measurement may be useful it does not automatically follow that it is worth obtaining, and restraining influences are often encountered which are sometimes overwhelming. The apparatus involved may be expensive, fragile, unreliable, bulky or difficult to install. It may need a trained operator, or the readings obtained may require too much work in recording and analysing. It is because of considerations such as these that many instruments used in an engine builder's development laboratory do not find application in the engine user's station in the normal course of events. In compiling this paper, instruments have been chosen or discarded by the same arguments that an engine user would apply, except that choice is not related to any one particular installation. The physical quantities to be measured are mainly pressures, temperatures, rates of flow, rotational speeds and distances. Pressures may be transient, or virtually steady, but other quantities will usually be steady. The types of instruments required for these various purposes are dealt with by the author, together with some notes on warning and emergency control devices. The author points out that blow-by meters can be useful to give an early indication of any loss of efficiency of the piston rings, and therefore to show when an overhaul is becoming necessary. Two methods are described. In one method, a pipe from the crankcase leads to a gas meter, the outlet of which is connected to an extractor. The extractor must be of a simple type, in which compressed air is produced through a nozzle in the stream of the gas and thus produces a suction. The arrangement used in the second method is shown in Fig. 13. A quill is fitted into the cylinder liner at a point just below the top piston ring at B.D.C. A pressure gauge is fitted to the quill with a non-return valve before it. The pressure below the top ring will thus open the ball valve and build up in the gauge until a balance is reached. Should the top ring become less effective, the indicated pressure will rise above its normal value. The instrument appears to be a very sensitive means of revealing the onset of ring sticking and is simpler and less cumbersome than the gas meter apparatus. The ball valve must be kept in good order but the duty is less severe than when this device is used for measuring peak cylinder pressures, and the valve may therefore be expected to require less attention.—*J. D. Thorn, Diesel Engine Users' Association, March 1952, Publication S 220.*



"FOX" BLOW-BY GAUGE

Engine Operation on Boiler Fuel

The 9,100-ton motor cargo liner *Clan Macintyre* of the Clan line is designed to burn boiler fuel in her main Diesel engine. The six-cylinder Brown-Doxford main engine develops 6,000 b.h.p. at 108 r.p.m., but is capable of giving 6,400 b.h.p. continuously in service at about 110 r.p.m. The controls are placed at the forward end of the engine. No difficulty was experienced during the trials in starting the engine on the heavy oil. The accompanying diagram shows the fuel system. The main fuel pump is set in the "fuel off" position; valves A, C and F are closed, also all valves in the filter block, with the exception of G and H. The valves B, D, E, G and H are opened, and the circulating pump is then used to draw the fuel from the heavy-oil daily service tank, through the heater from which it is discharged through the main fuel pump, distribution block, filter block, and the master valves, back to the heater. The purifier/clarifier equipment for heavy oil comprises three De Laval machines, each with two pumps and designed for a delivery of three tons per hour on high-viscosity fuel, up to 3,500 secs. One of these machines is a standby, but is provided with interchangeable bowls to enable it to undertake either duty. There are two steam heaters for the fuel and one for the lubricating oil which is purified by a centrifuge of similar make but for 3½ tons an hour. Another unit of equal capacity is installed for Diesel oil.—*The Motor Ship, Vol. 33, May 1952, pp. 47-52.*



Diagrammatic arrangement of the heavy fuel oil system

Frames for Multi-crankshaft Engines

In Fig. 4 is illustrated an arrangement for mounting banks of cylinders on a frame, allowing the use of several crankshafts. Referring to the upper diagram, the frame (1) has a bottom cover (6) for the oil sump, which is divided by a partition (11). Mounted in the frame are lower crankshafts (13, 14) with their associated inclined cylinders (15, 16). The frame is formed with an additional partition (22), at the top being the oil sumps (4) for the upper cylinders (19, 20) together with their crankshafts (17, 18). Through the central chamber of the frame a shaft (21) projects for a further power unit. The side elevation and plan views in the lower part of the diagram show an installation with output shafts (17, 21) driven through clutches (15, 19) and reducing gears (16, 20) from engines (18, 14), the arrangement being suitable for vessels with forward and after screws, such as icebreakers and ferries.—*British Patent Nos. 665,702 and 665,703. Soc. d'Etudes De Machines Thermiques, Paris. The Motor Ship, Vol. 33, June 1952; p. 121.*

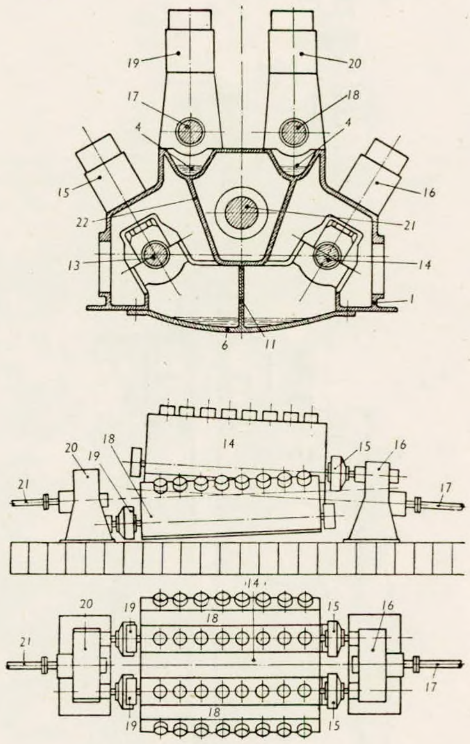


FIG. 4

Centrifugal Cargo Pump for Tankers

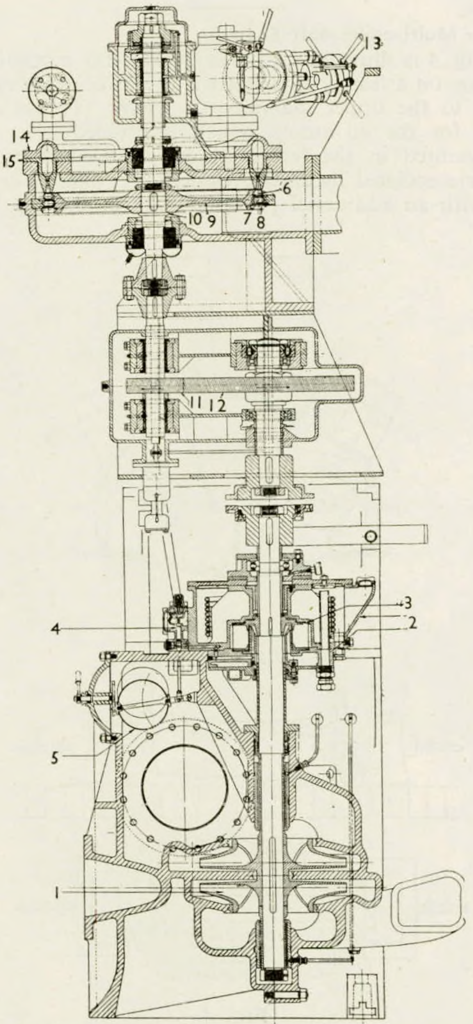
The motor tanker *Caltex Kenya* is propelled by a five-cylinder, 5,150 b.h.p. engine, and for the supply of steam to the four cargo pumps, there are two Foster-Wheeler oil-fired watertube boilers with an evaporation rate of 17,500lb. per sq. in. A Clarkson waste heat boiler is also installed. The cargo pumps, of the Worthington-Simpson type, are of the design shown in the accompanying sectional drawing, and have the following hourly outputs: —

500 tons of water at 125lb. per sq. in.

350 tons of oil at 2,000 secs. Red. No. I at 125lb. per sq. in.

300 tons of spirit at 0·7 spec. grav. at 110lb. per sq. in.

Of the two-stage type, each pump runs at 1,300 r.p.m. and has fully automatic self-priming and control arrangements. The casing, like the impeller, is of bronze construction, and it has a 12-in. suction and a 9-in. delivery. The primer is of simple construction without glands, and is automatically unloaded and thereafter rotates in air, thus absorbing no power. The rotor is the only moving part of the primer and revolves entirely free from metallic contact in the casing. The function of the control valve is to open and close the suction passage between the primer and the centrifugal pump. At the same time, however, the stem controls the ports which de-water the primer when the priming operation is completed, or alternatively, recharge the primer with water from the primer reservoir when the float is down, owing to air being in the main suction chamber. It is claimed that the primer will lift water up to 27 feet on the suction side of the centrifugal pump. The Mirrlees, Watson turbine is designed to operate with steam at a pressure of 220lb. per sq. in. and at 460 deg. F. with 20-in. vacuum, and runs at 6,000 r.p.m., the reduction gear giving the pump a speed of 1,300 r.p.m.—*The Motor Ship, Vol. 33, June 1952; p. 96-97.*



Sectional arrangement of a Worthington-Simpson centrifugal pump and turbine

1.—Impeller. 2.—Priming pump casing. 3.—Priming pump rotor. 4.—Float control valve. 5.—Float. 6.—First moving row blades. 7.—Fixed row blades. 8.—Second moving row blades. 9.—Turbine rotor. 10.—Turbine shaft. 11.—High-speed gear pinion. 12.—Low-speed gear wheel. 13.—Trip-valve lever. 14.—Steam chest. 15.—Nozzle block.

Smooth Plane Surfaces in Turbulent Flow

The paper gives the results of new experiments on the frictional resistance of smooth plane surfaces in turbulent flow. A comprehensive survey is also given of existing data. It is shown that all results, old and new, conform to a consistent picture when account is taken of the effect of the length/breadth ratio of the planes. There is no single friction line, but a family of lines varying with the length/breadth ratio. A line for zero value of this ratio, corresponding to two-dimensional flow, is approximately established for Reynolds' numbers from 0·1 to 10 million. This line is generally lower and of steeper slope than previously proposed lines. An upper line corresponding to a large value of 1/b is also proposed over the range of Reynolds' numbers from 1 to 100 million. This line is considerably higher than the line for $1/b = 0$ by an approximately constant ratio in the overlapping range from $R_n = 1$ to 10 million. No formulæ for these lines are proposed at this stage. It is hoped to carry out certain check experiments and to extend the range of Reynolds' number before final proposals are made. —*Paper by G. Hughes, read at a Meeting of The Institution of Naval Architects, 4th April 1952.*

Towboat with Variable Pitch Propellers

The new 3,000 h.p. towboat *Delta Cities* has several unusual features which include Kamewa controllable pitch propellers, an auxiliary bow barge and fairing hulls attached to the after end of the stern barge. The vessel is twin-screw, Diesel-powered, built by the St. Louis Shipbuilding and Steel Company. She has a length overall of 142 feet, beam 42ft. 6in., beam at headlog and at transom 35 feet, depth 11ft. 6in., and maximum draught 8ft. 6in. The two main engines are Fairbanks, Morse and Company ten-cylinder opposed-piston Diesel rated normally at 1,500 brake horsepower at 735 revs. per min. and capable of overload to 1,600 horsepower. Falk gears of 3 : 1 ratio reduce the speed to 245 r.p.m. at the shaft for normal operation. The Kamewa propellers are of stainless steel, 108 inch in diameter and were manufactured in Sweden by Karlstads Mekaniska Werkstad. Through mechanical control from the pilot house and with hydraulic power from within the hull, the pitch is fully controllable and reversible, allowing continuous operation of each main engine in one direction at constant speed. Pitch control permits efficient use of the full available power under all operating conditions, whether barges are loaded or empty, whether the tow comprises one, two, three or four barges. In addition, manœuvrability is improved, particularly the ability to stop the tow when under way. Large steering rudders of the contraguide type are provided, together with streamlined flanking rudders. Steering and flanking controls are each in duplicate so that a switch may be thrown in the pilot house to change to a different system in the event of electrical failure. Four pairs of steering levers and three propeller-pitch control stands enable the vessel to be manœuvred from any position in the pilot house.—*Marine Engineering and Shipping Review, Vol. 57, May 1952; pp. 60-63.*

Largest Motor Tanker

The motor tanker *Bérénice* is the largest motor tanker yet constructed and one of the biggest oil carrying ships in the world, with her deadweight capacity of 31,640 tons. The total machinery output is 13,500 b.h.p. and the mean speed attained on trials with the vessel fully laden was 15·95 knots. She uses boiler oil in her engines. The *Bérénice* was constructed for the Compagnie Auxiliaire de Navigation by the Chantiers et At. de St. Nazaire Penhoët, and a sister, the *Bethsabée*, will shortly be completed. The main characteristics are:—

Length overall	202·65 m.
Length on the waterline	196·10 m.
Length b.p.	188·70 m.
Moulded beam	25·90 m.
Draught	10·84 m.
Depth to main deck	14·15 m.
Deadweight capacity	31,640 metric tons
Displacement	42,740 „ „
Volume of fuel tanks	3,460 cubic m.
Volume of cargo tanks	39,600 „ „
Gross register	21,390 tons
Net register	12,040 „
Total power of engines	13,500 b.h.p.
Speed on trials fully loaded ...	15·95 knots

The hull is built on the Isherwood longitudinal system but the extreme forward and afterparts are constructed on the transverse system. Watertight transverse bulkheads divide the hull into nine cargo tanks, each tank being further divided into three by two longitudinal bulkheads. There are thus twenty-seven tanks each of approximately the same volume. The main pump room is aft of the tanks and forward of the engine room. There are two main bunker compartments, one at the forward end of the cargo tank and the other between the engine room and cargo tanks. The two propelling engines are Penhoët-B. and W. eight-cylinder two-stroke units with cylinders 740 mm. in diameter and a piston stroke of 1,400 mm., the total output at 122 r.p.m. being 13,500 b.h.p. To each engine the scavenging air is supplied from two rotary chain-driven blowers. Reversal of the direction of air supply is controlled from the manœuvring platform. Fresh water is employed for cooling the cylinders and lubricating oil for piston cooling. A thrust block of the Michell single collar type is incorporated in the bedplate of each engine. Steam is generated by two oil fired boilers and two La Mont exhaust gas boilers. The four boilers are provided with two reservoirs, each reservoir being common to one oil fired boiler and one exhaust gas boiler. The latter has a heating surface of 250 sq. m. and a maximum output of 2,960 kg. per hr. at 13 kg. per sq. cm. Each exhaust boiler is provided with an economizer for reheating the feed water, and with a steam drier. The output of the oil fired boilers is 12,500 kg. per hr., also at 13 kg. per sq. cm. Each complete boiler unit, comprising an oil fired boiler and an exhaust gas boiler, is equipped with a common reservoir containing 15 cu. m. of water, maintained at a pressure of 13 kg. per sq. cm., from which sufficient steam can be supplied in case of an unforeseen stop of the main engines to ensure the operation of the steam-driven auxiliaries, whilst waiting for the oil fired boilers to be placed in service. With this end in view, Diesel oil is used in the burners.—*The Motor Ship, Vol. 33, June 1952; pp. 90-95.*

Twin Screw Motor Pusher Tug

Trials were recently carried out on the raised propeller twin-screw motor pusher tug Adama built by Yarrow and Company for Shell service on West African waterways. The vessel has been specially designed for the duty of pushing an articulated train of eight 200-ton capacity barges to the bulk depot at Garoua in the French Northern Cameroons. In order to ensure the necessary manœuvrability under the difficult river conditions, including shallow waters, the vessel is fitted with flanking rudders in addition to steering rudders and the screws are arranged to operate in tunnels. The design of tunnels is an unusual one and the Adama is the first vessel built in this country to incorporate the present arrangement. Instead of being parallel with the shafting, the tunnels are of oblique form with a view to obtaining a more direct lead of water to the propellers and a corresponding reduction in power consumption. Before commencing construction, extensive model tests were carried out at the National Physical Laboratory to confirm the suitability of the design of the hull and also the positions and profiles of the steering and flanking rudders of the vessel. The principal particulars are: length overall 129ft. 0in., length L.W.L. 123ft. 0in., breadth moulded 32ft. 0in., depth moulded 6ft. 0in., draught loaded 4ft. 3in., maximum height above DL.W.L., 20ft. 0in., deadweight tonnage 110 tons, speed (running free) 10 m.p.h. The steering and backing or flanking rudders are of partially balanced single plate type with independent steering gear of Hyland hydraulic make, and include provision for the steering and flanking rudders to be operated simultaneously when required. The propelling machinery comprises two directly-reversible scavenge pump H.R.L. 5/40 two-stroke Crossley engines capable of driving the vessel at a speed of 10 miles per hour.—*Shipbuilding and Shipping Record, Vol. 79, 8th May 1952; p. 591.*

High Detergency Lubricants

Use of highly detergent crankcase oils has created a number of new filtering problems. Detergent additives not only effectively counteract the formation of engine deposits by polar suspension of the colloidal contaminants in the oil, but also render the bulk of the organic contaminating matter unfilterable. Establishment of an efficiency-promoting sludge bed on the oil filter elements is thus prevented, and colour-clean oil filtration made impossible. However, two factors which limit the life of heavy-duty lubricating oils should be understood. First, the fact that while detergent additives prevent the organic contamination from depositing on engine parts, they do not remove it from the crankcase. Consequently, the oil viscosity will show a gradual increase due to the dissolved and suspended organic contaminants until finally a point may be reached where satisfactory oil supply to splash-lubricated parts is no longer assured. The second point limiting the usefulness of heavy-duty lubricants is the exhaustible nature of the detergents. Their polarizing action depends on the quantity of detergent material available in proportion to the amount of contaminating matter present. Once the active detergent present has been used up, incipient sludge formation will take place in the same manner as if non-detergent oil were used. Considerable attention has been directed during the past few years to the possible use of oil drain analyses as an indication of oxidation resistance and detergency effectiveness. Since most of the current heavy-duty oils derive their detergency from compounds containing either calcium or barium, much can be learned about the condition of used oil samples by sulphate ash determinations. These metals may thus be readily analysed in new oils and have very definite values for each particular lubricant. In used oil samples, however, the same metals may show up in identical amounts without necessarily indicating their presence in an effective form. The sulphate ash analysis of used oil may also be increased by presence of undissolved or dissolved organic salts contributed by iron, lead, and dirt contamination products. On the other hand, reduced sulphate ash values may be found in the used oil which could be attributed to removal of some organic compounds by effective filtration. While it is generally felt that analysis for the calcium or barium present in the detergent compound is possible after filtration of the used oil through paper, these methods are far too complicated to be recommended for field use.—*H. M. Gadebusch, R. T. Karr, and W. B. Bassett, S.A.E. Journal, Vol. 60, April 1952; pp. 33-37.*

Oil Filters

It has been found that detergent-type oils have poorer filterability than straight mineral oils or oils containing only inhibitor additives. The theory for such poorer filterability has been essentially that any detergent to dispersant action keeps insoluble matter in such a fine state of dispersion in the oil that solid particles are not as readily trapped and retained by a filter. To study this phase of oil filtration, laboratory tests using the reference sludge were run on quite a variety of oils, ranging from non-detergent up to high detergency products. Some filter designs displayed no significant difference in oil filterability regardless of the type of oil tested, whereas other filters were found to be less efficient in removing insolubles from high detergency oils. The theory has frequently been advanced that compounded motor oils suffer additive depletion by adsorption of the additives on insoluble sludge particles, which are then removed by the oil filter. To study this possible action, numerous analyses for additive concentration in a variety of compounded oils were made during the course of filter test runs. To summarize this phase of the work, there was no indication of any appreciable removal of inhibitor-type additives by adsorption on insoluble matter; however, depletion of detergent-type additives was found to be quite appreciable. In a typical test on a high detergency oil, a total of five per cent insolubles was added to the oil charge over a 20 hour test period, and about four per cent of this added sludge was removed by the filter. In the course of the filtration, the detergent additive content of the oil was reduced by some twenty per cent. Although depletion of detergent additives by adsorption on sludge particles does occur, it does not appear that such is of high magnitude except in cases where excessively high rates of sludge contamination of the oil prevail.—*C. W. Georgi, J. F. O'Connell, and T. C. Eitel, S.A.E. Journal, Vol. 60, April 1952; pp. 27-32.*

Twin Arc Welding Process

There exist two serious obstacles to increasing the speed of welding and lowering welding costs. First, for any given weld size, there is a maximum electrode size and maximum current which must not be exceeded; and secondly, the electricity supply authorities do not like heavy welding currents which, with single-phase transformer sets, impose an unbalanced load on the mains at a very low power factor. The Twin-Arc process claims to solve both these problems and to offer welding speeds up to 100 per cent faster than orthodox single arc welding, while taking an almost completely balanced load from the supply mains at a comparatively high power factor, and without the use of elaborate automatic welding equipment. The Twin-Arc plant (Fig. 1) consists of a modified 3/2-phase Scott-connected transformer, taking a balanced load from the supply mains and delivering a two-phase output through the specially designed electrode holder to the twin-cored electrodes. When single phase alternating current is used for arc welding, there

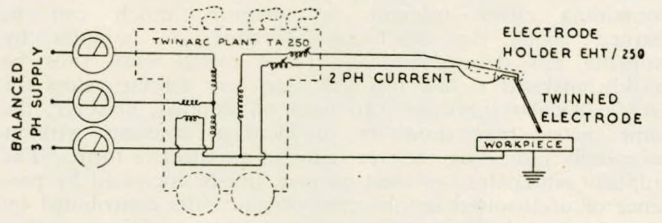


FIG. 1

is in each current cycle a period during which the current is zero and the arc is momentarily extinguished. With the Twin-Arc process, the two-phase secondary currents are 90 deg. out of phase, so that an arc is maintained continuously at one or other of the twin electrodes. Ionization due to the burning arc from one electrode assists in re-striking the arc at the other electrode, and temperature fluctuation in the arc zone is reduced, so that *there is no period of zero current* as there is in the case of normal a.c. welding. The arc never goes out. Because of the greatly increased arc stability, electrodes requiring a striking voltage of 60, 80 or 100 volts with single arc welding can be deposited with Twin-Arc with a striking voltage of only 45 volts. This low striking voltage means an improvement in power factor from 0·3 to 0·55 and this value is practically constant over the whole range of welding current. The power consumption (kVA) per pound of deposited metal is less than for any other manual arc welding process and the overall efficiency of the Twin-Arc plant is nearly 90 per cent.—*W. D. Waller, Welding and Metal Fabrication, Vol. 20, May 1952; pp. 162-168.*

Residual Stress and Yield Strength of Steel Beams

Under certain conditions continuous or "rigid" frames require less material than statically determinate structures designed for the same loads. In conventional elastic design methods, structures are designed with respect to the load at which the calculated maximum stress reaches the yield point, henceforth called the "initial yield load" of the structure. In the case of statically indeterminate structures (and to a lesser degree in determinate structures), a further increase in load may be realized even though yielding has occurred at some cross section. The use of the so-called "simple plastic" theory has been suggested by a number of authors who have recommended design on the basis of ultimate strength. It has been suggested that increased economy can be achieved if the design can be based on a load greater than that at initial yield. Questions are occasionally raised with regard to the possible application of the simple plastic theory. One reason for such inquiries is that too little is known regarding the basic plastic behaviour of steel structures. This report is one of a series in which the elastic and plastic behaviour of full-size steel members and frames are being studied. In order to investigate the behaviour of welded continuous frame structures, a series of tests on simulated frames and continuous beams were carried out to furnish additional information regarding elastic and initial plastic deformations and to correlate these results with existing analysis and design procedures. It has been established that welding may introduce in structural members residual stresses of the same magnitude as the yield stress of the base material. Connexion details introduce local concentrations of stress. Also, structural steel members in the as-delivered condition contain residual stresses due to cooling after rolling. The effects of these factors on the initial yield load have been observed and analysed in this paper. The buckling strength of columns or beams under certain conditions will be reduced by the presence of residual stress and a brief examination is made of this influence.—*Ching Huan Yang, L. S. Beedle and B. G. Johnston, The Welding Journal, Vol. 31, April 1952; pp. 205s-229s.*

Calculation of Rectangular Bar Helical Springs

Helical springs of square or rectangular bar section are sometimes used for cases where a large amount of energy must be stored within a given space. Particularly if the spring is coiled flatwise, it is clear that a larger amount of material may be provided within a given outside diameter and compressed length than if a circular section were used. Consequently, other things being equal, a larger amount of energy may be stored within a given space for such a design than would be the case if a circular bar section were used. Although theoretically the rectangular bar section does not have as favourable an elastic stress distribution as does the round bar section, for static loading or loads repeated only a few times, this disadvantage is of no particular importance since local yielding of the most highly stressed portions can occur without affecting the performance of the spring appreciably or the capacity for storing energy. However, where fatigue or repeated loading of the spring is present, this nonuniformity of stress distribution will be a disadvantage. In general when bar stock of rectangular section is coiled to a helical form, a keystone shape of cross section finally results. The formulæ given in the paper, however, are based on the assumption of a true square or rectangular shape. It is believed that these formulæ are sufficiently accurate for most practical purposes. In contrast to the round wire helical compression or tension spring where curvature effects can be neglected in calculating deflexions, such effects are particularly important for small index helical springs coiled flatwise. In such cases, neglecting curvature may result in errors of 15 per cent or more. To facilitate the calculations in such cases, charts are given in the paper. The formulæ given also neglect the effects of pitch angle which are small for most springs used in practice.—*A. M. Wahl, Journal of Applied Mechanics, Vol. 19, March 1952; pp. 119-122.*

New Super Tankers

Contracts recently let by the Sun Oil Company for the construction of two tankers at the Chester yards of the Sun Shipbuilding and Dry Dock Company illustrate the continuing super-tanker trend. The principal characteristics of these vessels are as follows:—

Length overall	641ft.
Length, between perpendiculars ...	615ft.
Breadth moulded...	84ft.
Depth moulded	45ft.
Design draught, keel	34ft.
Cargo oil capacity, 100 per cent full ...	250,600 bbl
Fuel capacity, 100 per cent full ...	1,345 tons
Reserve fuel, forward, 100 per cent full	1,890 „
Gross tonnage (estimated)	18,750
Shaft horsepower, normal	13,500
R.P.M., normal	100
Trial speed	16½ knots

The general arrangement of these vessels is shown in Fig. 1. They are of the three island type—poop, set-in bridge and forecastle; with straight raked stem, cruiser stern, and single continuous steel deck. These tankers will be propelled by a single screw, with the conventional location aft for propelling machinery, consisting of geared turbines and two watertube boilers. The main cargo pump room will be located at the aft end of the cargo oil space. The cargo tank space will be divided transversely into two wing tanks and a centre tank by two longitudinal oiltight bulkheads. Longitudinally there will be ten subdivisions by transverse oiltight bulkheads, making a total of thirty cargo oil compartments. Generally, the tanks will be 39ft. 4in. long and the overall length of the oil space will be 380ft. The principal dimensions and characteristics of the vessels were selected to provide a suitable, sea-kindly, easy-driving hull form. It has been noted that the supertankers have a tendency to plough through the North Atlantic waves rather than rise up to them, and accordingly the form forward has been given a decided flare in order to throw off the green seas. The vessels will have a flat sheer line, and the forecastle and poop will be raised at the ends of the vessel to give a sheer effect, and thereby contribute to the seaworthiness. To give added protection, solid bulwarks will be fitted for 40ft. aft of the forecastle. To provide adequate longitudinal strength a length-to-depth ratio of 13·7 was selected. The vessel will be propelled by a single, four-bladed, solid, bronze propeller, 22ft. in diameter, of Slocum design. The screw will be driven by Westinghouse cross-compound, double-reduction geared turbines, rated at 13,500 normal shaft horsepower at 100 revolutions per minute. Three bleeder stages will take the steam extraction from the turbines. A flexible coupling will be used between the turbines and the reduction gears. The two main boilers will be of the Babcock and Wilcox, standard merchant marine, two-drum type, and will supply steam at a pressure of 600lb. per sq. in. gauge, total temperature 840 deg. F. Each boiler will be fitted with four, variable capacity oil burners. The boilers will operate on forced draught. The combined rated capacity of the boilers will be 105,000lb. per hr. at normal rating. The feedwater will be delivered to the boilers at 300 deg. F. by a three-stage feed-heating system.—*Marine Engineering and Shipping Review, Vol. 57, May 1952; pp. 57-59.*

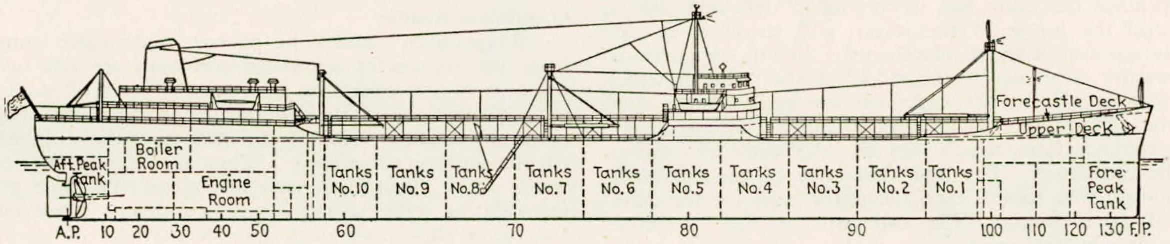


FIG. 1

Stress Rupture Test for Tubing

A large percentage of high-temperature alloys is used in tubular form for heat exchangers in oil refineries and also in steam boilers. Most of the high-temperature strength data for these materials are based on tests conducted in simple tension bar specimens. The reason for this is that tubular stress-rupture or tubular creep tests. have hitherto been too costly; firstly, because the tubular specimens used were too expensive, and secondly, because quite regularly the electric furnace used for heating the specimens was either damaged or destroyed when a specimen ruptured. An apparatus has now been designed in which these difficulties are largely avoided. The method consists in using tubular specimens approximating in length to 20 tube diameters, which are closed by plugs at both ends, while pressure is supplied at the top of the specimen through a connecting tube of stainless steel welded into the plug at the top and connecting with a high-pressure water reservoir. Internal volume of the specimen is reduced in order to minimize the explosive force during rupture. For this purpose, a close-fitting solid core is inserted, which takes up nearly the entire internal volume. By testing the specimen under internal pressure, actual service conditions are closely simulated, except for the external flue gas atmosphere and the temperature gradient through the tube existing in heat transfer service. After assembling the specimen in the testing furnace, a series of tests on the particular tube size material is started with short-time high-temperature tensile tests on duplicate specimens. This information is used to decide upon the stress and pressure levels to be used for the first few specimens with relatively short life tests. These tests furnish information for subsequent long-time tests. —*The Engineers' Digest, Vol. 13, May 1952; pp. 138-139.*

Metallizing

Metallized coatings have rather unique structures and properties because they are formed layer by layer of thin lamellæ when the atomized globules of the sprayed metal strike the surface being coated at high speed and with considerable impact. Initially, each particle is essentially a tiny casting which has solidified very rapidly and acquired a very thin oxide film during its rapid transit from the gun nozzle to the surface. On impact, the particles are instantly deformed into thin platelets or flakes which conform to the surface contour and bond to the prepared surface by mechanical interlocking with surface irregularities and with each other or by cold welding at regions where the oxide film is disrupted on impact and metal to metal contact obtains. Since sprayed coatings exhibit a lamellar type of structure, they have directional properties and have a greater tendency to split in a direction parallel to the long axis of the lamellæ. On grooved or threaded surfaces, this tendency is decreased as the flakes are not flat, but conform to the shape of the groove or threads. Cavities between adjacent flakes and oxide inclusions tend to make sprayed coatings porous and lower in density than the same metal in cast or wrought forms. This porosity makes the coatings more satisfactory for bearing surfaces as the pores will hold lubricants and the porous sprayed metal will provide an excellent surface for holding paint or other protective organic coatings. For some applications, the structures and properties of sprayed coatings limit their application. These coatings are brittle and have low elongation and tensile strength. Because of these conditions, sprayed coatings should not be used where they will be subject to direct impact or appreciable flexing.—*F. Keller, The Welding Journal, Vol. 31, April 1952; pp. 291-295.*

Determination of Moments in Rigid Plates

The determination of the moments arising in loaded plates usually involves expressing the loading and deflexion as Fourier series, and then obtaining the second derivative of the deflexion. Analytical methods of this type are time-consuming when some peculiarity of the shape or loading takes the plate considered outside the range covered by published tables. In this article, the author describes a simple experimental method of determining the moments. A model of the plate is made of a reflecting substance, such as silvered perspex or even polished metal, and arranged opposite a screen on which parallel lines are drawn. A camera is arranged which views the plate through the centre of the screen. An exposure is made with the plate unloaded, and this shows the lined screen as reflected by the plate. The load is then applied and a further exposure made. In the second exposure, the plate has undergone a deflexion due to the load, and the image of the screen will therefore be displaced. The amount of the displacement is directly proportional to the curvature taken up by the model at the point at which reflection occurs. If the two exposures are made on the same negative the photograph shows the so-called "moiré effect", giving interference lines which can be interpreted as contour lines of the curvature. The first derivative of the curvature, which can readily be found, then forms the basis for the determination of the moments. The apparatus required is simple, and the results obtained are accurate within $\pm$ 5 per cent, which is adequate for practical cases. There is a worked example, and a number of references are given.—*F. A. Ligtenberg, Ingenieur, Vol. 64, 29th February 1952; p. 0.42. Journal, The British Shipbuilding Research Association, Vol. 7, April 1952; Abstract No. 5967.*

Measurement of Ventilation by Radioactive Tracers

The authors summarize briefly the older methods of measuring the ventilation (number of air changes per hour) of buildings, i.e. by the measurement of thermal loss, or of the concentration of gases introduced into the system for that purpose. Then a modern procedure is considered, based on the introduction of radioactive tracers into the atmosphere under investigation. The rate at which the concentration of these tracers diminishes can be recorded and is a measure of the rate of air renewal in the building. Some radioactive Xenon, with a period of 5·4 days, was placed by the authors in one part of the laboratory, and the consequent ionization of the surrounding air produced by the emission of β particles was measured by means of an ionization chamber connected to a p.d. amplifier. From the manner in which the concentration at a given spot decreases with time, it is easy to calculate the rate of air renewal. This will not give an accurate result if conditions at the spot at which the measurements are being made are affected by the radioactivity that may build up in adjacent regions of stagnation. Another source of error to be considered is the possible unequal concentration of the tracer at different points in the same room. Nevertheless, the authors consider the method to be very promising.—*R. Cadiergues and P. Lévêque, Chaleur et Industrie, Vol. 33, January 1952; p. 21. Journal, The British Shipbuilding Research Association, Vol. 7, April 1952; Abstract No. 6033.*

Application of Ultrasonics to Metal Spraying

While the main range of applications of ultrasonic vibrations appears to lie in fields where a disintegrating or dispersive effect is to be attained, a recent invention proposes their employment for the purpose of consolidating sprayed metal layers. The invention referred to concerns a method of producing smooth antifriction metal coatings, particularly for bearings of aircraft and automobile engines, but a special type for Diesel engines has also been developed. The underlying principle of the invention consists in producing a smooth antifriction metal coating on a metallic supporting surface by spraying the molten metal in a finely divided state on to the surface while subjecting the latter to ultrasonic vibrations, the frequency of which may range from 20 to 50 kilocycles per second. The metal intended to form the coating is supplied to the spray gun in the form of a wire of lead, red copper, aluminium, or magnesium, or their alloys. Where at least two metals are simultaneously sprayed, a wire is used which has a core of one metal concentrically surrounded by at least one other metal. A core of flux may also be provided. Microscopic or colloidal flakes of graphite may also be included in the wire, so as to produce a self-lubricating sprayed coating. As it is practically impossible to wire-draw antimonated lead containing eight per cent of antimony as used for bearing bushes, the inventors propose the use of a compound wire, the body of which is of lead, either pure or combined with tin, and the core of which is of powdered antimony, either pure or mixed with copper and lead. A deoxidizing and plastifying flux may also be added.—*The Engineers' Digest, Vol. 13, May 1952; p. 137.*

Magnesium Anodes

Magnesium anodes to protect underwater ship surfaces from the ravages of sea water corrosion are now available to shipowners and operators after several years of successful testing. Corrosion of the underwater surfaces of ships is due primarily to some areas of the steel surfaces being more active chemically than other areas. When such conditions occur under water, small electric currents flow from the more active areas through the water to the less active areas. These currents, as they leave the active areas, remove particles of steel and, over a period of time, cause severe pitting of the ship's surface, resulting in serious and costly damage. Such corrosive action, it is claimed, can be controlled by simply stopping the flow of current away from the active areas of the ship's surface by the use of magnesium anodes. This method is known as cathodic protection. Magnesium is the most active of the commonly used metals. When it is connected to steel the electrical current flows from the magnesium to the steel. If a sufficient quantity of magnesium is used, it prevents any current from leaving the steel, thereby controlling corrosion. Claims of the effectiveness of magnesium anodes have been substantiated by the Royal Canadian Navy which, following successful tests over the last three years on several small vessels, recently ordered this method of cathodic protection installed on several of its larger vessels up to and including aircraft carriers. Recently the Dow Chemical Company's 13,000 deadweight ton tanker *Marine Chemist* became the first large commercial vessel in active service in the United States to use magnesium anodes for protection against sea water corrosion. Some 7,000 pounds of magnesium anodes were attached to the port and starboard sides of the *Marine Chemist*, several feet below the water line, directly aft of the bilge keel, for a length of about 75ft. on each side. The anodes, each with a length of 16 inch and weighing about 60lb., were designed to last a year, following which new ones will be installed when the tanker is dry docked for annual overhaul next October. The anodes are held securely in place by Monel Metal six inch studs, one inch diameter, "position welded" on the shell plate of the hull.—*The Log, Vol. 47, April 1952; pp. 56-57.*

Thermodynamic Properties of Saturated Water

The paper is divided into three parts, with an appendix. In the first, the general properties of the temperature-entropy diagram for water and steam are examined. By a simple device resulting from the use of Clapeyron's equation, it is shown that it is possible to give a very complete representation of the thermodynamic properties of saturated liquids by areas on this diagram. The second part of the paper constitutes a critical review of Callendar's hypothesis that saturated water contains in solution its own volume of saturated steam, and the pictorial representation of the properties of saturated water is here found to be very useful. In an appendix to the paper the use of Callendar's hypothesis as a working proposition is shown to give elegant and rapid evaluation of the relations required in the calorimetry of saturated water under ideal experimental conditions. This section of the paper is placed in an appendix as the ability to use the hypothesis under these conditions does not constitute a proof of its validity. It is, in fact, shown in the second part of the paper that, on the latest experimental data, the hypothesis fails to give an exact prediction of the thermal properties of saturated water. The third part of the paper shows that the failure of Callendar's hypothesis to fit the experimental data can be accounted for by supposing that the quantity of dissolved steam is related to, but less than, that postulated by Callendar. This leads to an interesting picture which bears some resemblance to certain aspects of the hole theory of liquids, to which Callendar's hypothesis has been compared. Both, however, are based on hypotheses, the validity of which can be tested only by the measure of agreement between theory and experiment.—*Paper by R. W. Haywood, submitted to The Institution of Mechanical Engineers for written discussion, 1952.*

New Ultrasonic Flaw Detector

A new design of ultrasonic flaw detector, utilizing the single-probe principle, has recently been introduced. This new unit employs only one crystal, which acts as both transmitter and receiver of the ultrasonic vibrations. These ultrasonic vibrations are produced by high-frequency electrical currents, which cause the crystal to vibrate. They are transmitted to the material which is being tested, by direct contact with

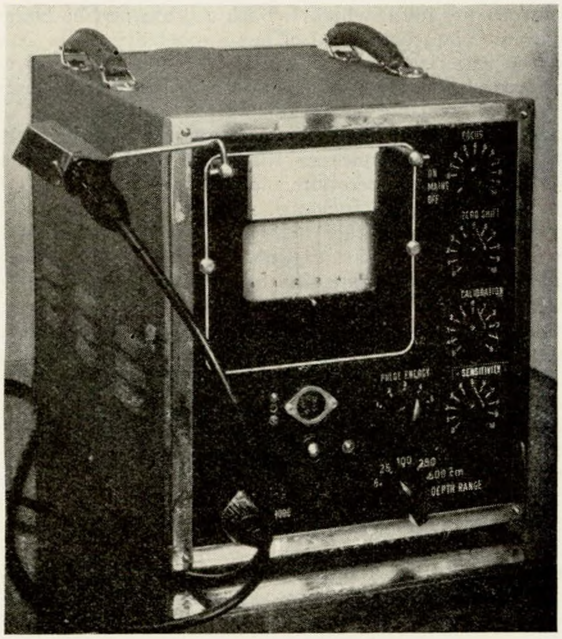


FIG. 1.—*Ultrasonic Flaw Detector*

the crystal. They travel through the material at speeds depending on the nature of the material, and they suffer only small loss of energy in the process. They can, therefore, travel long distances in a homogeneous object. If, however, they encounter a discontinuity, such as a crack, porosity, a foreign inclusion, or a juncture of two surfaces (e.g., metal to air at the end of the object, or metal to metal in between, even if these surfaces are optically plane), the vibrations are reflected, and only a very small portion of their energy passes on. The echoes so produced are received by the crystal on their return, and they are reconverted into electrical impulses, which are registered on a cathode-ray oscillograph. This oscillograph then indicates two or more peaks in the scanning trace. The first is produced when the transmitted wave enters the object (initial pulse), the second arises from the wave which is reflected from the far end (the bottom echo), while others, if present, are caused by the discontinuity or defect which is in between. The distances between these peaks on the oscillograph screen are a measure of the position of the discontinuity or of the metal face remote from the crystal. The field for this form of non-destructive testing is large. Machined parts, forgings and welded joints can be examined for the presence of cracks, slag inclusions, porosity, welding defects, laminations, and so on. The operator, in addition, is able to measure the thickness of objects in which inaccessibility makes direct measurement impossible (e.g., pressure vessels, long pipes or boilers, etc., which may have become subject to corrosion). The apparatus, which is quite portable, is illustrated in Fig. 1. For those applications where a double probe is more convenient, facilities are provided for their use, either as separate transmitter and receiver, or as double transceivers. Facilities for photographing the screen of the cathode-ray tube are built into the instrument, and thus a permanent record may be kept.—*The Shipbuilder and Marine Engine-Builder, Vol. 59, May 1952, pp. 367-368.*

Steering Gear Control Transmission Systems

Various methods are in use by which the motion of the wheel is transmitted to the steering gear compartment where it serves as the input signal to the steering gear control. These can be enumerated as follows: 1. Direct shaft transmission is the most reliable system for small vessels. 2. Flexible wire-rope transmissions over grooved drums is convenient, but requires some method of maintaining tension for the wire rope. 3. Plunger-type hydraulic telemotor systems consist of a pair of transmitting plungers in the pilot house connected by hydraulic tubing to a pair of receiving plungers at the steerer. It is necessary to provide a system for equalizing both sides of the system at amidships because of leakage, etc., by either a cam-operated or electrically-operated equalizing valve, or by providing equalizing or bypass ports for the transmitter plungers at the amidships position. 4. Rotary pump type hydraulic telemotor system provides very moderate wheel effort with a rotary piston type pump in the pilot house as a transmitter to a pair of receiver plungers at the steerer. There is no equalizing problem and the helm angle indication is "repeated-back" from the steering gear to the helmsman by electrical, mechanical, or hydraulic means depending upon requirements to suit the installation. 5. Pneumatic type control is found on most river towboats, etc., and is usually of the Westinghouse Air Brake type. 6. Electric self-synchronous systems have been used chiefly by the U.S. Navy and by larger vessels. An advantage is the ease of installation and operation for more than one steering station. However, difficulty has been experienced in synchronization on some installations when more than one type of control transmission system is used. 7. Electric "step-by-step" system as used with one type of steering gear is a purely electrical system with control of rudder angular movements in steps of about $\frac{3}{4}$ degree increments. 8. Sperry Gyro-Pilot system is a method of transmitting helmsman signal and also providing automatic steering through connexion to the gyro-compass. Under automatic steering, this system endeavours to provide a corrective signal equal to the rate the ship moves off course as well as the amount of change of heading. This system is an example of a complete servo-mechanism in which a pilot unit is made the slave of the helmsman or automatic pilot. The effort on the wheel is very moderate. The pilot unit in the steering-gear compartment responds proportionately to the helm motion to do the physical work of initiating the steering-gear input signal. In this sense, a miniature steering gear guides the main unit which moves the rudder in an overall control cascade. It is good engineering practice on large vessels to provide two separate control transmission systems. This usually is a Gyro-Pilot system and a hydraulic telemotor system (preferably the rotary pump type). There is an advantage in having one system independent of the other, viz., electro- versus hydro-mechanical, which may be used at random for hand-steering control. Each type serves as a stand-by to the other in the event of momentary power failure or danger. In addition, it is customary as a requirement of the U.S. Coast Guard to have a separate steering stand on the weather deck or deck housetop aft, with separate connexions to the steering gear.—*Paper by J. A. Olson, Abstracted in S.N.A.M.E. Bulletin, Vol. 7, May 1952; pp. 31-32.*

Removal of Engine Gears

A practical method of ensuring economy, speed and accuracy in the removal of the main engine gears of a cargo ship was employed at the Alameda (California) yard of Todd Shipyards Corporation on an American-Hawaiian C-4 vessel, the s.s. *Nevadan*. The vessel was fully loaded with cargo and speed was essential in performing the job. The system was to employ a wooden template to the exact dimensions of the gears and to use it as a guide in removing interference from the main engine room upward through the engine skylight casing and part of the ship's funnel through which the gears were removed. This system permitted the gear removal with a minimum removal of piping, gratings, insulation and other equipment and ship parts, by allowing only two inches of tolerance in the shaft fore and aft of the gears themselves.—*Marine News, Vol. 38, May 1952; p. 94.*

Constant Compression Engine

One of the principal means of increasing thermal efficiency and producing greater power output in automotive engines is an increase in the compression ratio. Increased compression ratio, however, demands fuel of higher octane number, and such fuels are not only expensive but in much shorter supply than those of ordinary knock resistance. The advantage of an engine which can utilize fuels of lower grade is therefore obvious. Perhaps the most interesting proposal directed towards the use of lower octane fuels in high-compression engines is that relating to the employment of a constant-compression engine. It is well recognized that peak pressures and temperatures are lower during part-throttle operation of conventional Otto cycle engines. If, during these periods of light load, the volumetric compression ratio could be increased, the compression pressure would be higher. It is therefore conceivable that an automatically variable compression ratio engine could be proportioned and controlled in such a way that the compression pressure would remain substantially constant, regardless of the load. In the system recently tested, constant compression is maintained by the use of a variable piston mounted above the power cylinder and free to move in its control cylinder. The cavity of the control cylinder is supplied with lubricating oil from the crankcase of the engine by the lubricating pump. The oil pressure will maintain the control cylinder in its lowest position at low load, but if the throttle is opened fully, the increasing compression pressure will force oil out of the control cylinder through the relief valve set at the highest compression pressure chosen. When the pressure decreases, the control piston will be forced down again to decrease the clearance volume.—*The Engineers' Digest, Vol. 13, June 1952; p. 174.*

Steam Oil Atomizers

One of the most important factors in the successful use of steam in oil burners is its catalytic effect in the oxidation of free carbon. When steam is brought in contact with carbon at high temperatures, it is broken down to hydrogen, and nascent oxygen which oxidizes the carbon to carbon monoxide and carbon dioxide. This is known as the "water-gas reaction", and it was probably this, as much as any other particular design feature, that was responsible for the early successes with burning heavy fuel oils. It is the high affinity of nascent oxygen for the free carbon present during stages of the combustion process, that makes the amount of water present of prime importance as a soot preventer. High temperatures also are necessary for this breakdown and reaction, Table 1, which indicates that water introduced or formed at the beginning of the combustion

TABLE 1

Temp. deg. F.	Per cent H_2O decomposed	Per cent H formed	Per cent CO formed	Per cent CO_2 formed
1,250	8·8	65·2	4·9	29·8
1,850	94·0	48·8	49·7	1·5
2,050	99·4	50·9	48·5	0·6

process, where it will be available for maximum breakdown and reaction with free carbon, is more effective than that introduced, or formed, in the latter parts of the combustion process. The water for such reaction comes not only from that introduced for oil atomization, but from the humidity of the air supply and from the combustion process itself. The purely chemical action of water vapour can be demonstrated by playing steam on a smoky oil lamp, or by introducing steam into a smoky furnace, such as to substantially eliminate any oil atomizing effects, and noting its smoke clearing effect. The use of steam jets within the furnace promotes mixing of the air and combustible, as well as dispersal of water vapour throughout the furnace. Steam atomizers, on the other hand, perform both oil atomizing and mixing in addition to water conditioning the furnace. There are two prime losses accompanying the use of steam for this purpose. The first, and most important, is the loss of ½ to 5 per cent of the steam generated when steam oil atomizers are used, which is both a drain on the boiler and evaporators. The second, and of less importance, is the heat loss due to the vaporization and superheating of the water added. While these are plant or boiler efficiency losses, they may not appear so appreciable when considered in the light of the increased combustion efficiency, increased heat transfer due to a clearer furnace and cleaner tube bank, and less frequently required soot blower operation. The increasingly poorer burning quality of available fuel oils, coupled with a marine boiler design trend toward highly rated small water-cooled furnaces, closely spaced tube banks, extended surface auxiliary heat reclaiming surfaces, wide range oil burners, and remote automatic combustion control, is giving impetus to the use of steam not only as an atomizing agent, but as a furnace water conditioner. When steam is not an atomization requisite, injection of water directly into the furnace, or introduction into the fuel oil line, has also shown promise. This will eliminate the item of steam demand on the boiler, but not loss of fresh water. Another problem that the poorer grades of residual fuels has created, but which possibly may be controllable to some extent by steam atomization, is the slagging of high temperature superheaters. Crude oils contain sodium, calcium, magnesium, manganese, iron, nickel and vanadium salts which are concentrated in residual fuels after the refining process. The increase in superheater temperatures, high firing rates, and closely spaced tube employed on marine boilers, has created a set of conditions favourable to the accumulation of a hard slag containing these salts on the superheater tubes. The ideal solution of selecting fuels not susceptible to this slagging condition is seldom possible or practical, and the condition can only be expected to deteriorate as refining processes advance. Recently, on a tanker experiencing such difficulties when using straight mechanical pressure oil atomizers, a considerable reduction in slag accumulation over an equal period of time resulted when steam atomizers of the Y-jet type were substituted. Whether this was a direct result of an increase in the quality of atomization, the catalytic effect of the steam on the combustion process, or the catalytic effect on the slag forming process itself, is not definitely known, but the cure is an important one which is keynoting further steam atomizer installations.—*J. F. Harvey, Journal of the American Society of Naval Engineers, Vol. 64, May 1952; pp. 301-330.*

Screw Propeller

An object of this invention is to provide a propeller of increased efficiency combined with minimized side slip and increased blade strength. The propeller shown in Fig. 6 rotates in the direction indicated by the arrow. Each blade is formed with two steps (3 and 4), which divide each blade into portions (5, 6 and 7). These steps have deep ends (8 and 9), and decrease in depth towards vanishing points (10 and 11), with

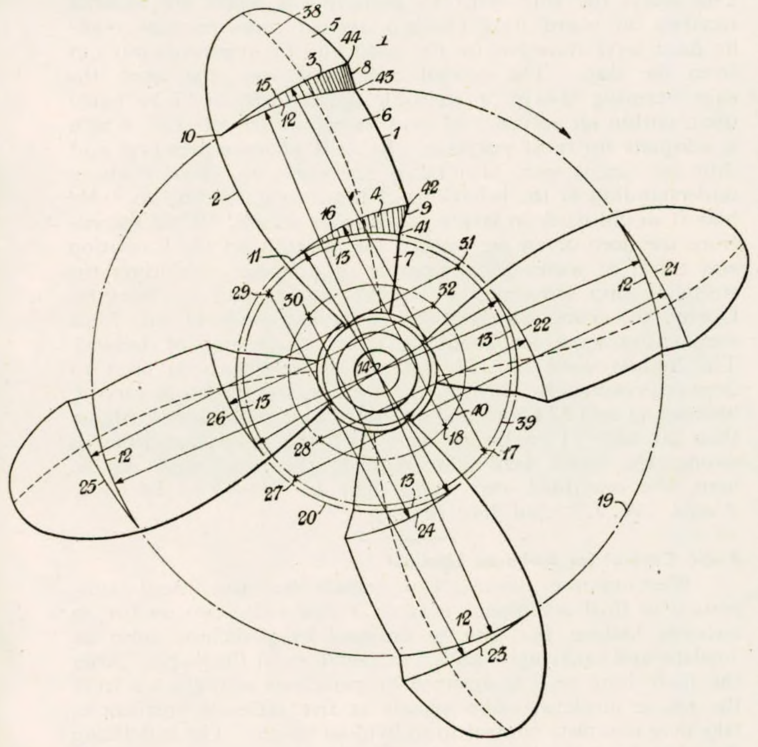


FIG. 6

the result that the pitch of portion (5) is greater than that of portion (7). In Fig. 6, the edges nearest the propeller axis of the steps on all the blades are arcs of circles with centres at the propeller axis, while the edges furthest from the propeller axis are arcs of circles having different centres.—*Patentee: J. S. Smith, Aberdeen. (British Patent No. 668,039.) Complete specification published 12th March 1952. World Shipbuilding, Vol. 2, May 1952; p. 69.*

French Passenger Steamship

The hull of the passenger steamship *Lyautey* of the Compagnie de Navigation Paquet is almost entirely electrically welded, Duralinox light alloy being employed extensively in the superstructure. The propelling machinery consists of a twin-screw arrangement of geared turbines built by the shipbuilders under sub-licence from the principal Parsons licensees, the Compagnie Electro-Mechanique. A three-casing-ahead arrangement is used with separate h.p. astern turbines and the l.p. asterns in the l.p. ahead casings. The turbines are arranged forward of the boilers, with the shafts passing between the latter. The total machinery power is 18,600 s.h.p. at 200 r.p.m., 10,500 s.h.p. being available astern. The single-reduction gears were cut by the Brown, Boveri Company at Baden. Most of the auxiliaries are electrically-driven, including the S.C.A.M. lubricating oil pump, Sulzer extraction pumps and S.C.A.M.-Gill circulating pumps. Steam is supplied at 885lb. per sq. in. and 896 deg. F. by three FCM47/60 boilers of which two are sufficient for normal service power. These two-drum boilers are of the all-water-wall type without brickwork and are very rapid steamers; full working pressure can be reached within thirty minutes of lighting up. Economizers and air preheaters are incorporated in the uptakes. The burners and registers are of F.C.M. design and the fuel pumps are by the S.C.A.M. The motor-driven feed pumps are of Sulzer pattern and discharge through feed heaters to give a final feed temperature of 295 deg. F. Each boiler has a turbine driven forced draught fan which can also be driven by a 5 h.p. motor when raising steam from cold. A Strombos-Valensi funnel of light alloy is fitted.—*The Marine Engineer and Naval Architect, Vol. 75, June 1952; pp. 248-249.*

Cargo Vessel for Arctic Service

The motorship *Kista Dan,* built by Aalborg Vaerft for J. Lauritzen of Copenhagen, has been chartered by the Greenland Trading Company to carry general cargo for Greenland settlements, in which trade she will be engaged during the summer. This vessel has been specially designed for navigation in Arctic waters packed with heavy ice. The principal particulars are:—

Length overall	212ft. 10½in.
Length b.p.	185 feet
Breadth moulded	36ft. 9in.
Depth to upper deck ...	22ft. 10in.
Deadweight as passenger vessel	820 tons d.w. on 15ft. 8½in. draught
Deadweight as cargo vessel	1,200 tons d.w. on 18ft. 1in. draught

The *Kista Dan* has been built in accordance with the highest requirements of Lloyd's Register of Shipping, "strengthened for navigation in ice", and has been classed as a full scantling vessel. Particular attention has been paid to strengthening and designing the hull to withstand arduous conditions of service in ice. The shell plating is about 75 to 100 per cent stronger than is normally required for a vessel of this size, the thickness of the shell plating being as much as 1 inch in places, and the frames throughout the ship are spaced at 1 foot intervals. There are intermediate frames on every frame from fore to aft, extending from tank top to upper deck. The 'tweendeck is approximately at sea level when the ship is fully loaded, and an extra ice stringer is fitted in the lower hold, an arrangement which makes the ship resistant to the pressure of heavy ice. Above the rudder there is an ice-cutter, designed to prevent the rudder and rudder stock from being damaged when the ship is going astern in ice-filled waters. The propeller itself is of the variable pitch type, which can be operated from the wheelhouse or from the crow's nest, and it is claimed that this type of propeller may occasionally increase the icebreaking capacity of the vessel by as much as thirty per cent over that with an ordinary fixed blade propeller. Special attention has been paid to the design of the crow's nest on the foremast. This forms a closed room in which two men may sit in complete shelter, from which they can navigate the vessel through ice and skerries. The crow's nest is in direct communication with the engine room and also, as has been stated, contains controls for the variable pitch propeller. The *Kista Dan* is propelled by a direct-reversing 6-cylinder Burmeister and Wain single-acting two-stroke Diesel engine developing 1,200 horsepower at 245 r.p.m., giving a laden service speed of 12 knots. The engine has a cylinder diameter of 350 mm. and a stroke of 620 mm.—*The Shipping World, Vol. 126, 18th June 1952; pp. 525-527.*

New Passenger Liner

The passenger and cargo liner *City of Port Elizabeth,* now fitting out at the Walker Naval Yard of Vickers-Armstrongs, Ltd., is the first of four ships of about 12,500 gross tons which these builders are constructing for Ellerman Lines, Ltd. The main particulars of the *City of Port Elizabeth* are as follows:—

Length overall	541 feet
Length b.p.	500 feet
Breadth, moulded	71 feet
Depth, moulded to upper deck	41 feet
Displacement	19,645 tons
Load draught	28ft. 6in.
Deadweight capacity	10,700 tons (approx.)
Gross register	12,500 tons (approx.)
Machinery	12,650 b.h.p.
Service speed, loaded	16½ knots

The twin screws will each be driven by a Hawthorn-Doxford oil engine and these together develop a total of 12,650 b.h.p. at 115 r.p.m. Each is a six-cylinder unit with a bore of 670 mm., and a combined stroke of 2,320 mm. and equipped to run on heavy fuel oil with a maximum viscosity of 3,500 secs. Red. No. 1 at 100 deg. F. Steam for domestic and fuel heating purposes will be supplied by two Clarkson thimble-tube composite boilers, each taking the exhaust gases from one engine and capable of evaporating 3,500lb. of steam per hour on exhaust gas and 4,000lb. per hour on oil—a total of 7,500lb. per hour at a pressure of 100lb. per sq. in.—*The Motor Ship, Vol. 33, July 1952; pp. 130-131.*

The Ship Fracture Problem

Remedial measures have been devised to overcome the problem of brittle failure of welded ships. These consist of riveted crack arresters which represent the best solution now available for the protection of large all-welded steel structures. These crack arresters have proven effective in halting a number of fractures, thereby undoubtedly preventing some ships from breaking in two. If, however, the load on the hull is sufficiently high, it is, of course realized that these crack arresters cannot maintain the integrity of the structure, particularly when the fractures have become extensive. It is noted that ships fitted with crack arresters have broken in two. Other remedial measures to existing ships are proposed. These emphasized modification and procedures to minimize the initiation of fracture. Some of these are: (a) Regulate loading to reduce bending stresses in a seaway; this is particularly emphasized in the case of tankers. (b) Omit bilge keels to eliminate this source of fracture; or alter bilge keels by tapering ends, eliminating cut-outs, riveting butt joints or other alterations to reduce likelihood of cracks originating in this area. (c) Increase the longitudinal strength of tankers; this modification will lower nominal bending stresses in the hull and thereby reduce the effect of stress raisers such as at interrupted bottom longitudinals and at weld defects in welded butts. (d) Inspect extensively strength welds in critical portions of the hull girder utilizing available methods for subsurface examination. The inspection should be directed particularly to the bottomshell butts in tankers and to the deck butts in dry cargo ships. The early importance attached to residual welding stresses and locked-in stresses, particularly as they might affect structural performance, directed the first research efforts to investigate these factors. An extensive research programme on full-scale weldments and on ships has yielded a large amount of information on the magnitude and distribution of these stresses, but no direct evidence has been found to indicate that these stresses are important in causing fractures in welded ships. It might appear that a return to riveting would be the solution of this problem. There are many advantages inherent in the all-welded ship that cannot be realized by riveting and which are translatable into savings in construction and operating costs. Some of these are: (a) Speed of construction; this is particularly important in the event of a national emergency. (b) Tightness of hull and tanks which is easy with welding—difficult with riveting. (c) Weight saving, resulting in greater cargo carrying capacity. (d) A smoother hull with consequent lower resistance, hence more speed with the same power. (e) The ease with which qualified welding operators can be trained as compared with riveters; utilization of women as welders. In consequence, a return to riveted construction is considered economically undesirable in time of peace and may be impossible in time of war since facilities for the construction of riveted ships cannot be quickly expanded.—*F. Jonassen, The Welding Journal, Vol. 31, June 1952; pp. 316s-318s.*

Wave Recorder in Research Ship

The research ship *Discovery II* owned by the National Oceanographic Council, which has returned to Plymouth after the first of a series of cruises in the North Atlantic, is the first ship to have a built-in wave recorder. This has been designed by scientists of the National Institute of Oceanography and made in Admiralty workshops. Through two small holes below the water line on each side of the ship, this recorder takes account of wave pressures, and of the movement of the ship, particularly the heave. After sailing from Plymouth on 29th May, the ship went to Perranporth where the records received on board were checked against measurements made by fixed wave recorders on the coast and by apparatus put out from the ship. The general conclusion was that, with the ship steaming slowly or stopped, the records could be relied upon within an accuracy of plus or minus 10 per cent, which is adequate for most purposes. Records of wave pressures and ship movement were also taken separately to allow a closer understanding of the behaviour of the instrument and to judge how it would work in larger and smaller vessels. Wave records from the deep ocean are wanted for research on the formation and travel of waves for a number of purposes, including the study of ship movement at various speeds and wavelengths. During the cruise which lasted 2½ weeks, winds of gale force were encountered for about 24 hours south-west of Ireland. The highest wave was 34 feet and its length from crest to crest approximately 360 feet; the wind at the time was varying between 45 and 52 knots, and one-third of the waves were higher than 20 feet. Two hours later, with the wind not quite so strong, the waves were more regular; the peaks were not so high, but one-third were more than 22 feet.—*The Shipping World, Vol. 127, 2nd July 1952, p. 19.*

Radio Control for Airborne Lifeboat

Westinghouse Electric Corporation has announced completion of final acceptance tests on a new radio control for an airborne lifeboat that can be dropped by parachute from an airplane and unerringly guided to survivors in the water. After the 30-ft. long craft is dropped by parachute into the sea from the rescue airplane, radio signals at five different frequencies take over complete control in individual stages. The stabilizing fins that hold the boat steady as it leaves the plane are jettisoned. A guard protecting the propeller and rudder is freed. The engine air vents are opened. The motor is cranked up and automatically choked. Following this, the clutch is engaged and the throttle advanced to send the craft forward under the guidance of the radio controller. When the lifeboat reaches the survivors, the airborne operator can bring it to a halt until the survivors board and then set the boat on its course again. If the physical condition of the rescued men is good, they can take over control of the boat themselves. If they are too weak for this activity, the airborne operator can guide them to shore or a rescue surface ship. The boat is equipped with triple controls, permitting passengers to break off radio control at any time and operate it electrically or manually. The 3,500-lb. craft can hold fifteen men, with provisions for ten days and fuel for an 800 mile cruise. It is also equipped with "walkie-talkie" radio sets for boat-plane communications, a machine for distilling fresh drinking water from sea water, and a zipper canopy to protect against the broiling sun.—*Marine Engineering and Shipping Review, Vol. 57, June 1952; p. 77.*

Aluminium Ore Carriers

The primary purpose of the paper is to describe the aluminium-hulled bauxite ore carriers proposed for the Alcoa Steamship Company in 1947, and to compare them, structurally and economically, with steel-hulled vessels of similar dimensions designed at the same time for the same owners. Two sizes of ships of both steel and aluminium construction were contemplated: one size 400 feet × 60 feet × 28 feet depth, for operation from the Paranam Mines of the Suriname River; and the other 330 feet × 54 feet × 27 feet depth, for operation from the Moengo Mines on the Cottica River, a tributary of the Suriname. The principal characteristics of each design are given in tabular form along with sections showing the general arrangements and midship sections of each vessel. The general arrangements are only briefly covered to permit a more detailed description of the aluminium structures and the novel problems posed by the naval architects and the marine regulatory bodies in regard to aluminium ship structures. The aluminium alloys and the practices recommended for ship structures in 1947 by Alcoa are described and details are given of their chemical composition and mechanical properties. Tests carried out by the Aluminium Research Laboratories of Alcoa to assist the ore carrier designs, as well as other tests of value to a general consideration of aluminium for hulls and other ship structures are briefly considered. From comparisons among the four designs of bauxite carriers, specific advantages for the aluminium hulls are brought out along with the disadvantages militating against adoption of aluminium merchant ship hulls in general in 1947. Advances made in the application of aluminium to ship design and construction since 1947 are noted, particularly for merchant ships, including the adoption of rules and regulations by classification societies and other bodies. Progress in the development of alloys specially suited for ship structures is given, along with the exceptional progress in the art of aluminium welding forced by the requirements of ship designers and builders. References are made to types of vessels for which aluminium structures and equipment are suitable, including such bulk carriers as oil tankers, ore carriers and barges.—*Paper by D. MacIntyre, abstracted in S.N.A.M.E. Bulletin, Vol. 7, May 1952; p. 23.*

Steam Trap

This trap is of the type in which the condensate is discharged through an orifice which is continually open to atmosphere. There is a constant loss of steam to atmosphere when no condensate is present, but the rate of steam flow is small compared with that of the condensate on account of the much larger volume occupied by the steam as compared with the discharged water. The article describes a system in which several orifices are arranged in series in order to reduce further the steam loss. It can be computed that the volume of water

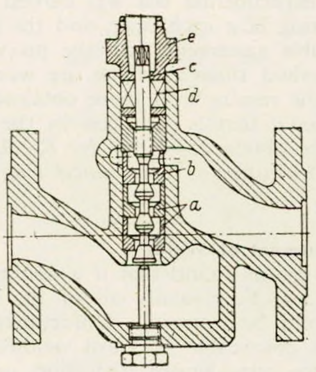


FIG. 1—*Three stage expansion steam trap for low rate of discharge. (a) orifices; (b) outlet orifice; (c) orifice pin; (d) packing; (e) nut*

at saturation temperature augmented by the amount of the flash steam, when expanded from 175lb. per sq. in. to atmospheric pressure, is 300 times the original volume of the condensate, while escaping steam is only expanded fifteen times in volume. If in a multi-stage orifice arrangement, the narrowest cross-sectional areas of each stage are of equal size, then the water and the flashing steam encounter greater resistance than if steam alone were flowing through the orifices. A more favourable flow rate for the discharge of condensate can be obtained by making the narrowest cross sections of successive orifices increasingly larger in order to take into consideration the volume increase due to the flashing of water into steam. Multi-orifice type traps incorporating this arrangement are outlined in Figs. 1 and 2. The trap shown in Fig. 1 incorporates three stages, while the trap illustrated in Fig. 2 is built with two stages and is designed to discharge as much as 250 tons of condensate per hour, the orifices of the traps being

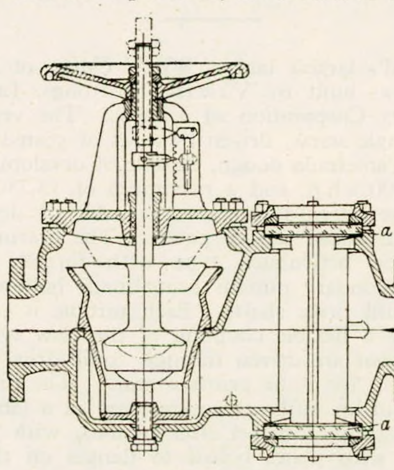


FIG. 2—*Two stage expansion steam trap for high rate of discharge*

made of corrosion resistant materials. Since each orifice stage has a larger cross sectional area than the preceding one, any dirt passing through the first stage cannot be retained in any succeeding stage and there will thus be no danger of choking except in the first stage. Multistage traps are not therefore more susceptible to choking than single stage traps. Clearing out the first stage orifice is easily performed by withdrawing the orifice pin (c) in Fig. 1 or by lifting the entire valve by means of the handwheel shown in Fig. 2.—*(Brennstoff-Waerme-Kraft, April 1952, p. 127.) Engineering and Boiler House Review, Vol. 67, June 1952; p. 180.*

Scantlings of Long Deckhouses of Aluminium Alloy

In this paper the determination of the scantlings of aluminium alloy long deckhouses which do not contribute to the longitudinal strength of a ship is considered. A method is developed for determining the scantlings of longitudinal material in terms of the scantlings given for steel houses by the Rules of Lloyd's Register of Shipping. The scantlings of deckhouses and house side stiffeners are dealt with and consideration is also given to the riveting of the sides of deckhouses to the decks on which they stand. The problem of the transverse stiffening of houses as a whole in order to resist static and dynamic forces when the ship is inclined to the vertical and forces due to wind pressure is dealt with. A comparison of the weights of steel and aluminium alloy houses is given, based on the scantlings considered desirable in the latter type of house, these weight estimates covering different lengths of ships and both one and two tiers of superstructures.—*Paper by W. Muckle, read at a meeting of the Institution of Naval Architects, 4th April 1952.*

Tug With Unusual Propulsion

The harbour tug *Kinderdijk,* which has been delivered by J. and K. Smit, Kinderdijk, to L. Smit and Co., has a novel method of propulsion. It is driven by a Diesel engine, direct coupled to a variable pitch propeller of de Schelde type. This is surrounded by a Kort nozzle which can be rotated in the horizontal plane through 45 degrees in either direction, and, in addition to improving the propulsive power, acts as a rudder. The de Schelde variable pitch propeller is itself an unusual design, in which opposing blades are mounted in pairs, with one pair of blades further aft than the other. This system of propulsion has the advantage for a harbour tug that good directional control is achieved when the vessel is exerting a pull but is stationary or moving only at very slow speed. The effect is somewhat reminiscent of the Kitchen rudder, which was at one time used on coasters, and is still fitted in certain classes of ships' boats in the Royal Navy.—*The Shipping World, Vol. 126, 25th June 1952; p. 544.*

Largest Tanker

The world's largest tanker, *World Unity,* of 31,745 tons deadweight, was built by Vickers-Armstrongs, Ltd., for the World Tankers Corporation of Liberia. The vessel is propelled by a single screw, driven by a set of geared turbines of Parsons type Pametrada design, capable of developing a service power of 12,500 s.h.p. and a maximum of 13,750 s.h.p. respectively. The astern turbines are capable of developing 60 per cent of the ahead service power. The gearing is of the double-reduction articulated type with forged nickel steel pinions, the secondary pinions being made hollow to accommodate the quill drive shafts. Each turbine is connected to the gearing by a flexible coupling of the claw type, and the secondary pinions are driven through "quill-drive" shafts and flexible coupling from the primary gears. The primary gears for the h.p. and l.p. turbines are enclosed in a fabricated steel gearcase consisting of nickel steel pinions, with forged steel built-up type with plates bolted to flanges on the rim and gearwheel shaft, enclosed in a fabricated steel gearcase and arranged for efficient lubrication of all gearwheels and bearings. The bearing bushes are independent castings arranged for easy removal without lifting main gearcase covers. The h.p. turbines run at 4,014 r.p.m. and the l.p. turbines at 3,691 r.p.m.; while the gear ratio is such that with these turbine speeds the propeller runs at 100 r.p.m. when the turbines are developing a normal service power of 12,500 s.h.p.—*The Shipping World, Vol. 126, 4th June 1952; pp. 489-491.*

Vibration of Single Screw Vessels

With the advent of new Great Lakes vessels, designed with power plants of 7,000 shaft horsepower turning propellers at 100 to 115 r.p.m. at a loaded speed of 16 miles per hour, coupled with the emergency requirements to drive the old vessels harder, the problem of excessive fantail vibrations has become increasingly serious. The *Wilfred Sykes,* powered with 7,000 shaft horsepower turning an 18-ft. 6-in. four-bladed propeller at 100 r.p.m. at 16½ miles per hour, was the first vessel in which this trouble developed to critical proportions. Structural reinforcing, new propeller blades, and other expedients were tried unsuccessfully. In reviewing the general theory of hull vibrations, the authors explain that the paper is limited to the discussion of vertical linear vibrations and not with horizontal linear or torsional vibrations of the ship, or with the vibrations which might originate in the propeller shaft-machinery system. Theoretical considerations which have been confirmed by experiment, and which are the basic facts known about vertical linear hull vibrations, are listed. Of these, the one most often referred to in the paper is the fact that the minimum number of nodes for which the ship can be considered as a free-free beam in vertical vibration is given approximately by the formula,

$$N = \frac{5L}{9D} = \frac{L}{B}$$

Roughly speaking, when the average distance between the nodes becomes equal to the beam or depth of the midship section, the ship ceases to act as a lineal free-free beam in vibration and must be treated as a three-dimensional body for all higher frequency vibrations. Calculation and experiment indicate that the frequency and amplitude distribution of the first node of vertical hull vibration can be calculated as if the ship were flexible in bending alone, but shear flexibility must also be considered in calculating all higher nodes than the first. In discussing various observations the authors explain why it is possible to have the phenomenon of no noticeable vibration up to 80 per cent of the full speed and an increasing fantail vibration above 80 per cent full speed; likewise, why there is no noticeable vibration forward of the after-quarter point. A detailed account of the work which was done on the *Wilfred Sykes* and the *Carl D. Bradley* is given, particular attention being given to the ship observations and the model tests. The fins as designed by Professor Baier were first tried out on a model and the results showed a considerable improvement in flow conditions to the propeller. The increase in resistance was negligible. The last part of the paper is devoted to the reporting of the fin tests on the *Carl D. Bradley.* The summary of maximum vibration amplitudes observed on the *Carl D. Bradley,* in light draft and in loaded draft, indicates the degree of success which was achieved in eliminating the vibrations by the installation of the fins. In loaded condition the fins reduced the amplitude of vibration to one-fifth of its previous value in deep water. The variation of the amplitude of vibration with increases in speed in deep water are also given.—*Paper by L. A. Baier and J. Ormondroyd, read at a meeting of The Society of Naval Architects and Marine Engineers at New York on 1st May 1952.*

Design of Tube Plates for Heat Exchangers

Up to the present time designers of heat exchangers have used an empirical method for determining the tube plate thickness. This is based on the formula for the maximum stress in a thin circular plate under uniform loading. It takes no account of the support given to the tube plate by the tubes, and does not attempt to differentiate the weakening effects of different tube hole spacings. In this paper, these two factors are considered. A definite algebraic expression is introduced to cover the weakening effect of the holes, and the support given by the tubes is accounted for by treating the tube plate as a thin circular plate resting on an elastic foundation. This gives rise to fairly complicated mathematics, which are fully set out, but there is no need to refer to the mathematics in the design of a particular tube plate, as the analysis leads to fairly simple design formulæ and the procedure for using them is indicated in simple terms. Four familiar types of heat exchanger are considered, and design formulæ have been developed for the maximum stress in both the tube plate and the tubes. An experimental test was carried out on the tube plate of an existing heat exchanger, and the results are shown to be in reasonable agreement with the proposed theory. To illustrate the method three examples are worked out, and by comparison of the results with those obtained by the existing method it is shown that a reduction in the thickness of the tube plate can be obtained.—*Paper by K. A. G. Miller, submitted to The Institution of Mechanical Engineers for written discussion, 1952.*

Stress Relief Treatment of Welds

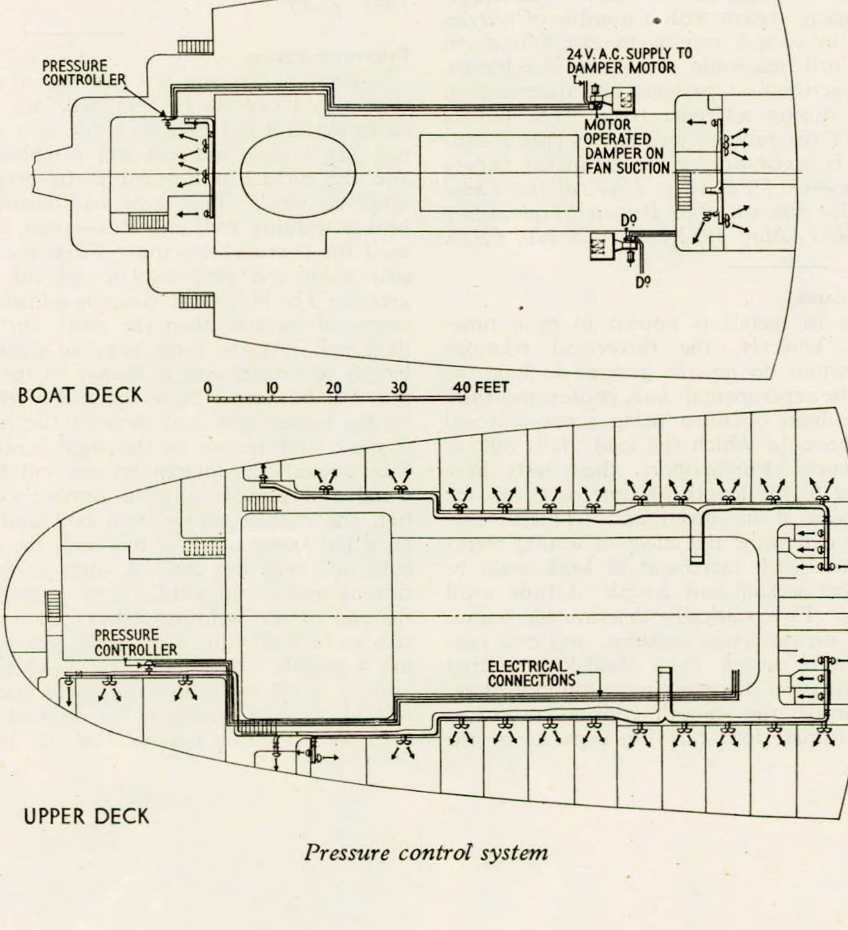
Early investigators found that if a weldment was annealed at 1,700-1,800 deg. F. virtually all of the properties of the virgin plate would be restored. Unfortunately, such a heat treatment is not practicable for most weldments since at this temperature range considerable distortion or partial collapse of the weldment will occur and serious scaling result, unless a controlled atmosphere is used. Because of these difficulties a compromise heat treatment has been widely adopted. This consists of a postwelding heat treatment at 1,200 deg. F. followed by relatively slow cooling, usually in the furnace. Numerous investigations and many experiences have shown that such a treatment produces a weldment which performs nearly as well as the unwelded parent plate. This type of heat treatment is specified in several codes. Such heat treatment is fairly expensive and in many cases cannot be used because of weldments being too large to be put into any available furnace. Because of these limitations several alternative treatments have been devised and advocated. The author and his colleagues in 1947 reported the results of tests made on large hatch corner type specimens which were given a 1,000 deg. F. postwelding heat treatment for eight hours. In these tests the performance of the preheated specimens were slightly better than the one which had postheat. From the results of these tests it appeared that the simpler and less expensive preheat at 400 deg. F. might be an effective substitute for the high-temperature postwelding treatment. From a series of tests conducted the author draws the following conclusions: The use of preheating at 400 deg. F., postwelding heat treatment at 1,200 deg. F., or controlled low temperature stress relief produces marked improvement in the performance of weldments under static load conditions. The results obtained by 400 deg. F. preheat are as good as those obtained by 1,200 deg. F. postwelding heat treatment. Controlled low temperature stress relieving does not improve weldment performance as much as either 400 deg. F. preheating or 1,200 deg. F. postwelding heat treatment. The microstructure obtained by the use of 400 deg. F. preheat is very nearly the same as that resulting from 1,200 deg. F. postwelding heat treatment but the heat affected zone is wider. The sharpness of the transition between the parent metal and the heat affected zone and between the heat affected zone and the weld metal is less in weldments which have 400 deg. F. preheat or 1,200 deg. F. postwelding heat treatment than in as-welded weldments or those treated by the controlled low-temperature stress-relieving process.—*E. P. De Garmo, The Welding Journal, Vol. 31, May 1952, pp. 233-s - 237-s.*

Ventilation Pressure Control

One of the minor disadvantages of mechanical ventilation on passenger vessels is the possibility of excessive noise being caused in the trunking. This is often a source of complaint from passengers and crew and is the result of punkah louvres being closed. A high trunk pressure is thereby built up which, in consequence, makes the remaining open outlets handle volumes of air greatly in excess of their designed capacities. To obviate this difficulty a pressure control system has been developed by the Norris Warming Company, Newcastle-upon-Tyne. The system consists of specially constructed marine-type motor-operated dampers, built as a self-contained unit, ready for bolting in the trunking or fitting to the fan eye. These are connected electrically to a special sensitive adjustable pressure controller fitted at the end of the index circuit of the trunking system. This controller will be normally set to operate at the minimum pressure for which the system has been designed, and will immediately commence to close the dampers on any build-up in excess pressure and conversely will open on any reduction in pressure. The equipment can operate over its full range in under a minute and therefore, for all practical purposes, is immediately responsive to all variations in pressure and virtually maintains at all times a constant desired pressure. The equipment operates on an electric supply of 24 volts a.c. taking approximately 60 watts, and should this supply not be available, then a small rotary converter would be fitted. A typical arrangement is shown in the accompanying drawing.—*Shipbuilding and Shipping Record, Vol. 79, 12th June, 1952; p. 751.*

Cold Driven Large Aluminium Rivets

Experience during the last war, especially in the aircraft industry, taught fabricators a great deal about the use of aluminium rivets, but as recently as five years ago it was still not possible to use aluminium rivets larger than about $\frac{3}{8}$ inch in diameter. In consideration of the practical difficulties connected with the use of either hot or frozen riveting, research was concentrated upon the development of a cold riveting method. A most satisfactory solution to the problem was



Pressure control system

found in the development of the annular point rivet which permits cold driving of aluminium rivets up to 1 inch diameter using standard riveting guns with only slight modifications. The new rivet was originally developed for use in an all-aluminium bridge in Canada and since then has been widely used in larger sizes for railway and shipbuilding purposes as well as numerous other applications. As the name suggests, the point or driven head of the new rivet is of annular shape and its driving involves the use of a specially designed riveting set with a curved profile leading to a central tip, which is inserted in a hole drilled in the shank of the rivet. The pneumatic hammer or gun is not held in line with the longitudinal axis of the rivet while it is being driven, but is rolled about this axis at an angle of about 8 to 10 degrees. The ultimate possibilities of annular point rivets will be discovered only in time, but even the first application proved that a two-man crew could cold-drive rivets of the new type as fast as a four-man crew could drive the alternative hot steel rivets.—*The Engineers' Digest, Vol. 13, June 1952; pp. 171-172.*

Combating Corrosion in Tankers

After several years of investigation both at sea and in the laboratory, the Shell Oil Company has developed a system for reducing corrosion in the oil tanks of tankers carrying refined petroleum. It is stated that the method reduces the rate of corrosion by 50 to 80 per cent. There are two different treatments, one for tanks that carry oil on some trips and sea water ballast on others, and the other for tanks that never carry ballast. For the former, the basis of protection is the galvanic polarization of the ship's steel by means of magnesium anodes suitably arranged throughout the tank, so that when the tank is filled with sea water a uniform alkaline deposit is formed on the tank walls. This gradually replaces the heavy scale, and gives maximum protection after about one year. Tanks that only carry oil are sprayed with a special solution of inhibitor that develops a relatively thin firmly-adhering coat, which gives maximum protection after about one and a half to two years. The equipment consists of a fixed-spray system with a number of nozzles located within the tanks in such a way as to give a uniform covering of the walls. Until maximum protection is achieved, the spray is applied on each ballast passage, but afterwards it is sufficient to apply it during alternate trips. The author discusses the economics of the process, and shows that a considerable sum of money is saved during the estimated twenty years of life of the tanker.—*G. D. Harden, Proc. of the Third Petroleum Congress, 1951. Journal, The British Shipbuilding Research Association, Vol. 7, May 1952; Abstract No. 6,130.*

Inelastic Strains in Steel Beams

Inelastic deformation in metals is known to be a time-dependent phenomenon; however, the theoretical relations between load and deformation do not, in general, include the effect of time. Most of the experimental data, confirming these theoretical relations, have been obtained using screw-powered or hydraulic testing machines in which the load "falls off" as inelastic deformation occurs. Furthermore, these tests have been made without regard to the length of time necessary for inelastic deformation to cease at any given load. This investigation was undertaken to determine the effect of testing members under dead load where each increment of load could be maintained on the member a sufficient length of time until equilibrium was attained. Five statically determinate beams, four mild-steel beams of various cross sections, and one rail-steel rectangular beam were tested in a dead-load testing machine. The load-deformation diagrams were found to have a stairstep appearance, unlike the smooth continuous curves usually reported. The ultimate load-carrying capacity of the mild-steel beams was found to be considerably below that predicted by theory, and time delays of appreciable magnitude were observed for the initiation of inelastic deformation at a given load. A more stable behaviour was observed for the rail-steel beam under dead load, and the experimental results were found to correlate well with theory.—*H. T. Corten, M. E. Clark and O. M. Sidebottom, Trans.A.S.M.E., Vol. 72, April 1952; pp. 349-354.*

Fire Prevention Under the 1948 Convention

It is the objective of this paper to review some of the requirements concerning fire prevention, fire detection, and fire extinguishing applicable to passenger ships. Among other items the 1948 regulations require that, if no fire detection system is fitted throughout, the hull, superstructure, structural bulkheads, decks, and deck houses shall be of steel. The boundary bulkheads separating accommodation spaces from machinery, cargo and service spaces are to be fire resisting. In the matter of fire detection the new regulations require all passenger ships to have an automatic detection system which will indicate the presence of fire in any enclosed space appropriated to the use or service of passengers and crew, also in all spaces not accessible to the fire patrol. Manual fire alarms are to be fitted to enable the alarm to be operated promptly if a fire is discovered. After the establishment of the required fire zones, there are three different methods of restricting fire within each zone. Method I visualizes the construction of a ship of fireproof material. No sprinkling system is required. Method II requires the installation of a sprinkling system with no restrictions on the type of material in the construction of cabins and public spaces. Method III provides for the spaces divided by the main fire bulkheads to be further subdivided by the introduction of partitions of fire retarding materials and a detection system being fitted. The paper concludes with brief comments on fire-extinguishing equipment, stressing the importance of the training of the crew to fight fires.—*Paper by A. J. Squires, abstracted in S.N.A.M.E. Bulletin, Vol. 7, May 1952; p. 30.*

Bronze-surfacing

Bronze-surfacing is a fast way to repair worn parts. Parts that would have to be scrapped, can be reclaimed by bronze-surfacing and put back to work in a short time. When wear-resisting bronze welding rod is applied to the worn surface, and the surface is finished to its original size, the part is as good as new. The same equipment—a welding blow-pipe, bronze welding rod, and flux—used for braze-welding, can be used for bronze-surfacing. First, the worn surface is cleaned with a file and steel wool to get rid of all old rust, scale or grease. The blow-pipe flame is adjusted so that it has a slight excess of oxygen, then the worn surface is heated to a very dark red. At the same time an inch or so of the end of a length of bronze rod is heated in the flame and then dipped into the flux can. Now the end of the welding rod is placed on the heated part and some of the rod melted. If the metal is clean and heated to the right temperature and the proper flux is used, the molten bronze will flow smoothly on to the metal and provide a good tinning coat. If the part is too hot, the molten bronze will boil and run around like water on a hot stove. If it is too cool, the molten bronze will form balls and will not tin. A dirty surface can also cause poor tinning and a bad weld. Now, maintaining the original heat, the end of the welding rod coated with flux is placed in the area to be built up. Rod metal is deposited on the part forming a puddle. The flame, rod, and puddle are moved slowly around in the worn area until a bronze rod has been deposited to build up the groove to the original surface.—*W. O. Whitehead, The Welding Journal, Vol. 31, May 1952; p. 419.*

ENGINEERING ABSTRACTS

Section 3. Shipbuilding and Marine Eningeering

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Neither The Institute of Marine Engineers nor The Institution of Naval Architects is responsible for the statements made or the opinions expressed in the following abstracts.

New Kort Nozzle

Although to date the Kort nozzle generally is credited with gains in thrust ranging from 10 to 50 per cent in the ahead condition, it always has suffered some serious shortcomings in the astern operation. Not only was there a loss in astern thrust compared to an open propeller but there is an undesirable tendency for a Kort nozzle equipped vessel to veer unpredictably to either port or starboard during astern operation. This veering is caused by a tendency of the reversed propeller slip stream to adhere to either one or the other side of the flared nozzle entrance which is, of course, particularly objectionable in single-screw vessels. An improved Kort nozzle completely eliminates these drawbacks. Fig. 3 shows a cross section of the conventional Kort nozzle with its characteristic airfoil shape. In Fig. 4 is shown the improved Kort nozzle, where instead of a pointed trailing edge, it now becomes well rounded. In addition to the rounding, there is a small step which serves to give proper separation of flow in ahead operation. Along the flared entrance of the nozzle a narrow flexible strip of rubber or leather is mounted. In ahead operation this strip, being fastened to the nozzle body by its leading edge,

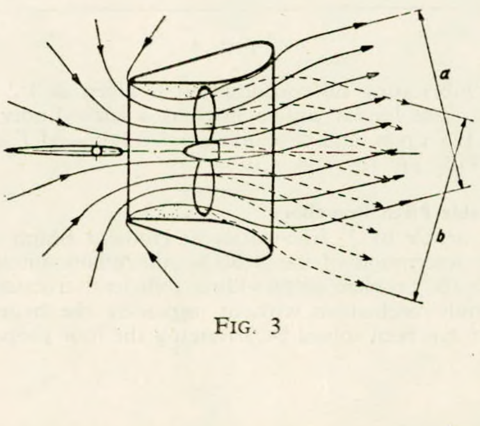


Fig. 3

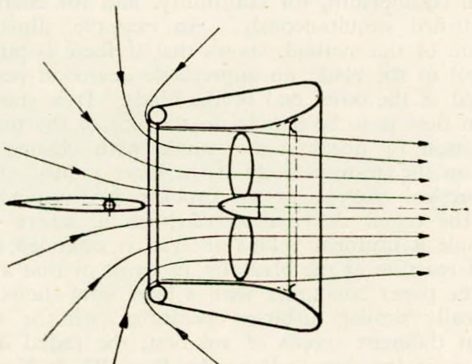


Fig. 4—*Improved Kort nozzle*

lies flat against the surface, thus having no effect. In astern operation, however, the trailing edge is sucked away from the nozzle surface and flips outward, thereby causing proper separation of the slipstream from the nozzle body and directing it in a narrow stream parallel to the propeller axis. This simple device, combined with the redesign of the nozzle, removes the last objection to installing the Kort nozzle on many types of ships. Though this invention is of considerable importance to the fixed Kort nozzle, it is virtually indispensable in the steering Kort nozzle, of which to date there have been but a few installations.—*Marine Engineering and Shipping Review, Vol. 57, June 1952; pp. 79-80.*

Deck Caulking Compound

A sealing compound known as Secomastic, widely used in house building where a sealing material that will remain permanently plastic is required, has recently been introduced into the marine field as a substitute for oakum as a caulking material for wooden decks. The Secomastic is introduced into the seam by means of a pressure gun, which can be operated either by hand or by compressed air. It is claimed that the process is both cheaper and more satisfactory than the use of oakum. It is still necessary afterwards to pay the seam with marine glue in the normal way. Secomastic is also being used as a watertight bedding material for such purposes as bedding side lights and other fittings required to be watertight. Surplus material can be removed with a knife dipped in white spirit, or smoothed into a fillet by a finger similarly dipped. It can be painted thirty-six hours after application.—*The Shipping World, Vol. 127, 30th July 1952; p. 54.*

Materials for Propulsion Gears

A paper by M. R. Gross, submitted to the American Society for Testing Materials, describes the laboratory testing of materials for marine gears. Gears usually fail by (i) pitting of the tooth contact surfaces because of cyclic compressive stresses and (ii) breaking of the teeth in the root area because of cyclic bending stresses. A contact roller test was used to evaluate the resistance to pitting, and on these machines six steels, one wrought and three cast Al alloys, Be-Cu, two cast Mg alloys, 78:22 Mn-Cu alloy, and five plastic materials were tested. Be-Cu was the best of the non-ferrous materials. A test called "the simulated gear-tooth fatigue test" was developed to evaluate the root fatigue strength of materials under reversed bending stresses. Three steels were tested, and the effects of hardening treatments, root radii, and surface finish were investigated. Increasing the fillet radius resulted in an increased fatigue resistance.—*Journal, Institute of Metals, Metallurgical Abstracts, July 1952; Vol. 19, p. 803.*

Steam Flow Through Turbine Nozzles and Blading

A method is given for calculating the radial distribution of pressure in a steam turbine with long blades, the conditions for radial equilibrium, for continuity, and for energy balance being satisfied simultaneously. An example, illustrating the application of the method, shows that if there is pure impulse at the root of the blade, an appreciable degree of reaction may be reached at the outer end of the blade. It is shown that if the steam flow is to be parallel to the axis of the turbine, then the variation of nozzle outlet angle with change of radius depends on the steam velocity at the inner radius. An alternative theoretical analysis of the problem is given which yields quickly the radial distribution of pressure where the nozzle outlet angle is uniform. This analysis is extended to give the degree of reaction at the blade tip in terms of that at the blade root. The paper concludes with a brief note showing that in geometrically similar turbines operating with the same blade speed but different speeds of rotation, the radial distribution of pressure is the same.—*Paper by Prof. W. J. Kearton, submitted to the Institution of Mechanical Engineers for written discussion, 1952.*

Straightening Structural Members in Place

When a structural member is bent, one edge of that member becomes longer than the other. If the two edges can again be made the same length, the straightening is accomplished. A member may be straightened by shortening the longer edge, by lengthening the shorter edge, or by a combination of both. Straightening by heating attacks the problem by shortening the longer edge. The basic principle of the heat-straightening method is restrained thermal expansion of the metal causing an upsetting action. This upsetting action shortens the member in the heated area and upon cooling, contraction "pulls" the member back into line. In general, heat must be applied in such a manner that the member itself can furnish sufficient restraint to cause upsetting. A bent piece of flat bar is shown in Fig. 1. To straighten this member, an oxyactylene torch is first applied at point B; heating at this point causes expansion in the immediate area. This expansion cannot cause much elongation of the bar because most of the bar is cold and resists such elongation. Thus the heated metal around point B upsets, once the yield point has been exceeded. At the temperatures (up to 1,200 deg. F.) used in straightening, the yield point of the metal in the heated area is considerably less than that of the cold bar. Having point B heated, the torch is used to heat the shaded area, working slowly from point B to the edge of the bar. As the torch moves toward the edge, upsetting occurs in the immediate area of heating. After cooling, the bar will have moved toward the straightened position shown by the arrows. Further "heats" (heating-and-cooling cycles) will complete the straightening.—*H. L. Harrison, The Welding Journal, Vol. 31, May 1952; pp. 257-s - 262-s.*

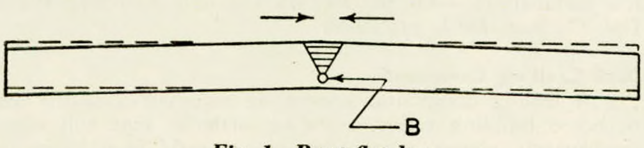


Fig. 1 Bent flat bar

Marine Diesel Engines

The Wumag two-stroke cycle marine Diesel engine shown in section in Fig. 4 is built in sizes up to 6,000 h.p. Its specific fuel consumption is given as 156 grams per h.p. hr. and its specific lubricating oil consumption is given as 1·2 grams per h.p. hr. The largest engine listed is a ten cylinder unit running at 125 r.p.m. and developing 6,000 h.p.—*M.T.Z., Vol. 13, April 1952; pp. 107-108.*

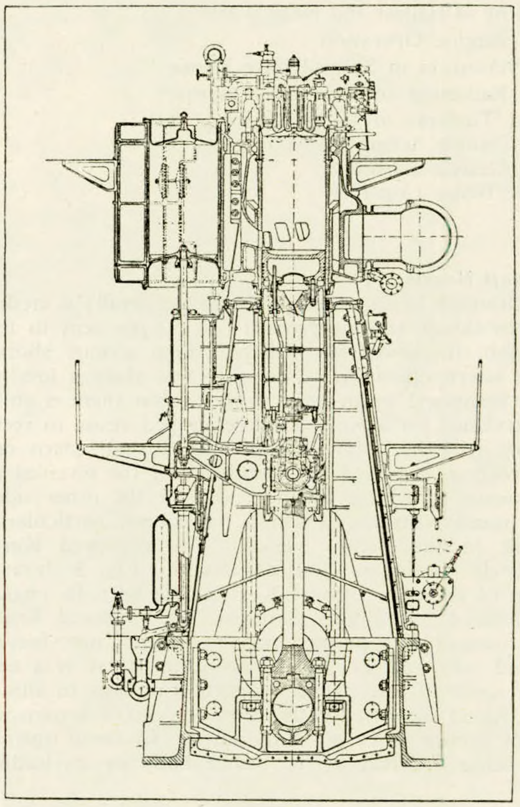


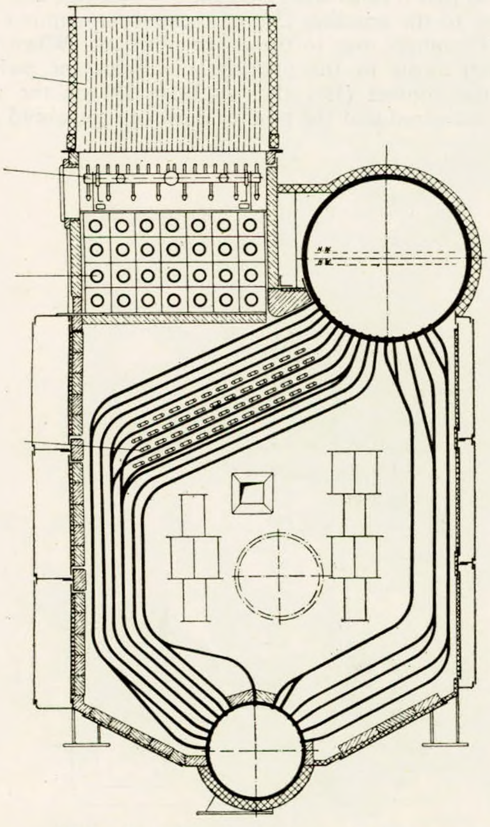
FIG. 4

Controllable Pitch Propeller

An article by J. F. Steiltjes in Holland Shipb. contains a detailed description of the Schelde controllable-pitch propeller, in which the problem of providing sufficient structural strength in the hub mechanism without impairing the hydro-dynamic efficiency has been solved by arranging the four propeller blades in two pairs, one behind the other, with the crank-shaped shank of each blade built into that of the opposite blade. In this way, the centrifugal forces are absorbed by the blade shanks, and the hub is freed from splitting forces. The tandem blade arrangement results in a somewhat longer propeller hub, which may prove an obstacle in installing the propeller in an existing single-screw vessel in which no allowance for a longer hub has been made. A full description is given of the oil-driven blade-adjusting mechanism, which is operated from the wheel house. The movement of the servo-piston indicating the actual position of the propeller blades is visible on the pitch indicator on the control stand. The time necessary for a complete reversal of pitch from full ahead to full astern is usually about ten seconds. If a propeller blade becomes accidentally damaged, it can be replaced without opening the hub. Among the vessels fitted with the Schelde propeller are the 2,500-b.h.p. ferry *Konigin Juliana* and the 600-b.h.p. harbour tug *Van Woelderen.—Journal, The British Shipbuilding Research Association, Vol. 7, June 1952, Abstract No. 6,152.*

Small Icebreaker

The icebreaker *Johann Dalmann* is a small vessel destined for service on the river Elbe. Its length overall is 28·25 m., its maximum draught is 3·05 m., and its displacement is 223·5 tons. The propulsion plant consists of a Hamburg type steam reciprocator of the double compound design built on the Rembold system with two crankshafts, each carrying a pinion engaging a common gearwheel. The high pressure cylinders have a diameter of 260 mm. and the low pressure cylinders are 360 mm. in diameter; each crankshaft revolves at 370 r.p.m. and the propeller shaft at 140 r.p.m. Engine output is 800 i.h.p. at 40 per cent cut-off and 17 atm.g. steam pressure and 300 to 320 deg. C. steam temperature. The steam is supplied by the boiler shown in the accompanying engraving which was built according to the designs of Wagner Hochdruck A.G., Hamburg. The boiler has a boiler heating surface of 80 sq. m. and a normal output of 4,500 kg. of steam per hr. at 19 kg. per sq. cm. g. steam pressure. Superheater surface is 14 sq. m., economizer surface is 77 sq. m. and air preheater surface is 64 sq. m. The oil burner is of the rotary cup type and is driven by an electric motor of 2 kW. capacity.—*O. Maasch, Schiff und Hafen, Vol. 4, June 1952; pp. 184-193.*



Boiler in icebreaker Johann Dalmann

New Wire-rope Clamping System

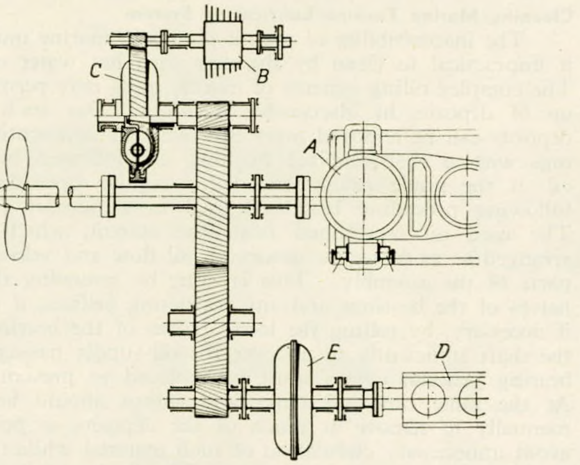
A new wire-rope clamping system eliminates the need for splicing when joins are being made or eyelets inserted. The system has been subjected to extensive tests and its use has been approved by Lloyd's Register of Shipping and other authorities. These tests have shown that joins in wire rope on this system are as strong as, or stronger than, spliced connexions, and, by adopting the process, there is a considerable saving in time and materials. After the rope has been inserted, the ferrule is placed between the two swages of a press, and pressure is applied to mould the ferrule and the two thicknesses of rope into one homogeneous mass. This action automatically changes the shape of the ferrule and confines the two thicknesses of rope into the same space normally occupied by one thickness of rope. A hand-operated press, which functions by means of a hydraulic pump, is sufficient to mould the smaller sizes of rope; while, for the larger sizes, a power press is employed.—*The Shipbuilder and Marine Engine-Builder, Vol. 59, July 1952; pp. 469-470.*

Cleaning Marine Turbine Lubricating System

The inaccessibility of the oil piping in marine units makes it impractical to clean by flushing with hot water or steam. The complex oiling systems of marine units may permit build-up of deposits in inaccessible locations. For such systems deposits can be removed most effectively by consecutive flushings with a rust-inhibited flushing oil, followed by turbine oil of the grade recommended for regular operation. The following procedure has been used in a number of cases: The used oil is drained from the system, which is then arranged so as to secure maximum oil flow and velocity to all parts of the assembly. This is done by removing the upper halves of the bearings and any restricting orifices, if used; or, if necessary, by rolling the lower halves of the bearings about the shaft sufficiently to uncover the oil-supply passages. The bearing pedestal covers must be replaced to prevent leakage. At the same time, all tanks and sumps should be cleaned manually to remove as much of the deposits as possible, to avoid unnecessary circulation of such material while the actual flushing operation is under way. The flushing oil (50 to 75 per cent of normal oil charge) is then placed in the system and heated to a temperature of 150 to 180 deg. F. by any of the means suggested previously. This improves the solvency of the oil and expands the piping and other parts, both of which contribute to the removal of the maximum amount of deposits. During flushing, the dehumidifier system (if used), oil-purifying equipment, and strainers should be kept in continuous operation. Near the end of the flushing operation, the turbine should be rotated by the turning gear a number of revolutions equivalent to about one revolution of the ship's propeller, in order to facilitate complete flushing. In some cases, auxiliary filters, pumps and lines have been employed to assist in the removal of contaminants. It is recommended that the hot flushing oil be circulated through the system for 2 hours, then stopped for one hour; and that this cycle be repeated twice more. Following this three-cycle schedule, the oil coolers, bearing oil header, and oil strainers should be cleaned, since this will permit later inspection of their condition to serve as an indication of the progress in cleaning. Circulation now should be resumed and continued until the system is clean. This will be determined each 6 hours by inspection of the oil coolers, bearing oil-header, and strainers. At more frequent intervals the pressure drop across the strainer should be observed, as a ready clue to the rate at which deposits are accumulating. When deposits no longer accumulate on the inspected parts, the system can be considered clean. Approximately forty-eight hours overall is usually sufficient for a thorough cleaning, even under extremely dirty conditions. The use of a lance has been found effective for washing down interior parts of the gear casing and sides of the gears. Temporary fine-mesh strainers or lintless cloth bags may be inserted in lines during preliminary flushing. When the system is clean, the flushing oil should be drained immediately while still hot, to promote complete drainage and to prevent precipitating out of the oil on the cleaned metal surfaces. Immediately after draining, new rust-inhibited turbine oil of the grade to be used for regular operation should be put in the system and circulated for about 2 hours for displacement purposes. During this period, the turbine should be rotated again by the turning gear. This will establish on all lubricated surfaces a film of the same oil which will be used normally. The turbine oil used for displacement must be drained completely, even from the low pockets that can serve as traps.—*Trans.A.S.M.E., Vol. 74, April 1952; pp. 327-331.*

Unusual Propulsion Plant

The accompanying drawing shows the propulsion plant of the German cargo boat *Arion* in which the single propeller shaft is driven by a steam reciprocator, a Bauer Wach exhaust steam turbine and a Diesel engine. The exhaust turbine is coupled to the propeller shaft in the usual manner, and another



Propulsion plant of German cargo boat Arion

A—Steam reciprocator C—Hydraulic coupling
B—Exhaust steam turbine D—Diesel engine
E—Hydraulic coupling

reduction gear with hydraulic coupling is provided for also coupling a Diesel engine of the submarine engine type of 1,200 e.h.p. with the propeller shaft. Both reduction gears are arranged in a common casing.—*Schiff und Hafen, Vol. 4, May 1952; pp. 160-165.*

Fire Prevention in Ships Under Repair

Overhead hot work, such as welding, or hot work in general in close adjacency to bunker tanks, is an ever-present problem. Gas inertion of the bunker is often the solution. The principle of inerting with carbon dioxide, or with other nonflammable gases, during certain types of ship repair work, was extensively used by the United States Navy during World War II, the immediate object of its use being to obtain a faster job and a quicker turn around of the vessel by avoiding the necessity of oil tank cleaning. The term "inerted", in the sense used here, is defined in the pamphlet entitled "Standards for The Control of Gas Hazards on Vessels to Be Repaired", issued by the joint Committee on Gas Hazards of N.F.P.A. and the American Bureau of Shipping as follows: "Inerted means that in the compartment or space so designated, carbon dioxide, or other nonflammable gas approved by the American Bureau of Shipping, has been introduced into the space in sufficient volume to maintain the oxygen content of the atmosphere of the space at or below 10 per cent during the whole of the inerting period, and to insure that the volume of the inerting gas shall never be less than 50 per cent of that of the void space". Under these conditions, it is possible to perform hot work on the exterior surfaces of the inerted compartment without risk of fire or explosion. In December 1949, the Todd Shipyards Corporation received approval from the American Bureau of Shipping of its Flue Gas Inertion Procedure. This followed a period of development in which the Engineering Department, Combustion Division and the Chemist group of the Todd Organization collaborated. The flue gas is generated by two vertical type, oil-fired Scotch boilers, located on a steaming barge, which is also used to supply steam to vessels during boiler repairs. The gases are collected by a gas diverter cone suspended at the top of the boiler and passed through a 5 inch line to a fan, which blows them up through a scrubber packed with lump marble, which is constantly washed by a spray of water. Here the gases are cooled and cleaned and the sulphur dioxide removed. The gases are metered and then conducted through flexible metallic hose to the tank to be inerted. The first job of this kind was carried out in May 1950, when eight double bottom tanks and a settling tank were inerted on a 10,000 ton passenger vessel. The entire job, docking and undocking of the vessel, inerting of the tanks, welding of rivets on the double bottom tanks, and welding a crack in the settling tank, was completed in twenty-four hours.—*F. L. Healy, The Log, Vol. 47, May 1952; pp. 49-50.*

Shaft Rotation Indicator

A shaft rotation indicator comprising a transmitter with a spindle (18) driven from a propeller shaft and a receiver in which is a motor (27) is shown in Fig. 4. When the propeller shaft starts to rotate, the arm (17) of a friction switch engages a contact (20) and the pump (16) fills the vessel (14) with mercury so that it sinks and closes the contacts (23, 25). Current then flows to the winding (30) of the indicator motor and the pointer (47) moves over to the astern position. When the propeller shaft turns in the opposite direction, the switch (17) engages the contact (19), the winding (29) of the indicator motor is energized and the pointer moves to the ahead position.

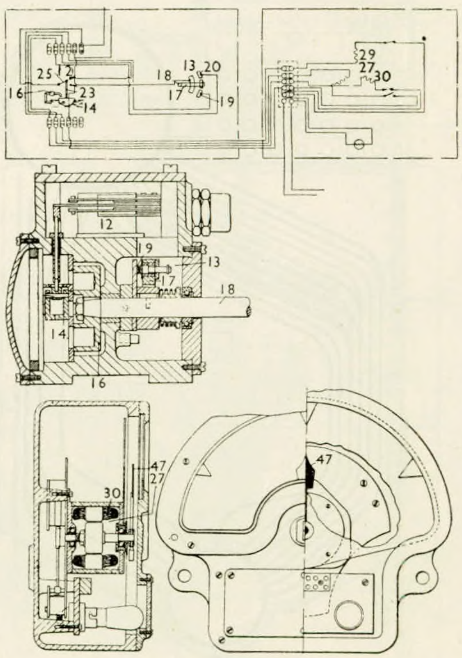


FIG. 4

An important feature of the device is the float-operated switch (12) in series with the friction switch (13), the former giving an instantaneous indication that the propeller shaft has stopped. The friction switch cannot be relied upon to do this, being merely capable of distinguishing between the ahead and astern directions of rotation. A storage of energy is provided by the weight of mercury pumped by the rotation of the shaft (18). When the speed is reduced to below 1 r.p.m., the mercury flows out of the float vessel faster than it is pumped in, and in consequence the switch changes over to the stop position.—*British Patent No. 667,668 issued to Chadburns (Liverpool), Ltd., and A. E. Brewerton. The Motor Ship, Vol. 33, July 1952; p. 159.*

Werkspoor Supercharged Two-stroke Engine

With the supercharged two-stroke engine shown in Fig. 1, there is a surplus of exhaust energy which cannot be utilized

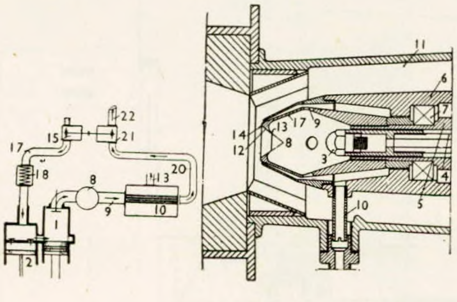
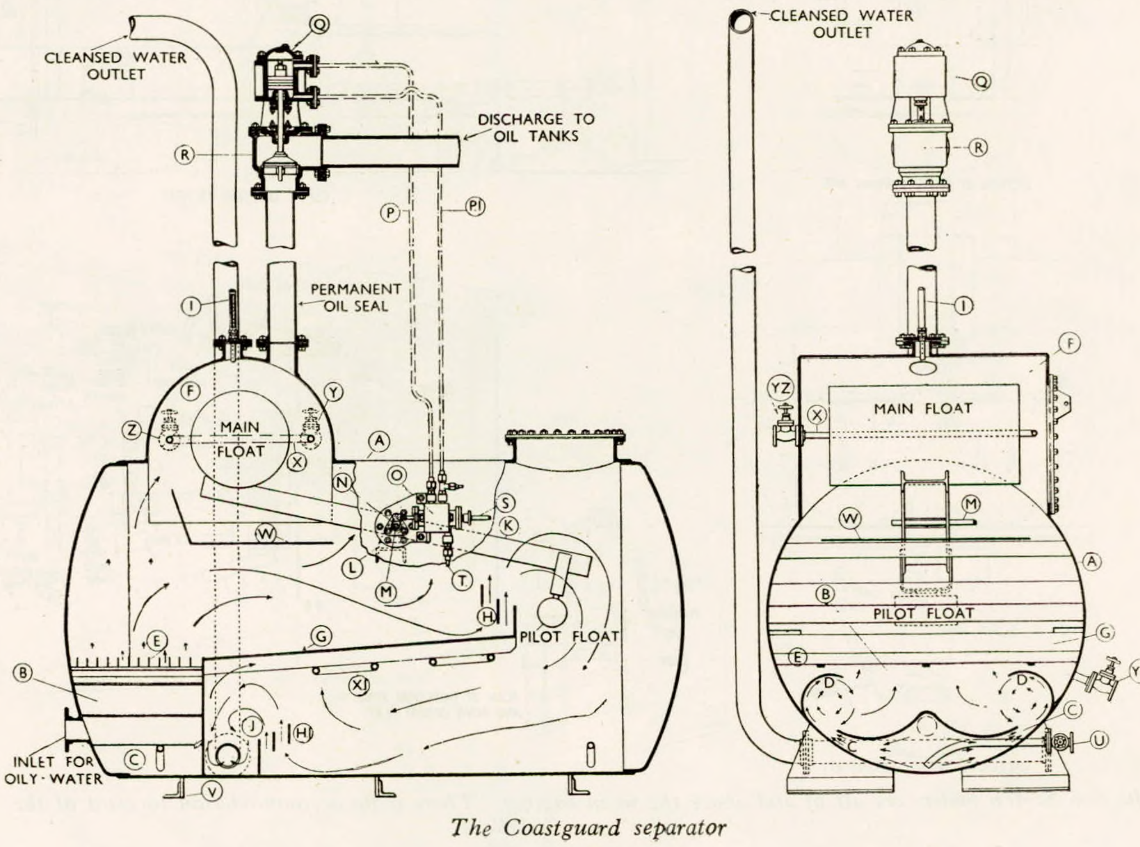


FIG. 1

fully in the exhaust gas turbo blower. A steam generator (10) is arranged in the path of the exhaust gas and acts as a choking resistance, creating a drop in pressure. Each engine cylinder (1) is connected to a scavenging pump (2), which produces a pressure considerably higher than normal. The exhaust receiver (8) communicates with the boiler through a pipe (9). Steam from the boiler passes through a pipe (13) and is used for various ship's services. The exhaust gas from the boiler passes through a pipe (20) to an exhaust gas turbine (21) before leaving through a discharge pipe (22). The turbine drives a blower (15) and the air passes through a pipe (17) to a cooler (18) and thence to the scavenging pump (2). As the exhaust gas from the engine increases, the air supplied by the blower (15) represents a larger share of the supply of scavenging air, as a result of which the output of the scavenging pump (2) decreases and the engine efficiency increases. The blower (15) and the pump (2) are connected in parallel, not in series, the pump having its own independent air inlet. The specification includes a stereometric diagram showing the proportions, pressures and timing arrangements of the air and exhaust gases.—*British Patent No. 665,517 issued to Werkspoor N.V., Amsterdam. The Motor Ship, Vol. 33, July 1952; p. 159.*

De-oiling of Ballast and Bilge Water

In the Coastguard separator, the oily water entering it is first dealt with in the "compactor" chamber (B). This comprises special nozzle plates (C), and curved baffle plates (D), so arranged in relation to each other that they form a twin centrifugal device which employs the inlet velocity of the mixture to rotate the flow at high speed immediately on entry, so destroying the forward velocity of the liquid into the separator without setting up disturbing currents throughout the mass. These gyratory zones tend to increase the separation of oil from the water and cause the oil particles to be forced into violent collision and to freely coalesce into larger masses. It is claimed that 99 per cent of the oil fouling is removed at this stage. The separated oil rises to the oil dome (F) and the water continues as a low velocity stream over the horizontal division plate (G), upwards through the "hydraulic" baffle (H) then downwards below the division plate to the lower hydraulic baffle (HI), thence to leave the separator as indicated. The "hydraulic" baffles H and HI comprise a number of suit-

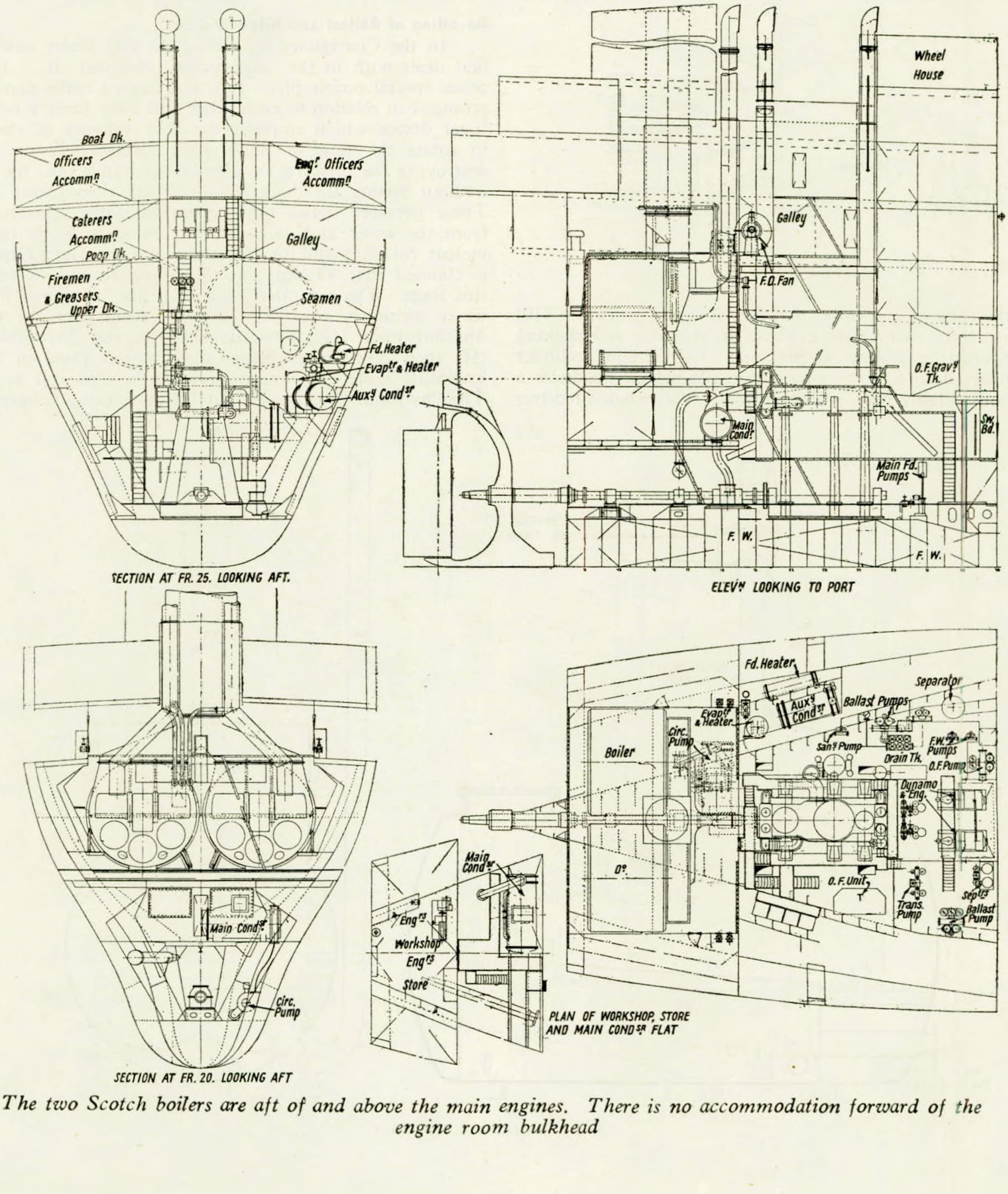


The Coastguard separator

ably spaced plates and have the general effect of diffusing the flow movement through the fluid mass in the separator so that the velocity will be sufficiently reduced at all points to permit the undisturbed settling of the entrained oil globules. The baffles also assist the coalescing of any oil in the water passing through them. The automatic oil discharge mechanism essentially comprises a float assembly as shown. When this assembly is immersed in a single fluid, the lower or pilot float has a bias which causes it to fall to its lowest position, thereby raising the main float to its highest position in the oil dome. An accumulation of oil in the dome causes the "upthrust" on the main float to decrease until it finally becomes less than the upthrust on the pilot float, hence the main float sinks to its lowest position in the dome and operates the oil discharge valve through a steam or electric relay system. When the predetermined amount of oil has been discharged from the dome the main float rises again and closes the oil discharge valve. A permanent oil seal is retained in the dome to avoid the discharge of free water. While the oil is being discharged, the water outlet valve is closed; hence when only oil is being fed to the separator, as when only settled remains in the ballast tanks, there is continuous oil discharge and no possibility of discharging oil from the water outlet, nor is there any need to slow down the pumps. The Coastguard separator is said to be the only completely self-operating separator offered today. It is sold with a guaranteed ability to remove oils of specific gravity up to 0·985 from fresh water up to a temperature of 200 deg. F.—*G. S. Emerson, The Marine Engineer and Naval Architect, Vol. 75, June 1952; pp. 236-245.*

Chilean Ore Carrier

The ore-carrier *Tofo,* built by William Gray and Co., Ltd., for the Compania Sud-Americana de Vapores of Valparaiso, is a single deck steamship of 9,500 tons d.w. with raised fo'c'sle and poop, and has been specially designed for carriage of iron ore, limestone, coal or other bulk cargoes. The four cargo



The two Scotch boilers are aft of and above the main engines. There is no accommodation forward of the engine room bulkhead holds, which are all arranged forward of the engine room, are cofferdammed from the ship's side, the side tank spaces being divided by a watertight stringer into upper and lower compartments. The propelling machinery has been constructed by the shipbuilder's Central Marine Engine Works. The main engine is of triple-expansion type having cylinders 23 inch, 36 inch and 65 inch diameter by 48 inch stroke. The steam conditions are 225lb. per sq. in. and 575 deg. F. and the output is 1,835 i.h.p. at 69·5 r.p.m. Drop valves are fitted to the h.p. and m.p. cylinders. It will be noted from the drawings that the l.p. cylinder is arranged in the centre and that the main condenser is carried athwartships and aft of the main engine. The two oil-fired Scotch boilers have an internal diameter of 15ft. 6in., a length of 11ft. 6in., and operate under Howden's system of forced draught. The boilers occupy a separate flat at the after end of the machinery space and each has three furnaces fitted with Todd burners.—*The Marine Engineer and Naval Architect, Vol. 75, June 1952; pp. 231-235.*

Geared Turbines of 1,500 s.h.p.

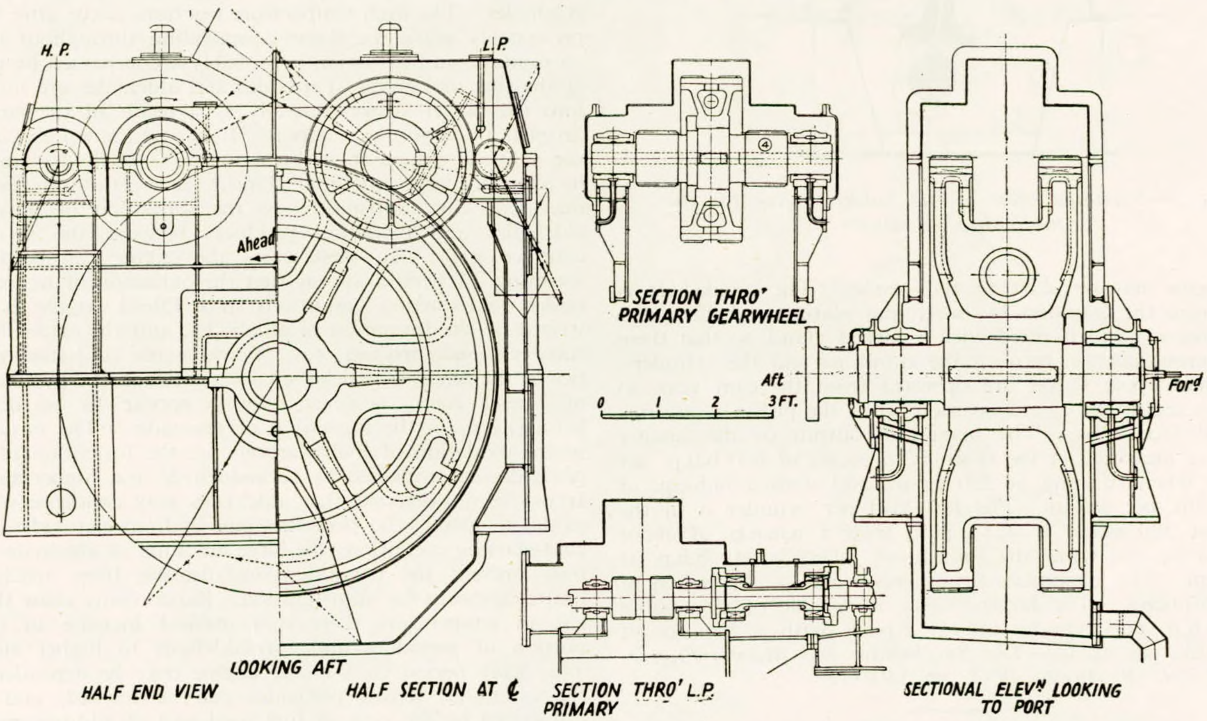
Two small steamships which Cammell Laird and Co., Ltd., have delivered to Manchester Liners, Ltd., are engaged in the new direct service which these owners have inaugurated between Manchester and Great Lakes Ports. Ships for this service must be built to the absolute limit of the locks through which they must pass in order to enter the Great Lakes, and the *Manchester Pioneer* and the *Manchester Explorer*, as the two new Manchester liners are named, have the following principal dimensions:—

Length b.p.	246ft. 6in.
Moulded breadth	43ft. 0in.
Moulded depth to shelter deck...	26ft. 6in.
Draught	18ft. 3in.
Deadweight capacity	2,750 tons (about)

The main engines consist of geared turbines of impulse pattern throughout, taking steam from Yarrow three-drum boilers at 250lb. per sq. in., and 650 deg. F. The high pressure turbine consists of one compounded-velocity stage followed by five impulse stages. Normal steam admission is through eleven nozzles in the lower half of the casing, and a further two nozzles can be brought into operation for maximum power. A feature of these turbines is that they are the first ones in which rolled sections have been used for the diaphragms. They are built up, using uniform section material, somewhat after the method used for Parsons' segmental reaction blading, and are not only simpler and more rapidly assembled but, by virtue of the method of construction, stronger. This enables thinner diaphragms to be used which, in turn, permit more stages to be fitted within a given casing, with consequent improved efficiency. The cast steel casing incorporates a bleeder belt after the third impulse stage, whence some steam is passed to the feed heater. The low-pressure turbine employs a cast steel blade-carrying barrel within a fabricated casing having a lower half of robust box-formation which acts as strength beam. The double-reduction gears are contained within a casing of fabricated construction and with primary and secondary shafts on the same horizontal centreline. A double-helical, interleaved, split-secondary gear train is employed which enables a very compact arrangement to be achieved. The primary gearwheel and secondary pinion shafts are of the same material and carry cast steel centres with 31-35 tons U.T.S. forged steel rims. The main gearwheel has a cast iron centre and 31-35 tons U.T.S. forged steel shaft and rims. Wide-tooth couplings are fitted between the turbines and their respective primary gear shafts, and sight holes are provided so that the lubricating oil sprayers can be observed. Steam is generated in two Yarrow three-drum-type boilers constructed by the shipbuilders. Each has a duty of 10,000lb. of steam per hour at 250lb. per sq. in. and 650 deg. F. The Superheater Company's MeLeSco single-pass superheaters with Concen metal-to-metal element joints are fitted to the inboard gas pass of each boiler and control of steam temperature is carried out by manipulation of dampers in the two uptake legs.—*The Marine Engineer and Naval Architect, Annual Steam Number, 1952; pp. 283-291.*

New Marine Diesel Engine

Sulzer Brothers, Ltd., have recently introduced a new engine design which is to be constructed in two sizes, viz., 580 mm. bore by 760 mm. stroke, and 760 mm. bore by 1,550 mm. stroke. The number of cylinders for either engine can be



Sections through the gearcase showing the "in-line" disposition of primary and secondary shafts and the wide-tooth couplings. The hand turning gear is seen connected to the l.p. primary shaft.

varied from four to twelve. The predominant feature of the design is that, from the cylinders downwards, the engine is constructed entirely of welded plate, though either engine can be accommodated on a cast bedplate, if necessary. This welded construction is not merely a variation of the cast design, for the form of most of the components had first to be revised, and it was finally decided to redesign the engine as a whole, instead of attempting to derive it from existing models. In order to obviate considerable lengths of fuel piping between the fuel pump and the injection nozzle, the fuel pumps are located at the cylinder-top level, and each feed pipe has a hot-water pipe immediately beneath it, the two pipes having common insulation. This arrangement avoids a considerable drop in fuel temperature. Injection is controlled by a spill valve.

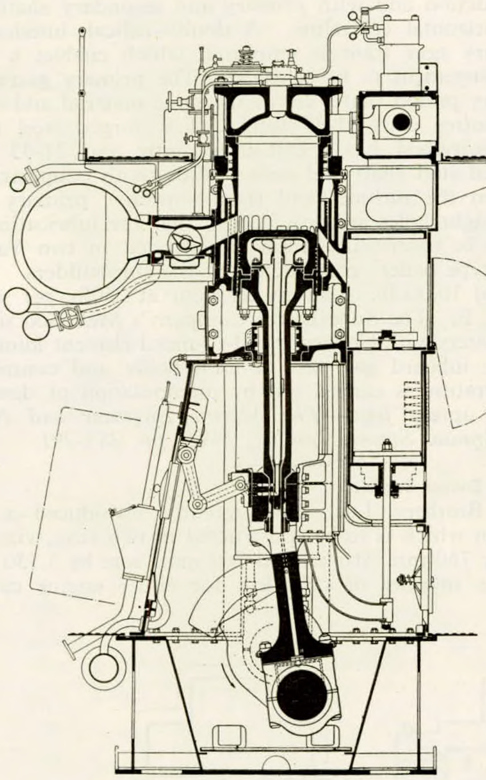


FIG. 1—*Sectional view of the Sulzer engine for the motorship* Middlesex

The engine has no skirt to the piston. The crankshaft is sealed from the cylinders by horizontal plating or baffles, and the connecting rod is fitted with a packed gland, so that there is no communication between the crankcase and the cylinders. The exhaust-port valves are operated from the cam gear, so that they are in the closed position when the piston is ascending, and vice versa. The maximum output of the smaller engine, as measured at the shaft, is in excess of 600 b.h.p. per cylinder when running at 250 r.p.m. and with a m.b.e.p. of about 80lb. per sq. in. The full load per cylinder is in the region of 500 b.h.p. at 225 r.p.m. with a b.m.e.p. of about 72lb. per sq. in., while the continuous rating is 450 b.h.p. at 225 r.p.m. The maximum firing pressure is in the region of 55 atmospheres. The larger engine is capable of developing 1,000 b.h.p. per cylinder at 115 r.p.m., with a b.m.e.p. of about 73lb. per sq. in.—*The Shipbuilder and Marine Engine-Builder, Vol. 59, August 1952; pp. 510-511.*

Suppressing Crankcase Explosions

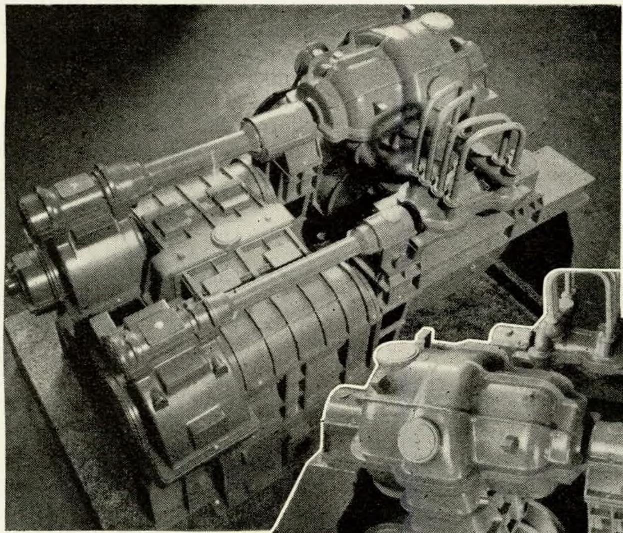
The problem of engine crankcase explosions has emphasized the fact that there is no unanimity in opinion as to the development and rate of explosion, nor as to whether it is advisable to suppress, relieve, or contain the explosion. A system used for suppressing explosions in aircraft petrol tanks has been suggested as being equally effective for explosions within a Diesel engine crankcase. This system is entirely automatic and comprises a detector operated by two spring diaphragms, which, on responding to a predetermined rise in pressure, close a pair of electrical contacts, thus exploding a high-speed detonator, which releases at high velocity a suppressant fluid. This emerges as a mist or blanketing cloud at a speed of about 300ft. per second, which is stated to be appreciably greater than the initial speed advance of a hydro-carbon flame front. Thus it is claimed that with the propagation of a crankcase explosion, the detectors, which would be fitted in the vicinity of the potential hot spots, would respond to the static pressure rise and suppress the explosion. This method has been proved most satisfactorily by the Royal Aircraft Establishment, where tests on petrol tanks showed that the initiation of the explosion was effectively suppressed before the pressure rise was sufficient to burst the tank walls. It is believed, therefore that this method should prove equally effective with crankcase explosions, as the rate of pressure rise in crankcases should be slower than that encountered in aircraft fuel tanks, the rate being, in fact, proportional in some degree to the capacity of the chamber. Although the detectors fitted within the crankcase can respond to a static pressure rise of 0·25lb. per sq. in., they would be arranged to operate at a rate of rise of 5lb. per sq. in. per sec., so that normal pressure pulsation will not affect the system.—*The Motor Ship, Vol. 33, August 1952; pp. 192-193.*

Chemical Reactions in Diesel Engine

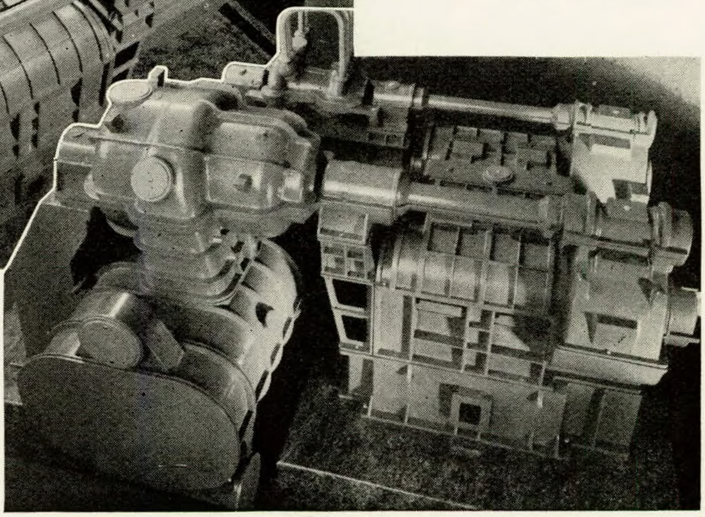
Experimental work has established that peroxides and aldehydes are formed by the reaction of the injected fuel with the hot, compressed air and that only a small fraction of the intermediates detected are due to the unscavenged exhaust gases. There is evidence of at least two separate reaction mechanisms. During the delay, period reactions occur around 350 deg. C. resulting in the formation of peroxides and aldehydes which reach peak concentrations at the point of ignition. These are followed by reactions at considerably higher temperatures, resulting in a second peak concentration of peroxides and aldehydes. The high temperature reactions occur after ignition, presumably while the flame is spreading throughout the fuel-air mixture, and oxidation is probably accompanied by pyrolysis of the fuel molecules. Peroxides and aldehydes are found well into the power stroke, possibly as a result of the larger fuel droplets undergoing oxidation. It is well known that in starting a Diesel engine at low temperatures, aldehydes are formed in relatively large amounts. Under such conditions the engine may seize due, apparently, to the formation of polymerized aldehydes and oxidation products between the piston and cylinder walls. In these cases the engine can be freed by warming. It would appear that the oxidation of hydrocarbons under cold-starting conditions in a Diesel engine is characterized by the formation of aldehydes, and the extent to which such reactions proceed may determine the cold-starting qualities of the fuel. The delay characteristics in the precombustion of Diesel fuels, however, would appear to be dependent primarily upon the formation of peroxides. The initial stages in the oxidation of hydrocarbons are the formation of hydroperoxides accompanied by formaldehyde and higher aldehydes. It has been suggested that aldehydes may condense with peroxides to give cyclic peroxides and hydroxy-peroxides. Under cold-starting conditions the large amounts of aldehydes present may prevent the peroxide concentration from reaching the limits necessary for auto-ignition. Experiments show that with rise in temperature there is a marked increase in the proportion of peroxides and formaldehyde to higher aldehydes. The delay period in a Diesel engine may be dependent upon the extent to which peroxides can be formed, and this is influenced by the type of fuel used and of additive present.—*F. H. Garner, W. E. Malpas, F. Morton, W. D. Reid and E. P. Wright, Journal of The Institute of Petroleum, Vol. 38, May 1952; pp. 312-343.*

Latest Geared Turbines

Fifteen single-screw geared turbine cargo liners of 10,000 tons d.w. are building in three different German yards for the Hapag and N.D.L. companies. In each case a service speed of 17½ knots will be obtained on about 9,000 s.h.p., with a maximum output of 10,000 s.h.p. Three turbine builders have been entrusted with the manufacture of the machinery, namely, A.E.G., of Berlin, Brown Boveri, of Mannheim, and Siemens-Schuckert, of Mulheim. The accompany illustrations show a model of the Brown Boveri Company's machinery as it will appear when completed. This gives a good general idea of



Two views of a model of the Brown Boveri two-casing double-reduction geared turbines now being built at Mannheim for the Hapag and N.D.L.



The usual gearing layout and stiff gearcase are well shown on the right

the two-casing arrangement, layout of the double-reduction gearing, and massive construction of the gearcase and foundations. Steam will be supplied by two Babcock sectional-header oil burning boilers, and the steam conditions at the boiler are: pressure 43 atm. (610lb. per sq. in.) and 450 deg. C. (842 deg. F.). The service power of 9,000 s.h.p. is produced at 115 r.p.m. of the screw; the corresponding speeds of the turbine rotors are 5,600 r.p.m. for the h.p. and 3,600 r.p.m. for the l.p. As the illustrations show, the arrangement of the double-reduction gearing is unusual, with the first-stage at the after end of the gearcase. The long shafts which pass to the primary pinions are tubular so as to give the desired degree of flexibility in the drive. The gearing itself seems to be normal and no shaving or other post-hobbing treatment is given to the gears. The main wheel is a massive cast iron affair with the rims shrunk on and provided with large countersunk-headed tap bolts in addition. A single-collar thrust block is provided and this is located at the forward end of the stiff well-ribbed cast iron gearcase.—*The Marine Engineer and Naval Architect, Annual Steam Number, 1952; pp. 295-296.*

Large Double Acting Diesel Engine

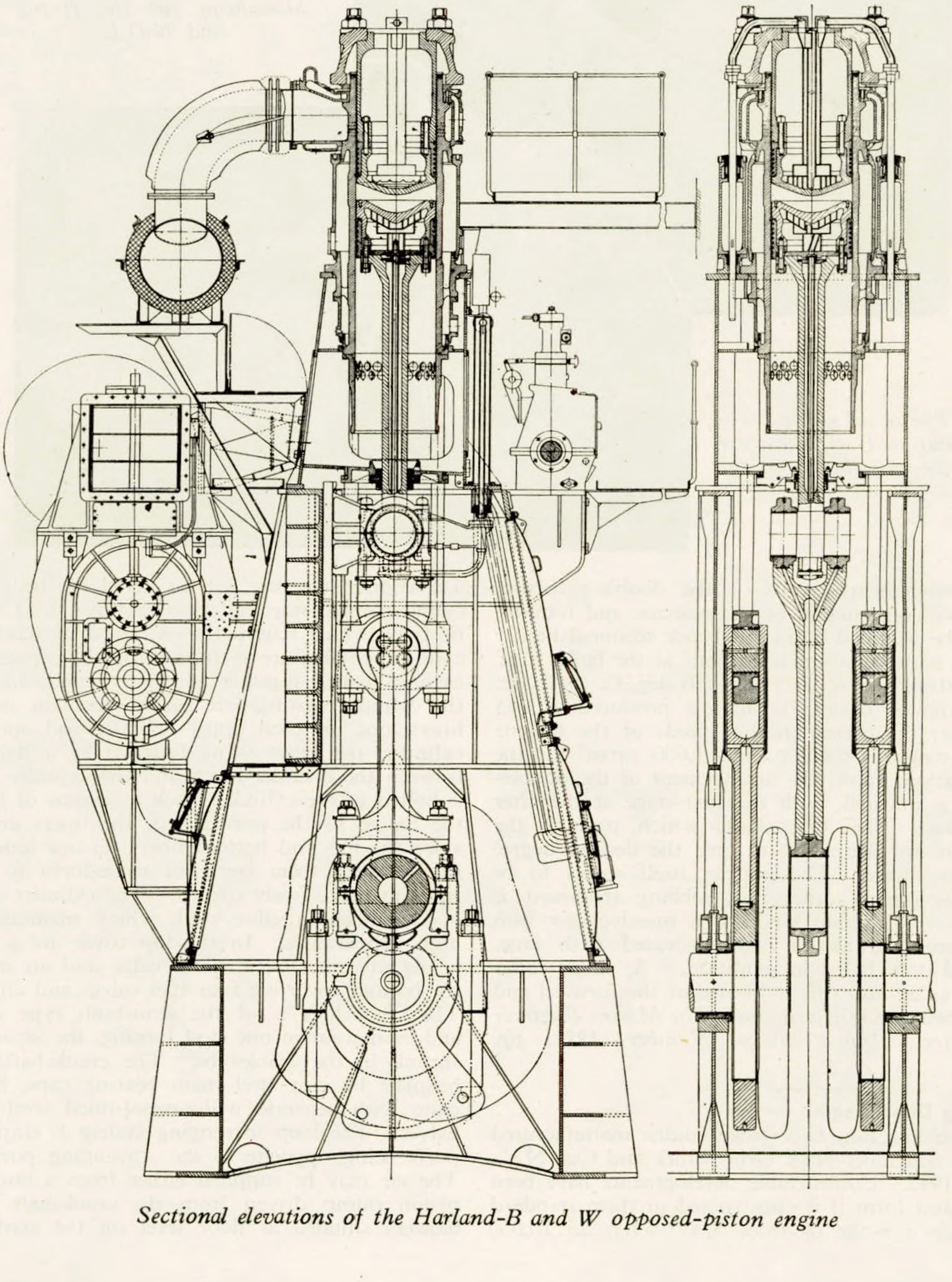
The Stork double-acting two-stroke engine manufactured by the Koninklijke Machinefabriek Gebr. Stork and Co., N.V., was first built in 1932. Considerable developments have been made and in its latest form it is constructed in three standard sizes which provide a range of from 5,000 b.h.p. to 10,000 b.h.p. in from six to nine cylinders, of which the details are as under:—

Bore, mm.	Stroke, mm.	Output per cylinder, b.h.p.	R.p.m.	M.e.p. kg./cm.^{2}	Mean piston speed, m/sec.
610	1,150	325	130	4·7	4·98
660	1,200	925	120	4·7	4·8
720	1,200	1,000	120	4·7	4·8

The engine structure is built up of the bedplate, columns and cylinder entablature, all iron castings, held by means of long tie bolts which relieve the cast iron of tension stresses. The cylinder entablature is formed of the separate single cylinder castings bolted together by rigid flanges and fitted bolts. In the cylinder castings are carried the cast iron chrome plated liners, one for each upper cylinder and one for each bottom cylinder, the liners being fastened by a flange which is held between the cylinder block and the cylinder cover. The cover is bolted to the cylinder block by means of long studs. From the flange to the ported end, the liners are free to expand, since the top and bottom liners do not touch each other, the gap between them being of wave-form to allow the piston rings to move freely over it. The cylinder covers are castings of molybdenum alloy steel, which maintains its strength at high temperature. In the top cover are a fuel valve, which is placed centrally, a safety valve and an indicator cock. In the bottom cover are four fuel valves and an air-starting valve. The crankshaft is of the semi-built type with the crankpin and crankwebs in one steel forging, the separate journals being shrunk in the crankwebs. The crankshaft is carried in the bedplate by cast steel main bearing caps, bolted to the bedplate with separate white-metal-lined steel bearing shells in halves. The loop scavenging system is employed, the exhaust ports being opposite to the scavenging portion in the liners. The air may be supplied either from a tandem double-acting piston pump driven from the crankshaft or by two Roots blowers situated at floor level on the starboard side of the engine. They are driven separately from the centre of the crankshaft by chain through a traction-type hydraulic coupling. There are three compartments in each blower, with two lobed impellers phased at an angle of 120 degrees between the compartments, so that the flow of scavenging air is comparatively silent and practically continuous. The air is drawn into silencers in the engine room and usually arranged on the starboard side. Rotary valves connected to the scavenging mechanism and suitable ducts in the blower casing automatically control the flow of air to the cylinders for operation of the engine in the ahead or astern directions respectively.—*The Motor Ship, Vol. 33, August 1952, pp. 172-174.*

Opposed Piston Engine

The motor cargo liner *Flowergate,* built by the Burntisland Shipbuilding Co., Ltd., for the Turnbull Scott Shipping Co., Ltd., is propelled by the first four cylinder, opposed piston engine of the Harland-B. and W.-type. This engine, built by John G. Kincaid and Co., Ltd., has a cylinder bore of 620 mm. with a piston stroke of 1,400 mm. plus an exhaust piston stroke of 470 mm.—a combined stroke of 1,870 mm.—and is of the same design as the Harland-B. and W. engine of 750-mm. bore, 2,000-mm. combined stroke and with eccentric-driven exhaust pistons. The engine is at present being built in units of 4, 6 and 7 cylinders, and may be constructed with up to 10 cylinders. The four cylinder engine is capable of developing continuously in service 3,300 b.h.p. at 125 r.p.m., with an m.i.p. of 6·5 kg. per sq. cm. (92·5lb. per sq. in.), and may operate on either Diesel oil or boiler oil. Although the main engine will run on boiler fuel, no special arrangements have been made for this in the engine itself, except that the fuel valves have been modified for fresh water cooling, and a small steam pipe is led in contact with the fuel oil supply pipe between the filter and engine for heating purposes. A steam heater is fitted in the fuel supply line between the surcharging and injection pumps, and this heater, capable of maintaining the oil at a temperature of 180 deg. F., is thermostatically controlled. An Auto-Klean twin oil fuel filter is fitted in the supply line between the supercharging pump and the heater. The main engine has its entablatures, frames and



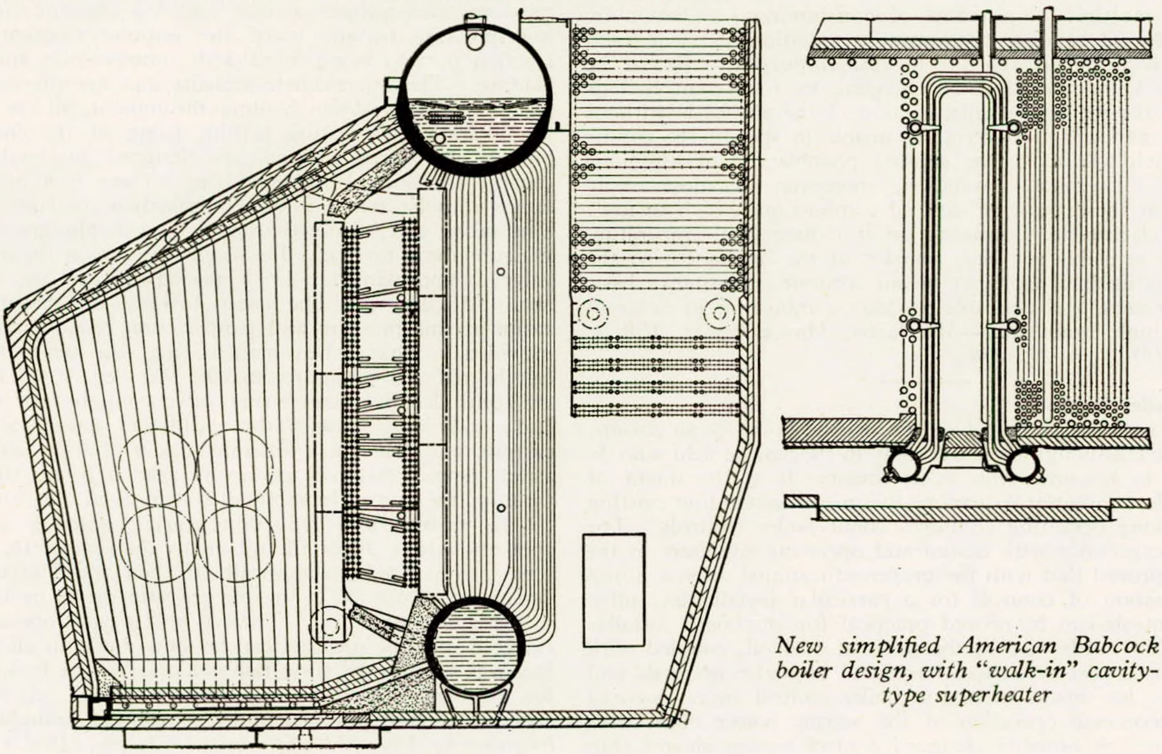
Sectional elevations of the Harland-B and W opposed-piston engine bedplate of welded steel construction. The scavenge entablature is of the deep type, to enable the pistons and rings to be examined in place without removal of the exhaust pistons and yokes, the bottom part of the cylinder being designed so that it can be lowered through the crankcase diaphragm, thus exposing the main piston. Each cylinder liner is isolated from the crankcase by this diaphragm, thus obviating the possibility of the lubricating oil in the crankcase being polluted with fuel oil or combustion deposits. The scavenging blower, designed to give a scavenging air pressure of 1¾-2lb. per sq. in., is arranged at the back of the engine and is of the rotary positive displacement type, chain driven by a Renold twin-duplex chain from a sprocket mounted on the crankshaft. The main and exhaust pistons are cooled by lubricating oil from the main system. A chain driven shaft mounted above the main fuel pump camshaft drives the cylinder lubricator and indicator gears. The lubricating oil, fresh water and sea water pumps are arranged at the forward end of the engine and driven by gears and cranks from the crankshaft. The total weight of the engine is about 230 tons and the length 8·58 m. or a little over 27ft.—*The Motor Ship, Vol. 33, August 1952; pp.178-181.*

Diesel Engine Operation

In his discussion of the problem of Diesel engine operation, Mr. A. F. Evans pointed out that no self-reversing engine can, with safety, be handed over to the bridge for direct operation. The response, from full speed ahead, is too slow and uncertain. Bridge operation is out of the question owing to the complexity of the manipulations. It appears to be common practice for modern gears to be supplied as separate units and driven through a flexible coupling. This is retrogressive to say the least. In the case of a self reversing engine the operation is for too protracted and uncertain. The complex mechanical operations on the engine, to effect reversal, remove the possibility of direct control from the bridge. For clarity, it must be understood that the reference made is to the reversal of the engine with the vessel moving ahead, through the water, at full speed. "Reversal" may be considered as the first movement of the propeller shaft in the astern direction. The timing of the operation is taken from the initial movement of any part of the control mechanism. In the case of bridge control, it is the first movement of the telegraph from the "Full Ahead" position. The cause of the delay in this operation is immaterial, if a brake has to be employed to bring the engine to rest, this has no further significance than that it is an added mechanical complication acting as a barrier against direct bridge control. It was hoped that the improved forms of reversing gear would remove all these barriers. Unfortunately this does not appear to be the case as there is an ominous pause required at mid-position of the telegraph, not a happy arrangement for panic conditions. Direct bridge operation must be strictly in accordance with the normal ship's telegraph; from "Full Ahead" to "Full Astern" as rapidly as possible, without pause, and at any moment. This is the least that can be acceped as correct. The engine, or gear, must respond in accordance with a time lapse, in the case of a 500 h.p. reversing engine, of not more than four seconds.—*Diesel Engine Users Association, S223, June 1952; p. 2.*

New Boiler Design

A new design of watertube boiler, known as the B. and W. drum-type boiler, is announced by the Babcock and Wilcox Company of America. It is of simplified design having fewer components to handle and assemble and has an improved casing construction with fewer seams and openings, which save considerable erection time and expense. It is lighter in weight and offers greater freedom in piping design. The most important feature is the "walk-in" type of cavity-type superheater with widened loops, which greatly simplifies maintenance, as a man can actually enter the superheater to inspect the tube nest supports and carry out thorough direct cleaning. As will be seen from the drawings, a portable insulated panel situated between the wet and dry headers reveals a cavity through which access can be obtained. This arrangement also dispenses with the necessity of providing withdrawal space at the rear of the boiler, as the superheater tubes can be withdrawn between headers into the firing aisle. Improvements elsewhere in the boiler include the use of standard fire bricks, a simplified flat brick pan and water-cooled furnace floor. A number of the new Mariner class vessels are to be fitted with this boiler.—*The Marine Engineer and Naval Architect, Annual Steam Number, 1952; p. 308.*



New simplified American Babcock boiler design, with "walk-in" cavity-type superheater

Boiler Scale Fuel Losses

The author gives the following rule for determining the fuel losses due to scale in boilers: "Multiply the square root of the thickness of the scale in inches by 48". The result is the percentage of fuel loss. For example, if the scale thickness is one-ninth of an inch, the square root of one-ninth is one-third. One-third of 48 is 16. The fuel loss is therefore 16 per cent. The surprising thing about this rule is that it shows a rapid increase in loss when the scale is very thin; that is, the increase is not directly proportional to scale thickness but varies as the square root of the thickness. Thus, after a thick scale is once formed, a little added thickness or a considerably greater thickness does not make much difference. The important point therefore is: remove *all* of the scale and then keep it off. The foregoing rule is based on numerous carefully made tests at the University of Illinois.—*W. F. Schaphorst, Marine Engineering and Shipping Review, Vol. 57, July 1952; p. 91.*

Flame Radiation and Furnace Efficiency

In furnace design, heat transfer is of prime importance and its calculation is one of the first cares of the designer. The furnace flame gives up its heat mainly by radiation, and it is at this early point that we meet a tantalising gap in our knowledge. *The furnace designer cannot predict on an accurate quantitative basis the luminous radiation from a given flame.* Non-luminous radiation from gases such as CO_2 plus H_2O he can predict, thanks largely to work by Hottel and Mangelsdorf in the U.S.A. and by E. Schmidt in Germany. For this he needs to know, or to be able to calculate, the composition of the burnt gases and their temperature; he can then deduce the heat transfer quite accurately. But if he is not satisfied with the low emissivity resulting from a non-luminous flame, he will wish to increase the heat transfer by developing a luminous flame, that is, a diffusion flame containing carbon particles due to a combustion and thermal cracking and to incomplete combustion. This is where he meets the gap in knowledge just referred to. When it is realized that the emissivity of a luminous flame may be five or even ten times that of a non-luminous flame, it will be seen that this is a very serious lack indeed. In practice the furnace designer will use his experience with the particular fuel and conditions obtaining and will multiply his estimate of non-luminous radiation by perhaps 2 or 3 to allow for luminous radiation and will reach a result accurate enough for his initial purpose. But if he wishes to know the effect of changing to a different fuel or changing the method of introduction of the air, he is without any information and is certainly unable to specify the conditions which will make the greatest possible use of luminous radiation. Luminous radiation, moreover, is most easily obtained at the expense of delayed combustion, which in itself is thermodynamically unsound, as it reduces the temperature difference available for heat transfer in the appliance; so the designer is unable to predict on an accurate quantitative basis to what extent it is desirable to delay combustion in order to obtain a high luminosity.—*M. Davies, Murex Review, Vol. 1, No. 10, 1952; pp. 233-238.*

Marine Boiler Controls

The automatic control of the marine boiler is an accomplished fact, although there are many in the marine field who do not care to recognize this achievement. It is the intent of this article to attempt to remove the misunderstanding existing today among operating engineers about boiler controls. The author's experience with design and operating engineers in the past has proved that with the proper educational approach and fair evaluation of controls for a particular installation, automatic controls can be proved practical for shipboard installations. The steady rise in the price of fuel oil, coupled with the increased cost of periodic overhaul of boiler internals and refractory, has made automatic boiler control more essential for the economic operation of the marine power plant than ever before. A properly designed control system aboard ship is capable of handling automatically load "swings" normally experienced by marine boilers while discharging cargo at the dock, or in responding to ahead and astern bells while manœuvring in and out of port. Under steady steaming conditions while under way it will maintain day after day the desired water level in the steam drum and efficient smokeless combustion for any speed of the vessel. It is hardly conceivable that a maritime vessel built today would not have some form of boiler control. In fact, modern design tendencies aboard ship are slowly approaching the refinements found in stationary power plants for metering and recording fuel, air, and steam flows. In the pneumatic type of system, the steam pressure is converted to a proportional air loading pressure by means of a bellows or bourdon tube linkage arrangement. Louvres or dampers are positioned by air-powered cylinders, and oil valves and feed valves are actuated by either diaphragms or air-powered cylinders. Systems are classified as "Series", or "Parallel" or a combination of the two. A "Series" system, as the name implies, is the control of one element after another, in succession, each responding to the demands of the factor before it. In a "parallel" system, one sensing element controls more than one other factor simultaneously.—*Paper by A. Waxman, abstracted in S.N.A.M.E. Bulletin, Vol. 7, May 1952; pp. 32-33.*

Twin-screw Cargo Liner

The 14,500-ton twin-screw passenger and cargo liner *Uganda,* the latest addition to the fleet of the British India Steam Navigation Company, was built and engined by Barclay, Curle and Co., Ltd., at their yard at Whiteinch, Glasgow, and is the sixty-fifth vessel to be built by them for the British India line. The principal dimensions are: length overall, 540ft., and, between perpendiculars, 517ft. 6in.; breadth moulded, 71ft.; and depth moulded, to B deck, 38ft. 6in. She has been constructed to carry 300 passengers, 191 in the first class and 109 in the tourist class, with part of the accommodation arranged so that it can be interchanged between the two classes. There are five holds which provide 390,000 cu. ft. of general cargo space and 25,000 cu. ft. of refrigerated space. The propelling machinery consists of two sets of Parsons steam turbines arranged to drive twin screws through single-reduction double-helical gears, each set of turbines consisting of high-pressure, intermediate-pressure and low-pressure units. Each high-pressure turbine is of the impulse reaction type, the reaction portion being fitted with stainless-iron and tightened blading. The intermediate-pressure and low-pressure turbines are fitted with reaction blading throughout, all the blading in the intermediate-pressure turbine being of the end-tightened type. The astern turbines are designed to develop 65 per cent of the normal service power. There is a high pressure astern impulse wheel in the intermediate-pressure ahead turbine casing and separated from it by a diaphragm, and a low-pressure ahead turbine. The steam pressure at the manœuvring valves is approximately 430lb. per sq. in. and the temperature about 750 deg. F. The astern turbines are designed to take steam at this pressure and temperature, but attemperators are provided so that, when manœuvring, the steam temperature can be reduced to approximately 600 deg. F. The turbines are controlled by manœuvring valves, supplied by Cockburns, Ltd., and designed with the ahead and astern valves in one casting, and there is a separate master shut-off valve for the astern range. Aspinall governing gear is fitted; this operates through the forced-lubrication system used for supplying oil to the turbine and reduction gearing bearings and to the sprayers, which direct the oil on to the gear teeth. The turbines are stopped automatically if their speed exceeds a predetermined value or if the oil pressure drops or the vacuum in the condenser is lost. There is also a hand operated control valve so that the turbines can be shut down in an emergency. Steam is supplied by three Babcock and Wilcox boilers designed for a working pressure of 480lb. of 21,117 sq. ft. and are arranged to burn oil fuel under a balanced draught system.—*Engineering, Vol. 174, 25th July 1952; pp. 118-119.*

ENGINEERING ABSTRACTS

Section 3. SHIPBUILDING AND MARINE ENGINEERING

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True Water Level in Boiler

Considering today's watertube boilers, the level that is recorded in the gauge glass or the remote water level indicator gives a reading which, on the average, is indicative of the boiler water level within the drum. Actually, with the drums now becoming cluttered up with desuperheaters, and superheater temperature control desuperheaters, and external downcomers, and the fast steaming rates with resultant turbulence in the drum, the absolute location of the water level is in some doubt. As a matter of fact there are some questions as to the shape of the water level. Be that as it may, it is generally accepted that the water level is considered to be somewhat higher in the drum than is indicated in the gauge glass due to the increase in density of the water in the glass which has undergone some cooling. This amount is generally not too significant and can be checked fairly well by blowing down the glass and determining whether or not the water returns to a new and higher level. In the old Scotch boiler it was possible to get some sort of check on the true water level by use of the "tri-cocks" although a certain experience was needed if the level was to be checked while under way. No matter what the water level was, since the water was above the saturation temperature at atmospheric pressure, the boiler water, upon being released through the tri-cocks, would flash into steam and it took an experienced engineer to determine whether steam or water entered the tri-cock on the boiler side. Experience has shown that for all modern boilers a safe water level exists in the boiler when a visible water level exists in a functioning gauge glass, be it attached directly to the drum or of the remote reading type.—*Marine Engineering and Shipping Review, Vol. 57, July 1952; pp. 94-95.*

Novel High Speed Vessel

The author proposes a novel type of ship's propulsion for high speed vessels. According to the accompanying engraving, Fig. 4, this drive consists of two propeller type pumps *b* and *f*. The pump *b* arranged at the bow and driven by the prime mover *d* draws in water through the nozzle *i* and discharges it through the diffuser *a* formed by a body of revolution *c*.

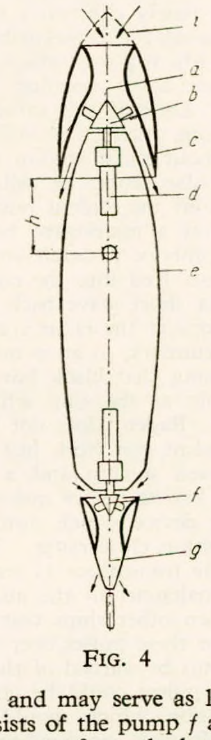


FIG. 4

The latter is hollow and may serve as liquid fuel storage, etc. The stern drive consists of the pump *f* and the ejector body *g*. As pump *f* draws in water from the boundary layer surrounding the hull, it prevents breaking away of the flow from the hull surface.—*F. Jahn, Schiffbautechnik, Vol. 2, June 1952; pp. 169-171.*

Velox-boilered Steamship

The twin-screw passenger vessel *Ville-de-Tunis* for the Marseilles-North African service of the French Line, and sister ship of the ex-*Ville-de-Marseille,* now *Maroc,* has been built at the Naval yard of Lorient. She has the following leading dimensions:—

Length overall	466ft. 0in.
Length b.p.	446ft. 0in.
Breadth moulded	62ft. 4in.
Load displacement	8,660 tons
Corresponding mean draught	20ft. 2¼in.
Deadweight capacity	2,500 tons
Gross tonnage	9,192 tons
Service speed	20½ knots

The profile of the vessel is modern, with a well-raked stem and cruiser stern. The bridge front is slightly streamlined, there is a single Strombos funnel of FCM-Valensi type, and the two masts are arranged close to it. The superstructure, bridge and funnel are of light alloy. There are four complete decks and three partial decks with superstructure. The hull is of riveted construction but welding was employed in many other parts of the ship. Like the *Ville d'Alger* and the *Ville d'Oran,* the ship is propelled by two sets of Parsons single-reduction geared turbines, developing a total power of 14,000 s.h.p. A noteworthy feature of the installation of the *Ville-de-Tunis* is that the turbines are supplied with steam by three Velox-Brown-Boveri steam generators, two (each of 30 tons per hour capacity) being sufficient for normal service; one is held in reserve. Steam conditions are: pressure 850lb. per sq. in. and final steam temperature 895 deg. F. The boilers were constructed by the Cie. Electro-Mecanique, of Le Bourget, near Paris.—*The Marine Engineer and Naval Architect, Annual Steam Number, 1952; pp. 296-298.*

Electronic Ship's Whistle

An electronic ship's whistle whose sound can be seen on radar is expected to reduce marine casualties and facilitate safe movement of vessels in congested and restricted areas. At present all ships look nearly alike on a radar scope and there is no simple positive means for distinguishing one from another. It is necessary to tell which pip is which ship in order for the radar man to be sure he is warning a particular ship of intended manœuvres. Lack of this information has led ships into dangerous situations during low visibility weather. When the operator at a harbour radar station wishes to find a particular ship on his radar scope, he calls that ship and asks its watch officer to point the Radent box at the radar station. The black box contains a microwave horn which the watch officer aims like a megaphone to catch some of the pulses from the radar. These pulses feed into the communications system which relays them via short wave back to the radar station. When fed into the scope at the radar station, the pulses cause a tail of light, or Radentmark, to grow out behind the pip that represents the ship using that black box. This marker positively identifies the pip as the ship which the radar station operator is talking to. Radent does not interfere with normal use of the radar. Radent can work just as well between two ships as it can between a ship and a shore radar station. Addition of a simple keying device makes the system work as a proximity warning device which automatically tells when another ship comes within close range. This keyer causes the special communications transmitter to emit continuously low-power radio pulses analogous to the audible blasts of a fog horn or whistle. When other ships come within range, their watch officers will hear these pulses over the special communications receiver and thus be warned of the presence of the first ship. If desired, the pulses could be coded to carry further identification information which would be useful in overcoming language difficulties encountered between ships of different flags. These pulses do more than the ordinary whistle or fog horn because the Radent system can tell which ship is sending them; and in addition, the system incorporates a direct means of communication between ships. The one fly in the ointment is the need for an assigned clear channel for the special communications system.—*Marine Engineering and Shipping Review, Vol. 57, July 1952; pp. 60-61.*

Torsional Vibration Recorder

The accompanying illustration shows a novel portable torsional vibration recorder developed by a German firm of instrument makers. As will be readily understood from the photograph, this device does not require permanent installation, but it is sufficient to contact the instrument with the shaft to be investigated by slightly pressing the instrument against he

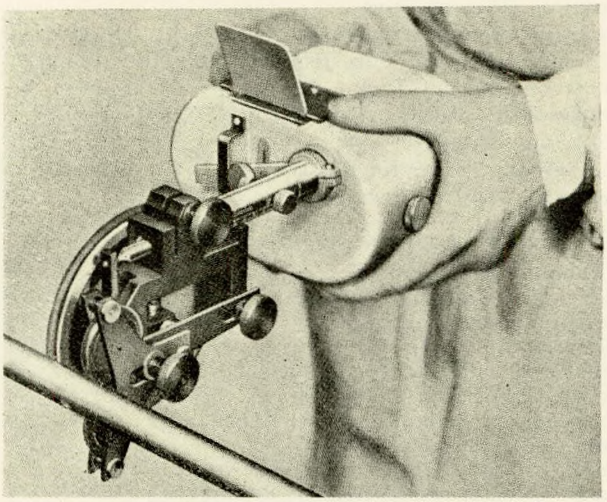


Fig. 16

shaft. The instrument is equally suitable for the recording of ordinary vibrations. All that is required is to remove the torsional movement transmission from the instrument. It is stated that a detailed description of the instrument will be published shortly.—*H. Behrmann, Schiff und Hafen, Vol. 4, July 1952, pp. 246-251.*

American Research Projects

Three research projects sponsored by The Society of Naval Architects and Marine Engineers are now under way at the Experimental Towing Tank of Stevens Institute of Technology. The first, to study scale effects in self-propelled model tests, is a joint effort with the Office of Naval Research. The Society is financing the construction of a propeller boat for carrying out open-water tests of propellers and a propeller-measuring apparatus to permit comparison between the propeller model and drawings from which it was constructed. After these two pieces of equipment have been completed, work will continue for the Office of Naval Research. This will involve running self-propelled tests of three model sizes of a Victory ship to determine how the several propulsion factors vary with the size of the model. It is planned to have this work parallel similar work being carried out by the Netherlands Shipbuilding Experiment Tank in Wageningen, The Netherlands. The second project involves testing a model of a T-2 tanker to measure the bending moments experienced while being towed in waves. The model will be constructed in two pieces and joined together at the centre by an apparatus which will keep a continuous record of the bending moment. Bending moments obtained in this manner will be compared with those previously calculated for the ship. The wave size selected for the model test will be the size generally used in standard calculations for a ship's strength. The third project concerns a study of the seaworthiness of a model of a merchant ship. The model will be tested in rough water, but instead of being free to heave and pitch, it will be constrained to move in a straight line, and measurements will be made of the forces exerted on it by the waves.—*Marine Engineering and Shipping Review, Vol. 57, July 1952; p. 81.*

New German Cargo Liner

The German firm Erst Deutsche Walfang-Gesellschaft, which has recently taken delivery of the cargo liner *Atlantik* from Howaldtswerke, is a new entrant into the field of cargo liner operation. The *Atlantik* is the first of a group of five ships which it has ordered. The four later vessels will be employed in the service of Deutsche Afrika-Linien, while the *Atlantik* is engaged in the South African service of Deutsche Ost-Afrika-Linie. The *Atlantik* is a motor vessel of some 4,000 tons gross, and has been built to the highest class of Germanischer Lloyd. She is an open shelterdecker with four holds and machinery amidships. There is no accommodation in the raised forecastle, and this has been used to give a second 'tweendeck for part of the length of the long No. 1 hold, which is served by two hatches. The principal particulars of the ship are as follows:—

Length overall	400ft.
Length b.p....	357ft.
Breadth moulded	54·2ft.
Depth to main deck	25·9ft.
Depth to shelter deck	34·2ft.
Draught at summer freeboard ...	23·4ft.
Gross tonnage	3,838 tons
Net tonnage	2,145 tons
Deadweight capacity	6,600 tons
Light ship displacement	3,205 tons
Horsepower	3,000 h.p.
Speed	13 knots

In her general arrangement and appearance the *Atlantik* is typical of the postwar cargo liners with which German shipowners are re-establishing their services. Welding has been used to a moderate extent, the butts of shell plating and butts and seams of decks being welded. The stern frame is of fabricated construction. There is a continuous double bottom, with six watertight bulkheads. The propelling machinery consists of a five-cylinder Howaldt-M.A.N. Diesel engine, of double-acting unsupercharged type. It develops 3,000 horsepower at 112 r.p.m. to give the service speed of 13 knots. Electric generating plant consists of three Diesel generators of 100 kW each and an emergency Diesel generator of 10 kW delivering current at 220 volts D.C.—*The Shipping World, Vol. 127, 9th July 1952; pp. 28-29.*

Largest Scandinavian Vessel

The Brita Onstad, which is the largest vessel ever built in a Scandinavian shipyard, has the following principal particulars. Length overall 649ft. 8in.; length b.p. 605ft.; breadth moulded 80ft. 6in.; oil cargo capacity 1,337,000 cu. ft.; mean draught on summer freeboard 32ft. 10½in.; loaded speed 14 knots. The vessel is all welded, with longitudinal framing at bottom and sides. Longitudinal and transverse bulkheads are of the Götaverken corrugated type. The main engine is of Götaverken's own design and manufacture. It is of the two-stroke single-acting type and has nine cylinders, with a diameter of 760 mm. and a stroke of 1,500 mm. At 112 r.p.m. the engine develops 10,000 i.h.p. The vessel is fitted with two five cylinder four-stroke single-acting auxiliary engines of the Götaverken type. The cylinder diameter is 300 mm. and stroke is 450 mm. Each engine develops 300 e.h.p. at 350 r.p.m. and is directly coupled to a 200 kW generator. There is also a compound steam engine developing 165 e.h.p. at 450 r.p.m., to which a 110 kW generator is coupled. For supplying steam to the pumps, windlass, etc., and for heating purposes, there are two boilers, each of 300 sq. m. heating surface. —*The Shipping World, Vol. 127, 16th July 1952, p. 53.*

Structural Action of Superstructures

The theory developed in the report by H. H. Bleich, published by the U.S. Ship Structure Committee, is based on the assumption that the hull and deckhouse act as individual beams, which are forced to act together by their connexions at deck level. These connexions transfer shear stresses such that the longitudinal stresses in deckhouse and hull at deck level are alike; the connexions also transfer vertical reactions but, because of the flexibility of the bulkheads, the vertical deflexions of deckhouse and hull will not be alike. For infinitely rigid bulkheads, hull and deckhouse will deflect as a unit, a condition that results in Navier's stress distribution. For very flexible bulkheads, only horizontal shear forces are transferred from hull to deckhouse, and the deflexions of hull and deckhouse will be different. The actual condition will lie between these extremes. The author derives expressions for the deflexions and stresses in the hull and deckhouse, assuming constant section of hull and house. A simplified ship's structure in which the action of vertical forces between hull and deckhouse is neglected is first considered, and this is followed by a study of the full problem. The solution of the general differential equation for two special loading cases is given and an approximate method is derived for using the results for any type of loading. A table of coefficients and a list of the formulæ required for the determination of the stresses in the midship section are given, together with a numerical example. The final section contains a review of the theoretical results obtained, discusses a test programme to check these theoretical results, and considers further research necessary to formulate design standards for ship superstructures.—*Journal, The British Shipbuilding Research Association, Vol. 7, June 1952; Abstract No. 6,154.*

Economy with Boiler Oil

The economy to be effected in operating the machinery of a motor ship on boiler oil instead of Diesel fuel averages £12 per day per 1,000 b.h.p., reckoning the mean differential between the two fuels at bunkering ports throughout the world as £3 per ton. Allowing for increased liner wear and amortization of capital cost, the saving is probably in the neighbourhood of £10 per 1,000 b.h.p. per day. This is borne out in practice in a very large number of ships with machinery ranging from 3,000 b.h.p. to 16,000 b.h.p. All new motor ships ought now to be equipped so that they can run on boiler oil, in view of the fact that there are indications of the increasing necessity for the maximum economy of operation in the coming years, when the saving of several thousand pounds annually in the fuel bill will be a determining factor in the economics of shipping. At present there are at least 800 motor ships which are either equipped for running boiler oil or which are to be provided with the necessary installation. They include fifty tankers in the service of the Anglo-Saxon Petroleum Co., Ltd., and another fifty to be converted, twenty-five vessels in the British Tanker Company's fleet and fifteen for which arrangements have been made to adopt boiler oil. The New Zealand Shipping Company has sixteen ships running on boiler fuel and will equip seven new vessels and one existing ship, making a total of twenty-four. The Union-Castle Mail S.S. Company has run the *Bloemfontein Castle* on boiler fuel for more than a year, and larger motor liners are to be similarly equipped. The Blue Funnel Line has many vessels using boiler oil and all the new tonnage of this company will operate on this fuel, whilst numerous other owners with substantial building programmes are arranging for boiler oil to be employed in their new ships.—*The Motor Ship, Vol. 33, August 1952; p. 168.*

New Clamp for Tanker Lines

A new pipe clamp for coupling loading and discharge lines to the pumping system of oil tankers has been successfully tested and will shortly be adopted as standard equipment on many Shell tankers. Devised by Mr. John Lamb, the new clamp enables the blank flange to be removed and the flexible shore line to be connected to the loading and discharge lines aboard the tanker in about 2½ minutes, as against 30 to 60 minutes for the connexions at present used. The simplicity of operation also makes for greater speed in handling. The new clamp consists of two parts, one section comprising a hinged adjustable collar immediately behind the flange on the flexible shore line. The other portion consists of a short length of mild steel piping permanently bolted to the end of the intake or discharge line on the tanker. On this pipe are four hinged arms, easily operated by hand. These hold the shore-to-ship lines in position and replace the present system of bolts and nuts and bolted clamps. As an added safety precaution and to ensure a perfect connexion, two guide arms 120 deg. apart project from the underside of the fitting, and once the short pipe is resting on these arms, it is virtually impossible to make a faulty connexion. The usual millboard packing ring prevents any leakage at the point of union. A pressure of 120lb. per sq. in. was maintained throughout the tests, but bench test pressure was three times greater.—*The Shipping World, Vol. 126, 25th June 1952, p. 535.*

Sulphurous Fuels for Diesel Engines

A considerable diversity of opinion exists on the desirability or otherwise of using sulphurous fuel in Diesel engines. On the one hand, it has been claimed that a relatively large proportion of sulphur is not disadvantageous. Authoritative opinions have nevertheless been expressed to the effect that the presence of sulphur is highly undesirable as it causes corrosion and produces deposits. The Bataafsche Petroleum Mij. propose that sulphurous fuels should be treated by the addition of a metal nitrate or carbonate. This treatment makes it possible to retain the ignition-improving properties of sulphur. The proposed treatment makes use of the fact that certain salts under conditions of combustion, form materials which react with the sulphur oxides or sulphur acids to form non-corrosive substances. These are expelled during the exhaust stroke instead of forming deposits. An alkali metal nitrate may form the nitrite or the oxide which then reacts with sulphur trioxide and water. In order to establish this point, the Bataafsche Petroleum Mij. operated a Fairbanks Morse Diesel engine for eighty hours on a Diesel fuel containing 0·7 per cent sulphur and measured the piston ring wear. The experiment was repeated with a solution of calcium nitrate in isopropyl alcohol injected into the air intake at the rate of 0·6 cc. per minute. The concentration of the solution was such that the fuel consumed contained 0·022 per cent, by weight, of calcium nitrate and the ring wear was reduced by 50 per cent. By the second method, the calcium nitrate was blended directly with the sulphurous fuel and the engine was run for the same number of hours as in the first experiment. The blending was apparently less beneficial than injecting the calcium nitrate into the air intake, as the ring wear was then reduced by 33 per cent. The concentration of calcium nitrate was then lowered to 0·0034 per cent and the ring wear was reduced by 11 per cent. In the fourth experiment, 0·0315 per cent of zinc nitrate was incorporated in the fuel instead of calcium nitrate, and the ring wear was then reduced by 21 per cent. A General Motors Diesel engine was subjected to trials with a fuel containing 0·7 per cent sulphur and 0·022 per cent of calcium nitrate, together with 1 per cent isopropyl alcohol and the ring wear was reduced by 43 per cent. Further experiments were undertaken and in every case an improvement in the ring wear was noticeable.—*The Motor Ship, Vol. 33, July 1952, p. 141.*

Dynamometers and Engine Test Plant

The rating of engines is expressed in terms of "horsepower", an expression introduced by James Watt. A "horsepower" is defined as the power required to lift a weight of 33,000lb. through a height of one foot in one minute. This is our unit of power. In the course of time, machines have been devised for measuring the power developed by engines and these are called dynamometers. The "Heenan-Dynamatic" or eddy current dynamometer consists essentially of a rotor assembly carried upon ball bearings so that it can revolve within a stator assembly. The bearings are mounted in the stator end covers, and not in the external supports. The stator assembly, in turn, is carried upon anti-friction ball-bearing trunnions so that it is free to swivel about the same axis as the rotor assembly. At the centre of the stator assembly is fixed a circumferentially wound field coil, the application of a small direct excitation current to which produces a toroidal magnetic field. The rotor, which is of special high permeability steel, is similar in appearance to a wide, coarse pitch gear wheel and forms part of the magnetic circuit, the teeth forming magnetic poles separated from the stator assembly by a small air gap. The stator casings and inner rings are also of special high permeability steel. The magnetic flux, passing through the rotor and through the stator assembly via the air gap, is concentrated at the rotor pole tips so that when the rotor is revolved, the interior surfaces of the inner rings opposite the poles and between the poles are alternately magnetized and demagnetized, thus inducing eddy currents in the inner rings. The magnetic fields set up by these eddy currents interact with the main field concentrations in such a manner as to oppose rotation, thus giving the machine its power absorbing capacity. The energy expended in generating the eddy currents is manifested as heat in the internal surface of the stator inner rings and this heat is carried away by cooling water which is admitted to the gap between the rotor and stator through ports at the top of the machine. The water is carried around the hot faces of the inner rings by the tips of the rotor teeth and emerges through ports at the bottom of the stator, from whence it flows by gravity, to a drain or hotwell as required. The forces opposing rotation react upon the stator assembly, which tends to turn upon its antifriction trunnion bearings, but this tendency is counteracted by means of a lever arm connected to a torque measuring apparatus which enables the power absorbed by the machine to be accurately measured. The machine works equally well in either direction of rotation and the torque measuring apparatus is also suitably arranged for measurements in the two directions. The load imposed on the engine by the dynamometer is governed by the amount of excitation current passed through the field coil. Thus, by controlling the excitation current relative to the speed, the form of the load/speed characteristic of the dynamometer can be varied.—*Paper by K. G. Reeves, Bulletin of the Liverpool Engineering Society, Vol. 25, May 1952; pp. 9-23.*

Ceramic Backing for Tube Joints

For the making of butt welds of high pressure high temperature tubing, a ceramic backing joint (Fig. 6) has been developed. Its first practical application was made in connexion with an installation of high pressure high temperature steam piping at the (U.S.) Naval Engineering Experiment Station in Annapolis, Maryland. The line carrying superheated steam of 1,050 deg. F. temperature and 2,000lb. per sq. in. pressure was 1½-in. tubing of 4/6 per cent chromium - 0·5 per cent molybdenum steel. A total of eighty joints were

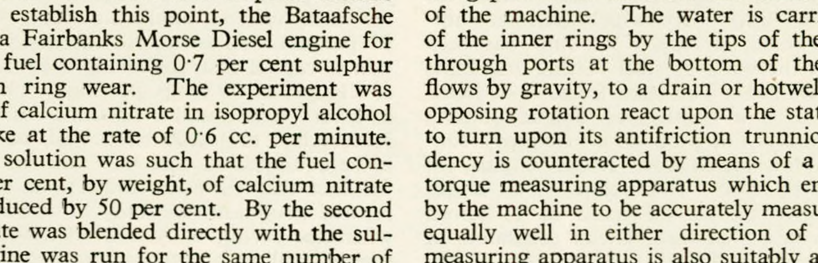
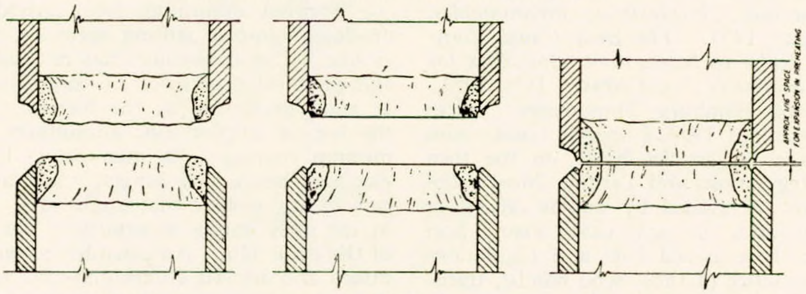


FIG. 5

MANUAL APPLICATION OF NON-METALLIC BACKING



AS APPLIED — TRIMMED — ASSEMBLED FOR WELDING

FIG. 6

required for the completion of this line from the superheater to the test assembly. The type of joint developed for this purpose is shown in Fig. 5. The distinctive feature of this design is that it is not symmetrical for wall thicknesses greater than ⅛ inch. One side is bevelled at 45 degrees, the other at 15 degrees, which is faired into the 3/16-inch radius at the root. The root is formed by two tips which are produced by counter-boring, thus raising the root edges 1/16 inch above the bottom of the joint. The root space between these edges is 3/32 inch. The ceramic backing is shown to be at least ⅜ inch thick and ⅜ inch wide and is also counterbored, forming an annular space under the root edges. These designs were found to result in satisfactory welds. Preparation and application of the ceramic backing and the welding technique employed in depositing the first pass of the weld are as follows. The backing material is sharp sand and the preferred binder is cellulose acetate. This material is a thermoplastic; its setting time in air is approximately half an hour. When it is desired to reduce the setting up time of the mould by torch heating, care must be taken not to impinge the flame on the exposed portion of the backing material. Heating the tube ends to 300 deg. F. reduces the setting up time to fifteen minutes. In preparing the non-metallic backing material, the sand and the binder are mixed into a putty-like consistency. The ratio of sand to binder is approximately 5 to 1. This mixture will adhere readily to the bore of the tubes to be joined. In the event that the mixture does not adhere readily, the bore of the tubes may be smeared with the binder. After the backing ring has been formed in each tube end to be joined, the material is allowed to set. When the backing material has hardened, it is faced-off to protrude beyond the end of each member, thus providing the joint with a root spacing. A trimming tool is used for this purpose. The heat of welding volatilizes the binder contained in the outer portion of the backing ring. This renders it very brittle. The vigorous pounding in dressing the completed first and subsequent passes of the weld shatters the brittle backing material which returns to its original form, namely sand particles. These can be removed by shaking or flushing with water or may be blown out by air. Few particles are fused on as a vitrified enamel. Such vitrified adhesions, measuring about ⅛ inch in length and width, were found on welds removed from the aforementioned steam line. Since this line had been subjected to several hundred thermal shocks of a very serious order, it is evident that such particles do not become dislodged and therefore do not constitute a threat to valve operation or fouling of turbine blades.—*B. Ronay, Journal of the American Society of Naval Engineers, Vol. 64, May 1952, pp. 359-369.*

Spark Machining Hard Metals

For machining materials that are difficult by conventional methods, Sparcatron, Ltd., Gloucester, have developed equipment which applies continuous electric spark discharges. The workpiece and an electrode are immersed in a liquid dielectric, which flows so as to carry away the disintegrated particles resulting from the sparks produced by the discharge of a condenser. The workpiece is connected so as to have positive polarity and the electrode is negative. Thus, the maximum erosion of the workpiece and the minimum erosion of the tool take place. The energy absorbed during the discharge is derived from a charged condenser. The condenser prevents arc formation after the discharge, due to the decrease in voltage across it and, consequently, across the gap. The cycle of operations starts with the condenser charging when it is connected to a direct-current voltage source. Initially, this voltage, and the voltage across the spark gap, is zero, but it rises exponentially until it balances the supply voltage, which is sufficient to break down the dielectric medium slightly before the condenser is fully charged. The discharge is of an over-damped nature with a frequency dependent on the capacity and inductance associated with the discharging circuit. The electric discharge leads to the development of intense energy at the target point on the workpiece. The circuit is designed to prevent the formation of a stationary arc, which would cause uncontrolled melting of the workpiece locally. The energy of the spark and, therefore, the amount of material removed, are directly proportional to the condenser capacity and the square of the applied voltage. Increasing the condenser capacity, however, also has the effect of increasing the time for charging the condenser, which results in no further improvement in stock removal. The rate of discharge varies from 12,000 to 100,000 sparks per second. The rate of removal of metal from soft workpieces is only economical at present when complex shapes and small quantity production are involved. However, on hard and unmachinable materials the process is of immediate economic interest in all fields of use. The metallurgical condition of workpieces is not affected by the process, since, though the sparks reach a temperature of 12,000 deg. C., their duration is extremely short and no appreciable heating of the metal occurs. The surface finish is non-directional; it consists of a series of very small pits which, in many applications, may be advantageous, e.g. for retaining lubricant.—*Engineering, Vol. 174, 25th July 1952; pp. 121-122.*

Dangerous Cargoes

There exists a considerable literature on the subject of dangerous goods. For more than fifty years the Board of Trade has published a *Memorandum Relating To The Carriage Of Dangerous Goods And Explosives In Ships*, regularly revised and augmented, lately taken up by the Ministry of Transport under the heading *Instructions to Surveyors and Notice to Shipowners, Shipmasters and Shippers: Conditions of Stowage and Dangerous Goods in Ships.* The long awaited *Report of the Departmental Committee on the Carriage of Dangerous Goods and Explosives in Ships* has just been published by H.M.S.O. In the U.S.A. there has existed since 1907 a Bureau for the Safe Transportation of Explosives and other Dangerous Articles which, by its annual reports, regular inspections, laboratory work, and various publications, has greatly contributed to increase the knowledge of the subject and has formed the basis of the *Regulations prescribed by the Coast Guard.* In France, an official document is the *Règle-*

ment pour le Transport et la Manutention dans les Ports Maritimes des Matières Dangereuses (Explosibles, inflammables, toxiques, etc.) dated February 1951. The Suez Canal Company publishes regularly its *Rules of Navigation: Appendix for Ships Carrying Dangerous Materials* (latest edition 1950-1951). For Germany the Union of Hamburg Shipowners (Verein Hamburger Rheeder) published in 1933 a special *Guide* with an alphabetical list of dangerous articles based on the then official German Seafreight Regulations and Tariffs. Most probably, other seafaring nations are guided by similar official or semi-official documentation and, in any case, many port authorities, the world over, have issued lists and regulations on the subject. The daily practice of those who handle, transport, and insure commodities has taught them their risks and dangers and has naturally led towards a thorough study of adequate packing and appropriate stowage.—*J. Aeby, The Shipping World, Vol. 126, 4th June 1952; pp. 483-484.*

Corrosion Resistant Tank Coatings

Rapid corrosion of steel occurs in cargo tanks of Navy tankers when successive cargoes of gasoline are carried. The corrosion results from salt water ballast, hot salt water jets used for gas freezing and moisture in conjunction with gasoline. The nature of the structures is such that only air drying paints are practicable. Search for such coatings began at the Industrial Test Laboratory, Philadelphia Naval Shipyard, Philadelphia, about 1943. Certain coatings were applied to several ships in 1947. Service under operating conditions resulted in the selection of a vinylidene chloride-acrylonitrile copolymer as most promising. These coatings dry by solvent evaporation, and require clean metal surfaces and careful attention to good safety practices during application. When multiple coats are applied to a total thickness of about 0·008 inch, it is estimated that the coatings will be adequate for four years against the combined effect of sea water and refined petroleum products, or equivalent corrosive conditions. By touching up the coatings at intervals of four years, their life expectancy can be extended indefinitely. Since the coatings are air drying and somewhat cheaper than various heat cured materials now used to protect tank car interiors and various types of equipment, their application may possibly be extended to other shore installations.—*W. W. Cranmer, Corrosion, Vol. 8, June 1952; pp. 195-204.*

Spring Failures by Corrosion

Corrosion is a more common cause of spring breakage than is usually appreciated by the user. It is caused in most valve springs by condensation of the products of combustion. A little pit is formed, or there is hydrogen embrittlement from the oxidation of the steel. It is revealing to know how fast this breakage may be. Perfect springs have been made to fail in three to six hours in an overcooled motor, or in one that was started and stopped before it could run long enough to scavenge the crankcase. The usual methods to overcome this trouble are (a) to protect the surface of the springs from corrosion; (b) to use stainless steel for the springs; or (c) remove the cause of corrosion. In any event, failure by corrosion is difficult to detect because the little pit or fleck of rust is not easily seen. An unbelievably small amount of corrosion on a spring in active use, as a valve spring, can do the damage, leaving a break that is somewhat like a regular fatigue fracture. When corrosion is likely to occur, every effort should be made to stop it, as failure is certain in highly stressed springs in rapid use. Under static conditions it is not necessarily so. Springs have rusted out as much as three-quarters of the wire diameter (with, of course, gradual load loss) without actually breaking as long as they were not called upon to move. Vibrating springs which depend on shot-peening to supply them with the additional endurance necessary will fail if this peening is improperly done or the stressed surface removed by corrosion. The fracture will be that of a typical fatigue failure.—*F. P. Zimmerli, Metal Progress, Vol. 62, July 1952; pp. 84-88.*

Sprayed Aluminium Coatings

Sprayed aluminium gives cathodic protection to steel and produces compact stifling corrosion products in the same way as zinc. The aluminium may be used either as wire or powder, and practical experience has suggested that the latter can give as good protection as the former. A recent development is the use of duplex zinc/aluminium coatings; the outer aluminium coating is in many cases less quickly corroded than zinc and hence lasts longer, while the undercoat of zinc takes care of any trouble that might arise at pores in the aluminium in the early stages of exposure, due to the slower breakdown of the oxide film. An extended research programme on layered, mixed and alloyed aluminium-zinc sprayed coatings, involving the atmospheric exposure testing of nearly 1,500 specimens at Cambridge, London, Greenford, the East Coast and Kure Beach, North Carolina, is now under way. For the highest mechanical properties, increased consolidation can be obtained by a short heat treatment somewhat above the melting point of aluminium. —*T. P. Hoar, Metal Spraying, Vol. 5, May 1952; pp. 171-174. Abstracted in Light Metals Bulletin, Vol. 14, 20th June 1952; p. 520.*

Corrosive Resistance of Titanium

Titanium possesses an anomalous set of corrosion characteristics. It is an inherently reactive metal. Yet one of its major uses will be established by its ability to resist corrosion. As a self-protecting metal, titanium is best known for its indifference to sea water. In this respect, it has no peer among common engineering materials. It has been subjected at Naval test stations to the corrosive action of sea water for extended periods under all conditions of exposures, with no observable attack. Specimens exposed for three years to salt atmospheres 80 feet from the breakers retained their original lustre. This property naturally suggests many marine applications. To mention but a few, there are lightweight piping systems handling salt water, condenser tubes operating with high water velocities, plumbing fixtures, and pump rods and rotor shafts. Relative economies will determine how many of the large-tonnage structural marine applications titanium can win for itself from stainless steel, cupro-nickel, Monel metal, Hastelloy "C", and other alloys. But, the opportunity for large-scale marine use of titanium is there. The incentive to titanium metallurgists is great.—*Westinghouse Engineer, Vol. 12, July 1952; pp. 114-117.*

Basic Engineering Standards

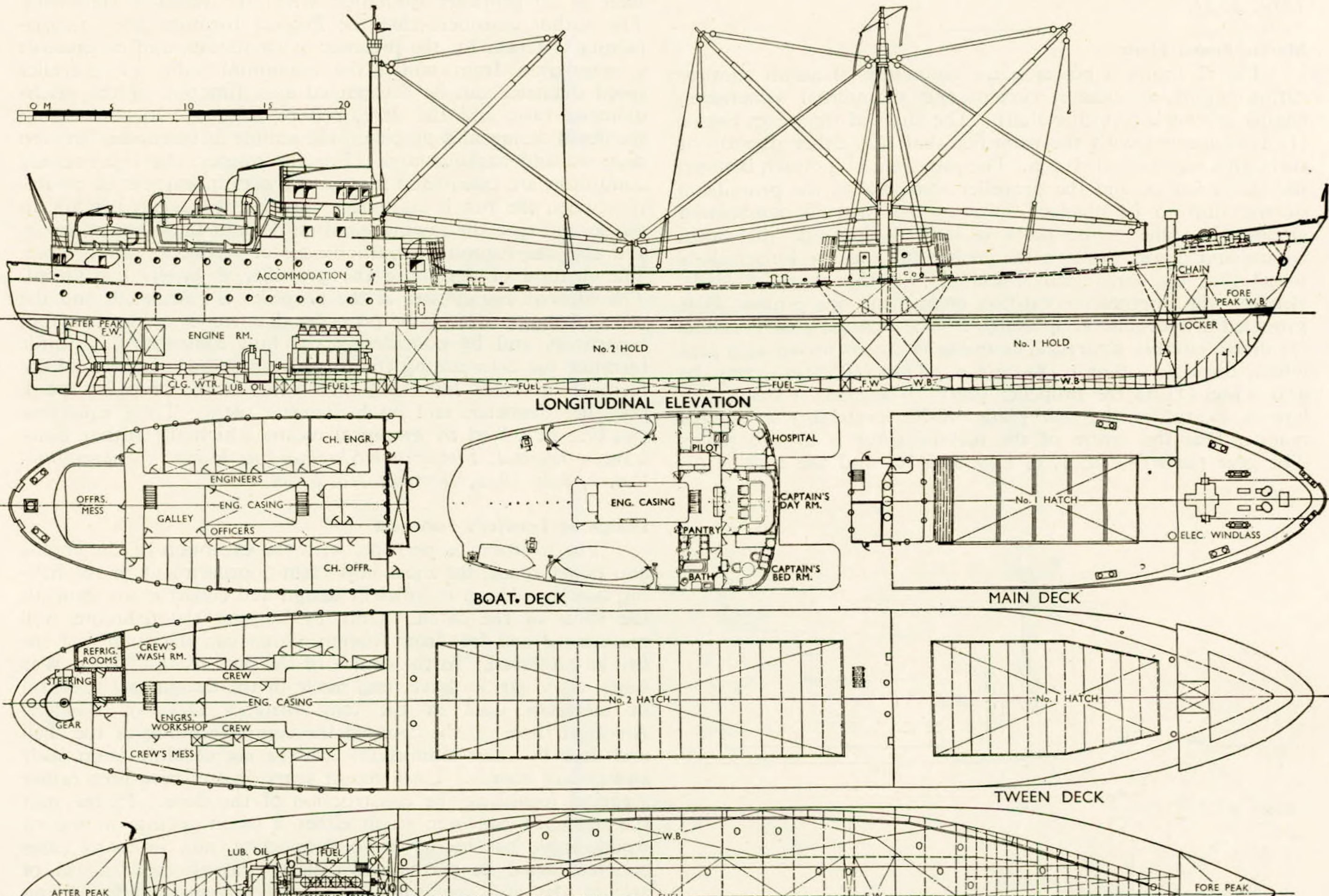
In this paper standardization in design is considered. The argument is developed that the detailed design of the parts of a mechanism demands a logical approach. The designer should state on the drawing, in the simplest possible terms, what he really wants. The necessary range of basic (or abstract) engineering standards, both for him to achieve this aim and to provide for economic production, are given. The basic standards cover definitions, geometric analysis, ultimate standards of size, basic sizes, limits and fits, measurement, surface texture, drawing practice, standard forms (for example, screw threads), and standards of design. Their nature and scope are examined in general terms and some of the main compromises necessary are discussed. The necessity is shown for a sound framework, wide enough to cover the normal needs of all engineers. The dangers of a parochial outlook are stressed and the needs of both small and large producers are emphasized. These standards are shown to be the essential preliminary to sound standardization of articles, which should be a natural by-product of sound design. Their main economic value, however, is that they affect every article which the engineer designs. At the present time there is only a partial framework and much disagreement on details. To standardize articles before agreement has been reached on the approach to detailed design of the articles, leads to difficulties in standardization and sometimes to bad standards. Several good solutions can be propounded for most problems, and many different ones are in local use. A single, wide, and all-embracing plan which can be used by everyone is needed. Education and explanation can then lead to general use, to the lasting advantage of the engineering industry.—*Paper by Captain G. C. Adams, R.N.(ret.), read at a meeting of the Institution of Mechanical Engineers, 14th March 1952.*

First Vessel with "Active" Rudder

The Nobiskrug shipyard at Rendsburg has recently completed the motor cargo vessel *Irmgard Pleuger* to the order of Pleuger and Company, Hamburg. This ship is in many respects one of the most interesting built in Germany since the war. She is the first cargo vessel to be equipped with the "active" rudder developed by her owners. The *Irmgard Pleuger* has the following main characteristics:—

Length overall	276ft. $4\frac{7}{8}$in.
Length b.p.	252ft. $5\frac{1}{2}$in.
Breadth	37ft. $8\frac{3}{4}$in.
Loaded draught	16ft. $0\frac{1}{16}$in.
Corresponding d.w. capacity...	2,360 tons
Gross register	1,834 tons
Net register	1,088 tons

Two four stroke, six cylinder 750 b.h.p. M.A.K. engines are installed, driving a single five bladed propeller through gearing and a Vulcan coupling. The engines have a cylinder diameter of 385 mm. and a stroke of 580 mm., the speed being 300 r.p.m. and the corresponding revolutions of the screw 105 r.p.m. A five bladed propeller was chosen instead of the normal propeller planned originally for another installation running at a higher speed. All the auxiliary machinery in the engine-room and on deck is electrically driven, current being supplied by three M.W.M. Diesel engines, each geared to a dynamo. The output of these three machines is 167 b.h.p., 125 b.h.p. and 64 b.h.p. respectively. The corresponding voltages are 120, 80 and 40, the electrical output for the three machines being 216 amps., 145 amps. and 47·7 amps. The active rudder incorporates a 125 b.h.p. waterproof A.C. motor and consists of a streamlined body with a tractor or pusher screw. On trials, a speed of 12·6 knots was attained with both the main screw and the active rudder running at full speed. With the two main engines stopped, the ship being driven entirely by the active rudder propeller, a speed of 3·5 knots at 880 r.p.m. was achieved. The speed of the active rudder in normal service, working together with the main screw at full speed, is about 1,000 r.p.m. In normal conditions, however, when no special manœuvres are expected, the active rudder is not used. The "wet" motor is switched off and the rudder is used in the ordinary way. At full speed the vessel was able, with the aid of the active rudder, to turn round in a circle having a diameter of about $2\frac{1}{4}$ times the ship's length. When the main engines were stopped, the *Irmgard Pleuger* could, by means of the active rudder motor working at full speed, practically turn round on its own axis. Two 8,000 ton vessels on order will be equipped with similar



General arrangement plans of the motor cargo vessel Irmgard Pleuger rudders. The "wet" motors to be installed will be of 250 b.h.p.-300 b.h.p.—*The Motor Ship, Vol. 33, September 1952; pp. 238-239.*

Steering Gear for Trawler

The factory trawler *Fairfree II* now building by John Lewis and Company, Aberdeen, for Chr. Salvesen and Company, Leith, is being especially constructed for fish processing and deep freezing, and is the outcome of experiments carried out on the *Fairfree*, a converted minesweeper. The new vessel is designed to take 600 tons of frozen fillets or 450 tons of frozen whole fish. She is a single-screw oil engined vessel fishing through a stern chute after the manner of a whale factory. The steering gear is important in this ship, in view of the way in which trawling is to be carried out. Supplied by John Hastie and Company, Greenock, it is of the electric hydraulic type. The gear is capable of moving from hard-over to hard-over through an angle of 70 deg. in 30 seconds, when the vessel is proceeding ahead at full speed, which is essential in a fishing vessel which fishes over the stern. The gear consists of two rams working in two hydraulic cylinders arranged athwartships, the cylinders surmounted by two pumps and electric motors. Each pump is independently driven by an 8 h.p. motor and each pump can move the rudder, but when both pumps are working simultaneously, the rudder can be put over from hard-over to hard-over in approximately 18 seconds.—*Shipbuilding and Shipping Record, Vol. 80, 3rd July 1952; p. 21.*

Marine Power Plant

Fig. 2 shows a power plant consisting of steam reciprocating engine, an exhaust turbine and an internal combustion engine driving a propeller shaft. The shaft of the steam engine (1) is connected with the propeller shaft (2) either directly or through a mechanical clutch. The provision of a clutch between the steam engine and the propeller shaft allows the propulsion of the ship to be changed over to the internal combustion engine (3) alone. The latter is located alongside the steam engine and drives through the pinion (4) and the intermediate wheel (4a) the large gear wheel (5) on the propeller shaft. Between the internal combustion engine and the pinion (4) is provided a hydraulic coupling (6). The exhaust steam turbine (7) drives another hydraulic coupling (9), constructed as a gear wheel, through a pinion (8), and a pinion (10) also drives the gear wheel (5) on the propeller shaft. The exhaust steam turbine is located in the gear plane (X-X), preferably in such a manner that the centre of the turbine rotor is in this plane. The gear parts (4, 4a, 5, 6, 8, 9 and 10) and the turbine (7)

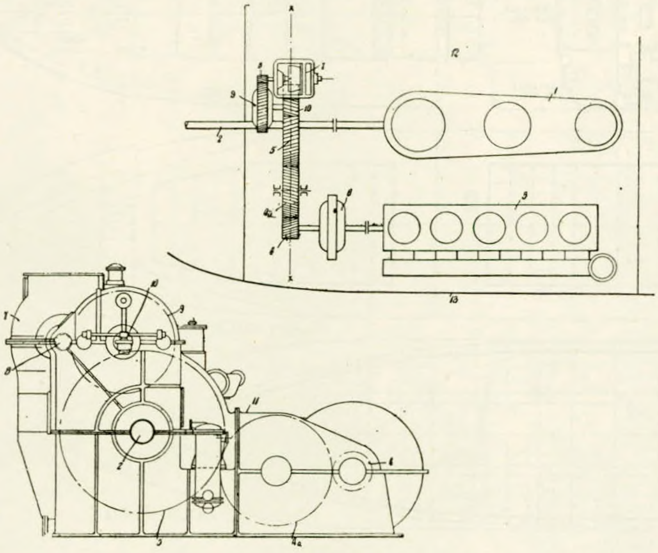


FIG. 2

are so mounted in the casing (11) that the two hydraulic couplings (6 and 9) lie on the two sides of, and the turbine (7) in, the gear plane (X-X).—*Patentees: Aktien-Gesellschaft Weser, Bremen. British Patent No. 673,789. World Shipbuilding, Vol. 2, August 1952; pp. 108-109.*

Propeller Design for Tugs

This is an abstract of a paper by M. Albiach presented at the IVe Congrès International de la Mer held at Ostend in July 1951. The formulæ due to Froude, which were established for free-running conditions, are not considered suitable for designing the propeller of a tug, which, when towing, is practically stationary. The author suggests that the use of the constants given by the theory of similarity will enable the characteristics of a propeller working under these conditions to be determined with an accuracy within some 3 per cent. The author employs two coefficients, the one a function of the shaft horsepower, the propeller revolutions, and the diameter, and the other a function of propeller thrust, revolutions, and diameter. It is found that these two coefficients remain constant for a given propeller working in conjunction with a typical form of tug over a wide range of propeller speeds if the conditions for dynamic similarity are satisfied. The author presents a nomogram connecting these two coefficients with the developed blade area and the pitch-diameter ratio. The results predicted by this nomogram are compared with the results of trials, and good agreement is found. Care must be taken that there is no propeller cavitation when the vessel is stationary. The author considers that the Poincet formula gives a satisfactory criterion for the presence of cavitation, and he presents a nomogram from which the maximum value of propeller speed diameter can be determined as a function of the pitch-diameter ratio and the developed blade area. In considering the detail design of a propeller, the author distinguishes between deep-sea and harbour tugs. For the former, the free-running conditions are considered first, and a certain amount of cavitation when the tug is stationary (towing) is accepted, while in the second case the towing conditions form the main criterion, and the free-running conditions are of secondary importance. The method of designing the propeller is briefly considered. The effective horsepower at the propeller is calculated, and the order of magnitude of the propeller diameter is arrived at from experience, and by considering the hull dimensions. Simple formulæ for determining the thrust and speed are given in the form of equations involving such terms as the propeller speed, propeller diameter, and pitch-diameter ratio. These equations can best be solved by graphical means which the author illustrates.—*Journal, The British Shipbuilding Research Association, Vol. 7, July 1952; Abstract No. 6,269.*

Design of Trawler's Fishroom

The fishroom is perhaps, with the exception of the engine and boiler space, the most important compartment in the fishing trawler. Upon its efficient design and construction depends the value of the catch. Only by keeping the fishroom well maintained and free from foreign matter can the quality of the fish be preserved. In the course of the post second World War years, rapid strides have been made in the design and selection of materials used in the long distance class of trawlers. Amongst these can be counted the complete lining of the shell and deck by sheet aluminium and the use of aluminium shelf and pound boards. Until recent years owners have been rather sceptical regarding the construction of the floor. In the past the tendency has been to fit either a wood ceiling on top of wood, angle bar beams or solid concrete, and in many cases concrete acted as permanent ballast, making the renewal of any of the hull structure for repairs extremely difficult and expensive. Wood was also considered disadvantageous because it is being constantly saturated by melted ice and fish slime. As time passed the progressive owner came to realize that these methods were a waste of valuable space, and that if the bilges were utilized as carrying space, the length of the vessel could be reduced or the capacity of the fishroom increased. Thus, in modern vessels, double bottom tanks for the storage of either fuel oil, fresh water or boiler feed water have been constructed. It will be realized that the tank contents also provide the necessary ballasting. It is common practice to spend the contents of these tanks on the vessel's outward passage to the fishing grounds before drawing on the main supply tanks, thus ensuring that the vessel's trim is not materially affected, as, by the time the tanks have been emptied fishing operations will have commenced, and the catch stowed in the fishroom, replacing the spent weight.—*A. Brammall, World Fishing, Vol. 1, July 1952; pp. 111-115.*

Electro-magnetic Couplings

The m.s. *Surrey,* which has been built by Alexander Stephen and Sons, Ltd., for the New Zealand Shipping Company, is an 8,400 ton, single screw ship equipped with two nine cylinder Sulzer engines, each developing 4,500 b.h.p. at 225 r.p.m. They drive the single propeller shaft through the medium of a B.T.-H. twin-pinion gearbox which, having a reduction ratio of 2·23 to 1, gives a propeller speed of 100 r.p.m. at full power. The engines are connected to their respective pinions through B.T.-H. electro-magnetic couplings which give a small slip between the driving and driven portions so that the actual pinion speed at nominal full power is about 223 r.p.m. The primary purpose of the electro-magnetic couplings follows from their inherent elastic and damping properties. This characteristic reduces the magnitude of the torsional oscillations transmitted from the engines to the gears to such a value that tooth separation does not occur and the risk of damaging the gears is substantially reduced. A secondary, but valuable, feature of the couplings is the improvement which they give to the ease of operating the engines. By running one engine in the ahead direction and the other astern, the screw can be turned in the required direction simply by energizing the appropriate coupling. Using this method, power can either be applied to or removed from the screw more quickly than by the normal method. There is also the added advantage that less starting air is used, which is a feature in itself, and the adverse effects on the engine cylinders due to repeated influxes of cold air are greatly reduced. If one engine is already running, no starting air at all will be required if the second is to be run up in the same direction, since this may be done simply by energizing the two couplings. If both engines are running ahead, and it is required to go astern, the couplings are de-energized and the engines stopped, following which they may be started in the astern direction under no-load and the power applied to the screw by reapplying the excitation current to the couplings. The general arrangement of the electro-magnetic couplings is shown in Fig. 4. The turning gear is a triple-reduction unit giving the propeller shaft one-fifth r.p.m. Power is supplied by a 3 h.p., 750 r.p.m. motor and the gears provide a reduction of 1,800/1 through a 50/1 worm gear and a 36/1 double-reduction spur gear. Concentric with the third reduction gear wheel is a sliding dog clutch which, under the control of a handwheel, engages a similar clutch located on the end of the port pinion shaft. The operating handwheel is interlocked to prevent the main engines from being started with the clutch engaged, also to prevent the turning gear motor from being started with the handwheel locked in the "out" position. The overall efficiency of the complete coupling and gearbox installation is of the order of 96·5 per cent.—*The Motor Ship, Vol. 33, September 1952; pp. 220-223.*

Stress Finder for Ship's Loading

A stress finder, the purpose of which is to compute in advance the effects of loading a ship to any proposed plan, has

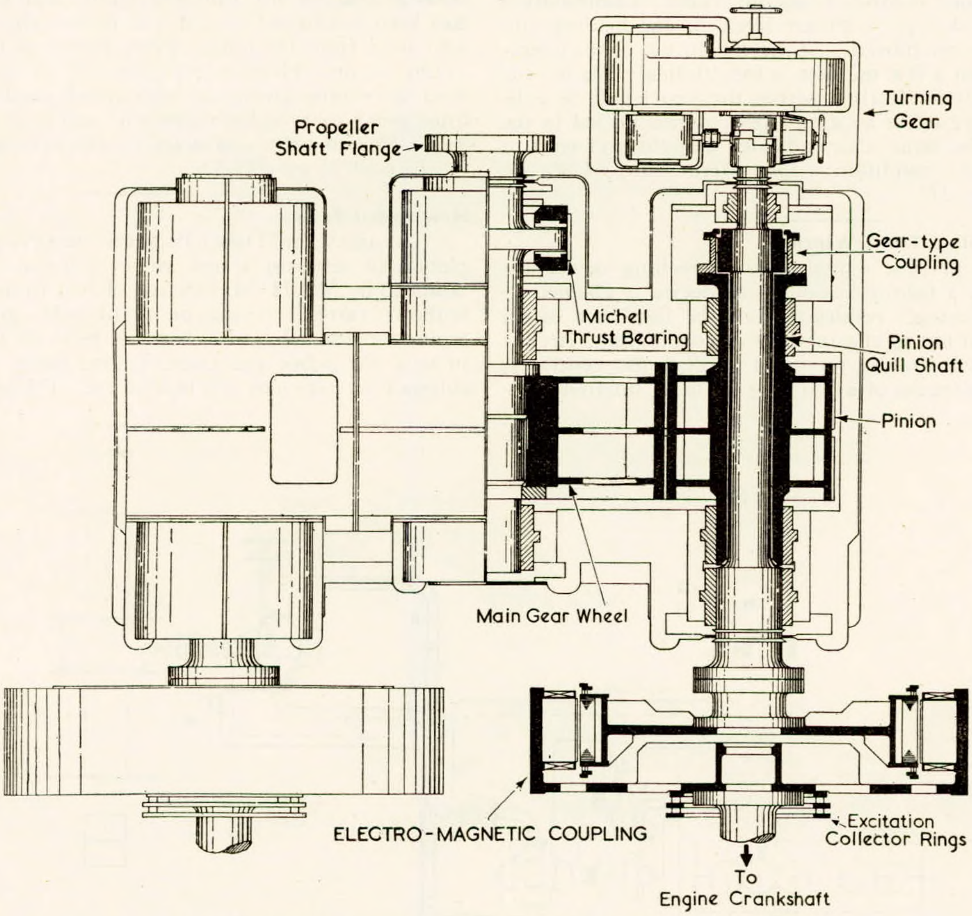
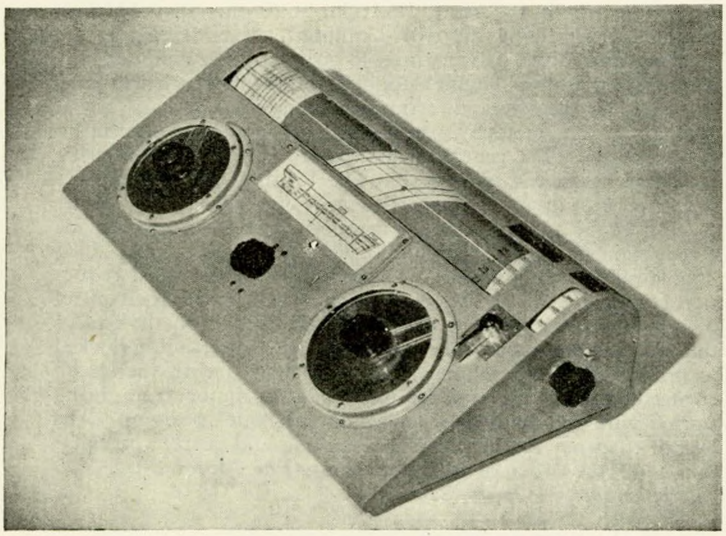


FIG. 4—*Arrangement of electro-magnetic couplings and gearbox*

been placed on the market by Kelvin and Hughes (Marine), Ltd., London. It is a manually operated device and entails no mathematical aptitude on the part of the operator beyond that required for elementary problems of addition and subtraction. Details of the proposed loading plan are fed into the instrument by means of two pointers and circular scales, one each for the cargo spaces forward and aft of amidships. A deadweight scale,



The Kelvin stress finder

operated by a separate control, is also provided. Computation is automatic and takes place progressively as the loading and deadweight controls are moved. At the conclusion of the operation, which takes but a few minutes, a longitudinal scale is consulted. This indicates clearly whether the vessel will be subjected to undue hogging or sagging stresses when loaded to the proposed plan. The same scale indicates draught and trim in the proposed loaded condition.—*The Motor Ship, Vol. 33, September 1952; p. 237.*

Hydraulically Controlled Trawl Winch

The patentees propose a hydraulic controlling device for the trawl winch in a fishing vessel. The device is claimed to supply all the advantages resulting from the flexibility of an electric transmission but to eliminate its disadvantages. It consists (Fig. 3) of a hydraulic pump (1), called the generator, which is coupled by means of a coupling (3) to an internal combustion engine (2). This internal combustion engine can also operate a dynamo. The generator, of constant volumetric capacity, is provided with a bypass (4) which limits the torque, and allows the short circuiting of the operating liquid and the stopping of the hydraulic motor by remote control. A hydraulic motor (5), of variable volumetric capacity, is connected with the generator by means of two pipes (6 and 7) in which flows a non-freezing liquid, such as oil, under a pressure of 25 kg. per sq. cm. or more. This motor drives the trawl winch (9) through a flexible coupling (9a). Alternatively, the generator may have a variable volumetric capacity and the motor a constant volumetric capacity. The generator and motor have pistons which reciprocate radially in a rotating cylinder block. Different speeds of the motor (5) are obtained by changing the stroke of the pistons; this is controlled, in the vicinity of the winch, by a control wheel (8). The circuit of the propelling liquid is of the closed type, and there is no tank between the outlet of the motor and the suction of the generator.—*Patentees: S.A. des Anciens Chantiers Dubigeon and P. A. Guinard, Saint Cloud. British Patent No. 674,123. World Shipbuilding, Vol. 2, August 1952; p. 108.*

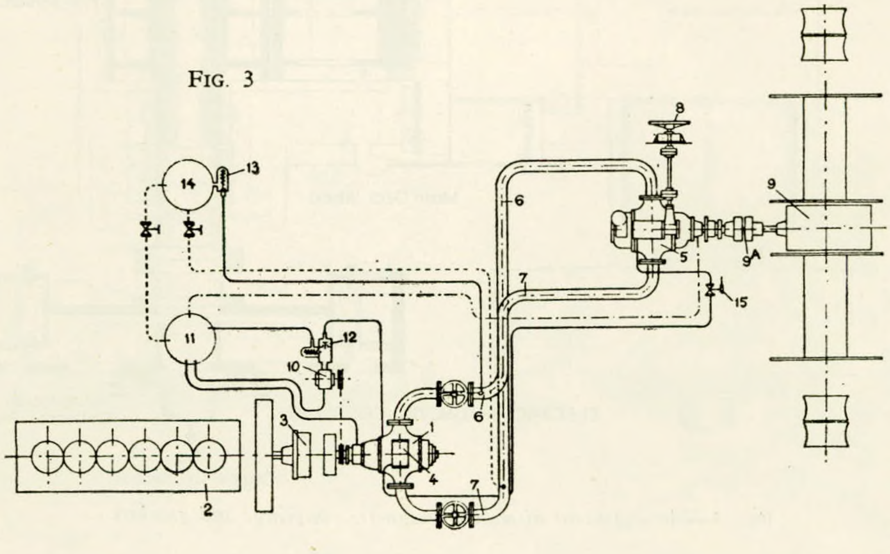
Vanes Singing in Water

In the course of propulsion experiments in the ring channel and rotating boom facility at the Aerojet Engineering Corporation, it was discovered that certain struts which are used to support underwater bodies would "sing" at surprisingly low speeds, e.g., 5 to 7 knots. Tail surfaces also sang. The note emitted was a clear musical tone in most instances, and, as the speed was increased, the note would fade, disappear, and then reappear as a note of higher frequency. This singing caused considerable apprehension as it was feared that the strut would fail at high speeds due to build-up of the vibrations. Analysis for flutter stability and torsional divergence had been conducted, and it was known that the operation was well away from the ranges where flutter or torsional divergence might occur. However, the severity of the singing did not tend to become greater at high speeds, and there were usually quiet speed zones at high speeds as well as at low speeds.—*Paper by C. H. Gongwer, abstracted in Mechanical Engineering, Vol. 74, July 1952; pp. 593-594.*

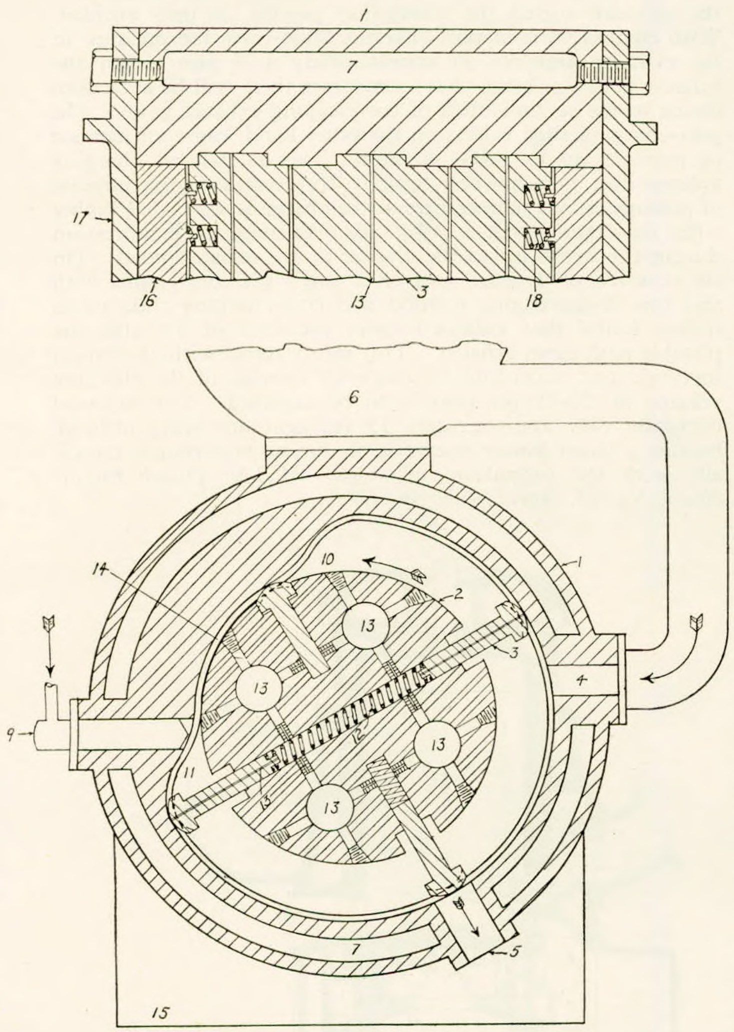
New Radial Engine

An article in "Diesel Progress" reports the successful completion of tests on a new rotary internal combustion engine, designed by Mr. H. M. Petersen of San Francisco. This engine, without valves, pistons or crankshaft, and with only five moving parts subject to heat, is believed to be revolutionary in both the petrol and Diesel engine fields. It is intended for automotive, stationary and marine use. The principle upon which

FIG. 3



the engine is based—using sliding vanes inside a housing—is not a new one; it has been and is still being used in oil pumps and compressors. Previous attempts, however, to use this principle in the design of a four-stroke cycle engine which provides its own suction have almost invariably been unsuccessful, as the compression which could be obtained was insufficient and there was not enough useful power. In such designs the rotor was placed eccentrically in the housing, and in most versions the vanes were moving during both expansion and compression. In the Petersen engine the rotor runs concentrically in the housing. This was made possible by the use of an attached or independent blower to introduce air, eliminating the necessity of creating its own suction. The significant feature of the design, however, according to its inventors, lies in the unique shape of the inner surface of the housing which forms the precompression and combustion chambers. Air introduced by the blower starts to compress when the vane enters the contour; at that point fuel is injected and the mixture is then forced, at high velocity, through the venturi-like channel between the rotor and the housing. When the vane leaves the contour



Sections through the new Petersen Diesel engine

1–Housing. 2–Rotor. 3–Sliding vanes. 4—Scavenging ports. 5—Exhaust. 6—Scavenging blower. 7—Cooling water jacket. 9—Fuel injector. 10—Precombustion chamber. 11—Combustion chamber. 12—Vane actuating springs. 13—Lubrication system. 14—Venturi channels. 15—Base. 16—Compression sealing pieces. 17—End plates. 18—Compression seal springs.

and presents its full area, ignition occurs, driving the rotor in the desired direction. When ignition takes place, the following vane is almost wholly within the rotor, presenting very little area for back pressure. It stays in that position almost to the end of expansion and the beginning of exhaust. Four power impulses occur at each revolution of the rotor, and for practical purposes, therefore, the engine should be considered as a two-stroke cycle, four-cylinder engine. A test engine has been run for 1,500 hours and there has been no perceptible wear. The lubricating system is self contained and lubricates both vanes and housing and cools the rotor by means of drilled oil passages; the housing is cooled by water. The overall dimensions of the engine, which develops 170 h.p., are: length 28½in.; height 25in.; width 20½in. The weight averages about 3·2lb. per h.p. The experimental engine, with 7·5 to 1 compression ratio, was designed to run on petrol, but tests showed that it would run on kerosene and light Diesel fuel due to its unusual precompression and combustion chambers. The Diesel version, however, while it has the same general contour, has a very close clearance between the rotor and contour, and the venturi-channels are machined into the housing. The blade construction, therefore, in the Diesel is different and the sealing effect against the end covers is done by separate sealing pieces, as shown. This design permits a compression ratio of about 14 to 1, and in the Diesel engine fuel is injected directly into the combustion chamber.—*Gas and Oil Power, Vol. 47, August 1952; pp. 184-185.*

Injection Characteristics and Diesel Knock

Diesel knock arises from vibrations set up in the engine structure by varying stresses resulting from the changing cylinder pressure during the combustion phase of the cycle. An elementary study of the response of an elastically supported mass to a varying applied force illustrates the connexion between the form of the cylinder-pressure/time relation and the excitation of vibrations in the engine. The dependence of the form of this relation upon fuel properties and injection characteristic is discussed with particular reference to pilot injection systems. Experiments with such systems are described and illustrated by some records of engine vibration and cylinder pressure diagrams. Preliminary quantitative data as to the effect of quantity and timing of the pilot charge on the cylinder pressure diagram are reported. The influence of these factors on ignition delay and maximum rate of increase of cylinder pressure is examined. Under the prevailing experimental conditions, the latter is seen to decrease as the quantity of pilot charge is increased and evidence that this phenomenon is primarily responsible for the reduction of Diesel knock is adduced.—*Paper by A. J. Davies, submitted to the Institution of Mechanical Engineers for written discussion, 1952.*

Turbo-charged Doxford Engine

Some two years ago William Doxford and Sons, Ltd., began to investigate the possibilities of increasing the power of their large two-stroke opposed-piston engines in view of the higher powers being required for the propulsion of single-screw tankers and cargo liners. It was known that the power of four-stroke engines had been increased by some 50 per cent, with brake mean effective pressures of 120lb. per sq. in. on large engines, over a considerable number of years, and that, since the war, the power obtained by turbo charging has been nearly double that of the unsupercharged engine. As a preliminary step Doxfords undertook tests on a three-cylinder engine with a cylinder bore of 600 mm. and a combined stroke of 2,320 mm., to determine the energy in the exhaust impulses available for driving a turbine without undue back pressure, and to ascertain the conditions of air pressure and temperature at the air ports to give the increased flow of air required for turbo-charging. As a result of these investigations and a thorough calculation of the conditions, it was decided to construct a three-cylinder engine with a 600-mm. cylinder bore and a combined stroke of 2,000 mm. and aim at supercharging so that the output is 50 per cent more than the normal rating. This turbocharged engine was started up in March last and already the designed power of 50 per cent more than the normal rating has been obtained with a low fuel consumption and perfectly clear exhaust. While this engine was initially built with the Doxford common-rail injection system, it has recently been converted to their new hydraulic accumulator injection system in order to give it a thorough trial during the turbo-charging experimental work and reliability trials. The turbo-charger takes its air from outside the engine room and delivers it through an intercooler into a large rectangular receiver mounted on the back of the engine from which the engine driven pump is supplied with air. During the preliminary tests of the engine, three arrangements were tried with the turbo-blower: (1) in parallel with the reciprocating blower (2) in series with it, or (3) with the turbo-blower only supplying the air and without any reciprocating blower. The fuel consumption of the engine at full load with the series arrangement was ·34lb. per b.h.p.-hour, and at 100 m.i.p. corresponding to 80 per cent power, it was ·325lb. per b.h.p.-hour. The consumption on an indicated h.p. basis is still higher than that of the normal engine, but it is anticipated that further development will bring about a reduction in this and, therefore, in the fuel consumption on a brake h.p. basis.—*The Motor Ship, Vol. 33, August 1952; pp. 188-189.*

Improved Scavenging System

In Fig. 3 is shown the M.A.N. reverse scavenging system, while the new T-scavenging system developed by this firm is shown in Fig. 4. In the new design the outer scavenging ports are getting larger during the gradual transition of the port heights, the outermost ports being rather directed slightly upwards. In connexion with this dislocation or shifting of the centre of gravity of the scavenging air current to the outer ports, the cross section of the exhaust ports is being increased towards the centre. The formation of a swirl not caught hold of by the scavenging process is thus avoided. The new arrangement of the ports, together with an investigation of the influence of the exhaust process on the scavenging process, offered the possibility to increase considerably the scavenging cross section compared with the cross sections up to now, and so to save scavenging air by reduction of pressure. The disadvantage inherent to the symmetric arrangement of the ports, of course, was not eliminated by this arrangement. The result of the forced development of the opening of the ports is that after termination of the scavenging process the cylinder is connected with the exhaust pipe till the exhaust ports are closed. The overpressure caused in the cylinder during scavenging is thus lost, the charging volume of this piston travel is pushed out by the piston. Now the cylinder is filled with air to such an extent that its pressure exceeds that of the outside air only slightly. M.A.N. have used a rotating slide valve during the development of special type engines, arranged in the exhaust socket of each cylinder, closing the exhaust towards the end of the scavenging process, so avoiding the escape of charging air. The slide valve bodies are as near the cylinder as possible; they have sufficient clearance with the slide face, so that touching the rotating part during operation is impossible. The seating of the slide valve shafts is such that ample space is available for longitudinal expansion. Drive is by roller chains off the camshaft. The slide valve rotates with the same speed as the crankshaft and is so adjusted that it closes the exhaust channel, when closing the scavenging ports through the main piston or also shortly before. Escape of the fresh air, introduced into the cylinder during the scavenging process, is thus avoided. With engines without post-charging slide-valve the pressure in the cylinder amounts to approximately 1·09 atm. when the exhaust ports are being shut; sometimes there will be a vacuum owing to the suction effect of the escaping exhaust gases. The post-charging slide valves, on the other hand, cause an increase of pressure up to 1·35-1·40 atm. The increase of charging volume does not, however, exactly correspond to the increase of pressure, as the temperature of the charge is somewhat higher when the exhaust port is being closed through the compression during the stroke up to the closing of the exhaust ports. On the occasion of detailed tests on a single cylinder engine with this new T-scavenging method and post-charging slide valve, it was found that indicated mean pressures of 8·5 atm. are possible with clean exhaust. This result agrees with theoretical investigations, according to which an increase of the charging volume by 22-25 per cent is to be expected. For practical operation only approximately 15 per cent are being utilized, because a larger power reserve is of utmost importance, especially with the propulsion of ships.—*M.A.N. Diesel Engine News, No. 25, April 1952; pp. 4-5.*

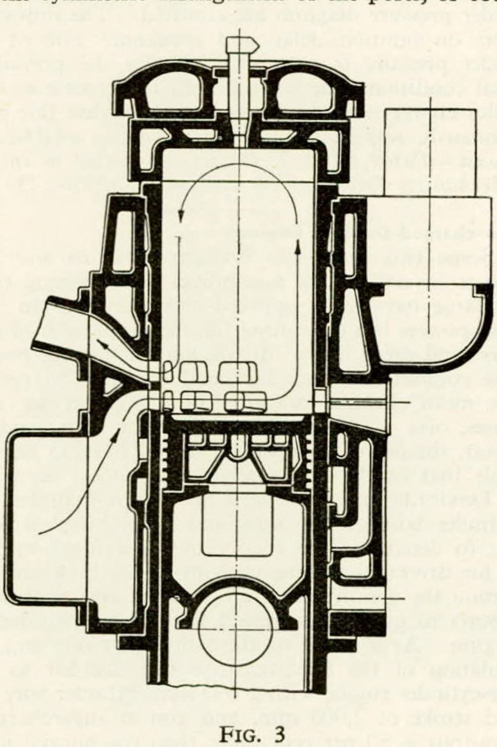


FIG. 3

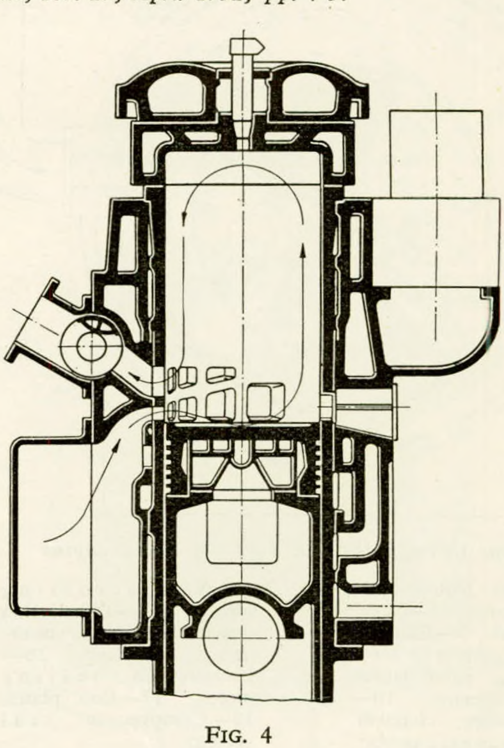


FIG. 4

Two-stroke Marine Diesel Engine

The Modag marine Diesel engine shown in sectional elevation in Fig. 5 is a two-stroke design having 225 mm. cylinder diameter and 330 mm. stroke. Output per cylinder is 70 e.h.p. at 500 r.p.m. and 80 e.h.p. at 600 r.p.m., the engine being built with three, four, five or six cylinders. Scavenging air is supplied by two Roots blowers. The fuel sprayers are designed for an opening pressure of 220 kg. per sq. cm. g. and the nozzles are provided with six holes of 0·3 mm. bore. The optimum fuel rate is achieved at 80 per cent full load and 4 kg.

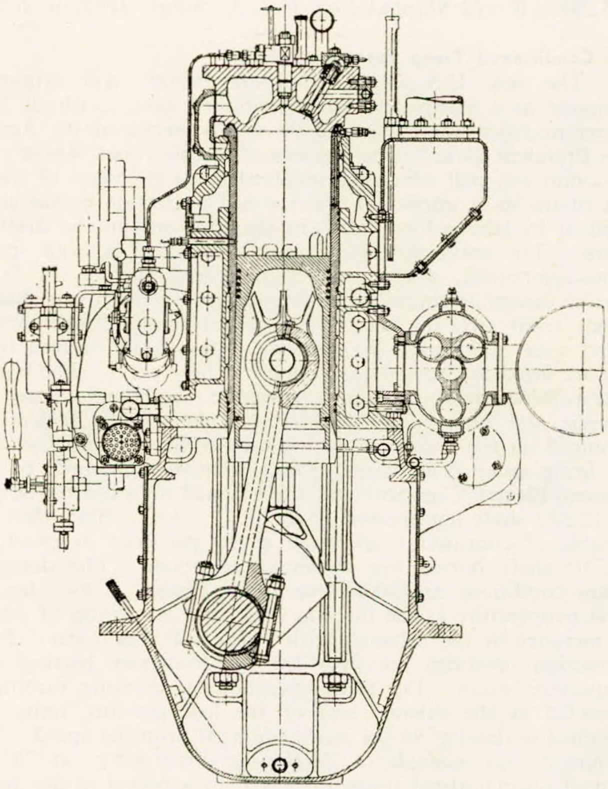


FIG. 5

per sq. cm. m.e.p. and even at 50 per cent full load the specific fuel consumption does not exceed 179 grams per e.h.p. hour. The temperature of the exhaust gases at full load and normal engine speed is 270 deg. C. Scavenging air pressure at rated load is 0·17 kg. per sq. cm. g. At full load and 500 r.p.m. the m.e.p. is 4·8 kg. per sq. cm. and at 10 per cent overload it is 5·3 kg. per sq. cm. The engine is equipped with aluminium pistons.—*H. Müller, M.T.Z., Vol. 13, July 1952; pp. 166-171.*

Electrical Pretreatment of Water

Electrical pretreatment of hard water, before it reaches the point of usage, is a scale preventing process for boilers, pipes, condensers, etc. Electrical pretreatment of hard water neither accelerates nor retards corrosion. It must be remembered, however, that as this treatment will keep boiler plates free from scale, these plates will naturally be more vulnerable to any corrosive properties that the water naturally has than would be the case if they were coated with scale, so that a little more care is sometimes necessary in watching the *p*H value of the water in steam raising boilers. The scale forming salts in solution in hard water consist principally of the bicarbonates of calcium and magnesium and sulphate of calcium, the former two being sometimes spoken of as temporary hardness, and the latter as permanent. As these salts are precipitated from solution, they first appear as small individual crystals. When the water has not been treated, more or less of these, depending upon the conditions of precipitation, bond together on the heating surface and form the well known scale, but if the water has been treated they remain as small crystals and do not become adhesive. In steam raising plant they form a sludge which can be disposed of by the normal process of blowdown, but where water is only heated they remain in suspension, pass through with the water and, for all practical purposes, are imperceptible. This effect is brought about by bringing as much as possible of the hard water into the intimate influence of the correct electrical force. In the apparatus under consideration, it is caused to pass through perforated monel metal plate called the electrode of the pipe unit. This electrode is electrically insulated from the outer casing of the pipe unit, and it is to this electrode that the positive lead from the control box is applied, the negative lead going to the outer casing. The electrode being electrically insulated from the outer casing, leaves only the water for the current to flow through, and as the electrode is the anode of the unit, and as all the water actually passes through this electrode, it is subjected to the influence of the anode potential.—*A. G. Freeborn, Transactions of the Institution of Engineers-in-Charge, Vol. 57, May 1952; pp. 155-166.*

Strengthening of T2 Hulls

In order to strengthen the hulls of American welded T2 tankers the American Bureau of Shipping requires that the section modulus must be increased 15 per cent above the original design figures. The 15 per cent was adopted arbitrarily; there is no way of arriving at the proper percentage mathematically; it is purely a matter of judgement. The American Bureau of Shipping does not state how this increase is to be accomplished; it is left to the owners to submit their individual proposals to the Bureau for approval. The American Bureau has indicated that the modulus for the upper and lower members should be increased respectively in about the same ratio as at present. The American Bureau of Shipping suggests that the increase be accomplished by adding either doublers, or keelsons and girders, or both. Other methods could be developed, but are not regarded as practical solutions. The Bureau's letter states that new plates for strengthening must be of special quality as per their latest Rules. These require fully-killed steel for plates over 1 inch thick and a suitable ratio of manganese to carbon for ½in. to 1in. thickness, irrespective of whether the plating is welded or riveted. It appears that special consideration may have to be given to this feature for the T2's, as the steel situation appears to be the major factor in the whole problem. The American Bureau of Shipping now requires a total of eight riveted crack arrestors. This includes the four straps with torch cuts previously required. They define an acceptable "crack arrestor" as a riveted doubler, or a girder connected to the shell or deck by riveting. The doubler must be of at least 30 sq. in. effective area of section, unless accompanied by a torch-cut slot. The previous double-riveted straps (four) with slot are, of course, accepted. The torch cut is not a requirement. In the writer's opinion a line of double riveting is not as effective as a crack arrestor as is a torch cut or a riveted seam. The four added crack arrestors required by the American Bureau to make up the total of eight have to be located two in the deck (one port, one starboard) and two in bottom shell (one port, one starboard). These must be located inboard of the wing bulkheads; i.e., in way of the centre tanks. In the new requirements the American Bureau gives no credit as arrestors to straps at the upper turn of bilge or at the sheer strake, which some T2's already have, nor to the riveting of the bilge keels. In the writer's opinion, as to riveted bilge strap versus riveted bilge keels, both are not needed but the strap would be preferable. Any riveted material added as arrestor-straps is, of course, entitled to be included as contributing to the 15 per cent increase in section modulus. The American Bureau of Shipping now requires the bilge keels to be double-riveted (instead of serrated welding) to the bilge strake of shell plating by means of a tee-bar or angle bar. They even suggest a riveted flat bar, with the bulb plate blade "in turn" welded to it. (This sequence is questionable.) They also suggest connecting the bulb plate to the tee by single-riveting, with which we concur since the riveted tee is a requirement. The American Bureau of Shipping recommends, but does not require, that at the welded butts of the tee bars copper strips be inserted to prevent the weld penetration from fusing into the underlying plate. (The strip is to be removed after welding.) The Bureau disclaims belief that such fusion is harmful but recommends avoiding it in order to facilitate possible repairs or renewals later on.—*R. W. Morrell, Marine Engineering and Shipping Review, Vol. 57, August 1952; pp. 72-76.*

Preventing Condensation

This invention is designed to prevent sweat and condensation in unrefrigerated compartments adjoining insulated and refrigerated cargo spaces. In these cases conditions exist where heat flows into the metal deck or bulkhead over the area of the unrefrigerated space; this heat is transmitted through the deck or bulkhead into the refrigerated spaces adjoining, and creates a temperature gradient in the metal varying according to the rate of heat transmission. This results in the temperature of the plate where it leaves refrigerated cargo spaces frequently being below the dew point of the atmosphere in the unfrigerated spaces, so that condensation results. Referring to Fig. 5,

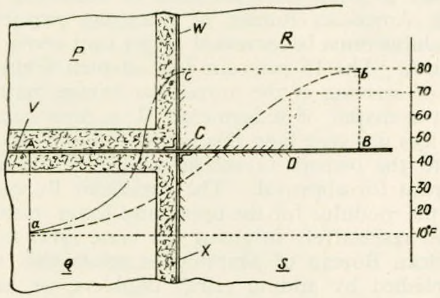


FIG. 5

P and Q denote insulated and refrigerated spaces above and below a steel deck V which extends into uninsulated and unrefrigerated spaces R and S. If the refrigerated spaces are at a temperature of 10 deg. F., and the uninsulated and unrefrigerated spaces are at 80 deg. F., a temperature curve a-b shows the typical variation in temperature along the deck V. At some point A within the refrigerated spaces the temperature of the deck approximates to the mean temperature of the refrigerated spaces, while at a point B in the unrefrigerated spaces the temperature of the deck approximates to that of these spaces. With a humidity of 70 per cent in the spaces R and S, the dew point of the atmosphere would be about 70 deg. F., and condensation would take place on that part of the

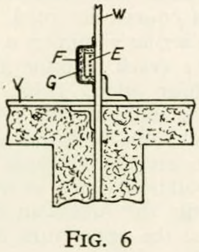


FIG. 6

deck which has a temperature below this level. Thus, the portion of the deck surface between C and D would be liable to condensation, since this area would have a surface temperature below 70 deg. F. The adjoining bulkheads W and X, which are metallically connected to the deck V, would have similar surface temperatures and would also be liable to condensation. By applying heat to the steel structure at a suitable position near the line of junction of deck and bulkhead denoted by C, the surface temperature in this position may be raised above the dew point temperature, resulting in a temperature gradient as represented by the curve a-c, thus ensuring that all metal surfaces within the spaces R and S are above the prevailing dew point temperature and that no condensation is possible. In the invention (Fig. 6) an electrical strip heater E encased in a metal sheath F is applied to the steel bulkhead to generate the required heat per foot run. This heater is preferably insulated as at G from the atmosphere of the unrefrigerated spaces, in order to prevent wasted heat raising the air temperature of the space.—*Patentees: I. M. Stewart, Sir David Allan Hay and D. D. Blackwood, Glasgow. British Patent No. 765,284. World Shipbuilding, Vol. 2, August 1952; p. 109.*

Air Conditioned Troop Transport Vessel

The new U.S. Navy transport *Barrett* was originally designed as a completely air conditioned vessel with de luxe accommodation for the round-the-world service of the American President Lines. The conversion of this vessel, whose construction was well advanced, involved many problems of which one of the most important was the full utilization by the shipyard of its labour force, both in the yard and in the drafting room. The main propelling unit consists of a high speed, cross-compound, double reduction geared turbine of latest marine design driving a single screw, supplied with superheated steam from two oil fired watertube sectional header boilers fitted with regenerative air heaters. Four stages of feed heating are fitted to provide an economical heat cycle. The boilers and turbine are located in a common machinery space, the turbine and gear being aft of the boilers. The boilers are arranged on the floor level facing each other giving a fore and aft firing aisle. The main turbines were manufactured by the General Electric Company and are designed for a normal output of 12,500 shaft horsepower at about 92 r.p.m. Also, they are capable of continuous operation at 10 per cent overload, or 13,750 shaft horsepower at about 95 r.p.m. The designed steam conditions are 600lb. per sq. in. gauge at 840 deg. F. total temperature at the throttle valve, and a vacuum of 28½in. of mercury at the exhaust, with 75 deg. F. sea water. Four extraction openings are provided for feedwater heating and evaporator steam. For stern operation, a reversing turbine is provided at the exhaust end of the low pressure unit, and designed to develop 80 per cent of normal propeller speed. The turbine is also capable of developing 5,000 s.h.p. at 70 per cent of normal ahead propeller speed for a period of one hour. The turbines are of the impulse type, the high pressure and low pressure units each having eight stages with single-row wheels throughout, while the astern unit consists of two stages with two and one row of blades, respectively. The steam flows aft through the high pressure turbine, forward through the low pressure turbine, and exhaust downward into a condenser placed athwartships, which is bolted directly to and supports the low pressure turbine. The turbine speeds are 6,608 and 3,213 r.p.m. for the high pressure and low pressure units respectively, corresponding to a propeller speed of 92 r.p.m. All steam to the main turbines passes through a steam strainer incorporated in a manœuvring-valve manifold. The reduction gear, also manufactured by the General Electric Company, is of the double reduction, double helical, articulated type, the high speed elements being arranged just forward of the low speed element, and all carried in a common housing. The gear consists of two high speed pinions which drive two intermediate gears, which in turn are connected by intermediate shafts through flexible couplings to the low speed pinions, which drive the low speed gear. With the unit developing 12,500 s.h.p. at 92 r.p.m., the "K" factors for the high and low speed pinions are approximately 76. The main thrust bearing is of the pivoted-segmental type, and is arranged in a housing on the forward end of the low speed gear casing. A motor driven turning gear is mounted on the after end of the high pressure, high speed pinion and is arranged to rotate the main shaft either ahead or astern, one revolution in about eight minutes.—*Marine Engineering and Shipping Review, Vol. 57, August 1952; pp. 48-71.*

Welded Ship Building

An article by E. W. Ansell in the journal "Welding" enumerates the advantages of welding over riveting, the chief of which is the saving in weight due firstly to the fact that a welded joint is stronger than a riveted joint so that the scantlings may be reduced, and secondly to the elimination of angle connexions, riveted overlaps, etc. Other advantages are: the greater rapidity of training welders as compared with riveters; the reduction in the time lost due to inclement weather when the sections are prefabricated under cover; and the greater ease of obtaining watertight joints. The planning and equipment of a shipyard for welded construction is then considered in general terms. This section covers punching machines, shearing machines, folding and bending machines, plate rolls, planing machines, and oxygen-cutting machines. The selection of the type of welding equipment to be employed is then discussed. The arguments governing the choice of whether A.C. or D.C. plant should be adopted are briefly that, while initial and running costs of A.C. equipment are generally considered to be the lower, for the small yard D.C. may prove to be of more general use; that A.C. plant employs no rotating parts, and the maintenance costs are, therefore, considerably lower than for D.C.; that for the welding of both non-ferrous metals and ferrous metals D.C. will give the better service, but for ferrous metals A.C. is superior by reason of the elimination of arc blow; and that, owing to the higher voltages employed, the risk of shock is somewhat greater for A.C. supply, although with proper safety precautions this need cause little anxiety. The crane capacity will govern the size of the units that can be prefabricated; the most satisfactory unit for handling is in the region of 15 tons. To make the best use of the available space the welding shops should be laid out so that the sections are constructed in the order in which they will be required on the building berths, and as one unit is completed so the next should be started in the space vacated. The drawing-office procedure required when welding is introduced is considered. Four basic plans which are required before the main construction drawings for an all-welded vessel are commenced include the arrangement of the prefabricated units, and the list of welding particulars. At first, the necessity for setting down a standard procedure for the guidance of yard personnel not previously acquainted with the special requirements of the welding process will involve some increase in the amount of drawing office work. As experience is gained in this method of construction, so the work of the drawing office should become correspondingly lighter. The supervision and inspection of welds is of the highest importance, a reasonable proportion of supervisors to welders being one supervisor to every twelve or fifteen men. Consistently good welds are likely to be obtained if welders are given some form of bonus incentive, and the radiographic examination of welded work has been found to lead to a rapid improvement in the standard of welding.—*Journal, The British Shipbuilding Research Association, Vol. 7, July 1952; Abstract No. 6,288.*

Diesel Trawler

The Diesel trawler *Prince Charles,* launched the other day, is the second of two sister ships being built at Cochrane and Sons' Selby Yard for the St. Andrew's Steam Fishing Company, Hull, and is the thirtieth new trawler built at Selby for British owners since 1945. Her principal dimensions are 160ft. 6in. registered length, by 29ft. by 14ft. 6in., and she will be propelled by a Crossley CRL8/20 type, 8-cylinder Diesel of 1,500 b.h.p., running at not less than 1,000 r.p.m. The vessel will be of the builders' latest design, with raked plate stem and cruiser stern, carrying a crew of twenty-three, all berthed either amidships or aft, and will be equipped in a most complete and comfortable manner. Separate cabins for captain, mate, engineers and greasers, and two cabins each for eight of the crew, have washing and clothes drying facilities close at hand. Deck auxiliaries consist of electric windlass, electric winch, and electric-hand-hydraulic steering gear.—*Shipbuilding and Shipping Record, Vol. 80, 31 July 1952; p. 152.*

Danish-built Tanker for Russia

The tanker *Apsheron,* handed over recently to her owners, the V/O Transmashimport, Moscow, U.S.S.R., was constructed by Burmeister and Wain. The main particulars are:

Length b.p.	141·73 m.
Breadth moulded	19·6 m.
Depth to main deck	10·56 m.
Draught	8·356 m.
Deadweight capacity	13,200 tons
Capacity of cargo tanks ...	17,895 cu. m.
Machinery	5,530 b.h.p.
Speed on trials, loaded ...	14½ knots

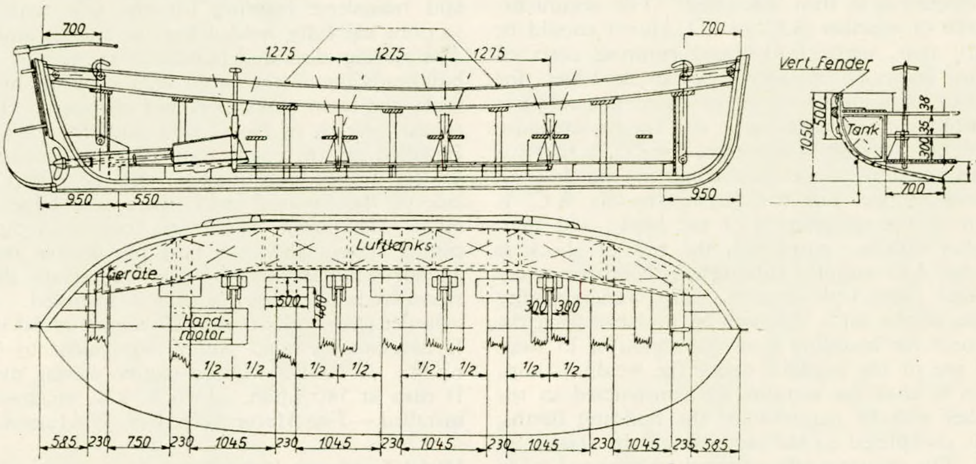
She has been constructed to the regulations of Det Norske Veritas class 1.A.L. and in accordance with Russian regulations. Longitudinal framing has been employed for the centre tanks and transverse framing for the side tanks. All tank intersections are fully welded but the frames and beams are riveted. The plating, deck and bulkheads are welded. Two longitudinal bulkheads divide the cargo section of the hull into eight centre tanks and eight tanks, port and starboard. There are two pump rooms, one aft of No. 2 tank and the other aft of No. 4 tank. Installed in these are four 250-ton duplex pumps and two 45-ton duplex bilge pumps. In the pump room, on the port side of the forward hold, there is a bilge pump, also a fuel oil transfer pump. There are four main pipelines in the cargo piping system and each tank has double shut-off valves. The anchor windlass and winches are steam driven, and Hastie's steam-hydraulic steering gear is installed. A standard of six-cylinder two-stroke B. and W. engine of 5,530 b.h.p. is installed. It develops its rated power (equivalent to 6,900 i.h.p.) at 115 r.p.m. A 60 kW. Diesel-engine-driven dynamo is provided. It runs at 540 r.p.m. Two 30 kW. steam-driven dynamos are installed.—*The Motor Ship, Vol. 33, August 1952; pp. 202-203.*

Model Tests with Icebreakers

Model experiments with two icebreakers have been carried out in recent years at the Swedish State Shipbuilding Experimental Tank. Since this type of ship is unique as regards both form and propulsion arrangements and since, moreover, there is only a very limited amount of published data on the subject, an account of these experiments and their results is given in this paper. The experiments consisted of model tests on a triple-screw icebreaker (two after propellers and one forward propeller) with a displacement of 2,200 cu. m. for the Swedish Government and on a quadruple-screw icebreaker (two after propellers and two forward propellers) with a displacement of 4,350 cu. m. for the Finnish Ministry of Commerce and Industry. Both ships were designed for Diesel-electric propulsion. The arrangement with one forward propeller has hitherto been the general rule for large icebreakers, particularly for those designed for service in the Baltic Sea and nearby waters. The forward propeller is not intended in the first place to contribute towards propulsion but its purpose is rather, when icebreaking, to break up and sweep aside the loosened ice. The latter applies mainly to work in pack ice, but the forward propeller can also be of use when breaking hard ice, since its suction helps to break the ice and the slipstream washes the sides of the ship, thus tending to prevent the ship becoming fast in the broken channel. It will be evident from the above that the forward propeller can be subjected to considerable strain and it must therefore be of very robust construction. Icebreakers which are designed for more severe ice conditions than those normally found in the Baltic Sea are generally not fitted with a forward propeller. This is the case, for example, with the Russian icebreakers which are designed for service in Arctic regions. In recent years, opinion has tended in favour of fitting icebreakers with *two* forward propellers, the main purpose being to increase the intensity of the aforementioned washing of the ship's sides. When only one forward propeller is fitted, experience has shown that the slipstream runs mainly along one side of the ship (the port side with a right-hand forward propeller, the starboard side with a left-hand propeller). With two forward propellers, however, the slipstream becomes symmetrical and the washing effect is thus the same on both sides of the hull. In this arrangement, the starboard forward propeller should be left-handed and the port one right-handed, i.e. the forward propellers should be inward turning. This idea has already been applied in practice in the Canadian icebreaking train ferry *Abegweit*.—*H. F. Nordström, H. Edstrand and H. Lindgren, Publications of the Swedish State Shipbuilding Experimental Tank, No. 20, 1952.*

Light Alloy Lifeboat

The accompanying illustration shows a lifeboat for forty-four persons constructed of light alloy and equipped with hand operated propeller drive. It is one of nine boats being built by a German shipyard for Deutsche Werft, Hamburg. Plate thickness of the hull is 2½ mm. The propeller shaft is of



chrome-nickel steel, and stern tube and propeller are of galvanized iron. The manual propeller drive consists of eight vertical levers, each of which is operated by two persons. The complete propeller drive weighs 500 kg. and the hull weighs 1,300 kg.—*Hansa, Vol. 89, No. 28/29, 1952, p. 838.*

Swiss Motorship

The motor cargo liner *Helvetia* is a ship of 5,762 tons gross, with a service speed of 15 knots. Her cargo spaces include refrigerated capacity, as well as a deep tank for vegetable oil, and space for benzine and for explosives. Her principal particulars are as follows:

Length overall ...	445 ft.
Length b.p. ...	410 ft.
Breadth, extreme ...	59·3 ft.
Depth to upper deck ...	37·4 ft.
Draught ...	24·3 ft.
Tonnage:	
Gross ...	5,762 tons
Net ...	3,355 tons
Deadweight ...	7,650 tons
Displacement ...	12,040 tons
Service speed ...	15 knots

The propelling machinery consists of a Sulzer Diesel engine, developing 4,900 h.p. to give the speed of 15 knots. A CO_2 fire extinguishing system has been installed. Navigational equipment includes radar, gyro compass and echo sounder.—*The Shipping World, Vol. 127, 3rd September 1952; pp. 185-187.*

Foreign Particles in Sleeve Bearings

Sleeve bearings operated under normal conditions are always subjected to some foreign solid particles in the oil supply. Internal combustion engines produce solids in the combustion process; other particles are produced by wear; and others enter as dirt, rust, and scale from the air or piping. A thorough understanding of the operating characteristics of sleeve bearings when subjected to certain particles in the oil, leads to an improved design of bearings, shafts, oil, and oil filters. The problem of filtering out small particles below 10 microns in size is extremely difficult, and in the majority of applications only a small per cent of the oil pump discharge is filtered. Even full flow filters have bypass arrangements to ensure an oil supply to the bearings in the event of the filter becoming clogged. Commercial automotive cartridge filters will not effectively remove particles below 8 microns and some will pass particles as large as 25 microns. This paper describes an experimental investigation of lead-base babbitt bearings operating with oil containing solid particles of graphite, molybdenum sulphide, red rouge, and corundum. The operating characteristics of a bearing operating on clean oil are compared with the same bearing operating on oil containing varying particle concentrations and sizes. It was found that particles could vary the coefficient of friction, increase wear, increase the operating temperature, and change the oil-flow characteristics of a bearing.—*Paper by H. G. Rylander, abstracted in Mechanical Engineering, Vol. 74, July 1952; p. 592.*

Sleeve Bearing Performance

The determination and understanding of the performance characteristics of cylindrical sleeve bearings is based upon three relationships. These are (a) the viscosity-temperature characteristic of the lubricant; (b) the bearing power consumption as a function of oil-film temperature; and (c) the oil flow through the bearing as a function of Sommerfeld number. The first two are well known, and this paper is concerned primarily with the nature and quantitative determination of oil flow, together with the simplified methods for the calculation of bearing performance made possible thereby. The discussion is restricted to those bearings having oil fed under pressure to their oil distribution grooves. Oil flows from the ends of these bearings because of the pressure in the oil grooves and because of the pressures generated in the load carrying portion of the oil film. The second type of flow is dependent upon shaft speed. Dimensionless parameters controlling both types of flow have been calculated, and experimental results on several bearing sizes confirm the theory. A detailed study of the circumferential flow of oil in the bearing shows that Petroff's law is an excellent approximation of power loss up to an eccentricity of 0·7, and that the temperature variation in the oil film may be estimated with simple assumptions. Knowledge of bearing oil-flow characteristics permits the ready calculation of bearing performance by means of the "operating-line method".—*D. F. Wilcock and M. Rosenblatt, Trans.A.S.M.E., Vol. 74, July 1952; pp. 849-866.*

ENGINEERING ABSTRACTS

Section 3. SHIPBUILDING AND MARINE ENGINEERING

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Cold Rolled Fillets

It is well known that the fatigue strength of many engineering components is determined by the strength at some "critical" section—a notch or stress concentration; therefore, processes which may be used for local strengthening are of great interest. This is especially true at the present time when there is a necessity to use lower-alloy materials. Small modifications to design and treatment may produce strength increases which more than compensate for the reduction of strength that would otherwise result from using materials which are basically of less strength. At the laboratory of the Motor Industry Research Association, a process devised for strengthening fillets, consisting of cold-rolling with steel balls, has given striking results. It was used, in fact, on cast crankshaft specimens, the material being a flake-graphite iron which is in current use for the production of a wide variety of crankshafts. Fatigue-test results have shown that, under reversed bending, the cold rolling has increased the limiting stress of crankshafts by 60 per cent, and that, under "one-way" loading, the increase of strength is as much as 80 per cent. The two kinds of loading were investigated because a crankshaft in service is probably subjected to a loading intermediate between these two conditions. These considerable strength increases have been achieved without any significant change of fillet radius. The method of rolling was to use three balls equally spaced round the fillet and held in place by a loading ring with an internal 45-deg. chamfer. When rolling crankpin fillets, the loading rings were, of course, split and assembled on the crankpin. In order to ensure that the surface is rolled uniformly, the fillet must be machined to a reasonable degree of accuracy of form and size before it is rolled. The rolling may produce a small ridge of metal (about 0·005in. in the present case) at the junction of the fillet and the journal, but this can be removed by a simple polishing operation.—*R. J. Love, Engineering, Vol. 174, 8th August 1952; p. 164.*

Failure of Shrink Fits in Crankshafts

According to an article by K. Gleitz published in Die Technik, in spite of extensive investigations, it is still difficult to obtain a clear idea of the radial and frictional forces existing in shrink fits, and to determine the correct amount of shrinkage necessary for various steels. It is, however, generally agreed that it is undesirable to disturb the stress distribution in the shrink fits by axially drilled holes. The author describes, with drawings and photographs, examples of the fatigue failure of shrink fits in a large gas engine crankshaft and a steam driven compressor crankshaft. Details are given of a repair executed on a broken crankshaft by the thermit-welding process. This procedure was based on a number of thermit-welding tests carried out with various steel specimens, particulars of which, including micro-photographs of the weld structures, are presented. Fatigue failures in stepped shrink fits in crankshafts show that, in such joints, axial pins fitted to prevent the parts from slipping are undesirable.—*Journal, British Shipbuilding Research Association, Vol. 7, July 1952; Abstract No. 6,349.*

Advantages of Titanium

Titanium's big advantage is its high strength/weight ratio. On this basis, titanium can replace aluminium and, below 1,000 deg. F., stainless steel. Many of titanium's other characteristics result from its affinity for oxygen, carbon, and nitrogen, which embrittle. For example: (1) Titanium is costly to produce because air must be excluded and carbon crucibles are out of the question. Furnaces must have a layer of solid titanium between melt and wall. (2) Above about 1,000 deg. F. titanium picks up the three contaminants so readily and loses strength so fast that it is useful only as a flame barrier—but very effective in that use. (3) The oxide film that titanium forms at room temperature makes it completely resistant to salt water and appreciably resistant to chlorine and other bleaches. Titanium forges satisfactorily at 1,700-1,800 deg. F. and rolls well at 1,400-1,600 deg. F.—the upper limits being set by oxidation and the lower ones by ductility. The pure-metal grades cold work without damage, with moderate strain hardening. Alloys can be cold worked about 25 per cent between anneals. Commercially pure titanium can be welded with itself by processes that exclude air. Machining requires slow speeds, heavy cuts, positive pressures, and very sharp tools because of titanium's tendency to gall and its low thermal conductivity. Oxide scale, if allowed to remain on titanium, will quickly dull the hardest tools. Plentiful as titanium is, it will probably never be as cheap as aluminium or stainless steel because of production costs.—*S.A.E. Journal, Vol. 60, July 1952; pp. 78, 82.*

Fatigue Strength of Stiffened Panels

The construction, and particularly the repair, of ships frequently requires joints to be made in frames, beams and bulkhead stiffeners. Failures are experienced in such joints occasionally, when these are executed in the form of butt welds. These failures have the characteristic appearance of fatigue failures. The investigation described in this report was carried out to determine the life of different types of welded joints in stiffeners when subjected to many repetitions of loading. The attachment of the stiffeners to the plating was also investigated. The resonance method was used to carry out these fatigue tests with specimens consisting of stiffeners welded to plates with and without welded joints in the stiffeners. Most of the specimens were made in the laboratory. The joints in these specimens were made with such great care as could not normally be expected in the shipyard under conditions of production. A number of specimens, typical of present day practice and fabricated in shipyards, were included in the series of tests. The fatigue strength of unjointed welded stiffeners is highest when the stiffeners are welded on by means of continuous fillet welds. If intermittent welding is used, staggered fillet welding is preferable to chain fillet welding. The most dangerous points at which fatigue failures are to be expected in unjointed welded stiffeners are the ends of intermittent fillet welds, the undercut along fillet welds connecting stiffeners to plating and, in the case of scalloped stiffeners, the return fillets. Unjointed channel stiffeners riveted to the plating withstood a larger number of cycles than stiffeners welded on with continuous fillet welds.—*R. Weck, The Welding Journal, Vol. 31, July 1952; pp. 338s-349s.*

Study of Buckling Problems

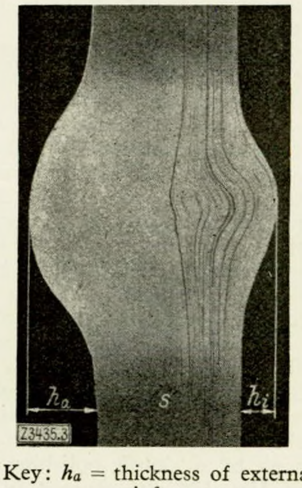
Until comparatively recent times, the study of buckling problems was confined, like Euler's column theory, to the idealized case of the neutral equilibrium for infinitesimal displacements of a perfectly elastic structure having a shape and loading for which such a condition exists. By the 1930's reasonably exact solutions of this classical stability theory had been obtained for most of the more basic cases, such as straight and circular rods, rectangular plates and circular cylinders, with clamped, hinged, and free boundaries, loaded to produce uniform compression or shear parallel or perpendicular to the boundaries. The engineers who had to use such elements in their machines and structures early found that these "exact solutions" sometimes showed little relationship to actual behaviour. Thus the classical theory is satisfactory for very slender struts, but because of the limits to the elastic behaviour of actual materials, empirical results are relied on to this day for most applications. When classical stability theories became available for more complex elements, it was found that non-elastic behaviour was only one of the causes for serious discrepancies between such theories and experiments. For example, the classical theory predicts many times the actual strengths of very thin shells under axial compression; on the other hand, the classical theory predicts only a fraction of the actual ultimate strengths of very thin hinged or fixed edge plates under compression or shear. Since these discrepancies become greater the thinner the material and hence the smaller the average stress, they can hardly be due to non-elastic effects. Adequate theories are needed even more for the more complex cases than for the case of simple struts, because the greater number of variables makes it less practical to cover all combinations by empirical methods.—*L. H. Donnell, Applied Mechanics Review, Vol. 6, July 1952; pp. 289-290.*

Flexural Vibrations of Thin Cylinders

The flexural vibrations of the walls of thin cylinders are considered. In this type of vibration many forms of nodal patterns may exist owing to the combination of circumferential and axial nodes. Theoretical expressions are developed for the natural frequencies of cylinders with freely-supported and fixed ends and a comparison is made with the frequencies obtained experimentally. In practice, the ends of cylinders are subjected to a certain degree of fixing by end-plates, flanges, etc., and the natural frequencies thus lie between the corresponding values for freely-supported and fixed ends. To make possible the estimation of such frequencies, a method is devised in which an equivalent wave-length factor is used. This factor represents the wave-length of the freely-supported cylinder that would have the same frequency as the cylinder under consideration when vibrating in the same mode. The results of experimental investigations with various end thicknesses and flange dimensions are recorded, and from these the equivalent factors are derived. Sets of curves calculated for cylinders with freely-supported ends and covering a range of cylinder thicknesses are given. From these it is possible to obtain close approximation to the frequencies of cylinders under other end conditions by the use of an appropriate factor. An example is given of frequency calculations for a large air receiver for which two frequencies were identified by experiment.—*Paper by R. N. Arnold and G. B. Warburton, submitted to The Institution of Mechanical Engineers for written discussion, 1952.*

Reinforced Steel Tubing

Steel tubes may be reinforced or flanged by upsetting under heat. Local induction heating is more suitable for this process than electric resistance heating, since the rolling scale of the tube would interfere with the uniform direct transmission of the current. The tensile strength of the material at the temperatures reached at various points of the tube wall determines size and shape of the reinforcement. Plastic deformation is usually restricted to regions heated above 750 deg. C. The smoother the temperature transitions within the material, the smoother will be the cross-sections after upsetting. The axial extension of the heated zone must be kept as short as possible. Folds and corrugations are avoided only if the heated length is less than three times the tube wall thickness, and only by induction heating can such narrow zones be obtained. The heated tube wall is upset by axial pressure and forms collars outside and inside. The outer collar is thicker than the inner collar, since deformation towards the inside is restricted by the decreasing diameter (Fig. 3). The flow of the material can, however, be controlled or directed wholly towards one side if restricting mandrils or rings are used. Internal reinforcements are more difficult to manufacture than external ones. A ring slipped



Key: h_a = thickness of external reinforcement.
h_i = thickness of internal reinforcement.
s = tube wall thickness.

FIG. 3

over the heated tube causes heavy friction and rapid cooling so that a large upsetting pressure is needed. An internal induction coil, though possible with large tubes, is disadvantageous from an electrical point of view. A combined heating and rolling device has proved a better solution; three induction coil segments and three pressure rolls are arranged evenly around the circumference of the tube, which is rotated under axial pressure from the rolls while being heated by induction. Heat and circumferential roller pressure thus act uniformly over the entire tube circumference and enforce a uniform flow of metal into the bore. A uniform axial movement of the fixture creates a cylindrical internal reinforcement (Fig. 7)

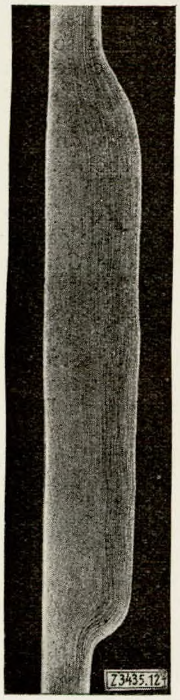


FIG. 7

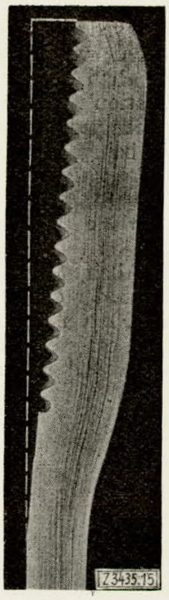


FIG. 8

of a speed depending on the speed of the axial motion. Reinforcements of varying shapes can be obtained by suitable changes of roller pressure, speed of axial motion, and temperature of the heated zone, e.g. tapered reinforcements of considerable thickness for the cutting of tapered threads in thin tubes (Fig. 8) or for other purposes. The position of the rollers may be adjusted so that an external reinforcement of specified thickness results. Orifice discs may be positioned in the tube and firmly fixed by upsetting the tube material around the disc *a* (Fig. 9). The plastically deformed tube material

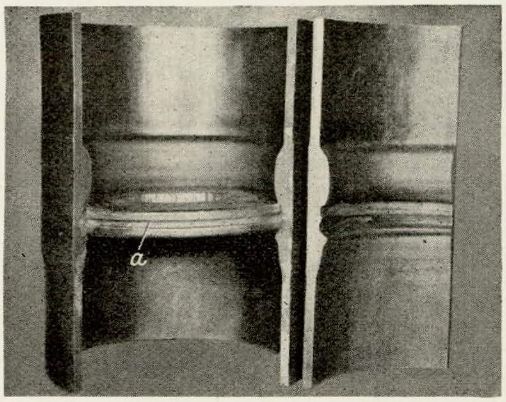


FIG. 9

will completely fill any external profile given to the disc.—*E. Hoermann, V. D. I. Zeitschrift, Vol. 94, 1952; pp. 343-345, abstracted in The Engineers' Digest, Vol. 13, July 1952; pp. 225-226.*

Light-weight Gas Turbine

The Boeing light-weight gas turbine is now being manufactured on a production basis for the U.S. Navy, Boeing Airplane Company has announced. .Current production engines are being built for the Navy Bureau of Ships and will be used to generate electrical power for minesweepers. Complete machine and sheet metal shops have been set up for the new turbine facility. Fourteen large cells are used to test the turbines under a variety of conditions and for a variety of purposes. Certain of the cells are set aside for production and acceptance testing of newly assembled engines. Others are designed for developmental testing of various turbine applications, and still others are used for research. The average cell is 10 by 10 by 20ft., with walls of reinforced concrete. By means of gauges, manometer tubes and automatic instruments, the entire story of the engine's performance is recorded.—*Marine Engineering and Shipping Review, Vol. 57, August 1952; p. 77.*

Wet Compression in Axial-flow Compressor

The author summarizes a study of the problem of wet compression in an axial-flow compressor. The basic relation between the rate of compression, size of water particles and overall pressure ratio is outlined. The possibility of introducing wet compression in a supersonic compressor is discussed. In his discussion of the paper, A. A. Hafer of the Turbine and Gear Section, Bureau of Ships, Washington, D.C., pointed out that there are two main advantages which have been associated with wet compression; that is, an increase in full-load efficiency and reduction in size per unit power output of the gas turbine plant. Several recent tests and studies indicate that the expected increase in plant efficiency has been less than expected. It would be well to mention several mechanical complications which may result from wet compression and which must be considered by the designer. Many gas turbine engines today use air bled from the compressor for bearing sealing and/or cooling. It is unlikely that this would be feasible with set compression owing to the danger of contaminating the lubricating oil with water. Further, a control is needed which would inject the proper amount of liquid to produce saturation of the air at the compressor exit. Such a control would have to sense ambient air temperature, relative humidity, pressure ratio, and compressor speed to provide for the proper water injection rate, and might be a complex mechanism indeed. Probably the most serious disadvantage of wet compression for Naval use is the need to use distilled water, as previously pointed out. The N.A.C.A. standard for the amount of water necessary to produce saturation of the air at the compressor exit is 0·048lb. of water per lb. of air at 59 deg. F. Taken at the Bureau of Ships standard ambient air temperature of 80 deg. F., this would be about 0·052lb. of water per lb. of air. If the amount of water required for wet compression in a typical gas turbine plant is compared with the make-up feedwater used in a standard Navy steam plant, the wet compression comes out second best by some margin. The make-up feedwater required by one class of Naval vessel averages about 0·049 gal. per h.p. hr. Under similar conditions, a simple gas turbine engine using wet compression would require about 0·326 gal. per h.p. hr. of injected water. This would indicate that wet compression requires roughly six times as much water as this particular steam plant. This number can hardly be termed a general ratio. It can be seen that the amount of water required for wet compression for a gas turbine plant of 5,000 h.p. operating continuously at full power would run into the very large figure of 39,000 gal. per day for even this modest sized plant. This would require the addition of 20 to 40 tons of distilling plant to the evaporator capacity of the vessel, depending upon whether steam or vapour compression were used. If a destroyer of 60,000 s.h.p. were powered solely by gas turbine engines using wet compression, it can be seen that the size and weight of the distilling plant required for wet compression would be staggering, if it were desired to operate the vessel at full power for long periods.—*Shao-Lee Soo, Trans.A.S.M.E., Vol. 74, July 1952; pp. 879-890.*

Results in 1,000-kW Gas Turbine Test

Having successfully completed about 1,000 hours of test running in both recuperative and non-recuperative form, the Allen 1,000-1,250-kW. shipboard gas turbine is shortly to be dismantled and moved from the Biddenham Works, Bedford, to the Naval Marine Wing of the National Gas Turbine Establishment, Pyestock. There it will be used primarily as a generating plant, running for extensive periods, so that maintenance requirements can be determined. Although this plant was designed for between-deck installation in a warship—the original specification having called for a maximum overall height of 7ft. and the ability to withstand very considerable shock loadings in the upwards, downwards and athwartships directions—the Admiralty's intention has always been to keep this prototype unit ashore and employ it as a "guinea pig". For that reason, a 50-cycle alternator was fitted rather than the 60-cycle types now standardized for Royal Naval vessels. All design calculations were based on tropical air conditions (100 deg. F.) and assumed that high losses would be encountered in the long inlet and exhaust trunking necessary aboard ship; on this basis, the predicted output was 1,000 kW. at a thermal efficiency of 19·75 per cent. In temperate air, the 14-stage axial compressor handles a mass flow of 37lb. per sec. and has a top compression ratio of 4·25 to 1. Sixteen diffuser pipes carry the compressed air to an annular crossflow air-in-tube heat exchanger, which gives a thermal ratio near 70 per cent. From the heat exchanger the preheated air flows forward into eight Lucas combustion chambers arranged around the turbine assembly. A two-stage turbine drives the compressor at speeds up to 8,000 r.p.m., and an independent single-stage turbine provides the useful output at a constant speed of 6,750 r.p.m. Speed reduction from 6,750 r.p.m. to the 50-cycle alternator speed of 1,500 r.p.m. is effected by a compact Allen-Stoeckicht epicyclic gear. Troubles encountered in the course of testing have been of a minor nature, the main rotating components having given no cause for concern. Perhaps the most disappointing feature of the tests has been the discovery of air leakage around the eight segments of the heat exchanger, which has caused the machine's present performance to fall a little short of the calculated values.—*The Oil Engine and Gas Turbine, Vol. 20, August 1952; pp. 148-149.*

Gas Turbine Progress

Details of progress in the development at the Pametrada Research Station, Wallsend, of the 3,500 s.h.p. marine gas turbine have been published in the Parsons and Marine Engineering Turbine Research and Development Association Progress Report for 1951. At the end of 1951 it had not been possible to carry out a continuous 100-hours full power test, owing to various causes, none of which was due to the design of the gas turbine. Since then, however, a 100-hours continuous run at full power has been carried out, in which the following mean performance figures were achieved:—

S.H.P. (corrected to 14·7lb. per sq. in. and 60 deg. F.) 3,532 h.p.
H.P. turbine inlet temperature (corrected to 60 deg. F.) 1,242 deg. F.
L.P. turbine inlet temperature (corrected to 60 deg. F.) 1,284 deg. F.
H.P. turbine speed (corrected to 60 deg. F.) 4,650 r.p.m.
Thermal efficiency ... ... 27·9 per cent
Fuel consumption (corrected to 60 deg. F.) 0·505lb. per b.h.p. per hr.

After the 100 hours continuous run at full power had been concluded, a complete opening up took place and an inspection was carried out by Lloyd's, who subsequently produced a very satisfactory report. During the period of opening up, opportunity was taken to carry out modifications as follows:—(a) New glands were fitted to the h.p. turbine to reduce sealing air consumption. (b) A water eliminator was fitted in the discharge side of the intercooler in order to prevent the admission of water to the h.p. compressor, where it caused deposits to adhere to the blading. (c) An additional row of blading was added to the l.p. compressor to raise the compression ratio to the designed figure. (d) Modifications were made to the mixer following the two reheat combustion chambers to reduce temperature variations over the gas stream. The designed consumption for the gas turbine as originally conceived was 0·54lb. per s.h.p. per hr. The best figure obtained so far is 0·49lb. per s.h.p. per hr. As a result of the modifications carried out, it is hoped to improve on this figure. The running to date has been carried out on distillate fuel. As soon as the turbine has been proved after reassembly, running on residual fuels will commence, which should take place shortly. Progress has been slower than expected due to unforeseen demands on the Research Station's resources by the Admiralty. These demands have now been reduced and the tempo of the gas turbine programme is being speeded up again.—*The Shipping World, Vol. 127, 20th August 1952; p. 152.*

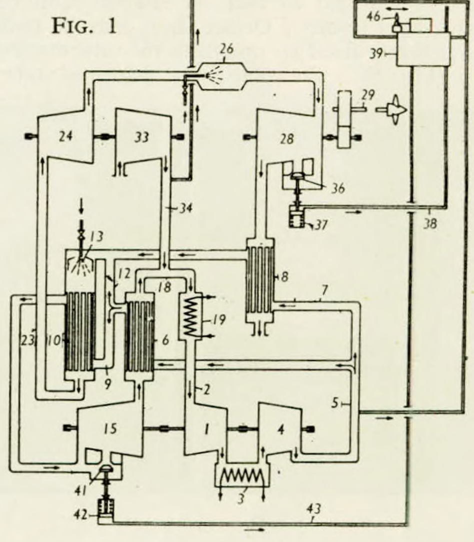
Small Gas Turbine

In addition to the 1,000-kW. gas turbo-alternator set built by W. H. Allen, Sons and Co., Ltd., for the Admiralty, a small set is under construction at the maker's Bedford works. This is a 200 h.p. machine intended to drive an alternator and is of an entirely different design from the larger set. It comprises a radial inward flow turbine of the Francis type, designed to run at 23,500 r.p.m. and fitted with epicyclic gear, giving a speed on the output shaft of 3,000 r.p.m. This set is not fitted with a heat exchanger and is of particularly limited dimensions.—*The Motor Ship, Vol. 33, September 1952; p. 237.*

Gas Turbine Control

In Fig. 1 is illustrated a gas turbine plant employing a semi-closed circuit. Low pressure air from the compressor (1) is passed to the cooler (3) and thence to the high pressure compressor (4). Air discharged through a pipe (5) is divided into two portions, one flowing through a heat exchanger (8) where it is again divided, one stream passing through a pipe (9) into the space surrounding the tubes of a gas heater (10) and the other passing into the combustion chamber (13). The heated air is supplied to a turbine (15) which drives the main com-

FIG. 1



pressor. From the turbine, the air flows into the tubes of the heat exchanger (6) and thence through the pipe (18) into a cooler (19). When the air reaches the pipe (2) the circuit is repeated. Part of the gas extracted from the circuit through the pipe (7) passes to the combustion chamber (13), together with gas from a pipe (12). The mixture flows through the pipe (23) into the charging compressor turbine (24) and thence to a reheater (26) on its passage to the power turbine (28) which drives the propeller shaft (29). As a replacement for the gas extracted from the circuit through the pipes (7, 12), atmospheric air is supplied by the charging compressor (33) through a pipe (34). For regulating the amount of gas flowing through the turbine (28), a first stage bypass valve (36) is provided, together with a servomotor (37) actuated through a pipe (38) leading from a regulating device (39). A similar adjustment is made to the main compressor turbine (15), which has a bypass valve (41) and a servomotor (42) supplied from a pipe (43). The effective power of the plant is controlled manually by a lever (46).—*British Patent No. 668,516. Sulzer Frères Soc. Anon., Winterthur. The Motor Ship, Vol. 33, August 1952; p. 206.*

Adjusting Gas Turbine Blade Clearance

In Fig. 4 is shown an arrangement for adjusting the blade clearance of a gas turbine. The rotor (1) has a zig-zag surface, of which the parts (7) opposite the guide blades (4) are inclined in the same direction as the inner wall of the casing (2). The

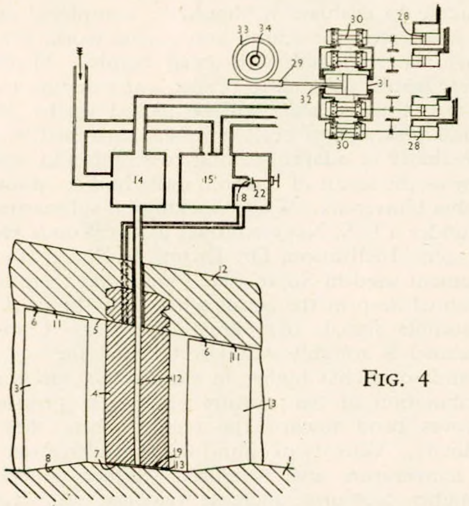


FIG. 4

portion (8) of the rotor surface carrying the blades (3) is oppositely inclined in such a manner that all the sealing surfaces (7) of the rotor have the same maximum and minimum diameter. Thus, the average diameter is the same all over the portion of the rotor opposite the blades (3, 4). The end edges (9) of the guide blades (4) are inclined at the same angle as the sealing surface (7) of the rotor. The clearance may be adjusted by the axial displacement of the casing (2) and the rotor (1), relatively to one another. Two sets of clearances (11, 13) are both nil at the same time, but owing to the end edges (9) of the guide blades and the sealing surface (7) of the rotor being less inclined than the end edges (6) of the rotor blades and the sealing surface (5) of the casing, the width of the clearance (11) will be increased more than that of the clearance (13) when the casing (2) is displaced to the right. The width of the clearance (13) may be used to determine the necessary axial displacement of the rotor and the casing by means of an adjusting device. Compressed air in the compartment (14) has a tendency to escape through the channel (12) and the guide blade (4), while air in the compartment (15) has a tendency to escape through the outlet (18). The outlet of the channel (12) having the same cross sectional area as the outlet (18), and the discharge from the compartments (14, 15) being effected against the same pressure, the delivery from the compartments (and the pressures therein) will be equal, as long as the distance between the outlet (18) and the throttle (22) is the same as the width of the guide blade clearance (13). Variation in this clearance corresponds with the difference in the compartment pressures, thus bringing a pressure differential device into action. This consists of a set of four pistons (28) coupled to slide valves (30) controlling the oil supply to cylinders (31), in which are pistons (32) secured to a toothed rack (29). This rack engages a gear wheel (33), the shaft (34) of which adjusts the position of the turbine rotor relative to the casing.—*British Patent No. 668,434. Helsingor Skibsvaerft A.B., Elsinore. The Motor Ship, Vol. 33, August 1952; p. 206.*

Corrosion of Ball Bearings

The Naval Research Laboratory of the Office of Naval Research, Washington, reports that a proper corrosion inhibitor can reduce or sometimes even prevent the corrosion of brass retainer ball bearings. This study was prompted by difficulties experienced by ball bearing manufacturers, military laboratories, and maintenance depots from corrosion of steel balls and races in brass-retaining ball bearings during storage. Corrosion in the form of fine specks was observed on steel parts of these bearings after storage in rooms controlled at 70 to 80 deg. F. and 30 to 40 per cent relative humidity. To solve the problem, it was first necessary to duplicate this corrosion and analyse the corrosion product. To duplicate in a short time conditions that developed after relatively long storage periods, special test specimens and conditions were employed. In laboratory tests, a special lubricant with a high concentration of rust inhibitor in the diester was used. To increase the amount of corrosion produced under laboratory conditions, specimens were exposed to temperatures of 136 deg. F. at a relative humidity of 36 per cent. Medium to heavy corrosion resulted in periods varying from 7 to 21 days. Observing the effect of humidity on corrosion of brass in contact with steel, a series of tests were made in desiccators over anhydrous calcium chloride. None of the specification lubricants caused corrosion on a steel-brass couple in the absence of water vapour, even at 136 deg. F. for 30 days. Corrosion encountered in these tests was shown to be electrolytic in nature and probably accelerated by small quantities of acids formed by oxidation or hydrolysis of the lubricant. It was then necessary to develop methods or lubricating compositions that could be used to alleviate this action. By combining acid neutralizing qualities of an amine with rust inhibiting qualities of an organic acid and thus developing amine-acid complexes, satisfactory corrosion and rust inhibiting compositions were evolved.—*Steel, Vol. 131, 28th July 1952; pp. 84, 87.*

Preventing Propeller Pitting

Investigations on the deterioration in service of cast iron marine propellers have been in progress (and are still continuing) since the early part of 1947, under the supervision of the Joint Propeller Panel of the British Cast Iron Research Association. A full account of this work will be published later, but the results so far achieved indicate that the severe pitting sometimes encountered in this type of attack is caused by a form of accelerated corrosion. It would be expected, therefore, that it should be possible to reduce or prevent the attack by the application of cathodic protection. A limited number of service tests on ship propellers have been carried out and very encouraging results have been obtained. There are two methods of applying cathodic protection and both are under investigation. A sacrificial anode may be used, or alternatively the protective current may be applied from a generator or storage cell coupled to an insoluble anode. Magnesium was chosen as the most suitable sacrificial anode and for various reasons it was attached to the propeller in the form of a cylindrical cone cap. A tugboat propeller was chosen for this trial. The propeller has been in use for three months and had just started to pit when the magnesium anode was fitted. Previous experience with a propeller of the same design on this tugboat had indicated that rapid pitting would have occurred during the subsequent three months' service, but in fact no further pits developed and the original pits were not enlarged. At this stage the propeller was taken out of service, for reasons other than pitting attack, and a magnesium cone cap was fitted to the new replacement propeller, which would normally be expected to show pronounced attack after a period of six months. The final results of this trial are awaited with interest, but it may be noted that after four months no attack has yet developed. A possible disadvantage of the magnesium cone cap is that it is consumed as it supplies protective current to the propeller, and must be replaced from time to time. Since there is always an ample supply of electricity on board ship it is possible that economic considerations would favour the alternative method of cathodic protection. This is being investigated on a collier fitted with a graphite anode. The current is supplied from two 12-volt storage cells, one of which is charging while the other is in use. A simple changeover switch is incorporated in the circuit, and also an ammeter to indicate whether the propeller is receiving the necessary current. The investigators wish to extend considerably the number of field trials of these methods of protection and would welcome offers of co-operation from any propeller manufacturer or shipowner who is interested in increasing the working life of the cast iron ship propeller and extending its field of application.—*The British Cast Iron Research Association, Journal of Research and Development, Vol. 4, August 1952; p. 392.*

Photographing Flow Patterns

A description is given of a non-return type smoke tunnel developed at the University of Notre Dame, U.S.A., and of the photographic technique employed. The tunnel has a working section of 2 × 2 × 3ft. and has glass on three sides. Low turbulence is effected by a reduction of about 12 to 1 and with multiple screening at the beginning of the entrance cone. The tunnel is powered by a 15 h.p. three-phase motor. Speed range is 15 to 90ft. per sec., and the *Re* range on an investigation on a flat plate is 2,500 to 725,000 and on a circular cylinder is 300 to 100,000. The smoke is generated by burning wheat straw with insufficient oxygen. Any camera may be used for photographing the flow. The lighting is commercially available electronic flashlamps; the exposure interval is about 1/100,000 sec. Motion pictures and stereoscopy have been tried. The latter is particularly adaptable to propeller and tip vortex studies. Many examples are given.—*F. N. M. Brown, Aircraft Engineering, Vol. 24, June 1952; pp. 164-169. (Abstracted in Index Aeronauticus, Vol. 8, August 1952; p. 22.)*

Reducing Probe Radiation Errors

The common assumption that a probe will come into equilibrium with gas temperatures at any temperature or velocity level, or that the error at high temperature can easily be calibrated and allowed for, has to be abandoned as temperatures approach or exceed 1,000 deg. F. and velocities increase to 2,000 f.p.s. and more. The temperature level is so important for radiation that radiant heat losses from a body, other things being equal, are about 250 times as much at 1,600 as at 60 deg. F. This loss is responsible for the radiation error of a probe. As velocity increases, the effective gas temperature at the probe increases in terms of static temperature. For a cylindrical shape perpendicular to flow, this increase amounts to about 200 deg. F. at 2,000 f.p.s. due to adiabatic compression as the gas strikes the probe and to shear work done on the boundary layer of the gas as it flows around the probe. The latter accounts for the fact that it is impossible to design a "static temperature" probe. It is possible to design a chamber which will stagnate the gas around the temperature element so that the probe will measure very close to "total temperature". For low temperature, high velocity work, total temperature probes with very little radiation shielding can measure gas temperatures accurately to within 1 or 2 deg. F. At the same velocity and about 1,200 deg. F., scaled up versions of these probes would still have a negligible velocity error, but a radiation error of 30 to 40 deg. F. The latter can be reduced by allowing the gas to flow past the thermo-element at a higher velocity to give a higher convection heat input, but this reduction is purchased at the price of a higher velocity error. Low velocities in flue gases are at the other extreme from high velocity measurement. The radiation error is so high as to give an advantage to accelerating the gas flow past the temperature element and accepting a slight velocity error in return for a large reduction in radiation error. Other design factors beside gas velocity can be manipulated to reduce overall error, but they never take its place. Among them are: 1. Controlling the emissivity of the probe. Since the radiation is directly proportional to this variable, a low-emissivity covering on the thermo-element is very effective. 2. Shielding the thermo-element by interposing shields of various types between element and the walls which are usually at a lower temperature. 3. Controlling the temperature of the shield between the thermo-element and the walls by auxiliary means, such as an electric heating coil. This has not proved practical and it has some serious theoretical objections.—*E. M. Moffatt, S.A.E. Journal, Vol. 60, July 1952; pp. 126-128.*

Underwater Sound Signals

The U.S. Navy has acquired basic patent rights to Sofar (sound fixing and ranging), a development which allows underwater sounds to be picked up more than 3,000 miles away. The (U.S.) Navy Bureau of Ships said that Sofar may be adopted for search and rescue operations. Tests under way in the Pacific to evaluate it should be completed this month. If Sofar is adopted for search and rescue work, life rafts and aircraft will be equipped with small bombs. Dropped overboard, there bombs wil sink to proper water depths and explode. Sound waves thus released will be picked up by Navy Sofar stations and positions of craft will be determined by triangulation. Possibility of adapting Sofar to search and rescue operations came as the result of research done by Dr. Maurice Ewing of Columbia University. While working on submarine detecting methods under a U.S. Navy contract at the Woods Hole, Mass., Oceanographic Institution, Dr. Ewing developed the principles and equipment used in Sofar. He found that there is a natural sound channel deep in the ocean which may be used for transmitting audible signals over great distances. Centre of this sound channel is roughly 4,200 feet below the surface of the Atlantic and somewhat higher in the Pacific. It is established by a combination of temperature and water pressure factors. Sound waves bend toward the region where they have the lowest velocity. Velocity of sound waves under water is affected by both temperature and pressure. Higher temperatures, as well as higher pressures, increase velocity. At depths above 4,200 feet in the Atlantic, the temperature factor is dominant. Sound waves in that area bend downward towards the lower temperatures where they will travel more slowly. At depths below 4,200 feet the pressure factor is dominant and sound waves at those depths bend upwards. Thus, at 4,200 feet, the pressure and temperature factors create a region of minimum sound velocity. A large part of any sound originating at this depth, therefore, is carried along this channel for great distances without hitting the ocean surface or bottom. It thus avoids high losses due to reflection, absorption, and scattering. Among the important features of the discovery is that sound signals on this channel can be distinguished from various other sounds which may occur in the ocean.—*Mechanical Engineering, Vol. 74, June 1952; p. 502.*

Optimum Single Propellers

The Betz process for minimizing the energy loss of single propellers is extended to the propeller operating in radially varying inflow, with a view toward the development of optimum stern propulsion for bodies of revolution. Assuming the usual lifting-line treatment of the propeller blades, an application of the isoperimetric problem in the calculus of variations is directed toward minimizing the energy loss while maintaining constant total thrust. Resulting expressions describe the optimum radial distribution of induced velocity in terms of an undetermined multiplier. The magnitude of the required total thrust, in turn, fixes the value of this multiplier, making the solution determinate. Inclusion of blade-profile drag at a later point in the development serves to determine an optimum propeller diameter for minimum overall energy loss. The method gains in accuracy as the ratio of blade number to advance ratio increases, due to an approximation in the relation between the circulation and induced velocity.—*F. Lane, Journal of Applied Mechanics, Vol. 19, September 1952; pp. 252-256.*

Dynamic Selector Winch

The Scott dynamic selector winch is the latest development of the Scott regenerative type of winch, which was introduced some six years ago. The new winch has been designed to give maximum hoisting and lowering speeds, compatible with safe and simple control, and without the use of friction brakes in ordinary operation. The winch is arranged to operate on direct current, and the electrical system incorporates electrical braking by regeneration, the current being either fed back to the line or absorbed by resistance, if there is insufficient external load to take the regenerated current. Four speed steps are provided in each direction, the low speeds being obtained by armature diversion. When hoisting, with the controller on the fourth (high-speed) step, the speed at full-load is about 130ft. per minute. With about two-thirds full-load, the speed is automatically increased by a load-discriminating contactor to about 200ft. per minute, and, at about half full-load, a further step of load discrimination increases the speed to about 250ft. per minute. The light-hook speed is 450ft. per minute. When lowering on the high-speed step, the load discriminations automatically limit the speed to about 450ft. per minute up to quarter-load, to about 360ft. per minute at loads between quarter and half, and to about 250ft. per minute at between half and full-load. Lower speeds can be obtained on other steps down to a landing speed (on the first step) of about 25ft. per minute. A magnetic brake is provided to hold the load steady when the controller is in the "off" position, and it also acts as an emergency stop should the supply of current be interrupted for any reason. The contactor gear and resistances are arranged in panel form, in order that they may be accommodated on deckhouse sides. This new winch is suitable for normal full load of 3 or 5 tons.—*The Shipbuilder and Marine Engine-Builder, Vol. 59, September 1952; p. 565.*

New Propeller Designs for Victory and C-3 Ships

The Lips Propeller Company have developed a series of new propeller designs for Liberty ships, 15-knot and 17-knot Victory ships, C-3 cargo vessels, and T2 tankers. Towing tests on a 15-knot Victory model showed that the turbines would attain their rated output of 6,000 s.h.p. at 93 r.p.m. of the original propeller, and would give a ship's speed of 15·3 knots; 15 knots would be attained at 90 r.p.m. and 5,610 s.h.p. In order to overcome the pitting of the gear wheels which has been observed in a number of these vessels, it was decided to reduce the pressure on the gear teeth by increasing the propeller speed to 95 r.p.m. for 5,610 s.h.p. It was also decided to reduce the torsional stresses in the propeller shaft which result from the uneven velocity field in the plane of the propeller by using a propeller of smaller diameter, with shock-free entry, and the Lips Unistrength blade-thickness variation. A propeller which fulfils these conditions has been designed and produced. Service results are to be published in a later article. The original 17-knot Victory ship was fitted with a propeller with which the full turbine power of 8,500 s.h.p. was developed at a speed of 81·1 r.p.m., giving the ship a speed of 16·8 knots. Although no pitting of the teeth of the reduction gearing has been reported, it was decided to develop a propeller which, with shock-free entry and Unistrength blade design, would absorb 8,500 s.h.p. at 82·5 r.p.m. Like the propeller of the 15-knot Victory ship, the new Lips design showed a markedly reduced tendency for cavitation compared with the original propeller. The C-3 ships as originally designed developed 8,500 s.h.p. at 81·8 propeller r.p.m., and had a speed of 16·7 knots. It was found that the pitch of the original propeller was too high for this power and that, as a result, the propeller-shaft torque and the pressure on the reduction gearing was too high. The thin section of the blade at the edges gave rise to a tendency for cracking. As a result, a propeller was designed to absorb the available power at 85 r.p.m., with the ship's speed remaining unchanged, and with shock-free entry and a thick leading edge. Particulars of the original and the modified propellers are tabulated in each case.—*J. A. van Aken, Schip en Werf, Vol. 19,1952; p. 343. Journal, The British Shipbuilding Research Association, Vol. 7, September 1952; Abstract No. 6,531.*

Compression-operated Fuel Pumps

The main propelling machinery of the Blue Funnel cargo liner *Alcinous* is fitted with the Archaouloff compression-gas-operated fuel system. This vessel is propelled by a two stroke, single acting, opposed piston engine of the Harland-B. and W. type, built under licence by John G. Kincaid and Co., Ltd. This engine develops 7,000-7,200 b.h.p. at 107 r.p.m., and the seven cylinders have a bore of 750 mm. and a combined stroke of 2,000 mm. The mean indicated pressure is 6 kg. per sq. cm. In the main, the engine follows the builders' standard practice, but the fuel injection equipment is the outcome of experiments carried out by the owners and Wilson and Kyle on the engine of a sister ship, the *Ascanius*, first with one cylinder and then with four. It was decided that the system afforded complete reliability of the propelling machinery, while the weight was slightly reduced, the noise diminished and the fuel consumption somewhat improved. As a result of the experiments on the *Ascanius*, and in anticipation of successful operation on the *Alcinous*, this system had already been specified as standard for every two stroke, single acting engine building for the Blue Funnel fleet—totalling eleven vessels. The Archaouloff fuel injection system has many advantages. In it the fuel pump, instead of having a mechanical drive, is operated by either compressed air or, as in this case, by gas passing from the engine cylinder. The Bergen S.S. Company's m.s. *Astrea*, which operates a weekly service between Newcastle-on-Tyne and Bergen, has engines fitted with compression-operated pumps of the type shown in Fig. 1. Each cylinder in this installation

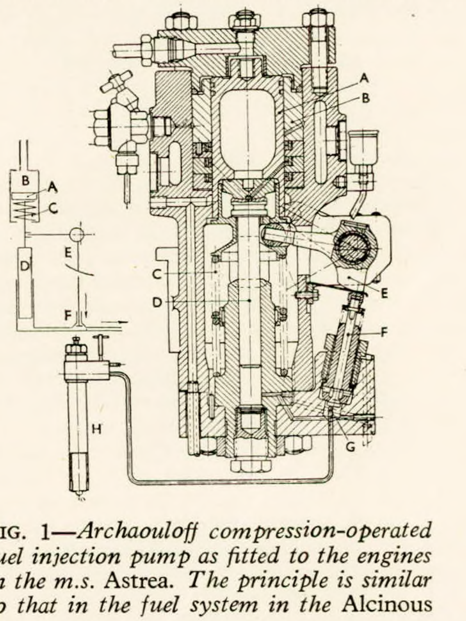


FIG. 1—*Archaouloff compression-operated fuel injection pump as fitted to the engines in the m.s.* Astrea. *The principle is similar to that in the fuel system in the* Alcinous

A—Compression piston. B—Cylinder. C—Return spring. D—Pump plunger. E—Quantity control lever. F—Suction and by-pass valve. G—Pump delivery. H—Injection valve.

develops only 400 h.p. At powers of about 1,000 b.h.p. per cylinder and above some difficulties apparently have been encountered with compression-operated pumps. This has been attributed to the size of the operating piston and to the fact that the quantity of gas being passed from the engine cylinder to the gas pump is almost trebled. Moreover, with the higher rating of the engine, the gas is hotter and the hot flame in the combustion chamber is swirled to the periphery, whence the gases are passed to the pump. However, with the successful development of this system, as is apparent on the engine of the *Alcinous*, many advantages are claimed. The need for the camshaft and cam-operated pumps is obviated, with the result that a cleaner and much more simple engine can be obtained. Without the need for the precision-built camshaft, cams, roller bearings, etc., the cost should be appreciably lower and the engine lighter, while, without the chain drive for the camshaft, the length may be reduced.—*The Motor Ship, Vol. 33, September 1952; pp. 216-218.*

Tests on Variable Pitch Propellers

Although their principles have been known for many years, variable-pitch propellers have only become generally available during the last two decades. It has been found that these propellers are fully as reliable as the fixed-blade type; and the designers have found it possible to accommodate the operating mechanism in a hub sufficiently small for the efficiency to be as high as that of the more conventional propeller. By making use of special blade sections, it has even been possible to obtain a propeller with a higher efficiency than that of a good standard-series propeller. The main advantages of a variable-pitch propeller are that the speed of the ship may be altered or the ship reversed while the main engines continue to turn in one direction at their most economical speed; that manœuvring may be controlled from the bridge; that the propeller can be set to operate at a high efficiency under varying conditions, i.e. towing and running free; and that savings are made in weight and space owing to the absence of reversing gear or astern turbines. The disadvantages are the initial expense, the maintenance required, and the susceptibility to damage. In the tests described in this paper, three model variable-pitch propellers were made and tested in conjunction with a model of a fishing vessel of length 98ft., and with an engine delivering 300 h.p. at 250 r.p.m. The model propellers differed by the design pitch to which the blades were made. The tests involved self-propelled trials with the propellers adjusted over a range of pitches, and hawser-pull tests with the vessel stationary and running at 4 knots. The results obtained are compared directly, without making any allowances for roughness and scale effect, and are presented in graphical and tabular form. The conclusions to be drawn from these tests are that in general the propeller whose design pitch is closest to the optimum pitch for the particular conditions encountered is the most efficient; this factor is, however, not unduly critical, since in the free-running condition a propeller whose designed pitch was 40 per cent below the optimum gave an efficiency, when adjusted to the optimum pitch, only two per cent of that of the propeller designed for the optimum conditions. At lower speeds, the decrease in efficiency of these propellers whose pitch had to be reduced, compared with that designed for these conditions, was rather more marked. The design pitch appeared to have only a small effect on the hawser pull developed. It is therefore suggested that, for ships which are required to have a high maximum speed, and at the same time good towing characteristics at a lower speed, the design pitch of the propeller should be that corresponding to the free-running speed. In the case of those vessels which, while not towing, will be spending a considerable proportion of their running time at speeds below the maximum, i.e. ferries or coasters making frequent use of canal system, the design pitch should lie between the optimum pitches for the main running speeds. This design pitch can best be determined by obtaining results for a number of design pitches, calculating the daily fuel consumption for each based on an estimate of the length of time spent at each speed, and extrapolating to obtain the pitch that will give the minimum fuel consumption. An example of this method of calculation is given.—*K. Tasseron, Schip en Werf, Vol. 19, 1952; p. 294. Journal, The British Shipbuilding Research Association, Vol. 7, September 1952; Abstract No. 6,530.*

Diesel Dredge for Indonesia

One of the most modern hydraulic pipeline dredges afloat was recently delivered by an American firm of dredge builders to the Republic of Indonesia. The new dredge, named the *Musi*, has a rated output of 650 cubic yards of solid material per hour at a maximum dredging depth of 39·4ft. below water. One of the most outstanding characteristics of this new dredge is that it is equipped for 24-hour operation. A crew of thirty-two men, representing three shifts, can be easily accommodated for an indefinite period. Complete living quarters, including a modern galley, two mess halls, refrigerating equipment and a recreation room help provide for such continuous operation. Engineering features of the *Musi* are of special interest. Inside diameters of the suction pipe and discharge pipe are 24 and 22 inch respectively. Two identical pumping units, each consisting of a Worthington turbo-charged Diesel engine of 1,320 horsepower directly connected to a 24-inch suction–22-inch discharge dredging pump, together have a rated output of 650 cubic yards of solid material per hour.—*Motorship, Vol. 37, August 1952; pp. 20-21.*

Twin-screw Cable Steamship

Built by Swan, Hunter and Wigham Richardson, Ltd., at their Neptune Yard, Walker, Newcastle-on-Tyne, for Cable and Wireless, Ltd., of London, the twin-screw cable steamship *Stanley Angwin* has recently entered her owners' service. Specially designed for laying and repairing submarine telegraph cables, the *Stanley Angwin* is the most modern ship of her type afloat. Operational requirements have necessitated the fitting of the propelling machinery aft. Constructed on the transverse framing system, the vessel has two complete steel decks (main and upper), a lower deck being arranged in way of the forward hold. Subdivision is effected by five main transverse watertight or oiltight bulkheads which extend to the main deck and subdivide the hull into six watertight compartments. The main propelling machinery, which has been constructed at the Neptune Works (Walker) of Swan, Hunter and Wigham Richardson, Ltd., comprises two sets of vertical triple-expansion steam engines. With cylinders 15, 25½ and 44 inch in diameter, and a stroke of 27 inch the engines are capable of developing a total of 1,450 i.h.p. at 104 r.p.m. Saturated steam at a pressure of 220lb. per sq. in. is generated in two single-ended multitubular Scotch boilers, which are designed to burn fuel oil under forced draught.—*The Shipbuilder and Marine Engine-Builder, Vol. 59, September 1952; pp. 547-552.*

Largest Quarterdecker Motorship

The single-screw cargo motorship *Hudson Deep*, built by John Readhead and Sons, Ltd., for the Hudson Steamship Co., Ltd., is a raised quarterdecker of 7,800 tons d.w., and is the largest vessel of this type to enter service. The *Hudson Deep* and her machinery are designed for a service speed of 12 knots at 109 r.p.m. and a fuel consumption of 13·5 tons per day. Loaded trials were carried out on the Newbiggin measured mile, with officials of the British Shipbuilding Research Association on board to carry out observations, and ten runs were made in all. During the seventh and eighth runs a mean speed of 13·214 knots was attained at 110 r.p.m. The ship has been designed specially for the carriage of bulk cargoes, for which purpose her five self-trimming holds, all arranged forward of the machinery, have extra large hatchways fitted with MacGregor patent steel covers. For added strength, longitudinal box girders are fitted on the raised quarter deck in way of the hatch coamings and the stringer plates have a thickness of 1·8 inch, being composed of two plates of 1-inch and

0·8-inch thickness riveted together. The main propelling machinery consists of a 4-cylinder N.E.M.-Doxford opposed-piston airless injection balanced oil engine designed to maintain a service output of 3,300 b.h.p. at 109 r.p.m., the diameter of the cylinders being 600 mm. and the stroke 2,320 mm. Operating at 3,000 b.h.p. and 106 r.p.m., it will give the ship a speed of about 12 knots. Two scavenge pumps are driven by levers from Nos. 1 and 2 centre connecting rods, and the following pumps are also lever driven: scavenging air pump; jacket and piston distilled water cooling pump (220 mm. by 510 mm., 150 tons/hr.); sea water cooling pump (240 mm. by 510 mm., 200 tons/hr.); and forced lubrication pump (110 mm. by 510 mm., 33 tons/hr.). The main fuel pump consists of four plunger rams driven at engine speed by the same chain that drives the camshaft, the independent fuel pressure priming pump being driven by an electric motor of $1\frac{1}{2}$ b.h.p. Steam for engineroom and deck auxiliaries is supplied by a three-furnace multitubular boiler with a length of 11ft. 6in. and an external diameter of 13ft. 9in., burning oil under Howden's system of "cold air" forced draught. The wing furnaces are arranged to accept exhaust gases from the main engine. There are two Weir feed water pumps, one for use as standby, and a Weir evaporator with a capacity of 20 tons per 24 hours.—*The Shipping World, Vol. 127, 17th September 1952; pp. 221-225.*

Improved Ljungstrom Air Heater

Referring to Fig. 7, the preheater comprises a rotor (10) divided into sector-shaped compartments, each containing a heat transfer mass and rotatable within an outer casing (11). On one side of the axis of the rotor is placed a flue gas passage (12) and on the opposite side of the axis is arranged an air flow passage (13). Air is caused to flow through the passage

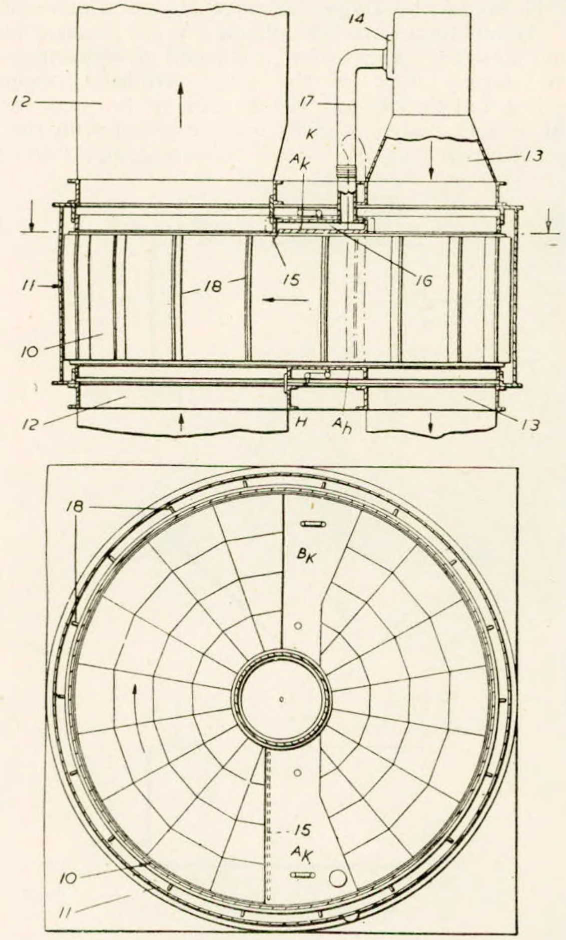


FIG. 7

by means of a blower (14). At the zone A leakage air that has passed both on the hot and the cold faces of the air preheater together with the carry-over air would normally be transported into the flue gas passage. The entry of air into this passage is limited to a thin strip below the separating sector plate A_k. The width of this entry place depends upon the rotational speed of the rotor (10) and upon the velocity of the flue gases within the passage (12). In accordance with the invention the sector plate A_k is formed larger than the normal section plate by the width of the entry place, and the plate at its rear edge is provided with a slit-shaped opening (15) extending along the entire length of the sector plate A_k. All leakage air must pass adjacent to the slit (15) before reaching the flue gas passage (12). Located on the outer face of sector plate A_k is a chamber (16) which, as shown in Fig. 7, is mounted on the walls of the gas passage and is in communication through a conduit (17) with a fan adapted to produce a somewhat higher vacuum than that prevailing in the flue gas passage (12). Preferably the conduit (17) communicates with the suction side of the blower (14). In consequence, air passes through the slit (15) and is sucked through conduit (17) back into the air passage (13). At the zone B the leakage air passing through the clearance spaces will pass in a direction of rotation of rotor (10) and thus opposite to the direction of flow of the carry-over gas. The leakage air enters the carry-over compartments of the rotor filled with gas and presses the gas back towards the flue gas passage. The two flows thus act in directions opposite to each other, and under certain conditions they may be arranged to neutralize one another completely. The sector compartments passing into the air passage at this transition zone will thus carry the leakage air, which has previously entered therein, back to the air passage.—*British Patent No. 676,129 issued to Aktiebolaget Ljungstroms Angturbin. Application made in Germany 9th February 1949. Complete specification published 23rd July 1952. Engineering and Boiler House Review, Vol. 67, September 1952; pp. 276-277.*

External Boiler Deposits

The problem of the fouling of watertube boilers by external deposits has received a considerable amount of attention from many investigators. In the present paper special attention has been given to the aspects of this trouble which are most concerned with the inorganic minerals in the coal and their behaviour in boiler systems. The different types of deposits are discussed, and correlations are suggested between the severity of trouble from these types and the amounts of various constituents such as chlorides, sulphur and phosphorus in the coals burnt. Consideration is also given to the factors influencing the vaporization of mineral substances in boilers and the subsequent condensation of these vapours on heating surfaces. In addition to the formation of bonded deposits due to chemical influences, other deposits are formed by physical means concerned directly with the temperatures of the gases and the metal heating surfaces.—*H. E. Crossley, Journal of The Institute of Fuel, Vol. 25, September 1952; pp. 221-225.*

Towing Tests

The model experiments described in this paper were carried out in order to determine the forces acting on a ship when anchored in a stream or tideway. Models of two ships were tested; these models were attached to the tank carriage, and the forces acting on them were measured at various speeds, angles of yaw, and conditions of trim. The resultant force was calculated, and the results obtained are tabulated. It appears that the speed has little effect on the coefficient of resistance when the angle of yaw is less than 45 degrees, while the mean draught is of greater importance than the trim. From the results obtained, the author develops expressions from which the equilibrium of a ship is determined when the forces acting are the wind, the current, and the force exerted by the anchor cable; in this manner the direction and rate of drift can be determined. The results are applied to a practical case in which a collision occurred between two vessels at anchor. It is concluded that for this to have happened in the prevailing conditions of wind and tide the vessel that dragged her anchor must originally have been lying in a different position from that asserted by her Master.—*G. Ambjörn, Trans. Chalmers Univ. Tech. (1952), No. 123. Journal, The British Shipbuilding Research Association, Vol. 7, September 1952; Abstract No. 6,523.*

14,000-ton Refrigerated Cargo Liner

The *Wellington Star* is practically a sister ship to the *Adelaide Star,* built in 1950, and is very similar to the *Tasmania Star,* also constructed in 1950, but with turbine machinery of about equal power to that in the motor vessels. The builders of the new ship were John Brown and Co., Ltd., and the owners are the Blue Star Line. The particulars are:—

Length o.a.	575ft.
Length b.p.	535ft.
Breadth	72ft. 6in.
Depth	40ft. 3in.
Deadweight capacity	14,000 tons
Service speed	16½-18 knots
Insulated space	449,860 cu. ft.
General cargo	399,254 cu. ft.
Passengers	12

The two six-cylinder Brown-Doxford propelling engines are of the standard design with a cylinder diameter of 725 mm. and a combined piston stroke of 2,250 mm., the total output being about 15,000 b.h.p. at 115 r.p.m.; the service speed is 18 knots. On trial a maximum speed of 21·127 knots was reached. As in the *Adelaide Star,* the machinery will run on heavy fuel, which is also used for starting and in river and coastal runs. The viscosity of the fuel will not exceed 1,500 secs. Redwood No. 1. The purifying arrangement is normal, with four De Laval separators, two acting as clarifiers and two as purifiers. They are installed in a separate compartment at the level of the second grating with the heaters adjoining. The fuel pipes are lagged and the fuel is maintained at a temperature of about 170 deg. F. The engines are fitted with a Bibby detuner and when this is locked there are no criticals. When the detuner is free, however, there are criticals at speeds of 79·7, 88·6, 99·7 and 114 r.p.m. and for continuous running the speed must not be within 3 r.p.m. of these figures. A torsionmeter is fitted to each propeller shaft. The main engines are of the standard Doxford type with distilled water cooling for the cylinders and the pistons and the controls are arranged at the forward end.—*The Motor Ship, Vol. 33, October 1952; pp. 256-259.*

German-built Dutch Cargo Liner

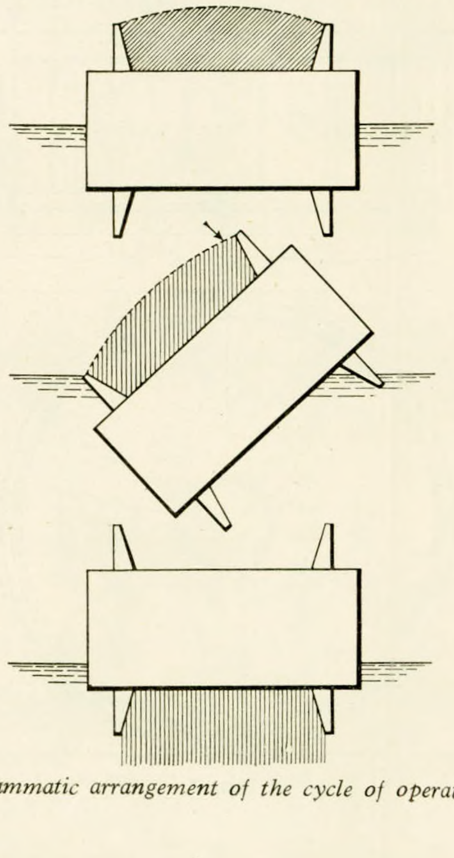
The 17-knot Rotterdam Lloyd motor cargo liner *Wonosari* from the Hamburg yard of Howaldtswerke A.G., is the first Dutch ship to be built in Germany since the war. A feature of this vessel is that it is fitted with one of the largest single-acting MAN engines yet built, this being a 10-cylinder unit of the two-stroke type, with a cylinder bore of 780 mm. and a stroke of 1,400 mm. Although the maximum output is 9,000 b.h.p. at 115 r.p.m., to suit the owner's requirements, it will have a service output of 7,500 s.h.p. at a corresponding engine speed of 110 r.p.m. The engine is equipped to burn heavy oil, having a viscosity up to 3,500 secs. Red. No. 1 at 100 deg. F. The engine is substantially welded, and scavenging air is partially supplied from the undersides of the working pistons, which form a scavenging pump for each cylinder. It is estimated that about two-thirds of the necessary air is provided in this manner; the remainder is supplied by the direct-driven scavenging pump.—*The Motor Ship, Vol. 33, October 1952; pp. 281-282.*

Keel Block Loads During Drydocking

As part of the study of the elastic behaviour of the transverse framing of naval vessels, dry-dock tests were performed on a destroyer during the summer of 1948. Since a knowledge of the magnitude and distribution of the external forces was required, it was necessary to provide a method of measuring and controlling the loads on the keel blocks. The maximum load has in the past been measured by installing compression test-pieces on the keel blocks, but these are not suitable for determining the load at any instant. The solution adopted was to insert three dynamometers under the wooden capping piece of each of a number of concrete keel blocks. Each dynamometer consisted of a steel cylinder to which electric-resistance strain gauges were attached. As the dock was pumped dry and the ship settled on the keel blocks, so the forces on these selected keel blocks could be determined. The measurement of the load was required as the ship settled, and then as the side blocks in way of the area under examination were removed. When the side blocks had been removed, it was desired to vary the load on the keel blocks according to a systematic procedure. To enable this to be done, each of the calibrated keel blocks was equipped with nine screw jacks. The strain-gauge readings for the desired load were calculated, and the jacks then adjusted until these readings were obtained. The design of the dynamometers and the keel block and jack assemblies is described and illustrated. The method of performing the tests is outlined, and the results obtained are tabulated. The system for measuring and controlling the loads proved satisfactory, and it is considered that it could be developed and permanently installed in dry docks to enable the loads on all keel blocks to be determined for any size of vessel.—*E. Wenk, Proc.Soc.Exp. Stress Analysis, Vol. 9, No. 2, 1952; p. 91. Journal, The British Shipbuilding Research Association, Vol. 7, September 1952; Abstract No. 6,563.*

Tilting Pontoons

The very difficult problem of dumping sticky waste materials has been overcome in a most original manner by I.H.C. Holland, The Hague, an organization comprising six Dutch shipbuilding yards specializing in the construction of dredging material. Their solution is based on elementary ship stability theory. One of the large petroleum companies approached I.H.C. Holland for a craft to be used for the removal of acid sludge, a sticky waste material with the very low specific gravity of 1·1. These builders designed and built



Diagrammatic arrangement of the cycle of operations the novel type of tilting pontoon which is here illustrated. These are ordinary pontoons except that the upper and lower surfaces are identical and serve alternately as bottom and load deck. These pontoons are completely suitable for the transport and dumping of all types of sticky material, and waste matter having a low specific gravity such as town refuse, waste material from chemical works, etc., the discharge of which from a normal tilting or dump barge is impossible or at the least very difficult. These pontoons operate as follows: When the deck has been loaded with the waste material, the pontoon is towed to the discharge point where a valve situated below the load water line is opened to permit the flooding of a side tank, which causes listing to the point of vanishing stability when the pontoon turns through 180 degrees and the load deck becomes the bottom. The load having now been discharged, the pontoon floats at her light draught and the side tank automatically empties through the valve already referred to which is still open and which has, of course come above the water line. This valve is then closed and the pontoon is ready for reloading in its original position.—*Shipbuilding and Shipping Record, Vol. 80, 28th August 1952; pp. 277-278.*

Oil Additive to Relieve Boiler Slagging

Significant results in relieving the problem of troublesome deposits on boiler tubes from the firing of residual fuel oil have been accomplished in both laboratory and field operations according to the Babcock and Wilcox Company, designers and manufacturers of steam generating equipment. Certain grades of oil such as Bunker C have long been recognized as having the disadvantage of containing ash contents, which, upon combustion, result in depositing on boiler heat transfer surfaces, particularly superheater tubes, a hard residue not readily removable by air or water lancing. Frequent interruptions in operation were required for thorough cleaning. This situation has been aggravated with the recent trend towards larger boilers with higher steam temperatures, and since an ash free fuel oil of this grade is not economically feasible, Babcock and Wilcox attacked the problem from the angle of controlling the characteristics of the ash deposits. Troublesome superheater deposits were found to be characterized by low-melting constituents, and laboratory work was carried out on selected materials that, when intimately mixed with the oil ash, would raise its melting point so that upon deposition on heating surface it would be dry and thus more readily removable by the customary means on an operating unit. The effect on fusing temperatures by intimately mixing synthetic oil ash with various additive compounds was studied. The next step in the investigation was to set up a pilot furnace for testing promising additives under simulated operating conditions. Additives in the form of finely divided materials suspended in the fuel and metallic organic compounds of the soap type (soluble or miscible with oil) were tried in the pilot-plant tests in various weight ratios to the ash in the oil. Alumina, magnesium oxide and calcium oxide were found to be the most promising of the additives tested in producing a powdery deposit that was easily removable from the coils. This contrasted with the hard, glassy, fused material that was formed when these additives were not used. Upon completion of the tests with alumina, a programme was initiated using dolomite as the additive. With the dolomite more of the fine powdery material was deposited in the first pass of the superheater. That section of the superheater extending into the second gas pass was found to be clean after a two-month operating period with dolomite, and the third gas pass, consisting only of saturated surface, was also clean. In addition to raising the fusing temperatures of ash, there are indications that the additives contribute another significant advantage in lowering the dew point of flue gases. The effect of dolomite on airheater corrosion is not yet fully known; however, the major constituent in the dolomite additive ash is $CaSO_4$, so that probably a much smaller amount of free SO_3 is present in the gases passing through the airheater. In general, the field tests with additives have indicated that it is commercially feasible to operate and to effect a real saving in the amount of labour required to keep a unit operably clean and operating efficiently with present day oil fuel. In addition, the corrosive quality of the gases from the stack is greatly reduced and the nuisance from flyash particles is not as great.—*The Log, Vol. 47, August 1952; pp. 51-52; 84.*

Gear Scuffing

The failure known as scuffing is a rapid form of local welding and tearing apart of minute particles from the opposing surfaces of bodies in sliding contact. On gears it tends to occur on the faces and flanks of the teeth under conditions of heavy surface loading in the regions of maximum sliding velocity. This failure, which is also known as "galling" or "scoring" in America, is the result of local breakdown of the adherent boundary layer of the lubricant, and must be clearly distinguished from pitting, the other form of surface failure which occurs on gear-teeth (usually near the pitch zone) and which is a surface fatigue failure of the gear material caused by excessive surface stress. To denote the anti-scuffing value of a lubricant, the term "film-strength" has been frequently used, but this is to be deprecated, since a fluid does not possess such a property. The lubrication of highly loaded gears is generally acknowledged to be boundary type—with very little assistance from any hydrodynamic film—and the scuffing load is a function of several other variables in addition to the properties of the boundary layer. A number of laboratory test machines have been devised, and are in use, for assessing the anti-scuffing properties of lubricants. In some of these an attempt has been made to reproduce the type of combined sliding and rolling action which occurs between gear-teeth, while in others the action is one of simple sliding, but the rating of lubricants by these machines is not always found in practice to agree with their rating in service as gear lubricants. It would seem that the best method of testing gear lubricants is by lubricating gears with them. The present paper gives a summary of investigations into some of the factors affecting gear scuffing, which have been carried out over a number of years by the Motor Industry Research Association and its predecessor the Institution of Automobile Engineers Research Department. These investigations were made in the I.A.E. 3¼-inch gear-lubricant testing machine, in which actual toothed gears are used as test specimens. A description of the machine, of the gears used in it, and of the development of the machine is included.—*H. D. Mansion, Journal of The Institute of Petroleum, Vol. 38, August 1952; pp. 633-645.*

Gear Tooth Wear

The engagement of the load-bearing areas in the gear assembly may be regarded as compounded of rolling and sliding motions. It is well known that, when two clean metallic surfaces are brought into contact, cohesion occurs across the interface and causes them to seize together. In practice, however, bearing surfaces are covered with thin films of oxidation products, adsorbed gases and vapours, and lubricant molecules, and it is between these films that contact occurs. The cohesive forces between such layers are small compared with the forces between the atoms in the bulk of the metal; hence, on parting the surfaces, separation occurs relatively easily within these non-metallic layers. But if the loading intensity is sufficiently high to cause such deformation of the underlying metal that the surface layers become stretched and ruptured so that metal is exposed, intermetallic contact and strong cohesion may ensue. It is evident, therefore, that in this case resistance to seizure is not primarily determined by the properties of the surface layers, but is related to the ability of the underlying metal to resist deformation and hence to support these layers. Consequently, surfaces which are pressed together without shear to a high loading intensity should consist of metals of high rigidities. A similar conclusion may be drawn for surfaces in rolling contact, as occurs in part of the contact cycle of the gear-tooth. Some measure of shear, which can be intermittent, may, however, occur between the surfaces, owing to elastic deformation and hysteresis in elastic recovery. In the pitch-line region of the gear-tooth, where the rolling is between surfaces of similar curvature, elastic deformation should not result in shear, provided the surfaces have the same rigidity. When a critical load intensity is exceeded the surfaces may rumple, or suffer fatigue failure after repeated application of the load. The severity of conditions is accentuated when the purely rolling mechanism of progressive load transfer from one region to another of the mating surfaces is accompanied by sliding shear. It now becomes possible for any boundary lubricant film to be sheared or rubbed away to expose the oxide layers. These in turn may become disrupted and give rise to compacted particles of debris which become foci of excessive loading intensity leading to plastic deformation of the underlying metal and possible local seizure. Once formed, such a weld tends to increase in extent as a result of the sliding motion. A weld will not, in general, shear in the plane of sliding; for the material at the junction is work-hardened, and the distribution of stress about the junction is generally such that failure will occur within the bulk of one surface, so that a fragment of metal will be torn out of one surface and left adhering to the other. This fragment will then score and tend to seize again to the surface sliding past it, and so the damage becomes progressively worse.—*G. I. Finch and R. T. Spurr, Journal of The Institute of Petroleum, Vol. 38, August 1952; pp. 623-624.*

Solid Fuel Fired Gas Turbine Plant

While up to the present gas turbines have generally been operated with gas produced from liquid or gaseous fuels, the present invention has for its object the building of a gas turbine power plant for operation with combustion gases produced from solid fuel. Referring to Fig. 5, in the plant for the gasification and complete combustion of the solid fuel under pressure, the fuel is first of all gasified in the gas producer (1), a quantity of air being added which is just adequate for gasification or not appreciably greater. The gas which results from the gasification process is passed through pipe (9) to the dust separator (10), after which it flows through pipe (11) to a combustion chamber (12). These pipes and also the dust separator have to be cooled if the gases coming from the producer have a temperature exceeding 600 to 700 deg. C. The greater part of the ash contained in the coal has already been removed through the ash sluice (5). The volume of the gas stream flowing from the gas producer is considerably smaller than that of the motive gas afterwards produced in the combustion chamber (12) with the addition of further air, with the result that the separator (10) for removing the fine dust particles contained in the gas can be made relatively small. In the combustion chamber (12) the producer gas, together with a slight excess of fresh air, supplied under pressure through pipe (13) from a compressor, is completely burnt to form motive gas which is then passed to at least one gas turbine (14). The gas turbine of a plant according to the invention produces a very high power due to the high temperature of the motive gas. In addition, there is also the output of the steam turbine plant in which additional useful power is produced from the waste heat and the heat in the cooling water.—*British Patent No. 675,583, issued to A.G. Brown Boveri et Cie. Application made in Switzerland 4th September 1948. Complete specification published 16th July 1952. Engineering and Boiler House Review, Vol. 67, September 1952; pp. 275-276.*

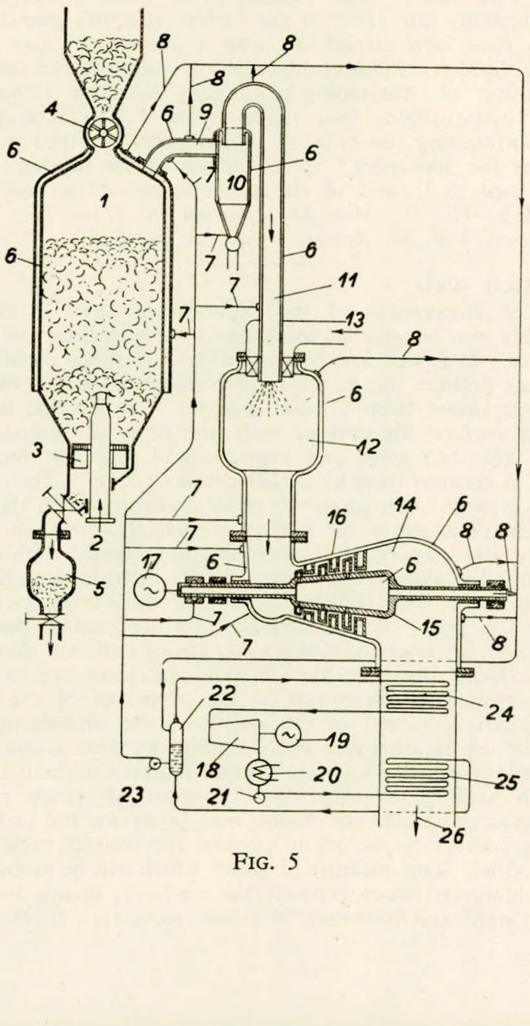


FIG. 5

Corrosion in Condenser Systems

The thirty-second annual report of the British Non-Ferrous Metals Research Association states that there is still a need for work in the study of corrosion in condenser systems and other parts of marine water systems. In the year under review, further laboratory tests have been completed on the behaviour of existing materials for marine water service when they are exposed to impingement attack by high velocity water carrying entrained air bubbles. As in the earlier tests, the results have been reassuring in that the proved alloys have stood up well under what appear to be more severe conditions of exposure than are normally encountered in existing equipment. One of the alloys developed for marine water services is required to be fabricated into various forms with much the same facility as copper and, while this appears to be possible in most cases, some troubles have been encountered in copper-smithing the alloy. It is thought that the reasons for these troubles are largely understood, but further experimental work has been done and is continuing with a view to advising members of manufacturing conditions to produce materials less likely to cause trouble in subsequent fabrication. The aluminium brasses, which have deservedly gained an excellent reputation for resistance to impingement attack, occasionally pit in waters heavily contaminated with organic matter, and this subject is among the items of further work now in hand.—*The Marine Engineer and Naval Architect, Vol. 75, September 1952; p. 422.*

Heat Transfer by Gas Conduction in Fibrous Insulation

Thermal conductivity measurements were made on samples of an experimental glass fibrous insulation ranging in density from 0·5 to 8·4lb. per cu. ft. Tests were carried out at atmospheric pressure with four different gases in the insulation samples, and the thermal conductivity with air was studied over a pressure range of 1 micron to 760 mm. of Hg. Gas conduction is the most important mechanism of heat transfer. A theory of gas conduction in fibrous insulations was developed, and agrees well with experimental results. Theoretical considerations of heat transfer by radiation were confirmed by the experimental thermal conductivity values at low pressure. Methods are discussed of producing considerable reduction in the thermal conductivity of fibrous insulations.—*J. D. Verschoor and P. Greebler, Trans.A.S.M.E., Vol. 74, August 1952; pp. 961-968.*

ENGINEERING ABSTRACTS

Section 3. Shipbuilding and Marine Engineering

Compiled and published by The Institute of Marine Engineers in co-operation with The Institution of Naval Architects.

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Control Device for Voith Schneider Propeller

Mechanism for the control of a Voith Schneider propeller is illustrated in Fig. 1. Located within the hollow propeller shaft (1) is a control shaft (8) having a crank (9) at the lower end. The crankpin (10) carries a sliding block (11). The forked lever (12) rotates about the pin (13) fixed to the body of the vane wheel. Each of the pins in a complete drive is coupled to a connecting rod (14) with a vane lever (16) fixed to the vane (15). By turning the control shaft (8) the crankpin (10), acting as the centre for rocking the vanes, is revolved in a circle around the axis of the propeller and the jet produced has its direction changed. The radius (17) determines the amount of the propeller pitch. The crankpin (10) is secured in the crank (9) by an eccentric bolt (18). The extent of eccentricity amounts to 5 per cent of the radius (19) and by easing a nut (20), the bolt can be turned and the radius on which the centre of the pin (10) lies can thus be altered. The pitch is thereby set to correspond with the speed of the engine.—*British Patent No. 673,230. J. M. Voith, G.m.b.H., Heidenheim/Brenz. The Motor Ship, Vol. 33, October 1952. p. 290.*

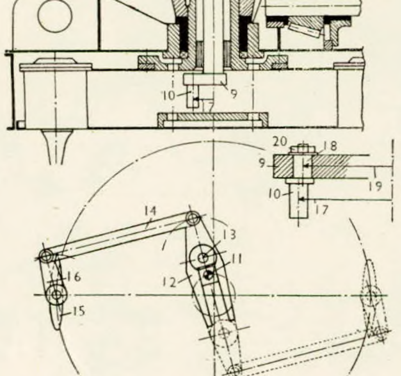


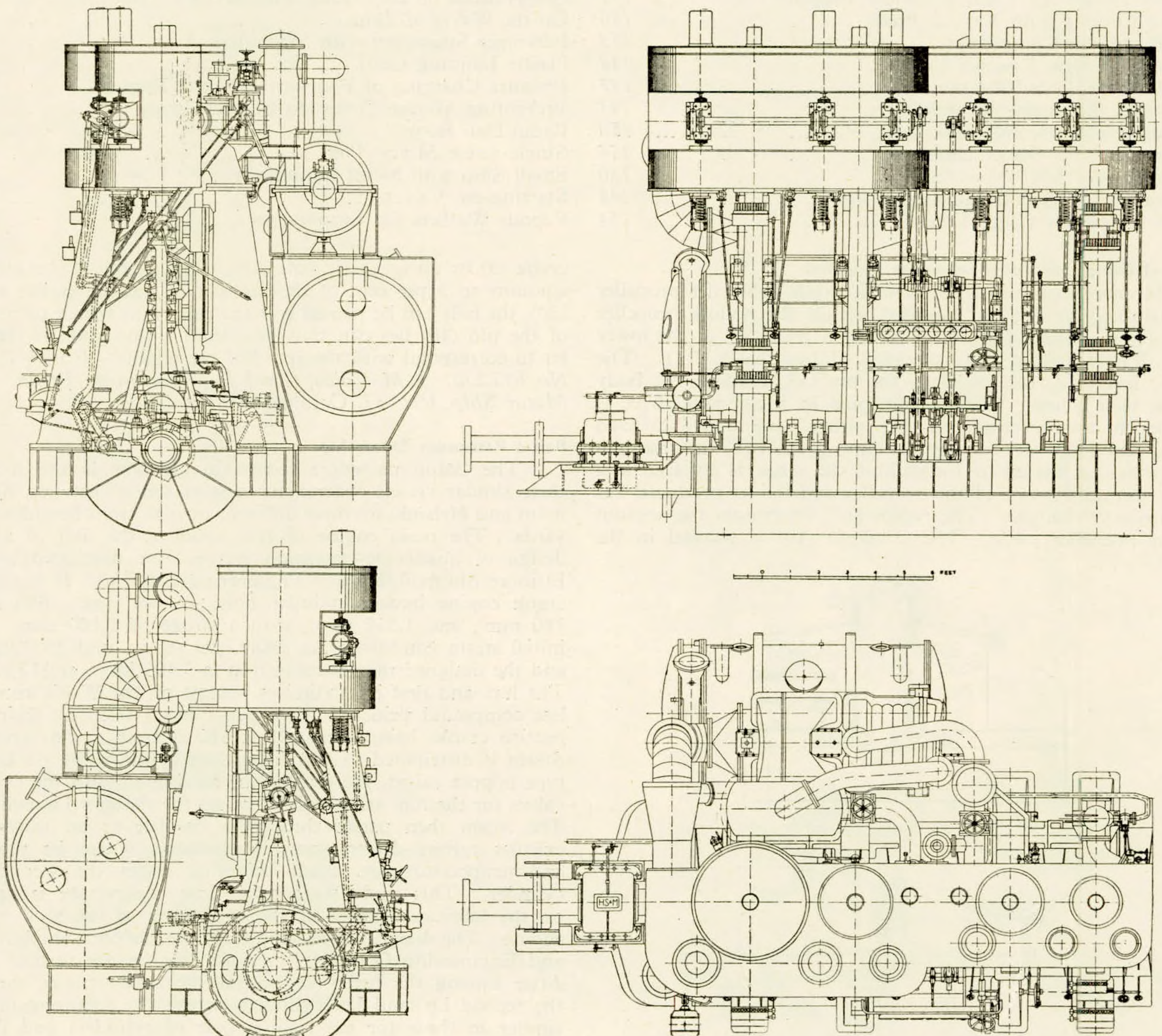
Fig. 1

Baltic Passenger Steamship

The Baltic passenger steamship *Aallotar* is the first of three similar vessels ordered for a joint service between Stockholm and Helsinki by three different owners from Scandinavian yards. The main engine of this vessel is the first of a new design of quadruple-expansion reciprocator developed by the Elsinore Shipbuilding and Engineering Co., Ltd. It is a four-crank engine having cylinder bores of 460 mm., 680 mm., 780 mm., and 1,350 mm., with a stroke of 1,100 mm. The initial steam conditions are 290lb. per sq. in. and 590 deg. F. and the designed maximum output is 3,400 i.h.p. at 113 r.p.m. The h.p. and first i.p. cylinders operate on the Woolf receiverless compound principle with direct steam transfer, their respective cranks being arranged at 180 degrees to one another. Steam is distributed to and from these cylinders by six Lentz-type poppet valves, the centre pair serving as both the exhaust valves for the h.p. and the inlet valves for the first i.p. cylinder. The steam then passes through a de-oiler to an inter-stage exhaust turbine-driven steam compressor, where its pressure and temperature are raised before it enters the second i.p. cylinder. This multi-stage axial flow compressor is carried on the fabricated frame of the condenser, at the back of the engine. The design has resulted from the Elsinore Shipbuilding and Engineering Company's research in the gas turbine field. After leaving the turbo-compressor the steam passes through the second i.p. and l.p. cylinders, where the arrangements are similar to those for the leading pair of cylinders and finally reaches the condenser via the exhaust turbine. The bedplate and condenser shell are fabricated from steel plate and columns are of cast iron. The unusual rectangular crosshead guides and box-pattern slippers can be clearly seen in the illustrations. The valves for each pair of cylinders are operated by oscillating cams in the usual Lentz manner, and the two camshafts are actuated by single-eccentric Klug valve motion arranged between the first and second i.p. columns. The Elsinore quadruple-expansion engine has a relatively late cut-off and a small expansion, in contrast to the normal Lentz-type engine employing the Woolf compound principle. The customary difficulty of obtaining a short exhaust lead from the single-eccentric Klug valve motion does not arise. The opposite in fact is the case, with the result that the reversing frame has had to be moved so close to the push rods which transfer motion to the camshaft that offset heads have been necessary in order to clear the frame. Steam is supplied at 290lb. per sq. in. and 590 deg. F., by two oil-fired Elsinore-Babcock and Wilcox integral-furnace watertube boilers, each with a normal evaporation of 18,740lb. of steam per hour. These are of the same two-drum design, with steam cyclones in the upper drums. With steam supplied to the h.p. cylinder at 290lb. per sq. in. and 590 deg. F., the turbo-compressor ran at 6,400 r.p.m., corresponding to 3,200 i.h.p. of the main engine, to raise the pressure of the steam between the first and second i.p. cylinders from 28·5 to 71lb. per sq. in. The normal compressor r.p.m. is 6,000, corresponding to the service power of 2,300 i.h.p.—*The Marine Engineer and Naval Architect, Vol. 75, September 1952; pp. 392-398.*

Aluminium Alloy for Elevated Temperature Service

According to a report published by the Naval Research Laboratory (U.S.A.), an alloy of aluminium with mischmetal (50 per cent cerium and the rest other rare earths, including lanthanum) shows considerable promise as a high temperature alloy in comparison with the conventional age hardening aluminium alloys which seem to be limited in long-time use to 600 deg. F. and less. Preliminary trials indicated the following composition as optimum: 11 per cent mischmetal, 2 per cent Si, 1·5 per cent Cu, 1·25 per cent Ni, 1·0 per cent Mn, 0·3 per cent Cr, 0·02 per cent Ti, balance aluminium. The natural mixture of rare earths seemed to be desirable, since a similar alloy made with commercially pure cerium did not have such good high-temperature properties. With a suitable melting and alloying technique, using a graphite crucible and induction heating, there was practically no melting loss of the mischmetal, and segregation was avoided. Fluidity tests showed that minimum casting temperature should be 1,400 deg. F.,



The Elsinore quadruple expansion engine with turbo-compressor and 1,500 deg. F. for thin sections. Casting temperatures as high as 1,800 deg. F. had no ill effect on the high temperature strength. The special aluminium mischmetal (SAM) alloy forges easily at 1,100 deg. F., which results in an increase in elongation from 0·5 per cent (as cast) to 10 per cent, and in Vickers hardness from 52 to 62, but a drastic reduction in elongation, probably due to the breaking down of the fine interlocking acicular structure of the casting. Tests at elevated temperature showed that the properties of SAM alloy were of quite a different order of magnitude from the age hardening aluminium alloys even though at room temperature SAM alloy is inferior. Thus, the following results were obtained for SAM alloy in comparison with Y alloy:—

	Y alloy	SAM alloy
Room temperature		
Ultimate strength	29,000lb. per sq. in.	15,000lb. per sq. in.
Elongation ...	1·0 per cent	1·0 per cent
Short-time tensile tests at 800 deg. F.		
Ultimate strength	5,500lb. per sq. in.	9,000lb. per sq. in.
Time to fracture under 4,000lb. per sq. in. at 800 deg. F. ...	1 min. (max.)	9 to 40 hr.

—*Light Metals Bulletin, Vol. 14, No. 16, 1st August 1952; pp. 623-625.*

Passenger Steamship with Machinery Aft

The *El Djezair* is a vessel of remarkable appearance, having a profile perhaps unique among passenger ships, owing to the disposition of her machinery at the after end of the hull. She has been built by the Forges et Chantiers de la Mediterranée (la Seyne) under the special survey of the Bureau Veritas. The hull is framed on the transverse system and is largely welded, the decks, bulkheads and double bottom being assembled by prefabrication and welding. There are three continuous decks. Owing to the high freeboard of the vessel and to increase the deadweight capacity, light alloys have been used extensively on C deck sections of the ship, the promenade deck and the boat deck. The ten lifeboats are also built of light alloy. The main particulars of the *El Djezair* are as follows:—

Length overall	433ft. 7in.
Length b.p.	413ft. 9in.
Moulded breadth	59ft. 5in.
Depth to upper deck	28ft. 6in.
Loaded draught	21ft. 8in.
Gross tonnage	9,100 tons
Deadweight capacity (cargo) ...	2,175 tons
Service power	12,000 s.h.p.
Designed service speed	20·5 knots
Maximum trial speed	23·25 knots

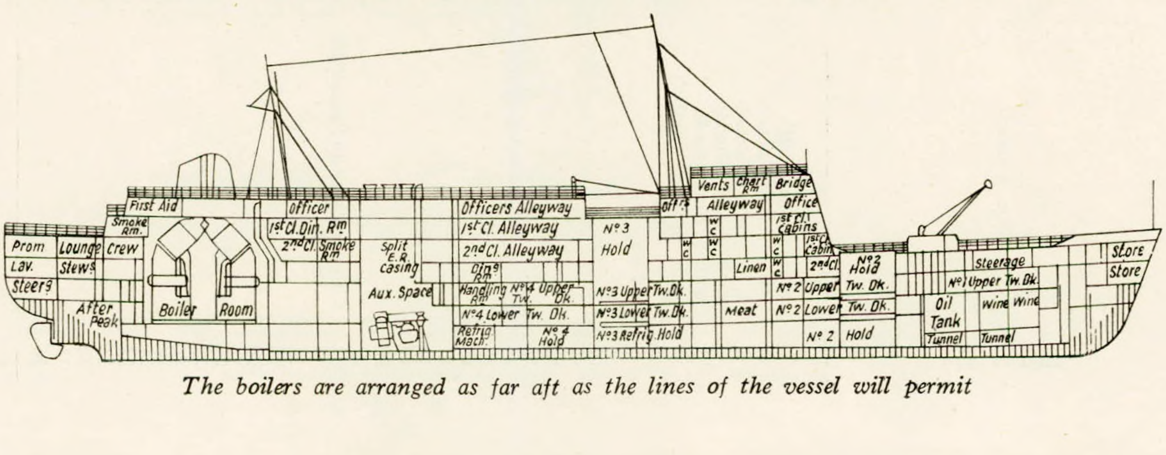
Twin-screw three-casing geared turbines capable of developing 12,000 s.h.p. at 180 r.p.m. are installed in a compartment situated at approximately one-third of the ship's length from the after perpendicular. Steam is generated at 350lb. per sq. in. and 710 deg. F. in two La Mont forced circulation boilers, each of which has a capacity of 66,000/88,000lb. of steam per hour. The boilers are arranged in echelon fore and aft in the space at platform level immediately forward of the after peak bulkhead. They are end-fired from a central aisle and, with the exception of the front walls which carry four Todd oil burners, all the combustion chamber surfaces are of waterwall type.—*The Marine Engineer and Naval Architect, Vol. 75, August 1952; pp. 360-362.*

High-wear Resistance Materials

In spite of its utmost importance in engineering problems, a better understanding of the real mechanism of the wear of metals is still lacking. In fact, the vast mass of empirical data extant has resulted in a number of unrelated and even conflicting statements, some true, some half-true, some perhaps not true at all. Logical approach to the problem leads to the conclusion that the ability of a surface to deflect out of the way of asperities on a moving mating surface or foreign particles and to spring back again seems to be important in wear resistance. Large amounts of elastic deflexion may be achieved by the selection of a material which has high strength and hardness and a low modulus of elasticity. This desirable combination of properties does not commonly occur in metals, but both the elastic limit and the modulus of elasticity of metals can be controlled within certain limits. Thus, there exists for the future considerable latitude in increasing the total elastic deflexion of metals or related materials with a view to increasing their wear resistance. The correctness of this concept of wear resistance is borne out by the fact that materials which are normally considered abrasive possess excellent wear resistance. This has been proved by tests conducted on cylinder liners of alundum. In addition to freedom from liner wear, the wear rate of the piston rings was also found to be greatly reduced. With economical methods of manufacturing alumina wearing surfaces, this material may therefore become generally accepted for this and other purposes.—*The Engineers' Digest, Vol. 13, September 1952; pp. 285-286.*

Observations on Experience with Welded Ships

This survey, which discusses the failures of welded ships of American construction, lists the total casualties suffered in the table reproduced here. For statistical purposes it has been assumed that the Liberty ships can roughly be divided into six broad classifications as indicated by lines (1) to (6) in Table I. This table has been compiled to show the service records of all the different types of ocean-going merchant ships built to class with the American Bureau of Shipping in quantities since just prior to the war and in which welding was used to any great extent. However, there have been omitted the records of two comparatively small groups of refrigerated cargo ships, since it is generally accepted that a number of the casualties reported in these ships resulted from the abnormally low temperatures to which the steel was subjected. For purposes of comparison, the figures for the all-welded ships



The boilers are arranged as far aft as the lines of the vessel will permit

TABLE I.—NUMBER OF CASUALTIES AND LENGTH OF SERVICE UP TO 31ST MARCH, 1952 FOR VESSELS OVER 300 FT. IN LENGTH BUILT TO CLASSIFICATION WITH THE AMERICAN BUREAU OF SHIPPING FROM 1938 UNTIL THE ADOPTION OF NEW STEEL SPECIFICATIONS (1948). (NOTE 5).

Line number	Type of vessel	Length (approx.)	Amount of riveting	All-welded ships: Number of ships compiling service record	All-welded ships: Length of service record (ship-years)	All-welded ships: Number of casualties group I	All-welded ships: Number of casualties group II	All-welded ships: Total number of casualties groups I and II	All-welded ships: Number of casualties groups I and II per 100 ship-years	Ships with some riveting: Number of ships compiling service record	Ships with some riveting: Length of service record (ship-years)	Ships with some riveting: Number of casualties group I	Ships with some riveting: Number of casualties group II	Ships with some riveting: Total number of casualties groups I and II	Ships with some riveting: Number of casualties groups I and II per 100 ship-years	Line number
	Liberty ships	417′ 8″														
1	with original details		None[1]	1,220	2,100	88	320	408	19·45							1
2	with improved details		None[1]	1,890	2,600	14	80	94	3·62							2
3	with improved details		Gunwale connection[2]							1,057[4]	4,435	21	91	112	2·51	3
4	with improved details		Gunwale connection[2]							497	2,250	10	50	60	2·67	4
5	with original details		All shell seams							208	330	1	16	17	5·15	5
6	with improved details		All shell seams[3]							313	1,713	2	42	44	2·57	6
7	Victory ships	436′ 6″	Gunwale angle							414	2,450	4	12	16	0·65	7
8	C1M ships	321′ 4″	Gunwale angle							218	1,020	2	0	2	0·20	8
9		365′	Side shell seams and gunwale							9	41	0	0	0	0	9
10		390′	None	46	190	1	8	9	4·74							10
11		390′	All shell seams							19	109	0	8	8	7·35	11
12		395′	None	10	70	0	6	6	8·58							12
13		395′	All shell seams							85	462	5	21	26	5·62	13
14		400′	All shell and deck seams							4	41	0	2	2	4·88	14
15		425′	Gunwale angle							14	59	0	0	0	0	15
16		425′	Side shell seams and gunwale							6	24	0	0	0	0	16
17		427′	None	3	29	1	1	2	6·90							17
18		431′	Gunwale angle							6	41	0	0	0	0	18
19		431′	Side shell seams and gunwale							3	12	0	0	0	0	19
20		435′	None	117	589	2	5	7	1·19							20
21		435′	Side shell seams							64	478	3	5	8	1·67	21
22	Cargo or cargo and passenger vessels	435′	All shell seams							33	298	0	14	14	4·70	22
23		445′	None	30	67	2	4	6	8·95							23
24		445′	Gunwale connection and deck strap							15[4]	96	2	5	7	7·28	24
25		445′	Gunwale angle and hatch coaming							9	60	0	2	2	3·33	25
26		450′	All shell seams							21	184	0	1	1	0·54	26
27		465′	None	138	960	6	40	46	4·79							27
28		465′	Gunwale connection							3	16	0	0	0	0	28
29		465′	Side shell seams							5	41	0	0	0	0	29
30		465′	Side shell seams and gunwale							11	65	0	0	0	0	30
31		465′	All shell seams							18	164	1	1	2	1·22	31
32		465′	All shell and deck seams and gunwale							9	89	0	0	0	0	32
33		496′ 7″	None	44	218	1	8	9	4·13							33
34		496′ 7″	Riveted gunwale							31	152	1	1	2	1·32	34
35		573′	Side shell seams							11	82	0	0	0	0	35
36		573′	All shell seams							10	71	0	0	0	0	36
37	Sub-totals for cargo or cargo and passenger vessels		All-welded ships	3,498	6,823	115	472	587	8·60							37
38			Ships with riveting added							1,072	4,531	23	96	119	2·62	38
39			Ships built with some riveting							2,021	10,252	29	175	204	1·99	39

40	T-2 tankers	503′	None	502	1,483	28	69	97	6·53							40
41			Riveted straps or girders							492(4)	1,772	21	43	64	3·61	41
42	T-1-M tankers	309′	None	29	117	1	0	1	0·85							42
43			Riveted straps							3(4)	8	0	0	0	0	43
44	Tankers	450′	None	2	18	1	0	1	5·55							44
45		450′	Side shell and deck seams							4	41	0	0	0	0	45
46		487′	All shell and deck seams							5	38	0	1	1	2·63	46
47		487′	Side shell and deck seams							34	214	0	1	1	0·47	47
48		500′	None	8	50	0	6	6	12·00							48
49		500′	Side shell and deck seams							14	135	2	7	9	6·67	49
50		505′	All shell and deck seams							4	22	0	0	0	0	50
51		505′	Side shell and deck seams							2	20	0	0	0	0	51
52		521′	None	23	149	3	8	11	7·38							52
53		521′	4 or 8 riveted straps							10(4)	57	1	8	9	15·80	53
54		525′	All shell and deck seams							31	276	0	4	4	1·45	54
55		541′	None	5	31	0	2	2	6·44							55
56	Sub-total for tankers		All-welded ships	569	1,848	33	85	118	6·39							56
57			Ships with riveting added							505	1,837	22	51	73	3·98	57
58			Ships built with some riveting							94	754	2	13	15	2·01	58
59	Grand totals		All-welded ships	4,067	8,671	148	557	705	8·13							59
60			Ships with riveting added							1,577	6,360	45	147	192	3·01	60
61			Ships built with some riveting							2,115	10,998	31	188	219	1·99	61

Note (1) In some cases frames were riveted but in all other respects vessels were entirely welded.
Note (2) In some cases vessels also had a riveted seam strap in upper deck.
Note (3) In some cases vessels also had a riveted gunwale angle and a riveted seam strap in upper deck.
Note (4) The riveting in these vessels was added after the vessels had had some service as all welded vessels.
Note (5) In this table there have been excluded two small groups of special refrigerated type vessels.

have been set apart from those for the ships with some riveted longitudinal joints and in the latter cases the number of such joints has been indicated. There is no differentiation as to the method of attaching vertical side frames; ships which have riveted side frames but which are otherwise all-welded are classified as being all-welded. In the table are given the number of ships of each group contributing to the service record and the number of ship-years comprising the record. It should be noted that in some types the same ship may have contributed to the service record of more than one group owing to the classification as to type having been changed. For instance, an all-welded Liberty ship which commenced service with original details, then later had the improvements made and still later had riveted crack arrestors installed will appear in the count of 1,220, 1,890 and 1,057 ships contributing to the service records of each of the first three types of ships listed, but only that length of time at which she was operated in the respective condition is included in the ship-year count. Since all of the all-welded Liberty ships with original details and all of the riveted seam Liberty ships with original details in class with the American Bureau have had improved details there are no longer being accumulated any additional service records for these two types and the figures given are final. With very few exceptions all of the all-welded Liberty ships with improved details have had riveted crack arrestors fitted so that the figures for this type are very near to being final. All of the T2 tankers in class with the Bureau have had at least four riveted crack arrestors since 1948 so that the figures for the all-welded T2 tankers became final at that time.—*D. P. Brown, The Welding Journal, Vol. 31, September 1952; pp. 765-782.*

Arc Welding of Low Chromium-molybdenum Steel Pipe

On the basis of the results obtained in this investigation of the arc welding of 0·5 per cent Cr - 0·5 per cent Mo steel pipe, it is concluded that:—

1. Welds of satisfactory quality and properties can be made in all positions, using either 0·5 per cent Cr - 0·5 per cent Mo or 1 per cent Cr - 0·5 per cent Mo low-hydrogen electrodes without preheating or postweld heat treatment.

2. The properties of welds made with conventional 0·5 per cent Cr - 0·5 per cent Mo cellulose-titania electrodes, either with or without preheating and postweld heat treating, were inferior to those of the low-hydrogen electrode welds, as-welded.

3. None of the welds made in this investigation could pass the free-bend test because the weld metal has considerably higher strength than the parent plate. However, other tests indicated adequate ductility, for the low-hydrogen electrode welds in particular.

4. The impact properties of low-hydrogen welds are adequate, both at room temperature and at somewhat lower temperatures. The transition temperatures for the low-hydrogen weld metals, as-welded, are lower than that of the parent metal, based on either of the criteria of 50 per cent of maximum absorbed energy or of a 15-ft.-lb. level of absorbed energy.

5. Prefreeze and interpass temperatures of −60 deg. F. have little, if any, effect on low-hydrogen welds in 0·5 per cent Cr - 0·5 per cent Mo steel pipe, as judged by the fact that subsequently they exhibit adequate room temperature physical properties.

6. A postweld heat treatment of up to 8 hr. at 1,050 deg. F. produces no improvement in physical properties and no significant metallurgical changes in low-hydrogen electrode welds in 0·5 per cent Mo steel pipe. However, some impairment of low-temperature impact properties is produced by this treatment, since the transition temperature is increased appreciably.

7. Postweld heat treatment of 16 hr. at 1,200 deg. F. or, possibly, about 1-2 hr. at 1,250 deg. F. produces relatively little improvement in the properties, some reduction in weld metal and heat-affected zone hardnesses, no appreciable metallurgical changes and relatively little change in impact properties, both at room temperature and at somewhat lower tem-

peratures (transition temperature), of low-hydrogen welds in 0·5 per cent Cr - 0·5 per cent Mo steel pipe.

8. Weldability and usability characteristics of the 0·5 per cent Cr - 0·5 per cent Mo and 1 per cent Cr - 0·5 per cent Mo low-hydrogen electrodes were found to be very good. Satisfactory welds were made in 0·5 per cent Cr - 0·5 per cent Mo steel pipe, in the as-welded condition, for all positions of welding, and at pipe temperatures as low as −60 deg. F.

9. In order to avoid weld metal hardnesses, in the as-welded condition, which may be excessive, it appears desirable to limit the maximum chromium content of the electrodes to 1 per cent. Likewise, low-hydrogen electrodes which deposit 0·5 per cent Cr - 0·5 per cent Mo weld metal are preferable to the 1 per cent Cr - 0·5 per cent Mo varieties.

10. The low-hydrogen electrode is somewhat more difficult to use than the conventional cellulosic-type electrode, but adequate training of welding operators can readily eliminate this difficulty.

11. Although this investigation was concerned specifically with the arc welding of 0·5 per cent Cr - 0·5 per cent Mo steel pipe, 5-inch o.d. by 0·750-inch wall thickness, the results are considered to be applicable to other size pipes or tubes, and to plates up to ¾ inch in thickness, whose chemical composition is similar.—*J. Bland, L. J. Privoznik and F. J. Winsor, The Welding Journal, Vol. 31, September 1952; pp. 783-791.*

New Sulzer Diesel Engine Features

In the standardized large Sulzer marine engine (built in two types with cylinder diameters of 600 mm. and 720 mm. respectively), various new design features have been incorporated. The larger unit, with a piston stroke of 1,250 mm. develops 700 b.h.p. at 125 r.p.m. and scores of engines of the class have been built. In the new Sulzer fuel pump (Fig. 1) the weight of the moving parts has been reduced to the admissible limit, so as to cut down the acceleration forces to be overcome by the return spring and thus to maintain good contact between the roller and the cam running surface during the downward stroke of the pump plunger. The new double-acting starting-air valve in the Sulzer engine is illustrated in Fig. 2. The essential feature of this design is that the closing, as well as the opening, process is controlled accurately and with considerable force, so that no delay occurs. The consumption of starting air per manœuvre is in this way reduced to a minimum. The braking of the engine during the reversing process is also rendered very rapid and efficacious. As measurements made during trials have shown, it is, for instance, possible, when reversing from full speed ahead at 120 r.p.m. and at a starting-air pressure of 355lb. per sq. in. to attain a mean indicated braking pressure of 55lb. per sq. in. in the working cylinders (Fig. 3). The top diagram shows the lift of the

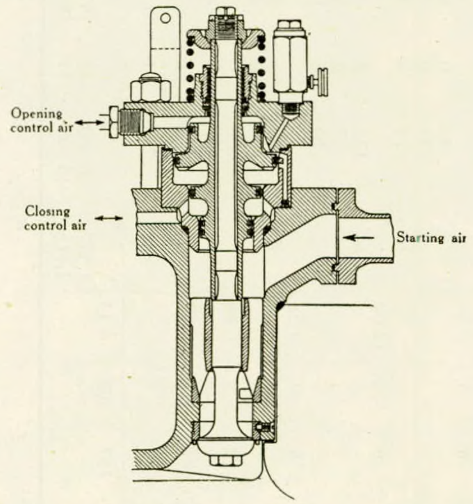


FIG. 2—*Cross-section through the starting-air valve*

starting-air valve, as a function of the piston stroke; below, the indicator diagram of the braking effect is plotted for a starting-air pressure of 355lb. per sq. in. In the new crankshaft design of this engine the oil passages previously adopted have been entirely abandoned. This step was made possible by the fundamentally new method of supplying oil to the crankpin bearing. The bearings no longer receive lubricant through oil ducts in the crankshaft, but from above through the crosshead and the hollow connecting rod. The crossheads themselves are supplied with oil through telescopic tubes from the central

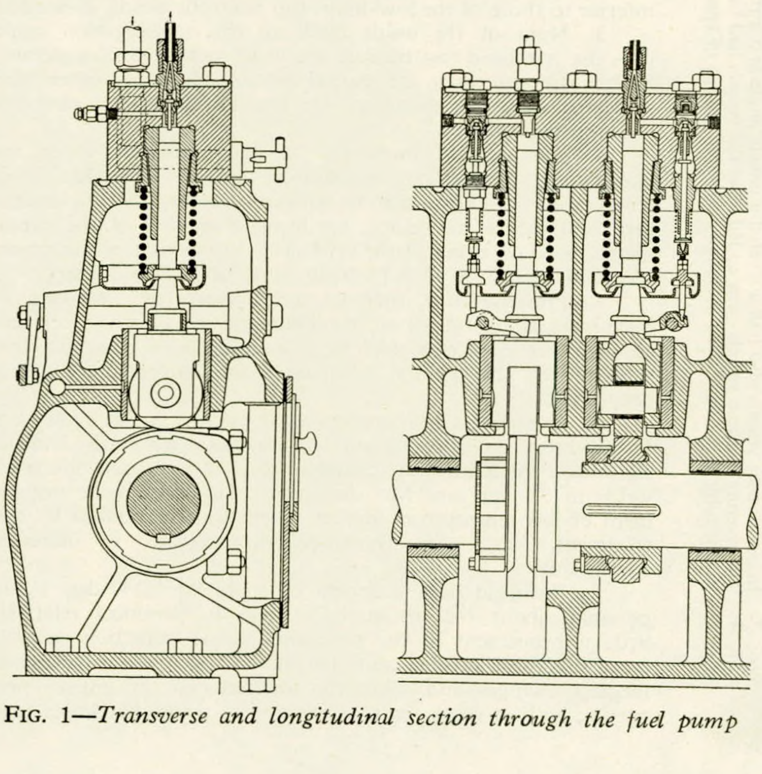


FIG. 1—*Transverse and longitudinal section through the fuel pump*

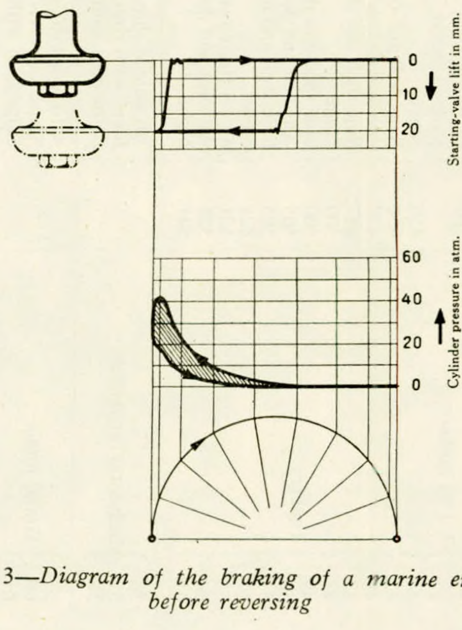


FIG. 3—*Diagram of the braking of a marine engine before reversing*

lubricating circuit. Part of this oil is branched off to cool the piston, while the rest is used for lubricating the running gear. The hot piston-cooling oil returning through a second telescopic tube is collected in special pipes which convey it to the oil tanks.—*The Motor Ship, Vol. 33, October 1952; pp. 283-284.*

Bonding Rubber to Aluminium

A relatively new method of bonding natural or synthetic rubber to aluminium is attracting considerable attention. This process, which puts the combined properties of aluminium and rubber at the disposal of the designer, requires a minimum of surface preparation, and either natural or synthetic rubbers may be bonded to similar or dissimilar surfaces at temperatures which are sufficiently low to prevent deterioration of the rubber. Also, the process can be completed at pressures which do not unduly distort even soft rubber. The bonding agent is a modified phenolic resin used in conjunction with a polyvinyl formal powder. The resin is applied in the form of a free-flowing emulsion, together with the polyvinyl formal powder hardener, to both the metal and rubber surfaces after these have been prepared. The respective surfaces are first degreased and then given a pretreatment dip in a mixture of chromic and sulphuric acids. The rubber to be bonded must be cyclized by surface immersion in concentrated sulphuric acid. This results in the hardening of the outer skin of the rubber and the production of a multiplicity of fine fissures on the surface, which materially assist the adhesion of the bonding resin. About one hour after the bonding agent has been applied, the surfaces are brought together under light pressure and subjected to dry heat at 110 to 120 deg. C. for a period of twenty minutes. By means of an accelerator, which is added to the resin emulsion, and by increasing the temperature up to 150 deg. C., it is possible to reduce the curing time to five minutes. But joints so produced are slightly deficient in strength.—*The Engineers' Digest, Vol. 13, September 1952; p. 288.*

Gas Turbine Blade Vibration

Among the Ministry of Supply's exhibits at the Society of British Aircraft Constructors' exhibition at Farnborough was a section dealing with the study of gas turbine blade vibration. The exhibit gave information concerning the latest developments in the investigation of compressor and turbine blades which are subjected to fluctuations in the gas flow under working conditions. These fluctuations are caused by repeated interruptions of the gas stream by other blades, both rotating and stationary, guide vanes and the outlet spiders, etc. Alternating pressures and strains have been recorded on running engines having frequencies in excess of 30,000 cycles per second. In order to investigate the modes of vibration excited by these alternating forces, the methods of ascertaining nodal patterns of compressor and turbine blades have been extended to cover frequencies of 30,000 cycles per second for turbine blades and 100,000 cycles per second for compressor blades. The nodal patterns obtained from four dissimilar blades were on show, together with the test equipment. In addition to the above forced vibration there is a possibility of self-induced vibration in axial flow compressor blades. In high performance compressors having high-pressure ratios and high mass flows there is a possibility of self-induced vibration in the early stages when operating at high incidence at or near the stall, usually occurring at medium rotational speeds.—*Gas and Oil Power, Vol. 47, September 1952; p. 220.*

New Zinc Coating Process

A process claimed to permit a permanent zinc coating to be applied to any iron or steel structure before or after erection, has recently been patented. It involves the application by brushing of a compound containing metallic zinc and other inorganic products in a water-soluble metallic silicate vehicle. It is usually applied to surfaces that have been descaled by sand-blasting or wire brushing. After application, the treated surface is heated to a temperature of between 300 and 400 deg. F. to fuse the coating and make it insoluble in water. This low temperature is claimed to avoid the distortion which may be caused by ordinary galvanizing. The process is said to give a weatherproof coating resistant to temperatures of up to 600 deg. F. in air, water and petroleum. The coating is also claimed to be impervious to food and fruit acids.—*Chemical and Process Engineering, Vol. 33, August 1952; p. 450.*

Preventing Marine Corrosion by Metallizing

Metallizing systems prevent rust by a combination of actions normally found singly in painting, hot-dip galvanizing and cathodic protection. A typical metallizing system consists of a clean blasted steel surface, a coat of zinc or aluminium and one or more coats of an organic film, nothing more. The surface is virgin steel and is rough. The zinc or aluminium is of very high purity and the organic film is compatible with the zinc. No flux or pickling is involved in applying the zinc and no treatment is required, such as an acid wash, to prepare the zinc for the top coatings. Zinc or aluminium is anodic to steel. Therein lies the major contribution of these metals as protective coatings. They hold a position above steel in the galvanic series. Coatings of bronze or stainless steel, for example, are both below steel and are cathodic to steel in sea water. Being cathodic, they accelerate corrosion of the steel if a break in the coating occurs. On the other hand, zinc or aluminium if ruptured sets up a cell of a reverse potential. The steel is then cathodic and cannot corrode as long as the anodic metal is in the circuit. The zinc or aluminium in a cell is a sacrificial anode providing cathodic protection when needed. This action is similar in nature to the work of a zinc slab on the stern of a ship. The slab is a sacrificial anode attempting to protect the steel of the adjacent area. More accurately stated, it presents itself as a *more readily accessible* anode than the zinc in the brass, preventing dezincification or pitting of brass adjacent to the stern. The question arises, "Why apply a paint or organic film over the anodic metal?" First of all, sprayed metal when first sprayed presents a surface rather like No. 0 sandpaper. The surface is actually porous, a fact that is in itself not a drawback as it is not intended as a barrier coat. In effect, because it is rough and porous it attracts initially liquid films. In other words, metallizing is an ideal base for paint. Because of the above condition, a limitation of some plastic materials is removed, that of difficulty of obtaining a good bond. Thicker coatings of paints are possible over this rough surface. It is estimated that paint life can be extended from two to five times by use of sprayed metal as a base. Likewise, the life of zinc can be extended two or three times by use of paint. In the fabrication of welded steel ships removal of slag from the weld areas has long been a problem. Slag is cathodic to steel and therefore is a source of initial corrosion, many times resulting in fracturing at or adjacent to the weld. This is commonly referred to as preferential corrosion. Standard metallizing procedures eliminate the danger of fracturing from this source. Removal of slag by the use of chipping hammers is not necessary because the metallizing preparation accomplishes this. Further, the presence of the anodic metal keeps the weld area cathodic and non-corrosive.—*H. Vanderpool, The Welding Journal, Vol. 31, September 1952; pp. 791-798.*

Radio Dan Buoy

A Dan Buoy which sends out radio signals for homing purposes has been developed. The buoy, of metal construction, weighs about 300lb. The body of the buoy contains a radio transmitter, which sends out a continuous note, broken at regular intervals by a code transmission, which can be arranged to be different for each buoy. The buoy works on a wavelength of 151 m., which is within the 150 m. waveband set aside for D/F purposes. In order to conserve battery strength, the transmissions can be interrupted by periods of silence; a normal setting would be two minutes of transmissions followed by eight minutes of silence. The time clock also allows the start of transmissions to be delayed for any given period after the buoy is put into the water. In addition to the radio transmissions, the buoy is fitted with an all-round light for close ranges. The shape of the buoy has been specially devised so as to cause it to rise and fall in a sea way while remaining vertical. This is important, as a rod type of aerial is used and rolling would affect the strength of transmissions at sea level. It would also reduce the visibility of the light. Stability is provided by the weight of the battery, which is housed in the foot of the buoy. It is claimed that the buoy provides the maximum reliability and requires the minimum of maintenance. The battery is charged by means of a watertight plug fitting on the exterior of the casing. Potential users of the buoy include the fishing and whaling industries. It also has obvious potentialities for minesweeping where radio silence is not necessary. When used by vessels fitted with radar, radar reflector plates are attached to the top of the buoy. For other vessels, these are replaced by a basket. The working radius of the buoy is about 30 miles.—*The Shipping World, Vol. 127, 24th September 1952; p. 242.*

Funnels for New Swedish Liner

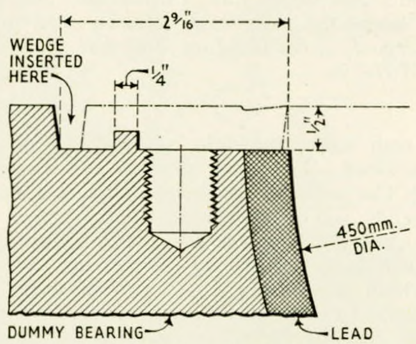
The new Diesel-engined transatlantic passenger liner for the Swedish American Line will have two funnels. It was required to utilize the midship section of the ship so far as possible, for public rooms, especially the dining room, hence, the machinery is placed further aft than usual, although the original idea of installing it right aft had to be abandoned. The funnel, which had necessarily to be arranged over the forward part of the main engine-room, was rather far aft, and in order to give an attractive appearance, a second funnel is placed forward. This is useful in accommodating the ventilation exhaust fans and emergency generators and accumulators. Tests were carried out at the National Aeronautical Research Institute, Amsterdam, to determine the size and shape of the funnels, which had to be as low as possible to enhance the appearance, and sufficiently high to avoid smoke or soot coming out on deck, as well as aerodynamically efficient. During the tests the angles of yaw were 0, 30, 90 and 180 degrees, and the wind velocities 11½, 19 and 26½ m.p.h. It was possible to note and photograph the effect of the ventilating and air conditioning exhaust, and the exhaust of the auxiliary engines and boilers and other determining factors.—*The Motor Ship, Vol. 33, October 1952; p. 262.*

Machining Crankshaft Journals *in situ*

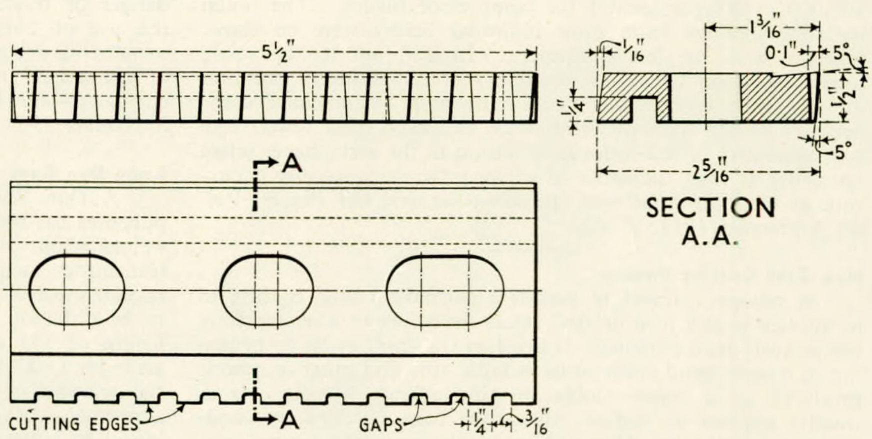
Once the main engines are installed in a ship, overhaul of the machinery is usually confined to such parts as can be handled by the lifting tackle provided. Any major repair which involves machining necessitates removal ashore and incidentally considerably increases the cost. It sometimes happens, however, that time and money are saved by the ingenuity of those in charge of repairs, a recent example being the machining of the crankshaft journals in the *Trevelyan,* a motorship owned by the Hain Steamship Company, London. The vessel, which has a gross tonnage of 7,289 tons, was built and engined by William Doxford and Sons, Ltd., in 1943, the propelling machinery being a 3-cylinder Doxford engine of standard type. At some period during the war it was suspected that the lubricating oil became contaminated by sea water, the result being that the crankshaft journals and pins were pitted to a depth of about 0·015 inch. Measures were adopted which prevented any increase in the pitting and recently it was decided to explore the possibility of cleaning up the journals without removing the crankshaft from the ship. It was decided to use a cutter clamped to the main bearing, the main engine turning gear supplying the drive. The modifications made to two spare half bearings consisted of remetalling and machining one to the shaft diameter and then undercutting the centre portion, while the other, also remetalled and machined to the reduced shaft diameter, was undercut at the sides. Both spare bearings were machined on one of the landings to accommodate the cutters. Preparatory to the machining of the crankshaft journals, the spare bearing with the recessed centre was fitted to the journal in question. This allowed the journal to be supported at the ends of the bearing only and machining of the centre portion would not cause the shaft to drop. In machining the journals the centre portion was first reduced in diameter by about 0·06 inch, using a short cutter. The spare bearing was then removed and replaced by the second spare, undercut at the sides. The large cutter was then fitted and both ends of the journal were machined simultaneously. During the machining of the journals the crankshaft was driven in an astern direction at a speed of one revolution in 16 minutes. It was found that running astern gave a more satisfactory torque. Machining was a laborious process, as the cutter had to be adjusted for every fresh cut; this adjustment was effected by inserting shims between the recess in the cutter and the key on the bearing landing. Owing to the construction of the cutter, a series of grooves were formed on the journal during the machining operation. This necessitated a lateral adjustment of the cutter in order to bring the journal down to size. About 0·01 inch was removed during each "roughing" cut, but in the finishing process the cutter was adjusted to remove only 0·02 inch.—*Shipbuilding and Shipping Record, Vol. 80, 9th October 1952; pp. 471–473.*

Atomic Engine

Under contract with the Atomic Energy Commission and the Navy Department, the Westinghouse Electric Corporation is building both the nuclear reactor—or atomic "boiler"—and the associated propulsion equipment for the U.S.S. *Nautilus,* atomic-powered submarine whose keel was laid 14th June, at Groton, Conn. The submarine will be built by the Electric Boat Division of the General Dynamics Corporation. The keel



Sketch showing how landing of spare bearing was adapted to carry the cutter



Detail of steel cutter used for machining crankshaft journals laying came 3½ years after Westinghouse first was assigned the task of building the first "atomic engine". It was on 29th December 1948, that the Atomic Energy Commission announced that a contract had been entered into with Westinghouse "for the construction of an experimental nuclear reactor to meet specifications for eventual use for ship propulsion". The detail design is being carried out jointly by the Argonne National Laboratory of the United States Atomic Energy Commission and Westinghouse. Although the work has been cloaked in silence, Westinghouse has been able to report "considerable progress" in this major engineering assignment. Research, design, and production work still is going on today at the Bettis Field site near Pittsburgh. A "land-based prototype" of the atomic engine is being built at the National Reactor Testing Station near Arco, Idaho. This experimental model is the basic pattern for the unit Westinghouse has been selected to build for installation in the U.S.S. *Nautilus*. The land-based prototype consists of a nuclear reactor, all its controls, the water for extracting heat from the reactor, and the means for converting this heat energy to power. This steam-propulsion system follows marine practice except for measures taken to reduce dimensions and weight. One of the greatest problems of design of this nuclear power plant, Westinghouse engineers explain, was to find suitable materials with which to construct the reactor core. These materials must have the proper strength at the operating temperatures, they must not deteriorate under intense radiation, and they must not absorb too many neutrons. Every material used, every part built, must be examined with great care in the light of the unusual operating conditions. This means the analysis of behaviour of conventional materials and also of strange new materials when they are exposed to nuclear radiation, and when they encounter other heretofore unknown conditions.—*Mechanical Engineering, Vol. 74, September 1952; pp. 749-750.*

Starting-air Valves

The starting-air valves normally employed in Diesel engines are opened by a simple pneumatically controlled piston and are closed by a return spring. In order to prevent these valves from opening at the wrong time, the diameter of the control piston is usually made only a little greater than that of the valve seat; as the compressed air which opens the starting valve also has to overcome the force of the closing spring, the starting-air valve opens slowly. On the other hand, even a strong spring cannot close the valve as quickly as would be desirable, since it must overcome the inertia of the valve spindle. These shortcomings cause unnecessary losses of starting air and thus restrict the number of starting or reversing manœuvres possible with a given supply of air. In order to get rid of this disadvantage of orthodox starting-air valves, Sulzer Brothers have developed a new type of valve. In this new double-acting valve both closing and opening are pneumatically controlled with suitably graduated forces. The multi-stage design of the control piston permits the use of a main piston with a diameter

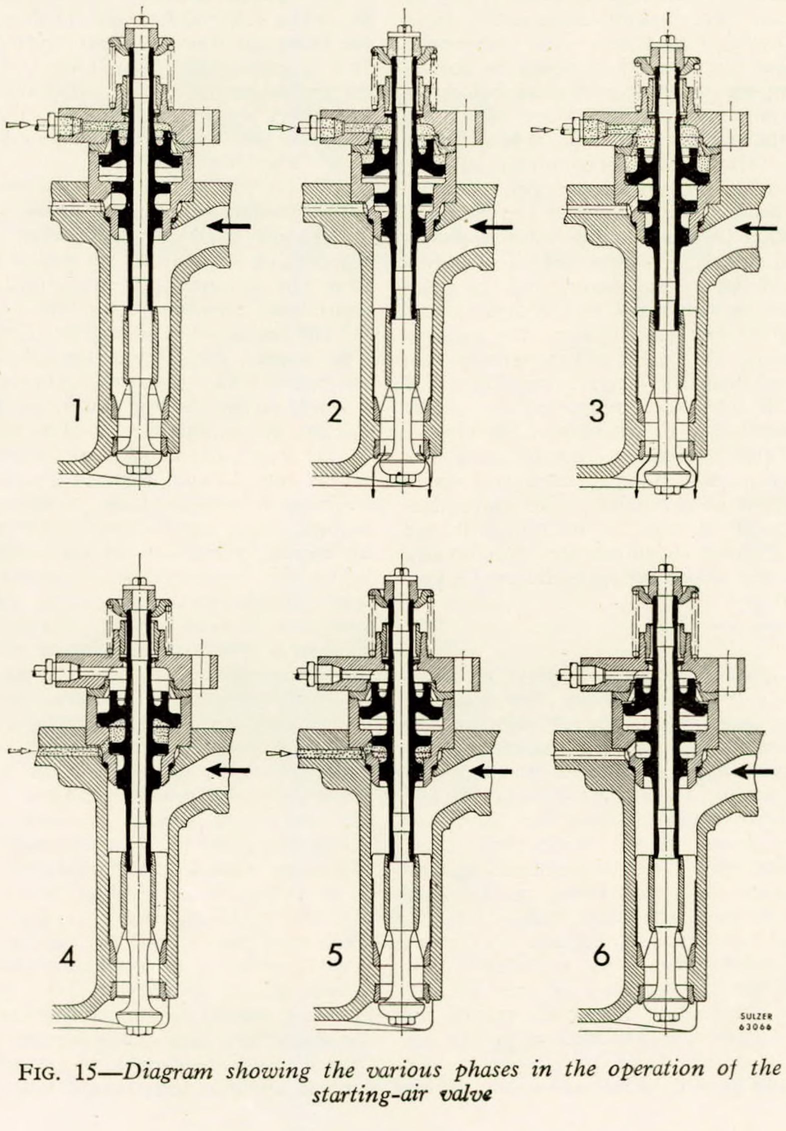


FIG. 15—*Diagram showing the various phases in the operation of the starting-air valve*

considerably greater than that of the valve disc. As a result, the valve operates very quickly in both directions, though without unduly stressing the valve seat, as the valve disc is braked shortly before coming to rest on the seat. The new valve also offers complete safety from untimely opening; for instance, when the pressure in the working cylinder is for any reason considerably greater than the starting-air pressure. It is accordingly impossible for combustion gases to make their way through the valve into the starting-air pipe. The compressed air needed for the control of the starting-air valve is taken from the starting-air container and regulated by a pilot valve. The method of operation of the Sulzer starting-air valve is illustrated in Fig. 15. In position 1, with the valve about to open, the control air acts only upon the smaller of the upper piston surfaces. The force thus applied is just sufficient to overcome the pressure on the valve disc, together with the spring and friction forces. The starting-air valve therefore opens only when the pressure of the starting-air is equal to or greater than the pressure prevailing in the combustion space. In the next position (2) the differential piston has moved downwards to such an extent that the ports milled in its cylindrical guide allow the control air to pass to the second and larger piston surface. The valve is now rapidly opened to its full lift and is held in this position by a relatively powerful force (position 3). This is a great advantage, particularly during reversing manœuvres, when the engine, after having been shut down, is driven by the propeller in its previous direction of rotation and must therefore be braked by starting-air before it can be restarted in the new direction. The braking effect results from the fact that the working cylinder now acts as a compressor and absorbs work. It is clear that this effect would be noticeably impaired if the starting-air valve should close before its time, and in fact premature closing of the valve may even keep the engine running in the original direction. The differential piston ensures that the valve is kept open under all conditions. Position 3 shows it in its completely open position, permitting starting-air to flow unhindered into the working cylinder. In the next position (4) the starting valve is shown before the commencement of closing. Compressed air is admitted below the large surface of the control piston, and the space above this part of the piston is connected to the atmosphere. Under this action and that of the valve spring, the valve is rapidly closed. When the valve has performed the greater part of its upward stroke in position 5, the larger lower surface of the control piston is shut off from the compressed air supply by the smaller piston surface below it, whereupon the closing force acting on the valve is greatly reduced. At the same time the air contained in the upper space is compressed and serves to damp the closing movement of the valve. The valve thus comes smoothly on to its seat in spite of its powerful and rapid closing movement. Position 6 shows the closed valve pressed firmly on its seat by the return spring.—*Sulzer Technical Review, No. 1, 1952; pp. 5-7.*

Machinery for Icebreakers

Electric propulsion equipment for the U.S. Navy's newest, largest and fastest icebreaker will be built by Westinghouse Electric Corporation. The new vessel, the *AGB4,* will be equipped with the most powerful propulsion equipment ever installed in a ship of this type. The *AGB4* will be about 310 feet long and have a displacement of about 8,600 tons. It will be 41 feet longer and 2,100 tons heavier than the Navy icebreakers *Edisto* and *Burton Island* or the Wind class Coast Guard icebreakers. The new vessel will be insulated against extreme below zero temperatures by a cork lining on the inner surface of its double hull. Beam of the cutter will be 74 feet. Westinghouse will also build electrical equipment to operate "heeling pumps" that will enable the cutter to "rock" itself free of imprisoning ice. When an icebreaker is once wedged into the ice, the friction of the hull of the vessel against the ice tends to hold it fast. To prevent this, heeling pumps are installed on these vessels to pump water from side to side between large ballast tanks and produce a rolling motion. This constant rolling or heeling motion enables the ship, in effect, to "shoulder" her way through ice.—*Marine Engineering and Shipping Review, Vol. 57, October 1952; p. 81.*

Hydrogen Foam from Crankshaft

Following the official trial of m.v. *Yama,* built at Yokohama Shipyard and Engine Works, small clusters of minute foam were found at the well-oiled boundary of the shrunk-on part of web and journal of the crankshaft of the main engine, a Yokohama-M.A.N. Diesel. The Committee of Lloyd's Register of Shipping in London, therefore, decided to restrict development to not more than 80 per cent of full power until another survey could be held after a half-year period. The m.v. *Panama,* built at Kobe Shipyard and installed with a Mitsui-B. and W. Diesel engine, and the m.v. *Phillippe,* built at Uraga Shipyard and installed with a Kawasaki-M.A.N. Diesel engine, were also included in the restriction because of the same phenomena. The m.v. *Asumasan Maru,* built at the Mitsui Shipyard and installed with a Mitsui-B. and W. Diesel engine, the m.v. *Siam,* built at Harima Shipyard and installed with a Mitsui-B. and W. Diesel engine, and all other motor vessels built in Japan, are going to suffer the same restriction fate. The Japan Shipbuilder's Association gave the problem serious consideration and formed a special committee to investigate the gas, the cause of the formation of foam, and its effect on the reliability and the strength of the shrunk-on fit of the crank journal. The Crankshaft Research Committee was composed of the leading engineers in the steel industry, crankshaft manufacturers, shipbuilders, and professors and they concluded that the foam gas was hydrogen emitted from the forged steel, that this is unavoidable even if the workmanship in the shrinking-on process is perfect, and that this phenomemon occasions no bad effect on the reliability or strength of the shrinkage fit.—*M. Ino, 1952 A.S.M.E. Oil and Gas Power Division Conference, Paper No. 52-OGP-8.*

Engine Cooling with Vapour Phase

In the operation of modern internal combustion engines the cooling system has become a very important factor, both from the standpoint of temperature control to ensure reliable continuous operation with low maintenance expense, and also for the reason of economy by means of efficient heat recovery. The "vapour phase" cycle considered in this paper, is primarily an engine cooling system. However, it is frequently used as a combination cooling and waste heat recovery system. Two circuits are employed: (1) The primary or water circuit, and (2) the steam and condensate or secondary circuit. The vapour phase unit, located between the engine and steam condenser, contains a built-in steam separator above the water level. A sedimentation chamber with the water outlet pipe extending up inside is built in at the bottom. Accessories include a liquid-level control valve connected to the water supply, a low-water alarm switch, pop valve, pressure-indicating gauge, air vent and vacuum breaker, gauge glass, and blow-down valve. The aerial-type steam condenser in this case is mounted slightly above the vapour phase unit so as to permit gravity return of the condensate to the primary circuit. The vapour phase unit is mounted above the engine so as to provide a positive head on the engine-circulating pump and to maintain the jackets full of water at all times. The liquid-level control valve, the low-water alarm switch, and the pop valve automatically protect the engine against overheating. The water is circulated continuously by the pump through the engine and the vapour phase unit without intentional cooling. The heat, being rejected to the jackets, is absorbed by the circulating water which eventually boils, causing steam to flash in the vapour phase unit. The steam passes from the vapour phase unit to the secondary circuit, where it is condensed and the condensate returns by gravity to the primary circuit. All air and non-condensable gases are vented to atmosphere through the pipe connected to the condensate tank at the bottom of the condenser. The condenser should be capable of condensing all steam generated at highest ambient temperature when the engine is operating at maximum load. The result will be a completely closed cooling system requiring only such make-up as will be necessary to replace loss of water from leakage. The circulating water enters the vapour phase unit tangentially causing a swirling action inside. Any solids in the water are thrown down into the sedimentation chamber, which is baffled to arrest the swirling and to trap the solids below the water outlet from where they are blown down occasionally. Any salts of temporary hardness contained in the make-up water are precipitated by boiling inside the unit and thus prevented from entering the engine jackets. Make-up water containing sulphates or elements that do not precipitate by boiling must, of course, be treated to prevent formation of scale in the primary circuit.—*L. C. Harbert, 1952 A.S.M.E. Oil and Gas Power Division Conference; Paper No. 52-OGP-9.*

Pressure Charging of Four-stroke Diesel Engines

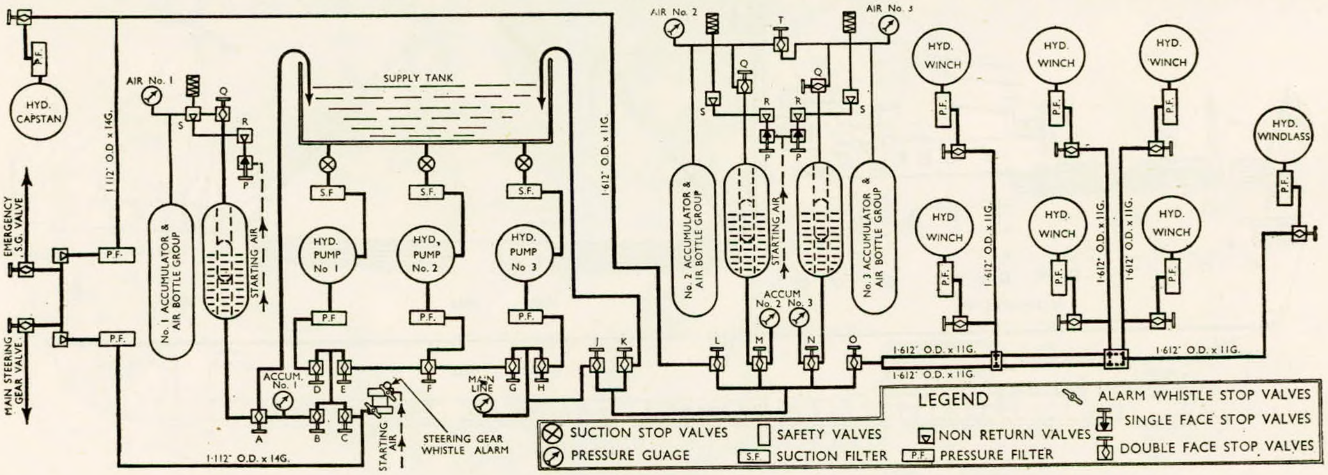
Most Diesel engine builders now build four-stroke engines with l.p. turbo-charging as standard model, but tests and development work in connexion with *h.p. turbo-charging* are everywhere in full swing. Engines can now be supercharged with Brown Boveri h.p. turbo-chargers and air coolers to mean working pressures of 15 kg. per sq. cm. This is not necessarily the limit of turbo-charging and it is possible that still higher mean effective pressures will be employed as soon as engines can be built to cope with them. The design of the turbo-chargers for such high pressures does not present any great difficulty; multi-stage chargers would be conceivable, but it might be more suitable in many cases to employ two independent sets, e.g. two h.p. chargers operated in series with inter- and after-cooling of the charging air. The h.p. set, of the same dimensions as hitherto, would be fitted directly on the Diesel engine, being connected to it by short exhaust pipes, while the primary set, which would have to deal with a larger volume of gas and run at a lower speed, could be installed in a convenient position near the engine. This development, however, is only for the distant future. The next stage is to employ on a wide basis the mean effective pressures of 12 to 15 kg. per sq. cm. attained with the experimental engines.—*The Brown Boveri Review, Vol. 39, Nos. 1-3, 1952; pp. 21-25.*

Motor Vessel with Special Features

There are many new developments in the m.v. *Dryburgh,* which the Grangemouth Dockyard Co., Ltd., has completed to the order of Messrs. Geo. Gibson and Company and James Rankine and Son, Leith. This vessel, the trials of which took place recently, is of about 1,380 tons d.w.c. on a draught of 14ft. 6in. and is designed for regular weekly service between Leith, Dundee and Rotterdam, carrying twelve passengers, general cargo, fruit and vegetables. Two outstanding features are that alternating current is supplied throughout, while the windlass, winches, capstan and steering gear are hydraulically operated. The hydraulic system is of especial interest in that a basically similar installation was made by the same makers, MacTaggart, Scott and Co., Ltd., in a vessel for these shipowners some three years ago, and it is some indication of the reliability and economy of this system that it has again been ordered for the owners' next new ship, with the further prospects of its adoption for another ship on order. The hydraulic arrangement in the *Dryburgh* comprises three MacTaggart, Scott multi-cylinder positive-displacement high-speed radial pumps situated in the engine room close to the main engine controls; each is driven by an 18 h.p. 1,000 r.p.m. constant-speed A.C. motor mounted vertically above the pump. These three pumps are grouped together under the oil tank and two are capable of supplying the necessary power for practically any operating condition of the ship. As the diagram shows, there are three accumulators, that on the side of the oil tank being used normally for the steering gear; the other two are also in the engine room. An automatic loading valve is fitted to each half of each pump to control the pump output as the pressure varies. Thus, each half of a pump is controlled consecutively to cut-in and cut-out at two stages—one half cutting-out at 1,350lb. per sq. in., and the other at 1,500lb. per sq. in.; each cuts in again at a different pressure, thus obviating a sudden heavy demand on the switchboard. The loading valves can also be hand-operated, preselecting the degree of pumping capacity, which then functions automatically. For instance, any one of the six half-pumps can be selected to supply the steering gear when, at sea, this is the only unit operating. From the three accumulators, pipes are led under the deck to the deck machinery, which includes six three-ton cargo winches arranged in three groups of two. Each winch is driven by a six-cylinder radial selective-type hydraulic motor, the selection being automatically determined by the operating load. These winches are of robust but compact construction, and each is controlled by a single handwheel. A safety or holding brake of the band type is arranged on the drum shaft to act automatically when the working pressure drops below a predetermined value.—*The Motor Ship, Vol. 33, November 1952; pp. 324-325.*

New Refractory Fibre

It has been found that by subjecting a molten stream of aluminium oxide, silica and certain modifying agents to a controlled blast of air, a ceramic fibre can be produced which should find many applications in industry. The new fibre resists temperatures which melt cast iron, yet its fineness is such that it can be used as a super-filter, as well as a base for entirely new types of insulation and fireproof and electrical papers. The development of the new fibre took its inception from the investigation of alumina bubbles which are used extensively as insulation in high-temperature commercial applications. These bubbles are made by blasting molten alumina with air. In carrying out this process, it was noted that the occa-



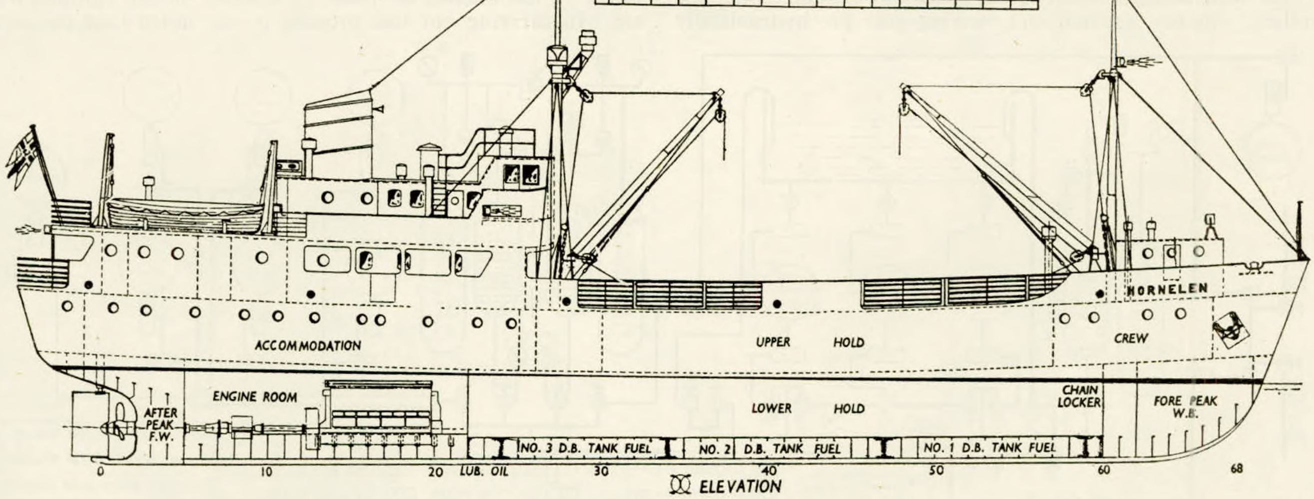
Diagrammatic arrangement of the hydraulic system on the m.v. Dryburgh sional formation of fibres took place. By experimenting with alumina and silica, and developing modifying agents, and by extensive experimentation with various air blast pressures at different temperatures, it was found possible to carry the blowing process beyond the bubble stage and, in effect, to blow each bubble into a fine fibre. Basically, the new product is a vitreous ceramic rather than crystalline. Relatively rapid cooling from the melt provides the fibres with a smooth vitreous surface and long length, and may also account for their resilience. The new material can be used immediately, in combination with, or as a replacement for, asbestos in many applications. The fibre retains all its properties at temperatures up to 2,300 deg. F. and does not soften at temperatures approaching 3,000 deg. F. The material is already finding application as high-temperature insulation in the combustion and exhaust systems of jet engines. —*The Engineers' Digest, Vol. 13, October 1952; p. 336.*

Vapour Washers for Evaporation

The purity of the make-up feed water can be considerably improved if the fine drops are removed from the steam when it issues from the evaporator. To realize this, Escher Wyss has reverted to a system developed by the firm and with which very good results have been obtained for many years in evaporating plants working with mechanical vapour compression, namely washing of the vapours with pure condensate. The steam issuing from the evaporator traverses a washer column that is usually vertical. Here pure condensate taken from the condensate circuit of the turbine is injected into the steam with the aid of a system of nozzles, so that a veil of water forms in the column and through which the steam must pass. In this way the many impure drops of water, contained in the steam, are diluted, because the wash water has a much lower concentration than the drops of liquid from the evaporator. With this washing effect, salts are continually taken up by the wash water so that continual sludge removal from the wash water and addition of pure condensate is necessary if the concentration of the wash water is to be maintained at the desired figure. Experience gathered in an up-to-date high-pressure power station in France has shown that it is possible to obtain a salt content of the boiler feed water amounting to about 0·5-0·7 mg./l. with such an apparatus employing normal preliminary chemical purification according to the lime-soda process, trinatrium-phosphate softening, followed by evaporation in a horizontal evaporator. The surprising fact about the results obtained at this plant, which has been in operation since the middle of 1950, is that, despite the continual sludge extraction, a content of about 2-5 mg. SiO_2 was determined in the wash water. From this it is apparent that a considerable part of the silica, that is otherwise difficult to reach, is washed out of the make-up steam by the washer after the evaporator. The use of a washer has a further important advantage in practical operation. As a consequence of its accumulation volume, both for water and steam, the washer also serves as a safety means against trouble in operation of the evaporator, such as, for example, sudden foaming, priming or the carrying over of water due to overfeeding of the evaporator. Such interferences which normally lead to the carrying over of salt into the feed water system are, if a washer is employed, almost entirely dealt with by the wash water and cannot, therefore, affect the boiler feed water any more. The operation of such a washer is very simple, because apart from the mechanical supervision of the circulating pump for the wash water it can be limited to regular checking of the salt content of the wash water, so as to determine the required addition of pure condensate to the wash water. A further advantage of the washer lies in the fact that the evaporator can be of simple design, because the purity of the steam after the evaporator need not be extremely high, in cases where the steam is subsequently to be washed. Especially for the usually adopted preliminary chemical purification, evaporators of simple design can be used because only small incrustation or, in fact, only sludge precipitation has to be expected.—*W. M. Stahel, Escher Wyss News, Vol. 23/24; pp. 55-57.*

Small Ship with Novel Equipment

The m.s. *Hornelen,* constructed by A/S Mjellem and Karlsen for the Fylkesbatane i Sogn og Fjordane, Bergen, is the first Norwegian ship specially built for carrying cargo on loaded pallets. The electrical equipment operates on alternating current and the cargo winches are of the hydraulic type. In addition, a reversible propeller is fitted, with control from the bridge. The construction is of the highest class of the Norwegian Veritas, and the hull is reinforced for operation in ice. The vessel is of the open shelter-deck type and is certified to carry 150 passengers. Length overall is 151ft. 11in. and length between perpendiculars is 136ft. 11in. Gross register is 396·12 tons. There are two main cargo hatches, No. 1 being served by one and No. 2 by two 4-ton hydraulic winches. A hydraulic capstan is also fitted. The derrick slewing gear is hydraulically operated. The necessary hydraulic equipment is located in the engine room and consists of two 40-kW. electric motors and pumps. The forward winch has port and starboard extensions



General arrangement plans of the m.s. Hornelen to the shaft with cable drums for the anchors, no separate windlass being provided. As far as possible, the cargo is loaded and unloaded by specially-built pallets, each taking approximately 2 tons. The pallets are lifted on board by the derricks and placed under one of the hatches, either on top or below one of the hatches on the main deck. By means of small electric loading trucks, each operated by one man, the loading pallets are then speedily moved to the particular position in the hold reserved for each unit. It is stated that with this system time is saved, and the loading and discharging expenses are considerably reduced. In addition, the cargo is better protected against damage. The length of the cargo hold on the main deck is about 63ft. and the corresponding length of the lower hold is about 74ft. A four-stroke Deutz Diesel engine is fitted for propulsion. It is of the eight-cylinder type, running at 380 r.p.m. and the maximum output is 660 b.h.p. The cylinder diameter is 320 mm., the piston stroke being 450 mm. A closed fresh-water cooling system is installed. There are two Diesel generating sets in the engine room, also cooled by means of fresh water, each driving a 60-kW. generator.—*The Motor Ship, Vol. 33, November 1952; pp. 322-323.*

Free Piston Air Compressor

A free piston air compressor delivering air at 3,000lb. per sq. in. was in use in German submarines during the last war. Since the end of the war the Worthington Company in the United States has produced a free piston compressor which is schematically shown in Fig. 2. After passing through a strainer, the air enters the intake at the left and is supplied to both sides of a double acting piston which provides both scavenging air and the first stage of compression. On the instroke of this piston, its inboard side forces air under low pressure (normally about 2lb. per sq. in.) into the annular scavenging air chamber in the central portion of the machine. Meanwhile, the outboard side of the piston is taking in air from atmosphere. When the piston moves outward again, its inboard side is on its suction stroke, taking air from atmosphere. The chamber on the outboard side of the piston has two sets of discharge valves. During the initial part of the outward stroke, scavenging air is discharged through the valves in the cylinder wall. At somewhat less than its half-stroke, the piston covers these valves and the first stage of compression begins, with the remaining entrapped air further compressed and discharged through the valves in the cylinder head. The air then passes through an intercooler to the second stage. The second stage cylinder is the outer and larger of the two concentric cylinders as shown at the right hand end of the unit. Air from the second stage goes through a two-pass intercooler and returns to the inner of the concentric cylinders previously mentioned, which is the third compressor stage. From here, the air passes through another cooler and returns to the left end of the unit to the fourth stage which is concentric with and inside the first stage and main scavenging air cylinders. The fully compressed air is taken from the fourth stage to the receiver through a pressure regulator (to be discussed later) and an after-cooler. The 2lb. per sq. in. air which is left in the scavenging air chamber is used to scavenge the power cylinder centrally located between the two opposed power pistons which in turn are integrally connected to the four compressor pistons. The power cylinder operates on the two-stroke Diesel principle. It has a fuel injector in the cylinder wall at its centre and there is a set of ports in the wall at each end of the cylinder, one set for scavenging and the other for exhaust. About midway between the power and compressor ends of each piston there is a portion of each piston that never enters either the power or compressor cylinder and is thus always exposed within the scavenging air chamber regardless of the piston stroke position. In this exposed section, each piston is fitted with a yoke. To the ends of the yokes are attached gear racks, of which there are four in all. The racks of one piston are paired off with those of the other by means of two pinion gears diametrically opposite each other outside the power cylinder and within the scavenging air chamber. The racks and pinions serve to keep the opposed pistons in phase with one another and also provide a means of driving the lubricating, fuel, and cooling water pumps, and of actuating and timing the fuel injector. Considering the cycle to begin with the pistons in their inner dead centre positions, they are forced outward by combustion in the power cylinder. The expansion of the combustion products provides the energy necessary to overcome friction, to compress the air in each of the four compressor stages as the pistons move outward, and to store up kinetic energy in the pistons as their outward velocity increases. When the exhaust ports are uncovered, at about 75 per cent stroke, most of the residual energy in the power cylinder is lost to the exhaust, but the pistons continue outward until their kinetic energy is completely absorbed by the work still being done in the compressor cylinders and the pistons stop at outer dead centre. At this point, the compressor stages cease to discharge air, and the air in their clearance volumes begins to expand, forcing the pistons back inward. This inward motion of the pistons compresses the new charge of air in the power cylinder and permits each of the compressor stages to take on a new supply of air from the preceding stage or from atmosphere. Fuel is injected into the power cylinder as the pistons approach inner dead centre and the cycle is then repeated.—*W. T. Toutant, Journal of the American Society of Naval Engineers, Vol. 64, August 1952; pp. 583-594.*

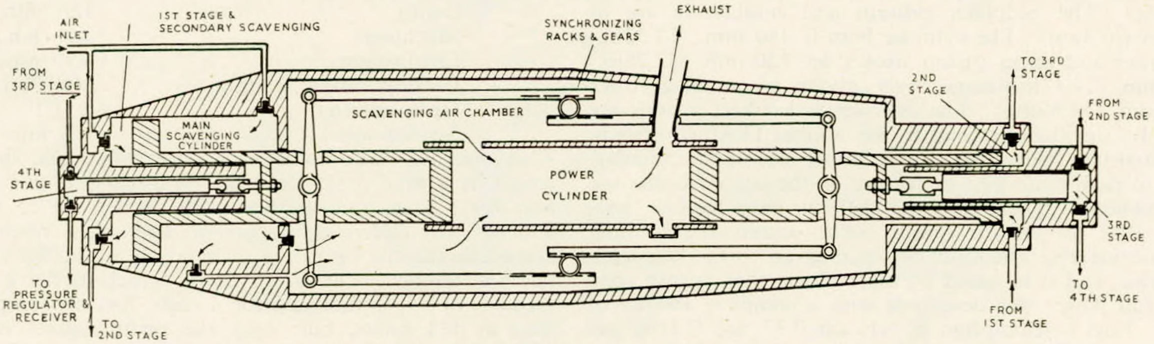
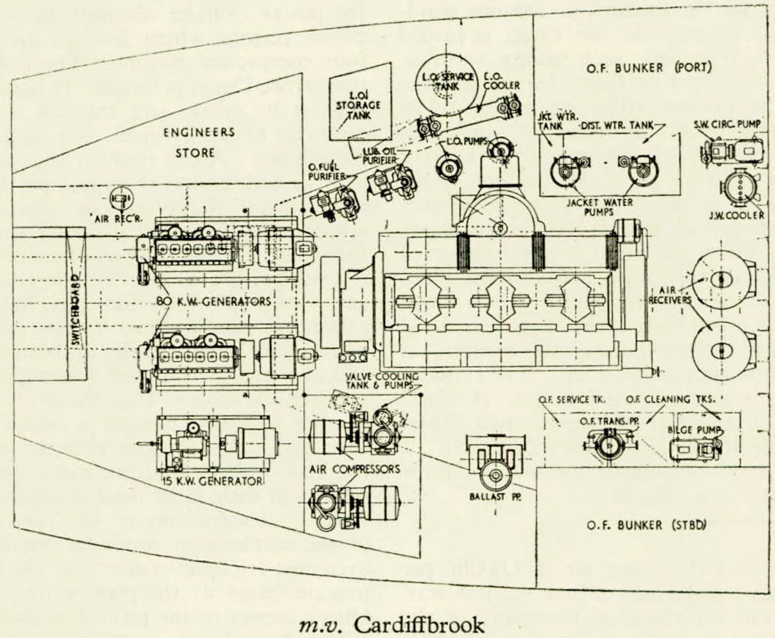


FIG. 2—*Worthington-Junkers 3,000lb. per sq. in. free piston air compressor*

New Motor Coaster

The motor vessel *Cardiffbrook,* of some 2,000 tons gross, has been delivered by John Lewis and Sons, Ltd., Aberdeen, to the Williamstown Shipping Co., Ltd. (Comben Longstaff and Co., Ltd.). The *Cardiffbrook* is of raised quarterdeck type with machinery aft, and is notable for having installed the first Diesel engine to be built by John Lewis under the Doxford licence which the firm took out recently. It is a three-cylinder engine developing 1,100 b.h.p. at 145 r.p.m. This engine ran extensive and satisfactory test bed trials before being installed in the ship. These trials were made on the new test bed which has been specially constructed for Doxford engines. This bed is capable of taking two 3,000 b.h.p. engines at once, and has a Heenan and Froude dynamometer positioned so that it can



m.v. Cardiffbrook

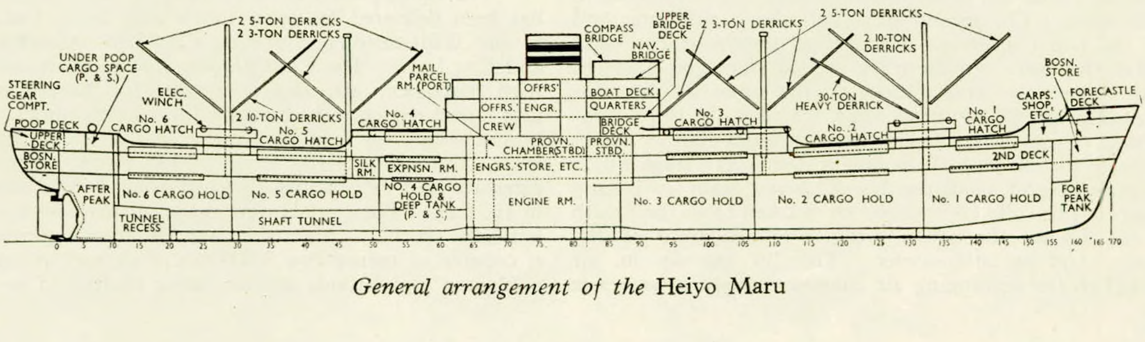
record the horsepower of either engine. At present the range of Doxford engines to be built by Lewis's extends from 600 to 2,000 b.h.p., but this range may later be extended upwards to 3,000 b.h.p. and downwards to 400 b.h.p. The Lewis-Doxford engine incorporates all the usual features of the Doxford engine. The bedplate, column and entablature are of welded construction. The cylinder bore is 440 mm. (17·32in.) and the lower and upper piston strokes are 820 mm. (32·28in.) and 620 mm. (24·41in.) respectively, giving a combined stroke of 1,440 mm. (56·69in.). The cylinder jacket and pistons are circulated by distilled water after the normal Doxford system, and the usual two fuel valves (one on either side of the cylinder) are fitted to each cylinder. A feature of the engine is the use of two flywheels. These and the shafting have been so proportioned that no critical speeds occur within the running range. Considerable attention has been given to the balancing of the engine, and it is stated by the builders that during shop trials the full power was developed with a complete absence of vibration. Fuel consumption is between 0·37 and 0·38lb. per b.h.p. per hour. The engine is unusual in that it is taller than it is long, the length over the flywheels being 20ft. 9½in., and the height from the bottom of the bedplate 21ft. 3in. The control gear is positioned at the forward end of the engine on the starboard side, the position in which controls would be found in a steam engine. The total weight of the engine, including thrust block, flywheels and the necessary ladders and gratings, is 85 tons.—*The Shipping World, Vol. 127, 8th October 1952; pp. 286-287.*

Modern Japanese Cargo Liner

The *Heiyo Maru* and the *Heian Maru* are two of a number of similar ships of 9,950 tons d.w.c. built by the Mitsubishi Shipyard and Engineering Co., Ltd. The main characteristics of the *Heiyo Maru* are as follows: —

Length overall	463ft. 1½in.
Length b.p.	432ft. 11in.
Breadth	59ft. 0in.
Depth	32ft. 8in.
Machinery	5,000 b.h.p.
Deadweight	9,950 tons
Corresponding draught ...	26ft. 4in.
Gross register	6,851·10 tons
Service speed	13½ knots

There are five cargo holds, each with two decks, and they are served by a total of 19 derricks, comprising 14 for 3-ton lifts, four for 5 tons, and one heavy lift derrick for 35 tons. The winches are electrically operated and have remote control arrangements, the operating pedestals being at the ends of the hatch coamings. The *Heiyo Maru,* which carries a total complement of 55, is designed for a daily fuel consumption of 17 tons at 13½ knots, but, with the main engines running on 85-90 per cent Diesel oil and 15-10 per cent boiler oil, and with the auxiliary generators running on Diesel oil only, the total daily fuel consumption is given as 18 tons. Cylinder lubricating oil consumption has been about 93 litres of DT5 oil per day, and about 50 litres are used for the main and auxiliary engines. The main propelling machinery comprises a seven-cylinder, two-stroke, single-acting engine known as the M.S. design and built by the Mitsubishi S.B. and E. Company. It has a bore of 720 mm. and a stroke of 1,250 r.p.m. This develops a maximum of 5,000 b.h.p. at 134 r.p.m. There is an independent scavenge pump to each cylinder, being driven from the crosshead and having a bore of 600 mm. with a stroke of 1,250 mm. The main engine fuel pumps are driven by



General arrangement of the Heiyo Maru

eccentric gear at the fore end of the crankshaft and discharge to accumulators above. From there the fuel passes to a common fuel line and thence to a distributor block at mid-length on the port side of the engine. Below this block is a chamber in which is the cam gear for the fuel injection and air starting valves, driven by gearing from the crankshaft. The pistons are oil cooled, while, in this ship, the fuel valves are cooled by fuel oil, but in subsequent vessels with this machinery they will be fresh-water cooled. Spring-operated shut-down arrangements are fitted to operate at any fall in pressure in the lubricating oil and sea water circulating systems, also in the event of overspeed. The main controls at the forward port side of the engine are designed so that all manœuvring, with the exception of astern running, may be effected by one handwheel. The wheel may be turned to a "braking" position, whereupon air is admitted to the piston tops. In effect, the control gear comprises two parts; one controlling fuel to the injectors and the other the starting pilot air which operates the opening and shutting of the starting air valves by acting on their balanced pistons. The fuel valves open at a minimum pressure of 160 atmos. and, at "dead-slow" about 200 atmos. The maximum fuel injection pressure is 1,000 atmos., but in normal running, or 80 per cent of the maximum b.h.p., it is 500-700 atmos.—*The Motor Ship, Vol.33, October 1952; pp. 285-289.*

Single-screw Motor Tug

Built by William Weatherhoad and Sons, Ltd., at Berwick-on-Tweed, under a sub-contract from the Fairmile Construction Co., Ltd., of Cobham, Surrey, the single-screw motor-driven tug *Felicidade* is intended for service at Recife, in Pernambuco. The design is to the order of Wilson, Sons and Co., Ltd.—a trading organization in South America. The design is characterized by the restricted headroom which has been limited to 8 feet, so that the vessel may negotiate the low bridges in the waterways forming the port. The propelling machinery consists of a Crossley four-cylinder, direct-reversing, Diesel engine (type E.R.L.-4/45), constructed by Crossley Brothers, Ltd. The engine is capable of developing 120 b.h.p.

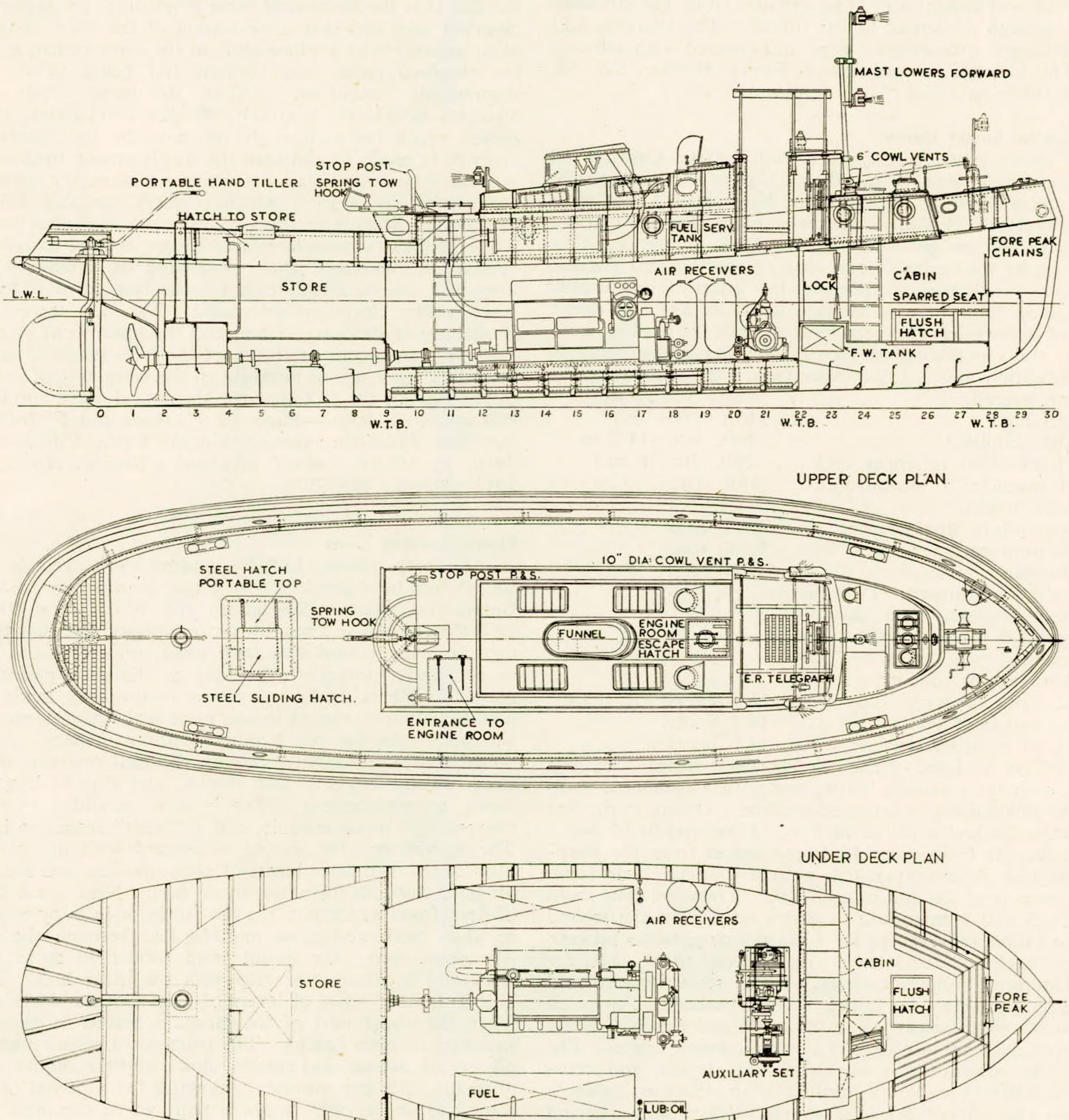


FIG. 2—*General arrangement of the motor tug* Felicidade

at 450 r.p.m. The engine has built-in air-starting and direct-reversing mechanism, which is operated by a single handwheel. The thrust block, which is of Michell type, is incorporated in an extension of the engine bedplate. Water cooling has been adopted for the cylinders and the exhaust manifold. In order to reduce corrosion, zinc pads are provided in the water jackets of the cylinders and water pumps. The circulating-water and bilge pumps are interchangeable, the system being arranged with interconnecting piping fitted with bronze cocks. The fuel system includes duplex fuel strainers, which are built-in to the engine, while a felt-type filter, capable of being bypassed, is incorporated in the fuel pipe-line. Lubrication is on the dry-sump system, and copious pressure feed, throughout the engine, is effected by means of lift and pressure lubricating pumps. Independent, adjustable, forced-lubricating oil feeds are provided for each piston and also to the water-pump rams. Piping from the exhaust manifold on the main engine is led to a small expansion chamber situated below the funnel. A short length of flexible metallic piping is incorporated, in order to provide for vibration and expansion. The exhaust from the auxiliary set is led through a silencer to the funnel. The silencers and piping are lagged with asbestos rope and covered with asbestos fabric.—*The Shipbuilder and Marine Engine-Builder, Vol. 59, November 1952; pp. 645-647.*

Italian Ships for Soviet Union

Two vessels have recently been built by the Cantieri del Mediterraneo, of Genoa, in the Pietra Ligura shipyard, to the order of the purchasing organization, Vseojuznoe Objedinenie Machinoimport, of Moscow. The principal particulars of these interesting vessels are given as follows: Built to the specifications and under the special supervision of the Registro Italiano Navale, these vessels have the highest class given by that society as ocean-going ships for the carriage of passengers and cargo. The first of the two has also been built to meet the requirements, and under the supervision of Lloyd's Register of Shipping to their classification 100 A.1. for passengers and cargo service.

Length overall	340ft. (101·95 m.)
Length b.p.	310ft. (94·4 m.)
Breadth moulded	46ft. 6in. (14·2 m.)
Depth moulded to upper deck...	26ft. 3in. (8 m.)
Depth moulded to second deck...	18ft. 1in. (5·5 m.)
Draught loaded	18ft. (5·47 m.)
Corresponding displacement ...	4,650 tons
Gross tonnage	3,500 tons
Net tonnage	2,280 tons
Propelling machinery: Two Fiat Diesel engines, each developing 1,500 b.h.p. at 200 r.p.m., giving a total power of 3,000 b.h.p. and driving twin screws	
Speed, full load trial	15·5 knots
Speed, half load trial	16·1 knots
Speed, in loaded service... ...	14·5 knots

The Norilsk is a closed shelter decker with raised forecastle combined with the foremast house, and with a combined poop and bridge deckhouse as a detached erection. Owing to the fine form of ship, the keel is raised forward of the middle of No. 1 hold and also aft from some 17 frame spaces from the stern-post. The bow is sharply raked, with a rounded plate stem, while the stern is of the full cruiser type. There are four main holds, Nos. 3 and 4 extending in depth only from the second deck to the tunnel tops, except for a central cargo recess between the shaft tunnels in No. 3 hold. Apart from space taken for trunked hatchways, engine casings, a small store forward and the steering gear aft, the entire shelter tweendeck space is devoted to accommodation. The forecastle and the long house on the upper deck are also mainly accommodation spaces. The deck auxiliary machinery is all electrically driven, and comprises a windlass capable of dealing with 49 mm. cable, a capstan on the upper deck aft, an electro-hydraulic steering gear, and eight cargo winches. The four derricks round the foremast are each of 5-tons capacity, while the two derricks on the twin pole main mast and the two derrick posts on the promenade deck aft are each of 3-tons capacity. In addition, there is a 15-tons heavy lift derrick fitted at the after side of the foremast. This serves the largest hatchway in the ship, into No. 2 hold. A small gaff is fitted on the top at the main-mast. The propelling machinery comprises two Fiat six-cylinder two-stroke Diesel engines, each developing a normal service power of 1,500 b.h.p. at 200 r.p.m. and driving twin bronze propellers. There are four Diesel generators, each of 85 kW. output and producing current at 220 volts D.C. Two of the generators incorporate compressors. There are also two emergency Diesel generators, each of 24 kW., in a special dynamo room on the boat deck. The ship sewage plant is located in the engine room and is of the pneumatic expulsion type. The engine room auxiliaries are all electrically driven.—*The Shipping World, Vol. 127, 15th October 1952, pp. 300-302.*

On the Waves of Ships

The interaction of wave formation and boundary-layer build up is investigated. The authors consider some well-known discrepancies in the theory of ship-wave profiles; these include the fact that the theoretical wave amplitudes are larger than the observed one, and that a weakening of the wave system at the stern together with a phase shift in the wave system is observed, the observed crests and troughs not being in the position theoretically calculated. After discussing some previous attempts by Havelock and by Wigley to elucidate these problems, which the authors do not consider too satisfactory, an attempt is made to consider the displacement thickness of the boundary layer and the corresponding necessary corrections to the source distribution which replaces the ship form. The method of Moriya is used to calculate the nonviscous flow, while Millikan's boundary-layer theory is used to calculate the (turbulent) boundary layer. Knowing the boundary layer, an improved source distribution for the ship form is found, and wave-surface elevations calculated. The new theory gives the weakening of the wave system and the phase shift of the waves. However, no account is taken of the free-surface effect and the boundary layer nor of viscosity in the wave system itself, which might explain the fact that the theoretical wave amplitudes are still much too large.—*Paper by J. Okabe and T. Jinnaka, Rep. Res. Inst. Fluid Engineering, Kyushu Univ., Vol. 7, September 1950, pp. 45-67. Allied Mechanics Review, No. 5, October 1952; Abstract No. 2976.*

Plastic Landing Craft

A 36-ft. plastic LCVP (landing craft, vehicle and personnel) has been developed by Puget Sound Naval Shipyard at Bremerton, Wash. Similar to the World War II wooden LCVP in design and weight, the new plastic boat has the advantage of being unsinkable, long lived, impervious to corrosion or rot, and permanently finished to eliminate painting. The plastic LCVP is the largest plastic casting ever made in closed moulds. It is produced in one piece without any seams. It has withstood over 500 test landings without damage. A steel box bolted into a rectangular hole in the hull contains the engine, rudder, propeller, and keel section, and can be lifted out for repair or replacement. The boat is moulded upside down between two metal moulds, and is "built" from the inside out. The bottom or male mould is covered with one thickness of glass cloth, then three layers of glass matting, and another layer of glass cloth to form the inner hull. Next come the blocks of Styrofoam which give the boat its built-in buoyancy. Layers of glass cloth and glass matting laid between the blocks of Styrofoam carry the liquid resin binder to form transverse webs and a continuous strip with the inner hull. The outer hull is another series of layers of glass cloth and glass matting. Then the upper part of the mould is sealed in place and the injection of resin begins. The mixture of resin, pigment, pine oil, glycol, xylene, and catalyst flows into the mould at the rate of about 10lb. per minute. Allowing for a period of levelling, a total of about eight hours is required to complete the injection. After 40 hours the top mould is removed and the 6,000-lb. hull is lifted off—complete except for minor patching and sanding down of high spots.—*H. E. Jackson, Marine Engineering and Shipping Review, Vol. 57, October 1952, pp. 82-85.*

ENGINEERING ABSTRACTS

Section 3. Shipbuilding and Marine Engineering

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Condensate Collection System

The most usual method is for the condensate to be collected and piped to a feed tank which is often below the boiler house floor or on a level with the boiler. If the hot well or feed tank is level with or below the feed pump, difficulty will be experienced in pumping due to cavitation in the pump caused by the water vapour, and at a temperature above about 170 degrees, except by special pumps, it is impossible to use the hot feed. As a consequence it is necessary to cool down the feed with consequent loss of heat and fuel. It is claimed that the Circulector System is much cheaper to operate than the normal pumping method, since the electrical power required to operate the control gear is infinitesimal and the steam required is only about a quarter of that required to operate a pump for the same duty and moreover practically all this is recovered. The attention required for maintenance of the system is very little, there being no rotating parts, glands or bearings and as there is no lubrication any risk of contamination by oil is eliminated. Another feature is that the system can be used as a feed water meter and also in a battery of boilers all working at different pressures, the lowest pressure boiler can control the apparatus. The essential parts of the plant (Fig. 2) are the lifter (11) with its float switches, the feeder (13), the control units (16 and 17) containing the steam inlet and outlet valves for lifter and feeder, the electro magnetic pilot valve (18) and the electro control panel (28). A counter (19) records the number of operations which, multiplied by the capacity of the lifter between the float switches, gives the exact quantity of water discharged to the boiler. The water level regulator (24) stops and restarts the plant in accordance with the feed requirements. The condensate and make-up water, if any, is collected in the closed tank (1), whence it flows to the lifter (11). Upon the lifter (11) becoming full, its two float switches operate the pilot valve which in turn changes the position of the valves in the control units. Steam is then admitted to the lifter and its water content is forced up into the feeder (13). When the latter is full, the steam is switched over to it so that the pressure in the feeder (13) is equalized to that of the boiler and the water feeds into the boiler by gravity.—*A. J. Simpson, Journal of the Junior Institution of Engineers, Vol. 63, October 1952; pp. 1-10.*

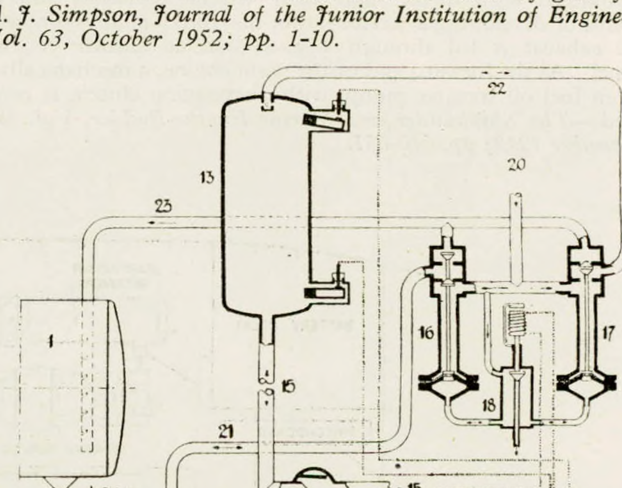


Fig. 2—*Essential components of Circulector system*

Single-screw Motorship

The single-screw motor-driven petroleum-carrying tank ship *Ben Harold Smith,* built by the Rowhedge Ironworks Co., Ltd., for the National Benzole Co., Ltd., has the following leading particulars:—

Length overall	136ft. 0in.
Length b.p.	132ft. 0in.
Breadth moulded	26ft. 0in.
Depth moulded	9ft. 6in.
Displacement, fully laden, tons	573
Deadweight, tons	320
Corresponding draught ...	7ft. 6in.
"Air draught", above load water-line	14ft. 6in.
Speed on trials, knots... ...	8·92

The vessel is of the single-deck type, and the propelling machinery is located aft. A trunk runs fore and aft in way of the main cargo tanks, and the top is extended aft to form the crown of the engine room, as a raised quarter deck. There are four main cargo tanks, which are of all-welded construction, and which, in compliance with the regulations of the Port of London Authority, are arranged inboard of the vessel's outer shell, but have been designed to form an integral part of the ship's main structure. The tanks, which have a total cargo oil capacity of 400 tons, are entered by means of hinged oil tight hatchways of rectangular shape, located on the trunk deck. Cofferdams are arranged at each end, beneath and at the outboard sides of the tanks, while a storeroom is situated between the forward cofferdam and the fore-peak tank. The main pump room is arranged in a separate compartment at the forward end of the engine room. The layout of the machinery space is shown by the drawing given in Fig. 2. The main engine consists of a single British Polar direct-reversing Diesel engine (type M441), constructed by British Polar Engines, Ltd. The engine, which has four cylinders, is arranged with direct shaft drive to the propeller, and is capable of developing a service power of 310 b.h.p. at 300 r.p.m. The exhaust is led through a water-injected silencer to the funnel. At the forward end of the main engine, a mechanically-driven fuel oil transfer pump, with disengaging clutch, is provided.—*The Shipbuilder and Marine Engine-Builder, Vol. 59, November 1952; pp. 640-651.*

Timber-carrying Steamship

The steamship *Aun* delivered by Nylands Verksted, Oslo, to A/S Finn Johnsens Rederi of Bergen, is a typical modern single-deck Baltic trader with Maierform lines, soft-nosed stem, cruiser stern, bridge structure amidships, raised poop and fo'c'sle. She has been built to the highest class of Det Norske Veritas and has principal particulars as follows:—

Length between perpendiculars... ...	250ft. 8½in.
Moulded breadth	41ft. 0in.
Moulded depth	19ft. 11in.
Deadweight capacity	2,700 tons
Hold capacity (grain)	139,000 cu. ft.
Hold capacity (bale).	130,000 cu. ft.
Loaded speed	11·4 knots

The main engine is a compound reciprocator of Nylands Verksted design, having cylinder bores of 425 mm. and 850 mm. and a stroke of 850 mm., working in conjunction with a Bauer-Wach exhaust turbine to give an output of 1,200 i.h.p. The Bauer-Wach turbine, Vulcan coupling and gearing were supplied by Barclay, Curle and Co., Ltd. Steam is supplied by two oil-fired cylindrical boilers which are arranged on each side of the main engine. This layout is a patent of the shipbuilder's and results in an exceedingly short engine room. The furnace fronts are at the forward ends of the boilers and the principal auxiliaries at the after end of the compartment. There are two steam engine-driven and one Diesel engine-driven generators. A speed of 13 knots was obtained on trials.—*The Marine Engineer and Naval Architect, Vol. 75, October 1952, pp. 447-448.*

Improving Crack Resistance in Ships

Since it is not known whether the present requirements for the construction of welded ships are sufficient to prevent structural failures, it may be well to consider further improvements to increase the crack resistance of ships. A number of such improvements are known and they can be instituted now in spite of lack of knowledge of quantitative requirements for notch toughness. Some of these are as follows: (1) Normalizing, particularly for the heavier plate thicknesses. (2) Reducing the strength requirement of shipbuilding steel by lowering carbon content; such a change will produce a tougher and more weldable steel. (3) Specifying the use of only killed steel for

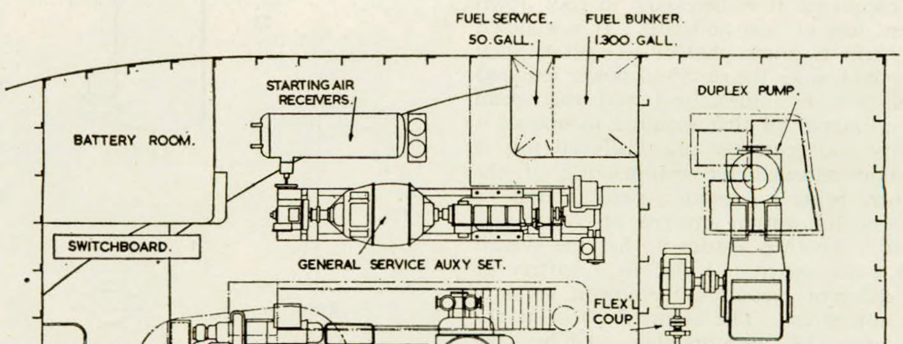


FIG. 2—*Machinery arrangement of the* Ben Harold Smith

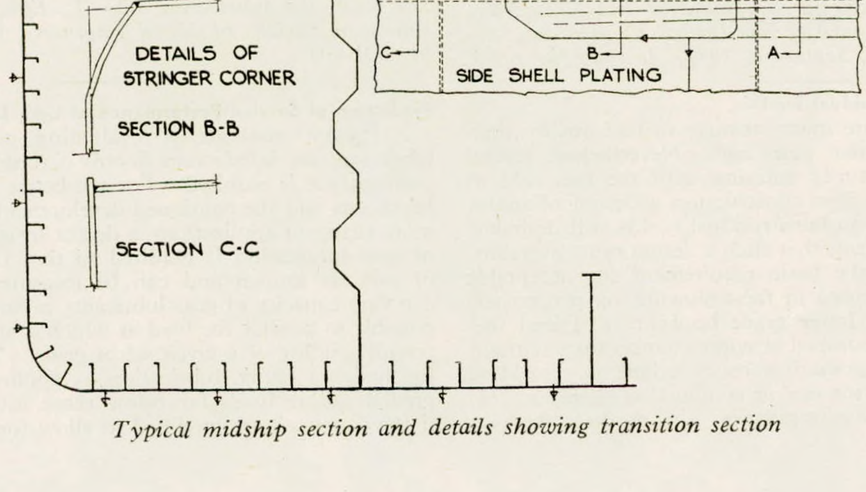
the mid-length of the ship or at least for the known critical areas of this portion of the ship. As mentioned earlier, additional improvements of steel quality result from the use of reduced carbon and increased manganese content, fine grain practice and normalizing. (4) Requiring subsurface inspection of welds, at least of welded butts in critical areas of the ship. (5) Specifying the use of low-hydrogen electrodes. (6) Modifying designs to reduce scantlings, thereby reducing plate thickness wherever possible will also add to the notch toughness of the structure. (7) Eliminating bulb shapes since sound butt welds are difficult to make in these shapes. The improvements proposed in the foregoing cannot, of course, be applied to existing vessels; however, remedial measures have been devised for ships in this category. These consist of riveted crack arrestors which represent the best solution now available for the protection of large all-welded steel structures. These crack arrestors have proved effective in halting a number of fractures, thereby undoubtedly preventing some ships from breaking in two. If, however, the load on the hull is sufficiently high, it is of course realized that these crack arrestors cannot maintain the integrity of the structure, particularly when the fractures have become extensive. It is noted that ships fitted with crack arrestors have broken in two.—*F. Jonassen, Marine Engineering and Shipping Review, Vol. 57, October 1952, pp. 67-68.*

Bent Plate Sheerstrake in Tankers

Götaverken have developed an interesting technique for the welded construction of tankers and similar types of vessel which have a uniform section and no sheer over a considerable proportion of their length. Experience has shown that the projecting free edge of the sheerstrake, customary in welded construction, is a source of danger, because the greatest stresses occur there and cracks can start from its more or less pronounced irregularities. The new design is intended to make this critical part of the hull as smooth and free from stress concentrations as possible. The sheerstrake is bent in three places so that it turns through approximately 90 degrees, to suit the deck camber chosen, and so that it can be connected by automatic welding to the deck stringer plate. Not only is there a saving in material, but the stiffness of the ship's section is thereby improved. The flat gunwale bar shown in the sketch is attached to the stringer plate by the lightest possible weld. The change from this to normal construction forward and aft has presented problems, which have been overcome by the use of transition sections at the breaks of the poop and forecastle. The accompanying drawing shows that this change takes place with a gradual variation of section. The first ship to which Götaverken have applied this construction method is the motor tanker *Brita Onstad*, recently completed to the order of Haakon Onstad. She is the largest vessel so far built in Scandinavia and is of all-welded construction with longitudinal bottom and side framing and longitudinal and transverse corrugated bulkheads. The bent plate construction extends over some 320 feet of the ship's 650 feet overall length and embraces nearly the entire tank space.—*The Marine Engineer and Naval Architect, Vol. 75, September 1952; pp. 398-399.*

Single-screw Motorship *Ebro*

The Royal Mail Lines single-screw motorship *Ebro* has been built by Harland and Wolff, Ltd., at their shipyard at Govan, Glasgow. A sister ship of the *Ebro*, the *Essequibo*, is also under construction at the same yard. Both vessels are intended for the company's cargo and passenger service between London, Bermuda, the West Indies, the Spanish Main and Central America. The propelling machinery is located just abaft amidships, and there are two holds, with associated 'tween-deck spaces, in the fore part of the ship and two aft. The propelling installation comprises a Harland-B. and W. oil engine of the latest design, constructed by Harland and Wolff, Ltd. The engine has six cylinders and is of the single-acting, two-stroke cycle, opposed-piston type. With a cylinder diameter of 620 mm. and a combined stroke of 1,870 mm., the engine is capable of developing 4,500 s.h.p. at 115 r.p.m. Designed to operate on heavy fuel and Diesel fuel, the engine is directly coupled to the propeller shafting. The bedplate and frames are of fabricated steel construction, and the thrust block is incorporated in the after end of the bedplate. Fresh-water cooling has been adopted for the main-engine cylinders, while the pistons are cooled with oil from the forced-lubrication system. The cooling of the lower part of the cylinder liners is effected by the surrounding air in the scavenge belt, which is incorporated in the entablature. An adequate number of coolers are incorporated in the fresh-water and lubricating-oil systems. The sea-water and fresh-water cooling pumps required for the operation of the main engine are of the reciprocating type, and are driven from the forward end of the crank-



Typical midship section and details showing transition section shaft. Scavenge air for the cylinders is supplied by rotary blowers arranged at the back of the engine. These units, which have silencers fitted to the air intakes, are driven from the crankshaft by means of roller chains. For measuring the temperature of the main-engine exhaust gases, a temperature indicator has been provided. Compressed air for starting and manœuvring is stored in a cylindrical air receiver of 800 cu. ft. capacity.—*The Shipbuilder and Marine Engine-Builder, Vol. 59, September 1952, pp. 541-546.*

The Problem of the Condenser Scoop

A comprehensive analysis of the flow through marine injection scoops and overboard discharges is given. The author attempts to formulate an exact theory for the system as a whole, using the momentum principle applied to "control spaces". An approximate theory is then presented for each of the major components, viz., scoop, condenser, and overboard discharge. Using some of the available experimental data, approximate relations are formulated for the average velocity, momentum flux, and kinetic energy available in the boundary-layer flow forward of the scoop. Definitions of system and scoop efficiencies are given; hitherto unpublished data are evaluated in these terms for one model scoop test. Final equations show that the solution depends upon four hydraulic coefficients, the values of which would have to be determined by properly controlled model experiments. A concise statement of similitude conditions to be satisfied in such experiments is next presented. The author concludes that too little is known about the flow patterns at the scoop and overboard discharge to permit an accurate prediction of the performance of any particular system. The writer advocates that future model tests should include detailed measurements of the flow patterns about separately tested scoops and overboard discharges.—*W. Spannhake, David W. Taylor Mod. Basin Report No. 790. Applied Mechanics Review, Vol. 5, August 1952; Abstract No. 2534.*

Tests on Stayed and Unstayed Masts

The object of this investigation was to determine whether the stresses as measured in stayed and unstayed masts in the loaded condition agreed with the stresses calculated by the usual methods. The general inference drawn from the analysis of the tests is that in the calculation of a stayed mast so many uncertainties are involved that, considered from a purely theoretical point of view, it is doubtful whether a close agreement with test results may be expected. On the other hand, the observed discrepancies are not sufficient to condemn the recognized methods of stress calculation as useless. These methods, which are fundamentally correct, would supply correct results if all the doubtful factors could be assessed correctly and taken into account. The main uncertainties are the effective modulus of elasticity of the steel wirerope stays, and the initial stresses in the stays. The sagging of the stays also affects the results. It is considered advisable to work to rather conservative upper limits of stress in the mast structure when designing stayed masts.—*A. Verduin and B. Burghgraef, Netherlands Research Centre for Shipbuilding and Navigation, Report 6S, June 1952. Journal, The British Shipbuilding Research Association, Vol. 7, September 1952; Abstract No. 6608.*

Marine Diesel Plant for Residual Fuel

Modern oil engines are more sensitive to fuel quality than those built some twenty-five years ago. Nevertheless, several motor vessels are satisfactorily running with the fuel sold as Bunker "C" Grade. For new construction a design of motor vessel exclusively specified to burn residual fuel is still desirable. To discuss the main problems that such a design must overcome it is useful to confront the basic requirement for acceptable fuel for Diesel use (condensed in the following six perquisites) with the deficiencies of a lower grade bunker: (a) Diesel fuel must be capable of being pumped at winter temperature without preheating. (b) Must not contain water or sediments. (c) Must not cause deposit on injector nor in combustion chamber. (d) Must not contain corrosive impurities, nor produce them as products of combustion. (e) Must not cause sludging of lubricating oil. (f) Must ensure easy starting under winter weather conditions. (A) When the fuel shipped is of high viscosity, steam coils in the fuel tank are needed. Since it is the modern usage to store the oil in the hull's double bottoms, heating is not easily attained by the modest steam generators usually fitted on motor vessels, owing to dispersion through the bottom which is surrounded by a wide wall between fluids having different temperature. To minimize such dispersion of heat, the double bottom tanks of a motor vessel built to run on boiler oil should be designed like the "compensation tanks" of some war vessels, where the suction is placed in the top, the level being maintained constant by replacing the consumption with sea water. This allows heating only of the upper share of the tank with less dispersion on account of the insulating effect of the lower liquid strata. Besides this, the natural possibility of containing fuel or water ballast as well in the same double bottom, is profitable for the autonomy and the stability of the ship, avoiding the troubles experienced with common plants when nautical exigencies require the filling of empty oil reservoirs with water. (B) The residual fuel is specified with a sediment tolerance not acceptable for Diesel use. The purification technique is well improved in the marine industry, but for boiler oil treatment the solid impurities separated may be of such a degree to make this process difficult by self-cleaning separators, especially when in rough seas the oil shakes up the settled sludge into the supplying double bottom. In the plant proposed in (A) above, the sludge deposited in the tanks cannot reach the suction pipe in heavy seas. Even so, settling tanks, with steam coils are always essential to relieve the purifiers. The method of purification by washing with a proper dosage of warm fresh water, mixed with the oil when being delivered to the separator, in order to remove every soluble impurity (e.g., sodium chloride) is to be recommended also if a further drying up is necessary. (C) The fuel heating equipment for Diesel must be a very suitable one regarding safety and must ensure thermostatic control of delivery however the consumption varies. A steam heater will scarcely fulfil the thermostatic condition while electric resistor heater increases the risk of oil cracking; this leads to the proposal (to be confirmed by experiments) of an electric heater with the resistor elements surrounded by a watertight jacket of distilled water, with steam, with steam dome of wide surface, radiating the heat to the oil. Each variation of temperature of the fuel is proportional to the variation of pressure in the steam jacket, a pressure switch which controls the power to the resistor, by solenoid contractor, can be set to keep the temperature at required value. (D) In two-stroke engines an excessive cylinder liner wear is to be expected. To make this engine capable of operating on heavy fuel oil, the cylinder gears must be corrosion proof. Since chrome hardened cylinder liners have twelve years of background, it is desirable that this improvement should extend to the two-stroke engine designed for boiler oil. (E) The engine with a partition between the cylinder in the crankcase, with a stuffing box through which the piston rod passes, is insensitive to fuel quality, because no products of combustion can reach the lubricating oil.—*L. Emanuele, Journal of the American Society of Naval Engineers, Vol. 64, August 1952, pp. 601-603.*

Prediction of Service Performance of Gear Lubricants

Present methods of evaluating gear lubricants in the laboratory are satisfactory if only a rough indication of service performance is required. For the better utilization of available lubricants and the continued development of improved ones for more stringent applications, a deeper insight into the mechanism of gear lubrication is required so that the desirable properties of oils are known and can be measured. Taking the load-carrying capacity of gear lubricants as an example, it is still not possible to predict the load at which a straight mineral oil will permit scuffing of a given set of gears. The classical equations for hydro-dynamic lubrication as applied by Martin to gears predict failure loads far below those actually obtained. Even if the equations are modified to allow for effects which will increase the allowable load carried, such as the increase of viscosity with increased pressure, the calculated failure loads are still below those actually obtained. Blok has postulated that each combination of lubricant and sliding system has a "critical temperature for failure" and that once this temperature is reached in the contact, lubrication will fail and seizure occur. The temperature in the contact, according to Blok, is higher than the bulk temperature of the gears by a temperature flash, of very short duration, due to the generation of frictional heat in the contact. Lane has further elaborated the postulate by suggesting that the surface layers of the path of contact will be at a higher temperature than the bulk temperature because of the repeated applications of frictional heat, and that the temperature flash must be superimposed on to this "surface temperature" to obtain the temperature in the contact. Although it is difficult to conceive any physical meaning for the "critical temperature for failure", it has been shown to account for the behaviour of straight mineral oils in the IAE $3\frac{1}{4}$-inch centres gear rig, and work on the Two-ball machine has lent further support. The lubricating ability of an oil can thus be expressed by its critical temperature for failure, which at present can be calculated from results on laboratory test rigs and which perhaps will eventually be capable of being measured directly. However, before the postulate can be applied to practice, even empirically, a considerable amount of experimental data is necessary. Even if the values of the critical temperature calculated from results on laboratory test rigs are acceptable and can be taken as applying to gears, it is necessary to know the temperature in the contact of the gears before the performance of a given lubricant can be predicted or a suitable lubricant recommended. To calculate these temperatures, it is required to know the coefficient of friction in the contact and the dependence of the equilibrium surface temperature in the path of contact on the geometry, material, and operating conditions of the gears. In addition, the physical meaning of the hypothetical critical temperature for failure must be ascertained before the postulate can be applied practically with any degree of confidence and before direct measurements of the critical temperature for failure can be undertaken.—*J. R. Hughes, Journal of The Institute of Petroleum, Vol. 38, September 1952, pp. 712-718.*

Swiss Cargo Motor Ship

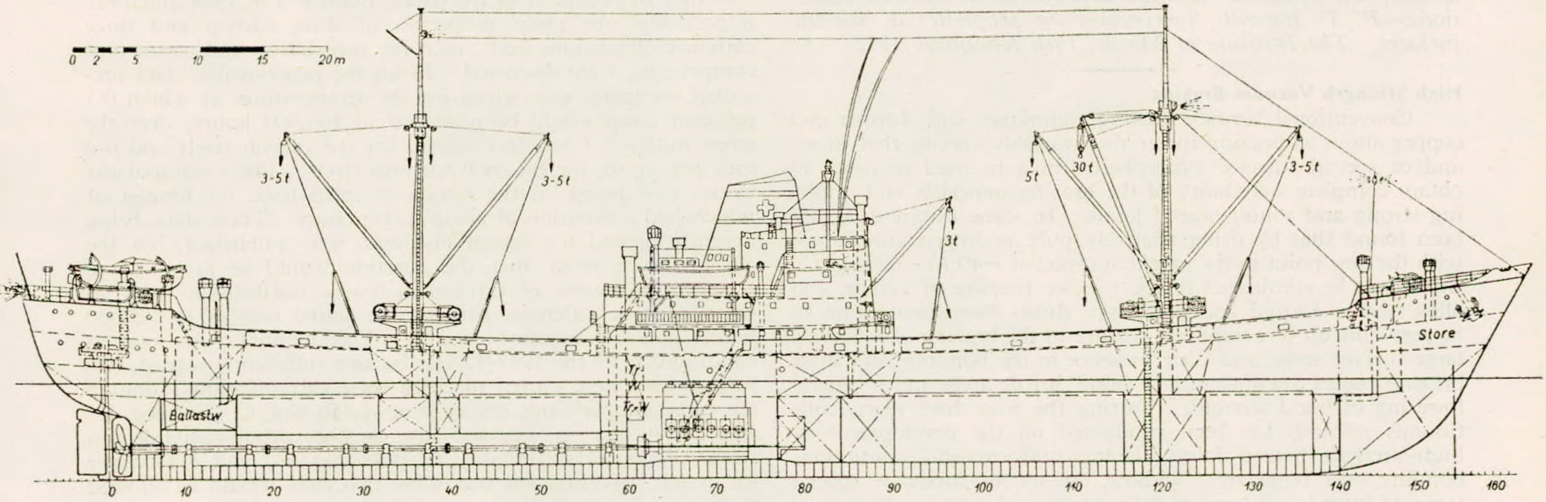
The Swiss cargo motorship *Maloja* was built at the Rickmers yard, Bremerhaven, for the Alpina Line, Basle. Overall length of the vessel is 118·58 metres, length between perpendiculars is 106·00 metres, deadweight is 6,700 tons, service speed is 13·5 knots. The vessel is equipped with two bipod masts of the Hallen type. The propulsion plant consists of a 2,600 h.p. single-acting two-stroke Sulzer engine turning at 135 r.p.m. Cylinder diameter is 600 mm. and stroke is 1,040 mm. There are three auxiliary generator sets of 106 kW. each, driven by Sulzer four-stroke Diesel engines of 160 h.p. at 500 r.p.m.—*Hansa, Vol. 89, 4th October 1952, pp. 1350-1355.*

Torsional Vibration of Flexible Coupling

Several special relations are derived that may be used to simplify the solution of certain phases of the torsional vibration problem. A solution is described for the vibration of a system with an untuned viscous damper. Numerical values are given for the nonlinear elasticity of the Falk-Babby type couplings. These values are rearranged into a form suitable for calculating undamped resonance curves of an engine installation which includes one of these couplings. An approximate solution for the resulting vibration is described and illustrated by calculation. A detailed examination of the methods used in the computations for torsional vibration reveals several important characteristics that are useful in solving certain phases of the problem. For example, the undamped, forced, vibration amplitude at the first mass of a concentrated-mass system may be obtained from the calculations of a standard Holzer table which is started at the end mass and carried through to the first mass. This amplitude, assuming that all the applied harmonic torques or impulses are equal, is the negative product of one impulse times the sum of the amplitudes at the impulses in the Holzer table, divided by the residual torque of the table. A solution is given for a system with an untuned viscous damper, the solution of which becomes relatively simple when using an equivalent mass for the whole system with this mass acted on by an equivalent impulse. The vibration of a system with a flexible coupling having nonlinear elasticity is considered. The whole system is reduced to two equivalent masses, one at each hub of the coupling where one of the masses is acted on by an equivalent impulse. An approximate solution is made by using in place of the coupling torque, its first harmonic for a harmonic variation of the amplitudes between the hubs.—*F. P. Porter, 1952 ASME Oil and Gas Power Division Conference; Paper No. 52-OGP-7.*

New Research Station

The research department of Babcock and Wilcox, Ltd., at Renfrew, is now subdivided into the following six sections: chemical, fuel testing, mechanical testing, combustion research, engineering research and metallurgical. The scaling of metals at high temperatures is an important research subject and the method, based on some years' experience, permits results to be extrapolated at about 100,000 hours of service. Each specimen consists of a tubular section machined from a solid bar of the material being investigated. It is suspended in the centre of an electric furnace, flue gas being supplied by a gas burner, with provision for injecting other gases as required. Correct treatment and control of feed water is essential for the trouble-free



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operation of all boilers and water analysis is a major activity of the chemical section. Salts carried over in the steam from high pressure highly-rated boilers can cause dangerous deposits on turbine blades and the purity of steam samples is also determined. Routine steam purity tests are made by comparative electrical conductivity methods, which must first be calibrated and checked by complete analysis. The evaporation to dryness of large quantities of condensate, in order to measure salts with concentration of less than one part per million, presents many difficulties, since condensed steam will dissolve sufficient quantities of most materials normally regarded as insoluble (including glass and many metals) to obscure entirely the original dissolved material. Furthermore, evaporation must be carried out in a dust-free atmosphere and without ebullition, to avoid dissolved solids being carried away with the steam. The apparatus designed in the laboratory utilizes a platinum basin heated from the surface by a radiant heater, thus avoiding the boiling which might occur if the vessel were heated from below. The whole unit is mounted in a dust-tight enclosure which is supplied with filtered air from a blower to assist in rapid evaporation. The evaporator vessel is mounted on a balance pan, and when sufficient water has been driven off to allow the pan to rise, a contact is made which refills the pan from the main specimen container by displacement with air from a pump. Tyratron control gear supervises the refilling of the pan and when the specimen bottle is completely empty, shuts down the entire unit. This apparatus is capable of dealing with five litres of condensate in approximately 25 hours.—*The Marine Engineer and Naval Architect, Vol. 75, October 1952, pp. 449-453*

Effect of Lubrication and Forms of Wear

In this paper the various forms of wear are described. The presence of an oxide layer generally reduces friction, but the conditions surrounding the sliding action may affect the type of oxide produced. The actual surface after repeated sliding is usually a complicated mixture of strained metallic material, oxides, and other possible reaction or decomposition products. There is evidence that the processes of friction and wear may differ between different crystal planes of the same crystal. Scuffing is shown to result from an unstable condition which tends to increase surface irregularity. Taper sections provide evidence that failure proceeds in stages, and microscopic evidence is given of plastic flow of metal adjacent to a rubbing surface. Pitting, a common cause of failure of ball bearings and gears, is attributed to fatigue of material below the surface and in the region of maximum shearing stress. The beneficial effects of phosphating are mentioned, and some experiments on anodized surfaces are discussed. The formation of metallic soap on a surface *in situ* is a good method of protection, and inorganic salts are effective under extreme conditions.—*F. T. Barwell, Symposium on properties of metallic surfaces. The Institute of Metals, 19th November 1952.*

High Strength Vacuum Brazing

Conventional furnace brazing techniques with copper and copper alloys as brazing materials invariably specify that fluxes and/or special furnace atmospheres must be used in order to obtain complete wettability of the brazing materials and resulting strong and sound brazed joints. In some instances, it has been found that by using relatively pure hydrogen atmosphere with the dew point in the neighbourhood of −40 to −60 deg. C., fluxes can be eliminated in the furnace brazing of carbon and alloy steels. Liquid and paste type fluxes have been found to be very difficult to completely remove in the brazing of relatively large surface areas, and their presence in the bonding zone after brazing causes discontinuity of bond, brittle areas and a general lowering of bond strength. During the past three years, continuous research has been conducted on the development of high-strength brazed joints having uniform and continuous bonding over large areas without the use of fluxes or special types of introduced furnace atmospheres. A system of vacuum brazing has now been developed wherein sound and continuous high-strength bonds can readily be obtained throughout areas of virtually unlimited size without the use of introduced furnace atmospheres and without contamination from fluxes. In the case of brazing of stainless steels, it is not necessary to nickel or iron plate the stainless surface before bonding in order to obtain a strong oxide-free bond. The work has shown that continuous brazed bonds can be produced between low and medium carbon steels and all of the three major classifications of stainless steels (ferritic, martensitic and austenitic). In addition, this same high-strength brazed bond, which averages from 40,000 to 60,000lb. per sq. in. shear strength can be attained without difficulty between low and medium carbon steels and pure nickel, Monel and Inconel. Even Hastelloy has shown promising results with vacuum brazing, although this alloy is still in the experimental stage. This development promises to open new fields of application in the brazing of large continuous surface areas, as brazing can be accomplished without entrapment of brittle flux particles which can cause non-uniformity of bond strength, and further, the use of vacuum pressures of between 29 and 30 inches of mercury furnishes tremendous pressures exerted uniformly over the entire area being brazed, which pressures can be maintained throughout the entire brazing cycle, ensuring a continuous and uniformly strong bond throughout. Heretofore, furnace brazing has been primarily utilized for the joining of small or intermediate sized assemblies due to difficulties in maintaining uniform pressures at the bonding interfaces during the brazing cycle and the possibilities of leakage of oxygen into the furnace, resulting in oxidation of bonding areas and lack of bond. This was especially true in the brazing of stainless steels, where extremely rapid oxidation of brazing surfaces presents a difficult problem. The vacuum brazing process has shown that the only limits of size in the brazing of plates are the confines of the brazing furnace cavity itself, no fluxes or atmosphere control being involved, and in the case of stainless steels, no special preparatory plating being necessary on the bonding surfaces. Copper has a tendency to penetrate steels at high temperatures, and if allowed sufficient time and if sufficient copper were present, could cause damage to the ductility of the adjacent steels. Extensive experimental research work has been carried on in connexion with this characteristic, and through control of the thickness and placement of the copper and copper alloy brazing layers, plus very close control over brazing cycles, and also important, the tendency of the vacuum to draw off excess brazing alloy, this penetration has been controlled to a degree where its effect is negligible on the physical properties of the brazed composite plate.—*R. C. Bertossa, The Welding Journal, Vol. 31, October 1952, pp. 441-s-447-s.*

Creep of Superheater and Pipe Steels

In Parts I and II of the paper, published in 1944 and 1945 respectively, the creep properties of three carbon and three carbon-molybdenum steels, used for superheater and steam pipe components, were discussed. From the experimental data presented, estimates were given for the temperatures at which 0·1 per cent creep would be produced in 100,000 hours; over the stress ranges 5-1 tons per sq. in. for the carbon steels and 6-2 tons per sq. in. for the molybdenum steels. These extrapolated values were based on the results of creep tests, the longest of which had a duration of about 5,000 hours. These data, being urgently needed for design purposes, were published; but the authors were aware that the question would be raised as to whether the degree of extrapolation was justified—in view of the very large difference between the actual time of test, 5,000 hours, and the required time of 100,000 hours. As soon as conditions after the 1939-45 war became sufficiently settled, two further tests were started to check these extrapolations: one on the carbon superheater header steel at 450 deg. C. (842 deg. F.) and 5 tons per sq. in., and one on the carbon-molybdenum steam pipe steel at 500 deg. C. (932 deg. F.) and 6 tons per sq. in. It was intended that these two tests should be allowed to proceed for the full time of 100,000 hours. They have now completed about 67,000 hours and, together with additional data furnished by tests continued after the publication of Parts I and II, have produced sufficient new information to enable revised estimates of the 100,000-hour data to be made, at these particular stresses, for these two materials. The revised estimates for the temperatures for 0·1 per cent creep in 100,000 hours, however, do not agree too well with the previous values. For the carbon steel these values are 443 deg. C. (829 deg. F.), and for the carbon-molybdenum steel 460 deg. C. (860 deg. F.) instead of 484 deg. C. (903 deg. F.). The report also gives revised temperatures for other strains and for a period of 10,000 hours. The tests, which are still in progress, will be continued for the full time of 100,000 hours. No metallurgical examination of the specimens has yet been made; it will be undertaken at the end of the tests.—*Paper by R. W. Ridley, submitted to the Institution of Mechanical Engineers for written discussion, 1952.*

Creep Tests on Nimonic Alloys

Among the alloys specially developed to meet strict limitations on permissible creep under particularly arduous conditions of stress and temperature, the nimonic series of the Mond Nickel Company, Ltd., are now well established and have found numerous applications in the gas turbine and other high temperature fields. In Figs. 1 and 2 are shown, graphically, series of long-time creep tests conducted at 700 and 750 deg. C., respectively, Nimonic 80 A. This alloy contains 80 per cent of nickel, 20 per cent of chromium, from 1·8 to 2·7 per cent of titanium, from 0·5 to 1·8 per cent of aluminium, and a maximum of 5 per cent of iron and of 2 per cent of cobalt. It will be noted from Fig. 1 that the creep curve for the alloy at 700 deg. C., under a load of seven tons per sq. in. has now been completed, the specimen fracturing at 34,065 hours, giving a strain of approximately 1·15 per cent. Fig. 2, showing creep data at 750 deg. C., has already been published by the firm; it indicates that the specimen, under a load of four tons per sq. in., fractured at 22,657 hours. It is concluded that although Nimonic 80 A was primarily designed for use at high temperatures for short times, these data show that this alloy is also suitable for use for long periods at these temperatures. Investigations are at present in hand to develop the best possible long-time creep properties of the alloy.—*Engineering, Vol. 174, 26th September 1952, p. 415.*

Influence of Aluminium on Creep Properties

In 1944 it was evident that an investigation was needed to determine the extent to which the creep resisting properties of basic open-hearth carbon-steel superheater tubes for use at high temperatures are affected by various commercial annealing treatments. Aluminium additions are commonly made to these steels to meet the requirements of rotary piercing, and the question of the amount of aluminium which may be added without causing a deterioration in the creep properties is one which has caused concern. Creep tests were accordingly made at the National Physical Laboratory on representative samples of basic open-hearth mild-steel tubes in various stages of manufacture, i.e. as pilgered, and also with further manufacture either as hot reduced or as cold drawn. Samples of these tubes were given various heat treatments before testing. Three steels were examined, similar except for aluminium additions which were 1, 2 and 3lb. per ton respectively; this range of aluminium was expected to provide examples of steels ranging from good to poor in creep resistance when tests were made on bars forged from the billets. The quality of the steels was judged, in the absence of a B.S.I. specification for quality of tube steels, according to the B.S.I. Specification B.S. 1271: 1945 for creep quality of carbon steel plate, which states that steels having an average creep rate (later referred to as the B.S.I. rate) of more than 50 millionths per hour between the 24th and 48th hour in creep tests carried out at 450 deg. C. and 8 tons per sq. in. would be regarded as having poor creep properties. A steel having an addition of 1lb. of aluminium per ton provided tubes having satisfactory creep properties in all conditions of fabrication and heat treatment. A steel with a larger addition, namely 2lb. of aluminium provided hot- or cold-drawn tubes which had good creep resistance, but a close annealing or normalizing heat treatment considerably reduced this resistance. A further steel having 3lb. of added aluminium was generally poor in creep resistance, both in bar and in tube form.—*Paper by D. C. Herbert and E. A. Jenkinson, read at a meeting of the North-East Coast Institution of Engineers and Shipbuilders, 24th October 1952.*

X-ray Detection of Flaws in Metal

A British firm of manufacturers of industrial X-ray equipment have produced for laboratory use a new version of their 150-KVp. mobile set, capable of penetrating up to $1\frac{3}{4}$ inches of

Fig. 1. 700 DEG. C.

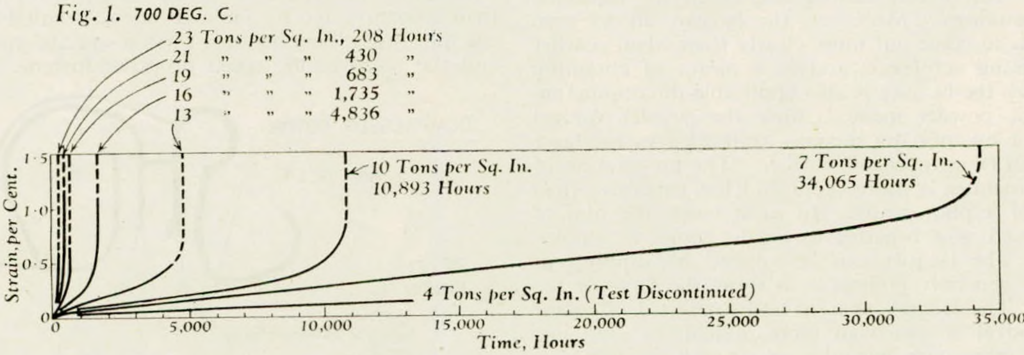
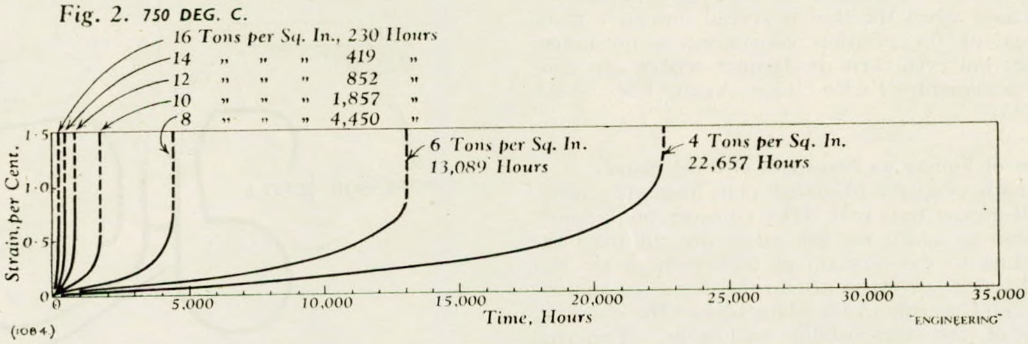


Fig. 2. 750 DEG. C.



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steel. The mobile equipment was designed for use in shipyards, boiler-works, etc., or for any site work where it is necessary to take the equipment to the work requiring examination. About ten mobile sets are engaged in the radiography of welds and welded keel plates, strakes and deck houses in the main shipbuilding areas of this country; the Wear Shipbuilders' Association have been supplied with two sets which are available when required for the local shipbuilding firms. The company point out that X-ray tests of the internal condition of castings and welded seams accurately indicate the presence of gas, sand and slag inclusions, cracks, shrinkage defects, incomplete root penetration, lack of fusion and similar faults. Not only is inspection work carried out more quickly and thoroughly by X-rays, but valuable developments of manufacturing techniques are possible with their aid. The tube stand of the mobile set gives a wide range of movement in all directions and can be fixed in positions up to 11 feet above its base line. The set is self-contained on a truck, and on arrival at the scene of operation, it is only necessary to make a plug connexion with the nearest source of electric power.—*Lloyd's List and Shipping Gazette, 15th October 1952, p. 5.*

Non-destructive Investigation of Surface Defects

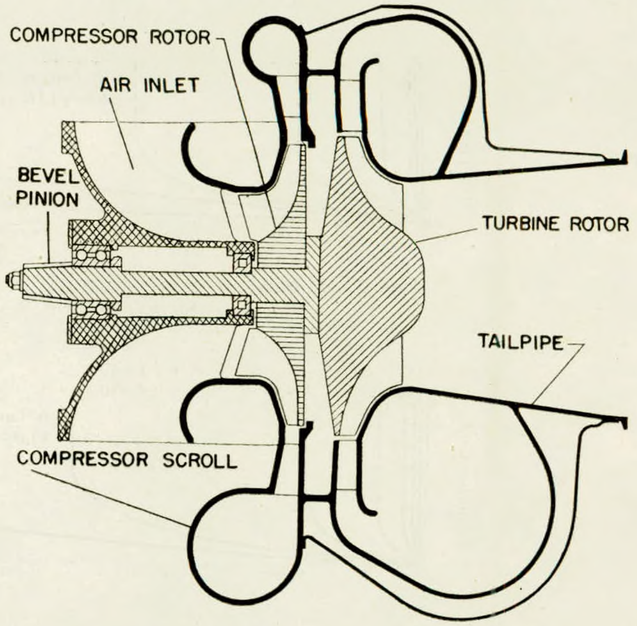
The Materials Testing Department of Escher Wyss Ltd., Zurich, have developed a new process for the non-destructive investigation of metallic surfaces. This process can be applied in conjunction with the fluorescence method or the dye method of flaw detection. A special lacquer is used as a developer in place of powder. The lacquer is transparent and colourless, and can be removed as a thin skin after drying. The purposes of this layer of lacquer are as follows: (1) Action as a developer: The fluorescent oil or the dye dissolves in the lacquer and is thus drawn out of the defective parts. (2) Action as a fixing substance: The image of the defect is fixed in the rapidly drying layer of lacquer. The developed image of the defect cannot be damaged or wiped off after the lacquer is dry. The defective specimen can therefore be conserved or transported without any damage to the developed image. (3) Production of a document: The lacquer provides a replica of the defective part, which is true to nature as regards the shape, relative position and size of the defects. As a developer, the transparent layer of lacquer, compared with the powder layer, has the advantage that it gives directly a translucent image of the surface of the specimen, so that the defects can be considered in connexion with their surroundings. Moreover, the lacquer allows even the smaller defects to come out more clearly than when powder is used. As a fixing substance, and as a means of obtaining permanent replicas, the lacquer is also applicable in conjunction with the magnetic powder method, since the powder applied as a suspension or by spraying becomes embedded in the layer of lacquer and can be stripped off with it. The preparation of a replica in this manner is more rapid and less expensive than the production of a photograph. In most cases, the film of lacquer can be used as a negative to obtain copies by photographic means. The lacquer can be applied by dipping or pouring, but it is generally preferable to spray the flaws or the suspected parts. The lacquer skin is easily stripped off plane surfaces; the removal is somewhat more difficult or even impossible in some cases with irregular or strongly curved surfaces. In such cases, when the skin is spread out on a plane surface, the image of the position considered is no longer geometrically true; but even then the lacquer replica can constitute a useful document.—*Escher Wyss News, Vol. 23-24, 1950/51, pp. 98-101.*

Effect of Direction of Rolling on Properties of Steel Plates

It is a common property of rolled plate that the energy absorbed in notch-impact tests may differ considerably, according to the direction in which the test pieces are cut from the plate, and according to the position of the notch in the test piece. These differences are attributed to the degree of lamination of the ferrite and pearlite in the plate, and to the character and distribution of the non-metallic inclusions. Preferred orientation of the crystals has not been found to occur to any extent in hot-rolled plate. If elongated inclusions are placed perpendicular to the direction of straining, a high stress concentration may be engendered at the ends. Moreover, in any situation, particularly if the stresses are non-uniform, there is a tendency for separation to occur on straining between the metal and non-metallic inclusions, owing to lack of cohesion between materials of different chemical composition and with different elastic constants. The role of inclusions in initiating fracture has been established; their part in initiating yield is not easy to determine, although it may be presumed to exist. The experiments reviewed in this paper were made to determine the effect of plastic strain and ageing on notch-impact test results, and on the yield point of a mild-steel plate, with the special purpose of investigating directional effects.—*C. F. Tipper, Journal of The Iron and Steel Institute, Vol. 172, October 1952, pp. 143-148.*

Inward-flow Radial Gas Turbine

The vast majority of gas turbine projects initiated to date have been of a type and size for which efficient axial-flow turbines could readily be designed. Not until the possibilities of small turbo-compressors and small gas-turbine power units were appreciated and investigated did the axial turbine begin to exhibit certain limitations, both from the performance and manufacturing aspect. Faced with the problem of finding satisfactory gas turbines of very small dimensions, research workers were obliged to re-examine the whole question of turbine design. In doing so, they applied to compressible fluids a similar mathematical treatment to that which water turbine designers had applied to incompressible fluids several decades previously. Having adapted the hydraulic engineering concept of *specific speed* as a means of comparing various types of turbo-machine, they completed some trial calculations and later borrowed the principle of the Francis turbine, together with its means of control. Specific speed, in water-turbine technology, is defined as the speed in r.p.m. at which the turbine rotor would revolve if it were reduced in size to the point where it would develop 1 b.h.p. under a head of 1ft. (or 1 metre). Use of this concept provides a measure of the capabilities of any given turbine design under a particular set of conditions, without reference to turbine efficiency. It enables a direct comparison to be made between the various available forms of turbo-machine and thus serves as a valuable guide in choosing a turbine for a given task. The centripetal type of water turbine, which was invented more than a century ago by James Francis, is suitable for a range of specific speeds lying between the low-specific-speed Pelton wheel and the high-specific speed propeller turbine. Radial inward-



flow turbines are found to be suitable only for a relatively narrow range of low specific speeds, the precise figures depending entirely on which formula is adopted. At higher specific speeds the axial turbine is preferable; at very low specific speeds, a case can be made out for using a small impulse turbine or, perhaps, a positive-displacement type of turbine, such as the Lysholm. In applications where it is desirable for the turbine to operate over a considerable range of mass flows without serious detriment to its efficiency, the radial inward-flow gas turbine is assured of a prominent position, because it can so readily be fitted with swivelling guide vanes connected to some governing device. Centripetal turbines are known to have been designed by the Allen, Centrax and Metropolitan-Vickers concerns, each with a different application in mind. The Allen turbine must be something of a borderline case, for it has been applied to a shipboard generating plant rated at the relatively high figure of 200 kW.; this may well prove to be an example of choosing a centripetal turbine for geometrical reasons rather than for its suitability on purely aerodynamic grounds. The future of the centripetal turbine in the gas turbine field will depend largely on the experience gained with the units now coming into use. One of the most important questions is whether high gas temperatures will prove unusable because of stress concentrations in the radial rotor.—*The Oil Engine and Gas Turbine, Vol. 20, October 1952, pp. 222-225.*

New Fluorescent Ink for Crack Detection

A new fluorescent ink has been developed which is designed as a tool for non-destructive crack detection for use with light metals, non-ferrous alloys, stainless steels and plastics and depends for its action upon deposition in surface cracks of a material which fluoresces when irradiated with ultra-violet light. The method of application of the "ink" is extremely simple and rapid. Only two minutes are required to prepare and inspect a typical degreased test piece. The test piece is dipped into the fluorescent ink, which is a true solution, and does not require any agitation, or alternatively a few drops of the ink are poured over the surface of the test piece. After allowing approximately one minute for the surface to become dry, the impregnated test piece is inspected under an ultra-violet light source. Surface cracks reveal themselves by their brilliant fluorescence which can be seen even on a background of redundant green fluorescent material. These cracks are clearly defined and they cannot be confused with tide marks of the fluorescent ink. However, to remove the fluorescent background, the test piece is dipped very quickly into carbontetrachloride, which, if the test piece is not left in for too long, removes the redundant fluorescing material without dissolving fluorescent material from the cracks. Again allowing about one minute for the surface of the test piece to become dry, inspection under an ultra-violet light source shows clearly the pattern of the surface cracks. Typical applications include aluminium and magnesium alloys which form structural members of internal combustion engines, turbine blades, and welded plates or any other welded structures which may have shrinkage cracks or porosity. Plastic materials, particularly plastic insulators, can be easily and quickly examined and the flatness of surfaces can be tested by applying the fluorescent ink to the surface and moving a straight edge across it. Further applications include inspection of alloy pistons, stainless steel parts and detection of cracks and holes in hydraulic systems.—*Engineering Inspection, Vol. 16, No. 3, pp. 125-126.*

Gas Turbine Operating Experience

The Anglo-Saxon tanker *Auris,* the first merchant ship in the world to be propelled by a gas turbine, has now completed her first year of service. The British Thomson-Houston turbine, which operates in parallel with three Diesel engines, has continuously borne more than its full share in the propulsion of the ship during a year of hard unremitting work, in which a total of 170,000 tons of cargo was carried for a distance of 52,898 nautical miles. She is now out of service for routine overhaul to the hull and Diesel machinery. The owners state that the gas turbine has given much satisfaction at economical cost. Though the nominal power of the turbine is a little more than one-quarter of that of the whole machinery, it has produced almost 40 per cent of the total power delivered to the propeller motor. In March the vessel, powered by the turbine alone, made the westward crossing of the Atlantic at an average speed of 7·35 knots. For this voyage the fuel used was an ordinary boiler oil of 1,500 secs. viscosity Redwood No. 1 at 100 deg. F. A marked absence of vibration was noticed and the turbine has proved to be extremely reliable. There has been virtually no need of maintenance work at sea, and in port this has been limited to the washing of the compressor blading, heat exchanger surfaces and other such simple operations. From these statements it would appear that heavy fuels of medium viscosity can now be used in suitable gas turbines. It is further stated that economies were observed in the consumption of lubricating oil, and that this engine's fuel consumption was about the same as that of an ordinary steam turbine of the same power. It still remains to be seen how quickly deposits on the blades are built up on the blades from the use of yet heavier fuels, and the life of the engine is also to be determined. The claim is made that had the ship been powered by gas turbines alone, she would have only required three days out of service for overhaul. No repairs were needed to the turbine apart from the calibration of instruments. As it is, the overhaul is expected to last three weeks to enable repairs to be made to the Diesel engines.—*The Shipping World, Vol. 127, 29th October 1952, p. 335.*

Combined Steam and Gas Turbine

The plant illustrated in Fig. 5 comprises a gas turbine having several air compressors and one or more turbines actuated by hot gases generated by the combustion of fuel in air under pressure. The gases contain a mixture of water and steam produced in evaporator-saturators (H1, H2, H3), these devices having cold-water inlets (J). The caps (K) compel the water to trickle outside the tubes and become partly vaporized

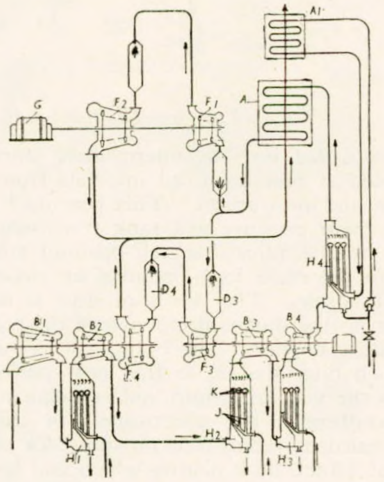


FIG. 5

by the flow of compressed air. The high-pressure and low-pressure turbines (F1, F2) drive a generator (G). The compressor set includes a low-pressure turbine (F4) preceded by a combustion chamber (D4) and driving low-pressure compressors (B1, B2). The high-pressure turbine (F3) is preceded by a combustion chamber (D3) and drives the compressors (B3, B4). At the discharge of the compressor (B4) the air flows through a fourth evaporator-saturator (H4) and the final mixture of air and steam is heated in a recuperator (A) which receives exhaust gas from the low-pressure turbines (F2, F4). A feed heater (A1) is provided for the evaporator-saturator (H4). (Brit. Patent No. 676,008, Soc. Rateau, and R. Anxionnaz, Paris.)—*The Oil Engine and Gas Turbine, Vol. 20, October 1952, p. 230..*

Vacu-Blasting

In the past, shot blasting, wire brushing and pneumatic scaling hammers have been extensively employed by steel fabricators for cleaning plates prior to welding. More recently a new type of equipment operating on a different principle has been developed. This equipment is particularly suitable both for cleaning oxygen-cut plate edges, as well as rusted material, prior to welding and for post-weld cleaning. Basically the Vacu-Blaster consists of a blast gun, pressure blast generator, abrasive reclaimer, dust collector, vacuum pump and motor. The action is initiated by closing a remote-control switch located near the blasting gun. The abrasive is then driven against the work surface under air pressure; next, the air stream through a vacuum return system effects a positive pick-up of all abrasive, scale, debris, dust, etc., which is carried to the abrasive reclaimer located above the blast generator. Here the abrasive is separated from the dust and other foreign matter and stored in the storage hopper. At regular intervals the stored abrasive is fed into an intermediate storage grit tank which is isolated at predetermined intervals from the abrasive storage hopper and pressurized. This permits the abrasive to be fed to the main pressure grit tank from which it is continuously fed by the adjustable, self-opening and self-closing feed valve, into the main high-pressure air stream, conveying it to the blast nozzle. The debris or dust is carried by the vacuum system to the dust collector where the heavier particles fall into the dust hopper. The light dust is stopped by the dust bags which filter the air so that only perfectly clean air is admitted to the vacuum pump and subsequently discharged into the atmosphere. The effectiveness of this method of cleaning is revealed by recent tests on steel deck plates. In one test, samples of ½-inch deck plating which had been badly corroded were cleaned first to a bright finish by the Vacu-Blast gun. Another set of samples were then cleaned by chipping and wirebrush methods. At the conclusion of the weathering tests, paint applied to the plates cleaned by the new method lasted thirty-nine times as long as paint applied to surfaces cleaned by the older methods. The equipment is extremely portable, the blast gun itself weighing only 9lb.—*Welding and Metal Fabrication, Vol. 20, October 1952, pp. 361-362.*

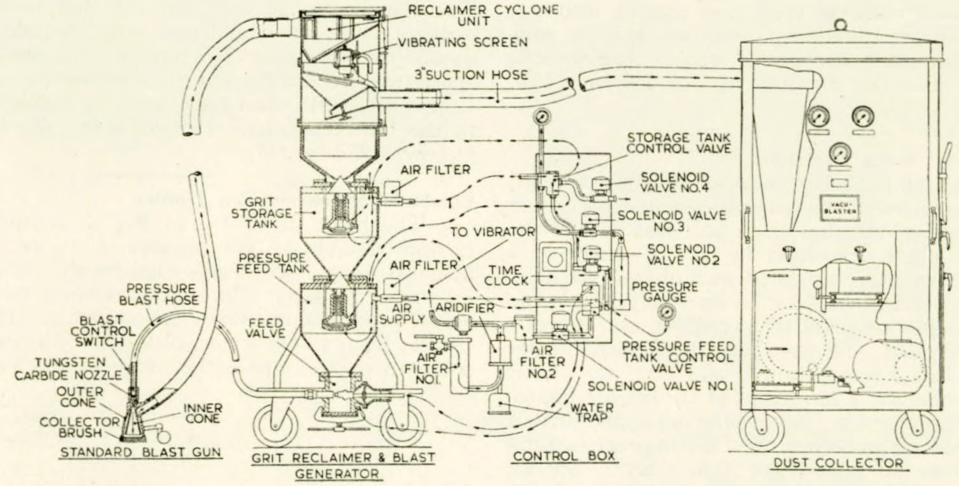


FIG. 6.—*Diagrammatic layout of continuously operating Vacu-Blaster unit*

Refractory Ceramic Protective Coating

Technically, the Solaramic coating is a thin, vitreous or semi-mat ceramic coating bonded tightly to the metal's surface. This seals the metal against destructive effects of hot gases and combustion products. The smooth coating surface offers little friction to gas flow. This, combined with prevention of surface oxidation, closes the door on hot spots and thus protects the parent metal against cracking and warping in high temperature operating conditions. Its extreme flexibility and bonding strength makes the Solaramic coating a good protection for sheets as thin as 0·001 inch. The coating can cover all type welds and various alloys in different thicknesses that may be used in making a single part. Standard components can be coated with little or no design changes. The Solaramic coating is also fairly resistant to impact. A sharp blow may fracture the coating at the impact area; but a thin protective coating will remain. In most cases these spots will heal themselves during operation by coalescing of coating from the surrounding region. This will protect the affected area about as well as the original coat.—*J. V. Long, SAE Journal, Vol. 60, September 1952, pp. 38–41.*

Chemical Behaviour as Influenced by Surface Condition

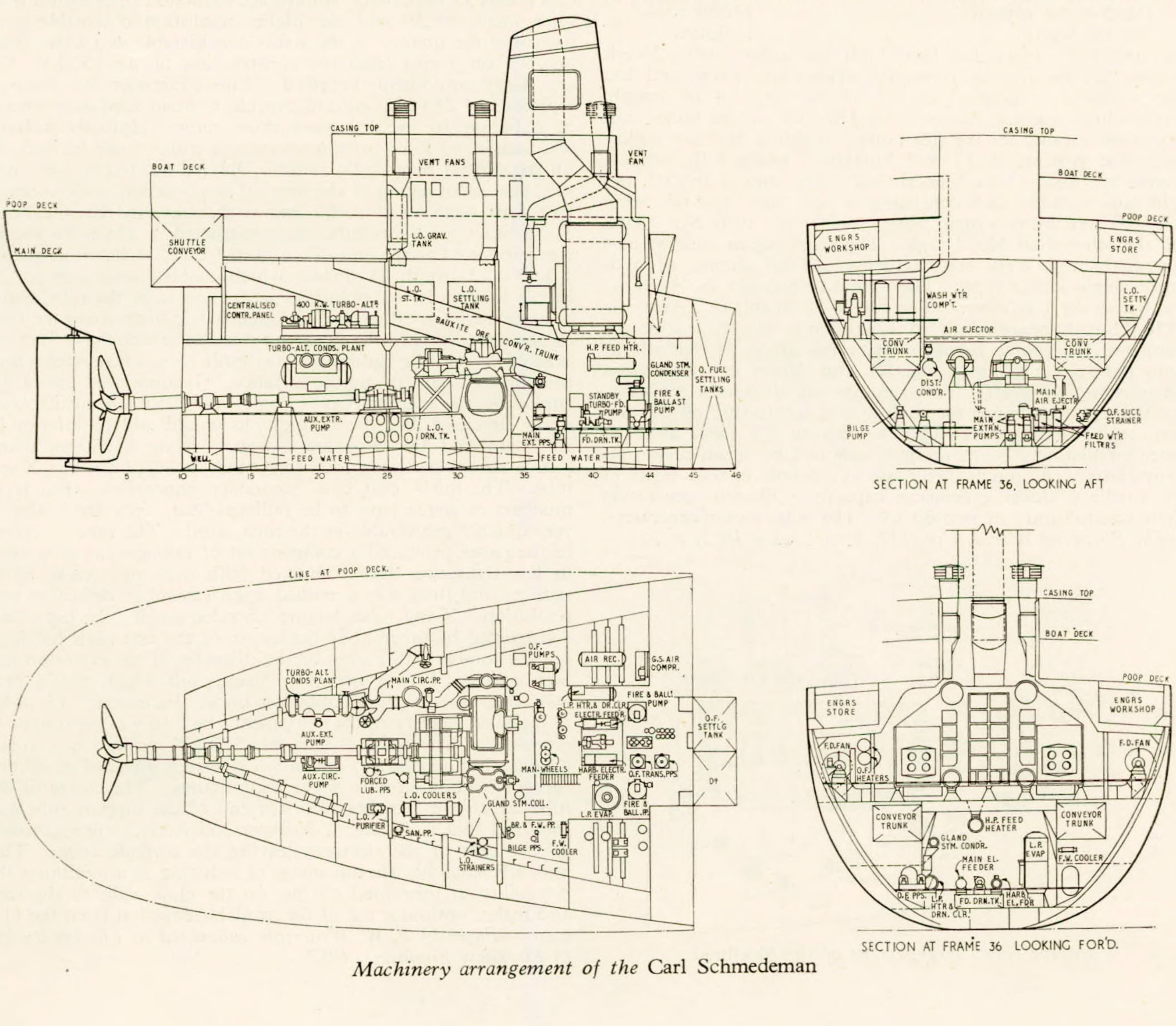
The effect of surface condition on corrosion probability, corrosion distribution, and corrosion velocity is discussed in this paper. The surface condition may sometimes influence the probability of attack, which may be much higher along a scratch-line than elsewhere; certain inclusions behave in the same way as roughness. The surface condition may also alter the distribution of attack; where the total attack is fixed by some external factor, e.g. the rate of oxygen supply, the corroded area will be smallest and the intensity of corrosion greatest when the surface is most nearly perfect. Where, however, there is no control by an external factor, a good surface is likely to be advantageous. In some cases the velocity of corrosion may be affected by the surface condition, but the influence on velocity is likely to disappear if and when the whole of the surface layer has been removed by corrosion. Surface defects are likely to increase the risk of corrosion-fatigue and stress-corrosion cracking, and they also increase the number of discontinuities in protective coats—an important matter at a time when the amount of metal available for coating is limited. Of the various types of surface treatment, peening appears, under some circumstances, to reduce the liability to corrosion-fatigue and stress-corrosion cracking; in certain liquids, however, peened steel suffers corrosion-fatigue more easily than finely ground steel. Electropolishing holds out a promise of providing a surface which, if not specially resistant to attack, should at least be reproducible, so that inhibitive treatments or protective coatings may be expected to produce consistent results.—*U. R. Ulick, F.R.S., Symposium on properties of metallic surfaces. The Institute of Metals, 19th November 1952.*

Ultrasonic Thickness Testing

The great economy, speed, and convenience of non-destructive thickness measurements by the ultrasonic thickness tester can be materially increased under awkward conditions by the use of a new magnetic fixture to hold the searching unit against the plate being tested. This valuable accessory assures good contact and prevents accidental shifting of the searching unit during tests, and permits one man to operate the instrument alone in different locations. It is particularly valuable when working on ladders or staging, and when test points are beyond easy reach, such as ship hulls and upper plates of bulkheads. The fixture consists of a flat spring with an Alnico permanent magnet coupled flexibly to each end, and means for attaching the searching unit quickly and easily to its centre. The standard magnets are of sufficient strength to hold the unit properly against surfaces that are slightly irregular or covered with a thin coat of paint; heavier magnets can be provided for use on cast iron and other rough surfaces, or on plates that are covered with thick coatings of paint or scale.—*Marine Engineering and Shipping Review, Vol. 57, October 1952, p. 138.*

Self-unloading Bauxite Carrier

The first self-unloading ore carrier to be used by the aluminium industry has recently been completed by the Barrow shipyard of Vickers-Armstrongs, Ltd. The vessel has been built to the order of Reynolds Jamaica Mines, Ltd., and is intended for the carriage of bauxite ore from Ocho Rios Bay in Jamaica, to Mobile, Alabama, and Corpus Christi, Texas. The vessel has been named Carl Schmedeman and is of the single-deck trunk type. It is constructed on the Isherwood system of longitudinal framing with the exception of the peaks, the forward deep tanks, the machinery space and the double bottom aft. The hull is practically completely welded, the only riveted connexions being one seam in the bilge and the connexion of the stringer bar to the main deck. Stern frame, rudder, bollards, fairleads, etc., are all fabricated from mild steel plate and welded. Hull castings have been entirely eliminated from the ship. The principal characteristics of the vessel are as follows: length overall 518ft., length between perpendiculars 500ft., breadth moulded 66ft., draught 27ft. 9in., deadweight 13,150 tons. The cross section through the bottom of the cargo holds is in the form of a W, with the conveyor belts of the self-unloading system running beneath the two bottom angles. The two conveyor belts, one port and one starboard, are each 42 inches wide. These belts are arranged horizontally in way of the cargo holds, and then inclined through trunks in the engine and boiler rooms to the main deck level aft, where they discharge on to a transverse belt shuttle conveyor 48 inches wide. The shuttle conveyor can be extended through doors in the ship's side to port or starboard to discharge the cargo to a specially designed shore-receiving plant. The bauxite ore is fed to the hold conveyors through specially designed gates at the base of each vee, and these are controlled from the conveyor working position. With this system it is estimated that the cargo of 12,500 tons can be transferred from the ship to the shore in about nine hours. The ore conveyors are controlled independently from a central



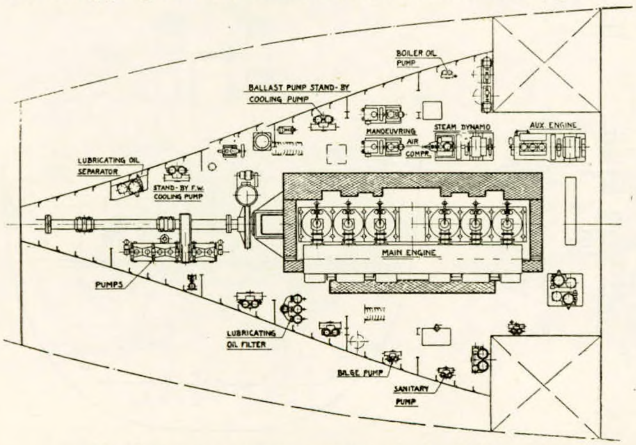
Machinery arrangement of the Carl Schmedeman control station situated on a thwartships platform on the after side of the shuttle conveyor recess. By means of a pendulum switch, the trim of the vessel is indicated by red, amber and green lights in the passages. The switch is set for 10 degrees normally, but is capable of adjustment up to 15 degrees list. The vessel is propelled by a single screw, driven by a set of geared turbines of Richardson, Westgarth-Brown Boveri, cross compound type, capable of developing a service power of 6,600 s.h.p., and a maximum power of 7,620 s.h.p. with propeller speeds of 112 and 116 per minute respectively. The astern turbines are capable of developing 4,600 s.h.p. at 95 r.p.m. Steam is supplied to the turbines at 440lb. per sq. in., superheated to 740 deg. F. Steam is supplied by two Foster Wheeler "D" type water tube boilers with cast iron grilled economizers at 450lb. per sq. in. working pressure and 750 deg. F. temperature at the superheater outlet.—*The Shipping World, Vol. 127, 22nd October 1952, pp. 320-323.*

Norwegian Tanker

The motor tanker *Skjelbred,* 13,250 tons deadweight, has been delivered by Burmeister and Wain to Skjelbreds Rederi A/S, of Kristiansand, Norway, following successful trials. The leading particulars of the *Skjelbred* are as follows:—

Length b.p.	465ft.
Breadth moulded	62·8ft.
Depth moulded	34·6ft.
Gross tonnage	8,630 tons
Deadweight capacity	13,250 tons
Service speed	14 knots

The *Skjelbred,* which has been built for registry with Norsk Veritas, has the normal forecastle, bridge and poop, and has been designed without sheer for 45 per cent of its length. Longitudinal framing has been used for the centre tanks, and transverse framing for the side tanks. Welding has been widely used, side plating, decks and bulkheads being fully welded. Frames and beams have been riveted. The ship is divided into eight tank sections, each consisting of one centre and two wing tanks. There are two main pump rooms, one abaft No. 2 tank and the other abaft No. 4 tank. The main engine consists of a Burmeister and Wain six-cylinder crosshead engine, of two-stroke single-acting type. The cylinder diameter is 740 mm., and the stroke 1,400 mm. The engine is capable of developing 5,750 i.h.p. corresponding to 4,600 b.h.p. at 110 r.p.m. A feature of the engine room auxiliary machinery is that all the main pumps are grouped together and driven by chain from the intermediate shaft. Three pumps are driven in this way, one two-cylinder pump for cooling and lubricating oil circulation, and two larger two-cylinder pumps for fresh and salt water circulation. Starting air is supplied by steam-driven air compressors. As much direct use as possible is thus made of the auxiliary steam generating capacity. Electric generating plant consists only of two 30 kW. 110 volts steam generators. —*The Shipping World, Vol. 127, 8th October 1952, p. 285.*



Engine room arrangement of the Skjelbred

Repair of a Diesel Engine

An interesting example of the application of the Metalock system to the repair of shipboard machinery is the repair of a fractured water jacket of No. 2 cylinder of a National Diesel engine driving a generator in H.M.S. *Eagle.* The fracture was caused by a seized piston, and the thickness of metal varied between ¾ inch and 1 inch. While the repair itself was straightforward, and a comparatively small job for a Metalock operator, it was estimated by the authorities that it would have cost at least £5,000 had the defective unit been replaced by a new one and would have taken a very much longer time. This high cost, of course, would have been due to the necessity of cutting steel decks to ship the new unit.—*Shipbuilding and Shipping Record, Vol. 80, 18th September 1952; pp. 373-374.*

X-ray Equipment for Gas Turbine Rotor Inspection

For radiographing welded-steel sections less than ⅝-inch thick, the use of radium or radioactive isotopes produces inferior results in a longer time than may be obtained by the use of an X-ray tube of quite moderate power, provided the tube target can be suitably positioned. For factory use, where many similar welds have to be radiographed, the questions of time and production rate are of first importance in the choice of a source of radiation. An average reduction in exposure time by a factor of 50 and the higher resolution obtainable have improved the quality of the welds considerably and more than justified on a cost basis the construction of the 150-kV. 50-c/s X-ray equipment described. This equipment has entirely replaced the 250-mg. radium capsule hitherto used as a source of radiation for welded gas-turbine rotors. Initially radium was used as no X-ray tube was available which could be inserted up the central bore of the rotor. Oblique techniques were not very successful owing to the internal construction, which meant that four sections of metal had to be traversed by the rays. Accordingly an X-ray tube was constructed in which the anode was supported at the end of a jacketed tube, of inside diameter 1 inch and length 43 inches, which enabled rotors up to 70 inches long to be radiographed with ease, since the tube could be inserted from either end through a 1·75-inch diameter hole in the rotor shaft. Radio-active sources which have become available since this equipment was built have advantages where portability is of prime importance. Iridium 192 could be applied to the examination of rotors and would be available at a low first cost, but the radiographs would still be inferior in definition and the necessary exposure using a 250-millicurie source would be thirty-four times that required for the X-ray tube. The initial cost is of secondary importance when large numbers of welds have to be radiographed, since the outlay is very quickly recoverable in the time saved. The tube described in the paper produced a complete set of radiographs of a rotor in less than two days compared with over two weeks using radium, and there was a marked improvement in definition and resolution. X-ray tubes having extended anode tube have been constructed by others, but the length of the extension has been limited to about 18 inches or the diameter of the extension has been enlarged by the use of focusing coils which would prevent their use in the application under discussion. In order to facilitate delivery of the equipment, the tube was continuously evacuated. The rated output was 150 kV. peak, 5 m.a. mean current, but satisfactory operation has been obtained at a continuous loading slightly above these figures. The centre of the tube target is 1·5 inches from the end of the support tube and the focal spot is 4 mm. in diameter and receives approximately 95 per cent of the electrons leaving the cathode stage. This high efficiency has the advantage of reducing to a minimum the possibility of unwanted charges on the glass walls of the tube and makes optimum use of the available emission from the filament.—*Paper by F. W. Waterton, submitted to The Institution of Electrical Engineers, 1952.*