Abstracts of the Technical Press

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The Elliott-Lysholm Marine Gas Turbine.

A lengthy paper entitled "A Marine Gas Turbine Plant" read at the recent annual meeting of the Society of Naval Architects and Marine Engineers by C. R. Soderberg, R. B. Smith and Lieut.-Com'r. A. T. Scott, U.S.N.R., was devoted to a detailed description of the experimental 2,500-s.h.p. unit built for the Bureau of Ships by the Elliott Company, Jeanette, Pa. (*described in abstract on pp. 111-113* of TRANSACTIONS, *December, 1945*). The set was first operated as a unit on 28th October, 1944, and, after a short period spent in correcting minor defects, the official tests were commenced in December, 1944. Since that time the installation has been undergoing a detailed examination at the makers' works. The unit was operated for a total of close on 500 hours under load, including one continuous period of 48 hours. A number of performance trials were carried out, and the following table gives particulars of the results, after making all necessary corrections :—

TABLE I.—CORRECTED TEST PERFORMANCE.

Test No.	9A	9B	9C	9D	16A	16B	16C	16D
Tested brake horse-power	590·0	1108·0	1756·0	2335·0	494·0	1148·0	1674·0	2148·0
Tested fuel flow, lb. per hr.	378·0	597·1	854·1	1112·6	374·0	627·0	849·0	1074·0
Tested fuel rate, lb. per h.p.-hr.	0·641	0·539	0·486	0·476	0·757	0·546	0·507	0·500
Per cent. power corrections :—								
Inlet temperature, 70 degrees F.	1·93	1·56	1·61	0·44	1·99	1·52	1·33	1·15
Inlet duct and filter	1·57	1·81	2·80	3·93	1·84	2·35	3·34	5·08
Stack	0·22	0·25	0·48	0·60	0·22	0·25	0·41	0·65
High-pressure combustion chamber	0	0	0	0	1·05	0·59	0·49	0·47
Air side inter-cooler	0	0	0	0	2·26	1·93	2·57	2·86
Total	+3·72	+3·62	+4·89	+4·97	+7·36	+6·64	+8·14	+10·21
Gross corrected b.h.p.	612·0	1148·0	1842·0	2451·0	530·0	1224·0	1810·0	2367·0
Per cent. efficiency corrections :—								
Inlet temperature, 70 degrees F.	−1·86	−1·48	−1·51	−0·41	−1·93	−1·44	−1·25	−1·07
Inlet duct and filter	−1·51	−1·71	−2·62	−3·67	−1·78	−2·23	−3·14	−4·76
Stack	−0·18	−0·20	−0·38	−0·47	−0·18	−0·20	−0·32	−0·52
High-pressure combustion chamber	0	0	0	0	−1·02	−0·56	−0·46	−0·44
Air side inter-cooler	0	0	0	0	−2·19	−1·83	−2·43	−2·69
Total	−3·55	−3·39	−4·51	−4·55	−7·10	−6·26	−7·60	−9·48
Gross corrected fuel rate	0·618	0·521	0·465	0·456	0·707	0·515	0·471	0·457
Gross corrected fuel flow, lb. per h.p.-hr.	378·2	598·1	856·5	1117·6	374·7	629·7	852·5	1081·0
Auxiliary power loss :—								
Injection pumps, h.p.	4·4	4·8	5·7	7·4	4·3	4·6	5·3	6·3
Cooling air, h.p.	35·7	43·2	51·6	56·3	35·7	43·2	51·6	56·3
Lube oil pumps, h.p.	8·2	8·2	8·2	8·2	8·2	8·2	8·2	8·2
Circulating water pumps, h.p.	0·5	0·5	0·5	0·5	0·5	0·5	0·5	0·5
Total auxiliary power, h.p.	48·8	56·7	66·0	72·4	48·7	56·5	65·6	71·3
Net corrected b.h.p.	563·2	1091·3	1776·0	2378·6	481·3	1167·5	1744·4	2295·7
Net corrected fuel rate, lb. per h.p.-hr.	0·672	0·548	0·482	0·470	0·779	0·539	0·489	0·471
Thermal efficiency (LHV), per cent.	20·41	25·04	28·11	29·22	17·62	25·38	27·70	29·43

The performance curves are shown in Fig. 5, from which it will be seen that efficiency was 29 per cent. at full load and 20 per cent. at one-quarter load, which is lower than had been anticipated, due to failure on the part of the designers to appraise correctly the influence of Reynolds number. In other respects the design of the turbines appears to be satisfactory, except for the carbon glands in the H.P. turbine, which proved incapable of standing up to temperatures above 850° F. and disintegrated. It was not found possible to control the cooling air accurately enough to keep the temperature of the carbon rings below this limit, added to which the lubrication provided by the leakage system under the rings was not sufficient to prevent seizing under the severe thermal expansions encountered. These glands were replaced with step-type labyrinth packing, which functioned satisfactorily, although it increased the consumption of cooling air. A serious problem arose as the result of temperature stratification at the H.P. combustion-chamber outlet. Temperature variations of the order of 150° F. across the H.P. turbine flange were noted. This variation was observed to be a function of the load, and is susceptible to some control by regulation of the positions of the burner cones. While 150° F. is a considerable temperature variation, it obviously affects the stationary parts of the unit only. Better control of temperature stratification will, it is hoped, be obtained in future combustion chambers by the results of investigations now being made into the eddy formations within the chamber itself. No appreciable stratification was observed in the L.P. combustion chamber. Although some reduction in the warming-through period of 2½ to 3 hours required with the experimental unit is certainly possible, it is clear that in future designs still more attention will have to be given to thermal expansion in order to attain quick starting characteristics. The success of the displacement compressor depends on the maintenance of close clearance, and some trouble was experienced due to the entry of foreign bodies into the rotors. In the late spring of 1945 a breakdown in the L.P. compressor occurred as the result of clearance difficulties, the prime causes being traced to faulty jacketing and improper alignment. The water jacket was designed in such a way that an air pocket occurred adjacent to a high-temperature region of the compressor casing. No completely satisfactory means of eliminating the objectionable noise made by the displacement compressor when running has yet been found, but it would appear that a combination of resonance dampers and sound absorption treatment should produce a definite improvement. Among the inevitable mechanical troubles which had to be overcome were faulty operation of the fuel pumps, over-running of the clutch, defective heat insulation and faulty measuring instruments. The high-temperature flange design was not altogether satisfactory, but this could be remedied by the use of proper gaskets and improved mechanical features. Trouble with bolts, which was expected as the result of high-temperature galling, was completely overcome by the employment of a special colloidal silver compound. The authors concluded by pointing out that this experimental unit is only the beginning of the development of the gas turbine as a prime mover, and that a great many problems still remain to be solved before it is established as such, although recent metallurgical developments open new possibilities for advances in working temperature, with resulting improvements in efficiency

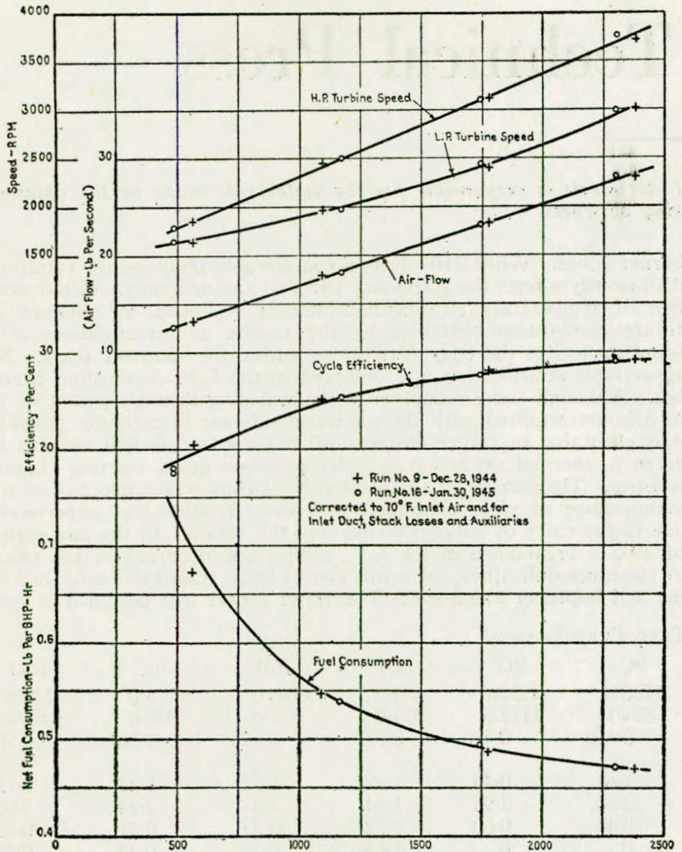


FIG. 5.—*Performance of the Elliott-Lysholm 2,500 h.p. gas turbine plant.*

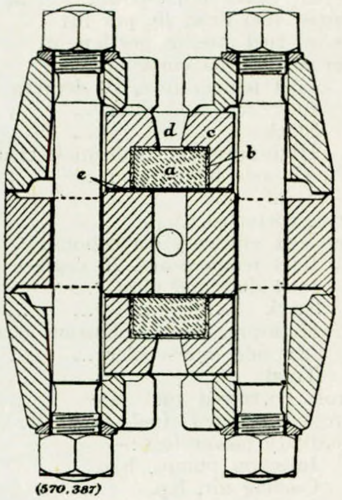
and reduction in size. While far from perfect, the Elliott gas turbine has given encouraging results, and has afforded valuable data for the three additional units now under construction.—*"The Motor Ship", Vol. XXVI, No. 311, December, 1945, pp. 293-295.*

Geared Turbines for "Loch" Class Frigates.

The war-time activities of the B.T.H. Company included the manufacture of a number of 5,500-s.h.p. twin-screw, double-reduction geared-turbine installations for H.M. frigates of the "Loch" class. Each set comprised a single-cylinder impulse turbine with seven ahead stages and one astern stage, an underslung condenser and a set of twin-drive D.R. gearing. Similar turbine units had previously been supplied by the firm for installation in minesweepers. A feature of this design is the steam admission valve assembly, which incorporates a series of four single-seated valves for controlling the steam flow to the four sections of the ahead nozzle belt and one similar valve for regulating the passage of steam to the astern nozzle belt. The valves are cam-operated by a common camshaft which is rotated by the manœuvring handwheel through D.R. gearing. This system replaces the conventional hand-operated valves and main valve systems formerly employed and has the advantage of ensuring that the correct valve sequence and opening relationship are maintained at all times. One handwheel operates the ahead and astern valves, and the turning effort involved is negligible. The turbine casing is of specially strong welded steel construction to carry the weight of the condenser and to resist the shock effects occasioned by possible underwater explosions. Such effects are, however, limited by the provision of rigid-resilient mountings at the fore-and-aft supporting points of the casing. The turbine speed of 5,000 r.p.m. is reduced to 198 r.p.m. at the propeller shafts by the double-helical double-reduction gears of the locked-train or divided-train type. With this arrangement, a quill shaft passes right through the hollow first-reduction pinion and connects the turbine to the pinion, the torque being transmitted through a gear-tooth type flexible coupling. The high-speed pinion engages two wheels, one on each side of it, and the power is transmitted to the second-reduction pinions from each of these wheels through gear-type couplings and quill shafts. The latter traverse the whole length of the gear-case, connecting at the after end of each of the second-reduction pinions through two further gear-type couplings. With this arrangement both second-reduction pinions are free axially to adjust themselves to the located slow-speed wheel. At the high-speed end of the gear-case, one of the first-reduction wheels is located by a ring-type thrust bearing and the high-speed pinion is free axially to adjust itself to this wheel. The remaining first-reduction wheel is free to follow the high-speed pinion. The employment of quill shafts throughout the assembly provides sufficient flexibility to accommodate the small accumulative pitch errors without any serious disturbance in the balance of the transmitted power. With gear teeth and coupling teeth of a high degree of pitch accuracy, little difficulty is experienced in obtaining an approximately equal division of load between the gear trains, both in the ahead and astern directions. For initial adjustment of load-sharing, the first-reduction wheels, second-reduction pinions and flexible couplings are provided with numbers of teeth containing high uncommon prime factors, giving a fine adjustment by the partial differential rotation of any or all of these parts. The duplication of the drive enables a greatly reduced gear face width to be used, with a corresponding saving of both space and weight. The design accommodates itself very well to gear-case construction, combining compactness with accessibility and a convenient lay-out.—*"The Marine Engineer", Vol. 68, No. 821, December, 1945, pp. 656-658.*

High-pressure Water Level Gauge.

An improved design of water-level indicating gauge for high-pressure boilers has recently been developed and patented by a well-known North Country firm specialising in the manufacture of boiler mountings and similar equipment. Water-level gauges for boiler pressures above 1,400lb./in.^{2} are liable to give trouble owing to the difficulty of maintaining a fluid-tight joint at the glass without setting up stresses which cause rapid fracture of the glass in service. In the design of W.L. gauge developed by the firm and illustrated in the accompanying sectional diagram, each glass (*a*) is set in a heat-resisting and hardening cement (*b*) in a recess in the cover plate (*c*), the inner face of each glass being flush with the face of the cover plate. The thickness of the cement between the walls of the recess and the glass (except at the observation gaps (*d*) is about ⅛in. The cement, when flush, retains the glass face flush with the face of the cover plate and so prevents any pressure-flow of the gaskets (*e*) into the cover plate around the glass. A water-level gauge of this design tested under service conditions on a boiler generating steam at a pressure of 1,400-1,500lb./in.^{2}, gave more than 2,000 hours' service, whilst other gauges of this type have given upwards of 1,200 hours' service under similar conditions. The cement used must harden and set under heat and must not deteriorate under the temperatures to which it is subjected. A satisfactory composition is mica, silica and phenol-formaldehyde resin.—*"Engineering", Vol. 160, No. 4,168, 30th November, 1945, p. 460.*

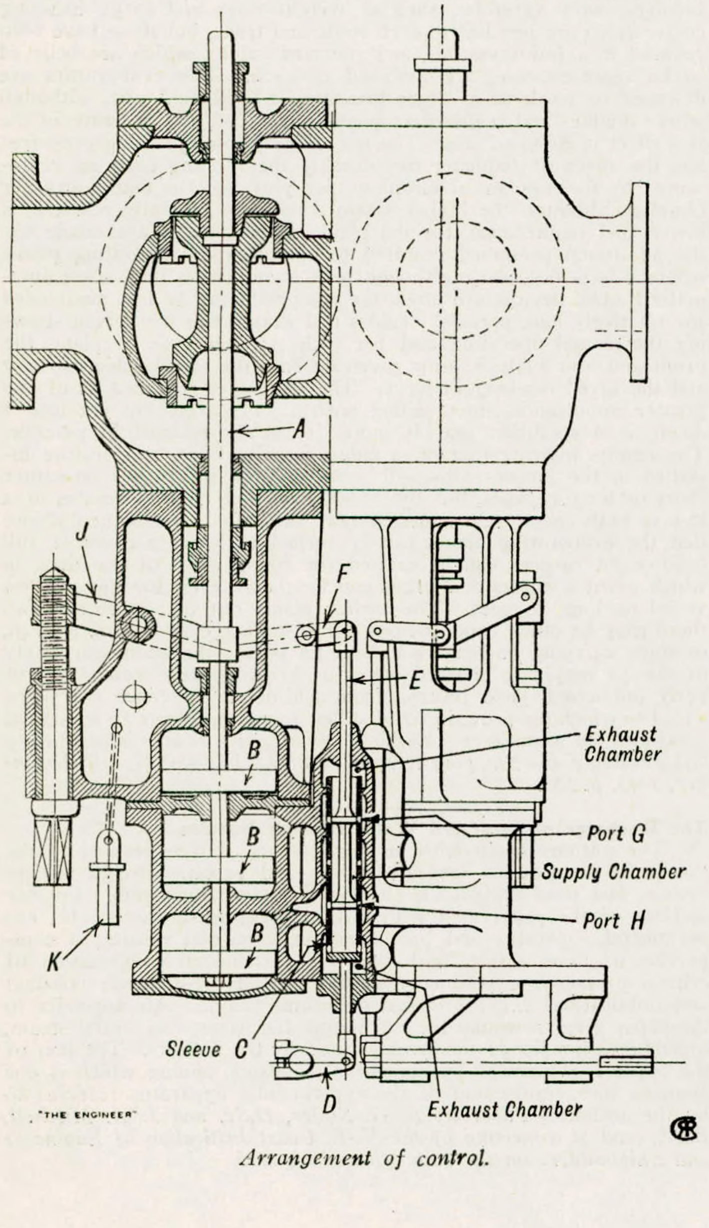


Expansion Problems in Steam Generators.

An article by H. Liessenberg and M. J. Fish in a recent issue of *Combustion* reviews the problems in expansion introduced by the increase in size of modern boilers and the high temperatures to which various parts are exposed in operation. The authors discuss details of drum supports, baffle attachments, feed connections, sootblower piping, superheaters, dampers, etc., from the aspect of providing for relative movement, avoidance of distortion and limitation of stress; also, the general arrangement of the main structural framework, boiler chocks and pipe lines. Appropriate freedom must be allowed to individual components, with safeguards against the transference of stress to other parts by constraint. As an example of a complete unit, the authors cite the case of a Combustion Engineering boiler having the furnace, water walls, drums, superheater and economiser suspended from an overhead steel structure. The front and side wall tubes and framework are supported from the top header, and the lagging is carried by the steel casing. Lugs on the headers are connected to the framework by rods. The sloping front and back lower part of the furnace are supported by a steel framework which, in its turn, is spring-supported from the bottom side-wall headers. The straight part of the furnace-back wall tubes is supported by structural steel which rests on the framework and moves up and down with it. The entire expansion of the furnace is downward from the top, and the spring system at the bottom readily absorbs the small difference in downward expansion between the side-wall and the front- and back wall headers.—*"Boiler House Review", Vol. 59, No. 12, December, 1945, p. 349.*

Servo-operated Steam Valve Control.

A well-known firm of Scottish valve manufacturers have developed a new hydraulic control device for ahead and astern manœuvring valves, which is characterised by its simple and positive action and permits marine engines to be manœuvred with a high degree of accuracy in regulation. The makers state that a number of vessels have already been equipped with these servo-controlled manœuvring valves, with satisfactory results. The controlling medium is oil taken from the forced-lubrication system, although in one installation water at feed pressure has been used instead. To operate the manœuvring valve throughout its range it is only necessary to move the indicator lever to the required steam position to cause the corresponding valve to open or shut down to the actual amount, the valve remaining in that position until the control lever is moved again. Little effort is required for operating this lever, which may, if desired, be fitted to the existing E.R. telegraph gear on the bridge. A feature of the device is that a very much heavier load is applied to the valve when closing it, thus ensuring steam-tightness; furthermore, there is no need to close the valve and then re-open it to obviate difficulties that might arise from differential expansion. The arrangement and operation of the control mechanism may be followed from the accompanying drawing, in which the ahead valve is shown in section. The spindle *A* of the main steam valve is extended downwards to form the rigid connecting-rod of three pistons *B* moving in superimposed hydraulic cylinders. The three pistons are actuated as one unit by inter-connected ports through which the pressure medium—in this case oil—is supplied from the valve-box on the right of the cylinder body. A sleeve *C* in the valve-box is directly coupled to a control lever *D*. Inside the sleeve is a piston *E*, coupled through its stem and a link *F* to the main valve spindle. When the control lever is moved to the opening position, the sleeve is pushed upwards the requisite amount and allows oil to flow through a port *G* to the lower sides of the hydraulic pistons; at the same time, another port *H* opening to the upper sides of the pistons, and holding the valve closed under oil pressure—is opened to exhaust. As the main valve spindle is forced upwards by the pistons the link *F* pushes the control valve piston down to cut off both the oil inlet and exhaust ports, and the main valve is held open to the exact amount required by the balanced oil pressure on each side of the hydraulic pistons. During movement of the ahead valve, the astern valve is retained in its shut position by maximum oil pressure on the tops of its hydraulic pistons; similarly, the ahead valve is kept closed during movement of the astern valve. When the control lever is in the "shut" position an overlap in both control valves loads each servo cylinder in the closed state. In the event of a breakdown in the hydraulic system, the valve may be readily converted to hand screw operation through the link *J* between the valve spindle and the screw gear. During hydraulic operation this link is free, but when necessary a lever connection may be made by inserting the fulcrum pin *K* into the hole at the centre of the link and the corresponding hole provided just below it in the main valve casting. An automatic drain and relief valve is fitted to the lower side of the astern manœuvring valve to prevent pressure from building up in case of a leakage and avoid accumulation of condensate. This valve is held lightly open by a spring, and as the valve is opened the increase in pressure automatically closes it against the spring load. The latter is adjusted to suit operating conditions and is usually set to about 5 per cent. of working pressure. —*"The Engineer", Vol. CLXXX, No. 4,693, 21st December, 1945, pp. 515-516.*



Arrangement of control.

Re-tubing Niclausse Boilers.

In an article entitled "H.M.S: Carnarvon" in which the author gives an account of his 2½ years' as senior engineer of the vessel, he mentions that she was equipped with six cylindrical and 22 Niclausse watertube boilers. The latter were of a French design and had double tubes, inclined at 6° to the horizontal and fitted into double-compartmented headers. There was an upper steam and water drum from which the water flowed down the front compartments of the headers, thence down the internal circulating tubes into the back ends of the boiler tubes, the mixture of steam and water rising up the back compartments of the headers. The sleeve end of each generator tube had four apertures cut in it to allow the steam and water to circulate; and on its outside were two turned cones which fitted into conical holes in the header. When put in position, the tubes were driven home by light taps with a lead hammer, and if the cones were in good condition, there was no leakage. After the generator tubes were fixed in place, the internal circulating tubes were inserted and screwed home. There was little tendency for a tube to be forced out of position, and any such movement was prevented by the dog. With the tools provided, the withdrawal and replacement of a tube was a simple matter, but it was essential that the coned surfaces should be kept in perfect condition. When the ship underwent a dockyard refit at Devonport in 1910, the Dockyard carried out repairs to the boilers, but left the removal and replacement of the tubes to the ship's staff. As the total number of inner and outer tubes in the 22 boilers was just on 14,000, the amount of work involved was considerable and called for special organization. As each tube was withdrawn, the coned surfaces were coated with vaseline and the sleeve ends wrapped up in material. About six or eight tubes were then placed mouth downwards in a coal sack for hoisting ashore and stacking. To expedite the work of cleaning the tubes, special machines were devised for clearing them both externally and internally. The author gives some sketches of these machines. A cage of four iron bars was provided with a shank at one end to which a pneumatic drill motor could be fitted. In the centre, a spare piston ring, running on rollers, was fixed to the cage. The mouth of the cage carried a home-made brush with steel bristles taken from hand wire scrubbers. A tube would be placed in the wooden V-blocks of the machine and then, as the cage revolved, would be pushed through the brush. One half done, the tube was reversed; although an improved type of machine was subsequently made in which the tube could be pushed right through. After the outside surfaces had been cleaned, the tubes were laid in notches cut in two planks placed edgewise, and the insides were cleaned with other brushes driven by pneumatic tools. To reach the bottoms of the closed tube ends, brushes of wire bristles, like big shaving brushes, were used. The cleaning done, the cones were examined and touched up, then greased and re-wrapped, and the tubes placed in sacks for lowering into the stokehold. The author declares that he never wanted a better boiler than the Niclausse.—*Engineer Captain E. C. Smith, O.B.E., R.N., "Engineering", Vol. 160, Nos. 4,170 and 4,171, 14th and 21st December, 1945, pp. 485-487 and 509-511.*

Wearing of Condenser Tubes.

During the First World War the life of a warship's condenser tubes was frequently less than 12 months, whereas now "condenseritis" is comparatively rare, despite the fact that condensers are often worked under more severe conditions. This improved performance is largely due to the research work carried out by British condenser tube manufacturers, which has led to the replacement of the unsatisfactory 70 per cent. copper, 29 per cent. zinc, 1 per cent. tin tubes of former days by condenser tubes of a 70/30 copper nickel alloy or of aluminium bronze containing 22 per cent. zinc, 2 per cent. aluminium with small quantities of other alloys. Corrosion trouble with condenser tubes has, however, not yet been wholly eliminated, and some interesting exhibits of types of corrosion were on view at the laboratories of the British Non-Ferrous Metals Research Association on their recently held Open Day. Among these exhibits was a condenser pitted so badly as to become entirely perforated. Such pitting is due to the local breakdown of the protective film on the surface of the metal, and is often associated with deposits in the tube. Condenser ferrules and tube plates are sometimes liable to similar impingement attack, and among the protective measures developed during the Second World War was the application of a protective coating to prevent such corrosion.—*"Fairplay", Vol. CLXV, No. 3,266, 13th December, 1945, p. 872.*

Riveted Seams of Cylindrical Boiler Shells.

In most cases, slight leakage at a riveted seam of a cylindrical boiler wrapper plate can be stopped by light caulking of the seam, but if the caulking tool is not handled properly, it may indent and damage the plates. An indentation is particularly favourable for the starting of a crack. Heavy caulking is also liable to force the edge of the plate or strap well away from the adjoining plate, in the manner shown in Fig. 2, so that there is no longer satisfactory bedding together of the plates. An instance of serious damage to a water-tube boiler by caulking was reported not long ago. As some of the riveted seams had developed serious leaks, it was decided to make an examination. When some of the rivets were removed, cracks were discovered about the rivet holes, and there was a dangerous fracture extending from rivet hole to rivet hole for a considerable distance at one of the circumferential seams. There was evidence that the plates had been subjected to excessive caulking, and the report on the boiler pointed out that the stresses set up by this caulking, etc., were far more severe than the stresses due to the internal working pressure, and were the main cause of the failure of the seams. Although cracks at riveted seams usually occur along a line of rivet holes, they may sometimes develop through the solid place, close against the lap edge, as shown in Fig. 3. Such cracks are generally caused by continual straining at the lap edge, this straining arising from the fact that the shell is not truly circular (owing to the inclusion of the lap joint) and that the internal pressure is constantly tending to make it so. In the example illustrated, steam was seen to be leaking through the boiler lagging, and when this was removed, a fracture nearly 12in. long was discovered. An examination of the defect from inside the boiler disclosed a crack nearly 24in. in length, indicating that it had started on the inside surface of the plate, as might have been expected from a study of the straining action. When the defective plate was cut out and thoroughly examined, no signs of heavy caulking or hammering could be found, and various tests and analyses of the plate material revealed nothing that would account for the fracture. It was therefore concluded that the crack had developed as the result of continual straining at the lap edge.—*E. Ingham, "The Steam Engineer", Vol. XV, No. 171, December, 1945, pp. 92-94.*

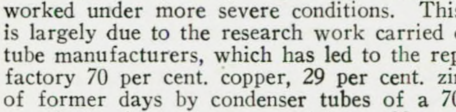


FIG. 2.

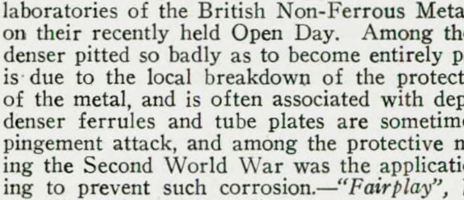


FIG. 3.

Distilling Plant for Merchant Ships.

In a paper entitled "Economic Features of Low-pressure Evaporating and Distilling Plant for Merchant Ships", presented at the recent annual meeting of the American Society of Naval Architects and Marine Engineers, by M. L. Ireland, the author examines the many factors involved as applied to four different types of merchant steamships ranging from a cargo vessel of 13,900 tons displacement and 6,000 s.h.p. to a large passenger liner of 35,400 tons displacement and 34,000 s.h.p. with accommodation for 1,200 passengers. The evaporating plant installed ranges from a single unit of 6,000 gall. (U.S.) per day—with a conventional H.P. type evaporator as spare—to four units of 40,000 gall./day normal capacity, the total fresh-water requirements being taken as either 45 or 60 gall. per day for passengers and crew, together with either 1·0 or 1·5 per cent. of make-up feed. Each installation is regarded as an investment, the return on which depends on the earning capacity of the additional cubic capacity or deadweight gained by the elimination of some of the ship's fresh-water tanks. The evaluation of the financial return involves many variables, such as freight rates and cargo handling costs, which are peculiar to each route and trade, but these have been reduced to a few essentials, and standard values, which are believed to be representative, are assigned to each. The evaporators are designed to work at a steam pressure of 7·5lb./in.^{2} abs., although where double- and triple-effect plant is installed, the pressure in the last effect is 20lb./in.^{2} abs. The use of very low operating pressures has the effect of reducing considerably the running costs as represented by the number of cleanings per year and the man-hours per cleaning, although the higher steam conditions generally result in a lower fuel requirement for the plant. Allowance is also made for the additional personnel required to operate the evaporating plants where this is necessary, although tests have shown that when automatic control devices are fitted, the equipment can be left unattended for relatively long periods. Tables and graphs are then given showing the annual operating cost for each size and type of plant, the profit and loss analysis being given on both the saved cubic capacity and the saved deadweight basis. The former is regarded as of the greater importance, since sailing with a full cargo, but not loaded down, is a condition that is more frequently realised in practice. The results indicate that on a cubic capacity basis, evaporators installed in the larger ships will soon pay for themselves on either short or long voyages, but the 13,900-ton cargo vessel operates at a loss in both cases. On a deadweight basis, the investigation shows that the evaporating plants can be turned to better account if full deadweight cargoes can be carried for 50 per cent. of the time, in which event a substantial profit can be shown even for the smallest vessel on long voyages. The author points out that in some cases there may be other good reasons for installing evaporators, as, *e.g.*, in ships carrying passengers to foreign ports; the additional safety of always supplying distilled water of known purity would, if properly publicised, yield returns from additional passenger carryings, added to which the provision of distilled water represents an additional service to the passengers for which a small extra charge is justified.—*"Shipbuilding and Shipping Record", Vol. LXVI, No. 23, 6th December, 1945, p. 553.*

The Discharge of Saturated Water through Nozzles.

The authors begin with an introductory section devoted to the theory of the flow of saturated water and vapour through nozzles orifices and then explain the theory of vapour formation. Further sections of the paper deal with critical pressure in the nozzle; experimental apparatus and procedure; experimental results; a comparison of these results with theory; experimental confirmation of critical pressure; experimental results with large-diameter nozzles; and implications for the design of heater drains. An appendix to the paper gives formulæ for calculating the passage of initial steam, together with a list of the symbols used by the authors. The text of the paper is illustrated by numerous diagrams, among which is one showing the arrangement of the experimental apparatus referred to by the authors.—*Paper by R. G. Silver, D.Sc. and J. A. Mitchell, B.Sc., read at a meeting of the N.-E. Coast Institution of Engineers and Shipbuilders on the 30th November, 1945.*

Prevention of Corrosion and Corrosion Fatigue.

After a foreword and a brief explanation of the general nature of corrosion, the author gives a series of examples of corrosion noted in various branches of engineering. The examples cited in marine engineering, etc., include hull corrosion, boiler-tube and condenser-tube corrosion, as well as the occurrence of corrosion effects in turbine gearing, crankshafts and propeller shafts. A list of 44 varieties of corrosion is then given, each form being separately defined and described. In dealing with methods for the prevention of corrosion, the author divides these into three groups, *viz.:* (*1*) surface treatments and coatings; (*2*) corrosion-resistant metals and alloys; and (*3*) water treatments and cathodic protection. Each of these methods is then discussed and reviewed in some detail. A list of the various scientific bodies engaged in research on corrosion is also given, together with a series of general conclusions put forward by the author.—*Paper by T. H. Turner, M.Sc., read at a meeting of the Institution of Locomotive Engineers on the 17th May, 1945.*

Astern-going and Electric Drive.

A paper contributed to the September, 1945 issue of the *Journal of the Franklin Institute* by R. Rudenberg, deals with the electric propulsion of ships, which, he says, has created a number of problems in the hydro-dynamical and electrical fields, the solution of which may lead to a design of propeller and motor giving the shortest possible stopping time after reversal from full speed ahead. Hitherto the knowledge of reversing forces of propellers has been developed to a large degree experimentally and for a steady state. The results of some of the experiments showed that the characteristics of thrust and torque changed their sign when the propeller was reversed. The propulsion motor must be capable of exceeding the maximum torque between full speed and zero speed of the propeller and must give a substantial torque when its speed is reversed. The author analyses the phenomena during the backing and reversal of a propeller at any velocity of the ship, deriving the thrust and torque characteristics by means of well-established hydro-dynamical considerations applied to: (*a*) the actual hydro-dynamical flow of the water under varying conditions, as shown by the streamline patterns; (*b*) the derivation of the forces of reaction of the water column through the propeller; (*c*) a separate, but summary analysis of the effects of the propeller blades on the water column; and (*d*) the derivation of the transient inertia effects of the water moved by the propeller. The conclusions are claimed to be in good agreement with many experimental results and give quantitative data on the reversal time and way of the ship, dependent on the characteristics of the propeller and its motor. Small-slip propellers require propulsion motors capable of exerting a high reversing torque, whereas with high-slip propellers the conditions are much easier. The normal slip depends largely on the area of the blades, so that propellers having a large blade area require powerful-reversing motors; on the other hand, they produce a high backing thrust and therefore stop the ship very quickly. As the backing thrust always produces a generating torque which drives the propulsion motor, the provision of an additional friction brake of the usual kind would enable even a weak-reversing motor to overcome the maximum thrust.—*"The Marine Engineer", Vol. 68, No. 821, December, 1945, p. 686.*

A New Werkspoor Engine.

Just before the war, the Werkspoor Co., Amsterdam, received an order for the supply of the complete E.R. installation for the twin-screw sloops "Murature" and "King", of the Argentine Navy, which have a displacement of 800 tons and a speed of 16 knots. The machinery was largely constructed during the German occupation of the Netherlands, and shipment to the Argentine, where the hulls had been built, took place in 1943, the transport being effected by rail from Amsterdam to Lisbon, and from there by ship to Buenos Aires. The four sets of propelling engines are 8-cylr. four-stroke reversible units of the trunk-piston type, with Büchi superchargers. The cylinders have a bore of 330 mm. and a piston stroke of 520 mm. The engines develop their rated power of 1,250 b.h.p. at 375 r.p.m. with a b.m.e.p. of 119lb./in.^{2}. The supercharge pressure is 11·3lb./in.^{2} and the fuel consumption at full load works out at just under 0·37lb./b.h.p.-hr. The mechanical efficiency is stated to be 86·6 per cent. The total weight of each engine, including the flywheel and thrust bearing, is 27·3 tons or 48·4lb./b.h.p. The bed-plate and casing are of welded steel, a Michell-type thrust bearing being incorporated in the former. The main bearing saddles are of cast steel. The cylinder liners are mounted in a C.I. frame and each cylinder head has two inlet and two exhaust valves. There are four exhaust manifolds, each of which is connected to two cylinders and to the Brown Boveri supercharger. The cylinders and cylinder heads are cooled by sea water and the fuel valves by fuel oil, whilst the pistons are uncooled. Lubricating oil is delivered by a gear-wheel pump driven off the solid-forged crankshaft, cylinder lubrication being effected by Bosch-type lubricators. A small gear-wheel pump and cooler are provided for the cooling of the fuel valves. The fuel valves and atomizers are of the Bosch type. Reversing is effected by a compressed-air-operated servo-motor. The engines were erected in the Argentine and installed in the ships by Argentine engineers without the aid or supervision of members of the Werkspoor technical staff, who were not allowed to leave their country by the Germans. The performance of the engines is stated to be highly satisfactory.—*"The Motor Ship", Vol. XXVI, No. 311, December, 1945, pp. 306-307.*

Big-end Bolts.

In a letter to the Editor, a correspondent calls attention to a method used successfully by Mirrlees, Bickerton & Day, Ltd., for preventing the failure of connecting-rod bolts in high-speed Diesel engines. Such failures are frequently due to the fact that the nut is not square with the bolt or with the foot of the connecting-rod or cap, and it has been the practice of the engine-builders in question to overcome this trouble by the provision of a spherical seating washer between the foot of the connecting-rod and the nut, the underside of the latter being faced to suit the washer. This arrangement eliminates the effect of the bending stress set up by tightening a nut out of the square, and no bolt failures have been recorded in any Mirrlees engines in which this practice has been adopted.—*"Gas and Oil Power", Vol. XL, No. 482, November, 1945, p. 432.*

Fatigue Strength of Crankshafts.

The annual report of the Automobile Research Committee of the Institution of Automobile Engineers includes a lengthy reference to cast-iron crankshafts. Fatigue bending tests of both steel and C.I. crankshafts have been carried out during the past year, and a report has been published on certain aspects of the fatigue strength of forged-steel crankshafts, including the effects of drilling lightening holes in crankpins and main journals, of shot peening the fillets, and of straightening the shaft. Work is now in progress on the effect of fillet radius. Single-throw crankshafts of one particular cast iron are being tested to find the effect of different features of design, including fillet radius, fillet profile, surface finish, thickness and width of webs, crank throw, overlap, length and diameter of crankpin, shape of web profile, and various special designs of web and cored holes incorporating stress-relieving features. It is also proposed to investigate different cast irons, cast steel, and various surface treatments, using one or more selected designs of shaft. Owing to the slow rate of crack propagation in cast iron, it has proved necessary to develop a special testing technique incorporating a method of detecting cracks without stopping the test. The shaft is counted as having failed when the first detectable crack appears. Using this method of test, no difference would be expected between the results obtained with the present constant-strain machines and those obtained in a constant-stress machine. A series of subsidiary tests on the cast materials is also being carried out to determine whether there is any correlation between the properties of the material and the fatigue strength of the shaft, for which purpose test-pieces are cut from test-bars cast at the same time as the crankshaft specimens and also from the crankshafts themselves. A number of transverse bending, hardness, and rotating bending fatigue tests have already been made and further tests will include extensometer tensile tests, impact tests, bending fatigue tests on notched specimens, torsion tests, fatigue tests under torsion, and possibly under combined bending and torsion stresses. Tests to determine the damping capacity and chemical composition are also provided for, together with examinations of the microstructure of the materials. The research programme will be extended to include torsional fatigue tests on the crankshaft specimens in a special testing machine which will be designed for that purpose.—*"Foundry Trade Journal", Vol. 77, No. 1,529, 6th December, 1945, p. 307.*

The t.s.s. "King Orry".

The twin-screw passenger steamship "King Orry", recently launched at Birkenhead, is the fourth vessel of the Isle of Man Steam Packet Co., Ltd., to bear this name. She is 344ft. 3in. in o.a. length, with a beam of 47ft. and a depth of 26ft. to shelter deck. There are five decks in all, four of which are to be used for accommodating 2,300 first- and third-class passengers. In addition to her ordinary streamlined rudder, operated by steam-hydraulic gear, the ship is being fitted with an auxiliary bow rudder, worked by a steam screw gear, to facilitate navigation stern first in restricted waterways. Both steering gears will be controlled by telemotor from the bridge.

The hull is subdivided by several transverse W.T. bulkheads, and the cellular double bottom under the machinery spaces and forward hold is arranged to carry water ballast and feed water. Deep tanks for trimming purposes are provided both forward and aft, and O.F. tanks are arranged in the boiler-room wings. Fresh-water tanks are fitted in the fore hold and shaft tunnel. The propelling machinery consists of two sets of S.R. geared turbines, each comprising one H.P. turbine of the impulse-reaction type and one L.P. turbine of the all-reaction type, with astern turbines incorporated in both the H.P. and L.P. ahead turbine casings. The H.P. astern turbines are of the impulse type, while the L.P. astern turbines are of the impulse-reaction design. Steam at a pressure of 250lb./in.^{2} will be supplied by three oil-fired Babcock and Wilcox boilers operating on the closed-stokehold system of forced draught. The designed speed of the vessel is 21 knots. A sister ship is under construction at Birkenhead. *—"The Shipbuilder", Vol. 52, No. 441, December, 1945, p. 524.*

Fresh Water Carriers.

Among the vessels specially built for the Allied invasion of Normandy in June, 1944, were 30 small Channel tankers—known by the short title of Chant ships—of prefabricated construction, each capable of carrying about 350 tons of petrol in bulk. After these vessels had successfully completed their primary function, they were adapted for service as fresh water carriers in the Pacific. The ships in question are 130×27×11ft., with machinery aft. Four tanks are arranged along the length of the hull and are separated by transverse W.T. bulkheads. A speed of 6 knots is ensured in normal weather by a 220-h.p. Crossley engine. The 13 officers and men are accommodated aft, and amongst the minor alterations which were made to the Chant ships to render them fit for their new duties in tropical waters, was the provision of mechanical ventilation for the living quarters and engine room, to supplement the lagging of the ships' sides and decks with heat-insulating material. To provide additional electric power for the fans, a second oil-engined generator of 7½ kW. capacity has been installed in the engine room. As finally fitted out, each vessel is able to carry 380 tons of fresh water, which can be handled by the cargo pump at the rate of 100 tons/hr.*—"The Journal of Commerce" (Shipbuilding and Engineering Edition), No. 36,751, 29th November, 1945, p. 2.*

Harland and Wolff Balanced Double-acting Engine.

A double-acting two-stroke engine of the coverless type, with the top piston valve larger in diameter than the main piston and the lower piston valve, is shown in Fig. 1. When the valves or secondary pistons are the same diameter as, or smaller than, the main piston the upward inertia forces are generally insufficient to nullify the effect of the downward dead load and there is no reversal of stress throughout the cycle. This is shown by the top pressure curve on the left, while the lower curve indicates the effect produced when the top piston valve is greater in diameter than the main piston. It will be seen from the sectional elevation of the engine that the main piston (A) is connected to the crank (D) by a piston rod (B) and a connecting rod (C). The top secondary piston (E) and the lower piston (F) are connected by side rods (G) to eccentric rods (H). The main piston controls the inlet ports (M) and the two secondary pistons uncover the exhaust ports (N, O). By designing the upper secondary piston appreciably larger in diameter than the main piston, the upward load on the piston (E) is greater than the downward load on the piston (A), with the result that the upward thrust on the eccentrics (J) exceeds that on the crank (D). The upper secondary piston (E) is made sufficiently large in diameter to ensure that the algebraic sum of the total upward pressure on the top piston, the upward inertia forces of the moving parts, the downward pressure on the main piston and the downward dead load on the main bearings will produce a pressure curve which is similar to that shown at the bottom on the left.*—"The Motor Ship", Vol. XXVI, No. 312, January, 1946, p. 384.*

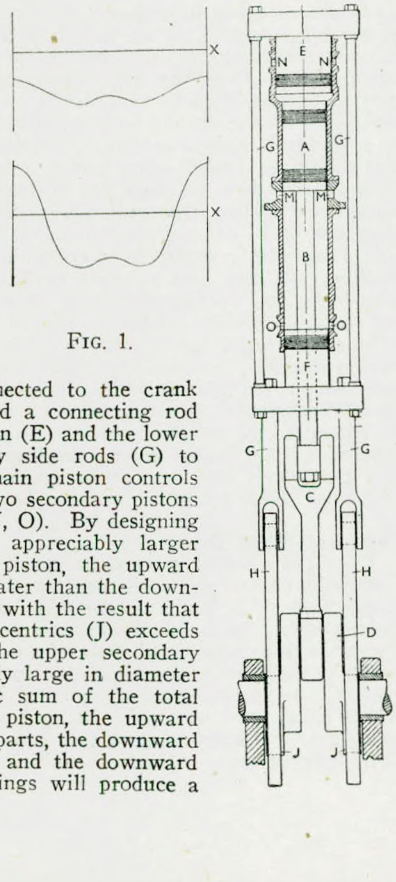


FIG. 1.

Canadian-built Steamships for Brazilian Owners.

The 4,450-ton cargo steamer "Cabedelo", recently completed for the Lloyd Brazileiro by Canadian Vickers, Ltd., was the first of four similar vessels ordered by the South American firm in April, 1944, to leave the Montreal shipyard. The remaining three, the "Atalaia", "Barbecena" and "Alegrete", will be completed very shortly and will be followed by six 7,500-ton ships. The "Cabeledo", like her sister ships, is a single-screw shelter-decker of 329×44×25ft., with four large cargo holds and 'tween-deck spaces and four refrigerated cargo compartments abaft No. 2 hold with a capacity of 16,730 cu. ft. The cargo-handling equipment includes two 15-ton and several 5-ton derricks. The propelling machinery consists of a triple-expansion engine with cylinders 21½in., 34in. and 62in. in diameter and a stroke of 42in., supplied with superheated steam at a pressure of 220lb./in.^{2} by two oil-fired Scotch boilers. The engine develops 1,800 i.h.p. and is designed to give the vessel a speed of 11 knots when fully loaded. The living quarters for the officers and crew are exceptionally roomy and well fitted. The ships are specially equipped for the Brazilian coastal trade. It is stated that 97 per cent. of the hull, machinery and equipment of these Canadian-built vessels was produced in Canada from Canadian materials, a large part of the remaining 3 per cent. consisting of the cargo winches, which were obtained from the U.S. at the special request of the owners.*—"The Nautical Gazette", Vol. 137, No. 10, October, 1945, pp. 56-57.*

The Motor Coaster "Eminence".

The London and Rochester Trading Co.'s new coaster "Eminence", now carrying coal from the Tyne to the Thames, is typical of the latest practice in the design of the smaller class of coasting vessel for the home trade. Built by John Lewis and Sons, Aberdeen, the "Eminence" is a single-screw ship of 554 gross tons, 162ft. in length b.p., 28ft. in moulded breadth and 12ft. 3in. in depth, the d.w. capacity being 740 tons on a mean draught of just under 12ft. 2in. The propelling machinery is aft of the two large cargo holds, which are served by two electric winches and tubular steel derricks. A motor-driven anchor windlass is provided on the forecastle deck and an electric capstan is fitted on the poop deck. The Tutin balanced-reaction rudder is operated by electric and hand steering gear. The captain's cabin and chart room are on the bridge deck at the forward end of the poop, in which there is accommodation for one deck and two engineer officers, together with seven members of the crew. The living spaces are roomy and well-equipped; they include a saloon, engineers' mess, bathrooms, pantries, a crew's mess, drying room, etc., all fitted with steam heating and a running hot and cold water supply. The main engine is a 5-cylr. Sirron unit of the two-stroke type, developing 500 b.h.p. at 300 r.p.m. and giving the ship a service speed of 9-10 knots when fully loaded. Up to 28 tons of Diesel oil can be carried in the two fuel tanks aft of the engine room. Electric current at 220 volts is supplied by two 25-kW. and one 8-kW. generators driven by Lister oil engines. The small set is of sufficient capacity to provide all the current needed for lighting and power at sea. The auxiliary equipment includes a set comprising two motors, a centrifugal ballast pump and a compressor, all in line with clutches between, so that if one of the motors requires removal for repair, the other can drive the compressor with the pump unloaded (or cut out, according to the circumstances) or the pump with the compressor unloaded or cut out.*—"The Motor Ship", Vol. XXVI, No. 811, December, 1945, pp. 316-820.*

The North Sea Passenger Ship "Astrea".

The Bergen Steamship Co.'s new motor vessel "Astrea", which was placed on the Newcastle-Bergen run last October, was built by the Crichton-Vulcan yard at Abo, Finland, for Finnish owners, in 1941. She was intended for the passenger and cargo service between Finland and England, but was sold immediately on completion to the A.B. Svea, of Stockholm, who in their turn re-sold the vessel to the Bergen S.S. Co. The latter had a good deal of reconstruction work carried out on the ship at Stockholm, adding to the public rooms and rebuilding the whole of the 'tween-deck spaces for passenger accommodation instead of cargo, with the result that the "Astrea" can now carry 70 first-class and 70 second-class passengers as compared with 34 and 16 respectively in the original arrangement. As now completed, she is a single-screw vessel of 3,190 gross tons and 2,550 tons d.w., 313ft. in o.a. length, 44ft. in breadth, 29ft. 3in. in depth (to upper deck), with a draught of 21ft. The hull, which is specially designed for navigation in waters where ice may be encountered, is of exceptionally strong construction. The four cargo holds have a total (bale) capacity of 105,840 cu. ft., Nos. 1 and 4 holds (totalling

39,490 cu. ft.) being insulated for the carriage of refrigerated cargo. The D.B. and peak tanks will hold 133 tons of fuel oil, 110 tons of fresh water and up to 387 tons of water ballast. The deck machinery comprises a windlass and eight cargo winches, all motor driven, as is the steering gear. The propelling machinery consists of a 7-cylr. s.a. two-stroke Krupp engine developing 3,300 b.h.p. (4,000 i.h.p.) at 125 r.p.m. and designed to give the ship a service speed of 15 knots. The engine is equipped with the Archaouloff system of fuel injection and has a separate scavenge pump for each working cylinder, the pump pistons being driven from their respective engine crossheads. The fuel consumption for all purposes at 14½ knots is stated to be 8·8 tons per 24 hours. Electric current at 220 volts is provided by three 105-kW. generators driven at 500 r.p.m. by 3-cylr. four-stroke Krupp engines. A 30-kW. Diesel-driven generator for emergency service is installed in the upper part of the engine room. The E.R. equipment includes a Sal log gauge at the control platform which tells the engineer on watch the exact speed in knots as well as the engine revolutions.—*"The Motor Ship", Vol. XXVI, No. 311, December, 1945, pp. 296-302.*

German Submarine Engines.

On 4th June, 1944, a U.S. warship compelled the surrender of the German submarine U.505, and subsequently brought her into an American port. A description of the engines of this modern submarine appeared in the October, 1945, issue of *Power*, from which it would seem that they are 9-cylr. s.a. supercharged 4-stroke units of M.A.N. design. The cylinders have a bore of 400 mm. and piston stroke of 600 mm., the normal output being 2,200 b.h.p. at 470 r.p.m., with a maximum rating of 2,500 b.h.p. at 490 r.p.m. The total engine weight (dry) is just under 24½ tons, or about 22lb./b.h.p. at maximum rating. The firing order of the cylinders is 1—3—5—7—9—8—6—4—2, the compression pressure 588lb./in.^{2}, the firing pressure 882lb./in.^{2}, the injection pressure, 3,675lb./in.^{2} and the b.m.e.p. at 2,500 b.h.p. about 125lb./in.^{2}. The construction embodies a cast-steel box frame with an aluminium oil sump, the frame supporting a cast-iron cylinder block with individual cylinder heads. The liners, of conventional form, are held in place by the cylinder heads and prevented from turning by dowels. Each cylinder head carries a rocker-arm assembly forming a complete unit, except for the reversing shaft which passes through all the rocker arms. The crankshaft is hollow, both in the crankpins and journals, and the openings in each end are sealed by cover plates secured by through bolts, as shown in Fig. 1. Drilled holes in the crank web provide for lubricating-oil flow. The crowns of the aluminium trunk pistons are bolted to the skirts just above the gudgeon-pin bosses. Each piston has six rings in addition to two scraper rings, one of which is fitted in the skirt just below the pin boss. The exhaust valves are water-cooled and the four valves are located symmetrically around the spray valve, which is in the centre of the cylinder head. Six of the nine cylinders receive starting air, the balanced-piston air-starting valves being actuated by a pilot valve mounted at the top of the engine. The camshaft is gear-driven from the crankshaft and is displaced longitudinally by a servo-motor on reversing, separate ahead and astern cams being used to operate the single push-rod which serves each pair of inlet and exhaust valves. The arrangement is shown in Fig. 2. The rocker arms are mounted on eccentrics which move through a full turn when the reversing gear is operated, lifting the rocker arms off the valve stems and replacing them when the push-rods are lowered on the new sets of cams. The Bosch system of fuel injection is used, fuel oil at a low pressure being circulated to cool the injectors.—*"The Motor Ship", Vol. XXVI, No. 311, December, 1945, p. 292.*

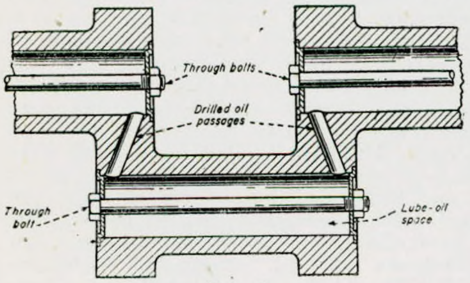


FIG. 1.

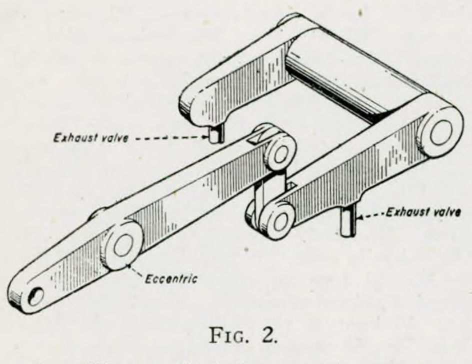


FIG. 2.

The New Atlas Diesel Fuel Injection System for Diesel Engines.

This descriptive article begins with a brief consideration of the ignition of the fuel injected into the combustion chamber of a Diesel engine, and then deals with the new two-stage cam in the fuel pump developed and patented by the Atlas Diesel Co. The new fuel injector is then described in detail, as are the delivery valves of the fuel injection pump. Other sections of the article deal with the co-operation between the two-stage cam, the delivery valves and the injector; the results obtained with the new Atlas Diesel fuel injection system; and the application of the system to 4-stroke engines. The illustrations which accompany the article include a number of indicator diagrams and sectional drawings of the new fuel injector.—*H. T. Pyk, "Transactions of the Institute of Marine Engineers", Vol. LVII, No. 10, November, 1945, pp. 119-124.*

Diesel Engine Cylinder-liner Wear.

A detailed analysis of the factors affecting cylinder wear in large marine Diesel engines is contained in a treatise entitled *The Cylinder Wear in Diesel Engines*, by Carl Hoegh, recently published in Oslo. The author has investigated the performance of the engines in 20 large ships owned by his company, among them being s.a. 4-stroke (pressure-charged and unsupercharged), s.a. 2-stroke and d.a. 2-stroke units. The author's conclusions are based upon service over a number of years, so that accidental effects may be ruled out. The basic cause of cylinder wear is the failure of the film of lubricating oil to prevent contact between the piston rings and cylinder walls. This inability must always be present and cannot be eliminated by increasing the supply of lubricating oil. There can never be complete lubrication, eliminating metallic contact between the rings and liners, unless the velocity of the piston over the cylinder wall and the oil viscosity are such as will permit the maintenance of an oil film capable of carrying the pressure exerted by the rings. In the zone of maximum wear, the piston velocity of large marine engines is low and the viscosity is reduced, due to the high temperature. This constitutes a fundamental disadvantage of marine oil engines which it is difficult to overcome. The author refers to clear evidence that liner wear increased with the number of starts for a given voyage, and that the machinery of tankers therefore shows favourable results in this respect. Thus, for example, the liner wear in a set of 4-stroke engines installed in a tanker over a long period of service varied from 0·047 mm. per 1,000 hours, whereas that in a similar set of engines in a cargo ship was 0·103 to 0·109 mm. In the case of d.a. 2-stroke engines, the corresponding figures were 0·104 to 0·143 mm. and 0·182 to 0·192 mm. per 1,000 hours, respectively. The basis of these figures was an average run of 280 hours per start for tankers and 100 hours per start for cargo liners. Cylinder wear is, as already stated, caused by failure of the lubricating-oil film, this failure being to some extent unavoidable, but the presence of abrasives in the fuel or air, heat distortion of the cylinders and corrosion are contributory causes. Cylinder wear is, moreover, dependent upon fuel characteristics, and can be reduced by the employment of high-grade Diesel oils. The effect of the presence of sulphur in the fuel does not appear to be very marked where the quantity involved does not exceed 2 per cent., whilst the influence of abrasives can be largely eliminated by the proper use of filtration and centrifuging. Cylinder distortion can cause increased wear, but may to a great extent be avoided by proper attention to design. The cold cooling water must enter the jacket at the coldest part of the cylinder. Bad combustion affects liner wear substantially, and if circumstances should make it necessary to operate on lower grades of fuel in the future, special attention will have to be given to obtaining the most effective combustion with such fuels by the designers and builders of Diesel engines. In any case, it will become necessary to use metal with greater wear-resistant properties for cylinder liners, and the advantages of chromium-plated liners may also be more fully explored, with the hope and anticipation that there will be a substantial reduction in their production costs.—*"The Motor Ship", Vol. XXVI, No. 311, December, 1945, p. 286.*

Floating Diesel-engined Pumping Station.

An article in the September, 1945 issue of *Diesel Progress* describes a floating pumping station used in the Oklahoma area to keep water from the Red River from flooding or seeping into the adjacent Cumberland oil field. The pumping station, which has a daily capacity of nearly 300,000 tons, is powered by two 600-b.h.p. Cooper-Bessemer oil engines which, together with their auxiliaries, are installed on board an anchored barge 85ft. long, 45ft. wide and of 5ft. draught, covered with a building 25ft. high. Each engine runs at 400 r.p.m. and is directly connected to a 30in. by 38in. centrifugal pump. Electric power at 440/220 volts a.c. is supplied by 100-kVA. three-phase generators, belt-driven at 900 r.p.m., from each crankshaft. The engines are cooled by water circulated through a closed system of coils by two motor-driven 6-in. centrifugal pumps, two 5-in. centrifugal pumps driven by electric motors being used to spray water over the coils and to circulate it through the lubricating-oil cooler. Fuel-oil storage is on the river bank, and the fuel is supplied to the barge through flexible pipes.—*"Gas and Oil Power", Vol. XI, No. 482, November, 1945, p. 437.*

Conversion of the Motorship "Vecta".

The twin-screw passenger and vehicle motorship "Vecta", completed in the spring of 1939 by J. I. Thornycroft & Co., Ltd., for the Southampton, Isle of Wight and South of England Royal Mail Steam Packet Co., Ltd., was originally equipped with two English Electric s.a. 4-stroke Diesel engines each developing 750 b.h.p. at 375 r.p.m. and driving Voith-Schneider propellers (*see abstract on p. 74 of* TRANSACTIONS, *May 1939*). It has now been decided to replace the Voith-Schneider drive by propellers of normal design, driven by the same prime movers through electric generators and propulsion motors. The new equipment, comprising generators, motors and switch-gear, has been manufactured at the Stafford works of the English Electric Co., Ltd., who are to carry out the conversion of the ship's propelling installation.—*"The Shipbuilder", Vol. 52, No. 441, December, 1945, pp. 505-509.*

The Evolution of Tanker Design.

This article, originally published in the January, 1944 issue of *Petroleum*, constitutes a brief survey of the development, since 1886, of the oil-carrying tank steamship and motorship of the present day. Separate sections deal with the history of the early transport of oil products; the evolution of the longitudinal and transverse longitudinal systems of hull construction; wing tank design; Diesel propulsion; latest designs of oil tankers; cargo pumping and heating arrangements; fore-and-aft pumping arrangements; propelling machinery and auxiliaries; venting and gauging of cargo oil tanks; deck lines and fittings of tankers; bridges and decks; crew accommodation; fore-and-aft bridge; and the tanker of the future. The article is illustrated by a set of seven diagrams comprising longitudinal elevations, midship sections discharge plans and suctions plans of representative tankers of different periods, which show the evolution of the present-day design.—*W. L. Nelson, O.B.E., "Transactions of the Institute of Marine Engineers", Vol. LVII, No. 10, November, 1945, pp. 124-126.*

A British-built Double-acting-engined Tanker.

Among the 15 large steam and motor tankers built for the Admiralty by Sir Jas. Laing & Sons, Ltd., during the war years, were two single-screw vessels equipped with 5-cylr. North-Eastern Richardson Westgarth Diesel engines. One of these tankers is the "Empire Chancellor" of 9,917 gross tons, with an o.a. length of 503ft. 10in.. a beam of 68ft. and a moulded depth of 36ft. The d.w. capacity of her 18 cargo oil tanks is 14.580 tons on a draught of 28ft. 2½in. There is also a dry cargo hold forward, with a bale capacity of 27,450 cu. ft. The ship's fuel tanks can hold over 1,200 tons. The five cylinders of the d.a. 2-stroke N.-E. R.W. engine have a diameter of 700 mm. and piston stroke of 1,200 mm. The service output of the unit is 4,500 b.h.p. at 105 r.p.m., which gives the ship a mean speed of 13·5 knots when fully loaded. This output of 900 b.h.p. per cylinder is obtained with a b.m.e.p. of only 61lb./in.^{2}. The engine-driven auxiliaries comprise two reciprocating scavenge-air pumps driven from the crossheads of Nos. 2 and 4 cylinders, their pump rods being extended to take the circulating-water, lubricating-oil, sanitary and bilge pump plungers. Two cylindrical boilers 13ft. in diameter and 11ft. 6in. long, located in a compartment above the after end of the engine room, provide steam for auxiliary and heating purposes. The working pressure is 180lb./in.^{2} and the total heating surface 4.100ft.^{2}. The wing furnaces take exhaust gas from the main engine. There are two 30-kW. dynamos, one of which is driven by a steam engine and the other by a Russell Newbury Diesel engine. The telemotor-controlled steering gear is of the steam-hydraulic type. The deck machinery consists of an anchor windlass and three winches, all of which are driven by steam. The main pump-room between Nos. 3 and 4 cargo tanks contains two 390-ton steam-driven horizontal duplex cargo oil pumps, in addition to a drainage pump, whilst the forward pump-room contains a fuel transfer pump and a ballast pump, all these units being steam driven.—*"The Motor Ship", Vol. XXVI, No. 311, December, 1945, pp. 310-313.*

Portuguese Motorships Building in Sunderland.

The Portuguese Government are subsidising the construction of 69 new merchant vessels, totalling 376,200 tons, and among these are two single-screw motorships, each of 9,100 tons d.w., to be built by Bartram & Sons, Ltd., Sunderland, for the Companhia Nacional de Navegacao. These vessels, the "Rovuma" and "Mossamedes", will be open shelter-deckers with a third deck over the four main cargo holds. Their dimensions are to be 425ft. × 58ft. 6½in. × 37ft. 8in., with a draught of 26ft. There is a deep tank for water ballast or cargo between No. 2 hold and the engine room. Steel centre-line bulkheads for grain cargoes will be provided in the lower 'tween decks and holds, and the D.B. tanks will be arranged to carry fuel oil or water ballast. The cargo-handling equipment will comprise one 30-ton, one 20-ton and nineteen 6-ton derricks, served by 18 steam-driven cargo winches. Between Nos. 3 and 4 hatches on the second deck there are four frozen meat chambers with a total capacity of 5.000 cu. ft., whilst cold-storage rooms for ship's use are arranged on the P. side of this deck abaft the engine room. Accommodation for 12 passengers in six single and three double staterooms is provided in a house under the boat deck. The ship's officers' quarters are amidships on the upper deck, while the crew will be berthed aft. The upper 'tween decks forward will be arranged for carrying native passengers, when required. The propelling machinery will consist of a Doxford oil engine with four cylinders, each 670 × 2,320 mm., developing 4,250 b.h.p. at 108 r.p.m. in service, and 4,900 b.h.p. at 117 r.p.m. on trial. The service speed is to be 13¾ knots on a daily consumption of 16 tons of good quality fuel oil. Steam at 120lb./in.^{2} pressure for the auxiliary machinery will be supplied by two oil-fired horizontal marine-type boilers, one of which will be of the composite type heated by the main-engine exhaust gases. Electric current at 110 volts will be generated by two 25-kW. dynamos.—*"Shipbuilding and Shipping Record", Vol. LXVI, No. 22, 29th November, 1945, pp. 528-529.*

The Navy's "Little Ships".

The author describes and illustrates some of the high-speed small craft which rendered such admirable service during the war in the Light Coastal Forces. When hostilities ceased, the approximate total of craft built exceeded 1.550, of which 176 of various types were lost. They took part in 782 actions and were responsible, directly or indirectly, for the loss to the enemy of over 500 vessels sunk, probably sunk or captured. This figure excludes the considerable number of enemy vessels known to have been sunk by mines laid by Coastal Force craft. Apart from some 210-ton steam-turbine-driven gunboats and a few individual types of special light craft, the bulk of the Light Coastal Forces was made up of small craft of under 150 tons displacement, built in serial production and comprising: (*1*) 480 (approx.) harbour defence motor launches (H.D.M.L.s) Dimensions—72 × 15ft., 46 tons displacement. Machinery—twin screws driven by 150-h.p. Diesel engines. Speed—11/12 knots. Endurance—2.000 miles at 10 knots. (*2*) 96 British Power Boat motor gunboats and motor torpedo boats (M.G.B.s and M.T.B.s) Dimensions—71ft. 8in. × 20ft. 7in.. 52 tons displacement. Machinery—triple screws driven by 1,250/1,350-h.p. supercharged Packard engines. Speed—39/42 knots. Endurance—600 miles at 15 knots. (*3*) 17 Camper and Nicholsons M.T.B.s Dimensions—117ft. × 20ft. 3in. (or 22ft. 2½in.). 95 or 115 tons displacement. Machinery—triple screws driven by 1.250/1,350 h.p. Packard engines. Speed—30/31 knots. Endurance—2.200 miles at 11 knots. (*4*) 12 Fairmile type "A" M.G.B.s. Dimensions 110ft. × 17ft. 5in.. 60 tons displacement. Machinery—triple screws driven by 600-h.p. Hall Scott engines; funnel exhaust. Speed—25 knots. Endurance—600 miles at 12 knots. (*5*) 388 Fairmile type "B" motor launches. Dimensions—112ft. × 18ft. 3in., 65 tons displacement Machinery—twin screws driven by 600-h.p. Hall Scott Defender engines. Speed—20 knots. Endurance—1.500 miles at 12 knots. (*6*) 24 Fairmile type "C" M.G.B.s. Dimensions—110ft. × 17ft. 5in. 72 tons displacement. Machinery—triple screws driven by 900-h.p. supercharged Hall Scott engines. Speed—26·6 knots. Endurance—500 miles at 12 knots. (*7*) 229 Fairmile type "D" M.G.B.s and M.T.B.s. Dimensions—115ft. × 221ft. 3in., 91 tons displacement. Machinery—four 1,250-h.p. supercharged Packard engines. Speed—31 knots. Endurance—1.200 miles at 10 knots. (*8*) Thornycroft M.T.B.s. Dimensions—75ft. 6in. × 16ft. 7in., 52 tons displacement. Machinery—four 650-h.p. Thornycroft engines on two shafts. Speed—29 knots. Endurance—325 miles at 25 knots. (*9*) 114 Vosper M.T.B.s. Dimensions—72ft. 6in. × 19ft. 2½in. and 73ft. by 19ft. 4½in., 40 and 46·7 tons displacement. Machinery—triple screws driven by 1,200-h.p. Isotta-Fraschini or 1,320-h.p. supercharged Packard engines. Speed—38·9/39·5 knots. Endurance—400/470 miles at 20 knots. (*10*) 6 White M.T.B.s. Dimensions—73ft. × 18ft., 46·6 tons displacement. Machinery—triple screws driven by 1,120-h.p. Stirling Admiral engines. Speed

—39·87 knots. Endurance—240 miles at 24 knots. The text of the article is amplified by a series of illustrations, including a double-page sectional drawing of a Vosper 73-ft. M.T.B.—*Lt. Com'r. A. Bray, R.N.V.R., "The Motor Boat", Vol. LXXVIII, No. 1,938, December, 1945, pp. 361-368.*

The Bristol Air-sea Rescue Boat.

The Bristol Aeroplane Co., Ltd., are constructing an unusual type of high-speed air-sea rescue boat driven by air-cooled aero-engines. The leading dimensions are an o.a. length of 105ft., a beam of 22ft. and a displacement of 80 tons at a maximum draught of 5ft. 9in. The hull is a composite structure, embodying a number of structural members of hollow box-girder type, prefabricated in waterproof plywood or suitable rebated wooden framing, glued and screw-fastened together. Large-scale use of salt-water resisting aluminium alloy for the outer skin and internal stressed joints, fittings and deck erections are a feature of the construction. The propelling machinery comprises four Bristol Hercules XVII radial air-cooled engines, each developing 1,675 b.h.p. at 2,900 r.p.m. and driving four Rotol hydraulically-operated variable-pitch and reversing propellers through reduction gears at 1,160 r.p.m. The engines are cooled by fans and are completely enclosed in ducts through which air is drawn at the forward end of the engine room and exhausted through four large outlets in the coach roof and decks overhead. The air inlet and discharge ducts are shuttered to exclude the entry of salt water in bad weather, waterproof deck ventilators being fitted to provide sufficient air for the engines to be run under these conditions. The deck-house, of light alloy and insulated against heat and sound, contains a wheel-house and chart room, an open (recessed) bridge, a W/T room and an engineers' control room from which immediate access to the engine room is provided. The engines are of a type which have proved their reliability to run in heavy aircraft for long periods without attention during flight, and it is not considered necessary for the engineers to be standing by them the whole time, as long as they have well-equipped control and instrument panels in their control room, from which they are able to operate the engine-throttle and propeller controls. Nearly 6,400 gallons of petrol are carried in 10 fuel tanks in compartments forward and aft of the engine room. The boat will have a maximum speed of 40 knots, a maximum continuous speed of 30 knots (with a corresponding range of 700 sea miles) and a speed of 10 knots with only one engine in use, the corresponding range being 4,200 sea miles. Accommodation is provided below deck for a complement of two officers, two petty officers and 12 men, in separate sections for each category. Sufficient food and water can be carried to enable the boat to operate away from its base for a period of 14 days. There is also a large sick-bay, to take eight stretcher cases, in the stern. A derrick is mounted on deck between the engine room and the sick-bay, which is available for lifting a fully-loaded life-saving dinghy out of the water, or for lifting a complete engine out of the engine room, thus making a replacement of power units a relatively simple matter. The builders claim that the special features of this type of vessel render her suitable, with smaller engines, for service as a police or Customs boat, as well as for a variety of war purposes.—*"The Motor Boat", Vol. LXXVIII, No. 1,938, December, 1945, pp. 372-377.*

British Merchant Tonnage under Construction.

The statistics relating to ships of 100 tons gross and upwards building in the U.K. and N. Ireland issued by Lloyd's Register of Shipping on the 24th October, 1945, are the first to be published by the society since 1939. The returns show that on the 30th September, 1945, there were 387 such merchant vessels under construction with a total tonnage of 1,496,243 gross tons, including 241 steel-built steamships and 133 steel-built motorships. Among these vessels are 51 oil tankers of or above 1,000 gross tons, 21 being steam-driven and 30 equipped with oil engines. The ships under construction in the U.K. and N. Ireland at the end of September included 25 steamships and 31 motorships of between 8,000 and 10,000 tons gross; four steamships and 10 motorships of between 10,000 and 12,000 tons: three steamships and eight motorships of between 12,000 and 15,000 tons; four steamships of between 15,000 and 20,000 tons, and one steamship of between 25,000 and 30,000 tons.—*"The Shipbuilder", Vol. 52, No. 440, November, 1945, p. 476.*

France's Diesel Industry.

An anonymous writer in a recent issue of *La Revue Nautique* points out that at the beginning of the present century French engineers were renowned for their advanced designs of marine water-tube boilers—as, *e.g.*, the Niclausse and Belleville types. In about 1906, also, when nothing better than dangerous petrol engines or unsuitable steam engines was available for the surface propulsion of submarines, the reputable French firm of Sautter-Harlé installed oil engines of their own design and manufacture in the first submarines of the "Opale" class. To-day, however, after an interval of 40 years, the few French engineering and shipbuilding firms who make Diesel engines, manufacture these under foreign licences. This means, the author says, that there is a time lag of four or five years, and that French oil engines are behind the latest designs of German, Swiss, Danish or British engines by that number of years. The engines now being designed for French ships to go into service in 1948 were conceived in 1936, so it is clear, the author declares, that this state of things is intolerable both for the war-time and peace-time requirements of the country's shipping and industries, since many of these constitute wide fields for the application of Diesel engines.—*"The Marine Engineer", Vol. 68, No. 821, December, 1945, p. 686.*

U.S. Yards to Build Small Motorship for Dutch East Indies Inter-Island Service.

Although the high building costs of American shipyards have deterred the Netherlands Government from placing orders for medium-sized motorships for local service in the East Indies with U.S. builders, contracts for the construction of large numbers of shallow-draught small craft for inter-island service have now been given to several American yards. The largest of these, secured by Higgins Industries Inc., of New Orleans, La., is for the construction of 212 single-screw vessels of a design which is a slight modification of the Ganso type of boat developed by these builders for service in the Gulf of Mexico. These Ganso boats are flat-bottomed craft with a modified form of tunnel. The principal characteristics of the type of vessel to be built for the Dutch Government is an o.a. length of 62ft. 4in., a moulded breadth of 14ft. 7in. and a depth of 6ft. amidships, with a cargo capacity of 14·1 tons on a maximum draught of 4ft. The steel hull is divided into seven W.T. compartments by transverse bulkheads and includes a cargo hold of 1,146 cu. ft. capacity which is served by a derrick mounted on a pole mast. A combined cargo and anchor winch is fitted on the forecastle. A wooden superstructure abaft the cargo hatch contains the wheel-house and the living quarters for the native crew of four. Removable stanchions are provided for supporting an awning which covers the whole of the upper deck. Provision is also made for towing barges, etc., there being a combined hollow towing bitt and ventilator just aft of the deckhouse. The propelling machinery consists of a 6-cylr. General Motors type 71 two-stroke engine, developing 165-b.h.p. at 2,100 r.p.m. and driving the propeller shaft through a 3 : 1 reverse-reduction gear eqipped with wheel-house control. The engine is of the uniflow scavenge design and is equipped with an electric starter. A heat exchanger is fitted forward of the engine for the closed cooling system. The fuel tanks hold about 750 gallons of fuel oil, while the water tanks have a capacity of some 540 gallons of fresh water or water ballast, in addition to 100 gall. of drinking water. Apart from these vessels, the Dutch authorities have ordered a number of small Diesel-engined tugs for service on the inland waters of Sumatra and Borneo, including about sixty 50ft. tugs of this type which are to be constructed by the Odenbach Shipbuilding Corporation, of Rochester, N.Y., who are also to build 120 steel 45-ton barges. All these craft are intended to carry food, medical stores, building materials and machinery to the rubber-growing areas of the islands and bring crude rubber to the ports on their return trips.—*"Gas and Oil Power", Vol. XL, No. 482, November, 1945, pp. 441-442.*

Measuring Wall Thickness.

A recent issue of the American periodical *Iron Age* contains an article describing an apparatus known as a "Penetron", developed by the Texaco Development Corporation, New York, for measuring the wall thicknesses of pipes, tanks, etc., without drilling a hole and using mechanical calipers. A very small quantity of radium salt enclosed in a needle incorporated in the device emits gamma rays, and by measuring the intensity of the back-scattered radiations, which increases as a direct function of the thickness of the material, the apparatus can be used for measuring thicknesses of steel, aluminium, brass, wood and plastic materials in 25 seconds without putting the pipe, tank or other vessel concerned out of service. The weight of the "Penetron" equipment is 40lb.—*"Foundry Trade Journal", Vol. 77, No. 1,531, 20th December, 1945, p. 360.*

Nickel in Marine Engines.

According to an article in *Canadian Transportation*, some hundreds of large nickel-iron cylinder castings have been supplied to Montreal engine-builders by the foundry of Canadian Vickers, Ltd. Many of these castings were for the 2,500-h.p. engines of frigates. The weight of a nickel-iron casting for the H.P. cylinders of one of these engines amounted to 7,300lb. after machining, and the castings had to withstand a water-pressure test of 340lb./in.^{2}. The material from which they were made was a hard, tough, close-grained iron containing 1 per cent. of nickel. The tensile strength called for in the specification was 35,000lb./in.^{2}, but the foundry average was actually maintained at 38,000lb./in.^{2}. The metal was poured at 2,550° F. The foundry produced the iron with a mix containing 55 per cent. of steel, the remainder being low-phosphorous pig and remelt. The resulting metal not only met with the requirements of the specification, but also possessed excellent machineability.—*"The Marine Engineer", Vol. 68, No. 820, November, 1945, p. 622.*

Metallisation.

There are three types of metal-spraying processes, *viz.* (*1*) Using molten metal; (*2*) using powdered metal; and (*3*) the wire process. The molten metal process is quite satisfactory for metals with a low melting point, such as zinc, tin and lead, but is less satisfactory with aluminium. It is inconvenient with metals of high melting point, as molten metal has to be poured into a container within the tool. The powder process has received much publicity and gives good results with zinc, but is not suitable for aluminium and not satisfactory for metals of high melting point. The wire process, which is the only one dealt with in this paper, is the most widely used of all three, and it would be fair to say that 95 per cent. of metal spraying to-day is carried out by this process. Although aluminium corrodes very quickly in the massive form, this metal forms an excellent protective coating when sprayed, the reason for this being that an aluminium coating 0·003 to 0·004in. in thickness remains somewhat porous to the atmosphere, and each small particle which goes to build up the coating can therefore be subject to some slight oxidation. The products of corrosion build up in this way and fill the very fine pores left in the coating, and as the oxide of aluminium is highly resistant to further corrosion, the whole coating has an extremely good protective value. Aluminium coatings are not quite so efficacious under conditions of immersion in water as they are in the atmosphere, but thicker coatings of aluminium can be used for the protection of steel against salt-water corrosion. Aluminium coatings from 0·008 to 0·010in. in thickness are also used for tanks containing edible oil. A metallic surface impregnated with aluminium is highly resistant to high-temperature oxidation, because alloys rich in aluminium tend to take on a thin film of aluminium oxide, which is extremely refractory. A development of sprayed-on aluminium coatings is the "aluminising" process which has proved very successful in this country and has been employed for the protection of aircraft engine exhaust manifolds, and for the treatment of annealing boxes, melting pots, electric furnace casings, etc. This process is also used on heat-resisting nickel chromium alloy surfaces, the function of the aluminium in this instance being to prevent attack by the sulphurous gases which are so harmful to nickel alloys. Protection against the effects of temperatures above 950° C. (1,742° F.) is obtainable by spraying with nickel chromium alloys such as Nichrome, the best results being secured with Nichrome which is not of the highest quality, but contains some iron. The spraying of tin has been very successful in this country, as the process gives a heavy deposit of this metal. Tin coatings on refrigerator coils, if made of pure tin, are liable to crumble at very low temperatures, but such trouble can easily be eliminated by adding a small quantity of bismuth to the tin. Lead can be sprayed quite readily and lead coatings give excellent protection to steel surfaces exposed to weak acid attack; they are widely used for the protection of steel structures, etc., in industrial atmospheres in the vicinity of chemical works. Lead coatings 0·005in. in thickness are also most effective for preventing attack by foaming sea water, and would provide excellent protection for the propellers of ocean-going ships if the lead were not so soft and therefore subject to mechanical damage. Nickel and cupro-nickel sprayed on pump rods and finally ground to size give excellent results for long service. Copper and copper alloys can also be sprayed quite easily, but are in the wrong position in the electro-mechanical series to protect steel. If the coating should be perforated or if pin-holes should appear, corrosion ensues and the entire protective coating will peel off. The application of metal spraying to the building-up of worn bearing surfaces, such as crankshafts and journals of all kinds, has proved highly successful, but it must be remembered that metal spraying does not add to the strength of the components treated and that it is therefore essential to see that these possess sufficient residual strength after they have been prepared for spraying, observing that the worn part must be reduced in size sufficiently to allow the sprayed-on coating to be at least 0·020in. thick after finishing to size. There are two methods of preparing the surface, *viz.* (*1*) By shot-blasting; and (*2*) by rough threading. This second method consists of cutting a V-shaped screw thread of about 22-28 threads per inch to a depth of 0·030in. with a tool so arranged that it breaks up the thread and gives it a certain amount of roughness. The part must afterwards be degreased with a solvent such as trichlorethylene, and should then be sprayed with the metal to be used for the repair, which is usually steel with a carbon content of at least 4 per cent. The spraying pistol is generally mounted on the tool post, so that the entire operation of building up can be carried out in the lathe. The sprayed part should be ground, rather than turned, to size with a medium hard wheel with a vitrified bond. The wheels used for grinding need frequent truing and dressing due to the micro-structure of the applied coatings, which differ considerably from cast or massive metals. An alternative method of surface preparation, known in America as "fuse bonding" or "arc spluttering", involves striking a low-voltage arc between the metal electrodes and the work, the electrodes being given a stroking motion and the deposited metal adhering to the surface in the form of a solidified foam on which the sprayed metal is subsequently deposited. The author considers this method to be too slow for general use, added to which it gives somewhat inconsistent results. A good deal of criticism was formerly levelled at the process of rough turning highly stressed parts, such as rapidly rotating shafts, because it was said to produce cracks and sharp edges that formed convenient spots for the starting of fatigue spots; experience with many thousands of reclaimed components rough turned before being sprayed and subsequently ground to size, has proved these criticisms to be fallacious. Parts reclaimed by metal spraying have a longer life in lubricated conditions than the original steel, and it was also found, during the war, that water-lubricated parts (such as ships' propeller shafts) had a much longer life when metal sprayed than the original or unsprayed parts. Similar considerations apply to hydraulic rams and pump spindles, which can be built up with most excellent results. It is worth noting that the specific gravity of sprayed metal is approximately 20 per cent. less than that of metal in its massive state, while its hardness is about the same, although it is difficult to obtain correct hardness figures due to the fact that the particles give under compression. Oxide inclusions in sprayed metal coatings may vary from 1 to 8 or 9 per cent., the latter figure referring specifically to copper. Sprayed silver coatings give the best electrical conductivity, copper being the next best and then aluminium.—*Paper by W. E. Ballard, F.R.I.C., read at a meeting of the Belfast Association of Engineers on the 14th November, 1945.*

Some Problems of the Metallic State.

The essential nature of the metallic state is considered from the viewpoint of a physicist, not that of a metallurgist. The author explains that in the initial annealed state, there are large regions of highly perfect crystalline structure in the metal. When slip occurs, it runs for long distances, the parameter (t) being large, and the yield point low. However, this very act of yielding creates dislocations which form new interfaces where differently orientated mosaic fragments meet. It is like a large ice floe, smooth and perfect when first formed, which under the action of winds and currents acquires ridges of fragments running across it in all directions which break it up into mosaic such as may be seen in polar photographs. The parameter t diminishes and the crystal becomes stronger. At the same time the interfaces are centres of highly localised strain, in which the energy of cold-work resides. As deformation proceeds, the mosaic elements yield one another after a "scrunch" along a plane of slip where the atoms move on one each time. The largest elements are the weakest and yield first. The process cannot be carried on beyond a certain limit, because of the recrystallizing power of the metal. However much cold-work is put into the metal, a limiting amount only can be retained. This corresponds to the crystal structure being broken into fragments of limiting small size, fitting as uncomfortably to each other as is possible geometrically. When this limit is reached, the elastic limit of the metal is determined approximately by an expression ns/t, where n is the coefficient of rigidity, s the distance between neighbouring atoms, and t the average range over which each event of gliding can run.—*Fourteenth Andrew Laing Lecture by Sir Lawrence Bragg, O.B.E., M.C., D.Sc., delivered at a meeting of the N.-E. Coast Institution of Engineers and Shipbuilders on the 2nd November, 1945.*

Some Practical Applications of Rubber Dampers.

The method of rubber damper design outlined by the authors has been developed owing to the repeated breakdown of the two-mass system method hitherto widely used. The new method, which is based on the study of the behaviour of the engine as a whole in conjunction with the damper, splits up the functioning of a damper into two parts, one of which is termed the detuning effect, and the other, the absorption effect. The first relies on the powerful tuning curve method, whilst the other is based on the results of exhaustive trials and physical tests carried out with rubber samples and on full-scale dampers. The method described in the paper shows that there is no rigid relationship between the frequencies of the engine and damper, and that the free end of the engine crankshaft is not the only place where a successful damper can be fitted. In addition to giving some particulars of the physical and mechanical properties of rubber, it also shows how to calculate the heat dissipated by the dampers. Practical support for the theory put forward by the authors is provided by accounts of vibration trials carried out with three widely different types of engines equipped with dampers, one of which was a 7-cylr. slow-speed, high-powered Diesel engine. A comparison of the calculated and experimental amplitudes is given in each case, and it is claimed that the close agreement between the two shows that the method outlined can be used with confidence.—*Paper by R. W. Zdanowich, M.A., and J. E. Moyal, "Proceedings of the Institution of Mechanical Engineers", Vol. 153, No. 3, pp. 61-76.*

Roller Bearings.

A lecture entitled "The Application of Roller Bearings in the Marine Industry" was recently delivered by Mr. W. Weatherston Watkins before the Greenock Association of Engineers and Shipbuilders. The speaker gave a brief summary of the various types of ball and roller bearings in which the angle of contact ranges from 0° in the purely radial type to 90° in the purely axial type, bearings having an intermediate angle of contact being designed to deal with a combination of radial and axial load. Self-aligning bearings of these types were also referred to. The lecturer described some of the mechanical properties of the balls and rollers used for bearings, as well as the high degree of accuracy aimed at in their manufacture. He enumerated the types of ball and roller bearings which have been employed for marine service. On the forecastle head, he stated, bollards are fitted with single-row ball bearings, while bollard sheaves have cylindrical roller bearings, and W.T. doors in bulkheads have rollers fitted with single-row ball bearings, which are also used for W.T. door operating gears. In deck cranes, including heavy-duty cranes capable of 6-ton lifts, the radial load in the footsteps is taken on a self-aligning roller bearing, the thrust load being carried by a bearing of the single-ball thrust type. Self-aligning roller bearings are used for the drums of cargo winches, while the combined radial and thrust load in boat davits is taken by single-row ball bearings. Among the many E.R. applications noted by the lecturer were Diesel engines having gudgeon pins carried on pin roller bearings, similar bearings being used for the cam rollers. A Swedish-built oil engine running at 1,000 r.p.m. is fitted with roller bearings for the gudgeon pins, crankshaft and connecting-rod ends. Self-aligning roller bearings have been utilised for intermediate and propeller shafts. The lecturer recalled the experiments carried out on the Continent in a steamship of 28,000 s.h.p., in which the frictional loss in the plain plummer-block bearings as measured by a torsional dynamometer proved to be 7 per cent. of the total s.h.p. This meant that the frictional loss in the intermediate shaft bearings alone amounted to 1,960 s.h.p. With roller bearings of the type already in successful use for this purpose, it was suggested that 80 to 90 per cent. of that loss could have been eliminated. The reduction in the annual fuel cost from such a saving, apart from the saving in lubricating oil and the advantages to be gained by the self-aligning properties of the bearings, are facts which compel attention to the possibilities of bearings of this type.—*"Shipbuilding and Shipping Record", Vol. LXVII, No. 18, 1st November, 1945, pp. 412-413.*

Post-War Training of Marine Engineers.

In this letter to the Editor, the writer—who is Senior Lecturer in Marine Engineering at the City of Liverpool Technical College and as such, has already instructed approximately 4,000 marine engineers studying for certificates of competency and B.o.T. surveyorships—discusses the recommendations on the future training of marine engineers contained in the recent report of the Merchant Navy Training Board. After making a number of—generally favourable—comments on the proposals put forward in the report, the writer expresses misgivings regarding the scope for advancement which the profession of marine engineering has to offer at the present time. He therefore suggests that certain responsible appointments ashore should be reserved for sea-going marine engineers. This he would ensure by the introduction of statutory regulations which would stipulate: (*a*) That the engineer in charge of any land engine or boiler plant above a determined size should be in possession of a First-Class Certificate of Competency; and (*b*) That all inspections of engines and boilers should be carried out by an engineer holding an Extra First-Class Certificate, the status of such inspectors being raised to approximately that of the M.o.W.T. Surveyors. While admitting that such proposals might seem to infringe on the province of the mechanical engineer, the writer declares that as a virile Merchant Navy is essential to the economic existence of this country, it must be regarded as an essential service and given priority as such. He points out that there is no training equal to that of the marine engineer to qualify a man for the maintenance and surveying of engines and boilers, and that the carrying out of these proposals would therefore result in an improvement in the efficiency of such shore installations.—*W. V. Doling, B.Sc. (Dunelm), "The Marine Engineer", Vol. 68, No. 821, December, 1945, pp. 681-682.*

The Royal Naval Damage Control School.

Since the establishment of the R.N. Damage Control School in a studio building at Baron's Court, London, W.8, in August, 1942, more than 7,000 naval officers of various ranks and branches passed through its intensive 7-day course. The instruction given there included lectures and demonstrations with scale models of ships of all types fitted with internal W.T. bulkheads, flooding valves and vents for all compartments, these models being set afloat in 20-ft. tanks provided for the purpose. There were also cut-away sections of ships showing the lay-out of the damage control headquarters and stations as arranged in modern ships. Another feature of the school was a collection of exhibits of various types of portable pumps, fire-fighting equipment, leak-stopping devices and shoring gear. Attached to the school was an extensive library containing every report of ship damage which was available. Many of these damage reports referred to ships of the U.S. Navy.—*"The Engineer", Vol. CLXXX, No. 4,692, 14th December, 1945, pp. 479-480.*

The Training of Refrigeration Engineers.

In the course of his Presidential Address to the Institute of Refrigeration on the 25th October, Mr. Kenneth Lightfoot deal with the progress that has been made in refrigeration and the need for special educational facilities for those entering the industry. About 25 years ago the temperature range over which refrigeration was used was between −10° F. and +30° F., but during the past ten years the range had been widened, and now extends from −120° F. to +70° F. The development in the upper side of the scale had been mainly in connection with air conditioning, whilst the very low temperatures were used for drying and freezing penicillin, as well as for research work on aircraft engines, lubrication and other engineering purposes. The greatest application of refrigeration was, however, still to the preservation of foodstuffs. The speaker stressed the need for the provision of a higher standard of technical knowledge and training for the industry, and declared that refrigeration would have to be regarded as a separate branch of engineering with its own problems that called for technical education and qualifications on the part of those who wished to enter it. A syllabus for a three years' evening course on refrigeration was being arranged at the City and Guilds Institution in London and at the Manchester Technical College, and it was hoped that these courses would be available early in 1946 for students who had attained the necessary standard in mechanical engineering. It was likewise proposed in the near future to arrange similar courses at other centres in the U.K., and also to provide a full-time post-graduate course at one of the larger universities. —*"The Engineer", Vol. CLXXX, No. 4,686, 2nd November, p. 347.*

Maritime Service Opens Electricians' School at San Francisco.

A school for ships' electricians was recently opened in San Francisco by the U.S. Maritime Service, where qualified men will undergo an intensive eight weeks' course of instruction in the installation, operation and maintenance of electrical equipment of every type now in use in the merchant marine. Candidates for admission to the school must either have served for at least six months in the E.R. department of a merchant vessel or produce evidence that they have been employed ashore for at least 12 months as an electrician or electrician's mate. They must also pass the prescribed "arithmetic computation test". The trainees will receive pay at the rate of $186 per month while at the school, but the time spent there will not be allowed to count as shore service under the Selective Service Scheme of the Recruitment and Manning Organisation.—*"Marine Engineering and Shipping Review", Vol. L, No. 10, October, 1945, p. 146.*

New Age in Naval Engineering.

In an address delivered by Captain (E) I. G. Maclean, O.B.E., R.N., to a recent conference of the Institution of Professional Civil Servants, the speaker referred to the achievements of the engineering branch of the Navy in maintaining the machinery of the Fleet in the face of the most adverse conditions. At the outbreak of war, there were about 1,500 officers and 28,000 ratings in the engineering branch of the Royal Navy, and at the conclusion of hostilities these numbers had increased to 6,400 and 120,000 respectively. Capt. Maclean remarked that from these figures it is easier to imagine the task of training the personnel than it was to carry out. The total h.p. of the main fleet units operating during the war amounted to close on 25 millions. The speaker stated that the present-day training syllabus of a naval engineer officer compares favourably with honours degree standards. Half the personnel of the Fleet Air Arm are engineers, whose function it is to service and inspect every part of the aircraft as well as the engines. At the beginning of the war, when the Navy had only just taken over the Fleet Air Arm from the R.A.F., the number of engineer officers attached to it was not more than a dozen, but by August, 1945, the number of such officers attached to the Naval Air Arm had risen to over 1,100, of whom over 900 belonged to the R.N.V.R. The number of men controlled by these officers was of the order of 40,000. Naval engineer officers who specialise in aviation must not only possess the equivalent of an honours degree in aeronautical engineering, but must also have flown service aircraft operationally. Speaking of certain developments in high-powered propelling machinery for light craft without adequate research work, Capt. Maclean mentioned the case of four 3,000-ton minelayers with machinery of 72,000 s.h.p. and a very high speed, which were built for the Royal Navy at the outbreak of war and which subsequently played an important part in it. The first of these ships had to carry out two operations at full speed and full power, before she was able to undergo her initial machinery trials. It is interesting to compare these ships, produced as the result of a fairly conservative outlook, placing great emphasis on reliability and on the ability to keep the seas at all times, with the product of the German engineer. The German "Narvik" class destroyers of 69,000 s.h.p. have very different machinery of a most advanced and complex design—utterly unsuited to a warship. The British ships operate with steam at a pressure of 300lb./in.^{2} and temperature of 660° F., whereas the Germans use steam at 1,100lb./in.^{2} at a temperature of over 900° F. Yet in spite of this thermodynamic advantage, the fuel consumption of the German ships is higher than that of the British vessels. The machinery spaces of the German destroyers take up 30ft. more in length, and the machinery weight is 25 per cent. greater than the British, and on the score of reliability all is in favour of our ships, whose E.R. complements are half those of the Germans. The German ships are, in fact, masterpieces of misapplication; and the tale illuminates a significant feature in naval engineering, the great advantage of having sea-going engineers in charge of machinery design. Capt. Maclean gave some particulars of the famous steam-driven gunboats of the "Grey Goose" class which formed part of the flotilla led by Peter Sdott. Known as steam gunboats to distinguish them from the more usual motor gunboats, these craft were designed for use against the German E-boats. For this they had the advantage of relatively silent operation, and could stalk and kill. They were equipped with water-tube boilers delivering steam at 400lb./in.^{2} pressure and 750° F. total temperature to turbines developing 8,000 s.h.p. The total all-in weight of the entire installation, including water, is under 50 tons, or just over 10lb./s.h.p., which is only one-third the specific weight of the most highly-forced destroyer machinery. One of the most serious design problems of the war arose from the severe shock effect of underwater explosions near a ship, but not contact with it, particularly magnetic mine explosions and near misses by bombs. The effect was much greater than from direct hits and caused widespread damage to machinery. This complicated problem was dealt with by a special section set up at the Admiralty by the Engineer-in-Chief. The first method was to mount the machinery on specially-designed rubber pads, but at a later stage an ingenious form of mounting which combined resilient materials with a rigid structure was evolved. At the end of the war in Europe it was discovered that the Germans, in attempting to solve the same problem, had not progressed beyond complicated and far less satisfactory spring devices. The speaker concluded his address by expressing the hope that real foresight will be displayed in making sure that this country has the engineering facilities it needs, and that the post-war world will not neglect the engineer, the practical man who turns the dreams of scientists and research workers into the practical realms of everyday life.—*"The Journal of Commerce" (Shipbuilding and Engineering Edition), No. 36,769, 20th December, 1945, pp. 3 and 8.*

Preservation of Laid-up Ships.

Captain H. G. Donald, U.S.N., Demobilisation Officer of the Bureau of Ships, recently addressed the American Merchant Marine Conference on the subject of applying Naval practice to the preservation of laid-up merchant ships. The main particulars of the preservation measures to be applied are: (*1*) The covering of all unprotected corrodible surfaces with a preparation known as Thin-Film Rust-Preventive Compound (Polar Type), which comprises an inert material that forms the protective film and a solvent carrier that evaporates. It may be applied by spraying, flushing, brushing-on or dipping at atmospheric temperature and need not be removed from machinery parts, etc., before putting these back in service; neither is it necessary to open up machinery to apply the preservative to the interior. The resultant film is sufficiently transparent to permit inspection of the coated surfaces for signs of corrosion. (*2*) The dehumidification of all enclosed spaces in order to inhibit corrosion, mildew, mould or rotting. Two methods of dehumidification are employed, that in most common use being termed the dynamic method. This involves the employment of a so-called dehumidifying machine with automatic starting, stopping and reactivation of the absorbent type dessicant used in the machine. No temperature control is required. One machine is used for small vessels and two or more for cruisers and larger ships. The interior of the hull is made weather-tight by blanking off or plugging all openings not fitted with closing devices. Free access must be available for inspection, but the interior of the hull is otherwise treated as a refrigerated space that is kept closed when not in actual use. The cost of maintaining an atmosphere sufficiently dry to inhibit corrosion within a steel hull is well below 20 cents per 100,000 cu. ft. of ship space per day on the basis of 1 cent per kW.-hr. The initial cost of the plant, including the control gear, varies according to the size of the vessel and the type and size of the machine or machines used, but may be estimated at not more than ⅓ to ¾ of a cent per cu. ft. of space. The cost of making the hull weather-tight is about the same, but decreases rapidly with increase in volume. It is not necessary to have the hull pressure-tight. This means of preservation is most effective for stores, etc., as well as for the hull structure and fittings and therefore allows the retention in the ship of everything normally carried. The alternative or static method of dehumidification involves the placing of a dessicant inside the space to be dried and is more expensive and laborious than the dynamic method, but is useful for spaces which are not accessible for the latter. (*3*) The application of high-grade paints to all external surfaces exposed to the weather. (*4*) The use of plastic paint for the preservation of the underwater portions of the hull. This paint, developed by the U.S. Navy, possesses exceptional protective qualities and allows the intervals between dry-docking to be increased. The speaker expressed the view that the above preservation measures could be applied with economic advantage to any type of steel merchant ship, and that dehumidification should, in any case, be resorted to for the preservation of machinery spaces and boiler rooms. The cost is, however, so small as to make this preservation measure applicable to the whole of the interior spaces of a vessel.—*"The Nautical Gazette", Vol. 137, No. 11, November, 1945, pp. 68-69.*

The Mechanicals and the Automobiles.

After negotiations spread over the last two years, it has now been announced that the Institution of Automobile Engineers is to be amalgamated with the Institution of Mechanical Engineers, but that the 3,000-odd members thus transferred will be formed into an Automobile Division, with an Automobile Divisional Council which will have a considerable degree of autonomy. There is thus no question of submerging the membership into the general body of the Institution of Mechanical Engineers, without preserving, to a large extent, its independence. The new Division is to be more distinctive in character than the former Groups and will, it is understood, be the precursor of other Divisions on similar lines. Though membership of a body over 20,000 strong may afford greater scope in certain directions, there may, however, be many specialised engineers who will desire to supplement that membership by adherence to a smaller organisation particularly adapted to talk their own language and to express, perhaps, a more restricted point of view.—*"The Power and Works Engineer", Vol. XL, No. 474, December, 1945, p. 578.*