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Tanker for Liquids Under Pressure

This patent concerns an arrangement in tankers for the carriage of liquids under pressure, particularly compressed, liquefied gases in pressure tanks. For such purposes it is the practice to use cylindrical tanks which are permanently installed in the ship. An important feature of the invention is the fact that in it the tanks are connected in groups, the tanks in each group being joined by connexions between the lower parts of the tanks as well as between their upper parts. Each such group of tanks is provided with a common expansion space, a common inlet and outlet device, and preferably with common control instruments. This results in a simplification of the emptying and filling of the tanks and also of the measuring of pressure and the level of the liquid, each group being operated as a unit. In Fig. 5, which shows a cross-section through the

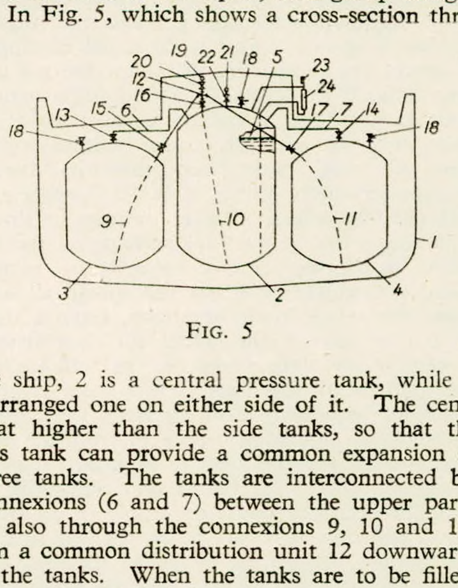
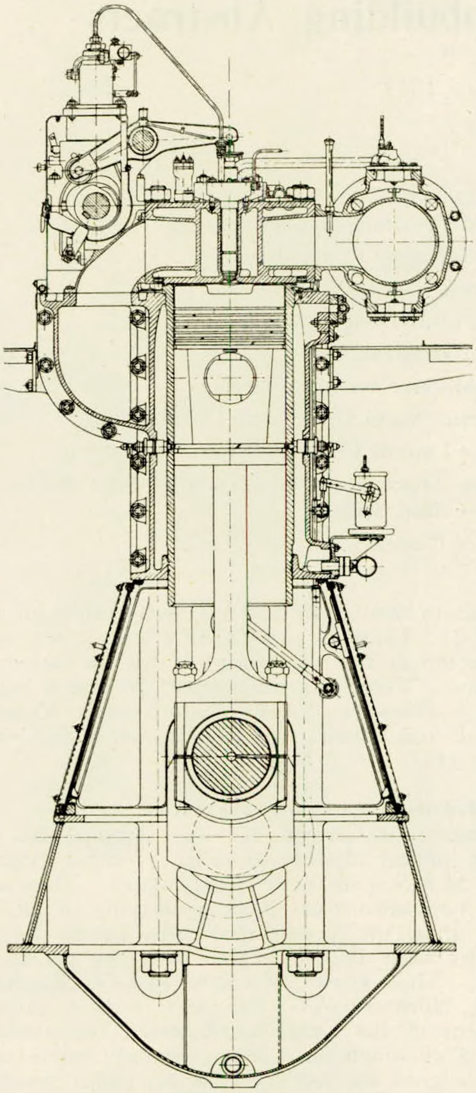


FIG. 5

hull of the ship, 2 is a central pressure tank, while 3 and 4 are tanks arranged one on either side of it. The central tank is somewhat higher than the side tanks, so that the upper part of this tank can provide a common expansion space (5) for the three tanks. The tanks are interconnected by means of pipe connexions (6 and 7) between the upper parts of the tanks, and also through the connexions 9, 10 and 11, which extend from a common distribution unit 12 downwards to the bottom of the tanks. When the tanks are to be filled, liquid or liquefied gas is supplied through the connexion (19) and is distributed through the pipes (9, 10, and 11). As the level of the liquid in the tanks rises, the pressure could, if necessary, be relieved by letting air and gas escape through the pipes 6, 7, and 21. Liquid is supplied to a level in the centre tank above the top of the side tanks, so that the latter are completely filled. There is a manometer (23) and a liquid-gauge glass (24).—*Patentees: Norsk Hydro-elektrisk Kvaelstofaktieselskab. British Patent No. 693,156. World Shipbuilding, November 1953; Vol. 3, No. 11.*

German Medium Speed Four-stroke Engine

A feature of German post-war shipping has been the increasing number of ships propelled by either direct-coupled or geared M.A.N. four-stroke Diesel engines. These are manufactured with exhaust-gas pressure-charging or as normally-aspirated units, the supercharged units having the relatively conservative mean effective pressure of 9·1 kg. per sq. cm. (129 per sq. in.). It is known, of course, that the Maschinenfabrik Augsburg Nürnberg A.G. has been actively pursuing the development of the highly supercharged four-stroke engine, the results of which have been previously published. Such engines, designed for, and operating on, higher pressures, have not yet been put into commercial service, although some are now on order, but there is, nevertheless, much of interest in the current design. This is an engine with a cylinder diameter of 400 mm. and a piston stroke of 600 mm., which, as a six-cylinder unit without supercharging, will develop 785 b.h.p. at 275 r.p.m., the corresponding piston speed being 5·5 m. per sec. The engine, which is also designed for industrial duties, is built with from five to ten cylinders—with and without pressure charging. Normal supercharging amounts to about 60 per cent, corresponding to an m.e.p. of 9·1 kg. per sq. cm., so that a 10-cylinder engine supercharged to this extent develops about 2,100 h.p. This is the continuous rating and does not include a 10 per cent overload allowance. A feature of the design is that arrangements have been made whereby a drive can also be taken from the forward end, if desired; this is particularly advantageous in such vessels as ferries, or for fishing boats where a drive is generally required for the trawl winch or winch generator. The exhaust-gas turbo-blower is of the standard M.A.N. design with self-aligning bearings of the multi-surface type between the turbine rotor and the blower, to ensure the minimum of friction. The construction of the engine is generally simple. The welded bedplate supports the columns and the cylinder block which, for the larger engines, comprises a number of units bolted together. Cast integral with the cylinder block is the air suction manifold which supports the camshaft seating and the fuel pumps. It will be seen that the arrangement of the camshaft is such that the need for push rods is obviated.



Sectional elevation of four-stroke M.A.N. engine

The drive for the camshaft is by means of a 2½-in. simplex chain. With four-stroke engines of similar size, reversing is generally effected in three stages, the push rods being lifted from and replaced on the cams in the first and third stages; the camshaft is moved to its requisite position during the second phase. With this engine, however, all cams have oblique surfaces, so that it is not necessary to lift the rollers from the cams, an arrangement which enables a simplification of the reversing gear and ensures a quicker response. Owing to the excellent heat transmission properties of the aluminium alloy of which the pistons are composed, the pistons are uncooled. With 60 per cent supercharging, the temperature at the centre of the piston crown, measured by thermo-elements 6 mm. below its surface, remains below 210 deg. C. The temperature within the vicinity of the topmost piston ring is about 20 deg. lower—about 190 deg. C. at the same load—at which temperature sticking of piston rings should not be encountered. An interesting point about the pistons is that they are ground spherically from the bottom to the top, i.e. with a smaller diameter at the bottom and top than in the middle. Furthermore, the pistons are ground slightly oval in their cross-section, the degree of ovalness increasing from the bottom upwards to about the top piston ring, where the cross section gradually reverts to round form.—*The Motor Ship, February 1954; Vol. 34, pp. 486–487.*

Shaving Machine for Large Gears

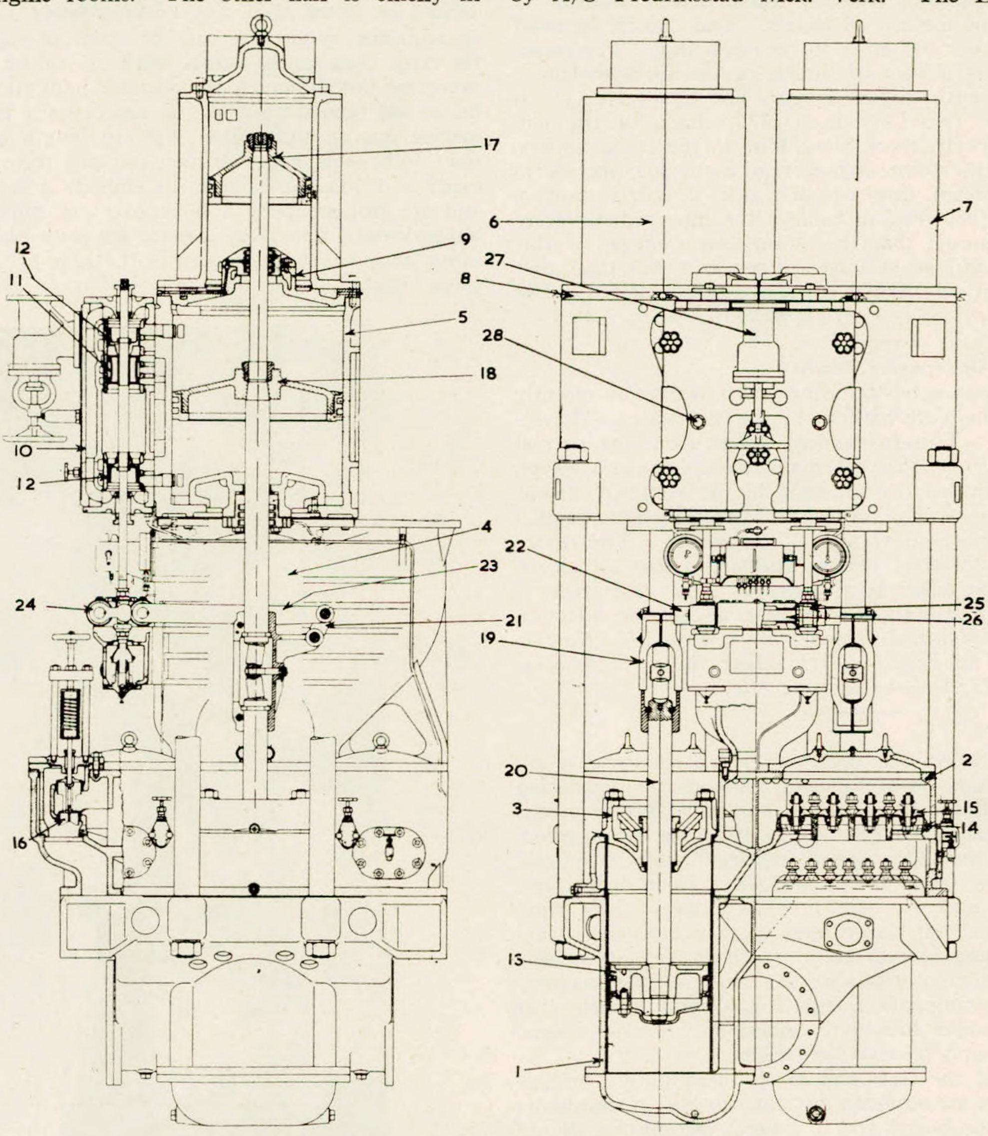
A turbine-gear shaving machine, which is believed to be the largest in the world, is now in use at the Clydebank shipbuilding works of John Brown and Co. (Clydebank), Ltd. It has been designed and built by David Brown Machine Tools, Ltd., Manchester, to accommodate turbine wheels of up to 220-in. diameter and weighing 100 tons. The machine is designed for "crowd" shaving of marine main propulsion wheels—a super-finishing process—for removing the minute undulations inherent in gears cut by the hobbing process. The main drive is from the headstock and through an Oldham coupling to the wheel which is being shaved. There is no rotational drive to the cutter, which is driven by contact with the main wheel. A power drive to the cutter head is solely for controlling the traverse of the saddle. The machine is being used in conjunction with a David Brown 48-in. pinion-shaving machine which is employed for shaving high-pressure, intermediate-pressure and low-pressure pinions. The cutter head of the machine is equipped with an oil-cooled brake on each side of the cutter to permit selective shaving, which may be necessary to obtain something of the order of a 95 per cent bearing across the face-width of the gear, allowing for slight relief at the ends. In cases where a precalculated amount has to be allowed for the torsional deflexion of the pinion under full load, the necessary adjustment in the shaving process is carried out on the pinion machine. This usually applies to high-pressure pinions of comparatively small diameter. A feature of the machine is that it is fitted with a pinion-mounting bracket at the rear, allowing the machine to be used as a testing bed so that the tooth marking can be determined without removing the large wheel from the shaving machine.—*Engineering, 4th December 1953; Vol. 176, p. 730.*

Fires in Ships

An oilpipe bursts or leaks, or a settling tank overflows, the oil spouts on hot exhaust valve seats on the motor top, on a flange of the exhaust pipe or on the furnace door of a boiler; it reaches its flashpoint (80 deg. C.) and the mixture of oil vapour and air is ignited. This is the usual development of a fire in the machinery compartments. How the gas was ignited is sometimes difficult to ascertain. The ignition temperature of oil gas is about 500 deg. C., and the exhaust gas is not as hot as that, but there are evidently other ignition sources in an engine room—electrical sparks from generators, disruptive discharge of cylinder safety valves, a boiler furnace of a boiler in use, and possibly others. Before the two or three men on watch in an engine room, who are perhaps on the floor when the fire starts on the top, or *vice versa*, or in the tunnel, can reach a hand extinguisher, the gas has spread all over and in a short time the whole room is ablaze, leaving the crew no alternative but to run up the ladder for their lives. Copper pipelines melt, the settling tanks on the bulkheads boil, the fire spreads underneath the floor, where there is always some spilt oil, and to the bilges. Four or more ventilators and the skylight provide an abundant supply of fresh air for the fire, and it is impossible for the crew to approach them and stop the influx on account of the flames and the smoke. The fire is nourished for hours by constant supply of oil from various containers. These fires were rare before the war and during the war, and it is probably correct to record the great increase of the number in the after-war period under the heading: inexperienced or careless engine room staff—it is usually an oiler or a motorman who was nearest to the place where the leakage took place. He probably handled the valves or the pipeline connexions or the oil transfer pump improperly and did not know what to do when the accident happened. Diesel and fuel oil cannot burn; the oil vapour can burn, but only if mixed with air in ratio 1·4 per cent to 6 per cent vapour to air. There is much air needed to maintain an oil fire. It might be thought that if the air supply could be cut off immediately after the ignition the fire would die as soon as the air present had been consumed. This could be attained if the engine room openings were constructed thus:—Skylight shutters to be hinged and supported in such a way that they can be closed by the pull of a wire or a rod from a safe distance on deck. Ventilators to be provided with shutters manageable in the same way. All doors in the engine room casing to be of self-shutting type and light openings in the casing to be provided with fire-resistant glass. Paint in the engine room to be of the fire-retarding type. The fire-pump station outside the engine room, prescribed by the 1948 Convention, to be connected with fog nozzles in the spaces in the engine room where oil may accumulate, ordinarily or by accident. Of the fires caused by ship repairs, about one-half in number are in engine rooms. The other half is chiefly in insulation and a few in accommodation rooms. It is obvious that the use of cutting or welding utensils, electrical, autogen or hydro-oxygen create a great risk of heating oil residues above their flash point and igniting the gases. There may not be any of the ship's engineers present and the ship's fire-fighting system will as a rule be out of use. For a long time the risk of having tankers at shipyards was quite considerable, but the catastrophes that occurred by starting welding work outside dubious tanks have taught everybody to be careful in connexion with gas-free certification, and this risk seems to have decreased.—*The Shipping World, 13th January 1954; Vol. 130, pp. 39-41.*

New Vertical Cargo Oil Pump

The 31,000-ton motor tanker *Octavian* is equipped with cargo oil pumps of a new design, and some 33 tankers are to be equipped with such units, including ships on order with Barclay, Curle and Co., Ltd., Harland and Wolff, Ltd., and Blyth Dry Docks. In Sweden, 11 Götaverken-built motor ships will have these pumps, as will nine vessels building in Norway by A/S Fredriksstad Mek. Verk. The Eureka pump is a



Section through the Eureka 510-ton cargo pump

1.—Pump cylinder. 2.—Valve chest. 3.—Cylinder cover. 4.—Air vessel. 5.—L.p. steam cylinder. 6.—H.p. steam cylinder (left). 7.—H.p. steam cylinder (right). 8.—Partition cover l.p.-h.p. (left). 9. Partition cover l.p.-h.p. (right). 10.—Steam valve chest. 11.—Piston slide valve h.p. 12.—Piston slide valve l.p. 13.—Pump bucket. 14.—Valve plate. 15.—Pump valves. 16.—Safety valve. 17.—H.p. piston. 18.—L.p. piston. 19.—Coupling. 20.—Pump rod. 21.—Link for coupling. 22.—Long lever. 23.—Short lever. 24.—Crank for front rocking shaft. 25.—Crank for back rocking shaft. 26.—Rocking shaft. 27.—Steam valve. 28.—Intermediate pressure safety valve.

duplex steam-driven unit, manufactured in three models, with respective outputs of 400, 510 and 750 tons of water per hour. The 510-ton model as installed in the *Octavian* is shown in section, and this has 16in. by 26in. steam cylinders with a pump diameter of 16 inches and a stroke of 24 inches. The 400-ton and 750-ton pumps are similar. The bottom covers of the pump are renewable in view of possible corrosion by electrolytic action, and the pump cylinders are fitted with bronze liners, secured in place by the cylinder covers (3). By means of these top covers and a special type of coupling (19), the pump buckets can be removed upwards as with a conventional simplex pump. By utilizing the air vessel as a structural member and to carry the pump discharge flange, a compact arrangement is obtained, yet allowing ample accessibility to the valve covers and to the pump itself. The steam end is supported by, and connected to, the water end by four steel columns, and the h.p. cylinders (6 and 7) are designed with integral steam passages. Ease of maintenance has again been assured. The internal division plate (8 and 9) between the h.p. and l.p. cylinders, and which carries the self-adjusting metallic packing for the piston rod, is secured by the bottom flange of the h.p. cylinders. This can be removed to permit the pistons and rods to be taken out. The steam chest valve (10) has a pair of double-piston spring-balanced valves, as is usual with duplex units. The h.p. valve (11) is placed between the two l.p. valves (12). Each of the h.p. cylinders has two ports, there being four in the l.p. cylinders. As the h.p. and l.p. steam cylinders at each side operate in tandem, and the steam flow of each side is independent, a cross-over valve is provided to balance the intermediate steam pressure. It is claimed that the steam consumption of this class of pump should be at least 30 per cent less than that of horizontal cargo oil pumps of conventional design.—*The Motor Ship, January 1954; Vol. 34, p. 443.*

Sonar Device Scans Underwater Depths

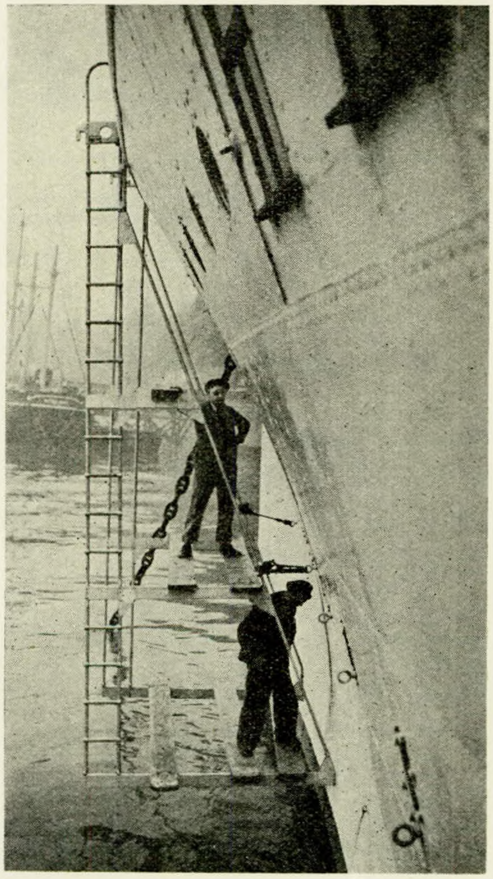
A new electronic echo-sounding instrument was recently demonstrated in New York harbour by the Minneapolis-Honeywell Regulator Co. This instrument differs from the normal type of echo-sounder in that the high-frequency sound waves, instead of being emitted continuously in the vertically downwards direction, can be sent out in any direction from parallel with the water surface to vertically downwards. The device also automatically traverses the transmitter so that an arc of up to 90 degrees on either bow is swept. The instrument is said to be of assistance both in navigation and in the detection of shoals of fish.—*Nautical Gazette, 1953; Vol. 148, No. 10, p. 20. Journal, The British Shipbuilding Research Association, December 1953; Vol. 8, Abstract No. 8,377.*

Fires in Ships

The author reviews the causes of recent major fires on board merchant ships, and discusses methods of preventing these accidents. Of the more serious shipboard fires reported during the year ending October 1952, 190 were investigated, and it was found that 110 started in cargo holds (two total losses), 35 in engine rooms (two total losses), 25 in cabins, etc. (two total losses), and 20 were fires in tankers (three total or nearly total losses). In cargo fires, spontaneous combustion and cigarette smoking shared the responsibility about equally. Spontaneous combustion was also the cause of the majority of fires in the accommodation, but it was very unlikely that engine room and tanker fires were caused by smoking. Some of the conclusions and observations reached are as follows:—More instruction of the crew and of the harbour fire brigade is necessary. Easily manipulated airtight shutters in ventilators should be installed on board, and in general, airtightness should be made greater use of in extinguishing fires. There should be no oil paint in the engine room, and the furniture and fittings in the accommodation should be simpler and safer. The fire pump outside the engine room, prescribed by the 1948 Convention, should be connected with fog nozzles over spaces in engine and boiler rooms where oil might accumulate, or a CO_2 system should be installed covering the lower part of these rooms. There should also be provided easily accessible switches for stopping ventilation fans, self-closing doors in the engine casing and in corridors; skylight shutters that can be closed from a distance on deck; and fire-resistant glass in engine room skylights. In general, automatic fire detectors and extinguishing systems could be used to a greater extent, but the crew should not be encouraged to rely on them so much that ordinary vigilance is sacrificed. The cost of the installation of various safety measures could be offset to some extent by marine insurance companies, which could encourage safety precautions by reduced premiums.—*Paper by T. Wikborg, read at the Conference of the International Union of Marine Insurance, San Sebastian, 18th September 1953. Journal, The British Shipbuilding Research Association, December 1953; Vol. 8, Abstract No. 8,405.*

Light Alloy Painting Stages

The flare of the bow in the modern vessel is considerable, and it is not easy to place a conventional stage, such as is carried on board ship, for working safely and effectively. In consequence, more time may be spent in rigging and shifting the stage than in the actual work of scaling or painting. To overcome this difficulty, the portable light alloy stage illustrated below has been developed. It comprises a pair of brackets of marine quality light alloy 20ft. in length and weighing less than 56lb. each, and two men can put them in position quite easily and quickly. The units embody a ladder in the design and are suspended by a hook over the gunwale angle bar or bulwark rail. Provision is made for stage planks in three positions, thus enabling an area 20ft. deep by the length of the stage planks, to be done at one time. Six men could be



Working under the flare of the bows, with vertical section of frame outboard and base secured to eyebolts employed comfortably on one set of brackets. Stay ropes and guys have been dispensed with, and to fleet the stage it is only necessary to release the lanyards at the toe of the brackets and slide the staging along the rail. It is necessary to have flush eyebolts at suitable intervals under the flare of the bow, but on the flat of the ship's side no eyebolts are necessary. When working on the flat of the ship's side the perpendicular side of the bracket is placed to the ship's side and, where conditions require, one bracket may be placed each way, that is, hypotenuse one end of the stage and perpendicular to the ship's side the other. By the use of this stage bracket, additional safety is provided and considerable painting time saved. The prototype was made to suit a vessel 266 feet by 35 feet by 25 feet, but it would be suitable for much larger vessels. It could be made to suit all vessels and could be carried as part of the ship's equipment, and also it might be used with advantage at regular terminals and at docks and ship repairing works. The design has been developed by Captain J. P. Thomson in conjunction with Mr. W. C. Coombs, Non-Corrosive Metal Products, Horton Road, Yiewsley, Middlesex.—*The Shipping World, 6th January 1954; Vol. 130, p. 16.*

High Temperature Turbine Machinery for Marine Propulsion

The highest steam conditions in use in British ships are those in the three Alfred Holt vessels, *Nestor, Neleus,* and *Theseus,* with a boiler pressure of 625lb. per sq. in. and a total temperature when running ahead of 950 deg. F. The maximum horsepower developed per set is 8,000 s.h.p. The turbine machinery, gears, and condensers were made by Metropolitan-Vickers Electrical Co., Ltd., to the specification produced by Cdr.(E) L. Baker, D.S.C., R.N.(ret.). Although this machinery has many valuable features of great interest to all engaged in the development of high-temperature turbines, for the present purpose the main part of the machinery which must be examined is the high-pressure turbine. The high-pressure turbine shown in Fig. 3 is associated with an intermediate-pressure and low-pressure turbine. The astern turbine built into the low-pressure turbine is supplied with steam at a temperature of 750 deg. F. and is, consequently, well within the range of present practice. As this high-pressure turbine is part of a three-casing installation, the heat drop handled is less than that in a high-pressure turbine forming part of a compound set of turbines. It can be seen (Fig. 3) that the high-pressure turbine contains a velocity-compounded stage followed by eight single-impulse stages. The rotor is an integral forging, and built-up diaphragms are employed. The glands of the labyrinth type are spring-backed. Steam is admitted to the top half of the casing in three controlled groups of nozzles, containing seven, three, and two nozzles respectively. The control valves for the groups are operated sequentially from the manœuvring hand-wheel and correspond to powers of 5,000, 7,250 and 8,000 s.h.p. At full power with steam conditions at high-pressure inlet of 600lb. per sq. in. and 950 deg. F., the intermediate-pressure inlet pressure is 125lb. per sq. in.; the low-pressure inlet pressure is 5lb. per sq. in. and the vacuum 28·44 inches of mercury. The materials employed in the high-pressure turbine

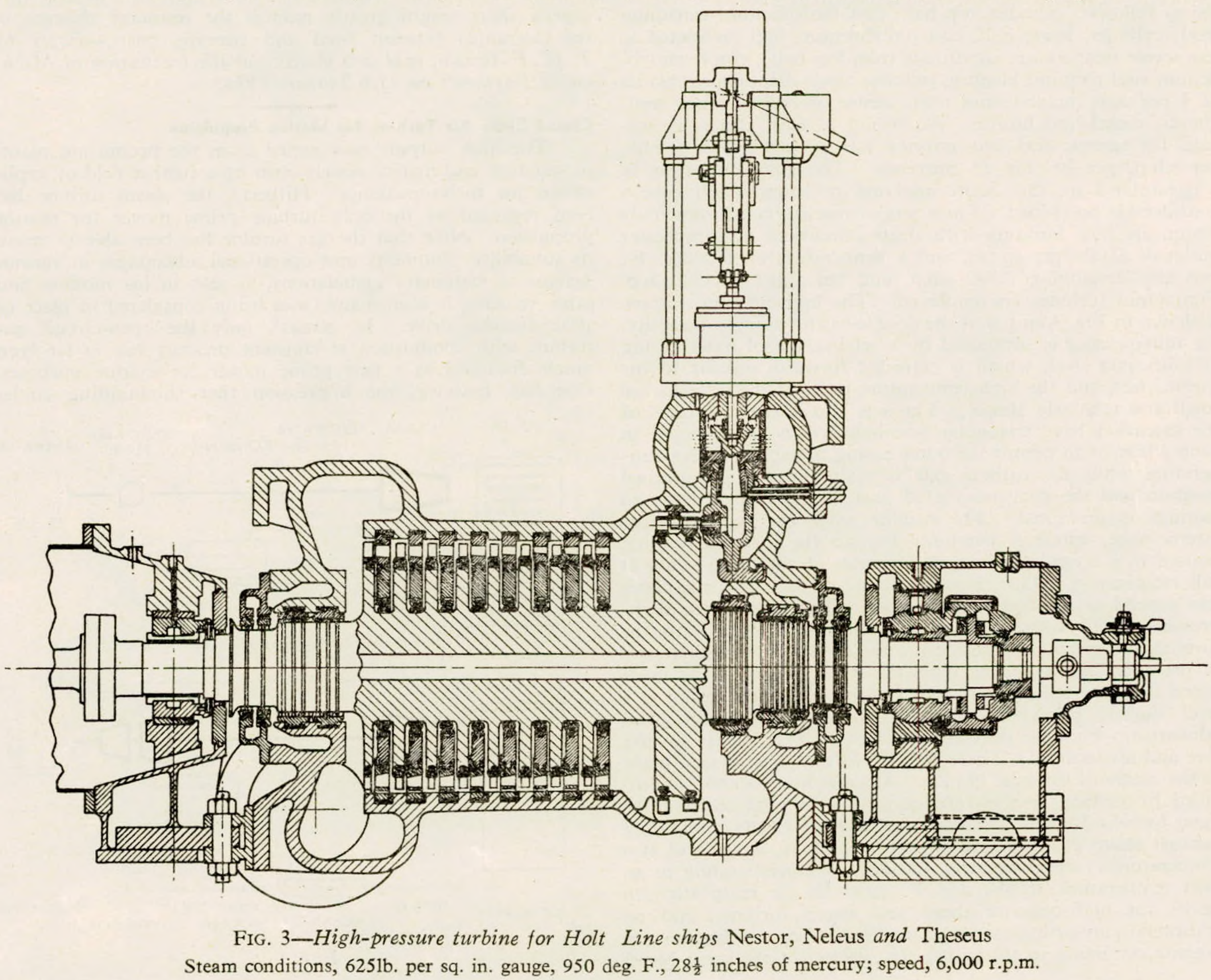


FIG. 3—*High-pressure turbine for Holt Line ships* Nestor, Neleus *and* Theseus

Steam conditions, 625lb. per sq. in. gauge, 950 deg. F., 28½ inches of mercury; speed, 6,000 r.p.m.

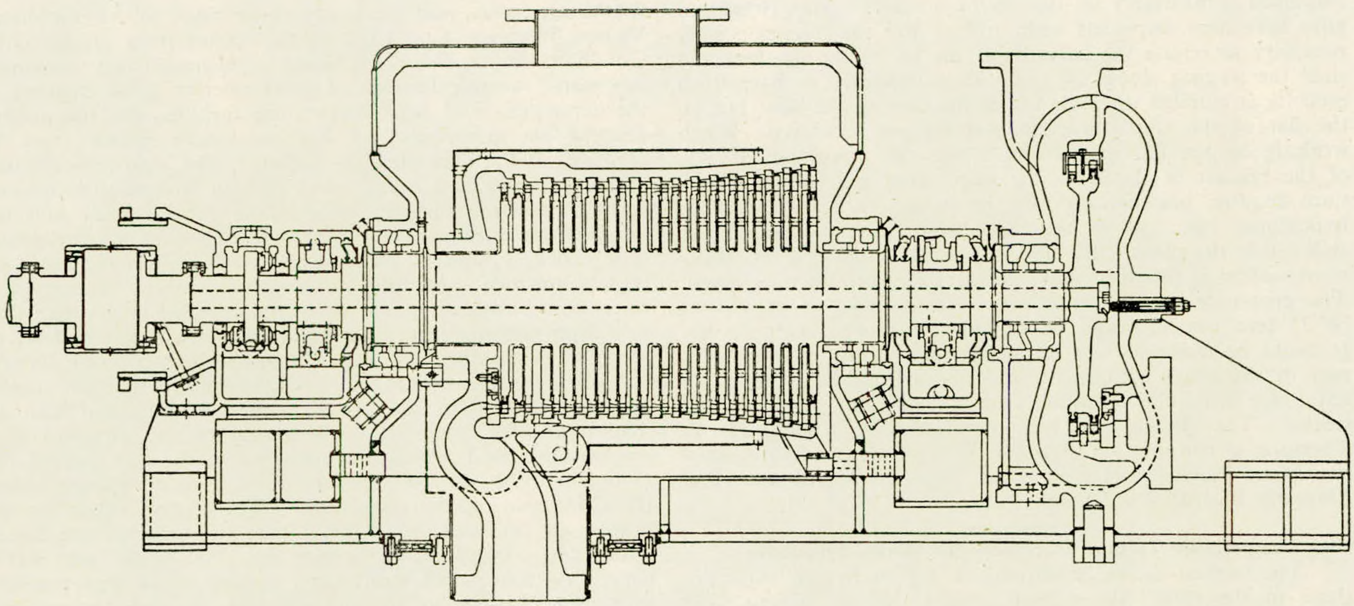


FIG. 4.—*High-pressure turbine for* Pametrada *installation of 12,500 s.h.p.*
Steam conditions, 600lb. per sq. in. gauge, 950 deg. F., 28½ inches of mercury; speed, 3,980 r.p.m.

are as follows: cylinder, top half, cast molybdenum-vanadium steel; cylinder, lower half, cast molybdenum steel (subjected to less severe temperature conditions than top half); rotor, molybdenum steel forging; blading, stainless steel; diaphragms, blades of ½ per cent molybdenum steel; centre of molybdenum steel; glands, nickel-lead bronze. According to Cdr. Baker, in service, the specific fuel consumption has worked out at 0·54lb. per s.h.p. per hr. for all purposes. The company is to be congratulated on this figure applying to ships which have a considerable hotel-load. Three sets of machinery of Pametrada design are now building with steam conditions at superheater outlet of 600lb. per sq. in. and a temperature of 950 deg. F., two sets developing 7,500 s.h.p. and the third 12,500 s.h.p. Compound turbines are employed. The high-pressure turbine is shown in Fig. 4 and is of the double-casing design. Basically, the inner casing is supported by a relatively cool outer casing of fabricated steel, which is extended forward and aft to the turbine feet, and the high-temperature parts of the cylinder are small and relatively simple. The side and bottom portions of the extension have triangular openings which are disposed in such a way as to permit the outer casing to expand under temperature while the turbine axis is maintained in its original position and the transmission of heat to the turbine feet and seatings is prevented. The turbine rotor carries a two-row astern stage, which is overhung beyond the forward bearing, housed in a separate casing, and capable of accepting steam at full temperature. This casing is bolted to the main side-plates and pinned at the bottom centre-line. The inlet to the high-pressure ahead turbine is on the centre-line underneath the turbine, and means are provided to reduce heat flow and stresses in the outer casing arising from the steam supply. The inner barrel is supported on four palms within the outer casing at a level slightly below the plane of the horizontal joint, and athwartship keys are provided in the two after palms to give fore and aft location. These keys are in the same vertical plane as the centre of the inlet branch. Athwartships location is provided by vertical keys on the centre-line at both ends of the inner barrel. By this construction, the outer casing, containing exhaust steam at a pressure of 25lb. per sq. in. gauge and at a temperature of approximately 400 deg. F. corresponding to an inlet temperature of 950 deg. F., provides the main strength girder for high-pressure ahead and astern turbines, and no additional supporting girder is required. For any hogging or sagging occurring in the casing the support of the inner barrel over a short length greatly reduces the resultant changes in the clearances between fixed and running parts.—*Paper by T. W. F. Brown, read at a meeting of the Institution of Mechanical Engineers on 15th January 1954.*

Closed Cycle Air Turbine for Marine Propulsion

The high outputs now aimed at in the propulsion plants of warships and marine vessels open up a further field of application for turbo-machines. Hitherto, the steam turbine has been regarded as the only turbine prime mover for marine propulsion. Now that the gas turbine has been able to prove its suitability, simplicity and operational advantages in various designs of stationary installations, as also in locomotives and other vehicles, it is in many cases being considered in place of steam-turbine drive. In general, only the open-circuit gas turbine with combustion at constant pressure has so far been much discussed as a new prime mover for marine purposes. One has, however, the impression that shipbuilding circles

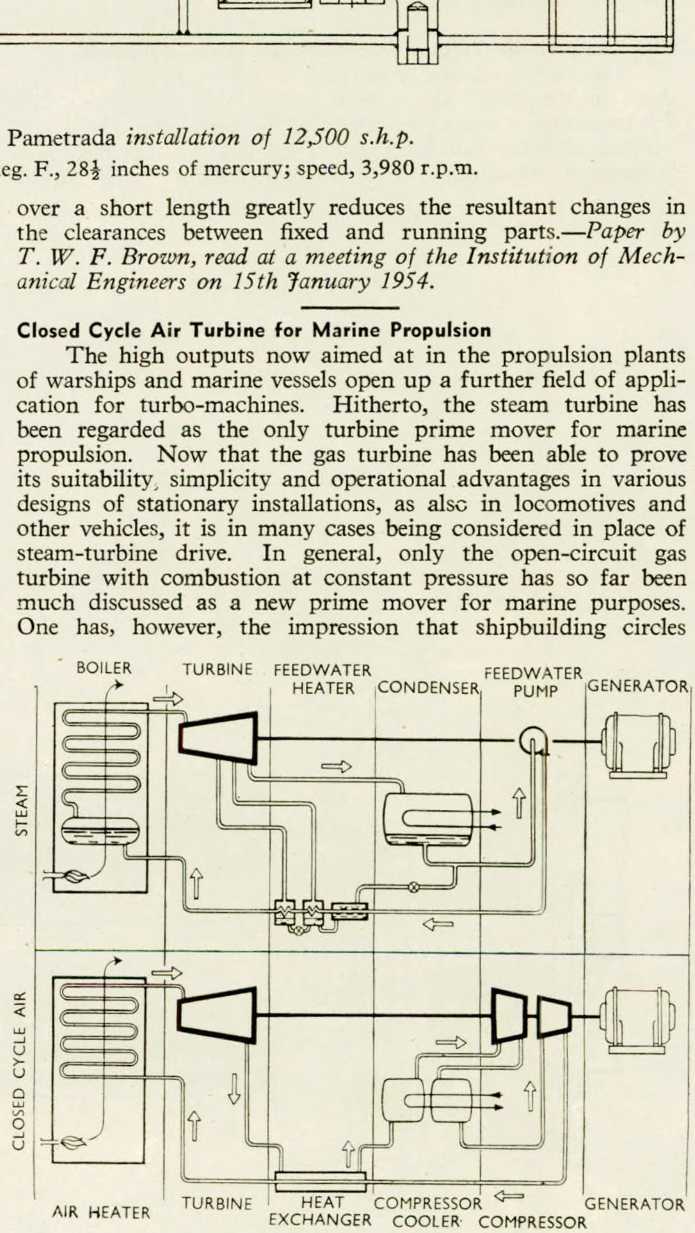


FIG. 1

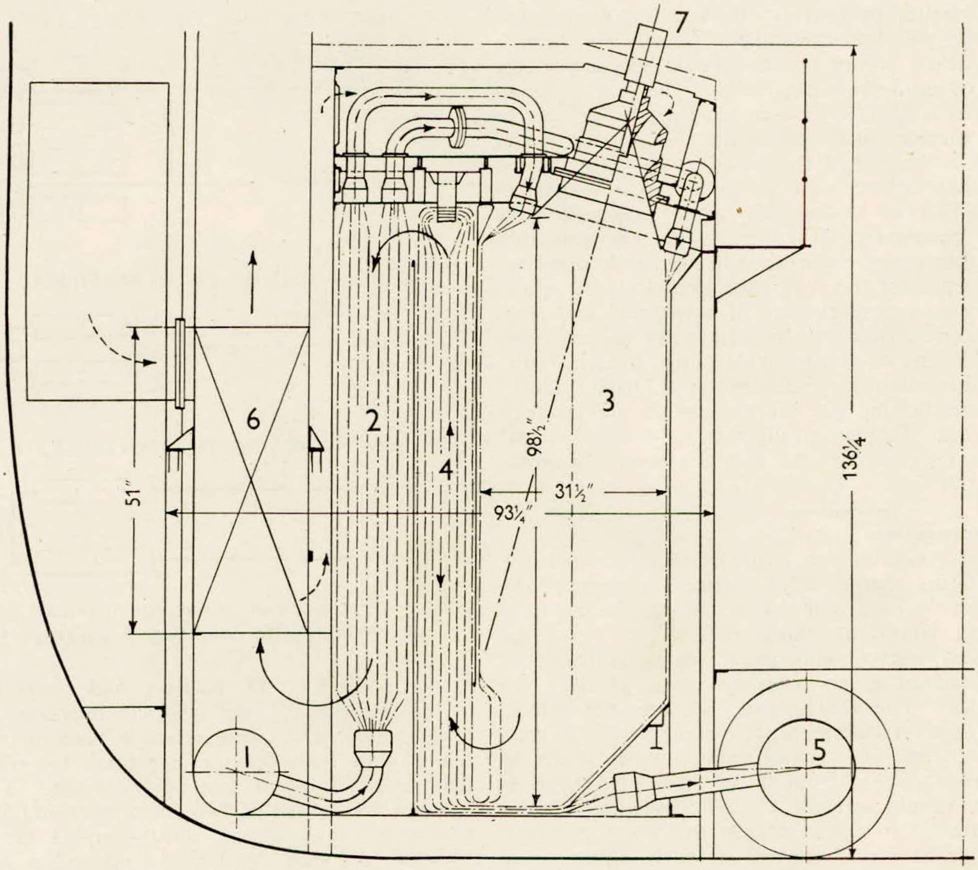


FIG. 4—*Section through an air heater element for a 10-12,000 s.h.p. marine set*

1.—Air inlet. 2.—Circuit air preheater. 3.—Radiation section for primary heating. 4.—Convection section for secondary heating. 5.—Air outlet. 6.—Combustion air preheater. 7.—Burners.

will decide only reluctantly to try out such open-cycle gas turbines. The striking simplicity of their design, which appears at first sight and led to astonishing results within a very short period in the field of aircraft propulsion, only proves to be advantageous for marine use in certain special cases. The fuel consumption of such simple gas turbines is high, especially under changing loads, and so are the requirements as to fuel quality. Moreover, the large outputs that are becoming more and more the rule in modern vessels are difficult to realize with simple propulsion units. The gas turbine employing a closed-cycle of heated air has characteristics which can be utilized with advantage for marine propulsion. Its method of operation has far greater similarity to steam turbines and steam drive than is the case with the combustion gas turbine (Fig. 1). In a closed-cycle installation, air serving as working medium circulates under a pressure above atmospheric and drives the turbine in a similar manner to steam in a steam plant. The working medium (air) is likewise heated from the exterior in an "air boiler", i.e. in the same way as steam. The air heater (air boiler) is, in principle, a simple tubular heat exchanger without drums. Since heating of the gaseous working medium does not lead to any change in its state, such as occurs with steam, whilst forced circulation exists *a priori*, the adoption of small thin-walled tubes (20 to 30 mm. diameter) becomes possible (Fig. 4). Because the temperature of the tube walls lies only 30 deg. to 50 deg. C. above the maximum turbine temperature—as a consequence of the high heat-transmission coefficients brought about by the internal pressure—and the stressing of the material amounts to no more than 1 to 2 kg. per sq. mm. (0·635 to 1·27 tons per sq. in.), very high-quality heat-resisting steels for these heating surfaces do not prove necessary. With materials such as are available on the market, and without special measures, working temperatures in the turbine of 700 deg. to 750 deg. C. (1,292 deg. to 1,382 deg. F.) can be dealt with. There is no danger of explosion in the air heater because no subsequent evaporation occurs as with steam. To attain higher efficiencies, every gas turbine system must provide for heat exchange between the fresh air and the waste heat of the turbine. The design conditions for this decisive part of the plant are particularly favourable for the closed cycle; the air, which is always clean, permits the use of small cross-sections for the passages, with finned surfaces.

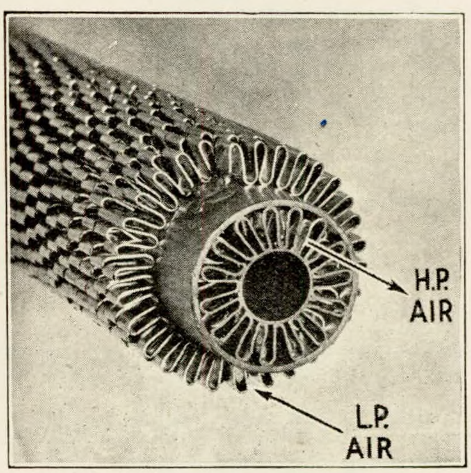


FIG. 5

Since increased pressure prevails on both sides of the heat exchanger surfaces, the heat-transmission coefficients are a multiple of those which prevail at atmospheric pressure on the low-pressure side of open-cycle gas turbines that are traversed by combustion gases. Also, with high recovery factors of the waste heat of the turbine, such heat-exchanging apparatus can be kept very small in the case of the closed-cycle system by the adoption of extended surfaces such as have been developed in recent years on the basis of modern flow theory and knowledge of heat-exchange phenomena (Fig. 5). The characteristics referred to show that closed-cycle air turbines with pressure-level control may represent the only class of machinery which permits the realization in a single unit of both small and large outputs in an economical manner. Especially for marine types with output requirements covering a wide range, it permits the elimination of double installation (for example Diesel engine/gas turbine or steam turbine/gas turbine) which are perforce now adopted for lack of other arrangements.—*C. Keller and W. Spillman, The Oil Engine and Gas Turbine, December 1953; Vol. 21, pp. 317-319.*

Diesel Engine Synchronization

The purpose of synchronizing is to obtain a fixed relative position of two rotating shafts. In a marine Diesel propelled installation this can be of value by removing, or at least reducing, disturbing vibrations which may occur in consequence of unbalanced inertia moments of the crankshafts, or resulting from a disadvantageous relative position of the rotating propeller blades. The De Schelde synchronizer, which has been installed in several ships with various kinds of propulsion, permits the angle of synchronization of the shafts to be set at any desired position from 0 deg. to 360 deg., even during running, by simply turning a small handwheel on the "adjusting differential". It will also keep this angle constant by means of sensitive automatic control of the fuel pumps on both engines (or groups of engines), without changing the position of the fuel-control levers. The different applications of the De Schelde synchronizer shown in Fig. 1 are: (i) Synchronizing of propellers only, as installed in the motor liner *Willem Ruys*; (ii) synchronizing of crankshafts only, as installed in the single-screw motorships *Carbet, Carimare* and *Caraibe* of the French Line. A similar installation was provided for

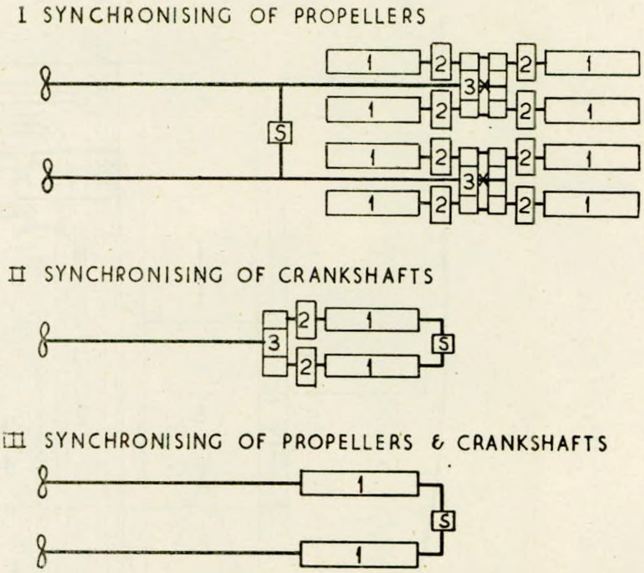


FIG. 1—*Applications of the synchronizer.* 1. *Main engine;* 2. *electro-magnetic coupling;* 3. *gearing;* 4. *synchronizer*

a motorship built by Kaldnes Mek. Verksted, Tonsberg, for Wilh. Wilhelmsen; and (iii) synchronizing of propellers and crankshafts. This arrangement is used in the three motorships which were built for the Argentine Government, and in the new Swedish motor liner *Kungsholm.* The engines in the *Kungsholm* consist of two Burmeister and Wain eight-cylinder two-stroke single-acting direct-coupled crosshead units, type 74 VTF 160, each developing 7,000 b.h.p. at 115 r.p.m. The synchronizer installed in this vessel comprises two main parts, as illustrated in Fig. 2. The first is the hydraulic differential (A) and its driving parts; and the second, the hydraulic coupling rod (B), mounted in the fuel pump control system and operated by the hydraulic differential. The hydraulic differential is an arrangement of two slides rotating one within the other. The outer slide is driven by the port engine and the

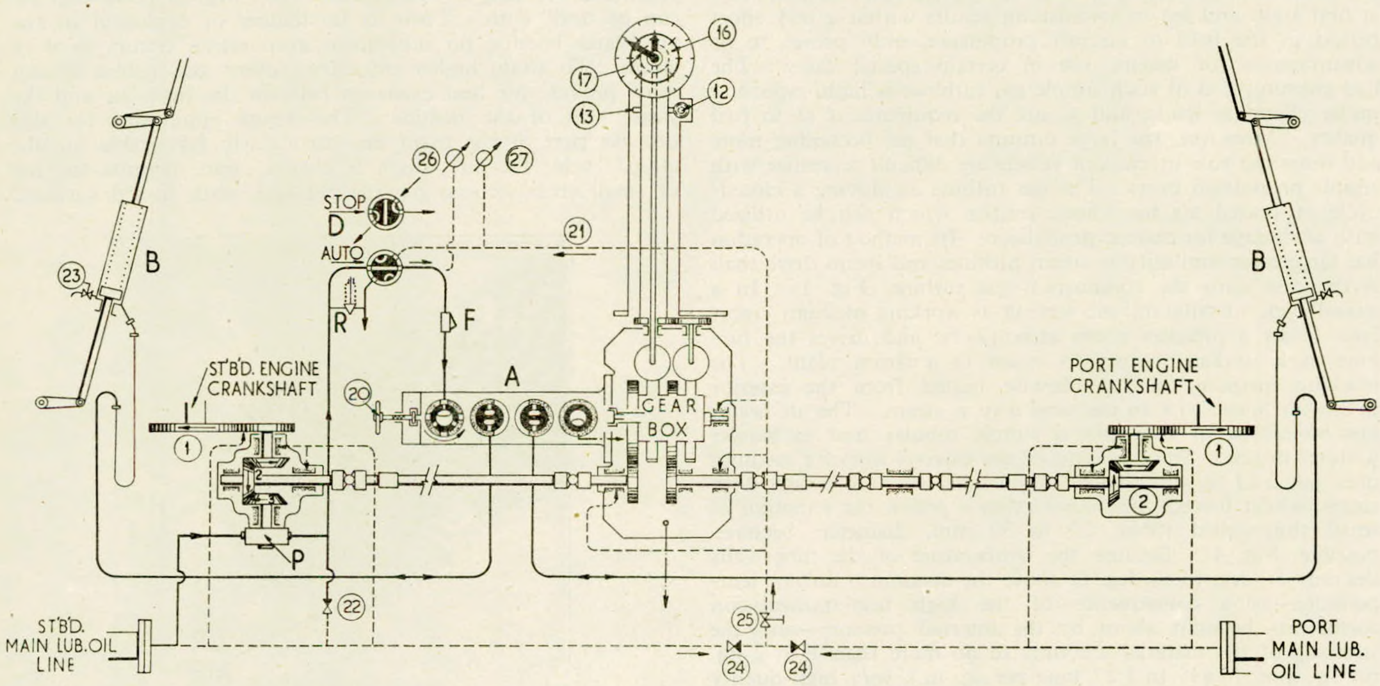


FIG. 2—*General arrangement of hydraulic differential and control*

inner by the starboard engine, each with a transmission ratio of 1 : 1. Both slides rotate in the same direction. If the starboard engine runs with the same r.p.m. as the port engine there will thus be no relative rotation between the two slides, and any relative rotation velocity of the slides is equal to the difference in r.p.m. between the two engines. Ports are milled in both inner and outer slides and, in addition two chambers are drilled in the centre of the inner slide. This divides the hydraulic differential into two parts (Fig. 3). Chamber "A"

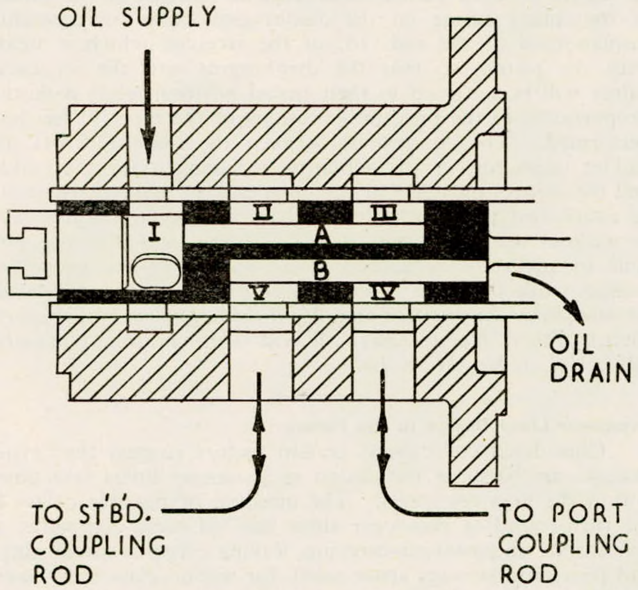


FIG. 3—*Cross-section showing position of ports and slides*

with ports I, II and III forms the oil supply side; and chamber "B" with ports IV and V forms the oil drain side. There is always an open connexion through port I between chamber "A" and the oil supply line, taken from the gear pump. Similarly, chamber "B" is always connected with the oil drain pipe through the synchronizing gearbox. Ports II and V provide the oil supply and oil outlet to and from the hydraulic coupling rod on the starboard engine; ports III and IV provide these for the port engine. The hydraulic coupling rod is connected in the fuel pump control system in place of an ordinary solid rod, and consists of a cylinder, a spring-loaded piston and piston rod. The action of the oil under pressure from the hydraulic differential underneath the piston is counteracted by the spring. When the synchronizer is not working, there will be no oil pressure in the hydraulic coupling rod. The spring holds the piston against the bottom of the cylinder and the coupling rod will then act as a solid connexion. If, however, oil pressure is directed from the hydraulic differential to the coupling rod, the cylinder will be moved downwards, the position of the piston being fixed by the fuel-oil hand-control lever, reducing the capacity of the fuel pumps and slowing down the engine. The stroke of the piston in the cylinders can be adjusted from 0 to 8 mm.—*The Shipping World, 20th January 1954; Vol. 130, pp. 116-118.*

New Tunnel Shaft Coupling

A demonstration was carried out recently, before a number of shipowners and shipyard representatives, on a vessel under construction in the A.G. Weser yard at Seebeck to show a method of tunnel shaft coupling fitting and withdrawal. The demonstration was arranged by Vereinigte Kugellagerfabriken A.G. Schweinfurt, an associate company of the Skefko Ball Bearing Co., Ltd., Luton. This method, which has been developed during recent years by SKF, considerably eases the task of mounting and withdrawing coupling flanges on shafting, and is being used to an increasing extent in many branches of engineering. When applied to ships' tunnel shafts, this method of mounting is used in conjunction with a new design of flanged coupling. Fig. 1 shows a cross-section of this new type of coupling. When mounting, each half coupling is first heated and then placed in position on the shaft where it is allowed to shrink into position. It is withdrawn hydraulically. Several installations of this type of coupling have been carried

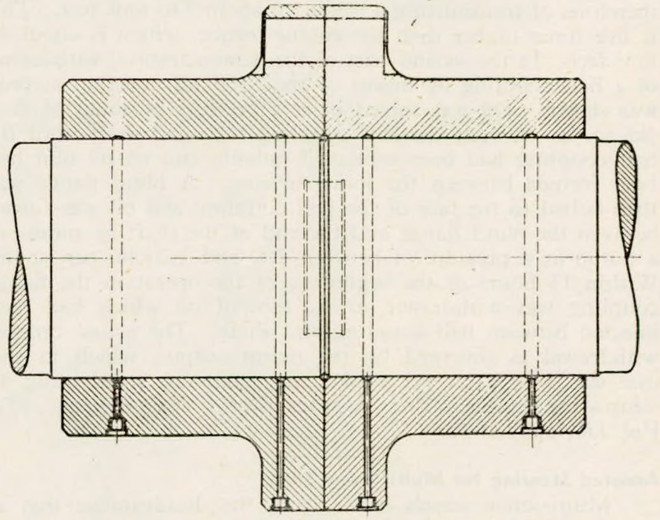


FIG 1—*Cross-section of the new SKF FK type of coupling for ships' tunnel shafts*

out in ocean-going vessels during the past few months, including the *Frisia IV*, built by Jos. L. Meyer, Papenburg-Ems, for A.G. Reederei Norden-Frisia. The *Frisia IV* is a twin-screw vessel in which eight of these couplings have been installed. The shaft diameter of this vessel is 125 mm., and, in conjunction with the flanged couplings, ten SKF spherical roller bearings 23128K mounted on adapter sleeves have also been installed. The demonstration was carried out on No. S.750, a vessel under construction for the Neptune Steamship Company. This vessel is equipped with ten SKF spherical roller bearings on the tunnel shafts and five flanged couplings. Each of the shafts is about 24ft. long. One of the half couplings was first heated by means of the equipment shown in Fig. 2. About 28 kW. was used to raise the temperature of the half coupling (which was of high quality cast steel) to 500 deg. F.—this taking about 1½ hours, the temperature being controlled automatically throughout. After being placed on the shaft the half coupling

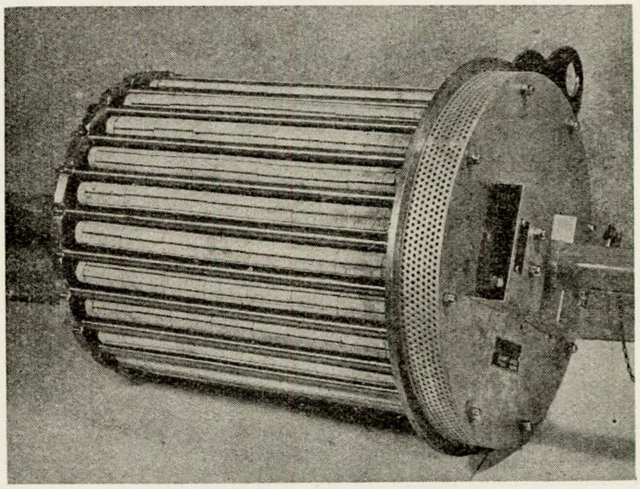


FIG. 2—*Electrical heating unit used to raise the temperature of the half coupling before being fitted to the shaft*

fitted tightly within a few minutes. The following physical values were determined:—

Tensile strength, 42 tons per sq. in.; elastic limit, 27 tons per sq. in.; expansion, 23 per cent.

Germanischer Lloyd requires a minimum expansion of 16·5 per cent, so the shrinkage in excess of this figure was about 0·5 mm. or 0·025 per cent the shaft diameter. The flange is capable, therefore, of transmitting a torque of about 310 tons feet. This is five times higher than the engine torque, which is about 62 tons feet. In the second part of the demonstration, withdrawal of a half coupling by means of the SKF oil injection method was shown. Oil was forced in at a pressure of about 6½ tons per sq. in. between the half coupling bore and shaft until the half coupling had been expanded radially and an oil film had been formed between the joint surfaces. A blind flange was then bolted to the face of the half coupling and oil was forced between the blind flange and the end of the shaft by means of a pump at a pressure of between 700 and 1,200lb. per sq. in. Within 1½ hours of the beginning of the operation the flange coupling was withdrawn on the film of oil which had been injected between half coupling and shaft. The actual time of withdrawal is governed by the pump output, which in this case was 5 to 6 cc. per stroke, the maximum speed being 40 strokes per minute.—*The Shipping World, 20th January 1954, Vol. 130, pp. 122-123.*

Assisted Steering for Multi-screw Ships

Multi-screw vessels suffer from the disadvantage that at slow speeds they are less responsive to changes in the position of the rudder (or rudders) than single-screw ships when the rudder is not acted upon by the propeller slipstreams to any considerable extent. To overcome this disadvantage, the steering is sometimes assisted by controlling the rate of revolutions of the main engines in a twin-screw ship in accordance with the setting of the rudder, and this invention relates to a mechanism through which this contribution to the steering can be attained in a particularly simple way in ships in which each engine possesses a control lever which pivots over a stationary toothed sector arc. The arrangement shown in Fig. 1 functions in the

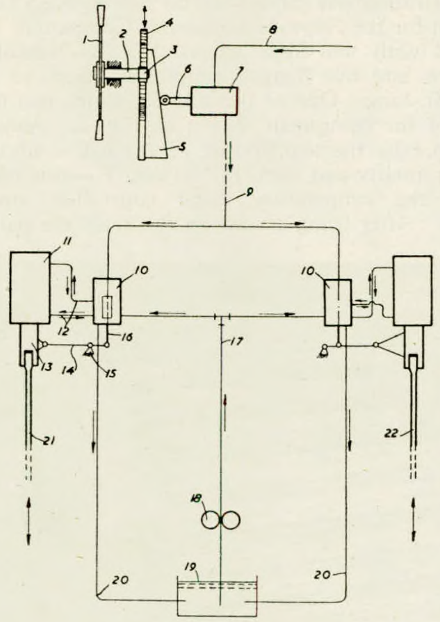


FIG. 1

following way. Turning the steering wheel (1) moves a rack (4) which in turn causes a displacement of a rod (6). This produces, say, an increase in the hydraulic pressure in a pipe (9), so that the diaphragms in both of two receivers (10) will be pressed down, thus allowing the supply of pressure oil to the upper of the pipes (12), and the draining of oil from the lower pipes to the drain pipes (20). The piston in the servo motor located to the left will thus move downwards, and through the control rod (21) will cause, say, an increase of the output of the port engine, while the piston in the starboard servo motor will move upwards, since the connexion pipes (12) between the receiver and the starboard servo motor cylinder are crossed, causing a corresponding reduction or increase of the output of the starboard engine. In each case the motion of the servo motor pistons will cause an increase of the tension of the spring acting on the diaphragms, by a corresponding displacement of the rod (16) of the receiver, which is linked with the piston, so that the diaphragms and the associated valves will be returned to their initial position when a motion proportional to the pressure variations in the pipe (9) has been performed. The connexions between the steering wheel, the rudder telemotor, or the actuating mechanism for the rudder and the control members of the main engines may, alternatively, be established pneumatically, mechanically or electrically, with or without the application of servo devices, and it is also possible to affect the regulation solely on one of the propelling engines while the other is set for a constant output.—*Patentees: Aktieselskabet Burmeister and Wain's Maskin-og Skibsbyggeri. British Patent No. 693,661. World Shipbuilding, November 1953; Vol. 3, No. 11, p. 160.*

Passenger Liner Design in the Future

Considered collectively, certain factors suggest that major changes are likely in the design of passenger liners laid down within the next few years. The question of possible delays in the turn-round of passenger ships has led some companies to concentrate on passenger-carrying, leaving cargo to special ships, and providing stowage space solely for second-class mail-carrying, baggage and motor cars. A tendency, and sometimes from a design point of view, a temptation to include refrigerating is waning. Space aft in any ship is limited, particularly if twin propellers are fitted. In passenger liners the decks above the waterline at the stern are frequently used for crew accommodation, and as they ascend to the superstructure the space is employed for open-air swimming pools and lido decks. This is denied, unless a very special arrangement is adopted, to the ship with machinery aft. There is, of course, the alternative of dividing the uptakes and running one up each side of the ship after the manner of a whale factory. Numerous arguments have been advanced against this in the past. As regards machinery details, an unorthodox conception can be accepted. Examination of the French Mediterranean vessel *El Djezair* reveals that her boilers are above and abaft the turbines; the latter are comparatively well forward, being, in effect, a little over 75 per cent of the total length of the ship from the bows. This ship is relatively modest in her power requirements, having well under 10,000 h.p. on twin screws. Any other form of propulsion needs a similar vertical disposition. For limited power output on a single propeller, such as might be required in some small passenger ships, multi-engine systems offer many advantages. For powers of, say, 20,000 h.p. on twin screws and above, geared Diesel equipment would involve complication of drive. If, therefore, advantage is to be taken of the low fuel consumption of the oil engine, there is no alternative to Diesel-electric drive. If the latter is considered suitable, then it would seem that provision should be made for the largest numbers of generators of small size and light weight, and that these generators should be so arranged as to supply the auxiliary load as well as the main load. Such an arrangement, if it were possible to flout the tonnage measurement regulations, could be built with minimum uptakes, the silencers arranged within the hull, only groups of exhaust pipes being led up to the open air. The "funnel" need not take on the usual appearance, but could be disguised in the structure of the ship. It is possible to visualize a triple-deck engine room, with the generators arranged in one 'tween deck and the motors of small size, geared in pairs or fours to each of the propellers with as short a shaft as structure, vibration and other considerations will permit.—*A. C. Hardy, The Journal of Commerce, Shipbuilding and Engineering Edition, 31st December 1953; No. 39,255, p. 5.*

Welding of Ductile Cast Iron

"Ductile Iron" is a relatively new engineering material which combines the castability and machinability of grey cast iron and the mechanical properties of cast steel to a remarkable degree. The material, sometimes referred to as "spheroidal-graphite cast iron", or "magnesium-containing cast iron" is characterized by a structure in which graphite is present as spheroids instead of the flake form found in grey cast iron. It is this structural feature which accounts largely for the unique characteristics of spheroidal-graphite cast iron. In many of the fields of application of spheroidal-graphite cast iron, weldability is an important consideration. With the increasingly wide acceptance of ductile iron, the need for more information on its response to welding as a means of fabrication, repair and salvage has become progressively greater. The authors review the response of ductile iron to a number of arc-welding methods, including the metal arc, the inert-gas-shielded arc and the submerged-arc welding processes. Although not included in the scope of the present discussion, which relates to arc-welding, reference should be made to the oxy-acetylene welding process. This method, employing cast ductile iron filler rod, is being used successfully by several foundries to weld ductile iron castings. On the basis of the present study, a few broad generalizations seem justified:—1. Ductile iron can be welded by most of the commonly employed fusion welding processes. 2. Ductile iron should be welded in the fully annealed condition for maximum welding response although it can be welded successfully in the as-cast condition with suitable selection of casting composition and joining process and procedure. 3. The lower the levels of those alloying elements in the casting composition which increase weld hardenability, the better is the welding response and the less important is the need for preheat. 4. Phosphorus has an adverse effect on weldability. A 0·10 per cent maximum is permissible when welding with nickel-iron electrodes or filler wire. A 0·05 per cent maximum should be observed if mild steel electrodes are employed. The following nominal composition responded well to welding using several processes: 3·60 TC, 2·40 Si, 0·30 Mn, 0·70 Ni, $<$ 0·05 P, 0·05-0·08 Mg. 6. Metal arc welding with austenitic nickel-iron electrodes has been applied successfully to a fairly broad range of casting compositions in both the as-cast and annealed conditions, with and without preheat. 7. Inert arc welding with austenitic nickel-iron filler wire offers promise. Joints in ductile iron cast plate of preferred composition, welded in both the as-cast and annealed conditions were readily made in plate thicknesses up to 1 inch. 8. Ductile iron may be joined to such dissimilar metals as mild steel, stainless steel, nickel, Monel and Inconel with austenitic nickel-iron electrodes. 9. One of the above joint combinations, ductile iron-to-mild steel, is frequently encountered in field applications. The joint is readily made and, in general, offers fewer hazards with respect to fusion line racking than those in which ductile iron comprises both members of the weldment. 10. Where machinability is a prime requisite, arc-welded joints should be fully annealed after welding (1,650 + 1,275 deg. F. treatment). 11. In the as-welded condition, joints on annealed plate are less troublesome to machine than those on as-cast plate. 12. Considerable improvement in the machining response of as-welded joints in castings of preferred composition for welding can be accomplished by special welding techniques and by brief torch annealing treatments, though machinability will be inferior to that of fully annealed joints. 13. A 1,275 deg. F. post-weld heat treatment (without the 1,650 deg. F. prior treatment) may provide an adequate improvement in machining response for some purposes. 14. Tungsten carbide tipped tools offer substantial advantages over tool steel bits where a hard heat-affected zone exists. 15. Low hydrogen-type mild steel electrodes hold some promise for joining ductile iron, provided a low-alloy, low-phosphorus casting composition is used and the castings are welded in the fully annealed condition. 16. Submerged arc studies were confined to joining of ductile iron to mild steel. The process may be useful for special applications but its field appears limited on the basis of present knowledge.—*T. E. Kihlgren and H. C. Waugh, The Welding Journal, October 1953; Vol. 32, pp. 947-956.*

Design and Operation of Air Heaters

According to the authors of this paper, air preheating has become the most widely accepted method of recovering heat from flue gases of high-efficiency steam-generating units. The drive to further reduce stack losses and increase overall efficiencies continues. The regenerative air preheater possesses unique characteristics which contribute to its ability to achieve maximum reduction in stack losses while permitting continuous operation over long periods. The paper deals with those features of the regenerative air preheater which are inherent in this type of heater which is created expressly for the purpose of realizing high efficiency co-existent with high availability. The purpose of Part I of this paper is to broaden understanding of the regenerative-type air preheater which continues to be one of the most effective means at the disposal of the designer in his striving for higher efficiency of steam generation. Part II of this paper is devoted to the operation of high-recovery regenerative-type air preheaters from the standpoint of removing deposits and controlling metal temperatures. Emphasis is placed on several requirements for an effective removal of deposits by blowing steam or air and washing with treated water. Attention is directed to the need for a dry-cleaning medium which has stimulated interest in the use of superheated steam and compressed air. The washing procedure currently recommended assures a higher degree of deposit removal with better protection from acid action. Alkalized or treated water, instead of raw water, accelerates the washing operation and produces a more thorough job. The control of metal temperature is discussed from several possible arrangements and combinations. The comparison is made of corresponding features and their effect on the operation and efficiency of the plant. The paper is intended to disclose more clearly the current practices and trends rather than establish new conclusions. The intense interest in supporting higher recovery and attaining a higher degree of availability in the face of a deteriorating fuel situation and mounting fuel and labour costs forces attention to control of deposits and corrosion, and the conditions contributing to their presence in the air preheater.—*Paper by G. D. Braddon (Part I), and J. Waitkus (Part II), read at the 1953 A.S.M.E. Autumn Meeting. Paper No. 53-F-22.*

Propeller Cavitation

This paper discusses the new King's College Cavitation Tunnel and gives the results of tests on propellers of moderately high blade-area ratio and also on a series of merchant ship propellers having different types of blade sections. Some observations on the singing of propellers are also given, based on experiments made in the tunnel and the paper concludes with a discussion on the use of the cavitation tunnel in studying ship propellers.—*Paper by L. C. Burrill and A. Emerson, read at a meeting of the North-East Coast Institution of Engineers and Shipbuilders, 13th November 1953.*

Transition Temperatures of Structural Steel Beams with Butt-welded Splices

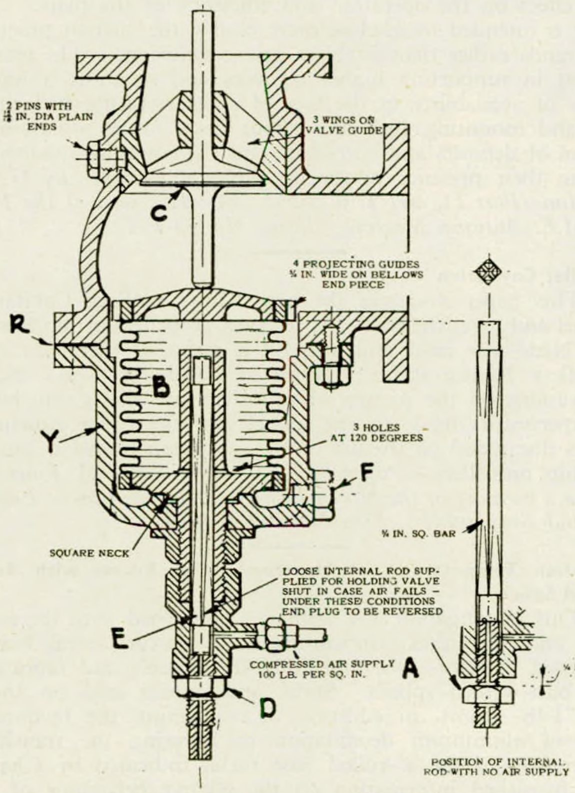
This investigation was primarily concerned with the resistance and transition temperatures of structural steel beams, composed of semi-killed and fully-killed steels and fabricated with butt-welded splices. Static and impact tests on 16-in. WF 71-lb. beams, in addition to confirming the favourable effect of aluminium deoxidation in lowering the transition temperature of the as-rolled base metal indicated by Charpy tests, furnished information on the relative behaviour of the two grades of steel with splices as-welded, welded and "stress-relieved" and when welded with preheat. The influence of these treatments was evaluated by increment drop impact tests on beams welded with E6011 and E6020 electrodes. Similar supplementary tests on beams composed of both steels when welded with low-hydrogen electrodes as-welded and with pre-heat, furnish comparative data. Other data deals with the character of fracture and the effect of flame-cut holes in the beam web. The influence of a sharp notch at a critical location in an unwelded beam and the tendency of crack propagation are indicated by the results of supplementary tests. This investigation was conducted by the Civil Engineering Research Laboratories of Columbia University, New York, under the joint sponsorship of the Office of Naval Research and the Welding Research Council of the Engineering Foundation, under direct supervision of the Structural Steel Research Committee of the Welding Research Council.—*W. J. Krefeld, and G. B. Anderson, The Welding Journal, November 1953; Vol. 32, pp. 538-s - 576-s.*

General Purpose Tanker

The Shell general purpose tanker *Helix*, recently delivered by the Wallsend yard of Swan Hunter and Wigham Richardson, Ltd., is the first of the turbo-electric type to be completed. She has been built to receive the highest classification of Lloyd's Register of Shipping and has principal particulars as follows:—

Length overall	557 feet 0 inches
Length between perpendiculars	530 feet 0 inches
Moulded breadth ...	69 feet 3 inches
Moulded depth... ...	39 feet 0 inches
Loaded draught ...	29 feet 8⅝ inches
Deadweight capacity ...	17,780 tons
Gross tonnage	12,089 tons

The hull form has resulted from model tests carried out at the Teddington tank of the National Physical Laboratory. The longitudinal system of framing is employed on the bottom and on the deck over the extent of the cargo tanks, with transverse frames at the sides in the wing tanks. Normal transverse framing is used at the ends of the ship. Practically the whole of the steel structure is welded in accordance with the builders' normal practice. A special painting technique was used on the *Helix*. This involved firstly, flame-cleaning the hull plating by means of oxy-acetylene burners and subsequent application of the full number of coats of bituminous and oleo-resinous paints and anti-fouling before launching. The primary coat was applied while the plates were warm, thus the vessel received the benefit of complete protection from the instant she entered the water. Fuel bunker tanks are provided forward and aft of the main tanks, and also in the engine room double bottoms. A dry cargo hold above the forward fuel bunker tanks is fitted for carrying case cargo. Improved pumping capacity is a feature of the new ship, and four 400 tons per hour, 12in. two-stage vertical-spindle 2,000 r.p.m. split-casing Drysdale pumps are installed in the main pump room aft. These are driven by Weir 10,100 r.p.m. geared turbines situated on a flat in the engine room 18 feet above the keel, thus reducing risk of petroleum entering the engine room in the event of partial flooding of the pump room. The vertical drive is by cardan-shaft with Hardy-Spicer universal joints. This arrangement saves floor space and at the same time enables the use of a frictionless gas-sealing gland to separate the pump room and engine room. The explosion hazard of an overheated packed gland is, therefore, eliminated. Another interesting feature is the use of cargo pump relief valves loaded by compressed air instead of springs which, in addition to relieving excess pressure, are used to control the output of the pumps between zero and maximum. Known as the Lightning valve, it was developed by Trewent and Proctor, Ltd. A detailed drawing is given from which the action of the valve can be seen. Up to 20 turns of the handwheel were necessary to operate the conventional bypass valves hitherto used when starting up. The pump can then be controlled rapidly with the least effort.—*The Marine Engineer and Naval Architect, January 1954; Vol. 77, pp. 24-28.*



Details of the 5-in. Lightning air-operated relief valve

Accelerated Oxidation of Metals Due to Vanadium

The anticipated increase in the use of crude fuel oils containing vanadium in high temperature installations has initiated further experimentation concerning the nature of accelerated oxidation caused by the action of certain oxides of the metals V, Mo, and W on heat resistant alloys at elevated temperatures. The effect of additions of various refractory metal oxides on the physical and corrosive nature of a vanadium oil ash has been investigated to determine the possibility of oxide additives as a method of preventing accelerated oxidation. Oxidation tests were also conducted to determine the effect of some of the major constituents of oil ashes on accelerated oxidation. Since a solution to the problem of accelerated oxidation may be best accomplished through a knowledge of the oxidation mechanism, chemical analysis and X-ray diffraction studies were conducted on the oxide scale formed during the accelerated oxidation of Type 347 stainless steel in contact with liquid V_2O_5. The metal-oxide interface was found to have the highest level of oxidation and the highest vanadium concentration. Also at this interface, X-ray diffraction evidence was found for a vanadium-oxygen-metal compound having the formula MVO_4. —*F. C. Monkman and N. J. Grant, Corrosion, December 1953; Vol. 9, pp. 460-466.*

Influence of Thermal Effects on Manœuvrability of Marine Turbine Machinery

This paper discusses the peculiar requirements of modern turbine machinery during manœuvring, when changes of temperature raise problems. The phenomena which occur during various manœuvres are described. Means are discussed by which the manœuvrability of marine steam turbine machinery may be improved. Although the paper deals mainly with the problem in relation to steam turbines, reference is also made to the gas turbine.—*Paper by B. J. Terrell, read at a meeting of the North-East Coast Institution of Engineers and Shipbuilders, Newcastle upon Tyne, 6th November 1953.*