ENGINEERING ABSTRACTS

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World Progress in Gas Turbine Design

This article lists more than ninety constant-pressure non-aircraft gas turbines which today are either completed, building, or in the design stage in a number of countries outside the Russian-controlled area of the world. The list enumerating gas turbine construction in this country includes one 1,000 kW. Allen-Bristol unit for the Admiralty of the open-cycle type, having two rotors, in stage of development; one 1,200 h.p. marine propulsion set (electric drive) of the open-cycle type, having two rotors, being built by British Thomson-Houston for the tanker *Auris* of the Anglo-Saxon Petroleum Co., Ltd.; one 6,000 s.h.p. open-cycle marine propulsion unit under construction by English Electric Co., Ltd. for the Admiralty, for a "Captains" class frigate; one 2,500 s.h.p. Metropolitan-Vickers marine unit under test for the Admiralty; one 3,500 s.h.p. marine experimental turbine by Pametrada under test at the Pametrada establishment, Wallsend-on-Tyne; and one Rolls-Royce turbine under construction for the Admiralty, for gunboat *Grey Goose*. The list for Switzerland includes one 7,500 b.h.p. experimental marine turbine of the semi-closed cycle type in operation in the works of Sulzer Bros., Winterthur. In the United States a 750 b.h.p. experimental marine gas turbine is being tested by the De Laval Co., while the Elliott Co. is reputed to have three 3,000 b.h.p. units of the open-cycle type under construction, two of these units to the order of the U.S. Navy and one unit for the U.S. Maritime Commission. The same firm completed tests on a 2,379 b.h.p. unit for the U.S. Bureau of Ships. The list for France gives a 3,900 s.h.p. marine propulsion unit by the Rateau concern under construction for Ateliers et Chantiers de Bretagne; two 800 h.p. marine propulsion units being designed by S.E.M.E.-S.I.G.M.A. for the French Merchant Marine; and one 3,500 s.h.p. marine propulsion unit by Turboméca under construction.—*The Oil Engine and Gas Turbine, Vol. 17, March 1950, pp. 396-401.*

Relative Corrosion Behaviour of Different Sea-waters

Experience accumulated over many years has shown that the corrosive attack of sea-waters on copper-base alloys varies considerably because of factors inherent in the sea-waters that are not easily revealed by ordinary chemical tests. The corrosive nature of a sea-water varies with the season of the year and also with the time during which the sample is stored before use. These variations in the corrosiveness of different samples make it very desirable that some indication should be given of the corrosiveness of the sea-waters when comparing corrosion experiments carried out in this medium. In view of this a simple test, known as the Copper Corrosion Index determination (C.C.I.), has been developed to gauge the corrosiveness of any particular sample of sea-water. It consists in immersing a piece of copper sheet of given area in the sample of sea-water and estimating the amount of copper dissolved in 22 hours under standard conditions. The paper describes in detail the technique of the test, its use for estimating variations in the corrosiveness of sea-waters, and its value in accounting for lack of reproducibility in sea-water corrosion tests on copper-base alloys.—*T. H. Rogers, The Journal of the Institute of Metals, Vol. 76, February 1950, pp. 597-611.*

French Naval Gas Turbine

In a survey of gas turbine trends the author makes brief reference to a 3,500 h.p. gas turbine now under construction at the works of the Société Turbomeca for installation in a

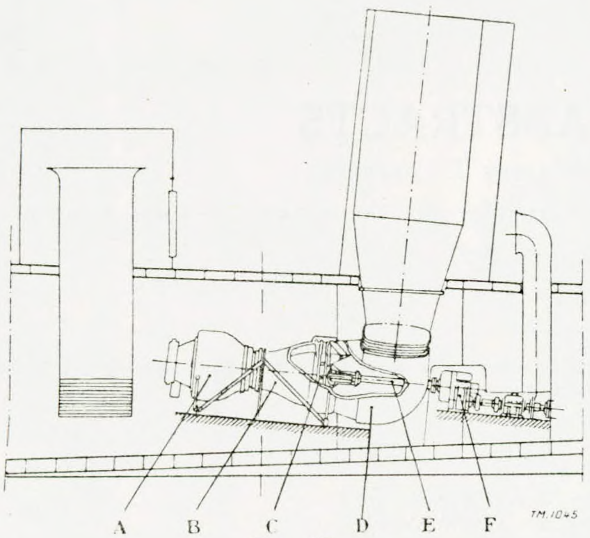


FIG. 17.

(A) Gas generator. (D) Discharge.
(B) Diffuser. (E) Shaft.
(C) Gas turbine (power turbine). (F) Reduction gear.

French naval craft. This turbine is supplementary to a Diesel engine which will cover the propulsive requirements at cruising speed.—*J. Szydlowski, La Technique Moderne, Vol 42, March 1950, pp. 80-88.*

Cementiferous Paints

In this paper the development of cementiferous paints based on the reaction between zinc dust and certain phosphate solutions is described. The paints dry by the formation of a zinc phosphate cement, and sufficient metallic zinc is left to afford cathodic protection to steel. The paints based on di-potassium and tri-potassium phosphate solutions dry at both high and low humidities. Laboratory tests, by immersion in natural sea water, indicate that they are superior to the earlier types of cementiferous paints based on chlorides, when applied to both pickled and rusty surfaces, as the zinc dust has a longer effective life. The paints are cheap and easy to prepare, but although they have an appreciable storage life, it is recommended that they should be used within a few hours of mixing. —J. E. O. Mayne. *Journal of The Iron and Steel Institute, Vol. 164, March 1950, pp. 289-293.*

Anti-fouling Paints

The role played by pigment particle size in the performance of toxic paints is discussed by A. L. Alexander, J. B. Ballentine and M. O. Yeiher in an article in "Industrial and Engineering Chemistry". Standard pigment samples classified into fractions of measured particle size were incorporated into a standard anti-fouling matrix and two slightly varied vehicles, and examined in an attempt to establish the precise effect of particle size on performance. Only initial leaching-rate values appear to be enhanced by predominating small particles of toxic pigment, the steady-state leaching rate remaining unaffected in a given matrix, regardless of particle size. In anti-fouling paints prepared from rosin and its derivatives larger pigments seem to reinforce the physical stability of the film much more effectively than extremely small particles; when, however, organic tougheners are added for the purpose of strengthening the film, the influence of pigment particle size becomes less significant as a stabilizer of film integrity.—*Metallurgical Abstracts, Institute of Metals, Vol. 17, February 1950, Part 6, p. 449.*

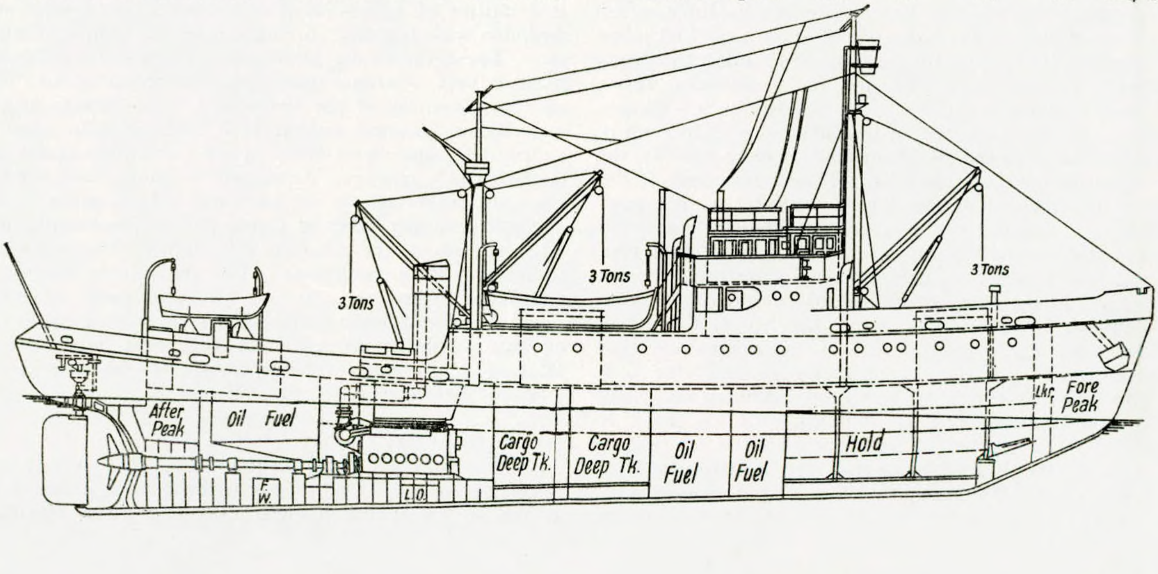
Treatment of Burns Due to Steam, by Aluminium

In an article by M. Tardy, published in *Bull. Ass. Franc. Proprietaires Appareils à Vapeur*, the advantages of using aluminium for treatment of burns are discussed. Using aluminium foil 1/10 mm. or even 2/100 mm. thick and of 99·99 per cent purity, it has been found that: all burns can be treated by aluminium; speed of healing is increased by one-third over other methods; there is no contraction of the scar; the action of aluminium appears to be electro-chemical; the thickness of metal is important only because it affects the degree of contact with the wound. The use of aluminium in powdered form has still to be investigated.—*Abstract No. 5,067, Fuel Abstracts, Vol. 6, December 1949, p. 90.*

Motor Sealer *Norsel*

In the construction of the Norwegian single-screw Diesel engined sealer *Norsel* the uncompleted hull of a steam tug intended for operation in the Baltic was used. At present the vessel is on charter for the transport of the Norwegian-British Antarctic Expedition. This is a duty for which the *Norsel* is particularly suited, being small and handy, comparatively highly powered, heavily reinforced for navigation in ice, and possessing recessed anchors. Having an exceptionally large range of action for such a small vessel, she was able to sail from London to Capetown non-stop. By using her cargo deep tanks for stowage of oil fuel, the *Norsel* can travel for three months at 12 knots. The principal particulars of this vessel, which was converted by the Flensburger Schiffbau Gesellschaft to the requirements of the Norske Veritas, are as follows:—

Length overall	152ft. 6in.
Length between perpendiculars ...	137ft. 0in.
Breadth	27ft. 6in.
Depth to main deck	13ft. 3in.
Net tonnage	252 tons
Gross tonnage	592 tons
Service speed	12¼ knots



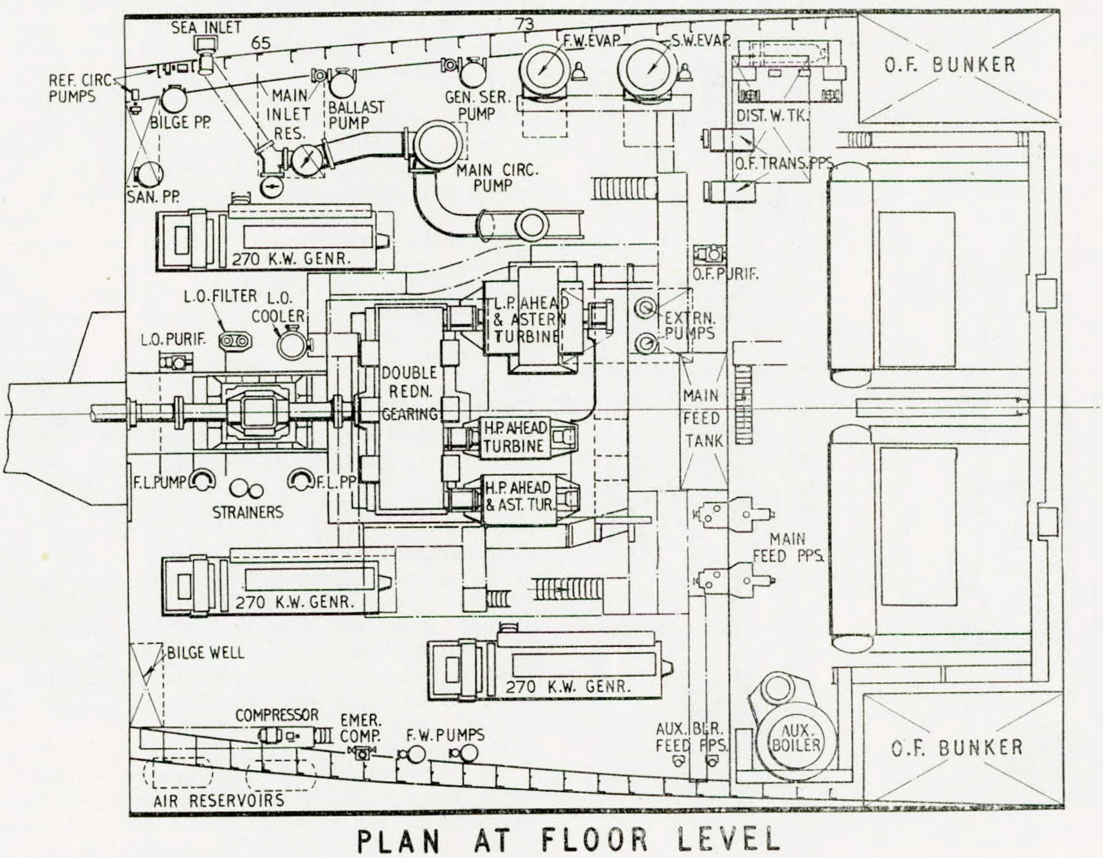
As will be seen from the accompanying sectional elevation of the ship, the main engine has been installed in the position which would have been occupied by the steam engine originally intended for her while the former boiler space has been used for cargo deep tanks. The main engine is a six-cylinder, four-valve-per-head, turbo-charged, four-stroke M.A.N. engine and is designed by its makers M6V 40/46 KBB type. This is the engine which was originally chosen by the Germans as the standard propulsion unit for the type XXI U-boats which were just coming into quantity production at the end of the recent war. The engine fitted in the *Norsel* is considerably derated from the designed output of 2,000 b.h.p. at 520 r.p.m. (143lb. per sq. in. b.m.e.p. and 908ft. per min. mean piston speed). The Brown Boveri (Mannheim) turbo-blower, type VTa 450, is fitted with two gas inlets and has a maximum continuous duty of 168 cu. metres of air per minute at 12,500 r.p.m. and maximum working temperature of 625 deg. C. (1,155 deg. F.). Between the engine and the flywheel, two chain drives, with clutches, are taken out to an 11 kW. generator and an air compressor arranged to port and starboard of the Deutsche Werfte thrust block respectively. Some details of the main engine are given in an appendix to the article.—*The Marine Engineer and Naval Architect, Vol. 73, February 1950, pp. 61-67.*

Turbine Steamship *Clan Shaw*

The first of a series of three single-screw turbine vessels on order for the Clan Line Steamers, Ltd., the 8,700 tons gross *Clan Shaw* has completed trials and has been accepted by the owners. Built by the Greenock Dockyard Co., Ltd., the *Clan Shaw* is of the complete superstructure type with tonnage opening, and having poop, bridge, and forecastle superstructures. The main dimensions of this vessel are as follows: length o.a. 512ft. 4in., length b.p. 476ft., breadth moulded 66 feet, depth moulded 40ft. 8in., load draught 28 feet, tonnage d.w. 10,700 tons, tonnage gross 8,700 tons. The propelling machinery constructed by the Parsons Marine Steam Turbine Co., Ltd., and installed by John G. Kincaid and Co., Ltd., consists of double reduction geared turbines of the latest Parsons type developing 9,400 s.h.p. with propeller revolutions of 108 per minute, but capable of developing 10,340 s.h.p. The main propelling machinery has been designed to operate with steam of 450lb. per sq. in. and 750 deg. F. and consists of three turbines working in series, h.p., i.p. and l.p. running at 4,200, 4,200, and 2,500 r.p.m. respectively. The turbines are of all-reaction type for ahead duty. For astern working an h.p. astern turbine consisting of an impulse wheel is incorporated with the i.p. turbine and separated from the ahead portion by a diaphragm. The gearing is of the double reduction interleaved type, the turbines, each through a flexible coupling, driving separate pinions which engage with separate primary wheels. The main condenser is of the Parsons two-flow regenerative type arranged under the l.p. turbine and has a cooling surface of 7,540 sq. ft. It is capable of maintaining a vacuum of 28½ inch with 30 inch barometer and sea temperature of 70 deg. F. when the turbines are developing full power. Steam is supplied by two Babcock and Wilcox marine type single-pass water-tube boilers.—*The Shipping World, Vol. 122, 25th January 1950, pp. 126-127.*

Self-priming Marine Pumps

Wherever the water flows to the pumps under pressure, which is usually the case, for instance, with circulating pumps, the normal design can be used. But where this positive inflow is replaced either permanently or temporarily by a suction head, reliability in service can only be ensured by a self-priming pump. The advantage of this type is that the pump and the suction pipe connected to it are automatically free of air not only during starting-up but also during service, when the failure of the pumps on account of the entry of air is precluded. Such troubles are particularly frequent in marine service, since the movements of the vessel may easily cause a disturbance of the suction liquid sufficient to uncover the opening of the suction pipe. A special advantage of the designs described is that any of the pumps can be made self-priming by the addition of a water-ring air pump. As can be seen in the



PLAN AT FLOOR LEVEL

section of a two-stage marine in Fig. 49, the impeller of the water-ring pump is driven by the bottom end of the extended pump shaft and is enclosed in a special casing with its own stuffing-box. This is screwed to the casing of the main pump and is also of vertically split design. Units equipped with water-ring pumps are provided with raised feet, as outlined below. The water-ring pump runs paralled with the centrifugal pump. A supply of operating water for the former is contained in the space between the double walls of the cast pump casing. Fresh water is normally used, but sea water may also be allowed in exceptional cases. The operating water, however, must always be completely free of foreign bodies. As a result of the presence of this water, the water-ring pump commences suction as soon as it is started up, and thus evacuates the air from the main pump and its suction pipe. The mixture of air and water now delivered makes its way into the operating water space, where the air is separated off and expelled to the atmosphere. The operating water is heated in the course of its circulation as a result of the output absorbed, which is employed partly for compressing the air drawn in and partly for overcoming the unavoidable friction. But as the operating-water container is housed in the casing of the main pump, through which the cold discharge water continually flows, there is a permanent exchange of heat through the walls separating the two water spaces, and the operating water is thereby cooled and kept within an admissible temperature range. To permit the water level to be checked when the pump is out of service, the operating-water container is fitted with two cocks, as these are more reliable in service than a glass water-level gauge. The purpose of the water-ring pump is to come into action whenever the main pump or its suction pipe contain air pockets which need to be got rid of, whether during starting-up or in normal service. Mounted on the float-valve casing is a special tubular cover containing the actual valve and connected through a pipe to the suction opening of the water ring pump. As soon as the pump is switched on and the water-ring pump comes into action, the suction pipe of the main pump and the space before the impeller are freed of air by way of the open float valve. When the vacuum in the suction pipe becomes so high that the water drawn in reaches the upper part of the float

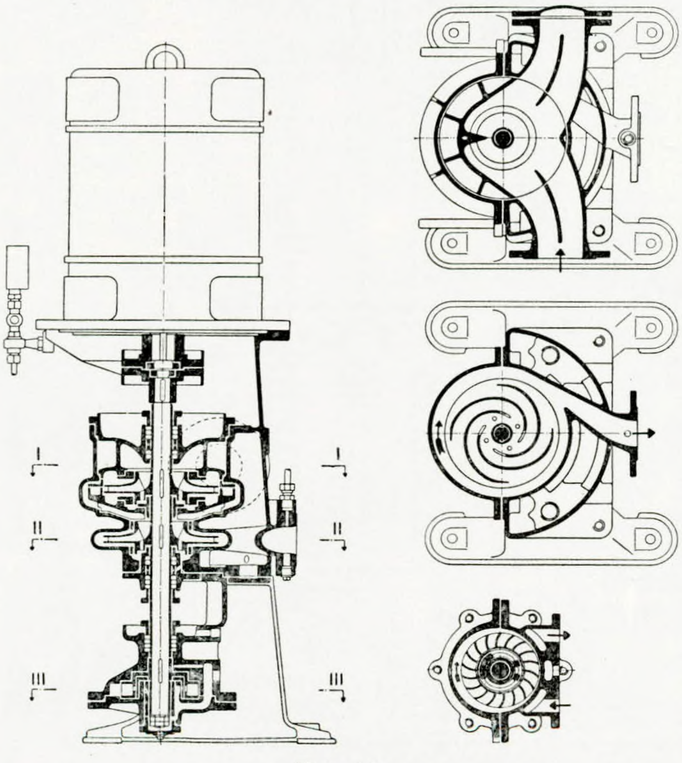


FIG. 49.

casing, the spherical float is raised and the needle valve controlled by it is closed. The communication with the water-ring pump is thus interrupted, and the latter continues to run unloaded, without supplying air. If air pockets should subsequently form in the suction pipe during normal pump service —whether as a result of bubble formation in the water or of a leakage in the suction pipe—this air will collect sooner or later at the highest point of the suction pipe, which, as already mentioned, is where the float-valve casing is fitted. The float consequently sinks lower, thereby opening the needle valve and again freeing the communication with the suction space of the water-ring pump, whereupon the air is automatically evacuated. —*J. Sprecher, Sulzer Technical Review, No. 3, 1949, pp. 24-31.*

Large Diesel Engine for Tankers

The 26,000-ton Diesel engined tanker ordered by Achille Lauro from S/A Ansaldo, will be equipped with the highest-powered machinery yet installed in a motor tanker. Two nine-cylinder two-stroke single-acting Fiat engines are to be provided, with cylinders 750 mm. in diameter and a piston stroke of 1,320 mm. The normal output of each engine will be 7,000 b.h.p. at 120 r.p.m. with a maximum output on sea trials of 9,000 b.h.p. at 135 r.p.m. This machinery is to operate on boiler fuel oil.—*The Motor Ship, Vol. 31, April 1950, p. 19.*

Doxford Engine Trials on Heavy Fuel

Trials on heavy fuel were carried out on a standard three-cylinder Doxford opposed-piston engine, 600 mm. bore and 2,340 mm. combined stroke, for a vessel being constructed for Jas. Nourse and Co., Ltd., after the shop test on pool Diesel oil had been completed. For both tests the power conditions were 2,500 b.h.p. at 108 r.p.m. and 87·8lb. per sq. in. m.i.p. for comparison purposes. The heavy fuel used was Shell Mex with a viscosity of 3,500 secs. Redwood No. 1 at 100 deg. F. Prior to the heavy-oil tests a surface heater was fitted beneath the puel pump, and piping arranged to facilitate the circulation of the heavy oil before starting. The priming pump was arranged to circulate the fuel system by drawing through the heater and discharging through the main engine fuel pump, and as far as the main engine distribution block. In order to keep the heat in the fuel line after leaving the heater, the h.p. oil piping was steam-heated and lagged from the h.p. oil bottles to the distribution block, and from the distribution block up to the h.p. oil filters. The priming pump suction and discharge were also steam-heated. All other test-bed fuel piping was lagged and steam-heated. The engine operated with complete satisfaction during these tests and the observations which were made during and after test included the following: (1) When starting the engine from cold on heavy oil, the exhaust was a light hazy blue colour for a few minutes. (2) The maximum pressures as measured from indicator cards, appear to be lower in the case of heavy oil than those obtained with pool Diesel oil. (3) Regarding fuel consumption, it was observed that the heavy fuel showed a 6 per cent increase over that for pool Diesel oil. This is approximately in the ratio of the calorific values of the fuels. (4) When circulating the fuel system when cold, the pressure at the pump discharge was such that full circulation could not be attained, some of the oil having to be by-passed to the pump suction. This pressure would probably have risen to between 300 and 350lb. per sq. in. (5) To ensure good starting torques and good manœuvring, the temperatures of the fuel entering the fuel valves should be maintained as near 180 deg. F. as possible. (6) The circulating water temperatures throughout the test were very similar to those on Diesel oil. (7) The entablature was in a normally clean condition and the scavenge and exhaust parts were free from carbon.—*The Motor Ship, Vol. 31, April 1950, pp. 8-11.*

Moisture Separator

This patent relates to apparatus for separating and removing from steam under pressure water entrained in the steam. The sectional arrangement, Fig. 3, shows the separator incorporated in a pipe for conveying saturated steam. The separator comprises a tube (1) which has fitted, adjacent to its upstream end, the inclined semi-elliptical baffle plates (2) and (3). A nozzle (6) projects into the downstream end of the tube (1) and is arranged to leave, between it and the tube well, a moisture trapping annulus (7) leading to an annular water collecting chamber (8). The tube (1) is surrounded by another tube (9) spaced from it by a ring (10) in such a way as to provide an annular space (11) closed at its upstream end by the ring (10), and open at its downstream end to the water collecting chamber (8) of the separator. At its downstream end the tube (1) is spaced from the sleeve (9) by a ring, which has its upper portion cut away in order to provide a passage (13) through which the steam passing through the annulus (7) into the water collecting chamber (8) can enter the annular space (11). A drainage sump (14) is located at the downstream end of the separator and forms a downward extension of the sleeve (9) around the separator body (1). Port (15) on the downstream side of the ring serves for the drainage of water from the chamber (8) into the sump (14), while the port (16) on the upstream side of the ring provides for the flow of steam from the sump into the annular space (11). At its upstream end the annular space (11) communicates with the interior of the body (1) by ports (17) through the wall of the separator on the downstream side of

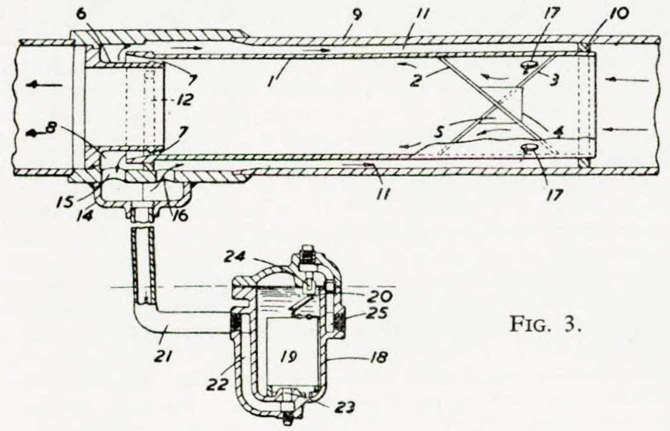


FIG. 3.

the baffles (2) and (3) and close to their trailing ends or upstream portions. Owing to the velocity of the steam flowing over the edges of the baffles (2) and (3), the pressure prevailing in the body (1) close to a baffle and on its downstream side will be lower than that of the main stream of steam passing through the separator, and also lower than the pressure in the water collecting chamber (8) and sump (14). In consequence, steam will flow from the sump (14) into and through the annular space (11) and thence through the ports (17) into the low pressure spaces on the downstream side of the baffle (2) and (3). This flow of steam reduces the pressure in the sump (14), and this reduced pressure in the sump induces the flow into it, of separated water from the water collecting chamber (8) and a small amount of steam from the separator. Thus, the removal of water from the neighbourhood of the trapping annulus (7) is ensured and the efficiency of the separator improved.—*Brit. Pat. No. 633,607, issued to The Superheater Co., Ltd., Engineering and Boiler House Review, Vol. 65, April 1950, pp. 134-35.*

Fusion-welded Boiler Drums

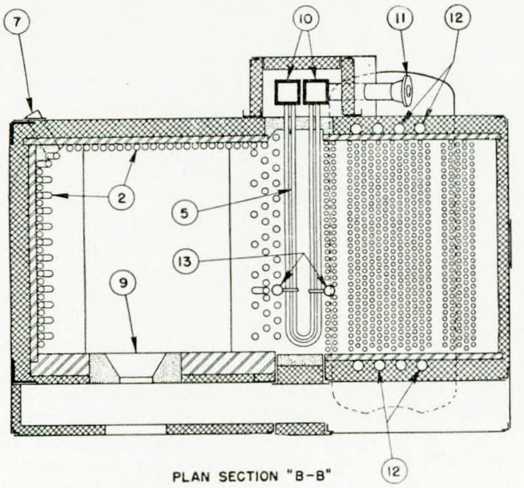
The manufacture of pressure vessels, up to 1931, had been carried out almost entirely by riveting and forging methods, but by that time it had become increasingly apparent that with advancing pressures and larger units alternative methods of manufacture would be worth consideration. Difficulty was even then being experienced in riveting heavy butt strap joints, while in the case of forged drums the maximum size was limited and the cost of manufacture heavy. In 1931 Babcock and Wilcox introduced a new process of metallic arc welding, using special electrodes of their own make, and laying the weld metal in longitudinal and transverse seams by means of automatically controlled machines. The decision to produce welded boiler drums and vessels for industry generally has involved not only the installation of metallic arc fusion-welding machines, but also a large stress-relieving furnace and X-ray apparatus suitable for operation under shop production conditions. The plates for the manufacture of pressure vessels are ordered to specified dimensions according to the requirements of the finished drum. They are checked by chemical analysis, mechanical tests and visual inspection at the platemaker's works to ensure that there are no defects which would cause difficulty in fabrication. A supersonic flaw detector is used to search for defects in newly delivered plate. The plates are marked off and then cut to size ready for the bending operation, and at the same time a piece of material is parted off to provide the test plates which will subsequently be required in the welding operation. They are then taken to a producer-gas-heated preheating furnace, where they are raised to red heat, picked up from the trolley on which they rest and taken to the bending plant, which consists of an 8,000 ton horizontal press. There is also a smaller vertical press which can be used as a roller when it is desired to roll a plate into a complete cylinder with only one longitudinal joint. For many years all plate bending was carried out cold, but in view of the increased thicknesses required it has been found economical to install a plate heating furnace 15 feet wide, 6 feet high and 45 feet long to enable the thicker plates to be brought to red heat before being bent in the horizontal press. Hot bending can be carried out much more quickly, as hitherto cold bent thick plates have had to be stress relieved sometimes more than once in the course of a bending operation. All plates over $2\frac{1}{2}$ inch thick are now hot bent. The half shells are edge-planed so that when butted together for the welding process a U-shaped groove is formed to receive the weld metal. In cases where a thick plate, such as the tube plate of a water-tube boiler, and a thinner plate are to be joined together, the thicker plate is tapered down at the edge to the same thickness as that of the thinner plate. The half-shells are then assembled and tack-welded together with the U-groove closed at the bottom by a backing strip, which is tack-welded in position inside the drum shell. Two welding processes are used at the Renfrew works, the Babcock multi-layer process and the Unionmelt submerged arc method; the latter being used for certain of the thinner drums. In the multi-layer process a number of layers of metal are deposited one upon the other from coated electrodes, the layers being staggered in the grooves to provide a certain degree of overlapping. Each layer has the effect of refining the grain structure of the one beneath and when the groove has been filled, additional layers are deposited in the same way above the plate level and subsequently chipped off, which enables the metal at the weld surface to be given a uniform amount of grain refinement. In this process the welding machines have automatic arc control and electrode feed, but the operator effects the centralisation of the electrode. The coated electrodes are made in the works, and the coating is produced specially to suit the particular metal to be welded. After the welding groove has been filled the backing strip is removed from the inside of the shell and the deposited metal at the bottom of the groove (i.e. the first layers which were laid from the outside) is cut out by a pneumatic chipping tool. A few layers of weld metal are then deposited by hand in this small interior groove, which ensures homogenity throughout the entire weld and eliminates any possibility of lack of penetration at the root of the groove. About 35 runs plus six or seven covering runs are necessary for a $2\frac{7}{8}$-inch thick seam. The welded seam is dressed flush with the surface of the shell both from the inside and outside and the ends of the drum are machined (again in V or U-groove form, according to the process) in preparation for welding the drum head in position. The drum heads are hot bent and pickled in acid to remove scale and machined to form the other half of the particular type of groove suitable for the welding process being used. The head is tack-welded to the shell and then the circumferential seam is welded by the same equipment as that used for the longitudinal seam. After all the welding has been completed the drum is stress relieved at 600 to 650 deg. C. in a specially constructed producer-gas-fired furnace. It is soaked at this temperature for a period of one hour greater than the thickness of the plate in inches, and then allowed to cool in a draught-free atmosphere.—*The Marine Engineer and Naval Architect, Vol. 73, April 1950, pp. 145-151.*

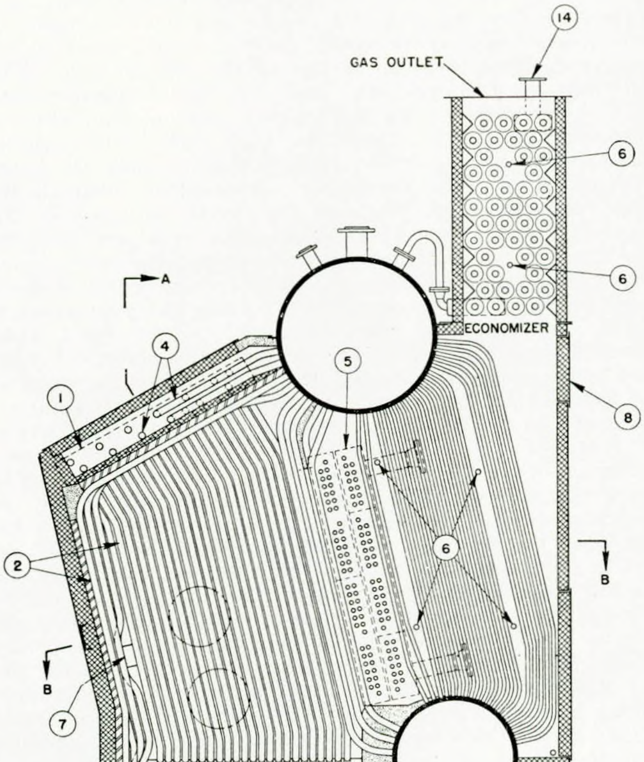
Norwegian Tramp Vessels

The 3,650-ton s.s. *Emu,* a new Norwegian-built tramp freighter equipped with Foster Wheeler boilers, recently completed its maiden voyage to New York, carrying a cargo of 3,000 tons of ilmenite, one of the titanium ores. The D-type steam generators installed on this vessel are shown in the accompanying schematic drawing. There is an alley between the two boilers permitting easy entrance to the rear of the boilers. Each steam generator consists of a two-drum, bent-tube boiler section, water-cooled side and rear walls, superheater, and extended-surface economizer. There are two oil burners installed in each boiler, and soot blowers are provided to clean the exterior surfaces of the tubes. The boiler section consists of a steam drum and water drum connected by screen and generator tubes. Side and rear headers are provided which connect the two drums through water-cooled side and rear furnace walls. In order to ensure proper natural water circulation in each boiler, eight 3-inch outside diameter downcomer tubes have been installed, connecting the upper and lower steam drums. The downcomer tubes are enclosed in the boiler casing but are not exposed to the hot furnace gases. The superheater is located between the screen and generator tubes to give uniform superheat temperature. It consists of U-bend elements rolled into headers which are parallel to the boiler tubes. The superheater elements extend across the boiler, at right angles to the boiler tubes. Steel diaphragms welded in the headers provide four passes of steam through the superheater. Each superheater is provided with a drain connection, vent valve, and coupling for thermometer connection. The economizer is made of U-bend extended-surface type elements which are arranged 12 rows high and 4 tubes wide, the ends being rolled into inlet or outlet connecting headers or return headers. From the economizer the feedwater goes directly to the steam drum. The products of combustion make a single pass through the screen tubes, superheater, and generator tubes, thence travel upward through the economizer and to the uptake. The normal steam generating capacity of each boiler is 13,500lb. per hr. at 220lb. per sq. in. and 572 deg. F. at the superheater outlet, and the stack temperature at normal load is 316 deg. F. Maximum superheated steam capacity is 18,000lb. per hr. and the desuperheated steam capacity is 2,500lb. per hr. Each boiler is equipped with a smoke indicator. A de-ærating feedwater heater and diatomaceous earth filter provide a supply of pure feedwater. The *Emu's* main engine is an 1,800 h.p. Fredrikstad steam motor, built by the Rosenberg Mek. Verksted from designs furnished by the A/S Fredrikstad Mekaniske Verksted of Fredrikstad, Norway. Bunker C fuel oil consumption is approximately 12·04 tons (80 bbl) per 24 hours at an average speed of 12·5 knots. The Fredrikstad Steam Motor claims a high mechanical efficiency, and has the low steam consumption of 9·8lb. per i.h.p. per hr. normal running, with main engine auxiliaries included. Vacuum is obtained by means of a regenerative condenser and first- and second-stage air ejectors, all of which are attached to the engine. The *Emu* and its sister ship, the *Congo*, have the following general specifications:

Length overall	328ft. 11in.
Beam, moulded	46 feet
Deadweight, tons	3,650
Grain cubic capacity ...	250,000 cu. ft.
Speed on trials	12·5 knots
Ship's complement	29 men

The vessel's machinery is located aft, and there are four main transverse bulkheads—the forepeak Nos. 1, 2 and 3 holds, and the machinery space. A 'tween deck extends from the forepeak to the machinery space.—*Heat Engineering, Vol. 25, January 1950, pp. 2-5.*





Ships' Hatch Covers

This invention relates to sectional steel covers for ships' hatches and makes particular reference to an improved method of moving the cover sections to one or other end of the hatch and stowing the moved cover clear of the hatchway. In Figs. 1 and 2 flat tracks (E3) are made to extend along the tops of the longitudinal side walls of the upstanding coaming (E) and the extension tracks (E2) are preferably carried beyond the ends of the hatchway opening at the cover stowage end for a distance approximately equal to the combined width of the up-ended close-set stowed cover sections. Adjacent cover sections are interconnected by hinges (U and V) arranged alternatively above and below the sections. Each cover section is provided on one end, near the hinge-connection with the adjacent cover, with a roller (G) which can be adjusted so as to rest upon the appropriate coaming track (E3) and raise the cover sections slightly clear of packing forming a cover-to-coaming jointing which is provided to make the sectional cover watertight. An exception to this position of mounting the cover rollers is usually made in the case of using an extra-wide endmost cover section, in which case the rollers are mounted at a suitable distance from the leading edge of the section (A1). The first pair of cover sections (A1 and A2) are lifted to the folded position from the normal flat position by means of the single rope (K) passing through "eyes" (B) on the sections (A1, A2 and A3) and a pair of fixed rollers (W) anchored to the post (X) or a nearby mast adjacent to the stowage end of the hatch.

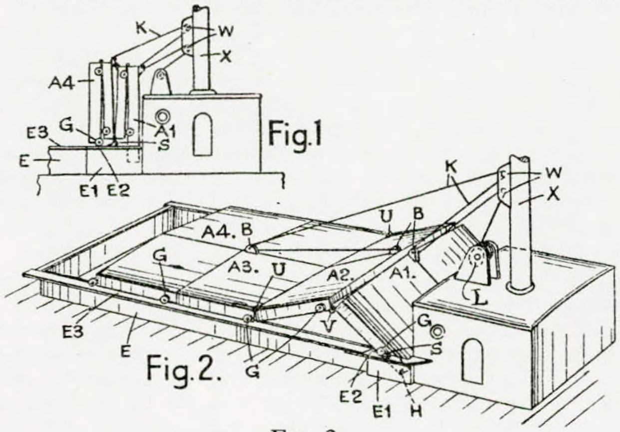


FIG. 2.

It will be seen from Fig. 1 that the single haulage rope (K) extends from the winch (L) over one of the rollers (W) for looping through the eye (B) provided adjacent to that edge of section (A1) which is remote from the stowing position, then passes back for looping through an eye (B) provided on the remote edge of section (A3) and finally extended for anchoring to a third eye device (B) on the near edge of section (A2). If more than four sections are employed, then the rope (K) is carried backwards and forwards over further rollers. As the first pair of sections (A1 and A2) are lifted to the folded position, the remainder of the interconnected sections are drawn along the coaming tracks (E3) on to the extension tracks (E2) by reason of the hinge connections of the remaining sections with the second section (A2) of the first pair. When the two sections (A1 and A2) of the first pair of sections have been folded to the face-to-face vertical position, the tackle continues automatically to fold the next pair of sections (A3 and A4). By suitably arranging the rope (K), each pair of sections may be folded in succession, not more than one pair being lifted for folding at any one time. Another rope (not shown) is connected to the endmost section (A4) for returning the collapsed cover sections to the hatch-closing position.—*Brit. Pat. No. 631,003, issued to J. MacGregor. Specification accepted 25th October 1949. The Shipping World, Vol. 122, 19th April 1950, p. 374.*

Canadian-built Coasters for Venezuela

Two Diesel coasters, the *Zulia* and the *Carabobo* were recently delivered by Canadian Vickers Ltd. to Compania Anonima Venezulana de Navegacion. The vessels are designed to trade along the Venezuelan Coast and up the Orinoco River, and it is expected that they will do much to develop the trade in the more remote and less accessible coastal ports and river districts. They are of the shelter deck type, relatively shallow draft and have a large cargo capacity for their size and deadweight. A full cargo, having a density as light as 82 cu. ft. per ton bale, can be stowed, and this results in great flexibility when carrying a cargo of mixed commodities. In addition to the spaces allocated to the carriage of dry cargo, there is also refrigerated cargo space, served by derricks, divided into two chambers, which is to be used for the carriage of meat and vegetables to and from outlying ports. The vessels are classed Lloyd's 100.A.1 and the principal dimensions and technical characteristics are as follows:

Length between perpendiculars ...	170 feet
Breadth moulded	30 feet
Depth moulded to 2nd deck	11ft. 2in.
Depth moulded to upper deck ...	18 feet
Full load draft	11ft. 0¾in.
Full load deadweight	680 tons
Total bale capacity	46,300 cu. ft.
Total refrig. capacity	1,230 cu. ft.

These vessels are each powered by a Nordberg six-cylinder Diesel engine, 13 inch bore by 16½ inch stroke, directly coupled to the propeller shaft; the engine is reversible and capable of developing continuously 900 b.h.p. at 450 r.p.m. It is fitted with a Büchi exhaust gas supercharger and a built-in roller thrust bearing of Timken make. A high water temperature and low oil pressure alarm is inserted in each of these systems. Although the Nordberg main engine drives the fresh water pump, the salt water, the scavenge lube oil and the pressure lube oil pump, there is also a motor-driven fresh water pump and a motor-driven lube oil pump which are used for circulation before and after the main engine is started or stopped, and also in case of breakdown of the engine-attached pumps. Their capacity enables the Nordberg Diesel to develop full power.—*Pacific Marine Review, Vol. 47, March 1950, pp. 46–47.*

Reversible Propellers for Scheldt Ferries

The Royal De Schelde Company, Flushing, has recently completed the motor ferry *Prins Bernhard,* which, with the motor ferry *Konigin Juliana,* also built by the De Schelde Company, maintain ferry services on the Scheldt from Flushing to Breskens. The vessels are owned by Provincial Steamship Services. In addition to 2,000 passengers in first and second class saloons, the ferries can carry about 60 motor vehicles. On the bridge deck there are two wheelhouses, one forward and the other aft. Four De Schelde-Sulzer Diesel engines, totalling 2,250 b.h.p., are installed, giving a speed of 16 knots. The *Konigin Juliana* is fitted with De Schelde patent reversible propellers, while the *Prins Bernhard* is propelled by Escher-Wyss propellers. Although it was originally intended to adopt Diesel-electric propulsion on the new ferries for a speed of 15 or 16 knots, it was finally decided, after tank tests, to simplify the design of the propelling machinery by using reversible propellers. After 3,000 hours' service the *Konigin Juliana* was taken out of service and investigations showed that both engines and propellers required no attention. The principal dimensions of the ferries are: length overall, 242ft. 8in.; length b.p., 235ft. 11in.; breadth on load line, 40 feet; depth to motor-car deck, 45ft. 3in.; and maximum draught, 13ft. 9½in.—*Shipbuilding and Shipping Record, Vol. 75, 20th April 1950, p. 488.*

Water-blast Method of Scaling Ships' Hulls

The purpose of the test was to obtain comparative figures of cost under identical conditions and hence establish the saving due to the use of the water-blast method. A vessel in average condition was selected for the test. The water-blasting was done by a single nozzle monitor mounted on a T-boat. The nozzle was kept from 12 to 20 feet from the shell of the ship. The pumping equipment consisted of a 60-h.p. Chrysler petrol engine driving a 500 g.p.m. Hale centrifugal pump operating a 250lb. per sq. in. pressure. Three men operated the T-boat, the pump, and the nozzle. The water-blasting on the entire starboard side took 73 man hours. It would, therefore, have taken 478 man hours to do both sides by hand-scaling, under similar conditions.—*U.S. Maritime Commission, Bureau of Marine Operations, Division of the Reserve Fleet. Abstract No. 3,596, Journal, The British Shipbuilding Research Association, Vol. 5, April 1950.*

Strength of Decks of Ships

The hull of a ship is generally considered to be a beam bent by its own weight, by its loading, and by the action of the surrounding water. The strength of the hull in bending depends essentially on the buckling strength of the flange plates. Of special importance is the deck, which has only relatively light reinforcement and is usually transversely stiffened in merchant-ship building. The buckling problem of the hull is formulated in this paper as follows: Consider the deck to be an infinitely long plate with transverse stiffeners. One of the long edges of the plate is assumed to be simply supported or elastically built-in along its other long edge. The compressive stress in the deck plate is assumed to be uniformly distributed and the compressive stress in the side plate to decrease linearly. The approximate magnitude of the buckling load is determined by the energy method.—*G. Schnadel, Reissner Anniv. Vol. J. W. Edwards, 1949, pp. 256-267. Abstract No. 1,376 in Applied Mechanics Review, Vol. 2, No. 11, 1949.*

Tests on Stayed Masts with Heavy Derricks

Measurements of mast deflections and stresses together with stay loads have been made during derrick tests carried out on four merchant ships. The arrangements included a 25-ton derrick and two 50-ton derricks all on masts supported by wire-rope stays, and a 120-ton derrick on a mast supported by solid-bar stays. In the case of the 25-ton derrick, the first 50-ton derrick and the 120-ton derrick, the highest measured stresses in the masts were of the order of 5 tons per sq. in. Higher stresses up to about 10 tons per sq. in. were measured in the mast of the second 50-ton derrick. The results have been analysed and except in the case of the second 50-ton derrick moderately good agreement has been obtained between experiment and calculations. Experience appears to indicate that the greater the number of stays on the mast the less amenable it is to accurate analysis. One of the doubtful items in this work appears to be the effective modulus of elasticity of steel wire-rope stays and the tests have shown the importance of having them set up reasonably "taut" in order to be fully effective. In view of these uncertainties it would appear prudent in design to work to conservative upper limits of stress in the mast structure.—*Paper by C. J. G. Jensen and A. G. Hadjispyrou, read at a Meeting of the North-East Coast Institution of Engineers and Shipbuilders, 14th April 1950.*

Japanese-built 17-knot Liner

The most important orders placed in Japan since the conclusion of the war are for three 9,400-ton cargo liners designed to maintain a service speed, loaded, of 17 knots. They are for the De La Rama S.S. Co. (National Development Co. of the Philippines), and will be placed on their service between Philippine ports and New York via the Panama Canal, calling at Los Angeles, San Francisco, Hawaii, Yokohama, Shanghai and Hongkong. The builders are the Nagasaki Shipyard and Engine Works (West Japan Heavy Industries), and the ships are being constructed to the rules of the American Bureau of Shipping A.I.E. Classification. The first, the *Dona Alicia,* of which the keel was laid on 19th April 1949, was launched on 19th January 1950. The leading particulars are as follows:—

Length b.p.	465ft. 11in.
Moulded beam	64ft. 3in.
Depth	41 feet
Draught	27ft. 7in.
Deadweight capacity (about)	9,400 tons
Gross register (about)	7,500 tons
Hold capacity (bale) (about)	14,500 cu. m.
Machinery	10,500 b.h.p.
Service speed, loaded	17 knots

Apart from the high power of the machinery, the vessels have some interesting features. The two vegetable oil tanks have a total capacity of 710 cu. m. (25,000 cu. ft.), and are of stainless steel with no inside framing, so that the tanks can be readily cleaned. They are not even provided with steam coils in direct contact with the oil, but the coils are arranged in independent water tanks below the oil tanks. This is considered a suitable arrangement for loading costly oil. The refrigerated rooms are divided into eight compartments, and their total capacity is 870 cu. m. or somewhat over 35,000 cu. ft. Four of them are maintained at 30 deg. F. and the others at 10 deg. F. In connexion with the air circulating system, the humidity and the amount of CO_2 are controlled, so that all kinds of fresh cargoes, such as fruit, meat, milk and eggs, may be stored. The propelling machinery is of a pre-war type. It is of the Mitsubishi single-acting two-stroke design, and each of the two engines has seven cylinders with a cylinder diameter of 720 mm. and a piston stroke of 1,250 mm., the continuous output being 5,250 b.h.p. at 140 r.p.m. A special scavenging-air system is employed. In the cylinder wall are three groups or right- and left-hand inlet ports. The shape is so designed that the entering air passes upwards along the cylinder wall and impinges on the under side of the cylinder cover. The exhaust gas is driven out of the cylinders through ports arranged on the opposite side to the inlet ports. The quantity of scavenging air required is between 1·2 and 1·3 times the combustion cylinder volume. The piston has no piston rod, but comprises a crown, a sleeve and a leg which connects the piston to the crosshead. The lubricating oil inlet and outlet pipes for the pistons are fixed to the arms driving the scavenging pumps. The fuel consumption of this engine is stated to be 0·36lb. per b.h.p.-hr. and the mechanical efficiency 83 per cent. The corresponding m.i.p. is 76lb. per sq. in.—*The Motor Ship, Vol. 31, April 1950, pp. 20-22.*

Percussion Welding Developments

Improved percussion welding methods now make it possible to flash weld aluminium tubing directly to copper, stainless steel, Monel or other alloys without regard to the dissimilar metals in the joint. This is made possible by reducing the fusion zone in the weld to less than one thousandth of an inch in width. Such a fusion zone is so small that practically no intermixing of elements occurs. Neither is there any change in grain structure alongside the weld. This is an important feature because it opens up a whole new field for the application of aluminium tubing and extruded shapes which can now be welded in the heat-treated condition with hardly any decrease in strength through the weld.—*The Welding Journal, Vol. 29, March 1950, p. 258.*

Steam Trawler *Andanes*

The steam trawler *Andanes,* built by Cochrane and Sons, Ltd., Selby, for the Rinovia Steam Fishing Co., Ltd., Grimsby, recently completed successful trials and attained a speed of over 14 knots. The principal particulars of the *Andanes* are as follows:

Length overall	198ft. 6in.
Length b.p.	180 feet
Breadth moulded	31 feet
Depth moulded	16 feet
Bunker oil capacity	292 tons
Diesel oil capacity	10 tons
Fishroom capacity	16,400 cu. ft.
Liver oil capacity	5,400 gallons
Fresh water capacity	19 tons
Feed water capacity	48 tons
Crew	30 persons
Engine i.h.p.	1,290

The steering gear is of the Donkin hydraulic type but, unlike most trawlers, which have both hand and power control on the bridge, this has a telemotor unit on the bridge connected to the gear aft. Hand-operated emergency steering gear is also fitted, control being from the deck above. The main propelling machinery, built by Amos and Smith, Ltd., Hull, consists of a triple expansion engine having cylinders 16½ by 28½ by 47 inch with a stroke of 30 inch. Two feed pumps and two bilge pumps are lever-driven off the main engine, all other auxiliaries being independent. The cylindrical multitubular boiler is fitted at a pressure of 225lb. per sq. in. and at a temperature of 600 deg. F. The boiler has three furnaces and is designed to burn oil fuel on the Wallsend-Howden hot-air, forced draught system.—*The Shipping World, Vol. 122, 5th April 1950, pp. 336-337.*

Oil Can Control Wear

A new development in engine lubricants has demonstrated that oil can control wear, where that wear is largely due to corrosion. Corrosion of cylinder walls and rings has long been known to be a factor in engine wear, but only a minor one. Therefore, little was done about it from the oil point of view until recently, developments being aimed at the recognized major problems of alloy bearing corrosion, ring sticking and engine deposits. A thorough study of engine wear has been undertaken during the last few years, to determine what could be done to minimize wear through engine oil development. The effect of the corrosive action of combustion products was found to be great in the case of certain high speed Diesel engine applications, particularly. Operating conditions and the fuel used were found to be important factors in those applications. Stationary engine operation with a given fuel is usually much more severe than operation of the same engine in a vehicle. It has been found that while fuels relatively high in sulphur are associated with high wear rates, there are many operating conditions where fuels relatively low in sulphur are associated with high wear as well. Where corrosive wear conditions prevail, heavy duty type oils were found to offer but little aid in wear reduction. A new engine lubricating oil has been developed which has been found to reduce wear to as much as one-tenth of that usually found in certain Diesel engine applications. Repeated field service tests in marine and stationary engines have confirmed this. In addition, significant reduction in engine deposits has been found with the new lubricant. In high specific output Diesel engine where ring sticking was a problem with heavy duty type oils, the new lubricant has been found to give excellent results. Because of the great demand for Diesel fuel during the last few years, it has been necessary to use components higher in sulphur in order to provide the quantities required. The development of the new lubricant is therefore particularly timely.—*R. E. Jeffrey, Jr. and J. M. Plantfeber, Corrosion, Vol. 6, April 1950, pp. 115-119.*

Reduction of Pressure Drop in Vortex Dust Collectors

The greatest disadvantage of vortex dust collectors is the large pressure drop caused by the whirling motion of the gas while performing the cleaning action. Even small reductions of the pressure drop will provide substantial savings in power consumption. In attacking the problem of reducing the high pressure drop, care must be taken not to destroy the vortex in the long separator cylinder, since this would seriously affect the dust-separating efficiency. If the vortex were changed to a flow of constant angular velocity, the pressure drop would be decreased considerably, but the apparatus would lose most of its value as a separator. Generally, the outlet of a collector, consisting of the rim of the inner cylinder leads into a reducer fitting which connects to a pipe of the proper dimensions. Nothing is done to prevent the spinning of the gas before it enters into curved pipe sections; therefore the pressure drop encountered is usually very high. One way to straighten the spinning flow into parallel flow is to let the discharge whirled from the collector expand into a cylinder with a closed top. The rotating mass of air is forced to reverse its axial-flow direction. It spirals along the cylinder walls and discharges with straight parallel flow into a tangential outlet near the level of the central entrance. Tests with a pressure-drop reduction device, which obtains a 47 per cent. reduction in pressure-drop, are described in this paper. An analysis of the air-flow patterns places the cause for the recovery of pressure drop on the conversion of kinetic energy into static pressure in the recovery cylinder and on the elimination of the central downdraught in the inner cylinder of the collector. From the tests it has been established that it is possible to create a vortex flow in a long slender cylinder simply by rotating a small central region of air with constant angular velocity. The application of this principle makes it possible to employ pressure recovery cylinders, not only on vortex collectors, but also on those of the centrifugal type.—*Paper by F. B. Schneider, read at the 1949 Annual Meeting of the A.S.M.E. Meeting, Paper No. 49-A-126.*

Powder Coupling

This new coupling employs a mixture of metallic powders treated with graphite, instead of a fluid, for the transmission of torque. The powder and graphite mixture is insensitive to heat, up to a certain temperature limit, and its viscosity varies

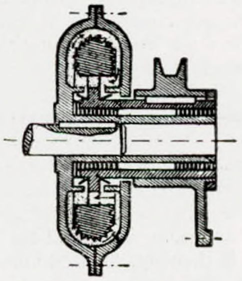


FIG. 1.

according to the power being transmitted. Extensive theoretical and practical investigations carried out over a period of twelve years have served to determine the fluidity of metal powders under various loads and different kinematic conditions, and have given ample proof of the suitability of metal powders as a torque transmitting medium in couplings. The coupling consists of a light-metal or steel casing rigidly connected to the driving shaft, and a light-metal disk situated inside the casing and mounted on the output shaft, which is connected to the driven machine either directly or through a pulley, as shown in Fig. 1. When the driving motor (or engine) is started up, the casing rotates while the inner disk remains stationary. As the motor reaches its normal running speed, the disk is gradually accelerated until it reaches the speed of the input shaft. The powder mixture, owing to the centrifugal forces generated, is forced outwards against the periphery of the casing. As a result of the special design of the casing and disk profiles, the powder is compressed during its outward motion and also circulates in the same way as a fluid. It thus gradually forms on the output side of the casing a relatively thick mass which builds up round the internal disk and finally entrains it, so that at full speed it is revolving at the same speed as the input shaft and casing. During the starting period of the driving motor and the driven machine, the powder behaves first as a powder, then as a fluid of increasing density, and finally as a solid body. When the motor is shut down, the speed with which the coupling comes to a standstill depends on the quantity of powder contained in the casing. The coupling is normally non-reversible, as reversible systems have a much lower efficiency, and it can only transmit power in one direction, i.e., from the motor to the driven machine. Special designs can, however, be developed to fulfil both these requirements. The coupling also gives automatic protection against overloads, as the maximum power which can be transmitted depends on the quantity of powder in the coupling. As soon as the overload is dropped and normal load conditions are reached again, the coupling stops slipping and rotates as a single unit. The coupling can slip for a very long period of time and thus presents the possibility of driving machines having heavy starting characteristics by meass of extremely low power motors. Furthermore, it is also possible to use a second coupling and a second motor at the other end of the driven machine for reversing the direction of rotation. The coupling of the second driving motor will slip until the power from the first motor is cut off, and when the second motor begins operating it will gradually take over and rotate the machine in the opposite direction.—*W. F. Bladergroen, Polytechnisch Tijdschrift, Part A, Vol. 5, Nos. 1-2, 10th January 1950. Abstracted in The Engineers' Digest, Vol. 11, April 1950, p. 114.*

Effect of Macro-roughness on Performance of Parallel Thrust Bearings

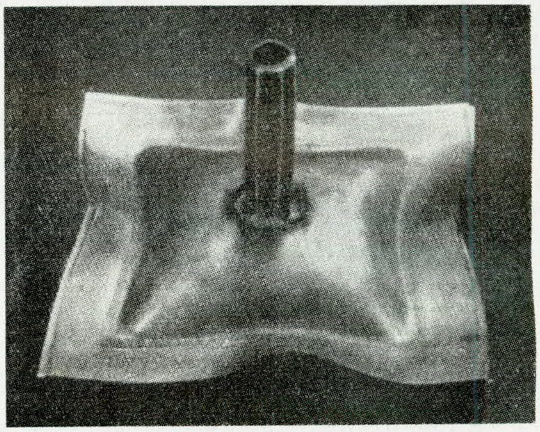
This work was initiated to investigate the effect of surface macro-roughness on the performance of the parallel-faces thrust bearing and, at the same time, to find a rational explanation of its behaviour. The problem is treated both theoretically and experimentally and the main result arrived at indicates that macro-roughness is a prime factor in the behaviour of the bearing, as it provides passages which both feed the surface with the lubricant and allow the formation of hydrodynamic films so that the performance corresponds closer to that for film lubrication. Further work on roughness is proceeding.—*Paper by M. E. Salaman, submitted to The Institution of Mechanical Engineers for written discussion, 1950.*

Effect of Internal Cooling Upon Centrifugal Compressor Performance

For many applications the advantages resulting from cooling a gas during compression have been clearly established. Usually this cooling is obtained by withdrawing the gas from the machine at one or more intermediate points in the compression and passing it through heat exchangers. The construction of a centrifugal compressor is such that, without much added expense, the gas may be cooled as it flows through the fixed passages. Because of the high velocities in these passages the heat-transfer film coefficients are high. The following questions may well be asked: What is the magnitude of these coefficients? How can one calculate the cooling effect which can be obtained in present commercial designs? What is the effect of such cooling on over-all performance and other economic factors affecting users of centrifugal compressors? This paper provides limited answers to the foregoing three questions. The answers are limited first in scope,, concerning themselves only with one commercial centrifugal design, and applying the results to a study of only one process condition, namely, compression of 7,500 cu. ft. per min. air at 68 deg. F. and 14·7 to 114·7lb. per sq. in. abs.—*Paper by W. E. Trumpler, R. W. Frederick, and P. R. Trumpler, read at the 1949 Annual Meeting of the A.S.M.E. Meeting paper No. 49-A-93.*

Seam Welding Monel Metal to Steel

This paper describes an investigation into the resistance seam welding of Monel to low-carbon steel in the 0·062--inch gauge. It was found that for the weld times investigated fusion of both the Monel and steel resulted in a heterogeneous weld nugget and led to porosity and cracking in the weld zone. To avoid the above porosity and cracking, seam welds of Monel to steel were made with fusion occurring only in the Monel. The optimum conditions for producing these "braze" type welds made by this method exceeded those of seam welds of steel to steel. The pillow test was found to be a valuable aid in determining the strength and pressure-tightness of seam welds. In fact it is the only test which approaches operating conditions of a seam-welded joint, and which will determine both the strength and the pressure-tightness of the welded seam.



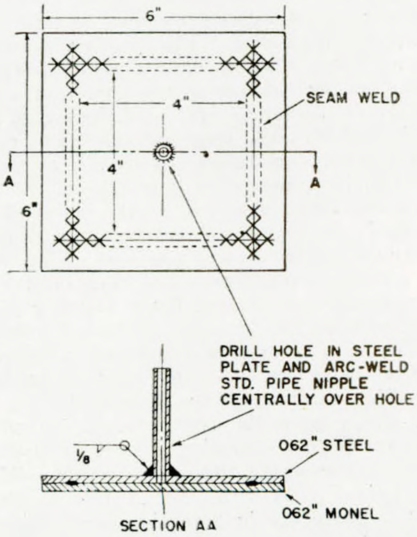


FIG. 10.

The pillow test specimen, shown in Fig. 10, was constructed from one flat 6-inch square sheet of Monel and one 6-inch square sheet of steel. Previous to seam welding, a small hole was drilled in the centre of the steel sheet and a ⅜-inch pipe nipple was centred over the hole and arc welded to the sheet. The steel and Monel sheets were placed together and tacked by spot welding in the corners to facilitate handling. Seam welds were then made parallel to the four specimen edges so as to enclose a 4-inch square area. Several series of pillow-test specimens were made at weld spacings of 5½, 6¾ and 7¾ welds per inch at various values of welding current. The pillow specimens were attached to the hydraulic system and the hydrostatic pressure gradually increased until rupture occurred. The pressures (in lb. per sq. in.) at which the pillows ruptured were recorded along with the seam in which the fracture occurred and the location of the fracture in the seam.—*E. F. Nippes, A. R. Pfluger, and G. M. Slaughter, The Welding Journal, Vol. 29, March 1950, pp. 134-3-140-s.*

High Frequency Notch Bend Test

The high frequency notch bend test was developed at the United States Naval Engineering Experiment Station, Annapolis, Maryland, where it has proved its usefulness during the past six years. The test is based on the empirical knowledge that metallurgical changes occurring in the heat-affected zones of multipass arc welds, executed in accordance with acceptable practices, are for a given steel consistently comparable regardless of the thickness of the material in excess of ½ inch. This contention was confirmed mathematically by the Rensselaer Polytechnical Institute group of research workers. It follows then that it is practicable synthetically to produce within a restricted portion of a specimen of suitable volume and geometry the same metallurgical changes which occurs within the heat-affected zones of a multipass arc weld produced in companion materials. This can be accomplished by the application of an appropriate heat source and heating method such as high-frequency induction. Evaluation of the synthetically produced metallurgical change as regards serviceability of the weldment was based on determining the degree of the concurrent notch sensitivity change. Notch sensitivity was selected as the criterion in that this property can be evaluated and correlated as regards serviceability by means of a simple notch-bend test. By design, the stress concentration value of the applied notch can be made equal to that which obtains, at the toes of the fillets of the familiar tee-band specimen. The latter, in turn, represents the most critical joint in weldments.—*B. Ronay, The Welding Journal, Vol. 29, March 1950 pp. 122-s-123-s.*

Explosion Testing of Welded Joints

Since notch sensitivity of steel and welded steel joints appears to be an important factor in service performance of fabricated structures of practically every type and description, including ships and other marine vessels, it was considered desirable to develop a reliable test to determine notch sensitivity of steel and of welded steel joints at different temperatures. The direct explosion method of testing would provide such a test if correlation between it and actual service performance could be established. Briefly, this test consists in detonating an explosive charge in direct contact with the specimen supported along its four edges, as follows: The supports consist of a concrete platform, 6 feet square, supporting a high-tensile steel plate, 3 feet square by 3 inch thick. The steel plate in turn supports four steel bars 4 inch high by 2½ inch wide, placed to form a hollow square 16 inch inside and 21 inch outside. The specimen is placed on the bars and overlaps the hollow square by 1 inch on all four sides. A cylindrical explosive charge is prepared by filling a round cardboard container 102 mm. internal diameter with a desired weight of specially formulated explosive and compressing it to a desired density. The charge is then placed in the centre of the specimen to be tested and surrounded on all sides with approximately 40lb. of white silica sand held in place by means of a paper cylinder 8½ inch in diameter and 12 inch in height. The charge is then exploded by means of a special detonator in such a manner that the front of the detonating wave travelling through the charge reaches the face of the specimen nearly simultaneously over the entire area under the charge. The effect of the impact of the wave is to first bend and then stretch the plate equally along its two axes, the amount of deformation being nearly linear with the charge. The minimum charge necessary to fracture the specimen is established by subjecting a number of identical specimens to the action of progressively greater charges until fracture occurs. Each specimen is subjected to the action of only one charge.—*G. S. Mikhalapov, The Welding Journal, Vol. 29, March 1950, pp. 109-s-122-s.*

Heating Electrode

An electrode has been developed in Germany which is similar to the customary covered electrode for arc welding, but which deposits practically no weld metal. The electrode deposits a slag that is readily removed. The heat evolved by the electrode is used for local preheating and post-heating to welding operations. The coating is basic (MgO), and if the arc is sufficiently long no weld metal is deposited.—*The Welding Journal, Vol. 29, March 1950, p. 210.*

Absorption of Gases by Welds

The absorption of atmospheric oxgyen and nitrogen by the molten metal of a weld involves changes in the chemical composition of the weld and has an unfavourable influence upon the mechanical properties. A further possibility is the absorption of hydrogen. In any weld seam the parent metal hardly absorbs any oxygen. Theoretically, the percentage content of the latter would be about 0·10 per cent in the fusion zone at a temperature of about 1,400 deg. C. This is never attained in practice owing to the rapid rate of heating and cooling, which is far from corresponding to the equilibrium conditions. In the fusion zone, the oxygen concentration may be considerably greater. The absorption of oxygen will depend on a number of factors: The welding process—oxyacetylene, or electric arc. The type of welding rod or electrode. The type and thickness of the coating or sheathing. The nature of the gases surrounding the fusion zone. In the oxyacetylene welding process there is, in effect, very little fixed oxygen present ($O_2 < 0{\cdot}050$ per cent) in the form of oxides of manganese and silicon (SiO_2). Iron oxide (FeO) is almost entirely reduced by the oxyacetylene flame, which is a typical reducing flame. Iron oxide is also reduced by the other constituents of steel (manganese and silicon) which is the reason for the presence of their oxides in the weld. In arc welding, the quantity of absorbed oxygen is considerably greater and may attain 0·30 per cent, principally in the form of the iron oxide (FeO). This absorption of oxygen may be controlled by modifying the electrode coating, i.e., by incorporating reducing elements which will eliminate the oxides by slagging. Coatings liberating a reducing gas (hydrogen, carbon monoxide) have a pronounced effect in diminishing the oxygen concentration of an arc weld ($O_2 = 0{\cdot}07$ per cent). Oxygen has some unexpected effects on the mechanical properties. All mechanical-strength values are reduced excepting the percentage elongation which remains practically constant. The author gives a graph which shows that in a given case the tensile strength of mild steel decreased from 42 to 32 kg. per sq. mm. for an increase in oxygen from 0 to 0·20 per cent; the elastic limit fell from 32 to 18 kg. per sq. mm. and the hardness from 100 to 90 Brinell. As in the case of oxygen, nitrogen is very little soluble at ordinary temperature (0·001 per cent), but the solubility increases rapidly with the application of heat, reaching 0·13 per cent at 600 deg. C. The quantity of nitrogen absorbed will depend principally on the conditions of execution of the weld. The most important factors influencing the absorption are as follows: welding process—oxyacetylene or arc. Type of steel. Nature of surrounding atmosphere. Type and thickness of the electrode coating, in arc welding. Type and length of arc. Melting by the oxyacetylene flame causes little fixation of nitrogen—of the order of 0·020 per cent (corresponding to basic Bessemer steel). In melting by the electric arc, on the contrary, the absorption of nitrogen may reach 0·15 to 0·20 per cent for bare thickness of the electrode coating. It has been found that increasing nitrogen content increases the resistance to deformation and decreases the capacity for deformation. To summarise, oxygen and nitrogen constitute impurities in steel welds, which perceptibly affect the mechanical properties. The degree of absorption of these gases is governed by a number of causes, but principally by the welding process used. It would appear that gas absorption is low in the oxyacetylene process, not exceeding 0·05 per cent for oxygen, and 0·02 per cent for nitrogen. Hence, the quality of the weld is not appreciably affected by such absorption of gases; this result being particularly due to the favourable characteristics of the oxyacetylene flame. In arc welding, absorption is more important, and varies with the nature and thickness of the electrode coating, as well as the conditions of excitation and maintenance of the arc. In the worst conditions —bare electrode and long arc—as much as 0·30 per cent oxygen and 0·20 per cent nitrogen will be absorbed; under the most favourable conditions, these figures are reduced to 0·05 per cent oxygen (coating releasing hydrogen) and 0·03 per cent nitrogen (thick coatings). Thus, the mechanical properties of arc welds are particularly influenced by this absorption. In addition to oxygen and nitrogen, the molten metal may also absorb hydrogen in considerable quantity. The agent responsible for this is the electrode coating; the nature of which plays a preponderant part. Torch welding introduces very little hydrogen as proved by tests on iron melted in the hydrogen flame. The present of hydrogen in steel is disclosed, in certain conditions, by the appearance of light spots in the fracture faces, showing a granular structure, while the rest of the metal is dark grey, and the structure fibrous. The appearance of spots or patches is accompanied by a diminution in the mechanical strength of the metal, particularly the resistance to deformation.—*D. Seferian, Sheet Metal Industries, Vol. 27, April 1950, pp. 339-346.*

Photo-elastic Laboratory

The authors describe the photo-elastic laboratory at the Newport News Shipbuilding and Dry Dock Company, in which they have assembled most of the best features of various laboratories of their acquaintance. Much information is given concerning design and techniques for a photo-elastic polariscope and auxiliary equipment, with the advantages and disadvantages of alternate systems. The article is of particular interest to one starting such a laboratory.—*B. R. Lee, R. Meadows, Jr., and W. F. Taylor, Proc. Soc. Exp. Stress Analysis, Vol. 6, 1948, pp. 83-110. Abstract No. 1,493, Applied Mechanics Review, Vol. 2, No. 12, 1949.*

Electric Welding and Cutting Under Water in the Soviet Union

The author has developed methods of electric welding under water on the basis of experiments carried out in 1942-43. Standard-type 5-mm. electrode wire with carbon up to 0·18 per cent is used. The coating is usually made of finely ground mineral substances mixed with waterglass and dried at 200-300 deg. C. to remove moisture entirely and to increase mechanical strength. The coating is required to develop a crater and to generate gases with a low ionization potential. It is possible to produce under water the same types of weld as are usual in air. The widths of the weld and the transition zones are smaller than in welds made in air because of the greater cooling effect of the water. The weld has a fine grain structure and has more non-metallic inclusions than welds made in air. The quality of welds is satisfactory and in rupture tests a tensile strength of 35·1 to 37·7 kg. per sq. mm. was measured; it was generally the base metal which broke. Visibility is usually very poor, but experienced welders can work by touch even when the water becomes entirely non-transparent as a result of the cloud of ferrous oxide which is generated during welding. The work is difficult because a diver easily loses his balance and his clothing is unsuitable for carrying out work demanding carefully controlled movement of the hands. Under-water welding has been used for repairing cracks and pipes and building up worn material. The distortion when welding under water is very small. Under-water cutting with an electric arc requires currents of 1,000 amp. or more, and a very thick electrode coating. The arc voltage is 40-50. The intense heat concentration causes a considerable amount of gas to be generated and this helps to remove the metal from the cut. In 1942, 432 sections of an ice-breaking structure of a bridge were cut under water in 40 six-hour shifts. The total length cut was 137 m. The cutting speed was about five times as high as when using an oxy-hydrogen flame. Cutting by electric arc is competitive with any other methods for thicknesses up to 15 mm. Experiments were also carried out with cutting by electric arc and an oxygen stream. A current of 300 amp. is required and the oxygen consumption is one-third to one-quarter of that for cutting with an oxy-hydrogen flame. Difficulties are encountered with the electrodes as these burn away very rapidly. Experiments with liquid fuels for cutting were also successful and a burner is at present being developed for under-water cutting with petrol atomized by an oxygen stream.—*K. K. Crenov, Svaiovani, Vol. 9, 1949; August, pp. 110-112; September, pp. 129-131. Abstracted in Journal of the Iron and Steel Institute, Vol. 164, April 1950, p. 493.*

Timbers for Marine Use

In the annual report of the Timber Development Association is described work which is at present being carried out on types of timbers for marine use. In one series of experiments, attempts are being made to find a method of combating the marine borer, both by selecting timbers which are naturally resistant to the borer and by treatment with preservatives. Eleven species of timber which show promise of being resistant to borers have been mounted on a frame and submerged in the sea, while five different preservatives are being investigated. Work is also going on to find a satisfactory timber to replace true teak for deck planking. Experimental planking has been laid in exposed positions in the liners *Port Philip, Haparangi, Hinakura* and *Sussex,* while a large-scale experiment is being carried out in the *Nottingham.—The Shipping World, Vol. 122, 26th April 1950, p. 386.*

The Exhaust-heated Gas-turbine Cycle

This paper discusses a simple cycle in which solid and other low-grade fuels can be burned with a thermal efficiency of the order of 20-25 per cent, excluding auxiliaries, and further to show how this may be brought up to nearly 40 per cent without departing from solid-fuel combustion, and without increasing the complexity of the plant unduly. The objection to burning solid fuels, and also certain low-grade liquid fuels, in an open-cycle gas turbine, lies in the difficulty of separating completely the ash from the combustion products. Ash passing through the turbine blades has a powerful erosive effect, while the accidental passage of any large pieces would be catastrophic. Furthermore, the deposition of solid matter on the blades has a deleterious aerodynamic effect that will demand frequent cleaning, necessitating opening the turbine. Residual fuel oils also may contain metallic salts which, after oxidation, may condense on the turbine blades, with serious effects. In the closed cycle, the compressed air is heated in a form of air heater, so that the working fluid is quite distinct from the combustion gases. The fluid passing through the turbine is pure air, while any deposition of solid matter from the combustion gases is

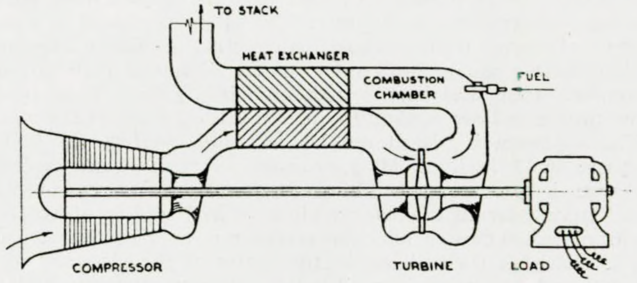


FIG. 1.

confined to stationary heat-transfer surfaces, from which it may be removed easily, if necessary, even while the plant is running. In what the author terms the exhaust-heated cycle, the air used for combustion is that rejected from the turbine, and heating of the air prior to entering the turbine is accomplished entirely by a heat exchanger. It is evident that in such a cycle, compared with a conventional open cycle operating at the same compression ratio, turbine temperature, component efficiencies, and so forth, the transposition of the combustion chamber will not affect the specific power output (power developed per pound of air circulating per second), and, if the exchanger had 100 per cent effectiveness or thermal ratio, would not alter the thermal efficiency. For any thermal ratio less than 100 per cent, however, the final discharge temperature obviously will be higher than in the open cycle, leading to a reduction in thermal efficiency.—*D. L. Mordell, Transactions, A.S.M.E., Vol. 72, April 1950, pp. 323-329.*

Corrosion Behaviour of Aluminium Alloys

This report, illustrated by photographs, gives the results of exposure tests of eighteen weeks and indicates that there is little to choose from a corrosion resistance standpoint between any of the four aluminium alloys under test. The 3 per cent magnesium alloy (AW5C) appears to be the most resistant to corrosion, with the 5 per cent magnesium (AW6D) almost as good. Both the 1½ per cent magnesium and clad dural are slightly inferior to these two, although the relative performance of all four materials under all conditions of test are very close. Joined to themselves, or joined with aluminium rivets to galvanised steel, painted or unpainted, all the alloys possess good corrosion resistance but coupled to more cathodic materials, the progress of corrosion is rapid. With a higher quality protective paint, however, it is conceivable that performance under these conditions might be improved. Unless the whole of the exposed aluminium surface, including rivet heads and points, can be given identical treatment, surface pre-treatment appears to be undesirable. When areas such as rivet heads are left untreated, attack in these areas is very much more rapid. In the tested materials, corrosion of rivet points when in contact with more cathodic materials is very much more rapid than on the rivet heads, and it is proposed to conduct electrode potential measurements to try to establish the relative tendency to corrosion of work-hardened as opposed to annealed rivet materials. It is emphasised than the results of these visual assessments can only be applied with caution; also that the fact that the area of aluminium to dissimilar metals in each specimen is electrochemically significant and would have a great deal of effect on the corrosion behaviour of the metals in contact.—*Admiralty Corrosion Committee Hull and Non-Ferrous Corrosion Sub-Committees, ACSIL/ADM/48/900. Abstract No. 3,595, Journal, The British Shipbuilding Research Association, Vol. 5, April 1950.*