ENGINEERING ABSTRACTS

Section 3. SHIPBUILDING AND MARINE ENGINEERING

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British Built Liner for French Service

The twin-screw passenger and cargo steam ship *Provence,* which was recently launched from the Walker Yard of Swan, Hunter and Wigham Richardson, Ltd., is built for the Société Generale de Transports Maritimes à Vapeur, Paris, for service between France and South America. Staterooms are arranged for 135 first-class, 100 tourist-class and 436 third-class passengers. In addition, 632 third-class beds are provided in 'tween-deck spaces. With the crew of 260, the ship will carry a total of about 1,563 persons. The propelling machinery, constructed by the shipbuilders, consists of two sets of Parsons turbines, each set comprising h.p., i.p. and l.p. turbines, connected to the propeller shaft through single-reduction gearing. Steam is supplied by three Babcock and Wilcox integral-furnace oil-burning boilers. With the exception of the turbo-feed pumps, the auxiliaries are electrically driven. The evaporating and distilling plant has a capacity of 220 tons of fresh-water per day.—*The Shipbuilder and Marine Engine-Builder, Vol. 57, September 1950, p. 611.*

Internal Liquid Cooling of Centrifugal Compressors

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 paper gives the results of a preliminary exploitation of the cooling rates which may be obtained in the internal passages of a centrifugal compressor. A method of carrying out the necessary calculations is proposed and the results are used for predicting the performance of a compressor of given duty assuming various cooling arrangements. Perhaps the most important conclusion to be reached from the findings of this investigation is that internal cooling makes possible low-cost, compact, multi-stage centrifugals for compression in relatively high pressures. In the past it has been general practice to supply air-compressor cases of only four or five stages, since more stages in a case would involve gas temperatures too high for economical compression. Thus the average 100lb. per sq. in. gauge air compressor consists of two cases plus intercooler. Based on the study presented, this arrangement can, with only a small loss in operating efficiency, be reduced to a compact single case containing all the stages without any external cooling.—*W. E. Trumpler, R. W. Frederick and P. R. Trumpler, Trans., A.S.M.E., Vol. 72, August 1950, pp. 797-804.*

Cargo Protection

Perishable cargo shipments on the new 19,600-ton *President Jackson,* of the American President Lines, recently launched, will be scientifically protected against spoilage bv an intricate automatic control system. Temperatures in the 500,000 cubic feet of cargo space on the vessel will be maintained constantly at predetermined levels. A member of the ship's crew, seated in front of an electronic precision indicator, will be able to check some twenty-four key points in the cargo hold in as many seconds. Immediate temperature corrections, if needed, can then be made. The system also provides the shipper with a strip chart recording of the hold temperatures during shipment; eliminates necessity for in-person checks of perishables and guarantees that the cargoes do not become infested with fruit flies and other pests.—*Marine Engineering and Shipping Review, Vol. 55, August 1950, p. 63.*

American-built Ferries for Brazil

Six new vessels for ferry services are being built in the yards of Higgins, Inc., New Orleans, for Empreza Internacional de Transportes, Ltda., of Sao Paulo, Brazil. Four of these new vessels will be for passenger service, and two are designed as truck ferries. All vessels on this order are to be powered with Fairbanks, Morse Diesels. The four 136-feet passenger ferries are each designed to carry 518 passengers. These will have a 33-feet beam, a moulded depth of 10½ feet, and will draw 6 feet of water. Approximate salt water displacement is calculated to be 405 long tons and speed will be in the neighbourhood of 13 m.p.h. Each of these four vessels will have a fuel oil capacity of 5,000 gals., lube oil capacity of 400 gals., and minimum fresh water capacity of 1,200 gals. Potable water capacity is 400 gals. These ferries will be of all welded steel construction, and will be built in accordance with the rules for vessels of this type and service. Propulsion power will be furnished by two Fairbanks, Morse marine Diesel Model 31A 8½×11½-inch direct reversing, direct drive engines, one of clockwise the other of counter-clockwise rotation. Each is a five-cylinder engine rated 312 b.h.p. at 540 r.p.m., giving each vessel a total of 624 b.h.p. —*Motorship, New York, Vol 35, August 1950, pp. 24-25.*

Large Finnish Ice-breaker

The new Diesel electrically driven ice-breaker *Into,* which is now under construction for the Finnish Government at A/B Sandvikens Skeppsdocka, Sweden, will have larger machinery power than any European ship built for ice-breaking purposes, and her dimensions are also greater than existing vessels. She is, moreover, the first ice-breaker to have two propellers forward and two aft. This design was utilized in the Canadian ship *Abegweit,* which, however, was intended as a ferry and was not designed purely for ice-breaking purposes. The main particulars of the *Into,* which will operate from Helsinki, are:—

Length overall	273·8 feet
Length b.p.	254·1 feet
Moulded breadth	63·6 feet
Depth on the waterline	61·2 feet
Mean draught	20·3 feet
Displacement	4,415 tons
Block coefficient	0·482
Machinery	12,000 b.h.p. maximum
Power on propellers	10,500 b.h.p. maximum
Power on propellers	8,400 b.h.p. normal
Number of propellers	4
Speed	16·5 knots
B.h.p. per ton displacement	2·38

There are four engine-rooms, the two Diesel engine-rooms being amidships with a propeller motor-room forward and another aft. An operating-room with electricity distribution boards is on the main deck amidships, and above this, on the upper deck, is a boiler-room with two automatic oil-fired boilers each having a heating surface of 45 sq. m. There is an emergency Diesel generator unit of 100 b.h.p. The two Diesel engine-rooms are similar, but independent. Each has an installation of three eight-cylinder two-stroke Polar Diesel engines of 2,000 b.h.p. driving d.c. generators of 1,370 kW. In the port and starboard wing of each of these engine-rooms is a 300 b.h.p. Polar Diesel engine driving an auxiliary generator. The four propelling motors, two in the aft compartment and two forward, are each rated at 3,500 b.h.p. In normal service each motor will have an output of 2,100 b.h.p., giving a total of 8,400 b.h.p. so that two of the Diesel generating sets may, if desired, be shut down for overhaul and the others run at maximum load, thus allowing the vessel to proceed at full speed. In addition, the total power of the generating plant may be divided so that two-thirds of it is supplied to the after propellers and one-third to the forward propellers, or vice versa. The vessel will be completed in 1952.—*The Motor Ship, Vol. 31, August 1950, pp. 166-167.*

World's Largest Tanker

The *Atlantic Seaman,* the world's largest tanker, was recently launched at the yard of the New York Shipbuilding Corporation, Camden, N.J. The vessel is the first of three sister ships being built for Philadelphia Tankers, Inc. The ships have an overall length of 659ft. 6in., a beam of 85ft., and a draught (summer) of 34ft. 2⅝in. At this draught, the displacement will be 39,500 tons. The capacity of the cargo tanks will be 257,900 barrels, and the bunker tanks will hold 21,000 barrels. The vessel is single screw, driven by a Westinghouse steam turbine of the cross-compounded double-reduction-gear type designed to develop 18,000 s.h.p. maximum, at 103 r.p.m. The propeller is four-bladed, 22 feet in diameter, built-up type with manganese bronze blades and cast-iron hub. The propeller weighs approximately 71,500lb., and the propeller shaft diameter is 24¾ inch. Steam is supplied to the high-pressure turbine from two Combustion Engineering oil-fired marine-type boilers which operate at 650lb. per sq. in. pressure and 1,020 deg. F. temperature. Bailey automatic boiler room equipment is used for control of steam pressure and temperature, and to ensure proper and efficient combustion at the oil burners. —*Marine Engineering and Shipping Review, Vol. 55, August 1950, pp. 50-51.*

Running Motor Vessels on Heavy Fuel

The motor ship *Nottingham,* built by John Brown and Co., Clydebank, for the Federal S.N. Company, is a recent example of a high-powered cargo vessel fitted for operation on heavy fuel. The *Nottingham* is a fast cargo ship with a considerable amount of refrigerated space, and the principal details of the vessel are given in the accompanying table:—

Length overall	480 feet
Length b.p.	450 feet
Breadth	61 feet
Depth	39 feet
Loaded draught	26ft. 3in.
Deadweight	8,600 tons
Immersion	52·8 tons per in.
Machinery	6,200 b.h.p.
Corresponding revolutions	115 per minute
Loaded speed	15 knots

The displacement is approximately 14,450 tons, while the gross and net registered tonnages are 6,688·63 and 3,701·3 respectively. The light draught is 11ft. 11in., and the figure for winter draught, loaded, is 25ft. 3in. Assuming a slip of 10 per cent, the speed of the vessel is 14·2 knots at 110 r.p.m. and 15·5 knots at 120 r.p.m. For manœuvring, when the speed of the engine is reduced to 34 r.p.m., the corresponding ship's speed is 4·4 knots. With no allowance for slip, the maximum speed is 17·2 knots. The main engine is of the standard Brown-Doxford, opposed-piston, all-welded design with six cylinders, having a diameter of 670 mm., the combined piston stroke being 2,320 mm. Scavenging air is supplied by three lever-driven pumps arranged at the side of the engine, and accordingly taking up no additional fore-and-aft space. A Bibby-type detuner is fitted, and with the device in the free position there are no dangerous critical speeds. With the detuner locked, the critical speeds are 116·1 r.p.m., 101·6 r.p.m., 90·3 r.p.m. and 81·3 r.p.m., continuous running being avoided 3 r.p.m. clear of any of these speeds. The engine speeds fixed for manœuvring in harbour are 90 r.p.m. for full speed, 65 r.p.m. for half speed, 45 r.p.m. for slow speed and 35 r.p.m. for dead slow. Continuous running is also avoided at a speed between 25 r.p.m. and 31 r.p.m. The exhaust gas from the main engine is led through a Cochran composite boiler. The heavy fuel purifying equipment includes three De Laval machines of the largest type, driven by 7½ h.p. motors. Two of these are used as separators, and a third machine is employed as a clarifier. One of the fuel separators can also be used as clarifier if necessary. The heavy fuel is taken from the wing bunker settling tanks, through steam heaters to the centrifugal separators, which supply the purified fuel direct and without intermediate heating to the clarifier. From the clarifier the oil is supplied to two 15-ton ready-use tanks, from which it is taken through heaters to the main fuel pumps. Steam-jacketed pipes take the fuel from the pumps to the injectors, and the final temperature is 150 deg. F. —*The Motor Ship, Vol. 31, August 1950, pp. 172-176.*

Combustion of Gas Oil

The authors have studied the combustion of a gas oil in a single-cylinder, direct-injection Diesel by measuring the flame temperatures in the combustion chamber of the engine from their colour with a special photo-electric pyrometer. They varied the air pressure between 1·4lb. per sq. in., 2·8lb. per sq. in., and 4·3lb. per sq. in. above atmospheric, the injection lead from 12·5 deg. to 20 deg., and the mixture strength from 0·34 to 0·48. The flame temperature at the beginning of the combustion was found to be nearly constant irrespective of the conditions, and about 1,680 deg. C. (3,055 deg. F.). In similar measurements of the maximum flame temperatures in an experimental furnace with the same type of fuel, the maximum temperature varied between 1,530 deg. C. (2,785 deg. F.) and 1,580 deg. C. (2,875 deg. F.). These results led the authors to the conclusion that the fuel droplets always burn in the same way. The concentration of combustible in the fuel-air mixture varies from the centre core to the surface from unity to zero, whereas the air concentration varies in the reverse sense. The flame which is apparent from the beginning of combustion of the droplet therefore proceeds gradually from the surface to the core until the upper ignition limit is attained. From then the remainder of the droplet will burn through diffusion of fuel gas and air.—*G. Monnot and R. Vichnievsky, Comptes Rendues, Acad. Sci., Paris, Vol. 230, 12th June 1950, p. 2,079. Abstract No. 3,968, Journal, The British Shipbuilding Research Association, Vol. 5, August 1950.*

Straightening Turbine Rotor Shaft

In straightening out a bent turbine rotor shaft it would be quite wrong to apply the heat to the concave surface of the bow. This is one of those numerous engineering and scientific situations in which just the opposite is done than one would guess. If the convex portion of the bow is heated quickly with a torch and allowed to cool, the shaft will straighten, or begin to straighten. What happens is this: when the convex surface of the bow in the shaft gets really hot a portion of that surface expands so quickly that the elastic limit of compression is exceeded. Then when this section cools down it will pull on the other metal fibres causing them to straighten out the shaft. The same principle would be used in truing up a turbine rotor. A forged rotor offers some difficulty as the heat has to be applied between the disks or wheels. With a built-up rotor it is possible to remove the disks and get at the shaft without interference. Under any conditions it is a big job and usually is done by specialists with considerable experience. Dynamic and static balancing should be checked after a rotor has undergone heat straightening.—*Marine Engineering and Shipping Review, Vol. 55, August 1950, pp. 76-77.*

Application of Inlet Grilles to Ventilating Systems

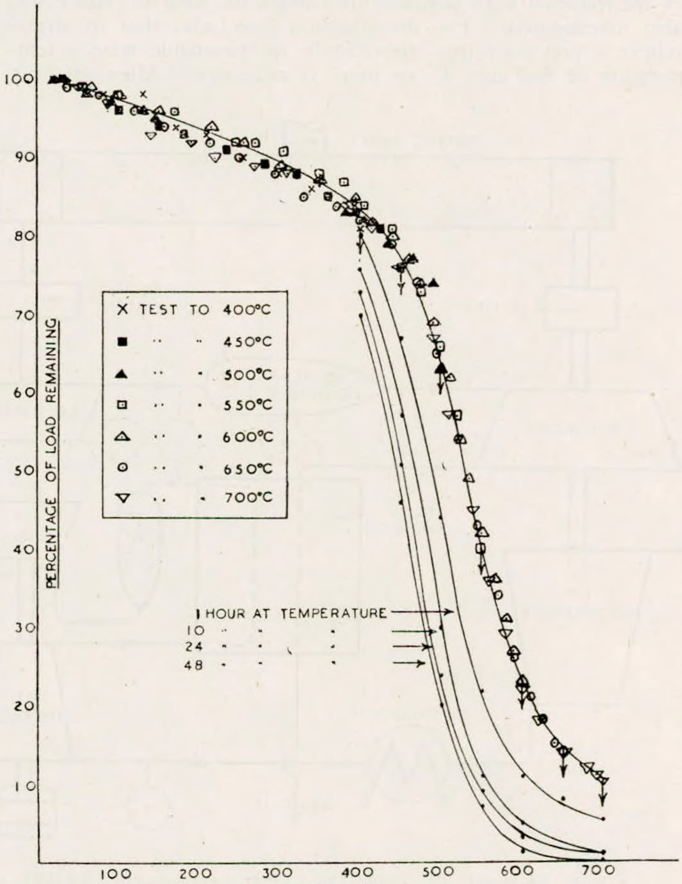
This paper presents in a practical manner the results of recent research with the object of assisting the designer of ventilating and air-conditioning systems to understand the subject on which text-books are generally vague. It has been found that for comfort and healthful conditions variable air movement is required. Draughts are, however, objectionable, and too little air movement gives rise to oppressiveness. Air flow from any outlet conforms generally to the laws governing flow from a jet, which, in the case of air, consists of a central stream gradually expanding at an inclusive angle of 3·5 deg. surrounded by an envelope of secondary circulation expanding at an angle of 14 deg. to 19 deg. It is this secondary circulation which keeps the air in the conditioned space comfortably in motion. The direction of air leaving the outlet is dependent upon the velocity and static pressure in the duct. The direction is controlled by the ratio of static to velocity pressures and by the use of guide vanes. The length of blow depends on the velocity at the outlet, the area of the outlet, and the residual velocity required. The high-velocity type of outlet using either nozzles of high-velocity louvre outlets has the advantage of effectively controlling direction and volume of each outlet and enables relatively small-sized ducts to be used.—*A. W. Evans, Journal of The Institution of Heating and Ventilating Engineers, Vol. 18, July 1950, pp. 155-172.*

Torsion of Shaft with Keyways

The torsion problem for a circular cylinder with a number of longitudinal notches is solved mathematically. In the particular case of one notch, the relationship between the maximum stress and the radius of curvature of the notch or the depth of the notch are discussed by the author. As an example, the problem of a circular shaft with one keyway in a form for practical use is solved. The results are compared with those obtained experimentally or numerically by previous investigators. It is found that there exists a considerable discrepancy between the respective theoretical and experimental findings.—*H. Okubo, The Quarterly Journal of Mechanics and Applied Mathematics, Vol. 3, Part 2, June 1950, pp. 162-172.*

Stress Relief by Heat Treatment of Cast Iron

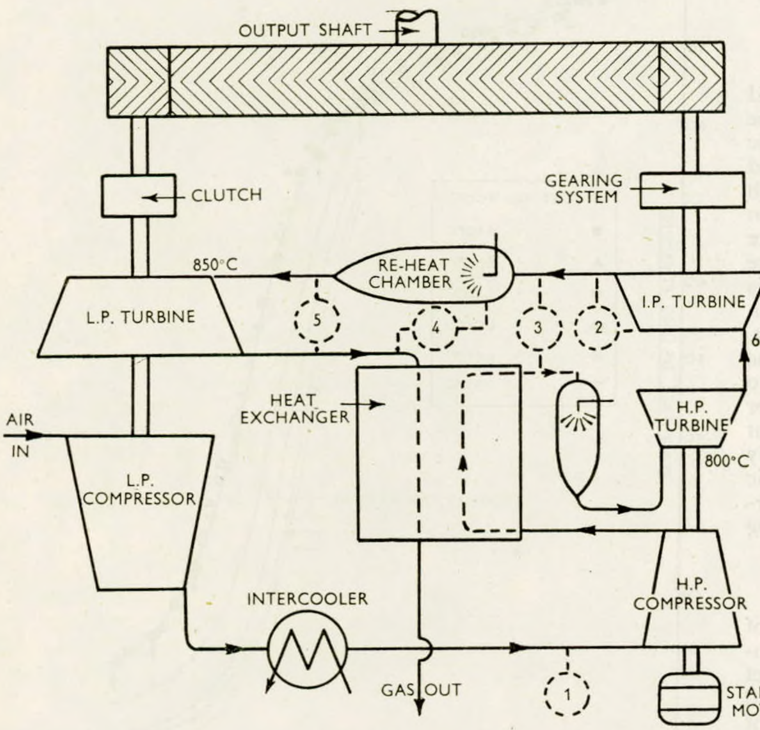
It is well known that internal stresses are present in many castings due to different rates of cooling of various section thicknesses in the casting. Little is known of the magnitude



Relaxation of load on reaching a given temperature and after 1, 10, 24 and 48 hours at temperature of these stresses or the process of their relief by heat treatment. An investigation is in progress to establish the effect of temperature and the time at elevated temperature on the progress of stress relief. It was decided to stress a test piece under conditions of measured stress and strain and then to raise the system to an elevated temperature and, maintaining the strain constant, progressively to reduce the stress. The test piece used is in the form of a ring cut radially in one place and held at a known gap. A ring test piece was chosen because it lends itself to a simple stressing procedure. A given stress applied to a ring produces a very large change in the gap compared with the extension that would be obtained under the application of the same stress in tension. It is thus possible to dispense with the use of an accurate extensometer and simplify the construction of the apparatus. Stress relieving tests were carried out at temperatures of 400 deg. C., 450 deg. C., 500 deg. C., 550 deg. C., 600 deg. C., 650 deg. C. and 700 deg. C. The rings were held for testing at a gap of 1·2 inch and required a load, which varied slightly from ring to ring, of about 4lb. to maintain the gap at room temperature. This represents a maximum stress on the ring of 9·7 ton per sq. in. The procedure for testing was to place the apparatus in the furnace at room temperature with the ring attached and then raise the temperature. The reduction of the load with both time and temperature was recorded. On reaching the test temperature the load was again recorded at intervals, depending on the rate of stress relief. The load remaining on the ring is expressed as a percentage of the initial load required to maintain the gap at room temperature, and also, after reaching temperature, as a percentage of the initial load at temperature. Fig. 5 shows the percentage of the load remaining on the rings as a function of temperature while the furnace heats up. In addition to the above tests, the extent to which the changing elastic properties of the material with temperature caused the load to reduce was also investigated. The investigation concludes that to stress-relieve a grey cast iron appreciably in reasonable time a temperature of 600 deg. C. or more is necessary. After reaching temperature, the rate of stress-relief increases with temperature over the first 20-40 hours. After this period it appears that at all temperatures the rate of stress-relief tends to become constant at any given time, irrespective of temperature. The heat treatment applied to the rings reduced the strength in all cases. An alteration in the initial stress applied to the ring did not materially change the shape of the stress-relief curve obtained while heating to temperature. About 1·5 per cent per 100 deg. C. of the initial load applied to the ring is recoverable on cooling, due, it is assumed, to the change in elastic properties with temperature of the material.—*G. N. J. Gilbert, Research Report No. 263. The British Cast Iron Research Association, Journal of Research and Development, Vol. 3, No. 7, August 1950, pp. 499-514.*

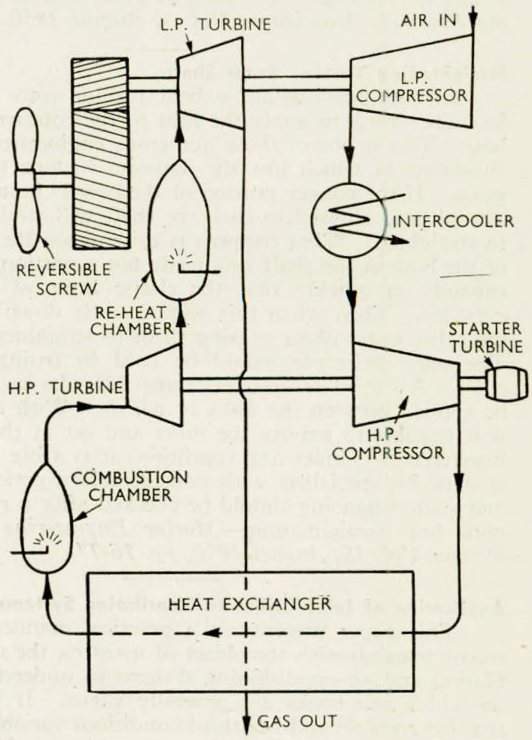
Gas Turbine Progress in France

The Compagnie Electro-Mécanique began the design of a 10,000 s.h.p. marine unit early in 1938; it was to have been fitted in a vessel of the Marine Nationale. This early design incorporated many advanced features and is worthy of study today. By referring to the cycle diagram it can be seen that there was to have been a low-pressure turbo-compressor line supplying part of the propulsive power through a clutch mechanism. The h.p. line was purely for compression purposes and would not have provided any propulsive effort. Most of the power output was to be derived from an intermediate pressure turbine, driving on to the main reduction gear through a gear system which could transform the uni-directional turbine rotation into reverse motion of the main gear. During reversing, of course, the l.p. line would have been declutched. The designed overall compression ratio was about 11·5 to 1 and the inlet temperature of the l.p. turbine was to have been 850 deg. C. (1,562 deg. F.). For operation under cruising conditions, it was proposed to use the h.p. line and the i.p. turbine only, the l.p. line being declutched. Trials of the two combustion chambers and the high pressure turbines are now virtually completed. Société Rateau since 1945 have developed



Cycle diagram of projected electro-mécanique 10,000 s.h.p. marine plant.

(1) Compressor by-pass. (2) (3) (4) Turbine safety discharge valves. (5) Low pressure turbine by-pass.



Cycle diagram of Rateau-designed 3,900 s.h.p. marine unit.

a 2,000 kW. experimental gas turbine plant. A new series of tests will soon be undertaken. Rateau have for some time been interested in the possibility of using mixed motive fluid in the gas turbine (e.g. mixed gas and steam), and there is talk of experiments along these lines being made on the 2,000 kW set shortly. The intention is to introduce steam into the cycle *without* injecting water in liquid form. The French Naval authorities are closely interested in the progress made. In collaboration with Société des Ateliers et Chantiers de Bretagne, of Nantes, the concern which builds all the marine turbines of Rateau design, a 3,900 s.h.p. marine gas turbine is now being built at Nantes for installation in a Liberty ship. As will be seen from the accompanying cycle diagram, the low-pressure line has a fifteen-stage axial compressor and a three-stage turbine. Inlet temperature to both l.p. and h.p. turbines is restricted to 700 deg. C. (1,292 deg. F.). Each compressor has a pressure ratio of 3 to 1, giving an overall compression ratio of 9 to 1. At full load, the h.p. line turns at 9,100 r.p.m., and the l.p. output line turns at 5,680 r.p.m. If the compressor and turbine efficiencies prove to be as high as those achieved on the small experimental plant, the overall thermal efficiency of the marine unit ought to exceed 30 per cent.—*The Oil Engine and Gas Turbine, Vol. 18, August 1950, pp. 139-144.*

Combined Gas and Steam Turbine

A combined gas and steam turbine having a special method of heating the condensate delivered as feed water is illustrated in Fig. 4. The compressor (1) is driven by and supercharges the engine (2). The exhaust gas from the engine passes through a steam generator (3) where more fuel is burnt and the discharge is taken to the gas turbine (4). The steam which is generated is supplied to the steam turbine (5) and exhausts into the condenser (6), eventually being delivered as feed water to the steam generator. The supply passes through the heat exchangers (9, 10, 11) used for cooling the oil in the transmission gearing (7, 8) driven respectively by the gas turbine (4) and the steam turbine (5). The lower diagram shows a type of tubular oil cooler which heats the condensate by cooling the lubricating oil and avoids the possibility of mixing the two fluids as a result of leakage. The condensate is supplied through the inlet (12) and flows through the inner tubes (13) to the outlet (14). The oil enters through the supply pipe (15) and flows over the outside of the tubes (13) to the outlet (16), the fluid being contained by the casing (17). Water, supplied as an intermediate circulating heat-exchange medium, enters through the annular jacketing spaces between the concentric tubes (13) and is discharged through the outlet (19).—*Brit. Pat. No. 639,234, R. W. Bailey and Metropolitan-Vickers Electrical Co., Ltd., London. The Oil Engine and Gas Turbine, Vol. 18, August 1950, p. 149.*

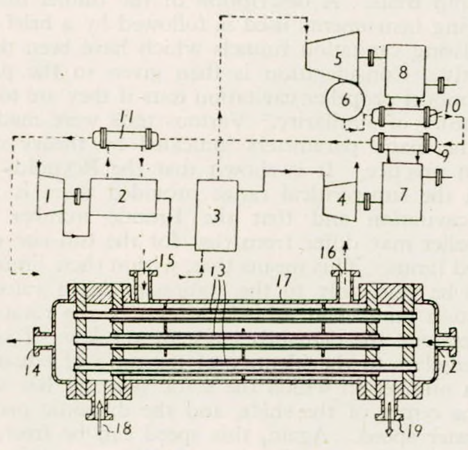


FIG. 4.

Oerlikon Radial Gas Turbine

A compact design of gas turbine is illustrated in Fig. 1. The left-hand diagrams refer to a three-stage machine. Gas enters the turbine through an inlet (1) and exhausts through a pipe (6). Four conduits (21) and another set (3) are placed between the first and second stages, also between the second and third stages. These conduits lead from the outlet (2) of a preceding stage to the inlet of the following stage. In each conduit (3) is an intermediate burner (32). Intermediate heating may be effected by an external supply, and in the right-hand diagram is shown a heat exchanger (5) incorporated in each pipe (3) in place of the combustion chambers. The heating supply for the turbine-operating gas passes through pipes (15) into the intermediate heater and out through pipes (25). This supply may be the working gas itself or the furnace gases of a steam boiler. It is indicated in the specification that the combination of radial turbines with means for intermediate heating permits an approach to isothermic expansion without requiring a considerable space for heating apparatus.—*Brit. Pat. No. 363,725, issued to Maschinenfabrik Oerlikon, Zurich, Switzerland. The Motor Ship, Vol. 31, August 1950, p. 183.*

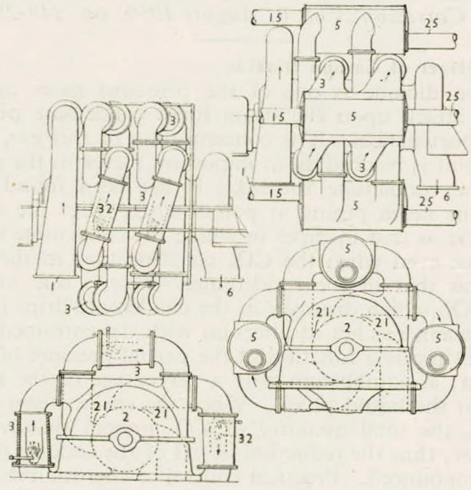


FIG. 1.

Influence of Stress upon Corrosion

This paper discusses the effects of stress upon the internal structure and energy characteristics of metals with relationship to their influence on corrosion reactions. The nature and importance of residual stresses and the non-homogeneity of worked metals are emphasized. Recent concepts of the nature of grain boundaries are reviewed and their importance in reactions where stress and corrosion act in a conjoint manner is described. A review of the literature reveals that stresses (either by applied loads or of a residual nature) may influence the nature, rate and distribution of corrosion reactions in several ways: (a) by increasing the internal energy level of the metal system and causing a possible shift of electro-chemical potential in a more active direction, (b) by causing an intrinsic increase in the rate of corrosion, (c) by damaging protective surface films, (d) by influencing polarization reactions, (e) by changing the metallurgical characteristics of the metal system in promoting phase transformations, precipitation, etc., (f) by accelerating the rate of corrosion by purely mechanical effects. The exact influence of stress on rates of general corrosion is still questionable, but does not appear to be of major consequence. The most serious effects of stress are in localized corrosion phenomena such as stress-corrosion and corrosion fatigue. Stress-corrosion of alloys is particularly discussed and the influence of metal composition and structure, environment, state and degree of stress is presented. Practically all known alloy systems can be made to crack from stress-corrosion in appropriate environments. The oxide film, mechanical and electro-chemical theories of stress corrosion cracking are reviewed and it is shown that the experimental evidence favours an electro-chemical mechanism. However, the exact mechanism of cracking may vary from one metal system to another and no theory presented thus far is adequate to account for all observed phenomenon. Stress-corrosion cracking of alpha brass, stainless steels and magnesium alloys is still not understood clearly. Methods of protection against stress-corrosion cracking are reviewed briefly.—*J. J. Harwood, Corrosion, Vol. 6, August 1950, pp. 249-259.*

Corrosive Effect of Carbon Dioxide

Carbon dioxide is one of the principal gases causing an aggressive attack upon the steam lines, condensate piping and related appurtenances. The concentration of this gas, wherever the dew point is reached, is an important factor in the aggresiveness of the condensate formed. It has been found that the corrosion in steam piping at points where drips are formed is not as severe as that in pipes in which the condensate is carried. This is true even when the CO_2 concentration in the steam is the same as that in the condensate. This is due to the fact that the CO_2, which dissolves in the condensate drips in contact with the steam, reaches equilibrium with the entrained gas, and this equilibrium is a function of the partial pressure of the total gas present; at equilibrium only a percentage of the total CO_2 dissolves in the liquid phase. When the entire steam supply is condensed, the total quantity of CO_2 present dissolves in the liquid phase; thus the reduction in pH of the condensate formed is more pronounced. Practical control of corrosion due to CO_2 in the steam lines (in the absence of oxygen) requires keeping the total concentration of this gas as low as possible. The combined effect of dissolved oxygen and CO_2 is more severe than the presence of either gas alone in the same respective concentration. It has been generally established that the CO_2 is more damaging to condensate collecting systems than the traces of oxygen usually found.—*S. T. Powell, L. G. von Lossberg, and J. K. Rummel, Combustion, Vol. 22, July 1950, pp. 37-44.*

Single-cylinder Turbine for Great Lakes Bulk Carrier

The latest single-cylinder turbine designed especially for low-powered vessels and for modernizing ore carriers on the Great Lakes is being built by General Electric for the s.s. *Homer Williams.* The equipment is scheduled for delivery to allow installation in time so that the vessel can be in regular service for the 1951 season. Steam conditions at the turbine will be 440lb. per sq. in. gauge, 740 deg. F. total temperature with back pressure at the turbine exhaust flange 1½ inch of mercury absolute. There will be eleven ahead stages and three astern stages mounted in a single casing, with separate inlets for ahead and astern operation. An opening is provided for the introduction of steam exhausted from auxiliaries at the tenth stage of the ahead turbine, thus making use of energy which would otherwise be distributed to the condenser. The reduction gear will be a two-plane double reduction gear of the single-helix locked train type incorporating the thrust bearing in the forward lower gear casing. The normal rating of the unit is 3,000 s.h.p. at 110 r.p.m. of the propeller with a maximum rating of 3,300 s.h.p. at 113·5 r.p.m. of the propeller.—*Marine Engineering and Shipping Review, Vol. 55, October 1950, p. 43.*

American Turbines in Dutch Vessels

Four Dutch vessels will be equipped with American-built steam propulsion plant of the type supplied by the General Electric Company, Schenectady, for C3 class vessels. The first of this group of ships is the *Diemerdijk* of the Holland America Line, which has recently been delivered by the Wilton-Fijenoord yard. Her two Foster Wheeler D-type water-tube boilers are also of United States origin but were assembled from components in the Dutch yard. Her sister ship, the *Dinteldijk* is being altered while under construction to convey a large number of passengers at low cost and will be renamed *Rijndam.* The third vessel is the Rotterdam Lloyd *Ampenan* building at the Rotterdam dockyard, while the fourth is the *Billiton* for the Netherlands Royal Mail Line, in hand at the Caledon Shipbuilding and Engineering Co., Ltd., Dundee. The propulsion equipment furnished for each vessel consists of one cross compound double-reduction geared turbine set having a normal rating of 8,500 s.h.p. when operating with steam at 440lb. per sq. in. gauge, 740 deg. F. total temperature at the steam-strainer inlet, and an absolute back pressure of 1·5 inch. The set consists of an eight-stage, 6,159 r.p.m. high-pressure turbine and an eight-stage 3,509 r.p.m. low-pressure turbine, each connected through flexible couplings to a double-reduction gear. The corresponding propeller speed is approximately 85 r.p.m. The set is capable of developing a maximum of 9,350 s.h.p. at approximately 88 r.p.m. A two-stage velocity-compounded astern element is included in the forward end of the low-pressure turbine. Under normal steam conditions, and with a steam flow equal to the normal ahead steam flow, the astern turbine will develop 80 per cent of normal ahead torque at a propeller speed of approximately 42·5 r.p.m. The set can be operated astern at approximately 65 propeller r.p.m. for a period of one hour. Three bleeding points are provided in the main machinery for the extraction of steam. Steam flow to the set passes through a manœuvring valve manifold which contains a steam strainer, an ahead valve, an astern valve, and an astern guarding valve. In addition to the ahead valve, steam admission to the ahead turbine is controlled by a governor valve included in the manœuvring valve manifold, and by three hand valves giving admission to three groups of three, six, and twelve nozzles at the high-pressure turbine. There are twelve permanently open nozzles. Steam to the astern turbine is direct from the astern-guarding and astern valves in the manifold.—*The Marine Engineer and Naval Architect, Vol. 73, October 1950, pp. 429-433.*

Cavitation on Screw Propellers

A report is given of research work carried out on the similarity of cavitation phenomena and a method of evaluating model results for full-size screws and their comparison with the results of ship trials. A description of the tunnel installation and measuring instruments used is followed by a brief account of other existing cavitation tunnels which have been developed independently. Consideration is then given to the principles underlying model propeller cavitation tests if they are to comply with the theory of similarity. Various tests were made to see which of the many parameters indicated by theory could be neglected in practice. It is shown that the Reynolds number must lie in the supercritical range provided there is no fully developed cavitation and that the Froude number for the model propeller may differ from that for the full-size propeller within stated limits. This means that, within these limits, attention has to be paid only to the stationary mean value of the local cavitation number at a blade section of the rotating propeller. Therefore, the demands made by the laws of similarity confine themselves to the identity of the ratio of advance, and a cavitation number in which the static pressure has to be referred to the centre of the shaft, and the dynamic pressure to the open water speed. Again, this speed can be freely chosen within the limits laid down by two subsidiary conditions which result from the influences of the Reynolds and Froude numbers. The practical range for systematic cavitation model experiments due to the limited choice of speed has been extended for a certain range of Froude numbers for the full-size propeller. It has been possible to confirm all these deductions and assumptions from the similarity tests by comparing model experiments with corresponding measured mile trial results, where marked cavitation influence has been apparent. For this purpose, it was necessary to re-calculate the results of the model tests with the propeller working in open water, starting from the thrust which has to be developed for a definite ship speed. This calculation is carried out in detail. There is a bibliography.—*H. Lerbs, Hamburgische Schiffbau Versuchsanstalt, Report No. 882, 1944. Admiralty Department of Research Programmes and Planning. ACSIL/ADM/50/166. Translation No. 431, 1950. Journal, The British Shipbuilding Research Association, Vol. 5, August 1950, Abstract No. 3,918.*

Unusual Steering Gear

The motor sealing vessel *Polarstar* owned by Mr. Martin Karlsen, Brandal, Norway, was built by James Lamont and Co., Ltd., Port Glasgow, and was especially designed and built to meet the exacting conditions of sealing operations in arctic regions, and it is probably the best equipped ship engaged in this trade. One of the unique features of equipment on board is the special steering gear and controls which were designed and manufactured by Donkin and Co., Ltd., Newcastle-on-Tyne, solely for sealing operations. It was desired to have the gear arranged so that it could be easily controlled from the crows nest as this is the best position for a man to observe seals in the quickest time. Hitherto the lookout man in the crows nest has had to shout orders down to the helmsman on the bridge, but in this case it is possible for him to steer the ship direct. As far as is known this is the first time that such an arrangement of steering has been done, and after the first season of service it was reported that the Donkin electric hydraulic steering gear had worked perfectly and the special controls had greatly facilitated the passage of the ship through ice. In order to provide the lightest possible unit in the crows nest the control was made up of a spring-loaded right- and left-hand switch which the helmsman can hold over to give port or starboard movement of the rudder, the switch being released as soon as the rudder has reached the desired position indicated by an electric rudder indicator. Limit switches are provided with the gear to prevent over-running at the hardover position. Change-over switches are provided on the bridge so that either of the three steering positions, namely, crows nest, flying bridge or main bridge can be selected. Only one of these positions can be in control at one time.—*Canadian Shipping, Vol. 21, August 1950, p. 30.*

Five-bladed Propellers

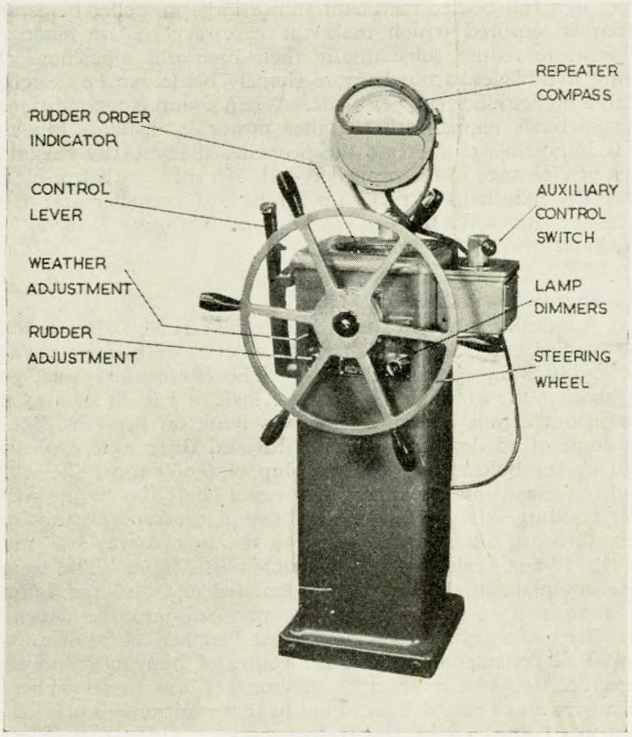
Propellers for merchant ships have long been standardized with three or four blades, and a five-bladed propeller is as yet quite unusual. However, with the increasing use of higher speeds and powers, the advantage of using five-bladed propellers for smoothness of operation and reduction of vibration will become more apparent, and lead to their more frequent use. The article includes illustration of a five-bladed propeller of 18-feet diameter designed by the author and in operation on two sister ships, where it replaces four-bladed propellers of the same diameter. These ships are turbine-driven vessels. The five-bladed wheels were installed to remedy a troublesome rumble in the reduction gears, which was cured completely by the change. An interesting feature of this change to five-bladed wheels was that the performance of the vessel was improved. Actual performance figures over a six months period are given in the article. One of the chief features or the five-bladed propeller is its effect in reducing vibration. This is of two types —hull vibration and torsional shaft vibration. Both arise from the same cause. In a single-screw ship, whenever a blade passes the stern frame, it is shrouded by the stern frame, which results in a drop both in torque and in thrust. Due to this effect, the propeller torque is not constant, which results in a like variation in the shaft torque. Similarly, the propeller thrust also varies, which produces a like variation in the hydraulic pressure on the ship's hull. The propeller acts like a pump, and this variation in pressure causes a pulsation in the flow which tends to set up vibration in the hull, or some member of the hull which has a natural period that synchronizes with this pulsation. Every propeller, whatever its design, is subject to this variation in torque and thrust due to the blades passing the stern frame. Turbine designers allow for a certain percentage of variation in torque when designing the turbine, but sometimes do not allow enough. In the present case there was a troublesome rumble in the low-speed reduction gears. This may have been due to unbalance in the turbine, as by by-passing more steam to the low-pressure turbine the rumble disappeared, but this was wasteful of steam. The installation of a five-bladed propeller, however, reduced the amount of variation in torque and effected a complete cure. As regards efficiency of propulsion, in a full-bodied merchant ship a large propeller blade area often is required which makes it necessary to use blades so wide as to reduce substantially their hydraulic efficiency. By using five blades, a much more shapely blade can be designed, with a higher efficiency per blade. When a ship is reconditioned, it sometimes happens that higher power is installed but that it is impossible to increase the propeller diameter by reason of lack of clearance in the propeller well. In this case a five-bladed propeller may help to make up for lack of diameter and avoid excessive slip.—*Marine Engineering and Shipping Review, Vol. 55, September 1950, pp. 63-64.*

The *Breconshire* Raised Off Malta

Admiralty salvage experts have raised H.M.S. *Breconshire,* the former Glen liner which made a series of historic voyages to supply Malta during the war. The *Breconshire* was lying in about 60ft. of water in Marsa Xlokk, a bay in Malta, and was about a mile offshore. She was lying on her port side at an angle of 85 deg. from the vertical and there were explosives still in her holds. An unusual ship of 9,600 tons, she was a tanker forward and normal cargo vessel abaft the engine room. Her flooding valves were open and five plates were missing from her starboard side. In April 1949 the first survey was made and a 12-feet scale model constructed in Malta. The weight of every plate in the ship was calculated and also the amount of air which could reasonably be pumped into the wreck to give her buoyancy. It was discovered that her centre of gravity would be considerably above her centre of bouyancy and that, therefore, the best method of moving her was to allow her to turn over on to her back and float in that position. This deduction was confirmed by the 12-feet model. The actual work of salvage started in April this year with the cutting away of 100 tons of superstructure. To close the flooding valves the divers had to enter a 3-feet cofferdam feet foremost and make their way along it to a space near the double bottom in complete darkness. The damaged plates were taken ashore, rolled flat and replaced by the divers. Some 40 air connexions had to be fitted under water. Blowing started on 7th August in the double bottoms and two days later the oil tanks were blown. Her bows lifted and she pivoted over on her stern, finally coming to rest at 25 deg. from the vertical, with her stern still on the bottom. Then air was blown into the after cargo spaces and she rose gently to the surface, bottom up.—*The Shipping World, Vol. 123, 13th September 1950, p. 200.*

Automatic Steering Control

The Athel Line tanker *Athelbeach* is the seventh ship of that line to be equipped with the new Sperry automatic steering control system. . The basic idea of the new control gear is to combine into one unit the steering wheel and gyro-pilot ta present fitted as separate installations, to some extent duplicating each other, in many ships. One single bridge unit is provided, with which the ship may be steered in normal hand control or, by moving a lever, in automatic control. Apart from this unit, the only other items of equipment carried on the bridge are a rudder angle indicator, mounted separately on the bulkhead, and, if desired, a course recorder. If, as in the *Athelbeach,* a standard compass of the projector type is used, the magnetic steering compass may also be eliminated. The bridge control unit, which is shown in the accompanying illustration, resembles to some extent earlier types of gyro pilot, but has a larger steering wheel, which is used both for hand steering and for setting the automatic control to a particular course. When in hand steering, a certain amount of turn on the wheel corresponds to a certain amount of rudder angle, as is usual. When in automatic steering, one complete turn of the wheel corresponds to an alteration of course of three degrees. It can be seen, therefore, that it is intended to be used when in automatic for adjustments or small alterations of course only. For larger alterations or to put the ship's head on to the right course in the first place, hand control is used. When the control lever is put from "Hand" to "Automatic", the ship will maintain whatever course she was on at that instant. The



Bridge control unit

control unit is surmounted by the usual gyrocompass steering repeater, and also contains a rudder order indicator geared directly to the steering wheel to show the helmsman what helm has been applied when in "Hand". When automatic steering is in use the movement of the rudder can be observed from the rudder angle indicator mounted on the bulkhead. There are two further controls on the unit, a rudder adjustment and a weather adjustment. These are set when in automatic steering, by the officer of the watch, to the position in which he finds the ship steering most easily. Both introduce a small lag into the control system, but at different places. The rudder adjustment varies the amount of rudder which is automatically applied for the first small deviation which the ship makes from her true course. It is set in accordance with the trim and loading of the ship, and need not normally be altered once the voyage has commenced. Too coarse a setting will make the ship sluggish in returning after yawing, while too fine a setting may produce a "hunt" either side of the true course. The weather adjustment alters the amount of yaw which is permitted before correcting rudder is applied. Normally this should be in the zero position, giving instantaneous correction. In rough weather, however, it will be found that the ship will steer more easily and the strain on the steering motor will be eased if a little initial yaw is permitted.—*The Shipping World, Vol. 123, 6th September 1950, p. 191.*

Electric Propulsion Regulating Device

The time taken to stop a ship is reduced if, instead of reversing the propellers immediately, the revolutions are maintained in the ahead direction at about one-quarter full speed until the ship's speed has fallen to about one-third, the propellers then being reversed to effect final stopping. The curve A in Fig. 2 represents the counter torque of the propeller while the ship is at full speed, plotted against the revolutions. Curves B and C are for lower speeds. The curve D represents the braking torque available and it will be seen that the propeller speed falls rapidly to that represented by the point on the line (N) where the curves A and D intersect. If the braking torque remains unchanged, the propeller speed will tend to dwell at N as the ship continues to lose way. By reducing the braking torque of the machinery, represented by the curves E and F, while the working characteristic of the propeller falls from A to B and C, the propeller speed can be maintained constant at N over a wide range of the ship's speed reduction. Diagrammatically, there is represented an alternator (1) supplying current to a motor (2) which drives the propeller (3). When the controls are moved to slow or stop, over-excitation is applied to the alternator field by closing a switch (9), thus short circuiting a resistance (10) in the field circuit of the exciter (11). An

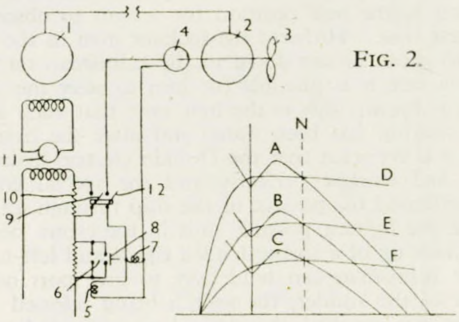
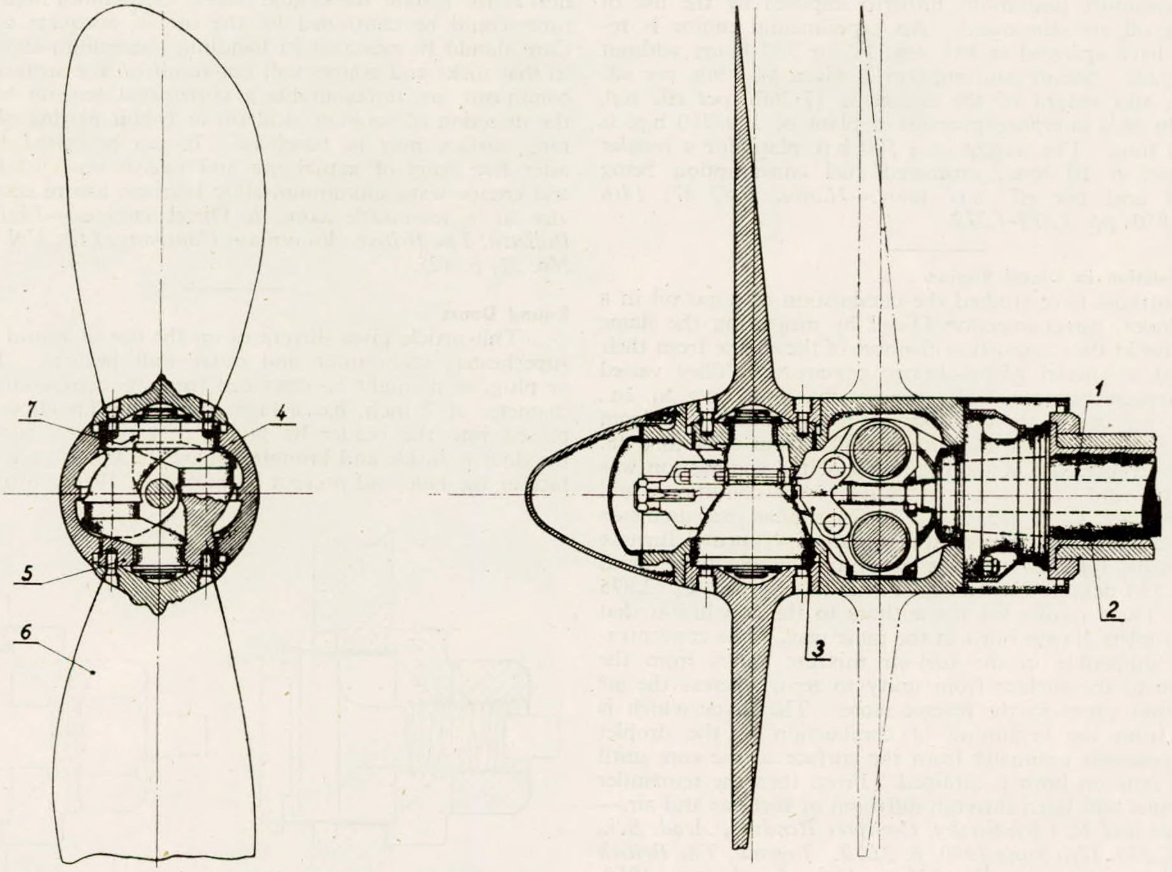


FIG. 2.

auxiliary contact (12) closes the circuit between the tachometer generator (4) and the coils (5, 7). While the propeller is losing speed, the voltage of the generator (4) causes the contact (8) to open, thus allowing the voltage regulator to function. The propeller speed falls to the desired lower revolutions (N) and the voltage regulator (6) exerts enough resistance in the alternator exciter field circuit to reduce the braking torque. The contact (8) subsequently closes, and the alternator is over-excited as before, so that the propeller reverses and synchronizes normally. When the machines have synchronized, and the over-excitation switch (9) is opened, the auxiliary contact (12) also opens and the automatic control is rendered inoperative.—*Brit. Pat. No. 637,221, issued to General Electric Co., Ltd., and R. G. Jakeman. The Motor Ship, Vol. 31, September 1950, p. 213.*

Dutch Ferries with Variable-pitch Propellers

In Holland two modern motor ferries with different types of variable pitch propeller and machinery installations are now engaged on the Flushing to Breskens service at the mouth of the Scheldt. The older design is that of the *Prins Bernhard* which, due to the fact that a directly coupled Diesel engine of the power required was not available at the time, has four engines geared to the single fore-and-aft shaft. After careful study and as a result of comparisons between Diesel-electric and direct drives, two reversible propellers were ordered from Escher Wyss in 1939. The ship model was thoroughly tested in the Dutch tank at Wageningen, and the propeller speed was fixed at 253 r.p.m. The four main engines are non-reversible single-acting trunk piston de Schelde-Sulzer four-stroke engines each with seven cylinders 320 mm. bore by 460 mm. stroke. At 375 r.p.m. the output of each engine is 580 b.h.p., giving an installed total power of 2,320. The other vessel, i.e., the *Koningin Juliana,* is equipped with a non-reversible single-acting trunk-piston de Schelde-Sulzer engine having nine cylinders 480 mm. bore by 700 mm. stroke and developing 2,500 b.h.p. at 208 r.p.m. This vessel is equipped with variable pitch propellers of de Schelde design. A feature of this four-bladed design is that the hub is of almost normal diameter, but due to considerations of mechanical construction, the four blades cannot be placed in the same axial plane. Models of this pattern were tested in the Wageningen experiment tank to determine whether an appreciable loss of efficiency would result from placing the blades in two planes. For the required power, however, this loss proved to be negligible and after full-scale tests with two tugs used by the de Schelde yard the propellers of the *Koningin Juliana* were built to this design. Referring to the drawing, the blades are actuated



Sectional drawings of the de Schelde propeller

by a control rod (1), which is located in the hollow tail shaft (2). Each blade of the propeller is attached to a crank-shaped spindle (4) and the journals of the two spindles in the same plane engage with one another (7) to form a strong assembly with bearings in the hub (5). The cranks are connected by means of links (3) to the control rod, and blade movement results from axial displacement of this rod. As the bearings are situated at the periphery of the hub, the smallest possible reaction forces are transmitted to the bearings, an arrangement resulting in reduced wear and tear. Due to the co-axially placed journals for each pair of blades it is impossible to arrange for a second pair of blades in the same plane and the tandem two-bladed type of propeller has been adopted. This, however, has resulted in the advantage of a smaller diameter hub and one which is, furthermore, not weakened by too many large diameter openings in the same plane. The control system employed with the de Schelde propeller is, in general, similar to the Escher Wyss arrangement, power being derived from a servomoter contained within the shafting.—*The Marine Engineer and Naval Architect, Vol. 73, September 1950, pp. 385-394.*

Novel Light Weight Steam Propulsion Plant

A novel light-weight steam propulsion plant especially suitable for river vessels has been developed in Germany. This plant consists of a drumless water-tube boiler of the natural circulation type for 600lb. per sq. in. operating pressure and 797 deg. F. steam temperature and a multi-cylinder high-speed steam reciprocator designed to operate without cylinder lubrication. Referring to Fig. 3, the piston is connected with the cross-head by a swivel joint so as to allow self-centring of the piston in the cylinder without touching the cylinder walls. This self-centring action is produced by the slight blow-past of steam between cylinder wall and the special labyrinth grooves in the piston. The amount of steam leaking past the piston is given as 2 per cent. The cross-head guide is seen to extend into the piston skirt. By omitting cylinder lubrication, the

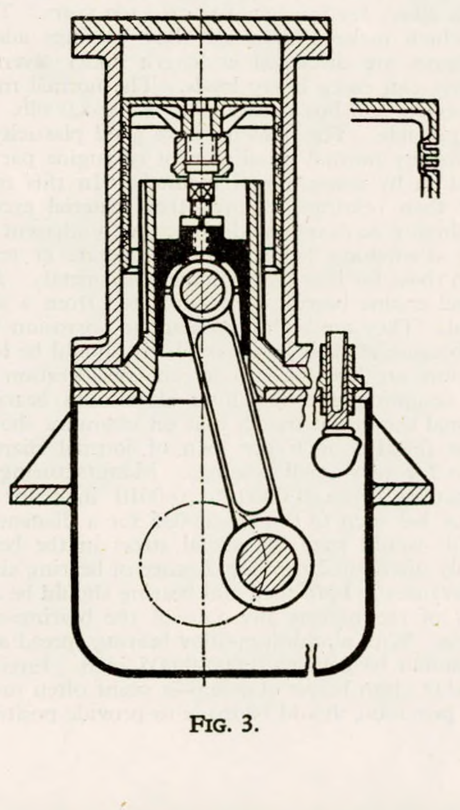


FIG. 3.

steam temperature limitations hitherto imposed by the use of lubricating oil are eliminated. An experimental engine is reported to have operated at 887 deg. F. for 500 hours without giving trouble. Steam consumption is given as 9·9lb. per eff. h.p. hour, and weight of the engine is 17·26lb. per eff. h.p. The weight of a complete propulsion plant of 200/240 h.p. is given as 6 tons. The weight of a 500 h.p. plant for a trawler is estimated at 10 tons; estimated fuel consumption being 0·99lb. of coal per eff. h.p. hour.—*Hansa, Vol. 87, 14th October 1950, pp. 1,278-1,279.*

Fuel Combustion in Diesel Engine

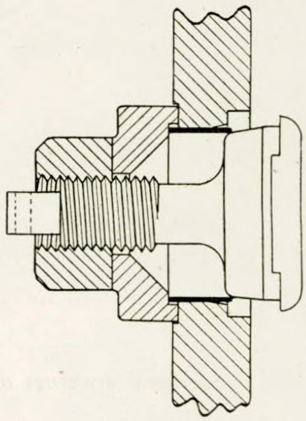
The authors have studied the combustion of a gas oil in a single-cylinder, direct-injection Diesel by measuring the flame temperatures in the combustion chamber of the engine from their colour with a special photo-electric pyrometer. They varied the air pressure between 1·4lb. per sq. in., 2·8lb. per sq. in., 4·3lb. per sq. in. above atmospheric, the injection lead from 12·5 to 20 deg., and the mixture strength from 0·34 to 0·48. The flame temperature at the beginning of the combustion was found to be nearly constant irrespective of the conditions, and about 1,680 deg. C. (3,055 deg. F.). In similar measurements of the maximum flame temperatures in an experimental furnace with the same type of fuel, the maximum temperature varied between 1,530 deg. C. (2,785 deg. F.) and 1,580 deg. C. (2,875 deg. F.). These results led the authors to the conclusion that the fuel droplets always burn in the same way. The concentration of combustible in the fuel-air mixture varies from the centre core to the surface from unity to zero, whereas the air concentration varies in the reverse sense. The flame which is apparent from the beginning of combustion of the droplet therefore proceeds gradually from the surface to the core until the upper ignition limit is attained. From then the remainder of the droplet will burn through diffusion of fuel gas and air.—*G. Monnot and R. Vichniersky, Comptes Rendues, Acad. Sci., Paris, Vol. 230, 12th June 1950, p. 2,079. Journal, The British Shipbuilding Research Association, Vol. 5, August 1950, Abstract No. 3,968.*

Aluminium Alloy Bearings in Diesel Engines

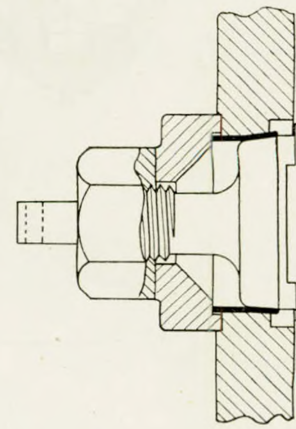
According to an article by D. B. Wood in the August 1950 issue of *Diesel Progress,* the Aluminium Company of America have been experimenting on the development of aluminium alloys for bearings for over ten years. The characteristics which make aluminium alloy bearings adaptable for Diesel engines are discussed at length under seven headings. These alloys can carry heavy loads. The normal maximum is 5,000lb. per sq. in., but occasionally 7,500-8,000lb. per sq. in. loads are possible. The bearings have good plasticity, and will conform to any normal misalignment of engine parts and can be scraped in by conventional methods. In this respect they are better than bearings in any other material except babbit. They are highly resistant to adherence with adjacent parts, and their heat dissipation helps them to operate at temperatures lower than those for bearings of some other metals. Aluminium alloy Diesel engine bearings are fabricated from a single piece of material. They are highly resistant to corrosion by modern oils, and because of their basic simplicity should be low in cost. Other factors are discussed to which consideration should be given in designing and installing aluminium bearings. The high thermal expansion means that oil clearance should always be at least 0·00125 inch per inch of journal diameter, with 0·002 inch for very small bearings. Manufacturing tolerances should increase from 0·0000 to 0·0010 inch for a journal diameter of 1-3 inch to 0·0000-0·0035 for a diameter of 12-20 inch. This would keep the actual stress in the bearing shell more evenly distributed through a range of bearing sizes. Stress due to tolerances in both shell and bearing should be considered. The taper of the parting line face of the bearing also affects crush stress. With aluminium-alloy bearing spread at the parting line should be held to 0·000-0·005 inch. Engines should be reasonably clean before starting—a point often overlooked—and some provision should be made to provide positive lubrication at the instant the engine starts. Sometimes high temperatures could be controlled by the use of adequate oil coolers. Care should be exercised in handling aluminium-alloy bearings so that nicks and gouges will not result on the surface. Where conditions are unfavourable a corrugated bearing surface (in the direction of rotation) and tin or babbit plating of the running surface may be beneficial. It can be stated fairly that after five years of actual use and twelve years of laboratory and engine tests, aluminium-alloy bearings assure excellent service at a reasonable cost in Diesel engines.—*Light Metals Bulletin, The British Aluminium Company, Ltd., Vol. 12, 1950, No. 21, p. 825.*

Round Doors

This article gives directions on the use of round doors for superheater, economizer and outer wall headers. The door, or plug, as it might be described from its comparatively small diameter of 2 inch, has a taper lip. This lip allows it to be passed into the header by giving it a sideways twist. Once the door is inside and brought square the lips engage the inside face of the hole and prevent withdrawal. Before fitting a door



A



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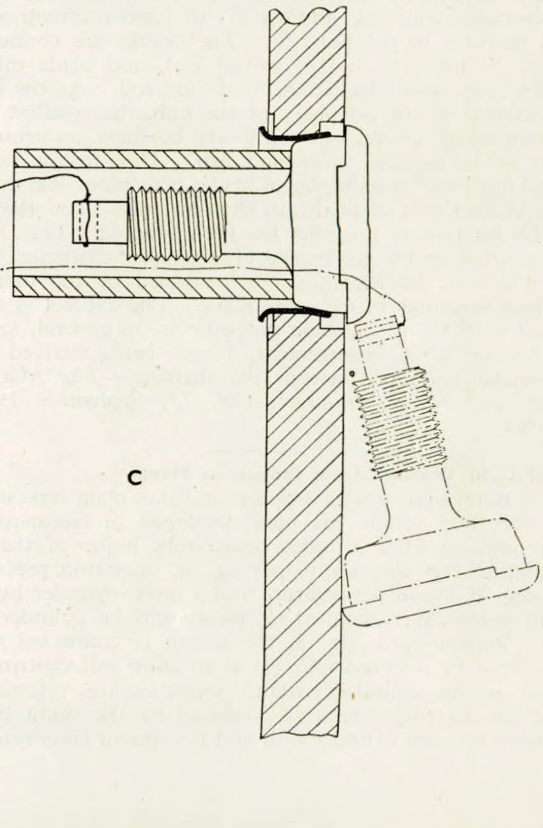


C

it is necessary to secure a piece of wire, about 12 inch long, to a hole in the stem. Having done this and passed the door into the header and pulled it into position the gasket—a metal brush ring shown in black in the accompanying sketches—is inserted into the hole with the square edge towards the operator; a plate, or dog, is then passed over the stem and secured with the nut, care being taken that the gasket fits squarely into the recess in the plate (see Fig. A). The nut ns tightened with a spanner, making sure that the dog is in contact with the header spot face. A small key used on the flats of the stem prevents the door from rotating until the gasket binds the door into the hole by being forced up the tapered body. A special spanner may be used on the dog or plate to prevent its rotation. The final state after securing is shown in Fig. B. To make inspection without renewing the gasket, remove the nut and dog, and secure a length of thin wire through the hole in the door stem. With a piece of pipe large enough to go over the stem, drive the door into the header. Slight marks should be made on the header and door to ensure that the door is reseated in approximately its original position. It is not advisable to reseat a door on an old gasket more than once. To renew the gasket turn over its edge before knocking in the door, this ensures that it will remain in the hole. The gasket may then be crushed and removed, and the door withdrawn (see Fig. C).—*The Naval Engineering Review, Vol. 33, July 1950, p. 88.*

New Model Resistance Data

The Society of Naval Architects and Marine Engineers, New York, has announced that the Hydromechanics Subcommittee of its Technical and Research Committee has completed a second group of model resistance and expanded resistance data sheets, for twenty unrelated models. This is in continuation of the project covering the compilation of data on ship resistance being carried out under the auspices of the society and directed by outstanding members of the industry. These new data sheets comprise pertinent information on twenty selected ship models tested at various establishments and twenty sets of data obtained by expanding the test results of these models to 400-feet ship size. With the forty previously released, there are now available data on a total of sixty models. The objective of this project is to make available on standardized forms to naval architects and marine engineers comprehensive information on a varied group of ship models giving model resistance data and the resulting expanded resistance data.—*Marine Engineering and Shipping Review, Vol. 55, October 1950, p. 40.*

Tanker Pipe-line System

The pipe-line system developed by David Williamson, Ltd., of London, utilizes the recesses formed through corrugating or fluting longitudinal bulkheads in an oil-tank ship. By enclosing the lower corrugations with plates of suitable form and size, welded to the bulkhead plating, conduits are formed, which can be used as substitutes for the usual pipe-lines. This form of construction, where vessels have pump rooms spaced so as to isolate groups of tanks for the carriage of special grades of oil, lends itself to complete isolation and immunity from contamination. With an eight-tank ship, having a pump room between Nos. 4 and 5 tanks, the arrangement on the port side would be to have the lowest enclosed conduit on the longitudinal bulkhead carried through to No. 1 tank without break, while the second enclosed conduit would be carried through to No. 3 tank. Similar arrangements aft of the pump room would deal with Nos. 7 and 5 tanks. The even-numbered tanks would be dealt with in a similar manner, using the lower conduits of the starboard longitudinal bulkhead. This arrangement eliminates the necessity of fitting isolating valves at each transverse bulkhead, which is usual in present pipe-line arrangements; in fact, the transverse bulkhead would not need to be pierced at all. Dealing with the normal single-grade oil-carriers, having one pump room situated aft, only the lower corrugation in the two longitudinal bulkheads would need to be enclosed, with the cross-over line arranged at No. 1 tank. If isolation valves were required, they could be arranged in the lines at each tank. It is claimed that this system is particularly suitable for vessels of high pumping capacity, as the enclosed corrugations would have a cross-section nearly equal to a 20-inch pipe-line. In order to guard against undue corrosion, the surfaces would be flame-cleaned and coated with inert resin paint before closure, and, after welding, the lower vee formed in the duct would be filled with polyvinyl cement, while the upper vee would be sprayed with inert resin paint.—*The Shipbuilder and Marine Engine-Builder, Vol. 57, October 1950, p 662.*

New Diesel-electric Tug

The Diesel-electric *Esso Tug No. 9* has a length overall of 102ft. 2in., in a moulded beam of 25 feet, and moulded depth of 12ft. 4in. Normal draught is 10ft. 1in. Of all-welded steel construction, it was built to the requirements of the American Bureau of Shipping for harbour and coastwise service. Power for main propulsion is supplied by a 12-cylinder, 2-cycle General Motors Diesel engine, rated 1,200 h.p. at 750 r.p.m., and direct-connected to an 814 kW., 560-volt Allis Chalmers d.c. generator, which in turn supplies current to a 1,020 h.p. 560-volt Allis Chalmers d.c. propulsion motor, operating at 700-875 r.p.m. The motor is directly connected to the high-speed pinion shaft of the Farrel Birmingham reduction gear. Over 1,000 s.h.p. at 160-200 r.p.m. can be delivered to the three-bladed propeller. The motor speed and, correspondingly, the propeller and ship's speed, can be controlled from any one of three stations—the pilot house, the engine room or the afterdeck conning station. When under heavy tow, the motors can be operated at reduced speed, but at full voltage, full power and full engine speed, by increasing the field current to a value which will allow maximum armature current without overload. The motor fields are protected against overheating at stalling condition by a field reducing contactor. A current-limiting device, which regulates the generator field current, is provided to limit the current in the propulsion loop to 125 per cent of full load value, and to protect the electrical machines against momentary excessive current caused by rapid acceleration and reversing.—*Motorship, New York, Vol. 35, September 1950, pp. 37-39.*

First English Channel Motor Train Ferry

The Diesel-engined train ferry *St. Germain* on order for the French National Railways will be the fastest and biggest vessel of this type to be constructed for the cross-Channel route. The deckhousing will be streamlined, and with a low funnel and sloping bow this will be an extremely striking vessel. Although her machinery will be sufficient to give her a speed of 18 knots and is of substantially higher power than that of the two British vessels *Shepperton Ferry* and *Hampton Ferry* on the Dover-Dunkirk run, the engine room is very much shorter, being about 85 feet against 110 feet for the combined engine-room and boiler room. The *St. Germain* is to be built by the Elsinore S. B. and E. Co. of Elsinore, Denmark. Overall length will be 379ft. 6in., length on waterline 366ft. 7in., breadth over fenders 62ft. 2in., breadth moulded 60ft. 6in., maximum deadweight 1,300 tons and loaded draught 13ft. 6in. The lines of the ship were designed after extensive trials had been carried out in the tank at Wageningen. The frames are riveted to the plating and one strake is riveted, but electric welding is employed for the greater part of the rest of the hull. For the support of the train deck and the superstructure reinforced web frames are employed. At each side of the engine-room are the heeling tanks. Two nine-cylinder B. and W. main engines are to be installed. They will be of the trunk-piston two-stroke type with cylinders 500 mm. in diameter, the piston stroke being 900 mm. and the normal revolutions 180 r.p.m. with a maximum of 195. The *St. Germain* is being built to the regulations of the Bureau Veritas and is due to be ready for service during the summer of 1951.—*The Motor Ship, Vol. 31, September 1950, pp. 204-206.*

New Cunard Cargo Liner

The new 8,700-ton Cunard cargo liner *Assyria* is a sister ship of the post-war cargo liners *Asia* and *Arabia.* She embodies the most modern features of cargo ship design, can carry 9,000 tons of cargo on 27ft. 7¾in. at a service speed of 16 knots, and has extensive insulated cargo spaces for the carriage of foodstuffs. Deck equipment is all electrically operated. The principal particulars of the new ship are as follows:—

Length, b.p.	480ft. 0in.
Breadth moulded	63ft. 9in.
Depth, moulded to upper deck	34ft. 10in.
Gross tonnage	8,683 tons
Nett tonnage	5,013 tons
Deadweight capacity, about	11,500 tons
Cargo capacity: Grain	463,994 cu. ft.
Bale	429,581 cu. ft.
Insulated	120,572 cu. ft.

Like the propelling machinery of the two earlier cargo liners of this class, the main turbines have been built by Richardsons, Westgarth and Co., Ltd., Hartlepool Engine Works, and consist of a single set of double-reduction geared turbines driving a four-bladed manganese bronze screw. All essential auxiliaries are electrically operated so that, at sea, steam is used for propulsion only. The boilers, which are oil fired, are of the Foster-Wheeler "D" type, giving high boiler efficiency in conjunction with a closed feed system. The service output of the machinery is 7,250 s.h.p. at 116 r.p.m. The ahead propelling machinery consists of two turbines, designed to use steam at an initial pressure of 455lb. per sq. in. and a temperature of not less than 750 deg. F., each driving a separate pinion and each gearing with a separate primary wheel. These are mounted on the secondary pinion shafts, the teeth of which are geared with a common wheel coupled to the propeller shaft. The h.p. turbine is of impulse reaction design and the l.p. turbine of pure reaction type. Two turbines are provided for astern working and are incorporated in the h.p. and l.p. ahead turbine casings respectively. Several new features, based on recent research, are embodied in the turbines. Principal of these are improved section turbine blades, special glands of the labyrinth type, hollow low-pressure rotor, and very effective drainage of the low-pressure turbine exhaust section to prevent erosion of the final stages of blading and the turbine cylinder in that region. The low-pressure turbine casing is of fabricated type. Shaft pedestals and the blade cone are of cast steel with a welded steel exhaust belt and branch to the condenser, the design being so arranged as to avoid misalignment under uneven temperature conditions. Manœuvring valves are fitted to control steam to the ahead and astern turbines, and strainers of stainless steel are inserted in the ahead and astern turbine inlet branches. During the trials of the vessel off the North-East Coast an interesting test was carried out. The machinery was run with the ballast pump only circulating the main condenser in order to ascertain just how much power could be developed under these unusual conditions and whether this power would be sufficient for seaworthiness. The ship was run for a time under these conditions, when 3,565 s.h.p. was developed at 92 r.p.m. The speed was appreciably in excess of 10 knots but the actual figure is not known. The drop in condenser vacuum was no more than ½ inch, although the condenser circulating water outlet temperature was naturally higher than with normal operation. The outlet temperature when using the ballast pump for circulating the condenser was 93 deg. F. as against 58 deg. F. when circulating in the normal manner at full output. In both cases the inlet temperature was 53 deg. F.—*The Marine Engineer and Naval Architect, Vol. 73, October 1950, pp. 413-419.*

Ship Model Testing

This report concerns an investigation of the behaviour of a ship model when struts of varying size are towed ahead of it at varying distances from the stem at the waterline. The model used is described and the results of the tests are set out in graphs. It is concluded that with vessels of normal form a strut ⅛-inch square or slightly smaller, placed about 8 inch or 12 inch from the model will produce the maximum increase in resistance at any speed of interest in a cargo or cargo and passenger vessel. It is felt that this conclusion may be applied to most vessels other than the most extreme and unusual types. —*M. R. Evans, National Research Council of Canada, Report No. MB-116. Journal, The British Shipbuilding Research Association, Vol. 5, August 1950, Abstract No. 3,915.*

New Packaged Lumber Carrier

The motorship *C-Trader,* originally built as the N3-M-A-1 *Laughlan McKay* by the Penn-Jersey Shipbuilding Corp. of Camden in 1944 by W. R. Chamberlain and Co., is being equipped as a packaged lumber carrier. The vessel is 269ft. 10in. overall in length, has a 42ft. 6in. beam. Main propulsion machinery consists of a Cooper-Bessemer 1,300 h.p. 2-cycle direct drive Diesel engine which will give the ship a speed of approximately 10½ knots. Auxiliary power will consist of two Buda Diesel engines turning Crocker-Wheeler 115-volt d.c. generators for ship's use and two General Motors G268A Diesel engines turning Westinghouse 440-volt 60-cycle a.c. generators, the latter of which will supply power for the operation of cargo gear. The vessel will lift from 1,800,000 to 2,000,000 board feet of lumber per voyage and will maintain a complement of twenty-seven men. She has house and machinery aft and three hatches forward. The hatches, because of their extremely large size, readily lend themselves to the stowage of "packaged lumber". They are 51ft. 2in. long and 31ft. 6in. wide; each hold in the ship is 56ft. long and 40ft. wide. Thus the dimensions of the hatches and the holds are so close they allow the elimination of further stowage of lumber products into wings or trunks; and instead of the hatch being merely a transfer point for cargo, the hatch itself becomes the stowage area for the cargo. Lumber is tied in bundles with wire rope and loaded and unloaded in that manner. The cargo gear will consist of two self-contained, full revolving, hydraulically powered, high-speed level-luffing kingpost type cranes. It is contemplated that by use of these two cranes a full cargo can be loaded in approximately 14 hours. This represents a substantial saving in time over the customary loading and discharging of lumber with conventional cargo handling gear. In operation, all motions of the cranes will be simple and positive in action, with the hoist, rotating and luffing motions actuated by two conveniently positioned control levers. Movement at the cargo hook will correspond directly to the motion and direction imparted to the control levers. Inherent characteristics of the Vickers' hydraulic equipment will prevent overloading of the cranes. Power limiting devices will prevent extreme rates of acceleration, and will effectively keep maximum power demands on the ship's generators with designed limits. The power unit on each crane is driven by a marine type, continuous rated squirrel cage electric motor manufactured by Westinghouse. The capacity of each crane varies from 10,000lb. at 50 feet maximum radius to 20,000lb. at 12 feet minimum radius, with a hoist speed varying from 50ft. per min. at full load to 150ft. per min. with no load. The boom can be luffed from maximum to minimum radius in about 18 seconds.—*Pacific Marine Review, Vol. 47, August 1950, pp. 33-35.*

A 20-knot 24,000 b.h.p. Tanker

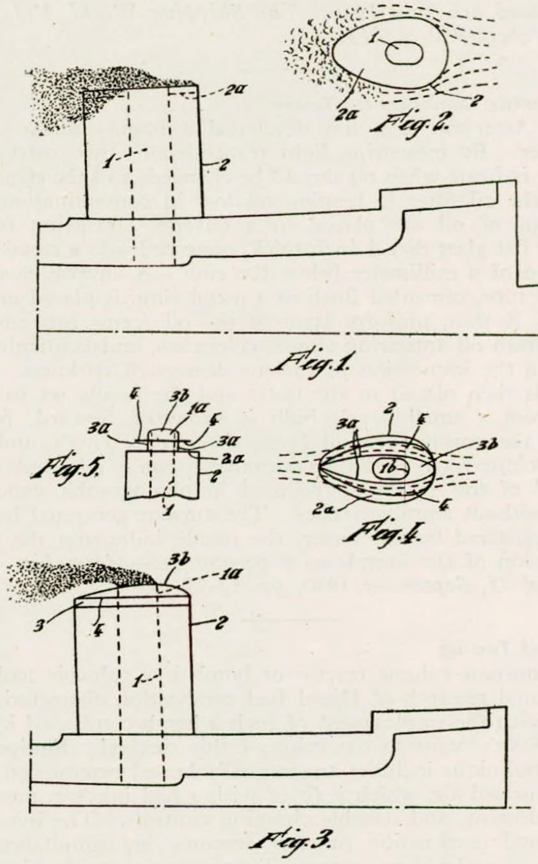
The German vessel *Altmark,* well known for her activities in Norwegian waters in 1940, was the highest powered tanker ever built. The vessel was 168m. in length b.p. (551 feet), the moulded beam being 22m. (72ft. 1in.), and the draught, fully laden, 9·31m. (30ft. 6in.). The amount of oil cargo carried was 11,585 tons, and the total deadweight 13,480 tons. Four 6,000 b.h.p. M.A.N. double-acting two-stroke engines were installed, running at 230 r.p.m., the propeller speed being reduced through Vulcan couplings to 115 r.p.m., corresponding to a ship's speed of 20·75 knots fully laden. For cruising speed the drive from one engine only was taken to each Vulcan gear, and in that case the combined output of the two engines was 8,900 b.h.p. at 165 r.p.m., corresponding to a propeller speed of 84·5 r.p.m. and a ship's speed of 15·5 knots. When two engines only were running, all the engine services were provided by two groups of piston-driven pumps, one driven by each shaft, and the necessary electric current was supplied from an exhaust gas boiler. When all four engines were in operation, further electric pumps were brought into service. Four two-stroke Diesel engines were installed, driving 250 kW. dynamos supplying current for all purposes; the demand was considerable, for the equipment of the ship included a very large refrigerating installation.—*The Motor Ship, Vol. 31, September 1950, p. 193.*

Stevens Towing Tank Activities

In his annual report of the activities of the Experimental Towing Tank of the Stevens Institute of Technology, Hoboken, New Jersey, Dr Kenneth S. M. Davidson, director, outlines the major developments in research which were undertaken during the year 1949. In the field of steering, turning, and stability, the past year has been characterized by emphasis on underwater problems. Some of the experimental work was incidental to particular design problems. However, these studies and others carried out during previous years have provided a background of basic information regarding the hydrodynamic characteristics of a wide variety of underwater forms and of the fins, rudders, and elevators needed to control them. To date, studies of steering, turning, and stability on course have been made under the simplifying assumption of smooth-water conditions with the full realization, however, that rough water is a factor which eventually must be considered. During the past year, a start was made on studies which will ultimately shed light on the effects of rough water. The work accomplished was an analysis of the forces and moments acting on a ship in waves. The forces and moments due to wave-surface slope and orbital velocity were computed for various positions of a ship relative to an assumed wave train, to show how the forces and moments vary with wave size, position of ship on the wave train, and relative heading of ship and waves. The data provide the first step in a study of the effect of rough water on the directional control of ships. Miscellaneous studies have correlated with theory much of the hydrodynamic data from tests, and have included various motion problems, starting from a theoretical basis and utilizing available test data. These studies have included such items as the motion stability of bodies, depth control of submerged bodies, etc. Calculations of the trajectories of a submerged body under various assumed conditions have been made on a differential analyzer to develop the various factors in the control problem. Another interesting research project has been in connexion with a new method of determining the forward-motion stability of a ship from observations of forced oscillations imposed on the ship by periodic oscillations of the rudder (zig-zag tests). There have been several outstanding developments in the work of the resistance and powerful group during the period of this report. Particularly interesting were the self-propulsion tests in which small models were used. Successful determinations were made of "r.p.m.", "s.h.p.", propulsive coefficient, true slip, apparent slip, thrust deduction, and wake fraction. One model so tested was a sea-going hopper dredge; another was a large channel dredge for use on the Mississippi River; and a third was a harbour utility boat of quite special design.—*Marine Engineering and Shipping Review, Vol. 55, September 1950, pp. 54-58.*

Ship's Funnel

This invention aims at providing a ship's funnel, the design of which ensures that smoke and other products of combustion are carried away clear of decks and accommodation spaces throughout the ship. Figs. 1 and 2 show a conventional ship's funnel in which the smoke issuing from the uptake is subject to down draught aft of the funnel. As shown in Figs. 1 and 2, the uptake (1) for smoke and/or combustion gases usually extends level with the upper edge of the funnel casing (2), the top (2a), of which usually is disposed somewhat below the upper edge. As indicated in Fig. 2, the ovoid shape of the funnel casing creates eddies and a region of low pressure aft thereof, with the result that the smoke issuing from the uptake is drawn down below the top of the funnel casing and cannot rise sufficiently to trail away clear of the decks. As envisaged by the inventor and illustrated in Figs. 3, 4 and 5, the upper end of the uptake (1) for smoke and/or combustion gases, which may be of elongated or oval cross-sectional shape, extends for a short distance above the top of the funnel casing (2), which is closed by a suitable top plate (2a). The projecting part (1a) of the uptake is enclosed in a cowling (3) which is of a streamline shape extending from front to rear of the funnel casing, the cowling having vertical sides (3a) and having a maximum width sufficient to accommodate the projecting part (1a) of the uptake (1). The length-breadth ratio of the streamline cowling is such that, for the range of air speeds normally encountered by ships at sea, smooth air flow around the cowling will be ensured. The vertical sides (3a) of the cowling (3) preferably extend to a level somewhat below the uptake outlet, and the top (3b) of the cowling (3) is constituted by a convex cap, which in the longi-



tudinal direction, presents a streamline profile and transversely is of varying convex formation. The shape of the cap or top surface of the cowling is designed to ensure smooth flow of air over it, with a minimum of eddy due to upflow of air from the vertical sides of the cowling. The uptake (1b) is arranged at a suitable position in the length of the cowling (3), which position is properly determined for maximum effectiveness. The smoothly flowing air stream around and over the cowling (3) serves to isolate the issuing smoke or combustion gases from the direct influence of the usual down draught aft, or to leeward, of the funnel casing (2) so that such smoke or combustion gases may rise freely from the top of the funnel to a height dependent on their velocity and density until they have trailed beyond a position where, in the absence of the cowling (3), they would be drawn into the turbulent low pressure zone which always is present aft, or to leeward, of the funnel casing (2), particularly when the wind direction is from an ahead quarter. The effectiveness of the device may be increased by fitting to the sides of the cowling (3) one or more flat air streams stabilizing plates (4) arranged parallel to the top of the funnel casing (2) but spaced from it so as to permit free flowing air streams between the underside of the stabilizing plate (4) and the top of the funnel casing (2). These stabilizing plates (4) may be provided to extend laterally from the side walls (3a) of the cowling (3). As shown in the drawing, they may extend from the top of the side walls (3a) so that only the convex cap forming top (3b) of the cowling (3) projects above the same. Furthermore, the plates (4) may be of more or less crescent shape in plan, as shown in Fig. 4, so that while lying within or conforming to the profile of the funnel casing (2) in plan, they afford the maximum effective area for stabilizing the air streams. The improved funnel according to this invention is most effective when the air flow is from forward to aft of the ship, but it is only slightly less effective with opposite air flow or when the general direction of the air flow is up to 20 deg. from the fore-and-aft centreline of the ship.—*Brit. Pat. No. 639,373, issued to John I. Thornycroft and Co., Ltd., and H. J. Watson. Application dated 8th July 1948. The Shipping World, Vol. 123, 18th October 1950, p. 315.*

Photo-electric Crankcase Oil Tester

An American firm has developed a photo-electric crank case tester. By measuring light transmission, this instrument serves to indicate when oil should be changed, and the effectiveness of the oil filter in keeping oil low in contamination. A few drops of oil are placed in a cuvette, consisting of an optically flat glass disk ¼-inch thick, cemented into a metal ring a fraction of a millimeter below the ring. A cuvette cover of the same type, cemented flush in a metal ring, is placed on the cuvette. A thin, uniform layer of the oil forms between the glasses, fresh oil appearing almost colourless, and contaminated oil giving the impression of carious degrees of darkness. The cuvette is then placed in the tester and the needle set to 100. Light from a small 6-volt bulb is projected upward, passes through the cuvette, the oil layer, the cuvette cover, and the orange colour filter, and then impinges upon a self-generating photocell of the dry-disk type used in photographic exposure meters, without amplifier tubes. The current generated by the cell is registered by the meter, the needle indicating the light transmission of the sample as a percentage.—*Motorship, New York, Vol 35, September 1950, pp. 52-53.*

Diesel Fuel Testing

A constant-volume reactor or bomb is a valuable tool for fundamental research of Diesel fuel combustion characteristics. Studies with the employment of such a bomb conducted in the United States point to the value of this method. Equipment for this technique includes an externally heated reactor containing pressurized air, which is fitted with a fuel injector, pressure sensing element, and suitable charging controls. The injection process and combustion pressure response are simultaneously shown on a cathode-ray scope. Time orientation of points on the cathode-ray tube sweep allows calculations in the injection-combustion cycle. Calibration of the pressure sensitive element and amplifying network permit calculation of pressure at any point. Advantages of the bomb method are simplicity, precision of control and measurement, and the small sample requirement. A great problem, notes the report, is applying data from this relatively static process to performance in a violently dynamic one of an engine. Tests made with this equipment have convinced investigators that the method can yield worthwhile qualitative and quantitative information. For future experimentation, they recommend: (1) Researches to establish fundamental relationships between operating conditions of temperature, pressure, fuel-air ratios, and injection. The aim would be to apply these relationships to full scale engine performance (2) Researches on fundamental relationships between size and structure of a hydrocarbon molecule and the combustion process as revealed by the bomb.—*S. A. E. Journal, Vol. 58, September 1950, p. 81..*

Continuous Viscosity Controller

An American firm has developed an automatic viscosity controller in which viscosity is measured continuously by passing a small portion of the fluid through a measuring tube at constant temperature and at a constant velocity; from this tube it returns to the main mass of fluid. Thus, in accordance with Poiseuille's equation, the pressure drop across the measuring tube is proportional to change in viscosity. The pressure differential is converted to an air pressure in a differential pressure transmitter and amplified. Thus a bourdon pressure gauge calibrated in viscosity units and placed in the line indicates viscosity continuously. The pressure can be impressed across a standard controller for actuation of valves, pumps, solenoids, etc., to correct the viscosity to the desired value. Also, by simple additions to the basic equipment, the apparatus can be made to perform many other operations, such as automatically turning heat on or off, etc.—*Westinghouse Engineer, Vol. 10, September 1950, p. 224.*

Pumps Without Stuffing Boxes

The radical method of eliminating stuffing-box leakage in a centrifugal pump is to eliminate the stuffing box altogether, and at least one American pump maker has taken this step. In this particular design stuffing boxes are obviated by providing the pump with a small secondary impeller which deals with the leakage. When the pump is slowing down, or is stopped altogether, a governor-operated seal closes the space between the pump casing and the shaft. Another firm of pump makers eliminates stuffing boxes in their submersible deep-well pumps by using a mercury seal which isolates an oil-filled motor from the pump. The employment of pumps with mercury seal is, however, restricted to cases where the liquid to be pumped will not sludge with mercury. In order to overcome this and other inherent limitations of the mercury seal the same firm of pump makers have developed a double mechanical seal which, in the submersible pump, isolates the pump from its motor. The motor chamber is filled with an electric motor oil of good dielectric characteristics and put under slightly greater hydraulic pressure than exists at the pump suction. Any slight leakage of the mechanical seal will, therefore, take place from the motor to the pump. A balance chamber with metal or synthetic rubber bellows provides for the thermal expansion of the oil. It is reported that the basic principle of this pump has been applied to numerous special cases as, for instance, the construction of a stuffing-box-less pump for use with pure water at 1,000 deg. F. and 5,000lb. per sq. in. pressure.—*The Engineers' Digest, Vol. 11, October 1950, p. 335.*

Use of Turning Vanes at Sharp Elbows

Cascades of turning vanes have long been employed in wind tunnels. To save space the return duct, commonly rectangular in cross-section, is filled with sharp 90 deg. elbows instead of easy bends, and in each a row of turning blades is inserted. In this way the velocity distribution at the corners is improved and the energy losses are reduced. The device has been so successful that its use is standard practice. Nevertheless, it has very rarely been employed in circular water pipes although the need for economy of space in their layout is often great. To discover whether cascades are useful under these conditions, an investigation with very simple apparatus has been made on a welded mitre elbow in a 6-inch pipe at velocities up to 10ft. per sec. The work was carried out at the Engineering Laboratory, Cambridge. The loss of head in a 6-inch elbow was found to be about seven times that in an easy bend. The insertion of a primitive cascade into the elbow reduced the ratio to about two, and from this two simple designs were evolved, in which the loss was only slightly greater than in the bend. From both the uniformity of the emergent stream was satisfactory.—*A. M. Binnie and D. P. Harris, The Engineer, Vol. 190, September 1st 1950, pp. 232-233, 235.*

Carbon Piston Rings

Carbon piston rings for reciprocating air or other gas compressors have become firmly established in industry and some of the leading makers of compressors fit these rings when required. The main advantage of the rings is that they enable a supply of compressed oil-free air or other gas to be obtained, due to the self-lubricating property of the carbon. Hitherto oil has always had to be introduced as a lubricating medium in the cylinder of reciprocating compressors and in most cases the compressed product carried entrained oil. This contamination was in many industries a big disadvantage, while in a few it was definitely dangerous. The carbon rings are capable of operating in a completely dry condition within the cylinder and lubrication of the latter is not necessary. "Morganite" piston rings have an overall fine ground finish and may be of either segmented construction with three or four segments to a ring, or of the Ramsbottom type with butt-joint. When used as single split rings, i.e., Ramsbottom type, they are ground to the nominal cylinder bore size in a contracted condition, with the

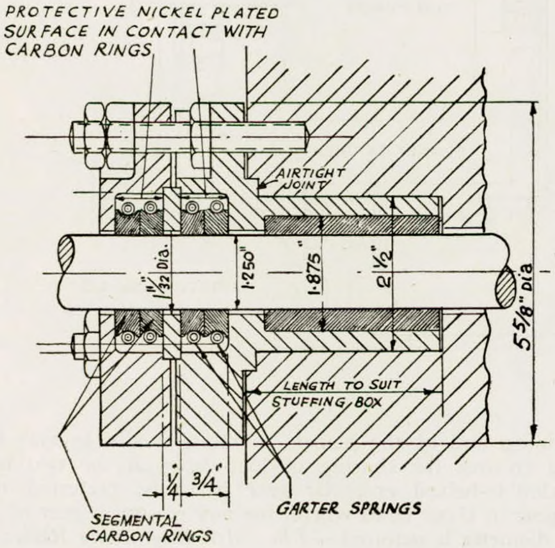


FIG. 8.—*Sectional arrangement of typical compressor stuffing box.*

joint closed, to ensure a sufficient outward movement to follow up wear without over-stressing the carbon. The cross-section of the rings is much greater than the normal for metal rings of small diameters, and this requires an increase in the radial depth of the grooves in the piston; a fact which, with the customary use of solid bearing rings, necessitates using a piston of built-up construction to permit assembly of the rings into the grooves. On account of the low modulus of elasticity of the carbon, it is necessary to use backing springs behind the piston rings to ensure that they exert adequate pressure against the face of the cylinder wall. The carbon rings may be used in either vertical or horizontal compressors, but with the latter type the weight of the piston causes one-sided wear of the rings. It is necessary, therefore, to make periodical examination of the rings and to turn them through about 120 deg. in order to present the lesser worn surfaces to the cylinder. Since there is no oil present in the cylinder it is necessary to prevent contact of the metal body of the piston with the cylinder wall. This problem is solved by the use of one or more carbon bearing rings on the piston. Unlike the standard metal rings, the carbon piston rings cannot be sprung into position over a piston. Accordingly, it is necessary to use a built-up piston with segmented or Ramsbottom piston rings. The stuffing box on the cylinder may be packed with segmented carbon rings and a short carbon neck bush fitted between these rings, as it is advisable to steady the piston rod. This bush is normally shrink fitted, but alternative methods may be used when necessary. The segmented carbon rings may take the form of a single nest of rings, but sometimes double rings are employed. The sectional arrangement, Fig. 8, shows a typical example of a compressor stuffing box fitted with segmented "Morganite" rings; the sizes given in the drawing are general proportions only, other sizes being available.—*A. E. Williams, Engineering and Boiler House Review, Vol. 65, October 1950, pp. 314-319.*

Oil Holes in Journal Bearings

In the lubrication of journal bearings the methods of admitting oil to the bearing is an important design problem. Fundamentally, the concept of the load-carrying oil film indicates that it is desirable to avoid oil holes or grooves which interfere with the normal development of hydrostatic pressure to support the load. In some bearing installations, however, it is not always possible to satisfy this requirement. For example, where loads on the bearings are fluctuating in both intensity and direction it is sometimes impracticable to apply the oil to the unloaded side throughout the complete load cycle. In other cases provision must be made for a continuous flow of oil to some other moving part. In Technical Report No. 1449 of the National Bureau of Standards, S. A. McKee and H. S. White evaluate the results of tests conducted on five different arrangements for feeding oil through the bearing shell. These included one hole at the centre of the unloaded side; two holes, one each on the loaded and unloaded sides; four holes, each 45 deg. from the line of the load; one axial groove at the centre of the unloaded side; and one circumferential groove. Tests were also made with three arrangements for feeding oil from the centre of the shaft, that is one and two oil holes in the shaft, and a one-hole arrangement terminating in a flat that extends along the surface of the shaft for one-half the length of the bearing. For all these arrangements each hole or groove was in the axial centre of the bearing and was connected to the source of oil supply.—*The Engineers' Digest, Vol. 11, October 1950, pp. 340-342.*

Impregnated Dry Lubrication Process

Processes that produce a solid film or dry lubricant impregnated into the surface of metals, plastics, rubber and ceramics to reduce friction are now offered by an American firm. It is claimed that the highly desirable characteristics of graphite are retained throughout wide ranges in temperature, in a permanent film which is unaffected by exposure to solvents or weather. These processes have already proved in regular production their value for reducing wear in internal combustion engines and other moving parts. They are in use in disk clutches, brakes, gears, worms and splines. The process is known as the electrofilm process.—*Marine Engineering and Shipping Review, Vol. 55, October 1950, p. 100.*

Efficiency of Planetary Gears

In this article the author investigates the efficiency of seventeen types of planetary gears. This investigation is conducted with the employment of a basic formula established by the author, the formula being applicable to both external and internal gearing. In view of the relatively low power losses in the bearings, these losses are neglected. General conclusions drawn by the author are that the tooth friction losses of planetary gears are affected by the gear ratio to a far greater extent than is the case with ordinary gear trains. Planetary gears of high speed ratio are particularly vulnerable in this respect, but by appropriate design measures the efficiency of gears with high speed reduction ratio can be kept within tolerable limits. In the case of composite gears, overall efficiency may be considerably affected by the relative speed reductions chosen for the component gear trains. Although this investigation is not based on actual test data, but on theoretical considerations, it should be useful as a means of establishing comparative efficiencies.—*R. Poppinga, Ingenieurarchiv, Vol. 18, 1950, pp. 39-52.*

Epicyclic Gearing

This article is complementary to an earlier one describing the Allen-Stoeckicht gegar (Engineering Abstracts, p. 51, April

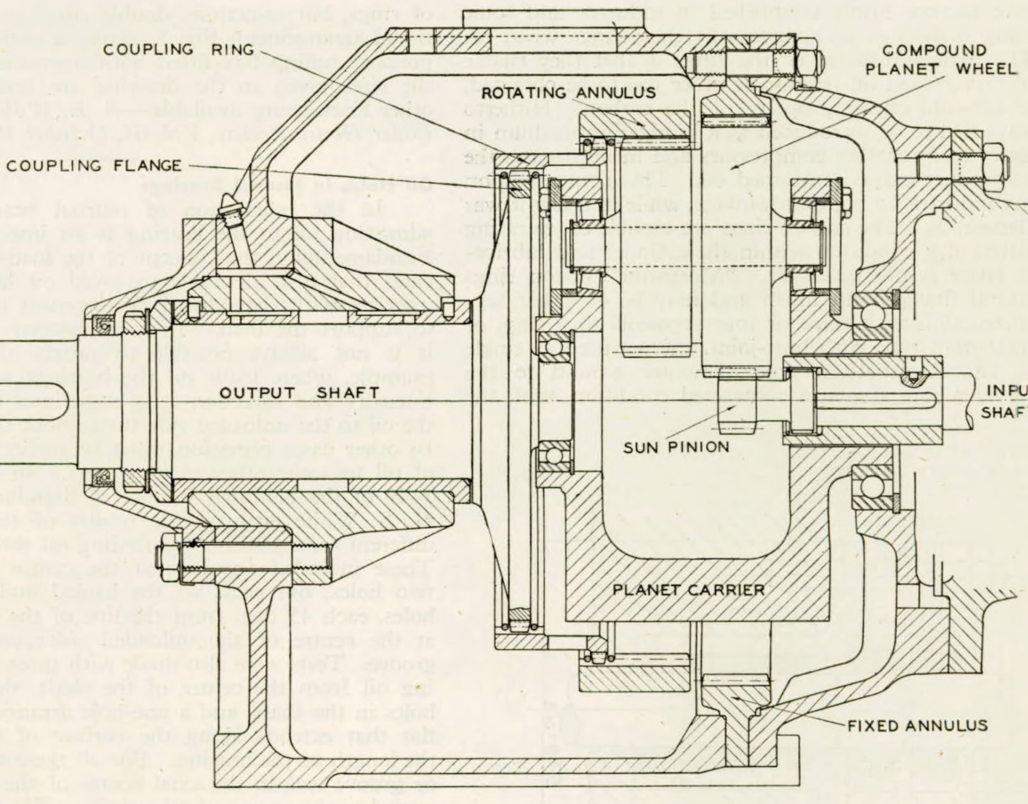


FIG. 3.

1950) and describes the solar and star arrangements of the simple epicyclic train, together with compound planet gears, including those with two annulus rings, and also double-helical epicyclic gears. In the solar gear the sun is the fixed centre of the system. Ratios between 1·1:1 and 1·7:1 are obtained with this arrangement with high efficiency. In the star gear the planet carrier is fixed, while sun and annulus rotate, and, for this reason, is generally known as a star gear, since the "planets" or "stars" are now fixed in space. In this arrangement the output and input shafts rotate in opposite directions, whereas in a planetary gear previously described, the shafts have the same sense of rotation. In this type of gear the torque reaction on the casing is equal to the sum of the input and output torques. Gear ratios between 2:1 and 11:1 can conveniently be obtained with this arrangement. It is sometimes convenient to obtain ratios from about 12:1 to 25:1 by means of a compound planet gear. This type of gear is one in which the planet or star wheels consist of two gearwheels rigidly connected, one wheel meshing with the pinion, and the other with the annulus. In addition, high-ratio gears incorporating compound planet wheels and two annulus rings can be supplied for reduction ratios between 12·7:1 and 1,600:1. A typical gear of this type is shown in the sectional drawing, Fig. 3. In general, these gears are intended for speed reducing gears with input shaft speeds up to about 2,000 r.p.m. As shown in the drawing, the planet carrier is free to revolve about its own axis, and the speed of the output shaft is largely determined by the difference in numbers of teeth on the two halves of the planet and on the two annulus rings. The efficiency of this form of gear is exceptionally high compared with a conventional worm drive for the same duty, while for large ratios and output shaft torques, it will be found to be more compact and lighter. Load sharing between the planets is achieved by means of a floating annulus on the output shaft. The double-helical gear is essentially two simple planetary trains in parallel. The two separate flexibly mounted annulus rings ensure load equalization between the planets and the freedom of the floating pinion and of the planets to move axially as may be required ensures the sharing of load between the two helices. The double-helical epicyclic gear is to be preferred to the spur gear in those cases where, for any reason, a gear of minimum diameter is required.—*The Allen Engineering Review, No. 25, October 1950, pp. 6-9.*

New Hidden Arc Welding Process

A new welding process employs welding-current densities on 5/64-inch, electrode wire which melt the electrode at speeds comparable to using 10,000 amp. on a standard $\frac{5}{16}$-inch diameter coated hand electrode. The new process uses either a $\frac{3}{32}$ or a 5/64-inch diameter electrode wire. Welding currents up to 600 amp. are used with these wires which, on the small cross-sectional area of the wire, produce extremely high-current densities. These high densities create a deeply penetrating arc which in turn allows the use of high-welding speeds. This also means that in general little or no edge preparation of joints is required, and therefore less weld metal is used in completely fusing the joint.—*The Welding Journal, Vol. 29, September 1950, pp. 806, 808.*

Locked-in Stresses in Welded Box Girder

A large welded box girder, made of relatively thick plates and embodying a high degree of constraint, was fabricated and then trepanned for the purpose of determining the distribution of the locked-in stresses. These stresses were obtained by the relaxation method, and changes in strain were measured by means of electrical strain gauges. The girder was subdivided at four transverse sections. This paper gives the distribution of the locked-in stresses and discusses strain-gauge drift and other factors affecting the probable accuracy of the data. The limitations of a quasi-destructive method as a tool for determining locked-in stresses are also treated.—*J. Vasta, Welding Research Supplement, The Welding Journal, Vol. 29, September 1950, pp. 484-s-493-s.*