TECHNICAL ABSTRACTS

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SHIPYARDS AND DOCKS

Ship Repairing—Some Aspects of the Industry Today. SILLEY, H. A. J. *I.N.A. paper read* 20 Mar. 1956.

The Author points out some of the difficulties with which the ship-repairing industry has to deal. These include the shortage of skilled labour ; shortage of steel ; restrictive practices of trade unions ; increase in the size of ships, particularly tankers, making dry-docking more difficult ; increased complexity of modern ships necessitating a larger number of specialists to effect repairs ; increased amount of electrical wiring and piping making the removal of machinery from the ship more difficult ; the necessity of providing facilities for the testing of large turbine units ; desirability of providing means for handling large prefabricated units ; the disposal of oil sludge and oily water discharged by tanks.

It would be useful if designers could make some provisions in the shipside framing and plating to facilitate the removal of machinery. The pre-treatment of structural steel to remove mill scale would also appear to be worthy of consideration, because this would reduce corrosion troubles, and consequently the time needed to deal with them in the repair dock. The introduction of a greater degree of standardization, particularly for smaller items of equipment, would facilitate repairs.

GAS TURBINES

Design Considerations for Naval Gas Turbines. Graves, G. L., Jr. *A.S.M.E., Paper No. 56–GTP–1, read at Gas Turbine Power Conference, Washington, D.C.,* 16–17 Apr. 1956.

The principal advantages of the naval gas turbine are its low specific weight, and its reliability of starting. Its design will represent a compromise between the aircraft and the industrial types. The degree of compromise should reflect the importance of weight, performance, and engine life for the specific application. Present and possible applications are discussed. Small gas turbines of modified aircraft design can be used for several alternative purposes ; an emergency gas-turbine-driven fire pump has successfully operated as a de-icer in the Arctic as well as a smoke generator. The transition from an emergency prime-mover to use as a stand-by or continuous-duty engine depends on improved reliability of engine components and accessories, increased engine life, and reduced fuel consumption. About 200 engines have been installed in small boats for operational testing with the fleet. Gas turbines are also to be used in combination with base-load prime-movers as boosters or peak-load engines for the power increment required less than 1 per cent of the time. It is proposed that mass-produced jet engines should be used as replaceable short-life gas-producing sections, and longer life power turbines and gears be developed for the output section. If certain developments and modifications were carried out, such engines could probably burn the (U.S.) Navy special fuel used in boilers. An engine with a low pressure ratio is preferred. An expression is given comparing the cruising range obtainable with a continuous-duty gas turbine, and that obtainable with any other power plant. From this it appears that there are good prospects for a naval gas turbine in the intermediate power range. The total fuel consumption of an open-cycle gas turbine could be almost as good as that of a Diesel engine, while the total specific weight for the whole propulsion-machinery plant is estimated at one-half that of the other plants considered.

Multi-engine plants possess many advantages over a single engine, especially with regard to maintenance and overhaul. The importance of reliability, maintenance, and ease of fabrication and of overhaul results in a great many aerodynamic and thermodynamic compromises. These are discussed and illustrated by graphs. Turbine efficiency is critical ; compressor efficiency less so. For powers up to 500 h.p. it appears desirable to consider radial turbines. Because of the importance of back pressure on gas turbines, the aerodynamics of the exhaust duct must be considered.

References are given.

DIESEL AND OTHER I.C. ENGINES

Applications of the Deltic Engine. Proposed Installations for Merchant Ships. Chatterton, E. *Shipp. World,* **134** (1956), p. 228 (29 Feb.).

The Deltic type of two-stroke Diesel engine has been described in Abstracts No. 7644 (June 1953) and 10,449 (July 1955). The savings in space and weight offered by this engine have been demonstrated in many design studies, some of which are illustrated in this paper. The use of such light-weight and compact machinery gives a wide freedom of choice of position of the engines in the ship. They may be placed either at the after end or, with Diesel-electric drive, forward, in spaces that cannot be employed as profitably for cargo-carrying as the 'midship portion of the ship. Deltic engines are at present being produced for commercial marine use in two forms, the first with 18 cylinders and the second with 9. The 18-cylinder engine has a continuous rating of 1,749 s.h.p., and the

9-cylinder 872 s.h.p. The minimum anticipated period between piston examinations is 5,000 hours. Both types are supplied with all pumps and filters, the only additional item required being the heat exchanger for oil and water cooling. The engines supplied to the Admiralty for use in fast patrol boats are identical in form, but rated to give a maximum output of 2,500 h.p. at 2,000 r.p.m. Most of the development running has been done under these overload conditions. The opposed-piston design gives the engine great rigidity and robustness coupled with small maintenance requirements.

Its light weight and compactness makes it suitable for lifting as a complete unit by normal ships' cargo-handling gear. This, together with the fact that every component, major assembly, and structural unit is interchangeable, permits repair by replacement, both of individual components, and of the whole engine at the end of the known period of reliable service. The type is eminently suitable for multi-engine installations. Various methods of coupling and gearing are discussed. These are (*a*) direct coupling to a common gearbox containing the mechanism for ahead and astern operation ; (*b*) direct coupling to a normal reduction gearbox driving controllable-pitch propellers ; and (*c*) using the Deltic engines to drive flange-mounted D.C. generators or alternators. The output-torque curve from the 18-cylinder engine is very smooth, which eases gearing problems. The multi-engined arrangement gives considerable flexibility in the use of the available power, and a degree of reliability unattainable with a single engine. Five proposed ship installations are described. (1) For a general-cargo ship four Deltic engines are mounted in two pairs placed one above the other, and geared down to 110 r.p.m. through a reverse-reduction gearbox. (2) Two Deltic engines placed one above the other driving through fluid couplings and replacing the present engines in an existing 7,500-ton general-cargo ship. The machinery weight would be reduced from 229 to 34·9 tons for the same power, and the cargo space increased by 12 per cent. (3) A modification of (2) with the Deltic engines geared to the existing propeller shaft. (4) A fish-factory vessel with Deltic engines forward, and electric power transmission. (5) Six 18-cylinder Deltics in a 17-knot twin-screw cargo and passenger liner. The almost complete lack of engine vibration is a great advantage.

NUCLEAR POWER

Survey of Atomic Power for Marine Propulsion. TACKETT, D. E. *Bull. Soc. N.A.M.E.*, **11,** No. 1 (1956), p. 14 (Feb.).

The Author gives a comprehensive summary of the principles of reactor theory and technology, and also considers reactor kinetics and control, reactor materials, fuels, moderators and reflectors, coolants, cladding of structural materials, control rods, and shielding materials. Finally, two reactor systems are discussed which might be suitable for marine applications. The first system is the gas-cooled heterogeneous reactor plant in which the coolant gas drives a gas turbine. The gas used may be helium or carbon dioxide. If helium is used, there is no necessity for shielding the system outside the reactor itself, because helium does not become radio-active. Also, helium has very good heat-transfer properties under moderate pressure, and is non-corrosive. On the other hand, unless leakage is kept down to very small amounts, the cost for make-up helium would be very high. Carbon dioxide is considerably cheaper than helium and has fairly good heat-transfer properties, but it becomes radioactive when passing through the reactor and so introduces serious shielding problems. The gas-cooled system possesses some very good features. For example, control of the power output may be achieved by controlling the system pressure or by by-passing the low-pressure turbine. Also, the amount of gas in the system can be varied in a simple manner by changing the pressure in the gas accumulator.

The other reactor system considered is the homogeneous liquid-fuel reactor. Possible fuels for this system include an aqueous solution of uranium or plutonium salts (the solvent being light or heavy water) or a slurry of fine fuel particles suspended in liquid sodium. Dispersing the fuel in a low-melting glass-like fused salt might also be considered. In this type of reactor either a one-loop or a two-loop circulation system might be used. In the latter case, the liquid fuel would be circulated through the reactor vessel and a heat exchanger where heat would be imparted to a coolant pumped through a steam generator. In the former case, the fuel would be circulated directly through the steam generator. In both cases, some system of superheating the steam might be arranged.

References are given.

Atomic Propulsion of Ships. DAHL, O. *Shipbuild. Shipp Rec.*, (International Design and Equipment Number, 1956) p. 6.

Nuclear fuel would seem ideal for ship propulsion, because the intrinsic heat value of pure nuclear fuel is about 3 million times higher than that of coal. Pure nuclear fuel, as used in bombs, is extremely costly to produce, and it probably takes more energy to make than it can yield. A practical reactor would most likely burn slightly-enriched uranium, which is at present both costly and scarce. Within the next ten years it is to be expected that sufficient secondary fuel will be produced much more cheaply in operating reactors to satisfy the growing demand. Such fuel is suitable for enriching natural uranium.

Essentially the reactor takes over the function of the present oil or coal-fired boiler, and may feed any conventional steam reciprocating or turbine plant in use in ships. The Author considers that basically a ship reactor will be a spherical pressure shell about 12 ft in diameter, contained in a composite radiation shield of lead, cast iron and concrete with an outside diameter of 18 ft. The aggregate weight will be about 350 tons. It is probable that water will provide part of the shielding. The fuel may be installed as a unit in the reactor boiler, and would probably permit a ‘ burn-up ’ corresponding to 10,000 megawatt days per ton of fuel before processing was required. Calculations indicate that a medium-sized ship will probably be able to cruise at service speed for at least one year before refuelling. It should not be difficult to unload spent fuel from ships. There are no safety problems in handling fresh fuel.

International action would be necessary to devise methods of safeguarding such ships ; to make bunkering and service stations available for ships of all nations ; to provide facilities for re-processing partly spent fuel ; and to arrange for the disposition of the unwanted radio-active waste products.