TECHNICAL ABSTRACTS

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STABILITY, MANŒUVRABILITY, AND SEAWORTHINESS

Ship Stabilizing Equipment. *Motor Ship*, **34** (1953), p. 132 (June).

A patent has been granted for a new ship-stabilizing apparatus. The equipment includes three chambers in contact with the sea on each side of the hull. The hydrostatic pressure inside these chambers is transmitted through a system of air lines fed by a tank to manometric capsules. The angle of roll is indicated by a gyroscope coupled to a controlling circuit, in combination with the hydrostatic-pressure indicating equipment. The impulses given to the circuit operate a controller driving the stabilizing equipment, which may be either of the rolling weight or pumping type.

WELDING AND OTHER METHODS OF CONSTRUCTION

Electric Arc Cutting of Aluminium. WARREN, W. G. *Welding*, **21** (1953), p. 88 (March).

At present most cutting of aluminium alloy is carried out by mechanical means, but a more flexible cutting process is desirable. It is possible to cut with a gas flame using an injected flux, but the quality of the edge obtained in such a process is not good.

This article describes a cutting process for aluminium in which an electric arc is employed as the source of heat, and the discharge from a ferrous-wire electrode as the cutting agent. The cutting action is very rapid with little disturbance to the plate being cut, and the edges are sufficiently smooth to permit welding without further treatment. The equipment consists essentially of a reel of ferrous welding wire fed into the arc at constant but controllable speed. D.C. (positive polarity) is fed into the wire through a copper contact tube at the cutting head, where argon shielding is also provided. The current and wire-feed rates are such that the arc is self regulating. A.C. can also be used, provided arrangements are made for arc stabilization. The principal result of the use of A.C. is a reduction in cutting speed to about one-half of its value with D.C. The plate is normally fixed and the cutting head is attached to a carriage running on rails, but occasionally the head is fixed and the plate is traversed past it.

Cutting tests carried out with D.C. equipment are illustrated by photographs and briefly described. The conditions found most suitable with the equipment available are summarised in tabular form. Successful cuts were obtained with NS6 and NP5/6 of thickness $\frac{1}{8}$, $\frac{1}{4}$, and $\frac{1}{2}$ in., cutting speeds ranging from 50 to 96 in/min, currents ranging from 360 to 700 A, and with an argon flow of 10 cu. ft/hr. Wherever a heat-affected zone was observed, it never exceeded 0·005 in. in depth. No measurable pick-up of iron resulting from the cutting process was observed.

Many metals can be cut by the same process, particularly those with a low melting point. Brief details of cuts obtained in some other non-ferrous metals and stainless steel are given.

The cutting process is the subject of an Admiralty patent application.

SHIPBUILDING (GENERAL)

Ship and Boat Builder Annual Review 1953.

Among the articles in this annual review are the following :—

Ordering a Coastal Tanker, by R. Swinson. The Author discusses the considerations to be borne in mind when a coastal tanker is ordered ; these include adequate pumping facilities and safety precautions, the port conditions peculiar to the route served, and the need for providing accommodation of a sufficiently high standard to attract the right type of ship's company.

Admiralty Adopts Diesel Engines, by R. V. B. Blackman. All new R.N. craft of the smaller type are now being fitted with Diesel engines. The Author gives brief details of many of these vessels, and also of the Admiralty Standard Range of Diesel engines (see Abstracts No. 5905, March 1952, and 6590, Sept. 1952).

The Smaller Craft of 1952 is a survey of the small ships and boats produced during the year.

Light Alloy Craft on Tropical Service, by E. C. B. Corlett. There are many advantages in using aluminium alloys rather than wood or steel for barges, tugs, and other vessels to be engaged on tropical service and in under-developed areas. The choice of materials and the question whether these craft are best riveted or welded are discussed.

Selecting the Best Engine for the Job, by M. R. Horne. The requirements of the various classes of craft are discussed, and mention is made of special points to be observed when selecting engines for overseas service.

Design for Durability, by M. G. Duff. The possibilities of improving the durability of small wooden craft by sound design and good maintenance are discussed. The value of regular surveying is emphasised, and many constructional pitfalls are indicated.

Equipment for Craft and Yard: Developments in 1952. This article gives a concise summary of many of the interesting new developments in equipment for small craft and yards during 1952.

The *Annual Review* also contains a Directory of Builders and Repair Yards, Specifications of both Main and Auxiliary and Outboard Marine Engines, Directories of Light Metal Stockists, Paint Manufacturers, Manufacturers and Supplies of Marine Fittings and Yard Equipment, Consultants, Owners of Small Craft, a list of Associations, and lists of the Dock and Harbour Authorities of the United Kingdom, and of Commercial Diplomatic Officers and Trade Commissioners.

First British Diesel-Electric Trawler. *Motor Ship*, **34** (1953), p. 120 (June).

An order has been placed by the Admiralty on behalf of the D.S.I.R. with Hall, Russell & Co., Ltd., for a Diesel-electric trawler intended for fishery research. The vessel will be about 125-ft b.p. and have a fish-hold capacity of 4,000 cu. ft.

The Diesel-electric installation, which was designed by Metropolitan-Vickers Electrical Co., Ltd., consists of four Meadows six-cylinder Diesel engines, each with a 24-hour rating of 200 b.h.p. at 1,400 r.p.m. and direct-coupled to a 125-kW constant-current generator by a flexible coupling. The propulsion motor is of the double-unit type with an output of 600 s.h.p. at 200 r.p.m. fitted with a speed-limiting governor. A Michell-type combined thrust and journal bearing is at the after end, water-cooled by a shaft-driven pump. The motor is watertight up to the shaft level.

The trawl winch is driven by two 75-h.p. motors of the horizontal-spindle marine type driving through a bevel gearbox. These motors are of the constant-current type, fitted with forced ventilation. The full-load speed is about 1,000 r.p.m. and the light-load speed about 1,750 r.p.m. They can withstand a stalled torque of 1·5 times full load for 30 minutes without overheating. Control is similar to that of a steam winch, with a handwheel for speed regulation and a lever for reversing.

The propulsion and trawl-winch motors operate on the same constant-current series loop, through which a constant current of 500 amp is circulated, at a full load maximum voltage of 1,080, the voltage above earth never exceeding 540. The torque and direction of the motors is controlled by altering the excitation. The propulsion motor is controlled by a metadyne exciter circuit controlled from the bridge or engine room, the winch motors being controlled by a direct-reversing potentiometer.

Under normal conditions, the ship will be controlled from the bridge, and she will be fitted with a combined controller and engine-room telegraph. Auxiliary current is at 220 volts generated by two 135-kW level-compound machines driven by two Diesel engines of the same type as those used for propulsion.

Light-Alloy Patrol Launch. *Shipping World*, **128** (1953), p. 435 (6 May) and *Shipbuilding and Shipping Record*, **81** (1953), p. 604 (7 May).

A 55-ft light-alloy patrol launch has been built by Grimston Astor, Ltd., by the two-way tension method (see Abstract No. 7263, March, 1953).

The leading dimensions are :—

Length, o.a.	55 ft
Beam	14·3 ft
Draught, light	2·5 ft
Speed, cruising	14 knots
Endurance	900 miles

The launch is propelled by twin Perkins direct-drive Diesel engines, each developing 65 h.p. at 2,5000 r.p.m. The total displacement complete with engines is about 6·5 tons. Skegs have been fitted to protect the propellers and allow the hull to ground on a hard or soft bottom.

The hull plating is made of 10-gauge corrosion-resistant light-alloy N.S5. The keel is of $3\frac{1}{2}$-in by $3\frac{1}{4}$-in by $\frac{5}{16}$-in by $\frac{3}{8}$-in tee-section light alloy N.S5. The combined shaft brackets and skegs are made from heat-treated high-tensile light alloy L.M.10WP, and the stern and rudders are light-alloy castings. The shafting is of stainless steel, and the three-bladed propellers are made of light alloy.

The engine is cooled by fresh water in a closed circuit with a heat exchanger. The arrangements of the interior are very flexible : the spaces can be divided in a number of different ways.

MATERIALS : STRENGTH, TESTING AND USE

The Brittle Fracture Problem from a Shipbuilder's Point of View. LEIDE, N. G. *West of Scotland Iron and Steel Institute, paper read at Conference on Brittle Fracture in Steel held on* 15 May, 1953.

Since the introduction of welding in shipbuilding, the question of brittle fracture in steel has attained increased importance, but this phenomenon is not confined to welding and may also occur in riveted construction. The causes of brittle fracture are to be found in the behaviour of the steel ; and this is affected by the service or testing conditions, which include the temperature, the rate of deformation, and the stress condition, and by the properties of the material. The Author discusses the effects of each of these factors. The properties of the steel are of primary importance ; the tensile and bend tests formerly employed do not give sufficient information on the liability of the steel to brittle fracture, and a number of new tests have been introduced. Most of the results from these tests are not comparable, and no test which can give information about the notch toughness of steel has been generally accepted. In the Malmö shipyard, the Schnadt test is employed ; the various specimens employed in this test are illustrated, and a method of presenting the results in graphical form on the basis of three or four tests is shown. The results obtained from a number of plates, some brittle and others ductile, are given.

Methods of avoiding cracks in practice fall under two main headings, namely the reduction of stress concentrations by good design and workmanship, and the use of a material that will not crack even at low temperatures. Some examples of good design practice are given, and the use of high-quality steel plates as crack arresters is described.

Some references are given.

New Ultrasonic Flaw Detector. *Engineering*, **175** (1953), p. 363 (20 March). *The Engineer*, **195** (1953), p. 424 (20 March). *Welding*, **21** (1953), p. 127 (April). *Metal Treatment*, **20** (1953), p. 192 (April). *Iron and Steel*, **26** (1953), p. 133 (April).

A new portable supersonic flaw detector, designated Mark 5, has been produced by Kelvin and Hughes, of Ilford. It is specially designed for internal inspection of welded pressure vessels, although it has many other applications. It has been made as light and compact as possible, so that it can be passed through a manhole. The instrument, which is self-contained, measures 17 × 9 × 5 in. and weighs less than 30 lb. It has a scale that can be expanded so that the width of the screen represents only a small part of the total range, and closely-grouped flaws can be individually detected. The face is very bright and can be viewed in ordinary daylight. The instrument can be operated with all Kelvin & Hughes probes, but a special combined transceiver probe provides many advantages of the dual-probe system while allowing ease of handling inherent in a single probe. An edge-illuminated perspex screen facilitates photographic recording, for which a special camera can be provided. The instrument operates from 200–250 V, 50 c.p.s., A.C. mains, and its operating frequencies range from $\frac{5}{8}$ to 5 Mc/s.

Fracture in Metals. *Mechanical World*, **133** (1953), p. 163 (April).

The Author discusses briefly the complex mechanism of metal fracture and some of the various theories of its nature. Research has shown that metals have more than one fracture strength, and fracture can occur inside a metal wherever and whenever the fracture strength of one of its constituents is exceeded. Fracture can take place along one or more of the following paths : along grain boundaries, along the boundaries between unlike planes, across the grains of the matrix or preferred planes, across a compound or minor phase on preferred planes, and along defects. A combination of these can occur.

The intricacy of the problem is such that simple physical and mathematical relations between the structure and the causes of cracks and their propagation cannot be derived. The fact that a microconstituent of a metal is cracked does not inevitably mean that the metal itself will be brittle. The propagation of brittleness by such microscopic discontinuities is mainly governed by whether the matrix in which the cracked constituent is embedded is capable of deforming sufficiently to lessen the concentration of stress in the region of such cracks. If the matrix is ductile enough, it will not allow a crack to propagate.

BOILERS AND STEAM DISTRIBUTION

Service Performance of Boiler Brickwork—The Causes and Extent of Wastage. TAYLOR, B. and BOOTH, H. *Transactions, Institute of Marine Engineers, paper read* 12 May 1953.

The investigation described in this paper was undertaken by the British Shipbuilding Research Association and the British Ceramic Research Association with the following objects ; to determine the extent of deterioration of refractory materials in water-tube boilers in the merchant service ; to formulate the main causes of wastage ; to consider ways of improving the life of furnace brickwork ; and to provide a background for any experimental work that may be desirable.

Brief details are first given regarding the furnace linings commonly used, and the information gained from examination of over forty boilers of eight different types is then summarized.

It was found that thermal spalling or fracture is undoubtedly the most common and serious type of damage ; cracking of bolted blocks and oxidation of the bolts is probably the next. Damage directly attributable to slag action is negligible, but it is possible that slag penetration of the firebrick may play some part in promoting spalling. More severe damage of all types occurs when the lining is swept by flame.

The aluminous firebricks now generally used have adequate refractoriness, but it appears that rammed plastic refractory materials could be substituted with advantage in certain positions, notably in those sections containing the burner openings.

The influence of service conditions on the life of refractories is examined ; and it is concluded that the forcing rate (lb oil/hr./sq. ft. of projected radiant heating surface) may be taken as a general indication of the severity of the operating conditions and also the extent of slag deposition.

Information relating to the useful life of sections of the linings of various types of boilers is given, and suggestions are put forward for improving the performance of boiler brickwork.

Advances in Naval Boiler Design. STONE, R. E. *Society of Naval Architects and Marine Engineers (Philadelphia Section), paper read* 16 Oct. 1952.

The trend in the design of naval boilers is towards reduced size and weight in order that the vessel's cruising radius and fighting efficiency may be increased, while at the same time a high degree of reliability is required. In recent years, there has been a tendency to change from the two-furnace superheat-control boiler to the single-furnace integral super-heater unit, owing to the simpler construction, easier operation, and better adaptability to automatic control of the latter type. The increased heat-release rates and the resulting decrease in boiler size have necessitated the development of fuel-oil burners of greater capacity. These burners now have such high firing rates that lighting-up or extinguishing is accompanied by considerable shock to the boiler ; as a result, it has been found necessary to develop burners capable of operating over a wide range of firing rates (see also Abstract No. 7738). Reductions in the size and weight of boilers have been made possible by introducing forced or controlled circulation.

Problems accompanying these advances in boiler design include leakage at superheater-tube seats. In order to keep size and weight to a minimum, small-diameter superheater tubes are used, and in view of the high steam temperatures these are of 18/8 steel stabilised with columbium or titanium. Seating these small tubes in heaters, usually of different materials, by conventional rolling and seal welding has not proved satisfactory. Suitable corrective measures have been found to include manifolding a number of tubes into a single large nipple, welding nipples of the same material as the header to the alloy tube, and improving the welds so that they more nearly approach strength welds. Another problem is that of steam baffling or moisture separation. While considerable improvements have been made, further advances are desirable.

An Ultrasonic Equipment for Descaling Boilers. *The Engineer*, **195** (1953) p. 638 (1 May).

An illustrated description is given of the 'Crustex' ultrasonic boiler descaler manufactured in Great Britain by H.N. Electrical Supplies, Ltd., of London. The instrument generates ultrasonic pulses of energy, which are transmitted through the boiler water and induce vibration in the boiler shell. Because the scale and the metal upon which it is deposited have different moduli of elasticity, the effect of the ultrasonic pulses is to cause the scale to fracture and flake off, the fragments being ejected by the usual blowdown.

The equipment consists of a generator and an oscillator for producing pulses of energy at 28,000 c.p.s. and directing them through the boiler water. The generator operates from 200–250 V, 50 c.p.s. mains, has a consumption of 20 W, and is capable of supplying four oscillators ; it is a simple transformer and a valve rectifying circuit which is housed in a metal case 13-in. by 10-in. by 6-in., and supplies pulses of D.C. to an oscillatory circuit consisting of a condenser and a solenoid. The solenoid is mounted inside a nickel-plated brass cylinder 1½-in. diameter and 5-in. long, forming the oscillator housing, which also contains the oscillating element consisting of a nickel tube whose middle portion is brazed to the housing. Part of this tube is surrounded by the solenoid. The oscillator is screwed to some convenient point of the boiler and the pulses of current in the solenoid induce contraction and expansion of the tube under the influence of a fluctuating magnetic field ; the damped oscillations thus produced are transmitted to the water by the free end of the nickel tube. The condenser is charged by the generator and is discharged through the solenoid, the alternate charging and discharging being effected by a commutator or switch in which the contact element is an oscillating column of mercury. The generator may be mounted at any convenient place up to 50 yards from the boiler, and is connected to the oscillator by a flexible cable.

Generally, the system is applicable to plant operating with pressures up to 450 lb/sq. in. and, for water of average hardness, with evaporate rates up to 15,000 gallons/hr. Under such conditions, scale is removed continuously as it is formed, with a deposit of eggshell thickness being left on the metal. Existing deposits as much as one inch in thickness will also flake away after a few weeks of operation.

STEAM ENGINES AND STEAM TURBINES

Maintenance of Marine Turbines. BUTCHER, R. O. *Marine Engineering*, **58,** No. 7 (1953), p. 43 (July).

The Author lays down rules for the care of turbine machinery, particularly at start-up and shut-down. He amplifies these with a comprehensive inspection schedule, and with diagrams and illustrations. He ends with a list of the common causes of operating difficulties with turbines.

GAS TURBINES

Gas-Turbine Power for Royal Naval Vessels. *Oil Engine and Gas Turbine*, **20,** (1953), p. 454 (Mid April).

The Royal Navy has conducted a considerable amount of research into the use of gas turbines at sea. Since the war *M.G.B. 2009* (now *M.T.B. 5559*) was the first vessel to be fitted with a gas-turbine propulsion unit (*see* Abstract No. 5901, March 1952).

Gas turbines are likely to find use as booster units in capital ships to supply the peak outputs required occasionally in service, thus enabling the steam-turbine machinery to be made smaller and more efficient.

In the future, the gas turbine is likely to replace the steam turbine and Diesel engine as propelling units, provided that residual fuels can be successfully burnt. Gas turbines are also of great use for auxiliary machinery, and it is likely that in the near future ships of the Royal Navy will be fitted with them for that purpose.

Endurance Trials of a Coal-Fired Turbine. *Oil Engine and Gas Turbine*, **21,** (1953), p. 30 (May).

An open-circuit coal-burning Allis-Chalmers gas turbine developing 4,000 h.p. was built in U.S.A. in 1951. This turbine is fitted with two all-metal ring-supported combustion chambers. Since any particles larger than about 20 microns were shown to destroy the first stage of stator blades, a centrifugal ash separator was developed to clean the gases before entering the turbine. A high-load test of this unit was recently performed of 750 hours duration.

Owing to difficulties with the fly-ash separator, a great deal of coarse matter was allowed into the turbine and caused considerable erosion to the blades of the first five stages. The average specific fuel rate was 1·03 lb per h.p.-hr., with a thermal efficiency of 18·7 per cent., the average turbine inlet temperature being 650°F).

The combustion was satisfactory, the coal pumps working well, and the combustion chambers were in excellent condition after the test. The combustion efficiency was over 95 per cent., and no oil pilot flame was used at all. The dust in the exhaust was calculated as less than 0·2 lb per 1,000 lb of exhaust.

It is stated that there is no difference in operating a coal-burning open-cycle gas turbine at high gas temperature (1,300°F) or low gas temperature (800°F), the main difficulty being to remove all ash particles larger than 20 microns (about one thousandth of an inch).

Some references are given.

DIESEL AND OTHER I.C. ENGINES

The 2,500 b.h.p. ' Deltic ' Diesel Engine. *The Engineer*, **195** (1953), p. 596 (24 April).

This article gives a comprehensive description of the Deltic Diesel engine referred to in Abstract No. 6219 (June 1952), which has been developed by D. Napier & Son, Ltd. for the Royal Navy.

This triangular two-cycle opposed-piston engine derives its name from the cylinder arrangement. All components are small enough to permit the use of modern aero-engine materials and manufacturing techniques, such as fully-hardened crankshafts, thin-wall lead-bronzed bearings, and case-hardened and ground gears. All parts of the engine are fully interchangeable.

The engine has 18 cylinders of $5\frac{1}{8}$-in. bore and $7\frac{1}{4}$-in. stroke, arranged in three banks, giving an effective capacity of 5,300 cu. in. (86·9 litres). It develops 2,500 b.h.p. at a crankshaft speed of 2,000 r.p.m., the continuous rating being 1,875 b.h.p. at 1,700 r.p.m. It weighs 8,725 lb (i.e. 3·5 lb per horse-power), excluding the reverse gear which weighs 1,775 lb. A b.m.e.p. of 91·9 lb/sq. in. is attained, and the piston speed at 2,000 r.p.m. is 2,416 ft./min.

The overall dimensions are : length 10 ft. 11 in., width 6 ft. $2\frac{1}{2}$ in., height 7 ft. 1 in. It is produced as a self-contained power plant, complete with all pumps and filters ; the reverse gear is operated by a single lever.

Although designed for marine propulsion, the engine has many possible applications ; and a nine-cylinder version is being produced, maintaining the triangular form but using three-throw instead of six-throw crankshafts.

The cylinder layout and construction as well as the gearing are described in detail and illustrated.

Failure of High-Pressure Fuel Pipes. *The Engineer*, **195** (1953), p. 628 (1 May).

A description is given of an investigation into the cause of failures of high-pressure fuel pipes in Diesel engines, carried out by C.A.V., Ltd. Such failures, which have been experienced with many engines, usually appear as fatigue fractures due to transverse bending. The investigation, which was conducted on small Diesel engines (of the order of 10 litres cylinder capacity) showed that these fractures were caused by resonant vibrations of the pipe system. The maximum bending stresses encountered ranged from 5 to 20 tons/sq. in.

A table of fatigue limits is presented for pipes with different terminations, made of mild steel, hard nickel, soft nickel, half-hard Monel, soft Monel, and Everdur. The table also includes damping factors for the different materials.

To reduce the vibrations, it is of prime importance that the mounting of the pump on the engine should be as rigid as possible, since, other things being equal, pipe stresses are proportional to the amplitude of vibration of the pump with respect to the engine. The required rigidity is seldom achieved in practice. Other means of reducing the likelihood of fracture include increasing the fatigue limit of the pipe material and joint, increasing the damping capacity of the pipe material, or imposing restraint on the pipe, e.g. by clamping.

The investigation has shown that, apart from the possible exception of stainless steel, no material is much better than mild steel, which is almost invariably used for high-pressure piping. The reduction of the stresses by clamping the pipe to the engine structure has been found to be a completely satisfactory method and is recommended. For this purpose, a C.A.V. synthetic-rubber damper or clamp has been designed, which consists of rubber bush held in a metal housing which fits but does not deflect the rubber. The pipe should be clamped to the engine structure at about the mid-point. The damper, which is illustrated, is available for single, double, or triple pipe units.

MARINE POWER INSTALLATIONS (GENERAL)

Atomic Propulsion with Special Reference to Marine Propulsion. COCKCROFT, SIR JOHN. *Transactions, Institute of Marine Engineers*, **65** (1953), p. 105 (April).

Nuclear propulsion will make use of nuclear reactors as a source of heat to replace the oil-burning or coal-burning equipment of conventional power units. A nuclear reactor is an assembly of uranium with other suitable materials in a proportion such that a nuclear chain reaction in uranium can develop. This causes large numbers of uranium nuclei to be split up, and the energy released becomes available in the form of heat.

The action of a simple type of reactor is considered in some detail, and the various types of reactor are then described. In the early days of nuclear propulsion, the heat generated in the reactor will most probably be used to generate steam, and the Author illustrates a number of alternative cycles for this purpose. The marine reactor will be subject to limitations of weight. The reacting core must be surrounded by a shield to prevent injury to the operating personnel by the dangerous nuclear radiations. To reduce the weight of this shield, attention has been focussed on reducing the size of the reacting core itself. In addition to the technical problems associated with the development of nuclear propulsion, there is also the question of economics. The Author estimates the capital costs of a nuclear-propulsion unit to be about three times that of conventional machinery, while a rough calculation of the fuel costs gives the figure of 2d. per b.h.p. hour.

The most important advantage of nuclear propulsion is that it makes long voyages between re-fuelling possible. The disadvantage is the highly radioactive core, with the result that any leakage will be dangerous.

After presenting the paper, the Author answered questions put by members of the audience.

Combination Propulsion Plants for Naval Vessels. McMullen, J. J., Comdr., U.S.N. *American Society of Mechanical Engineers, Paper No.* 53–*SA*–71, *read at Semi-Annual Meeting, Los Angeles, Calif.*, 28 June–2 July 1953.

Many schemes have been devised to maintain high efficiency at cruising powers and at the same time to meet the full-speed requirements of naval fighting vessels, but none has resulted in appreciable reduction of the total weight of machinery and fuel. The prospects of such a reduction with conventional steam or Diesel propulsion plant is not promising for large powers ; therefore other arrangements should be considered, such as the application of a simple, light booster gas turbine in combination with basic machinery which has good efficiency at cruising conditions. Since all fighting vessels (except submarines) use more than 50 per cent. full power for less than 1 per cent. of their sailing time, a combination plant with booster gas turbines is most logical for this group.

The Author points out the advantages and difficulties connected with combination plants and then reviews the various possible combinations, which he divides into the following groups :—

Steam and Gas-Turbine Plant

(*a*) Oil-fired cruising steam plant with gas-turbine boosters.
(*b*) Nuclear-fired cruising steam plant and gas-turbine boosters.
(*c*) Waste-heat steam boiler operating on gas-turbine exhaust.

Gas Turbine and Gas Turbine

(*a*) Complex open-cycle cruising gas-turbine plant (with intercooling and regeneration) with gas-turbine boosters.
(*b*) Oil-fired closed-cycle cruising gas-turbine plant with gas-turbine boosters.
(*c*) Nuclear-fired closed-cycle gas-turbine plant with gas-turbine boosters.

Free Piston and Gas Turbine

(*a*) Free-piston gas-generator–turbine plant for cruising with gas-turbine boosters for higher powers.

(*b*) Free-piston gas-generator–turbine plant with afterburning firing a waste-heat boiler for auxiliary purposes.

Diesel and Gas Turbine

(*a*) Diesel engine for cruising with gas-turbine boosters.

LUBRICANTS AND LUBRICATION

A New Mechanical Grease Lubricator. *Scientific Lubrication*, **5**, No. 3 (1953), p. 25 (March).

An illustrated description is given of a mechanical grease lubricator manufactured by Davies & Metcalfe, Ltd., of Romiley, which is designed for long life and the minimum of maintenance. The lubricator may have six or twelve outlets, but it incorporates a single robust piston pump which will deliver grease at pressures up to 3,000 lb/sq. in. Each feed is individually adjustable from zero to 2·5 oz/hr. The lubricator is suitable for all types of soft grease and can be supplied with a grease container to hold 13 lb. or 22 lb. It can be adapted to rotary or ratchet drive, and, since it works on the valveless principle, it has very few moving parts.

The lubricator is made to take either $\frac{5}{16}$-in. or $\frac{3}{8}$-in. outside-diameter pipe, and the overall height is 21 in. when the larger grease container is fitted, and 16·5 in. with the smaller reservoir.

INSTRUMENTS AND CONTROL DEVICES

Bearing Temperature Monitored Electrically by New Device. White, C. E., *Bureau of Ships Journal*, **2,** No. 2 (1953), p. 31 (June).

The U.S. destroyer *Timmermann* has been equipped with an electronic scanning and recording system enabling the temperatures of 48 bearings in the main propelling machinery to be automatically and continuously controlled. Measurements are taken by 48 thermocouples, the readings of which are electronically amplified and transmitted to a central control unit equipped with a scanning switch by which the temperatures at all or selected points can be instantly verified. Arrangements are made for selected points to be continuously scanned, with a warning device operating at some predetermined, critical bearing temperature. Further research includes the development of more reliable magnetic amplifiers for the same purpose.

CORROSION, FOULING, AND PREVENTION

How You Can Fight Corrosion. Gray, A. G. *Steel*, **132** (1953), p. 102 (6 April).

After discussing losses incurred through corrosion and the high costs of preventive maintenance, the Author goes on to review methods of protection and prevention. Among these are insulation between sheets and bolts of dissimilar metals, the safeguarding of aluminium and iron from water contaminated by copper and similar metals, and the extended use of corrosion-resistant metals whenever possible.

Paper impregnated with an amine-nitrite inhibitor will protect steel articles in packages or containers from atmospheric corrosion without the necessity for coating the steel itself.

With paint, thickness of the coating and preparation are all-important. Use of an incompatible paint should be avoided when touching up over a previous coating. Chemically-inert resins present an entirely new concept of surface protection by paint. Vinyl coatings are very resistant to solvents, boiling water, steam and acids ; and chlorinated-rubber coatings to acids and alkalis. Alkyd-base paints weather well, and furane resins and the epoxy resins are proving very durable. Bitumen compositions are widely used as a low-priced protection against acid fumes ; those with a coal-tar base are more resistant to water but are less stable to weathering and direct sunlight than the asphalt-base compounds.

Cathodic protection, properly applied, is an efficient method of protecting buried metals and storage tanks. Stray currents are a frequent source of trouble with electric-welding systems and in the electroplating industries. Metallic coatings, apart from those which are anodic to the base metal, such as zinc, cadmium, and aluminium, have a tendency to promote corrosion at discontinuities in the coating under certain conditions. Zinc is mainly used for coating steel, and much has been done to improve its appearance by supplementary treatment. The application of chromate films to zinc will retard the formation of bulky white corrosion products, to which it is subject at high temperatures and humidities. The electrolytic protection afforded by cadmium is about equal to that of zinc, but aluminium only protects steel under conditions where it can remain active. Nickel-chromium and copper-nickel-chromium is used where a bright finish is also required ; its protective value depends primarily on the thickness of the coating. U.S. Government restrictions on nickel have necessitated modifications, and in one process chromium is deposited directly on copper. A coating of clear baked enamel is advisable under outdoor conditions.

Apart from atmospheric protection, chemical coatings retard corrosion by stopping the passage of electric currents between anodic and cathodic areas. Phosphate coatings result from chemical reaction of phosphoric acid with the metal surface. They increase the adhesion of subsequent paint films and retard the spread of corrosion where the paint is scratched or abraded.

Among the new organic coatings, silicone-alkyd finishes are invaluable where heat as well as corrosion resistance is required ; they will adhere to metal at temperatures of 400° to 500°F.