TECHNICAL ABSTRACTS

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SHIPBUILDING (GENERAL)

22.6 Knots with Variable Pitch Propellers. *Shipbuilding and Shipping Record*, **72** (1948), p. 286 (2 Sept.).

The motorship *Los Angeles* (9,010 tons), which ran trials in August, 1948, and reached a speed of 22.6 knots, is claimed to be the fastest cargo liner in the world. She was built and engined at the Kockums shipyard, Malmo, for the Johnson Line's Pacific Service and has accommodation for 10 passengers.

The *Los Angeles* has KaMeWa variable-pitch, stainless steel propellers of 17-ft diameter. They are operated from the navigating bridge, and it is believed that the ship will get a better speed under ballast conditions by altering the pitch according to circumstances. The fuel injection, and thus the number of revolutions and the power of the main engines, can also be controlled from the bridge.

She was built as an all-welded open shelter-decker with ice strengthening, and with scantlings allowing additional draught.

The propelling machinery consists of two 7-cylinder double-acting two-stroke Kockum-M.A.N. engines developing a total of about 16,400 i.h.p. or 14,000 e.h.p. at 110 r.p.m.

PROPULSION, RESISTANCE AND FLUID MOTION

Underwater Photographs Reveal Ship Flow Patterns. *Marine Journal*, **74** (1948), p. 24 (Sept.).

A method of taking underwater photographs that reveal the flow patterns about surface vessels has been developed by the Experimental Towing Tank Laboratory of Stevens Institute of Technology. The method utilizes loosely hanging threads attached to the model itself or to fine wires extending from it. These threads follow the flow pattern during the run of the model and are photographed by a submerged camera. The method can be used for locating the optimum position of the rudder and of the propeller and appendages. It can also be useful in studies of the basic hull shape. A decided advantage of this method, in addition to its simplicity, is that it yields a picture of the simultaneous flow pattern over a wide area.

The report on this subject, prepared by William H. Sutherland and published recently by the Stevens Institute of Technology, describes the type and position of the camera in relation to the model, and is illustrated by photographs showing flow patterns on a model making a turn with the rudder at 35°, on the bow of a model which was being studied to determine the best position of the bilge keels, and on a partially submerged portion of a planing surface with a step.

WELDING AND OTHER METHODS OF CONSTRUCTION

Standards for Welds in Ship Construction. RUDKIN, R. J. W. *Welding*, **16** (1948), p. 335 (Aug.).

No satisfactory method has yet been developed for stress-relieving the main strength welds of a ship. Builders and classification societies have, therefore, introduced systems of welding sequences to reduce, as far as possible, residual stresses set up in the process. If radiographic examination shows defects of a serious nature, in a completed weld, this weld has to be cut out and rewelded out of sequence, and therefore under highly restrained conditions. The question arises whether it is sounder practice to accept the defects in the weld, or to cut them out and be left with a radiographically acceptable weld, but one which may be under considerable residual stress even before the normal working load is applied to the joint. In the recorded instances of major structural failures in welded ships, it has been found that failures occurred principally because of the inability of the material to yield to plastic flow when subjected to a complex system of multi-axial stresses, and because of an inherent tendency to fracture without deformation at low temperatures. Such stresses can exist undetected in welds that are radiographically acceptable. As far as the Author is aware, failure has never been directly attributed to defects in the welding. Before acceptance tests can be formulated for structures such as ships, far greater knowledge of the effect of various defects of different proportions on the load-carrying capacity of joints is required.

The general use of radiographic inspection would add considerably to the cost of welding. Figures are quoted which give some indication of the amount of welding in the main structural items of a 10,000-ton cargo liner of about 490-ft length. The figure given for the total, about 26,000 ft, does not include any of the important welding on water-tight bulkheads, oil bunkers, etc.

There is, however, a real use for radiography as an aid in the development of welding technique, weld design, and the training and grading of welders. Before any welded joint of new design is used in production, samples of the joint should be prepared as nearly as possible under identical conditions to those that will exist in production. The samples should then be radiographed, sectioned, etched, and tested mechanically. Samples of new ideas of welding technique should be similarly treated. Correctly handled, regular radiographic tests of work carried out by all production welders can raise the standard of workmanship considerably.

Taking 30 Feet off Liberty Ship Converts her to Collier. *Marine News*, **35** (1948), p. 22 (Aug.).

A description is given of the conversion of a Liberty ship into a collier, which involved the shortening of the vessel by 30 ft in order to permit mechanical unloading of all hatches by existing gear at piers of limited length. This was accomplished by removing a section just forward of the house and rejoining the remaining fore and aft sections of the hull in the floating dock to form a vessel 386 ft long between perpendiculars. The entire task of cutting and removing the section was accomplished in $27\frac{1}{2}$ days. The main deck was removed in one section, each side in two sections and the entire inner bottom in two large sections weighing about 40 tons each. The alignment of the two sections to be joined was carried out by placing the fore section on the keel blocks and ballasting the after section so that it would float on an even keel while being moved into position. The difference in shear heights at the joining (about 6 in) due to the shortening of the ship required a special design of the filler pieces used on the side shell, the adjustment of bulwark heights, and realignment of the main deck plating for several feet forward of the junction of the two sections.

Other alterations included the removal of the second deck, fitting of eight deep transverse webs, replacement of original cargo hatches by 10 new hatches with hinged steel covers, strengthening of the sheer- and deck-stringers, and the construction of new ballast tanks in No. 4 and 5 holds by installing a new tanktop of 1 in plates at the level of the shaft-tunnel top.

Welding in Engineering Production. FERGUSON, J. R. *Transactions Institute of Welding*, **11** (1948), p. 170 (Oct.).

This article is a summary of a lecture delivered on 29th April, 1948, during the spring meeting in Manchester of the Institute.

One of the main results of the large-scale changeover from cast-iron construction to welding fabrication of large engineering components, such as marine gear cases, was that the drawing office became the focal point of design and construction, a tendency which was accentuated when heavier and more complicated gear cases and low-pressure turbines were undertaken. The only rational way of producing these components was by employing sub-assembly methods of construction. The drawing office was responsible for determining the nature of these sub-assemblies and for deciding the constructional methods to be used in the shops.

The need for the development of manipulators for handling large components was brought home to industry by the necessity for welding them quickly and efficiently. An illustration is given showing a 15-ton manipulator being used to facilitate the welding of two low-pressure turbine covers. Analysis over a number of years has shown that the bigger the components, the greater the necessity to arrange for them to be handled by turntables or trunnions, to cut down the non-productive time in the production cycle. The high quality of flame cutting to be obtained with modern equipment obviates the necessity for machining plate edges.

Production welding on light-weight structures can be carried out by several welding methods ; and it is the function of the welding engineer to decide which is the best method for the particular component at the design stage, and to see that it is shown clearly on the drawings and that the best technique available for that type of welding be used. On modern controlled equipments, spot welding is perfectly sound up to $\frac{3}{4}$ in added thickness. Freedom from distortion is a particularly useful feature on $\frac{1}{4}$ in added thickness. Poor plate, *i.e.*, rusty or deformed plate, endangers the success of the method. The limit for portable equipments would seem to be those capable of welding two $\frac{1}{8}$ in sheets together. Projection welding generally requires large quantities to justify the expensive tools required, but it is suitable for certain links and levers which can be welded with flat patterns and require no tools. For welding studs up to $\frac{3}{4}$ in diameter, stud welding is now the ideal method. Stud-welding guns can be designed with hydraulic operation for welding studs automatically at rates of over 1,000 welds per hour. This is particularly suitable for the motor-car industry, where it can be used on disc wheels, bumper bars, exhaust silencers, etc.

MATERIALS : STRENGTH, TESTING, AND USE

A Study of the Properties of 0.5% Chromium—0.5% Molybdenum Pipe Steel. FITZGERALD, R. C., WILDER, A. B., SMITH, G. V., and WHITE, A. E. *Welding Journal*, **27** (1948), *Welding Research Council Supplement*, p. 457-s (Sept.).

The occurrence of severe local graphitization and failure of the welded joints of molybdenum steel in a high-pressure steam line gave rise to this investigation into the fundamental factors involved in the reversion of carbide to graphite, with a view to developing alloys and manufacturing practices which would inhibit the formation of graphite during commercial use.

It has been generally considered that the addition of chromium would be the most effective means of preventing graphitization, and this possibility was investigated.

A study of the mechanical properties, including creep, and of the welding and fabrication characteristics of steel containing 0.5% chromium and 0.5% molybdenum, designed for elevated temperature service, has shown this grade to be essentially similar at ordinary temperatures to 0.5% molybdenum steel without chromium. However, elevated temperature exposure tests have shown the steel, whether deoxidized with aluminium or not, to be resistant to graphitization in butt-welded pipe as well as bead weld tests lasting up to 15,000 hr at 1,025°F, and 12,000 hr at 1,100°F. Scaling tests and hardness and notch-impact tests before and after air exposure at elevated temperature have indicated that only slight oxidation and little or no embrittlement may be anticipated during service with this grade of steel.

The Fracture of Mild Steel Plate. TIPPER, C. F. E. *Admiralty Ship Welding Committee, Report No. R.3.*

The occurrence of failure in service of mild-steel ship plates, where fracture was observed without previous plastic deformation and consequent energy absorption, led to an examination of the steel used in shipbuilding. The results are summarized in the present report. It contains many diagrams, photographs, and references, and begins with the description of fractures and of the experiments designed to reproduce similar fractures in the laboratory. It was found that they could be produced by a simple tensile test at a given temperature in the presence of a notch. There are remarks on the properties of steel, and the report describes metallurgical investigations of the plates which were carried out in order to establish why some steels fractured in this manner at higher temperature than others, and what factors influenced the transition temperature other than composition of the plate. Finally, the report deals with some fundamental experiments on the effect of notches on the ductility and fracture of mild steel.

It has been shown that a very large number of the plates sent for test are liable to cleavage fractures at normal working temperatures, while conforming to existing specification as regards composition and the tensile test. If the transition temperatures were below 0°C the chances of failure in service would be considerably reduced even when serious defects introduced a notch effect. If the ductility were such that stress relief by plastic flow could be achieved before the formation of a crack, failure would also be less likely to occur. Stress relief by plastic flow becomes more difficult in large structures, and the difficulty is increased by restraint, and the net result of increase in both these directions is equivalent to raising the transition temperature.

In the absence of a low transition temperature and good ductility, fractures such as those described are inevitable, and they may be extensive in a welded structure where notching breaks the continuity. Although similar cracks may arise in riveted structures, it is unlikely that they would pass from one plate to another.

The ideal solution would be to use steel which has a low transition temperature. In the present state of our knowledge, that could only be achieved by carrying out a series of notch tests to eliminate those steels which have a high transition range. It is also doubtful whether any thicker plates, as at present manufactured, would give satisfactory results in a notch test. It may then be necessary to rely on an increase in ductility, which can be gained at the expense of yield strength and ultimate strength by lowering the carbon content, or by improving both these values by the addition of alloying elements.

POWER TRANSMISSION

The Gehres Drive. *Motorship*, **33** (1948), p. 36 (Aug.).

A description is given, with a cross-sectional drawing, of a new marine reverse and reduction gear, which includes two variable-speed, eddy-current slip couplings and reverse and reduction gears in a single compartment.

In this gear, the engine-shaft flange is rigidly bolted to the driving member of the coupling, which includes two coils which are energized independently of one another. Separated from their driving members by an air gap, two driven members of the coupling are respectively bolted to an outer shaft which connects with the reduction gear and an inner shaft connecting with the reverse gear. Thus, energizing one coil of the coupling will drive the propeller ahead and energizing the second coil will reverse the propeller rotation. An interlock prevents both coils from being energized at the same time.

The high efficiency of 93 to 94% is claimed, which exceeds the efficiency that can be obtained with full Diesel-electric drive and yet it is equally flexible and easy to operate.

Gehres Drive is to be supplied with Cooper-Bessemer Diesel engines FV in 6, 8, 12, and 16-cylinder sizes ranging from 600 to 1,600 h.p. for use on river towboats, sea-going tugs, and equivalent applications.

The electrical equipment required is claimed to be very simple, and consists of two very simple rugged windings, one set of three slip rings, and a small exciting generator which should have a capacity of approximately 2½ kW per 800 h.p.

INSTRUMENTS AND CONTROL DEVICES

Marine Engine Speed-Governors. Patent No. 574,853. Dufty, N. E. *Patent Specification, Abridgt., Group XXVI.*

A means is described for preventing racing of a ship's engines when the propeller rises out of the water. It consists essentially of a kinetic coupling which operates in an air chamber communicating with a port in the hull near the propeller, so that the change of air density due to pitching changes the coupling effect and so operates on an engine control. The enclosed coupling itself consists of an impeller driven by an electric motor at constant speed, and a driven vaned element, the former acting on the latter through the atmosphere in the coupling chamber and against the action of a spring which limits the motion. The movement of the driven element is transferred to the control of the engine power output through a cam disc on the shaft of the driven coupling element, the cam acting on a follower which in turn operates the electric control contact.

Modifications of the device employ a parallel or co-axial second coupling in place of the spring, the second coupling being enclosed in a chamber which opens to the atmosphere or to air vessels forward of the propeller.

BOILERS AND STEAM DISTRIBUTION

Methods and Apparatus for Descaling Boilers. *Shipping World*, **119** (1948), p. 154 (25 Aug.).

An electrolytic method is described which, it is claimed, can effect the complete descaling of a heavily scaled boiler in about 36 hours, and is particularly suitable for cleaning marine boilers. The boiler, which acts as the cathode, is connected to the negative pole of the electric supply ; and a number of flexible anodes, insulated by perforated flexible coverings, are passed between the tubes and other internal obstructions. If the rapid removal of scale is the primary objective alkali is added to the boiler water to give a 3% alkaline solution which serves as an electrolyte. If oil is present in the boilers, a small quantity of trisodium phosphate is also added.

A direct current of from 300 to 500 amps at 20 to 50 volts is required, the actual value of the current depending on the condition of the boiler.

The Boiler Explosion on the " Esso Saranac." *Shipbuilding and Shipping Record*, **72** (1948), p. 253 (26 Aug.).

The report of the preliminary inquiry held under the Boiler Explosion Act, into the explosion of a main boiler on board the *Esso Saranac* has been published by the Ministry of Transport.

A description is given of the boiler, which was of the single-ended, multitubular cylindrical type, with oil firing using Howden's forced draught. Coil superheaters were fitted in the two wing combustion chambers. The boiler was six years old at the time of the accident. An account is given of the continuous trouble experienced in maintaining the water levels in the ship's boilers, due to leakage. Finally, the crown of the port wing furnace collapsed over a length of 5 ft and ruptured at a point 26 in from the front end, where the distortion reached a depth of 30 in. Two men lost their lives and two more were injured.

In his observations appended to the report, the Engineer Surveyor in Chief, Mr. James Jarvie, stated that " continual difficulty in maintaining a proper water level in the boilers, and considerable trouble with the main engines and the bilge pumping arrangements, seem to have resulted in the boiler in which the explosion occurred being worked short of water to the extent that the crowns of the wing furnaces were uncovered ; they became overheated and bulged and the bulged plate of the port furnace ruptured."

Steam Pipe Inspections. INGHAM, E. *Engineering and Boiler House Review*, **63** (1948), p. 300 (Oct.).

The Author describes methods of carrying out the inspection of steam pipes. The metal thickness of pipes is usually sufficient to withstand pressures far in excess of the normal working pressure, and this thickness is very rarely reduced seriously by external or internal corrosion. Therefore, when steam piping does fail it is generally because it has been subjected to unusual stresses such as those caused by heavy bending moments due to inadequate supports, faulty expansion devices, and local sagging of the portion of the pipe which may lead to the risk of " water hammer."

The principal points to be watched during the inspection are therefore the examination of all supports, expansion joints, and the gradient of the piping, which should be not less than 1 in in a length of 30 ft.

The lagging should be removed only if it is found to have become damp, and if there are any reasons to believe that the piping is being exposed to corrosive action or to excessive stresses caused by heavy bending moments as a result of which the presence of cracks is suspected.

Benson Boilers in Germany for Naval and Mercantile Marine Use. *B.I.O.S., Final Report No.* 1784, *Item No.* 29.

This lengthy document contains a large amount of useful material, from both the design and the operational points of view, on Benson boilers in German naval and mercantile vessels. It includes many diagrammatic layouts, detail drawings of boiler parts, photographs, and performance charts. In addition, there are statements by the chief boiler designer of the German Admiralty and by a German naval engineer, an extract of a German naval conference on a Benson boiler installation in a battleship, and the complete thermal and stress calculations of a Benson boiler designed for escort vessels. All boilers of this type were designed and constructed by Blohm and Voss, and reference is made to a paper by their chief designer which can be inspected at B.I.O.S. headquarters.

From the report it appears that, whereas this forced-circulation boiler was originally constructed without a drum, most of the installations have since been converted by the addition of a vertical drum. Nevertheless, some merchant vessels, *e.g.*, the *Uckermark*, *Pretoria*, and *Windhuk*, had Benson boilers fitted without a drum.

Precision of operation is a very important factor with Benson boilers, as pressures and temperatures would otherwise fluctuate violently ; a very reliable automatic control system is therefore required. The Askania system selected is fully described and illustrated with examples, including the fuel-oil control in an " O " battleship, and the feed-water regulation in a " Z " destroyer. There is also a description of the semi-automatic system used in the cruiser *Potsdam*.

The chief troubles experienced in naval service were evaporation of the hot return water from the feed pump, with resultant disturbance to the hydraulic balance of the pump, tube corrosion, and tube failures through overheating by uneven distribution of water, steam, or mixture. It was observed also that considerable temperature differences of more than 200°F occurred in individual superheater tubes.

In later designs, controlled feed-water circulation was adopted, and a special circulation pump was installed to exclude the return of hot water to the main feed pump. Nevertheless, comparing Bensons with natural circulation boilers, like the Wagner boiler, the boiler designer of the German Admiralty regarded the former as always being more complicated and difficult to operate than the latter.

John I. Thornycroft & Co., Ltd., have built a model of the installation for the battleship " O," showing the complicated flow circuit. Photographs of this model are reproduced in the report. The boiler is built vertically with the heating zones divided into an economizer zone, two evaporating zones, and a superheating zone. It is typical of all Blohm and Voss Bensons that extensive use is made of large-bore water-cooled supporting tubes.

The six Bensons that were run in a " Z " destroyer could be started in not more than 20 min, and even in 10 min in cases of emergency. Their economic working pressure was 1,320 lb/sq. in. (at 17 knots), and their maximum working pressure roughly 1,820 lb/sq. in. The oil consumption under these conditions was 4-5 and 28 tons/hr. respectively and the superheat temperature varied from 840° to 880°F at normal and overload conditions (41.5 and 60 tons/hr. of steam respectively). No trouble was encountered with the high pressures, but salt deposits caused jamming in the governor valves of turbo-auxiliaries. Trouble occurred also in the supply pump from the de-aerator tank to the main feed pump. The supply pump raced when the pressure dropped below about 45 lb/sq. in.

The only items of interest in the Blohm and Voss oil burners are the lighting-up pistols and the air shutter mechanism. The former use ignition cartridges charged with a mixture of magnesium powder and an oxidizing agent such as potassium nitrate, and are electrically ignited. The air-shutter arrangement of the boiler is controlled by a link mechanism connected to a control piston, which is actuated by the fuel-oil supply pressure.

The all-tube Bensons designed for merchant ships with a pressure of 3,200 lb/sq. in. were found to be heavier and more expensive to build than boilers working at a lower pressure. Trials carried out at the critical pressure of 3,600 lb/sq. in. were a success in so far as it was proved that steam generation is possible with such a pressure. Great care had to be taken, as in naval boilers, to reduce salt deposits to a minimum. The feed system was made a closed cycle with de-aerator tank, the condensate being pumped to the de-aerator and then to the feed pump ; the water was also chemically treated. Nevertheless, the salt concentration in the boiler was so heavy that it had to be washed out during shut-down periods. Much attention was also given to the movement in the boiler of the zone where salt separation takes place. Attempts were made to influence the position of this zone by varying boiler load, steam temperature, or feed temperature ; and it was decided to lower the steam temperature from 790°F to 700°F by reducing the oil quantity. This had a beneficial effect on the salt deposit.

DIESEL AND OTHER I.C. ENGINES

Cylinder Liner Wear in " Auricula." *Shipbuilding and Shipping Record*, **72** (1948), p. 314 (9 Sept.).

This tanker has now completed two years' service since her conversion for burning boiler fuel of 1,500 secs Redwood 1 viscosity in her 4,000 i.h.p. Hawthorn-Werkspoor Diesel engine.

During recent drydocking, the cylinder liners and piston rings were gauged for wear. It is stated that the average wear of the six cylinder liners is :—

Per 1,000 hours	0.087 mm
Per 1,000,000 revolutions	0.013 mm

At the present rate of wear it will require 70,000 hours or 12 years normal operation for the maximum enlargement of these 650-mm diameter cylinder liners to reach 6 mm. In that time the ship will have covered approximately a million miles.

After examination of the piston rings it has been found that, on the whole, best results are obtained with rings having a Brinell hardness number between 210 and 275. The Brinell hardness of the cylinder liners in this ship is 200 to 230.

All fuel and exhaust valves examined during the drydocking were in excellent condition and were refitted as taken out.

The centrifugal purifier and clarifier were opened up during operation for cleaning once per 24 hours. This entailed about half-an-hour's work.

It is stated that other tankers of the Anglo-Saxon Petroleum Company are operating with equal success on boiler fuel, and conversions are being carried out as quickly as the purifying equipment can be procured.

Turbo Charging and Gas Turbines. BUCHI, A. J. *Journal of American Society of Naval Engineers*, **60** (1948), p. 261 (Aug.).

A brief description of the first turbo-charged Diesel engine, built in 1911 in Switzerland at the Sulzer works, is followed by an account of some of the outstanding achievements of more recent engines of this type. The success of the turbo-charging system in four-cycle Diesel engines depends primarily on the augmentation of the amplitude and on the timing of the pressure fluctuations in the exhaust gas conduits between the engine and the exhaust-gas turbine. For multi-cylinder engines, multiple exhaust pipes with separated inlets to the turbine are employed. A typical curve is given showing the pressure fluctuations in the exhaust manifold leading to the gas turbine of a Buchi turbo-charged Werkspoor 8-cylinder four-cycle Diesel engine.

An account is given of the Buchi duplex turbo-charging system, which uses two blowers, the first, preferably of the centrifugal or axial type, driven by the Diesel engine itself, or some other convenient source of power, and the second, an exhaust-gas-driven turbo-charger. During starting and light loads, the mechanically driven blower supplies air through non-return flap valves direct to the Diesel engine. On higher loads, it delivers its air to the exhaust turbo-charger, which then feeds all the charging air to the Diesel engine. The advantages of this system are discussed.

When the power obtained from the combustion of the fuel is compared for Diesel and petrol engines, it is obvious that even the most highly-developed Diesel engine cannot be compared with the best petrol engines in this respect. If it were possible to use smaller air-fuel ratios, the output of a given Diesel engine could be further materially increased. Several means for improving combustion have been introduced with promising results. A very compact combustion face with a cooled surface small as compared to its volume is used, all surface irregularities being avoided. The distribution and atomization of the fuel is assisted by a very pronounced swirl action, which also ensures better mixing with the combustion air. The inlet and exhaust port areas are large, and large, single-hole fuel-injection nozzles are used.

A description is given of a new centrifugal blower for turbo-charging. The centrifugal type of blower is considered by the Author to be more satisfactory than the axial rotary compressor. It has a very flat characteristic, and the volume of gas delivered can be varied within wide limits without any material change in the air pressure and blower efficiency or the risk of surging. It can also be designed as a shorter unit than the axial type. In the improved form of blower, a limited number of diffusers of circular section is used for each blower runner. These diffusers have a far higher efficiency of conversion of air velocity to air pressure than the conventional types. A diagram is included of a new blower, showing the new diffuser, which has a maximum adiabatic efficiency of 92% with a pressure ratio of about 1.4 : 1. The design of the gas turbine itself has also been improved by using in the turbine blading an expansion to a lower pressure than the effectively existing back pressure behind it. This makes it possible for the turbine-rotor-blade angles to be made relatively large.

These blower and turbine improvements can be used for raising the charging rate with mechanically or turbine-driven chargers. The increase in output which could be achieved with the 4,000-kW gas turbine used by the City of Neuchâtel for reserve and peak load service, by the introduction of these improvements, is estimated to be as high as 28.7%.

A scheme is outlined for using a four-cycle Diesel engine as a gas producer for a gas turbine which is acting as a prime mover. In the case of a ship, the gas turbine could drive the propeller shaft through gears, hydraulic drives, or electrical means. With 88% turbine efficiency, the fuel consumption of such a plant would only be about 0.33 lb/b.h.p/hr. ; its weight and overall dimensions would be small ; torsional vibrations could be avoided completely by careful design ; lubricating-oil consumption would be low ; no extra starting and accelerating power engine would be required ; and the gas turbine would be able to work with high back pressures, the gases being forced out by the positive displacement piston gas producer.

Exhaust Temperatures and Engine Maintenance. HALLWORTH, S. E. *Oil Engine*, **16** (1948), p. 216 (Oct.).

Useful information can be obtained from the exhaust temperature on the general running condition of an oil engine. The safe maximum temperature for a four-stroke engine is generally accepted as 800°F. All the common troubles associated with running detract from the engine's performance, and if more fuel is injected to compensate for the loss in output the result will be a higher exhaust temperature. Adequate and intelligent maintenance can prevent the occurrence of many of these faults.

Warning is given against the harmful practice of reducing the output of an engine to 70% of its known capacity in order to keep within selected exhaust temperature limits. To allow for high ambient temperatures, the engine should be de-rated by deducting 2% for every 10°F by which this temperature exceeds 85°F.

GAS TURBINES

The Axial Compressor Blade Fouling Problem. DAVIDSON, I. M. *Summary of paper presented to the Seventh International Congress of Applied Mechanics in London, September*, 1948.

Bench tests of aircraft gas-turbine engines have shown that the fouling of the blades of an axial-flow compressor by the smoke content of a typical industrial atmosphere can produce very large losses in performance. Even if the rate of fouling could be reduced by a factor of a thousand, these losses would still be sufficient to disqualify the gas turbine in many industrial fields.

The paper mentions briefly the present state of knowledge concerning the fouling process and, as the mean diameter of the particular matter responsible for the trouble is about one micron, it would appear that there is at present no means of combating the phenomenon.

A possible line of attack would be the development of air filters of unprecedented efficiency, and it is suggested that the best type of filter would be that employing a scrubbing process followed by centrifugal separation. The basic physical problems concerned with centrifugal separation have now been solved, but much research has yet to be done in connection with the scrubbing process.

Finally, it is possible that, in addition to the reduction of the rate of fouling by air filtration, much may be done by so designing axial compressors that when they do become fouled the inevitable loss in performance is minimized.

OPERATION AND MAINTENANCE

Metallizing in Relation to Marine Engineering. STILES, J. BARRINGTON. *Transactions Institute of Marine Engineers, paper read* 9th Nov. 1948.

The Author describes the metallizing process, dealing briefly with the equipment used to spray metal and considering in some detail the characteristics of the coatings produced. Various methods are discussed by which bonding to the base material may be achieved, and techniques for finishing sprayed metal coatings are considered. The many applications of the process to marine engineering are conveniently divided into two main groups : (*a*) the reclamation of worn parts, and (*b*) protective coatings to resist corrosion.

A number of interesting examples of the successful use of the process are described. During the late war, a destroyer (H.M.S. *Verity*) was found on trial to have distorted the port main turbine casing on either side of the packing gland, to a depth of about 0.008 in on each flange. The Author was able to repair the damage with a metal-spraying gun, using mild-steel wire, so that the ship was ready to go to sea after a very short delay. Severe pitting, as much as $\frac{3}{8}$ in deep in places, was found aft of the stern glands and forward of the A-bracket bearings on each of H.M.S. *Stevenstone's* propeller shafts. There was not time for the shafts to be withdrawn and they were therefore repaired in dry dock by metal spraying. A brief description is given of the improvised device used for machine-finishing the surface after metal-spraying. The result was very satisfactory. Before D-day, metallizers were busy making good the ravages of corrosion on the tailshafts of landing craft. Although many of these had rusted up solid, owing to the electrolytic action of the steel in contact with bronze in the presence of salt water, it was possible to salvage them well inside the time limit.

A procedure is given which is recommended for zinc-spraying a ship's hull, to provide a protective coating. Vessels having steel propeller shafts and cast-iron propellers may have the exposed part of the shaft and the propeller coated with zinc, but vessels fitted with bronze propellers and shafts must have such parts coated with Monel metal. A large American coal barge, metallized in 1934, is still giving excellent service. Examples are given of the use of the process to provide protection for a number of parts, including steel tanks and holds.