ENGINEERING ABSTRACTS

Section 3. SHIPBUILDING AND MARINE ENGINEERING

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Hull Design for Laminar Flow

According to the modern aerodynamic theory as applied in the aeronautical field, the attainment of laminar flow over a sufficient length to give an appreciable reduction in the skin friction drag depends primarily on three factors: (i) positive velocity gradient in the streamline flow along the surface, (ii) freedom from turbulence in the fluid itself, (iii) a sufficiently smooth surface finish. Reynolds number does not enter directly, though it is known to influence the degree of smoothness required, for a given length of surface. Accuracy of contour is also of importance, but its effect may probably be included under (i), i.e. if the inaccuracies are not so great as to reverse the velocity gradient the flow may be expected to remain laminar. Aircraft wings have been designed for laminar flow and up to full-scale Reynolds numbers in the region 10^8 but this is not necessarily the upper limit. In ship model work, Reynolds number has generally been considered the critical factor, but there are grounds for discarding this hypothesis and exploring the possibility of full-scale drag reduction. Methods of calculating the velocity gradient, including wave effects, are discussed, also the necessary accuracy of construction and possibility of boundary layer control.—*Paper by J. L. Taylor, read at the Joint Meetings of the Institution of Naval Architects, the Institution of Engineers and Shipbuilders in Scotland, and the N.E. Coast Institution of Engineers and Shipbuilders on 29th June 1950.*

Arrangement of Corrugated Bulkheads

This invention relates to an arrangement of transverse and longitudinal bulkheads in ships in which the bulkheads consist of corrugated plate having horizontal bending lines which define parts alternately parallel with and oblique to the plane of the bulkhead. Where a transverse bulkhead of this design intersects a longitudinal bulkhead of similar construction, the intersection has previously been so arranged that the vertical parts in the one bulkhead intersect the vertical parts in the other bulkhead, so that the sloping parts in the one bulkhead also intersect the sloping parts in the other one. Such an arrangement of the bulkhead demands rather much adjustment, which is difficult to make because the sloping parts of the two bulkheads do not intersect at right angles, so that the edges must be bevelled accordingly. The connexion of the bulkheads by welding is also made difficult because at different parts of

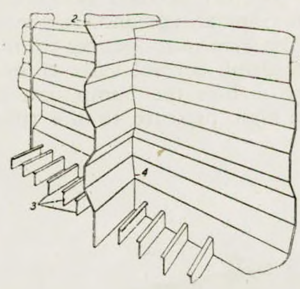


FIG. 1.

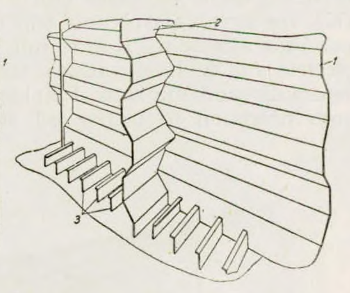


FIG. 2.

the line of intersection between the bulkheads the welding must be effected in the bottom of a relatively acute angle between the two intersecting planes. In the design covered by the present invention these disadvantages are claimed to be avoided because the corrugations in the one of the two bulkheads are displaced in such a manner relatively to the corrugations in the other bulkhead that each vertical part of one bulkhead intersects a sloping part in the other bulkhead and vice versa. The parts will therefore everywhere intersect one another at right angles, so that the welding lines will always be easily accessible. In Fig. 1 is shown a perspective view of two intersecting bulkheads arranged in accordance with the practice previously followed. Here the corrugations are arranged so that vertical parts in one bulkhead intersect vertical parts in the other bulkhead, and sloping parts intersect sloping parts. In Fig. 2 the corrugations in conformity with the invention are displaced relatively to each other in such a manner that the vertical parts in bulkhead (1) intersect or are intersected by the sloping parts in bulkhead (2) and vice versa. It will be noted that the extension of the vertical parts in the vertical direction is slightly greater than the vertical projection of the sloping parts. Hence the vertical parts of the two bulkheads will intersect one another along short distances in the neighbourhood of their upper and lower extensions, these intersections also being at right angles to one another.—*British Patent 635,112, issued to D. Tom-Peterson. Complete specification published 5th April 1950. The Shipping World, Vol. 122, 7th June 1950, p. 510.*

Stabilizing Gear in the *Chusan*

The Denny-Brown stabilizer installed in the P. and O. 24,000 tons passenger liner *Chusan* consists of two rectangular fins—each 12 feet by 6½ feet—lying approximately in a horizontal plane, one on each side of the ship and projecting from the hull in the vicinity of the bilge. Each fin is mounted on a shaft arranged so that the fin is hydrodynamically balanced. When operating, the fins are tilted about their zero position and controlled so that their angular movements are equal and opposite. The forward velocity of the ship causes the water to exert an upward force on one fin and a downward force on the other, combining to damp down any roll imposed by wave action. The fins are retractable, and when not required can be withdrawn into recesses within the hull line. They are extended and housed by hydraulic machinery controlled from the bridge. When the machinery is operating to reduce the ship's roll, control is effected by two small gyroscopes, one measuring the angle and the other the velocity of the roll. The sectional view Fig. 2 illustrates the sequence of operation when the captain operates the "Start Motor" switch:—This illuminates the control panel on the bridge which registers on (B) the signal for the engineer to switch on (C)—the starters. This starts the motors for the servo unit (D) and (E) which is the main power unit, comprising variable delivery hydraulic pumps. The engineer then signals back to the bridge "Motors Running". By another switch on his panel, the captain then operates by remote control (F) the housing and extending control valve which admits oil from (D) to (G) which is the extending housing and cylinder ram. This pushes the fin (H) from its housed position in the fin box (J) to its working position as shown. When the fins are fully extended, the bridge is automatically signalled "Fins Out". The bridge then switches on (K), the gyro control unit which takes charge and, as the sea conditions cause the ship to roll, the gyro unit operates through electric and hydraulic relays, the tilting control valve through hydraulic and mechanical linkage, brings the pump unit (E) into operation to deliver oil at high pressure to the tilting cylinders (M). These tilt the fin (H) via the tilting levers and shaft (N), the system being arranged to tilt the fins in opposite directions. When the fins are fully tilted, they automatically stop the oil delivery from the main pumps by means of the cut-off gear (P). The stabilizer is manufactured by Brown Brothers and Co., Ltd., Edinburgh.—*The Shipping World, Vol. 122, 7th June 1950, p. 511.*

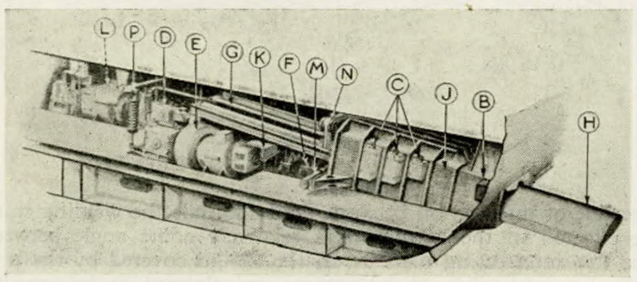


Fig. 2.

Design of Seakindly Ships

The author enumerates the qualities of a seakindly ship, and with data obtained from experienced seamen, the effect of fullness upon the best direction for the ship to meet the weather to ensure easy handling in a seaway is deduced. The effect of the weather upon steering is discussed and the essential features of hull form for easy steering in rough wather are deduced from model experiments and observations made in ships at sea. The various motions of a vessel in a seaway are considered and attention is called to those portions of hull shape and loading which produce uneasy motions of the ship in storms. The causes of shipping seas and spray are examined, and the different features in hull design that add to the quantity of water and spray taken inboard, are pointed out. The reasons for eddies, back draughts and excessively high wind speeds over open decks are discussed. Reference is made to wind speed measurements taken on the boat and sun decks of the old *Mauretania* which show that very high wind velocities do occur along open decks, even when the actual wind blowing at the time has a low speed. Streamlining to lessen the wind pressure is an attractive idea to a designer. But by

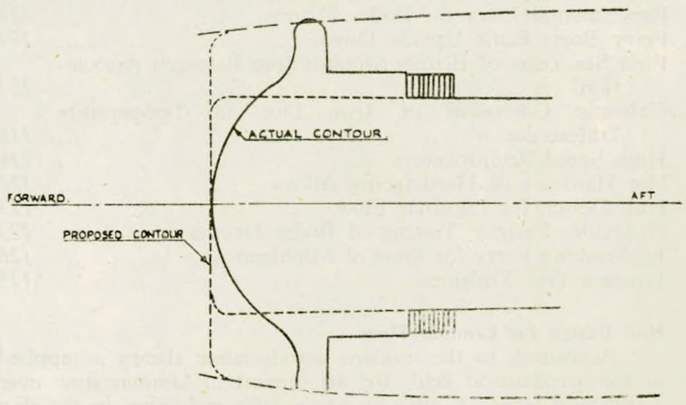
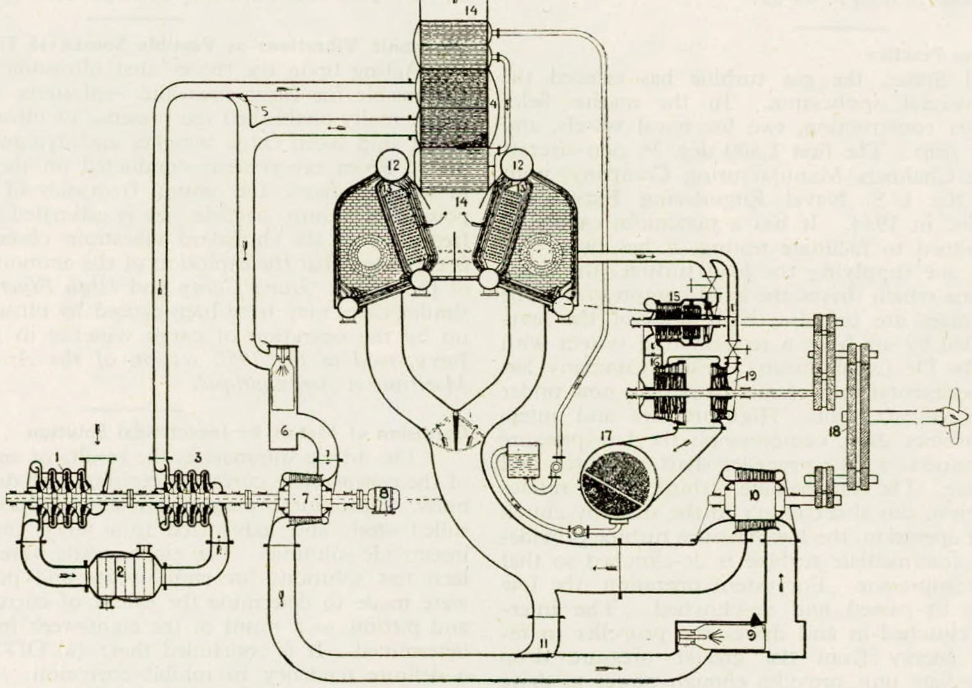


Fig. 15.

Bernoulli's law, any decrease in wind pressure due to streamline form, is accompanied by an increase in wind velocity. Thus a streamlined superstructure rising from an open deck, will inevitably induce high wind speeds across that deck in way of superstructure. This was particularly well shown during some observations of wind velocities and directions made on a liner running at 24½ knots into a true wind speed of just over 30 knots meeting the ship at 18 deg. on port bow. At the boat deck level the shape of the superstructure rising from it was as drawn in Fig. 15. Measurements by pitot tube of the wind velocities around the starboard (i.e. the leeward) side of the ship on the boat deck near the bridge structure, showed increases in relative wind speeds from over 70 knots to something greater than 175 knots, which was the limit of the pitot gauges used. From two to three days this portion of the promenade deck had to be forbidden to passengers, even though the weather was fair. Had the bridge superstructure not been streamlined, but shaped somewhat as shown dotted in Fig. 15, the wind speeds would have been quite low and the promenade deck always available to passengers. It is especially important in way of ladders leading from one open deck to another, to avoid the formation of wind eddies, which may give rise to unexpected and violent wind gusts and cause an unwary passenger to lose his footing and suffer injury. This is also true at the corners of promenade decks and the open end of alleyways, where the voyager may suddenly step into wind eddies sufficiently violent to upset his balance.—*Paper by J. L. Kent, C.B.E., read at a meeting of the North-East Coast Institution of Engineers and Shipbuilders on 29th June 1950.*

New Gas Turbine Plant

Proposals are being examined for the installation of a gas turbine plant in an 18,000-ton tanker by the A/B De Lavals Angturbin, Stockholm, and Eriksbergs Mek. Verk. A combined steam and gas turbine is proposed instead of a straight gas turbine drive, for the reason that reliability is assured since, in the event of failure of the gas turbine, the steam plant can remain in operation. It is also anticipated that the efficiency would be somewhat higher than with the normal gas turbine system. In the design, the plant comprises a geared steam turbine and a gas turbine, each developing about equal power. The gas turbine also provides the hot gases supplied to the boiler, first for superheating the steam, secondly, for generating saturated steam and, finally, for regeneration in the gas turbine cycle and feed water heating in an economizer. The turbine includes h.p. and l.p. independent units, also an astern turbine, and if the gas turbine is out of action the boiler is oil-fired. The general layout of the plant now suggested is illustrated. The plant now being designed is to develop about 8,200 b.h.p., but construction has not commenced. The thermal efficiency will, it is hoped, be about 33 per cent, corresponding to a fuel consumption of 0·42lb. per s.h.p. hr.—*The Motor Ship, Vol. 31, June 1950, p. 105.*



Proposed gas steam turbine propelling plant.

(1) First stage centrifugal compressor. (2) Intercooler. (3) Second stage centrifugal compressor. (4) Regenerator. (5) Change-over valve. (6) Combustion chamber. (7) H.P. gas turbine. (8) Generator and starting motor. (9) Combustion chamber. (10) L.P. propelling gas turbine. (11) By-pass. (12) Boiler. (13) Superheater. (14) Economiser. (15) H.P. steam turbine. (16) L.P. steam turbine. (17) Condenser. (18) Reduction gear. (19) Astern turbine.

Japanese Gas Turbines

A 2,200 b.h.p. Japanese gas turbine was completed in May 1949, as a result of work by the Gas Turbine Research Laboratory of the Railway Technical Research Institute; the plant, which is at present running experimentally, was built by concerns prominent in the steam turbine field. A further gas turbine rated at 1,500 b.h.p. is now in course of construction. For the development of marine gas turbines, a research committee is being established in the Ministry of Transportation.—*The Oil Engine and Gas Turbine, Vol. 18, June 1950, p. 77.*

Production of Gas Turbine Blades

This article lists the various processes employed for making gas turbine blades. Referring to the recently developed Mercast process of precision casting with mercury, the authors state that this process appears to be the first significant improvement in precision casting since the adaptation of the dental process of "lost wax" casting to commercial use several years ago. In Mercast, frozen mercury patterns are used instead of wax or plastic. These patterns are dipped in ceramic to provide a relatively thin mould instead of investing the patterns in a large bulk of ceramic to make the mould, as in the wax and plastic pattern method. Mercury freezes at −40 deg. F., requiring the use of refrigeration equipment capable of holding −100 deg. F. continuously for the moulding of the patterns, precoating storage and ceramic coating. The basic steps for making precision castings by the Mercast process are the following. Liquid mercury is poured into a master mould made of metal or other material. The mercury filled mould is then chilled in a bath at a temperature below −40 deg. F. The frozen mercury pattern is then removed from the master mould and is dipped in a chilled refractory slurry made up of very fine ceramic particles. Several coatings are given the part until it has a ceramic shell of from ⅛ to ¼ inch. When the shell-like mould is thoroughly dried in a cold box, the mould is removed to room temperature where the mercury melts out and the mould is then fired in a kiln. The next step consists in conventional pouring or centrifugal casting. The mould breathes to allow air and gases in the molten metal to escape, preventing blow-holes. When cool enough to handle, the thin ceramic mould is broken from the casting. The characteristics of the Mercast process may be divided into those resulting from the use of mercury as pattern material and those resulting from the nature of the ceramic investment material and the method of application. Frozen mercury exhibits unusual cohesiveness. Two clean surfaces of solid mercury will weld together with very slight pressure. This provides a very convenient and simple way of building up complex mercury patterns. Another advantage arises from the fact that the surface of the mercury pattern exhibits no concavity or sink resulting from shrinkage, which is a serious defect with wax patterns. Because temperatures lower than −40 deg. F. must be used with mercury patterns, water is not used in the ceramic slurry from which the refractory mould is built up. The problems arising from the necessity of driving off water are therefore eliminated. The process holds much interest for complicated hollow parts, such as turbine blades and vanes, particularly for new designs to improve heat transfer. Excellent surface finish can be obtained, and dimensional tolerances are about 50 per cent closer than with the present wax method.—*A. T. Colwell, K. M. Bartlett and R. E. Cummings, S.A.E. Journal, Vol. 58, June 1950, pp. 48-52.*

American Gas Turbine Practice

In the United States, the gas turbine has crossed the threshold of commercial application. In the marine field, three units are under construction, two for naval vessels, and one for a merchant ship. The first 1,500 deg. F. non-aircraft unit, built by Allis Chalmers Manufacturing Company, went into operation at the U.S. Naval Engineering Experiment Station at Annapolis, in 1944. It has a maximum capability of 3,500 h.p. Designed to facilitate testing, it has two combustors in parallel, one supplying the load turbine, the other supplying the turbine which drives the axial compressor. The first two turbine stages are impulse; both sides of the first-stage wheel are cooled by air from a recirculating system with external cooler. The De Laval Steam Turbine Company has built a 750 h.p. experimental unit of marine design, now under test. This is a threeshaft unit. High-pressure and intermediate pressure turbines drive compressors; the low pressure turbine normally connects to the propeller shaft by clutch and double reduction gear. The intermediate turbine, which rotates in the reverse direction, can also connect to the shaft by clutch and gear. In ahead operation, the low pressure turbine provides all output, and the intermediate turbine is de-clutched so that it drives only its compressor. For astern operation, the low pressure turbine is by-passed and de-clutched. The intermediate turbine is clutched-in and drives the propeller in reverse. Additional energy from the greater pressure drop through the intermediate unit provides enough power to drive both compressor and shaft. All three turbines are Birmann-bladed. In this design the gas enters radially, makes a 90 deg. turn in the blading, and leaves in an axial direction. The vanes which direct the entering gas-flow into the rotor can be rotated about their axis, acting very much like the gates of a hydraulic turbine, controlling both direction and rate of flow. The first American gas turbine unit was completed in 1944 by the Elliott Company. Built as an experimental unit for the U.S. Navy and ultimately dismantled for compound studies, it was of two-shaft design, with one intercooler and one reheater. It employed multi-stage reaction turbines and Lysholm compressors, and burned Diesel fuel in an elbow-type combustion chamber. Operating at 1,250 deg. F., with a 75 per cent regenerator, it tested at 29·5 per cent efficiency. This plant is being essentially duplicated for three additional marine units to operate at 1,400 deg. F. At rated output, 3,000 h.p., overall efficiency is 32·6 per cent. Under Navy sponsorship, the Lima-Hamilton Corporation has developed free-piston gasifiers, using a typical rack and pinion combination for piston synchronization. The original unit has been under test since 1945. Since then a completely integrated plant comprising twin free-piston gasifiers feeding into a Westinghouse gas turbine driving one of the larger standard marine electric generators has been completed, and testing begun. In addition, a third identical free-piston gasifier has been set up for component testing. American gas turbine designs employ both impulse and reaction blading, independently and in combination. Several designs for temperatures in excess of 1,300 deg. F. have used air cooling for the first-stage disc. In one design, with an overhung rotor, a separate cooling circuit at first-stage pressure is powered by a rotary blower, and the circulating air gives up its heat in a cooler. Another design uses water cooling of stator and rotor. The rotor is cooled by radiation to water-cooled pads placed adjacent to the turbine discs. In this same unit a small amount of cooling air passes through holes in the nozzle partitions, and also cools the inside nozzle ring and the rim of the first-stage wheel. Practically all designs use air bled from the compressor for gland seals on the turbine shaft. Most of the work in marine applications has been done experimentally for the U.S. Navy. The large amount of research and development work so sponsored will be of great benefit to the field as a whole. No great interest has developed as yet in commercial ship applications.—*Paper by L. N. Rowley and B. G. A. Skrotzki, read at the Fourth World Power Conference, London, on 14th July 1950, Section G, Paper No. 4.*

Ultrasonic Vibrations as Possible Source of Fires and Explosions

Acting upon the theory that ultrasonic vibrations may be responsible for cargo fires and explosions, the author has experimentally established the presence of ultrasonic vibrations on board ship when cargo winches and dynamos are operating in port. From experiments conducted on the velocity of sound in sodium nitrate, the natural frequency of ammonium nitrate powder of 1 mm. particle size is estimated to approximate the frequency of the shipboard vibrations observed. The opinion is expressed that the explosion of the ammonium nitrate cargoes of the vessels *Grand Camp* and *High Flyer* in 1947 and other similar cases may have been caused by ultrasonic vibrations set up by the operation of cargo winches in port.—*Paper by R. Jarry, read at the 1950 session of the Association Technique Maritime et Aeronautique.*

Corrosion of Metals by Insecticidal Solution

The article summarizes the results of an investigation made of the comparative corrosion resistance of stainless steel, copper, brass, aluminium, magnesium alloy, aluminium alloy, cold rolled steel, and galvanized iron when immersed in various insecticide solutions. The eight metals were immersed in fourteen test solutions for eight weeks and periodic observations were made to determine the extent of corrosion. Weight loss and pitting, as a result of the eight-week immersion, were also determined. It is concluded that: (a) DDT in water displays a definite tendency to inhibit corrosion; (b) 2-4-D inhibited corrosion on all metals tested; (c) Chlorodane is a corrosive acid insecticide; (d) Insecticides in kerosene or a fuel oil base are not corrosive; (e) The most corrosive insecticide solutions are chlorodane in water, sodium arsenite in water, and DDT in salt water; (f) Stainless steel is the only completely corrosion-resistant metal; (g) Aluminium is of satisfactory corrosion resistance in all of the solutions except sodium arsenite.—*G. S. Cook and N. Dickinson, Corrosion, Vol. 6, May 1950, pp. 137-139.*

Galvanic Corrosion of Iron Due to Temperature Differences

The relative damage caused by galvanically coupling a piece of iron at high temperature to another piece at low temperature in an electrolyte is a question of practical importance. Combinations of this kind occur in designs of industrial equipment such as condenser tubes, water-cooled radiators, boiler tubes, etc. A laboratory study of cells in which seamless-steel tubing electrodes were immersed in sodium chloride solutions, with one electrode at 100 deg. C. and the other at 25 deg. C., revealed that: (1) The potential difference in 3 per cent NaCl under specific conditions of aeration and stirring is 0·024 volt, with the hot electrode the anode. (2) Decrease of aeration, stirring, or NaCl concentration decreases the measured potential difference. (3) The short-circuit current in 3 per cent NaCl amounted to 0·00043 ampere per sq. in., equivalent to an anodic corrosion rate of 0·03 ipy. In nitrogen saturated solution, this current falls to zero. (4) The short-circuit current is limited apparently by polarization of the cathode rather than resistance of the electrolyte between 0·125 per cent and 3 per cent NaCl. It appears that the iron electrode at 100 deg. C. as sacrificial anode will cathodically protect iron at 25 deg. C. of equal area to which it is coupled in 3 per cent NaCl solution.—*H. H. Uhlig and O. F. Noss, Corrosion, Vol. 6, May 1950, pp. 140-143.*

Corrosion Fatigue

Corrosion fatigue cracking is often ascribed to a preferential attack of disarrayed material along slip bands produced during the application of alternating stress. If this suggestion is correct, there is danger that material which has already been subjected to dry fatigue, would be abnormally susceptible to corrosion fatigue if precautions against corrosion were temporarily relaxed. Against this, it is by no means certain that disorganized material which is subsequently exposed to corrosive influence is so susceptible as material which is exposed to corrosion during the process of derangement. It appeared important to ascertain whether the increased susceptibility really does arise, or whether the strain-hardening effect of prior fatigue leads to an improvement in the corrosion-fatigue life. An answer to this question was obtained by carrying out a two-stage test; a period of dry fatigue was followed by corrosion fatigue up to failure; for comparison, a second set was submitted to corrosion fatigue without previous dry fatigue. With both cold-drawn and annealed wires, little or no change in corrosion-fatigue life was brought about by preliminary dry fatigue under the conditions tested. A metallographic study was also made of changes during air-fatigue and corrosion-fatigue processes. In air-fatigue, the repeated application of a stress, greater than the fatigue limit, results in the plastic deformation of many grains as a preliminary to the development of micro-cracks and failure. Simultaneously, heat is generated in the specimen and a superficial oxidation of the surface follows. In corrosion-fatigue at a stress below the air-fatigue limit, a localized attack leads to stress intensification, and hence to corrosion along slip bands. Attack spreads around the circumference of the wire, with subsequent weakening. The major damage, estimated by loss in tensile strength, occurs towards the end of the process, both in air fatigue and corrosion fatigue.—*D. Whitwham and U. R. Evans, Journal of the Iron and Steel Institute, Vol. 165, May 1950, pp. 72-79.*

Corrosion of Heat Resisting Steels by Vanadium Containing Oil Ash

The action of fuel oil ashes containing vanadium on heat resistant steels in the temperature range from 650 deg. C. to 850 deg. C. has been investigated. The results were as follows: (1) Fuel oil ashes containing vanadium very markedly accelerate the scaling of all the heat resistant steels which were investigated, provided that the temperature was above the melting point of the ash. (2) The attack increases sharply with rising temperature. (3) It also increases in proportion with the quantity of the reacting medium and the time of exposure. (4) The alkali content of the fuel oil also influences the extent of the attack. (5) In a reducing atmosphere no attack occurs. (6) The mechanism of the attack seems to consist in the fact that the vanadium compounds prevent the formation of, or destroy, the protective scaling on heat resistant steels. Layers permeable to oxygen and of little resistance to scaling are formed. The vanadium compounds apparently act as oxygen carriers, with vanadates as an intermediary stage. The existence of such vanadates has been proven by X-ray investigations, and the upper limit of their temperature stability was approximately determined. (7) Steels containing molybdenum are particularly strongly affected. Under the influence of the vanadium compounds molybdenumtrioxide is formed, which sublimates from the scale leaving it in a weakened state. The action of vanadium-containing ash on molybdenum steels is characterized by a puncture-type attack.—*P. Schlaepfer, P. Amgwerd and H. Preis, Schweizer Archiv, Vol. 15, No. 10, pp. 291-299.*

Studies on Marine Fouling Organisms

This paper summarizes the work which has been done on the biological aspects of the fouling problem, mainly at Millport (Firth of Clyde) during the period 1944-1948. Much of this work has been published in the appropriate biological journals. A continuation of non-toxic panel exposures, both at Millport and elsewhere, has added fresh details to what was known about the seasonal sequence of settlement and emphasized the extent of variations in density of settlement from year to year. Laboratory determinations of the sensitivity of most of the major fouling organisms to copper and mercury have revealed many complexities in this phenomenon which, it is suggested, can only be resolved by fundamental studies of the action and interaction of these poisons. Many observations have been made on the general biology of a number of animal fouling organisms. The ecology of their inter-relationships and of their relationships with marine plants, deserves further study. —*K. A. Pyefinch, Journal of the Iron and Steel Institute, Vol. 165, June 1950, pp. 214-220.*

Performance of Anti-corrosive Compositions in Sea Water

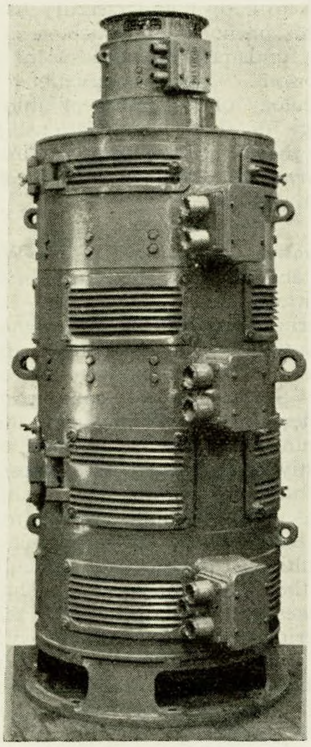
The paper presents and discusses the results of the Marine Corrosion Sub-Committee's researches which show that different methods of surface preparation have a marked effect on the performance of anti-corrosive compositions in sea water. Paint gives poor protection against exposure to sea water if applied over millscale. Since, however, some paints fail to adhere to a completely descaled, freshly prepared, and unrusted steel surface, it is recommended that the descaled steel surface be allowed to rust slightly or be treated with phosphoric acid wash before the application of the priming coat of anti-corrosive composition. In the case of ships' hulls, weathering the steel plates until they have shed their millscale completely should therefore yield good results. In practice it is difficult to ensure complete descaling of all the component parts of a ship's bottom, and descaling of the plates by grit-blasting or by pickling, followed by a short weathering period or treatment with a surface wash is recommended. Rates of pitting up to 0·16in. per year have been observed at "holidays" (bare areas in a paint film) on an immersed steel plate. The presence of intact millscale beneath the paint may also promote pitting, but if about 90 per cent of this is removed by weathering, pitting will probably be no more severe than when the millscale is removed by pickling. The procedure of launching a ship with the bottom unpainted is not recommended because, owing to the slower removal of millscale, pitting may result; it is also difficult to clean the surface before painting. With a few exceptions, the relative behaviour of a given set of bottom painting schemes is the same whether applied to new specimens of unpainted steel or to specimens which have previously been painted and exposed to an immersion test. This applies in the main to both the protective and anti-fouling properties of the painting schemes. Formulated anti-corrosion compositions developed by the Marine Corrosion Sub-Committee give good results as priming paints under a bottom painting scheme. A mixed red lead and white lead paint in linseed oil is less satisfactory, although much better than a red iron-oxide paint in linseed oil. Zinc or aluminium coatings on steel improve the performance of bottom painting schemes applied over them; lead, however, promotes pitting. Results of a raft test and those of a patch-painting trial are in good agreement.—*J. C. Hudson, Journal of the Iron and Steel Institute, Vol. 165, July 1950, pp. 314-334.*

The Corrosion of Steel in Estuarine Tropical Waters

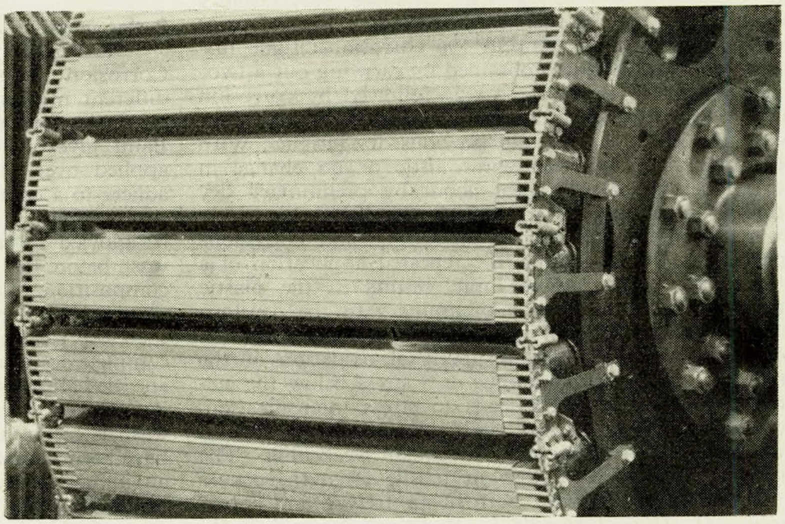
The corrosion of various steels in estuarine tropical waters at Freetown, Sierra Leone, has been investigated, and the result compared with exposure in ordinary tropical seat water at Takoradi on the Gold Coast. The results are interpreted in the light of the work of other investigators, in particular those of the Sea Action Committee of the Institution of Civil Engineers. Some of the operative factors concerned in the corrosion, e.g., molluscs, sulphate-reducing bacteria, etc., are discussed.—*S. A. Main and T. H. Arnold, Journal of Iron and Steel Institute, Vol. 165, July 1950, pp. 268-278.*

Turbo-electric Machinery of the *Kairouan*

The turbo-electric liner *Kairouan* of the Compagnie de Navigation Mixte was launched in 1942, but little work was done upon the hull which, in 1944, was scuttled by the retreating Germans in 100 feet of water off Toulon. It has now been raised and the vessel is being completed at the Chantiers Navals de la Ciotat (Bouches du Rhone), while the machinery, which had not been installed at the time of scuttling, is also in course of installation on board. The propelling machinery of the 8,000 ton vessel consists of a twin-screw arrangement of turbo-electric equipment capable of maintaining a speed of 23 knots continuously. Each 36-pole three-phase synchronous propulsion motor is directly coupled to its propeller shaft and is rated at 12,000 s.h.p. at 187 r.p.m. Current is normally supplied to each motor by a 9,020 kW. 3,375 r.p.m. two-pole turbo-alternator operating with initial steam conditions of 500lb. per sq. in. and 750 deg. F. For optimum economy at lower speeds than the service figure—or for emergency operation—one turbo-alternator can supply both propulsion motors, when a total output of 10,900 s.h.p. is available at 145-150 r.p.m. When at sea under normal steady-steaming conditions the propulsion motors are in synchronous operation with their respective turbo-alternators, the speed reduction being locked electrically at 18 to 1, this being the ratio between the number of poles in the propulsion motor and alternator rotors. The propeller speed is regulated by adjustment of the speed of the alternators, which in turn is controlled by the quantity of steam supplied to the turbine. When the ship is being manœuvred, the turbo-alternators are reduced to about one-quarter full speed, when the propulsion motors are operated asynchronously by means of the copper bar squirrel cage windings embedded in the rotor pole faces as shown in the accompanying engraving. Reversal is achieved by changing over two of the three phases in the main leads between the alternators and the motors; this is done by means of air-break switches operating at no excitation. The central control position is in the turbine room and all manœuvring, as well as the change-over from two to one turbo-alternator, is carried out from this point. The boiler room is disposed between the turbo-alternator and the motor rooms. The various auxiliaries for the two 12,000 s.h.p. propulsion motors are installed in the motor room. The exciter sets are of the vertical-spindle, sandwich-type, as shown. There is one set for each main alternator/propulsion motor unit, with one set in reserve for duty with either. The next compartment forward of the propulsion motor room contains the four La Mont forced-circulation boilers. Each of these can deliver 77,000lb. of steam per hour at 570lb. per sq. in. and 800 deg. F. at the superheater outlets. The boilers are designed to develop full power when burning oil fuel with a lower calorific value of 9,700 calories per kg. Three boilers are sufficient to maintain full power on the propeller shafts but only two boilers need be connected when one turbo-alternator is running. An open stokehold is employed, the vertical-spindle motor-driven forced draught fans being arranged in the wings of this compartment. The fan controller resistors are arranged in the flow of cold air to the fan intakes. These fans discharge through preheaters to the air boxes in front of each boiler.—*The Marine Engineer and Naval Architect, Vol. 73, July 1950, pp. 303-308.*



Vertical exciter set



Manœuvring windings in rotor pole faces of propulsion motors

Application of Diesel Features to Steam Engines

In a paper read at a meeting of the shipbuilding and marine engine building section of the V.D.I., Prof. A. Oppitz reviewed the operating characteristics of the combination of steam reciprocator with exhaust turbine, making especial reference to exhaust pulsations. By comparing this propulsion unit with a Diesel engine with exhaust gas turbine, the author finds himself able to make recommendations concerning the optimum utilisation of the exhaust energy rejected by the steam reciprocator. The employment of single expansion engines with exhaust ports in the cylinder wall is recommended. Both two-shaft and Vee-type engines are considered and various possible engine designs are discussed. The tentative layout of a four-cylinder double-acting single-expansion Vee-type steam reciprocator with exhaust ports is reproduced in the article. This engine is designed with a cylinder bore of 300 mm., a stroke of 600 mm., and a speed of 300 r.p.m., the steam conditions being assumed as 235lb. per sq. in. and 716 deg. F. With regard to the Vee-angle enclosed by the cylinder rows, its choice will be primarily governed by the number of cylinders to be used, as the latter is important from the aspect of engine starting. Thus in the case of four cylinders a 60 deg. Vee-arrangement with cranks at 120 deg. will permit starting of the engine from any position with about 40 per cent cut-off; with a Vee-angle of 45 deg. and 135 deg. crank angles, the four cylinder arrangement will require about 50 per cent cut-off for starting. Eccentric-operation of the inlet valves is recommended. The paper makes fairly full reference to design details, but the treatment of the subject matter is entirely tentative and no actual performance data are given.—*The Marine Engineer and Naval Architect (Annual Steam Number) 1950, p. 290.*

High Speed Reciprocators

In this article the author stresses the fact that high speed reciprocators are especially suitable as marine propulsion plant. The small space requirements of high speed steam reciprocators as compared with the much larger space requirements of low speed steam engines of the triple-expansion type are exemplified with particular reference to the Hamburg reciprocator. Engines of the latter type are available for powers from 520 i.h.p. up-

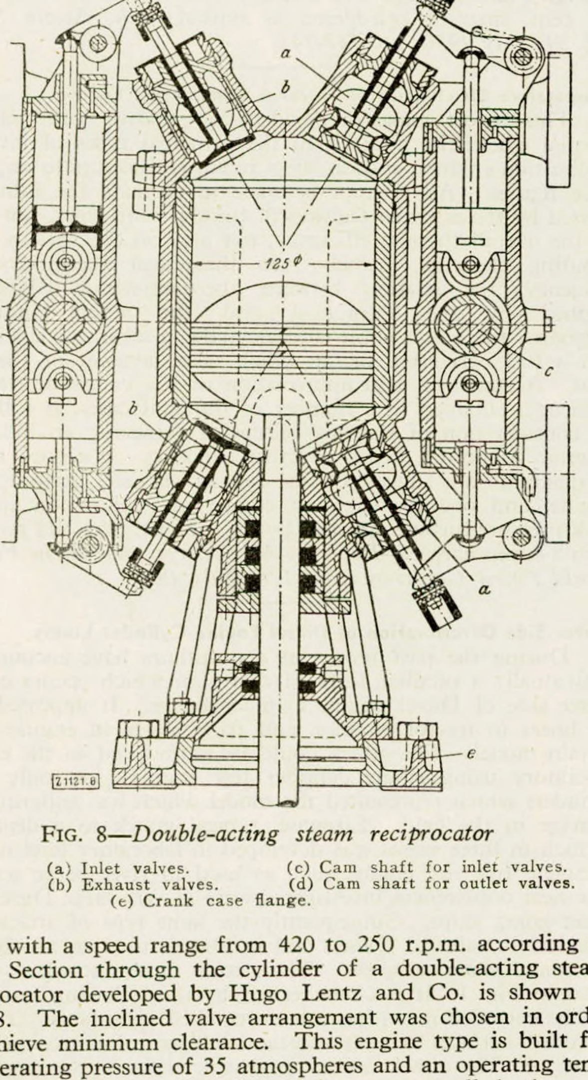


FIG. 8—*Double-acting steam reciprocator*

(a) Inlet valves. (c) Cam shaft for inlet valves.
(b) Exhaust valves. (d) Cam shaft for outlet valves.
(e) Crank case flange.

ward, with a speed range from 420 to 250 r.p.m. according to size. Section through the cylinder of a double-acting steam reciprocator developed by Hugo Lentz and Co. is shown in Fig. 8. The inclined valve arrangement was chosen in order to achieve minimum clearance. This engine type is built for an operating pressure of 35 atmospheres and an operating temperature of 400 deg. C. Cut-off is cam-controlled, the cam shaft being axially displaceable. Three cylinder units of this type are built for powers of up to 400 i.h.p. with speeds of up to 2,000 r.p.m.—*V. Rembold, VDI Zeitschrift, Vol. 92, 1st June 1950, pp. 401-403.*

Effect of Gas Content of Sea Water upon Cavitation Tests

The presence of atmospheric gases dissolved in water is of great importance in testing technique in cavitation tunnels. When the pressure is lowered during a cavitation test, oxygen and nitrogen are released in accordance with Henry's law, so that a new state of equilibrium results corresponding to the new pressure. This state of equilibrium is not determined, in any case not in cavitation tunnels of the conventional type, by the pressure which is exerted on the model propeller and which is chosen according to the pressure conditions required. Some of the gases which separate under the low pressure around the model propeller become redissolved in other parts of the tunnel; the state of equilibrium therefore depends upon some mean pressure in the tunnel. Thus, the properties of the cavitation tunnel which depend upon its construction are of great importance in evaluating the test results and comparing them with those for the ship. Experiments showed that the characteristics at high advance coefficients (equal to or greater than 0·73) are considerably influenced by sheet cavitations on the faces of the blades. But this effect is independent of the quantity of gas dissolved in the water. At lower advance coefficients, however, within the peak efficiency range and below, where the propeller blades are mainly working with bubble cavitation on their suction sides, the characteristics fall rapidly with increasing gas content. The author presents graphs which show that gas separation and bubble formation are made easier in sea water and have a tendency to increase as gas content decreases. This behaviour can be accounted for by the existing reserve of chemically fixed carbon dioxide. By drawing upon this reserve, CO_2 separation in the low pressure sections of the cavitation tunnel is stimulated. Therefore, when sea water, as opposed to tap water, is used, a larger quantity of separated gas can be assumed to be present in the low pressure region around the model propeller; this is so even if tap water shows the same gas content as salt water when tested at atmospheric pressure before and after each experiment. CO_2 separation, in other words, occurs more readily in sea water than in tap water due to the release at low pressures of free dissolved carbon dioxide from the sea water's chemically fixed reserve. The author points out that his data indicate a distinct difference between the performances in tap and sea water respectively, in that the effect of cavitation upon thrust and torque becomes evident earlier in sea water. But the differences recorded are not nearly so great as those observed by Numachi in his experiments in glass nozzles.—*H. Edstrand, Publications of the Swedish State Shipbuilding Experimental Tank, No. 15, 1950.*

Schnitger Propeller

In the Schnitger propeller a light conical circular shroud is either welded at half propeller radius, in separate segments, between the propeller blades, or is made in one casting with the

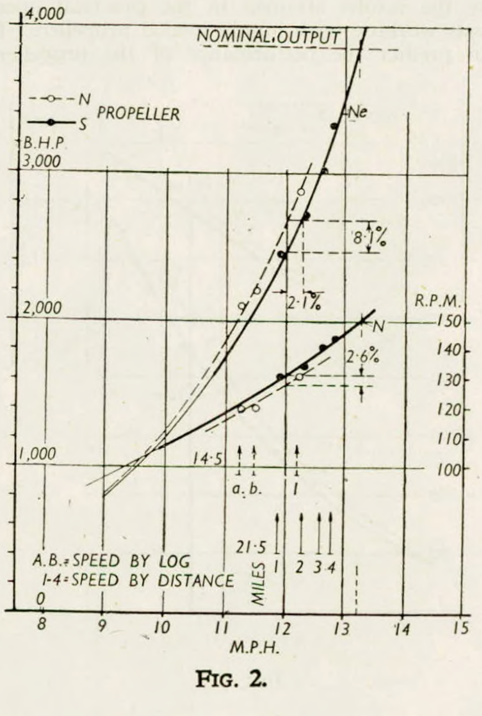


FIG. 2.

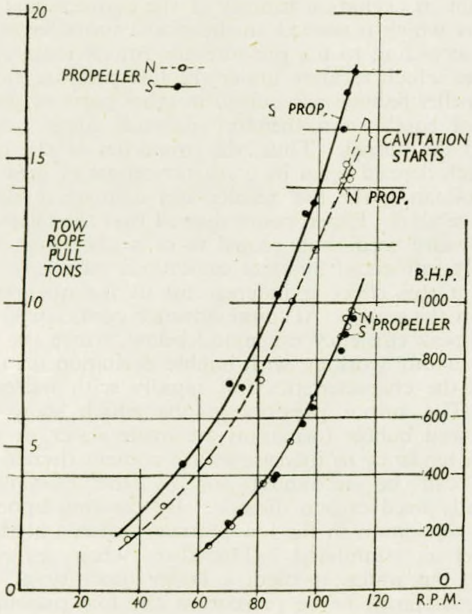


FIG. 4.

propeller when the propeller is being built. In contrast to the Kort nozzle, which is fixed rigidly to the ship's body, the shroud rotates with the propeller. In common with all guide mechanisms, it has the effect of preventing the swirling of the water in front of the propeller and within the propeller itself. On account of its conical shape and the flow of water, the shroud has a "contra-propeller effect", similar to that in the Kort nozzle and the Star contra-propeller. The shroud reduces the tendency of the water to flow down radially on to the pressure side of the blade tips. On highly loaded screws this undesirable radial flow has the consequence of cavitation on the outer edge of the blades, and this is more or less prevented by the shroud, because otherwise a vacuum would arise in the region of the shroud. The hydro-dynamic action within the shroud has not yet been fully explained. However, the hypothetical assumption and theoretical considerations have been verified by the results attained in the practical operation of many vessels working with highly loaded propellers. It is now possible to predict the performance of the propeller with a

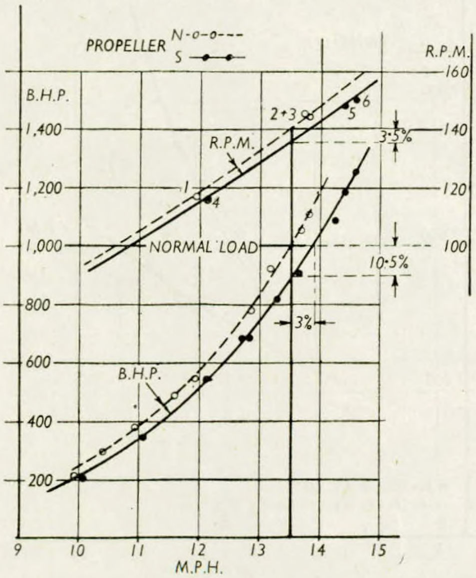


FIG. 5.

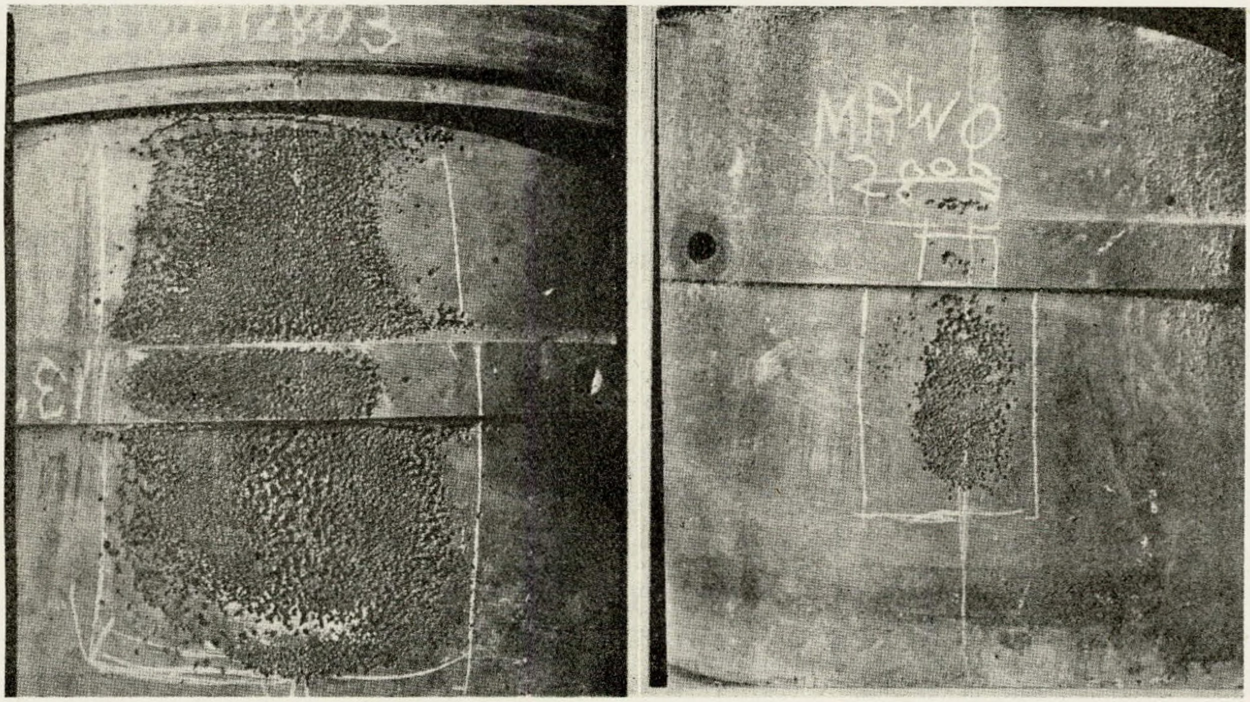
reasonable degree of accuracy. The theory is that the device causes an acceleration of the water in front of the propeller surface. The smaller angle of attack, therefore, causes a higher efficiency. It has to be taken into consideration that the nozzle profile itself produces a thrust component in the direction of propulsion. The practical development of this propeller has mainly been based upon the determination of facts resulting from full-scale service measurements, which have confirmed test data from tank experiments. Schnitger propellers are fitted to the Norwegian twin-screw motor tanker *Ringfjell*, which has a displacement of 14,000 tons and is equipped with two 2,350 i.h.p. B. and W. engines. Power measurements on the mile, as certified by an independent expert of the Hamburg Chamber of Commerce, are shown in Fig. 2. A second example is the whaler *Krutt*, and the results of trials are shown in Fig. 4 and Fig. 5. The improvements in efficiency of 10.5 per cent. may be considered as typical.—*The Motor Ship, Vol. 31, July 1950, pp. 142-143.*

Comparative Efficiencies of Internal Combustion Engines

This report makes a detailed comparative study of the thermal efficiencies attained in the principal types of internal combustion engines, and discusses recent endeavours to improve these figures. An attempt is made to estimate the influence exerted by the essential features of the different types, not only on the overall thermal efficiency, but also on the various contributing elements, namely, the theoretical thermodynamic efficiency, the relation between thermodynamic efficiencies implied by the theoretical and the actual indicator diagrams, the combustion efficiency, the mechanical efficiency, and a fuel correction factor which takes account of the fuel used. A statement and appreciation of the values of thermal efficiency, obtained in a number of different cases, is followed by consideration of the possibilities of achieving an indicator diagram connoting greater practical efficiency. Two new forms of diagrams are suggested, one for an ordinary reciprocating engine, and one for such an engine in conjunction with a back-pressure turbine operated by the exhaust gases and possibly with a supercharger.—*Paper by M. Serruys, read at the Fourth World Power Conference, on 12th July 1950.*

Water Side Deterioration of Diesel Engine Cylinder Liners

During the past few years the authors have encountered individually a peculiar form of corrosion which occurs on the water side of Diesel engine cylinder liners. It appeared first on liners in tractor engines, and particularly in engines of a certain model. The attack could be reproduced in the engine laboratory using single cylinder test engines, but only with cylinders which represented the model which was suffering the damage in the field. Likewise, typical attack to a depth of $\frac{1}{16}$ inch in three weeks was developed in laboratory tests with a complete full size engine such as used in river barge service. The next occurrences investigated were in very large Diesels on ocean-going ships. Subsequently the same type of attack was observed in railroad Diesels and in Diesels used to tow barges on inland waterways, etc. The nature of the attack is illustraed in Fig. 1. It is characterized by the following features: 1. The corroded metal has a honeycombed appearance. 2. The corroded surfaces remain substantially free of corrosion products. 3. The attack occurs in sharply defined areas with the boundary between the affected and unaffected metal being very sharp and abrupt, although usually irregular in outline. 4. The centre lines of the areas of greatest attack are characteristically 90 deg. from the centre line of the crankshaft. Attack on one side is usually more severe than on the other. Frequently, attack is much deeper towards the bottom—the looser end of the liner, and is often absent in the centre portion, but may appear to a lesser degree near the top, as shown in Fig. 1. 5. The location of this particular kind of attack does not seem to be determined to any primary extent by the location of the water inlet and outlet passages, nor by so-called "hot spots". 6. The rate of attack has been amazingly high, e.g. $\frac{9}{16}$ inch in 900 hours which is equivalent to about 3 inch per



SCAVENGING SIDE EXHAUST SIDE

FIG. 1. *Water side erosion of cylinder liner after six months' service. Cylinder bore 20½ inch.*

year. 7. This peculiar attack is not confined to any one design or make of engine. It may appear in only a few engines of a particular type and sometimes only in certain cylinders of one engine. By comparing this attack with the erosion produced on test pieces in vibratory cavitation-erosion tests, the authors come to the conclusion that this damage may be due to the vibration of the liners. This assumption is supported by surveys of vibration in engines which have suffered this type of liner attack. A considerable amount of high frequency vibration of the liners was detected with observed frequencies of the order of 1,500 cycles per second. It is suggested by the authors that the ultimate solution to this peculiar corrosion problem will require the co-operation of the mechanical engineers with attention to mechanical features of the design and construction of engines. More thorough surveys of high frequency vibrations will be required before they can be eliminated by changes in design that probably need be only minor in nature. Such surveys can be made most effectively on engines operated under normal load conditions and fitted with devices for the detection of high frequency vibration of the cylinder liners.—*F. N. Speller and F. L. LaQue, Corrosion, Vol. 6, July 1950, pp. 209-215.*

Research on Exhaust Pipes

The importance of proper design and choice of an exhaust system for an internal combustion engine is emphasized by Dr. P. H. Schweitzer of the Pennsylvania State College. The exhaust system is usually neglected and considered a nuisance, but there is recoverable energy in the engine exhaust. About one-third of the fuel energy generally goes out of the exhaust, of which 6 to 10 per cent. is recoverable. A properly tuned exhaust system may mean an increase of 30 per cent over a poorly tuned system in a single-cylinder two-cycle engine. Exhaust pressures propagate waves in the exhaust pipe. A pressure wave is generated by the exhaust blowing down into the pipe. The pressure wave travels along the pipe and returns from the open end. If the pipe length is such that the natural frequency of the exhaust system equals the engine speed, worse conditions obtain. If the pipe is tuned, so that a vacuum wave is present when the exhaust opens and that turns to positive pressure when the exhaust closes, the best possible tuning is achieved. In a multi-cylinder engine interference is most important; that is, the exhaust of one cylinder is obstructed not so much by the returning wave from the stack but by the exhaust of another cylinder. If a cylinder exhaust blows down while in an adjacent cylinder the exhaust is open, the exhaust will propagate into that cylinder and obstruct the exhaust and charging of that cylinder. How bad it is depends on the number of cylinders and on the firing order. The problem resolves itself in finding such shapes of exhaust pipes which minimize or prevent exhaust interference. A good manifold produces a partial vacuum. This was achieved by the use of quarter round exhaust branches, venturis, and separator vanes or the introduction of a smaller tube in the exhaust manifold, to lead the exhaust of an offending cylinder beyond the danger point into a venturi. This design exceeded all expectations, and was even better than no exhaust manifold at all in that instead of creating a back pressure, the aspirator type manifold with venturis created a vacuum. Instead of opposing the charging of the cylinders, it helps it by the suction effect.—*S.A.E. Journal, Vol. 58, June 1950, pp. 85-86.*

Light Alloy Pistons of Spanish Manufacture

An article by V. B. Fernandez in a recent issue of *Ingenieria Naval* describes in detail the local manufacture in Spain for the first time of light alloy pistons for a pressure charged 1,500 h.p. Diesel engine. The alloy composition to be used was determined by metallurgical investigation of an old piston of the engine in question. This yielded the following analysis: 12·2 per cent silicon, 1·4 per cent copper, 1·29 per cent. magnesium, 1·27 per cent nickel, 0·51 per cent iron, 0·1 per cent manganese, balance aluminium. A trial casting made was a "modified" casting with the addition of about 2 per cent of a 35 per cent sodium chloride—67 per cent sodium fluoride salt mixture at 940 deg. C. This method of casting was abandoned in favour of a modified casting with the addition of metallic sodium at the rate of 600 grams per 100 kg. alloy at 730 deg. C., pouring temperature being

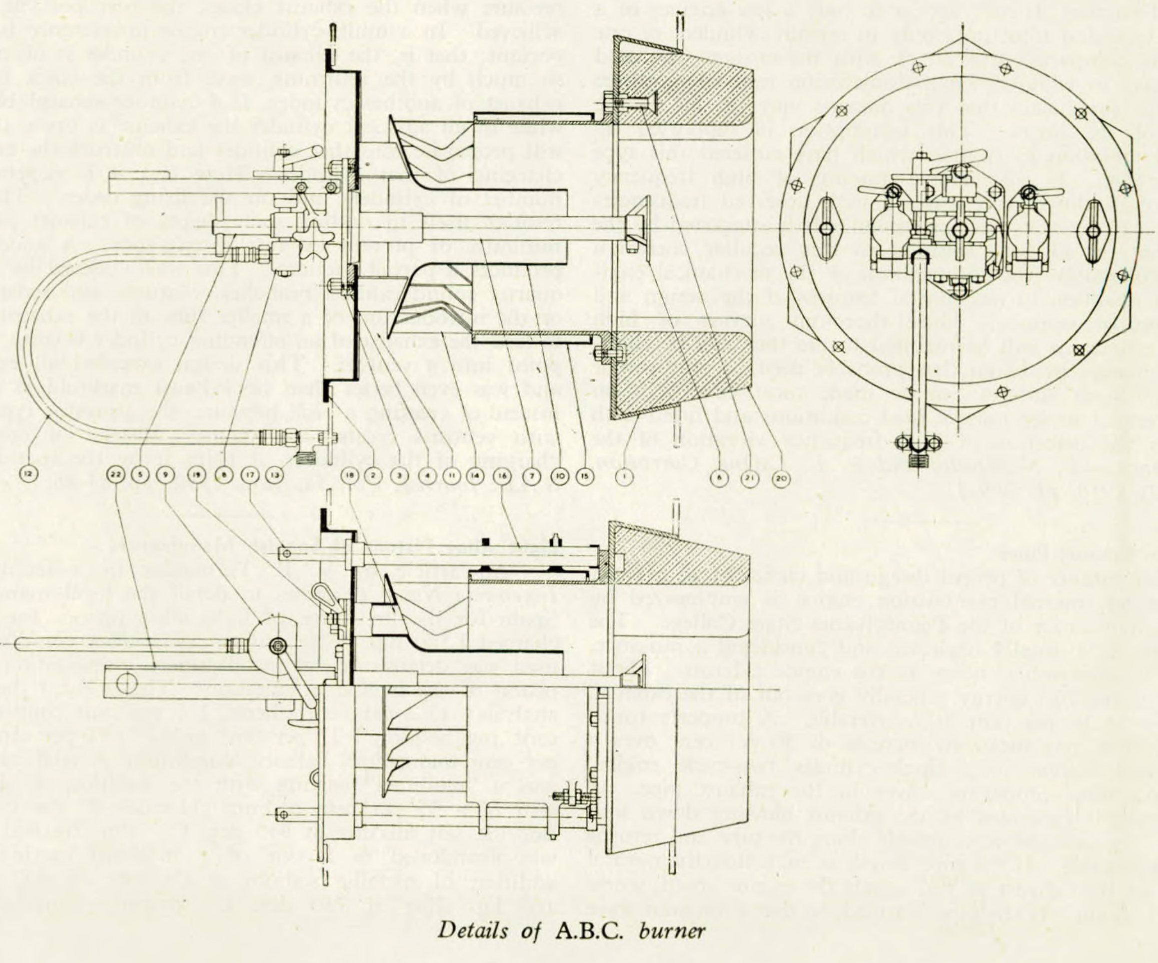
660 deg. C. The Brinell hardness ranged from 85 to 90, and U.T.S. averaged 20 kg. per sq. cm. *Gas and Oil Power Vol. 45, June 1950, p. 153.*

Marine Oil Burner

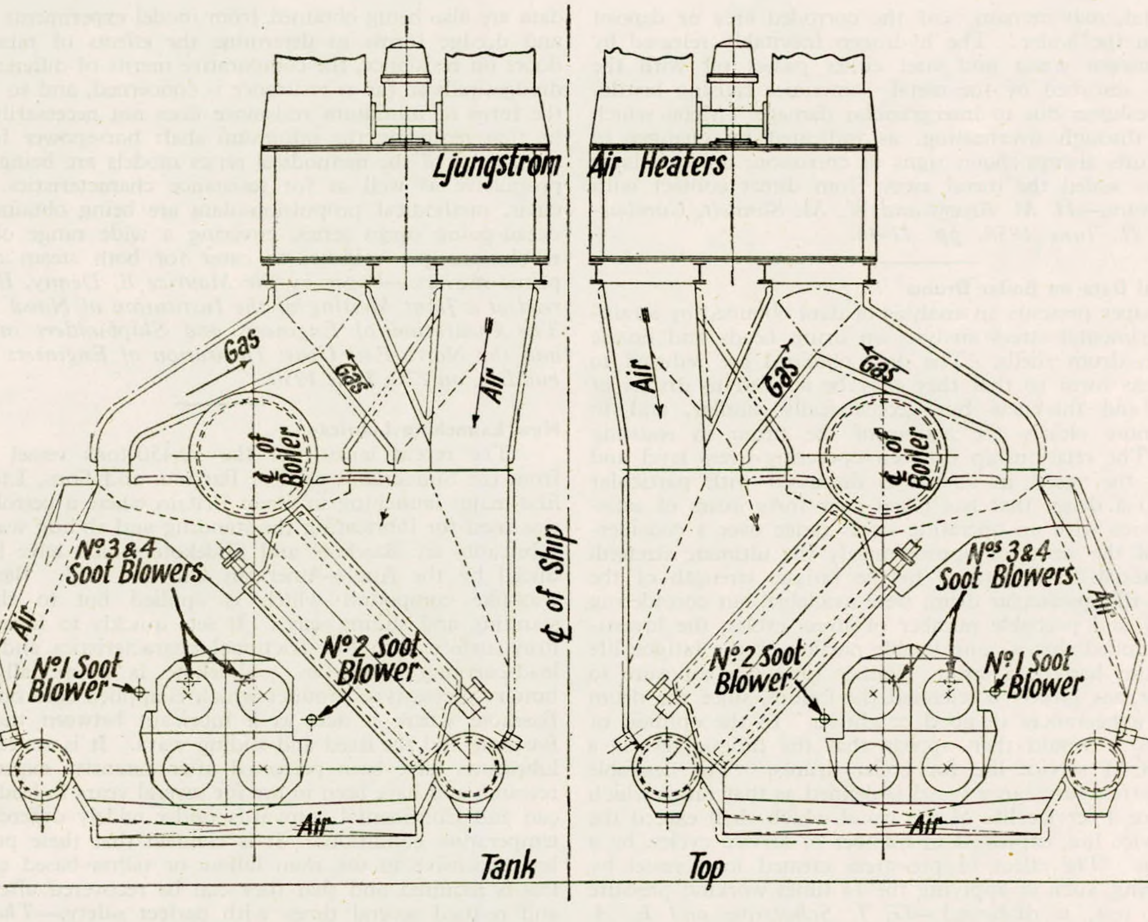
The A.B.C. burner produced by the Associated British Combustion Ltd. incorporates features which are claimed to ensure that the atomizers will steam for periods up to 1,500 hours, even on heavy oils, without requiring cleaning. Provision is made in this burner for the prevention of cross-currents which might produce eddies, etc., by having the vanes nearest to the furnace so formed that complete cover is provided against linear entry of air. A large number of vanes are used to facilitate mixing of air and fuel. Seventeen fixed vanes (14) as shown in the engraving are placed around the circumference of the register, each vane being accurately shaped so that correct mixing is obtained at all loads without the necessity for adjusting the degree of the swirl. The employment of fixed vanes is claimed to be a good feature because for a given design of burner with a spray of definite characteristics there can only be one type of air flow through it. Movable vanes, it is argued, are used in a register to produce either more or less swirl when the load of a burner is varied, and adjustment will upset the air flow, and hence combustion, unless other adjustments—e.g. the position of the burner—are made. Often when using movable vane registers closing of the vanes is resorted to when the operator is attempting to burn small quantities of oil through a large brick tube; and under these conditions the air flow to the burner is usually at too low a velocity to ensure much effective air swirl. In the A.B.C. register the flame is maintained stable at all loads by means of a tip plate which is placed in the path of the air stream from the centre tube so that a low air velocity is formed immediately in front of the atomizer. With this arrangement the flame is said to be maintained stable at all loads, and even with the highest air pressures it is claimed that it is impossible for the flame to be extinguished. The positive flow of air over the tip plate also provides a measure of protection and as only a small quantity of residual oil is held in the burner, carbonization is not encouraged.—*The Marine Engineer and Naval Architect, Vol. 73, Annual Steam Number, 1950, pp. 252-256.*

Yarrow Three-drum Water-tube Boilers

The latest three-drum type of Yarrow boiler shown in the drawing is designed for an output of 62,000lb. per hour at a pressure of 500lb. per sq. in. and a final steam temperature of 800 deg. F. This boiler retains established Yarrow characteristics in that all the pressure parts are circular in section and the generating tubes are only slightly curved. With the exception of the manhole doors in the drums, there are no bolted or riveted joints in the pressure parts, which are always a possible source of trouble in the maintenance of the boiler over the years. The number of fittings inside the steam drum have been kept to a minimum to facilitate internal inspection and cleaning and to avoid interfering with natural circulation. The superheater incorporated with this boiler is of the Melesco design of The Superheater Co. Ltd., which has recently been incorporated in numerous examples of the Yarrow three-drum boiler. Superheat control is provided by means of a simple form of regulator in the uptakes which varies the proportion of the furnace passing up the superheat side of the boiler. By designing the superheater to give the final steam temperature of 800 deg. F. at the normal maximum output with only 70 per cent of the gases passing up the superheat side, it is possible to maintain the final steam temperature at the designed figure at lower outputs. It is also possible rapidly to reduce the final steam temperature at any output when such a course is required for manœuvring. When the regulator is set at the



Details of A.B.C. *burner*



minimum superheat position the flow of the furnace gases is deflected up the non-superheat side of the boiler, thus providing sufficient protection. The brickwork on the front and back walls is considerably thicker than has been the practice in the past. The thickness of these walls is 9 inch and the tiles are retained by tee-shaped bars bolted to the inside of the casings which engage in slots cut in the tiles. Boilers with this type of brickwork are today running for periods of seven to eight months without any repairs being necessary—a practical point of first importance to the owner and his technical staff. As will be seen from the drawing, this boiler is fitted with an air pre-heater of the Howden-Ljungstrom type. This is designed to recover sufficient of the heat from the funnel gases, and transfer it to the combustion air, to maintain a full load boiler efficiency of 88 per cent calculated on the higher calorific value of the fuel. With boilers operating at this pressure it is preferred by the designers that the feed into the boiler should be at a temperature of 300 to 350 deg. rather than that a lower temperature should be employed in conjunction with an economizer.—*The Marine Engineer and Naval Architect, Annual Steam Number, 1950, pp. 281-282, 256.*

Hydraulic Fatigue Testing of Boiler Drums

When testing pressure vessels to destruction under hydraulic pressure, these vessels usually fail at pressures from three to five times the allowable working pressure. Where the vessels are made of boiler plate the relatively large amount of plastic deformation, which of necessity occurs in the weakest section of the design, goes far beyond the operating strain range so that the final values have very little bearing on the behaviour of such vessels in regular operation. In the final stages of a static-pressure destruction test one will not therefore be testing the same shape nor the same material as that of the original vessel. For this reason considerable work has been done on testing pressure vessels under conditions of pulsating fatigue from zero to a maximum internal pressure. Although this test does not simulate service conditions, it does bring out points of severe stress concentration, or is a means of demonstrating that such stress concentrations do not exceed those that are unavoidable in pressure vessel design. Where a boiler drum may be subjected to but a few hundred major cycles during its service lift, a pulsating fatigue test of 100,000 cycles at or above working pressure will establish confidence that the design does not contain regions of severe strain which could result in premature failure. The paper describes a special pulsating machine developed for producing pressures up to 6,000lb. per sq. in. with a minimum of power consumption. Under actual service conditions the metal of a boiler drum is exposed to saturated steam and water. It is therefore desirable to investigate the effect of temperature as well as the contact with steam and boiler water. An apparatus to perform a pulsating fatigue test under simulated service conditions was designed, and scale model vessels of about one tenth the actual size were tested in a saturated-steam and water atmosphere of 2,000lb per sq. in.—*L. F. Kooistra and R. U. Blaser, Trans. A.S.M.E., Vol 72, July 1950, pp. 579-589.*

Localized formation of Magnetic Iron Oxide in Boilers

A thin film of magnetic iron oxide normally protects boiler metal from spontaneous attack by water. Corrosion occurs if, and only if, the protective film is destroyed. Erosion, sudden temperature changes and other physical or mechanical factors may damage the protective film and permit corrosion. Chemical breakdown of the film may be caused by oxygen, galvanic forces set up by porous or lightly adherent deposits, strong concentration of boiler water caustic or exposure to superheated steam at very high temperature. Any condition that aids these corrosive influences—localized overheating, retarded circulation, steam blanketing, etc.—contributes to the attack. Magnetic iron oxide, produced in proportion to the loss of metal, may remain near the corroded area or deposit elsewhere in the boiler. The hydrogen inevitably released by reaction between water and steel either passes off with the steam or is absorbed by the metal, sometimes causing brittleness and weakness due to intergranular damage. Metal which has failed through overheating, as indicated by changes in microstructure, always shows signs of corrosion, unless a layer of scale has sealed the metal away from direct contact with water or steam.—*H. M. Rivers and W. M. Sonnett, Combustion, Vol. 21, June 1950, pp. 41-46.*

Experimental Data on Boiler Drums

This paper presents an analysis of data obtained by strain-gauge experimental stress analysis on drum heads and nozzle openings in drum shells. The data obtained are reduced to dimensionless form so that they may be applied to drums of other size and thickness but geometrically similar, and to illustrate more clearly the action of the drum in resisting pressure. The relationship between operating-stress level and the life of the vessel in service is discussed with particular reference to a drum that has given over forty years of satisfactory service with an operating-stress range over a considerable area of the vessel of approximately the ultimate strength of the material. No data as to the fatigue strength of the material of this particular drum were available, but considering the severity and probable number of stress cycles, the investigators concluded that a considerable portion of the fatigue life of this drum had been spent. Neither time nor exposure to boiler water has greatly accelerated the failure, since the drum was to all appearances in good condition. In the opinion of the authors it would then appear that the fatigue test is a reliable test of service life for boiler drums. The desirable maximum stress range in a vessel is defined as that range which will produce a service life of the vessel which shall exceed the desired service life, expressed in number of service cycles, by a safe margin. The effect of pre-stress created in a vessel by overpressuring, such as applying the 1½ times working pressure hydrostatic test, is discussed.—*G. J. Schoessow and E. A. Brooks, Trans. A.S.M.E., Vol 72, July 1950, pp. 567-577.*

First Six Years of British Shipbuilding Research Association

In reviewing the activities of the British Shipbuilding Research Association during the first six years of its existence, Sir Maurice E. Denny refers to the fact that one of its first actions was to take over from the Shipbuilding Conference and extend a comprehensive programme of methodical model experiments on a series of ocean-going vessels of three separate block coefficients, 0·65, 0·70, and 0·75. The programme included the study of the effect of changes in longitudinal centre of buoyancy position, bilge radius, and draught. This series was devoted to ocean-going vessels of 400 feet length b.p. × 55 feet beam × 26 feet maximum draught, but as the work proceeded the programme was extended and modified to cover the effects of other variables. The effect of fineness is being investigated by interpolating models of 0·675 and 0·725 block coefficient in the series. The 0·65 block series parent form has also been expanded laterally to several greater beams, so that this series will be devoted to investigating the effect of beam increases. This is an example of an applied research. Since there has been renewed interest in bulbous bow forms during recent years, this same 0.65 block parent form has been chosen to form the basis of a subsidiary series of tests on bulbous bows. From these it is hoped to learn whether substantial advantages may be gained from this particular hull feature, and what are its most desirable characteristics. In this particular case, rough water tests are also to be made. The member firms of the Association have a wide variety of interests, and methodical tests are, therefore, in hand on several types of craft. Trawler forms are being investigated to determine the effects of increasing midship area and fining the ends, also other design features. These particular models are being self-propelled in waves so that any deduction drawn from smooth water experiments shall be verified in rough water conditions. Some basic design data are also being obtained from model experiments in hopper and dredge forms to determine the effects of raised hopper doors on resistance, the comparative merits of different types of dredge wells so far as resistance is concerned, and so on. Since the form of minimum resistance does not necessarily prove to be that requiring the minimum shaft horsepower for propulsion, most of the methodical series models are being tested for propulsive as well as for resistance characteristics. In particular, methodical propulsion data are being obtained for the ocean-going cargo series, covering a wide range of propeller revolutions per minute, to cater for both steam and Diesel prime movers.—*Paper by Sir Maurice E. Denny, Bt., K.B.E., read at a Joint Meeting of the Institution of Naval Architects, The Institution of Engineers and Shipbuilders in Scotland, and the North-East Coast Institution of Engineers and Shipbuilders, on 27th June 1950.*

New Launching Lubricant

The recent launch of the 10,450-tons vessel *Kieldrecht* from the Sunderland yard of Bartram and Sons, Ltd., was the first major launching in Great Britain where a petroleum blend was used for lubricating the standing and sliding ways. These lubricants are Basekote and Slidekote which have been introduced by the Anglo-American Oil Co., Ltd. Basekote is a wax-like compound which is applied hot to the wooden standing and sliding ways. It sets quickly to form a smooth firm surface with low frictional characteristics and very high load-carrying properties. Slidekote is a specially prepared buttery grease-type product which is applied cold on top of the Basekote where it acts as a lubricant between the layers of Basekote and the fixed and sliding ways. It is stated that these lubricants have been perfected after extensive experiment and research and have been in use for several years in leading American and Continental shipyards under widely different ambient temperature conditions. It is claimed that these products are less expensive to use than tallow or tallow-based compounds, less is required and that they can be recovered after a launch and re-used several times with perfect safety.—*The Shipping World, Vol. 23, 9th August 1950, p. 113.*

Ferry Boats Built Upside Down

The Galveston yard of Todd Shipyards Corporation recently completed the construction of two ferry boats for the State Highway Commission of Texas. In building these vessels Todd employed a unique "upside-down" method, starting with the laying of the deck plating and working up towards the keel. The bottoms were then picked up with cranes, turned over and placed in dry docks for the building of the superstructure and installation of machinery. Due to the unorthodox manner of these shipbuilding jobs, there were no launchings of the vessels from ways as in general practice. Instead, the dry docks were submerged, and the ferries towed out to the channel by tugs.—*Marine Engineering and Shipping Review, Vol. 55, July 1950, p. 74.*

New Ore Carriers

The single-screw motor vessels *Pathfinder* and *Prospector,* specially designed for the carriage of ore (bauxite) in bulk, recently completed successful trials and have been delivered to the Pan Ore Steamship Company, Inc., of Panama City. Built by R. and W. Hawthorn, Leslie and Co., Ltd., at the Hebburn shipyard, these 7,500-tons d.w. vessels feature special flood-lighting arrangements, steel hatch covers which operate fore and aft by specially arranged winches, and a special air washing plant which, together with filters, is designed to prevent fine dust from the bauxite ore cargo being admitted to the accommodation and engine room where it may cause damage to the generators, air compressors and other engine room equipment. The propelling machinery, manufactured by R. and W. Hawthorn, Leslie and Co., Ltd., consists of a single-screw Hawthorn-Doxford oil engine having five cylinders each with a bore of 560 mm. and a combined stroke of 1,680 mm. The engine develops 3,400 b.h.p. in service at 135 r.p.m. Compressed air for starting is supplied at 600lb. per sq. in.—*The Shipping World, Vol. 123, 12th July 1950, pp. 38-41.*

Self-unloading Ships

In this review of the achievements of the American belt-conveyor industry the author points out that for the shipping and marine industry the conveyor industry has developed self-unloading ships that can discharge 10,000 tons of bulk cargo and neatly pile ashore in about five hours, with as few as three men handling the conveyors and, if dock space permits, without assistance of any shore-based equipment. These ships need not be built specifically for self-unloading. Many successful conversions have been made of cargo ships that have been operated for as long as thirty years by old-fashioned methods of unloading. In general a self-unloader conversion consists of hoppering the hold to serve two belt conveyors symmetrically arranged on either side of the ship's centreline. These conveyors deliver to an inclined-plane conveyor which carries the cargo to the deck. At this point it is discharged to a boom conveyor, the boom of which is pivoted to the deck and carried by an "A" frame structure. Some of these booms are as long as 275 feet. It may be swung over the side of the vessel and topped up to any desired angle, within certain limits. The boom conveyor discharges the cargo on the dock, or if desired, into railroad cars or other ships. In one instance, a system of movable gantries on the dock that suspend elevators feeding to belt conveyors has so drastically cut down the turn-around time of a ship transporting sugar, that she can make three round trips in the time formerly required to make two. A major problem confronting the maritime industry today is the cost of the time spent in stowing boxed cargoes; about 25 per cent of the total man-hours involved in loading is consumed. Three of America's newest and fastest round-the-world passenger-cargo ships, now being built for the American President Lines, indicate the way to solve the problem. By means of a system of elevators and conveyors, 1,500 pieces of boxed cargo of a maximum weight of 250lb., can be loaded per hour. The boxed cargo is brought aboard through side loading hatches where portable conveyors carry it to the elevators that automatically discharge it to any of the lower cargo decks. In unloading the ship, the same flexible system saves a similar amount of time and money by reversing the operation.—*H. von Thaden, Mechanical Engineering, Vol 72, July 1950, pp. 549-552.*

New York Ferryboats

Each of the three new ferryboats being built for the Manhattan-Staten Island service of the City of New York will be driven at 18 miles per hour by a six-cylinder Skinner Unaflow engine developing 4,000 i.h.p. Three oil-buring, header-type Babcock and Wilcox boilers (one of which will serve as a stand-by) will furnish superheated steam to the engine at a pressure of 300lb. per sq. in. and at a temperature of 647 deg. F. Individually, the boilers can deliver 17,000lb. of steam per hour under normal conditions, but their outputs can be increased to 28,000lb. per hour per boiler. The Unaflow engines have maximum ratings of 5,000 i.h.p. The new ferryboats will have overall lengths of 290 feet, which is a 23 feet increase over the lengths of the craft now in use. The beam, over guards, will be 69 feet and the depth, amidships, 20 ft. 10 in. Each vessel should displace 2,350 tons at the designed draught of 13ft. 2in. At that draught the water line is 275ft. 10in. long and the beam measures 48 feet. The new vessels will accommodate 3.000 passengers each.—*Marine Engineering and Shipping Review, Vol. 55, July 1950, pp. 51-52.*

Structural Strength of River Barges

The author who is connected with the Germanic Lloyd, discusses the problem of structural strength arising from the conversion of a dumb barge into a self-propelled vessel. Specific reference is made to a barge of 67 metre length to be converted into a self-propelled barge of 80 metre length, propelled by two 450 h.p. engines. Investigation of the structural strength indicated that the existing bottom plating of 7 mm. thickness would be subjected to excessive compressive stress which would lead to buckling. It is therefore recommended to fit stiffeners by welding. The point is made that a revision of the existing rules of the classification society should be made.—*K. Schellenberger, Schiff und Hafen, Vol. 2, April 1950, pp. 82-94.*

Shipbuilding in Australia

At the Whyalla shipyards of the B.H.P. Co., Ltd., welding is playing an increasing part in shipbuilding. In the early days welding was restricted to items such as eyeplates, cleats and the connecting of these small parts to the ship structure. More experience by the welding team then permitted the welding of the secondary ship structures such as deck houses, engine and boiler room casings. Various shipboard houses are now prefabricated by welding in sections up to 10 tons, with stiffening and internal bulkheads attached, to avoid buckling when being lifted into positions. Plates of the maximum width are used to reduce the number of joints. In the Yampi class ore ships of 12,500 tons, 1,100 tons of the 4,600 tons of steel required is now welded. This covers all main watertight and oil-tight bulkheads, all main transverse members on decks and wing tanks, No. 4 hold flat, engine and boiler room casings, bridge deck, deck houses, main turbine seatings, masts, inner and outer funnels. Prefabrication work in the shops is handled by two Unionmelt machines wherever possible. Plug welds are made by a semi-automatic machine developed in the yards and operated on Unionmelt principle. It will do a plug weld in 10 seconds after the correct length of the electrode, to fill the hole, has been ascertained.—*Welding, Vol. 18, July 1950, p. 315.*

"Wind" Class Ice-breakers

This paper describes the propulsion and auxiliary machinery in the Wind Class ice-breakers of which a total of seven vessels was built during the war, plus one Great Lakes vessel with slightly different propulsion motor speed. The Wind Class ice-breaker has a length of 269 feet beam of 63ft. 6in., draught of 25ft. 9in. at a displacement of 5,040 tons, and has 10,000 s.h.p. available for distribution to three propellers. The propulsion power plant of the Northwind Class ice-breakers consists of six 2,000 b.h.p. opposed-piston Diesel engines, driving direct-current generators. When delivering full rated power the fuel consumption is less than 0·4lb. per b.h.p. hr. The engine generator sets are arranged in pairs in three engine rooms, separated by watertight bulkheads. Any combination of three starboard generators can be connected to a starboard propulsion bus to supply power to the starboard stern motor, while any combination of the three port generators can be connected to the port stern motor. Either or both forward generators can be connected to supply power to the bow motor at the same time the remaining generators supply power to the stern motors. Thus the full 10,000 available s.h.p. can be equally divided between the two stern propellers or equally between the three propellers. Each of the six propulsion generators is designed for parallel operation and to produce 900 volts at its terminals at full speed. This is 50 per cent higher than the usual marine d.c. propulsion generator voltage, and 300 per cent higher than would be used in the more common series or loop circuit, where three generators apply power to one propulsion motor. The approximate power requirements of the stern motors as a function of motor r.p.m. is shown in Fig. 1. The power required for a free-running vessel is represented by curve A, while the power required during maximum ice-breaking is represented by curve B. When running at 105 r.p.m., the motor output is 5,000 h.p. for maximum ice-breaking conditions, while the output is less than 2,000 h.p. for a free-running vessel. To utilize the available power from the engines, it is therefore necessary to speed up the motors by reducing the motor shunt field current. When one or two generators only are used with each motor, the available power is reduced; but the generator voltage remains at 900 volts as long as the engines run at full speed. This is, of

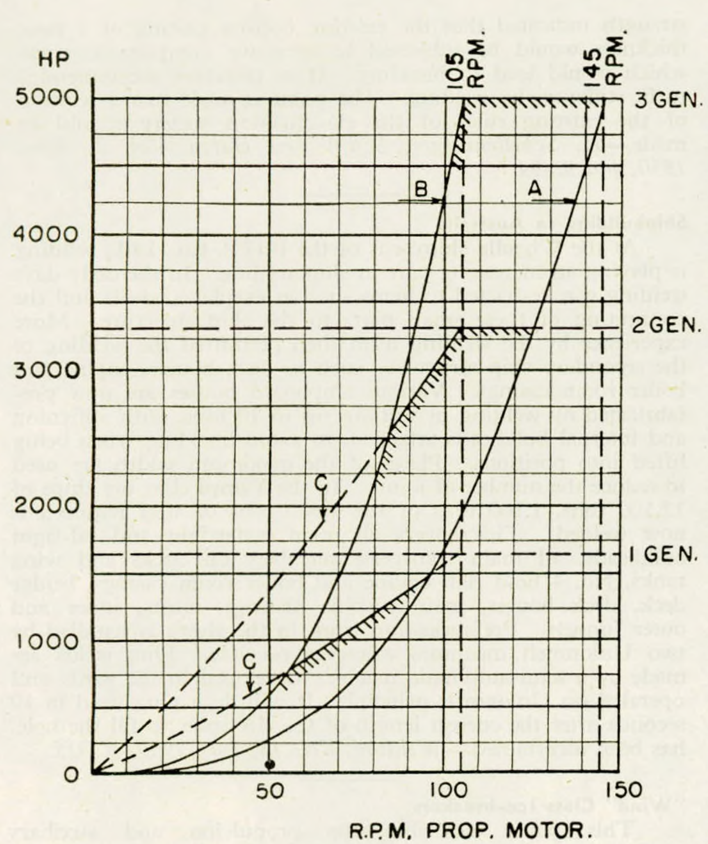


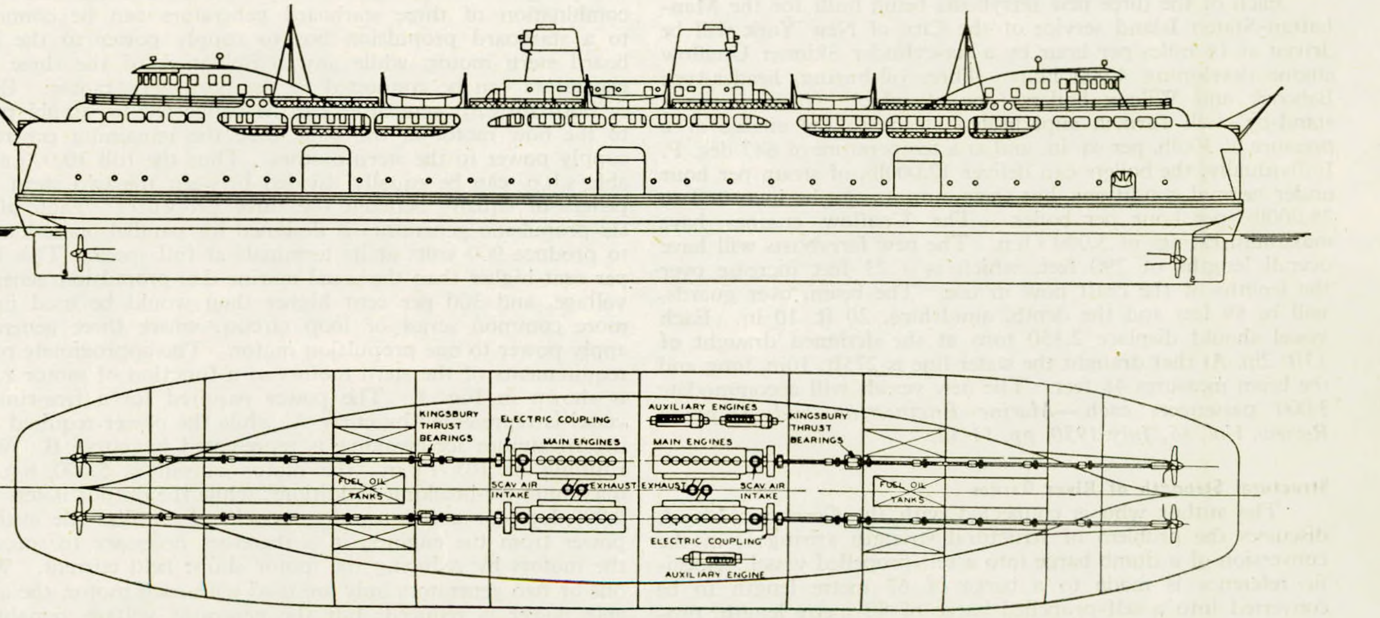
Fig. 1. Propeller power requirements.

A. Power required for a free running vessel.
B. Power required during maximum ice-breaking conditions.
C. Generator output at reduced engine speeds.

course, the only condition under which they can produce rated horse-power. With 900 volts impressed upon the motor armature, the minimum stern motor speed is 105 r.p.m. At this speed, and maximum ice-breaking conditions, the power requirement of each motor is 5,000 h.p., but only 3,300 h.p. with two engines, or 1,660 h.p. with one engine, is available. The engines are therefore overloaded, and a torque-limiting feature of the engine governor, which limits torque as a function of speed, reduces the engine speed. As a result, the generator voltage, and consequently the motor speed, are reduced and the motor load decreases. The speed will reduce to a point at which the propeller requirement equals the engine output. This is indicated in Fig. 1 where lines for the available power at reduced speeds, for one or two generator operation, have been added. It will be noted that, under maximum ice-breaking conditions and with two engines in operation, only 2,500 h.p. at 80 r.p.m. is available at the propeller, and with one engine, 800 h.p. at 55 r.p.m. It will also be noted that no engine speed reduction is required for two-engine operation, and very little reduction for one-engine operation when the vessel is running free. The two 5,000 h.p. stern motors and the 3,300 h.p. bow motor are designed for 900 volts to match the generator bus voltage. They have a wide range of speed over which they are capable of supplying full rated horsepower, this range being 105/145 r.p.m. (38 per cent) for the stern motors, 140/210 r.p.m. (50 per cent) for the bow motor. The transfer of 220 tons of sea water, between six wing ballast tanks through three 24-inch pipes, by reversible motor driven propeller-type pumps, was one of the interesting problems encountered in the design of the ice-breakers. The heeling motion, caused by the continual shift of ballast, is used to keep the hull plating continually moving, to prevent sticking by static friction while in contact with the ice.—*J. A. Wasmund, The Engineering Journal, Vol. 33, April 1950, pp. 271-275.*

Ice-breaking Ferry for State of Michigan

A Diesel-powered double-ended ice-breaking automobile ferry is now being built for the Michigan State Highway Department by the Great Lakes Engineering Works, River Rouge, Michigan. The vessel, as illustrated in the accompanying drawing, will be a steel, double-ended craft with twin screws at each end, strengthened for ice. Length overall will be 360 feet, moulded beam 73ft. 6in., and depth to the spar deck 43ft. 4in. The total installed maximum shaft horse-power will be 9,300. This will be equally divided between the four propellers. It is anticipated that full power on all screws will only be used in the most severe ice conditions. For other open water service, schedules can be maintained with reduced power, using two engines each way. There will be four Nordberg direct-reversible marine Diesels. They are eight cylinder units of 21½ inch bore by 31 inch stroke. Each of these engines develops 2,360



OUTBOARD PROFILE AND PLAN OF ICE-BREAKING FERRY NOW UNDER CONSTRUCTION b.h.p. at 165 r.p.m Of the two-cycle, port scavenging, solid-injection type, they will be fitted with attached engine-driven scavenging blowers. Each engine will drive a single propeller through an electric coupling. The electric couplings on each propeller shaft provide a number of operating features particularly desirable in ferry service. They act as clutches, permitting each individual engine to be disconnected from its propeller shaft. This facilitates manœuvring and allows forward screws to windmill when the vessel is being propelled by two after screws with the forward engines dead. When the vessel is working in heavy ice, they prevent transmission of shock torques from propellers through lineshafts to engines. They also help to contain torsional vibration criticals of the propulsion system within reasonable limits. Considerable speed reduction, as in dead slow operation with low power input can be obtained by slipping the couplings. With propulsion engines working at 100 r.p.m., the propeller speed can be varied between 20 and 100 r.p.m as desired.—*Marine Engineering and Shipping Review, Vol. 55, July 1950, pp. 68-71.*

Weather Deck Coating System Sought

The U.S. Bureau of Ships and the U.S. Bureau of Yards and Docks are developing a coating system for use on steel weather decks of vessels and pontoon decks. The present U.S. Navy standard paint coating system for steel weather decks is two coats of zinc chromate primer, or alternately, two coats of red lead primer, followed by two coats of grey deck paint. This is essentially a long oil alkyd resin base coating system with some admixture of phenolic resin base varnish in the grey deck paint. The present coating system for steel pontoon decks is two coats of coal tar pitch emulsion. Other systems have been tried on drydocks including the weather deck system noted above, but the results have been disappointing. The service environment on weather and pontoon decks is basically the same. The paint system will be applied to horizontal steel surfaces and exposed to prevalent and all possible variable weather conditions associated with ships at sea and sea coasts. In addition the systems are subjected to heavy foot traffic and to bumping and dragging of gear. In the case of Naval oil tankers when loaded and floating drydocks in operation the weather decks are frequently awash. It is impractical to set deck areas aside for prolonged periods in order to accomplish painting. Coating systems must be rapid-drying. A desirable but not essential property to be achieved in the coating system is the factor of non-skidding. Presently used deck paints do not afford adequate protection. Pin point and general corrosion is noticeable often within a few weeks after application of presently used paint systems on many vessels, especially gasoline and oil tankers and on pontoons of operating floating drydocks. Formulations based on vinyl and vinyl-alkyd resins and others based on chlorinated rubber, chlorinated paraffin and phenolic resin varnishes have been tested on one U.S. Naval Tanker. After eight months service, a system based on a metal conditioner (vinyl wash coat), vinyl resin primer and vinyl alkyd topcoat was found to be in good condition. The wash coat primer was found to help the standard system.—*A. C. Goetz, Corrosion, Vol. 6, July 1950, pp. 16-18.*

Ventilation of Ships' Holds

In the "Cargocaire" system the practice is to use air from the atmosphere as the ventilating medium whenever this air is drier than the air in the hold, that is, when the dewpoint of the atmosphere is lower than that within the cargo space, and to employ recirculation of the air within watertight bulkheads when the air on the bridge shows a higher dewpoint than the air issuing from any particular hold. In the latter case dry air must be added so that moisture given off from the cargo has less chance of condensing on the ship's steelwork. This also ensures that fresh air is continuously added to the hold. The damper in the exhaust fan house is partially open so that an equal volume of air may escape from the hold. Dry air is also used when there is a likelihood of moisture from cargo condensing under the weather-deck through a fall in the atmospheric temperature, even although the atmosphere is sufficiently dry for direct ventilation. In systems using air drying machines, which employ silica gel as drying medium, fresh air from the deck is drawn in by a fan, dried by its passage through a bed of silica gel, and delivered in a dry state to the holds through a dry air duct. By using dual beds, so that one is being dried while the other is in use as an absorber, the process is made continuous. Approximately 150 ships are equipped with silica gel driers. A further nine ships have adopted a drying machine based on the use of lithium chloride, which was developed as a competitor to the silica gel drier. In this type of machine, the fresh air to be dried is drawn in from the deck and subjected to a spray of concentrated lithium chloride solution in a conditioning chamber. The lithium chloride solution removes the moisture from the air and becomes diluted in the process. The air passes on into a dry air-supply duct, after the mechanical removal of the lithium chloride solution. The lithium chloride is brought up to strength for re-use by being sprayed over steam coils. In this way the process is made continuous. In this country, it was inevitable that the process of cooling should be adapted sooner or later to the purpose of drying air, once the practice of providing dry air to ships' holds had been established. So many ships already have refrigerating machinery on board, that the use of brine pipes to remove the water from the humid sea air required no inventive step. Twenty-eight ships (including those under construction) incorporate a system of ventilation using air dried by refrigeration. The installations provide for the ventilation of the cargo space by outside air as long as it is drier than the air in the hold. The drying unit consisting of a brine cooler, is located alongside the fan-and-damper house on deck. The air to be dried comes from the hold. When the dampers are arranged to recirculate the air, part is diverted over the cooler and rejoins the main stream after it has had the major part of its moisture removed as liquid water.—*S. J. Duly, Journal of the Royal Society of Arts, Vol. 98, 14th July 1950, pp. 710-725.*

Hot Hardness of Hard-facing Alloys

Hot hardness, which is of interest chiefly because of the implied hot wear resistance, has been surveyed at 600, 800, 1,000 and 1,200 deg. F. for a number of hard-facing alloys, using a Rockwell diamond indentor technique. Some indication of creep resistance, which becomes important as a variable at the higher temperatures, is obtained by incorporating a time factor in the tests. Arc welds, gas welds, and castings of wear-resistant alloys are included in the survey, which includes most of the types in the current American Welding Society classification of hard-surfacing alloys. For a few materials creep and stress-rupture data are correlated with hot hardness. Tempering response, secondary hardening, intrinsic solid solution hot strength, and the contribution of hard compounds (chiefly carbides) all influence hot hardness. Low alloy steels with little resistance to tempering loss hardness rapidly. Alloys such as chromium, tungsten and molybdenum, which cause marked secondary hardening, contribute to good hardness retention up through 1,000 deg. F. At 1,200 deg. F. solid solution hot strength and primary carbides appear of major importance. The Cr-Co-W alloys generally exceed the other alloys in hardness at 1,200 deg. F., but their properties vary widely with the carbon content. Since toughness, as indicated by compression tests, varies inversely with the carbon content, a compromise between hardness and toughness is required.—*H. S. Avery, The Welding Journal, Vol. 29, July 1950, pp. 552-578.*

Metal Spraying of High-temperature Metals and Alloys

This paper describes the spraying of high-melting-point metals and alloys, the properties of the deposits, and the densification achieved by sintering. The materials reported include molybdenum and nickel, molybdenum-nickel alloys and three commercial high-temperature alloys, Hastelloy C, Vitallium and CM 469 (containing 60 per cent Cr, 25 per cent Mo and 15 per cent Fe). A deposit of sprayed molybdenum was found to be composed of layers of molybdenum metal which are separated by voids and oxide. This is typical of sprayed metals in that a lamellar structure is formed in which oxide is entrapped between layers of metal. To determine the effect of the oxide content of sprayed metal upon its strength a special hydrostatic bursting apparatus was developed. Since the strength of sprayed metals is largely affected by the amount of oxide and the number of voids they contain, sintering in hydrogen at elevated temperatures was carried out to improve the strength of sprayed deposits. Even though sintering of sprayed molybdenum resulted in improved properties, sintering in the presence of a liquid phase gave a further improvement. To achieve a liquid phase during sintering of sprayed molybdenum deposits, small amounts of nickel were added by different techniques. A coating of nickel was first sprayed on the top of the coating of molybdenum. Although some liquid phase was then formed when the composite was sintered, its passage into the molybdenum deposit was limited. The most successful technique was to paint or spray a deposit of molybdenum with successive coatings of a solution of very fine nickel metal powder or nickel salts suspended in alcohol. The porous deposit absorbed the suspension and distributed the nickel throughout the spray coat.—*R. T. Thurston and J. Wulff, The Welding Journal, Vol. 29, July 1950, pp. 313-s-319-s.*

Brazing and Welding Coated Materials

In the first part of this article the author discusses the techniques for brazing various types of coated materials. A brief reference to the bronze welding of galvanized iron or steel is made. While this process does not involve fusion of the steel, it is still remarkable in that the minimum temperature of application is considerably above the melting point of zinc, and very close to its volatilizing temperature (930 deg. C. approx.). The joint is made with an oxy-acetylene flame and a normal bronze-welding rod and flux, but the coating on either side of the joint is first protected by the application of a special flux. This appears to prevent any damage to the zinc coating, which is undisturbed right up to the deposited weld metal. The second part of the article is devoted to resistance welding methods. The author points out that with resistance welding the coatings should be as thin as possible, but when brazing is adopted, slightly heavier coatings can normally be used.—*E. V. Beatson, Welding, Vol. 18, June 1950, pp. 232-242.*

Aircomatic Welding Process

The Aircomatic process may be defined as inert-gas-shielded metal-arc welding. A consuming electrode is used which differentiates this process in one respect from the inert-gas-shielded welding process which uses non-consuming tungsten electrodes. Fundamentally, the tungsten arc process simply provides a protected source of heat for fusing metals. Filler metal may or may not be added to the arc as an independent operation. The Aircomatic process is characterized by an inert-gas-shielded arc between the workpiece and a consumable electrode through which metal is transferred to the workpiece where it becomes part of the joint. The transfer of material through the protected arc column increases the efficiency of heat input to the workpiece over that obtained in the tungsten arc process. This increase in efficiency is partially the result of the heat content of the superheated metal passing through the arc. The resultant high intensity heat source permits very rapid welding. Practical means for applying the Aircomatic process have been developed: one method employs a manually manipulated welding gun; another method uses an automatic head. Both methods use a continuously fed bare wire in coil form for the electrode. The Aircomatic process was first applied to the welding of aluminium. This process is simple and straightforward. All the commercial austenitic type stainless steels can be successfully welded with the Aircomatic process. Welding with the manual gun may be performed in all positions. Preheat is not required for welding. It is necessary to use controlled filler wire compositions to avoid the cracking difficulties commonly encountered in welding stainless steel. The precautions which must be observed are similar in many respects to those used in balancing core wire compositions for coated electrodes, except allowances do not have to be made for loss of elements in transfer. At present ⅛-in. and heavier plate can be welded. The welding of aluminium bronze by the Aircomatic process has been investigated. Welding proved to be surprisingly simple and some excellent results have been obtained. The equipment required is essentially the same as that necessary for welding aluminium. Two aluminium-bronze welding wire analyses have been used successfully for overlay and joining purposes. One analysis, an α-β type composition, contains about 10 per cent aluminium, one per cent iron and the balance copper; the other is an α bronze containing 8 per cent aluminium without iron. Welded joints have been made in aluminium bronze, carbon steel and propeller-type bronze. Various metals have been surfaced with welded overlays suitable for bearing purposes including mild steel, grey cast iron, deoxidized copper, naval brass and manganese-bronze marine propeller casting alloy. No attempt has yet been made to deposit hard abrasion resistant overlays of higher aluminium content. The mechanical properties of aluminium bronze welds are excellent.—*A. Muller, G. J. Gibson, and E. H. Roper, The Welding Journal, Vol. 29, June 1950, pp. 458-482.*

New French Cable Ship

The new French cable ship *Ampère* built to the order of the French Postal, Telegraph and Telephone Administration, was recently launched from the Normandie shipyard of the Société des Chantiers et Ateliers de Saint-Nazaire (Penhoët). The keel of the *Ampère* was laid in 1943, but construction was delayed because of the war. The *Ampére*, the first cable ship completed in France since the war, is the third ship to be acquired by the French Postal, Telegraph and Telephone Administration since 1945. The others were the *Pierre-Picard*, also built by Penhoët, and the *D'Arsonval*. The latter underwent complete reconversion at the Penhoët shipyard. The new *Ampére* is 298ft. 5¾in. long, and the propelling machinery consists of two turbines of 1,200 h.p. driving two variable-pitch propellers, the first instance of a French cable ship fitted with such propellers. The vessel, fully loaded, will attain 14 knots with one boiler only in service. The ship has been designed for a load of 1,600 tons d.w., of which the cable load will account for the maximum of 1,000 tons, and the range at sea will be 40 days.—*The Shipping World, Vol. 123, 19th July 1950, p. 54.*

Accelerated Cavitation Research

This paper describes an accelerated-cavitation machine of the vibrating type and its application to the testing of a wide range of materials including cast iron, brass, cast and rolled stainless steels, welded stainless steel, and base metals used by the U.S. Navy in connexion with Thiokol rubber overlays. Stellite was found to have by far the greatest resistance to pitting of all materials tested. Cavitation tests were also conducted on Thiokol rubber sprayed on various materials used for a base. Visual inspection of the test specimens indicated that the rubber overlay gave considerable resistance to pitting. The composition of the base metal apparently has very little influence on the resistance of the rubber to pitting. The U.S. Navy has used this rubber overlay with considerable success on propeller shafts, rudders, and struts of naval vessels where pitting was being encountered. One of the important features of the successful use of rubber overlays is proper application. The U.S. Navy sandblasts the base metal to obtain a clean surface. The metal is heated to a temperature somewhat above the surrounding air temperature. The rubber is then sprayed on with a gun, using the powder and gun developed by the Schori Process Corporation. The results of the tests in the accelerated-cavitation machine, and the results obtained by the Navy under actual operating conditions, indicate that it might be desirable to investigate the performance of this rubber when used for hydraulic-machinery parts subject to pitting.—*W. J. Rheingans, Trans. A.S.M.E., Vol. 72, July 1950, pp. 705-724.*