TECHNICAL ABSTRACTS

The following abstracts are reproduced from the 'Journal of the British Shipbuilding Research Association', Vol. 8, Nos. 4 and 5.

SHIP RESISTANCE AND FLUID MOTION

Improvements in Ship Performance. ALLAN, J. F. *Transactions, Institute of Marine Engineers, paper read* 10 March 1953.

This paper is a review of the improvements in ship performance over the last twenty-five years.

The Author first discusses hull resistance in general, with particular reference to the comparison of the performances of ships as determined from their models. He then goes on to describe the reduction in resistance achieved by careful design of the hull form, which is estimated as resulting in improvements of up to 7 per cent. In addition to this, the adoption of the cruiser stern, with suitable modifications for specialised ships, has resulted in reductions of the order of 5 per cent. in hull resistance. In particular, the application of the cruiser stern to cross-channel ships is mentioned. These ships, being of shallow draught, are fitted with knuckle sterns, combining the cruiser-stern profiles, which have good resistance characteristics, with hollow under-water sections, which have good propulsion characteristics.

Great attention has been paid to the design of the rudder and stern frame. The square post with plate rudder and exposed arms has been replaced by the streamlined post and faired rudder, with a reduction of resistance of about 8 per cent. In general, unbalanced rudders hung on the deadwood are preferred to those of the balanced type with deadwood cut away, owing to the better directional stability, although manœuvrability suffers slightly.

The introduction of the flush-welded hull has resulted in great decreases in resistance owing to the reduction in structural roughness, but this advantage may be masked in service by the roughness due to fouling. Intially, the flush-welded hull shows a saving of up to 20 per cent. of the resistance of an all-riveted hull, but it is not known how long this advantage is maintained in service. Attention is being paid to the present method of calculating surface friction, as this has been shown by recent ship trials to give consistently high values, and values, and some modification in the method is necessary.

The increase in speed and power of merchant ships, with no corresponding increase in propeller diameter, has increased propeller thrust and torque loading, and so great attention has been paid to the design of propellers to reduce cavitation and vibration. Propeller efficiency has increased by about 5 per cent. during the period under review.

The controllable-pitch propeller has found favour in certain applications, notably in tugs and trawlers, because of its ability to use full-power torque at any speed of advance. Its ability to give astern thrust without reversing the engines is an advantage in connexion with Diesel engines and gas turbines. This type of propeller is, however, less efficient than a solid one at normal ahead speeds, because of the larger boss and the restrictions on area distribution.

Nozzle propellers have been widely adopted in tugs, owing to the great increases (40 to 50 per cent.) in the bollard pull.

Much work is being done on hull vibration, and care is taken to avoid synchronism at all important speeds.

Completely successful methods of roll stabilization have been developed, effected by the use of activated fins. In general, however, not much progress has been made in the field of seakindliness, and research is needed into this subject.

Finally, a comparison is given between the *Queen Mary* and the *United States*.

The paper is illustrated by diagrams and photographs. References are given.

PROPELLERS AND PROPULSION

The Effect of Radial Pitch Variation on the Performance of a Marine Propeller. BURRILL, L. C., and YANG, C. S. *Transactions, Institution of Naval Architects, paper read* 26 March, 1953.

The Authors describe the results of an investigation, by means of strip-theory calculations, of the comparative effects of various forms of radial-pitch variation on the efficiency and performance of a marine propeller working in a uniform stream, and also in various non-uniform wake-streams representative of twin-screw and single-screw wake patterns. Strip-theory calculations were first made for a four-bladed aerofoil propeller of good modern design as fitted to a large twin-screw liner ; the results were found to be closely in agreement with the test-tank figures. The screw had a hyperbolic pitch-reduction towards the root of fourteen per cent., and complete calculations were made for a series of screws having the same blade shape, sections, etc., and differing only in the shape of the pitch-variation line from root to tip, selected on a basis of possible practical alternatives.

For simplicity, these calculations were first made for all the propellers working in a uniform stream, corresponding to the mean wake speed of the original design ; later, the investigation was extended to cover various non-uniform streams representative of various twin-screw wakes.

In addition to the various arbitrary pitch lines mentioned above, further calculations were made with pitch curves corresponding to the methods proposed by several investigators for the design of propellers with minimum energy loss, both for the uniform streams and for the variable-wake streams.

It was found that, from the point of view of overall efficiency, no material advantage appeared to be gained from the adoption of a radial variation in pitch, both in uniform and variable-wake streams. There was also no advantage to be gained from the various alternative methods of design based on the principle of minimum energy loss, since any gain in the hydrodynamic efficiency is very small, and is overshadowed by the effects of blade efficiency introduced by the changes in angle of incidence when the wake concentration is high. On the other hand, the results suggested that no special loss in efficiency is to be expected from the adoption of moderate pitch variations which are favourable from the point of view of cavitation or flow breakdown.

The paper is illustrated by diagrams. References are given.

New Propeller Design. *World Shipbuilding*, 3 (1953), p. 37 (Feb.).

A patent has been granted for a propeller with three or more blades, in which each blade has a leading edge curved outwards on an arc from the hub portion. The rear edge is straight and perpendicular to the axis, except towards the root where it terminates in a recess. Throughout its full extent the blade has uniform pitch. It is claimed that this propeller form eliminates almost all slip.

Rotol Variable Pitch Propellers. *Shipbuilding and Shipping Record.* **81** (1953), p. 348 (12 March).

Rotol marine variable- and reversible-pitch propellers are available for high-speed boats, tugs and submarines. These propellers cause a considerable saving in fuel at cruising speeds, and when fitted to firefloats permit the total power of the engines to be apportioned between propulsion and pump in any desired ratio. In tugs, an increase in efficiency of 40 per cent. is claimed over, fixed-pitched propellers.

Operation and servicing are simple, and one naval tug has successfully operated with one of these propellers for five years without replacements.

STABILITY, MANOEUVRABILITY AND SEAWORTHINESS

The Motion of an Aircraft Carrier at Sea in Relation to the Operation of Naval Aircraft. BARTLETT, J. L. *Transactions, Institution of Naval Architects, paper read* 26 March 1953.

Information about the maximum vertical movements, velocities, and accelerations that may occur in the various parts of a flight deck of an aircraft carrier, under conditions representing the limit beyond which the operation of aircraft would become impossible, is of importance to aircraft designers.

The Author firstly discusses the relationship between waves and ship motion, and also the probability of meeting waves of specific heights. A series of tests on the pitching and heaving motions of a model aircraft carrier are then described. The data obtained from these model tests are analysed, and figures are given for the motions of the flight deck which represent the limit at which aircraft operation is possible, and also the maximum motions likely to be encountered.

There are a number of references.

WELDING AND OTHER METHODS OF CONSTRUCTION

The Scope of Stud-Welding. TAYLOR, R. W.; *Engineering*, **175** (1953), p. 315 (6 March).

Many industries have made great use of the stud-welding process, but the Author believes that its greatest scope lies in shipbuilding. The fixing of ventilation ducting, cables, wiring and pipe runs, insulation, the fitting of cleats, cargo battens, holding-down studs, and the laying of wood decking are among its shipyard applications.

The present range of stud and fixture diameters that can be stud-welded may be taken as $\frac{1}{8}$ in. to $\frac{3}{4}$ in., though both smaller and larger attachments have been handled. The attachments need not necessarily be cylindrical; and rectangular, elliptical, or other sections may equally well be welded, provided that the ratio of length to breadth of the section does not exceed 4 to 1. At present $\frac{5}{8}$ in. is the limiting maximum diameter of attachment for which consistent full-area stud welds can be guaranteed on a vertical plane. For sound welds, the arc must be stable and the initial electrical contact between the stud and the plate should be ensured by cleaning, e.g., with a scratch brush or by shot-blasting; if this is impracticable, a good centre-pop mark is usually effective.

Consistently good results are nowadays obtained with naval-brass studs, whose quality is controlled, welded to steel plate ; brass studs may also be welded to copper, provided that it is de-oxidised, and some satisfactory stud-welding has also been carried out on monel metal. For ferrous stud-welding where maximum penetration into the parent metal is desirable, the plate should be positive and the stud negative ; but for certain non-ferrous metals, notably brass, the reverse polarity should be used. When welding mild-steel studs to mild-steel plate whose carbon content exceeds 0·25 per cent. some preheating may be necessary.

Materials normally suitable for metallic-arc welding are, in general, also suitable for stud welding, but local hardening effects in medium-carbon or even low-carbon steels are more pronounced. Considerable research has been done and is continuing on stud-welding aluminium and its non-heat-treatable alloys, but little progress has yet been achieved with heat-treatable aluminium alloys. Ways of eliminating excessively hard zones formed immediately below the weld in the parent metal when stud-welding air-hardening steels are being extensively studied.

If the parts are properly designed, stud welding can lead to substantial savings in labour costs and materials ; and an example is quoted in which the fixing of studs was over 50 per cent. cheaper if performed by stud-welding than by drilling and tapping. Drilling causes some local weakening of the structure which may sometimes be undesirable, and also, in the case of sheet steel, it promotes rusting. Stud-welding eliminates these disadvantages, and the flexibility and portability of the equipment are also advantageous.

SHIPBUILDING (GENERAL)

Launch of the Royal Yacht. *Admiralty Handout No.* 99/53.

The hospital ship that is to be used as a Royal Yacht in peace time was recently launched by John Brown & Co., Ltd. Special attention has been paid to the funnel design of this vessel, experiments having been carried out to make the ship as free from smoke as possible. Aluminium alloy is being used in the funnel and part of the superstructure. The hull is built to conform to Lloyd's rules, and is well subdivided, power-operated water tight doors being provided on the lower deck where transverse bulkheads are pierced.

In addition to the normal fire-fighting arrangements, a sprinkler system will be provided in the royal and state apartments. The ship will be fitted with a stabilizer to reduce her roll in bad weather. The distilling capacity of the ship will render her independent of shore fresh-water supplies if necessary ; full water-purification plant will be fitted. The after end of the shelterdeck will be strong enough to allow a helicopter, carrying patients, to land on it.

The principal dimensions of the vessel are :—

Length, o.a.	413 ft.
waterline	380 ft.
Breadth	55 ft.
Depth, moulded	32·5 ft.
Load displacement	About 4,000 tons

BOILERS AND STEAM DISTRIBUTION

Caustic Cracking in Steam Boilers. PARKINS, R. N. *Chemistry and Industry*, No. 9 (1953), p. 180 (28 Feb.).

Many theories have been proposed to account for the formation of intergranular cracks in mild-steel components exposed to certain corrodants and subjected to tensile stresses of sufficient magnitude. The Author reviews and discusses the more important of these theories, which fall into the following main classes : hydrogen theories, precipitation theories, oxide-film theories, mechanical theories, and boundary-distortion theories.

Particular attention is given to the question whether there is sufficient in common between caustic cracking and nitrate cracking for theories developed from laboratory tests on the latter to be applicable to the former. It is concluded that, although the two types of cracking are similar with regard to the effect of stress, the effect of cold-work, the nature of the cracking, and the nature of the corrosion, a full comparison of the two phenomena is prevented by a lack of systematic data on the influence of steel composition or heat treatment of the steel. Despite the consequent difficulty in discussing the application of theories based on nitrate cracking to the caustic cracking of boilers, sufficient data are available to show that some of them are untenable. The most acceptable explanation of caustic cracking in boilers appears to be that based on the distorted nature of ferrite in the region of the grain boundaries.

Caustic cracking may be prevented by removing any one of the critical conditions that must obtain if it is to occur. For existing boilers, the addition of some chemical that will inhibit the action of sodium hydroxide appears most suitable, while the stress concentration can be reduced by replacing riveted seams by welding, or by eliminating defective workmanship in riveted seams.

The paper is accompanied by an extensive list of references.

Soot Blowing for Steam Boilers with Dry Compressed Air. *Combustion Engineering*, **7** (1953), p. 35 (Feb.).

In order to avoid the scoring and damage produced by steam-operated soot blowers in boilers, the use of dry compressed air has been adopted in American power stations. Compressors operating at pressures between 200 and 400 lb per sq. in. are used, drawing intake air through a suitable air drier. The Kemp Oriad Drier is described ; it has two absorption towers, through either of which the air flow may be directed without interruption of the supply, and uses a drying agent which may be re-activated by the application of heat.

STEAM ENGINES AND STEAM TURBINES

The Double Flow Condenser. SIDUN, A. *Heat Engineering*, **27** (1952), p. 174 (Nov.).

A new compact pattern of condenser, using a double flow of steam, occupies only about 60 per cent. of the volume of the standard type, and requires about 40 per cent. less head-room.

The cooling tubes are divided into two groups by a central vertical passage, and each group is divided by a horizontal baffle into an upper and a lower bank. Some of the exhaust steam goes through the upper bank, whence the condensate falls to the bottom, whilst the rest of the steam proceeds via

the central passage up through the lower bank of cooling tubes. The steam condensed in this lower bank falls as droplets through the incoming steam, thus giving long contact between condensate and incoming steam and thorough mixing. Condensate from the upper bank falls on to the baffle, and thence to the bottom of the condenser.

Pressure losses are reduced because of the large area of entrance of the steam and the short depth of the tube banks.

The paper is accompanied by diagrams, photographs and performance data.

GAS TURBINES

A 6,500-S.H.P. Marine Gas Turbine. *Motor Ship*, **33** (1953), p. 520 (March).

A description is given of the parallel-flow gas turbine developed by the English Electric Co., which was originally intended for use in a frigate. It was designed for long life and reliability, and to supply current for an A.C. driving motor giving 6,000 s.h.p. at the propeller. The power turbine develops 6,500 h.p. at 5,600 r.p.m. The compressor is of the axial type with 15 stages, running at 4,000 r.p.m. and giving a mass flow of 128 lb of air per minute. The starting motor, which drives the set through a hydraulically-operated friction clutch, is rated at 250 h.p., and is capable of running the set at 1,000 r.p.m. without fuel. The rotors, which were built up by welding three austenitic-steel forgings, are air-cooled in use. A new design of flame tube is used and the combustion chamber, which has a high resistance to oxidation, maintains its circular shape. A prototype survived several hundreds of hours of operation under severe conditions, including running at a gas-outlet temperature of 1,200°C. (2,192°F.). Boiler oil was burnt during the trials. Two stationary heat exchanges are used, one for the power turbine, and one for the charging set.

The set can be brought from cold to driving condition in five minutes, and to full load in 20 minutes. As the charging set may be left running at any required speed, independently of the state of the power turbine, by means of a blow off, the installation is very manœuvrable, the time required to bring the turbine from " Stop " to " Full power " being a few seconds.

The article is illustrated by diagrams and a photograph.

The Use of Low Grade Fuels in Gas Turbines. BUCHER, J. B. *Gas and Oil Power*, **47** (1952), p. 284 (*Annual Technical Review Number*).

One of the main advantages of the gas turbine over steam plant is that the waste heat from the gas turbine is discharged at a temperature considerably above atmospheric, and can consequently be used for drying large quantities of fuel or for other purposes without impairing the power generation. Thus poor-quality fuels such as peat and wet coal can be used. The Author mentions a peat-burning gas turbine (see Abstract No. 5776, Feb. 1952), and describes a 2,000-kW closed-cycle installation for burning wet coal which is dried from 25 per cent. to 5 per cent. moisture. A plant of this type has been extensively used at Clydebank on various grades of coal including pond slurries.

One of the major problems of the coal-fired gas turbine is the disposal of the ash, which must be prevented from reaching and fouling the turbine and heat exchanger. This calls for special features in the design of the air heater which are briefly described. In addition to its ability to burn low-grade fuels, the gas turbine has the advantage that it can compete favourably with the steam plant as a generating unit on any type of solid fuel.

See also Abstracts No. 6006 (April 1952) and No. 6465 (Aug. 1952).

DIESEL AND OTHER I.C. ENGINES

The Use of Heavy Fuels in Diesel Engines of Marine Auxiliary Sizes. SMAITH, J. *Transactions of the North East Coast Institution of Engine and Shipbuilders, paper read* 24 April 1953.

The increasing use of heavy fuels for the larger marine-propulsion Diesel engines has led to an increasing demand that marine auxiliary Diesel engines should operate on the same fuel.

The Author describes tests performed on a single-cylinder experimental engine with a stroke of 12 in. and a bore of 9 in. running at 600 r.p.m., of a type which, with from 3 to 8 cylinders and both in normally aspirated and pressure-charged form, has been supplied in large quantities for marine auxiliary use. The tests were carried out to determine the modifications that would be necessary to enable the engine to perform satisfactorily on heavy fuel with the lowest operational costs, particularly in relation to cylinder-liner wear.

The analyses of the fuels used are given. The results of the tests indicate that it is possible to run on all the fuels tested with little increase in maintenance costs, provided that the fuel is centrifuged and clarified, and heated to have a viscosity of not more than 130 secs Redwood No. 1 at the fuel pump ; that the water inlet temperature to the cylinder jacket is not less than 160°F. ; and that the cylinder liner is chromium-plated.

MACHINE PARTS

Gland Seals for Moving Surfaces and a New Approach to Cavitation Problems. THOMSON, A. G. *Marine Engineer*, **76** (1953), p. 23 (Jan.).

This paper gives brief details of the work carried out at the British Hydromechanics Research Association's laboratories during the twenty months that they have been in use.

The Association is studying a number of problems associated with the sealing of rotating and reciprocating shafts. From the standpoint of economics, it is considered likely that a small controlled leak may be preferable to a seal which is costly either in initial outlay or in maintenance : the friction torque when there is no leakage may be ten times that when a small leak is allowed. Many commercial seals are being tested to determine their performance and to study the fundamental processes involved. The Association is also studying the fundamentals of friction and lubrication of seals ; and has found that the friction of rubber and other elastically-deformable materials is more subject to small changes in the test conditions than are most engineering materials.

The cost of many hydraulic machines could be reduced if it were possible to increase their speed ; the limiting factor is generally the onset of cavitation caused by low absolute pressures resulting from high fluid velocities. An investigation into the fundamentals of cavitation is being carried out for the Association, the theory under examination being based largely on an apparent similarity between cavitation-erosion and corrosion-fatigue. In the case of cavitation, it is known that erosion in non-corrosive liquids occurs at a considerably lower rate than in water, and that in a water test erosion can be reduced by

cathodic protection. The suggestion that in the initial stages of cavitation the metal is corroded is being examined by means of magneto-striction apparatus in which specimens are dipped into small quantities of liquid. The vibration subjects the specimen to accelerations of about 10,000 g, which are sufficient to cause severe cavitation, and the amounts of corrosion and erosion are then measured.

FUELS AND COMBUSTION TECHNOLOGY

Compact New Fuel Oil Heater. *Marine Engineer*, **76** (1953), p. 36 (Jan.).

A new design of fuel-oil heaters employs a type of extended surface which enables a high performance to be obtained in relation to its size and weight. Steam is used for heating, and the element contains an inner tube which delivers steam to the far end whence it passes back against the direction of oil flow. The element has a large number of copper studs welded to its outer surface, which are crimped over to lie along the surface in helicoidal form. The element is enclosed in an outer casing, the space between the two forming the oil passage. The helicoidal arrangement of the studs tends to lead the oil in a spiral path and lengthens the time during which it is in contact with the heating surface ; this form also promotes a self-cleaning action in service. When it is desired to remove the element for cleaning, it is only necessary to break the steam joints ; the element can then be withdrawn from its casing, which carries the oil connections. The present range of eight sizes covers outputs of 0·3 to 11 tons/hr when heating fuels with a viscosity of 130–350 secs Redwood No. 1 from 50°F. to 175°F. or 0·125 to 4·5 tons/hr when heating heavy fuels in the viscosity range 400–2,000 secs Redwood No. 1 from 85°F. to 175°F.

This type of extended surface is also applied to heat exchangers used for economizers and air preheaters. The copper studs there used are longer and are not crimped over. Copper studs which have had their surfaces specially treated can be used for temperatures up to 1,450°F. ; for higher temperatures the studs are sheathed with steel of a grade applicable to the working conditions.

AUXILIARY EQUIPMENT AND MACHINERY

The BICERA Compressor. TRYHORN, D. W. *Shipbuilder and Marine Engine Builder*, **60** (1953), p. 139 (March).

A new rotary compressor has been developed by the British Internal-Combustion Engine Research Association for the pressure charging of internal-combustion engines. It is a fault of other compressors used for this purpose that they develop their maximum output at a fixed speed, taking no account of the varying requirements of the engine. Most chargers are coupled to the engine, and when the engine speed drops, so will the output of the charger ; but it is just under these conditions that the engine needs more output from the charger. The BICERA charger has been designed to eliminate these and other faults.

The BICERA compressor is based upon the Roots-type pressure charger, being of figure-of-eight form, with two contra-rotatory hollow rotors containing no ports. Inside the rotors are tubular valves which contain hollow slotted sleeves. The valve timing can be altered while the compressor is in operation by rotating these sleeves, and in this manner the output of the compressor is altered.

By coupling this valve-timing mechanism to the governor of the engine, the output of the compressor is automatically altered to suit the demands of the engine and the maximum output can be arranged to occur at the point where it is most needed. The compressor may be used both with compression-ignition and spark-ignition engines.

The results of tests performed upon the prototype compressor are presented, and charts given of the performance.

INSTRUMENTS AND CONTROL DEVICES

Pressure-Reducing Valve. *Engineering*, **175** (1953), p. 320 (6 March).

A new range of pressure-reducing valves, suitable for either liquids or gases and capable of reducing pressures from up to 250 lb/sq. in. down to between 5 and 125 lb/sq. in., is manufactured by Sir W. H. Bailey & Co., Ltd. The maximum steam capacity of the largest valve in the series is 3,900 lb/hr. for an initial pressure of 250 lb/sq. in. when reducing to 125 lb/sq. in. The valves, which are of the diaphragm type and therefore have neither glands nor packing are made in six sizes for a range of pipe diameters of $\frac{1}{2}$ in. to 2 in. and their overall heights range from $10\frac{1}{2}$ in. to $20\frac{1}{2}$ in.

OPERATION AND MAINTENANCE

Steam Cleaning Aboard Ship. LOVATT, F. W. *Marine News*, **39**, No. 8 (1953), p. 36 (Feb.).

A new method has been developed for cleaning large surfaces on board ship. Suitable detergents are applied to the surfaces by a steam gun consisting of a Venturi nozzle with the steam forced through at high pressure. The steam draws in the detergent, and the two mix together to form a powerful stripping agent.

This method of cleaning has several advantages ; no abrasives are used, the high-pressure spray penetrates into all corners, the heat loosens oil and grease, and the detergent removes surface deposits. A great deal of time is saved as compared with other methods of cleaning, and no special skill is necessary in operation. The gun may be used in any place where steam is available.

The Author quotes some examples of the application of this method ; he states that up to ten coats of gray enamel have been removed from Diesel engines on L.S.T.s, and that frigate hulls have been cleaned by two men in a time of between one-and-a-half to two days, as compared with five men working six days using older methods.

The gun may be operated with air instead of steam ; it has been used in this manner to apply a mixture of paraffin and a solvent detergent to remove oil and grease preservatives from the equipment in a ship's engine room.

The article is illustrated by diagrams and a photograph.

PIECE OF THROAT BRICK FRACTURED BY CARBON BUILD-UP WITHIN THE BRICK