TECHNICAL ABSTRACTS

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Design of Stacks to Minimise Smoke Nuisance. NOLAN, R. W. *Society of Naval Architects and Marine Engineers (New York), paper read at annual meeting, 14th November,* 1946.

The main function of a smoke stack is to discharge the products of combustion so that they stay clear of the ship ; many ships fail in this respect. Accordingly, the Author's firm undertook an investigation, as yet incomplete, of the problem ; this paper constitutes a preliminary report.

The tests were carried out by placing water-line models (on a scale of 1 to 96) in a wind-tunnel and discharging the proper quantity of smoke through the stack. Experiments were made with the smoke at various temperatures, with the wind in directions up to 30° off the bow and at various velocities, on fourteen stack models, ranging from normal elliptical and streamlined sections to conical profiles with inclined exit orifices and stacks with louvre ventilators. During tests, the models were floodlit and photographs were taken. Indications of turbulence were obtained by means of cotton streamers tied to vertical wires ; the amplitude of the whipping of a thread gives an approximate idea of the turbulence at that point. The criteria of similarity for smoke tests are discussed, and the application of model tests to the design of stacks is shown to be a far from exact procedure.

The Author concludes that complete elimination of smoke troubles is probably impossible with stack heights acceptable to the public. In order to keep the smoke above the turbulent zone, increasing the height of the stack is preferable to employing a high stack velocity ; an effective value for the ratio stack height/height of fiddley is about 1·75. The diameter of the top of the stack should be kept as small as possible so as to reduce the unused area to a minimum, since the larger the diameter of the outer funnel, the greater is the downdraught. It is suggested that previous standards of 10-20 ft./sec. for gas exit velocities from stacks should be doubled, and that with air-encased water-tube boilers stack velocities of up to 150 ft./sec. may be required.

Launching Notes. STEELE, J. E. *Marine Engineering and Shipping Review (New York)*, 51 (1946), pp. 123 and 87 (September and October).

Launching operations at the yard of the Consolidated Steel Corporation at Orange, Texas, U.S.A., are described ; vessels are launched into a river.

End-launching of destroyers. Thirty-one destroyers and thirty-five destroyer escorts were launched in this way. The destroyers had dimensions 369 ft. × 39·3 ft. × 22·7 ft. ; the destroyer escorts were smaller, but their dimensions are not given. Three building ways were laid down, each consisting of a reinforced concrete slab 400 ft. × 120 ft. with a declivity of $\frac{5}{8}$ in. per foot, making it possible to build two ships side by side on each way ; the declivity of the ground ways was increased to 11/16 in. per foot. The sliding ways, each in three hinged sections, were 310 ft. long for the destroyers. The fore and after poppets, releasing device, and checking devices are described. As the river is narrow, the ship had to be stopped quickly ; this was accomplished by locking and bracing the propellers, by attaching a timber mask to the propeller struts, and by using two 10 in. manila ropes for final stopping. Later launchings employed a welded steel fore poppet.

Side-launching of destroyers. Eight destroyers and fifty-eight destroyer escorts were launched in this manner. A continuous length of side-launching ways was built, 1,000 ft. long and 49 ft. wide, on which two destroyers or three destroyer escorts were accommodated end to end. A similar continuous building way was constructed inboard of the launching ways and gantry track. Fifteen fir-timber ground ways, with a declivity of $1\frac{1}{2}$ in. per foot, were used for side-launching. The sliding ways and cradles and the releasing and starting operations are described.

Model experiments. A large number of destroyer escorts had been successfully side-launched before it was decided to side-launch destroyers, and, as it was not certain that the same arrangements would be suitable, model experiments on destroyers were carried out. The effects of declivity, velocity of ship at end of ways, drop-off at end of ways, metacentric height, and displacement, on the safety of launching were investigated.

Other subjects which are briefly discussed include the transfer of destroyers from the building ways to the launching ways, the end-launching of LCI(L), checking of hull stresses, bending of bilge keels, crushing strips, and the greasing of underwater ground ways.

Aluminium Alloys in Shipbuilding. West, E. G. *Syren and Shipping*, **202** (1947), p. 41 (1st January).

The advantages of aluminium alloys for marine purposes are : low weight (about one-third that of steel) ; freedom from rusting and high resistance to marine corrosion, due to a passive film of aluminium oxide ; ready formability by all the metal-working processes, in particular by extrusion ; a modulus of elasticity about one-third that of steel which, although a disadvantage in some ways, reduces stress concentrations at joints of dissimilar metals in composite structures ; high electrical and thermal conductivity, making it particularly suitable for bus-bars ; a pleasing appearance for decorative features, resulting from various methods of surface treatment ; and ultimate strengths approaching 40 tons/sq. in. in certain cases.

Although ideas to the contrary are widespread, aluminium and its alloys possess greater inherent resistance to sea-water corrosion than ferrous materials, excepting stainless steels. Wrought alloys recommended for marine conditions include those containing about 3·5% Mg., about 5% Mg., and Alclad materials. Cast alloys specially resistant to sea-water attack are those containing 3-5% Mg., 9-11% Mg., and 10-12% Si. The electrolytic action between mild steel and aluminium is small. Aluminium is much better than steel respecting its resistance to corrosion in the holds of oil tankers, and may prove useful for lining fish-holds and refrigerated chambers. Other applications include aluminium-alloy lifeboats and the superstructures of large vessels ; some examples are discussed.

All-Aluminium Ships for Bauxite. *Shipbuilding and Shipping Record,* **69** (1947), p. 51 (9th January).

An American firm is planning the construction of two all-aluminium shallow-draught ships to carry bauxite ore from Dutch Guiana to Trinidad. The use of aluminium throughout will save nearly 50% in the hull weight. One ship will have dimensions 422 ft. × 60 ft. × 20 ft. maximum draught, with displacement and cargo carrying capacity of 10,300 and 8,150 tons respectively, and the other will be 348 ft. × 54 ft. × 19 ft. maximum draught, with displacement and cargo carrying capacity of 6,700 and 5,100 tons respectively. Both ships will have air-conditioned passenger and crew accommodation.

Arc Welding and Cutting Under Water. MILLS, L. *Transactions Institute of Welding,* **9** (1946), pp. 128 and 156 (August and October).

Unless there is a combination of good conditions of depth, flow of current, footing, visibility and temperature, successful underwater arc-welding is difficult. The Author favours training a skilled welder to dive rather than a skilled diver to weld. Ordinary flux-coated electrodes, even when varnished, show signs of leakage after a few hours' immersion. The Peillon process, using special electrodes and electrode holders so designed as to be completely watertight, is more efficient ; rubber sleeves and washers are employed, and the electrode consists of a metal core and three coatings. D.C. or A.C. may be used for underwater welding, but D.C. from a constant-voltage Diesel generator with an output of 400 amps. at 50-80 volts is preferable.

Some details of equipment and techniques are given. The arc must be struck in exactly the right place so as to maintain the bubble formed in a state of equilibrium, as this ensures correct deposition. The technique of underwater welding is very similar to that of surface welding, but it is recommended that the current be increased by 20% for a similar size of electrode ; suggested current settings are given. Overhead welding presents the biggest problem as far as positioning of the welder is concerned. Owing to the intense cooling influence of the water upon the welding zone, deformation and shrinking stresses are reduced, but on closer examination it will be seen that the rapid chilling effect reduces the grain size and the heat-affected zone. Some test results with single-Vee underwater butt welds are discussed.

For underwater cutting, the oxy-hydrogen and oxy-carbon arc processes are the most efficient and economical ; unlike surface cutting, continuous pre-heating is required. A typical oxy-hydrogen cutting blowpipe has three concentric nozzles : the cutting nozzle (innermost), the heating nozzle, and the compressed air nozzle. The latter is required to shield the flame and localise the heat.

Hydrogen as a pre-heating fuel has no depth limitations, such as acetylene has, and gives a more stable, but cooler, flame than acetylene. Gas pressures are much higher than those employed with surface cutting. Ignition apparatus for underwater use is usual. Equipment used in this process and in the oxy-carbon arc process is described.

German Gas Welding and Cutting Industry. *C.I.O.S., File No. XXXIII*—49, *Items No.* 18 and 21.

This report consists of information regarding German gas welding and cutting, of interest in the design of fighting vehicles, which was obtained by the British Tank Welding Mission ; visits were made to eight works.

In Britain, most flame-cutting machines are of the elbow-arm type working over a limited radius. All the German machines are of the type having a carriage running longitudinally on rails mounted on a table ; this carriage carries a cross slide on the end of which is mounted the cutting head. This type of machine will cut over a far greater area than the elbow-arm type, and permits the cutting of bevels in any direction without moving the plate. Although each machine occupies more space than British types, less time is taken in moving plates. Shops were well laid out, the machines were on good foundations, and substantial structures for supporting the work were provided.

Nozzles and jets were of the standard annular type, similar to pre-war designs. The average quality of work was not up to the standard attained in Great Britain. There were no specific data for guidance in cutting armour, pressures and speeds being based on mild-steel cutting. Plates were not descaled prior to cutting ; starting holes were pierced either with the machine burner or manual burner. In the manufacture and design of oxy-acetylene equipment there was no radical change from pre-war equipment. Evidence of the shortage of copper was noticeable in both welding and cutting equipment, steel tubes being used for welding and cutting blowpipes.

The above is a general summary of the information obtained. Details of the equipment found at the various factories are given under separate headings. There are some illustrations of various machines and components.

Development of Steam Turbines for Main Propulsion of High-Powered Combatant Ships. WARREN, G. B. *Transactions Society of Naval Architects and Marine Engineers (New York), paper read 14th November*, 1946.

The paper describes the development by the American G.E.C. of main propulsion steam turbine plants for battleships, aircraft carriers, cruisers, and destroyers for the U.S. Navy. The first designs were for a rating of 42,000 h.p. per vessel at 385 lb./sq. in. pressure and 620°F. with the possibility, without modifications to superheaters and turbines, of 52,000 h.p. at 375 lb./sq. in. and 825°F. A cruising turbine arrangement was chosen for these designs, the speed being 10,500 r.p.m. In accordance with power station practice, the condenser was placed under the low-pressure turbine with the exhaust opening underneath. The lower half of the low-pressure turbine was constructed as a girder.

This basic design was modified and improved subsequently after careful tests in the laboratory and at sea. The experiments revealed difficulties when running astern, so it was decided to provide in future two astern turbines, one at each end of the low-pressure turbine.

For battleships, the pressure was further increased to 600 lb./sq. in. at a temperature of 825°F. at the boiler drum, and to 525 to 550 lb./sq. in. at the turbines. It was also found in practice that higher-speed vessels gained much more from the use of cruising turbines than the slower ships like battleships and cruisers. Cruising turbines were therefore omitted in most of these larger ships. Control of the high-pressure turbines was effected directly by a handwheel operating self-locking worms of relatively high efficiency.

Similar improvements were carried out in the engine sets for cruisers, aircraft carriers, and destroyers. Generally, a standardization of turbine sizes and parts was achieved. The ratings were reduced to four sizes : 25,000, 30,000, 37,500, and 53,000 h.p. respectively.

Extensive tests on these new designs are described. There is also a discussion of the design of turbine casings, joints and boltings, diaphragms and nozzles, packings, valves, and astern turbines. Difficulties encountered in service are enumerated, and the remedies adopted are described.

Some space is devoted to studies on astern operation, and on the temperature in high-pressure wheels of H.P. turbines when running at maximum speed ahead and astern. The paper concludes with remarks on the sticking of valve stems, vibrations and their prevention, and on the failure of bearings. A programme of manufacturing and of future improvements is included.

Gas Turbine Development in 1946. *The Engineer*, **183** (1947), pp. 12, 53, 77, 97, and 119 (3rd, 10th, 17th, 24th and 31st January).

The progress made by different firms in the design and construction of gas turbines during 1946 is outlined. C. A. Parsons & Co. built a 500-h.p. 6,000-r.p.m. experimental unit, which is being employed for studying combustion processes. John Brown are constructing a 500-h.p. open-cycle impulse unit from a design prepared by PAMETRADA, which, among other activities, is carrying out experimental work on gas turbines. Many orders for gas turbines were placed with Brown Boveri in Switzerland, and others were completed ; the latter include a 4,000-h.p. locomotive installation and a 10,000 kW. gas turbine plant for Rumania, and the former two plants for service in Iran to run on natural gas. Again in Switzerland, Sulzer Bros. have developed a semi-closed gas turbine cycle ; a 7,000-9,000 s.h.p. unit of this type, specially designed for marine use, is nearing completion. Another important order placed with Brown Boveri is for a 40,000 kW. gas-turbine power station for use in Switzerland ; it will consist of two units, one of 13,000 kW. and the other of 27,000 kW., which will burn furnace oil and drive three-phase 50-cycle alternators. At Zürich, a 12,500 kW. closed-cycle gas-turbine plant is being constructed by Escher-Wyss ; it will have four compressors and two turbines. British Thomson-Houston are building a 1,200-h.p. open-cycle unit, with an axial-flow compressor and two turbines, which will be installed in an oil-tanker as part of the main propelling machinery. For larger powers, this firm is developing a more efficient cycle embodying two-stage combustion, compression, and expansion. During 1946, Metropolitan-Vickers constructed a ducted fan augmenter for use with jet-propulsion aircraft engines ; they are also building a 2,500 h.p. gas-turbine electric locomotive, employing an open cycle and axial compression. The Oerlikon works in Zürich completed a 1,000 kW. three-stage compression two-stage expansion experimental gas turbine unit during 1946; the compressor, of novel design, is radial-flow and employs intercooling. One of the most important American gas turbines of the year is the 3,500-h.p. Allis-Chalmers plant, still under test at the U.S. Navy's experimental station. The Elliott Co. and the Westinghouse Electric Corporation have also built experimental units. Several gas turbines for locomotives were designed during the year ; one design utilised electric transmission, in another the turbine was geared to the axles. Coal-fired gas turbines are in the experimental stage.

Coal-Burning Gas Turbine. *Marine Engineering and Shipping Review* (*New York*), **51** (1946), p. 103 (December).

In November 1946, at a meeting in New York sponsored by the manufacturers, a coal-burning gas-turbine, which should be ready to undergo trials early in 1948, was described and discussed ; a summary of the discussion at the meeting is given here.

Although intended for locomotive drive, the turbine should be suitable for other applications as well. It is a 3,750-h.p. unit operating at 5,600 r.p.m. on a simple open cycle, and consists of an axial-flow compressor, regenerator, six-stage reaction turbine, and combustion system. The D.C. generator, driven through reduction gearing, consists of two shafts arranged in parallel with two armatures on each shaft rotating at 1,350 r.p.m. The temperature of the gases leaving the combustor is 1,300°F., and those parts of the turbine exposed to them are of chrome-nickel-cobalt alloy steel. The air leaves the compressor at a pressure of 73 lb./sq. in. absolute. The thermal efficiency of this gas turbine, based on 1,300°F. turbine-inlet temperature and 80°F. air-inlet temperature, is 24-25%. In terms of comparative fuel costs in the U.S.A., a coal-burning gas turbine of this efficiency is more economical than steam and Diesel engines ; further advantages are negligible lubricating costs, and probably lower maintenance as compared with Diesel engines. The development of suitable coal-burning equipment caused considerable difficulty, the problems of fly-ash elimination and pulverisation being the most important.

German Wartime Technical Developments. SCHADE, H. A., Commodore, U.S.N. *Society of Naval Architects and Marine Engineers (New York), paper read at Annual Meeting, 14th November*, 1946.

A general description is given of certain selected items in Germany which have been reported by the U.S. Naval Technical Mission in Europe. The author's remarks fall under the following headings :—

Submarines. The Type VIIC submarine, of conventional design, was built in large numbers during the war. Of the revolutionary Type XXI, 119 were completed, but none went out on war service. This type was designed as a highly-manoeuvrable high-speed vessel, which could remain submerged for long periods and operate at greater depths than most submarines. The submerged speed was 18 knots, and the surface speed 16 knots with superchargers and somewhat less without them ; back pressure in the Schnorchel (breathing-tube) prevented the engines from attaining their rated capacity, so the superchargers were removed as the Schnorchel was indispensable. Trouble with the hydraulic system, which was far more extensive than is usual in submarines, was a major defect of Type XXI. These vessels, about 250 ft. long and with all-welded hulls, were prefabricated in nine sections which were welded together.

Surface Vessels. The all-welded triple-screw battleships *Bismarck* and *Tirpitz* were 821 ft. long, had load displacements of 52,700 tons, and were propelled at 30 knots by three sets of geared-turbine machinery totalling 150,000 s.h.p. A design known as battleship " H " was developed, and construction was started, but plans were changed frequently. Originally 910 ft. long, 56,400 tons displacement, and 30 knots on three shafts, each having four Diesels of 12,500 s.h.p. per engine, the ultimate design was 1,132 ft. long, 141,500 tons displacement, and 30 knots on four shafts, two with four Diesels each totalling 60,000 s.h.p. per shaft, and two shafts each with geared turbines of 80,000 s.h.p. per shaft. The *Prinz Eugen*, 692 ft. long with a load displacement of 19,500 tons and a speed of 32.5 knots, was fitted with anti-rolling tanks, and was propelled by three geared-turbine sets. The S-38, a Diesel-propelled wooden-hulled 45-knot torpedo boat, had special side rudders for decreasing the required power at high speeds.

Turbines and Gears. In general, the German turbine propulsion equipment was inferior to similar American machinery. The policy of using single reduction gearing with three or four pinions meshing with the main gear resulted in low turbine speeds and high specific weights. Turbine design and manufacture were mediocre, and there was poor utilisation of energy in the heat cycle ; the steam conditions should have produced high propulsion efficiencies. Some specific plants are discussed.

Diesel Engines. The six-cylinder and twenty-four cylinder M.A.N. were well-developed and reliable. The Daimler-Benz Model MB 511 is an outstanding four-cycle supercharged lightweight Diesel for naval craft ; on a continuous rating of 1,980 b.h.p. at 1,480 r.p.m., the bare engine weight is 4.4 lb./b.h.p.

The Hamburg Model Basin. A large variable-pressure cavitation water tunnel and a smaller tunnel were constructed, but were completed too late to be used. A new towing carriage, an extended towing basin, and a new manoeuvring basin were under construction.

An appendix lists the relevant Naval Technical Mission Reports.

Marine Auxiliaries Driven by A.C. Supply. PORTER, A. *Transactions of Institute of Marine Engineers, paper read 10th December*, 1946.

The use of A.C. supply for operating auxiliaries, lighting and heating on ships has been visualised for some time by the Classification Societies for all types of ships, and rules have been formulated for its application for all duties. The change from D.C. to A.C. motors does not necessitate any radical changes in the types of auxiliaries, but the use of A.C. motors in general means that the auxiliaries must be run at a definite speed range, as reduced speeds can only be arranged by a sacrifice of efficiency, except in cases where pole-changing motors can be used.

Of the types of A.C. motors available, induction motors are most widely used. They are either of the squirrel-cage or slip-ring type. The paper gives a graphical representation of the performance characteristics and starting conditions of both, and the advantages and disadvantages of induction motors in general are enumerated. Methods of starting are given consideration.

The A.C. supply can be provided by Diesel or turbo-driven alternators in exactly the same way as D.C. Alternatively, in Diesel-electric or turbo-electric vessels the auxiliary power may be taken from the main propulsion circuit while the ship is at sea. Particulars are given of four such ships, built in Great Britain, America, and Germany ; and there is a discussion of the performance of pumps, fans, compressors, separators, refrigerating installations, and electro-hydraulic steering gear under different service conditions. A table gives details of the various auxiliaries likely to be fitted in modern ships, as well as of the type of motor and method of starting likely to be used.

Winches and windlasses are difficult to convert to A.C., but such machines are being made on the Continent. Lighting and heating circuits for both methods of supply are considered.

Developing the Air Compressor. BELYAVIN, P. *Oil Engine*, 14 (1947), p. 298 (January).

The article is concerned mainly with the improvement of the efficiency of reciprocating compressors for Diesel engines and gas turbines. There is also a brief review of the development of rotary compressors which, in the Author's opinion, are not likely to be further improved in the near future.

It is demonstrated in a set of diagrams that, whereas an increase in the clearance volume of a reciprocating compressor causes little loss of power, an increase in valve resistance from 0·5 lb./sq. in. to 2 lb./sq. in. nearly doubles it. Valve resistance appears therefore to be the most important single factor affecting the efficiency of Diesels. Similarly, the efficiency of the compressor of a gas turbine determines the useful output of the latter, as the compressor absorbs about 75% of the total power developed by the turbine.

In order to improve the overall efficiency, the author suggests a combination of gas turbine and reciprocating compressor, and illustrates this with further diagrams.

The article mentions also some practical applications of the Circoflex valve, which is stated to have been successful.

Some Notes from the interview of Mr. Berendt of Blohm and Voss on the Blohm and Voss System of Oil Burning in Marine Boilers and an Ignition Starter for Cold Boiler Starting. *J.I.O.A., Final Report No.* 70.

The Blohm and Voss oil-burning system, developed for automatic control, uses pressure-atomising burners, supplied with fuel at a steady pressure of 35 atmospheres. The system is controlled by automatically cutting out some burners when less steam is required. At least one burner in each combustion chamber must be left burning, to ignite the others when they are again supplied with fuel. During long " low load " periods the burners not being used should be removed, or they will be damaged by tip carbonisation, due to prolonged exposure to the high temperature without oil flowing through them.

The ignition for cold boiler starting cannot be strictly regarded as automatic, since it depends on the use of an electrically ignited cartridge placed near the tip of the first burner in the combustion chamber. When oil fuel is fed to this burner, the pressure closes a switch in the cartridge circuit.

The system was only installed in warships.

Mr. Berendt appeared to be of the opinion that the rotary atomising Saacke system is superior to the Blohm and Voss system.

The Pametrada Research Station. *Engineering*, 162 (1946), p. 559 (13th December), and *Shipbuilding and Shipping Record*, 68 (1946), p. 657 (12th December).

During the past year this Association has made considerable progress in the construction of buildings for the full-scale testing of marine machinery. The steel-framed office and research building, the foundations of which were laid in July, 1945, was completed in August, 1946. The boiler-house, constructed so as to be capable of withstanding an internal pressure of 30 in. water gauge, is virtually complete, and the boiler, working at 1,200 lb./sq. in. and 950° F. outlet steam temperature, has been installed. The turbine test house is well advanced, and the 75-foot test bed is capable of taking upward and downward reactions of 80 tons on any 2-foot length of the surface ; a 75-ton overhead-travelling crane is installed, and a 60,000 h.p. hydraulic dynamometer is on the premises awaiting erection. Construction of further buildings has been started.

During the year, many enquiries were received, and over 120 preliminary designs of turbines and gearing were prepared. Research work carried out so far includes a photo-elastic stress analysis of some straddle-root forms of turbine blading, and steaming tests over a range of ratios of blade speeds to steam speeds. Heavy-oil sprayers for gas turbines are being investigated.

Shipbuilding and Marine Engineering in 1946. *The Engineer*, **183** (1947), pp. 22, 51, 71 and 94 (3rd, 10th, 17th and 24th January).

During 1946, about 1,000,000 gross tons of merchant ships were completed in British yards, and many vessels were reconditioned for peace-time services. Available shipbuilding capacity is one-third greater than in 1939, and 1947 production is expected to exceed that of 1946. More than 1,000 ships, totalling over 3,000,000 tons gross, were on order or under construction at the end of 1946 ; 25-30% of this comprises foreign orders. The first annual report of B.S.R.A. appeared early in August, and in the same month the offices of PAMETRADA were opened. Important ships of the year include the reconditioned *Queen Elizabeth*, the passenger vessel *America*, the C.P.R. Co.'s four Beaver class cargo ships, the passenger liner *Hinemoa*, the whale factory ship *Balaena*, the turbo-electric tanker *Helicina*, the tanker *Auricula*, and cross-Channel vessels such as the *King Orry* ; all these ships are briefly described. Many standard reciprocating steam engines were manufactured, and so were steam turbines and Diesel engines, particularly those of the Doxford type ; particulars of the machinery manufactured by various firms are given. At the end of the year, Babcock and Wilcox had on order boilers for about 90 ships, and many Foster-Wheeler and Yarrow boilers were also being built. During 1946, several Lobnitz pressure-lubricated steam reciprocating engines were built ; this new type of engine, which is briefly described, is a multi-expansion totally-enclosed unit of welded design.