# ENGINEERING ABSTRACTS

Section 3. Shipbuilding and Marine Engineering

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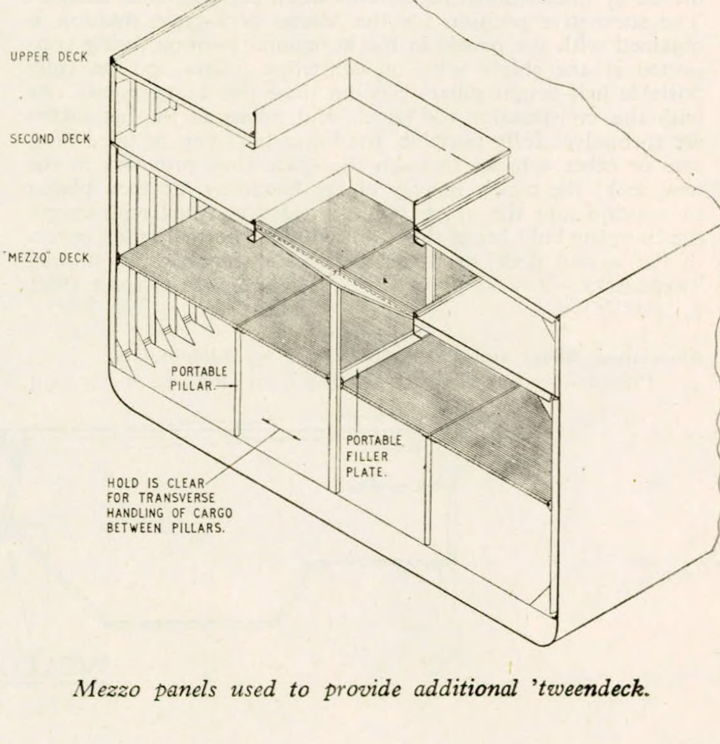
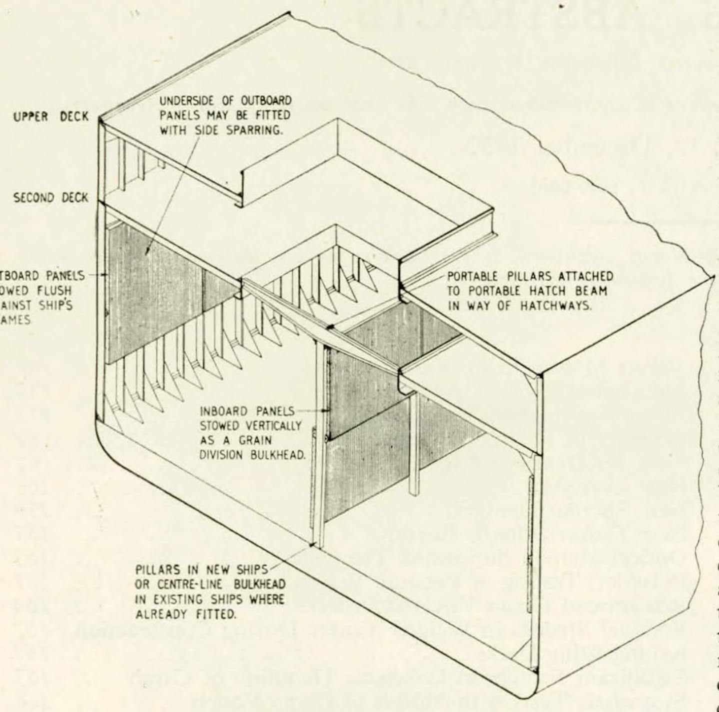
### The Mezzo-deck Grain Division

The Mezzo-deck grain division is a recent British invention which makes it possible to convert an ordinary tramp or general cargo steamship at moderate cost into a dual-purpose vessel which is equally suitable for the carriage of bulk dry cargo such as grain, or parcel cargo, such as motor cars, etc. The normal tramp ship has a series of deep holds, usually divided by a centreline bulkhead with wooden temporary bulkheads along the spaces under the hatchways, and has either no 'tweendeck space or, at most, one tier of 'tweendecks. This design is well suited for the carriage of export bulk cargoes, like coal, outward and import bulk cargoes, like grain, homeward. Unfortunately, deep holds are not suitable for carrying parcel cargoes, that is, units of manufactured goods, and if a coal cargo outward is not available, only parcels which can be stacked one upon the other can be stowed in the holds. Thus when, for example, cars are carried in deep holds, they must be boxed in strong and expensive wooden cases. When neither bulk cargoes or cased goods are available for outward trips, ships of this type have to travel in ballast which means that the freight on the return trip must pay for the whole voyage. The need now therefore is for a new type of cargo ship, capable of carrying either bulk or parcel goods and bulk cargoes homeward.. It is claimed that this need, to a large extent, is met by the use of the Mezzo-deck grain division. As for the carriage of grain cargoes, these ships must in any case have some form of centreline bulkhead to prevent the grain moving, the technique has been to make use of this division to form a deck whenever it is required to carry parcel cargoes. The Mezzo deck consists of hinged or portable panels whose dimensions are determined by the breadth of the ship and to some extent




*Mezzo panels used to provide additional 'tweendeck.*




*Mezzo panels used to form centreline division.*

by the depths of the holds and the required depth of the additional 'tweendeck space. They may be either fixed panels which hinge on to the bulkhead or deck positions in a few moments, or fully portable panels which can be stowed in any part of the ship when not in use. Panels which are always in place forming either a deck or a bulkhead, according to need, have certain advantages, and this is the system shown in the accompanying diagrams. It will be seen that the outboard panels hinge against the ship's framing when the hold is filled with a grain cargo. The inboard panels hinge against a row of widely-spaced pillars, on the centre line, forming the centreline division required by international regulations when carrying such cargoes. The alternative position for the Mezzo deck-grain division is obtained with the panels in the horizontal position, being supported at the ship's sides on centreline pillars and on fully portable half-height pillars between these two hinge points. As with this construction the panels and pillars in the hatchways are themselves fully portable, the lower hold can be filled with cars or other vehicles through the space thus provided in the new deck; the panels in way of the hatchway are then placed in position and the upper hold can also be filled with cargo, the complete hold being closed up with the normal hatch covers in the second deck, or upper deck in a ship without normal 'tweendecks.—*The Shipping World, Vol. 123, 4th October 1950, pp. 264 265.*

**Aluminium Alloys and Their Application to Shipbuilding**

Present-day knowledge regarding light alloys in so far as it applies to shipbuilding is summarized. Only aluminium-base alloys are considered, although some information on available magnesium-base alloys is given in an appendix. It does not appear, however, that the magnesium-base alloys will be of much use in marine work. The available aluminium alloys are discussed generally and reference is made to their physical and mechanical properties. The alloys are mainly of two kinds: those whose strength is increased by cold working, and those whose strength is increased by heat treatment. In the former are the alloys containing small percentages of magnesium and the latter include the duralumin type alloys. The most suitable for shipbuilding purposes appear to be non-heat-treatable alloys containing 3½ per cent and 5 per cent magnesium known as A.W.5 and A.W.6 and a heat-treatable alloy containing silicon known as A.W.10. These are medium strength alloys with minimum ultimate strengths ranging from 14 to 20 tons per sq. in. and have very high resistance to marine corrosion. Stronger alloys of the duralumin type are available, but are not considered suitable for marine work in view of their reduced corrosion resistance. Corrosion and fouling are discussed. With regard to the latter the usual anti-fouling compositions used on steel ships are unsuitable as the mercury and copper compounds attack the alloys. The development of suitable compounds is being pursued and preliminary work suggests that a satisfactory solution will be found. Painting and surface treatment are dealt with; this differs from the treatment given to steel plates and details of various processes are given. With regard to the joining of light alloys riveting appears to be the only practical proposition at the moment although the practical development of arc welding is being pursued. Possible immediate applications to shipbuilding are suggested such as: superstructures, lifeboats and davits, masts and derricks, minor bulkheads, hatch covers, etc. Problems requiring further study are discussed and suggestions put forward for future investigations. Principal among these are: strength and watertightness of riveted joints in thick plates, arc welding, temperature effect in composite steel-aluminium structures due to differential expansion, etc. Work on most of these is already under way.—*W. Muckle, The British Shipbuilding Research Association, Report No. 22, November 1948.*

**Anticipated Distortion by Welding**

In a lecture given on the occasion of a joint meeting of the Bedford Scientific and Engineering Society and the North London Branch of the Institute of Welding at the works of W. H. Allen, Sons & Co., Ltd., Mr. J. E. Willey dealt with the application of electric welding in general engineering. He pointed out the difficulties that may occur in the fabrication of any design can be foreseen only by experience, when the necessary precautions can be taken. The condenser end cover shown in Fig. 9 provides an example. It was appreciated that the pull exerted by the contraction of the cooling weld metal at the rectangular flange would be so great that severe distortion must inevitably occur. To avoid this, before putting down weld "A", the frame was bent ⅜in. at both ends from its true position, as indicated by the dotted lines. After weld "A", which was the last welding operation, the flange was perfectly flat and within machining limits. By this method of controlling distortion by pre-setting, machining limits can be kept

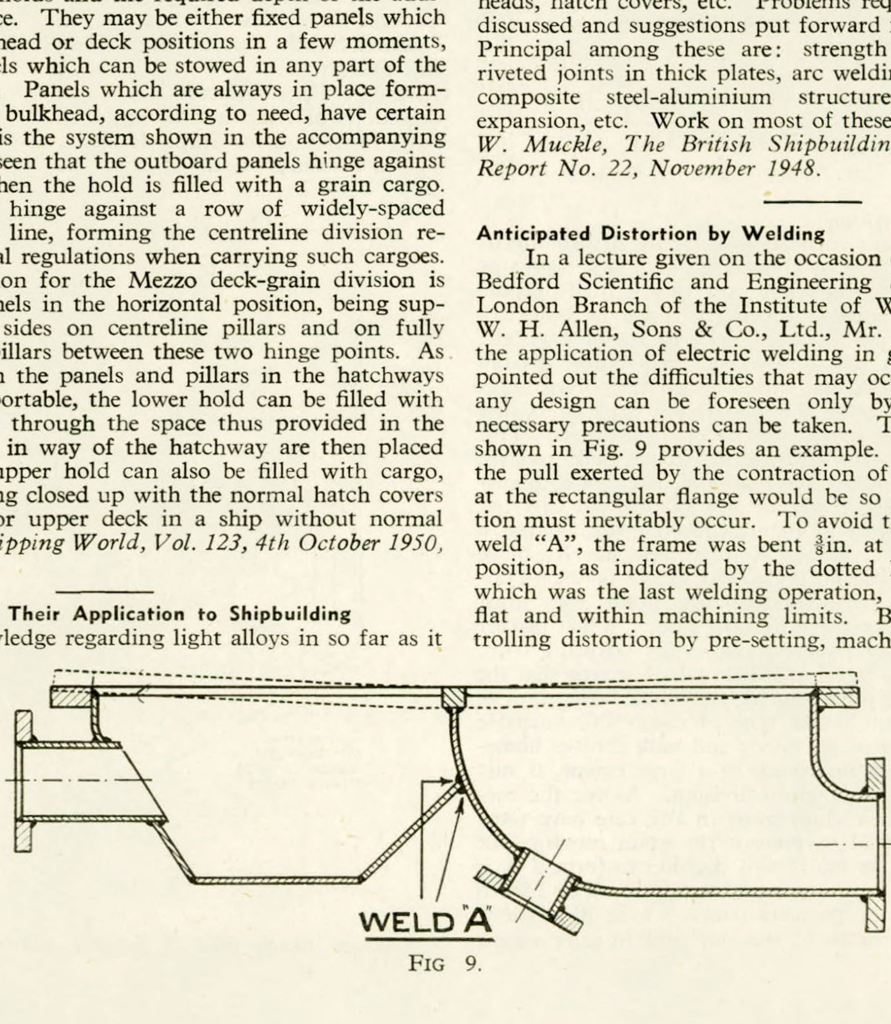



FIG 9.

down to a minimum and considerable time saved in flattening. All welded structures invariably contain internal or "locked-up" stresses, due partly to preliminary bending and partly to welding. Considerable difficulties may thus arise in machining, the release of these stresses permitting further distortion to occur, so that the part may have to be re-machined, or even, in extreme cases, may become unusable; in such instances the fabricated structure should be given a stress-relieving treatment. There are, of course, other reasons that arise from machining considerations for the stress-relieving of fabricated structures. Distortion may occur, for example, in service, if the part is used at high temperature, as with a steam engine piston working with superheated steam. Stress-relieving at a temperature higher than any possible service temperature ensures prior distortion which is corrected by machining, the possibility of distortion in service being thus prevented. It is obvious that jigs and fixtures must always be stress-relieved.—*Welding, Vol. 18, September 1950, pp. 391-398.*

**Welded Pressure Vessels**

It is easy for designers of welded pressure vessels to go wrong by assuming that steels are unaffected by fabrication, low temperature and restraint; that strains are only elastic and that stress throughout the vessel is uniform and equal to the nominal stress which is the number substituted in the design formula to arrive at the shell thickness. Actually all cold-forming operations raise the yield point closer to the ultimate strength; welding generally reduces the toughness of the heat-affected metal and always locks up a lot of stress in the joints; and even the most ductile material, according to measurements on un-notched laboratory specimens tested at room temperature, fails brittlely under conditions of low temperature or restraint preventing plastic flow. It is a mistake to assume that each cubic inch of metal in the shell of a pressure vessel behaves under service conditions exactly as each cubic inch of metal near the middle cross-section of a conventional tensile-test specimen behaves in the laboratory. Notches, of which cracks are the extreme example, exist in all welded structures due to faulty materials, design or workmanship. The presence of these notches explains why occasional failures occur under moderate loads. A notch may result in a crack which, under some conditions of residual stress in, and general loading of, the vessel, relieves the local high stresses and stops, but which, under other general stress and loading conditions, may aggravate the local stress intensity, wipe out the so-called "factor of safety", and result in a general failure. Obviously, what is needed to assure safety is one of the following conditions: (1) materials, design and fabrication so perfect that there are no notches in the vessel either geometrical or metallurgical; (2) materials so tough that sufficient local plastic straining can occur at each notch, no matter how sharp, to prevent the formation of a new crack; (3) neither of the idealized conditions (1) or (2), but a combination of conditions approaching them both such that cracks starting at notches will relieve the local stresses and then stop. Condition (3) is that of most pressure vessels. No vessel is perfect, and very few vessels fail in a big way, yet cracks are not uncommon during fabrication, under test and less often in service.—*H. C. Boardman, Welding Research Supplement, The Welding Journal, Vol. 29, September 1950, pp. 422-s-432-s.*

**Ductility of Arc Welds in Mild Steel**

It has long been realized that the ductility of an arc weld in mild steel is influenced by the rate at which the cooling weld traverses temperatures in the region of 1,000 deg. F. Such "elevated-temperature" cooling rates are believed to affect the nature of the austenite transformation and their influence has been widely studied. While less attention has been given to the possibility that ductility may also be affected by the rate at which the weld cools through lower temperatures, there have been indications that these "low-temperature rates" may also be significant. Recent investigations show that weld ductility is strongly affected by the rate of cooling even at temperatures well below 400 deg. F. and they suggest that this influence is one of considerable practical importance. They show also that the hydrogen content of the weld is, in part at least, responsible for the phenomenon. The present evidence does not exclude the possibility that other factors, such as the retention of austenite or the precipitation of nitrides or carbides, may also be involved. Nor is the role of thermal stress clear.—*A. E. Flanigan, S. T. Bocarsky and G. B. McGuire, Welding Research Supplement, The Welding Journal, Vol. 29, September 1950, pp. 459-s-466-s.*

**Explosion of Empty Diesel-oil Fuel Tank**

The vapours of petrol, when mixed with the proper proportion of air, are highly explosive, a fact which is known to most men whose work requires them to handle this fuel. In some quarters, however, there seems to be an impression that the vapours of Diesel oil are not dangerous. This is a fallacy which, in one recent casualty, caused the death of a workman who was attempting to weld a leak in a Diesel-oil tank. As regards the explosive qualities of Diesel-oil vapours, these are of approximately the same order as those of petrol. The reason that Diesel oil is safer to handle than petrol is that it is not as volatile. Consequently the liquid does not evaporate as readily, and, therefore, at any given temperature, petrol will evolve a greater quantity of fumes than Diesel oil. When, however, due to heat or other circumstances, Diesel oil has evaporated, its vapours are as dangerous as those of petrol and have only to be mixed with the correct proportion of air to form a combination merely awaiting a source of ignition to explode. In the case referred to, an uninspected fishing vessel, powered with Diesel motors, developed a leak in one of its fuel tanks. A welder was sent for to repair the leak. As preparation for his operations, the tank was emptied of all fuel, but no attempt was made to gas-free it. The welder, who was equipped with a petrol torch for welding the tank, seated himself on a stool at the end of the tank and prepared to weld the defective seam. Shortly after the work was begun an explosion occurred which knocked a nearby crew member down without injuring him to any extent and threw the welder against a column in the vessel, fracturing his skull A fire ensured and due to the heat, gas, and smoke, the compartment containing the tanks could not be entered until the arrival of the town fire department approximately 10 or 15 minutes later, at which time firemen with gas masks extricated the welder from the tank room, placed him in an ambulance, and rushed him to the local hospital where he died approximately 10 hours later. The lesson from this casualty is obvious—no tank which has contained oil fuel, even Bunker C, should be worked on with a welding torch until it has been gas-freed.—*Marine Engineering and Shipping Review, Vol. 55, September 1950, p. 80.*

**New Suction Dredger**

The M.S. *Sandpiper* is a new suction dredger, which has recently been completed by Canadian Vickers Ltd., Montreal, for the Creole Petroleum Corporation of New York. Designed by the marine department of the Standard Oil Co. of New Jersey, this new vessel is of the most modern type for a specialized service and her equipment, controls and recording instruments are most complete. She is what is known as a trailer suction dredger and is equipped with her own hopper spaces for carrying the dredged materials to the dumping ground, thus being completely independent of any other craft during dredging operations. The principal particulars are as follows:—

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| Length overall | 250 feet |
| Breadth | 46 feet |
| Depth | 18 feet |
| Total hopper capacity | 1,076 cu. yds. |
| Maximum draught | 15 feet |
| Corresponding deadweight | 1,980 tons |
| Loaded trial speed | 11 knots |

Dredging is carried out by means of two 22-inch suction pipes, one on each side of the ship, which can be lowered down to the sea or river bottom. These pipes are connected to a large electrically driven hydraulic pump situated in the forward part of the ship and are supported by two davits on each side. When in operation, the dredge pump draws up a mixture of spoil and water and discharges this into the hoppers, where the spoil settles out and the excess water is drained off through specially designed overflows. When the vessel is moving ahead and dragging her suction pipes over the bottom, the shocks and stresses due to an uneven bottom may be very considerable and large spring-type shock absorbers are fitted to the davits to eliminate this. The vessel is provided with a total of eight hoppers, each having an independent door at its bottom operated by a hydraulic cylinder. This method enables all hopper doors to be opened simultaneously from a central control point or individually, as required. The recording instruments fitted on this vessel are in line with her modern equipment and include automatic devices to indicate the depth to which the ship is dredging, the fore and after draughts of the ship and an automatic recorder which gives, at any time, a permanent record of the depth to which the drag pipes have been submerged.—*Canadian Shipping and Marine Engineering News, Vol. 21, August 1950, pp. 25-26.*

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**Corrosion of Iron and Steel in Sea Water**

The results so far obtained in the course of the Corrosion Committee's work relating to the corrosion of structural irons and steels when immersed in sea water are presented and examined. The presence of mill scale on the iron or steel is shown to promote serious pitting in sea water. The rate of general corrosion of mild steel when immersed in British waters after removal of the mill scale is found to be approximately 3-5 mils per year. There is little, if any, difference in the corrosion rates, under these conditions, of ordinary unalloyed ferrous materials, such as mild steel, ingot iron, or wrought iron. Of a wide range of alloying elements incorporated in a series of low-alloy steels, only two, chromium and nickel, are shown to have any significant effect in reducing the corrosion rate. Steels containing 2-3 per cent of chromium were found to corrode at one-half or one-third of the rate of unalloyed steels of the same carbon content. The effect of nickel additions were less marked. No significant difference has been observed in the behaviour of ordinary and of copper-bearing steels when totally immersed in sea water.—*J. C. Hudson, Journal of the Iron and Steel Institute, Vol. 166, October 1950, pp. 123-136.*

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**Hot-dipped Aluminium Coatings on Steel Sheet**

Aluminium coatings formed on steel by hot dipping vary from ½ to approximately 3 mils (1 mil=0·001 inch) in thickness, possess good continuity, and a relatively thin interfacial layer. An American company is now using this method to produce "aluminized" steel sheet on a commercial basis. The process involves pre-heating the steel in a controlled atmosphere before it enters the aluminium bath. Other aluminium hot dip processes are similar to hot dip galvanizing, using a pickle followed by a molten flux, after which the steel enters the molten aluminium bath. To permit bending and forming of coated products, the brittle interfacial layer must be kept at minimum thickness. This can be accomplished by the addition of silicon to the aluminium coating bath. Temperature is another important factor in the coating bath, as an increase in temperature tends to increase the thickness of the interfacial layer.—*Mechanical World, Vol. 128, 29th September 1950, p. 303.*

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**Embrittlement of Weld Metal**

Mild steel metallic-arc welds are quite ductile when made with normal welding procedures designed to avoid excessive quenching effects. The rate of cooling of the weld, however, can be greatly intensified by the use of electrodes small in gauge relative to the mass of plate, thick plates, and cold atmospheric conditions. If the rate of cooling is such that the weld deposit reaches 100 deg. C. in less than one minute, very low ductility of the weld results. Such rates of cooling are similar to the highest rates met with in heat-treatment practice (*i.e.*, water-quenching of small sections). It is therefore of the utmost importance in welding practice that attention should be paid to the rate of cooling of the weld bead; where high cooling rates are expected and heat cannot be concentrated locally by such procedures as block welding, preheating up to 100 deg. C. is essential. These conditions occur infrequently, but will be present increasingly as fabrication by welding is extended to thicker plates. In underwater welding the difficulty cannot be completely overcome, and welds made under water cannot be expected to possess high ductility. In addition to the rate of cooling, factors affecting fissure formation are carbon, nitrogen, hydrogen, and alloy contents of the weld. Carbon and nitrogen exert most influence in steels by promoting thermal hardening. Once regions of the weld are reduced in ductility it is well known that hydrogen can intensify embrittlement and cause cracking. In multi-bead deposits each succeeding run will have a higher hydrogen content, owing to the migration of the gas from the ferrite to the austenite existing at an elevated temperature. A concentration will develop sufficient to cause fissuring. After such fissuring the next bead of weld metal is not usually fissured, and it is assumed that part of the hydrogen in the previous layer is fixed in or around the fissures. This process of concentration up to the point of fissuring can be repeated. When a fissured layer of weld metal is reheated by the nest bead, the hydrogen concentrated around the fissure will probably react with inclusions rich in iron oxide, to form water. The presence of molybdenum, chromium, and vanadium, in small quantities, reduces the number of fissures, but large amounts of these elements increase fissuring.—*E. C. Rollason, Journal of the Iron and Steel Institute, Vol. 166, October 1950, pp. 105-112.*

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**Hot Radiography**

With the process of hot radiography recently introduced in America, successful radiographs have been obtained, while the metal under examination was at 900 deg. F. temperature. It is not therefore necessary to wait until the metal cools down before it can be radiographed. It is thus possible to obtain radiographs during intermediate stages of welding without delays due to stress relieving and slow cooling. It is claimed that for this reason a better weld inspection together with a time saving is made possible.—*The Welding Journal, Vol. 29, September 1950, p. 788.*

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**Fatigue Strength of Joints**

A paper by K. H. Lenzen, published in the Bulletin of the American Railway Engineering Association, gives the results of tests conducted on three groups of structural joints, identical except for the fasteners, which were subjected to completely reversed fatigue loading. The fasteners were: (a) hot-driven rivets, (b) cold-driven rivets, and (c) high-tensile-strength bolts. The specimens represented double-strap butt-joints in ¾-inch thick steel plates with two ⅜-inch thick splice plates. The material conformed to ASTM specification A-7. The fasteners were ¾-inch diameter and the drilled holes were 13/16-inch diameter. The tension-shear-bearing ratios for the main series of tests were 1.00:0.57:0.89. The main purpose of the investigation was to determine the effect of the clamping force exerted by the fasteners on the fatigue strength of joints. Supplementary studies were made during the fatigue test of the slippage of a joint and of the reduction in the clamping force of bolts. Static tests were made to determine (a) tensile properties of the materials, (b) physical properties of the driven rivets, (c) initial tension in the rivets, (d) the torque-clamping force relation for the bolts, and (e) the effect of plate tension on the clamping force. The fatigue tests were made in the 250,000-lb. capacity structural-fatigue machine at Northwestern University, Evanston, Ill. The clamping stress developed in the cold-driven rivets was about 3,400lb. per sq. in., and that in the hot-driven rivets about 12,000 lb. per sq, in. The bolts were tightened so as to develop a minimum of 50,000lb. per sq. in. The fatigure strengths at 2 million cycles were ±17,200lb. sq. in. for the cold-driven rivets, hot-driven rivets, and bolts respectively. The decrease in clamping force in the bolted joints ranged from 0 to 18 per cent. No loosening of the nuts was noted. Static tests with one bolt and also with nine bolts indicated that the coefficient of friction was approximately 0.35. If sufficiently high clamping force is developed in the bolts, the fatigue failure may occur outside the joint. The crack may not go through holes filled with highly stressed bolts.—*Applied Mechanics Review, Vol. 3, September 1950; Abstract No. 1675.*

#### Individual Heating, Cooling and Ventilating Unit

A new heating, cooling and ventilating system has been developed by the technical department of the Broström Shipping Concern, Gothenburg, and the equipment has been installed in the motor ship *Hainin* owned by the Swedish East Asiatic Co. after tests had been made over a period of many months. An individual ventilating, heating or cooling unit is installed in each cabin or messroom. The circulating medium, water, is heated or cooled by a suitable plant in the engine-room and is led through pipes of small diameter to the units in the cabins. Each cabin has a separate inlet to provide the necessary fresh air, and this is mixed with the cabin air in the unit in the requisite proportion. The air is heated or cooled according to the temperature required before it is blown out into the cabin from the heating and ventilating unit. The proportion of the cabin air to the air drawn into the cabin from outside, also the degree of heating or cooling, can be adjusted on the unit within wide limits, and, if desired, it can be arranged to exhaust air from the cabin by suction. In the experimental units installed in cabins it was found that it was possible to maintain the temperature six or seven degrees C. lower than the outside temperature although a reduction of only two or three degrees was anticipated.—*The Motor Ship, Vol. 31, September 1950, p. 206.*

#### Thermal Insulation

A short survey of heat transfer data with particular reference to insulation problems is followed by an analysis of heat transmission through insulated steel-work forming refrigerated spaces, including a graph giving coefficients for various structures. A proposal is made for evaluating insulation thickness on an economic basis and suggestions are put forward for overcoming condensation and moisture penetration. Properties of insulation materials for both heat and refrigeration are discussed. The various methods of specifying insulation thickness for marine boiler and pipe work are analyzed and a chart gives economic thicknesses for temperatures up to 1,000 deg. F. Finally, recommended thicknesses of insulation for structural insulation are given, also a table giving temperature drop in ventilation ducts.—*Paper by G. Laing, read at a Meeting of The Institution of Engineers and Shipbuilders in Scotland, 24th October 1950.*

#### New Corrosion Test

An article by T. E. Lloyd in the September 1950 issue of the Journal of Metals, describes the alternate condensation method developed by Sam Tour and Co., New York, for testing corrosion resistance of a metal or the corrosion protection provided by a coating on a metal This appears to offer a technique more comparable to normal weather corrosion action than any yet devised. Unlike any of the generally used corrosion resistance testing methods, it uses a condensate rather than a dip method or a spray to effect the corrosive action on the metal. The apparatus consists of a turntable, upon which samples to be tested are mounted, and chambers or tunnels through which the turntable revolves so that the samples are exposed to the atmospheric conditions of each chamber. There is alternate exposure to saturated air at 160-170 deg. F. and air at 70 deg. F. with a relative humidity of 25 per cent. The method accelerates to about a 4 min. time cycle, the weathering action of a full day in any area where the day to night temperature gradient is sufficient to cause dewing. Other chambers can be added for the introduction of atmospheric contaminants such as sulphur dioxide and sulphuretted hydrogen.—*Light Metals Bulletin, The British Aluminium Company Ltd., Vol. 12, No. 21, 815.*

#### Ultrasonic Flaw Detector

At the recent International Convention on Ultrasonics at Rome, an ultrasonic flaw detector of Belgian make was demonstrated. The demonstration showed the detection of an air film by a straight-through transmission test on a laminated material. The equipment in question consists of three electrical units, together with quartz crystals for receiving and transmitting, each mounted in a test head or probe on the end of a long cable. In testing for flaws in laminated materials the probes are placed opposite each other with the sheet under test between them and, as is well-known, an air film of the order of 0·001 inch will cut down the strength of the mechanical wave being transmitted very markedly, provided that the lateral dimensions of the flaw are sufficient to give a "shadow" effect. In general an area of flaw of a few per cent of the beam area is sufficient for detection, when using a sensitive indicator. For this purpose the alternative means provided were a meter, a loud speaker and three lamps (good transmission, feeble and bad). Segregations can be revealed in certain circumstances and, by searching, holes of a fair size can be detected and their approximate position indicated. It appears that the equipment can be used for iron and steel castings as well as for forged and rolled metals and for certain laminated insulating materials.—*G Bradfield, Electronic Engineering, Vol. 22, September 1950, pp. 391-394.*

#### Gear Case Moisture Control

An article in *Marine News* describes the Marine Control Company's Dehydrator and Reactivator which, although designed for another purpose, has been used for drying the air in sumps and marine reduction-gear cases. The drying agent is silica gel. The first unit was fitted in the gear case of the tanker *Mobilight*, and, after a year's service, there was no evidence of corrosion or rust. Moreover, despite the coating of oil on its surface, the silica gel had lost very little of its effectiveness. The unit occupies a little more than 13 cubic feet of space.—*Journal, The British Shipbuilding Research Association, Vol 5, October 1950, Abstract No. 4125.*

#### Nested-type Reduction Gears

The advantage of the nested-type reduction gear is that for a given horse-power and similar turbine-propeller speeds it is a simpler reduction gear than the articulated reduction gear. Specifically the nested gear has fewer bearings with a decrease in friction losses; it has fewer flexible couplings, and it does not use quill shafts. Another advantage from the point of view of space saving is that the overall fore-and-aft dimensions are considerably reduced with the nested gear. The differences are thus physical, or concerned with the dimensions of the units, because as far as power transmission is concerned the differences are negligible.—*Marine Engineering and Shipping Review, Vol. 55, November 1950, p. 69.*

#### Vibrations of Marine Shafting

The subject of torsional vibrations has long been investigated both theoretically and experimentally, and one may say that it has been analysed with such a degree of perfection that a satisfactory answer may be obtained by calculation for any particular one of the many and varying problems. Yet, even to this date, the subject is being considered by many as not warranting special attention, especially in cases of simple low-powered marine installations. This may be due to the fact that many smaller shipyards do not possess the skilled personnel that could carry out the necessary calculations, and also to the fact that isolated cases of failure, or other forms of trouble, often have been attributed to other causes, until recent mass-failures on the Liberty ships have shown the urgency of more diligence and prudence in design. It has been the aim of the author in preparing the paper to develop a method which, with minimum effort and skill, will give maximum results on as many of the important aspects of the problem as possible. The method followed refers to the fundamental one-node pattern of vibration, which is the most important in affecting intermediate and tail-end shafts for the greater number of marine installations and especially the low-powered ones, for which the information given will be found most helpful. The theoretical calculations are carried out for a two-mass system with damping applied at the propeller and the engine. Any multi-mass system can be reduced into an equivalent two-mass system. The method will be found to be advantageous, as compared with the conventional methods used up to the present. The author gives the results of experimental investigations made at the hydraulic laboratories of the Baldwin Locomotive Works. Among the precautionary measures recommended by the author with regard to new construction, and as far as possible to existing vessels, are the following. The hull lines must be made such as to minimize abrupt changes in the wake form. Also the best possible immersion of the propeller in the light condition must be aimed at. The geometry of the system must be made such as to remove the critical considerably from the running speed range. The most effective means would be to increase the shaft diameter. On existing ships a change in the number of blades will raise or lower the critical speed (r.p.m.) but there may be other limitations in this corrective measure imposed by considerations of other forms of shaft and hull vibrations. The author cautions against hasty decisions in changing the number of blades without having full information available first; a haphazard change may deteriorate rather than improve conditions. A few instances have come to his notice where 5-bladed propellers were designed after the basic principles of this theory became known to the interested parties, with the hope that the change from 4 to 5 blades would put an end to the tailshaft trouble; although this may prove effective, the author mentions the case of at least one vessel which has lost four propellers at sea since she was built in 1939, three of which were 4-bladed and one 5-bladed. It is significant that the 5-bladed propeller lasted a much shorter period than any of the 4-bladed. The explanation lies in the fact that the critical speed may cover a wide range, and a haphazard change in the number of blades may move the running speed deeper into the "troubled region". For this particular vessel a 3-bladed propeller is being tried at present.—*Paper by E. Panagopulos, read at the Annual Meeting at New York of the Society of Naval Architects and Marine Engineers, 9th-10th November 1950.*

#### Diesel Engine Research

This paper reviews Diesel engine research carried out at the Diesel Research Laboratory of Caterpillar Tractor Co. under the sponsorship of the author as Director of Research. For many years intensive effort has been made to understand the combustion process in this type of engine by a better knowledge of the fundamentals of ignition and the mechanism of the combustion process, and this study has been developed in the laboratory on a competitive basis. Originally six combustion systems were put to trial and a modified precombustion-chamber engine won the palm of victory on the basis of its ability to maintain uniformity over extended periods of operation. Briefly, the character of the comparative combustion studies followed two general classifications: (1) visual combustion studies; (2) study of combustion-chamber deposits. In order to make extended studies of the combustion phenomena by visual means, a quartz window was designed to achieve maximum cleanliness without the distraction of soot condensation on the cold windows. The author describes the precombustion-chamber process, and deals with the composition of combustion gases, flame duration, temperature distribution, the mechanism of ignition, and combustion-chamber deposits. He also discusses the development of fuel-injection equipment, pretiming, precalibrating, and the evolution of the fuel pump; he describes the characteristics of several types of check valve and fuel valve, and the fuel-pump control of engine torque characteristics. Spray characteristics and the flow through the fuel-valve orifice are also examined. Comments are made upon materials for cylinder liners and piston rings, and the effect of fuel inclusions on cylinder wear; lubrication is also considered. It is believed that excellent performance has been achieved in the precombustion-chamber engine with a minimum of complication in the fuel-injection equipment, and that the development of this principle of combustion has not yet reached its limit of progress.—*James Clayton Lecture by C. G. A. Rosen, read at a meeting of The Institution of Mechanical Engineers, 14th November 1950.*

#### Exhaust Process in Four-stroke I.C. Engines

In this paper the author analyses the influence of engine design and operating variables upon the effectiveness of the exhaust process. Effectiveness is measured by the calculated pressure ratio (cylinder pressure divided by exhaust manifold pressure) near the end of the exhaust stroke. The variables that have an important effect upon this pressure ratio are the gas-velocity parameter (which is a ratio including the engine speed, piston displacement, exhaust-valve area, exhaust-valve flow coefficient at maximum valve lift, etc.) and the effective exhaust valve closing angle. The variables that have an unimportant effect are the pressure ratio at the effective exhaust-valve opening angle (which, however, does become important for highly supercharged engines), the effective exhaust-valve opening angle, the engine compression ratio, the ratio of crank throw to connecting-rod length, and the ratio of specific heats. The maximum value recommended for the gas-velocity parameter is 0.0325. From this value the minimum exhaust-valve area can be directly calculated for any given engine speed, displacement volume, etc. For large values of the gas-velocity parameter the exhaust valve should be closed as late as possible. For most current engine operating conditions the correct exhaust-valve area does not depend upon the intake-valve area or upon the ratio of intake-to-exhaust-manifold pressure (except for highly supercharged engines).—*J. D. Stanitz, 1950 ASME Oil and Gas Power Division Conference, Paper No. 50-OGP-4.*

#### Flow of Flashing Mixture of Water and Steam

The design of piping, such as the cascade drain lines between feed-water heaters, which convey initially saturated liquid from a source at one pressure to a receiver at a lower pressure, has been a perplexing problem. Experience has proved that sizing valves and pipes for this service by the usual criteria for liquid flow is unsatisfactory. The alternate procedure of determining size by empirical formulæ or arbitrary selection not only is costly, but, more important, offers no guarantee that the resultant capacity of the piping system will be adequate. The paper presents a simple method of designing piping and valves, particularly heater drain piping, to carry a flashing mixture of water and steam. Rational design formulæ are derived form the energy, continuity, and dynamic equations on the basis of an assumed uniform mixture at any point in the path of flow. Earlier papers have predicted and experimentally verified the existence of a critical pressure under certain conditions at the end of a pipe carrying a flashing mixture. Results calculated from the derived formulæ compare favourably with these published test data, it is stated. It is noted that if the initial assumption of a uniform mixture is not fulfilled, the limitations imposed on the piping are less severe than for the uniform mixture case, as the capacity of both valves and pipes will be greater than predicted by the formulæ. A scheme is suggested for eliminating flashing completely in heater drain systems employing drain coolers.—*Paper by W. F. Allen Jr., at 1950 A.S.M.E. Autumn Meeting, Paper No. 50-F-27.*

#### New Air Distributor for Oil Burner

The new Wallsend-Howden Single Control Air Distributor is designed as a single control unit to enable all classes of low-grade liquid fuels to be efficiently handled, and a number of vesesels has been equipped with this new oil-burning equipment with very satisfactory results. The principal advantage of this latest development is that good combustion is maintained with low-grade fuels, a short bushy flame, resulting in a steep temperature gradient through the boiler being produced at all loads. The pulverizing of the oil is so fine that the formation of deposits on the surfaces of the boiler and superheater is virtually eliminated. Any deposits leaving the funnel top, observation has shown, are perfectly dry and entirely free from any oily substance or combustible matter. The new air distributor has an air control sleeve for closing off the air supply to the burner when not in use, otherwise this sleeve is fully opened to admit the necessary supply of air to the burner so as to complete combustion. Some of the very heavy liquid fuels at present being used in marine boilers have a viscosity of 6,500 sec. Redwood No. 1 at 100 deg. F. and are inclined to give a slightly narrower angle of spray than the ordinary fuels. Bearing this in mind it has been arranged for the burner to be mounted on a sliding foot so that it can be withdrawn slightly when using these extra heavy fuels, thereby ensuring the flame entirely fills the firebrick quarl and gives good combustion.—*A. G. Dobbs, The Marine Engineer and Naval Architect, Vol. 73, November 1950, p. 473, 487.*

**Cooling Effect of Tube Holes in Thick Shells of Marine Boilers**

The design of boilers, especially in the marine field, where space is limited, often requires thick, low tube-ligament efficiency drum shells. Where these thick drum shells are exposed to hot furnace gases, it is necessary to cool them so as to insure: (*a*) A metal temperature throughout the shell thickness which will result in acceptable design stresses. (*b*) A temperature gradient throughout the shell thickness which will prevent excessive thermal stresses. (*c*) A metal surface temperature less than the progressive oxidation temperature of the material. Tube holes have a cooling effect on the shell plate because of the increased cold surface which is available for heat transmission. A simple expedient approximation of the cooling effect can be obtained by resorting to a fluid analogy which uses a broad-crested weir to simulate the region about a tube hole under a condition of constant heat flow. This method is particularly meritorious for relative comparisons, and it permits rapid appraisal of various proposed or existing designs. Such comparisons make up a good portion of preliminary design, and may play an important rôle in the final analysis when more exact solutions are not possible. The analogy shows the limit of the cooling zone to extend a distance equal to the shell thickness from the edge of the tube hole or plain seats. The shell metal temperature within this zone is dependent upon the shell-to-tube thickness ratio, with the thinner tubes affording greater cooling. The cooling effect diminishes rapidly with distance from the edge of the tube hole, hence the spacing of these holes largely determines the shell metal temperature, and whether additional shell protection in the form of alloy or refractory protection must be provided. Tube seats often are grooved to increase their holding power. This procedure reduces the shell cooling effect, particularly if the grooving is placed close to the hot face of the shell. Tube seats of high holding power, yet high shell cooling value can be obtained by confining the grooves to a region at a distance from the hot face of the shell equal to at least one-third of the shell thickness.—*Paper by J. F. Harvey, read at the Annual Meeting of The Society of Naval Architects and Marine Engineers, New York, 9th-10th November 1950.*

**Significant Factors in Economic Handling of Cargo**

This paper includes suggestions for the use of electronic classification of miscellaneous and general cargo. The point is made that there is a need for mechanical separation and classification of individual shipments which tends to prevent high tiering of this cargo and consequently results in loss of valuable dock space and an increase in handling. Expenses could be greatly reduced by uniform packing provision and mechanical separation of cargo. Mechanical separation could be accomplished by the use of sensitive electronic tripping devices installed into a conveyor of the roller type. Miscellaneous cargo could be packed in geometrically similar containers furnished by the carriers. The boxes would be stencilled by the shipper indicating the intended consignee, but the factor that would permit mechanical electronic selection to take place would be that metals of different alloy content give off different frequencies or else the use of the principle of different colours of paint reflecting different amounts of light. Master metallic letters or colours stencilled on the containers would react differently to electrical impulses and trip themselves down separate chutes. The packages could be stowed into the cargo hold by mechanical rollers, taking into consideration only the port of destination, as the separation progress would provide the proper selections of the consignee. Sorting and classification would be eliminated from the apron of the pier. This is an important factor because the pier is one of the key points in determining the rate of discharge of miscellaneous cargo which also determines the terminal time of the ship.—*Paper by M. L. McGowan, Bulletin, The Society of Naval Architects and Marine Engineers, Vol. 5, October 1950, pp. 20-21.*

**Motorship for Red Sea Service**

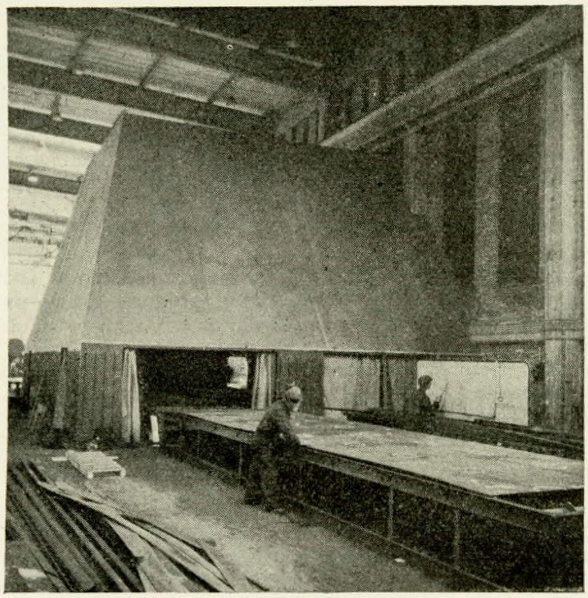
The single-screw cargo and passenger motorship *El Kerym* was recently completed by the Ardrossan Dockyard, Ltd., for the Halal Shipping Co., Ltd., which will use the vessel in its services between Red Sea ports. The principal particulars of the vessel are as follows:

| | |
|---|---|
| Length overall ............... | 289 ft. 9 in. |
| Length b.p. ...................... | 270 feet |
| Breadth moulded ............ | 42 feet |
| Depth moulded to upper deck | 27 feet |
| Draught and deep draught... | 16 feet and 18 ft. 10¼ in. |
| Deadweight .................. | 2,030 tons |

There are two continuous decks, shelter and main, while the erections comprise a forecastle, a two-tier superstructure amidships with aluminium wheelhouse above, and deckhouses aft. The main propelling machinery consists of one Kincaid-Polar type M.56.T., direct-reversible, single-acting, two-stroke cycle Diesel engine developing 1,824 b.h.p. at 190 r.p.m. The six cylinders have a diameter of 500 mm. and the piston stroke is 700 mm.—*The Shipping World, Vol. 123, 25th October 1950, pp. 332-333.*

**Optical Method Supersedes Templates**

In connexion with the building of new plating shops at the Götaverken shipyard, Gothenburg, a novel optical method of marking has been adopted. Before Götaverken started working along these lines at the end of last year the new method, which is of German origin, had only been tested at two German yards, in both instances on a much smaller scale than is now the case at Götaverken. Thus the installation at this Swedish yard is the first large plant in existence. The engineers who have specialized on the new system at Götaverken have extended and completed the system as a result of the experience gained during the past year. When fully built, this plant will comprise six projectors, of which four will be used for marking of plating, while two will simplify the marking of frames. Götaverken is the first shipyard to use the new method on frames. With the new system special drawings are made in 1:10 or 1:5 scale and photographed. The photographic negatives are then placed in a projector high up under the ceiling of the plating shop and an enlarged picture—in full scale—appears on the material placed on a special table on the floor of the plating shop. After markings have been applied, the material is moved on for further treatment. The new method gives better accuracy than the old one. Wooden templates are influenced by moisture and are not absolutely reliable. This risk is eliminated when the glass plate negative is used. The negatives are 9×12 cm. and are easily filed for further use, for instance when a sister ship is to be built or when a ship which was built at the yard is to be repaired. The special drawings which are required for the new system are made with the utmost precision and care. For instance, the breadth of the lines drawn must not exceed 0·10 mm., and this is con-



*Special table on floor of plating shop where projected image is marked*

trolled with the aid of a microscope. A checking measure is also placed on each drawing and when the projection of the negative is visible on the material below, this measure should read exactly 1 metre when checked. To obtain complete accuracy when making projections it is necessary to have double sets of negatives, one for materials on the starboard side and one for materials on the port side. It is not possible to use a negative turning it upside down, as the thickness of the glass in the negative would cause too large an error.—*The Shipping World, Vol. 123, 8th November 1950, p. 375.*

**Refrigerated Cargo Vessel *Baltrover***

The cargo steamship *Baltrover* of the United Baltic Corporation, Ltd., London, was completed in 1949 as the *Marstenen,* at the shipyard of A/S Fredrikstad mek. Versted, Fredriksstad, Norway, for a Norwegian shipowner. The principal particulars of this vessel, which complies with the requirements for class 100 A.1 of Lloyd's Register, are as follows:—

| | |
|---|---|
| Length overall ... ... ... | 351 feet |
| Length b.p. ... ... ... | 320 feet |
| Breadth moulded ... ... | 50ft. 6in. |
| Depth ... ... ... ... | 18ft. 10in. |
| Height of 'tweendeck ... ... | 12ft. 6in. |
| Gross tonnage ... ... ... | 2,179·04 tons. |
| Net tonnage ... ... ... | 1,058·52 tons. |
| Deadweight as 18ft. 9in. draught ... ... ... | 3,260 tons. |
| Speed ... ... ... ... | 14 knots (approximately). |

The principal alteration carried out to the orders of the United Baltic Corp., Ltd., was the insulation of the lower holds. Part of No. 2 hold has been taken into the engine room to house the refrigerating plant. This is, perhaps, an unusual arrangement, but one with many advantages. The plant is always under the supervision of the engineer on watch, while long distance electrical thermometers, close to the main engine controls, enable constant check and adjustment of the temperatures from the engine room. The main propelling machinery consists of a Fredriksstad steam motor, which is a double compound engine built on the Woolf principle with four cylinders working on separate cranks. The main engines in the *Baltrover* have two high pressure cylinders with a diameter of 450 mm. and two low pressure cylinders of 1,080 mm., the length of the stroke being 985 mm. The boilers are arranged in the 'tweendeck and abaft the main engines, an arrangement being adopted to an increasing extent. The two Scotch-type oil-fired forced draught boilers supply steam to the main engines at a pressure of 220lb. per sq. in. and at a temperature of 570 deg. F. Electrical power throughout the ship is provided by three dynamos —one of 30 kW. and two of 20 kW.—these machines being arranged to run in parallel. No pumps are driven off the main engines, all auxiliaries being independent and steam-driven.—*The Shipping World, Vol. 123, 22nd November 1950, pp. 413-414.*

**Vinyl Protection for Ships' Hulls**

An article in British Plastics reports that a new primer Wash Primer No. 1, for the underwater protective coating of ships' hulls has been developed, having a basis of polyvinyl butyral resins, and serving both as an adhesive and anti-corrosive agent for the metal. The new primer gives excellent adhesion to a wide range of metals, including aluminium, anodized aluminium, steels, zinc and galvanized iron, cadmium, chromium, nickel, copper, and magnesium. It may be used with conventional finishing coats. A complete underwater protective system for naval craft has been developed, which is based entirely on vinyl resins, and in which the application of the primer coating is followed by an anti-corrosive undercoat and an anti-fouling top coat, all three coatings being applied by spraying. Photographs illustrate its protective action on steel plates.—*Journal, The British Shipbuilding Research Association, Vol. 5, October 1950 (Abstract No. 4,144).*

**Rolling Wing Decks**

Tests of the rolling-wing decks, now being used on the *Francis X. McGraw,* being operated by the U.S. Navy, reveal that they may save as much as 50 per cent of the cost of loading vessels. Basic principle of the rolling wing decks is the use of two movable decks in each hold. These decks cover the recesses on each side of the hatch and are mounted on 4-inch-diameter wheels which roll on flat-bar tracks. When the ship is ready to load, the rolling-wing decks are moved out from the recesses by the power of the cargo hook and existing winches until they meet at the centre-line of the ship, directly under the hatch opening. Cargo can then be stowed directly on them. When the rolling decks are loaded, they can be rolled into the wing recesses with the cargo hook in 19 seconds and then the space between them is similarly loaded. During unloading, the system is reversed. The principal advantage, of course, is that all cargo is stowed directly under the hatch space. In the former system, cargo, after being lowered into the hold, had to be pulled 20 to 30 feet into the wings. Not only was this a slower process, but it often required intricate rigging skids and dunnage flooring and sometimes resulted in property damage or personal injury.—*Marine Engineering and Shipping Review, Vol. 55, November 1950, p. 62.*

**Tug Design**

Prior to the first world war, ocean-towing vessels were developed in Europe and Great Britain especially for salvage and rescue work, with 2,000 and 3,000 h.p. and a length of between 200 and 300 feet. These vessels, when not otherwise engaged, made numerous tows for long distances—several of them between Great Britain and ports in the Indian Ocean. This type of vessel is very much in existence today, but, due to tremendous size and power and high cost of operation, its purely towing service is limited to extremely long distances, and vessels of less size, power and expense perform the shorter haul work. The interesting contrast between the American and European designs of ocean tugs is the location of the towing bitts, or in the European design, the towing hook. In the European design, this permits a smaller arc of rudder travel and also a smaller area of rudder blade. However, it restricts the space allocated to machinery. In the American design, the disadvantage of the shorter distance between the towing bitts and the rudder is overcome by increasing the rudder travel to 100 deg., increasing the blade area and the use of balanced rudders. This permits much greater freedom in the layout of machinery and living quarters on such vessels of short length. The advantages of electric drive definitely outweigh the added cost of this installation. Among the more important advantages are pilot-house control and also control from the after steering station on the upper deck, constant rotation in one direction of the Diesel engine, and the use of electric auxiliaries for starting the Diesel, for steering engines and for automatic electric towing machines. Such auxiliaries have proven to be completely dependable and satisfactory. An additional advantage of electric drive is the ability to furnish sizable quantities of electric power to other vessels and to shore connexions, and such service has been supplied on numerous occasions. In long-distance ocean towing, the automatic electric towing machine has been found to play a most important part through its inherent ability to maintain selected line tensions and keep the tow line length at the desired scope without supervision. These two primary advantages of automatic towing machines have come to attention many times, particularly under adverse weather conditions. Through the ability of this machine to pay out in times of excess pull and to reave in when too little pull produces an excessive bight, the wear and tear on the towing cable has been reduced substantially, and the life of the cable prolonged. Numerous tests on dynamometers with the tug having no forward velocity have revealed a fairly constant relationship between installed horse-power and two-line pull, resulting in a pull of between 28·5 and 30lb. per s.h.p. This is not a true measure of the pulling ability of a tug in a seaway and other factors such as more displacement, greater draught, and general hull characteristics vary this relationship in actual practice.—*E. F. Moran, Jr., Marine Engineering and Shipping Review, Vol. 55, November 1950, pp. 50-54.*

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**Damage from Use of Heavy Oils as Engine, Boiler and Turbine Fuels**

An article by B. Engel in Erdöl u. Kohle states that erosion can be due to sand, ash, and cavitation; the first two causes can be largely diminished by centrifugal purification of the fuel. Main causes of corrosion are sulphur oxides, products of incomplete combustion, and presence of vanadium and alkaline earths in the ash. Published work on ash reduction of fuel oils is reviewed, with particular reference to that of Lamb. Tests were made on reduction of vanadium content of fuels from Venezuelan and Middle East crudes. Vanadium is present in oil-sol form, and whilst reduction of vanadium content by chemical and physical means was small, some success was achieved by the addition of materials (such as, chlorinated hydrocarbons) which inactivate the vanadium present. Corrosion can be caused by attack, on metal and refractories, of carbon and hydrogen formed by cracking reactions. Reactions such as $CO_2 + SO_2 = CO + SO_3$ can also be harmful. Carbon formed by incomplete combustion of inadequately atomized fuels can be detrimental to surface of metal and of furnace linings; hence excess air is preferable to insufficient air. Refractory ceramics should contain $<40$ per cent $Al_2O_3$.—*Journal, The Institute of Petroleum, Vol. 36, September 1950, p. 411A, Abstract No. 1,924.*

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**Sulphur-containing Exhaust Gases of Internal Combustion Engines**

Starting from the assumption that knowledge of the $SO_3$-content of exhaust gases would assist the study of the influence of $SO_3$ on wear and fouling of internal-combustion engines, the $SO_3$-content of exhaust gases of some spark-ignition and Diesel engines was determined by the authors. The quantity of $SO_3$ present was found to be very low in all cases, by far the greater part of the sulphur being present as $SO_2$. The correct determination of $SO_2$ in addition to $SO_3$ in the exhaust gas is, however, very difficult, because $SO_2$ is rapidly oxidized during sampling and analysing due to compounds of the peroxide type present in the exhaust gas and to water. Oxidation will also occur on cold cylinder walls, and the $SO_3$ thus formed is considered as a main source of wear and fouling of engines. The authors found that there was obviously no relation between the true $SO_3$-content of the exhaust gas and the $SO_3$ found on the cylinder walls, and $SO_3$-determinations of the exhaust gas were therefore of little use for the wear and fouling problem of engines.—*M. J. van der Zijden, J. E. van Hinte, and J. C. van den Ende, Journal, The Institute of Petroleum, Vol. 36, September 1950, pp. 561-574.*

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**Flow Conditions in Centrifugal Pump**

The object of the paper is to examine the flow conditions observed in a specially designed 6-inch centrifugal pump; firstly, when the directions and magnitudes of velocities of flow were obtained by means of Pitot tubes, and secondly, when the flow was examined with an electronic stroboscope, through an inspection window of "Armourplate" glass in the casing. To provide uniform entry conditions a single-entry pump was chosen, preceded by a long length of straight suction-piping but at small discharges a powerful forced vortex was found to exist with a spiral flow extending backwards for some distance from the pump inlet. This phenomenon was investigated by traverses with a direction vane and Pitot tubes, and an explanation of its cause is offered. The direction and magnitude of the absolute velocity at the impeller outlet were measured by cylindrical Pitot-tube traverses across the passage at two positions ,and at small discharges a component of flow from the casing towards the suction was found to occur through a portion of the impeller on the side nearest to the suction pipe. Similar traverses were made at two positions around the volute casing. These indicated a symmetrical, double spiral-flow at the best-efficiency point, and at other discharges this was modified to a single-direction vortex having a core at a much lower pressure than that on the outside of the casing. Pressure tappings on the casing, with an open-sided impeller and diffuser, showed the effect of shock on the inlet tips of the diffuser vanes, and inspection through the window confirmed a flow surging to and fro at small discharges. The effect of impeller blade loading on "head slip" is also investigated—two impellers showed a direct relationship—and values of the resulting "slip constant" are given. A graphical analysis shows the head slip, and head losses in the impeller and casing for the full range of discharge. Finally, the performance curves of the pump, operating in reverse as a turbine, are given, from which the "runaway" speed under any head and any resisting torque may be estimated.—*Paper by J. F. Peck, presented at a General Meeting of The Institution of Mechanical Engineers on 10th November 1950.*

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**Initial Bolt Stresses**

In highly stressed bolted connexions, it is important to know the magnitude of the initial stresses produced by tightening before external load is applied. It is obvious that the initial stress should neither be too high for reasons of mechanical strength nor too low in consideration of joint tightness or rigidity. Direct measurement of bolt stress when screwing-up tight is difficult, and where danger of overstressing exists it is usual to limit initial tensile bolt loading by using torque wrenches or spanners equipped for dial indication of the torque applied. It is easily seen that these methods cannot take account of the influence of varying thread friction. Where more accurate knowledge of the initial bolt tension is required, direct measurement of the bolt elongation due to tightening is required. More often than not, direct external measurement of the elongation will not be possible, and in the case of studs it is, of course, altogether impossible. A simple but effective solution to the problem is available in cases where the bolt or stud may be provided with a central bore sufficiently large to permit insertion of the feeler of a dial gauge, which affords direct indication of the elongation. An instrument of this kind, suitable for bolts up to five inch long, has been subjected to exhaustive trials, which, it is reported, have proved its accuracy and general utility.—*The Engineers' Digest, Vol. 11, November 1950, pp. 375-376.*

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**New Tanker *Atlantic Engineer***

The recently launched 30,000-ton d.w. tanker *Atlantic Engineer* is the second of three sister ships being built for Philadelphia, Tankers, Inc., at the yard of the New York Shipbuilding Corp., Camden, New Jersey. The ships have an overall length of 659ft. 6in., a beam of 85 feet and a draught (summer) of 34ft. 2⅝in. At this draught, the displacement will be 39,500 tons. The capacity of the cargo tanks will be 257,900 barrels, and the bunker tanks will hold 21,000 barrels. Spacious deck houses enclose stateroom type accommodation for a crew of about 50 officers and men. The vessel is single screw, driven by a Westinghouse steam turbine of the cross-compounded double reduction gear type designed to develop 18,000 s.h.p. maximum, at 103 r.p.m. The propeller is 4-bladed, 22 feet in diameter, built-up type with manganese-bronze blades and cast-iron hub. Steam is supplied to the high-pressure turbine by two Combustion Engineering oil-fired marine-type boilers which operate at 650lb. per sq. in. pressure and 1,020 deg. F. temperature. Bailey automatic boiler room equipment is used for control of steam pressure and temperature and to insure proper and efficient combustion at the oil burners. The steam cycle is designed for maximum fuel economy and embodies many new engineering developments. Steam is extracted from the turbines at four bleed points and four feed-water heaters are installed to heat the feed water to approximately 418 deg. F. at the inlet to the boiler. Electric current for lighting, auxiliary power and the numerous electrical services is generated by turbine generators at 440 volt, 3 phase, 60 cycle. These auxiliary turbines are operated from the high-pressure, high-temperature steam system. Cargo pumping equipment of the motor-driven centrifugal type will discharge a full cargo of oil in approximately 12 hours.—*Marine Engineering and Shipping Review, Vol. 55, November 1950, pp. 43-44.*

**Italian Motorship for the Argentine**

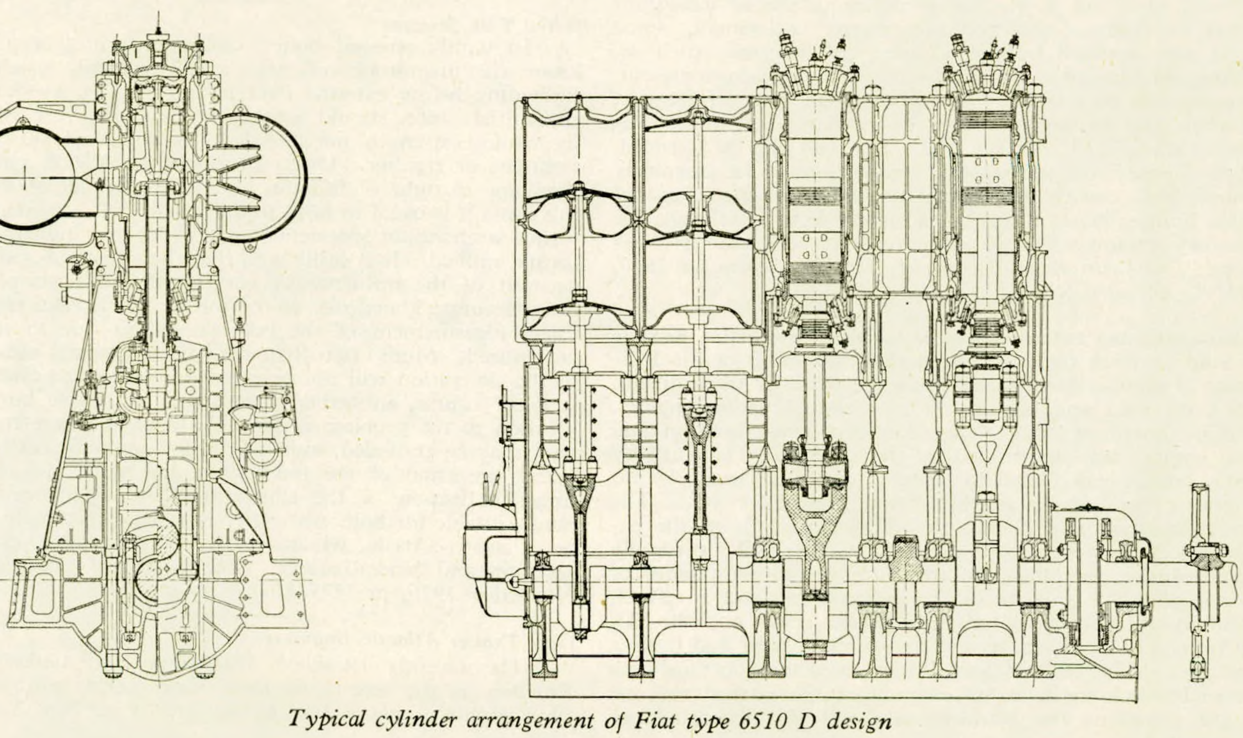
The motorship *Rio de la Plata* built by Cantiere Ansaldo for the Flota mercante del Estado (Argentine Republic) is the first of three twin-screw vessels of 16,900 tons each, with the following principal characteristics: length b.p. 155·45 metres, length o,a. 166·8 metres, breadth 20·01 metres, deadweight 8,670 tons, propulsive power 18,400 h.p. at 20 knots. The vessel is equipped with two Fiat double-acting two-stroke cycle Diesel engines of 9,200 h.p. at 160 r.p.m. of type 6510 D having ten cylinders of 650 mm. diameter, the stroke being 960 mm. Unit weight of the engines is 48 kg. per h.p. When developing 24,600 h.p. on trials a speed of 21·5 knots was attained. Normal fuel rate is 170 gr. per h.p. hour.—*C. Martini, Bollettino Technico Fiat Stabilimento Granli Motori, No. 2, 1950, pp. 33-42.*

**Future Power Plant Possibilities**

This paper briefly describes a few of the salient points of existing new, and proposed, installations of marine power plants. The development of such plants is based on certain restrictions imposed by the marine engineer in his choice of equipment from other similarly related fields such as stationary, locomotive, and others. A particular problem of present day design is how to adopt high-speed one-direction rotation power units to the present and future propellers. To use the conventional means of stopping, backing, and driving the ship requires a two-directional rotation of the prime mover. The reversal of the shaft requires high torque factors in the shaft design, and additional expense for the reverse mechanism in the particular prime mover. Modern power plants can be grouped as follows: (*a*) Diesel engines, (*b*) turbines, gas and steam, and (*c*) atomic energy power plants. For these respective classifications a table has been prepared to indicate the relative size and magnitude of these plants. Attempt has been made to illustrate in this paper some of the possible arrangements and types of marine plants that will appear in the future. As can be seen, the combination of propeller, gearing, and type of prime mover will have much to do with the general arrangement and space requirements of the future marine plants, especially of those used on naval vessels. Whether the prime mover is Diesel, steam or gas turbine, or a combination of these remains to be seen. It is believed that the possibility of atomic propulsion must not be too far away if the U.S. Navy feels that such a plant can be built and placed in a submersible vessel.—*Abstract of paper by H. R. McKinstry, Bulletin, The Society of Naval Architects and Marine Engineers, Vol. 5, October 1950, p. 16.*

**Systematic Tests With Models of Cargo Vessels**

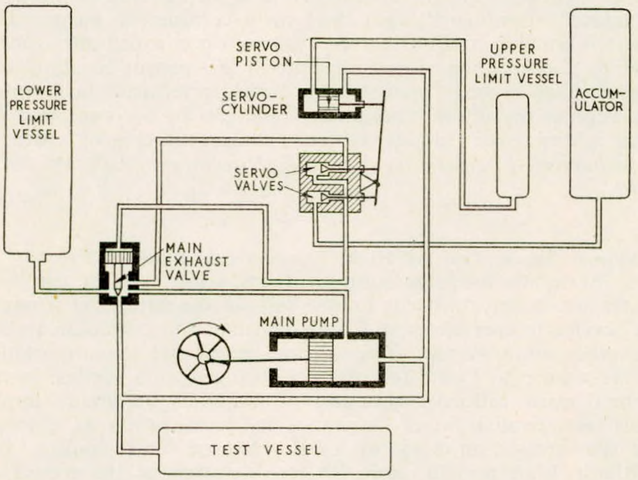
This paper gives the results of tank tests on ten models of fast cargo vessels, with a block coefficient of 0·575 and represent a continuation of earlier tests conducted on eleven models of fast cargo vessels with a block coefficient of 0·625. Resistance tests were carried out with all models and self-propulsion tests were also made with four of them. The aim of the in-



*Typical cylinder arrangement of Fiat type 6510 D design* vestigation was to study the influence of length, L.C.B., and breadth/draught ratio upon the resistance. In each series, the author started with a normal form, from which the other models in the series were developed systematically. Thus the author has tried to follow the principle of "one variable at a time". The parent form for all the models may be considered as corresponding, in the conventional meaning, to a practical ship form. As for the developed forms, the chief aim has been to study the effect of the above-mentioned factors upon resistance and the question of whether the developed models can be said to represent practical ship forms has been given only secondary consideration. The tests were carried out at the Swedish State Shipbuilding Experimental Tank in Göteborg.—*H. F. Nordström, Publication No. 16 of the Swedish State Shipbuilding Experimental Tank, 1950.*

**Pulsation Testing of Pressure Vessels**

A new pulsating pressure plant has recently been installed in the pressure vessel laboratory of the British Welding Research Association at Abington, near Cambridge. This plant is intended to test vessels by repeated applications of pressures. The advantages of this type of test over the normal static pressure tests are (1) the vessels which will be subjected to varying pressures in service can be tested under similar conditions during their initial development so that a relation between material properties, service stress and life expectation can be established; and (2) it will distinguish between two designs of otherwise equal merit far more readily than will a static test. The simplest form of plant for this purpose would be a pump whose connexion with the test vessel is alternately made and severed. Several designs of pulsating pressure plant are possible, the main difference being the manner in which the valve which controls this connexion is operated. In the plant at Abington this valve is controlled by




*Pulsating testing of pressure vessels*

a pneumatic-hydraulic arrangement. The controlling mechanism consists of a piston travelling in a cylinder which is so designed that the piston will move when the pressure difference between its two sides is 1-1½ per cent. To the space in the cylinder on one side of this piston is communicated the pressure in the test vessel, and to the other side that set in the "upper-pressure-limit vessel". The main exhaust valve controls the passage of fluid from the test vessel to the large cylinder in which is set the lower pressure limit. When this valve is open, the test vessel and the "lower-pressure-limit vessel" are in connexion, and therefore the pressure in the test vessel is that of the lower-limit vessel. When the valve is closed, the main pump draws fluid from the lower pressure limit vessel, and pumps this into the test vessel. As stated previously, this pressure is communicated to one side of the servo-piston, and when it reaches 1½ per cent more than the upper pressure limit, the piston travels along the cylinder. This moves the connecting lever which operates the two servo-valves which are arranged so that when one is open the other one is closed. Assuming that the test vessel has been pumped to its upper limit and the piston has travelled along its cylinder, the upper servo-valve will be opened and a direct passage is available for fluid from the top of the exhaust valve to the suction side of the pump. Since there is now very little pressure above the exhaust valve and the full upper limiting pressure below it, this valve is forced open. As soon as this is done, fluid flows from the test vessel into the lower pressure limit vessel, and the pressure in the test vessel drops to that in the lower limit vessel. At the same time the pressure on one side of the servo-piston drops to this lower limit, and, therefore, the piston travels in the reserve direction, closing the upper servo-valve and opening the lower one. This permits fluid under pressure from the accumulator to pass to the top of the exhaust valve piston, and since the pressure on the top is now greater than that at the bottom, this valve closes and a fresh cycle of pumping-up begins. The main pump, by means of which the test vessel is subjected to pressure, is a three-ram pump capable of a delivery of 12 gallons per minute against a pressure of 6,000lb. per sq. in., and is driven by a 75 h.p. electric motor. In addition, there is a small pump capable of a delivery of one gallon per minute against a pressure of 6,000lb. per sq. in., and an air compressor with an intake of 40 cu. ft. per minute. The latter are used for pumping air and water into the lower pressure limit vessel, the upper pressure limit vessel and the accumulator before the start of the test for setting the desired conditions.—*The Shipping World, Vol. 123, 15th November 1950, p. 394.*

**Calculated v. Measured Wave Making of Hull Forms**

This paper, which is a communication from the National Physical Laboratory, reports that the available methods of calculating wave phenomena for hull forms have been considered from the point of view of their application as a means of analysing practical ship hulls in terms of resistance. For this purpose the approximate solution due to Havelock has been found to be most suitable. A series of calculations and experiments has been made to assess the limits of application of the Havelock method. So far this work has been limited to simple narrow full forms. Comparisons of measured and calculated profiles and wave resistance have been made. The effects of preventing sinkage and trim on the models, and of carrying the vertical and horizontal sub-division of the hull in the calculations have been investigated. The approximate calculations have been found to agree well with exact calculations made by Wigley, and to reproduce the general features of the measured results. Agreement between measured and calculated results is reduced if the sub-division of the hull is reduced. The main discrepancies for the models used appear to be due to neglect of viscosity and to interference between the wave system and the hull form. Consideration has been given to the possibility of a quantitative analysis of the discrepancies, and a tentative programme for further investigation is suggested.—*Paper by J. R. Shearer, read at a Meeting of the North-East Coast Institution of Engineers and Shipbuilders, 17th November 1950.*

**Residual Stresses in Welded Tanker During Construction**

The author reports that in the autumn of 1948 it was decided to undertake tests to ascertain the order of lock-in stresses on one of the new 26,000-ton d.w. tankers to be constructed for the Standard Oil Co. From these tests it was desired to find the magnitude, the direction, and if possible, the primary cause of such stresses at a number of selected locations. These tankers are longitudinally framed and single screw, and have twin longitudinal bulkheads in the cargo tanks. The vessels are 628 feet overall, have a moulded beam of 82ft. 6in. and a moulded depth of 42ft. 6in. The vessels are all welded except for riveting in the centre-line strap on upper deck; the seam in upper deck plating about one-quarter beam off centre-line; the gunwale angle to upper deck stringer plating and sheer strake; the seam between sheer and topside strakes; and the seams between bilge and adjacent strakes. The actual installation and the reading of the gauges were started in January 1949, and the gauges were removed in August of the same gears. The gauges used for the test were the rosette electrical type. In this design the bulkwarks amidship are inboard of and clear of the sheer strake, the upper edge of which passes the midship in a straight unbroken line. There are thus no "fashion plates" amidships such as have given trouble on certain "T-2" class tankers. Aft, however, the sheer strake sweeps up to the forward end of the poop deck, and it was felt that this might be a place where locked-in stress might appear. Accordingly, the gauges were placed in two transverse sections of the vessel, one amidships and one near the forward end of the poop deck. Gauges were installed on the various plates before sub-assembly and initial readings taken before any welding was done. As the sub-assemblies were fabricated and in turn assembled on the building ways, readings were taken. To keep the number of readings to a minimum, they were taken only after each major event in the progress of constructing the vessel or at least once a month, if no major change had occurred. A summary of the results of the test is as follows: (1) The highest tensile stress was about 6,000lb. per sq. in. and was found in the poop deck fashion plates. (2) The highest compressive stress was about 17,000lb. per sq. in. and occurred in the flat plate keel amidships. The history curve for this gauge shows that this stress developed gradually during the construction of the vessel. (3) There was little change in stress when the vessel became water-borne at launching, indicating that the still-water hogging stress in the vessel is small (4) All welded shell and upper deck seams and butts were flame stress relieved just prior to launching. The results show no conclusive effects of this on the locked-in stresses at the gauge stations.—*Abstract of Paper by J. F. Watson, Bulletin, The Society of Naval Architects and Marine Engineers, Vol. 5, October 1950, p. 13.*

**Compressibility Effect in Hydraulic Servo-mechanisms**

This paper is the first of a series of investigations of compressibility effects in hydraulic servo-mechanisms, and it makes a preliminary investigation of the effects of the elasticity of the fluid on the response to an input signal of a typical valve-controlled servo-mechanism. In the piston and cylinder of a control system of the type being discussed, the valve on the driving side opens when a signal is applied and pressure is assumed to reach some value $F/A$ instantaneously. The piston and the load start to move, and the fluid in the retarding side is forced out of the cylinder through the discharge orifice. Friction in the discharge line is neglected in this analysis. As the piston and load reach the desired position as indicated by the input signal, the outlet orifice will be closed along with the inlet valve. During this stage of the response, the analysis becomes considerably more complicated. The present discussion is limited to the initial stage of the response when the area of the discharge orifice remains essentially constant. Equations of motion are derived for the case when the fluid is considered as incompressible. The effect of considering the changes in density of the fluid with changes in pressure are also discussed. It is shown that this last factor is of little or no importance in the practical case. The final analysis consists of taking into account the fact that a finite length of time is required for pressure changes to be transmitted in any system. In other words, the effects of the pressure waves generated by the movement of the piston are considered. In the case of an incompressible fluid, all pressure changes are assumed to be transmitted with infinite speed.—*R. S. Wich, 1950 ASME Industrial Instruments and Regulators Division—Instrument Society of America Conference, Paper No. 50-IIR-1.*

**Theory of Valves for Compressors**

The inlet and discharge processes of a reciprocating compressor equipped with spring-loaded valves of the automatic type have been analysed to determine the effects of the main design variables on performance. The most important criterion is found to be a parameter involving effective flow area through the valves and piston speed. Valve dynamics are a secondary consideration. For optimum valve dynamics, the valve would have no weight and a very small spring constant, giving an infinite natural frequency of the valve system. If certain valve characteristics are known (or measured by static-flow test), the performance of a compressor using these valves can be predicted with fair accuracy.—*M. Costagliola, ASME Applied Mechanics Division Conference 1950, Paper No. 50-APM-12.*

**Aluminium Coated Steel**

It has been established that aluminium-coated steel has high rust-resistant properties suitable for industrial and sea coast exposures, and has been found superior to steel with galvanized coatings of similar thicknesses. There are two types of aluminium coatings on steel. The first is a surface layer of aluminium-iron alloy, which prevents scaling by oxidation at high temperatures. It is important that the compound should not form to such an extent that the surface becomes brittle and spalls. The second is a surface coating of aluminium to protect the steel from corrosion. There may or may not be an interfacial layer of aluminium-iron alloy which, if present, should be kept to a minimum. Several methods may be used to coat steel with aluminium, and each produces its own type of coating with individual characteristics. Four processes are in present-day commercial operation; hot dipping, cladding by rolling, spraying, and calorizing. Three other processes have been developed but are not widely used: electroplating, chemical reaction, and casting (aluminium around steel, or vice versa, in the Alfin process). Aluminium coatings formed on steel by hot-dipping vary from ½ to approximately 3 thousandths of an inch in thickness, possess good continuity, and relatively thin interfacial layer. From an operating viewpoint, this process appears to be the most economical. The Armco Steel Corporation in America is now using this method to produce "aluminized" steel sheet on a commercial basis. The process involves preheating the steel in a controlled atmosphere before it enters the aluminium bath. To permit bending and forming of coated products, the brittle interfacial layer must be kept at minimum thickness. This can be accomplished by the addition of silicon to the aluminium-coating bath.—*Mechanical Engineering, Vol. 72, November 1950, pp. 909-910.*

**Thermal Shock Test of High Temperature Alloys**

Materials used for equipment operating at high tempera-tuers are chosen primarily on the basis of the structural strength at service temperatures and their resistance to corrosion by air or other atmospheres. The authors emphasize the importance of resistance to cyclic temperature changes, as a further factor which must influence selection of materials for many applications. Evaluation of resistance to deterioration as a result of the stresses imposed in cyclic heating and cooling has hitherto been possible only by consideration of the record of individual cases of service behaviour, but the authors have developed a test which is believed to be capable of discriminating among the various high-temperature alloys with regard to their relative resistance to thermal fatigue. The test provides for sudden and large variations in temperature, and the design of the test piece is such as to incorporate stress-raisers equivalent to those which, in service, frequently accentuate the influence of sudden temperature fluctuations. The cycle of heating and cooling simulates service involving alternate heating and water quenching, with the important difference that industrial service usually involves longer times of heating. Using the apparatus described, thermal-fatigue tests were made on partially ferritic and substantially austenitic grades of 26-12 chromium-nickel-iron alloys, and 35-15, 60-12, 68-18 and 20-26 per cent nickel-chromium-iron alloys, in various conditions. The results are reported in detail.—*H. S. Avery and C. R. Wilks, Alloy Casting Bulletin, May 1950, pp. 1-9, Abstracted in The Nickel Bulletin, Vol. 23, August/September 1950, p. 162.*