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Conversion of Hospital Ship into Liquid Chemical Tanker

A conversion and jumboizing job which has been estimated as costing in excess of $6m has resulted in a former U.S. Navy hospital ship being put back into service as a modern liquid chemical carrier.

The ship in question is the 24 000 dwt steamer *Alaskan*, formerly the U.S. Navy hospital ship *Haven*—which had been laid down during the war at the Sun shipbuilding yard as the C4-S-B2 freighter *Marine Hawk* but was converted to the hospital ship role before completion.

As *Haven*, the vessel had an over-all length of 520 ft and a rated deadweight of about 15 000 tons. The beam and depth were not affected by the massive jumboizing operation.

A new midbody, 330 ft long, 71 ft 6 in wide and 43 ft 6in moulded depth at side, was built at the Bethlehem Beaumont yard. The new midbody was constructed with a tank top at 5 ft above the base line, with centreline and longitudinal wing bulkheads, which divide the midbody into four tanks abreast. A trunk deck 5 ft above the main deck extends between the longitudinal wing bulkheads which are 22 ft 6 in off the centreline, port and starboard.

The existing bow and stern of *Haven* were utilized in the conversion, and with the insertion of the new mid-body, the vessel was lengthened by 145 ft. Cutting and joining of old and new sections were handled on Bethlehem-Beaumont's floating dry dock. After the ship was docked stern first, the aft cut was made and the new midbody was joined to the original stern. The original bow and midbody section was then docked bow first, the forward cut was made and the forward joint was completed.

Principal particulars are:

Length, o.a.	665 ft 0 in
Length, b.p.	641 ft 0 in
Breadth, moulded	71 ft 6 in
Depth to main deck at side, moulded	43 ft 6 in
Draught, full load, moulded ...	34 ft 1½ in
shp, normal	9000
Deadweight, nominal	24 000 tons
28 cargo tanks approximate capacity	170 000 bbl.

The midbody is longitudinally framed and divided into 28 cargo compartments. Each cargo compartment is equipped with an independent cargo loading system consisting of an individual fill and discharge line and deepwell cargo pump.

Three stainless steel deck tanks are mounted aft on the trunk deck. The tanks are 12 ft 8 in i.d. by 52 ft 6 in i.l. with flanged and dished heads, each supported by three saddles and oriented with the long axis of the tank athwartships. Each tank is equipped with individual stainless steel piping, pump, vent and closed gauging system.—*Shipbuilding and Shipping Record, 6th June 1969, Vol. 113, pp. 783–784.*

British Sea Barge Carrier

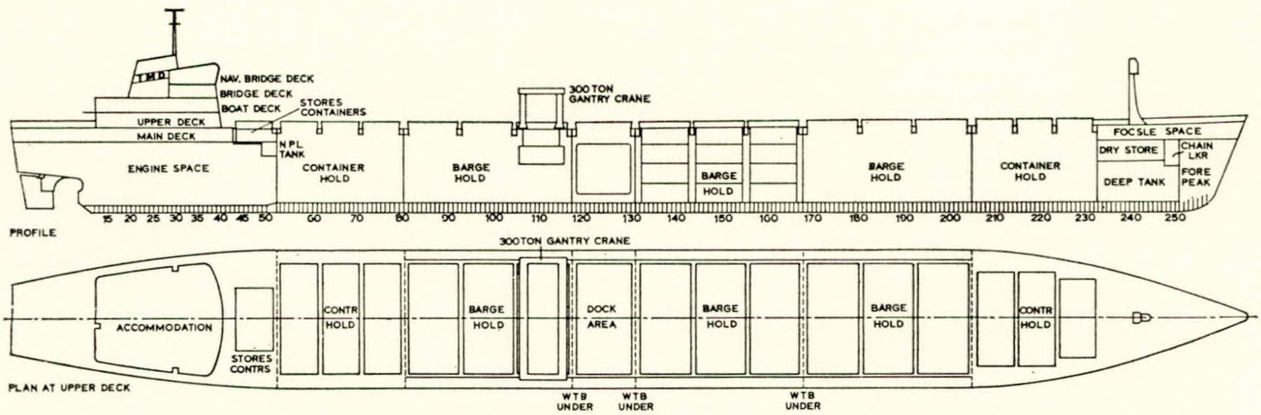
The concept of unit bulk loads is now being further developed with the introduction of the Sea Barge Carrier, a number of which are at present under construction in America and Japan.

In essence, the Sea Barge Carrier is a vessel designed as a travelling port system, complete with container barges which can be stowed on board and then unloaded and towed away for subsequent cargo handling, leaving the carrier free to proceed to other ports of call. The operation is, of course, reversible, thus reducing the vessel's total cargo handling time and allowing the maximum utilization of possible sea-going time.

The British BOB (barges on board) system has been developed by Turnbull Marine Design Co. Ltd.

An essential item of equipment for cargo ships built to carry loaded barges is a travelling gantry crane having a capacity in the order of 300 tons. Such a crane could lift or lower loaded barges over or through the stern of the ship, but maintaining adequate trim of the ship becomes difficult while this operation is in progress. In addition, stern loading also raises problems in connexion with the design of the ship and its propulsion.

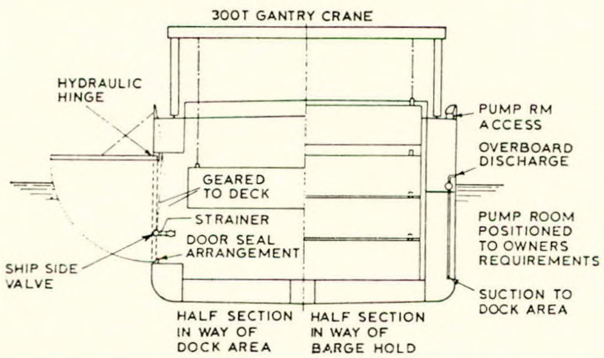
In the Turnbull Marine barge-carrier proposals, the stern lift section has been replaced by a watertight dock compartment located amidships and extending the full breadth of the vessel. Large, hinged, shell access openings port and starboard allow barges to be floated into and out of the dock compartment at will. Fore and aft of the dock compartment



General arrangement showing container and barge holds and 300-ton gantry crane

the ship is divided, by watertight bulkheads, into a number of holds for the stowage of the barges.

When the parent ship is to be loaded with barges the dock compartment is flooded by opening a sluice valve connected, via a strainer and a ship's side valve, to the sea. As soon as the hold is flooded level with the sea either of the access doors may be opened by operating an hydraulic hinge. This hinge, which contains a space into which oil can be pumped to act on a radial fin, pivots the access door through 90°, the door being retained in an open position by wire stays. the barge containers can then be floated into the flooded dock compartment and transferred to the ship's holds by a shipboard travelling gantry crane.



Half-sections through dock area and barge hold

By using an amidships dock compartment the Turnbull system offers a number of advantages not available with the stern loading type of carrier. For example, the parent ship will have less motion amidships than astern. Consequently, the barges awaiting a pick-up will be practically motionless within the dock compartment and can be picked up by the crane without the use of special tensioning devices. It is also easier to guide the barges into an amidships dock compartment during rough weather than it is to enter barges into a stern pick-up area.

Unloading the barges from the parent ship is a similar operation, the barges being lifted from their holds by the gantry crane and successively lowered into the dock compartment to be floated out of the ship and towed away by a tug.

In order to give the greatest possible cargo flexibility the Turnbull BOB carrier is envisaged as a combined barge carrier and container ship, with container holds forward and aft of the barge holds. The dock compartment is capable of being pumped out and the shell doors rendered watertight by an inflatable seal operated by either air, water or oil. This section may be utilized as an additional hold.—*Marine Engineer and Naval Architect, May 1969, Vol. 92, pp. 200–201.*

Stresses in Tail-Shaft due to Bending and Shrinking-on of the Propeller

This article examines stresses caused by bending of the shaft at the critical region between the liner and propeller boss and radial compression of the shaft under the propeller boss and liner.

A flat model, made from a photo-elastic material with an epoxy-resin base, was subjected to radial pressures created by screws. A screw clamping device, simulating the tail shaft liner, was mounted rigidly in a frame, and another screw clamping device, simulating the propeller boss, was suspended and subjected to an alternating lateral bending moment. In order to ensure that the model results would be correct for an actual shaft, the linear dimensions of the model were scaled to approximately 1/20 of the actual dimensions of the shaft of a ship of the *Praga* class.

Curves produced show that radial pressure due to shrinking increases sharply at the ends of the liner and boss. There is no axial pressure in the central parts of the shrunk-on components, but it does appear and reach its maximum towards the ends of the liner. When bending stresses are superimposed on radial pressure the character of the stress distribution changes. In addition to this its form is different for fibres under tension and fibres under compression. In the first case the radial-stress concentration peak, in the critical regions at the ends of the liner, falls off, but at the ends of the boss it remains as before. In the second case the concentration peak at the ends of the liner increases sharply, while at the ends of the boss it decreases slightly.

Monochromatic stress patterns were also obtained under polarized light and helped to define the coefficient of stress concentration at the ends of the shrunk-on components (the critical regions of the shaft) for different radial-pressure/bending-stress relationships. A graph of these stress concentrations shows that, in shrinking on a propeller, if the tightness of fit is increased, the coefficient of axial-stress concentration is also increased and this must be considered when selecting the tightness of fit.

The authors make a comparison of theoretical and experimental results, which shows close agreement between them.—*Iskritskij, D. E. and Lukyanov, I. S., Sodostroenic, No. 1, January 1969, pp. 36–39; Jnl of Abstracts of the British Ship Research Association, May 1969, Vol. 24, Abstract No. 27 452.*

Computer Analysis of Complete Large Hull Structure

An advanced computer project which is being conducted jointly by Chevron Shipping Co. (Standard Oil Co. of California) and the American Bureau of Shipping is expected to have a profound influence on the design of large vessels. The Arizona Project, as this venture is called, will enable the computer analysis of the entire hull structure of a giant vessel under expected service conditions to be undertaken. Hitherto such computer analysis has been applied only to individual hull sections. It will now be possible to analyse in detail the bending and sheer stresses in the more critical areas throughout the hull.

The project makes use of aircraft computer analysis practice. Ships, like aircraft, consist of internally stiffened plated surfaces but the structure of a ship, as well as its responses, are somewhat different to those of an aircraft and the computer analysis has had to be modified and extended to take this into account. DAISY (Displaced Automated Integrated System) employs the Finite Element method of investigation, replacing the actual continuous ship structure with a mathematical model which is sub-divided in the longitudinal transverse vertical and horizontal planes into a large number of elements of finite size having known elastic and geometric properties. Stresses are then calculated for the points at which these families of planes or surfaces intersect. These nodal points coincide with the frames of the actual vessel. A good analogy is a large net wrapped around the hull of a ship where each corner of the square mesh represents a nodal point. The hull is thereupon broken down into smaller pieces which are mathematically tested for certain assumed operating conditions. The reactions at these individual segments of the hull can then be used to assemble the resultant properties of the complete structure. The smaller the elements being investigated the more accurate the final analysis becomes. Very close examination of any point of special interest, such as bulkhead, can be performed by taking the output for this particular area from the initial three-dimensional run and putting it through the computer again with a finer two-dimensional mesh. This can be taken a stage further, for instance, to find the stress distribution in a component part of the bulkhead, by taking a third run utilizing an even finer mesh.—*Marine Engineer and Naval Architect, June 1969, Vol. 92, p. 254.*

Duel-fuel Engines for LNG Tankers

The liquefied natural gas is at a temperature of approximately 162°C and thus only occupies 1/600th of its gaseous volume.

By suitably insulating a tank, the gas is maintained at this temperature. However, despite satisfactory insulation of the tank, the loss by evaporation amounts to 0·25–0·5 per cent of the total load per day.

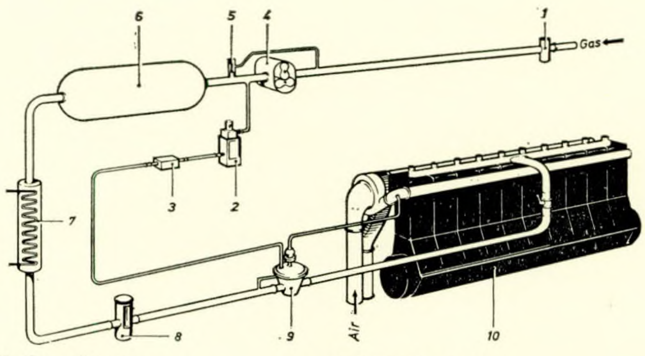
One idea to prevent loss would be to provide for reliquefication of the load. Nevertheless, even if it were possible to provide loss free, isothermal compression and to use the best possible liquefying process at approximately 80 per cent efficiency, 0·28 Wh/Nm^3 CH_4 would still be required to liquefy the gas.

It is considerably more economical to use the evaporating natural gas as fuel for the main propulsion engine. Here, the corresponding amount of liquid fuel is saved. The highest output is obtained from the evaporating gas if dual fuel engines are used, the efficiency of which is the highest of all the propulsion engines that could be considered for this purpose.

If a dual engine is employed, the power demand of the main propulsion engine can be fully covered at an evaporation rate of 0·35 per cent/d (normal speed provided).

With dual fuel engines it is possible to run the engine on Diesel oil only or on gas. If the gas supply fails, the engine is automatically switched over to Diesel operation whilst running without any resulting breaks in output or speed. If the available gas is not sufficient to meet the full load requirements, the fuel charge is automatically balanced by an increase in the proportion of Diesel oil. Maximum reliability is, therefore, attained as regards operation of the vessel.

All manoeuvring and starting is carried out in the usual manner on Diesel oil only. Most of the gas evaporating during this time remains in the tanks. This increases the



1) Shut off valve
2) Heat value adjuster
3) Pressure transformer
4) Gas compressor
5) Release tank
6) Expansion tank
7) Heat exchanger
8) Automatic gas shut-off valve
9) Diff. pressure regulator
10) Dual-fuel engine

Arrangement for delivery of evaporated natural gas to M.A.N. dual-fuel engine

pressure somewhat but slight excess pressure is allowed for in the design of most tanks. The gas could also be stored in a tank between the liquid gas tank and the engine. This tank is required in any case to provide the engine with a continual supply of gas at constant controlled pressure. The figure shows arrangement for the delivery of the evaporated gas to the engine. Besides the expansion tank, a compressor, heat exchanger and regulator are installed, serving to bring the gas to the required condition for operation of the engine (pressure approximately 2·3 kg/cm^2). The figure also shows the heat value adjustment plant.—*Klaunig, W., Shipbuilding and Shipping Record, 30th May 1969, Vol. 113, pp. 742–744.*

Production of Liquid Gas for Supply to Refrigerated Containers

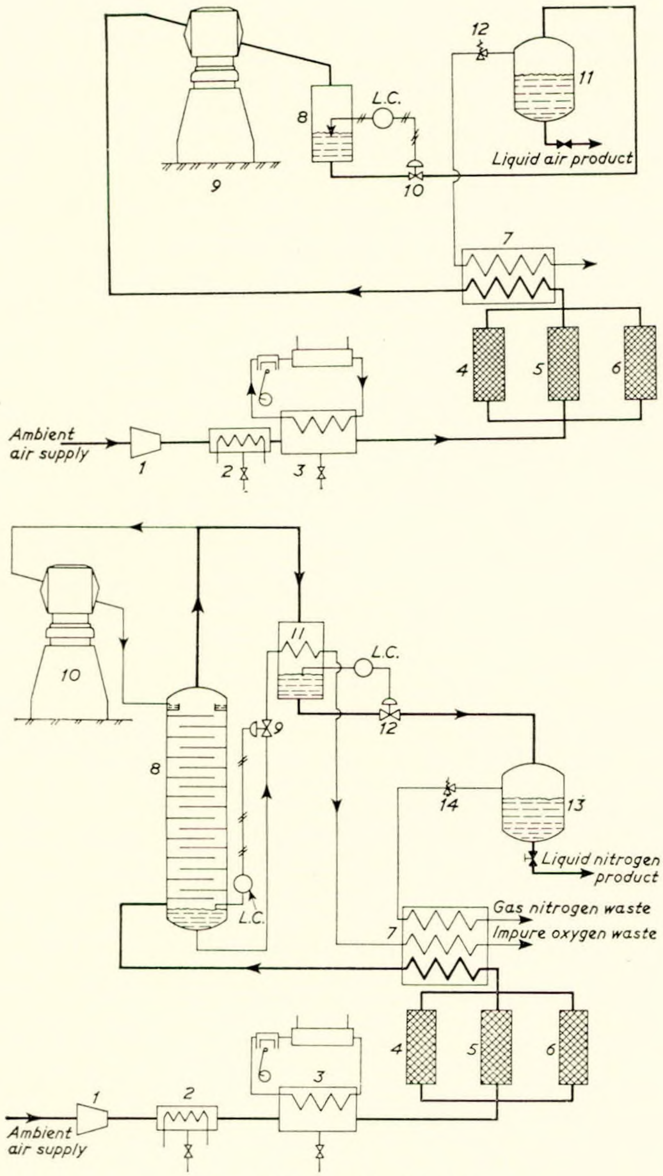
Liquid nitrogen refrigerated containers for the transport of deep frozen or cooled perishable goods have been in use for some time. For individual containers of this type, advantages that can be claimed with respect to individual mechanical refrigeration are: simple, unattended operation; perfect control between narrow limits of temperature in the container; minimal maintenance; short container precooling time and almost non-existent desiccation of the product with the accompanying thawing of the cold evaporator surfaces provided with mechanical systems.

However, these advantages will only be realized so long as the liquid nitrogen storage bottles of the containers still contain liquid gas or if a sufficient supply of liquid gas to these bottles at any moment can be guaranteed. Because the storage capacity of the liquid nitrogen bottles in the containers is limited and until now their filling has been at shore facilities, liquid nitrogen refrigerated containers are only used on shipboard for regular, short range services.

A solution to the problem of providing a reliable supply of liquid gas to the containers on board, could be the on board production and distribution to the container bottles of liquid gas.

Nowadays liquid nitrogen for container refrigeration is supplied by gas producers from large air separation plants on shore. These plants, however, are generally meant for oxygen production in the first place, while gaseous impure nitrogen is blown off as waste gas. Liquefied waste nitrogen is supplied should liquid refrigerant gas for container transport be required. For the liquid gas production unit on board, liquid air can be chosen as the end product as well as liquid nitrogen. If only the production unit itself were to be considered, liquid air would be preferable, because a liquid air unit is less complicated than a liquid nitrogen unit.

The air, taken in from the ambient atmosphere, is compressed, pre-cooled, dried in absorbers and cooled down in counterflow with the waste gases, as in the inert gas plant



Top—*CGR liquid air plant*
Bottom—*CGR liquid nitrogen plant*

scheme. The liquid air collected in the vessel and also the liquid nitrogen collected in the evaporator-condenser are both produced under pressure and are then discharged into the atmospheric storage vessels and via expansion valves. The flash gas generated here is blown off as waste gas to free atmosphere via the counterflow heat exchanger.

From the storage vessels the liquid gas products can be distributed to the bottles in the containers when required.

The dimensions of the storage vessel determine the flexibility of the use of full load capacity of the liquid gas plant, e.g. this vessel makes it possible to produce liquid for containers expected to arrive but not yet on board. From the user's point of view there may be some preferences from either liquid air or nitrogen. Nitrogen can present a danger of suffocation, if the container is entered without necessary precautions being taken. On the other hand, nitrogen seems to have a good influence on the quality of some cooled perishables, because the metabolism of living product will be retarded by an inert gas atmosphere, though this advantage is not valid for deep frozen products. Another disadvantage is discoloration of blood rich products and a progressive growth of very detrimental bacteria, propagating in an oxygen-starved atmosphere.

Liquid air is sometimes said to be dangerous because of possible oxygen-enrichment by slow evaporation, resulting in escape of nitrogen-enriched vapour from the storage vessel or from the container liquid gas bottles. However, this danger is mostly exaggerated and can eventually be prevented by technical means.—*Meulenberg, R. E. and Abell, T. W. D., Trans. I.Mar.E., July 1969, Vol. 81, p. 225.*

Vanguard Class Ore/Oil Ships

The three 130 000-dwt Vanguard vessels for the San Juan Carriers' Ltd. fleet are being built in Japan. Two of the vessels, Hulls 900 and 901, will be built by Mitsubishi Heavy Industries, and the third vessel, Hull 1117, by Kawasaki Dockyard Ltd.

The vessels are all welded ore/oil carriers, steam turbine propelled, engines and accommodation aft, of a design and layout similar to San Juan Carriers' earlier designs which have now become fairly conventional. Extra features of this particular design are: a single controllable-pitch propeller, extensive engine room automation, high standards of accommodation and remote control of the cargo-oil system from a central control room. A bulbous bow of the builder's standard design will be installed. Extensive use of high-tensile steel has been made in the hull design and riveted seams have been eliminated at the upper deck and the bilge.

Principal particulars are:
(Tonnages are approximate)

Length, o.a.	957 ft 9½ in
Length, b.p.	908 ft 4¼ in
Breadth, moulded	137 ft 9½ in
Depth, moulded	74 ft 1¾ in
Designed draught, moulded ...	52 ft 4 in
Deadweight at designed draught	129 570 tons
Registered gross tonnage ...	77 000 tons
Ore (including hatch), 100 per cent full	2 691 000 cu ft
Ore (including hatch), self-trimmed to 35° rest angle ...	2 340 000 cu ft
Cargo oil (including hatch), 100 per cent full	5 756 000 cu ft
Trial speed, designed draught ...	16·4 knots
Service speed, designed draught	15·9 knots
Designed fuel consumption ...	114·5 tons per day
Endurance	23 000 sea miles

The machinery is not identical for the three ships. Mitsubishi has a licence agreement with Westinghouse, and builds its turbines in Japan; while Kawasaki builds its own design. MHI builds Combustion Engineering boilers, while KDY builds to its own design.

The propulsion turbines are two-cylinder cross-compound type consisting of one H.P. turbine and one L.P. turbine. The turbines are designed for use with a controllable-pitch propeller; therefore, no astern element is provided.

The turbines with the c.p. propeller are capable of developing ahead or astern power with rated steam and exhaust conditions. They are designed for the maximum efficiency obtainable consistent with reliable operation when delivering normal rated power with bleeding. The power is divided approximately equally between H.P. turbine and L.P. turbine under maximum power conditions. The turbine rotors are of flexible-shaft design to minimize steam leakage across the diaphragms and glands.

Connexions are provided to permit independent operation of the hp turbine and lp turbine in emergency situations. This is accomplished by an emergency steam supply to the L.P. turbine or an exhaust connexion from the H.P. turbine exit to the main condenser.

Five remote-operating bleeding connexions are provided for the extraction of steam from the turbines for heating the seawater distilling plant, feedwater heaters and L.P. steam generator.

The main propulsion turbines operate at a constant rev/min and the control of the ship's speed and direction is accomplished by varying the pitch of the propeller. The main propulsion turbines are fitted with a hydraulic constant-speed governor which is capable of maintaining the propeller rev/min at either 85 or 50 rev/min. During manoeuvring condition, the propeller speed is controlled at 50 rev/min and during normal at-sea operations at 85 rev/min.

The main reduction gear is of the double-reduction tandem articulated type. The casing is a rigid casing of welded construction.

The steam generating plant consists of one main boiler and one auxiliary boiler.

The main boiler has sufficient capacity to supply necessary steam for propulsion and domestic use at sea.

The main boiler is a marine watertube boiler, consisting of two drums and watertubes between them, water-cooled furnace, super-heater, economizer and a rotary regenerative gas air heater.

The main boiler is arranged for burning oil under forced draught and is provided with automatic combustion-control equipment, feedwater regulator, automatic superheater steam temperature control equipment and burner automatic control equipment.

The main boiler is equipped with four fuel-oil burners on the roof wall of the furnace. The burners are 'Volcano A.B.C.' steam and mechanical pressure atomizing type, manufactured by licensee in Japan. The burner consists of an atomizer gun, and forced-draught air register with fuel shut-off valve. These burners have a turn-down ratio of 5·5:1. The fuel oil is distributed to each burner from a burner manifold by a branch connection pipe.—*Thompson, N. J. and Thomas, T. B., Maritime Reporter/Engineering News, 15th June 1969, Vol. 31, pp. 24; 26.*

First Europe–U.S. West Coast Container Service

Axel Johnson is built to the American Bureau of Shipping class ✠ A1 Iceclass C ✠ ACCO (partly unmanned engine room), and to Det norske Veritas Class F. Of a total hold capacity of about 1 000 000 ft³, some 275 000 ft³ is refrigerated. The non-cellularized holds comprise 192 000 ft³ dry cargo space and 75 000 ft³ refrigerated space; the rest is cellular hold space.

Principal particulars are:

Length, o.a.	566 ft 8 in
Length, b.p.	515 ft 9 in
Beam moulded	84 ft 6 in
Depth to upper deck	52 ft 0 in
Draught, max.	33 ft 0 in
Deadweight, max.	14 000 tons
Contracted (speed) (27 ft draught)	23 knots

The arrangements for refrigerated containers are similar to those employed in the ACT and OCL ships: air from Stal coolers in deckhouses is ducted to containers individually via supply and return systems. Duct branches terminate in openings which are matched to similar openings in the container end walls, blanking plates closing off any openings which are not in use. The refrigerating system is designed to maintain cargo at controlled temperatures down to −25°C and is fully automatic, with data logging facilities.

When refrigerated containers are stowed on deck they are cooled by separate clip-on packs connected to the ship's electric mains. On shore such containers may be connected to shore mains, if suitable, or Diesel-powered units may be clipped on instead. A number of containers will also be in use which incorporate permanent electric refrigerating machinery within the 20 ft module.

The total number of containers carried by *Axel Johnson* is 548 × 20 ft (184 on deck) and 62 × 40 ft (16 on deck). Converting the latter to 20 ft units, she can therefore fairly be described for purposes of comparison as a 672-container carrier.

The machinery of *Axel Johnson* represents a logical development of Johnson Line practice: multiple medium-speed Diesels viewed more as a prime power source for all shipboard requirements, rather than as purely propulsion engines.

The total requirement of 26 000 bhp is supplied by two 12-cylinder and two 16-cylinder Wärtsilä-S.E.M.T.-Pielstick engines rated at 5580 bhp each and 7440 bhp each, respectively. Running at 485 rev/min, they drive twin KaMeWa propellers (implying adequate submersion in all states of loading) at 136 rev/min through Fawick couplings and gearing supplied by the British AEI company. The main engines run on fuel of 3500 sec Redwood No. 1 viscosity.

Separate take-offs from each gear-box drive to shaft generators of ASEA make, each rated at 1050 kVA, this output being adequate for normal sea loads. Electrical power is also supplied by three Hedemora-Pielstick Diesels which develop a total of 2660 kVA. These engines, which run on Diesel oil, comprise two type V12 A/12 units developing 1140 bhp at 1200 rev/min and one type V8 A/12 unit developing 760 bhp at 1200 rev/min.—*Shipbuilding and Shipping Record, 27th June 1969, Vol. 113, pp. 871–874.*

Strick Line Vessel for Middle East Service

The Readhead Division, South Shields, of Swan Hunter Shipbuilders recently delivered 14 411-dwt cargo liner *Tabaristan* to Strick Line, a member of the P & O group.

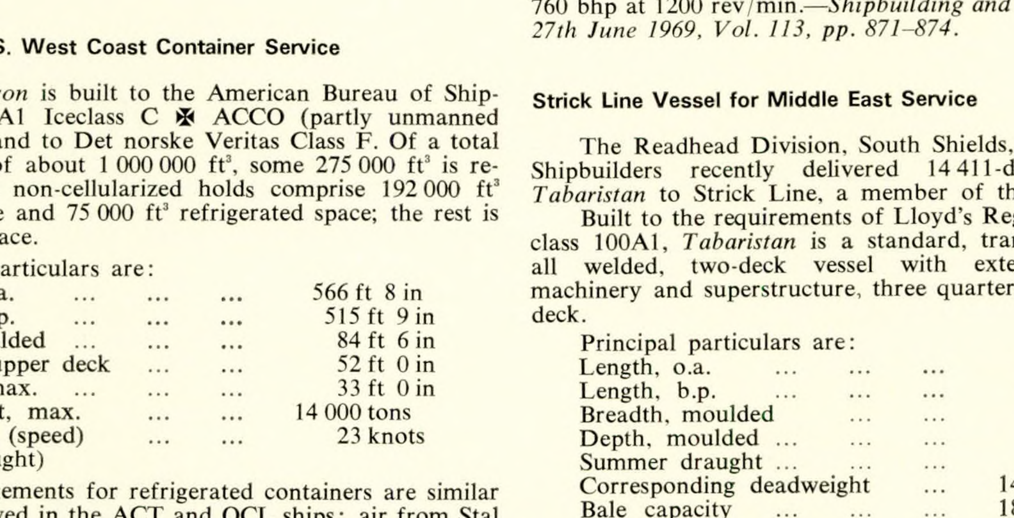
Built to the requirements of Lloyd's Register of Shipping class 100A1, *Tabaristan* is a standard, transversely framed, all welded, two-deck vessel with extended forecastle, machinery and superstructure, three quarters aft and a poop deck.

Principal particulars are:

Length, o.a.	152·40 m
Length, b.p.	144·78 m
Breadth, moulded	21·04 m
Depth, moulded	12·19 m
Summer draught	9·16 m
Corresponding deadweight ...	14 411 tons
Bale capacity	18 122 m³
Refrigerated capacity	258 m³
Service speed	17½ knots

Main engine:

Doxford 67J6 developing 10 800 bhp 120 rev/min



Container Ship Axel Johnson

Tabaristan is equipped with a combination cargo handling installation comprizing five cranes, six derricks and a Stülcken derrick. Electrically driven twin Gemini cranes with a capacity of 10½/21 tons serve hatches No. 1 and 2. Port and starboard at the aft side of No. 4 hatch are located two fixed Clarke Chapman electric deck cranes with a capacity of 10 tons. No. 5 hatch is served by a centreline Clarke Chapman 10-ton capacity fixed unit. Located between hatches No. 3 and 4 are two Stülcken masts for the operation of the 150-ton capacity Stülcken derrick which is capable of plumbing No. 3 and No. 4 hatches.

Tabaristan is propelled by a 670 mm-bore, 2140 mm-stroke six-cylinder opposed-piston Doxford type 67J6 engine having a rated service output of 10 800 bhp at 120 rev/min and giving a service speed of 17½ knots. Turbocharging of the engine is effected by two single stage Brown, Boveri turbochargers and a single electrically driven auxiliary blower. For manoeuvring, in addition to local control, the main and auxiliary engines can be automatically operated from the bridge as well as from an air conditioned, insulated control room in the machinery space. The main engine control, which incorporates electric, hydraulic and pneumatic systems, was developed by Doxfords and the General Electric Co. The control room console for the main and auxiliary machinery is designed to provide all salient information relevant to this machinery as well as actuating the controls. Temperature, pressure and tank contents gauges are grouped in banks, each one of which relates to one service. All alarms are visible and audible, the visible alarm taking the form of dual voltage indicator lights and the sound alarm being a klaxon for primary faults and a bell for secondary faults. These sound alarms can be muted instantly by push-button.

The main pumps can be operated from the control room console, with the watchkeeper selecting the run and standby pumps. Should pressure in the pump system fall below a certain prescribed level the standby pump system automatically comes into operation.

Tabaristan is the P & O Group's first ship to go metric, her draught readings being given in metres as well as in feet. Strick say the reason for the dual readings is to prepare ships' personnel for the metric changeover, scheduled to come into force in 1971.—*Shipbuilding and Shipping Record, 13th June 1969, Vol. 113, pp. 807–808.*

Versatile Ro/Ro Container Ship

The high-speed combination cargo vessel *Mormacsea*, first of a group of four ordered by Moore McCormack Lines, was constructed by Ingalls Shipbuilding Division of Litton Industries. The new design has been designated the Sea-Bridge Class by the owner. The Maritime Administration designation is C5-S-78a.

A large machinery-aft design was adopted. Although the original intent was to have a completely convertible RO/RO design, the fineness of the hull, the stability requirements, and the subdivision requirements dictated that the second deck was the only practical roll-on/roll-off space.

As it developed, the second deck comprised about 50 per cent of the total below deck cubic capacity. Hence, when carrying RO/RO and containers, the split was approximately ⅓ containers below deck, ⅓ RO/RO, and ⅓ containers on deck. Second deck RO/RO obviously presents some over-stowage problems, but consistent with the needs of high peformance, the number of ports-of-call must be held to a minimum, which in turn limits problems of this nature.

Using the previous Constellation class design as a basis for this new class of vessels, the engine room arrangement was modified due to engine-aft installation, a more sophisticated steam cycle and improved equipment design. To provide for more equipment space area, a platform level was provided between the lower level and the operating flat. This has proven extremely effective in providing a servicing area. The shaft alley, shafting and tail shaft removal details were carefully studied and a model was built to prove the feasibility of the design. The plant is designed for one-man operation capability.

To obtain the economies of reduced fuel consumption at such high power, a steam cycle with four stages of feed heating and regenerative air heaters was selected.

The main propulsion turbines are high-speed, cross compound geared type connected through flexible mechanical couplings to a double-reduction gear arranged to drive a single propeller. The turbine elements are of the impulse type with wheel and diaphragm type construction, designed for maximum economy when operating at maximum shaft horsepower with steam extraction from four points. The general construction features are those normally supplied by the vendor.—*Heess, F., Marine Engineering/Log, May 1969, Vol. 74, pp. 47–53.*

Cargo Vessel Converted for Heavy Lifts

N.V. Zaanlandse Scheepsbouw Maatschappij, Zaandam, recently converted the cargo motor vessel *Valkenburg* of Rederij 'Marlot', Rotterdam, for the carriage of heavy lifts, for which purpose the vessel was provided with heavy cargo-handling gear. This gear consists of a new mast placed amidships on the port side. The mast is provided with supports and a 60-ton derrick. Its height is 19·5 m and the length of the derrick attached to it is 17 m. To enable the ship to sail with the derrick in the topped position the mast has been provided with an outrigger with a bridle. The derrick is hauled home by means of a separate wire. The safe working load of the derrick is 60 tons at an angle of 40°—a radius of 13 m—which is 3·5 m outboard on the starboard side. The maximum slewing angle of the derrick is 2 × 90°, so that the load hoisted from outboard can be swung to above and into the two hatchways. A cargo winch and a topping winch, both of 10 tons capacity, were installed on deck and connected to the existing hydraulic system. In order to keep the ship's list within limits when handling heavy lifts, new sidetanks were built onto the sides of the vessel over a length of 36 m. As these new tanks have a breadth of one metre, the overall breadth of the vessel increased to 12·80 m.

The side-tanks are subdivided into six compartments, each provided with manholes, sounding and venting pipes. They are connected to a new ballast system, which makes it possible to fill or empty the tanks independently, either from the sea or from the SB and PS tanks.—*Holland Shipbuilding, June 1969, Vol. 18, p. 45.*

Stone Dump Barge

Recently delivered by D. Boot N.V., Alphen a.d. Rijn, the stone dump barge *Noordzee* owned by Zinkcon N.V. Hellevoetsluis is intended for laying a uniform bed of stone below the water surface.

For this purpose the vessel is provided with ten electro-magnetically activated vibratory chutes which dump the cargo of stone evenly over the vessel's starboard side.

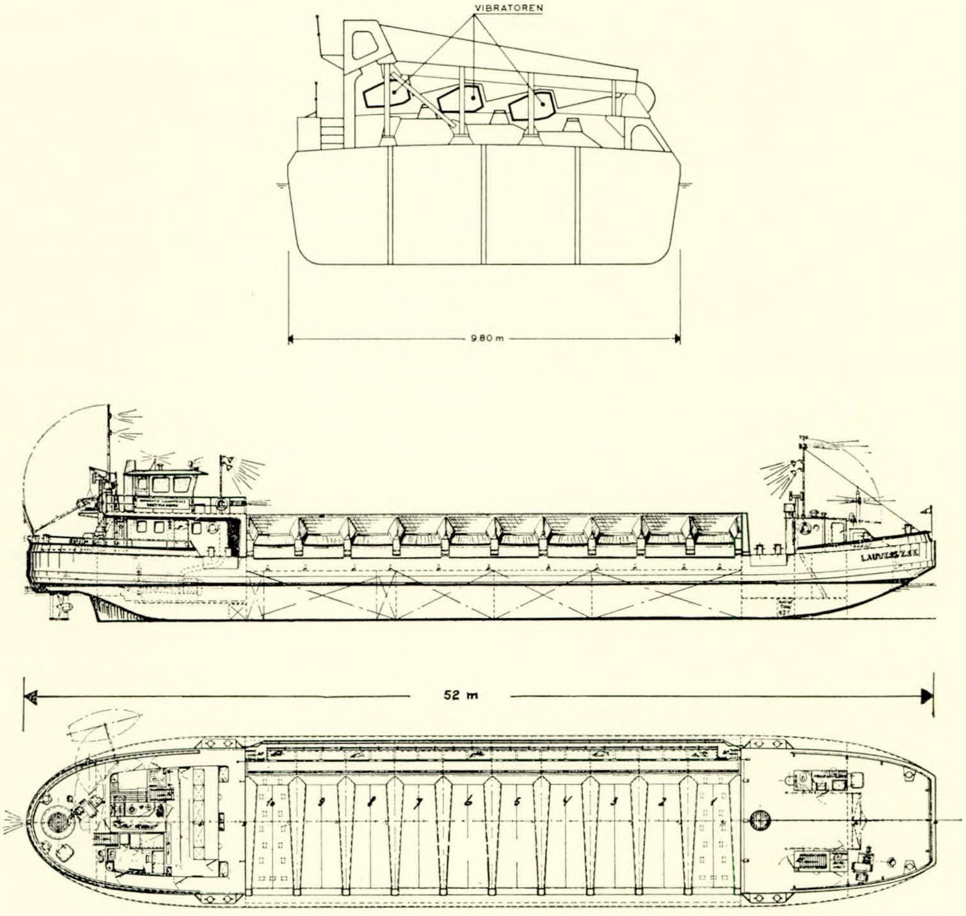
The principal characteristics of the *Noordzee* are as follows: length, o.a., 173 ft 10 in; length, b.p., 160 ft 9 in; breadth moulded, 32 ft 2 in; and breadth, o.a., 32 ft 4 in.

Depth to main deck at side is 9 ft 2 in, draught loaded 7 ft and the cargo deadweight capacity is 375 tons.

Main propulsion machinery consists of two Schottel Navigators, type SPR 225, each driven by a 12-cylinder Klöckner-Humboldt-Deutz Diesel engine type BF 12 M 716, with a continuous output of 400 bhp at 1500 rev/min.

The starboard Diesel engine also drives the main 230-400-V alternator, which supplies power for driving the vibratory chutes. It has an output of 340 kVA, at 1500 rev/min. Both main Diesels and the alternator are flexibly mounted on vibration dampers.

The dumping installation is installed on the main deck.



General arrangement of Noordzee

It consists of ten vibratory chutes built into one unit. These are placed free of each other on resilient supports on the deck and three electro-magnetic vibrators are provided at the underside of each chute. The armature, which is alternately attracted and released, is suspended from heavy blade springs in the same housing. The connexion to the vibratory chute is at the point where the armature is attached to the central point of the blade spring.

The type of current employed is alternating on which a direct current is superimposed. By increasing or decreasing the direct current, the zero-line of the direct current is shifted to a greater or lesser extent, thus regulating the intensity of the magnetic impulse. The armature is attracted by the stator under the influence of the magnetic impulse; the resilience of the blade springs retracts the armature as soon as the magnetic impulse drops away.

The stator and armature do not come into contact and there are no frictional or sliding parts.

The frequency is about 50 vibrations/sec and resilient supports prevent the transfer of vibrations to the surroundings.

The discharging operation starts with hydraulically hinging down the cargo flaps which prevent the cargo from dropping off while proceeding to the dumping site.

When the vibrators are switched on the piles of stone slowly collapse in a vertical direction. Sideways movement is seen only on the discharge side, where the stone goes overboard quite evenly until eventually all the remaining lumps of stone are in contact with the cargo surface. Only then does a sideways movement become manifest over the entire surface.—*Ship and Boat International July 1969, Vol. 22, pp. 17–18.*

Dutch-Built Tanker for British Owners

N.V. Nieuwe Noord-Nederlandsche Scheepswerven, Groningen, recently delivered to Messrs. F. T. Everard and Sons, Ltd., London, the 1335-dwt tanker *Activity*, the first of two sisterships ordered from the same builders. Constructed to Lloyd's Register of Shipping 100 A1, Oil and Chemical Tanker S.W. up to 1·5, the ship is of all-welded construction.

Principal dimensions are:

Length, o.a.	242 ft 8 in
Length, b.p.	220 ft 5¾ in
Breadth, moulded	33 ft 9¼ in
Depth	14 ft 7¼ in
Draught on summer mark ...	13 ft 0½ in
Deadweight on summer mark ...	1335 long tons
G.R.T.	697·67 tons
N.R.T.	394·99 tons
Total tank capacity	1770 m^3
Total W.B. tank capacity ...	190 tons

The cargo tanks are provided with heating coils made of seamless steel pipes. Steam coils are fitted at the bottom shell and extend up the ship's side to half height of the tanks. The steam for the heating of the cargo tanks is provided by a Spheroid Cochran boiler. This boiler has a capacity of 8800 lb/h. Its working pressure is 125 lb/in² and its maximum pressure 150 lb/in². The boiler is equipped with an electrically driven feed pump.

Deck machinery includes a Norwinch hydraulic windlass and capstan, while a Svendborg electric-hydraulic steering gear is installed. For handling cargo hoses there is a one-ton derrick attached to a single mast amidships. The ship has been provided with a Tornado bow thruster made by LMG, Lübeck. The bow thruster, which develops a thrust of 1·5 tons, is driven by an electric motor of 132 hp at 1450 rev/min. The propeller is made of stainless steel and has a diameter of 800 mm. The transverse tunnel has an inside diameter of 816 mm. The bow thruster is operated from the wheelhouse.

Activity is powered by a Deutz RBV6M 358 Diesel engine, developing 1380 hp at 275 rev/min. Control is from the bridge by a system supplied by the Newbury Diesel Co., Ltd. There are two identical auxiliary sets, each consisting of a Lister-Diesel engine developing 90 hp at 1500 rev/min which is flexibly coupled to a Hansa alternator of 50 kVA at 1500 rev/min. Coupled through a friction clutch connected to the generator is a Houttuin general service pump with a capacity of 48 m^3/h against a manometric head of 20 m. From the second shaft of the Lister Diesel engine is driven through a v.d. Graaf friction clutch a Hatlapa compressor with a capacity of 55 m^3/h at an end pressure of 30 kg/cm^2. A Norwinch hydraulic pump, is driven from the second shaft of the Lister engine by means of a flexible Lister coupling, a v.d. Graaf friction clutch and V-belts.—*Holland Shipbuilding, June 1969, Vol. 18, pp. 47–48; 58.*

Laker with Triple Mirrlees Propulsion

Hall Corporation of Canada, one of the biggest operators on the Great Lakes, have recently taken delivery of their largest laker *Ottercliffe Hall* of 27 080 dwt.

The *Ottercliffe Hall*, which has been designed to carry bulk cargoes of grain, coal and iron ore, is of all-welded construction, riveting being limited to deck stringer bar. She is of the single-deck type with short forecastle and full poop, and has a slightly raked stem, bulbous bow and modified transom stern with propelling machinery aft.

Principal particulars are:

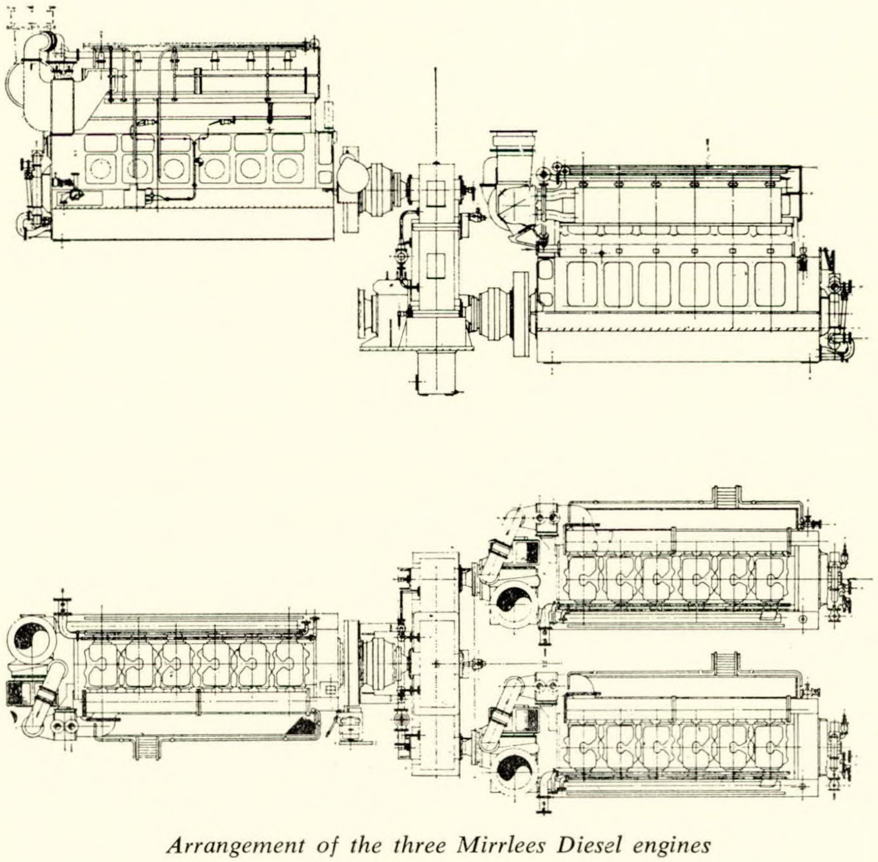
Length, o.a.	730 ft 0 in
Length, b.p.	709 ft 3 in
Breadth, moulded	75 ft 0 in
Depth, moulded	39 ft 8 in
Draught (summer, full)	26 ft $5\frac{1}{4}$ in
Corresponding deadweight ...	27 080 tons
Propulsion power	3 × 2770 bhp
Speed, designed fine weather, loaded	16·6 knots

The machinery arrangement of the *Ottercliffe Hall* is probably the most unusual feature of the vessel. To meet operational requirements with the best possible combination of flexibility and economy, the owners specified a three-engine installation in which all engines drive a KaMeWa c.p. propeller through a three-in, one-out gear-box.

The engines are of Mirrlees' well-proven and robust marine and industrial KMR6 Major design, each of 43·5 tons weight and each rated at 2772 bhp at 525 rev/min. Two engines are arranged forward of the gear-box, a special Lohmann and Stolterfoht design of 4·357:1 reduction ratio, and the third engine is mounted on a substantial stool aft of the gear-box and 7 ft above the two forward engines.

A particularly important feature of this installation is its short length. This is only 27 ft and as the gear-box can transmit 8067 bhp at an output shaft speed of 120 rev/min it must be regarded as a particularly significant installation. It is also noteworthy that, including the gear-box and the Pneumaflex clutch-type couplings, the total weight of the installation is less than 140 tons.

In normal operation the engines are started on light fuel oil and on reaching the required running temperature they are switched to a residual grade fuel of 1550 sec Redwood No. 1 viscosity, by remote control from an operating console in the engine room.—*Shipbuilding and Shipping Record, 18th July 1969, Vol. 114, pp. 13–14.*



Arrangement of the three Mirrlees Diesel engines

Advance in Navigation Technology

The existence of important requirements and critical problems of marine exploration has led to the development of a fully automated, self-contained, all weather system that provides continuous real-time precision navigation throughout the world. The new system was made possible by recent advances in navigation technology.

The Litton Marine Navigator (LMN), integrates a sonar-doppler velocity sensor and navigation satellite receiver with an inertial navigation system.

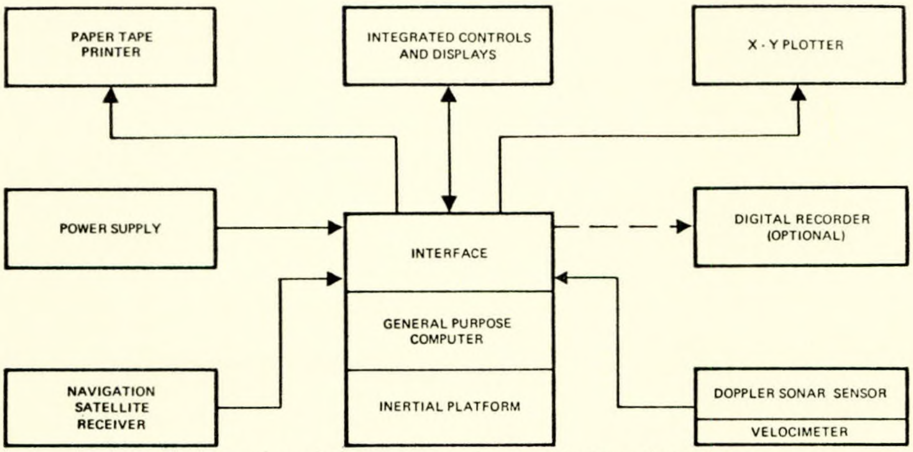
The inertial navigation system, with its associated general purpose computer, is the nucleus of the LMN. Its continuous operation over the total dynamic range of vehicle kinematics (independent of all environmental and operational characteristics) ensures the availability of timely and accurate data, free from interruption and loss of information. It provides the required multiple-angle resolution and filtering of the sonar-doppler velocity, thus ensuring its fidelity over the spectrum of vehicle dynamics and minimizing the effects of spurious doppler noise.

The sonar-doppler velocity information is introduced into the inertial system in a fashion commonly referred to as either a "damped inertial mode" or a "continuous gyrocompass mode". The desired degree of damping is a function of the characteristics of the operating environment and is automatically selected by the system. The way in which the system is integrated yields velocity accuracies bounded only by the limitations of sonar-doppler accuracy (more accurate than a ship's log) and inertial platform heading accuracy (more accurate than a gyrocompass).

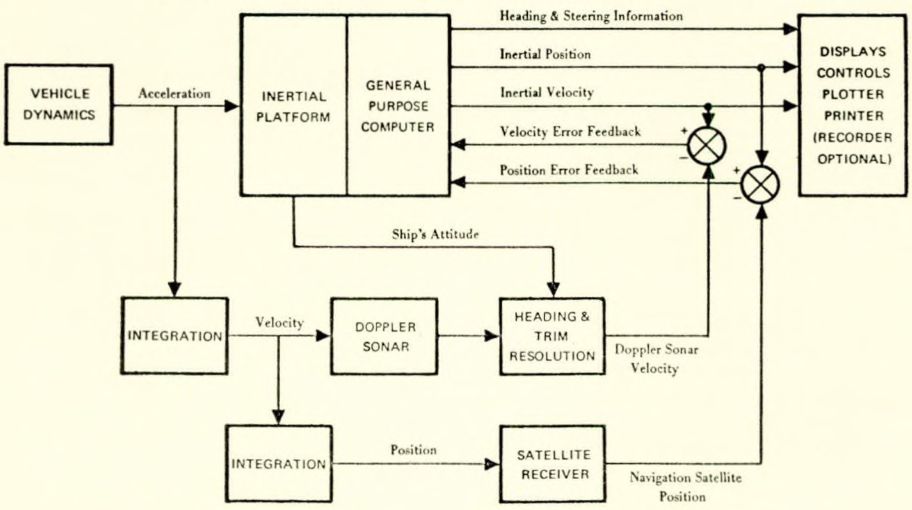
The long-term position accuracy of the LMN is automatically obtained from periodic position resets from the U.S. Navy Navigation Satellite System, which is now available for commercial use. The uninterrupted precision velocity information from the sonar-doppler augmented inertial system essentially removes errors (caused by the inaccuracy of the user's knowledge of his own velocity) from the position fix by the navigation satellite.

The LMN system includes the required data channels and controls for incorporating a multi-channel digital recorder to provide a record of all generated velocity, position, attitude, and sensed information. The digital recorder is an optional unit that can be furnished by the user if desired. An X-Y plotter and paper tape printer are part of the basic system.

The requirements for system power are met with input of 115 V, 60-cycle, 3-phase power. In addition, the unit contains batteries that ensure continuous operation of the inertial navigation system during an interruption of the primary power source.—*Wanamaker, W. A. and Lipman, J. S., Maritime Reporter/Engineering News, 15th June 1969, Vol. 31, p. 40.*



Block diagram relating the basic subsystem elements of the Litton Marine Navigator.



Advance in navigation technology—Representation of flow of information

Progressive Shipbuilding Methods on the Slip

The "island" method of hull construction employed in the series building of large ships in the Soviet Union is described and its advantages over other methods discussed.

The ship's hull is divided into two or three "islands" which are constructed simultaneously on the slip. The number of "islands" depends on the size and type of ship, the size of the slip, and the technology of the yard. For some types of ship it is necessary to incorporate one or two short "joining sections"; each of these is first fabricated as a complete unit, forming a kind of cofferdam, and then welded, simultaneously around the whole perimeter, first to one and then to the other adjoining "island". For large vessels it is essential that the butts of the shell plating and the longitudinal framing of "islands' 'to be joined are in the same plane around the whole perimeter of the hull. Construction, installation of machinery, and other fitting-out work are carried out simultaneously wherever possible, while the ship is still on the slip.

In "two-island" construction, without a "joining section", the after-part and fore-part "islands" are built simultaneously after laying down the bottom of the after-part. The after-part is built up, starting from its centre, in both fore and aft directions. The fore-part is built up in only the forward direction. If a "joining section" is incorporated, both islands are built up from their centres in both fore and aft directions. This variation is employed when the time taken to construct the fore-part exceeds that for the after-part.

For the larger vessels, "three-island" construction incorporating one or two "joining sections" is employed. "Three-island" construction with one "joining section" begins with the starting of the after-part (first island) of the first hull to be constructed, at the top of the series-production slip. This part is then moved to the bottom of the slip. The mid-body (second island) is then built on to it and the fore-part (third island) is constructed simultaneously, together with a "joining section" between the second and third islands, higher up the slip. Simultaneously, building of the "first island" of the second hull is carried out at the top of the slip. When the first hull has been completed and launched, the "first island" of the second hull is moved down to the bottom of the slip and the procedure repeated.

The advantages of the "island" method are that it reduces the time each ship spends on the slip and in the fitting-out basin, reduces costs, and allows more intensive and uniform employment of labour.—*Verdnikov, Y. V., Sudostroenie, 1968, No. 12, pp. 34–36; Jnl Abstracts B.S.R.A., March 1969, Vol. 24, Abstract No. 27 196.*

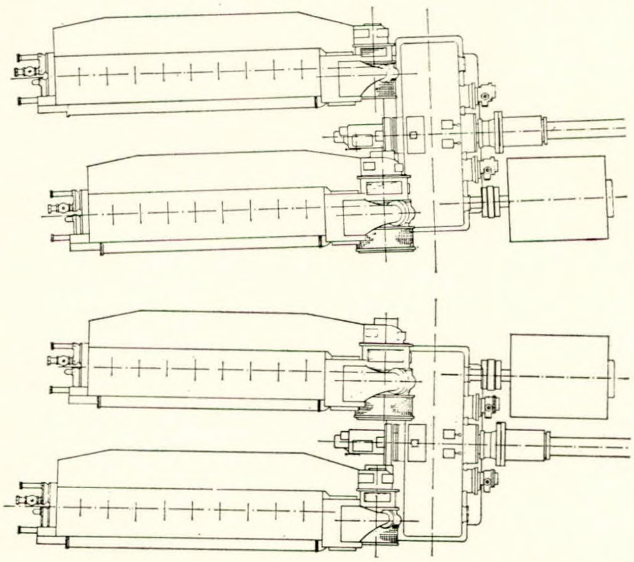
Cooling System for Icebreaker Power Plants without using Sea Water

Sea-water cooling systems in icebreakers are subject to frequent breakdown due to ice blocking the inlet pipes and pumps despite protective grids. This paper discusses the feasibility of using the "Shell-Cooling" system which has been incorporated successfully in some West and East German inland-waterway icebreakers, and, in particular, the West German dredger *Ludwig Franzius*.

Such a system cannot, however, be applied to the main propulsion machinery of large icebreakers because the wetted area of shell plating required to cool the water from the large power plants involved would be too great. For example, an icebreaker of 12 000 tons displacement powered by a Diesel engine with a specific power of 3 hp/ton displacement would require up to 30 per cent of the total wetted area of the hull for cooling, and for a steam-turbine installation the requirement would be approximately ten times greater. It was suggested, however, that the shell cooling system would be advisable for cooling important auxiliary power plants, e.g. emergency Diesel generators, for use in emergency situations like the sudden breakdown of the sea-water cooling system due to ice blockage. The specific operational power required for the auxiliary machinery in such ships is not more than 0·15–0·20 hp/ton displacement, which would require not more than 2 per cent of the total wetted hull surface for cooling.—*Aleksandr, M. L. and Klimov, V. V., Sudostroenie, January 1969,, pp. 41–44; Jnl Abstracts B.S.R.A., May 1969, Vol. 24, Abstract No. 27 462.*

New Type of Ro-Ro Ship

Trosvik Mekaniske Verksteder, of Brevik, Norway, has designed, in co-operation with the owners, Stena AB, Gothenburg, Sweden, a new type of Ro-Ro ship, of which two will be built by Trosvik and one by Kristiansand Mek. Verksted. To facilitate transportation of trailers, the propulsion and generating units had to be low-height machines and after due consideration the owners and the shipyards decided that Normo multi-engined plant would be ideal for the task. Four



New type of Ro-Ro ship—Plan showing position of motors in complete unit

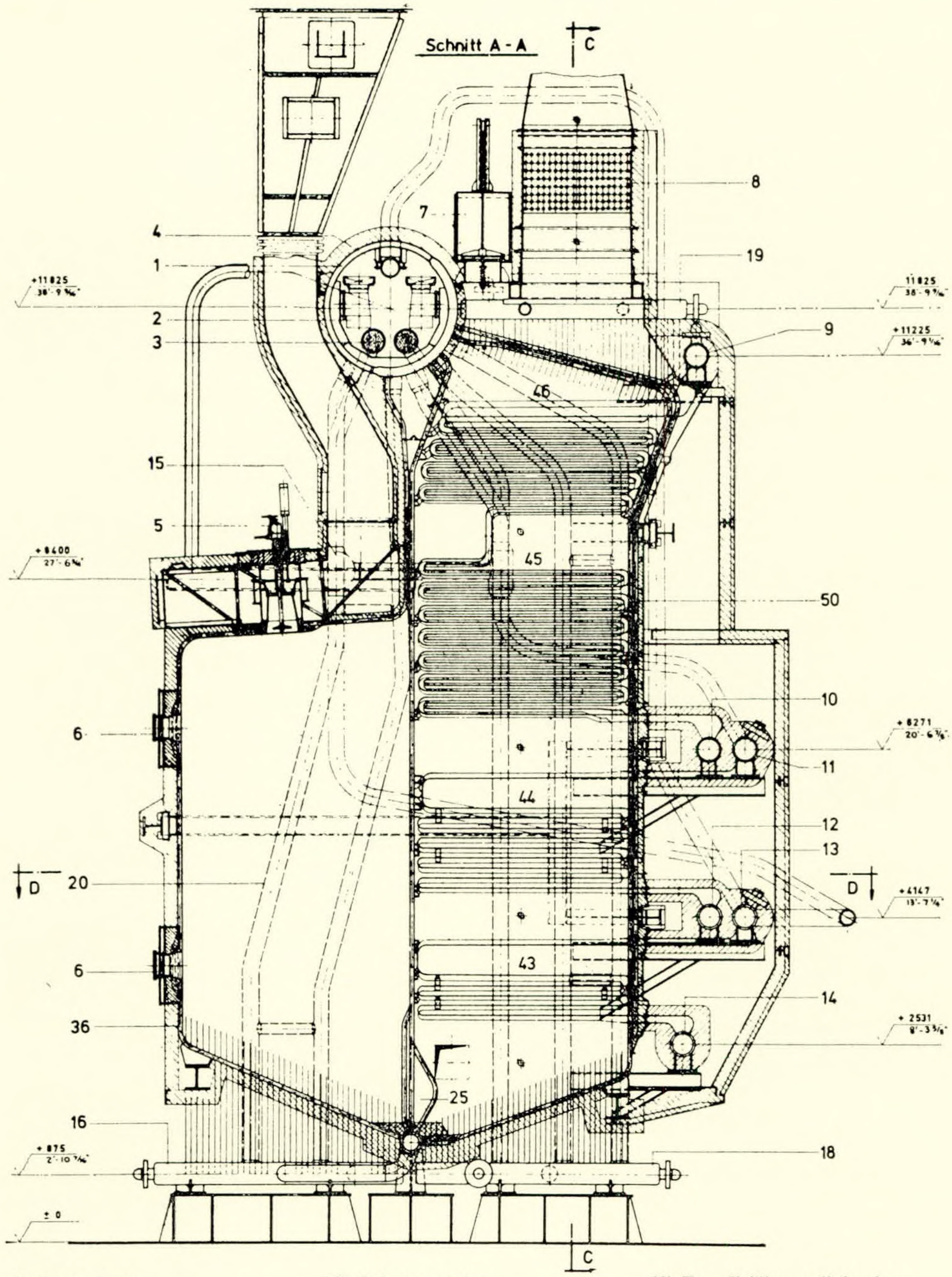
Normo Diesel engines, two of the LSM 8 type and two of the LSM 9 type placed in the arrangement shown, and having a total continuous rated output of 4600 bhp on intermediate fuel oil, will give the ships a speed of about 17 knots. The engines will drive two controllable-pitch propellers through two reduction gears; two 400 kVA alternators will also be driven by two of the main engines. One Bergen Diesel engine of the RSGB-3 type, coupled to a 300 kVA generator will supply the ship with electricity when in port.

The ships will be classed under Det Norske Veritas IS-B and will have the EO notation for unmanned engine room operation.—*Shipbuilding and Shipping Record, 28th March 1969, Vol. 113, p. 444.*

Esso Norway's Reheat Plant

Sea trials have taken place of the first European supertanker powered by a reversing turbine and reheat boiler. The *Esso Norway*, 190 000 dwt, built by Howaldtswerke Deutsche Werft, is equipped with a 30 000 shp MST 14 steam turbine of GE design, supplied by a single radiant reheat boiler built by Deutsche Babcock and Wilcox to a basic design by Babcock and Wilcox Ltd.

As can be seen from the illustration, this consists of a single furnace with control of reheat "ahead", and protection of the reheater at other times, by means of dampers situated in a cool gas zone at the boiler outlet. Similar to the now well established Babcock marine Radiant boiler for non-reheat



1) Steam drum
2) Steam cyclones
3) Attemperator
4) Dry steam
5) Babcock Venturi register
6) Observation door
7) Air sealing damper
8) Economizer
9) Reheater inlet
10) Reheater outlet
11) Secondary superheater inlet
12) Secondary superheater outlet
13) Primary superheater inlet
14) Primary superheater outlet
15) Three-way valve
16) Rear wall header
18) Bottom dividing wall header
19) Top dividing wall header
20) Downcomers
25) Access to furnace
36) Membrane wall tube panel
43) Primary superheater tubes
44) Secondary superheater tubes
45 & 46) Reheater tubes
50) Uptake side wall tubes

The Esso Norway's *marine Radiant re-heat boiler*

cycle machinery, the marine Radiant reheat boiler incorporates a large furnace of membrane construction, eliminating exposed refractory and providing a combustion chamber of ample proportion to assist in complete combustion with minimum excess air. The oil firing equipment, also of Babcock design, is roof-mounted, and the four burners are of steam atomizing Racer "Y"-Jet type fitted in Venturi air registers.

Separated from the furnace by a membrane screen wall, the convection pass of the boiler is separated into two parallel gas paths by a division wall. This latter and all the enclosure walls are also of membrane construction.

A superheater surface is arranged in each gas path, and a reheater is located in one gas path to correspond with secondary economizer surface situated in the other gas path. Gas flow over the reheater (and hence the reheat steam temperature) is controlled by regulating the dampers. Whenever there is low steam flow in the reheater, the dampers above it will close. If the reheat steam flow is further reduced or stopped, an air sealing damper opens, admitting air at windbox pressure into the space beneath the reheater dampers. The increase in pressure in this zone further restricts the residual gas flow until it is cooled by the superheater surfaces to a temperature below the maximum "ahead" metal temperature of the reheater. Main steam temperature is controlled between primary and secondary superheaters by an attemperator situated in the steam drum.

Boiler operating data

		Normal Load	Maximum Load
Total main steam flow	lb/h	189 100	218 290
Superheater outlet pressure	lb/in^2	1490	1490
Superheater outlet temperature	deg F	955	955
Feed water temperature	deg F	480	476
Reheat steam flow	lb/h	126 300	121 200
Reheater inlet steam temperature	deg F	619	613
Reheater outlet steam temperature	deg F	955	955
Excess air	per cent	5	5

—*Tanker & Bulk Carrier, August 1969, Vol. 16, pp. 191–192.*

Tasmania–Australia Ferry Ro/Ro Service

While the *Princess of Tasmania*, with accommodation for 333 passengers, is essentially a passenger/car ferry, the *Australian Trader* is able to lift more than 2000 tons of cargo as well as accommodating 200 passengers together with as many passengers' cars as required.

Principal particulars are:

Length, o.a.	445 ft 1 in
Length, b.p.	405 ft 0 in
Breadth, moulded	70 ft 0 in
Depth, moulded to vehicle deck	24 ft 6 in
Depth moulded to shelter deck ...	41 ft 6 in
Gross register	7005 tons
Nett register	3402 tons
Cargo deadweight	2000 tons
Machinery rating, max.	2 × 6500 bhp
Service speed	$17\frac{1}{2}$ knots
Maximum speed	$19\frac{1}{2}$ knots
Complement (crew)	69
Complement (passengers) ...	200
Car capacity	90

Propulsion is by twin 16-cylinder PC 2V400 Atlantique Pielsticks each developing 6500 bhp at 500 rev/min and driving twin screws through Renk 2·5:1 reduction gearboxes and Geislinger flexible spring hydraulic couplings. This is the first outfit of Pielsticks installed on a ship operating on the Australian coast. The main Diesel alternators comprise four Ruston Paxman 12YHC2 Diesels driving ASEA 500 kW alternators.

Operation of the engines is effected from a central control console in the engine room and there is a high degree of automation including monitoring and data logging by a Sperry-TKS EM20 installation. Remote control of the main engines from the navigating bridge is also by TKS equipment.

As is fairly common practice in ferry operations nowadays a bow thruster is fitted.

Australian Trader is the first Australian-built ship to be fitted with two independent stabilizing systems. The Bass Strait, as is well known, is notorious for the uncomfortable conditions which prevail at certain times and anything which can be done to improve a passenger ferry's sea-keeping qualities on the Tasmania–Australia run will be welcomed.

The two systems comprise a Denny Brown AEG retractable fin outfit and a Flume passive tank system. Unlike the fin stabilizer, the tank stabilizer is equally efficient at all speeds, does not increase the resistance of the ship through the water and does not use any power. The combination of two systems is considered more efficient than a larger size of either type on its own.—*Shipbuilding and Shipping Record, 4th July 1969, Vol. 114, pp. 18–20.*

Tests of Synchronous Alternators with Thyristor Unit

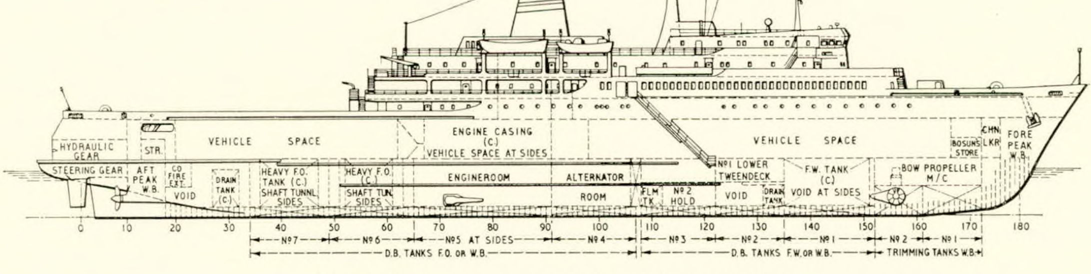
The application of thyristors as electronic excitation regulators in correction circuits permits a 20–30 per cent reduction in the overall weight of the compounding system and an increase in the speed of operation of the automatic voltage regulation system of self-excited synchronous alternators. Static and dynamic tests of self-excited synchronous alternators provided with a thyristor correction unit were carried out in the large sea-going trawlers *Mayakobskij* and *Yaronimus Uborevichus* in order to assess the reliability of such thyristor units in marine conditions. The thyristor correction units were constructed at the Leningrad Electrotechnical Institute.

The tests showed that the alternators were reliable during both single and parallel operation, and this type of alternator is now installed aboard the large sea-going trawler *K. Pozhela.*

It was suggested that further tests of such units are, however, desirable before their application in other ship types.—*Ilin, G. P., Maksimox, Y. I. and Yukhnovich, V. A., Sudostroenie, January 1969, No. 1, pp. 56–48; Jnl Abstracts B.S.R.A., May 1969, Vol. 24, Abstract No. 27 464.*

Stresses Around an Elliptic Hole in a Cylindrical Shell

A theoretical analysis is presented for the membrane and bending stresses around an elliptic hole in a long, thin, circular cylindrical shell with the major axis of the hole parallel to the axis of the shell. The analysis has been carried out for the case of axial tension. The method of solution involves a perturbation in a curvature parameter and the results obtained are valid, if the hole is small in size compared to the shell.—*Murthy, M. V. V., Trans. A.S.M.E., Jnl of Applied Mechanics, March 1969, Vol. 36, pp. 39–46.*



General arrangement of Australian Trader

New Swedish Medium Speed Engine

The new Swedish engine has been carefully designed and evaluated to meet one of today's leading growth markets in the marine machinery field; compact, high-output propulsion engines. Initially rated at 1000 bhp/cylinder it has plenty of "stretch" built in to enable 1250 bhp/cylinder and even higher unit outputs to be attained without major modifications. The type should, therefore, be assured of a long life and initial examples, being probably slightly underrated, may be expected to be relatively trouble-free machines. Development is not yet complete, however. The programme for the initial rating is not expected to be completed until July next year and the first ship with UDAB engines is not expected to be at sea until 1971.

Two UDAB machines are now running, a three-cylinder, in-line engine at Nohab's works and a six-cylinder vee-type engine at Götaverken. Eventually vee-type machines with 8, 10, 12, 14, 16 and 18 cylinders will be produced, also six and nine-cylinder in-line machines.

The UDAB is a monobloc engine with an underslung-type crankshaft, the main bearing caps being keyed by serrations. The cylinder block, which is fabricated of steel plate with cast steel brackets for cylinder head studs and cast steel main bearing housings, is a single unit, even for 18-cylinder engines. All joints are butt welds or TK-welds and machined for complete penetration. The block is placed on top of the engine base and the two components are held together by heavy bolts, thus forming a rigid unit that can be mounted on four brackets, two on each side of the base. The base also functions as a dry sump for the crankcase lubricating oil.

The journal and big end bearings are of the reticular tin or tri-metal type. Good performance of these bearings presupposes perfect alignment of the crankshaft and the cylinders and UDAB believe that this can easily be obtained with the rigid monobloc design.

At the time of the first demonstration of the UDAB V6 engine, a total of 170h running had been attained on Götaverken's testbed, 20h being at the full load of 1000 bhp/cylinder, 17·5 kg/cm² mep and 425 rev/min. Specific fuel consumption at this rating was measured at 157 g/bhp h and the temperature at the turbo-charger gas inlet was 560°C.—*Shipbuilding and Shipping Record, 13th June 1969, Vol. 113, pp. 803–806.*

Unexplained Hull Damage

A description is given of the damage which occurred to the Japanese tanker *Yoho Maru* on 9th August 1968. The 88 000-ton vessel was making 15½ knots in the Persian Gulf under full load, and the damage, consisting of a large hole and surrounding torn and buckled region (50 × 20 m) in the 21 mm plate of the starboard side, apparently occurred without the crew noticing anything other than a slight shudder. Weather was normal for the monsoon season, with a fairly high sea.

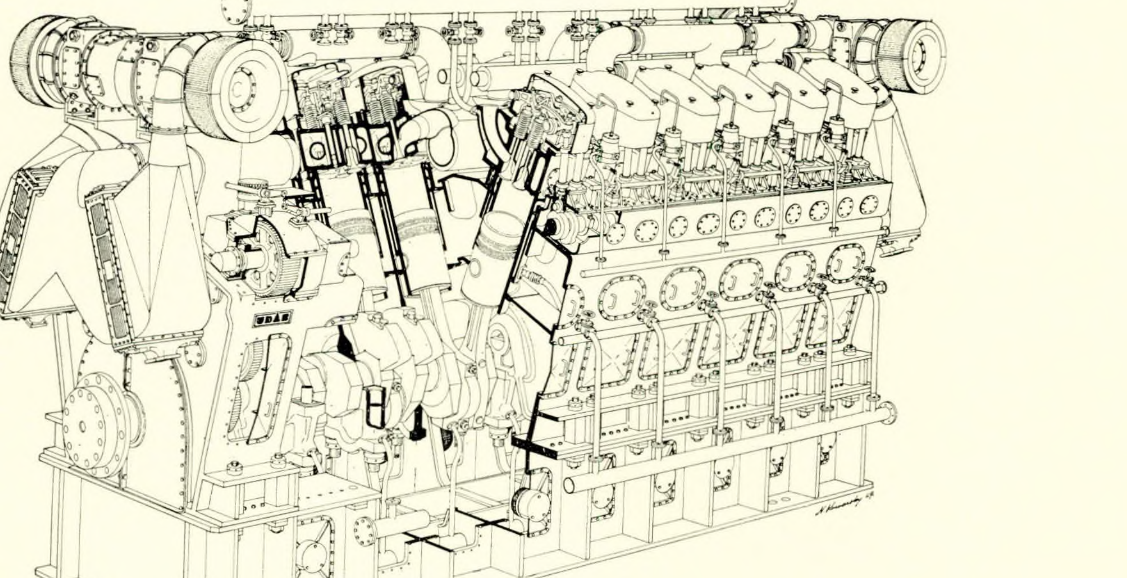
The damage occurred in the No. 3 starboard wing tank, which was at the time empty and gas-free, although some 11 000 tons of cargo was lost when the bulkhead between the wing tank and No. 3 centre tank was ruptured, and further leakage occurred from the adjacent wing tanks. The vessel returned to port, where it will take about three months to replace an estimated 1100 tons of hull plating.

Various theories have been put forward to account for the damage. It was at first thought that the ship had collided with a submarine, but drydock examination tended to rule this out. Explosion was eliminated as a possible cause, on the double ground that not only was the tank gas-free, but also that the deck plating was entirely untouched. The repair yard's own theory is that the ship collided with some object.—*Sjöfarts Tidning, Svensk, 14th February 1969, Vol. 65, p. 20; Jnl Abstracts B.S.R.A., April 1969, Vol. 24, Abstract No. 27 354.*

Propeller-Shaft Damage in Bezhitsa-Type Vessels

During routine inspection of the propeller shaft in several *Bezhitsa*-type general-cargo vessels after 11 000 operating hours, identical damage, consisting of fatigue cracks in the region of the cone base under the propeller and extensive fretting-corrosion on the propeller boss and shaft, was discovered.

An investigation, conducted to establish the cause of the damage, showed that the basic cause of the fatigue cracks was the high level of alternating tangential and bending stresses due to the fretting effect, which, in turn, was caused by the method of seating the boss on the liner and the local heating during soldering. Consequently, the soldering of the



New Udab engine—18-cylinder, 18 000 bhp liner to the shaft is to be discouraged.—*Yermoshkin, N., Balatskij, L. and Filiminov, G., Morskoj Flot, November 1968, No. 11, pp. 20–21; Jnl Abstracts B.S.R.A., May 1969, Vol. 24, Abstract No. 27 454.*

Exhaust Valve Corrosion in Diesel Engines Operating with Residual Fuel

A common theory in connexion with the use of residual fuels in four-stroke Diesel engines is that valve face corrosion leads to "guttering" and that this is due to the deposition of vanadium and/or a number of vanadium-sodium compounds from the fuel in use. The melting point of vanadium is around 649°C (1200°F) and, should exhaust gases be released at or about this temperature, the vanadium in its molten state may well stick to the valves and cause corrosion. This action would be aggravated if the valves themselves were operating at about the same temperature. It should be noted that a few of the vanadium/sodium compounds have even lower melting points than the temperature given above, as can be seen from Table I.

Table I

Compound	Melting point (°C)	Melting point (°F)
Sodium pyrosulphate $Na_2S_2O_7$	682	1260
Vanadium pentoxide V_2O_5	691	1275
Sodium sulphate Na_2SO_4	885	1625
Sodium metavanadate $NaVO_3$	629	1165
Sodium pyrovanadate $Na_4V_2O_7$	632–754	1170–1210
Sodium orthovanadate Na_3VO_4	849–866	1560–1590

It is significant that eutectic mixtures of V_2O_5 and sodium metavanadate and sodium pyrovanadate and sodium metavanadate have even lower melting points of 566°C (1050°F) and 577°C (1070°F) respectively. Sodium sulphate also forms a eutectic mixture with V_2O_5 which, with a melting point in the region of 538°C (1000°F), is lower still.

The adverse effects of the high sulphur content in residual fuels is well known in engineering circles and manufacturers recommend that, in these cases, engine operating temperatures be kept as high as possible in order to minimize the formation of strong acids resulting from the combustion of sulphur and subsequent mixing of the sulphur trioxide with moisture.

To satisfy this theory given above the following exercise was carried out:

Two badly-burned exhaust valves loaded with deposits were taken from an engine for examination and deposit analysis after approximately 500 hours running on the fuel analysed in Table II.

Table II—Analysis of residual fuel

Specific gravity at 60°F	0·964
Viscosity Redwood No. 1 at 100°F	1114 seconds
Gross calorific value	18 650 Btu/lb
Sulphur, by weight, per cent	3·1
Ash, by weight per cent	0·02
Water, by weight, per cent	Nil
Conradson carbon, by weight, per cent	10·5
Flash point (closed)	200°F (93°C)
Pour point	45°F (7°C)
Vanadium (parts per million)	48
Sodium	Not quoted

Chemical spectographic analysis of small parts of the valve deposits reveal that the major elements were vanadium, sodium, sulphur, calcium, iron, silicon, nickel, cobalt and chromium. Much smaller quantities of lead and manganese were detected together with traces of tin, copper, cadmium and potassium.

The source of the various elements given above were allocated as follows:

Element	Source
Vanadium, sodium, sulphur	Fuel oil
Calcium	Lubricating oil
Iron, nickel, silicon	Valves and seat inserts
Cobalt, chromium	Valve facing alloy

Examination of the samples confirmed that the deposit was in the nature of an extremely hard slag well bonded to the metal of the valve.

Having determined that the source of the vanadium, sodium and sulphur was the residual fuel (as above) the tests continued to endeavour to determine the mechanism of the deposition and the sequence leading up to the seat "guttering".

The bulk of the evidence appeared to be that "guttering" was due more to indentation of very hard particles of either vanadium and/or carbon slag than straightforward vanadium compound corrosion; corrosive action on the valve face could be attributed to sulphuric acid-soaked carbon filling the indentations.—*Gas and Oil Power, June 1969, Vol. 65, pp. 130–133.*

Navigation System for High Speed Craft

Sealane is a new navigation system for high-speed surface craft which provides a world-wide navigation capability designed for the BH7 naval patrol hovercraft ordered from the British Hovercraft Corporation for the Royal Navy.

Developed by Elliott Automation Space and Advanced Military Systems Ltd. (EASAMS), under contract to the Ministry of Technology, Sealane follows the navigation system designed for the SRN.3 hovercraft which uses Decca Navigator equipment comprising an aircraft type flight log combined with an Omnitrac 1A digital computer and a Decca true motion radar. This system is the basis for Sealane, which is scheduled to complete development trials at sea in 1970 and to enter service in 1971. The system includes Decca Navigator Mk. 19 as the automatic fixing device, Decca 71 H doppler which, together with an Arma-Brown gyro-compass Mk. 5 heading reference sub-system, forms a D.R. component, and a Decca Transar Group 8 high definition navigation radar as the primary sensor for collision avoidance and in-shore pilotage. Processing of the data from these sensors and the provision of navigation displays is accomplished digitally by a computing sub-system based on the Decca Omnitrac 70 computer.

The system operates in any one of three modes. In the primary mode, navigation is accomplished in a combination dead reckoning/auto fixing configuration using a predictor-corrector technique to eliminate both error in D.R. navigation and noise on the automatically derived fixes. In the event of failure of either the Decca Navigator of the doppler, the system automatically reverts to the remaining sensor and illuminates mode status indicators on the navigation control panel. Any of the three modes may also be selected, if required. In the doppler mode, facilities are provided to trim out systematic D.R. error. In the Decca fixing mode, fixes are smoothed. The system allows destinations to be specified on two consecutive legs, as either tracks and distances from present position or as geographical co-ordinates. A Steer command then initiates repetitive computation and display to the navigator of present position, distance-to-go and cross-track error on decimal read-outs, required and actual track-made-good and ground-speed on meters and trace of craft position on a Decca Mk. 6 flight log.—*Shipbuilding and Shipping Record, 4th July 1969, Vol. 114, p. 28.*

Medium Speed Diesels will not burn Trinidad Residual Fuel

Ten ships in the 22 000/24 000 dwt range ordered by the parent companies of Scottish Ship Management Ltd., Glasgow, from Norwegian and British yards are to be powered by Ruston type AO medium-speed Diesel engines. Two vessels ordered by Lyle Shipping from Kaldnes Mek. Verksted, Tonsberg, are to be chartered by Saguenay Shipping and will be propelled by a Horten-Sulzer slow-speed direct-coupled engine of the 6RD76 type, rated at 9600 bhp at 119 rev/min.

The reason for the selection of these engines in the case of the Saguaney vessels was due to availability of Trinidad heavy oil on what will be their route. Scottish Ship Management state that this fuel is not suitable for Ruston *or any other design* of medium-speed propulsion machinery.—*Shipbuilding and Shipping Record, 13th June 1969, Vol. 113, p. 809.*

Construction of the Beaver Submarine

Welding and related metal fabrication techniques have permitted the construction of *Beaver Mark IV*, one of the first submarines so far designed to carry out important peacetime work in oceanic environments. *Beaver* is the prototype of a craft which North American Rockwell Corporation's Ocean Systems Operations Division, Long Beach, California, will manufacture for other companies throughout the world if its performance is in conformity with current expectations.

Beaver is a steel, glass fibre, and aluminium structure weighing 15 ton. With its three 4 hp electric motors, it is capable of carrying a 1 ton payload at speeds ranging from 0–5 knots for periods up to 12h. In terms of speed, this performance capability may not seem remarkable, but it is more than sufficient for an environment in which a speed of only 1 knot could be too fast.

Beaver's basic external and internal structures were made for North American Rockwell by Hahn and Clay Co., Houston, Texas, mainly because the latter firm had specialized experience and equipment which permitted the fabrication and welding of large components from HY-100 steel to tolerances as close as ±0·030 in. Even slight deviations from critical tolerances in this instance could have reduced the craft's safe depth capability several hundred feet.

In the Houston factory, components were initially fabricated with press and press brake equipment from 1 in thick plate. Then welding was done with metal-arc and submerged-arc equipment, and requisite tolerances were achieved by tediously removing excess material with machine tools at a rate of 0·001 in on each pass.

Stress-relieving was subsequently carried out in a large furnace, after which the components were rigorously tested with ultrasonic equipment to ensure their structural soundness.

This assignment involved the production of two steel spheres which, together with an interconnecting crawl-away, comprise *Beaver*'s basic internal structure. The forward sphere is 7 ft diameter, or just large enough to provide comfortable quarters for the craft's two-man crew, while the rear sphere (which has a lock-in/lock-out hatch for divers) is 5½ ft in diameter.

Beaver also has three titanium spheres, each 3 ft in diameter and capable of holding 20 gal of water as variable ballast (which gives the craft some of its manoeuvrability). These, like other non-ferrous structures which are now part of the submarine, were built with specialized welding and metal fabrication equipment in North American Rockwell's Los Angeles Division.

Beaver is remarkable in that all of its exterior appendages are jettisonable. More precisely, it has provisions that will enable its crewmen to discard its engines, mechanical arms, 5000 lb of batteries, and ballast tanks in the event of an emergency. Attachments for these external appendages are essentially the same as devices used to jettison fighter aircraft wing tanks.

Aluminium and glass fibre components were extensively used inside *Beaver* to minimize weight without a sacrifice of other desirable characteristics. Inert-gas shielded metal-arc welding techniques facilitated the joining of aluminium members, while both heat-fusion and heat-curing methods were employed in processing organic binders for glass fibres.—*Welding and Metal Fabrication, July 1969, Vol. 37, pp. 297–298.*

Effects of Technological Developments on Ship Management

The technological developments now taking place in shipping are having a marked effect on the management of ships and may briefly be summarized as follows:

i) larger, faster and more specialized ships are being built causing shipping companies to carry out extensive technical and economic feasibility studies;
ii) ships are now being seen as only one link in the through-transport chain causing companies to pay more attention to the scheduling of ships and to the inland movement of cargoes;
iii) ships are becoming more expensive and more complicated vehicles causing companies to pay more attention to the calibre and training of their personnel;
iv) new instruments, equipment and materials are becoming available causing top management to rely more heavily on the advice of their technical experts;
v) new methods of operation, most of which are aimed at reducing time in port, are causing companies to pay more attention to personnel management and to develop sound, practical maintenance philosophies.

—*Shipping World and Shipbuilder, July 1969, Vol. 162, pp. 942–943.*

Effect of Water Chemistry and Design on Corrosion of Carbon Steel-Tubed Feedwater Heaters

This investigation deals with the factors responsible in controlling the corrosion of carbon steel-tubes feedwater heaters. Water chemistry variable include *p*H, hydrazine and carbon dioxide. Heater design considerations include the effect of velocity and inlet channel distribution. Although there are certain unexplainable findings with respect to corrosion behaviour, the installation tested proves the acceptability of carbon steel for feedwater heater service.—*Morris, E. B. and Phillips, H., Trans. A.S.M.E., Jnl of Engineering for Industry, April 1969, Vol. 91, pp. 102–108.*

Apparatus for Determining Dynamic Modulus of Elasticity and Internal Damping Capacity

Investigations of the damping mechanism of metals and alloys require damping capacity measurements to be made over wide stress, frequency and temperature ranges. The apparatus described fulfills these requirements in all respects except that it has a limited low stress range. It also provides elastic modulus data over corresponding stress, frequency, and temperature ranges.—*James, D. W., Materials Evaluation, May 1969, Vol. 27, pp. 102–106.*

Approximate Solution for Thermal Performance of Stirling-Engine Regenerator

An approximate closed-form solution for the thermal performance of a Stirling-engine regenerator is derived. The solution is for sinusoidal mass flow rate and sinusoidal pressure variation with a phase angle relative to the mass flow. The solution provides the net enthalpy flux along the regenerator and the change of phase between the mass flow and the pressure. The method is similar to that developed by Rea, and the results agree well with his experimental data.—*Quale, E. B. and Smith, J. L., Trans. A.S.M.E., Jnl of Engineering for Power, April 1969, Vol. 91, pp. 109–112.*

On the Stability of Grillage Beams

A general method for obtaining the stability criteria of a grillage is presented. Axial loads in both sets of intersecting beams are considered. Properties and arrangements of beams are fairly arbitrary, as are permissible boundary conditions. However, the analysis is restricted to include only initially straight compression members.—*Chang, Pin-Yu and Michelsen, F. C., Jnl of Ship Research, March 1969, Vol. 13, pp. 23–31.*

Vibration Analysis of Grillage Beams

A simple method of analysis of the vibration characteristics of grillage beams is introduced which is proven to be extremely simple to use. Irregularities in structural details of many types are admissible. Hence, the method is particularly applicable to ship structures. The natural frequency is shown to be a solution of a transcendal frequency equation. By application of the Rayleigh-Ritz method, approximate natural frequencies can be derived.—*Chang, Pin-Yu and Michelsen, F. C., Jnl of Ship Research, March 1969, Vol. 13, pp. 32–39.*

Experimental Determination of Steady and Unsteady Loads on a Surface Piercing, Ventilated Hydrofoil

Measured steady and unsteady lift and moment coefficients at two spanwise locations on a surface-piercing ventilated hydrofoil are presented. The foil, of wedge cross-section, was supported vertically, and submerged one chord length from the tip. Excitation in rigid-body rolling and pitching modes to the cantilevered foil produced the unsteady loads. All tests were made at a nominal angle of attack of 12°.—*Ransleben, G. E., Jnl of Ship Research, March 1969, Vol. 13, pp. 1–11.*

Recommended Emergency Welding Procedure for Temporary Repairs

The new merchant cargo ships use a large variety of steels in their construction; the steels range in yield strength from 40 to 100 kg/in^2. Since some of these steels require a close control of the welding procedure as well as other special techniques to assure serviceability, it was felt that a special repair welding procedure must be developed. The recommended temporary welding repair procedure and a discussion of the survey which led to the recommendations are described in this report.—*Lowenberg, A. L. and Watson, P. D., Ship Structure Committee, May 1969, Report SSC-195.*

Brittle Fracture Strength of a Welded Joint

The evaluation of brittle fracture strength of welded joints with defects is one of the most important factors for the design of welded structures from the aspect of brittle fracture. Brittle fracture initiation characteristics of the bond and the weld metal are influenced by heat input and welding procedures. The author discusses brittle fracture initiation and arresting characteristics with regard to the quality of the steel in question.—*Ikeda, K., Japan Shipbuilding and Marine Engineering, May 1969, Vol. 3, pp. 17–22.*

Analysis and Interpretation of Full-Scale Data on Midship Bending Stresses of Dry Cargo Ships

Results of the analysis of stress data from full-scale measurements on two C-4 type cargo vessels, s.s. *Wolverine State* and s.s. *Hoosier State*, are presented in the form of histogram and cumulative distributions, which together with previously analysed full-scale data cover a total of five years of normal ship operation in the North Atlantic. In addition, results of analysis of full-scale data are given for two additional ships, *Mormacscan* and *California Bear*.—*Hoffman, D., and Lewis, E. V., Ship Structure Committee, June 1969, Report SSC-196.*

Investigation of the Utility of Computer Simulation to Predict Ship Structural Response in Waves

Methods of computer simulation of ship structural response to waves are described, with emphasis given to the slowly varying bending moments due to waves and to slamming responses. Analogue, digital, and hybrid computer systems are analysed, and results obtained by the use of the most efficient computational procedures for each type of structural response. The vertical and lateral bending moments due to waves are determined by use of a digital computer; and sample computations illustrated for determining frequency domain outputs.—*Kaplan, P., Sargent, T. P. and Raff, A. I., Ship Structure Committee, June 1969, Report SSC-197.*

The Consumable Nozzle Electroslag Welding Process with Movable Current Terminal

The consumable nozzle electroslag welding process with movable current terminal is an automatic single-path vertical welding method as is the ordinary type of consumable nozzle welding. The wire is fed through a stationary, consumable nozzle of non-flux coating to the weld area, and weld metal is continuously cast under a shielding medium which is a blanket of molten flux. In the new process, both a current terminal and copper shoes are designed movable upwardly with weld progression.—*Nakajima, M., Ishikawa, Y. and Shimamoto, T., Mitsubishi Heavy Industries Technical Review, 1969, Vol. 6, No. 1, pp. 1–9.*

New Machinery Arrangement in 89 000 dwt Ore/Oil Carrier

The features adopted by the author include varying the height of the third deck of the engine room to be at the same level as the engine top platform, assembling the auxiliary machinery into compact units and determining the passages for pipes, cables, and trunkings at the initial design stage so that they can be led in straight lengths as far as practicable.—*Togawa, S., Mitsubishi Heavy Industries Technical Review, 1969, Vol. 6, No. 1, pp. 72–82.*

Detection of Incipient Failure in Bearings

The detection of incipient failure in general is related to the detection of the basic causes of failure. In this paper, defects which lead to failure are created and/or simulated and are detected, utilizing resonant frequency techniques falling in the ultrasonic frequency range. Rotational frequencies of the bearing are calculated and identified. Correlation is shown between R.M.S. amplitude at these frequencies and the severity of the defects incorporated.—*Balderston, H. L., Materials Evaluation, June 1969, Vol. 27, pp. 121–128.*

Economic Considerations in Shipboard Design Trade-Off Studies

The economic aspects of shipboard design trade-off studies are given a comprehensive analysis. The net present value criterion is employed in developing a procedure which can practicably be used to assess the economic merits of design alternatives. Examples, which illustrate the procedure developed, are given.—*Harrington, R. L., Marine Technology, April 1969, Vol. 6, pp. 197–210.*

Acoustic Holography as a Tool for Non-destructive Testing

Acoustical imaging by means of holography has been shown to be an effective means for producing an optical image of an acoustical pressure field. Several applications are described and results of initial investigations presented. These applications include imaging flaws in butt welds, voids in 4-in thick aluminium or steel.—*Brenden, B. B., Materials Evaluation, June 1969, Vol. 27, pp. 140–144.*

Investigation into Flange Forces in Winch Drums

This paper describes a series of experimental tests carried out to investigate the forces acting on a winch drum during multi-layer rope winding. Consideration is given mainly to flange forces, which are one of the prime causes of winch drum failure. A new method of measuring flange forces is demonstrated and comparisons are made of test results for different rope constructions, rope tensions, and spooling. —*Paper by Bellamy, N. W. and Phillips, B. D. A., presented to I.Mech.E. for written discussion, 1969, paper P27/69.*

Experimental and Analytical Studies of the Compression Ignition of Fuel-oxidant Mixtures

The paper describes an approach employed for predicting the time variation of the state of a non-adiabatic reacting charge undergoing a change in density, such as that in a motored auto-igniting engine or the "end gas" of a spark ignition engine. To test the approach, hydrogen gas is employed as a fuel in the closely controlled environment of a specially developed compression apparatus which is closely akin to that of the piston engine, yet more amenable to control and analysis.—*Paper by Karim, G. A. and Watson, H. C., submitted to I.Mech.E. for written discussion, 1969, paper P37/69.*

General Theory of Fatigue Damage Accumulation

To develop a general linear theory of isotropic cumulative failure involves a phenomenological consideration of fatigue damage accumulation under very general conditions. To accomplish this, it is necessary to extend the basic notions of cycle-dependent behaviour for a harmonic stress variation to more complicated situations. The mean and alternating components of a conventional waveform are given a suitable interpretation to account for irregular stress-time variations. —*Sorensen, A., Trans. A.S.M.E., Jnl of Basic Engineering, March 1969, Vol. 91, pp. 1–14.*

Feasibility Study of Model Tests on Ship Hull Girders

An efficient programme is identified for ultimate strength testing of hull girder models representative of longitudinally framed ship construction. The purpose of the tests is to generate data to provide the basis for engineering design of the primary structure of the hull girder. The major loads are longitudinal compression induced by primary hull bending, normal pressure from the sea, and athwartship compression induced by the horizontal pressure on the sidewalls.—*Becker, H., Ship Structure Committee, May 1969, Report SSC-194.*

Liquid/Vapour Action in a Vessel During Blowdown

Vapour bubble rise forms the basis for a theoretical study of liquid/vapour action in a saturated system during blowdown. Methods are developed and demonstrated for predicting time and space dependent mixture properties. Graphs are presented for estimating the time dependent mixture level during steam, water, and mixture-blowdowns from 1000 lb/in^2 absolute. Theoretical mixture levels are compared with vapour blowdown experiments.—*Moody, F. J., Trans. A.S.M.E. Jnl of Engineering for Power, January 1969, Vol. 91, pp. 53–61.*

The Effect of a Wake on the Wave Resistance of a Ship

This paper discusses the viscous effects which cause errors in predicting the resistance of a thin ship by Mitchell's linear theory. Assuming the position of separation streamlines, the author presents the wave resistance calculations by use of Mitchell's integral.—*Milgram, J. H., Jnl of Ship Research, March 1969, Vol. 13, pp. 69–71.*

Froude Number Effects on Two-Dimensional Hydrofoils

The performance is considered of a two-dimensional hydrofoil of arbitrary camber, moving at arbitrary Froude number at a constant depth below a free surface. The treatment is based on the use of singular distributions and thin foil theory. By assuming an appropriate series form the vortex distribution representing the hydrofoil, it is shown that the problem can be reduced to the solution of a set of linear algebraic equations. Numerical results for the performance characteristics for several hydrofoil configurations are given.—*Hough, G. R. and Moran, J. P., Jnl of Ship Research, March 1969, Vol. 13, pp. 53–60.*

Some Results from the Inverse Problem of the Annular Airfoil and Ducted Propeller

Calculations were carried out to predict the shape of annular airfoils with prescribed pressure distributions when in the presence of a propeller. The annular airfoil was mathematically modelled, in the linear sense, by a system of ring vortices and ring sources. An actuator disc model was used for the propeller and hence only the average effect of the propeller was considered.—*Morgan, W. B., Jnl of Ship Research, March 1969, Vol. 13, pp. 40–52.*

Thermal Effects in Slider Bearings

The authors have shown previously by solving numerically the relevant mathematical equations describing lubricant flow, heat transfer, and thermal distortion of bearing components in a slider bearing of infinite width, that for the particular operating and boundary conditions assumed, thermal distortion rather than variation of the lubricant properties is the cause of hydrodynamic lubrication of initially parallel, radially grooved, thrust bearings. In this paper, numerical solutions are presented to show the effect of relaxing these conditions.—*Paper by Hahn, E. J. and Kettleborough, C. F. presented to I.Mech.E. for written discussion; 1969, paper P31/69.*

Effect of Hot Surface on Combustion of Injection Fuels

Ignition characteristics and combustibility of Diesel fuels injected against hot surfaces were determined in a combustion-bomb apparatus. Experimental results were: (1) with higher hot surface temperatures there is shorter ignition delay and more rapid combustion, (2) with higher ambient pressures, shorter ignition delay occurs, (3) with low hot-surface temperature and ambient pressures there is a large effect on ignition delay by atmospheric temperature, (4) with large injection angle there are longer ignition delays at low ambient pressures.—*Teshirogi, N., Uchiyama, Y. and Motohashi, K., Jnl Mechanical Laboratory, 1966, Vol. 12, pp. 1–9; Applied Mechanics Reviews, April 1969, Vol. 22, p. 404.*