DESIGN AND COMMISSIONING OF STEAM TURBINE INSTALLATIONS

J. F. Preston, C.Eng., M.I.Mech.E. (Associate Member)

Further Correspondence

Dr. P. A. Milne, B.Sc. (Associate Member) wrote that unrealistic assumptions in heat balance calculations were often made at the tender stage or during the introduction of new machinery types. Margins were reduced and load levels taken at unrealistic values so that the best possible fuel consumption could be claimed. Figures were then written into a contract which would not be realized in service. The author made no allowance in his assessment of the four cycles for the improved boiler efficiencies normally associated with a more complex cycle. It was possible to obtain some improvement in this area by reducing excess air and uptake temperatures even if the 90·5 per cent mentioned in the paper was regarded as ambitious. Similarly, there were other features in the plant such as low propeller revolutions, steam conditions and additional stages of feed heating which would be developed from their existing values to reduce total fuel consumption without reducing reliability or complicating operation. An economic justification of the type used in the paper should be made in each case with a proper allowance included in the first cost for additional water treatment plant. The degree of development chosen in each area of the plant would depend partly on the costing and partly on service experience.

When the treatment of feed water was being considered, a good case was made for a 5 micron Duplex filter and it would be interesting to know whether this was a full flow or bypass unit. The justification for an ion exchange plant was not dealt with in such detail. What persuaded the author to fit one and where did he consider it should be located in the feed system? Was the output of the evaporator treated before going to the storage tanks, or did the make-up to the fed system itself go through the ion exchange unit before going into the main system?

Now that there was a Shipbuilding and Marine Industry Standards Committee in the British Standards Institution, there would appear to be some virtue in raising a marine code of practice for commissioning. Each company had done a certain amount of work on this problem, the emphasis being on the areas where they had experienced the most difficulty. This practice could be brought together into one document to establish a standard for the industry. The British Ship Research Association had already done some work in this area, but confined their attention to controls and instrumentation. It was interesting to note that they considered it necessary to investigate and specify the format in which technical information would be made available. Lack of precise technical information or directive, in other words an undefined standard, was in many cases one of the main problems in implementing adequate quality control procedures.

In the case of control equipment, there were four basic stages of commissioning, starting with a check of the equipment and connexions to each item once they had been installed in the ship. A loop check could then be made to confirm the action of the loop to various pre-set signals. This should be done before the associated equipment had been run so that the third stage could include commissioning and checking of the loop under the load conditions available during commissioning. Final checks could then be made under the full load conditions available on the sea trial. The emphasis put on commissioning plant and neglecting the associated controls and instrumentation was one of the main problems. Part of this difficulty might arise from the tendency to make changes in the control specification up to a late stage in the design of the ship.

When acid cleaning was discussed, cleaning *in situ* was the only possibility considered. In the case of the feed system and the steam systems, it was possible to clean each individual pipe using the same basic processes and then to purge the system with either clean water or steam once it had been assembled in the ship. This, in many cases, was a more convenient process because a large number of bypasses had to be put into the system if it was done after assembly.

Mr. D. S. Macfarlane (Member) wrote that Mr. Preston's paper, in covering the design and commissioning of steam plant, laid out an argument on the choice of cycle. As one of the reasons for the choice of the particular heat cycle the author instanced operational problems on gas air heaters. Considerable effort and redesign had been made over the last seven or eight years to overcome objections of this nature and by worldwide co-operation, significant changes had been made in the design and operational reliability of rotary gas air heaters.

Marine gas air heaters were now fitted with heating surface elements coated with vitreous enamel. This coating reduced surface fouling, inhibited considerably corrosion from flue gases, and had virtually eliminated damage from soot fires. Sootblowers were now fitted on both gas outlet and air inlet ducts allowing for in-port cleaning using the air side blower. Water washing of the surface could be carried out on load by using the fixed multi-nozzle pipe fitted in the top gas or air duct and by reducing the rotor speed to 1/15th rev/min. This operation could be carried out at boiler loads up to 80 per cent or 90 per cent full load.

Maintenance of the preheater had been simplified by the removal of oil circulation and cooling water requirements and by sizing all components to have a minimum life of fifteen years. All parts subject to wear and tear were readily accessible and easily replaced. Replacement of all parts was possible, with the exception of the rotor seals, from outside the heater with the boiler on load.

Since 1960 some 180 tankers and bulk carriers, including the largest in the world, had been, or were being, fitted with gas air heaters, the total number of heaters being over 300.

Reports from many sources indicated that the gas air heater, in providing a more efficient cycle had not placed a heavy burden on seagoing staff nor proved costly on repairs.

MR. P. A. KNOWLES (Associate Member) in a written contribution, remarked that the need for a common language and agreed standards amongst filter people had been long felt and a great deal of work was being done to remedy this. However, the difficulties were tremendous. Filtration was still largely an art, despite brave attempts to turn it into a science. He did not mean that science could not be applied anywhere in the field of filtration but, science had not been able to provide the practical engineer with basic parameters in a form suitable for designing into an engineering project. Filtration science must be built on a foundation knowledge of the capture mechanism of a particle from the fluid by a filter medium, but this capture mechanism was not yet fully understood.

Filtration was a difficult subject and must be treated with caution. Having sounded the warning, he gave design engineers three guide lines (slanted for lubricating oil application other than I.C.E. systems) which should lead them to select confidently filtration equipment for their particular applications. The author referred specifically to disposable paper elements but this was not the only type of element that could be used for lubricating oil. Recent advances in synthetic fibre materials had made paper less attractive as a filter medium.

Referring to Fig. 9, the curve could be very helpful providing it was propertly interpreted. The author, referring to the curve, stated that "the filter will remove 94 per cent of all particles of 15 micron or over in a single pass". This conclusion was only strictly valid if:

a) the contaminant used during the test work to obtain data for the curve was representative of the contaminant built into and generated in the lubricating oil system in question;
b) the liquid used during the tests was of the same viscosity as that in the system;
c) the flow rate through the test medium was the same as that which passed through the filter in the system.

The fact was that the contaminant, viscosity and flow rate would vary according to operating conditions and therefore the per cent efficiency of the filter would vary. Accepting that the filter would vary in efficiency according to operating conditions, it was now a matter of deciding whether the variation would be significant for practical purposes. No indication from the curve could be given without knowing the details of the test procedure used to produce the data for the curve. However, from the author's experience one could presume that any efficiency variation could be accepted. With this assurance, Mr. Knowles referred back to the test curve and used it as a basis for specifying the filter performance. Thus the filter could be specified by "94 per cent of all particles of 15 micron or over to be removed". The 94 per cent might not be the best level to take but this method of specifying by relating a micron size with efficiency, although not the complete story, was nevertheless sufficient to eliminate a large number of unsatisfactory filters which, by accepting sales propaganda, would otherwise appear suitable. The first guide line then was never to accept a filter quoted on micron size alone, it was meaningless without the qualification of per cent retention efficiency.

The author also specified the above filtration as a "total cut-off of 20 microns". Unfortunately a "total" cut-off was difficult to achieve and equally difficult, if not impossible to measure. The existing methods of counting the number of particles getting through a filter were statistically too in-

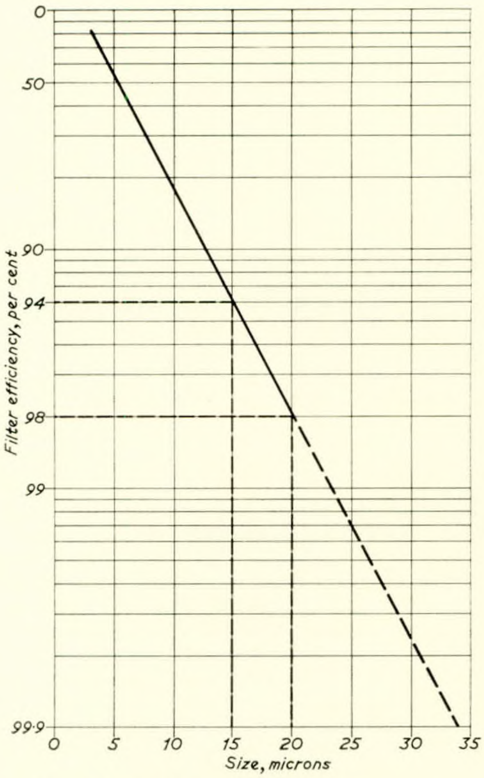

FIG. 21—*Efficiency of paper element*

accurate when dealing with transmission of particles below one per cent. This was illustrated in Fig. 9 because the curve did not appear to cut the 100 per cent efficiency line and therefore did not really give a true cut-off value. (Taking into account that the curve might not have been reproduced exactly as the original.) The cut-off value, e.g. where the curve should cut the 100 per cent efficiency, had to be estimated and this was better done by redrawing the curve with a log scale for efficiency as shown in Fig. 21. It so happened the curve came out as a straight line. Extrapolating to the 99·9 per cent line one obtained a figure of 34 micron which was above the cut-off figure quoted by the author. Admittedly the extrapolation might not be strictly valid but it did illustrate the care that must be taken when deciding the cut-off value. A great number of very accurate particle transmission tests would be necessary to obtain points to check the lower dotted part of the curve but it was evident that the "true" cut-off value would in any case be higher than the 20μ quoted by the author. For practical purposes, as always, one must compromise and ignore the few larger particles that might get through (represented by the 0·1 per cent not accounted for), and take on a level of 99·9 per cent, or near this, as the "effective" cut-off size. The 99 per cent level could be taken and was much easier to determine, but from practical experience and laboratory work Mr. Knowles thought that there was a strong case for going even higher, say, to the 98 per cent level for the "effective" cut-off value. This value was more reliable and could therefore be used with confidence. It should be remembered that, with paper elements, there was a rising efficiency coupled with a lowering "effective" cut-off value as the element was loaded with contaminant. Now referring to the revised curve, the 98 per cent level gave 20 micron which brought one back to the author's quoted level, but if this value was used it must be qualified as the "effective" cut-off. The second guide line then was never to accept the term "total" or "absolute" cut-off size. It was better to use the term "effective" cut-off which, for engineering purposes, could be confidently taken as that size qualified by an efficiency of 98 per cent (or higher, but with caution).

During the discussion the author, again referring to Fig. 9, mentioned the "Nominal" micron rating of the filter. This was taken at the 50 per cent efficiency level which gave a 5 micron value. This might have some use for sales purposes but was of no use for system design purposes. For some psychological reason, nominal 5 micron had become the magic "degree of filtration" in the engineering industry and had been used loosely to differentiate between "fine particle" filtration and the rather coarser filtration associated with wire gauze, spaced disc and wire-wound filters. Unfortunately the language of sales literature became coloured with customer phraseology resulting in the presentation of a great variety of filters apparently achieving the same 5 micron results. "Nominal rating", from any viewpoint, was completely meaningless and the design engineer was advised to disregard it. Most filter manufacturers were able to provide efficiency curves for the filter medium relevant to the fluid being filtered, and with this pressure drop/flow characteristics of the whole filter unit. The third guide line then was never to accept a quoted nominal rating but ask for efficiency data; the pressure drop/flow characteristics would indicate the size of the unit required.

Finally, he put in a plea for design engineers and, for that matter, seagoing engineers to be more aware of the performance capabilities of their filtering equipment. The importance of filtration had been amply illustrated by the author (with special reference to Fig. 14) and by users, judging by their readiness to blame the filter when mechanical things went wrong. By examining "condemned" elements it was usually possible to exonerate them from blame and at the same time by analysing the captured dirt it was often possible to get an indication of the real cause of machinery failures. There was now enough performance data and a variety of good quality filters available for a fairly confident selection of size and type for the job. It was up to the shipbuilder to raise his standards of cleanliness to prevent initial overloading and the user to maintain performance by regular "clean" servicing.

Author's Reply

In reply to the additional correspondence, Mr. Preston wrote that Dr. Milne had touched on five points in the paper some of which required direct answers and others comment only.

On the subject of fuel rates as quoted in tenders and contracts, there was little point in examining these figures closely unless one realized what the figures constituted. Nothing was gained if the fuel rate quoted was meant as Dr. Milne implied, to create an image. As far as the author's company was concerned, the fuel figures shown in the contract and indeed the fuel figures looked for in tendering were those which would be reproduced in service over the life of the ship. In this case the fuel rate was used in the economic appraisal also and, therefore, there was little point in accepting something which was unrealistic. It might well be, however, that with other owners a fuel rate was quoted or sought which could be more easily checked on sea trials but which bore no resemblance to that which they hoped to achieve in service. On sea trials it was easier to check out a fuel rate where all subsidiary loops and circuits such as accommodation heating etc. had been eliminated. Turbine designs varied very little as far as the claimed non-bled steam rate was concerned and, therefore, any fuel reduction must be in the cycle and the complexity built into it. The fuel rate was not the sacred cow that one used to imagine; it was now realized by all shipowners, the author believed, that it was really meant as a yard-stick to gauge whether or not the plant was capable of being operated as designed.

As far as gaining economy in operation from other aspects of the plant, these possibilities must of course be examined very carefully during the design stages. It was often the case that a greater economy could be accrued from such things as slower turning propellers etc., than could ever be squeezed from the fuel rate.

The next point raised was feed water treatment insofar as filtration and demineralization was concerned. The five micron duplex filter mentioned in the paper was a full flow unit placed in the drains tank extraction pump discharge.

The length of the paper had limited the comments possible on items such as the ion exchange units fitted. All make-up feed water was passed through this unit before it entered the feed system. The process consisted of passing the water to be treated through a mixture of strongly acidic cation exchange resin and strongly basic anion exchange resin, the assumption being that sodium chloride was the main trace contaminant in the make-up water with copper and CO_2 present. The exchange unit served a very useful purpose as a feed water polisher, eliminating the sodium chloride and removing the copper element which, from tests, had proven to be 10 per cent of the total copper transported to the boiler. The utilization of this demineralizing plant did ensure that all water reaching the boiler from the make-up system was pure and neutral, diminishing the requirement for treatment chemicals which in turn helped to keep down the total dissolved solids of the boiler.

The building up of a code of practice for commissioning would be most welcome. This would need to be on a world-wide basis since shipowners generally were international in nature. Such codes of practice would certainly assist the industry beyond measure. The author would agree with the point that when a code of practice was produced it must contain precise technical information and directive, otherwise it would not fulfil the use for which it was meant. However, where precise technical information was included, there was a requirement for continual up-dating, otherwise it would fall into disuse by falling out of phase with technical advances.

The author welcomed the comments on commissioning of instrumentation and controls and found that his inclinations were very much in line with those of Dr. Milne. The importance of commissioning this section of plant methodically could not be over-emphasized nor would it be necessary to do so once the industry had savoured the advantages to be gained from so doing. As far as the continual process of making modifications in the control systems was concerned, it was to be hoped that as the science became more commonplace and the loops more familiar, the requirements for modification would decrease, making the problem a transient one.

The suggestion of acid cleaning pipes for steam and condensate systems prior to fitting in the ship was not new. Unfortunately, experience had shown that, with the extended periods of time required for fitting out, poor storage and rather indifferent blanking off methods used for pipelines, after treatment had always produced unsatisfactory results. The author was convinced that circulating acids during fitting out processes would prove to be of little inconvenience providing this was taken into account in the design stages. This pre-planning had already been touched upon by Mr. Cochrane*, during the verbal discussions.

Mr. MacFarlane had taken up the cudgels on behalf of the rotary gas air heater and its inclusion, in its latest improved form into advanced heat cycles.

It was true that one reason given in the paper for non-adoption of the complex cycle was the undue burden on staff and high repair costs experienced in the past. The extraction of one item from the list of reasons given was not however the most realistic way of examining the problem. With the adoption of gas air heaters, the feed system must be further complicated by added feed heaters etc., if the advantage claimed for this mode of heat recovery was to be taken.

Fig. 3 in the paper did, in fact, show a yearly saving for cycle B. After taking into account the effect of capital the saving was small although positive and of an acceptable rate of return and, therefore, one was left to decide whether or not the additional risk of lost operational hours due to the added complexity was amply covered for. Whilst accepting that more modern design and improved materials contributed to the improved performance of air heaters, the fact still remained that a maintenance load existed. This manpower absorption must also be taken into account, bearing in mind the increasing labour costs which were shown on the labour cost curve as opposed to the constant fuel cost.

It was only after taking all these things into account that the validity of a paper saving must be looked at. Having established what the maximum yearly saving could be and viewed the amount of extra equipment involved the author's company concluded that there were more fruitful channels to explore before attempting to achieve savings from the last drop as far as fuel rate was concerned.

Mr. Knowles had kindly taken up the subject of filtration and dealt with it in a full and authoritative manner. The author was most grateful for the precise manner in which the three guidelines had been laid down, the reasoning being amply described.

There was not much more to add on the subject, other than to mention that where fibrous material had been used in the past for filtration, problems had been experienced when water was present in lubricating oil. Coalescing of water on the fibres inhibited the free passage of the oil, producing symptoms of loading when this was not the case. Presumably the recent advances mentioned by Mr. Knowles in the use of synthetic fibres had overcome this difficulty.

* Cochrane, D. 1969. Contribution to discussion on "Design and Commissioning of Steam Turbine Installations." *Trans. I.Mar.E.*, Vol. 81, p. 14.

Marine Engineering and Shipbuilding Abstracts

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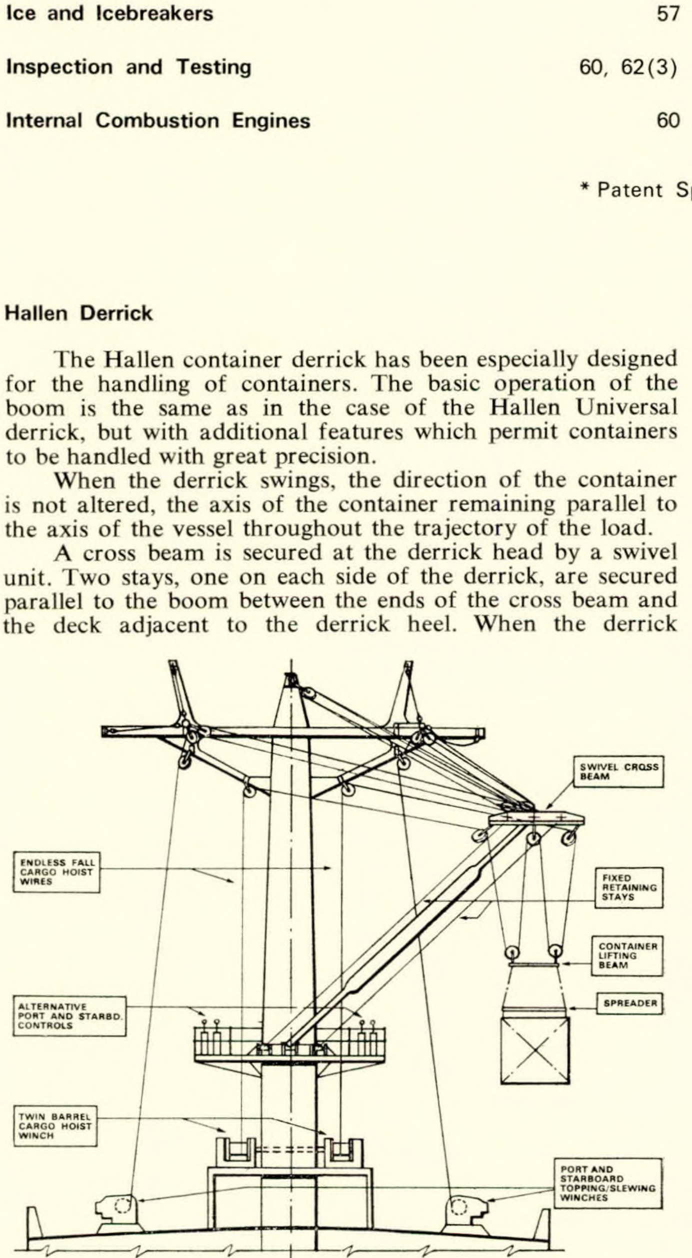
Hallen Derrick

The Hallen container derrick has been especially designed for the handling of containers. The basic operation of the boom is the same as in the case of the Hallen Universal derrick, but with additional features which permit containers to be handled with great precision.

When the derrick swings, the direction of the container is not altered, the axis of the container remaining parallel to the axis of the vessel throughout the trajectory of the load.

A cross beam is secured at the derrick head by a swivel unit. Two stays, one on each side of the derrick, are secured parallel to the boom between the ends of the cross beam and the deck adjacent to the derrick heel. When the derrick swings, these stays ensure that the derrick head cross beam retains a position of 90° to the axis of the vessel in all positions on the derrick.



Hallen container derrick

The cargo hoist winch contains two barrels geared to the same shaft. Each end of the cargo hoist wire is connected to each of these barrels forming an endless fall between three upper cargo hoist blocks at each end of the spreader.

When miscellaneous general cargo is being handled, only two upper cargo hoist blocks are used with one single sheave block at the cargo hook, or alternatively, two separate wires joined in union at the cargo hook.

The hoist tackle described above in addition to affording facilities for the precise handling of containers, also provides an anti-pendulum device when handling miscellaneous general cargo without any loss in the hoisting speed and therefore improves the efficiency of the cargo operation.—*Shipbuilding and Shipping Record, 23rd and 30th August 1968, Vol. 112, p. 269.*

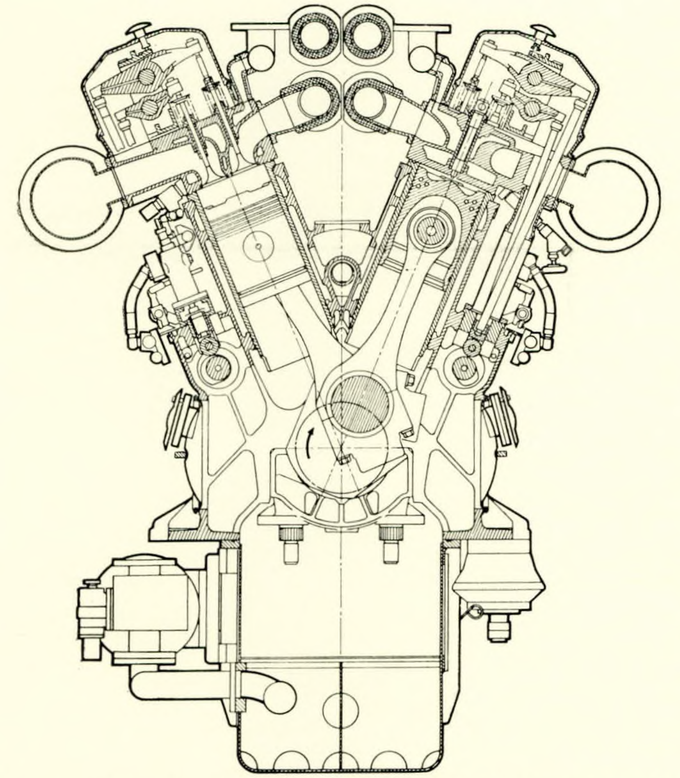
Belgian Minesweeper Support Ship

The Cockerill Yards at Hoboken, Belgium, have recently delivered a command and logistic vessel for minesweepers to the Royal Belgium Navy. *Zinnia* (A961) has staff quarters, accommodation, stores and outfit on a scale which will enable her to operate, together with a flotilla, as an autonomous unit.

Principal particulars are:

Length, o.a.	326 ft $0\frac{3}{8}$ in
Breadth, moulded	45 ft $11\frac{1}{8}$ in
Draught	11 ft $9\frac{3}{4}$ in
Speed	over 18 knots

The hull is of all welded construction, longitudinally-framed on the double bottom and under the decks and transversely-framed at the shell. The bulkheads are arranged to obtain a two-compartment subdivision. As is usual nowadays the entire vessel is of gastight construction for defence against radioactive, bacteriological and chemical attack. Great attention has been paid to fire protection and there are four 90 ton/h pumps for this duty alone, as well as a



Cross-section through the Cockerill TR240CO engine with cast steel upper crankcase, cylinder block supported on resilient mountings with fabricated steel sump suspended below, stepped rockers and two-deck cylinder head. Pistons are cooled by a flow of oil through a steel tube cast under the crown

4500 litre/min foam generator. The pumps could also be used for pre-wetting purposes. The navigational equipment is of the most up-to-date type, to naval standards with wireless, gyro-compass, log, radio-telephones, radio direction finder, Decca Navigator, radar and echo-sounder. A 400 hp hydraulically-powered bow thruster to assist in berthing and a tank-type stabilizer are provided.

The main machinery has been supplied by Cockerill-Ougree-Providence and consists of two V12TR240CO engines, which are 12-cylinder vee-form versions of the six and eight-cylinder 240CO in-line engines already in rail traction service. The main characteristics of the engines are as follows:

Number of cylinders	12
Vee angle	45°
Cylinder bore	$9\frac{1}{2}$ in
Piston stroke	12 in
Continuous output	2500 bhp at 1000 rev/min
Maximum output	2750 bph at 1033 rev/min
B.m.e.p. at nominal speed and continuous rating	191 lb/in²
Mean piston speed	1999 ft/min
Dry weight	13·75 tons

For railway traction, the maximum rating proposed for the V12TR240CO is 3000 bhp at 1000 rev/min but the crankshaft has been approved by Lloyd's Register and Bureau Veritas for up to 3900 bhp at 1050 rev/min.

An important design feature is the use of a single-piece steel casting for the cylinder block/crankcase.

The underslung crankshaft has journals which are induction-hardened, and ground, and carried in reticular-tin-aluminium steel-backed shell bearings. The oil-cooled pistons are of aluminium-silicon alloy. Two inlet and exhaust valves are fitted in detachable cages and operated by stepped rockers and push-rods from camshafts arranged at the outside of the cylinder banks. The oil and water pumps are driven from the engine and all the crankcase running gear can be examined through doors fitted above the level of the crankshaft.

The engine is turbocharged and inter-cooled, there being one Hispano Suiza HS509A2 turbocharger and two Serck inter-coolers. Direct injection of fuel is adopted and the individual Bosch pumps are controlled by a Woodward PGA speed-droop-type governor. This is pneumatically controlled from the wheelhouse.—*Marine Engineer and Naval Architect, May 1968, Vol. 91, pp. 168–170.*

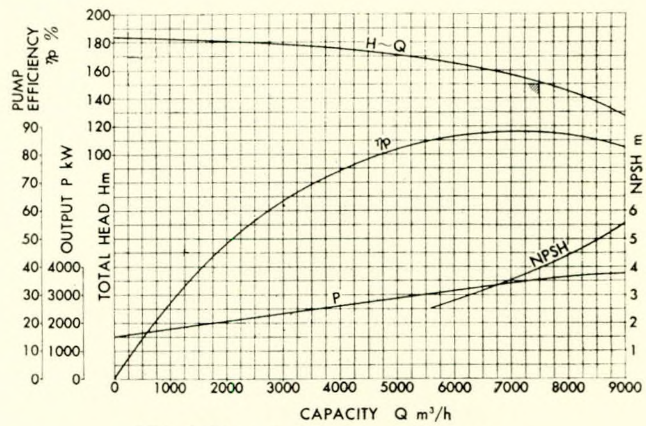
7500 m³/h Cargo Pump by Shinkokinzoku

Closure of the Suez Canal and the resultant rocketing of tanker sizes has led the Hiroshima pump specialists to design a cargo pump and driving turbine of capacity commensurate with the 400 000–500 000 dwt ships of the future. This large pump has now been made and tested satisfactorily. In order to be able to use it at full output for as long as possible, special attention has been paid to ensuring that the suction head at which cavitation occurs (NPSH), is as low as possible and this is less than 4 m.

Principal particulars are:

Cargo Pump		*Steam turbine*	
Type	Vertical	Type	Vertical two-stage Curtis
Capacity	7500 m³h	Output	4000 kW (5864 hp)
Head	150 m	Steam pressure	60 kg/cm²
Suc. bore	850 m	Steam temp.	430°C
Dis. bore	600 m	Exh. pressure	0·3 kg/cm²

The pump has a vertically-split, double-volute casing and the shaft is supported in two grease-lubricated ball bearings. Stuffing boxes fitted with US-1 type mechanical seals are used. The Cardan shaft has tooth-type flexible couplings and a ball race steady bearing.



Shinkokinzoku pump performance (4000 kW steam rate=2900 kg/h)

For the test programme Shinkokinzoku made two impellers for pumping rates of 7500 m³/h × 150 m and 6000 m³/h × 150 m respectively and the performance at 100, 85 and 70 per cent of the normal full speed of 5516/750 rev/min was established. When the speed was reduced to 85 and 70 per cent of full speed the maximum efficiency improved by 5 and 3 per cent respectively for both impellers, the value of NPSH becoming 3·5 m for the 6000 m³/h impeller and 3·9 m for the 7500 m³/h impeller, indicating that with increase in capacity this value also increases. Conversely, the maximum pump efficiency for the 6000 m³/h impeller was 86 per cent and that for the 7500 m³/h impeller was 88 per cent, showing that it improves with increased capacity.—*Marine Engineer and Naval Architect, September 1968, Vol. 91, p. 374.*

Canadian Ice Breaking Buoy Tender with CODAGE Machinery

Canadian Vickers Ltd have launched the buoy-tending and supply vessel C.C.G.S. *Norman McLeod Rogers* for the Canadian Department of Transport. The ship will be based at Quebec to serve Canada's Atlantic coast, the Gulf of St Lawrence and Eastern Arctic waters. The design is by G. T. R. Campbell and Co., Montreal, consulting naval architects.

Principal particulars are:

Length, o.a.	295 ft 0 in
Breadth	62 ft 6 in
Loaded draught	20 ft 0 in
Speed	15 knots
Shp	12 000
Displacement	6320 tons
Crew	55 persons

In addition to icebreaking and buoy-tending duties the vessel will supply general and refrigerated cargo to remote bases in the Eastern Arctic where delivery by conventional carriers is hazardous. There is space for up to 900 tons of cargo which can be off-loaded into and transferred ashore by two 50 ft landing barges. A Flume stabilization system is incorporated and manoeuvrability is improved by a bow-thruster. A helicopter will operate from a flight deck fitted with a telescopic hangar, at the aft end.

The propulsion system, unique in this type of vessel, comprises four single armature Diesel-driven d.c. generators and two double-armature gas turbine-driven d.c. generators, supplying power to two 6000 shp double armature main propulsion motors. Machinery control is from a soundproof room overlooking machinery compartments and from the bridge. Speedcranes Ltd, of Gourock, have supplied a 20-ton derrick twin-span rig which has a five-ton auxiliary hoist. The three Clarke Chapman electric winches for hoist topping and slewing are housed below deck with the self-spooling gear. Compensator wires automatically adjust the suspension as the derrick is swung outboard from the centreline. This eliminates twisting in the derrick head and assists in level luffing and slewing.—*Marine Engineer and Naval Architect, July 1968, Vol. 91, p. 274.*

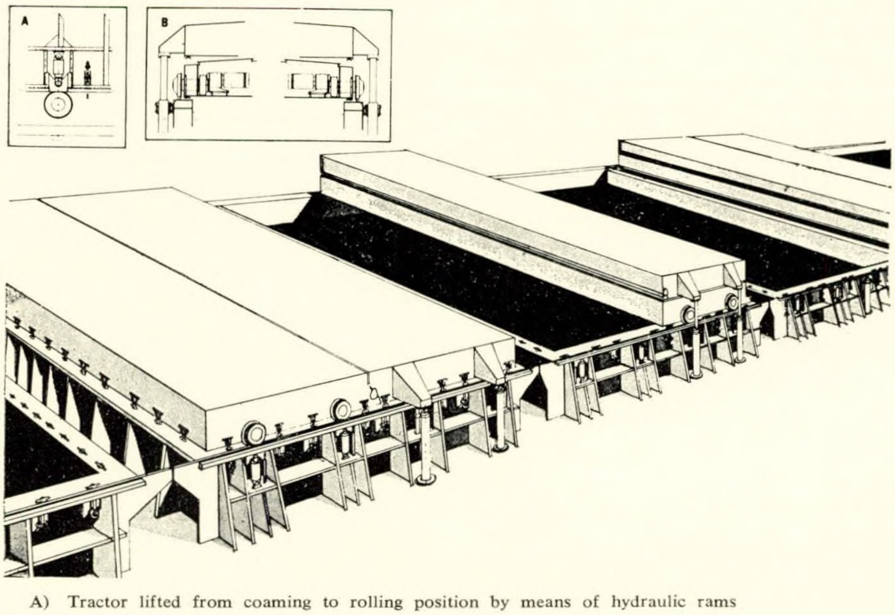
New Hatch Cover

A new type of Kvaerner Brug fore and aft rolling hatch cover is so designed that each hatch is covered equally by two steel pontoon type sections built as airtight box girders. One of the two sections is lifted by hydraulic cylinders to allow for the other section—which is self-propelled—to roll under and below the first section. The first section is then lowered to ride "piggyback" on the second section which is the tractor section. Together the two sections will perform as a motorized, self-propelled package which can be moved electrically to any available position over adjacent hatchways along rail tracks placed on each side of the coaming top and extending fore and aft also between hatches. The tracks have stress-relieving expansion joints at each side between hatches. Any of the aforesaid sections may be divided in two and bolted together with watertight joints for facilitating transportation and future dismantling.—*Shipbuilding and Shipping Record, 17th May 1968, Vol. 111, p. 698.*

Transfer of Oil Cargo at Sea

With the depth of water available at most European ports in mind, the design concept of the large deadweight tankers to be built for Shell International Marine Ltd was largely determined by the fully laden draught which was limited to 54 ft and indicated a ship of about 165 000 dwt. An investigation into the economics of scale, however, revealed that for a moderate increase in capital cost it was possible to build a ship having a deadweight capacity of 200 000 tons and a draught of 62 ft. Although such a tanker could not enter Western European ports at that draught, it was known that work was already in hand to deepen several harbours so that ships of over 200 000 dwt could be berthed. A further examination of the operational costs of such ships showed that they were more economical than 165 000 tonners, the margin being such, over their service life, that it would be viable to run ships of this size at a reduced draught until the port dredging programmes were completed. These interesting findings influenced the decision to order a number of tankers of the 200 000 dwt class, of which several are now entering service. It was appreciated that it was possible to take full economic advantage of size, provided the larger ship could make fully laden voyages and then transfer enough of its cargo at sea to another tanker to enable the outsize ship to enter various ports at the present restricted draught.

Apart from the question of solving the engineering



A) Tractor lifted from coaming to rolling position by means of hydraulic rams

B) Self-propelled tractor section showing drive motors

Covers ordered for Star Bulk Shipping Malmanger *series close hatchway (24·40 m × 21·20 m)* problems of oil transfer at sea which past experience had indicated was quite feasible, there was a need for a study, on paper, of ship movements in relation to the transfer so as to gain an insight into the factors involved. These included the contract delivery dates of new ships, details of voyages to fit in with crude oil movements from the Middle East to Western Europe and oil supply and demand estimates. The study involved the furnishing of special weather information, also local forecasts concerning the rendezvous area, the choice of which depended upon weather.

The promising results of the paper exercise prompted the decision to put theory into practice and to modify the 70 000 dwt tanker *Drupa* to act as a lightening vessel. For her special duties *Drupa* now carries four main and three smaller fenders. The former include two bag fenders of 11-ft diameter filled with compressed air and weighing 4·5 tons, and two fenders consisting of five 10-ft diameter tyres mounted on a heavy axle and each weighing 18·5 tons.

The first sea trial, using sea water instead of oil, was carried out with *Drupa* approaching the starboard side of the anchored tanker *Macoma*. With the ships linked up pumping was carried out at a rate of 6000 tons/h. Including approach link-up and break-away manoeuvres, this represented ten hours for the transfer of 30 000 tons and about 16 hours for 70 000 tons. The first actual transfer of crude oil took place on 30 May when *Macoma*, from the Middle East, linked up with *Drupa* in a position eight miles off Berry Head, South Devon, and 65 650 tons of crude oil were transferred without spillage. After the two tankers uncoupled on 31st May, *Macoma* sailed for Europoort and *Drupa* for Thames Haven.—*Shipbuilding International, July 1968, Vol. 11, pp. 28–32.*

Vertical Conveyor for Small Pallets

Kornylak's new Autoload Vertiflo is a fully integrated conveyor for the high speed vertical conveying of pallet loads at maximum rates, with fully automatic control. Innovations included in this unit are:

1) automatic loading or unloading from the same side of the unit for either up or down conveying;
2) capacity to 4000 lb unit loads;
3) height of lift to unit, designed to permit six basic modes of loading with either rotation or non-rotation of the pallet.

These modes may be varied at each floor level and all can be tied in with Kornylak's Palletflo conveyors on the floor to permit complete automated movement, accumulation or storage of the pallets without the use of fork trucks within the system. The Autoloader delivers the pallet to the carrying tray of the Vertiflo conveyor in the desired orientation and locks it in place for safe travel to the destined level. The loading system accommodates to a deviation of $\pm 1\frac{1}{2}$ in in the stopping level of the vertical conveyor tray. The trays are rigidly held in a horizontal plane while carrying the load and rotate to a vertical plane for empty return in a narrow slot at the rear of the conveyor. This compact design results in a conveyor cross-section only slightly larger than the pallet load.—*Shipbuilding and Shipping Record, 26th July 1968, Vol. 112, p. 120.*

Rotating Bollard

The traditional method of mooring with bollards requires three or four men and can sometimes be dangerous if the ship should surge before the line is properly made up on the bitts. To overcome these, and other problems, Pusnes has developed the Roto-Bollard. This comprises two rotating bollard heads, each incorporating a ratchet wheel allowing it to rotate in the heaving-in direction only, and a snatch cleat, all mounted on a common base.

Once a line has been made fast ashore, turns are taken round the Roto-Bollard and the fall led through the snatch cleat to the warp head or capstan. Once any warping required has been completed, the fall is taken off the warp end. The Roto-Bollard, having rotated freely during the hauling operation, automatically locks and in effect becomes a fixed set of bitts. No further action is required and the line ashore retains whatever tension has been given from the warp head. This entire operation can be effected by one man.

A slipping system is incorporated between the ratchet wheels and axles to allow rotation of the bollard heads if the line stresses exceed the pre-set tension. If movement of the ship, caused by a change of tide or draught, increases the tension of the rope to above the pre-set figure, the Roto-Bollard will automatically slip until the rope tension is reduced to just below this figure. The rope is thus protected and no manual attention is required. All the ropes in use are automatically compensated and no line can be overloaded.

If, on the other hand, the lines need to be taken in, all that is necessary is to take the loose fall to the warp end or capstan, re-tension the line and then cast it off the warp end. When lines have to be let go under tension they are first slackened by operation of an hydraulic control which may be positioned either adjacent to the Roto-Bollard or remotely. Operation of this control releases the brakes in the bollard and allows it to render. Furthermore, this hydraulic control permits the mooring line to be checked without touching either the rope or the bollard.—*Shipbuilding International, August 1968, Vol. 11, p. 62.*

Doppler Sonar Navigation

A prime requirement for the high degree of accuracy now demanded in the navigation, manoeuvring and docking of ships is the determination of true velocity and drift relative to the ocean bottom. One way of achieving this is by the doppler sonar system manufactured by the Marquardt Corporation of California and navaids utilizing this technique are being developed for:

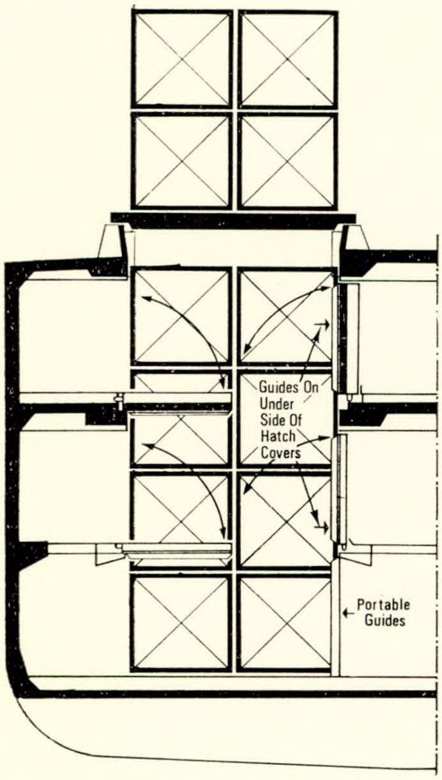
a) tankers and other commercial cargo vessels;
b) deep submergence vehicles;
c) swimmer delivery vehicles;
d) off-shore geophysical survey vessels.

Doppler sonar navigation is achieved by directing four beams of sonar energy to the ocean bottom and measuring the doppler shift of the return sonar energy to provide velocity indications relative to each of the four axes of the ship. The system is limited in height above bottom operational capabilities by the frequency selected and other design features of the equipment. Doppler sonar navigation has been explored by the U.S. Navy and a few commercial operations over the past five years with relatively little success due to limited height above bottom operational capabilities. The Marquardt Corporation has recently developed a pulse doppler sonar system that now permits operation over all regions of the continental shelf, i.e. to heights above bottom of 600 ft. Beyond this bottom contact depth, the system is capable of providing approximate velocity information relative to the ocean water mass. The doppler system operating from bottom return presents velocity and distance travelled information to the ship's operator within a maximum error of 0·2 to 0·5 per cent of distance travelled. The system has recently been interfaced with the ITT satellite navigation equipment to provide an updating of positon each time a satellite pass is observed. The Marquardt system provides the required velocity input to the satellite navigator and provides precision navigation between fixes.

One of the most important new applications of the doppler sonar equipment is in the docking and navigation of large supertankers.—*Shipbuilding and Shipping Record, 26th July 1968, Vol. 112, pp. 124–125.*

French Polyvalent Cargo Vessels

Last year Compagnie Générale Transatlantique ordered two reefer/multi-purpose vessels from Constructions Navales et Industrielles de la Mediterranée La Seyne. An order for a third similar vessel was also placed with the same yard in March this year.



French polyvalent cargo vessels

Principal particulars are:

Length, o.a.	498 ft 8 in
Length, b.p.	459 ft 4 in
Breadth, moulded	68 ft 11 in
Depth, moulded	41 ft 0 in
Draught, loaded	26 ft 3 in
Deadweight	8620 tons

These ships, which will be employed on the Europe-West Indies services, will combine the functions previously carried out by two different types of vessel.

Exports from Europe require vessels of the *Suffren* type, able to carry general cargo in containers or palletized. From the West Indies, however, refrigerated spaces are required, particularly for bananas and tank space for the carriage of rum.

Depending on voyage requirements, these versatile ships can be adapted to the loading of containers, as well as vehicles and general cargo. A considerable proportion of their cargo space is devoted to refrigerated cargo. Each vessel has four cargo holds, refrigerated spaces No. 2 and No. 3 being polyvalent depending on the position of the tween deck hatch covers. These consist of two sections which can be set vertically. The lower surface of the sections are fitted with guide rails for containers, so making cellular provision for I.S.O. 20-ft. containers. Holds No. 2 and No. 3, each with two hatch covers so equipped, can take 64 20-ft. containers in cellular stowage, in addition to 40 containers stowed two deep on deck.

When, however, holds No. 2 and No. 3 are employed entirely as refrigerated spaces a total of 7745m^3 is available including 875m^3 in No. 4 hold.

As well as loading and discharging by the conventional vertical method, vehicular cargo handling is possible throughout the upper tween deck. Two large ports (4·5 × 2·8m) will be installed on each side, one forward and one aft, and with openings in the three transverse bulkheads, circulation is possible from forward to aft on the upper tween deck. Access to the lower tween deck and No. 2 and No. 3 lower holds is also possible by lifts fore and aft. The size of the side ports as well as the area of manoeuvring space allows truck-to-truck pallet operation.

As with *Suffren* and *Rochambeau* the vessels will have c.p. propellers.—*Shipbuilding and Shipping Record, 31st May 1968, Vol. 111, p. 760.*

Pioneer Class Vessel

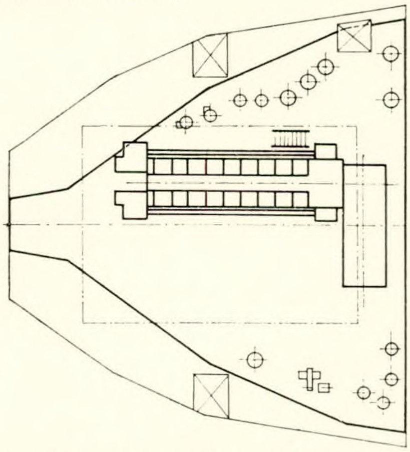
The chine-hulled, 21 600 dwt cargo vessel *Jag Dev* is the first of the Blohm and Voss Pioneer class of Liberty ship replacements. Tank test results of the multi-plane hull show most satisfactory results when compared with a conventional round bilge, curved hull and the main problem may well be the reluctance of owners to accept the extraordinary appearance of a polyhedron hull when applied to large vessels.

Jag Dev was constructed at the builders' Hamburg shipyard for Indian owners, Great Eastern Shipping Co. Ltd., of Bombay. The Pioneer series of multi-carrier ships is available in four sizes of ship from 14 300 to 24 750 dwt, but *Jag Dev* is actually an intermediate size between variants II/III.

Principal particulars are:

Length, o.a.	162·20 m
Length, b.p.	151·45 m
Breadth	22·80 m
Depth	14·40 m
Draught	10·36 m
Corresponding dwt	21 600
Gross register	13 325 tons
Hold capacity (grain)	1 000 000 ft^3
Classification	LR ✠ 160 A1E3

The owners intend to employ the vessel both as a self-trimming bulk carrier and as a general cargo ship. This degree of flexibility is achieved by fitting folding decks in the cargo holds. When the decks are hinged up under the hatch side coamings, the vessel is then converted from a two-deck ship to a self-trimming bulk carrier having a grain hold capacity of about 1 000 000 ft^3. On a freeboard draught of 10·36 m the vessel can carry 21 600 tons, or 17 500 tons at a restricted draught of 8·99 m (29 ft 6 in).



Arrangement of main engine of Pioneer class vessel

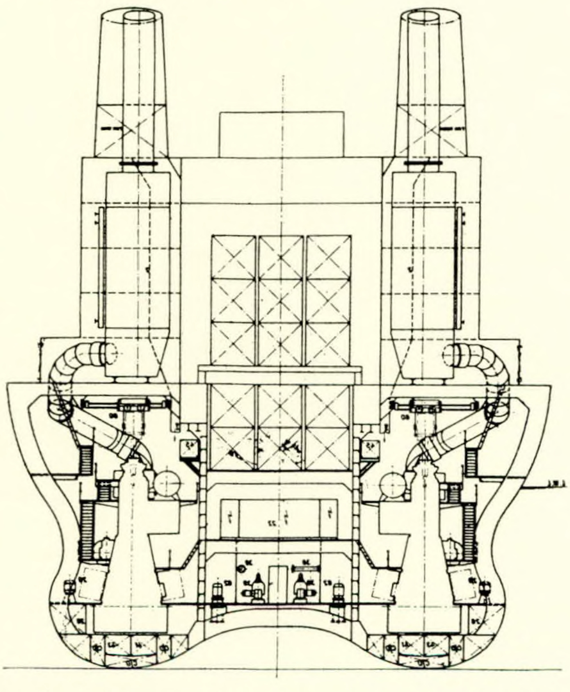
To obtain maximum utilization of cargo space, wing tanks have not been fitted, so that the cargo holds are completely rectangular and cargo can be stowed to almost the total hold volume. This arrangement has been extended as far as possible fore and aft thus obtaining a very good ratio between the length of ship and cargo capacity.

Although an 18-cylinder O.E.W.-Pielstick PC2V-type engine is installed for main propulsion, the engine room length is the standard Pioneer length, i.e. suitable for single engine installation of a 10, 12, 14, 16 or 18-cylinder unit or twin engine arrangements. The engine in *Jag Dev* develops 9000 bhp and is arranged for burning heavy oil of 1500 sec. Redwood No. 1. A trial speed was attained of 16·6 knots on a draught of 9 m.—*Motor Ship, August 1968, Vol. 49, pp. 246–247.*

Sulzer Proposals for High Powered Motorships

The development of the large tanker is, without doubt, one of the greatest events in the history of the merchant marine.

The bulk carrier is similar in many aspects to the tanker which has already led to the combined bulk carrier/oil tanker. The development in the size of bulk carriers is in fact similar, but has not progressed so rapidly as the tanker. More recent but no less rapid is the development of special ships such as gas tankers, roll-on/roll-off cargo ships and container ships of completely different concept but requiring similarly large powers. All these ships have one common problem, namely, that the engine room, which must be aft, should be as short as possible. The buoyancy of a long aft-end engine room and the concentration of homogeneous cargo in the middle of the ship tend to increase sagging.



Section through proposed Sulzer container ship engine rooms, showing central control room and auxiliaries with cargo stowage above

The position of the propelling machinery for a single screw ship is determined by the fullness of the afterbody. By combining fuller after lines with a stern tube pod the propelling plant can be moved further aft, while fitting a tailshaft which can be withdrawn aft permits further space saving. This involves the use of removable flange couplings such as those of the hydraulically-deformable SKF design which are now available up to the maximum powers used in practice. Spade rudders can be designed so that little dismantling is necessary for removal of the tailshaft.

These measures make it possible to plan a somewhat shorter engine room but bring no substantial advantage in the position of the forward engine room bulkhead. Great difficulties are also encountered in planning a shorter engine room for a twin-screw installation. Only here is it possible by the choice of the screw arrangement and the use of a modified ship's form to achieve substantial space saving.

Concurrently with the tanker study, an investigation of proposals for container ships was undertaken. This, however, soon showed that it was impossible to provide the required power in the available engine room and it appeared that the large Diesel engine would not be compatible with a container ship of conventional construction.

In co-operation with Maierform and Chantiers de la Ciotat, a project for a special container ship was drawn out, based on the body plans of the double stern ship.

The hydrodynamic proportions of the container ship are quite different from those of the large tanker, having a breadth to draught ratio of about 3·7 in contrast to 2·2 loaded and 5·8 in ballast for the tanker. The catamaran-stern ship shows to greater advantage with increasing breadth to draught ratios, as is evident from the speed prediction of the 280 000 dwt tanker in the ballast condition and that of the container ship. Much remains to be done in the development of the ship lines and propellers of the container ship project. For example, the paint streak test reveals that the water flow in the propeller plane has a certain angular momentum which must be fully utilized.

The container ship machinery installation calls for new ideas on the arrangement of the auxiliaries. Since the main engines are situated so far outboard, the various auxiliary systems must be arranged in the centre. They are placed in groups, around the central control cabin, an arrangement which permits some of the space between the main engines to be used for additional cargo or can be used to accommodate a stern door for a roll-on/roll-off cargo handling system.—*Smit, J. A., June 1968, "New possibilities for Diesel propulsion in combination with a modified ship's form", Schiffbau-Technische Gesellschaft, Lucerne; Marine Engineer and Naval Architect, September 1968, Vol. 91, pp. 355–356; 358.*

Versatile Test Engine

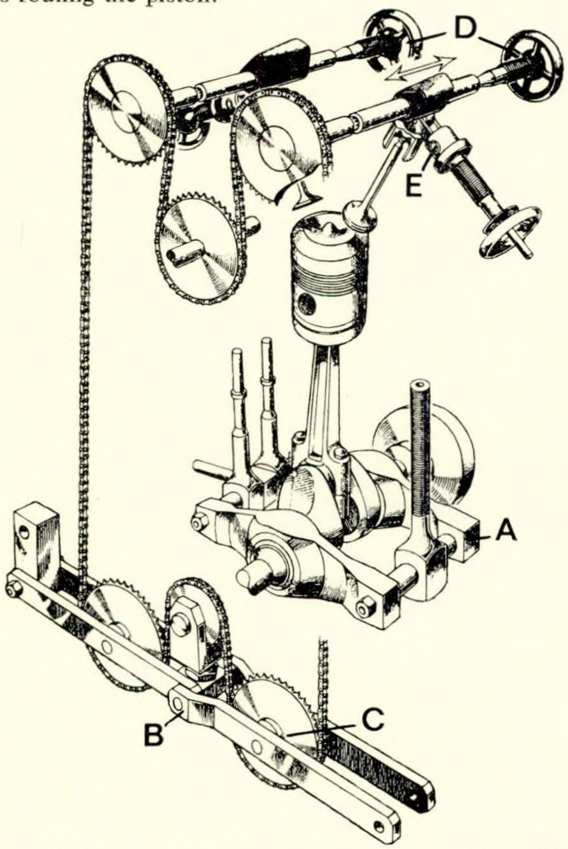
Much work in educational establishments and in research laboratories has to be effected in circumstances of compromise because commercial engines have to be adapted and modified, insofar as modification is practicable with due regard for cost.

A specialized 814cm³ single-cylinder, four-stroke engine has been evolved as part of a comprehensive test installation. It allows unusual facilities for altering vital factors such as compression ratio, valve timing and ignition timing while running. Combustion processes and exhaust gases also can be investigated.

Its specification is a bore of 3·75 in and a stroke of 4·5 in, developing 10 bhp at 2000 rev/min as a normally-aspirated petrol or Diesel engine. The compression ratio is variable between 4·5 : 1 and 25 : 1. Maximum speed is set at 2000 rev/min; overspeed cuts off the fuel, shorts the magneto and applies maximum load on the dynamometer. The unit cannot be started as a petrol engine if the compression ratio is too high. Supercharge can be applied. The crankshaft is of cast steel and has separate cast balance weights bolted on to the webs. A single chain drives the two overhead camshafts which actuate one inclined valve apiece. Lubrication to all bearings is effected at a pressure of 30 to 40 lb/in².

The figure shows how components are moved to effect desired functional changes. The crankshaft is held in a swinging cradle (A) to enable the compression ratio to be increased by upward movement, or lowered by a downward one. To avoid interference with valve, injection or ignition timing, there are two cradles (B) pin jointed at the centre by a trunnion assembly of which the fork end is mounted on the crankshaft and locates the driving sprocket (C). The pivot point of one cradle is fixed, but the other is indirectly located by a short swinging link so that length variations caused by crankshaft movement can be counteracted automatically. The chain tension is not altered, neither is the timing of any driven item.

Valve timings can be varied by axial displacement of either camshaft (D), lengthening the valve's fully open period, i.e. the flat portion of the valve-opening curve for the profile of the cam in use or another scheme is movement of the valve rocker fingers (E), displacing the whole timing diagram without stopping the engine. Safety devices prevent valve heads fouling the piston.



Controllable elements affecting compression ratio and timing functions of versatile test engine

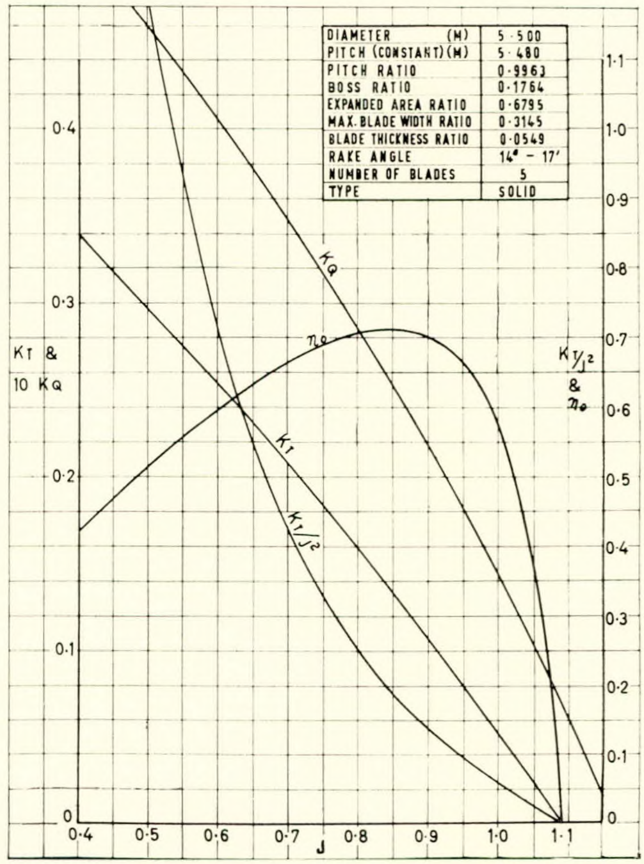
Different valve timing and opening patterns can be obtained by the use of other cam forms and camshafts, and each valve may be regulated independently.—*Gas and Oil Power, September 1968, Vol. 64, pp. 228–229.*

Cargo Liner for Taiwan

The first of a series of four fast cargo liners ordered from Uraga Heavy Industries Limited, Japan, has entered service.

This new vessel was delivered on 9th April to the Chinese Maritime Trust Ltd. of Taiwan, an affiliate of the C. Y. Tung Group.

Ling Yung has been built to classification CR 100 ✠E CMS✠ and RMS✠ of the China Corporation Register of Shipping and to the American Bureau of Shipping classification ABS✠ A1 E✠ AMS and RMC. She has a teardrop-shape bulbous forefoot, finely raked stem and Mariner stern.



Cargo liner for Taiwan—propeller characteristics on a base of advance coefficient

Below the main deck the vessel has been divided by eight watertight bulkheads into nine compartments; forepeak, four cargo holds, machinery space, two cargo holds and afterpeak. There is a deep cargo oil tank in the bottom of No. 1 hold, and two deep cargo oil or water ballast tanks in No. 5 hold. The last mentioned tanks can also be used for latex. Refrigerated cargo spaces have been arranged in No. 5 upper tweendeck and in No. 4 lower tweendeck.

Flume stabilizing tanks have been arranged in No. 4 upper and lower tweendecks at the forward end of the machinery space. The forepeak tank is used for fresh water or ballast water, and the afterpeak tank for fresh water only.

The propelling machinery in *Ling Yung* consists of an eight-cylinder 8RD76 Uraga-Sulzer turbocharged Diesel engine having a maximum output of 12 800 bhp at 122 rev/min and a normal output of 10 900 bhp at 116 rev/min. This engine drives a five-bladed propeller having a diameter of 5·50 m, 5·48 m pitch and an expanded area ratio of 0·6795. Control of the main engine and some of the auxiliaries is from a console in an air-conditioned compartment. Control is also arranged from the wheelhouse.

Details and performance curves for the five-bladed propeller fitted to this ship are given in the figure. These show the variation in the thrust coefficient, K_t, the torque coefficient, K_q and the open water efficiency η_o for variation in the advance coefficient J. These curves were derived from model propeller open water experiments.—*Shipping World and Shipbuilder, June 1968, Vol. 161, pp. 965–968.*

Heat Transfer in Contact-plate Freezers

The method of investigating the heat transfer performance and characteristics of freezer plates described in these tests has been shown to be practicable, but use of the method does require that the effective temperature difference between the liquid in the outer ducts and that in the plate be evaluated correctly in order to ensure that the results obtained are true. Also, the apparent advantages of the method are its relative simplicity and flexibility, in that the same apparatus can be used again and again to test various plates of similar dimensions and assess their performance with different primary and secondary refrigerants.—*Templeton, J., Torry Research Station, Ministry of Technology, Aberdeen, 1968, Memoir No. 313.*

Roughness Allowance and the Scale Effect on the Wake Fraction of Supertankers

The Hughes extrapolating method was used for the analysis of the results of the standardized speed trials of supertankers whose deadweights are from 45 000 to 130 000 tons and tank tests of the corresponding ship models to obtain the roughness allowance and the scale effect on the wake fraction for the full load condition.—*Yazaki, A. and Yokoo, K., Papers of the Ship Research Institute, Japan, January 1968, No. 26, pp. 8–11.*

Cavitation of Propellers in Non-uniform Flow

Important problems in designing screw propellers from the cavitation point of view are:

1) the most severe kind of voyage condition;
2) the wake distribution at each radius under such a condition.

The authors deal with these problems with reference to typical cases, such as cargo ships and tankers making use of the test results obtained at the Ship Research Institute.—*Ito, T. and Takahashi, H., Papers of the Ship Research Institute, Japan, January 1968, No. 26, pp. 26–29.*

Vibratory Forces Induced on the Rudder Behind a Propeller

In this paper the author discusses the characteristics of the slip stream of the marine propeller. In addition, the vibratory forces induced on the rudder in the stream were investigated, treating the rudder as an unsteady wing with low aspect ratio.—*Sugai, K., Papers of the Ship Research Institute, Japan, January 1968, No. 26, pp. 40–46.*

Model Experiments on Shallow Water Effect upon Turning Ability

The effect of shallow water on the manoeuvrability of mammoth tankers in harbour or channels has become a serious problem. An experimental study was carried out on the shallow water effects upon turning ability using two ship models, the one representing a cargo ship and the other a mammoth tanker.—*Koseki, N. and Yamanouchi, Y., Papers of the Ship Research Institute, Japan, January 1968, No. 26, pp. 102–108.*

Rough Surface Effects on Cavitation Inception

Cavitation inception and the associated bubble dynamics in turbulent boundary layers adjacent to surfaces roughened with triangular grooves is investigated in a two-dimensional recirculating water tunnel. The experiments resulted in the significant conclusion that the cavitation inception index is directly related to the skin friction coefficient for both smooth and rough boundaries.—*Arndt, R. E. and Ippen, A. T., Trans. A.S.M.E., Jnl Basic Engineering, June 1968, Vol. 90, pp. 249–261.*

Development of Nondestructive Testing

The current definitions of nondestructive testing are critically reviewed. Some aspects of the history and current status of the technology are discussed to provide a background for guidelines for the development and expansion of the art under the headings: training, research and expansion of nondestructive testing to areas not currently using the techniques.—*Mullins, L., Materials Evaluation, June 1968, Vol. 26, pp. 93–105.*

Ultrasonic Inspection of Boiler Tubes

An immersion unit has been designed and constructed for ultrasonic measurements of the erosion and corrosion patterns in boiler tubes. It enables the transducers to be aligned in tubes of varying internal diameters. This search unit, as well as a dual-transducer for pit depth evaluations, is described. The test interpretations are also discussed.—*Ostrofsky, B. and Parrish, C. B., Materials Evaluation, June 1968, Vol. 26, pp. 106–108.*

Acoustic Emission in Metals as a Nondestructive Testing Tool

Acoustic emission is a term adopted to describe the pressure wave (stress wave) produced in metal by the energy imparted as the metal deforms and fractures. Basic characteristics of the detected signals and the acoustic signature of metallurgical events, e.g. deformation, ductile fracture and brittle fracture, are discussed. The information presented in this paper has been generated in the course of a current development programme to apply acoustic emission as a technique for detecting the formation and/or growth of flaws in reactor pressure piping and vessels. This is but one of many potential applications for this very promising nondestructive testing tool.—*Hutton, P. H., Materials Evaluation, July 1968, Vol. 26, pp. 125–129.*

Dynamic Balances of Dissolved Air and Heat in Natural Cavity Flows

In steady, fully developed and unventilated cavity flows occurring in practice, air and heat are diffused through the fluid towards the interface providing a continuous supply of air and vapour to the cavity. This must be balanced by the rate of entrainment of volume of air and vapour away from the cavity in the wake. These equilibria, which determine respectively the partial pressure of air within the cavity and the temperature differences involved in the flow, are studied in this paper which refers to a relatively simple axisymmetric flow as an example.—*Brennen, C., July 1968, National Physical Laboratory, Ship Division, Rep. No. 115.*

Transportation of Coal Slurry by Ship

The main reason for introducing the slurry form in coal transportation is to reduce transport cost. The coal slurry is to be transported by special ships designed for this purpose but its characteristics cause problems from the aspect of safety while the ship is at sea. Model tests were therefore carried out regarding the rolling of coal slurry carrying vessels. —*Yamanouchi, Y., Okada, S., Sugai, K., Kan, M. and Nonaka, K., Report Ship Research Institute, Japan, March 1968, Vol. 5, pp. 1–20.*

Oblique Flow Headers for Heat Exchangers

The problem of the design of oblique flow headers for heat exchangers flowing low density fluids is considered. It is demonstrated by test that the theory already available in the literature provides an adequate basis for design for the single-pass "parallel flow" and "counter flow" configurations. The theory is summarized in the form of design equations and illustrated by specific application to the air-side flow in a gas turbine regenerator.—*London, A. L., Klopfer, G. and Wolf, S., Trans. A.S.M.E., Jnl Engineering for Power, July 1968, Vol. 90, pp. 271–286.*

Toothed Couplings—Analysis and Optimization

This paper is a theoretical analysis of a toothed coupling. It shows, firstly, the inherent necessity of backlash and its optimal value, secondly, a critical comparison of all the existing designs and those proposed by the author, based upon:

a) maximum and total lag angle between the shafts as a function of misalignment;
b) maximum backlash that may appear between the teeth;
c) angles at which the teeth are in contact;
d) power losses;
e) type of contact stresses;

and, finally, it presents the coupling with conical teeth against conical teeth as an optimal toothed coupling.—*Moked, I., Trans. A.S.M.E., Jnl Engineering for Industry, August 1968, Vol. 90, pp. 425–434.*

Gear Couplings

The authors present a discussion and mathematical analysis of the operation of gear couplings at angular misalignment. Transmission of uniform motion, tooth separation, tooth load distribution, coupling load capacity, tooth bearing and special tooth forms are discussed.—*Renzo, P. C., Kaufman, S. and De Rocker, D. E., Trans. A.S.M.E., Jnl Engineering for Industry, August 1968, Vol. 90, pp. 467–474.*

Two Models for Cavity Flow—Theoretical Summary and Applications

A summary is given of two-dimensional, steady-state, non-linear theory for two finite-cavity models and their solutions. Two applications are described:

1) the influence of the foil's depth of submersion below a free surface on cavity length and foil performance;
2) the effect of a blunt nose on a circular-arc hydrofoil.

—*Street, R. L. and Larock, B. E., Trans. A.S.M.E., Jnl Basic Engineering, June 1968, Vol. 90, pp. 269–274.*

Patent Specifications

Propulsive Device

Fig. 1 shows a stationary propulsion nozzle (20) within which operates a screw propeller (19). Fixed aft of the propeller within the exit end of the nozzle is a vertical rudder post (11) and the upper and lower sections of which are angled so as to present these sections at suitable angles of incidence to the screw race, thereby to extract lift from it as it rotates.

Fig. 1.

The rudder post (11) is arranged as a fixed forward portion of the rudder blade, the movable portion of the rudder consisting of a flap (12) hinged to the trailing edge of the post (11). The latter comprises a vertical bar (13) without twist to which are attached upper and lower faired arms (14), (15) as shown in Figs. 2 and 3, these arms being of opposite incidence angle and thereby matched to the incidence angle of flow of the screw race. The junction between the two faired arms is effected by means of a horizontal axial bulb (16) in alignment with the propeller boss (17) and from this bulb run two further faired arms (18) extending horizontally out to the nozzle wall. The fairings of the arms (18) are likewise

Fig. 2.

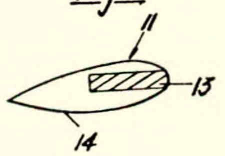
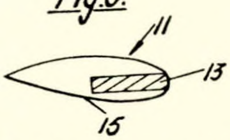


Fig. 3.



angled to suit the incident flow and the whole forms a stationary counter propeller which tends to counteract rotation of the screw race and, in so doing, extracts useful energy as hydrodynamic lift on its surfaces, the forward component of which is added to the propulsive thrust of the propeller (19).—*British Patent No. 1 129 262 issued to Hydroconics Ltd. Complete specification published 2nd October 1968.*

Floating Device for Loading or Unloading a Ship in Open Water

This invention relates to a floating device for loading or unloading a ship in open water. The device consists of a large sized floating body with at least one long side alongside which a ship can be moored. The floating body rotatably supports a second body provided with anchoring means such as chains or cables and with connexions for supply and discharge lines.

In Figs 1 and 2, the hull (1) has, near the bow (3), a vertical hole (4) extending from top to bottom. Fitted in this hole is a rotatable body (5) which, near the lower and upper ends of the hole (4), is provided with rollers (6) moving in a horizontal roller track (7) provided on the wall of the hole. The body (5) is adapted to rotate in the hole about its vertical axis by means of these rollers (6) and the roller track (7) and is thus at the same time kept in place in the hole in the hull. During operation the body (5) is anchored by means of chains (8) and anchorages (9), so that the hull (1) can rotate about the body. In Fig. 1 eight anchorage points are shown. At the lower end of the body (5), a pipe line (10) is suspended. It has an elbow (11) adapted to rotate. The line (10) serves to load or unload the tanks in the hull via the elbow (11).

FIG-1

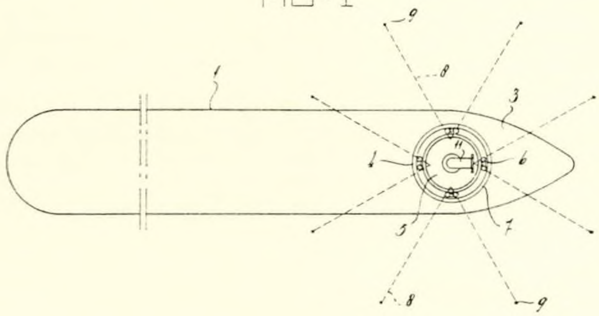
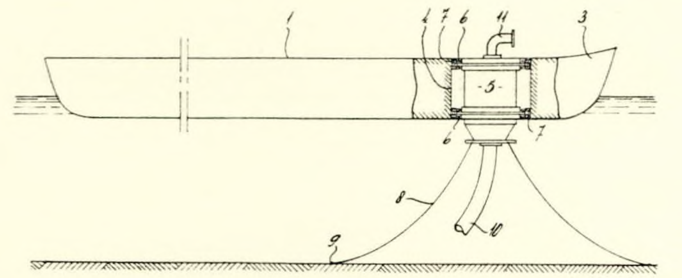


FIG-2



A tanker to be loaded or unloaded may come alongside and moor, and may be loaded from the tanks of the hull (1) serving as temporary storage spaces or may unload into these tanks. During this process, the tanker may swing together with the device about the body (5) when the current or the wind changes.—*British Patent No. 1 129 935 issued to N. V. Werf Gusto V/H Firma A. F. Smulders. Complete specification published 9th October 1968.*

Hydraulic Jet Propulsion Apparatus

Figs 1 and 2 show an hydraulic jet propulsion apparatus or bow thruster at (1). It includes a vertical impeller housing (2) that extends upwards from the keel (4) of the watercraft (6). The hull (8) is provided with a number of underwater intake conduits (10) extending from the sides of the hull radially inwardly to communicate with the impeller housing (2). Above the keel (4) is provided a transverse passageway or tunnel (12).

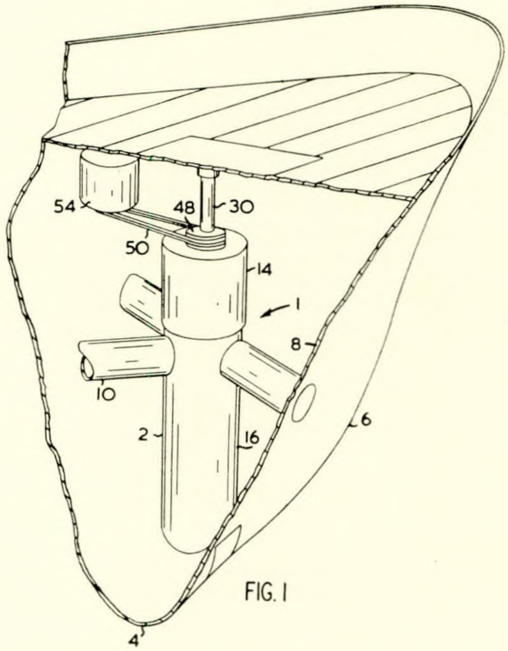


FIG. 1

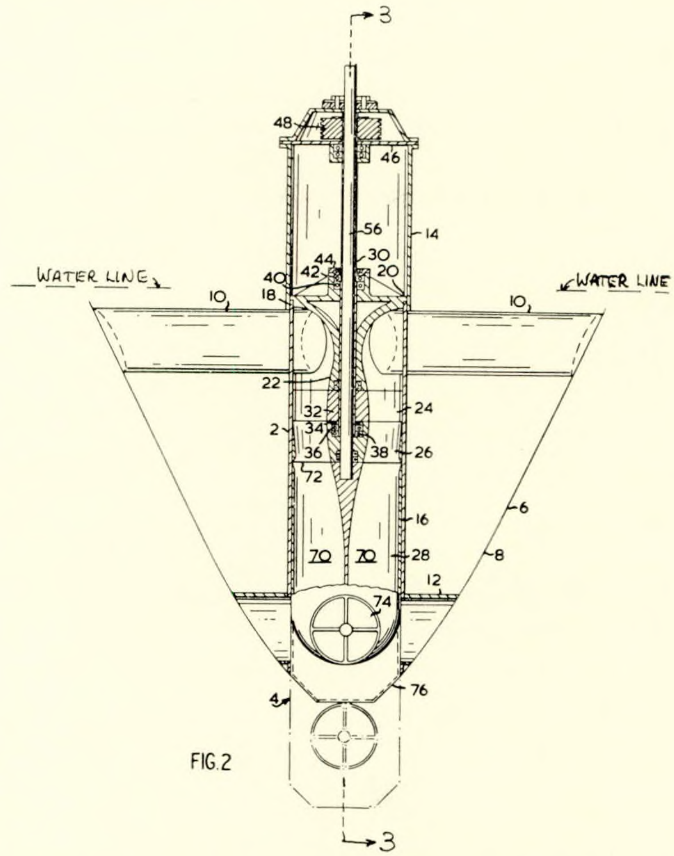


FIG. 2

The housing (2) includes an upper tube (14) and a lower tube (16), the upper end of which is integral with or detachably receives the inner terminal ends of the conduits (10). The upper end of the tube (14) lies within the tube (16) and provides an annular shoulder (18) on which is seated a peripheral flange (20) of a flow-directing rigid body (22) concentrically positioned within the lower tube of the housing (2). The rigid body (22) is so shaped as to define with the housing an annular venturi tube. In the lower tube (16) is a rotatable screw-propeller (24) associated with a number of flow straightening vanes (26) and a thrust nozzle (28).

A hollow shaft (30) passes through the centre of the rigid body (22) and is fixed to the hub section of the impeller (24).—*British Patent No. 1 130 378 issued to Tamco Ltd. Complete specification published 16th October 1968.*