M.C.M., SURVEY AND AUXILIARY VESSELS

BY

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The following article describes some of the principal problems met during the Author's tenure of office, from April, 1966, to May, 1968, as Head of the D.G. Ships Section, dealing with M.C.Ms., Survey Ships and Auxiliary Vessels.

R.F.A.s RESOURCE AND REGENT

The largest task undertaken by the Section during this period was the completion and trials of the R.F.A.s *Resource* and *Regent*. These ships of 20,000 tons carry armament and other stores, and are designed to operate with a Task Force. Because of this role the machinery had to be quiet and shock-proof and meet GRMEs.

These ships were fully described in the article 'Fleet Replenishment Ships' by Mr Doust in Vol. 17, No. 3 of the *Journal*. It is, however, worth adding some more detailed comments concerning the ships' trials, when certain difficulties and shortcomings were found. It is felt that some lessons can be learnt from the principal problems which are described below.

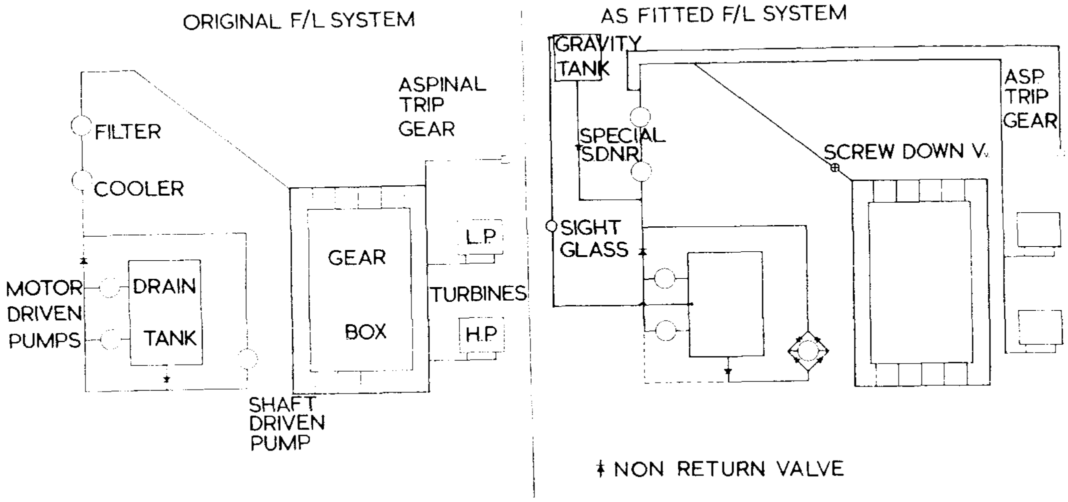

FIG. 1—FORCED LUBRICATION SYSTEM—R.F.A.S 'RESOURCE' AND 'REGENT'

Forced Lubrication System

The system was designed as shown in FIG. 1. At sea one M/D pump is in use and one is stand-by. Each pump can supply only 50 per cent of the requirements at full power. At below 60 shaft rpm, the shaft-driven pump's output is less than one of the motor pumps, and part of the oil leaving the M/D pump goes straight into the system and part goes through the shaft-driven pump. At higher speeds, the shaft-driven pump takes all the output from the M/D pump plus any further oil it can pump direct from the tank via a non-return valve. To balance the supply of oil between the turbines and the gearing, variable orifice valves were specified. These however were omitted on building because orifice plates had been fitted to all thrust bearings and it was claimed that all pipe sizes for bearings were balanced so that no further restrictions were needed nor could be accepted. However, trials soon showed that once the oil warmed up and its viscosity came down there was only about 3 lb/sq in. on the turbine bearings and the Aspinall trip gear to protect the turbine against various mishaps could not be set. The solution to this problem had to take into account:

(*a*) Getting variable orifice valves and fitting them would involve a long delay.

(*b*) The shipbuilder was responsible for the lubricating oil system but not the turbine and gearbox which were Admiralty Supply Items (ASIs) so he had no direct responsibility. He however gave very good service in producing new pipe systems at very short notice.

(*c*) DFMT(N)'s officers and the Section were keen on having at least 5 lb/sq in. showing on all bearings under the worst conditions, as there were no sight flow indicators or other means of seeing if oil was flowing adequately to all bearings. We felt bearing temperatures would only tell you the answer too late.

(*d*) The ring main system for the lubricating oil supply did not give equal pressures all round so that balancing by trial and error with orifice plates was hopeless, particularly as draining off the oil took a long time.

(*e*) Larger pumps could not be obtained quickly nor could their speed be altered.

(*f*) DFMT(N) said that as all merchant ships had emergency gravity tanks, one should be fitted. Lloyds agreed with this. A complete electrical blackout with loss of all pumps while the ship drifted to a stop without oil on the bearings reinforced this view.

As a first step the supply of oil for the gearbox ring main was separated from that to the turbines. By means of a valve on the supply to the ring main the oil pressure to the turbines was improved. The tapping to the Aspinall was brought back close to the filters. However, the oil pressure everywhere was still only borderline so it was decided to increase the quantity of oil being pumped by reconnecting the shaft-driven pump in parallel instead of in series. A bunch of 4 special German made non-return valves were fitted to make the shaft-driven pump give a supply even when going astern. An emergency gravity tank could only be fitted in one place and that required an F/L pump discharge pressure of at least 18 lb/sq in. to prevent it running down. Fortunately that pressure could be produced and the last of our troubles with this system was over.

Feed System

(*a*) Copes feed regulators had been specified on the grounds of simplicity and DFMT(N) had agreed, with some misgivings. On trials they initially refused to work due to incorrect installation of the steam and water pipes. By the time these defects had been found and rectified confidence had been weakened. Naval experience also had shown that they had certain limitation in rough weather and in rapid manoeuvring, and if not very carefully maintained they were inclined to stick. Subsequently DFMT(N) had the regulators changed to Robots at the first guarantee docking.

(*b*) The TWL feed pump governors also refused to work. The design was such that steam forces acting on the steam valve tended to jam it. This was only discovered after a lot of time had been spent on them. A modified valve and chest of different design were quickly made and fitted. As the pumps were ASIs the shipbuilder had no direct responsibility for this.

(*c*) *The feed connections on the boiler*—The specification called for a simple arrangement of main and auxiliary feed checks supplying water from the various pumps to the economizer. Somehow the detailed design departed from this and the auxiliary feed check was connected direct to the steam drum which meant that if you went onto the auxiliary feed check you ran the danger of burning out the economizer. This was not picked up on approval of the drawings, where it may have been that the wood was not seen for the trees. When it was discovered, we wanted to return to the specification but Lloyds and DFMT(N) both liked the steam drum connections for emergencies, so we compromised by having both with suitable isolating valves.

Evaporators

When the evaporators were made and installed the Board of Trade said all copper surfaces in contact with the vapour and made water must be tinned to prevent copper entering the water. The Navy had given up this practice during the war. It was impracticable to do it at this stage. Eventually after some discussions the B.O.T. agreed that provided the water had less than 1 ppm of copper, it was alright. Samples taken from these evaporators and those in GMDs showed that all were well within this limit.

H.P. Turbine Horizontal Joint

The steam to the nozzle group in the bottom half casing of the HP turbine passed through passages in the castings from the top half. The steam from this passage leaked at the horizontal joint. Examination of the joint faces showed them to be far from flat. This could have been partly due to thermal distortion.

As remaking of these joint faces would have affected all turbine clearances the joint was remade with special liquid jointing compounds. They appear to have been effective.

The Gearbox

Vibration of the gearbox was found. This was due to axial loads imposed by the propeller and this was worst at about the normal service speed. Neither we nor DFMT(N) were very keen on using a resonance changer to damp it out because of the possibilities of maloperation and the lack of knowledge in the field of its operation and upkeep. The worst vibration was on the light alloy covers which carried small thrust bearings to locate the primary wheels. These were stiffened and the amplitude was reduced to acceptable limits.

A gearbox explosion occurred in *Regent* during trials when the ship was in the Firth of Clyde, a gale was blowing and it was night. An anxious time was had by all as the ship would not steer at low speeds and no-one was keen to run the gearbox too fast; also it was too rough for tugs to help. When the gearbox turning gear was subsequently opened up, the remains of a ring used in manufacture to balance it were found. The ring of $4\frac{1}{2}$-inch diameter and 1-inch cross-section had broken into pieces and sheared off some bolt heads. The impact had welded some parts together. Fortunately nothing had passed through the gears.

The Emergency Valve for the Main Turbines

An emergency valve was specified to isolate steam from the main turbines. It operated on loss of oil, loss of vacuum, overspeeding or excessive axial movement of the rotor, and once shut, it had to be re-opened by hand. The snag was that it shut steam off both turbines so that there was no means of stopping the ship, and hence stopping the shafts trailing, if any defect occurred. This was modified so that it guards only the ahead turbines and the astern turbine has a manually operated valve.

On the whole it is felt that DFMT(N) will find these ships easy to steam and, because of the lack of automation, simple to maintain.

HECLA CLASS SURVEY SHIPS

The first ships obtained under the 'design and build' policy were the survey ships *Hecla, Hecate* and *Hydra.* They were built to a very general Statement of Requirements. The *Hydra* was the last and she entered service in May, 1966. The propulsion machinery is Diesel-electric with three Paxman Ventura V12 main generators.

Our main running problem has been the frequent failure of these Diesel engines where, among other defects, cracked cylinder heads have occurred all too frequently. The reason for this is obscure but it is thought to be overloading caused by the main propulsion system. We have attempted to reduce the load on the engines by ensuring that the ships use sufficient engines.

The second problem has been the two evaporators. These are simple steam coil sets working at a shell pressure of 10 lb/sq in. Scaling up occurs so rapidly that they will only produce their rated output of 10 ton/day for a day or so. The reasons for their initial selection are an unhappy tale. A search has been made for a suitable replacement which would fit in the restricted space and give as high an output as possible on the already inadequate steam supplies. The *Hecla* and *Hecate* have now been fitted with a Braby 12 ton/day steam heated set working at high vacuum. They are proving satisfactory and H.M.S. *Hydra* is to be so fitted. Stand-by capacity will be provided by carrying complete pumps and tube stacks.

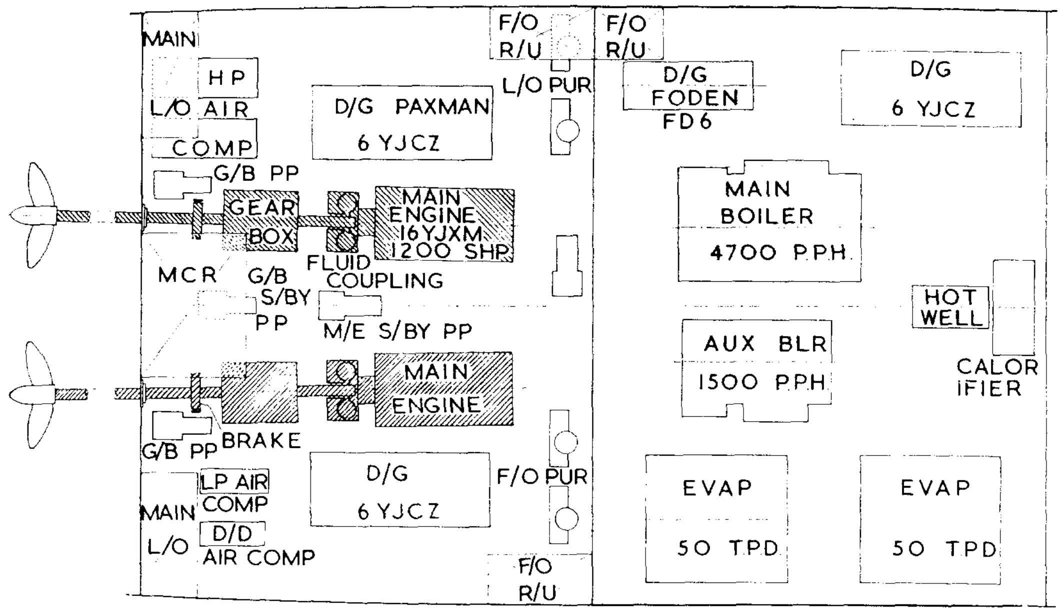

FIG. 2—MACHINERY LAYOUT—H.M.S. 'ABDIEL'

The third problem was the waste-heat boiler which the designer intended should use waste heat from the main engines. The engines produce insufficient heat even at full power so there was a shortage of steam. The shipbuilders fitted an oil burner unit to one pass which has proved satisfactory.

Spare gear was originally to be to Lloyds 'long voyage' requirements. This was quite insufficient in scope and quantity. We have since had to buy a great deal and sort out the resulting chaos in the D787. They will shortly be supported by SPDC.

Now these design problems have been resolved these ships are giving good service.

M.C.M. SUPPORT SHIP

H.M.S. *Abdiel* was built to a slightly more detailed Statement of Requirements and spare gear was brought fully under our control. She has replaced H.M.S. *Plover* and can lay mines for sweeping practice and also support MCMVs for three weeks during exercises. She has no warlike capabilities. The machinery layout is shown in FIG. 2 and a brief description is as follows:—

Main engines

2 Paxman Ventura V16 producing 1345 bhp at 1250 rpm drive through a fluidrive scoop controlled coupling to a Wiseman 4:1 reverse reduction gearbox. A shaft brake is fitted to assist changing shaft direction.

Generators

3 Paxman Ventura 6-cylinder engines driving 375 kW 120 volt DC generators. A Foden FD6 120 kW generator is provided for night load duties.

Boilers

2 Spanner swirlyflow oil fired fire tube boilers provide steam for evaporators and ships use.

Evaporators

2 Buckley and Taylor 4-stage flash evaporators each of 50 ton/day capacity. The water is mostly for the MCMVs.

Diving

She has air compressors for diving and recompression chambers.

The following problems have been experienced:

Engine Control System

The engine governors, the fluid coupling scoops and the gearbox reversing levers are all controlled pneumatically by single lever control either from the Machinery Control Room or under NBCD conditions from the Bridge. No means of local mechanical control was fitted other than levers on the machines themselves. On trials the system gave trouble. This was traced to time delay units of American manufacture. They were replaced by some equivalents of British manufacture which though less sophisticated did work. All went well until an underwater explosion off Spithead caused a nylon pipe to come loose and shut the engines down in the middle of a consumption trial. Later we tried manoeuvring from the Bridge and when one engine was rather unwisely put astern while the ship was doing close to her full speed of 15 knots an unexpected thing happened. As soon as the astern clutch engaged and the scoop refilled, the momentum of the shafting, gearbox and output half of the scoop were too great for the engine which stalled and turned astern. This resulted in black smoke from the air intake, low lubricating oil alarms going off and general consternation, and the ship has had to apply limitations to the use of the controls. To make it possible to operate the machinery locally in the engine room the shipbuilder made extension rods to the clutch and scoop controls.

LP Air Supply

Another problem was LP air supply. Only one LP air compressor was fitted to supply syrens, windscreen wipers, engine controls, laundry and workshops. If one used the syren too much it took all the air and affected the engine controls. The shipbuilder installed a second compressor.

Refrigerating Plant

A final problem lay in the refrigerating plant where the centrifugal sea-water circulating pump was fitted above the water line and would not take suction. This was easily cured by being moved down one deck but an air eliminator still had to be fitted on its suction as, particularly when going astern, a lot of air is entrained under the ship.

To sum up, *Abdiel* is on the whole despite these shortcomings quite a well designed and economical ship for her limited task.

COASTAL SURVEY CRAFT

The name can be a little misleading as although these ships are intended for coastal survey work, this work can be anywhere in the world and they are required to be self-sufficient for 10 months when working in pairs. They are small ships of just under 1000 tons and look like a cross between a coastal minesweeper and a luxury yacht. They have a crew of 38 and are fully air conditioned. We are concerned whether the engine room complement of senior rates of 1 CERA or ERA and 3 POMEs will be able to cope with maintenance and breakdown loads of these rather sophisticated craft.

The machinery installation is shown in FIGS. 3 and 4 and is briefly as follows:

Engines There are two engines per shaft driving through a gearbox to a C-P propeller. The engines are Lister Blackstone 8-cylinder

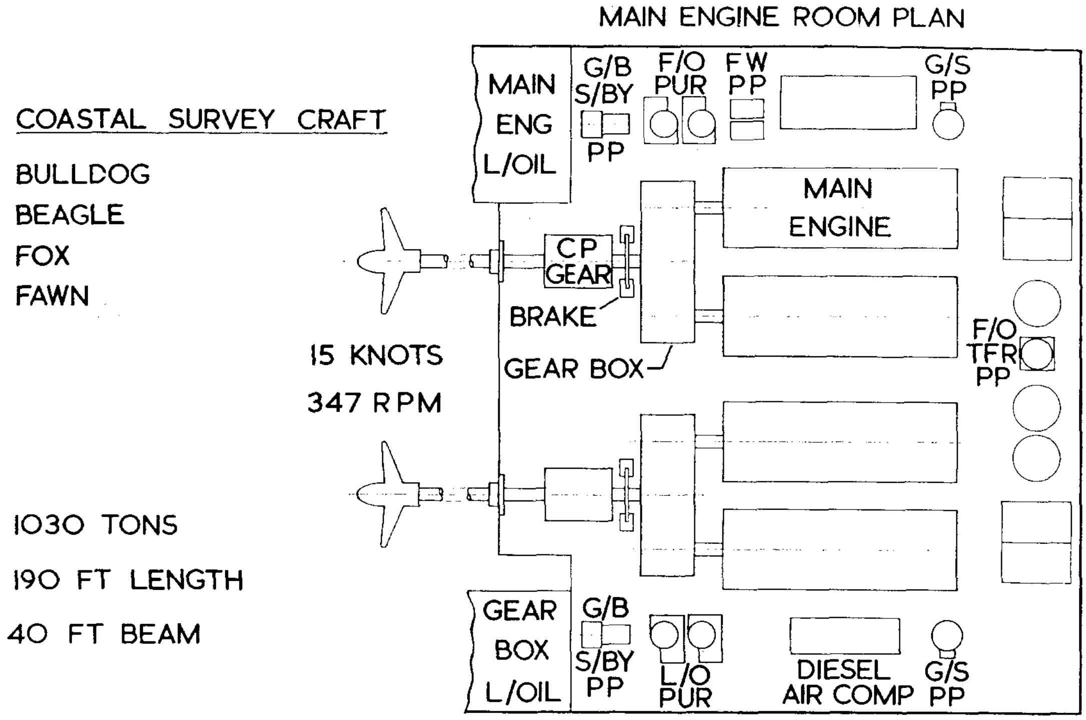

FIG. 3

in-line engines and develop 600 bhp at 750 rpm. The gearboxes are also Lister Blackstone's.

Generators There are four Lister Blackstone 4-cylinder in-line engines giving 290 bhp at 720 rpm. Most of their parts are interchangeable with the main engines.

Boilers 2 Stones boilers are fitted to supply ships services and the evaporators.

Evaporators These are Marshall spray type flash evaporators and should produce 5 ton/day each.

Miscellaneous There are refrigerating, air conditioning and HP air systems in addition.

Lister Blackstone engines were chosen partly on the Hydrographers insistence that he wanted reliability above all else and partly because one felt a lower rated engine which had given good service commercially and in PAS craft would be more suitable for this application than a high-speed highly-rated engine.

The C-P propeller gear is made by Bamfords. The principle of operation of the pitch control gear is that a hydraulic piston in the engine room transmits its thrust down a 3-in. rod inside the propeller shafting to the hub. Mounted on the rod is a cam block in which are machined slideways which engage with pegs attached to the blade roots.

Engine control is by Bloctube rods to the engine control room and from there to the bridge (which is the normal operating position) by a simple pneumatic system. The ship is manoeuvred by a single lever for each propulsion unit. Movement of the lever first increases pitch and then, once full pitch is set, increases engine speed.

PLAN AT GALLERY DECK LEVEL

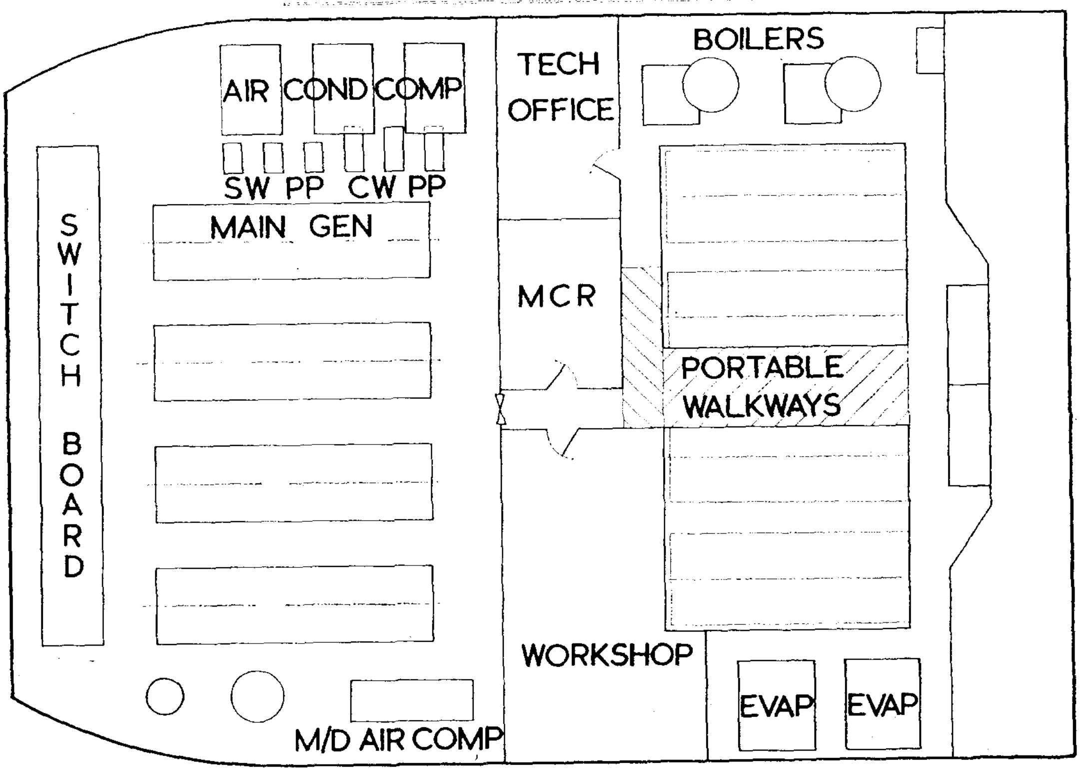

FIG. 4

Trials Results

The propulsion machinery of the first of these craft to be completed, H.M.S. *Bulldog*, worked very well during the Contractor's sea trials and the engines are pleasantly quiet. The C-P propeller pitch was set up empirically to give the speed required by the contract without exceeding the rated horsepower of the engines.

The major problems encountered were as follows:

Evaporators

The evaporator plant was installed above the water-level without taking into account that the sea-water pump was not self-priming. The pressure drop in the steam range between the boiler and the evaporator was also forgotten and this has meant resetting the boiler pressure which is fortunately easily done on Stone's boilers.

Steering Gear

This worked very well going ahead but when going astern even at low speed the ram anchorages deflected and there were unpleasant hydraulic noises. It was not laid down what speed astern the steering gear should be able to cope with, but in a warship half of the ahead shaft speed is the normal figure. This would give us 7 knots in these craft.

The C-P Propellers

The propellers of the first craft were examined after sea trials to check on their condition. They were found not to be fully watertight but this was rectified by a small design change. Sealing of the rotating blade roots imposes a difficult

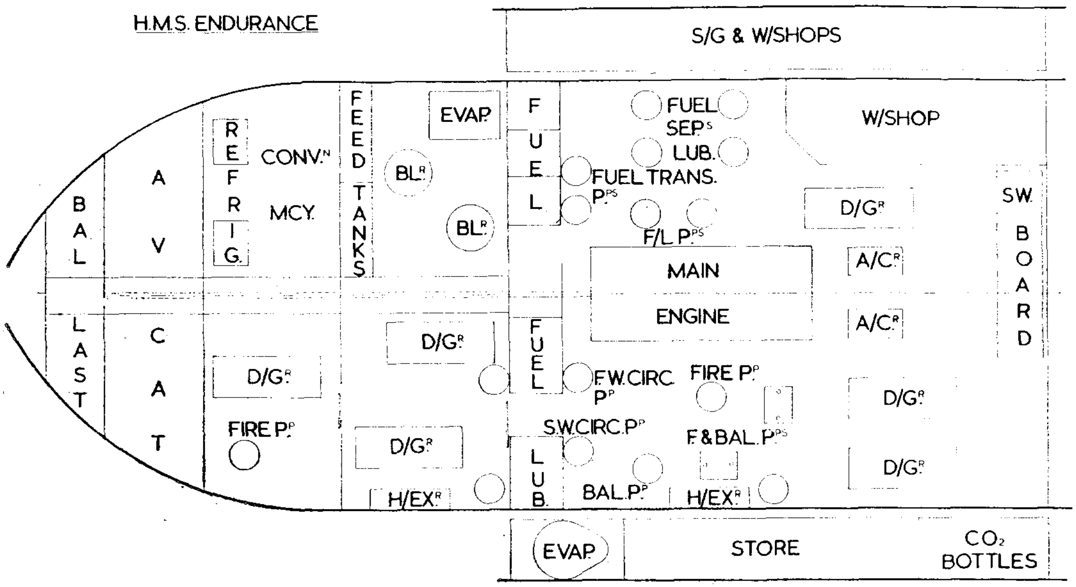

FIG. 5—MACHINERY INSTALLATION—H.M.S. 'ENDURANCE'

engineering problem. In addition some minor casting defects had to be made good. The nickel aluminium bronze from which they are made is a difficult material to cast. However these propellers give the craft very good manoeuvrability and simplicity of control.

To sum up on these craft, we feel reasonably happy that they are suited for their job but will require careful assistance from their Administrative Authorities.

H.M.S. ENDURANCE

A replacement for H.M.S. *Protector* for duty in the Antarctic had been under consideration for some time. The main requirement was for a military presence in the Falkland Islands area with subsidiary roles of surveying and helping the BAS. A specification for an icebreaker was drawn up some years ago but the tenders were all too high and this project lapsed.

In the summer of 1966, a replacement became a matter of urgency as the *Protector* was running out of life. Various possibilities were considered and eventually it was decided that the Danish ship *Anita Dan* be purchased and converted. She is an ice strengthened ship built in 1956 for Lauritzens of Copenhagen for the Greenland mineral trade. Similar but smaller sister ships such as the *Magga Dan* had been to the Antartic.

The ship was bought in early 1966 and delivered to Harland & Wolff for conversion to meet a Statement of Requirements. The principal work was to fit a flight deck and hangar for two Whirlwind helicopters aft of the bridge superstructure and to fit out the holds to take additional machinery, store rooms, offices and junior rates' accommodation. She entered into service in June, 1968.

Her machinery installation is shown in FIG. 5 and is as follows:

Main Engine	Direct drive reversible Diesel engine of 3000 shp. Burmeister & Wain 5-cylinder 2-stroke crosshead type with exhaust valve in the head and inlet via ports in the liner.
Diesel Generators	3 in No. Burmeister & Wain 170 kW generators were already fitted. 3 more of the same type were added. They are 3-cylinder 4-stroke engines.
Boilers	2 Stones vapour boilers were added for the evaporator, ships heating, and domestic services.

Evaporators An existing waste heat plant is being retained and a new Marshalls flash plant was added.

Other Machinery Refrigerating plant
Avcat system
Laundry
HP air.

Provision of spare gear will be difficult as much of it will have to come from Denmark. Handbooks, drawings, maintenance schedules, operating instruction boards, etc., were provided to ensure that as far as possible the crew have every chance to compete with this unfamiliar task.

DESIGN AND BUILD SHIPS

General Comments

For ships built to GRMEs I feel that there are a number of requirements covered either in GRMEs or in the specification which although a case can be made for their inclusion yet it is questionable whether they are still worth the money. We seem in some cases to lose sight of commercial good sense in our efforts to reach still higher technical standards of design and production.

Building ships to Lloyds' requirements has its drawbacks. Lloyds are useful in that they provide a minimum basic standard to which the shipbuilder must work but it must not be fogotten that there are large areas in machinery installations that are not covered by Lloyds. In addition Lloyds trials are to a different standard from RN practice as they are designed to meet different requirements where financial considerations are all important.

Endless trouble can ensue from not clearly laying down in the specification exactly who will do each trial and to what standards.

With design and build there are certain inherent shortcomings. These are as follows:

(*a*) *Quality of design*

With the short building time of about 18 months the shipbuilder has to order his machinery as soon as possible without having had time to check the specification in detail and do any detailed installation design work. Detailing only just keeps ahead of installation as the job proceeds and by the time MOD(N) see any drawings it is often too late to do anything about any shortcomings. In addition, the financial stringency limits the quality and quantity of professional and technical effort put in on the design. I feel that if we are to improve things in the future we must allow more time after awarding a contract for the shipbuilder to do his design work and insist that more drawings are available for inspection and discussion before work is put in hand. In the US Navy such a period is allowed.

(*b*) *Logistic, Repair and Training Problems*

By letting the shipbuilder choose commercial equipment one saves on first cost but one immediately adds to the cost of spares support, identification and refitting information, dockyard overhaul facilities, and training of both dockyard and naval personnel. Once one has commercial equipment one needs to look closely at its cost relative to its overhaul cost. There appear to be a number of mass produced items which are cheaper to replace by new units than to refit.

Steam Supplies in Diesel Ships

One problem that has arisen with our Diesel ships has been that of providing a suitable steam supply. This does not arise in Type 41/61 frigates where all heating and distilling is done electrically, but in our design and build ships steam has to be provided for:

Ships heating
Distilling
Galley, laundry and water heating.

The boiler has to run continuously while the ship is away from shore supplies and the maintenance load on a Stones vapour boiler is frequent and requires skill. Also if one chooses a boiler to meet full steam demand and also a second for stand-by, one is left with the problem of providing steam when neither the distilling plant nor the ships heating is needed. The steam demand under these conditions is very low and intermittent. Whatever size of boiler is fitted it means that the boiler would often be below its minimum continuous firing rate and would be cycling on and off. I am concerned how a boiler will stand up to months of cycling. In some ways a waste heat boiler would be useful to provide steam under these conditions but they are bulky and difficult to install if they are to pick up heat from all engines. It would seem that all electric galleys, laundries and water heating would avoid this minimum-load problem.