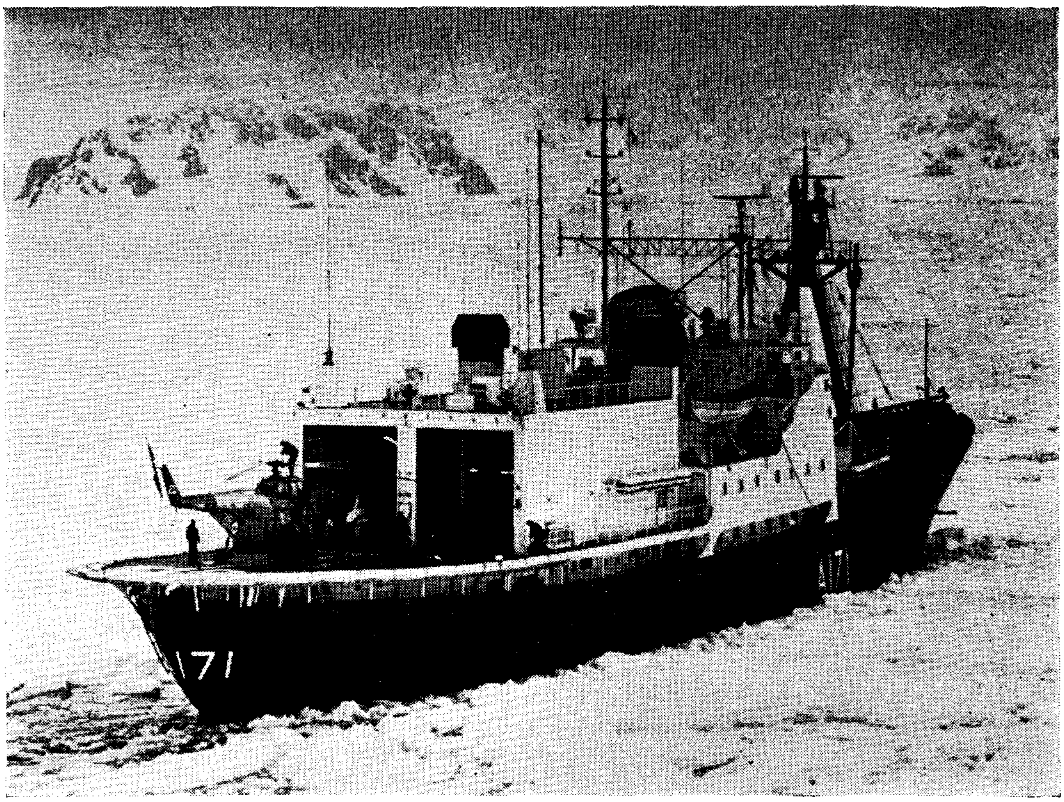

FIG. 1—H.M.S. 'Endurance' IN PACK ICE

H.M.S. ENDURANCE

ICE PATROL SHIP

BY

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On arriving in the shipyard of Messrs. Harland and Wolff, Ltd., Belfast, to stand by the ex-Danish M.V. *Anita Dan*, which was to be converted to an Ice Patrol Ship as a replacement for H.M.S. *Protector*, and upon being shown a rather rusty cargo ship, I knew this was to be an unusual appointment.

The ship, which had been built in Germany in 1956, was 3,250 tons, had four cargo holds, and the hull was specially strengthened for navigation in ice. This latter feature was, of course, why she was purchased by MOD(N). For reasons of economy, as much as was practicable of the original structure was retained, and the majority of the conversion work was to commercial standards and only where necessary were R.N. standards applied. Here, therefore, was a 12-year old merchant ship to be refitted and converted to a mixture of MOD(N) and Lloyd's requirements, all to be completed in time to take over *Protector's* commitments the following year.

Initially, there was some confusion; many aspects of the work fell between the specifications of the two supervising authorities, and were covered only by that undefinable term 'To Best Commercial Practice'. Eventually all went well, however, and to the credit of all concerned, the ship builder, the overseers, and MOD(N) representatives, who took such a keen interest in the ship, the work was completed on time and to a good standard.

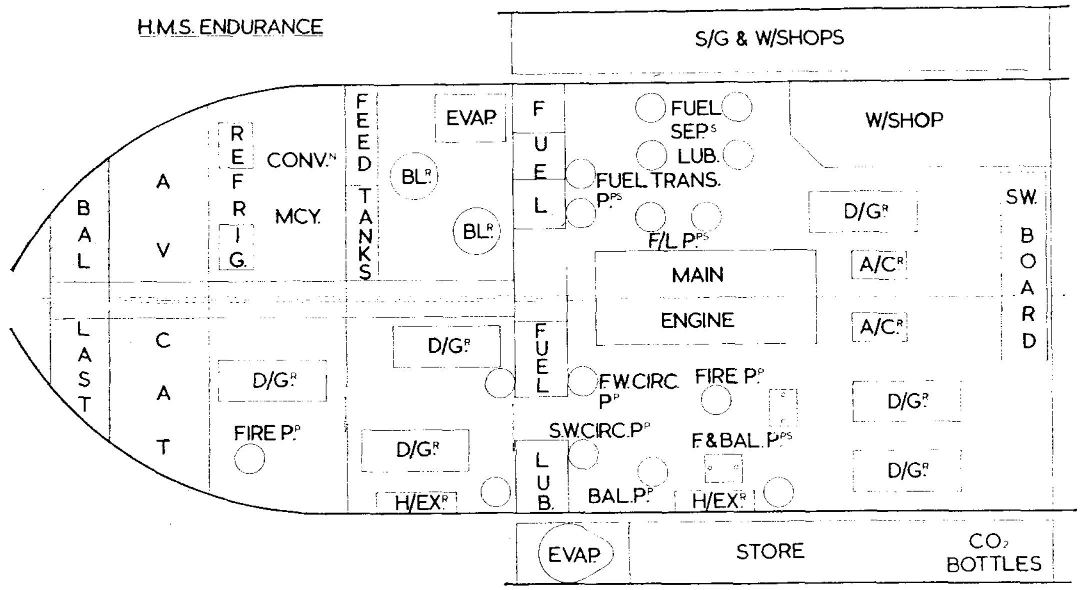

FIG. 2—MACHINERY LAYOUT

As far as the machinery was concerned, the majority of the original installations, including the main engine were retained. These were all of foreign manufacture. Most of the new equipment fitted was housed in new spaces built in the lower section of what was originally No. 3. hold, and with the exception of the generators, which for reasons of standardization were similar to the original ones, were all British manufacture, but much of it was to Commercial specifications. Aviation fuel and H.P. air services to the hangar were also fitted.

FIG. 2 shows the layout of the machinery, the details of which are as follows:

Main Engine	Burmeister and Wain 550 VTBF—5-cyl., 3220 ihp at 170 rpm. Two-stroke crosshead type direct reversible with two exhaust driven superchargers of French manufacture (Societé Rateau) and poppet exhaust valves.
Diesel Generators	3 original and 3 new Burmeister and Wain 170kW, 3-cyl. 4-stroke Supercharged Trunk type.
Starting Air Compressors	2 Burmeister and Wain 2-stage M/D, 58 bhp at 900 rpm, 125 m^3/min (4410 ft^3/min).
Boilers	2 Stones Vapor type DC 6145 ME, 4,500 lb/hr at 110 lb/sq in. fitted with Hymatic air compressors Type S.R. 1800.
Evaporators	I Original Atlas Type A.F.G.—12 metric tons daily. Waste heat type using heat from machinery cooling system. 1 New Marshall 'Aqua Chen'—24 ton/day, steam heated 2-stage Flash type.
Refrigerating Plant	Sterne W 500 H.A.—S.W. cooled with duplicate compressors fitted. *Note:* Potato Room supplied by separate air cooled unit (Sterne 100 FH).
Steering Gear	Svenborg Skibsvaert electro-hydraulic with 'Arkas' Auto Pilot fitted.

In those early days, a number of problems occupied our thoughts, one of which was pre-commissioning training. The only Service courses which were of any help were those for aviation fuel and Stones Vapor boiler, and although all ratings joining were ICE trained, few if any had ever seen, let alone operated, machinery like some of that fitted. The training therefore had to be largely a matter of self-help; there were very few instruction books in English available at that time, so it was a case of chasing the systems and badgering the shipbuilder's staff for information. Fortunately, they were particularly helpful and without doubt, taught us much. Also with their help and by the kindness of Messrs. Burns & Laird Ltd., I was able to spend four days on board their Belfast to Glasgow Ferry, *Scottish Coast*. The machinery in this vessel, although not the same, has a number of similarities, and I was given some very valuable tips from the Chief Engineer and his staff. In addition, the CERA spent a few useful days with the Marshall Engineering Co. Ltd., and witnessed the pre-installation trials of the evaporator.

Another problem, which will shortly be facing everyone, was metrication. The original instrumentation was all metric, and the MOD(N) decided, rightly I think, that not only should it remain so, but that all the new instrumentation, excepting that for the HP air and aviation fuel, should also be metric. Initially, all kinds of difficulties adapting the watchkeepers to the unfamiliar units were imagined and the provision of conversion charts was considered. Finally it was decided that this would only delay the adaption so apart from ensuring that correct working figures, together with safety margins where necessary, were made available, no extra steps were taken. All readings were logged in metric where applicable, and after the first surprise, everyone quickly accepted the new units, and it was soon quite natural to log such items as the firemain as 7 kgs/cm^2. I must admit that for some time I found myself mentally converting degrees C back to degrees F, and it took time to get used to the main engine L.O. pressure gauge reading between 0·8 and 1 kgs/cm^2.

Spare gear presented yet another problem. A large proportion of the spares previously borne for the original machinery was used during the refit, and had to be replaced. There was also the additional requirement for the new equipment. Allowance lists had to be finalized and in fact, apart from the late delivery of some items, the main difficulties of storage, etc. were caused by not knowing the total quantities to be supplied until a very late stage. The ship left Belfast far short of the full allowance, and, although more was received at Portsmouth, sailed south with about 85 per cent of all mechanical and electrical spare gear. Still more was received at Montevideo and the Falkland Islands, and finally about 95 per cent was held. By this time, all available stowages had been filled and part of No. 1 Hold, which fortunately had remained unaltered, was appropriated.

Special arrangements had to be made for the subsequent replenishment of the commercial type spares, which made up the largest part of the spares carried. A contract was placed with Harlands to arrange supply with the various manufacturers concerned, and the ship had to order through them via the Principle Naval Overseer, Belfast. It was necessary for a demanding procedure to be introduced, so forms based on the normal demand forms, but allowing for the necessary additional data, were produced on board.

The day of acceptance eventually arrived, CSTs had been completed satisfactorily, and it was now up to us. There were some at Harlands who may have doubted our ability to make Portsmouth, and it was not without a little trepidation that we took over, but the trip was completed without difficulty and we went on to a curtailed but satisfactory work-up at Portland before returning to Portsmouth for final storing before sailing south.

There are many interesting features about the machinery installations. Firstly, with the exception of the steering gear and aviation fuel system, most of the main machinery is contained within the main and new auxiliary machinery rooms, all of which, including the shaft tunnel, are interconnected by water-tight doors. A very convenient arrangement for the watchkeepers.

The main engine, although small by Merchant Navy standards, is large for the Royal Navy, and in many ways resembles the steam reciprocating engine in *Loch* Class frigates; the sizes of the bottom end and main bearings, and even the top speed of 172 rpm are about the same.

An aid to watchkeeping was the extensive alarm system. The original panel, which covered such diverse items as high bilge level, low main engine lub. oil pressure, and high and low fuel tank levels, was retained, and Teddington alarm and auto shut-down panels were fitted to each generator. The fire pumps were fitted with auto cut-ins, the boilers were fully automatic and the evaporators each had high salinity alarms fitted; in addition, the Marshall set was fitted with automatic dumping valves on the distillate and condensate discharges.

The machinery cooling systems in the main and auxiliary spaces serve all the cooled equipment including the main engine in each space. Each system has its own pumps and heat exchanger but the header tank is common to both, and the systems can be cross-connected if required. A useful feature of this arrangement is that the main engine can be kept warmed through by using heat from the generators. Also incorporated in the main machinery room system is an evaporating plant and under steady steaming conditions it is possible to utilize the waste heat.

Another unfamiliar equipment is the steering gear. Although of the electro hydraulic type, there is no hunting gear or separate telemotor system. Control is by means of a small hydraulic pump incorporated in the helm wheel. So long as the wheel is turned, the main pumps remain on stroke, and to safeguard against overloading at the limit of rudder movement the rams operate by-pass valves. In the event of main pump failure, the helm hand pump is automatically connected directly to the rams, and becomes the emergency hand pump. Also incorporated in the control system is a reversible electrically driven pump which is in parallel with the helm pump and enables the rudder to be controlled either by a tiller arm on the bridge and in the crow's nest on the foremast, or by auto pilot control. Extensive use was made of the auto pilot, thereby saving in seamen watchkeepers. On passage, the ship was in fact steamed by a total of five on watch: two, including the O.O.W. on the bridge, and three in the engine room.

Because the accommodation available was limited, the complement was of necessity down to the bare minimum, and the most efficient use had to be made of the men available. This factor influenced the arrangements fitted in the machinery spaces which enabled the machinery to be operated and supervised adequately with three watchkeepers, and at the same time keep up to date with most of the planned maintenance during the long periods at sea. Apart from the MEO, who being the only Technical Officer borne is also responsible for the WE Department, the Marine Engineering complement consists of a CERA, 4 ERAs (Unit), 2 Shipwrights, 4 LM(E)s (1 MEO Wtr) and 8 M(E)s. One junior rating was required as motor boat driver/maintainer for the detached Survey Party and was virtually lost to the Department most of the time down south. Because of the small numbers, the junior ratings had more demands put upon them and consequently found their work more interesting, but on occasions the shortage was very apparent, and it was due only to the close co-operation of the ME and WE Departments and the willingness of the SRs to muck in and do some of the donkey work, that crises were avoided. During refit and leave periods, the shortage of numbers becomes critical and it is important that some form of base support over and above that normally within the terms of reference of FMUs is provided.

On occasions, the particular talents of a Ch M(E)/POM(E) were missed. The Shipwright whose lot it was to take over some of their traditional duties, e.g., fuelling and fire-fighting equipment, often wished one was carried. There was one occasion in particular, in Punta Arenas in Chile, when fuelling was by road tankers. This was permissible only by night, and the whole operation took three nights!

The trip south went very well indeed; except for some early fuel valve (injector) troubles, and one main engine exhaust valve spring cage fracture necessitating a complete unit change at Gibraltar, there were no major problems and we were free to enjoy the delights of South America. On passage the Atlas waste heat evaporator proved its worth, running continuously with the minimum of attention and producing about 7 tons of fresh water daily for no extra fuel cost. It was only necessary to run the steam plant about every third day to boost the fresh water total and to top up the MUF.

Not long after arriving in the Antarctic, the day arrived that we had all been waiting for: our first entry into pack ice. A British Antarctic Survey (BAS) aircraft had forced-landed on the Larsen Ice Shelf, through lack of fuel, and the ship was diverted from South Georgia to assist. After about a week of very heavy seas, we entered the ice and proceeded to batter our way south for several days, until we were finally stopped just north of the Antarctic Circle. This was near enough to the BAS base at Adelaide for the helicopters to use it as a staging point to Stonnington, the nearest base to the aircraft, where they waited for favourable weather before flying over the mountains to the aircraft with the vital fuel supplies.

For those of us who had never been in ice before it was fascinating. As far as one could see the ice spread out before us, the surface broken by hummocks of pressure ice and the occasional iceberg. Depending upon the quality of the ice it was either like driving across a ploughed field or across the top of a giant Christmas cake. Remarkably the problems we experienced were less than had been anticipated, and we soon became accustomed to the jolting of the ship when it contacted a particularly hard patch of ice and to the rather frightening noise of the ice scraping down the side and under the ship.

Problems from icing were negligible for during the Antarctic summer the air is generally dry and there is little precipitation. Temperatures experienced were seldom abnormally low, and although a large proportion of the main service is exposed, the lagging and provision of leak-off cocks at the extremities were sufficient to prevent freezing. The exposed hydrants on the flight deck were the only parts to be affected.

The main sea-water cooling system remained relatively trouble free; the system is fitted with high and low suctions and, to prevent icing, a proportion of the discharge can be led back to the suction.

The fire pump suctions, however, were badly affected being frequently choked by 'mush' ice passing under the ship and being forced into the suctions.

The main engine presented the biggest problem, for it was necessary to run it for long periods under most undesirable conditions; i.e., heavy loading, low revolutions, and with frequent starting, stopping and reversing. As described earlier, it is possible to keep the engine warmed through, using the heat from the generators, and this proved a great advantage. As a precaution against overloading, the same limitation in power as for towing was imposed.

The adverse effect of these running conditions was evident when the piston rings were examined, the lower ones were found to be badly carboned up. (*N.B.* It is possible to carry out a periodic examination of the piston rings by crawling into the scavenge chamber and sighting the rings through the scavenge ports, while turning the engine with the turning gear.)

One of the thoughts which was always uppermost in our minds was the possibility of damage to the propeller and rudder, especially when going astern, On these occasions the Captain directed the ship from aft, using a portable radio. Also, when stopped in ice, it was vital that the stern was kept clear and this was done by moving the rudder at regular intervals, and by kicking the engine ahead when necessary. Ice against the rudder under these conditions naturally put a heavy load on the steering gear, and was at least in part the cause of one of the pump motor windings catching fire on a later occasion when the ship was in the Arctic.

Without doubt, this year has been a most successful beginning to what I think is one of the Navy's most interesting ships. During the first season south, a considerable period was spent in the ice, a great deal of valuable survey work achieved, and useful assistance was rendered to the BAS—not to mention the many friends we made in South America. Finally, to round off the commission, the ship sailed North to the Arctic, and once again entered pack ice off the north coast of Spitzbergen, to rendezvous with the British Trans-Arctic Expedition at the end of their long trek across the North Pole. The main engine clocked up 3650 hours and a total of 40,290 miles were steamed without base support. The only major mishaps were the failure of a bottom end bolt in one of the original generator engines, which caused extensive damage to the machine, and a dented bow caused by a collision with a small iceberg.

From the Engineer Officer's point of view, I have been well pleased with the machinery installation and with my staff, who took it all in their stride. As one who has suffered the old type of evaporator for so long, I think those in *Endurance* are worthy of mention, for they have given good service maintaining a steady output without the necessity for chemical injection, descaling or acid cleaning, and required the minimum of attention.

Considering her unusual origin and the limited time in which the purchase, design and conversion were completed, it is remarkable that *Endurance* has gone so well. She has been a truly happy ship, and a few more like her might help to ease the manning problem.