THE TYPE 22 FRIGATE

ELECTRICAL ASPECTS

BY

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The Ship Concept

The Type 22 frigate is an ASW ship designed as a replacement for the *Leander* Class frigates and, in size, is about the same as the Type 42 destroyer. The ships can carry two Lynx helicopters and are armed with air-launched and surface-launched torpedoes, EXOCET, and two SEAWOLF systems. There is an extensive sonar fit, a new doppler surveillance radar, ABBEYHILL and CAAIS. Ship and weapon stabilization is derived from two Mk 19 compasses. The external communications are based on ICS3 and SCOT I and the internal communications on RICE Mk 2. There are two shafts with controllable-pitch propellers each driven by a Tyne or an Olympus gas turbine in a COGOG arrangement similar to that in the Type 21 frigates and Type 42 destroyers.

The Main Electrical System

The ship's electrical power is derived from four 1 MW Paxman Ventura diesel-generator sets. There are two switchboard rooms, each containing a breaker rack and a separately mounted secondary electrical control panel. Each switchboard has three sections, the outer ones being supplied by the

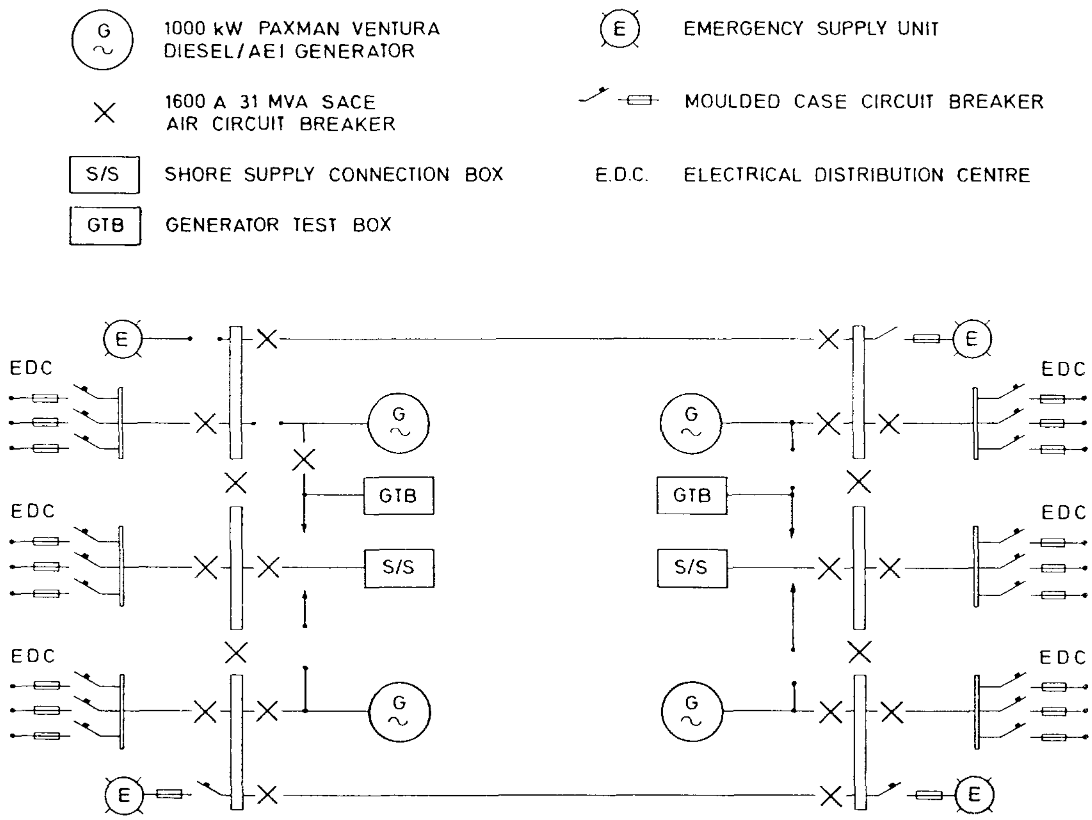

FIG. 1—DIAGRAMMATIC ARRANGEMENT OF MAIN SUPPLY SYSTEM

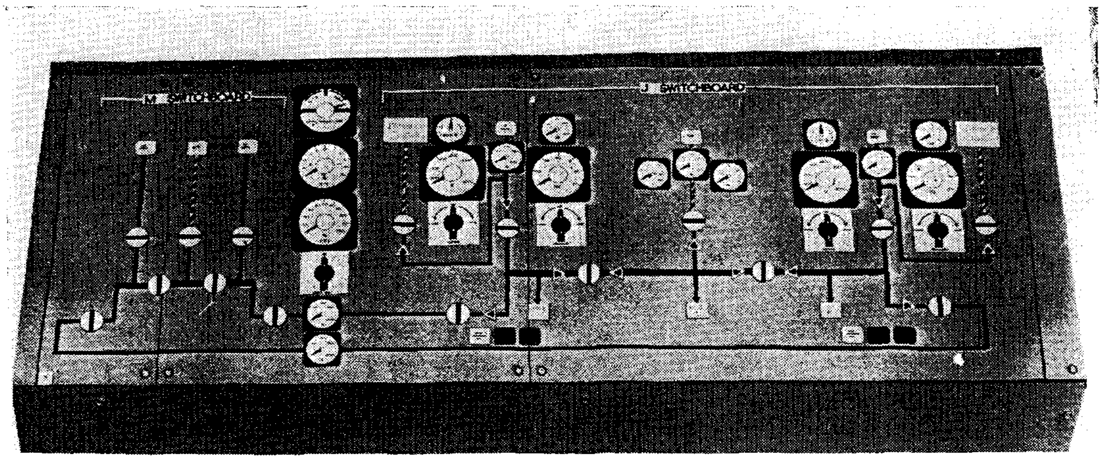

FIG. 2—'J' SECONDARY ELECTRICAL CONTROL PANEL

generators and the centre section being linked to the shore supply connection box. Each switchboard section has one feeder breaker supplying an electrical distribution centre (EDC), and the usual inter-connecting and linking breakers. The secondary electrical control panels show the state of the whole system but provide control only over the generators and breakers associated with their own switchboard. The system is shown diagrammatically in FIG. 1 and a secondary electrical control panel is shown in FIG. 2.

There are two shore connection boxes (SCBs), one starboard forward and the other port aft. Beside each SCB is a generator test box to which load barge or shore generator test cables will be connected, thus avoiding having to drag the cables through the ship. The generator test boxes allow any generator to be tested without affecting the running of the others or the use of shore supply.

The main electrical system will normally be controlled from the primary electrical control console (which is a part of an integrated machinery and electrical control console assembly (MECCA)) mounted in the ship control centre (SCC). The primary control console carries all the controls, indications, warnings and alarms needed to start and stop the diesels, parallel the generators and operate the switchboard breakers. A check synchronizer is fitted for easy parallelling of the generators, but the system is not designed for continuous parallel running. There is an automatic logging and warning system which logs the loads on the generators and produces warning signals should the load on any generator fall below or rise above set limits or should a diesel develop defects. The primary electrical control console is shown in FIG. 3.

The Electrical Distribution System

There are six electrical distribution centres (EDCs) sited near load centres in the ship. Each consists of racks of manually-operated moulded-case circuit breakers (MCCBs), each MCCB being colour coded to show the importance of the service which it supplies. Normal and alternative supplies for important services are taken from EDCs supplied from diametrically opposite switchboard sections. This makes it almost impossible accidentally to make up the system in such a way that both normal and alternative supplies for any service are derived from the same generator.

The distribution from the EDCs is conventional. However, a new series of starters has been introduced to specification DGS 252. The series has three 'standard' ranges in different current ratings—20A, 60A, and 180A. All starters in each range are identical, and many components are common to the whole series. The basic circuitry is also the same in the whole series.

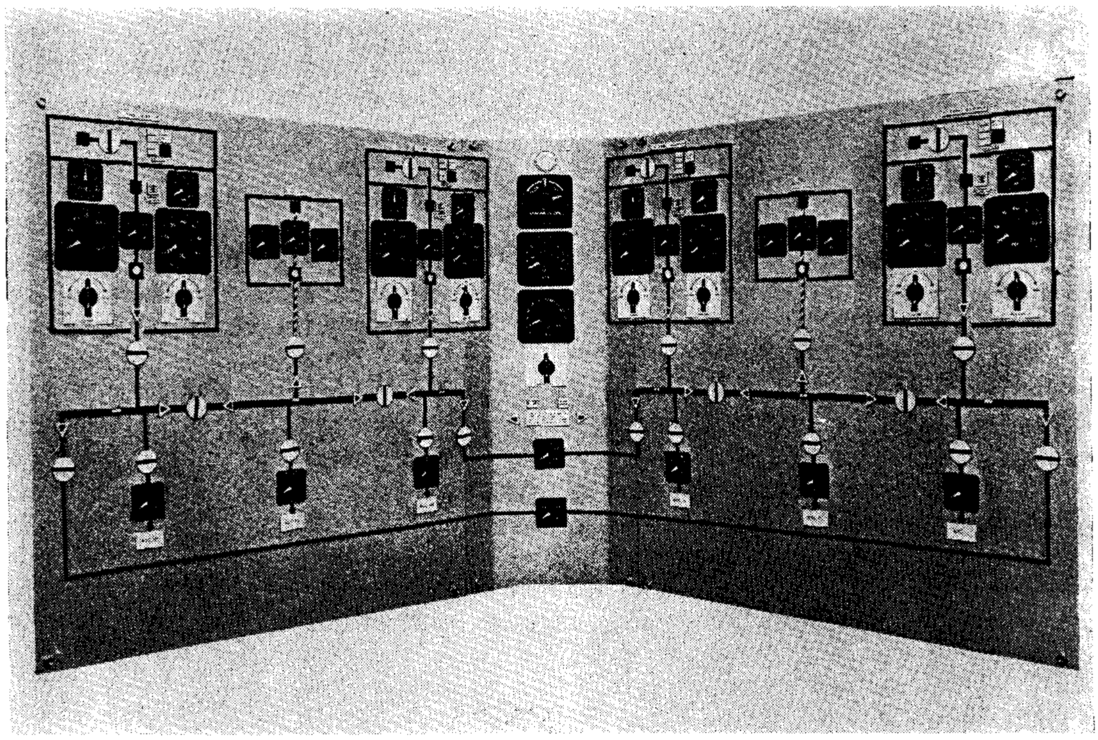

FIG. 3—MOCK-UP OF THE PRIMARY ELECTRICAL CONTROL CONSOLE

The range of 'standard' starters covers the needs of most of the motors in the ship, but in some machinery plants additional functions are needed. In these cases, 'special' starters are specified but these again use the same basic components and circuitry as the 'standard' starters. The starters are very much smaller than existing designs and should be easy to repair and, of course, the number and diversity of spares is much reduced.

Converted Supplies

Almost all converted supplies are derived from static frequency changers (SFCs) or transformer rectifier units (TRUs), and these are mounted as close as possible to the equipments which they serve. Important services are either provided with a standby SFC or TRU or are battery supported. The early unsatisfactory designs of SFC are being phased out and the newer designs should be much more reliable and maintainable.

Internal Communications

The ship is to be fitted with an improved Rationalized Internal Communications Equipment (RICE) based on that in H.M.S. *Bristol* but of simplified design. The major differences between RICE and earlier systems is that where the old systems had one central amplifier per system the RICE system has separate amplifiers at each loudspeaker/headset and microphone position so that all signals in the system can be set to a standard level; also a failure of one amplifier does not put the whole system out of action.

The ship is to have the new electronic telephone exchange which has 128 internal lines and 6 external lines suitable for working directly into the MOD tie-line system. The exchange uses time division multiplex techniques with push-button dialling. It should prove very reliable since it has a large amount of built in redundancy. A ten-line version of the exchange has already had a sea trial and a further sea trial of the full exchange is in hand. There will be two telephone booths for ship/shore use by the ship's company when at sea and four coin box telephones for use when alongside.

The Steering System

The steering system is electrically controlled and provides a choice of hand or automatic (autopilot) steering from the bridge or hand steering only from the secondary steering position (SSP). The hand-steering units and the autopilot produce 'desired rudder position' signals which are passed to servo amplifiers mounted in the SSP console. The amplifiers also receive an electrical feedback of rudder position from Linvars on the rudder head. The outputs from the amplifiers drive torque motors on the swash-plate servo systems of the VSG pumps. The electrical feedback from the rudder head means that the floating lever mechanism is no longer required and allows a better layout of the tiller flat.

The hand-steering units and autopilots are developments of the units fitted in the Types 42 and 82 destroyers and have been simplified to improve reliability and maintainability. A dual system is fitted throughout and it is hoped to provide a continuous monitoring system which will indicate failures, particularly in the standby system, as soon as they occur.

In case the electrical control system should suffer a complete failure, a form of mechanical steering is to be fitted and, of course, there will be the hand pump for centralizing the rudder under complete power failure conditions.

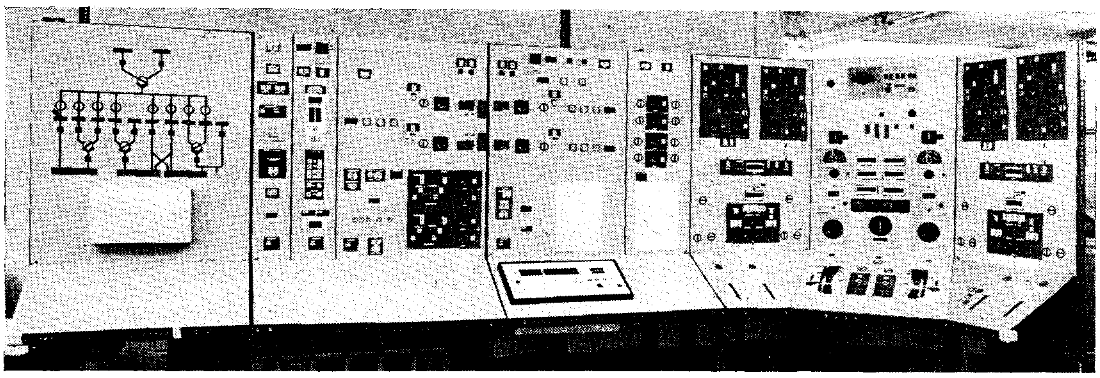

FIG. 4—MOCK-UP OF THE MACHINERY CONTROL SECTIONS OF MECCA

Machinery Control

The machinery control system is designed to allow all main machinery and all important auxiliaries to be operated and monitored from the SCC. In addition, the bridge can take over the control of the power and pitch system via a servo link to the SCC.

All the centralized machinery controls, indications, warnings and alarms are mounted on the MECCA in the SCC. In FIG. 4 showing the machinery control sections of the MECCA, the 'throttle watchkeeper's' panel is in the corner on the right; on either side are panels with flow diagrams of the engines, gearboxes, shafts and propellers with state lights, alarms, warnings and instrumentation. To the left, the next five panels are laid out geographically to show the fuel and lubricating oil systems with their control and instrumentation; these panels also carry the control and instrumentation for the other auxiliaries, again shown geographically in their correct compartment. On the far left is the LP electrical control panel which selects and controls the LP electrical supplies to the machinery system.

In the complete MECCA, the primary electrical control console is sited to the left of the LP panel, the whole assembly being shaped like an unused paper staple. The engineer officer of the watch has a desk set back from but facing the long side of the console.

The engine and CPP control system is electronic and is based on that in the Type 21 frigates and the Type 42 destroyers though the design has been further rationalized and simplified. The system has the following main functions:

(*a*) Start/stop control and interlocking.

(*b*) Propeller pitch and engine throttle control.

(*c*) Engine change-over control.

The start/stop controls and interlocking ensure that all related conditions are correct for the action required and phase the necessary operations in the correct time sequence. Typical start interlocks, for example, are HPSOC closed, turning gear disengaged and lubricating oil available. The start interlocks can be overridden by a (covered) override switch on the console which may be used if the interlock is known to be defective but in a safe condition.

When an engine is started but not selected, it is automatically run up and controlled to its idling speed. When an engine with the power lever set to zero is then selected, the system will cause the appropriate clutch to engage and the engine will then be controlled to turn the shaft at 50 r.p.m. with the propeller at zero pitch.

With the Tyne engine running and selected, as the power lever is moved ahead from zero, the pitch schedule will cause the propeller pitch setting to move to a new position defined by lever position, and the throttle schedule will cause the Tyne throttle to be opened to a point which theoretically should maintain the shaft speed at 50 r.p.m. (If the Olympus is selected, the throttle schedule has no effect because the Olympus output at idling is sufficient to turn the shaft at 50 r.p.m. up to full propeller pitch.) Actual shaft speed is monitored at the gearbox and any departure from 50 r.p.m. causes the throttle schedule signal to be modified to open or close the throttle as required.

As the lever is moved through the 27 per cent. lever position, the pitch schedule calls up full pitch and from then on the system causes the throttle only to be operated, again with the shaft speed correction feed back. Beyond full pitch, therefore, shaft speed is proportional to lever position. When going astern, full pitch is achieved at 40 per cent. lever setting but astern power is automatically limited by the system to 50 per cent. of the maximum ahead Olympus fuel. There is no fuel limitation on the Tyne.

To change from Tyne to Olympus or vice versa, it is necessary only to start the new engine and select it. The control system will cause the incoming engine to run up to the speed at which its clutch engages and then to increase its power whilst the other clutch disengages; the outgoing engine is then reduced to idling speed. If the Tyne is selected while the Olympus is driving at a greater power than can be achieved by the Tyne, the system will automatically reduce the Olympus power to a level at which the Tyne can take over. It should be noted that the engine change-over can only be initiated from the selector switch on the MECCA and does not take place automatically as the Bridge lever or MECCA lever settings are changed.

In addition to the safeguards and interlocks built into the MECCA part of the control system, there are additional on-engine protection devices to prevent overheating.

The machinery control system and the ship's navigation and internal communciation systems are battery supported and can operate for at least half an hour under conditions of complete failure of the ship's main electrical power. During such a failure, lubricating oil is supplied by an air-driven pump supplied from the ship's H.P. air bottles. Normally, ship's supplies would be restored well within the endurance of the H.P. air bottles but, if this were impossible, the engines can be shut down without damage.

As mentioned in the article by Commander Laslett in this *Journal* (Vol. 21, No. 2, p. 183), the machinery control system also incorporates servo-manual controls which enable the automatic control system to be bypassed and the throttle and pitch actuators to be controlled manually from the MECCA, thus providing an intermediate level of control between automatic and local. The ship is also fitted with Decca ISIS which automatically monitors up to 240 main and auxiliary parameters and prints out routine logs as required; it also produces a warning and print-out when a parameter moves outside set levels. ISIS is fitted to reduce the routine watchkeeping task and so save men.

It is also planned to fit a Dynamic Data Recording system using a tape-recorder recording continuously on endless tape up to 91 selected parameters. The tape can be played back onto a 12-channel UV recorder to enable post-mortem investigations of malfunctions.

Electrical Annexes

Previously, ships' main passageways have always become cluttered with electrical boxes of one sort or another—usually because there has been nowhere else to put them. In the Type 22 frigate, the electrical equipment has either been kept out of the passageways completely or else been grouped into electrical annexes set back from the line of the passage. Unfortunately, certain equipment, e.g. emergency terminals and cables, must stay in the passage; it is hoped, however, to achieve much less clutter than has been usual in the past.

Weatherdeck Fittings

Considerable effort has been made in these ships to overcome the many weaknesses associated in the past with weatherdeck fittings: new fittings with rear cable entry are being developed to get rid of cable guards; large fittings, such as shore connection boxes, will be recessed and covered by doors; communication equipment which has required several small boxes grouped together for a particular function is being integrated into a single box; fittings which corrode and seize up are being redesigned; and, perhaps most important, investigation has shown that quite a lot of fittings can be dispensed with altogether.

Upkeep by Exchange

The ship has been designed from the start for upkeep by exchange. Removal routes for all large items are being specified and the machinery spaces and main passage are fitted with gantries to make it easy to move equipment through the ship. At each end of the machinery space section of the ship, there are a series of hydraulically operated portable plates opening up through the decks to allow heavy equipment to be lifted straight out of the ship and replacements lowered in. Stocks of spares will be built up so that defective or time-expired items can be immediately replaced with 'as good as new' items, the old items being repaired ashore in slow time.

Con Con

Those who have been associated with the Type 21 or 42 ships will already have heard such phrases as 'Configuration Control', 'Batch Production', 'Identicality', 'Datum Pack' and so on. For those to whom these phrases are new, these are jargon words used in the process of trying to build a class of ships to be as nearly as possible identical—both in their equipment fit and even in the small details of their layout—and in the attempt to keep them the same throughout their lives. If a degree of identicality can be achieved, there are many advantages to be gained; the number of drawings to be produced by follow-on shipbuilders is reduced, time spent in line-out and installation inspections is reduced; less training is required; As and As can be really common to a class and so can be worked out in detail for all the ships of the class; spares will be common and will fit. All these points save money, in particular in administrative costs, and so leave more for the ships.

The task is admittedly somewhat daunting and will indeed lead to many miles of computer print-out. It is, however, intended to employ these techniques in the build of these ships and, if successful, then the same junction-box and the same fuse panel will be in the same place in all the ships, refits will be much easier, the ships will get the right spares, and the time and effort required of the ships' staffs will be substantially reduced.

In Conclusion

A lot of effort is being put into designing the ship and her equipment to make life easier for the ships' staffs and dockyards. Only time (and S 2022s and As and As!) will show whether this has been achieved.