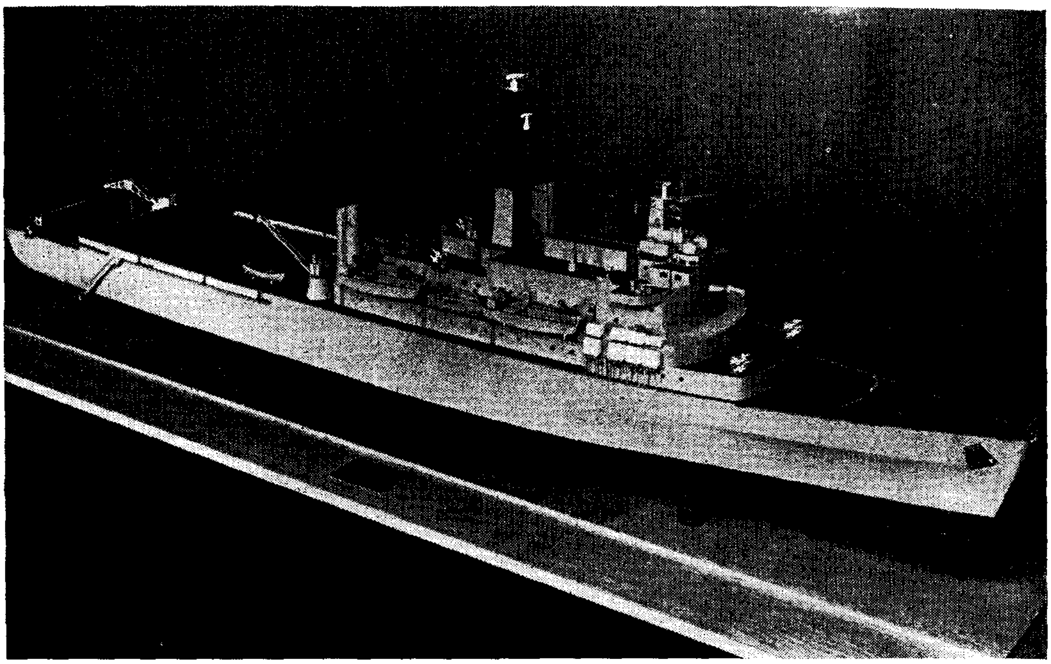

FIG. 1—MODEL OF THE ASSAULT SHIP

THE ASSAULT SHIPS

BY

LIEUTENANT-COMMANDER J. G. RICHARDS, R.N., A.M.I.MECH.E., M.I.MAR.E., M.R.I.N.A.

Introduction

The basic requirement for an assault ship was to land a Brigade Group, comprising:

1,800 men
40 tanks
100 '3-ton equivalents' (a military term and a unit of area, not of weight. It is the parking space occupied by a standard 3-ton Bedford truck. A loaded Bedford actually weighs about 8½ tons.)

This requirement could not be met by one ship but one ship should nevertheless be capable of carrying a balanced proportion of these numbers.

The choice of design lay between the L.C.T., the L.S.T. and a type of 'dock ship'. The L.C.T. was not fast enough or ocean-worthy. The L.S.T. required shallow-draught forward and bow doors, and these factors combined to prevent a speed greater than about 13 knots in rough weather. This left the dock ship, and the basic design was produced in the Admiralty in 1940. The design was taken to the United States in 1941, and the Americans built fifteen ships to the basic design. Although some of these ships were used in a follow-up capacity at Normandy, they were never actually used in an assault role.

The original American L.S.D. (Landing Ship, Dock) was comparatively small and had an open dock. This design has now been developed by the U.S. Navy into the L.P.D. (Landing Platform, Dock) which is a larger ship and has a covered dock to provide a helicopter landing platform.

The British L.S.A. (Landing Ship, Assault, usually known as the Assault Ship) is similar to the American L.P.D., but has two significant differences:

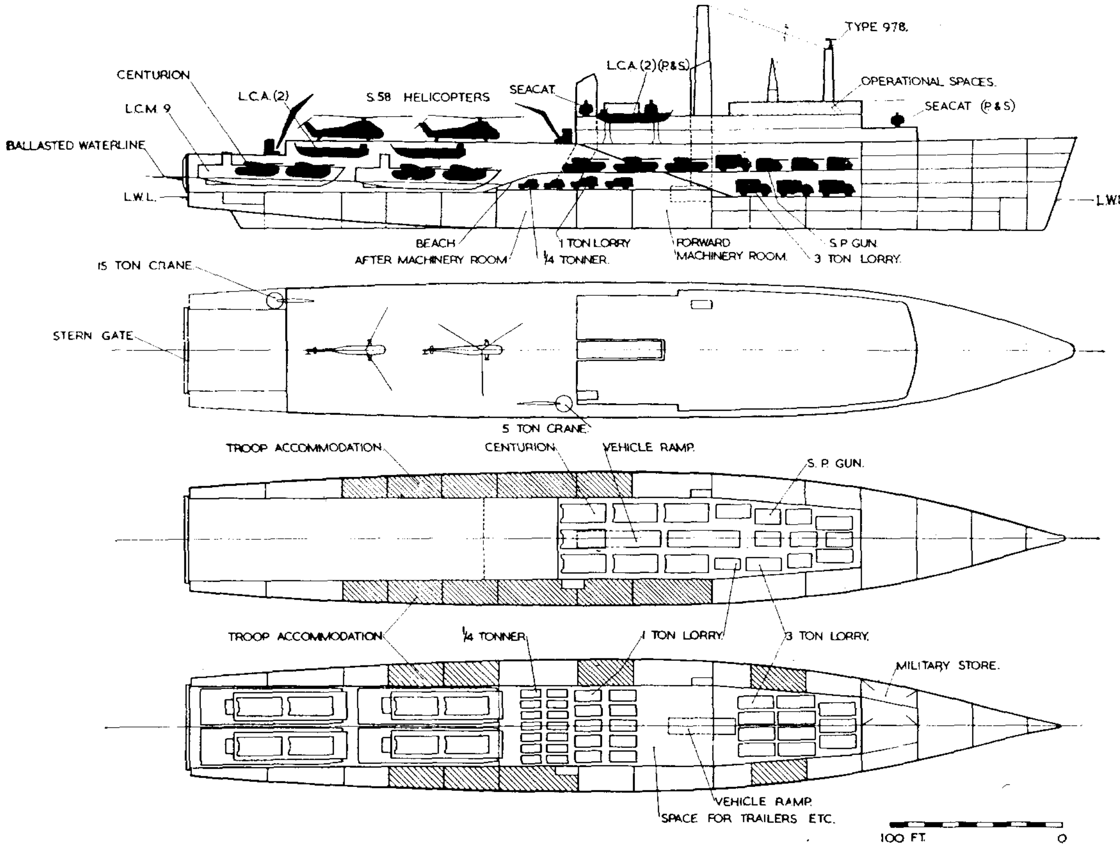

FIG. 2—MAIN LAYOUT

Firstly, in addition to four L.C.M.9s (Landing Craft, Mechanized Mk. 9) carried in the dock, the L.S.A. carries a fleet of 4 L.C.A.s (Landing Craft, Assault) in hydraulically operated davits and can land a wave of 140 Commandos in them. The L.P.D. carries no landing craft in davits.

Secondly, the L.P.D. is designed to carry large quantities of palletized stores and is provided with fork trucks and other heavy equipment to handle these stores. The L.S.A. carries stores in the embarked vehicles on the roll-on-roll-off principle, and the vehicle decks are therefore correspondingly larger.

Otherwise, the L.S.A. and the L.P.D. are very similar in speed, size and general layout.

One of the complications in the assault ships is the number and variety of liquids carried. A novel method will be used for Mogas supply to the beach. It is intended to carry dracones, flaked out on the helicopter deck. These will be filled alongside and then towed inshore.

Fin stabilizers are not fitted to the assault ships. The reason for this is that the main problems occur when disembarking and embarking the L.C.M.9s, and this will take place either at anchor or at a ship's speed of $3\frac{1}{2}$ to 4 knots, and fin stabilizers do not function under these conditions. With the dock flooded, a good degree of roll-damping is provided by the water in the dock, plus the longitudinal centre-line dock barrier, which virtually acts as a bilge keel, pointing upwards. It is of interest to note that if this centre-line dock barrier is removed, the L.S.A. is capable of docking an inshore minesweeper.

The L.S.A. is never intended to operate alone, but in conjunction with a Commando carrier which would fly the first waves of assault troops ashore. Both these ships would have a small ship escort, and also, if possible, a carrier operating fixed-wing strike aircraft. Logistic support on follow-up would be provided at first by L.S.L.s (Landing Ship, Logistic) followed by conventional transports.

The remaining L.S.T.s will be replaced by the L.S.A.s, and it can be seen that the L.S.A. is basically a cold-war weapon. In fact the role of the L.S.A. is that of a fire-engine, to suppress minor conflagrations and to prevent them spreading and becoming hot war.

There are at present two L.S.A.s building, and these ships should join the Fleet next year.

Engineering Layout

The assault ship is twin-screwed and the machinery is arranged in two well separated and self-contained units. Each unit is controlled from its own air-conditioned machinery control room; the forward M.C.R. is the controlling one and is fitted with limited monitoring facilities of the after unit.

Cross-connections between the units are limited to main and auxiliary superheated steam, saturated steam, closed exhaust, extraction pump discharge, servo-air and general service air. These cross-connections are not intended to be used in the normal sea or harbour state, but to enable defects or damaged states to be dealt with.

For harbour conditions, one unit will remain flashed up and supply the domestic load, with the other unit shut down and isolated.

After Machinery Unit

The two units are similar, and for the purpose of this article, the after unit will be considered. The after unit has been selected because the layout is rather more congested than in the forward unit. This congestion is caused by the slope down at the after end of the machinery space (caused by the beach above) and the fact that the forward (port) shaft passes through the compartment. As shown in FIGS. 3 and 4, there are two distinct levels of machinery in each compartment, and each item will be taken in turn, starting with machinery on the upper level.

Main Turbine

The main turbine is a down-rated Y.100 type with different nozzling arrangements. As in merchant ship practice, the assault ship is designed to run continuously at or near full power.

Main Boiler

The boiler is boxed, with the blowers taking their supply from the box and discharging into the air casing. A spill burning system is fitted and steam is supplied at 550 lb/sq in. and 850 degrees F, controllable down to 725 degrees F. The boiler is of the two drum, single furnace type and is fitted with an economizer. The output is 120,000 lb/hour and the flexibility requirement demands an increase to full power from 10 per cent power in three minutes in emergency.

The soot-blowers are air-operated and remote controlled.

The combustion system is conventional for remote controlled ships. The boiler is fitted with one pilot register (burning dieso) and four main spill burners of the 10-inch Admiralty suspended flame wide-range type, each with a maximum output of 2,500 lb/hour at an air/fuel ratio of 17 : 1. The turn-down is 16 : 1.

The boiler is provided with simmering coils. Steam purging equipment is fitted in conjunction with all main burners.

The boiler box may be decontaminated by water-spray nozzles.

Forced Draught Blowers

Two blowers, each of 100 per cent duty are fitted. They are sited as close to the boiler box as possible and are provided with an inlet silencer and with self-closing shutters on the discharge side. The blowers are horizontal and comprise a Type 81 turbine driving a Type 12 impeller.

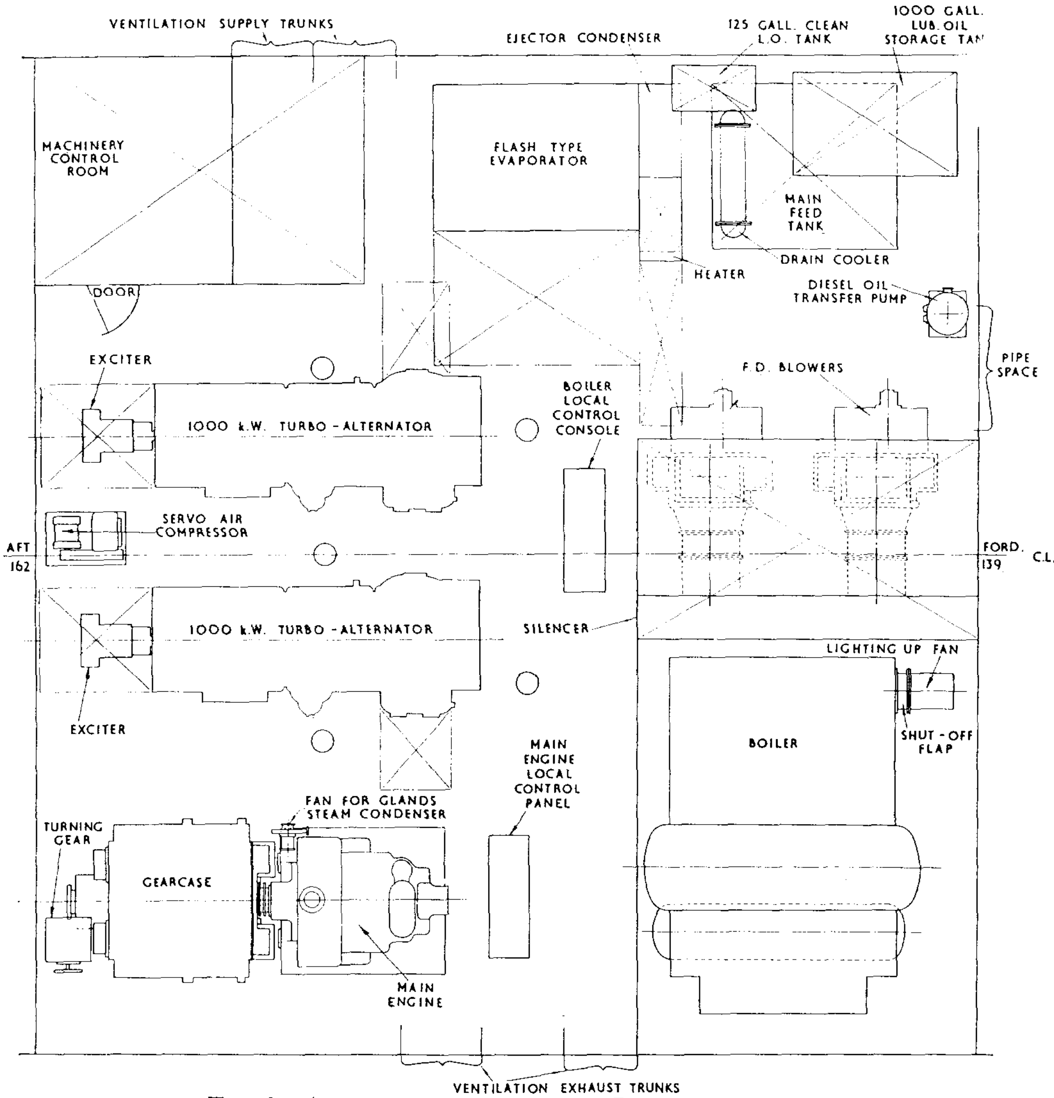

FIG. 3—AFTER MACHINERY SPACE—PLAN AT UPPER LEVEL

Experience in earlier ships, particularly Type 81 frigates, has led to a recent modification to fit additional electrically-driven forced lubrication pumps with auto cut-in facilities. This is to cater for slow-running conditions and for heat soak after shut-down.

Main Feed Pump

One main feed pump is fitted. A centrifugal, horizontal spindle, geared turbo-driven pump, it is identical to the G.M. destroyer and Type 81 main feed pumps. However, in the assault ship the duty is less and the steam conditions lower than in the G.M. destroyer.

Auxiliary Feed Pump

It was originally intended to fit a half-size pump, identical to the Type 81 cruising feed pump. It has recently been decided to increase the rating of this pump to that of the main feed pump, thus providing 100 per cent stand-by capacity. This change was decided upon in the light of experience in previous ships, particularly Type 12 frigates, where it has been realized that 100 per cent stand-by feed pump capacity is essential.

Feed System

The closed feed controllers are integral with the main condenser sumps.

Controllers are also fitted to the turbo-alternators, but the available space does not permit these controllers to be integral with the sumps and they are therefore separate.

Under harbour conditions, the turbo-alternator extraction pumps supply the auxiliary feed pump, with the turbo-alternator condensers supplementing from the main feed tank.

Steam conditions are below 650 lb/sq in. and therefore a feed heater and not a deaerator is fitted. Adequate deaeration is achieved by spray injection of the supplementary feed water from a baffled main feed tank into the tops of the main and turbo-alternator condensers.

Feed Heater

A simple pressure feed heater, identical to the Type 81 is fitted. The drains are educted to the main feed tank by a feed pump operated eductor, utilizing the leak-off.

Extraction Pumps

Two main extraction pumps are fitted in each unit. They are both constant speed, direct turbo-driven (1-16-3 turbine) vertical spindle type pumps and are identical to those fitted in Type 81 frigates. The pumps may be operated in parallel, but they are both 100 per cent capacity, so that the requirement for parallel operation will only arise while changing from one to the other.

Turbo-Alternators

Two generators are fitted in each unit. They are self-condensing, 1000 kW., 60-cycle, 3-phase, 440-volt A.C. machines. Originally these generators were intended to have been 750 kW sets, but fortunately they were uprated immediately before going out to tender for the first ship. The harbour electrical load, which is intended to be supplied from one unit was originally estimated at 600 kW. The present estimated harbour load is 930 kW. This is derived from an estimated connected load of 1290 kW., and assuming a diversity factor of 60 per cent, giving 774 kW. Applying a 20 per cent growth factor produces 930 kW.

Evaporators

One set is fitted in each unit. These plants are of the flash type and the assault ships will be the first new construction ships to be so fitted. They are four-stage and their designed output is 6 tons per hour per set. During shore trials, this output has been achieved with ease. The installed distilling capacity of 288 tons per day should be very adequate.

Main Circulators

One only is fitted to each set of main engines. In the event of failure, the ship would continue to steam ahead on scoop and shut down on firemain, astern running would not be possible.

The unit is of the vertical geared turbo-driven axial flow type, the turbine being similar to the *Daring* type and the pump is similar to the *Blackwood* type, but with an increase in diameter from 16 to 22 inches.

F.F.O. Supply and Service Pumps

Each machinery space is fitted with two 100 per cent pumping units. They are identical to those fitted in Type 81 frigates, each unit comprising two independent rotary positive displacement pumps driven by a common geared turbine. The pumps can be changed over remotely from the M.C.R.

The bilge area around the pumps, filters and heaters is boxed in to prevent minor F.F.O. spills from spreading to the rest of the compartment.

Forced Lubrication Arrangements

There are three pumps fitted in each unit, one shaft-driven, one turbo-driven

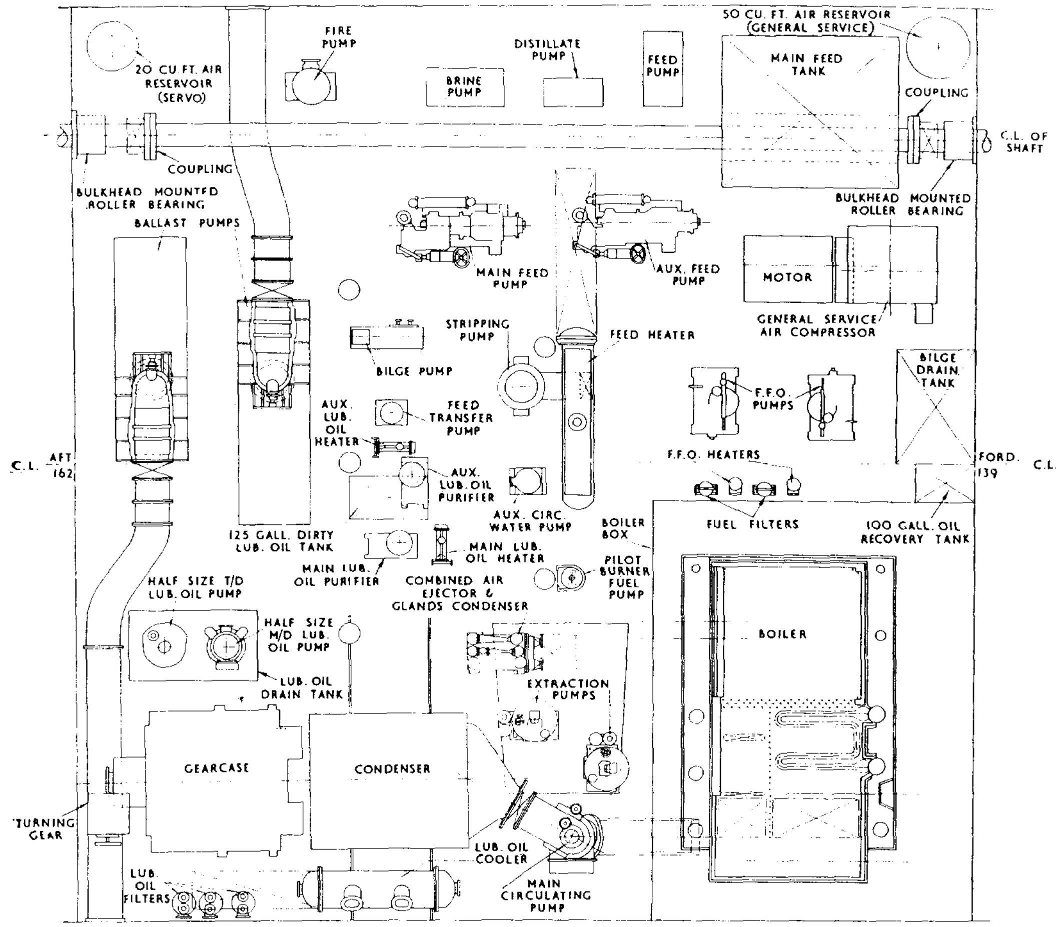

FIG. 4—AFTER MACHINERY SPACE—PLAN AT LOWER LEVEL

and one motor-driven. The turbine is a Type 1-16-3, interchangeable with the main extraction pumps. The pump ends of the turbo and motor-driven units are interchangeable and are of new design, although similar to the pumps fitted in the G.M. destroyers. As in the G.P. frigates and the G.M. destroyers, a shaft-driven pump is fitted. The reasons for fitting the shaft-driven pump were those of economy and ensuring reliability in a ship controlled from M.C.R.s.

General Service Air Compressors

One is fitted in each unit and supplies the sirens in addition to general service low pressure air requirements. The compressor is also stand-by for servo-air. The unit has been selected from the standard range of motor-driven, oil-free sea-water cooled machines, and produces 400 cu ft/min of free air at 120 lb/sq in. Air intake is from inside the boiler box. A 50 cu ft reservoir is fitted and the compressor is auto-start when the system pressure falls to 100 lb/sq in.

Servo Air Compressors

One servo air compressor is fitted in each unit. It is from the standard range, producing 55 cu ft/min of free air at 120 lb/sq in. A 20 cu ft reservoir is fitted, and the air is taken from inside the gas citadel.

The servo-air systems in the two units can be cross-connected, as can the General Service Low Pressure air systems, from which air is taken into the servo system if the servo pressure falls below 90 lb/sq in.

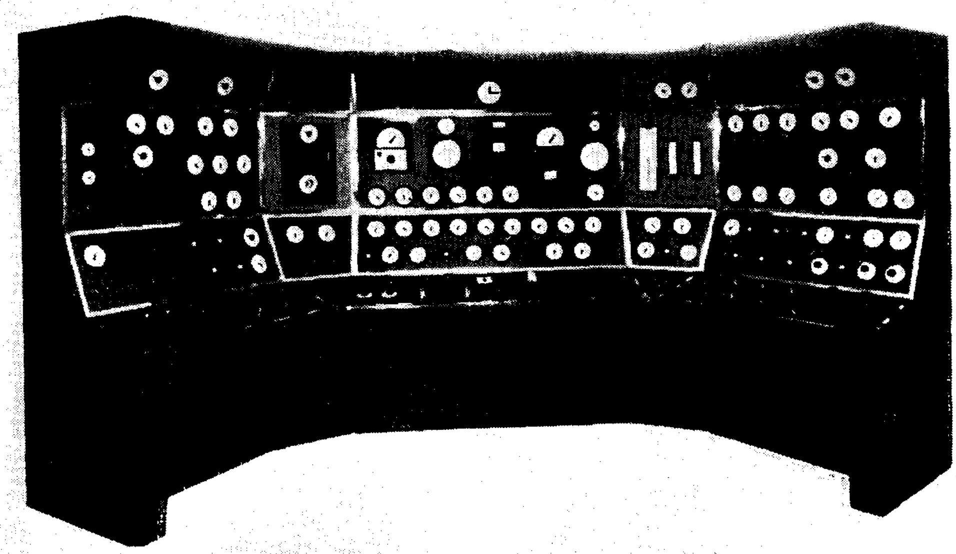

FIG. 5—MOCK-UP OF THE FORWARD MACHINERY CONTROL ROOM CONSOLE

'Outside Machinery'

H.P. Air Compressor

The need for a second H.P. air compressor has recently been confirmed by increased diving demands and by the possible introduction of ventilated suits, which require air derived from a high pressure source.

These compressors are from the standard range, producing 40 cu ft/min of free air at 4,000 lb/sq in. They are firemain-cooled and the air intake is from inside the gas citadel.

Diesel Generators

Two 450 kW sets are fitted, one sited well forward and the other well aft. Each has its own Diesel-driven air compressor for air starting.

These Diesel generators are intended for salvage duties only, the salvage load including 50 per cent armament.

Steering Gear

The steering gear is very similar to that fitted in Type 12 frigates. The only refinement is that the whole equipment is made submersible because it is well below the water-line when the ship is docked down.

Twin rudders are fitted and automatic steering is available.

Hydraulic Systems

There are two systems and these systems may be cross-connected, but will normally be run independently. One system has two pumps and operates the dock gates. In this system, both pumps are required to operate the gates at their designed speed, but one pump will cope at reduced speed. The second system has three pumps and is used to operate the six L.C.A. davits, two R.A.S. winches and four whip aerials.

Air Conditioning

The ship is fully air-conditioned. Three 1·2 million B.T.U./hour plants are fitted in conjunction with a chilled water system.

Refrigerating Plants

Two sets are fitted, each of 40,000 B.T.U./hour capacity and each dealing with the full load of cold, dairy, fruit and vegetable rooms. In addition, there are four ready-use cupboards, three refrigerated counters and a deep freeze unit.

Machinery Control

Normal control under harbour and seagoing conditions will be from the machinery control rooms. At sea, the Engineer Officer of the Watch will control from the forward M.C.R.

The M.C.R.s are air-conditioned from the ship's system. Local control consoles are also provided for the boiler and engine in each unit.

A full-size mock-up of the forward M.C.R. console has been made, and is shown in FIG. 5. As can be seen from this photograph, a number of changes have been made, and the present layout is thought to be the best for easiest operation. The consoles are opaline green in colour and have the minimum number of shiny surfaces. As an additional refinement, even the clocks have in-built rim lighting.

The philosophy behind the layout of these consoles is based on main vertical grouping, and horizontally the most important gauges are sited at eye-level. Grouping is as follows:

Left Hand Panel

Auxiliary machinery, turbo-alternators and salinometers.

Left Corner Panel

Main engine forced lubrication, including a remote temperature indicator. Unfortunately, the temperature indicator is of the manual selection type as the automatic scanner is still being developed and will not be available in time.

Centre Panel

Main engines information and forward unit control. Telegraphs, shaft revolution counters, gauges and throttles. The most relevant gauges are lined vertically above the throttles.

The watchkeeper's desk is on the right and above it are sited the important repeats from the after unit.

Right Corner Panel

Feed system and controls. The feed tanks' contents gauges are sited at the top, three boiler level gauges (two pneumatic and one Igema) placed at eye-level and below them are situated the feed pump and feed check controls.

Right Hand Panel

Boiler combustion gauges and controls. The fuel and blower gauges and controls are grouped on this panel. A smoke density indicator is fitted and warning devices include high temperature steam, boiler-box fire alarm and flame-out indicator.

All the control pipes and cables are led out of the back of the console, and down through the M.C.R. floor into the machinery space. There is an 18-inch gap behind the console to allow panels to be removed for maintenance.

The Ballast System

It is no exaggeration to say that the ballast system is virtually the main armament of the assault ships. The control equipment of this system is being manufactured to aircraft standards by a well-known firm of aircraft engineers, and the type of electro-hydraulic control employed has been designed to be simple and robust.

Under normal steaming conditions, the ship is at between 18 ft and 20 ft draught. On approaching the operational area, she sinks herself bodily to 23 ft draught, which does not flood the dock. Finally, she trims to 32 ft aft, remaining at 23 ft forward, and this trim by the stern floods the dock. During the unloading of the ship, more water is added as required to compensate for the weight removed.

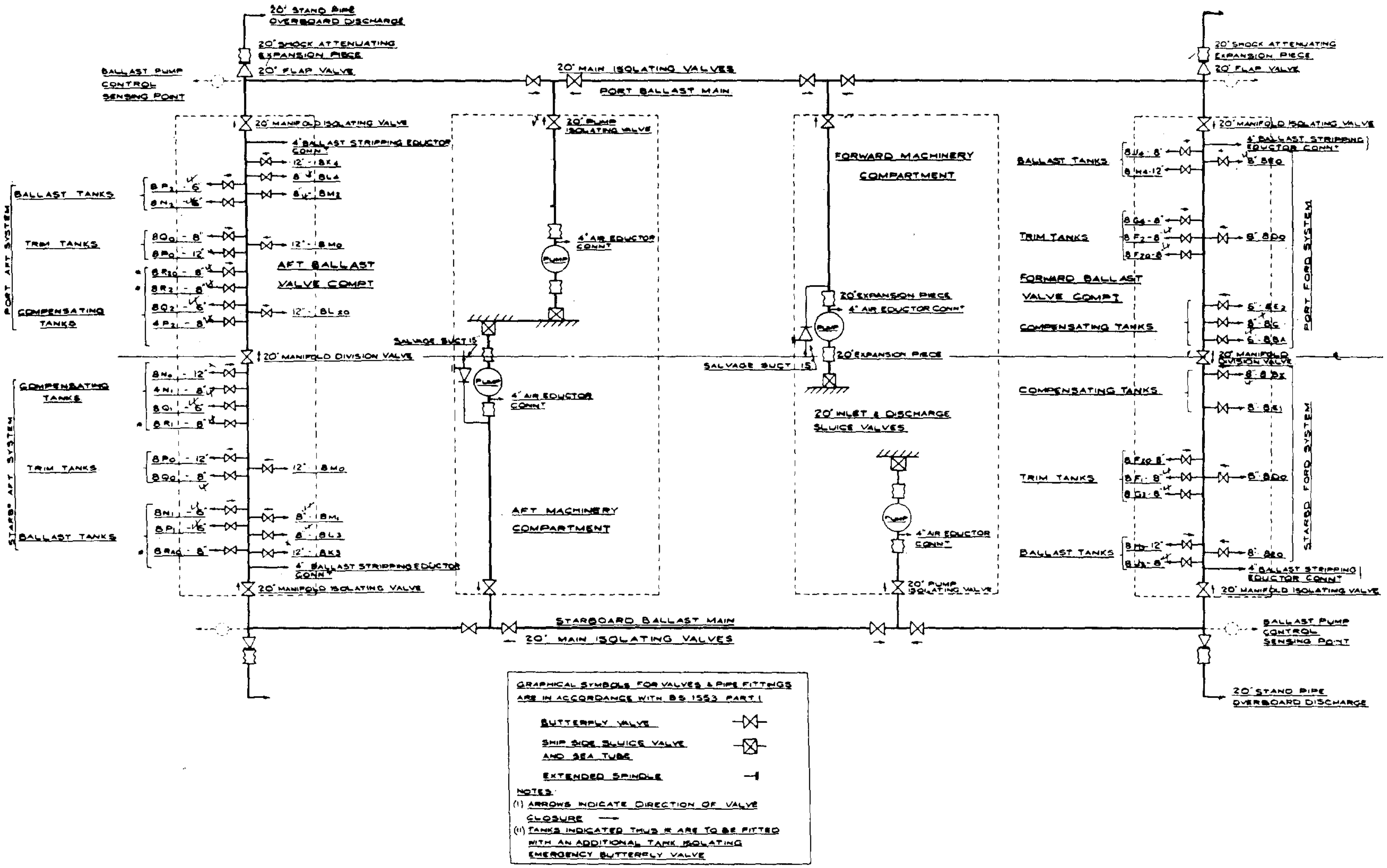

FIG. 6—DIAGRAMMATIC ARRANGEMENT OF BALLAST SYSTEM

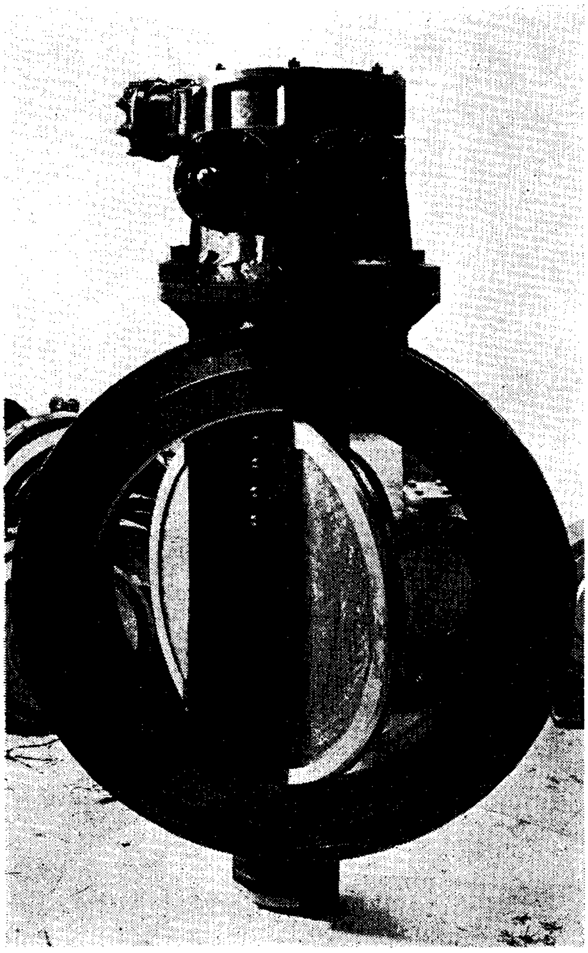

FIG. 7—BALLAST SYSTEM—A 20-INCH INTERNAL DIAMETER BUTTERFLY VALVE

Before considering our own system in any detail, it is worth having a quick look at the French and American systems.

The French use a large diameter metallic ring-main with separate pumps for ballasting and deballasting.

The United States Navy employs free flooding to ballast their tanks, through large motorized sea valves. Deballasting is achieved by blowing the water from the tanks, using air compressors. No stripping system is fitted. This system does, of course, mean strengthening the tanks to withstand the air pressure.

The system fitted in the L.S.A.s comprises a 20-inch internal diameter ring-main, made of thermo-setting epoxide resin reinforced with high strength glass fibre. Both the internal and external surfaces of this epoxy-resin pipe are reinforced with woven acrylic fibre, giving a high measure of resistance to internal abrasion and external damage. In machinery spaces, the piping is Durestos-lagged. It is worth noting here that an epoxy-resin ballast system is approximately one-fifth the weight of an equivalent metallic system. Four turbo-driven, axial flow ballast pumps, fitted with reversing gear-boxes are connected to the ring-main, two pumps being fitted in each machinery space. The nominal capacity of each pump is 2,500 tons per hour when ballasting and 1,250 tons per hour for deballasting. One pump in each machinery space is available for salvage duties.

As can be seen in FIG. 6, the ring-main is roughly rectangular, and passes athwartships through the forward and after ballast valve compartments. These ballast valve compartments contain large gunmetal manifolds, from which connections are taken to the various ballast tanks. The water speeds in the system are generally high and reach 40 ft/sec in some places.

Main isolating valves, manifold isolating valves and manifold division valves are located in the ring main in order to cater for failure of any pump or damage to any section of the piping. The valves in the system are all of the butterfly type (FIG. 7), except for the four pump sea valves which are of the sluice type.

Possible pressurization of the tanks is prevented by the fitting of full-bore stand-pipes with overboard discharges at a suitable height.

The complete system will be operated by the Dockmaster (a shipwright officer) from the ballast control room, which is situated on the starboard side aft and overlooks the dock. The ballast control console provides remote control of the pumps (except reversing, which is done by remote manual controls), the servo-hydraulic pumps and all valves in the system except sea valves and

TABLE I

	L.C.M. 9	*L.C.A.*
Length	85 ft	43 ft
Beam	21 ft 6 in	10 ft 6 in
Maximum Draught	5 ft 6 in	About 3 ft
Displacement: Deep	176 tons	16 tons
Light	74 tons	11·5 tons
Speed	10 knots	10 knots
Payload	2 tanks or 4 3-ton Bedford trucks	35 equipped troops or 2 Land Rovers
Crew	7	4
Engines	2 Paxman A6YHAXM	2 Foden FD6 Mk. 6
Steering	Swivelling Kort Nozzles	Single Rudder

emergency isolation of tanks. Console instrumentation includes tanks contents gauges, indication of valve positions, pump tachometers and rotation direction indicators, pump running lights and servo-air pressure gauges. Heel and trim indication is provided adjacent to the console.

The valves in the system are normally operated by a switch on the ballast control console. Making this switch energizes a solenoid in an airbell in the valve compartment, the solenoid opens a valve admitting hydraulic oil pressure to one side of a piston in the actuator on top of the butterfly valve. This operates the butterfly valve, and a hydraulic position relay feeds this movement back to the airbell where a relay switch operates at the end of the stroke, taking power off the solenoid and thus shutting the hydraulic valve.

All the equipment is submersible, being fitted in airbells where necessary. Hydraulic power for the actuators is supplied by four motor-driven pumps. Normally, each pump will provide the hydraulic power for the appropriate quadrant of the system, but in the case of pump failure, the port and starboard quadrants can be cross-connected. Each pump has its own header tank. Emergency manual operation of the valves is provided by means of independent cylinders and hand pumps for the 20-inch and 12-inch valves and by means of a detachable lever for the 8-inch and 6-inch valves.

A stripping system is fitted. This comprises 8 × 100 ton/hour eductors and ordinary hand operated screw-down non-return valves. This system is provided to strip the tanks and to educt air from various high points in the system, as well as draining the manifolds.

Mock Up

A one-twelfth scale mock-up of the after machinery space was built by the Yarrow-Admiralty Research Department, and this model was used in conjunction with the guidance drawings in the production of the specification. The model was eventually sent to the leading main machinery contractors and is still in use in their engine drawing office.

A full-size mock-up of the after machinery space has been built and has now had its final inspection.

THE L.C.M.9s AND L.C.A.s

Some brief particulars of the L.C.M.9 and the L.C.A. are shown in TABLE I.

CONCLUSION

It should be noted that this article is not intended to be in any way a comprehensive description of the assault ships and no attempt has been made to discuss questions of A.B.C.D. arrangements, workshops, complement, refitting policy, etc. It is merely intended to provide some 'post-launch but pre-commissioning' information on the history of these ships, their intended function and a brief description of the machinery being fitted in them.

Acknowledgements

The Y.124, L.S.A.01 and Class Machinery Specification was produced to the requirements of the D.M.E. Ship and Specialist Sections by the Yarrow-Admiralty Research Department. Y.-A.R.D. have also carried out a full investigation into the design details of the ballast system.