THE INSTITUTION OF NAVAL ARCHITECTS
(AUSTRALIAN BRANCH)

PASSENGER/CARGO VESSEL, M.V. "KOOJARRA" FOR STATE SHIPPING SERVICE, GOVERNMENT OF WESTERN AUSTRALIA

BY

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SYDNEY

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1. INTRODUCTION:

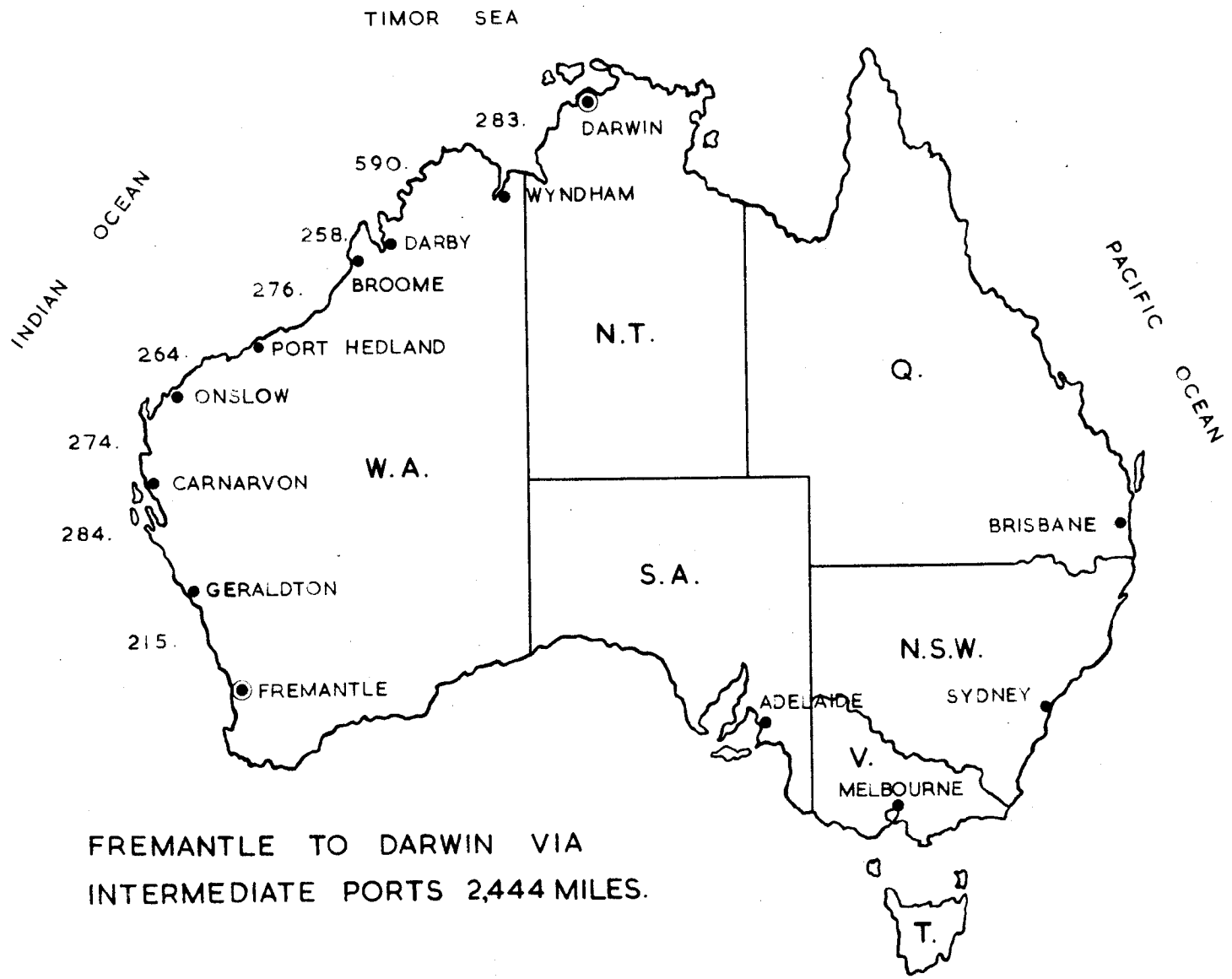
This paper deals with the construction in an Australian shipyard of a small passenger/cargo vessel for service on the Australian coast. The vessel had to provide a service to the developing areas of Western Australia between Fremantle and Darwin, with accommodation for approximately 60 passengers and to carry general and refrigerated cargo.

The recent discovery of uranium bearing ore and the search for oil in the State has greatly added to the demands on coastal shipping for the transport of equipment and stores to these expanding ventures.

In December 1953, the Australian Shipbuilding Board was commissioned to prepare the design of a vessel for the State Shipping Service, Government of Western Australia, to meet the ever increasing needs for this essential Service.

Docking facilities at Fremantle are limited to a patent slipway having a maximum capacity of 2,400 tons, with the result that the proposed vessel had to be designed with a light ship weight within the limit of the slipway.

The fall in tide at a number of north west ports, particularly Broome and Derby where the drop in the spring tides is 28'0" and 36'0", would, on occasions, leave the vessel high and dry at the wharf, and special consideration had to be given to additional bottom stiffening. The problem of salt water cooling of generators when the vessel was aground had to be overcome by retaining water ballast in at least one double



FREMANTLE TO DARWIN VIA
INTERMEDIATE PORTS 2,444 MILES.

bottom tank. This tank was also used for the salt water sanitary services during the period when the vessel was aground.

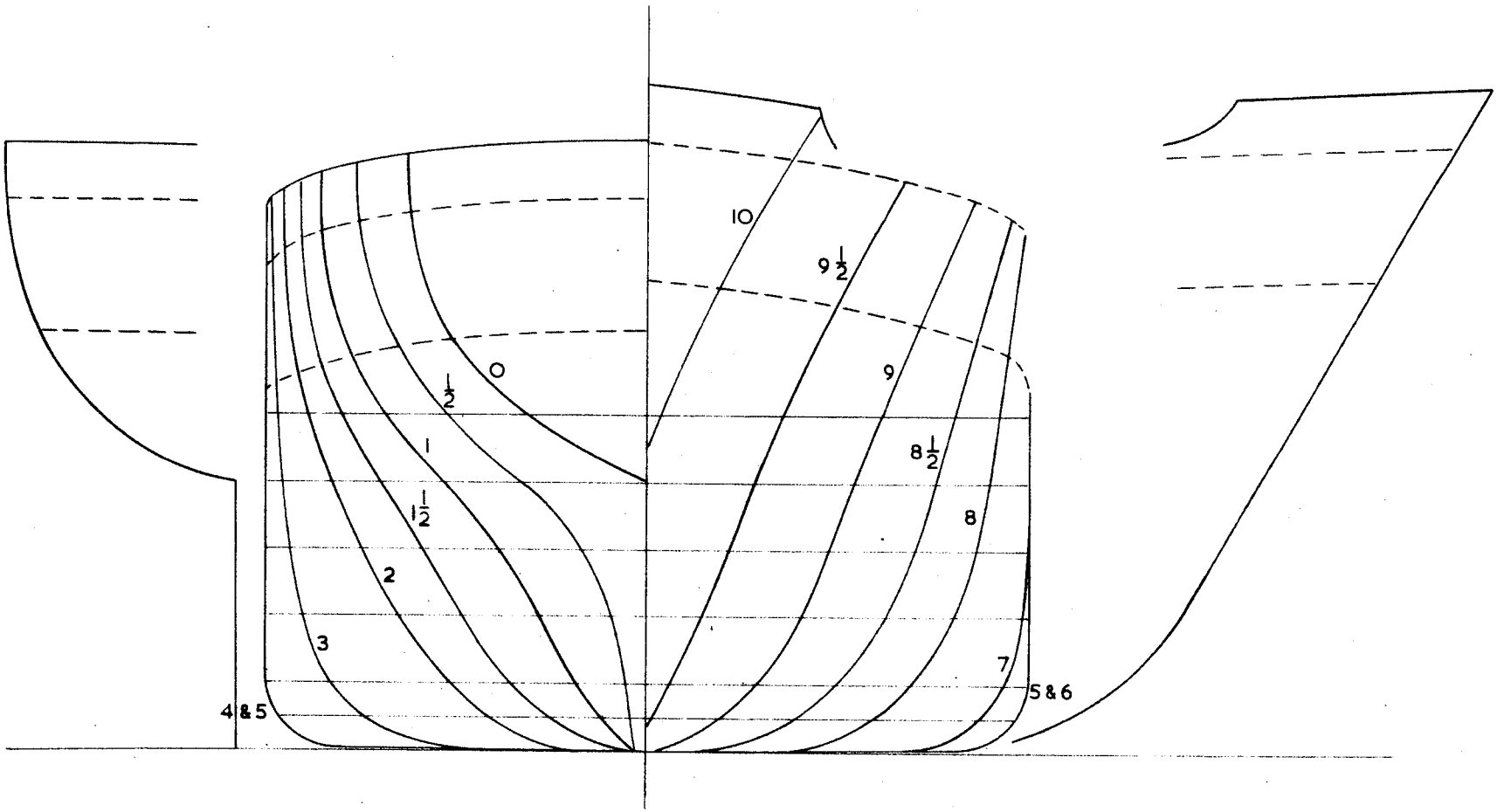
The contract for the construction of the vessel was placed with the State Dockyard, Newcastle, N.S.W., and the keel was laid in November 1954 and completed in September 1956.

2. DESIGN:

The vessel contemplated was of the single deck type with a forecastle, combined bridge and poop and superimposed deckhouses. Five cargo holds, three forward and two aft of the engine room, with an orlop deck extending between the engine room and the fore peak to provide a 'tween deck in the forward holds, generally met the Shipowner's requirements.

The principal dimensions were made similar to those of m.v. "Kabbarli", already in the Company's service between Fremantle and Darwin, principally with the object of standardisation of machinery and auxiliaries and keeping the lightship weight somewhere about 2,000 tons. The profile, however, was altered at the Shipowner's request to include a cruiser stern and an excessively raked stem, partly for appearance at the after end and at the fore end to increase the length of the forecastle deck to accommodate a deck cargo of large timber piles about 65'0" in length which, when stowed, would extend from the bridge front to well forward on

FIG. 1.



M.V. "KOOJARRA".

LINES.

the forecastle deck.

The vessel has been assigned the classification Lloyd's ✝100 A1 and also constructed to the requirements of the Merchant Shipping (Construction) Rules 1952 and the Australian Navigation Act.

The principal dimensions and particulars are given in Table I.

Table I

Length overall	297'3"
Length between perpendiculars	270'0"
Breadth moulded	46'0"
Depth moulded to upper deck	21'6"
Depth moulded to bridge deck	29'0"
Load draught	18'0"
Load displacement	4,400 tons
Hull co-efficients at 18'0" draught:-	
Block	.695
Prismatic	.71
Midship Area	.98
Gross tonnage	2958.56 tons
Registered tonnage	1656.25 tons
Deadweight on 18'0" draught	2,311 tons
Brake horsepower at 300 R.P.M.	1,820
Service speed	12 knots

The hull form is that of a model tested at the N.P.L., Teddington, for the Board some years ago. The report of the results of the experiments showed the lines to be of good form although it was stated that some improvement could have been obtained if the centre of buoyancy had been moved further aft. However, for reasons of trim it was considered that no change should be made in the disposition of the buoyancy and the lines remained unaltered and similar to m.v. "Kabbarli".

The results of the experiments are given in Table II as effective horsepowers. These powers represent the towrope horsepowers which would be required by the vessel with a clean bottom in smooth salt water and contain no allowance for appendages, air or rough water resistance.

Table II

Speed in Knots	E.H.P.
8	198
9	286
10	408
11	584
12	808
13	1142
14	1650

A "Helliston" propeller, designed and manufactured by J. Stone & Co. Ltd., London, has been fitted to the vessel.

Fig. 1 shows the body plan and stem and stern profile.

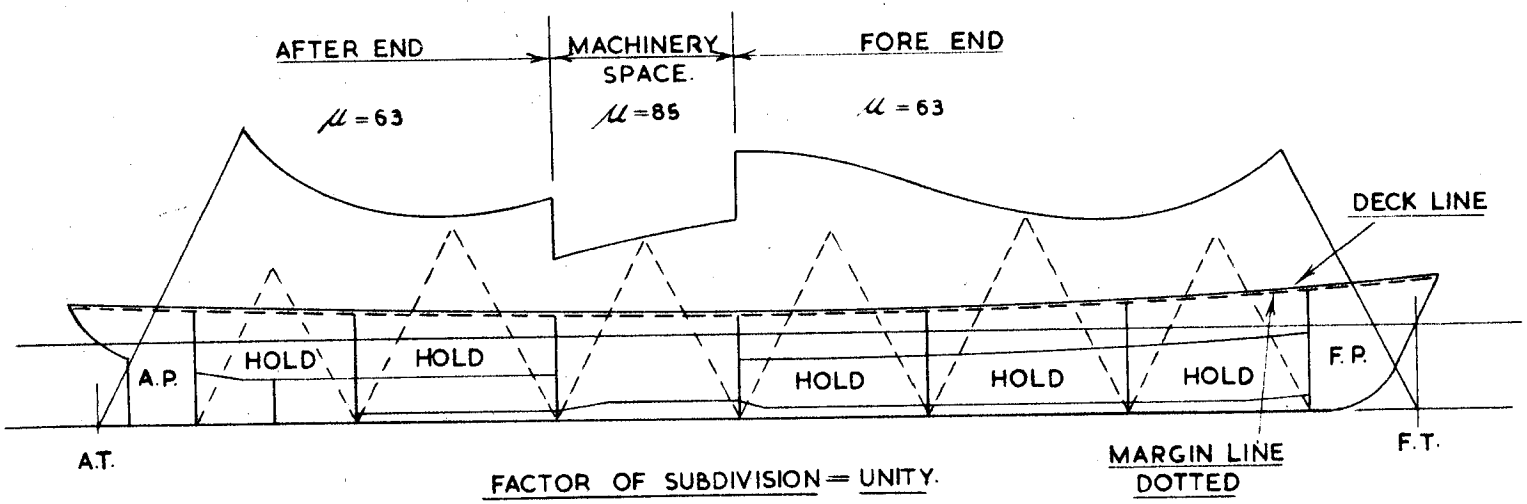
3. WATERTIGHT SUB-DIVISION:

The spacing of the watertight bulkheads has been arranged from the floodable length curve shown in Fig. 5. The floodable length of any part of the ship is the spacing of the transverse bulkheads consistent with a factor of sub-division of unity where the flooding of any one compartment will not submerge the ship beyond the margin line, which is an assumed line parallel to, and 3" below, the upper deck at side.

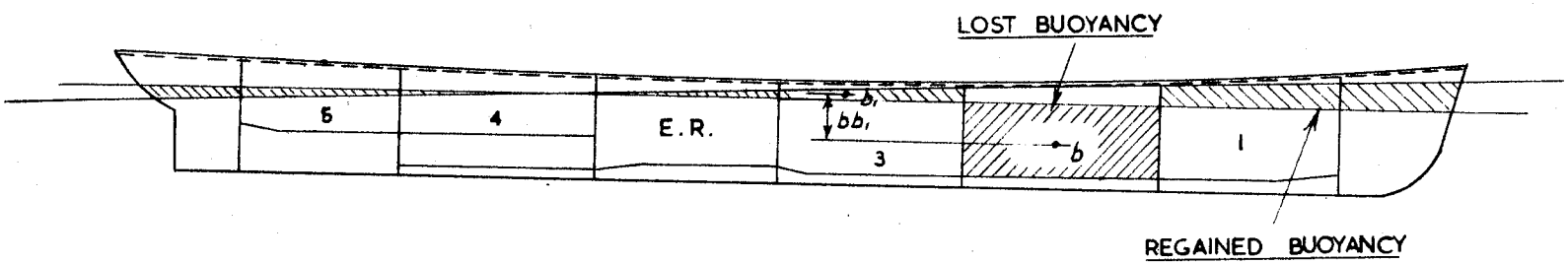
The sub-division draught of the vessel is 18'0" and average permeabilities of 63% for the fore and aft ends and 85% for the machinery space have been used in the calculations. These permeabilities are laid down in the Ministry of Transport Rules and may be said to represent a standard by which passenger vessels are designed. Whilst the permeability is assumed and, therefore, the condition of loading of the ship merely hypothetical, it is a governing factor in determining the length of a compartment or hold. Additional safety is provided where necessary by the use of a higher permeability, such as in the engine room where the floodable length is considerably less as will be seen from the floodable length curve.

All sub-division bulkheads are carried watertight to the upper deck. A sliding watertight door is fitted on bulkhead 46, giving access to the shaft tunnel, and one on bulkhead 65 providing access to the refrigerating machinery room. The

FIG. 5
FLOODABLE LENGTH CURVE.



FACTOR OF SUBDIVISION = UNITY.



N°2 HOLD FLOODED.

M.V. "KOOJARRA".

SUBDIVISION.

operation of the watertight doors is manual and can be performed by hand gear adjacent to the door, and also by remote gear from a position above the upper deck and outside the engine room.

The fore peak bulkhead is within the prescribed .05L to .05L+10 from the forward perpendicular and the aft peak bulkhead at the fore end of the sterntube.

The effect of flooding a part of the ship affects the vessel in a number of ways, not the least of which is a change in draught, increase in V.C.B. and reduction in B.M., all having an effect on the stability. The bulkheads of No. 2 hold are spaced to the limit of the floodable length and the effect of admitting the sea into this hold is to increase the draught and change the trim by the stem until the vessel settles at the margin line.

4. STABILITY IN FLOODED CONDITION:

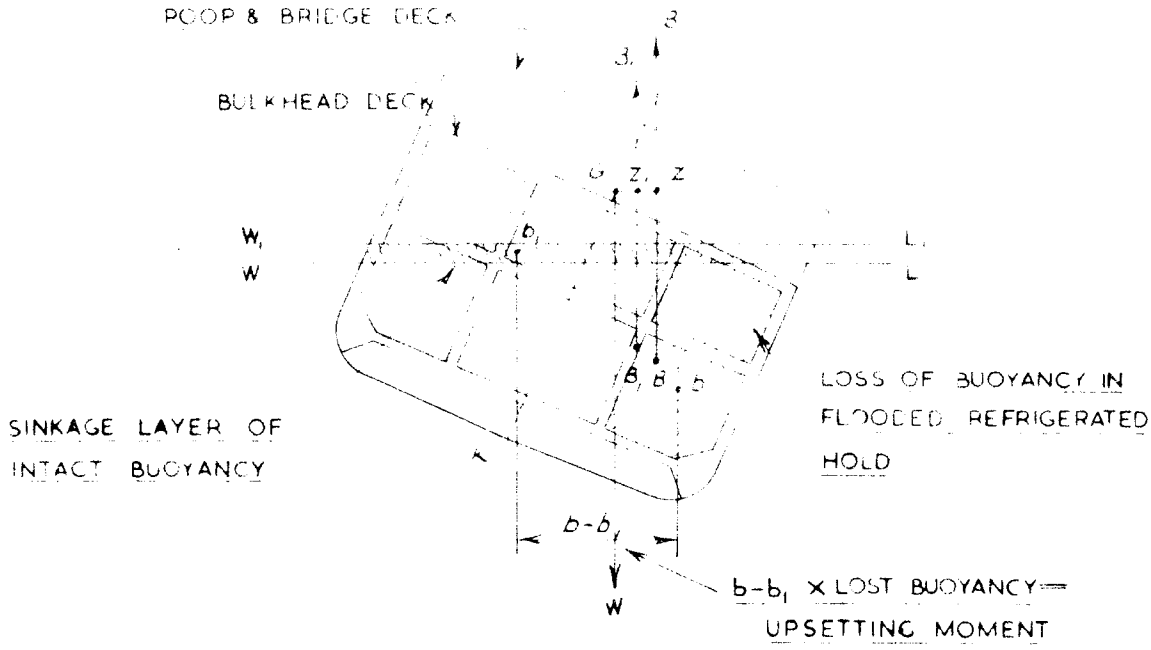
The intact stability must be sufficient to withstand the flooding consequent upon assumed damage and that, if there is any list, it will not endanger the ship.

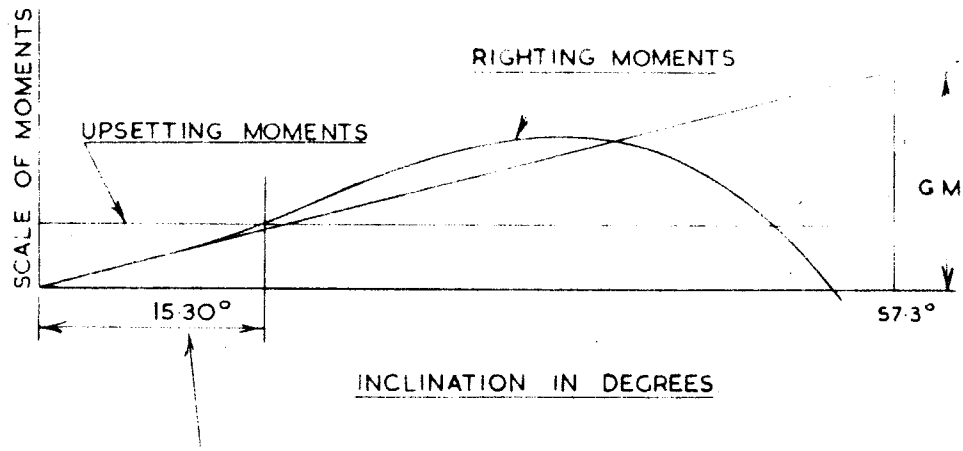
If the flooded spaces are symmetrical, so that there is no heeling moment from buoyancy of unsymmetrical intact spaces, the metacentric height should be positive. If there is a heeling moment, a positive metacentric height may not be sufficient to prevent the vessel heeling so as to immerse the

FIG 6

M V KOOJARRA

DAMAGE STABILITY.





INCLINATION BEFORE CROSS FLOODING.

margin line and perhaps admit floodwater to other compartments or from heeling to such a degree as to become unworkable.

Calculations of damage stability have been made for the anticipated worst service condition, i.e., arrival condition with full cargo and practically all fresh water and oil fuel in the bottom of the ship expended. A condition is calculated for individual damage to each hold.

Side damage is assumed to have affected all five holds and the engine room symmetrically and Nos. 2, 3 and 4 holds unsymmetrically. The internal subdivision of Nos. 2 and 3 'tween decks and No. 3 lower hold into small refrigerated cargo spaces virtually forms a series of intact watertight spaces which, in effect, create a heeling moment when flooding is sustained on either side of the 'tween decks or hold. Damage to the Starboard side of No. 3 hold causes the greater extent of flooding, resulting in a larger angle of heel to Starboard than if the damage had been on the Port side.

Calculations showed that flooding of the outer cargo spaces of No. 3 hold and the refrigerated machinery room resulted in a heel of 15·30°. The loss of buoyancy of the flooded cargo spaces is compensated by the sinkage layer of intact buoyancy and the vessel settles to the deeper water-line.

Referring to Fig. 6, it will be observed that, due to the transfer of lost buoyancy to the intact buoyancy of the

sinkage layer, the original centre of buoyancy B has moved inboard to a position at B_1. The original righting lever GZ has now been reduced to GZ_1 with a consequent reduction in the residual righting moments.

The statutory requirements in regard to unsymmetrical flooding are that the angle of heel must not exceed 7° and the margin line must not be submerged. In the case of the unsymmetrical flooding in No. 3 hold, it was necessary to provide cross flooding arrangements to restore the vessel to a near upright position and this was achieved by flooding either Port or Starboard sides of Nos. 1 and 2 double bottom tanks, depending on which side the list had occurred.

Unsymmetrical flooding also occurred in Nos. 2 and 4 holds, but with less angle of heel than in No. 3 hold. In both cases the list was small and very little corrective measures were necessary to restore the vessel to an upright position.

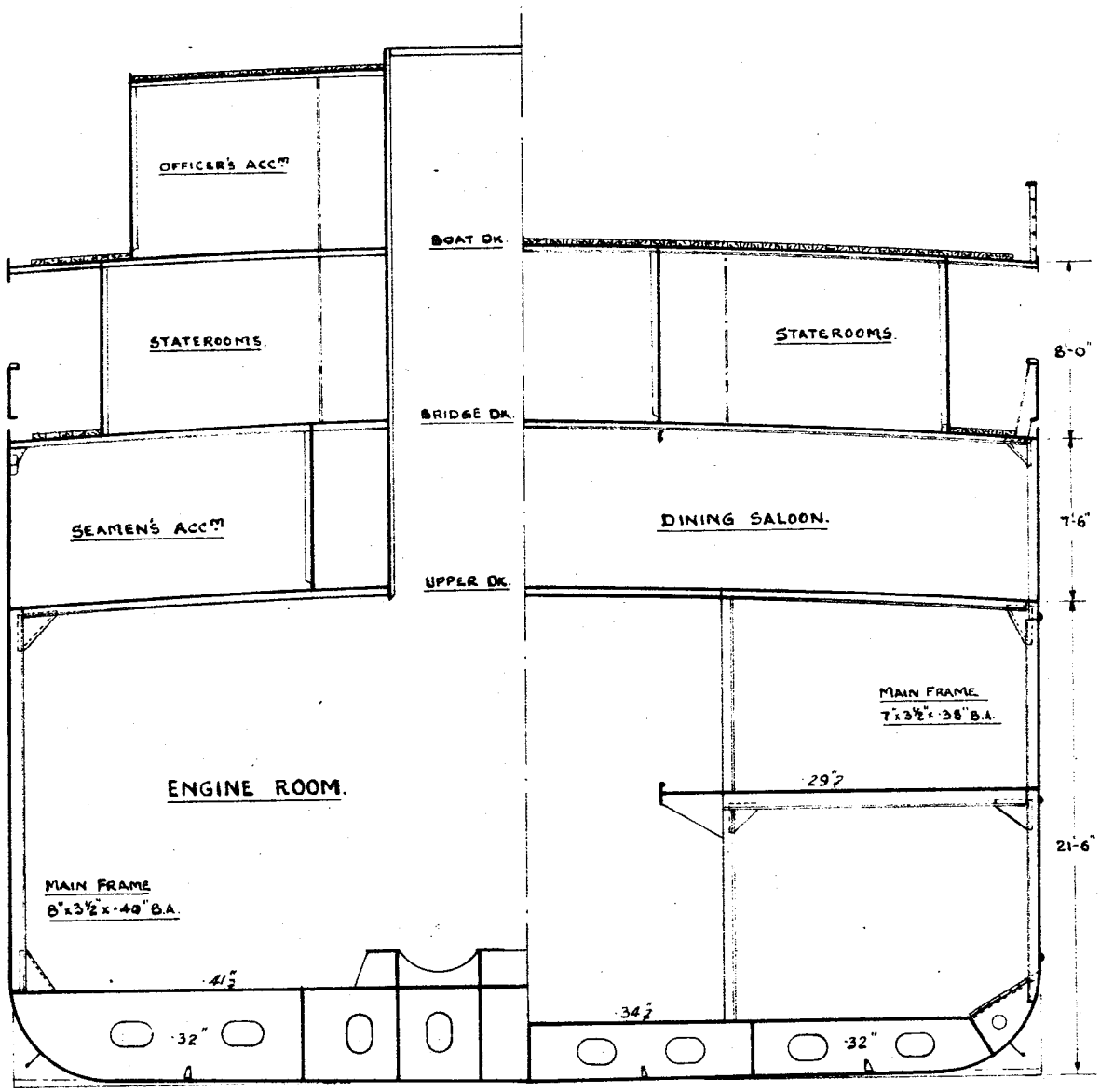
5. CONSTRUCTION:

Structural steel plans were submitted to, and approved by, Lloyd's Register of Shipping and the Marine Branch of the Department of Shipping and Transport. The Marine Branch administers the Navigation Act and the regulations are such that they cover the statutory requirements of the Ministry of Transport and Civil Aviation, consequent upon the Merchant

FIG. 2.

M.V. "KOOJARRA".

MIDSHIP SECTION.



KEEL 44"x·58"

SIDE SHELL ·43" IN WAY OF BRIDGE, ·48" CLEAR OF BRIDGE FOR ·4L TO ·3L AT ·05L FROM AFT END & ·45" IN FORD ·15L.

BOTTOM SHELL ·50" IN WAY OF BRIDGE ·53" CLEAR OF BRIDGE FOR ·4L TO ·3L AT ·05L. FROM ENDS & ·57" BETWEEN ·05L & ·25L FROM FORD END.

Shipping Act 1952 and the International Convetion of 1948, to which the vessel had to be built.

Fig. 2 shows the Midship Section.

The vessel is transversely framed at 24" spacing throughout the length, and typical framing is shown on the Midship Section. The shell is welded at all butts and seams with the exception of the sheerstrake, bilge strake and flat keel which are riveted in accordance with the Classification Society requirements.

There are seven main transverse watertight bulkheads to meet the requirements of the Merchant Shipping (Construction) Rules in regard to watertight sub-division. Longitudinal bulkheads are fitted in No. 3 upper and lower holds to provide small parcels of dissimilar refrigerated cargoes.

The upper deck is continuous over the entire length of the vessel and the main transverse bulkheads are carried to this deck, which is the sub-division deck. The forecastle deck is extended aft to the foremast, where it is specially stiffened to support a deck cargo of hardwood timber piles. There is no hatch on the forecastle deck, but merely a large opening over No. 1 hatch on the upper deck.

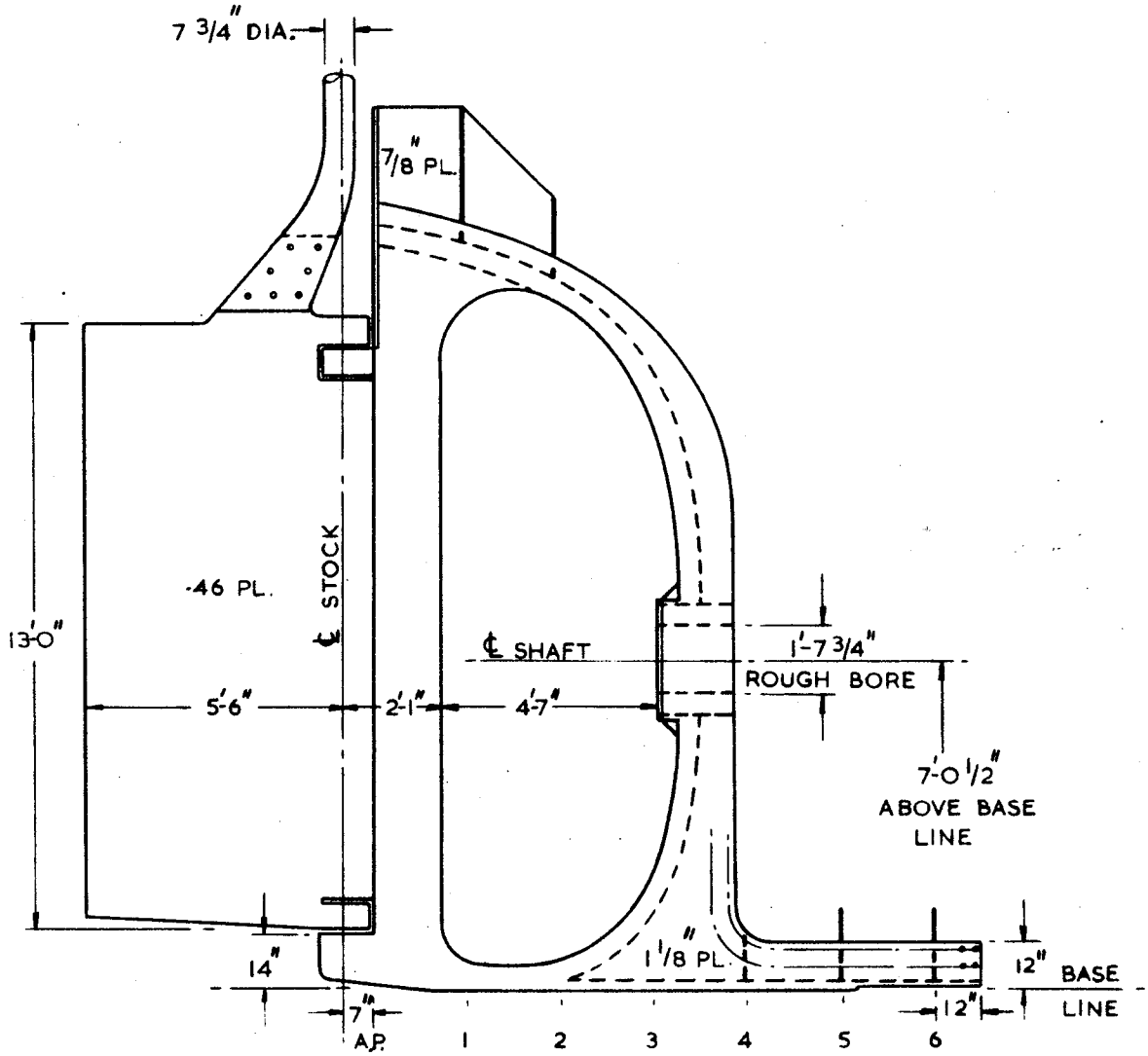
An orlop deck is fitted in Nos. 1, 2 and 3 holds and made watertight in No. 3 hold to provide for dissimilar refrigerated cargoes above and below the deck.

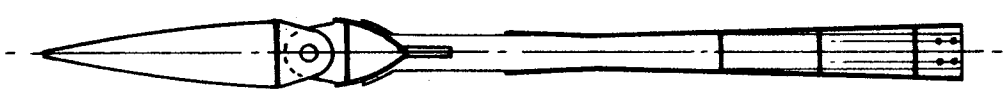
The hold flat in Nos. 4 and 5 holds forms the tunnel top

FIG. 3.

M.V. "KOOJARRA".

STERNFRAME & RUDDER (FABRICATED)





SECTION AT LOWER PINTLE

with wing oil fuel and fresh water tanks underneath at the sides. The upperworks consist of a bridge deck, boat deck and navigating bridge with associated deckhouses.

The vessel has five holds, three forward and two aft of the engine room. The after end of No. 2 'tween deck and the entire No. 3 upper and lower holds have been constructed for the carriage of refrigerated cargoes. The deck beams of the upper deck and orlop decks in way of the refrigerated holds have been made of increased scantlings for the hanging of two tiers of meat carcases.

The double bottom is of cellular construction, divided into tanks for the carriage of salt water, fresh water and oil fuel. Transverse solid floors are fitted on every frame in conjunction with shell longitudinals to provide additional stiffening to the bottom of the vessel for resistance against grounding.

The sternframe is constructed of mild steel plates and welded throughout. The solepiece and gudgeons are profiled to shape from the solid and welded into position. The rudder is also welded and, along with the rudder post, forms a complete streamline section.

Fig. 3 shows the rudder and sternframe.

The main engine seats form an integral part of the double bottom and the longitudinal girders are carried down to the shell, forming a metal-to-metal foundation.

Cargo hatches throughout the vessel are of the MacGregor steel single-pull type, except those on the boat deck which are of the MacGregor flush type and wood sheathed to match the surrounding wood deck. These flush hatches provide additional deck area for passenger recreation. The opening and closing of these MacGregor hatches is by means of a single hauling wire led over guide posts to the nearest cargo winch adjacent to the hatch.

All decks, other than the upper and forecastle decks, are sheathed with Burma teak, 2" thick.

A horizontal sliding watertight door has been fitted on the watertight transverse bulkheads at frames 45 and 65, in accordance with the Statutory Requirements. These doors are hand-controlled from positions outside of the engine room and also adjacent to the doors.

All decks in passenger spaces are 8'0" apart and elsewhere they are 7'6" with a camber of 11½" on all decks. Amendments to the vessel, particularly the introduction of an air conditioning system and a sprinkler fire control service, indicated a need for additional 'tween deck height on all decks to accommodate the mass of pipes, ventilating trunks and electric cable trays, and a standard height of 8'6" throughout would have simplified the outfitting and, no doubt, improved the appearance of the passenger spaces.

The bridge front is well curved and slopes gently back

from the upper deck to the top of the steel wheelhouse.

Deckhouses are all steel with internal divisions of steel around bathrooms, galley, pantries, washrooms and crew's cabins. Bulkheads of increased scantlings are provided for structural protection against the spread of fire in passenger, crew, galley, control and navigational spaces. The spaces above the upper deck are sub-divided by fire resisting bulkheads 131'0" apart, all in accordance with the Construction Rules.

6. WATER AND OIL SERVICES:

The pumping arrangements are arranged to meet the requirements of the Ministry of Transport for pumping and fire fighting in a foreign-going vessel.

Three (3) 60-ton/hour electrically-driven bilge pumps are fitted, namely the general service pump, bilge and ballast pump and the emergency bilge pump. Each pump takes suction from the bilge main, the ballast main and the sea and discharges into the ballast main or overboard. The bilge and ballast pump and the emergency bilge pump also provide suction direct from the engine room bilge. The emergency bilge pump is a submersible pump with controls above the upper deck. The pump can operate on electrical power supplied by the emergency generator or the main generators.

A 10-ton/hour sanitary pump is provided. It draws

from the sea and delivers to the sanitary main, from which branches are taken to toilets in the passengers' and crew's accommodation. A branch is also taken to the condensers for the refrigerated stores machinery.

The fresh water system is of the pressure type, being fed by a 5-ton/hour pump which is pressure controlled. The pump cuts in at 45 lbs./sq. inch and compresses air in the pressure dome mounted on the top of the filters to approximately 60 lbs./sq. inch. The fresh water passes through the filters before delivery to the various services.

Fuel oil and lubricating oil is carried in double bottom tanks. Three (3) 1,200-gallon gravity tanks are fitted in the engine room, one for settling purposes and two for centrifugal oil. A 30-ton oil transfer pump delivers fuel oil to the settling tank, from which the contents gravitate to the oil centrifuge. The purified oil is delivered by the centrifuge gear pump to the gravity tanks.

In order to guard against the building up of pressure in the filling pipes while fuel is being taken aboard, a relief valve is fitted on the filling main. The outlet relief valve is led to a fuel oil overflow tank in the double bottom.

Cargo fuel oil is carried in No. 6 wing tanks and a 60-ton/hour pump is provided to discharge this cargo at the ports of delivery.

7. CARGO GEAR AND RIGGING:

Cargo gear is arranged at the fore and main masts and a pair of derrick posts to allow for one gang working each hatch and hold. The masts and derrick posts are devoid of shrouds and of such scantlings as to be self-supporting, thus leaving the deck clear for deck cargo or passenger recreation space. The masts have been stepped two decks into the hull, i.e. approximately 16'0" to provide firm and secure attachment to the structure.

All derricks are 42'0" long and of 5 tons S.W.L. at Nos. 1, 4 and 5 holds, 10 tons at No. 2 hold and 2 tons at No. 3 hold. Preventer stays are provided on the foremast when the 10-ton derricks are in use. The cargo runners are generally linked together forming a "union" purchase, but in the case of the 10-ton derricks, provision is also made for the derricks to be used singly as slewing derricks.

2-ton, 3-ton and 5-ton electric winches are arranged at No. 3 hold, Nos. 1, 4 and 5 holds and No. 2 hold respectively, in conjunction with topping units. Contactor panel rooms are built in the masthouses for the 3-ton and 5-ton winches. Due to the fairly intense heat from the contactors when the winches are in operation, special ventilation had to be provided.

A triatic stay is fitted between the fore topmast and the main topmast and carries three pair of signal halyards and

a number of secondary radio aerials. The main radio aerial also extends between the topmasts. A fore topmast forestay extends to the stem and carries the forward anchor light and, similarly, the main topmast backstay carries the aft anchor light.

8. EQUIPMENT AND MOORING ARRANGEMENTS:

The equipment consists of the following :-

3 - 37 cwts. stockless bower anchors

1 - 12½ cwts. stockless stream anchor

240 fathoms - 1.9/16" H.T.S. stud link cable

75 " - 4¼"x6/12 S.W.R. for stream anchor

90 " - 4"x6/12 S.W.R. for towline

4x90 " - 2½"x6/12 S.W.R. for hawsers and warps

4x120 " - 2½"x6/12 S.W.R. for springs

4x90 " - 7" sisal for mooring lines

Cable stoppers are fitted on the forecastle deck immediately abaft of the hawse pipes. Four wire compressors, two on the forecastle and two on the poop, are fitted for use with the forward and after mooring lines so that the vessel can be easily moved along a wharf by a few seamen.

An electrically-driven windlass is fitted on the forecastle deck. The windlass is driven by a 30 H.P. motor, has a pull at either cable lifter of 11 tons at 24 feet/min., and a pull at each warping end of 3½ tons at 85 feet/min., and slack rope of 170 feet/min.

An electrically-driven capstan with a 31 H.P. motor is fitted aft for working the hawsers and mooring lines; it can exert a pull of 3 tons at 80 feet/min. and heave in slack at 160 feet/min.

The steering gear is of the electro-hydraulic type with two separate motor-driven pumps, either of which is capable of moving the rudder under maximum torque conditions. The gear is controlled by telemotor from the bridge and by mechanical control from the docking bridge and in the steering gear compartment.

9. LIFEBOATS AND DAVITS:

The lifeboat complement consists of four (4) 24'0" aluminium boats, one of which is a Class "B" motorboat fitted with a Diesel engine, and the remainder, hand-propelled boats thus dispensing with sails.

The boats are slung in overhead gravity davits at the level of the Engineers' housetop with the embarkation positions at the boat deck level where gates are fitted in the guard rails. A boat hoisting winch is provided for each set of davits which are rigged with wire falls led through deck sheaves to the winch barrel. The winches are of the hand type fitted with a "deadman" brake to ensure safety when lowering the boats and a small portable power unit for lifting the boats back into the stowed position.

A 12'0" dinghy for working duties is stowed in chocks on the docking bridge and is lifted overboard by No. 5 cargo gear.

10. NAVIGATING EQUIPMENT:

The vessel is equipped with a gyro compass installation. The master gyro is situated in the wheelhouse with repeaters on the wheelhouse top and the wings of the navigating bridge. Three compasses are fitted in teak binnacles, one for steering in the wheelhouse, one for steering on the docking bridge, and one to serve as a standard compass on the wheelhouse top.

An echo sounding machine is fitted with a transmitter and receiver in the double bottom and a recorder in the chart-room.

The radar equipment is of the latest type developed for merchant vessels. Special attention has been paid in the design to achieve a compact lay-out, which was so necessary in view of the limited space available for the unit. The main problem was to provide an adequate view for the scanner, while at the same time keeping the height to a minimum to avoid possible damage from shore cargo cranes. The solution was to mount the scanner on top of a small hut situated on the Starboard side of the wheelhouse top, giving a height above deck of eight feet.

The small, compact units lent themselves very well to this installation, and the 20 kilowatt transmitter, with its associated generator and power unit, are all accommodated in

the hut. Although only 5'0" square, there is adequate room for the equipment and ample room for inspection.

The display unit is mounted on a special pedestal which allows the unit to be both tilted and turned to give the optimum viewing angle for the officer working the equipment.

Ranges of 0·6, 1·2, 3·0, 10·0 and 30·0 miles are provided, the accurate range of targets being obtained from range rings generated in the unit.

11. FIRE PROTECTION:

The realism of a ship on fire at sea is occasionally and graphically brought to one's mind from press reports and photographs of a vessel in distress and facing loss unless the fire is quickly brought under control. The fire potential of a passenger vessel is fairly high and springs from such items as wood bulkheads and lining, furniture, soft furnishings, floor coverings and paintwork, all of which will usually burn fiercely.

Structural protection against the spread of fire has been provided in passenger, crew, service and navigational spaces by the fitting of fire resisting divisions. "A" Class divisions of steel insulated to withstand the one hour statutory fire test are fitted 131'0" apart in the passengers' and crew's accommodation on the bridge and upper decks. The integrity of these divisions has been maintained where

pierced for electric cables, pipes, ventilation trunks, etc., and in the case of ventilation trunks, controlled dampers are fitted and made operable from both sides of the bulkhead. Fire doors are also fitted in these divisions and can be readily closed from either side as well as being self-closing after a small link in the hold-back catch has fused through the action of the fire.

"A" Class divisions have also been constructed at decks and casings in way of machinery spaces, galley, pantries, stores, food lifts, stairways, mail room and radio office.

The Construction Rules give a choice of three methods of fire protection in accommodation and service spaces and Method II has been adopted on this vessel. Method II, as distinct from Methods I and III, imposes no restrictions on the construction of cabins, but accommodation and service spaces are protected by an automatic sprinkler, alarm and fire detection system.

A pressure tank with a standing charge of 500 gallons of fresh water under a pressure of 70 lbs./sq. inch, plus the head of water to the highest sprinkler and connected to an air compressor, maintains the pressure in the system at all times. The sprinkler heads operate at a temperature between 155°F. and 200°F. inclusive, each head discharging 20 gallons of water/minute at 25 lbs./sq. inch pressure.

The sprinkler heads are grouped in sections, each

section being controlled by a valve at each control station. A self-contained piping arrangement serves the system with connections to the ship's firemain and a shore supply in case of failure of the independent power pump used solely for automatically discharging water from the sprinkler heads. The power pump has an independent direct sea suction and continues the automatic discharge of salt water from the sprinkler heads before the standing charge of fresh water has been exhausted.

The protection of the cargo spaces presented quite a different problem as the extinguishing medium had to be able to reach the farthest corners of the hold as quickly as possible, and to meet these conditions a CO_2 installation has been fitted.

To detect fire, a fan located on the wheelhouse top and perpetually in motion, draws air from every hold and the merest trace of smoke registers on an indicator adjacent to the gas storage bottles and also rings an alarm on the bridge. The system is under the control of the bridge and gas can be automatically directed to any hold suspected of being on fire.

Liquid CO_2 for the system is stored in twenty-five steel bottles and provides about 11,250 ft.^{3} of free gas which is distributed through $\frac{3}{4}$" bore solid drawn steel pipes to the discharge nozzles. The smoke detection system also uses the gas discharge piping.

A salt water firemain is fitted over the entire length of the vessel with 2½" hose connections and control valves located so that a hose can be used to direct a stream of salt water at a fire in any hold or accommodation space on the vessel.

12. ACCOMMODATION AND CATERING SERVICES:

Accommodation for the passengers, officers and crew is of a high standard, and for the officers and crew is in accordance with the latest Navigation (Crew Accommodation) Regulations.

Accommodation for the passengers is arranged on the bridge and boat decks in single, double and three-berth cabins. Each cabin or stateroom is fitted with wardrobes, dressing table, chair, washbasin with hot and cold water and the various toilet fittings. Watertight sliding windows of the rack and pinion type and hinged jalousies are provided in each of the rooms.

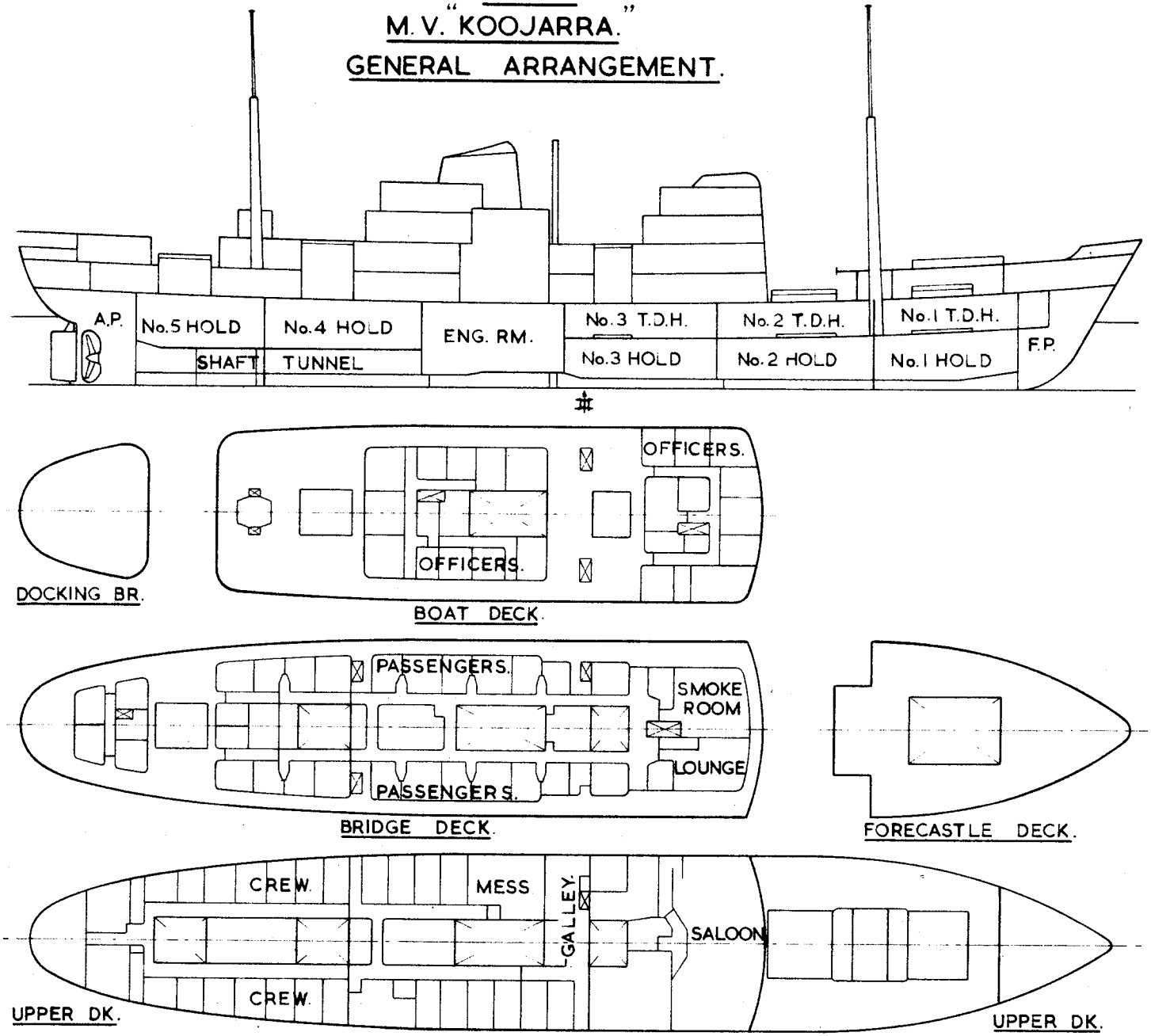
The main entrance to the passenger spaces is on the bridge deck and a stairway leads from a vestibule on this deck down to the dining saloon, which extends across the full width of the ship and seats 52 persons at various sizes of tables.

A smoke room and a lounge room for the use of the passengers are built at the forward end of the bridge deck. Sliding glass-panelled doors are arranged on the bulkhead

FIG. 4.

M.V. "KOOJARRA."

GENERAL ARRANGEMENT.



dividing the two rooms and hinged wood doors on the outboard bulkhead leading to the bridge deck promenade.

A completely equipped bar is arranged at the after end of the smoke room.

Washrooms and toilets are generally arranged on the centreline of the ship. The arrangement provides toilets, showers and washbasins in the ratio of approximately one to every six passengers. Clothes washing and ironing facilities are also provided for the passengers.

All passenger accommodation decks in cabins and public rooms are laid with coloured rubber flooring matching the interior decoration. Washroom decks are covered with ceramic tiles.

Navigating officers and engineers occupy single-berth cabins on the bridge deck, furnished somewhat similarly to those for the passengers. The Master has a suite on the navigating bridge deck and the Chief Engineer, one on the bridge deck. A lounge room for officers is arranged on the bridge deck and dining facilities provided in the main dining saloon.

Seamen, oilers, cooks and stewards are berthed on the upper deck in two-berth cabins and P.O's. in single-berth cabins in the poop house. Two recreation rooms for the deck and catering sections of the crew are provided at the aft end of the upper deck and messing arrangements amidships abaft the

galley. A direct plate service is provided from the galley to the crew's messroom through a service opening direct into the hot press. The service opening is provided with a fire-proof flap which, when closed, maintains the fire-proof integrity of the bulkhead. Washrooms and toilets are arranged on the centreline of the vessel and fitted out somewhat similarly to those for the passengers.

The decks in the crew's accommodation are covered with vinyl tiles to withstand the continuous heavy wear usually found in this part of a vessel.

The galley and scullery are arranged on the upper deck between the engine casing and No. 3 hatch trunk and extend the full width of the vessel. Shell doors are fitted to serve the dual purpose of loading stores and providing additional ventilation. The galley is equipped with an oil-fired range, electric fish fryer, electric pressure griller, steam pressure cooker and stock pot. A 50-quart food mixer with attachments is fitted in the scullery.

Forward of the galley on the Port side is a bakery and a pantry. The bakery is fitted with an electric baking oven, dough trough, racks and shelves, all necessary in the making of bread and pastry. The pantry, which is immediately behind the dining saloon, is fitted with a 30 $ft.^3$ refrigerator, electric toaster, bread cutter, ice cream maker, hot water boilers and an electric bain marie. Service to the

dining saloon is provided from the bain marie, which is built against the serving windows on the forward bulkhead.

Dry store rooms, beer store, butcher's shop and refrigerated store rooms are arranged on the Starboard side of the galley.

The refrigerated store rooms comprise a meat room, dairy produce room, vegetable room and a handling room. These rooms are in close proximity to the galley and provide the cooks with a compact arrangement of stores. The butcher's shop is adjacent to the stores and equipment is provided for the daily preparation of the vessel's requirements of meat.

A Stewards' night pantry is arranged on the Starboard side of the bridge deck, from which morning tea is served.

13. MACHINERY ARRANGEMENT:

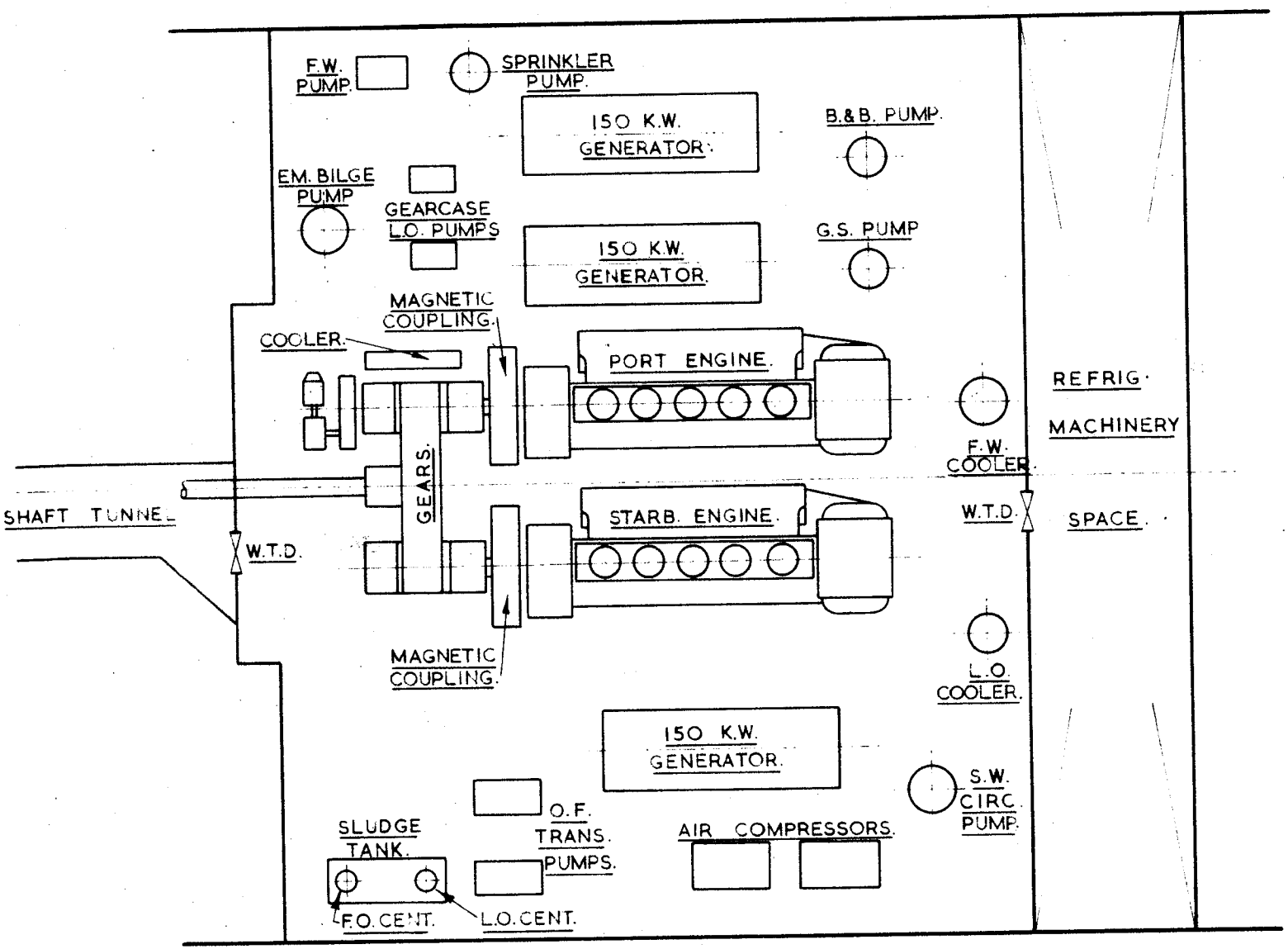
The main propulsion engines consist of two M45M British Polar Diesel engines, driving through electro-magnetic couplings and a gear box to the one propeller shaft. The crankshafts are of a special design in order to carry the overhung weight of the inner member of the magnetic coupling. The maximum speed of the engines is 300 R.P.M. giving a propeller speed of 130 R.P.M.

Each magnetic coupling requires 53 amps. for excitation and this allows a coupling slip of approximately 1.20%. The coupling air gap is about 0.30 inches.

FIG. 7.

M.V. "KOOJARRA."

MACHINERY ARRANGEMENT.



The engines are designed for independent manoeuvring, i.e., one engine can be run in the "Ahead" direction and the other in the "Astern" direction, and manoeuvring can be carried out by exciting either coupling as required. Such an arrangement requires that the couplings be of the double squirrel cage type with a high torque transmitting characteristic at 100% slip. Special sensitive governors have also been fitted in order to protect the engines from overspeeding should the load be suddenly disconnected during manoeuvring or electrical failure.

Three (3) 150 k.w. Diesel-driven generators are installed and are fitted with automatic stopping devices which operate from high jacket temperatures or low lub. oil pressures.

Fig. 7 shows the machinery arrangement.

7-12-56

CONSTRUCTION OF M.V. "KOOJARRA"

REX C. ELLIS (MEMBER)

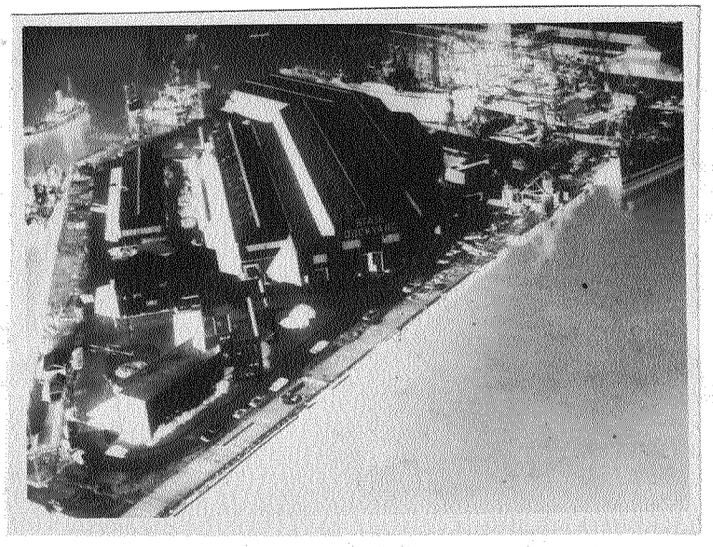
The principal particulars already given do not suggest that this is a ship of gigantic proportions, nor do they give the impression that there is anything unusual about its construction and outfit. However, the facts are that within the comparatively minor dimensions of the hull are embodied all the most modern services and appointments usually found on a much larger ship.

Working drawings were prepared with a view to utilizing to the fullest extent the Dockyard's modern welding, burning and handling facilities and block and panel prefabrication construction methods.

The ship was constructed on the prefabricated "unit" system, the units being depicted on the drawings as "panels" or "blocks" in accordance with a predetermined production schedule based on the availability of automatic and manual welding facilities and crane power at site of prefabrication.

The working drawings for shipyard use, necessarily embody a great deal more information than is the case of the orthodox built riveted ship. Apart from the multiplicity of welding notes the drawings show clearly the limits of the sections to be prefabricated the weights and in cases of irregular sections the position of the centre of gravity for lifting purposes.

It will no doubt be of interest to many to have an idea of the layout of the Dockyard where this vessel was constructed. It is also proposed to briefly describe the standard practice employed by the Dockyard in the prefabrication of ships hulls up to the laying of the keel as the construction of "Koojarra" falls within this category.

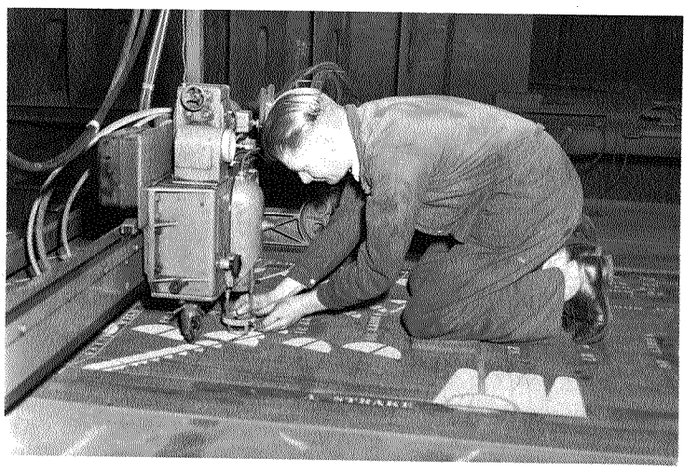


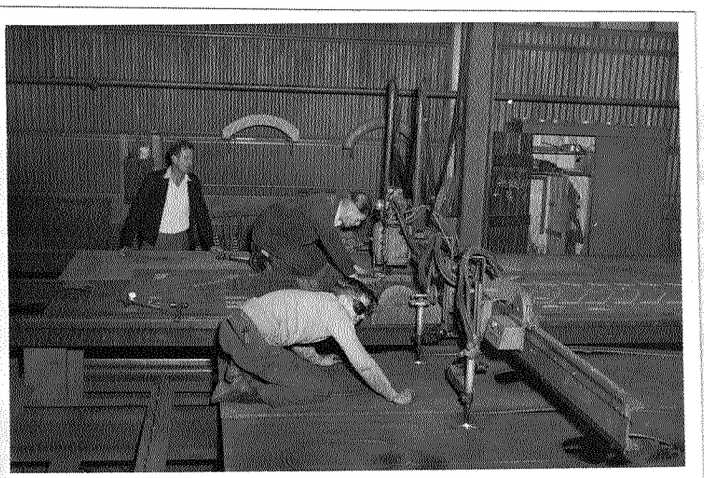
The main ship construction shops are grouped around the Building Berths and are conveniently situated to permit the most economical flow and mechanical handling of materials one to another, from the steel storage yard and to the prefabrication and assembly areas and the Building Berths. The aerial photograph (1) shows the Mould Loft, Steel Construction Shops and Steel Storage Yard at right, whilst on the immediate left of the Building Berths the Shipwrights and Painters and Dockers shops are located. Further to the left are the various Engineering shops and the Administrative Building.

The "unit" system assists considerably in the ordering, racking and intake of material for fabrication and contributes greatly to efficient interlocking of Loft work, marking off and assembly processes.

Loftwork has changed considerably with the introduction of prefabrication methods. The amount of templating has been greatly reduced but other information such as buttock and waterline battens applicable to the various prefabricated sections is supplied to facilitate the fairing of panels on the skids prior to erection on the Building Berth.

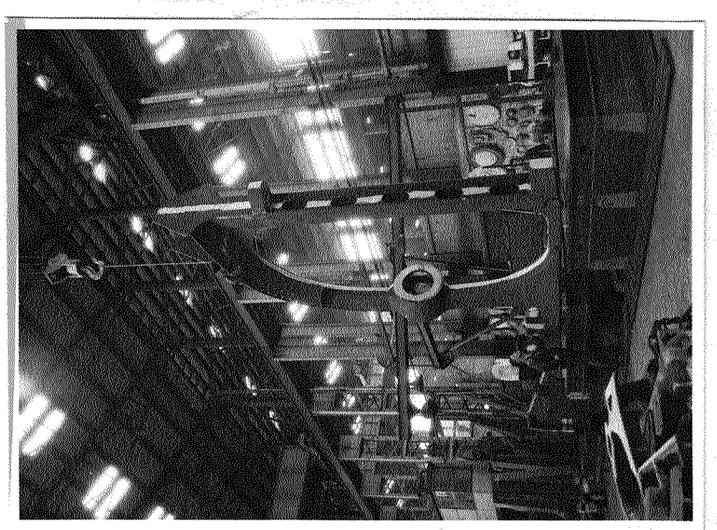
A special scrieve of the bottom section is also supplied and fitted to the tracing table of a large "Nova Rex" gas profiling machine which has been equipped with two cutting heads and an extended table.





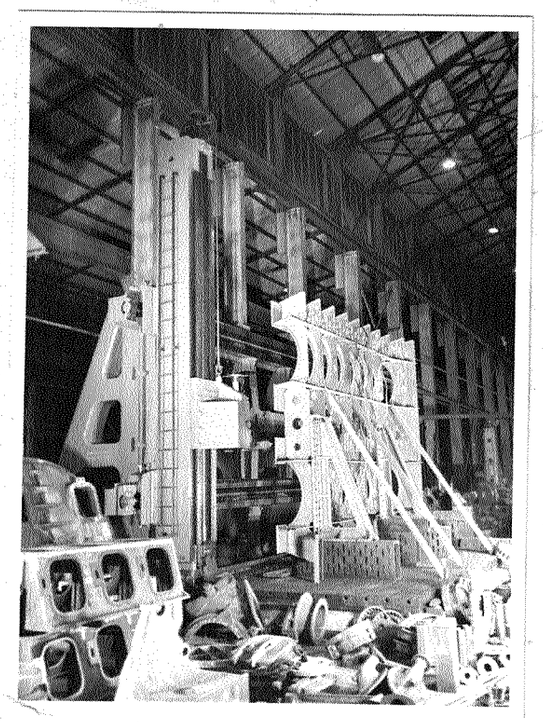
Scrieve boards on which the lines have been adjusted for kerf are fastened to the tracing table of the profile cutter and by means of a manual tracing control, Port and Starboard floor plates are cut to shape simultaneously.

Intercostals, Beam Knees, Brackets and other similar components of which there are a considerable number of the same dimensions are cut to shape on the same machine but in this case a steel template is used and a magnetic tracer is fitted to the tracing control.



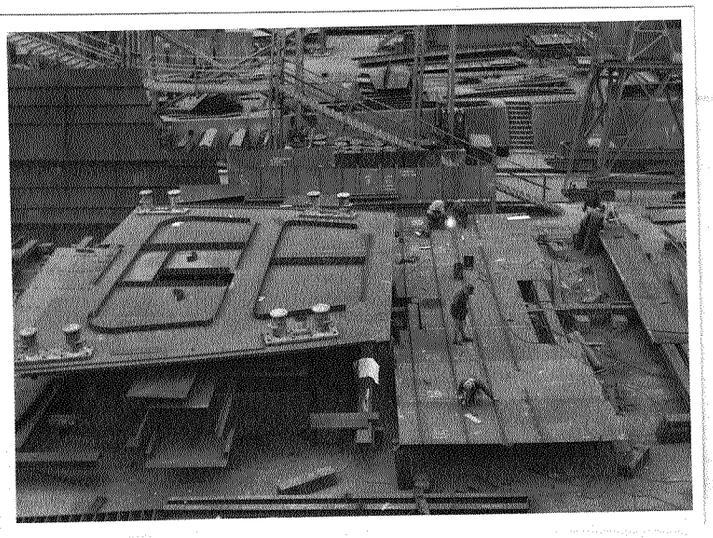
Sections including Double Bottoms, Bulkheads, Decks, Masts, Engine Seatings, Stern Frame etc., to the full capacity of the cranes are completed in this shop ready for erection

on the Building Berth.



Bulkhead stiffeners are slightly cambered and Deck beams over cambered before being welded to the plating so that they will respectively finish straight and with the correct camber after welding.

The welding sequence is such that each component being assembled into a full section is positioned to enable most welds to be made in the downhand position. Extensive use is made of the "Hidden Arc" process which eliminates to a great extent the necessity of veeing the plate edges.

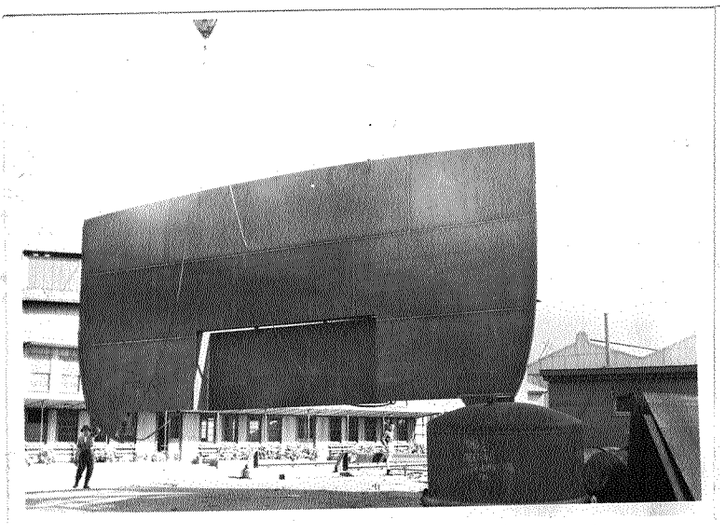


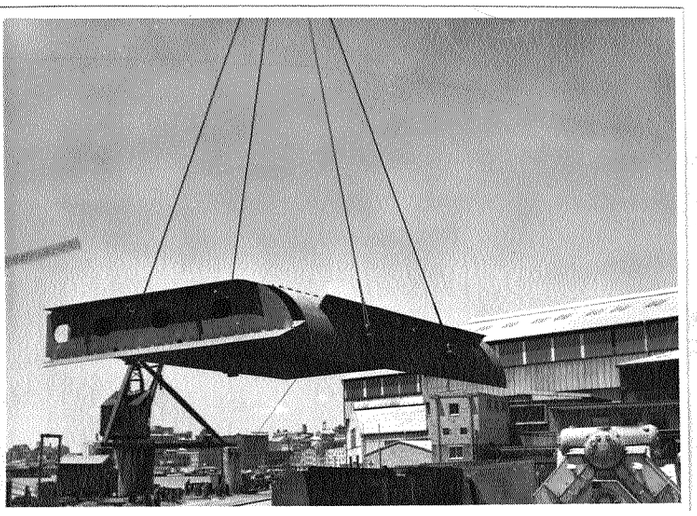
In the course of assembling Double Bottom Units, all pipes, bulkhead pieces, manhole covers etc. are fitted. The deck sections including hatch sides, bulwarks various coaming plates etc. are completely fitted with Bollards, fairleads, mooring pipes and all rigging fittings. Masts and Derrick Posts are completed in all respects and finished painted before they are taken from the shop.

The primary objects of proceeding to this degree of completion before erection were to perform welding under conditions most conducive to economy and efficiency, to minimise the number of welds in situ on the Building Berth and thus eliminate locked in stresses, to considerably reduce confined space work in tanks and to obviate the necessity of the erection and continual movement of complete rows of staging inside and outside the ship on the Building Berth. The procedure adopted has however also expedited the fitting out and painting of the ship generally.

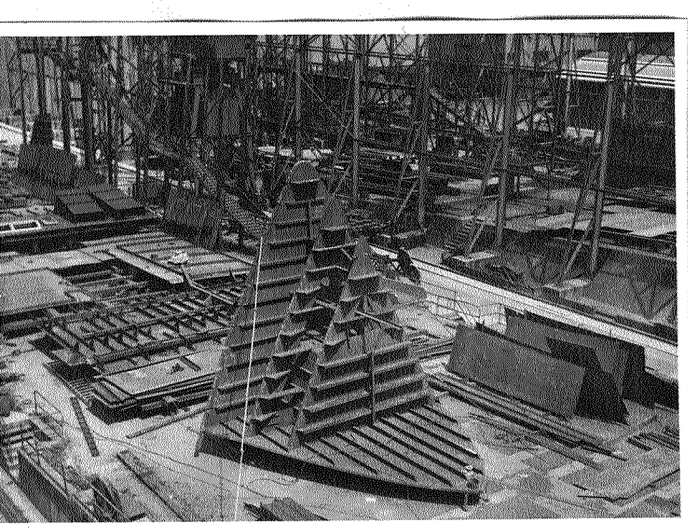
The well formed spacious roads conveniently disposed between the various shops and alongside each Building Berth facilitate the transportation of completed sections by jinker from the main fabrication shop to the sub-assembly areas or direct to the Building Berth.

"Koojarra" was constructed on No. 4 Building Berth which is 520 ft. long and 75 ft. wide. Three travelling cranes of 5 tons, 6 tons and 45 tons capacity serve the Building Berth and the adjacent assembly and prefabrication areas.





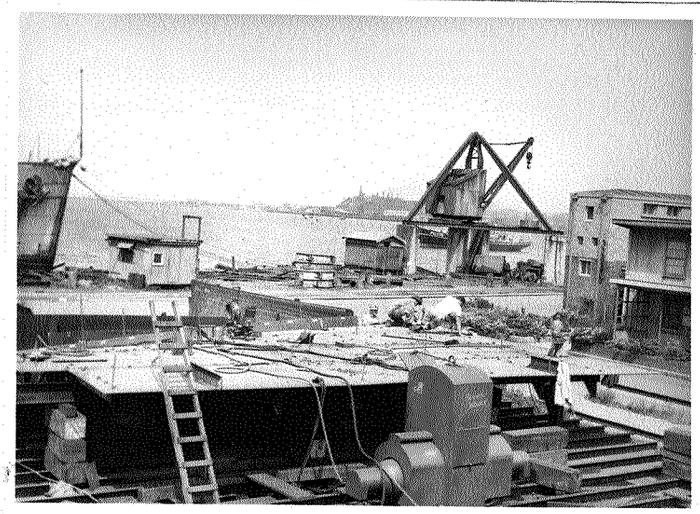
The 45 tons travelling crane has an auxiliary hoist which in conjunction with the main hoist enables large sections to be turned over without the aid of another crane and as the turning process is performed in mid-air the necessity of providing turning pits to accommodate projections is obviated.



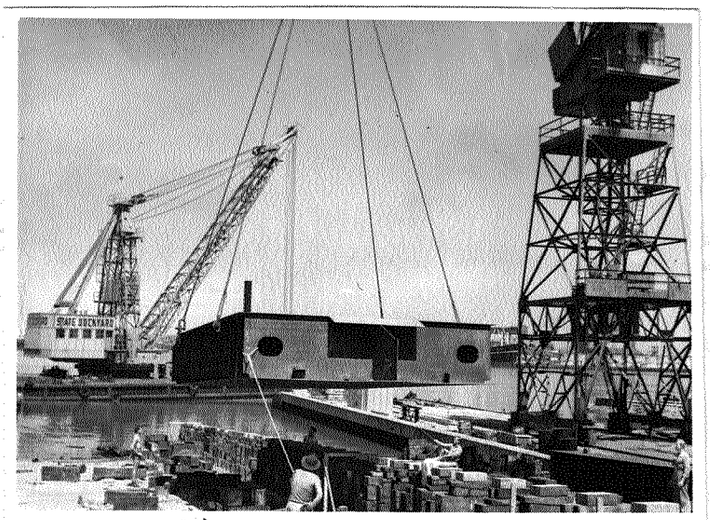
Complete Bow and Stern Units, side shell panels and double bottom units etc. which are beyond the capacity of the shop cranes are prefabricated on the assembly areas within reach of the 45 tons travelling crane. The final assembly and welding together of smaller components prior to erection on the Building Berths is also carried out.

As no suitable sections are obtainable in this country for welded main frames, bulb angles are used and these members are riveted to the shell plating. The riveting however is completed on the assembly area.

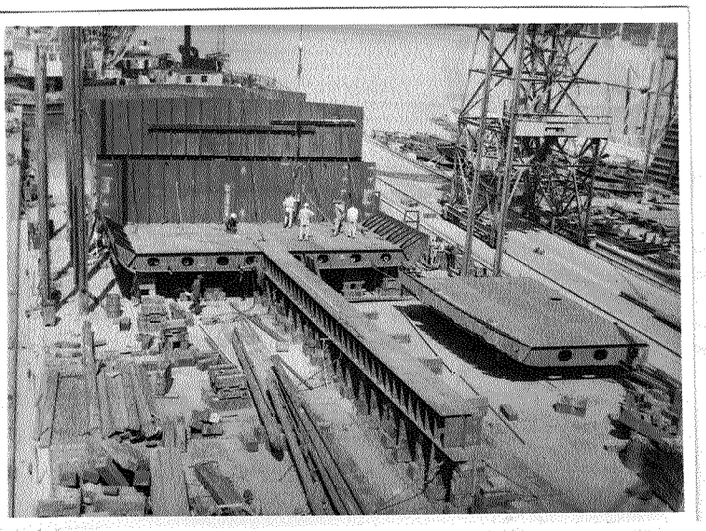
Storm Valves, air escape pipes, cargo lashing rings and even spar ceilings are fitted to the shell panels before erection.



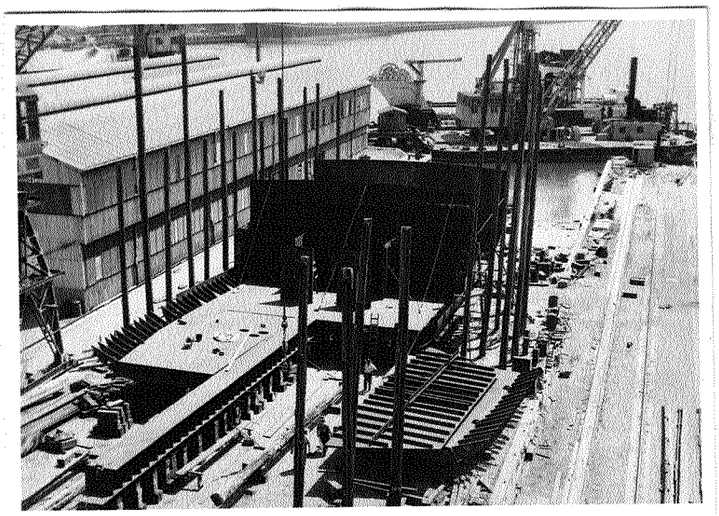
No jigs are used in fairing the shell panels, but a rather novel method of fairing by means of the erection and "winding in" of steel waterline offset battens has proved very successful.



The Keel or more correctly the midship double bottom unit was erected on the building berth on 11th November, 1954.

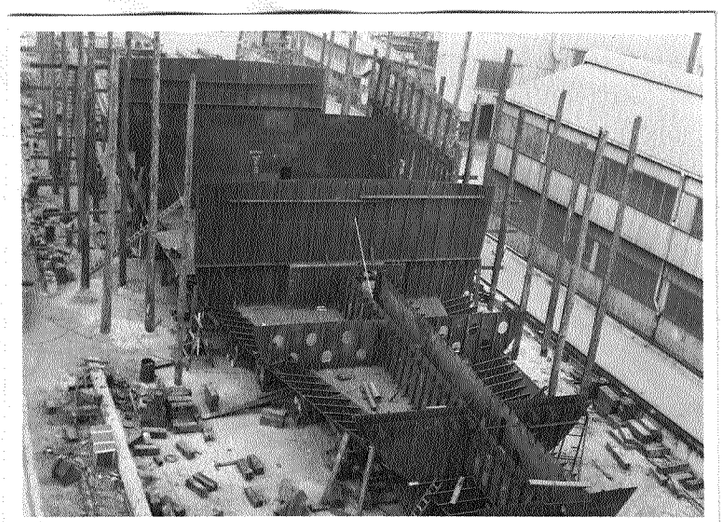


From then on prefabricated units were erected in a definite sequence, Port and Starboard units being positioned simultaneously and progressively from midships towards each end.



The general welding procedure was to commence at the centre and work towards the extremities of each unit: i.e., Welders were employed Port and Starboard and required to work towards the sides and ends simultaneously so that at all times in every direction welding was advanced towards a free end.

Employment of prefabrication methods reduced to a minimum the welding in situ and as by virtue of the welding sequence already described the only restraint on the joining welds was that due to a units own weight it is believed that "Locked In" stresses have been almost eliminated.

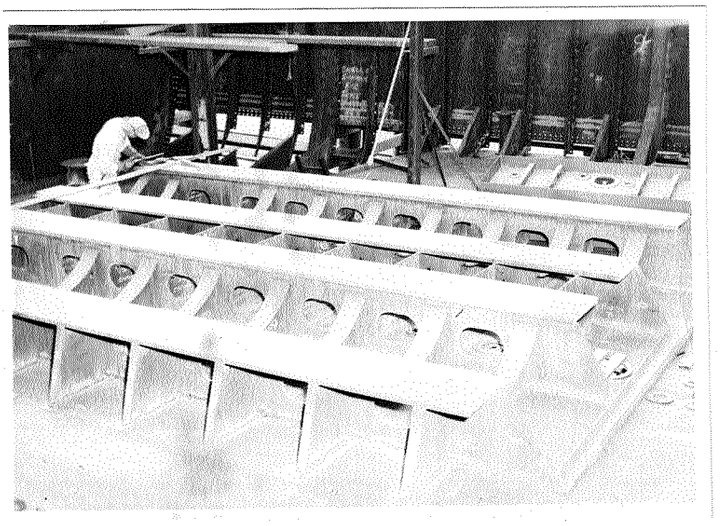


When the welding together of the double bottom units had been completed, Radiographic examination of important welds on the shell and inner bottom was carried out by the Standard Research Laboratories in accordance with the requirements of the Australian Shipbuilding Board.

A certain amount of shrinkage takes place with the welding together of the various sections, but it has been found to be uniform and no great difficulty is experienced in matching beam knees with frames, frames with bilge brackets etc.

At no time was any rigid restraint put on shrinkage, the cleats and dogs used for holding the butting surfaces together for welding being so arranged that the material was free to move along the direction of the weld and as there was always a free end in the direction normal to the weld movement was also unrestricted.

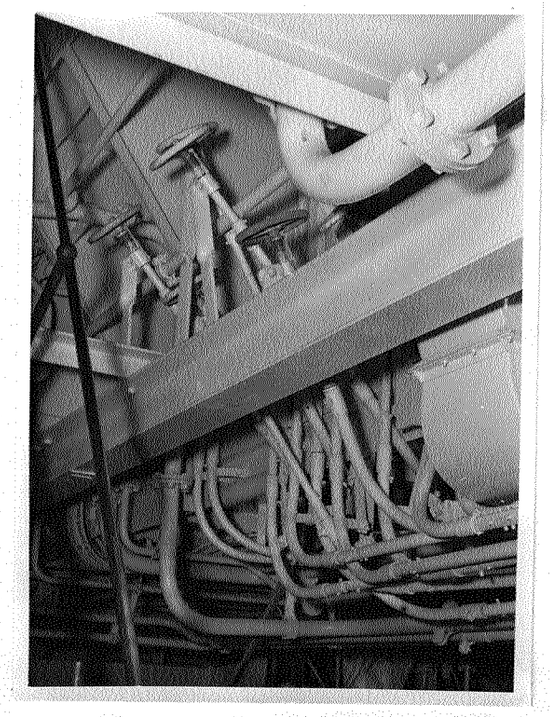
During erection and the subsequent welding together of the prefabricated units a systematic check was made of any resulting misalignment and in the few cases where it was found necessary it was rectified by slightly varying the welding sequence.



It was possible without varying the normal erection and welding procedure to finish the steelwork in way of the Engine Room and Refrigerated Holds quite early in the erection programme and thus enable a large labour force of outfitting trades to be employed in these areas.

Tank testing which is considerably expedited by the welded prefabrication methods employed was also at an advanced stage very early in the erection sequence.

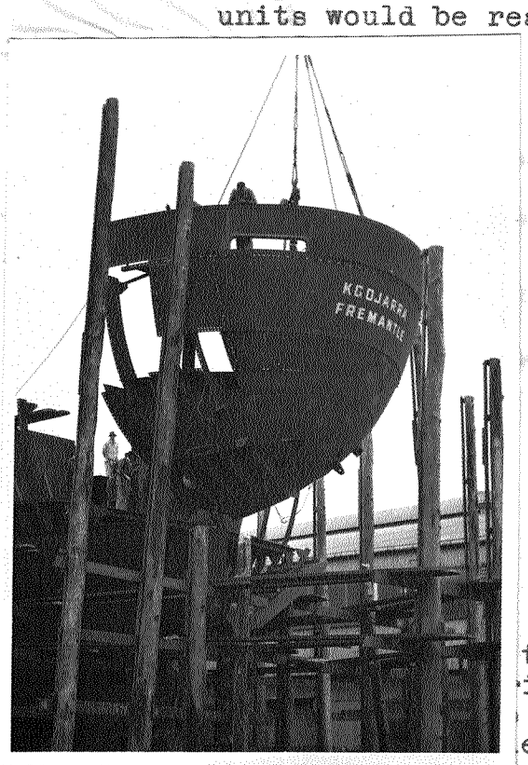
The insulation of the Refrigerated Holds has been the most complicated yet undertaken by the Dockyard. Three different insulating mediums were used in various places, the whole being bonded with hot bitumen for which a special thermostatically controlled electrically heated tank had to be devised.

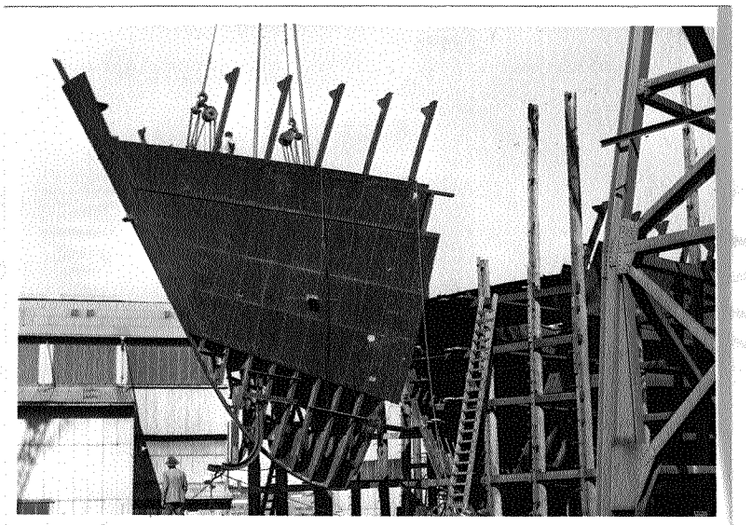


As the hull steelwork was being progressively erected considerable progress was made with the outfitting of the machinery spaces with its multiplicity of pipe lines, pumps, auxiliary generators and other auxiliary equipment.

After all eyeplates, lifting beams and other permanent fixtures had been located on the Deckhead of the Engine Room an immediate start was made with the Insulation and cleading as this would have been impossible after the electric cables, extended spindles and various ventilating ducts had been installed.

On an adjacent Building Berth the assembly of complete Bow and Stern Sections was proceeding so that these units would be ready for erection as scheduled.





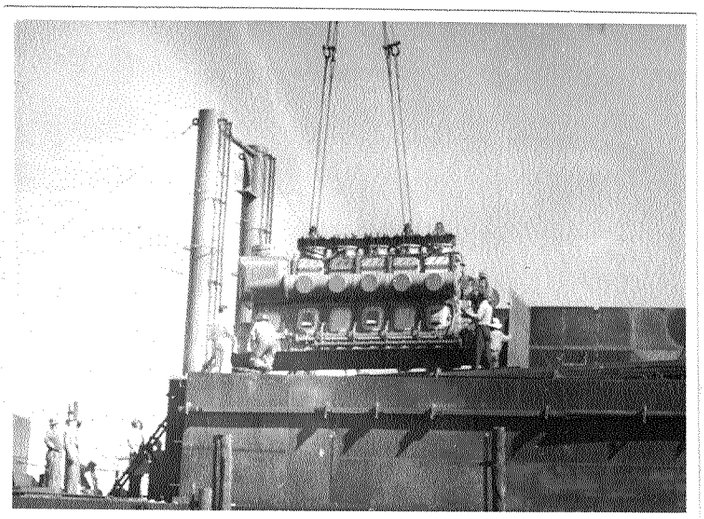
the various divisional bulkheads between the ridge Deck were erected many items of equip- be passed through passage ways and doorways ed. These included such items as the Galley Range, Bain Marie, Bakers Oven, Domestic Refrigerators and Steering Gear etc.

When the main steelwork had been erected a further radiographic examination was carried out of site welding subjected to high structural strains. Particular attention was given to cross welds.

Nearly 23 tons of electrode wire were deposited in the construction of the ship.

In the limited space available the lining off and installation of the many services throughout the accommodation presented a major problem and necessitated the closest co-operation between the various trades.

Positions had to be found for hot and cold fresh water services, fire main and wash deck services, CO_2 and Grinnell Sprinkler piping system, Brine piping for Domestic Refrigeration, Iced Water lines, Electric lighting and Power Cables, Air conditioning ducts, Mechanical Ventilation, Natural ventilation, as well as the numerous scuppers and drains and filling, sounding and air pipes to the various tanks.



The Main Engines were installed on 8th December, 1955 and work in the square of the Engine Casing was thus enabled to progress.

The Launching arrangements were put in hand before the first unit was erected on the Building Berth.

It is the Shipyard's standard practice to lie the standing ways on the Berth before the steelwork is erected and thus avoid as far as possible the manhandling of these heavy timbers.

The oregon sliding ways (30" wide) were greased at the head of the Berth and moved down to their positions under the ship by means of temporary rollers fitted on the outside and timber skids under the Ribbands on the inside. This was done to reduce the thickness of packing on top of the ways.

"Koojarra" was named and launched by Mrs. H. C. Strickland, wife of the Minister for the North West and Shipping Western Australian Government on 14th January, 1956.

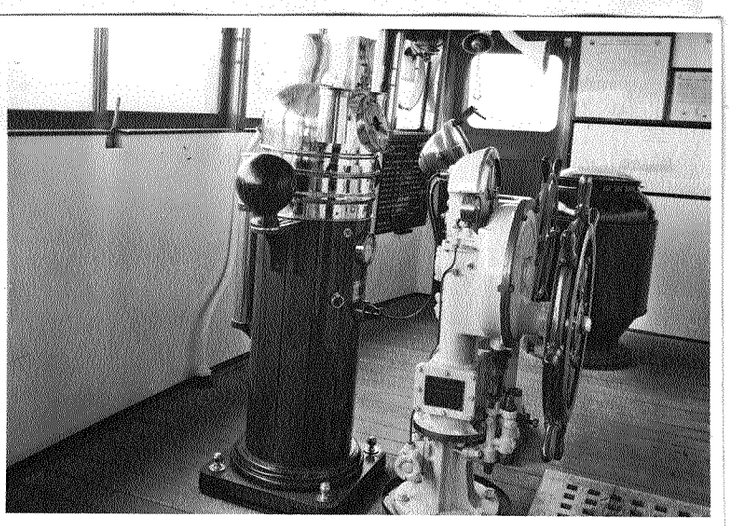
The launched weight was 1,832 (One thousand eight hundred and thirty-two) tons, mean static pressure on grease 1.72 tons per square foot and the ship moved down the ways at an average speed of 7 (seven) miles per hour on a declivity of 23/32" (twenty-three..thirty-seconds) per foot.

Extensive use was made of the Nelson Stud Welder in fitting out the ship. The fastening of wood grounds in Refrigeration and accommodation spaces, Teak Decking, Electric Cables, Ventilation Ducts and various pipes was considerably expedited by this method. The necessity of drilling and tapping or through bolting some 57,000 (fifty-seven thousand) holes was therefore eliminated. A considerable quantity of insulation was also fastened to bulkheads by means of this tool using insulation pins and speed clips. 22,000 (Twenty-two thousand) super feet of Teak was used in the wood decks and handrails. The decks after being payed were planed all over.

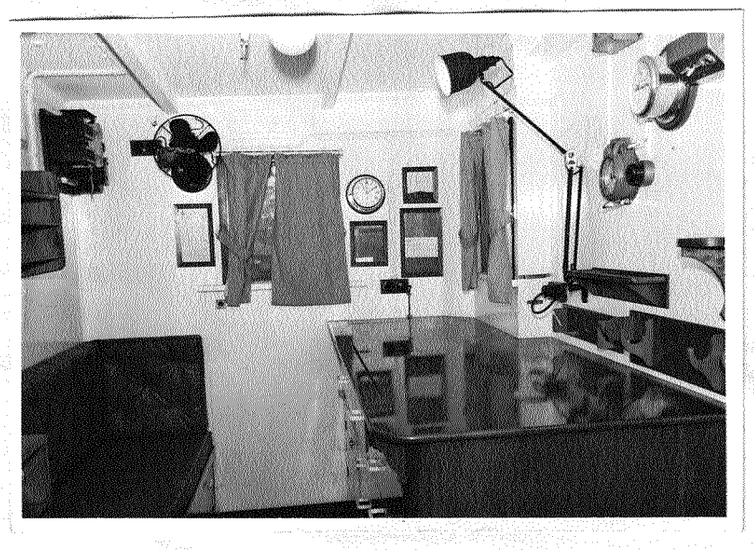
The Steel Decks throughout the crews, officers, and passengers accommodation and public rooms were covered with semtex fleximer underlay and overlaid respectively with Vynle Tiles, Sheet Rubber and Rubber Tiles.

As previously mentioned the air conditioning and ventilating ducts were of considerable proportions and their installation together with the many other services in the limited spaces available presented a major problem.

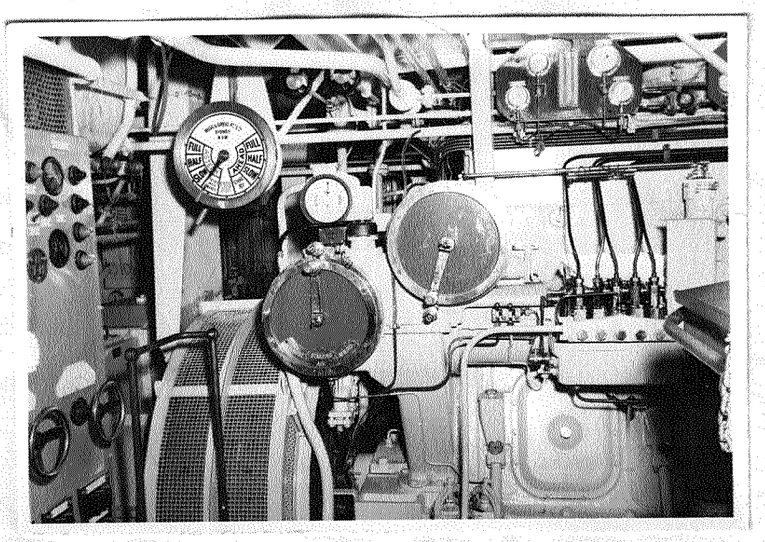
The Air Conditioning Ducts were in the main constructed of 16 gauge galvanized iron having monel-metal "Pop Riveted" and soldered joints. On completion the whole was insulated with "Onozote" stuck to the ducts with "Laminex Adhesive" and wrapped with insulating tape. The magnitude of this work may best be appreciated by the fact that some 13 (Thirteen) miles of industrial tape were required to cover the insulation.



In addition to the usual electrically operated Engine Room Auxiliaries, Winches, Windlass and Galley equipment the ship has some modern aids to navigation in the form of Radar, Echo-sounding, Gyro Compass and Automatic Pilot and each stateroom is fitted with a microphone which is wired to the Ships Pantry and enables the passengers to speak to the Steward. The total length of cable used in the ship amounted to 19.5 miles.

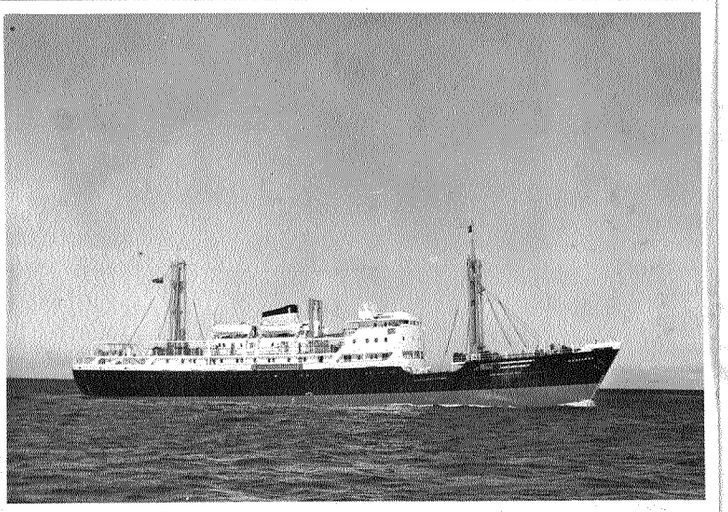


Separate trials each of 72 (Seventy-two) hours duration were carried out on the Cargo and Domestic Refrigeration Plants, and the Air Conditioning and Mechanical Ventilation systems.



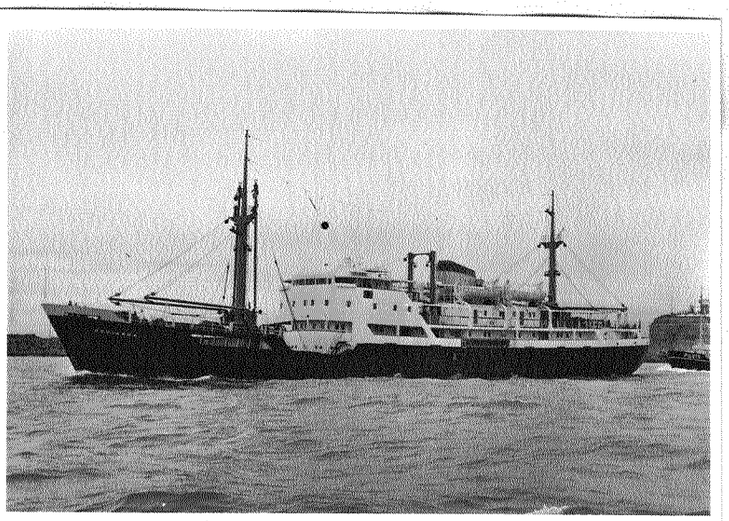
On completion of the testing of all the ships services, Cargo Gear, Windlass, Steering Eng., Auxiliaries and Fire Fighting Equipment, Basin trials of 8 hours continuous running were carried out.

The vessel was docked on 20th August, 1956. An inclining experiment was performed on 22nd August, and the compasses adjusted the same day.



On 28th and 30th August, the vessel underwent Sea Trials. A mean speed of 12.75 knots was obtained with the main Engines developing 1,375 (One thousand three hundred and seventy-five) B.H.P. and the propeller revolutions being 130 (One hundred and thirty). The corresponding consumption figures were 0.428 lb./B.H.P./Hour.

"Koojarra" was formally handed over to the Australian Shipbuilding Board and then to the Western Australian State Shipping Service on 14th September, 1956.



After being loaded with Cargo "Koojarra" was subjected to a further Sea Trial of 24 hours duration on the successful completion of which she proceeded to Fremantle. "Koojarra" has now taken her place with the other units of the Western Australian State Shipping Service and it is hoped that this, the most modern "Little Big Ship" on the Australian Coast designed and built by Australians will serve Australia well.

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M.V. "KOOJARRA"

VENTILATION

OF

ACCOMMODATION SPACES

The ventilation of m.v. "Koojarra" has been given special consideration because of the abnormally hot and humid climatic conditions experienced on the north-western coast of Australia on which the vessel regularly trades. The living spaces and public rooms have been air conditioned, the galley and pantry areas, washplaces and storerooms ventilated by mechanical supply and exhaust systems and an alternative system of natural air circulation has been provided for emergency use.

The ventilation of living spaces and public rooms is completely distinct and separate from the ventilation of the galley and pantry areas, washplaces and storerooms, etc., whilst each system utilises its trunkways for emergency natural air circulation.

AIR CONDITIONING:

As nature does not always supply an atmosphere of a particular degree of humidity, the air conditioning plant has been devised to supply throughout selected spaces a continuous supply of pure air which may be cooled or heated as desired, that is, air of desired humidity. Air conditioning is in reality an improved method of ventilation inasmuch that to ensure the maximum conditions of health and comfort are maintained, the movement of clean air, predetermined in temperature and relative humidity within a selected space, is controlled.

In the case of m.v. "Koojarra" the air conditioning employs a

centrally located air circulating unit, which circulates air to the various selected living spaces and public rooms through a single line duct system, terminating in louvres or diffusers so arranged to suit the requirements of the individual spaces concerned. The installation can be arranged to provide simple mechanical ventilation supply or complete air conditioning with air cooling and dehumidification as required.

Briefly, air is drawn from the accommodation spaces along the passageways into and up the return air duct in the after starboard corner of the engine casing, through the air conditioning plant and then returned down the air duct in the after port corner of the engine casing and trunked to the various accommodation spaces, re-entering the rooms through louvres or diffusers.

The fans, which are really suction fans, draw air from the return air duct and auxiliary fresh air intake opening in the fan room side, through the copper gauze cleaning filters, sucks it through the humidifiers where the air passes over brine cooled coils in order to reduce the return air temperatures, and then through the heater and finally drives it down through the air ducts to the various rooms. In other words the air within the accommodation spaces of the vessel is being continuously withdrawn from those spaces to the fan room, where it is cleaned, conditioned and then recirculated to whence it came. The quantity of recirculated air is augmented with approximately fifteen per cent. (15%) of outside air via the fresh air intake, which not only allows for losses of

circulating air because of the opening of doors, etc., but also helps to repurify the system.

Whenever the air conditioning system of ventilation is in operation, the vessel is completely closed up, that is, all weather doors, sidelights, windows, natural ventilators and internal doors leading from the galley and pantry areas, washplaces and storerooms, etc. are closed and the fresh air intake in the fan room side is opened sufficiently to admit the required amount of fresh air.

To deal with possible out of balance dry bulb temperatures in the public rooms, a small reheat coil has been installed in each of the trunkways servicing these spaces and operated by special water valves connected to a hot water line, the valves being actuated by pneumatic type thermostats placed within the conditioned spaces.

In order to maintain a constant pressure in the main delivery duct regardless of air flow quantity, a static pressure regulator with a sensitivity of 0.01" water gauge has been provided, which operates pneumatic type motors coupled to the main control dampers at the fan discharge connection. This instrument regulates the delivery duct pressure, thus obviating any unbalanced air flow caused by individuals making adjustments to the cabin distributors. The pneumatic motors are spring loaded and return the dampers to the shut position in the event of air control or other equipment failure. The dampers can also be manually shut from without the fan room and therefore brought into the fire control scheme.

The ductwork has been insulated with Onazote of varying thicknesses - 2" thick in the main supply and return ducts, 1" thick on

all external trunks and ½" thick on all internal main trunks. Off-takes from the main internal trunks are not insulated, as it will be appreciated that once the conditioned air has entered an air conditioned space it commences to do its work whether by conduction through the ducting or distribution through the main outlets, that is, diffusers or louvres.

When air conditioning is considered unnecessary because of ambient conditions, the air conditioning trunks are used for mechanical ventilation of the living spaces and public rooms. The cooling and heating coils are closed down, the fresh air intake fully opened and air is discharged by the air conditioning fans into the main duct. Should the weather doors, windows and sidelights be left closed up as for air conditioning conditions, the air is drawn up the return air uptake in a manner similar to that under air conditioning conditions and augmented by the supply from the fully open fresh air intake. However, it makes no difference whether the vessel is closed up or open so far as mechanical ventilation is concerned.

An alternative system of natural ventilation utilising the air conditioning trunks has been incorporated for emergency use and this system provides for not less than six (6) square inches of intake area for each person likely to use any one space at the same time. For this purpose a natural air scoop has been built abreast the main supply trunk and discharges direct into this trunk when called upon. The scoop is fitted with an airtight opening and

remains closed when the air conditioning or mechanical ventilation of the living spaces and public rooms is operating.

Two centrifugal fans, each bearing half the load and discharging into the main plenun, supply the air conditioning and, alternatively, the mechanical ventilation requirements and give the following number of air changes per hour :-

Spaces	Air Conditioning	Mechanical Ventilation
Living Spaces	18	24
Public Rooms	24	30

In all, approximately 22,500 and 28,000 cubic feet of air per minute is necessary for the air conditioning or mechanical ventilation systems, respectively, and to ensure that each individual space receives the required number of air changes per hour, the air flow velocities of each louvre or diffuser within the space concerned have been checked by a "Velometer" in order to obtain the correct balancing of the systems.

All calculations with regard to the air conditioning of the spaces as mentioned have been based upon the particular requirements of the vessel inasmuch that 90°F is maintained with 45-50% relative humidity in the spaces air conditioned when the outside dry bulb temperature is 100°F and wet bulb temperature 85°F, the relative humidity being 53% with appropriate intermediate ranges.

The entire control system of the air conditioning plant is of the pneumatically-controlled type.

A simple pneumatic thermostat actuated by the temperature of the main brine service to the air conditioner and which reacts direct on to the compressor capacity reduction gear in order to match the compressor capacity against refrigeration load requirements as directed by the brine delivery temperature, assures that a constant temperature is maintained.

Another pneumatic thermostat situated in the return air duct and operated by the return air temperature controls the main brine thermostat in such a way that it can reset that instrument to any predetermined temperature in order to bring on refrigeration according to the demands of the air conditioned section of the vessel. This instrument also regulates the hot water flow to the reheater coils.

As humidity control plays an important part in an air conditioned function, a pneumatic humidistat positioned in the return air duct can override the return air thermostat to the extent that when the humidity rises refrigeration can be called upon in such a way that the humidity controller reacts on the control point of the main brine thermostat, varying the dew point by means of brine temperature control.

Diverting relays and air switches have been installed in the fan room and a master switch provided to enable the plant to run on summer or winter conditions. Under winter operation heating only has been provided for, with no attempt at humidity control.

MECHANICAL VENTILATION:

Whilst the mechanical ventilation of the living spaces and public rooms utilises the same trunkways as the air conditioning system, the galley and pantry areas, washplaces and storerooms, etc. have been mechanically ventilated by supply and exhaust systems, which give the following number of air changes per hour :-

Spaces	Supply	Exhaust
Galley, Pantry, Butcher's Shop, Baker's Shop and Drying Rooms	30	50
Washplaces	20	40
Linen Rooms and Storerooms	10	20

The supply fans are housed in a small fan room with an opening at the after end covered with copper wire cleaning filters, through which air is drawn into the fan room and distributed by the fans through trunks to the various compartments. The exhaust fans are located in convenient places upon the open deck.

As the exhaust from all the abovementioned spaces is in excess of the mechanical supply, care has to be taken to ensure that the minimum amount of conditioned air is drawn into the spaces through open doors, etc. and close fitting doors and strong hydraulic door stops have therefore been fitted in way of all openings adjacent to the passageways.

Of particular interest is the pantry area abreast the dining saloon. There is no fixed division between these spaces and to ensure that the odours from the pantry do not infiltrate into the saloon and also that too much conditioned air from the saloon is

not lost due to the mechanical exhaust in the pantry, a branch duct from the mechanical exhaust main has been arranged to run athwartships across the forward end of the pantry. This branch has been arranged to exhaust the air from the forward end of the pantry and the aft end of the saloon in such a manner as to balance the air flow from the mechanical supply in the pantry and the conditioned air lost from the saloon. It was found from experimenting that the exhaust in this area had to equal exactly the mechanical supply to the forward end of the pantry.

Natural air scoops, similar to those fitted to the air conditioning system, have been fitted to the mechanical supply systems and where found necessary because the total area of the louvres within the specific spaces had not given the six (6) square inches of intake area per person, an auxiliary natural ventilator has been fitted to augment the emergency natural air supply.

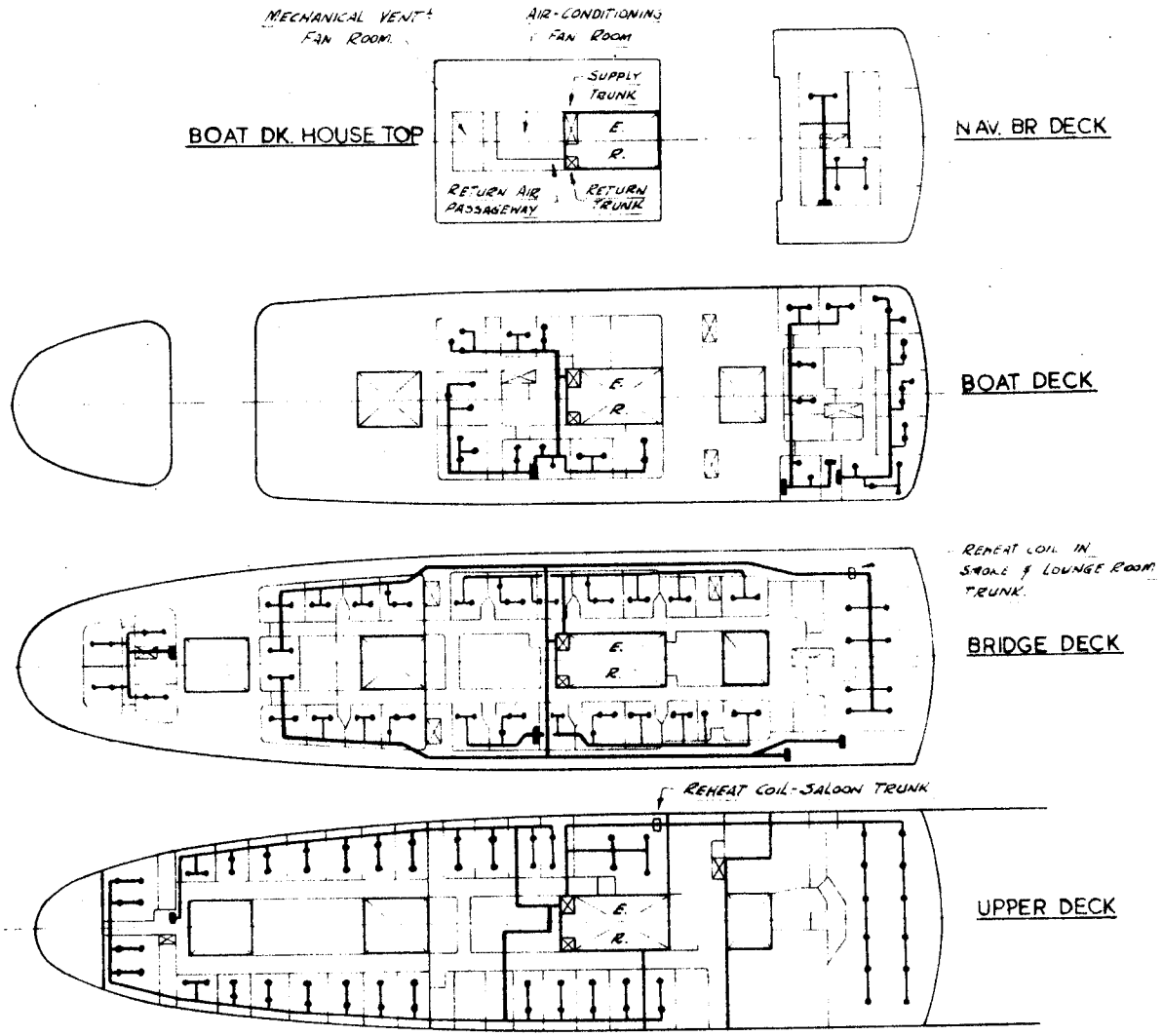
Particular attention has been given to the fire protection of the vessel with regard to all ventilation systems. Wherever a ventilation trunk passes through a fire bulkhead, a fire damper has been fitted, which is held in the open position by a fusible link and, when broken, causes a spiral spring to close the flap. These dampers can also be operated manually. At the inlet side of all supply fans, a cover plate can be quickly positioned closing the suction side of the fans and manually operated dampers have been

fitted in the discharge head of each exhaust fan. Thus, in the event of a fire aboard the vessel, every precaution has been taken to prevent fire spreading via the ventilation trunks.

For the purpose of complete ventilation of the vessel, that is, all fans and air conditioning machinery operating to give the air changes per hour to each space previously mentioned, approximately 450.amps. are required to power the entire ventilation plant.

M.V. "KOOJARRA".

ARRANGT. OF AIR CONDITIONING.



MECHANICAL VENTILATION FAN ROOM - AIR SUPPLY TO GALLEY AREAS, STORE ROOMS & WASHPLACES, ETC.

AIR-CONDITIONING FAN ROOM - CONDITIONED AIR OR MECHANICAL SUPPLY TO LIVING SPACES AND PUBLIC ROOMS.

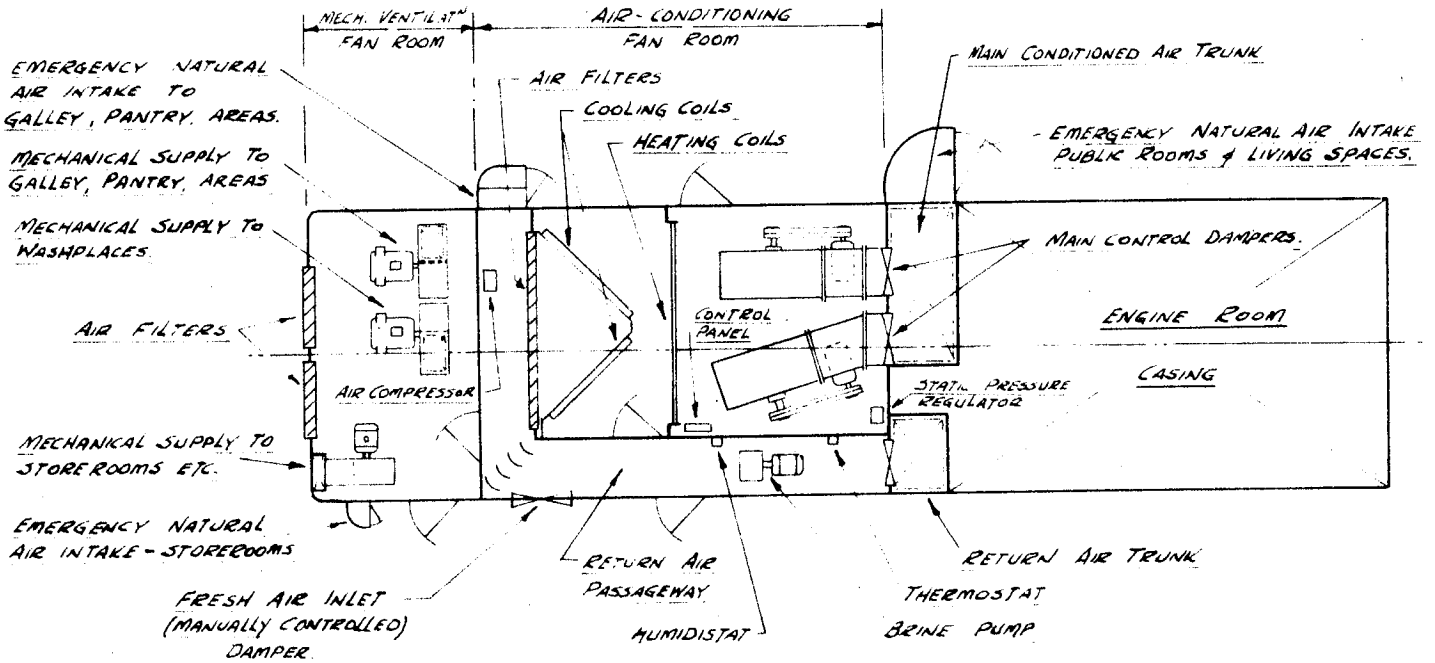
PUBLIC ROOMS - A/C AIR DISCHARGED INTO ROOMS THROUGH DIFFUSERS

CABINS AND STATEROOMS - A/C AIR DISCHARGED INTO ROOMS THROUGH 'PUNKAH' LOUVRES.

FIGURE 1.

M.V. "KOOJARRA".

ARRANGT OF FAN ROOMS.



THE FAN ROOMS ARE COMPLETELY SEPARATE.

ALL DOORS ARE OF AIR-TIGHT CONSTRUCTION.

FANS ARE OF THE VARIABLE SPEED TYPE.

AIR-CONDITIONING PLANT IS PNEUMATICALLY CONTROLLED.

EACH FAN ROOM COMPLETELY INSULATED WITH ONOZOTE.

DECK INSULATION COVERED WITH CONCRETE.

DRAINS FROM DECK SCUPPERS ADJACENT TO COOLING COILS ARE BRINE SEALED.

FIGURE 2

M.V. "KOOJARRA".

MECHANICAL VENILATION OF GALLEY & PANTRY AREAS.

ALL 'PUNKAH' LOUVRES SIZE 5" THERMOTANK.

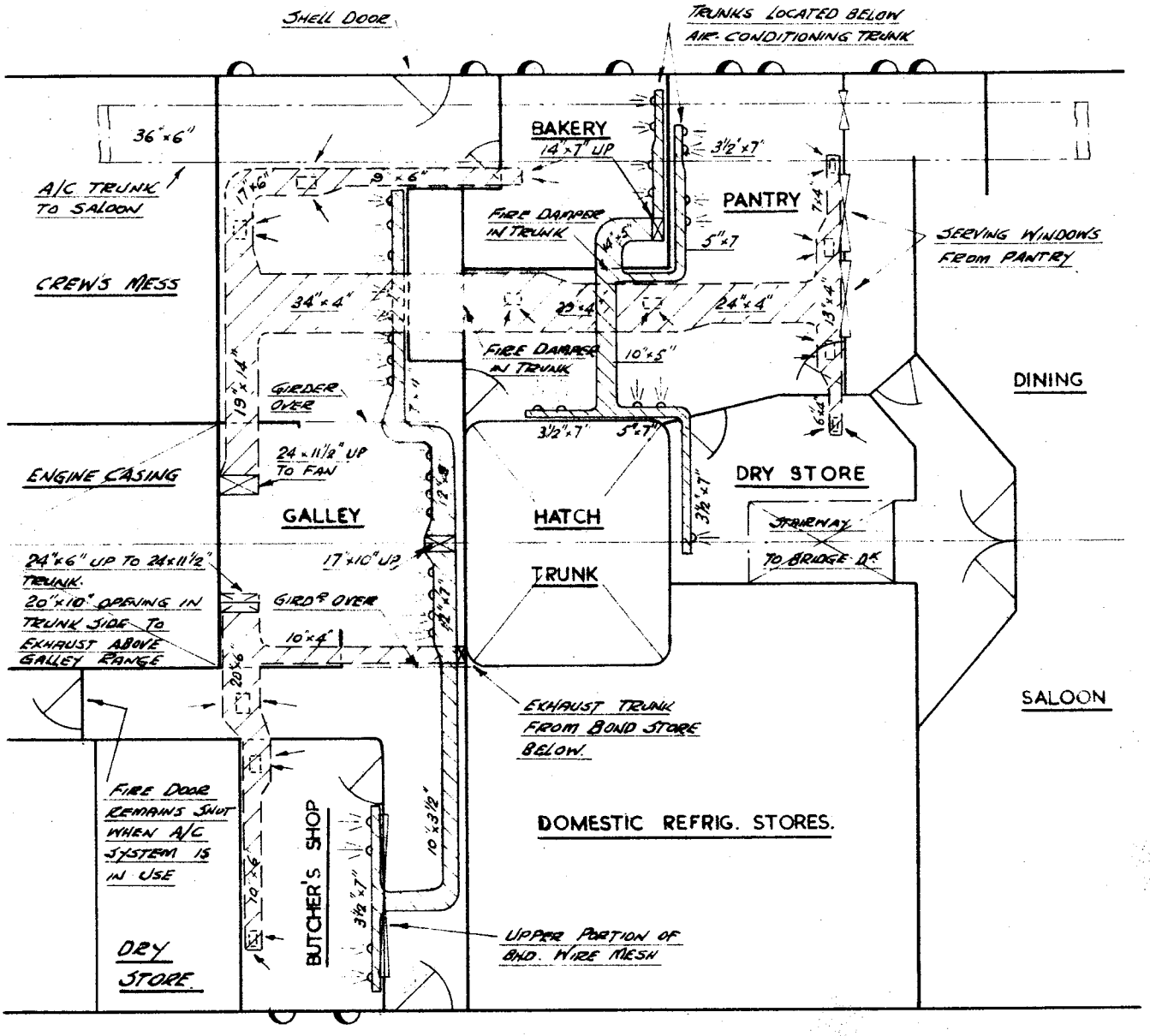


FIGURE 3.