ENGINEERING IN THE ROYAL AUSTRALIAN NAVY

PART II

BY

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This is the second part of an article compiled from a series of briefs written by R.A.N. officers presenting a compact and easily read survey of the engineering activities going on in the R.A.N. today. The first part appeared in Vol. 12, No. 2.

Since many of the items are subject to continuous change, the article should be used for general information only, details being checked before being used for official purposes.

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CURRENT CONSTRUCTION OF NEW R.A.N. SHIPS

Darings

R.N. *Darings* were designed by Admiralty for the 1944 Programme of Naval Construction.

R.A.N. *Darings* (1947 Programme) followed closely the R.N. design, general layout, and methods of construction, the exceptions being brought about by Naval Staff requirements for the war-time role of the ships, habitability requirements to suit operation in tropical zones, and some alteration in methods of construction of the main structure to suit the individual shipbuilders. They have A.C. main electrical supply systems generally similar to the A.C. *Darings* of the R.N.

The selected primary role of the ships was to give support to a Task Force with surface action with the latest anti-submarine weapons as a strong secondary consideration. To effect this it was necessary to make a major alteration to the layout of equipment on the after portion of the vessel as follows:—

(*a*) A Mortar Mk. 10 mounting and auxiliary equipment was fitted on the quarter deck in lieu of a squid mounting
(*b*) 'X' 4·5 in. mounting was moved forward 15 ft 6 in. from frame 87 to frame 84
(*c*) A new main transverse bulkhead was introduced at frame 84
(*d*) 'X' magazine and shell room were moved forward accordingly in relation to 'X' gun, causing modifications to oil fuel tanks. Two additional oil fuel tanks were arranged
(*e*) Considerable structural modification and addition under the Mortar
(*f*) After superstructure was completely re-designed
(*g*) C.R.B.F. director and power house re-sited
(*h*) Mainmast re-sited
(*j*) Whaler stowage re-sited
(*k*) Rearrangement of spaces forward to embody a mortar stabilizing compartment
(*l*) The after mounting of torpedo tubes was deleted.

Resulting from the fitting of the Mortar Mk. 10 it was necessary to alter the types of asdics.

The Gun Direction System Mk. 2 was superseded by G.D.S.2* and this together with the mortar control equipment and additional asdic equipment necessitated larger operations and asdic control rooms. The increase in the

area of these two spaces resulted in the wheelhouse being sited on the fo'c'sle deck.

To adjust the habitability standards to Australian requirements it has been necessary to make arrangements for the following :—

(1) To fit airconditioning of all accommodation spaces
(2) Replace General Messing by Cafeteria Messing
(3) Fit bed berths in lieu of hammocks.

The air conditioning system for each ship consists of six air handling units and two refrigeration centres. Each of the six air handling units are identical in layout and operation, but some differ in size and capacity. They are supplied with chilled water at a constant temperature of 50 degrees F. and are also fitted with electric heaters for heating purposes. The two refrigeration plants, one forward and one aft, have a combined duty of 900,000 B.T.U. Electric controls are fitted throughout the installation and comprise 'on' and 'off' safety controls for maintaining temperature and humidity conditions.

The cafeteria messing system is arranged with an all-electric galley fitted with a 'Bain Marie' for the fast handling of hot food to ratings who receive the food in separate utensils on a tray and not a dished tray. Adjacent to the galley is the junior ratings dining hall which serves as a recreation space and cinema during 'off duty' periods. A separate baker's oven is fitted in the after galley so that bread baking does not interfere with normal cooking routine. Senior ratings do not receive their meals at the cafeteria but are served in a separate dining room.

Separate sleeping spaces for ratings are fitted with hinged aluminium alloy bed berths in tiers of two or three, each bed being fitted with a mattress, individual reading lamp and an ash tray.

Kit lockers are fitted in the sleeping spaces. A portion of the senior ratings' sleeping spaces is fitted as a recreational space.

Miscellaneous items differing from R.N. equipment are :—

(i) The combination of main engines and boilers differs from the R.N., i.e. Foster Wheeler Boilers and English Electric Engines
(ii) The electric capstan as fitted by the R.N. was replaced by a steam capstan with structural modification to suit
(iii) Water ballasting of oil fuel tanks was introduced using the 70-ton portable pump as a ballast pump in a fixed position. Ballasting is designed to preserve the half-oil condition coincident with typhoon conditions
(iv) All accommodation spaces have been insulated with 'Insulwool' (a rock wool) in conjunction with the air conditioning of the spaces
(v) An Americal type fog generating plant has been installed in lieu of C.S.A. equipment
(vi) R.A.N. *Darings* are fitted with cathodic protection of the hull using an impressed current system and silicon iron anodes.

The methods of construction of the main structure followed closely on those generally used in the building of R.N. *Darings*. The hull was built of pre-fabricated welded units, each unit being erected separately on the skids, and then joined with the other units on the berth. The design of the units was such that each was self-jigging and self-bracing, considerable saving of time and costs being effected by the elimination of temporary stiffening and supports.

Type 12 Frigates

The R.N. Type 12 frigates were designed by the Admiralty for the 1949/50 Programme of Naval Construction, and the R.A.N. ships closely follow the R.N. design as regards construction but again they have been considerably

revised internally to suit the requirements of the Naval Staff.

These revisions embrace modifications to the armament, radar, habitability, communications and endurance under certain conditions. These in turn lead to alterations in the electrical load and the complement required for the vessels.

The R.N. Type 12 frigates ordered under the 1954/5 Programme, and known as the ' Follow-ons ', were generally similar to the earlier ones but with certain improvements incorporated. Where possible these improvements have also been made to the R.A.N. frigates.

The principal modifications made in the R.A.N. vessels have been as follows :—

Hull Side

(i) *Prefabrication.* The first R.A.N. frigates are constructed throughout mainly on the panel system although this involves more pieces than the conventional method which is being employed on the second one. This consists of forming the hull out of units up to No. 3 deck level and then using panels. Experimentation in this manner is proving very informative for Australian shipyards.

(*ii*) *Preservation.* Experiments are being made with various methods to combat corrosion. One of the vessels will have large internal areas zinc-sprayed and another will be coated with a combination of red oxide and zinc chromate primer and ' galvaniting '.

(iii) *Ballast tanks and water-tight compartments.* A ballast tank aft has been converted to carry additional fuel oil and a W.T.C. forward similarly converted. A ballast tank at the forward end of the boiler room has been removed to facilitate the siting of an additional Diesel generator. The asymetrical condition found in the first R.N. vessels will be eliminated.

(iv) *Aluminium.* Non load-bearing bulkheads in main compartments will be made of aluminium.

(v) *Fresh water system* will be re-designed as a continuous flow system with two 5-ton/hr pumps. No gravity or pressure tanks will be fitted.

Electrical

(i) The switchboard room has been re-positioned outside the boiler room.

(ii) The capacity of the steam generators has been increased from 300 to 400 kW and three Diesel generators are fitted.

(iii) Electric ranges are provided in the galleys with a separate baking oven.

Engine Room

Consideration is being given to fitting an air conditioned control room in the engine room.

Armament

Appreciable alterations to the R.N. armament are envisaged leading to differences in the radar and asdic gear with consequent modifications to compartments, etc.

Habitability

(i) A separate dining hall will be provided for leading rates and crew.

(ii) The vessels will be air-conditioned throughout.

(iii) Re-designed kit lockers will be provided and separate attaché case racks fitted.

In all, the differences listed above have led to the re-positioning of some forty compartments, the elimination of four in the original R.N. design and the addition of six new ones. This has needed a big design effort on the part of the *Constructive Section of the 3rd Naval Member's Department.*

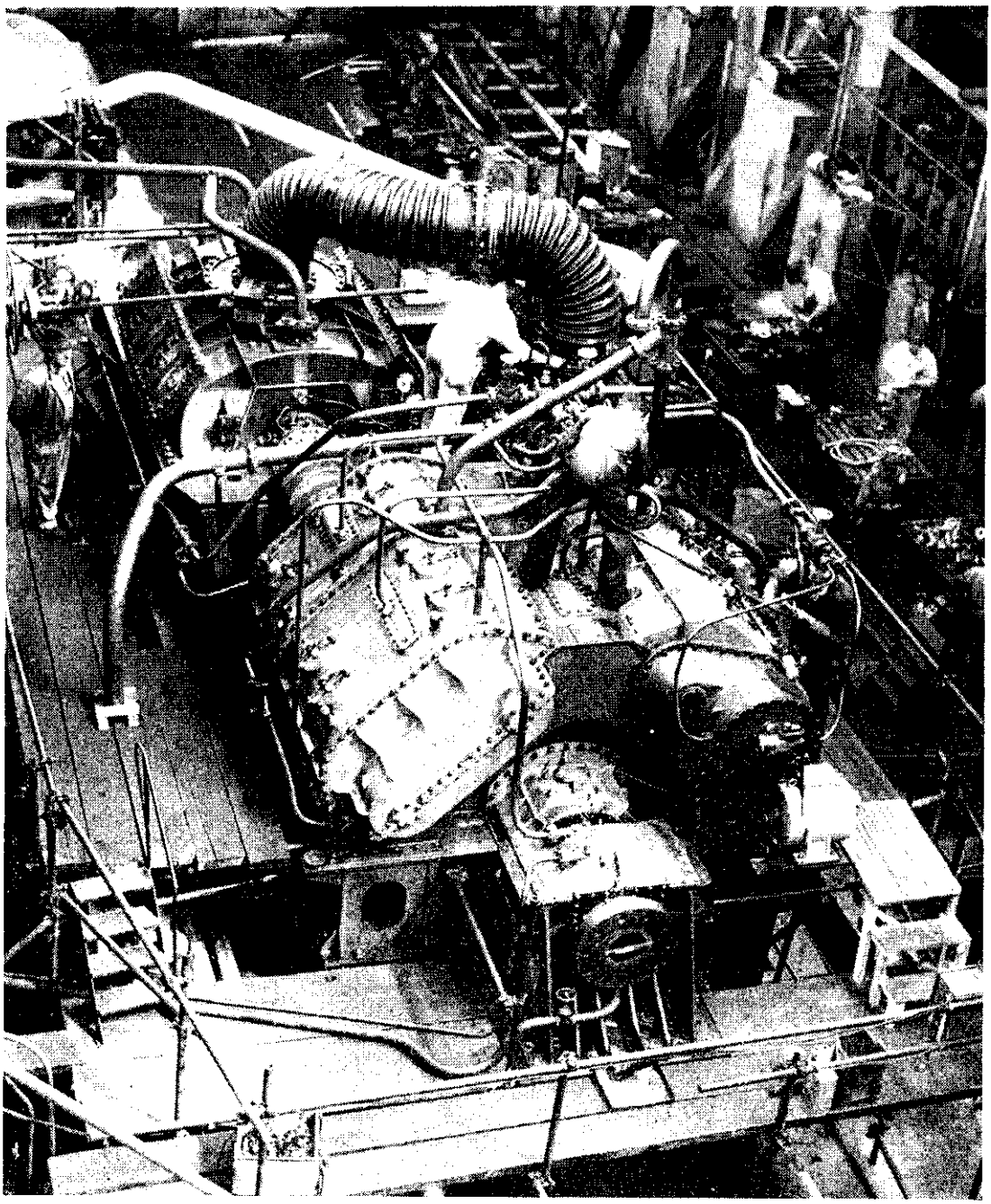

FIG. 1—SHOP TRIALS OF DARING CLASS MACHINERY AT COCKATOO ISLAND

MANUFACTURE OF MACHINERY

Turbines

Manufacture of steam turbines for naval purposes is undertaken by Cockatoo. Earlier designs made were those for the *Tribals* and *Battles* and these were built largely from locally produced components. More recently English Electric designs for the *Darings* and Type 12 frigates have been produced and present-day facilities and general 'know-how' are now sufficient to allow any modern naval turbine design to be constructed. Jigs and tools for these sets have in the main been manufactured in Australia. On completion, sets of machinery are shop tested in the usual manner.

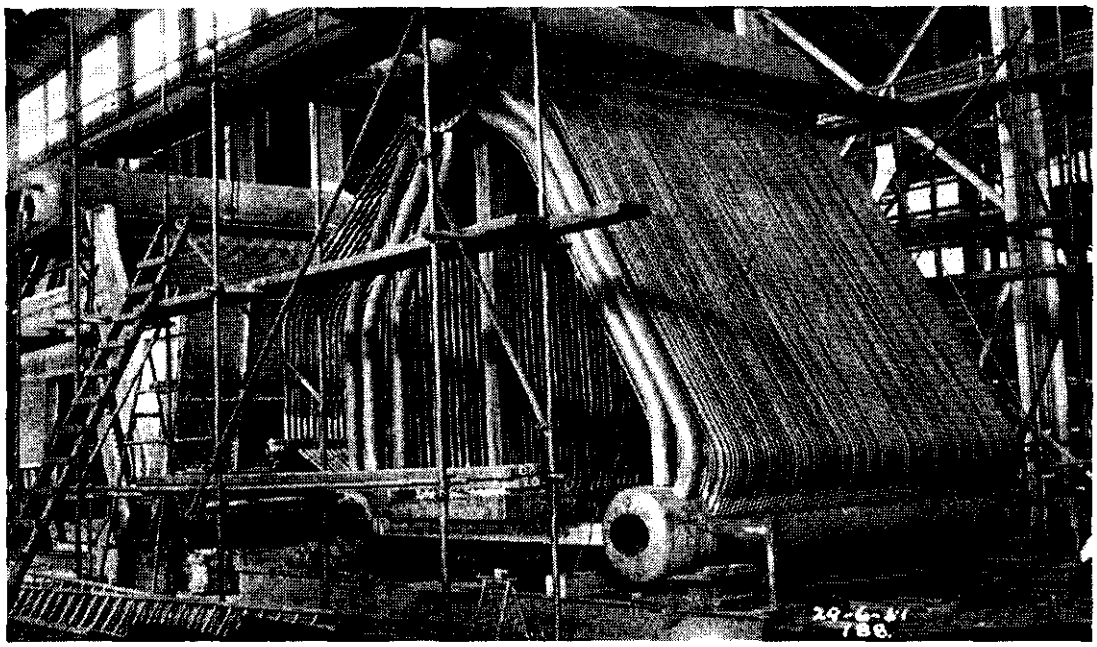

FIG. 2—ASSEMBLY OF DARING FOSTER WHEELER BOILERS AT COCKATOO ISLAND

Alloy steel rotors for the *Darings* and the earlier Type 12 frigate turbines were imported in the rough machined state from the United Kingdom. Currently, however, some Type 12 frigate rotors are being forged in Newcastle (100 miles north of Sydney) by the Commonwealth Steel Corporation using a 5,000-ton press now installed there.

Cockatoo possess a comprehensive range of Cincinnati machines for profile milling turbine blades and nozzle segments. Straight and radial broaching facilities are available for forming blade roots, and a newly installed Société Genevoise jig borer greatly simplifies many of the precision boring operations previously carried out on an older machine. A range of dynamic balancing machines ensures that all rotating components can be balanced to within the specified limits.

Boilers

In recent years *Daring* Foster Wheeler boilers and Type 12 frigate B. and W. boilers have been assembled by Cockatoo. For the former the drums were imported from the United Kingdom but in the latter instance the steam drums were welded in Australia from imported plate. It is of interest that the first H.T. steel all-welded boiler drum to be constructed in Australia was for the Y.100 project, while the water pockets were constructed from solid forgings imported from the United Kingdom in the undrilled condition.

All boiler tubes are manufactured in Australia to Admiralty Standards and B. and W. (outside Sydney) possess equipment for the manufacture of studded tubes.

Fire bricks are manufactured in Australia but owing to the type of clay available difficulty is experienced in attaining the highest standards ; nevertheless, they are proving satisfactory in service.

Gearing

Modern naval gearing sets are manufactured by the Government Ordnance Factory, situated at Bendigo, 100 miles north-west of Melbourne. Forgings for the gearing components are largely supplied from a sister establishment at Maribyrnong on the outskirts of Melbourne.

To date three *Daring* sets have been made (Fairfield design) and at present

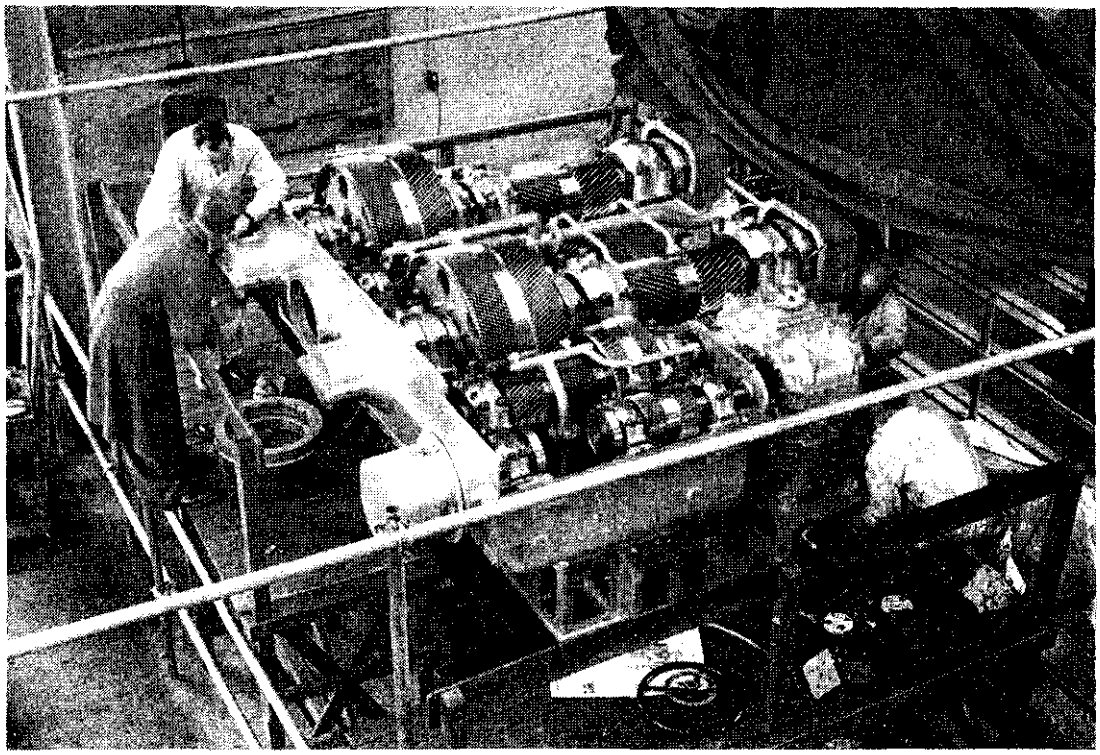

FIG. 3—MANUFACTURE AND ASSEMBLY OF TYPE 12 FRIGATE GEARING AT BENDIGO ORDNANCE FACTORY

manufacture is in hand of the David Brown Mk. II design for the Type 12 frigates. The only imported items being used are thin wall bearings (by Glacier) and certain specialized instruments such as remote reading thermometers, etc.

The section of the factory devoted to gear manufacture is well equipped and fitted with air-conditioning—it is capable of production of gearing to the Grade A standard.

A large (MH.100) David Brown hobbing machine was commissioned a couple of years ago and M.A.A.G. pinion grinding facilities are available although no provision has yet been made for a bull wheel grinding machine.

Auxiliary Machinery

Weir's, Drysdale's and Allen's auxiliaries are all made under licence by the 'Federated British Engineers Co.' in Sydney.

The majority of the auxiliaries for the *Darings* were imported from the United Kingdom but in the case of the Type 12 frigates now building, a proportion will be supplied by F.B.E.

Miscellaneous

Pipes. All requirements are normally met by British Tube Mills of Adelaide, or Stewards and Lloyds, Newcastle (N.S.W.). Some of the larger sizes of alloy steel pipes are more economically imported when only required in small quantities.

Valves. Some special valves are imported in view of the small numbers required but all requirements of standard forges and cast steel can be met from local sources. M. B. Johns and Co. at Ballarat (Vic.) and Codock (Sydney) are the principal suppliers.

Condenser tubes. All R.A.N. requirements are met by Metal Manufacturers Ltd., Pt. Kembla (N.S.W.), who also supply all other non-ferrous tubing.

Steel forgings. Comsteel (Commonwealth Steel Corporation at Newcastle, N.S.W.) supply the majority of R.A.N. requirements including all propeller

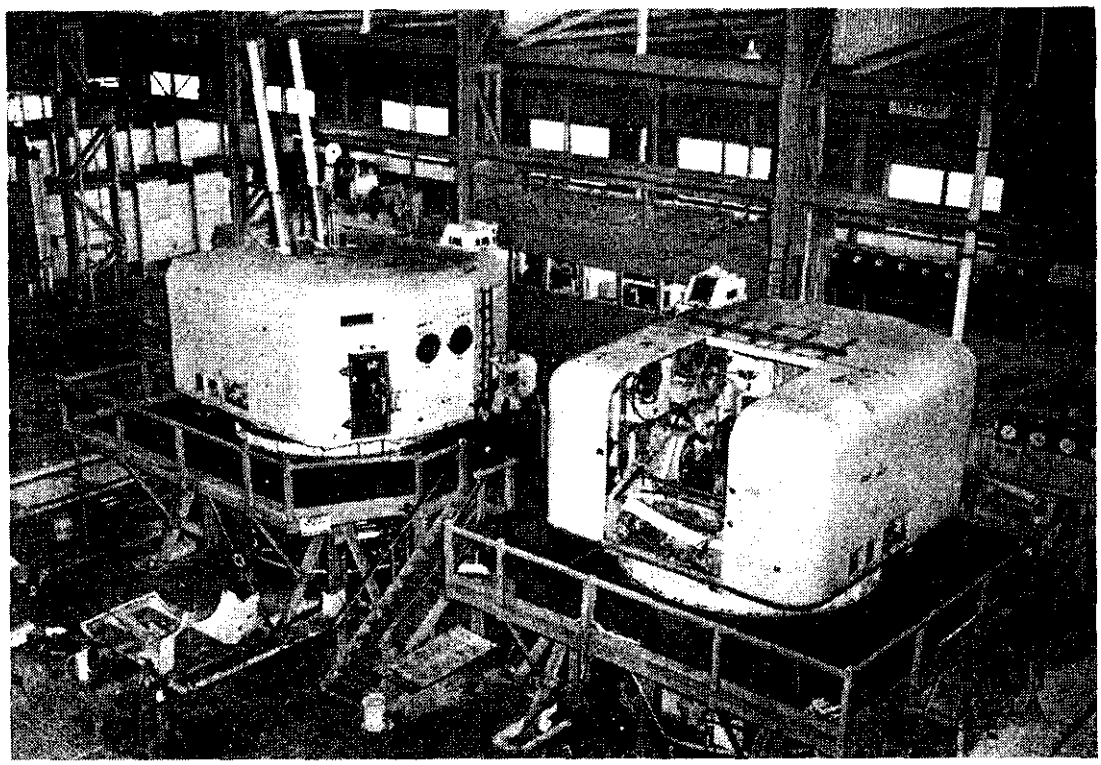

FIG. 4.—PRODUCTION OF 4·5-INCH GUN MOUNTINGS AT BENDIGO ORDNANCE FACTORY

shafting which is subsequently hollow bored by Codock.

The Government Ordnance Factory at Maribyrnong provide quite a few forgings, particularly alloy steel ones for gearing pinions and other elements.

MANUFACTURE OF NAVAL ARMAMENT EQUIPMENT

Bendigo

The Ordnance Factory is located on the outskirts of the city, which is one of the principal inland cities of Victoria and is approximately 100 miles from Melbourne. The majority of work undertaken on behalf of the Navy is the production of 4·5 mountings and marine gearing.

The shops are well laid out and the equipment is modern and has a capacity for very large items. The 4·5 gun mountings are fabricated and fully tested at the factory with the exception of firing trials. The factory also has an excellent metrology section. All forgings used at Bendigo are supplied by the Ordnance Factory at Maribyrnong.

Maribyrnong

The Ordnance Factory is situated near the Maribyrnong River on the northern side of the Yarra. It is in an industrial area approximately eight miles from Melbourne. It is in close proximity to the Defence Research Laboratory. The major portion of work undertaken on behalf of the Navy is for forgings for gearing, manufacture of Staag mountings, torpedo tubes, A/S mortars, plane converters and stabilizers, re-conditioning of tachometric boxes, radar sets, etc. As at Bendigo the shops are well equipped and airy.

Maribyrnong is capable of a very large output when required and works in close co-operation with Bendigo in the supply of forgings, etc., and the standard of workmanship is good.

Torpedo Establishment

The Royal Australian Naval Torpedo Establishment is situated on the shores of Neutral Bay, in Sydney Harbour, near the northern end of the Sydney Harbour Bridge. The establishment was built by the Commonwealth Government during the last war and was completed in early 1943.

The Superintendent is a naval captain who is responsible to the Director of Ordnance and Underwater Weapons, who in turn is responsible to the Naval Board. Inspection is carried out by a resident ordnance inspecting officer, who is responsible through the Inspector of Naval Ordnance to the Naval Board.

During peace-time, approximately 300 people are employed on one shift and this can be increased during emergencies to 1,500 men and women in three shifts. The establishment is self-administered having its own design and planning, secretariat, supply and manufacturing sections.

The main function of the Torpedo Establishment is to manufacture and service torpedoes and other naval equipment for the R.A.N. and other British Commonwealth Governments. During the war 18-inch Mk. 15 torpedoes were made and other servicing work carried out. Since the war 21-inch Mk. 9* torpedoes have been produced and at present electrically driven torpedoes are being made.

MANUFACTURE OF ELECTRICAL AND RADIO EQUIPMENT

General

The electrical and radio industry in Australia has developed continuously and the expansion has been accelerated by the recent introduction of television services.

During the 1939–1945 War, a very wide range of electrical and radio equipment was made in Australia for the R.A.N. For example, all such items required for the sixty O.M.S. vessels built in the period, were made in Australia, including steam engine and Diesel engine driven generating sets, motors and control gear for ventilating fans, pumps, refrigerators, etc., electric cables, breakers, switchboards, junction boxes, lighting fittings, incandescent lamps, signalling and searchlight projectors, wireless transmitters and receivers, radar sets, cooking and heating equipment.

Similarly, a large proportion of the electrical and radio items for the eight A/S frigates and four A.A./A.S. frigates built during the war was made in Australia.

Ship construction programmes since the war have provided for small numbers of ships of any one class. Production of small quantities of the very wide range of special electrical and radio items to meet naval requirements, including ability to withstand severe shock and vibration, high ambient temperatures and relative humidities, has reduced the amount of these items which can be economically manufactured in Australia in peace-time.

Electrical Equipment

Electrical equipment being made in Australia for R.A.N. Type 12 frigates includes A.C. motors and control gear for ventilating fans, refrigerators, air-conditioning plant, domestic machinery, pumps and other auxiliary machines, fuse panels, lighting fittings, incandescent lamps, cooking and heating equipment, cinema projectors, etc.

Many of the manufacturing firms in the United Kingdom who make equipment for the R.N. are affiliated with firms in the Australian electrical industry. Some Australian firms are connected with firms in the U.S.A. Hence know-how and design data are usually available and the main limitation to production of electrical equipment for the R.A.N. in Australia is the relatively small production runs.

Radio Equipment

In peace-time the manufacture in Australia of radio equipment for the R.A.N. is also limited by the relatively small production runs. Communications equipment currently being made include MF/HF L.P. transmitters and receivers, U.H.F. radio automatic teletype terminal apparatus, MF/HF radio automatic teletype outfits, tape recorders, panoramic radio adaptors, MF/HF S.S.B. transmitters and receivers for shore establishments, VHF telegraph link equipment, etc.

As in the electrical industry, many of the firms manufacturing radio equipment in Australia are associated with large organizations in the industry in the United Kingdom and/or the U.S.A. and, in consequence, technical knowledge would be available if circumstances warranted production in Australia of equipment for the R.A.N.

WEAPONS TEST FACILITIES IN AUSTRALIA

Weapons Research Establishment, Woomera and Salisbury

The Weapons Research Establishments were set up to provide facilities for testing and to co-operate in research and development on guided weapons. The projects in the main are initiated in the United Kingdom and the primary contribution of Australia is the provision of the facilities for testing the weapons in the various stages of development and analysing the test data. To perform these tests much preliminary testing is necessary and extensive supporting facilities are required. These are set up at Salisbury, just outside Adelaide.

The laboratories are on the site, seven square miles in area, which was used originally for an explosives establishment.

The policy has been to locate as many facilities as possible in Salisbury to keep to a minimum the number of people required in the costly environment of Woomera.

Trials and Instrumentation Wing

The work done under the joint project at Salisbury falls generally under four headings, namely Trials and Instrumentation, Engineering, Administration, and Air Support (Royal Australian Air Force). The Trials and Instrumentation Wing deals with the planning and execution of the trials which take place at the range and the reduction of recorded data. They are also concerned with the planning and development of the ranges and data reduction facilities to meet the forecast trials programmes.

Research and development in connection with the latter is carried out in the fields of instrumentation, data reduction and computation, systems assessment, weapons recovery techniques and target aircraft.

The Engineering Group administers the drawing office and industrial section of the establishment. The Engineering Group is also responsible for the provision of facilities at Woomera.

The air support is provided by a unit of the Royal Australian Air Force at Edinburgh Airfield which was built for the purpose at Salisbury. Air operations are also constructed from airfields at Woomera. The R.A.A.F. unit, besides being responsible for all the flying facilities for weapon trials, operates the Jindivik pilotless target aircraft.

Situated within the technical area of the Salisbury Establishment are the buildings for accommodating the representatives in Australia of the United Kingdom industrial firms engaged in the development of guided weapons and components. From these firms flow the prepared test vehicles and weapons to be test flown at the ranges. Weapons or component parts and various items of associated equipment and apparatus are brought to Edinburgh Airfield or Port Adelaide from the United Kingdom and thence to the firms' workshops at Salisbury for assembly. At a later stage they are transported to Woomera by aircraft or truck, where the firms have further facilities for pre-flight checking and preparation for firing.

FIG. 5—MARALINGA VILLAGE

Joint Services Trials Units

Also situated at Salisbury are the headquarters of the Joint Services Trials Units. These are composite units which may comprise Royal Navy, British Army and Royal Air Force officers and men whose purpose is to carry out Service acceptance trials of certain weapons.

These units have complete service type-testing facilities at Salisbury and are solely responsible for the preparation and firing of Service Acceptance missiles.

Woomera and the Ranges

Construction at Woomera began in 1947 and is continuing.

The main elements are : the Village, the Technical Area, the Main Weapons Range, the Air Range and minor ranges and services. The technical area is located about four miles north of the village. Directly alongside the technical area is the Woomera airfield which is the terminal for Air Services from Salisbury and the R.A.A.F. base for the area.

The technical area includes the administration building, main technical building, project hangar, power house, workshops, stores, etc.

On the airfield are two hangars for servicing and maintenance of aircraft, air radio equipment and an air transport terminal. Storage and explosives, fuels and oxidants have been provided in two separate areas nearby.

The main weapons range is about twenty-five miles northwest of Woomera, at Koolymilka.

The line of fire extends north-westerly overland for a distance of 1,250 miles and could be further extended over the sea if required. Observation posts are to be established toward the end of the overland range in connection with the trials of ballistic missiles.

Facilities at the range include the launching aprons, with associated equipment centres and test posts for the final checking immediately prior to launching and behind the apron, test shops for preparation and checking of weapons after arrival from Salisbury and prior to delivery to the launchers, oxidant and fuel filling posts, boost fitting shops, storage for a number of rounds and boosts,

and a large central instrumentation building housing the main control, communications and recording equipment for trials.

About two miles to the north is Evett's Field from which target aircraft are flown as required.

There is also a short missile range which is now unused. Buildings and equipment are maintained in case of future requirements. Equipment on loan from the U.S.A. for tracking satellites is sited here. There is an air range at Lake Hart, a large dry salt lake fifteen miles long and six miles wide.

Facilities also exist for bomb ballistic trials.

Woomera village provides all the facilities normally available in a modern township. There are 500 houses and six blocks of flats are under construction. Single quarters for men and women are also available and further accommodation is being erected.

Messes for officer, N.C.O. and other rank grades are provided. A post office, hospital, a theatre, a community shopping centre, a fire station, a police station and courthouse cater for civic facilities. In addition, there are three churches and two schools.

Sporting facilities cater for swimming, football, cricket, tennis, basketball, baseball, golf and shooting.

A permanent water supply is provided by 100 miles of pipeline which taps the Morgan-Whyalla pipeline near Port Augusta. In addition to a daily air service from Adelaide, Woomera is also connected by road and rail to Adelaide

The Maralinga Atomic Weapons Proving Ground

Australia is the only country in the 'British World' which has adequate empty space for testing atomic weapons. In choosing a suitable site it was required to find one which, apart from other considerations, would assure a reasonable standard of effort and hygiene.

The first atomic weapons trial in the Australian mainland took place at Emu Field, over a hundred miles to the north of the present site, in 1953. The preparations for and execution of this trial, which was almost entirely supported by air, proved a tremendous burden.

The Maralinga site was selected mainly because the Transcontinental Railway provided a rail head (Watson) within fifty miles of the range itself and the area satisfied the paramount safety factors. Maralinga village is sited in the vicinity of a plateau named Tietkin's Plain, named after William Henry Tietkin, a noted South Australian explorer of the 19th century. It is on high ground 900 feet above sea level and for interest is 700 miles from the nearest big town, Adelaide, and 900 miles from Perth. Limestone rock is available for civil engineering purposes but there is no fresh water at all.

As a result the site is very akin to that of a ship on a sea of red sand and salt bush and surrounded by lots of widely spaced stunted trees. The temperature varies from 126 degrees F. in the summer to 27 degrees F. in the winter, and frequently accompanied by strong winds containing fine powdery sand. However, even after the most blistering hot day some relief can be expected in the evening from a southerly wind and night temperatures are not oppressive. The rainfall in the area averages five inches per year.

The engineering problems in building a village, roads and an airfield in an uninhabited village 800 miles from the nearest port can be imagined. During the construction phase fresh water requirement of 100,000 gallons a week was brought in by rail for many months. At present the village itself has accommodation for a permanent force of nearly 1,000 and can cope with nearly 2,000 for short periods.

The living quarters are by Bristol or Wiles prefabricated buildings and provide separate rooms for officers and two to four ratings per room. S.M.D.

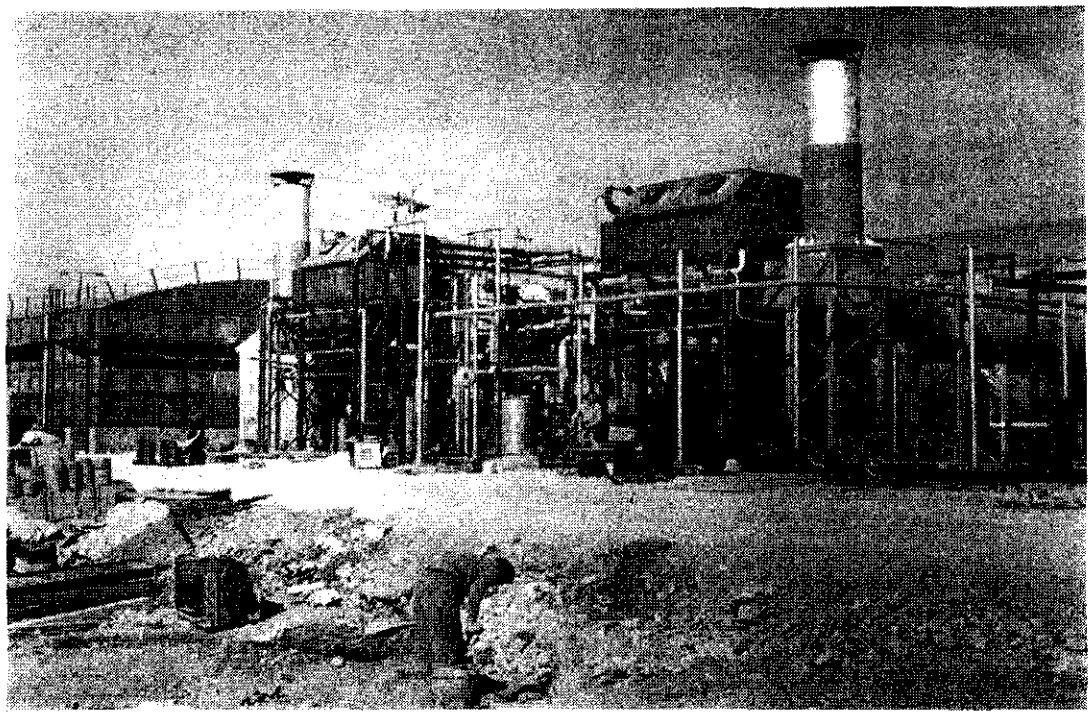

FIG. 6—WASTE HEAT BOILERS, MARALINGA

(Hawkesley Industries) buildings are used for offices, workshops and laboratories.

Maralinga differs from Woomera in that it is not so permanent in conception. Piped water is not available and no accommodation for women is provided. As a result shopping areas, churches, schools, etc., are non-existent. Nevertheless, the recreational facilities include tennis courts, swimming pool, and cinema. The food is excellent and so are the canteen services. Wet canteen provides a good supply of beer at 4s. (Australian) a small bottle.

To meet the power requirements a power station of 2,000 kVA capacity with 500 kVA reserve was built. The prime movers for the main generators are Ruston and Hornsby gas turbines, the first to be installed in Australia. The waste heat from these turbines is used in boilers to supply steam to evaporating plants which produce fresh water from the raw bore water obtained from a score or more bores around the site. In addition, a sizable sewerage plant is provided and the clear effluent from this is used as cooking water for the steam installation.

The whole of the installation mentioned above is maintained by the naval contingent at Maralinga. They are also responsible for a large number of "field" Diesel generator plants in remote areas around the range and for the electrical distribution lines which are carried on 60-ft high posts at a voltage of 6,000 v.

The entire set-up is administered by a range commandant, an Australian Army officer, who is responsible for a heterogeneous collection of six Service contingents mostly mixed United Kingdom and Australian. The naval contingent is of mixed composition with an engineer and electrical officer (one of whom at least is a Lt.-Cdr.) the senior one of which is in charge be he Australian or R.N. For disciplinary purposes all R.N. personnel at Maralinga are treated as if they were R.A.N. and this works extremely well. Excellent co-operation and friendship exists between the R.N. and the R.A.N. personnel.

The airfield has been designed to take the heaviest aircraft likely to be in service and has all the normal airfield facilities.

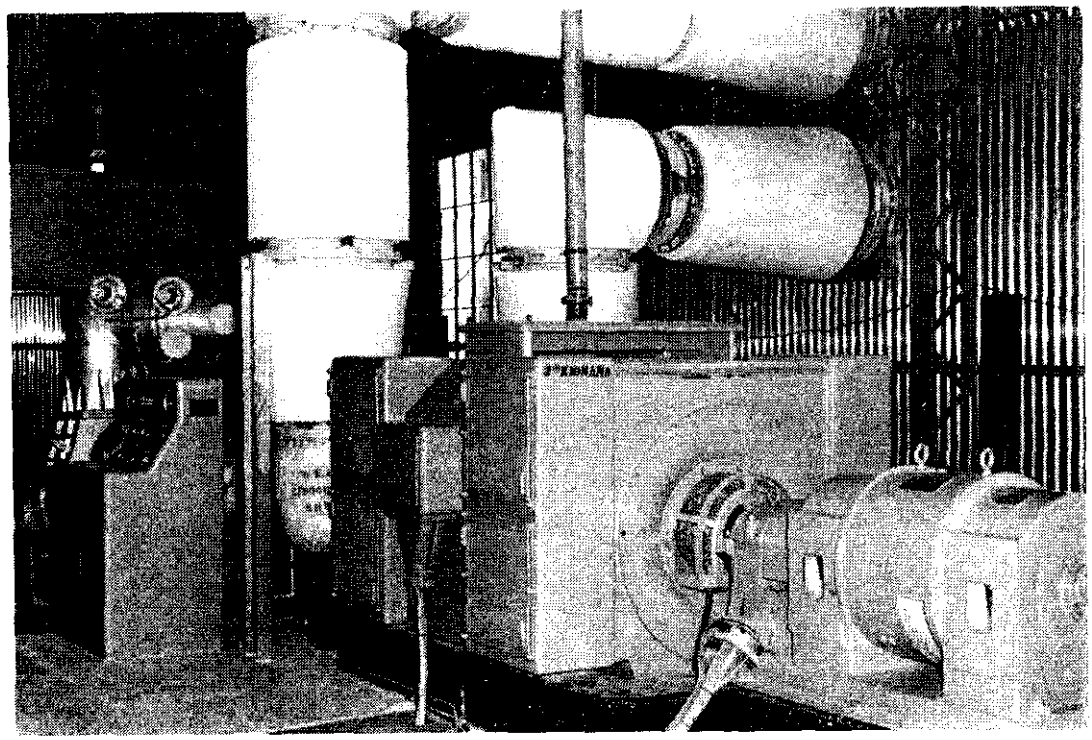

FIG. 7—GAS TURBINE GENERATING PLANT, MARALINGA

Eighty miles of bitumen road and 200 miles of graded tracks have been built in the area. An instrumentation area some fifteen miles north of the village centralizes all communications and metering for trials and from here the range proper fans out northwards.

Maralinga Range has been sited, laid out and equipped, together with an elaborate meteorological network to gain the maximum information from tests, both of weapons and other devices within a certain limited range of size and in circumstances where safety to all can be assured. An important feature of the test ground is the opportunity offered to the Armed Services and Civil Defence to gain practical experience of the problems which this new threat has created and to devise means to meet and mitigate its impact should it ever be used against us.

Torpedo Range (Sydney)

The Torpedo Range is situated at Taylor's Point on Pittwater, near the entrance to Broken Bay. It is twenty-five miles from the Torpedo Establishment itself and is under the control of a range officer (Lt. or Lt.-Cdr.) who is responsible to the Superintendent.

The range consists of a workshop building (170 ft × 90 ft) for the preparation of torpedoes, a 700-ft jetty connecting the workshop to the firing point and the running range itself on which three targets are moored at 1,000-yard intervals, giving a total distance of approximately 3,300 yards. After running, the torpedoes are recovered by 35-foot motor launches.

Recently submarines have also carried out firing exercises off the entrance to Broken Bay, approximately six miles from the Torpedo Range, which supplies boats, etc., for recovery and also performs post range overhauls.

FLEET AIR ARM

History

H.M.A.S. *Albatross*, the R.A.N. Fleet Air Arm shore base at Nowra, 100 miles south of Sydney, was commissioned on 31st October, 1948. It had

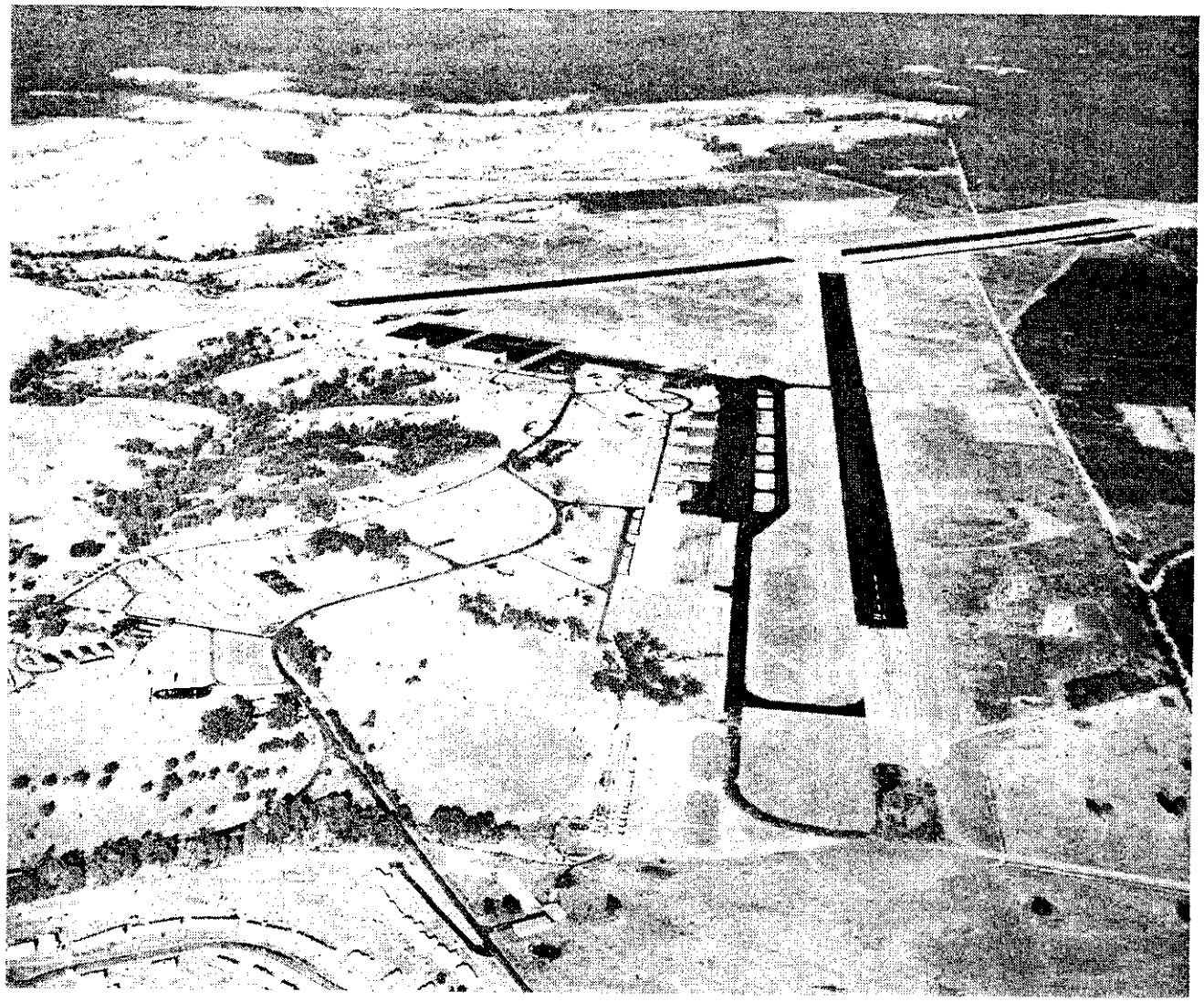

FIG. 8—AERIAL VIEW OF H.M.A.S. 'ALBATROSS'

previously been used by the Royal Australian Air Force and the Royal Navy but had fallen into disuse with the cessation of hostilities. Renovation of the buildings and runways was commenced in December, 1947, and R.A.N.A.S. Nowra received her first operational aircraft when the 20th Carrier Air Group disembarked from the light fleet carrier H.M.A.S. *Sydney* in June, 1949.

The squadrons of the C.A.G. were 805 which was equipped with 12 Sea Fury FB11s and 816 comprising 12 Firefly FR5s.

In November, 1950, the 21st Carrier Air Group arrived from the United Kingdom in *Sydney*.

During the Korean war a composite group from the 20th and 21st C.A.G.s formed the *Sydney* Air Group and saw active service in the United Nations force in the area.

In 1952, the first Sycamore helicopters arrived at N.A.S. Nowra and during 1954 the now familiar scream of jet engines disturbed the peaceful south coast when Australian-built de Haviland Vampire trainers were obtained.

The R.A.N. carrier, H.M.A.S. *Melbourne*, which has an interim angled deck, steam catapult and mirror landing aids, disembarked to N.A.S. Nowra in May, 1956, Sea Vemon F.A.W. 53 and Gannet AS1 aircraft belonging to the re-equipped 808, 816 and 817 Squadrons.

The resident squadrons at the Air Station are :—

723 Squadron with Sycamores

724 Squadron, a jet conversion unit, equipped with Sea Venom and Vampires

725 Squadron, a Gannet conversion, communication and Fleet Requirement Squadron, equipped with Gannets AS.I.s and T.2.s, Austers and Dakota aircraft and using Sea Furies and Fireflys as target tugs.

Aircraft Maintenance

H.M.A.S. *Albatross* provides all the usual repair and maintenance facilities associated with a large air station. In addition to a number of small hangars, inherited from the R.A.A.F., recent construction has provided four major hangars, each capable of housing about twenty-four aircraft of present naval specifications. Two of these hangars are designated for immediate flying commitments and the other for repair backing. The repair hangars are well equipped with several sets of 5-ton overhead lifting tackle, electrically operated and numerous pneumatic and electrical floating points for hand tools. An annexe to one of the repair hangars provides for engine and starter servicing.

Subsidiary to these facilities is a machine shop and a sheet metal shop with equipment for all normal machining tasks, heat treatment, welding and metal fabrication.

The Air Engineer Officer also controls an air ordnance section, with carrier, gun and ejection seat workshops, a large-scale avgas and avtur installation and twenty re-fuelling vehicles, the Station transport maintenance pool of some 120 vehicles, and a salvage section equipped with heavy rescue vehicles including 20-ton Coles cranes and tracked bush recovery vehicles.

Administration of the Air Engineering organization is on a centralized basis. Centralized maintenance as distinct from squadron maintenance, was introduced at Nowra in mid-1956 in order to effect a more efficient utilization of the maintenance man-power available at that time.

First line servicing, up to and including 'maincheck 3' inspections, is carried out by the Maintenance Unit (M.U.), while a line unit undertakes all flying commitments and between flight servicing.

Unserviceability and minor repairs estimated to take longer than 48 hours to rectify, are transferred to the Long Term Maintenance Unit (L.T.M.U.),

which also undertakes all ' maincheck 4 and 5 ' inspections. Major repairs and engine changes go to the Major Repair Section (M.R.S.), which also includes the engine and starter servicing bays. Periodic maintenance is carried out generally in conformity to current R.N. instructions and publications. Although strong arguments may be used against centralized maintenance, at Nowra such a scheme is working and producing aircraft to meet the flying task with 15 per cent less man-power than that required under the squadron system.

The centralizing of maintenance in the *Melbourne* Air Group was deferred until mid-1957 but, since that date, the carrier has undertaken two major cruises and one minor one, with similar results to those at Nowra.

Civilian Repair Organizations

The R.A.N. does not have a naval aircraft repair yard and modernization, reconditioning and major repair of airetaft is undertaken by civilian contractors.

In most cases an Australian subsidiary of the manufacturers of the original equipment is the contractor. This proves satisfactory as each firm has close ties with its parent company in the United Kingdom and can thus be assisted in the solution of technical problems which arise.

The main contractors are all situated in the Sydney area, naval control of the work being carried out through the Naval Air Engineer Overseer and his staff. The N.A.E.O. ensures that the requirements of the Director of Aircraft Maintenance and Repair are faithfully met by the civilian firm.

The firms maintain adequate technical staff for the progressing of work, development of local modifications and carrying out technical investigations as required. A resident naval technical officer maintains the necessary technical liaison between D.A.M.R. and the contractors.

To avoid unnecessary duplication of inspection by inspection staff, naval work is inspected to the requirements of D.A.M.R. by officers of the Aeronautical Inspection Directorate, Department of Air.

Procurement and Supply of Air Stores

The overseas provisioning of air stores, in particular ' type ' spares, is processed through and arranged by the Director of Naval and Air Stores at Navy Office, Melbourne. There is, however, a considerable measure of local provisioning mainly in respect of oils, fuels, paints, raw materials and some A.G.S. parts. The main Air Stores Depot is at Randwick, N.S.W., which is approximately seven miles from the harbour wharves. Employed at the Store Depot are permanent A.I.D. staff who in addition to inspecting items on receipt carry out a continuous shelf inspection.

The Naval Staff Officer (Air) in charge of the Stores Depot is also responsible for the maintenance of Embodiment Loan stocks and the processing of major spares requiring repair by a civilian repair organization.

The Directorate of Aircraft Maintenance and Repair is situated in Navy Office, Melbourne. Responsible to a director of captain's rank are technical, air equipment and personnel sections under uniformed officers, but with staffs of civilian engineers and technical officers.

The Naval Air Engineer Overseer is based in Sydney, with his own staff, but is directly responsible to and part of the staff of D.A.M.R.

Rating Structure

The rating structure of the R.A.N. Fleet Air Arm closely follows that of the R.N.

New entry disciplinary training of thirteen weeks is carried out at Flinders Naval Depot, Crib Point, Victoria, followed by technical training at the School of Aircraft Maintenance, Nowra, N.S.W.

The engagement period is for nine years and the shore/sea billet ratio is approximately 4 : 1.

Training of Maintenance Ratings

The School of Aircraft Maintenance Engineering was established at Nowra in 1950 and subsequently moved to H.M.A.S. *Nirimba* at Schofields, near Sydney, in 1952. When Schofields was paid off as a naval air station the School returned at Nowra where it was re-established early in 1955.

Two hangars, divided into classrooms and housing instructional aids, provide the main classroom accommodation and an instructional cinema and workshop adjoin. The workshop houses a comprehensive range of machine tools and equipment for practical workshop training.

The Officer in charge of S.A.M.(E) is of lieutenant-commander's rank and has three officers as assistants. The instructional staff is made up of 18 aircraft artificers and air mechanicians and 15 chief and petty officers. An average of 70 ratings are under training at the school. In addition to entry basic training the School also conducts ratings' advancement courses for (A), (E) and (O) trades as well as 'type' courses. Air mechanicians A/E and air mechanicians (O) are also trained. The Air Mechanician Course of 88 weeks is based on the R.N. syllabus.

Apprentice Training

The R.A.N. Apprentice Training Establishment at H.M.A.S. *Nirimba* is training a small number of aircraft artificer apprentices for the R.A.N. Fleet Air Arm.

These apprentices complete three years' instruction at the R.A.N.A.T.E. and will undertake their final year of training at the S.A.M.(E), Nowra, where emphasis will be on the types of aircraft in current front line service.

The first naval trained aircraft artificers completed their apprenticeship and became 5th class A.A.s in July, 1960.

R.A.N. Aircraft Maintenance Examination Board

The standards of this Board are equivalent to N.A.M.E.B. in the United Kingdom.

Boards are convened as required using suitable officers from Nowra. The Deputy Director of Aircraft Maintenance and Repair, Navy Office, Melbourne, is the permanent President of R.A.N.A.M.E.B. The staff consists of one Special Duties List engineer officer (A/E), two chief aircraft artificers (A/E), one chief aircraft artificer (O), and one air engineer officer's writer.

To provide greater independance and integrity, R.A.N.A.M.E.B. is administered by the Naval Board as part of the Directorate of Aircraft Maintenance and Repair.

Although at the present time the major active units of the Fleet Air Arm consist only of H.M.A.S. *Melbourne* and R.A.N.A.S. Nowra (H.M.A.S. *Sydney* paid off into reserve in May, 1958), the flying intensity and small number of accidents bear witness to the efficiency and skills of the Air Engineering organization.

RESEARCH AND DEVELOPMENT AND ASSISTANCE TO THE R.A.N. ON SCIENTIFIC MATTERS

General

As a rule the R.A.N. derives most of its technical and scientific knowledge from R.N. sources. However, a nucleus of scientific personnel has been established under the Director of Scientific Services with the assistance of officers of the R.N.S.S. loaned by the Admiralty, and locally recruited personnel who are being trained at Admiralty research establishments in the United Kingdom. In addition to the above the R.A.N. is fortunate in being able to call upon certain outside organizations for specialized assistance from time to time ; these are referred to below. From the financial angle the R.A.N. has a R. and D.

vote to cover such expenditure. When work is done by an outside agency such as C.S.I.R.O., and is sponsored by the R.A.N. then this automatically becomes the financial responsibility of the Service.

Nevertheless, in the case of the laboratories associated with the Department of Supply the latter usually accepts financial liability except where special equipment or stores require to be procured for the project.

The R.A.N. have recently established a research laboratory at Sydney, and a converted boom working vessel has been equipped as a sea-going research vessel in connection with the current programme of hydrographic investigation.

Commonwealth Scientific and Industrial Research Organization

This large organization possesses powerful scientific resources which could be made available to the R.A.N. in emergency. At present the problems of marine fouling, being closely associated with that of marine biology, have provided a field of common interest and the C.S.I.R.O. have a biologist at Cronulla (just south of Sydney), who is subsidized by the R.A.N. in support of his work on fouling organizations. The National Physical Laboratory established by the C.S.I.R.O. within the grounds of Sydney University, provides the know-how and ability to produce complex instrumentation when approached by the R.A.N. and this has proved extremely valuable.

Defence Standards Laboratories

These laboratories come under the aegis of the Department of Supply and comprise a main establishment at Maribyrnong (outside Melbourne), and branch establishments at Alexandria (N.S.W.) and Finsbury (South Australia).

At Maribyrnong the organization is divided into four divisions, namely Materials and Explosives, Metallurgy and Engineering, Physics, and Protective Chemistry. The branches are chiefly organized for work in the fields of chemistry and metallurgy.

The broad function of the D.S.L. is the application of scientific knowledge and research to the problems arising in design, development, manufacture, inspection, storage and use of defence material. In particular consultative service is given to the Department of Supply and the three Services. Apart from routine checking of materials for Service use the D.S.L. undertake a lot of work for the R.A.N., but this understandably is restricted to that of the highest priority.

Aeronautical Research Laboratory

Again under the Department of Supply and situated at Fisherman's Bend in Melbourne, these laboratories are organized in four main scientific divisions, viz. :—Aerodynamics, Mechanical Engineering, Structures, and Materials.

Their terms of reference are naturally extensive and in the main they cover all aspects of aircraft, missiles, propulsion methods and so on.

They act as consultants and conduct investigations for government departments, semi-government agencies, and private industry when such work requires the special facilities or resources which exist only at the A.R.L.

Their resources have been put to good use by the Service and have recently been used in solving problems associated with towing the S.A.A.B. Anti-Aircraft Target Near Miss Indicator.