NAVAL ENGINEERING IN AUSTRALIA

by

ENGINEER CAPTAIN G. I. D. HUTCHESON, B.E., R.A.N.

General

The Engineering Branch of the Royal Australian Navy is organised on similar lines to the Engineering Branch of the Royal Navy, but for various reasons (such as the smaller service, obtaining of basic designs from Britain, etc.) it has been found possible to allocate to it duties usually undertaken by other Branches.

In the central administration at Navy Office, Melbourne, and in the dockyards and shipyards generally, the Engineering and Construction Branch, which (within the general Administration and Command) is under the direction of Engineer Officers, is responsible for all ship construction and ship repair and maintenance—hull, engineering and electrical.

In H.M.A. Ships, and in establishments other than the above, the Branch is at present responsible only for the work of the Engineering Department.

New construction

Until 1938 Naval Shipbuilding in Australia had been confined to intermittent building by Cockatoo Dockyard, and after an interval of several years a small programme was started in this yard in 1934 and was gradually extended until, at its peak in 1942, seven shipyards were building Naval vessels—*Bathurst* class Australian mine sweepers, *River* class frigates, and (at Cockatoo only) *Tribal* destroyers.

Between 1934 and the present time four sloops, four boom working vessels, 60 *Bathurst* class minesweepers, 11 *River* class frigates, and 3 *Tribal* destroyers, besides numerous small craft, were completed.

With the end of hostilities, Naval building has been much curtailed, and at present there are under construction only one frigate (nearing completion) and two *Battle* class destroyers. Approval has been given to construct four destroyers of *Daring* class.

Material and equipment

At the beginning of the period under review, much of the material and equipment for ships building, including forgings for turbines and shafting, boiler tubes, condenser tubes, and all auxiliary machinery, electric cable, etc. was imported from Britain ; but Australian manufactures have now been greatly increased, and about seventy per cent. of materials and equipment are now being manufactured in Australia.

Materials and equipment which have been produced locally to Admiralty specifications include :—

Mild and D.W. steel plate and most sections required.

D.W.R. rivet steel.

Boiler plate for small and moderate sized boilers.

Boiler tubes (including superheater tubes) for boilers up to and including those for Tribal destroyers.

Forgings for turbines and shafting.

Condenser tubes (Cu.Ni. and Al. Brass).

All steel castings required for structure or machinery for small cruisers.

S.D. copper piping up to 7-in. bore.

S.D. steel piping up to 5-in. bore.

Steel wire rope, flexible and extra flexible, up to 6-in. (Wire rope has been made for commercial purposes up to 10-in.).

Electrical cable of the following types :—

L.A. sheathed R.I. up to 30 core.

All types cabtyre sheathed up to 30 core.

Single core L.A. sheathed up to 37/083.

Various braided cables.

The manufacture of polyvinyl chloride insulated cable is contemplated.

Steel chain cable—forged steel up to 2-in. (Note : Cast steel cable can be made up to any size).

Reciprocating machinery of Weir type for destroyers, frigates and smaller vessels.

Steam driven reciprocating boiler room fans.

Steam driven generators up to 70 K.W.

Diesel driven generators up to 20 K.W.

Electric fans up to 20-in axial and 20-in. centrifugal.

Ruston Hornsby Marine Diesel engines of 170 H.P.

Gray Marine Diesel engines, 165 H.P.

Propellers up to and including those for *Kent* class cruisers.

Firebricks.

Over many years attempts had been made to produce satisfactory firebricks locally, and although some of them appeared very promising on test the results on service were disappointing. Research continued, however, and eventually firebricks of the highest quality, including those for the 1943 boiler fronts, were produced, and gave results on service at least equal to any others used.

Condenser tubes had been made to Admiralty specification prior to the war, and copper nickel tubes for the first *Tribal* were also manufactured. The later ships were equipped with aluminium brass tubes. Season cracking occurred in these, and it was discovered that this was due to slight hollow sinking, and occurred more frequently in tubes which were plug drawn than in those which were mandrel drawn.

In order to overcome the difficulty, a low temperature heat treatment, somewhat similar to that used in the United States, was introduced as the final stage in the manufacture of these tubes. In this, an electric current was passed through the tube, which was held in a pair of grips at each end. As the temperature rose, and the tube was heated to the desired temperature, it expanded sufficiently to cut off the current automatically as required for the correct heat treatment. The tubes still remained hard enough to resist " necking," and after the introduction of this process no further difficulties with season cracking were experienced, though plug drawing continued to be used to accelerate the production. Throughout the period of production after this process was introduced, a proportion of tubes was tested for liability to season cracking by the mercurous nitrate test on completion ; but the annealing proved completely satisfactory.

NOTE.—*This was the subject of a recent letter from the Australian Naval Board asking for the Engineer-in-Chief's opinion of a request from an Australian manufacturing firm for plug drawing of condenser tubes to be made universal. One particular point brought up was that nitrided bars which were necessary for mandrel-drawing were difficult to obtain in Australia.*

On investigation into the pros and cons of Plug versus Mandrel-drawn tubes it was found that even after a low temperature anneal, as carried out in Australia, a very much higher residual skin stress in the material existed. In addition, the process of plug-drawing, allowing relative motion and flow of the material of the bore, tends to " gloss over " any inherent defects in the bore, while in the mandrel-drawn tube, the material of the bore is merely pressed on to the mandrel and since some elongation occurs defects are enhanced.

Nitrided bars, the supply of which is available in U.K., are, however, only required for Cu-Ni tubes which do not suffer from season cracking, and Al-Brass tubes can be drawn on mild steel mandrels. E. in C's. view is, therefore, that nothing will be gained by reverting to plug-drawing for either Cu-Ni or Al-Brass, but in the Australian case plug-drawing could be used for Cu-Ni tubes if the supply of nitrided bars is difficult. The investigation, however, still continues.

" Hollow-sinking " is the term given to " ruffles " which seem to appear in some plug-drawn tubes.—EDITOR.

Repairs and Maintenance

Numerous large ship repairs were undertaken for ships of the R.A.N. and various Allied Nations, and during the early part of the war in the Pacific, and before facilities which were later provided became available, the resources of Australian yards were availed of to the full to deal with general repairs and action damage. Several very interesting shaft alignment jobs were undertaken, and one variation from the method of ship alignment described in " Papers of Engineering Subjects," No. 17, Page 37, may be noted. By damage from near misses or torpedoes, the sterns of several ships were distorted irregularly, and, in order to pick up a satisfactory line to connect the propeller shaft with the existing installation of the turbines, a tubular light box with small sighting holes at the centre of diaphragms some two or three feet apart was constructed. The flanges of this were machined accurately, and it was bolted on to the after coupling of the thrust block. An electric light bulb was inserted before the foremost diaphragm and projected a beam of light through the sighting holes in the diaphragms, in the true line of the gear wheel shaft to the after end of the " A " brackets. By setting up sighting boards at each necessary place, it was possible to determine the amount of the distortion of the tubes, etc. and the adjustment necessary to bring the shaft bushes back into line. This method was considered preferable to running a wire, as, with distorted tubes, it is very difficult to obtain a clear picture as to the best method of repair. In boring out for shaft bushes the boring gear was carried in temporary hangers which could be conveniently welded to the ship. It has been found in Australian conditions that the temperature changes during a twenty-four hours' cycle move the stern of the ship considerably.

" A " Bracket bushes

In two cruisers, the lignum vitae bearings in the " A " bracket bushes (similar trouble is mentioned in " Papers on Engineering Subjects," No. 18) wore down very rapidly and destroyed the bushes, fortunately without damaging the shafts. It is evident that the rate of wear in the second ship increased very rapidly shortly before failure occurred. Poker gauges had been fitted locally prior to the decision of the Admiralty to fit them generally ; and readings had shown normal clearances after several months steaming, when suddenly the clearance in one " A " Bracket bush increased to above 6 in. Considerable investigations into lignum vitae were made, and it is not believed that the quality of the lignum vitae fitted had anything to do with the failures, as the rapid wear was found in bushes which had previously given long and satisfactory service, and some of the bushes had been fitted in the United Kingdom, South Africa and Australia. Careful attention to the clearance of the outer stern bush was given ; and it is considered that this must be kept as near the design limit as possible ; otherwise, if it is excessive, whipping in the shaft will occur, and it is believed that this, and not the quality of the lignum vitae, caused the failure of the bushes.

In numerous vessels, " A " bracket bushes were found to be loose, and a very satisfactory repair was carried out by boring out the " A " brackets and by fitting brass liners made from surplus $\frac{1}{2}$-in. thick R.N.B. condenser diaphragm plates to the backs of the bushes. These were carefully rolled into shape and, having been fitted into recesses which were turned on the back of the bushes, were pinned and welded at the ends and then turned to the required sizes. These repairs have been completely satisfactory and have obviated the necessity of fitting new bushes. Intermediate and propeller shafts for a damaged cruiser were forged and machined, including the trepanning of the bore, for the first time in Australia.

Auxiliary machinery

A common defect encountered in auxiliary machinery was lack of correct alignment of the shafts of turbo feed pumps ; and a large number of these required complete refit and re-alignment. This defect was found in ships of the R.N., R.A.N., and two Allied Navies, and in capital ships, cruisers and destroyers. In several pumps the centre casting had altered its shape and the flange to which the pump was bolted was not at right angles to the line of shaft. Several of the shafts were fractured, and in one shaft there was extensive cracking in the cone on which the impellers fitted.

Replace shafts were manufactured locally; and, when machined from suitable steel bar and correctly heat treated, were entirely satisfactory.

Conversion and fitting of auxiliary vessels, transports, etc.

Five armed merchant cruisers and numerous transports and auxiliary vessels were converted and fitted out and defensive armament was fitted in many merchant ships.

Armament

A torpedo factory and torpedo range were established and, under the immediate control of Engineer Officers, torpedoes were assembled from parts manufactured in Australia, and gave satisfactory trials in a very short time. Some 25 high angle gun mountings were built in the dockyard. Considerable additional close range armament was adapted for ships use and fitted in H.M. and H.M.A. Ships.

British Pacific Fleet

Most of the Naval Construction programme had been completed by the time the British Pacific Fleet arrived, and practically the whole of the resources of Australian Yards were required to carry out the necessary urgent repairs to the B.P.F. and to the ships of the Fleet Train. The experience gained during the war, and the vastly increased industrial background which was available, were of great value, and assisted the B.P.F. to operate prior to the provision of the additional repair services which would have been necessary to keep a large fleet operating in the Pacific.