PART II

JAPANESE RESEARCH AND DEVELOPMENT

In Vol. 1, No. 3, of this Journal, Commander (E) A. J. Stewart, R.N., made reference in his article on Japanese Gun Mountings to the technical ability of the Japanese. As he was only referring to one particular sphere of technical development, it will be of interest to examine the extent of Japanese research covering naval engineering in its wider aspect. The following article is a series of extracts from a Summary Report issued by the U.S. Naval Technical Mission to Japan, and is reproduced through the courtesy of the U.S. Naval Authorities.

Japanese Steel Manufacturing Methods

Japanese steel manufacturing processes are similar to those used in the United States and England, but through chemical analysis charts obtained through Japanese personnel, pre-war steels appear to be refined to a greater extent, the phosphorus and sulphur content being quite low. During the war, when nickel became a critical alloying element, substitute steels with little or no nickel were used. The phosphorus and sulphur content increased, indicating that the Japanese encountered difficulties in obtaining good grades of pig iron.

Heavy Armour

All Japanese production armour steel was made in the acid open hearth furnace. Average sulphur and phosphorus contents each ran below 0.02%. There was a tendency toward fairly high carbon content which was never below 0.35% and usually about 0.45 to 0.50%. Tensile strengths averaged slightly above those of American armour produced during the war, but the ductility was lower, particularly the reduction of area.

Light Weight Gun Mountings

The Japanese had recognised the advantage of installing many light-weight, free-swinging mountings. However, the size of the average Japanese man was a handicap in the use of this type of mount. The Japanese had not been able to design a free-swinging mount carrying more than one gun, or an easily controllable mount in the 25 mm. size larger than the triple style. The French influence on machine gun design was predominant as a result of several Japanese officers having been sent to France, where they studied design and production methods. The scarcity of high quality materials and machine tools prevented satisfactory mass production methods and the adoption of new designs. For example, the 40 mm. Bofors, which was captured in 1942 and considered a desirable addition to the armament, was not produced in time to be used in the war. Also, the few assemblies completed would not function satisfactorily.

Surface Warship Machinery Design

Apart from the *Shimakaze*, the latest destroyer and the only ship of her class, there were no really new design features in main machinery plants of major Japanese combatant surface vessels since the late 'thirties. Design trend was to open boiler rooms with doublecase boilers. There were centre line bulkheads in practically all main machinery and boiler spaces of cruisers and larger vessels.

The conventional arrangement was to group the boiler rooms forward of the engine rooms. In all later designs the main turbines were of two general types : in battleships, two H.P.'s and two L.P.'s operating in parallel with a cruising turbine connected to one of the H.P.'s in each space through a reduction gear and jaw clutch ; and in other ships, an H.P., I.P. and L.P. with a cruising turbine driven through its own gear and a jaw clutch on the outboard shafts only.

The main lubrication system supplied all main turbine auxiliaries except those too low to drain to the main sump. There was a central lubrication system for all auxiliaries in each boiler room.

Apparently a concerted effort was made to install main plants which were economical at cruising speeds even at the expense of considerable increase in weight.

There were emergency steam and exhaust connections to main lube oil pumps from adjoining spaces. Main generators were located outside the machinery spaces. There were no fuel oil booster pumps and no deaerating feed tanks.

Auxiliaries were small, compact, and accessible. Machinery spaces were not cramped. With the exception of Diesel generators no equipment appeared to have given much trouble.

" Matsu " Class

This class was the first and only class of warship to have a machinery arrangement of boiler room—engine room—boiler room—engine room. There was no cross connection between the high pressure sides of the main feed systems of the two boiler rooms, or the high pressure sides of the fuel oil systems so characteristic of other Japanese vessels. Cruising turbines and connected lines were removed after they were found to be impracticable.

Underwater Protection

In underwater side protection, the Japanese had developed empirical formulae for the thickness of protective bulkheads and bulge widths. These formulae were used with considerable confidence, since they were based on model and full scale experiments.

They had arrived at systems differing considerably from both U.S. and British with regard to methods of protection. When using liquid layers, which they considered to be the best, they placed them next to the protective bulkhead because their model experiments had shown this to be advantageous.

In some ships, such as *Yamamoto*, the air layer method was still used because the protection was essentially designed against diving shells. The bulges were then considered to be adequately strong without water layer protection.

Boiler and Machinery Design

The general status of Japanese boiler and machine design was on a rather low level. What was good appeared to have been copied from United States or British design—it was not Japanese. German design influence strangely seemed to be lacking.

There was an apparent lack of knowledge of furnace and steam drying design. Wasted furnace volume was the basic reason for Japanese ships having only half the shaft power of U.S. Navy ships of similar tonnage. Inability to design boilers for dry steam delivery to the superheaters caused excessive outage for boiler and machinery repairs.

Lack of application of fuel-economy principles sharply reduced the cruising radii of ships. The use of high-resistance air-heaters, rather than economisers, seriously hampered flank-speed running. Automatic control was seldom used.

The fine arts of oil-burning were nowhere in evidence.

Design elements very often appeared to be the work of designers unskilled in operation. Evidence of lack in dual training-theory and its application seemed to crop up everywhere.

Gas Turbines

The Japanese Navy attempted to design a gas turbine for small craft. One unit which was being tested when the war ended was actually a reaction steam turbine running at low pressure but with a high temperature fluid. No successful runs were made.

Diesel Engines

The Diesel engine industry of Japan did not play as important a part in the war effort as did the American Diesel engine industry. Two major reasons were :—

(i) The lack of ability to design suitable engines of high power output.

The crux of the design problem in Japan at the outbreak of war was not so much the scarcity of trained engineers and designers, but rather the lack of originality which these designers displayed. As a result, no high speed, high output engines comparable to American models became operational, and only one experimental engine of the type ever approached successful completion.

(ii) Factors limiting production :

(*a*) Complicated design.
(*b*) Inadequate knowledge of " tooling up to do the job."
(*c*) Inability to make the maximum use of available labour.
(*d*) Lack of co-ordination between the Army and Navy in respect to engine design, development, and production.

Welding

The Japanese showed little appreciation of the real advantages to be gained by the use of welding ; their lines of research, none of which were original, were aimed at increasing output rather than at improving the quality of the product. Their equipment and workmanship were poor. In fact the Japanese were years behind the U.S. and Great Britain in the development of welding.

Damage Control

Compared to American and British standards, Japanese damage control organisation, training, and equipment were inferior. Although definite improvement was made during the war in all three phases of damage control, good results never were obtained.

Wood, Textiles, Rubber, and Plastics used in Japanese Naval Vessels

Wood of many varieties was used extensively in Japanese naval vessels, and the workmanship in wood was very careful. Even on modern steel ships, wood was used for equipment such as furniture, shelving, and cabinets. Textiles, rubber, and plastics in moderate amounts found essentially the same uses as in U.S. Naval vessels. Supply of certain types of wood became critical, but suitable substitutes were made. Near the end of the war, Japan's natural rubber supply was cut off, but she had not completely used up her stock-pile of rubber when the war ended.

Fuel and Lubricants

The significant feature of the Japanese Navy's petroleum policy is the fact that it did not rely upon industry for research and refining. Instead, the Navy built, just before the outbreak of war, one of the world's largest fuel and lubricant research institutions at Ofuna, and also built and operated two of the largest refineries in Japan. While the Army and private industry carried on independent research, the investigation indicated that the research of the Navy was foremost and, therefore, the referenced and detailed reports on fuels and lubricants present the most advanced technological information in Japan.

Aside from the purely technical aspects of fuel and lubricant development, comments are presented relative to the scientific stature of the Japanese people, and it is concluded that Japanese technical ability has been underestimated.

Aviation Gasoline

Considerable research attention was concentrated by the First Naval Fuel Depot, Ofuna, on developing a wide variety of processes, including : Alkylation, isomerization polymerization, hydrogenation, catalytic reforming and catalytic cracking for manufacturing iso-octane and other high octane blending stocks. The research and development work of the Japanese Navy played a leading part in the growth of the aviation industry in Japan.