JAPANESE GUNMOUNTINGS

by

COMMANDER (E) A. J. STEWART, R.N.

This article is confined to a description of the more interesting features of the Japanese 18 *in. turrets. The author's knowledge of the subject is limited to such information as he was able to acquire during a three and a half months' stay in Japan whilst attached to the American Naval organisation known as Navtecjap.*

THE JAPANESE 18 in. GUNS AND MOUNTINGS

Although it was suspected during the war that the latest Japanese battleships were fitted with guns larger than 16 in., it was not known definitely until after the arrival of the Allies in Japan that these were 18 in./45 calibre guns (18.11 in. actual bore diameter).

Shortly after the First World War, work was begun in Kure Dockyard and at Kamegakubi proving ground, on the design and manufacture of a 48 cm. (19 in.) gun and cradle. The first gun split during test firing and a second was built which fired satisfactorily. This, together with its cradle and slide, was still at Kamegakubi in December, 1945. Work on guns of this calibre was stopped by the Washington Treaty and the project remained in abeyance for the next twelve years. In 1934, the topic of large naval guns was reopened in Japan with the problem of the armament to be carried by the new battleships *Yamato* and *Musashi.* It was decided that the 19 in. guns were too large, but that an advance on the old 1919 designed 16 in. in *Nagato* was necessary to obtain superiority over the U.S. and British 16 in., and so a 46 cm. (18.11 in.) was selected, and was designated—Type 94, 40 cm./45 calibre. In calling this a 40 cm. gun, instead of 46 cm. the Japs were following our example of the First World War, when, in an attempt to keep secret the size of the 18 in. guns being built for H.M.S. *Courageous* and H.M.S. *Glorious* we referred to these as " the new 15 in."

The design of the 18 in. guns and mountings were completed and production begun in 1939-40. It was originally intended to build three battleships—*Yamato*, *Musashi* and *Shinano*, each to carry three triple 18 in. turrets, but *Shinano* was altered to an aircraft carrier and sunk before completion. These ships had a displacement of approximately 70,000 tons on a waterline length of 838 feet, a beam of 121 feet, and with a designed speed of 27 knots at 150,000 S.H.P. On trials *Yamato* obtained 27.7 knots.

All the guns and turrets were built by dockyard labour under the supervision of naval engineers and technicians in the Ordnance Department of Kure Dockyard. It has never been the practice in Japan to use civilian firms for this type of work, as is done in this country. Kure Dockyard corresponded, roughly, to a combination of Vickers-Armstrongs, Portsmouth Dockyard and Woolwich Arsenal, and was responsible, both for the detailed design and the building of all large naval guns and their associated turrets.

These were the first large turrets ever to be designed and built by the Japanese. Almost every part of these 18 in. mounting was a complete departure from the old design, which had been almost identical with the large British mountings designed prior to the First World War, such as was fitted in the battleship *Kongo.*

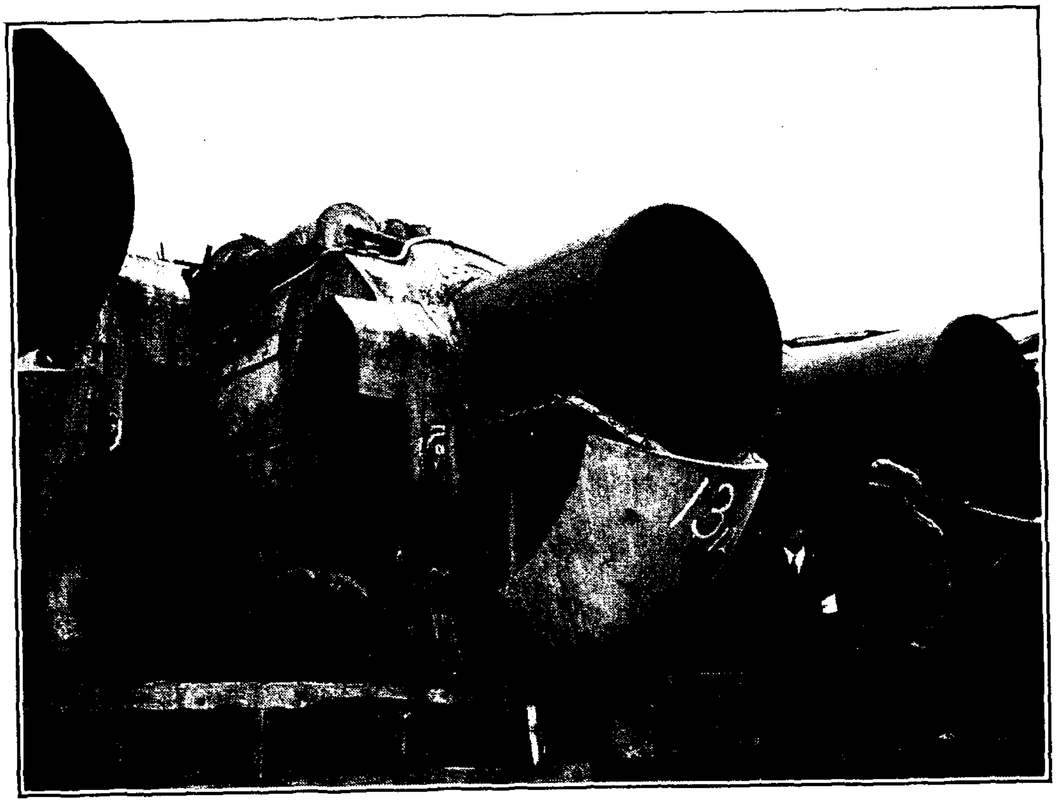

FIG. 1.—SPARE 18″ CRADLES

As both *Yamato* and *Musashi* were sunk in action, the author has not seen any of these turrets fitted in ships. Further, all drawings and handbooks were destroyed either by bombing, or deliberately by the Japanese ; all information was therefore obtained by inspection of a partially completed trial mounting and portions of a spare turret at Kamegakubi, and by questioning all available Japanese who had knowledge of these mountings.

General Data

Guns

Length overall	69 feet $1\frac{1}{2}$ inches
Weight with breech mechanism	363,000 lb.
Weight of shell (A.P.)	3,220 lb.
,, ,, ,, (Common)	3,000 lb.
Weight of service charge	728 lb.
The life of the gun before relining was necessary was thought to be 200-250 equivalent full charges.	
Range at 45° elevation	45,960 yards

Mounting

Total revolving weight of triple turret	2,510 tons (metric)
Thickness of gunhouse armour. Front	25.6 in.
Side	9.85 in.
Back	7.49 in.
Roof	10.63 in.
External diameter of roller path	42.8 feet
Length of recoil	4.69 feet

Rate of Fire

At maximum elevation	1.5 rounds/min.
At loading angle	2 rounds/min.

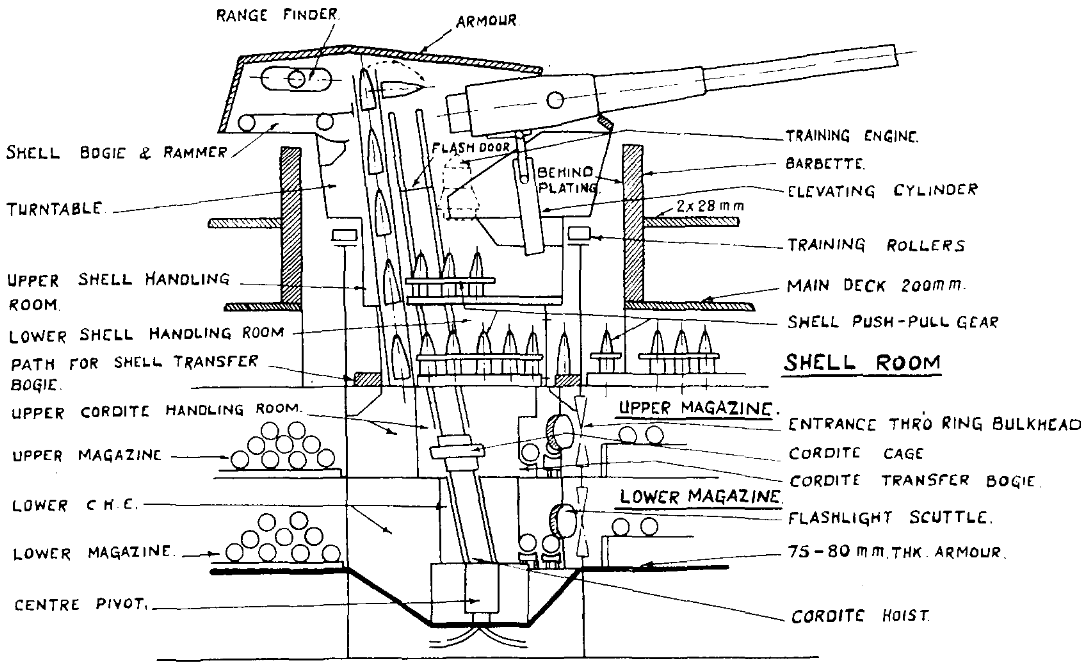

FIG. 2.—SIDE VIEW OF TYPE 94—18″ TRIPLE MOUNTING

Shell Stowage

60	rounds/gun	in	revolving	structure.
40	,,	,,	,,	shell room.
100	,,	,,	,,	Total

Training Speed. 2°/sec.

Elevating Speed. 6°/sec. (designed) 8°/sec. (actual).

Description of Mounting

A rough general arrangement sketch of the mounting is given in Fig. 2. The turrets were built and transported in three main sections, all of which are in Fig. 4, viz. :

(A) Turntable.
(B) Lower and upper shell handing rooms.
(C) Lower and upper cordite handing rooms.

The centre pivot, turret machinery, cradles (Fig. 1) and gunhouse armour (Fig. 3) were transported separately.

Magazines and C.H.R.'s were on two levels below the shell rooms. Shell rooms were fitted on one level only, as the majority of shells were stowed in the revolving structure, in the upper and lower S.H.R.'s. As in most large American turrets, shells were stowed vertically.

The most interesting and unusual features in these mountings were :

(i) The method of shell stowage and handling in the shell and shell handing rooms.
(ii) Gunloading shell bogies and rammers.
(iii) The cordite cages and gunloading rammers.
(iv) The attachment of the elevating piston rod to the slide.
(v) The wormless training gears.

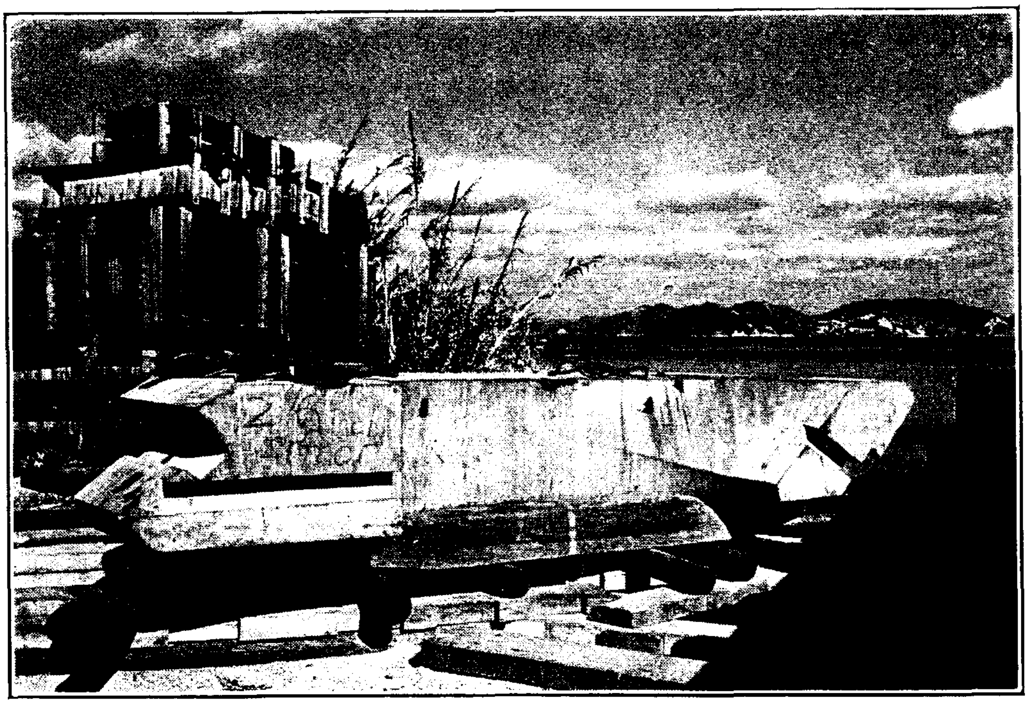

FIG. 3.—FRONT ARMOUR FOR 18″ TURRET (25.6″ THICK)

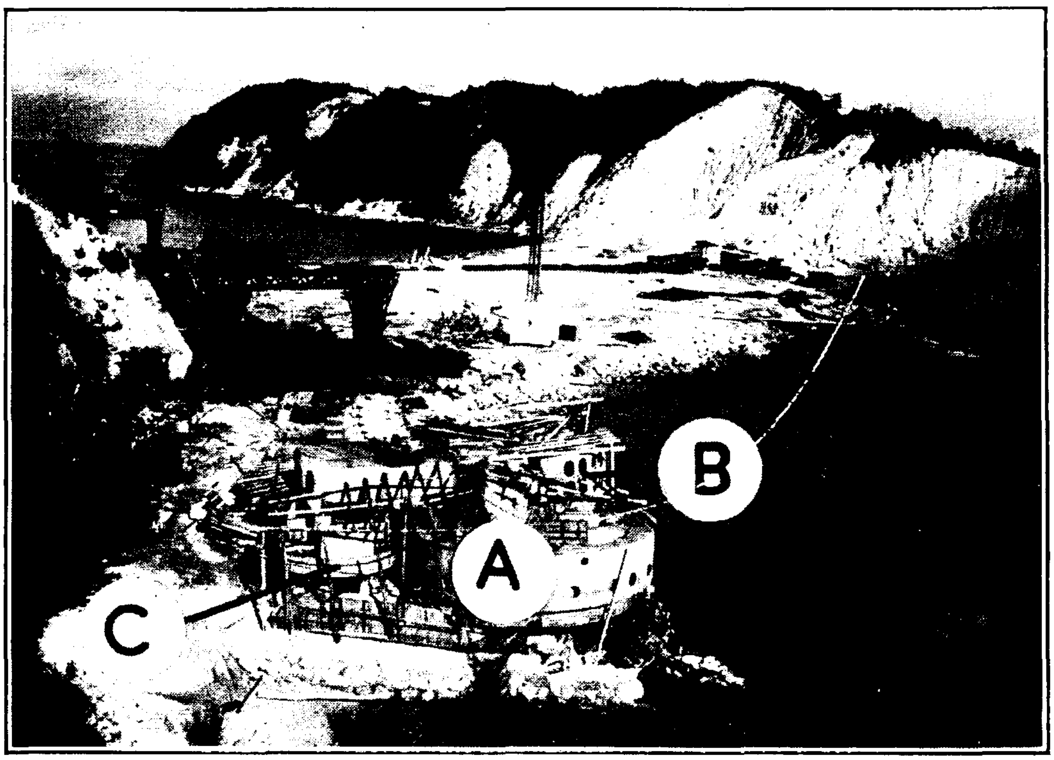

FIG. 4.—SECTIONS OF 18″ TURRET ON PROVING GROUND AT KAMEGAKUBI

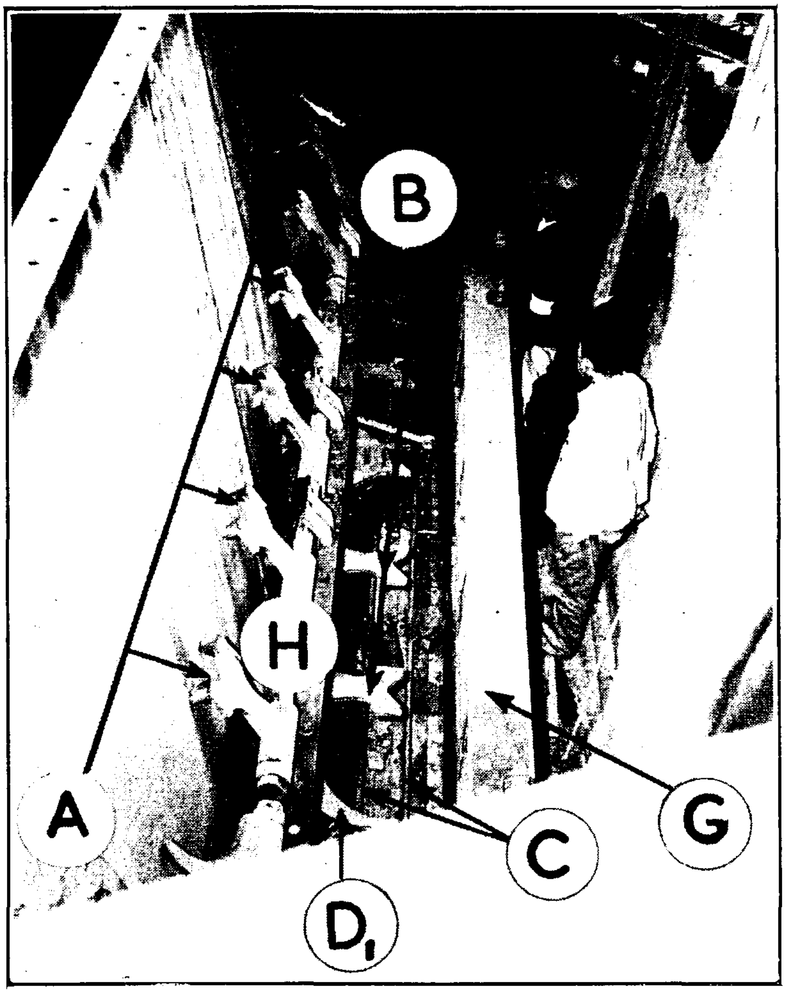

FIG. 5.—" PUSH-PULL " GEAR IN SHELL HANDING ROOM

Shell Stowage and Handling

The whole available deck space in the shell and shell handing rooms was occupied by shells standing on their bases between fore and aft and athwartship guide rails, to all of which was fitted the mechanism for moving the shells step by step up to, and into, the hoists. The shell handling gear has been christened " Push-Pull " gear and is illustrated in Figs. 5 and 6. The shells stood on twin skids (C) and between heavy girders (G).

The shells were held and moved between the girders (G) by two *gates* (A) and (B). The upper gate (A) was known as the *fixed gate* and was capable only of being rotated in the vertical plane through 90° about the shaft to which it was keyed. When (A) was in the *down* or horizontal position, the fingers of the gate were around the shell just below the ballistic cap. The function of this gate was simply to support the shells against rolling and pitching, and to keep them correctly spaced when not being supported by the lower gate (B). The lower gate was known as the *moving gate* and was capable both of rotation through 90° in the vertical plane about a shaft level with the centre of gravity of the shell, and of moving bodily backwards and forwards between the girders. In the " secured " position, the fixed gate (A) was down, and moving gate (B) was in the " up " position, completely clear of the shell. The sequence of operation when loading shell in the hoist was as follows :—

(i) Moving gate lowered.
(ii) Fixed gate raised clear of shell.

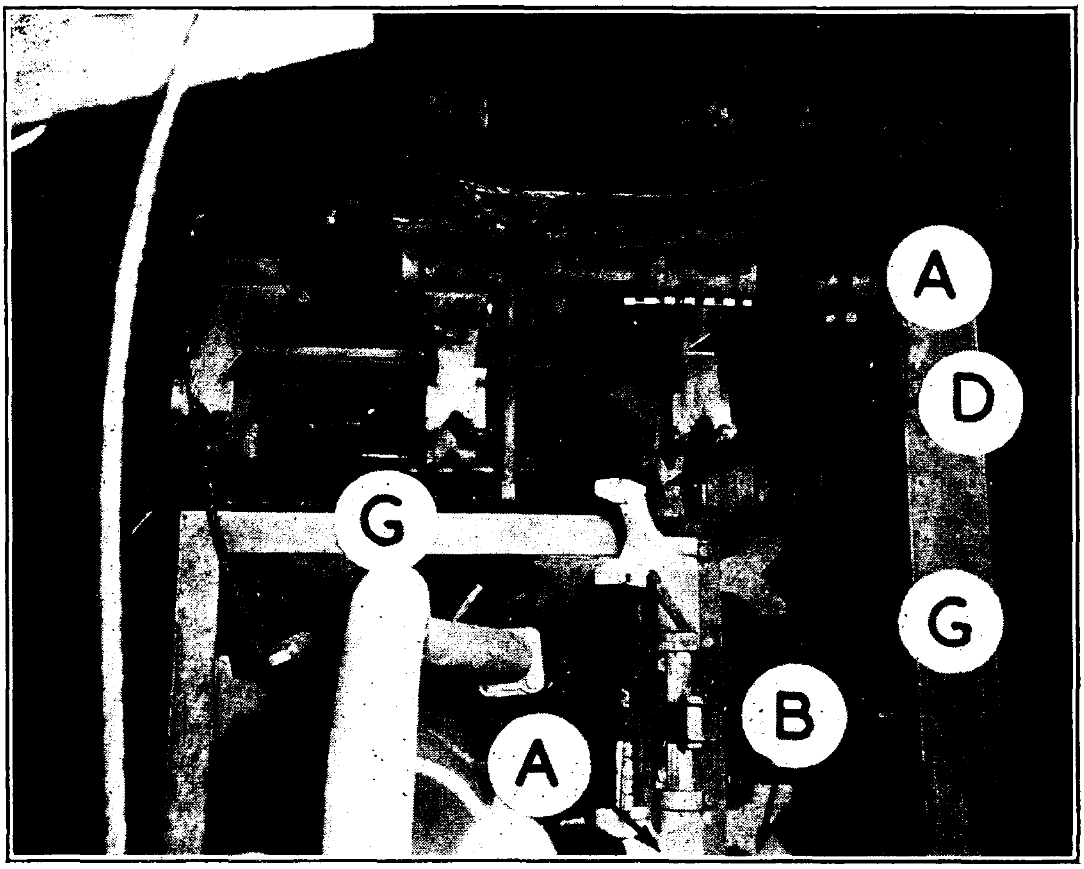

FIG. 6.—" PUSH-PULL " GEAR IN SHELL HANDING ROOM.

(iii) Moving gate moved horizontally one shell space, taking with it all shells in the gate. (Six in gate shown.)
(iv) Fixed gate lowered.
(v) Moving gate raised.
(vi) Moving gate returned one shell space ready for the next cycle.

There were hooks at each end of the gate. The function of the first was to *pull* a shell out of an athwartships bay, into a fore and aft bay, and of the second (D_1) to *push* a shell from the end of its bay into the shell hoist. Hence the name " Push-Pull " gear. It was operated by normal hydraulic pistons through suitable bell cranks, racks and pinions.

The push-pull gear was used not only for loading, but also for stowing shell in handing rooms and shell rooms when ammunitioning ship.

Shell Hoists

The shell hoists were of the conventional pusher type hoists, each hoist having an opening at both the upper and lower S.H.R. levels. The normal practice at the commencement of an action was to use shells from the lower S.H.R., at the same time supplying more shells to this handing room from the shell rooms on the fixed structure. As the rate of supply from the shell rooms was not normally sufficient to keep up with the rate of fire, it was necessary to continue the supply from the upper S.H.R., as soon as that on the Lower S.H.R. was exhausted. The total of sixty rounds per gun stowed in the revolving structure was thought to be sufficient for any normal action, and the transfer of ammunition from the fixed to moving structure was intended only to be carried out between actions.

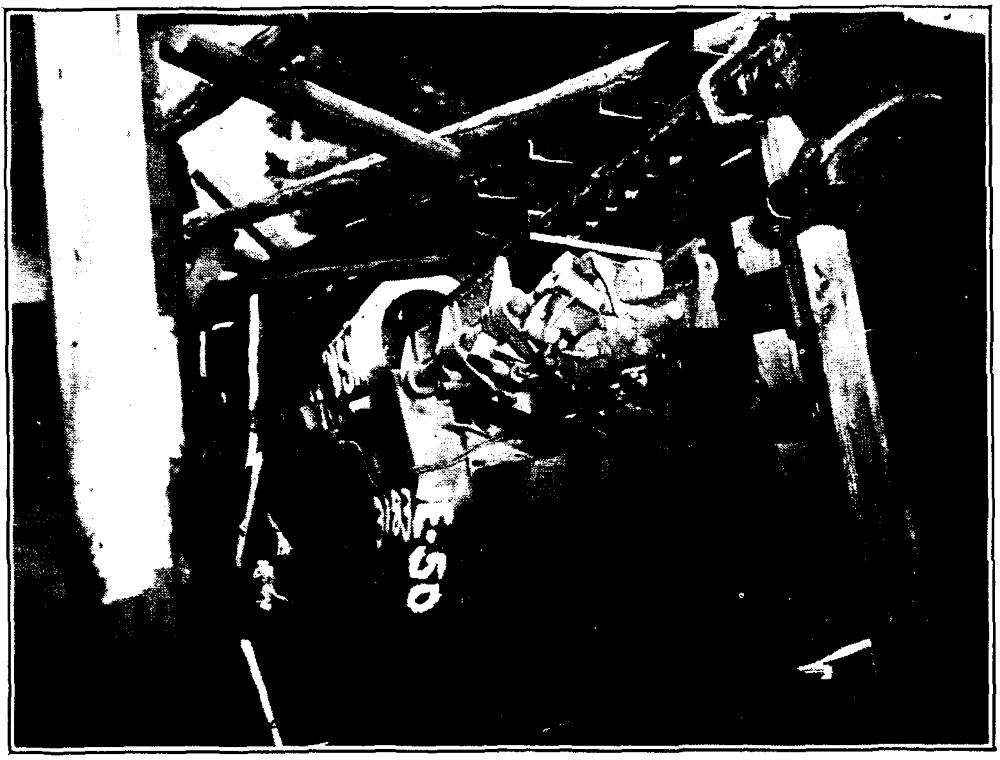

FIG. 7.—GUNHOUSE SHELL BOGIE AND RAMMER

Shell rammer (Fig. 7)

On arrival at the top of the hoist the shell entered a tilting bucket, in which it was tilted to 8° above the horizontal and allowed to roll on to a waiting tray, whence it was again rolled on to the loading tray of a massive combined shell bogie and shell rammer at the rear of the gunhouse in line with the gun. The bogie was mounted on four wheels, running on rails parallel with the bore. In the stowed position, the upper surface of the tray was inclined at 8° to the horizontal. As the bogie was moved towards the gun, the front wheels ran down a ramp to the loading position, bringing the bogie and shell to an angle of 3° above horizontal—the loading angle of the gun. This arrangment was necessary to allow room for the separate cordite rammer and gunloading cage cylinder to swing into line with the bore underneath the shell loading tray when the bogie was in the stowed position. Power for moving the bogie and for ramming was supplied through telescopic pipes along the sides of the bogie.

Cordite cages and cordite gunloading rammers

Cordite hoists (three per turret) were flashtight trunks 3 ft. 1 in. by 9 ft. 5 in. internal dimensions running straight from the upper and lower cordite handing rooms to the gunhouse, and fitted with rails to take a single cordite cage. An anti-flash door was fitted in the hoist just above the turntable floor and it was operated automatically by the cordite cage on its passage up and down the hoist.

Cage lifting gear was fitted to the front of each hoist in the lower shell handing room. The old wire and sheave type hydraulic press had been discarded by the Japanese in favour of what they considered to be a more efficient gear. This consisted of a hydraulic cylinder and piston fitted with a rack extension to the piston rod, driving a train of pinions connected to a wire-winch drum. An idea of the cumbersome nature of this very heavy gear can be gathered from Fig. 8.

The gunloading cage consisted of an open framework running on rails in

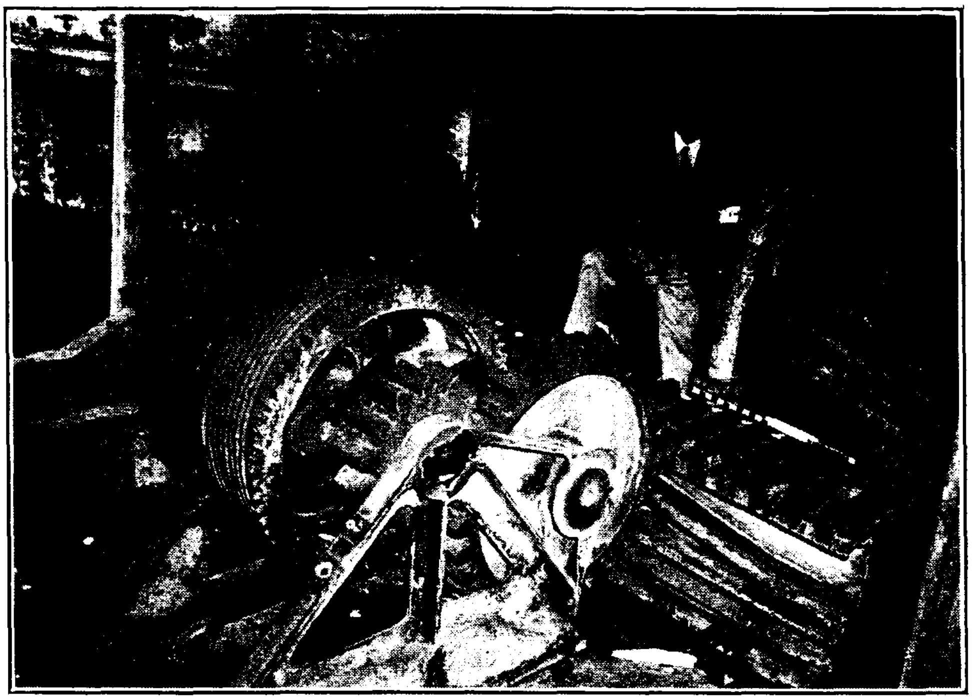

FIG. 8.—CORDITE CAGE OPERATING GEAR

the hoist trunk, and fitted with a flashtight cylindrical container, which could hold six one-sixth charges end to end. The mechanism of the cage was such that on arrival in the gunhouse the container, with its charge, was swung sideways out of the cage proper (which remained in the hoist trunk at one side of the gunwell) into line with the bore of the gear, and was then given a forward movement to take it into the gun far enough to cover the breech threads. The cordite chain rammer which was situated on the opposite side of the gunwell, was then pivoted about its base to bring it into line with the charge container, and the six one-sixth charges loaded with one stroke of the rammer.

Elevating gear

The normal cylinder and piston type elevating gear was used, but the attachment of the piston rod to the cradle was of an unusual design. The upper end of the piston rod was connected to a crosshead and slipper running in a pair of slipper guides fitted to the underside of the rear end of the cradle. This crosshead was connected to a small piston rod and piston working in a hydraulic " shifting cylinder," pressure to which was controlled by a hand lever on the side of the cradle. It was thus possible to vary the elevating radius arm. In the " in " position this radius arm was a minimum, and in this position the elevating limits of the gun were +45° to −5°. In the "out" position the radius arm was a maximum and the elevation of the gun was limited to +41° and +3°. The gun was normally used with the crosshead in this position. The crosshead could be locked at either end of its stroke by handwheel-operated bolts.

The object of this movable attachment was to replace the slide locking gear. To bring the gun from the firing to the loading position with the crosshead in the " out " position, it was only necessary for the layer to put his handwheel hard over to depress, and the gun would automatically be stopped at the loading angle of +3° by the normal cut off gear coming into operation as the elevating piston arrived at the limit of its travel on the cylinder. The slide was not locked during loading, but the handwheel was kept to " depress " until a

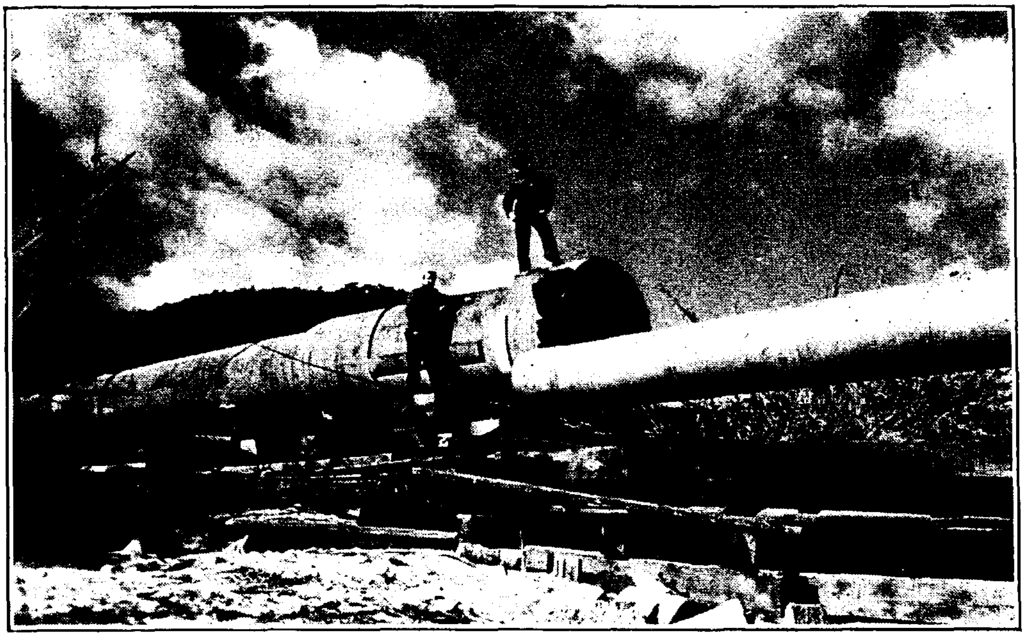

FIG. 9.—REMOVING 18″ GUNS FOR PROVING IN U.S.A.

" tell-tale " worked by the rammer number showed the layer when the gun was loaded and rammers withdrawn.

The Training gear

Two entirely independent sets of training gear were fitted 180° apart in each turret, but only one was used at a time. In the opinion of the Japanese, there were two main disadvantages in fitting a normal type of worm and wormwheel driven training gear to a mounting of this size. Firstly, it would require too much *horizontal* space, and would so require a very large roller path diameter, and, secondly, it was feared that the loading on the worm would be so high that severe pitting would occur on the driving faces.

It was therefore decided to design a wormless training gear. A 500 H.P. vertical swashplate motor was built into each side of the turntable. This motor drove, through a cone clutch, the inner member of a " coaster gear "—named after the ordinary bicycle drive which it closely resembled. The inner member of the coaster gear drove the outer member frictionally through three (total of six—three for each direction of training) " flattened rollers." The outer member was keyed to the front of a train of straight toothed pinions ending in a normal training pinion driving the turret at 12°/sec.

It was originally intended to fit the " coaster " gear in conjunction with a hydraulically operated band brake on the driving shaft of the training motor. The band brake was to have acted as a non-reversing mechanism ; a function normally performed by the worm ; but the trial gear was unsuccessful and was not fitted. The training gear, in its final form, was therefore *not* non-reversing, and the " coaster " gear served only as a substitute for the normal friction discs to assist in absorbing the throw off when firing an outer gun, or the inertia of the turret on sudden reversal of direction of training. It was claimed that this gear absorbed about 50% of the inertia of the turret when the direction of training was suddenly reversed at full speed, and the slip under these conditions was about 30 minutes of arc, the remaining inertia being absorbed on the training motor itself.

Considerable trouble was experienced in the early stages with severe scoring of the driving face of the outer drum of the " coaster " gear. This was overcome by adding forced lubrication—without, it was claimed, unduly increasing the slip.

Although the design of the " coaster " gear and band brake was not successful as a non reversing gear, it was considered a stroke of luck in that the trials had resulted in a neat and compact substitute being found for the normally used but bulky friction discs. The overall dimensions of the "coaster" gear was stated to be about 3 feet external diameter by 8 to 9 inches high. This would indicate a very small area of driving face on the rollers. Unfortunately no sample of this gear could be found, so these data were not confirmed.

Performance on Service and Conclusion

The designers of this mounting were very favourably impressed by its performance on service. They fully expected that with such a large turret, containing, as it did, many novel features, complaints from sea would be numerous. This was not so. They admit that these turrets were only in service for about three years, and therefore certain inherent defects had not time to develop to a stage at which they would become troublesome. This is correct, but on the other hand, it is usually found that the first few years in the life of a new mounting are those when most troubles are experienced.

The most troublesome feature was stated to be the large amount of lubricating oil used by the cordite hoist racks and winches, and by the training gears, which had begun to show signs of heavy pitting. Complaints were also made, about the noise of the rollers in the " coaster " gear and of difficulty in working the shell hoists when the ships were rolling more than 5°, but no further information was available on this. The blast from these guns was very great, and was particularly troublesome to bridge personnel.

These 18 in. guns were used against aircraft—mainly against large formations of torpedo bombers and " fortresses," and also for bombardment, but were never fired in a surface action.

Compared with British practice, the mountings were simple in design. They had no complicated hydraulic safety interlocks and comparatively few mechanical ones. Reliance was placed on good drill rather than interlocks to avoid accidents. Even taking into account the size of the gun, the general impression gathered was that an unduly large factor of safety had been allowed in the design of the turret machinery as a whole, resulting in a very heavy mounting, the total revolving weight of which was 2,510 metric tons. It was stated by the Japanese that a great deal of attention had been paid to flash-tightness throughout the turret. The impression was gathered, however, that this was not up to British standards, but it is difficult to express a definite opinion on this without having seen a completed turret.

It is considered that the design and production of these turrets goes a long way to disprove the general belief that the Japanese are unable to do anything but copy the ideas of other nations.