

4.5-IN. R.P. 41 MARK 6—MODEL
GENERAL VIEW WITH GUN BAY RING BULKHEAD REMOVED

THE DEVELOPMENT OF DESTROYER MAIN ARMAMENT 1941 TO 1945

BY

CAPTAIN (E) G. C. DE JERSEY, R.N.

PART II

In September 1942, it being considered that the immediate future was catered for, the Naval Staff decided that the time was ripe to consider an entirely new design of destroyer main armament equipment, which would supersede the 4·5-in. Mark IV as soon as practicable. Discussions were consequently opened with Messrs Vickers-Armstrongs Ltd., with a view to producing a new 4·5-in. twin H.A. mounting which would use the same 4·5-in. ammunition, but in which *all* the lessons learnt during the war up to that date would be incorporated. The mounting was to be designed in the first place to work with the U.S. Mark XXXVII fire control system.

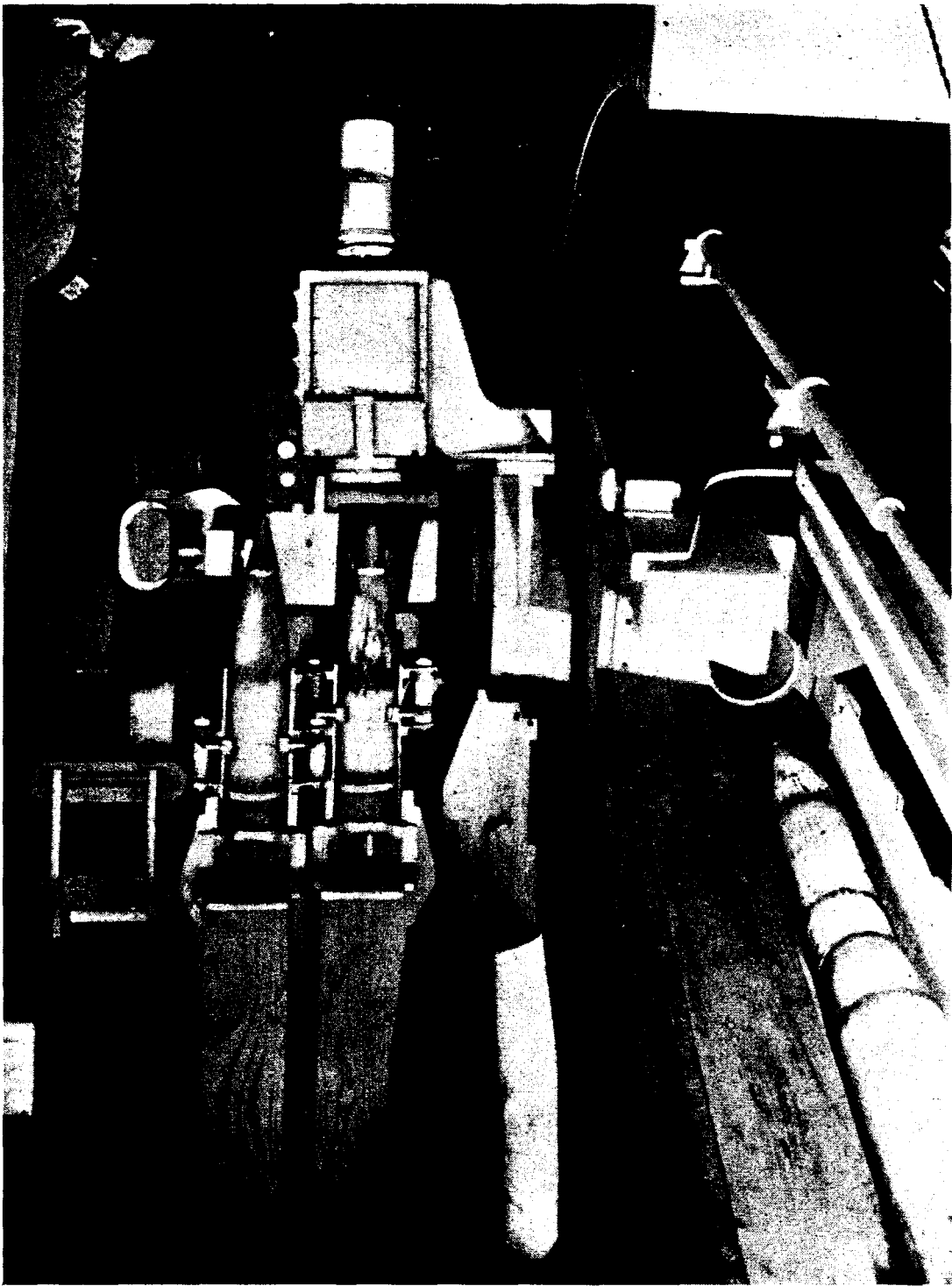
The basic specification produced at that date stressed the following requirements :—

- (a) At least 12 rounds per gun per minute,
- (b) All angle loading,
- (c) Greater depression (15° if possible),
- (d) High elevating and training speeds and accelerations,
- (e) R.P.C. gear incorporated initially,
- (f) Quick change over of nature of shell,
- (g) Minimum handling of ammunition during loading,
- (h) 'Dead time' to be kept as short and constant as possible and contiguous with this, fuze-setting to be on the cradle or as near to the breech as possible,
- (i) Weight to be kept to the absolute minimum,
- (j) Continuous all-round training, if possible.

It was arranged to put a full-scale and very elaborate mock-up in hand at Newcastle during December 1942, and the first inspection of this took place in January 1943. At this time it was contemplated to use fixed ammunition and almost entirely mechanical handling of the ammunition, including swinging loading arms to transfer the rounds from hoist to loading tray.

The first criticism, received in March 1943, was of the low rate of fire by comparison with the 5-in. U.S. Mark XXX, which was in many ways a comparable mounting, and this led to a conference early in April 1943, at which the pros and cons of fixed and separate ammunition and loading arms versus hand-loading were discussed, the main aim being to improve on the previously specified 12 rounds per gun per minute.

As a result of this meeting it was decided that high rate of fire (18 rounds per gun per minute quoted) and rapid change of nature of shell were the overriding considerations. For these reasons it was decided to adopt separate ammunition and hand transfer of shell and cordite from hoist to loading tray. This decision



4.5-IN. R.P. 41 MARK 6—MOCK-UP
LEFT-HAND SIDE OF GUNHOUSE

was confirmed by trials carried out on the mock-up by personnel from H.M.S. *Excellent*. In addition, trials were carried out on an 'auxiliary shell-tray' device, which however proved unsatisfactory.

About this time it was also decided that, to provide sufficient supply to enable nature of shell to be changed *during* an engagement, a second shell hoist per gun on the revolving structure would be necessary. One hoist would be used for

shell fuze 'time mechanical' and would have a fuze-setting machine above it, the other being used for all other natures. It should be added that at about this time the design of the Mark VII fuze-setting machine (metadyne controlled) began to be developed, principally for this mounting.

In June 1943, as a result of further discussions with D.N.C. and *Excellent*, a suggestion was put up to make the gun bay circular though this was not at first favoured. However this was the shape which it finally became. At the same time it became apparent that two shell and two cordite hoists on fixed structure would be necessary to compete with rate of fire and compartment arrangement.

A firm order was placed during the latter part of May with Messrs Vickers-Armstrongs Ltd., for the 'pilot' mounting.

A further inspection of the mock-up took place in June 1943, and shortly afterwards D.N.C. protested very strongly against the base-ring diameter of the mounting, owing to it necessitating a heavy cantilever design of deck support, and also against the weight of the gunhouse. On the first point no change was made as it was considered that the amount of redesign involved would delay production too badly. On the second point, the shield plating thickness was reduced to $\frac{3}{8}$ -in. from $\frac{1}{2}$ -in. in September 1943.

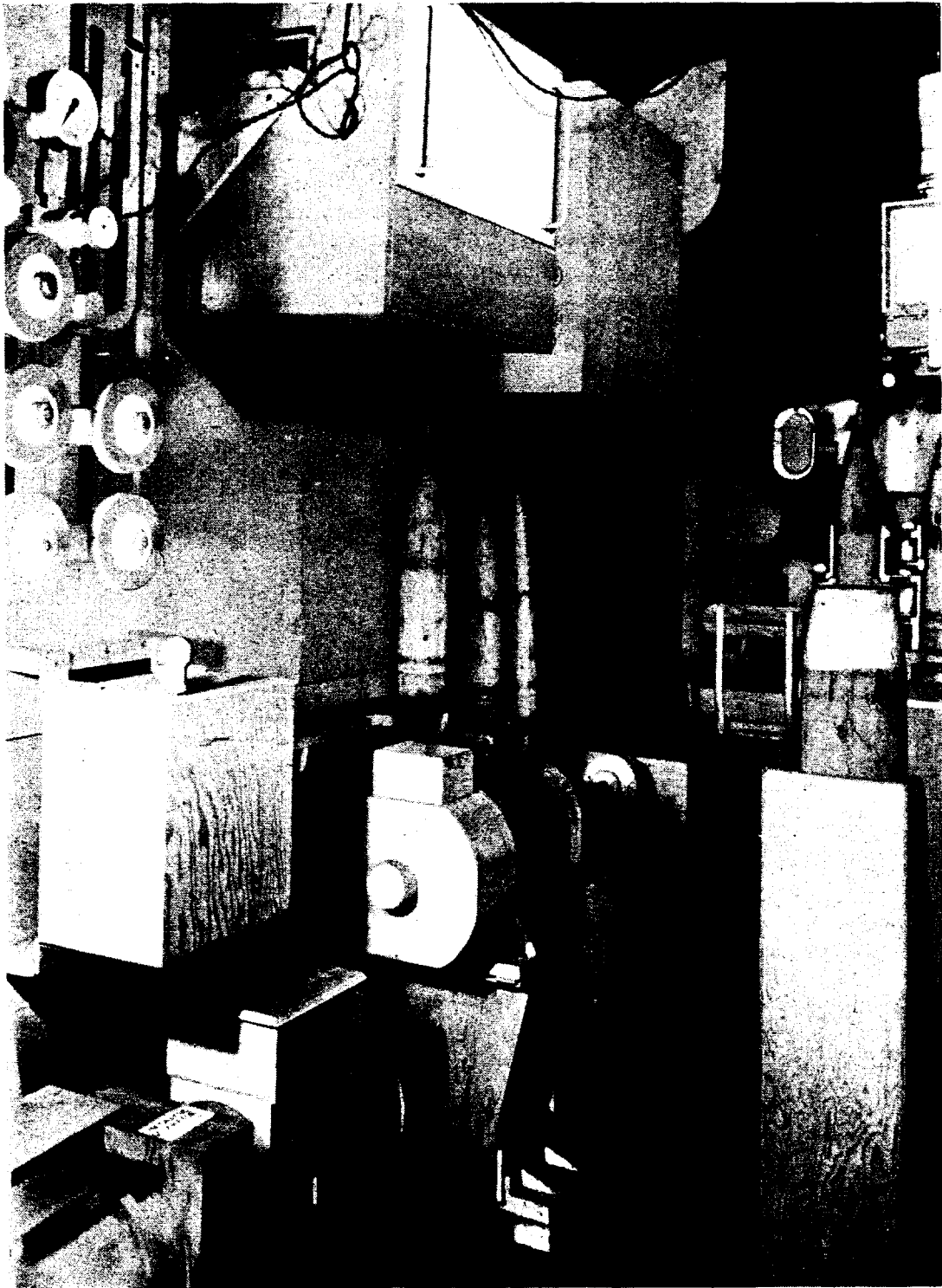
About this time, as a further 'red herring' it was decided to design another mounting (to be known as the 4.5-in. Mark VII) basically similar to the Mark VI but with a larger diameter roller path, for use in the new large fleet carriers of the 'Gibraltar' class, then being contemplated. From this time forward, all detail drawings where applicable, were made for 4.5-in. Mark VI and VII mountings.

In August 1943 a decision was taken to fit the first two 4.5-in. Mark VI mountings in one of the 1943 programme 'Battle' class destroyers ordered on Messrs Hawthorn Leslie. (It will be noted that history repeated itself here, as the first 4.5-in. Mark IV also went into a Hawthorn Leslie ship.) It was at this time expected that the pilot mounting would be available in March 1945 and the second one in the following month, though this was considered optimistic even during the war.

A further modification was made to the gun bay mock-up with a view to meeting D.N.C.'s objections to the overhung cantilever support, by incorporating pillars. These were found to interfere unduly with the ammunition supply and it was decided to revert to D.N.C.'s earlier suggestion of a circular gun bay. The mock-up was modified and was further inspected on 4 November 1943, some ammunition supply 'runs' being carried out by *Excellent*. Further trials were carried out in December and it was finally decided that handling of shell and cordite in the gun bay between fixed and moving hoists would be impossible. It was therefore decided to fit circular troughs around the base of the mounting.

It must be appreciated at this point that very considerable changes in design were being incorporated in this mounting, the major items of which were as follows :—

- (a) Entirely new design of loose-liner gun with the liner withdrawing to the rear through the breech ring.
- (b) New design of breech ring incorporating a large balance weight carrying part of loading tray and including recoil and recuperator cylinders.
- (c) New design of rammer gear, carried on the cradle, including light alloy rammer head and other parts.
- (d) New design of breech of practically cantilever construction.
- (e) New design of all-fabricated cradle, including parallel roller bearing trunnions and new design semi-automatic breech operating gear.
- (f) New design fabricated trunnion brackets.



4.5-IN. R.P. 41 MARK 6—MOCK-UP
LEFT-HAND SIDE OF GUNHOUSE

- (g) Variable 'A'-end (R.P.41) controlled ram elevating gear.
- (h) All fabricated turntable structure and base ring, and many other slightly less 'major' features.

As a result of this it was decided in July 1943 to order up a special twin cradle complete with fabricated trunnion brackets for mounting in a proof structure,

to enable as many as possible of the special features to be tried out in advance of the completion of the pilot mounting. The order was placed in March 1944. Owing to the peculiar shape of the breech rings it was also necessary to order two special single cradles to enable proof of guns and breech rings to be carried out.

A number of 'final' drawings began to appear in January 1944 showing that the arrangement whereby the Equipment Officer concerned spent much of his time travelling to Elswick to approve preliminary drawings was beginning to pay a dividend in the rapidity with which the design progressed. This was an extension of a scheme originally employed in 1939 to 1940, whereby a headquarters officer was permanently stationed at Vickers-Armstrong Ltd., Barrow, to approve drawings of the 4.7-in. Mark XX and XXII, and a few final drawings of the 5.25-in. Mark I and II and 4.5-in. Mark II and III mountings which were then in production.

It had been decided that the fire control system which was to be used with these mountings was to be the American Mark XXXVII system then being supplied under Lease-Lend, normally used in conjunction with the U.S. 5-in./38 calibre single and twin mounts which were the standard anti-aircraft armament of all large ships, and the standard main armament of all American destroyers. In order to take full advantage of the stabilization and other features of this well-engineered system, it was necessary to ensure that adequate power was available on the mounting, particularly for the training gear which had to be able to compete with the very rapid cross-level corrections required at high angles of sight in a rolling ship. The magnitude of this problem had never been fully appreciated prior to the advent of R.P.C.

To provide the power required for this and for the ramming and ammunition supply, it was decided to have three separate power units. 'A'-end controlled in the case of elevating and training, and constant pressure for the general services pump which dealt with hoisting and ramming. It was also decided, in the interests of simplicity and weight reduction, to make the fixed structure hoists similar in construction to those on the mounting, and thus an additional pump per mounting was fitted on the fixed structure for this service.

It became apparent that it was going to be very difficult to provide sufficient power for these services using normal D.C. supply at 220 volts, without the motors and starters occupying undue space and being very heavy, and it was at this time that tentative suggestions were made that American practice should be followed and A.C. supplies generated in ships, so that advantage could be taken of the smaller and lighter motors and starters that are needed to supply a given horse power. It was also pointed out that A.C. squirrel-cage motors are relatively more robust and require less maintenance than do D.C. motors of similar horse power.

At the time many arguments were produced against this change, particularly that of the difficulty of giving the necessary instruction to the electrical ratings who would have to operate and maintain the gear, but the result of this argument can be seen today in the fact that four of the 'Daring' class are 'A.C. ships'.

The peak electrical h.p. required to drive these mountings and their fixed hoists was worked out to be approximately 117, which compares with about 80 for the 4.5-in. Mark IV Mounting and its fixed hoists. This increase is almost entirely due to the combination of higher performance in elevating, training and higher rate of fire.

In May 1944 further inspection of the mock-up took place. By this time it was a very elaborate and representative structure, and its ultimate high cost was considered to have been well worth while. Decisions were taken regarding the

siting of many electrical fittings, including the embryonic arrangements which finally resulted in the 'Captain of Turret's Dashboard' which was another new feature of these mountings, and the forerunner of similar fittings in later designs of mounting.

Consideration was also given at this time to the use of 'screw and nut' elevating gear in place of the ram gear whose control in R.P.C. was proving unexpectedly difficult. The fact that the Americans used screw gear in several of their heavy turrets to which R.P.C. was fitted, appeared to augur well for this system, but in fact after making two sets for trial it was finally abandoned as it appeared to have more 'snags' even than the ram gear, which was finally adopted.

Further discussions also took place in May 1944 on the demarcation between Vote 8 and Vote 9 responsibilities for the breech and its operating gear, and final decisions were reached and a letter sent to overseers concerned with the joint inspection of these items. This was subsequently incorporated in an A.F.O. which was promulgated for general guidance.

In June 1944, it was arranged that the twin proof cradle that was to be used for the proof of the first two guns would also be fitted with ram elevating gear, which it was found could be accommodated on the proof structure at Eskmeals Range, to enable advance trials of this gear to be carried out under firing conditions. At the same time it was also decided that preliminary trials of the rammer gear should be carried out after the proof of guns and provision for this was also made on the proof cradle.

In July 1944, discussion was begun on a programme of firings which were to be carried out on the pilot guns in the proof cradle. These firings were also to include strain-gauge firings to check the strength of the breech ring and block.

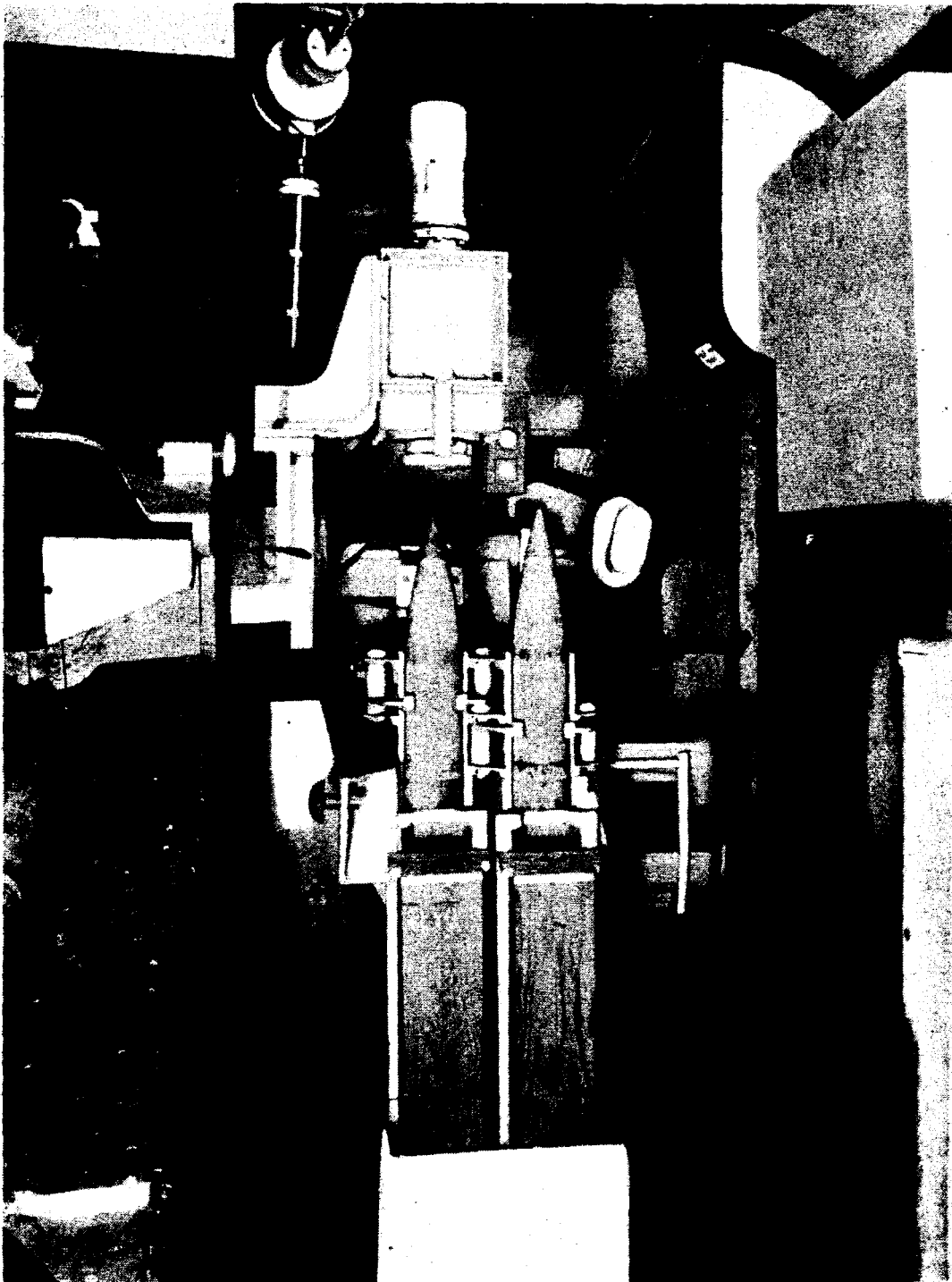
In August 1944, it was decided to make a special rig-up, representative of the arrangement at the top of the inner shell-hoist of the 4.5-in. Mark VI, for testing the prototype Fuze Setting Machine Mark VII, which was being developed by Metropolitan-Vickers and Ferguson Pailin Ltd., at Manchester, at this time.

In September 1944, after a very long discussion it was finally decided, with reluctance, to give up the requirement for continuous all-round training, as the problems associated with the very large number of slip-rings, and particularly with the 'screening' of certain leads were considered to be insuperable. It should be noted that this requirement had twice been postulated by D.N.O. (for the 4.5-in. Mark IV and 4.5-in. Mark VI) and both times had been turned down, the former on account of the difficulties associated with the large hydraulic centre-pivot and the latter as stated above.

Also, during this month it was decided that a 4.5-in. Mark VI Mounting would be supplied to the Fraser Gunnery Range at Portsmouth, both for evaluation and instructional purposes. It was beginning to appear by this time that the completion dates of ships carrying this mounting would not, in fact, be as early as originally expected.

It was decided in October 1944, to erect the first shell hoist to be completed in one of the shop pits, to enable it to be tried out prior to completion of the prototype mounting. This was felt to be necessary as the design of these light-weight 'pusher hoists' included quite a number of fairly revolutionary features, and they were designed for a much higher rate of supply than previously contemplated for this type of hoist.

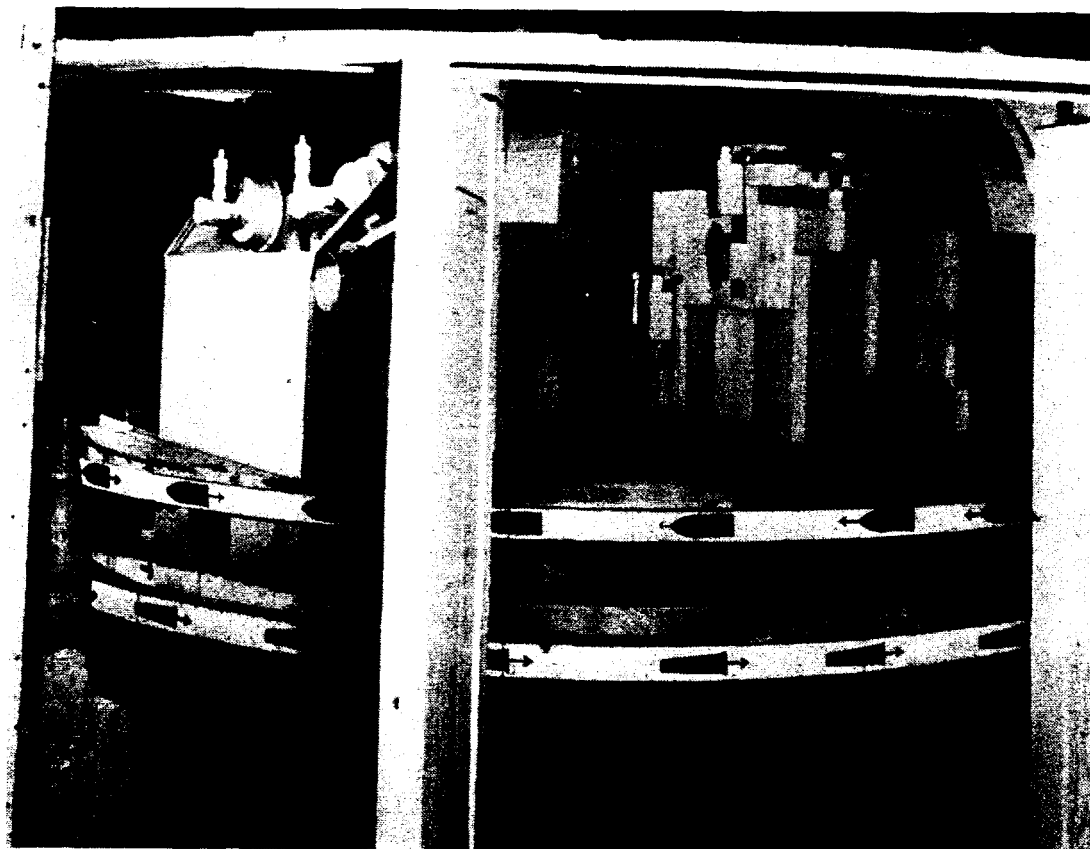
Owing to various production difficulties, and the additional requirements for trials to be carried out with the twin proof cradle when finally completed, the date for the first firing gradually receded past the end of the year. It was not,



4.5-IN. R.P. 41 MARK 6—MOCK-UP
RIGHT-HAND SIDE OF GUNHOUSE

in fact, until a very cold day in March 1945, that the first proof firing (horizontal only) took place at Ridsdale Range to the north-west of Newcastle. This range was used for this trial because it was fairly close to Elswick Works where the guns and cradle had been built, and it was felt wise not to go too far afield until the gun and breech mechanism had been proved.

The initial firings were considered reasonably satisfactory, but there were some slightly disquieting signs of deformation of the breech block in way of the



4.5-IN. R.P. 41 MARK 6—MOCK-UP

GUN BAY, SHELL AND CORDITE RINGS AND EXPENDED CARTRIDGE COMPARTMENT

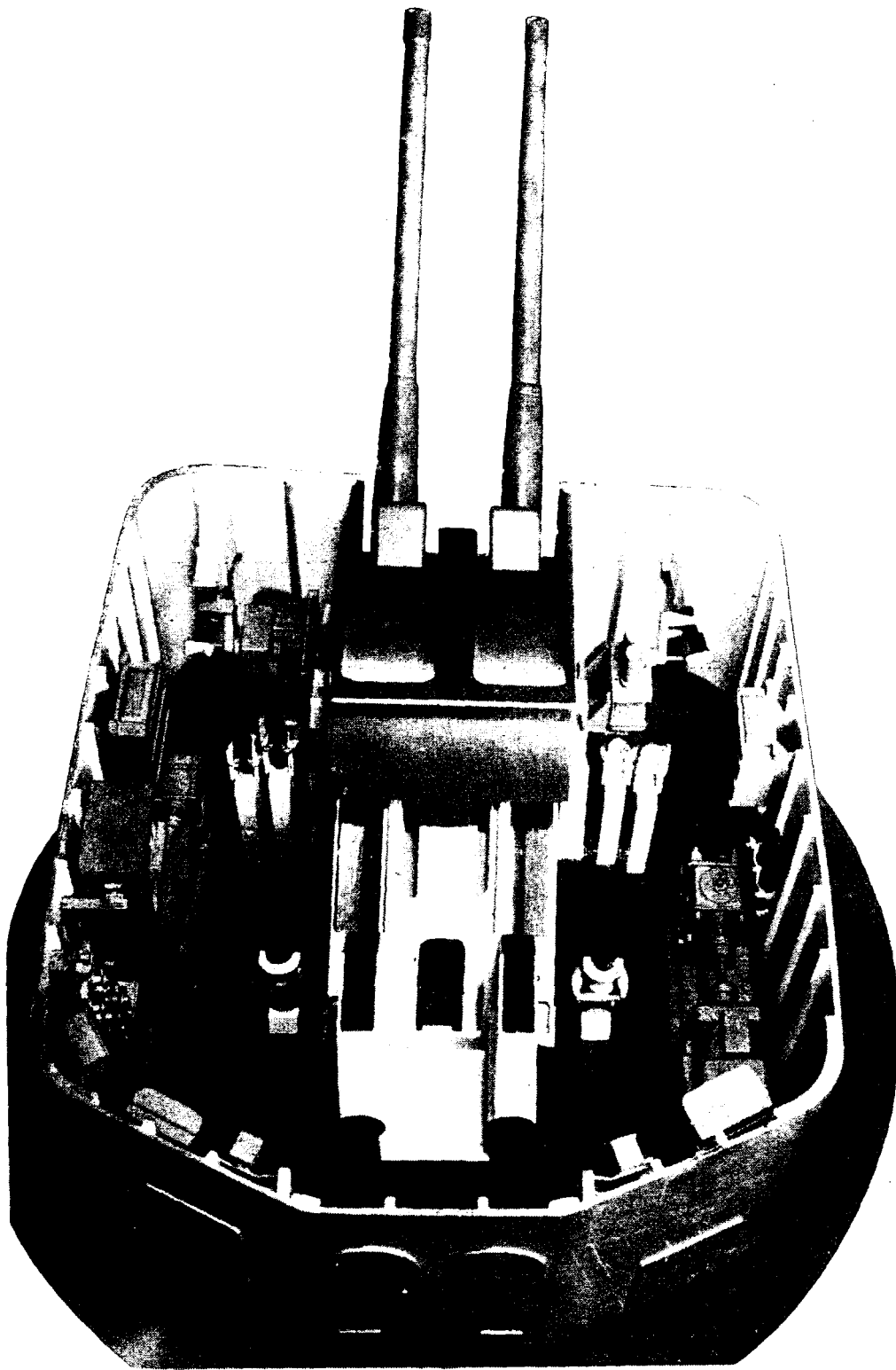
over-hung horns of the breech ring which acted as a partial support for the block when closed. However, it was decided that it was safe to continue firing and as a result the proof cradle, complete with trunnion brackets, elevating gear and all associated fittings, was transferred to Eskmeals Range in Cumberland, where it was scheduled to carry out gun functioning trials. Subsequently trials of rammer gear, semi-automatic gear, air blast and gun functioning at varying elevations, and trials of the ram elevating gear were also carried out.

These trials, which also included trials of two differing designs of breech block, one with single and the other with double thrust faces, began in April. Further trouble was revealed regarding strength of breech blocks and horns of breech rings, but it was decided that rammer trials should be progressed while keeping breeches under constant supervision.

In view of the troubles experienced, and as the European war had now come to an end, the urgency for the completion of these mountings had greatly reduced. As a result, further trials at Eskmeals were cancelled and the proof structure removed to Shoeburyness, to enable strain-gauge readings of the breech rings to be taken under firing conditions.

These trials continued until approximately the end of 1945, by which time the decision had been reached that the single-thrust type of block, with a modified heat-treatment (to give a higher yield) was satisfactory.

The author of this article left Naval Ordnance Department at the end of May 1945, after nearly $4\frac{1}{2}$ years, and is therefore unable, except by indirect evidence, to tell any more of this story, but it is felt that the article may be of



4.5-IN. R.P. 41 MARK 6—MODEL
GUNHOUSE WITH ROOF REMOVED

some interest, both to 'Gungineers' and others, as showing the amazing rapidity with which development went forward during the critical years 1941 to 1945.

If people are critical of the 4·5-in. Mark 4 and Mark 6 (to give them their modern titles, which were adopted after the war), it may be as well to remember the rapidity with which they were developed. Allowance must also be made for the fact that both in the N.O.D. and at Messrs Vickers-Armstrongs Ltd., all concerned with these designs were putting the major part of their effort into producing and maintaining many other older designs in service, by no means all of which were entirely trouble-free. In fact improvement and modification is a process from which gun mounting design can never be free, observing that improvements in control systems, fuzes and ammunition, to name only a few, must almost invariably have their corresponding effect on the mounting.