

# SOME NOTES ON RADAR IN H.M.S. 'VANGUARD'

The following Radar equipment is fitted :—

Warning of Aircraft, Type 960.

Warning of Surface Craft and Heightfinding of Aircraft, Type 277.

Warning of Surface Craft, Type 268.

Target Indication set, Type 293P.

Gunnery Surface Fire Control sets for the Main 15" Armament. Two Type 274, one for each of the Forward and After L.A. Directors.

Main Armament Fall of Shot set, Type 930, associated with the Forward L.A. Director and Type 274.

Close Range Gunnery Fire Control sets. Six Type 262 sets associated with the C.R.B.F. Directors and one Type 262 set for the S.T.A.A.G. mounting.

I.F.F. Interrogator sets associated with Types 960, 277, 293 and 275, including an interrogator for "G" band I.F.F., I.F.F. Transponders and Beacon Type 953.

One Main Radio Maintenance Room and three Auxiliary Radio Maintenance Rooms, the latter for the servicing of Type 262 equipment.

Displays for above equipments are situated as follows :—

1. *Radar Display Room.* Types 960 and 277 are operated and controlled from the R.D.R. Displays in the R.D.R. consist of :—

A coupled pair of P.P.I.'s for Type 960.

Outfit JL. This consists of a U.D.U. (Universal Display Unit) for Height Estimation from Type 960.

Outfit JM. A U.D.U. switchable to either Type 960 or Type 277 for Interrogation.

Outfit JN. An Azicator for Type 960, used to assist Type 277 to get on to the target for heightfinding.

P.P.I.'s for Type 277 and for Type 293.

2. *Operations Room.* One P.P.I. switchable to either Type 277 or Type 293.

Outfit JR. An Auto-Radar plot, i.e. a plan display of surface information worked in conjunction with the A.R.L. plot.

3. *Aircraft Direction Room and Target Indication Room.*

Outfit JK. A Skiatron display switchable to either Type 960 or Type 277.

One P.P.I. switchable to Types 277/960 and Types 277/293.

Two Target Indicating Units are fitted, one for Long Range and the other for Short Range use.

4. *Air Defence Position.* One P.P.I. switchable to Types 277 or 293, with a similar P.P.I. in the Captain's Shelter, Admiral's Bridge and Bridge Plotting Room.

*Air Warning Radar, Type 960.* This set at present only exists in two other ships apart from H.M.S. *Vanguard*, namely H.M.S. *Illustrious* and H.M.A.S.

*Australia*, a few explanatory words are therefore called for.

Type 960 is in place of the Type 281BQ or Type 79B set. In aircraft carriers Type 960 replaces Type 79B set. In aircraft carriers Type 960 replaces both the Type 281 and Type 79 sets. The set is designed to meet the need for a long range W.A. set, with a rather better general performance than Type 281BQ, and a display and operational control system suitable to the Radar Display Room organisation, which is part of the A.I.O. arrangement. With regard to the displays provided, ease of operation is obtained by the Universal Display Unit and there are full remote control arrangements provided for the control of the set from the R.D.R. Anti-jamming facilities, including the remote control of change of transmitter frequency and receiver alignment to the transmitter frequency, are provided from the R.D.R. The design is intended to provide compactness, reliability and ease of servicing and tuning. The aerial array will not be noticed to be distinctive as it very much resembles the aerial array for Type 281BQ, and similarly is continuously rotatable.

*Main Armament Radar, Type 274.* Fitted to both the forward and after directors. This is the most accurate fire control radar in existence and it is unlikely that there will be any development of a replacement Gunnery Surface set for the control of conventional surface gunnery. Little improvement could be obtained by the use of more modern techniques than those included in Type 274 and the next advance in G.S. sets will almost certainly be radar for the control of guided missiles.

Type 274 in H.M.S. *Vanguard* is, however, the first set of this type at sea to be fitted with auto-follow arrangements. The addition of auto-following completes the advance in facilities for accurate surface fire control offered by radar.

In conjunction with the Mark X A.F.C.T., auto-following permits the production of really smooth and accurate range and bearing plots and consequent quick calculation of enemy rates.

The use of auto-following does not in itself reduce the effect of "radar spot wander" (echo paint wander). The important feature of the use of auto-following is that the complete system possesses characteristics which are accurately calculable, repeatable and free from the effects of operator idiosyncrasies. This allows a number of non-linear and other special devices to be included in the circuits for the specific purpose of reducing echo-paint wander effects.

The use of auto-following in conjunction with the Mark X table has one further important advantage. It is possible to derive the inclination of the target by means of a mechanism controlled by the speed-along and speed-across shafts. When following is automatic the correlation between the "jitter" in speed-along

and speed-across is maintained and this allows a shorter smoothing time-constant to be used in obtaining the target inclination.

The ship is fitted with a special splash spotting radar set, Type 930, associated with the forward Type 274. Type 930 was designed by R.R.D.E. for army coastal batteries and was adapted for use in the Fleet until the Canadian Type 931 splash spotting set was available. H.M.S. *Vanguard* is the only ship fitted with Type 930 and further fittings are not envisaged. The true naval version, i.e. Type 931, is available now in small numbers and is in fact fitted in three cruisers. Ships of the post war fleet will either be fitted with Type 931 or Type 932; the latter is a British copy of the Canadian set. The size of the Type 930 aerial and its methods of mechanical scanning made the set a difficult proposition to fit in H.M.S. *Vanguard*, difficulties which are overcome in the Types 931/2, which are designed for Naval use. However, Type 930 provides accurate splash information but is handicapped in that its design was not intended to cater for fitting at sea.

*H.A./L.A. Armament Radar, Type 275.* Each of the ship's four Mark XXXVII H.A. Directors and computers are equipped with a Type 275 set, a set which supersedes the Type 285 set and variations. Consequent on the functions it is designed to fulfil, the set is complex in nature. Ample range performance, discrimination and high degrees of bearing, range and elevation accuracies are achieved. However, no auto-follow arrangements are incorporated and the set has two inherent disadvantages. Firstly, it has no spotting tube as the conical scanning system of Type 275 is fundamentally unsuitable for working a B-scope. Secondly, the set cannot follow accurately in elevation at angles of sight between  $\frac{1}{2}$  degree and  $3\frac{1}{2}$  degrees. At present intelligent operation is the only answer to the latter disadvantage, controlling the director in elevation by amount control and smoothing the fluctuations with the meter of pip-match presentation, without regard to the violent swings observed.

#### GENERAL OBSERVATIONS

Having listed the equipment in the ship and commented on certain sets where explanation appeared necessary, the equipment as a whole will be reviewed. The ship contains the latest radar equipment and from a technical point of view is a luxury ship. Her size and complement are very much in her favour for maintaining a high standard of technical performance under normal sea-going and war conditions.

Every item of radio equipment when installed in a new ship requires a full test. Trials and inspections are necessary to confirm that the equipment has been installed correctly and is operationally sound. On the spot corrections may be necessary and certainly future fittings must benefit from lessons learnt in the past. Investigations and trials are necessary to study how the numerous equipments "tie-up" operationally. Lastly, and a very important aspect, it is vital to ensure that the mutual interference between so many radio sets is a very minimum.

A thorough investigation of the equipment as fitted and under sea conditions has been made by Admiralty Signal Establishment scientific and design personnel.

If the right kind of radio equipment is to get to sea it is essential that the officers concerned in its development gain first hand experience of the equipment at sea.

A brief summary of a few of the trials carried out by the ship is worthy of mention in this article. In May 1946 shock and vibration trials were carried out off the North coast of Ireland. Some twenty-four broadsides from 15" turrets were fired and 23 broadsides from 5.25" armament and a number from Bofors. The turrets were fired to the full limits of arc. These trials revealed that the Type 274 aerial reflectors needed stiffening and that breakages of the Type 275 aerial nacelle perspex covers occurred under extreme conditions of blast. However stringent a laboratory test it appears such a test is not infallible unless proved by an actual test. Complete Fire Control operational tests were also carried out in May.

In June and July steaming trials determined the mechanical effect of vibration, effects from funnel gases on aerials etc., and a party of A.S.E. scientific officers were present to study the various effects.

In July Radar Display Room trials were carried out with massed dummy air attacks, while the ship was on passage from the Clyde to Devonport. The Action Information and Warning Radar trials section of H.M.S. *Dryad* studied the A.I.O. in general in order to test the operational efficiency.

*Interference.* The problems of mutual interference between radar sets and between radar and communication sets in such a multi-set ship were fully brought to light in H.M.S. *Vanguard* trials. The operation of such a great amount of radio equipment in one ship has provided valuable information and many lessons have been learnt. It is no exaggeration to say that mutual radar interference and other forms of radio interference constitute a severe problem and warrants the closest investigation. The difficulties of such an investigation are considerable, and in order to make the survey in this particular ship some 21 technical personnel were required. A summary demonstrating the types of interference encountered is as follows:—

Serious interference was caused to communication receivers by Type 960 and was cured by a 30 mc/s L.P. filter in the aerial lead to the receivers, or by the use of noise limiters.

Interference from Type 275 sets to communication receivers in the 30-150 mc/s range was experienced and was partially cured by earthing the screened cables to the transmitter nacelle at their entry to the nacelle and enclosing them in metal braid. A further modification which will radically reduce the interference from Type 275 consists of the closing of the gap between the reflector dish and transmitter nacelle by a gauze ring. (*Note.*—The revised wiring arrangements are shown in the latest Installation Specification for Type 275. Readers are advised that the screening rings mentioned above will be supplied to ships fitted with Type 275 but are not yet in production.)

Type 268 interfered with Type 930 due to operation in the same frequency band: a possible cure in such cases is the spacing of frequencies or I/F suppression of the Type 930.

Mutual interference occurred between Type 262 sets and between Type 275 sets, also between Types 274, 277 and 293. Interference was due to working on adjacent frequencies with small separation of the sets and their aerials.

It is not proposed further to detail the interference problems experienced in the ship but to reiterate that the fitting of so great an amount of radio in one ship has demonstrated the difficulties that must be overcome. The design of every item of radio equipment must be such that interference is adequately suppressed. Moreover the layout of offices, positions of aerials, cabling, etc., must be such that the very minimum interference is experienced. Absolute freedom from interference is difficult to achieve but it is a firm requirement. It would be pointless to provide new sets of increased power if their increased performance is lost operationally due to interference. Technically, H.M.S. *Vanguard* is a luxury ship but the wealth of radio equipment is not without its problems.

### *SPECIAL ARRANGEMENTS FOR THE ROYAL CRUISE*

The Air Warning Type 960 set and aerial array have been removed from the ship for the period of the Royal Cruise. The removal of the aerial array was necessary in order that the Royal Standard may be worn at a polemast on the mainmast. The S.T.A.A.G. mounting on B turret has also been removed. Otherwise the radar arrangements have not been altered.

The Commanding Officer has been asked to carry out a number of trials with the radar equipment as practicable during the cruise. Apart from Type 274 auto-follow trials, the trials asked for are limited mainly to a study of radar performance under varying propagation conditions. In order that propagation conditions may be determined, special meteorological equipment is being supplied to the ship by the R.N.M.S. to provide records of temperature and humidity gradient, raindrop size and rainfall amount.