RADAR TYPES 274 & 275

TRIALS

INFORMATION AND RECOMMENDATIONS AS A RESULT OF TYPE 275 TRIALS IN H.M.S. BARFLEUR.

Ranges to be Expected

(From Destroyer, height of aerial 45 feet)

Air

1. Max. Range on Medium Bomber - 35,000 yards.
2. Reliable Tracking on Medium Bomber - 30,000 yards.
3. Type 242 gave adequate identification over this range on aircraft above 500 feet. At 50 feet this range was reduced to 6,000 yards.

Surface

1. Max. Range on Aircraft carrier 40,000 yards.
2. Accurate tracking on Aircraft Carrier 34,000 yards.
3. Max. Range on Destroyer - 30,000 yards.
4. Max. Range on Submarine (fully blown), 15,000 yards.

Spotting

4.5" Shell splashes gave 3/1 S/N radio at 17,500 yards.
4.5" Practice shell splashes gave 2·5/1 S/N at 13,000 yards.

Spotting for Range

(a) Single Gun Salvos.

(i) In 24 single gun salvos , the sense was correct in all cases.

(ii) The average residual error of Radar M.P.I. about the true M.P.I. (Rake record) was 40 yards.

(b) Multigun Salvos.

It is not possible accurately to appreciate the M.P.I. if the line spread is greater than the range gate or if there is a hit.

(c) For Blind Range Spotting.

It is necessary momentarily to switch from Automatic Gain Control to Manual Gain Control, in order that small splashes may be observed, the manual control having previously been turned fully up. It must at present be done by the Radar Layer acting on the F.O.S. rattler although the Range Operator is spotting for range.

Line Spotting.

Accurate information as to the sense of line error was obtained by watching for transient deflections of the Bearing Meter (Remember R and L are reversed on the meter). The splashes should not be strobed, the strobe remaining on the target.

Quantitative estimations of line error were of very doubtful value.

Tracking Aircraft below Angles of Sight of 4°.

1. Using normal methods but ignoring random and misleading fluctuations in the meter, the summary of residual errors showed that an average residual error in elevation of 17 minutes could be expected.

2. The following method of assessing elevations below 4° was tried:-

(a) The A/S of the director was fixed at $3\frac{1}{2}$°.

(b) The circuit of the layer's meter was modified so that the zero could be adjusted by means of a potentiometer. The knob and pointer on the potentiometer covered 300° and using aircraft runs, the scale was calibrated to read A/S for centring of the meter zero. The scale proved to be open and linear, the range $1\frac{1}{2}^{o}$ - 4° covering the full 300° of the scale.

The results of this experiment were encouraging.

(i) Average residual elevation error on 6 runs was 7 minutes of arc.

(ii) These errors were increased by rough weather and errors in the stabilising system.

(iii) The readings were misleading below $1\frac{1}{2}^{o}$.

No attempt was made to devise a method of laying the system using this data.

Wander of Point of Aims with Large Targets.

With high rates of change of target bearing, a conscientious but inexperienced operator will, by slavishly following random and erratic fluctuation of the Bearing Meter, produce a bad point of aim. An attempt to smooth the data by switching off rate-aiding was less successful than the balancing of the fluctuations equally about the meter zero which the operator was able to do after some experience.

On surface targets, giving large multiple echoes setting the strobe on the leading edge of the echo was found to introduce additional errors into the point of aim due to the range gate as selected by the strobe being less than the target width. The A.G.C. is selected by the Range Gate and does not in this case cover the whole target, and thus considerable flutter was introduced into the meter indication thus giving rise to errors in point of aim.

By strobing on the top of the target echo instead of the leading edge, a considerable improvement was effected, although a range error of about 30 yds. (for all ranges) was introduced. It was recommended that this procedure be adopted for large and multiple surface echoes where a very real improvement in point of aim outweighs the disadvantage of the need for a constant range correction of 30 yards.

Local Oscillator CV116 for Type 275.

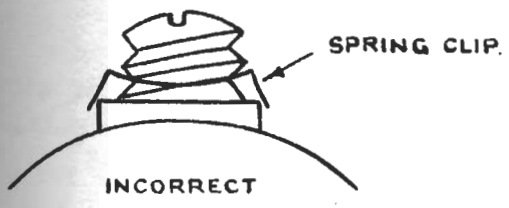
(1) The test for local oscillator CV116 in para.14, page 195 of Handbook RH.460(2) should be modified to read :-

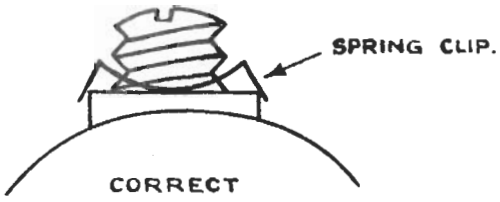
"If on rotating the control anti-clockwise the crystal current is less than one half of that in the clockwise direction, the CV116 should be changed".

(2) Great care must be taken that the valve is oscillating in the correct mode and not in one of the minor modes.

(3) The oscillator current should not exceed 25 m.a. (not 30 m.a. as stated in para.2 Page 195 of the Handbook), and generally, the power should be the least possible with adequate crystal current.

(4) The locking devices, if not properly secured, are liable to slip and allow the turning plungers to move. The spring locking clips should be well bowed.





Adjusted with good tension in the clip, the device will function satisfactorily.

Types 275 and 242.

The display of Type 242 on the Type 275 suffers from the fact that there is a range error of 1000 yards between target echo and I.F.F. response. Development is now completed and a modification to correct this error will be introduced. The work involved in fitting the new components is not difficult and can be carried out by ships' staffs.

Lining up of Aerials for Type 274.

The arrays fitted consist of a double reflector with fixed transmitter beam, the whole structure capable of independent adjustment in training with respect to the director line of sight. There are two independently adjusted receiver beams. The original structure was difficult to adjust accurately in training but a modification has since been introduced which overcomes this difficulty.

Some doubt seems to exist amongst users that, because the transmitter beam is not independently adjustable in training, the target may be unevenly illuminated and an error in training may result.

The practical consequences of a small misalignment of the transmitter aerial are unimportant and modifications which are being introduced to adjust the transmitter horn in training are being embodied merely in order to make easier the operation of lining up.

The maximum surface range of a Radar Set is proportional to the eighth root of the peak power of the transmitter so that the decrease in maximum range due to a small misalignment of the transmitter beam is negligible. Also, though the maximum amplitudes of left and right hand echoes may not then be equal for equal errors in line for opposite directions, there is no error in the observed bearing. This does however, affect quantitative line spotting but this has never been recommended with Type 274 and with the introduction of Types 930 and 931, the use of Type 274 for spotting will be less.

The issue of polar diagram test gear is felt to be unjustified on the basis that the measurement is difficult to carry out in a ship. The method of setting up using a point source such as a range marker is considered to be perfectly satisfactory.

A-J Measures for Type 274.

The following anti-jamming measures are in hand; some of them are being sent out immediately, some are not yet produced.

Patt. 55531	Filter Unit 'Video' Design 8 is an addition.
Patt. 58213	Amplifier Unit 'Video' Design 2 will replace Patt. W7030 Amplifier M65.
Patt. 59092	Amplifier Unit 'Video' Design 4 will replace Patt. W7036 Amplifier M66.

When these A-J measures are completed the set will be known as Type 274M.

Type 274 Beam Switch Commutator.

Did you see Admiralty "A" Message 584A? This gave details of a method of preventing mush due to faulty commutation. Other experimental work is going on at high priority to decrease the frequent cleaning needed by this apparatus.

Protection of Crystals in Type 275.

Cases have occurred in multi-set ships of receiver crystals being damaged by a large signal from an adjacent set. This may occur if the first set is switched off so that the gas-switch is not operating.

A solenoid operated relay is being developed which will virtually introduce a short circuit into the gas switch circuit until the priming voltage is switched on. This will affect a permanent cure but meanwhile care must be taken and a drill evolved on ships. The following methods are suggested :

(i) A metal painted canvas cover to be placed over nacelles when the set is not to be used for some time.

(ii) A drill to make sure that all receivers are switched on and the gas switches primed before transmitting on any set.

(iii) A common source of gas switch priming voltage for all sets.

(iv) A drill to train directors not manned so that transmissions from one will not impinge directly into another.

RADAR TYPE 293M

TRIALS

The following surface ranges were reported by H.M.S. BARFLEUR on trials using a control table giving a rotation speed of 10 r.p.m.

"Type 293 - Range Performance on Various Surface Targets.

The under-tabulated data has been collected from observation of the performance of radar Type 293 on surface targets.

TARGET	RANGE	REMARKS
H.M.S. BIRMINGHAM	37,000 yards.	Detected. Sea moderate.
H.M.S. NORFOLK	40,000 yards.	Detected. Sea rough.
CONVOY IN MEDITERRANEAN	48,000 yards.	Seen opening. Towards end, painting intermittently - Sea calm.
MERCHANT SHIP 10,000 tons.	33,000 yards.	Seen opening. Sea calm.
H.M. SUBMARINE (1) (fully surfaced)	15,000 yards	Sea calm.
H.M. SUBMARINE (2) (H.M.S. VAMPIRE)	16,000 yards.	Detected. Sea moderate to rough.
2 Light Fleet Aircraft Carriers.	40,000 yards (intermittent to 45,000 yards)	Seen opening. Detected closing at 44,000 yards. Painting separately an strongly at 37,000 yards."

H.M.S. BARFLEUR also reported ranges on a Mosquito aircraft closing approximately as follows:-

HEIGHT OF A/C	RANGE OF MIN. COVER	RANGE OF MAX. COVER
0 ft.	23,000 yards	24,000 yards
500 ft.	26,000 yards	34,000 yards
5,000 ft.	24,000 yards	34,000 yards
10,000 ft.	29,000 yards	37,000 yards
20,000 ft.	30,000 yards	34,000 yards

H.M.S. BARFLEUR emphasised in her report the very great importance of correct setting up and testing and commented on the variations between consecutive runs. A variation in ranges on aircraft of as much as ± 10% between runs, is in fact to be expected and should occasion no alarm or despondency.

In her Radar Routine Report dated 24:4:45, H.M.S. UGANDA reports as follows:-

"Type 293 (with aerial AQR) is now giving satisfactory results. Aircraft regularly appear at 25,000 - 40,000 yards. Continuous paints are obtained reliably within 20,000 yards except for a short fade at 13,000 yards. Runs were carried out at all heights up to 8,000 feet and operational experience has indicated no decrease in reliable range up to 15,000 feet. The set was very disappointing until all details had been thoroughly checked, very careful tuning carried out and a high ratio crystal fitted."

Reliable ranges included in H.M.S. UGANDA's report are as follows:-

"Buoys	9,000 yards
MTB/ML's	12,000 yards
Trawlers	18,000 yards
Destroyers	33,000 yards
Light Cruisers ..	37,000 yards
Heavy Cruisers ..	42,000 yards
Battleships.. ..	49,000 yards
Carriers	47,000 yards
Aircraft up to 10,000 feet ..	18,000 yards"

The ranges given above are not to be regarded as an obsolute standard. They are published to shew the ranges that can be obtained with normal equipments. While all equipments may not give as good results as these, it is considered that 18,000 yards on aircraft should be regarded as a minimum to be expected for reliable painting for Target Indication and if it cannot be obtained the setting up and testing of the set rather than its design should be suspected. For warning purposes ranges of about 25,000 yards on aircraft should normally be expected as evidence shews that at this range there is a 75% probability of detecting a medium twin-engined bomber closing at heights up to 20,000 ft.

RADAR TYPE 931

Radar Type 931 is a K-Band set which is being produced in Canada to meet the need for better spotting facilities for low angle gunnery than those provided by Radar Type 274. It is not intended to replace Type 274 which will remain the primary fire control set, but it is being provided with an accurate ranging system and remote bearing tube so that it will provide a stand-by set in the event of Type 274 being put out of action or successfully jammed.

The display system comprises three 5" cathode ray tubes, all of which provide range-azimuth ("B") presentation.

Two alternative pictures will be available as follows :-

$\pm 5^{\circ}$ in azimuth horizontally across the tube and 0 - 40,000 yards in range vertically. This provides a plan of a sector 10° wide and extending out to 40,000 yards and will be used when the whole field is to be examined.

$\pm 5^{\circ}$ in azimuth horizontally and $\pm$ 1000 yards relative to the range setting. This provides a plan of a sector 10° wide and 2000 yards long and will be used for spotting fall of shot relative to a selected target, which will appear in the centre of the picture. It will also be used for accurate ranging and following in bearing when Type 931 is used for these purposes. Bright lines generated electronically are presented on this picture at intervals of 200 yards in range and 1° in azimuth, the centre lines on the tube being brighter than the remainder.

The major units of which the set is comprised are as follows :-

AERIAL OUTFIT ANQ.

This will be fitted on the roof of the D.C.T. underneath the Type 274 Aerial, being supported by brackets from the roof, these brackets carrying trunnion bearings fitted at each end of the aerial.

In ships fitted with the stabilised Type 274 aerial, aerial outfit ANQ will be stabilised by the same unit, probably by a link motion from the Type 274 aerial. In those ships fitted with an unstabilised Type 274 aerial it will be necessary to fit a stabilising unit on the D.C.T. roof for stabilising Aerial Outfit ANQ. This unit will then stabilise the aerial by means of a quadrant at the starboard end.

The fitting of the aerial will in all cases need to be carried out by a dockyard, because certain structural alterations will be necessary. In some ships fitted with unstabilised Type 274 it will also be necessary to raise the AUO aerial 7 inches to obtain space for fitting Type 931 aerial underneath.

EQUIPMENT FITTED INSIDE THE D.C.T.

To make room for the Type 931 equipment, the inclinometer will be removed leaving a clear space in the port forward corner of the after upper compartment of the D.C.T. This space will then be used to accommodate the following units :-

Panel 3CA Modulating and Controlling.

This unit which is built in the form of a 3 drawer filing cabinet will be fitted athwartships facing towards the Rate Officers' seat. This unit consists of a Rectifier Unit Des. 116, a Modulator Unit Design 16 and Azimuth Sweep, Generator and Monitor Unit Des. 1. Withdrawal space is required in front of this panel for servicing.

Control Unit Des. 47.

This is fitted on the top of Panel 3CA at the right hand side and is used to control the Transmitter-Receiver 10R described below.

Cathode Ray Unit Des. 41.

This unit is fitted on top of Panel 3CA beside Control Unit Des. 47. This unit requires withdrawal space in front and below it, as for servicing purposes it may be drawn out to the full extent and hinged down. The question of withdrawal space for this unit and also Panel 3CA has been carefully investigated and the only obstruction will be the Rate Officers' seat which may have to be removed temporarily during servicing of a drawer of Panel 3CA.

Transmitter Receiver 10R.

This unit will be suspended on resilient mounts from the roof of the D.C.T. above Panel 3CA with a waveguide from this unit to the aerial.

A D.C. pulse at approximately 1000 volts is generated in the modulator unit. This pulse is of $\frac{1}{4}$ microsec. duration and occurs 2000 times per second. This is conducted to the Transmitter Receiver 10R by means of a shielded cable where a pulse transformer steps up the voltage to 10,000 volts. This voltage is applied to a magnetron.

The entire receiver is contained in this unit consisting of T.R. cell, A.F.C. unit, local oscillator, mixer, 8 stages of I/F amplification a detector, video amplifier-limiter and cathode follower output. The video output pulse leaves the unit at a level of about 1·0 volts.

The setting up of this unit will normally, it is hoped, be done in the test room but certain operational adjustments will be required with the unit in position in the D.C.T. This unit is therefore being arranged so that it can be easily removed from its operational position and will also have removable access covers for making final adjustments in position.

BOX JUNCTION.

3 Way with 3 Sockets.

The magnetron voltage pulse from Transmitter 9U is normally conducted by means of a cable to Modulator 3AW. This junction box is fitted in the cable and the Type 274 pulse is conducted to Panel 3CA as a sync. pulse to control the 2000 cycle recurrence generator so that when Type 931 and Type 274 are both operating, their transmitter pulses are synchronized. Type 931 will operate in the absence of a synchronizing pulse from Type 274.

BLOWER.

Final arrangements regarding the supply of cooling air for Panel 3CA have not been made. A blower is being supplied by D.N.O.

EQUIPMENT FITTED ELSEWHERE.

Panel L56 (RS).

The location of this equipment depends on the class of ship fitted, the preferred position being in the T.S. In the K.G.V. class there will not be room in the T.S. and this unit will be fitted in the Type 274 office on the Admiral's Bridge.

This panel contains a Rectifier Unit Des. 117, Ranging Unit Des. 2, Phase Adjusting Unit Des. 4, Cathode Ray Unit Des. 41, Panel Control Unit Des. 48 and Cathode Follower Unit Des. 15.

Withdrawal space is required in front of the unit and space will be needed for an operator to observe the cathode ray tube and operate the Range Transmission Unit Mark VII which is mounted on the front of the panel.

The R.T.U. Mark VII is fed from the A.F.C.T. with "Range Rate" derived from Type 274. In the event of Type 274 being out of action, the R.T.U. Mk. VII on Panel L56 will become the controlling R.T.U. and will feed target range to the A.F.C.T.

Distribution Board Patt. W6435A.

This board which distributes power to the various units of the set will be fitted in the same compartment as Panel L56 and should be sited as close to it as possible.

Cathode Ray Unit Des. 41.

This unit is for the bearing plot operator at the A.F.C.T. and serves as a stand-by for the Type 274 Bearing Panel L32. It should be sited in the most convenient position for this operator and may be tilted up or down as desired. Withdrawal space is required in front and below this unit.

Rectifier Unit Des. 115.

This unit provides the necessary power for the Cathode Ray Unit Des. 41 and should be conveniently sited such that the cable run between the units does not exceed 15 feet. The unit must be mounted horizontally and space in front of the unit is required to allow for its removal for servicing.

Power Supplies.

In order to reduce fitting work to a minimum and to make use of existing work where possible, it is proposed to supply Type 931 as follows :-

(a) In ships with one Type 274 only (except HOWE and K.G.V.) use A.C. outfit DUE existing (part of Type 274).

(b) In K.G.V. use A.C. outfit DUE for Types 292/3/4/5 for which there should be existing wiring to the old Type 284 office and T.S.

(c) For BELFAST - as for K.G.V. Class.

(d) For SUPERB and ONTARIO and any other cruisers fitting 3 Type 275's use A.C. outfit DUC.

(e) For RENOWN - as for K.G.V. class above.

It is not expected that it will be necessary to provide a separate power supply for any of the ships to be fitted but if such is required, Outfit DUF will be used.

Rectifier Unit Patt. W3275.

Two of these units are being supplied. One will be sited in a radar office in the bridge structure or other convenient position where the cable run through the D.C.T. support tube to Transmitter Receiver 10R does not exceed 100 feet. The second unit will be sited in a convenient position close to the test rack used for adjusting the spare Transmitter-Receiver 10R.

THE RADAR TRAINING SIGHT

The Radar Training Sight provides a new compact training tube for use with Type 285. It has been primarily designed to overcome the difficulties which have been experienced in fitting, operating and servicing the existing training tube, the Cathode Ray and Rectifier Unit, Design 'A', in Rangefinder Directors and Three-Man Rangefinders with Type 285, but it can be adapted also for use in H.A. Directors (with Type 285). The Radar Training Sight, as designed for use in Rangefinder Directors and Three-Man Rangefinders, is known as Outfit RAA. The equipment which is being developed for use in H.A. Directors is known as Outfit RAB. These outfits differ only in the form taken by parts of the equipment.

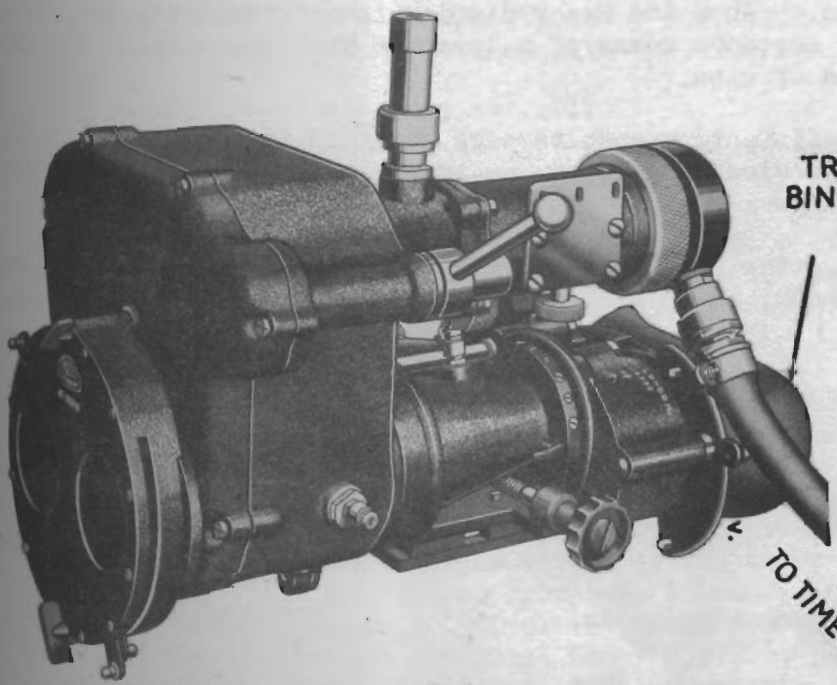
The Radar display of this equipment is not viewed directly on the cathode ray tube on which it is produced, but an image of it is projected into one eyepiece of the trainer's binoculars and so appears superimposed on the trainer's field of view. Two alternative scans are provided. One is a normal scan, covering the range 0 - 20,000 yards and synchronised by the sync pulse from the main display equipment. The other is a speeded scan which covers a distance of 1500 yards either side of the target echo selected by the operator of Panel L24; this scan is synchronised by the strobe pulse of Panel L24 and, when it is in use, the target echo always appears in the centre of the trainer's field of view. The sight receives a separation pulse from the aerial equipment so that each echo appears as two separated peaks, as on the Cathode Ray and Rectifier Unit.

Outfit RAA is illustrated on Page 25. The principal units are the Time Base Unit, Design 20, which is fitted in a position in the director within convenient reach of the trainer's left hand, and the Radar Sight, Design 1, which is fitted in between the colour filter box and the front face of the trainer's binoculars. Other Outfits will vary only in the design of the Radar Sight and the mounting bracket for the telescope. The sight used with Outfit RAB will be known as Radar Sight, Design 2.

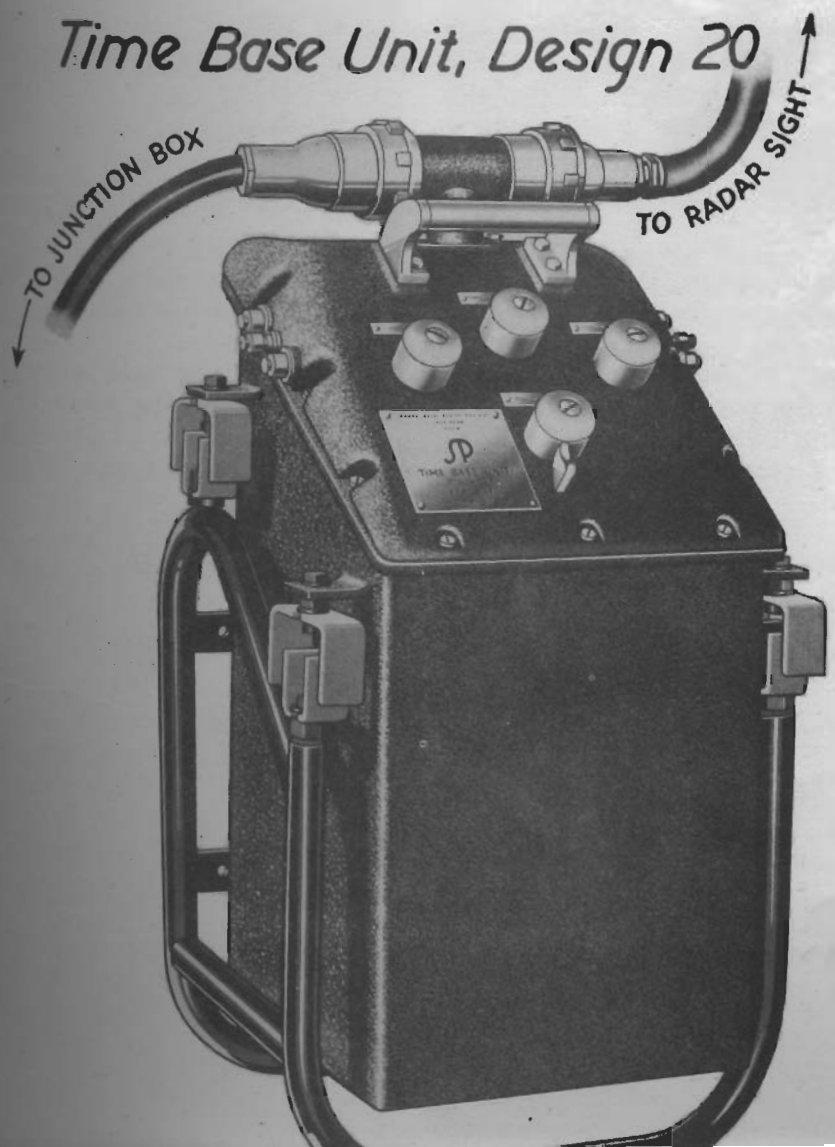
The Time Base Unit houses all the radar circuits except the Cathode Ray tube. The input signals and the power supplies are identical with those fed to the Cathode Ray and Rectifier Unit Design A, which the outfit replaces. The Time Base unit is mounted in a different position from the original unit and an extension of the original input leads is required. A special junction box and flexible multi-core cable are therefore provided for connecting the time base unit to the existing wiring. The RANGE switch, which selects either of the two alternative sweeps, and the FOCUS, BRILLIANCE and ECHO SEPARATION controls are mounted on the front panel of the Time Base Unit. Steps

RADAR TRAINING SIGHT OUTFIT RAA

Radar Sight, Design I.



Time Base Unit, Design 20



have been taken to keep the unit dry and watertight; all the control knobs have their own integral air seals and provision is made for attaching a dessicator and pump to pass dry air through the unit.

The Radar Sight contains the cathode ray tube and the mirrors by means of which the picture on the screen of the tube is projected into the binoculars. When the Radar display is not required, the mirror system can be moved by means of a lever so that the display is removed from the field of view.

Very satisfactory results were obtained in trials of a Development Model in a Home Fleet destroyer, as the following extracts from Commodore (D)'s report show :-

"..... the sight entirely came up to expectations and the (development)model is in general satisfactory .....

Summary of Results.

	Run.	Max. Error.	Arithmetic Mean Error.
Visual training - Radar Out,	2	0° 27'	8·6'
	23	0° 48'	19·0'
Visual training - Radar In,	3	0° 30'	14·8'
	10	0° 30'	9·0'
	17	0° 15'	7·4'
R.T.S. training,	4	1° 18'	24·0'
	11	0° 51'	17·0'
	14	0° 21'	9·0'
	18	0° 24'	11·0'
	21	0° 21'	9·5'
	25	1° 42'	33·0'
	28	1° 03'	24·0'

The general design, layout, construction and finish of both sight and time base were thought to be excellent and set a new standard ....."

It is hoped to have some production models in July working up to 100 per month in September. Special arrangements are being made to get the Radar Training Sight out to the Far East, where no difficulties in installing it are envisaged owing to the ease with which it can be fitted.

N.B.

The time base unit will operate only with a Panel L24 which has been modified in accordance with C.A.F.O. 1767/44.

(Editor's Note :- The Radar Training Sight was invented and designed by a Radar Officer - Lieutenant L.E. Crawford, R.N.V.R.)