

A C.A.F.O. will be issued shortly setting out the number and position of the various remote displays to be fitted in conjunction with warning sets. The remote displays are as follows :-

Display	Handbook	Fitting out Specification	Use
Outfit JE (P.P.I.) (H.P.I.)	C.B.4298(43)	B312/44.	Plan Position Indicator. Height Finding (Type 277).
Outfit JK. (Skiatron)	H.464-H.464A.	B325/43.	Plan Position Indicator.
* Auto Radar Plot	-	-	A development of the Skiatron.
* L37 (Sector Display)	-	-	Ranging on a target without stopping the aerials rotating
* L43 (Sector Display)	-	-	Interrogating
* L44 (Sector Display)	-	-	Height finding (Types 281 or 79)
* Not yet in production.			

In certain cases switches will be provided so that the unit may display the output from one of two sets. Some notes on switching of P.P.I's and Skiatrons will be found in C.A.F.O's 1049/44 and 1050/44.

In order to work a remote display, signal, sync, A.C. power supply and step by step bearing transmission, must be provided.

PROVISION FOR SIGNAL DISTRIBUTION

The most satisfactory signal for a P.P.I., Skiatron or an Auto Radar Plot should not exceed three times the noise level. This is done by suitably designing the output circuit. Such an output is called "limited". P.P.I's., Skiatrons or Auto Radar Plots may however be run from unlimited outputs as the units themselves contain a limiter. For 'A' scan or similar presentation such as L37, L43 and L44, an unlimited signal is required.

A low impedance line is required to take the signal to a remote display. A line of approximately 68 ohms is used. This line must be matched at its transmission end by a similar impedance in a cathode follower unit, and at the display end by a similar impedance in the display unit. In the case of the Skiatron and the Auto Radar Plot the low impedance is not incorporated in the unit, but in a junction box (Pat. 55010 for the Skiatron).

Owing to the number of remote displays it is often necessary to run more than one display from the same cathode follower. The maximum number of displays which can be run from one output depends upon the nature of the displays, the cathode follower used and the length of line involved. The following points should be noted :-

- (i) As stated above, to provide the best results P.P.I.'s, Skiatrons and Auto Radar Plots require limited outputs, while L37, L43 and L44 require unlimited outputs.
  - (ii) A local and a remote display may often be conveniently run from the same output, particularly where there are two plugs on the cathode follower. The lead to the local display should be kept as short as possible and the display should be modified so as to present a high impedance. This can be done by removing the resistance between the signal input and earth (R85 in the case of P.P.I.) Two displays in the same office can be run from one output. In this case one should present a high impedance and one a low impedance. The lead from the point where the signal line from the office divides to the high impedance display must be kept short. Care must be taken that the proper matching of the line is maintained when a display is switched from one set to another.\* When two displays, situated in separate positions, are to be taken from the same output, the signal lead should be run to the nearest office where a short branch line should be taken to a high impedance display. The signal lead should then go to the second position and terminate in a low impedance display.
- (a) Type 281/B. The signal outputs from receivers P13 and P23 are not immediately suitable for supplying remote displays; the signal must first be inverted.

The mixer units required for displaying the interrogator also provide the inversion of the Type 281/B signal and the necessary low impedance cathode follower outputs.

Mixer Unit Design C. Patt. W9282. This unit contains one cathode follower, but two plugs are provided so that a local and a remote display may be run from it. By suitable adjustment of the gain control the output may be made limited or unlimited. A switch in the radar office provides either "radar" or "radar + I.F.F." output. (C.A.F.O. 2496/43 refers).

Mixer Unit, Design 5. Patt. 54448. This unit is similar to Design C except that the I.F.F. control is in the remote position. (Draft C.A.F.O. in hand).

Multiple Mixer Rack. A few ships have been supplied with a rack consisting of three Mixer Units Design 5 and a rectifying unit to provide the necessary power supply. Type 281 can provide sufficient rectified power for one mixer only. (Handbook H557 refers).

\* Editors Note:- This can best be done by incorporating the terminating resistance in the switch.

Mixer Unit, Design 7. This unit will be available shortly. It contains five cathode followers with the following outputs :-

Cathode Follower.	Interrogator Mixed or Unmixed.	Limited or Unlimited.	No. of Output Plugs.
No. 1	Either (switch in A.D.R.)	Limited.	1
No. 2	Either (switch in A.D.R.)	Limited.	1
No. 3	Either (switch in A.D.R. and Office)	Limited.	2
No. 4	Unmixed	Limited.	1
No. 5	Unmixed	Unlimited.	1

- (b) Types 276, 277 and 293. A unit consisting of three cathode followers is included in these sets. The outputs are unlimited. There is also a high impedance output which may be used to work an additional cathode follower unit, of which two types will be available shortly, a three way cathode follower Patt. 53197 and a six way cathode follower Patt. 53198. The outputs from these units are limited.

#### PROVISION FOR SYNC. DISTRIBUTION.

When more than one remote display is run off the same sync. distribution line considerations similar to those referred to in the previous section apply. Requirements are not, however, so stringent. The impedance of the line used is approximately 47 ohms.

P.P.I's. are always internally "terminated" and cannot be adjusted to present a high impedance to the sync. line.

- (a) Type 281/B. The Mixer Units referred to in the previous section, other than Mixer Unit Design 7, provide sync. outputs to correspond with the signal outputs. The sync. output from Mixers Design C and 5 is adequate for two terminated lines only. When Mixer Unit Design 7 is used a separate sync. distribution box will be required.
- (b) Types 276, 277 and 293. The low impedance sync. output is provided in the set and all the necessary remote displays can be run from this by means of a sync. distribution box.

PROVISION OF POWER SUPPLIES.

P.P.I.'s require 180 volts 500 cycles power supplies. These supplies are taken from the set in connection with which the display is run except in the case of displays from Type 281/B where any convenient source of 180 volts 500 cycles must be used.

PROVISION FOR BEARING TRANSMISSION.

All displays require half degree 'M' Type Transmission. The P.P.I. is designed to take either true or relative bearings. The Skiatron, except for early models (see C.A.F.O. 1049/44), requires true and relative bearing. It contains two true bearing receivers and one relative bearing receiver, the latter being for the aerial bearing indicator. The Patt. 54782 Transmitter Attachment, which will be available shortly for fitting to control unit 20D of Type 281/B, provides two true bearing transmitters and one relative bearing transmitter. Types 276, 277 and 293 provide true bearing and a relative bearing transmitter. The receivers in P.P.I.'s and Skiatrons require a fair amount of power and approximately five only can be run from each transmitter in the case of Type 281. The transmitter fitted in control table for Types 276/277/293 is more powerful and will drive 7 or 8 P.P.I.'s. The efficiency of a transmitter is improved by fitting three 500 mfd. condensers in "star" across the outputs. Patt. 50089 condenser is suitable. In some cases it may be necessary to fit a Bottle Transmitter (Patt. 4356M).

ERRATA

Bulletin No. 1.

- Page 35 Para. 5 - for .003 read .03
- Last Para. - for "readings on the galvanometer" read "log of readings on the galvanometer".
- Page 36 Para. 2 - for "these rapid changes is" read "the 10 cm component is"
- Page 43. First item under "Fitted in Ships" read "271/2/3/5, 286, 291" etc.

DIGEST OF H.M.S. VICTORIOUS  
REPORT ON TYPE 277

The facts and figures given below are of special interest because the Type 277 in H.M.S. VICTORIOUS is the first set of its type to be used operationally at sea against the enemy.

DETAILS OF INSTALLATION.

Length of Waveguide ..... 34 feet.  
Aerial height above waterline ..... 87 feet.

PERFORMANCE

Aircraft at heights between 500 and 7,000 feet can be detected up to ranges between ...-... miles (depending on type of aircraft). (Editors Note :- The figures given exceed expectations). The reduction in range on aircraft above angles of sight of  $5^{\circ}$  is found in practice to be approximately 40%.

For height finding purposes an average accuracy of + 500 ft. has been attained on aircraft subtending an angle of sight greater than  $5^{\circ}$ . The use of an angle of sight-range-height conversion graph gives a greater accuracy but there is an additional delay in reporting. On very high flying closing aircraft, less accuracy is experienced because of the rapid rate of change of angle of sight.

APPLICATIONS.

Type 277 is suitable for close range interceptions and for catching the low flying "snooper". The freedom from side lobes gives a very good P.P.I. picture at low angles of sight. If an aircraft is above an angle of sight of  $5^{\circ}$  the Type 277 has to hold the target both in bearing and elevation and the P.P.I. picture disappears, and if a rapidly moving aircraft is lost some time may elapse before it is relocated.

When several aircraft are flying in close formation, particularly if they are flying in line ahead, it is difficult to estimate the numbers, and the figure given from inspection of the "A" scan echo is inclined to be on the low side. The width in degrees of bearing on the P.P.I. "paint" gives a better indication when the aircraft are flying in line abreast. The usual estimation rules employed on the WA set fail when applied to Type 277. (Editors Note :- A tight formation of between 2 and 3 aircraft gives an increase in location range).

Provided that protecting fighters are kept within range of the set, it is possible to orbit their patrol in the expected direction of a high level bombing attack, and to indicate the height of an approaching group of which previous warning has been given by the WA set. The set's principal weakness is the necessity for 'holding for height' which means that only one formation can be tracked at a time.

#### METHOD OF OPERATION.

When operating as a height finding set, two main inherent problems arise :-

- (a) Indicating the WA target to the Type 277 which is required to sweep both in azimuth and elevation to locate same.
- (b) The need for close co-operation between the P.P.I. and H.P.I. operators when 'holding for height'.

To cope with these two problems H.M.S. VICTORIOUS has made the following additions to the office equipment :-

- (i) The fitting of cut switches and indicator lamps associated with the P.P.I. and H.P.I. The lamp being operated by the P.P.I. operator is placed over the H.P.I. and vice-versa.
- (ii) It is also suggested that a Design "B" P.P.I. be fitted over the Type 277 P.P.I. and fed from Type 281B, rather than to have this P.P.I. situated over the height plot as it is at present. It is hoped that in due course two Design "B" P.P.I.'s, one over the height plot and one over the Type 277 P.P.I. may be fitted and connected via a change-over switch to the Type 281B.
- (iii) The counter drum range receiver operated by the R.T.U. 52 has been fitted directly over the H.P.I. to indicate target range.

#### OPERATING DRILL.

No.1 is the P.P.I. operator and tells on the WS reporting line.

No.2 is the "A" scan operator who controls inter-rotation and investigates the echo. He assesses the numbers and type of target. Hand operating of the Type 242 aerial is used, providing the most satisfactory method.

No.3 is the H.P.I. operator who reports heights on the height filter line.

On detecting a target at low elevation, No. 1 reports range and bearing, No.2 interrogates and ranges with R.T.U.52, the strobe spot being used as a pointer to indicate the position of the "A" scan at which the I.F.F. signal

should or should not appear. If told to investigate the echo, No.1 holds the target while No.2 assesses numbers and classifies the echo, then all round sweeping is resumed. In the case of an approaching aircraft above 7000 feet small sweeps in azimuth and elevation are carried out on the WA bearing and at the estimated angle of sight until the target is located. When the aircraft's bearing and height are not known, searching is carried out by using a fast all round sweep and elevating the aerials in steps of 2° after every two complete sweeps. On locating the echo, No.1 reports "ECHO" 060/37,000 (for example), holds the echo, presses his cut lamp switch and reports "ON BEARING 36,000".

No.2 runs the strobe out to the target range and interrogates.

No.3 sweeps over the echo, reports "TARGET", presses lamp cut switch and reads off the target height.

No. 2 reports "3 PLUS AIRCRAFT, I.F.F. setting 3" (for example).

No.1 passes this supplementary report on the WS line while continuing to "Hold for height".

The cut switches and lamps and H.P.I. range receiver then render any further conversation between numbers 1 and 3, unnecessary. No.2 operator also ensures that both P.P.I. and H.P.I. operators are on the same target. At Action Stations a fourth operator looks after the transmitter and associated equipment and acts as logger and eye relief.

A sweep rate of 4 to 6 R.P.M. has given optimum results for normal searching and warning.

Operators experience difficulty in controlling the aerials for bearing when "holding" a target and the neutral position of the induction regulator is hard to find. It is suggested that a large control handwheel be fitted. (Editors Note :- A new handwheel is being produced).

#### GENERAL.

The average ratio of P.P.I. location ranges to "A" scan location range is as follows :-

Aerial training 5-6 r.p.m.	
on Aircraft	- 79%
Surface craft	- 92%
Aerial training 10 r.p.m.	
on Aircraft	- 70%

In view of the reduced P.P.I. location range, watch is maintained on both the "A" scan and P.P.I. when searching.

OPERATING INSTRUCTIONS.

STATE 'D' - 15 minutes notice.

180V Motor Alternator stopped, 230V M/A and waveguide drier running, all other switches 'OFF' except radiator and panel heater units.

Note :- Normally waveguide drier and blower is to be switched on 4 hours before set is brought to short notice.

STATE 'C' - To switch on to 5 minutes notice :-

1. Ensure that all panel switches are 'OFF', HT Variac is fully anti-clockwise and IFF switch is on to "R.D.F."
2. Select M/A and put Hand/Auto switch to "AUTO".
3. Start up 180V M/A (and 230V M/A if not already running) and adjust output voltages to normal (180V and 230V).
4. ON DISTRIBUTION BOARD :-
  - (a) Make 180V 500 cycles switch to modulator.
  - (b) Start Tx. Blower motor - 30 seconds on "Start", then switch straight over to "Run".
5. Switch Magnetron filament to "Start", wait 30 seconds then switch to "Run".

STATE 'B' - To switch on to immediate notice :-

6. ON DISTRIBUTION BOARD :-
  - (a) Make 230 V, 50 cycle switch to Control Table.
  - (b) Make 220 V, D.C. switch to Control Table.
  - (c) Make 180 V, 500 cycle switch to Control Table
  - (d) Make 180V, 500 cycle switch to Receiver.
  - (e) Make 180V, 500 cycle switches to Interrogator, Cathode Follower Unit, RTU 52 and H.P.I.
7. Switch ON Trigger HT.
8. Switch ON G86 monitor.
9. Switch ON local P.P.I. and H.P.I.



10. Make appropriate switches on Control Table and line up and check main and interrogator aerials, P.P.I., aerial repeaters and H.P.I. (See separate instructions on Control Table).
11. Adjust brilliancy and focus and check calibration of L26 scan, P.P.I., and H.P.I. and set up RTU 52 (See Footnote).
12. Check pulse on G86 monitor at monitor points C and E.

STATE "A" - To commence operating :-

13. Plug in G86 monitor to point "A".
14. Ensure that HT Variac is fully anti-clockwise and make HT switch.
15. Turn up HT Variac SLOWLY, observing pulse on monitor. If steady and no signs of waveguide sparking, continue to increase HT voltage to 13 kV. Then SWITCH OFF MAGNETRON FILAMENTS.
16. Commence training main aerials slowly.
17. Check operation of thermostat.
18. After 5 minutes check local oscillator tuning and crystal current.
19. Check monitor pictures at points A,B,C,D,E,& F - if correct switch OFF monitor.

REVERTING TO STATES B, C or D.

Switch OFF in the reverse order to that for switching ON. Always leave aerials pointing to Ship's head.

NOTE :-

Set must not be reported at "Immediate Notice" (State B) until a test transmission (State A) has been carried out and all scans calibrated.

(Editors Note :- It is suggested that it might be a good plan to letter the appropriate switches to facilitate the above procedure).