RESTRICTED

AIR PUBLICATION

**2897R**

**VOLUME 1**

*(Second Edition)*

**BOOK 2**

L. 7& 'A'

# FIXED COIL DISPLAY SYSTEMS FOR GROUND RADAR STATIONS

## (CONSOLES—WIRED FRAMEWORKS)

## GENERAL AND TECHNICAL INFORMATION

Prepared by direction of
the Minister of Aviation

Henry Hardman

Promulgated by Command
of the Air Council

M. J. Dean

AIR MINISTRY

(Reprinted Feb. 1961)

# DANGER-HIGH VOLTAGE


APPARATUS IS SAFE - ONLY IF YOUR APPROACH IS CORRECT

# AMENDMENT RECORD SHEET

**To record the incorporation of an Amendment List in this publication, sign against the appropriate A.L. No. and insert the date of incorporation.**

| A.L. No. | Amended by | Date |
|---|---|---|
| 1 | Incorp. in reprint | Feb. 1961. |
| 2 | J.H. Machin | MAR 1962 |
| 3 | [illegible] | AUG 1962 |
| 4 | [illegible] | FEB 1963 |
| 5 | [illegible] | MAY 1963. |
| 6 | [illegible] | MARCH 1965 |
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## FIXED COIL DISPLAY SYSTEMS FOR GROUND RADAR STATIONS

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## PREFACE

Volume 1, Book 1 contains Part 1, Sections 1 to 4, which deal with the general principles of fixed coil deflection systems and with the rack assemblies used.

Volume 1, Book 2 contains Part 1, Section 5, Part 2 and Part 3, which deal with the fixed coil display consoles, servicing and fault diagnosis.

To cater for variations in design, consoles are now known as wired frameworks (housing different units) instead of consoles Type 64, 64A, 64B, etc.

# NOTE TO READERS

The subject matter of this publication may be affected by Air Ministry Orders, or by "General Orders and Modifications" leaflets in this A.P., in the associated publications listed below, or even in some others. If possible, Amendment Lists are issued to correct this publication accordingly, but it is not always practicable to do so. When an Order or leaflet contradicts any portion of this publication, the Order or leaflet is to be taken as the overriding authority.

The inclusion of references to items of equipment does not constitute authority for demanding the items.

Each leaf, except the original issue of preliminaries, bears the date of issue and the number of the Amendment List with which it was issued. New or amended technical matter on new leaves which are inserted when the publication is amended will be indicated by triangles, positioned in the text thus ◀——▶ to show the extent of amended text, and thus ▶◀ to show where text has been deleted. When a Part, Section or Chapter is issued in a completely revised form, the triangles will not appear.

## LIST OF ASSOCIATED PUBLICATIONS

| | A.P. |
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| *Radar Type* 13 (*Mk.*◀6, 7 *and* 8▶) *and* 14 (*Mk.* 7, 8, 9, 10 and 11) *RVT* 500, 501, 502 *and static versions* ... | 2527B |
| *Information generator for radar stations* ... | 2527C |
| *Test equipment for mobile and static radar stations* ... | 2527D |
| *Information generation and distribution for static radar stations* ... | 2527E |
| *Static radar stations*: | |
| *Type GCI* ... | 2527H |
| *Mobile operations room Type* 1 (*RVT*.510) ... | 2897Q |
| *Consoles Type* 60 *and* 60*A* ... | 2897NA |
| *Consoles Types* 61, 61A *and* 61B ... | 2897NB |
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ERRATUM

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# Chapter 1

# INTRODUCTION AND INDICATING UNIT (CRT) TYPE 35

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## INTRODUCTION

**1.** A general description of the console Type 64, with brief information on the units in it, has already been given in Chap. 2, Sect. 1 of this Part. The chapters of Section 5 deal with the console units in greater detail. The location of these units in the console is shown in fig. 1 of Chap. 1, Sect. 1, Part 2.

## INDICATING UNIT

**2.** The *indicating unit* (*CRT*) *Type* 35 (Stores Ref. 10Q/16085) forms the upper part of the console Type 64, as shown in fig. 1. In the indicating unit are located :—

(1) the tube unit, containing the cathode ray tube with its focus and deflector coils ;

(2) the following sub-units, which are fully described in subsequent chapters :—

(a) *amplifying unit* (*video*) *Type* 312,

(b) *waveform generator* (*video gating*) *Type* 80,

(c) *blanking unit Type* 26,

(d) *panel* (*control*) *Type* 859.

The remaining units of the console (notably the deflection amplifiers), the console framework and the control desk with its desk cover, do not form part of the indicating unit.

**3.** The indicating unit may be drawn out on its runners (*fig.* 2) without detaching any of the connectors and without interrupting the operation of the console. This permits running adjustments to be made to certain preset controls (including FOCUS and BRILLIANCE) located on the sub-units. When lowering the indicating unit into the main framework, care must be taken not to trap the cableforms. Information on this and on the adjustment for taking up " sag " on the runners is given in Chap. 1, Sect. 2, Part 2. The circuit diagram of the indicating unit is given in fig. 7. Only the circuit of the tube unit has been drawn in full ; the remaining sub-units, listed in para. 2, are shown as blocks. The full circuit diagrams of these appear in later chapters in this Section.

### General description

*Framework*

**4.** The indicating unit, which weighs 119 lb. complete with its sub-assemblies, is constructed in a rigid welded steel frame (*fig.* 3). To allow free circulation of air round all units this framework is not covered in except by the front panel, which is cut away for the CRT screen and the adjoining control panel. The massively-constructed mumetal-covered tube unit, cylindrical in shape, is attached to the front panel by four bolts around the circumference. On the left-hand side of the tube unit (as seen by the operator) is a hinged inspection flap giving access to the CRT final anode side-cap and its EHT connector. To the rear of the main tube housing is attached the focus/deflector-coil assembly. At the rear of the indicating unit framework are its two input panels (right-hand and left-hand), which are inclined at an angle of 60 deg. to the main framework members, so

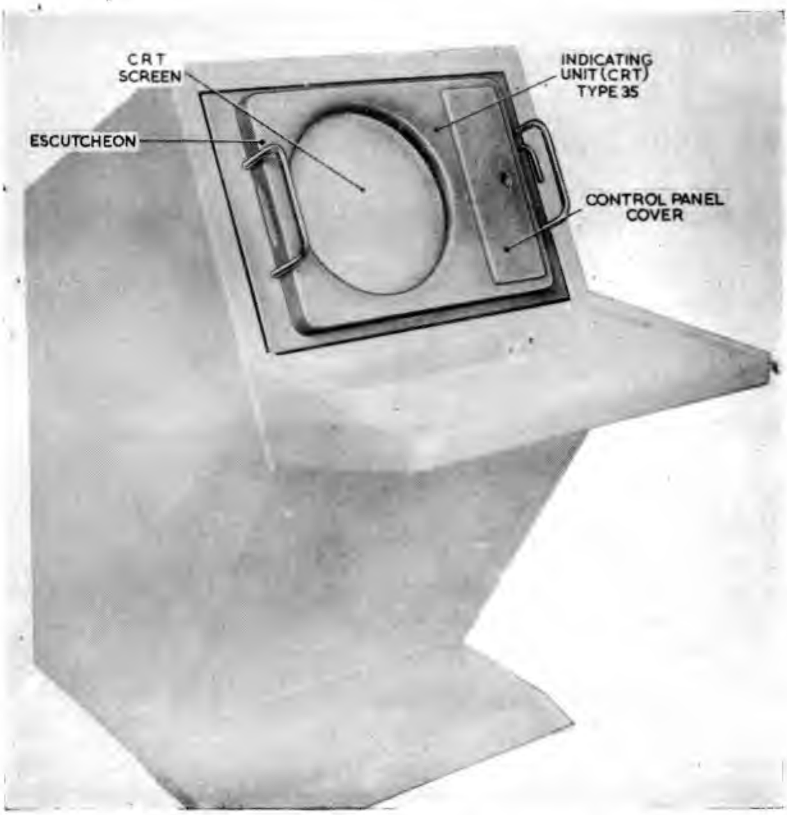


**Fig. 1. Location of indicating unit in console Type 64**

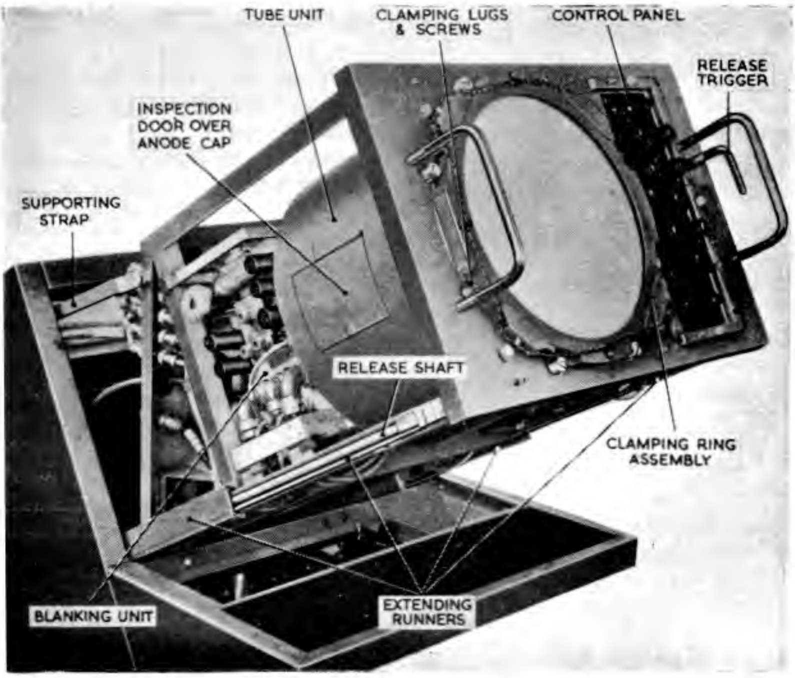


**Fig. 2. Indicating unit withdrawn from console**

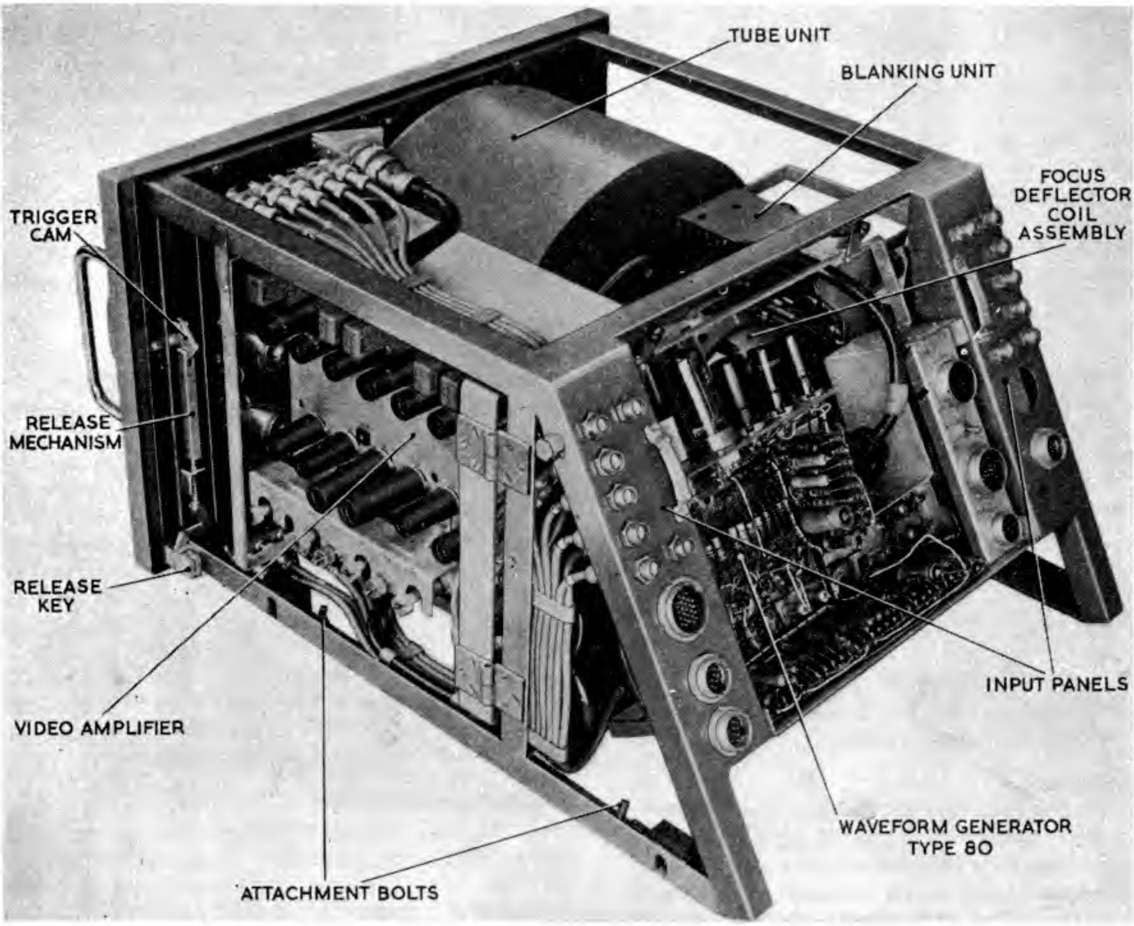


**Fig. 3. Rear view of indicating unit**

that the input panels will be vertical when the unit is in position in the console. The input panels carry coaxial and multicore panel-mounting couplers to which are brought most of the electrical connections to the indicating unit.

#### *Sub-units*

**5.** The control panel is fixed to the front panel of the indicating unit by four countersunk-head 2 BA screws. Side illumination of the knobs and markings on the control panel is provided by four 6V lamps (known as the *dial lights*) concealed inside a C-shaped lamp mounting channel running round three edges of the panel (*fig.* 2). Similar side illumination for any engraved transparency that may be placed in front of the CRT screen is available from four other 6V lamps (known as *screen lights*) concealed in the clamping ring assembly. In normal working, both the lamp mounting channel and the clamping ring assembly are hidden by a plain sheet-metal escutcheon (*fig.* 1), which clips on to the front panel between the two handles. The escutcheon is cut away for the CRT screen, and has a rectangular hinged cover to give acess to the control panel.

**6.** The video amplifier chassis is hinged into the right-hand side of the indicating unit (as seen by the operator), and retained by a single knurled captive screw. The BRILLIANCE control is located on this unit. The blanking unit (which carries the FOCUS control) is the small chassis mounted in a similar manner on the left-hand side. The waveform generator Type 80, which has a portion cut away to clear the CRT base (*fig.* 3), is at the rear of the framework and is retained by two captive screws to the upper horizontal member.

**7.** When in position in the console framework the indicating unit is mounted on three-draw telescopic runners (*fig.* 2). These runners are inclined at 30 deg. to the horizontal, so that in the working position the front panel slopes back at 30 deg. to the vertical. To bring the unit out to the forward position shown in fig. 2, it is only necessary to grip the two front handles, pull the release trigger and draw the unit forwards and upwards along the runners. Spring-loaded catches at the rear of the forward runners engage when the unit has been pulled right forward, and hold it locked in the forward position ; but as an extra precaution it is advisable to take part of the weight off the catches by erecting the supporting straps (*fig.* 2) at either side, before working on the unit. When servicing has been completed the unit may be returned to the normal position by removing the supporting straps, grasping the two front handles, pulling the release trigger, and allowing the unit to slide back down the runners under control.

*Release mechanism*

**8.** When the release is pulled, it operates the trigger cam (*fig.* 3), which turns the release key at each side of the unit by means of a link and coupling mechanism. The release keys engage with release shafts (*fig.* 2) mounted one inside each forward runner. When turned, the release shafts disengage the spring-loaded catches at the rear of the forward runners, enabling the indicating unit to be slid in and out.

*Attachment to runners*

**9.** Four slotted support blocks—of which two may be seen on the nearer framework member in fig. 3—fit over support spigots on the forward runners. Attachment bolts, working in the support blocks, engage in the support spigots and so secure the indicating unit to the runners. These attachment bolts may be turned and disengaged from the spigots so that the indicating unit may be lifted right off the runners.

**Note . . .**
*Full instructions for dismantling and re-assembly operations, including removal of the indicating unit, are given in Part 2 of this Volume.*

**Cathode-ray tube**

**10.** The cathode-ray tube, on the screen of which the actual PPI display is produced, is a CV429. This is a 12-in. tetrode tube with electromagnetic focusing and deflection ; its maximum usable screen diameter is 250 mm. (about 10 in.). The screen material is a Type 008 (fluoride) phosphor, aluminium-backed to give better brightness and freedom from ion-burn. The afterglow of this screen averages 40 seconds, which well exceeds the usual trace rotation period, so that a complete PPI picture is always visible while continuous search is in use. The trace colour is amber ; an amber-tinted filter is available as an optional accessory to improve picture visibility when there is a good deal of external lighting.

**11.** The CRT has a 12-pin spigot base (Type B12A), though only seven pins are actually present, and two of them are not connected. The pin connections, using the usual numbering convention, are as follows :—

**1.** Heater
**2.** Grid (*i.e.*, modulator electrode)
**3.** —
**4.** —
**5.** —
**6.** Not connected
**7.** Not connected
**8.** —
**9.** —
**10.** First anode
**11.** Cathode
**12.** Heater
**Side-cap:** Second anode.

**12.** The heater supply to the tube is rated at 6·3V, 0·6A. The first anode is operated at +400V, and the final anode at +15 kV. The cathode is held at a potential (controlled from the video amplifier) not far from earth, and positive-going brightness-modulation signals (above a negative bias level set in the video amplifier) are applied to the grid. The negative voltage required at the grid for complete beam cut-off varies considerably between different specimens of the CV429, but averages about 50V. The beam current varies from nothing in the dark parts of the picture to about 80 $\mu$A in the brightest parts.

*CRT mounting*

**13.** The bulb of the cathode-ray tube is supported at the back, where it joins the neck, by the deflector-coil assembly, which is spring-loaded and presses closely against the flare. Fig. 4 is a view inside the tube unit with the CRT removed, showing the deflector coils with the aperture for the CRT neck. The front part of the bulb is supported by twelve sponge-rubber pads disposed round a spring-mounted support ring. The CRT is forced home against the deflector coils and the support ring by the rubber-lined clamping ring assembly (*fig.* 2), which is held to the front panel by the eight clamping lugs. These engage on eight equally-spaced shoulders around the clamping ring. In normal use the clamping ring assembly is concealed by the escutcheon.

*Focus/deflector-coil assembly*

**14.** The focus and deflector coils are mounted in a cylindrical assembly attached to the rear of the tube housing by three bolts. A thin cylindrical mumetal shield protects the coil assembly and CRT neck from external magnetic fields. Fig. 5 shows the assembly with the coil shield in position and the CRT removed. Fig. 6 shows the assembly with the shield taken off and the CRT put back.

*Focus coil*

**15.** The purpose of the focus coil is to produce a steady magnetic focusing field along the beam axis (parallel to the CRT neck). The coil winding is entirely enclosed in a soft-iron case except for a narrow annular air-gap at the end nearer the screen.

*Position adjustments*

**16.** To ensure good definition all over the screen it is necessary to ensure that the focusing field has no deflectional effect on the spot, *i.e.*, that the axis of the focusing field is exactly parallel to the beam axis, and has no component perpendicular to it. To enable the focus coil to be positioned to meet this requirement, means have to be provided (*a*) to rotate the coil about two mutually perpendicular axes, and (*b*) to shift the whole coil relative to the CRT neck in two perpendicular directions.

**17.** To permit coil rotation about the beam axis, the rear part of the focus-coil housing—in which the coil is actually mounted—is made to rotate inside the front part. The rear part may, in fact, be turned through any desired angle, limited only

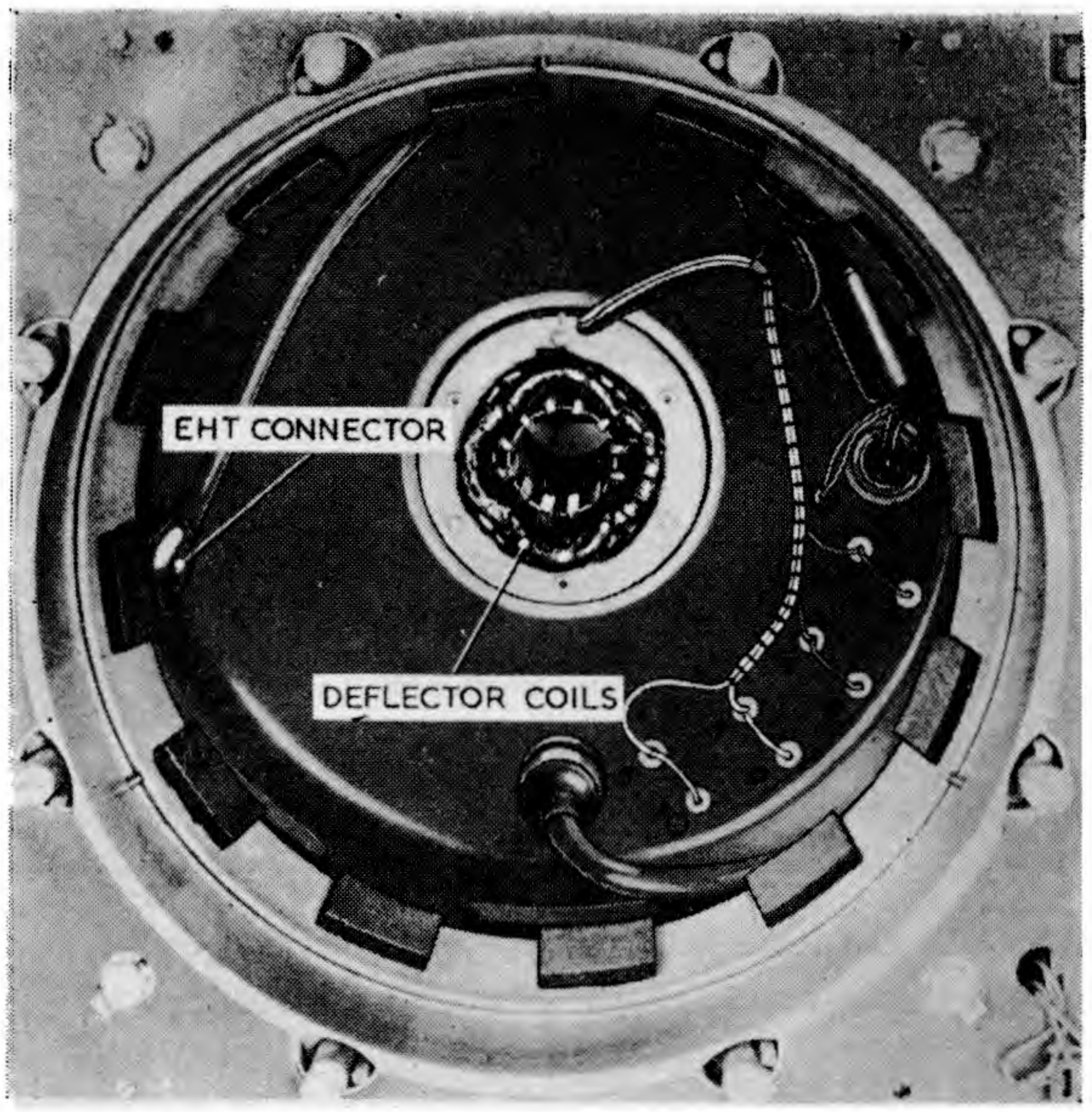


**Fig. 4. Interior of Tube housing**

by the amount of slack on the focus-coil leads (*fig.* 6). When a satisfactory position has been found, the rear part may be secured there by tightening down the screws on the clamp ring.

**18.** To allow rotation of the focus coil about an axis at right-angles to the beam axis, the focus coil is pivoted inside the rear part of the housing on two pointed grub screws located at opposite ends of a diameter. Tilt of the coil about the axis of these grub screws is limited at one side by a spring on which the coil case bears; the large flat-headed retaining screw for this spring may be seen on the left of the tube aperture in fig. 5. The coil is held up against the spring by the focus-coil tilt screw, marked on fig. 6. Turning this tilt screw alters the tilt angle of the coil; when the correct position has been reached the tilt screw is secured by its lock nut.

**19.** To provide for shift of the focus coil in two perpendicular directions, the whole focus-coil housing may be moved over a small arc about each of two centres of rotation, which are spaced 90 deg. apart around the flanges joining the focus-coil housing to the deflector-coil housing. The focus-coil shift screws, which effect these movements, are marked **A** and **B** on fig. 6. When the correct position has been found, further movements are prevented by tightening the associated clamp screws. (The drill for setting up all these items will be issued in Part 2.)

**20.** The normal focus current is about 38 mA, and a good deal of heat is developed in the coil. To dissipate this heat, ventilation holes are provided on both parts of the focus-coil housing. The two focus-coil ends are brought out through the housing to the small terminal strip seen in fig. 5; from there the flexible leads run down to PL2 on the tube housing.

**21.** The focus current comes from the blanking unit, where the focus current stabilizer is located; the current is drawn from a raw +570V bulk power supply. The purpose of R1 and C1 in series across the focus coil (*fig.* 7) is to prevent excessive voltages being induced across the coil when the supply is broken, either during setting-up or by accident.

*Deflector coils*

**22.** The purpose of the deflector coils is to produce, across the neck of the CRT, magnetic fields which vary in exactly the same way as the voltage waveforms at the input to the deflection amplifiers. The fields required are (*a*) vertical (X), producing horizontal spot displacements and corresponding to the line scan of a television receiver, and (*b*) horizontal (Y), producing vertical movements and corresponding to the frame scan. Iron-cored coils are used, which have several advantages over air-cored coils, including greater sensitivity, smaller size, and minimum deflection defocusing and interaction between X and Y coils. The core is built up of laminations of high-permeability material to minimise eddy currents. The laminations are slotted (*fig.* 4), and into the slots are assembled twelve saddle-shaped windings, arranged to secure the best possible uniformity of field across the neck. The windings are internally connected in threes so that there are in effect four deflector coils (X1, X2, Y1, Y2). One end of each coil is commoned and brought out (*red lead*) to a stabilized +250V HT supply. The other four coil ends are brought out, inside the tube housing, to coaxial sockets for connection to the anodes of the final deflection amplifiers situated in the lower part of the console. It will be seen that the two coils of a pair act in push-pull; when the spot is centred a current of 120 mA flows in each coil, and a movement of the spot to the edge of the screen is effected by an increase of 80 mA in the current in (say) the

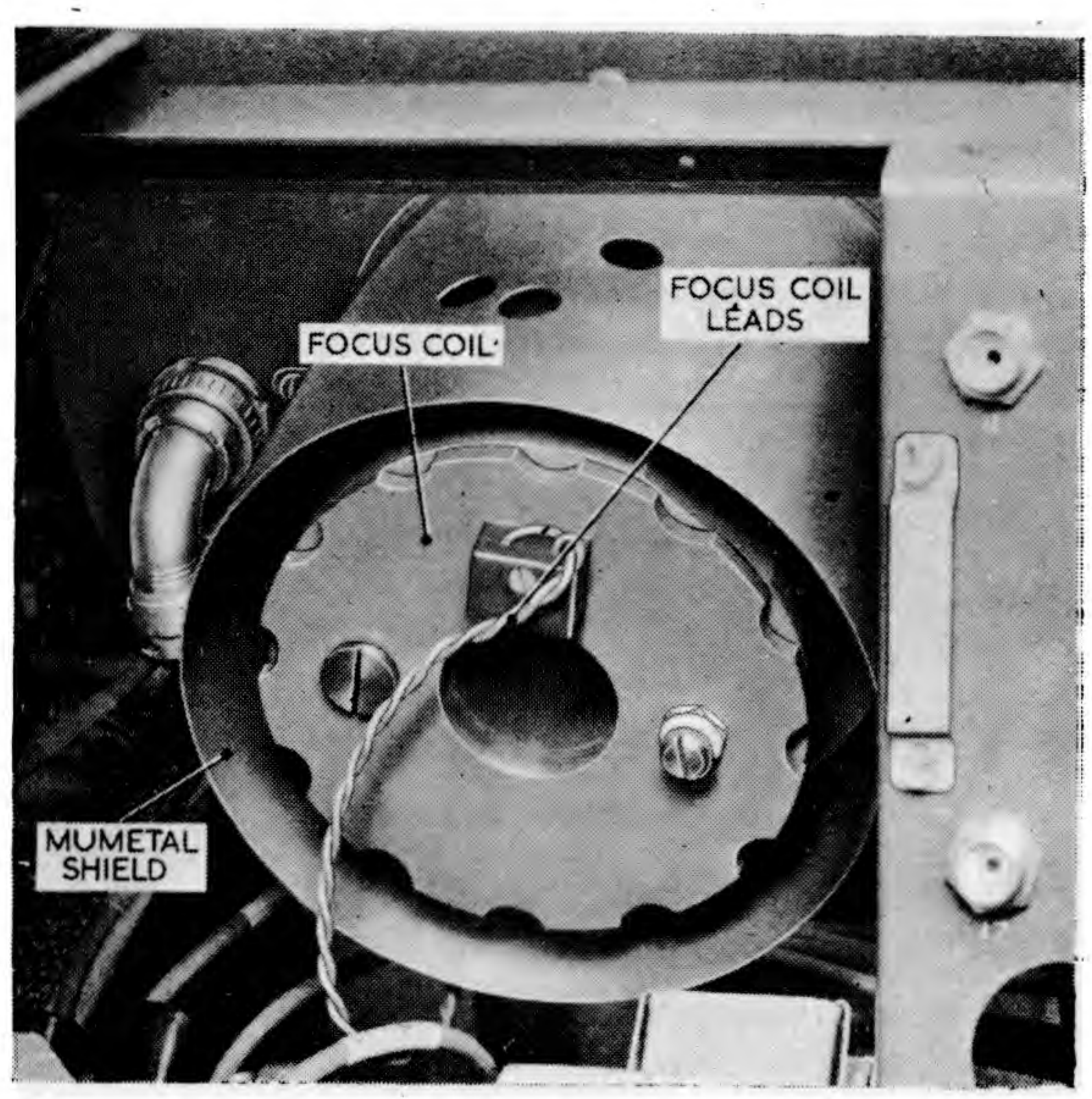


**Fig. 5. Coil assembly, shield on**

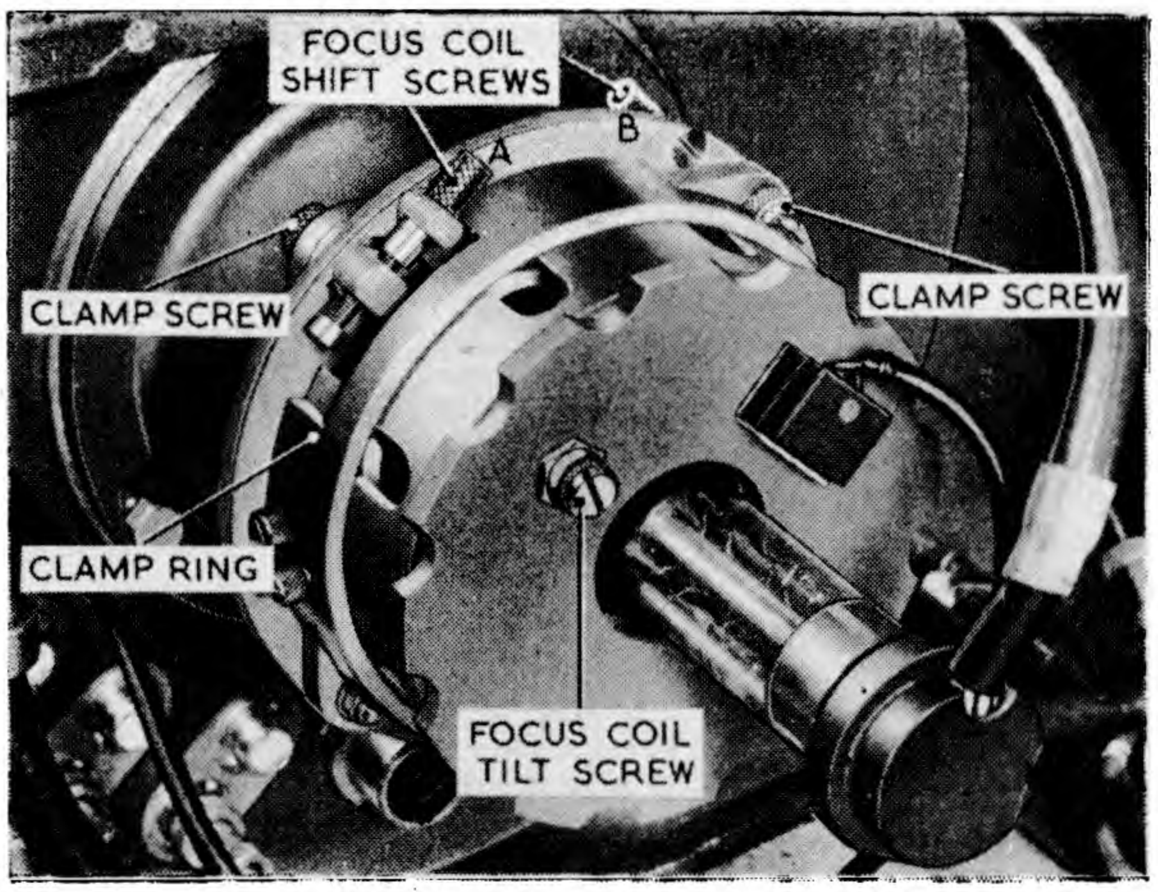


**Fig. 6. Coil assembly, shield off**

X1 coil and an equal decrease in current in the X2 coil. Parallel connections are taken off from the deflector coil input sockets to the blanking unit, for scan failure blanking. The colour-coding of the leads from the coils to the sockets is as follows :—

| Service | Colour | Connection |
|---|---|---|
| X1 .... .... .... | Yellow | SK5, SK9 |
| X2 .... .... .... | White | SK6, SK10 |
| Y1 .... .... .... | Green | SK3, SK7 |
| Y2 .... .... .... | Brown | SK4, SK8 |
| Common (+250V).... | Red | PL2/C |

**23.** The deflector-coil assembly is mounted on three springs, so that the front of the coils presses closely against the flare of the CRT bulb ; in this way the need for any special centring controls is avoided. The slots through which the outer deflector-coil housing is secured to the main tube housing allow a few degrees angular adjustment to the coil assembly, to ensure that the X deflection is truly horizontal and the Y vertical. This position is set up by the manufacturers and will not need to be touched in the Service unless for any reason the whole focus/deflector-coil assembly has to be removed.

**Cable identification system**

**24.** Each sub-unit within the indicating unit—including the tube unit and the pair of input panels—is allotted a unit number, as follows :—

| Unit | Number |
|---|---|
| Tube unit .... .... .... .... | 01 |
| Panel (control) Type 859 .... | 02 |
| Amplifying unit (video) Type 312 | 03 |
| Waveform generator Type 80 .... | 04 |
| Blanking unit Type 26 .... .... | 05 |
| Indicating unit input panels .... | 06 |

**25.** Within each sub-unit, all plugs and sockets of all types are taken together and numbered in a single series. Each end of a connecting cable is marked with a four-figure number, of which the first two figures show the unit number, and the second two the plug or socket number, to which that cable end is to be connected. For example, the coaxial which runs from SK10 on the video amplifier (unit No. 03) to SK5 on the waveform generator (unit No. 04), is marked 0310 at one end and 0405 at the other.

**26.** This system of cable identification implies different markings at each end of the same cable. To facilitate cross-reference between fig. 7 and the cable table (*Table* 2), a series of reference numbers—ringed on fig. 7—is used. These reference numbers are exclusive to Table 2 and fig. 7, and will not be found marked on the cables.

**27.** In the case of multicore cables, the pin letters always correspond at the two ends of the cable. Thus in cable number 62, which runs from PL10 on unit 06 to PL18 on unit 02, the wire which originates on PL10/J at the former end runs to PL18/J on the latter.

**TABLE 1**

**Component details**

**Note . . .**
*This list of components is issued as an aid to servicing, but reference should be made to Vol. 3 of this publication when demanding spares.*

| Circuit ref. | Name | Value | Rating | Tol.(%) | Ref. No. |
|---|---|---|---|---|---|
| R1 .... .... | Resistor (fixed) .... | 10,000 ohms | ¾W | 10 | Z222132 |
| C1 .... .... | Capacitor .... .... | 0·1 μF | 350V | 20 | Z115506 |
| C2 .... .... | Capacitor .... .... | 1 μF | 400V | 20 | Z112823 |
| LP1 to LP4 .... | Lamps, filament .... | — | 6V | — | X951236 |
| LP5 to LP8 .... | Lamps, filament .... | — | — | — | X951239 |
| CRT .... .... | Cathode-ray tube .... | — | — | — | 10CV/429 |
| PL2 .... .... | Mk. 4 plug (6-way med.) | — | — | — | Z560170 |
| SK3 to SK10.... | Socket Type 783 (coax.) | — | — | — | 10H/19861 |
| SK11 .... .... | Connector, valve 105 (EHT socket) | — | — | — | 10HA/12924 |

## TABLE 2

**Services on cables**

| Cable ref. (Ringed on fig. 7) | Type | From | | | To | | | Service |
|---|---|---|---|---|---|---|---|---|
| | | Unit | PL or SK | Cable ident. marking | Unit | PL or SK | Cable ident. marking | |
| **61** | 25-way | 06 | 8 | 0608 | 02 | 17 | 0217 | *A to J.* Range switching<br>*K to R.* Sector selector switching<br>*S. T.* Dial lights supply<br>*U.* −50V<br>*V.* Earth<br>*W.* Anti-clutter switch<br>*X.* HT reset<br>*Y.* Head combining switch<br>*Z.* HT on switch |
| **62** | 12-way | 06 | 10 | 0610 | 02 | 18 | 0218 | *A.* Earth<br>*B, C.* Off-centre (horiz.) pot.<br>*D.* Spare<br>*E, F.* Off-centre (vert.) pot.<br>*G.* Off-centre (horiz.) voltage<br>*H.* Off-centre (vert.) voltage<br>*J.* HT reset<br>*K, L.* Screen lights supply<br>*M.* Spare |
| **63** | Coaxial | 06 | 1 | 0601 | 02 | 1 | 0201 | Radar video signals |
| **64** | Coaxial | 06 | 2 | 0602 | 02 | 2 | 0202 | Inter-trace bright-up |
| **65** | Coaxial | 06 | 3 | 0603 | 02 | 3 | 0203 | Video map |
| **66** | Coaxial | 06 | 4 | 0604 | 02 | 4 | 0204 | H/R strobe |
| **67** | Coaxial | 06 | 5 | 0605 | 02 | 5 | 0205 | Range rings |
| **68** | Coaxial | 06 | 6 | 0606 | 02 | 6 | 0206 | IFF |
| **69** | 12-way | 06 | 9 | 0609 | 03 | 16 | 0316 | *A.* −50V to H/R strobe relay<br>*B.* Earth<br>*C.* −50V to IFF relay<br>*D.* −50V to Video map relay<br>*E, F* (strapped). 6·3V heaters<br>*G.* −50V to Range rings relay<br>*H.* −50V to I.T.B.U. relay<br>*J, K* (strapped). 6·3V heaters (paired with E, F)<br>*L.* −50V to Dimmer relay<br>*M.* +50V return line |
| **70** | Coaxial | 06 | 7 | 0607 | 04 | 4 | 0404 | Radar bright-up |
| **71** | Twin flex | 02 | 13 | 0213 | — | Dial lights | | 6·3V |
| **71a** | Twin flex | 02 | 14 | 0214 | — | Dial lights | | 6·3V |
| **72** | Coaxial | 02 | 7 | 0207 | 03 | 4 | 0304 | Radar video signals |
| **73** | Coaxial | 02 | 8 | 0208 | 03 | 8 | 0308 | Inter-trace bright-up |
| **74** | Coaxial | 02 | 9 | 0209 | 03 | 6 | 0306 | Video map |
| **75** | Coaxial | 02 | 10 | 0210 | 03 | 3 | 0303 | H/R strobe |
| **76** | Coaxial | 02 | 11 | 0211 | 03 | 7 | 0307 | Range rings |

| Cable ref. (Ringed on fig. 7) | Type | From | | | To | | | Service | |
|---|---|---|---|---|---|---|---|---|---|
| | | Unit | PL or SK | Cable ident. marking | Unit | PL or SK | Cable ident. marking | | |
| **77** | Coaxial | 02 | 12 | 0212 | 03 | 5 | 0305 | IFF | |
| **78** | Coaxial | 03 | 10 | 0310 | 04 | 5 | 0405 | Trace compensation | |
| **79** | Coaxial | 03 | 9 | 0309 | 04 | 6 | 0406 | Video gate | |
| **80** | 6-way (med.) | 03 | 15 | 0315 | 04 | 12 | 0412 | *A.* | +400V |
| | | | | | | | | *B.* | −300V |
| | | | | | | | | *C.* | +250V |
| | | | | | | | | *D.* | −500V reference |
| | | | | | | | | *E.* | Earth |
| | | | | | | | | *F.* | −50V |
| **81** | 6-way (med.) | 03 | 1 | 0301 | 01 | 1 | 0101 | *A.* | +400V (CRT 1st anode) |
| | | | | | | | | *B.*, *C.* | 6·3V (CRT heater) |
| | | | | | | | | *D.* | CRT grid |
| | | | | | | | | *E.* | Earth |
| | | | | | | | | *F.* | CRT cathode |
| **82** | Twin flex | 02 | 15 | 0215 | — | Screen lights | | 6·3V | |
| **82a** | Twin flex | 02 | 16 | 0216 | — | Screen lights | | 6·3V | |
| **83** | 6-way (med.) | 04 | 11 | 0411 | 05 | 2 | 0502 | *A.* | +570V unreg. |
| | | | | | | | | *B.* | +250V |
| | | | | | | | | *C.* | −300V |
| | | | | | | | | *D.* | +250V |
| | | | | | | | | *E.* | Earth |
| | | | | | | | | *F.* | — |
| **84** | Coaxial | 04 | 7 | 0407 | 05 | 11 | 0511 | Blanking | |
| **85** | 6-way (med.) | 05 | 8 | 0508 | 01 | 2 | 0102 | *A.* | Focus coil |
| | | | | | | | | *B.* | Focus coil |
| | | | | | | | | *C.* | +250V (defl. coils) |
| | | | | | | | | *D.* | +250V (strapped to C in unit 01) |
| | | | | | | | | *E*, *F.* | Spare |
| **86** | Coaxial | 05 | 10 | 0510 | 06 | 14 | 0614 | Octagonal blanking | |
| **87** | Coaxial | 05 | 9 | 0509 | 06 | 13 | 0613 | Octagonal blanking | |
| **88** | 12-way | 05 | 1 | 0501 | 06 | 18 | 0618 | *A.* | Earth |
| | | | | | | | | *B.* | Off-centre pot. (horiz.) |
| | | | | | | | | *C.* | Off-centre pot. (horiz.) |
| | | | | | | | | *D.* | — |
| | | | | | | | | *E.* | Off-centre pot. (vert.) |
| | | | | | | | | *F.* | Off-centre pot. (vert.) |
| | | | | | | | | *G*, *H.* | (strapped) 6·3V heaters |
| | | | | | | | | *L*, *M.* | (strapped) 6·3V heaters |
| | | | | | | | | *J.* | +250V reg. (ext.) |
| | | | | | | | | *K.* | — |

**TABLE 2** *(contd.)*

| Cable ref. (Ringed on fig. 7) | Type | From | | | To | | | Service |
|---|---|---|---|---|---|---|---|---|
| | | Unit | PL or SK | Cable ident. marking | Unit | PL or SK | Cable ident. marking | |
| **89** | Coaxial | 06 | 11 | 0611 | 01 | 10 | 0110 | X2 deflection |
| **90** | Coaxial | 06 | 16 | 0616 | 01 | 7 | 0107 | Y1 deflection |
| **91** | Coaxial | 06 | 12 | 0612 | 01 | 9 | 0109 | X1 deflection |
| **92** | Coaxial | 06 | 15 | 0615 | 01 | 8 | 0108 | Y2 deflection |
| **93** | Coaxial | 01 | 6 | 0106 | 05 | 6 | 0506 | X2 scan fail blanking |
| **94** | Coaxial | 01 | 3 | 0103 | 05 | 3 | 0503 | Y1 scan fail blanking |
| **95** | Coaxial | 01 | 5 | 0105 | 05 | 5 | 0505 | X1 scan fail blanking |
| **96** | Coaxial | 01 | 4 | 0104 | 05 | 4 | 0504 | Y2 scan fail blanking |

# Appendix 1

## INDICATING UNIT (CRT) TYPES 16452 AND 16453

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### LIST OF ILLUSTRATIONS



### LIST OF TABLES



**Purpose**

**1.** When the fixed coil display system is used with phase 1A equipment, the console Type 64, with its sub-units, is re-referenced to become a wired framework and a number of sub-units. Variations of basic sub-units are selected to suit various requirements.

**2.** The indicating unit (CRT) Types 16452 and 16453 are modified versions of the basic Type 35. Type 16452 is merely a re-referenced Type 35 without its sub-units. The modification described in para. 3 and 4 applies only to the Type 16453.

**3.** In order to focus the c.r.t. it is necessary to disconnect SK2 from the tube unit so that the focusing signal may be connected to the focus coil. To prevent damage to the output valves of the deflection amplifiers, the screen supplies as well as the anode supplies, are now carried via SK2.

**4.** The Type 16453 has the following additional modification. A 9·1K resistor is wired in parallel with each of the four deflector coils.

**TABLE 1**

**Additional component details (Type 16453)**

| Circuit ref. | Name | Value | Rating | Tol. (%) | Ref. No. |
|---|---|---|---|---|---|
| R2 | Resistor (fixed) | 9·1K | 3/4W | 5 | 5905-99-021-5358 |
| R3 | Resistor (fixed) | 9·1K | 3/4W | 5 | 5905-99-021-5358 |
| R4 | Resistor (fixed) | 9·1K | 3/4W | 5 | 5905-99-021-5358 |
| R5 | Resistor (fixed) | 9·1K | 3/4W | 5 | 5905-99-021-5358 |

(All other components as per Type 35)

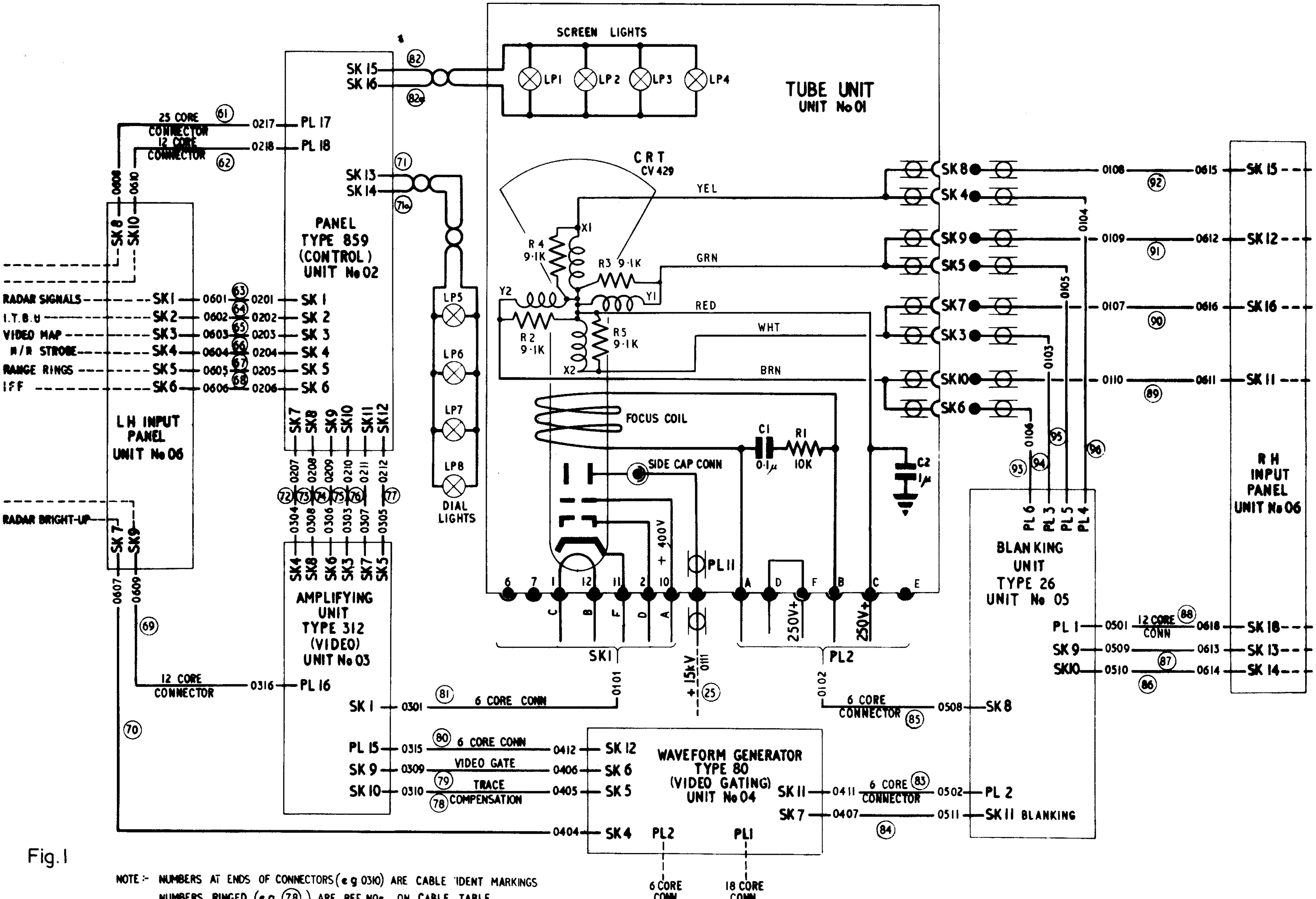


Fig. 1

NOTE :- NUMBERS AT ENDS OF CONNECTORS (e.g. 0310) ARE CABLE IDENT MARKINGS
NUMBERS RINGED (e.g. (78)) ARE REF NOs. ON CABLE TABLE.

Console Type 64

Fig. 1

Indicating unit (CRT) Type 16453-circuit

Printed for H.M. Stationery Office by James Townsend and Sons Ltd., Exeter.
924/8/6693/26425/250848/881/9/62.

# Chapter 2

# AMPLIFYING UNIT (VIDEO) TYPE 312

ERRATUM

The following should appear after the list of illustrations

## LIST OF APPENDICES

# Chapter 2

# AMPLIFYING UNIT (VIDEO) TYPE 312

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## INTRODUCTION

**1.** The *amplifying unit* (*video*) *Type* 312 (Stores Ref. 10U/16762) forms part of the indicating unit (CRT) Type 35 in the fixed-coil display console (console Type 64). Fig. 1 shows how the video amplifier fits into the indicating unit on the right hand side as seen by the operator.

### Purpose

**2.** The purpose of the video amplifier is to accept all the video inputs required to be displayed as brightness modulation during the trace and inter-trace periods, to mix them at appropriate levels, to limit and amplify them, and finally to apply them to the CRT grid. The inputs are as follows:—

(1) Radar video

(2) Video map

(3) Range rings (*alternative to video map*)

(4) IFF

(5) Range strobe

(6) Inter-trace bright-up.

**3.** The video amplifier also receives from the waveform generator Type 80 a video gating waveform, incorporating radar bright-up, blanking and anti-clutter. (This video gating waveform should not be confused with the inter-trace deflection gates which originate in the radar office and are applied to the deflection amplifiers.) The gate thus operated shuts off the first five video inputs listed above, and admits only the inter-trace bright-up pulse during the inter-trace period, so as to display the inter-trace marker ; this facility is not necessarily used on all consoles.

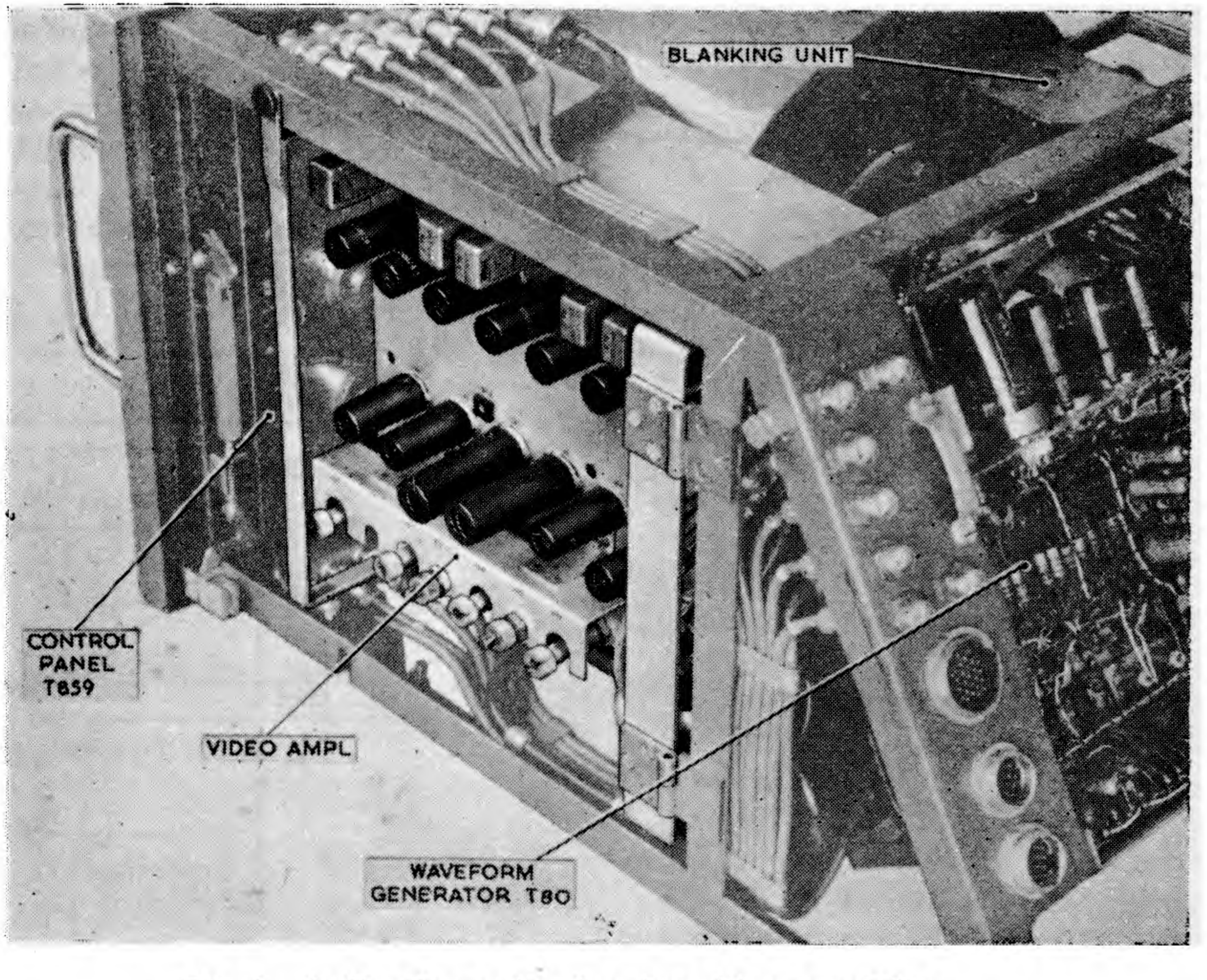



**Fig. 1. Indicating unit, showing video amplifier**

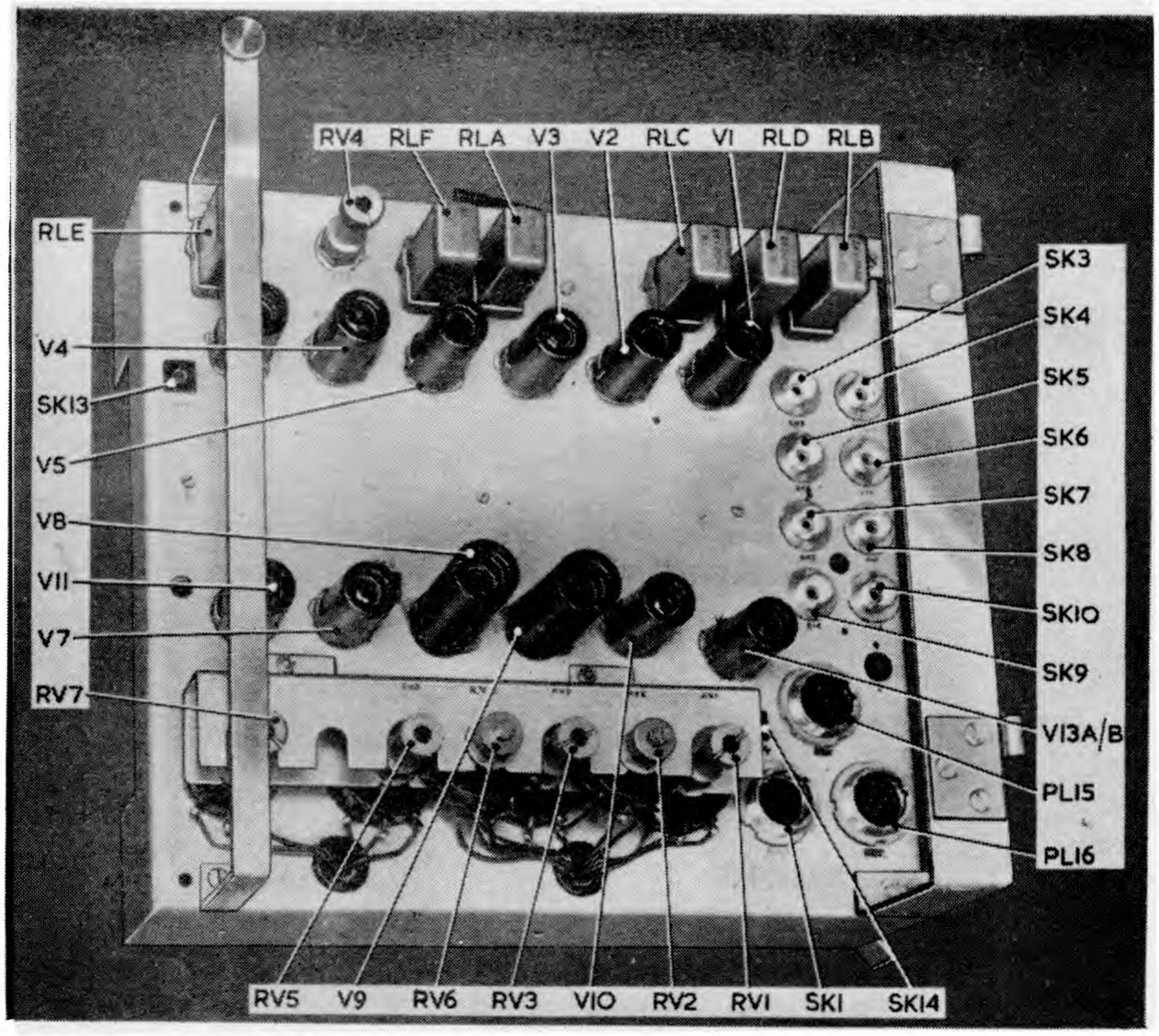



**Fig. 2. Video amplifier—general view**

**4.** The unit also receives from the waveform generator Type 80 a trace compensation waveform to ensure uniform painting all over the display. Protection circuits are incorporated to prevent burning of the CRT screen phosphor in certain eventualities ; they operate on the CRT cathode.

#### Power supplies

**5.** Power supplies to the unit comprise stabilized +250V and −300V lines originating in a bulk power supply (*Rack assembly Type* 305) and regulated in the waveform generator Type 80. Some 80 mA are drawn from the positive rail, and 18 mA from the negative. The 6·3V 4·0A heater supply comes up from the distribution panel and is balanced about earth by a pair of 1 KΩ resistors (R80 and R81).

#### Construction

**6.** The video amplifier is built on a 12 in. × 11⅜ in. × 3¼ in. chassis which hinges into the side of the indicating unit. For servicing during operation the milled captive screw shown at the top left of fig. 1 is loosened and the unit swung out on the two hinges seen at the right. This procedure gives access to all the under-chassis components ; if it is necessary to remove the unit completely, the console must be switched off, all connectors removed, and the chassis lifted right off the hinges. Fig. 2 is a closer view of the unit showing the location of principal valves, relays and controls ; the layout of components below the chassis is shown in fig. 12. The unit weighs 12½ lb.

## CIRCUIT DESCRIPTION

#### General

**7.** Fig. 3 is a block diagram showing how the successive stages of the amplifier may be considered to fall into five main groups ; these are explained in more detail in the paragraphs which follow. Simplified circuit diagrams are included where necessary for the purpose of circuit explanation; the complete circuit diagram is shown in fig. 13.

#### Initial mixing amplifier

**8.** A simplified circuit diagram of the initial mixing amplifier stages is given in fig. 4. Grid stoppers, metering resistors, etc., have been omitted from this diagram, leaving only the components of major importance in the circuit operation.

**9.** The circuit contains three high-gain pentodes V1, V2 and V3 (all CV138). These valves are DC-coupled, with a DC feedback path provided from V3 anode to V1 grid (via R20 and R19) to minimize changes in operating currents when valves are changed. V1 is connected as a single-ended pentode amplifier ; taken by itself, it has a gain of about 25. Video signals applied to its grid are amplified and developed across its 4·7 KΩ anode load, R21. The phase-inverted output is DC-coupled by the divider chain R26, R25 to the grid of V2, where it is therefore attenuated by about 2/3.

**10.** V2 is arranged as a pentode cathode-follower with a 3·3 KΩ cathode load, R31. Signals are developed across R31 without voltage gain ; they are injected into the cathode of V3, the grid of which is at a fixed positive potential, set by potentiometer RV2. V3 stage then amplifies the signals about 6 times without phase inversion, and the resulting signals appearing at its anode are passed on to succeeding stages. One advantage of this arrangement of V2 and V3 is that an extra stage of amplification is obtained without

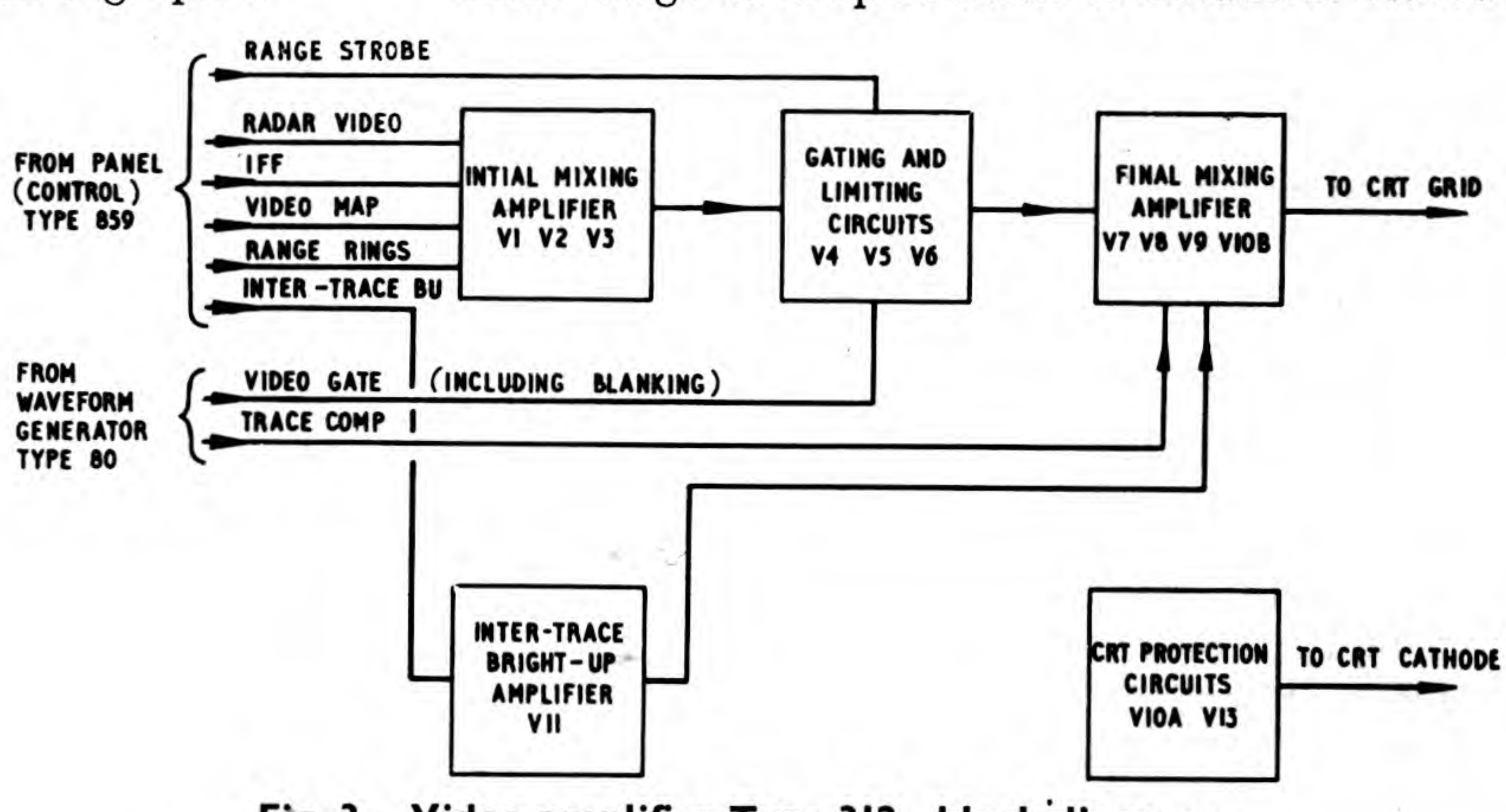



**Fig. 3. Video amplifier Type 312—block diagram**

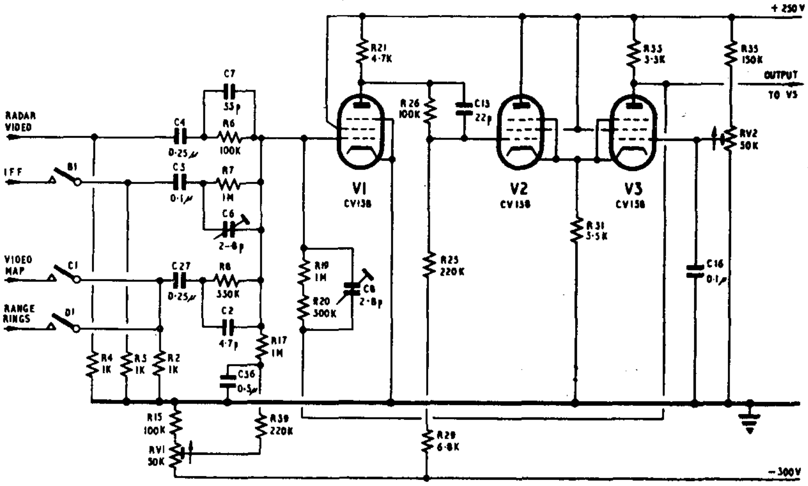



**Fig. 4. Initial mixing amplifier**

phase inversion, thus permitting negative feedback to be applied via R19 and R20. The potentiometers RV1 and RV2 are " zero set ', controls which fix the DC operating conditions of all three valves.

**11.** The gain of the three stages thus appears to be over 100. In fact, however, the gain on any one channel is very much less due to the inclusion of series input resistors (R6, R7 and R8) in each input channel, and of the overall negative feedback from V3 anode to V1 grid provided by R19 and R20. The capacitors across the input resistors are included to ensure good response at all video frequencies found in the signals.

*See-saw amplifier*

**12.** Considering any one channel by itself, the circuit is seen to be a three-valve form of the so-called *see-saw amplifier*, shown diagrammatically in fig. 5. Here R1 is the input resistance, and R2 the feedback resistance. Provided that the amplifier has appreciable gain A, and phase-inverts the signal, the overall gain of such a system is nearly R2 divided by R1. The point *E* remains near earth potential, and is known as a virtual earth ; the potentials at the ends of the resistive arms R1 and R2 may be said to see-saw about the point *E*. Such a circuit greatly improves overall DC stability as well as frequency response, and has a low output impedance ; it is sometimes referred to as the " anode-follower ".

**13.** In the present amplifier different values of input resistor have been used in each input channel to give the correct values of " overall gain " and so equalize the outputs at V3 anode. The three channels involved at this stage are radar video, IFF and a third channel carrying video map or range rings as selected by the operator. With this method of input, any or all of the input channels can be switched in together (by the relays operated from the control desk) without any interaction.

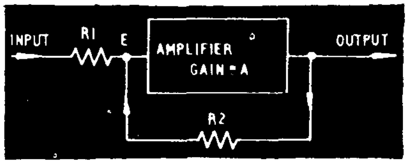



**Fig. 5. See-saw amplifier**

*Radar video input*

**14.** The radar video signals arrive at SK4 from the *panel (control) Type* 859. They are positive-going, and are developed across the 1 KΩ resistor R4 (*waveform a, fig.* 7). They are AC-coupled by the 0·25μF capacitor C4 to the grid of V1 via the 100 KΩ see-saw input resistor R6. The gain on this channel approaches 1·3 MΩ divided by 100 KΩ, and is therefore just over 10.

**15.** The amplitude of the radar signals and noise arriving at SK4 depends upon the setting of a potentiometer in the control panel, but at the maximum, there are about $1\frac{1}{2}$V of echoes, etc., and $\frac{1}{2}$V of noise. Accordingly, the output at the anode of V3 includes a maximum of 5V of noise together with echoes and ground returns of greater amplitude, all negative-going (*waveform b, fig.* 7).

*IFF input*

**16.** The positive-going IFF signals are fed from the control panel to SK5 at a maximum amplitude of 5V and, provided relay B is closed, are coupled to the grid of V1 by the 0·1 μF capacitor C3 and the 1 MΩ input resistor R7. (Relay B is operated from the IFF switch on the control desk.) The gain on this channel approaches 1·3 MΩ divided by 1 MΩ, and in practice is just over unity ; the IFF signals thus appear at V3 anode as negative-going pulses of some 5V amplitude.

*Video map or range rings input*

**17.** Either video map or range rings are introduced by closing relay C or relay D from a switch on the control desk. Either signal arrives from the control panel at a level of about $1\frac{1}{2}$V positive-going, and is applied to V1 grid by way of C27 (0·25 μF) and the input resistor R8. R8 is 330 KΩ, giving an overall gain on this channel of about $3\frac{1}{3}$ ; video map or range ring signals thus appear at V3 anode at a level of about 5V negative-going.

*Protection capacitor*

**18.** When power to the video amplifier is switched on, the + 250V supply normally comes on after the − 300V. If no precautions were taken this would cut off V1, and so cut off the feedback loop via R19 ; the result of this would be a negative-going surge at V3 anode which

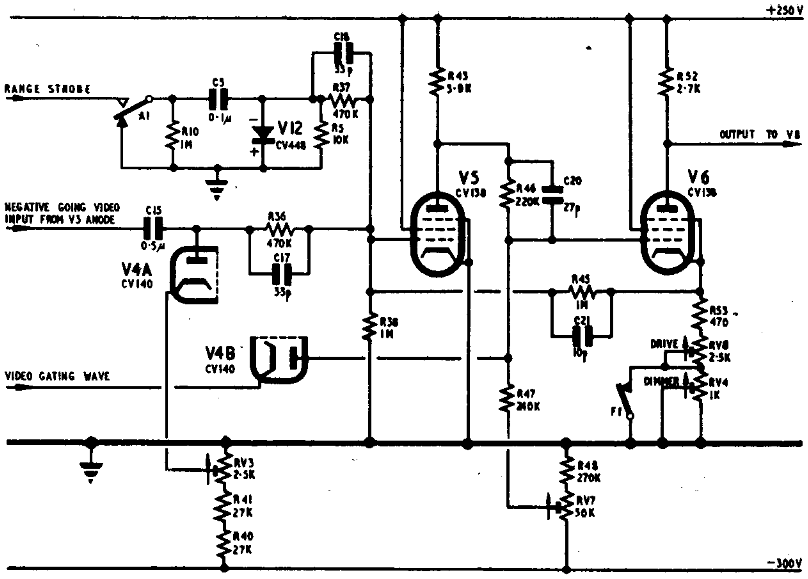


**Fig. 6. Gating and limiting circuits**

would result in a positive surge of dangerous amplitude at the CRT grid. The $0 \cdot 5\ \mu F$ capacitor C36 has therefore been included to delay the application of the negative rail to V1 grid by the time constant of C36 and R39 (220 KΩ).

### Gating and limiting circuits

**19.** A simplified circuit diagram of the gating and limiting circuits is shown in fig. 6, from which metering resistors, etc., have been omitted for clarity. The circuit contains two pentodes V5 and V6 (CV138) and a double-diode V4 (CV140). V5 is the limiting valve, and V6 the gating valve.

**20.** Negative-going signals comprising radar video, IFF, and video map or range rings are AC-coupled from V3 anode by C15 ($0 \cdot 5\ \mu F$). They are DC-restored by diode V4A to a small negative voltage set by RV3, which is a " zero set " potentiometer for V5, and is adjusted so that just sufficient current flows through V4A to give the correct bias voltage on V5 grid.

**21.** The signals are then applied to V5 grid through the 470 KΩ input resistor R37. The range strobe pulse, which is negative-going and about 5V in amplitude, is also applied through a 470 KΩ input resistor R37 to V5 grid, provided that relay A is closed from a switch on the control desk. Corresponding positive-going signals appear at V5 anode, and are DC-coupled by an input resistor R46 (220 KΩ) to V6 grid.

**22.** The DC level of V5 grid is so adjusted that whenever the amplitude of the negative-going signals from V3 anode exceeds 5V, V5 is cut off. This is the limiting action which prevents excessively large signals from reaching the CRT grid.

**23.** During the inter-trace period and the blanking period, if any, the video gating wave (*waveform c, fig.* 7) is at −15V, so that the diode V4B is conducting and keeps V6 cut off. Consequently all the trace-period inputs are shut off during the blanked and inter-trace periods.

**24.** During the trace period, or that part of it permitted by the blanking waveform, the video gating wave is at + 10V, so the diode V4B does not conduct and V6 is no longer cut off. V5 and V6 now behave as an ordinary see-saw amplifier, with negative feedback taken from V6 cathode by the 1 MΩ resistor R45 to V5 grid. The DC operating conditions of this stage are set up by the 50 KΩ potentiometer RV7.

**25.** The current switched on in V6 by the gating waveform amounts to 1 mA, so that a negative pedestal of about 2·7V amplitude carrying the negative-going radar and other video signals appears at V6 anode (*waveform d, fig.* 7, shows the signals at V6 anode without anti-clutter or blanking, and *waveform c* shows them with both). This combination is passed on to succeeding stages of the amplifier.

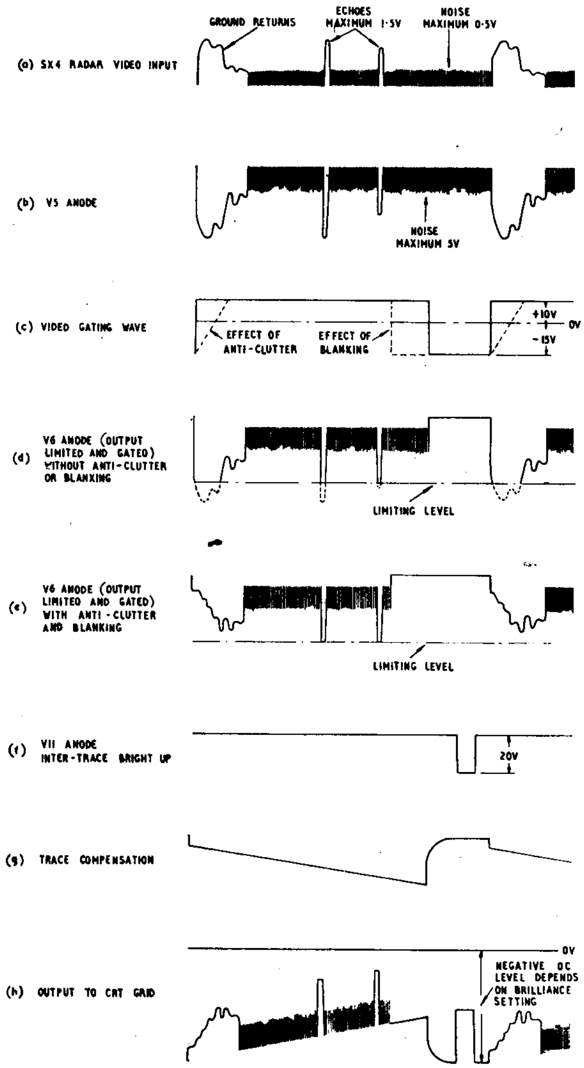


**Fig. 7. Video amplifier Type 312—waveforms**

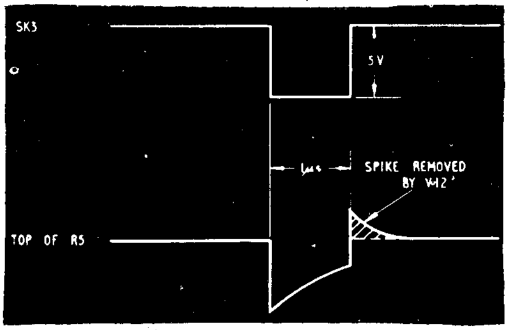



**Fig. 8. Range strobe waveform**

**26.** The exact amplitude of the signals appearing at V6 anode depends upon the amount of current negative feedback provided by the three un-decoupled resistors in series with V6 cathode ; these are as follows :—

(1) R53, 470Ω fixed.

(2) RV8, 250 KΩ variable. A preset *drive* control.

(3) RV4, 1 KΩ variable. A preset *dimming* control, which is normally short-circuited by relay contact F1 ; if, however, rotation of the aerial head stops, a line from the magslip resolver in the radar office de-energizes relay F and brings RV4 into circuit, so dimming the trace and preventing screen burn.

**27.** The 10 KΩ resistor R5 is included as a leak for the 0·1 µF capacitor C5, through which the range strobe pulse is injected. If R5 were not included, C5 would tend to remain charged after a waveform of long duration had been applied to V5 grid from the other input.

**28.** The inclusion of R5 results in a certain degree of differentiation being applied to the incoming range strobe pulse, giving it a positive-going spike at the end of the pulse (*fig.* 8). If it were allowed to reach the input to V5 in this form, a large negative spike would be applied to V6 grid, resulting in paralysis of V6. Accordingly, the germanium diode V12 (CV448) is included to eliminate the positive spike.

### Final mixing amplifier

**29.** A simplified circuit diagram of the final mixing amplifier is shown in fig. 9. The circuit includes two high-current pentodes V8 and V9 (CV2127), a double-diode V7 and part of another double-diode V10 (both CV140). V8 is a mixing amplifier, and V9 a cathode-follower.

**30.** The negative-going video output from V6 anode, with a peak amplitude of about 25V, is AC-coupled into the amplifier by C22 (0·25 µF) and is then DC-restored by diode V7a to be negative with respect to a small negative voltage from the junction of R56 and R57. The result is then applied to V8 grid via the 820 KΩ input resistor R55.

**31.** The 20V negative-going inter-trace bright-up pulse (*waveform f, fig.* 7) is similarly AC-coupled from V11 anode by the 0·1 µF capacitor C14 and applied to V8 grid via an 820 KΩ input resistor R62.

**32.** The trace compensation wave (*waveform g, fig.* 7) is produced by the waveform generator Type 80 and serves to give the spot steadily increasing brightness as it moves out from the origin of the display ; this compensates for the

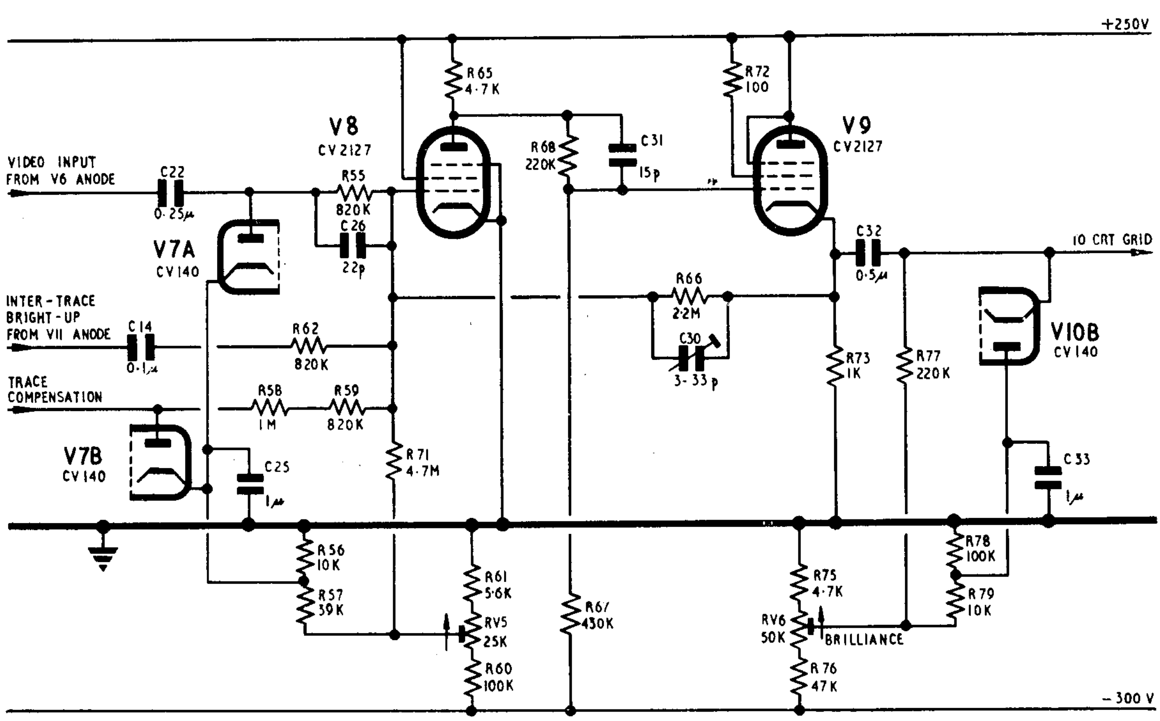



**Fig. 9. Final mixing amplifier**

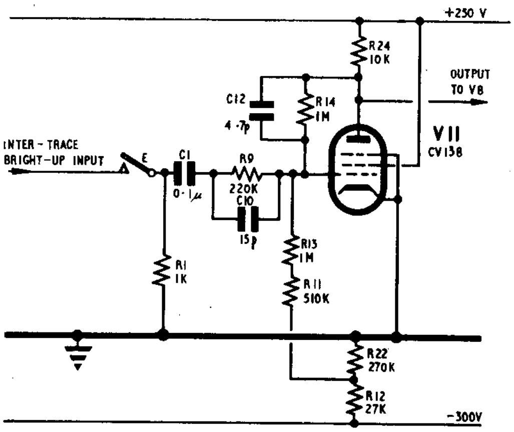



Fig. 10. **Inter-trace bright-up amplifier**

increasing separation between traces and thus forms a picture of apparently uniform brightness. The slope of the trace compensation sawtooth will necessarily vary according to trace expansion.

**33.** The trace compensation wave comes in at SK10 and is DC-restored by V7b to the same small negative potential as was the main video input. The input resistors R58 and R59 in this channel total 1·82 MΩ.

**34.** V8 acts as a normal pentode amplifier, its operating conditions being set by the potentiometer RV5, to the slider of which is returned the 4·7 MΩ grid resistor R71. Positive-going video signals, now including inter-trace bright-up and trace compensation, are developed across the 4·7 KΩ anode load R65. The signals are then DC-coupled by the divider chain R68, R67 to the grid of V9, which is connected as a triode cathode-follower and normally passes about 10 mA. R73 is the 1 KΩ cathode load for V9, and positive-going signals appearing across it are fed out by the 0·5 μF capacitor C32 to SK1/D and so to the CRT grid for brightness modulation (*waveform h, fig.* 7).

**35.** Negative feedback is taken from V9 cathode to V8 grid by the 2·2 MΩ resistor R66. V8 and V9 together may thus be regarded as a see-saw amplifier, with an overall gain of over 1½ for the radar and inter-trace bright-up channels, and about ¾ for the trace compensation channel. Therefore, the modulating signals applied to the CRT grid have a peak amplitude of some 40V, and are superimposed on a trace compensation wave with a slope and amplitude depending on trace expansion.

**36.** The signals applied to the CRT grid via C32 are DC-restored to a negative voltage set by the 50KΩ potentiometer RV6, which is the console *brilliance* control. It is preset and not normally accessible to the operator. The DC restoration is effected by the diode V10B; to prevent possible failure of restoration due to heater-cathode leakage in this diode, or grid-cathode leakage in the CRT, V10B is kept permanently in slight conduction by returning its anode to the junction of R78 and R79, which is slightly positive relative to the diode cathode.

**Inter-trace bright-up amplifier**

**37.** The inter-trace bright-up amplifier is a straightforward see-saw amplifier and inverter, containing a single pentode V11 (CV138). A simplified circuit diagram appears in fig. 10.

**38.** Positive-going inter-trace bright-up pulses arrive at SK8 from the control panel with a maximum amplitude of 5V. When relay E is closed (from a switch on the control desk) the pulses are developed across the 1 KΩ resistor R1, and are AC-coupled to the amplifier by C1 (0·1 μF).

**39.** The gain of the stage is 1 MΩ divided by 220 KΩ, or approximately 4; negative-going inter-trace bright-up pulses with a maximum amplitude of 20V are therefore developed at V11 anode and passed on to V8.

**CRT protection circuits**

**40.** The CRT protection circuits include the diode-triode V13 (CV137) and V10A which is one-half of a double-triode CV140. The contingencies against which protection is provided are:—

(1) Failure of + 250V supply

(2) Failure of — 300V supply

(3) Normal switching-off operation, which has the same effect as the first two because the CRT EHT volts remain after the tube bias has decayed.

**41.** V13A and V10A are for protection in the event of failure of the + 250V supply; if they were not included, the large positive spike at the CRT grid (originating from the sharp fall at V6 anode) would cause screen burn. To counteract this, the negative edge from the failing HT line is

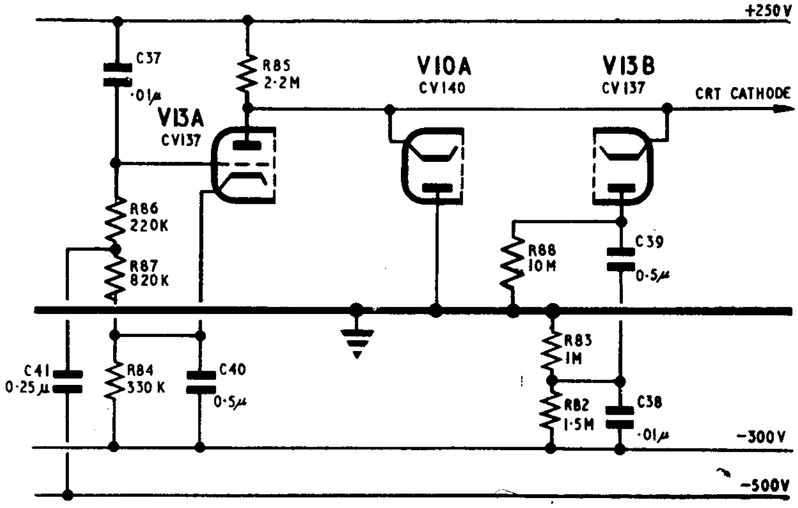



Fig. 11. **CRT protection circuits**

applied through C37 to the grid of V13A, cutting it off. Consequently V13A anode rises (for a short time) and cuts off the diode V10A, thus releasing the CRT cathode from earth potential. The CRT cathode then jumps positive and the beam current is cut off.

**42.** V13B is for protection against the effect of – 300V failure ; without it, the exponential positive wavefront at the CRT grid from V9 shortly after—300V failure would cause a dispersed and defocused but very bright bloom over the screen. However, the positive edge from the negative rail is applied via C38 and C39 to V13B anode, so carrying the CRT cathode positive and cutting off the beam current. (V13A does not affect this action because it is cut off by the same positive edge applied to its cathode via C40.)

## TABLE I

### Component details

**Note . . .**

*This list of components is issued for servicing use only. When ordering spares for this unit refer to Volume 3 of this publication or to the appropriate section of A.P.*1086.

**Resistors (fixed)**

| Circuit Ref. | Value (Ohms) | Rating (Watts) | Tolerance (%) | Inter services Ref. No. | Circuit Ref. | Value (Ohms) | Rating (Watts) | Tolerance (%) | Inter-services Ref. No. |
|---|---|---|---|---|---|---|---|---|---|
| R1 to R4 | 1 K | ½ | 10 | Z222005 | R48 | 270 K | ¾ | 10 | Z223093 |
| R5 | 10 K | ½ | 10 | Z222131 | R49 | 100 | ½ | 10 | Z221110 |
| R6* | 100 K | ½ | 1 | Z216446 | R50, R51 | *not fitted* | — | — | — |
| R7* | 1 M | ¾ | 1 | Z216655 | R52 | 2·7 K | ¾ | 10 | Z222060 |
| R8* | 330 K | ½ | ·1 | Z216558 | R53 | 470 | ½ | 10 | Z221194 |
| R9* | 220 K | ½ | 5 | Z216722 | R54* | 10 | ½ | 5 | Z215002 |
| R10 | 1 M | ½ | 10 | Z223164 | R55* | 820 K | ¾ | 5 | Z216751 |
| R11* | 510 K | ½ | 5 | Z216740 | R56* | 10 K | ½ | 5 | Z216002 |
| R12* | 27 K | ½ | 5 | Z216052 | R57* | 39 K | ¾ | 5 | Z216073 |
| R13*, R14* | 1 M | ¾ | 5 | Z216757 | R58* | 1 M | ¾ | 5 | Z216757 |
| R15 | 100 K | ¾ | 10 | Z223039 | R59* | 820 K | ¾ | 5 | Z216751 |
| R16* | 10 | ½ | 5 | Z215002 | R60 | 100 K | 1 | 10 | Z213327 |
| R17 | 1 M | ¾ | 10 | Z223165 | R61 | 5·6 K | ½ | 10 | Z222101 |
| R18 | 100 | ½ | 10 | Z221110 | R62* | 820 K | ¾ | 5 | Z216751 |
| R19* | 1 M | ¾ | 5 | Z216757 | R63 | 100 | ½ | 10 | Z221110 |
| R20* | 300 K | ½ | 5 | Z216728 | R64* | 10 | ½ | 5 | Z215002 |
| R21* | 4·7 K | 1 | 5 | Z215324 | R65 | 4·7 K | 3 | 5 | Z244233 |
| R22* | 270 K | ¾ | 5 | Z216727 | R66 | 2·2 M | ¾ | 10 | Z223207 |
| R23* | 10 | ½ | 5 | Z215002 | R67* | 430 K | ¾ | 1 | Z216583 |
| R24 | 10 K | 1 | 10 | Z212255 | R68* | 220 K | ¾ | 1 | Z216526 |
| R25* | 220 K | ¾ | 1 | Z216526 | R69 | 100 | ½ | 10 | Z221110 |
| R26* | 100 K | ¾ | 1 | Z216447 | R70 | *not fitted* | — | — | — |
| R27 | 100 | ½ | 10 | Z221110 | R71 | 4·7 M | ¾ | 10 | Z223249 |
| R28* | 6·8 K | ¾ | 1 | Z215837 | R72 | 100 | ½ | 10 | Z221110 |
| R29 | 100 | ½ | 10 | Z221110 | R73 | 1 K | 6 | 5 | Z244002 |
| R30* | 10 | ½ | 5 | Z215002 | R74* | 10 | ½ | 5 | Z215002 |
| R31* | 3·3 K | 1 | 5 | Z215304 | R75 | 4·7 K | ½ | 10 | Z222089 |
| R32* | 10 | ½ | 5 | Z215002 | R76 | 33 K | 1 | 5 | Z216064 |
| R33* | 3·3 K | ¾ | 5 | Z215303 | R77 | 220 K | ½ | 10 | Z223080 |
| R34 | 100 | ½ | 10 | Z221110 | R78 | 100 K | ½ | 10 | Z223038 |
| R35 | 150 K | ¾ | 10 | Z223060 | R79 | 10 K | ½ | 10 | Z222131 |
| R36*, R37* | 470 K | ½ | 1 | Z216590 | R80 | 1 K | ½ | 10 | Z222005 |
| R38* | 1 M | ¾ | 5 | Z216757 | R81 | 1 K | ½ | 10 | Z222005 |
| R39 | 220 K | ½ | 10 | Z223080 | R82 | 1·5 M | ¾ | 10 | Z223186 |
| R40, R41 | 27 K | 1 | 10 | Z212260 | R83 | 1 M | ¾ | 10 | Z223165 |
| R42 | 100 | ½ | 10 | Z221110 | R84 | 330 K | ¾ | 10 | Z223102 |
| R43* | 3·9 K | ¾ | 3 | Z244229 | R85 | 2·2 M | ¾ | 10 | Z223207 |
| R44* | 10 | ½ | 5 | Z215002 | R86 | 220 K | ¾ | 10 | Z223081 |
| R45* | 1 M | ¾ | 5 | Z216757 | R87 | 820 K | ¾ | 10 | Z223156 |
| R46* | 220 K | ¾ | 5 | Z216723 | R88 | 10 M | ¾ | 10 | Z223291 |
| R47* | 240 K | ¾ | 2 | Z216539 | | | | | |

* *High stability*

## Resistors (variable)

| Circuit Ref. | Value (Ohms) | Rating (Watts) | Tolerance (%) | Inter services Ref. No. | Circuit Ref. | Value (Ohms) | Rating (Watts) | Tolerance (%) | Inter-services Ref. No. |
|---|---|---|---|---|---|---|---|---|---|
| RV1 (DC SET, V1) | 50 K | 1 | 10 | (Type 11100) 10W/19107 | RV5 (DC SET, V8) | 25 K | 1 | 10 | Z272301 10W/19107 (Type 11100) |
| RV2 (DC SET, V3) | 50 K | 1 | 10 | Z272410 | RV6 (BRILLIANCE) | 50 K | 1 | 10 | (Colvern CLR3207/9S) |
| RV3 (DC SET, V5) | 2·5 K | 1 | 10 | Z271755 | RV7 (DC SET, V6) | 50 K | 1 | 10 | Z272410 |
| RV4 (DIMMING) | 1 K | 1 | 10 | Z271605 | RV8 (DRIVE) | 2·5 K | ½ | 10 | Z271751 |

## Capacitors

| Circuit Ref | Value (μF except where stated) | Rating (Volts DC) | Tolerance (%) | Inter-services Ref. No. | Circuit Ref. | Value (μF except where stated) | Rating (Volts DC) | Tolerance (%) | Inter-services Ref. No. |
|---|---|---|---|---|---|---|---|---|---|
| C1 | 0·1 | 200 | 20 | Z115631 | C23 | 22 pF | 500 | 5 | Z132276 |
| C2 | 4·7 pF | 500 | ±0·5 pF | Z131167 | C24 | 10 pF | 500 | ±0·5 pF | Z132252 |
| C3 | 0·1 | 200 | 20 | Z115631 | C25 | 1 | 150 | 25 | Z115569 |
| C4 | 0·25 | 150 | 25 | Z115563 | C26 | 22 pF | 500 | 5 | Z113276 |
| C5 | 0·1 | 200 | 20 | Z115631 | C27 | 0·25 | 150 | 25 | Z115563 |
| C6 | 2 to 8 pF | 70 | — | Z167003 | C28 | 10 pF | 500 | 10 | Z132253 |
| C7 | 33 pF | 500 | ±0·5 pF | Z132281 | C29 | 2 to 8 pF | 70 | — | Z167003 |
| C8 | 2 to 8 pF | 70 | — | Z167003 | C30 | 3 to 30 pF | 70 | — | Z167005 |
| C9 | 4·7 pF | 500 | ±0·5 pF | Z132251 | C31 | 15 pF | 500 | 5 | Z132068 |
| C10 | 15 pF | 500 | 5 | Z132068 | C32 | 0·5 | 350 | 5 | Z115568 |
| C11 | 2 to 8 pF | 70 | — | Z167003 | C33 | 1 | 150 | 25 | Z115569 |
| C12 | 4·7 pF | 500 | ±0·5 pF | Z131167 | C34 | 0·1 | 350 | 20 | Z115506 |
| C13 | 22 pF | 500 | 10 | Z132277 | C35 | 0·1 | 350 | 20 | Z115506 |
| C14 | 0·1 | 350 | 20 | Z115506 | C36 | 0·5 | 350 | 25 | Z115568 |
| C15 | 0·5 | 350 | 25 | Z115568 | C37 | 0·01 | 350 | 25 | Z115625 |
| C16 | 0·1 | 200 | 20 | Z115631 | C38 | 0·01 | 350 | 25 | Z115625 |
| C17 | 33 pF | 500 | ±0·5 pF | Z132281 | C39 | 0·5 | 350 | 25 | Z115568 |
| C18 | 33 pF | 500 | ±0·5 pF | Z132281 | C40 | 0·5 | 350 | 25 | Z115568 |
| C19 | 2 to 8 pF | 70 | — | Z167003 | C41 | 0·25 | 500 | 20 | Z115510 |
| C20 | 27 pF | 500 | 5 | Z132279 | | | | | |
| C21 | 10 pF | 500 | 10 | Z132253 | | | | | |
| C22 | 0·25 | 350 | 25 | Z115565 | | | | | |

## Relays, fixed plugs and sockets

| Circuit Ref. | Description | Inter-services Ref. No. |
|---|---|---|
| RL A to F | Relays, magnetic | Z530040 |
| PL15 | 6-way (medium) | Z560543 |
| PL16 | 12-way | Z560155 |
| SK1 | 6-way (medium) | Z560322 |
| SK2 | 25-way | Z560380 |
| SK 3 to 10 | Type 783, co-axial | *(10H/19861)* |
| SK 12 to 14 | Type 714 | *(10H/19641)* |

**Note . . .**
*Valve types and base connections may be obtained from the circuit diagram at the end of this chapter (fig. 13).*

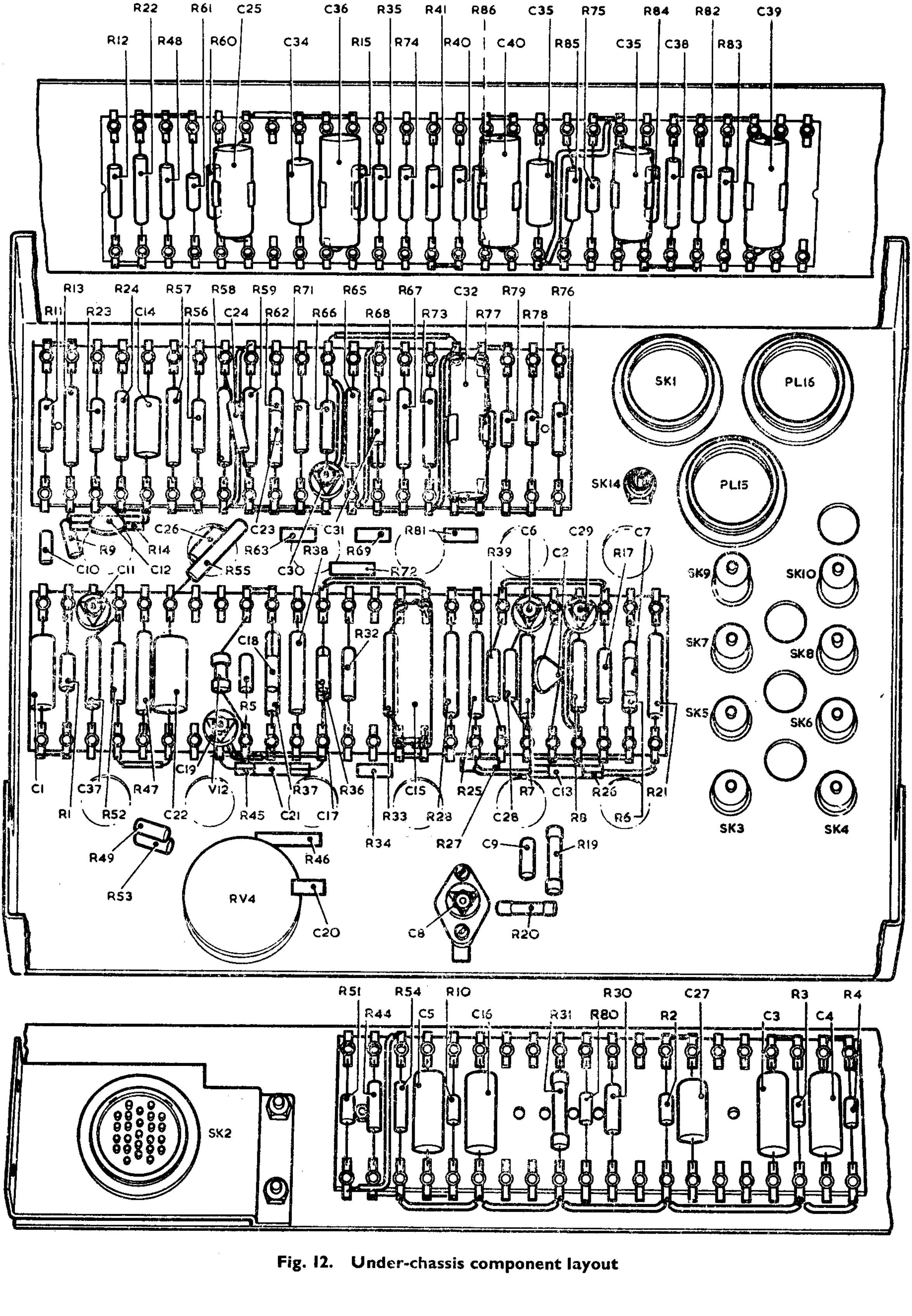
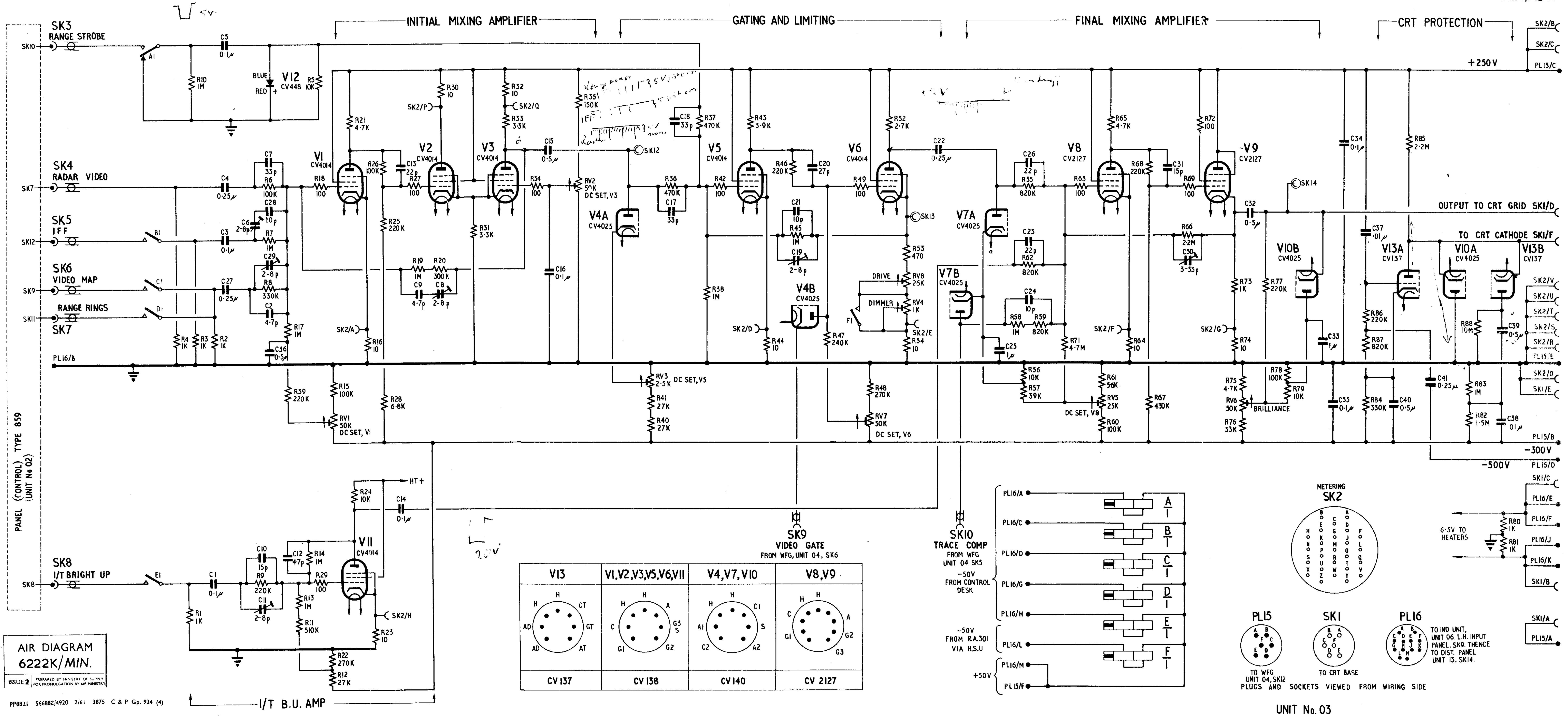



**Fig. 12. Under-chassis component layout**




**Video amplifier Type 312 - circuit** **Fig.13**

RESTRICTED

# Appendix 1

# AMPLIFYING UNIT (VIDEO) TYPE 312A

## LIST OF CONTENTS



## LIST OF TABLES



## LIST OF ILLUSTRATIONS



### Purpose

**1.** When the fixed coil display system is used with phase 1A equipment, the console Type 64, with its sub-units, is re-referenced to become a wired framework and a number of sub-units. Variations of basic sub-units are selected to suit various requirements.

**2.** Video amplifier Type 312A is used with head and p.r.f. facilities and is similar to Type 312 with the exceptions given in the following paragraphs.

**3.** To prevent bright-up due to spurious inputs, a long c–r is connected to each of the paths from SK4, SK5, SK6 and SK7 (fig. 1). Details of the components used are given in Table 1. Location of the components is given in fig. 2.

**4.** To allow the "radar signal" to be switched off when I.F.F. is being displayed, and because "range strobe" services are no longer required, relay contact A1 is removed from SK3 and connected into the SK4 input path.

**5.** Relay contact E1 is by-passed because switching is performed by I.T.B.U. modulator, Type 4430.

**TABLE 1**

**Component details**

Resistors (fixed)

| Circuit Ref. | Value (Ohms) | Rating (Watts) | Tolerance (%) | Inter services Ref. No. |
|---|---|---|---|---|
| R89, R90, R91, R92 | 100K | ¼ | 10 | 5905–99–022–3038 |

Capacitors

| Circuit Ref. | Value (μF) | Rating (Volts d.c.) | Tolerance (%) | Inter services Ref. No. |
|---|---|---|---|---|
| C42, C44 | 50 | 6 | 20 | 10C/26514* |
| C43, C45 | 0·05 | 250 | 25 | 5910–99–011–9825 |

*R.A.F. Stores Ref. No.

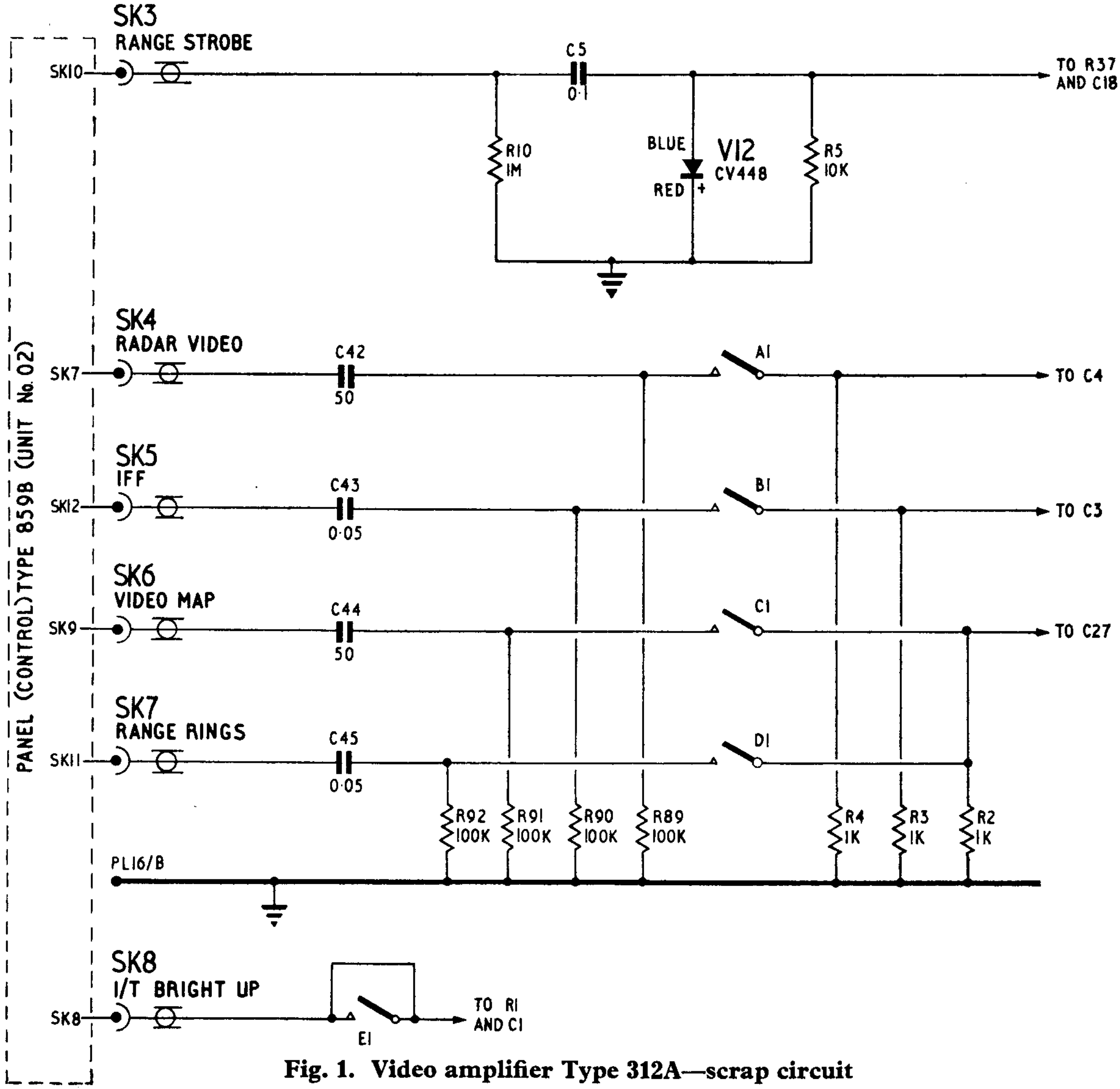



**Fig. 1. Video amplifier Type 312A—scrap circuit**

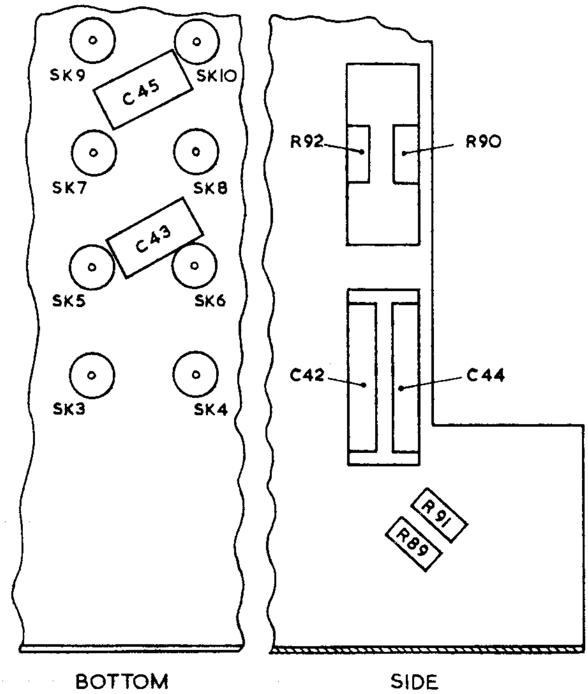



**Fig. 2. Under-chassis component layout—scrap diagram**

# Chapter 3

# WAVEFORM GENERATOR TYPE 80

ERRATUM

The following should appear after the list of illustrations

## LIST OF APPENDICES

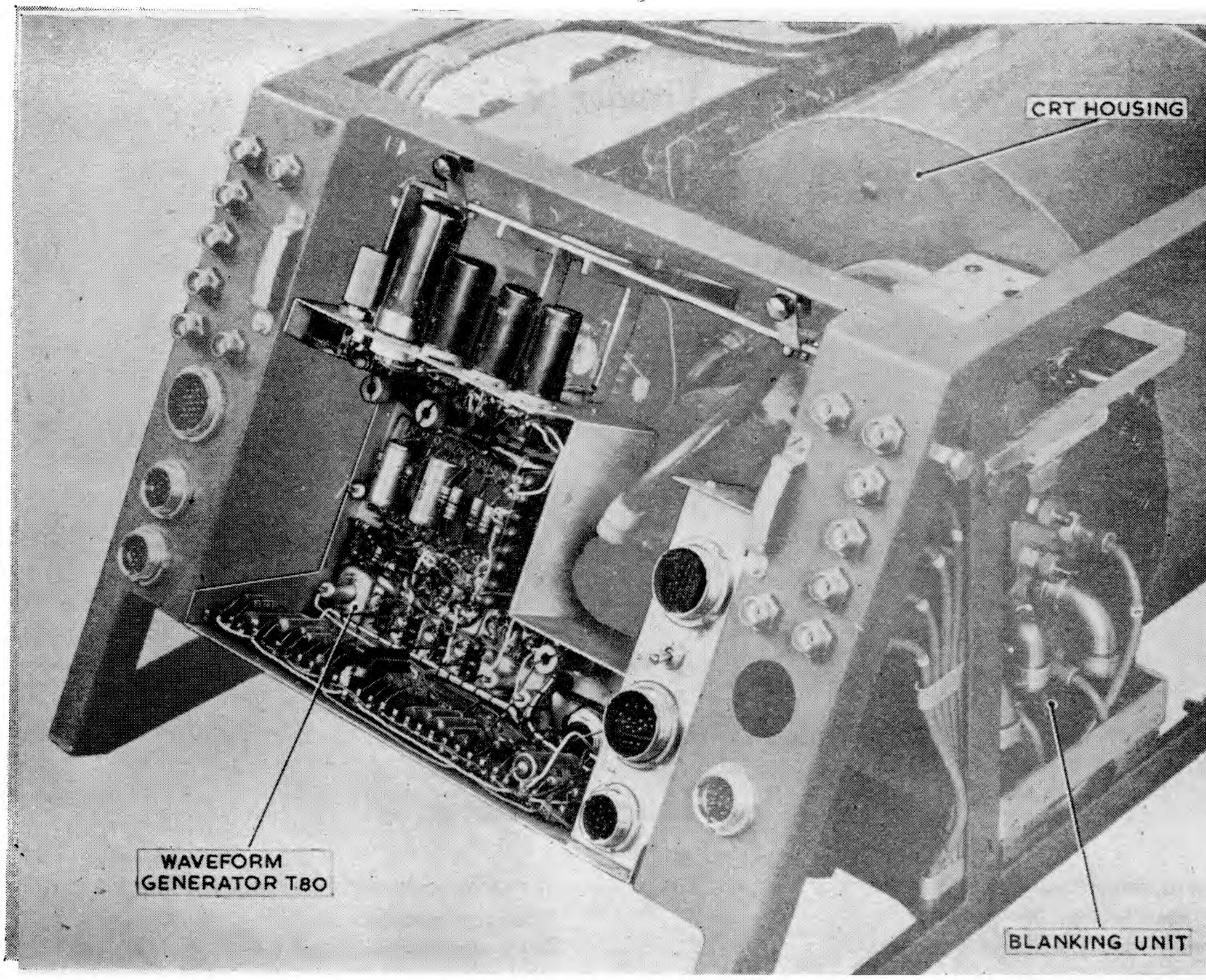



**Fig. 1. Indicating unit, showing waveform generator**

captive screws seen at the top of the photograph, and (after switching off the console and removing all connectors) by withdrawing the unit upwards and outwards from the indicating unit. Fig. 2 is a closer view of the unit showing the position of the principal components; the underside of the chassis and the component layout is shown in fig. 10.

### CIRCUIT DESCRIPTION

**6.** A complete circuit diagram of the waveform generator Type 80 is given in fig. 11; a simplified block diagram is given in fig. 3. The unit may be considered as falling into five main groups; these groups are described in the following paragraphs with the inclusion of simplified circuits of each group.

#### Negative regulator

**7.** A simplified circuit of the negative regulator appears in fig. 4. The incoming negative power supply from the rack assembly Type 305 is nominally at −470V, but is in practice subject to fluctuations due to load changes or mains voltage variation. The function of the negative regulator is to provide from the −470V input an accurately stabilized −300V supply, both for use within the waveform generator Type 80 and in some other units of the console.

**8.** The stabilized −500V from the rack assembly Type 338 is used for reference, as in the rest of the fixed-coil equipment. The −300V stabilized

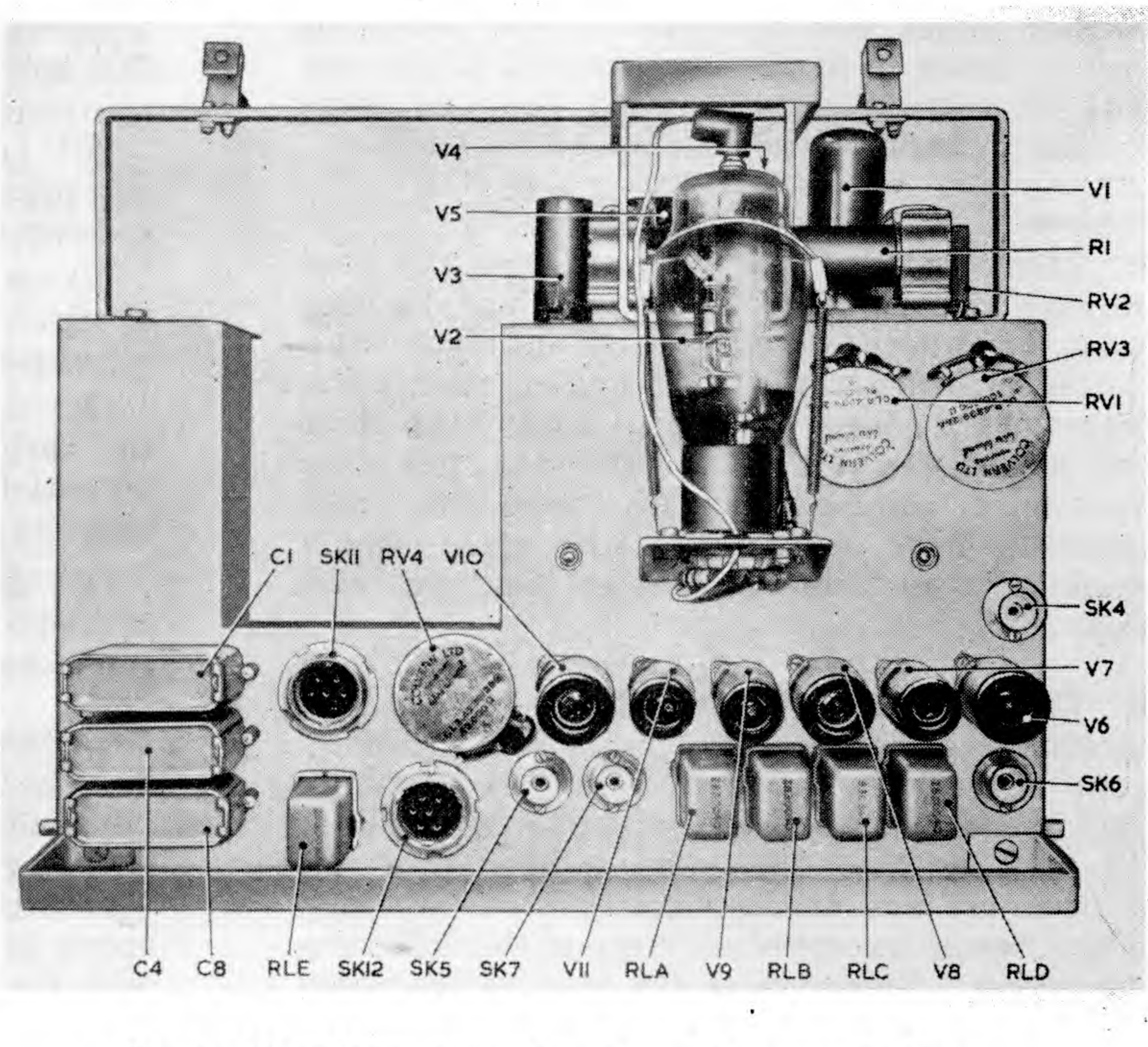



**Fig. 2. Waveform generator Type 80—general view**

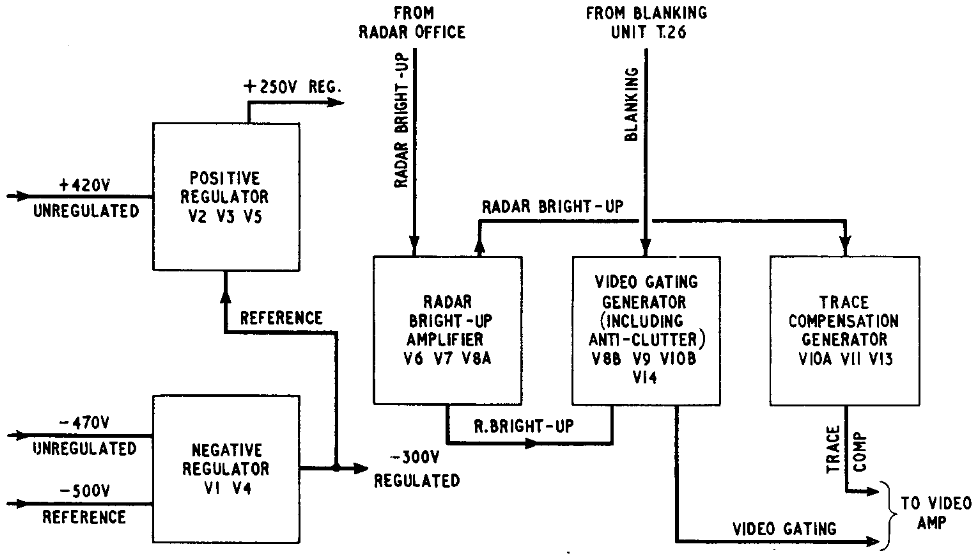



**Fig. 3. Waveform generator Type 80—block diagram**

supply produced by the negative regulator is in its turn used as a reference voltage for the positive regulator in the waveform generator unit. The advantage of referring the positive regulator to the −300V line is that if the latter should drift slightly, the positive HT voltage will drift equally in the opposite direction and so minimize the adverse effect on the zero stability of the various DC amplifiers in the unit.

*Action of the negative regulator*

**9.** The negative regulator employs a tetrode V1 (CV391) in a shunt regulator circuit. The more usual series regulator circuit is not practicable here because the series regulating valve would have to be placed in series in the negative line, so that the grids and cathodes of the associated control amplifiers would have to be returned to an even more negative supply capable of delivering the amplifier currents ; such a supply is not available.

**10.** When any fluctuation of the −300V output occurs, due to change of load current or to fluctuation in the −470V input, the circuit is arranged so that the current drawn off through the tetrode V1 is automatically varied, and the potential drop across the 30-watt 2·2 KΩ resistor R1 thus altered just enough to restore the output voltage to −300V.

**11.** V4 is a double triode (CV455) used to provide two stages of DC amplification. The grid of V4B is returned to an accurately stabilized reference potential which is slightly more negative than −300V ; this reference potential is obtained from the slider of a 100 KΩ potentiometer RV2, which is the setting-up potentiometer for the regulator. RV2 forms part of a divider chain extending from earth down to the −500V reference line. The cathode of V4B is taken to the −300V line.

**12.** If some fluctuation suddenly occurs so that the −300V line tries to move to, say, −298V, the cathode of V4B becomes 2V more positive and its anode current is reduced ; the consequent amplified voltage rise at V4B anode is DC-coupled by the divider chain R14, R15 and R39 to the grid of V4A. Hence the anode current of V4A is increased, and an amplified fall in voltage at its anode is DC-coupled to V1 grid. The anode current of V1 is thus reduced by about 1mA, so that the potential drop across R1 becomes 2V less and the output is restored to the correct value of −300V.

**13.** If the fluctuation is in the other direction, causing the output voltage to move to −302V for

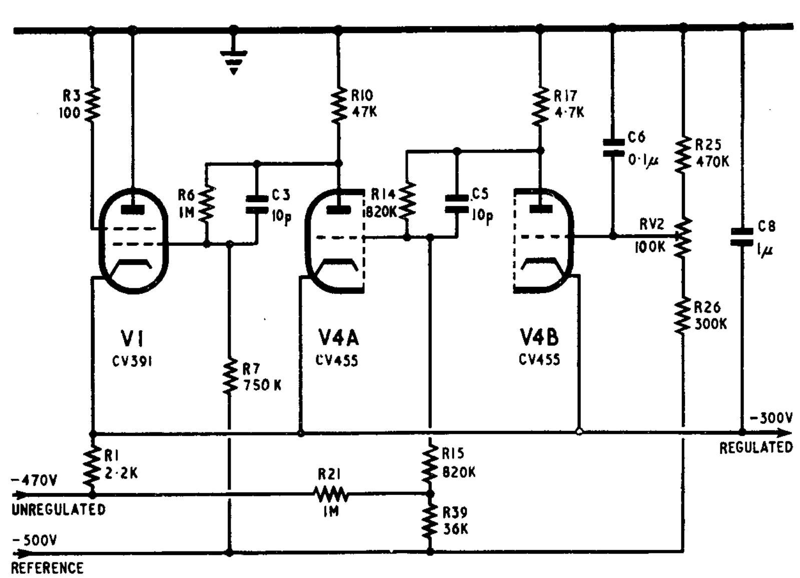



**Fig. 4. Negative regulator**

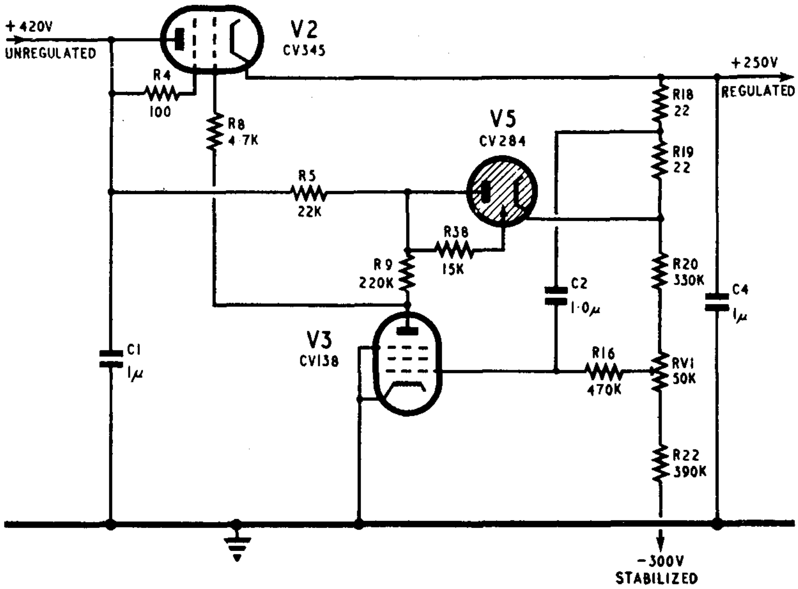



**Fig. 5. Positive regulator**

example, the opposite action occurs and the current drawn off by V1 increases by 1mA so that the output is again regulated to −300V.

**14.** The 1 MΩ resistor R21 has been included to ensure 100 per cent. compensation for fluctuations in the −470V bulk power supply. Without R21 compensation would not be quite complete, and a change in the bulk power supply would result in a smaller but discernible change in the same direction in the regulated output. As with all similar control systems having negative feedback, full 100 per cent. compensation can never be quite achieved by the feedback system alone, because some change in the controlled output must take place before control can be effective. To obtain 100 per cent. compensation for bulk power supply fluctuations therefore, a small fraction of such fluctuations is fed via R21 and R15 to V4A grid to supplement the changes applied from V4B anode.

**15.** The regulator is equally effective in dealing with short-term voltage fluctuations; if therefore any ripple is present on the −470V line it will be almost eliminated by the regulator (ripple may be especially marked when the bulk power supply is fully loaded). The 10 pF capacitors C5 and C3 are included to alter the phase shifts in each stage for high frequencies and so improve the HF response and prevent HF oscillation.

**Positive regulator**

**16.** The circuit of the positive regulator, which includes the valves V2, V3 and V5, is shown in simplified form in fig. 5. The purpose of the device is to provide an accurately stabilized +250V HT supply from a +420V (nominal) power supply which is subject to fluctuations. The stabilized +250V supply produced is used both within the waveform generator unit and also in other units of the console Type 64 (except the deflection amplifiers).

*Action of positive regulator*

**17.** The circuit used is that of a series regulator. When for any reason a fluctuation of the +250V

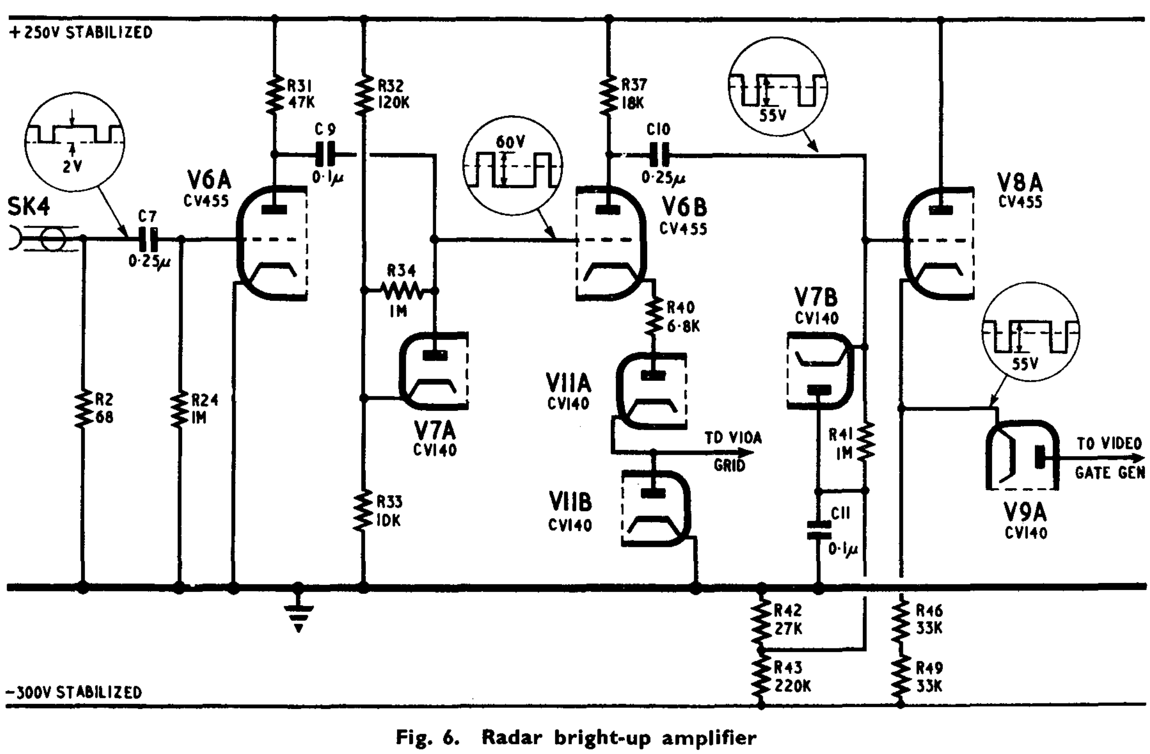



**Fig. 6. Radar bright-up amplifier**

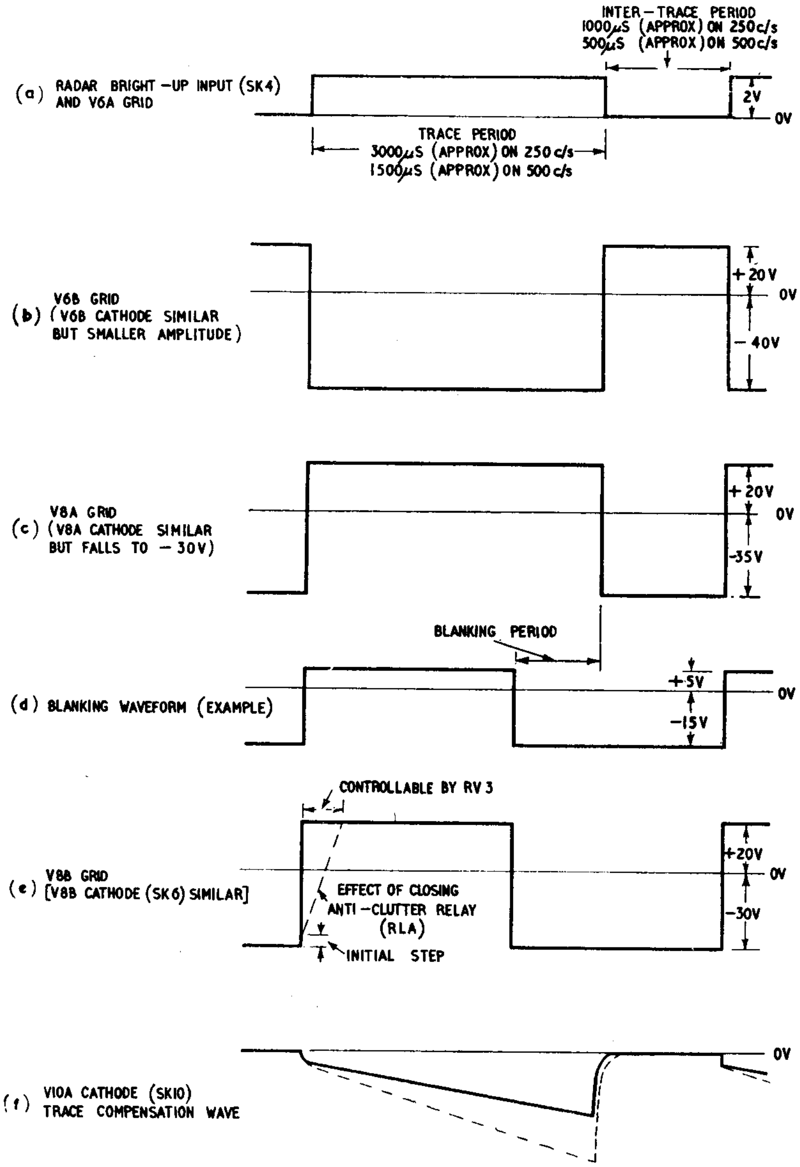



**Fig. 7. Waveform generator Type 80—waveforms**

line occurs, it is arranged that the impedance of the large tetrode V2 (CV345) is automatically changed sufficiently to compensate for the fluctuation and restore the output to its correct value of + 250V.

**18.** The valve amplifier controlling this compensation is the pentode V3 (CV138). The grid of V3 is returned via the 470 KΩ resistor R16 to the slider of the setting-up potentiometer RV1 (50 KΩ). This potentiometer forms part of a resistance chain extending from the +250V line down to the stabilized —300V line, which is used as a reference voltage. Any change occurring in the +250V line with reference to the —300V line thus produces a small but proportionate change at V3 grid.

**19.** Voltage changes at V3 grid are amplified and phase-inverted by that valve, the anode load of which is over 220 KΩ. The changes are then applied to the control grid of the series tetrode V2, and thus control the current flowing through that valve. The 4·7 KΩ grid resistor R8 is merely an anti-parasitic resistor to prevent HF oscillation of the circuit.

**20.** The 0·1 μF capacitor C2 provides extra AC compensation for ripple and short surges; nearly twice as much compensation is obtained as for DC changes.

**21.** If the top of the 220 KΩ load R9 were returned direct to the +250V regulated output rail, V3 would pass only a small fraction of 1mA at the setting of RV1 which would give an output of +250V. In that region of the CV138 characteristics the mutual conductance is low, so that the gain and thus the degree of control obtained, would also be low. With V2 passing the required current, its grid-cathode voltage, corresponding to the voltage drop across R9, would only be about 10V.

**22.** However, the HT supply to V3 is given a 70V boost by taking it from the anode of the neon V5 (CV284), connected between the +420V and +250V lines. The gain of V3 is improved and the voltage across R9 is about 80V, which gives a much greater range of control than the 10V quoted in para. 21.

**23.** As in the negative regulator, full 100 per cent. control is never possible by feedback action alone, as there must be some deviation from +250V always present to effect the control. To ensure 100 per cent. compensation for fluctuations in the input rail, therefore, a small fraction of such fluctuations is applied to V3 grid via R5 (22 KΩ), V5 and the potentiometer chain. Since AC compensation is already twice as good as DC compensation (*para. 20*), only half as much control via R5 is required in the AC case; this is why C2 is returned to the junction of the two 22Ω resistors R18 and R19.

#### Radar bright-up amplifier

**24.** The radar bright-up amplifier stages include the miniature double-triode valve V6 (CV455) and one half of V8, which is of the same type. They also include the double-diode V7 (CV140). A simplified circuit diagram of these stages is shown in fig. 6. The function of this part of the unit is to accept at SK4 the radar bright-up wave distributed from the radar office via the head selector unit, and to apply two versions of this rectangular

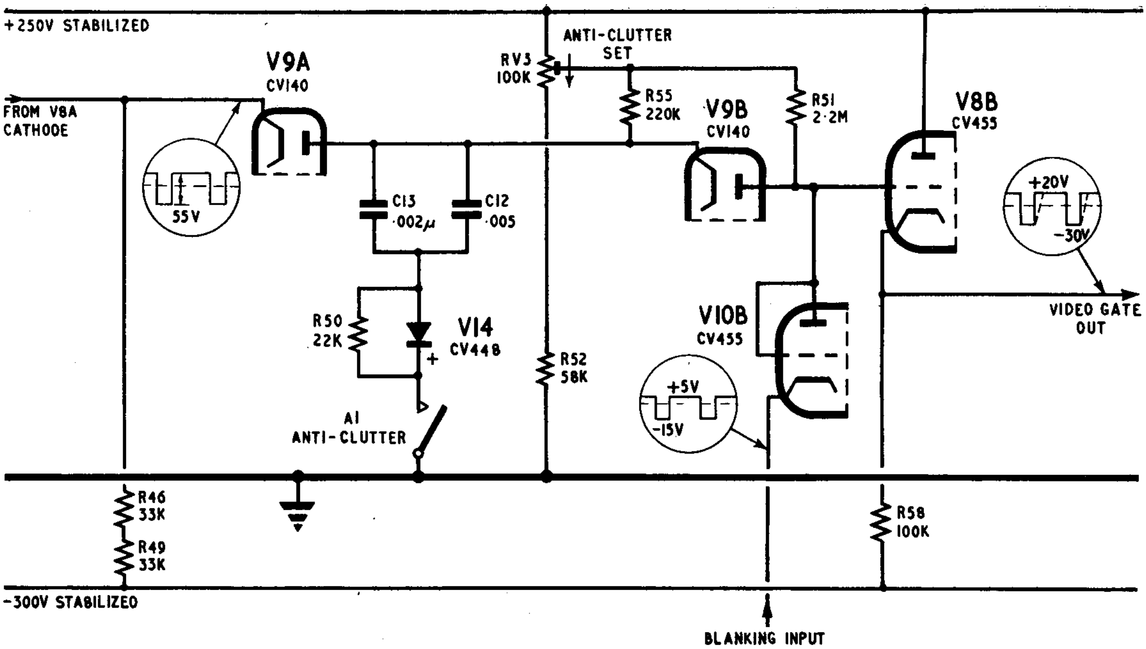



Fig. 8. Video gate generator

wave, with the correct polarities, amplitudes, and DC levels, to the video gating wave generator and to the trace compensation wave generator.

**25.** The radar bright-up wave appears at SK4, where its line is terminated by the 68Ω resistor R2. It has an amplitude of about 2V (*waveform* (*a*), *fig.* 7), and is positive-going during the trace period. The bright-up duration is approximately 3,000 μS when a 250 c/s radar head is being displayed, and approximately 1,500 μS for a 500 c/s head. The correct radar bright-up wave is automatically routed to the console by the head selector unit when the operator sets his head selector switch.

**26.** V6A is a straightforward triode amplifier with a 47 KΩ anode load R31 ; in the absence of any signal it passes about 4mA. Its gain is about 30, and so a phase-inverted rectangular wave of some 60V amplitude is applied to the grid of V6B via the coupling network C9, R34. V7A is a DC-restoration diode with its cathode returned to the junction of R32 and R33. This junction is at +20V ; the rectangular wave at V6B grid is thus kept wholly below the +20V level (*waveform* (*b*), *fig.* 7).

**27.** V6B is an amplifying triode of which the cathode circuit to earth is completed by the two series diodes V11A and V11B. These diodes are switching diodes for the trace compensation generator V10A (*para. 35*). During the trace period V6B is completely cut off by the 40V negative potential at its grid and the anode consequently rises to full HT, +250V. During the inter-trace period, however, the grid is raised to +20V to earth, and the valve draws over 3mA, causing the anode to fall to +195V. The current switched on in this valve is limited by the inherent negative feedback provided by the 6·8 KΩ resistor R40 in the cathode circuit.

**28.** The resulting rectangular wave of about 55V amplitude from V6B anode is applied via the coupling network C10, R41 to the grid of a triode cathode-follower V8A. A diode V7B is connected to provide DC-restoration positive with respect to −33V, this being the potential at the junction of R42 and R43 to which the diode and the grid resistor R41 are returned (*waveform* (*c*), *fig.* 7). The cathode load of V8A total 66 KΩ, and is returned to the −300V line so that the output,

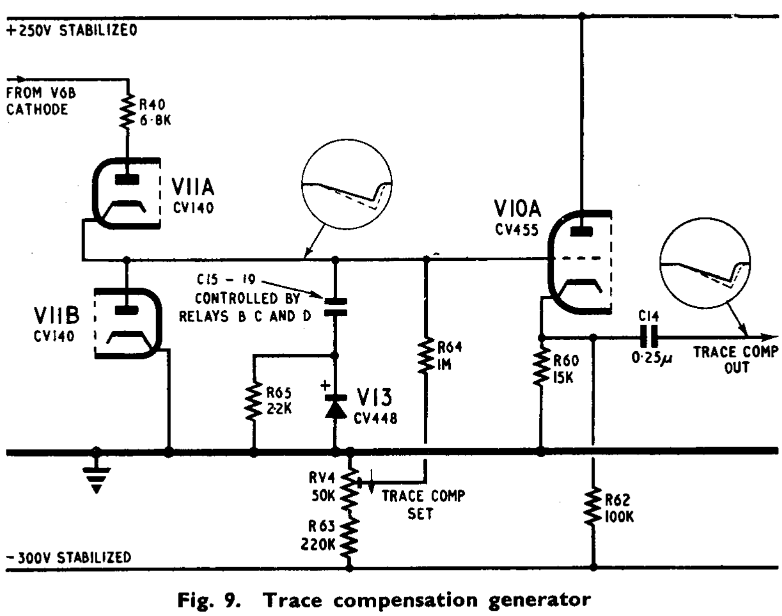



Fig. 9. Trace compensation generator

which looks similar to *waveform* (*c*), can embrace both positive and negative voltages. This output is passed on to the circuits forming the video gating wave generator.

### Video gate generator

**29.** The video gating wave generator includes the double-diode V9 (CV140), the germanium diode V14 (CV448), the triode V8B (one half of a CV455) and the triode V10B (one half of a CV455 but strapped as a diode). A simplified circuit diagram of the arrangement is shown in fig. 8. Its purpose is to accept the radar bright-up wave (from the R.B.U. amplifier stages) and the blanking wave which comes in at SK7 from the blanking unit Type 26, and to produce from these the video gating wave for application to the video amplifier. The circuit contains an optional anti-clutter facility which, when switched on, provides a sloping edge at the beginning of the video gating wave and so reduces the trace brightness over the first few miles of the scan ; this facility helps to eliminate the disturbing effect of short-range ground returns.

**30.** Relay A is the anti-clutter relay, and is operated from a corresponding switch on the control panel Type 859. When it is open (ANTI-CLUTTER OFF), the capacitors C12 and C13 are not in circuit. During the inter-trace period, the cathode of diode V9A is at a level of about −30V. Its anode is returned to a positive potential determined by the setting of the 100 KΩ potentiometer RV3 ; the diode therefore conducts, and keeps the cathode of V9B at about −30V also. Ignoring for the moment any effect of the blanking input, it is seen that the grid of triode V8B is consequently held at about −30V during the inter-trace period.

**31.** When the radar bright-up period starts, the cathode of V9A is raised abruptly, so cutting off the diode momentarily, since its anode cannot immediately assume the positive potential of RV3 slider because stray capacitances to earth must first charge through R55 (220 KΩ). As the stray capacitances charge however, V9B cathode potential rises, and V8B grid potential rises at a slightly slower rate. When the anode

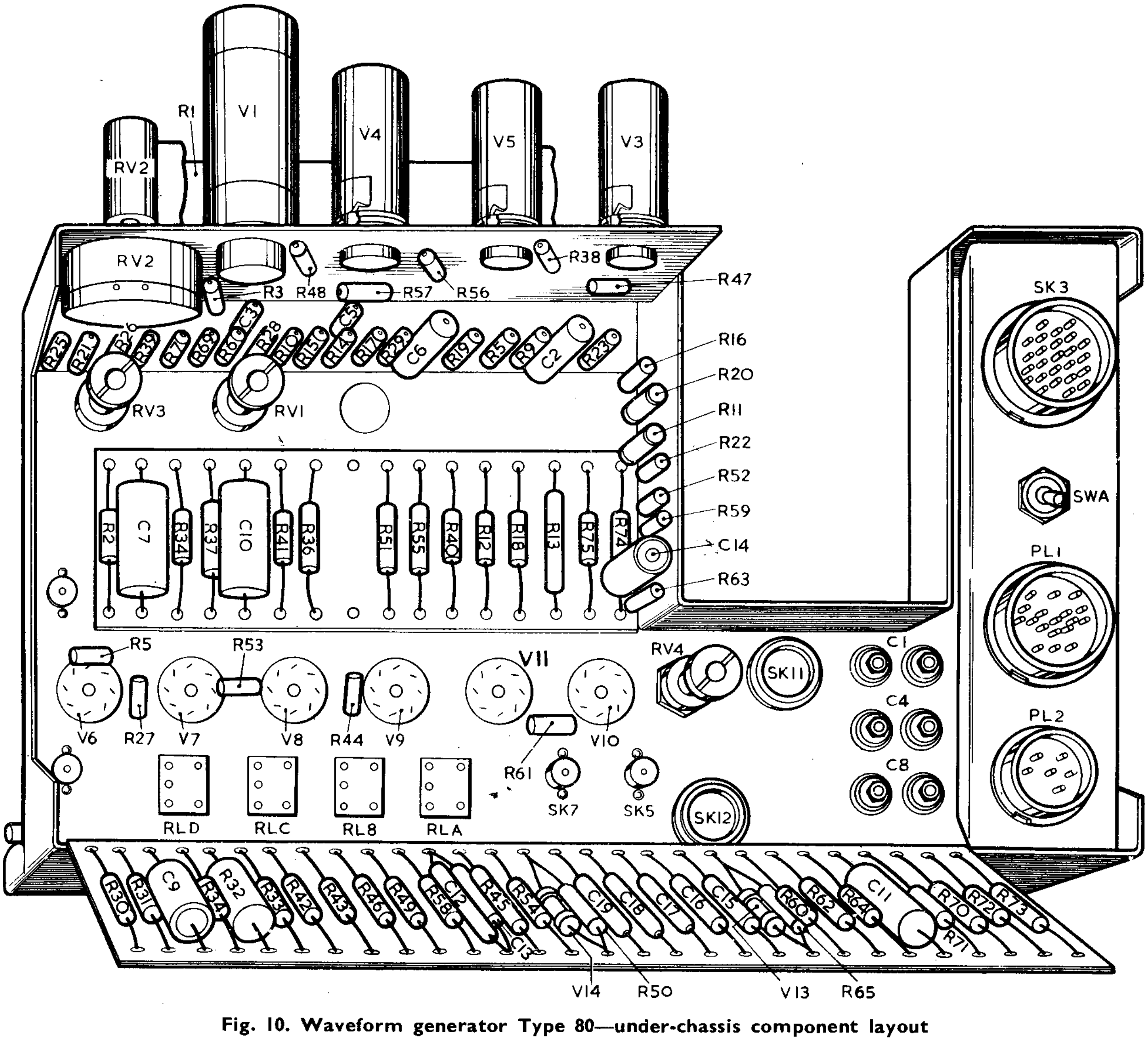



**Fig. 10. Waveform generator Type 80—under-chassis component layout**

of V9A reaches +20V, V9A conducts, as does V9B when its anode reaches +20V. The diodes continue to conduct until the end of the bright-up period, so holding V8B grid +20V during that time. At the end of the bright-up period, both the anode and cathode of V9B revert to −30V as before, the stray capacitances discharging via V8A cathode resistor.

**32.** If the relay A is closed (ANTI-CLUTTER ON), then in addition to the stray capacitances referred to in para. 31, capacitors totalling 0·007 μF are connected from V9B cathode to earth through a 22 KΩ resistor R50. Instead of assuming its positive potential quite quickly at the start of the trace period therefore, V9B cathode (and V8B with it) rises exponentially as C12 + C13 charge towards RV3 slider potential through the 220 KΩ resistor R55. When they reach +20V, V9A conducts and they rise no further. Thus only the first, fairly linear, portion of the charging curve is utilized; this linear slope appears at the beginning of the video gating wave (*waveform (e), fig. 7*), and constitutes the anti-clutter waveform. The complete video gating wave is fed out from V8B cathode via SK6. The potential set by RV3 forms the "aiming potential" for the charging of C12 + C13, and therefore controls the anti-clutter slope and duration. Without V14 there would be a tendency for a vertical step to appear at the start of the anti-clutter waveform, due to initial charging current through R50, but this is much reduced by the forward resistance of V14, which is a germanium diode (CV448), in parallel with R50.

**33.** At the end of the radar bright-up period, V8A cathode falls. In doing so it causes both plates of C12 + C14 to fall as well, because their lower plates are not now earthed, but return to earth via R50 (22 KΩ) with the high back resistance of V14 in parallel. V8B grid therefore returns to −30V quite quickly (fall time limited only by stray capacitances) whereas the lower plates of C12 and C13 re-charge to earth level in their own time, via R50.

*Blanking action*

**34.** When for any reason there is no scan, or the trace is deflected beyond the tube face (as often occurs when considerable trace expansion or off-centring are used), a negative blanking input of −15V amplitude arrives at SK7 and is applied to the cathode of the diode V10B, which therefore conducts heavily and keeps V8B grid low. Thus during the blanking the ordinary radar bright-up action at V8B grid is overridden, and the CRT beam current is cut off. On the other hand, when the grid of V8B is held at +5V by the blanking wave, the positive excursion of the gating waveform is limited to this value.

**Trace compensation generator**

**35.** The trace compensation circuit (*fig. 9*) includes the triode V10A (part of a CV455), the germanium diode V13 (CV448), and the two diodes V11A and V11B (CV140) which are located in the cathode circuit of V6B. The purpose of the circuit is to produce from the R.B.U. rectangular wave a trace compensation wave for application to the video amplifier. The trace compensation wave is a fairly linear negative-going sawtooth lasting the full duration of the trace period; its function, after being mixed with the other video waveforms in the video amplifier, is to effect a gradual increase in trace brightness as the scan progresses, so compensating for the increased trace separation at the higher ranges and ensuring a picture which paints uniformly all over the screen. To give correct compensation on all trace expansions, it is necessary to provide a different compensation slope for each degree of trace expansion, the steepest being required on maximum expansion (i.e. on the 40-mile picture).

**36.** During the inter-trace period the R.B.U. amplifier triode V6B is conducting to the extent of about 3mA via the two diodes V11A and V11B which are in series in its cathode. In consequence, the grid of V10A, being returned to the junction of the diodes, is held at earth potential right through the inter-trace period. V10A is therefore conducting, and its output (taken from the cathode) is steady at a small positive potential.

**37.** When the trace period starts, V6B is cut off, the diodes V11A and V11B cease to conduct, and V10A grid is no longer held at earth potential. As a result, the capacitor marked C15-19 starts to discharge exponentially through R64 (1 MΩ) towards the potential set by the slider of RV4 (the 50 KΩ TRACE COMPENSATION SET potentiometer). Due to the low forward resistance of V13, the lower plates of C15-19 are held at earth potential during this time.

**38.** When the trace period ends V6B conducts once again, and so do the diodes V11A and V11B. V10A grid therefore returns rapidly to earth level; as V13 has a high back resistance the 2·2 KΩ resistor R65 now becomes effective and ensures that the top and bottom plates of C15-C19 move together without discharge.

**39.** The different rates of run-down required for different trace expansions are obtained by switching in different values of C. Reference to the full circuit diagram (*fig. 11*) shows that when all three relays, B, C and D, are open, C is only 0·01 μF (C15), so giving rapid run-down for the maximum expansion. As relays B, C and D are closed in succession (from the operator's trace expansion RANGE switch on the panel Type 859), the capacitors C16 to C19 are added in turn, giving the reduced slopes for the lesser trace expansions.

**Protective relay**

**40.** The relay E and the associated switch SWA seen in fig. 11 are part of a protective trip circuit to switch off the console HT if the +250V regulator in this unit fails (or if the −300V regulator fails and so causes the +250V to vary). One end of the relay winding is returned (via R76) to the +250V rail here and the other end goes to a comparison +250V from the bulk power supply, via interconnections in the blanking unit Type 26 and the indicating unit, Type 35 (provided SWA is in the NORMAL position). In the event of any substantial difference existing between these two supplies relay E is energized so opening contact E1 and operating the protective trip circuit in the distribution panel, details of which will be found in Chap. 9 of this Section.

**41.** If SWA is turned to the TEST position, the circuit of relay E winding is opened and the trip line closes again; this feature makes it possible to decide whether a fault which has tripped the HT lies in this unit or in the voltage stabilizer Type 51.

## TABLE I
### Component details

**Note . . .**

*This list of components is issued mainly to give ratings and tolerances for servicing use. When ordering spares for this unit refer to Volume 3 of this publication, or to the appropriate section of A.P.1086.*

**Resistors (fixed)**

| Circuit ref. | Value (ohms) | Rating (watts) | Tol. (%) | Inter-serv. ref. |
|---|---|---|---|---|
| R1 | 2·2 K | 30 | 1 | 10W/19105 (Welwyn Type C43) |
| R2 | 68 | ½ | 10 | Z221089 |
| R3 | 100 | ½ | 10 | Z221110 |
| R4 | 100 | ½ | 10 | Z221110 |
| R5 | 22 K | 6 | 5 | Z244129 |
| R6* | 1 M | ¾ | 2 | Z216659 |
| R7* | 750 K | ¾ | 2 | Z216635 |
| R8 | 4·7 K | ½ | 10 | Z222089 |
| R9 | 220 K | ¾ | 10 | Z223081 |
| R10 | 47 K | ¾ | 10 | Z222216 |
| R11 | 47 K | ½ | 10 | Z222215 |
| R12 | 100 K | ½ | 10 | Z223038 |
| R13 | 47 K | ¾ | 10 | Z222216 |
| R14* | 820 K | ¾ | 5 | Z216751 |
| R15* | 820 K | ¾ | 5 | Z216751 |
| R16 | 470 K | ½ | 10 | Z223122 |
| R17 | 47 K | ¾ | 10 | Z222216 |
| R18 | 22 | ½ | 10 | Z221026 |
| R19 | 22 | ½ | 10 | Z221026 |
| R20* | 330 K | ¾ | 2 | Z216563 |
| R21* | 1 M | ¾ | 5 | Z216757 |
| R22* | 390 K | ¾ | 2 | Z216579 |
| R23* | 33 | ½ | 5 | Z215062 |
| R24 | 1 M | ½ | 10 | Z223164 |
| R25* | 470 K | ¾ | 2 | Z216595 |
| R26* | 300 K | ½ | 2 | Z216554 |
| R27 | 100 | ½ | 10 | Z221110 |
| R28* | 33 | ½ | 5 | Z215062 |
| R29* | 33 | ½ | 5 | Z215062 |
| R30* | 33 | ½ | 5 | Z215062 |
| R31 | 47 K | ¾ | 10 | Z222216 |
| R32* | 120 K | ¾ | 5 | Z216711 |
| R33* | 10 K | ½ | 5 | Z216002 |
| R34 | 1 M | ½ | 10 | Z223164 |
| R35 | 100 | ½ | 10 | Z221110 |
| R36* | 33 | ½ | 5 | Z215062 |
| R37 | 18 K | 1 | 10 | Z212258 |

**Resistors (fixed)**—*cont.*

| Circuit ref. | Value (ohms) | Rating (watts) | Tol. (%) | Inter-serv. ref. |
|---|---|---|---|---|
| R38 | 15 K | ½ | 10 | Z222152 |
| R39* | 36 K | ½ | 5 | Z216067 |
| R40 | 6·8 K | ½ | 10 | Z222110 |
| R41 | 1 M | ½ | 10 | Z223164 |
| R42* | 27 K | ½ | 5 | Z216052 |
| R43* | 220 K | ¾ | 5 | Z216723 |
| R44 | 100 | ½ | 10 | Z221110 |
| R45* | 33 | ½ | 5 | Z215062 |
| R46 | 33 K | 1 | 10 | Z212261 |
| R47 | 100 | ½ | 10 | Z221110 |
| R48 | 100 | ½ | 10 | Z221110 |
| R49 | 33 K | 1 | 10 | Z212261 |
| R50 | 22 K | ½ | 10 | Z222173 |
| R51 | 2·2 M | ¾ | 10 | Z223207 |
| R52 | 68 K | ¾ | 10 | Z223018 |
| R53 | 100 | ½ | 10 | Z221110 |
| R54* | 33 | ½ | 5 | Z215062 |
| R55 | 220 K | ½ | 10 | Z223080 |
| R56 | 100 | ½ | 10 | Z221110 |
| R57 | 100 | ½ | 10 | Z221110 |
| R58 | 100 K | 1 | 10 | Z213327 |
| R59* | 33 | ½ | 5 | Z215062 |
| R60 | 15 K | ½ | 10 | Z222152 |
| R61 | 100 | ½ | 10 | Z221110 |
| R62 | 100 K | 1 | 10 | Z213327 |
| R63 | 220 K | ¾ | 10 | Z223081 |
| R64 | 1 M | ½ | 10 | Z223164 |
| R65 | 2·2 K | ½ | 10 | Z222047 |
| R66* | 680 | ½ | 5 | Z215222 |
| R67 | — | — | — | — |
| R68 | — | — | — | — |
| R69* | 10 | ½ | 5 | Z215002 |
| R70* | 300 K | ¾ | 1 | Z216551 |
| R71 | 100 K | ½ | 10 | Z223038 |
| R72 | 100 K | ½ | 10 | Z223038 |
| R73* | 300 K | ¾ | 1 | Z216551 |
| R74 | 1 K | ½ | 10 | Z222005 |
| R75 | 1 K | ½ | 10 | Z222005 |
| R76 | 1 K | ½ | 10 | Z222005 |

**High stability.*

**Resistors (variable)**

| Circuit ref. | Value (ohms) | Rating (watts) | Tol. (%) | Inter-serv. ref. | Function |
|---|---|---|---|---|---|
| RV1 | 50 K | 1 | 10 | Z272410 | +250V SET |
| RV2 | 100 K | 1 | 10 | Z272549 | −300V SET |
| RV3 | 100 K | 1 | 10 | Z272549 | ANTI-CLUTTER SET |
| RV4 | 50 K | 1 | 10 | Z272410 | TRACE COMP. SET |

**Capacitors**

| Circuit ref. | Value (μF except where stated) | Rating (V.DC) | Tol. (%) | Inter-serv. ref. |
|---|---|---|---|---|
| C1 | 0·1 | 1500 | 20 | Z111458 |
| C2 | 0·1 | 350 | 20 | Z115506 |
| C3 | 10 pF | 500 | 10 | Z132253 |
| C4 | 1 | 600 | 20 | Z112823 |
| C5 | 10 pF | 500 | 10 | Z132253 |
| C6 | 0·1 | 350 | 20 | Z115506 |
| C7 | 0·25 | 350 | 25 | Z115565 |
| C8 | 1 | 600 | 20 | Z112823 |
| C9 | 0·1 | 350 | 20 | Z115506 |
| C10 | 0·25 | 350 | 25 | Z115565 |
| C11 | 1 | 150 | 25 | Z115569 |
| C12 | 0·005 | 350 | 20 | Z124321 |
| C13 | 0·002 | 350 | 20 | Z124175 |
| C14 | 0·25 | 350 | 25 | Z115565 |
| C15 | 0·01 | 350 | 20 | Z115552 |
| C16 | 0·01 | 350 | 20 | Z115552 |
| C17 | 0·02 | 350 | 20 | Z115553 |
| C18 | 0·02 | 350 | 20 | Z115553 |
| C19 | 0·01 | 350 | 20 | Z115552 |

**TABLE 1**—*continued*

**Component details**—*continued*

**Relays, switch, fixed plugs and sockets**

| Circuit ref. | Description | Inter-services Ref. No. |
|---|---|---|
| RL A to E | 50V relay | Z530040 |
| SWA | D.P. toggle switch | Z510302 |
| PL1 | 18-way | Z560190 |
| PL2 | 6-way (medium) | Z560542 |
| SK3 | 25-way | Z560380 |
| SK 4 to 7 | Type 783 (coaxial) | (*10H/19861* |
| SK 8 to 10 | Type L.714 (test) | (*10H/19641*) |
| SK11 | 6-way (medium) | Z560321 |
| SK12 | 6-way (medium) | Z560323 |

**Note . . .**

*Valve types and base connections may be obtained from the circuit diagram (fig. 11)*

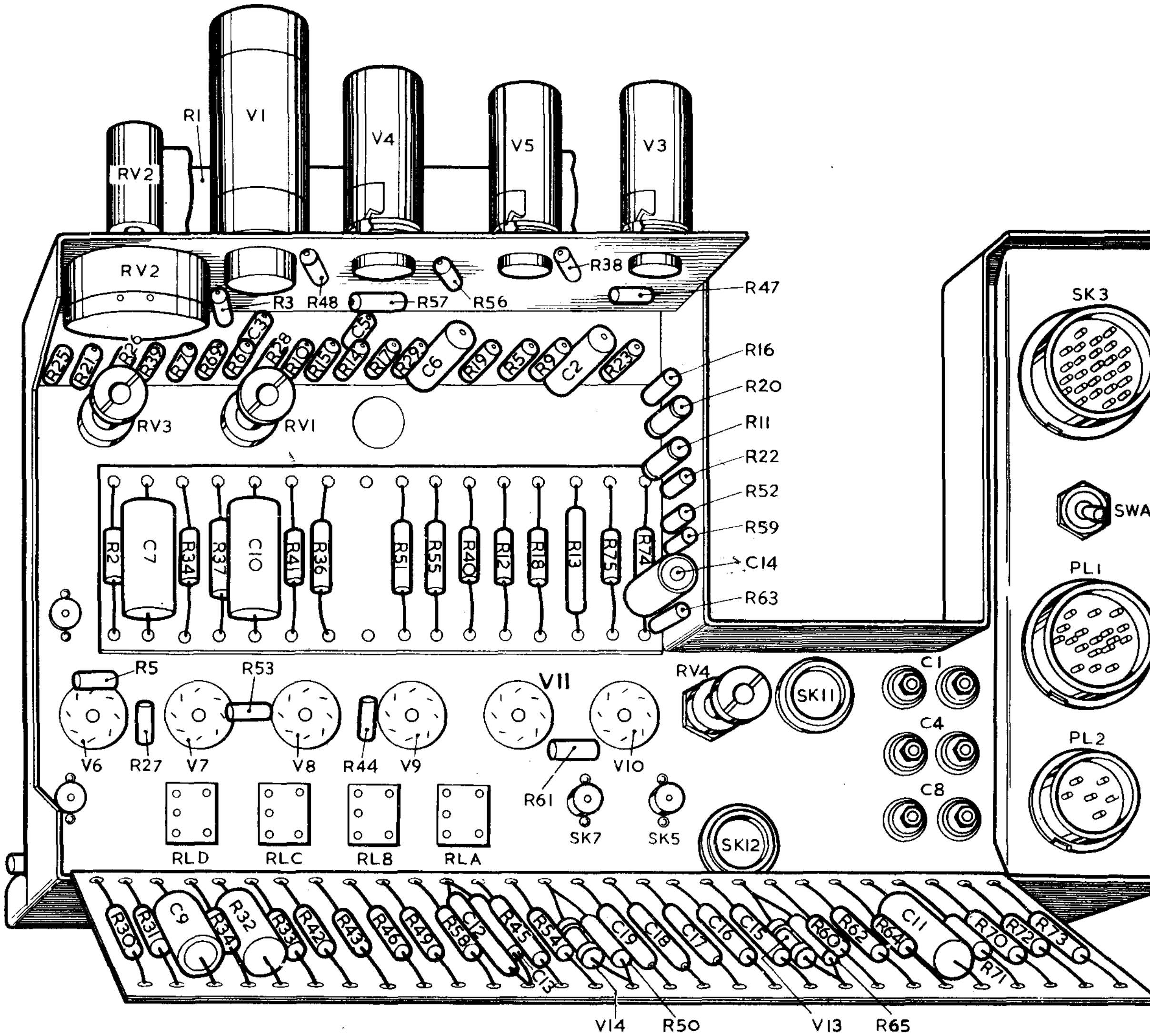



**Fig. 10. Waveform generator Type 80—under-chassis component layout**



(*A.L. 19, Dec. 55*)

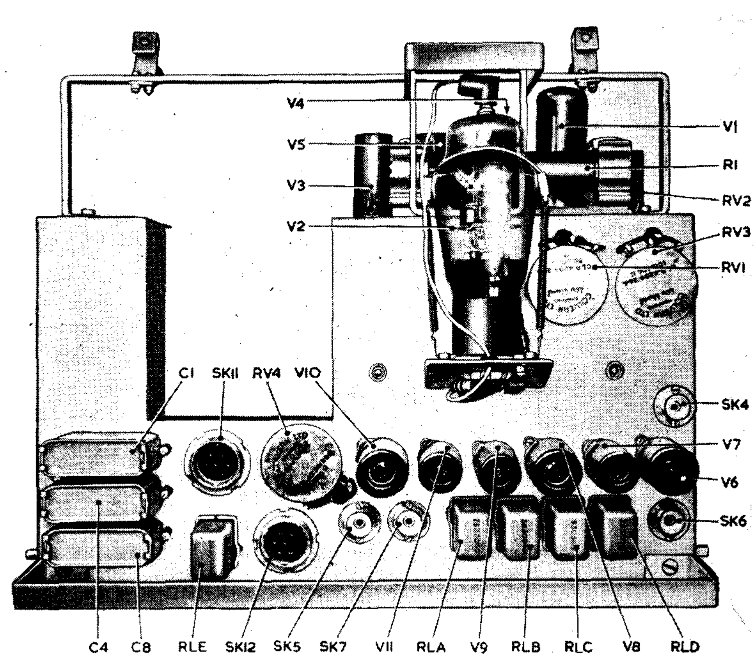
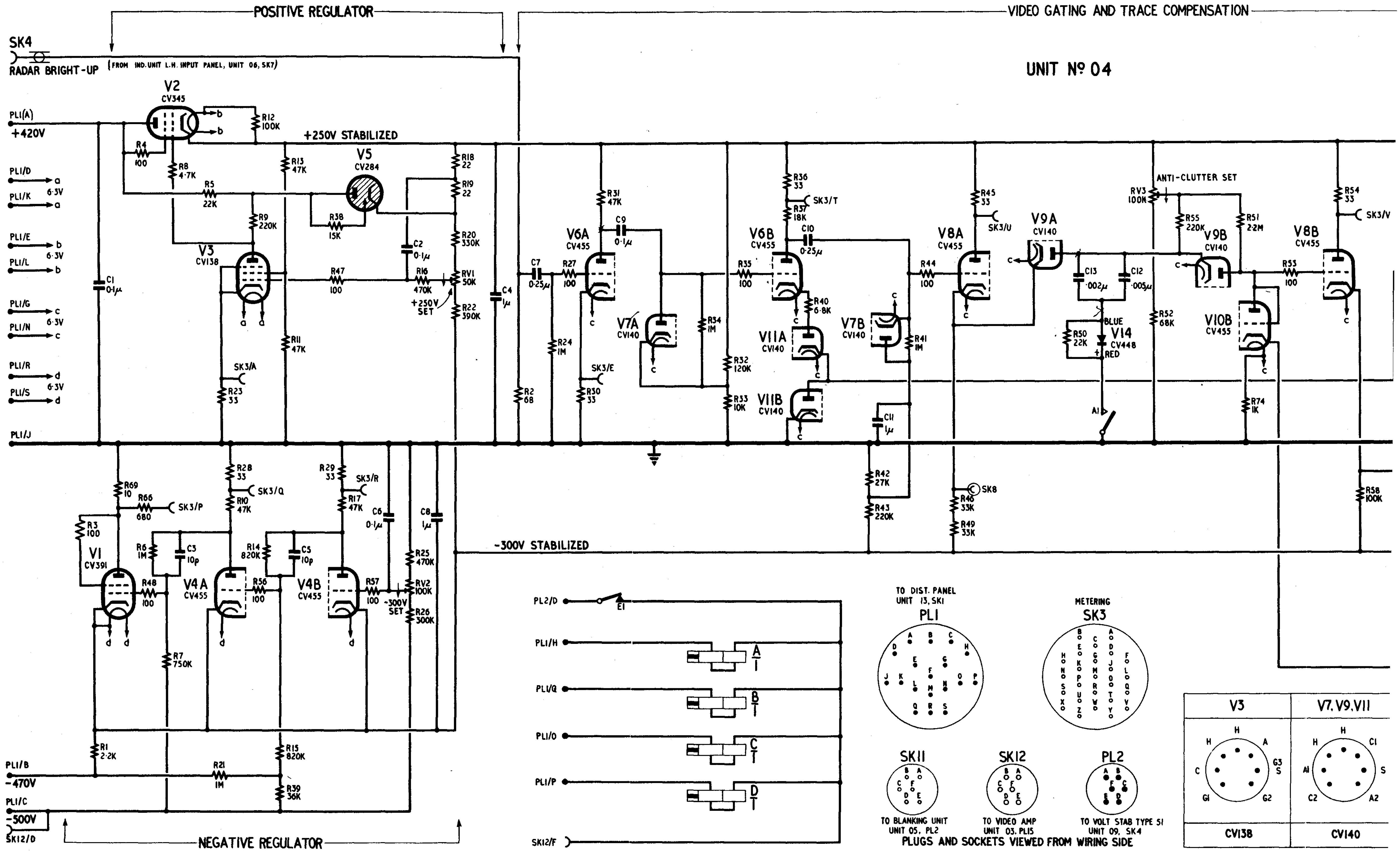



**Fig. 2. Waveform generator Type 80—general view**




AIR DIAGRAM
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# Waveform generator Type 80-circuit

RESTRICTED

# Appendix 1

## WAVEFORM GENERATOR TYPES 80B AND 80C

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LIST OF ILLUSTRATIONS



### Purpose

**1.** When the fixed coil display system is used with phase 1A equipment, the console Type 64, with its sub-units, is re-referenced to become a wired framework and a number of sub-units. Variations of basic sub-units are selected to suit various requirements.

**2.** Waveform generators Types 80B and 80C are similar to Type 80 with the exceptions given in the following paragraphs.

**3.** Types 80B and 80C allow for the new termination of R.B.U. The Type 80B has, in addition, a modification to certain h.t. and heater lines in connection with the modification mentioned in Chap. 1, App. 1, para. 3. It is used in consoles with mixing amplifier systems and head and p.r.f. selection. The Type 80C is used only with head and p.r.f. facilities.

**4.** To facilitate new termination of R.B.U. on Types 80B and 80C, resistor R2 is changed to 68K $\pm 10\%$, 3/4W, Ref. No. 5905-99-3018.

**5.** The Type 80B (fig. 1) also has the following modifications to the h.t. line:

(*a*) A connection is provided from SWA to PL1/F instead of SWA to PL1/D.

(*b*) The connection from SK11/D to PL2/C is removed.

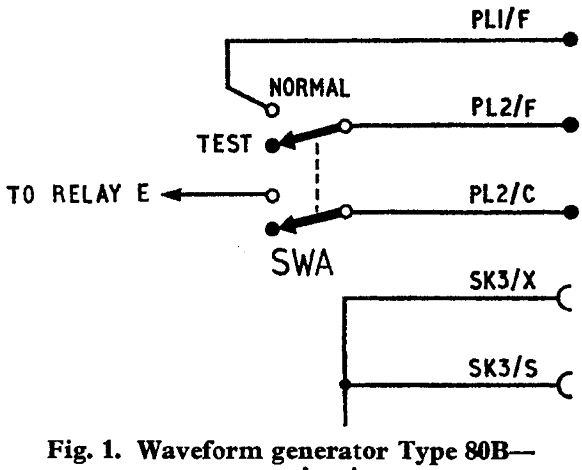



**Fig. 1. Waveform generator Type 80B—scrap circuit**

# Chapter 4

## BLANKING UNIT TYPE 26

ERRATUM

The following list of appendices should follow the list of illustrations:

### LIST OF APPENDICES

# Chapter 4

# BLANKING UNIT TYPE 26

## (with focus current stabilizer)

### LIST OF CONTENTS



### TABLE



### LIST OF ILLUSTRATIONS



### INTRODUCTION

**Location**

**1.** The unit described in this chapter is the *blanking unit Type 26* (Stores Ref. 10D/18641), which forms part of the indicating unit Type 35 in the fixed-coil PPI display console (console Type 64). The position of the blanking unit, on the left-hand side of the indicating unit as seen by the operator, is shown in fig. 1.

**Purpose**

**2.** The purpose of the unit is to produce a blanking waveform for supply to the waveform generator Type 80; the waveform has to effect blanking of the CRT in either of the following two contingencies :—

(1) Failure of the X or Y scan components, or both, with resulting danger of screen burn. (Such failure may arise at several stages of the fixed-coil system, so the blanking has to be equally effective in all cases. Stoppage of aerial head rotation, or failure of the selsyn system from head to timebase resolver, is however catered for separately, by the dimming circuit to the video amplifier.)

(2) Deflection of the spot beyond the normal screen area due to ordinary trace expansion or off-centring. If the beam is not blanked down beyond the screen area, electrons scattered from the sides of the CRT bulb cause undesirable illumination of the screen; light produced at the points of impact on the bulb may also reach the screen and reduce picture visibility. There is even a danger of puncture of the glass envelope and destruction of the CRT.

**3.** To produce the blanking waveform the blanking unit receives control waveforms from the anode circuits and the cathode circuits of the final X and Y deflection amplifiers (CV345) in the amplifying units Type 313 and 314.

**4.** The unit also incorporates a stabilizer circuit for the focus-coil current of the CRT, and the preset FOCUS control itself is therefore located in this unit; the focus stabilizer is located here only for convenience and has no blanking function.

**Power supplies**

**5.** Stabilized HT supplies at +250V and −300V for this unit come from the regulators in the waveform generator Type 80. An unstabilized +570V (nominal) supply is also brought in for the focus coil circuit (from the stabilizer Type 51, via the waveform generator Type 80). The single 6·3V 3·0A 50 c/s heater supply comes from transformer 3 in the distribution panel. The keys to the plugs and sockets on fig. 13 give the origins of the supplies.

**Construction**

**6.** The blanking unit is built on a small rectangular chassis, 9¾ in. × 5¾ in. × 3 in. If the

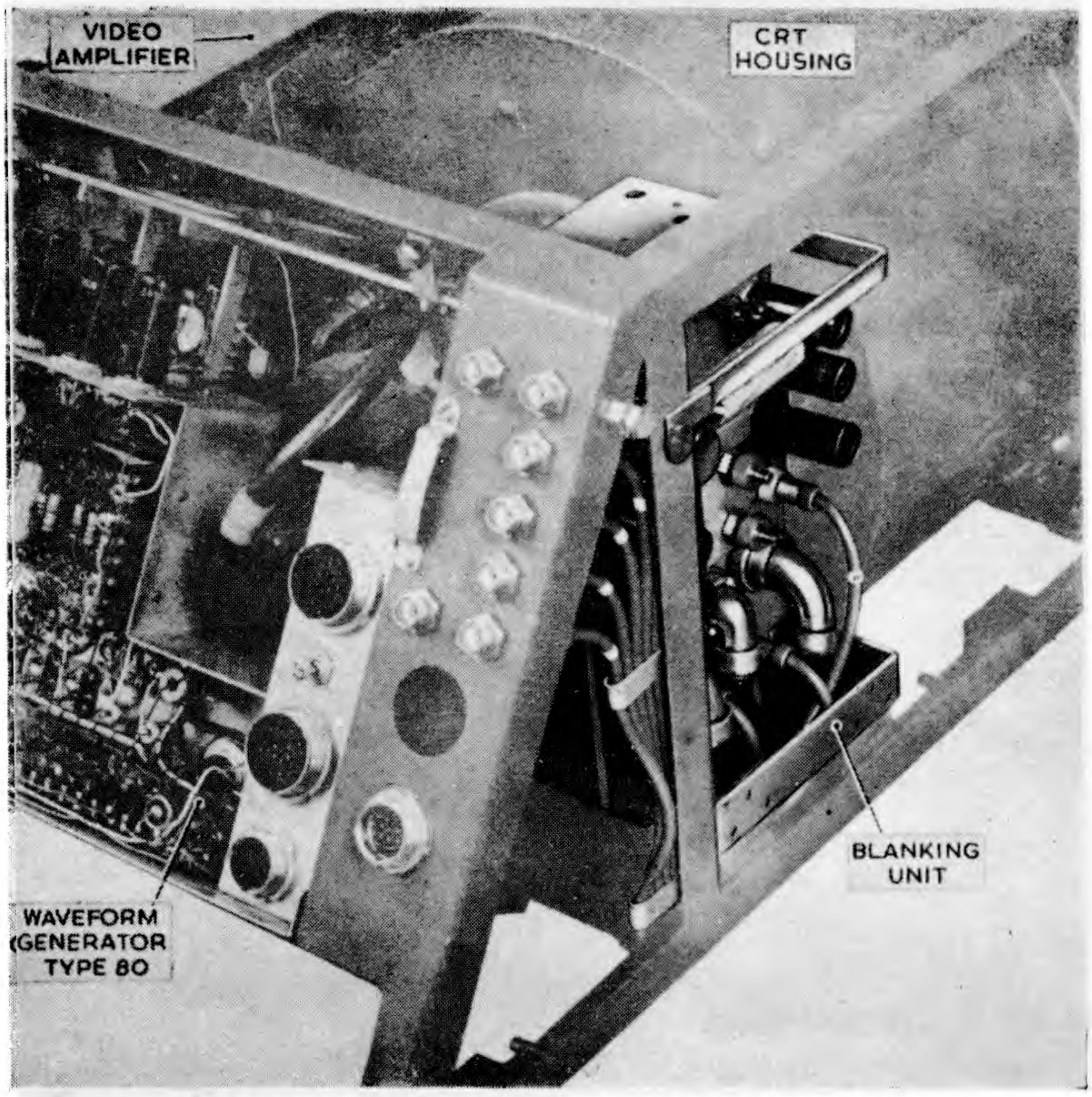



**Fig. 1. Indicating unit, showing blanking unit**

single milled captive screw at the top left of the unit in fig. 1 is released, the unit may be swung outwards and downwards on two hinges, giving access to all under-chassis components without interrupting the operation. The unit may be readily removed altogether, when the console has been switched off and all connectors to the unit unplugged, by shifting it forwards off the hinges. A closer view of the unit, showing layout of major components above the chassis, is given in fig. 2. Fig. 12 shows the under-chassis component layout of the unit.

## CIRCUIT DESCRIPTION

### General

**7.** Reference to fig. 3 shows how the unit may be broken down into four distinct groups, namely :—

(1) Circuit for CRT blanking in the event of scan failure.

(2) Circuit for CRT blanking when the beam is deflected beyond the normal screen area ("octagonal blanking").

(3) Blanking mixer and cathode-follower.

(4) Focus current stabilizer.

Fuller descriptions of these stages, with simplified circuit diagrams, are given in the succeeding paragraphs. A complete circuit diagram, including all plug and socket connections, is shown in fig. 13.

### Scan failure blanking

**8.** The circuit which provides for blanking in the event of failure of X or Y scan, or both, is shown in simplified form in fig. 4. Its operation depends on the existence of a rate of change of current through the X deflector coils of the CRT and also upon a rate of change of current through the Y coils, when both scans are operating correctly. When both these rates of change cease to appear, or when one ceases to appear and the other falls below a certain minimum value, blanking is effected.

*Rate-of-change voltage*

**9.** For example, during the scan period, when the PPI scan direction is horizontal (pointing east), the deflector current in the X1 coil will have a definite and steady rate of change. (The current waveform in the X2 coil is an antiphase version of that in the X1 coil.) In the extreme case of minimum expansion with centred picture, the deflector current rises from 120mA to 200mA during a period of 1,977 $\mu$S (*waveform* (*a*), *fig. 5*). Since the deflector coil has both inductance and resistance, the voltage across it during this time comprises a falling linear sawtooth superimposed on a pedestal (*waveform* (*b*), *fig. 5*). Similar voltages are produced across the Y1 and Y2 coils. Each voltage wave is applied to one of the CR circuits C1, R1, etc., seen in fig. 4, where the capacitor is 0·05 $\mu$F and the resistor 43 K$\Omega$. The purpose of this CR circuit is to extract the rate-of-change component from waveform (*b*) and apply it to the cathode of one of the diodes (*waveform* (*c*), *fig. 5*) and thence to V3A. In the case being considered, the rate-of-change voltage is $-3{\cdot}4$V ; it will be proportionately higher on the higher trace expansions.

**10.** As the PPI scan rotates, the current sawtooth amplitude in the X1 coil varies through zero

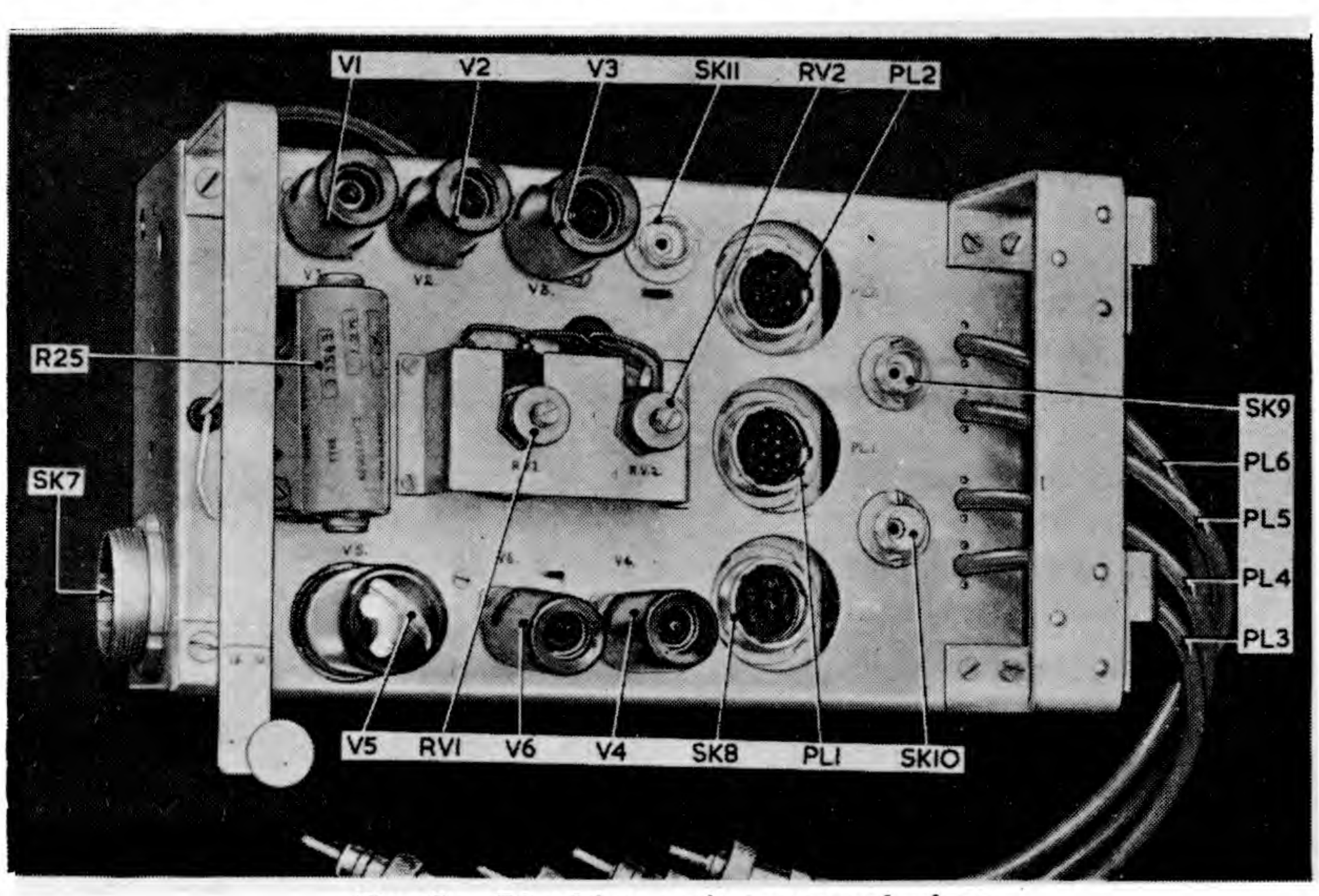



**Fig. 2. Blanking unit—general view**
**(On later models RV3 is mounted above the chassis, by RV2)**

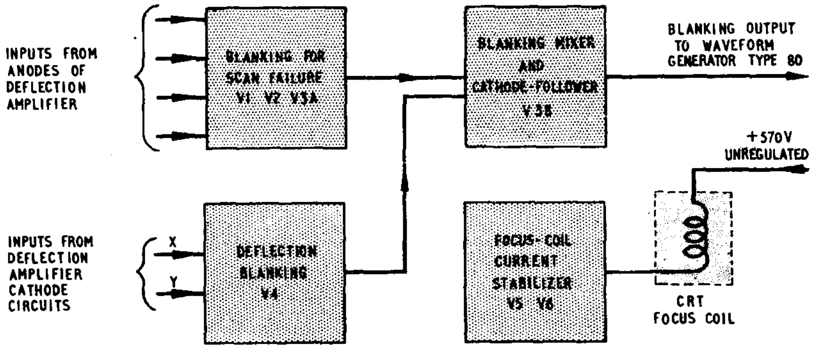



**Fig. 3. Block diagram of blanking unit**

to negative values and back in a sinusoidal manner, taking one complete period of aerial rotation to complete the cycle. In consequence, the rate-of-change voltage resulting from differentiation varies between $-3 \cdot 4$V and $+3 \cdot 4$V during the same period. To ensure that there is always a rate-of-change voltage of correct polarity (negative) and sufficient amplitude to operate V3A and thus hold off the blanking, inputs are accepted from all four deflector coils (X1, X2, Y1, Y2). Provided the scan is operating correctly, there is then always one of the four rate-of-change voltages sufficiently negative to hold off the blanking, whatever the trace position (*fig.* 6).

**11.** When the trace is inclined at 45 deg. to the horizontal (second *trace position* in *fig. 6*), the slope of the X1 coil current sawtooth is reduced by a factor of $\sqrt{2}$ (as compared with the voltage in the first *trace position*), so the rate-of-change voltage from that coil is reduced to $1/\sqrt{2} \times -3 \cdot 4$V, which is $-2 \cdot 4$V. Now the DC conditions of V3A and V3B are set by RV2 (the 5 KΩ SET potentiometer for this type of blanking) so that an input to V3A grid of about $-2$V is quite sufficient to produce an output exceeding the non-blanking value of $+3 \cdot 5$V required from V3B cathode. (Note, however, that RV2 is in practice set up for the blanking condition rather than the non-blanking.) While the X1 scan is holding off the blanking via PL5, the anode of V2A is more negative than $-2 \cdot 4$V, so the other three diodes are backed off and have no effect on the circuit. As the scan comes round to the S.E. 45 deg. position, X1 input moves less negative towards $-2 \cdot 4$V, and Y2 input at PL4 moves more negative towards the same value, so that control of the circuit passes from X1 to Y2 coil as the trace moves through the 45 deg. position. The actual voltage applied to V3A grid is shown by the heavy line in fig. 6.

**12.** The anode of V3A is DC-coupled to the blanking mixer and cathode-follower valve V3B. Provided the octagonal blanking valve V4 is having no effect on the circuit, the DC conditions of the arrangement are such that with no rate-

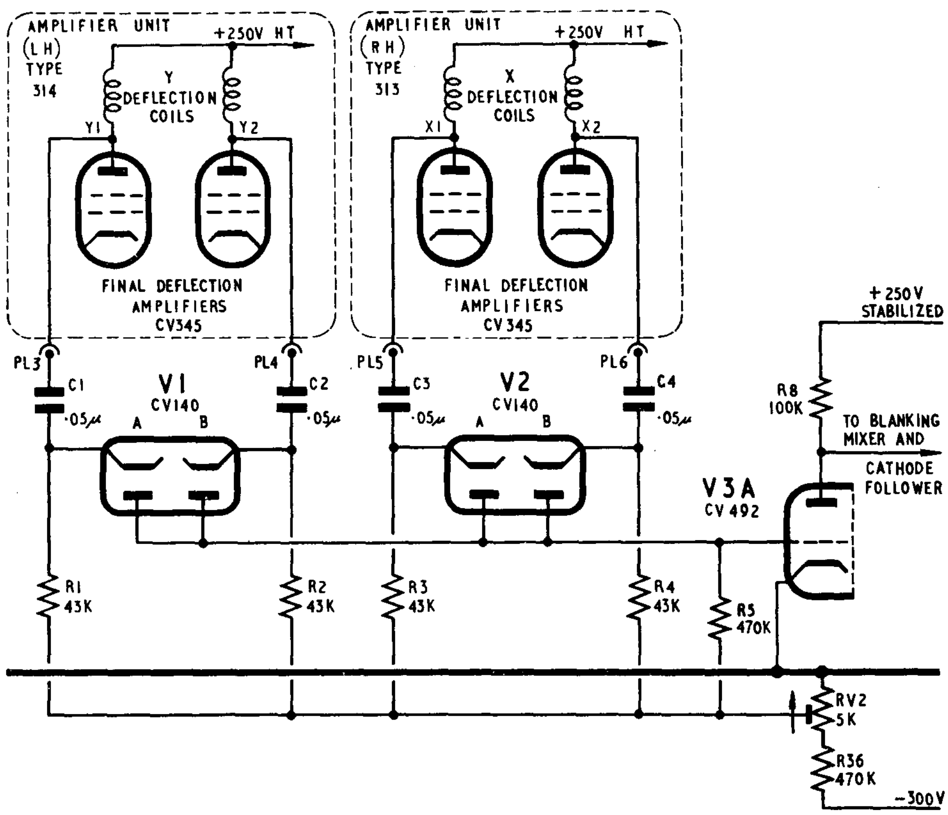



**Fig. 4. Scan failure blanking**

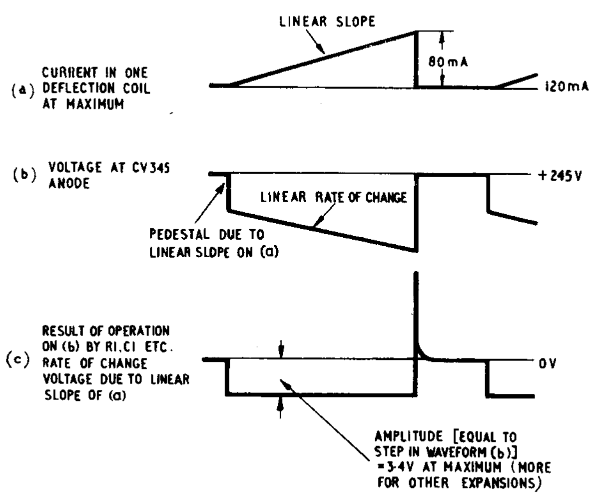



**Fig. 5. Scan failure blanking—waveforms**

of-change voltage appearing at V3A grid the output from SK11 will be a steady −11·5V, which is fed out to the waveform generator for blanking. When, however, a rate-of-change voltage more negative than −2V (approx.) appears at V3A grid, additional to the negative voltage already there, its anode rises and V3B cathode goes up to a positive value of at least +3·5V, so ending the blanking. The voltages of −11·5V and +3·5V quoted for the blanking and non-blanking condition are outside limit values only; the actual values are set up in conjunction with the particular waveform generator and video amplifier in use, the blanking requirements of which may vary somewhat from the average.

**13.** Blanking therefore occurs whenever there is no rate-of-change voltage more negative than −2V (approx.) available across any deflector coil. For example, if the display is centred, with minimum trace expansion, and the Y (or cosine) component ceases to arrive at the console, the display will collapse to a horizontal line of varying amplitude (positive and negative). This line will be blanked out over the middle portion, because the scan velocity is so low there that the rate-of-change voltage is insufficient to hold off the blanking. If the X scan fails as well, the display collapses to a single spot which will be blanked to a safe level because there is no rate-of-change voltage from any deflector coil.

**14.** There are limiters in the deflector amplifiers which clip the extremes of the sawtooth components and so cause the rate-of-change voltage to vanish there. This does not, however, occur until deflection currents corresponding to points well beyond the screen area have been reached, so that the octagonal blanking circuit (para. 16-25) invariably comes into action first and extinguishes the trace just beyond the screen edge.

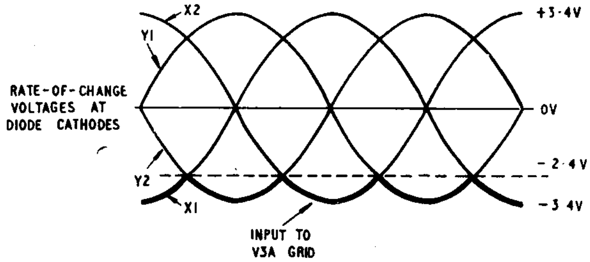



**Fig. 6. Rate-of-change voltages**

**15.** The above description and waveforms neglect the effect of inter-trace azication markers, etc., which will cause rate-of-change voltages to appear at the diode cathodes during the inter-trace period, and so produce " spikes " on the blanking wave output during that time. Such spikes cannot, however, have any effect on the inter-trace markers because they do not occur during the radar bright-up period, and so get no further than the waveform generator Type 80. The inter-trace markers are in fact not blanked at all, in any circumstances, but they do no harm because their duration is so short.

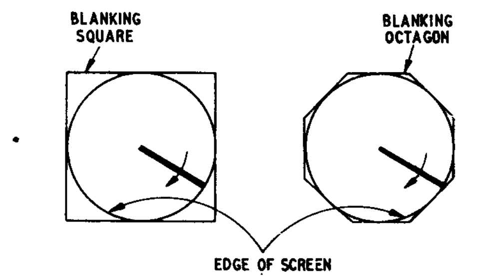



**Fig. 7. Square and octagonal blanking**

**Octagonal blanking**

**16.** The octagonal blanking stage, which includes the pentode V4 (CV138), is included to effect CRT blanking whenever (due to trace expansion or off-centring) the spot is deflected beyond the visible screen area. The reasons for this are explained in para. 2 above. Ideally, blanking would be circular, with the beam current cut off just beyond the screen edge. As a close approximation to circular blanking involving less circuit complexity, octagonal blanking is adopted. Here the spot is blanked whenever it is deflected beyond the boundaries of a regular octagon enclosing the visible screen area. Octagonal blanking has been developed from a simpler circuit giving square blanking (*fig.* 7) which gave inadequate blanking at the corners of the square.

**17.** Fig. 8 is a simplified circuit diagram showing the octagonal blanking stage V4 together with the relevant parts of the deflection amplifier cathode circuits. While V4 is cut off, it has no effect on V3B grid and the blanking output is then wholly controlled by the scan failure blanking circuits described in para. 7 to 14. If, however, V4 is brought into full conduction by applying a less positive voltage to its cathode, the grid potential of V3B will be pulled down, overriding the other input and producing a negative blanking output from SK11. The object of the input circuit to V4 therefore, is to apply, to V4 cathode, voltages derived from the X and Y deflection amplifier cathodes, of the correct amplitude and timing to effect octagonal blanking.

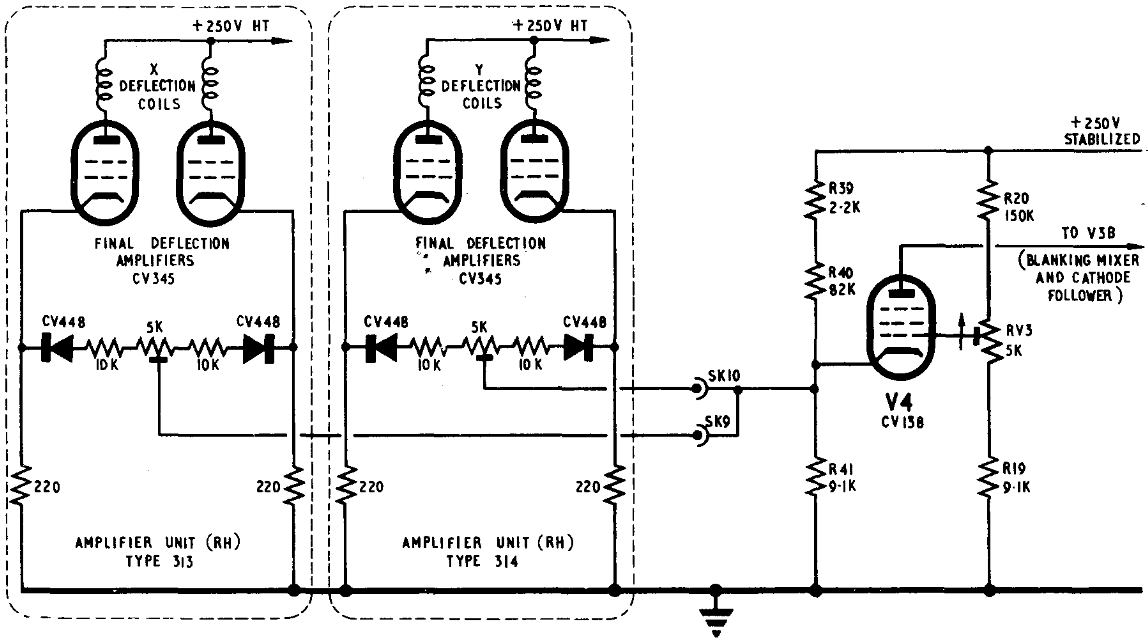



**Fig. 8. Octagonal blanking**

**18.** The potentials at the X deflection amplifier cathodes have virtually the same waveform as the X deflector coil currents. The waveform at one X cathode is in antiphase to that at the other. Between the cathodes is connected a symmetrical circuit containing two germanium diodes (CV448), two 10 KΩ resistors and a 5 KΩ potentiometer from the slider of which a waveform is brought into the blanking unit at SK9. An identical chain is connected in the cathode circuit of the Y deflector valves, the output being brought into SK10.

**19.** The cathode potential of the X1 deflector valve (for example) is proportional to X1 deflector coil current, and is therefore a measure of the displacement of the spot from the centre in an eastward direction. When the spot is centred on the screen, 130mA passes through each deflector valve, being 120mA to anode and 10mA to screen, approximately. (These figures are subject to small variations for precise centring.) Therefore the potential at each cathode is +28·6V, due to the 220Ω cathode resistors. As the spot moves out along the X axis, one cathode potential moves up and the other down until such time as they run into limits (imposed earlier in the deflection amplifier unit) at +55V and + 2·2V respectively. However, the edge of the tube face is attained when the cathodes have reached only +11V and +46·2V respectively (subject to variation up to 2·2V for centring), so the circuit is designed to effect blanking when these figures are reached.

**20.** The sense of connection of the germanium diodes is such that blanking control is accepted only from that cathode which is the least positive of the four, the other cathodes being virtually disconnected from SK9 by the high back resistance of the CV448's. The input at SK9 is applied to V4 cathode, and provided that RV3 (the 5 KΩ SET potentiometer for this type of blanking) has been correctly set up, a voltage more positive than +11V cuts off V4, whereas a voltage less positive than +11V brings it into conduction and causes blanking.

**21.** Due to small variations between different cathode-ray tubes of the same type, a centred spot does not always correspond to a potential of precisely +28·6V at each cathode, and the controls which are provided in the deflection amplifiers to effect centring will alter that potential slightly. To take up such variations, the blanking control is taken not from a fixed centre tap between the two fixed 10 KΩ resistors but from the slider of the 5 KΩ potentiometer, which thus provides a centring control for the blanking boundary.

**22.** Since a similar input is accepted at SK10 from the Y deflector valve cathodes, blanking operates when any one of the deflector valve cathode potentials moves below +11V. If the resistor chain R39 to R41 were omitted, the result of this would be a square blanking boundary (representing the +11V limits along the axes of the four deflector coils), the exact size of the square being set by RV3, and its centring round the tube face by the 5 KΩ potentiometers in the CV345 cathode circuits.

**23.** To produce an octagonal blanking boundary instead of a square one, it is necessary to ensure that blanking occurs (i.e. that V4 is switched on) not only when one of the CV345 cathode potentials falls below +11V, but also in the regions of the corners of the blanking square (*fig. 7*), i.e., when one X cathode potential and one Y cathode potential fall simultaneously below +16·2V. This figure differs from the central value of

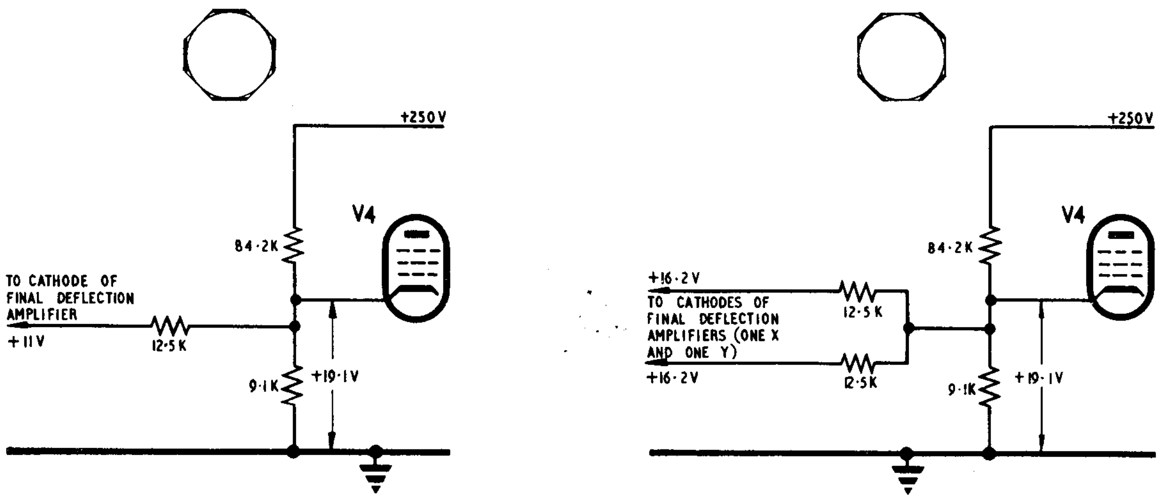



**Fig. 9. Octagonal blanking networks**

$+28{\cdot}6$V by $1/\sqrt{2}$ times $(28{\cdot}6-11{\cdot}0)$V, i.e., $12{\cdot}4$V (a function of the sine or cosine of 45 deg.).

**24.** To ensure that V4 is brought into conduction not only when either an X or a Y cathode falls below +11V but also when one X and one Y cathode together fall below +16·2V, the network R39 to R41 has been included. Fig. 9 shows in simplified form the effective circuits which hold good (*Left*) when one cathode falls below +11V and (*Right*) when one X cathode and one Y cathode both fall below +16·2V. Analysis of these circuits by Kirchhoff's Laws shows that in each situation the current through the 9·1 KΩ resistor to earth is the same and amounts to just over 2mA, corresponding to a V4 cathode potential of +19·1V. Therefore the blanking operates at the same range with a diagonal scan as it does with a horizontal or vertical scan, ensuring that the blanking boundary is indeed a regular octagon with equal sides.

**25.** These diagrams and voltage figures only apply exactly when the sliders on the 5 KΩ potentiometers in the deflector valve cathode circuits are central. Adjustment of these potentiometers enables the blanking octagon to be precisely centred about the tube face, but may cause slight distortion of the shape of the octagon. The size of the octagon is controlled by RV3.

#### Blanking mixer and cathode-follower

**26.** In the blanking mixer and cathode-follower, stage (V3B, one-half of a double-triode CV492) the two kinds of blanking are combined and fed out from SK11 to the waveform generator Type 80. A simplified circuit diagram appears in fig. 10, and shows the stage to be a straightforward cathode-follower with its 220 KΩ load R15 returned to the negative rail.

**27.** Coupling from the blanking stages V3A and V4 into V3B is DC and uses the resistance chain R8 to R10 and R12. The values are chosen so that either type of blanking gives an output voltage at SK11 of at least 11·5V negative, whereas in the absence of blanking the voltage is at least 3·5V positive.

#### Focus stabilizer

**28.** The CRT focus-coil current of about 40mA is drawn from the +570V (nominal) bulk

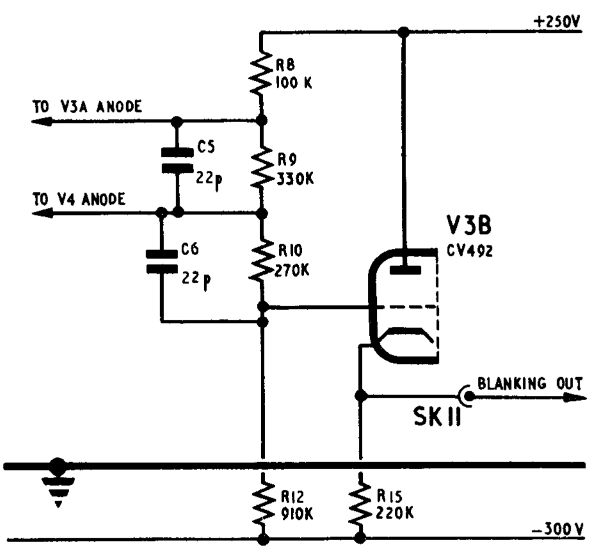



**Fig. 10. Blanking mixer and cathode-follower**

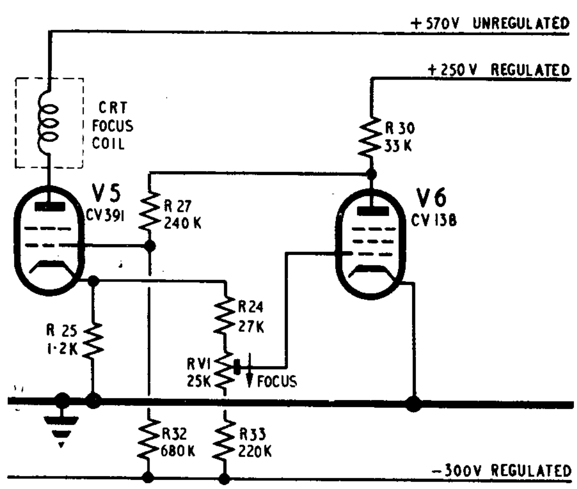



**Fig. 11. Focus stabilizer**

power supply, which is subject to considerable fluctuations; also the resistance of the focus coil changes as the console warms up. In order to preserve the sharpness of the picture at all times without the necessity for continual adjustments, it is therefore necessary to stabilize the focus current. The stabilizer (*fig. 11*) which does this is located in the blanking unit assembly, although it has no blanking function. It includes the valves V5 and V6, and is designed to hold the focus current steady to within 1 per cent.

**29.** In series with the focus coil is placed the large tetrode (triode-connected) V5, a CV391. This valve has a 3-watt 1·2 KΩ cathode resistor R25 of high temperature stability, and the cathode voltage variations thus provide an accurate measure of focus current fluctuations, however caused. A proportion of such fluctuations is picked off at the slider of the preset FOCUS potentiometer RV1 (25 KΩ), which is in a chain from V5 cathode to the negative rail, and applied to the grid of the control pentode V6 (CV138).

**30.** If, for example, the focus current tends to increase (due perhaps to a rise on the +570V rail), then V5 cathode potential goes up. A smaller but proportionate rise occurs at V6 grid, causing an amplified drop in voltage at V6 anode. This fall is fed back again to V5 grid by the DC coupling chain R30, R27, R32. The focus current is thus restored very nearly to its previous value. If, on the other hand, the focus current tries to drop, the

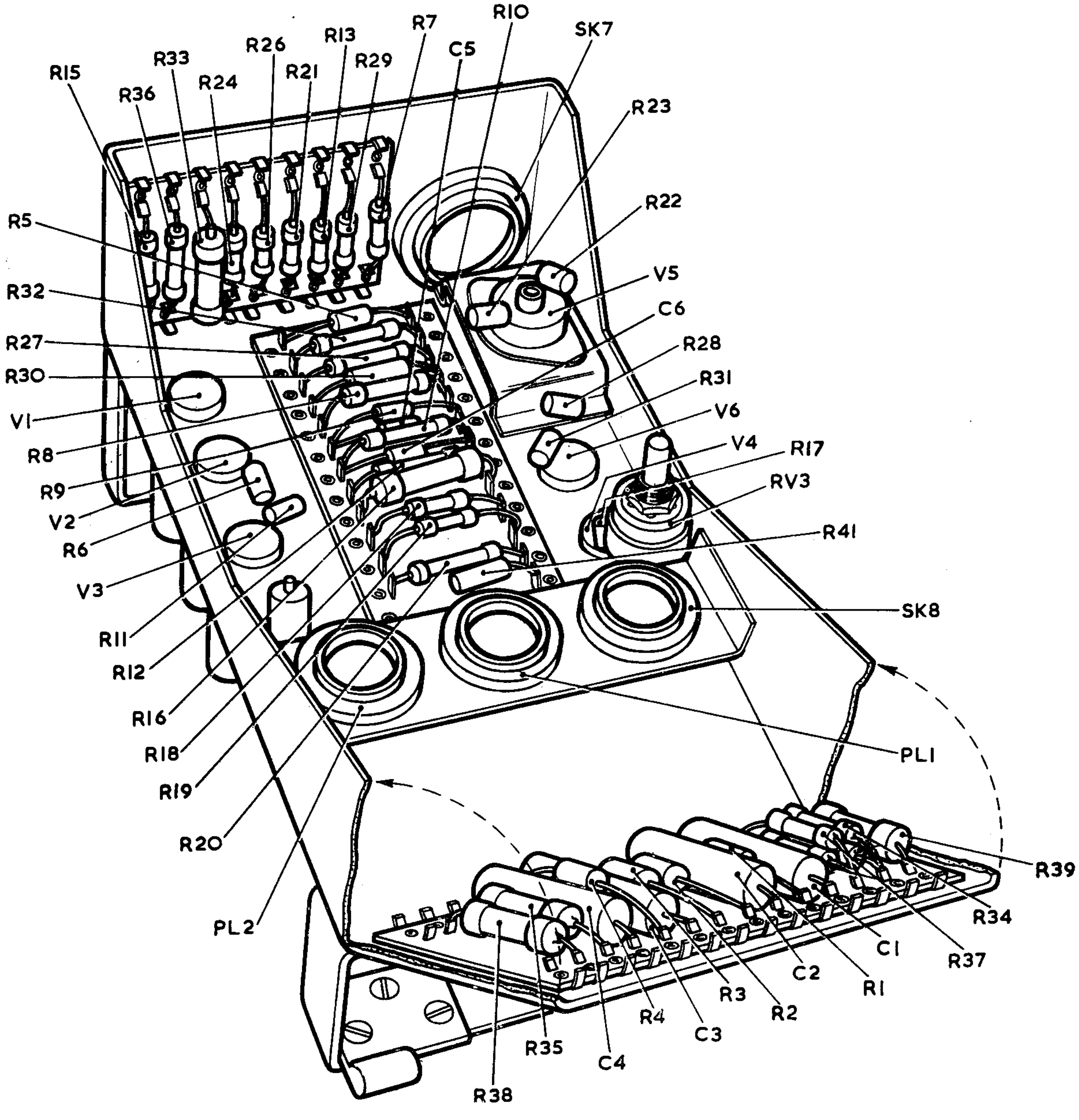



**Fig. 12. Under-chassis component layout of blanking unit**
**(On later models RV3 is mounted above the chassis, by RV2)**

opposite action occurs and restores the value. The FOCUS control RV1 fixes the DC conditions of the loop and so enables the focus current to be set for the sharpest picture ; the range of variation obtainable is roughly from 34mA to 50mA.

**Off-centring resistor chain**

**31.** The resistors R34, R37, R35, and R38 form part of the off-centring potentiometer chain, being in series with the off-centring helipots on the control panel Type 859. The resistors are located here only for convenience and have no blanking function.

**TABLE I**

**Component details**

**Note . . .**

*This list of components is issued for information only. When ordering spares for this equipment refer to Volume 3 of this publication or to the appropriate section of A.P.1086.*

**Resistors (fixed)**

| Circuit ref. | Value (ohms) | Rating (watts) | Tol. (%) | Inter-serv. ref. |
|---|---|---|---|---|
| R1* .... .... | 43 K | ½ | 5 | Z216077 |
| R2* .... .... | 43 K | ½ | 5 | Z216077 |
| R3* .... .... | 43 K | ½ | 5 | Z216077 |
| R4* .... .... | 43 K | ½ | 5 | Z216077 |
| R5 .... .... | 470 K | ½ | 10 | Z223122 |
| R6 .... .... | 330 | ½ | 10 | Z221173 |
| R7* .... .... | 150 | ½ | 5 | Z215142 |
| R8* .... .... | 100 K | ¾ | 2 | Z216452 |
| R9* .... .... | 330 K | ½ | 2 | Z216562 |
| R10* .... .... | 270 K | ½ | 2 | Z216546 |
| R11 .... .... | 330 | ½ | 10 | Z221173 |
| R12* .... .... | 910 K | ¾ | 2 | Z216651 |
| R13* .... .... | 150 | ½ | 5 | Z215142 |
| R14 .... .... | *not fitted* | — | — | — |
| R15 .... .... | 220 K | ¾ | 10 | Z223081 |
| R16* .... .... | 100 K | 1 | 5 | Z216124 |
| R17 .... .... | 330 | ½ | 10 | Z221173 |
| R18* .... .... | 22 K | ½ | 2 | Z216292 |
| R19* .... .... | 9·1 K | ½ | 2 | Z215871 |
| R20* .... .... | 150 K | ¾ | 2 | Z218753 |
| R21* .... .... | 680 | ½ | 1 | Z215596 |

**Resistors (fixed)**—*cont.*

| Circuit ref. | Value (ohms) | Rating (watts) | Tol. (%) | Inter-serv. ref. |
|---|---|---|---|---|
| R22 .... .... | 100 | ½ | 10 | Z221110 |
| R23 .... .... | 330 | ½ | 10 | Z221173 |
| R24* .... .... | 27 K | ½ | 5 | Z216052 |
| R25* .... .... | 1·2 K | 3 | 1 | 10W/19103 |
| R26* .... .... | 10 | ½ | 5 | Z215002 |
| R27* .... .... | 240 K | ½ | 5 | Z216724 |
| R28 .... .... | 330 | ½ | 10 | Z221173 |
| R29* .... .... | 33 | ½ | 5 | Z215062 |
| R30 .... .... | 33 K | 1 | 10 | Z212261 |
| R31 .... .... | 100 | ½ | 10 | Z221110 |
| R32* .... .... | 680 K | ¾ | 5 | Z216747 |
| R33* .... .... | 220 K | 1 | 5 | Z216148 |
| R34* .... .... | 100 K | ¾ | 5 | Z216123 |
| R35* .... .... | 120 K | ¾ | 5 | Z216711 |
| R36 .... .... | 470 K | ½ | 10 | Z223122 |
| R37* .... .... | 100 K | ¾ | 5 | Z216123 |
| R38* .... .... | 120 K | ¾ | 5 | Z216711 |
| R39* .... .... | 2·2 K | ½ | 5 | Z215282 |
| R40* .... .... | 82 K | 1 | 2 | Z216433 |
| R41* .... .... | 9·1 K | 1 | 2 | Z215871 |

**High stability.*

**Function Resistors (variable)**

| Circuit ref. | Value (ohms) | Rating (Watts) | Tol. (%) | Inter-serv. Ref. No. | |
|---|---|---|---|---|---|
| RV1 | 25 K | 1 | 10 | Z272301 | FOCUS |
| RV2 | 5 K | ½ | 10 | Z272001 | BLANKING SET, SCAN FAILURE |
| RV3 | 5 K | ½ | 10 | Z272001 | BLANKING SET, OCTAGON SIZE |

**Compacitors**

| Circuit ref. | Value (μF except where stated) | Rating (V.DC) | Tol. (%) | Inter-serv. Ref. No. |
|---|---|---|---|---|
| C1 | 0·05 | 200 | 20 | Z115630 |
| C2 | 0·05 | 200 | 20 | Z115630 |
| C3 | 0·05 | 200 | 20 | Z115630 |
| C4 | 0·05 | 200 | 20 | Z115630 |
| C5 | 22pF | 500 | 10 | Z132277 |
| C6 | 22pF | 500 | 10 | Z132277 |

**Plugs and sockets**

| Circuit ref. | Description | Inter-services Ref. No. |
|---|---|---|
| PL1 | 12-way plug | Z560153 |
| PL2 | 6-way plug | Z560541 |
| PL3 to 6 | Type 790 (coaxial) | 10H/19698 |
| SK7 | 25-way | Z560380 |
| SK8 | 6-way (medium) | Z560320 |
| SK9 to 11 | Type 783 (coaxial) | (10H/19861) |

**Note . . .**

*Valve types and base connections may be obtained from the circuit diagram (fig. 13) at the end of this chapter.*

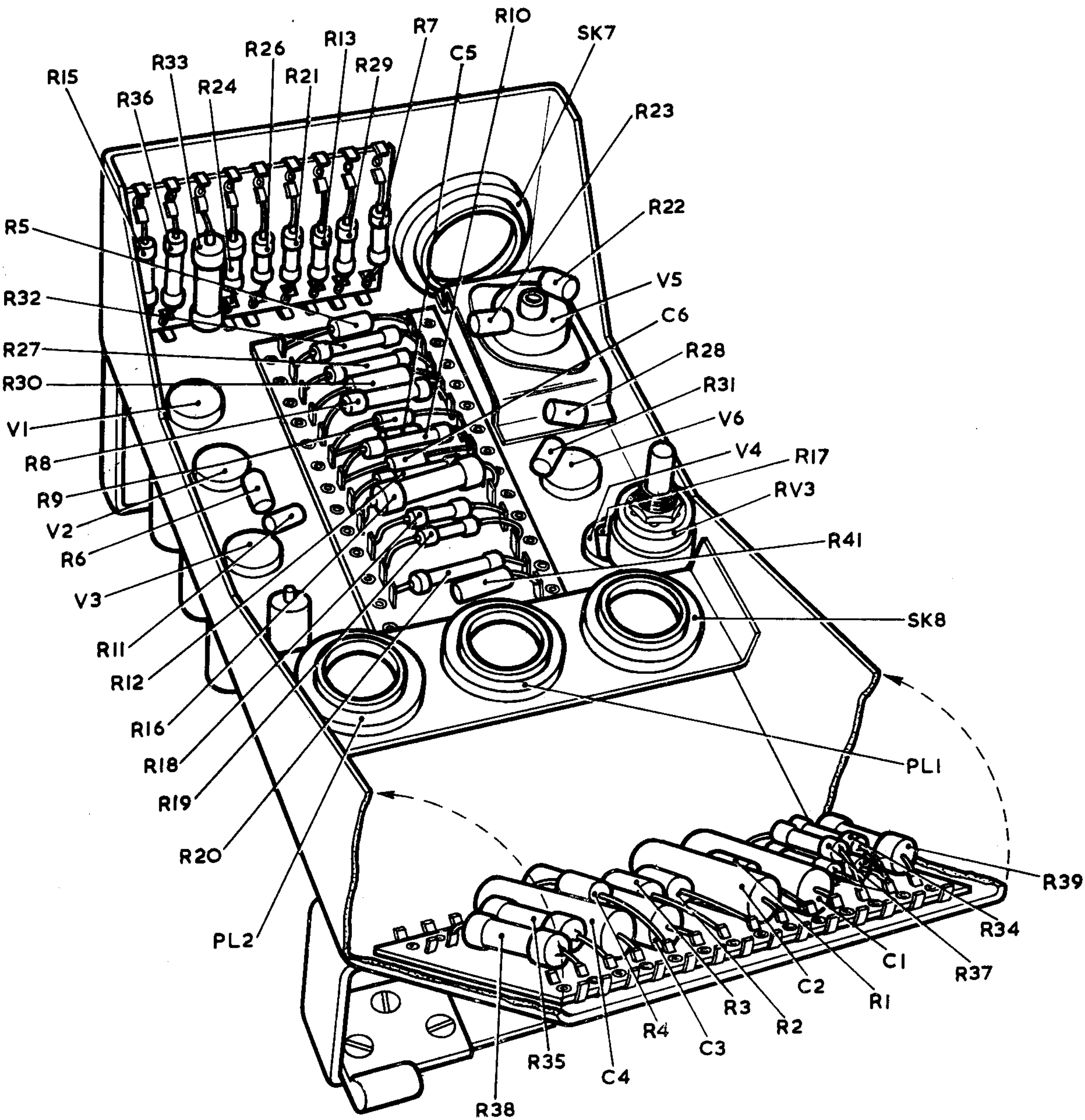
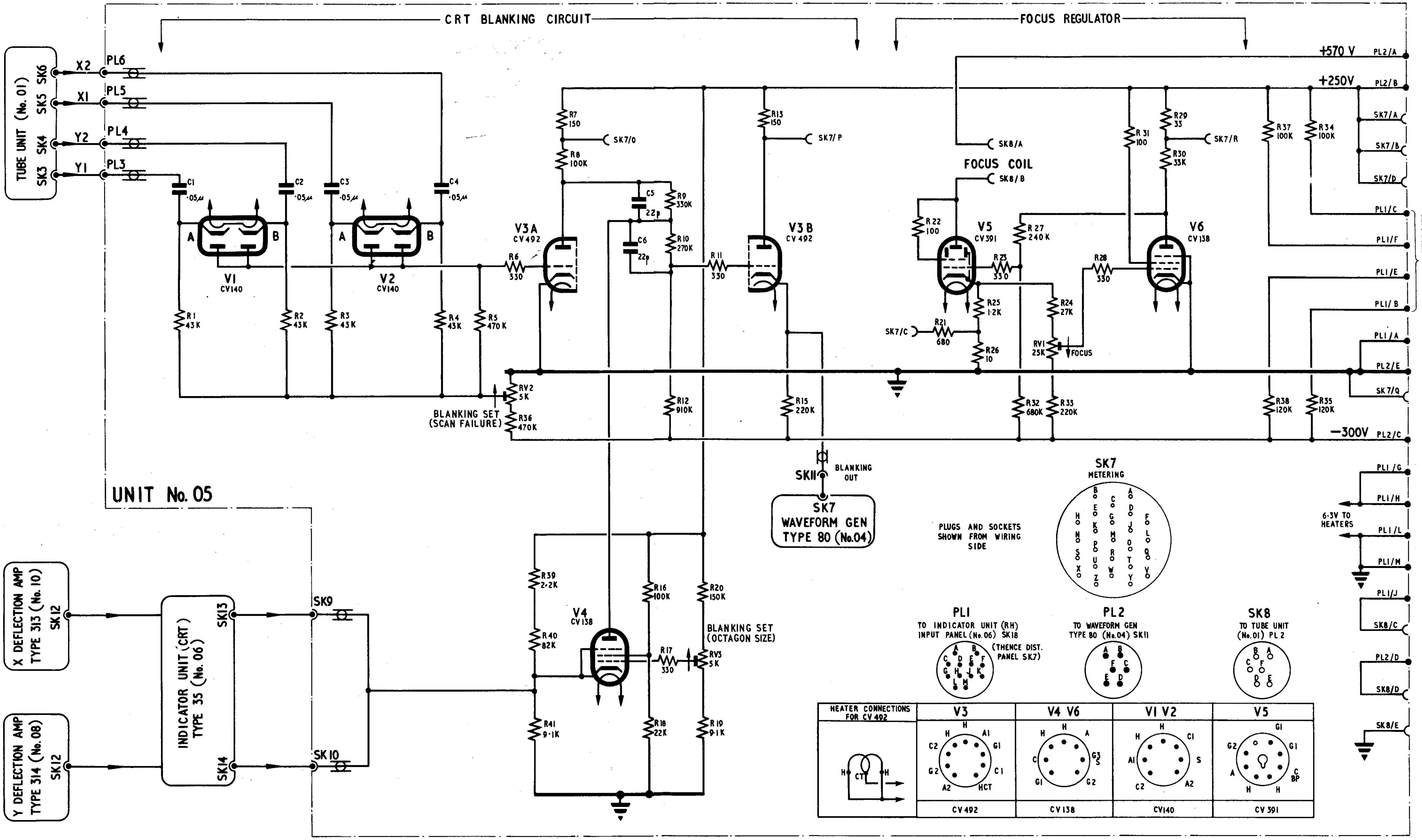



**Fig. 12. Under-chassis component layout of blanking unit**
**(On later models RV3 is mounted above the chassis, by RV2)**




| AIR DIAGRAM 6222M/MIN. |
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Blanking unit (and focus-coil current stabilizer) Type 26—circuit

Fig.13

RESTRICTED

# Appendix 1

## BLANKING UNIT TYPES 26A AND 26B

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### LIST OF ILLUSTRATIONS



### LIST OF TABLES



**Purpose**

**1.** When the fixed coil display system is used with phase 1A equipment, the console Type 64, with its sub-units, is re-referenced to become a wired framework and a number of sub-units. Variations of basic sub-units are selected to suit various requirements.

**2.** The blanking unit Types 26A and 26B are modified versions of the basic Type 26. The modification described in para. 4 applies to both these versions.

**3.** In the Type 26B the +250V h.t. supply has been re-routed as shown in fig. 1. This change is to avoid damage to the deflection amplifiers and is related to the modification to the indicator unit (CRT) Type 16453 (See Chap. 1, App. 1, of this Section).

**4.** The Types 26A and 26B have the following modification:—

The values of the off-centring resistors have been changed to increase the range of the off-centring control for long range working. R34 and R37 are now 56K each, R35 and R38 are now 100K each.

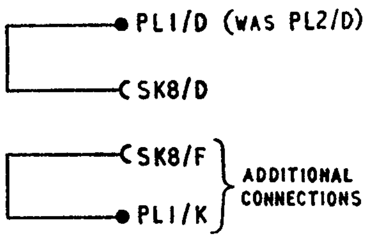


**Fig. 1. Amendments to blanking unit Type 26B**

**TABLE 1**

**Amended component details (Types 26A and 26B)**

| Circuit Ref. | Value (ohms) | Rating | Tol. (%) | Ref. No. |
|---|---|---|---|---|
| R34 | 56K | 3/4W | 5 | 5905–99–021–6093 |
| R35 | 100K | 3/4W | 5 | 5905–99–021–6123 |
| R37 | 56K | 3/4W | 5 | 5905–99–021–6093 |
| R38 | 100K | 3/4W | 5 | 5905–99–021–6123 |

(All other components as per Type 26)

# Chapter 5

# PANEL (CONTROL) TYPE 859

ERRATUM

The following list of appendices should follow the list of illustrations:

## LIST OF APPENDICES

# Chapter 5

# PANEL (CONTROL) TYPE 859

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## TABLE



## LIST OF ILLUSTRATIONS



### Location

**1.** The *panel* (*control*) *Type 859* (Stores Ref. 10D/18643) is part of the indicating unit (CRT) Type 35 in the fixed-coil display console Type 64. Fig. 1 shows the location of the control panel just to the right of the tube face, and fig. 2 shows a close-up view of the front of the panel, with the cover pulled open.

### Purpose

**2.** The control panel carries those controls which may require occasional adjustment by the operator (as opposed to those on the control desk, which are likely to require continual use). The controls are as follows, and their functioning is set out in the succeeding circuit description (see also the circuit diagram, *fig. 4*, at the end of this chapter).

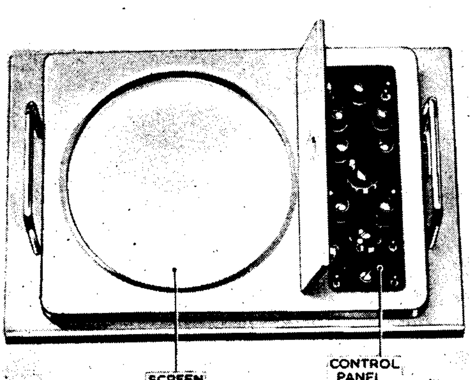


**Fig. 1. Position of control panel**

(1) ANTI-CLUTTER switch
(2) SECTOR switch
(3) HEAD COMB. switch
(4) RADAR SIGNALS input control
(5) VIDEO MAP input control
(6) STROBE MARKERS input control (controls inter-trace marker brightness)
(7) RANGE STROBE input control (controls range strobe brightness)
(8) IFF input control
(9) RANGE RINGS input control
(10) OFF CENTRE VERT. helipot
(11) OFF CENTRE HORIZ. helipot
(12) SCREEN LIGHTS switch
(13) DIAL LIGHTS switch (SCREEN LIGHTS BRIGHTNESS switch on later models)
(14) HT RESET button
(15) RANGE switch
(16) HT ON switch.

### Supplies

**3.** The panel contains no valve circuits and there are no power supplies as such, but switching and off-centring lines, and supplies for dial lights and screen lights, arrive at fixed Mk. 4 plugs, and signal services enter and leave by coaxial sockets. Relays in other units are operated by switching a 50V negative supply to them; the positive is earthed in the radar office.

### Anti-clutter switch

**4.** Switch D is the anti-clutter switch, a single-pole switch which completes a —50V circuit to the anti-clutter relay in the waveform generator


**Fig. 2. Control panel, front view**

Type 80 (via the panel Type 861). When this switch is closed, a slope is applied to the leading edge of the video gating wave supplied to the video amplifier, so reducing the brightness on the first few miles of the trace and reducing the disturbing effect of ground clutter.

#### Sector switch, and head combining switch

**5.** The SECTOR switch is switch B, a Type H wafer switch, which only takes effect when the HEAD COMB. switch SWC is closed. The purpose of the SECTOR switch is to choose the sector where the head combination facility is to be used. (This is the facility by which two "back-to-back" radar heads are used to obtain twice the normal amount of information over a 180 deg. sector of the terrain). The routing of video signals to a console, from each head alternatively, is performed by a sector relay in the head selector unit (R.A.184), which is, in its turn, worked by a cam-operated switch in the resolver rack (R.A. 301). The SECTOR switch here applies 50V out via the distribution panel at the bottom of the console to the sector relay in the head selector unit. The switch positions provide for head combination over the following sectors :—

(1) 270 deg —90 deg (W to E)
(2) 315 deg. —135 deg. (NW to SE)
(3) 360 deg. —180 deg. (N to S)
(4) 45 deg. —225 deg. (NE to SW)
(5) 90 deg. —270 deg. (E to W)
(6) 135 deg. —315 deg. (SE to NW)
(7) 180 deg. —360 deg. (S to N)
(8) 225 deg. —45 deg. (SW to NE)

The sector scanned is that obtained by moving clockwise from the first bearing mentioned to the second.

#### Radar signals

**6.** Radar signals at video frequency arrive at SK1 from the radar office (head selector unit) via the input panel at the base of the console, and are terminated by the 70Ω wirewound potentiometer RV1. From the slider of RV1 an adjustable proportion of the signals are fed out via SK7 to the video amplifier. RV1 (marked RADAR SIGNALS) thus provides a control of the relative gain on the radar channel.

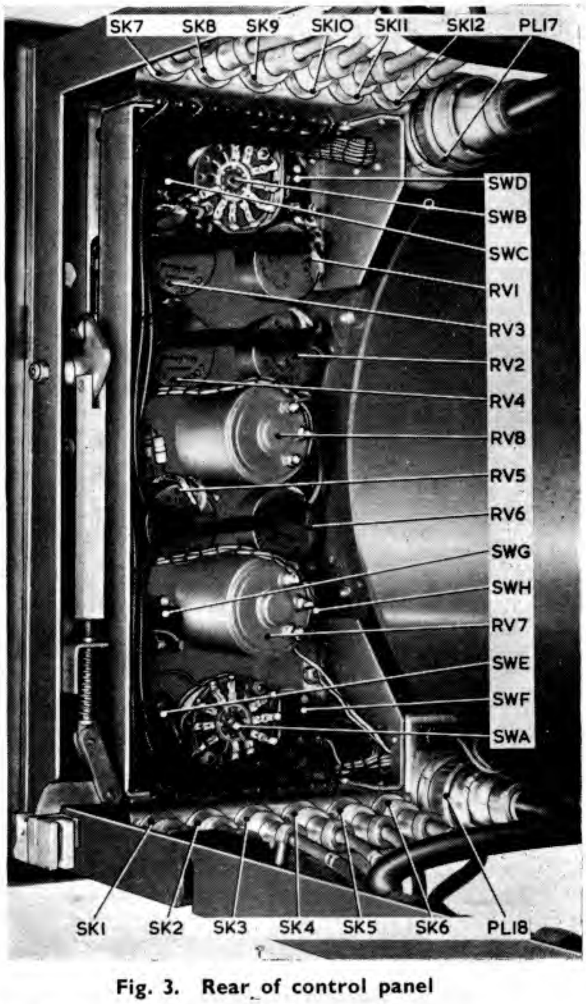


**Fig. 3. Rear of control panel**

**Strobe markers**

**7.** Inter-trace bright-up pulses (used to brighten the strobe or azication markers) arrive at SK2 from the radar office and their line is terminated by the 70Ω potentiometer RV2; the output to the video amplifier via SK8 is taken from the slider, so that the control, marked STROBE MARKERS, provides adjustment of the relative gain on the inter-trace channel.

**Video map**

**8.** Similarly, video map signals arriving at SK3 from the radar office are terminated by the 70Ω potentiometer RV3, and the output from the slider fed via SK9 to the video amplifier.

**Range strobe**

**9.** The range strobe pulse arrives on a coaxial line at SK4 and is developed across a 5 KΩ potentiometer RV4; this value is used because the cable originates from a valve anode circuit. The control is engraved RANGE STROBE, and adjusts the *relative brightness* of the range strobe appearing on an azicating console picture. This control must not be confused with the azication range control on the control desk of an azicating console, which affects the *range* at which the range strobe appears.

**◀IFF, range rings**

**10.** The IFF signals are fed in from the head selector unit at SK6 and out to the video amplifier via SK12. The range rings arriving from the head selector unit at SK5 are of too great an amplitude for use in the video amplifier and are therefore reduced by a resistance chain before being fed out via SK11. The controls RV6 and RV5 affect the relative gain of each channel.▶

**Off centre controls**

**11.** The OFF CENTRE VERT. control RV8 is a helipot (spirally wound potentiometer with very long track) from the slider of which a d.c. voltage, adjustable between +41·6V and −41·6V (equivalent to ±200 miles), is fed out via PL18/H to the Y deflection amplifier, there to cause the required vertical shift of the picture. The helipot forms part of a resistance chain extending from +250V through a 100 KΩ resistor, through RV8, and a 120 KΩ resistor down to −300V. These two fixed resistors are located in the blanking unit Type 26. The OFF CENTRE HORIZ. control RV7 forms part of an identical circuit, but its output is routed via PL18/G to the X deflection amplifier for horizontal picture shift.

**Screen and dial lights**

**12.** On early models SWG is the DIAL LIGHTS on-off switch, and when it is closed 6·3V is applied (via wander plugs inserted in SK13 and SK14) to four lamps round the panel, which shine through on to the controls. On production models (fig. 4) there is no dial lights switch; SWG is then a screen lights brightness switch, to give a choice of two degrees of illumination on the screen lights. These are four 6·3V lamps spaced round the CRT screen to illuminate any engraved transparency that may be placed over it; the SCREEN LIGHTS on-off switch is SWH.

**Range switch**

**13.** The RANGE switch SWA has four positions, marked 80, 160, 240 and 320 nautical miles. These are the distances represented by the whole screen *diameter* on each degree of trace expansion. The contacts connected to PL17 pins *A* to *D* route −50V via the distribution unit to the waveform generator Type 80 (video gating), there to operate the trace compensation relays, and also to the trace expansion relays in the X and Y deflection amplifiers. The contacts connected to PL17 pins *E* to *J* are spare.

**HT reset and HT on**

**14.** The HT RESET button and the HT ON switch are part of the complete HT safety circuit, the relays for which are located in the distribution unit; the safety circuit is covered in Chapter 9 of this Section. Neither of these controls is normally used by the operator unless the HT circuit has tripped and needs to be reset; the HT ON switch is usually left closed, the console ON–OFF switch on the control desk being used to turn the display on and off.

**Component layout**

**15.** A rear view of the control panel, showing the component layout there, is given in fig. 3.

**TABLE 1**

**Component details**

**Note . . .**

*This list of components is issued for information only. When ordering spares for this unit refer to Volume* 3 *of this publication or to the appropriate section of A.P.*1086.

**Resistors (fixed)**

| Circuit ref. | Value (ohms) | Rating (watts) | Tol. (%) | Inter-serv. Ref. No. |
|---|---|---|---|---|
| R1* ... ... | 560 | ½ | 5 | Z215212 |
| R2* ... ... | 82 | ½ | 5 | Z215112 |
| ▶ | | | | |
| R5 ... ... | 1 | 3 | 10 | Z243445 ◀ |

**High stability*

## TABLE 1

## Component details—(contd.)

**Resistors (variable)**

| Circuit ref. | Value (ohms) | Colvern Type No. | Ref. No. | Function |
|---|---|---|---|---|
| RV1 | 70 | CLR3207/15 | 10W/19109 | Radar signals |
| RV2 | 70 | CLR3207/15 | 10W/19109 | Strobe markers |
| RV3 | 70 | CLR3207/15 | 10W/19109 | Video map |
| RV4 | 5 K | CLR3207/15 | 10W/19108 | Range strobe |
| RV5 | 70 | CLR3207/15 | 10W/19108 | Range rings |
| RV6 | 70 | CLR3207/15 | 10W/19108 | IFF |
| RV7 | 50 K | CLR2503/15 | 10W/19106 | Off centre horiz. |
| RV8 | 50 K | CLR2503/15 | 10W/19106 | Off centre vert. |

**Switches, plugs and sockets**

| Circuit ref. | Description | Inter-service Ref. No. |
|---|---|---|
| SWA | Wafer switch, Type H | 10F/510076 |
| SWB | Switch 2152 | 10F/17409 |
| SW C to E | Toggle switch | Z510300 |
| SW F | Switch 2156 S.P.S.T. biased | 10F/17419 |
| SW G and H | Toggle switch | Z510300 |
| SK1 to 12 | Type 579 (coaxial) | (10*H*/4953) |
| SK13 to 16 | Belling Type L316 | (10*H*/19641) |
| PL17 | 25-way fixed plug | Z560200 |
| PL18 | 12-way fixed plug | Z560152 |



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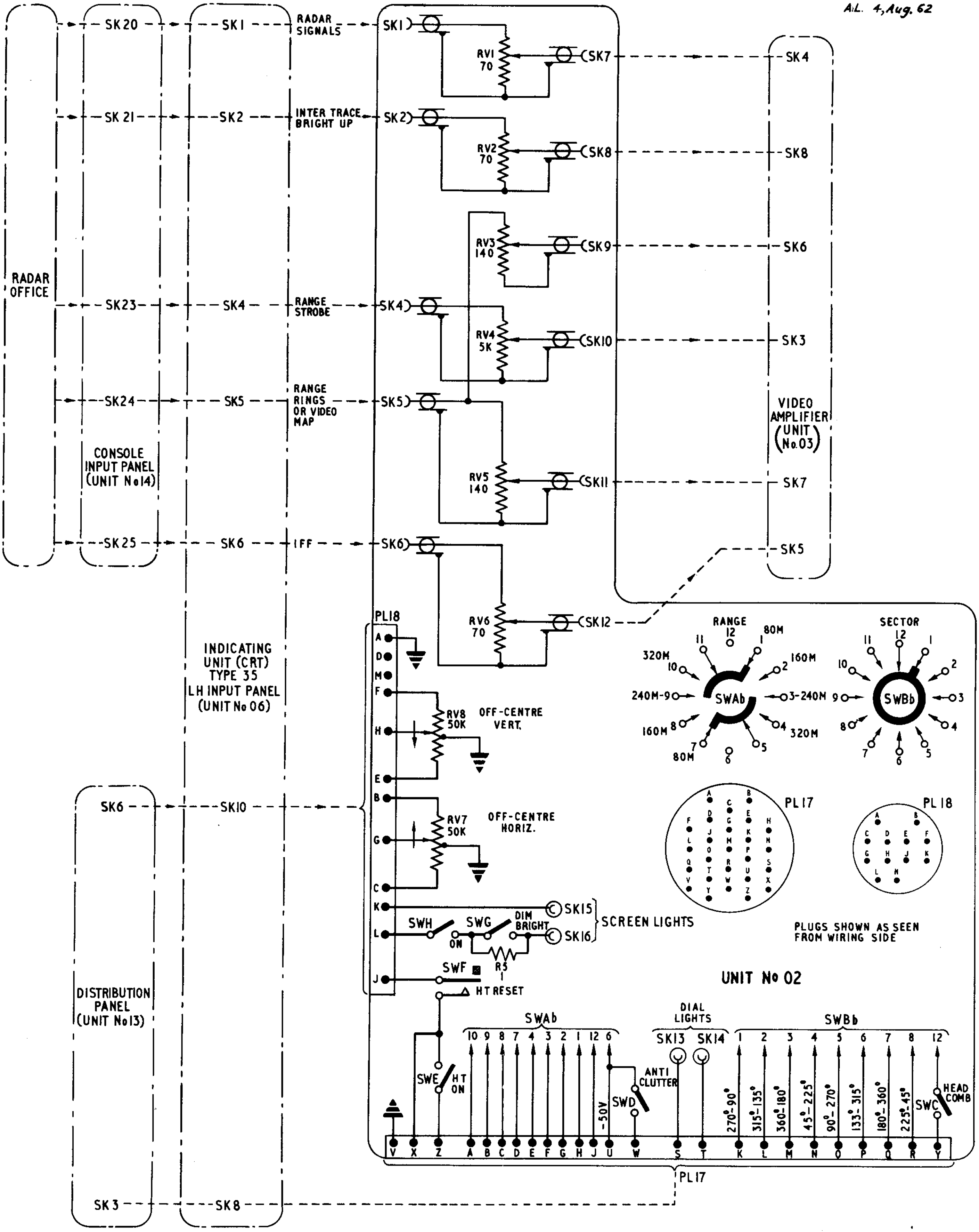


Console Type 64

Fig. 1 Panel (control) Type 859B – circuit

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# Appendix 1

## PANEL (CONTROL) TYPES 859B AND 859C

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### LIST OF ILLUSTRATIONS



**Purpose**

**1.** When the fixed coil display system is used with phase 1A equipment, the console Type 64, with its sub-units, is re-referenced to become a wired framework and a number of sub-units. Variations of basic sub-units are selected to suit various requirements.

**2.** The panel (control) Types 859B and 859C are modified versions of the basic unit Type 859. The modification in para. 3 applies to both of these versions.

**3.** The VIDEO MAP and RANGE RING signals are now fed to the panel via one cable. Both these signals are fed in via SK5 (fig. 1) and are then fed, via separate variable resistors (RV3 and RV5) to the outputs to the video amplifier. As the variable resistors are now in parallel the value of each resistor has been doubled and is now 140 ohms. The RANGE RING resistor network has been further modified by the deletion of R1 and R2.

**4.** The panel (control) Type 859B (not Type 859C) has a modification to the off centre potentiometers RV7 and RV8. The connections to PL18 from the ends of the windings of each potentiometer have been reversed (fig. 1) to change the polarity of the off-centring voltage. This enables the panel (control) Type 859B to be used with the amplifying unit (mixer) Type 4428.

# Chapter 6

# DEFLECTION AMPLIFIERS

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## LIST OF ILLUSTRATIONS



## LIST OF APPENDICES



## INTRODUCTION

**1.** There are two deflection amplifiers in each fixed-coil PPI display console (Type 64), one for X deflection and one for Y deflection. The X amplifier is officially known as the *amplifying unit (R.H.) Type* 313 (*Stores Ref.* 10U/16763), and the Y amplifier as the *amplifying unit (L.H.) Type* 314 (*Stores Ref.* 10U/16764). The two amplifiers are fitted on a mounting tray with the voltage stabilizer Type 51 (*Chap.* 7) between them. The mounting tray fits into the console framework below the indicating unit (CRT) Type 35, with the Type 313 on the right as seen by the operator, and the Type 314 on the left.◀For certain applications, Types 12476 and 12477 are used. These units are described in App. 1.▶

**2.** Fig. 1 shows where the deflection amplifiers are located in the lower half of the console, and fig. 2 shows them assembled on the mounting tray. A general view of the X amplifier (Type 313) appears in fig. 3; the Y amplifier, which in layout is a mirror image of the other, is shown in fig. 4.

**3.** The function of the X deflection amplifier is to feed a deflecting current waveform into the X deflector coils and so cause the spot on the CRT to execute the required movements in the X or East–West direction during the radar scan period, and also during the inter-trace period (when azication or other markers are being displayed). The waveforms of current in the deflector coils have to be an exact replica of the input voltage waveforms to the amplifier; the unit is therefore sometimes referred to as the X voltage-to-current convertor. The Y deflection amplifier performs similar functions for spot movements in the Y or North–South direction.

**4.** Each amplifier has to switch electronically between trace and inter-trace period inputs, and to do this it accepts positive and negative gating waves produced originally in the radar office rack assembly Type 304. These are not to be confused with the video gating wave produced by the waveform generator Type 80 in the console indicating unit. Each amplifier has also to perform the functions of trace expansion (which enables particular parts of the picture to be examined in greater detail), and of off-centring (which enables the whole picture to be shifted so as to bring any particular region of interest to the centre of the screen). The design ensures that when, due to off-centring, a particular point in the scanned area has been brought to the centre of the screen, that point remains at the centre of the screen on all degrees of trace expansion. In other words, the picture expands about the centre of the screen and not about the origin of the radar scan. From the final amplifier stages, blanking waveforms are fed out to operate the blanking unit Type 26.


**Fig. 1. Lower half of console Type 64**
(Mounting tray drawn forward, and deflection amplifiers swung out)

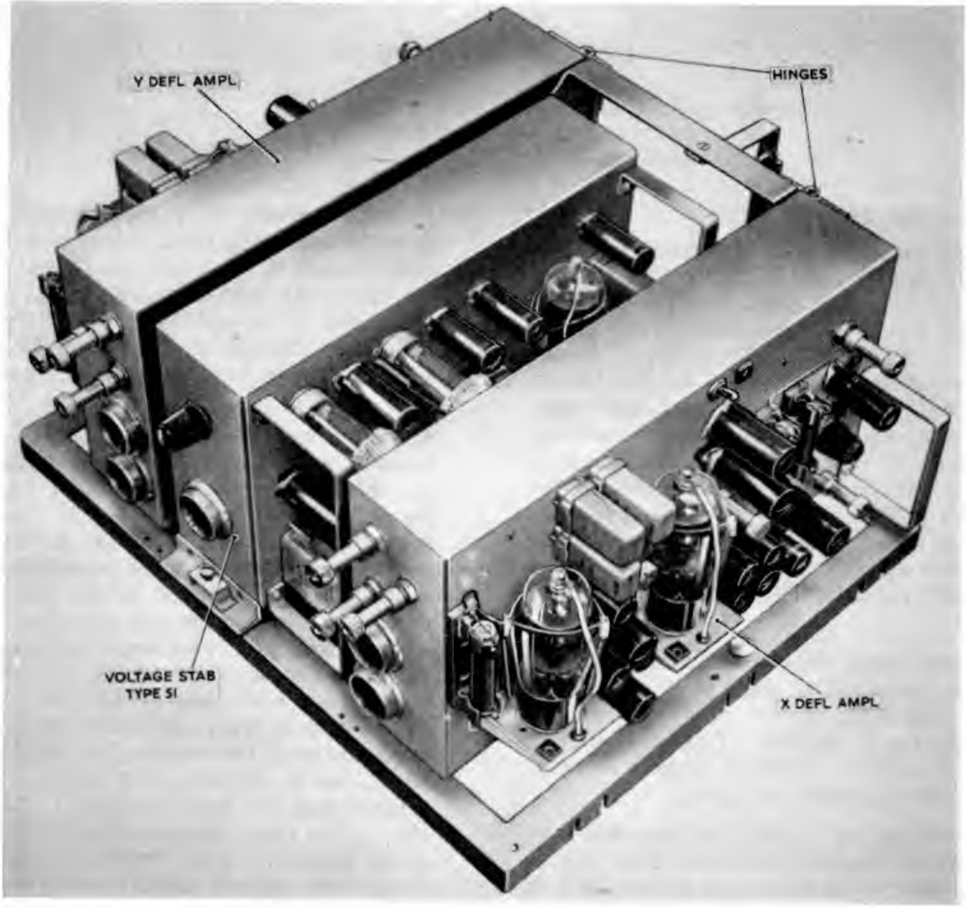


**Fig. 2. Deflection amplifier mounting tray**

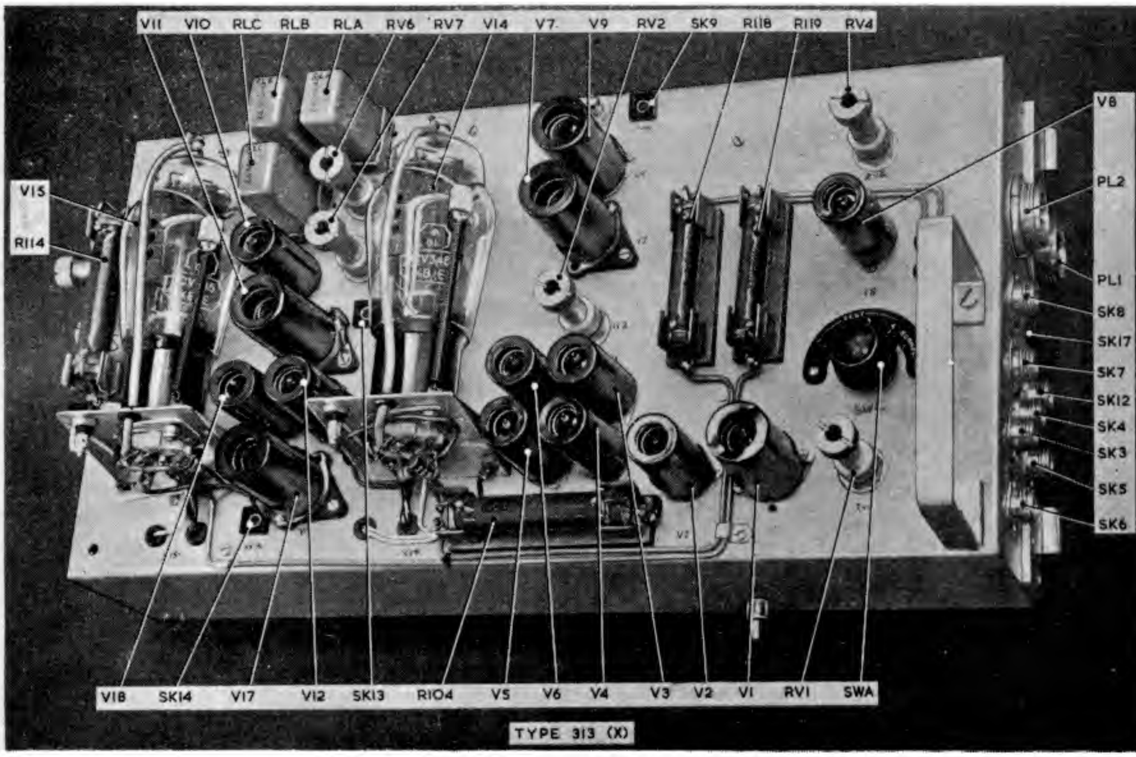


**Fig. 3. X amplifier (Type 313)**

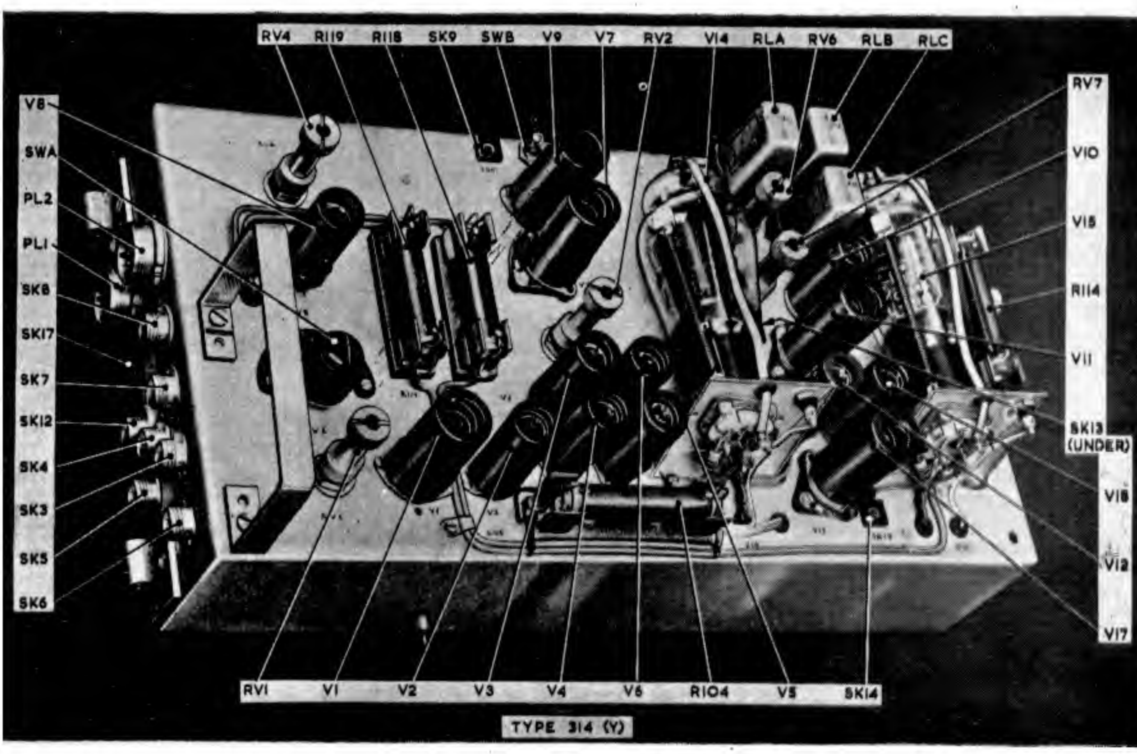


**Fig. 4. Y amplifier (Type 314)**

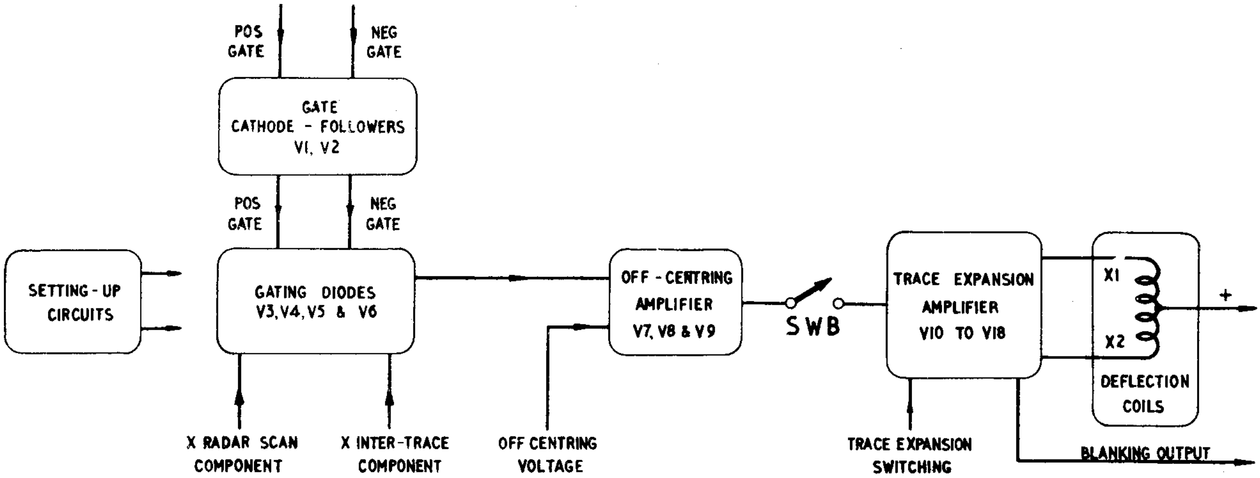


**Fig. 5. Block diagram of X amplifier**

**5.** To allow for off-centring and for superposition of strobes on the radar picture, DC connection has to be adopted throughout the amplifier. In consequence, special attention is paid, in the design, to the prevention of DC drift which would reduce the accuracy of the display; thus widespread use of high-stability resistors is made in all stages, and special double-triode circuits having almost complete freedom from drift are employed at key points. In addition, to reduce the number of preset controls to be set up, resistors of very close tolerance are used at certain points; the greatest care must be taken in servicing that the value of all these features is not lost by the use of incorrect components or wrong setting-up procedure.

**6.** The power supplies to each amplifier include three 6·3V 50 c/s heater pairs from the distribution panel Type 861, stabilized HT lines of −300V, + 250V and + 400V from the voltage stabilizer Type 51 and, for the final (deflector coil) stages, a stabilized + 250V line direct from the bulk power supply (rack assembly Type 305).

## CIRCUIT DESCRIPTION

### General

**7.** A complete circuit diagram of the amplifying unit (R.H.) Type 313 (X amplifier) is given in fig. 14. The circuit of the amplifying unit (L.H.) Type 314 (Y amplifier) is the same except for minor differences in the setting-up circuit and heater circuit (marked on the diagram). The circuit description which follows deals with the X amplifier, but it applies equally well to the Y amplifier except where otherwise stated. In particular, reference should be made to the circuit diagram (*fig. 14*) to verify the connections to twin valves, since a and b in these may be reversed due to the mirror image layout of the two amplifiers. Explanation of the circuit operation is facilitated by breaking it down into five main groups (see block diagram, *fig. 5*) as follows :—

(1) Gate cathode-followers

(2) Off-centring amplifiers

(3) Gating diodes

(4) Trace expansion amplifiers

(5) Setting-up circuits

These groups are described in order in the following paragraphs.

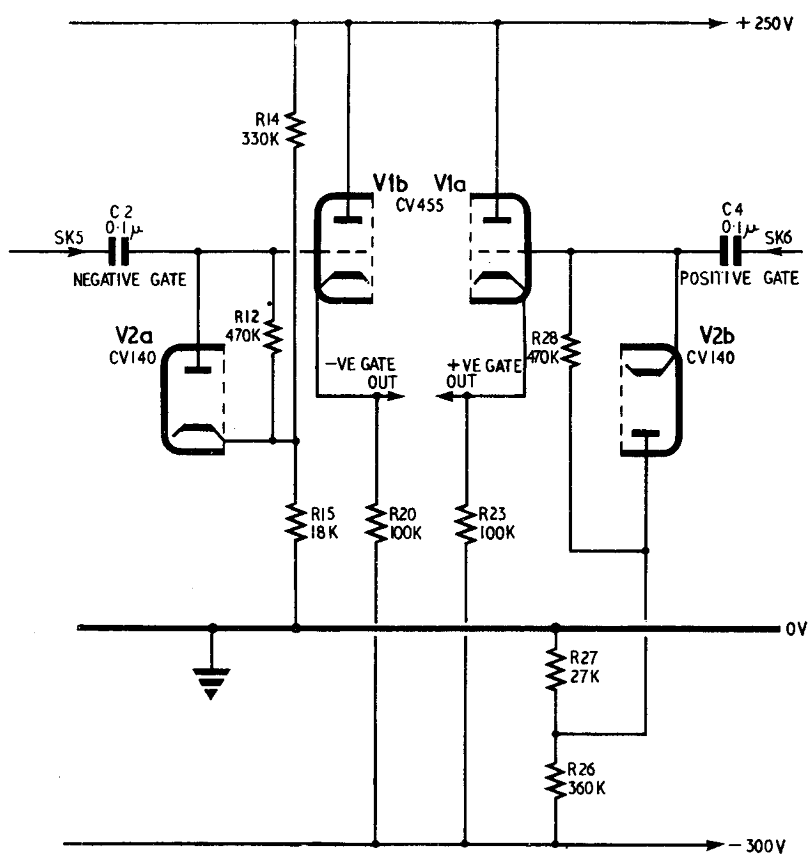


**Fig. 6. Gate cathode-followers (simplified)**

**Gate cathode-followers**

**8.** On arrival from the radar office rack assembly Type 304, the positive and negative inter-trace gating waves consist of square pulses of about 30V amplitude recurring at 250 c/s (*fig. 9*). The leading edges of the gate pulses coincide with the end of a 500 c/s radar timebase. Both pulses last for 270 μS, which is about half a 500 c/s inter-trace period. This method of timing means that when information from a 250 c/s radar head is being displayed, inter-trace markers come up after every scan; but when a 500 c/s head is in use, they show after every second scan.

*DC restoration*

**9.** The DC levels of the gating waves are indeterminate on arrival from the radar office and have to be accurately set before application to the gating diodes, so that the waveforms shall straddle earth level symmetrically. Accordingly they are AC-coupled from SK5 (negative gate) and SK6 (positive gate), and then DC-restored by the diodes V2A and V2B (CV140) (*fig. 6*). V2A cathode is returned to a positive potential at the junction of R14 (330 KΩ) and R15 (18 KΩ), chosen so that the negative gating wave is held wholly below +15V when fed out from the cathode-follower V1B. Similarly, the anode of V2B is returned to a negative potential at the junction of R26 (360 KΩ) and R27 (27 KΩ) such that the positive gating wave is held wholly above −15V at V1A cathode.

**10.** V1B and V1A (CV455) are triode cathode-followers for negative and positive gate respectively. Their 100 KΩ cathode loads are returned to the −300V stabilized line, and the outputs go to operate the gating diodes.

**Off-centring amplifier**

**11.** Basically, the off-centring amplifier (*fig. 7*) consists of the two double-triode valves V7 (CV492) and V9 (CV491), and the purpose is to accept the X radar scan component, superimpose the off-centring voltage, and apply the result to the trace expansion amplifier, with an overall gain of unity.

**12.** When inter-trace markers are to be displayed, the input has to be switched from the ordinary timebase component to the inter-trace marker component. The gating diodes which do this are shown symbolically as a simple change-over switch in fig. 7; their action is explained later in this chapter (*para. 23-26*).

*Simple circuit description*

**13.** The off-centring voltage consists of a steady potential somewhere between plus and minus 41·6V, representing shift of up to 200 nautical miles either way. It is applied from the operator's off-centring control on the control panel Type 859. Once it has been introduced, giving all deflection waveforms a definite DC level, the remaining stages of the amplifier must clearly be DC-coupled throughout. To reduce the danger of DC drift, due to changes in valve characteristics or to other causes, and to maintain linearity, it is necessary to use a high-gain amplifier and then apply heavy negative feedback from output to input. The circuit here adopted is a form of see-saw amplifier, with a 1 MΩ resistor in any one input channel forming the input arm of the see-saw, and another 1 MΩ resistor forming the feedback arm. Since the arms are equal, the gain on any one channel is about unity, subject to small variations for setting-up purposes. The point **P** (*fig. 7*), which never moves far from earth level, is the " pivot " of the see-saw, and since the gain from **P** to the output at SWB is high, any hum or other unwanted voltage picked up at **P** has a particularly serious effect on the display. Special precautions have therefore been taken in the design to avoid such trouble (*para. 46*).

*Full circuit description*

**14.** There are several important features of the off-centring amplifier which are not brought out in the above simplified description, but which may be seen in the full circuit diagram (*fig. 14*). This shows that coupling from V7B to V7A is by their common cathode resistor R34 (150 KΩ). The reason for the use of this double-triode circuit here is that a gain of about 30 is obtained without phase reversal, and without such serious heating drift as is found with pentodes; also, any drift due to heater voltage variations will be self-cancelling, such variations having opposite effects on the two cathodes.

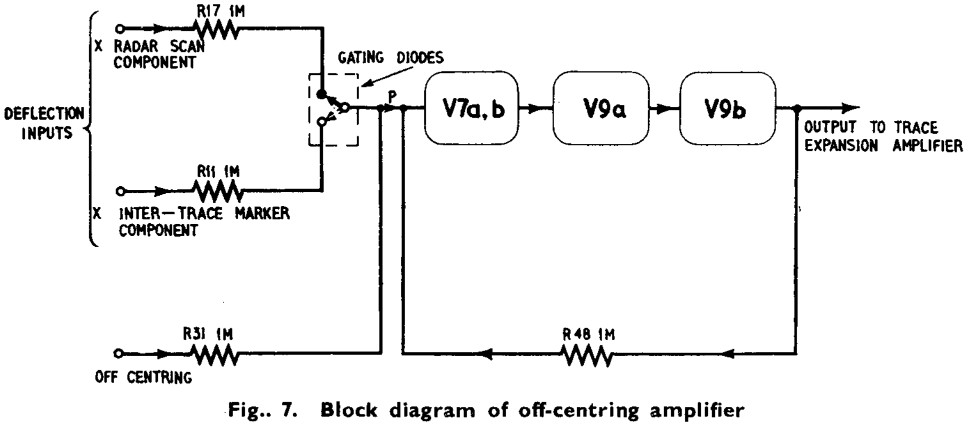


Fig.. 7. Block diagram of off-centring amplifier

**15.** Coupling from V7B to V9A (another triode) is effected by the DC divider chain R36, R40, R42; the anode load for V9A is R44 (47KΩ), and the gain is about 10. This stage introduces the necessary phase reversal for the see-saw action; its output is applied by another potentiometer chain (R46, R47) to the cathode-follower V9B, the total cathode load of which amounts to over 55 KΩ. It will be seen that no controls are provided for setting the DC conditions of these stages; to reduce the number of adjustments needed, close tolerance resistors have been used.

**16.** Although the input resistor to the see-saw is exactly 1 MΩ (R31) for the off-centring input, on the radar scan input it consists of the 1 MΩ resistor R17 plus some extra resistance from the gating diode circuit and from part of RV2. The same applies to the inter-trace input arm via R11. The reason for including RV2 is that it is important to ensure exact equality of the input arms, in order to obtain correct superposition of a strobe marker with its corresponding point on the radar picture. If the input arms were not exactly equal, a strobe spot marking a point 20 miles out (for example) would not coincide on the display with an echo or point on the video map at the same range, due to the unequal overall gain on the two channels. As a result of component tolerances R11 and R17 may not be quite equal. To enable any difference to be taken up, the 25 KΩ potentiometer RV2 is connected between the input arms, and the input to V7A grid taken from its slider.

**17.** Small variations in diode characteristics are liable to introduce small differences in DC levels on scan and inter-trace input, resulting in different levels at **P** even when SK3 and SK4 are both earthed. If uncorrected, this results in lack of coincidence between the scan origin and the strobe origin; so to provide a compensation for such differences each input is given a small positive DC level (*fig.* 8), which is fixed for the radar-scan input (junction of R10 and R16) and variable for the inter-trace (slider of 2·5 KΩ potentiometer RV1). RV1 thus provides an adjustment to ensure coincidence of scan origin and strobe origin.

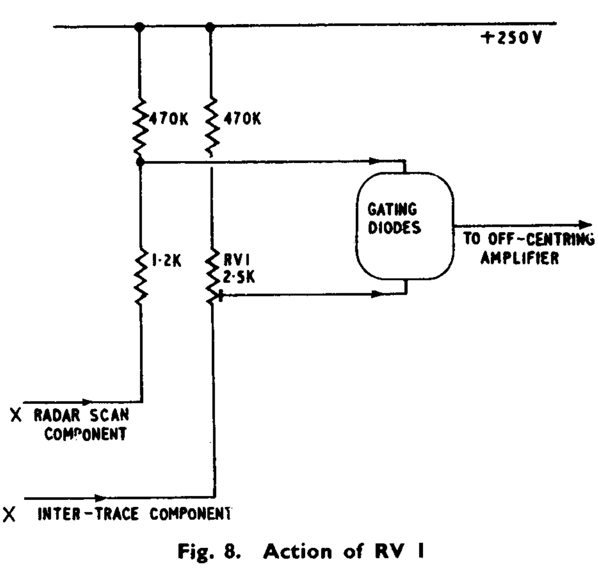


**Fig. 8. Action of RV 1**

*Gain adjustment*

**18.** The feedback arm of the see-saw is R48 (1 MΩ). It originates not at V9B cathode itself but at the slider of a 50 KΩ potentiometer RV4 in the cathode circuit; RV4 is returned to earth via R41 (220 KΩ) and controls the negative feedback to V7A. The potentiometer therefore provides a control of overall gain on all the channels together (scan, inter-trace and off-centring). Such control enables the gains of the X and Y amplifiers to be made equal; if they were not, the picture would be distorted, and (for example) range rings would appear oval in shape and not circular.

*Purpose of R60*

**19.** Earthed input on all channels does not produce zero voltage at V9B cathode, but +7·5V. The necessity for this arises because the DC conditions in the subsequent stages (trace expansion amplifier) demand a level of + 7·5V at V11B grid for centred spot. Now it is necessary that the feedback arm to **P** should originate from a point which is at earth potential during earthed input. The feedback arm is therefore not taken direct from V9B cathode but from a point lower down the cathode chain at the bottom of R60 (1·2 KΩ); this drops the required 7·5V.

*Limiting diodes*

**20.** The purpose of the feedback-limiting diodes V8A and V8B is to ensure that excessive drive, either positive or negative, is never applied to V7A grid. If, for example, there were no diodes and a sawtooth went far enough negative to cut off V9A, the interruption of the feedback loop would result in large negative drive at V7A grid (which otherwise never moves far from earth because of the see-saw amplifier action). The thermal condition of V7 in these two states might be different enough to cause changes of valve characteristics and so of DC levels. A similar trouble could arise if V7A grid were taken far enough positive by a sawtooth to run V9A into grid current. These so-called "heating drifts" would cause the origin of the scan to wander about as the trace rotated.

**21.** Accordingly, diode V8B is connected from **P** to a positive potential at the junction of R57 and R58 in order to limit the positive excursion at V7A grid; diode V8A is similarly arranged to limit the negative excursion. The change at V9B cathode which just causes the spot to traverse the whole tube face on minimum expansion is plus and minus 35·2V from the centre value of +7·5V, i.e. between +42·7V and −27·7V. The diode return potentials are arranged not to cause limiting until values well beyond these figures have been reached, so as to allow the blanking unit and the limiters in the trace expansion amplifier to operate first.

**22.** There is a danger of HF oscillations round the loop when the amplifier runs into one limit or the other, because when either diode is conducting the feedback arm is practically short-circuited. To prevent such oscillations the circuit R38, R39, C18 is included at V8A diode anode, and the circuit R61, C19 at V8B diode cathode. The purpose of these components is to reduce by a factor of about twelve the amount of any HF signal voltage fed back via the conducting diode. The danger of HF oscillations is also reduced by the capacitors C5 and C8 which preserve constant phase shift through the amplifier up to the higher frequencies of the video band.

**Gating diodes**

**23.** The gating circuit contains four double-diodes V3 to V6 (CV140). These eight diodes are arranged to admit the X timebase component to the off-centring amplifier during the non-gated period (i.e. trace period plus last part of inter-trace period), and the X inter-trace deflection component during the other part of the inter-trace period (i.e. the gated period). The action is controlled by positive and negative gating waves (*fig. 9*) received from the gate cathode-followers.

*Trace period*

**24.** Considering first the radar input side (*fig. 10*) it is seen that during the trace period V4B cathode is held at +15V, and V4A anode at −15V, so that neither of these diodes passes more than a fraction of 1mA. The input at the point **F** is therefore passed straight on to RV2 and thence to the amplifier input ; the route is via V3A when the input is positive to earth and via V3B when it is negative.

*Inter-trace period*

**25.** At the end of the trace period V4B cathode moves to −15V, and V4A anode to +15V, so that current starts flowing round from V4A through the 6·8 KΩ resistors to V4B, so holding V3A anode at −15V and V3B cathode at +15V. RV2 is the " pivot " of the see-saw amplifier and is therefore always near earth potential, so both V3A and V3B are now cut off. There is now no path by which any input from **F** may reach the amplifier.

**26.** A similar circuit is provided in the inter-trace marker input arm (double-diodes V5 and V6, CV140), but all the diodes are connected in the opposite sense to the ones in fig. 10, so that the action is just the reverse of that described above. The inter-trace deflection component is therefore admitted during the gate pulse, and excluded at other times. The reason for the inclusion of RV2 between the two input arms was explained in para. 16.

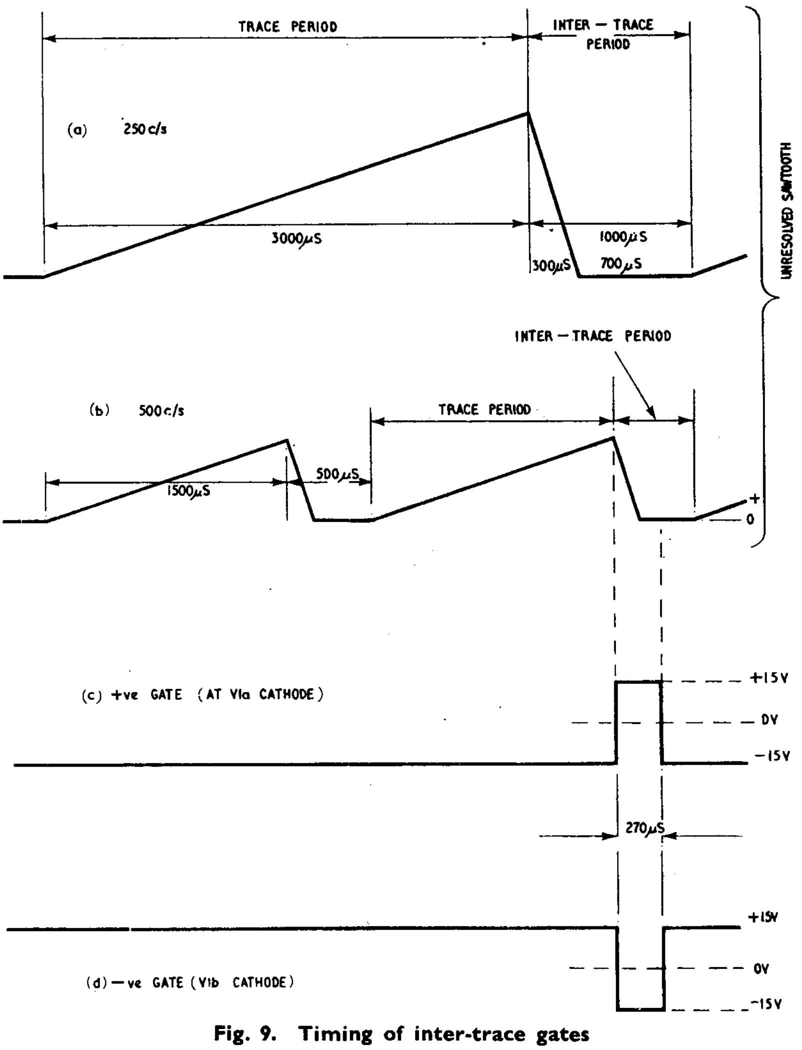


**Fig. 9. Timing of inter-trace gates**

**Note . . .**

*It is stressed that the above explanations apply to the X amplifier (Type 313). On the Y amplifier (Type 314) the action is identical but some of the double valves have different numbering (fig. 14) because of the mirror-image component layout.*

**Trace expansion amplifier**

*General*

**27.** The valves which actually drive the X deflector coils are V14 and its paraphase valve V15, both beam tetrodes CV345. The drive for V14 is obtained from the off-centring amplifier via the amplifiers V11 and V12, and for the paraphase tetrode from V14 cathode circuit via the amplifiers V17 and V18. A simplified circuit diagram of the arrangement is shown in fig. 11.

**28.** The object of the whole circuit is to produce in the X coils anti-phase current waveforms which are a linear reproduction of the input voltage waveform at SWB (subject to trace expansion and limiting effects). The X1 coil current waveform is closely reproduced by the voltage at V14 cathode, so negative feedback is taken from there to the grid of V11. The whole X1 amplifier circuit may thus be regarded as a see-saw circuit, with the input arm made variable to give different values of gain for the different trace expansions. The X2 amplifier

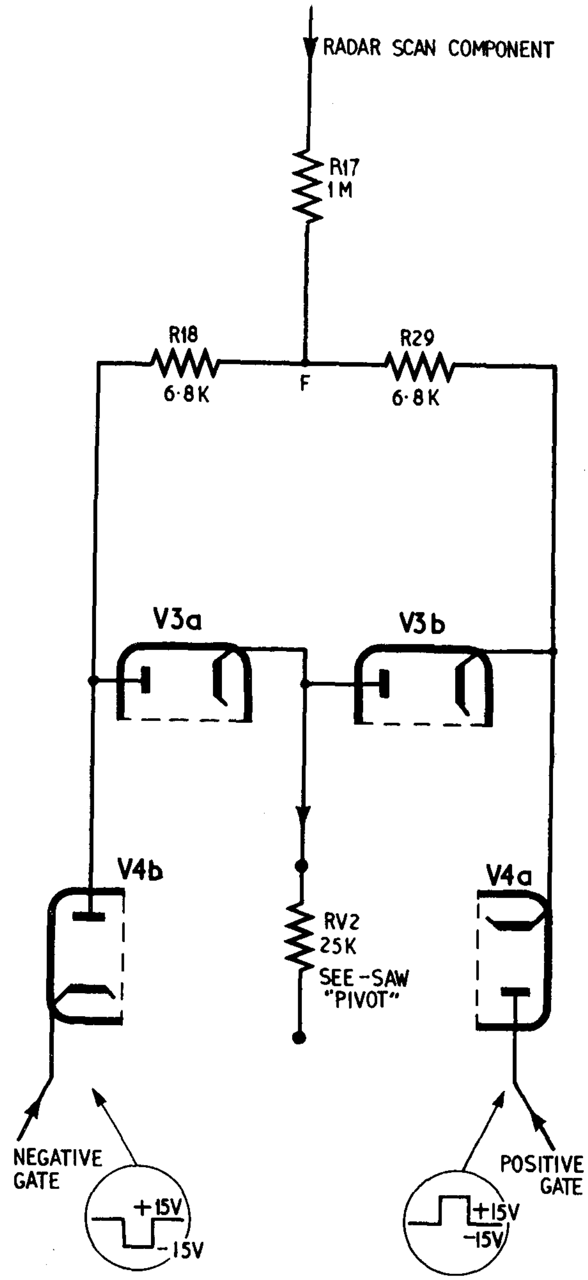


**Fig. 10. Radar side of gating diodes**

may also be regarded as a see-saw amplifier with its drive taken from the X1 tetrode cathode.

*Trace expansion*

**29.** The input see-saw arm has R71 + R75 (total about 180 KΩ) always in circuit, in series with extra resistors varying with the degree of trace expansion (*Table 1*). On the greatest degree of expansion (RANGE switch *position 1*, 80 M) the scan sawtooth is at its steepest (assuming trace pointing East) and one CRT radius then represents a range of 40 nautical miles. On the least expansion (RANGE switch *position 4*, 320 M), the sawtooth slope is least, and the tube radius then represents a range of 160 nautical miles. Superposition of strobe markers on the picture remains accurate on all degrees of expansion, since all deflector voltages appearing at SWB undergo the same overall gain through the amplifier. The RANGE switch itself, which operates the trace expansion relays A, B and C, is located on the control panel Type 859; note that the figures marked on it refer to CRT *diameter*, not to radius.

**TABLE 1**
**Trace expansion**

| RANGE SW Position | RANGE SW Marking (CRT diam.) nautical miles | Relay closed | Total input arm to V11A grid | Overall gain SWB to V14 cathode |
|---|---|---|---|---|
| 1 | 80 | RLC | 1 × 180 KΩ | 2/1 |
| 2 | 160 | RLB | 2 × 180 KΩ | 2/2 |
| 3 | 240 | RLA | 3 × 180 KΩ | 2/3 |
| 4 | 320 | None | 4 × 180 KΩ | 2/4 |

*V11 and V12*

**30.** The double triode V11 (CV492) is a cathode-coupled amplifier whose gain, taken by itself, is about 30 without phase reversal. The circuit has the usual advantage that the effect of heater voltage variations on the DC conditions is negligible. The grid of V11A is not earthed but returned to a small positive potential at the slider of the 25 KΩ potentiometer RV3. This potentiometer enables the DC operating conditions of V11, and thus of V12 and V14 as well, to be accurately set.

**31.** DC coupling from V11A anode to V12 grid is effected by the divider chain R93, R94 (both 1 MΩ). The pentode V12 (CV138) has a 47 KΩ anode load and a gain of approximately 150. Coupling from V12 to V14 is also DC, using the resistors R101 (240 KΩ) and R102 (330 KΩ).

*V17 and V18*

**32.** The circuit of V17 and V18, the paraphase drive stages for V15, is closely similar to that of V11 and V12, except that the input to V17A comes from V14 cathode via the see-saw input resistor R106 (100 KΩ). The " pivot " point of this see-saw is the grid of V17A, and the feedback arm to it is another 100 KΩ resistor R113, taken from V15 cathode. The DC operating conditions for V17, and thus for V18 and V15 as well, are set by altering the negative return of R134 at the slider of RV5 (25 KΩ); the grid of the other triode of the pair (V17B) is earthed. There are no separate limiters on this side.

*Final amplifiers V14 and V15*

**33.** The final amplifiers V14 and V15 are beam tetrodes, CV345. They operate as a balanced paraphase pair, with the X1 CRT deflector coil in the anode circuit of V14 and the X2 coil in that of V15. The ends of the coils remote from the anodes are common and are taken to +250V stabilized HT from the bulk power supply. A 10-watt dissipation limiting resistor of 130Ω is included in series with each coil. A single damping resistor of 33 KΩ is connected right across the pair of coils; its purpose is to eliminate coil ringing at sharp edges, for example at a transition from trace end to strobe marker position, or from marker back to trace origin. The tetrode screens are connected out via PL1/C to a common

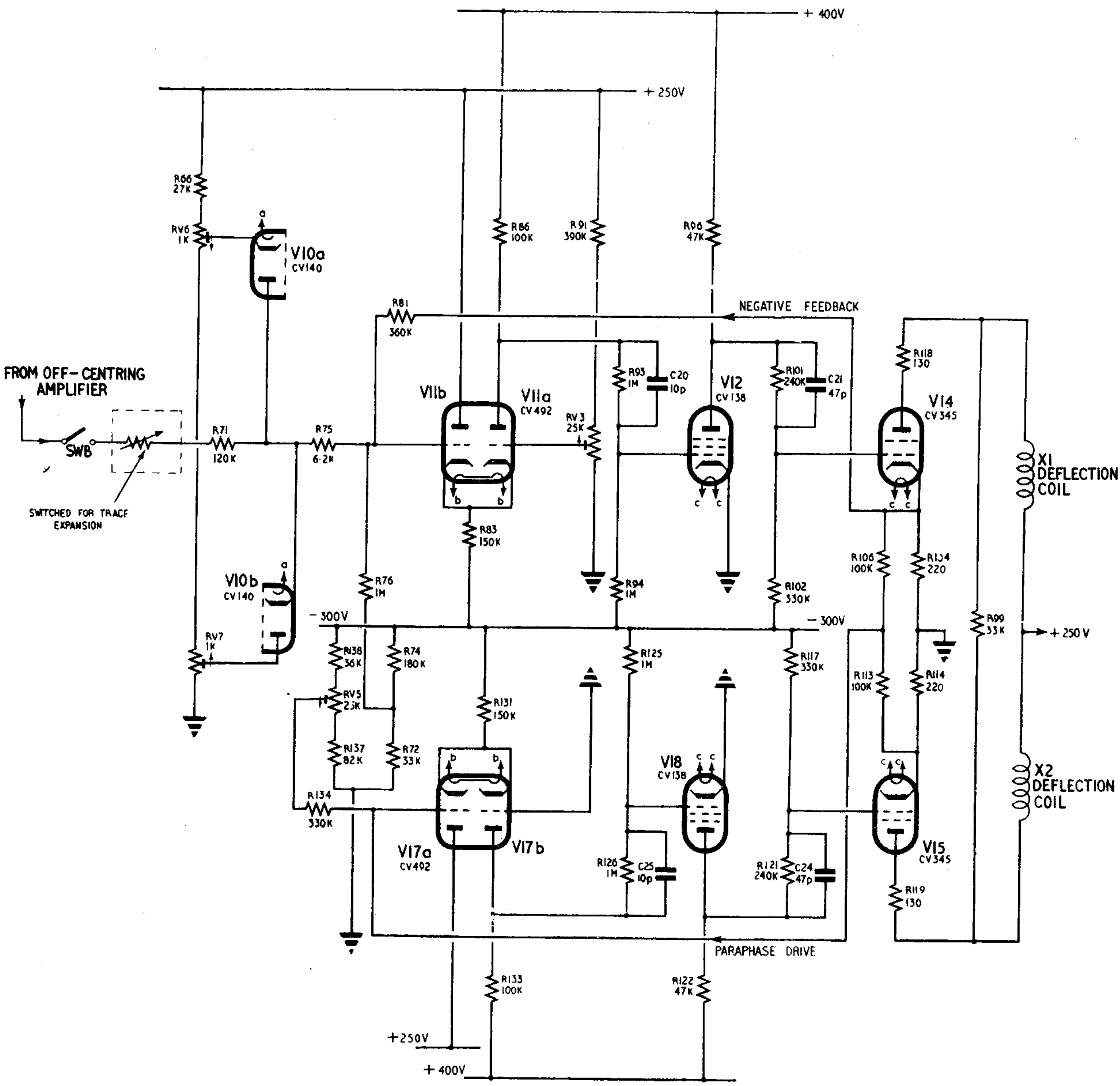


**Fig. 11. Trace expansion amplifier (simplified)**

1·8 KΩ screen resistor located in the voltage stabilizer Type 51 ; the resistor is connected to the +250V stabilized supply fed to the stabilizer Type 51 from the rack assembly Type 305 via the other units in the console (see *Chap. 9* for a fuller description of the HT system).

**34.** In series with the cathode of each tetrode is a 15-watt 220Ω resistor (tolerance 1 per cent) which provides the necessary cathode potentials for negative feedback and for the paraphase drive ; the latter is via the 100 KΩ input arm of the paraphase see-saw. The potentials developed across the 220Ω cathode resistors are a close replica of the coil current waveforms These cathode potentials are also used for blanking purposes, the connections to the blanking unit being made via the germanium diodes V13 and V16 (CV448). A full explanation of the blanking action is given in the chapter on the blanking unit, Chap. 4 of this Section.

**35.** The normal cathode current of each tetrode for centred spot is 130 mA, comprising about 10mA to the screen and the remainder through the anode and deflector coil. The corresponding cathode potential is +28·6V. The setting-up procedure for this part of the circuit will be issued in full in Part 2 of this Volume, but is briefly as follows :—

(1) Open SWB to remove all deflectional input.

(2) Adjust RV3 until V14 is passing 130 mA (observed by metering the potential at the cathode, SK16/K).

(3) Adjust RV5 until V15 is also passing 130mA (SK16/L).

(4) Re-adjust RV3 to bring spot exactly to *geometrical* centre of tube face. This final adjustment is necessary because, due to tolerances in the CRT electrodes, exactly balanced coil currents may not produce a centred spot ; the limit of the possible disparity is 15 mm, corresponding to 10mA coil current.

*Diode limiters*

**36.** Diode limiters V10A and B are included to prevent either tetrode from ever being cut off or going into excessively heavy conduction. If there were no limiting, a large positive voltage at V11B grid (for example) would cause a large fall at V14 grid, cutting it off ; at the same time, V15 would be driven into excessive conduction. This interruption of the feedback loop would allow an even greater rise at V11B grid, and thus an abnormally large rise at V11A anode, which could be seen by connecting an oscilloscope to SK13. Fig 12 shows the effect of a large positive sawtooth input (e.g. at full trace expansion) when there is no limiting ; the abnormal rise starts at the point of the sawtooth corresponding to V14 cut-off. Though this effect occurs well beyond the edge of the tube face, it is undesirable because of the heating drift effects already referred to in para. 20, which would cause centre wander. V10A is therefore included to limit the positive excursion of the input waveform to V11B grid just before the abnormal rise starts ; RV6 controls the return potential for V10A and so the exact limiting level, whose correct position is shown by the horizontal broken line in fig. 12.

**37.** Similarly, it is essential to limit the negative excursion at V11B grid, in order to prevent V15 from cutting off or V14 from being driven into excessive conduction. The limiter here is diode V10B, whose anode is returned to a small positive potential set by RV7. To set up this limiter, a negative sawtooth is applied at SWB, maximum trace expansion is switched in, and the oscilloscope is connected to SK14. RV7 is then adjusted so that limiting occurs just before the abnormal rise starts (*fig. 12*).

**38.** The reason for splitting the 180 KΩ permanent input resistor into two parts (R71 and R75), and connecting the two limiting diodes to the junction, is that the voltage swings at V11B grid itself are too small to operate the diodes, and they cannot satisfactorily be connected at V9A cathode, since the current demanded during limiting would be much too great. The diodes are therefore connected part way along the input resistor.

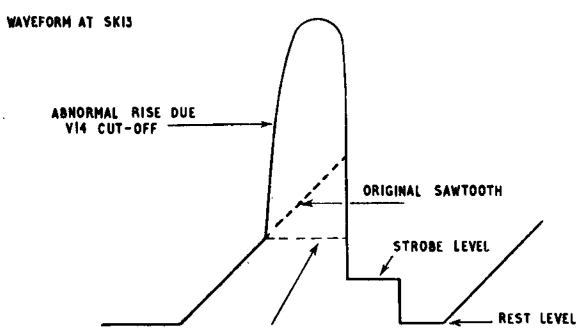


**Fig. 12. Limiting in trace expansion amplifier**

*Correction capacitors*

**39.** As shown in simplified form in fig. 11, the circuits ensure accurate reproduction of a linear input sawtooth at the tetrode *cathodes*, but this does not necessarily ensure an accurate current sawtooth in the coils. In fact, due to the presence of the damping resistor across both coils, and due to the stray capacitances all along the V11B input resistor chain R62 to R75 (relay contacts, diodes etc.), there is a tendency to a slow start on the current sawtooth. If uncorrected this non-linearity near the trace origin would result in misleading superposition of trace and strobe markers there, and would cause range rings to appear too crowded together near the start. Pre-correction is therefore applied by the capacitors C13 to C16 across the series resistors in the input arm.

**Setting-up circuits**

**40.** The heart of the setting-up circuit is the TEST switch, SWA in fig. 14. Three wafers of SWA are used and they affect the input channels as follows :—

| | |
|---|---|
| SWAac | Off-centring input |
| SWAab | Inter-trace deflection input |
| SWAcb | Radar scan input |

Associated with the switch is a chain of resistors (R1 to R7), giving the positive and negative potentials required for setting-up the correct super-position of strobes and scan.

**TABLE 2**
**Setting-up switch (SWA)**

| Switch position | Switch wafer blade | | | | | |
|---|---|---|---|---|---|---|
| | Aac (Off-centring) | | Aab (Inter-trace) | | Acb (Radar scan) | |
| | To wiper | Conn. | To wiper | Conn. | To wiper | Conn. |
| TEST 1 | 8 | Earth | 2 | Earth | 2 | +25V |
| TEST 2 | 9 | Earth | 3 | Earth | 3 | Earth |
| TEST 3 | 10 | +41·6V | 4 | −41·6V | 4 | −41·6V |
| TEST 4 | 11 | −41·6V | 5 | +41·6V | 5 | +41·6V |
| NORMAL 5 | 12 | PL2/M | 6 | SK3 | 6 | SK4 |

**41.** There are five switch positions (*Table 2*), of which position 5 is NORMAL and positions 1 to 4 are for TEST. In the NORMAL position the three inputs listed in para. 40 go straight into the amplifier, but on the other four the fixed test potentials are applied instead. (*Note that the positions 1 to 5 do NOT correlate with the wiper numbers on fig. 14.*) The TEST positions are used in the order 2, 3, 4, 1. Positions 2, 3 and 4 concern the correct super-position of trace and inter-trace information, and are adjusted on each amplifier separately ; position 1 is used to equalize the gain of the X and Y amplifiers.

*SWA position 2*

**42.** In position 2 of SWA, the three input arms are all earthed. This feature enables the relative DC origin levels on scan and inter-trace sides to be set by adjustments of RV1. In general, two spots (representing scan and inter-trace origins) are seen near the screen centre, and all that is necessary is to adjust RV1 for coincidence of the two spots. Since there is no voltage across the input arms, the setting of RV2 has no effect on this adjustment, which should be done on ***maximum*** expansion (RANGE switch to 80-mile position).

*SWA position 3*

**43.** Position 3 of the switch enables a potential of −41·6V (representing 200 miles deflection) to be applied to the scan and inter-trace arms simultaneously, so permitting the *relative* gain of the amplifier on these two channels to be exactly equalized by adjustment of RV2 (*para. 16*), and so ensure correct superposition of inter-trace markers and radar picture for negative-going deflections. The test is carried out on ***maximum*** expansion, and since −41·6V represents a deflection far beyond the tube edge, an opposing deflection of +41·6V is applied to the off-centring arm in this position, to bring the spots back near the screen centre. RV2 has to be adjusted until the two spots (one from the scan channel and one from the inter-trace) exactly coincide.

*SWA position 4*

**44.** Position 4 of SWA applies a potential of +41·6V to scan and inter-trace input arms, providing a similar adjustment of relative gain to position 3, but for positive-going deflections. Here an opposing deflection of −41·6V is applied to the off-centring arm, to bring the two spots back into view. The adjustments in positions 3 and 4 must be done successively to obtain coincidence in both positions; if this proves impossible, the setting of RV2 giving ***minimum*** separation in each position must be used. The discrepancy is due to differing diode characteristics in the gating circuit ; in serious cases a change of diodes may be tried. If this course is adopted the setting-up on position 2 must be repeated.

*SWA position 1*

**45.** In position 1 of SWA (as shown on *fig. 14*), the off-centring input arm of the amplifier (at R31) is earthed, and so is the inter-trace input arm (at RV1). But the radar scan input arm (at R16) is connected to a +25V point at the junction of R3 and R4 ; the same potential is available at the banana socket SK17. On the Y amplifier (Type 314), the connection from SWAcb/2 to the +25V is not made ; instead, the +25V from the X amplifier (Type 313) is brought in (when setting up) by a flying lead between the two SK17's. This enables the *same* potential to be applied to the scan input arms on X and Y amplifiers, so that the gain may be made equal in the X and Y directions on the display. The drill for this will be issued in Part 2 of this Volume, but is briefly as follows :—

(1) Set the X gain correctly by adjusting RV4 in the 313 until, on minimum expansion, 320 miles of range rings just fill the tube diameter in the horizontal direction. (SWA on the 313 must be on the NORMAL position for this, so that the radar scan component is available. The magslip resolver in the radar office supplying the scan components must have been manually turned until the X component is at its maximum.)

(2) Open SWB in the 314 in order to eliminate Y deflection ; turn SWA on the 313 to *test position 1*. The spot then moves out a certain distance in the X1 direction, corresponding to +25V (120 miles). Measure this distance with a wooden or plastic rule.

(3) Turn SWA on the 314 to *test position 1*, and run a flying lead between SK17 on the 313 and SK17 on the 314.

(4) Open SWB on the 313, and close SWB on the 314. The spot then moves out a certain distance in the Y direction ; using the rule, adjust RV4 in the 314 until this distance is the same as was obtained in operation (2).

(5) Remove the flying lead, close SWB in the 313.

**Heater supplies**

**46.** Reference to fig. 14 shows that there are three separate 6·3V 50 c/s heater supplies to each deflection amplifier, as follows :—

(1) **a-a** Centred to a level of about −20V by the 100-ohm resistors R51 and R52, which are returned to the junction of R26 and R27. This negative potential prevents the heaters of the gating diodes from ever going positive to earth ; if they did, hum could be introduced at the sensitive "see-saw pivot" point **P** (*para. 13*) by electronic heater-to-cathode conduction. (R51 and R52 omitted on 314—common supply with 313.)

(2) **b-b** Centred to the same negative level as supply (1) by the 100-ohm resistors R53, R54, and for the same reason. (Omitted on 314—common supply with 313.) This supply is also used in the waveform generator Type 80, the voltage stabilizer Type 51, and for RLB in the distribution panel Type 861.

(3) **c-c** Centred to earth by the 100-ohm resistors R68, R69 ; this supply is used for the final amplifier tetrodes and their drive pentodes.

**Metering Facilities**

**47.** Small resistors are included in the anode or cathode circuit of every important valve in the unit, and connections brought out from them to the 25-way metering sockets SK15 and SK16. Thus the current in each valve may be checked quickly by plugging in the standard metering unit.

**Note . . .**
*These lists of components are issued for information only. When ordering spares for this unit refer to Volume 3 of this publication, or to the appropriate section of A.P.1086.*

## TABLE 3

### Component details

**Resistors (fixed)**

| Circuit ref. | Value (ohms) | Rating (watts) | Tol. (%) | Inter-serv. ref. |
|---|---|---|---|---|
| R1* .... .... | 100 K | ¾ | 2 | Z216452 |
| R2* .... .... | 5·6 K | ½ | 2 | Z215821 |
| R3* .... .... | 4·7 K | ½ | 2 | Z215801 |
| R4* .... .... | 10 K | ½ | 2 | Z216212 |
| R5* .... .... | 24 K | ½ | 2 | Z216302 |
| R6* .... .... | 27 K | ¾ | 2 | Z216312 |
| R7* .... .... | 120 K | ½ | 2 | Z216472 |
| R8 .... .... | *not fitted* | — | — | — |
| R9* .... .... | 470 K | ½ | 5 | Z216738 |
| R10* .... .... | 470 K | ½ | 5 | Z216738 |
| R11* .... .... | 1 M | ¾ | 1 | Z216655 |
| R12 .... .... | 470 K | ½ | 10 | Z223122 |
| R13 .... .... | 100 K | ½ | 10 | Z223038 |
| R14* .... .... | 330 K | ¾ | 5 | Z216731 |
| R15* .... .... | 18 K | ½ | 5 | Z216032 |
| R16* .... .... | 1·2 K | ½ | 5 | Z215252 |
| R17* .... .... | 1 M | ¾ | 1 | Z216655 |
| R18* .... .... | 6·8 K | ½ | 2 | Z215841 |
| R19* .... .... | 6·8 K | ½ | 2 | Z215841 |
| R20 .... .... | 100 K | 1 | 10 | Z213327 |
| R21* .... .... | 33 | ½ | 5 | Z215062 |
| R22 .... .... | *not fitted* | — | — | — |
| R23 .... .... | 100 K | 1 | 10 | Z213327 |
| R24* .... .... | 33 | ½ | 5 | Z215062 |
| R25 .... .... | 100 K | ½ | 10 | Z223038 |
| R26* .... .... | 360 K | ¾ | 2 | Z216571 |
| R27* .... .... | 27 K | ½ | 2 | Z216312 |
| R28 .... .... | 470 K | ½ | 10 | Z223122 |
| R29* .... .... | 6·8 K | ½ | 2 | Z215841 |
| R30* .... .... | 6·8 K | ½ | 2 | Z215841 |
| R31* .... .... | 1 M | ¾ | 5 | Z216757 |
| R32 .... .... | 330 | ½ | 10 | Z221173 |
| R33* .... .... | 150 | ½ | 5 | Z215142 |
| R34* .... .... | 150 K | ¾ | 5 | Z216715 |
| R35* .... .... | 150 | ½ | 5 | Z215142 |
| R36 .... .... | 100 K | ¾ | 10 | Z223049 |
| R37 .... .... | 330 | ½ | 10 | Z221173 |
| R38 .... .... | 10 K | ½ | 10 | Z222131 |
| R39 .... .... | 1·5 K | ½ | 10 | Z222026 |
| R40* .... .... | 1 M | ¾ | 5 | Z216757 |
| R41* .... .... | 220 K | ½ | 1 | Z216525 |
| R42* .... .... | 1 M | ¾ | 5 | Z216757 |
| R43 .... .... | 330 | ½ | 10 | Z221173 |
| R44 .... .... | 47 K | 6 | 5 | Z244150 |
| R45* .... .... | 33 | ½ | 5 | Z215062 |
| R46* .... .... | 360 K | ¾ | 1 | Z216567 |
| R47* .... .... | 470 K | ¾ | 1 | Z216591 |
| R48* .... .... | 1 M | ¾ | 1 | Z216655 |
| R49 .... .... | *not fitted* | — | — | — |
| R50 .... .... | 330 | ½ | 10 | Z221173 |
| R51 (*on Type 313 only*) | 100 | ½ | 10 | Z221110 |
| R52 (*on Type 313 only*) | 100 | ½ | 10 | Z221110 |
| R53 (*on Type 313 only*) | 100 | ½ | 10 | Z221110 |
| R54 (*on Type 313 only*) | 100 | ½ | 10 | Z221110 |
| R55* .... .... | 8·2 K | ½ | 2 | Z215861 |
| R56 .... .... | 47 K | 6 | 5 | Z244150 |
| R57* .... .... | 100 K | 1 | 5 | Z216124 |
| R58* .... .... | 18 K | ¾ | 2 | Z216273 |
| R59* .... .... | 33 | ½ | 5 | Z215062 |
| R60* .... .... | 1·2 K | ½ | 5 | Z215252 |
| R61 .... .... | 1·5 K | ½ | 10 | Z222026 |
| R62* .... .... | 180 K | ½ | 1 | Z216505 |
| R63* .... .... | 180 K | ½ | 1 | Z216505 |
| R64 .... .... | *not fitted* | — | — | — |
| R65* .... .... | 180 K | ½ | 1 | Z216505 |
| R66 .... .... | 27 K | 6 | 5 | Z244135 |

**Resistors (fixed)**—*cont.*

| Circuit ref. | Value (ohms) | Rating (watts) | Tol. (%) | Inter-serv. ref. |
|---|---|---|---|---|
| R67 .... .... | — | — | — | — |
| R68 .... .... | 100 | ½ | 10 | Z221110 |
| R69 .... .... | 100 | ½ | 10 | Z221110 |
| R70 .... .... | *not fitted* | — | — | — |
| R71* .... .... | 120 K | ½ | 1 | Z216466 |
| R72* .... .... | 33 K | ½ | 2 | Z216332 |
| R73 .... .... | *not fitted* | — | — | — |
| R74* .... .... | 180 K | ¾ | 2 | Z216511 |
| R75* .... .... | 62 K | ½ | 1 | Z216396 |
| R76* .... .... | 1M | ¾ | 2 | Z216659 |
| R77 .... .... | 330 | ½ | 10 | Z221173 |
| R78, 79, 80 .... | *not fitted* | — | — | — |
| R81* .... .... | 360 K | ½ | 1 | Z216566 |
| R82* .... .... | 150 | ½ | 5 | Z215142 |
| R83* .... .... | 150 K | ¾ | 5 | Z216715 |
| R84 .... .... | *not fitted* | — | — | — |
| R85* .... .... | 150 | ½ | 5 | Z215142 |
| R86 .... .... | 100 K | ¾ | 10 | Z223039 |
| R87 .... .... | 330 | ½ | 10 | Z221173 |
| R88, 89, 90 .... | *not fitted* | — | — | — |
| R91* .... .... | 390 K | ½ | 5 | Z216734 |
| R92 .... .... | 22 K | 1 | 10 | Z212259 |
| R93* .... .... | 1 M | ¾ | 2 | Z216659 |
| R94* .... .... | 1 M | ¾ | 5 | Z216757 |
| R95 .... .... | 330 | ½ | 10 | Z221173 |
| R96 .... .... | 47 K | 6 | 5 | Z244150 |
| R97* .... .... | 33 | ½ | 5 | Z215062 |
| R98 .... .... | *not fitted* | — | — | — |
| R99 .... .... | 33 K | ½ | 10 | Z222194 |
| R100* .... .... | 10 K | ½ | 2 | Z216212 |
| R101* .... .... | 240 K | ¾ | 2 | Z216539 |
| R102* .... .... | 330 K | ¾ | 2 | Z216563 |
| R103 .... .... | 330 | ½ | 10 | Z221173 |
| R104 .... .... | 220 | 15 | 1 | (Welwyn AW3124) |
| R105* .... .... | 10 K | ½ | 2 | Z216212 |
| R106* .... .... | 100 K | ½ | 1 | Z216446 |
| R107 .... .... | 100 | ½ | 10 | Z221110 |
| R108* .... .... | 33 K | ½ | 1 | Z216327 |
| R109* .... .... | 33 K | ½ | 1 | Z216327 |
| R110* .... .... | 33 K | ½ | 1 | Z216327 |
| R111* .... .... | 33 K | ½ | 1 | Z216327 |
| R112 .... .... | 100 | ½ | 10 | Z221110 |
| R113* .... .... | 100 K | ½ | 1 | Z216446 |
| R114 .... .... | 220 | 15 | 1 | (Welwyn AW3124) |
| R115 .... .... | *not fitted* | — | — | — |
| R116 .... .... | 330 | ½ | 10 | Z221173 |
| R117* .... .... | 330 K | ¾ | 2 | Z216563 |
| R118 .... .... | 130 | 10 | 5 | Z243111 |
| R119 .... .... | 130 | 10 | 5 | Z243111 |
| R120 .... .... | 22 K | 1 | 10 | Z212259 |
| R121* .... .... | 240K | ¾ | 2 | Z216539 |
| R122 .... .... | 47 K | 6 | 5 | Z244150 |
| R123* .... .... | 33 | ½ | 5 | Z215062 |
| R124 .... .... | 330 | ½ | 10 | Z221173 |
| R125* .... .... | 1 M | ¾ | 5 | Z216757 |
| R126* .... .... | 1 M | ¾ | 2 | Z216659 |
| R127 .... .... | 330 | ½ | 10 | Z221173 |
| R128, 129, 130 | *not fitted* | | | |
| R131* .... .... | 150 K | ¾ | 5 | Z216715 |
| R132* .... .... | 150 | ½ | 5 | Z215142 |
| R133 .... .... | 100 K | ¾ | 10 | Z223039 |
| R134* .... .... | 330 K | ½ | 2 | Z216562 |
| R135* .... .... | 150 | ½ | 5 | Z215142 |
| R136 .... .... | 330 | ½ | 10 | Z221173 |
| R137* .... .... | 82 K | ½ | 5 | Z216112 |
| R138* .... .... | 36 K | ½ | 5 | Z216067 |
| R139, 140 .... | *not fitted* | — | — | — |

*High stability.*

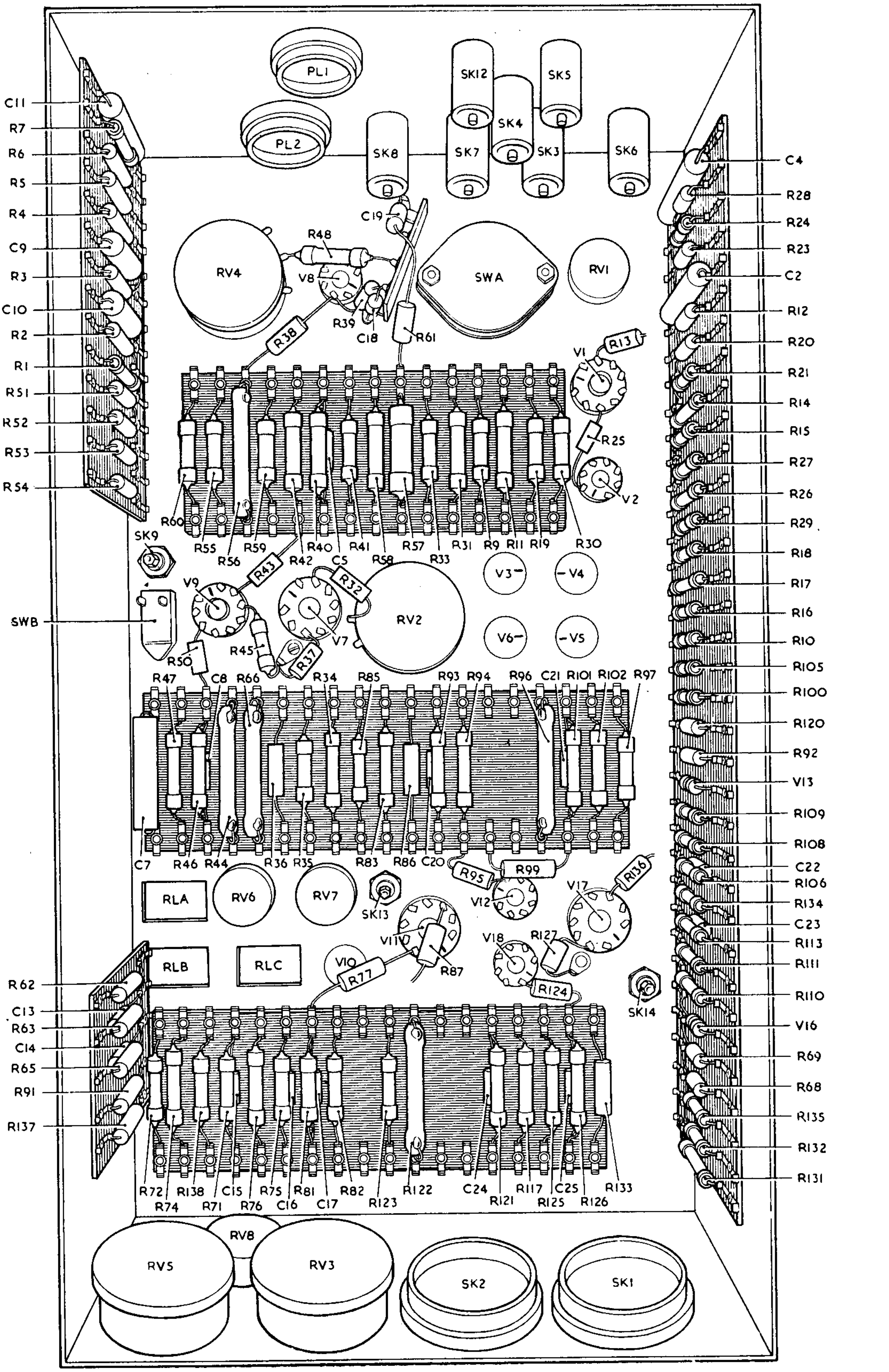


**Fig. 13. Under-chassis layout of Y amplifier (Type 314)**

**The drawing if of a prototype unit. Minor layout changes may appear on production models. In layout, X amplifier is mirror image of Y.**

# Appendix 1

# DEFLECTION AMPLIFIERS

(Amplifying unit (deflection) R.H. Type 12476 and amplifying unit (deflection) L.H. Type 12477)

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## LIST OF TABLES



## LIST OF ILLUSTRATIONS

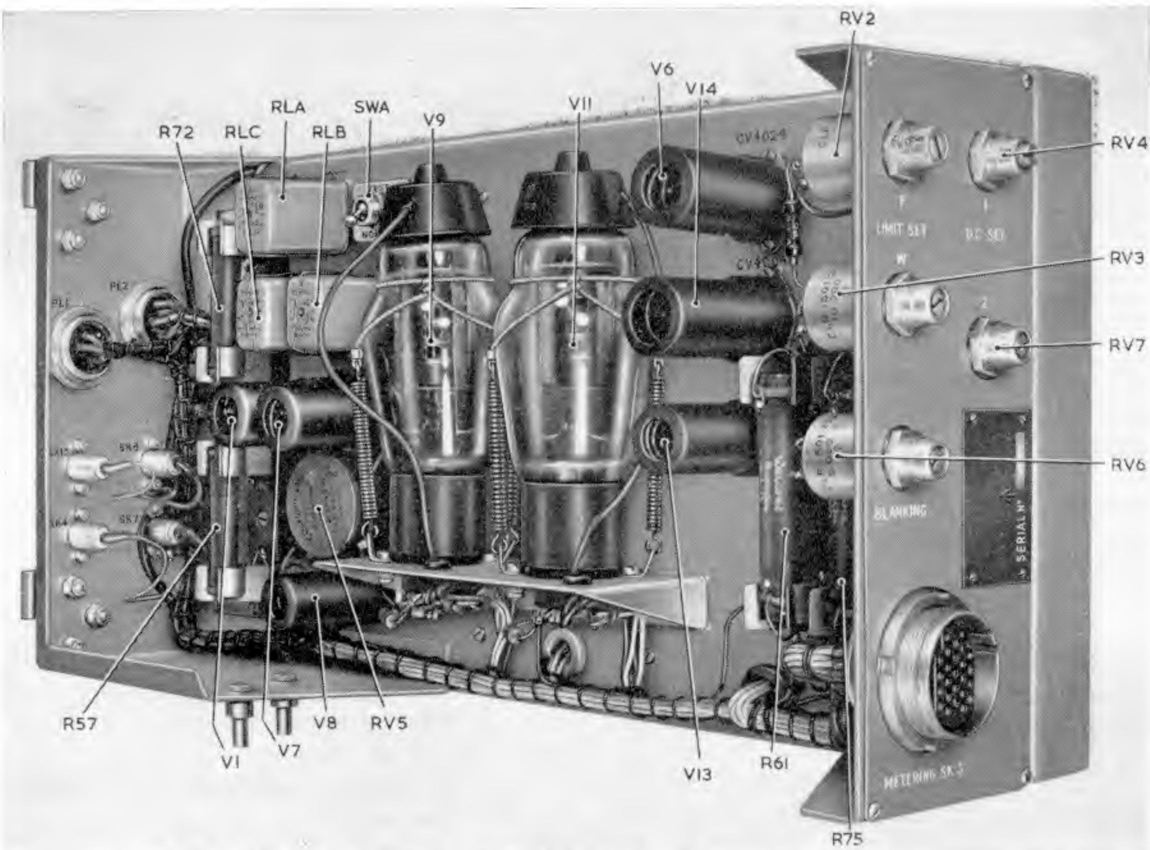



**Fig. 1. Deflection amplifier (RH) Type 12476: overchassis view**

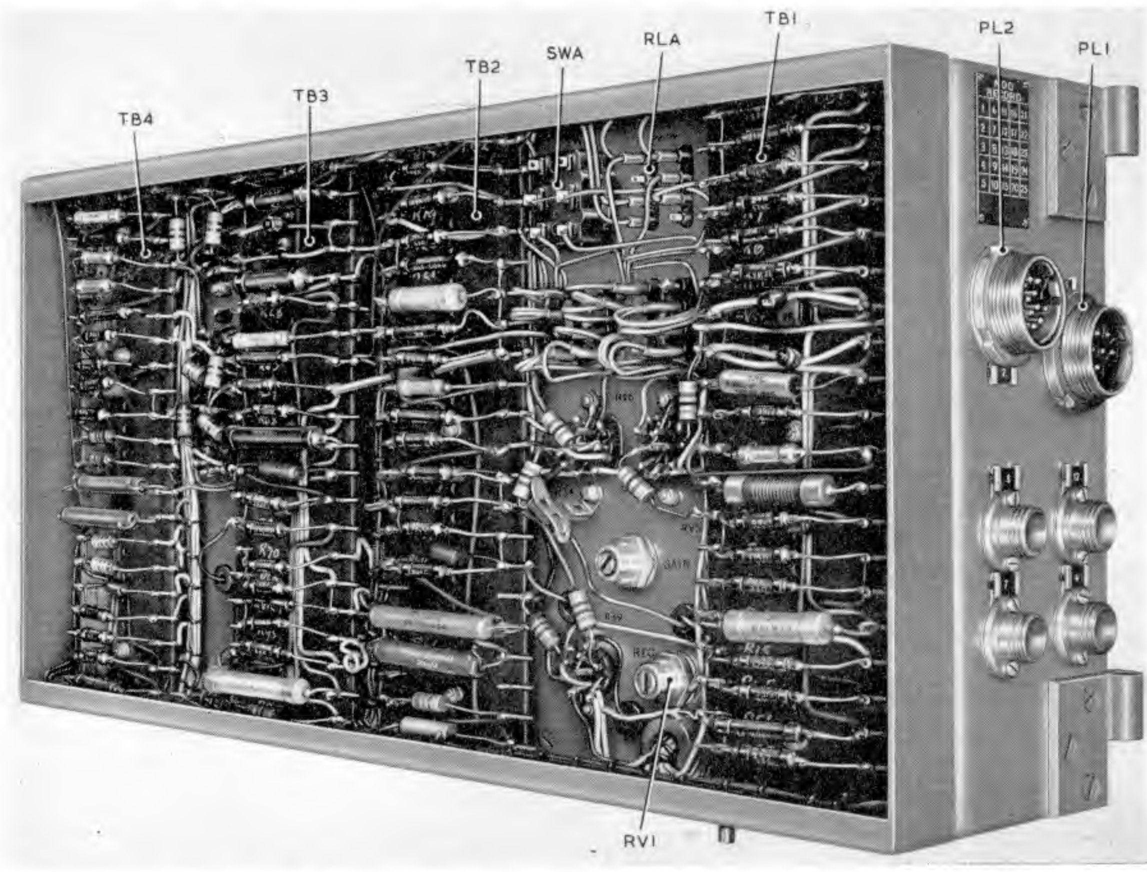



**Fig. 2. Deflection amplifier (RH) Type 12476: underchassis view**

## INTRODUCTION

**1.** The amplifying units, Type 12476 and 12477 (Stores Ref. 10U/17408 and 10U/17409 respectively) take the place of amplifying units Type 313 and 314 in a console Type 64 when the console is used in a full intertrace system. The units are mounted in the lower half of the console as shown in fig. 1, Chap. 6, but with the under-chassis (component boards, etc.) facing outward.

**2.** Since, in the intertrace systems, the mixing of the radar trace with the various intertrace marker signals is carried out in the amplifying unit (mixer) Type 4428 the input to the Types 12476 and 12477 is composite. Amplifying of the off-centring voltage also takes place in Type 4428.

**3.** Figs. 1 and 2 give a general view of the X amplifier (Type 12476). The layout of the Y amplifier is a mirror image of the X amplifier.

### Circuit description

**4.** A full circuit diagram of Type 12476 (R.H.) is shown in fig. 8. The circuit of Type 12477 is exactly the same except for the annotation of some components. The circuit of Type 12476 is basically the same as the trace expansion amplifier section of Type 313 which is amply described in Chap. 6, so this appendix will be concerned only with the improvements which have been incorporated.

*Differentiating amplifier*

**5.** V1 and its associated circuitry has been introduced to overcome lag in the beginning of the current sawtooth (and therefore possible discrepancies in range) due to the large inductance of the deflection coils. The operation of the amplifier (shown simply in fig. 3) is that of a normal feed-back amplifier which works to hold its input at zero signal potential, i.e. it produces a virtual earth at its input. It may be shown that the output is equal to a constant times the differential of the input. The output from V1 is varied by changing the value of the feedback resistance, selected from R5 to R8 by the operation of the trace expansion relays RLA, RLB, and RLC. When a sawtooth input, fig. 4 (1), is fed to V1, the output is the differentiated waveform (3). At the initial transition from d.c. level to a sawtooth scan, a sharp pulse is produced which is limited in amplitude by diodes V2 and V3. When waveforms (1) and (3) are applied simultaneously to V7 the output waveform to the deflection coils (4) is representated by the addition of waveforms (2) and (3). The commencement of rise of current in the deflection coils shown in waveform (4) is therefore registered to the commencement of the sawtooth waveform (1). This is assisted by the sharp pulse at the leading edge of waveform (3). Fine adjustment is effected by the setting of SET REGIST. potentiometer RV1.

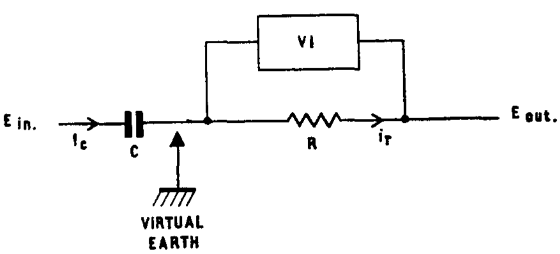



**Fig. 3. Differentiating amplifier: simplified diagram**

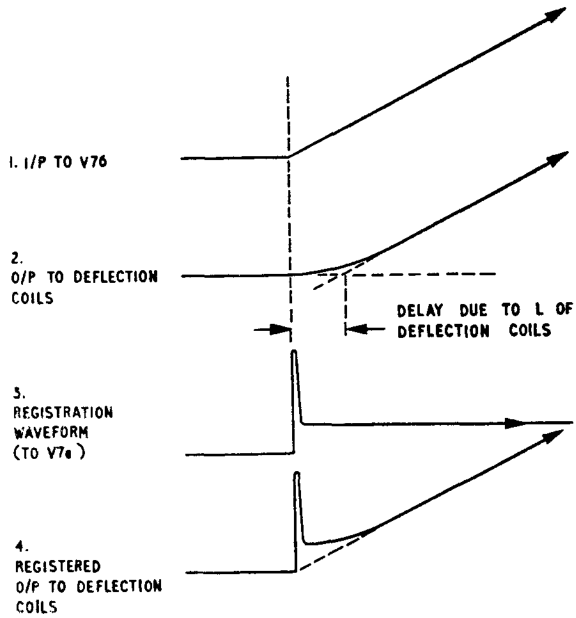



**Fig. 4. Action of registration waveform**

*Double triode* V7

**6.** The current to the deflection coils is limited to an amplitude necessary just to scan the tube-face by the action of diodes V4 and V5 limiting the excursion of V7 grid. The output impedance of the cathode followers V6a and V6b is very low and effectively clamps the junction of R20, R21 to the potential set by the SET LIMIT potentiometers RV2 and RV3 when V4 or V5 conducts.

*Pentodes*

**7.** V8 and V13 operate as in Type 313, but have the additional circuitry C8, R37 and C9, R83 to stabilize the amplifier and to prevent spurious oscillation occurring.

*Output stages and feedback (fig. 6 and 7)*

**8.** Beam tetrodes V9, V11 operate in the same way as their counterparts in Type 313 with the following differences:—

(1) Damping of the deflector coils to avoid ringing is effected by a 9·1 k-ohm resistor across each of the coils in the indicator unit.

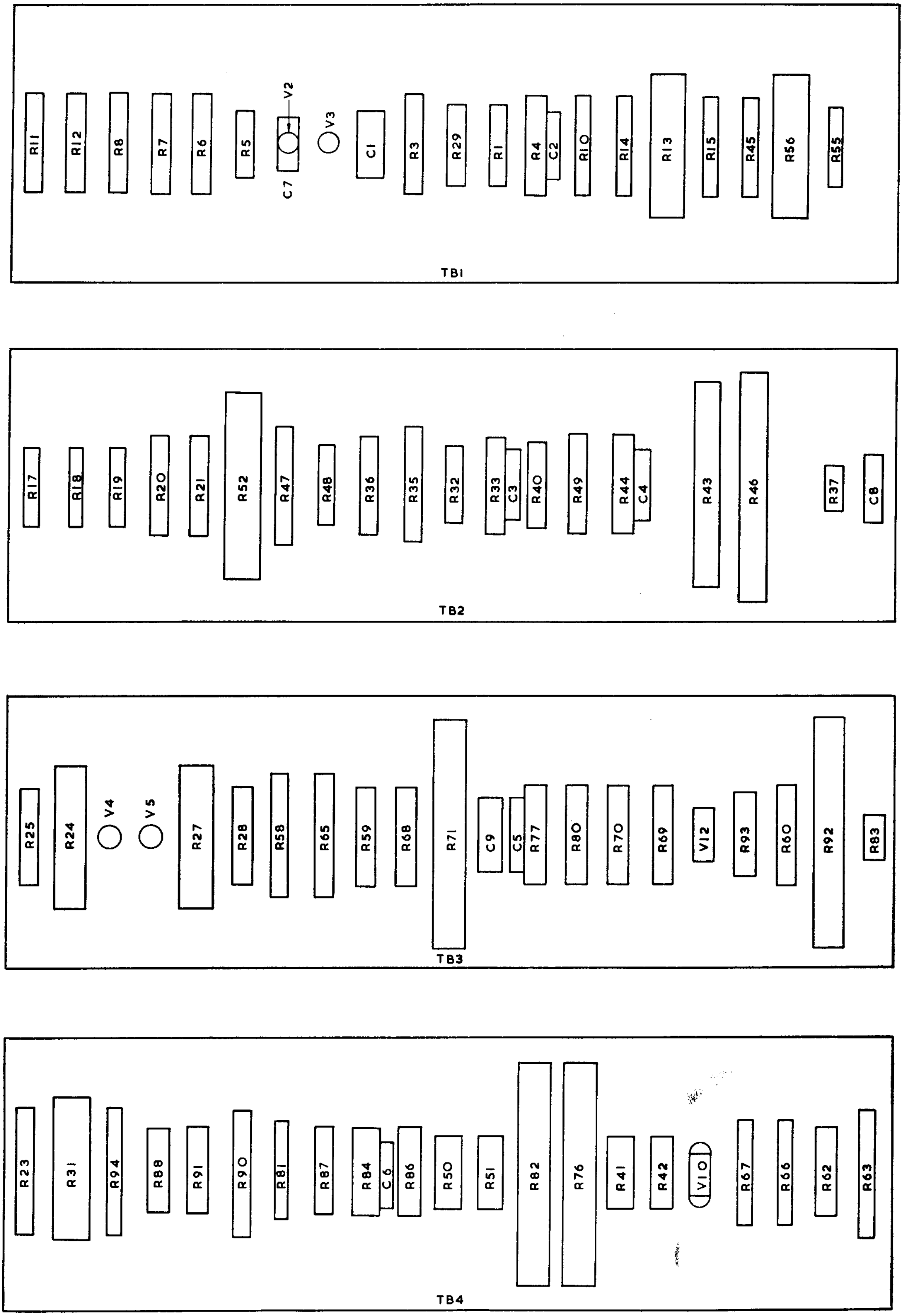



**Fig. 5. Component boards: layout**

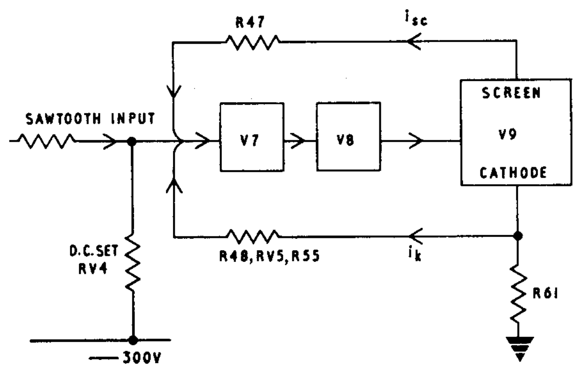



**Fig. 6. Feedback: simplified circuit**

(2) In order to improve the accuracy of the output waveform, which is a function of anode current, the feedback voltage is composed of the cathode and screen signals of the output valve V9, since $i_a = i_k - i_{sc}$. Similarly the input signal and the feedback to the paraphase amplifier are taken from the cathode and screen of V9 and V11 respectively.

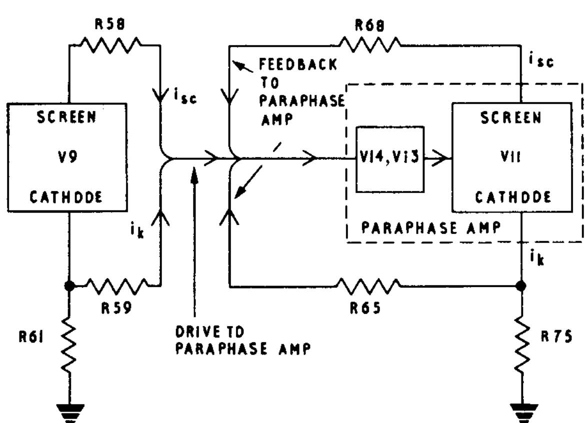



**Fig. 7. Paraphase drive and feedback : simplified circuit**

*Paraphase amplifier*

**9.** The d.c. operating conditions of V11 are accurately set by RV7 in the grid circuit of V14b.

*Heater supplies*

**10.** There are two separate 6·3V, 50 c/s supplies to each deflection amplifier:—

(1) a—a centred to earth by R41, R42; this supply is used for the final amplifier tetrodes and their drive pentodes.

(2) b—b centred to a level of about −20V by R50 and R51 which are returned to the junction of R62 and R63. This negative potential prevents the heater of the triodes from ever going positive to earth and introducing hum into the circuits by heater-to-cathode conduction.

**Setting up**

**11.** The normal cathode current of each tetrode for centred spot is 130mA, comprising about 10mA to the screen and the remainder through the anode and deflector coil. The corresponding cathode potential is +28·6V. The full setting up procedure appears in Part 2 of this Volume, but is briefly as follows:—

(1) SWA is set to TEST to remove all deflectional input.

(2) DC SET (1) (RV4) is adjusted until V9 is passing 130 mA (observed by metering the potential at cathode SK3/G).

(3) DC SET (2) (RV7) is adjusted until V11 is also passing 130 mA (meter at SK3/L).

(4) A spot is obtained on the c.r.t. and its position is checked in relation to the geometrical centre; DC SET (1) is re-adjusted to centre the spot to correct for tolerances in the c.r.t. electrodes, as for Type 313.

*The setting of registration*

**12.** A 220 miles range marker is obtained on the eastern half of the c.r.t. face by the operation of the switch unit (test registration) Type 16292 or switches in the panel patching (I.C.M.) Type 12953. (When setting the registration in amplifier Type 12477, the range marker appears on the northern half of the c.r.t. face). The ten mile range rings are then injected; the 220 miles range marker should appear near the 220 miles range ring. The marker is then set near to the centre of the c.r.t. face by adjustment of the off-centring controls. SET REGIST. (RV1) is adjusted until, with the range expanded to 80 miles, the strobe marker lies exactly on the 220 miles range ring.

*Gain setting*

**13.** Trace expansion is set to minimum (320 miles) and the gain control (RV5) is adjusted to make the radius of the 160 miles range ring coincide with that of the c.r.t.

**TABLE 1**

**Component details: resistors (fixed)**

| Circuit ref. | Value (ohms) | Rating (watts) | Tol. (%) | J.S. ref. |
|---|---|---|---|---|
| R1 | 47K | 1½ | 5 | 5905-99-021-6085 |
| R2 | 470 | ¼ | 10 | 5905-99-022-1194 |
| R3 | 33 | ½ | 5 | 5905-99-021-5062 |
| R4 | 680K | ½ | 2 | 5905-99-021-6626 |
| R5 | 47K | ½ | 1 | 5905-99-021-5366 |
| R6 | 56K | ½ | 1 | 5905-99-021-6386 |
| R7 | 24K | ½ | 1 | 5905-99-021-6297 |
| R8 | 10K | ½ | 1 | 5905-99-021-6207 |
| R9 | 470 | ¼ | 10 | 5905-99-022-1194 |
| R10 | 1M | ½ | 2 | 5905-99-021-6658 |
| R11 | 1K | ½ | 5 | 5905-99-021-5242 |
| R12 | 1K | ½ | 5 | 5905-99-021-5242 |
| R13 | 120K | 1 | 5 | 5905-99-021-6130 |
| R14 | 33 | ½ | 5 | 5905-99-021-5062 |
| R15 | 5·6K | ½ | 5 | 5905-99-021-5332 |
| R16 | not fitted | | | |
| R17 | 47K | ½ | 1 | 5905-99-021-6366 |
| R18 | 47K | ½ | 1 | 5905-99-021-6366 |
| R19 | 47K | ½ | 1 | 5905-99-021-6366 |
| R20 | 24K | ½ | 1 | 5905-99-021-6297 |
| R21 | 24K | ½ | 1 | 5905-99-021-6297 |
| R22 | 470 | ¼ | 10 | 5905-99-022-1194 |
| R23 | 120K | ¾ | 5 | 5905-99-021-6711 |
| R24 | 100K | 1½ | 5 | 5905-99-021-6125 |
| R25 | 33 | ½ | 5 | 5905-99-021-5062 |
| R26 | 470 | ¼ | 10 | 5905-99-022-1194 |
| R27 | 100K | 1½ | 5 | 5905-99-021-6125 |
| R28 | 33 | ½ | 5 | 5905-99-021-5062 |
| R29 | 150 | ½ | 5 | 5905-99-021-5142 |
| R30 | 470 | ¼ | 10 | 5905-99-022-1194 |
| R31 | 68K | 1½ | 5 | 5905-99-021-6105 |
| R32 | 220K | ½ | 1 | 5905-99-021-6525 |
| R33 | 680K | ½ | 1 | 5905-99-021-6622 |
| R34 | 470 | ¼ | 10 | 5905-99-022-1194 |
| R35 | 180K | ¾ | 1 | 5905-99-021-6506 |
| R36 | 150 | ½ | 5 | 5905-99-021-5142 |
| R37 | 330 | ¼ | 10 | 5905-99-022-1173 |
| R38 | 100 | ¼ | 10 | 5905-99-022-1110 |
| R39 | 470 | ¼ | 10 | 5905-99-022-1194 |
| R40 | 1M | ½ | 1 | 5905-99-021-6654 |
| R41 | 100 | ¼ | 10 | 5905-99-022-1110 |
| R42 | 100 | ¼ | 10 | 5905-99-022-1110 |
| R43 | 47K | 6 | 5 | 5905-99-011-3437 |
| R44 | 240K | ½ | 2 | 5905-99-021-6538 |
| R45 | 33 | ½ | 5 | 5905-99-021-5062 |
| R46 | 220 | 6 | 5 | 5905-99-011-3381 |
| R47 | 100K | ¾ | 2 | 5905-99-021-6452 |
| R48 | 39K | ½ | 2 | 5905-99-021-6351 |
| R49 | 330K | ½ | 2 | 5905-99-021-6562 |
| R50 | 100 | ¼ | 10 | 5905-99-022-1110 |
| R51 | 100 | ¼ | 10 | 5905-99-022-1110 |
| R52 | 110K | 1 | 2 | 5905-99-021-6463 |
| R53 | 100 | ¼ | 10 | 5905-99-022-1110 |
| R54 | 330 | ¼ | 10 | 5905-99-022-1173 |
| R55 | 15K | ½ | 2 | 5905-99-021-6252 |
| R56 | 150K | ¾ | 2 | 5905-99-021-8753 |
| R57 | 130 | 10 | 5 | 5905-99-024-1163 |
| R58 | 100K | ¾ | 2 | 5905-99-021-6452 |
| R59 | 100K | ½ | 1 | 5905-99-021-6446 |
| R60 | 33K | ½ | 5 | 5905-99-021-6062 |
| R61 | 220 | 15 | 1 | 5905-99-911-4545 |
| R62 | 22K | ½ | 5 | 5905-99-021-6042 |
| R63 | 270K | ¾ | 5 | 5905-99-021-6727 |

## TABLE 1

**Component details: resistors (fixed)—(*contd.*)**

| Circuit ref. | Value (ohms) | Rating (watts) | Tol. (%) | J.S. ref. |
|---|---|---|---|---|
| R64 | not used | | | |
| R65 | 100K | ¾ | 2 | 5905-99-021-6452 |
| R66 | 33K | ½ | 5 | 5905-99-021-6062 |
| R67 | 10K | ½ | 2 | 5905-99-021-6212 |
| R68 | 100K | ½ | 1 | 5905-99-021-6446 |
| R69 | 33K | ½ | 5 | 5905-99-021-6062 |
| R70 | 33K | ½ | 5 | 5905-99-021-6062 |
| R71 | 33K | 1½ | 1 | 5905-99-021-6330 |
| R72 | 130 | 10 | 5 | 5905-99-024-1163 |
| R73 | 100 | ¼ | 10 | 5905-99-022-1110 |
| R74 | 330 | ¼ | 10 | 5905-99-022-1173 |
| R75 | 220 | 15 | 1 | 5905-99-911-4545 |
| R76 | 220 | 6 | 5 | 5905-99-011-3381 |
| R77 | 240K | ½ | 2 | 5905-99-021-6538 |
| R78 | 100 | ¼ | 10 | 5905-99-022-1110 |
| R79 | 470 | ¼ | 10 | 5905-99-022-1194 |
| R80 | 330K | ½ | 2 | 5905-99-021-6562 |
| R81 | 33 | ½ | 5 | 5905-99-021-5062 |
| R82 | 47K | 6 | 5 | 5905-99-011-3437 |
| R83 | 330 | ¼ | 10 | 5905-99-022-1173 |
| R84 | 680K | ½ | 1 | 5905-99-021-6622 |
| R85 | 470 | ¼ | 10 | 5905-99-022-1194 |
| R86 | 1M | ½ | 1 | 5905-99-021-6854 |
| R87 | 220K | ½ | 1 | 5905-99-021-6525 |
| R88 | 150 | 1½ | 5 | 5905-99-021-5142 |
| R89 | 470 | ¼ | 10 | 5905-99-022-1194 |
| R90 | 180K | ¾ | 1 | 5905-99-021-6506 |
| R91 | 150 | ½ | 5 | 5905-99-021-5142 |
| R92 | 27K | 1½ | 1 | 5905-99-022-6310 |
| R93 | 10K | ½ | 2 | 5905-99-021-6212 |
| R94 | 270K | ¾ | 5 | 5905-99-021-6727 |
| R95 | 5·6K | ½ | 5 | 5905-99-021-5332 |

## TABLE 2

**Component details: resistors (variable)**

| Circuit | Value (ohms) | Rating (watts) | Tol. (%) | J.S. ref. | Function |
|---|---|---|---|---|---|
| RV1 | 10K | ½ | 10 | 5905-99-011-9851 | Amplitude registration waveform to V7a grid |
| RV2 | 10K | ½ | 10 | 5905-99-011-9851 | Deflection limit positive |
| RV3 | 10K | ½ | 10 | 5905-99-011-9851 | Deflection limit negative |
| RV4 | 25K | 1 | 10 | 5905-99-027-2301 | D.C. set V7b |
| RV5 | 50K | 1 | 10 | 5905-99-027-2410 | Amplifier gain (see-saw control) |
| RV6 | 5K | ½ | 10 | 5905-99-011-9850 | Octagonal blanking centring |
| RV7 | 25K | 1 | 10 | 5905-99-027-2301 | D.C. set V14B |

## TABLE 3

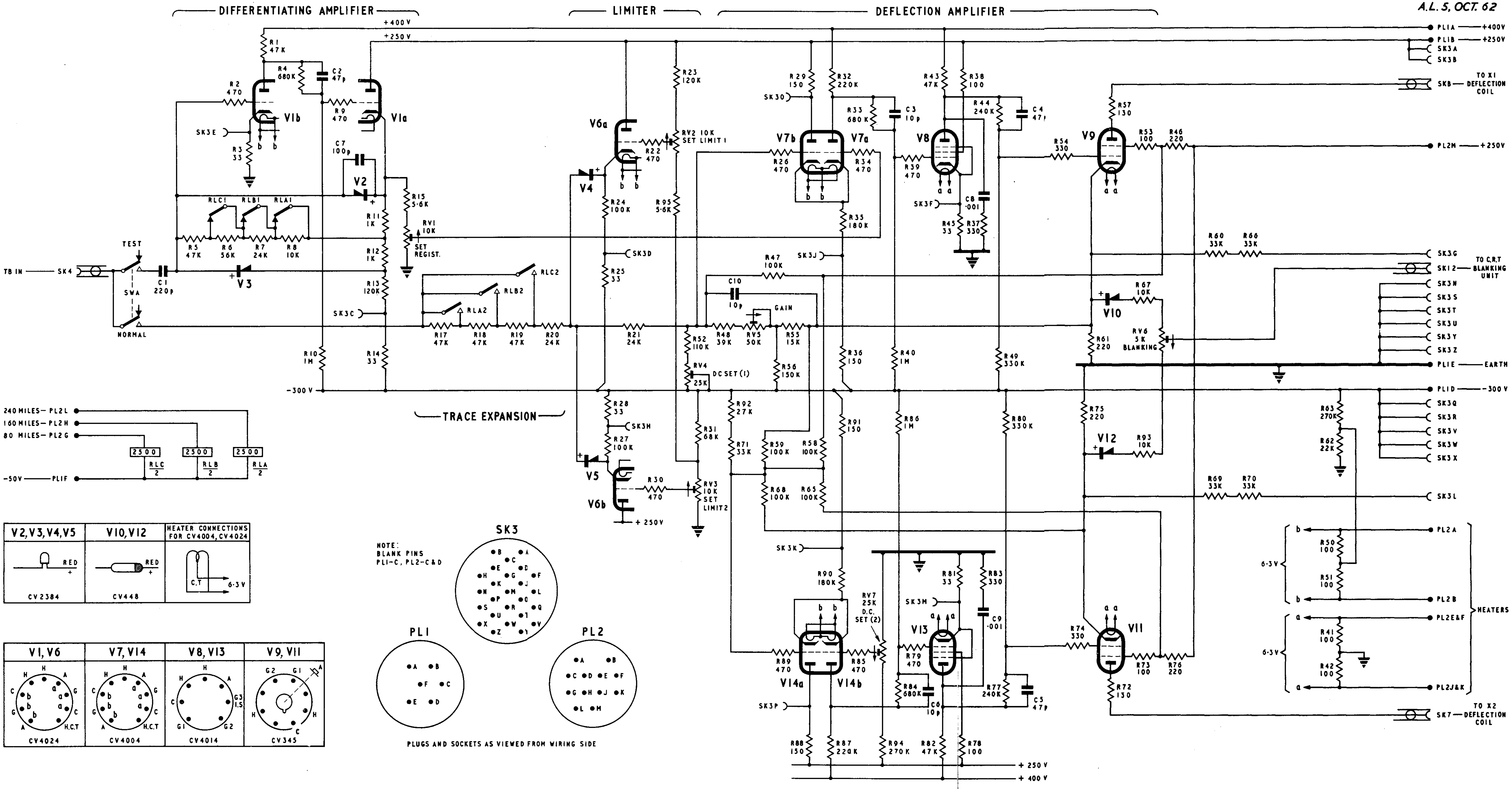
**Component details: capacitors**

| Circuit ref. | Value (μF except where stated) | Rating (V.D.C.) | Tol. (%) | J.S. ref. |
|---|---|---|---|---|
| C1 | 220p | 500 | 10 | 5910–99–011–9208 |
| C2 | 47p | 500 | 10 | 5910–99–011–9204 |
| C3 | 10p | 500 | 10 | 5910–99–011–9200 |
| C4 | 47p | 500 | 10 | 5910–99–011–9204 |
| C5 | 47p | 500 | 10 | 5910–99–011–9204 |
| C6 | 10p | 500 | 10 | 5910–99–011–9200 |
| C7 | 100p | 500 | 10 | 5910–99–011–9206 |
| C8 | ·001 | 350 | 20 | 5910–99–011–5623 |
| C9 | ·001 | 350 | 20 | 5910–99–011–5623 |
| C10 | 10p | 500 | 10 | 5910–99–011–9200 |

## TABLE 4

**Component details: miscellaneous items**

| Circuit ref. | Description | Type | J. S. reference |
|---|---|---|---|
| RLA, RLB, RLC | Relay (50V) | — | 5945–99–011–9882 |
| SWA | Lever-operated switch D.P.C.O. | | 5930–99–051–0554 |
| PL1 | 6-way plug | 1500V 2·5A | 5935–99–056–0541 |
| PL2 | 12-way plug | 350V 2·5A | 5935–99–056–0151 |
| SK3 | 25-way socket | 350V 2·5A | 5935–99–056–0380 |




Amplifying units (deflection) R.H. (Type 12476) and L.H. (Type 12477): circuit

Fig.8

for H.M. Stationery Office by James Townsend and Sons Ltd., Exeter
236/33739/280195/881/1/63

RESTRICTED

# Chapter 7

## VOLTAGE STABILIZER TYPE 51

ERRATUM

The following should appear after the list of illustrations

### LIST OF APPENDICES

# Chapter 7

# VOLTAGE STABILIZER TYPE 51

## LIST OF CONTENTS



## TABLE



## LIST OF ILLUSTRATIONS



## INTRODUCTION

### Location

**1.** The unit described in this chapter is the *stabilizer, voltage, Type 51* (Stores Ref. 10D/18642, which forms part of the fixed-coil PPI display console (console Type 64). Fig. 1 is a front view of the lower part of the console with the panel removed, showing the voltage stabilizer in position between the two deflection amplifiers.

### Purpose

**2.** The purpose of the voltage stabilizer is to accept unregulated positive and negative HT supplies from an external source (in present installations the source is a bulk power supply rack assembly Type 305 in the radar office), and to produce from them stabilized HT at +400V, +250V and −300V. These supplies are used in the deflection amplifiers, where good long-term and short-term stability of HT, and absence of ripple, are essential if the accuracy of the display is to be maintained. The incoming lines to the voltage stabilizer are nominally at +570V, +420V and −300V respectively, but are in practice subject to considerable fluctuations due to load and mains voltage variations.

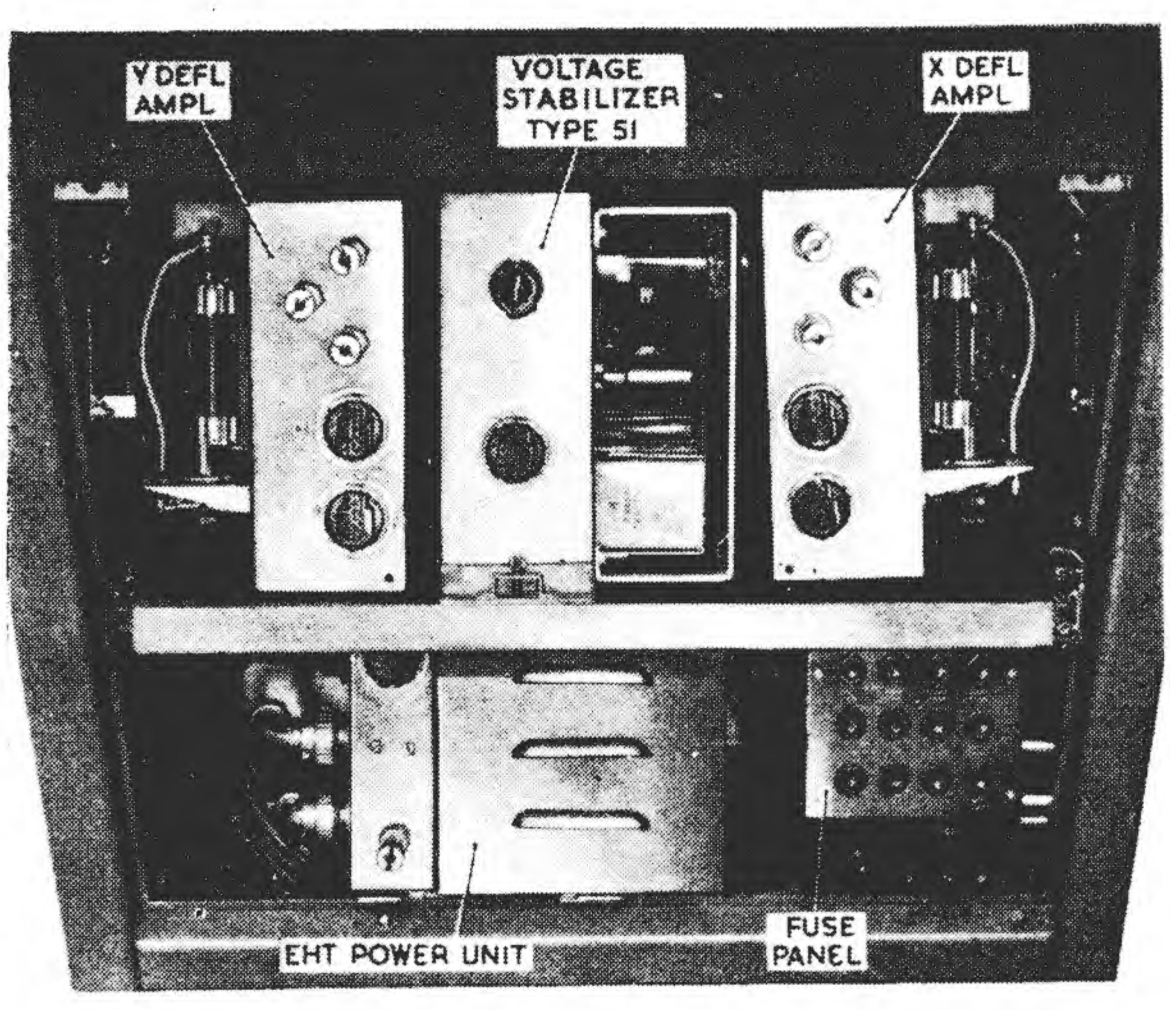



**Fig. 1. Location of voltage stabilizer Type 51 at front of console**

### Heater supplies

**3.** Because of the different cathode levels of some of the valves in the unit, four separate 50 c/s heater supplies are necessary ; they originate from the heater transformers in the distribution panel Type 861, and are as follows :—

(1) **a-a** 6·3V 1·5A from T1 ; one side held at −300V and used for those valves with cathodes negative to earth (V1 and V4).

(2) **b-b** 6·3V 3·0A (used also in the waveform gen. T80, deflection amplifiers and panel 861) from T1 ; earthed in the amplifier Type 313. Used for V3 and V6.

(3) **c-c** 6·3V 1·0A from T3 ; held by a 100 KΩ resistor R12 to +400V, and used for V2 only.

(4) **d-d** 6·3V 1·0A from T2 ; held by a 100 KΩ resistor R52 to +250V, and used for V7 only.

### Construction

**4.** The unit is built on a 13½ in. × 8¼ in. × 3¼ in. chassis, and, as fig 1 shows, it is mounted on its side between the deflection amplifiers, on the deflection amplifier mounting tray. It is possible to obtain access to all parts of the unit without switching off by removing the lower front panel of

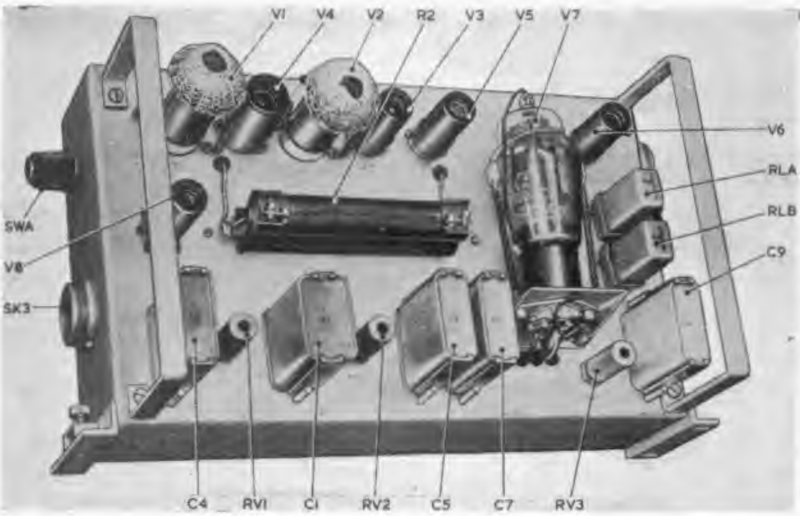



**Fig. 2. Voltage stabilizer—general view**

amplifier current ; such a supply is not available. A similar circuit is used in the waveform generator Type 80 (*Chap. 3* of this Section).

**8.** The circuit is arranged so that when any variation of the −300V output tends to occur, whether due to load fluctuation or to changes in the bulk −470V input, the current drawn by the regulator tetrode V1 is automatically varied so as to alter the potential drop across the 1·5 KΩ resistor R2 and restore the output voltage very closely to its original value.

**9.** V4 is a double triode (CV455) used to provide two stages of DC amplification of line variations, and so control V1. An accurately stabilized reference potential slightly more negative than −300V is applied to V4B grid from the slider of the 100 KΩ potentiometer RV1. This is the setting-up potentiometer for the regulator, and forms part of the resistance chain R27 (470 KΩ), RV1, R29 (300 KΩ) which extends from earth down to the −500V negative reference line. V4B cathode is connected to the −300V output, fluctuations there being cathode-injected into V4B to operate the regulator.

the console, pulling the deflection amplifier mounting tray right forward on its runners, and hinging the two deflection amplifiers outwards. If the unit is to be removed entirely, however, it is necessary to switch off the console and remove all connectors attached to the stabilizer ; the single captive screw visible at the lower middle of the unit in fig. 1 may then be loosened and the whole unit removed upwards and outwards.

**5.** A closer view of the unit, showing the layout of the valves, is given in fig. 2, and fig. 3 is an under-chassis drawing for use as a guide to the layout of components, plugs and sockets.

## CIRCUIT DESCRIPTION

### General

**6.** A complete circuit diagram of the voltage stabilizer is given in fig. 4, which also gives details of valve base connections and interconnections to other units. It will be seen that the unit really comprises three separate regulators (whose circuit operation is described in succeeding paragraphs) together with two trip relays and switch. The −300V output is stabilized with reference to the −500V negative reference supply used all over the Station. In their turn the two positive outputs are stabilized with reference to the −300V line. The advantage of this arrangement is that if, in spite of the regulation, the −300V line should drift slightly, the positive lines will drift an equal amount (approximately) in the opposite direction, and so minimize any consequent drift in the deflection amplifiers.

### Negative regulator

**7.** The negative regulator, which provides a stabilized −300V supply from the −470V (nominal) bulk power input, includes the valves V1 and V4. The tetrode V1 (CV391) is connected in a shunt regulator circuit, and not in the more familiar series regulator arrangement. The reason is that a series regulating valve would have to be placed in the negative line, thus requiring the associated control amplifier to be operated from a stable supply even more negative than −300V and capable of supplying the full

**10.** If some fluctuations occurs and the −300V line moves to −298V (for example), then V4B cathode becomes more positive by 2V, and its anode current falls. The resulting amplified voltage rise at V4B anode is DC-coupled by the chain R19, R17, R18, R28 to the grid of V4A. Hence V4A anode current is increased, and the amplified potential drop at its anode is DC-coupled by R10, R6, R7 to the regulator tetrode V1. The anode current of V1 is then reduced by about 1·4mA, so that the potential drop across R2 becomes 2V less and the output is restored to the correct value of −300V.

**11.** If the fluctuation is in the other direction, causing the output to move to −302V, for example, the converse action occurs and the current by V1 increases by 1·4mA so that the output is again restored to −300V.

**12.** As with all similar control systems having negative feedback, full 100 per cent compensation can never be quite achieved by the feedback system alone, because some change in the controlled output must exist before control can be effected at all. To obtain 100 per cent. compensation for fluctuations in the bulk—470V supply, therefore, a small fraction of such fluctuations is fed from the −470V line via R25 (1 MΩ) to the grid circuit of V4A, there to supplement the changes applied from V4B anode.

**13.** C10 and C6 are 10pF capacitors which are included to minimize the phase shifts in each stage at high frequencies, and so prevent HF oscillation of the whole loop. The 100Ω grid stoppers R54 to R56 help to prevent HF parasitic oscillations.

**14.** The regulator deals equally effectively with short-term as with long-term fluctuations. If, therefore, there is appreciable ripple present on the +470V line (it may amount to 10V peak-to-peak) as there is usually when the bulk supply is fully loaded, it will be almost entirely eliminated from the output by the regulator.

#### 400V positive regulator

**15.** The 400V positive regulator uses the +570V power supply coming (normally) from the radar office, and its output is used in the deflection amplifiers. The regulator includes the valves V2, V3 and V5. The tetrode V2 (CV391) is connected in a series regulator circuit, and when for any reason a fluctuation of the +400V line tends to occur, the circuit ensures that the current passed by V2 is automatically corrected by grid control so as to bring the output voltage back closely to its original value.

**16.** The valve amplifier controlling this action is the pentode V3 (CV138), whose grid is returned via the 470 KΩ resistor R20 to the slider of the setting-up potentiometer RV2 (50 KΩ). This potentiometer forms part of a resistance chain R22 to R26 extending from the +400V line down to the −300V stabilized line, which is used as the reference voltage. Any change occurring on the +400V line with reference to the −300V line thus produces a proportionate change at V3 grid.

**17.** Voltage changes at V3 grid are amplified and phase-inverted by the valve and applied to the control grid of V2 to restore the output voltage to +400V. The 4·7 KΩ resistor R5 is merely an anti-parasitic resistor.

**18.** The 0·1 μF capacitor C3 provides extra circuit gain for ripple and short surges ; the value of C3 compared with the resistor R20 is such that the AC circuit gain is $2\frac{1}{3}$ times greater than the DC gain.

**19.** If the top of the 220 KΩ anode load of V3 (R11) were returned direct to the +400V regulated output rail, V3 could only be passing about 0·05mA, to provide the normal V2 grid-cathode voltage of about 10V across R11. In that region of the CV138 characteristics the mutual conductance is so low that the gain, and thus the effective control obtained, would be very poor. To boost the HT supply to V3, therefore, the 70V neon V5 (CV284) has been included. This improves the gain and raises the control voltage across R11 to about 80V.

**20.** As in the case of the negative regulator, full 100 per cent. compensation is not possible with the circuit as it stands, as there must be some deviation from +400V always present to effect the control at all. To ensure 100 per cent. compensation for fluctuations in the input line (which are the more serious in this equipment), the resistor R3 (22 KΩ) is inserted to apply a small fraction of such fluctuations to V3 grid, by injecting them across the top 44Ω of the potentiometer chain via the neon V5. Since the AC circuit gain is already over twice the DC gain (*para. 16*), only about half as much compensation via R3 is required for AC fluctuations, and this is why C3 is taken to the junction of the two 22Ω resistors R22 and R23.

#### *Relay A and V8*

**21.** RLA is connected via the 5·1 K resistor R50 to the stabilized +400V line at one end, and at the other via SWA to the junction of R48 and the 150V neon V8. The other side of V8 is taken via SWA (when in its NORMAL position) to SK4/C, where there is a reliable external stabilized +250V. The relay thus compares the internal +400V with another +400V obtained by adding 150V to the external +250V, and if the internal deviates more than about 10V RLA closes and contact A1 open-circuits the trip line and switches off the console HT at the remote power supply. (For the overriding action of SWA, see *para. 26* below.)

#### 250V positive regulator

**22.** The 250V positive regulator works from the +420V (nominal) power supply coming from the radar office, its output being used in the early stages of the deflection amplifiers (whereas the final deflection amplifiers are supplied with +250V regulated HT direct from the remote power supply). The regulator includes the valves V6 and V7. The tetrode V7 (CV345) is connected in a series regulator circuit, and it is arranged that any variation on the +250V line causes the current passed by V7 to be corrected and the output thus brought back very closely to its original value.

**23.** The amplifier which controls the action is the pentode V6 (CV138). The grid of this amplifier is returned via the 470 KΩ resistor R43 to the slider of RV3, which is a 50 KΩ SET potentiometer for this regulator, and forms part of the divider chain R40, R41, R42, RV3, R45 extending from the +250V line down to the −300V stabilized line, which is used as the reference voltage. Any fluctuation of the +250V output with respect to the reference voltage therefore causes a proportionate change at V6 grid.

**24.** V6 amplifies and phase-inverts the changes appearing at its grid, and applies them to the control grid of V7 in order to control the current passed by that valve, and so to restore the output to +250V. The 0·1 μF capacitor C8 has been included to provide extra circuit gain for ripple and surges, and its value is such that the AC circuit gain obtained is nearly twice the DC. The 220 KΩ anode load of V6 (R31) is returned to the +400V stabilized supply from the other positive regulator, thus avoiding the necessity for any HT boosting device. The 4·7 KΩ resistor R34 is placed in series with V7 grid to prevent parasitic oscillations.

**25.** As with the other positive regulator, 100 per cent. compensation for power supply fluctuations

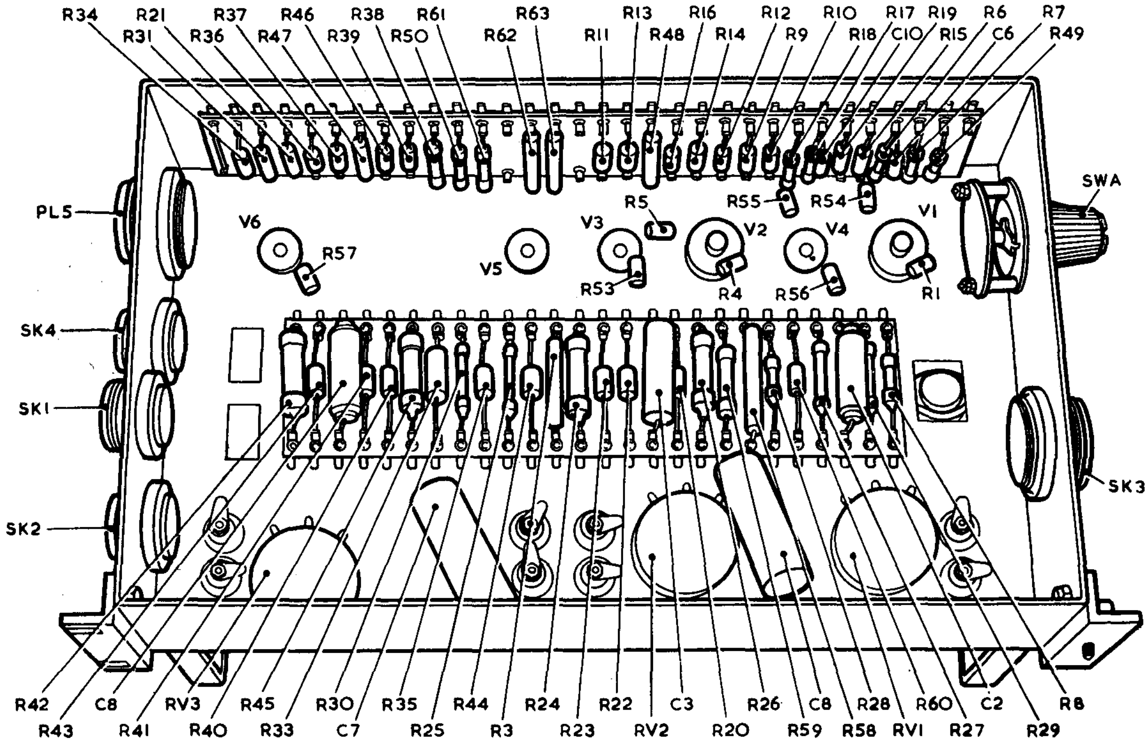



**Fig. 3. Voltage stabilizer Type 51—under-chassis component layout**

is obtained by injecting a small fraction of such fluctuations into the V6 grid circuit, across R40 and R41, so supplementing the ordinary changes at V6 grid. For AC only half as much of this extra compensation is needed because the AC circuit gain is already nearly twice as high as the DC, and therefore the capacitor C8 is taken from the junction of the two 150Ω resistors R40 and R41.

#### Relay B and switch A

**26.** One end of RLB is connected via the 1 KΩ resistor R61 to the +250V stabilized output, the other goes via SWA to SK4/C and thence to a +250V external power supply line. In the event of a serious difference developing between the two, RLB operates, and contact RLB1 open-circuits the trip line (PL5/N to SK4/D) and switches off the console HT. (Chap. 9 includes details of the HT trip circuit.) This applies with SWA in its NORMAL position, but if SWA is now turned to the TEST position, RLB, and RLA as well, are open-circuited and the trip line is closed again. This feature makes it possible to decide quickly whether a fault which has tripped the safety circuit lies in this unit or another.

### TABLE I

#### Component details

**Note . . .**

*This list of components is issued here for information only. When ordering spares for this unit refer to Volume 3 of this publication or to the appropriate section of A.P.1086.*

**Resistors (fixed)**

| Circuit ref. | Value (ohms) | Rating (watts) | Tol. (%) | Inter-serv. ref. |
|---|---|---|---|---|
| R1 .... .... | 100 | $\frac{1}{2}$ | 10 | Z221110 |
| R2* .... .... | 1·5 K | 30 | 1 | 10W/19104 |
| R3 .... .... | 22 K | 6 | 5 | Z244129 |
| R4 .... .... | 100 | $\frac{1}{2}$ | 10 | Z221110 |
| R5 .... .... | 4·7 K | $\frac{1}{2}$ | 10 | Z222089 |
| R6* .... .... | 1 M | $\frac{3}{4}$ | 2 | Z216659 |
| R7* .... .... | 680 K | $\frac{3}{4}$ | 2 | Z216627 |
| R8* .... .... | 10 | $\frac{1}{2}$ | 5 | Z215002 |
| R9* .... .... | 33 | $\frac{1}{2}$ | 5 | Z215062 |
| R10 .... .... | 47 K | $\frac{3}{4}$ | 10 | Z222216 |
| R11 .... .... | 220 K | $\frac{3}{4}$ | 10 | Z223081 |
| R12 .... .... | 100 K | $\frac{1}{2}$ | 10 | Z223038 |
| R13* .... .... | 33 | $\frac{1}{2}$ | 5 | Z215062 |
| R14 .... .... | 100 K | $\frac{3}{4}$ | 10 | Z223039 |
| R15* .... .... | 33 | $\frac{1}{2}$ | 5 | Z215062 |
| R16 .... .... | 47 K | $\frac{1}{2}$ | 10 | Z222215 |
| R17* .... .... | 820 K | $\frac{3}{4}$ | 2 | Z216643 |
| R18* .... .... | 820 K | $\frac{3}{4}$ | 2 | Z216643 |

**Resistors (fixed)**—*cont.*

| Circuit ref. | Value (ohms) | Rating (watts) | Tol. (%) | Inter-serv. ref. |
|---|---|---|---|---|
| R19 .... .... | 47 K | $\frac{3}{4}$ | 10 | Z222216 |
| R20 .... .... | 470 K | $\frac{1}{2}$ | 10 | Z223122 |
| R21* .... .... | 33 | $\frac{1}{2}$ | 5 | Z215062 |
| R22 .... .... | 22 | $\frac{1}{2}$ | 10 | Z221026 |
| R23 .... .... | 22 | $\frac{1}{2}$ | 10 | Z221026 |
| R24* .... .... | 330 K | 1 | 2 | Z216564 |
| R25* .... .... | 1 M | $\frac{3}{4}$ | 5 | Z216757 |
| R26* .... .... | 240 K | 1 | 2 | Z216540 |
| R27* .... .... | 470 K | $\frac{1}{2}$ | 2 | Z216594 |
| R28* .... .... | 36 K | $\frac{1}{2}$ | 5 | Z216067 |
| R29* .... .... | 300 K | $\frac{1}{2}$ | 2 | Z216554 |
| R30* .... .... | 300 K | $\frac{3}{4}$ | 1 | Z216551 |
| R31 .... .... | 220 K | $\frac{3}{4}$ | 10 | Z223081 |
| R32 .... .... | 100 | $\frac{1}{2}$ | 10 | Z221110 |
| R33 .... .... | 220 K | 1 | 10 | Z213331 |
| R34 .... .... | 4·7 K | $\frac{1}{2}$ | 10 | Z222089 |
| R35 .... .... | 100 K | $\frac{1}{2}$ | 10 | Z223038 |
| R36 .... .... | 47 K | $\frac{1}{2}$ | 10 | Z222215 |

## TABLE I—*continued*

### Component details—*continued*

**Resistors (fixed)**—*cont.*

| Circuit ref. | Value (ohms) | Rating (watts) | Tol. (%) | Inter-serv. ref. |
|---|---|---|---|---|
| R37 | 47 K | ½ | 10 | Z222215 |
| R38* | 1 M | ¾ | 1 | Z216655 |
| R39 | 470 K | ½ | 10 | Z223122 |
| R40 | 150 | ½ | 10 | Z221131 |
| R41 | 150 | ½ | 10 | Z221131 |
| R42* | 330 K | 1 | 2 | Z216564 |
| R43 | 470 K | ½ | 10 | Z223122 |
| R44 | 15 K | ½ | 10 | Z222152 |
| R45* | 390 K | 1 | 2 | Z216580 |
| R46 | 100 K | ½ | 10 | Z223038 |
| R47* | 300 K | ¾ | 1 | Z216551 |
| R48 | 22 K | 6 | 5 | Z244129 |
| R49 | 470 K | ½ | 10 | Z223122 |
| R50 | 5·1 K | ½ | 10 | Z215327 |
| R52 | 100 K | ½ | 10 | Z223038 |
| R53 | 100 | ½ | 10 | Z221110 |
| R54 | 100 | ½ | 10 | Z221110 |
| R55 | 100 | ½ | 10 | Z221110 |
| R56 | 100 | ½ | 10 | Z221110 |
| R57 | 100 | ½ | 10 | Z221110 |
| R58 | 100 K | ½ | 10 | Z223038 |
| R59* | 300 K | ¾ | 1 | Z216551 |
| R60* | 680 | ½ | 5 | Z215222 |
| R61 | 1 K | ½ | 10 | Z222005 |
| R62 | 1·8 K | 3 | 5 | Z244213 |
| R63 | 1·8 K | 3 | 5 | Z244213 |

**High stability.*

**Resistors (variable)**

| Circuit ref. | Value (ohms) | Rating (watts) | Tol. (%) | Inter-serv. ref. |
|---|---|---|---|---|
| RV1 (−300V SET) | 100 K | 1 | 10 | Z272549 |
| RV2 (+400V SET) | 50 K | 1 | 10 | Z272410 |
| RV3 (+250V SET) | 50 K | 1 | 10 | Z272410 |

**Capacitors**

| Circuit ref. | Value (μF except where stated) | Rating (V.DC) | Tol. (%) | Inter-serv. ref. |
|---|---|---|---|---|
| C1 | 0·1 | 1500 | 20 | Z111458 |
| C2 | 0·1 | 350 | 20 | Z115506 |
| C3 | 0·1 | 500 | 20 | Z115507 |
| C4 | 1 | 600 | 20 | Z112823 |
| C5 | 1 | 600 | 20 | Z112823 |
| C6 | 10 pF | 500 | 10 | Z132253 |
| C7 | 0·1 | 1500 | 20 | Z111458 |
| C8 | 0·1 | 350 | 20 | Z115506 |
| C9 | 1 | 600 | 20 | Z112823 |
| C10 | 10 pF | 500 | 10 | Z132253 |

**Relays, switch, plugs and sockets**

| Circuit ref. | Description | Inter-service Ref. No |
|---|---|---|
| RLA | 50V relay | Z530040 |
| RLB | 50V relay | Z530040 |
| SWA | Wafer switch, Type H2157 | 10F/17420 |
| SK1 | 6-way (medium) | Z560321 |
| SK2 | 6-way (medium) | Z560320 |
| SK3 | 25-way | Z560380 |
| SK4 | 6-way (medium) | Z560322 |
| PL5 | 18-way | Z560191 |

**Note . . .**
*Valve type numbers and base connections may be obtained from the circuit diagram (fig. 4) at the end of this chapter.*

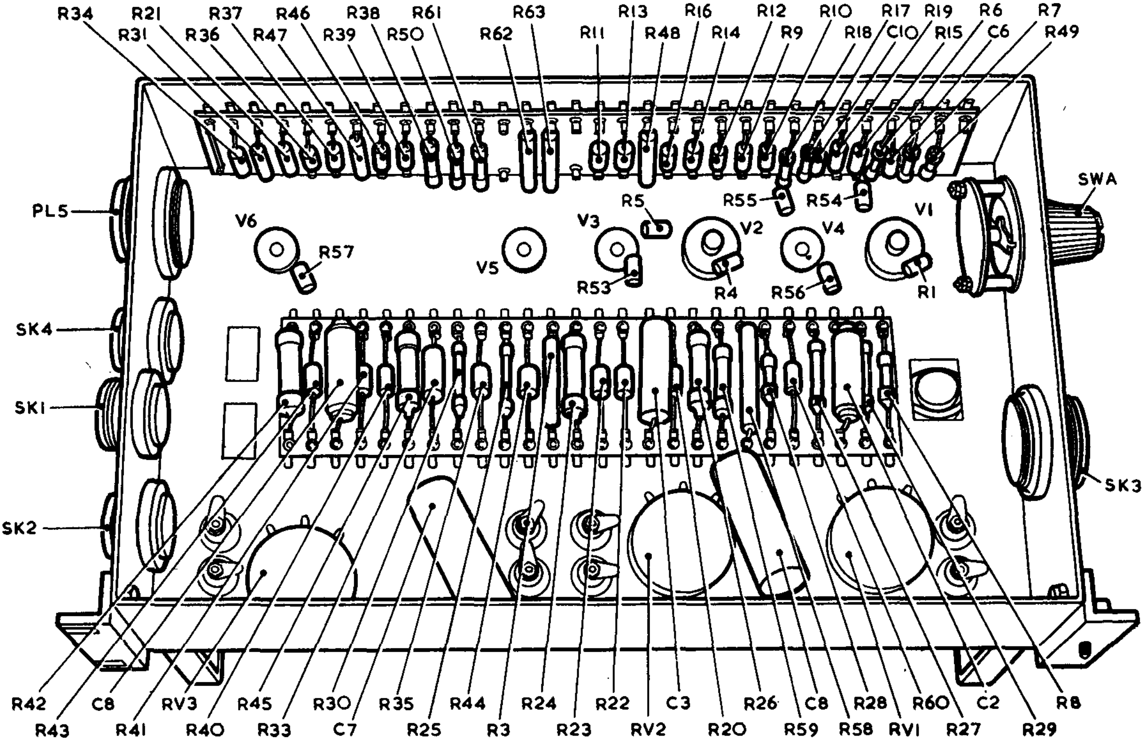



**Fig. 3. Voltage stabilizer Type 51—under-chassis component layout**

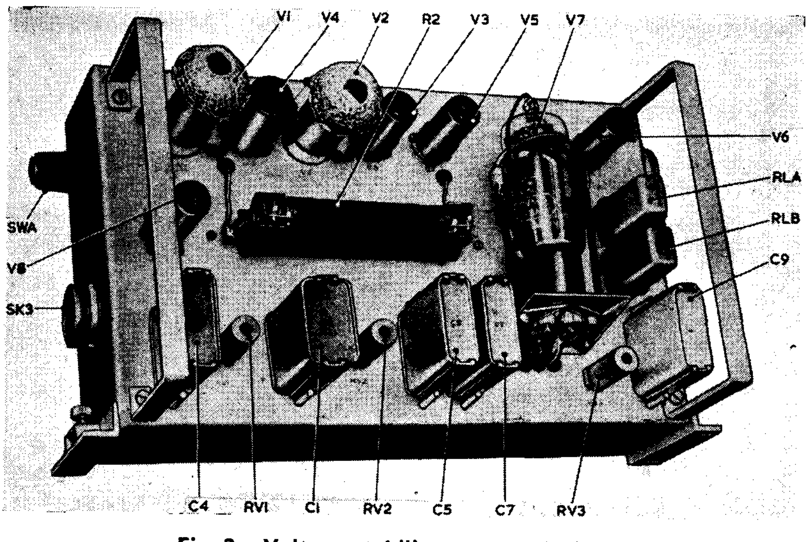



**Fig. 2. Voltage stabilizer—general view**

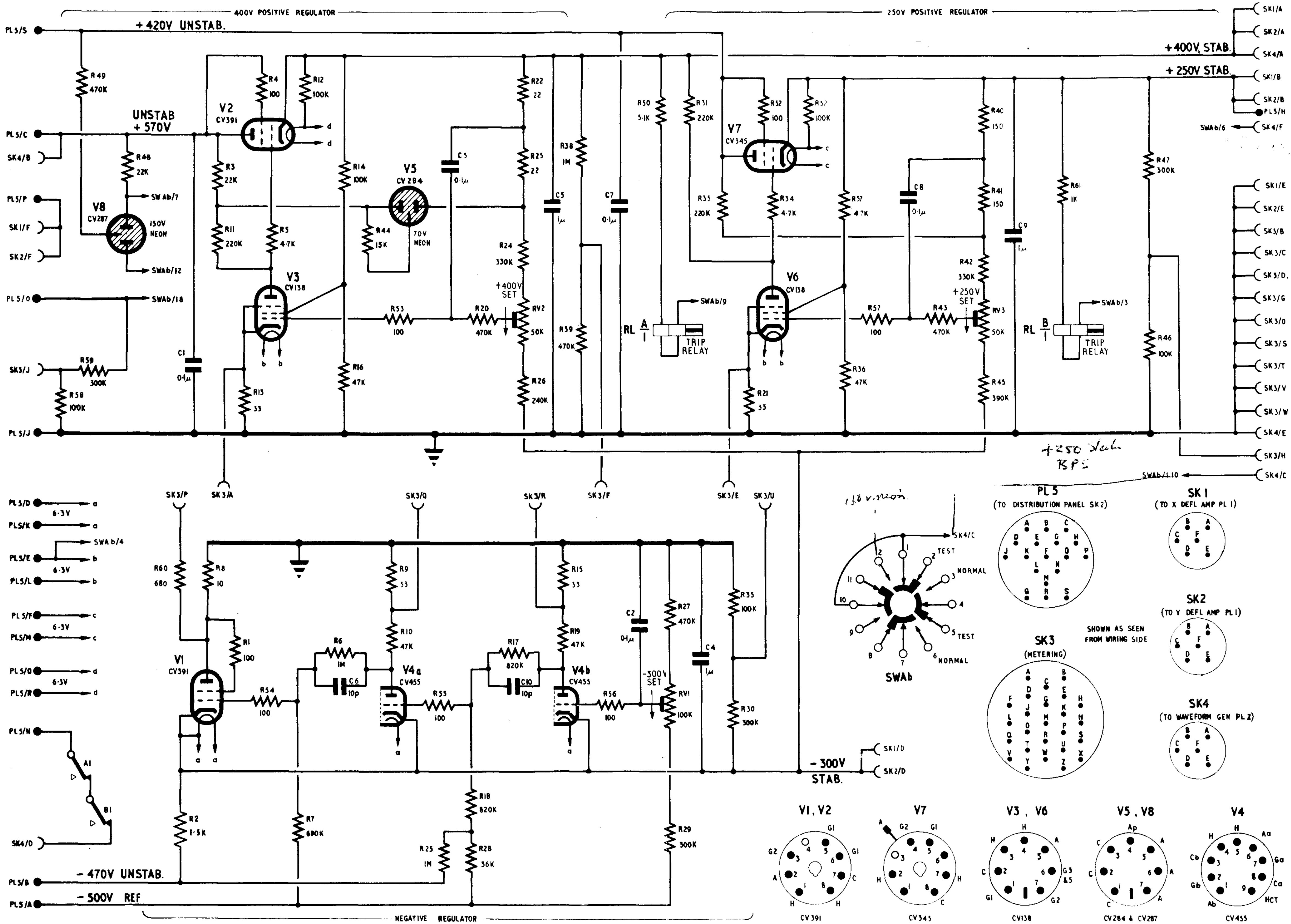



Fig. 1

Voltage stabilizer Type 51A - circuit

Fig. 1

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924/8/6693/26425/250848/881/9/62.

# Appendix 1

## VOLTAGE STABILIZER TYPE 51A

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### LIST OF ILLUSTRATIONS



**Purpose**

**1.** When the fixed coil display system is used with phase 1A equipment, the console Type 64, with its sub-units, is re-referenced to become a wired framework and a number of sub-units. Variations of basic sub-units are selected to suit various requirements.

**2.** The Type 51A was produced to allow for the re-routing of certain h.t. and heater lines in connection with the modification mentioned in Chap. 1, App. 1, para. 3.

**3.** The Type 51A (fig. 1) is similar to Type 51 except that the former has the following modifications:—

(*a*) One of the connections to SWAb/10 is from PL5/0 direct, instead of from SK1/C via R62.

(*b*) The connection to SWAb/10 from SK2/C via R63, is removed.

(*c*) The connection to SWAb/4 is from PL5/E instead of PL5/0.

# Chapter 8

# POWER UNIT (EHT) TYPE 898

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## LIST OF TABLES



## LIST OF ILLUSTRATIONS



## INTRODUCTION

**1.** The *power unit (EHT) Type* 898 (Stores Ref. 10K/16952) is part of the console Type 64 (fixed-coil PPI display console). It is a wholly enclosed and self-contained unit located at the base of the console near the front, as shown in fig. 1. Fig. 2 is a general view of the unit with the case on; another view with the case off, showing the principal components is given in fig. 3.

**2.** The unit supplies +15 kV EHT to the final anode of the CRT in the indicating unit Type 35. The EHT is required to be accurately regulated to within 75V of a nominal +15 kV, for all CRT beam currents up to 100 $\mu$A; the reason is that any appreciable change of EHT voltage with beam current would result in variations of deflection sensitivity, and so mar the accuracy of the display. In addition, the output is required to be virtually ripple-free, so that no ripple-patterns appear on the trace. The unit incorporates a safety device to prevent the output from rising sharply if the regulator fails, as any large rise above +20 kV would cause damage to either the CRT or the EHT cable and plugs, or both. A single preset potentiometer enables the output to be set to exactly +15 kV.

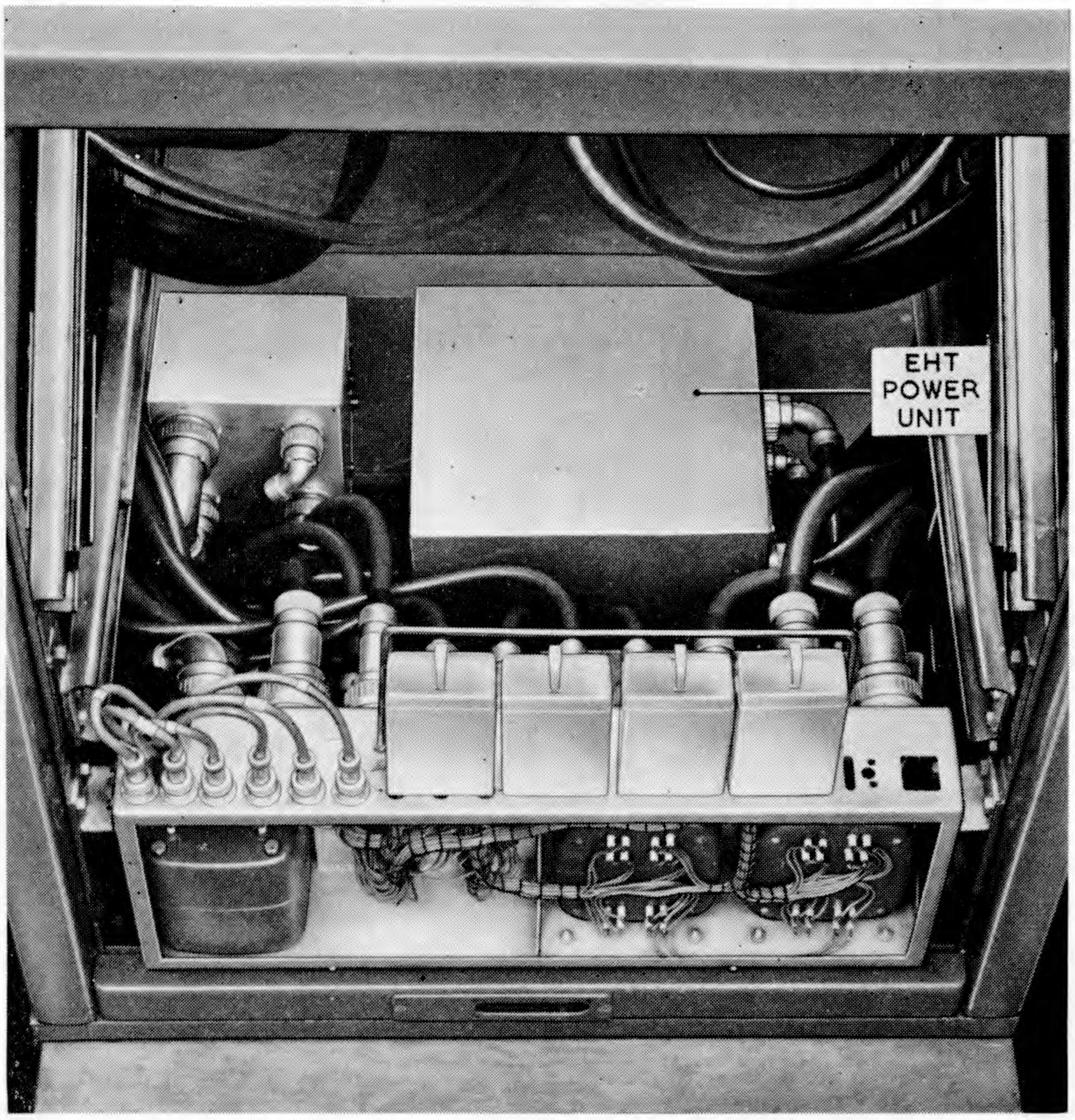



**Fig. 1. Console Type 64—rear view**
(Rear panel off, indicating unit and deflection amplifier tray pulled forward)

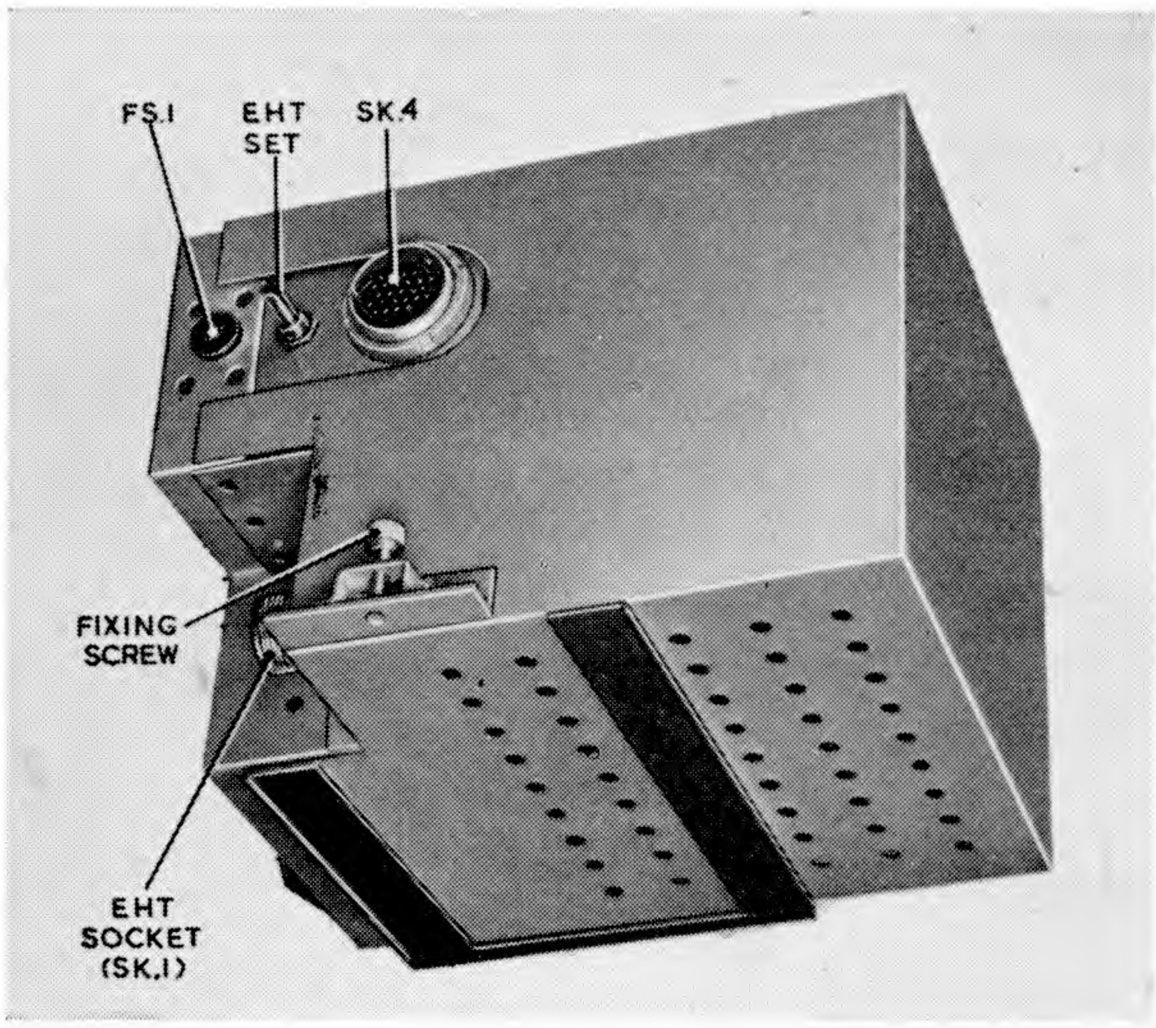



**Fig. 2. Power unit (EHT) Type 898 (case on)**

**3.** The unit takes its HT from the nominal +420V unregulated bulk power supply (rack assembly Type 305), from which it draws about 70 mA. The 150 mA fuse FS1 protects this supply. For reference voltage the stable − 500V Station reference supply is used. Less than 1 mA is drawn from this source. Two 6·3V 50 c/s heater supplies enter from the distribution panel; only one is used.

**WARNING . . .**

**The EHT output from this power unit can inflict a serious shock which could, in some circumstances, prove fatal. If it is necessary to run the unit with the case off for servicing, take special care to avoid the high voltage sides of components (those further from the chassis). Before touching the EHT side, switch off and earth the high potential side of C12 and C20 to C23.**

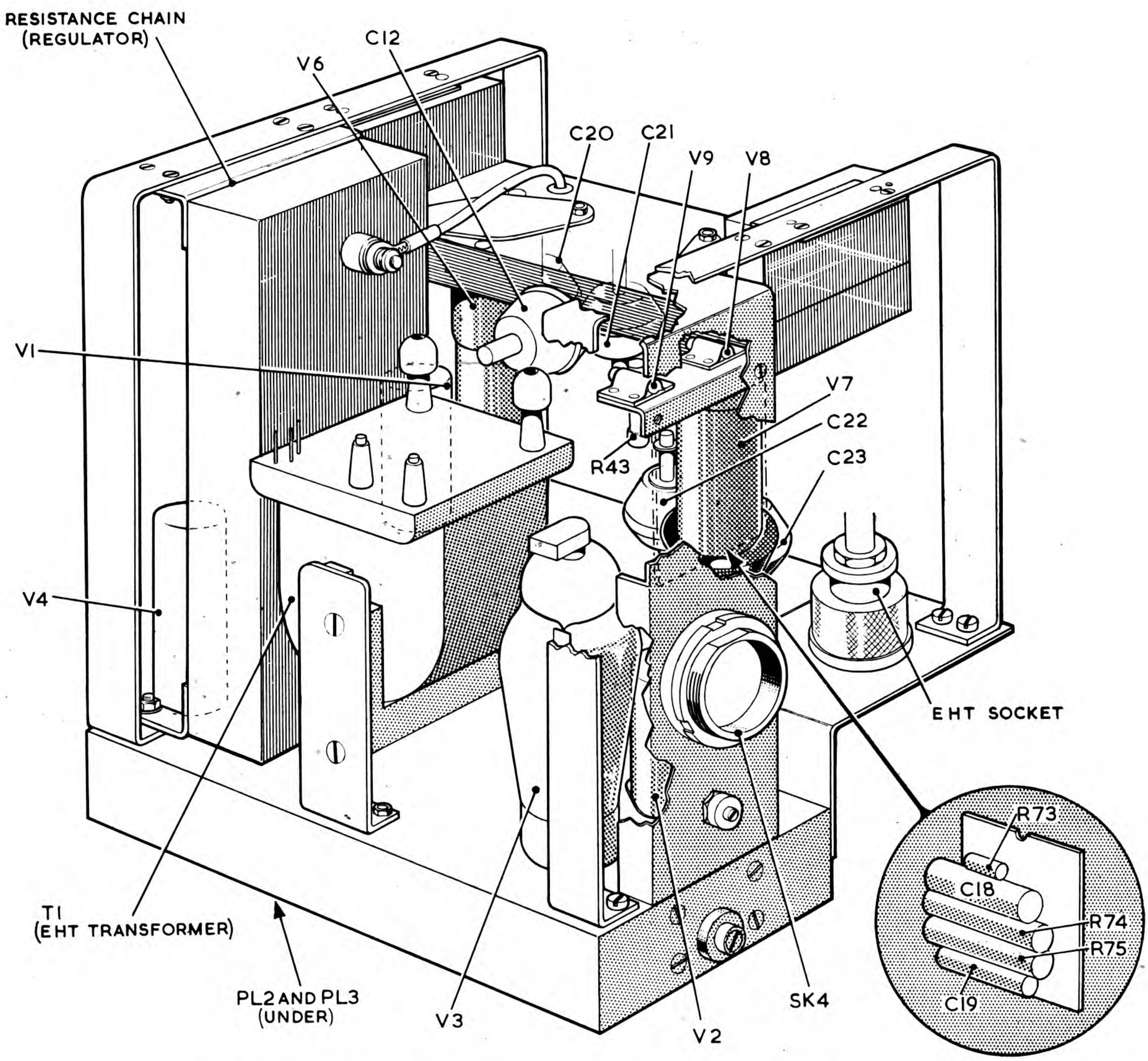



**Fig. 3. Power unit (EHT) Type 898 (case removed)—general view**

## CIRCUIT DESCRIPTION

### General

**4.** A complete circuit diagram of the EHT power unit is given at the end of this chapter (*fig.* 7). The simplified block diagram (*fig. 4*) shows how the circuit may be broken down into six stages, as follows :—

(1) multivibrator,
(2) buffer and shaper,
(3) switching valve,
(4) EHT transformer and rectifier/doubler,
(5) regulator valve,
(6) safety diodes.

The principal waveforms in the unit are shown in fig. 5. Note that waveform (*d*) is included only to help clarify the circuit operation; no attempt should be made to examine this waveform in a working unit or damage to the oscilloscope will result. A scaled-down version of the waveform may be examined at V8 anode (transformer pin C), where the peak-to-peak amplitude should be about 400V.

### Multivibrator

**5.** The pair of triodes V1 (CV 491) is cross-connected as an ordinary unsymmetrical multivibrator (*fig.* 7). It is free-running, the frequency being about 6·5 kc/s. Both grid resistors are returned to the HT line, ensuring a steep grid return slope during the capacitor re-charge, and so preventing erratic operation. The 100 KΩ anode loads R3 and R6 are returned to the HT rail via a common 47 KΩ resistor R5; since one or other triode is always in conduction R5 keeps the effective HT (and thus the anode voltage of the non-conducting triode) below a safe level of 300V.

**6.** The square-wave at the anode of V1B has an amplitude of about 200V (*waveform* (*a*)). It is AC-coupled via C3 to the next stage.

### Buffer and shaper

**7.** V2 (CV 138) is a pentode shaping amplifier and buffer stage which isolates the multivibrator from the switching valve and EHT circuits. It is alternately cut off and saturated by the square-wave at its grid, so that an antiphase waveform (*waveform* (*b*)) of some 120V amplitude appears at its anode; this is applied to the switching valve.

**8.** The coupling network from V2 to V3 consists of C6 and a resistance chain in the regulator circuit. It is deliberately made inadequate (i.e. of insufficiently long time constant) in order to make it possible to couple back fast fluctuations from the regulator to V3 grid. If not allowed for, this would cause a sag on the top of the square-wave applied to the switching valve grid, whereas a slight rise is actually required. The waveform is therefore corrected in advance by adding a rising top to the square-wave at V2 anode. This is done by splitting the effective 55 KΩ anode load into two parts, R13 and R14, and connecting the 0·01 $\mu$F capacitor C5 from the junction to earth. When now V2 is cut off by the negative edge at its grid, its anode rises not to full HT but only to the existing potential at the junction of R13 and R14. C5 now starts to charge towards the effective HT (which is the potential at the junction of R12 and R13, decoupled by C4) through R13. The rising top to the waveform ensues (*waveform* (*b*)) because V2 anode follows the potential of the top plate of C5 (no anode current). Neither potential has time to approach the effective HT level very closely before the square-wave reverses once more.

### Switching valve

**9.** V3 (CV 450) is the switching valve, a television line pentode capable of withstanding large positive and negative voltage swings at the anode. To its grid is applied the switching waveform from V2, which, due to the coupling of medium time constant referred to in para. 8, is almost square (*waveform* (*c*)). The waveform settles with its mean level at the potential of the junction of R23 and R26, which is controlled by the regulator valve and is always well below V3 cut-off.

**10.** During the positive part of the square-wave (shown shaded in *waveform* (*c*)), V3 conducts, and the full steady anode current flows through the portion **E-D** of the main winding on the EHT transformer T1. When the grid is driven negative this current is abruptly cut off. As a result the transformer winding rings violently, producing a positive excursion of some 5 kV at V3 anode, followed by a similar negative swing (*waveform* (*d*)). The natural frequency of the ring, which depends on the inductance of the transformer winding and on various stray capacitances, is about 20 kc/s.

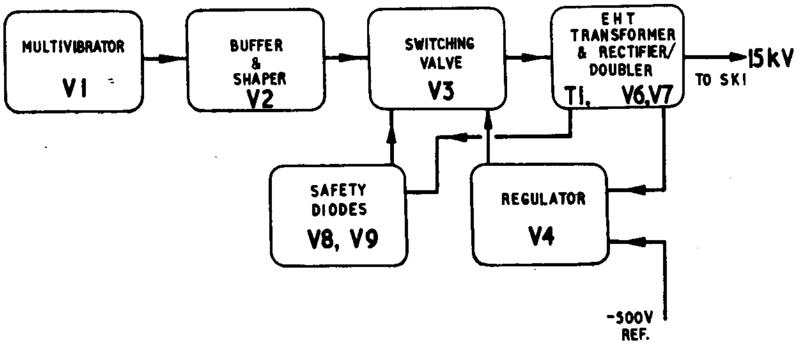



**Fig. 4. Power unit (EHT) Type 898—block diagram**

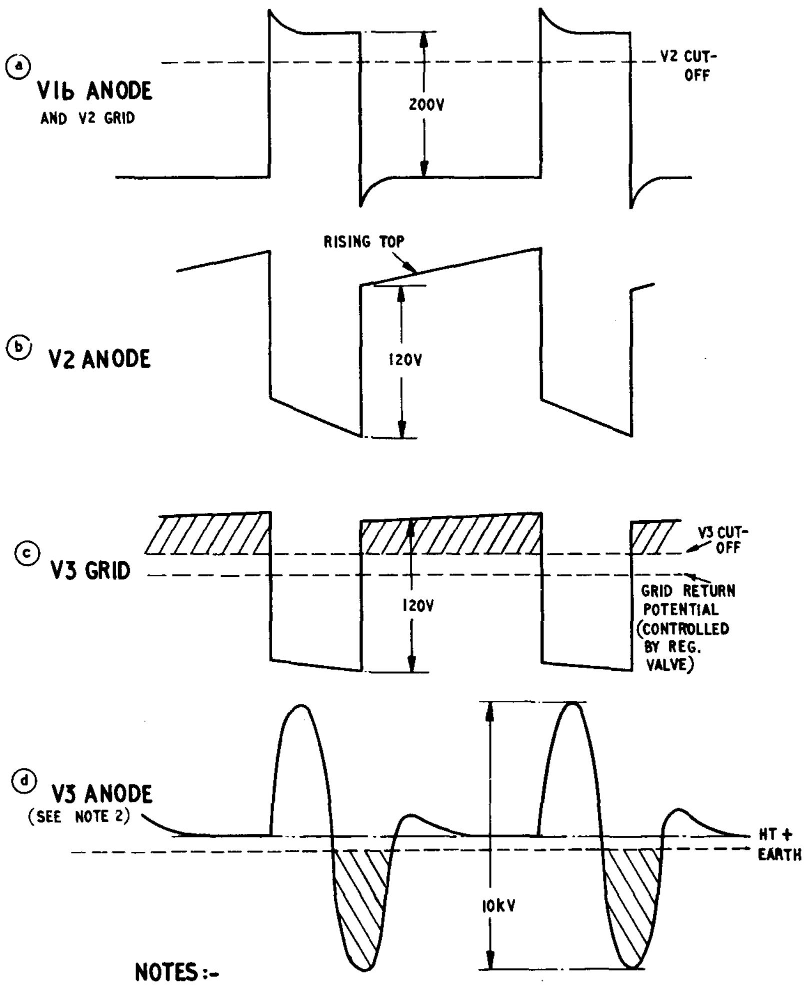
**11.** The period during which the anode is negative is shown shaded on waveform (*d*). The timing is such that when the anode is most negative the square-wave goes positive again and switches on the valve current, which all goes to the screen-grid. As soon as the anode swings positive again it starts to draw current, and the remainder of the ring is damped out. The valve continues in conduction for the rest of the cycle.

**12.** The amplitude of the initial positive swing at V3 anode (and thus the size of the rectified output) is proportional to the anode current, by whose cut-off the swing was caused. It therefore depends on the height of the shaded portion on waveform (*c*), which in turn is controlled by the regulator valve.

**EHT transformer and rectifier/doubler**

**13.** The main winding on the EHT transformer T1 is overwound 50 per cent to **F** from the V3 anode tap **E**, so that the positive voltage swing applied to the rectifier/doubler circuit via C12 is about 7·5 kV in amplitude, and the negative swing is about the same. The EHT rectifier diodes V6 and V7 (both CV 2115) are connected in a cascade doubler circuit, whose principle of operation is as follows :—

(1) Ignoring the effect of V7, the succession of ring waveforms applied from the transformer causes the right-hand side of C12 (*fig.* 7) to charge up to a *mean* potential equal to the peak positive amplitude of the input waveform (+7·5 kV). The potential at V6 cathode therefore swings between +15 kV and zero, due to the large ring waveform superimposed on the mean potential.




NOTES :-
(1) AMPLITUDES SHOWN ARE SUBJECT TO WIDE VARIATIONS
(2) DO NOT ATTEMPT TO 'SCOPE WAVEFORM (d) ON A WORKING POWER UNIT

**Fig. 5. Power unit (EHT) Type 898—waveforms**

(2) V7 rectifies the potentials at V6 cathode, producing across C20 plus C21 a steady output of about 15 kV, as the current drain into the load is very small. (C20 and C21 are effectively returned to earth, via C11).

(3) Traces of 6·5 kc/s ripple are removed by the 1 MΩ smoothing resistor R43.

**14.** Some 6·5 kc/s ripple reaches the output through various stray capacitances from the EHT transformer ; to cancel it out, an antiphase ripple is taken from tap **B** on the four-turn auxiliary safety winding **AC**, and injected via C22 and C23. Two further auxiliary windings **G** and **H** on T1, each of one turn only, supply the directly-heated cathodes of the EHT diodes V6 and V7.

**Regulator**

**15.** A sampling chain of twenty-six 10 MΩ resistors (R46 to R71 inclusive), mounted in silicon fluid in a rectangular perspex container, is connected from the EHT output line down to the −500V Station reference supply. The grid of the regulator valve V4 (pentode CV138) is tapped across the lowest resistor R46, so that any change on the EHT line with reference to the −500V produces a small but proportionate change at the grid. The anode is DC-coupled back to the grid of the switching valve V3. The level of the whole waveform at V3 grid (and so the EHT output level) is thus shifted up or down in opposition to the original variations, restoring the output almost to its original value.

**16.** The regulator valve is entirely DC-coupled, extra gain for the elimination of AC fluctuations (in particular the 100 c/s and 300 c/s ripple often encountered on the +420V bulk power supply) is obtained from the capacitive divider C20 + C21, C11. The function of C9 is to filter out any 6·5 kc/s ripple, which would otherwise drive V4 into grid current. C10 is the coupling for low frequency AC fluctuations. C8 is added to reduce the gain at HF, and so prevent any possibility of oscillations.

**17.** The DC conditions of V4 are arranged so that if the bottom of R45 is earthed, the EHT output is stabilized at +12·5 kV. When, therefore, R45 is returned to a negative point along the chain R32 to R34, the EHT output is in-

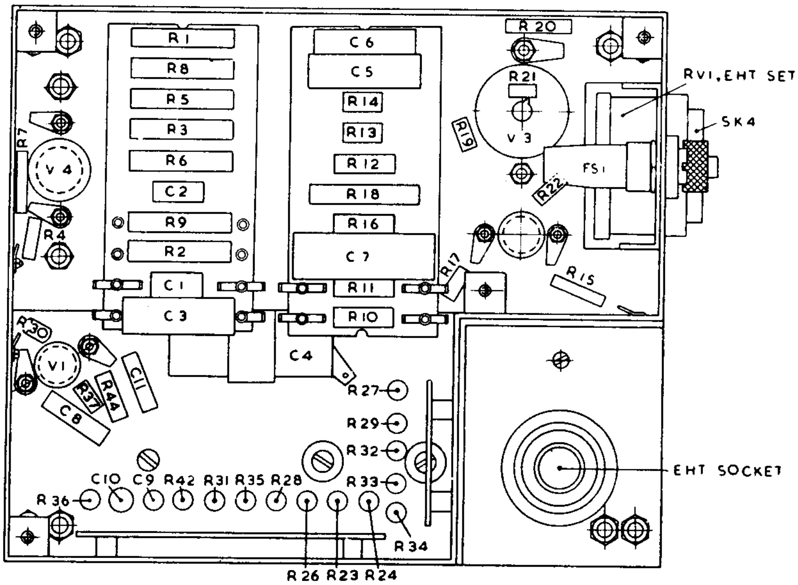



**Fig. 6. Power unit (EHT) Type 898—under-chassis layout**

creased ; by adjustment of the EHT SET potentiometer RV1 it may be stabilized at exactly +15 kV.

### Safety diodes

**18.** There is a danger that if the regulator valve fails, the output will rise to +30 kV or more, causing damage to equipment. To prevent such an occurrence the safety diodes V8 and V9 (both CV469) are included. Their operation is as follows :—

(1) V8 is a sampling rectifier connected across the four-turn auxiliary winding **A-C** on the EHT transformer. Its diode load is R73 (2·2 MΩ) with the 0·01 μF capacitor C18 in parallel.

(2) V8 cathode is held at the potential of the junction of R74 and R75, which is about +140V. In normal operation, the amplitude of the ring waveform is enough to build up a potential drop of about 130V across R73, so V9 cathode stands at about +10V. Since its anode is held several volts negative, V9 is normally cut off.

(3) If the amplitude of the ring waveform increases substantially (due, for example, to regulator failure), the drop across R73 increases in proportion, taking the cathode of V9 negative until it conducts and holds V3 grid down to a small negative level. The EHT output is by this means held below the maximum safe value of +20 kV.

### Component layout

**19.** Fig. 6 is an under-chassis view of the power unit annotated to show the location of the replaceable components. It should be used in conjunction with the Table of components which follows.

**Note . . .**
*The Tables of components which follow are issued for information only ; when ordering spares for this unit refer to Volume 3 of this publication, or to the appropriate section of A.P.1806.*

**TABLE I**

**Component details—resistors (fixed and variable)**

| Circuit ref. | Value (ohms) | Rating (watts) | Tolerance (%) | Inter-services ref. |
|---|---|---|---|---|
| R1* | 510 K | ¾ | 1 | Z216599 |
| R2* | 680 K | ¾ | 1 | Z216623 |
| R3* | 100 K | ¾ | 1 | Z216447 |
| R4* | 33 | ½ | 5 | Z215062 |
| R5* | 47 K | ¾ | 1 | Z216367 |
| R6* | 100 K | ¾ | 1 | Z216447 |
| R7* | 33 | ½ | 5 | Z215062 |
| R8* | 680 K | ¾ | 1 | Z216623 |
| R9* | 680 K | ¾ | 1 | Z216623 |
| R10 | 1 M | 1 | 10 | Z213339 |
| R11 | 1·2 M | 1 | 10 | Z213340 |
| R12 | 47 K | 1 | 10 | Z212263 |
| R13 | 33 K | ½ | 10 | Z222194 |
| R14 | 22 K | ½ | 10 | Z222173 |
| R15* | 33 | ½ | 5 | Z215062 |
| R16 | 180 K | 1 | 10 | Z215330 |
| R17 | 330 | ½ | 10 | Z221173 |
| R18 | 10 K | 3 | 5 | Z244241 |
| R19 | 100 | ½ | 10 | Z221110 |
| R20* | 680 | ½ | 5 | Z215222 |
| R21* | 10 | ½ | 5 | Z215002 |
| R22* | 470 | ½ | 10 | Z221194 |
| R23* | 430 K | ¾ | 2 | Z216587 |
| R24* | 470 K | ¾ | 2 | Z216595 |
| R25 *not fitted* | — | — | — | — |
| R26* | 620 K | ¾ | 5 | Z216745 |
| R27* | 510 K | ¾ | 5 | Z216741 |
| R28* | 120 K | ¾ | 1 | Z216467 |
| R29* | 560 K | ¾ | 5 | Z216743 |
| R30* | 150 | ½ | 2 | Z215441 |
| R31 | 220 K | 1 | 10 | Z213331 |

## TABLE 1 (*continued*)

| Circuit ref. | Value (ohms) | Rating (watts) | Tolerance (%) | Inter-services ref. |
|---|---|---|---|---|
| R32* | 3·9 K | ¾ | 5 | Z215313 |
| R33* | 470 K | ¾ | 5 | Z216739 |
| R34* | 680 K | ¾ | 5 | Z216747 |
| R35 | 220 K | 1 | 10 | Z213331 |
| R36 | 1 M | ½ | 10 | Z223164 |
| R37 | 330 | ½ | 10 | Z221173 |
| R38 to 41 *not fitted* | | — | — | — |
| R42 | 270 K | ½ | 10 | Z223092 |
| R43* | 1 M | ¾ | 5 | Z216757 |
| R44 | 2·2 M | ½ | 10 | Z223206 |
| R45* | 1 M | ¾ | 5 | Z216757 |
| R46* to R71* (each) | 10 M | 1½ | 1 | Z216707 |
| R72 *not fitted* | — | — | — | — |
| R73 | 2·2 M | ½ | 10 | Z223206 |
| R74* | 22 K | 1 | 1 | Z216289 |
| R75* | 27 K | 1 | 1 | Z216309 |
| RV1 (EHT SET) | 100 K | 1 | 10 | Z272549 |

*High stability

## TABLE 2
## Component details—capacitors

| Circuit ref. | Value (μF except where stated) | Rating (V.DC) | Tolerance (%) | Inter-services ref. |
|---|---|---|---|---|
| C1 | 330 pF | 500 | 5 | Z132316 |
| C2 | 100 pF | 500 | 5 | Z132185 |
| C3 | 0·01 | 500 | 20 | Z115525 |
| C4 | 0·25 | 500 | 20 | Z115510 |
| C5 | 0·01 | 500 | 20 | Z115525 |

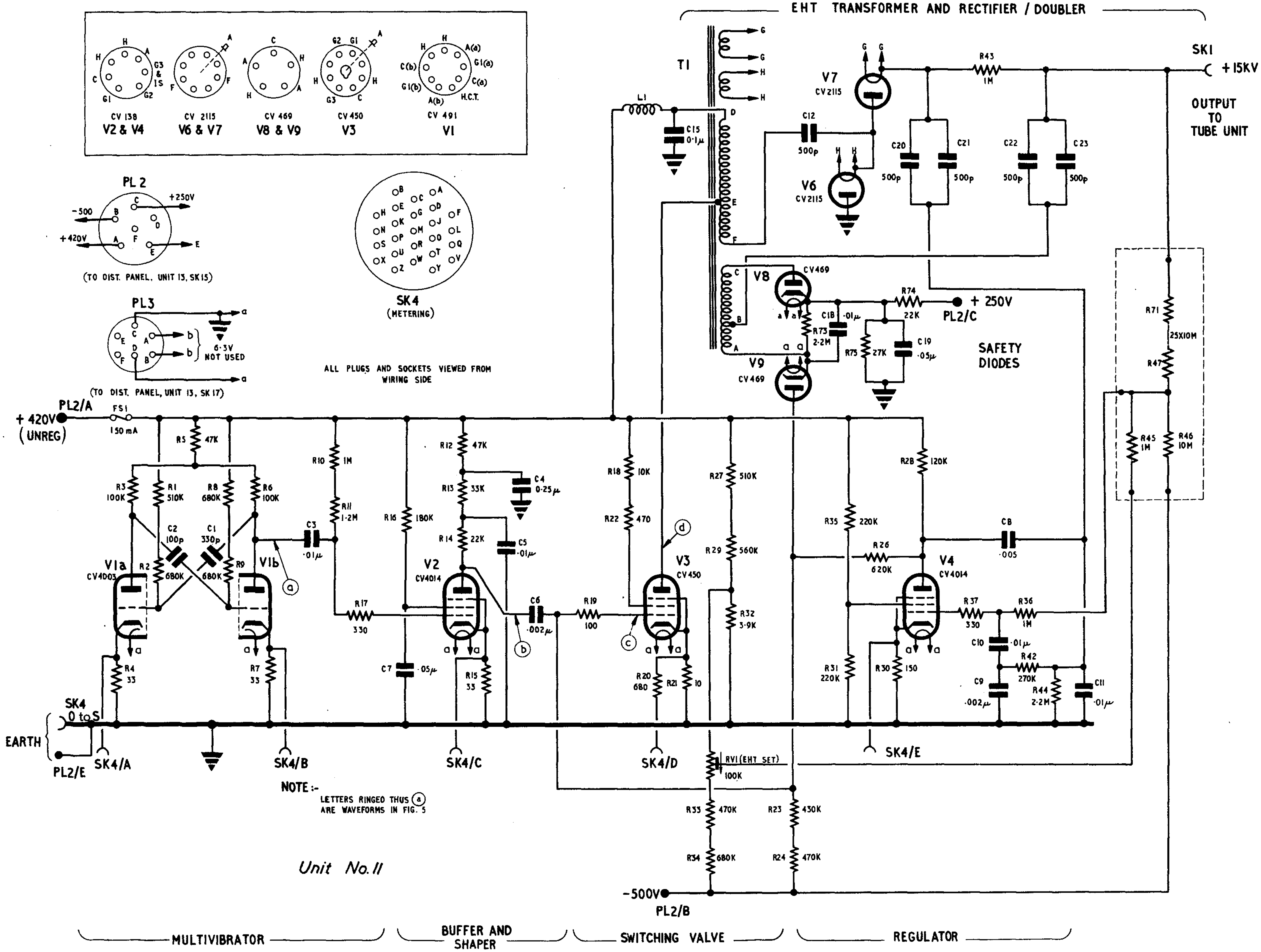
## TABLE 2 (*continued*)

| Circuit ref. | Value (μF except where stated) | Rating (V.DC) | Tolerance (%) | Inter-services ref. |
|---|---|---|---|---|
| C6 | 0·002 | 500 | 20 | Z115551 |
| C7 | 0·05 | 500 | 20 | Z115505 |
| C8 | 0·005 | 500 | 20 | Z115524 |
| C9 | 0·002 | 350 | 20 | Z115624 |
| C10 | 0·01 | 350 | 20 | Z115552 |
| C11 | 0·01 | 350 | 20 | Z115552 |
| C12 | 500 pF | 15,000 | 20 | (Erie Type 410) |
| C13, 14, 16 and 17 *not fitted*— | | | — | — |
| C15 | 0·1 | 500 | 20 | Z115507 |
| C18 | 0·01 | 350 | 20 | Z115552 |
| C19 | 0·05 | 350 | 20 | Z115554 |
| C20 to 23 (each) | 500 pF | 15,000 | 20 | (Erie Type (410) |

## TABLE 3
## Component details—miscellaneous

| Circuit ref. | Description | Inter-services ref. |
|---|---|---|
| FS1 | 150 mA cartridge fuse (M.O.S./A) Type 19 | (10H/95) |
| T1 | EHT transformer, Type 3364 | 10K/17767 |
| PL2* | Mk. 4 plug (6-way, medium) | Z560541 |
| PL3* | Mk. 4 plug (6-way, small) | Z560080 |
| SK4* | Mk. 4 socket (25-way) | Z560380 |
| SKI | EHT socket | (Plessey CZ64649) |
| L1 | Inductor | — |

*On Mk. 4 plugs and sockets the internal moulding position is shown by the last digit of the inter-services ref. number.




AIR DIAGRAM
6222R/MIN.

ISSUE 2 | PREPARED BY MINISTRY OF SUPPLY FOR PROMULGATION BY AIR MINISTRY

Power unit (EHT) Type 898 —— circuit

Fig. 7

PP8821 566888/4920 2/61 3875 C & P Gp. 924 (4)

# Chapter 9

## MISCELLANEOUS UNITS AND CABLING

ERRATUM

The following list of appendices should follow the list of illustrations:

### LIST OF APPENDICES

# Chapter 9

# MISCELLANEOUS UNITS AND CABLING

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## LIST OF ILLUSTRATIONS



## DISTRIBUTION PANEL

### Location

**1.** The *panel (distribution) Type* 861 (Stores Ref. 10D/18645) is located at the bottom rear of the console Type 64, just above the input panel and the rear lamp. Fig. 1 is a view of the console from the rear, showing the distribution panel in position. Fig. 2 shows the layout of the panel as seen from the front.

### Purpose

**2.** The distribution panel serves as the principal junction box for interconnections between the different units in the console (including the input panel, for external connections) by multicore cables. Most of the coaxial services, however, do not pass through the distribution panel but are connected directly between the units concerned. The panel also carries the console switching relays and the three heater transformers. A full circuit diagram appears in fig. 8.

### Console switching circuit

*Introduction*

**3.** A simplified diagram of the console switching circuit, including those parts located in other units besides the distribution panel, is shown in fig. 3. The HT supplies originate outside the console; in most types of Station they come from a bulk power supply rack in the central radar office, where are located the relays which actually switch HT to any particular console. These relays, and the bulk power supply heaters relay, are operated from the console as described later.

**4.** A " trip line " runs out to the two voltage stabilizers in the stabilizer (voltage) Type 51, and returns via the one in the waveform generator Type 80. It is arranged that if the output from any of these stabilizers diverges far from a comparison voltage from the bulk power supply, the trip line is open-circuited and the HT to the console is switched off. (It is assumed to be unlikely that a voltage stabilizer output and the bulk power supply comparison voltage will deviate simultaneously.) The system gives protection against faults in the negative regulators too, since the positive regulators are referred to them. Fig. 4 shows the circuit of the 250V bulk power supply comparison voltage through the console units. This circuit trips the HT line if the units are not properly connected, during normal operation.

*Circuit action*

**5.** The action begins when the console ON switch (SWG on desk Type 862, but having a different designation on other Types) on the control desk is closed, applying −50V to the red lamp LP2, to the relay RLA/4, and to the heaters relay in the bulk power supply rack. One such rack

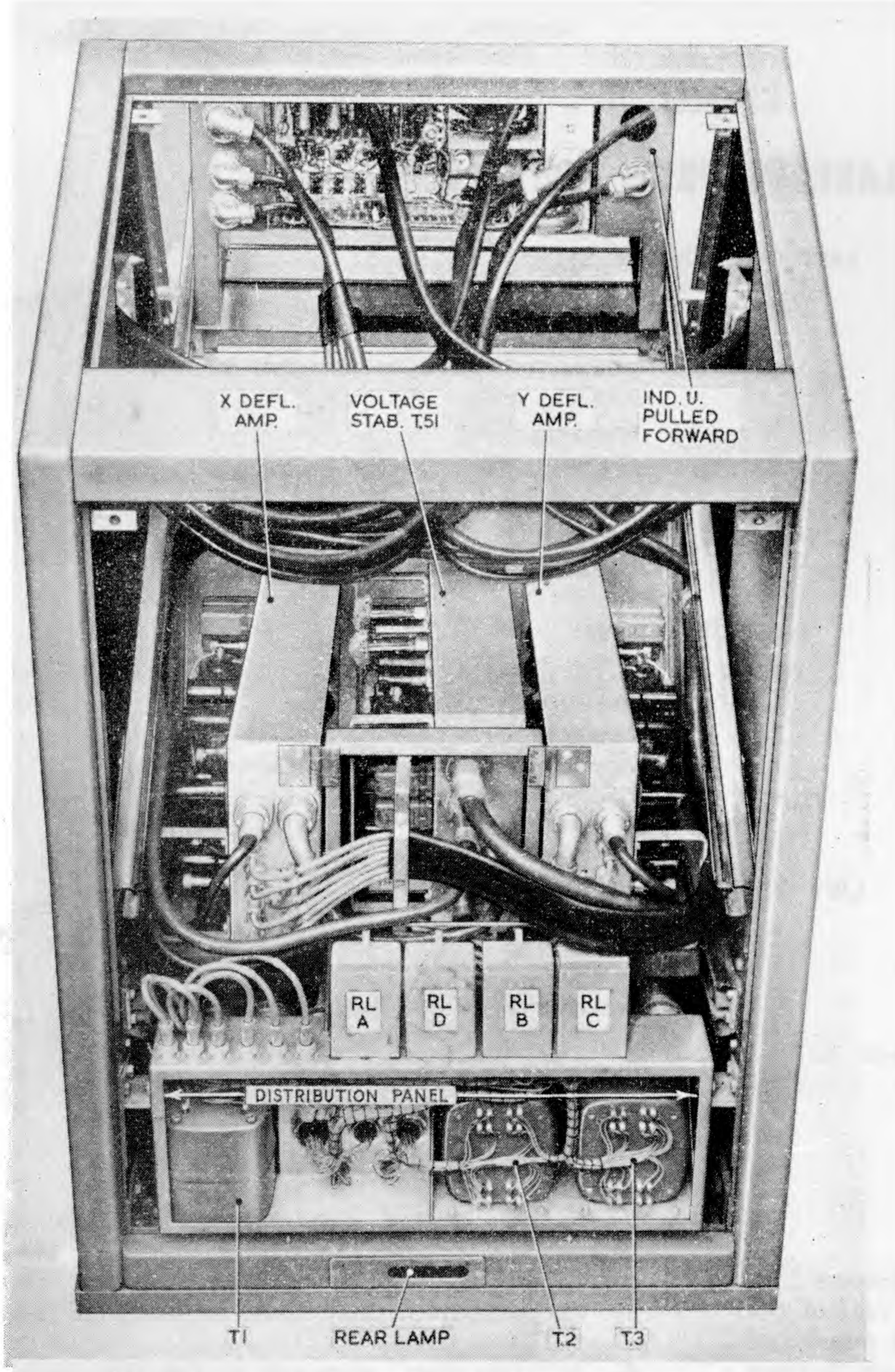



**Fig. 1. Console Type 64 (rear view, panels removed)**

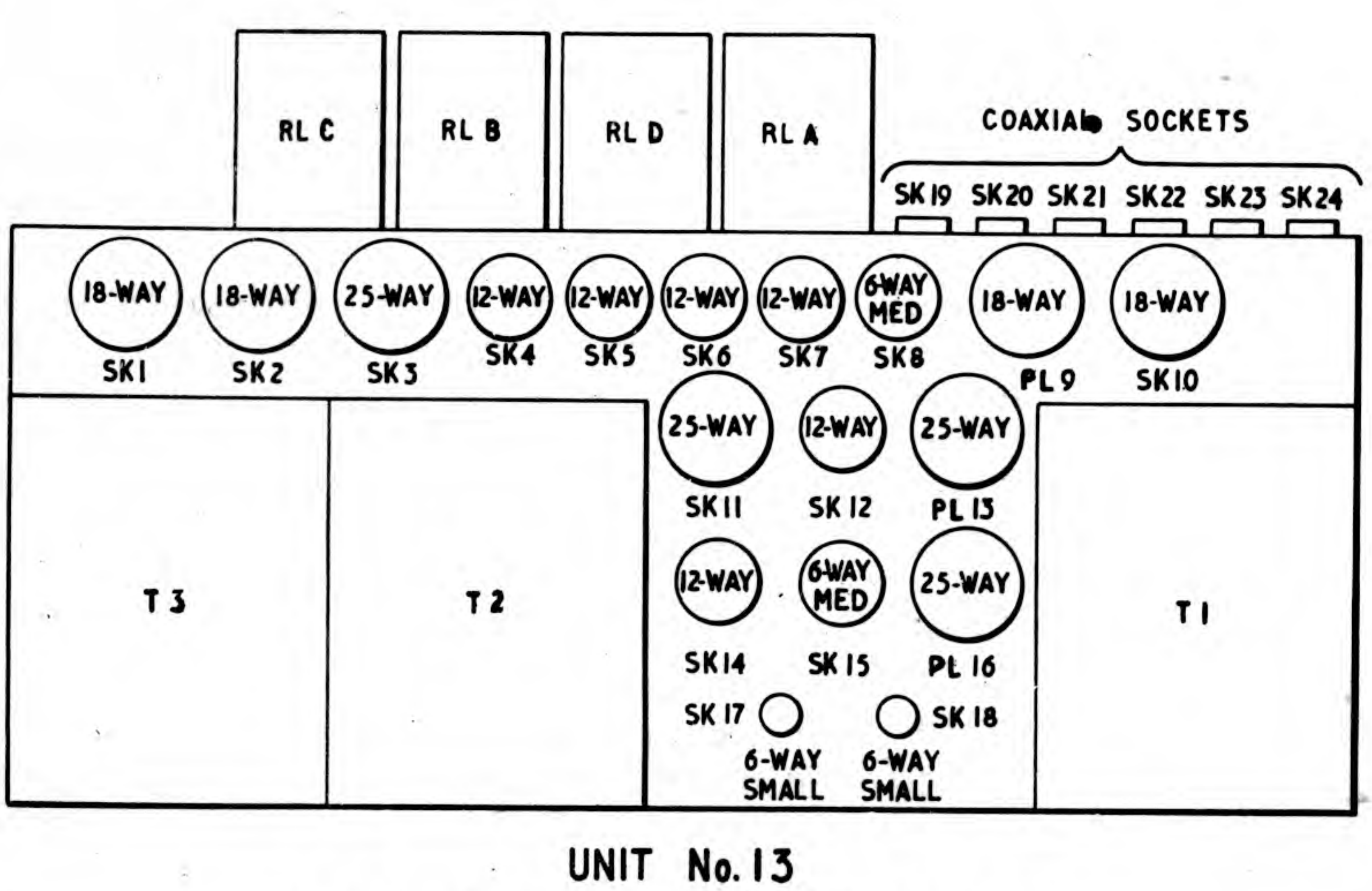



**Fig. 2. Front view of distribution unit**

supplies six consoles with raw HT; their ON switches are all effectively in parallel, so that the first console of the six to be switched on at the beginning of a watch starts up the bulk power supply heaters. (When closing down, the last console of the group to be switched off turns off the B.P.S. heaters.) At the same time as the B.P.S. heaters come up, another relay in the negative reference rack switches on −500V reference to the B.P.S. rack, which after a delay of one minute starts to produce HT; the HT is not yet fed out to the console.

*RLA/4*

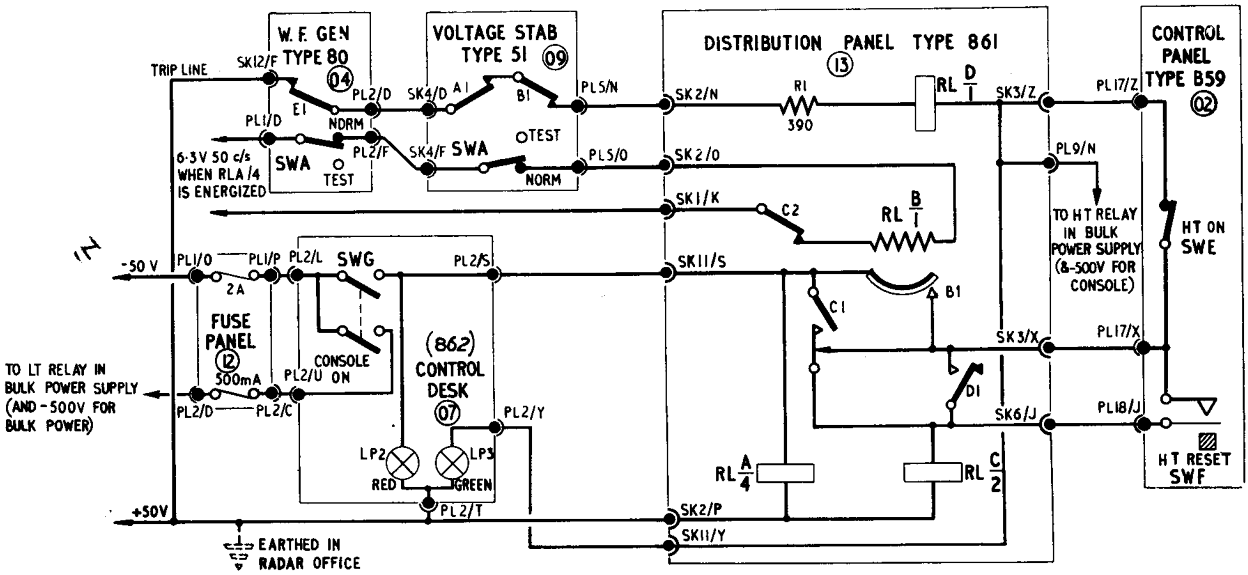
**6.** When RLA/4 is energized, its contacts 1 to 4 close and apply 230V 50 c/s mains to all three heater transformers. 6·3V are now applied to all valve heaters (including the CRT heater) throughout the console, and also to the heating element of the thermal delay relay RLB/1. (This assumes that the TEST/NORMAL switches in the various voltage stabilizers are in the NORMAL position.)

*RLB/1 and RLC/2*

**7.** After a delay of approximately one minute contact B1 closes, applying −50V to the winding of RLC via its own make-before-break change-over contact C1. When C1 has changed over, it holds in RLC independently of the thermal contact B1. In addition, C2 opens and switches off the thermal delay heating element, which starts to cool off. After a further delay of one minute the thermal delay contact B1 re-opens without further effect on the circuit.

*RLD/1*

**8.** Provided the HT ON switch (control panel 859) is closed, then the initial closing of the thermal delay contact B1 applies −50V to one side of RLD/1, whose other side is returned via a small limiting resistor R1 and the trip line to the 50V positive. Provided the trip line is closed (i.e. none of the safety relays are energized) RLD is energized and it is held in—even after the thermal delay relay has dropped




NOTE:-
CONTACTS OF RL$\frac{A}{4}$ (NOT SHOWN) CLOSE 230V TO T1, T2, T3, AND APPLY 6·3V HEATER SUPPLIES TO ALL UNITS

**Fig. 3. HT switching circuit**

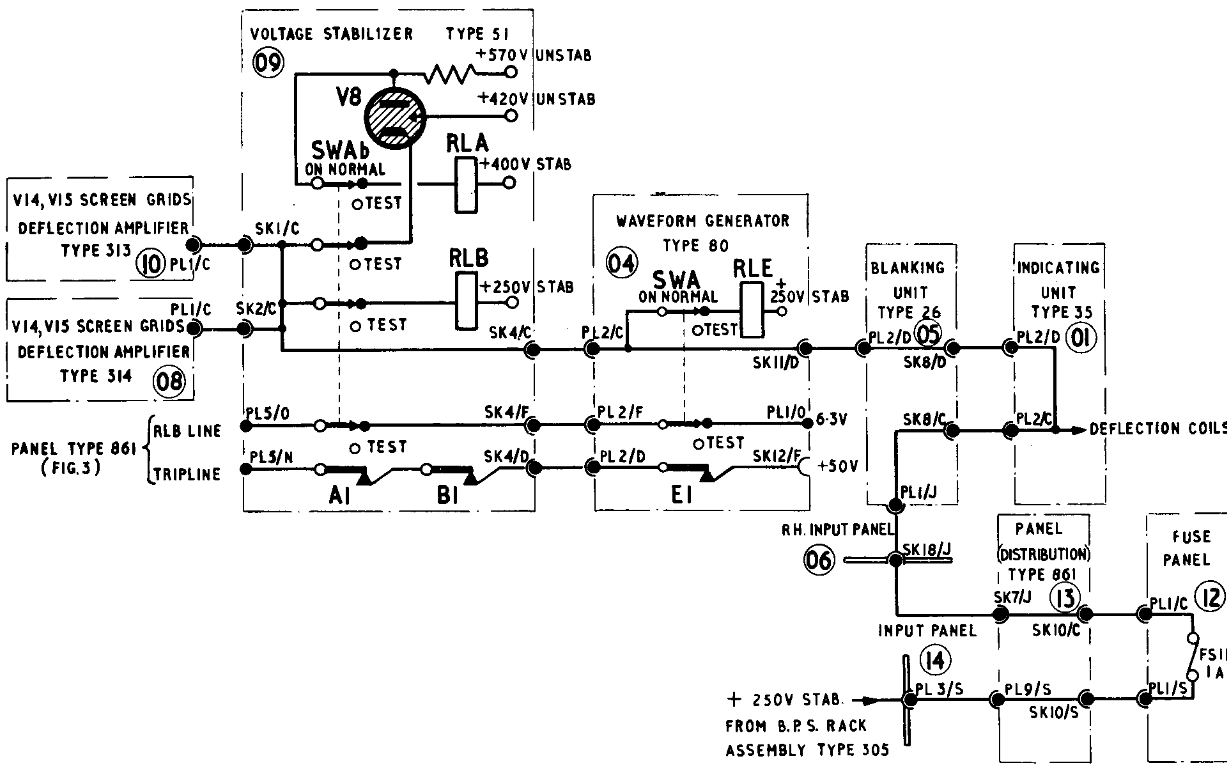



**Fig. 4. Circuit of +250V stabilized line associated with TEST switches**

out—by its own contact D1. At the same time as RLD is energized, the green lamp LP3 on the control desk lights up. Also the —50V is fed out to the bulk power supply rack, closing a relay there which routes regulated and raw HT back to the console. Simultaneously the —50V is applied to a relay in the negative reference rack, which starts supplying —500V reference to the console. As a result of all this, the PPI display is brought on.

*HT trip action*

**9.** In normal circumstances the circuit remains in this state while the console is in use, with relays A, C and D energized and the thermal delay RLB inoperative. Assuming that the TEST switches in the waveform generator Type 80 and the voltage stabilizer Type 51 remain closed, there are now two possible ways in which the circuit may be tripped :—

(1) *Console switched off* at control desk ; this de-energizes relays A, C and D here, the HT relay in the bulk power supply rack and the −500V relay in the negative reference rack. As a result the console is shut down completely (including heaters), leaving only the three-pin mains socket on the fuse panel alive for soldering-irons, etc. (If the console is the last of its group of six to be switched off, the B.P.S. heaters and the −500V to the B.P.S. rack are also switched off.) If the console is now switched on again, the full action explained in para. 5 to 8 is repeated.

(2) *Circuit of RLD/1 opens*, due to the trip line being open-circuited by the operation of any of the safety relays in the console. (The same result is obtained if the HT ON switch on the control panel be opened.) When RLD is de-energized in this way, its hold-on contact D1 opens, cutting off −50V from the HT relay in the B.P.S. rack, and so stopping HT supplies to this console. Since RLA and RLC here remain energized however, the console heaters stay alight, and it is only necessary to short-circuit contact D1 by pressing the HT RESET button on the control panel to bring up the HT again right away (provided the HT ON switch is still closed). If, however, the fault which opened the trip line has not cleared, the HT will disappear again immediately the HT RESET button is released, because RLD cannot be held on.

#### *Protection while thermal delay cools*

**10.** After thermal delay contact B1 has closed and brought up the HT, a further minute elapses before the device cools off again ; during this minute contact D1 is short-circuited by B1, so there is no need for the operator to touch the HT RESET button during ordinary switching-on. It should be noted, however, that this feature results in the trip line being rendered temporarily ineffective ; but the HT fuses in the panel (fuse) Type 860 afford sufficient protection against major faults during this first minute.

#### *Purpose of TEST switches*

**11.** The TEST switch in the waveform generator Type 80, shown as SWA within the waveform generator block in fig. 3, is in fact one wafer of a switch whose other wafer (*fig. 4*) open-circuits the safety relay RLE there, so preventing it from energizing and open-circuiting the trip line. The switch is mainly used when setting-up the voltage stabilizer there, to prevent the HT circuit from continually tripping while the stabilized output is being adjusted. The purpose of opening the thermal delay heater line by the same switch is to prevent the console from being inadvertently switched on after the next shut-down without the protection of the trip line.

**12.** The switch marked SWA in the voltage stabilizer Type 51 block in fig. 3 has a similar purpose to the one in the waveform generator Type 80, but it has *two* other wafers which render ineffective the two safety relays in that unit during setting-up.

**13.** The TEST switches are also useful to determine quickly which of the safety relays has tripped the HT supply ; the procedure is :—

(1) Turn the TEST switch on the waveform generator Type 80 from NORMAL to TEST, so rendering ineffective the safety relay RLE there.

(2) Press and release the HT RESET button on the control panel. If the HT now comes on again, then RLE must have been the one that operated ; but if not, then it must be one of the safety relays in the voltage stabilizer Type 51.

(3) Confirm the latter indication by turning SWA in the voltage stabilizer Type 51 to TEST, and pressing the HT RESET button once more.

#### Heater transformers

**14.** There are three totally-enclosed C-core transformers, T1, T2 and T3, to supply all the 6·3V valve and CRT heaters, and dial and screen lights throughout the console. T1 primary has its own 230V 50 c/s mains input, of high stability (marked 2A SW.H.S. on *fig. 8*), and carries windings numbered 1 to 4. T2 and T3 primaries are in parallel across an ordinary 230V supply (5A SW.). (On many static installations, however, these two mains inputs are paralleled external to the unit.) All the mains input lines are switched by the console ON relay RLA explained in para. 6, and are protected by cartridge fuses located in the panel (fuse) Type 860. A full list of the heater windings showing the rating, DC level and external destination of each winding is given in Table 1.

#### *Thermo cut-outs*

**15.** As a safeguard against overheating of any transformer, a *thermo cut-out* (Stores Ref. 10AE/655) is attached to each transformer casing, to open-circuit the primary if the transformer temperature exceeds a safe value.

#### Plugs and sockets

**16.** The remainder of the distribution panel consists of a number of interconnected plugs and sockets ; their destinations and circuit are shown in fig. 8. Sockets 19 and 24 inclusive are coaxial sockets for distribution of the positive and negative gating waveforms. All the remainder are Mk. 4 miniature plugs and sockets of various sizes, for use with the multicore cables which run out to all units of the console. To prevent any connector from being inadvertently inserted into the wrong plug or socket, no two plugs (or sockets) of the same size and number of pins have the same internal moulding position with respect to the guide spigot. The moulding position—of which there are six, numbered 0 to 5—is shown by the last digit of the Inter-services Ref. No. for the plug or socket, listed in Table 2.

### FUSE PANEL

#### Location

**17.** The *panel (fuse) Type 860* (Stores Ref. 10D/18644) is located at the bottom front of the console ; access to it is obtained by removing the lower front panel of the console, below the control desk.

**Purpose**

**18.** The fuse panel is a simple unit carrying cartridge fuses for all three mains inputs, all bulk power supplies, and the 50V relay lines. (There is no fuse here for the −500V reference, as each −500V outlet is separately fused in the negative reference rack.) A full list of fuse ratings and type numbers for replacement is given in Table 3; fig. 5 is a diagram of the fuse layout. The circuit diagram, which includes full details of plug and socket connections, is shown in fig. 6.

**19.** The unit also carries a standard 3-pin 230V 50 c/s 5A switched mains socket (UNSW. & UNREG. on *fig. 6*). If SWA is closed, this socket remains alive when the rest of the console has been switched off; it is intended to supply a soldering iron or other servicing equipment.

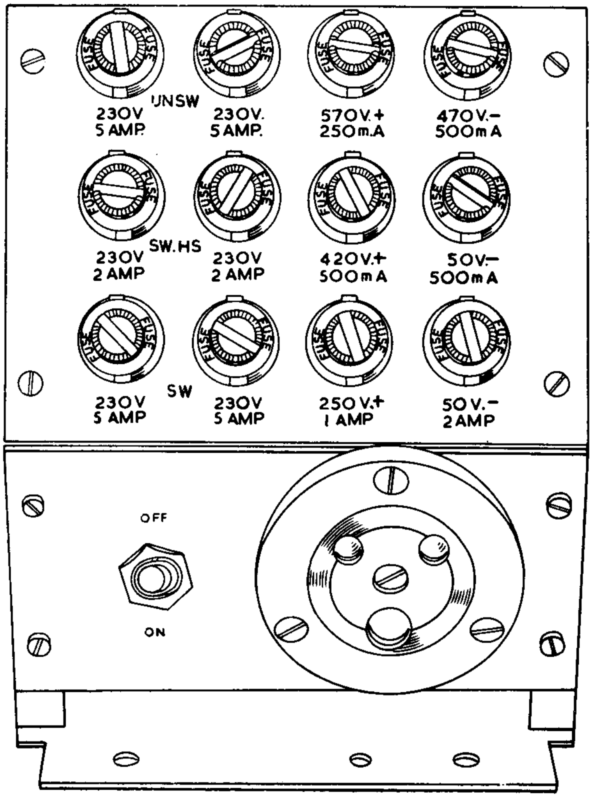



**Fig. 5. Fuse layout**

## CONSOLE CABLING

**20.** Fig. 9 is an "unfolded" view of the console, showing all the inter-unit cabling within the console proper. (Cables within the indicating unit are dealt with in Chap. 1 of this Section.) The reference numbers given to the cables in fig. 9 are to be used in conjunction with Table 6 to find the type of cable and the connections at either end. For completeness Table 7 is included, giving details of cabling within the indicating unit.

**Cable ident. markings**

**21.** Each end of every cable, both in the console proper and within the indicating unit, is marked with the unit number and the number of the plug or socket to which it is to be connected. In any one unit all the outlets, whether plugs or sockets, are numbered in one series to avoid confusion. For example, the cable which runs from PL1 on the fuse panel (unit No. 12) to SK10 on the distribution panel (unit 13) is marked 1201 at one end and 1310 at the other. A complete list of the unit numbers, which are ringed on fig. 9, is given in Table 5.

## CONTROL DESK CONNECTOR PANEL

**22.** The control desk connector panel (unit 07) which forms part of the console framework and does not have an individual type number, lies at the front of the console just behind the control desk itself. The panel carries seven multicore sockets (*fig. 7*) which provide all the connections, including GPO services, required for different types of control desk. Free plugs from the control desk plug into the sockets, which are merely "straight-through" couplers without any interconnections. Not all the sockets are used with any one type of control desk (*Chap. 10*).

## INPUT PANEL

**23.** The input panel (unit 14) also forms part of the console framework; it lies right at the base of the console and all the external connections, together with cooling air, are brought in through it. The panel, whose layout is shown in fig. 7, carries only "straight-through" couplers, both multicore and coaxial.

**24.** A complete list of the external connections made via the input panel is given in Table 8. It should be noted however, that on some consoles—particularly in early installations—not all the connections are made, as the number of facilities provided on any one console depends largely upon current operational requirements.

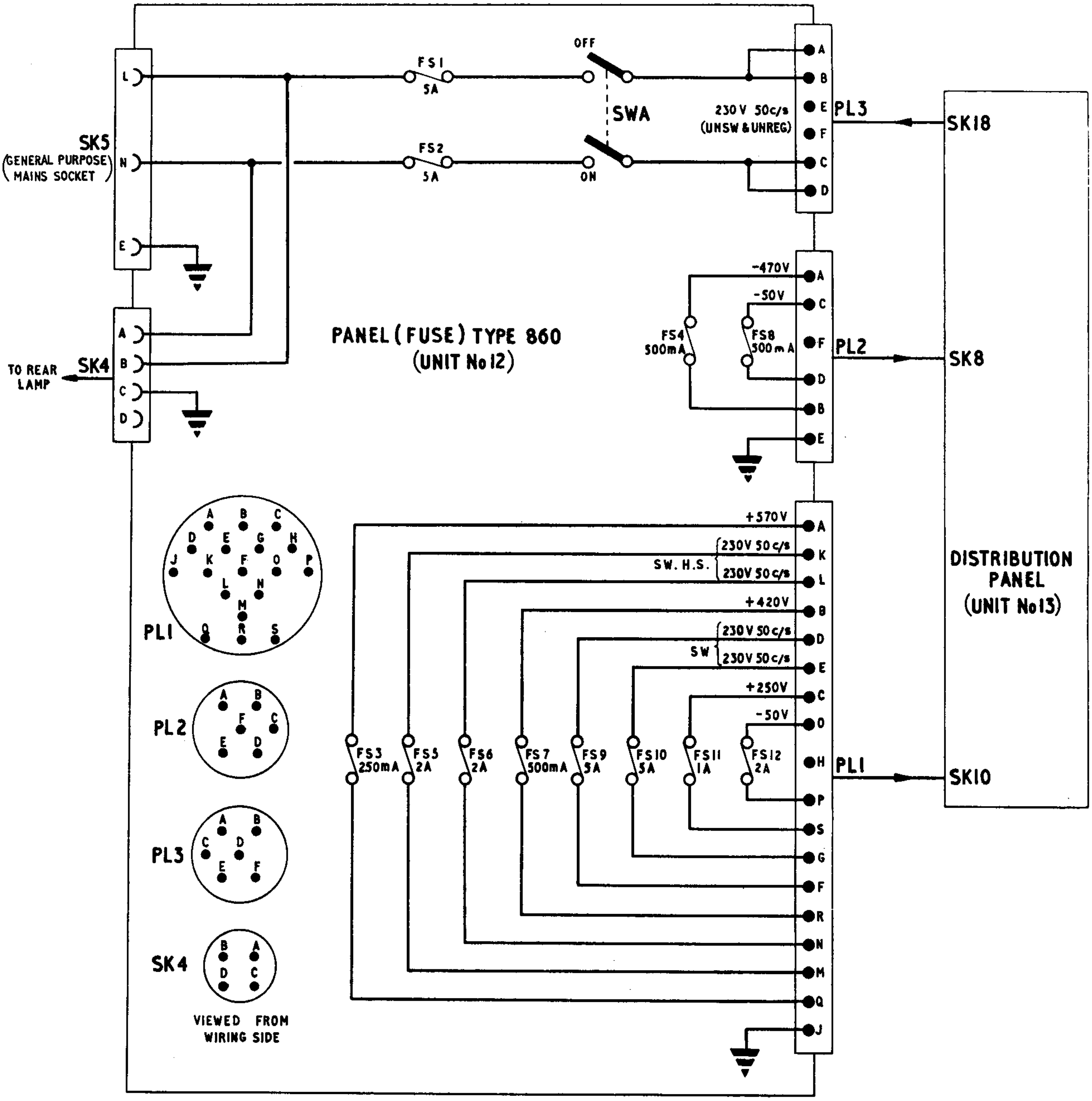
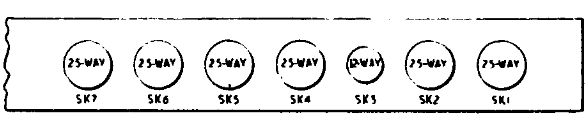
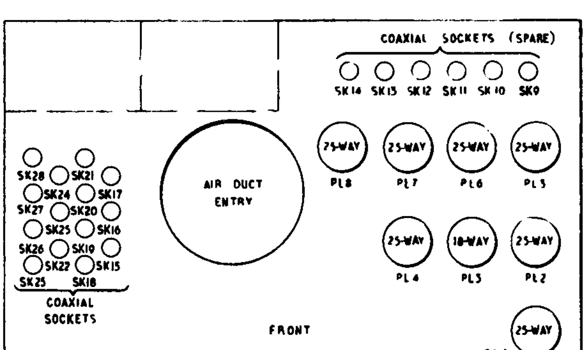



Fig. 6. Panel (fuse) Type 860—circuit




UNIT No.07




UNIT No 14

Fig. 7. Control desk connector panel (07) from rear and input panel (14) from above

## TABLE 1

### 6·3V 50c/s heater windings

| Winding number on fig. 8 | Rating (amps) | DC level (approx.) | Pin numbers on dist. panel | Destination: Unit number (see Table 5) | Destination: Valve group |
|---|---|---|---|---|---|
| **Transformer TR1** | | | | | |
| 1 | 1·5 | −300V | SK2/D SK2/K | 09 | a |
| 2 | 3·0 | −20V | SK5/C SK5/D | 10 | b |
| | | | SK4/C SK4/D | 08 | b |
| | | | SK2/E SK2/L | 09 | b |
| | | | SK1/D SK1/K | 04 | a |
| | | | (Also: thermal delay RLB/1 in dist. panel) | | |
| 3 | 3·0 | Earth | SK17/C SK17/D | 11 | a |
| 4 | 3·0 | — | — | Spare | — |
| **Transformer TR2** | | | | | |
| 5 | 1·0 | +400V | SK2/Q SK2/R | 09 | d |
| 6 | 1·5 | −300V | SK1/R SK1/S | 04 | d |
| 7 | 2·0 | +250V | SK1/E SK1/L | 04 | b |
| 8 | 3·0 | Earth | SK3/S SK3/T | 02 | Dial lights |
| 9 | 3·0 | Earth | SK1/G SK1/N | 04 | c |
| 10 | 4·0 | Earth | SK4/EF SK4/JK | 08 | c |
| 11* | 5·0 | −20V | SK4/A SK4/B | 08 | a |
| | | | SK5/A SK5/B | 10 | a |
| **Transformer TR3** | | | | | |
| 12 | 1·0 | +250V | SK2/F SK2/M | 09 | c |
| 13 | 1·5 | Earth | SK17/A SK17/B | 11 | b (not used) |
| 14 | 2·0 | Earth | SK6/K SK6/L | 02 | Screen lights |
| 15 | 4·0 | Earth | SK5/EF SK5/JK | 10 | c |
| 16 | 3·0 | Earth | SK7/GH SK7/LM | 05 | a |
| 17* | 5·0 | Earth | SK14/EF SK14/JK | 03 | a (and CRT) |
| 18 | 3·0 | — | SK11/W SK11/X | 07 | Desk lights |

* *On 5A windings, voltage is 6·8V to allow for cable drop.*

## TABLE 2

### Components on panel (distribution) Type 861

**Note . . .** *This list is issued for information only. When ordering spares for this unit refer to Volume 3 of this publication.*

| Circuit ref. | Nomenclature | Type | Inter-serv. ref. | Remarks |
|---|---|---|---|---|
| SK1 | Socket | Mk. 4 | Z560370* | 18-way |
| SK2 | Socket | Mk. 4 | Z560371* | 18-way |
| SK3 | Socket | Mk. 4 | Z560380* | 25-way |
| SK4 | Socket | Mk. 4 | Z560330* | 12-way |
| SK5 | Socket | Mk. 4 | Z560331* | 12-way |
| SK6 | Socket | Mk. 4 | Z560332* | 12-way |
| SK7 | Socket | Mk. 4 | Z560333* | 12-way |
| SK8 | Socket | Mk. 4 | Z560320* | 6-way (med.) |
| PL9 | Plug | Mk. 4 | Z560190* | 18-way |
| SK10 | Socket | Mk. 4 | Z560372* | 18-way |
| SK11 | Socket | Mk. 4 | Z560381* | 25-way |
| SK12 | Socket | Mk. 4 | Z560334* | 12-way |
| PL13 | Plug | Mk. 4 | Z560200* | 25-way |
| SK14 | Socket | Mk. 4 | Z560335* | 12-way |
| SK15 | Socket | Mk. 4 | Z560321* | 6-way (med.) |
| PL16 | Plug | Mk. 4 | Z560201* | 25-way |
| SK17 | Socket | Mk. 4 | Z560260* | 6-way (small) |
| SK18 | Socket | Mk. 4 | Z560261* | 6-way (small) |
| SK19 to 24 | Socket | 783 | (10H/19861) | Coaxial |
| RL.A | Relay | SM3/HV60 | Z530187 | — |
| RL.B (XA) | Relay | SH3-2 | Z530325 | Thermal delay |
| RL.C | Relay | SM3/LV38 | Z530215 | — |
| RL.D | Relay | SM3/LV201 | Z530366 | — |
| TR1 | Transformer | 2971 | (10K/17151) | Heater windings 1 to 4 |
| TR2 | Transformer | 2972 | (10K/17152) | Heater windings 5 to 11 |
| TR3 | Transformer | 2972 | (10K/17152) | Heater windings 12 to 18 |
| C1, C2 *not fitted* | | | | |
| C3, C4 | Capacitor | — | Z115560 | 0·1 μF, 150V, 25 per cent. |
| R1 | Resistor (fixed) | — | Z243365 | 220Ω, 3W, 5 per cent. |
| FS1, FS2, FS3 | Thermo cut-out | — | (10AE/655) | — |

* *Orientation of moulding inside Mk. 4 PLs and SKs is indicated by last digit of inter-services reference number.*

## TABLE 3
### Cartridge fuses
(All on fuse panel Type 860)

| Fuse number on fig. 6 | Stores Ref. | Rating | Supply | Units supplied (see Table 5) |
|---|---|---|---|---|
| FS1 | 10H/11718 | 5A | 230V 50 c/s unreg. | **12** (mains socket and rear lamp) |
| FS2 | 10H/11718 | 5A | 230V 50 c/s unreg. | |
| FS3 | 10H/107 | 250 mA | +570V unreg. | **05** (via 04), **09** |
| FS4 | 10H/238 | 500 mA | −470V unreg. | **04, 09** |
| FS5 | 10H/10269 | 2A | 230V 50 c/s sw.H.S. | Transf. T1, for heater wdgs 1, 2, 3 and 4 (*see* Table 1) |
| FS6 | 10H/10269 | 2A | 230V 50 c/s sw.H.S. | |
| FS7 | 10H/238 | 500 mA | +420V unreg. | **04, 09** |
| FS8 | 10H/238 | 500 mA | −50V | **07** |
| FS9 | 10H/11718 | 5A | 230V 50 c/s sw. | Transf. T2 and T3, for heater wdgs 5 to 18 (*see* Table 1) |
| FS10 | 10H/11718 | 5A | 230V 50 c/s sw. | |
| FS11 | 10H/9613 | 1A | +250V reg. | **01** (via 05), **07** |
| FS12 | 10H/10269 | 2A | −50V | **07** (for relay switching) |

## TABLE 4
### Fixed plugs and sockets on fuse panel

| Circuit ref. | Nomenclature | Type | Inter-serv. ref. | Remarks |
|---|---|---|---|---|
| PL1 | Plug | Mk. 4 | Z560192* | 18-way |
| PL2 | Plug | Mk. 4 | Z560140* | 6-way (med.) |
| PL3 | Plug | Mk. 4 | Z560581* | 6-way (small) |
| SK4 | Socket | Mk. 4 | Z560250* | 4-way (small) |
| SK5 | Socket (5A) | (Crabtree Type L.7170) | | 3-pin mains |
| SWA | Toggle switch | — | Z510306 | ON/OFF switch |

* *Orientation of moulding inside Mk. 4 PLs and SKs is indicated by last digit of inter-services reference number.*

## TABLE 5
### Unit coding for cable identification

**01** Tube unit
**02** Panel (control) Type 859
**03** Amplifying unit (video) Type 312
**04** Waveform generator (video gating) Type 80
**05** Blanking unit Type 26
**06** Indicating unit (CRT) Type 35
**07** Control desk connector panel
**08** Amplifying unit (L.H.) Type 314 (*Y defl. amp.*)
**09** Voltage stabilizer Type 51
**10** Amplifying unit (R.H.) Type 313 (*X defl. amp.*)
**11** Power unit (EHT) Type 898
**12** Panel (fuse) Type 860
**13** Panel (distribution) Type 861
**14** Input panel

## TABLE 6
### Console cabling

| Cable ref. number (on fig. 9) | Type | From: Unit number (ringed on fig. 9) | From: PL or SK number | From: Cable ident. marking | To: Unit number (ringed on fig. 9) | To: PL or SK number | To: Cable ident. marking |
|---|---|---|---|---|---|---|---|
| 1 | Coaxial | 06 | 11 | 0611 | 10 | 8 | 1008 |
| 2 | Coaxial | 06 | 12 | 0612 | 10 | 7 | 1007 |
| 3 | Coaxial | 06 | 13 | 0613 | 10 | 12 | 1012 |
| 4 | Coaxial | 06 | 14 | 0614 | 08 | 12 | 0812 |
| 5 | Coaxial | 06 | 15 | 0615 | 08 | 7 | 0807 |
| 6 | Coaxial | 06 | 16 | 0616 | 08 | 8 | 0808 |
| 7 | Coaxial | 08 | 4 | 0804 | 14 | 16 | 1416 |
| 8 | Coaxial | 08 | 3 | 0803 | 14 | 15 | 1415 |
| ◀ 9 | Coaxial | 14 | 28 | 1428 | 13 | 21 | 1321 |
| 10 | Coaxial | 14 | 27 | 1427 | 13 | 24 | 1324 |
| 11 | Coaxial | 13 | 23 | 1323 | 10 | 5 | 1005 |
| 12 | Coaxial | 13 | 22 | 1322 | 08 | 5 | 0805 |
| 13 | Coaxial | 13 | 20 | 1320 | 10 | 6 | 1006 |
| 14 | Coaxial | 13 | 19 | 1319 | 08 | 6 | 0806 ▶ |

**TABLE 6**—*continued*

| Cable ref. number (on fig. 9) | Type | From: Unit number (ringed on (fig. 9) | From: PL or SK number | From: Cable ident. marking | To: Unit number (ringed on fig. 9) | To: PL or SK number | To: Cable ident. marking |
|---|---|---|---|---|---|---|---|
| 15 | Coaxial | 14 | 20 | 1420 | 06 | 1 | 0601 |
| 16 | Coaxial | 14 | 21 | 1421 | 06 | 2 | 0602 |
| 17 | Coaxial | 14 | 22 | 1422 | 06 | 3 | 0603 |
| 18 | Coaxial | 14 | 19 | 1419 | 10 | 4 | 1004 |
| 19 | Coaxial | 14 | 23 | 1423 | 06 | 4 | 0604 |
| 20 | Coaxial | 14 | 18 | 1418 | 10 | 3 | 1003 |
| 21 | Coaxial | 14 | 24 | 1424 | 06 | 5 | 0605 |
| 22 | Coaxial | 14 | 25 | 1425 | 06 | 6 | 0606 |
| 23 | Coaxial | 14 | 26 | 1426 | 06 | 7 | 0607 |
| 24 | 18-way | 04 | 1 | 0401 | 13 | 1 | 1301 |
| 25 | EHT single | 01 | 11 | 0111 | 11 | 1 | 1101 |
| 26 | 12-way | 06 | 18 | 0618 | 13 | 7 | 1307 |
| 27 | 6-way (med.) | 04 | 2 | 0402 | 09 | 4 | 0904 |
| 28 | 12-way | 10 | 2 | 1002 | 13 | 5 | 1305 |
| 29 | 6-way (med.) | 13 | 15 | 1315 | 11 | 2 | 1102 |
| 30 | 6-way (small) | 13 | 17 | 1317 | 11 | 3 | 1103 |
| 31 | 25-way | 07 | 7 | 0707 | 14 | 8 | 1408 |
| 32 | 25-way | 07 | 6 | 0706 | 14 | 5 | 1405 |
| 33 | 25-way | 07 | 5 | 0705 | 14 | 2 | 1402 |
| 34 | 25-way | 07 | 4 | 0704 | 14 | 7 | 1407 |
| 35 | 12-way | 07 | 3 | 0703 | 13 | 12 | 1312 |
| 36 | 25-way | 07 | 2 | 0702 | 13 | 11 | 1311 |
| 37 | 25-way | 07 | 1 | 0701 | 14 | 6 | 1406 |
| 38 | 18-way | 12 | 1 | 1201 | 13 | 10 | 1310 |
| 39 | 6-way (small) | 12 | 3 | 1203 | 13 | 18 | 1318 |
| 40 | 4-way | 12 | 4 | 1204 | Rear lamp | — | — |
| 41 | 6-way (med.) | 12 | 2 | 1202 | 13 | 8 | 1308 |
| 42 | 25-way | 14 | 1 | 1401 | 13 | 13 | 1313 |
| 43 | 18-way | 14 | 3 | 1403 | 13 | 9 | 1309 |
| 44 | 25-way | 14 | 4 | 1404 | 13 | 16 | 1316 |
| 45 | 12-way | 06 | 9 | 0609 | 13 | 14 | 1314 |
| 46 | 12-way | 06 | 10 | 0610 | 13 | 6 | 1306 |
| 47 | 12-way | 08 | 2 | 0802 | 13 | 4 | 1304 |
| 48 | 25-way | 06 | 8 | 0608 | 13 | 3 | 1303 |
| 49 | 18-way | 09 | 5 | 0905 | 13 | 2 | 1302 |
| 50 | 6-way (med.) | 09 | 1 | 0901 | 10 | 1 | 1001 |
| 51 | 6-way (med.) | 09 | 2 | 0902 | 08 | 1 | 0801 |

**TABLE 7**

**Console cabling**

(Connectors within indicating unit)

| Cable ref. number (Chap. 1) | Type | From: Unit number (ringed on (fig. 9) | From: PL or SK number | From: Cable ident. marking | To: Unit number (ringed on fig. 9) | To: PL or SK number | To: Cable ident. marking |
|---|---|---|---|---|---|---|---|
| 61 | 25-way | 06 | 8 | 0608 | 02 | 17 | 0217 |
| 62 | 12-way | 06 | 10 | 0610 | 02 | 18 | 0218 |
| 63 | Coaxial | 06 | 1 | 0601 | 02 | 1 | 0201 |
| 64 | Coaxial | 06 | 2 | 0602 | 02 | 2 | 0202 |
| 65 | Coaxial | 06 | 3 | 0603 | 02 | 3 | 0203 |
| 66 | Coaxial | 06 | 4 | 0604 | 02 | 4 | 0204 |
| 67 | Coaxial | 06 | 5 | 0605 | 02 | 5 | 0205 |
| 68 | Coaxial | 06 | 6 | 0606 | 02 | 6 | 0206 |
| 69 | 12-way | 06 | 9 | 0609 | 03 | 16 | 0316 |
| 70 | Coaxial | 06 | 7 | 0607 | 04 | 4 | 0404 |
| 71 | Twin | 02 | 13 | — | Dial lights | — | — |
| 71a | Twin | 02 | 14 | — | Dial lights | — | — |
| 72 | Coaxial | 02 | 7 | 0207 | 03 | 4 | 0304 |
| 73 | Coaxial | 02 | 8 | 0208 | 03 | 8 | 0308 |
| 74 | Coaxial | 02 | 9 | 0209 | 03 | 6 | 0306 |
| 75 | Coaxial | 02 | 10 | 0210 | 03 | 3 | 0303 |
| 76 | Coaxial | 02 | 11 | 0211 | 03 | 7 | 0307 |
| 77 | Coaxial | 02 | 12 | 0212 | 03 | 5 | 0305 |
| 78 | Coaxial | 03 | 10 | 0310 | 04 | 5 | 0405 |
| 79 | Coaxial | 03 | 9 | 0309 | 04 | 6 | 0406 |
| 80 | 6-way | 03 | 15 | 0315 | 04 | 12 | 0412 |
| 81 | 6-way | 03 | 1 | 0301 | 01 | 1 | 0101 |

## TABLE 7—*continued*

| Cable ref. number (Chap. 1) (on fig. 9) | Type | From: Unit number (ringed on fig. 9) | From: PL or SK number | From: Cable ident. marking | To: Unit number (ringed on fig. 9) | To: PL or SK number | To: Cable ident. marking |
|---|---|---|---|---|---|---|---|
| 82 | Twin | 02 | 15 | — | Screen lights | — | — |
| 82a | Twin | 02 | 16 | — | Screen lights | — | — |
| 83 | 6-way | 04 | 11 | 0411 | 05 | 2 | 0502 |
| 84 | Coaxial | 04 | 7 | 0407 | 05 | 11 | 0511 |
| 85 | 6-way | 05 | 8 | 0508 | 01 | 2 | 0102 |
| 86 | Coaxial | 05 | 10 | 0510 | 06 | 14 | 0614 |
| 87 | Coaxial | 05 | 9 | 0509 | 06 | 13 | 0613 |
| 88 | 12-way | 05 | 1 | 0501 | 06 | 18 | 0618 |
| 89 | Coaxial | 06 | 11 | 0611 | 01 | 10 | 0110 |
| 90 | Coaxial | 06 | 16 | 0616 | 01 | 7 | 0107 |
| 91 | Coaxial | 06 | 12 | 0612 | 01 | 9 | 0109 |
| 92 | Coaxial | 06 | 15 | 0615 | 01 | 8 | 0108 |
| 93 | Coaxial | 01 | 6 | 0106 | 05 | 6 | 0506 |
| 94 | Coaxial | 01 | 3 | 0103 | 05 | 3 | 0503 |
| 95 | Coaxial | 01 | 5 | 0105 | 05 | 5 | 0505 |
| 96 | Coaxial | 01 | 4 | 0104 | 05 | 4 | 0504 |

## TABLE 8

### Console inputs and outputs

**Note** . . . *This Table gives a complete list of inputs and outputs to a fixed-coil console Type 64, but some consoles—particularly on early installations—do not require all the facilities listed, so that some of the connections are not always made.*

| PL or SK number on input panel | Pin | Service | External destination (R.A. = rack assembly) |
|---|---|---|---|
| **Multicore** | | | |
| **PL1** | A | Range strobe range | Console Type 61 via R.A. (misc.) Type 306 |
| | B | 300V for range strobes | Console Type 61 |
| | C | Range strobe (azic. marker) range | R.A. (azic.) Type 302 via R.A. (misc.) Type 306 |
| | D | | |
| | E | | |
| | F | IFF on-off | R.A. (head selector units) Type 184 |
| | G | Head combining | R.A. (head selector units) Type 184 |
| | H | Strobe key | Console Type 65 |
| | J | Fine/coarse key | R.A. (head selector units) Type 184 |
| | K | Type 7 extra high key | R.A. (head selector units) Type 184 |
| | L | Type 7 high key | R.A. (head selector units) Type 184 |
| | M | Type 7 full cover key | R.A. (head selector units) Type 184 |
| | N | 250 p.r.f. forward key | R.A. (head selector units) Type 184 |
| | O | Type 11 key | R.A. (head selector units) Type 184 |
| | P | Type 54 key | R.A. (head selector units) Type 184 |
| | Q | 500 p.r.f. forward key | R.A. (head selector units) Type 184 |
| | R | 500 p.r.f. backward key | R.A. (head selector units) Type 184 |
| | S | — | R.A. (head selector units) Type 184 |
| | T | Selector switch earth | R.A. (head selector units) Type 184 |
| | U | CRT dimming | R.A. (head selector units) Type 184 |
| | V | Azic. key | R.A. (misc.) Type 306 |
| | W | Off-centre X | Inter-trace switching cabinet |
| | X | Off-centre Y | Inter-trace switching cabinet |
| | Y | | |
| | Z | | |
| **PL2** | A to Z | Inter-trace switching | Inter-trace switching cabinet |
| **PL3** | A | −470V unregulated | R.A. (bulk power supply) Type 305 |
| | B | −500 reference | R.A. (negative ref. supply) Type 338 |
| | C | −50V | Rectifier Type 15 (in I.G.) |
| | D | 230 50 (c/s | Radar office power board |
| | E | 230V 50 c/s | Radar office power board |
| | F | Paralleled to pin D | Radar office power board |
| | G | Paralleled to pin E | Radar office power board |
| | H | +50V | Rectifier Type 15 |
| | J | Neutral (HT common earth) | R.A. (bulk power supply) Type 305 |
| | K | 230V 50 c/s | Heating and lighting fuse board |
| | L | Paralleled to pin K | Heating and lighting fuse board |
| | M | 50V console on-off | R.A. (bulk power supply) Type 305, and R.A. (neg. ref.) Type 338 (for B.P.S.) |
| | N | 50V console HT on-off | R.A. (bulk power supply) Type 305, and R.A. (neg. ref.) Type 338 (for console) |
| | O | 230V 50 c/s | Heating and lighting fuse board |
| | P | Paralleled to pin O | Heating and lighting fuse board |
| | Q | +570V unregulated | R.A. (bulk power supply) Type 305 |
| | R | +420V unregulated | R.A. (bulk power supply) Type 305 |

**TABLE 8** *(continued)*

**Console inputs and outputs** *(continued)*

| PL or SK number on input panel | Pin | Service | External destination (R.A. = rack assembly) |
|---|---|---|---|
| **Multicore**—*contd.* | | | |
| | S | +250V regulated | R.A. (bulk power supply) Type 305 |
| **PL4** | A to D | Range selector switch | Inter-trace switching cabinet |
| | E to J | Spare | — |
| | K | Sector selector switch 270 deg-90 deg | R.A. (resolver magslip) Type 301 |
| | L | Sector selector switch 315 deg-135 deg | R.A. (resolver magslip) Type 301 |
| | M | Sector selector switch 360 deg-180 deg | R.A. (resolver magslip) Type 301 |
| | N | Sector selector switch 45 deg-225 deg | R.A. (resolver magslip) Type 301 |
| | O | Sector selector switch 90 deg-270 deg | R.A. (resolver magslip) Type 301 |
| | P | Sector selector switch 135 deg-315 deg | R.A. (resolver magslip) Type 301 |
| | Q | Sector selector switch 180 deg-360 deg | R.A. (resolver magslip) Type 301 |
| | R | Sector selector switch 225 deg-45 deg | R.A. (resolver magslip) Type 301 |
| | S to Z | Spare | — |
| **PL5** | A to V | Spare | — |
| | W | Radar 13 turning-gear | Selector unit Type 100 |
| | X | Radar 13 turning-gear | Selector unit Type 100 |
| | Y | Inching potentiometer | R.A. (misc.) Type 306 |
| | Z | Inching potentiometer | R.A. (misc.) Type 306 |
| **PL6** | A to Z | GPO services | — |
| **PL7** | A to Z | Mk. 10 IFF (when available) | — |
| **PL8** | A to Z | Inter-trace switching | Inter-trace switching cabinet |
| **Coaxial** | | | |
| **SK9 to SK14** | — | Spare | — |
| **SK15** | — | Inter-trace cosine (Y) component | R.A. (azication) Type 302 |
| **SK16** | — | Radar scan cosine Y) component | R.A. (head sel. units) Type 184 |
| **SK17** | — | Spare | — |
| **SK18** | — | Inter-trace sine (X) component | R.A. (azication) Type 302 |
| **SK19** | — | Radar scan sine (X) component | R.A. (head selector units) Type 184 |
| **SK20** | — | Radar video | R.A. (head selector units) Type 184 |
| **SK21** | — | Inter-trace bright-up (strobe markers) | R.A. (misc.) Type 306 — |
| **SK22** | — | Video map | R.A. (head selector units) Type 184 |
| **SK23** | — | Range strobe | Console Type 61 |
| **SK24** | — | Range rings | R.A. (head selector units) Type 184 |
| **SK25** | — | IFF video | R.A. (head selector units) Type 184 |
| **SK26** | — | Radar bright-up | R.A. (head selector units) Type 184 |
| **SK27** | — | Negative I.T. gating waveform | R.A. (gating waveform) Type 304 |
| **SK28** | — | Positive I.T. gating waveform | R.A. (gating waveform) Type 304 |

# Appendix 1

# DISTRIBUTION PANEL TYPE 861A

## LIST OF CONTENTS



## LIST OF ILLUSTRATIONS



**Purpose**

**1.** When the fixed coil display system is used with phase 1A equipment, the console type 64, with its sub-units, is re-referenced to become a wired framework and a number of sub-units. Variations of basic sub-units are selected to suit various requirements.

**2.** The distribution panel type 861A is a modified version of the type 861 and the circuit is shown in fig. 3.

**3.** One of the changes is to the stabilized +250V h.t. circuit. This circuit has been modified (fig. 1) so that the supply to the deflector coils and the supply to the screens of the output valves (V9 and V11 in the deflection amplifiers) are carried by the same cable.

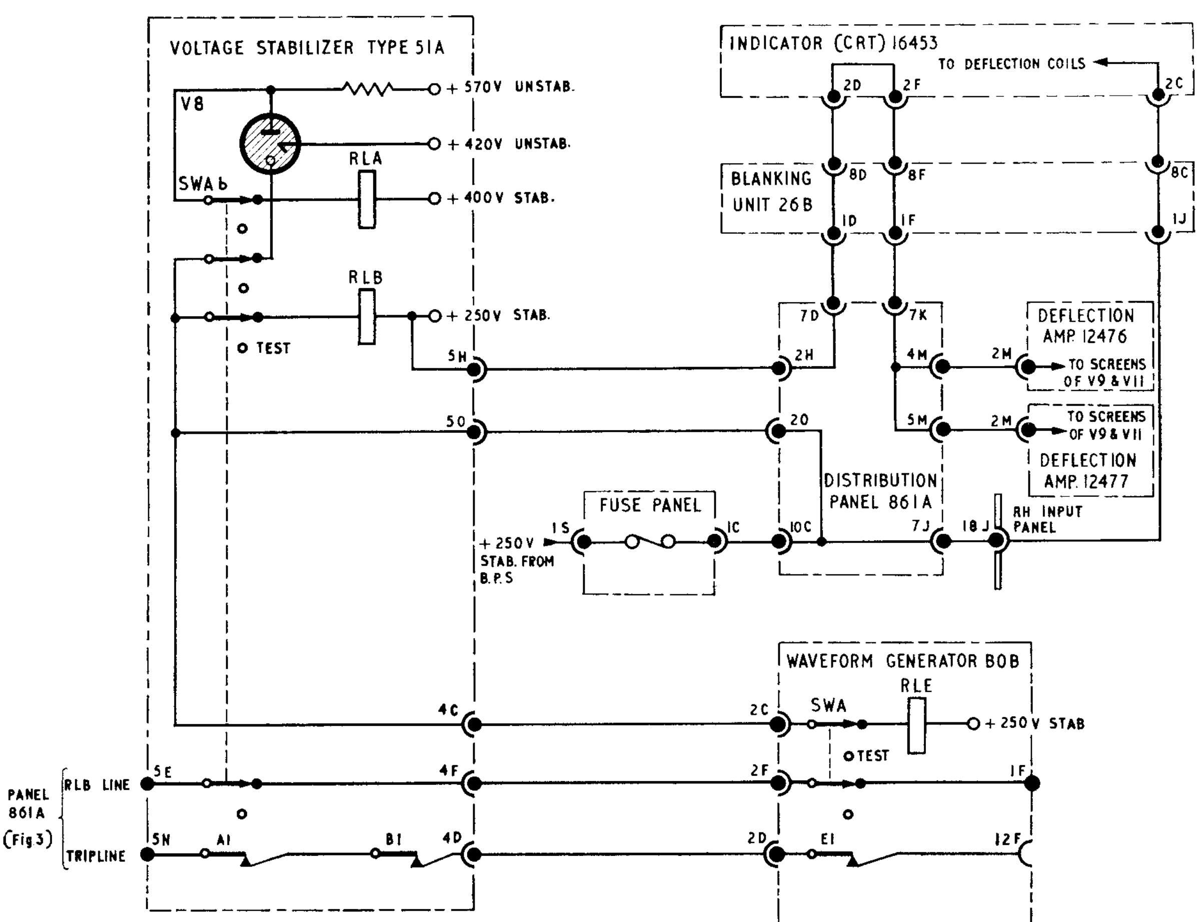



**Fig. 1. Modified circuit of +250V stabilized line**

**4.** The other change to the distribution panel concerns the h.t. switching circuit (fig. 2). The indicator lamps (LP1 and LP2) in the control desk are now operated from a 6·3V supply. When RLD is operated (see para. 8 of main chapter 9), a second contact, D2, closes and completes the 6·3V supply to the H.T. ON lamp ILP2.

**5.** If the trip is made open-circuit, RLD operates (see para. 9 of the main chapter 9). Contact D2 opens and the supply to ILP2 is interrupted.

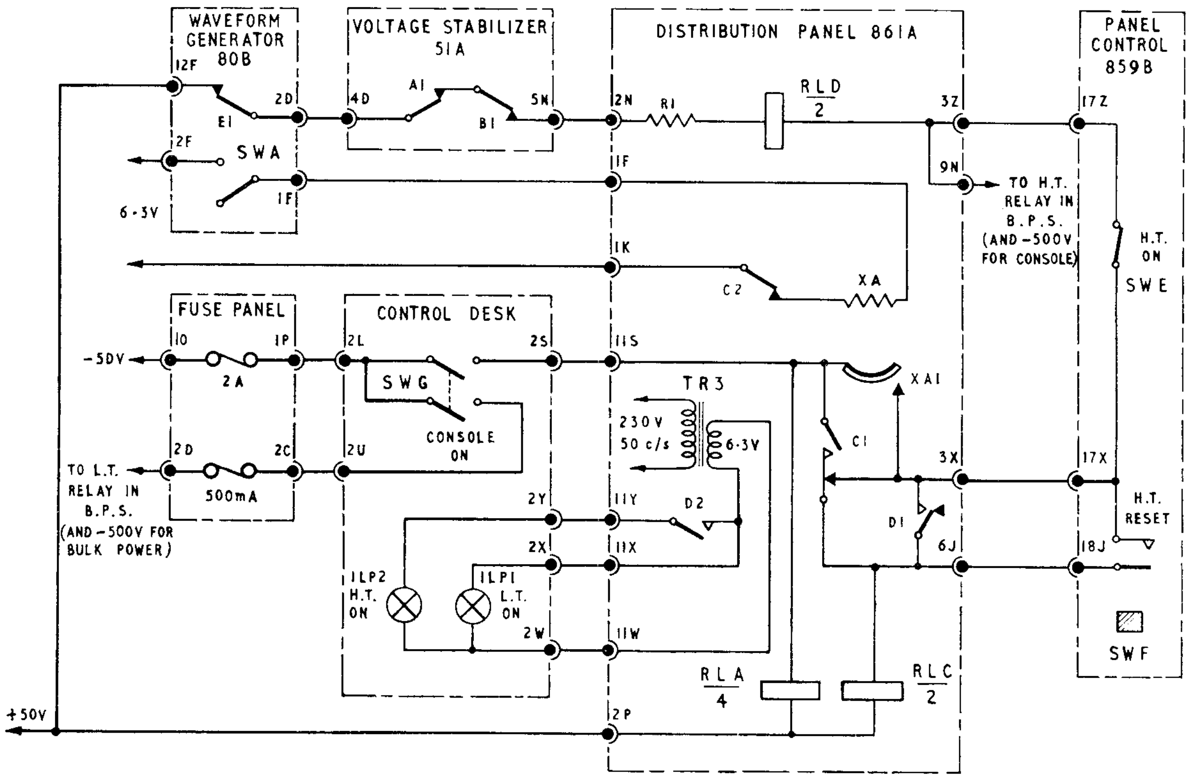



**Fig. 2. H.T. switching circuit**

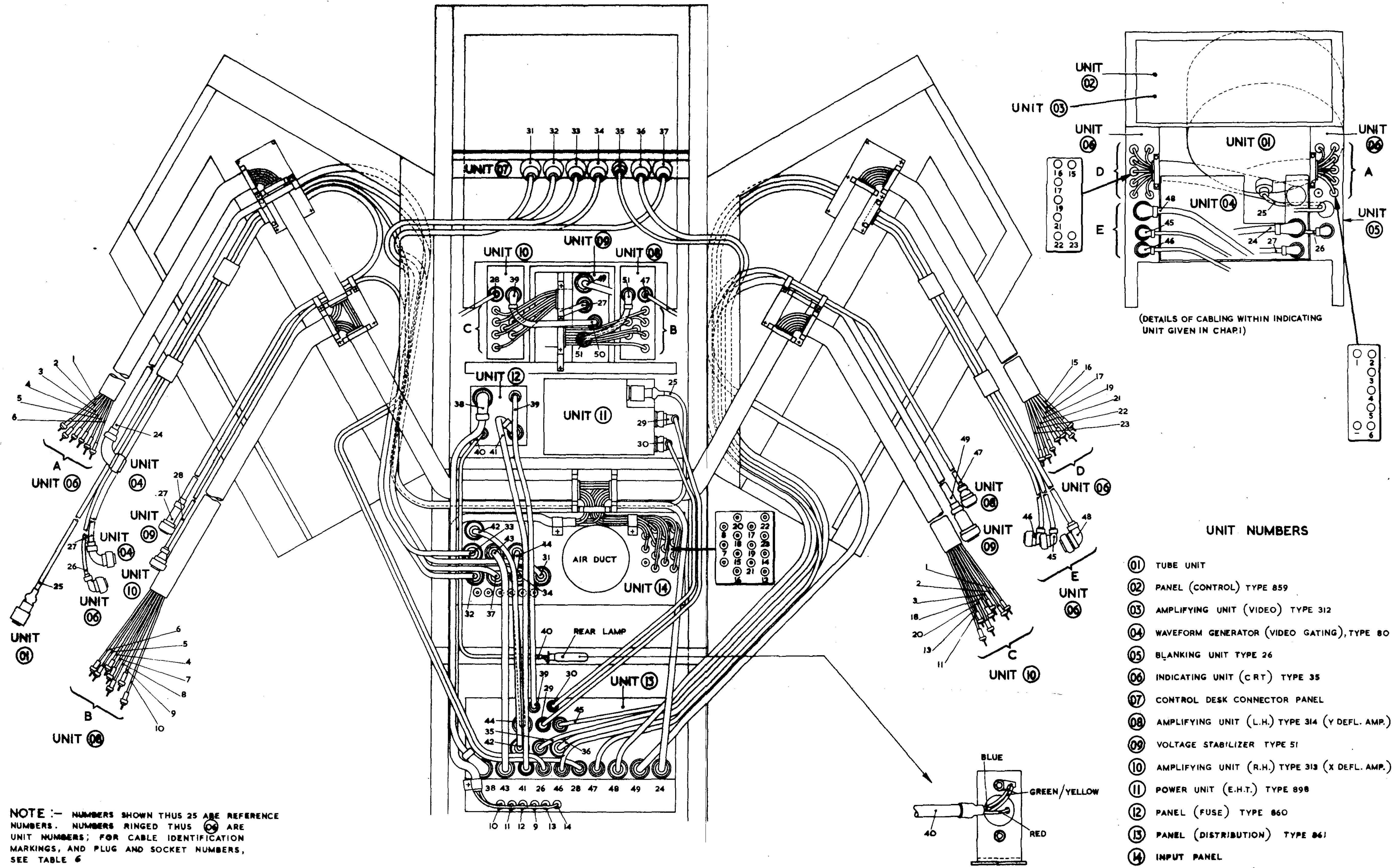


Printed for H.M. Stationery Office by J. Looker Ltd., Poole
Wt. 26424 D/d 6692 875 9/62 375/3


Fig. 3

Distribution panel Type 861 - circuit

Printed for H.M. Stationery Office by James Townsend and Sons Ltd., Exeter.
924/8/6693/26425/250848/881/9/62.




AIR DIAGRAM 6222T/MIN.

ISSUE 1 | PREPARED BY MINISTRY OF SUPPLY FOR PROMULGATION BY AIR MINISTRY

Console Type 64 cabling (unfolded view)

Fig.9

# Chapter 10

This chapter supersedes Chap. 10 issued with A.L.21

# CONTROL DESKS

## LIST OF CONTENTS



## LIST OF ILLUSTRATIONS

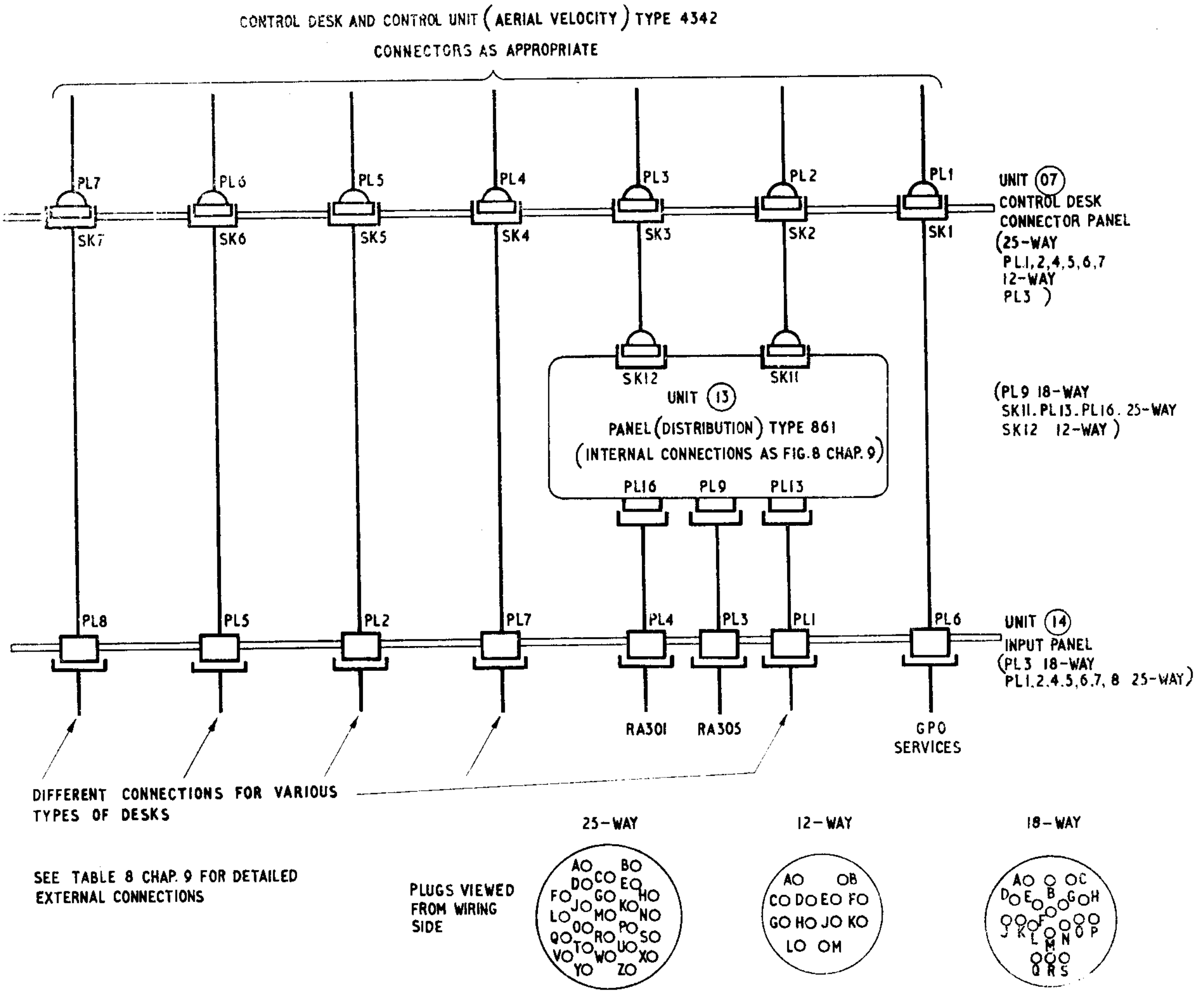



**Fig. 1. External connections to control desks—block diagram**

## Introduction

**1.** To enable the fixed-coil p.p.i. console Type 64 to be used in its various applications on ground radar stations, a number of different types of control desk have been designed. There are three basic types, which are as follows:—

(1) Type 862 to 907. These desks have provision for selecting IFF Mk. 3.

(2) Type 4550 to 4555C. These desks have provision for selecting the various facilities of IFF Mk. 10.

(3) Type 16284 to 16291. These desks have been designed to fulfil the requirements of the "Phase 1A" operation.

**2.** The less frequently used controls, common to all users of the console Type 64, are situated on the panel (control) Type 859 (Chapter 5 of this Section), situated behind the small door on the right of the c.r.t. screen.

**3.** The controls on the desks affect circuits in other units of the console, or elsewhere on the radar station. Detailed information on these circuits is not given in this Chapter, but reference is made to the relevant chapter, where necessary. The operating instructions for the control desks are to be found in Sect. 2 of this Part.

*External connections*

**4.** On all types of control desk, external connections are made via free plugs, which mate with panel-mounted sockets on the console control desk connector panel (unit 07). There are seven sockets on this panel, to cater for the various applications of the different types of desk, and connections are made as appropriate. Fig. 1 shows the services that are made available by the external connections, with reference to more detailed sources of information. The circuit diagrams of the individual control desks show which connectors are used.

*Aspects common to all desks*

**5.** As shown in the illustrations of the different types of desk, they are all in the form of a rectangular steel frame with an inset tray carrying the controls. The control inscriptions are engraved on the black-painted inside surface of a perspex panel, mounted in the tray, and a number of 6- or 12-volt panel lights provide edge-illumination of the engravings without radiating light externally.

**6.** The desks are mounted on the console Type 64 (and its variants) by inserting the desk side flanges into their guide channels on the console framework and sliding the desk into position. The desk is then secured to the console framework by two captive screws.

**7.** The assembly is completed by fitting the sheet-metal or fibreglass outer desk cover, which protects the components on the control desk and provides a convenient ledge for an elbow-rest or for writing (fig. 5, Chap. 2, Sect. 1 of this Part). The sheet metal desk cover carries studs which engage in keyhole-shaped slots in the sides of the console. Removal of the cover is effected by striking it underneath at each end and lifting it upwards and outwards, clear of the control desk.

**8.** All desks carry a toggle switch for switching-on the console. Behind this switch are two indicator lamps (HT and HEATERS ON). In addition, most desks with inter-com. facilities have an indicator lamp (INTERCOM. CALL lamp) at the rear of the desk on the left. The external connections for any particular control remain the same for all types of desk, so it will not be necessary to trace them for every desk.

### Complete range of desk controls

**9.** All the controls that have been used on any desk are described under this heading. Reference should be made to this description for an explanation of the controls listed in fig. 1a and 1b. These figures show the complete range of desks, each with their various combinations of facilities. Complete circuits of the majority of desks are shown in figs. 10 to 39. Where there is only a minor difference in circuitry, two or more desks are shown in one figure. The appearance of only a small selection of desks is given in this chapter (fig. 7, 8 and 9). The variations on these basic types may easily be visualized.

PANELS (CONTROL DESK) SERVICES

| TYPE No. | A.M. Ref. No. | Fig. No. of circuit | KEYS | JACKS | VM/RR | COARSE/FINE | MODE SEL. | CODE SEL. | MK3/OFF/MK10 | IFF/MIX/RADAR | IFF | RADAR | AD/AD + MKR | H/R STROBE | RADAR HEAD (NSU35): RADAR | RADAR HEAD (NSU35): VIDEO | HEAD & PRF. SEL. | AZ/AZ + RS | AZ MARK ON | CONTROL UNIT (AERIAL VEL.) 4342 | RANGE POT | PASS/CALL | ANTI-JAM KEYS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | P.O. FACILITIES | | | CALIBRATION | | | IFF SWITCHING | | | | | | HEAD & VIDEO SEL. | | | | | | | | |
| 862 | 10D/18646 | 15 | 3 | 2 | * | * | | | | | * | | | * | * | | | | | | | | |
| 893 | 10D/18942 | 17 | | 2 | * | * | | | | | | | | * | * | | | * | | * | * | | |
| 893A | 10D/22361 | 11 | 1 | 2 | * | * | | | | | | | | * | * | | | | * | * | * | * | |
| B93B | 10D/22362 | 12 | 1 | 2 | * | * | | | | | | | | * | * | | | * | | * | * | | |
| 894 | 10D/18943 | 13 | 3 | 2 | * | * | | | | | * | | | * | * | | | * | | * | * | | |
| 894A | 10D/21455 | 14 | 3 | 2 | * | * | | | | | * | | | * | * | | | | * | * | * | | |
| 895 | 10D/18944 | 10 | | 4 | * | * | | | | | | | | * | * | | | | | | | | |
| 895A | 10D/22895 | 16 | | 4 | * | * | | | | | | * | | | | * | * | | | | | | |
| B96 | 10D/18945 | 17 | | 4 | * | * | | | | | | | | * | * | | | * | | * | * | | |
| 907 | 10D/18996 | 17 | | 4 | * | * | | | | | | | | * | * | | | * | | | * | | |
| 4550 | 10D/19373 | 18 | 3 | 2 | * | * | * | * | | * | | | | * | * | | | | | | | | |
| 4550A | 10D/21269 | 19 | 3 | 4 | * | * | * | * | | * | | | | * | * | | | | | | | | |
| 4550B | 10D/21424 | 20 | 3 | 4 | * | * | * | * | | * | | | | * | * | | | | | | | | |
| 4550C | 10D/21483 | 19 | 3 | 2 | * | * | * | * | | * | | | | * | * | | | | | | | | |
| 4550D | 10D/22312 | 21 | 3 | 4 | * | * | * | * | | * | | | | * | * | | | | | | | | |
| 4550E | 10D/22313 | 22 | 1 | 4 | * | * | * | * | | * | | | | * | * | | | | | | | | |
| 4550F | 10D/22314 | 23 | 1 | 4 | * | * | * | * | | * | | | | * | * | | | | | | | | |
| 4550G | 10D/22311 | 23 | 1 | 4 | * | * | * | * | | * | | | | * | * | | | | | | | | |
| 4550H | 10D/22386 | 24 | 3 | 4 | * | * | * | * | | * | | | | * | * | | | | | | | | |
| 4550J | 10D/22384 | 24 | 3 | 4 | * | * | * | * | | * | | | | * | * | | | | | | | | |
| 4550K | 10D/22385 | 21 | 3 | 4 | * | * | * | * | | * | | | | * | * | | | | | | | | |
| 4550L | 10D/22823 | 25 | 1 | 4 | * | * | * | * | | * | | | | | | * | * | | | | | | |
| 4551 | 10D/19374 | 26 | | 2 | * | * | * | | * | | | * | | * | * | | | * | | * | * | | |
| 4552 | 10D/19375 | 27 | 3 | 2 | * | * | * | | * | | | * | | * | * | | | * | | * | * | | |
| 4553 | 10D/19376 | 28 | | 4 | * | * | * | | * | | | * | | * | * | | | | | | | | |
| 4553A | 10D/21268 | 29 | | 4 | * | * | * | * | | * | | | | * | * | | | | | | | | |

| TYPE No. | CONTROLLER 1 OR 2 | INDICATORS | T13/TFPS6 | CALL/CANCEL | JOYSTICK UNIT | RING/OFF/DOT | ICM RING/DOT | RESET | MARK ON | INTERIM INTER-CONSOLE MARKING (WITHOUT AMP UNIT (MIXER) TYPE 4428) | MASTER RESOLVER KEY | INTER-CONSOLE MARKING (WITH AMP UNIT (MIXER) TYPE 4428) | HEIGHT LEVER | RECORD HEIGHT | NO HEIGHT | CONSOLE AVAIL. | TYPE No. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | FPS6 | | | HEIGHT SHARING | | I.T. MARKING | | | | | | | HEIGHT FINDER | | | | |
| 862 | | | | | | | | | | | | | | | | | 862 |
| 893 | | | | | | | | | | | | | | | | | 893 |
| 893A | | | | | | | | | | | | | | | | | B93A |
| B93B | | | | | | | | | | | | | | | | | B93B |
| 894 | | | | | | | | | | | | | | | | | B94 |
| 894A | * | | | | | | | | | | | | | | | | 894A |
| 895 | | | | | | | | | | | | | | | | | B95 |
| 895A | | | | | | | | | | | | | | | | | 895A |
| B96 | | | | | | | | | | | | | | | | | B96 |
| 907 | | | | | | | | | | | | | | | | | 907 |
| 4550 | | | | | | | | | | | | | | | | | 4550 |
| 4550A | | | | | * | | | * | * | 4 SEND SWITCHES | | | | | | | 4550A |
| 4550B | | | | | | | | | | LINK ADDED TO RECEIVE I.I.C.M | | | | | | | 4550B |
| 4550C | | | | | * | | | * | * | INT/EXT SWITCH FOR U.T.F. LINK | | | | | | | 4550C |
| 4550D | | | | | * | | | * | * | 6 POSITION SWITCH, SEND/RECEIVE TO MC/SITE 1/SITE 2 | | | | | | | 4550D |
| 4550E | | | | | * | | | * | * | 4 POSITION SWITCH, SEND/RECEIVE TO SITE 1/SITE 2 | | | | | | | 4550E |
| 4550F | | | | | * | | | * | * | 6 POSITION SWITCH, SEND/RECEIVE TO CC1/CC2/CC3 | | | | | | | 4550F |
| 4550G | | | | | | | | | | | | | | | | | 4550G |
| 4550H | | | | | * | | | * | * | 3 POSITION SWITCH. SEND 1/C'S (4 SEND SWITCHES) SEND MC/RECEIVE MC. | | | | | | | 4550H |
| 4550J | | | | | | | | | | | | | | | | | 4550J |
| 4550K | | | | | * | | | * | * | 2 POSITION SWITCH SEND/RECEIVE | | | | | | | 4550K |
| 4550L | | | | | | | | | | | | | | | | | 4550L |
| 4551 | | | | | | | | | | | | | | | | | 4551 |
| 4552 | | | | | | | | | | | | | | | | | 4552 |
| 4553 | | | | | | | | | | | | | | | | | 4553 |
| 4553A | | | | | | | | | | | | | | | | | 4553A |

KEY

* FACILITY AVAILABLE

× RANGE RINGS ONLY

⊗ REWIRED FOR USE WITH MIXER

FULL TITLES OF CERTAIN UNITS NAMED ABOVE ARE AS FOLLOWS:

INDICATORS: INDICATOR (ELECTRICAL) TYPE 12956

JOYSTICK: CONTROL UNIT (JOYSTICK) TYPE 12270

HEIGHT LEVER: CONTROL UNIT (LEVER) TYPE 12955

Fig. 1a. Panels (control desk) services—Part 1

RESTRICTED

PANELS (CONTROL DESK) — SERVICES

| TYPE No. | A.M. Ref. No. | Fig. No. of circuit | P.O. FACILITIES: KEYS | P.O. FACILITIES: JACKS | CALIBRATION: VM/RR | CALIBRATION: COARSE/FINE | IFF SWITCHING: MODE SEL. | IFF SWITCHING: CODE SEL. | IFF SWITCHING: MK3/OFF/MK10 | IFF SWITCHING: IFF/MIX/RADAR | IFF SWITCHING: IFF | IFF SWITCHING: RADAR | IFF SWITCHING: AD/AD + MK9 | H/R STROBE | HEAD & VIDEO SEL.: RADAR HEAD (HSU35): RADAR | HEAD & VIDEO SEL.: RADAR HEAD (HSU35): VIDEO | HEAD & VIDEO SEL.: HEAD & PRF. SEL. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4553B | 100/22894 | 30 | | 4 | * | * | * | * | | * | | | | | | * | * |
| 4554 | 100/19377 | 31 | | 4 | * | * | * | | * | | | * | | * | * | | |
| 4555 | 100/19378 | 32 | | 4 | * | * | * | | * | | | * | | * | * | | |
| 4555A | 100/21267 | 29 | 1 | 4 | * | * | * | * | | * | | | | * | * | | |
| 4555B | 100/22383 | 29 | | 4 | * | * | * | * | | * | | | | * | * | | |
| 4555C | 100/22381 | 33 | | 4 | * | * | * | * | | * | | | | | | * | * |
| 16284 | 100/22363 | 34 | 1 | 4 | * | * | * | * | | * | | | * | | | * | * |
| 16285 | 100/22364 | 35 | 3 | 4 | * | * | * | * | | * | | | * | | | * | * |
| 16286 | 100/22365 | 36 | 3 | 4 | * | * | * | * | | * | | | | | | * | * |
| 16287 | 100/22366 | 37 | 1 | 4 | × | * | | | | | | * | | | | | |
| 16288 | 100/22367 | 38 | 1 | 4 | * | * | * | * | | * | | | | | | * | * |
| 16289 | 100/22368 | 39 | 1 | 4 | * | * | * | * | | * | | | * | | | * | * |
| 16290 | 100/22369 | 37 | 1 | 4 | × | * | | | | | | * | | | | | |
| 16291 | 100/22370 | 39 | 1 | 4 | * | * | * | * | | * | | | * | | | * | * |
| M3 | 100/22689 | – | | | * | | | | | | | | | | | | |
| M4 | 100/22698 | – | | | * | | | | | | | | | | | | |
| M5 | 100/22691 | – | | | * | | | | | | | | | | | | |

| TYPE No. | AZ/AZ+RS | AZ MARK ON | CONTROL UNIT (AERIAL VEL.) 4342 | RANGE POT | PASS/CALL | ANTI-JAM KEYS | FPS6: CONTROLLER 1 OR 2 | FPS6: INDICATORS | FPS6: T13/TFP56 | HEIGHT SHARING: CALL/CANCEL | HEIGHT SHARING: JOYSTICK UNIT | I.T. MARKING: RING/OFF/DOT | I.T. MARKING: ICM RING/DOT | I.T. MARKING: RESET | I.T. MARKING: MARK ON | INTERIM INTER-CONSOLE MARKING (WITHOUT AMP. UNIT (MIXER) TYPE 4428) | MASTER RESOLVER KEY | INTER CONSOLE MARKING (WITH AMP UNIT (MIXER) TYPE 4428) | HEIGHT FINDER: HEIGHT LEVER | HEIGHT FINDER: RECORD HEIGHT | HEIGHT FINDER: NO HEIGHT | HEIGHT FINDER: CONSOLE AVAIL | TYPE No. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4553B | | | | | | | | | | | | | | | | | | | | | | | 4553B |
| 4554 | * | | * | * | | | | | | | | | | | | | | | | | | | 4554 |
| 4555 | * | | | * | | | | | | | | | | | | | | | | | | | 4555 |
| 4555A | * | | | * | | | | | | | | | | | | | | | | | | | 4555A |
| 4555B | * | | | * | | | | | | | | | | | | | | | | | | | 4555B |
| 4555C | ⊗ | | | * | | | | | | | | | | | | | | | | | | | 4555C |
| 16284 | | | | * | | | | * | | | * | * | | * | | | * | | | | | | 16284 |
| 16285 | | | | | | | | | | | * | * | * | * | | | | 6 I.C.M. 'ON' SWITCHES | | | | | 16285 |
| 16286 | | | | | | | | * | * | * | * | * | * | * | | | | | | | | | 16286 |
| 16287 | | | | | | 3 | | | | | | | | | | | | | * | * | * | * | 16287 |
| 16288 | | | | | | | | | | | * | * | * | * | | | | 6 I.C.M. 'ON' SWITCHES | | | | | 16288 |
| 16289 | | | | | | | | | | | * | * | | * | | | | | | | | | 16289 |
| 16290 | | | | | | | | | | | | | | | | | | | * | * | * | * | 16290 |
| 16291 | | | | | | | | | | | * | * | * | * | | | | SEND 1, SEND 2, RECEIVE 1/OFF/ RECEIVE 2 SWITCHES | | | | | 16291 |
| M3 | | | | | | | | | | | | | | | | | | | | | | | M3 |
| M4 | | | | | | | | | | | | | | | | | | | | | | | M4 |
| M5 | | | | | | | | | | | | | | | | | | | | | | | M5 |

(M3, M4, M5:) FOR DETAILS OF OTHER CONTROLS, REFERENCE SHOULD BE MADE TO THE RADAR PUBLICATION

**KEY**

* FACILITY AVAILABLE

× RANGE RINGS ONLY

⊗ REWIRED FOR USE WITH MIXER

FULL TITLES OF CERTAIN UNITS NAMED ABOVE ARE AS FOLLOWS:

INDICATORS: INDICATOR (ELECTRICAL) TYPE 12956

JOYSTICK: CONTROL UNIT (JOYSTICK) TYPE 12270

HEIGHT LEVER: CONTROL UNIT (LEVER) TYPE 12955

Fig. 1b. Panels (control desk) services—Part 2

*Control unit (aerial velocity) Type 4342*

**10.** This unit (Stores Ref. 10L/16215) is mounted on the right-hand side of those desks which make provision for controlling a Type 13, height-finder, aerial head. The unit is shown in the illustration of panel (control desk) Type 896. A rear view of a unit with the cover removed is shown in fig. 2 and a dismantled view, showing the gearing and cam switches, is given in fig. 3. The circuit diagram is given in fig. 4.

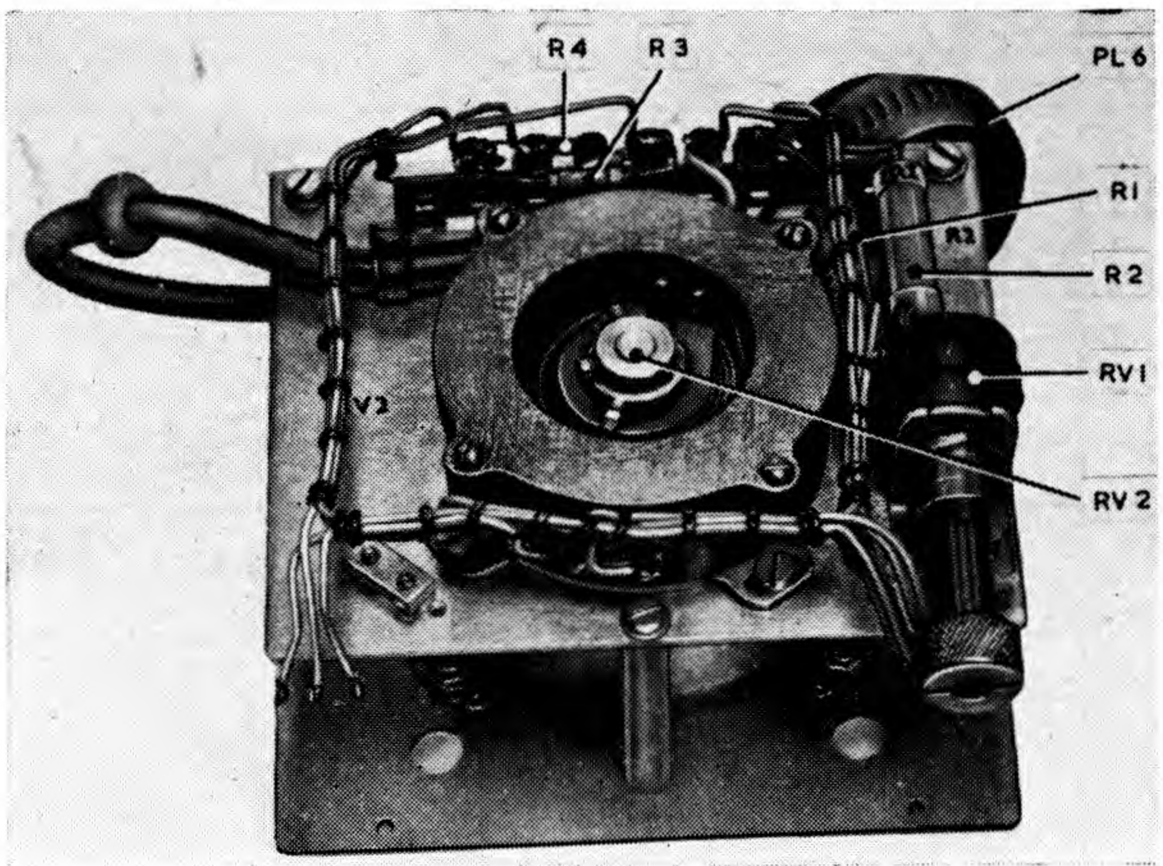



**Fig. 2. Control unit (aerial velocity) Type 4342 rear view with cover removed**

**11.** *Mechanical description.* The front part of the unit, seen on the left of fig. 3, contains a spring mechanism and a locking device, which are unlikely to develop faults and are not, therefore, shown dismantled. The spring mechanism causes the laying control to return freely to its central position when released from clockwise or counter-clockwise rotation. To prevent the control from being turned too far in either direction, stops project from the periphery of the annular gear driving the potentiometer spindle. The control may be locked within a few degrees of the maximum clockwise or counter-clockwise position by depressing the locking button. To release the button, turn the knob slightly clockwise, or counter-clockwise, as appropriate to take the load off it.

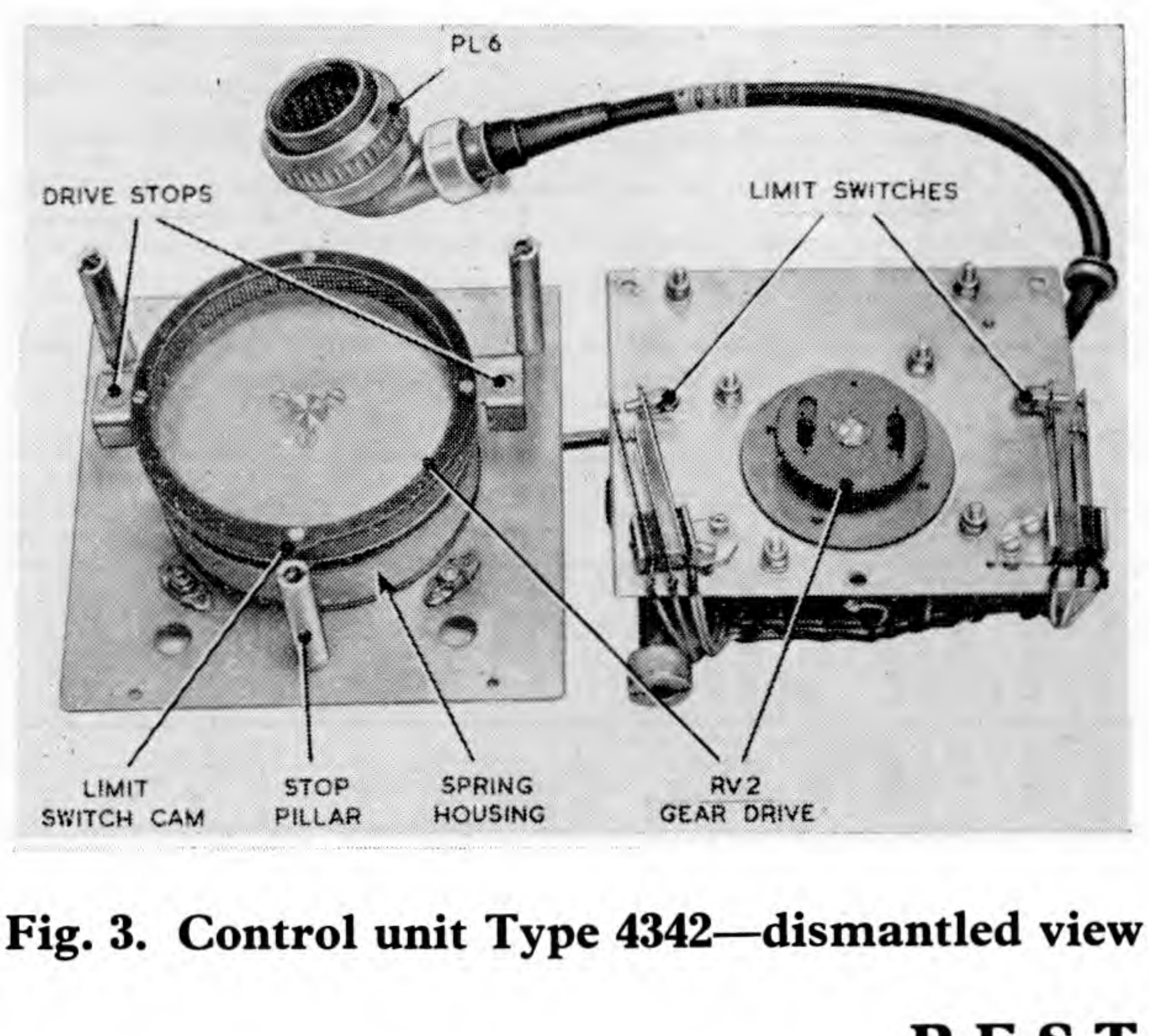



**Fig. 3. Control unit Type 4342—dismantled view**

**12.** The stops permit the control knob to turn the annular gear through 180 deg. (90 deg. in each direction). With the unit assembled, this drives the potentiometer (RV2) spindle through an anti-backlash gear of such ratio as to turn the potentiometer over its complete range. A cam on the periphery of the annular gear operates a switch at each extreme of the control rotation.

**13.** *Electrical function.* The external connections to the unit (PL6/W, X, Y and Z in fig. 4) are connected to the unit 07 socket SK6, feeding the plug PL5 on the console input panel (unit 14 in fig. 1). From here Y and Z are connected to the radar Type 13 turning gear via selector unit Type 100, while W and X are connected to the relay unit (AZ. c/o) Type 192 in the RA306, which selects either the main or

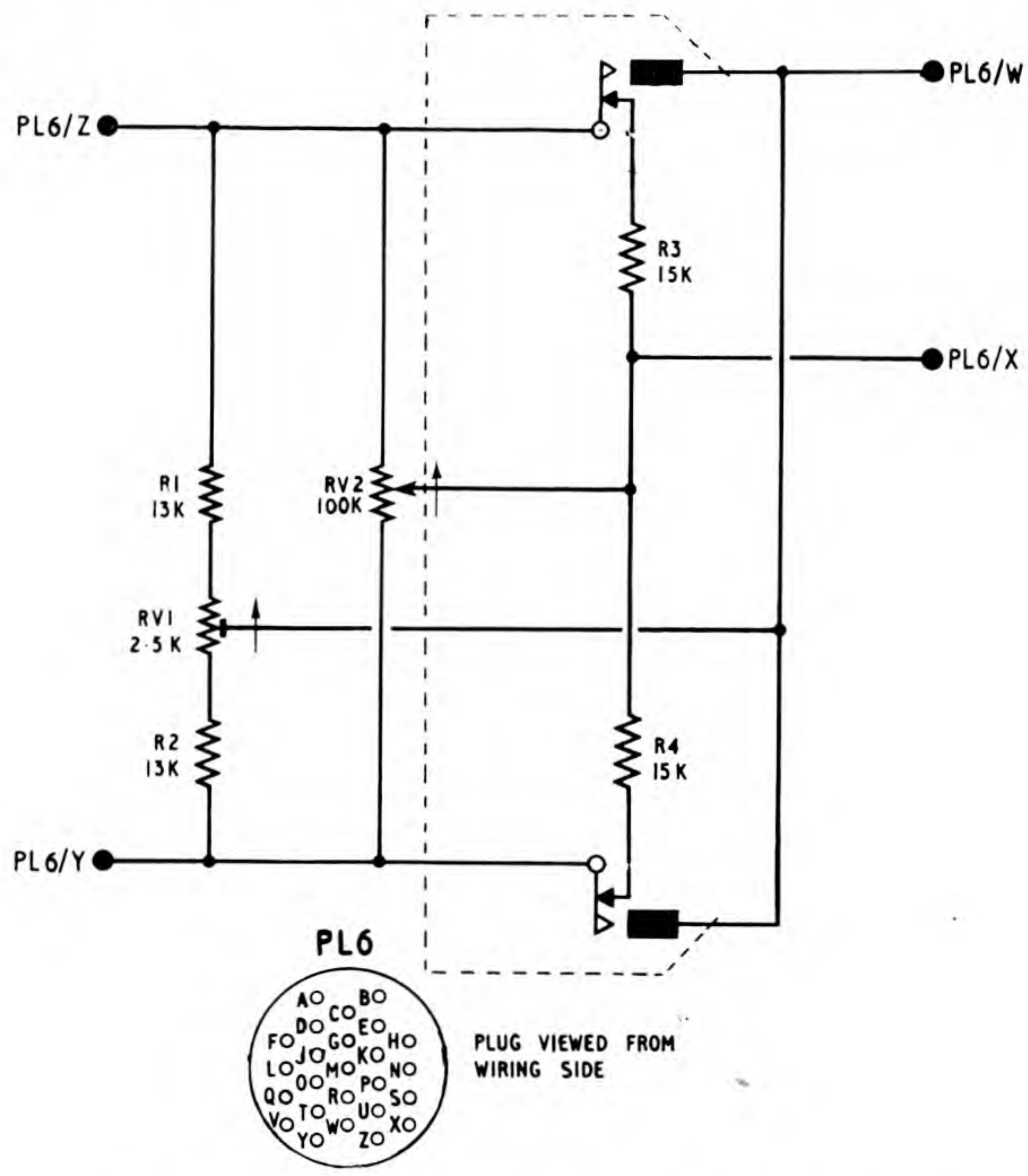



**Fig. 4. Control unit Type 4342—circuit**

standby console and completes the connection to the turning gear via the selector unit Type 100. Fig. 5 gives the interconnections between the control unit 4342 and associated equipment for controlling one Type 13 head. The selector unit (training) Type 100 has six identical channels, only one of which is shown in fig. 5. Full details of the control system are given in A.P.2886H.

**14.** The 120V d.c. control voltage from the turning gear control unit Type 600 is applied across PL6/Z and Y of the control unit Type 4342 in the selected console. This consists mainly of a bridge circuit, of which the variable potentiometer RV2 (shunted by R3 and R4 to give the required characteristic) constitutes two arms, while the preset RV1 (with its series resistors R1 and R2) constitutes the other two. With RV2 in its central position, RV1 is adjusted to balance the bridge so that zero potential exists between PL6/W and X. There is then zero output to the servo amplifier Type 297, which controls the field current of the amplidyne generator feeding the turning motor of the radar Type 13 aerial head. The head is therefore stationary when the 4342 control knob is in the central position to which it is spring-loaded.

**15.** Clockwise rotation of the knob produces a positive-going output which results in clockwise rotation of the aerial head, while counter-clockwise rotation of the knob produces a negative-going output and counter-clockwise rotation of the head. The speed of rotation is dependent on the angle through which the control is turned.

**16.** When the control reaches the limit of rotation in either direction the cam on the drive gear operates the appropriate limit switch, the make-before break contacts of which cut out the bridge circuit and make a direction connection to the control voltage, thus giving maximum speed of rotation of the aerial head. The control may be locked, to maintain this speed, by pressing the locking button.

*PO facilities*

**17.** The first three switches, viz:—

(1) INTERCOM. C.C.F.M.
(2) R.T. TRANS.
(3) MON. SPEAK

are connected into the communications system via PL1, along with the telephone headset jack (or jacks) and the intercom. call lamp LP7.

**18.** The communications facilities afforded by these components and by the loudspeakers and microphones associated with the consoles, are outside the scope of this volume, but a brief indication of their use is given to round off the description.

**19.** With the INTERCOM. key in its central position the p.p.i. reader receives information via his loudspeaker, but, by operation of the key to C.C. or F.M., he can convert his loudspeaker to a microphone for communicating with the Chief Controller or Fighter Marshall. The call lamp LP7, previously used to indicate the allocation of the communications link (in parallel to the p.p.i. readers of the two teams in an interception p.p.i. cabin) to each reader in turn for half minute periods, is not now used.

**20.** The R.T. TRANSMIT key is in parallel with a key performing the same function on the communications console, and permits communication with fighter aircraft via the v.h.f. transmitter–receiving link. The monitor speak key provides a similar function for communication with the operator monitoring the radio transmission.

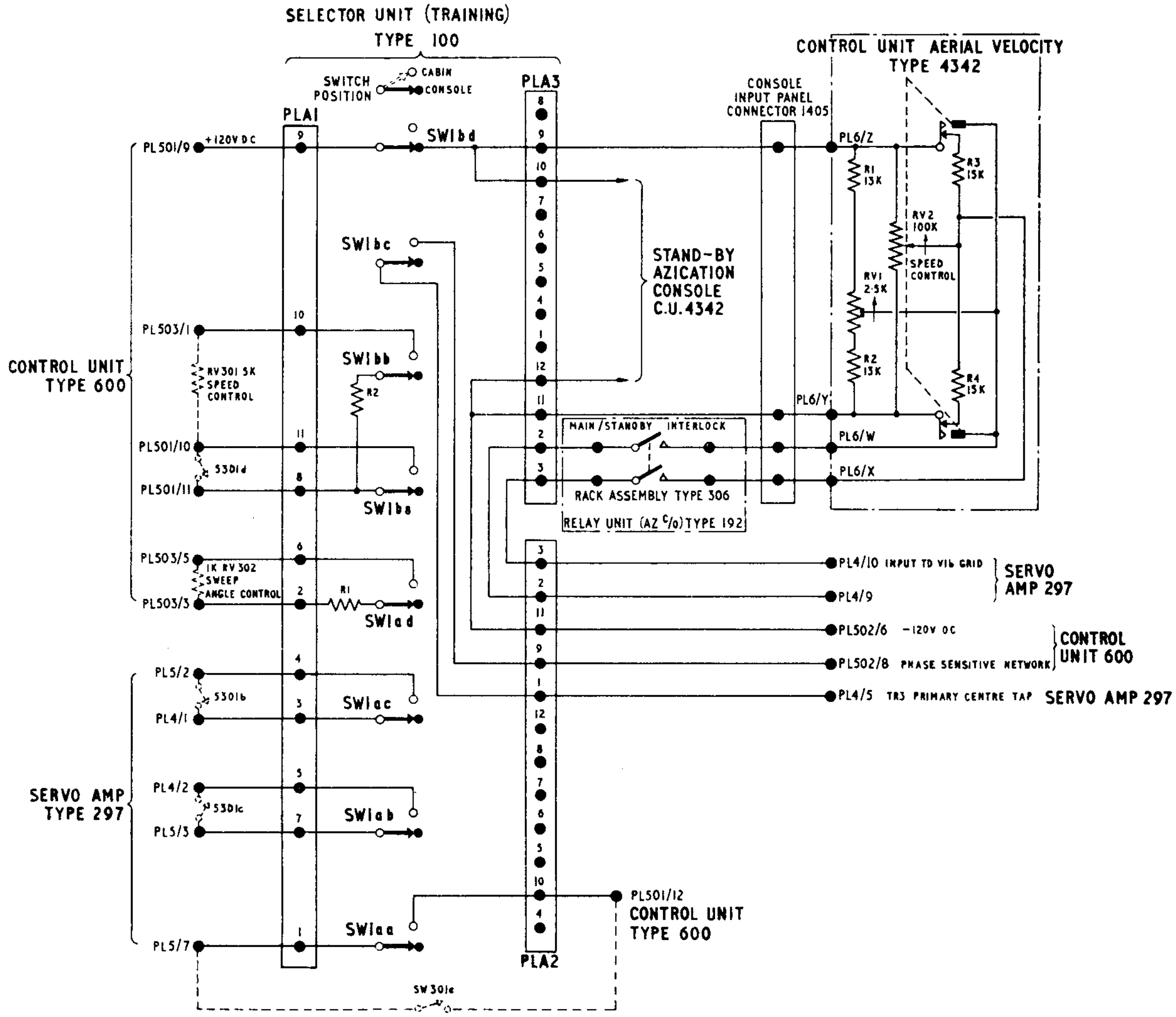



**Fig. 5. Interconnections for speed control of a radar Type 13 head**

**21.** Later versions of the control desks have different uses for the P.O. facilities. The first key may be labelled SPEAK TEAM/CONTROLLER and the last key used as spare. Other desks have only one key which is simply labelled SPEAK.

*IFF facilities*

**22.** On the 862 range of desks only one key (IFF) is fitted. It is connected via PL2 to the amplifying unit (video) Type 312 in the console and to the IFF equipment in the radar head (via the appropriate head selector rack Type 184). On the 4550 range three keys are labelled IFF and are connected to the external circuits via PL2 and PL4. Where only one key is fitted, it switches on the Mk. 3 IFF in the Type 14 aerial head cabin. Where three keys are fitted the first key (MODE SEL.) selects mode 1, 2 or 3 (Mk. 10), the second key selects ALL SIGS/ONE CODE/ CALL CODES, and third enables RADAR, IFF or MIXED signals to be selected. In all cases the IFF input to the amplifying unit (video) Type 312 is made by applying the −50V operating supply to relay B in this unit.

*AD/AD+MKR*

**23.** Certain of the 16000 series desks are fitted with an AD/AD+MKR switch. This switch is used in conjunction with active IFF decoders, to provide a square marker around the normal console marker (AD+MKR). In the AD position the square marker does not appear.

**24.** Switches labelled CALIBRATION, are connected via PL2 to the indicator unit Type 35 and to the head selection system. The first key permits the selection of video map (V.M.) or range rings (R.R.) while the second key gives FINE or COARSE video map signals, when V.M. has been selected, or the choice of 5-mile or 10-mile range rings on R.R. The selected signals are applied to the video amplifier Type 312 by applying −50V to relay C (video map) or relay D (range rings)in this unit.

*Radar signals*

**25.** When the RADAR SIGS. switch is operated the +50V supply is changed from PL4/E to PL4/D and other switch contacts change over the −50V line. The −50V line is used to operate a relay in the radar signals lead to the video amplifier Type 312. This relay is only fitted, and used, when IFF Mk. 10 is fitted, and is required to supply Mk. 10 signals without radar signals. This relay has been superseded on later types of desk by the IFF/MIX/ RADAR key.

**26.** The non-locking key labelled H/R STROBE applies +50V, via PL2/Z, to the console Type 65, where a relay is energized to complete the circuit which produces a bright-up to call the attention of the associated console 65 operator to a particular target (see A.P.2897S for details of console 65 circuits).

*Azication mark/range strobe*

**27.** In the AZ. MARK position this key applies:—

(1) −50V to PL2/Q, which feeds the ITBU relay (E) in the video amplifier Type 312, and

(2) −50V to PL3/G, which feeds the appropriate azication relays in the relay unit (AZ. c/o) Type 192 (RA306) ensuring that the services fed into this unit (azication marker range voltage, H/R strobe range voltage, ITBU and turning gear control services) are allocated to the console on which the key has been pressed. The interlock system in the relay unit then prevents the second console in the pair from taking the services, which are limited to the console on which the key is pressed first.

**28.** In the AZ. MARK, RANGE STROBE position the key again energizes these circuits, but also applies −50V to PL2/R, which feeds the range strobe relay (A) in the video amplifier Type 312, to allow the range strobe signal from the console Type 61 to be fed into the amplifier, producing a single range ring on the c.r.t., at the same range as the azication mark.

*Azication mark range*

**29.** The control marked RANGE determines the distance from the centre of the c.r.t. of the azication mark and range strobe, which are displayed on the p.p.i. when the appropriate switch is operated. The azication mark indicates to the p.p.i. operator the direction in which the Type 13, FPS6 or T54 radar aerial is heading, this information being fed from the repeat-back selsyn at the head via the azication resolver.

**30.** The control also enables the p.p.i. operator to direct the attention of the H/R operator (console 61) to a particular target. He does this by using the RANGE control to make the range ring (para. 28) coincide with the target response on his p.p.i. Interconnections between the consoles 61 and 64 then cause an expanded trace, embracing the selected response, to occur on the IFF tube of the console 61.

**31.** Basically the RANGE control consists of two potentiometers (RV1 and RV3) which are ganged to the control spindle. In the Type 16284 desk only one potentiometer, RV1 is fitted. RV2 and RV4 are preset potentiometers, used for setting-up. The control is connected to the external circuits via PL3. +250V from PL1/C in the fuse panel Type 860 (unit 12) is applied to RV3 (RV1 in Type 16284) via PL3/L, the other end of RV3 (RV1) being earthed at PL2/K (PL3/M). The variable potential at PL3/K is then applied, via the RA306, to the RA302, where it changes the bias level in the mixer stage of the waveform generator Type 100 (entering on SK14/C) and so determines the range of the azication marker.

**32.** At the same time a potential of +300V, originating in the console 61 is applied via PL1/3 on the input panel (unit 14) to PL3/J, and the variable potential at PL3/H is fed out via PL1/A (unit 14) back to the console 61, via the RA306. In the console 61 it initiates the expanded trace, embracing the selected response on the IFF c.r.t. (para. 29) and produces the range strobe which is fed back to the video amplifying unit Type 312 in the console 64, to provide the single range ring (see A.P.2897N for details of circuits in console Type 61).

*Head selection*

**33.** On the extreme right of the inset panel is the RADAR HEAD selector switch. This switch applies +50V from PL2/T to the appropriate selector circuit in the rack assembly Type 184 (A.P.2527E, Vol. 1, Part 1, Chap. 3).

**34.** On the sites with head and p.r.f. selection the control desks are fitted with two rotary switches. One wafer of the radar switch feeds +50V from PL2/T to the appropriate selector, whilst the second wafer feeds a common line at PL4/K to the selection system of the IFF Mk. 10 equipment. The video switch feeds +50V from PL2/T to the relay unit (head) in the head and p.r.f. rack.

*On/off switch*

**35.** The ON/OFF switch accepts −50V from PL2/L and when in the ON position completes the circuit for the LP1, HEATERS ON lamp. At the same time the −50V is fed to the panel (control) Type 859, to the distribution panel Type 861 via PL2/5, and to the fuse panel via PL2/U. The feed to panel 861 energizes RLA, which switches on the l.t. transformers (fig. 8, Chap. 9 of this Section). On later types of desks, the HEATERS ON lamp is fed by 6·3V from the l.t. transformer.

**36.** The feed to the fuse panel, via PL2/U is applied to the RA338 (negative reference) to switch on the −500V reference to the RA305 (bulk power supply) and to the RA305 to operate the LT relay. The h.t. switching circuit, for operating the RA305 HT relay which supplies h.t. to the console and the associated trip line, are shown in fig. 3, Chap. 9 or fig. 2 of App. 1. The H.T. ON lamp LP2 lights when the h.t. circuit is completed, the −50V (or the −6·3V) returns on PL2/Y.

*FPS6*

**37.** The Types 893A and 894A desks are fitted with a PASS/CALL switch. This control is part of the FPS6 time sharing system (See A.P.2527U). The Type 894A has facilities for switching the control to either of two controllers (CONTROLLER 1/CONTROLLER 2).

*Anti-jam keys*

**38.** The Type 16287 desk is fitted with anti-jam keys (SWW, SWX, SWY). These keys are duplicates of the control group which are fitted to the FPS6. This desk may be given control of the anti-jamming facilities by use of a remote control switch on the FPS6.

*Height sharing*

**39.** Switch SWN on the Type 16286 desk enables the operator to select the type of height finding system FPS6 of T13, as required. Indicator lamps, ILP8 and ILP9, show whether either of the systems is available.

**40.** The centre biased CALL/CANCEL key, SWO, is in parallel with the floor CALL button (switch unit 16234). Demand is made on the height finding system by the use of either of these switches. If, after the demand, is made, the system is not subsequently required, the switch should be set to the CANCEL position.

*Indicator (electrical) Type 12956*

**41.** Three of these indicators (fig. 6) are mounted on each of the desks Type 16284 and 16286. The purpose of the indicators is to enable any three digit number, representing hundreds of feet, to be displayed.

**42.** The indicators consist of three hollow discs, each having the figures 0 to 9 marked around their periphery. A small magnet is fixed in the centre of each disc, the poles of the magnet being aligned with the diameter of the disc. Adjacent to each disc is a printed circuit board upon which are mounted ten coils. The coils are arranged in a circle so that they fit inside the periphery of the hollow discs. Opposite pairs of the coils are wired in series. A solenoid is fitted below the three discs, and is connected, by linkage, to a disc locking system.

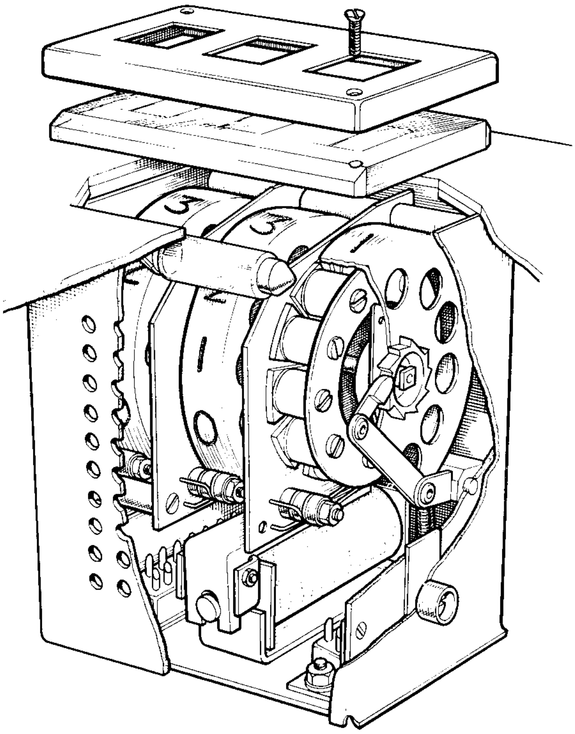


**Fig. 6. Indicator, electrical Type 12956**

**43.** When it is required to set the indicator to a specific number, the solenoid is energized, thus freeing the discs. A polarising voltage is then fed, in the required direction, through the appropriate pair of coils. The freed disc, with its magnet, will then align itself with the energized coils. After a delay of a few seconds, the solenoid is de-energized, thus allowing spring-loaded pawls to lock the discs in position. The polarizing voltage is then removed and a festoon lamp in the indicator is lit, enabling the numbers to be read.

**44.** Four indicator lamps are used in conjunction with the indicator, electrical. Two of these lamps, ILP4 and 5, indicate NO HEIGHT, whilst the other two lamps ILP6 and 7, indicate UP or DOWN respectively.

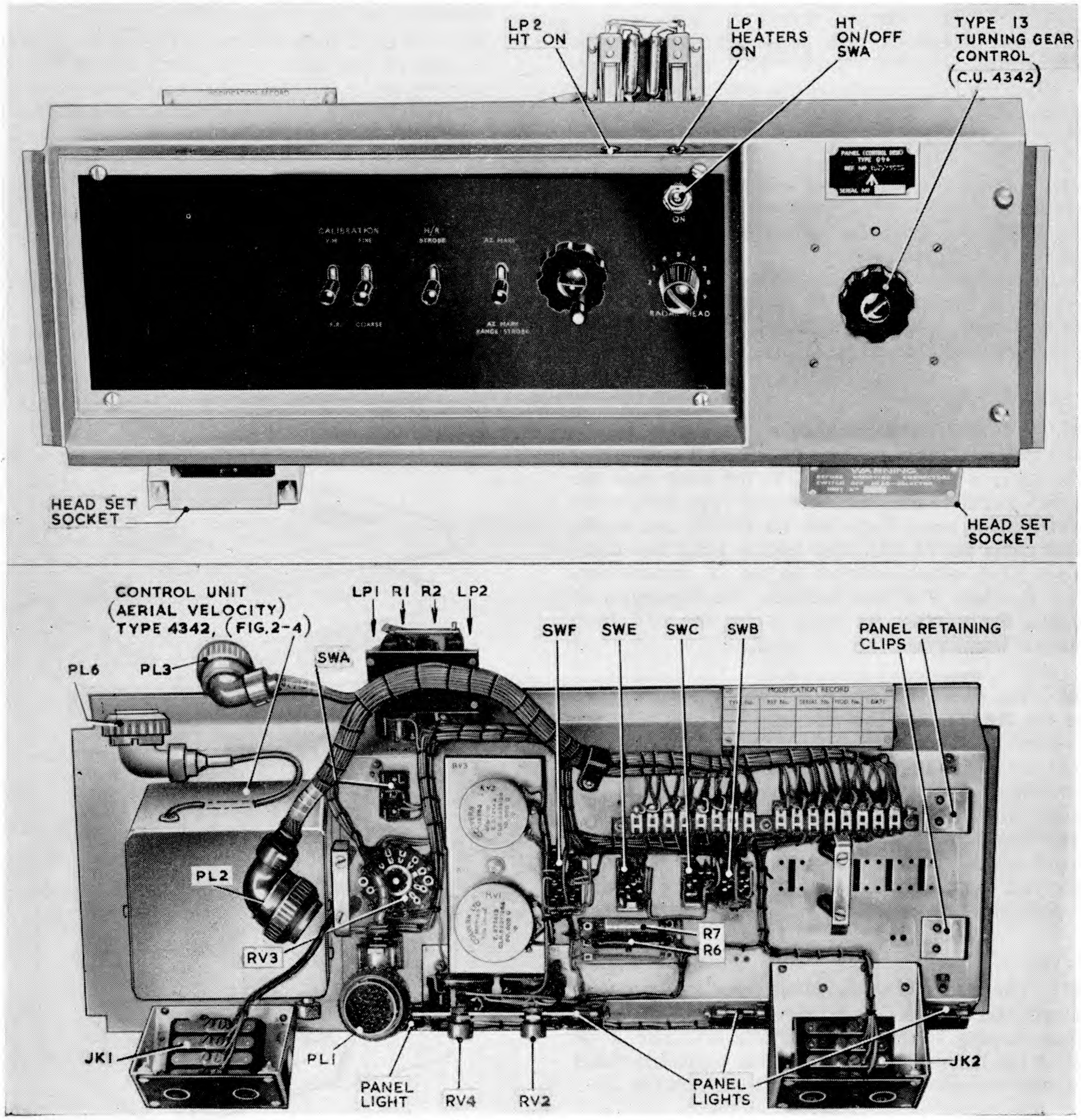



**Fig. 7. Panel (control desk) Type 896—front and rear views**

**45.** The indicators and lamps are employed as follows:—The indicators, from left to right, show the intercepter aircraft height, the target height and the difference in height between the two. If the target is higher than the intercepter aircraft, the UP lamp is lit. If the target is lower, the DOWN lamp is lit. If information from the height finder is not available, the NO HEIGHT lamp is lit.

*Inter-trace marking*

**46.** To enable the inter-trace markers to be positioned as required on the displays a joystick unit is fitted.

**47.** *Control unit (joystick) Type* 12270. The control unit (joystick) Type 12270 is shown in fig. 9. This unit consists of two precision potentiometers which are driven, via gears, by movement of the joystick. The joystick pivots by a central ball joint and may be moved in any direction. When the joystick is moved to the left or right, the movement is transmitted, through a quadrant gear, to a pinion fitted to the shaft of one of the potentiometers. When the joystick is moved up or down, a similar arrangement alters the setting of the other potentiometer. If the joystick is moved at, for example, 45 degrees, a resultant movement of both potentiometer wipers will occur.

**48.** *Control unit (lever) Type* 12955. A control unit (lever) Type 12955 is fitted to the desks Type 16287 and 16290. This unit is similar to the joystick unit, but has only one potentiometer. A plate is fitted to restrict the movement of the lever to only one plane.

**49.** A fine/coarse switch is fitted to the joystick units, and is operated by a button set in the top of the lever. When the button is depressed, the input to the amplifying unit (joystick voltage) is fed via a series resistor, and a Miller integrator circuit is obtained. When the lever is released, the input is fed via a capacitor and a see-saw amplifier effect is obtained (see A.P.2527X, Vol. 1 Part 1, Sect. 5, Chap. 2).

*Reset*

**50.** A RESET switch is fitted to all desks supplied with joysticks. This switch connects +50V to the joystick amplifiers to centre the marker if it is deflected off the display.

*Ring/dot*

**51.** When the RING/DOT switch (SWR) is in the RING position, the pass wire to the amplifying unit (mixer) Type 4428, via PL7/5, is earthed. In the DOT position the pass wire is earthed and also +50V is connected to PL7/T. This voltage energizes the ring/dot relay in the amplifying unit (mixer). When the switch is in the centre position both of the connections are open circuit.

*ICM ring/dot*

**52.** This switch, SWZ, has no centre position, the pass wire is remotely controlled. In the DOT position the +50V line is fed to the mixer via PL7/U. When the switch is set to the ICM RING position the line to PL7/U is open circuit.

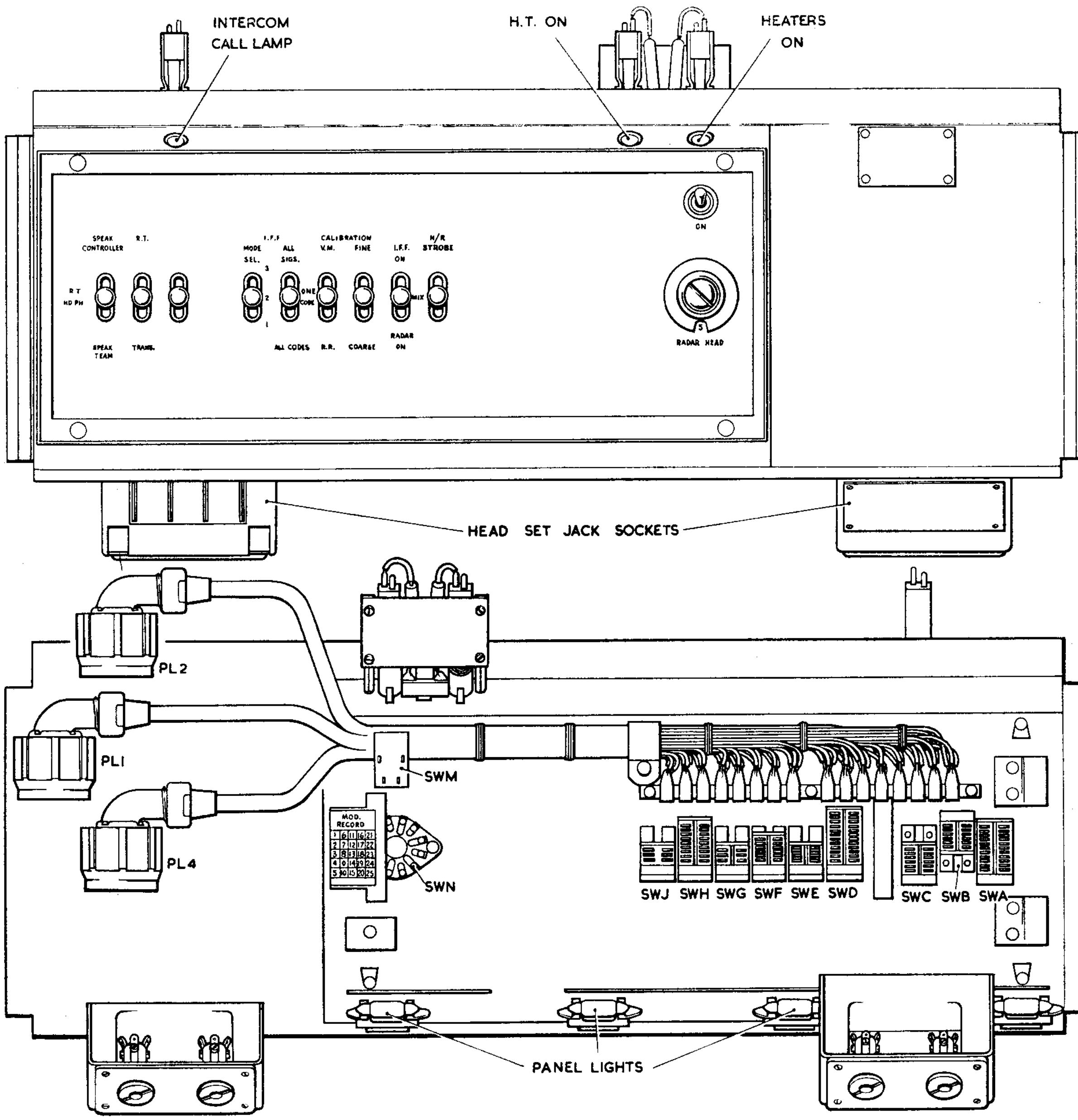



**Fig. 8. Panel (control desk) Type 4550B—front and rear views**

**53.** Certain of the desks in the 4500 series control the interim inter-console marking system. The MARK ON switch SWZ controls the ITBU relay in the consoles own video amplifier Type 312. Some of the 4500 series desks also contain switches for controlling the interconsole and interstation marks of the interim system (see fig. 1a and 1b).

*ICM*

**54.** Two of the control desks, Types 16289 and 16288, are fitted with six ICM ON switches. These control the positions of the selectors in the panel, patching, ICM, Type 12953, hence determining from which console the ICM is originating.

**55.** The Type 16291 desk is fitted with two toggle (SWW and SWX) and one rotary switch (SWY). These control relays in the panel, patching link, Type 16135 for marking at remote sites.

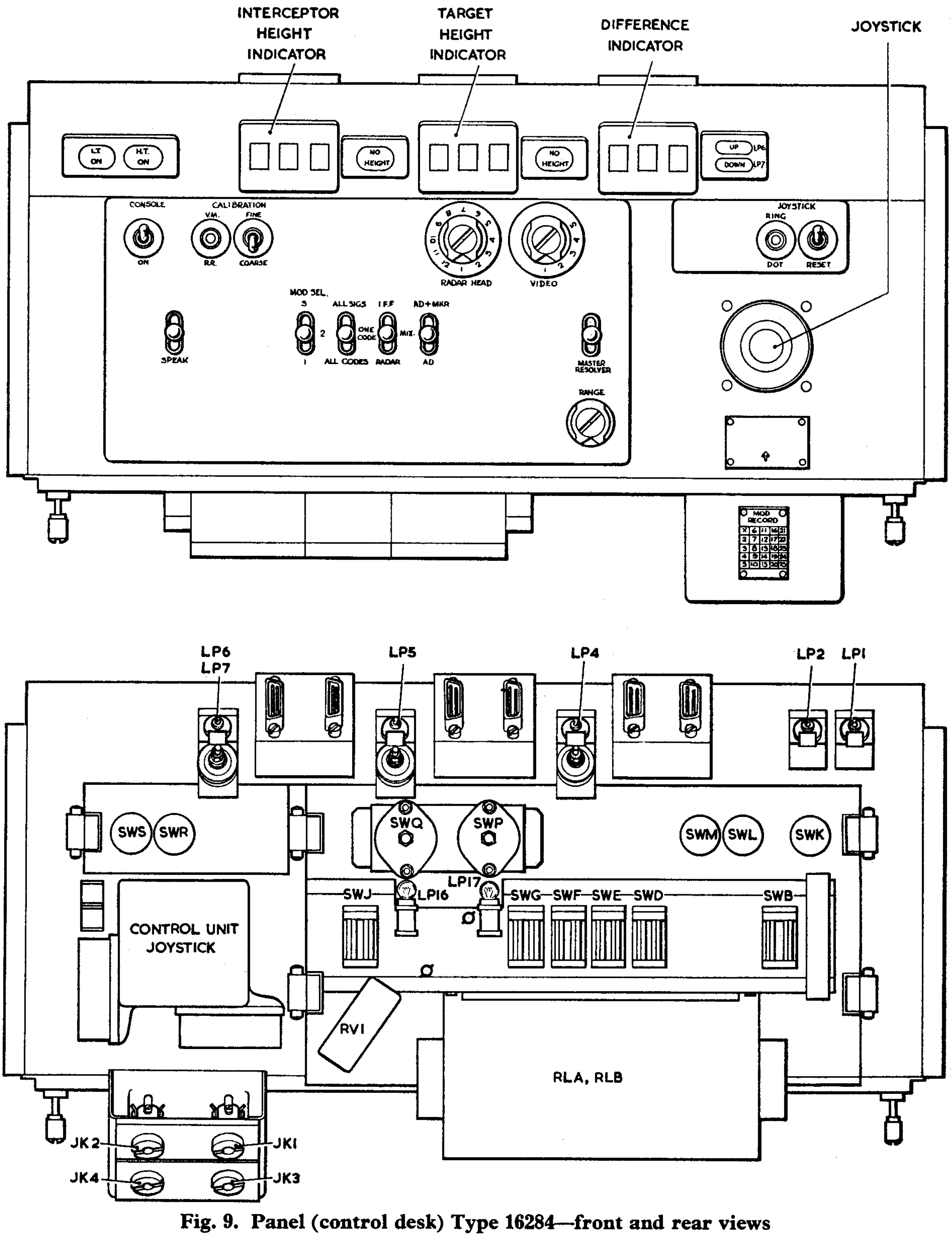



**Fig. 9. Panel (control desk) Type 16284—front and rear views**



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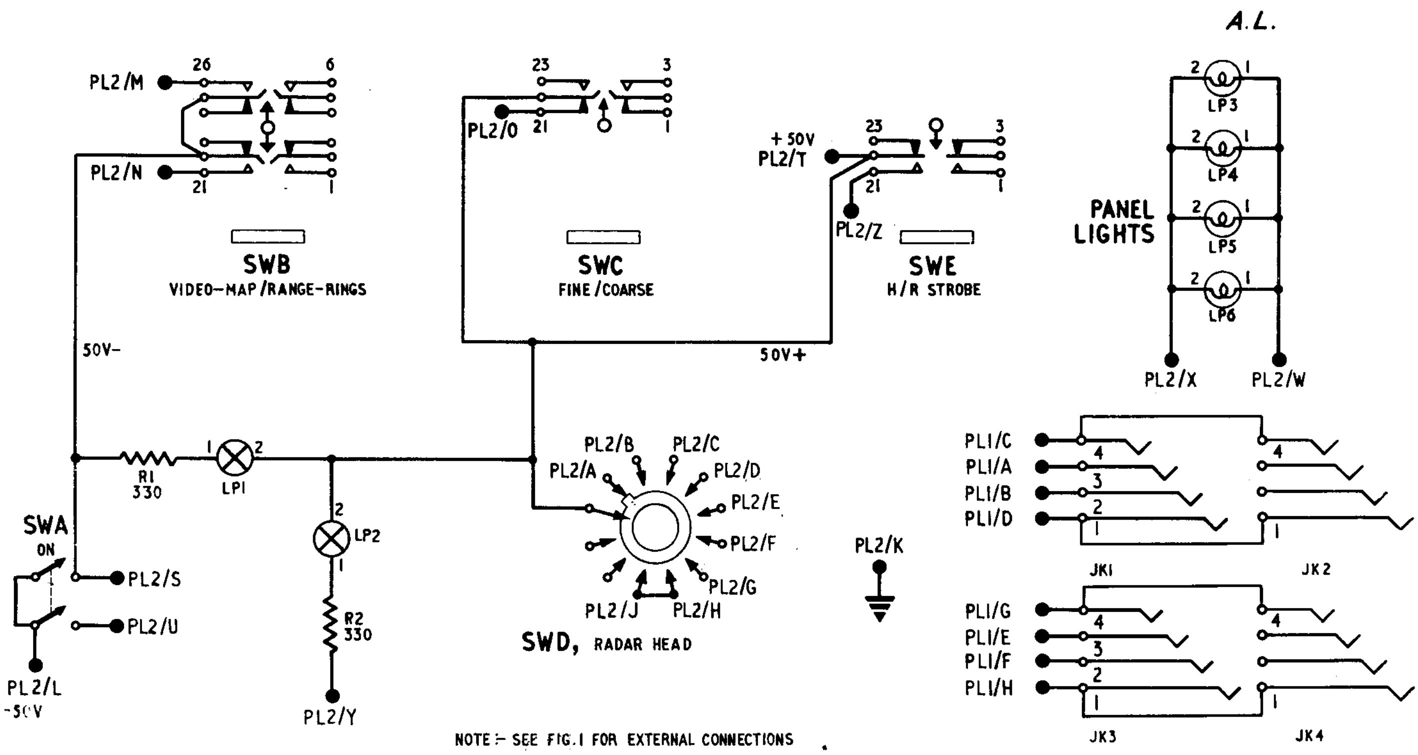


Fig. 10 Panel (control desk) Type 895 – circuit



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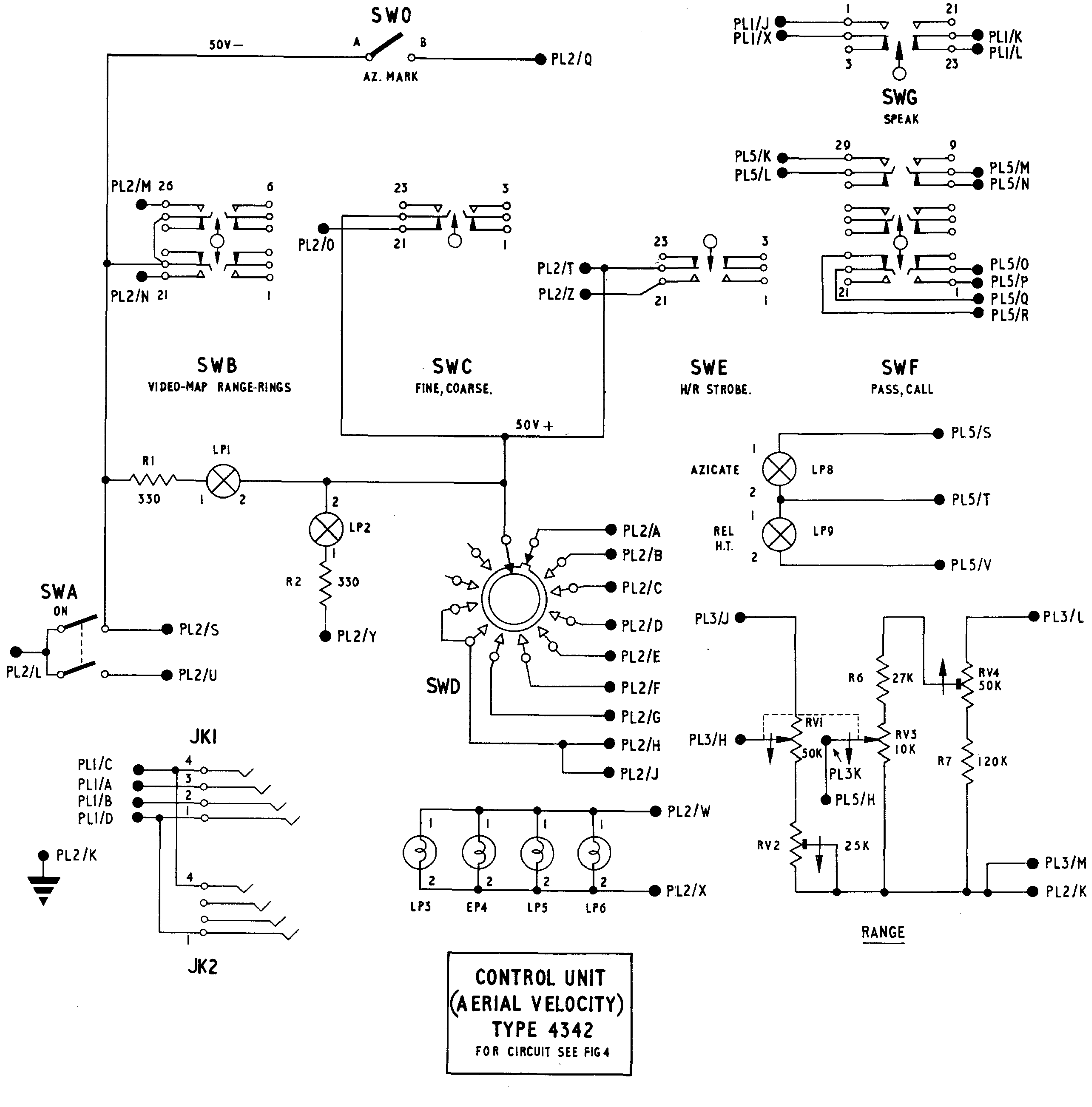


Fig. 11 Panel (control desk) Type 893A - circuit



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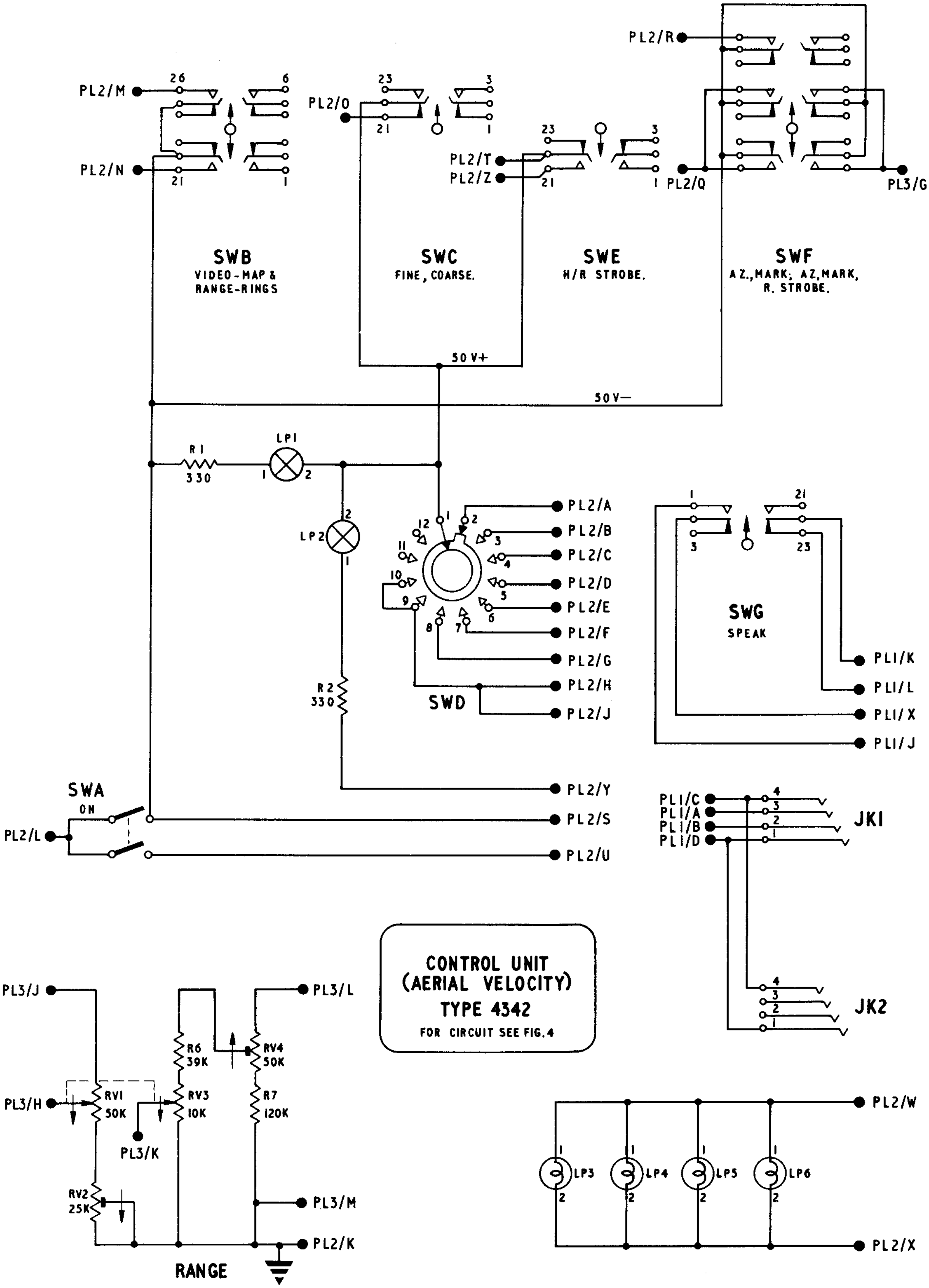


Fig.12 Panel (control desk) Type 893 B-circuit

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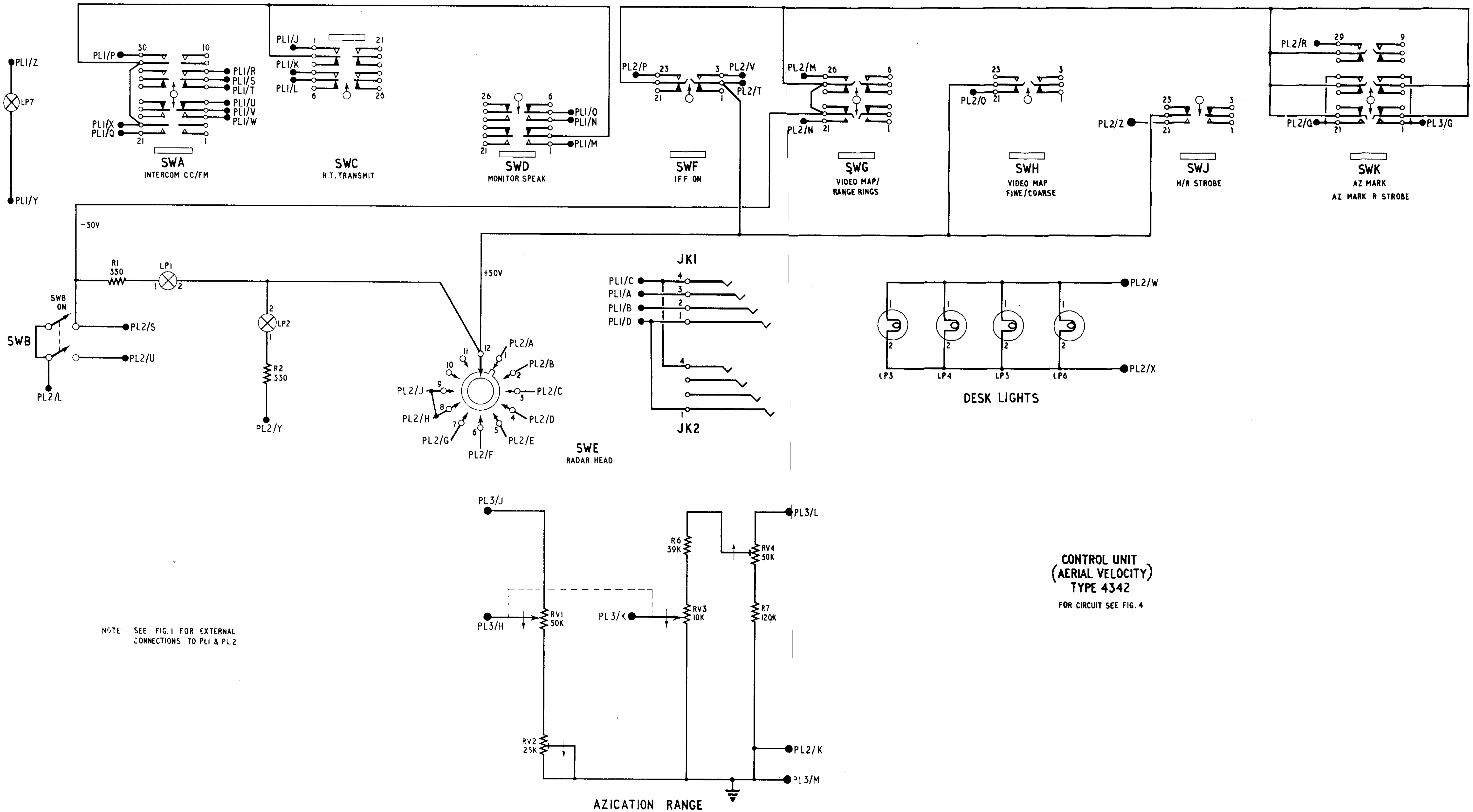


Fig 13

Panel (control desk) Type 894 - circuit

Fig. 13

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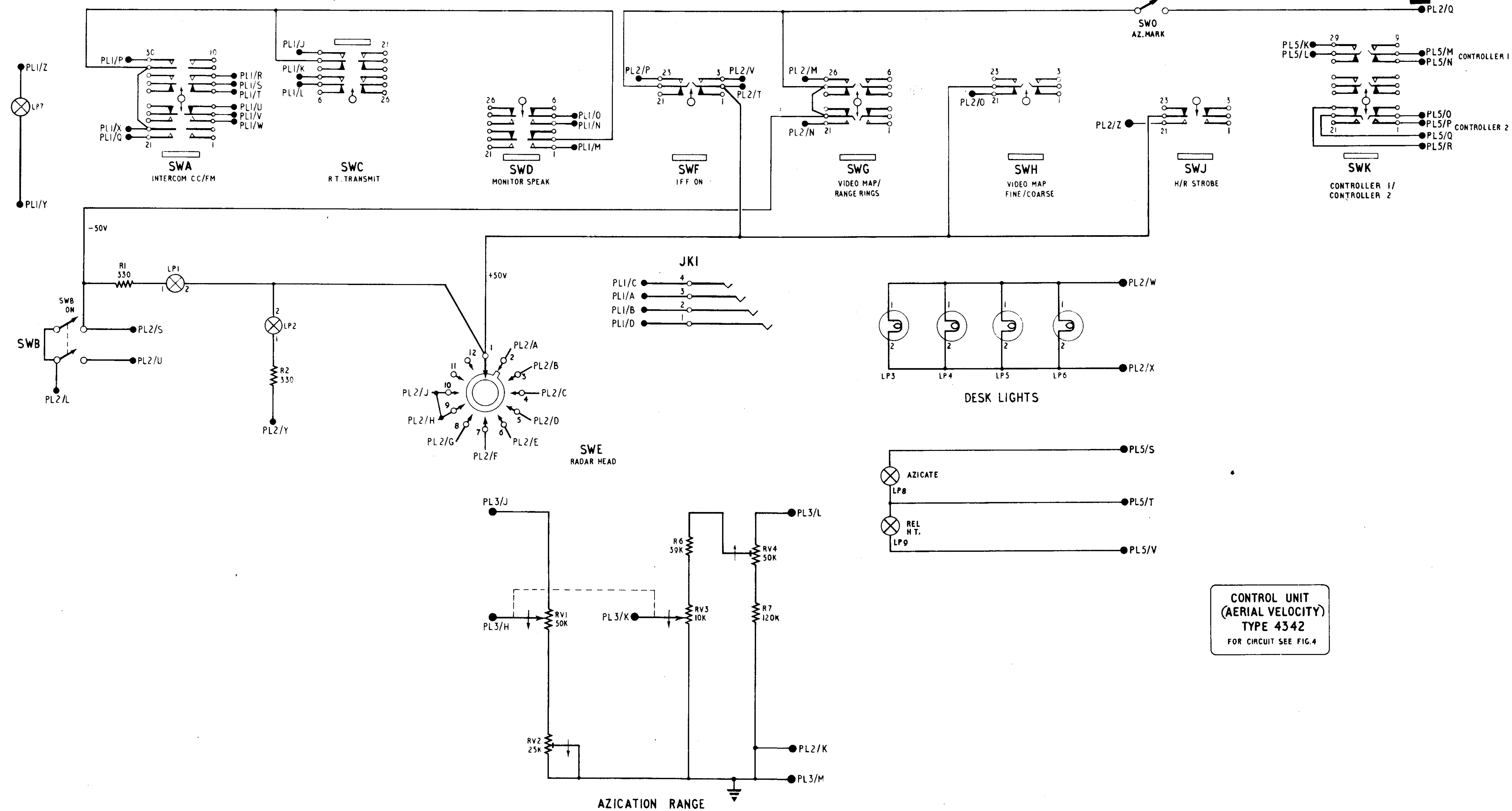


Fig. 14 Panel (control desk) Type 894A-circuit Fig. 14

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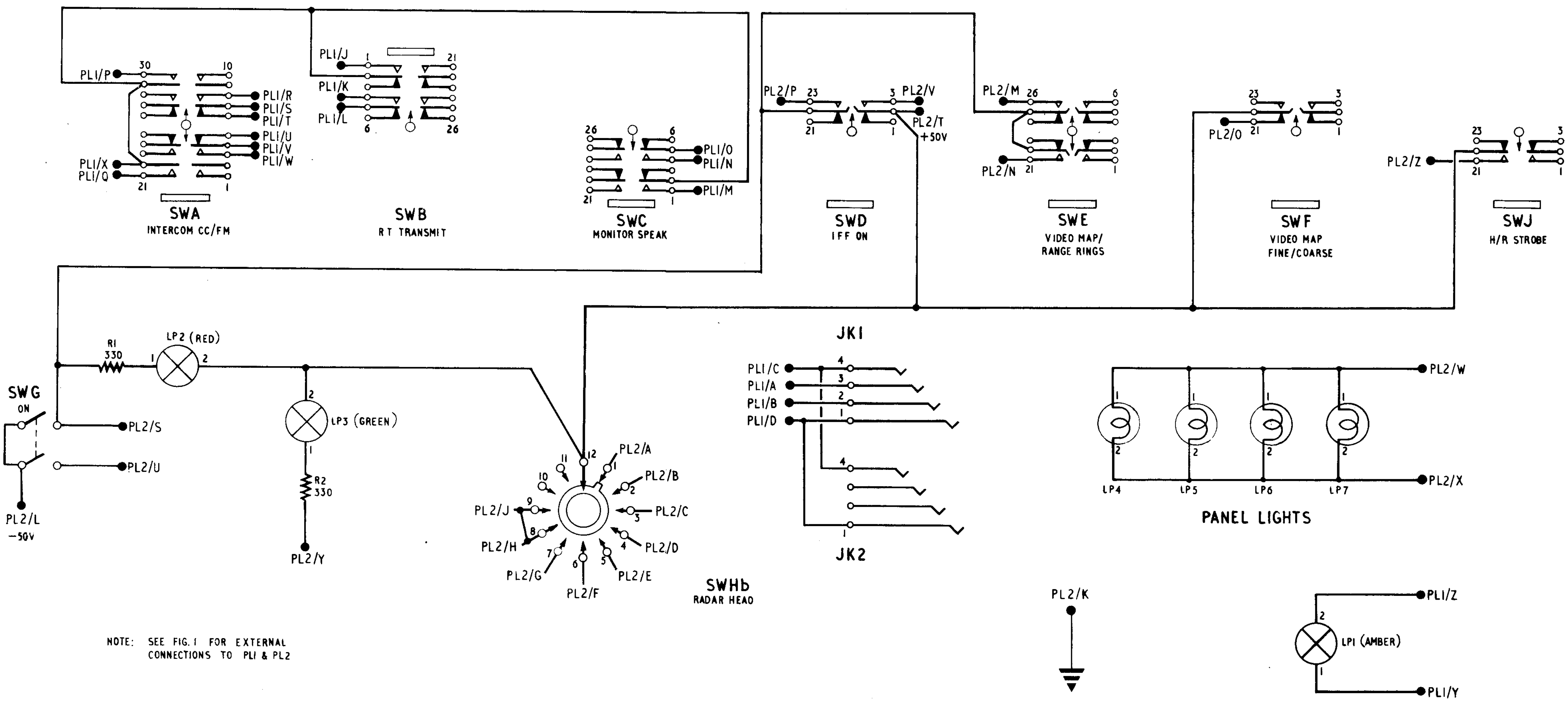


Fig. 15 Panel (control desk) Type 862 circuit Fig. 15

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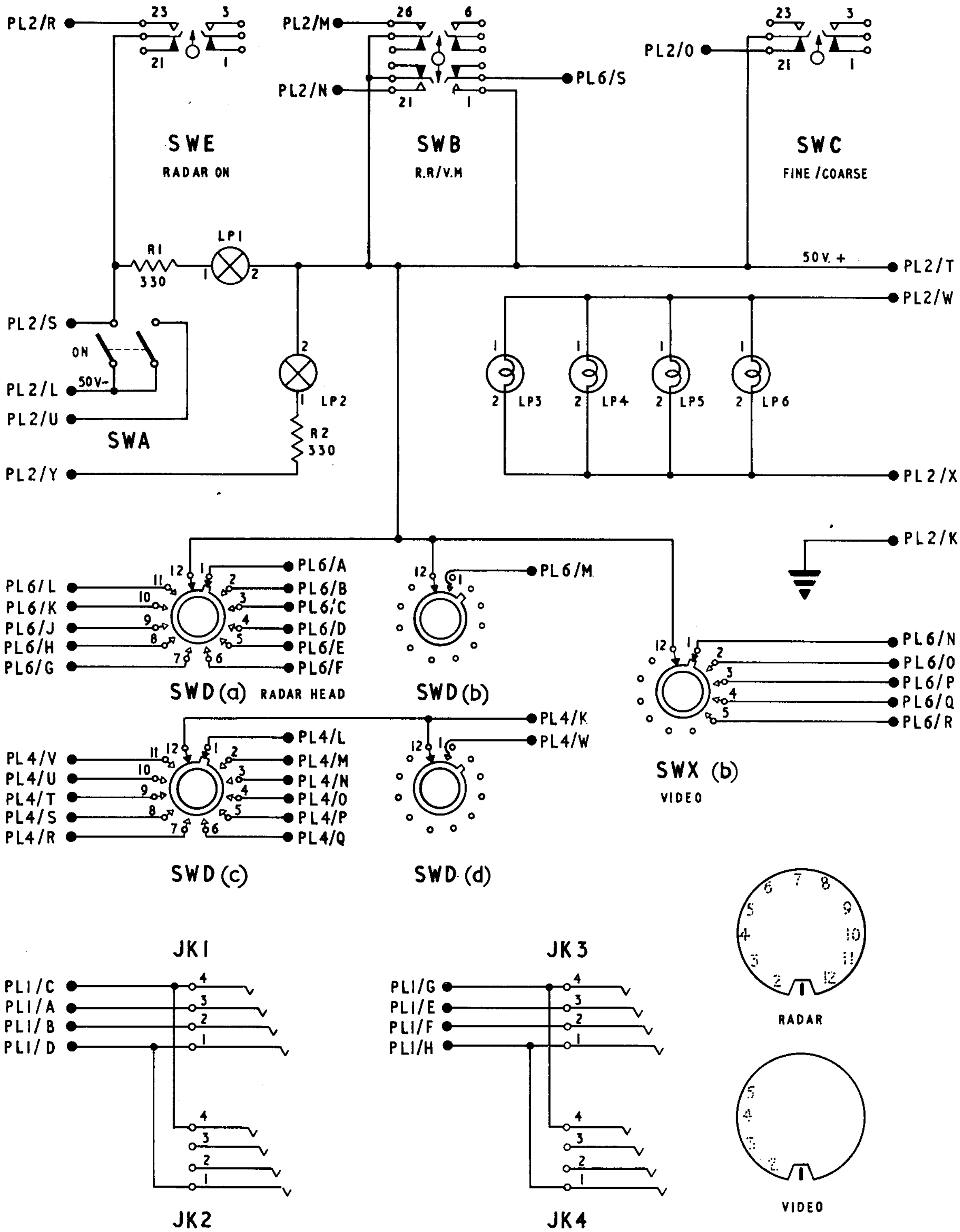


Fig.16 Panel (control desk) Type 895 A-circuit



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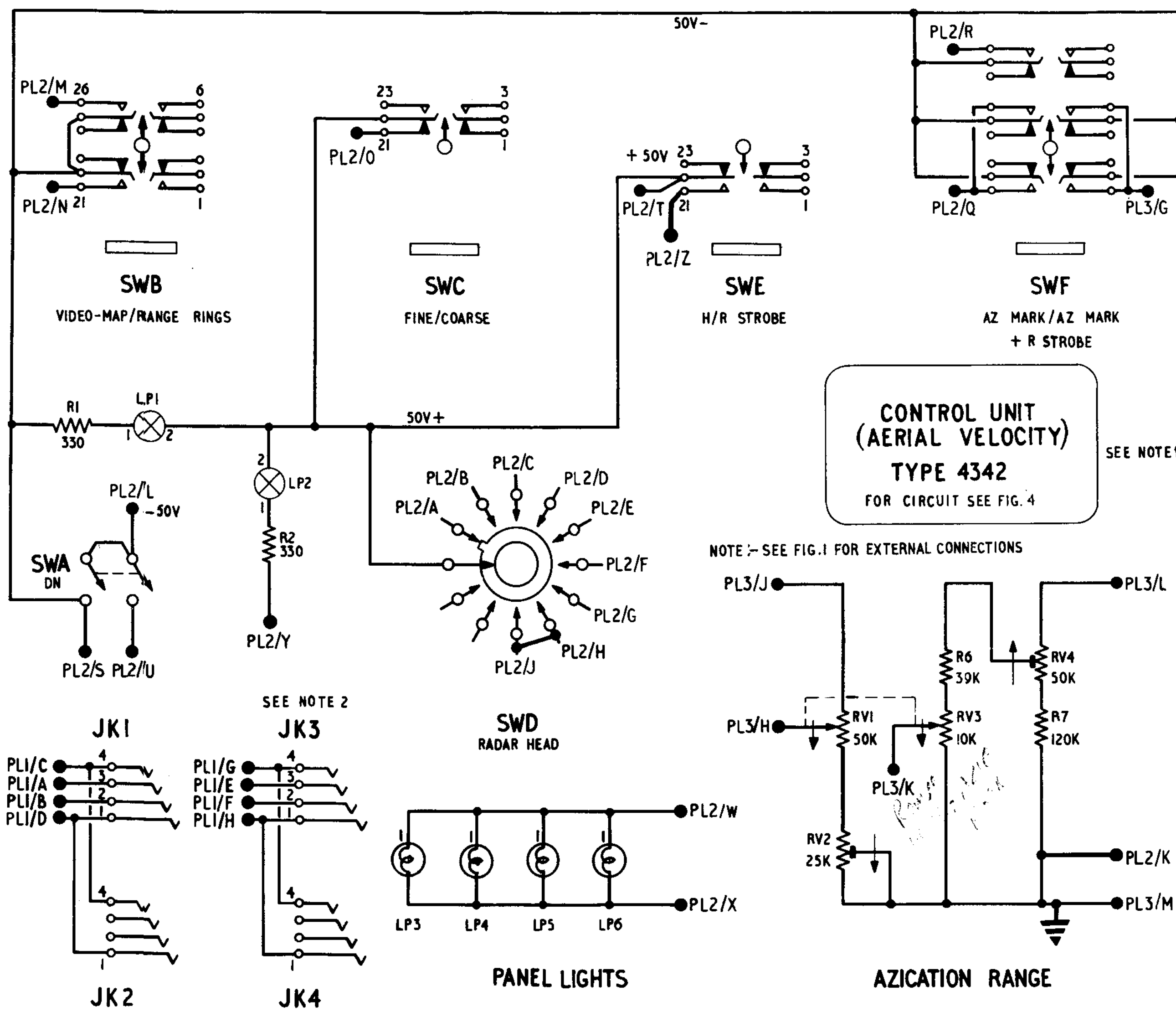


NOTE 2.
JK3 AND JK4 ARE NOT FITTED TO TYPE 893.

NOTE 1.
CONTROL UNIT (AERIAL VELOCITY) TYPE 4342 IS NOT FITTED TO TYPE 907.

Fig. 17 Panel (control desk) Types 893 896 & 907 – circuit



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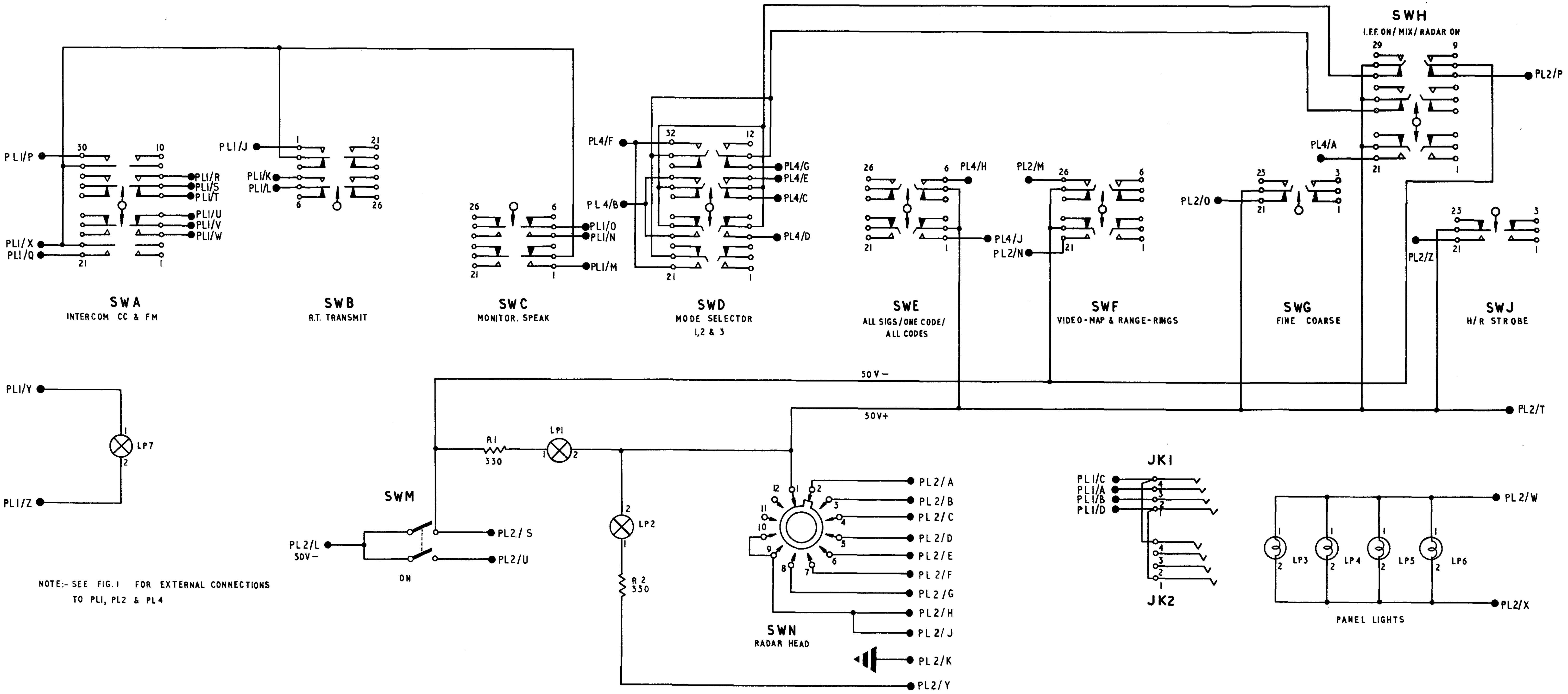


Fig. 18 — Panel (control desk) Type 4550 — circuit — Fig. 18

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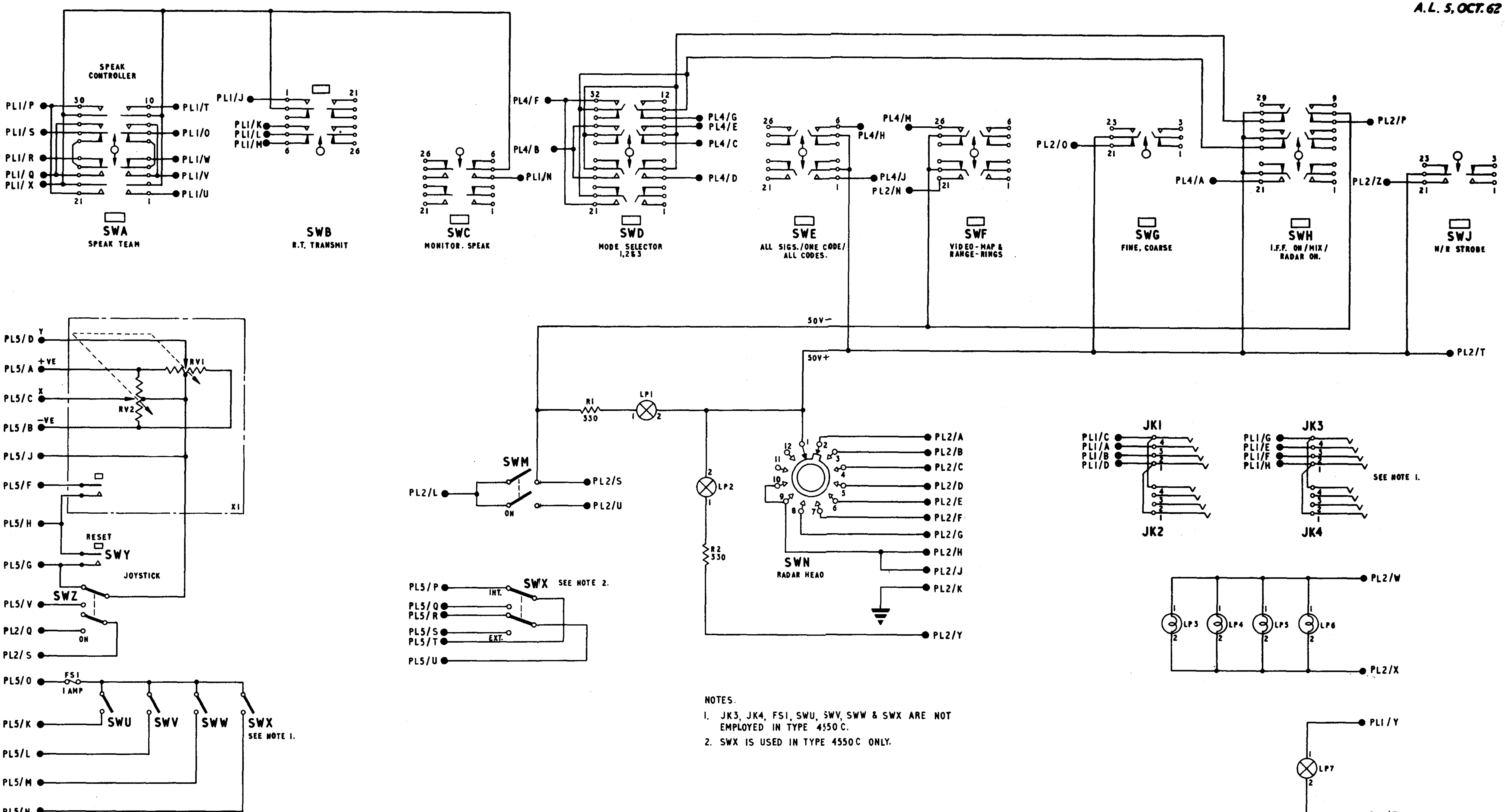


NOTES.

1. JK3, JK4, FS1, SWU, SWV, SWW & SWX ARE NOT EMPLOYED IN TYPE 4550 C.
2. SWX IS USED IN TYPE 4550 C ONLY.

Fig. 19

Panel (control desk) Types 4550A & 4550C - circuits

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Fig. 19

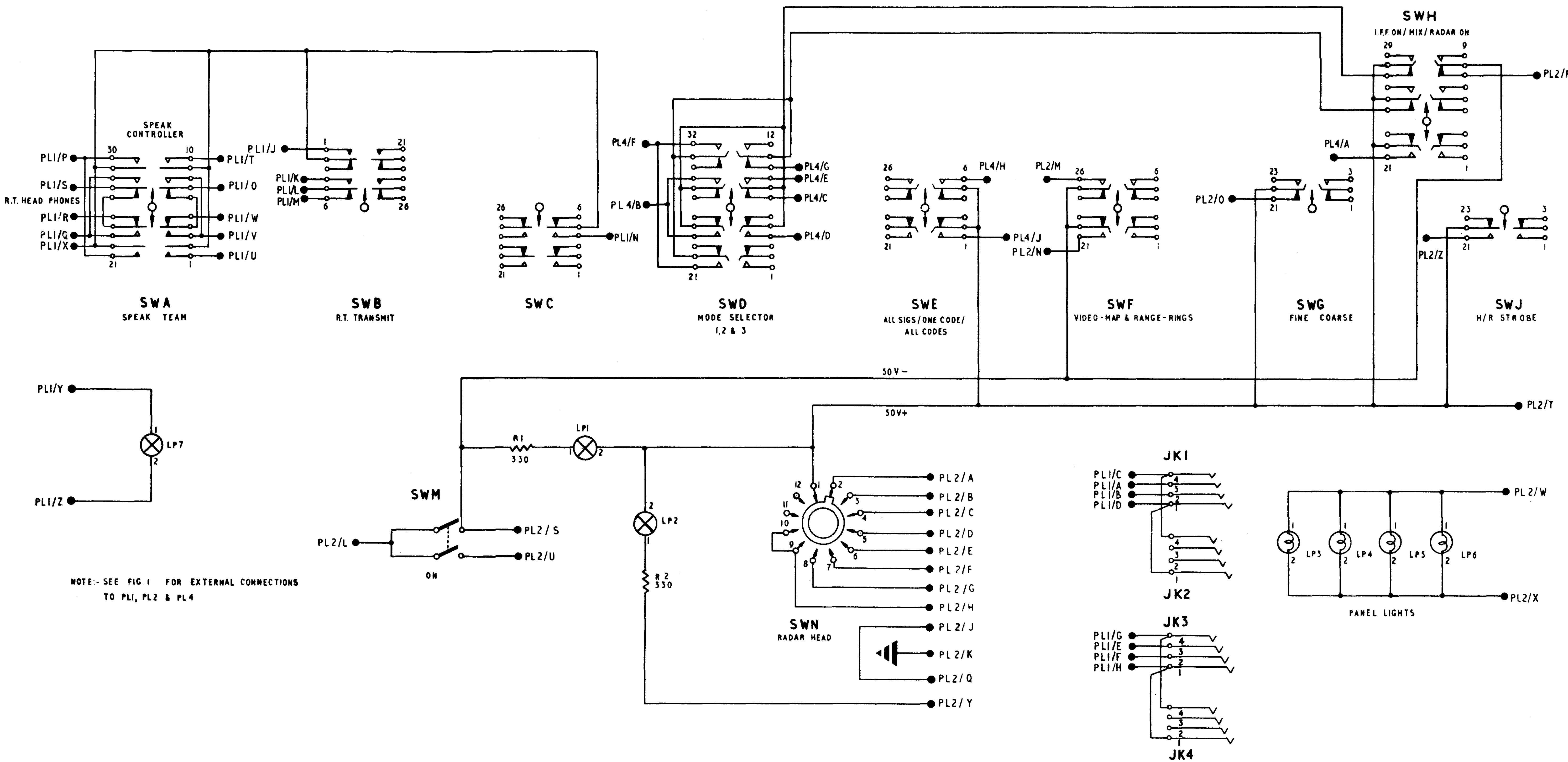


Fig. 20 — Panel (control desk) Type 4550B-circuit — Fig. 20

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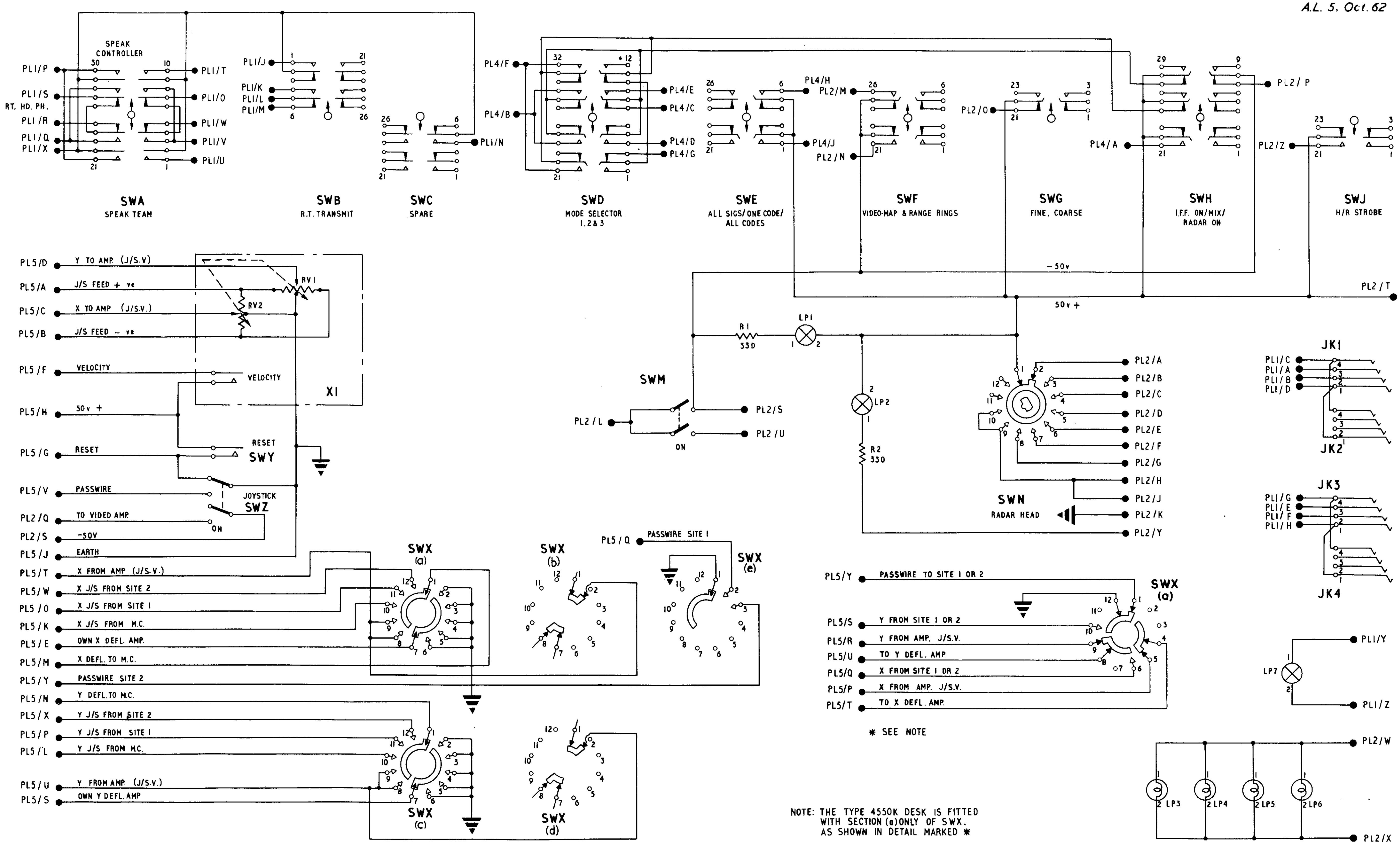


Fig. 21 Panel (control desk) Types 4550D and 4550K - circuit Fig. 21

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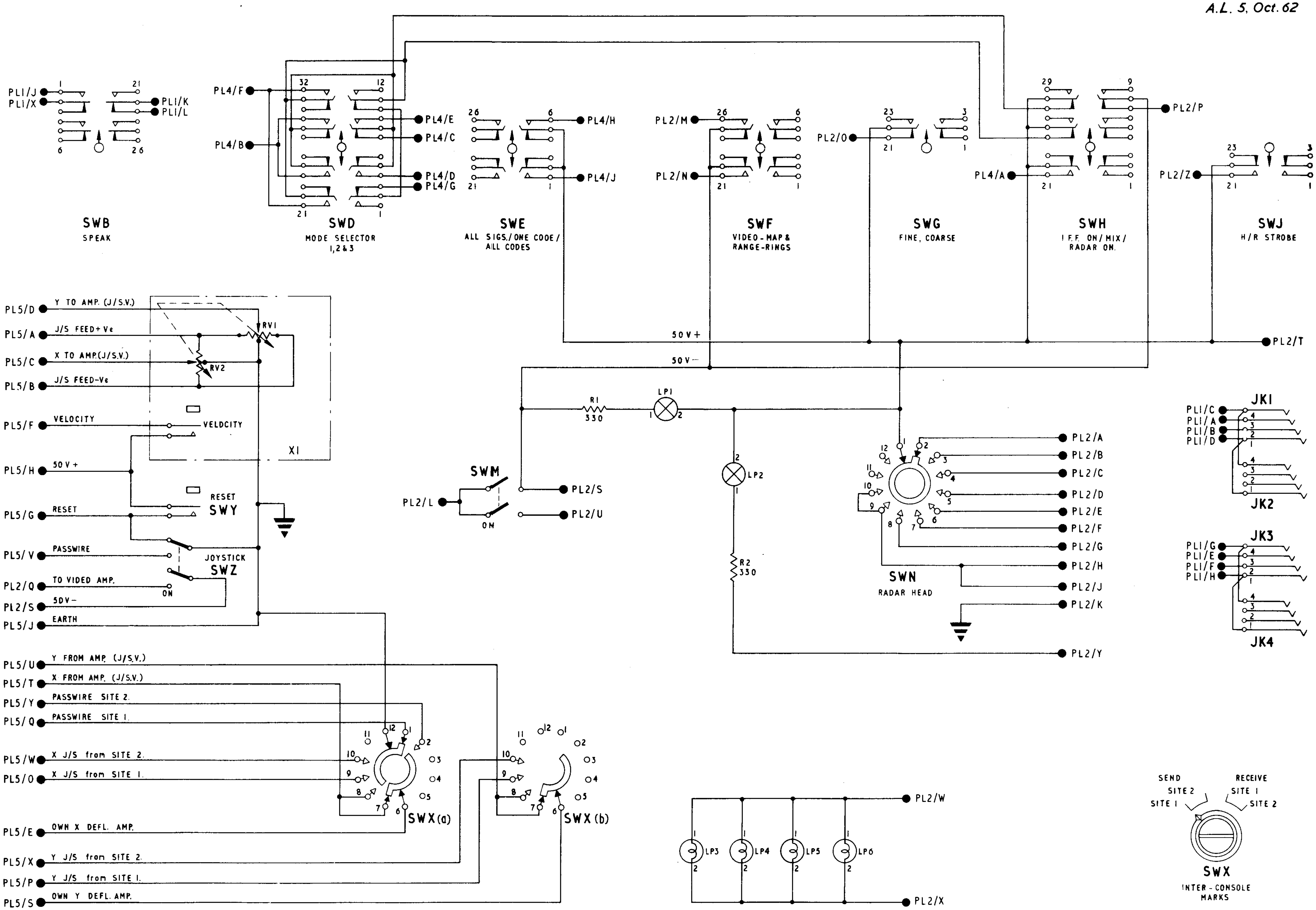


Fig.22 Panel (control desk) Type 4550E-circuit Fig. 22

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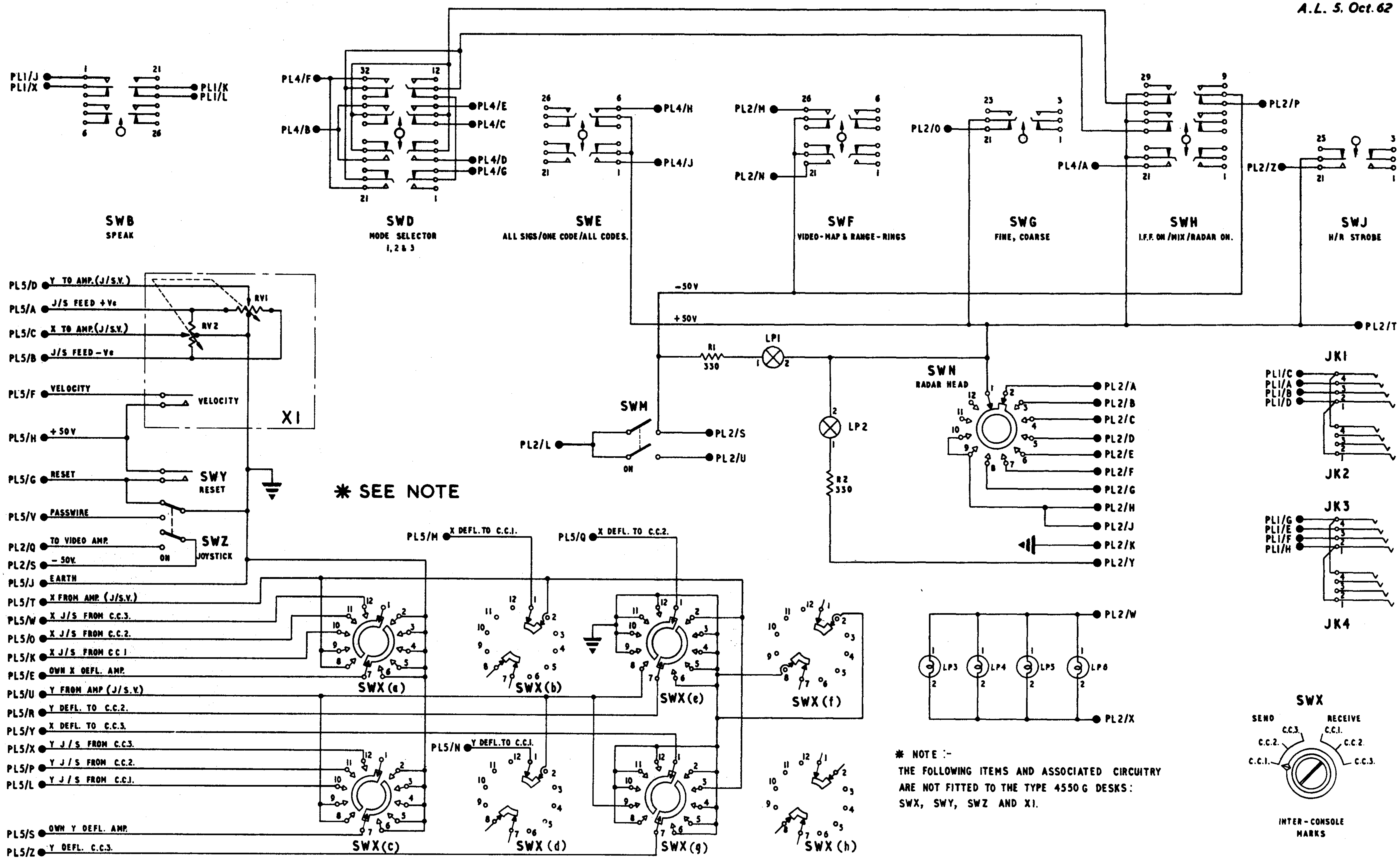


Fig. 23 Panel (control desk) Types 4550F and 4550G — circuit Fig. 23

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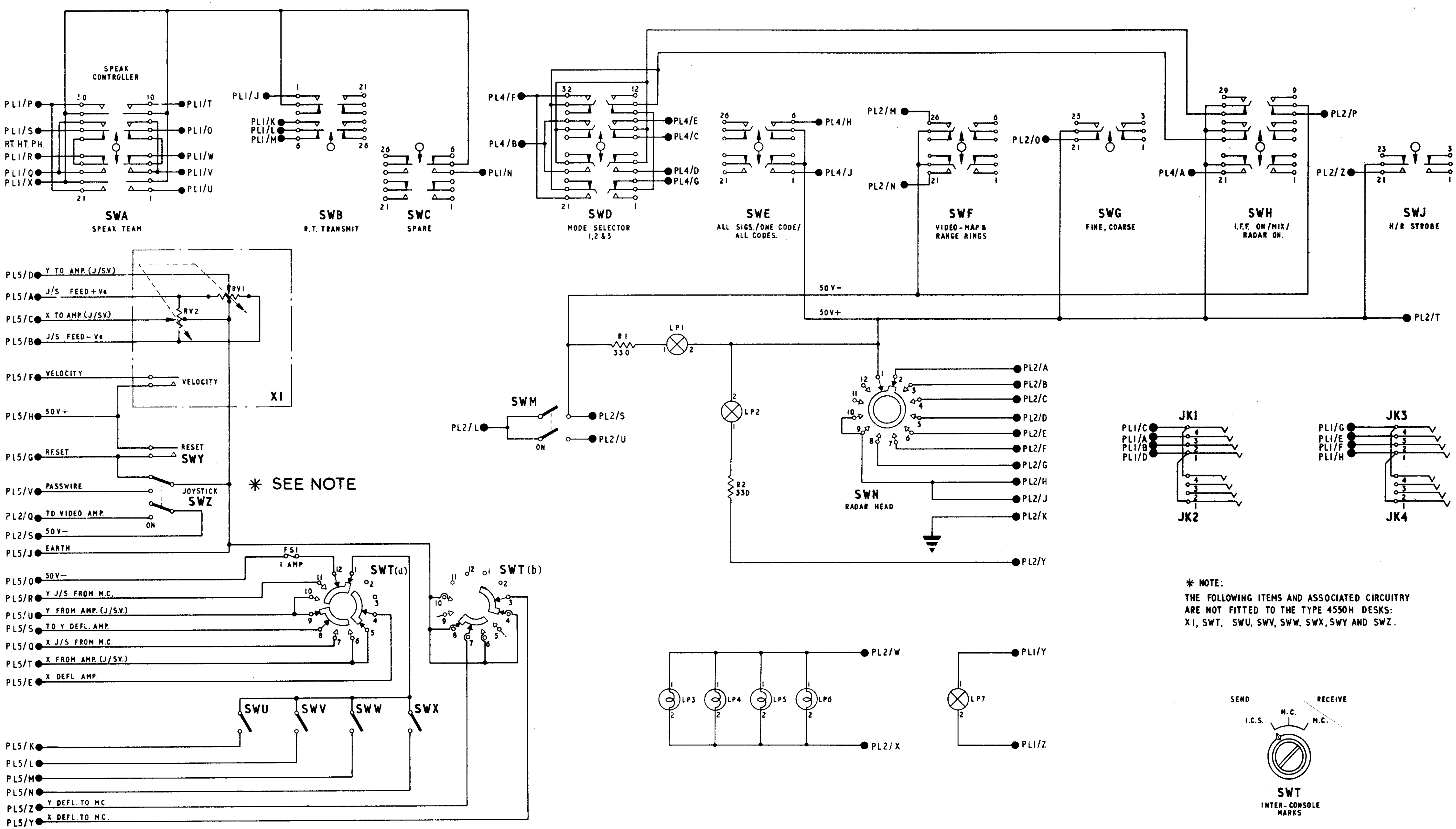


Fig. 24 Panel (control desk) Types 4550H and 4550J – circuit Fig. 24

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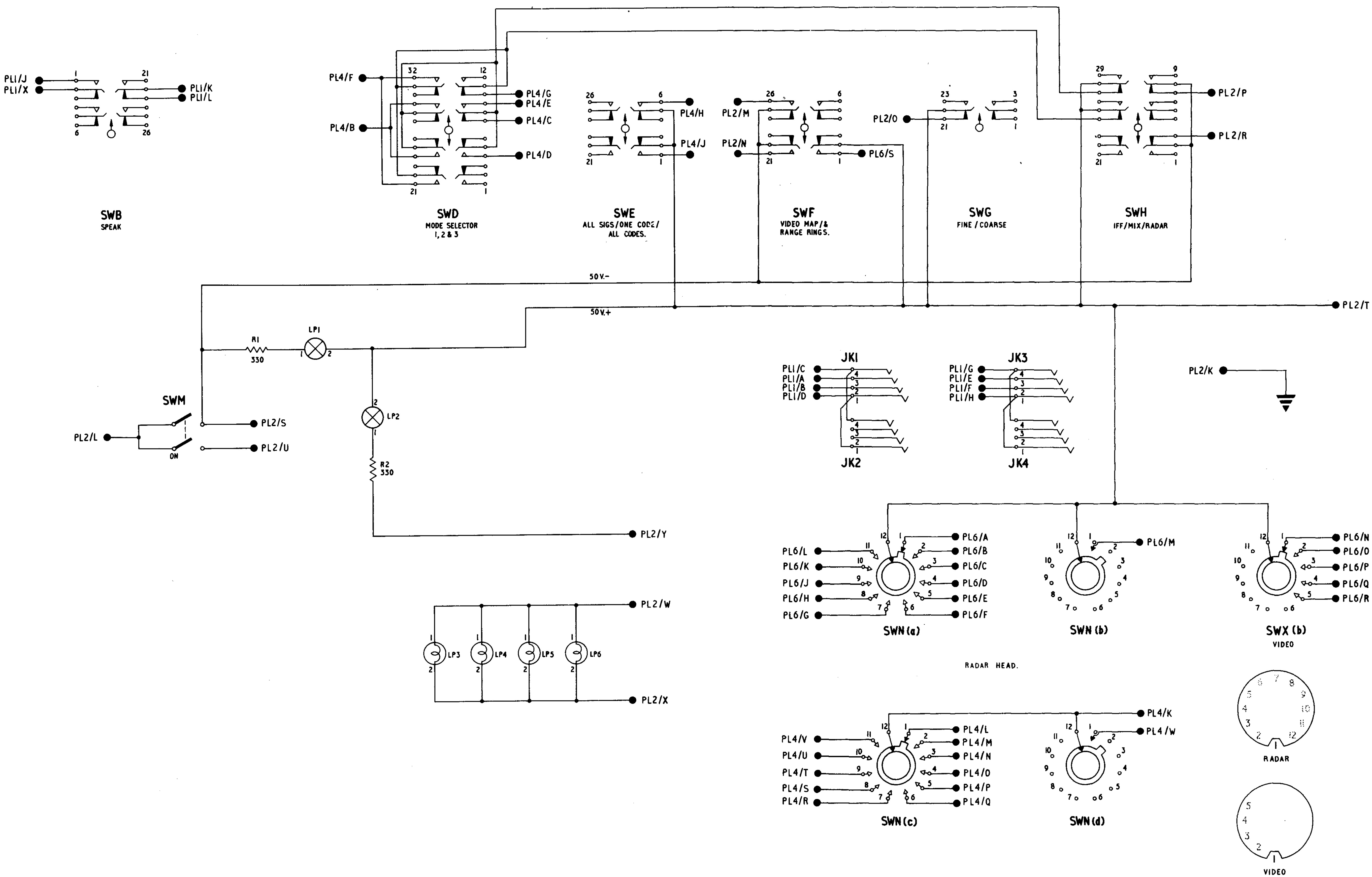


Fig. 25 Panel (control desk) Type 4550L – circuit. Fig. 25

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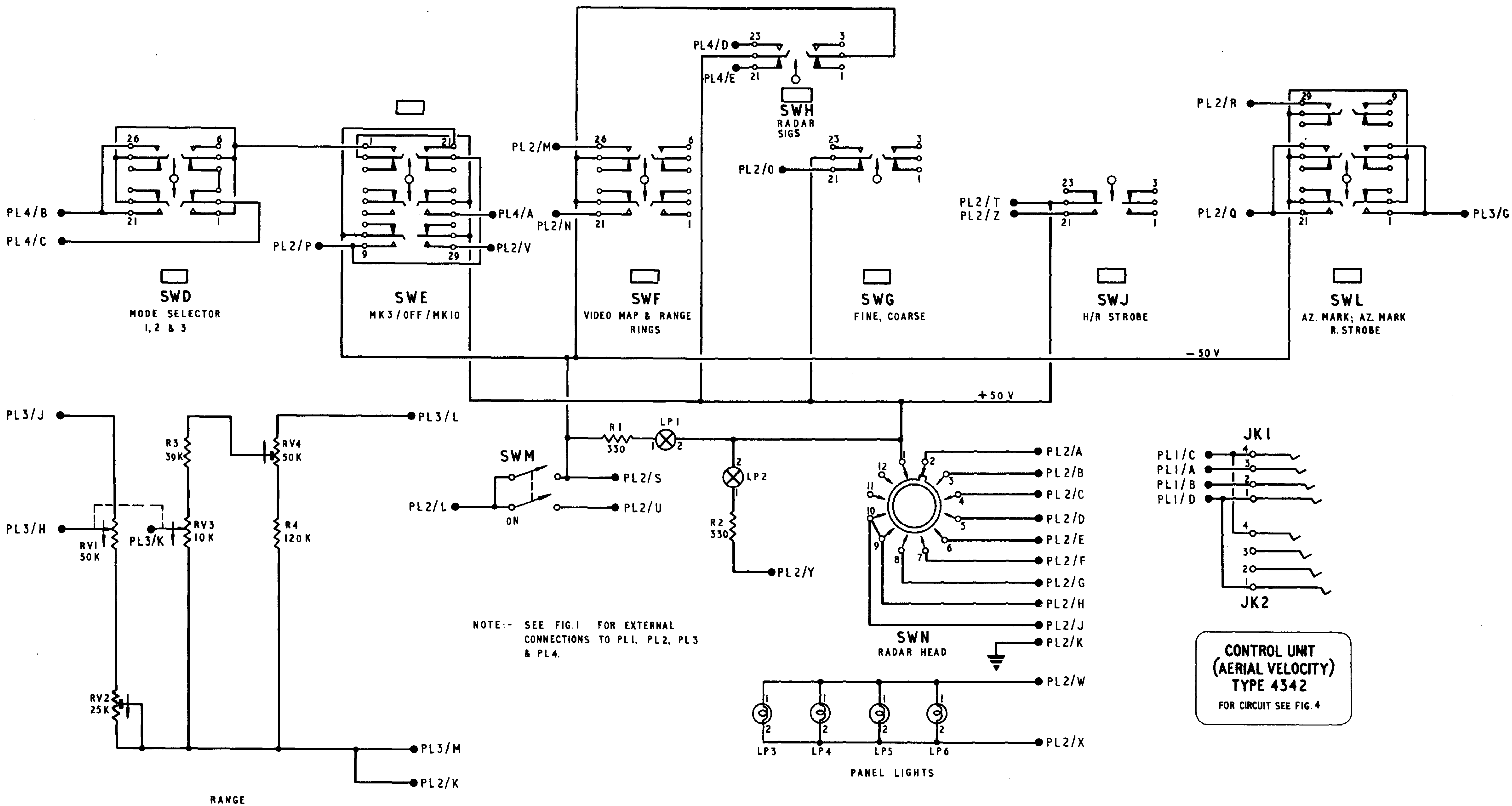


Fig. 26 Panel (control desk) Type 4551 - circuit Fig. 26

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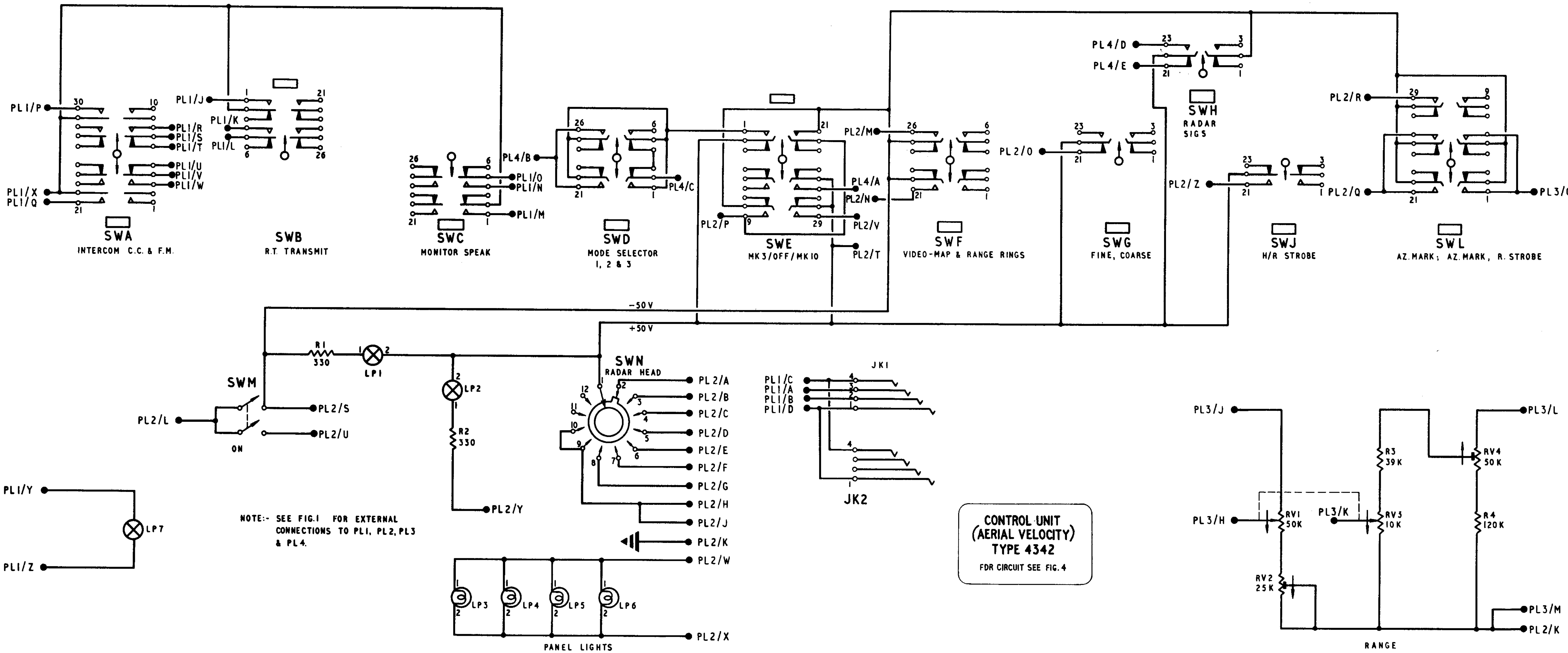


Fig.27

Panel (control desk) Type 4552 - circuit

RESTRICTED

Fig.27

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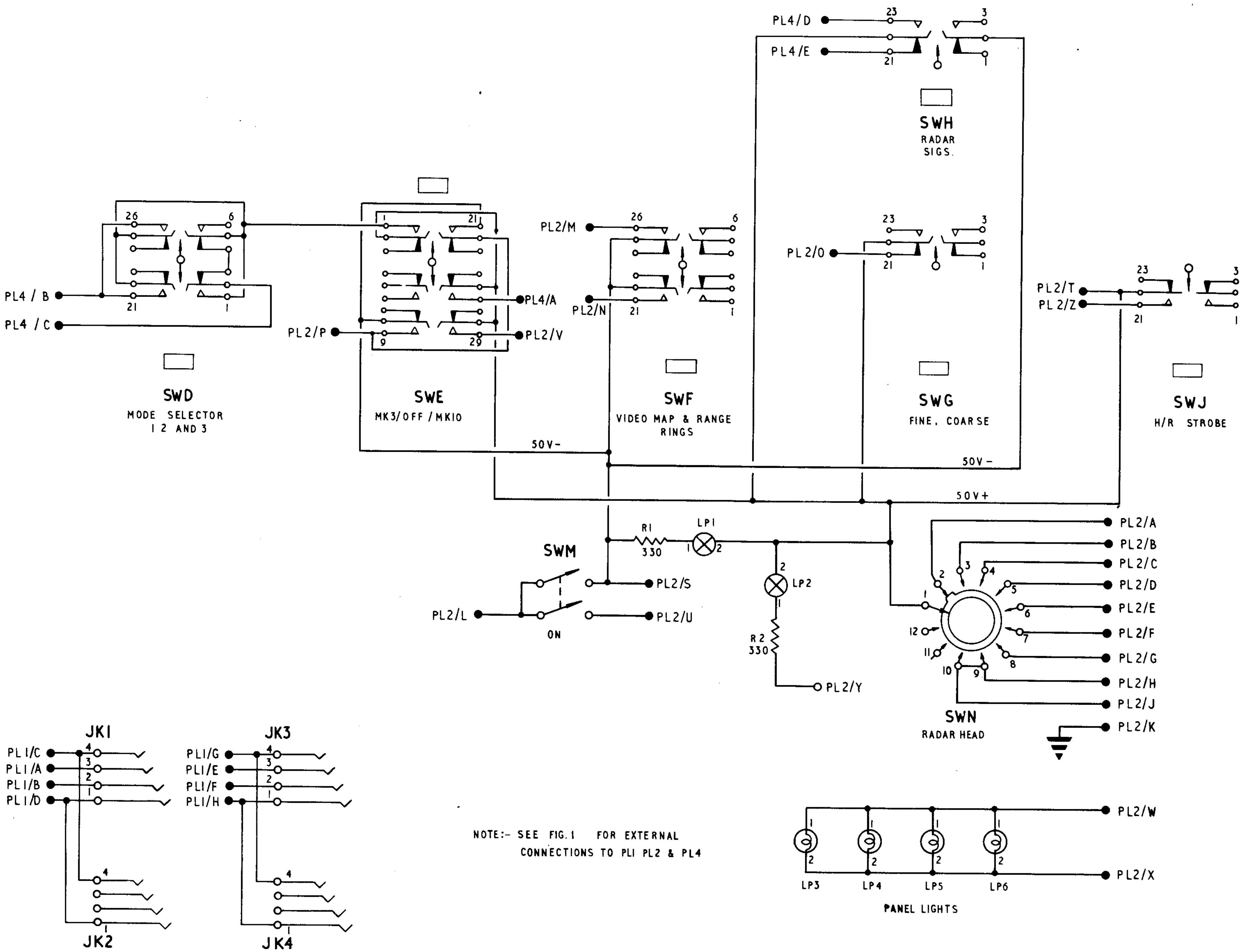


Fig. 28 Panel (control desk) Type 4553—circuit Fig. 28

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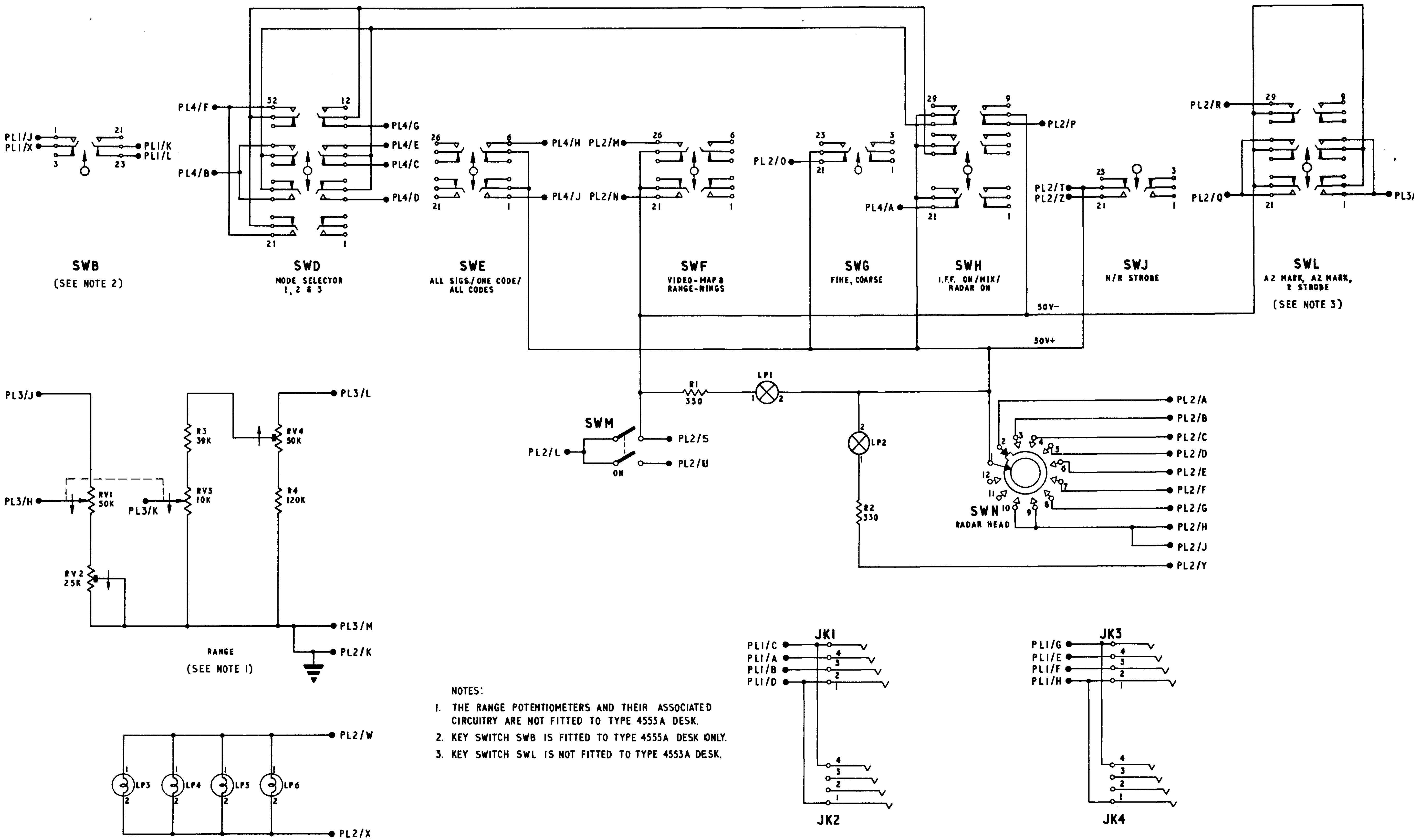


NOTES:

1. THE RANGE POTENTIOMETERS AND THEIR ASSOCIATED CIRCUITRY ARE NOT FITTED TO TYPE 4553A DESK.
2. KEY SWITCH SWB IS FITTED TO TYPE 4555A DESK ONLY.
3. KEY SWITCH SWL IS NOT FITTED TO TYPE 4553A DESK.

Fig. 29

Panel (control desk) Types 4553A. 4555A and 4555B – circuit

Fig. 29

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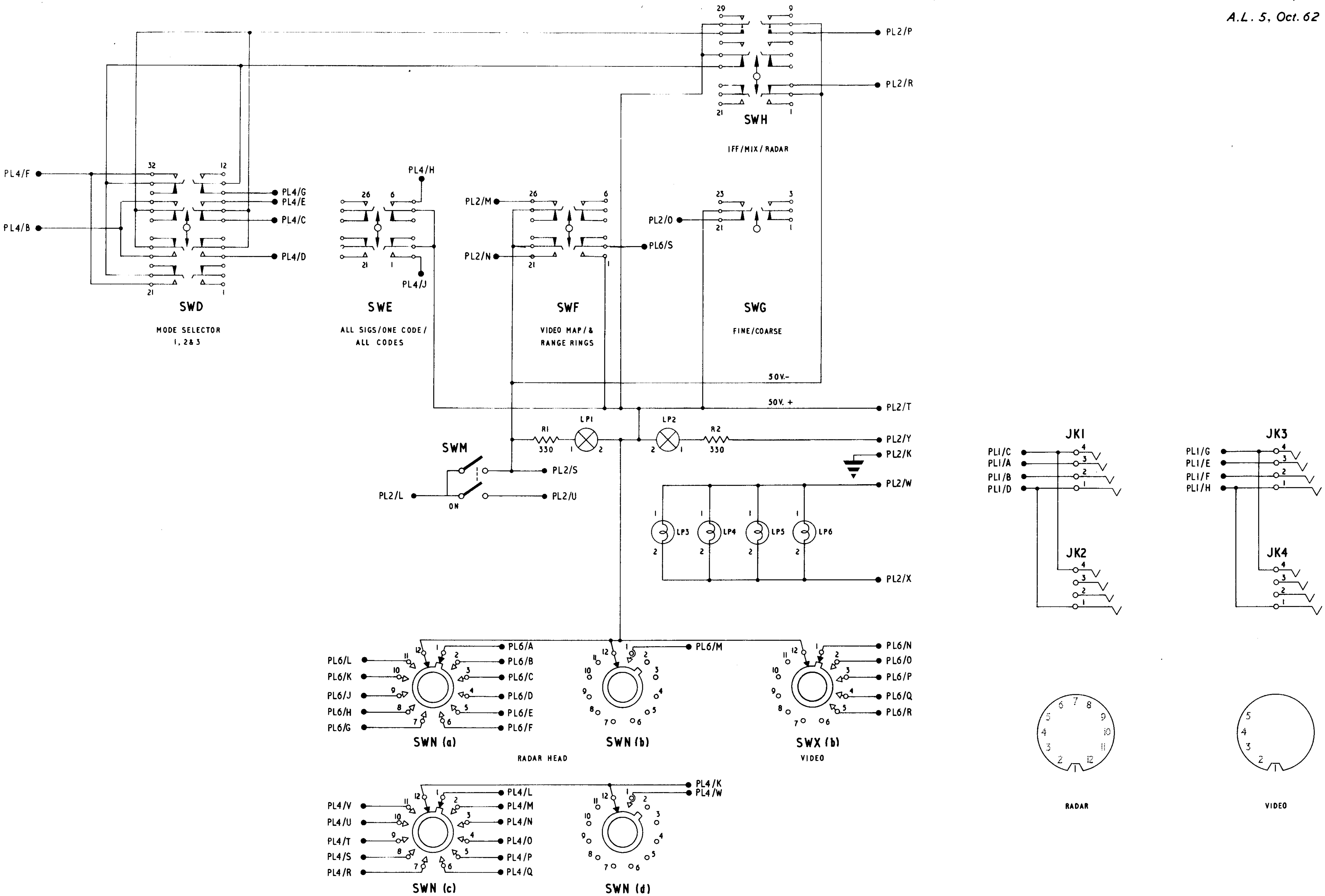


Fig. 30 Panel (control desk) Type 4553B—circuit. Fig. 30

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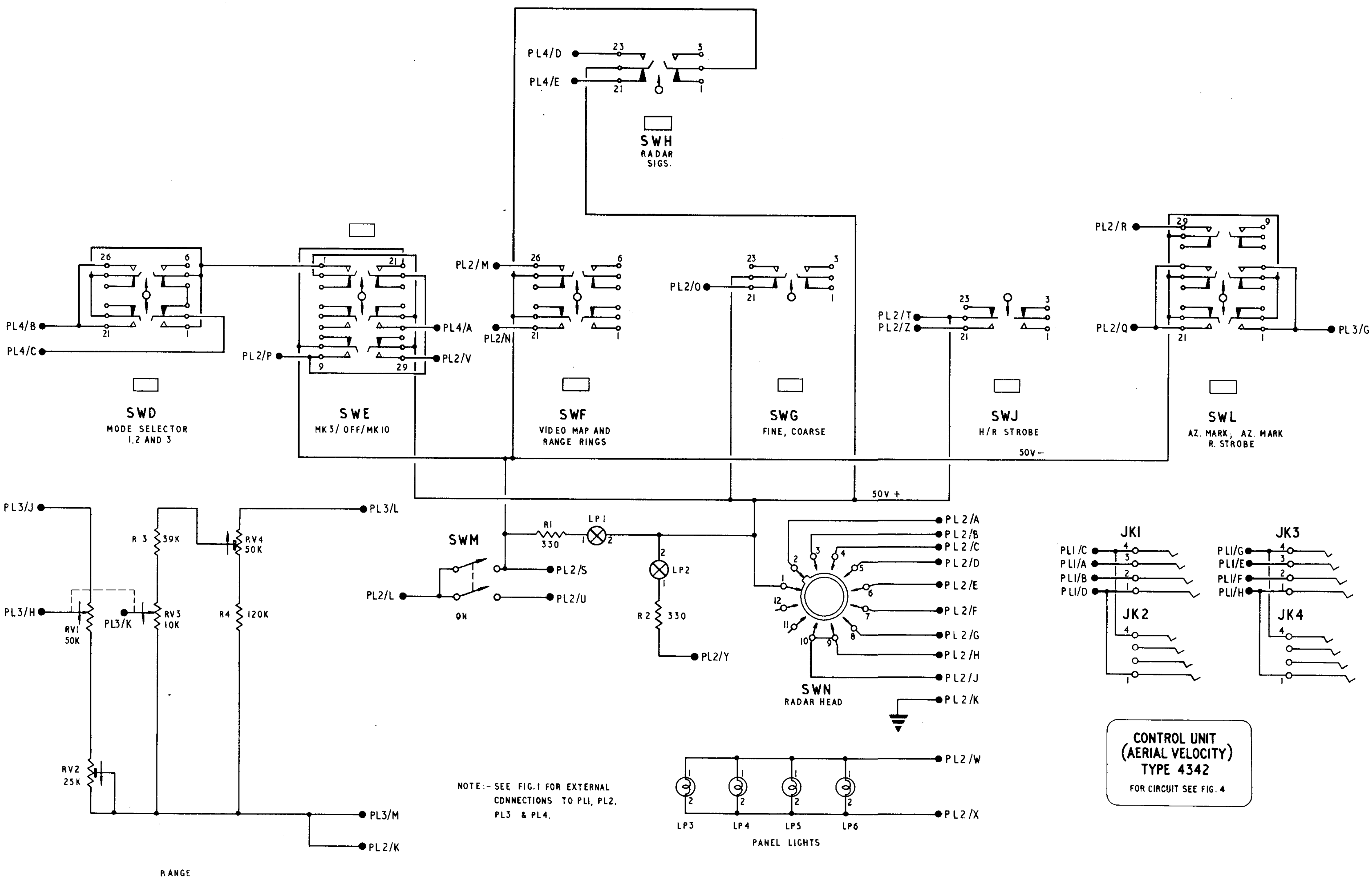


Fig. 31 Panel (control desk) Type 4554—circuit Fig. 31



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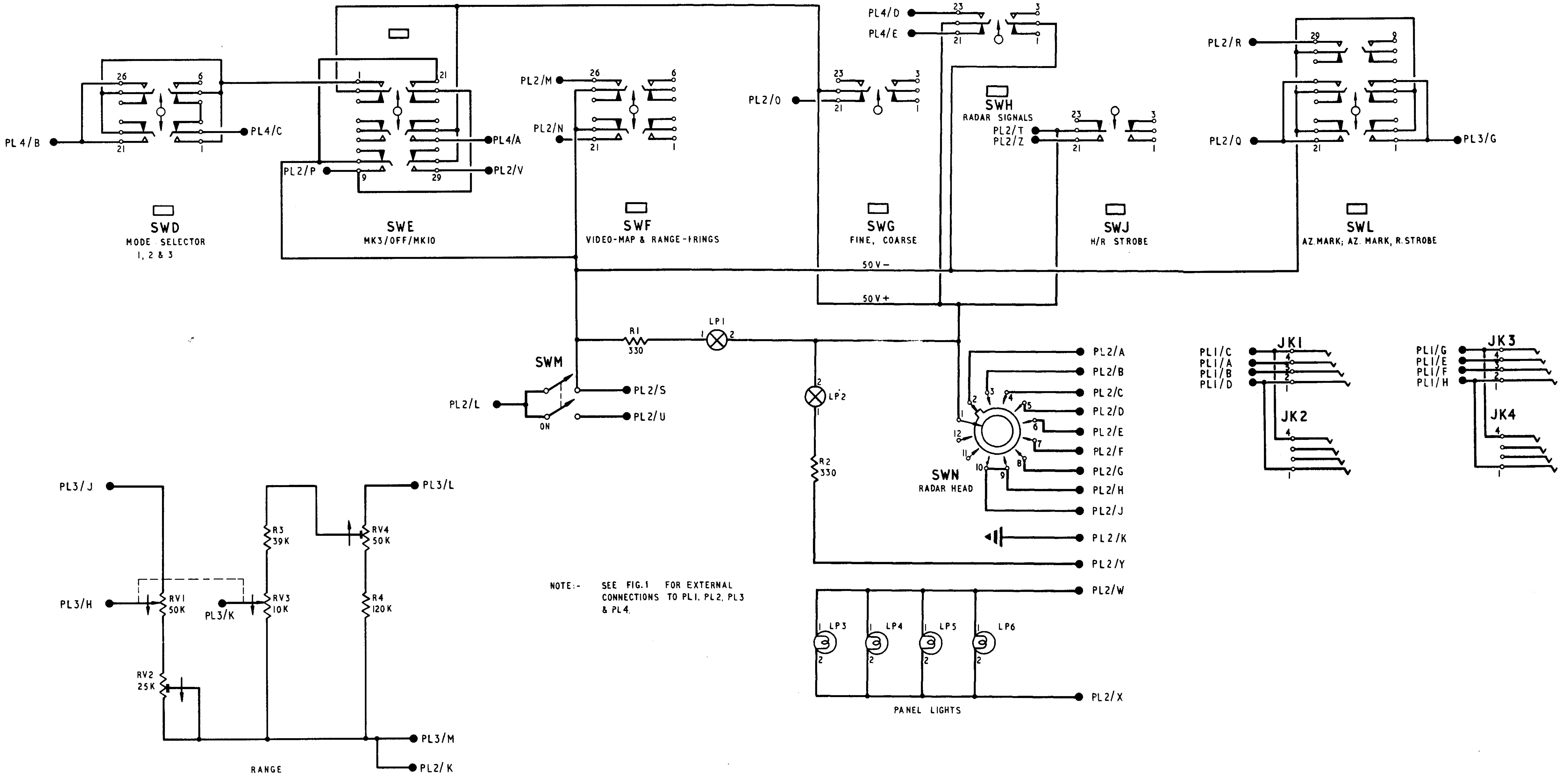


Fig.32

Panel (control desk) Type-4555-circuit

Fig.32



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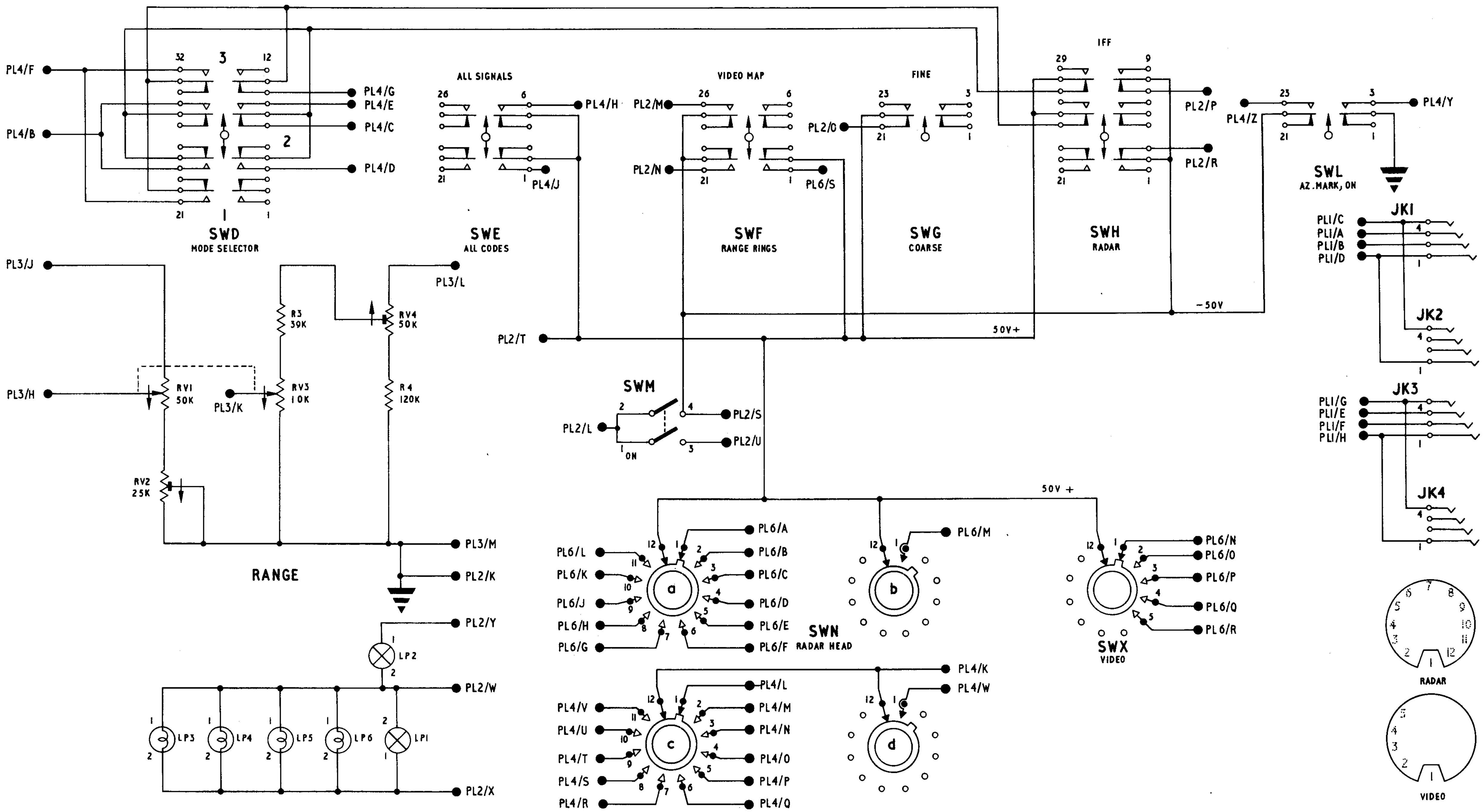


Fig. 33 Panel (control desk) Type 4555C–circuit Fig. 33

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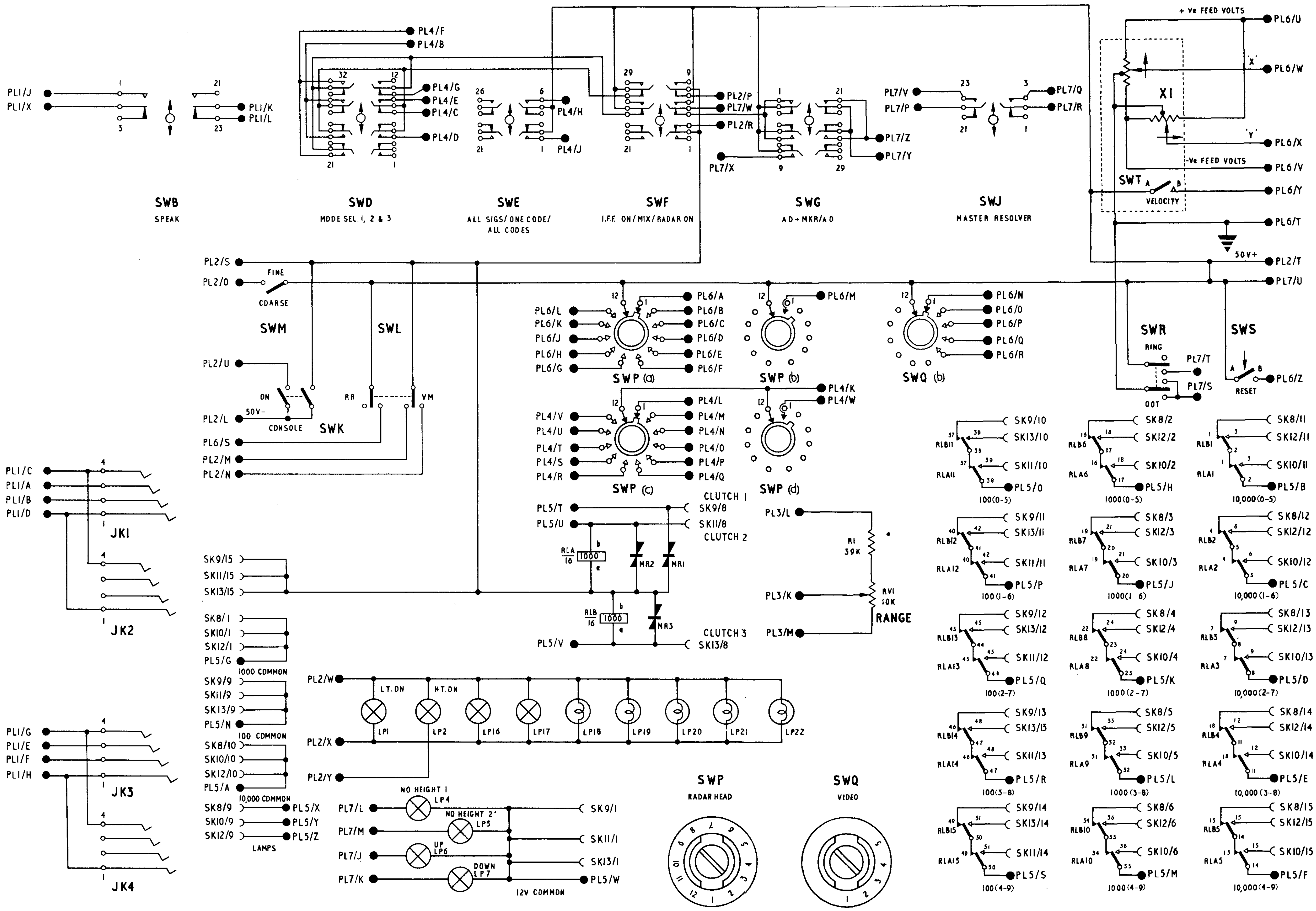


Fig. 34

Panel (control desk) Type 16284 - circuit

Fig. 34

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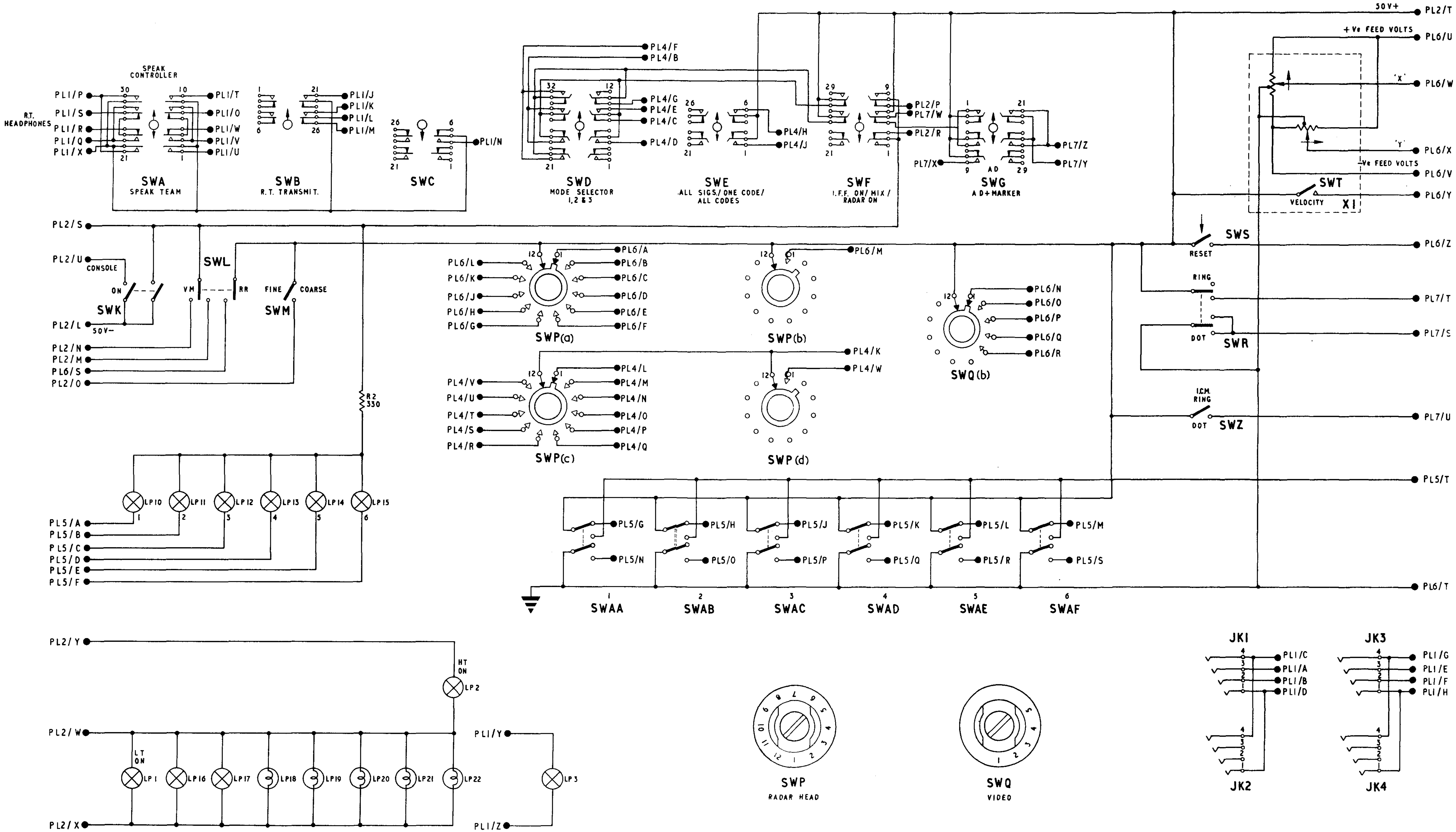


Fig. 35

Panel (control desk) Type 16285-circuit

Fig. 35

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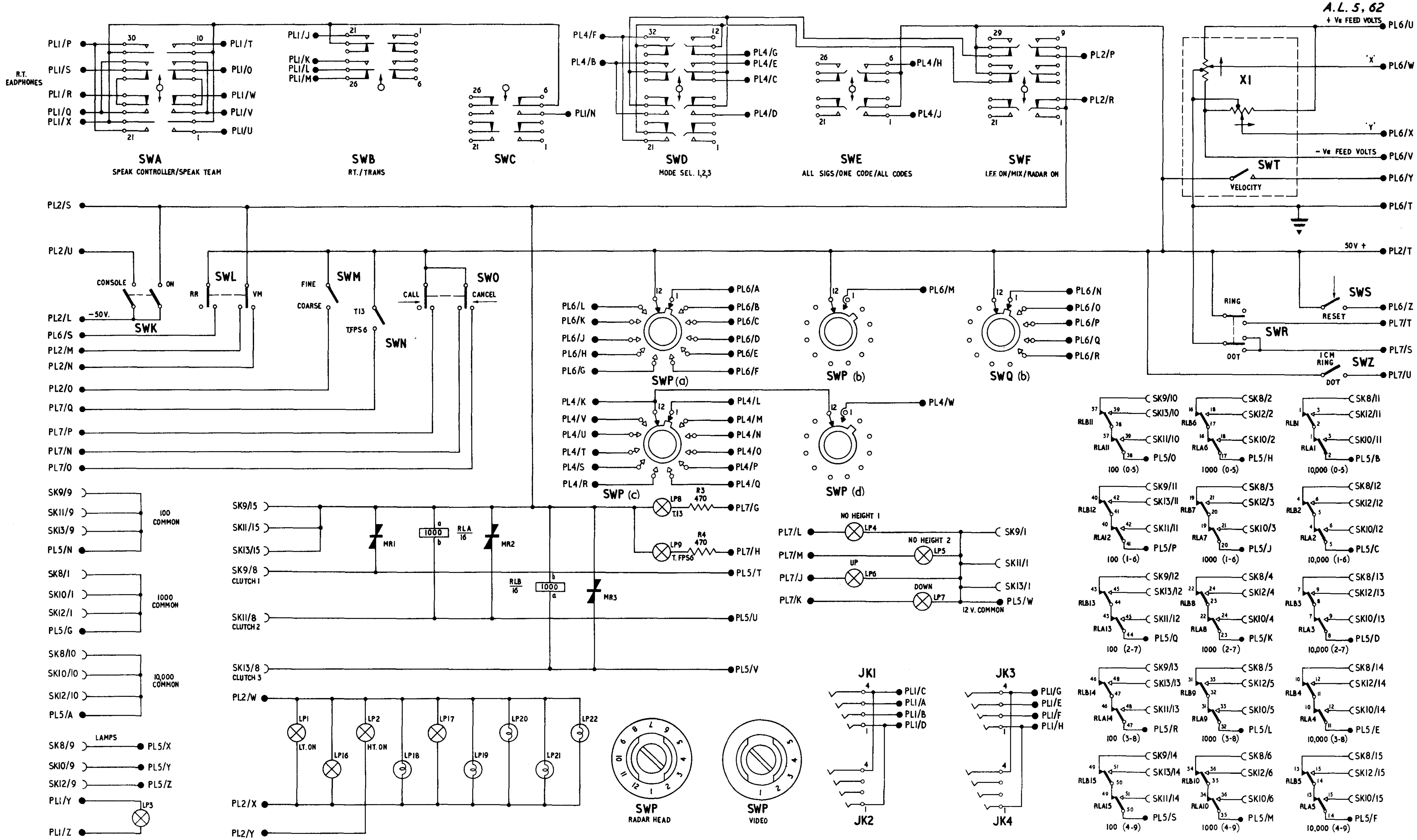


Fig. 36

Panel (control desk) Type 16286 – circuit

Fig. 36

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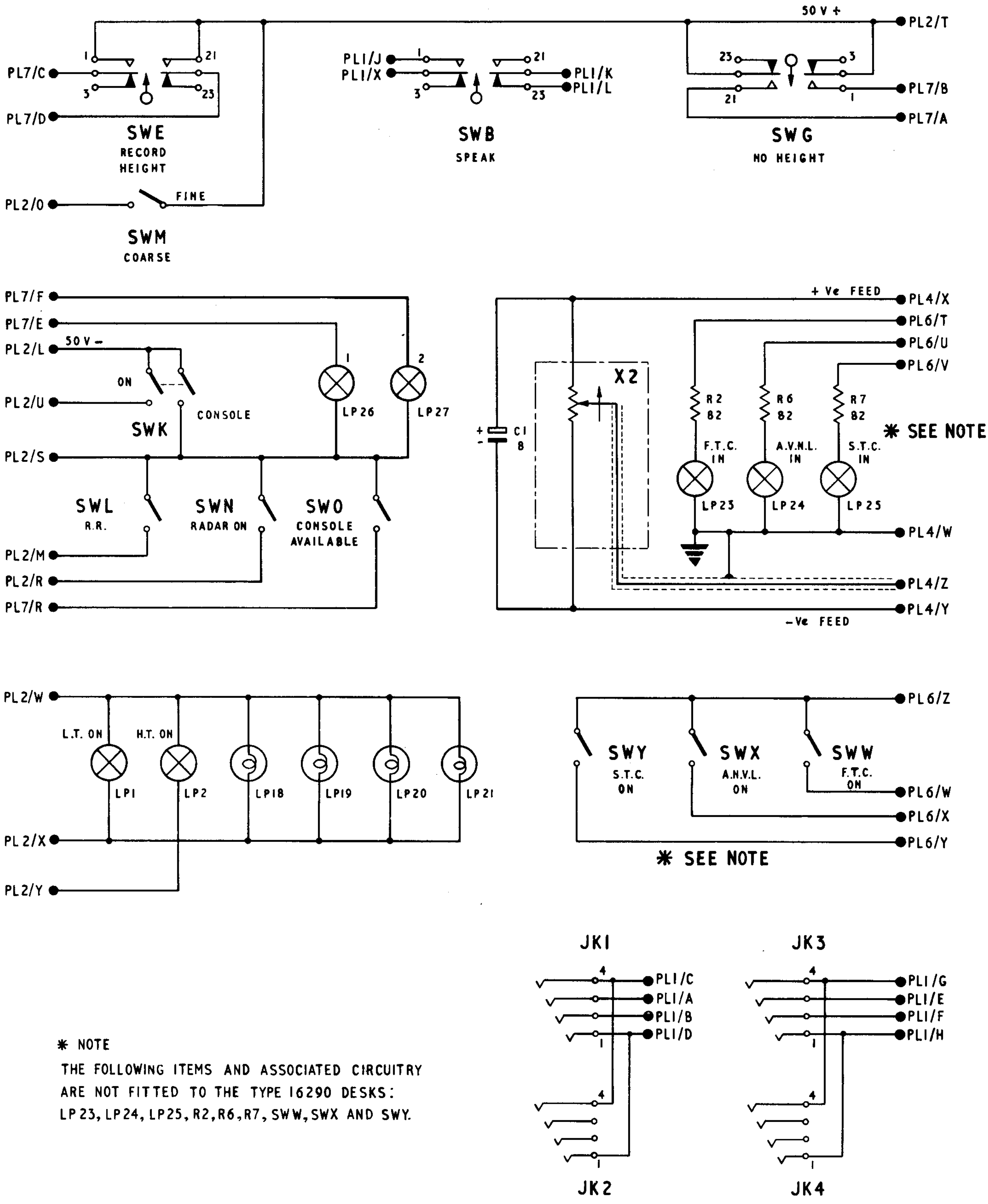


Fig.37 Panel (control desk) Types 16287 & 16290 - circuits

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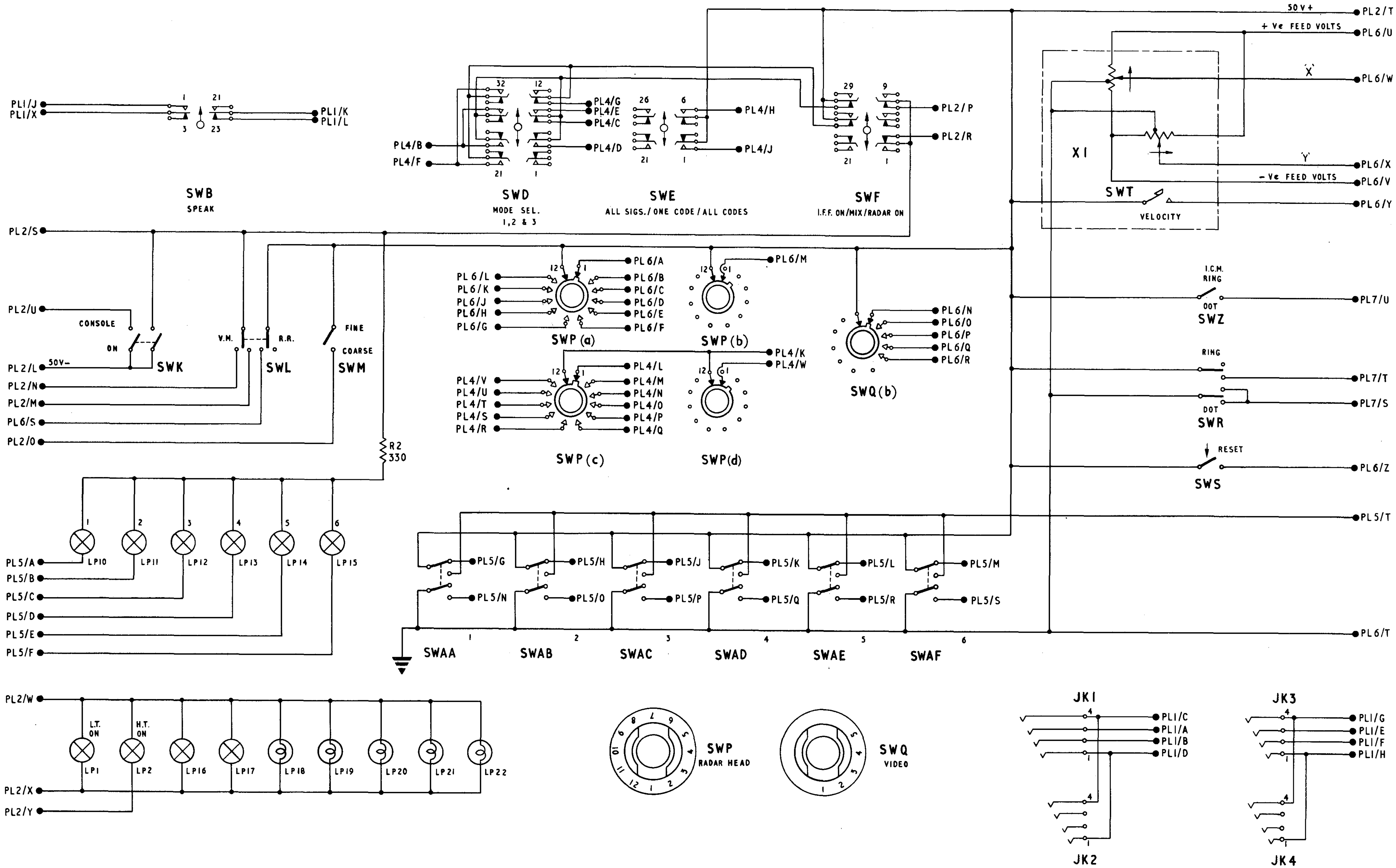


Fig. 38

Panel (control desk) Type 16288 – circuit

Fig. 38

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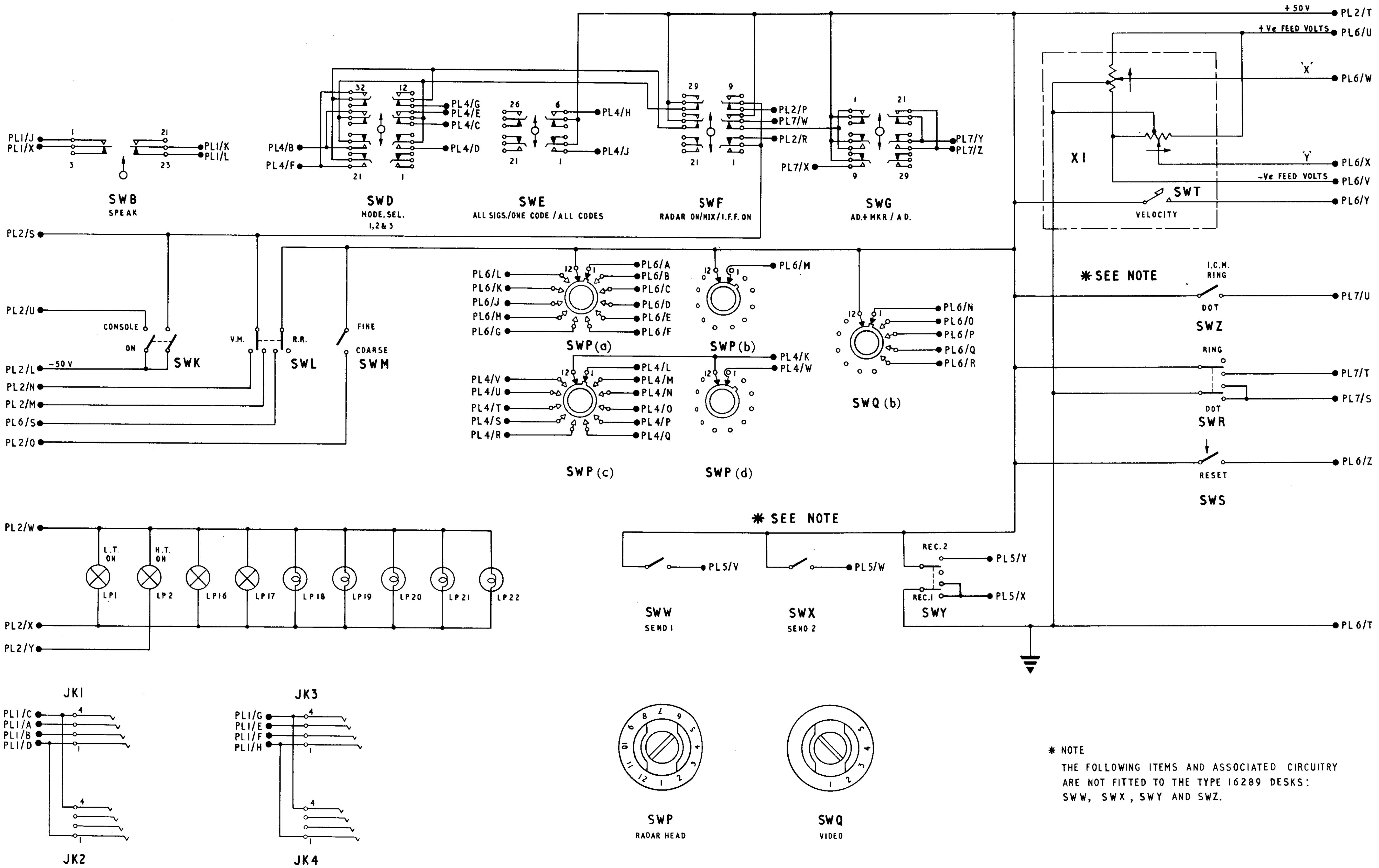


Fig. 39 Panel (control desk) Types 16289 and 16291 – circuit Fig. 39

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# PART 2

# TECHNICAL INFORMATION (SERVICING AND TESTING)

RESTRICTED

C & P Gp 873

# SECTION 1

# SETTING-UP AND TESTING



P30840 567086/4442 2/61 125 C & P Gp 375

# Chapter 1

# CONSOLE TYPE 64 AND CONTROL DESKS
## (SETTING-UP AND TESTING)

## LIST OF CONTENTS



## LIST OF TABLES



## LIST OF ILLUSTRATIONS



## ◀LIST OF APPENDICES

## INTRODUCTION

### Scope of chapter

**1.** The information in this chapter is intended for technicians who have to service and prepare for operations fixed-coil PPI display consoles Type 64. It is impossible to include here servicing information covering every possible fault or operational requirement on equipment of this complexity, and efficient servicing must be based on a thorough understanding of the purpose and functioning of each component unit, as described in Part 1, Sect. 5 of this Volume. The component lists provided in Part 1, Sect. 5 give ratings and tolerances as an aid to servicing. To supplement the circuit diagrams provided in Part 1, Sect. 5, some routeing charts, which will assist in tracing faults to a particular unit or sub-unit of the console, are issued in Part 3. Actual switching on and operating instructions will be found in Part 1, Sect. 2, and dismantling instructions in Part 2, Sect. 2.

**2.** The sources of information listed in para. 1, plus the information in the following paragraphs, will enable first and second line servicing to be carried out on operational sites. Such servicing may be defined as follows:—

(1) *First-line servicing*

(*a*) Mechanical security checks (*Part* 2, *Sect*. 2).

(*b*) Functional test of the installation (present chapter), including adjustment for efficient operation.

(*c*) Locating faults in defective assemblies (*Part* 3) and replacing the assemblies with serviceable items.

(*d*) Rectifying minor unserviceability, e.g. replacing readily removable connectors, indicator lamps and fuses.

(2) *Second-line servicing*

(*a*) Servicing the installation in accordance with the *Progressive Servicing Schedules* (e.g. 90G/2614/2026 Vol. 4, Part 2—Radar Stations Type G.C.I., Radar Office Equipment).

(*b*) Rectifying assemblies found faulty at first-line by replacing serviceable for unserviceable sub-assemblies (where the subsequent use of elaborate test gear is not required) and by renewing valves found to be faulty during the progressive servicing checks.

(*c*) Incorporating minor modifications and special technical instructions as authorized.

(*d*) Checking for correct and efficient operation following the servicing activities.

(*e*) Maintenance of servicing records and submission of reports as required.

**3.** First and second line servicing is within the scope of the personnel resident on a Station, using the test gear provided for Station use. Details of servicing methods are given in para. 5–8. Third line servicing is carried out by Ground Radio (*including radar*) Servicing Squadrons. In the past the personnel of these Squadrons have travelled from Station to Station, carrying out repairs and overhauls which were outside the scope of the resident personnel. This mode of servicing has made Stations non-operational for long periods, and it is now intended to send faulty assemblies and sub-assemblies (replaced by serviceable items at second-line stage) to third-line units for repair, so as to interrupt operations as little as possible.

**4.** These third-line units will be equipped with certain items of test gear not found on operational sites (*Table* 1) and their activities are outside the scope of this Volume. Details of the test gear will be found in A.P.2527D and third-line servicing procedures will be promulgated in A.P.2897R, Vol. 6.

### Operational station servicing methods

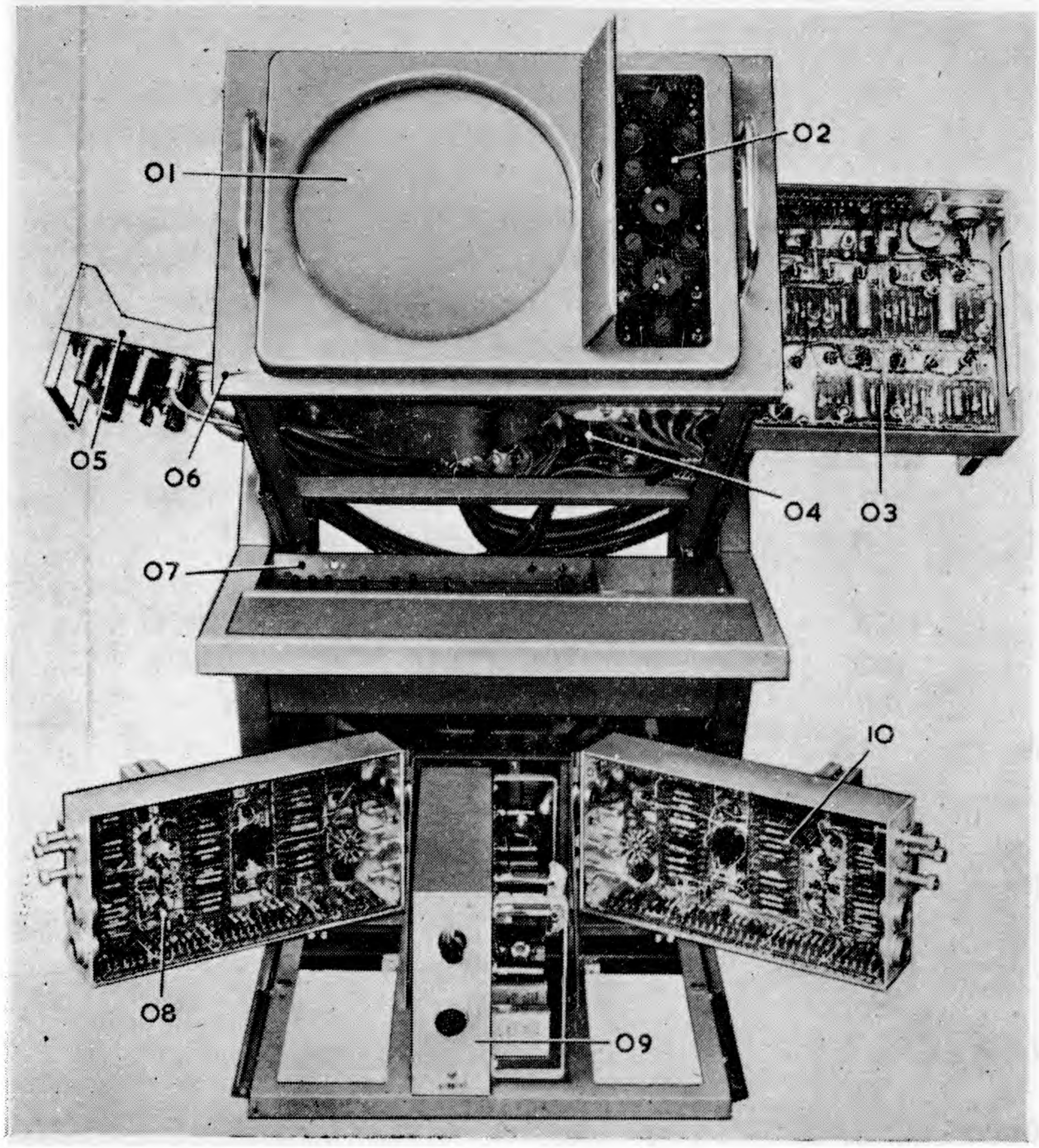
**5.** When a console in any particular cabin or track-telling room is reported faulty, immediate action will be required to decide the nature of the fault, normally by observing the picture when the different controls are manipulated, and by quick checks of valve conditions, using the multimeter Type 100. If the fault is not rectified within a few minutes, the defective unit must be removed from the console to the radar workshop for attention and a serviceable unit put into the console instead.

**6.** Such quick checks, and the adjustments which must necessarily be made on a console when a new or repaired unit is put into it, are referred to in this chapter as "cabin servicing", corresponding roughly to "first-line servicing" as defined in the "Technical Services Manual" (*A.P.*3158, *Vol.* 1, *Sect.* 4, *Chap.* 2) or as in para. 2. To avoid interference with operations, the amount of cabin servicing has to be kept to a minimum.

**7.** In the radar workshop, there is an "exploded" console (*fig.* 1) which should normally be stocked with serviceable, correctly set-up units. This console receives most of the power and waveform services available to operational consoles, so that a defective unit, or a unit newly received on the Station or recently repaired, may be substituted into the console for thorough checking and setting-up under normal conditions. Such work is referred to in this chapter as "workshop servicing" (corresponding roughly to conventional second-line servicing). The procedures set out as workshop servicing may of course equally well be performed on a unit in isolation, i.e. not mounted in a console, provided the normal power supplies and waveforms can be fed into it. Care must be taken that such units do not overheat while out of the usual cooling-air stream.

**8.** The information given in this chapter is, unless otherwise stated, applicable to all consoles Type 64 no matter what kind of control desk is fitted. The various controls mentioned are normally marked, on the equipment, with their RV or C numbers; if these are illegible, refer to the layout diagrams and photographs in Part 1 of this Volume for identification of the components. When locking any potentiometer spindle after setting-up, check the appropriate voltage or current to make sure that tightening the collet has not altered the setting. Take special note of the following points:—

(1) When changing any component in this equipment, make sure that the new component is correct to circuit diagram and parts list (*Part* 1, *Sect.* 5). Pay special attention to tolerance and stability ratings of resistors, to voltage ratings of capacitors, and to moulding orientation of Mk. 4 plugs and sockets. After any component change, scrape off excess soldering flux and shake out loose wire clippings and pieces of solder before switching on power supplies.




01 TUBE UNIT
02 PANEL (CONTROL) TYPE 859
03 AMPLIFYING UNIT (VIDEO) TYPE 312
04 WAVEFORM GENERATOR TYPE 80
05 BLANKING UNIT TYPE 26
06 INDICATING UNIT (CRT) TYPE 35
07 PANEL (CONTROL DESK)
08 AMPLIFYING UNIT (LH) TYPE 314 (Y DEFL. AMP.)
09 STABILIZER (VOLTAGE) TYPE 51
10 AMPLIFYING UNIT (RH) TYPE 313 (X DEFL. AMP.)

CONCEALED AT BASE OF CONSOLE
11 POWER UNIT (EHT) TYPE 898
12 PANEL (FUSE) TYPE 860
13 PANEL (DISTRIBUTION) TYPE 861
14 INPUT PANEL

**Fig. 1. Console stripped for setting-up**

**WARNING**— *Take care to avoid shocks from exposed HT and EHT circuits when the console is in this state.*

(2) All multimeter Type 100 readings listed in this chapter assume that PRESS-TO-READ button is pressed. It is recommended that records of the readings be kept for each unit since a change in any reading will give a pointer for fault diagnosis.

(3) The high-speed relays used in several units of this console cannot be opened up for adjustments to gap or spring sets; a defective relay must be changed for a good one.

(4) All valve current figures are taken with drives (sawtooth, square-wave or pulse) removed, unless otherwise stated.

(5) When the tests call for connection to pins on Mk. 4 plugs or sockets, it will be found impracticable to clip leads to the backs of the pins themselves but connection may be made to a nearby resistor or capacitor located from the unit circuit diagram.

**TABLE 1**
**List of servicing and test equipment for console 64**
**(abstracted from the approved list for GCI and CEW installations)**

| Nomenclature | Type No. | Ref. No. | Air Publication |
|---|---|---|---|
| **CABIN SERVICING** | | | |
| Multimeter .... .... .... .... | 100 | 10S/16576 | 2527D |
| Oscilloscope (Cossor 1035A) .... | 9172 | 10S/16817 | — |
| *superseding* | | | |
| Oscilloscope (Cossor 1035) .... .... | 8165 | 10S/16707 | — |
| Testmeter | | | |
| (electrostatic 0–18·5 kV) .... .... | 100 | 10S/16190 | — |
| **Not provisioned** | | | |
| Tool, extractor, radio valves .... .... | B7G/B9G | 1H/100 | — |
| Wooden foot rule (*para.* 99) .... | — | — | — |
| 4 ft. jumper lead (*para.* 99) .... | — | — | — |

| Nomenclature | Type No. | Ref. No. | Air Publication |
|---|---|---|---|
| **WORKSHOP SERVICING** | | | |
| Multimeter | 100 | 10S/16576 | 2527D |
| Multimeter | 1 | 10S/16411 | 2536C |
| *or* | | | |
| Testmeter | F | 10S/1 | 1186E |
| Multimeter (electronic) | CT38 | 10S/16308 | 2879AG |
| Tester, insulation resistance | D or A | 5G/203 *or* 5G/1621 | — |
| *or* | | | |
| Tester, megger bridge | B | 5G/1708 | |
| Oscilloscope (*calibrated as in para.* 57) | 9172 | 10S/16817 | — |
| Test oscillator (5 c/s) | 101 | 10S/16577 | 2527D |
| Test set | 3 | 10S/16585 | |
| *comprising* | | | |
| Pulse generator (video) | 4073 | 10S/16600 | 2527D |
| Power unit | 903 | 10K/17131 | 2897R |
| Testmeter | 100 | 10S/16190 | — |
| Battery, dry, 120V (*para.* 107 *and* 126) | 1A | 5J/1333 | — |
| Battery, dry, 15V (*para.* 61) | — | 5J/3015 | — |
| **Not provisioned** | | | |
| Buzzer or lamp set for continuity tests | — | — | — |
| Trimming tool for capacitors | — | — | — |
| Tool, extractor, radio valves | B7G/B9G | 1H/100 | — |
| Blower, air, portable | A | 5A/1901 | — |
| Heater transformer 230V/6·3V (*para.* 28) | — | — | — |
| Capacitor 0·001μF, 20 kV working (*para.* 28) | — | — | — |
| Resistor, fixed, 20M 10%, ¾W. (*para.* 28) | — | — | — |
| Accumulator 2V (*para.* 89) | — | — | — |
| Dummy loads | | | |
| 5·1K, 18W; 3·6K, 18W; 13K, 13W (*para.* 12) | — | — | — |
| 9·1K, 10W; 1·8K, 35W (*para.* 48) | — | — | — |
| 39K, 6W (*para.* 64) | — | — | — |
| 10K, 10W; 1K, 60W (*para.* 103) | — | — | — |
| *See also Table* 16 | | | |
| Test rigs—*see fig.* 3, 7, 8, 9, 11 *and* 14 | — | — | — |
| **For third-line servicing** | | | |
| Amplifier (gated) | 4480 | 10U/16847 | 2527D |
| Test cradle (for console units) | 4660 | 10S/16660 | 2527D |

## STABILIZER (VOLTAGE) TYPE 51

### Cabin servicing

*Voltage checks and adjustments*

**9.** The −300V, +250V and +400V stabilizers in the stabilizer (voltage) Type 51 should be checked and, if necessary, adjusted in the order shown in Table 2, using the multimeter Type 100 plugged into SK3. Turn the TEST/NORMAL switch to TEST while making adjustments, and restore to NORMAL when completed; but remember that the console can never be switched on by the desk ON/OFF switch after complete shut-down (including heaters) unless the TEST/NORMAL switches here and on the waveform generator Type 80 are in the NORMAL position. As there is a protection circuit which compares the internally stabilized +250V against the external +250V produced by the bulk power supply, it is im-

**TABLE 2**

**Stabilizer 51—voltage readings**

| Multimeter switch position | Control to adjust | Multimeter FSD | Multimeter reading Nominal | Actual |
|---|---|---|---|---|
| GU | RV1 : −300 SET | 300V | 300V | 300V |
| JW | (*external supply* | 300V | 250V | About 250V |
| HV | RV3 : +250V SET | 300V | 250V | As JW |
| FT | RV2 : +400V SET | 1,000V | 400V | JW+150V |

portant to measure the external one and then adjust the internal one to the same multimeter reading, even though this is not exactly 250V; the internal +400V must then be adjusted to 150V more. Also, the positive stabilizers are referred to the −300V, so the −300V must be set up first. After any adjustment of the voltage stabilizer, the deflection amplifiers should be set up again (*para.* 95).

### Workshop servicing

*General*

**10.** When the stabilizer is first received in the workshop for checking, setting-up or repair, take the following routine action :—

(1) Use the hot air blower to remove all dust, condensation, etc., from the chassis.

(2) Inspect the valves for cracks or softness (shown by white staining on gettering) and loose bases. Make sure they are all secure in their holders and that they are properly held by their retainers or spring screening cans.

(3) Check the fixed plugs and sockets for metal scraps, etc., between pins, and test that their wiring is soundly soldered to the pins.

(4) Check mechanically the action of SWA.

(5) Inspect all fixed resistors for signs of over-heating.

*Power supplies required*

**11.** The information on power supplies in Table 3 is given in case a stabilizer (voltage) Type 51 has to be tested in isolation on the workshop bench (i.e., not mounted in a console). The supplies should be switched on in the order shown. The 6·3V heater supplies must be separate and isolated from earth.

*Dummy loads*

**12.** If the voltage stabilizer is not connected normally into a console, attach improvised dummy loads across the output sockets and earth, as follows, to simulate the normal console load :—

| *Supply* | *Socket and pin* | *Load current* | *Load resistor (ohms)* | *Wattage* |
|---|---|---|---|---|
| −300V | SK1/D | 59mA | 5·1K | 18W |
| +250V | SK1/B | 69mA | 3·6K | 18W |
| +400V | SK1/A | 31mA | 13K | 13W |

*TEST/NORMAL switch*

**13.** If the voltage stabilizer is mounted in a console for servicing, turn the TEST/NORMAL switch on the stabilizer to TEST to prevent the console HT circuit from tripping, except where instructed otherwise.

*Output ranges*

**14.** Connect a multimeter Type 1 to each output rail in turn, and check that swinging each adjusting potentiometer over its range gives a variation of output not less than the figures below. Leave each output adjusted to its correct nominal value, but note that a final adjustment to these controls should be made in accordance with para. 9, after the stabilizer is put into the console where it is to be used.

| *Supply* | *Socket and pin* | *Control to adjust* | *Minimum range limits* | *Average total range* |
|---|---|---|---|---|
| −300V | SK1/D | RV1 | −300V± 8V | 40V |
| +250V | SK1/B | RV3 | +250V± 7V | 50V |
| +400V | SK1/A | RV2 | +400V±11V | 120V |

**TABLE 3**

**Supplies required for testing stabilizer 51**

| Plug and pin | Voltage (nominal) | Upper limit | Lower limit | Load (approx.) | Ripple volts (approx.) peak-to-peak | Normal source |
|---|---|---|---|---|---|---|
| PL5/D,K | 6·3V (*a*) | +2½% | −2½% | 1·2A | (50 c/s) | Console dist. panel |
| PL5/E,L | 6·3V (*b*) | +2½% | −2½% | 0·6A | (50 c/s) | ,, ,, ,, |
| PL5/F, M | 6·3V (*c*) | +2½% | −2½% | 1·6A | (50 c/s) | ,, ,, ,, |
| PL5/Q, R | 6·3V (*d*) | +2½% | −2½% | 0·9A | (50 c/s) | ,, ,, ,, |
| PL5/A | −500V stab. | — | — | 1·1mA | OV | Rack assy. (neg. ref.) 338 |
| PL5/B | −470V | −442V | −522V | 150mA | 9·4V+10% | Rack assy. (B.P.S.) 305 |
| PL5/S | +420V | +466V | +395V | 74mA | 12·6V+10% | ,, ,, ,, 305 |
| PL5/C | +570V | +633V | +536V | 54mA | 11·4V+10% | ,, ,, ,, 305 |

*HF oscillation and hum*

**15.** Connect the oscilloscope Type 9172 to each of the three output rails in turn, and check that:—

(1) There is no sign of HF oscillation.

(2) The hum voltage on any rail does not exceed 15mV peak-to-peak over the minimum output ranges given in para. 14. If possible, vary the raw DC inputs to the stabilizer over the ranges shown in Table 3, and repeat the hum check at different points in the range. (Where a bulk power supply rack is the source of DC, the voltages may be varied by using the dummy loads provided in the workshop.)

**Note . . .**

*To avoid excessive dissipation in V1 of the stabilizer, the nominal −470V input should not be held more negative than −498V longer than ½ minute when making this test.*

*+250 trip relay*

**16.** When the TEST/NORMAL switch on the stabilizer is set at NORMAL, a trip relay RLB is connected between an external +250V stabilized supply and that produced internally. If any substantial difference develops between these two, RLB is energized and open-circuits a trip line (*Chap.* 9, *Sect.* 5) switching off the console HT. Check the correct operation of this device as follows, noting the differences in procedure when a stabilizer is being tested in isolation instead of in an otherwise serviceable console :—

(1) Turn SWA to TEST, and connect the multimeter Type 1 (250V and then 25V DC ranges) between the internal (SK1/B) and the external (SK4/C) +250V rails.

(2) Adjust the internal +250V rail by RV3 until the meter indicates zero difference between internal and external.

(3) (*a*) *Stabilizer in console.* Turn SWA to NORMAL ; if the trip circuit is in order the console HT will remain on. Now vary RV3 until the console HT trips ; this should occur at a meter reading between 10V and 20V. Restore RV3 to about its previous position, and bring on the console HT again (HT RESET button). Repeat the check with RV3 turned in the other direction. Finally, set RV3 for zero meter reading.

OR (b) *Isolated stabilizer.* Connect a continuity tester (buzzer or another testmeter) across contact B1 (connect to SK4/D and the wire joining contacts B1 and A1). Turn SWA to NORMAL ; B1 should show continuity, i.e., RLB not energized. Now vary RV3 until continuity is broken ; this should occur at a meter reading showing a difference between internal and external supplies of between 10V and 20V. Repeat the check with RV3 turned in the other direction. Finally, set RV3 for zero difference between internal and external supplies.

*+400V trip relay*

**17.** A similar trip relay RLA compares the +400V produced internally against a +400V derived from the raw +570V input but stabilized at +400V by a 150V neon V8, which is referred to the external +250V stabilized. To check this system proceed as follows :—

(1) Turn SWA to TEST, and connect the multimeter Type 1 (250V and then 25V DC ranges) between the internal +400V rail (SK1/A) and the +400V comparison point (SWAb/7).

(2) Adjust the internal +400V by RV2 until the meter reads zero difference.

(3) (a) *Stabilizer in console.* Turn SWA to NORMAL, and vary RV2 until the console HT trips ; this should occur at a meter reading between 20V and 40V. Restore RV2 to about its previous position, and bring on the console HT again (HT RESET). Repeat the check with RV2 turned in the opposite direction. Finally, set RV2 for zero meter reading.

OR (b) *Isolated stabilizer.* Connect a continuity tester across contact A1 (use PL5/N and the wire joining contacts B1 and A1). With SWA at NORMAL, contact A1 should show continuity, i.e., RLA not energized. Now vary RV2 until continuity is broken ; this should occur at a meter reading between 20V and 40V. Repeat with RV2 turned in the opposite direction. Finally, set RV2 for zero meter reading, and remove the multimeter.

*Overall trip circuit test*

**18.** The following overall trip circuit test should be done on a stabilizer if it is reported to trip the console HT frequently and without apparent reason :—

(1) Make sure all three stabilizer outputs are at their correct values, with multimeter 100 plugged into SK3 (*Table* 2).

(2) (a) *Stabilizer in console.* Check that, with SWA at NORMAL, the console HT does NOT trip when the +250V output at SK1/B is varied ±5V by RV3 or when the +400V output at SK1/A is varied ±5V by RV2.

OR (b) *Isolated stabilizer.* Connect a continuity tester across contacts A1 and B1 (PL5/N to SK4/D) and check that continuity is NOT broken when the rails are varied as in (*a*).

*Valve currents*

**19.** Table 4, showing valve currents, is included for general circuit checking with the multimeter. Type 100.

## POWER UNIT (EHT) TYPE 898

### Cabin servicing

*Voltage check*

**20.** Cabin servicing on the power unit (EHT) Type 898 is normally confined to checking the EHT voltage under working conditions ; this should be done as laid down in the progressive servicing schedules. It is not recommended that EHT adjustments by RV1 should be attempted in

**TABLE 4**
**Stabilizer 51—valve current readings**

| Valve | Electrode | Multimeter switch position | Multimeter FSD (mA) | Normal current Min. (mA) | Normal current Max. (mA) |
|---|---|---|---|---|---|
| V3 | Cathode | AO | 10 | 0·3 | 0·7 |
| V1 | Anode | BP | 100 | 24 | 71 |
| V4A | Anode | CQ | 10 | 0·3 | 3·1 |
| V3B | Anode | DR | 10 | 1·3 | 3·6 |
| V6 | Cathode | ES | 10 | 0·8 | 1·3 |

cabins unless time is particularly short. All other servicing must be done in the workshop. The EHT voltage may be checked as follows :—

(1) Trip the console HT by switching OFF, and ON again, the HT ON switch on the panel (control) Type 859. (The valve heaters stay on when this is done.)
(2) Make sure the EHT circuit is safe by earthing the final anode cap to console framework. (Access to the anode cap is had through the small spring door at the side of the tube housing).
(3) Obtain the electrostatic voltmeter Type 100. Clip one lead to frame and nip the other under the CRT final anode cap. Ensure that the connection between the anode cap and the voltmeter is adequately insulated from earth.
(4) Bring on the HT (and with it the EHT) again by pressing the HT RESET button on the panel (control) Type 859.
(5) Draw a moderate beam current from the EHT supply by turning up the BRILLIANCE control (RV6 on video amplifier) until a trace is just visible on the screen.
(6) Check that the electrostatic voltmeter reads 15,000V $\pm$75V, and that the reading is steady and free from sudden changes as the BRILLIANCE control is swung over the range from trace extinction to maximum permissible trace brightness.
(7) Turn down the BRILLIANCE control. Trip off the HT as before, earth the CRT anode, and remove the electrostatic voltmeter.

### Workshop servicing

*General*

**21.** When an EHT unit is first brought into the workshop for servicing, take the following routine action :—

(1) Take the metal covers off the unit, and use the hot air blower to remove dust, condensed moisture, etc., from the chassis.
(2) Check the HT fuse FS1 for continuity and correct rating (150mA).
(3) Inspect the valves for cracks, loose bases or softness (indicated by white appearance of gettering). Make sure they are secure in their holders and are properly held by retaining harness or screening can, and that (where applicable) the top cap connector is secure.
(4) Check the fixed plugs and sockets for metal scraps between pins, and test the soundness of connection of their leads.
(5) Inspect the perspex container which holds the regulator resistance chain (R46-R71) for signs of leakage of silicone fluid ; wipe off any small surplus. When the air bubble exceeds about 1 cu. in. the chain is liable to early breakdown and must be changed.
(6) Inspect all fixed resistors for signs of overheating (charring or melted wax).

*Safety note*

**22.** The EHT voltage produced by this unit is capable of inflicting a severe shock, so special care is needed when working the unit with the covers off. Always switch off and discharge the EHT capacitors (preferably by earthing the anti-corona plates on V6 and V7 cathodes) before touching any part of the high-voltage components. Never attempt to monitor EHT circuits with the oscilloscope direct. Make connections to the EHT output socket with correct plug and cable as used in the console, and not with odd pieces of wire. Wear a cap when leaning over a working unit (loose hair is attracted by high potential points).

*Power supplies*

**23.** Information on power supplies is given in Table 5 in case a power unit (EHT) Type 898 has to be tested in isolation on the workshop bench (i.e. out of a console). The normal source of each supply is indicated. The supplies must be switched on in the order shown in Table 5.

**TABLE 5**
**Supplies required for testing power unit (EHT) 898**

| Plug and pin | Voltage (nominal) | Upper limit | Lower limit | Load (approx.) | Ripple volts (approx.) | Normal source |
|---|---|---|---|---|---|---|
| PL3/C, D | 6·3V | +2½% | −2½% | 3A | (50 c/s) | Console distrib. panel |
| PL2/B | −500V stab. | — | — | 1mA | OV | Rack assy. (neg. ref.) Type 338 |
| PL2/C | +250V stab. | — | — | 6mA | OV | Rack assy. (BPS) Type 305 |
| PL2/A | +420V | +466V | +395V | 70mA | 13V | ,, ,, ,, ,, 305 |

*Output range and +15 kW setting*

**24.** (1) Switch off the HT supplies, and discharge the EHT capacitors.

(2) Connect a multimeter Type 1 (0-1A DC range) in series in the +420V raw DC input line.

(3) Connect the 0-18·5kV electrostatic voltmeter across the output, using a proper plug.

(4) Switch on supplies to unit.

(5) Check that the EHT output can be varied over a range of at least 14·5kV to 15·5kV by swinging the EHT SET control RV1 over its range.

(6) Set the output at 15kV using RV1, and check that the +420V feed current does not exceed 65mA (set meter to 0-100mA range for final reading). Leave RV1 locked in the 15kV position.

*Brushing and corona*

**25.** With the unit producing a 15kV output listen for the crackling or hissing noises characteristic of brushing discharge. Operate the unit in the dark (e.g., under a dark cloth), and look for signs of corona from EHT points (also detectable by the smell of ozone). Small corona discharges become more apparent if moist air is breathed over the unit. These discharges must be minimized because they reduce the efficiency of the unit and may cause erratic changes in output. Corners or points on soldered joints may cause brushing which can, however, be prevented by enlarging and rounding the joints with solder. EHT components whose surfaces have become pitted or damaged should be changed. Also check for sounds of brushing later in these tests when the metal covers have been replaced.

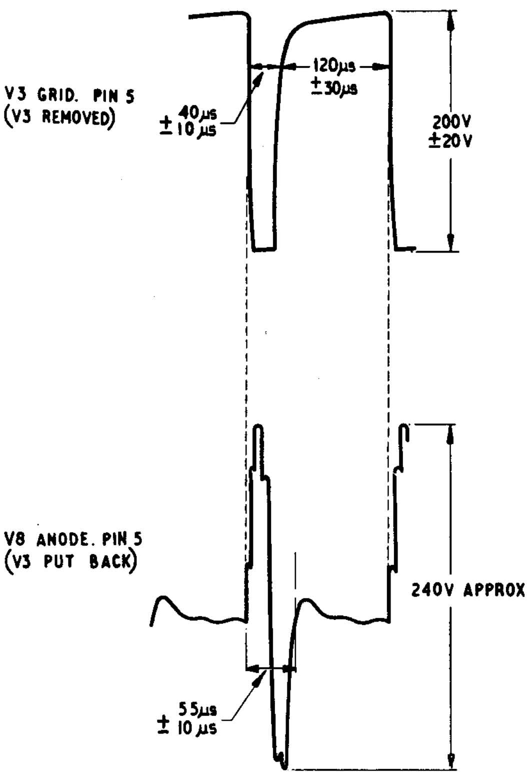



**Fig. 2. EHT unit waveforms**

**26.** If the unit is not operating satisfactorily use the oscilloscope 9172 to check the multivibrator waveform as shown in fig. 2. Use only the test points shown in the figure.

**Note . . .**

*Use* A.C. TO Y2 *connection on the CRO; the waveforms on the screen will be inverted forms of those shown in fig.* 2.

*Ripple test*

**27.** It is important that excessive 6·5 kc/s ripple should not be present at V4 (regulator valve) grid, or it may be driven into grid current. Connect the oscilloscope (A1 INPUT, 5 VOLTS range) to the junction of C10, R37 and R36 (on tagboard under chassis), and check that the observed ripple is below 3V peak-to-peak.

*Hum test*

**28.** Mains hum on the EHT output can have a bad effect on displays, as CRT deflection sensitivity depends on EHT and the hum may produce patterns on the screen. Check the EHT hum content as follows (*a*) with normal bulk power supply input and (*b*) with severe hum on the same input.

(1) Switch off, and discharge the EHT unit.

(2) Across the 15kV output connect (in addition to the electrostatic voltmeter) the resistor, capacitor and oscilloscope 9172 as shown in fig. 3.

(3) In series with the raw +420V input line connect a spare heater transformer having a well insulated 6·3V, 1A winding (*fig.* 3).

(4) Switch on power, and check hum levels :—

(*a*) With 6·3V transformer not switched on, hum must not exceed 15V peak-to-peak (use 5 VOLTS range on CRO).

(*b*) With 6·3V transformer switched on, hum must not exceed 31V peak-to-peak (use 50 VOLTS range on CRO).

(5) Switch off power supplies, discharge the EHT unit and remove test components and transformer.

*Over-voltage test*

**29.** The next test is to check the effectiveness of the protective diodes which prevent the EHT output rising dangerously high if the regulator valve V4 fails. Since the top safety limit is an EHT output of 20kV, an electrostatic voltmeter with this range is desirable, but the testmeter Type 100 (range 0-18·5kV) provisioned on sites

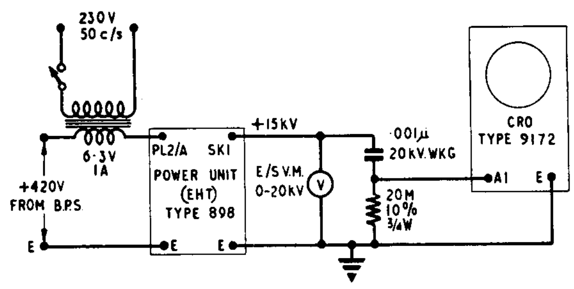



**Fig. 3. EHT unit hum test**

**TABLE 6**
**Power unit (EHT) 898—valve current readings**

| Valve | Function | Multimeter switch position | Multimeter FSD (mA) | Average current (mA) |
|---|---|---|---|---|
| V1A | Multivibrator A | AO | 10 | 1·6 |
| V1B | Multivibrator B | BP | 10 | 2·4 |
| V2 | Buffer/shaper | CQ | 10 | 4·4 |
| V3 | Switching valve | DR | 100 | 42 |
| V4 | Regulator | ES | 3 | 1·26 |

may serve since excessive outputs will deflect the meter needle off the top of the scale. This test MUST be completed as quickly as possible to prevent damage to the unit :—

(1) Connect the electrostatic voltmeter to the EHT output.

(2) Remove V4 from the unit.

(3) Switch on, and check that the EHT output is greater than +17kV but less than +20kV.

(4) Switch off, discharge the EHT and put back V4.

*Valve currents*

**30.** The average valve currents (measured at cathodes) are included in Table 6 for general checking. The figures are subject to a tolerance of ±25 per cent and are taken with a multimeter Type 100 plugged into SK4 on a working EHT unit with the HT supply at its nominal +420V.

## INDICATING UNIT (CRT) TYPE 35

**31.** The indicating unit (CRT) Type 35, which occupies the upper half of the console Type 64, contains the following sub-units :—

(1) Tube unit (including CRT in housing with deflector and focus coils).

(2) Waveform generator (video gating) Type 80.

(3) Amplifying unit (video) Type 312.

(4) Blanking unit Type 26.

(5) Panel (control) Type 859.

**32.** There are two methods of doing workshop servicing involving faults and setting-up operations on these five sub-units. One is to remove the entire indicating unit to the workshop for servicing and setting-up in the exploded console there, and the other is to remove the affected sub-unit only and to substitute a good one. The choice of method must be decided locally in the particular circumstances of the fault. It should be remembered, however, that while the video amplifier and blanking unit are both fairly easy to remove from the indicating unit, the waveform generator is more difficult. Also the control panel and tube housing are practically a structural part of the indicating unit and are very unlikely to be removed from it. The data set out in the following paragraphs should be equally useful whichever method of servicing is adopted. It must always be borne in mind that there are certain setting-up operations involving several units together (e.g. deflection amplifiers stabilizers and blanking unit) which must be carried out on the console as a whole, before it is ready for use. (See overall console setting-up, *para.* 128).

## TUBE UNIT

### Cabin servicing

*Screen lights*

**33.** There is no cabin servicing that may usefully be done on the tube unit except changing burnt-out 6V lamps (screen lights) around the CRT edge as follows :—

(1) Pull off the escutcheon from the front of the indicating unit.

(2) To avoid upsetting the CRT focus, do NOT take off the front CRT clamping ring. Instead, unscrew the lampholder from the inside of the ring.

(3) Change the defective lamp and put back the lampholder and escutcheon.

### Workshop servicing

*Deflector-coil assembly re-alignment*

**34.** The deflector-coil assembly should never be disturbed unnecessarily, as it is mounted and aligned in manufacture, and any changes necessitate re-alignment not only of the deflector-coils but of the focus-coil as well. Instructions concerning removal and replacement of the deflector-coils are given in Chap. 1, Sect. 2 of this Part. After such work the deflector-coil assembly requires to be re-located. The coils are mounted on spring-loaded slides and press closely against the flare of the CRT bulb, so that the only factor which is adjustable is their orientation around the CRT neck ; this has to be set so that the Y-deflection is truly vertical on the screen.

**35.** The adjustment is made by rotating the whole casting which contains the deflector and focus coils. This is possible because the three bolts which secure the casting to the main tube housing pass through slots which allow about 15 deg. of rotation. Mount the indicating unit in an exploded console where the deflection amplifiers have already been zeroed, and proceed as follows :—

(1) Turn SWB on the amplifying unit (RH) Type 313 (X deflection amplifier) to TEST in order to eliminate X deflection.

(2) Allow normal Y scan waveforms to trace out a line on the screen in the Y direction from

top to bottom. Check whether this line is truly vertical by reference to the two cleat fixing screws located at 12 o'clock and 6 o'clock on the clamping ring assembly. (The metal escutcheon must be taken off the front of the indicating unit to reveal these screws.) If the line is not truly vertical, continue to operation (3) *et seq.*

(3) Trip the console HT (HT ON switch *off* and *on* again).

(4) Slide back the mumetal shield which screens the focus deflector-coil assembly (made easier if the blanking unit is swung out of the way), and allow the shield to rest on the focus-coil leads.

(5) Loosen off (but do not withdraw) the three bolts which secure the whole casting to the rear of the tube housing.

(6) Bring on console HT (HT RESET button).

(7) Turn the casting until the line produced by repeating operation (2) is truly vertical on the screen.

(8) Tighten up the bolts, (checking that this has not affected the adjustment), trip the console HT, and put back the mumetal shield.

(9) Turn down the brilliance, replace the front escutcheon, and return SWB on the 313 to NORMAL.

*Deflector-coil resistance*

**36.** The DC resistance of any one deflector-coil disconnected from its circuit and measured with the multimeter Type 1 is approximately 40 ohms.

*Deflector-coil insulation*

**37.** Check the insulation resistance from deflector-coils to frame, after removing all coaxial connectors and PL2 on the tube unit. Use the 500 V Megger (tester, insulation resistance, Type A) ; the resistance should be at least 20 megohms.

*Focus-coil re-alignment*

**38.** For an accurate and consistent picture, with uniform quality all over, it is essential that the focus-coil shall exert no deflectional effect on the spot, i.e., that the focused spot shall, in the absence of deflector-coil currents, coincide with the unfocused spot, which is often referred to as the "natural centre" of the display, and should be within 15 mm. of the geometrical centre.

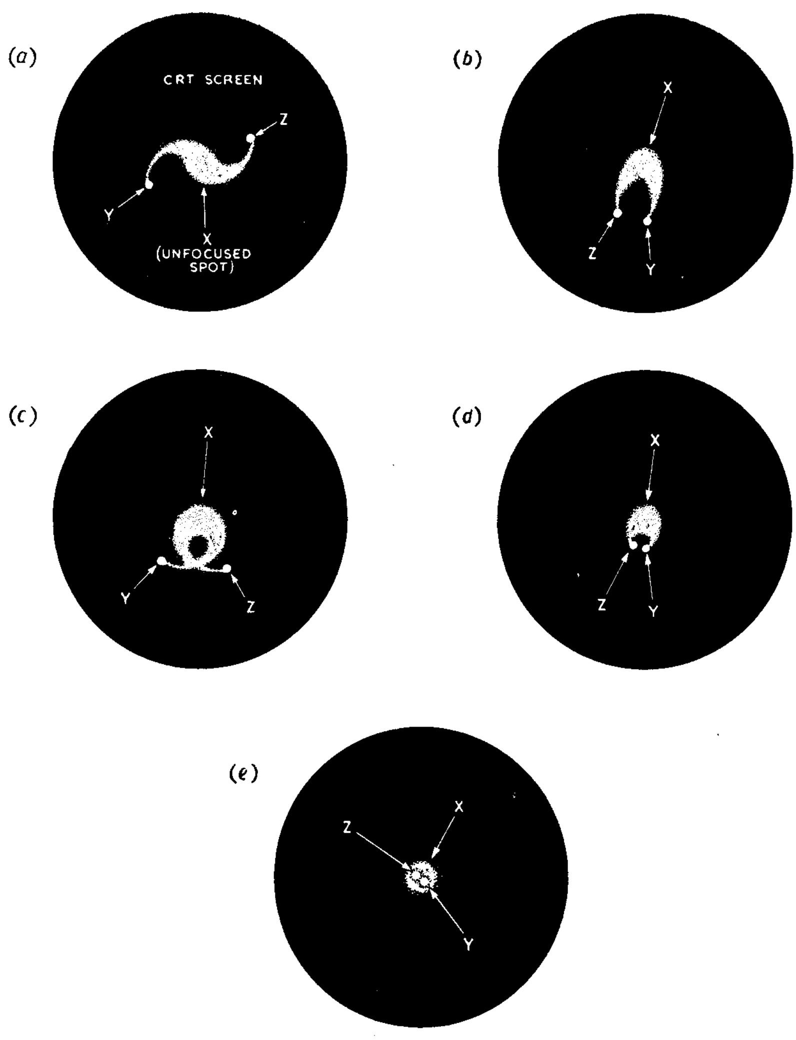


**Fig. 4. Stages in focus-coil adjustment**

**39.** This state occurs when the focusing field coincides exactly with the beam axis of the CRT and to achieve it the focus coil mounting has been designed to have four degrees of movement (see also *Part* 1, *Sect.* 5, *Chap.* 1, *fig.* 6), as follows :—

(1) Transverse shifts in mutually perpendicular directions, using shift screws **A** and **B** accessible through holes in the mumetal shield.

(2) Tilt about an axis perpendicular to the CRT axis, altered by the tilt screw at the rear of the housing. This tilt screw is secured by a locknut.

(3) Rotation of the focus-coil on the CRT axis, effected by turning the whole focus-coil casing inside the front part of the housing. This movement is normally prevented by a tightening screw in the clamp ring which encircles the housing.

**40.** The focus-coil must be re-aligned not only when setting up a new console but also whenever the focus/deflector-coil assembly has been disturbed or the CRT has been changed. To facilitate the work, the test oscillator Type 101 has been designed to drive a 5 c/s sinewave of current in the focus-coil instead of the usual steady focus current. When the current is zero the unfocused spot appears (**X** on *fig.* 4). When the current is maximum one way the focused spot **Y** is displayed; when it is maximum the other way the focused spot **Z** appears instead. Tube afterglow makes the whole appear as one picture without much flicker. The procedure is to manipulate the focus-coil adjustments until both the focused spots coincide with the middle of the unfocused spot. Proceed as follows :—

(1) Trip off the console HT.

(2) Improve access to the focus/deflector coil assembly by swinging back the waveform generator Type 80.

(3) Turn down the BRILLIANCE control (RV6 on video amplifier) and remove normal deflections by earthing SK4 on each deflection amplifier. Set the RANGE switch on control panel 859 to 320M.

(4) Remove the normal free socket from PL2 on the tube housing, and insert the connector from the test oscillator Type 101 instead.

(5) Make sure that the meter on the bulk power supply rack in the radar office is not switched to the +250V position associated with this console. (When PL2 on the tube housing is disconnected, the +250V stabilizer in the B.P.S. rack, being unloaded, produces nearly 500V, which could wreck the meter).

(6) Bring on the console HT, and then switch on the test oscillator.

(7) Turn up the BRILLIANCE control until a reasonably bright picture as fig. 4(*a*) is obtained. If necessary, adjust the AMP. and BAL. controls on the test oscillator until the focused spots at each end of the pattern are sharp. Where the focus-coil is badly out of adjustment, the picture will look like fig. 4(*a*), or worse.

(8) Do not attempt to set up a mirror (as in television servicing) to view the screen while working on the focus-coil. For sufficient accuracy a direct examination of the screen must be made after each stage of adjustment.

(9) Slacken off the rotation setscrew through the hole in the mumetal screen, and also the tilt locknut on the rear of the assembly.

(10) Adjust the transverse shift screws alternately until the two " horns " of the pattern (**Y** and **Z**) are on the same side as in fig. 4(*b*), and continue to adjust these until the " horns " cross over as in fig. 4(*c*).

(11) Manipulate the rotation and tilt adjustments until the " horns " coalesce and open out a little nearer the unfocused spot **X**, as in fig. 4(*d*).

(12) Continue operations (10) and (11) until the focused spots **Y** and **Z** coalesce in the middle of the unfocused spot **X**, as in fig. 4(*e*). It will be acceptable if **Y** and **Z** are within 2 mm. of each other and of the centre of **X**.

(13) Clamp up all focus-coil adjustments, reduce brilliance, switch off the test oscillator, switch off console HT, remove test oscillator, put back PL2 on the tube unit, switch on HT again and bring up the brilliance slowly.

(14) Adjust for the sharpest spot using the normal FOCUS control (RV1 on the blanking unit).

(15) Use the OFF-CENTRE controls to shift the spot to all sides of the screen, and check that the focus is reasonably uniform all over.

(16) Turn down the BRILLIANCE control, and restore normal deflection inputs to the X and Y deflection amplifiers.

*Focus-coil resistance*

**41.** The DC resistance of the focus-coil, disconnected from its normal circuit and measured with the multimeter Type 1, is approximately 3·9K. The most convenient point to make this check is the small terminal block to which the focus coil leads are brought out on the rear of the coil assembly.

*Focus-coil insulation*

**42.** Check the insulation resistance between the winding (with HT off and leads disconnected) and frame using the 500V Megger (tester, insulation resistance, Type A) ; the tester should indicate at least 20 megohms.

## WAVEFORM GENERATOR (VIDEO GATING) TYPE 80

### Cabin servicing

*Voltage stabilizers*

**43.** The −300V and +250V stabilizers in the waveform generator should be checked and if necessary adjusted with the multimeter Type 100 plugged into SK3 ; the details are set out below. After switching on the console, turn the TEST/NORMAL switch (SWA) to TEST while making adjustments, and restore to NORMAL when completed.

**44.** As there is a protection circuit which compares the internally stabilized +250V against the external +250V received from the bulk power supply, it is important to measure the external one first and then adjust the internal one to the same multimeter reading, even though this may not be exactly 250V. Also, the positive stabilizer is referred to the negative, so the negative must be set up first. Proceed as follows :—

(1) Plug the multimeter into SK3 on the stabilizer (voltage) Type 51, select position JW, and note the reading. This is the stabilized bulk power supply, and should read within a few volts of 250V.

(2) Plug the multimeter 100 into SK3 on the waveform generator Type 80 and select position LY. If the reading is not exactly 300, adjust RV2 (−300V SET control) until it is. Lock RV2.

(3) Select position KX on the multimeter and adjust RV1 (+250V SET control) until the

reading is exactly the same as in operation (1). Lock RV1.

**45.** The remaining two controls, RV3 (ANTI-CLUTTER SET) and RV4 (TRACE COMP. SET), are approximately set in the workshop and adjusted for best results as part of the overall console setting-up (*para.* 128).

### Workshop servicing

*General*

**46.** Carry out the following routine on any waveform generator Type 80 brought into the workshop :—

(1) Use the hot air blower to remove dust and condensation from the chassis.

(2) Inspect the valves for cracks or softness, and for loose bases or distorted pins. Make sure they are all secure in their holders and firmly held by their retaining harness or screening cans.

(3) Make sure the high-speed relays are secure in their sockets.

(4) Examine the fixed plugs and sockets for metal scraps between pins, and see that their wiring is soundly soldered to the pins.

(5) Inspect all fixed resistors for signs of overheating (charring or melted wax).

*Power supplies*

**47.** Table 7 gives the power supplies required by the waveform generator ; the normal source of each supply is indicated. They should be switched on in the order shown.

*Dummy loads*

**48.** If the waveform generator is not mounted normally in a console, attach improvised dummy loads across the stabilizer output sockets and earth, as follows, to simulate the normal console load :—

| *Supply* | *Socket and pin* | *Load current* | *Load resistor (ohms)* | *Wattage* |
|---|---|---|---|---|
| −300V | SK12/B | 34mA | 9·1K | 10W |
| +250V | SK11/B | 140mA | 1·8K | 35W |

*TEST/NORMAL switch*

**49.** If the waveform generator is mounted in an exploded console for servicing, turn the TEST/NORMAL switch on the WFG to TEST (except when otherwise instructed) while adjustments are being done, to prevent the HT circuit from tripping.

*Output ranges*

**50.** With the stabilized outputs properly loaded (*para.* 48), connect a multimeter Type 1 to the −300V rail, and check that swinging the adjusting potentiometer over its range gives a variation of output not less than that shown below. Leave the rail set at −300V exactly, and make the same test on the +250V rail. Leave the +250V rail exactly set, but note that a final adjustment to these controls should be made after the WFG is put into the console where it is to be used, in accordance with para. 44.

| *Supply* | *Socket and pin* | *Control to adjust* | *Minimum range limits* | *Average total range* |
|---|---|---|---|---|
| −300V | SK12/B | RV2 | −300V ±8V | 90V |
| +250V | SK11/B | RV1 | +250V ±7V | 50V |

*HF oscillation and hum*

**51.** Connect the oscilloscope Type 9172 to each output rail in turn, and check that :—

(1) There is no sign of HF oscillation.

(2) The hum voltage does not exceed 15mV peak-to-peak on the −300V, and 10mV peak-to-peak on the +250V, over the minimum range limits given in para. 50. If possible, vary the raw DC inputs to the stabilizer over the ranges shown in Table 7 and repeat the hum check at different points in the range. (Where a bulk power supply rack is the source of DC, the voltages may be varied by switching on from one up to five other consoles fed from the same rack or by using the dummy load Type 4481.)

*+250V trip relay*

**52.** When the TEST/NORMAL switch on the WFG is set at NORMAL, a trip relay RLE is connected between an external +250V stabilized supply and that produced internally. If any appreciable difference develops between these two, RLE is energized and open-circuits a trip line, so switching off the console HT. The method of checking the operation of this system varies according to whether (*a*) the WFG is mounted in an otherwise serviceable exploded console, or (*b*) the WFG is being tested in isolation on a bench.

**TABLE 7**

**Supplies required for testing waveform generator Type 80**

| Plug and pin | Voltage (nominal) | Upper limit | Lower limit | Load (approx.) | Ripple volts (approx.) | Normal source |
|---|---|---|---|---|---|---|
| PL1/D, K | 6·3V (*a*) | +2½% | −2½% | ½A | (50 c/s) | Console dist. panel |
| PL1/E, L | 6·3V (*b*) | +2½% | −2½% | 2A | (50 c/s) | ,, ,, ,, |
| PL1/G, N | 6·3V (*c*) | +2½% | −2½% | 2A | (50 c/s) | ,, ,, ,, |
| PL1/R, S | 6·3V (*d*) | +2½% | −2½% | 1½A | (50 c/s) | ,, ,, ,, |
| PL1/C | −500V stab. | — | — | 1·1mA | OV | Rack assy. (neg. ref.) Type 338 |
| PL1/B | −470V | −442V | −522V | 100mA | 10V | Rack assy. (BPS) Type 305 |
| PL1/A | +420V | +466V | +395V | 150mA | 13V | Rack assy. (BPS) Type 305 |

*Trip relay check in console*

**53.** To check the +250V trip relay operation on a WFG mounted in a console :—

(1) Turn SWA to TEST, and connect the multimeter Type 1 (250V and then 25V DC ranges) between the internal (SK11/B) and external (PL2/C) +250V.

(2) Adjust the internal +250V by RV1 until the meter indicates zero difference between internal and external supplies.

(3) Turn the TEST/NORMAL switch on the WFG to NORMAL ; if the trip circuit is in order the console HT should remain on.

(4) Note the RV1 spindle position, then vary the internal +250V by swinging RV1 slowly until the console HT trips (showing that RLE has been energized). This should occur at a testmeter reading between 10V and 20V.

(5) Return RV1 to about its previous setting, and bring on the console HT again (HT RESET button). Swing RV1 in the opposite direction ; the console HT should again trip at a meter reading between 10V and 20V.

(6) Restore RV1 to about its previous setting again, bring on the HT, make an accurate setting of RV1 for zero difference, and remove the multimeter.

*Trip relay check on isolated WFG*

**54.** To check the +250V trip relay functioning on an isolated WFG Type 80 : perform operations (1) and (2) of para. 53 then continue as follows :—

(3) Connect a continuity tester (a buzzer or another testmeter) across contacts E1 ; it should indicate continuity, proving that RLE is not energized.

(4) Swing RV1, varying the internal +250V, until continuity is broken, showing that RLE has been energized. This should occur at a multimeter reading between 10V and 20V. Repeat with RV1 turned in the other direction ; continuity should again be broken somewhere between 10V and 20V.

(5) Reset RV1 so that the difference is zero, and remove the multimeter.

*Valve currents*

**55.** The limit figures for valve currents are included in Table 8 for general checking. They are measured on a multimeter Type 100 and assume that the HT rails have been set to their correct values, and that there are no signal inputs.

*Waveform checks*

**56.** Fig. 5 overleaf shows the normal waveforms, with permissible limits of amplitude and level, through the waveform generator *without* the effect of blanking ; the blanking input to SK7 should be removed before making waveform checks. The normal radar bright-up input or similar 500 c/s input from pulse generator (video) 4073 to SK4, is, however, essential.

*Oscilloscope technique*

**57.** The ordinary A1 calibration on the oscilloscope Type 9172 will be sufficient for checking waveform amplitudes and timing, but special care is needed when checking DC levels. Proceed as follows :—

(1) Connect a multimeter Type 1 (0-250V DC) between Y1 plate and earth ; the meter live lead must be jammed under the A1 AMP. OUTPUT link under the trapdoor at the L.H. side of the oscilloscope.

(2) Operate the A1 shift control to move the Y1 trace between two convenient marks on the graticule and note the corresponding voltage change on the multimeter.

(3) Connect the multimeter between Y2 plate and earth, use the A2 shift to move the Y2 trace between the SAME two graticule marks and note the voltage change.

(4) Divide (3) by (2) to obtain the ratio of the deflection sensitivities on the two plates.

(5) Unlink the Y1 plate from its amplifier and earth it.

(6) Use the A2 shift to set the Y2 trace to coincide with the Y1, and measure the voltage between the Y2 plate and earth ; this is the Y2 zero error.

(7) To measure the DC level of a particular part of a waveform, connect the waveform direct to Y1 plate (unlinked from A1 amplifier). Leave Y2 plate linked to A2 amplifier and connect the testmeter between Y2 plate and

**TABLE 8**

**Waveform generator 80—valve current readings**

| Valve | Function | Electrode | Multimeter switch position | Multimeter FSD (mA) | Current (mA) Min. | Current (mA) Max. |
|---|---|---|---|---|---|---|
| V3 | +250V control valve | Cathode | AO | 10 | 0·3 | 0·7 |
| V1 | —300V regulator | Anode | BP | 100 | 18·0 | 61·0 |
| V4A | —300V control valve (A) | Anode | CQ | 10 | 0·3 | 3·1 |
| V4B | —300V control valve (B) | Anode | DR | 10 | 1·3 | 3·6 |
| V6A | RBU amp. (A) | Cathode | ES | 10 | 3·0 | 5·0 |
| V6B | RBU amp. (B) | Anode | FT | 10 | 2·3 | 4·1 |
| V8A | RBU cathode-follower | Anode | GU | 10 | 2·0* | 3·7* |
| V8B | Video gate valve | Anode | HV | 10 | 2·3 | 3·3 |
| V10A | Trace comp. cathode-follower | Anode | JW | 10 | 2·8 | 4·0 |

**With RV3 fully counter-clockwise*

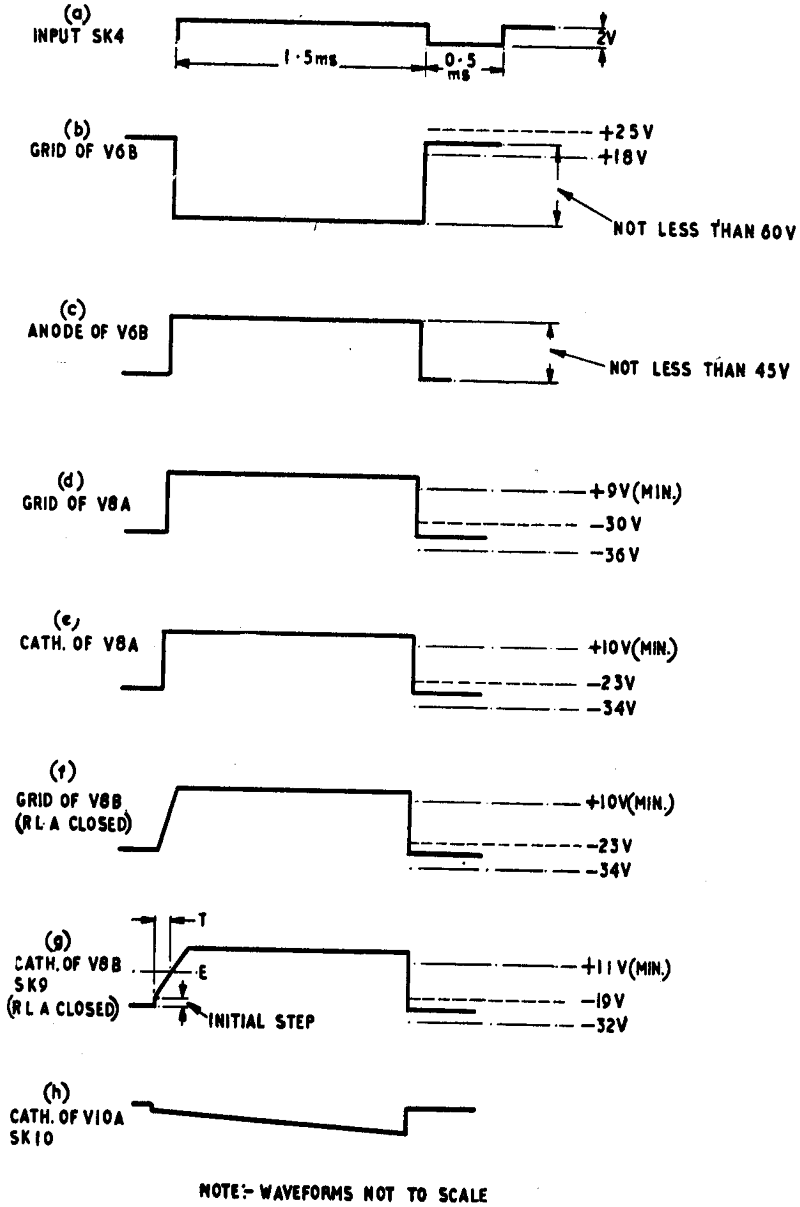



**Fig. 5. Waveform generator Type 80—waveforms**

earth. Set the Y2 trace on the part of the waveform whose level is wanted; the test-meter reading, corrected by the sensitivity factor (4) and the zero error (6), is the required DC level.

*Anti-clutter waveform*

**58.** To check the anti-clutter waveform (*g*), energize RLA by applying +50V to PL2/D with negative return on PL1/H (normally by closing ANTI-CLUTTER switch on the control panel). With RV3 fully counter-clockwise the amplitude of the initial step should be less than 3V. Check that the rise time *T* can be adjusted by RV3 over a range of at least 160-220 $\mu$S. Leave set at 200$\mu$S unless otherwise instructed. Further check that the waveform (*g*) is within the limits shown when the amplitude of the input at SK4 is reduced to 1·6V. Then return the amplitude of the input to 2V.

**59.** De-energize RLA, and check that the rise time of waveform (*g*) is under 8$\mu$S and its fall time less than 6 $\mu$S (with normal connection of video amplifier and connecting cable to SK6). (If the WFG is being tested in isolation, connect a 100pF capacitor between SK9 and earth to simulate normal loading.)

*Trace compensation waveform*

**60.** The trace compensation waveform (*h*) must have an apparently linear fall whose slope increases with clockwise rotation of RV4. With RANGE switch set to 80M (i.e. no trace compensation relays energized) check that RV4 can give a slope of 3·5V per millisecond over the first millisecond. Operate relays B, C and D in succession by turning the RANGE switch to 160M, 240M and 320M, and check that the slope of the waveform is reduced to approximately $\frac{1}{2}$, $\frac{1}{3}$ and $\frac{1}{4}$, respectively, of its value on 80M. (Relays B, C and D are operated with +50V to PL2/D and negative return to PL1/Q, O and P, respectively.)

*Blanking check*

**61.** Use a battery to apply −15V to the blanking input SK7 and check that the cathode voltage of V8B does NOT rise above −8V during the radar bright-up period. Apply +4·5V to SK7 and check that V8B cathode does NOT fall below +6·5V during the radar bright-up period.

## AMPLIFYING UNIT (VIDEO) TYPE 312

**Cabin servicing**

**62.** Cabin servicing on the video amplifier is confined to certain final adjustments to RV6, RV8 and RV4 when a console as a whole is being set up and prepared for operations. The remaining five variable resistors and the six variable capacitors are not to be touched except as detailed under "Workshop servicing". Set up the three controls mentioned, under correct subdued lighting conditions, as follows :—

(1) Set the OFF-CENTRE controls (RV7 and RV8) on the control panel 859 to about mid-position, and the RANGE switch to 160M. Make sure that all signal controls on this panel are turned fully counter-clockwise, and that all signal keys on the console control desk are at OFF.

(2) On the amplifying unit 312, set the DRIVE control RV8 to about mid-position.

(3) Operate the head selector switch to obtain normal deflection inputs to the console.

(4) Turn up the BRILLIANCE control RV6 until the rotating scan appears, then turn it back until the scan is just extinguished. *Re-establish this condition after each adjustment to RV8 which follows.*

(5) Operate the control desk keys to obtain RANGE RINGS—FINE.

(6) Gradually turn up the RANGE RINGS input control on the control panel, and observe the appearance of the resulting range circles on the screen. If they "bloom" (i.e. produce a fogged display of excessive brilliance) *before* the input control is turned fully clockwise, turn *down* the DRIVE control RV8 (counterclockwise). But if they do not "bloom" before the input control is turned right up, turn to RV8. The correct setting for RV8 is the one where the range rings are just starting to "bloom" when their input control is turned fully clockwise. Lock RV8 there, and also lock RV6.

(7) Turn back the RANGE RINGS input control until the range rings are of moderate brightness.

(8) Have the appropriate magslip resolver in the radar office stopped by breaking its selsyn drive; this should de-energize RLF here in the video amplifier and bring the DIMMER potentiometer RV4 into circuit, and at the same time stop the scan rotating so that nothing is seen but a row of range dots. Adjust RV4 until these dots are approximately as bright as were the range rings before. Lock RV4 and have the magslip resolver started again.

(9) Turn down the RANGE RINGS input control, and turn OFF the associated desk keys.

**Workshop servicing**

**63.** When a video amplifier is first brought into the workshop for check, overhaul or repair, either alone or as part of an indicating unit, take the following action :—

(1) Use the hot air blower to remove dust and condensation from the chassis.

(2) Inspect the valve for cracks, distorted pins or softness (indicated by white appearance of gettering). Make sure all the high-speed relays are secure in their sockets.

(3) Check the fixed plugs and sockets for metal scraps, etc., between pins, and for soundness of soldering of their leads.

(4) Inspect all fixed resistors for signs of overheating or molten wax.

*Power supplies*

**64.** The power supplies listed in Table 9 are required if a video amplifier is operated in isolation out of a console; the drain and the normal source of these supplies are indicated. They should be switched on in the order shown.

*Valve conditions*

**65.** Before starting valve current measurements, test that the HT supplies shown in para. 44 are correct, and adjust if necessary (normally on waveform generator Type 80). Use the multimeter Type 1, and measure across C35 (−300V) and C34 (+250V). Set RV4 and RV8 fully clockwise and RV6 fully counter-clockwise; the five remaining variable resistor controls should be left untouched unless there is reason to alter them. If the setting-up is being done in a console, remove the input plugs from SK4, 9 and 10 on the video amplifier, and see that all function keys on the control desk are in the OFF position.

*RV1 and RV2 (DC SET, V1-V3)*

**66.** Plug the multimeter Type 100 into SK2. When the valves have had time to warm up check all V1-V3 valve currents to Table 10 and if necessary adjust RV1 and RV2. These two controls interact, so make several adjustments of each until the currents are within the indicated tolerance, then lock the potentiometers; note that RV2 chiefly affects V1 current, and RV1 affects V3 current.

*RV3 and RV7 (DC SET, V5 and V6)*

**67.** Leave the multimeter plugged into SK2. Check the current in V5 and V6, and if necessary adjust RV3 and RV7, according to Table 10. Do not lock RV3 and RV7 yet as a small further adjustment may be needed (*para.* 78).

*RV5 (DC SET, V8)*

**68.** The next step is to adjust the operating conditions of V8 and V9, using RV5, as indicated in Table 10; check also that the current in V11

**Table 9**

**Supplies required for testing amplifying unit (video) Type 312**

| Supply | Plug and pin | Load (approx.) | Normal source |
|---|---|---|---|
| 6·3V ±2½%, 50 c/s (isolated) | PL16/E + F (strapped) | 5A | Console distribution panel |
| | PL16/J + K (strapped) | | |
| −300V | PL15/B | 17mA | Waveform generator Type 80* |
| +250V stab. | PL15/C | 70mA | Waveform generator Type 80 |

**If the stabilizers in a waveform generator Type* 80 *are being used to supply a video amplifier* only, *a dummy load* 39*K*, 6*W*, 5 *per cent should be added across SK*11/*C to earth on the waveform generator to bring up the drain on the* −300*V stabilizer there to the normal figure of about* 25*mA*.

**TABLE 10**
**Amplifying unit (video) 312—valve current readings**

| Multimeter switch position | Valve | Control to adjust | Multimeter FSD (mA) | Multimeter reading (mA) | Permissible tolerance (mA) |
|---|---|---|---|---|---|
| AO | V1 | RV2 | 30 | 10·5 | ±1·5 |
| BP | V2 | — | 30 | 8·5 | ±1·5 |
| CQ | V3 | RV1 | 30 | 4·0 | ±0·75 |
| DR | V5 | RV3 | 30 | 5·0 | ±0·5 |
| ES | V6 | RV7 | 30 | 1·5 | ±0·25 |
| FT | V8 | RV5 | 30 | 24 | ±3 |
| GU | V9 | — | 30 | 8 | ±2 |
| HV | V11 | — | 30 | 9·5 | ±3·5 |

is as shown. When adjustments are completed, lock RV5.

*Trimming capacitors*

**69.** The video amplifier contains six small air-spaced concentric trimming capacitors which shunt various resistive arms in the feedback-amplifier circuits to improve the response at the higher video frequencies. These capacitors are adjusted and sealed in position by the manufacturer and it is emphasized that they should not be touched during service unless there is strong reason to suspect, as a result of deterioration of picture quality confirmed by pulse tests as set out below, that due to component or valve replacements they require adjustment.

**70.** The shift calibration on the recommended oscilloscope has a possible error of ±15 per cent, and this should be taken into account before condemning an amplifier for incorrect gain. The tests detailed below require :—

(1) Oscilloscope Type 9172.

(2) Pulse generator Type 4073 and coaxial input lead.

(3) 3 ft. UR32 coaxial cable to connect from test points specified to A1 terminal of oscilloscope. Earth the outer conductor at each end.

**71.** Before making the tests, which are normally done with the video amplifier mounted in the exploded console, remove all unwanted video inputs by taking out the coaxial leads from sockets 3, 4, 6, 7, 8 and 10 on the video amplifier. The six trimming capacitors may now, if necessary, be set in succession for optimum pulse response, working from the output end of the amplifier back to the input. When any capacitor has been trimmed, apply a drop of lacquer to the spindle to secure it in position.

*C30*

**72.** Check, and if necessary, adjust the setting of C30 as follows :—

(1) Remove V6.

(2) Clip the *negative-going* output of the pulse generator to the junction of R52 and C22 (where V6 anode is normally connected).

(3) Connect the CRO to the video output at SK14.

(4) Set the pulse generator to 25 μS. Adjust its pulse amplitude until the output pulse at SK14 is 18V.

(5) Transfer the CRO to the input point (R52/C22) and check that the pulse amplitude there is 9V ±1V. Note the pulse shape.

(6) Return the CRO to SK14 and, if necessary, adjust C30 until the output pulse is an undistorted version of the input. Pay special attention to (*a*) fast edges to pulse, and (*b*) flat top to pulse with minimum overshoot.

(7) If C30 has been trimmed, set the pulse generator for 18V output, and check that the input is still 9V ±1V. Disconnect the pulse generator, and put back V6.

*C19*

**73.** Next, check C19 as follows :—

(1) Remove V3.

(2) Feed in a 25 μS *negative-going* pulse at the junction of R33/C15 (where V3 anode would normally be connected).

(3) Set the video gate permanently " open " for the next few tests (*until para.* 78) by pulling out the coaxial lead from SK9 on the video amplifier.

(4) Leave the CRO on SK14 and adjust the output of the pulse generator until an 18V pulse is again obtainable at SK14.

(5) Connect the oscilloscope to the input point (R33/C15) and check that the pulse amplitude there is 2·5V ±0·5V.

(6) Return the oscilloscope to SK14 and, if necessary, adjust C19 for best undistorted output, as before. If C19 has been touched, set the pulse generator for 18V output, and check that the input is still 2·4V ±0·5V.

(7) Check that the output at SK14 suffers little distortion for all settings of RV8, and that it can be reduced below 0·25V by turning RV8 fully counter-clockwise. Return RV8 to the fully clockwise position.

(8) Disconnect the pulse generator and put back V3.

*C8*

**74.** Check C8, which is part of the radar video input channel, as follows :—

(1) Feed in a *positive-going* 25 $\mu$S pulse at SK4, the radar video input socket.

(2) Adjust the pulse generator until the amplitude of the output seen at SK14 is 18V.

(3) Check that the pulse amplitude at SK4 is 250mV $\pm$50mV.

(4) If necessary, adjust C8 for undistorted output at SK14; then adjust the pulse generator for 18V output and check that the input pulse at SK4 is within the tolerance.

*C29*

**75.** Check C29 (video map and range rings channel) thus :—

(1) Feed the *positive-going* 25 $\mu$S pulse from the pulse generator into SK6.

(2) On the control desk, operate the *video map/range rings* key to V.M. to energize RLC and so close contacts C1.

(3) Adjust the pulse generator until the amplitude of the output seen at SK14 is 18V.

(4) Check that the pulse amplitude at SK6 is less than 1V (nominally 0·8V).

(5) If necessary, adjust C29 for undistorted output at SK14; then adjust the pulse generator for 18V output and check that the input pulse at SK6 is still within the amplitude tolerance.

(6) Transfer the pulse generator to SK7.

(7) Switch the *video map/range rings* key to R.R. to close relay contacts D1 instead of C1.

(8) Check that the gain and pulse response is unchanged.

(9) Return the V.M./R.R. key to off (central position).

*C6*

**76.** The following procedure is now used to check C6, which is in the IFF input channel :—

(1) Apply the 25 $\mu$S *positive-going* pulse to SK5.

(2) Close the I.F.F. key on the control desk to energize RLB and so close contacts B1.

(3) Adjust the pulse generator until the pulse amplitude at SK14 is 18V.

(4) Check that the pulse amplitude at SK5 is 2·5V $\pm$0·5V.

(5) If necessary, adjust C6 for undistorted pulse output; then adjust the pulse generator for 18V output and check the input pulse at SK5.

(6) Operate the control desk I.F.F. key to OFF.

*C11*

**77.** C11, in the inter-trace bright-up channel, needs to be checked only on consoles displaying inter-trace information. Proceed as follows :—

(1) Apply the 25 $\mu$S *positive-going* pulse to SK8.

(2) Close the azication key (or other inter-trace key, as appropriate) on the control desk to energize RLE and close contacts E1.

(3) Adjust the pulse generator output to give a pulse amplitude of 18V at SK14.

(4) Check that the pulse amplitude at SK8 is 2·75V $\pm$0·25V.

(5) If necessary, adjust C11 for undistorted pulse output; then set the pulse generator for 18V output and check the pulse amplitude at SK8.

(6) Switch off the inter-trace key.

*Bright-up pedestal, and radar signal limits*

**78.** At the output socket, check and adjust the size of the " pedestal " waveform (which is based on the radar bright-up incorporated in the video gating waveform), as follows :—

(1) Reconnect the video gating lead to SK9 of the video amplifier.

(2) With the CRO connected to SK14, check that a rectangular pedestal, positive-going during the trace period, is obtained with amplitude between 3V and 6V.

(3) From the pulse generator inject a positive 25 $\mu$S pulse into the radar video input channel at SK4. Increase its amplitude until the output pulse at SK14 just runs into a limit; check that the output amplitude is 42·5V $\pm$2·5V.

(4) Reduce the input signal amplitude so that the output amplitude at SK14 is reduced by 10 per cent, then check that the input signal is less than 0·65V.

(5) If necessary, adjust RV3 and RV7 until the figures shown in operations (2), (3) and (4) are obtained. RV7 affects the sum of pedestal and pulse, while RV3 affects their ratio.

(6) Lock RV3 and RV7, and disconnect the pulse generator.

*Trace compensation check*

**79.** To check the correct functioning of the trace compensation channel, the trace compensation waveform from the waveform generator Type 80 must have been previously set up (*para.* 60). Proceed as follows :—

(1) Eliminate any blanking waveforms (leaving only the basic radar bright-up input) by disconnecting SK7 on the waveform generator Type 80.

(2) Connect the trace compensation lead, from the waveform generator SK5, to SK10 on the video amplifier.

(3) Check with the CRO that, at monitor point SK14 on the video amplifier, there is now an inverted trace compensation waveform, undistorted, superimposed on the ordinary radar bright-up pedestal.

**80.** When the above checks on the video amplifier have been completed, make sure that all the valves are securely held in their sockets by the screening cans, and shake out any loose scraps of wire or solder from the chassis. The video amplifier is now ready to be put back in an operational console, where the overall console setting-up will include setting the three remaining controls, RV4, RV6 and RV8.

## BLANKING UNIT TYPE 26

### Cabin servicing

**81.** Cabin servicing on the blanking unit (including focus regulator) includes setting the three variable resistors RV1 to RV3. If satisfactory results cannot be obtained within the range of any of these controls, the blanking unit should be removed to the workshop for servicing.

*RV1*

**82.** RV1 is the console FOCUS control ; set it as follows :—

(1) Use the head selector switch to obtain 250 c/s (radar Type 7) or 270 c/s (radar Type 80) timebase components.

(2) Turn RV2 and RV3 on the blanking unit fully counter-clockwise.

(3) Turn the RANGE switch on the control panel 859 to 320M.

(4) Turn up fully the DRIVE control (RV8 on the video amplifier).

(5) Turn up the BRILLIANCE control (RV6 on the video amplifier) until the full trace can be seen, then turn it back until the trace just becomes invisible.

(6) Switch on RANGE RINGS (COARSE) using the keys on the control desk.

(7) Turn up the RANGE RINGS input control (RV5) on the control panel 859 until the range circles are moderately bright.

(8) If necessary adjust the FOCUS control (RV1 on the blanking unit) until the rings are sharp. Lock RV1.

*RV2*

**83.** Continue by setting RV2 (the BLANKING SET, SCAN FAILURE control) as follows :—

(1) Centre the rings on the screen using the OFF-CENTRE controls (RV7 and RV8 on the control panel 859).

(2) Remove Y deflection by opening SWB on the amplifying unit (LH) Type 314. The display now collapses to a horizontal line of range dots ; the length of the line varies continuously between positive and negative values, through zero, as the head rotates.

(3) Adjust RV2 until blanking occurs whenever the trace length is within a small region around the scan centre. (By " blanking " is meant the extinction of the trace.)

(4) Close SWB on the 314, and open SWB on the 313 to introduce Y and remove X deflection.

(5) Check that blanking occurs over approximately the same range of trace lengths as in operation (3).

(6) Open SWB on the 314 as well as the 313 to remove all deflection. Check that the resulting single spot on the screen is blanked to a very low brightness level. Lock RV2.

*Octagonal blanking*

**84.** Now set the BLANKING SET, OCTAGON SIZE control (RV3 on the blanking unit) and the two OCTAGONAL BLANKING, CENTRING controls (RV8 on each deflection amplifier) as follows :—

(1) Close SWB on each deflection amplifier, and remove the range rings.

(2) Set RV3 on the blanking unit fully clockwise.

(3) Turn up the BRILLIANCE control (RV6 on video amplifier) until a continuous trace of moderate brilliance is obtained. An approximately octagonal boundary to the display should now be visible.

(4) Use RV8 in each deflection amplifier to set the blanking octagon symmetrically within the circular CRT perimeter.

(5) Turn RV3 on the blanking unit counter-clockwise until the blanking octagon is close to the CRT perimeter.

(6) Adjust RV8 on each deflection amplifier to set the octagon symmetrically inside the perimeter.

(7) Finally, turn RV3 a little further counter-clockwise to set the octagon just beyond the CRT perimeter. Turn to other positions of the RANGE switch (240M, 160M, 80M) and check that nowhere is any part of the octagonal boundary visible on the tube face. If necessary, make small adjustments to RV3 to ensure this.

(8) Lock RV3 and the RV8s.

**Note . . .**
*If any difficulty is experienced in setting-up the octagonal blanking, check the tetrode currents in the deflection amplifiers (para. 95 et seq.)*

### Workshop servicing

**85.** The following routine action should be completed on any blanking unit brought into the workshop for servicing :—

**TABLE 11**
**Supplies required for testing blanking unit Type 26**

| Plug and pin | Voltage (nominal) | Upper limit | Lower limit | Load (approx.) | Ripple volts p–p | Normal source |
|---|---|---|---|---|---|---|
| PL1/G+H (strapped) PL1/L +M (strapped) | 6·3V | +2½% | −2½% | 2·4A | (50 c/s) | Console distribution panel |
| PL2/C | −300V stab. | — | — | 4mA | 15mV (max.) | WFG Type 80 |
| PL2/B | +250V stab. | — | — | 14mA | 10mV (max.) | WFG Type 80 |
| PL2/A | +570V | +633V | +536V | 50mA* | 12V | R.A. (BPS) Type 305 |

**Complete circuit by connecting focus coils across SK8/A and B.*

(1) Remove dust and condensation with the hot-air blower.

(2) Inspect the valves for cracks, loose bases or softness. Make sure they are secure in their holders and firmly held by the screening cans.

(3) Check the fixed plugs and sockets for metal scraps between pins, and test the soundness of connection of their leads.

(4) Inspect all fixed resistors for signs of overheating (charring or molten wax).

*Power supplies*

**86.** The supplies listed in Table 11 are required by the blanking unit. The normal source of each supply (when the blanking unit is cabled up in a console) is indicated. The supplies should be switched on in the order shown.

*Focus current range and regulation*

**87.** Make sure V5 anode circuit is completed by a standard focus coil between SK8/A and B. Connect a multimeter Type 100 to SK7 and select position CQ to measure the focus current. Switch on the raw +570V and check that the variation of focus current obtainable by swinging RV1 includes the range 30mA to 46mA. If possible, vary the +570V input over the range shown in Table 11 by switching on dummy load resistors and check that the change of focus current for any one setting of RV1 does not exceed ½mA.

*HF oscillation*

**88.** Connect the oscilloscope Type 9172 to the cathode of V5 and check that there is no sign of HF oscillation over the focus current range stated in para. 87.

*Scan-failure blanking check*

**89.** (1) Remove the octagonal blanking valve V4 and connect a multimeter Type 1 (25V DC range) between V3B cathode (SK11) and earth. Adjust RV2 until the testmeter reads −11·5V.

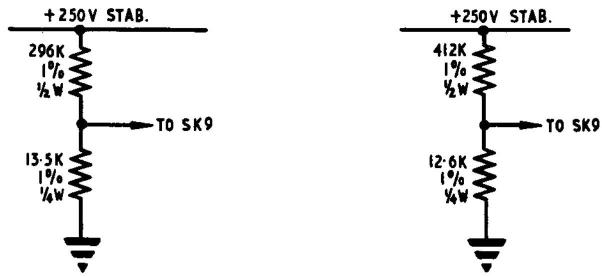
(2) Connect a floating source of −2·2V (e.g. a well-charged accumulator) across R1, R2, R3 and R4 in turn and check in each case that the potential at SK11 exceeds 3·5V. Remove the −2·2V source.

*Octagonal blanking check*

**90.** Leave the multimeter on SK11, and check the octagonal blanking circuits as follows :—

(1) Put back V4.

(2) Connect a source of −10V between V1 anodes and earth to cut off V3A.




(a) (b)

**Fig. 6. Octagonal blanking test potentials**

(3) Improvise the resistor chain shown in fig. 6(*a*), connect to SK9 as indicated, and check that the output at SK11 can be set to −11·5V by RV3.

(4) Improvise the resistor chain shown in fig. 6(*b*), connect to SK9 as indicated, and check that SK11 can again be set to −11·6V by RV3.

**Note . . .**

*The values shown in fig.* 6 *should be adhered to, as source impedance is important as well as voltage input.*

*Valve currents*

**91.** The readings in Table 12 are average valve currents taken with the multimeter Type 100, the HT rails being set to their correct nominal values.

## PANEL (CONTROL) TYPE 859

**Cabin servicing**

*Dial lights*

**92.** The only cabin servicing that can usefully be done on the panel (control) Type 859 is to change burnt-out 6V lamps (" dial lights "). These lamps are mounted in a U-channel which is exposed by pulling the front escutcheon off the indicating unit.

**Workshop servicing**

**93.** It is normally best to service the control panel in position in the indicating unit ; access to the rear of this panel can be had by taking away the video amplifier. Take the opportunity to remove the control knobs and clean up the front of the panel ; mark the SECTOR and RANGE knobs to make sure they are put back correctly. Remove dust from the rear of the panel using the hot-air blower.

**TABLE 12**
**Blanking unit Type 26—valve current readings**

| Valve | Function | Electrode | Multimeter switch position | Multimeter FSD (mA) | Current (mA) Min. | Current (mA) Max. |
|---|---|---|---|---|---|---|
| V3A | Scan-fail blanking amp. | Anode | AO | 3 | 0·3 | 1·5 |
| V3B | Blanking cathode-follower | Anode | BP | 3 | 1·0 | 1·6 |
| V5 | Focus regulator | Cathode | CQ | 100 | 30·0 | 46·0 |
| V6 | Focus reg. control | Anode | DR | 10 | 2·0 | 6·0 |

**94.** If intermittent faults are complained of in the wafer switches SWA and SWB, clean the contacts with carbon-tetrachloride to which a few drops of light oil have been added. Faults in any of the control potentiometers (including the Colvern helipots) should be dealt with by changing the potentiometer.

### DEFLECTION AMPLIFIERS

#### Cabin servicing

**95.** The X deflection amplifier is officially the amplifying unit (R.H.) Type 313, and the Y deflection amplifier is the amplifying unit (L.H.) Type 314. The cabin servicing on newly-installed deflection amplifiers is more extensive than on other units because most of the amplifier presets must be set in conjunction with the actual tube unit, deflector coils and blanking unit. In addition, a check must be carried out of scan/inter-trace superposition controls, using SWA (*para.* 98-100), to take up possible changes with valve and component ageing.

*RV3, RV5*

**96.** Often the trace expansion DC SET controls RV3 and RV5 will have been set approximately during workshop servicing, but final adjustments must always be made in the actual console to take up the characteristics of its CRT and deflector coils. Proceed as follows :—

(1) Set the RANGE switch on the panel control) Type 859 to 320M and turn down the brilliance (RV6 on the video amplifier 312).

(2) Turn SWB on both amplifiers to TEST to isolate the trace expansion stages from previous amplifier stages.

(3) Plug the multimeter Type 100 into SK16 on the 313.

(4) Turn the meter selector switch to position KX and close the PRESS-TO-READ switch to meter the cathode current of V14. Adjust RV3 (DC SET V11) until this current is 130mA (FSD of meter =300mA).

(5) Turn the meter selector switch to position LY and close the PRESS-TO-READ switch to meter the cathode current of V15. Adjust RV5 (DC SET V17) until this current too is 130mA and then lock RV5.

(6) Turn up the brilliance carefully to obtain a spot on the CRT. Set the spot exactly on the vertical axis of the CRT by final adjustment to RV3, then lock RV3.

(7) Next set RV3 and RV5 on the 314, by the same method, to set the spot on the horizontal axis of the CRT, i.e., the spot is now in the centre of the tube face.

*RV1*

**97.** The next three paragraphs (97-99) deal with the use of the setting-up switch SWA. The first step is to adjust the relative DC scan and inter-trace origins to be coincident, first on the 313 (X) amplifier and then on the 314 (Y), using RV1. This adjustment is only necessary on amplifiers for consoles which display any form of inter-trace markers (e.g., azicating consoles). On amplifiers in other consoles (e.g., simple track-telling consoles) the adjustment need not be made and RV1 may be left locked, in about its mid-position. The console CRT is used for the setting-up, as follows :—

(1) Turn down the brilliance (video amplifier 312), and turn SWB on the 314 to TEST to eliminate that amplifier for the present. Turn the RANGE switch on the control panel 859 to 80M.

(2) Turn the setting-up switch SWA on the 313 to position 2, thus earthing all three deflectional inputs (radar scan, inter-trace and off centring).

(3) Carefully turn up the BRILLIANCE control (RV6 on the video amplifier) until a single spot (representing the radar scan origin) is just visible near the screen centre. DO NOT turn up the brilliance too far or the CRT phosphor will be damaged. If necessary, adjust the FOCUS control (RV1 on the blanking unit Type 26) to get a sharp spot.

(4) Turn down the STROBE MARKER input control (RV4 on the control panel 859) and throw the azication marker key (or other inter-trace control key appropriate to the control desk) to the ON position.

(5) Carefully turn up the STROBE MARKER input control until a second bright spot, representing the inter-trace origin, is just visible near the other. (It may already be coincident with the other ; test this by misadjusting RV1).

(6) Adjust RV1 on the 313 until the two spots are exactly coincident. Lock RV1, making sure that this does not affect the coincidence.

(7) Turn SWB on the 313 to TEST and SWB on the 314 to NORMAL.

(8) Turn SWA on the 314 to position 2 and adjust RV1 as described for the 313. Lock RV1.

(9) Turn SWB on the 314 to TEST again, but leave the RANGE, BRILLIANCE and STROBE MARKER controls untouched, ready for the next adjustment.

*RV2*

**98.** The next adjustment is to ensure correct superposition of scan and inter-trace information by equalizing the relative gain on radar scan and inter-trace channels, using RV2, first on the 313 and then on the 314. (This work too is only strictly necessary on amplifiers for consoles showing inter-trace markers; on other consoles RV2 may be left locked in approximately its mid-position.) Proceed as follows :—

(1) On the 313, turn SWB to NORMAL and SWA to position 3. In this position a negative voltage corresponding to 200 miles is connected to the radar scan input channel and to the inter-trace ; to bring the two spots thus produced back on the screen an opposing voltage is automatically applied to the off-centring channel by another wafer on SWA.

(2) Adjust RV2 until the spots coincide on the tube face.

(3) Now turn SWA to position 4. Here a positive voltage corresponding to 200 miles is connected to both channels, radar scan and

inter-trace, while an opposing negative voltage is applied to the off-centring channel to bring the spots back near the screen centre.

(4) Check that the two spots coincide. If they do not, adjust RV2 to obtain partial coincidence (within 1mm.) and theu go back to position 3 of the switch to check that the spots are equally near. Make successive adjustments of RV2 on switch positions 3 and 4 until the best results are obtained on both.

**Note . . .**

*If it proves impossible to get the spots within 1 mm. on positions 3 and 4 of SWA, the trouble may be due to ill-matched diodes in the gating circuit (V3-V6). Try changing V3 or V6. Go back to position 2 of SWA and adjust RV1 before setting RV2 again, whenever any of the diodes V3-V6 have been changed.*

(5) Lock RV2 and turn SWB to TEST.

(6) On the 314, repeat operations (1) to (5).

(7) Turn down the BRILLIANCE and STROBE MARKER controls.

*RV4*

**99.** The next operation is to set the comparative gain of the X and Y deflection amplifiers so that the picture may be undistorted and true to scale in both directions. First, set the gain of the X amplifier (313) correctly to give the right diameter of picture across the X axis, as follows :—

(1) Bring in 250 c/s resolved timebase waveforms by selecting a normally rotating 250 c/s head on the head selector switch (for 250 c/s read 270 c/s where radar Type 80 is master head).

(2) Turn the RANGE switch on the control panel 859 to 320M.

(3) Turn SWA on the 313 and 314 to NORMAL position and turn SWB on the 313 and 314 to NORMAL.

(4) Turn up the BRILLIANCE control (RV6 on the video amplifier) until the rotating trace can be seen and then turn the control back until the trace is just invisible.

(5) Throw the CALIBRATION key on the control desk to the range rings position (R.R.), and the adjoining FINE/COARSE key to COARSE to obtain 10-mile markers.

(6) Turn up the RANGE RINGS input control (RV5 on the control panel 859) until the range circles are clearly visible but not excessively bright, and centre them. Do not be disconcerted if these " circles " are in fact ellipses ; this will be corrected when the setting-up is completed.

(7) Adjust RV4 on the 313 until 32 of the 10-mile intervals between range rings just fill the visible CRT diameter in the X (horizontal) direction. Lock RV4.

(8) Switch off the range rings at the control desk and turn down the input control on the panel 859. Leave the RANGE switch on 320M.

(9) Turn SWB on the 314 to TEST to eliminate Y deflection.

(10) Turn SWA on the 313 to test position 1. The inter-trace and off-centring channels are now earthed, and approximately +25V is being applied to the radar scan input (corresponding to 120M deflection).

(11) Turn up the BRILLIANCE control until the deflection spot is just visible. Measure accurately its distance from the scan centre. using a wooden or plastic (*not steel*) ruler. The inter-trace marker indicates the scan centre on consoles having inter-trace facilities; on others, the position of the scan centre may be marked by turning SWA momentarily to position 2 (in which the scan input is earthed) and then back to 1 again ; the afterglow of the resulting centre spot will last long enough to take the measurement. Be careful to view the CRT and ruler squarely to avoid parallax error.

(12) Turn SWB on the 313 to TEST, and SWB on the 314 to NORMAL. Turn SWA on 313 to position 2 to avoid double loading on the 25V.

(13) Turn SWA on the 314 to test position 1, and run a flying lead from SK17 on the 314 to SK17 on the 313. This applies to the radar scan channel on the 314 the same +25V that was used on the 313. The spot now moves out a certain distance in the Y direction.

(14) Use the ruler to measure the deflection of the spot from the scan centre in this direction. Adjust RV4 on the 314 until the distance is the same as was measured in operation (11). Lock RV4, and turn down the brilliance.

(15) Remove the flying lead, turn SWB to NORMAL and turn SWA to position 5 (NORMAL) on both amplifiers.

(16) Turn up the range rings and see that they appear circular and equally spaced as judged by eye. Turn the RANGE switch to the 240M, 160M and 80M positions and check that the right number of 10M range ring intervals fill the CRT diameter in each position. Turn down the range rings.

*RV8*

**100.** RV8 on each deflection amplifier is concerned with the blanking circuit, and should be set in conjunction with the blanking unit (*para.* 84).

**Workshop servicing**

**101.** The information under this heading applies equally well to the 313 or 314, except where otherwise stated. When either deflection amplifier is brought into the workshop for repair or checking, take first the following action :—

(1) Remove dust and condensation from the chassis using the hot-air blower.

(2) Inspect all the thermionic valves for cracks, distorted pins or softness. Make sure the valves and the high-speed relays are secure in their sockets.

(3) Check the fixed plugs and sockets for metal scraps etc., between pins, and for soundness of soldering of their leads.

(4) Check the mechanical action of SWA.

(5) Inspect all fixed resistors for signs of overheating (molten wax or charred appearance of body).

*Power supplies*

**102.** The information on power supplies in Table 13 is included for general checking on the 313 and 314, and will also be useful if a deflection amplifier has to be set up or tested in isolation (but in the latter case read carefully *para.* 100). Switch on in the order shown.

*Testing isolated amplifier*

**103.** When the amplifier is mounted in the " exploded " console and properly cabled up, the normal power supplies and waveforms will be available without further trouble, and this is the recommended procedure. If, however, it is necessary to service and test an amplifier in isolation, the following points should be noted :—

(1) The RANGE switch circuit should be simulated by the improvised test circuit shown in fig. 7.

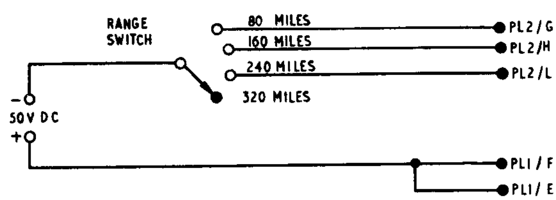



**Fig. 7. Simulated range switch circuit**

(2) The OFF-CENTRE control (horizontal for 313 or vertical for 314, as appropriate) should be simulated by the improvised resistor network of fig. 8. The +250V and −300V stabilized supplies should be the same as those feeding the amplifier under test.

(3) *On the* 314 *only*, the heater supplies (*a*) and (*b*) should be held to a negative level by the improvised resistor network shown in fig. 9.

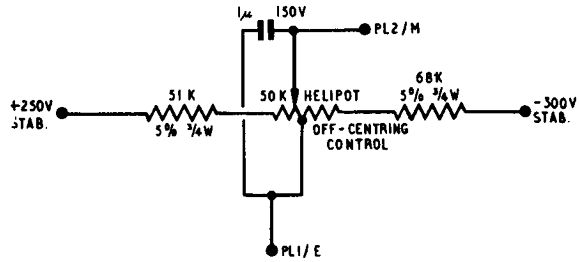



**Fig. 8. Simulated off-centring control**

The −300V stabilized supply should be the same as the one feeding the amplifier under test. No similar network is needed on the 313 as it is already connected internally.

(4) Connect SK7 and SK8 to standard deflector coils via 14 ft. of Uniradio 70 coaxial cable, and thence to the external +250V supply. Alternatively, connect the coils by short leads and add 330 pF capacitance in parallel to simulate the cable capacitance. In this case keep the coils well clear of metal chassis.

(5) Connect PL1/C to the +250V stabilized (external) supply via a 1·8 KΩ, 5 per cent tolerance, 3W resistor if this is not already in circuit in the stabilizer (voltage) Type 51 (R62 for 313 and R63 for 314).

(6) If a stabilizer (voltage) Type 51 is being used to supply the −300V stabilized, the loading on this rail must be brought up to the normal two-amplifier level of 59mA by using a dummy load resistor of 10KΩ, 5 per cent tolerance, 10W.

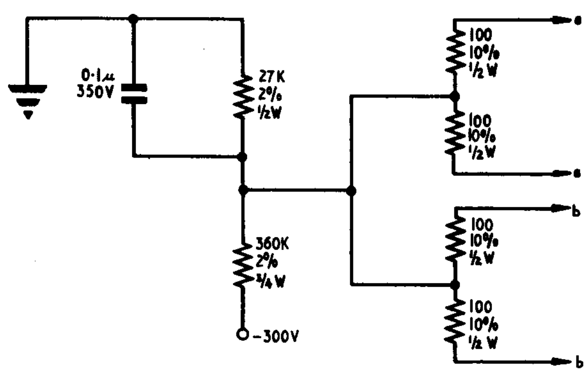



**Fig. 9. Heater levels on Y deflection amplifier (314)**

**TABLE 13**

**Power supplies required for testing deflection amplifiers 313 and 314**

| Supply | Plug and Pin | Load (approx.) | Normal Source |
|---|---|---|---|
| 6·3V±2½%, 50 c/s (*a*) | PL2/A and B | 2·4A | Console distribution panel |
| 6·3V±2½%, 50 c/s (*b*) | PL2/C and D | 0·9A | ,, ,, ,, |
| 6·3V±2½%, 50 c/s (*c*) | PL2/E+F and J+K | 4·1A | ,, ,, ,, |
| −300V stab. | PL1/D | 29mA | Stabilizer (voltage) Type 51 |
| +250V stab. (int.) | PL1/B | 31mA | ,, ,, ,, 51 |
| +400V stab. | PL1/A | 15mA | ,, ,, ,, 51 |
| +250V stab. (ext.) | * | 260mA | Rack assy. (BPS) Type 305 |

**The* +250*V stab. supply from BPS is fed into the unit at SK7 and SK8 via the deflector coils, and also into PL1/C via a* 1·8*K*Ω *dropping resistor situated in the stabilizer* (*voltage*) *Type* 51.

(7) The loading on the external +250V stabilized supply from BPS rack must be brought up to the usual two-amplifier figure of 520mA by a dummy load resistor of 1KΩ, 5 per cent tolerance, 60W.

*RV3 and RV5*

**104.** Check and set RV3 and RV5 provisionally as shown below ; a final setting will be required when the deflection amplifier is put into its own console (*para.* 96) :—

(1) Turn SWB to TEST to isolate the trace expansion circuit from previous stages.

(2) Turn RV6 and RV7 fully counter-clockwise.

(3) Connect the multimeter Type 100 to SK16, and select position KX to measure the cathode current of V14 (FSD=300mA).

(4) Check that the variation of V14 cathode current obtained by swinging RV3 includes the range 120 to 140mA. Leave set at 130mA.

(5) Select multimeter position LY to measure V15 cathode current (FSD=300mA).

(6) Check that V15 cathode current can be set to 130mA by RV5, and leave at that value.

*Valve currents in trace expansion stages*

**105.** With SWB still at TEST, and RV3 and RV5 set as in para. 104, the currents in the other trace expansion valves, measured with the multimeter Type 100 plugged into SK16, should be as quoted in Table 14.

*Gate cathode-followers—static test*

**106.** To check the static condition of the gate cathode-followers V1A and V1B, proceed as follows :—

(1) Disconnect the gating waveform inputs from SK5 and SK6.

(2) Disconnect the inter-trace and radar scan inputs from SK3 and SK4 respectively, and earth those sockets.

(3) Set SWA to NORMAL. The off-centring voltage is for the moment immaterial.

(4) Use the electronic multimeter Type CT38 to check that the voltage at V1B cathode lies between the limits of +12V and +18V to earth, and that the voltage at V1A cathode lies between −12V and −18V relative to earth (nominal 15V in each case).

*Limits in off-centring amplifier*

**107.** To check the action of the limiting diodes V8A and B, leave the unit without gating waveforms or deflectional inputs as in para. 106 and proceed as follows :—

(1) Connect the electronic multimeter Type CT38 between monitor point SK9 and earth to measure the voltage at V9B (313) or V9A (314) cathodes.

(2) Vary the off-centring voltage applied to PL2/M until the output at SK9 runs into a positive limit. This must occur at between +55V and +67V to earth.

(3) Vary the off-centring voltage until SK9 runs into a negative limit. This must occur at between −39V and −48V to earth. Remove the electronic multimeter.

(4) Remove the earth from the radar scan input at SK4 and apply a normal resolved timebase sawtooth at 250 c/s p.r.f. there (270 c/s on radar 80 sites).

(5) Set RV4 fully counter-clockwise.

(6) Connect the oscilloscope Type 9172 (DC TO Y1) to SK9, and check that with the off-centring control in about its mid-position a resolved sawtooth appears at SK9. The gain from SK4 to SK9 should be about unity.

(7) Swing the off-centring control and check that the sawtooth runs into a positive limit one way as in operation (2), and into a negative limit the other way as in operation (3) (*fig.* 10). Inside the limits the waveform must not be visibly distorted. Check also that there is no sign of HF oscillation anywhere on the waveform whatever the degree of off-centring.

(8) Carry out a similar check on the inter-trace channel by reversing the conditions at SK3 and SK4, i.e., earth SK4 and apply the

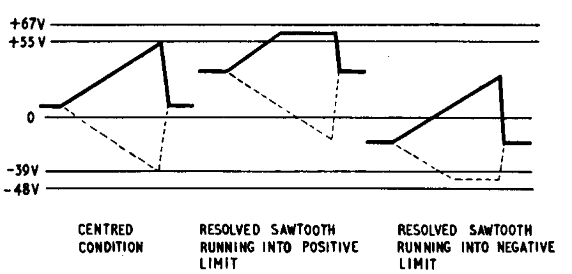



**Fig. 10. Limits in off-centring amplifier**

**TABLE 14**

**Deflection amplifiers—valve currents in trace expansion stages**

| Valve | Electrode | Multimeter switch position | Multimeter FSD (mA) | Current (mA) Min. | Current (mA) Max. |
|---|---|---|---|---|---|
| V11A and B | Cathodes | AO | 3 | 1·8 | 2·3 |
| V11B | Anode | FT | 3 | 0·5 | 2·0 |
| V12 | Cathode | HV | 10 | 2·2 | 4·7 |
| V17A and B | Cathodes | BP | 3 | 1·8 | 2·2 |
| V17B | Anode | GU | 3 | 0·5 | 1·9 |
| V18 | Cathode | MZ | 10 | 2·2 | 4·7 |

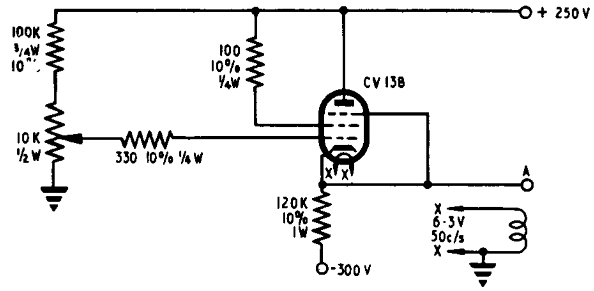



**Fig. 11. Low-impedance voltage source for para. 108 tests**

resolved sawtooth to SK3. Simulate the "inter-trace gate" condition in the gating diodes by applying (from external battery) −20V DC to the anode of V2A, and +12·5V to the cathode of V2B. Now repeat operations (6) and (7), and check that the same limits hold good. Remove the test voltages from V2.

*RV1 and RV2*

**108.** If unsatisfactory operation of RV1 (the ORIGIN COINCIDENCE, SCAN/I.T. control) or of RV2 (the GAIN EQUALIZE, SCAN/I.T. control) is suspected, the test circuit shown in fig. 11 must be improvised using the same +250V and −300V that feed the amplifier under test, and a thorough check made as follows :—

(1) Set SWA to position 2, thus earthing all input channels ; remove all inputs from SK5 and SK6.

(2) Connect the electronic multimeter Type CT38 between SK9 on the amplifier and point *A* in the test circuit of fig. 11. Swing RV1 over its entire range and check that the variation of multimeter reading exceeds 1V. (Use the multimeter on its 2·5V range, and adjust the potentiometer in the test circuit so that the variation is conveniently placed on the scale.)

(3) Apply −20V and +12·5V to V2 as in para. 107 (8) to simulate the "gated" condition, and check that the new potential at SK9 falls within the range previously obtained by varying RV1. Note this potential then remove the −20V and +12·5V from V2 and adjust RV1 so that the potential in each condition is the same.

(4) Set SWA to position 3 and check that the variation obtainable at SK9 by swinging RV2 over its entire range exceeds 0·8V. Apply the −20V and +12·5V to V2 as before and check the range of variation. These two ranges must overlap, i.e., there must be a position of RV2 which gives the same output at SK9 in the gated and non-gated conditions. Set RV2 to this position.

(5) Set SWA to position 4 ; the difference of potential at SK9 in the gated and non-gated conditions must not now exceed 120mV.

**Note . . .**
*These settings of RV1 and RV2 are only provisional and a final setting must be made when the amplifier is returned to its own console (para. 97-98).*

*Valve currents in off-centring amplifier stages*

**109.** Plug the multimeter Type 100 into SK15, set SWA to position 2 and measure the valve currents through the off-centring amplifier ; the current readings should be within the tolerances shown in Table 15.

**110.** Check the overall operation of the amplifier from input to output, as follows :—

(1) Obtain a standard 250 c/s (or 270 c/s) unresolved sawtooth waveform, negative-going, by switching off the selsyn drive to one of the magslip resolvers in the radar office and turning its hand drive for maximum negative output.

(2) Apply the sawtooth to SK4 and earth SK3.

(3) Turn SWB and SWA to NORMAL.

(4) Make sure that RV6 and RV7 are still turned fully counter-clockwise (*para.* 104 (2)).

(5) On the panel (control) 859 set the off-centring control RV7 (horizontal) or RV8 (vertical), as appropriate for the amplifier under test, to approximately its mid-position.

(6) Turn the RANGE switch to 320M (minimum expansion).

(7) Connect the CRO (DC TO Y1) to V14 cathode (monitor point SK10) and check that a linear negative-going sawtooth is present, as fig. 12 (*a*).

(8) Turn the RANGE switch successively to greater expansions (240M, 160M, 80M) and check that the sawtooth at SK10 increases in slope but runs into a limit corresponding to V14 cut-off, as fig. 12(*b*), (*c*) and (*d*).

**TABLE 15**

**Deflection amplifiers—valve currents in off-centring amplifier stages**

| Valve 313 | Valve 314 | Electrode | Multimeter switch position | Multimeter FSD (mA) | Current (mA) Min. | Current (mA) Max. |
|---|---|---|---|---|---|---|
| V1A | V1A | Cathode | BP | 10 | 2·4 | 3·3 |
| V1B | V1B | Cathode | AO | 10 | 2·7 | 3·6 |
| V7A and B | V7A and B | Cathodes | CQ | 3 | 1·8 | 2·2 |
| V7A | V7B | Anode | VH | 3 | 0·2 | 1·9 |
| V9A | V9B | Cathode | MZ | 10 | 2·4 | 3·9 |
| V9B | V9A | Cathode | DR | 10 | 5·0 | 5·9 |

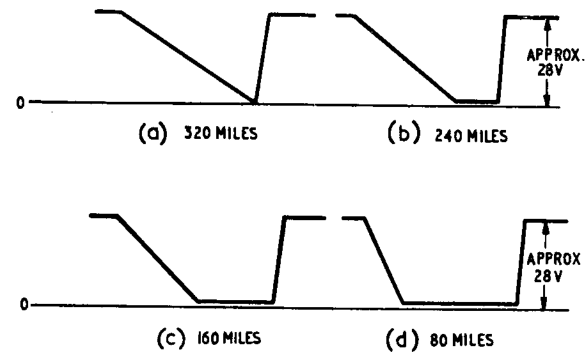



**Fig. 12. Waveforms at cathode of V14 (SK10) or V15 (SK11)**

The nominal gain of the circuit from SK4 to SK10 should be :—

| *Range* | *Gain* |
|---|---|
| 320M | ½ |
| 240M | ⅔ |
| 160M | 1 |
| 80M | 2 |

*Limiters in trace expansion amplifier*

**111.** Leaving all inputs and controls as in para. 110, set the limiter controls RV6 and RV7 as follows :—

(1) Turn the RANGE switch to 80M.

(2) Transfer the oscilloscope to V11A anode (monitor point SK13), using connection AC TO Y2.

(3) With RV6 fully counter-clockwise the waveform at SK13 should be like fig. 13(*a*). The abnormal 70V rise marks the interruption of the feedback loop by V14 cut-off ; it is preceded by a normal linear sawtooth of such small amplitude at this stage as to be invisible to the naked eye.

(4) Turn RV6 clockwise until the amplitude of the waveform is reduced to 25V ±5V, as fig. 13(*b*).

(5) Connect SK4 to a positive-going 250 c/s (or 270 c/s) unresolved sawtooth waveform, and transfer the oscilloscope to V15 cathode (monitor point SK11).

(6) Check that at SK11 a linear negative-going sawtooth is present, as fig. 12(*d*), running into a limit corresponding to V15 cut-off.

(7) Transfer the oscilloscope to V17B anode (monitor point SK14), using connection AC TO Y2.

(8) With RV7 fully counter-clockwise the waveform at SK14 should be as fig. 13(*a*).

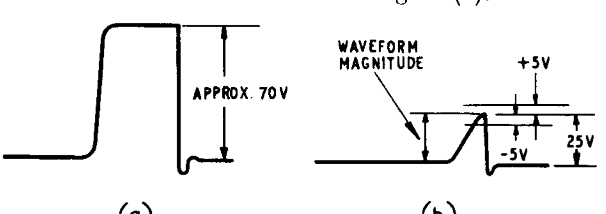



**Fig. 13. Waveforms at anode of V11A (SK13) or V17B (SK14)**

(9) Turn RV7 clockwise until the amplitude of the waveform is reduced to 25V ±5V, as fig. 13(*b*).

*HF oscillation, and distortion*

**112.** Connect SK4 to a 250 c/s (or 270 c/s) resolved sawtooth, and the oscilloscope to SK10. Check that a resolved sawtooth appears at SK10 in all RANGE switch positions, that there are no signs of HF oscillation anywhere on the waveform and that inside the limits the waveform is not visibly distorted. Check on the second oscilloscope trace that the waveform at SK11 is a paraphase version of that at SK10, and that it also is undistorted and free from HF oscillation.

*V14, V15 current limits*

**113.** Check the tetrode currents corresponding to the limits set by RV6 and RV7 as follows :—

(1) Earth SK4 ; leave SWA and SWB at NORMAL.

(2) Turn the RANGE switch to 160M.

(3) Connect multimeter Type 100 to SK16 and select position KX to measure V14 cathode current (FSD=300mA).

(4) Turn the off-centring control until V14 current runs into its lower limit. This should be less than 15mA.

(5) Select multimeter position LY in order to measure V15 cathode current.

(6) Turn the off-centring control until V15 cathode current runs into its lower limit ; this too must be less than 15mA.

*RV4*

**114.** Make a provisional setting of the AMPLIFIER GAIN control RV4 as follows ; a final setting must be made after the amplifier is mounted in its own console (*para.* 99).

(1) Leave connections as in para. 113 and revert to multimeter position KX.

(2) Use the off-centring control to set V14 cathode current to exactly 130mA.

(3) Run a spare lead from SK4 to an improvised but accurate source of +25V. (The internal +25V associated with SWA is not accurate enough.)

(4) Check that swinging RV4 over its entire range now produces a current change in V14 which includes the range 188 to 195mA. Set to 192mA.

(5) Remove the +25V lead.

*Octagonal blanking germanium diodes*

**115.** Test the germanium diode output which works the octagonal blanking circuits in the blanking unit as follows :—

(1) (*a*) Make sure SK12 is connected to a working blanking unit Type 26.

OR (*b*) Improvise the test circuit shown in fig. 14 for connection to SK12 to simulate the normal blanking unit load.

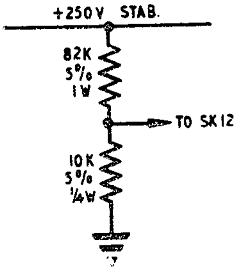



**Fig. 14. Test resistors for SK12**

(2) Feed a 250 c/s (or 270 c/s) resolved sawtooth to SK4.

(3) Use the oscilloscope to check that the waveform at the junction of the germanium diode V13 and R100 corresponds to that at V14 cathode (monitor point SK10) when the latter is negative-going.

(4) Check also that the waveform at the junction of V16 and R105 corresponds to the one at V15 cathode (monitor point SK11) when the latter, too, is negative-going.

*Hum and noise*

**116.** Check hum and noise outputs as follows :—

(1) Set SWA to position 2 to earth all input channels.

(2) Set the RANGE switch to 80M (maximum expansion).

(3) Connect the oscilloscope to V14 cathode (monitor point SK10) and check that the mixed hum and noise signal there does not exceed 35mV peak-to-peak.

(4) Check that the corresponding signal at V15 cathode (monitor point SK11) is also less than 35mV.

*Gate and cathode-followers—dynamic test*

**117.** Check the pulse operation of the gate cathode-followers V1A and V1B :—

(1) Set SWA to NORMAL and the RANGE switch to minimum expansion (320M).

(2) Apply a 500 c/s resolved timebase sawtooth to SK4.

(3) Apply the normal negative gate pulse to SK5, and the positive to SK6.

(4) Check with the oscilloscope that the negative gate pulse amplitude at V1B cathode is at least 85 per cent. of that SK5, and that the positive gate pulse amplitude at V1A cathode is at least 85 per cent of that at SK6.

*Inter-trace gating action*

**118.** Check that inter-trace strobe levels are properly gated into the deflection waveform :—

(1) Leave the same test conditions as for para. 117.

(2) To simulate an inter-trace deflection level, improvise a source of DC voltage variable between ±50V, and connect to SK3. (The voltage from the second off-centring helipot, i.e., the one not feeding the amplifier under test, will serve for this purpose.)

(3) Transfer the oscilloscope to monitor point SK9 and check that a waveform as fig. 15

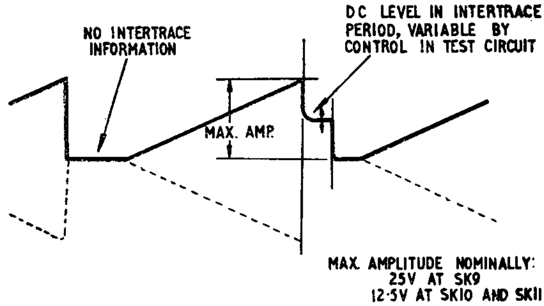



**Fig. 15. Waveforms at SK9, 10 and 11 with I.T. level**

is present. Vary the test voltage at SK3 and see that the level in the inter-trace period (which occurs after every alternate 500 c/s sawtooth) varies in unison.

(4) Repeat the check at SK10, and also on the paraphase waveform at SK11.

(5) Restore normal input connections and remove the oscilloscope.

*Final note*

**119.** On satisfactory completion of the foregoing tests and adjustments, remove any extemporized test circuits and shake out any loose wire and solder remaining after repair work. See that SWB and SWA are at NORMAL. The amplifier is now ready to be returned to its own console, where final adjustments will be made to RV1, RV2, RV3, RV4, RV5 and RV8 (*para.* 96-100).

### OTHER ITEMS

**Panel (fuse) Type 860**

**120.** Servicing on the fuse panel is confined to changing burnt-out fuses, and routine continuity checks in the event of power supply faults. Always use fuses of correct rating ; if any fuse blows repeatedly, investigate to find which unit is drawing excessive current using the power supply routeing chart in Chap. 2, Part 3, of this handbook.

**Panel (distribution) Type 861**

**121.** The panel (distribution) Type 861 is basically a large junction box containing a number of Mk. 4 and coaxial plugs and sockets and their inter-connections together with the console heater transformers and the relays associated with the console switching circuit. Most servicing will consist of checks for suspected open-circuit or short-circuit faults in the Mk. 4 plugs and sockets and their wiring. The insulation resistance between all leads not electrically connected should be not less than 20M as tested with the 500V Megger, with PL9 on the panel removed.

*Heater transformers*

**122.** Table 16 shows the dummy loads required across the various transformer pins if a distribution unit is being tested in isolation. The on-load RMS voltage at each winding must fall within the limits shown, with supply to each primary at 230V ± one per cent., 50 c/s. Make all measurements with the multimeter Type 1 (AC volts). The load currents shown are subject

**TABLE 16**

**Panel (distribution) Type 861—dummy loads required for testing**

| Winding No. on circuit diagram | Socket and pin | Socket and pin | DC level (approx.) | Load current (A) | Dummy load | | Voltage (V) | |
|---|---|---|---|---|---|---|---|---|
| | | | | | Ohms | Watts | Min. | Max. |
| **Transformer T1: Primary SK10/K and SK10/L** | | | | | | | | |
| 1 | 2/D | 2/K | −300V | 1·5 | 4·2 | 10 | 5·97 | 6·51 |
| 2 | 5/C | 5/D | −20V | 3·0 | 2·1 | 20 | 5·97 | 6·51 |
| 3 | 17/C | 17/D | Earth | 3·0 | 2·1 | 20 | 5·97 | 6·51 |
| 4 | (*not used*) | — | — | — | — | — | — | — |
| **Transformer T2 : Primary SK10/F and SK10/G** | | | | | | | | |
| 5 | 2/Q | 2/R | +400V | 1·0 | 6·3 | 7 | 5·05 | 6·51 |
| 6 | 1/R | 1/S | −300V | 1·5 | 4·2 | 10 | 6·03 | 6·51 |
| 7 | 1/E | 1/L | +250V | 2·0 | 3·15 | 13 | 6·01 | 6·51 |
| 8 | 3/S | 3/T | Earth | 3·0 | 2·1 | 20 | 5·97 | 6·51 |
| 9 | 1/G | 1/N | Earth | 3·0 | 2·1 | 20 | 5·97 | 6·51 |
| 10 | 4/E+F | 4/J+K | Earth | 4·0 | 1·57 | 26 | 6·01 | 6·51 |
| 11 | 4/A | 4/B | −20V | 5·0 | 1·36 | 32 | 6·46 | 7·04 |
| 11* | 5/A* | 5/B* | −20V | 5·0 | 1·36 | 32 | 6·46 | 7·04 |
| **Both connections should be loaded and tested, but NOT simultaneously.* | | | | | | | | |
| **Transformer T3 : Primary SK10/F and SK10/G** | | | | | | | | |
| 12 | 2/F | 2/M | +250V | 1·0 | 6·3 | 7 | 6·05 | 6·51 |
| 13 | 17/A | 17/B | Earth | 1·5 | 4·2 | 10 | 6·03 | 6·51 |
| 14 | 6/K | 6/L | Earth | 2·0 | 3·15 | 13 | 6·01 | 6·51 |
| 15 | 5/E+F | 5/J+K | Earth | 4·0 | 1·57 | 26 | 6·01 | 6·51 |
| 16 | 7/G+H | 7/L+M | Earth | 3·0 | 2·1 | 20 | 5·97 | 6·51 |
| 17 | 14/E+F | 14/J+K | Earth | 5·0 | 1·36 | 32 | 6·46 | 7·04 |
| 18 | 11/W | 11/X | — | 3·0 | 2·1 | 20 | 5·97 | 6·51 |

to a tolerance ±5 per cent. The DC level to which each heater winding is held when in normal service in a console is also indicated.

*Relay tests*

**123.** If testing a distribution unit in isolation, check the relay operation as follows, taking off the relay dust covers in order to see them operate :—

(1) Apply 50V DC between SK11/S and SK2/P, and check that RLA is energized, closing contacts A1 to A4.

(2) Apply 6·3V 50 c/s across SK1/K and SK2/O and check that the thermal relay RLB operates after a time delay of 60 sec. ±20 sec. When RLB has operated, check that contact B1 closes and energizes RLC, opening C2 and closing C1. RLC should remain locked on ; RLB should cool off and release in 60 sec. maximum.

(3) Apply 50V DC between SK3/Z and SK2/N and check that RLD is energized, closing contact D1.

*Relay adjustments*

**124.** Instructions for adjusting residual air gap, armature travel and spring pressures on these relays will be found in A.P.2487, Vol. 1, Sect. 2. It is emphasized that servicing of relays should only be undertaken by experienced personnel using the correct tools and methods.

**Panels (control desk)**

**125.** All the different types of control desk are easy to remove from the console, so that when any control desk fault is suspected the normal procedure should be to remove the desk to the workshop for tests on the appropriate switches and keys. Such tests should check the mechanical operation of the switches and continuity between contacts, cleaning as necessary. Full circuit diagrams are given in Part 1, Sect. 5, Chap. 10. Replacement of desk lights and indicator lamps is straightforward.

*Control unit (aerial velocity) Type 4342*

**126.** This unit is fitted to certain control desks on the console Type 64. It provides a controllable voltage to lay the position of a radar Type 13 aerial. If its action is suspect, carry out mechanical and electrical checks as follows :—

(1) Check that the laying control returns freely to its central position from (*a*) maximum and (*b*) one-eighth clockwise and counter-clockwise rotation.

(2) Ensure that the retaining mechanism of the laying control functions correctly as follows:–

(*a*) Rotate the knob fully clockwise, depress the button and release the knob whilst the button is held down. The control should lock a few degrees off this maximum clockwise position.

(*b*) To release the locking button, turn the knob slightly clockwise, after which it should return freely to its central position.

(*c*) Repeat the tests for counter-clockwise rotation of the control.

(3) Check the electrical operation of the control unit as follows :—

(*a*) Ensure that the sliding contact of RV2 is making direct electrical connection to its centre tap.

(*b*) Connect multimeter Type 1 between points PL6/X and W (positive and negative, respectively), and 120V DC (e.g. HT battery capable of providing 14mA) between PL6/Y and Z (Z positive).

(*c*) Vary RV1 and check that the total range, as shown on the multimeter, is between the tolerance ±4·5V and ±6V.

(*d*) Adjust RV1 until zero volts are indicated on the multimeter (2·5V range).

(*e*) With the multimeter on the 25V range, set the laying control (RV2) 37 deg. clockwise of its central position. Check that the output voltage is within the tolerance 6 to 10 volts.

(*f*) Rotate the laying control in a clockwise direction and check that the output voltage increases smoothly (but not linearly) to a value between 57 and 63 volts, before jumping to 120 volts.

(*g*) Repeat the electrical tests (*e*) and (*f*) with meter connections reversed and RV2 rotated in a counter-clockwise direction.

**Console cabling, input panel and rear lamp**

**127.** Faults in the interconnecting cables in the console and the base input panel may be traced with the aid of the console cabling diagram in Chap. 2, Part 3, of this handbook, together with routine checks using continuity tester and Megger. Failures in services and supplies are more likely to be due to imperfect connections in Mk. 4 or coaxial plugs and sockets than to actual cable failure. The rear lamp, whose 230V supply comes from the input panel, may easily be changed from the back of the console.

## OVERALL CONSOLE SETTING-UP

**General**

**128.** The following notes give in correct order the full cabin setting-up procedure on a console, all of whose units are believed to be serviceable. The sequence can, of course, be entered at any point if previous stages are definitely known to have been completed beforehand. It is assumed that all necessary power supplies and waveform services are arriving at the console input panel, and that the air-blowing system is running properly at 120 cu. ft./minute. The various adjustments will be easiest to do if the console is in the state shown in fig. 1, i.e., with panels off and the indicating unit and deflection amplifier tray in the withdrawn position. (Where space is restricted it will not be essential for the video amplifier, blanking unit and deflection amplifiers to be swung out as they are in fig. 1.)

**129.** The checks set out here should be carried out at the intervals laid down in the progressive servicing schedules. There is no need to disturb any control unless the check shows that adjustment is necessary.

**Switching on**

**130.** See that the following controls on the panel (control) Type 859 are in the positions shown :—

(1) ANTI-CLUTTER switch : OFF

(2) HEAD COMBINING switch : OFF.

(3) Video input control (RADAR SIGNALS, VIDEO MAP, STROBE MARKER, RANGE STROBE, IFF, RANGE RINGS) : turned right down (counter-clockwise).

(4) HT ON switch : in ON position

(5) Remaining controls : position is at present immaterial.

**131.** See that :—

(1) All the intercom. and services keys on the control desk are in the centralized (off) position.

(2) The BRILLIANCE preset control (RV6 on the amplifying unit (video) Type 312) is turned right down (counter-clockwise).

(3) The TEST/NORMAL switches on the voltage stabilizer Type 51 and the waveform generator Type 80 are in the NORMAL position.

**132.** Switch on the console as follows :—

(1) Close the console ON switch on the control desk.

(2) Note that the red lamp on the control desk, and valve heaters all over the console, light up.

(3) After about 1 minute, note that the HT relays are heard to close and the green lamp on the control desk lights up.

(4) Without delay, turn the TEST/NORMAL switches on the voltage stabilizer Type 51 and the waveform generator Type 80 to TEST. If this is not done the HT may trip off again within 1 minute (when the thermal delay cools off) before there has been time to set up the voltage stabilizers in those units.

**Setting-up procedure**

**133.** After a console has been on for 5 mins. (to let the circuits settle down), carry through the setting-up procedure on the complete console in the following order :—

(1) Check and adjust the three outputs from the stabilizer (voltage) Type 51 in accordance with para. 9. When they are correct, turn SWA on the stabilizer to NORMAL.

(2) Check and adjust the two outputs from the voltage stabilizers in the waveform generator Type 80 as instructed in para. 43-44. When correct, return SWA there to NORMAL.

(3) Check the EHT output voltage in accordance with para. 20, paying particular attention to the safety precautions.

(4) Accurately set RV3, RV5, RV1, RV2, and RV4 on each deflection amplifier as detailed in para. 96-99.

(5) Adjust RV1 (FOCUS), RV2 and RV3 on the blanking unit, and RV8 on each deflection amplifier, in accordance with para 82-84.

(6) Adjust RV4, RV6 (the BRILLIANCE control), and RV8 on the video amplifier as detailed in para. 62.

(7) Select the allocated radar head using the head selector switch on the control desk, and turn up the RADAR SIGNALS input control on the control panel until a satisfactory picture is seen. In particular, there should be a faint but even noise display all over the screen area. If the noise paint is not even, adjust the TRACE COMPENSATION control (RV4 on the waveform generator Type 80) until it is, and check the setting on the other three ranges.

(8) Turn ON the ANTI-CLUTTER switch on the control panel, and check that a small circular blackout area of radius about 20M is produced around the scan centre. If necessary adjust the ANTI-CLUTTER control (RV3 on the waveform generator Type 80) to suit local conditions. Check on all four ranges. Turn OFF the ANTI-CLUTTER switch.

(9) Turn on such other display facilities (video map, IFF, azication marker, range strobe, range rings, etc.), as may be available with the type of control desk in use. Turn up the appropriate input control and check that each type of display paints clearly and evenly both alone and in combination with the others.

(10) The console is now ready for use in accordance with Part 1, Sect. 2, Chap. 1 of this handbook.

# Appendix 1

# CONSOLE TYPE 64 AND CONTROL DESKS (PHASE 1A)
## (SETTING UP AND TESTING)

### LIST OF CONTENTS



### LIST OF TABLES



**Introduction**

**1.** The information in this appendix is supplementary to that in the preceding chapter. It details the setting-up and testing procedures to be used with units modified for use at phase 1A radar stations. Each modified unit or series of units is dealt with in a separate paragraph in sequence with the original units in the preceding chapter.

**Stabilizer (voltage) Type 51A**

**2.** The voltage checks and adjustments for the –300V, +250V and +400V stabilizers in the stabilizer (voltage) Type 51A are similar to those for the Type 51 and are described in the preceding chapter, para. 9 to 19.

**Indicating unit (CRT) Type 16452 and 16453**

**3.** The indicating unit (CRT) Type 16452 is a re-referenced Type 35 without sub-units, and the Type 16453 is a modified version. Both of these units are set up and tested as described in the preceding chapter, para. 31 to 42. The units contain the following sub-units:—

(1) tube unit (including c.r.t. in housing with deflector and focus coils)

(2) waveform generator (video gating) Type 80B or 80C

(3) amplifying unit (video) Type 312A

(4) blanking unit Type 26A or 26B

(5) panel (control) Type 859B or 859C

**Waveform generator (video gating) Type 80B and 80C**

**4.** These units are set up and tested in a similar manner to the Type 80 as detailed in the preceding chapter, para. 43 to 61.

**Amplifying unit (video) Type 312A**

**5.** Cabin servicing for the video amplifier Type 312A is confined to final adjustments to RV6, RV8 and RV4 when a complete console is set up and prepared for operation. The remaining five variable resistors and six variable capacitors are adjusted during workshop servicing. Setting up the controls is a similar procedure to that described for the Type 312 in the preceding chapter, para. 63 to 80 with the following exceptions in the workshop servicing procedure. To check C11 in the inter-trace bright-up channel in consoles displaying inter-trace information:—

(1) Apply the 25μs positive-going pulse to SKT8.

(2) Adjust the pulse generator output to give a pulse amplitude of 18V at SKT14.

(3) Check that the pulse amplitude at SKT8 is 2·75V ±0·25V.

(4) If necessary adjust C11 for undistorted pulse output; then set the pulse generator for 18V and recheck the amplitude at SKT8.

(5) Operate the inter-trace key to off.

**Blanking unit Type 26A and 26B**

**6.** Setting-up and testing procedures for these units are similar to those for the Type 26 as described in the preceding chapter, para. 81 to 91.

**Panel (control) Type 859B and 859C**

**7.** Setting-up and testing procedures for these units are similar to those for the Type 859 as described in the preceding chapter, para. 92 to 94.

**Deflection amplifiers**

*Cabin servicing*

**8.** Cabin servicing on the X deflection amplifying unit Type 12476 and Y deflection amplifying unit Type 12477 (Ref. No. 10U/17408 and 10U/17409 respectively) describes the setting-up of the amplifier preset controls in conjunction with the tube unit, deflector coils and blanking unit. A periodic check must be carried out for possible changes of component value due to aging.

**9.** *RV*4, *RV*7.—The trace expansion DC SET (1) and DC SET (2) controls RV4 and RV7 respectively are adjusted when located in the actual console to conform to the characteristics of the c.r.t. and deflector coils. Setting-up procedure is as follows:—

(1) Set the BLANKING SET, OCTAGON SIZE control (RV3 on the blanking unit) fully anti-clockwise and turn down the RANGE RINGS and STROBE MARKER input controls in panel (control) Type 859 B or C (RV5 and RV4 respectively).

(2) Turn down the brilliance (RV6 on the video amplifier 312A).

(3) Turn switch SWA on both amplifiers to the TEST position to remove all deflectional input by isolating the trace expansion stages from the paraphase amplifier and the limiting stages.

(4) Plug the multimeter Type 100 into SKT3 on the amplifier unit (X or Y deflection) under test and switch on the h.t. supply to the console.

(5) Check at SKT3 (G) the cathode current of V9. Adjust RV4 (DC SET 1) until this current is 130mA (FSD of meter=300mA).

(6) Check at SKT3 (L) the cathode current of V11. Adjust RV7 (DC SET 2) until this also is 130mA and lock RV7.

(7) Turn up the brilliance carefully to obtain a spot on the c.r.t. Set the spot exactly on the horizontal axis of the c.r.t. by adjustment of RV4 (DC SET 1) and then lock RV4.

(8) Set RV4 and RV7 on the Type 12476 by the same method to set the spot exactly on the horizontal axis of the c.r.t.

**10.** *RV*1.—Adjust the relative d.c. scan and inter-trace origins to be coincident on the X deflection amplifier and Y deflection amplifier using SET REGISTRATION RV1 on the amplifier under test. The reference inter-trace marker dot at a voltage corresponding to a range of 220 miles is supplied from an amplifying unit mixer 4428. The console c.r.t. is used for setting up as follows:—

(1) Plug the amplifying unit (mixer) Type 4428 into socket SKT4 on the amplifier unit (Type 12476 or 12477) under test.

(2) Turn the TEST/NORMAL switch SWA on the amplifier unit to NORMAL and turn the RANGE switch on the control panel 859B or C to 80M (maximum expansion).

(3) Carefully turn up the BRILLIANCE control RV6 on amplifying unit 312A until a horizontal trace is just visible on the cathode ray tube screen.

(4) Throw the 10-mile range rings control key appropriate to the control desk to the ON position.

(5) Carefully turn-up the RANGE RINGS and STROBE MARKER input controls (RV5 and RV4 respectively) on panel (control) 859B or C, until dots are clearly visible. The strobe marker should appear near the 220-mile range ring and near the centre of the tube face.

(6) Adjust RV1 on the amplifier unit until the two spots are exactly coincident and lock RV1.

(7) Turn the RANGE switch on the control panel 859B or C through each of the three remaining ranges of expansion, to ensure that the position of the strobe marker lies within $\pm\frac{1}{4}$mm of the 220-mile range.

**11.** *RV*5.—The comparative gain of the X and Y deflection amplifiers is set by using RV5 on the control panel 859B or C to ensure the range rings are circular and equally spaced on each degree of expansion. The amplifying unit (mixer) is fed with an unresolved +250 c/s timebase waveform and the available intertrace sequences earthed. D.C. voltage from the panel (control) 859B or C to the amplifying unit (mixer) provides off-centering control. Continue setting up as follows:—

(1) Connect the output from the amplifying unit (mixer) to SKT4 on the amplifier under test.

(2) Turn the RANGE switch on the control panel 859B or C to minimum expansion 160M to a radius. A horizontal line should appear on the c.r.t. extending from the centre to the right-

hand boundary of the tube face. The earthed intertrace sequences should produce a dot corresponding to the start of the sawtooth.

(3) Turn up the BRILLIANCE control (RV6 on the video amplifier) until the rotating trace is clearly visible.

(4) Throw the calibration key on the control desk to the RANGE RINGS position and FINE/COARSE key to COARSE to obtain 10-mile markers.

(5) Adjust the off-centering control on the panel (control) 859B or C until the intertrace dot is in the centre of the tube face.

(6) Turn up the RANGE RINGS input control RV5 on the control panel 859B or C until the range rings are clearly visible.

(7) Check that adjustment of GAIN SET RV5 to give 160 miles to a radius is possible. This adjustment of RV5 will cause a slight d.c. shift in the whole display.

(8) Adjust the off-centring control on the panel (control) 859B or C until the intertrace dot is in the centre of the tube face.

(9) Remove the unresolved +250 c/s sawtooth from the amplifying unit (mixer) input and connect instead a 250 c/s resolved timebase waveform.

(10) Turn up the range rings controls and see that they appear circular and equally spaced. Re-adjustment of the brilliance, range rings and strobe marker brightness controls may be necessary.

(11) Turn down the range rings and strobe marker controls.

(12) Remove the output connection from the amplifying unit (mixer) from SKT4.

(13) Bring in a +250 c/s unresolved timebase waveform to both amplifiers 12476 and 12477 under test.

(14) Turn up the BRILLIANCE control (RV6 on the video amplifier) until a radial line appears on the tube face (approximately at 45 deg.).

(15) Turn up the RANGE RINGS input control RV5 on the control panel 859B or C until a series of dots is clearly seen on the trace. The trace should be checked for any signs of "hooking" beyond the first five miles from the centre of the tube face.

(16) Repeat sub-para. (13) to (15) inclusive with SKT4 of one of the amplifier units under test connected to the —250 c/s unresolved timebase waveform and SKT4 on the other amplifier unit connected to the +250 c/s unresolved timebase waveform.

(17) Obtain the conditions as at the end of sub. para. (10).

(18) Turn the RANGE switch to the 240M, 160M and 80M positions and see they appear circular and equally spaced. Check that the right number of 10-mile range ring intervals fills the c.r.t. diameter in each position. The corresponding number of 10-mile range rings to a radius is 12, 8 and 4.

### Panel (Distribution) Type 861A

**12.** The panel (distribution) Type 861A is similar to Type 861 and servicing checks are as detailed in Part 2, Sect. 1, Chap. 1, Para. 121 to 124 inclusive with the exception of relay tests. If testing a distribution unit in isolation check the relay operation as follows, taking off the relay dust covers in order to see the relays operate:—

(1) Apply 50V d.c. between SKT11/S and SKT2/P and check that RLA is energized, closing contacts A1 to A4.

(2) Apply 6·3V 50 c/s across SKT1/K and SKT1/F and check that the thermal relay RLXA operates after a time delay of 60 sec. ±20 sec. When RLXA has operated, check that contact XA1 closes and energizes RLC, opening C2 and closing C1. RLC should remain locked on; RLXA should cool off and release in 60 sec. maximum.

(3) Apply 50V d.c. between SK3/Z and SK2/N and check that RLD is energized, closing contact D1.

## OVERALL CONSOLE SETTING UP

**13.** The setting up procedure on the complete console is similar to the procedure described in Part 2, Sect. 1, Chap. 1, Para 133 with the following exceptions:—

(1) Check and adjust the three outputs from the stabilizer (voltage) Type 51A in accordance with para. 9. When they are correct turn SWA on the stabilizer to NORMAL.

(2) Check and adjust the two outputs from the voltage stabilizers in the waveform generator Type 80B and 80C as instructed in para. 43-44. When correct, return SWA to NORMAL.

(3) Accurately set RV1, RV4, RV5 and RV7 on each deflection amplifier as detailed in para. 9, 10 and 11 of this appendix.

(4) Adjust RV1 (FOCUS) RV2 and RV3 on the blanking unit and RV8 on each deflection amplifier, in accordance with para. 81-84 in the preceding chapter.

(5) Operate the ANTI-CLUTTER switch on the control panel 859B or C, and check that a small circular blackout area of radius about 20 miles is produced around the scan centre. If necessary adjust the ANTI-CLUTTER control (RV3 on the

waveform generator Type 80B and 80C) to suit local conditions. Check on all four ranges. Switch off the ANTI-CLUTTER switch.

(6) Switch on such other display facilities (video map, IFF range rings, IT marking RING/OFF/DOT, ICM RING/DOT, also joystick operation and reset button operation) as may be available with the type of control desk in use. Increase the appropriate input control and check that each type of display paints clearly and evenly both alone and in combination with the others.

(7) The console is now ready for use in accordance with Part 1, Sect. 2, Chap. 1 of this publication.

### Joystick marking system

**14.** The following tests concern only the 12 in. p.p.i. displays.

(1) At the modulator (I.T.B.U.) 4430 switch the TEST/NORMAL switch to NORMAL and turn the ring size control fully clockwise. Set the RANGE switch to 320M. Press and release the joystick RESET switch. Set the joystick RING/DOT switch to RING. Check that a circular or an elliptical mark appears and adjust if necessary the STROBE MARKERS brilliance control. Set the joystick RING/DOT switch to DOT and check that a dot marker appears in the same position. Set the joystick RING/DOT switch to the off (upright) position and check that no mark appears.

(2) Set the joystick RING/DOT switch to RING and set the RANGE switch to 80M. Check that the ring is round and, if necessary, adjust the RING PHASE control until the axes of the ellipse lie in north–south and east–west directions. Adjust the RING PARAPHASE AMP control until the mark appears circular and if necessary readjust the RING PHASE again. Display fine range rings and adjust the RING SIZE control until the ring diameter is 2 miles $\pm\frac{1}{2}$ mile. Switch the RANGE switch to each range in turn and check that the ring diameter increases as the range is increased according to the following table:—

| *Range* | *Ring diameter* |
|---|---|
| 80 | $2\pm\frac{1}{2}$ miles |
| 160 | $3\pm\frac{1}{2}$ miles |
| 240 | $4\pm\frac{3}{4}$ miles |
| 320 | $5\pm1$ miles |

(3) Check that when the joystick is moved forward away from the operator (north) the mark moves in a northerly direction on the tubeface. Check similarly for southerly, easterly, and westerly movement of the mark on the tubeface.

(4) With the console RANGE set to 80M move the joystick mark off the tubeface. Press and release the joystick RESET switch and check that the mark reappears within 30M of the centre of the tubeface.

(5) The following test is designed to prove that range switching services are correctly fed to the joystick racks. For this test, mark velocities are measured but the measurement is only approximate and is used to prove that the range switching is effective.

(*a*) Switch the RANGE switch to 320M and press the joystick RESET switch. Set the joystick mark to the extreme northerly position on the tubeface and set the joystick lever to the extreme southerly position. Press the velocity button on the joystick and record the time taken for the mark to travel a distance of 300 miles in a southerly direction. Check that this time is between 3 and 10 seconds.

(*b*) Switch the RANGE switch to 240M and repeat the test in (*a*) but using a distance of 225 miles. The time should be within $\pm25$ per cent of the time taken in (*a*).

(*c*) Perform similar tests for 160 miles range over 150 miles, and 80 miles range over 75 miles.

### Inter-console marking

**15.** While a console is undergoing test, the STROBE MARKERS (or I/T MARKS) control should be set for the correct brilliance of joystick marks. The TEST/NORMAL switches on the modulators (I.T.B.U.) 4430 and the modulators (9 channels) 16134 should be in the NORMAL position. For routeing checks the I.C.M. RING/DOT switch and the joystick RING/DOT switch on all panels (control desk) should be in the RING position. For accuracy checks, where possible RING/DOT switches should be set to DOT. Information required concerning the panel (patching ICM) 12953 can be found in A.P.2527X.

**16.** On the panel (patching ICM) patch the cables detailed in column 2 of Table 1 to the sockets listed in column 3. On the control desk situated at the console listed in column 4, set the ICM control switches to each set of conditions listed in columns 5 and 6 in turn, and check that the lamp detailed in column 7 lights. For each set of conditions check the routeing and the accuracy of two way marking between the consoles listed in columns 8 and 9 as follows, with the consoles on maximum expansion:—

(1) *Routeing*.—Put the joystick mark on the console listed in column 8 to approximately 200 miles range in a northwesterly direction. On the console listed in column 9 lay the joystick mark over the ICM received from the first console. At this first console check that the two marks displayed are coincident to within $\pm1{\cdot}0$ mm.

(2) *Accuracy*.—Select, where possible, dot markers. Set the joystick mark on the console listed in column 8 of Table 1 to lie on the range ring at 200 miles north. At the console listed in column 9 check that the ICM appears within $\pm2{\cdot}0$ mm of the 200 miles range ring on a northerly bearing. Repeat the test at 100 miles range, then repeat for east, south, and west at 200 and 100 miles range.

**TABLE 1**

**ICM tests**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|
| Test No. | Patching | | At Console | Control position | | | Check marking between | |
| | Cable | Console | | Switch on | Switch off | Check lamp on | | |
| 1 | MC1 | 53 | 47 | 1 | others | 1 | 47 | 53 |
| | MC2 | 54 | 47 | 2 | 1 | 2 | 47 | 54 |
| | MC3 | 55 | 47 | 3 | 2 | 3 | 47 | 55 (S) |
| | MC4 | 56 | 47 | 4 | 3 | 4 | 47 | 56 (N) |
| | MC5 | 53 | 47 | 5 | others | 5 | 47 | 53 |
| | MC6 | 54 | 47 | 6 | 5 | 6 | 47 | 54 |
| | — | — | — | — | all | none | — | — |
| 2 | CC1–1 | 1 | 53 | 1 | others | 1 | 53 | 1 |
| | CC1–2 | 3 | 53 | 2 | 1 | 2 | 53 | 3 |
| | CC1–3 | 19 | 53 | 3 | 2 | 3 | 53 | 19 |
| 3 | CC1–4 | 1 | 53 | 4 | others | 4 | 53 | 1 |
| | CC1–5 | 3 | 53 | 5 | 4 | 5 | 53 | 3 |
| | CC1–6 | 19 | 53 | 6 | 5 | 6 | 53 | 19 |
| | — | — | — | — | all | none | — | — |
| 4 | CC2–1 | 6 | 54 | 1 | others | 1 | 54 | 6 |
| | CC2–2 | 8 | 54 | 2 | 1 | 2 | 54 | 8 |
| | CC2–3 | 20 | 54 | 3 | 2 | 3 | 54 | 20 |
| 5 | CC2–4 | 6 | 54 | 4 | others | 4 | 54 | 6 |
| | CC2–5 | 8 | 54 | 5 | 4 | 5 | 54 | 8 |
| | CC2–6 | 20 | 54 | 6 | 5 | 6 | 54 | 20 |
| | — | — | — | — | all | none | — | — |
| 6 | CC3–1 | 11 | 55 | 1 | others | 1 | 55 (S) | 11 |
| | CC3–2 | 13 | 55 | 2 | 1 | 2 | 55 | 13 |
| | CC3–3 | 21 | 55 | 3 | 2 | 3 | 55 | 21 |
| 7 | CC3–4 | 11 | 55 | 4 | others | 4 | 55 (N) | 11 |
| | CC3–5 | 13 | 55 | 5 | 4 | 5 | 55 | 13 |
| | CC3–6 | 21 | 55 | 6 | 5 | 6 | 55 | 21 |
| | — | — | — | — | all | none | — | — |
| 8 | CC4–1 | 35 | 56 | 1 | others | 1 | 56 (N) | 35 |
| | CC4–2 | 37 | 56 | 2 | 1 | 2 | 56 | 37 |
| | CC4–3 | 50 | 56 | 3 | 2 | 3 | 56 | 50 |
| 9 | CC4–4 | 35 | 56 | 4 | others | 4 | 56 (N) | 35 |
| | CC4–5 | 37 | 56 | 5 | 4 | 5 | 56 | 37 |
| | CC4–6 | 50 | 56 | 6 | 5 | 6 | 56 | 50 |
| | — | — | — | — | all | none | — | — |

**17.** For tests 6 to 9 it is necessary to set the receive key to RECEIVE and the marks ON/OUT key to OUT on the associated panel (control) 4825A. For tests 1, 3, 5, 7 and 9 it is not necessary to perform the accuracy check described in para. 16 (2). All of the marks displayed are rings with the exception of the marks from consoles 1, 3 and 19 to console 55 in test 2 and 3, and the marks from consoles 6, 8 and 20 to console 54 in tests 4 and 5. These marks are dots.

# Chapter 2
# FIXED-COIL RADAR OFFICE EQUIPMENT

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## ◀LIST OF APPENDICES

## INTRODUCTION

**1.** Under normal conditions the rack assemblies associated with the fixed coil consoles are set up using the waveform monitor rack Type 339. Another procedure is, however, required for use when the monitor rack is not available. This chapter therefore contains two setting-up procedures. A third section deals with the setting-up procedure for the waveform monitor rack.◀The Appendix contains additional information.▶

*Sequence of setting-up*

**2.** The rack assembly (negative reference) Type 338 supplies —500V reference voltages to all fixed coil equipment, power units and consoles. Setting-up operations on this rack must therefore, in general, be completed before work is started on the remaining equipments. The other power units may be set up immediately afterwards, but in this chapter they are included in the relevant rack assembly setting-up sequence.

**3.** Before proceeding with the setting-up, it is also necessary to ensure that:—

(1) the appropriate switches on the radar office MAINS switchboard are ON,

(2) the two 50V relay supplies (rectifier units Type 15) are connected, and

(3) the delay units Type 31, associated with:—

(*a*) the 250 c/s and the 500 c/s sync. to the RA 300 and

(*b*) the 250 c/s sync. to the range marker units Type 27, have been properly set up.

**4.** The RA 300 must be set up before the rack assemblies Type 301, and the RA 304 before starting on the rack assemblies Type 302. Similarly the bulk power supplies (RA 305) must be set up before the consoles Type 64, and the rack assemblies Type 302 (azication) before the azicating monitor and the stop-and-look consoles Type 64 (*Chap.* 1 *of this Section*).

## SETTING-UP AND TESTING WITHOUT WAVEFORM MONITOR

### Test equipment

**5.** The required items of test equipment are:—

| *Item* | *Stores Ref.* | *A.P.* |
|---|---|---|
| Oscilloscope Type 13A | 10S/831 | 2879AF |
| *or* | | |
| Oscilloscope Type 8165 (Cossor Type 1035) | 10S/16707 | |
| Test set Type 402 | 10S/16157 | 2527D |
| Multimeter Type CT38 (Electronic) | 10SB/16308 | 2879AG |
| *or* | | |
| Multimeter Type 1 | 10S/16411 | 2536C |
| *or* | | |
| Testmeter Type V | 10S/821 | 1186E |
| Multimeter Type 100 | 10S/16576 | 2527D |

Test rigs as fig. 1 and fig. 2.

### Calibration of oscilloscopes

**6.** An oscilloscope is required for measuring the durations and amplitudes of waveforms and for checking delay times. Neither the Type 13A nor the Cossor Type 1035 is able to do this without prior calibration. Thus, although the Type 13A produces calibration marks internally, at intervals of 10 μS or 1 μS, these must be checked against the crystal-controlled 5-mile markers of the test set Type 402. In the case of the Type 1035, either the 5-mile markers from the test set Type 402 or the markers from the marker unit Type 27 must be displayed simultaneously with the monitored waveform (but see *para.* 10) since no suitable internal calibration is provided in the 1035. For calibrating the Y-deflection of both oscilloscopes, a known voltage must be used.

*Oscilloscope Type* 13A

**7.** To check the internal calibration:—

(1) Connect A1 of the oscilloscope to the 5 MILE output socket (SK6 or SK7) of the test set Type 402.

(2) Select 10 μSEC calibration markers on SW.5, labelled CAL. MARKERS, of the 13A. The spacing of the 5 nautical miles marks is equivalent to 61·78 μS, so that two of these marks should just encompass seven 10 μS marks.

(3) Make any adjustment that may be required by varying the inductance of the calibration oscillator coil L1.

(4) Also calibrate the 1 μSEC marks, adjusting inductor L2 as required (L1 and L2 are accessible when the oscilloscope case has been removed—full details in A.P.2897AF).

**8.** To measure Y-deflection sensitivity, the internal 50V peak-to-peak sine wave may be applied from the front panel 50 c/s socket to the Y-plate to be used in the test and the corresponding deflection marked on the CRT screen graticule. When using the CRO amplifiers, the GAIN controls must be adjusted to display the required waveform and the amplitude of the latter marked on the graticule. The waveform source is then disconnected and a small external sine wave from a heater transformer or a BFO injected instead. No adjustments must be made to the CRO GAIN controls when displaying this waveform. The amplitude of the external sine wave may be measured on a peak valve voltmeter and the CRT screen graticule calibrated accordingly.

**9.** Fig. 1 shows a simple peak-voltage measuring circuit. The value of the cathode capacitor of the CV140 is not critical and any high resistance voltmeter may be used, the principle being that the long CR of the circuit permits the capacitor to charge to the peak value of the positive half-cycle of the input waveform, which is then read on the meter. Since the circuit loads the input source whilst the capacitor is charging, it is more suitable for use with a small transformer than a BFO. Alternatively the AC voltage from the small transformer may be measured directly by the multimeter Type CT38 or Type 1. The reading will be RMS and will have to be multiplied by a factor of 1·414 to obtain the peak value.

*Cossor oscilloscope Type* 1035

**10.** For checking waveform durations and delay

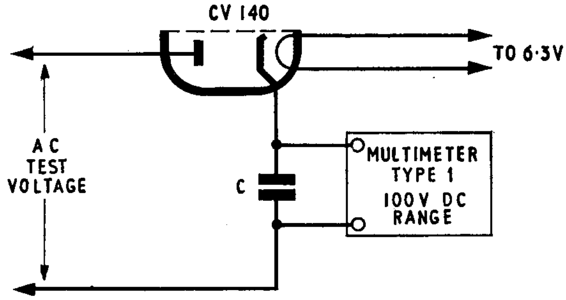


**Fig. 1. Peak-voltage measuring circuit**

times, this CRO is normally triggered by the master trigger and calibrated by the range unit Type 27. Alternatively, it may be possible to inject the 5 MILE marks output from the test set Type 402 into the CRO A1 amplifier, for display on Y1 trace, and at the same time to inject the waveform to be observed, for display on Y2 trace. The waveform source ought properly to be triggered by the test set Type 402 to ensure synchronization, but where this is not feasible and the two traces will not synchronize, reliance will have to be placed on the CRO dial readings for timebase amplitude and velocity. These may be calibrated by noting the number of 5-mile marks displayed on the various settings as the controls are turned clockwise from zero to maximum.

**11.** For measuring waveforms of large amplitude the internal 50V, 50 c/s sine wave may be used as a standard, or alternatively, check the Y-deflection sensitivity as follows :—

(1) Apply a measured alternating voltage (*para.* 9) directly to either Y-plate.

(2) Turn the Y SHIFT control to move the trace through a distance equal to the peak-to-peak amplitude of the displayed waveform (this will be twice the peak valve voltmeter reading and 2·828 times the RMS reading).

(3) Note the number of dial graduations through which the Y SHIFT control has moved.

(4) Repeat the procedure with the test waveform and calculate the amplitude with reference to the dial graduations.

**12.** For measuring waveforms of smaller amplitudes, apply the calibration and test waveforms in turn to a Y-amplifier. The significance of the GAIN control A1 and A2 VOLTS RANGE dial graduations, in terms of amplification factors, may be derived, using the waveform of known amplitude, and then applied to the test waveform.

## RACK ASSEMBLY (NEGATIVE REFERENCE) TYPE 338

### Power unit Type 906—Ref. 1

**13.** (1) Ensure that the radar office powerboard switches are ON and, on the power unit Ref. 1, switch the ON/OFF SW.A to ON.

(2) On the relay unit Type 186 :—

(a) Check that both −50V supplies are reaching the rack (i.e., LP7 (SUPPLY 1) and LP8 (SUPPLY 2) are ON).

(b) Operate the meter change-over SW.F to REF. 1.

(c) Operate the supply keys SW.A and SW.B to REF. 2.

(3) Press the START button on the power unit.

(4) Check that the power unit thermo-delay operates, by seeing that :—

(a) a reading is obtained on the meter within 15 to 45 sec. after switching on,

(b) LP9 (REF 1) on the relay unit lights.

(5) Set the power unit PROTECTION WARNING SW.D to OFF and ensure that the WARNING NEON LP1 blinks.

(6) Adjust the VOLTAGE SET control RV1 on Ref. 1 power unit to give a reading of 500 on the meter.

(7) Connect multimeter Type 100 (MMT.100) into the power unit SK3 and select position KX. (Close the PRESS TO READ switch on the multimeter).

(8) Adjust PROTECTION SET control RV2 to give a reading of zero on MMT.100. Press the button labelled PROTECTION FINE (SW.E) for fine adjustment.

(9) Set PROTECTION WARNING switch to ON, and vary the VOLTAGE SET control to increase the reading on the relay unit meter. Check that the protection circuit cuts out between the limits of 515-535V.

(10) (a) Set PROTECTION WARNING switch to OFF and press START button.

(b) Adjust VOLTAGE SET potentiometer to give a reading of 500 on the built-in meter.

(c) Set PROTECTION WARNING switch to ON.

(d) Adjust VOLTAGE SET to lower the voltage and see that the protection circuit operates between the limits of 485-465V.

(11) Set PROTECTION WARNING switch to OFF, press START button and re-adjust VOLTAGE SET to give a reading of 500 on the meter.

(12) Set PROTECTION WARNING to ON. The Ref. 1 power unit is now ready for operational use.

*Ripple voltage*

**14.** (1) Set the sensitivity of the calibrated Cossor CRO Type 1035 to 50mV. Connect terminal A1 to the live side of C9 in the power unit and the EARTH terminal to the other side.

(2) Check that the voltage ripple does not exceed 10 mV peak-to-peak. Also check that the amplitudes of any transient spikes do not exceed 20 mV.

### Power unit Type 906—Ref. 2

**15.** Change over to the Ref. 2 power unit (SW.A on the relay unit Type 186) and repeat the operations outlined in para. 13 and 14.

### Relay unit (change-over) Type 186

**16.** (1) Check that both −50V IN green lamps LP7 (SUPPLY 1) and LP8 (SUPPLY 2) are on, indicating that both 50V supplies are reaching the rack.

(2) Operate the −50V CHANGE-OVER key to SUPPLY 1 and SUPPLY 2 alternately; the −50V OUT lamps, LP1 and LP2 respectively, should light in turn, indicating the change-over.

(3) Check that both −500V in red lamps LP9 (REF. 1) and LP10 (REF. 2) are on, indicating that both power units are functioning.

(4) Operate the −500V CHANGE-OVER key, selecting REF. 1 and REF. 2 in turn and check that LP3 and LP4, respectively, light to indicate the change.

(5) Check the automatic change-over of the 50-volt supply by switching off the rectifier Type 15 which is in use. The indicator lamps should indicate the failure of the supply and the automatic change-over, while the alarm bell should ring to indicate the failure.

(6) Press the ALARM RELEASE button SW.D and switch on the rectifier Type 15, then repeat the test on the other rectifier unit.

(7) Check the automatic change-over of the −500V supply by pressing the RELEASE button (SW.C) on the power unit in use. This breaks the HT primary circuit but leaves the power unit heaters on. The indicator lamps should indicate the failure of the supply and the change-over while the ringing of alarm bell draws attention to the failure.

(8) Press the ALARM RELEASE button (relay unit) and the START button (power unit) then repeat the test on the second power unit.

**Relay unit Type 185**

**17.** Remove each fuse in turn and note that the appropriate neon lamp glows.

## RACK ASSEMBLY (TIMEBASE GENERATOR) TYPE 300

**18.** Make sure that the master trigger unit is ON, that the TIMEBASE (1), (2), (3) and (4) switches on the MAINS switchboard are ON, that the rectifier unit Type 15 is supplying 50V for relays, etc., and the negative reference rack is in operation.

**Power unit Type 903**

**19.** These operations are carried out on each of the four power units in turn.

(1) See that SW.B (OFF/SET/CHECK/LOAD) is in the OFF position and set the main switch SW.A to ON.

(2) After allowing ½ minute for the valve heaters to warm up, turn SW.B to SET. The red HT ON lamp LP6 and the LOAD ON neon LP5 light up.

(3) Check the stabilized HT voltages by plugging the multimeter Type 100 into the 25-way METERING socket SK5, then
   (a) select position FT on the multimeter switch (operating PRESS TO READ switch) and adjust the −300V SET potentiometer RV4 to give a F.S.D. of 3;
   (b) select position DR on MMT.100 and adjust +300V SET (RV2) to give a reading of 3 on the meter. Lock the potentiometer spindles.

(4) Select position ES on the MMT.100 and adjust SET CUT-OUT (RV3) for zero reading on the MMT.100.

**Note . . .**
*This control is sluggish due to the long time constant of the circuit.*

(5) Turn selector switch (SW.B) to CHECK and ensure that the protective circuit operates by removing the −300V fuse; the power unit should close down and extinguish the neon LP5 and the HT ON indicator LP6.

(6) Replace fuse, turn selector switch to SET and allow 20 sec. for the neon to glow. LP6 should also be on.

(7) Turn selector switch to CHECK; LP5 and LP6 should remain ON.

(8) Turn selector switch to LOAD; HT ON (LP6) should remain on, but LP5 should go out.

(9) Check with MMT.100 that the −300V and +300V output voltages (switch positions FT and DR, respectively) are unaffected by the transfer to normal load conditions.

*Ripple voltage*

**20.** (1) Disconnect trigger input from SK3 of the timebase unit Type 140, associated with this power unit.

(2) Set the sensitivity of the calibrated Cossor CRO Type 1035 to 50 mV.

(3) Connect CRO terminal A1 to the line side of C11 in the power unit (−300V rail) and check that the ripple voltage does not exceed 10mV peak-to-peak.

(4) Connect A1 to the line side of C6 (+300V rail); the ripple should not exceed 10 mV peak-to-peak.

(5) Disconnect CRO and re-connect trigger input to SK3.

**Timebase units Type 140**

**21.** There are four timebase units in the rack, two for 500 c/s (120 mile) and two for 250 c/s (240-mile). On each range, one is in use while the other is standby. It is most important that the waveforms are accurately set up relative to each other; otherwise when head combining is used, or a change to another head is made, the change-over points will not line up. Aligning is therefore done in two stages:—

(1) each waveform is adjusted independently to give reasonably accurate results and then,

(2) one is selected as master and the others aligned to it.

**22.** Each timebase unit can generate either a 500 c/s or a 250 c/s output, but normally each unit is used for one frequency only. Change-over is effected by operating the RANGE switch to 120 or 240, respectively, and by connecting the appropriate trigger frequency.

**23.** The setting-up of the sawtooth is done in two stages:—

(1) amplitude (voltage) and

(2) duration (proportional to velocity).

The amplitude of each range is adjusted independently but as the velocity is the same for both ranges, if it is set correctly on one range, it will be correct for the other.

◀ **Note . . .**
*The appendix contains information on 270 c/s operation.* ▶

**TABLE I**

**Timebase unit Type 140—meter readings**

| Valve | Socket letters and meter positions | | Scale | Current mA | |
|---|---|---|---|---|---|
| | | | | 500 c/s | 250 c/s |
| V1A | SK14 | P – B | 10 | 4·7 – 6·5 | 4·7 – 6·5 |
| V3 | | Q – C | 10 | 3·2 – 4·5 | 3·2 – 4·5 |
| V4 | | R – D | 10 | 1·2 – 1·9 | 1·2 – 1·9 |
| V5B | | S – E | 10 | 2·2 – 4·4 | 2·2 – 4·4 |
| V5A | | T – F | 10 | 1·2 – 7·0 | 1 2 – 7·0 |
| V6B | | U – G | 3 | 0·9 – 1·4 | 0·9 – 1·4 |
| V6A | | V – H | 3 | 0·5 – 1·2 | 0·5 – 1·2 |
| V8 | | W – J | 10 | 3·6 – 6·0 | 3·1 – 5·5 |
| V9 | | X – K | 30 | 10·1 –13·0 | 10·2 –13·5 |
| V10B | | Y – L | 3 | 0·5 – 1·2 | 0·5 – 1·2 |
| V10A | | Z – M | 3 | 0·9 – 1·4 | 0·9 – 1·4 |
| V11 | SK15 | O – A | 10 | 2·5 – 5·0 | 3·0 – 5·5 |
| V12 | | P – B | 30 | 19·2 –23·2 | 18·5 –22·5 |
| V14 | | Q – C | 30 | 13 –21 | 13 –21 |
| V15 | | R – D | 30 | 13 –21 | 13 –21 |
| V16B | | S – E | 10 | 4·0 – 4·8 | 4·0 – 4·9 |

**24.** The procedure is as follows :—

(1) Ensure that all coaxial cables are plugged in and that the unit is being triggered at the correct p.r.f.

(2) Check that the appropriate selector switch (SW.A or SW.B) on the distribution panel Type 868 (base of rack) is switched to the unit under test.

(3) Plug MMT.100 into the front panel METERING sockets A and B (SK14 and SK15) in turn, and check that all meter readings are within the limits given in Table 1.

(4) Check that the waveform is a linear sawtooth, free from distortion or " ringing ".

(5) Check that the amplitude of the sawtooth is 51V (25·5V) adjusting, if necessary, the RANGE SET 240 miles control RV5 (RANGE SET 120 miles control RV4).

(6) Check that the range of the timebase forward stroke is 245 (122·5) miles, adjusting, if necessary, the VELOCITY FINE control RV11.

(7) Set SW.A to 120 (240) miles and check that the amplitude of the sawtooth is reduced to 25·5V (increased to 51V), adjusting, if necessary, the RANGE SET 120 (240) miles control. Reset SW.A to 240 (120) miles.

*Rest level adjustment*

**25.** (1) Disconnect trigger input from SK3.

(2) Set range of multimeter (electronic) Type CT38 to 250 mV DC and connect between SK5 (TB+) and earth.

(3) Check that this point is at earth potential. If necessary, adjust RV3 (TB ZERO SET FINE).

(4) Repeat for SK6 (TB−).

(5) Disconnect multimeter and reconnect trigger to SK3.

*Amplitude and range adjustment*

**26.** The procedure is given for 250 c/s units with the alternatives for 500 c/s units in brackets.

(1) Trigger a calibrated CRO Type 13A, or Cossor Type 1035, from sync output socket at bottom of master trigger unit, at 250 c/s.

(2) Connect Y2 to monitor socket X14 (X13) on marker unit 27 and display 10-mile (5-mile) range marks.

(3) Connect Y1 to SK5 on timebase unit and display TB+ sawtooth, with RANGE switch SW.A on 240 (120) miles.

*Clamp trigger delay*

**27.** Once more the procedure is for 250 c/s, with variations for 500 c/s in brackets.

(1) Trigger oscilloscope Type 13A from back edge of GWG drive by connecting sync lead to SK4 on TB140 unit and setting CRO TRIG SYNC switch SW.1 to +VE trigger. Display internal 10$\mu$s markers.

(2) Connect Y1 to SK9 and display clamp trigger " spike ".

(3) Set SW.A to 240 (120) miles.

(4) Check that the amplitude of the " spike " is within the limits 40–60V positive-going.

(5) Check that it occurs at 210 (120) $\mu$S from trace origin, adjusting, if necessary, the PULSE DELAY 240 (120) miles control RV9 (RV10).

(6) Set SW.A to 120 (240) miles, adjusting, if necessary, the PULSE DELAY 120 (240) miles control.

(7) Reset SW.A to 240 (120) miles.

*GWG drive and timebase bright-up—amplitude*

**28.** (1) Trigger CRO Type 13A or Cossor 1035 from sync output socket at bottom of master trigger unit.

(2) Connect Y1 to SK4 and display GWG drive waveform. Check that the amplitude of the square wave is within the limits 23 to 33V negative-going.

(3) Disconnect Y1 and connect A1 to SK7 and SK8 in turn to display RADAR BRIGHT-UPS 1 and 2.

(4) Check that the amplitude of each square wave is within the limits 1·85V to 2·45V positive-going.

*Final adjustment of timebase waveforms*

**29.** Before carrying out this check, it will be necessary to ensure that the resolver units associated with the radar heads Type 14, Mk. 8 and Mk. 9, have been correctly set up.

(1) Display 5-mile range rings on the monitor console and set the console RANGE control to 240 miles. Set the RADAR HEAD selector switch on the control desk to position 4 (250 c/s display).

(2) Select "A" and "B" 250 c/s timebase units alternately (SW.B on the panel, distribution and switching, Type 868) and check that the range rings are coincident for both timebases, adjusting if necessary, the VELOCITY FINE control on the "B" timebase unit.

(3) Leave the "A" 250 c/s timebase unit in service and select the "A" 500 c/s timebase unit.

(4) Set the HEAD COMBINE switch on the panel (control) Type 859 of the monitor console to ON and check that the range rings are coincident for both 500 c/s and 250 c/s timebase units, adjusting, if necessary, the VELOCITY FINE control on the "A" 500 c/s timebase unit.

(5) Select the "B" 500 c/s timebase unit and check that the range rings are coincident for both 500 c/s and 250 c/s timebase units, adjusting, if necessary, the VELOCITY FINE control on the "B" 500 c/s timebase unit.

**30.** If rotational facilities are not available, the four timebase units can be lined up by applying the timebase waveforms from each unit in turn direct to the "X" amplifying unit (RH) Type 313 in the monitor console and displaying the 5-mile range markers at the same time. For this purpose it is convenient to make up a change-over rig consisting of two coaxial leads to connect to sockets SK5 (TB+) of two TB140 units, and a change-over switch feeding a coaxial lead connected to SK4 (radar scan) of the amplifying unit Type 313. The "A" 250 c/s timebase unit is then taken as master and the timebase of this unit is applied to the console alternately with that from first the "B" 250 c/s unit and then the "A" and "B" 500 c/s units in turn. Operation of the change-over switch will enable the after-glow from the two sets of range markers to be compared and the VELOCITY FINE controls on the last three units adjusted to give coincidence with the master unit.

## RACK ASSEMBLY (RESOLVER MAGSLIP) TYPE 301

**Power unit Type 904**

**31.** This power unit gives three HT outputs, viz. :—+400V, +300V and −300V. Since the −300V uses the −500V for reference, while the +400V is referred to the −300V and the +300V is derived from the +400V, it is essential that the following setting-up sequence is maintained :—

(1) Ensure that the radar office powerboard switches are ON, then set power unit ON/OFF switch SW.A to ON, and selector switch SW.B to SET.

(2) Check that H.T. ON indicator lamp (LP6) comes on and wait approximately 20 secs. for neon LP5 (LOAD ON) to glow.

(3) Connect multimeter Type 100 to SK5 and select position FT.

(4) Adjust −300V SET (RV4) to give a reading of 3 (F.S.D.) on meter (i.e. 300V).

(5) Switch multimeter to BP and adjust +400V SET (RV1) to read 0·4 on the meter (i.e. 400V).

(6) Switch multimeter to DR and adjust +300V SET (RV2) to read 3 (F.S.D.) on the meter (i.e. 300V).

(7) Switch meter to ES and adjust SET CUT-OUT (RV3) for zero readings on the meter. This control is sluggish due to the long internal CR.

(8) Turn SW.B to CHECK. If the HT trips (LP5 and LP6 go out) repeat the preceding sequences. If it still trips the power unit is unserviceable.

(9) Assuming serviceability, remove the −300V fuse and check that the protective circuit operates and the power unit closes down, extinguishing LP5 and LP6.

(10) Replace fuse, set SW.B to SET and wait approximately 20 sec. for neon to glow.

(11) Set SW.B to LOAD and check with MMT.100 (positions FT, BP, DR respectively) that the −300V, +400V and +300V supply voltages are unaffected by the transfer to normal load conditions.

*Ripple check*

**32.** (1) Disconnect the timebase input plug from SK22 on the resolver unit associated with this power unit.

(2) Set the sensitivity of a calibrated Cossor oscilloscope Type 1035 to 50 mV, and connect A1 to the live side of C13 in the power unit.

(3) Check that the ripple present at this point (−300V rail) does not exceed 10 mV peak-to-peak.

(4) Repeat ripple check by connecting A1 to live side of C6 for the +400V rail and of C8 for the +300V rail.

(5) Disconnect CRO.

**Resolver unit (magslip)**

**33.** (1) Put SELSYN ON/OFF switch (SW.A) to OFF and with SK22 still disconnected, check meter readings with Multimeter Type 100, to Table 2.

**TABLE 2**

**Resolver unit (magslip)—meter readings**

| Valve | Socket letters and meter positions | | Scale | Current mA |
|---|---|---|---|---|
| V1B | SK15 | A – 0 | 3 | ·05 – 1·0 |
| V1A | | B – P | 30 | 5 –15 |
| V3 | | C – Q | 10 | 5·7 – 7·0 |
| V5 | | D – R | 100 | 23 –28 |
| V6 | | S – E | 10 | 4·4 – 5·8 |
| V7 | | T – F | 30 | 9 –16 |

(2) Unplug multimeter Type 100, reconnect SK22 and switch SELSYN ON/OFF switch to ON.

(3) Rotate magslip from associated head. Switch SELSYN ON/OFF switch to OFF and note that trace dimming relay (RLB) operates.

(4) By reference to the monitor console ensure that when the SELSYN ON/OFF switch is put to ON, the magslip automatically aligns on NORTH. (The backward looker Type 14 Mk. 8 automatically aligns on South).

**Amplifying unit (clamping and distribution) Type 504**

**34.** Unplug timebase input plug (SK22) and ensure that all other coaxial leads are connected. Plug in multimeter Type 100 and ensure that valve currents are within the limits given in Table 3.

**TABLE 3**

**Amplifying unit (clamping and distribution) Type 504—metal readings**

| Valve | Socket letters and meter positions | | Scale | Current mA |
|---|---|---|---|---|
| V1A | SK17 | O – A | 3 | 0·15 – 0·45 |
| V1B | | P – B | 10 | 4 – 8 |
| V3A | | Q – C | 10 | 4 – 7 |
| V3B | | R – D | 10 | 0·5 – 2 |
| V5 | | S – E | 30 | 7 –13 |
| V6 | | F – T | 30 | 6 –11 |
| V7 | | U – G | 30 | 5 –10 |
| V8A | | V – H | 3 | 0·75 – 1·35 |
| V8B | | W – J | 3 | 1·1 – 1·7 |
| V9 | | X – K | 10 | 3·6 – 5·6 |
| V12A | | Y – L | 3 | 0·4 – 0·6 |
| V12B | | Z – M | 3 | 0·3 – 0·6 |
| V13A | SK18 | A – O | 10 | 1·7 – 2·7 |
| V13B | | P – B | 10 | 5·2 – 7·4 |
| V14A | | Q – C | 3 | 0·75 – 1·35 |
| V14B | | R – D | 3 | 1·1 – 1·7 |
| V15 | | S – E | 10 | 3·6 – 5·6 |
| V18A | | T – F | 3 | 0·4 – 0·6 |
| V18B | | U – G | 3 | 0·3 – 0·6 |
| V19A | | H – V | 10 | 1·7 – 2·7 |
| V19B | | W – J | 10 | 5·2 – 7·4 |

*Rest levels*

**35.** (1) SK22 should still be unconnected.

(2) Connect CT38 (or multimeter Type 1), on the 250 mV (2·5V) range, between SK7 and earth.

(3) Adjust DC LEVEL SET X, COARSE (RV3) for zero on meter.

(4) If necessary, adjust DC LEVEL SET X, FINE (RV5) for zero on meter (multimeter Type 1 on 50$\mu$A range).

(5) Repeat for Y component. with meter connected between SK8 and earth, and adjusting DC LEVEL SET controls RV4 and RV6.

(6) Disconnect meter before replacing SK22.

**Note . . .**

*In the case of resolver units associated with remote Type 7 installations the X and X component rest levels are not set to earth, but to a specified voltage above or below earth depending on the co-ordinates of the remote site relative to the station centre.*

*Amplitude check*

**36.** The purpose of the sine and cosine amplifiers is to restore the amplitude lost in the resolver, that is, to ensure that the amplitudes of the output sawtooth waves (at maximum) are the same, at SK7 and SK8, as the input at SK22. Therefore the basis of this test is to measure the difference between amplitudes at SK22 and SK7 or SK8, using the test rig as in fig. 2, and to adjust for zero. Since it is essential for the amplifier gains to be the same in all units on the Station, to ensure coincidence of the range rings on change-over, the gain is initially adjusted individually in each amplifier, and then final adjustment is made by selecting one as master and adjusting the others during the head combining operation.

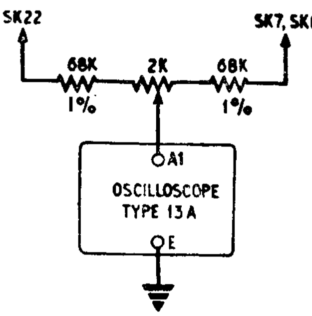


**Fig. 2. Bridge circuit**

GAIN X

**37.** (1) Trigger calibrated CRO Type 13A from the sync output socket at the bottom of the master trigger unit.

(2) Set Y PLATE SELECTOR switch to DC.

(3) Connect Y1 to SK7 and display X component waveform. Check that the waveform is a linear sawtooth, free from distortion, sweeping smoothly above and below earth, without any apparent shift of the rest level.

(4) Set SELSYN ON/OFF switch to OFF and locate exact negative maximum by rotating the magslip manually.

(5) Check this by transferring Y1 connection to SK8 and ensuring that Y component output is at minimum.

(6) Connect the bridge circuit (*fig.* 2) between SK22 and SK7, and disconnect the CRO from SK8.

**Note . . .**

1. *The exact centre point of the bridge should be preset before use, thus :—*

(*a*) *Connect 50V across the bridge and connect multimeter Type 1 (100 V range) between the potentiometer slider and one end.*

(*b*) *Adjust potentiometer to give 25V reading.*

(*c*) *Connect meter between centre tap and the other end, and check the adjustment.*

2. *A simpler bridge consisting of two 100K (1 per cent. tolerance) resistors may be used, so long as the same end is connected to SK22 for all tests.*

(7) Set Y PLATE SELECTOR to A1 A2 and connect CRO terminal A1 to the junction of the bridge.

(8) Set A1 GAIN control to maximum and check that the resultant sawtooth voltage appearing at this point has been set as close as possible to zero, adjusting, if necessary, the amplifying unit Type 504 GAIN X FINE control (RV7).

GAIN Y

**38.** (1) Find the maximum Y component waveform by manual rotation of the magslip, with SK8 connected to Y1, checking for minimum X component at SK7.

(2) Check for zero at the bridge junction, with the bridge across SK22 and SK8, and CRO A1 connected to the junction. Adjust GAIN Y FINE (RV8) if necessary.

(3) Disengage manual turning wheel and reset SELSYN ON/OFF switch to ON.

**39.** For the final adjustment it is convenient to use the " backward looking " head, Type 14, Mk. 8, as master, the associated resolver unit having been set up as described (*para.* 32-38).

(1) Display 5-mile range rings on monitor console Type 64.

(2) Set console RANGE selector (SW.A panel Type 859) to 240 miles.

(3) Set HEAD COMBINE switch to ON.

(4) Set RADAR HEAD selector switch, on the control desk, to the head associated with the resolver unit under test.

(5) Check that the range rings are coincident for " backward looking " and " forward looking " heads.

(6) If the rings do not coincide, recheck the resolver unit under test.

**Note . . .**

*This final test will not apply to the remote Type 7 resolver unit, as the range rings relating to it will be displaced a predetermined distance.*

## RACK ASSEMBLY (GATING WAVEFORM) TYPE 304

**Power unit Type 903**

**40.** These power units are identical with those in the RA300 and the setting-up procedure is identical with that given in para. 19. For the ripple voltage check (*para.* 20), the 250 c/s trigger input to SK3 and the 500 c/s timebase square-save to SK4 must be disconnected on the associated waveform generator.

**Waveform generator (gating waveform) Type 101**

**41.** With all coaxial leads connected and with SW.A on the panel (distribution and switching) Type 879 switched to the unit under test, check that all meter readings obtained with the multimeter Type 100 are within the limits given in Table 4. ◀(See also Appendix to this chapter.)▶

**TABLE 4**

**Waveform generator Type 101—meter readings**

| Valve | Socket letters and meter positions | | Scale | Current mA |
|---|---|---|---|---|
| V1A | SK17 | O – A | 10 | 4·5 – 5·7 |
| V2B | | P – B | 3 | 1·3 – 1·9 |
| V2A | | Q – C | 10 | 1·1 – 1·6 |
| V4 | | R – D | 3 | 0·6 – 0·9 |
| V5 | | S – E | 10 | 1·6 – 3·0 |
| V6A | | T – F | 3 | 1·9 – 2·7 |
| V7 | | U – G | 10 | 1·8 – 3·2 |
| V8A | | V – H | 3 | 1·8 – 2·5 |
| V9 | | W – J | 10 | 1·8 – 3·2 |
| V10B | | X – K | 3 | 1·3 – 1·9 |
| V12 | | Y – L | 3 | 0·5 – 0·8 |
| V14B | SK18 | O – A | 10 | 2·4 – 3·1 |
| V14A | | P – B | 3 | 0·3 – 0·5 |
| V16A | | Q – C | 10 | 5·1 – 8·6 |
| V16B | | R – D | 3 | 0·3 – 0·7 |
| V17 | | S – E | 10 | 1·2 – 3·1 |
| V19B | | T – F | 3 | less than 0·4 |
| V19A | | U – G | 10 | 4·9 – 5·9 |
| V21 | | V – H | 3 | 0·9 – 1·6 |
| V22 | | W – J | 3 | 0·9 – 1·6 |

***250 c/s gate***

**42.** (1) Trigger calibrated CRO Type 13A from the sync output socket at the bottom of the master trigger unit.

(2) Connect CRO Y2 monitor point X14 on marker unit Type 27 and display 10-mile range markers.

(3) Connect Y1 to MONITOR POINT 3 (SK11) on Type 101 unit and display gating square-wave (*fig.* 7, *Chap.* 3, *Sect.* 3, *Part* 1).

(4) Check width of positive-going square-wave (227 miles or 280$\mu$S) adjusting 250 C/S GATE (RV1), if necessary.

***Setting of bright-ups***

**43.** (1) Trigger CRO from SK12 (MONITOR POINT 2).

(2) Set TRIG SYNC on CRO to +VE trigger and display internal 10$\mu$ SEC calibration marks.

(3) Connect A1 to SK5 and display half bright-up waveform.

(4) Check width of squarewave to be 50 μS, adjusting BRIGHT-UP DURATION 2 control (RV4) if necessary.

(5) Change A1 connection to SK9 and display ITBU No. 1. Adjust BRIGHT-UP DURATION 1 (RV3) to give a pulse width of 100 μS.

(6) Check that amplitude is within the limits 4V to 6V positive-going.

(7) Connect A1 to SK10 and display ITBU No. 2. Check that amplitude of square-wave is between 4V and 6V positive-going.

*Positive and negative gates*

**44.** (1) Trigger CRO 13A from SK12 and display internal 10 μSEC CAL MARKERS.

(2) Connect Y1 to SK7 and display positive gate.

(3) Adjust BRIGHT-UP DELAY (RV2) to give a square-wave width of 270 μS.

(4) Check amplitude (30V to 40V positive-going).

(5) Transfer Y1 to SK6 and display negative gate. Check amplitude (29V to 39V negative-going).

*Azication drive*

**45.** (1) Trigger CRO 13A from SK12.

(2) Connect Y1 to SK8 and display azication drive.

(3) Check square-wave amplitude—15V to 25V negative-going.

**Distribution unit (gating)**

**46.** With all coaxial leads connected and panel (distribution and switching) Type 879 switched to the unit under test, check that all meter readings obtained with the multimeter Type 100 are within the limits given in Table 5.

**TABLE 5**

**Distribution unit (gating)—meter readings**

| Valve | Socket letters and meter positions | | Scale | Current mA |
|---|---|---|---|---|
| V1A | SK20 | O – A | 3 | 1·5 – 2·3 |
| V2 | | P – B | 3 | 1·2 – 2·6 |
| V3 | | Q – C | 3 | 0·1 – 3 |
| V4 | | R – D | 3 | 1·2 – 2·6 |
| V5 | | S – E | 3 | 0·1 – 3 |
| V6 | | T – F | 3 | 1·2 – 2·6 |
| V7 | | U – G | 3 | 0·1 – 3 |
| V8 | | V – H | 3 | 1·2 – 2·6 |
| V9 | | W – J | 3 | 0·1 – 3 |
| V10 | SK21 | O – A | 3 | 1·2 – 2·6 |
| V11 | | P – B | 3 | 0·1 – 3 |
| V12 | | Q – C | 3 | 1·2 – 2·6 |
| V13 | | R – D | 3 | 0·1 – 3 |
| V1B | | S – E | 10 | 2·8 – 4·7 |
| V14 | | T – F | 10 | 2·0 – 4·7 |
| V15 | | U – G | 3 | 0·1 – 3 |
| V16 | | V – H | 10 | 2·0 – 4·7 |
| V17 | | W – J | 3 | 0·1 – 3 |

**TABLE 5**—*cont.*

| Valve | Socket letters and meter positions | | Scale | Current mA |
|---|---|---|---|---|
| V18 | SK23 | O – A | 10 | 2·0 – 4·7 |
| V19 | | P – B | 3 | 0·1 – 3 |
| V20 | | Q – C | 10 | 2·0 – 4·7 |
| V21 | | R – D | 3 | 0·1 – 3 |
| V22 | | S – E | 10 | 2·0 – 4·7 |
| V23 | | T – F | 3 | 0·1 – 3 |
| V24 | | U – G | 10 | 2·0 – 4·7 |
| V25 | | V – H | 3 | 0·1 – 3 |

*Positive gates*

**47.** (1) Trigger CRO 13A from SK4 on gating waveform generator Type 101.

(2) Set TRIG SYNC to +VE trigger.

(3) Connect Y1 to SK5, 6, 7, 8, 9 and 10 in turn to display positive gates.

(4) Check amplitudes—28V to 38V positive-going.

(5) Select 1 μSEC CAL. MARKERS.

(6) Increase CRO scan velocity and check that the leading edge of each square-wave reaches 80 per cent. of its maximum value within 10 μS.

(7) Select 10 μSEC CAL. MARKERS. Check that the trailing edge falls to 20 per cent. of its maximum value within 10 μS.

*Negative gates*

**48.** (1) CRO as (1) and (2) para. 47.

(2) Connect Y1 to SK12, 13, 14, 15, 16 and 17 in turn and display negative gates.

(3) Check amplitudes (27V to 37V negative-going).

(4) Check leading and trailing edges as (5) to (7), para. 47.

**Panel (distribution and switching) Type 879**

**Note . . .**

*This operation is included here because the panel* 879 *is in the RA*304 *but it is, in fact, carried out after the alignment of the azication resolvers* (*para.* 53 (10)).

**49.** (1) Display azication mark on monitor console. Check that it is of uniform brilliance with clearly defined edges.

(2) Operate SW.A from "A" unit to "B" unit and check that the azication mark remains unaffected, except for a momentary flicker.

(3) Set the A/B (main/standby) switch on the panel (switching) Type 876 in the RA306 to the alternative position and check as in (2).

**RACK ASSEMBLY (AZICATION) TYPE 302**

**Power unit Type 905**

**50.** This power unit is similar in circuitry, though not in layout, to the power unit Type 904, and the same sequence for setting-up is followed (*para.* 31). For the ripple check (*para.* 32) the circuit references are different :—

(1) Disconnect drive input from SK17 on associated waveform generator.

(2) Set sensitivity of calibrated CRO (Cossor 1035) to 50 mV and connect A1 to live side of C11 (−300V rail) in the power unit. The ripple should not exceed 10 mV peak-to-peak.

(3) Repeat for +400V rail ; A1 to live side of C4. The ripple should not exceed 15 mV peak-to-peak.

(4) Repeat for +300V rail ; A1 to live side of C6. The ripple should not exceed 10 mV peak-to-peak.

(5) Disconnect CRO and reconnect SK17.

**Waveform generator (azication) Type 100**

*Meter readings*

**51.** (1) Set SW.A to EARTH and SW.B to TEST.

(2) With all connections made, check the meter readings, obtained with the multimeter Type 100, to Table 6.

**TABLE 6**
**Waveform generator (azication) Type 100—meter readings**

| Valve | Socket letters and meter positions | | Scale | Current mA |
|---|---|---|---|---|
| V1A | SK8 | O – A | 1 | 0·1 – 0·5 |
| V1B | | P – B | 3 | 1·5 – 2·5 |
| V2 | | Q – C | 10 | 3 – 5 |
| V3A | | R – D | 3 | 0·5 – 1·5 |
| V3B | | S – E | 3 | 0·5 – 1·5 |
| V4A | | U – G | 10 | 6·0 – 9·0 |
| V4B | | T – F | 10 | 0·6 – 2·0 |
| V5A | | W – J | 3 | 0·2 – 0·6 |
| V5B | | V – H | 3 | 0·2 – 0·6 |
| V6A | | X – K | 10 | 5 – 8 |
| V6B | | L – Y | 10 | 1·5 – 2·5 |
| V7A | SK13 | P – B | 3 | 0·2 – 0·6 |
| V7B | | O – A | 3 | 0·2 – 0·6 |
| V8A | | R – D | 10 | 5 – 8 |
| V8B | | C – Q | 10 | 1·5 – 2·5 |

*Rest levels*

**52.** (1) With SW.A to EARTH and SW.B to TEST, connect multimeter electronic Type CT38 (on 250 mV DC range), or multimeter Type 1 (on 2·5V range) between SK11 (MONITOR POINT 4) and earth.

(2) Adjust D.C. LEVEL SET PARAPHASE COARSE (RV5) and FINE (RV4) to give zero reading (i.e. rest level at earth). On multimeter Type 1 turn to 50 μA range for FINE adjustment.

(3) Connect multimeter between SK12 (MONITOR POINT 3) and earth. Check that the X component rest level is set to earth, adjusting D.C. LEVEL SET X COARSE (RV11) and FINE (RV6).

(4) Repeat for Y component ; SK16 (MONITOR POINT 1) ; D.C. LEVEL SET Y COARSE (RV8) and FINE (RV9).

(5) Set SW.A on the resolver unit to OPEN and SW.A on the waveform generator Type 100 to 25V.

(6) With multimeter on the 250 mV range between monitor point 1 (SK8) on the resolver unit and earth, check that this point (the electrical centre of the sine/cos pot.) is at earth, adjusting GAIN PARAPHASE (RV3) on the waveform generator.

(7) Disconnect meter and re-set SW.A on the resolver unit to EARTH.

*Balancing X and Y*

**53.** (1) Set waveform generator SW.A to 25V and SW.C to X.

(2) Connect multimeter (100V DC range) between SK15 (MONITOR POINT 2) and earth.

(3) Locate approximate X-component positive maximum by manually rotating sine/cos. pot. on resolver unit, then set SW.C to Y and adjust sine/cos. pot. for an accurate minimum, progressively increasing the sensitivity of the meter. This gives accurate X maximum.

(4) Disconnect meter and re-set SW.C to X.

(5) Set range of meter to 250 mV DC and connect between MONITOR POINTS 2 (SK15) and 5 (SK10).

(6) Check that the potential between these two points is zero, adjusting GAIN X control (RV7).

(7) Disconnect multimeter and set SW.C to Y. Accurately locate Y maximum as for X maximum, then leave SW.C on Y and disconnect meter.

(8) Check that potential between SK15 and SK10 is zero as in (5) and (6), adjusting GAIN Y control (RV10).

(9) Disconnect meter and re-set SW.B to NORMAL.

(10) Display the azication markers from resolvers 1, 2, 3 and 4 in turn on the monitor console, as in para. 49.

**RACK ASSEMBLY (MISC. ITBU) TYPE 306**

**Power unit Type 903**

**54.** The setting-up procedure for these units is given in para. 19. For the ripple check (*para.* 20) disconnect the ITBU input from SK12 on the associated distribution unit.

**Distribution unit (ITBU)**

**55.** (1) Terminate ITBU output to workshop SK19 (panel, switching, Type 876) with a 68-ohm resistor.

(2) With all leads connected and panel 876 switched to the unit under test, check multimeter Type 100 readings to Table 7.

(3) Trigger calibrated CRO Type 13A from MONITOR POINT 2 (SK12) on waveform generator (gating waveform) Type 101, with CRO TRIG SYNC on +VE trigger.

(4) Connect CRO A1 to SK3, 4, 5, 6, 7, 8, 9 and 10 in turn to display inter-trace bright-ups. Check that the amplitude of each square-wave is within the limits 4V to 6V positive-going.

**TABLE 7**
**Distribution unit (ITBU)—meter readings**

| Valve | Socket letters and meter positions | Scale | Current mA |
|---|---|---|---|
| V1A | SK13 O – A | 10 | 2·8 – 7·2 |
| V2 | P – B | 3 | 1·2 – 2·5 |
| V4 | Q – C | 3 | 1·2 – 2·5 |
| V5 | R – D | 3 | 1·2 – 2·5 |
| V7 | S – E | 3 | 1·2 – 2·5 |
| V8 | T – F | 3 | 1·2 – 2·5 |
| V10 | U – G | 3 | 1·2 – 2·5 |
| V11 | V – H | 3 | 1·2 – 2·5 |
| V13 | W – J | 3 | 1·2 – 2·5 |

**Panel (switching) Type 876**

**56.** This will already have been tested in accordance with para. 49 (3).

**Relay unit (azication change-over) Type 192**

**57.** Check that, by operation of the AZICATION MARK key switches on the control desks of each associated pair of consoles Type 64, all azication facilities can be transferred from the main azicating console to the standby.

**58.** On stations where a "stop-and-look" console is installed :—

(1) Set STOP-AND-LOOK/MONITOR switch to MONITOR.

(2) By operation of the AZICATION MARK key on both the monitor and the stop-and-look consoles, check that the monitor console has over-riding selection and control of the azication mark.

(3) Operate switch to STOP-AND-LOOK and check that the stop-and-look console now has over-riding selection and control of the azication marks.

## RACK ASSEMBLY (BULK POWER SUPPLY) TYPE 305

**59.** No HT is supplied from this rack unless at least one of the consoles in the group supplied by the rack is switched on.

**60.** (1) Switch on one of the consoles supplied by the rack.

(2) Put the main switch (on relay unit Type 184) to ON.

(3) Check that the time delay operates within the limit of 55 sec. to 65 sec. and that it brings on the +420V, —470V and +570V supplies as indicated on the built-in meter on the stabilizer unit Type 100.

(4) Switch on all consoles in the group and check that HT services are present.

*+420V rectifier Type 100*

**61.** (1) Check the +420V rectifier output is within the limits of 400V to 435V, with all consoles in the group switched on.

(2) Set the sensitivity of the Cossor Type 1035 oscilloscope to 15V and connect to +420V test socket on the relay unit Type 184. The ripple should not exceed 12·6V peak-to-peak.

(3) Switch off all consoles except one and check that the voltage rise does not exceed 22V.

*Stabilizer (voltage) Type 100*

**62.** (1) Switch all consoles supplied by the rack to ON.

(2) Turn the selector switch on the relay unit Type 184 to each 250V output in turn. In the stabilizer unit, adjust RV1 to RV6, as appropriate, to give voltage readings of 250V.

(3) Check the anode currents for each pair of valves Type CV345 on the built-in meter. The ratio of the currents in these valves should not exceed 2 : 1 and the sum of the currents for each pair should be within the limits 190 mA to 310 mA.

(4) Set the sensitivity of the Cossor Type 1035 oscilloscope to 50 mV. Connect, in turn, the lower potential end of R4, R19, R33, R49, R64 and R79 to A1. The ripple should not exceed 50 mV peak-to-peak.

*+570V rectifier Type 101*

**63.** (1) Check on the built-in meter that the output voltage is within the limits of 558V – 626V with one console ON, and 558V – 603V with all consoles in the group ON.

(2) Set the sensitivity of the Cossor Type 1035 oscilloscope to 15V. Connect to the 570V test socket on the relay unit Type 184. The ripple should not exceed 11·4V peak-to-peak.

*—470V rectifier Type 102*

**64.** (1) Check (on the built-in meter) that the output voltage is within the limits of 466V and 528V with one console ON and 466V and 500V with all consoles in the group ON.

(2) Set the sensitivity of the Cossor Type 1035 oscilloscope to 15V and connect to —470V test socket on relay unit Type 184. The ripple should not exceed 9·4V peak-to-peak.

## SETTING-UP USING THE WAVEFORM MONITOR

**65.** For correct setting-up it is essential that the sequence of operations should be in the order given in the following paragraphs. Reference to the front panel label of the indicating unit Type 4064 (*fig.* 13, *Chap.* 1, *Sect.* 4, *Part* 1) will show that the monitoring facilities are divided into two main headings, viz.:—WAVEFORM INSPECTION and SETTING-UP. This division allows a quick check to be made that waveforms (illustrated in *fig.* 1 *Chap.* 2, *Sect.* 2, *Part* 1) are available before any accurate setting-up is undertaken. In addition to the waveform monitor rack Type 339, a multimeter Type 100 and a calibrated CRO are required. The RA339 tests are summarized in Table 9 at the end of this chapter.

#### Sampling procedure

**66.** Since the sampling facilities of the amplifying unit Type 515 are used for much of the setting-up procedure a general note on sampler operation follows :—

(1) Unless otherwise specified, the SELECTOR switch (SW.A) of the amplifying unit should first be set to EARTH and the SAMPLER GAIN (SW.C) to LOW.

(2) The SAMPLER REFERENCE (FINE) control (RV2) should now be adjusted until a display (*waveform* (*q*) or (*r*)) is obtained. Although the nature of the transients cannot be predicted, the flat portion of the trace, between the transients, known as the " sampled period ", should move up and down as RV2 is varied ; this flat portion should be adjusted until it is in line with the beginning of the trace.

(3) Switch SAMPLER GAIN to HIGH and repeat the adjustment (known as "zeroing" the sampler).

(4) Set SELECTOR switch to SIGNAL and adjust the appropriate control of the unit under test until the sampler is again " zeroed ".

(5) To measure the extent of the displacement of the sampled period from the reference voltage, set SELECTOR switch to CAL. and CAL. switch (SW.B) to O, then zero the sampler.

(6) With SELECTOR still on CAL. operate CAL. switch to a calibration voltage, e.g., +0·01V; a displacement of the sampled period corresponding to this voltage is obtained and may be used for estimating the displacement of the signal.

### RACK ASSEMBLY (NEGATIVE REFERENCE) TYPE 338

**67.** The waveform monitor has no application in this rack and the setting-up is as described in para. 13–17.

### RACK ASSEMBLY (TIMEBASE) TYPE 300

#### Power unit Type 903

**68.** This unit is set up as described in para. 19–20.

#### Timebase unit Type 140

**69.** The initial setting-up and checking with the multimeter Type 100 is performed as described in para. 21–24. The waveforms (*fig.* 1, *Chap.* 2, *Sect.* 2, *Part* 1) are then displayed on the monitor CRO in the RA339 by operation of CABINET SELECTOR SWA and WAVEFORM SELECTOR SW.B on the panel Type 890.

*Rest levels*

**70.** (1) Display timebase positive rest level on the waveform monitor (SW.A/7 and 8, SW.B/1 and 7, *waveform* (*q*)). The monitor trace commences at the end of the inter-trace or rest period and the sampled portion is bounded by transients.

(2) Check that the rest level has been set to earth (i.e., the sampled portion is level with the start of the trace), adjusting, if necessary, the T.B. ZERO SET controls (COARSE RV2 and FINE RV3) on the front of the relevant TB140 unit.

(3) Repeat for –VE S/T REST LEVEL (S.W.A/7 and 8, S.W.B/2 and 8), adjusting AMP. ZERO SET COARSE (RV8) and FINE (RV7).

*250 c/s units*

**71.** (1) Set TB140 RANGE SW.A to 240 miles.

(2) Display +VE SAWTOOTH (SW.A/1 and 2, SW.B/7, *waveform* (*f*)). Check that the waveform is a linear sawtooth free from distortion or ringing.

(3) Display timebase VELOCITY waveform (SW.A/7 and 8, SW.B/9, *waveform* (*r*)). Check that the velocity as indicated by the sampler is correct (i.e., the sampled portion between the transients is level with the rest of the trace). If necessary, adjust timebase VELOCITY controls (COARSE RV1, FINE RV11) on the TB140.

**Note . . .**
*About 10 mV of hum is apparent on the sampled period and the mean of its extremes should be taken for zero adjustment.*

(4) Display timebase DURATION waveform (SWA/7 and 8, SW.B/10 *waveform* (*s*) ). Select 10-MILE range marks (SW.E on TB141 unit) and check that the duration of the square-wave is 245 miles, adjusting the TB140 RANGE SET 240 miles control (RV5).

(5) Display RES. CLAMP TRIGGER (SW.A/1 and 2, SW.B/12 *waveform* (*j*) ). Check that the amplitude of the trigger pulse is between 40V and 60V positive-going.

(6) Select 10/50 $\mu$ SECS on SW.E of the TB141 and check that the spike occurs at 210 $\mu$S from the scan origin. Adjust PULSE DELAY 240 miles control (RV9) on TB140, if necessary.

*500 c/s units*

**72.** (1) Set TB140 RANGE SW.A to 120 miles.

(2) Display +VE SAWTOOTH (SW.A/1 and 2, SW.B/1 *waveform* (*a*) ) and check that it is linear and free from distortion or ringing.

(3) Display VELOCITY waveform (SW.A/7 and 8, SW.B/3, *waveform* (*r*)) and check that it is correct ; if necessary, adjust TB140 VELOCITY controls (see *Note* to *para.* 71 (3)).

(4) Display DURATION waveform (SW.A/7 and 8, SW.B/4, *waveform* (*s*)). Select 10-MILE calibration marks and adjust the timebase square-wave duration to 122·5 miles by means of RANGE SET 120 control (RV4).

(5) Display RES. CLAMP TRIGGER (SW.A/1 and 2, SW.B/6, *waveform* (*e*)). Check that the amplitude of the trigger " spike " is within the limits 40V to 60V, positive-going.

(6) Select 10/50 $\mu$ SECS calibration marks and check that the spike occurs at 120 $\mu$S from the scan origin. Adjust PULSE DELAY 120 (RV10), if necessary.

*Radar bright-ups*

**73.** (1) Display in turn 500 c/s BRIGHT-UP NO. 1 and NO. 2 (SW.A/1 and 2, SW.B/3 and 4, *waveform* (*c*)). Check that the amplitude of each square-wave is within the limits 1·85V to 2·45V positive-going.

(2) Repeat for 250 c/s BRIGHT-UP NO. 1 and NO. 2 (SW.A/1 and 2, SW.B/9 and 10, *waveform* (*h*)).

*Linearity*

**74.** (1) Display waveforms from each TB140 unit in turn (SW.A/7 and 8, SW.B/5 and 11, *waveform* (*t*)).

(2) Set SELECTOR switch on video unit Type 515 to SIGNAL and adjust LINEARITY control (RV7) on this unit until a waveform of the general form of (*t*) is obtained.

(3) Check that the period between transients starts and finishes on the horizontal CRT graticule line.

(4) Check that the degree of non-linearity (indicated by the amount of negative or positive "bowing") does not exceed 2 cm.

*Paraphase gain*

**75.** (1) Display waveforms from each TB140 unit in turn (SW.A/7 and 8, SW.B/6 and 12, waveform (*u*)).

(2) Set SELECTOR switch to SIGNAL and SAMPLER GAIN to HIGH.

(3) Adjust AMP. BAL. (paraphase gain control RV6) on the TB140 unit until there is no slope during the trace period of the displayed waveform.

*Final test*

**76.** When the other rack assemblies have been set up, so that a display can be made on the monitor console Type 64, checks on velocity and amplitude are made as follows :—

(1) Display 5-mile range rings on the monitor console and set console RANGE control to 240 miles.

(2) Set RADAR HEAD selector switch to position 4 (250 c/s display).

(3) Select "A" and "B" 250 c/s timebase units alternately on SW.B of panel 868 at the base of RA300, and check that the two sets of range rings coincide. If not, re-check the TB140 units to para. 70, then use the "A" unit as master for checking "B" unit. Finally, leave the "A" unit in service.

(4) Select the "A" 500 c/s timebase unit and set the HEAD COMBINE switch on the monitor console to ON.

(5) Check that the range rings are coincident for both the 250 c/s and 500 c/s "A" timebase units. If not, re-check the 500 c/s unit to para. 71, adjusting it to agree with the 250 c/s unit.

(6) Select the "B" 500 c/s unit and check for coincidence with the "A" 250 c/s unit, adjusting the 500 c/s unit, if necessary.

## RACK ASSEMBLY (RESOLVER MAGSLIP) TYPE 301

**Power unit Type 904**

**77.** The RA339 is not used here and the procedure follows para. 31–32.

**Resolver unit (magslip)**

**78.** The initial procedure follows para. 33 ; the RA.339 checks, described in para. 80 to 83, indicate setting-up errors in the complete resolver sequence.

**Amplifying unit (clamping and distribution) Type 504**

**79.** The valve readings are checked to Table 3, para. 34 and, with the resolvers working normally, the waveforms are displayed on the RA339 monitor CRO (SW.A/6, SW.B/1 to 12, *waveform* (*p*)). The checks (SW.A/9 to 11, SW.B/1 to 12) outlined in the following paragraphs are carried out on each resolver in turn.

*Rest levels (SW.A/9 and SW.B/1 to 12)*

**80.** (1) Zero the sampler (*para.* 66).

(2) Display "X" component rest level and, with magslip rotating, check that the mean rest level has been set to earth (movement of the sampled period with magslip rotation should not exceed $\pm 12 \cdot 5$ mV), adjusting if necessary, the DC LEVEL SET X FINE control (RV5).

(3) Repeat for "Y" component, adjusting DC LEVEL SET Y FINE (RV6).

**81.** (1) When the resolver unit is associated with a remote Type 7, the "X" and "Y" component rest levels will not be set to earth, but to a specified voltage either above or below earth, depending on the co-ordinates of the remote site relative to the Station centre.

(2) Check that the "X" component rest level has been set to the correct voltage for the Station by setting the SELECTOR switch (SW.A), on the RA339 video unit Type 515, to REMOTE X (assuming the reference voltage on this switch position has been set up correctly) and adjusting, if necessary, the DC LEVEL X FINE control (amplifying unit Type 504).

(3) Repeat for "Y" component, referring to REMOTE Y on the video unit Type 515 SELECTOR switch and adjusting the Type 504 unit DC LEVEL Y FINE control.

*Amplifier gains*

**82.** (1) Display resolver "X" component (SW.A/6, SW.B/1, 3, 5, 7, 9 and 11) and check that the waveform (*p*) is a linear saw-tooth free from distortion, sweeping smoothly above and below earth.

(2) Set SELSYN ON/OFF switch on the resolver unit to OFF.

(3) Select resolver "X" AMPLITUDE on the RA339 (SW.A/10, SW.B/1, 3, 5, 7, 9 and 11) and zero the sampler.

(4) Turn SELECTOR to SIGNAL on 515 unit and locate the exact positive maximum (i.e., point of highest positive displacement of the sampled period) by rotating the magslip manually.

(5) With SELECTOR on SIGNAL, re-zero the sampler as shown in the illustration of waveform (*r*) (i.e., bring the sampled portion in line with the rest of the trace) by adjusting the GAIN X FINE control on the amplifying unit Type 504, with the video unit Type 515, SAMPLER GAIN at HIGH.

(6) Repeat (1) to (5) for the " Y " component (SW.A/6, SW.B/2, 4, 6, 8, 10 and 12) for sawtooth displays and SW.A/10, SW.B/2, 4, 6, 8, 10 and 12 for AMPLITUDE checks). Adjust GAIN Y FINE control.

*Checking resolved timebase linearity*

**83.** (1) With the resolved waveform at maximum amplitude (*para.* 82 (4)), turn to LINEARITY check (SW.A/11, SW.B/1 to 12), *waveform* (*x*)).

(2) Adjust the 515 unit LINEARITY control until the start and end of the trace period lie along the horizontal axis of the CRT screen.

(3) The departure of the trace from this axis during the radar scan period gives a measure of non-linearity. This should be checked regularly for deterioration.

**Note . . .**

*Before carrying out the tests (para. 82 and 83) on the unit associated with the remote Type 7, the " X " and " Y " components rest levels must be set temporarily to earth.*

## RACK ASSEMBLY (HEAD SELECTOR) TYPE 184

**Setting-up head selector waveforms**

**84.** Provision is made, when the H.S. cabinets are selected (S.W.A/12 to 17, SW.B/1 to 4), for setting-up the rest levels of the resolved timebase waveforms at the outputs of the H.S. units.

(1) Inspect the waveforms on SW.V/1 and 2.

(2) Display the REST LEVELS (S.W.B/3) and adjust the DC levels of the H.S. outputs.

(3) Display the AMPLITUDES waveforms (SW.B/4) and adjust the GAIN controls of the H.S. amplifiers, following the procedure given in para. 82.

## RACK ASSEMBLY (GATING WAVEFORM) TYPE 304

**Power unit Type 903**

**85.** The RA339 is not used for setting-up the power unit ; refer to para. 19 and 40.

**Waveform generator (gating waveform) Type 101**

**86.** (1) For meter reading checks refer to para. 41 and Table 4.

(2) Check the width of the GATING SQUARE-WAVE as outlined in para. 42.

*Bright-up waveforms*

**87.** (1) Display HALF BRIGHT-UP (panel Type 890 SW.A/3 and SW.B/5 and 11, *waveform* (*l*)).

(2) Select 10/50 μSECS calibration marks (TB141 unit) and check that the square-wave has been set to 50 μS, adjusting, if necessary, the BRIGHT-UP DURATION 2 control (RV4).

(3) Display ITBU No. 1 (SW.A/3, SW.B/3 and 9, *waveform* (*k*)).

(4) Check that the width of the square-wave is 100 μS, adjusting the BRIGHT-UP DURATION 1 control (RV3) if necessary.

(5) Check that the amplitude of the waveform is within the limits of 4V to 6V, positive-going.

(6) Display ITBU No. 2 (SW.A/3, SW.B/4 and 10, *waveform* (*k*)).

(7) Check that the amplitude is within the limits of 4V to 6V, positive-going.

*Gating waveforms*

**88.** (1) Display +VE GATES (S.W.A/4 and 5, SW.B/1 to 6 *waveform* (*n*)).

(2) Select 10/50 μSECS calibration marks.

(3) Adjust BRIGHT-UP DELAY control (RV2) to give a square-wave length of 270 μS.

(4) Check that the amplitude is within the limits of 28V to 38V, positive-going (disparity from 30V to 40V limits, quoted in *para.* 44, due to line losses).

(5) Display –VE GATES (SW.A/4 and 5, SW.B/7 to 12, *waveform* (*o*)).

(6) Check that the square-wave amplitudes are within the limits of 27V to 37V, negative-going.

*Azication drive*

**89.** (1) Display AZ. MARK DRIVE (SW.A/3, SW.B. /6 and 12, *waveform* (*m*)).

(2) Check that the amplitude of the square-wave is within the limits of 15V to 25V, negative-going.

**Distribution unit (gating)**

**90.** Meter checks are carried out as outlined in para. 46 and Table 5.

*Positive gates*

**91.** (1) Display +VE GATES 1 to 6 in turn (SW.A/4 and 5, SW.B/1 to 6).

(2) Check that the amplitude of each square-wave is within the limits 28V to 38V, positive-going.

(3) Select 10/50 μ SECS calibration marks.

(4) Check that the leading edge of each square-wave reaches 80 per cent. of its maximum value within 10 μS.

(5) Check that the trailing edge falls to 20 per cent. of its maximum value within 10 μS.

*Negative gates*

**92.** (1) Display –VE GATES 1 to 6, in turn (SW.A/4 and 5, SW.B/7 to 12).

(2) Check that the amplitude of each square-wave is within the limits 27V to 37V, negative-going.

(3) Select 10/50 μ SECS calibration marks and check that the leading edge of each square-wave reaches 80 per cent. of its maximum value within 10 μS.

(4) Check that the trailing edge falls to 20 per cent. of its maximum value within 10 μS.

**Panel (distribution and switching) Type 879**

**93.** (1) Display AZICATION MARK on monitor console.

(2) Check that the mark is of uniform brilliance and that the edges are clearly defined.

(3) Switch SW.A from "A" unit to "B" unit and check that the azication mark remains unaffected except for a momentary interruption.

(4) Set the A/B (*main/standby*) switch on the panel Type 876 in the RA306 to the alternative position and re-check as above.

## RACK ASSEMBLY (AZICATION) TYPE 302

**94.** Waveforms (*v*) and (*w*) are not yet available on switch positions SW.A/18, 19 and SW.B/7, 8, pending the fitting of the panel Type 4448 to the RA302. Refer to para. 50 to 53 for setting-up instructions.

## RACK ASSEMBLIES TYPE 306 AND TYPE 305

**95.** The monitor rack has no application here; refer to para. 54–64.

## RACK ASSEMBLY (WAVEFORM MONITOR TYPE 339—SETTING-UP AND TESTING

**External connections**

**96.** The waveform monitor rack will be connected to the equipment and supplies in the radar office, as listed in Table 8.

**TABLE 8**
**Connections to RA339**

| Panel (distribution) Type 891 | | External connections |
|---|---|---|
| **Multi-pin connections** | | |
| PL1 | A | Neutral } 230V, |
| | B | Line } 50 c/s |
| | C | —500V Ref. RA338 |
| | D | Negative } 50V Rectifier unit |
| | E | Positive } Type 15 |
| | F | —50V control for —500V RA338 |
| PL2 | A to F | As PL1 above |
| PL3 | A to F | As PL1 above |
| PL4 | D | Negative } 50V Rectifier unit, |
| | E | Positive } Type 15 |
| SK5 | | PL66—Panel 868, RA300—TB |
| SK6 | | PL67—Panel 868, RA300—TB |
| SK7 | | PL60—Panel 877, RA301 (A) —Res. |
| SK8 | | PL61—Panel 877, RA301 (A) —Res. |
| SK9 | | PL60—Panel 877, RA301 (B) —Res. |
| SK10 | | PL61—Panel 877, RA301 (B) —Res. |
| SK11 | | PL56—Panel 879, RA304 —GWG |
| SK12 | | PL57—Panel 879, RA304 —GWG |
| **Coaxial connections** | | |
| SK14 | | SK23—Panel 868, RA300—TB |
| SK15 | | SK1—Panel 877, RA301 (A) —Res. |
| SK16 | | SK1—Panel 877, RA301 (B) —Res. |
| SK17 | | SK19—Panel 879, RA304 —GWG |
| SK18 | | Head selector RA184, No. 1, wander lead |
| SK19 | | Head selector RA184, No. 2 wander lead |

**TABLE 8**—*cont.*

| Panel (distribution) Type 891 | External connections |
|---|---|
| SK20 | Head selector RA184, No. 3 wander lead |
| SK21 | Head selector RA184, No. 4 wander lead |
| SK22 | Head selector RA184, No. 5 wander lead |
| SK23 | Head selector RA184, No. 6 wander lead (not usually wired) |
| SK24 | 250 c/s MTP (incoming)—Master trigger unit |
| SK25 | 250 c/s MTP (outgoing) to RA304 |
| SK26 | SK15—Panel 868, RA300 —Radar BU 2B |
| SK27 | SK5—Panel 868, RA300 —Radar BU 1B |
| SK28 | 10-mile range marks—IG Rack |
| SK29 | 70 ohms termination—line terminating unit Type 34 |
| SK47 | SK48—Panel 878, RA302 (B) —Azic. |
| SK48 | SK48—Panel 878, RA302 (A) —Azic. |

**97.** For setting-up the rack assembly Type 339 the multimeter Type 1, the multimeter Type 100, the multimeter, electronic, Type CT38 and the Cossor oscilloscope Type 1035 will be required. Before proceeding with the setting-up and testing of the rack assembly the equipment listed in Table 8 should have been set up as described earlier in this chapter under the heading "*Setting-up and testing without use of waveform monitor*". Accurate setting-up of all the associated units is not essential for the purposes of the tests, but the delay units Type 31 associated with

(1) 250 c/s and 500 c/s sync to the RA300;

(2) 250 c/s sync to the range marker unit Type 27, should have been correctly set up.

**Initial conditions**

**98.** (1) *Panel (distribution) Type* 891—MAINS switch (SW.B) ON.

(2) *Power units Type* 4065—MAINS switches (SW.A) and rotary switches (S.W.B) to OFF.

(3) *Panel (control) Type* 890—selector switch SW.A to position 22 (MANUAL). 50V switch (SW.C) to ON.

(4) *Monitoring unit Type* 102—BRILLIANCE control (RV2) turned fully counter-clockwise.

(5) *Panel, indicating, Type* 4064. Check the operation of the indicator lamps (LP1 to LP6) labelled TIMEBASE and GWG, by switching the change-over switches to A and B units in turn, on panel (distribution) Type 868 (SW.A and SW.B) for RA300 units and panel (distribution) Type 879 (SW.A) for RA304 units, to ensure that the appropriate lamps light up.

#### Power unit Type 4065

**99.** This series of operations is carried out on each power unit in turn.

(1) Set MAINS 230V SW.A to ON and SW.B to SET.

(2) Check that HT indicator lamp (LP6) comes ON and wait approximately 20 seconds for neon LP5 (SET-CHECK) to glow.

(3) Connect multimeter Type 100 to SK2 and select position TF. Check that the negative supply has been set to —300V and adjust RV4 (—300V SET), if necessary.

(4) Select position BP on the multimeter and check that the positive 400V supply has been set correctly; adjust RV1 (+400V SET), if necessary.

(5) Select position DR on the multimeter and check that the positive 300V supply has been set correctly; adjust RV2 (+300V SET) if necessary.

(6) Select position ES on the multimeter. Adjust RV3 (SET CUT-OFF) for zero volts (this control is sluggish due to long internal time constant).

(7) Set SW.B to CHECK; neon LP5 should remain ON. Ensure that the protective circuit operates by removing the —300V fuse (FS5). The power unit should close down, extinguishing neon LP5 and the HT ON indicator LP6.

(8) Replace fuse FS5 after 30 seconds. Set SW.B to SET and wait for neon LP5 to glow. Wait ten seconds and set SW.B to CHECK; the neon should remain ON.

(9) Set SW.B to LOAD. The HT ON LP6 should remain ON and the SET-CHECK LP5 should be extinguished.

(10) Select positions TF, DR, and BP in turn on the multimeter and check that the —300V, +300V and +400V supply voltages are unaffected by transfer to normal load conditions.

**100.** With selector SW.A on the panel (control) Type 890 in position 22, and the sensitivity of the calibrated Cossor oscilloscope Type 1035 adjusted to 50 millivolts, connect terminal A1 on the CRO to the live side of C13 (i.e., the —300V rail) in the power unit. Check that the ripple present at this point does not exceed 10 millivolts peak-to-peak. Repeat the check for the +300V and +400V rails by connecting A1 to the live sides of C8 and C6, respectively, ensuring that the ripple does not exceed 10 mV peak-to-peak in each case. Disconnect the CRO at the completion of the test.

### MONITORING UNIT TYPE 102

**101.** With the panel Type 890 SW.A still in position 22 and the power unit rotary switches on LOAD;—

(1) Turn the BRILLIANCE control (RV2) clockwise until a spot is visible on the monitor CRO screen.

(2) Adjust the SHIFT controls, RV3 and RV4, until the spot is displayed near the centre of the tube face. Ensure that the spot can be focused and that it remains reasonably well focused when the shift controls are adjusted over their complete range of travel.

(3) Depress the meter switch (SW.A) and ensure that the pointer of the meter can be deflected by more than 90 per cent. of the F.S.D. in both directions by adjustment of the Y SHIFT control. Ensure that the spot moves along the Y axis of the screen a distance of 1·3 to 2·0 centimetres for half the F.S.D. of the meter, in both directions, when the Y SHIFT control is adjusted accordingly. Clockwise rotation of the Y SHIFT control should move the spot upwards and the meter pointer should be deflected in a clockwise direction.

(4) Check that the clockwise rotation of the X SHIFT control moves the spot to the right of the tube face and that counter-clockwise rotation moves the spot to the left.

(5) Set the VIDEO GAIN control (SW.D) on the amplifying unit Type 515 to the LOW, MEDIUM and HIGH positions in turn and check that the 50V, 12·5V and 5V indicator lamps (LP1 to LP3) on the monitor unit light up in the same sequence.

#### Timebase unit Type 141

**102.** (1) Set the CABINET SELECTOR switch SW.A on the panel (control) Type 890 to position 1, and the WAVEFORM SELECTOR switch SW.B to position 7 to display the 250 c/s positive sawtooth from TB140 unit "A".

(2) Adjust the BRILLIANCE control on the monitoring unit Type 102 until the waveform displayed is of normal brightness. Ensure that no flyback is visible. If necessary adjust RV8 (BU amplitude) on the TB unit. Some further adjustment of the BRILLIANCE control may then be required.

(3) With the Y SHIFT control on the monitoring unit Type 102 set so that the horizontal portion of the waveform lies along the centre reference line of the CRT graticule, check that the trace begins and ends as near as possible to the periphery of the CRT screen. If necessary, adjust the X SHIFT control on the monitoring unit for correct position, and adjust the T.B. AMPLITUDE control (RV6) on the TB141 unit for correct length of trace.

(4) Check the linearity of the trace by switching to 10-MILE pips and checking that they are evenly spaced.

*Internal calibration marks*

**103.** (1) Set the WAVEFORM SELECTOR SWB to position 12 (SW.A still on position 1) to display the TB140 unit "A", 250 c/s resolver clamp trigger waveform.

(2) Set the CALIBRATOR switch (SW.E) on the TB141 unit to the 10/50 μ SECS. position and check that blackout markers at 10 μ sec. intervals with more prominent markers at 50 μ sec. intervals, sufficiently distinct for operational use, are displayed on the CRT. If the 50 μ sec. markers do not count exactly five 10 μsec. markers, RV11 should be adjusted.

(3) If necessary, adjust RV10 to set the amplitude of the 10 μ sec. markers and RV12 to set the amplitude of the 50 μ sec. markers, after which a further adjustment of the BRILLIANCE control and RV8 may be required.

(4) Check that the 10 and 50 μ sec. markers are spaced evenly along the horizontal axis of the trace, as judged by eye.

(5) Set the WAVEFORM SELECTOR SWB to positions 10 and 12 alternately and check that both the waveforms displayed are of a suitable operational brightness. If not, repeat the adjustments of the BRILLIANCE and RV8 controls.

*Frequency of internal calibration markers*

**104.** (1) Set the CABINET SELECTOR SWA to position 22. Remove the plug connector (ref. 0502) carrying the 250 c/s MTP, which mates with SK2 in the TB141 unit and, using a back-to-back type of connector and an extension lead, connect this plug to SK5 (EXT. SYNC.).

(2) Set the *sync* and *delay* selector switch (SW.D) to +VE and the T.B. RANGE switch (SW.C) to position 5.

(3) Set the CALIBRATOR switch (SW.E) to the 10 MILE position.

(4) Adjust the T.B. VELOCITY control (RV7) until approximately 80 miles of trace is displayed on the monitoring unit.

(5) Mark on the CRT mask the position of the sixth 10-mile range mark. Set the CALIBRATOR SW.E to 10/50 μ SECS. and check that this mark occurs at 740 μ secs. ± 10 μ secs. from the start of the trace.

*Manual checks*

**105.** With CABINET SELECTOR SWA still in position 22, the TB141 SW.D still on +VE and SK5 connected to SK2 on the TB141 :—

(1) Turn the VELOCITY control (RV7) on the TB unit fully counter-clockwise and check that a timebase is available for positions 1 to 8 of SW.C (T.B. RANGE), increasing in duration in eight stages from approximately 50 μ sec. to approximately 35 μ sec.

(2) Check the duration of each timebase by the appropriate calibration markers control position (for slower scans operate SW.E to the 10 MILE position).

(3) With T.B. RANGE switch to position 2 and SW.E to 10 MILE markers, set SW.D to +VE D1 and turn the MANUAL DELAY control RV1) fully counter-clockwise.

(4) Turn the MANUAL DELAY control clockwise until the trace appears. Check that at least five 10-mile markers cross the tube face from right to left as the control is rotated. Jitter on the 10-mile markers should not exceed 5 μ sec.

(5) With T.B. RANGE to position 2 and SW.E to 10 MILE markers, set SW.D to +VE D2, and turn the MANUAL DELAY control fully counter-clockwise.

(6) Turn the control clockwise until the trace appears. Check that at least seventeen 10-mile markers cross the tube face from right to left as the control is rotated. Jitter on the 10-mile markers should not exceed 5 μ sec.

(7) Disconnect the 250 c/s BU lead (0404) from SK4 in the video unit Type 515 and connect it to the EXT. SYNC. SK5 in the TB141 unit (instead of the 250 c/s MTP input).

(8) Check on −VE, −VE D1 and −VE D2 positions of SWD (with DELAY control in mid-position) that the circuit will trigger from the negative edges of the BU waveform.

(9) At the completion of the tests replace the 250 c/s MTP connector mating with SK2 in the TB141 unit, and the 250 c/s BU connector mating with SK4 in the video unit.

*Automatic operation*

**106.** Set the CABINET SELECTOR SWA to position 3 and the WAVEFORM SELECTOR SWB to position 1. Check that a trace of approximately 500 μ sec. is displayed as measured by the 10 and 50 μ sec. markers. Check that these markers are evenly spaced along the length of the trace, as judged by eye.

**Note . . .**

(1) *References to waveforms in the following paragraphs apply to fig. 1, Chap. 2, Sect. 2, Part 1.*

(2) *To cater for Stations having 250 c/s units only, the test instructions are, in general, given for these units.*

*Delay settings*

**107.** 3·5 μ SECS.

(1) Set the WAVEFORM SELECTOR SWB to position 3 (SWA still in position 3 also) to display the inter-trace BU No. 1 waveform (*k*) (from the GWG "A").

(2) Adjust the 3·5 μ SECS delay preset RV2 until the BU starts 400 μS from the beginning of the trace (250 c/s operation). 500 c/s BU PIP shown on waveform (*k*) is not applicable.

(3) Check that the horizontal jitter on the inter-trace BU waveform is less than 5 μS.

**108.** 350 μ SECS (only applicable to 500 c/s Stations).

(1) Set the CABINET SELECTOR SWA to position 7 and the WAVEFORM SELECTOR SWB to position 1 (*waveform* (*q*)).

(2) Turn the SELECTOR SW.A on the amplifying unit Type 515 to EARTH.

(3) Set SAMPLER GAIN (SW.C) to LOW.

(4) Check that the gated portion of the trace occurs at the end of the inter-trace period. If necessary, adjust the 350 μ SECS delay control.

**109.** 1300 μ SECS.

(1) Set WAVEFORM SELECTOR SWB to position 3 for 500 c/s unit or to position 9 for 250 c/s. A waveform as in fig. 1 (*r*) should be displayed.

(2) Ascertain, from the indicating lamps on panel Type 4064, which 500 c/s (or 250 c/s, where applicable) TB140 unit is not operating. Set the CABINET SELECTOR SWA either to position 7 or position 8 (whichever corresponds to the non-operational TB140 unit) and the WAVEFORM SELECTOR SWB to position 4 (or 10) to display the radar BU waveform from the non-operational TB140 unit.

(3) Set the TB141 calibrator switch (SW.E) to 10 MILE and adjust the appropriate RANGE SET control on the non-operational TB140 unit so that the positive-going portion of the BU waveform, displayed on the monitor CRO, has a width corresponding to 115 miles (or 230 miles) as measured by the 10-mile range marks (*fig.* 1 (*s*)).

(4) Set the SELECTOR SW.A of amplifying unit 515 to SIGNAL and WAVEFORM SELECTOR SWB to position 3. Check that the gated portion of the trace, displayed on the CRO, is divided into two approximately equal parts (*fig.* 1 (*y*)).

(5) If necessary, adjust 1300 μ SECS (delay control RV4) until the corrected gated waveform is obtained.

(6) Set the WAVEFORM SELECTOR SWB to position 4 (or 10) and re-adjust the RANGE SET control on the non-operational TB140 unit until the positive-going portion of the BU waveform displayed has a width corresponding to 122·5 miles (or 245 miles) as measured by the 10-mile range marks.

**110.** 790 μ SECS.

(1) Set the WAVEFORM SELECTOR SWB to position 7, the SELECTOR switch on the 515 unit to EARTH and the calibrator switch on the TB141 unit to 10/50 μ SECS.

(2) Check that the gated portion of the trace occurs at the end of the inter-trace period. If necessary, adjust the 790 μ SECS. control (RV3).

### Amplifying unit (video) Type 515

**111.** Connect the multimeter Type 100 to SK17 and set the selector switch on the multimeter to position KX. Check that the super-regulated supply has been set to +300V, adjusting the +300V SET control (RV8) if necessary.

*Deflection sensitivity*

**112.** (1) Set the CABINET SELECTOR SWA to position 22.

(2) Set the Y SHIFT control (monitoring unit 102) until the meter reads zero (PRESS SWITCH TO READ)

(3) Set the VIDEO GAIN SW.D on the amplifying unit to $\phi_1$ (LOW) and connect the front panel SK5 ($\phi_1$) to earth.

(4) Remove plugs PL13 and PL14 at the rear and connect multimeter Type 1 (set to the 100V DC range) between sockets SK13 and SK14 (video amplifier output).

(5) Check that the meter reading is zero, adjusting the VIDEO CENTERING control (RV9), if necessary.

(6) Disconnect the multimeter and replace PL13 and PL14.

*Zeroing the sampler and adjusting GATE WIDTH*

**113.** (1) Set the CABINET SELECTOR SWA to position 7 or 8 and the WAVEFORM SELECTOR SWB to position 3 (*waveform* (*r*)).

(2) Set the SAMPLER REFERENCE (FINE) control (RV2) to the middle of its traverse.

(3) Set the SAMPLER GAIN SW.C to LOW.

(4) Set the calibrator switch on the TB141 unit to 10/50 μ SECS.

(5) Check that the width of the displaced gated portion of the trace, as displayed on the CRO, is 100 μ sec. as measured by the blackout markers. If necessary, adjust the GATE WIDTH control (RV6).

(6) With the SELECTOR SW.A at EARTH, adjust the SAMPLER REFERENCE (COARSE) control (RV1) until the gated portion of the trace is level with the remainder of the trace.

(7) Re-adjust with the SAMPLER gain switch set to HIGH.

*Balancing the sampler*

**114.** (1) Switch OFF the 10/50 μ SECS. calibration and check that about fifty per cent. of the sampled period is horizontal.

(2) If necessary, adjust RV10 (anode circuit of V1 and V2) inside the 515 unit. This will make re-adjustment of the SAMPLER REFERENCE controls necessary.

*Sampler tests*

**115.** (1) Set the SELECTOR SW.A to CAL. and with the CAL. switch (SW.B) on the amplifying unit Type 515 set to O, check that the gated portion of the trace is still level with the remainder of the trace.

(2) Set the CAL. switch in turn to −0·01V and +0·01V. Check that the sampled portion moves more than 4 mm. downwards and upwards respectively.

**116.** Set SAMPLER GAIN to LOW and CAL. to +0·1V and −0·1V in turn and check that deflections within ± 1 mm. of those obtained in the para. 115 (2) test are obtained.

**117.** (1) Set CABINET SELECTOR SWA to position 9 and SWB to a position from 1 to 12, as appropriate, to select a remote Type 7 "X" or "Y" component.

(2) Set SELECTOR to SIGNAL and zero the sampler.

(3) Switch to REMOTE "X" or REMOTE "Y", as appropriate, and check that the sampler is still zeroed, adjusting RV3 (X) or RV4(Y).

(4) Check that the rest levels of this resolver have been set to the voltages specified (depending on the remote aerial position) by measuring the voltages between the potentiometer sliders and earth, using a multimeter, electronic, Type CT38.

*Slope correction*

**118.** (1) Set SELECTOR (video 515) to EARTH and SAMPLER GAIN to HIGH.

(2) Set CABINET SELECTOR SWA (Panel 890) to position 7 or 8 to select a non-operational timebase unit Type 140 in the RA300 and set WAVEFORM SELECTOR SWB to position 7.

(3) Zero the sampled portion of the trace by turning the SAMPLER REFERENCE (FINE) control.

(4) Switch SELECTOR to SIGNAL and adjust the rest level on the selected TB140 unit until the sampled portion is again zero.

(5) Set WAVEFORM SELECTOR SWB to position 9.

(6) Set SELECTOR to EARTH and re-adjust SAMPLER REFERENCE (FINE) control until the sampled portion is again zeroed.

(7) Set SELECTOR to SIGNAL and, with SAMPLER GAIN switch to HIGH, check that the sampled portion is again level with the rest of the trace, adjusting if necessary, the VELOCITY controls of the TB140 unit and the SLOPE CORRECTION control (RV5) of the amplifying unit Type 515.

*Linearity*

**119.** With the CABINET SELECTOR SWA at position 7 or 8 as in para. 118 (2), select position 11 on the WAVEFORM SELECTOR SWB. Turn the Type 515 unit SELECTOR switch to SIGNAL and ensure that the waveform displayed is as in fig. 1 (t), adjusting, if necessary, the LINEARITY (RV7) and Y SHIFT (monitoring unit Type 102) controls.

**Note . . .**

*The character of the transients of this waveform cannot be predicted and the figure diagram is a simplification.*

*Amplifier checks*

**120.** (1) Set the CABINET SELECTOR SWA to either position 1 or position 2, depending on which TB140 unit is non-operational, as in the previous tests.

(2) Turn WAVEFORM SELECTOR SWB to position 7 and check, using the built-in meter on the monitoring unit Type 102 (operating PRESS TO READ switch), that the amplitude of the timebase waveform (*fig.* 1(*f*)) is 49V to 53V.

(3) Turn WAVEFORM SELECTOR SWB to position 9. Check the amplitude of the displayed waveform (*fig.* 1(*h*)). This should be 1·85V to 2·45V positive-going.

(4) Set CABINET SELECTOR SWA to position 3 and WAVEFORM SELECTOR SWB to position 9. This displays the inter-trace BU waveform (*fig.* 1 (*k*)). Check the amplitude of the waveform displayed against the built-in meter. The amplitude should be 4V to 6V.

(5) Set CABINET SELECTOR SWA to position 6 and WAVEFORM SELECTOR SWB to display a 250 c/s resolved sawtooth waveform (switch positions 1 to 12) as shown in fig. 1 (*p*). Check that the waveform does not suffer distortion when the Y SHIFT control is adjusted.

**Overall tests**

**121.** (1) Set the six toggle switches (SWD to SWJ) inside the panel Type 890 in such positions as corresponds with the operating recurrence frequency of the resolver units in the rack assemblies Type 301.

(2) Make an overall check to ensure that the main services of the rack assembly Type 339 are correctly provided, as indicated in Table 9, for all positions of the two switches (SWA and SWB) of the panel, control Type 890.

**Note . . .**

*It is not necessary that all the associated units should be accurately set up for the purpose of these tests.*

**TABLE 9**

**Rack assembly Type 339—overall tests**

| Panel Type 890 SWA | SWB | Waveforms (Fig. 1, Chap. 2, Sect. 2, Part 1) | Remarks |
|---|---|---|---|
| | | | Where no other remarks are made, inspect waveforms and compare with diagrams. |
| 1 and 2 | 1 | (a) | |
| | 2 | (b) | |
| | 3 and 4 | (c) | |
| | 5 | (d) | |
| | 6 | (e) | Set SW.E (TB141) to 10/50 μ SECS. and check blackout markers. |
| | 7 | (f) | |

| Panel Type 890 SWA | SWB | Waveforms (Fig. 1, Chap. 2, Sect. 2, Part 1) | Remarks |
|---|---|---|---|
| 1 and 2 | 8 | (g) | |
| (*cont.*) | 9 and 10 | (h) | |
| | 11 | (i) | No waveform displayed. |
| | 12 | (j) | |
| 3 | 3, 4, 9 and 10 | (k) | |
| | 5 and 11 | (l) | Check 10/50 μ SECS. markers. On 500 c/s units check 500 C/S BU PIP MARKER. |
| | 6 and 12 | (m) | |
| 4 and 5 | 1 to 6 | (n) | |
| | 7 to 12 | (o) | |
| 6 | 1 to 12 | (p) | Check that the amplitudes of the W/F vary with rotation of the resolvers in rack assembly 301. Check that the horizontal portion of the trace does not move. |
| 7 and 8 | 1 and 2 | (q) | Set SW.A (SELECTOR) of amplifying unit 515 to EARTH. Adjust REF. FINE control to obtain W/F as in fig. diagram. Check sampler delay (350 or 790 μ SECS.). Set to SIGNAL and recheck that W/F is displayed on all settings of SAMPLER GAIN control. A slight, damped oscillation may be observed in the sampled period. Check, on CAL., that the rest level is within 10 mV. |
| | 3 and 9 | (r) | On amplifying unit Type 515 set SELECTOR switch to EARTH, zero sampler by REF. FINE control. Set SAMPLER GAIN to LOW and then set SELECTOR to SIGNAL. Check waveform. The polarity of the transients cannot be predicted. (It may be necessary to reset the FINE VELOCITY control of the associated TB140.) |
| | 4 and 10 | (s) | Check timebase DURATION. |
| | 5 and 11 | (t) | Set SELECTOR switch to SIGNAL and adjust the LINEARITY control (amp. unit 515) and SHIFT control (mon. unit 102) to obtain this waveform. |
| | 6 and 12 | (u) | The presets (RV1 and RV2) in panel (dist. and switching) Type 868 must be off-set slightly to verify this waveform and should be reset after test. |
| 9 | 1 to 12 | (q) | Set SELECTOR switch to EARTH. Set SAMPLER GAIN to HIGH, on amp. unit 515 and zero the sampler. Set to SIGNAL. Check that movement of the sampled portion does not exceed ± 12·5 mV. |
| 10 | 1 to 12 | (r) | Input waveform set to a maximum by turning appropriate resolver. Also note SW.A/7, SW.B/3. |
| 11 | 1 to 12 | (x) | Input waveform set to a maximum. See SW.A/7, SW.B/5. |
| RA 184, No. 1 12 | 1 | (p) | Sawtooth waveform (wanderlead of rack assembly 184, No. 1 plugged to X16 on a HS Unit). |
| | 2 | (c) | 500 c/s radar bright-up waveform (plugged to X5 on a HS Unit). |
| | 3 | (q) | Sawtooth waveform REST LEVEL. |
| | 4 | (r) | Sawtooth waveform VELOCITY. |

**TABLE 9** *(contd.)*

| Panel Type 890 SWA | SWB | | Waveforms (Fig. 1, Chap. 2, Sect. 2, Part 1) | Remarks |
|---|---|---|---|---|
| RA 184, No. 2 | | | | |
| 13 | 1 to 4 | As for RA 184, No. 1 | | |
| RA 184, No. 3 | | | | |
| 14 | 1 to 4 | As for RA 184, No. 1 | | |
| RA 184, No. 4 | | | | |
| 15 | 1 to 4 | As for RA 184, No. 1 | | |
| RA 184, No. 5 | | | | |
| 16 | 1 to 4 | As for RA 184, No. 1 | | |
| RA 184, No. 6 | | | | |
| 17 | 1 to 4 | As for RA 184, No. 1 | | |
| *18 and 19 | 7 | — | (v) | Set the SAMPLER GAIN control on the amplifying unit to HIGH and set the unit selector switch in the distribution unit of the rack assembly Type 302 to select a W/F generator unit (azi. marker) which has been correctly set up. Set the GAIN and SEQUENCE switches of this distribution unit to positions 4 and 1 respectively. Set the switches on the W/F generator and its associated resolver unit as follows :—<br>TEST/NORMAL to TEST, E/25V to E (W/F gen.)<br>Selsyn to OFF, Sine/Cos/pot to OPEN (res. unit.)<br>The paraphase zero preset of the W/F generator shall be slightly offset to verify that the waveform in fig. 1 (v) is displayed and then returned to its correct setting. |
| | 8 | | (w) | The condition should be as above with the exception that the TEST/NORMAL switch on the W/F generator should be set to NORMAL and the sequence switch of the distribution unit to set position 6. |

*These tests cannot be carried out until the panel (dist. and switching) Type 4888 has been fitted to the rack assembly Type 302.

## APPENDIX

**122.** The information on setting-up the waveform generator (gating) Type 101, given in para. 41, applies only to stations on mixed 500 c/s and 250 c/s working. On "250 c/s only" stations, and stations operating with a p.r.f. of 270 c/s, the readings in Table 4 do not apply. The appropriate readings are as follows :—

| Valve | Socket letters and meter positions | Scale (mA) | Current (mA) 250 c/s | 270 c/s |
|---|---|---|---|---|
| V1A | SK17 O–A | 10 | 4·5–5·7 | 4·5–5·7 |
| V2B | P–B | 3 | zero | zero |
| V2A | Q–C | 10 | 3·6–5·4 | 3·6–5·4 |
| V4 | R–D | 3 | 1·0–1·4 | 0·8–1·2 |
| V5 | S–E | 10 | 1·5–2·9 | 1·5–2·9 |
| V6A | T–F | 3 | 1·9–2·8 | 1·5–2·8 |
| V7 | U–G | 10 | 1·8–3·3 | 1·8–3·3 |

| Valve | Socket letters and meter positions | Scale (mA) | Current (mA) 250 c/s | 270 c/s |
|---|---|---|---|---|
| V8A | V–H | 3 | 1·8–2·5 | 1·8–2·5 |
| V9 | W–J | 10 | 1·8–3·3 | 1·8–3·3 |
| V10B | X–K | 3 | 1·3–1·9 | 1·3–1·9 |
| V12 | Y–L | 3 | 0·5–0·8 | 0·5–0·9 |
| V14B | SK18 O–A | 10 | 2·4–3·1 | 2·3–3·1 |
| V14A | P–B | 3 | 0·4–0·7 | 0·4–0·7 |
| V16A | Q–C | 10 | 4·9–8·5 | 4·9–8·5 |
| V16B | R–D | 3 | 0·4–0·9 | 0·5–1·0 |
| V17 | S–E | 10 | 1·2–3·1 | 1·2–3·1 |
| V19B | T–F | 3 | less than 0·4 | less than 0·4 |
| V19A | U–G | 10 | 4·9–5·9 | 4·9–5·9 |
| V21 | V–H | 3 | 0·9–1·6 | 1·0–1·8 |
| V22 | W–J | 3 | 0·9–1·6 | 1·0–1·8 |

These readings are taken with no trigger pulse to SK3, 250 c/s or 270 c/s timebase square wave to SK4, as appropriate, the link LK1 across R23 removed and the intertrace bright-up delay set to 250 μS.

**123.** In the case of the distribution unit (gating) and the waveform generator (azication) Type 100 the effect of the increased gate length (350 μS) is small enough to be included within the tolerance on the figures given in para. 46 and 51, respectively. There is no effect at all in the case of the distribution unit (ITBU), for which readings are given in Table 7 (*para.* 55).

**124.** When stations are set up to operate on a p.r.f. of 270 c/s the meter readings for the timebase unit Type 140 differ from those given in Table 1 (*para.* 23). The readings for the resolver unit (magslip) in Table 2 and for the amplifying unit Type 504 (*Table* 3) still apply. The 270 c/s p.r.f. meter readings for the timebase unit Type 140 are as follows :—

| Valve | Socket letters and meter positions | | Scale (mA) | Current (mA) 270 c/s |
|---|---|---|---|---|
| V1A | SK14 | P – B | 10 | 4·7 – 6·5 |
| V3 | | Q – C | 10 | 3·7 – 5·0 |
| V4 | | R – D | 10 | 0·6 – 1·4 |
| V5B | | S – E | 10 | 1·7 – 4·0 |
| V5A | | T – F | 10 | 0·6 – 6·5 |
| V6B | | U – G | 3 | 0·9 – 1·4 |
| V6A | | V – H | 3 | 0·5 – 1·2 |
| V8 | | W – J | 10 | 3·0 – 5·4 |
| V9 | | X – K | 30 | 10·5 – 13·8 |
| V10B | | Y – L | 3 | 0·5 – 1·2 |
| V10A | | Z – M | 3 | 0·9 – 1·4 |
| V11 | SK15 | O – A | 10 | 3·1 – 5·7 |
| V12 | | P – B | 30 | 18·2 – 22·2 |
| V14 | | Q – C | 30 | 14 – 23 |
| V15 | | R – D | 30 | 14 – 23 |
| V16B | | S – E | 10 | 3·9 – 4·8 |

# Appendix 1

# FIXED-COIL RADAR OFFICE EQUIPMENT (PHASE 1A)

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## SETTING UP USING THE WAVEFORM MONITOR

**1.** For correct setting up it is essential that the sequence of operations should be in the order given in this appendix. In addition to the rack (monitor) 16505 a multimeter Type 100 (Ref. No. 10S/16576) a multimeter electronic Type CT 38 and a calibrated oscilloscope Type 13A or a Cossor Type 1035 are required. Reference to the front-panel label of the indicating unit 4064B (Part 1, Sect. 4, Chap. 1, App. 5) shows that the monitoring facilities are divided into two main headings: namely WAVEFORM INSPECTION and SETTING UP. This division allows a quick check to be made that the waveforms illustrated in Part 1, Sect. 2, Chap. 2, App. 1 are available.

## RACK (MONITOR) 16505

### Amplifying unit (video) Type 515C

**2.** (1) Connect the multimeter Type 100 to SKT17. Set the SELECTOR switch on the multimeter to position K. Check that the positive supply has been set to +300V, adjusting if necessary the +300 SET control. Remove the multimeter.

(2) *Deflection sensitivity.*—Set the CABINET SELECTOR switch SA on the panel (W/F selector) 16504 to position 23. Set the Y-Shift control on the monitoring unit Type 102 until the meter reads zero (press the switch to read). Set the VIDEO GAIN switch on the amplifying unit to ø 1 LOW and connect SKT5 (ø 1) to earth. Remove plugs PL13 and PL14. Connect the multimeter Type 100, set to the 100V D.C. range, between sockets 13 and 14. Check that the meter reading is zero, adjusting if necessary the VIDEO CENTRING control. Disconnect the multimeter and replace PL13 and PL14.

(3) Set the CABINET SELECTOR switch SA to position 4 or 5, the P.R.F. SELECTOR switch to Q C/S. Set the SAMPLER REFERENCE (FINE) control to the middle of its traverse. Set the SAMPLER GAIN switch to LOW.

(4) Set the CALIBRATOR switch on the timebase unit Type 141B to 10/50 $\mu$ SEC. Check that the width of the gated portion of the trace displayed is 100 microseconds as measured by the blackout markers. If necessary adjust the GATE WIDTH control. With the SELECTOR SWITCH on the amplifying unit at EARTH, adjust the SAMPLER

REFERENCE (COARSE) control until the gated portion of the trace is level with the remainder of the trace. Reset the SAMPLER GAIN switch to HIGH.

(5) Switch the CALIBRATOR switch to OFF. Check that about 50 per cent of the sampled portion is horizontal, adjusting if necessary RV10 inside the amplifying unit. This will require re-adjustment of the SAMPLER REFERENCE controls.

(6) Set the SELECTOR SWITCH to CAL. and with the CAL. switch on the amplifying unit set to 0, check that the gated portion of the trace is still level with the remainder of the trace. Set the CAL. switch in turn to —0·01v and +0·01v. Check that the sampled portion moves more than 4 mm downwards and upwards respectively. Record the amount of movement.

(7) Set the SAMPLER GAIN to LOW and set the CAL. to +0·1v and —0·1v and check that deflections within ±1 mm of that obtained in the previous paragraphs are now obtained.

(8) *Slope correction.*—Set the SELECTOR switch to EARTH, set the SAMPLER GAIN to HIGH and the NORMAL/L.R. TIMEBASE switch SK to NORMAL. Set the CABINET SELECTOR switch SA on panel (W/F selector) 16504 to position 4 or 5 to select a non-operational timebase unit Type 140A and the WAVEFORM SELECTOR on the same panel to position 7. Zero the sampled portion of the trace by means of the SAMPLER REFERENCE (FINE) control. Set SELECTOR switch to SIGNAL and adjust the rest level of the selected timebase unit until the sampled portion is again zero. Set the WAVEFORM SELECTOR switch SB to position 9. Set the SELECTOR switch to EARTH, re-adjust the SAMPLER REFERENCE (FINE) control until the sampled portion is again zeroed. Set the SELECTOR switch to SIGNAL and, with the SAMPLER GAIN switch to HIGH, check that the mean of the sampled portion is again level with the remaining portion of the trace, adjusting if necessary the VELOCITY controls of the timebase unit Type 140A and the SLOPE CORRECTION control of the amplifier 515C.

(9) Set SK on the amplifier 515C to L.R. TIMEBASE and P.R.F. SELECTOR switch on the panel 16504 to P C/S. Repeat the procedure detailed in para. 2 (8) adjusting the timebase rest-level with the WAVEFORM SELECTOR in position 1, and the time-base velocity with the WAVEFORM SELECTOR in position 3. It will be necessary to reset the SLOPE CORRECTION control.

### Timebase unit Type 141B

**3.** (1) *Internal calibration marks.*—Set the CABINET SELECTOR switch to position 1 and WAVEFORM SELECTOR switch to position 12 to display the 240-miles resolver clamp trigger waveform.

(2) Set the CALIBRATION switch on the timebase unit to 10/50 μ SEC and check that 10 and 50 microseconds blackout markers, sufficiently distinct for operational use, are displayed. If the counting of the 10 microsecond marks is incorrect, RV11 should be adjusted. If necessary adjust RV10 and RV12 to set the amplitudes of the 10 and 50 microsecond markers respectively; a further adjustment of the brilliance control and of RV8 may then be necessary.

(3) Check that the 10 and 50 microsecond markers are spaced evenly along the horizontal axis of the trace, as judged by eye.

(4) *Frequency of internal calibration markers.*—Set the CABINET SELECTOR switch A to position 23. Remove PL2 from the timebase unit Type 141B (SKT2) and, by means of an F and E back-to-back connector and extension lead, connect the plug to SKT5 (ext. sync). Set the EXT. SYNC. & DELAY SELECTOR switch to +VE and the T.B. RANGE switch to position 5. Set the CALIBRATOR switch to 10 MILE.

(5) Adjust the timebase T.B. VELOCITY control until approximately 80 miles of trace is displayed on the monitoring unit. Mark on the c.r.t. mask the position of the sixth 10-mile range mark. Set the CALIBRATOR switch to 10/50 μ SEC and check that this mark occurs at 740 microseconds ±10 microseconds from the start of the trace. Restore PL2 to normal.

(6) Set the CABINET SELECTOR switch SA to position 7 and the WAVEFORM SELECTOR switch SB to position 11. Check that a trace of approximately 750 microseconds is displayed, as measured by the 10 and 50 microseconds markers. Check that these markers are evenly spaced along the length of the trace, as judged by eye.

(7) *Timebase delay setting (P c/s).*—Set the CABINET SELECTOR switch SA to position 7, the WAVEFORM SELECTOR switch SB to position 1 or 2 and the P.R.F. SELECTOR switch SC to P C/S. Set SA on the panel (distribution and switching, marker sequence) to position 1. Check that the gating waveform displayed commences 50 microseconds from the start of the trace, adjusting if necessary RV2 (P C/S T.B. DELAYS).

(8) *Timebase delay setting (Q c/s).*—As in paragraph 3 (7), setting the CABINET SELECTOR switch SA to position 9, the P.R.F. SELECTOR SC to Q C/S, and adjusting RV14 (Q C/S T.B. DELAYS).

(9) *Sampler delays.* Set the CABINET SELECTOR switch SA to position 4, the WAVEFORM SELECTOR switch SB to position 1, and the SELECTOR switch on the amplifying unit to EARTH. Zero the sampled portion of the trace and set the SELECTOR switch to SIGNAL and the SAMPLER GAIN to LOW. Set the P.R.F. SELECTOR switch SC to P C/S, and SK on the amplifying unit to L.R. TIMEBASE. Check that the gated portion of the trace occurs at the end of the intertrace period. Adjustment beyond the end of the intertrace period, by means of the P C/S SAMPLER DELAYS control, is observed by a change in shape of the sampled portion. Reset the control accordingly.

# Appendix 1

# FIXED-COIL RADAR OFFICE EQUIPMENT (PHASE 1A)

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## SETTING UP USING THE WAVEFORM MONITOR

**1.** For correct setting up it is essential that the sequence of operations should be in the order given in this appendix. In addition to the rack (monitor) 16505 a multimeter Type 100 (Ref. No. 10S/16576) a multimeter electronic Type CT 38 and a calibrated oscilloscope Type 13A or a Cossor Type 1035 are required. Reference to the front-panel label of the indicating unit 4064B (Part 1, Sect. 4, Chap. 1, App. 5) shows that the monitoring facilities are divided into two main headings: namely WAVEFORM INSPECTION and SETTING UP. This division allows a quick check to be made that the waveforms illustrated in Part 1, Sect. 2, Chap. 2, App. 1 are available.

## RACK (MONITOR) 16505

### Amplifying unit (video) Type 515C

**2.** (1) Connect the multimeter Type 100 to SKT17. Set the SELECTOR switch on the multimeter to position K. Check that the positive supply has been set to +300V, adjusting if necessary the +300 SET control. Remove the multimeter.

(2) *Deflection sensitivity*.—Set the CABINET SELECTOR switch SA on the panel (W/F selector) 16504 to position 23. Set the Y-Shift control on the monitoring unit Type 102 until the meter reads zero (press the switch to read). Set the VIDEO GAIN switch on the amplifying unit to ø 1 LOW and connect SKT5 (ø 1) to earth. Remove plugs PL13 and PL14. Connect the multimeter Type 100, set to the 100V D.C. range, between sockets 13 and 14. Check that the meter reading is zero, adjusting if necessary the VIDEO CENTRING control. Disconnect the multimeter and replace PL13 and PL14.

(3) Set the CABINET SELECTOR switch SA to position 4 or 5, the P.R.F. SELECTOR switch to Q C/S. Set the SAMPLER REFERENCE (FINE) control to the middle of its traverse. Set the SAMPLER GAIN switch to LOW.

(4) Set the CALIBRATOR switch on the timebase unit Type 141B to 10/50 μ SEC. Check that the width of the gated portion of the trace displayed is 100 microseconds as measured by the black-out markers. If necessary adjust the GATE WIDTH control. With the SELECTOR SWITCH on the amplifying unit at EARTH, adjust the SAMPLER

REFERENCE (COARSE) control until the gated portion of the trace is level with the remainder of the trace. Reset the SAMPLER GAIN switch to HIGH.

(5) Switch the CALIBRATOR switch to OFF. Check that about 50 per cent of the sampled portion is horizontal, adjusting if necessary RV10 inside the amplifying unit. This will require re-adjustment of the SAMPLER REFERENCE controls.

(6) Set the SELECTOR SWITCH to CAL. and with the CAL. switch on the amplifying unit set to o, check that the gated portion of the trace is still level with the remainder of the trace. Set the CAL. switch in turn to —0·01v and +0·01v. Check that the sampled portion moves more than 4 mm downwards and upwards respectively. Record the amount of movement.

(7) Set the SAMPLER GAIN to LOW and set the CAL. to +0·1v and —0·1v and check that deflections within ±1 mm of that obtained in the previous paragraphs are now obtained.

(8) *Slope correction.*—Set the SELECTOR switch to EARTH, set the SAMPLER GAIN to HIGH and the NORMAL/L.R. TIMEBASE switch SK to NORMAL. Set the CABINET SELECTOR switch SA on panel (W/F selector) 16504 to position 4 or 5 to select a non-operational timebase unit Type 140A and the WAVEFORM SELECTOR on the same panel to position 7. Zero the sampled portion of the trace by means of the SAMPLER REFERENCE (FINE) control. Set SELECTOR switch to SIGNAL and adjust the rest level of the selected timebase unit until the sampled portion is again zero. Set the WAVEFORM SELECTOR switch SB to position 9. Set the SELECTOR switch to EARTH, re-adjust the SAMPLER REFERENCE (FINE) control until the sampled portion is again zeroed. Set the SELECTOR switch to SIGNAL and, with the SAMPLER GAIN switch to HIGH, check that the mean of the sampled portion is again level with the remaining portion of the trace, adjusting if necessary the VELOCITY controls of the timebase unit Type 140A and the SLOPE CORRECTION control of the amplifier 515C.

(9) Set SK on the amplifier 515C to L.R. TIMEBASE and P.R.F. SELECTOR switch on the panel 16504 to P C/S. Repeat the procedure detailed in para. 2 (8) adjusting the timebase rest-level with the WAVEFORM SELECTOR in position 1, and the time-base velocity with the WAVEFORM SELECTOR in position 3. It will be necessary to reset the SLOPE CORRECTION control.

**Timebase unit Type 141B**

**3.** (1) *Internal calibration marks.*—Set the CABINET SELECTOR switch to position 1 and WAVEFORM SELECTOR switch to position 12 to display the 240-miles resolver clamp trigger waveform.

(2) Set the CALIBRATION switch on the timebase unit to 10/50 μ SEC and check that 10 and 50 microseconds blackout markers, sufficiently distinct for operational use, are displayed. If the counting of the 10 microsecond marks is incorrect, RV11 should be adjusted. If necessary adjust RV10 and RV12 to set the amplitudes of the 10 and 50 microsecond markers respectively; a further adjustment of the brilliance control and of RV8 may then be necessary.

(3) Check that the 10 and 50 microsecond markers are spaced evenly along the horizontal axis of the trace, as judged by eye.

(4) *Frequency of internal calibration markers.*—Set the CABINET SELECTOR switch A to position 23. Remove PL2 from the timebase unit Type 141B (SKT2) and, by means of an F and E back-to-back connector and extension lead, connect the plug to SKT5 (ext. sync). Set the EXT. SYNC. & DELAY SELECTOR switch to +VE and the T.B. RANGE switch to position 5. Set the CALIBRATOR switch to 10 MILE.

(5) Adjust the timebase T.B. VELOCITY control until approximately 80 miles of trace is displayed on the monitoring unit. Mark on the c.r.t. mask the position of the sixth 10-mile range mark. Set the CALIBRATOR switch to 10/50 μ SEC and check that this mark occurs at 740 microseconds ±10 microseconds from the start of the trace. Restore PL2 to normal.

(6) Set the CABINET SELECTOR switch SA to position 7 and the WAVEFORM SELECTOR switch SB to position 11. Check that a trace of approximately 750 microseconds is displayed, as measured by the 10 and 50 microseconds markers. Check that these markers are evenly spaced along the length of the trace, as judged by eye.

(7) *Timebase delay setting (P c/s).*—Set the CABINET SELECTOR switch SA to position 7, the WAVEFORM SELECTOR switch SB to position 1 or 2 and the P.R.F. SELECTOR switch SC to P C/S. Set SA on the panel (distribution and switching, marker sequence) to position 1. Check that the gating waveform displayed commences 50 microseconds from the start of the trace, adjusting if necessary RV2 (P C/S T.B. DELAYS).

(8) *Timebase delay setting (Q c/s).*—As in paragraph 3 (7), setting the CABINET SELECTOR switch SA to position 9, the P.R.F. SELECTOR SC to Q C/S, and adjusting RV14 (Q C/S T.B. DELAYS).

(9) *Sampler delays.* Set the CABINET SELECTOR switch SA to position 4, the WAVEFORM SELECTOR switch SB to position 1, and the SELECTOR switch on the amplifying unit to EARTH. Zero the sampled portion of the trace and set the SELECTOR switch to SIGNAL and the SAMPLER GAIN to LOW. Set the P.R.F. SELECTOR switch SC to P C/S, and SK on the amplifying unit to L.R. TIMEBASE. Check that the gated portion of the trace occurs at the end of the intertrace period. Adjustment beyond the end of the intertrace period, by means of the P C/S SAMPLER DELAYS control, is observed by a change in shape of the sampled portion. Reset the control accordingly.

(10) Set the P.R.F. SELECTOR to Q c/s and the WAVEFORM SELECTOR to position 7. Set NORMAL L.R. TIMEBASE switch on the amplifying unit to NORMAL. Repeat the check described in paragraph 3 (9) adjusting the Q c/s SAMPLER DELAYS control as necessary.

(11) 1300 *microsecond delay*.—Set the WAVEFORM SELECTOR to position 9. With the oscilloscope Type 13A synchronized from the test delay unit in the associated master trigger unit, monitor on one trace the output pulse at SKT1 and on the other trace the 10-mile range marks at SKT6 of the timebase unit Type 141B. Adjust RV4 the 1300 μ SEC T.B. DELAY control until the pulse at SKT1 is coincident with the eleventh 10-mile calibration mark.

(12) Set the CABINET SELECTOR to position 8, and the WAVEFORM SELECTOR to position 1. Check that Dekatron pulses are displayed at the beginning of the trace and, at least in part, at the end of the trace.

## RACK (TIMEBASE) 16340

**4.** Before proceeding with the following tests, it will be necessary to ensure that the R.A.338 (negative reference supply) and the delay unit Type 31 associated with (*a*) the 250 c/s sync. to the rack (timebase) 16340, (*b*) the 250 c/s sync. to the range marker units Type 27A have been correctly set up.

### Power unit Type 903

**5.** (1) Set the ON/OFF switch to ON and switch B to SET. Check that the H.T. ON indicator lamp comes on and wait approximately 20 seconds for the LOAD ON indicator (LP5) to glow. Connect the multimeter Type 100 to SKT5 and select position T. Check that the negative supply has been set to –300V, adjusting if necesary the –300V SET control.

(2) Select position D on the multimeter and check that the positive supply has been set to +300V, adjusting if necessary the voltage set +300V SET control.

(3) Select position E on the multimeter. Adjust SET CUT-OUT for 0 volts (this control is sluggish due to a long internal time constant). Set switch B to CHECK and the neon should remain on. Check that, by removing the –300V fuse, the protective circuit operates and the power unit closes down, extinguishing the LOAD ON and the H.T. ON indicators. Replace the fuse, set switch B to SET and wait for the neon to glow. Wait 10 seconds and then set switch B to CHECK; the LOAD ON indicator should remain lit.

(4) Set switch B to LOAD; the H.T. ON indicator should remain lit and LOAD ON extinguish. Select positions T and D on the multimeter, in turn, and check that the –300V and the +300V supply voltage are unaffected by the transfer to normal load conditions.

(5) Disconnect the sync input from SKT3 on the associated timebase unit Type 140A or timebase unit 12269 as appropriate. Set the sensitivity of the calibrated Cossor oscilloscope Type 1035 (or equivalent) to 50 millivolts. Connect A.1 to the live side of C11. Check that the ripple present at this point, the –300V rail, does not exceed 10 millivolts peak-to-peak. Repeat the above check for the +300V rail by connecting A.1 to the live side of C6. Check that the ripple does not exceed 10 millivolts peak-to-peak. Disconnect the oscilloscope and reconnect the sync. input to SKT3.

### Timebase unit Type 140A

**6.** (1) With all controls in their operational position, all coaxials connected, the unit triggered at its operational p.r.f. and the distribution panel Type 868B switched to the unit under test, check that all meter readings obtained with the multimeter Type 100 are within the limits given in the table below:—

**TABLE 1**

**Valve currents for the timebase unit Type 140A**

| Valve | Socket | Pin | Scale | Current mA 250 c/s. |
|---|---|---|---|---|
| V1A | SK14 | P | 10 | 4·7 – 6·5 |
| V3 | SK14 | Q | 10 | 3·2 – 4·5 |
| V4 | SK14 | R | 10 | 1·2 – 1·9 |
| V5B | SK14 | S | 10 | 2·2 – 4·4 |
| V5A | SK14 | T | 10 | 1·2 – 7·0 |
| V6B | SK14 | U | 3 | 0·9 – 1·4 |
| V6A | SK14 | V | 3 | 0·5 – 1·2 |
| V8 | SK14 | W | 10 | 3·1 – 5·5 |
| V9 | SK14 | X | 30 | 10·2 – 13·5 |
| V10B | SK14 | Y | 3 | 0·5 – 1·2 |
| V10A | SK14 | Z | 3 | 0·9 – 1·4 |
| V11 | SK15 | O | 10 | 3·0 – 5·5 |
| V12 | SK15 | P | 30 | 18·5 – 22·5 |
| V14 | SK15 | Q | 30 | 13·0 – 21·0 |
| V15 | SK15 | R | 30 | 13·0 – 21·0 |
| V16B | SK15 | S | 10 | 4·0 – 4·9 |

(2) Display +VE S–T REST LEVEL on the central waveform monitor. Check that the timebase rest level has been set to earth, adjusting if necessary, the T.B. ZERO SET FINE control. Repeat for –VE S–T REST LEVEL. Overall variation of rest levels in the order of 10 millivolts should be ignored.

(3) *Alternative method*.—Disconnect the sync. input from SKT3. Set the range of multimeter electric Type CT38 to 250 millivolts d.c. and connect between SKT5 and earth. Check that the potential at this point has been set to earth, adjusting if necessary, the T.B. ZERO SET FINE control. Repeat for timebase negative (SKT6) adjusting, if necessary, the AMP. ZERO SET FINE control. Disconnect the multimeter and reconnect the sync. to SKT3.

(4) *Velocity and radar bright up.*—

(*a*) Set RANGE switch to 240 MILES.

(*b*) Display TIMEBASE +VE SAWTOOTH on the central waveform monitor. Check that the waveform is a linear sawtooth free from distortion or ringing.

(*c*) Display T.B. VELOCITY waveform on the central waveform monitor. Check that the timebase velocity as indicated by the sampler is correct, adjusting if necessary, the VELOCITY FINE control.

(*d*) Display the R.B.U. waveform on the central waveform monitor. Select the 10-mile range calibration marks. Check that the duration of the square wave has been set to 245 miles, adjusting if necessary, the RANGE SET 240 control.

(5) *Alternative method.*—

(*a*) Trigger a calibrated oscilloscope Type 13A (or Cossor Type 1035) from the sync. output socket at the bottom of the master trigger unit at 250 c/s. Connect Y.2 to monitor socket X.14 on marker unit 27A and display 10-mile range marks. Connect Y.1 to SKT5 on the timebase unit and display the TIMEBASE +VE SAWTOOTH. Set RANGE switch to 240.

(*b*) Check that the waveform is a linear sawtooth free from distortion or "ringing".

(*c*) Check that the amplitude of the sawtooth is 51V adjusting, if necessary, the RANGE SET 240 control.

(*d*) Check that the range of the timebase forward stroke is 245 miles, adjusting if necessary, the VELOCITY FINE control.

(6) *Clamp trigger.*—Set RANGE switch to 240. Display RESOLVER CLAMP TRIGGER on the central waveform monitor. Check that the amplitude of trigger "spike" is within the limits 40V to 60V positive-going. Select 10 microseconds calibration marks and check that the spike occurs at 210 microseconds from the scan origin, adjusting if necessary, the PULSE DELAY 240 control.

(7) *Alternative method.*—Trigger an oscilloscope Type 13A (or equivalent) from the back edge of the g.w.g. drive by connecting a sync. lead to SKT4. on the timebase unit and setting the sync. selector switch to +ve trigger. Display the internal 10-microsecond markers. Connect Y.1 to SKT9 and display the clamp trigger "spike". Set RANGE switch to 240. Check that the amplitude of the spike is within the limits 40V to 60V positive-going. Check that the spike occurs at 210 microseconds from the trace origin, adjusting if necessary, the PULSE DELAY 240 control.

(8) Display the G.W.G. DRIVE at the central waveform monitor and check that the amplitude of the square wave is within the limits 23V to 33V negative-going.

(9) *Alternative method.*—Trigger the oscilloscope Type 13A (or Cossor Type 1035) from the sync. output socket at the bottom of the master trigger unit. Connect Y.1 to SKT4 and display the g.w.g. drive waveform. Check that the amplitude of the square wave is within the limits 23V to 33V negative-going.

(10) Display R.B.U. 1 and 2, in turn, at the central waveform monitor Check that the amplitude of each square wave is within the limits 1·8V to 2·5V positive-going.

(11) *Alternative method.*—Trigger the oscilloscope Type 13A (or Cossor Type 1035) as for para. (9). Connect A1 to SKT7 and SKT8 in turn, and display radar bright-ups 1 and 2. Check that the amplitude of each square wave is within the limits 1·8V to 2·5V positive-going.

(12) Before carrying out this test the whole of paragraph 7 must be checked in order to verify the operation of the panel distribution Type 868B. On panel (W/F selector) 16504 on the rack (monitor) 16505 set the CABINET SELECTOR switch (SA) to position 4 and the WAVEFORM SELECTOR switch (SB) to position 12. Set the SELECTOR switch on the amplifying unit Type 515C to SIGNAL and check that the waveform (t) in Fig. 1 of Part 1, Sect. 2, Chap. 2, App. 1 of this Volume is obtained. Adjust the AMP. BAL. control on the timebase unit Type 140A until this waveform is reduced to zero.

**Panel distribution Type 868B**

**7.** (1) On panel (W/F selector) 16504 on the rack (monitor) 16505 set the CABINET SELECTOR switch SA to position 4 and the WAVEFORM SELECTOR switch SB to position 12. Set the SELECTOR switch on the amplifying unit Type 515C to SIGNAL. Check that the waveform (t) in Fig. 1 of Part 1, Sect. 2, Chap. 2, App. 1 of this Volume is obtained. Adjust the AMP. BAL. control on the "A" timebase unit Type 140A until the waveform is reduced to zero. Operate the reversing switch on the panel (distribution) Type 866B at the base of the rack (timebase) 16340 and check that the waveform is still zero, adjusting if necessary, RV1 and AMP. BAL. until zero level is obtained for both positions of the reversing switch.

(2) Set SA and SB on panel (W/F selector) 16504 to positions 5 and 12 respectively and repeat as above for the "B" units, but for RV1 on panel (distribution) Type 868B read RV2.

**Timebase unit (long range) 12269**

**8.** (1) Set the TEST/NORMAL switch to NORMAL. With no input applied to SKT1 or SKT2 connect a multimeter Type 100 in turn to SKT12 and SKT11 and check the valve currents.

**TABLE 2**

**Valve currents for timebase unit 12269**

| Valve | Current (mA) | Scale | Metering point |
|---|---|---|---|
| V1A | 0·19 to 0·34 | 3mA | SKT12 (A) |
| V1B | 4·2 to 7·0 | 10mA | SKT12 (B) |
| V3 | 6·0 to 8·0 | 10mA | SKT12 (C) |
| V4B | 0 | 10mA | SKT12 (R) |
| V4A | 3·8 to 5·1 | 10mA | SKT12 (S) |
| V5 | 0 | 3mA | SKT12 (F) |
| V6B | 5·5 to 7·5 | 10mA | SKT12 (U) |
| V6A | 2·6 to 3·6 | 10mA | SKT12 (V) |
| V7B | 3.9 to 5.1 | 10mA | SKT12 (W) |
| V7A | 0 | 10mA | SKT12 (X) |
| V9 | 0 to 2·7 | 30mA | SKT12 (Y) |
| V10 | 0 to 2·7 | 30mA | SKT12 (Z) |
| V14 | Less than 1·0 | 10mA | SKT11 (A) |
| V15A | 5·8 to 8·1 | 10mA | SKT11 (P) |
| V16 | 6·0 to 11·0 | 30mA | SKT11 (C) |
| V15B | 6·0 to 11·1 | 30mA | SKT11 (D) |
| V17B | 0·5 to 1·2 | 3mA | SKT11 (S) |
| V17A | 0·9 to 1·4 | 3mA | SKT11 (T) |
| V18 | 5·0 to 8·5 | 10mA | SKT11 (G) |
| V19 | 8·4 to 10·0 | 30mA | SKT11 (V) |
| V22B | 0·19 to 0·35 | 3mA | SKT11 (J) |
| V22A | 4·3 to 7·3 | 10mA | SKT11 (K) |
| V23B | 4·2 to 5·4 | 10mA | SKT11 (Y) |
| V25 | 0 to 1·0 | 10mA | SKT11 (Z) |

(2) (*a*) Set SA and SB on the panel (W/F selector) 16504 in the rack (monitor) 16505 set to position 1, check that waveform as (*a*) of Fig. 1 in Part 1, Sect. 2, Chap. 2, App. 1 is displayed.

(*b*) Ensure that the step commences at 40 miles by switching in the 10-miles calibration marker and adjusting, if necessary, the 35-mile delay preset.

(*c*) Check that the e.l.r. +VE SAWTOOTH waveform is free from ringing.

(3) Set SB on the panel (W/F selector) 16504 in the rack (monitor) 16505 to position 2. Ensure that a pulse is displayed at 40 miles from the start of the timebase and that the amplitude exceeds 10 volts.

(4) (*a*) Display the e.l.r. R.B.U. 1 on the central waveform monitor (SB to position 3). Check that the amplitude of the square wave displayed is within the limits 1·8V to 2·5V positive-going.

(*b*) Ensure that the leading edge commences at X miles from the start of the timebase, adjusting if necessary the r.b.u. DELAY preset control. (X miles to be start of the linear portion of the sawtooth).

(*c*) By means of an oscilloscope ensure that the lagging edge of the radar bright-up waveform, obtained from the timebase unit SKT3 terminates 20 microseconds before normal timebase sync., adjusting if necessary the associated delay unit 31 in the rack assembly (master trigger).

(5) Display e.l.r. R.B.U. 2 on the central waveform monitor by setting SB on the panel (W/F selector) 16504 to position 4. Check that the amplitude of each square wave is within the limits 1·8V to 2·5V positive-going.

(6) Display the e.l.r. G.W.G. DRIVE on the central waveform monitor by turning SB on the panel (W/F selector) 16504 to position 5. Ensure that the amplitude of the square wave is within the limits 23V to 35V negative-going.

(7) (*a*) Set SB on panel (W/F selector) 16504 to position 6 on the central waveform monitor to display the RESOLVER CLAMP TRIGGER. Ensure that the amplitude is greater than 30 volts positive-going.

(*b*) Select 10 microseconds calibration markers and check that the spike occurs at 210 microseconds from the scan origin.

(8) Display the e.l.r. timebase positive rest level on the central waveform monitor (SA to position 4, SB to position 1). Check that the timebase rest level has been set to earth, adjusting if necessary, the e.l.r. T.B. ZERO SET FINE control. Fluctuation of rest level in the order of 5 millivolts may be experienced but can be ignored.

(9) *Velocity measurement.*—

(*a*) On amplifier 515C in the central waveform monitor set the NORMAL/LONG-RANGE switch to LONG RANGE.

(*b*) Set the TEST/NORMAL switch on the timebase unit (L/R) to TEST.

(*c*) Display the e.l.r. timebase velocity waveforms (SA to position 4, SB to position 3). Check that the timebase velocity as indicated by the sampler is correct, adjusting if necessary, the e.l.r. VELOCITY FINE control.

(10) *Waveform step adjustment.*—Set the TEST/NORMAL switch to NORMAL. Check that the amplitude of the waveform at the 110-mile point is correct by using the sampler, adjusting if necessary the SET STEP control.

**Comparison of timebase linearity**

**9.** The tests described in this section must be performed on each timebase unit in the rack (timebase) 16340, both normal and e.l.r.

(1) On the monitor console turn the RANGE selector switch to 80 M, and display 10-mile markers. On the amplifying unit (mixing) 4428 remove PL20 from SKT20. On the amplifying unit (deflection) R.H. 12476 turn the TEST/NORMAL switch SA to TEST.

(2) Insert into SKT20 a coaxial wander lead from SKT5 (normal) or SKT7 (e.l.r.) on the

timebase unit (*a*). Adjust the RANGE RINGS control until range marks appear bright. Off-centre the display until the 110-mile mark is in the centre of the tube-face. Remove the wander lead fromSKT5 (or SKT7) of the timebase unit (*a*), listed in Column A below, and plug it into SKT5 (or SKT7) of the timebase unit (*b*) listed in Column B. Check that the 110-mile marks coincide. Check that all other 10-mile marks coincide to within ±2 mms.

| *Column A* | *Column B* |
|---|---|
| Timebase unit 140A (*a*) | Timbebase unit 140A (*b*) |
| Timebase unit 12269 (*a*) | Timebase unit 12269 (*b*) |

## RACK (RESOLVER MAGSLIP) 16357

**10.** Before proceeding with the following tests, it will be necessary to ensure that the R.A.338 (negative reference supply), the rack (timebase) 16340 and the delay units Type 31 associated with (*a*) the 250 c/s sync. to the rack (timebase) 16340, (*b*) the 250 c/s sync. to the range marker units Type 27A, have been correctly set up.

### Power unit Type 904

**11.** The setting-up of this unit is described in para. 31 and 32 of the preceding chapter.

### Resolver unit (magslip)

**12.** The setting-up of this unit is described in para. 33 of the preceding chapter.

### Amplifying unit (clamping and distribution) Type 504

**13.** The setting-up of this unit is described in para. 34 to 39 of the preceding chapter. After rest levels have been set the following should be noted:—

(1) For e.l.r. units set the TEST/NORMAL switch on the timebase unit 12269 to NORMAL and set the NORMAL/L.R. switch on the panel amplifier 515C on the rack (monitor) 16505 to L.R.

(2) When the resolver unit is associated with a remote radar Type 7, the "X" and "Y" component rest levels will not be set to earth, but to a specific voltage either above or below earth depending on the co-ordinates of the remote site relative to the radar Type 80.

*Resolver linearity checks*

**14.** The following additional tests must be carried out with a normal sawtooth input to the resolver. For the purpose of these checks one normal sawtooth should be patched into the Type 80 e.l.r. resolver when testing this unit. This can be most easily accomplished by reconnecting cables on the panel (distribution) 877A at the foot of rack 2 as follows.

| *Remove cable ident. mark* | *From* | *Replace in* |
|---|---|---|
| 1335 | SKT35 | SKT32 |
| 1338 | SKT38 | SKT27 |
| 1339 | SKT39 | SKT26 |

After completing the checks on this resolver reconnect these cables to their original positions. For the purpose of these tests any one set of resolving units is taken as a reference, and the remaining five sets compared with the reference. On the resolver unit associated with the radar Type 7, the offset voltages are to be set to zero during these tests.

(1) On the monitor console turn the RANGE selector switch to 80 M and switch on the 10-mile range rings. Connect a coaxial wander lead from SKT7 on the reference amplifier (clamp and distribution) Type 504 to SKT8 on the amplifier (mixer) Type 4428, and a similar lead from SKT8 to SKT20 on the amplifier (mixer) Type 4428. Manually adjust the associated resolver for zero X output. Off-centre the display until the centre of the tubeface is approximately 110 miles in a Northerly direction. Adjust the RANGE RINGS control until the range marks appear bright. Remove the coaxial wander leads from SKT7 and SKT8 of the Type 504 and connect them to the corresponding sockets of the second Type 504. Check that the 110-mile marks coincide, adjusting the resolver if necessary, and that all range marks now painting are within ±2 mm of the afterglow of the range-marks from the reference resolver. Repeat at 50 miles North, 180 miles North and 240 miles North. Repeat also at the same ranges in an Easterly direction adjusting the resolver for zero Y output.

(2) As in para. 14 (1) for the reference resolver and the third set of resolver units.

(3) As in para. 14 (1) for the reference resolver and the fourth set of resolver units.

(4) As in para. 14 (1) for the reference resolver and the fifth set of resolver units.

(5) As in para. 14 (1) for the reference resolver and the sixth set of resolver units.

## RACK (AZICATION) M2

**15.** Before proceeding with the following checks it will be necessary to ensure that the R.A.338 (negative reference supply), the rack (timebase) 16340, and the rack (marker sequence) 4195 have been correctly set up.

### Power unit 905

**16.** The setting-up of this unit is described in para. 31 and 50 of preceding chapter.

### Waveform generator (azication) Type 100

**17.** Before carrying out the tests in this section connect a wander lead between SKT17 of the waveform generator to be tested, and SKT10 on either of the operation waveform generators (gating) 12274 in the rack (marker sequence) 4195. Setting-up and testing may then proceed as described in para. 51 to 53 of the preceding chapter.



Printed for H.M. Stationery Office by J. Looker Ltd., Poole
Wt. 23122 D/d 254 875 5/64 375/3

# SECTION 2

# DISMANTLING AND RE-ASSEMBLY



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# Chapter 1

# CONSOLE TYPE 64 AND CONTROL DESKS

## (DISMANTLING AND RE-ASSEMBLY)

### LIST OF CONTENTS



### LIST OF ILLUSTRATIONS



## INTRODUCTION

### Scope of chapter

**1.** This chapter gives instructions for the dismantling and re-assembly of the console (fixed coil) Type 64 and its associated control desks. The information is based on prototype units, and may thus be subject to later amendment in the light of Service experience with the equipment. The instructions should be read in conjunction with the descriptive chapters in Part 1 of this volume, where illustrations and lists of components for individual sub-units may be found.

### Safety Notes

**2.** As there are no safety switches to operate when panels are removed from the console, care is needed to avoid electric shocks when the console is " on " and the internal sub-units are exposed. Except when adjustments are to be made to preset controls on the sub-units, the console is to be switched OFF before the indicating unit is withdrawn or any panel removed. While making such adjustments, keep one hand in the pocket and use a well-insulated screwdriver. Keep well clear of the EHT power unit and the CRT final anode cap.

**3.** Note particularly that the 3-pin mains socket on the fuse panel will—if its nearby switch is closed—remain alive when the console has been switched off, and even after the main switch for the console, on the radar office power board, has been opened (*see instructions in para. 26, following*).

## DISMANTLING INSTRUCTIONS

### General

**4.** Time will be saved during re-assembly if every screw removed during dismantling is put back into its hole or bush, after the part it secures has been removed.

**5.** The Mk. 4 plugs and sockets, used extensively in the console to terminate multicore cables, are liable to develop intermittent open or short circuits if subjected to incorrect treatment. Do not disturb any of these connectors, therefore, unless it is absolutely necessary. When it is essential to remove a connector from a unit, unscrew fully the knurled coupling nut on the free member. Then, retaining a firm grip on the free member, withdraw it slowly, straight out from the fixed member. Do not rock the connector from side to side during withdrawal and never pull on the cable itself when withdrawing the connector, or the above mentioned faults will be created.

**Removal of panels**

**6.** Access to the interior of the console is obtained by the removal of three panels: rear, top and lower front. The rear panel clips into position at the bottom and is secured by two large captive screws at the top. The underside front panel and the top panel are fixed in a similar manner. Any of these panels may therefore be removed by loosening the appropriate captive screws and easing the panel upwards and outwards away from the console framework.

**Indicating unit withdrawal**

**7.** Most ordinary servicing on the sub-units forming part of the indicating unit (CRT) Type 35 (viz. blanking unit Type 26, waveform generator Type 80, video amplifier Type 312 and control panel Type 859) can be done by withdrawing the indicating unit to the forward position, as follows:—

(1) Grasp the two front handles, and at the same time pull the release trigger situated under the right-hand grip.

(2) Pull the indicating unit forwards and upwards along the runners until the spring catches, at the rear of the forward runners, are heard to engage, so locking the unit in the forward position.

(3) Erect the two supporting straps, one at each side.

**Video amplifier**

**8.** Once the indicating unit has been pulled forwards, the preset controls, valves and relays on the amplifying unit (video) Type 312 are readily accessible without further dismantling. Access to components under the video amplifier chassis may be had without interrupting the operation of the console, by loosening the knurled captive screw which secures the unit to the right-hand upper framework member of the console, and swinging the unit outwards and back on its hinges.

**9.** If it is now desired to remove the video amplifier entirely, the console must first be switched off at the control desk and all coaxial and multicore connectors to the video amplifier must be removed. The unit may then be lifted off the hinges.

**Blanking unit Type 26**

**10.** With the indicating unit drawn forwards, the valves and preset potentiometers on the blanking unit Type 26 are accessible from the left-hand side of the indicating unit. Under-chassis components may be reached, without switching off the console, by loosening the captive screw at the top left of the unit, and swinging the unit outwards and downwards on its two hinges.

**11.** To remove the blanking unit completely the console must be switched off, all connectors to the blanking unit removed and the unit shifted sideways to slide it off its hinges.

**Waveform generator Type 80**

**12.** Owing to the way the waveform generator is mounted at the rear of the indicating unit, access to small components, preset potentiometer spindles and a few valves, is easily obtained with the indicating unit in the forward position. But it is difficult to reach most of the valves and the relays in that position, and it is better to proceed as follows:—

(1) Switch off the console.

(2) Pull forwards the indicating unit.

(3) Disconnect from the waveform generator and indicating unit side panels those cables which impede the removal of the waveform generator. Take off the two coaxial cable cleats from the indicating unit side panels.

(4) Loosen the two captive screws which secure the waveform generator to the upper rear horizontal framework member of the console.

(5) Swing the waveform generator outwards and downwards on its hinges.

(6) Disconnect the four coaxial and two multicore cables from the sockets on the front of the unit.

(7) Remove the waveform generator, taking care to avoid damage to the neck of the CRT.

**Control panel**

**13.** Complete removal of the panel (control) Type 859 is seldom necessary, since work on the panel can usually be carried out with the indicating unit in the forward position. If it should prove essential to remove the unit, proceed as follows:—

(1) With the indicating unit in the forward position, and the console switched off, remove the front escutcheon and the video amplifier.

(2) Remove the dial lamp mounting channel by loosening its three captive screws and allow it to hang by its wiring.

(3) From the rear of the control panel, detach all the multicore and coaxial connectors, and, also the banana plugs which feed the dial and screen lights.

(4) Unscrew the four 0-BA screws which secure the control panel to the indicating unit front panel, and remove the control panel towards the rear.

**Cathode-ray tube**

**14.** There is no need to remove the indicating unit completely in order to take out the cathode-ray tube. The sequence is:—

(1) Switch off the console.

(2) Prepare a transit case to receive the CRT.

(3) Withdraw the indicating unit to the forward position (*para.* 7).

(4) Remove the console top panel.

(5) Pull off the front escutcheon.

(6) Using a large screwdriver, loosen the eight clamping screws around the CRT screen. Turn the clamping lugs through 90 deg. so as to release the clamping ring assembly. Remove the clamping ring assembly and allow it to hang by its wiring.

(7) Ease the 12-pin CRT holder off the CRT base.

(8) Open the inspection trap at the left-hand side of the tube housing. Earth the EHT connector to the metal housing with a long screwdriver. Ease the connector carefully off the final anode cap.

(9) Withdraw the CRT to the front, taking care not to foul either the final anode cap or the sealing-off pip on the opposite side.

(10) Place the CRT in the transit case so that it will not be damaged.

**Indicating unit removal**

**15.** Complete removal of the indicating unit from the console is seldom necessary, except for major mechanical repair. The all-up weight of the unit is nearly 1 cwt. and two men are required to remove it. The procedure is:—

(1) Switch off the console at the control desk, then remove the rear and top panels.

(2) Withdraw the indicating unit to the forward position (*para.* 7), remembering to erect the supporting straps.

(3) Disconnect the EHT connector from SK11 on the rear of the CRT housing. Withdraw the cable through the hole in the indicating unit left-hand input panel and hook it over the rear framework of the console, where it will be accessible later. Do *not* allow this cable to hang down into the lower part of the console.

(4) On the indicating unit left-hand and right-hand input panels, unscrew the cleats which retain the coaxial cable forms and disconnect all 13 coaxial cables. Leave the cleats on the cables.

(5) Disconnect the four multicore connectors from the indicating unit input panels, and also the two from the rear of the waveform generator Type 80.

(6) Keeping a firm grip on the front handles, take off the side supporting straps and release the four attachment bolts (two at each side) which secure the indicating unit to the outer runners.

(7) Lift the indicating unit up and clear of the runners.

**Focus/deflector-coil assembly**

**16.** The dismantling and repair of the focus/deflector-coil assembly is only likely to be called for in an emergency. All the operations listed below can be performed without complete removal of the indicating unit from the console.

*Focus-coil removal*

**17.** To remove the focus-coil, proceed thus :—

(1) Switch off the console and remove the top, rear and lower front panels.

(2) Withdraw the indicating unit to the forward position (*para.* 7), remembering to erect the supporting straps.

(3) Remove the cathode-ray tube (*para.* 14).

(4) Remove the waveform generator Type 80 (*para.* 12).

(5) Swing the video amplifier and blanking unit out so that work on the coil assembly is not impeded.

(6) Unsolder the two focus-coil leads from the small terminal strip on the back of the focus-coil housing.

(7) Remove the outer mumetal coil shield by taking out the three screws which secure it to the housing.

(8) Loosen off the locking screw, and the two stop screws which bear in grooves round the focus-coil inner housing.

(9) Withdraw the focus-coil inner housing clear of the rest of the assembly. The focus-coil may now be seen inside the housing.

(10) Withdraw the coil tilt adjusting screw so that the coil does not bear too hard against the spring on the other side.

(11) Withdraw the locking nuts and the two grub screws on which the focus-coil pivots. Partly withdraw the coil.

(12) Unsolder the focus-coil leads from the inside terminal strip. Complete the withdrawal of the coil.

*Deflector-coils removal*

**18.** To remove the deflector-coils, proceed as for focus-coil removal to operation (7), then continue as follows :—

(1) Unsolder the deflector-coil leads from the rear of the coaxial sockets, inside the tube housing, and free the leads from the nearby cleat.

(2) Take off the complete coil assembly by undoing the three hexagonal-headed bolts which secure it to the tube housing.

(3) Detach the focus-coil assembly from the deflector-coil mounting. This involves releasing the two items which secure the focus-coil rocking-plate to flanges on the deflector-coil mounting casting. One is the special pivot screw with stiffnut and plain washer, and the other is the knurled nut, with D-wire retainer and spring washer, which forms part of the focus-coil shift adjustment.

(4) There now remains the deflector-coil assembly in its housing. Take off the rubber CRT support, which is sandwiched between two circular mumetal coil screens, by removing the six 6-BA fixing screws.

(5) Remove the three large cheeseheaded screws which attach the deflector-coil assembly to the rear of the housing. Pull the assembly forward out of the housing.

(6) Make a note of the colour-coding scheme for use on re-assembly, then unsolder the deflector-coil leads from the terminal strip.

(7) Slacken off the clamping ring round the laminations.

(8) Remove the deflector-coils forwards from the mounting plates.

**Control desk removal**

**19.** The dismantling procedure is the same for all types of control desk, as follows :—

(1) Remove the outer desk cover, by striking it smartly underneath at each end and lifting it upwards and outwards, clear of the control desk proper.

(2) Loosen the two knurled captive screws at the right-hand end of the control desk.

(3) Slide the control desk part of the way out towards the front, as far as the wiring permits.

(4) Unplug the connectors from the rear connector panel, and complete the withdrawal of the desk.

**Deflection amplifiers and voltage stabilizer**

**20.** The amplifying units Types 313 and 314 are mounted, together with the stabilizer, on a square mounting tray which slides on horizontal telescopic runners. Access to all parts of these units may be had by taking off the lower front panel of the console, pulling the mounting tray forwards and swinging the deflection amplifiers out at 60 deg. to the voltage stabilizer. There are catches to secure the amplifiers in this position.

**21.** Removal of the deflection amplifiers is effected as follows :—

(1) Switch off the console.

(2) Remove the rear and lower front panels.

(3) Disconnect all cables from the rear of the amplifiers.

(4) Pull forwards the mounting tray.

(5) Swing the amplifiers away from the voltage stabilizer; lift them off their hinges and remove them from the tray.

**22.** Once the deflection amplifiers have been taken off, it is easy to remove the voltage stabilizer by loosening, at the front, the captive screw securing it to the mounting tray, then removing its four connectors and sliding it out, free of the tray.

**23.** It may be necessary on occasion to remove the entire deflection amplifier mounting tray (e.g., for access to units on the base of the console). In these circumstances there is no need to remove the deflection amplifiers and voltage stabilizer from the tray. Proceed as follows :—

(1) Switch off the console and remove the front and rear panels.

(2) Unplug all connectors from the deflection amplifiers and voltage stabilizer.

(3) Uncleat the coaxial cable forms from the rear of the mounting tray.

(4) Slide the mounting tray forwards and loosen the two captive screws (one at each side) which secure it to the forward runners.

(5) Lift the tray away from the runners.

**EHT power unit**

**24.** It is essential to switch off the console and to wait ten seconds before removing the power unit (EHT) Type 898. Then unplug its three connectors, loosen the single captive screw retaining it, and slide the unit forwards out of the console.

**25.** The case of the EHT power unit is secured by four captive screws. When the case has been removed, earth the live sides of the EHT capacitors before doing anything else on the unit.

**Fuse panel**

**26.** All the fuses on the panel (fuse) Type 860 may be changed with the unit in position, simply by removing the lower front panel of the console. If, however, it proves necessary to remove the fuse panel entirely, proceed thus :—

(1) Switch off the console at the control desk.

(2) Switch off the main 230V, 50 c/s input to the console, on the radar office power board.

(3) Switch off the " heating and lighting " 230V, 50 c/s supply at the local fuse board (if this interrupts work on other consoles in the same cabin, isolate this console by removing the appropriate fuse on the heating and lighting fuse board, instead of switching off).

(4) Remove the deflection amplifier mounting tray (*para.* 23) and the EHT power unit (*para.* 24).

(5) The fuse panel is now seen to be attached to the console framework by five screws. Three are long screws extending right through the fuse panel and engaging in hexagonal pillars at the side. The other two are at the base. Free all five screws.

(6) Unplug the four connectors from the fuse panel and remove it from the console.

**Distribution panel**

**27.** Most work on the panel (distribution) Type 861 can be performed without removing it from the console. If complete removal proves necessary, proceed as for fuse panel removal (*para.* 26) for operations (1) to (4), and then continue as follows :—

(1) Unplug all coaxial and multicore cables from the panel.

(2) Withdraw the four hexagonal-headed bolts (two at each side) which secure the panel to the console framework.

(3) Remove the panel from the console.

**Rear Lamp**

**28.** The rear lamp in its lampholder assembly may be withdrawn—without any other console

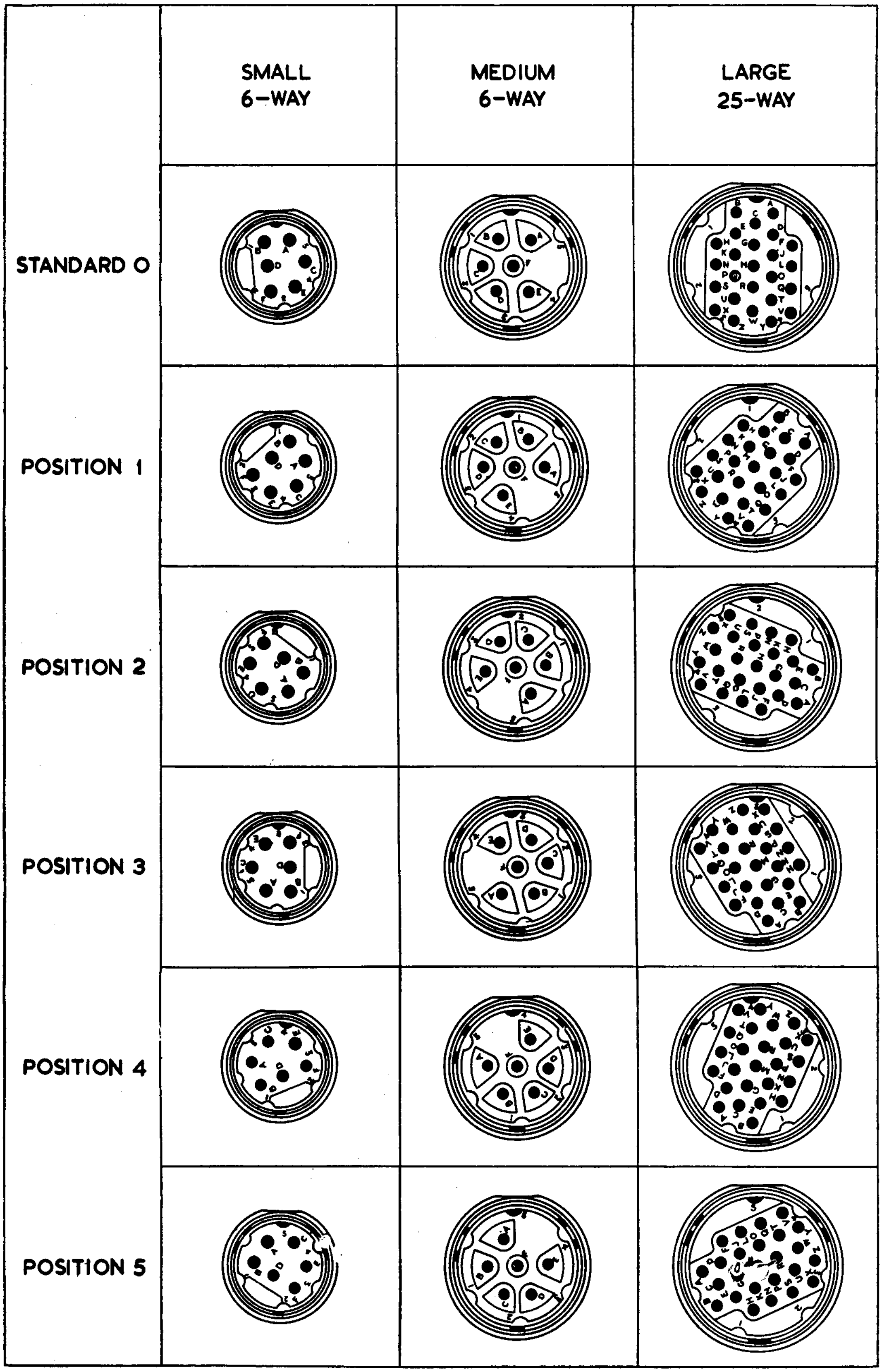



**Fig. 1. Moulding orientations on Mk. 4 fixed plugs**

(Viewed from pin side)

dismantling—by taking out the two 4-BA countersunk fixing screws.

## RE-ASSEMBLY INSTRUCTIONS

### General

**29.** In general the console may be re-assembled by following the dismantling instructions in the reverse order. The following supplementary notes are, however, given to draw attention to certain essential points which must be observed during re-assembly.

### Indicating unit

**30.** When the indicating unit has been put back on the runners, make sure that the four attachment bolts which secure it to the forward runners are properly closed. Keep the indicating unit under control as the release trigger is pulled and the unit slides back down the runners. Damage may result if the unit is permitted to crash home under the force of gravity (*see also para.* 46 *to* 53).

### Cathode-ray tube

**31.** When putting back the cathode-ray tube, take especial care to avoid striking the final anode cap or the sealing-off pip against the tube housing. Before tightening down the eight lugs on the clamping ring assembly, press the palms of the hands gently on the CRT screen to make sure that the tube is seating properly against the deflector-coils and against the spring-mounted support ring. Re-align the focus-coil (*Sect.* 1 *of this Part*) whenever the CRT has been disturbed or changed.

### Focus-coil

**32.** Make sure the air gap in the focus-coil casing is at the front (i.e., nearer the screen) when the coil is put back on its pivot screws in the housing. Note that the full procedure for correct focus-coil alignment (*Sect.* 1 *of this Part*) must be followed after re-assembly is completed.

### Deflector-coils

**33.** When putting repaired or new deflector-coils into their assembly, make sure that the engraved line on the laminations coincides with the engraved line on the forward mounting plate. This line has to be at 12 o'clock when the whole assembly is put back on the tube housing. Do not fail to put back both circular coil screens (one on each side of the rubber, tube support) before re-mounting the focus-coil assembly.

**34.** When the whole focus/deflector-coil assembly is being fastened back on the tube housing, do not tighten up the three hexagonal-headed securing bolts until the assembly has been correctly orientated to ensure exact North-South and East-West deflection (*Sect.* 1).

### Mk. 4 plugs and sockets

**35.** Miniaturized Mk. 4 plugs and sockets are used extensively throughout the console, and the following notes are given to facilitate repairs to these items.

**36.** There are three different shell sizes (large, medium and small), and a number of different pin combinations ranging from 2-way to 25-way. All items are available as "free members" and "fixed members". The free members (designed to terminate standard multicore cables of the *METVINSMALL* Type) may be either plugs or sockets, and a similar range of fixed members is available to mate with the free members. The fixed members may be ordinary plugs or sockets, at the rear of which are soldered leads from circuits, or they may be simply panel-mounting couplers to provide a set of straight-through connections from one multicore cable to another.

**37.** The pins and sockets which make up the connector are embedded in a plastic moulding, which is shaped to give longer leakage paths between some adjoining pins than between others. The moulding is stamped with the pin letter references. The fixed items have a flat on one side, so that the item may be mounted without ambiguity in a similarly shaped hole in a unit panel. They also have grooves inside the aluminium shell, corresponding to spigots on the free member, thus providing a keyway system which ensures that the free item cannot be pushed home, and no electrical contact can be made, until all the pins are correctly aligned.

#### *Moulding orientations*

**38.** The range of different plugs and sockets available has, in effect, been increased sixfold by making the internal moulding orientation variable relative to the keyways. The different orientations are shown—for three of the most widely used types of fixed plugs—in fig. 1; those for other types not shown are on exactly the same principle. The orientation number is always given by the last digit of the inter-services reference number of the item.

**Note . . .**
*Before unsoldering any leads from a defective plug or socket, make a written note of the colour-coding and pin letters, to ensure correct connection to the new plug or socket.*

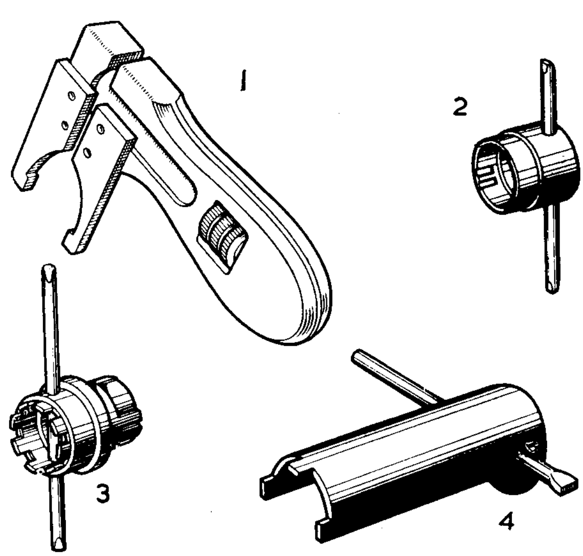



**Fig. 2. Tool kit for Mk. 4 plugs and sockets**

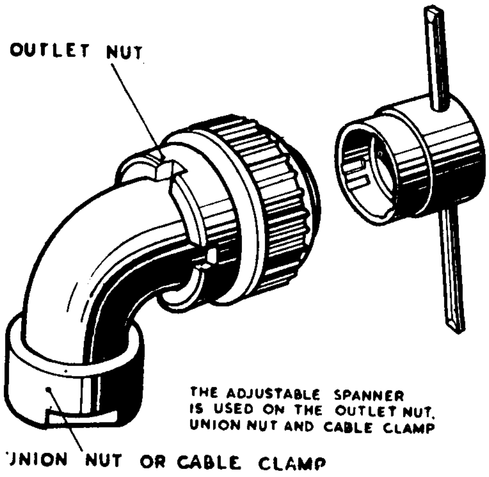



**Fig. 3. Method of tightening free items**

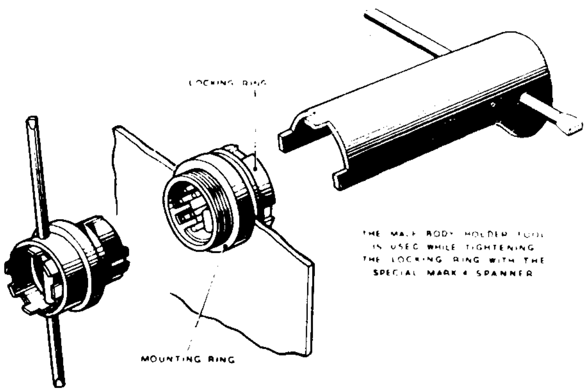



**Fig. 4. Method of tightening fixed items**

*Tools*

**39.** The set of tools required for assembling and mounting Mk. 4 plugs and sockets is shown in fig. 2. The special Mk. 4 spanner, the male body-holder and the female body-holder are all available in three sizes, corresponding to large, medium and small shells. When assembling free members, the female body-holder is used to grip the body assembly (*fig.* 3), while the outlet nut, etc., is tightened with the adjustable spanner. With fixed members, the body assembly is gripped by the male body-holder (*fig.* 4), while the locking ring is tightened with the Mk. 4 spanner.

*Connection of free items*

**40.** The sequence of operations when wiring up Mk. 4 free plugs and sockets with *METVINSMALL* cables is shown in fig. 5, and the relevant dimensions for stripping back the sheath, braiding and conductors are given in fig. 6. The cable must first be drawn through the coupling nut and the various fittings, and the conductor ends stripped back about $\frac{1}{8}$ in. and tinned. Hellerman rubber sleeves are fitted at this stage so that they can later be rolled down over the soldered joints.

**41.** The "bucket" contacts to which the leads are to be soldered should first be freshly tinned, care being taken to avoid blobs of solder. The free plug/socket should be assembled with a mating item (to hold the pins steady) and gripped in a vice. Soldering-up can now be performed, starting with the bucket on the left of the bottom row and continuing with the other contacts in order from left to right and from bottom to top. The minimum of heat must be used, or damage to the PVC cable insulation will result. An electric soldering-iron having a well-tinned, narrow pencil bit (e.g., the "Adcola") will be found effective. As each row of contacts is completed, excess flux must be scraped off, the joints checked by a sharp pull, and the rubber sleeves rolled down over the joints until they are flush with the top of the moulding.

*Special note: 6-way (medium) and 18-way items*

**42.** The multicore cables used with 6-way (med.) and 18-way Mk. 4 plugs and sockets have individual braided screening round some of the conductors. The method recommended for

FITTINGS FOR METVINSMALL TYPE CABLES

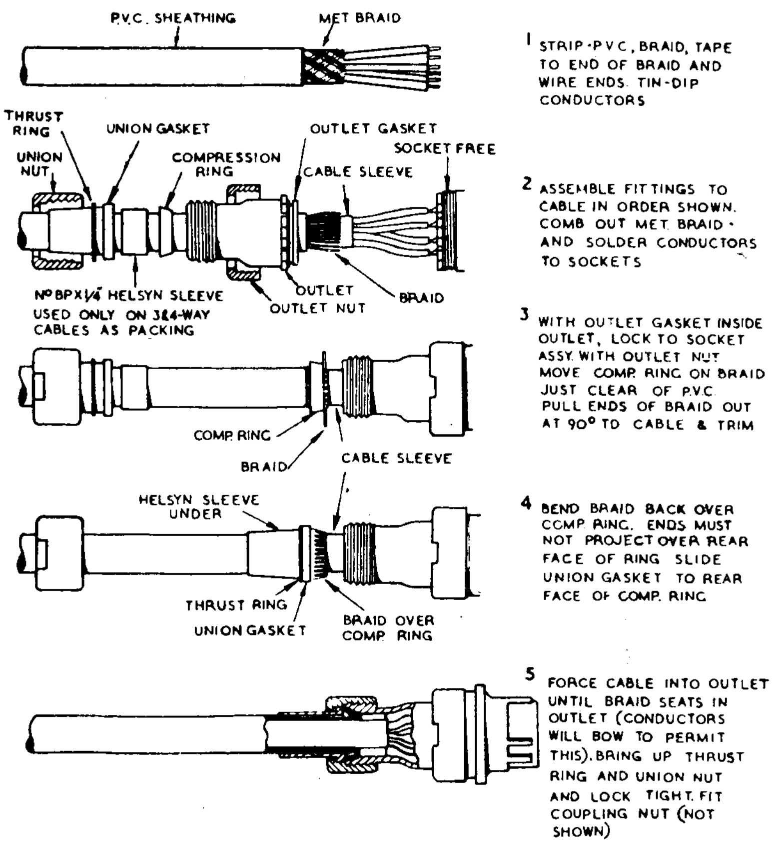
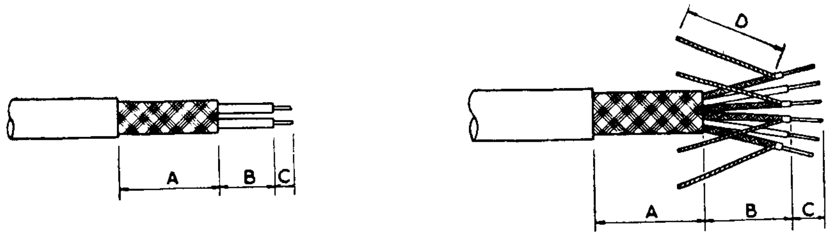



**Fig. 5. Method of wiring free items**




METVINSMALL — COREMETVINSMALL

**KEY TO FIG. 6**

| CABLE | | FOR USE WITH FREE PLUG/SOCKET TYPE | SHELL SIZE | STRAIGHT OUTLET INCHES A | B | C | D | 90 DEG. OUTLET INCHES A | B | C | D |
|---|---|---|---|---|---|---|---|---|---|---|---|
| DUMETVINSMALL | 2·5 } | 2-WAY | SMALL | 1/4 | 1/2 | 1/8 | – | 3/4 | 5/8 | 1/8 | – |
| DUMETVINSMALL | 16 } | | | | | | | | | | |
| TRIMETVINSMALL | 2·5 | 3-WAY | SMALL | 3/8 | 3/8 | 1/8 | – | 5/8 | 1/2 | 1/8 | – |
| QUADRAMETVINSMALL | 2·5 | 4-WAY | SMALL | 3/8 | 3/8 | 1/8 | – | 5/8 | 1/2 | 1/8 | – |
| QUADRAMETVINSMALL | 16 | 4-WAY | MEDIUM | 1/4 | 1/2 | 1/8 | – | 3/4 | 5/8 | 1/8 | – |
| SEXTOMETVINSMALL | 2·5 | 6-WAY | SMALL | 3/8 | 3/8 | 1/8 | – | 5/8 | 1/2 | 1/8 | – |
| TWELVEMETVINSMALL | 2·5 | 12-WAY | MEDIUM | 1/4 | 1/2 | 1/8 | – | 3/4 | 1/2 | 1/8 | – |
| TWENFIVEMETVINSMALL | 2·5 | 25-WAY | LARGE | 3/8 | 5/8 | 1/8 | – | 3/4 | 3/4 | 1/8 | – |
| SEXTOCOREMETVINSMALL | 1 | 6-WAY | MEDIUM | 3/4 | 1 | 1/8 | 5/8 | 1 1/4 | 7/8 | 1/8 | 5/8 |
| EIGHTEENCOREMETVINSMALL | 1 | 18-WAY | LARGE | 3/4 | 1 1/4 | 1/8 | 5/8 | 1 3/8 | 1 1/2 | 1/8 | 5/8 |

**Fig. 6. Stripping dimensions**

earthing this braid is illustrated in fig. 7. Proceed as follows :—

(1) Strip off the conductors in accordance with fig. 6. Comb out the braids and twist them to form earthing tails.

(2) Begin assembly and solder up the leads as in fig. 5.

(3) Fit the bonding clip tightly around the cable.

(4) Insert into the slot in the socket the earth lead from the bonding clip and solder.

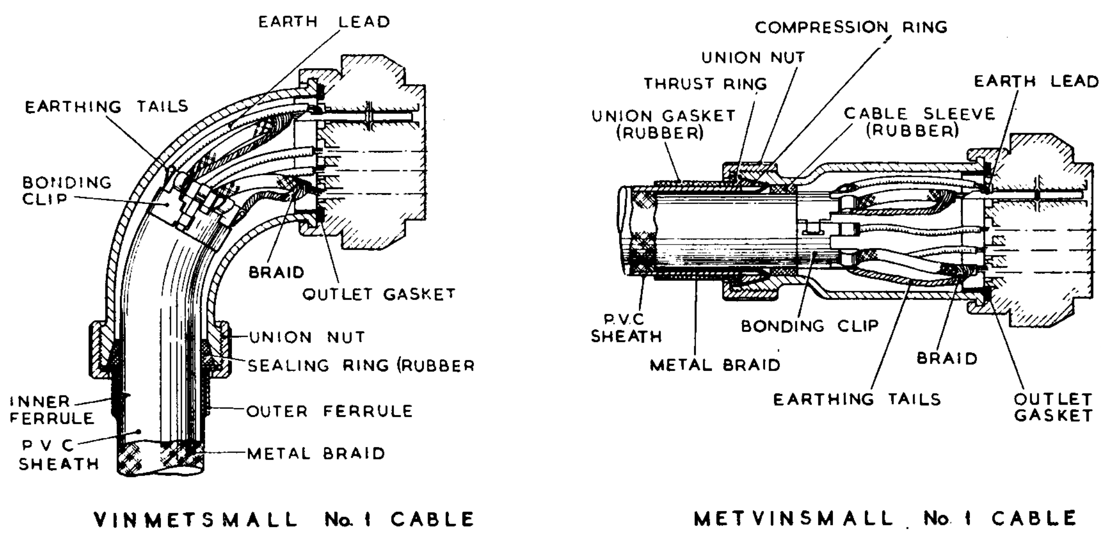
(5) Nip the earthing tails tightly under the tags around the bonding clip and solder.

*Assembling free items*

**43.** When all leads have been soldered up, assembly of the plug or socket may be completed according to fig. 5. The outlet fittings, screen, etc., have to be carefully eased over the leads until the castellations can be engaged at the desired angle. Care must be taken to ensure that the outlet gasket is properly inserted so that it lies flat. With the outlet pressed against the body of the plug/socket, the outlet is screwed home finger-tight. The plug or socket body must then be held with the female body-holder (*fig.* 3) and the union nut screwed up tight.

*Connecting and mounting fixed items*

**44.** Soldering leads to the bucket-contacts on the back of fixed plugs and sockets is a straightforward job. The notes in para. 41 apply equally well here. The leads may be soldered on, either before or after the item is mounted on its panel, according to location and accessibility. To prepare




VINMETSMALL No. 1 CABLE — METVINSMALL No. 1 CABLE

**Fig. 7. Method of connecting "coremetvinsmall" cables**

**the fixed item for mounting,** the plain mounting **ring must be screwed up the** body until it touches **the rubber gasket, which** should then lie in the **hollow inner edge** of the ring without distortion.

**45.** **The item must next** be pushed through the **panel and the locking ring** screwed down finger-**tight. For panels** less than $\frac{3}{32}$ in. thick, the **mounting washer must** be used under the locking **ring, but** is not required for thicker panels. **Finally, the plug** or socket body must be held **with the male** body-holder (*fig.* 4) while the Mk. 4 **spanner is used** to tighten down the locking ring.

**Arrangement of cableforms**

**46.** Unless the cables, which link the various units of the console Type 64, are correctly arranged, they will foul either the runways or the frame of the console, when the units are pushed or lowered home after having been withdrawn from the console. The cable guide will only function if the cableforms are correctly arranged in the first place.

**47.** On past occasions, incorrect arrangement has resulted in cables being trapped between the frame and the indicating unit chassis, or between

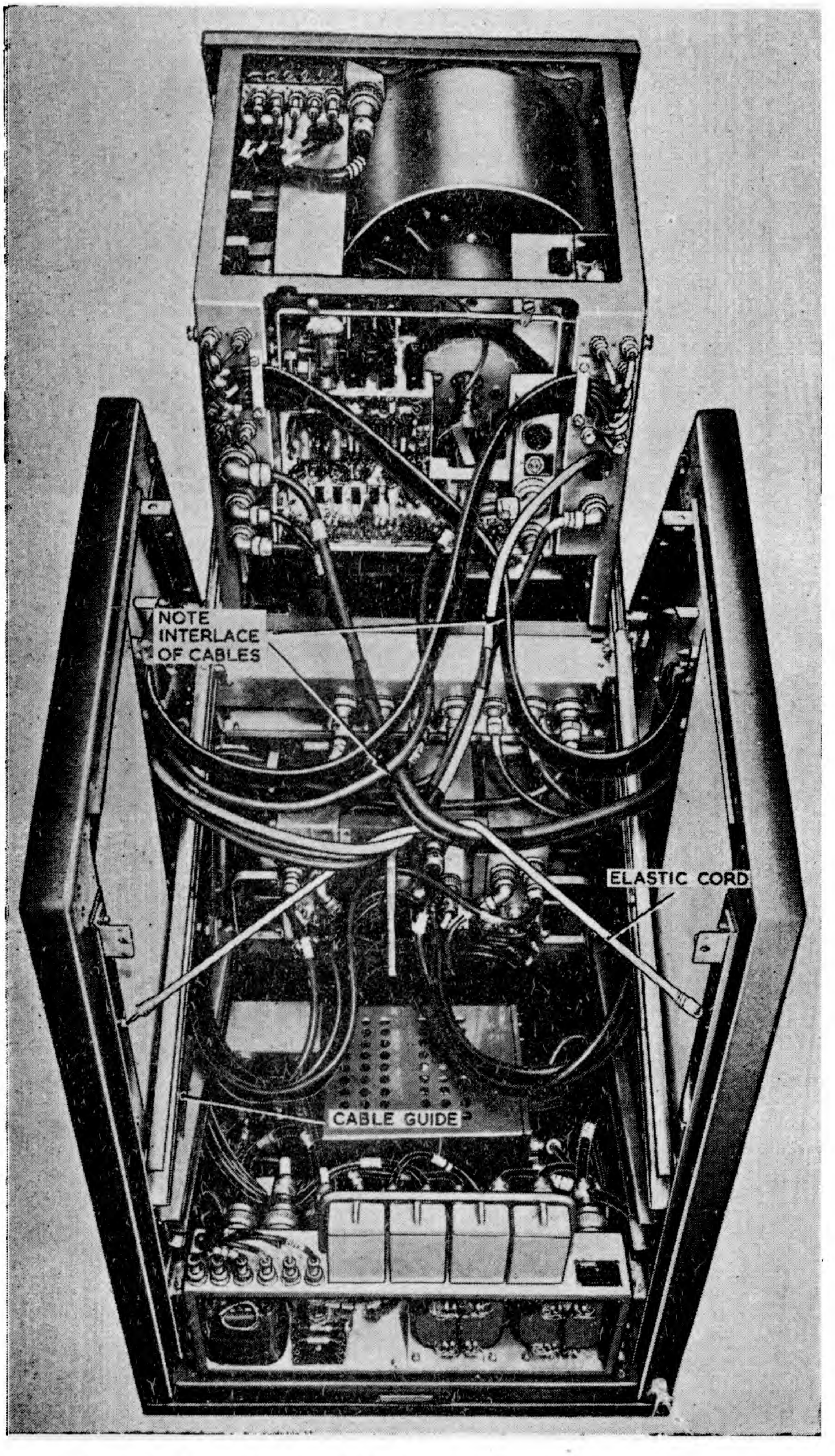



**Fig. 8. Console Type 64—both chassis fully withdrawn**

the lower chassis (deflection amplifiers and voltage stabilizer) and the cable guide. The weight of the indicating unit and the force used in pushing home the lower chassis have cut through the cables and major repairs have become necessary as a result.

**48.** To obviate the recurrence of faults of this nature, a standard arrangement of the cableforms has been evolved, and a modification, involving the fitting of an elastic cord, has been introduced.

**49.** Fig. 8 shows a rear view of a console Type 64, with top and rear panels, and part of the frame, removed so as to give an unobscured view. The illustration shows both the upper and the lower chassis withdrawn to the full extent of their runners. The interlacing of the cables, evolved to promote easy meshing of the cables when the units are slid home, and the looping of the elastic cord, fitted to start the cables sliding in the right direction when the indicating unit is lowered into the frame, are clearly shown in the illustration. The elastic cord is secured by existing screws to the frame of the console, using eyelets fastened to the ends of the cord.

**50.** Fig. 9 shows the lower unit pushed home, with the cables sliding snugly between the two runways on each side. Fig. 10 gives a close-up view of the upper unit lowered into the frame, with arrows indicating the points at which the cables were apt to jam when incorrectly fitted.

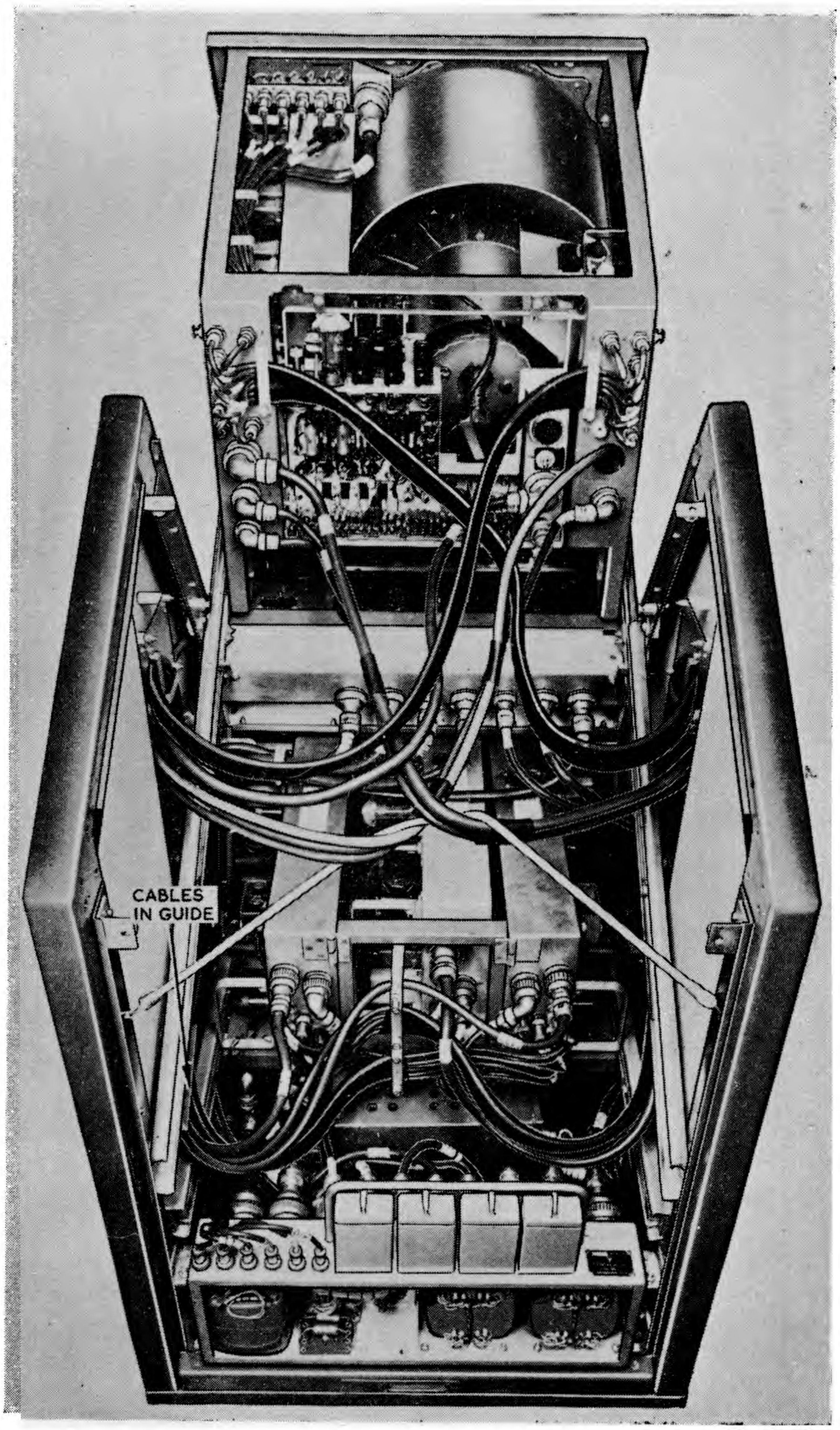



**Fig. 9. Console Type 64—lower chassis pushed home**

Where possible the cable identification numbers have been emphasised in the reproduction as a guide to re-fitting the cables in their proper places after dismantling the console.

**51.** A close-up view, showing the lower unit pushed home, is reproduced in fig. 11. Again the cable identification numbers are emphasized. The photograph gives a clear picture of the cable guide fitted on the left-hand side of the frame. This guide counteracts the greater possibility of trapping the cable forms, as compared with the other side, consequent upon more cables being routed down this side than down the other.

**52.** Fig. 12 shows the arrangement of the cables at the front of the indicating unit, as viewed from below with the unit withdrawn. The point at which cables might be trapped between chassis and frame, unless they were tucked in, is clearly indicated. The screw-cap and securing chain, shown adjacent to the moulded polystyrene connector, is only required to exclude moisture before the console is installed and it should be removed upon installation.

**53.** If, after servicing the console with the units withdrawn on their runners, there appears to be any obstruction to replacing the units, remove the rear panel and watch the cables whilst an assistant lowers or pushes the units home. The snags may then be observed and corrected.

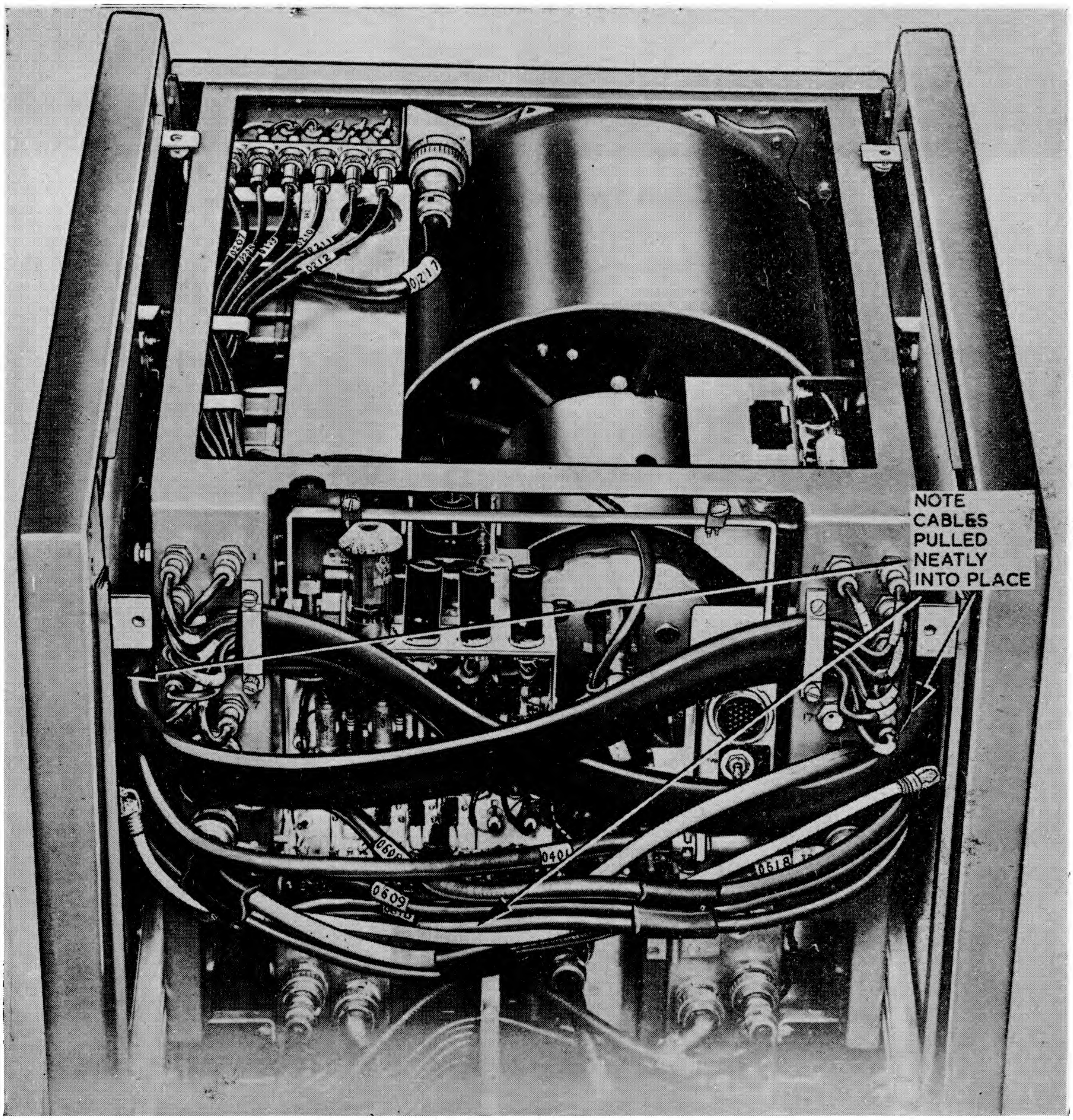



**Fig. 10. Console Type 64—upper chassis lowered into frame (close-up)**

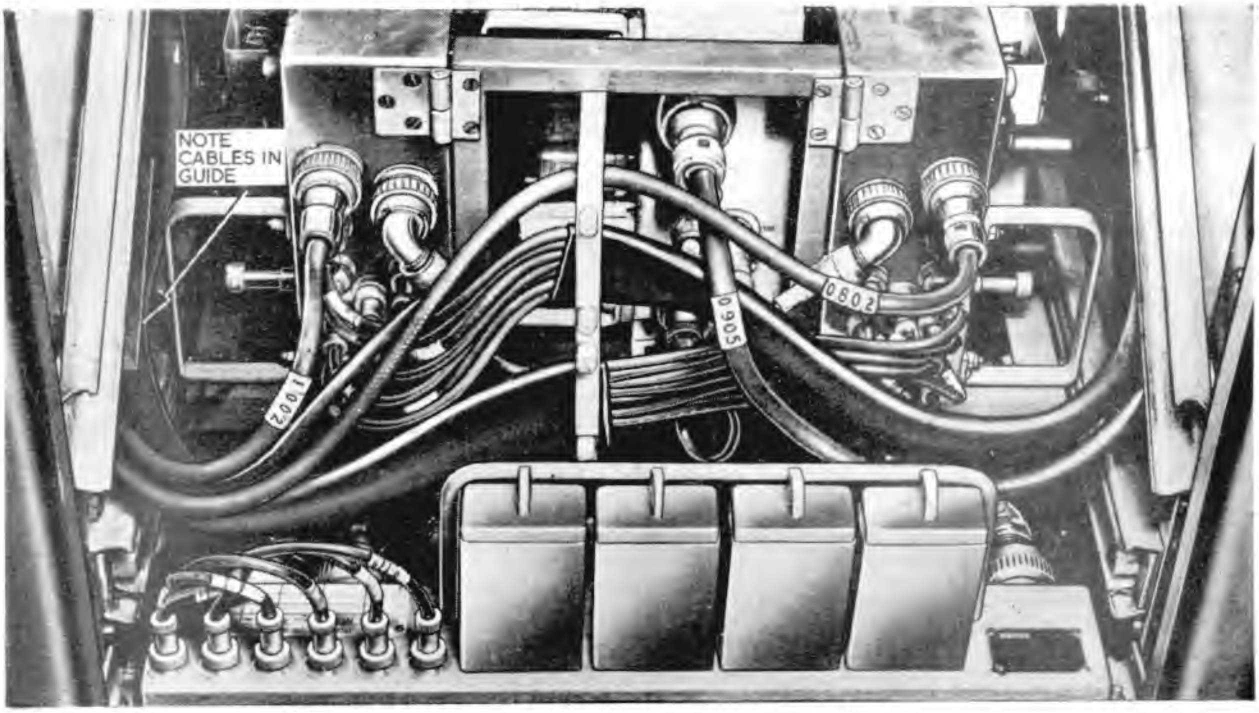



Fig. 11. Console Type 64—lower unit pushed home (close-up)

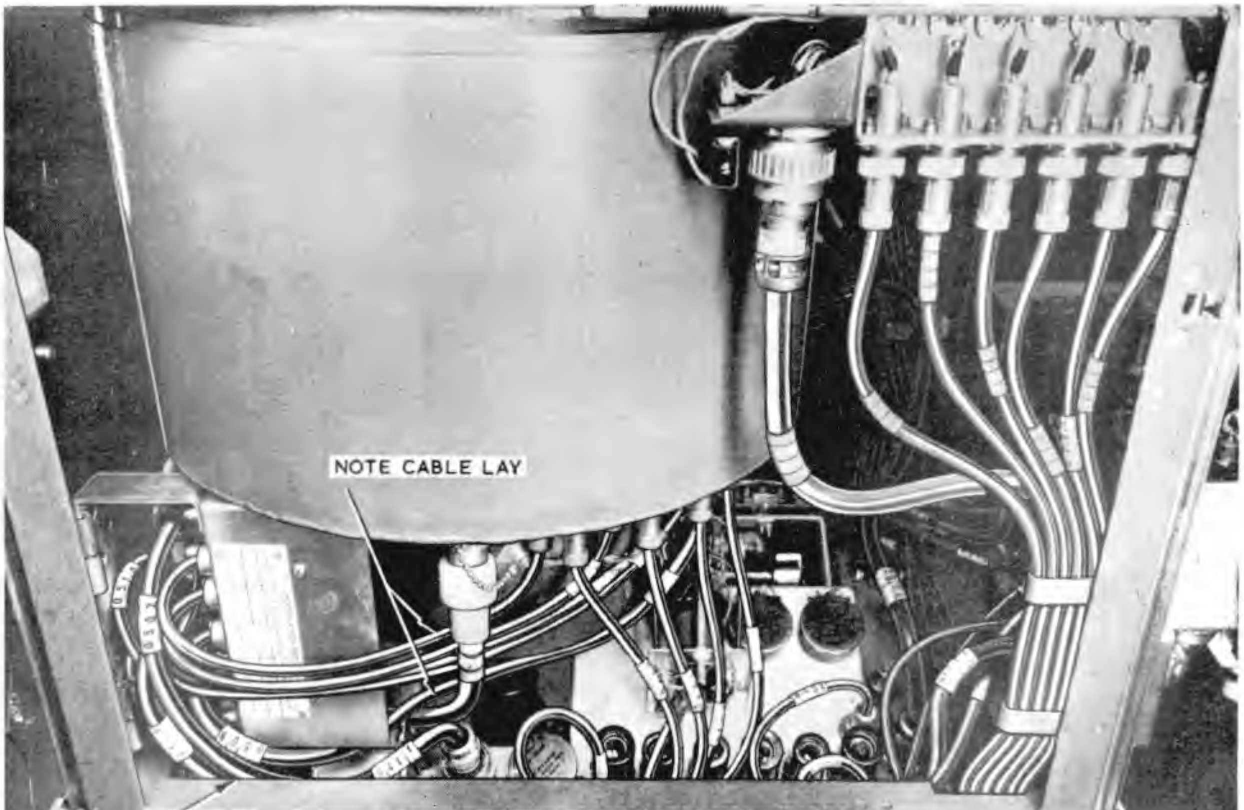



Fig. 12. Console Type 64—underside of upper unit

**◀Console 64 runner adjustment**

**54.** It has been found that the runners, on which the indicating unit (CRT) Type 35 draws out from the console, have a tendency to sag after a period of use, so that a gap develops between the top of the indicating unit and the console framework, when the unit is pushed home. Accordingly, a modification has been introduced to permit the runners to be raised slightly at the front to close the gap.

**55.** The runners, on either side of the indicating unit, may be identified in fig. 9. An illustration of the adjustable fixing at the front end of the runner on the right-hand side of fig. 9 is given in fig. 13. Similar provision is made for the other runner.

**56.** The lower bolt-hole in the runner fixing bracket (*fig.* 13) is slotted to permit movement of the runner in the vertical plane, the bolt being fixed in the console framework. The upper bolt-hole is drilled out to take the projecting part of the cam washer (*inset in fig.* 13). The bolt-hole through this washer is eccentric, while the bolt itself is fixed in the console framework, so that when the washer is rotated the front end of the runner rises and falls, as it pivots about its rear fixing.

**57.** To raise the runners, proceed as follows :—

(1) With the indicating unit pushed home, note the width of gap to be closed at the top of the unit.

(2) Withdraw and secure the indicating unit.

(3) With a pencil, mark the present positions of the tops of the runner fixing brackets on both sides and also the new positions to which they must be raised to close the gap.

(4) Slacken the runner fixing bolts slightly.

(5) Rotate the cam washers with a suitable spanner, to raise the unit the desired amount on each side.

(6) Tighten the fixing bolts.

(7) Lower the indicating unit home and check that its top just clears the console framework.

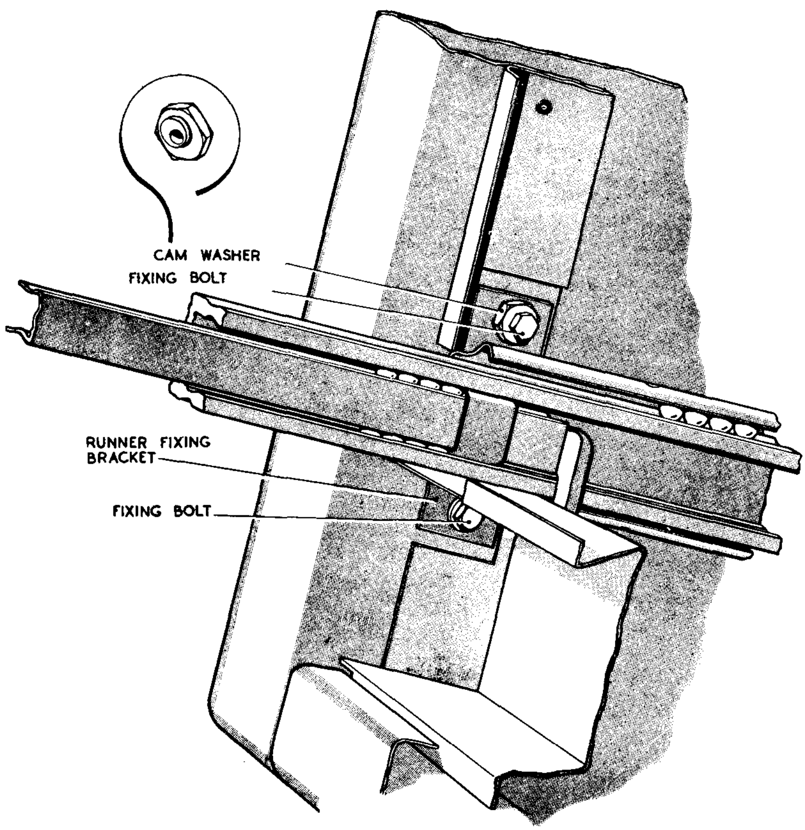



**Fig. 13. Console Type 64—runner adjustment▶**

# Chapter 2

# FIXED-COIL RADAR OFFICE EQUIPMENT

*DISMANTLING AND RE-ASSEMBLY*

## LIST OF CONTENTS



## LIST OF ILLUSTRATIONS



**Introduction**

**1.** The dismantling and re-assembly of all the radar office rack assemblies, associated with the fixed-coil consoles, is not a subject on which it is necessary to give a detailed description for each rack, since the racks are built to a standard pattern. Moreover, much of the procedure will be obvious to Service personnel, familiar with the equipment through working on it from day to day. This chapter is therefore primarily intended to offer general guidance, applicable to most of the equipment, to ensure that the dismantling and re-assembly is tackled along the right lines. Particular information is also included, however, regarding noteworthy aspects of individual racks and units. Fig. 10 gives a typical layout of the racks in the radar office.

## GENERAL INFORMATION

**Removal and replacement of units**

**2.** With the exception of the monitor rack Type 339, all the racks have front and rear doors with automobile-type handles ; the rack 339 has only a rear door. These doors may be lifted off their hinges to facilitate access to any particular rack. Apart from the distribution panels, which are attached to the bases of the racks by long screws passing right through them, and certain switching and relay units which are mentioned later, the units may be drawn from the racks on sliding runners, from which they may be lifted when it is necessary to remove them from the racks for servicing. The methods of attaching the units to the runners are described and illustrated in the chapters on individual racks in Part 1.

**3.** Before a unit is removed from a rack, precautions should be taken against electric shock (e.g., the rack power supplies should be turned off on the radar office switchboard, or the supply to the unit itself turned off) and then all plug and socket connections must be unscrewed at the rear, with the unit pushed home so that, when the rack cables are allowed to hang free, they do so clear of the units lower down in the rack, and the mishap of having a dangling connector smash a valve is avoided. The unit may then be withdrawn and, in the case of units attached directly to runners, released by unscrewing the fixing screws, after which it may be lifted from the runners, preferably by two people, one on either side. With the unit removed, the runners should be pushed back into the rack out of harm's way.

**4.** The smaller units, fixed side by side on mounting trays, may be lifted clear of the trays, which are left attached to the runners. Each separate unit carries four projections, two at the front and two at the rear, for securing it to the tray. The two projections at the rear fit into holes in the rear member of the tray, while the two at the front engage in L-shaped slots in a spring-loaded catch assembly. When the catch is released the front of the unit may be lifted clear, then the unit may be drawn clear of the rear member of the tray.

**5.** When replacing units in the rack it is desirable to have someone to steady the runners, in the fully withdrawn position, particularly in the case of units mounted directly on the runners, to prevent the latter from sliding as the unit is lowered on to them.

**Rack cabling**

**6.** Should the need arise to replace any of the

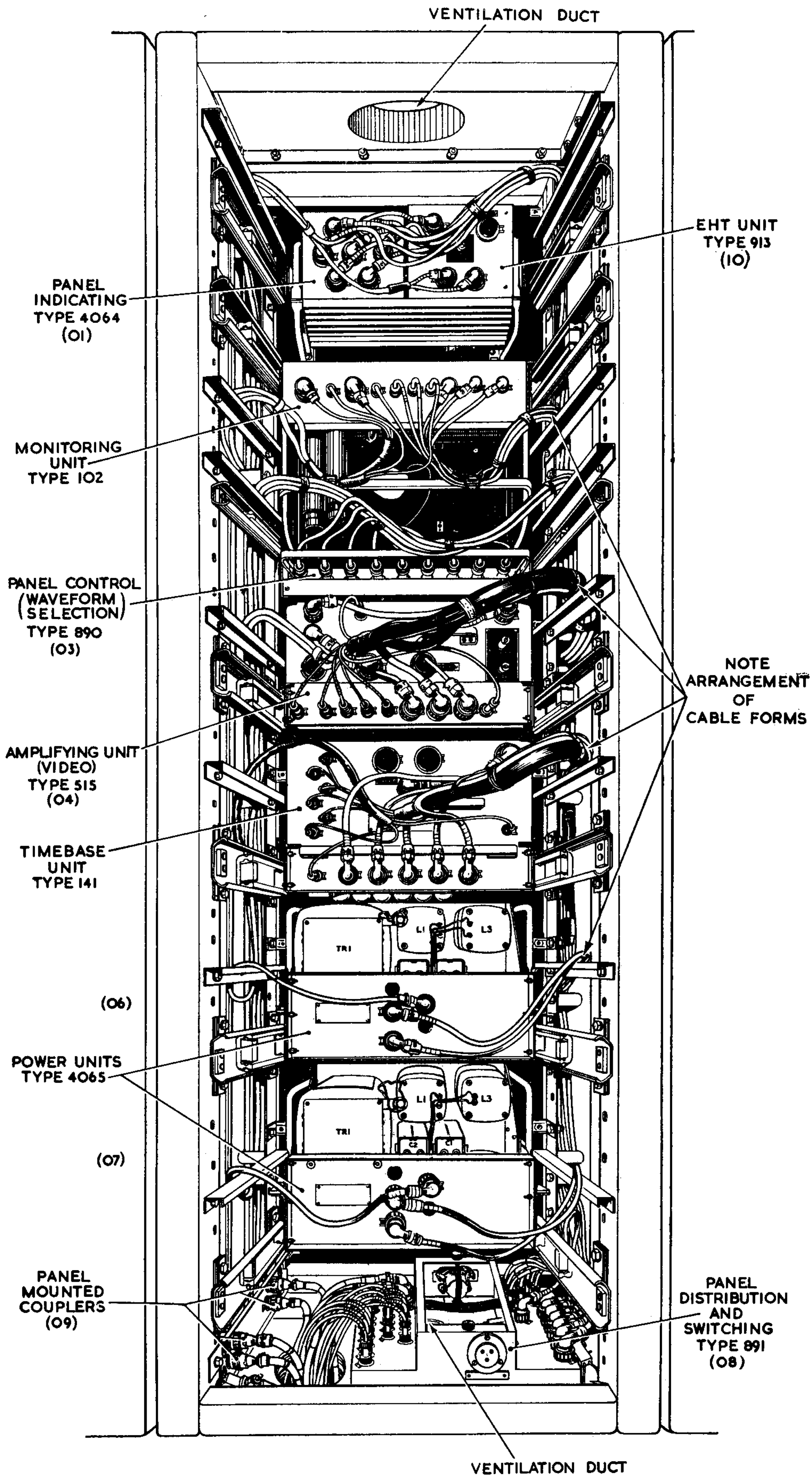



**Fig. 1. Rack assembly Type 339—general view from rear**

cables which are attached to the rack frame, reference should be made to the cabling diagrams included in the descriptive chapters of Part 1. The cables themselves are clearly marked to indicate the unit and the connector to which they should be attached (thus the first two figures of the marking code give the reference number of the unit in its rack, while the last two give the number of the connector in the unit). Plugs and sockets are numbered consecutively to avoid duplication of PL and SK numbers. Information on dismantling and replacing the Mk. 4 connectors, which terminate the cables (free items) and provide mating components on the units (fixed items), is given in Chapter 1 of this Section.

**7.** Although the cable forms are made to the desired pattern and the cables are cut to the required lengths, care must be taken when connecting the free plugs and sockets to the fixed mating components on the units, to ensure that no snags will arise when the units are pushed back and forth along the runners. In the case of units with few rear connectors, it is only necessary to see that the cables are looped over the appropriate side members of the rack frame work in such a manner that they are not trapped and cut when the units are pushed home. This may occur if the cables are looped over the runners instead of the side members above the runners.

**8.** With units possessing more connectors, more care is needed to ensure that the cables do not trap each other and so cause kinks and strains which would damage the cables. Whether or not the cables slide over each other easily can generally be observed by pulling the units in and out a few times, but, in the case of the rack assembly Type 339, which has more elaborate cableforms than the other racks, illustrations have been prepared to show the best way of arranging the cables (*fig.* 1 *to* 6).

### DETAILED INFORMATION

**Rack assembly Type 339**

**9.** Apart from the distribution panel Type 891, which is secured to the base of the rack by two screws (*fig.* 3), the units are mounted directly on to flanges attached to the runners. Before the units can be slid out on the runners, the front panel fixing screws must be removed. Fig. 1 gives a general view of the rack from the rear, with the units fully withdrawn, for identification of the units. Fig. 2 gives a close-up view of the units in the upper half of the rack and fig. 3 gives a similar view of the lower half. It will be observed that, with the units fully withdrawn, there is ample length of cable and no straining occurs.

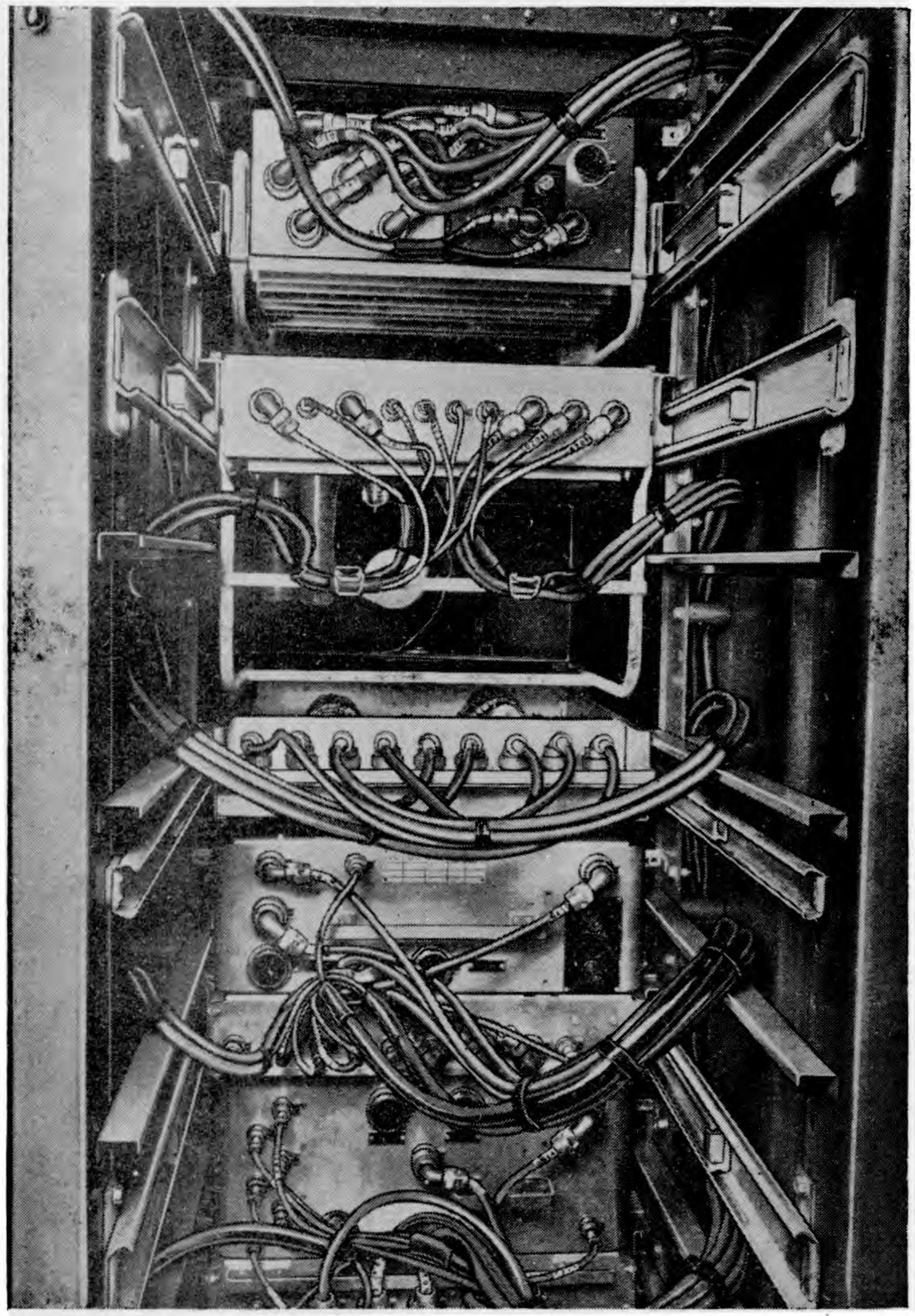


**Fig. 2. RA339—upper units withdrawn**

The positions of the cable clips and the routing of the cables over the side members of the rack framework are also apparent.

**10.** Fig. 4 gives a close-up view of the upper half of the rack with the units pushed fully home. It is again apparent that no straining occurs and no cables are trapped. Fig. 5 illustrates the way in which cables from the right-hand side of the rack go to the left-hand side of the panel Type 890 (at the top of the picture) and vice-versa. The illustration also provides details of the interweaving of the cabling to the amplifying unit (video) Type 515. This is illustrated further in fig. 6, which shows the lower units of the rack pushed home. Only one power unit Type 4065 is included in this view, because the cabling for the other looks the same.

*Removal of units*

**11.** With the runners fully extended, the units may be detached from the supporting flanges by unscrewing the three knurled and slotted, captive screws on each side (except on the panel Type 890,

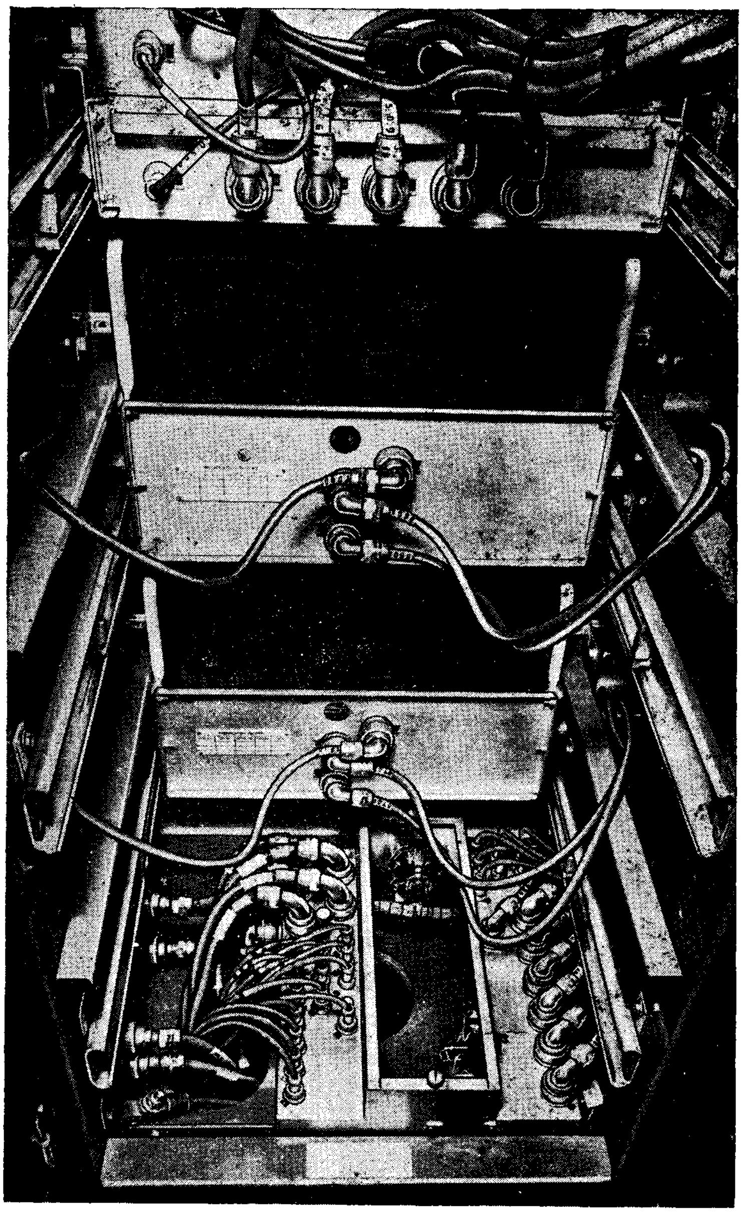


Fig. 3. RA339—lower units withdrawn

which has two screws on either side). Illustrations of units removed from the rack are given in the appropriate descriptive chapters in Part 1.

12. Once the units are on the servicing bench, dismantling of such sub-assemblies as are removable follows normal practice. The layout of the chassis is such that no difficulty should be experienced in removing and replacing faulty components.

13. The EHT unit Type 913 may be removed from the panel, indicating, Type 4064 when the latter has been taken from the rack. The four small bolts, securing the EHT unit to the indicating unit, are accessible from underneath the indicating unit chassis. Once the EHT unit has been removed, the screening cover may be taken off by removing two screws from the top front and two from the bottom rear. As for all power units, the capacitors should be discharged through a resistor (e.g., 5K, 1W) before attempting any servicing.

*Removal of CRT*

14. The CRT may be removed from its turret in the monitoring unit Type 102 by withdrawing it from the front, after :—

(1) taking off the front screen by removing four screws ;

(2) loosening the two screws holding the clamping ring around the neck of the tube, at the rear ;

(3) removing the base socket, together with its cover ;

(4) partly withdrawing the CRT until the final anode cap is accessible, and then removing this cap.

**Rack assembly Type 300**

15. This rack requires very little description to supplement the general information already given. The arrangement of the units and rack cabling is illustrated in Chap. 1 of Sect. 3, Part 1. The timebase units Type 140 and the associated power units Type 903 are mounted side by side in pairs, each pair on a square mounting tray fixed to telescopic runners. Any of the units may be removed from their respective trays by detaching the connectors at the rear, pulling the mounting tray forward on the runners, releasing the spring clip at the front of the unit and pulling the unit forwards and upwards to disengage its two projecting studs at the rear.

16. The timebase unit Type 140 is designed so that it will stand on the servicing bench on its top, bottom or either side for easy access to components and it has a handle for lifting at the front and at the rear. The power unit Type 903 has U-shaped guard handles at each corner, for protection and lifting. It can be serviced standing on its base and the components behind the hinged front panel are accessible when the two fixing screws are released and the panel is opened.

**Rack assembly Type 301**

17. This rack is described and illustrated in Chap. 2, Sect. 3, Part 1. Each magslip resolver unit is mounted alongside its amplifying unit on a mounting tray, while each power unit Type 904 extends the full width of the rack and is supported directly by the runners. The units are removed from trays and runners, respectively, as in the RA300 and RA339.

*Resolver units*

18. These units may be lifted on to the servicing bench using the U-shaped guard brackets at each end of the chassis. The drive unit assembly,

which includes the selsyn motor, gears, switches and magslip, may be removed from the main chassis by unscrewing four ¼-in. BSF fixing bolts. It is expected that this unit will only need servicing attention after a prolonged period of use, but when it proves necessary to inspect the component parts the unit may be dismantled, after marking the mating of items to ensure correct replacement. A dismantled drive unit is illustrated in fig. 7, 8 and 9. In the following dismantling procedure, the key letters (in brackets) refer to these illustrations.

(1) *Selsyn*

(a) To inspect the brushes, remove the two moulded caps from the end frame and extract the brushes.

(b) To inspect the slip rings and bearing, remove the selsyn end frame from the main carcase by unscrewing the four hexagonal head bolts. The inner and outer bearing cover plates may be removed by unscrewing the three small bolts which pass through them.

(c) To remove the selsyn (N) from the gearbox/switching assembly, unscrew the three ¼in. BSF bolts (A) securing the mounting ring.

(2) *Gearbox*

With the selsyn removed, the inside bearing is accessible; the selsyn pinion (M) and the gears (L, K) may also be observed.

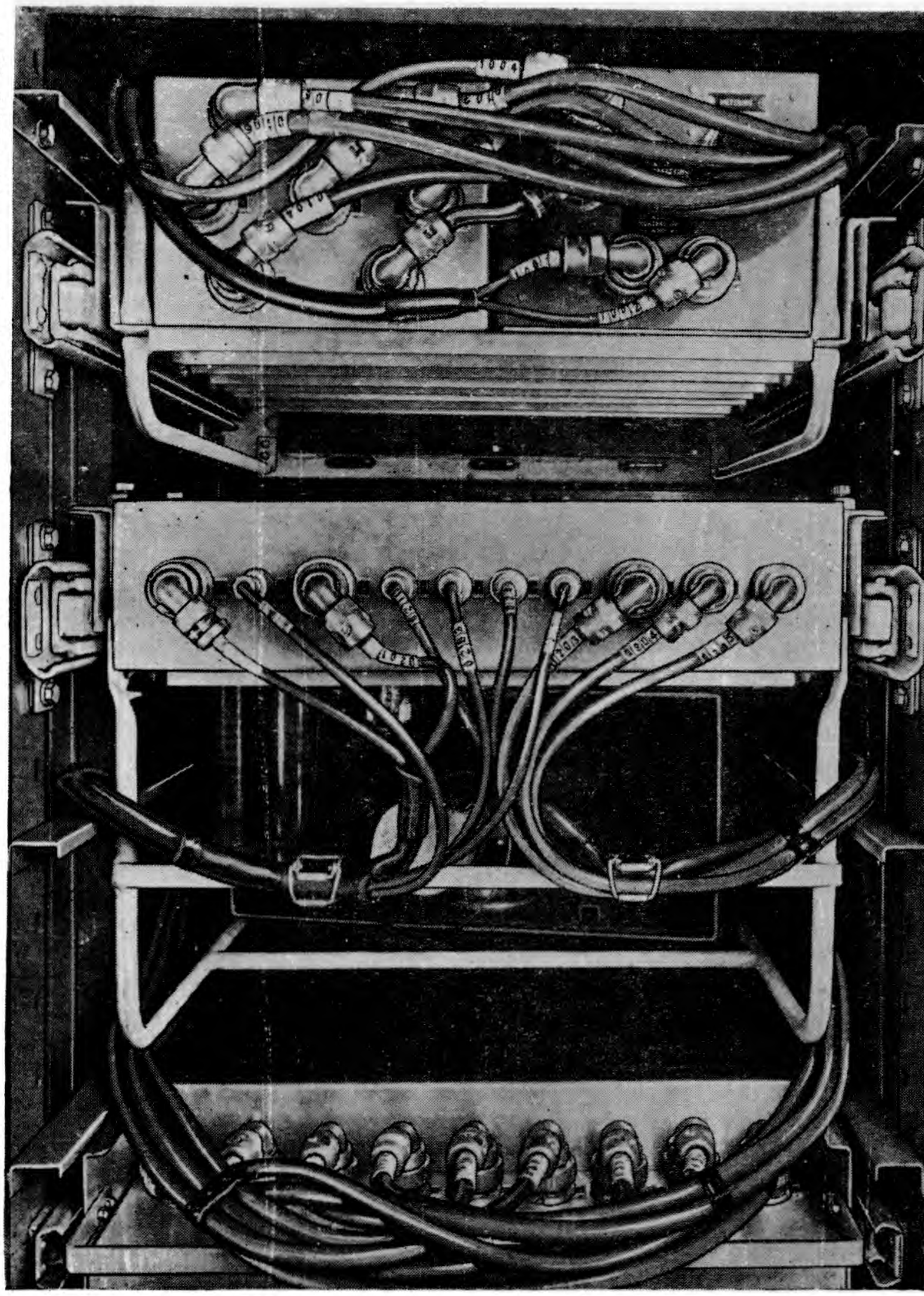


**Fig. 4. RA339—upper units pushed in**

(3) *Cam switching*

The cams (E, F), switches and magslip coupling (B, C, D) are exposed when the magslip assembly is removed from the main carcase by unscrewing the three appropriate ¼-in. bolts (A), securing the magslip adaptor clamp ring. The switches should not be dismantled, except for replacement, but may be cleaned by passing a strip of unglazed paper between the contacts.

(4) *Magslip*

This may be removed from its adaptor by unscrewing the nuts (R) from the two long bolts (Q) passing through the control ring and the end fixing plate, and also removing the two cheesehead screws (P) securing the control ring to the magslip carcase. It should not be necessary to dismantle the magslip itself, as the brushes and lubrication provided on original assembly should last throughout the normal life of the equipment.

**19.** Fig. 9 illustrates a resolver drive unit assembly dismantled to show the range of movement of the magslip carcase relative to the control ring (and therefore relative to the gearbox). This movement is restricted to a 180 deg. arc by the peg beside the magslip coupling plate, working in the semi-circular slot in the control ring. For use with a normal, forward-looking head, the peg is at one end of the slot, so that the reference line engraved on the magslip carcase is near the " N " line on the adaptor. For conversion to use with a back-looking head (from which the auto-align impulse comes when it is looking South), the magslip carcase is rotated until the peg is stopped by the other end of the semi-circular slot ; the reference line is then near the " S " line on the adaptor, opposite the " N " line.

**20.** The drive unit may be re-assembled without any difficulty by reversing the steps taken to dismantle it.

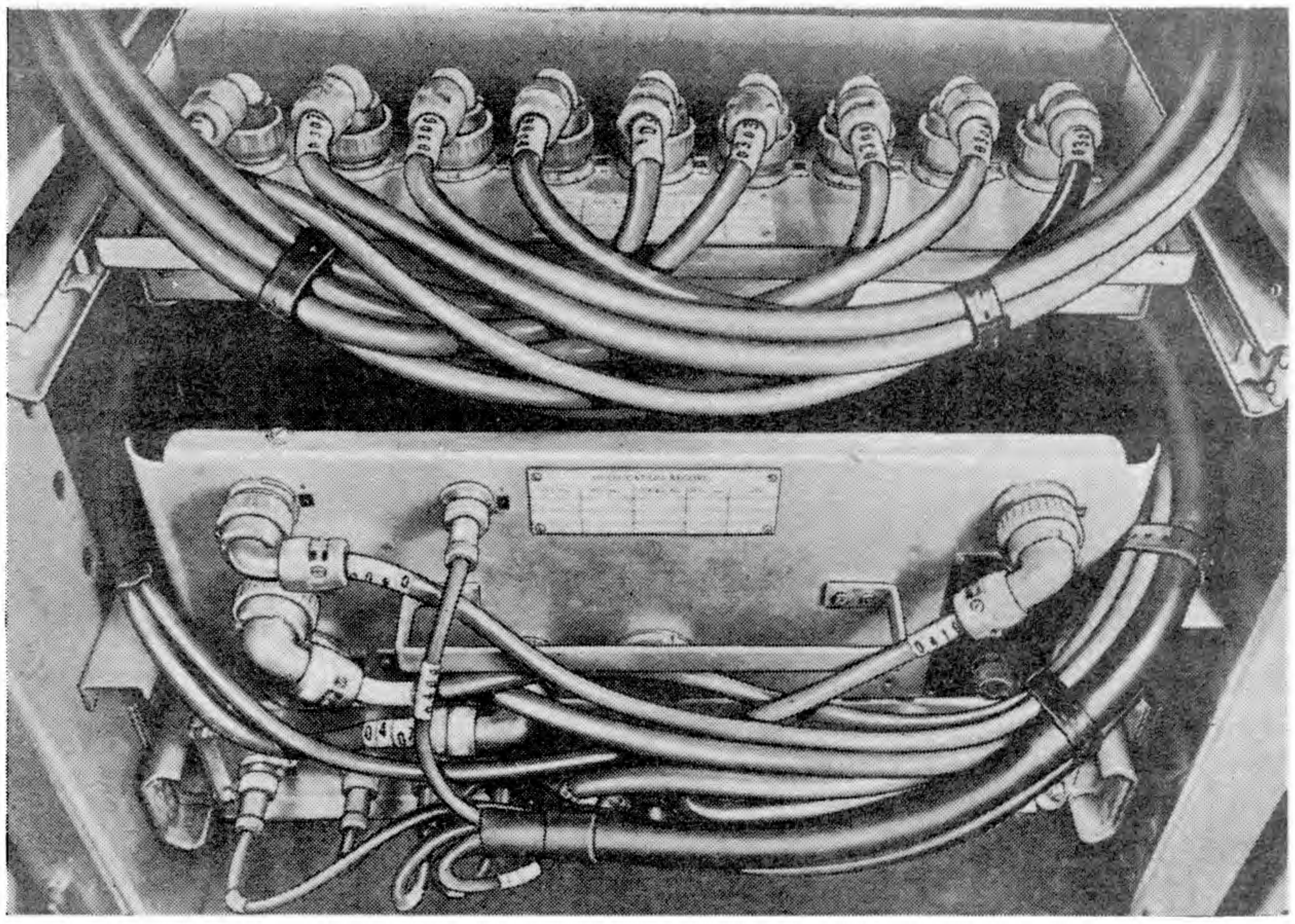


**Fig. 5. Cabling of panel Type 890 and amplifying unit Type 515**

**Rack assembly Type 302**

**21.** Here again the units are mounted side by side on trays. The drive unit of the azication resolver is identical with that of the magslip resolver already described. The sine/cos. potentiometer is at the end occupied by the magslip in the RA301 resolvers. Illustrations are given in the descriptive chapter in Part 1. If it should become necessary to replace the potentiometer, the assembly may be removed from the main carcase by taking out the three ¼-in. bolts which secure it.

**Rack assembly Type 304**

**22.** Once more the units are mounted side by side in pairs, on trays, as in the RA300, and they are removed in the same way. The components are easily accessible for servicing and there are no sub-assemblies to dismantle.

**Rack assembly Type 305**

**23.** The units in this bulk power supply rack are mounted slightly differently from those in the racks already described. The rectifier unit Type 100, the stabilizer Type 100, the rectifier units Types 101 and 102, and the relay unit Type 184 are mounted beneath each other, in the order given, on pairs of telescopic runners, each unit being secured to its runners by two screws at each side. In addition, each unit is held in the rack by two screws, one at each side. With these unscrewed and the rear connectors detached, the units may be slid out on the runners, the four fixing screws released and the units lifted clear of the rack. Two men are required for lifting because of the weight of the transformers and chokes in the units. Once the units are on the servicing bench the replacement of components follows normal practice.

**24.** The main transformer in the base of the rack is also mounted on runners. It cannot be withdrawn until its rear sockets have been disconnected (with the power supply OFF) and the two fixing lugs at the bottom front corners loosened; then it will slide out on its runners. Access to the terminals is obtained by removing the cover plate. To remove the transformer from the rack entirely, the input terminals (400V, 3-phase, 50 c/s input) must be disconnected and the ends of the cables taped up as a safety precaution. After releasing the transformer from its fixing bolts at the base, it may be lifted by a rope passed through the two rings, mounted on the top at diagonally opposed corners. The cover plate may be replaced to protect the terminals, but no attempt should subsequently be made to lift the transformer by the cover plate, which is not strong enough for this purpose.

**25.** The dismantling of the magnetic relays and the time delay relay is a specialized subject outside the scope of this volume. Special equipment is required for servicing these components and no adjustments should be made to them by inexperienced personnel. Reference should be made to A.P.2487, Vol. 1 (*Telephone, Telegraphic and Automatic Switching Equipment*) for guidance on the subject. If erratic operation is caused by contacts becoming slightly oxidized, they may be burnished by rubbing a 0·002-in. feeler gauge gently between them and cleaned by drawing a strip of unglazed paper between them. It must be remembered, however, that the slightest speck of fluff or dust (particularly magnetic dust in the relays) will upset the delicate mechanism, and the greatest care should be taken to prevent such contamination if the covers should be removed from the relays.

**Rack assembly Type 306**

**26.** The two distribution units (ITBU) are mounted side by side with their respective power units Type 903 on two trays, fixed to sliding runners as described for the RA300, and the method of release is the same. The other two principal units, panel (switching) Type 876 and relay unit (azication change-over) Type 192, are equipped with flanges and are secured to mounting brackets at each side of the rack by ¼-in. BSF screws passing through the flanges. These units may be removed from the rack after disconnecting the plugs and sockets at the front and removing the side screws. The change-over switch (SWA-SWB) is then accessible from the rear of the panel 876. The relays on the AZ c/o unit Type 192 are accessible from the front.

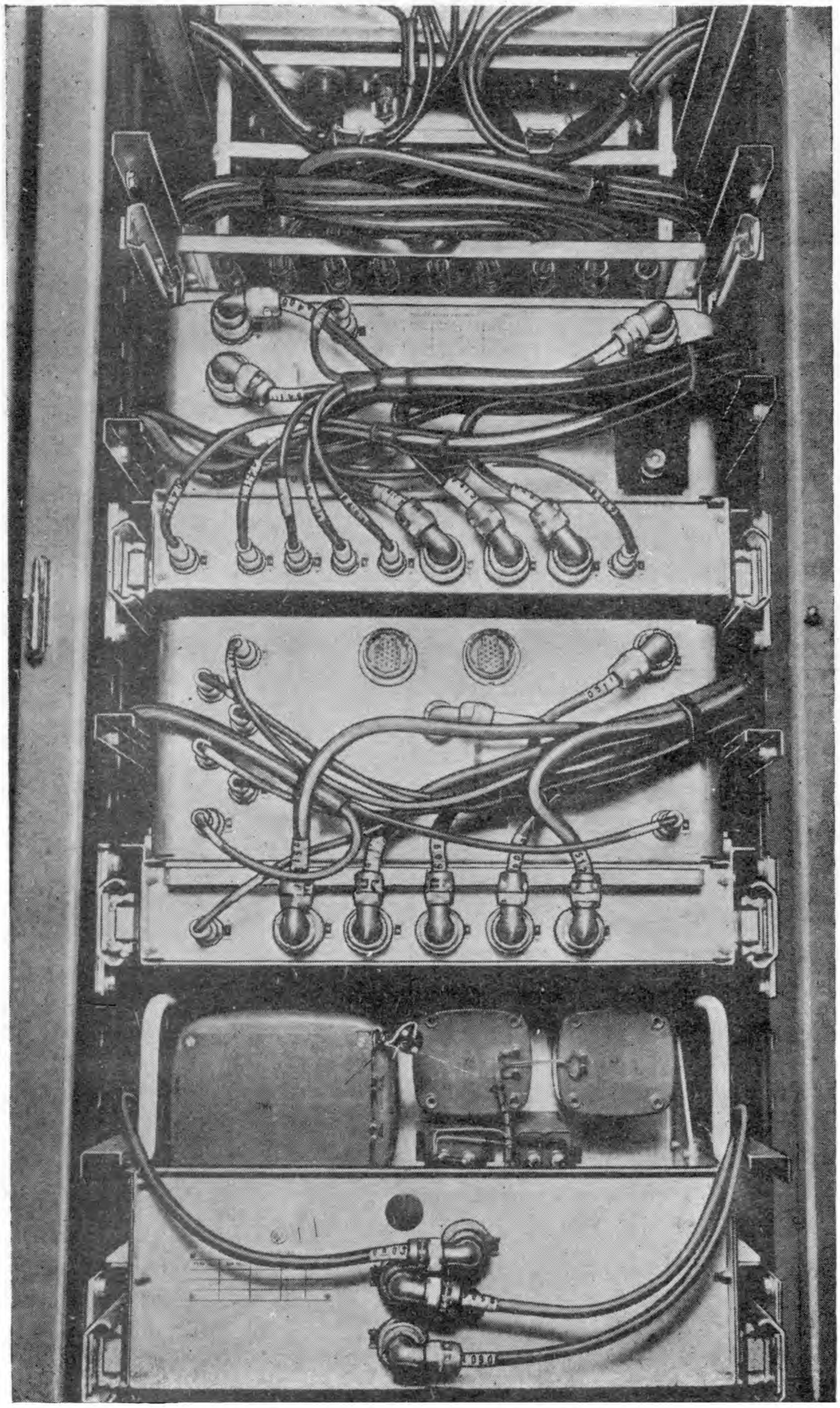


**Fig. 6. RA339—lower units pushed in**

**27.** Particular care should be taken, by referring to the cable numbering, to ensure that the coaxial plugs are replaced correctly when the panel Type 876 is returned to the rack. Similar care should be taken with the Type 192 unit connectors, although the possibility of error has been minimized by using different moulding orientation positions for the two sets of Mk. 4, 6-way connectors.

**Rack assembly Type 338**

**28.** The two power units Type 906 and the relay unit (change-over) Type 196 are mounted on runners and may be released by unscrewing the fixing screws. There are no detachable sub-assemblies, but the components are readily accessible with the units removed to the servicing bench. For the relay units Type 185, vertical rectangular mounting frames are fitted to the front and rear of the rack, and each relay unit may be removed after unscrewing the four captive screws, two on each side. The relay covers may be withdrawn for inspection of the relay contacts.

**KEY TO FIG. 7, 8 AND 9**

- **A** $\frac{1}{4}$-IN. BSF × $\frac{5}{8}$-IN. HEXAGONAL HEAD BOLT
- **B** MAGSLIP ROTOR SHAFT
- **C** SOCKET ON MAGSLIP COUPLING PLATE
- **D** STUD MATING WITH ITEM C
- **E** AUTO-ALIGN CAM
- **F** SECTOR SELECTION CAM
- **G** HAND DRIVE
- **H** MAGSLIP CARCASE
- **J** $\frac{1}{4}$-IN. CLEAR, FIXING HOLES

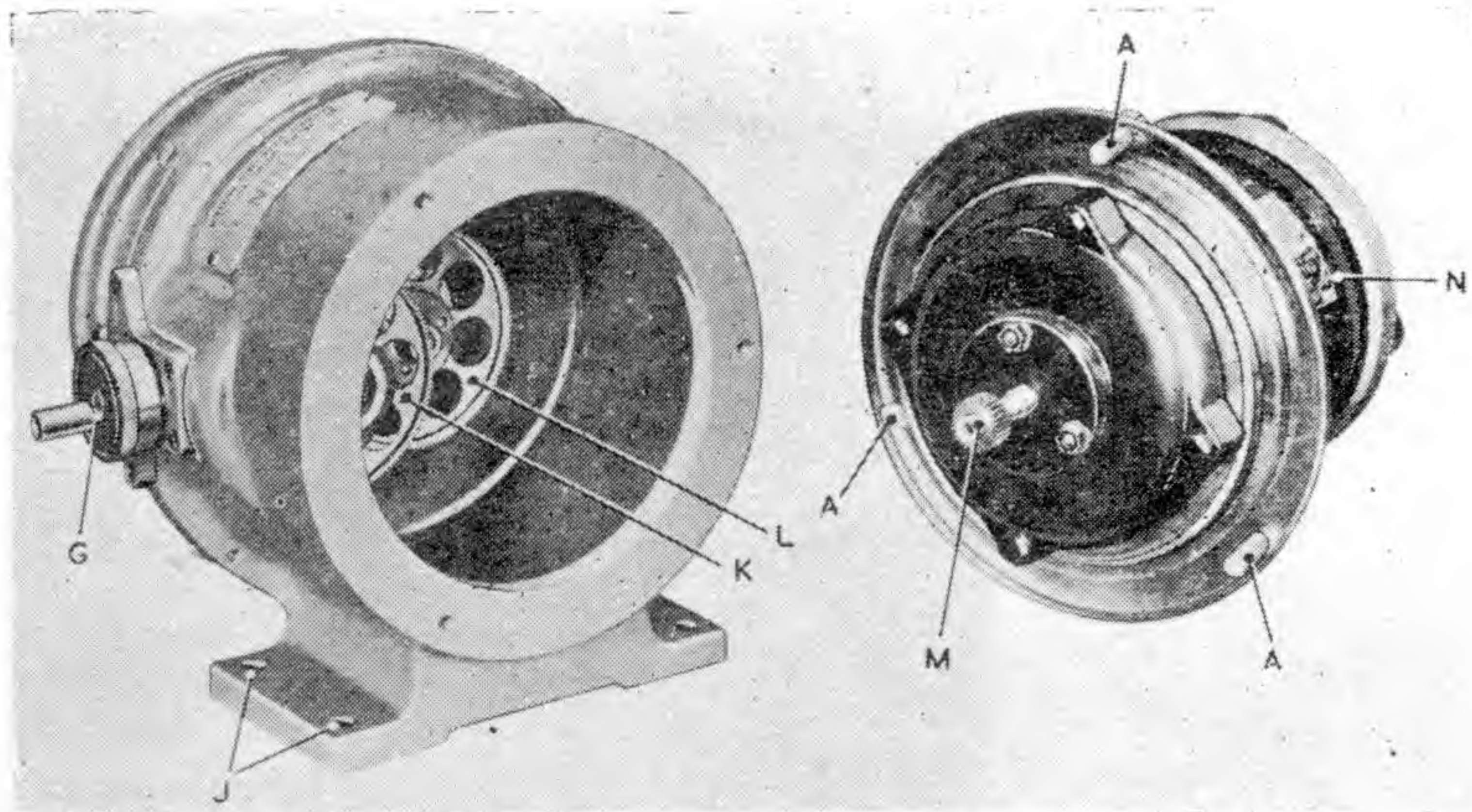



**Fig. 7. Resolver unit (magslip)—selsyn coupling and gearbox**

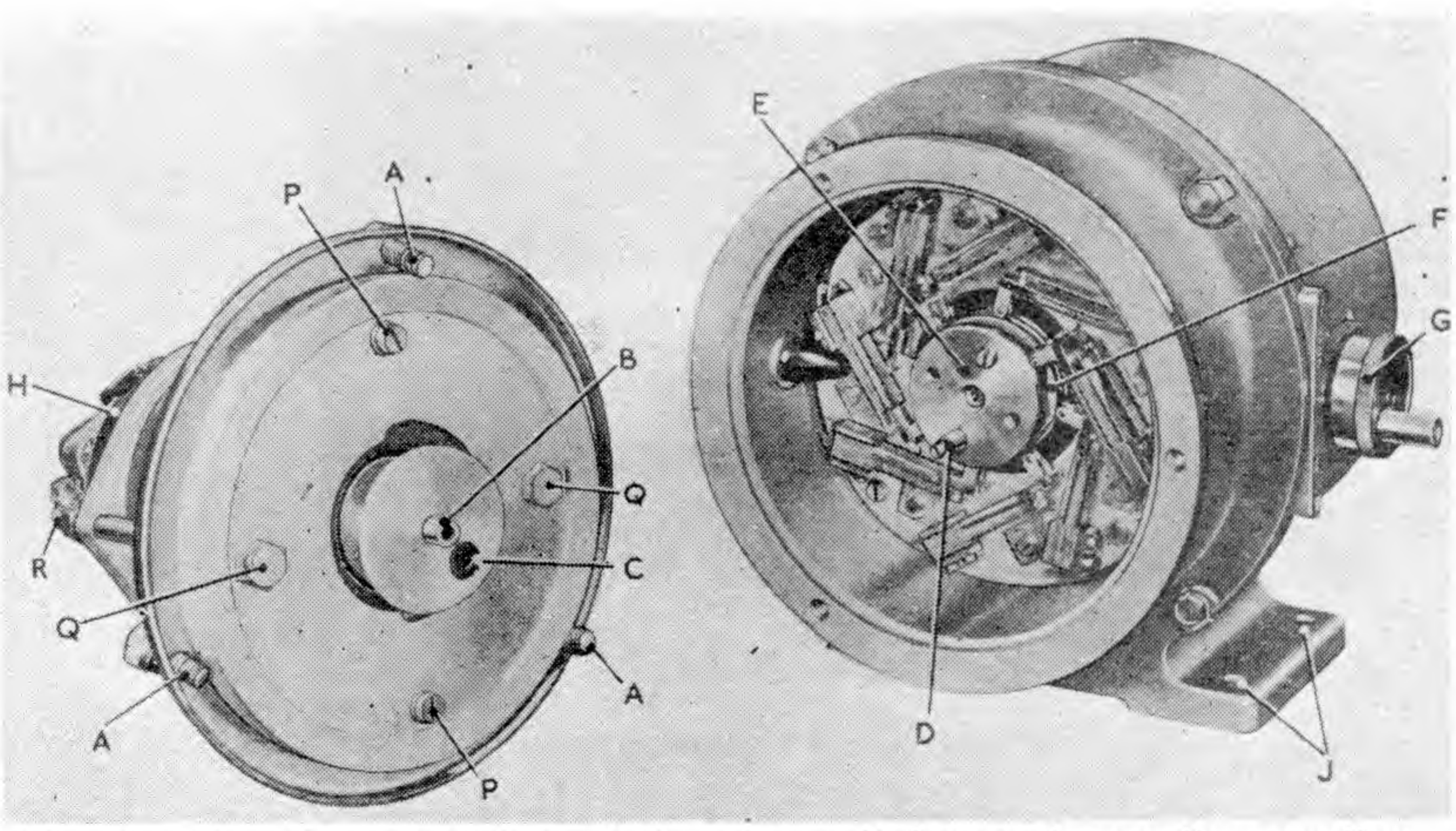
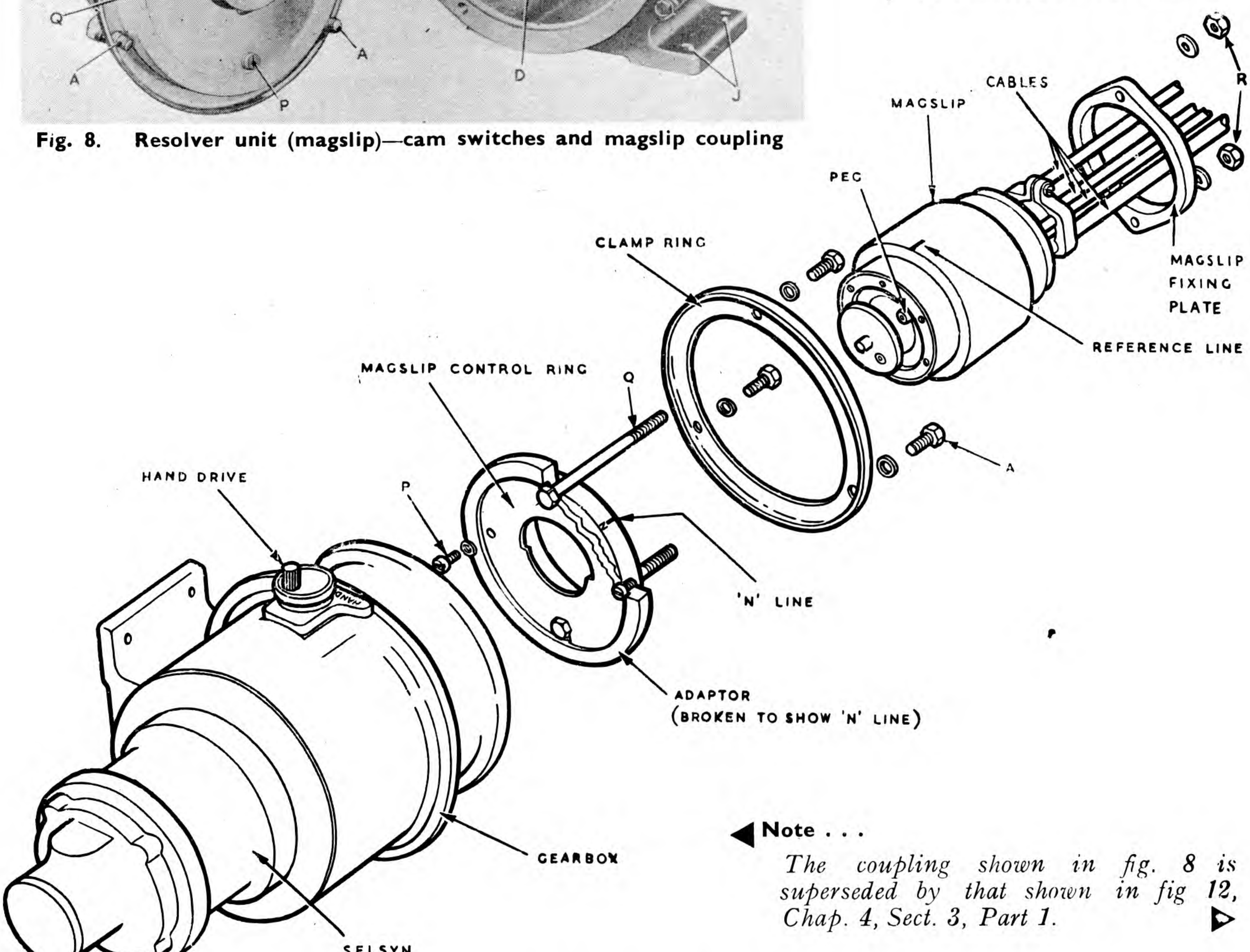



**Fig. 8. Resolver unit (magslip)—cam switches and magslip coupling**

- **K** 150-TOOTH GEAR-WHEEL ON LAY-SHAFT
- **L** 150-TOOTH GEAR-WHEEL ON MAGSLIP DRIVE-SHAFT
- **M** 30-LEAF PINION ON SELSYN SHAFT (MESHES WITH K)
- **N** SELSYN CARCASE
- **P** 2 BA × $\frac{1}{2}$-IN. CHEESEHEAD SCREW
- **Q** $\frac{1}{4}$-IN. BSF × 4-IN. HEXAGONAL HEAD BOLT
- **R** $\frac{1}{4}$-IN. HEXAGONAL HEAD STIFFNUT




◀ **Note . . .**

*The coupling shown in fig. 8 is superseded by that shown in fig 12, Chap. 4, Sect. 3, Part 1.* ▷

**Fig. 9. Resolver (magslip)—assembly of magslip to gearbox**

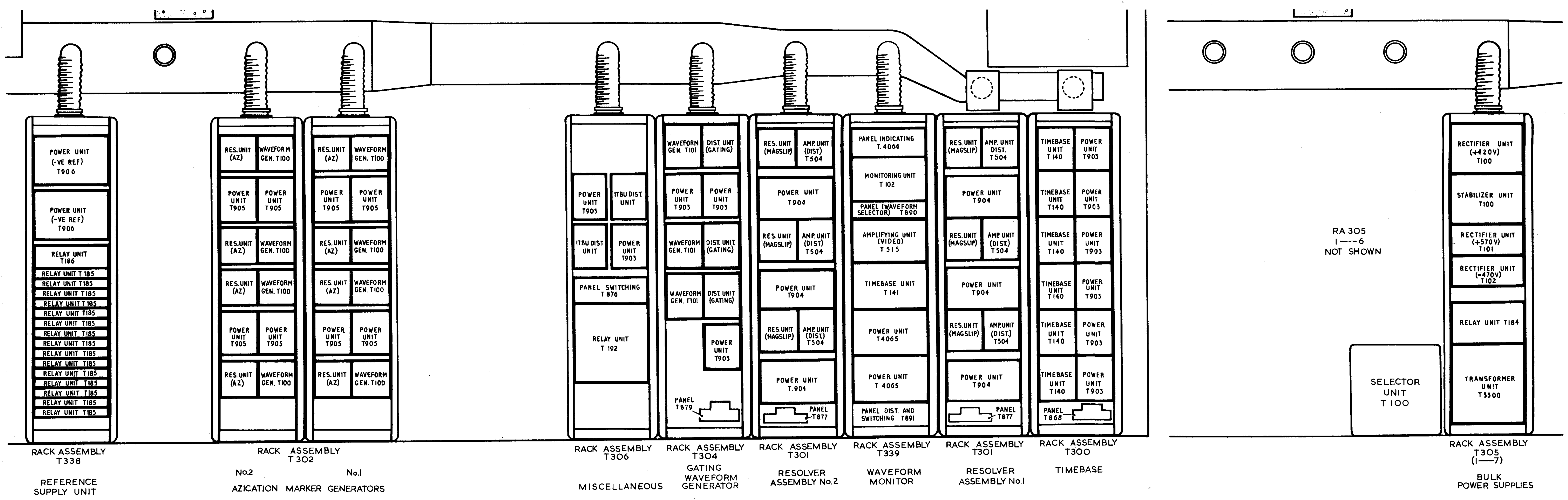



Fig.10

Typical arrangement of fixed-coil racks

Fig.10

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(A.L.13, Aug, 55)

# PART 3

# FAULT DIAGNOSIS



P30866 567650/4942 3/61 125 C & P Gp 375

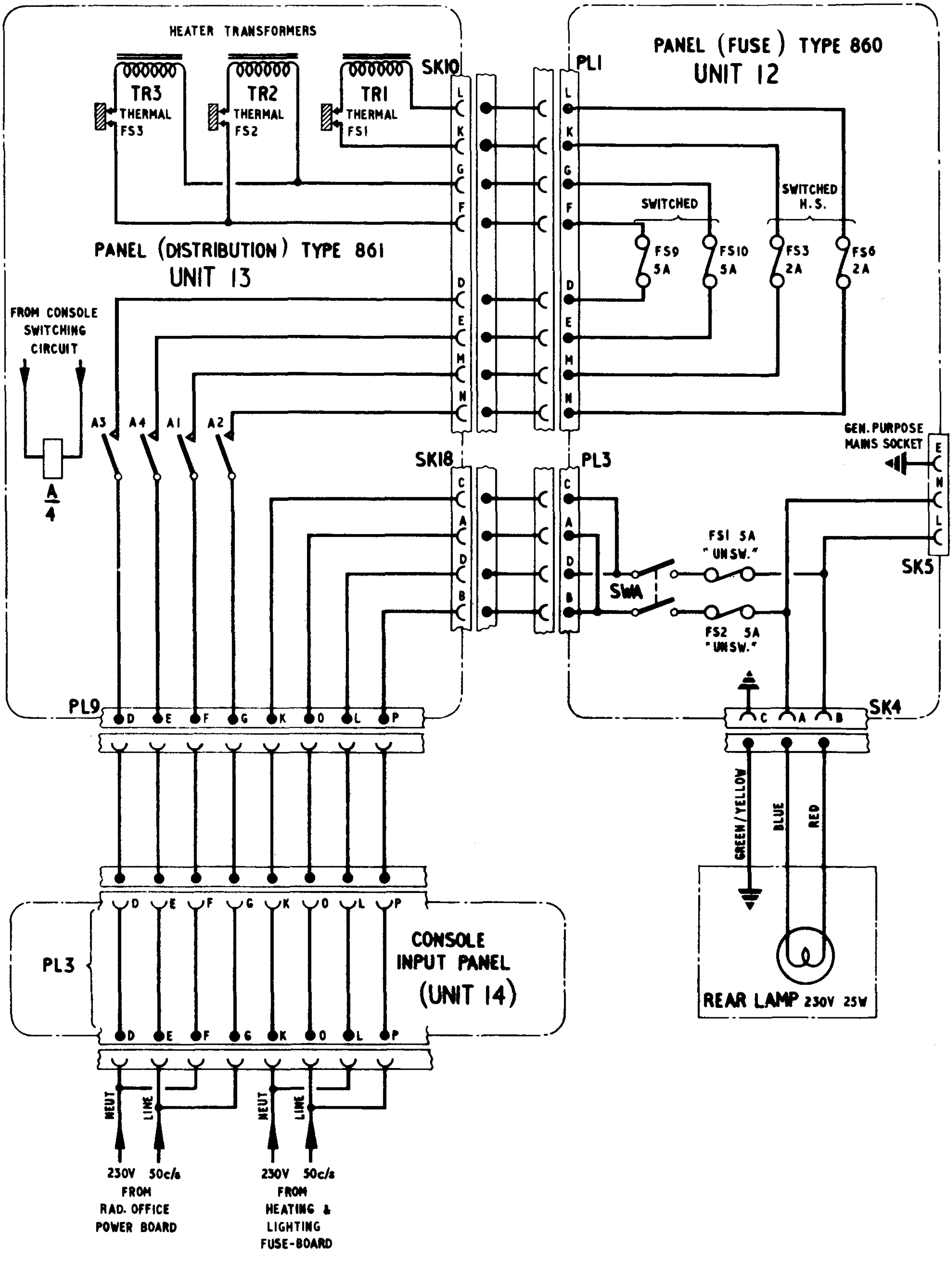
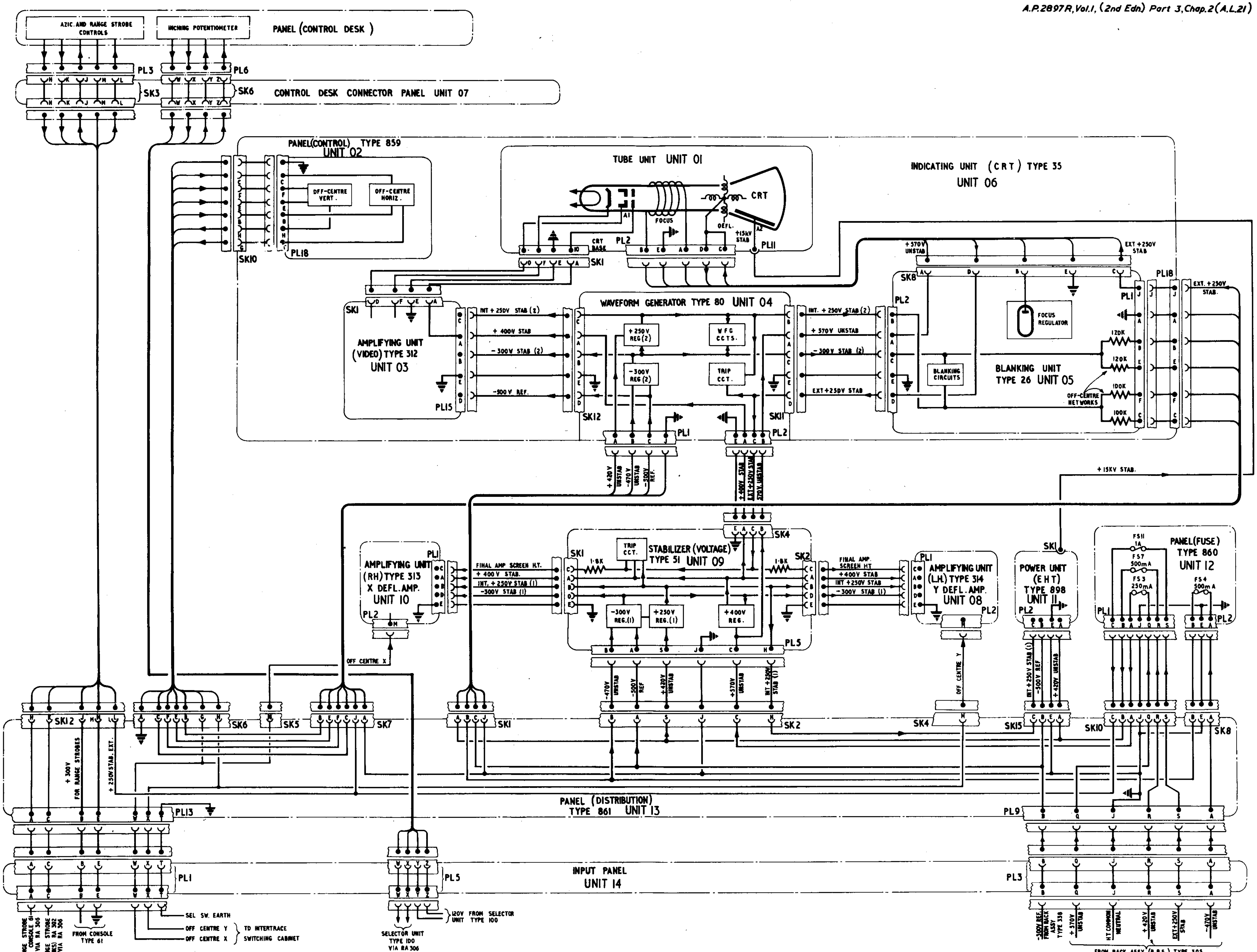



Fig. 1. 230V 50c/s circuits on console Type 64




AIR DIAGRAM 6222Z/MIN.

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HT reference and control voltage circuits on console Type 64

Fig.2

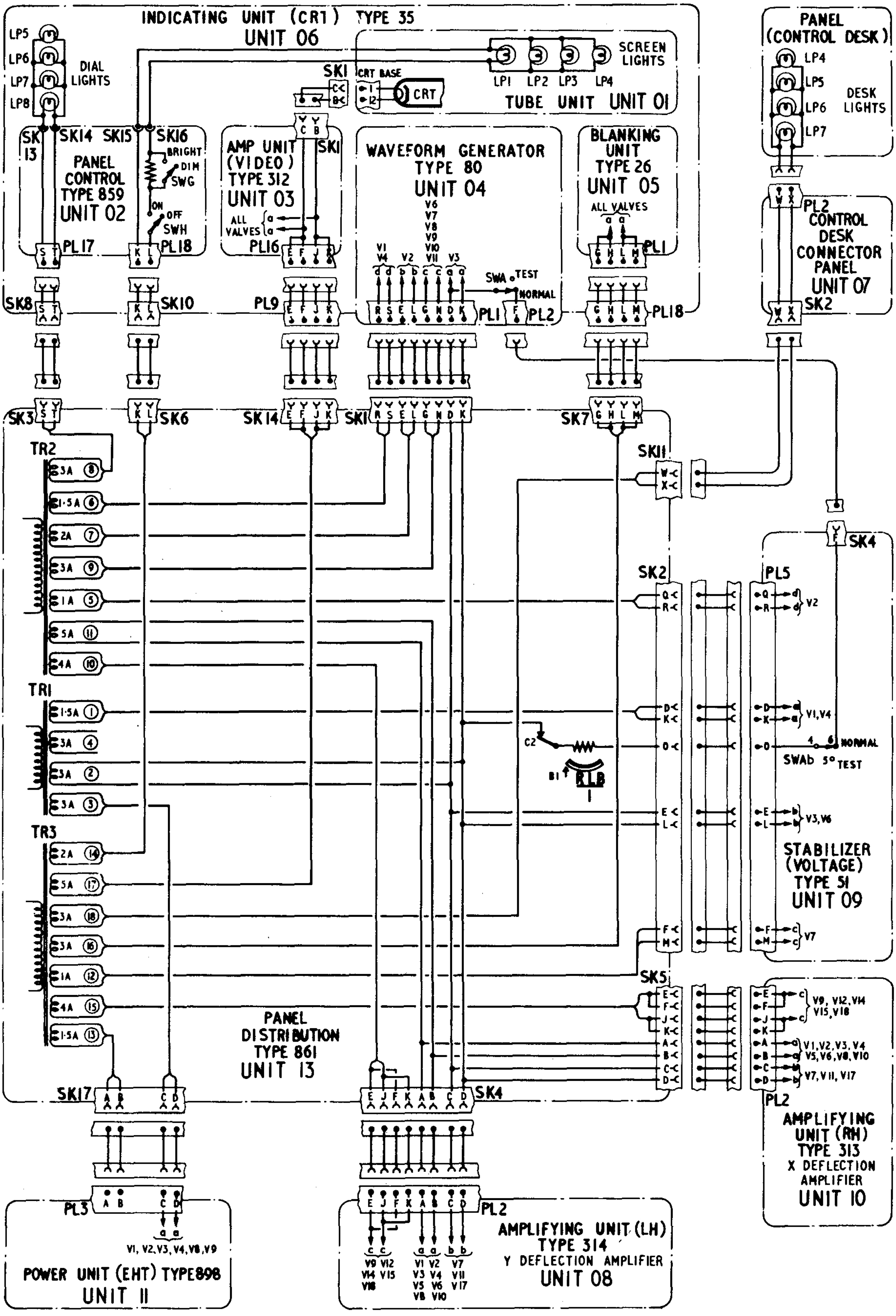


Fig.3 6·3V 50c/s circuits on console Type 64

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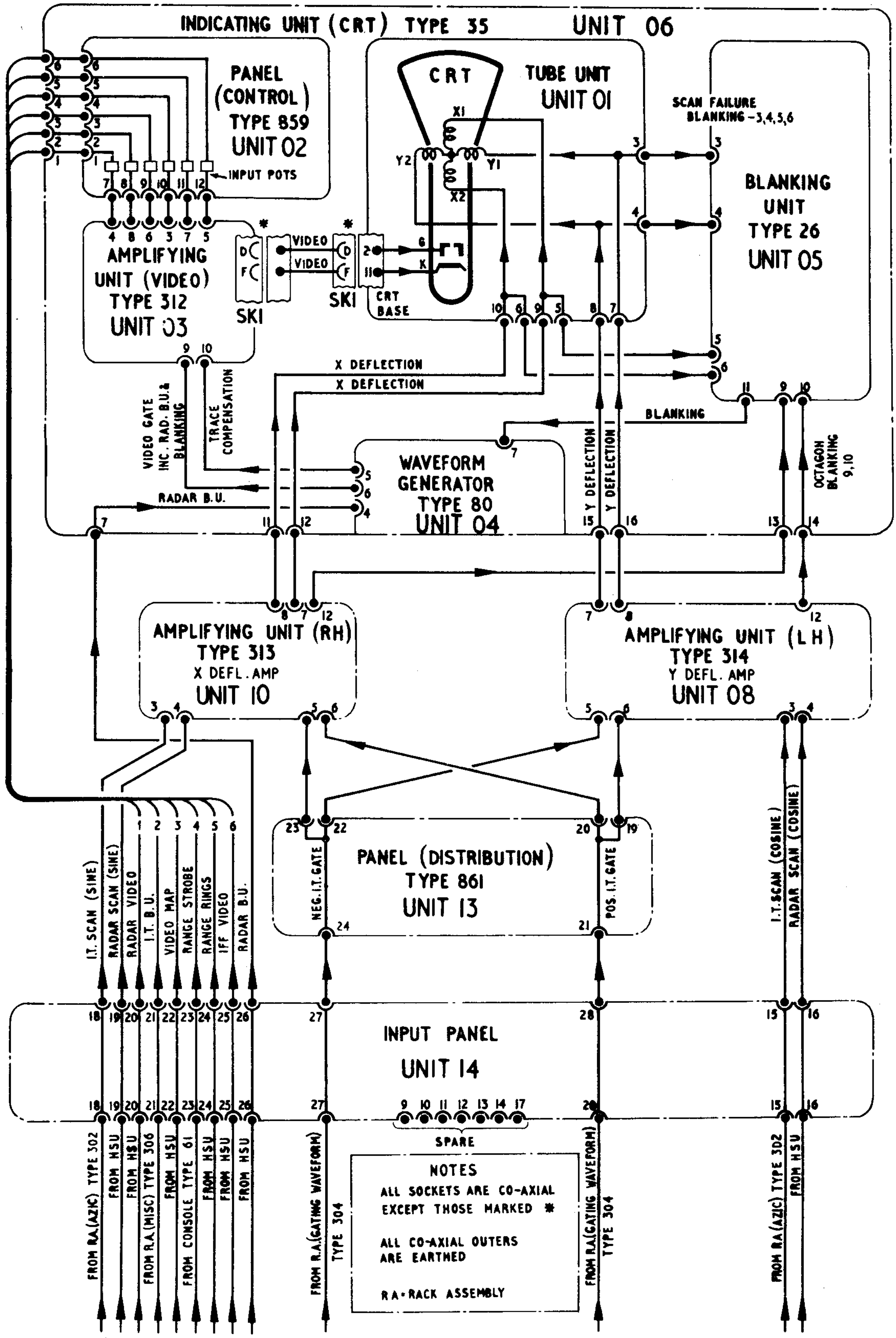


Fig.4. Co-axial and video services on console Type 64

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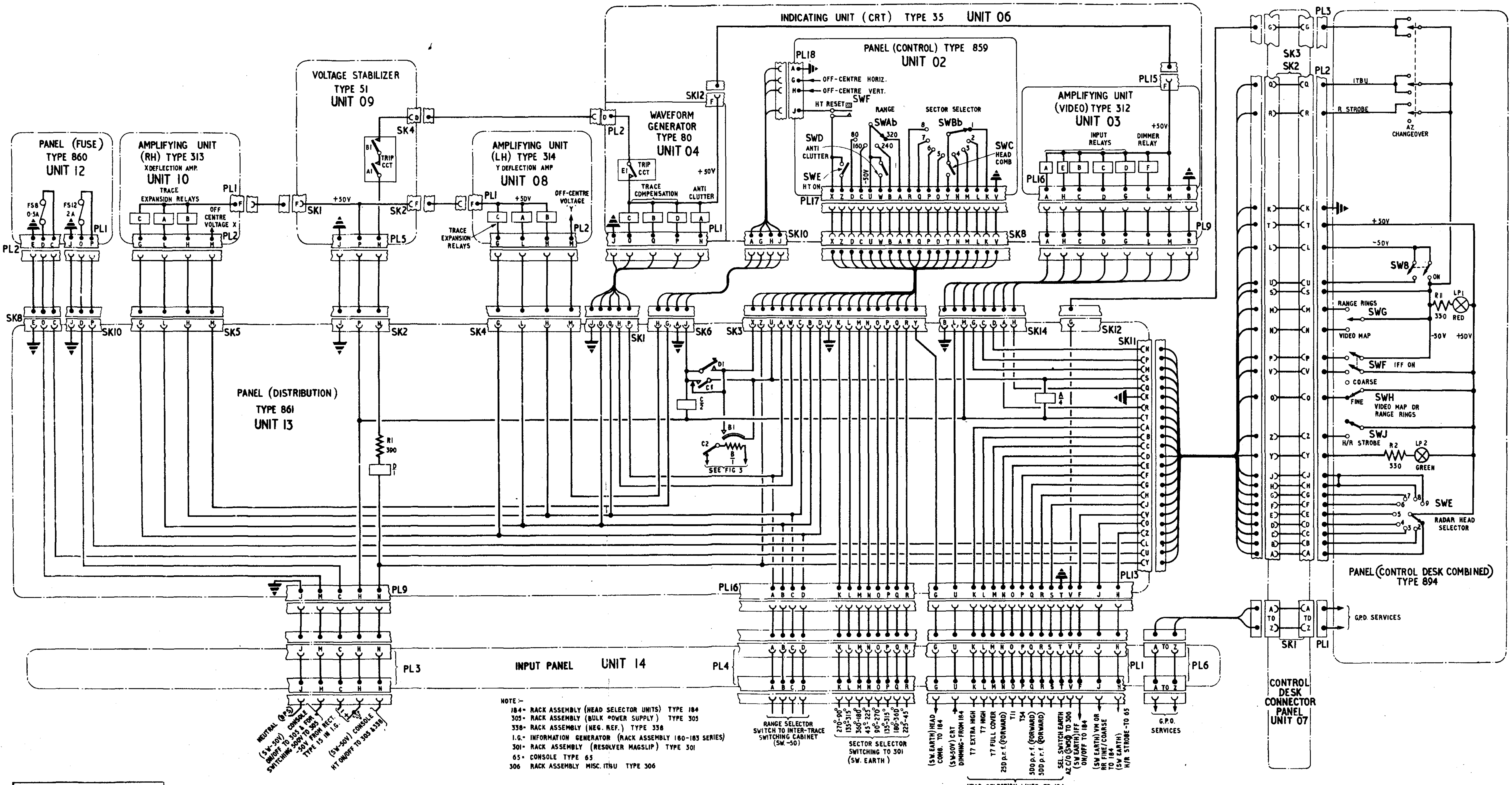


50V Switching circuits on console Type 64

Fig.5

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