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AIR PUBLICATION

**2897R**

VOLUME 1

(Second Edition)

BOOK 1

L. 75

**FIXED COIL DISPLAY SYSTEMS  
FOR GROUND RADAR  
STATIONS**

**(RACK ASSEMBLIES)**

**GENERAL AND TECHNICAL INFORMATION**

Prepared by direction of  
the Minister of Aviation

*Henry Handway*

Promulgated by Command  
of the Air Council

*H. J. Dean*

**AIR MINISTRY**

Reprinted Feb. 1961



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# **DANGER-HIGH VOLTAGE**



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## LAYOUT OF A.P.2897R

### ◀ FIXED COIL DISPLAY SYSTEMS FOR GROUND RADAR STATIONS ▶

*Heavy type denotes the books being issued under this  
A.P. number; when issued they will be listed in A.P.113*

<b>VOLUME 1</b>	<b>Leading particulars. General and technical information</b>
<b>VOLUME 2</b>	<b>General orders and modifications</b>
<b>VOLUME 3, Part 1</b>	<b>Schedule of spare parts</b>
<b>VOLUME 3, Part 2</b>	<i>Inapplicable</i>
<b>VOLUME 3, Part 3</b>	Scales of unit equipment <i>(application to be decided later)</i>
<b>VOLUME 3, Part 4</b>	Scales of servicing spares <i>(application to be decided later)</i>
◀ <b>VOLUME 4</b>	<b>Planned servicing schedules</b>
<b>VOLUME 5</b>	<i>Inapplicable</i>
<b>VOLUME 6</b>	<b>Repair and reconditioning instructions</b> <i>(to be issued later)</i>

## 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.▶



## 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

	<i>A.P.</i>
◀ <i>Radar Type 13 (Mk. 6 and 7) and 14 (Mk. 7, 8, 9, 10 and 11) RVT</i> <i>500, 501, 502 and static versions</i> ....	2527B▶
<i>Information generator for radar stations</i> . ....	2527C
<i>Test equipment for mobile and static radar stations</i> ....	2527D
<i>Information generation and distribution for static radar stations</i> ....	2527E
<i>Static radar stations:</i>	
<i>Type CHEL</i> ....	2527F
<i>Type CEW</i> ....	2527G
<i>Type GCI</i> ....	2527H
<i>Mobile operations room Type 1 (RVT.510)</i> ....	2897Q
◀ <i>Consoles Type 60 and 60A</i> ....	2897NA
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<i>Console Type 65</i> ....	2897S
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  - 2 Description of fixed-coil display system (GCI stations, phase 1 installations)
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**PART 1**

**LEADING PARTICULARS AND  
GENERAL INFORMATION**

## **SECTION 1**

# **GENERAL DESCRIPTION**

## Chapter 1

# PRINCIPLES OF FIXED-COIL PPI DISPLAYS

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#### Introduction

##### Scope of chapter

1. In this chapter the principles of fixed-coil PPI display technique are explained in a general manner and certain terms and phrases peculiar to this type of equipment are introduced and defined. It must be realized that the use made of the different facilities here described is bound to depend on the stage of installation reached and on operational requirements; the description of any particular display facility included in this chapter should therefore not be taken as any indication that it will be available on any particular station. No attempt is made here to describe the actual circuits and interconnections used; for these, reference should be made to subsequent chapters of this publication.

##### PPI display

2. The plan-position indicator (PPI) is a form of cathode-ray tube radar display which is widely used in both ground and airborne radar equipment. In its usual ground radar application (*fig. 1*) the PPI provides a "realistic" display of target movements in relation to the station itself. The term "realistic" is used because the display takes the form of a plan of the scanned area centred on the radar station, on which targets, prominent landmarks and coastlines appear in their correct map relationship. From

such a display the position of a target may be read off either as a range and a bearing angle, or as a grid reference from a map superimposed on the screen.

3. The principle of the PPI display involves the use of a cathode-ray tube with a linear trace. In the case where the picture is centred on the tube face, the spot starts off from the centre of the screen at the instant the radar pulse is transmitted, and moves in a straight line with constant velocity towards the circumference of the tube. The direction of the radial line so formed on the screen is usually arranged to be the same as the direction in which the radar aerial itself is pointing, the top of the screen being taken as geographical North. The trace is arranged to rotate in synchronism with the aerial by the use of some angle-transmission system, so that the directions of each are always the same.

4. When a radar echo is received from a target it is applied to the display system in such a manner as to brighten the trace momentarily. The distance of the resulting bright mark from the display centre is clearly proportional to the range of the target from the station, because the time  $t$  between transmission of the pulse and receipt of the echo is proportional to the target range, and the distance traced out on the screen

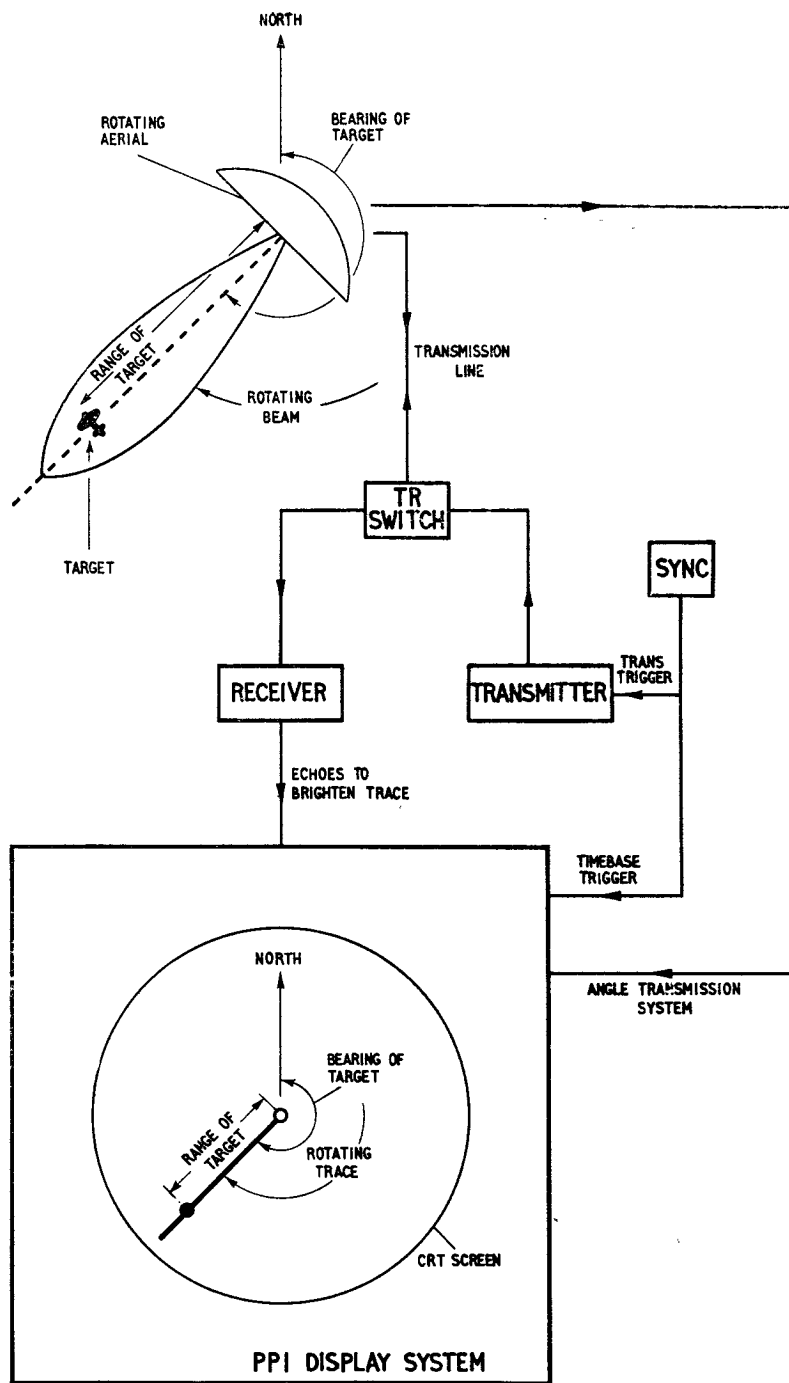


Fig. 1. PPI for ground radar

by the spot is also proportional to  $t$  because of the constant spot velocity.

5. If the CRT screen has a long afterglow, one revolution of the trace "paints" a complete plan of all targets in the area which return echoes to the station before the trace ends. The centre of the display, since it corresponds to zero range, must represent the station itself.

6. A map of the region may be superimposed on the screen in order to show the relation of targets to geographical features or grid squares. This map may take the form of an engraved trans-

parency placed over the screen, or it may (as in the present system) be produced electronically by "video-map" signals separately produced and mixed in with the ordinary radar signals for brightness modulation of the trace.

#### Methods of producing PPI displays

7. The various different methods of producing a rotating trace for PPI display purposes are set out in fig. 2. The two principal groups are:—

- (1) Mechanical trace rotation methods.
- (2) Electronic trace rotation methods.



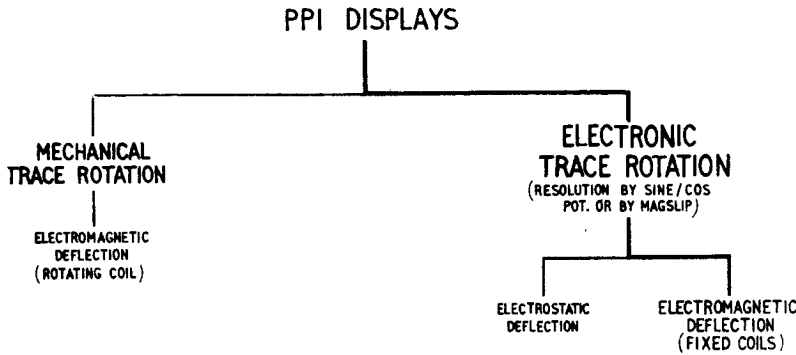


Fig. 2. PPI display methods

10. When the transmitter fires, the timebase circuit is fired simultaneously (usually by the same sync pulse) and the current starts to increase in a linear manner. A steadily increasing magnetic field is thus produced across the path of the electrons, so deflecting the beam in a direction perpendicular to the axis of the coil system and producing a linear trace on the screen.

11. To make the trace rotate, the coil system is rotated (often by a selsyn angle-transmission

The chief features of these are set out in the following paragraphs.

**Mechanical trace rotation**

8. The only important example of mechanical trace rotation is the well-known rotating deflector-coil principle. This principle has been widely used in ground radar display systems, including those using the console Type 16 (display unit Type 5) and the console Type 60.

9. In the rotating-coil system a single deflector coil is mounted so that it may be rotated about the neck of the CRT (fig. 3). Through this coil system is passed a sawtooth current waveform as shown in fig. 4. Before the transmitter is fired, the coil current is zero, so no deflecting magnetic field is produced and the spot remains at the centre of the screen. Exact spot centring is usually obtained by the use of auxiliary shift coils.

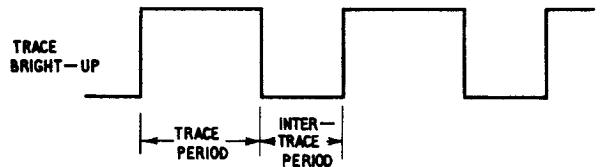
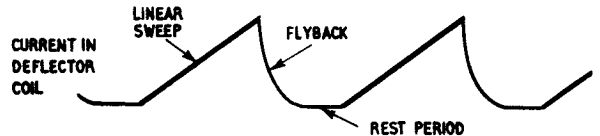


Fig. 4. Waveforms for rotating-coil PPI

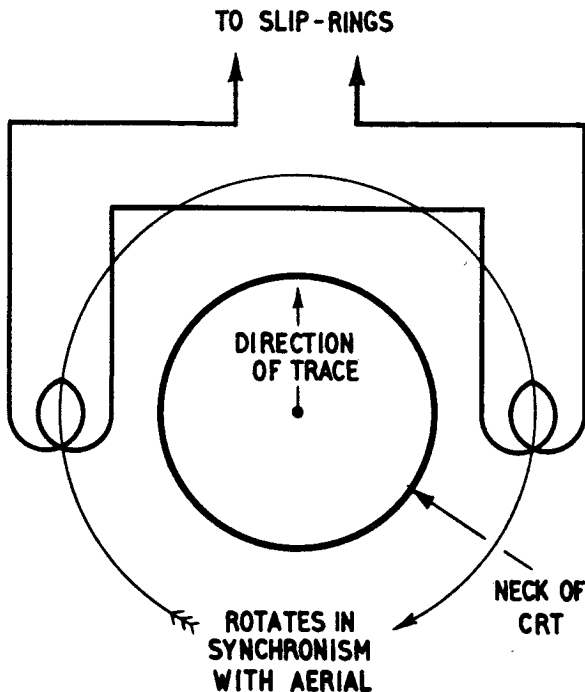


Fig. 3. Rotating deflector coil

system) in synchronism with the aerial, the deflection current being supplied through slip-rings. Since the trace duration is very short compared with one period of aerial rotation, there is no tendency to curvature of the trace.

**Bright-up waveform**

12. It is usual to brighten up the trace itself and to black out the inter-trace period which includes the flyback and the rest period (fig. 4). To do this a waveform of the type shown in fig. 4 as "trace bright-up" is applied to the CRT grid, with radar and other video signals superimposed.

**Features of rotating-coil system**

13. With the rotating-coil system, the inter-trace period cannot easily be used for the electronic display of auxiliary information such

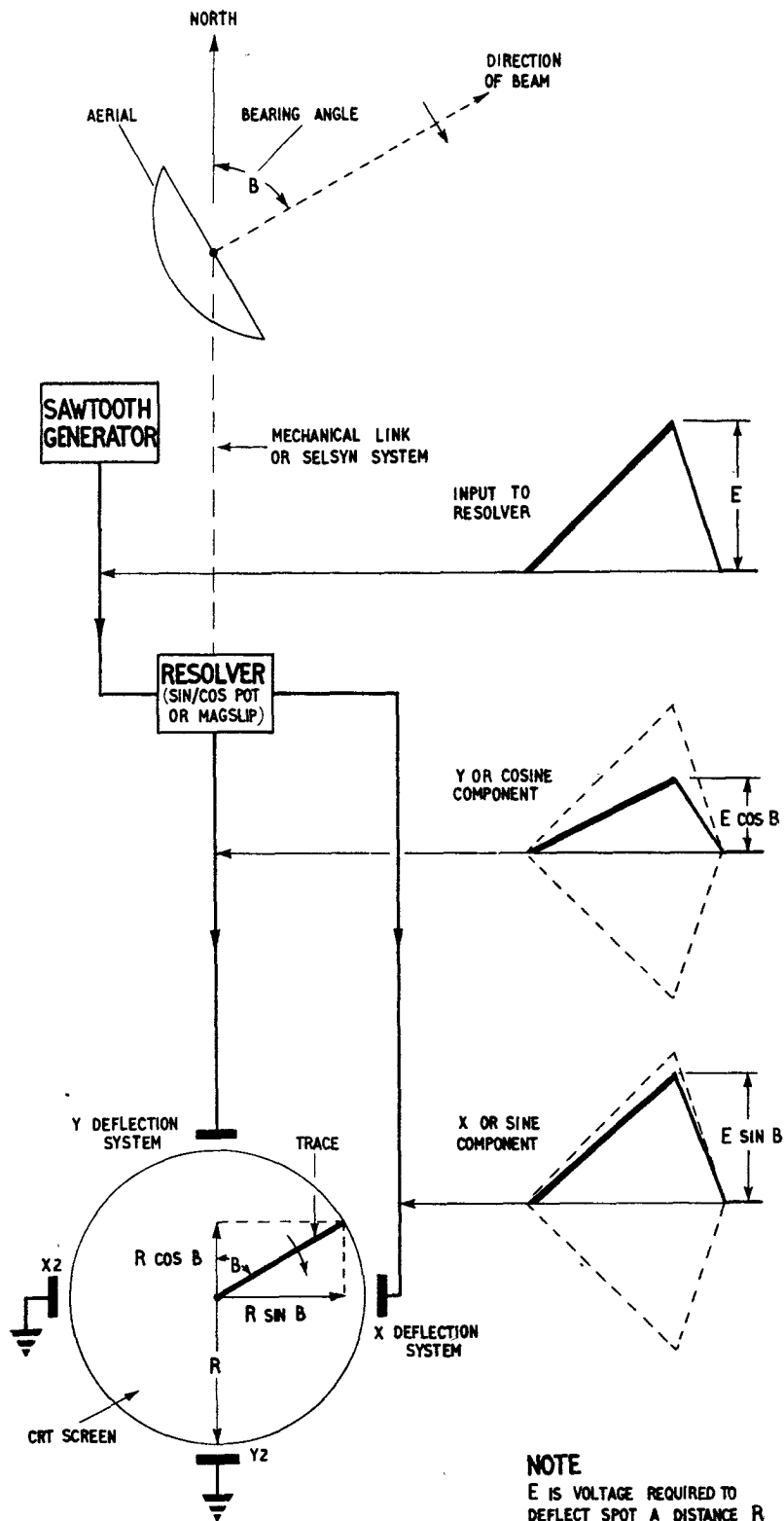


Fig. 5. Electronic trace rotation

as inter-console or azication markers. For these, which are necessary to indicate to a PPI operator the bearing on which an associated height-finding aerial is "nodding", it is necessary to use some associated optical-mechanical device, such as the line-of-light facility on the console Type 16

(D.U.5), or the azication cursor on the console Type 60. A limitation of such devices is that they cannot be used with an off-centred picture. In any case, off-centring is much more difficult to obtain with a rotating-coil PPI than it is with a fixed-coil (*para.* 48).

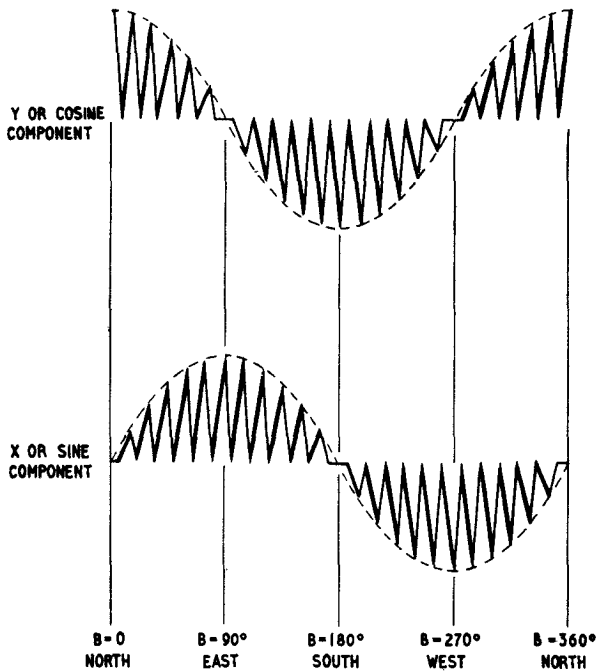


Fig. 6. Variation of sawtooth components

14. With the rotating-coil system, it is possible to obtain, by suitable switching, a "back-to-back" display showing radar information from two different heads pointing in opposite directions; but it is not normally possible to achieve an interlaced display showing information from several independent aerial heads. This latter facility is quite possible with a system having electronic trace rotation, though it is not at present used in the fixed-coil system.

15. The mechanical devices used for rotating the deflector-coil system and the azication marker (including selsyns and reduction gearing) necessarily occupy a considerable space; in consequence a rotating-coil PPI console is usually rather bulky.

#### Electronic trace rotation

16. A rotating trace linked with an aerial for PPI display can also be produced by purely electronic means (electronic so far as the display console itself is concerned, though there will usually have to be some mechanical resolvers, etc., elsewhere on a station). For any one aerial position it is necessary to resolve the timebase sawtooth waveform into two components at right-angles (*fig. 5*), one component being normally in the Y or North-South direction, the other in the X or East-West direction. Resolving a waveform means resolving the amplitude of the waveform at each instant; the process may be compared with the method of locating a point on a map by two grid references, one expressing displacement from a fixed point in an easterly direction, the other in a northerly direction. The combined effect of the two components on the CRT deflection system will be to form a straight

trace pointing in the desired direction on the screen, and this trace will rotate in synchronism with the aerial as the magnitude and polarity of the two components change.

#### Electrostatic deflection

17. Where electrostatic deflection is in use, a linear sawtooth voltage waveform is required from the sawtooth generator; the amplitude  $E$  of this original sawtooth must be sufficient (after amplification by one or other timebase amplifier) to sweep the spot from the screen centre through a distance  $R$  to the circumference. This sawtooth is then resolved into the two components, as shown by the heavy lines in *fig. 5*. The cosine component is applied to the Y-plate, and the sine component to the X-plate, after equal amplification of each. The combined effect of the two components on the spot is to sweep it from the centre to the outside in a direction corresponding to that of the aerial. As the aerial rotates, the sawtooth components vary in the manner shown in *fig. 6*, and the trace rotates in synchronism. The dotted lines in *fig. 5* show the extreme values (both positive and negative) taken by the components; it should be noted that when the Y component is at its maximum (corresponding to a vertical trace) the X component is zero, and vice versa.

#### Electromagnetic deflection

18. Where electromagnetic deflection is in use, it is necessary to convert the voltage waveforms of *fig. 5* into current waveforms of the same shape, in the X and Y deflector coil systems (corresponding to the line and frame coils in television receivers), which are mounted round the CRT neck. Unlike the deflector coil in the rotating-coil system, these coils are permanently fixed in position; the system of producing a PPI display using electronic trace rotation with electromagnetic CRT deflection is therefore referred to as the *fixed-coil* system. In the console Type 64, as used in the present system, electromagnetic deflection has in fact been used, mainly because of the superior trace brilliance and focus obtainable; it is therefore referred to as a fixed-coil console.

19. In consequence of the use of electromagnetic deflection, X and Y timebase amplifiers are necessary to convert the voltage waveforms of *fig. 5* into closely similar current waveforms in the coils. These amplifiers are therefore sometimes referred to as "voltage-to-current converters" or "current amplifiers". In the following paragraphs, when reference is made to voltage deflections waveforms, it must therefore be understood that they are, in the present system, subsequently converted into current deflection waveforms in the deflector coils, by the timebase amplifiers.

20. The actual process of resolving the original sawtooth into sine and cosine components may be performed either by a sine/cosine potentio-

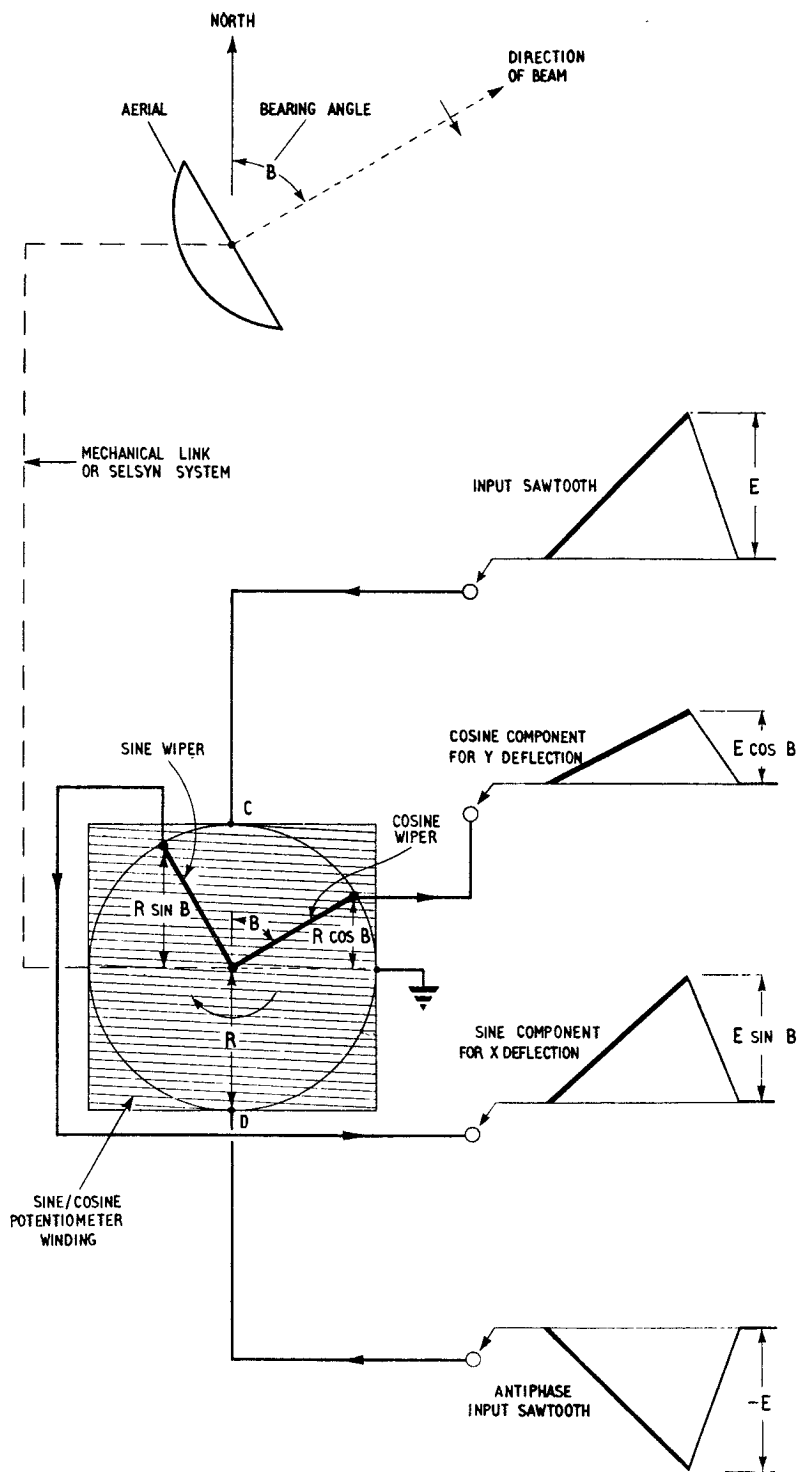


Fig. 7. Sine/cosine potentiometer resolver

meter or by a magstrip; the principles of these two methods are set out in the following paragraphs.

#### Sine/cosine potentiometer resolver

**21.** One established method of resolving a time-base sawtooth into sine and cosine components is by the use of a sine/cosine potentiometer. The most familiar form of this consists basically of a potentiometer winding on a square frame (fig. 7).

The centre of the winding is earthed, and the voltages which are to be resolved are applied to the two ends (equal and opposite timebase voltages are required for this type of resolver).

**22.** The potentiometer has two wiper arms at right-angles, the cosine wiper and the sine wiper. Both rotate, in synchronism with the radar aerial. As fig. 7 shows, if the wiper radius is  $R$  in., the strip of potentiometer wires lying between the



cosine wiper contact and the earthed centre is  $R\cos B$  in. wide. If steady voltages  $+E$  volts and  $-E$  volts are being applied to the ends of the winding, the volts drop across **CD** will be  $E/R$  volts per inch, and so a voltage  $E/R$  times  $R\cos B$  (i.e.,  $E\cos B$ ) will be picked off by the cosine wiper. Similarly a voltage  $E\sin B$  will be picked off by the sine wiper, because the strip of potentiometer wires between the sine contact and earth has a width of  $R\sin B$  in.

**23.** If now, instead of a steady voltage, a recurrent sawtooth wave of peak amplitude  $+E$  be applied at the point **C**, and an equal but negative-going sawtooth be applied to the other end at **D**, then the cosine wiper will pick off a sawtooth component of peak amplitude  $E\cos B$ , while the sine wiper will pick off a component of peak amplitude  $E\sin B$ . The antiphase input at **D** is necessary to provide the negative-going sawtooth waves required in certain trace positions. The two components, seen in fig. 7, may be applied to the deflection system of the CRT to produce a trace, which will rotate in synchronism with the potentiometer wipers and so with the aerial.

#### Features of sine/cosine potentiometer resolver

**24.** The sine/cos pot. resolver has the disadvantage that as the wipers move over the individual wires of the potentiometer winding, the value of the output components will change, not smoothly and continuously, but in a series of discontinuous steps. As a result, the trace on the PPI jumps from one angular position to the next, giving a "spoking" effect on the picture. The trouble may be reduced by the use of finer wire in the potentiometer winding; but such a winding suffers severe wear from the continuous rotation of the wipers, and so tends to need frequent replacement.

**25.** As a result, the sine/cos pot. has not been employed for the sawtooth resolution in the present system; however, it is quite suitable for resolution of an inter-trace marker voltage where the wipers are not required to be in continuous rotation. Sine/cos pots. are accordingly used on the present system for resolution of the azication markers (*Part 1, Sect. 3*).

#### Magslip resolver

**26.** Basically, the magslip is a rotary resolver having a rotor coil and two stator coils. (The magslips used in the present system have, in fact, four stators or input coils and two rotors or output coils, but, for simplicity, only the basic type is described in this chapter). The stator coils, which may be referred to as the **X** (or sine) stator and the **Y** (or cosine) stator, have their axes at right-angles (*fig. 8*).

**27.** If a sinewave of amplitude  $E$  volts peak is applied across the rotor, and if the rotor is turned

so that its axis is directly parallel to the axis of the **Y** stator, then a sinewave of amplitude  $E$  volts peak will appear across the **Y** stator, and nothing across the **X** stator (this assumes perfect coupling and an equal number of turns on rotor and stator).

**28.** When the rotor is turned to an angle  $B$  to its previous position, as in *fig. 8*, a sinewave of peak amplitude  $E\cos B$  will appear across the **Y** stator, and another of amplitude  $E\sin B$  will appear across the **X** stator. In other words, the magslip acts as a pair of transformers whose ratios are variable between  $+1$  and  $-1$ , depending on the angle to which the rotor is turned.

**29.** If, instead of the sinewave, a sawtooth waveform of peak amplitude  $E$  is now applied across the rotor, it will be resolved into cosine and sine components in just the same manner, as shown in *fig. 8*. These components may be applied to the deflection systems of the CRT to produce a trace rotating in synchronism with the magslip rotor. As the magslip rotor is linked by an angle-transmission system to the aerial, the required synchronism between aerial and trace is thus obtained.

#### Features of magslip resolver

**30.** Unlike the sine/cos pot., the magslip give, smooth and continuous rotation of the traces provided that precautions have been taken to eliminate hunting from the associated selsyn system. It has a much longer working life because wear is confined to the rotor brushes and the bearings. The input required is a single sawtooth waveform, whereas the sine/cos pot. requires two waveforms in antiphase. The linearity of a sawtooth, however, deteriorates on passing through a magslip resolver, and to maintain linearity in the output, negative feedback has to be taken from auxiliary magslip windings to the input circuits.

**31.** The magslip may be regarded as a pair of variable-ratio voltage transformers, and the coupling between input and outputs is an AC coupling only. As a result, when either magslip output is connected to a subsequent amplifier input circuit, the component sawtooth waveform always settles down at a DC level such that the areas **P** and **Q** above and below earth level are equal (*fig. 9, waveform (b)*). Since the shape of the waveform is changing all the time as the aerial and trace go round, the result is that the trace starts at different points and the trace origin wanders about. To ensure that the trace always starts at the same point therefore, it is necessary to clamp the waveform to earth level during the inter-trace period, by an auxiliary clamping circuit. The resulting waveform after clamping is shown in *fig. 9 (waveform (c))*.

**32.** The need for drive amplifiers to supply the master sawtooth to the magslip input from a low impedance source, for the feedback circuits

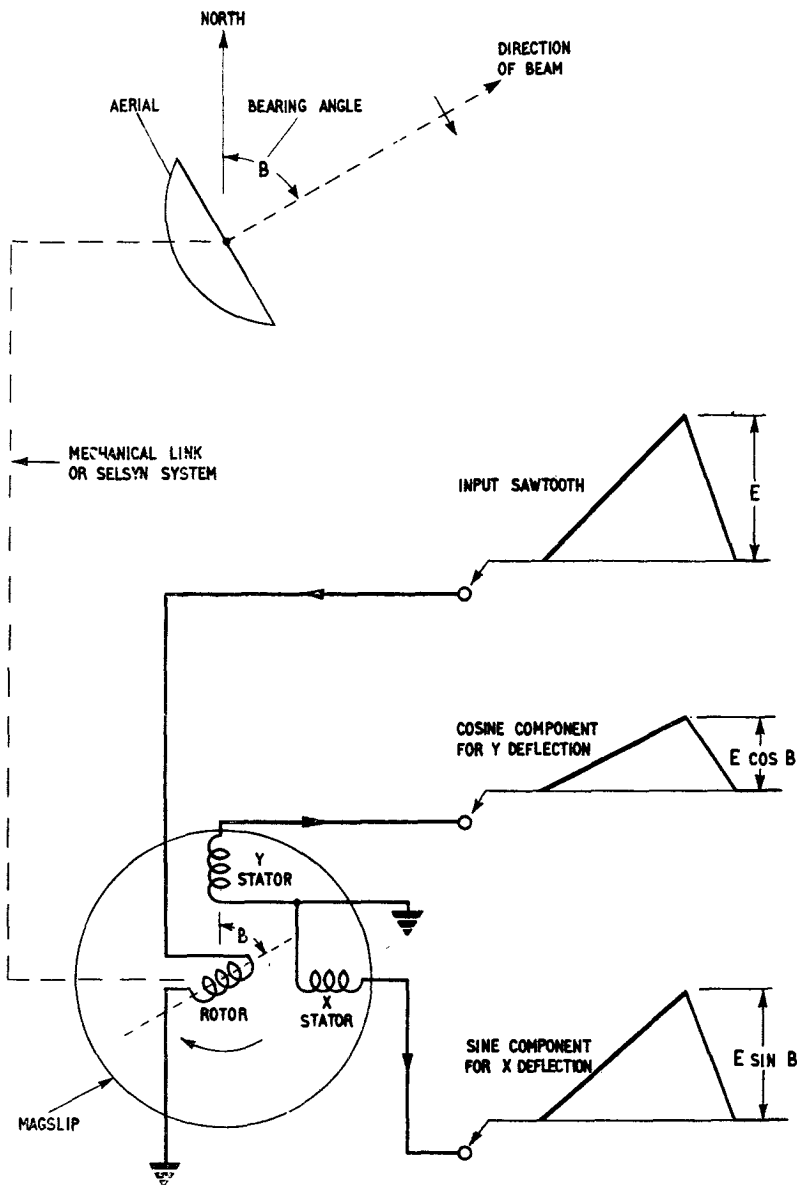


Fig. 8. Magslip resolver

mentioned in para. 30, and for rest-level clamping circuits, makes the magslip resolver more bulky than the equivalent sine/cos pot. resolver unit. Nevertheless, because of the advantages listed above, it is the method adopted at present for timebase resolution in the fixed-coil system used with the console Type 64 and associated equipment.

#### Use of inter-trace period

33. An important feature of the fixed-coil system is that the inter-trace period may be utilized for the electronic display, on the tube face, of additional independent information. This is possible because, unlike the rotating-coil system, the fixed-coil system allows the spot to be moved by supplementary deflection waveforms to any part of the screen to show up the required

inter-trace information, and then to be returned to the trace origin in time for the start of the next trace. To accomplish this, the input to the X and Y deflection systems has to be switched from radar timebase information to inter-trace information during the timebase period. With a single rotating deflector coil, on the other hand, the spot is confined to a line perpendicular to the axis of the coil. The simplest use is for the display of a simple strobe marker (fig. 10); this is a single bright spot which can be moved to any position on the picture wholly independent of the trace position; it can be used by an operator to mark the position of a particular target on his own console for reference, or (since the component voltages producing the strobe can be fed to another console and used to produce a strobe spot there) it can be used to draw the attention of another operator to a target.

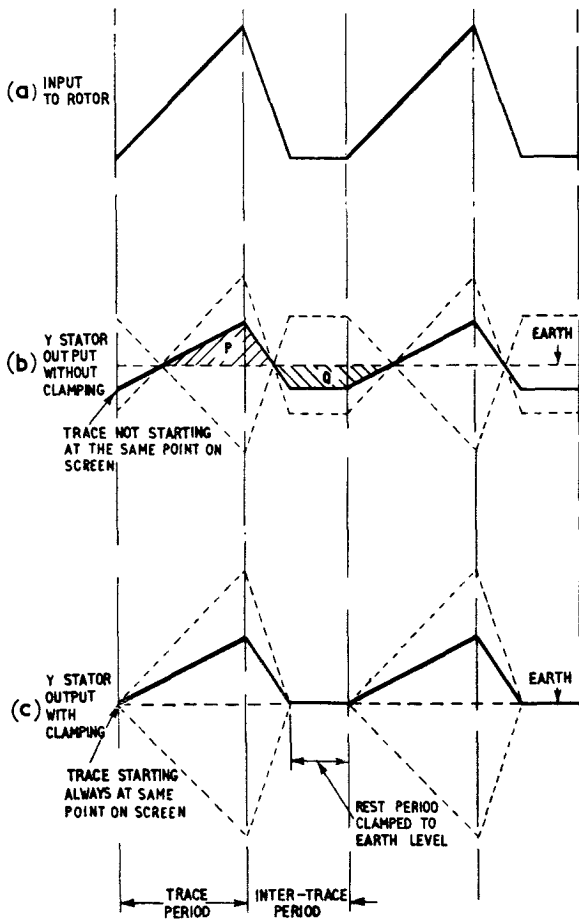


Fig. 9. Clamping a resolved sawtooth

#### Display of strobe marker

**34.** To display a strobe marker in the position shown in fig. 10, at range  $S$  and bearing  $C$ , it is necessary to produce two component DC voltages,  $E \sin C$  and  $E \cos C$ , and to apply them to the X and Y deflection systems during the timebase rest period (in the example shown,  $\sin C$  is negative because  $C$  is over  $180^\circ$ ). It is also necessary to brighten up the spot by means of an inter-trace bright-up wave (waveform (d)).

**35.** The following movements of the spot then occur in every timebase cycle (simplified account) :—

(1) Moves linearly from centre of display (assuming centred picture) out to circumference, so forming the trace; this is brightened up by the trace bright-up square-wave.

(2) Moves to strobe marker position.

(3) Waits short time in strobe marker position where it is brightened up by the inter-trace bright-up pulse.

(4) Returns to centre (clamped level) to await start of a new trace.

The afterglow of the CRT screen and the operator's persistence of vision cause him to see both the radar trace and the strobe marker continuously and concurrently although they are really painted in succession.

#### Display of ring strobe marker

**36.** One development of the simple strobe spot is the ring strobe marker, consisting of a small bright ring, electronically produced, that can be moved to any position on the tube face by the operator in order to draw attention to, or to record, the position of a target on his own or another console.

**37.** The ring strobe is produced in a similar manner to the strobe spot, except that a small continuous sine-wave of constant amplitude and fairly high frequency is superimposed on the strobe Y component, and another sine-wave of the same amplitude and frequency but lagging  $90^\circ$  in phase is superimposed on the strobe X component (fig. 11). Instead of a spot, a small circle or ring is now traced out, centred at the position determined by the DC components; its diameter is constant (corresponding to the peak-to-peak amplitude of the sine-wave), but it can be moved to any desired position on the trace by alteration of the DC components.

**38.** During display of a ring strobe marker the following movements of the spot take place during each timebase cycle :—

(1) Moves linearly from centre of display out to circumference, so forming trace; this is brightened up by the trace bright-up square-wave.

(2) Moves to ring strobe marker position.

(3) Traces ring round central strobe position, a certain number of ring cycles being brightened up by the inter-trace bright-up wave.

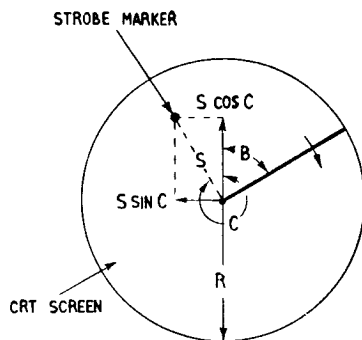
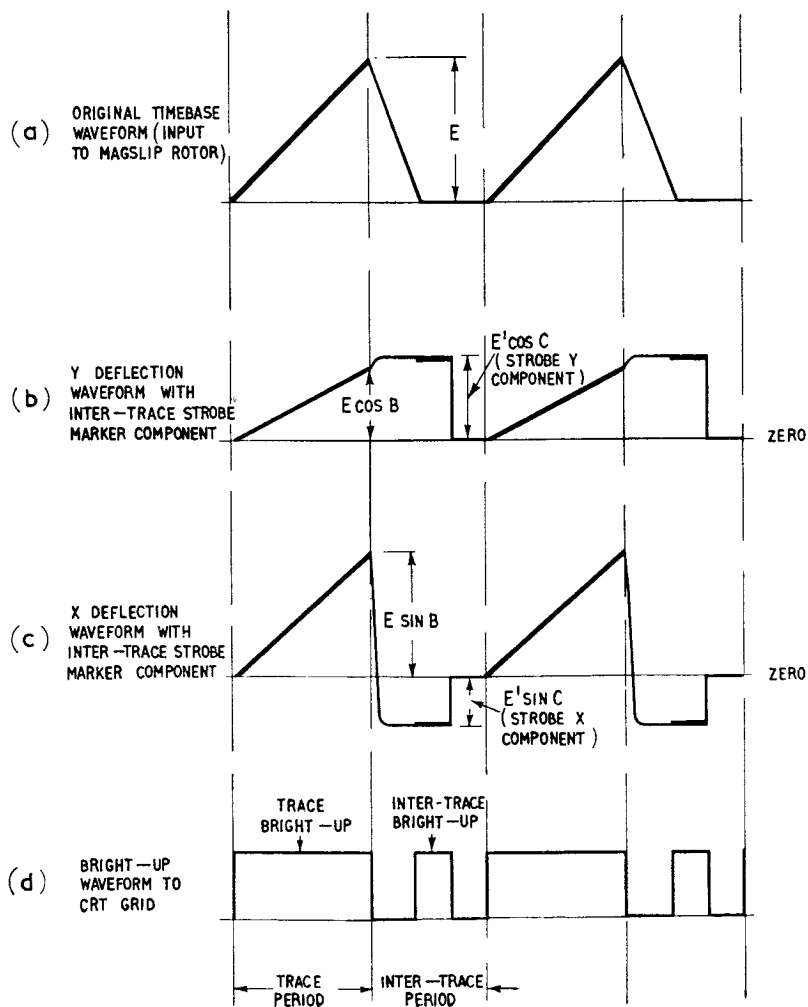
(4) Returns to centre to await start of new trace.

As before, the tube afterglow and the operator's persistence of vision cause him to see the radar picture and the ring strobe simultaneously.

#### Display of azication marker

**39.** Another type of marker which can be displayed during the inter-trace period is the azication marker. This consists of a short bright line along part of a radius from the scan centre (fig. 12); its normal use is to indicate the azimuth along which an associated height-finding radar head, controlled by the PPI operator, is "nodding".

**40.** An azication marker is formed originally from a steady ranging voltage (corresponding to the range at which the marker is required to be displayed). To this is added, during the inter-trace period, a small sawtooth waveform



**NOTES**

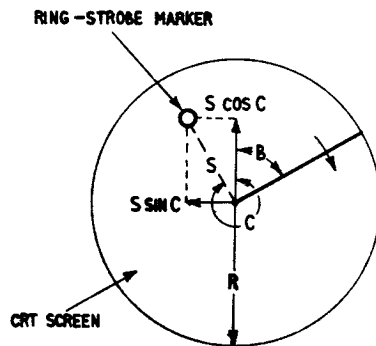
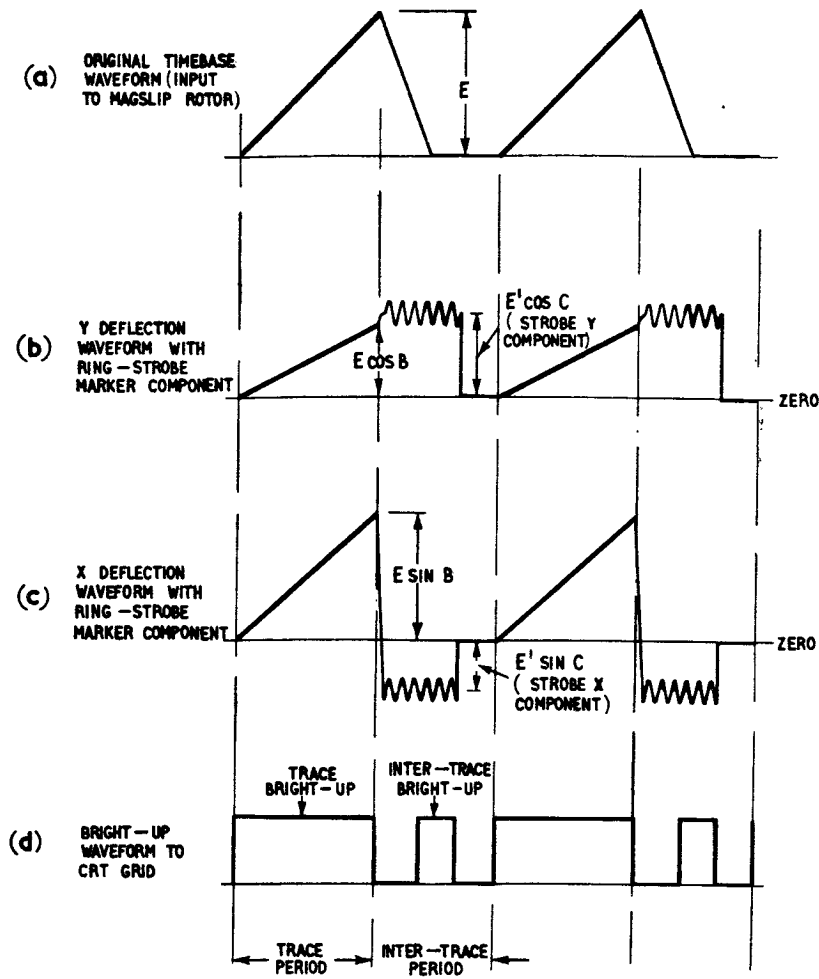
E IS VOLTAGE REQUIRED TO DEFLECT SPOT A DISTANCE R  
 E' IS VOLTAGE REQUIRED TO DEFLECT SPOT A DISTANCE S

**Fig. 10. Inter-trace strobe marker**

with an amplitude more than enough to give the desired length of the azication line on the picture.

41. The combined waveform is shown at (b) in fig. 12; note that the azication sawtooth does not last the whole of the inter-trace period, but only occupies part in order to allow the spot to reach the scan centre well before the start of a new trace. Waveform (b) and an antiphase waveform are next applied to the azication resolver,

which consists of a sine/cos pot. resolver (*para. 21*) rotated by tell-back selsyn information from the height-finder. The original waveform is thus resolved into two components; which are applied to the deflection amplifiers of the display unit during the inter-trace period; their combined effect on the CRT spot is to produce a supplementary sweep of the spot, part of which only is seen while the inter-trace bright-up pulse lasts.



**NOTES**

E IS VOLTAGE REQUIRED TO DEFLECT SPOT A DISTANCE R  
 E' IS VOLTAGE REQUIRED TO DEFLECT SPOT A DISTANCE S

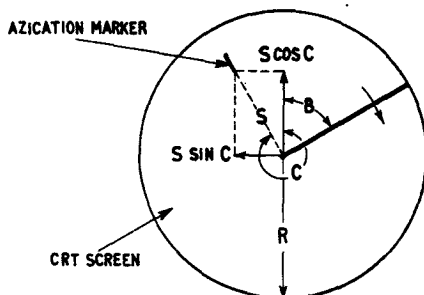
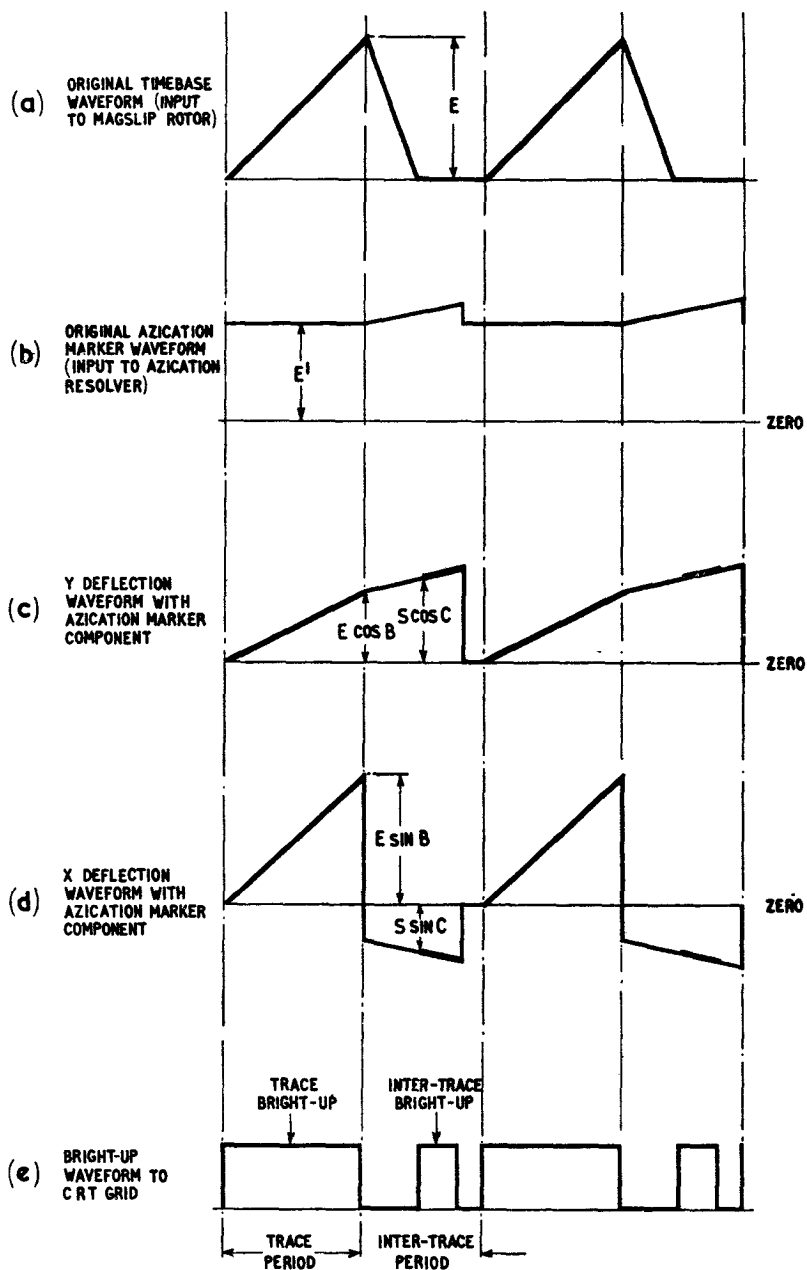
**Fig. 11. Ring-strobe marker**

**42.** The azication marker position is wholly independent of the trace direction, and, provided that the azication range and azimuth settings remain the same, the marker stays in the same place on the screen in spite of the radar trace rotation.

**Gating**

**43.** It is necessary, at the inputs to the X and Y

timebase amplifiers, to combine the sawtooth component waveforms coming from the magflip resolver unit with the inter-trace information (whether ordinary strobe marker or azication marker). To do this, a gate circuit must be employed to switch electronically from radar trace input to inter-trace, and back. Rectangular waveforms, known as gating waves, are required to operate these gate circuits; the units which



**NOTES**

E IS VOLTAGE REQUIRED TO DEFLECT SPOT A DISTANCE R  
 E' IS VOLTAGE REQUIRED TO DEFLECT SPOT A DISTANCE S

**Fig. 12. Azication marker**

produce them are called gating waveform generators.

**Inter-trace marker sequencing**

44. It is quite possible with the fixed-coil

system to display several inter-trace markers in different positions on the tube face, including combinations of markers of different types (spot, ring strobe or azication). The duration of an inter-trace period is not sufficient to display more



than one marker, so that it is necessary to employ an inter-trace marker sequence circuit. This samples the different marker components in succession, either one during each inter-trace period, or one during each group of several periods.

**45.** If, for example, eight markers are to be displayed, the circuit takes a total of eight timebase cycles (or equal groups of timebase cycles) to sample each marker waveform in succession, and then returns to the first to repeat the process. The two sequences of strobe marker components (one for X and one for Y) are then applied to the inter-trace sides of the gating circuits in the X and Y deflection amplifiers.

#### **Trace expansion**

**46.** To obtain PPI pictures to four different scales representing maximum ranges right across the screen of (say) 80, 160, 240 and 320 nautical miles, it is necessary to include a switching arrangement in each deflection amplifier to give four different values of overall gain. This process is referred to either as trace expansion or as range switching.

**47.** It is important that the relation between target positions and video map (if used), which are displayed during the trace period, and the strobe or azication marker positions (displayed during the inter-trace period) should remain accurate on all ranges. To ensure this, the trace expansion circuits must come at a later stage of the deflection amplifiers than do the gating circuits, so that equal expansion takes place of both scan and inter-trace components.

#### **Off-centring**

**48.** When it is desired to move the whole picture across the tube face to examine one sector of the operational area only, at greater expansion,

appropriate DC components may be added to the deflection waveforms, causing constant shift currents in the deflector coils. The process, which is known as off-centring, must be performed at a stage of the deflection amplifiers subsequent to the gating circuit to ensure that the radar picture and the strobe markers will be equally displaced and so remain in the correct relationship.

**49.** It is possible to ensure, by effecting the trace expansion after the off-centring in the timebase amplifiers and using DC connection throughout, that the picture expands about the screen centre and not about the scan origin; i.e. that a target which is seen at the centre of the tube face on one degree of expansion remains at the centre on all other degrees of expansion, whatever the amount of off-centring.

#### **Video blanking**

**50.** When the picture is considerably off-centred or expanded, the electron beam will, at certain times in the timebase cycle, strike the side walls of the CRT envelope. This is undesirable because the reflected electrons cause patches of light on the screen and confuse the operator, and many even result in puncture of the glass neck and destruction of the CRT. To prevent it, the beam has to be cut off by a video blanking waveform from a special blanking circuit whenever it is deflected beyond the normal screen area.

#### **DC and see-saw amplifiers**

**51.** The technique of producing, by fixed-coil methods, displays with a high standard of precision and freedom from drift involves the extensive use of DC amplifiers with negative feedback of various types, including the see-saw amplifier. A full description of such amplifiers is not within the scope of this volume; reference may be made to Chapter 7 of the *Inter-services Radar Manual (A.P.1093E)* for further information.

## Chapter 2

### DESCRIPTION OF FIXED-COIL DISPLAY SYSTEM

(GCI STATIONS. PHASE 1 INSTALLATIONS)

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### INTRODUCTION

#### Scope of chapter

1. In this chapter, the purpose and functioning of the various units of the fixed-coil system are described with particular reference to the first phase of installation of the system on GCI stations; the location of the individual units is also indicated. The chapter covers both the fixed-coil consoles themselves and the associated equipment, which is centrally located in the radar office. Operating instructions, detailed circuit descriptions and power supply and cabling information are not given here, but are available in subsequent chapters of this volume (refer to Table 1 for index). The theoretical background of the fixed-coil display was outlined in Chapter 1 of this Section. ◀ Additional new equipment and modifications to existing equipment required to give inter-console marking and long range time-base facilities in Phase 1 are described in A.P. 2527V(2). A full description of the additional new equipment and modifications required for a full intertrace system (Phase 1A) is given in A.P. 2527X. ▶

#### Purpose of system

2. The fixed-coil display system is a versatile set of equipment for the production of PPI (Plan Position Indication) displays in GCI and other ground radar stations. It comprises a number of fixed-coil consoles (Type 64) varying (in the GCI case) from 15 upwards, according to the class of station, together with the associated equipment racks in the radar office. The amount of equipment located in each console has been reduced to a minimum by providing most of the radar, inter-trace (where applicable) and power supply services in bulk to all consoles from the radar office. The whole equipment has a high degree of accuracy, linearity and stability in PPI presentation, and can be dovetailed in with the existing radar office equipment for information generation and distribution described in A.P.2527C and A.P.2527E.

3. Facilities are provided for radar information to be accepted from a number of search heads of different types, some operating at a pulse

repetition frequency of 250 p.p.s. and some at 500 p.p.s. The aerials belonging to the different search heads normally rotate in synchronism (apart from one "stop-and-look" head), but one of more of them is "back-looking", i.e. at 180 deg. to the rest. Signals from the back-looking head can be combined in with those from a normal head in such a way that information from both is displayed alternately; as each head covers the same 180 deg. sector of the terrain, the sector is thus inspected twice as often. Any PPI operator can select information from one of a number of search heads for display on his console. He has a choice of trace expansions which cause one screen diameter to represent distances of 80, 160, 240 and 320 nautical miles which, if the display is centred, give maximum ranges of 40, 80, 120 and 160 nautical miles. In addition, the picture may be off-centred up to 200 nautical miles. (*Note that the provision of these ranges on the consoles does not necessarily mean that they are available from all, or any, radar heads.*)

4. In addition to ordinary radar video information (echoes), provision is made to display other

information during the radar timebase period, including some or all of the following:—

- (1) *Video map* (a map of the operational region, with the usual grid for references, which is scanned and displayed electronically in correct scale relation to the radar picture).
- (2) *Range rings* (set of range markers at intervals of five miles or ten miles, available as an alternative to the video map, and also useful for calibration).
- (3) *IFF responses* (Identification, Friend or Foe).
- (4) *Height-range strobe* (a single range ring at a range under the operator's control, for azicating consoles only).

5. During the inter-trace period, when the above information is not being displayed, an azication marker is produced on the azicating consoles. It consists of a short bright line along part of a radius, at the same range as the height-range strobe. Its bearing is determined by that of the associated height-finding radar head, which in turn is controlled by the azicating PPI operator (*para.* 36).

## LAYOUT AND FUNCTIONS OF UNITS

### GENERAL

6. The distribution of the various units in the racks in the radar office, and in the consoles Type 64, is shown in fig. 8. The equipment situated in the console itself is confined to the following main units:—

- (1) *Video amplifier*, together with its associated blanking unit and waveform generator and a control panel. The waveform generator incorporates a voltage stabilizer. These items, together with the CRT in its housing with the deflection and focus coils, make up the *indicating unit (CRT) Type 35*. This occupies the upper half of the console.
- (2) *Two deflection amplifiers*, one for X-deflection and one for Y-deflection, and an associated voltage stabilizer.
- (3) *EHT power unit* for the CRT final anode.
- (4) *Distribution and fuse panels*.
- (5) *Control desk*, of which there are several variants to provide different operational functions.

7. The remaining units in the display system are concentrated in the radar office, whence bulk radar and inter-trace services, together with both regulated and unregulated HT supplies are routed to fixed-coil consoles dispersed about the station. There is extensive duplication of radar office units to provide stand-by equipments which are ready for immediate use in the event of circuit failure.

8. As well as the units associated with fixed-coil consoles, the radar office also contains further racks which were already in use in the Service before the introduction of the fixed-coil system for PPI displays. These racks, including the master trigger unit, the information generator and the head selector units, are described fully in A.P.2527C and E.

### RADAR OFFICE

9. The functions of the different radar office units in the fixed-coil display system are outlined in the following paragraphs; reference should also be made to the functional block diagram of the system (*fig.* 1) and to the principal waveforms (*fig.* 3 and 4). The appearance of the standard radar office racks is shown in *fig.* 2.

#### Master timebase units

10. Four master timebase units (*timebase unit Type 140*) are located in the *rack assembly (timebase) Type 300*, together with four power units to supply them (*power unit Type 903*) and a *distribution and switching panel (Type 868)*. Two of the master timebase units are normally set for 250 c/s operation, and two for 500 c/s operation (one operating and one stand-by in each case).

#### 250 c/s timebase

11. The 250 c/s timebase unit is triggered by the 250 c/s positive sync. pulses from the master trigger unit. Each sync. pulse is about 2  $\mu$ S in duration and at least 10V in amplitude (in practice usually much larger); refer to *fig.* 3, *waveform (a)*. The unit produces an accurately linear positive-going sawtooth waveform which reaches 50V amplitude after a duration of 2966  $\mu$ S (*waveform (c)*), representing an absolute maximum range of 240 nautical miles. This master sawtooth wave is fed out from a low-impedance source to the 250 c/s magstrip resolver unit for resolution and clamping. A similar but negative-going sawtooth wave is also produced but not used in the present application of the system.

#### 500 c/s timebase

12. The 500 c/s timebase unit is triggered by the 500 c/s sync. pulses from the master trigger unit. Each pulse is again about 2  $\mu$ S in duration

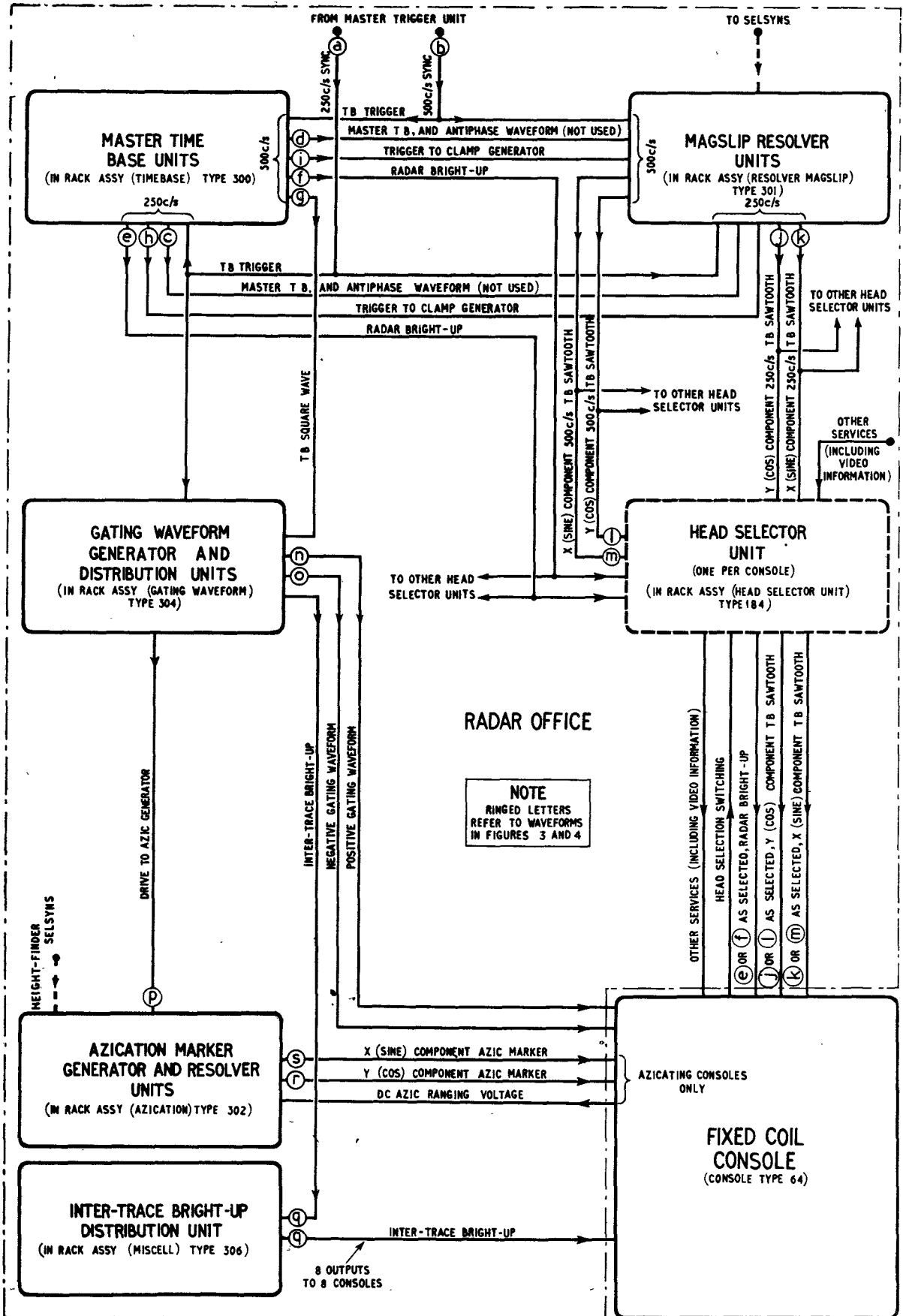


Fig. 1. Functional block diagram of system

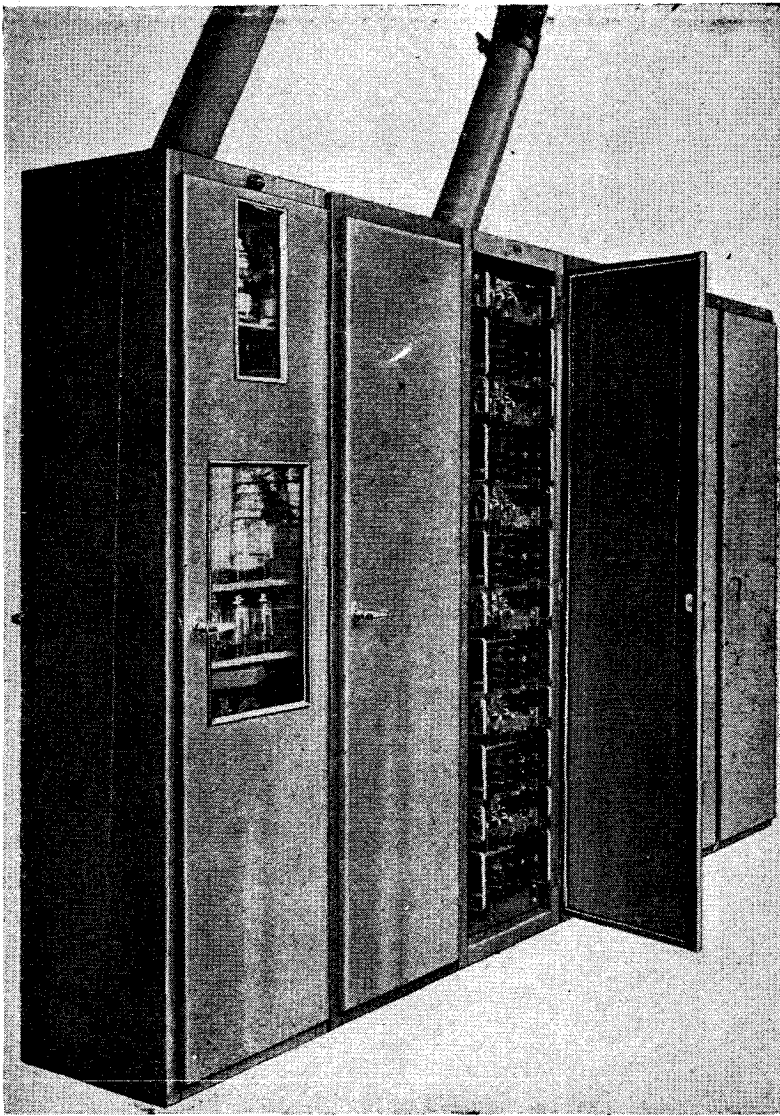


Fig. 2. Radar office racks

and at least 10V in amplitude (*waveform (b)*). The unit produces an accurately linear positive-going sawtooth wave which reaches 25V amplitude after a duration of 1483  $\mu\text{S}$  (*waveform (d)*). This master sawtooth is fed out from a low-impedance source to the 500 c/s magflip resolver unit for resolution and clamping. A similar but negative-going sawtooth is also produced, but it, too, is not used in the present application of the system.

#### Radar bright-up

**13.** Each timebase unit also produces a radar bright-up, rectangular wave of 2V amplitude (*waveforms (e) and (f)*) at the appropriate repetition frequency. These waves are positive-going during the scan period and zero during the inter-trace period. They are fed out to the head selector units. When the operator of any one console selects information from one particular radar head, his head selector unit automatically provides to that console a radar bright-up wave of the correct repetition frequency (either 250 c/s or 500 c/s) for the head in use.

**14.** Each timebase unit also originates positive trigger pulses of 40V amplitude to the clamp generators associated with the magflip resolvers in the rack assembly Type 301. These trigger pulses are timed to occur during the inter-trace period, 210  $\mu\text{S}$  after the end of the trace in the 250 c/s case, and 120  $\mu\text{S}$  after the end of the trace in the 500 c/s case (*waveforms (h) and (i)*, *fig. 3*). They are used to initiate the clamp waveforms used in the magflip resolvers (*para. 17 and 18*, below).

#### Timebase square-wave

**15.** The 500 c/s timebase unit produces, in addition, a 500 c/s rectangular wave of 25V amplitude, known as the timebase square-wave (*waveform (g)*). It is negative-going during the scan period, and positive-going during the inter-trace period; thus it is in anti-phase to the 500 c/s radar bright-up wave. The timebase square-wave is fed out to the gating waveform generator in the rack assembly Type 304, in order to initiate the gating waves (*para. 22*, below). The 250 c/s timebase unit produces a similar timebase square-wave at 250 c/s, which is not used in the present system.

#### Magflip resolver units

**16.** Three magflip resolver units (no type number) are located in the rack assembly (resolver magflip) Type 301. With each magflip resolver unit is associated an amplifying unit (*clamping and distribution*) Type 504, and a power unit (*power unit* Type 904). The rack also includes a distribution panel Type 877. On most stations the whole rack is duplicated, depending on current operational requirements. Normally one resolver unit is associated with each radar head, so that one (or more) of the resolver units is employed for 250 c/s timebase resolution, and one (or more) for 500 c/s timebase resolution; any remaining are employed as stand-by units for either repetition frequency.

#### 250 c/s magflip resolver

**17.** Each 250 c/s magflip resolver unit accepts a master timebase waveform (*waveform (c)*) from the 250 c/s master timebase unit, and rotational (selsyn) information from the selsyn patching panel. The master timebase waveform is resolved into two components as explained in Chapter 1 of this Section. One is the X or sine scan component, and the other is the Y or cosine scan component. The amplitudes of the two components vary sinusoidally between +50V and

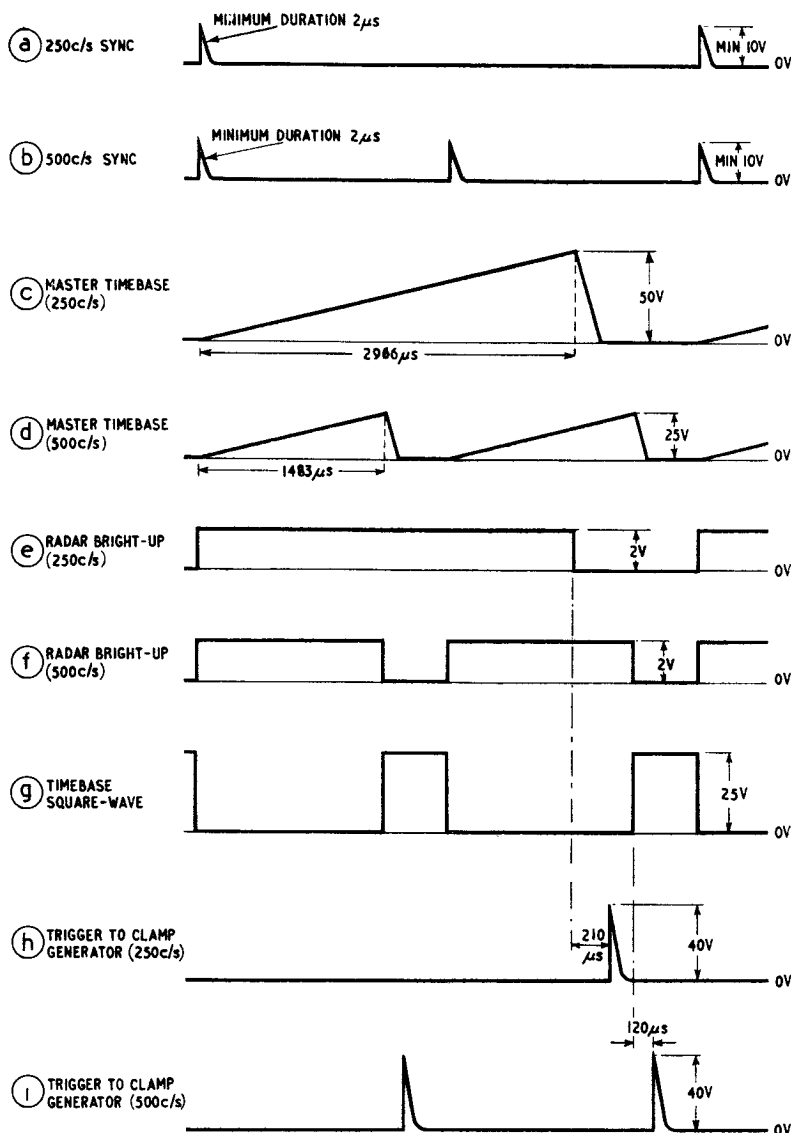


Fig. 3. Principal waveforms (l)

—50V, the envelope of sawtooth amplitudes of one being in quadrature to that of the other.

#### Clamping

**18.** To ensure that the timebase sweep always starts from zero voltage, the two components have to be clamped to zero level during the latter part of the rest period (*Chapter 1 of this Section, para. 31*). The clamping action is initiated by the trigger pulse (*waveform (h)*) from the 250 c/s master timebase unit, and is terminated by the 250 c/s sync pulse from the master trigger unit which coincides with the start of a new trace. The clamping process is performed in the amplifying unit (clamping and distribution) Type 504, which then feeds out the clamped components (*waveforms (j) and (k), fig. 4*) at low impedance to all the head selector units.

#### 500 c/s magflip resolver

**19.** Similarly, each 500 c/s magflip resolver unit

accepts a master timebase wave (*waveform (d)*) from the 500 c/s master timebase generator, and rotational (selsyn) information from the selsyn patching panel. The master timebase wave is then similarly resolved, and the components are clamped (*waveforms (l) and (m)*) to earth during the rest period and fed out at low impedance to the head selector units.

**20.** When the operator of any one console turns his head selector switch to bring in information from a particular radar head, his associated head selector unit in the radar office automatically routes X and Y scan waveforms for the head chosen to the console, together with the other services.

#### Gating waveform generators

**21.** Three gating waveform generators (waveform generator, gating, Type 101) are mounted in one rack assembly (gating waveform) Type 304. With each gating waveform generator is associated a distribution unit (gating) and a power unit Type 903. The rack also contains a distribution and switching panel Type 879. In this rack there is no division of units between the two repetition frequencies, because all the gating waveforms are produced at 250 c/s. One gating waveform generator is normally operating, one is operating under stand-by conditions, and the third is merely stored in the rack as a spare.

#### Gating waveforms

**22.** The main purpose of the gating waveform generator is to produce the rectangular positive and negative gating waveforms (*fig. 4 (n) and (o)*) for application to gate circuits in the deflection amplifiers of the azicating (and combined azication-interception) PPI consoles, via the gating distribution units. (The waveforms are applied to the other PPI consoles too, but not used.) The gating waveforms are 30V in amplitude; they start just at the end of 500 c/s timebase sweep and end approximately 270  $\mu$ S later. They are, therefore, initiated by the positive edge of the timebase square-wave which comes in from the 500 c/s master timebase unit, and terminated internally 270  $\mu$ S later. Sync pulses at 250 c/s are also accepted to operate circuits which ensure that the gating waveforms, although related to the end of a 500 c/s timebase sweep, only appear at a repetition rate of 250 c/s, during the rest period of a 250 c/s timebase sweep. The reasons for this arrangement are explained

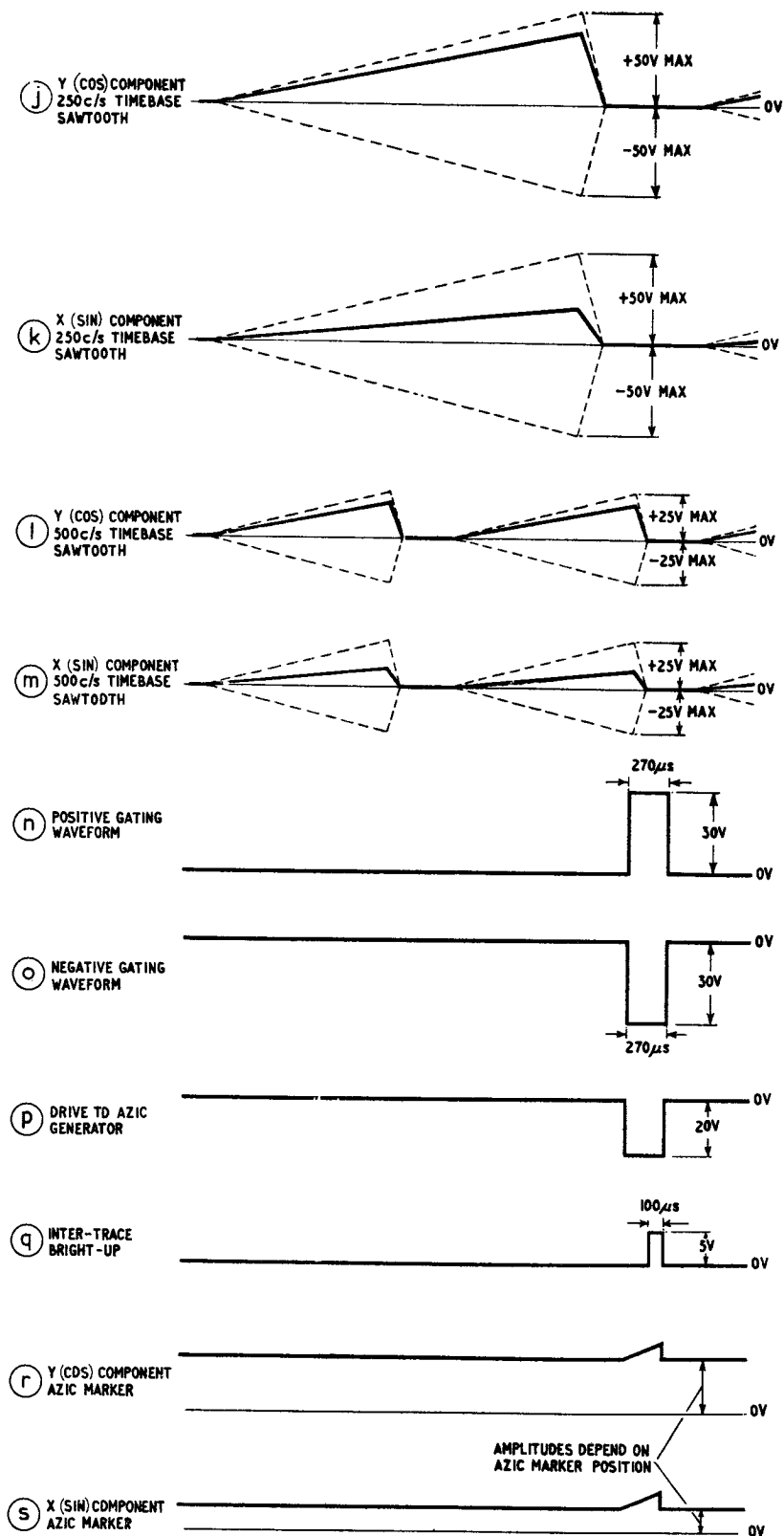


Fig. 4. Principal waveforms (2)

in the paragraphs below which deal with the console itself.

#### Inter-trace bright-up

23. The gating waveform generators also produce

an inter-trace bright-up pulse (*waveform (q)*). This is a positive-going pulse of 5V amplitude which occupies the final 100  $\mu$ S of the gating waveforms, and like them, has a repetition frequency of 250 c/s. There are two identical



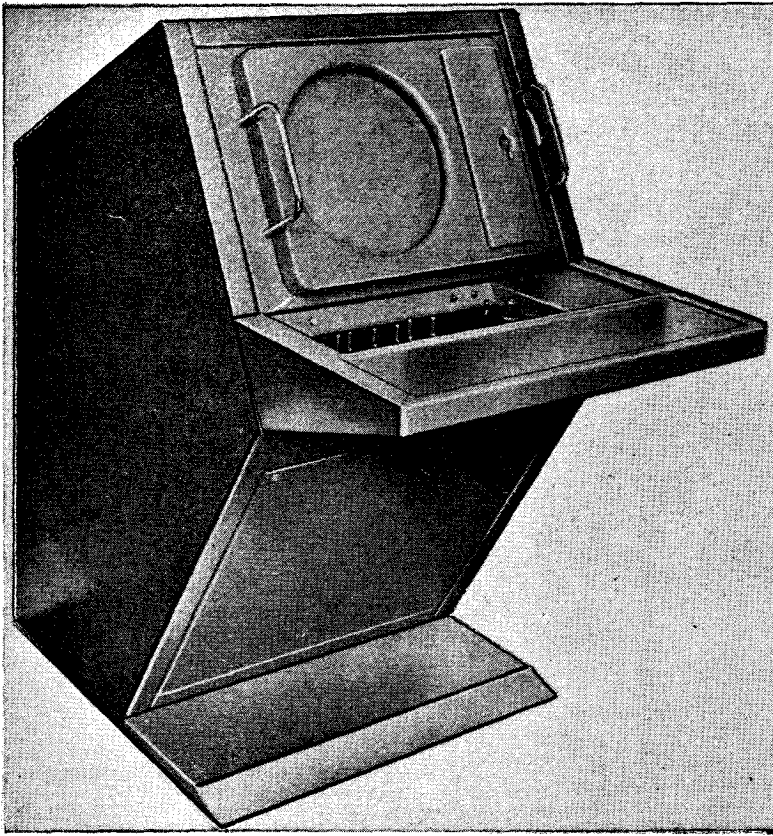


Fig. 5. Console Type 64

outputs which are applied to the inter-trace bright-up distribution units in the rack assembly Type 306.

24. The gating waveform generator produces, in addition, a  $-20V$  250 c/s rectangular pulse (*waveform (p)*) which drives the azication marker generator in the rack assembly Type 302. This pulse has the same timing as the negative gating wave, from which it differs only in amplitude, and is used to generate the azication marker sawtooth during the inter-trace period.

#### Azication marker generator and resolver

25. Four azication waveform generators (*waveform generator Type 100*) are located in the rack assembly (*azication*) Type 302. With each generator is associated a *resolver unit (azication)* and a *power unit Type 905*. The rack also includes a *distribution and switching panel Type 878*. On most classes of station the whole rack is duplicated.

26. Each azication resolver unit, which includes a sine/cosine potentiometer (*Chap. 1 of this Section*), receives rotational information from a corresponding height-finding radar head (Type 13), so the number of resolvers and associated units actually operating at one time depends on operational conditions. Normally there are not more than six Type 13 heads in use, so that a total of six resolvers (three in each rack) is used

for ordinary azication resolution. One of the remaining resolvers is rotated by selsyn information from the master search head (usually Type 7), and the continually rotating azication line thus produced can be applied to the monitor PPI console for synchronizing the rotation of the slave search heads. The other remaining resolver unit is available as a spare.

27. Each azication marker generator receives from its azicating PPI console a DC azication ranging voltage which determines the range at which the marker is to be displayed. It also receives, from a gating waveform generator, the 20V, 250 c/s rectangular pulse (*waveform (p)*) mentioned in para. 24, which is negative-going during the initial 270  $\mu S$  of alternate 500 c/s inter-trace periods: During this 270  $\mu S$  the azication generator adds to the DC ranging voltage a sawtooth of small amplitude. The combination of DC and sawtooth is applied to the azication resolver unit where it is resolved into X and Y components (*waveforms (r) and (s), fig. 4*). These components are then repeated back to the azicating PPI console concerned, for display.

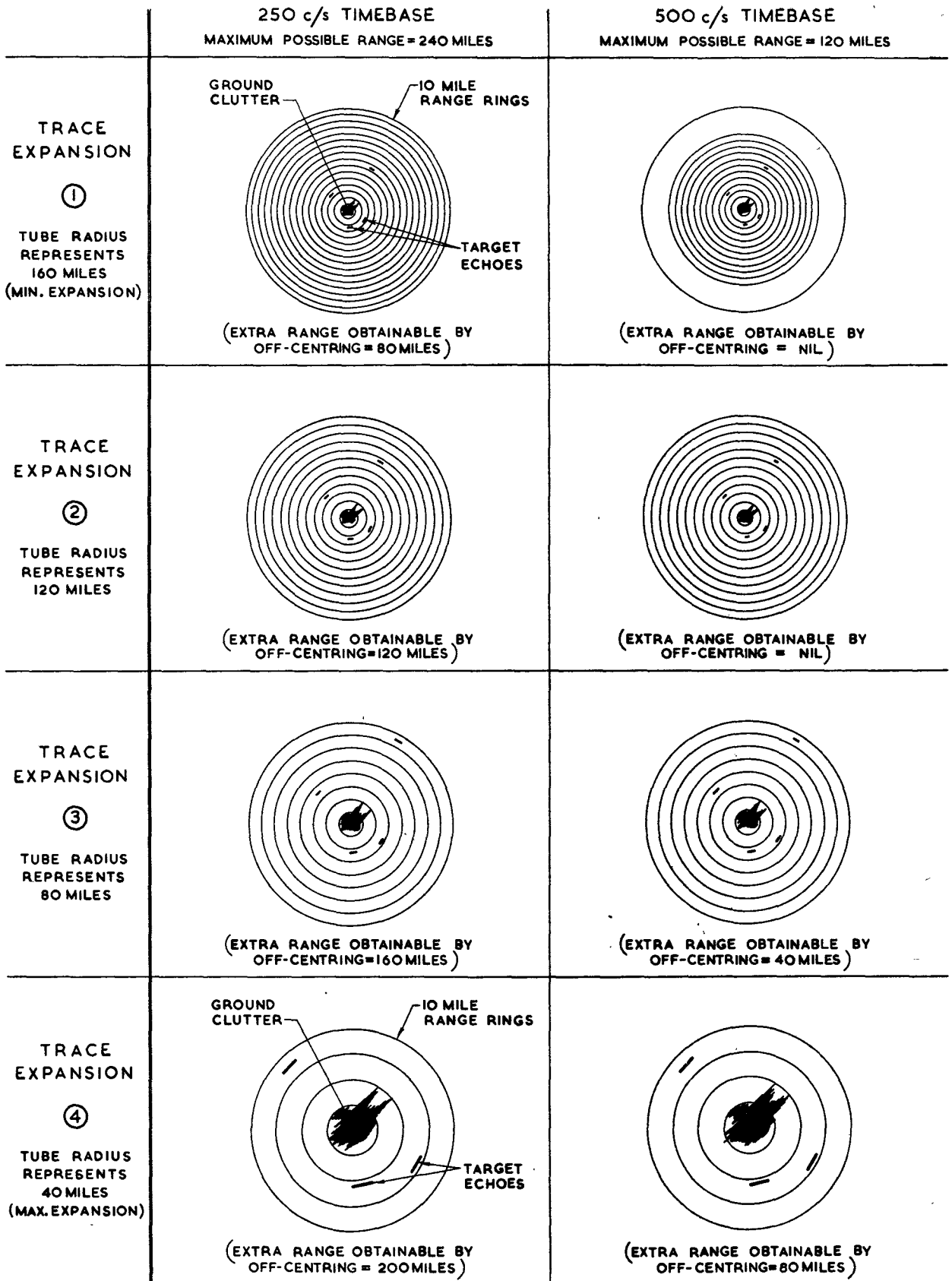
#### Inter-trace bright-up distribution rack

28. There are two *distribution units (inter-trace)* in each rack assembly (*miscellaneous*) Type 306, together with two *power units Type 903*, a *panel (switching) Type 876* and a *relay unit (azication change-over) Type 192*. Normally, one distribution unit and its power pack are in use and the other distribution unit and its power pack are operating under stand-by conditions, ready for immediate use.

29. The function of the distribution unit is to accept the inter-trace bright-up pulse from the gating waveform generator and to distribute it to the azicating consoles via the switching panel (which selects either distribution unit for use). The function of the relay unit (*azication change-over*), which is controlled from each azicating PPI console, is to re-route all azication information to and from a stand-by console in the event of unserviceability of a main azicating console.

#### Negative reference supply

30. The purpose of the rack assembly (*negative reference*) Type 338 is to supply an accurate and reliable  $-500V$  reference voltage wherever required on the station, so ensuring that the calibration of all display equipment remains accurate and consistent. Included are two *power units (negative reference) Type 906*, an automatic change-over unit (*relay unit Type 186*), and a



PICTURE MAY BE OFF-CENTRED UP TO 200 MILES

NOTE : - ALL DISTANCES ARE IN NAUTICAL MILES

Fig. 6. Trace expansion

considerable number (according to operational requirements) of output units (*relay units Type 185*), each providing five switched and fused outlets. Each voltage stabilizer in the fixed-coil equipment is fed from a separate outlet.

#### **Bulk power supply**

31. The bulk power supply comprises the *rectifier unit (+420V) Type 100*, the *rectifier unit (+570V) Type 101*, and the *rectifier unit (-470V) Type 102*, together with the *stabilizer (voltage) Type 100* (which provides stabilized +250V outlets to console deflection amplifiers) and the *relay unit Type 184* which provides remote power-supply switching from the consoles. The +420V, +570V, and -470V outputs are not stabilized, the regulators for these supplies being located in the consoles. All the above items are mounted in a *rack assembly (bulk power supply) Type 305*, and there is one such rack assembly to every six fixed-coil consoles installed on the station. The wiring is arranged so that even if one bulk power supply rack becomes unserviceable, consoles adjacent to an affected console continue in operation because they are not fed from the same bulk power supply rack.

#### **Waveform monitor rack**

32. The *rack assembly (waveform monitor) Type 339* is a CRT monitor unit for testing and monitoring the operation of all the fixed-coil radar office racks ; it includes facilities for waveform sampling and for velocity and linearity testing.

#### **Monitor PPI console**

33. One standard *console Type 64* is located in the radar office to facilitate setting-up and checking of the various racks ; it is also used for setting anti-jamming facilities.

### **CONSOLE TYPE 64 AND CONTROL DESKS**

#### **Introduction**

34. The console *Type 64* is a fixed-coil PPI display console of considerable versatility which provides accurate and stable presentation of information from search heads on ground radar stations, together with additional information displayed between traces. A number of these consoles varying from 15 upwards (according to operational requirements) is installed in a GCI station, in association with the radar office equipment mentioned previously. The general appearance of the console *Type 64* is shown in fig. 5.

35. There are four main types of PPI console for the different users on a GCI station, as follows :-

- (1) *Plotting console* (least facilities).
- (2) *Interception console* (carries more complex intercom. facilities, including RT, and has height-range strobe key to brighten the trace on an associated height-finding A-scope).

(3) *Azicating console* (has control of the turning gear of associated height-finding radar *Type 13* and *FPS/6* and carries height-sharing and azication marker facilities).

(4) *Combined console* (has the facilities of (2) and (3)).

Details of the height-sharing facilities available at the azicating console are given in A.P.2897RA, Vol. 1, Sect. 1, Chap. 1.

36. The operator of an azicating console (or a combined console) who requires a height reading to be taken on a target he has seen on his PPI, operates turning gear, which turns a *Type 13* or an *FPS/6* height-finder in the horizontal plane to bring it round to the bearing of the target. To indicate to him the height-finder bearing and so enable the turning operation to be done accurately, a tell-back selsyn from the *Type 13* or *FPS/6* operates his azication resolver in the radar office to produce an azication marker on his display. This marker consists of a short line along a radius from the scan centre ; the bearing of the line is that of the height-finder, and it intersects a single range ring known as the height-range strobe. The range of both is under the azicating operator's control (using ganged potentiometers). The actual information from the height-finder appears on a special display console, on the screen of which the height-range strobe shows as a bright vertical line, thus indicating the target, the height of which is required.

37. The timebase component waveforms received from the radar office have a peak amplitude of just over 50V when a 250 c/s search head has been selected, or of just over 25V for a 500 c/s head. The duration of the 250 c/s trace period is just over 2,966 $\mu$ S, corresponding to a maximum possible range of 240 nautical miles. The duration of the 500 c/s trace period is just over 1,483 $\mu$ S, corresponding to a maximum possible range of 120 nautical miles. The sweep velocity of either timebase is therefore the same, but the 500 c/s lasts only half as long and "paints" twice as often, as the 250 c/s.

38. Every PPI console has four degrees of trace expansion available by use of the RANGE control ; they are illustrated in fig. 6, which shows a simple radar picture with range rings at 10-mile intervals as seen on the four different degrees of trace expansion. Other video information normally carried, such as video map, IFF, etc., has been omitted for clarity. It will be seen that when the display is centred on the tube face, the four degrees of trace expansion correspond to maximum visible ranges of 160, 120, 80 and 40 nautical miles, i.e. to screen diameters of 320, 240, 160 and 80 nautical miles. With minimum expansion and a 500 c/s timebase the tube face is not fully utilized, but in all other cases the whole tube face is scanned when the display is centred.

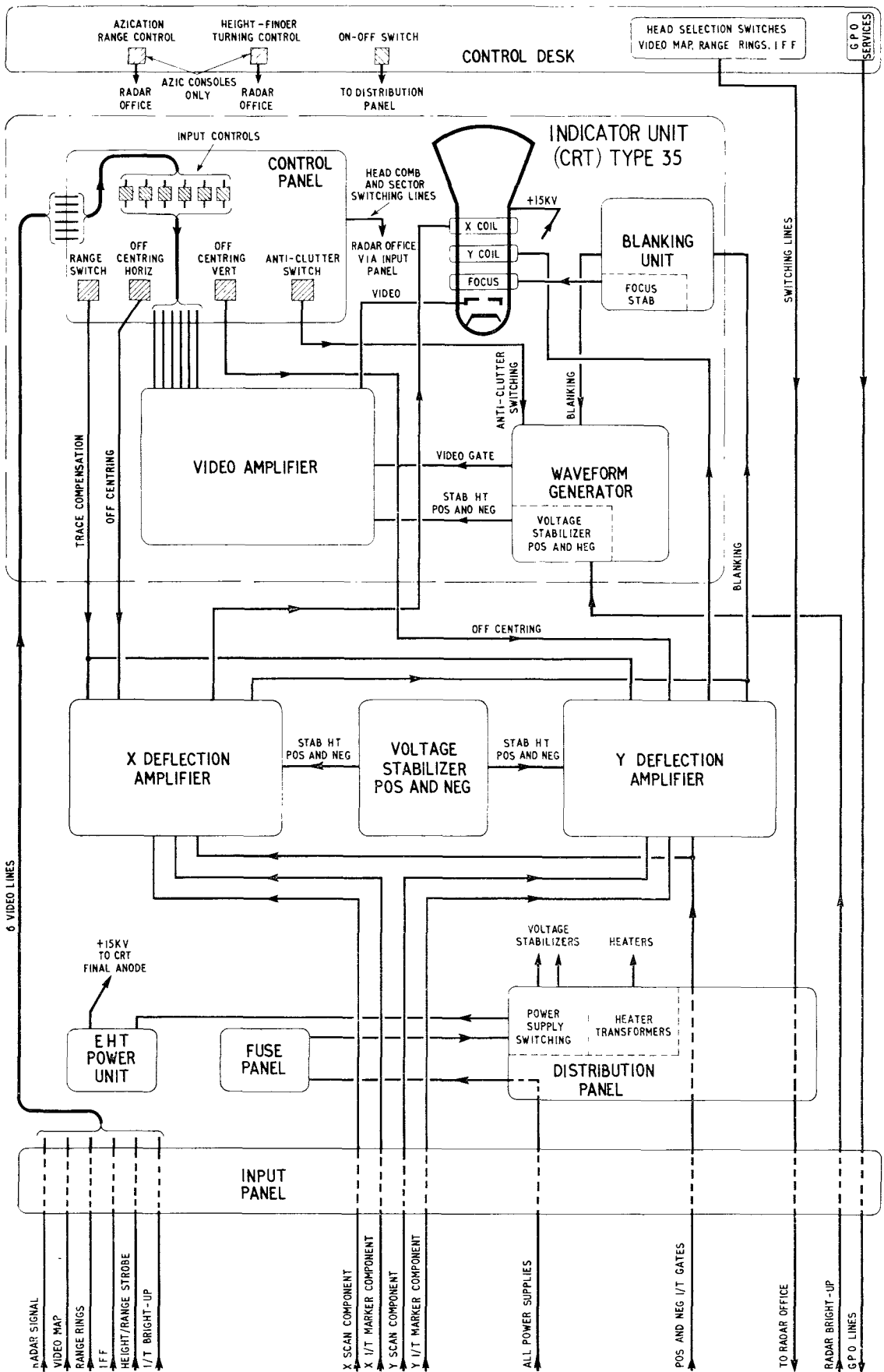


Fig. 7. Console and control desk—simplified block diagram

39. Any display may be off-centred up to a distance corresponding to 200 nautical miles, which enables any particular part of the operational area to be viewed at greater expansion. The video map and all other video facilities remain in true relationship to target echoes because they are all expanded and off-centred equally. With off-centring, the extreme range available from a 250 c/s head can be viewed even on maximum expansion. It is arranged that even when off-centring is applied, a point of the operational area which is painted at the screen centre on one degree of expansion remains there on all other degrees of expansion.

40. The console is constructed so that all important units may be withdrawn easily for setting-up, testing and repair; on each unit are available metering sockets into which a portable metering set may be plugged for rapid checking of circuit voltages and currents. All units are cooled by a current of air entering via a duct at the base of the console, from a balanced blowing system. All controls used by the operator can be illuminated for easy adjustment in the dark. A lamp at the rear base of the console shines into the rear gangway to facilitate movement of servicing personnel during operations.

41. The functions of the various units making up the console Type 64 are outlined in the following paragraphs, which should be read in conjunction with the simplified console block diagram, fig. 7. More detailed circuit descriptions are given in Section 5 of this Part.

#### Indicating unit (CRT) Type 35

42. The indicating unit (CRT) Type 35 forms the upper half of the console Type 64, and includes the cathode-ray tube (CV429) in its housing. The CV429 is electromagnetically focused and deflected, and its screen gives an orange trace of long afterglow; an orange mask, which may have auxiliary information engraved on it may, if desired, be mounted in front of the screen. The CRT operates with its cathode and grid circuits near earth potential, and its final anode at +15 kV. The CRT housing contains the focus coil and the X and Y deflector-coil systems, and the necessary mechanical adjustments for aligning them correctly.

43. The indicating unit also includes the video amplifier (*amplifying unit (video) Type 312*), the *waveform generator Type 80* (with voltage stabilizer), the *blanking unit Type 26* (with focus current stabilizer) and the *panel (control) Type 859* which carries the less frequently used operator's controls. The functions of these sub-units are outlined below.

#### Video amplifier

44. The function of the video amplifier is to accept from the control panel all the video inputs to be displayed as brightness modulation during the trace period, to mix them at appropriate levels, limit and amplify them and apply them

to the CRT grid. The inputs involved are as follows:—

- (1) Radar video signals.
- (2) Video map.
- (3) Range rings.
- (4) IFF.
- (5) Height-range strobe.

45. The video amplifier also accepts from the control panel the inter-trace bright-up pulse and, from the waveform generator Type 80, a wave known as the video gate. This is basically a combination of the radar bright-up and a blanking waveform from the blanking unit Type 26, together with an internally produced anti-clutter waveform, and gives (when required) a graduated reduction in brightness over the first few miles of the trace to reduce the disturbing effect of close-in ground clutter on picture visibility. The main purpose of the video gate waveform, however, is to operate a circuit in the video amplifier which passes to the CRT radar and other trace-period signals when permitted by the blanking, and excludes them during inter-trace periods. The inter-trace bright-up pulse (where required) is displayed during alternate 500 c/s inter-trace periods.

46. The video amplifier accepts, in addition, a trace compensation wave, which is also produced in the waveform generator. This wave is another modified form of the radar bright-up wave from the radar office. It has a linear slope to give gradually increasing brilliance as the spot moves from the scan centre towards the outside, so compensating for the increasing trace separation and giving a picture which appears uniformly bright all over.

47. Adequate protection circuits are incorporated in the video amplifier to prevent burning of the CRT screen in the event of trace rotation ceasing, or of one of the HT supplies failing. Fuller details of all these facilities are given in the relevant chapters in Section 5 of this Part.

#### Waveform generator Type 80

48. The waveform generator also forms part of the indicating unit and its function is to produce the video gating wave described in para. 46 as well as the trace compensation wave. The unit also carries positive and negative HT stabilizers, which accept raw HT from the bulk power supply and feed stabilized HT to the video gating circuit and other parts of the indicating unit.

#### Blanking unit

49. The blanking unit supplies to the waveform generator blanking voltages which are used to modify the video gate wave. The blanking output is controlled by waveforms from the cathode circuits of the final deflection amplifiers, arranged to effect blanking whenever the deflection coil currents are large enough to deflect the beam

beyond the screen edge; the blanking output is also controlled by a direct input from the coils themselves which causes blanking if, for any reason, normal scanning fails altogether. The latter facility protects the screen from burning in the event of timebase or deflection amplifier failure. The unit also contains a stabilizer for CRT focus-coil current.

#### Control panel

50. The remaining sub-unit of the indicating unit is the control panel Type 859, which carries the less frequently used operator's controls, and is situated behind a hinged cover to the right of the screen.

#### Deflection amplifiers

51. The X deflection amplifier is known as the amplifying unit (R.H.) Type 313, and the Y as the amplifying unit (L.H.) Type 314. They are situated on a mounting tray below the indicating unit, with their voltage stabilizer between them, the Type 313 being on the right as seen by the operator. Apart from one minor difference their circuits are identical, and in component layout one is a mirror image of the other.

52. The deflection amplifiers are sometimes referred to as voltage-to-current converters, because their main function is to accept sine and cosine scan component waveforms of voltage from the radar office and to convert them into identical current waveforms in the deflector coils. The amplifiers have also, during the inter-trace period, to shut off the normal input lines, and, by means of a gating circuit, to pass instead the inter-trace marker components, also from the radar office. (Note, however, that not all consoles display inter-trace markers). From the radar office, too, come the positive and negative inter-trace gating waveforms which operate these gates.

53. Each amplifier also performs the functions of picture expansion and off-centring, the controls for these being located on the control panel Type 859.

#### Voltage stabilizer

54. The stabilizer (voltage) Type 51 is mounted between the two deflection amplifiers, to which it supplies accurately stabilized positive and negative HT. The regulators here and in the waveform generator are all ultimately referred to the station -500V reference voltage.

#### EHT power unit

55. The power unit (EHT) Type 898 is situated on the front base of the console. It produces a stabilized and almost ripple-free EHT supply of +15 kV for the CRT final anode.

#### Miscellaneous units

56. The panel (fuse) Type 860 and the panel (distribution) Type 861 are located at the base of the console. The distribution panel forms the main junction unit for interconnections between other units and the input panel (part of console framework); it also carries the HT relays and the heater transformers.

#### Control desks

57. With every console is associated a control desk, which has been made a separate stores item so that consoles for different functions can be made up from the same basic console Type 64 with different control desks (para. 35).

58. The control desk is attached to the front of the console so as to provide a convenient ledge for use as an elbow rest and for taking operational records. It carries the controls most frequently used by the operator, and the intercom. facilities.

TABLE I  
Reference List of Units

Nomenclature	Type No.	Ref. No.	Descriptive title	Where described
<b>OPERATION EQUIPMENT</b>				
Rack assembly (timebase)	300	10D/18666	Master timebase rack	A.P.2897R, Vol. 1, (2nd Edn.) Part I Sect. 3, Chap. 1
<i>including :—</i>				
Timebase unit	140	10D/18695	Master timebase unit	Sect. 3, Chap. 1
Power unit	903	10K/17131		Sect. 3, Chap. 1
Panel (distribution and switching)	868	10D/18696		Sect. 3, Chap. 1
Rack assembly (resolver magstrip)	301	10D/18667	Magstrip resolver rack	Sect. 3, Chap. 2
<i>including :—</i>				
Resolver unit (magstrip)		10AE/625	Magstrip resolver unit	Sect. 3, Chap. 2
Amplifying unit (clamping and distribution)	504	10U/16772	Magstrip clamp unit	Sect. 3, Chap. 2
Power unit	904	10K/17132		Sect. 3, Chap. 2
Panel (distribution and switching)	877	10D/18864		Sect. 3, Chap. 2
Rack assembly (azication)	302	10D/18668	Azication rack	Sect. 3, Chap. 4
<i>including :—</i>				
Waveform generator (azication marker)	100	10V/16063	Azication marker generator	Sect. 3, Chap. 4
Resolver unit (azication)		10AE/626	Azication marker resolver	Sect. 3, Chap. 4

(Continued overleaf)

TABLE 1—contd.

Nomenclature	Type No.	Ref. No.	Descriptive title	Where described
Power unit	905	10K/17133	Azication marker resolver	Sect. 3, Chap. 4
Panel (distribution)	878	10D/18865		Sect. 3, Chap. 4
Rack assembly (gating waveform)	304	10D/18670	Gating waveform rack	Sect. 3, Chap. 3
<i>including :—</i>				
Waveform generator (gating)	101	10V/16064	Gating waveform generator	Sect. 3, Chap. 3
Distribution unit (gating)		10D/18917		Sect. 3, Chap. 3
Power unit	903	10K/17131		Sect. 3, Chap. 1
Panel (distribution and switching)	879	10D/18866		Sect. 3, Chap. 3
Rack assembly (bulk power supply)	305	10D/18671	BPS rack	Sect. 3, Chap. 7
<i>including :—</i>				
Rectifier unit (+420V)	100	10D/18698		Sect. 3, Chap. 7
Stabilizer unit (voltage)	100	10D/18697	+250V stabilizer unit	Sect. 3, Chap. 7
Rectifier unit (+570V)	101	10D/18699		Sect. 3, Chap. 7
Rectifier unit (—470V)	102	10D/18700		Sect. 3, Chap. 7
Relay unit	184	10F/16208		Sect. 3, Chap. 7
Transformer	3300	10K/17396		Sect. 3, Chap. 7
Rack assembly (misc. ITBU)	306	10D/18672	ITBU rack	Sect. 3, Chap. 5
<i>including :—</i>				
Distribution unit (ITBU)		10D/18918		Sect. 3, Chap. 5
Panel (switching)	876	10D/18863		Sect. 3, Chap. 5
Relay unit (azication change-over)	192	10F/16273		Sect. 3, Chap. 5
Power unit	903	10K/17131		Sect. 3, Chap. 1
Rack assembly (negative reference)	338	10D/18832	Negative reference rack	Sect. 3, Chap. 6
<i>including :—</i>				
Power unit (reference)	906	10K/17134		Sect. 3, Chap. 6
Relay unit (change-over)	186	10F/16226		Sect. 3, Chap. 6
Relay unit	185	10F/16209		Sect. 3, Chap. 6
Rack assembly (waveform monitor)	339	10D/18860	Waveform monitor rack	Sect. 4, Chap. 1 to 4
<i>including :—</i>				
Monitoring unit (CRT)	102	10T/ 6156	Monitor CRO panel	Sect. 4, Chap. 1
Panel (waveform selection)	890	10D/18934		Sect. 4, Chap. 4
Amplifying unit (video)	515	10V/16785	Monitor video amplifier	Sect. 4, Chap. 3
Panel (indicating)	4064	10D/19032		Sect. 4, Chap. 1
Timebase unit	141	10D/48953	Monitor timebase unit	Sect. 4, Chap. 2
Power unit (EHT)	913	10K/17453	Monitor EHT unit	Sect. 4, Chap. 1
Power unit	4065	10K/17832		Sect. 4, Chap. 1
Panel (distribution)	891	10D/18935		Sect. 4, Chap. 1
Console (fixed-coil)	64	10D/18579	Fixed-coil PPI console	Sect. 5
<i>including :—</i>				
Indicating unit (CRT)	35	10Q/16085		Sect. 5, Chap. 1
Amplifying unit (video) ( <i>part of indicating unit</i> )	312	10U/16762	Console video amplifier	Sect. 5, Chap. 2
Waveform generator (video gating) ( <i>part of indicating unit</i> )	80	10V/16062		Sect. 5, Chap. 3
Blanking unit ( <i>part of indicating unit</i> )	26	10D/18641		Sect. 5, Chap. 4
Panel (control) ( <i>part of indicating unit</i> )	859	10D/18643	Control panel	Sect. 5, Chap. 5
Amplifying unit (R.H.)	313	10U/16763	X deflection amplifier	Sect. 5, Chap. 6
Amplifying unit (L.H.)	314	10U/16764	Y deflection amplifier	Sect. 5, Chap. 6
Stabilizer (voltage)	51	10D/18642	Defl. amp. voltage stabilizer	Sect. 5, Chap. 7
Power unit (EHT)	898	10K/16952	Console EHT unit	Sect. 5, Chap. 8
Panel (fuse)	860	10D/18644	Console fuse panel	Sect. 5, Chap. 9
Panel (distribution)	861	10D/18645	Console distribution panel	Sect. 5, Chap. 9
Input panel ( <i>part of console framework</i> )				Sect. 5, Chap. 9
Panel (control desk)	862	10D/18646	Interception controller's desk	Sect. 5, Chap. 10
Panel (control desk)	893	10D/18942	Azication desk for intercept cabin	Sect. 5, Chap. 10
Panel (control desk)	894	10D/18943	Combined controller/azication desk	Sect. 5, Chap. 10
Panel (control desk)	895	10D/18944	Track-telling desk	Sect. 5, Chap. 10
Panel (control desk)	896	10D/18945	Azication desk for track-telling room	Sect. 5, Chap. 10
Panel (control desk)	907	10D/18993	"Putting-on" desk for stop-and-look head	Sect. 5, Chap. 10
Panel (control desk)	4550 to 4555	10D/19373 to 10D/19378		Sect. 5, Chap. 10
◀ Panel (control desk)	16284 to 16291	10D/22363 to 10D/22370		Sect. 5, Chap. 10 ▶
<b>SPECIAL TEST EQUIPMENT</b>				<i>A.P.2527D, Vol. 1</i>
Multimeter	100	10S/16576	Fixed-coil metering unit	Chap. 15
Test oscillator	101	10S/16577	5 c/s osc. for focus-coil adjustment	Chap. 16
Pulse generator	3	10S/16585	Video test set	Chap. 17
<i>including :—</i>				
Pulse generator unit	4073	10S/16600		Chap. 17
Power unit	903	10K/17131		
Test unit (resolver)		10S/16584		Chap. 18

**RACK ASSEMBLY  
(TIMEBASE) TYPE 300**

TIMEBASE UNIT TYPE 140	POWER UNIT TYPE 903
TIMEBASE UNIT TYPE 140	POWER UNIT TYPE 903
TIMEBASE UNIT TYPE 140	POWER UNIT TYPE 903
TIMEBASE UNIT TYPE 140	POWER UNIT TYPE 903
PANEL (DISTRIBUTION AND SWITCHING) TYPE 868	

**RACK ASSEMBLY  
(RESOLVER MAGSLIP) TYPE 301**

RESOLVER UNIT (MAGSLIP)	AMPLIFYING UNIT (CLAMPING AND DISTRIBUTION) TYPE 504
POWER UNIT TYPE 904	
RESOLVER UNIT (MAGSLIP)	AMPLIFYING UNIT (CLAMPING AND DISTRIBUTION) TYPE 504
POWER UNIT TYPE 904	
RESOLVER UNIT (MAGSLIP)	AMPLIFYING UNIT (CLAMPING AND DISTRIBUTION) TYPE 504
POWER UNIT TYPE 904	
PANEL (DISTRIBUTION AND SWITCHING) TYPE 877	

**RACK ASSEMBLY  
(GATING WAVEFORM) TYPE 304**

WAVEFORM GENERATOR (GATING) TYPE 101	DISTRIBUTION UNIT (GATING)
POWER UNIT TYPE 903	POWER UNIT TYPE 903
WAVEFORM GENERATOR (GATING) TYPE 101	DISTRIBUTION UNIT (GATING)
WAVEFORM GENERATOR (GATING) TYPE 101	DISTRIBUTION UNIT (GATING)
	POWER UNIT TYPE 903
PANEL (DISTRIBUTION AND SWITCHING) TYPE 879	

**RACK ASSEMBLY  
(AZICATION) TYPE 302**

RESOLVER UNIT (AZICATION)	WAVEFORM GENERATOR TYPE 100
POWER UNIT TYPE 905	POWER UNIT TYPE 905
RESOLVER UNIT (AZICATION)	WAVEFORM GENERATOR TYPE 100
RESOLVER UNIT (AZICATION)	WAVEFORM GENERATOR TYPE 100
POWER UNIT TYPE 905	POWER UNIT TYPE 905
RESOLVER UNIT (AZICATION)	WAVEFORM GENERATOR TYPE 100
PANEL (DISTRIBUTION AND SWITCHING) TYPE 878	

**RACK ASSEMBLY  
(NEGATIVE REFERENCE SUPPLY)  
TYPE 338**

POWER UNIT (REFERENCE) TYPE 906
POWER UNIT (REFERENCE) TYPE 906
RELAY UNIT (C/O) TYPE 186
RELAY UNITS TYPE 185

**RACK ASSEMBLY  
(BULK POWER SUPPLY)  
TYPE 305**

RECTIFIER UNIT (+420V) TYPE 100
STABILIZER (VOLTAGE) TYPE 100
RECTIFIER UNIT (+ 570V) TYPE 101
RECTIFIER UNIT (- 470V) TYPE 102
RELAY UNIT TYPE 184
TRANSFORMER TYPE 3300

(ONE PER 6 CONSOLES INSTALLED)

**RACK ASSEMBLY  
(WAVEFORM MONITOR)  
TYPE 339**

PANEL (INDICATING) TYPE 4064	POWER UNIT (EHT) TYPE 913
MONITORING UNIT TYPE 102	
PANEL (WAVEFORM SELECTOR) TYPE 890	
AMPLIFYING UNIT (VIDEO) TYPE 515	
TIMEBASE UNIT TYPE 141	
POWER UNIT TYPE 4065	
POWER UNIT TYPE 4865	
PANEL (DISTRIBUTION) TYPE 191	

NOTE: ON CERTAIN CLASSES OF STATION, SOME RADAR OFFICE RACKS ARE DUPLICATED ACCORDING TO OPERATIONAL REQUIREMENTS.

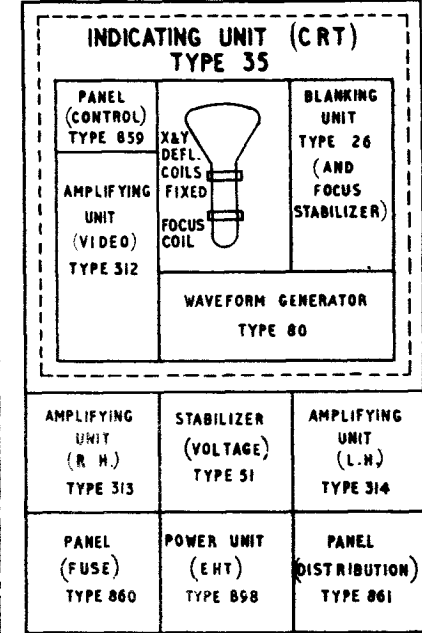
ALL UNITS EXCEPT CONSOLES AND CONTROL DESKS ARE SITUATED IN RADAR OFFICE

**RACK ASSEMBLY  
(MISCELLANEOUS)  
TYPE 306**

POWER UNIT TYPE 903	DISTRIBUTION UNIT (ITBU)
DISTRIBUTION UNIT (ITBU)	POWER UNIT TYPE 903
PANEL (SWITCHING) TYPE 876	
RELAY UNIT (AZIC C/O) TYPE 192	

PANEL (CONTROL DESK) TYPE 862 (DR VARIANTS)
--

**CONSOLE TYPE 64**



NOTE: NUMBER OF CONSOLES INSTALLED VARIES WITH CLASS OF STATION

Fig. 8

Location of units. Fixed-coil display system (Phase 1 installation, GC1)

Fig. 8

(A.L. B. May '55)



## **SECTION 2**

# **OPERATING INSTRUCTIONS**

# Chapter 1

## CONSOLE TYPE 64 WITH CONTROL DESKS

(Operating Instructions)

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<i>Track-telling console</i> .. .. .	22	<i>"Putting-on" console for "stop-and-look"</i>	
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#### Notes to user . . .

(a) Read paras. 1 to 21, then turn to the paragraphs later in the chapter which concern your own console.

(b) Although called "operating instructions", this chapter is not to be taken as authority for radar operator trades to touch any particular switches or controls. The division of responsibilities between officers using consoles, radar operators and radar fitters will be the subject of local or Group instructions.

### INTRODUCTION

1. In these notes, which apply in the first place to Phase 1 GCI stations, it is assumed that all associated radar office equipment and all radar heads have been run up and are functioning properly. It is also assumed that the consoles have been properly set up in accordance with the instructions in Part 2 of this volume. It is also assumed that the air blowing system is in order.

2. The only controls which are dealt with in this chapter are those on the exterior of the console, situated either on the panel (control desk) or on the panel (control) Type 859 (the latter located behind the door to the right of the CRT screen). Certain controls which in earlier consoles were available to the operator are, on the Type 64, screwdriver-preset controls located inside the unit; these include certain DEFLECTION controls and the BRIGHTNESS and FOCUS controls. These controls must be set up as part of an accepted servicing procedure (Part 2). Haphazard running adjustments to them must be avoided, or picture accuracy and quality will be degraded.

3. The different control requirements of the various controllers and operators on a large station have been satisfied by using the basic console Type 64 in conjunction with a number of different types of panel (control desk), so that separate complete sets of operating instructions might be thought desirable for each type. However, a large number of controls is common to them all, and operations using these are summarized in para. 4 to 21 below in order to avoid unnecessary

repetition. The particular operations which are peculiar to each type of control desk then follow; as and when other control desks are designed, information about them will be added by amendment action.

### OPERATIONS COMMON TO ALL CONSOLES

4. Before switching on, make sure the chair is the right height for the operator's eyes to view the CRT screen squarely and the elbows to rest comfortably on the control desk outer cover. Plug the telephone headset into the jack socket located under the desk at the right hand side.

#### *Switching on*

5. Open the door to the right of the CRT screen to obtain access to the panel (control) Type 859. See that the following toggle switches are in the positions indicated:—

- (1) Anti-clutter : OFF (*but see para. 13*)
- (2) Head combining : OFF
- (3) Screen lights : OFF (unless otherwise instructed)
- (4) HT on : ON.

6. See also that the following information input controls on the same panel are turned right down (counter-clockwise):—

- (1) RADAR SIGNALS
- (2) VIDEO MAP
- (3) STROBE MARKERS
- (4) RANGE STROBE
- (5) I.F.F.
- (6) RANGE RINGS.

7. On the control desk, see that all the P.O. keys are in the central (OFF) position. Switch on the console as follows:—

- (1) Close the console ON switch at the right-hand side of the desk. If incoming supplies are in order, the red lamp lights to indicate that valve heaters throughout the console are alight.
- (2) Within one minute the green lamp should light to indicate that HT supplies throughout

the console are on. If the green lamp does not light, the console requires servicing. Do NOT hold down the HT RESET button in an attempt to bring on the H.T

(3) Once the HT is on, EHT is being applied to the cathode-ray tube and a display may be obtained. Before attempting to obtain accurate plots, allow (if possible) a period of at least five minutes for the circuits to settle down.

#### Head selection

8. Ascertain which radar head (or which dipole stack on Type 7 head) is to be used as the source of signals for the display, and select it by means of the RADAR HEAD switch at the right-hand side of the control desk. The head code numbers used on early GCI installations are as follows : any variations from this list will be promulgated locally :—

Number	Head
1	Type 7 (extra high cover)
2	Type 7 (high cover)
3	Type 7 (full cover)
4	Type 14 (low PRF*, forward-looker)
5	Type 11
6	Type 54
7	Type 14 (high PRF†, forward-looker)
8	Type 14 (high PRF†, backward-looker)
9	Spare

\* Low PRF = 250 c/s (giving absolute maximum range = 240 miles).

† High PRF = 500 c/s (giving absolute maximum range = 120 miles).

9. When radar head selection has been made, the console's associated head selector unit in the radar office automatically supplies video signals from the chosen head together with the appropriate timebase components and radar bright-up waveforms, without any further action by the operator.

#### Range selection

10. Ascertain, in the light of the terrain to be covered, which degree of picture expansion is required, and select it by means of the RANGE switch at the bottom of the panel (control) Type 859B. This switch has four positions : 80, 160, 240 and 320 nautical miles. Each figure indicates the range of terrain represented by the CRT screen *diameter* on that degree of trace expansion.

#### Range rings

11. (1) Turn the CALIBRATION key on the control desk to "R.R." (range rings), and turn the adjacent FINE/COARSE key to FINE (if the 80M or 160M picture is in use) or to COARSE (for the 240M or 320M picture).

(2) Turn up the RANGE RINGS control until the concentric range rings are just visible.

(3) Bring the scan centre approximately to the centre of the CRT screen by means of the OFF-CENTRE VERTICAL AND OFF-CENTRE HORIZONTAL controls.

(4) Check the nominal picture range by counting the number of visible range rings.

The range ring interval is 5M on FINE, and 10M on COARSE.

(5) Switch off the range rings when not in use, to avoid obscuring target echoes. Use the VM/RR key on the control desk for this ; the RANGE RINGS input control on the control panel once set, should not be touched again.

#### Obtaining a picture

12. Turn up the RADAR SIGNALS control on the panel (control) Type 859B until a satisfactory picture is obtained. The noise or "grass" should paint a faint but uniform speckled background over the whole screen. Target echoes should paint clearly and strongly, leaving a pronounced afterglow. When the head has completed several rotations, the afterglow from several successive paints of an aircraft target should form a clearly visible "tail" to the new paints, showing the target's course. When experience has been gained, this control may be set up to give a known "paint" brightness on a reliable permanent echo using one particular search head ; suitable echoes are obtainable from church spires, lightships, islands, etc.

#### Anti-clutter

13. On certain sites and with certain radar heads heavy ground or sea clutter may obscure close-in target echoes over the first few miles of the scan. This trouble may be mitigated by reducing the video level in this region ; to do this close the ANTI-CLUTTER switch in the top left-hand corner of the panel (control) Type 859B.

#### Video map

14. On stations having a video map installation, electronic display of a map of the terrain, complete with grid squares, may be superimposed on the ordinary radar display. Proceed as follows :—

(1) Throw the CALIBRATION key on the control desk to "V.M."

(2) Throw the adjoining FINE/COARSE key to FINE (for 80M and 160M pictures) or COARSE (for 240M and 320M pictures) in order to obtain a map of suitable scale.

(3) Turn up the VIDEO MAP control on the panel (control) Type 859 gradually until the map detail is just visible. Do NOT turn up this control so far that target echoes are obscured by map detail.

#### Off-centring

15. The whole picture, including auxiliary information such as video map, may be off-centred on the screen by any distance up to 200 nautical miles using the OFF-CENTRE VERTICAL and OFF-CENTRE HORIZONTAL controls on the panel (control) Type 859. By using this facility in conjunction with the trace expansion afforded by the RANGE switch, responses from one small part of the terrain may be examined in greater detail.

16. There is a danger of "losing sight" of a target, or of being confused between responses, when making alterations to off-centring and trace expansion (e.g. during control of an interception). To minimize this danger, proceed as follows :—

(1) Using the long-range picture, bring the target of interest to the screen centre, using the OFF-CENTRE controls.

- (2) Now obtain the desired degree of picture expansion by using the RANGE switch. The circuits have been designed to ensure that a target which painted at the screen centre on one range remains there on all other ranges.

#### H/R strobe

**17.** It is possible to "flash" the trace on an associated H/R console Type 65 by depressing momentarily the key marked H/R STROBE on the control desk. This is usually done at the instant the Type 64 trace paints a target the height of which is required to be found by the Type 65 operator, using split technique with the Type 7 head. This facility is needed because the 65 has a range/deflection display only, and its operator has no indication of the bearing of the Type 7 head, and so no means of distinguishing between targets.

#### Head combining

**18.** It is possible to obtain improved coverage of a chosen 180 deg. sector of the terrain by using the head combining facility. This involves two Type 14 radar heads, one forward-looking and one backward-looking, which are rotation-synchronized. Switches and relays in the console's associated head selector unit route radar signals from the forward-looker while it sweeps the chosen sector, and then from the backward-looker as it sweeps the same sector. Appropriate time-base waveforms, etc., are supplied automatically. Proceed as follows:—

- (1) Use the head selector switch on the control desk to select the forward-looking head.
- (2) Select the sector to be scanned in this manner by means of the SECTOR switch at the top centre of the panel Type 859.
- (3) Close the HEAD COMBINING switch at the top right-hand corner of the panel Type 859.
- (4) Off-centre the picture so as to move the unwanted sector partly off the screen and obtain a fuller picture from the wanted sector.
- (5) If the video map is in use, a small adjustment to the VIDEO MAP input control may be necessary, as the map is not painted during the sweep of the back-looker, and reliance must be placed on the video map afterglow during that time.

#### CRT mask

**19.** Most consoles are fitted with an amber-tinted transparent mask fitting over the CRT screen. This may, on certain stations, carry engraved information to supplement, or replace, the video map facility. To provide edge-illumination of this engraved information, close the SCREEN LIGHTS switch on the panel (control) Type 859. Set the associated BRIGHT/DIM switch (labelled DIAL LIGHTS on early models) on the same panel, to suit the operator.

#### Temporary shut-down

**20.** If the console is not to be used for a period, but it is desired to leave it with valve heaters

alight so that it will be ready for immediate use when required, trip the HT circuit by momentarily switching OFF and ON again the HT ON switch on the panel (control) Type 859. The green lamp on the control desk will go out but the red lamp should remain alight. To resume operation, it is now only necessary to press the HT RESET button on the same panel. This facility is useful on the "stand-by" consoles which, though not normally used, may be required at short notice.

#### Complete shut-down

**21.** To switch off the console completely, turn OFF the CONSOLE ON switch at the right-hand side of the control desk.

### OPERATIONS ON PARTICULAR CONSOLES

#### Track-telling console

**22.** The track-telling console consists of the basic console Type 64 fitted with a panel (control desk) Type 895. It is the simplest form of PPI console, having no facilities at all apart from those explained in para. 4 to 21. It is used in the track-telling room on GCI stations to obtain plots, which are passed to the operations room.

#### Azicating console for track-telling room

**23.** An azicating PPI console for use in the track-telling room consists of a basic console Type 64 fitted with a panel (control desk) Type 896. In addition to taking ordinary plots to be fed to the operations room, it is used for "putting-on" a Type 13 (height-finder) head to targets when heights are required. The turning-gear controls for the Type 13 are therefore here on the control desk, and the azication marker indicating the actual bearing of the Type 13 head appears on the PPI display. But the actual heights are read off from the elevation-scan display on an adjacent console Type 61.

**24.** To use the azicating facility on any particular track, proceed as follows:—

- (1) Turn the azication function key on the control desk to AZ. MARK RANGE STROBE.
- (2) Turn up the STROBE MARKER input control on the panel (control) Type 859 until the azication marker is sufficiently clear on the screen.

(This marker is "painted" in the inter-trace period but thanks to afterglow and persistence of vision it appears continuously superimposed on the radar picture. It appears as a short, bright line in a radial direction from the scan centre. The deflection components which produce this marker originate in the azication marker rack 302 (radar office) to which there is a tell-back selsyn link from the Type 13 (height-finder) head. Thus the bearing indicated by the azication marker is the *actual* bearing at which the Type 13 is "nodding". The range at which the marker appears may be altered by the operator, using the AZIC. RANGE control on the control desk).

- (3) Turn up the RANGE STROBE input control on the panel (control) Type 859 until the range strobe appears equally as bright as the azication marker.

(The range strobe (not to be confused with the entirely different H/R strobe facility explained in para. 17) is a single bright circle, centred on the scan centre, intersected at one point of its circumference by the azication marker. It is painted in the scan period by pulses generated in the elevation-scan console Type 61. The time of these pulses after time zero (i.e. the range indicated by the circle) is governed by a voltage from a potentiometer on the control desk here on the PPI console. This potentiometer is ganged to the one controlling the azication marker range (sub-para. (2) above, so that both are moved in and out simultaneously by the AZIC. RANGE control on the desk. The same pulses expand part of the IFF CRT trace on the console Type 61, indicating to its operator the particular target the height of which is required).

- (4) Turn the AZIC. RANGE control until the range strobe circle lies over the latest paint of the target of which the height is required.
- (5) Operate the AZIC. LAYING control to put the Type 13 head on to the target, as indicated by the azication marker line lying over the latest paint.

(The head may be "inched" in either direction at speeds up to about 3 r.p.m. by turning the control a small distance in the corresponding direction. For large changes of bearing, the head may be turned at its full speed of 6 r.p.m. by turning the control hard over in the desired direction, until the internal switches engage.)

**25.** If the normal azicating console goes unserviceable during operations:—

- (1) Return the AZICATION FUNCTION key to the central position.
- (2) Switch off the console and report it for servicing.
- (3) Move to the adjoining stand-by azicating console (also fitted with a similar panel (control desk)), and resume operations.

#### **Azicating console for intercept cabin**

**26.** An azicating console for use in an intercept cabin consists of a basic console Type 64 fitted with a panel (control desk) Type 893. It is mainly used to "put on" a Type 13 (height-finder) head to targets when their heights are required by the interception controller. The turning-gear controls for the Type 13 are therefore to be found here on the control desk, and the azication marker indicating the actual bearing of the Type 13 head appears on the PPI display. But the actual heights are read off from the elevation-scan display on an adjacent console Type 61.

**27.** Apart from the fact that it has only one telephone jack socket instead of two, the panel (control desk) Type 893 is identical with the panel (control desk) Type 896 as used on azicating consoles for the track-telling room. The operating instructions are therefore the same as those in para. 24. The emergency instructions of para. 25 also apply, except that the stand-by azicating console is actually a "combined azicating/interception" console as explained in para. 31 below.

#### **Interception controller's console**

**28.** An interception controller's console consists of a basic console Type 64 fitted with a panel

(control desk) Type 862. It has all the facilities required by interception controllers for carrying out ground-controlled interceptions, and is also the type of console used by the Chief Controller and the Fighter Marshal.

**29.** In addition to the facilities explained in para. 4 to 21, an interception controller's console carries the following extra functions:—

- (1) INTER-COM., C.C./F.M. key. To call either the Chief Controller or the Fighter Marshal, turn the key to the appropriate position.
- (2) R.T. TRANS. key. To call a controlled aircraft by RT, turn this key to the transmit position.
- (3) MON. SPEAK. key. To communicate with the operator who is monitoring the VHF transmission, depress this key.
- (4) GPO call lamp. This lamp is not now used.
- (5) Identification, friend or foe (IFF). To use this facility, turn the I.F.F. key on the control desk to ON. (The first console on the station to have its I.F.F. key closed starts up the IFF interrogator, and other consoles can then obtain IFF facilities as required.) Turn up the IFF input control on the panel (control) Type 859 until satisfactory responses from friendly aircraft are observed. Do not turn up this control too far or other responses may be masked by excessively bright IFF responses.

#### **Note . . .**

- (1) To avoid over-interrogation of aircraft responders, always switch OFF the I.F.F. key when the facility is not actually in use.
- (2) For MK. 3/MK. 10 IFF facilities see Chap. 10, Sect. 4, Part 1.

**30.** If the console goes unserviceable during an interception, proceed as follows:—

- (1) Switch off the console and report it for servicing.
- (2) Move to the adjacent "combined azicating/interception" console (which should be kept in a stand-by condition with heaters on), press the H.T. RESET button and resume operations.

#### **Combined azicating/interception console**

**31.** The combined azicating/interception console consists of the basic console Type 64 fitted with a panel (control desk) Type 894. It is usually installed in an intercept cabin between the interception controller's console and his azicating console, and is available as a stand-by for either of these. If it is being used for interception control, see para. 4 to 21 and para. 29 for operating instructions.

#### **"Putting-on" console for stop-and-look" head**

**32.** The console used for "putting-on" the stop-and-look radar head consists of a console Type 64 fitted with a panel (control desk) Type 907. It is situated in the track-telling room; next to it is a console Type 61A (Type 61 connected as an A-scope).

**33.** The console 64 thus fitted has the basic facilities listed in para. 4 to 21, together with certain facilities for strobing targets not unlike those on an azicating console. The strobed zone is marked by a 10-mile shadow on a small subsidiary range/deflection display on the console Type 61A (A-scope), and the 10-mile region is expanded to fill the whole tube diameter on the main A-scope display. Thus shipping echoes, etc., may be examined in detail. On the 64, proceed as follows:—

- (1) Select the "stop-and-look" head (usually Type 54).
- (2) Turn the azication function key on the control desk to AZ. MARK RANGE STROBE.
- (3) Turn up the RANGE STROBE input control on the panel (control) Type 859, until the range strobe circle appears sufficiently clearly on the screen.
- (4) Use the RANGE potentiometer on the control desk to expand the range strobe circle until it intersects the latest point of the target of interest. (The RANGE potentiometer supplies a voltage to the console Type 61A to control the delay of the range strobe pulses after time zero. This controls both the range of the selected zone seen on the A-scope and the radius of the range strobe circle on the console Type 64 PPI display.)
- (5) Operate the controls on the adjacent stop-and-look turning-gear control unit to bring the head directly on to the latest point of the target, and hold it there. The echoes from the target should now be visible on the A-scope.

## Appendix 1

### CONSOLES AT PHASE 1A RADAR STATIONS

(operating instructions)

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#### Introduction

1. The consoles in use at phase 1A radar stations are consoles Type 64 that are fitted with control desks in the range Type 16284 to Type 16291. For the purposes of this appendix it is assumed that the consoles have been properly set up in accordance with the instructions in Part 2 of this publication, and that the air-blowing system is in order. The comments in the preceding chapter, para. 2 to 4 apply equally to the consoles discussed here.

#### *Preliminary check*

2. Set the CONSOLE switch on the control desk and the H.T. switch on the panel (control) 859B to OFF. Turn RV6, the brilliance control on the amplifier unit (video) Type 312A fully counter-clockwise. Check that the indicator lamp on the associated rack (BPS) 305 is not lit, and that it does light when the CONSOLE switch is switched to ON ; then switch to OFF.

#### *Switching on*

3. Set the TEST/NORMAL switches on the stabilizer Type 51A and on the waveform generator Type 80B to NORMAL. Switch the H.T. switch on the panel (control) Type 859B to ON. This panel is accessible by opening a door to the right of the c.r.t. screen. Switch the console switch to ON and check that after a delay period of 45 to 75 seconds the H.T. ON indicator lights. The comments in the preceding chapter, para. 7 should be noted.

#### *Head selection*

4. Ascertain which radar head is to be used as the source of signals for the display, and select it by means of the RADAR HEAD switch and the VIDEO switch positions. The head code numbers used at phase 1A sites are shown in the following list. Any variations from this list will be promulgated locally.

#### Switch positions

RADAR	HEAD	VIDEO	Video	Range rings	Video map
1	1	Type 80 log.	normal	Type 80 (normal)	
1	2	Type 80 lin.	normal	Type 80 (normal)	
2	1	Type 80 log.	E.L.R.	Type 80 (E.L.R.)	
2	2	Type 80 lin.	E.L.R.	Type 80 (E.L.R.)	
5	1	Type 54	normal	Type 54	
6	1	R.R.1.	normal	none	
7	1	R.R.2.	normal	none	
8	1	C.T.	normal	*See note	
12	1	Type 7	normal	Type 7	

\* Note :—The radar selected on switch unit (trainer control) 4572B.

#### *Other facilities*

5. The facilities detailed in the preceding chapter, para. 10 to 16 apply equally to phase 1A stations. These facilities are : range-selection, range-rings, anti-clutter, video-map and off-centring.

#### *Joystick marking*

6. At the modulator (ITBU) 4430, switch the TEST/NORMAL switch to NORMAL. Set the console RANGE switch to 320M. Press and release the joystick reset switch. Set the joystick RING/DOT switch to RING and check that a circular, or elliptical, mark appears, adjusting if necessary the STROBE MARKERS brilliance control. Now set the

RING/DOT switch to DOT and check that a dot marker appears in the same position. Set the RING/DOT switch to the off (upright) position and check that no mark appears.

#### *Head combining*

7. Select any radar head that is suitable, other than the Type 7. Switch the SECTOR selector switch to the 270-90 position. Switch the HEAD COMBINE switch to the ON position. Check that the Type 7 radar signal is displayed between approximately 270 and 90 degrees, and that the other selected radar signal is displayed during the period when the Type 7 radar is moving from 90 deg. to 270 deg. Repeat this procedure for the other seven positions of the SECTOR selector switch.

8. *Monitor console only.* With the HEAD COMBINE switch in any position switch off the Type 7 resolver. Check that the selected radar signal is displayed continuously and no head combining occurs.

### **OPERATIONS ON PARTICULAR CONSOLES**

#### **Console function**

9. The function of a particular console is dependent upon the function of the control desk fitted. For this reason a list of phase 1A control desks and their functions is given here.

Type No.	Function
16284	Radar office monitor with master resolver key.
16285	Chief controller's console
16286	Interception controller's console
16287	FPS/6 H/R console
16288	Master controller's console
16289	Display controller's and recovery console
16290	Type 13 H/R console
16291	Raid recognition officer's console

#### **Console facilities**

##### *Master controller*

10. The master controller's control desk is fitted with a joystick, which controls the position of a mark on the display. By operating the appropriate inter-console-marking switch the mark can be made to appear on any or all of the chief controller positions. Six switches, of which only four are normally used, are fitted to the master controller's desk with six corresponding indicator lights. A mark from one of the chief controller's positions can be displayed on the master controller's console and is indicated by the appropriate light. The incoming mark to be displayed is determined by the first I.C.M. switch operated by the master controller.

11. The master controller's own joystick mark can be switched off or displayed as a ring or a dot by a three-position switch on the desk. The dot is normally only used during servicing, but an incoming I.C.M. may be displayed as a dot if it is so required. When the display is off-centred or expanded the master controller's own joystick mark may not be seen on the display, thus making

the actual position of the mark obscure and its location difficult. A key marked RESET is provided and, when pressed, ensures that the joystick mark is displayed on the tube face.

##### *Chief controllers 1 and 2*

12. The controls provided at these consoles are the same as those at the master controller's position with the addition of IFF and Post Office facilities. Six I.C.M. switches are used to switch the chief controller's mark on to any or all of the associated intercept positions. The chief controller sees his own ring mark and can receive the mark from any of his intercept controllers; the mark displayed being indicated by a lighted indicator lamp. The intercept controller's mark is displayed as a dot to distinguish it from the master controller's mark.

##### *Chief controllers 3 and 4*

13. Console Type 4476 is used at these positions, No. 4 being a standby unit. Four joysticks are fitted to the console and are used by the chief controller, his assistant and two executives. Inter-station marking is provided between this position and the consoles at two tactical control centres. The console Type 4476 is described in detail in A.P.2897U.

##### *Raid recognition officer*

14. This officer's console is fitted with a joystick and the associated reset and mark on/off controls. The console can mark to either or both of the tactical control centres and receive a mark from either by selection.

##### *Interception controllers*

15. All intercept control consoles are fitted with joysticks to control ring marks, and the controllers can obtain height information from the height-sharing pool. The chief controller is able to display his mark as a ring on the intercept controlling consoles.

##### **Height/range consoles**

16. A height/range console operator has three main controls: a unidirectional joystick for control of the height mark, and two keys for recording a 'height' or 'no height.' He also has a switch marked 'console available' to connect his console into the height-finding pool, and a set of lamps to indicate whether the appropriate controller requires one or two heights.

17. In front of the height-finder consoles there are two electrical indicators (height loading) 12957 attached to the wall. The left-hand indicator is for the FPS/6 height finders and the right-hand one is for the Type 13 height finders. The unit consists of four rows each containing twelve lamps. The twelve lamps in the top row bear numbers corresponding to the numbers of the twelve intercept controller's consoles. The other three rows of lamps are controlled by the height finders: row two for FPS/6 No. 1 or Type 13 No. 1, row three for FPS/6 No. 2 or Type 13 No. 2, row four for FPS/6 No. 3. The fourth row on the Type 13 indicator is not used.



**18.** When the height finder consoles are operational, the lamp at the end of the appropriate row illuminates the height finder type and number. When an intercept controller calls for a height the corresponding console number on the appropriate height-finder's indicator is illuminated. When the height finder connects to the intercept controller the lamp that lights is the one below the relevant console number and in the correct row for that

particular height finder. Should a controller call for a height and there is not a vacant height finder of the selected type, then only the console lamp lights (in the top row) and the console becomes next in the queue. When a height finder becomes vacant it is connected to the queueing controller's console and the corresponding height finder lamp lights.

## Chapter 2

# FIXED-COIL RADAR OFFICE EQUIPMENT

(operating instructions)

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#### Introduction

##### *Scope of chapter*

1. This Chapter gives brief operating instructions for those rack assemblies in the radar office which are closely concerned with the fixed-coil PPI display consoles (Type 64). It does not deal with such rack assemblies and control units as are covered in other publications (for example, the master trigger unit and head selector units); nor does it include detailed instructions for setting-up, testing and fault diagnosis; these are issued in Parts 2 and 3 of this volume. It is assumed here that the equipment is serviceable and properly set up, and only minor checks and observations that may be made on front panels of units are included. *This chapter is no authority for the actual division of duties between fitter trades and operator trades, which will be the subject of local or Group orders.*

##### *Order of switching on*

2. The order set out in the following paragraphs is recommended to be followed at all times; in particular the rack assembly (negative reference) Type 338 must be switched on and in running order before the other rack assemblies, because the timebase unit and all stabilized power packs require the —500V reference potential.

#### **Rack assembly (negative reference) Type 338**

##### *Running up*

3. Switch on the rack assembly (negative reference) Type 338 as follows :—

(1) See that both —50V supplies for relays etc. are reaching the rack from the rectifier units Type 15 (this will be shown by the lighting of the lower pair of green lamps marked —50V IN : SUPPLY 1 and SUPPLY 2 (LP7 and LP8) on the relay unit (change-over) Type 186).

(2) On the radar office power switch-board, turn the switches marked REFERENCE SUPPLY (1) and REFERENCE SUPPLY (2) to the ON positions. This applies single-phase 230V 50 c/s to both power units in the rack.

(3) On reference power unit No. 1 (the lower of the two power units (reference) Type 906 in the rack), operate the PROTECTION switch (SW.D) to OFF for the time being. Close the power unit ON switch (SW.A), then press and release the START button (SW.B).

(4) After a delay of  $\frac{1}{2}$  minute, relays inside the unit close and it starts to produce HT; this is indicated by the lighting of the lower red lamp marked —500V IN : REF 1 (LP9) on the relay unit Type 186. At the same time the PROTECTION WARNING, neon (LP1) on the power unit starts “winking” as a reminder that the protection circuit is not yet effective. —500V is now being supplied to the relay units Type 185 and so to external units demanding it.

(5) Turn the meter selection switch (SW.F) on the relay unit Type 186 to the —500v REF. 1 position, so that the meter indicates the voltage produced by the power unit. If

the voltage is not exactly 500, loosen the locknut on the VOLTAGE SET control (RV1) on the power unit, adjust with a screwdriver to exactly —500V, and re-tighten the locknut. Restore the meter selection switch to OFF.

(6) If the PROTECTION SET preset control (RV2) on this power unit has not been previously set up, it must be done now (see Part 2, Sect. 1, Chap. 2). Throw the PROTECTION switch (SW.D) to ON, extinguishing the WARNING neon.

(7) On reference power unit No. 2 (the upper power unit (reference) Type 906 in the rack), repeat operations (3) to (6) inclusive.

4. Since ref. 1 power unit was the first one to be switched on, it is now the operational one, while ref. 2 power unit is working into a dummy load in the relay unit. This state of affairs is shown by the lighting of the red lamp LP3 (marked —500V OUT : REF. 1) on the relay unit Type 186. If for any reason it is desired to go over to ref. 2 power unit, the —500 CHANGEOVER key (SW.A) on the relay unit) should be pressed to position 2, and released. Similarly, the —50V CHANGEOVER key (SW.B on the relay unit) may be used for manual change-over between the two incoming —50V supplies.

#### Alarm action

5. If the operational power unit develops a fault its protection circuit operates and automatic change-over to the stand-by power unit takes place. Similarly, if one —50V supply fails, automatic change-over takes place to the other. In either of these eventualities, and also when the stand-by power unit or —50V supply fails, the alarm bells ring out to warn personnel in the radar office that there is now no margin of safety against further failures. When the alarm bells ring, they may be silenced by pressing the ALARM RELEASE button (SW.D on the relay unit Type 186). No time must be lost before examining the indicator lamps on the relay unit to see what has gone wrong, and in taking remedial action. For example, if the green lamp LP7 (—50V IN : SUPPLY 1) has gone out, the appropriate rectifier unit Type 15 elsewhere in the radar office (or the cable from it) requires servicing. If the red lamp LP10 (—500V IN : REF. 2) has gone out, the ref 2 power unit must be replaced by a serviceable spare without delay, and the defective unit serviced in the workshop.

#### Closing down

6. The —500V supplies may be switched off, without extinguishing valve heaters, by pressing the RELEASE button (SW.C) on each power unit (which will cause the alarm bells to ring). Complete close down is effected by switching OFF both power units, and switching OFF both the corresponding 230V mains switches on the radar office power switchboard. In principle, the —500V reference supply should be switched off last of all fixed-coil equipment ; but when required, a rapid shut-down of all fixed-coil consoles and radar office racks may be effected by switching off the —500V first, as all voltage stabilizers referred to it will then trip.

## Rack assembly (bulk power supply) Type 305

### Switching on

7. The rack assembly (bulk power supply) Type 305 is switched on as follows :—

(1) Close the appropriate switch marked BULK POWER SUPPLY CABINET on the radar office switchboard, applying three-phase and single-phase 50 c/s mains to the BPS rack.

(2) Close the ON switch (SW.C) on the relay unit Type 184. Nothing will now happen until one of the six consoles fed from the rack is switched on by the console's operator.

(3) When the first console has been switched on, a relay switches the single-phase 50 c/s mains through to heater transformers in the different rectifier units, so that the valves start warming up and a 1-minute time switch starts. At the same time the red light at the top of the rack lights.

(4) After a 1-minute warming-up period a contactor in the relay unit closes and applies three-phase, 50 c/s mains to the rectifier units, so that they start producing HT. These HT supplies are now fed out to any consoles demanding them.

### Voltage and ripple checks

8. The voltage of the different HT supplies should be checked as follows :—

(1) Throw SW.A on the stabilizer unit (voltage) Type 100 to EXTERNAL.

(2) Throw SW.A on the relay unit Type 184 to VOLTS.

(3) Turn SW.B on the relay unit Type 184 (meter selector switch) to each of its nine positions in succession, and see that the readings lie within the limits shown in Table 1. If there are any discrepancies, the relevant rectifier units and/or stabilizer units require servicing (see Parts 2 and 3 of this book).

TABLE 1  
RA305 voltage checks

SW.B position	Rail (volts)	Nominal reading (division)	Permissible tolerance (divisions)
1	—470 unstab.	235	233–246
2	+250 stab. (1)	250	None
3	+250 stab. (2)	250	None
4	+250 stab. (3)	250	None
5	+250 stab. (4)	250	None
6	+250 stab. (5)	250	None
7	+250 stab. (6)	250	None
8	+420 unstab.	210	208–219
9	+570 unstab.	285	282–298

(fully clockwise)

9. The ripple level of the three unstabilized rails should be checked as follows :—

(1) Leave SW.A on the stabilizer unit Type 100 in the EXTERNAL position.

- (2) Throw SW.A on the relay unit Type 184 to RIPPLE.
- (3) Turn SW.B on the relay unit Type 184 to positions 1 (-470V), 8(+420V) and 9(+570V) in succession, and see that the ripple level indicated on the meter lies below the red line marked NORMAL.

#### Switching off

**10.** When the last console of the group has been switched off, the rack will automatically close down, and no further action is necessary. But if servicing is to be undertaken on the rack or on one of the associated consoles it is advisable to turn OFF the ON/OFF switch on the relay unit Type 184, and the relevant mains switch on the radar office power board.

#### Rack assembly (waveform monitor) Type 339

##### Switching on and checking

**11.** It is assumed that the monitor rack is connected to the associated equipment and supplies as listed in the chapter on setting-up (*Chap. 2, Sect. 1, Part 2.*), and that all the racks have been set up correctly, in accordance with the instructions given in the same chapter. The following instructions therefore deal only with the sequence for normal operation. Initially the controls are set thus for checking (with the switches marked MONITOR (1), MONITOR (2) and MONITOR (3) on the radar office switchboard to the ON positions) :—

- (1) *Panel (distribution) Type 891*—MAINS switch (SW.B) to ON (heaters and edge lighting (LP7 to LP11) of panel 4064 label come on).
- (2) *Power units Type 4065*—MAINS 230V switches (SW.A) and rotary switches (SW.B) to OFF.
- (3) *Panel (control) Type 890*—50v switch (SW.C) to ON. Selector switch SW.A may be left on position 22 (MANUAL) to begin with (actuators may be heard operating).
- (4) *Monitoring unit Type 102*—to avoid excessive brilliance and burning of the CRT fluorescent screen, turn the BRILLIANCE control (RV2) 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 the *panel (distribution) Type 868* (SW.A and SW.B) for RA 300 units and *panel (distribution) Type 879* (SW.A) for RA 304 units, to ensure that the appropriate lamps light up.

**12.** The rack is now brought into operation as follows :—

- (1) *Power units Type 4065*—on each unit in turn :—
  - (a) MAINS 230V SW.A to ON, and rotary SW.B to SET.
  - (b) Check that HT indicator lamp (LP6) comes ON and wait approximately 20 seconds for neon LP5 (SET-CHECK) to glow.

- (c) Set SW.B to CHECK ; the neons LP5 and LP6 should remain ON, but a fault in the power supplies will cause the protective circuit to operate ; the power unit will then close down and so extinguish the neons. In this event refer to the setting-up chapter.
- (d) Assuming no fault, set SW.B to LOAD ; the HT ON lamp LP6 should remain on and the SET-CHECK LP5 should be extinguished, indicating that the units in the rack are now fully operational.

#### (2) *Monitoring unit Type 102*

- (a) Turn the BRILLIANCE control clockwise until a spot is visible on the monitor CRO screen and adjust the focus control RV1 for optimum focus.
- (b) Adjust the SHIFT controls, RV3 and RV4, until the spot is displayed near the centre of the screen.
- (c) 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 (LPI to LP3) on the monitor unit light up in the sequence given.

#### General

**13.** The monitor rack is now ready for use. Reference to the front panel label of the panel (indicating) Type 4064 (*fig. 13, Chap. 1, Sect. 4, Part 1.*) will show that the functions of the rack are divided into two main headings, viz : WAVEFORM INSPECTION and SETTING UP. Although there are one or two exceptions which will be noted at the appropriate time, this division allows a quick check to be made (on INSPECTION switch positions) of the existence, or absence, of the expected waveforms, before any accurate setting-up is undertaken (as outlined in the paragraphs on each rack assembly). The full series of twenty-five waveforms, with CABINET SELECTOR SW.A and WAVEFORM SELECTOR SW.B positions for both WAVEFORM INSPECTION and SETTING UP, is illustrated in *fig. 1.*

#### WAVEFORM INSPECTION

##### Timebase waveforms

**14.** For panel Type 890 SW.A positions 1 and 2, and SW.B positions 1 to 12, the waveforms as illustrated in *fig. 1 (a) to (j)* should be displayed (it may be necessary to adjust the X SHIFT control to position them on the screen). These waveforms may be measured, if required, using the built-in meter of the monitoring unit Type 102. To read the amplitude of a waveform displayed on the CRT screen, the trace may be displaced a distance equal to the waveform amplitude, by operation of the Y SHIFT control. The movement of the meter needle over the appropriate scale (as indicated by the lamps LP1 to LP3) then indicates the amplitude of the input waveform.

**15.** To check the delay of the *resolver clamp*

*trigger pulses* (SW.A/1 and 2, SW.B/6 and 12), set the *CALIBRATOR* switch (SW.E) on the TB141 unit to the 10/50  $\mu$  SECS. position. Blackout markers at 10 $\mu$ S intervals, with more prominent markers at 50 $\mu$ S intervals, will be superimposed on the displayed waveform. The delay of the trigger pulse on the 120 miles range should be 120 $\mu$ S (*fig. 1 (e)*), and the delay of the pulse on 240 miles range should be 210  $\mu$ S (*fig. 1 (f)*). If necessary adjust the preset potentiometers RV10 (PULSE DELAY 120) and RV9 (PULSE DELAY 240) on the front panel of the timebase unit Type 140 from which the waveforms originate.

#### **GWG waveforms**

**16.** Waveforms as in *fig. 1(k) to (o)* should be displayed on SW.A positions 3 to 5 with SW.B as detailed on the figure. The amplitudes can be measured if required using the built-in meter.

**17.** The duration of the *ITBU* waveforms should be 100 $\mu$ S; it may be checked using the 10/50 $\mu$ S markers. The delay of the waveforms from the end of the 500 c/s timebase can also be checked by depressing the toggle switch SW.G) labelled 50 c/s B.U. PIP MARKER and measuring the interval between the displayed positive pip and the onset of the BU pulses (*fig. 1 (k)*).

#### **Resolver waveforms**

**18.** The two rack assemblies Type 301 are monitored with SW.A (CABINET SELECTOR) in position 6. The first six positions of SW.B are associated with resolver cabinet No. 1, and the last six positions with resolver cabinet No. 2. By observing the *resolved saw-tooth waveform (p)* the operator can check:—

- (1) that the magstrip resolvers are being rotated in synchronism with the aerial heads, as indicated by the rising and falling amplitude of the displayed waveform;
- (2) that the X and Y outputs have maximum amplitudes equal to the amplitudes of the unresolved waveforms from the TB140 units (*waveform (f)*);
- (3) that the rest levels of the resolved waveforms are clamped, as indicated by the levels remaining steady on the CRT screen.

#### **Head selector waveforms**

**19.** The selection of waveforms from HS racks is not fully automatic. On turning SW.A (panel 890) to position 12, for example, to select the first HS rack, it is then necessary to plug the wander lead of that rack into one of the numerous test points provided, according to the check that is being carried out. It must be remembered that a DC connection is made to the video amplifier Type 515 in each case, and for large signals (e.g. resolved timebase waveforms), SW.B on the panel 890 should be set to position 1 (LOW GAIN) and for small signals (e.g. radar echoes) SW.B should be set to position 2 (HIGH GAIN).

#### **SETTING UP**

**20.** Since this application of the rack assembly Type 339 is fully covered in the appropriate chapter (*Chap. 2, Sect. 1, Part 2*) it is not proposed

to discuss it here, although the waveforms to be expected on the various panel Type 890 switch positions are given in *fig. 1* for convenience.

#### **Switching off**

**21.** To switch OFF the RA339, proceed thus:—

- (1) Turn the BRILLIANCE control on the monitoring unit Type 102 fully counter-clockwise.
- (2) Operate the 50V switch on the panel Type 890 to OFF.
- (3) Operate SW.B and SW.A on both power units Type 4065 to OFF.
- (4) Turn the MAINS switch (SW.B) on the panel Type 891 to OFF.
- (5) Turn the appropriate switches on the radar office power switchboard to OFF.

#### **Note . . .**

*On stations where the R.A. (waveform monitor) has not yet been installed, the checks called for in this chapter must be done as far as possible with a portable oscilloscope.*

#### **Rack assembly (timebase) Type 300**

##### **Switching on**

**22.** The rack assembly (timebase) Type 300 is brought into use as follows:—

- (1) Make sure that the master trigger unit is ON, that the rectifier unit Type 15 is supplying 50V for relays etc., and that the negative reference rack is in operation.
- (2) Turn ON the switches marked TIMEBASE (1), (2), (3) and (4) on the radar office switchboard.
- (3) On the uppermost power unit Type 903 (unit No. 05 in the rack), see that SW.B (OFF/SET/CHECK/LOAD) is in the OFF position, and turn ON the toggle switch SW.A. This lights valve heaters in the power unit and the associated timebase unit.
- (4) After allowing at least  $\frac{1}{2}$  minute for the valves to warm up, turn the SW.B to SET. The power unit is now producing HT across internal dummy loads only, and the protective cut-out circuit is not functioning. The red HT ON lamp (LP6) lights if  $-50V$  is present. The LOAD ON neon (LP5) also lights to show that the  $-300V$  rectifier is working.
- (5) Turn SW.B to CHECK, bringing the protective cut-out circuit into play while keeping the HT supplies across the dummy loads. If all is well the HT ON lamp remains alight; continue to operation (6). But if the HT supplies trip and the HT ON lamp goes out, the power unit needs adjustment (see setting-up procedure in *Chap. 2, Sect. 1, Part 2*).
- (6) All being well, turn SW.B to LOAD, applying HT (and also  $-500V$  reference) to the timebase unit. Although the LOAD ON neon goes out at this stage, the red HT ON lamp remains alight.
- (7) Repeat operations (3) to (6) inclusive on the other three power units Type 903.

- (8) On each timebase unit Type 140 make sure the VCU/NORMAL switch (at rear) is set to NORMAL, and set the RANGE switch to 120 (for 500 c/s timebase) or 240 (for 250 c/s timebase) as required. The normal allocation of timebase units, between frequencies is given in Sect. 3, Chap. 1 of this Part. One unit at each frequency is operational, and one is stand-by, decided by the switches on the distribution panel at the base of the rack.
- (9) Using the waveform monitor rack, check the timebase waveforms for rest-level, velocity and duration (*fig. 1 (q), (r), (s), (t) and (u)*), and if necessary re-adjust the appropriate controls as detailed in Part 2 of this book. Also check the GWG DRIVE, DELAYED CLAMP TRIG., and RBU waveforms from all the timebase units. Remember that the "stand-by" units and their power units must be in just as serviceable a state as the "main" or operational units.

#### Change-over to stand-by

**23.** If either operational timebase unit, or its power unit, should develop a fault during operations, change straight over to the stand-by, using the appropriate switch (SW.A or SW.B) on the panel (distribution and switching) Type 868 at the base of the rack. The defective unit must be serviced without delay or replaced by a good unit.

#### Closing down

**24.** The rack may be closed down by restoring SW.B and SW.A on each power unit to OFF, and turning off the relevant switches on the radar office power board.

#### Rack assembly (resolver magflip) Type 301

##### Switching on

**25.** It is assumed that all the radar search heads have been started up from the combined head control rack, and are rotating normally and supplying selsyn information. It is also assumed that -50V for relays is being supplied by the rectifier Type 15, that the -500V negative reference rack is in operation, that correct timebase and delayed clamp trigger waveforms are coming from the timebase rack, and that trigger pulses are reaching the rack from the master trigger unit. Switch on the rack as follows (assuming that this is No. 1 resolver rack):—

- (1) On the radar office power switchboard, close the switches marked RADAR RESOLVER CABINET NO. 1 (1), (2) and (3).
- (2) On the uppermost power unit Type 904, see that SW.B (OFF/SET/CHECK/LOAD) is in the OFF position, and turn ON the toggle switch SW.A. This lights valve heaters both within the power unit and in the associated resolver unit (magflip) and amplifying unit (clamping and distribution) Type 504.
- (3) After allowing  $\frac{1}{2}$  minute for valves to warm up, turn SW.B to SET. The power unit is

now producing HT supplies at +570V (unreg.), +400V, +300V and -300V, but they are not yet connected out to the external units, and the protective cut-out circuit is not operative. The red HT ON lamp LP6 now lights if the relay circuit is in good order. The LOAD ON neon LP5 also lights to show that the -300V rectifier is working.

- (4) Turn SW.B to CHECK, bringing the protective cut-out circuit into play without as yet connecting HT to the external loads. If the power unit is already correctly set up the HT ON lamp remains alight; continue to operation (6). But if the HT supplies trip and the HT ON lamp goes out, the power unit requires readjustment. Revert to the SET position and refer to the setting-up instructions (*Chap. 2, Sect. 1, Part 2*).
- (5) Turn SW.B to LOAD, applying HT to the external units. Although the LOAD ON neon goes out at this stage, the red HT ON lamp remains alight.
- (6) Repeat operations (2) to (6) inclusive on the other two power units Type 904.
- (7) Switch ON the selsyn motor on each resolver unit (magflip) using the SELSYN ON/OFF switch (SW.A). Using the waveform monitor rack, see that the sine and cosine timebase components from each resolver are varying smoothly and continuously in accordance with the rotation of the associated radar heads (*fig. 1 (p)*).

#### Changing faulty units

**26.** Normally at least one set of properly adjusted resolver equipment (power unit, resolver unit and amplifying unit) is kept in resolver rack No. 2 fully run up but without selsyn drive; the set is available for spares. When a fault develops on one of the operational units, replace it immediately by the spare unit so that the faulty unit may be removed for servicing. If in doubt exactly where the fault lies, replace the whole set of resolver equipment by the spare set.

**27.** In certain emergencies (*see para. 4 of Chap. 2, Sect 3 of this Part*) it is required to run the selsyn in one resolver in parallel with the selsyn in another (rotation-synchronized) resolver, instead of running it directly from the associated radar head. Thus, if instructed to run the selsyn in resolver No. 3 in parallel with the selsyn in resolver No. 1 because the selsyn services to No. 3 are interrupted, proceed as follows:—

- (1) Switch OFF the selsyns on resolver units Nos. 1 and 3, using SW.A on each unit.
- (2) Remove the selsyn input socket from PL5 on resolver unit No. 3, and instead connect to PL5 the special cable kept for the purpose inside the rack door.
- (3) Connect the other end of the special cable to SK11 on resolver unit No. 1.
- (4) Restore SW.A on both resolver units to ON. There must be no delay in restoring normal

selsyn services to resolver unit No. 3 so that the special cable may be dispensed with.

#### Closing down

**28.** To close down the rack assembly completely:—

- (1) Switch OFF the selsyns on each resolver unit.
- (2) Return SW.B and SW.A on each power unit. Type 904 to OFF.
- (3) Turn OFF the appropriate three switches on the radar office power board.

#### Rack assembly (gating waveform) Type 304

##### Switching on

**29.** Before switching on the rack, see that:—

- (1) The negative reference rack is functioning.
- (2) The master trigger unit is ON.
- (3) The rectifier Type 15 is supplying  $-50V$ .
- (4) The timebase rack is supplying G.W.G. DRIVE (i.e. 500 c/s timebase square-wave).

**30.** Run up the rack units as follows:—

- (1) On the radar office power board, turn ON the two switches marked GATING WAVEFORM GENERATOR (1) and (2).
- (2) Switch on and check the two functioning power units Type 903 as already detailed in para. 15, operations (3) to (6) inclusive.
- (3) As soon as power supplies reach the gating waveform generators and their distribution units they should start to function without any further switching, provided they have been properly set up.

**31.** Use the waveform monitor rack for a quick check that both sets of gating waveform generator equipment are producing the waveforms shown in fig. 1(k) to (o) with correct polarity, amplitude and duration.

#### "A" and "B" units

**32.** Use the selector switch on the panel (distribution and switching) Type 879 to choose either gating waveform generator "A" (plus associated units) or G.W.G. "B" (plus associated units) as the operational set. If the operational set develops a fault during operations, use the same selector switch to go over the stand-by. Replace the faulty unit by a spare good unit so that there is once more a margin of stand-by equipment ready for use. Service the faulty unit.

#### Closing down

**33.** Close down the rack by turning OFF both switches on each power unit, and also the mains switches on the radar office power board.

#### Rack assembly (azication) Type 302

##### Switching on

**34.** This rack assembly contains four quite separate sets of azication marker equipment (waveform generator, azication resolver unit and power unit), together with a distribution panel at the rack base. Each set is associated with a radar height-finder (Type 13) head, or in the case of No. 4 resolver in No. 1 rack with the master search head (usually a Type 7). It is assumed here that these heads have been properly run up and are supplying selsyn services (including auto-align) to their associated resolvers in this rack.

**35.** Make sure that the negative reference rack is functioning, that the rectifier Type 15 is supplying  $-50V$  for relays etc., and that the rack assembly (gating waveform) Type 304 is supplying 250 c/s azic. gen. drive pulses.

**36.** Turn ON the mains switches on the radar office power board marked AZICATION MARKS RESOLVER CABINET NO. 1 (1-4) or NO. 2 (1-4) as appropriate. Then proceed as follows:—

- (1) Switch on the four power units Type 905; the procedure is exactly the same as for the power unit Type 904 (see para. 25, operations (2) to (5) inclusive), in spite of the different front panel layout and the lack of a raw  $+570V$  output.
- (2) On each waveform generator (azication) Type 100, see that SW.B (TEST/NORMAL) is set at NORMAL, and that SW.A (25V/EARTH) is set at EARTH. SW.C (X/Y) is only used when setting up and its position during operations is immaterial.
- (3) On each resolver unit make sure that the SINE/COS POT, OPEN/EARTH switch (SW.A) is set to EARTH; turn the SELSYN switch (SW.B) to ON to start the resolver "machinery" rotating.
- (4) On resolver No. 4 in azication rack No. 1, which is associated with the master search head, leave the SELSYN switch in the OFF position unless the resolver is required in association with the monitor console; otherwise undue wear of the sine/cos pot. will result from the continuous rotation.
- (5) Unless otherwise instructed, leave the LOCAL/REMOTE switch (SW.A) on the panel (distribution) Type 878 in the REMOTE position.
- (6) The operation of each of the three ordinary sets of azication equipment now depends on the reception of a DC azication ranging voltage from its associated azicating console. The voltage comes via the rack assembly (misc. ITBU) Type 306, which should be switched on next.

#### Unserviceability

**37.** On most stations, one set of azication equipment (normally No. 4 in azication rack No. 2) is kept supplied with power and trigger pulses etc., but without selsyn drive, so that it is available to provide spare units, ready warmed up, if any of the operating ones become unserviceable.

**38.** As each waveform generator is set up in conjunction with one particular azication resolver, it is recommended that when any unit develops a fault, the whole set of azication equipment (i.e. waveform generator, resolver unit and power unit) should be replaced by the spare set. The faulty unit must be serviced without delay in order to make up a good spare set.

#### Closing down

**39.** Close down the rack as follows:—

- (1) Turn OFF the SELSYN switch (SW.B) on each azication resolver unit.

- (2) Turn OFF SW.B and SW.A on each power unit Type 905.
- (3) On the radar office power board, turn OFF the relevant mains switches.

**Rack assembly (misc. ITBU), Type 306**

*Switching on*

**40.** Before touching the rack, make sure that :—

- (1) The rack assembly (negative reference) Type 338 is functioning.
- (2) The rectifier Type 15 is supplying  $-50V$  for relays etc.
- (3) The rack assembly (gating waveform) Type 304 is supplying two identical ITBU pulse inputs.

**41.** To switch on the rack, proceed as follows :—

- (1) On the radar office power board, turn ON the mains switches marked INTER-TRACE BRIGHT-UP (1) MISC and (2) MISC.
- (2) Switch on each power unit Type 903 as instructed in para. 22, operations (3) to (6) inclusive.

- (3) Use SW.A on the panel (switching) Type 876 to select either "A" or "B" ITBU distribution unit as the operational one; the other remains available as stand-by.
- (4) See that SW.A (STOP-&-LOOK/MONITOR) on the relay unit (azication change-over) Type 192 is left in the STOP-&-LOOK position.
- (5) The rack is now in operation and will supply ITBU pulses to azicating consoles (or their stand-bys) as soon as their AZICATING keys are closed.

*Change-over*

**42.** If the operational ITBU distribution unit or its power unit develops a fault during use, use SW.A on the panel (switching) Type 876 to go over to the stand-by, and service the faulty unit.

*Closing down*

**43.** Close down the rack by turning OFF SW.B and SW.A on each power unit, and switch OFF both mains supplies on the radar office power board.



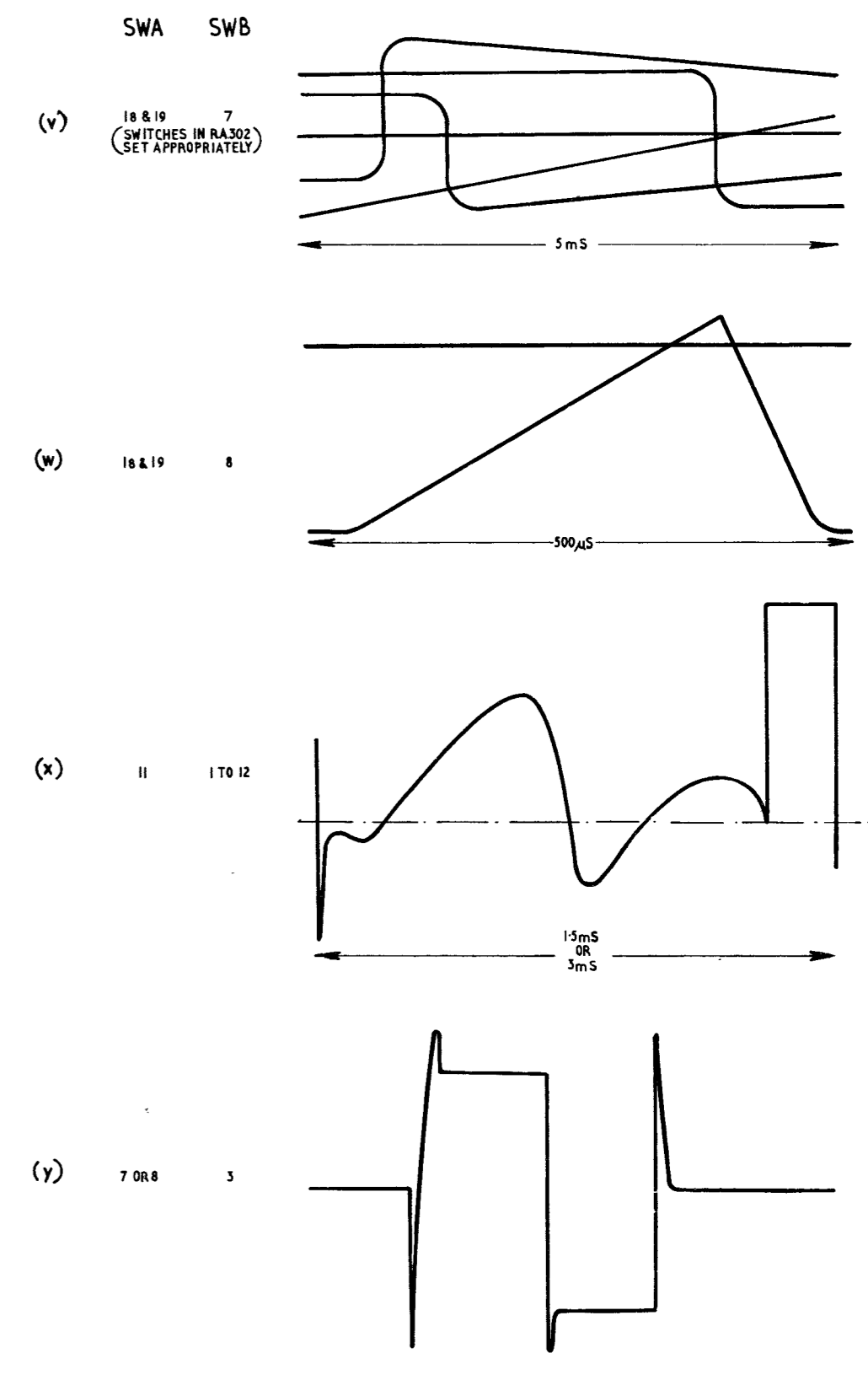
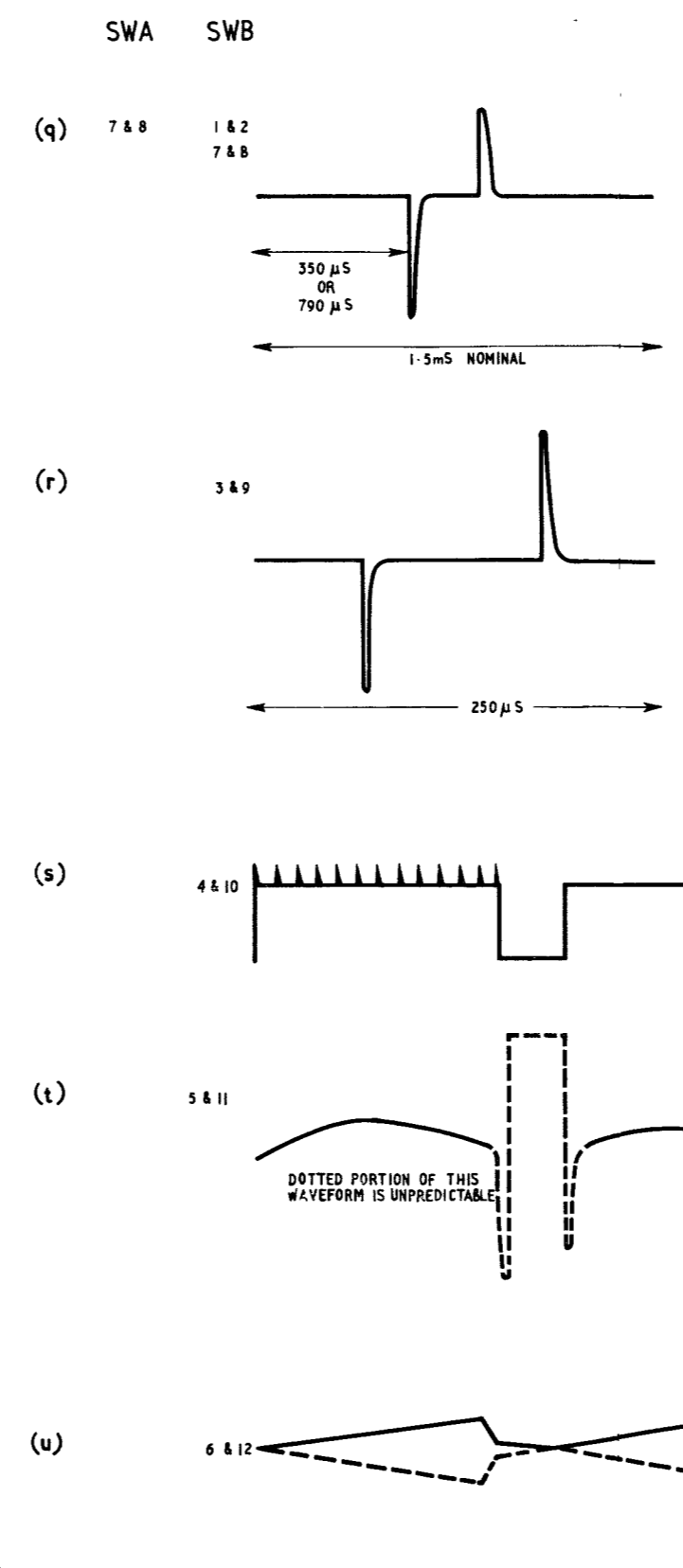
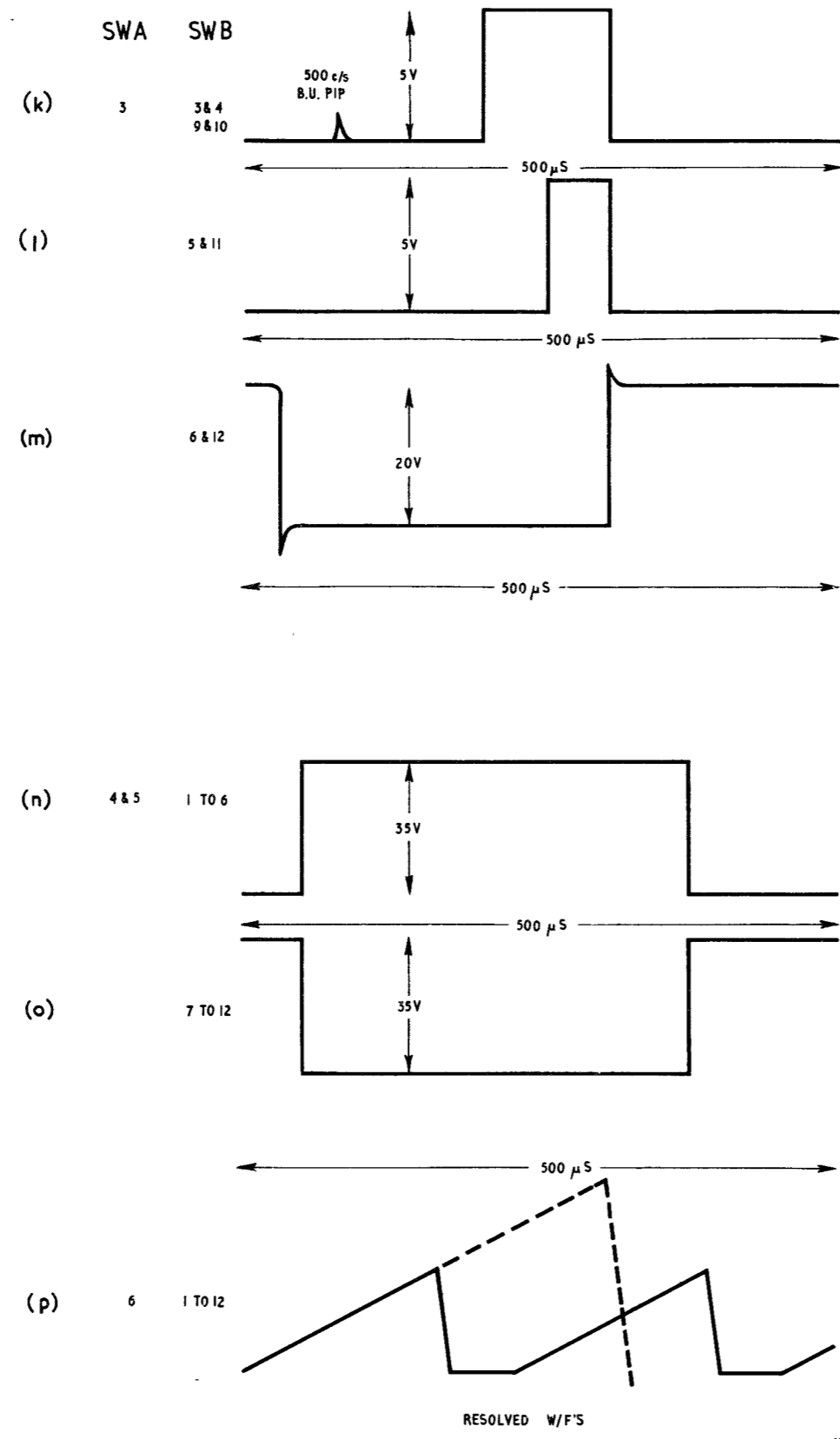
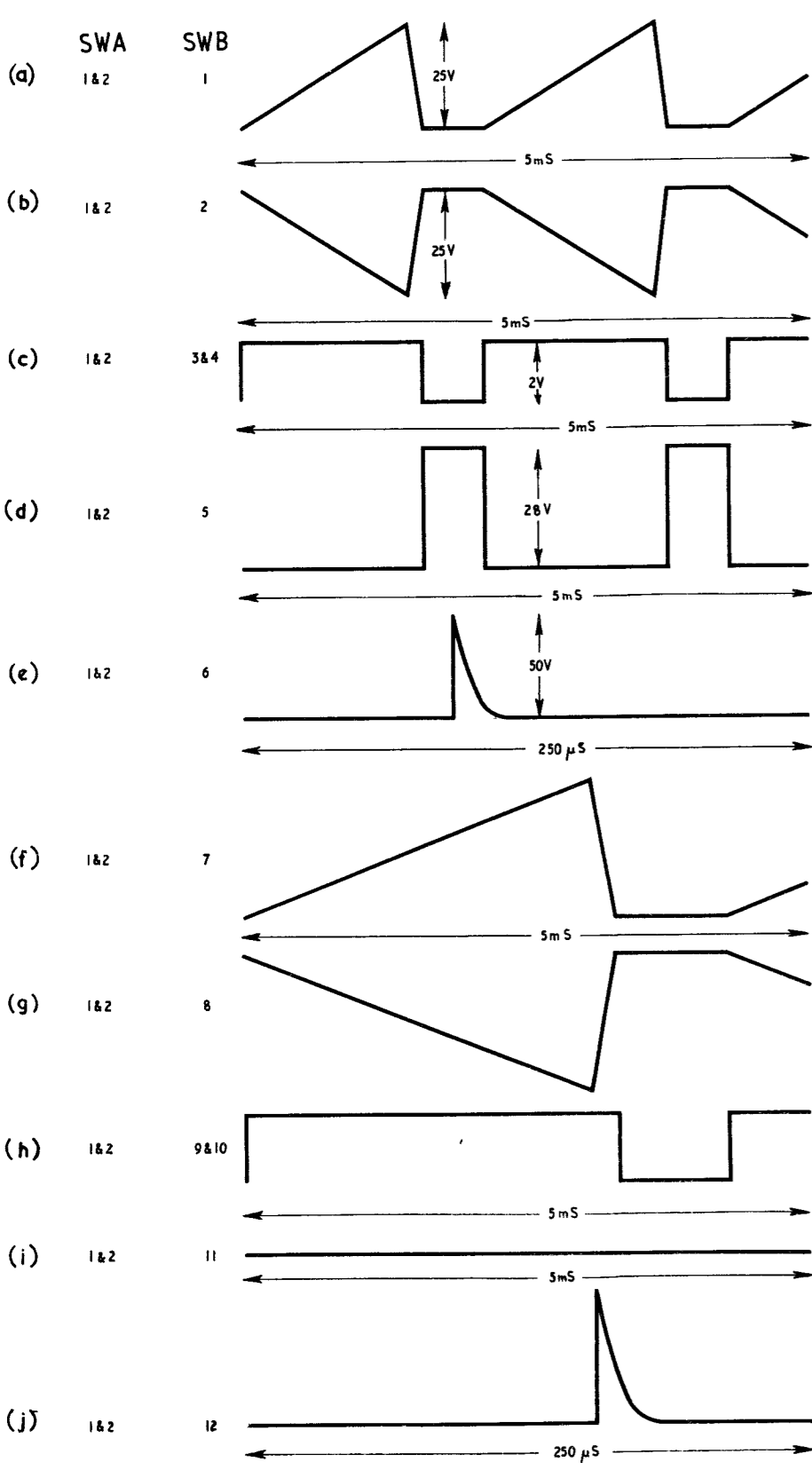


Fig. 1

NOT TO SCALE  
WAVEFORM AMPLITUDES & DURATIONS ARE NOMINAL  
Test waveforms - RA 339

Fig. 1

## Appendix 2

# FIXED-COIL RADAR OFFICE EQUIPMENT (TYPE 85) (OPERATING INSTRUCTIONS)

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**Introduction**

1. This appendix gives information concerning the operating instructions for racks at stations where radar Type 85 is installed. A number of racks used in this installation are dealt with in other publications (notably P.B.118) and operating instructions are not included here. Detailed instructions for setting up racks dealt with in this publication are given in Part 2 of this volume.

**Cabinet electrical equipment, sweep, 5975-99-953-7535**

2. The rack normally forms a part of the Type 85 installation and under routine conditions the INTEGRATED DISPLAY DISPLACEMENT switch SA on the distribution panel is the only switch used. It is set to ON or OFF according to operator requirements. However, a number of switches are fitted to individual units of the rack and it is advisable to check that they are in the normal position when the rack is first switched on. Unit switch positions should be as follows:—

**TABLE 1**

**Normal switch positions**

Unit	Switch	Position
Regulator voltage 6110-99-948-8985	SA	LOAD
	SB (1)	} H.T. ON
	SC (2)	
	SD (3)	
Generator sweep displaced 5840-99-947-6320	SA	NORMAL
Amplifier offset timebase 5840-99-946-8028	SB	position 1
Generator de-stagger 5840-99-953-7536	SA	NORMAL
Panel distribution sweep	SA	OFF initially ON to requirements

## Appendix 1

### FIXED-COIL RADAR OFFICE EQUIPMENT (PHASE 1A) (operating instructions)

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<i>Rack (monitor) Type 16505</i> .. .. .	3	<i>Rack (resolver magflip) Type 16357</i> .. ..	6
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#### Introduction

1. This appendix gives information concerning the operating instructions for racks at phase 1A radar stations, that is, those stations with full intertrace facilities. It does not deal with such racks as are covered in other publications (notably A.P.2527X). Detailed instructions for setting up and testing are issued in Part 2 of this volume.

2. Certain racks used at phase 1A stations are similar to those detailed in the preceding chapter, but are re-referenced and have modified units fitted. These racks are detailed here :

Original Type No.	Phase 1A Type No.
R.A. 339	Rack (Monitor) 16505
R.A. 300	Rack (Timebase) 16430
R.A. 301	Rack (Resolver Magflip) 16357
R.A. 302	Rack (Azication) M2

Three racks are used that are unchanged ; these are R.A. 338, 304, and 305. The operating instructions for these racks are, of course, identical to those detailed in para. 2 to 10 and para. 29 to 33 of the preceding chapter.

#### Rack (monitor) Type 16505

3. Initially para. 11 to 13 of the preceding chapter should be read. The units fitted to the R.A. 16505 are as detailed in Part 1, Sect. 4, Chap. 1, App. 3 of this publication. These units are, however, only modified units of the basic types described in the preceding chapter.

#### Waveform inspection

4. Reference to the front-panel label of the panel indicating Type 4064B (Part 1, Sect. 4, Chap. 1, App. 5) enables a check to be made on the expected waveforms. The full series of waveforms for both waveform inspection and setting up is illustrated as figure 1.

#### Rack (timebase) Type 16340

5. The rack 16340 is described in Part 1, Sect. 3, Chap. 1, App. 1 of this publication. The units fitted to this re-referenced rack are as described in that appendix and the rack is operated in a similar manner to that described in para. 22 to 24 of the preceding chapter.

#### Rack (resolver magflip) Type 16357

6. The rack 16357 is very similar to the rack 301 and the same operating procedure as described in para. 25 to 28 of the preceding chapter may be used. The rack 16357 is described in Part 1, Sect. 3, Chap. 2, App. 1 of this publication.

#### Rack (azication) Type M2

7. The rack M2 is similar to the rack 302 and the same operating procedure as described in para. 34 to 39 of the preceding chapter may be used. The rack M2 is described in Part 1, Sect. 3, Chap. 4, App. 1 of this publication.

#### Rack (marker sequence) 4195

8. The rack 4195 used at phase 1A radar stations supersedes the function of the rack assembly (azication) Type 302 at other radar stations. The rack 4195 is described in A.P.2527X, Part 1, Sect. 1.

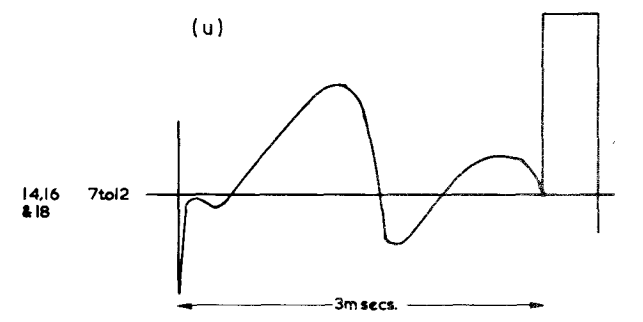
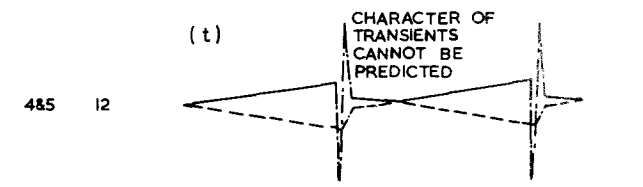
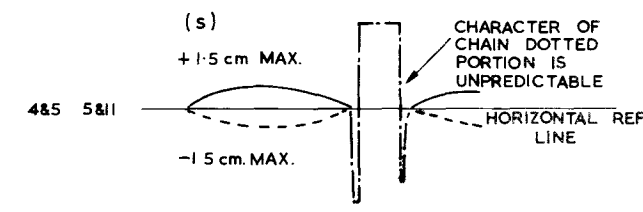
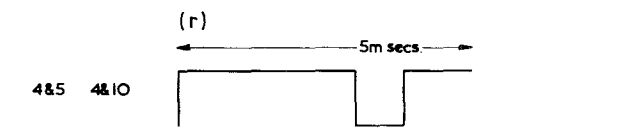
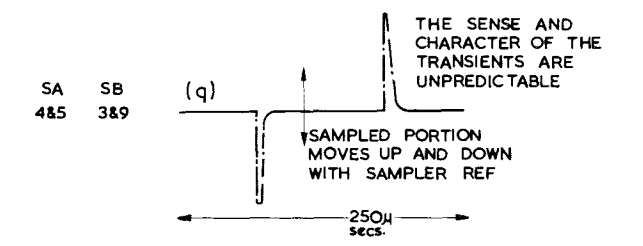
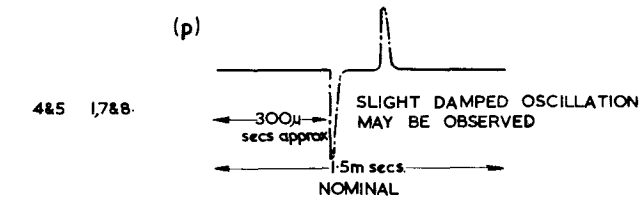
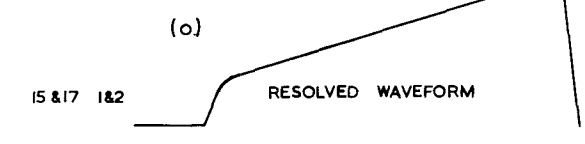
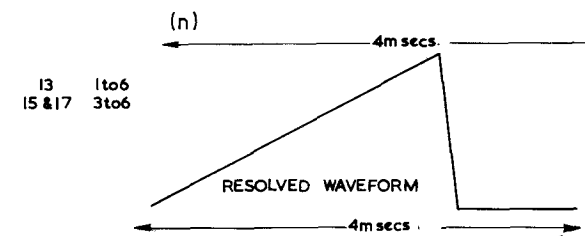
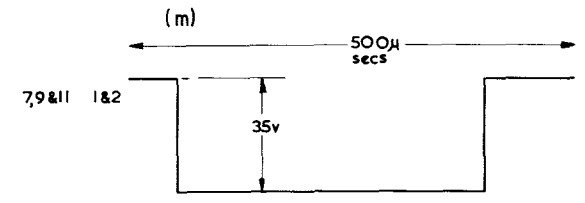
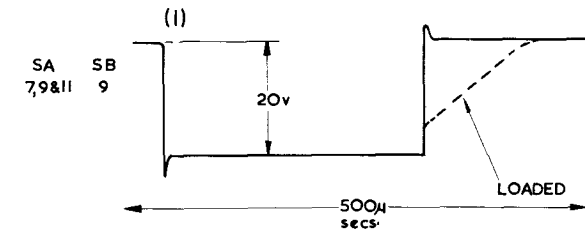
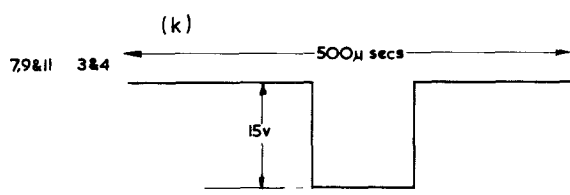
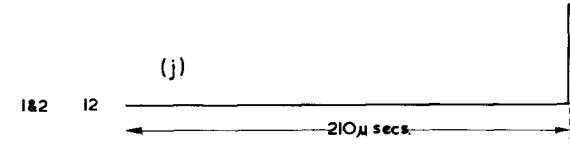
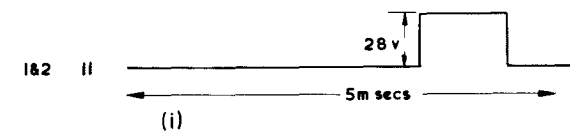
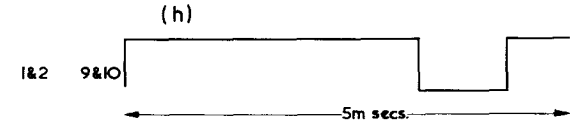
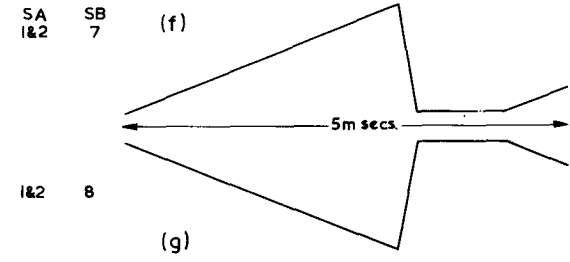
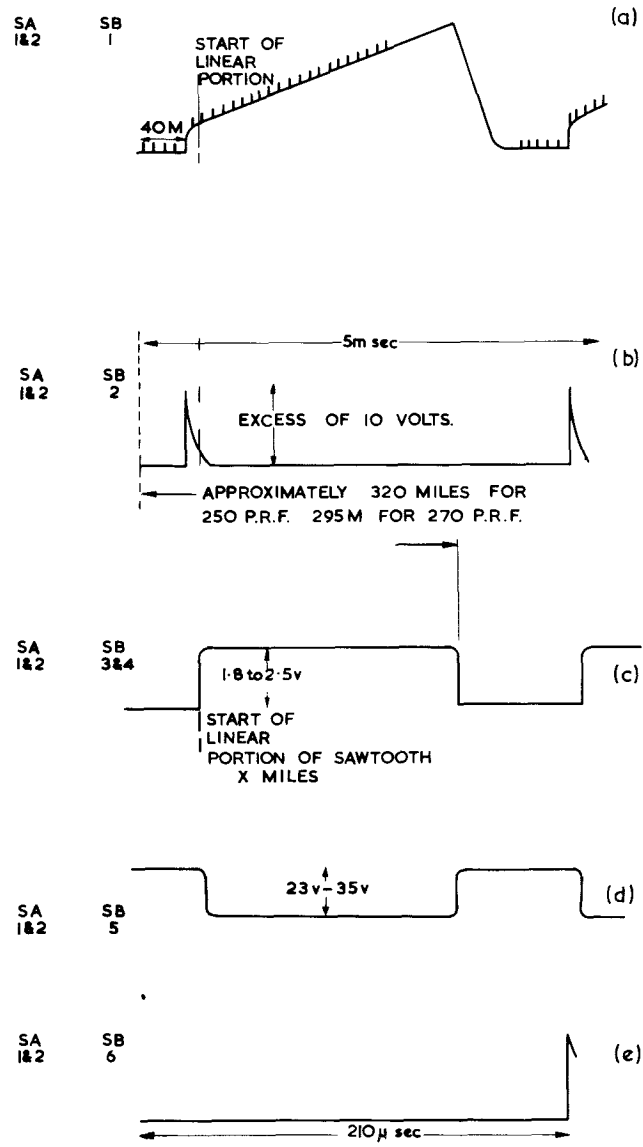


Fig.1

Fig.1

## **SECTION 3**

# **CIRCUIT DESCRIPTION AND LAYOUT FIXED-COIL RADAR OFFICE EQUIPMENT**



## GENERAL

### Purpose of equipment

1. The rack assembly (timebase) Type 300 (Stores Ref. 10D/18666) is a central source of master timebase waveforms and certain associated waveforms (listed in *para.* 15) used in the fixed-coil display system. Advantages of locating the timebase generating equipment in a central rack are:—

- (1) space is saved in the individual display consoles;
- (2) it is easier to maintain the relative accuracy of PPI pictures and inter-trace information;
- (3) a single sawtooth waveform may be supplied to a number of timebase resolvers associated with different radar search heads, so preserving the same standard of linearity and accuracy when a console changes over from one head to another.

2. Waveforms are produced at each of the repetition frequencies at present in use (250 c/s and 500 c/s) and, since the reliable provision of waveforms at both frequencies is essential to the operation of all the fixed-coil display equipment, two timebase generators (designated "A" and "B") are provided for each frequency. All four units are kept properly set up and operating, ready for immediate use, so that the auxiliary units may be switched in if the units in use should fail.

### Location and construction

3. The rack assembly is situated in the radar office, in close proximity to the magflip resolver racks. It is of the standard 19 in. wide Air Ministry type, 7 ft. in height, with full-length steel doors at the front and rear, opened by automobile type handles to provide easy access to all units. All cables for external connections to the rack come from the station cable trunking system under the false floor of the radar office and enter the rack through holes in its base plate. Cooling air from the ventilation system also enters at the base of the rack and is withdrawn at the top. The rack doors may be opened for servicing without impairing the ventilation of adjacent racks, coupled to the same system, because the inlet pressure and exhaust suction are balanced to maintain the air flow through the closed circuit.

4. The general arrangement of the units in the rack is shown in fig. 1. Each timebase unit Type 140 is mounted side-by-side with its associated power unit Type 903 on a square mounting tray fixed to telescopic runners. Any of these units may easily be removed from its tray 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 spigots at the rear. ◀ In fig. 1 two power units have been removed to show the runners and the cabling. ▶

### Allocation of units

5. The functional arrangement of the units is

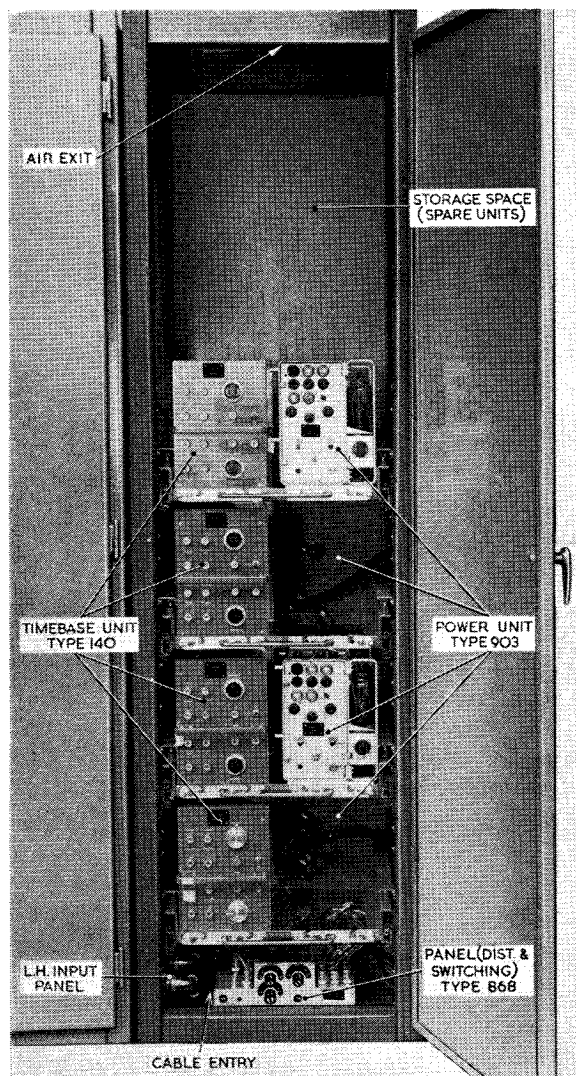
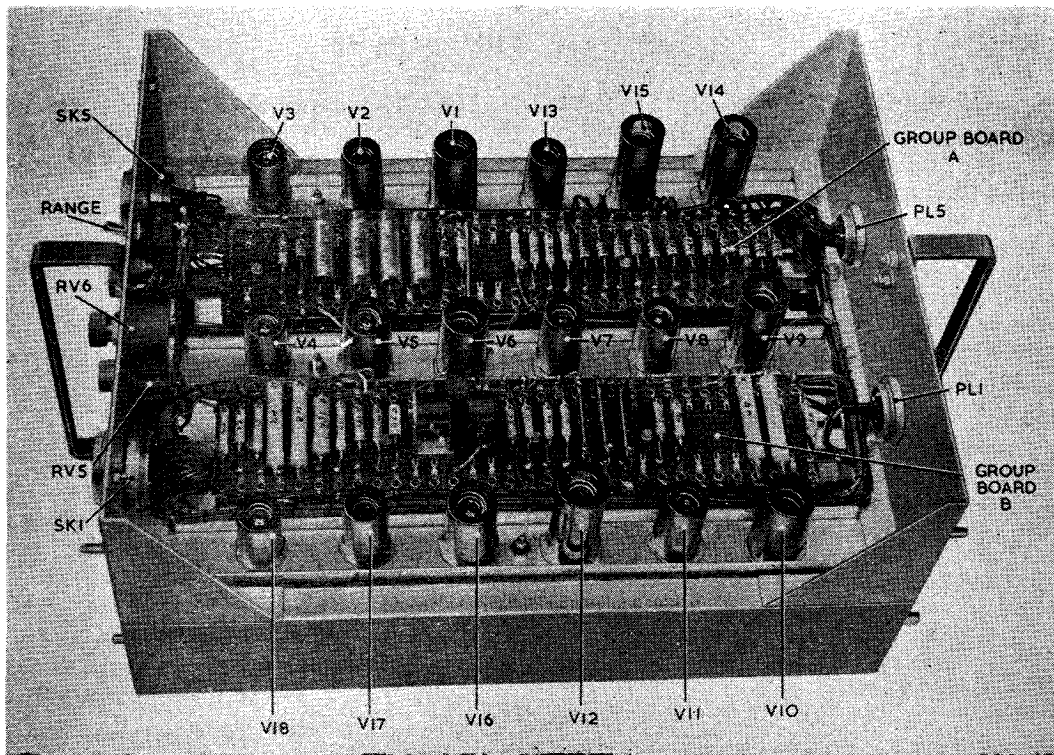


Fig. 1. Rack assembly (timebase) Type 300—  
front view

seen in fig. 2. To provide cable identification references (*see figs.* 3 and 19) the units in the rack are given numbers from 01 to 14, working from the top of the rack to the bottom. The top four positions (01 to 04) were reserved for velocity control units, but these are not now installed and the space may be used for the storage of spare units.

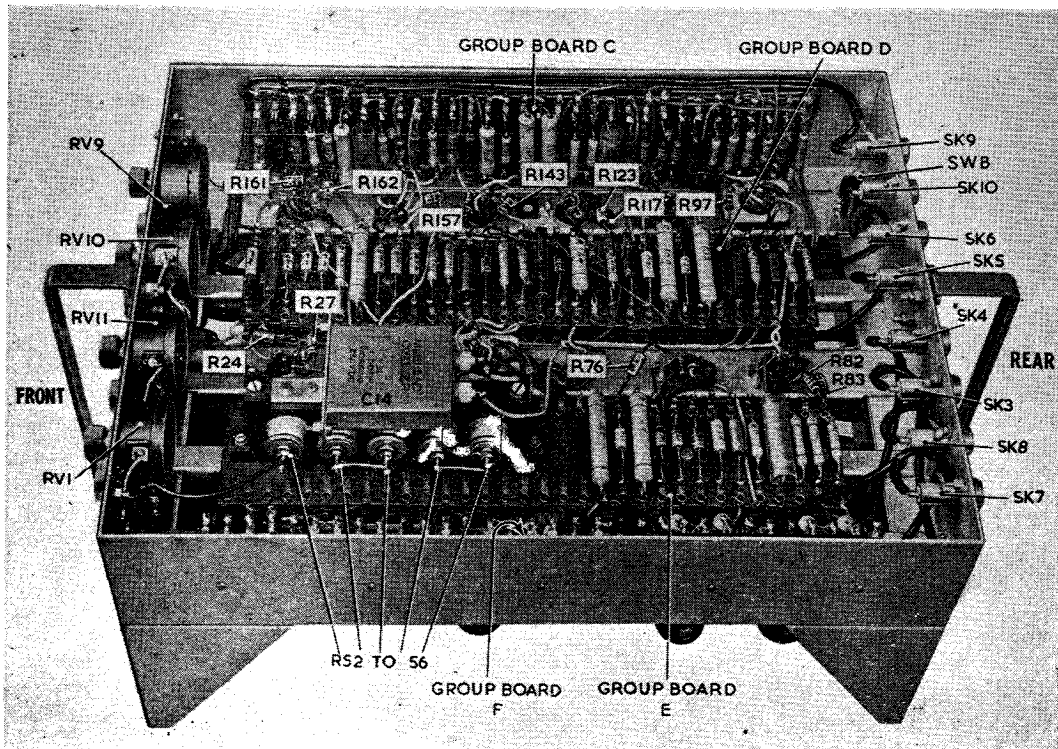
6. The normal allocation of the units at present in use in the rack is as follows:—

- (05) Power unit Type 903, supplying heater current and stabilized 300V positive and negative HT to unit 06.
- (06) Timebase unit Type 140, 250 c/s "A".
- (07) Power unit Type 903, supplying LT and HT to unit 08.
- (08) Timebase unit Type 140, 250 c/s "B".



**Fig. 5. Timebase unit Type 140—over-chassis component layout**

**Note.** . . . Metering Sockets labelled SK 1 and SK 5 should read SK 14 and SK 15, respectively.



**Fig. 6. Timebase unit Type 140—under-chassis component layout**



**Metering sockets**

7. On the front panels of all units containing valve circuits (units Type 140 and Type 903), metering sockets are mounted so that the standard metering unit (multimeter Type 100) may be plugged in for a rapid check of currents and voltages at appropriate points in the circuits.

This facility, together with the waveform monitoring arrangement mentioned in para. 6 (13), means that the correct operation of these units may always be checked without switching them off or removing them from the rack. The more important preset controls, which may all be locked in position after they have been correctly adjusted, are located on the front panels of their respective units.

**Rack cabling**

8. The complete rack circuit diagram (*fig. 3*) shows the electrical interconnections between all units in the rack assembly. These interconnections are made by coaxial connectors and multicore cables terminating on Mk. 4 miniature plugs and sockets. The actual run of those cables which form part of the rack assembly is shown in the cabling diagram (*fig. 19*), which gives a rear view and two side views of the rack.

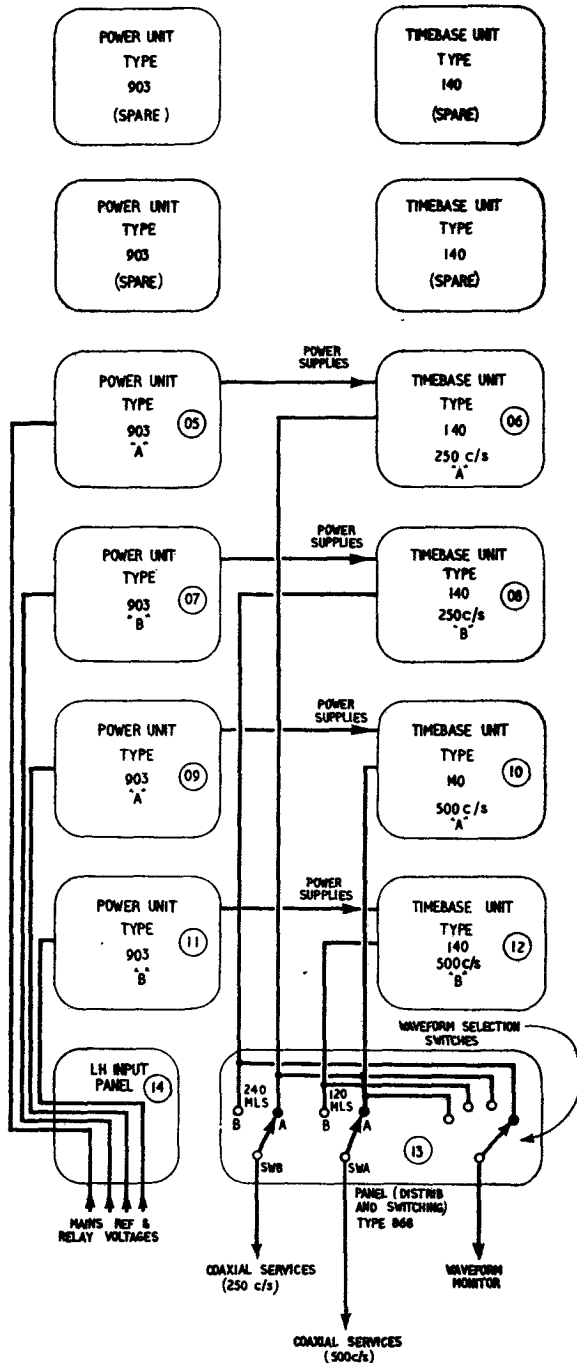
**Cable identification**

9. Each end of each cable is marked with a four-figure identification number. Since the numbers are different at each end of any particular cable, reference to *fig. 3* is essential to find the run of the connector. The first two figures of the identification number show the number of the unit (*para. 6*) to which the cable goes, and the second two figures the number of the plug or socket on that unit. There is no likelihood of confusion between plugs and sockets, because all the outlets on any one unit are numbered in a single series. For example, the connector which runs from SK5 on unit 10 (500 c/s timebase unit "A") to SK38 on unit 13 (panel Type 868) bears the identification numbers 1005 at one end and 1338 at the other.

10. It must not be assumed that all the plugs and sockets on the units have a connector running to them; apart from the metering sockets mentioned in *para. 7*, some extra outlets have been provided in case of future developments and—on the power units—because the same type of power unit is used in another rack assembly where the interconnections are not the same.

**Mk. 4 plug and socket orientation**

11. The plastic moulding carrying the connectors within a Mk. 4 plug or socket may be given any one of six different orientations relative to a locating spigot on the housing, when the connector is assembled during manufacture. Thus even where two Mk. 4 plugs or sockets with the same number of pins are located on the same unit, there is no danger of a connector being plugged inadvertently into the wrong mating component because the two outlets have been allocated different moulding positions. The moulding position is always indicated by the last figure of the inter-services reference number of plugs and sockets used in all fixed-coil radar office equipment.



**Fig. 2. Rack assembly (timebase) Type 300—block diagram**

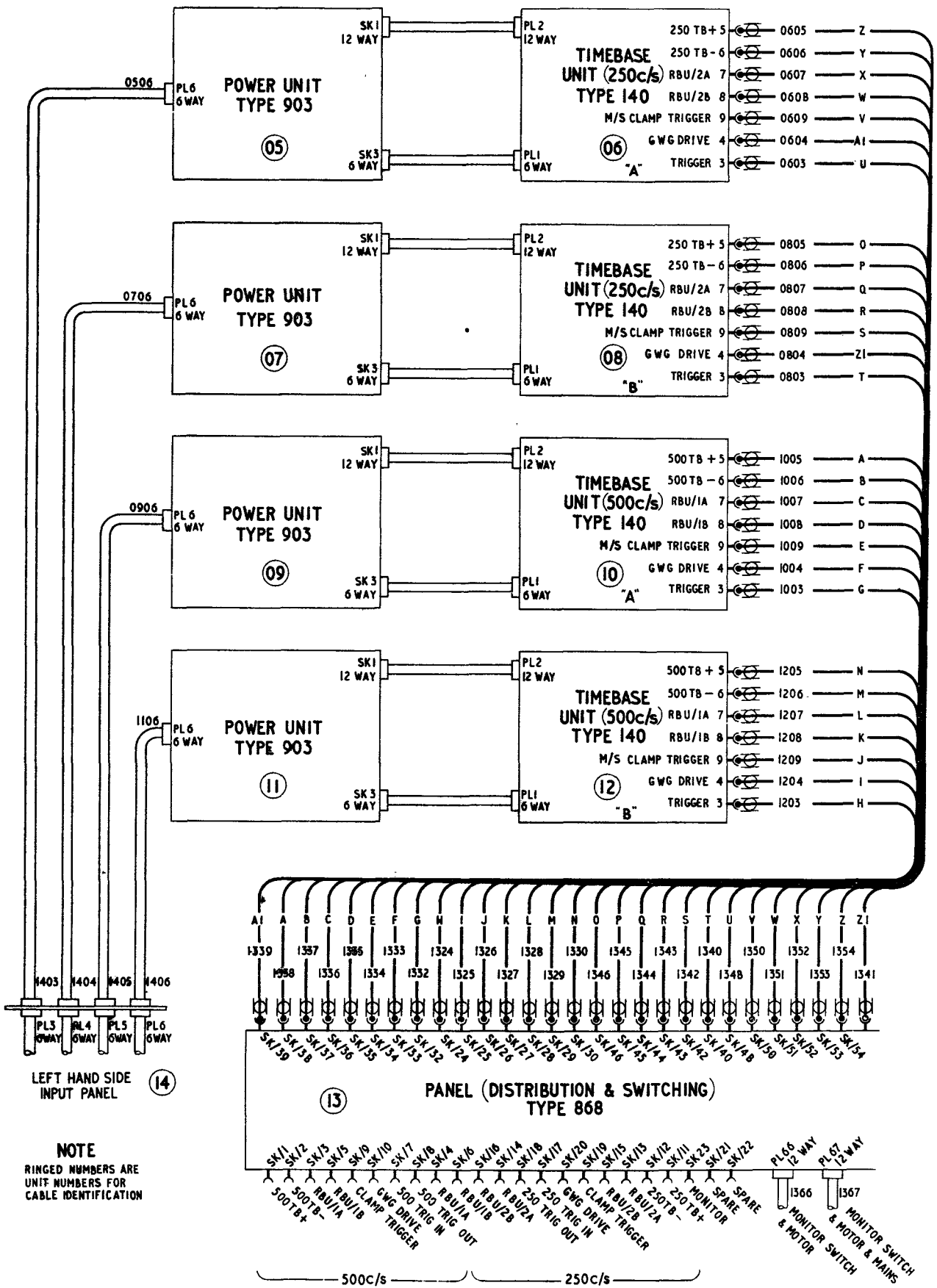


Fig. 3. Rack assembly (timebase) Type 300—circuit

## TIMEBASE UNIT TYPE 140

### INTRODUCTION

12. Fig. 4 gives a front view of the timebase unit Type 140 (Stores Ref. 10D/18695), sometimes called the master timebase unit. This view shows the RANGE switch, the preset controls and the metering sockets on the front panel. Fig. 5 gives a view from the right-hand side, showing the valve layout, and fig. 6 a view from the left-hand side, while fig. 7 shows the component layout on the group boards annotated in fig. 5 and 6.

### Construction

13. The unit is constructed on a rectangular frame which clips into position on its side on the standard rack mounting tray, alongside its associated power unit. In addition to the controls and 25-way metering sockets mounted on the front panel, there are two fixed plugs for power supplies from the power unit Type 903, mounted on the same tray, and coaxial sockets for all signal connections to and from the unit. These connectors are mounted on the rear panel.

14. The valveholders are set out along three parallel U-shaped valve mounting channels; when the unit is in the working position all the valves lie horizontal. They are held firmly in their sockets by their screening cans. Nearly all the resistors and condensers in the circuit are mounted on accessible tagboards which run almost the full length of the unit (fig. 5—7).

### Purpose

15. The unit is designed to produce the following waveforms, which are of fundamental importance in the fixed-coil display system:—

(1) *Master timebase waveform (TB+)*: an accurately linear, positive-going sawtooth waveform of constant amplitude (*waveform (e)*, fig. 8), used in the magslip resolver rack as the basis of the timebase waveforms fed out to all PPI consoles.

(2) *A negative-going version (TB-)* of the master timebase waveform, of the same amplitude (*waveform (f)*): not now used (*para.* 16).

(3) *Timebase square-wave (GWW DRIVE)*: a rectangular wave which is negative-going during the sweep period (*waveform (d)*), used in the rack assembly (gating waveform) Type 304 to drive the gating waveform generators.

(4) *Radar bright-up (RBU)*: a 2V rectangular waveform (*waveform (h)*), positive-going during the sweep period, supplied to consoles via their head selector units for trace brightening. One RBU output at 250 c/s goes first to the selector unit Type 33 to be gated before being routed to consoles displaying radar Type 7 with inter-stack switching. Because extensive use is made of this waveform there are two identical outputs from any one timebase unit known as RBU (A) and RBU (B).

(5) *Delayed trigger pulse (waveform (m))* for the clamp generator associated with each magslip resolver in the rack assembly Type 301.

### Design note

16. The timebase unit was designed in the first place to feed a number of sine/cosine potentiometer resolvers, which required antiphase (positive- and negative-going) sawtooth waveforms, the DC levels of which could be set very accurately. Now that the resolution is performed by a magslip, which needs only the

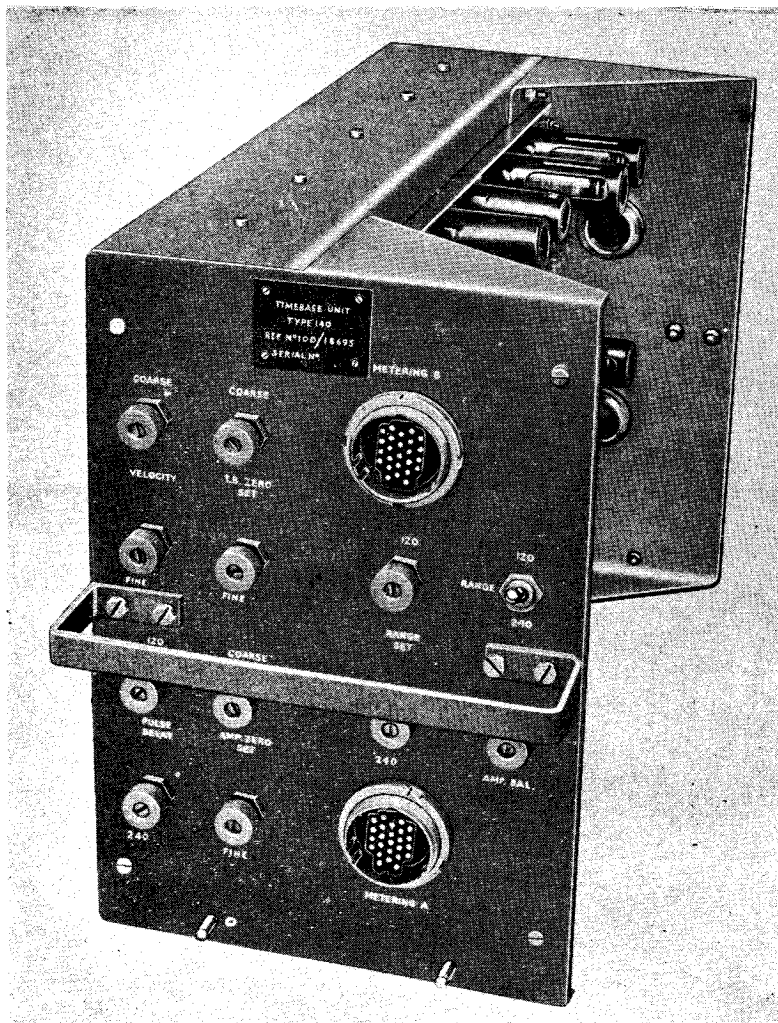
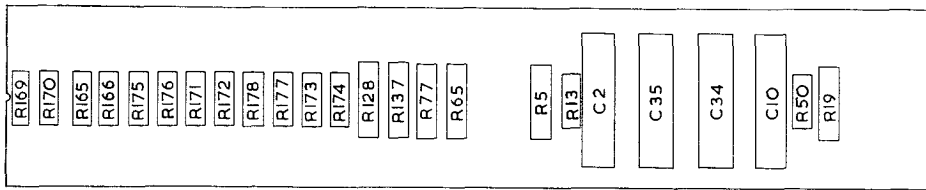
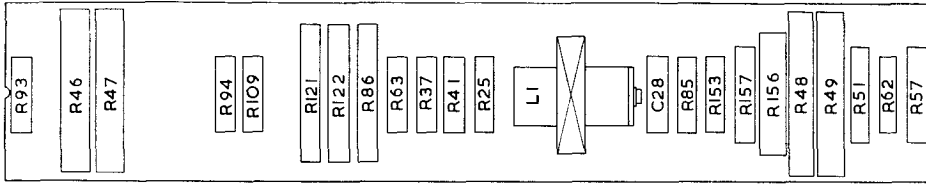


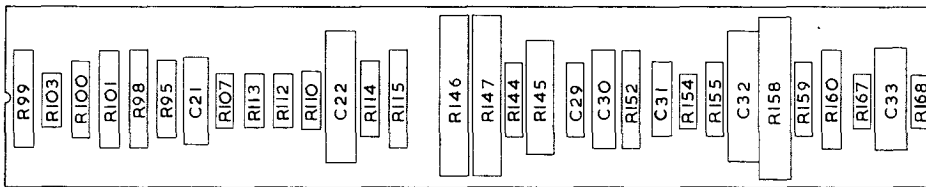
Fig. 4. Timebase unit Type 140—front view



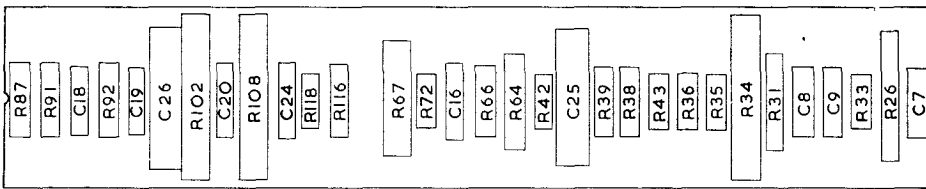
GROUP BOARD A



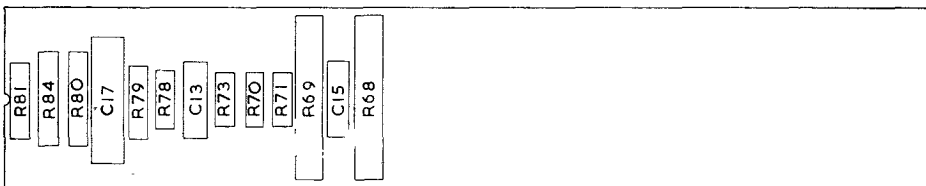
GROUP BOARD B



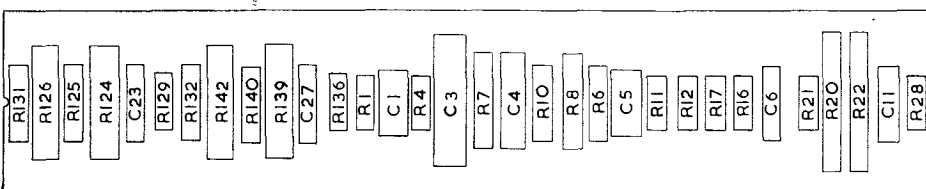
GROUP BOARD C



GROUP BOARD D

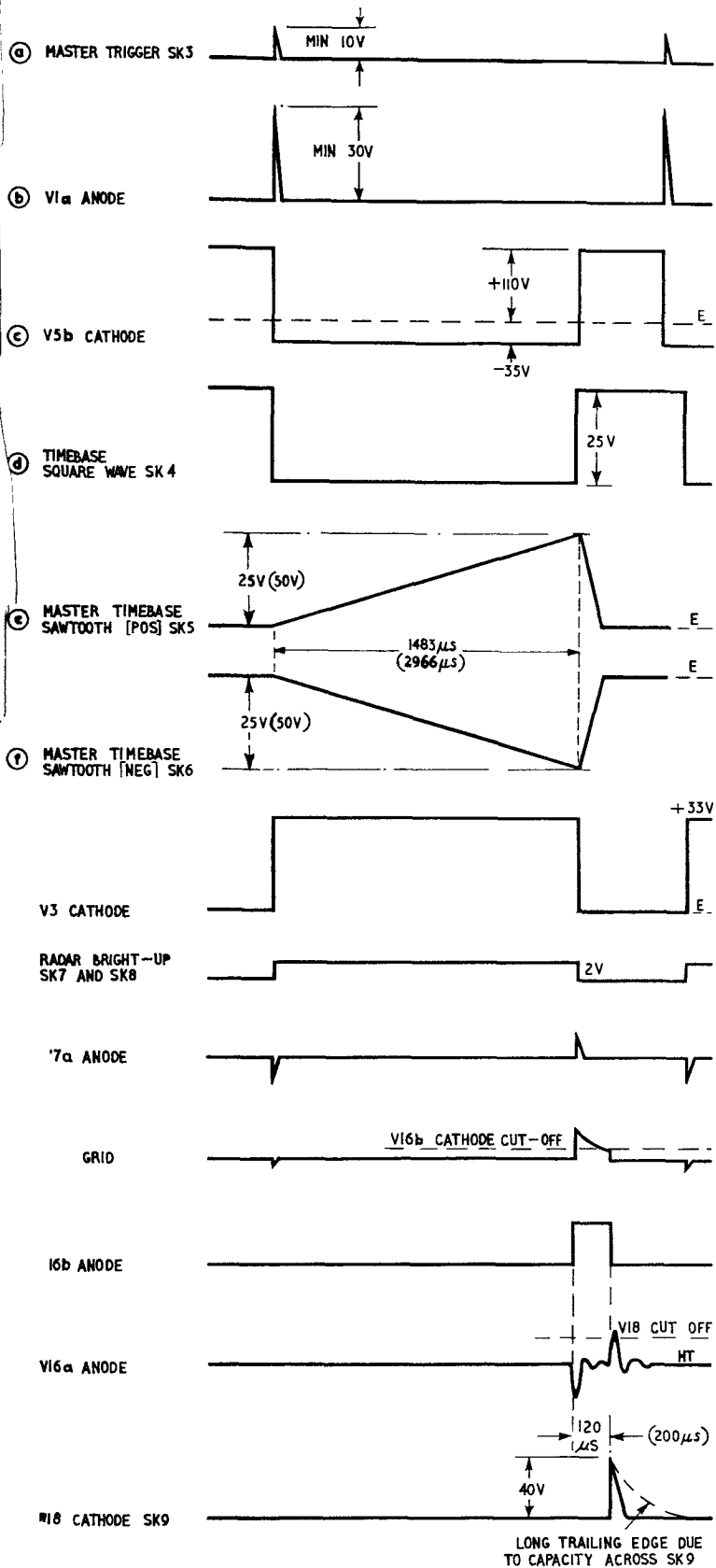


GROUP BOARD E



GROUP BOARD F

Fig. 7. Group boards on timebase unit Type 140



NOTE-TIMINGS IN BRACKETS ARE FOR 250c/s OTHERS 500c/s

Fig. 8. Timebase unit Type 140—waveforms

positive-going sawtooth and which (being essentially an AC-coupled device) does not demand accurate DC levels, some provisions of the unit are not utilized. Nevertheless they have been retained in case of a later decision to revert to sine/cos. pot. resolution. Provision has also been made for the connection of a velocity control unit (v.c.u.), but this is not now used. The v.c.u. socket (SK10) is therefore not connected and the v.c.u./NORMAL switch at the rear is always left in the NORMAL position.

#### Timing

17. Any timebase unit Type 140 may be operated at either 250 c/s or 500 c/s simply by setting the RANGE switch on the front panel to 120 for 500 c/s, or 240 for 250 c/s, and by applying trigger pulses at the desired repetition frequency. Usually, however, each timebase unit is permanently allocated to, and set up for one frequency only (*para.* 6).

18. All the waveforms produced in the timebase unit are timed from the pulses supplied by the master trigger unit (*fig.* 8). On 500 c/s the peak amplitude of the sawtooth is just over 25V and the sweep duration about 1500 μ sec., leaving about 500 μ sec. before the start of the next trace. When the unit has been set up correctly, the 25V level is actually reached after 1483 μ sec., corresponding to a radar range of 120 nautical miles. The sweep does not, however, end abruptly at that point, but continues for a further few microseconds before the flyback occurs. The flyback occupies about 150 μ sec.

19. On 250 c/s the sawtooth reaches a level of 50V after 2996 μ sec. and continues for a few more microseconds before the flyback, which takes about 300 μ sec. The sweep velocity is identical on either frequency, so that when a PPI display is switched from a 250 c/s to a 500 c/s head, ranges on the display remain the same.

20. ▶ ◀

21. The timebase unit Type 140 is not free-running; the application of one trigger pulse produces one sawtooth only and the unit then remains quiescent until the next trigger pulse arrives. It is therefore important that every unit should not only be supplied with trigger pulses of the correct frequency, but also that the RANGE switch should be set to the appropriate position (120 for 500 c/s, or 240 for 250 c/s), for, if the switch is inadvertently set to 120 and 250 c/s trigger pulses are fed in, sawtooth waveforms of the 500 c/s type will be produced but at a repetition frequency of 250 c/s. If, on the other hand, the switch is set to 240 and 500 c/s trigger pulses are applied, normal 250 c/s waveforms will be produced, but there is an even chance of them being 180 deg. out of phase with other 250 c/s equipment on the station.

#### Power supplies

22. The timebase unit accepts four 6.3V, 50 c/s heater supplies on plug PL2 from socket SK1 on its adjacent power unit Type 903. These four supplies actually originate from three heater windings on transformer TR2 in the power unit, the parallel connections being made in the power unit. Spare cables in the 12-way multi-core connector between the units are connected in parallel, to carry the load. From the same unit come stabilized HT supplies at +300V and -300V. The -500V station reference supply, needed for accurate and stable timebase velocity control, also comes in via the power unit.

#### CIRCUIT DESCRIPTION

23. A block diagram of the timebase unit Type 140 is given in fig. 9. It shows how the circuit may be regarded as being divided into six major parts, as follows:—

- (1) Trigger pulse amplifier
- (2) Timebase square-wave generator

- (3) Sawtooth generator
- (4) Sawtooth paraphase repeater
- (5) Radar bright-up generator
- (6) Clamp trigger pulse generator.

These stages are described in succeeding paragraphs. To follow the description, reference should be made to the full circuit diagram (fig. 16) and to the chart of waveforms (fig. 8). Simplified circuit diagrams are given to clarify the description of the square-wave and sawtooth generators. In the circuit diagrams, double valves (in the same envelope) are designated "a" and "b" to agree with the pin connections shown in fig. 16.

#### Trigger pulse amplifier

24. The master trigger pulses arriving at SK3 have a duration of about 2 microseconds (*waveform (a)*), and their amplitude may be as low as 10V. To fire the timebase circuits, trigger pulses of the same polarity as the master trigger pulses (positive) but of at least 30V amplitude are required, so the double-triode V1 (CV455) is included as a trigger pulse amplifier.

25. V1b is connected as a cathode-follower, cathode-driving the triode amplifier V1a via C3. This arrangement provides adequate gain without phase reversal, using only one valve envelope. To fix the operating conditions of the triodes, the grids of both are returned to a positive potential of about +50V at the junction of R8 and R10. In the absence of pulses the cathode of V1b is just above +50V so that the valve is nearly cut off (passing only  $\frac{1}{4}$  mA), whereas V1a is passing about 5 mA. The arrival of a trigger pulse via the AC-coupling from SK3 produces a similar pulse at V1b cathode and hence at V1a cathode, so that an amplified trigger pulse appears at V1a anode. This pulse (*waveform (b)*) is fed to the next stage via C5 (0.01  $\mu$ F).

#### Timebase square-wave generator

26. The chief purpose of the timebase square-wave generator is to produce the negative-going square-wave which operates the sawtooth generator. Similar square-waves with the same polarity and timing but with different amplitudes are supplied to the clamp trigger pulse generator and to SK4 for external use driving gating waveform generators. In addition, an antiphase form of the timebase square-wave goes to the radar bright-up generator.

27. The circuit contains two pentodes, V3 and V4 (both CV138), a double-diode V2 (CV140) and a double-triode V5 (CV491). Fig. 10 gives a simplified circuit. The two pentodes are connected in a DC cross-

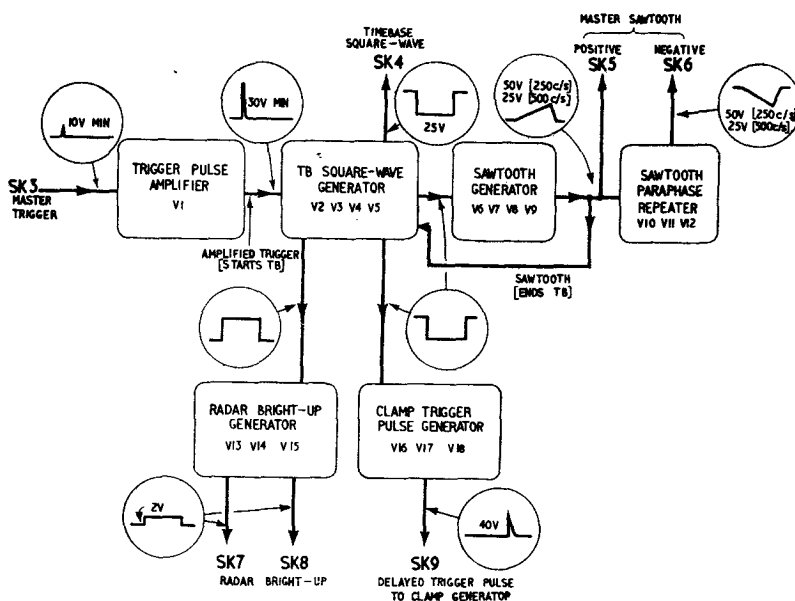


Fig. 9. Timebase unit Type 140—block diagram

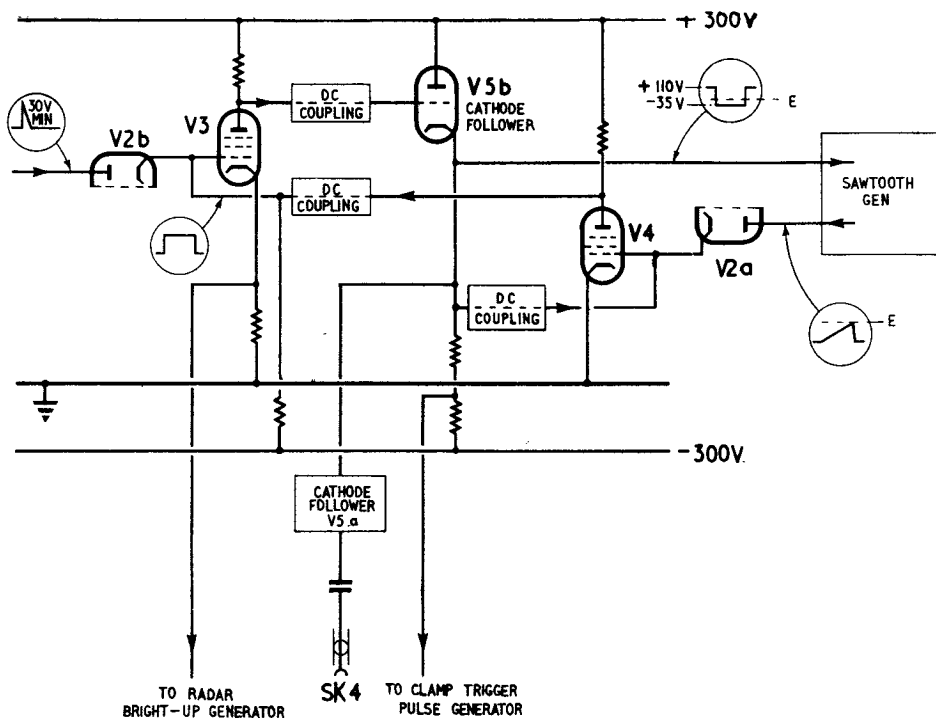


Fig. 10. Timebase square-wave generator—simplified circuit

coupled trigger circuit, which is similar in principle to a flip-flop but has no internal time-constant to terminate the square-wave, so that it has two stable states. V3 anode is connected to V4 control grid via the direct-coupled cathode-follower V5b and V4 anode is connected to V3 grid via R16 and the grid stopper R18, V3 being biased from the junction of R16 and R17 between V4 anode and  $-300\text{V}$ . The cathode-follower V5b also serves to feed out the timebase square-wave (via SK12) to the other circuits which require it.

#### Circuit action

28. In the quiescent state (i.e., in the absence of trigger pulses) V3 is cut off and V4 is conducting, the resistance values being chosen so that the cathode of V5b rests at about  $+110\text{V}$ . In this state the anode of the trigger diode V2b is at the negative potential of the junction R11/R12; V3 grid is not so far negative and so V2b is cut off.

29. When a positive trigger pulse of some  $30\text{V}$  amplitude appears at V2b anode the diode conducts momentarily and raises the grid of V3, bringing this valve into conduction as well. The consequent fall at V3 anode is coupled to the grid of V5b, the cathode of which falls sharply and cuts off V4; the rise at V4 anode is direct-coupled back to V3 grid and cumulative action ensures that V3 is brought into full conduction. In this second state the potential at V5b cathode is about  $-35\text{V}$  and the negative edge of  $145\text{V}$  amplitude ( $+110\text{V}$  to  $-35\text{V}$ ) is applied to the sawtooth generator to start the scan.

30. The circuit remains in this second stable state until some external factor causes it to

revert to the original state. The external factor is the sawtooth waveform fed back from the sawtooth generator on to the grid of V4 via the diode V2a. When this sawtooth (which is only a scaled-down version of the actual output sawtooth, of a negative level) nears earth potential V4 is brought into conduction once more and the circuit reverts to state 1, ending the square-wave and so terminating the scan. Until this has happened no trigger pulses can have any effect on the circuit, because the trigger diode V2b is cut off by the positive feed to V3 control grid from V4 anode.

31. The figures of  $110\text{V}$  and  $-35\text{V}$  mentioned in para. 28-29 are not highly critical and no setting-up potentiometers are included in the square-wave generator circuit to fix them; sufficient accuracy has been obtained by using high-stability components of fairly close tolerance in the resistance chains.

#### Sawtooth generator

32. The sawtooth generator stages are the ones which actually produce the master timebase waveform. This is a linear sawtooth of accurately determined velocity, which reaches an amplitude of  $25\text{V}$  in  $1483 \mu\text{sec}$ . on  $500 \text{ c/s}$  repetition frequency, or an amplitude of  $50\text{V}$  in  $2996 \mu\text{sec}$ . on  $250 \text{ c/s}$  (waveform (e)). These timings correspond to absolute maximum radar ranges of 120 and 240 nautical miles respectively; the desired waveform is selected by the RANGE switch (SWA). The circuit is controlled by a timebase square-wave from V5b cathode; it is arranged that the square-wave ends when the sawtooth has reached the desired amplitude, so that the amplitude is independent of the velocity.

**33.** The circuit used is shown in simplified form in fig. 11. It is a development of the familiar Miller timebase, with some additional complexity due to the need for especially high accuracy and stability, and to the original intention to use sine/cosine potentiometer resolvers requiring accurately set DC levels. In place of the single pentode with capacitive feedback from anode to grid used in the basic Miller circuit, there are here four valves (V6 to V9). V7b (half a CV140) is a catching and trigger diode which fixes the initial potential of the grid of V6a (half a CV492 double-triode) and which also applies the timebase square-wave to V6a grid. The remaining valves form a feedback loop, the Miller condenser C14 being connected between the cathode of V9 and the grid of V6a. V9 is a high-current pentode (CV2127), triode-connected as a cathode-follower to feed out the sawtooth waveform to the resolvers; this stage was originally designed to drive up to four 32K sine/cosine potentiometers in parallel.

**34.** The Miller condenser C14 ( $0.005 \mu F$ ) is a major factor in determining the sawtooth slope and is a special component of very close tolerance and good temperature stability; it must never be replaced by an ordinary condenser. The Miller resistor totals  $2.5M$  (R52 to R56); this chain of five  $\frac{1}{2}M$  resistors is used because it is difficult to obtain a single  $2.5M$  resistor of sufficiently high stability. In contrast with the basic Miller circuit (in which the resistor is returned to a positive potential) the Miller resistor here is taken from V6a grid down to an adjustable negative potential at the slider of RV1 (the VELOCITY COARSE control). The potential at this point is also affected by the VELOCITY FINE control RV11 (fig. 16). As a result, V6a grid aims towards this negative potential during the sweep period and the sawtooth output is positive-going (at the cathode of V9) instead of negative-going as it is in the basic circuit. To ensure constancy of sawtooth slope and accurate superposition of timebases (as when signals from a 250 c/s head and a 500 c/s head are head-combined on a single PPI picture), the

negative aiming potential is not derived from the locally produced  $-300V$  line but from the station reference supply at  $-500V$ .

**35.** The principal amplifier in the feedback loop is the pentode V8 (CV138), which is preceded by a pair of cathode-coupled triodes V6a and V6b, which provide some initial gain without phase-inversion and minimize the drift effect due to heater voltage fluctuations. In principle, V6b is a grounded-grid amplifier, but to make it possible to set the DC condition of all four valves in the circuit its grid potential is made adjustable, using RV2 and RV3 (TIMEBASE ZERO SET, COARSE and FINE).

#### Quiescent state

**36.** In the absence of a timebase square-wave (i.e., when no trigger pulse has arrived), the circuit rests in a quiescent state. Any tendency for V6a grid to go negative is arrested by conduction in the diode V7b, the anode of which is returned via the 68K resistor R67 to the cathode of V5b (held at about  $+110V$ ). The grid of V6a therefore rests at a small positive potential, and the corresponding level of V9 cathode (when the TB ZERO SET controls have been properly adjusted) is zero, so that V7a is conducting as well. In practice the TB ZERO SET controls are adjusted while the timebase is in operation, by sampling out a portion of the rest level between sawteeth and setting that to zero, using the monitor rack Type 339.

#### Scan period

**37.** To start the scan the timebase square-wave changes from  $+110V$  to  $-35V$ , cutting off diode V7b (and V7a as well). V6a is now free to start charging towards the negative potential of about  $-210V$  at the slider of RV1 (VELOCITY COARSE). This negative sweep is amplified and phase-inverted by the succeeding valves, producing, at V9 cathode a positive-going sweep which is coupled back by the Miller condenser C14 to V6a grid. The familiar equilibrium condition is set up, with a fall of very small amplitude at V6a grid and a large linear rising voltage at the output. The slope of the sawtooth depends principally on the values of C14 and R52-56, and on the aiming potential set by the VELOCITY controls. Because of the high gain of the loop, V6a grid does not have to move very far negative to produce a 50V rise at the output. Hence diode V7b cannot re-establish conduction before the end of the sweep; nor can V7a, the cathode of which is moving positive.

**38.** It is necessary to terminate the timebase square-wave and so end the sawtooth as soon as the latter has reached the specified positive potential (a little over

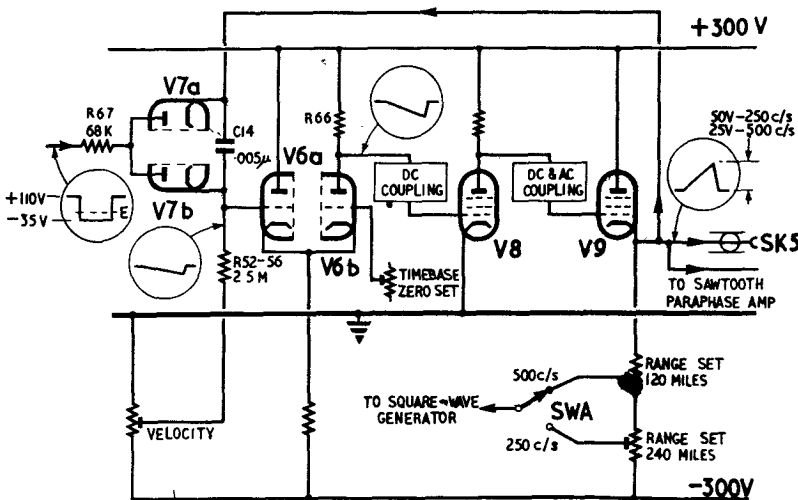


Fig. 11. Sawtooth generator—simplified circuit



25V on 500 c/s, or a little over 50V on 250 c/s). To do this, a RANGE SET potentiometer for each repetition frequency is included in the cathode chain of V9, and the slider of the appropriate potentiometer is connected back to the timebase square-wave generator. During a 250 c/s sweep, for example, the front panel RANGE switch (SWA) is set to the 240 mile position. As the main sawtooth output moves from earth level up to +50V, the potential at RV5 slider moves up proportionately from a negative level towards earth. When it nears earth potential it brings V4 in the square-wave generator back into conduction (*para.* 30) and ends the square-wave.

**39.** When the timebase square-wave reverts to +110V, V7b (but not V7a) conducts once more and brings back V6a grid to above earth potential, ending the sawtooth. The duration of the fly-back depends on the time C14 takes to discharge via R67 and V9 cathode, and is approximately 150  $\mu$  sec. on 250 c/s and 75  $\mu$  sec. on 500 c/s. The purpose of V7a is to conduct as soon as the V9 side of C14 approaches earth level and so to re-establish the correct rest level. The circuit remains in this quiescent state (with both diodes conducting) until the beginning of the next scan.

#### Sawtooth paraphase repeater

**40.** The sawtooth paraphase repeater is designed to produce at SK6 an accurate antiphase master sawtooth (negative-going) having the same amplitude as the positive-going master sawtooth and a rest level at zero (*waveform (f)*). The circuit is capable of driving up to four sine/cosine potentiometers in parallel; when magstrip resolvers are employed the output is not used.

**41.** The circuit includes the pair of cathode-coupled triodes V10 (CV492), the phase-reversing pentode amplifier V11 (CV138) and the large pentode (triode-connected) cathode-follower V12 (CV2127). It will be observed that the circuit closely resembles that of the sawtooth generator (V6, V8 and V9); the main difference is that instead of a Miller feedback condenser the feedback component used here is resistive, consisting of R92 plus RV6 (AMPLIFIER BALANCE), totalling about 155K. The positive-going sawtooth input from V9 cathode is introduced through a resistive input arm R87 plus R91, which also totals 155K. The whole circuit is therefore really a see-saw amplifier, the overall gain of which is about equal to the ratio of the feedback arm to the input arm (since the amplifier gain from V10b grid to V12 cathode is large). This ratio is unity and the overall gain may be set exactly to unity by adjustment of RV6, a 10K variable resistor in the feedback arm.

**42.** The repeater circuit is DC-coupled from input to output. The DC levels, including the output rest level, are controlled by the preset potentiometers RV8 and RV7 (AMPLIFIER ZERO SET, COARSE and FINE, respectively), which govern, in the first place, the grid potential of V10a.

#### Radar bright-up generator

**43.** One radar bright-up (RBU) generator circuit, which includes the diode V13b (half a CV140) and the triode-connected pentode V14 (CV2127), has to supply a sharp-edged 2V positive-going square-wave (*waveform (h)*) from a low-impedance source. The square wave, identified as RBU (A), goes out from SK7 to several head selectors in parallel; the connecting cable offers considerable capacitance as it is not matched at the far end. A second circuit, using diode V13a and pentode V15, is identical with the first and produces an identical output RBU (B) at SK8, which feeds another group of head selector units. A description of RBU (A) will serve for both circuits.

**44.** The drive for the RBU generator is derived from the cathode circuit of V3 in the square-wave generator. The 3.3K resistor R21 in series with V3 cathode develops a 30V antiphase version (*waveform (g)*) of the timebase square-wave, which is applied to the cathode of V13b. Before the sweep period starts, therefore, V13b is conducting and holds the top of R125 (*fig.* 16) at about earth potential; V14 grid is kept well below cut-off and no current flows through R131. At the instant the sweep starts, V3 cathode rises to +30V, cutting off diode V13b and allowing V14 grid potential to rise to a positive value. Conduction starts in V14 and the current is controlled at 20 mA by the feedback from anode to grid via R124 + R125, and this current should remain unaltered even if another CV2127 of different characteristics is substituted. At the end of the sweep period, V3 cathode falls back to earth potential and V13b comes into conduction again and cuts off V14. The 20 mA through R131 (100 ohms) ceases and ends the 2V square-wave.

#### Clamp trigger pulse generator

**45.** This circuit is required to produce a sharp positive pulse of some 40V amplitude, delayed 120  $\mu$  sec. after the end of the trace period, on 500 c/s timebase units, or 210  $\mu$  sec. after the end of the trace period on 250 c/s units. This pulse is applied, via SK9, to the magstrip resolver rack, where it starts the clamp circuits which hold the sawtooth rest levels to zero after resolution.

**46.** The circuit includes the double-triode flip-flop V16 (CV491), the diodes V17 a and b (CV140), and the triode-connected pentode cathode-follower V18 (CV138). Before the sweep period starts, the circuit rests with V16b conducting. V16a grid resistor R152 is returned to a large negative potential at the slider of RV9 or RV10 (depending on the setting of SWA), but the grid is "caught" by diode V17b at a small negative potential from the junction of R155 and R158, which is sufficiently negative, however, to keep V16a cut off.

**47.** From a tapping on the cathode chain of V5b (junction of R35 and R36) comes a proportion of the timebase square-wave (*as waveform (c)*) but one-third smaller in amplitude). This square-wave is differentiated by the short time-constant circuit C31-R154, producing (*waveform (i)*). The

negative pip, which occurs at the start of the trace period, has no effect because V16a is already cut off, but the positive pip at the end of the trace period causes V16a to start conducting and the flip-flop triggers over. V16b is cut off and (*waveform (k)*) starts at the anode.

**48.** In the anode circuit of V16a is the small inductor L1, and the negative spike produced at the anode when V16a starts conducting is followed by a "ring" (*waveform (l)*). Neither the negative spike nor the "ring" have any effect on the cathode-follower V18, which is already cut off by the negative grid return to the junction of R159 and R160.

**49.** V16a having been triggered at the end of the trace period, C29 starts to charge, in the familiar flip-flop manner, towards the negative potential

set by one or other of the PULSE DELAY potentiometers (as selected by SWA (a)), so that V16a grid moves negative (*waveform (j)*), followed by the common cathodes. When V16b cathode has fallen as far as the broken line on (*waveform (j)*), the valve comes into conduction again and the flip-flop triggers back. The time taken by the flip-flop sequence is the pulse delay interval, as set by RV9 or RV10 (PULSE DELAY controls), which determine the "aiming potential" of C29.

**50.** Due to the presence of L1, the sudden cut-off of V16a, at the end of the flip-flop sequence, causes a sharp positive spike at its anode, followed by a "ring" (*waveform (l)*). The peak of this spike is sufficient to bring V18 momentarily into conduction, so producing the required delay pulse at V18 cathode (*waveform (m)*). Cable capacitances across SK9 give the pulse an extended trailing edge, shown in broken line.

## POWER UNIT TYPE 903

### INTRODUCTION

**51.** The power unit Type 903 (Stores Ref. 10K/17131) is a general purpose HT and LT power unit designed for several applications in the radar office racks associated with the fixed-coil display system on ground radar stations. In the rack assembly (timebase) Type 300, one such power unit is associated with each timebase Type 140.

#### Purpose

**52.** The unit produces seven 6.3V 50 c/s heater supplies for internal as well as external use. (*fig. 17*), and stabilised HT supplies at +300V and -300V. Up to 100 mA can be drawn from either HT rail without loss of regulation. The -300V stabilizer uses the -500V station reference supply as a reference voltage, and the +300V stabilizer is, in turn, referred to the -300V line. The advantage of this arrangement is that if, in spite of the stabilization, the -300V should drift slightly, the +300V output will move in the opposite direction and so minimize any adverse effect on the DC amplifiers and other circuits in the external unit. The -500V reference voltage is itself fed out to the external unit along with the other supplies.

#### Cut-out and protection

**53.** A special protection circuit closes down the HT supplies if either of them moves more than a few volts away from the nominal value. This provides a safeguard against gross overloads in the external circuit as well as against stabilizer faults. In addition, ordinary fuses in the mains and HT lines protect them against overloads, and thermal fuses mounted on the transformers disconnect both transformers from the mains if either of them overheats. LP1 indicates an open circuit in the 5A cartridge fuse FS1 or the thermal fuses FS6 and FS7.

#### Construction

**54.** The power unit is built on a rigid steel chassis, with U-shaped guard handles on either side, as seen in *fig. 12*. When the unit is in the rack, in the working position, the transformers, chokes, capacitors and small valves are mounted on the left-hand side as seen from the front of the rack, while the large valves (rectifiers and regulators) are on the right. The front panel, which carries the indicator lamps, cartridge fuses, switches and preset controls (lockable) may be hinged outwards (*fig. 13*) to obtain access to the control valve circuits, which are on a small sub-chassis behind the panel. The rear panel carries all the plug and socket connectors for the unit, with the exception of the metering socket, which is on the front.

### CIRCUIT DESCRIPTION

**55.** The complete circuit of the power unit, comprising the LT and HT transformers, the positive and negative HT supplies rectifiers and stabilizers, the cut-out circuit and the test switch circuit with its associated relays and lamps, is shown in *fig. 17*.

#### -300V supply

**56.** The -300V supply starts with the 420V-0-420V winding on the HT transformer TR1 feeding V9 (CV378), a double-diode with indirectly heated cathode (5V heater), connected in a conventional full-wave rectifier circuit. Then comes a single condenser-input filter section C8, L2, C9 which eliminates most of the 100 c/s ripple. The 1 M resistor (R56), which shunts the filter output, serves to discharge the filter condensers after the power unit has been switched off, in the absence of an external load. In series with the positive side of the supply is the 250 mA cartridge fuse FS5, with indicator neon LP3 across it to show when the fuse has blown. The voltage between

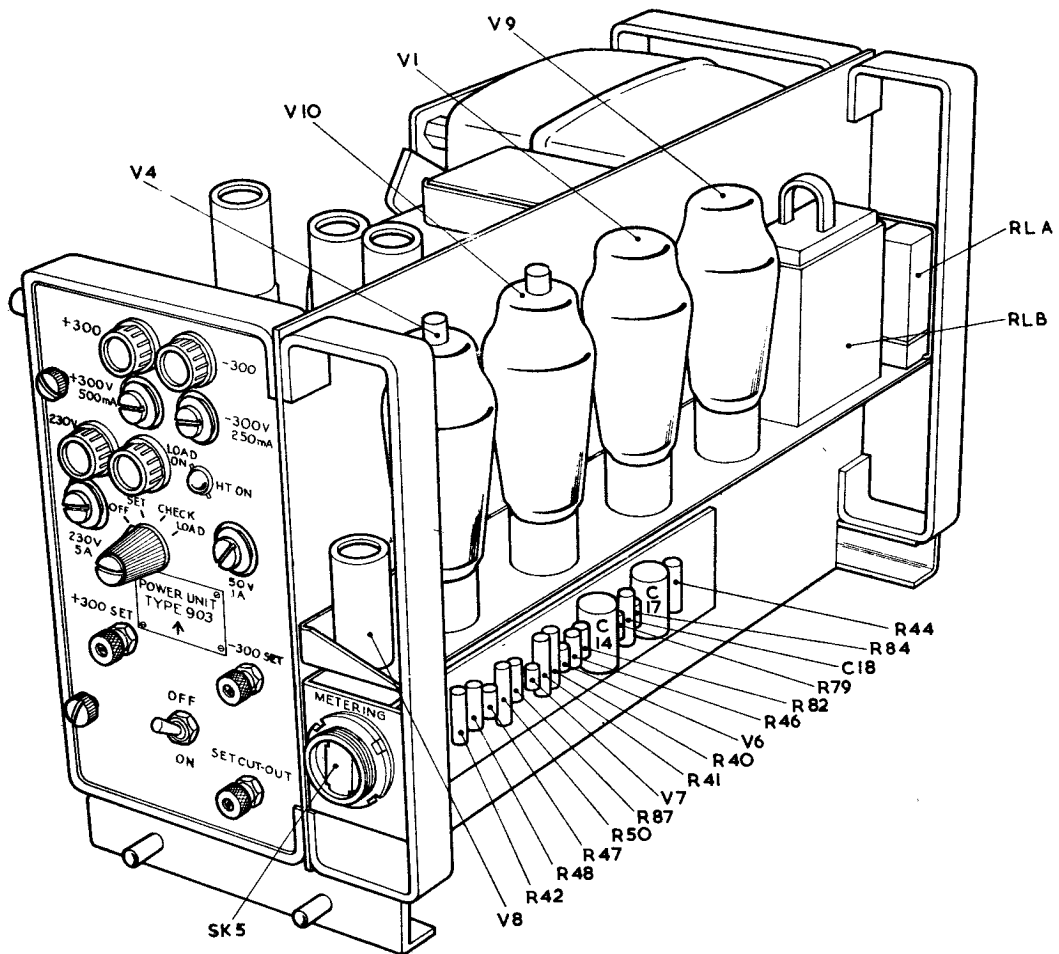


Fig. 12. Power unit Type 903—general view

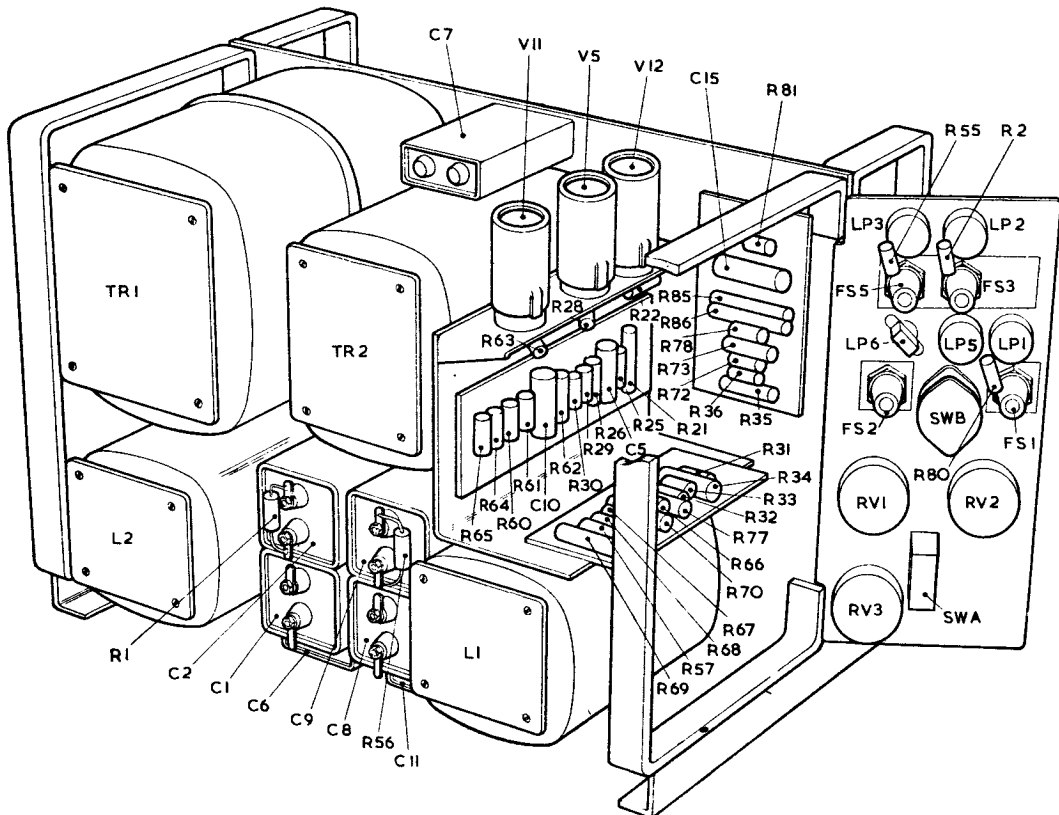


Fig. 13. Power unit Type 903—component layout

the two sides of the supply at this point is nearly 500V and neither side is earthed yet.

#### Stabilizer

**57.** After the fuse comes the series regulator valve V10 with its associated circuit, the purpose of which is to produce a stable and ripple-free 300V supply. The positive pole is subsequently earthed but it is easier to understand the operation of the stabilizer if the earthing of V10 cathode and the positive pole of the output is temporarily ignored. The action of the circuit is, in any case, the same whichever pole is subsequently earthed.

**58.** The regulator valve V10 is a CV345 beam tetrode, triode-connected. The potential drop across it is controlled by its grid voltage, which is governed by the control pentode V11 (CV138). The grid of V11 is returned to the slider of potentiometer RV4 (—300 SET), which forms part of a resistance chain connected between the positive pole of this supply and the station reference voltage of —500V. Thus, a proportion of any fluctuation in the potential difference between these two lines is direct-coupled to V11, at the anode of which appears an amplified fluctuation in opposite phase. This is applied to the V10 tetrode grid via R59, a 4.7K anti-parasitic resistor. The resulting potential change across V10 corrects the output voltage.

**59.**◀The anode load for V11 is in two parts: R60 (330K) returned to the positive side of this supply and R61 (680K) returned to the +300V line from the positive HT regulator. If R60 alone were used, it would limit the current of V11 to a maximum of 1 mA, at which value the IR drop across it, applied to V10 as bias, would cut off V10. With V11 anode current adjusted to permit V10 to pass current, the voltage drop across R60 could not exceed the grid-cathode voltage of the tetrode V10 (a few volts only) and V11 anode current would not exceed a fraction of 1 mA. Very poor control would be the result of operating so near cut-off, so R61 has been included to provide extra anode current without making V11 anode voltage low enough to cut down the anode current of V10 below the required value. The network is equivalent to a single anode load of 220K taken to an HT supply of about 100V more positive than if R61 were omitted.▶

**60.** Extra control for fast fluctuations and ripple is obtained by injecting them straight into V11 grid circuit via C10. Residual "hum" (predominantly 100 c/s) at V10 anode is applied via R57 (220K) to the control resistance chain and an appropriate value of hum voltage is tapped from the potential divider R67-R68 for application to V11 via C10 to suppress fluctuations at the output.

**61.** The —300V SET control RV4, which governs the DC condition of V11 and V10 and so sets the regulated output, is adjusted with the aid of the standard metering unit (multimeter Type 100) connected across the output (SK5/T,F); for this

reason the metering resistor R73 has been made a 1 per cent tolerance, high stability resistor.

#### +300V supply

**62.** The circuit of the +300V rectifier is very similar to that of the —300V supply. It is fed from the 475V-0-475V winding on TR1 and incorporates the double-diode V1 (CV378) and the filter section C1, L1, C2. The fuse for this line is FS3, rated at 500 mA and shunted by the indicator neon LP2. The negative side of this supply is earthed at the centre tap on the transformer secondary winding.

#### Stabilizer

**63.** The series regulator valve V4 (CV345) for this supply is arranged in a similar circuit to that of the —300V supply, although the DC conditions are slightly changed because of the larger current normally drawn from the +300V line.

**64.** The anode load for the control valve V5 is the 220K resistor R25. Ideally R25 would be returned to the stabilized +300V output, but this would raise the same problem as was mentioned in para. 59, i.e., that the control valve would have to operate very near cut-off and control would be very poor. R25 is therefore taken to the anode of a boost neon V12 (CV284), which draws current via R21 from the unstabilized side of the supply. The voltage drop across V12 while it is drawing current is a constant 83V, so that V12 gets 83V more HT than would otherwise be the case, without the disadvantages that would arise from using raw, unstabilized HT. The residual ripple on the current passing through V12 is applied to the output resistance chain and a suitable voltage is tapped from the potential divider R32-R33, for application to V5 control grid via C5, for neutralizing ripple in the output.

**65.** The setting of RV2 (+300v SET) affects the DC level of V5 and so controls the output voltage. When setting-up this control, the output is measured at SK5/D using the standard metering unit. The metering resistor R35 has the same tolerance as R73. Since the reference for the +300V supply is the —300V supply, the latter must be set up first. For setting-up SWB is operated to position 2 (SET) which connects the dummy loads R85 (—300V) and R86 (+300V) in circuit, to ensure steady loading conditions.

#### Protection (cut-out) circuit

**66.** The protection valve V8 (CV138) and the protection relay RLA are included to cut off the HT supplies completely if the +300V line moves more than a few volts from its nominal value. This provides a safeguard against failure of the —300V stabilizer as well, because of the way the positive rail is referred to the negative. The circuit is also connected to the 50V relay supply for RLB and to the —500V station reference, so that failure of these supplies will cause the cut-out to operate. Finally a safeguard is provided against overload faults in the external

unit, because when an exceptionally large current, which may still not be enough to blow the fuses, is drawn from either the +300V or the -300V rail, the regulator will be unable to hold up the voltage and the cut-out will operate.

**67.** With the circuit properly set-up, RLA is de-energized as long as the +300V output is correct, but any variation of the output energizes the relay, so opening the normally closed contact A1 and tripping the HT. RLA is a sensitive Carpenter relay and each of its two 675-ohm coils is in series with a germanium diode Type CV425 and a limiting resistor. The CV425 has a forward resistance of about 200 ohms and a back resistance approaching 60K. The two relay coil circuits, in which the germanium crystals are connected in opposite senses, are in parallel between V8 cathode and earth.

**68.** When the positive rail is at exactly +300V and the potentiometer RV3 (SET CUT-OUT) has been correctly adjusted, V8 cathode rests at earth potential. In this state neither of the germanium diodes is conducting and all the V8 cathode current completes its circuit via R44 and the -50V line. If, however, the +300V line now moves positive with respect to the -500V, which is used for reference, V8 grid rises proportionately and the cathode starts to rise by cathode follower action. V7 now conducts and offers a fairly low resistance path to earth via R41 and one winding of RLA, so that the greater part of the valve current flows this way and the relay is energized. Likewise, if V8 grid goes down due to a fall on the positive rail, the cathode falls and brings the other germanium diode into conduction, diverting the valve current through the second relay winding and energizing the relay.

**69.** The protection circuit is set up (after the test switch has been turned to SET and the -300V and +300V have been correctly adjusted) by metering V8 cathode (SK5/E), using the standard metering unit, and turning RV3 (SET CUT-OUT) until the potential at V8 cathode is zero.

#### **Power unit switching**

**70.** The ON-OFF switch for the power unit is SWA, a double-pole, single-throw, toggle switch which brings in 230V 50 c/s mains and -50V for operating relay RLB and for application to V8 cathode return and to PL6/F. Assuming SWB is in the OFF position, when SWA is closed only the LT transformer TR2 is energized, via FS1, FS7 and FS6, these fuses being bridged by the indicator LPI with its series resistor; the HT transformer TR1 is open-circuited by relay contacts RLB1. LT is fed to the internal regulator and protection circuit valves, but not to the rectifiers; the external unit is also fed via connections on SK1, while other external supplies are made available on SK2.

**71.** The HT is now brought on in three stages, using the four-position wafer switch SWB. This has two wafers and there are two contact groups on each wafer. On SWBa, contacts 2 to 5 concern the +300V output, and contacts 8 to 10 the HT relay and indicator lamp circuit. On SWBb,

contacts 4 and 5 relate to the -500V reference output, and contacts 8 to 11 to the -300V output.

#### **SET position**

**72.** When SWB is turned from OFF, to the SET position, SWBa contacts 8 and 9 complete the circuit to earth of one side of the operating coil of RLB, the other side being connected to the -50V line. The four sets of contacts of the relay are closed and operate as follows:—

(1) Contacts B1 complete the 230V mains circuit to TR1, bringing on the positive and negative rectifiers V1 and V9.

(2) Contacts B2 complete the earth return of the red HT ON lamp LP6, which lights up.

(3) Contacts B3 route -50V out via PL6/F to the negative reference rack, there to close a relay which supplies -500V reference voltage back to the power unit Type 903 via PL6/C.

(4) Contacts B4 are not used.

**73.** In the SET position of SWB the protection circuit is not effective and all three SET controls may be adjusted without tripping the HT. So that the stabilizers may be set up under standard conditions, contacts 8 and 9 of SWBb connect the 22K dummy load R85 to the -300V output and the similar load R86 is connected to the +300V output by SWBa contacts 2 and 3. The LOAD ON indicator lamp LP5, with its series resistor R78, is in parallel with R85 to indicate the presence of the -300V supply.

#### **CHECK position**

**74.** In the CHECK position of SWB the dummy loads R85 and R86 stay across the outputs, but the relay circuit is altered by the breaking of SWBa contacts 8 and 9, and the making of contacts 9 and 10. Instead of being earthed via SWBa alone, the operating coil of RLB is now earthed via SWBa, the protection circuit relay contacts A1 and the HT relay contacts B2. If the setting-up potentiometers are incorrectly adjusted RLA will be operated and contacts A1 will be open so that RLB will trip. The CHECK position thus gives an opportunity to confirm that the power unit is in order before any HT is applied to the external load. If RLB drops out at this stage, as indicated by the extinction of LP6, it is necessary to revert to the SET position and to make sure that the setting-up has been done correctly. The resistor R81 and the electrolytic condenser C15, across the contacts 8 and 10 of SWBa, prevent RLB from tripping due to momentary interruption of current when switching from SET to CHECK.

#### **LOAD position**

**75.** If all is well on the CHECK position, SWB is turned to LOAD. Here the same relay circuit is maintained as in the CHECK position, to keep the protection circuit effective. SWBb contacts 8 and 9 are broken, while 9 and 11 are made, thus transferring the -300V from the internal to the external load. Similarly SWBa contacts 2 and 3 are changed to 3 and 5 to transfer the +300V. C17—R84 and C14—R82 suppress any sparking that may tend to arise when switching from CHECK to LOAD and vice-versa. The LOAD ON lamp LP5 goes out on switching from CHECK

to LOAD; the -500V reference output is applied to SK3/F and SK4/F via SWBb contacts 4 and 5.

76. SK2 and SK4 are not used when the power

unit Type 903 is installed in a rack assembly (timebase) Type 300, but they are included because the same type of power unit is also installed in other rack assemblies where two units are fed from one power unit.

## PANEL (DISTRIBUTION AND SWITCHING) TYPE 868

### INTRODUCTION

77. The panel (distribution and switching) Type 868 (Stores Ref. 10D/18696) is located at the base of the rack assembly Type 300 (fig. 1). All the coaxial services (both 250 c/s and 500 c/s), between the units in the rack and the rest of the radar office, are routed through this panel. As outlined in para. 6, the panel also contains manual change-over switches for each repetition frequency (SWA and SWB) for diverting the coaxial services from unit "A" to unit "B" and vice-versa. The manual switch SWF, the preset potentiometers RV1 and RV2 and the relays A and B (remotely operated from the waveform monitor rack) allow for checking that the negative sawtooth waveforms are equal in amplitude to the positive versions. The monitor switches C and D, also operated from the rack assembly Type 339, connect a coaxial line from this monitor rack to any one of the services from any timebase unit, to display the waveform on the monitor CRT. Finally, the panel carries a general purpose 5A stabilized mains socket (SK68) for a soldering iron or item of test gear.

### Construction

78. The unit is constructed in the form of an inverted T, and it is fixed to the base plate of the

rack, over the air inlet, by two captive screws, one at the front and one at the rear; these are accessible with the bottom timebase unit Type 140 and associated power unit Type 903 removed from the rack. As seen from the front of the rack, the coaxial sockets for external connections are on the left-hand horizontal arm of the T, while those for internal connections are on the right. The mains socket, switch and fuses are accessible from the rear. Fig. 14 gives a top view and fig. 15 an underside view of the unit.

### CIRCUIT DESCRIPTION

79. Fig. 18 gives the complete circuit diagram of the unit. The circuit is best considered in three parts: the 500 c/s change-over switch, the 250 c/s change-over switch and the monitor switches.

#### 500 c/s CHANGE-OVER switch

80. Switch A is the 500 c/s change-over switch, and it has two positions, labelled 120 MLS A and 120 MLS B, selected by a knob on the front of the panel. In the A position, the group of coaxial sockets SK32 to SK38, marked 500 c/s TIMEBASE UNIT A and connected to unit 10 in the rack, is connected through to the group SK1 to SK10, marked 500 c/s SERVICES and feeding the external units (fig. 18). In SWA position B, the group SK1

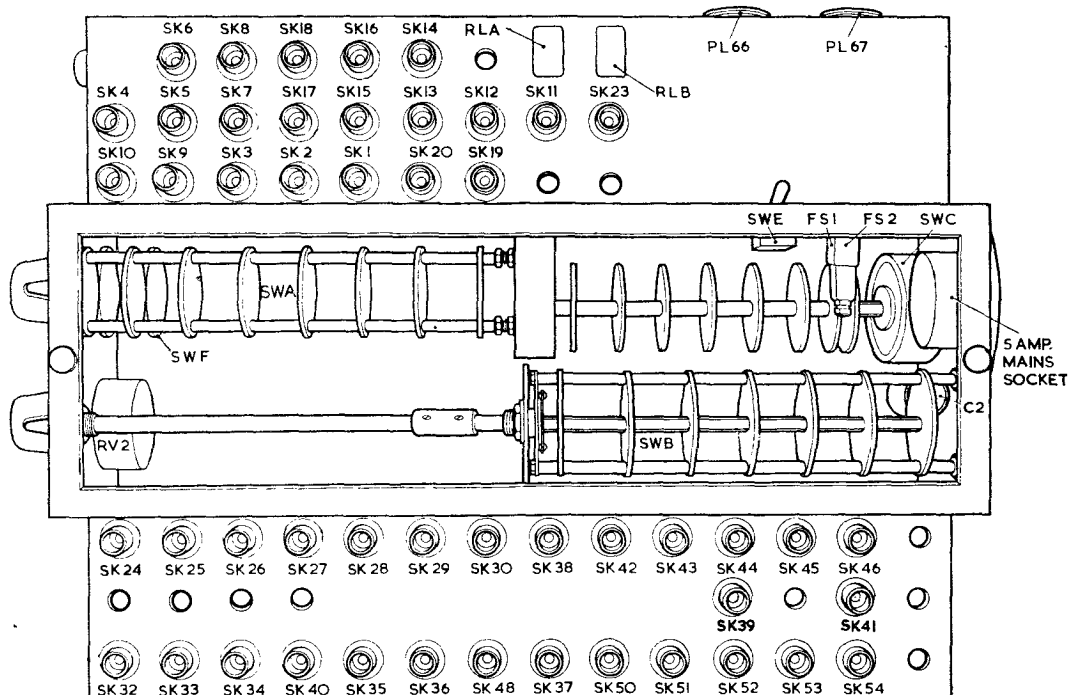


Fig. 14. Panel (distribution and switching) Type 868—top view

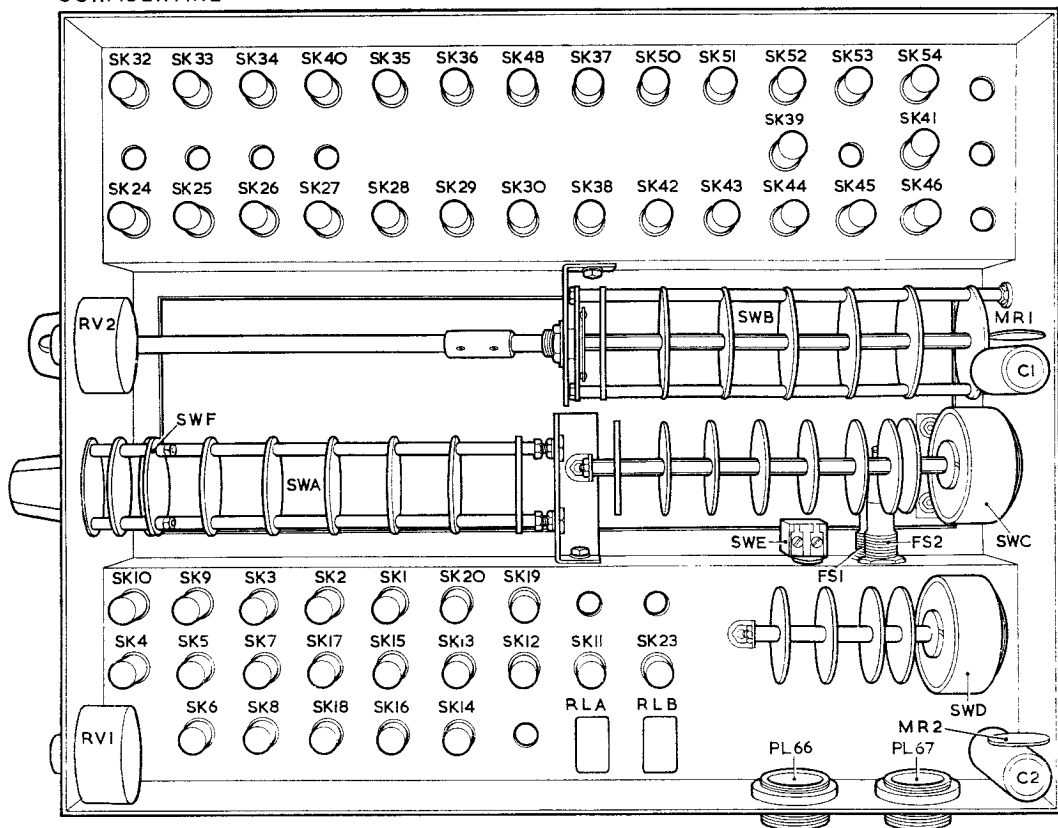


Fig. 15. Panel (distribution and switching) Type 868—underside view

to SK10 is linked to the group SK24 to SK30 marked 500c/s TIMEBASE UNIT B and connected to unit 12 in the rack. Note, however, that the 500 c/s master trigger pulses by-pass the switch and are permanently applied to both A and B units viz SK7 and SK8 linked to SK24 and SK32.

#### 250 c/s CHANGE-OVER switch

81. The corresponding switch (labelled 240 MLS A and 240 MLS B) for 250 c/s services is SWB, which connects sockets SK11-SK19 (250 c/s SERVICES) to rack unit 06 (250 c/s timebase unit A) or to unit 08 (timebase unit B) on the appropriate switch positions. The master trigger pulses on SK17 and SK18 again by-pass the switch and are applied direct to SK40 and SK48, which feed the timebase units. ▶ ◀

#### Waveform monitor lamps

82. The lines from SWAg to the waveform monitor rack, via PL67/F, G and H, operate lamps in the panel, indicating, Type 4064, to show which 500 c/s timebase unit is in use. SWBg and connections PL67/F, J and K perform the same function for the 250 c/s timebase units.

#### Monitor switches and relays

83. The purpose of the monitor switches is to select any one of the 22 waveforms from the different timebase units and to feed it out via SK23 for display on the waveform monitor CRT. The switches (C and D) are turned by rotary actuators, operated by switching lines from the

rack assembly Type 339, entering the panel Type 868 at PL 66/A to M (SWC) and PL67/A and D (SWD); PL67/E carries the return line for SWC, SWD and for the relays RLA and RLB. The operation of the actuators is described in para. 2 of Chap. 1, Sect. 4 of this Part.

84. SWD is the primary selector, which selects the "A" group of eleven waveforms on position 1 (as in fig. 18), by connecting SK23 to SWC wafers d and e (front), via relay contacts RLA1, or alternatively selects the "B" group of waveforms on position 8, by connecting SK23 to SWC wafers b and c (front), via relay contacts RLB1. The secondary selector SWC then selects the required waveform, which may be identified for the various switch positions (12 in all) by the letters on the switch leads, corresponding with letters on the coaxial socket leads (fig. 18). It will be observed that the twelve positions of SWC are made possible by SWCa (rear) with the insulated wiper contact 9 and the staggered switch blade, which make the wiper position 8 on the front wafer operative.

85. Relays A and B are operated from the monitor rack via PL67/B and E when checking the paraphase gain of the timebase units. At the same time SWD is operated to position 1 to select the timebase waveforms from "A" units, or to position 8 to select those from "B" units. Meanwhile SWC is operated to position 6 for selecting 500 c/s units, or to position 12 for selecting 250 c/s units.

86. Thus, on position 6 of SWC, wafer SWCg selects the positive and negative 500 c/s timebase waveforms from unit "A". These are applied via SWFc to opposite ends of potentiometer RV1. The slider of this control is connected, via RLA/1 and SWDc, to SK23, feeding the waveform monitor (SWD on position 1). With the positive and negative waveforms correctly adjusted to equal amplitude (*para. 35-36 and para. 42*) RV1 is set to give zero output with SWF on NORMAL, and again with SWF on REVERSE. By playing off one setting against the other the exact electrical centre of RV1 is found. If, during subsequent operation of the equipment, the paraphase gain should alter, the output from RV1 will not be zero, but will be a positive or negative sawtooth, representing the difference in amplitude of the two waveforms.

87. Similarly (SWC still on position 6), wafer SWCf selects the positive and negative 500 c/s timebase waveforms from unit "B". These are applied via SWFa to RV2, the slider of which (previously adjusted to its electrical centre point) feeds SK23 via RLB/1 and SWDb (SWD on position 8).

88. With SWC on position 12, wafer SWCg selects the positive and negative timebase waveforms from the 250 c/s unit "A" while SWCf selects those from the 250 c/s unit "B". As in the case of the 500 c/s waveforms, they are applied via SWF to RV1 and RV2, feeding RLA/1 and RLB/1, respectively. SWD then selects either the "A" or "B" unit waveforms for application to SK23, as before.

**TABLE I**  
**Timebase Unit Type 140**  
(Stores Ref. 10D/18695)  
**Component details**

Resistors (fixed)					Resistors (fixed)—cont.				
Circuit ref.	Value (ohms)	Rating (watts)	Tol. (%)	Inter-serv. ref.	Circuit ref.	Value (ohms)	Rating (watts)	Tol. (%)	Inter-serv. ref.
R1	47 K	1/2	10	Z222215	R46*	82 K	1/2	1	Z216429
R2	330	1/2	10	Z221173	R47* to R49*	150 K	1/2	1	Z216489
R3	deleted.				R50	470 K	1/2	10	Z223122
R4	220 K	1/2	10	Z223080	R51*	220 K	1/2	5	Z216723
R5*	33	1/2	5	Z215062	R52* to R56* (Type 11357) (Muirhead D333)	500 K	1	1/2	10W/19578
R6*	6.8K	1/2	5	Z215342	R57*	220 K	1/2	5	Z216723
R7*	10 K	1/2	5	Z216003	R58 to R60	deleted.			
R8*	220 K	1/2	5	Z216723	R61	330	1/2	10	Z221173
R9	330	1/2	10	Z221173	R62*	4.7 K	1/2	5	Z215322
R10*	47 K	1/2	5	Z216082	R63*	150	1/2	5	Z215142
R11	47 K	1/2	10	Z222215	R64*	220 K	1/2	2	Z216531
R12	1 M	1/2	10	Z223164	R65*	150	1/2	5	Z215441
R13	1 K	1/2	10	Z222005	R66*	100 K	1/2	2	Z216451
R14, R15	deleted.				R67*	68 K	1	2	Z216413
R16	1 M	1/2	10	Z223164	R68*	300 K	1/2	2	Z216557
R17	2.2 M	1/2	10	Z223206	R69*	470 K	1/2	2	Z216597
R18	330	1/2	10	Z221173	R70	22 K	1/2	10	Z222173
R19*	33	1/2	5	Z215062	R71	180 K	1/2	10	Z223071
R20	47 K	6	5	Z244150	R72	2.2 K	1/2	10	Z222047
R21	3.3 K	1/2	10	Z222068	R73	1 K	1/2	10	Z222005
R22	47 K	6	5	Z244150	R74, R75	deleted.			
R23, R24	330	1/2	10	Z221173	R76	330	1/2	10	Z221173
R25*	33	1/2	5	Z215062	R77*	33	1/2	5	Z215062
R26	47 K	6	5	Z244150	R78	33 K	1	10	Z212261
R27	330	1/2	10	Z221173	R79*	470 K	1/2	5	Z216738
R28	10 K	1/2	10	Z222131	R80*	1 M	1/2	5	Z216757
R29, R30	deleted.				R81*	10	1/2	5	Z215002
R31*	680 K	1/2	2	Z216626	R82, R83	100	1/2	10	Z221110
R32	330	1/2	10	Z221173	R84*	1.6 K	1/2	1	Z215687
R33	470 K	1/2	10	Z223122	R85*	820	1/2	1	Z215616
R34*	1.5 M	1	2	Z216668	R86	22 K	6	5	Z244129
R35, R36	33 K	1/2	10	Z222195	R87*	4.7 K	1/2	5	Z215322
R37*	33	1/2	5	Z215062	R88 to R90	deleted.			
R38*	100 K	1/2	5	Z216122	R91*	150 K	1/2	1	Z216486
R39*	33 K	1/2	5	Z216062	R92*	150 K	1/2	1	Z216486
R40	330	1/2	10	Z221173	R93*, R94*	150	1/2	5	Z215142
R41*	33	1/2	5	Z215062	R95*	100 K	1/2	2	Z216451
R42	4.7 K	1/2	10	Z222089	R96	deleted.			
R43	33 K	1/2	10	Z222195					
R44, R45	deleted.								



TABLE I (contd.)

Resistors (fixed)—cont.

Circuit ref.	Value (ohms)	Rating (watts)	Tol. (%)	Inter-serv. ref.
R97	330	1	10	Z221173
R98*	220 K	1	2	Z216531
R99*	220 K	1	5	Z216723
R100*	3.6 K	1	5	Z215307
R101*	220 K	1	5	Z216723
R102*	300 K	1	2	Z216557
R103	1 K	1	10	Z222005
R104, R105	deleted.			
R106	330	1	10	Z221173
R107	2.2 K	1	10	Z222047
R108*	470 K	1	2	Z216597
R109*	33	1	5	Z215062
R110	33 K	1	10	Z212261
R111	deleted.			
R112	22 K	1	10	Z222173
R113	180 K	1	10	Z223071
R114*	470 K	1	5	Z216738
R115*	680 K	1	5	Z216747
R116*	10	1	5	Z215002
R117	100	1	10	Z221110
R118	1 K	1	10	Z222005
R119, R120	deleted.			
R121, R122	6.8 K	6	5	Z244082
R123	10 K	1	10	Z222131
R124*	300 K	1	1	Z216552
R125*	33 K	1	5	Z216062
R126*	470 K	1	1	Z216592
R127	330	1	10	Z221173
R128*	10	1	5	Z215002
R129	4.3 K	3	5	Z244231
R130	100	1	10	Z221110
R131*	100	1	2	Z215401
R132*				
R133 to R135	deleted.			
R136	4.3 K	3	5	Z244231
R137*	10	1	5	Z215002
R138	100	1	10	Z221110
R139*	300 K	1	1	Z216552
R140*	33 K	1	5	Z216062
R141	330	1	10	Z221173
R142*	470 K	1	1	Z216592
R143	330	1	10	Z221173
R144*	33	1	5	Z215062
R145*	22 K	1	2	Z216294
R146*	33 K	1	5	Z216065
R147*				
R148 to R150	deleted.			
R151	330	1	10	Z221173
R152*	620 K	1	2	Z216619
R153*	430 K	1	2	Z216586
R154	100 K	1	10	Z223038
R155*	15 K	1	2	Z216252
R156*	18 K	1	5	Z216034
R157*	12 K	1	5	Z216013
R158*	100 K	1	2	Z216454
R159*	22 K	1	2	Z216292
R160*	470 K	1	2	Z216595
R161	100	1	10	Z221110
R162	330	1	10	Z221173
R163, R164	deleted.			
R165, R166	100	1	10	Z221110
R167	33 K	1	10	Z222194
R168	470 K	1	10	Z223122
R169 to R175	100	1	10	Z221110

Resistors (fixed)—cont.

Circuit Ref.	Value (ohms)	Rating (watts)	Tol. (%)	Inter-serv. ref.
R176	47 K	1	10	Z222215
R177	22 K	1	10	Z222173
R178	330 K	1	10	Z223101

\*High stability

Resistors (variable)

Circuit ref.	Value (ohms)	Rating (watts)	Tol. (%)	Inter-serv. ref.	Function
RV1	50 K	1	10	Z272410	VELOCITY COARSE
RV2	5 K	1/2	10	Z272001	T.B. ZERO SET, COARSE
RV3	500	1/2	10	Z271501	T.B. ZERO SET, FINE
RV4	1 K	1	10	Z271605	RANGE SET 120
RV5	1 K	1	10	Z271605	RANGE SET 240
RV6	10 K	1	10	Z272141	AMP. BAL.
RV7	250	1/2	10	Z271401	AMP. ZERO SET, FINE
RV8	5 K	1/2	10	Z272001	AMP. ZERO SET, COARSE
RV9	50 K	1	10	Z272410	PULSE DELAY 240
RV10	50 K	1	10	Z272410	PULSE DELAY 120
RV11	10 K	1	10	Z272141	VELOCITY FINE

Capacitors (fixed)

Circuit Ref.	Value (μF except where stated)	Rating (V.DC)	Tol. (%)	Inter-serv. ref.
C1	.01	350	20	Z115625
C2, C3	0.1	350	20	Z115506
C4	.01	350	20	Z115552
C5	.01	350	20	Z115625
C6	15 pF	500	10	Z132073
C7	100 pF	500	10	Z132300
C8	15 pF	500	10	Z132073
C9	33 pF	500	10	Z132283
C10	0.1	350	20	Z115506
C11	100 pF	500	10	Z132300
C12	deleted.			
C13	100 pF	500	10	Z132300
C14	.005	250	1	10C/20462

(Type 7604) (Muirhead B518T)

C15	33 pF	500	10	Z132283
C16	2,200 pF	350	10	Z124193
C17	0.1	350	20	Z115506
C18,	10 pF	350	10	Z123007
C19				
C20	33 pF	500	10	Z132283
C21	2,200 pF	350	10	Z124193
C22	0.1	350	20	Z115506
C23	470 pF	350	10	Z123411
C24	100 pF	500	10	Z132300
C25,	0.1	150	25	Z115560
C26				
C27	470 pF	500	10	Z123411
C28	100 pF	500	5	Z132185
C29	560 pF	350	10	Z123477
C30	.01	350	20	Z115552

TABLE 1 (contd.)

## Capacitors (fixed)—cont.

Circuit Ref.	Value ( $\mu$ F except where stated)	Rating (V.DC)	Tol. (%)	Inter-serv. ref.
C31	470 pF	350	10	Z123411
C32	0.1	350	20	Z115506
C33	.02	350	20	Z115553
C34, C35	0.1	350	20	Z115506

## Miscellaneous items

Circuit ref.	Description	Type	Stores ref.
SWA	D.P.D.T. Toggle switch (RANGE 120/240)	—	Z510304
SWB	S.P.S.T. Toggle switch (v.c.u.)	—	Z510300

## Miscellaneous items—cont.

Circuit ref.	Description	Type	Stores ref.
L1	Inductor, RF, 0.115H, 5%	2174	10C/20423
PL1*	6-way fixed plug	Mk. 4	Z560541
PL2*	12-way fixed plug	Mk. 4	Z560152
SK3 to SK9	Socket (coaxial)	783	10H/19861
SK10 to SK12	Socket (Belling-Lee T.L.316)	714	10H/19341
SK13	Socket (coaxial)	783	10H/19861
SK14*	25-way fixed socket	Mk. 4	Z560380
SK15*	25-way fixed socket	Mk. 4	Z560380

\*Moulding position on Mk. 4 plugs and sockets is shown by last digit of Z-number.

TABLE 2

## Power Unit Type 903

(Stores Ref. 10K/17131)

## Component details

## Resistors (fixed)

Circuit Ref.	Value (ohms)	Rating (watts)	Tol. (%)	Inter-serv. ref.
R1, R2	1 M	1	10	Z213339
R3	100 K	$\frac{1}{2}$	10	Z223038
R4 to R20	<i>deleted.</i>			
R21	22 K	6	5	Z244129
R22	15 K	$\frac{1}{2}$	10	Z222152
R23	100	$\frac{1}{2}$	10	Z221110
R24	<i>deleted.</i>			
R25	220 K	1	10	Z213331
R26*	33	$\frac{1}{2}$	5	Z215062
R27	4.7 K	$\frac{1}{2}$	10	Z222089
R28	100	$\frac{1}{2}$	10	Z221110
R29, R30	47 K	1	10	Z212263
R31	470 K	$\frac{1}{2}$	10	Z223122
R32, R33	22	$\frac{1}{2}$	10	Z221026
R34*	330 K	1	2	Z216564
R35*	300 K	$\frac{3}{4}$	10	Z216551
R36	100 K	$\frac{1}{2}$	10	Z223038
R37	150	$4\frac{1}{2}$	5	Z243113
R38, R39	<i>deleted.</i>			
R40*	5.6 K	1	5	Z215334
R41*	<i>deleted.</i>			
R42	6.8 K	$4\frac{1}{2}$	5	Z244081
R43	100	$\frac{1}{2}$	10	Z221110
R44*	12 K	1	5	Z216014
R45	100	$\frac{1}{2}$	10	Z221110
R46	22 K	$\frac{1}{2}$	10	Z222173
R47	2.2 M	$\frac{1}{2}$	10	Z223206
R48*	620 K	$\frac{3}{4}$	1	Z216615
R49	<i>deleted.</i>			
R50*	1 M	$\frac{3}{4}$	1	Z216655
R51 to R54	<i>deleted.</i>			
R55, R56	1 M	1	10	Z213339
R57	220 K	1	10	Z213331
R58	100	$\frac{1}{2}$	10	Z221110
R59	4.7 K	$\frac{1}{2}$	10	Z222089
R60	330 K	1	10	Z213333
R61	680 K	1	10	Z213337
R62*	33	$\frac{1}{2}$	5	Z215062

## Resistors (fixed)—cont.

Circuit Ref.	Value (ohms)	Rating (watts)	Tol. (%)	Inter-serv. ref.
R63	100	$\frac{1}{2}$	10	Z221110
R64, R65	47 K	1	10	Z212263
R66	470 K	$\frac{1}{2}$	10	Z223122
R67	220	$\frac{1}{2}$	10	Z221152
R68	330	$\frac{1}{2}$	10	Z221173
R69*	470 K	$\frac{3}{4}$	2	Z216595
R70*	300 K	$\frac{3}{4}$	2	Z216555
R71	<i>deleted.</i>			
R72	100 K	$\frac{1}{2}$	10	Z223038
R73*	300 K	$\frac{3}{4}$	1	Z216551
R74 to R76	<i>deleted.</i>			
R77*	330 K	1	2	Z216564
R78, R80	220 K	1	10	Z213331
R79, R81	470	$\frac{1}{2}$	10	Z221194
R82, R84	220	$\frac{1}{2}$	10	Z221152
R83	<i>deleted.</i>			
R85, R86	22 K	6	5	Z244129
R87*	47 K	$\frac{1}{2}$	5	Z216082

\*High Stability.

## Resistors (variable)

Circuit ref.	Value (ohms)	Rating (watts)	Tol. (%)	Inter-serv. ref.	Function
RV1	<i>deleted.</i>				
RV2	50 K	1	10	Z272410	+300V SET
RV3	50 K	1	10	Z272410	-300V SET
RV4	100 K	1	10	Z272549	SET CUT-OUT

## Capacitors (fixed)

Circuit ref.	Value ( $\mu$ F)	Rating (V.DC)	Tol. (%)	Inter-serv. ref.
C1, C2	4	800	20	Z112529
C3, C4	<i>deleted.</i>			
C5	0.1	500	20	Z115587

TABLE 2 cont.

## Capacitors (fixed) cont.

Circuit ref.	Value ( $\mu$ F)	Rating (V.DC)	Tol. (%)	Incr.-serv. ref.
C6	1	600	20	Z112823
C7	2	200	20	Z112882
C8, C9	4	800	20	Z112529
C10, C12	0.1	500	20	Z115587
C11	1	600	20	Z112823
C13 deleted.				
C14, C17	0.5	500	20	Z115512
C15, C18	3	100	-20, +50	Z145017
C16 deleted.				

## Miscellaneous items

Circuit ref.	Description	Type	Stores ref.	
SWA	Toggle switch (D.P.S.T.)	—	Z510302	
SWB	Wafer switch H	2176	10F/17465	
FS1	Fuse (5-amp.) MOS(A)	21	10H/11718	
FS2	Fuse (1-amp.) MOS(A)	5	10H/9613	
FS3	Fuse ( $\frac{1}{2}$ -amp.) MOS(A)	29	10H/238	
FS4 deleted.				
FS5	Fuse (250mA) MOS(A)	23	10H/107	
FS6	Thermo cut-out	—	10AE/655	

## Miscellaneous items—cont.

Circuit ref.	Description	Type	Stores ref.	
FS7	Thermo cut-out	—	10AE/655	
L1	Choke LF (16 H) L1195	1138	10C/19262	
L2	Choke LF (20 H) L1274	1153	10C/19297	
◀ TR1	Transformer L1196A	3143	10K/17339	
TR2	Transformer L1202A	3145	10K/17341	
LP1	Neon lamp	—	X962106	
LP2	Neon lamp	—	X962106	
LP3	Neon lamp	—	X962106	
LP4 deleted.				
LP5	Neon lamp	—	X92106	
LP6	Filament lamp	—	X959220	
◀ RLA	Relay magnetic (Carpenter relay 6U33) (675+675 ohms)	1339	10F/18105	
RLB	Relay magnetic (2,000 ohms)	60/3HV	Z530187	
SK1*	12-way fixed socket	Mk. 4	Z560332	
SK2*	12-way fixed socket	Mk. 4	Z560333	
SK3*	6-way fixed socket	Mk. 4	Z560321	
SK4*	6-way fixed socket	Mk. 4	Z560321	
SK5*	25-way fixed socket	Mk. 4	Z560380	
PL6*	6-way fixed plug	Mk. 4	Z560140	

\*Moulding position on Mk. 4 plugs and sockets is shown by last digit of Z-number.

TABLE 3

## Panel (distribution and switching) Type 868

(Stores Ref. 10D/18696)

## Component details

Circuit ref.	Description	Type	Stores ref.	Circuit ref.	Description	Type	Stores ref.
SK1 to SK54	Socket (coaxial)	783	10H/19861	SWF	Wafer switch	H	—
PL66*	12-way fixed plug	Mk. 4	Z560151	FS1, FS2	Cartridge fuse, 5-amp. MOS(A)	21	10H/11718
PL67*	12-way fixed plug	Mk. 4	Z560152	R1 to R4	Resistors (fixed) 47K	$\frac{1}{2}$ W, 1% tol.	Z216366
SK68	3-pin 5-amp. socket	Crabtree Type L1770	5C/1042	RV1, RV2	Resistors (variable) 1K	1W, 10% tol.	Z271605
SWA, SWB	Wafer switch H	2341	10F/17774	RLA, RLB	Relays	SM8	Z530040
SWC	Uniselector unit (wafer switch H + Ledex rotary selector)	4597	10F/17778	MR1, MR2	Resistor unit (non-ohmic, 50VDC)	514	10W/19566
SWD	Uniselector unit (wafer switch H + Ledex rotary selector)	4067	10F/17463	C1, C2	Capacitors (fixed) 0.05 $\mu$ F	350VDC 20% tol.	Z115554
SWE	D.P. on-off switch	—	Z510306				

\*Moulding position on Mk. 4 plugs is shown by last digit of Z-number.

**TABLE 4**  
**Rack assembly (timebase) Type 300**  
**List of input and output connections**

**Note . . .**

The following list, which applies in the first place to GCI stations, is issued here for early information only, and may be supplemented or superseded by current orders. Full cabling schedules will be issued separately on the particular type of station concerned.

13 = Panel (dist. and switching) Type 868. 14 = Side input panel. R.A. = Rack assembly.

PL or SK	Type	Location	Moulding position	Pin	Service	Destination
PL3	6-way med.	14	0	A	230V 50 c/s neutral	Radar office power board.
				B	230V 50 c/s line	Radar office power board.
				C	-500 V ref.	R.A. (neg. ref.) Type 338.
				D	50V -	Rectifier Type 15.
				E	50V +	Rectifier Type 15.
				F	50V - neg. ref. switching.	R.A. (neg. ref.) Type 338 (paired with C).
PL4, PL5, PL6 as PL3.						
SK1	Coax.	13	—	—	500 c/s TB+	R.A. (mag. res) Type 301 No. 1 and 2.
SK2	Coax.	13	—	—	500 c/s TB-	Not wired.
SK3	Coax.	13	—	—	500 c/s R.B.U.-A	R.A. (HSU) Type 184 No. 1, 2 and 3.
SK4	Coax.	13	—	—	T-junction to SK3	Not wired.
SK5	Coax.	13	—	—	500 c/s R.B.U.-B	R.A. (HSU) Type 184 No. 4 and 5.
SK6	Coax.	13	—	—	T-junction to SK5	R.A. (w/f mon.) Type 339.
SK7	Coax.	13	—	—	500 c/s master trig.	Master trigger unit.
SK8	Coax.	13	—	—	T-junction to SK7	R.A. (mag. res.) Type 301 No. 1 and 2.
SK9	Coax.	13	—	—	Delayed clamp trig., 500 c/s.	R.A. (mag. res.) Type 301 No. 1 and 2.
◀ SK10	Coax.	13	—	—	G.W.G. drive 500 c/s	R.A. (gating waveform) Type 304. ▶
SK11	Coax.	13	—	—	250 c/s TB+	R.A. (mag. res.) Type 301 No. 1 and 2.
SK12	Coax.	13	—	—	250 c/s TB-	Not wired.
SK13	Coax.	13	—	—	250 c/s R.B.U.-A	R.A. (HSU) Type 184 No. 1, 2 and 3.
SK14	Coax.	13	—	—	T-junction to SK13	Selector units Type 33.
SK15	Coax.	13	—	—	250 c/s R.B.U.-B	R.A. (HSU) Type 184 No. 4 and 5.
SK16	Coax.	13	—	—	T-junction to SK15	R.A. (w/f mon.) Type 339.
SK17	Coax.	13	—	—	250 c/s master trig.	Master trigger unit.
SK18	Coax.	13	—	—	T-junction to SK17	R.A. (mag. res.) Type 301 No. 1 and 2; R.A. (w/f mon.) Type 339; R.A. (gating w/f) Type 304.
SK19	Coax.	13	—	—	Delayed clamp trig., 250 c/s.	R.A. (mag. res.) Type 301 No. 1 and 2.
◀ SK20	Coax.	13	—	—	G.W.G. drive 250 c/s	R.A. (gating waveform) Type 304. ▶
SK21, SK22 deleted.						
SK23	Coax.	13	—	—	Selected waveform to monitor.	R.A. (w/f mon.) Type 339.
PL66	12-way	13	1	A to M	Monitor switching (SW.C).	R.A. (w/f mon.) Type 339 (direct conn.).
PL67	12-way	13	2	A to E	Monitor switching (SW.D).	} R.A. (w/f mon.) Type 339 (direct conn.).
				F to K	Monitor lights	
				L, M	230 V 50 c/s	

(09) *Power unit Type 903*, supplying LT and HT to unit 10.

(10) *Timebase unit Type 140, 500 c/s "A"*

(11) *Power unit Type 903*, supplying LT and HT to unit 12.

(12) *Timebase unit Type 140, 500 c/s "B"*.

(13) *Panel (distribution and switching) Type 868*. This unit, which is located at the bottom of the rack, provides a junction box and switching unit for all coaxial services in the rack and contains manual change-over switches for units "A" and "B" providing each repetition frequency. SWA is the change-over switch for the 500 c/s units and SWB the switch for the 250 c/s units. The

panel also contains a manual switch (F) and preset potentiometers RV1 and RV2 for use in conjunction with the monitoring facilities provided by the rack assembly Type 339. There are, in addition, two actuator operated switches (C and D) and two relays (A and B), remotely operated from the monitor rack for connecting a coaxial line from this rack to anyone of the coaxial services from any timebase unit. Finally the unit contains a standard 5A, 3-pin MAINS socket (SK68) for servicing use.

(14) *L.H. side input panel*. This is not classified as a separate unit, but forms part of the rack framework. It carries panel-mounted couplers for connecting mains, reference and relay voltages from the cable entry to the individual power units.

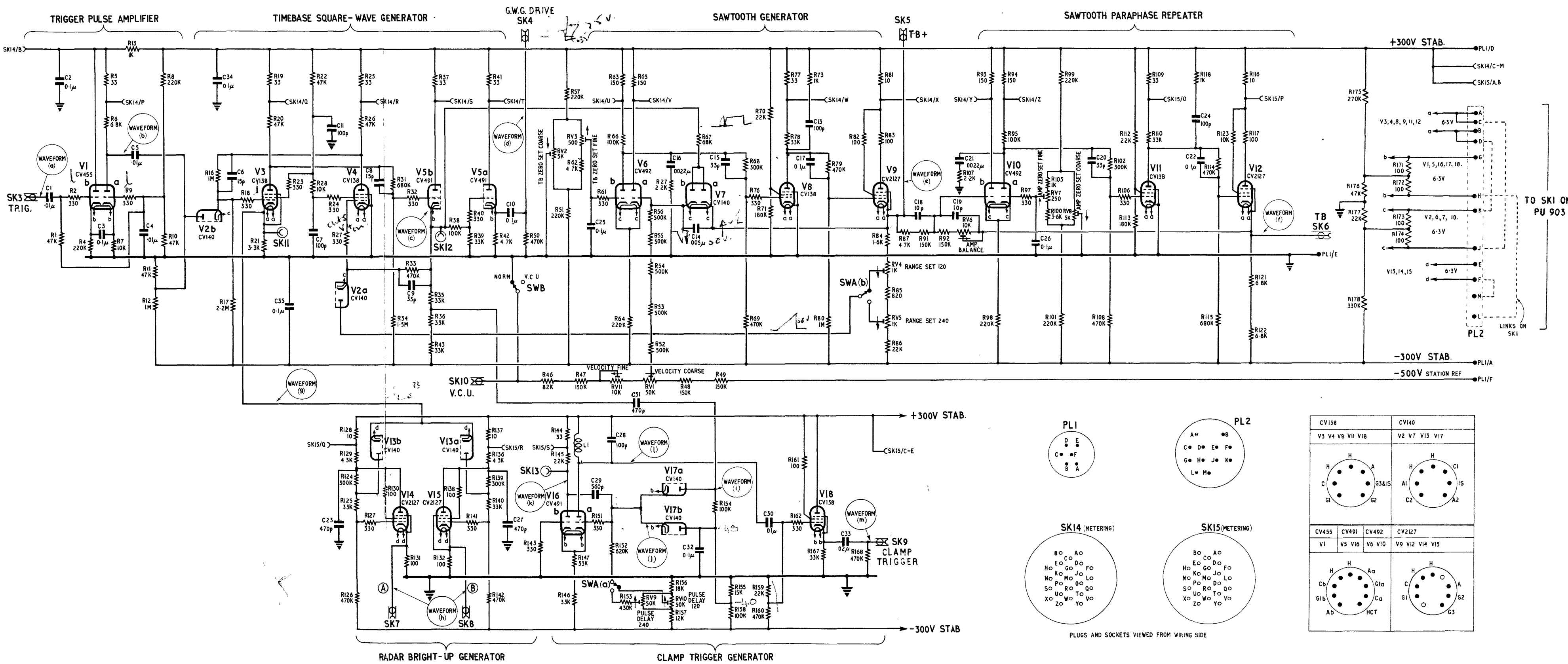
**TABLE 4**  
**Rack assembly (timebase) Type 300**  
**List of input and output connections**

**Note . . .**

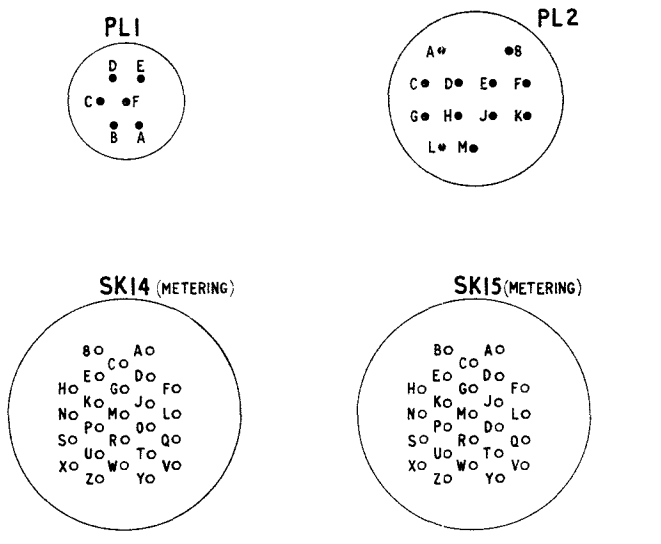
The following list, which applies in the first place to GCI stations, is issued here for early information only, and may be supplemented or superseded by current orders. Full cabling schedules will be issued separately on the particular type of station concerned.

13 = Panel (dist. and switching) Type 868. 14 = Side input panel. R.A. = Rack assembly.

PL or SK	Type	Location	Moulding position	Pin	Service	Destination
PL3	6-way med.	14	0	A	230V 50 c/s neutral	Radar office power board.
				B	230V 50 c/s line	Radar office power board.
				C	-500 V ref.	R.A. (neg. ref.) Type 338.
				D	50V -	Rectifier Type 15.
				E	50V +	Rectifier Type 15.
				F	50V - neg. ref. switching.	R.A. (neg. ref.) Type 338 (paired with C).
PL4, PL5, PL6 as PL3.						
SK1	Coax.	13	—	—	500 c/s TB+	R.A. (mag. res) Type 301 No. 1 and 2.
SK2	Coax.	13	—	—	500 c/s TB-	Not wired.
SK3	Coax.	13	—	—	500 c/s R.B.U.-A	R.A. (HSU) Type 184 No. 1, 2 and 3.
SK4	Coax.	13	—	—	T-junction to SK3	Not wired.
SK5	Coax.	13	—	—	500 c/s R.B.U.-B	R.A. (HSU) Type 184 No. 4 and 5.
SK6	Coax.	13	—	—	T-junction to SK5	R.A. (w/f mon.) Type 339.
SK7	Coax.	13	—	—	500 c/s master trig.	Master trigger unit.
SK8	Coax.	13	—	—	T-junction to SK7	R.A. (mag. res.) Type 301 No. 1 and 2.
SK9	Coax.	13	—	—	Delayed clamp trig., 500 c/s.	R.A. (mag. res.) Type 301 No. 1 and 2.
◀ SK10	Coax.	13	—	—	G.W.G. drive 500 c/s	R.A. (gating waveform) Type 304. ▶
SK11	Coax.	13	—	—	250 c/s TB+	R.A. (mag. res.) Type 301 No. 1 and 2.
SK12	Coax.	13	—	—	250 c/s TB-	Not wired.
SK13	Coax.	13	—	—	250 c/s R.B.U.-A	R.A. (HSU) Type 184 No. 1, 2 and 3.
SK14	Coax.	13	—	—	T-junction to SK13	Selector units Type 33.
SK15	Coax.	13	—	—	250 c/s R.B.U.-B	R.A. (HSU) Type 184 No. 4 and 5.
SK16	Coax.	13	—	—	T-junction to SK15	R.A. (w/f mon.) Type 339.
SK17	Coax.	13	—	—	250 c/s master trig.	Master trigger unit.
SK18	Coax.	13	—	—	T-junction to SK17	R.A. (mag. res.) Type 301 No. 1 and 2; R.A. (w/f mon.) Type 339; R.A. (gating w/f) Type 304.
SK19	Coax.	13	—	—	Delayed clamp trig., 250 c/s.	R.A. (mag. res.) Type 301 No. 1 and 2.
◀ SK20	Coax.	13	—	—	G.W.G. drive 250 c/s	R.A. (gating waveform) Type 304. ▶
SK21, SK22	<i>deleted.</i>					
SK23	Coax.	13	—	—	Selected waveform to monitor.	R.A. (w/f mon.) Type 339.
PL66	12-way	13	1	A to M	Monitor switching (SW.C).	R.A. (w/f mon.) Type 339 (direct conn.).
PL67	12-way	13	2	A to E	Monitor switching (SW.D).	} R.A. (w/f mon.) Type 339 (direct conn.).
				F to K	Monitor lights	
				L, M	230 V 50 c/s	



CV138	CV140
V3 V4 V6 V7 V18	V2 V7 V13 V17
CV455	CV491
CV492	CV2127
V1	V5 V6
V5 V6	V5 V10
V9 V12 V14 V15	

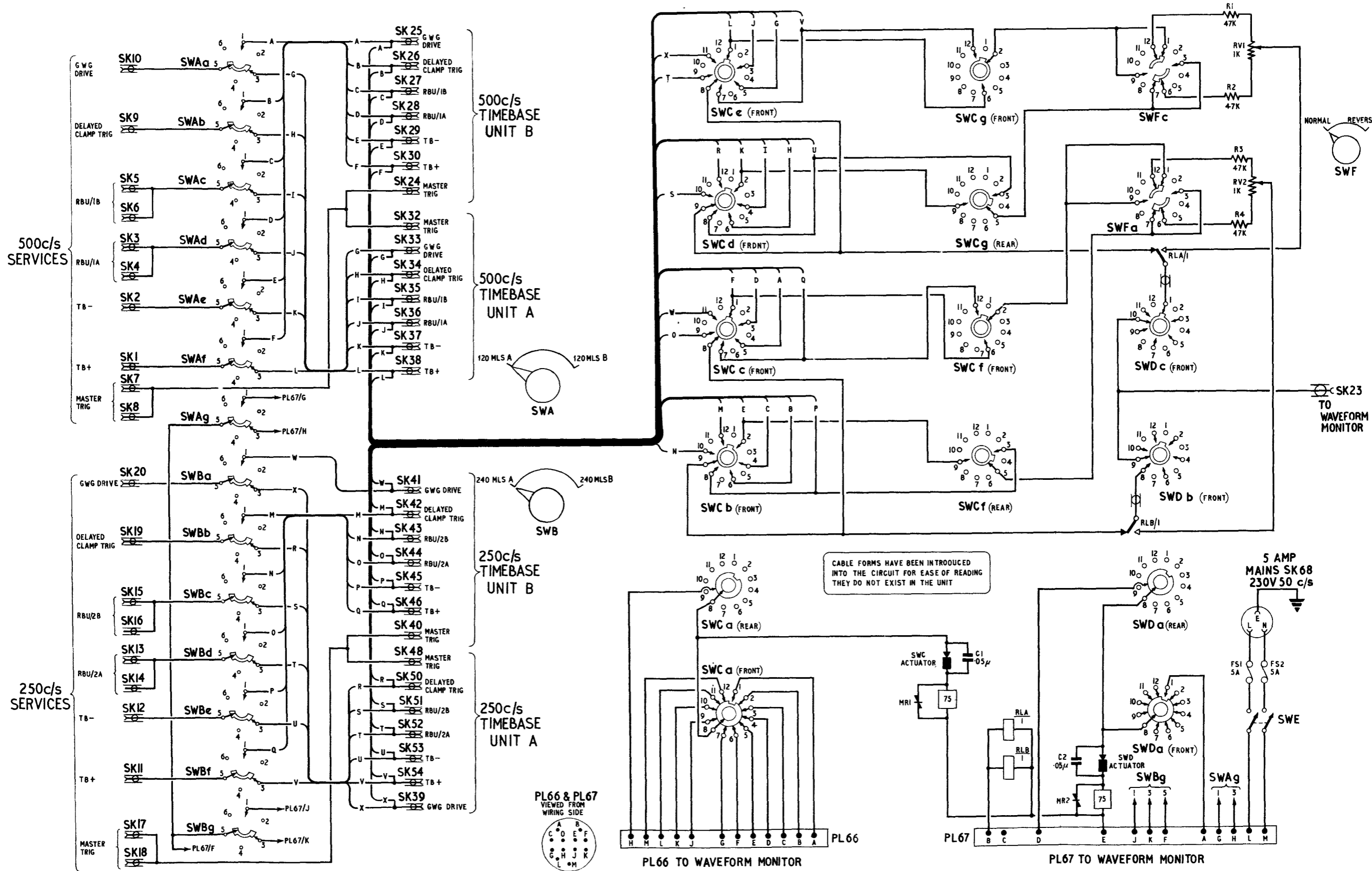


PLUGS AND SOCKETS VIEWED FROM WIRING SIDE

Fig.16

Timebase unit Type 140-circuit

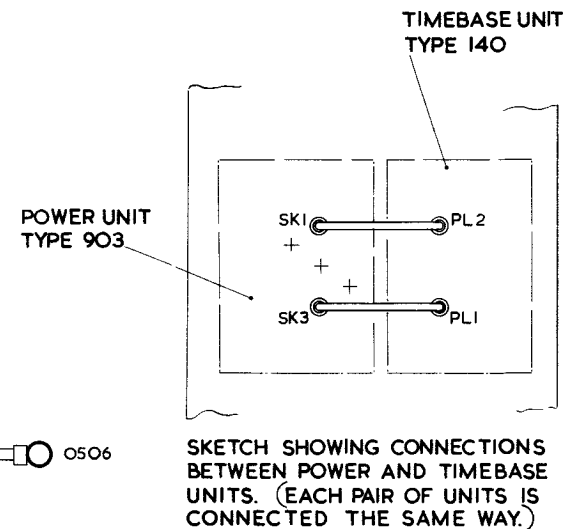
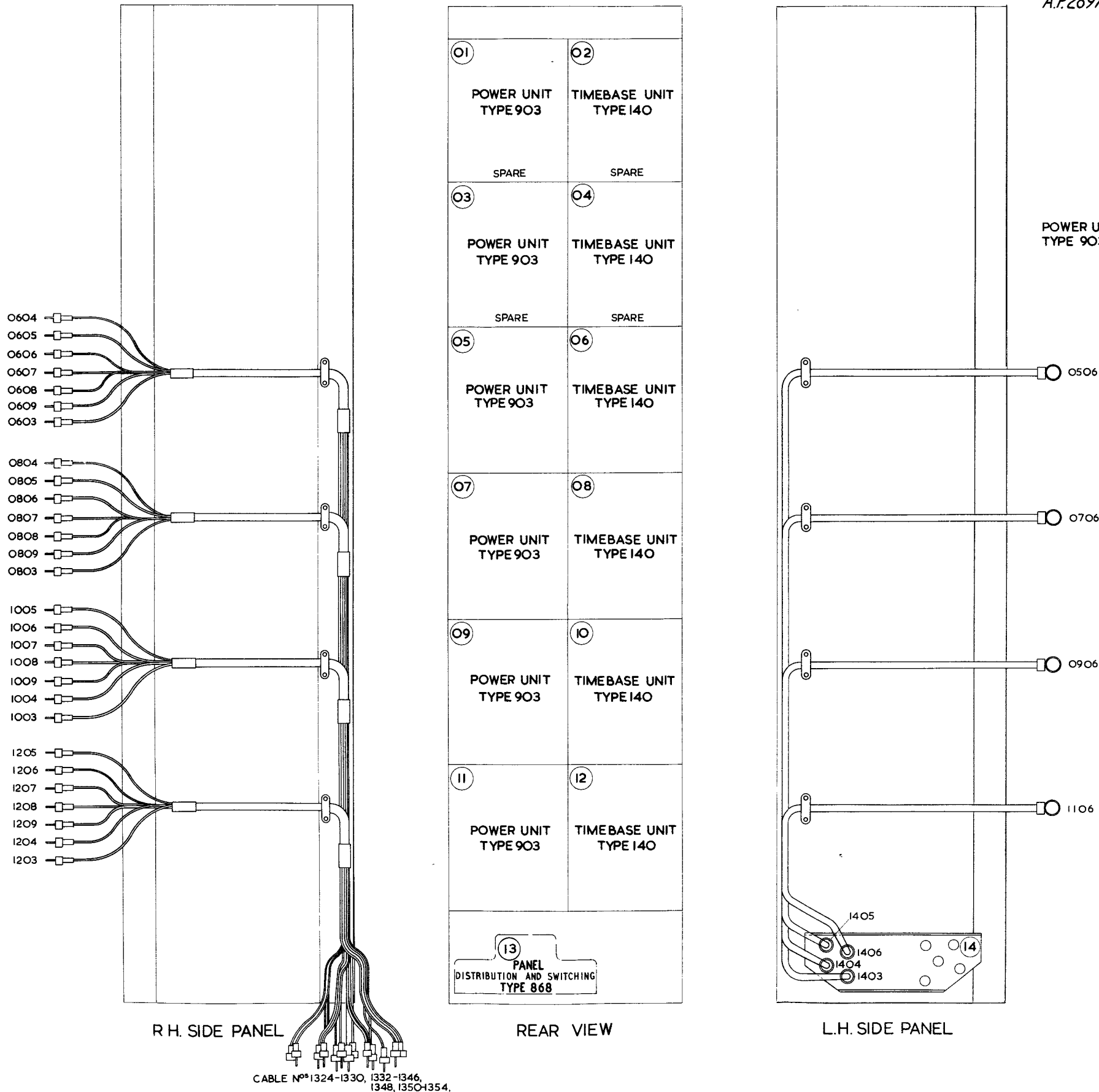
Fig.16



Panel (distribution and switching) Type 868-circuit

Fig.18  
(A.L.26, Sep. 57)





Rack assembly (timebase) Type 300 - cabling

Fig. 19  
(A.L.26, Sep. '57)

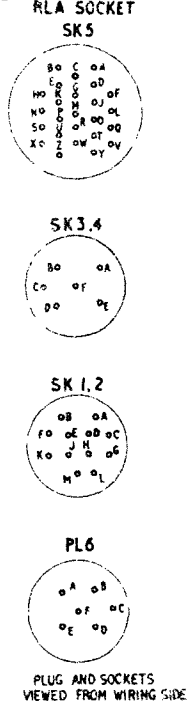
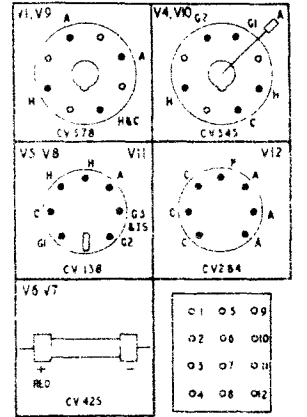
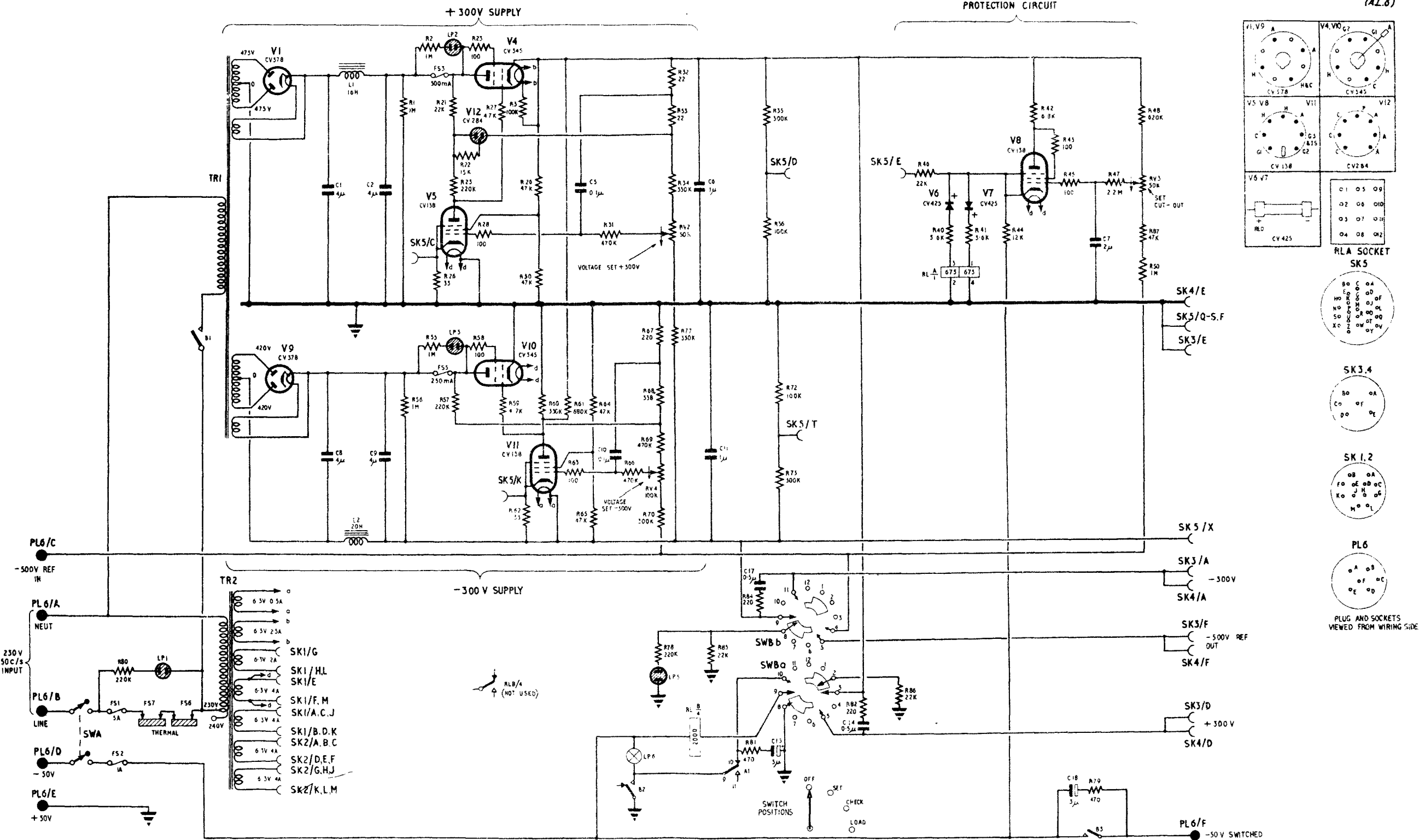


Fig. 17 Power unit Type 903—circuit

Fig. 103

## Appendix 1

### RACK (TIMEBASE) TYPE 16340

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#### INTRODUCTION

1. On stations where long range working is in operation and/or AN/FPS-6 height finding equipment has been integrated, whether or not these stations are using Phase 1A facilities, the source of master timebase and associated waveforms is the rack (timebase) Type 16340 (Ref. No. 10D/22373). This designation applies to the wired framework or to any combination of units which the rack accommodates in the provision of waveforms for the above purposes.

#### General description

2. The cabinet containing the units is similar to the cabinet rack assembly (timebase) 300, with similar cabling. The differences are the four extra coaxial leads for long range timebase facilities, and the four coaxial leads and two multicore cables

for use in integrating AN/FPS-6 equipment with station equipment. Fig. 1 shows a rack 16340 equipped with all units for which provision is made within the rack. These units are as follows:

1 panel (distribution and switching) Type 868A (Ref. No. 10D/21266) or Type 868B (Ref. No. 10D/23175).

2 timebases Type 140 to provide the normal range sawtooth waveforms.

2 timebases (long range) Type 12269 (Ref. No. 10D/18664) to provide the long range sawtooth waveforms.

1 pulse generator (range) Type 12408 (Ref. No. 10S/17297) for AN/FPS-6 integration.

5 power units Type 903 (Ref. No. 10K/17131) to provide the power for the four timebase units and the pulse generator.

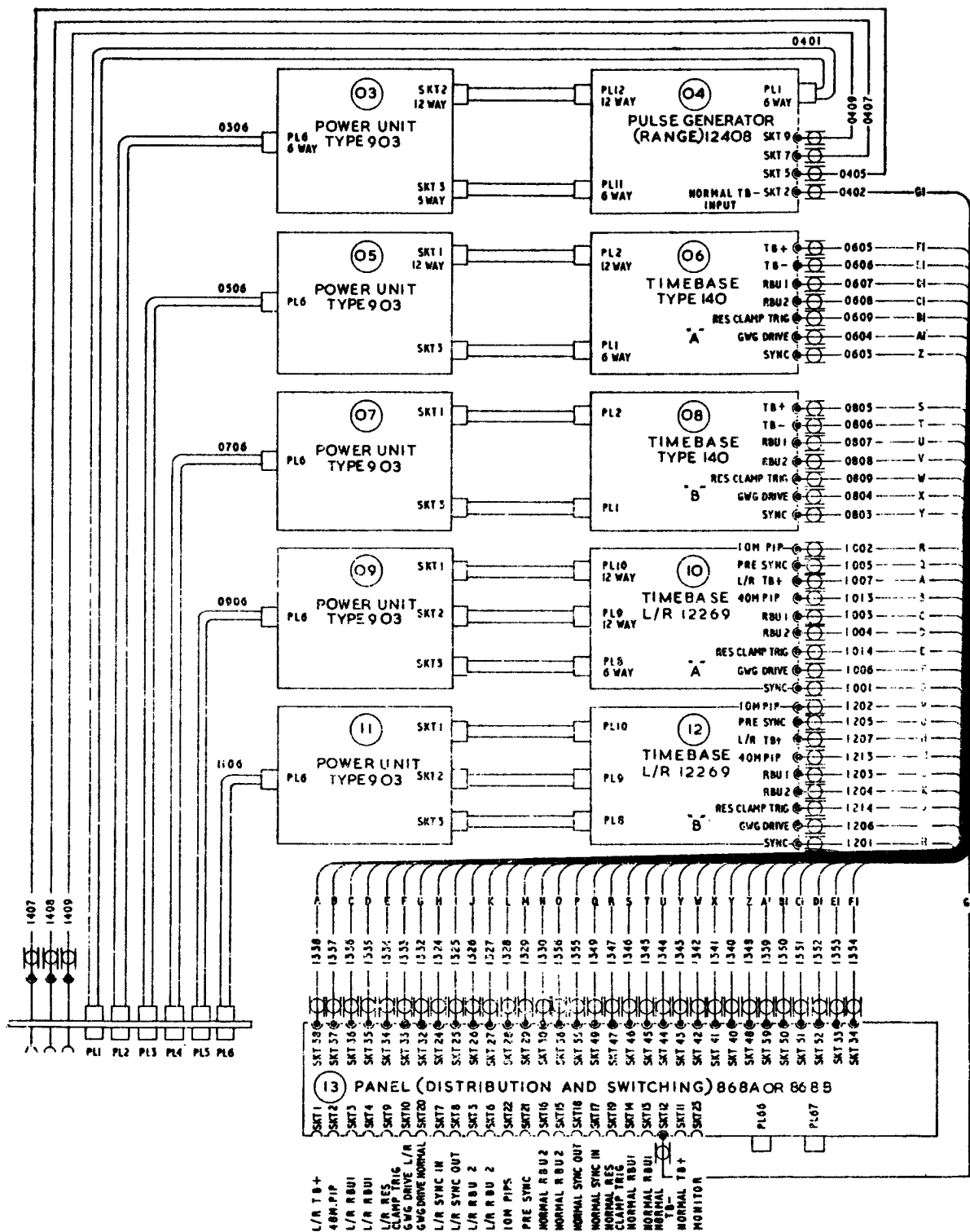


Fig. 1. Rack (timebase) Type 16340—circuit

### LONG RANGE WORKING

#### Panel (distribution and switching) Type 868A

3. For long range working the panel 868A is fitted in the rack 16340. This panel has inputs for pre-sync SKT21, and for 10 mile pips SKT22

(fig. 2 and fig. 3). The pre-sync signal passes straight through the panel to SKT49, feeding the long range timebase A, and SKT56, feeding the long range timebase B (stand-by). The ten mile pip signal passes straight through to SKT47 feeding the long range timebase A, and SKT55 feeding the long range timebase B.

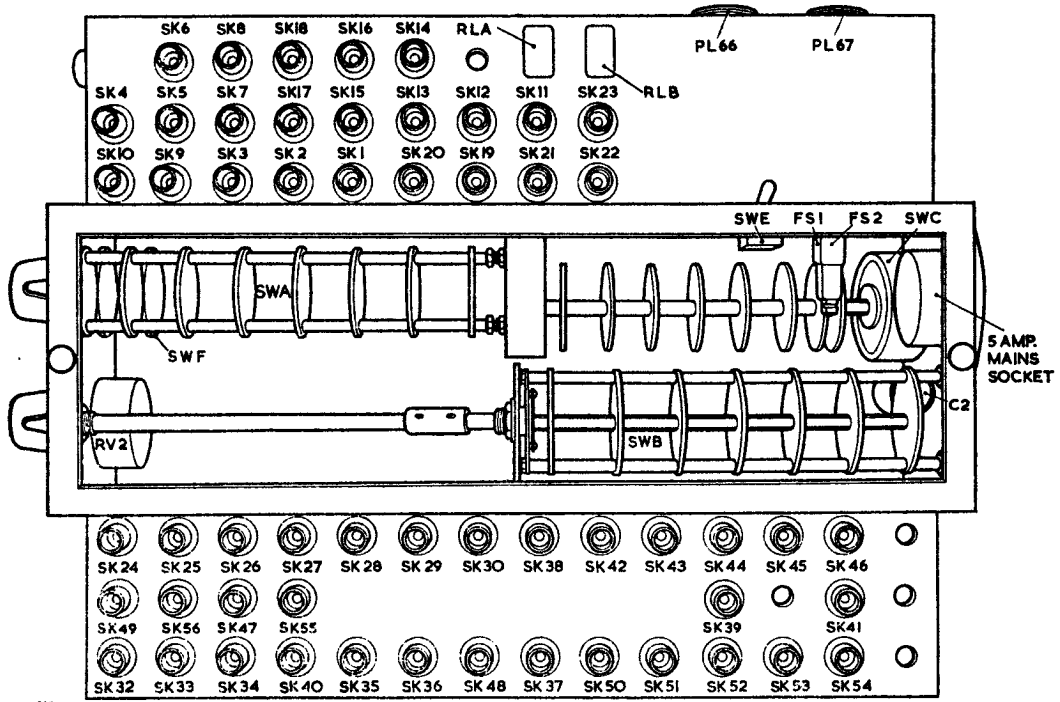


Fig. 2. Panel (distribution and switching) Type 868A—top view

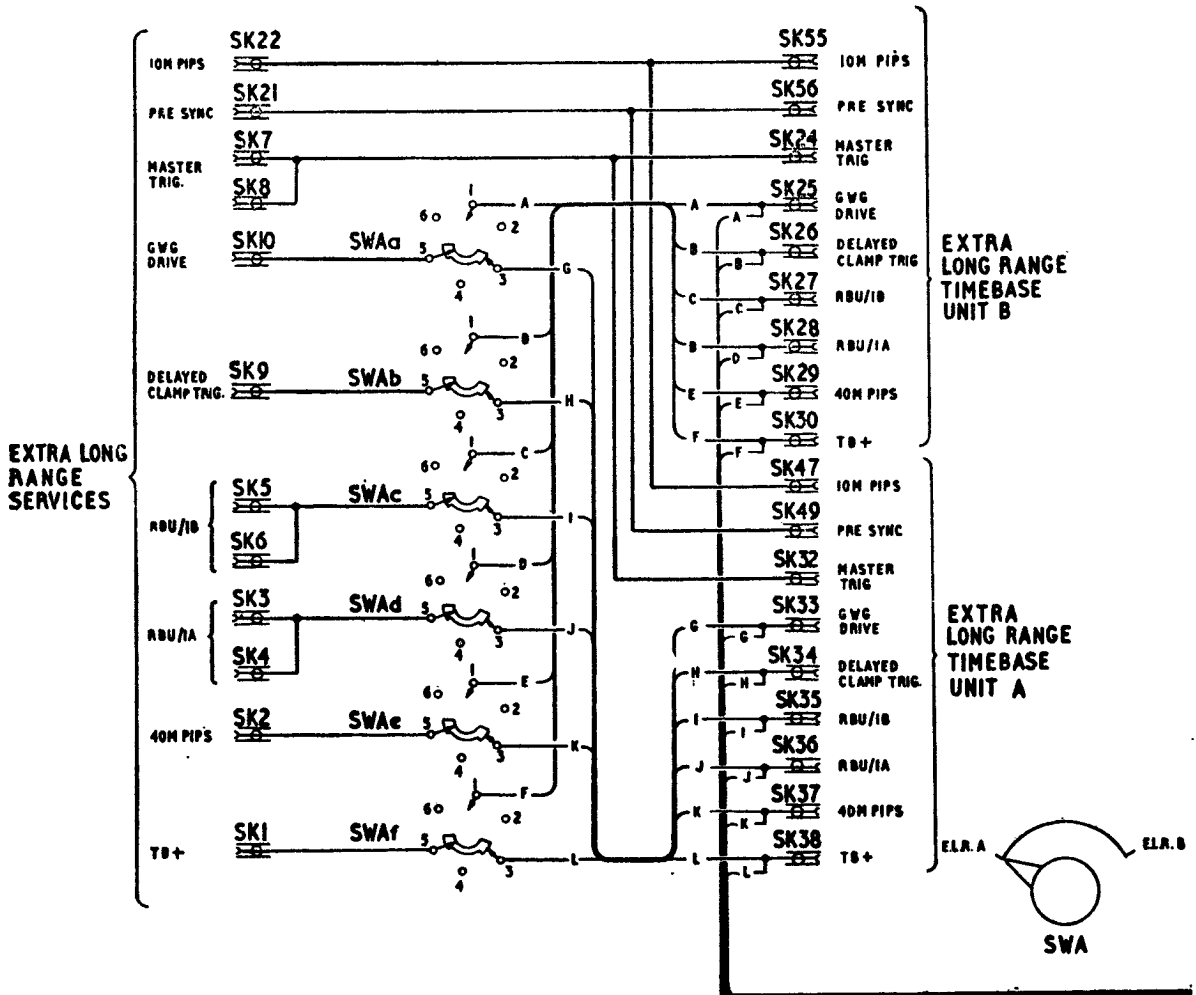


Fig. 3. Panel (distribution and switching) Type 868A—scrap circuit

### Timebase (long range) Type 12269

4. For information on the timebase (long range) Type 12269, reference should be made to A.P.2527V (2nd Edn.), Volume 1, Chapter 4, where a complete description is available. A scrap view of the power unit interconnections with the timebase 12269 is included in this appendix as fig. 4, to facilitate fitting the timebase unit.

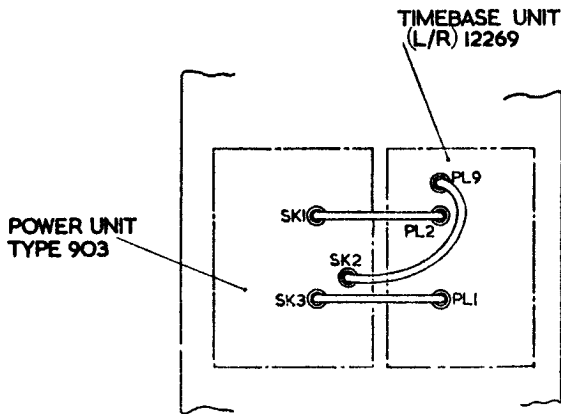


Fig. 4. Timebase (long range) Type 12269—scrap view

### PHASE 1A MODIFICATIONS

#### Panel (distribution and switching) Type 868B

5. At stations where Phase 1A working is in operation, the panel 868B is fitted in the rack 16340 in place of the panel 868A. The panel 868B provides identical facilities to those of panel 868A, except for routing the supply to the timebase indicator lights in the waveform monitor rack. The wiring for this purpose is, therefore, not fitted in panel 868B, and PL67 pins J and K are used in parallel with pins L and M for the mains input.

#### Timebase Type 140A

6. For Phase 1A working the timebase type 140 is modified to timebase Type 140A (Ref. No. 10D/22419). This modification introduces two new resistors, R133 and R134, into the radar bright-up generator circuit in the timebase unit. The resistors are both 100k. R133 connects from V14 cathode to the  $-300V$  line and R134 connects from V15 cathode to the  $+300V$  line. These resistors prevent the bright-up voltages on sockets 7 and 8 from increasing when the load on the sockets is removed. Thus during switching operations in the rack (head and p.r.f. selection) Type 12294 the bright-up voltages will not cause unnecessary flashes on the radar trace.

### AN/FPS-6 INTEGRATION

#### General description

7. The integration of AN/FPS-6 equipment with other site equipment may take place at stations incorporating normal working, long range working, or Phase 1A modifications. To bring about integration a pulse generator (range Type 12408 with its associated power supply is fitted in the

rack 16340. The pulse generator is fed with a negative sawtooth waveform from one of the timebases Type 140 in the rack 16340 via the panel Type 868A or 868B

### PULSE GENERATOR (RANGE) TYPE 12408

#### Introduction

8. The pulse generator (range) Type 12408 (Ref. No. 10S/17297) is fitted in the rack (timebase) Type 16340 (Ref. No. 10D/22373). To supply the pulse generator 12408 an extra power unit Type 903 (Ref. No. 10K/17131) is fitted in the rack 16340, adjacent to the pulse generator 12408, as shown in fig. 1.

#### General description

9. The pulse generator 12408 (fig. 5 and 6) contains three separate sections. Each section is capable of accepting a negative sawtooth waveform and the positive output voltage from a range potentiometer in a control desk. By comparing these two inputs, the pulse generator 12408 will produce a pulse to provide range information at the AN/FPS-6 equipment. The input sockets SKT2, SKT3 and SKT4, for the three individual units are interconnected. The range potentiometer voltage inputs are separately fed to PL1/A, PL1/B, and PL1/C. Three separate outputs are available on SKT5, SKT7, and SKT9.

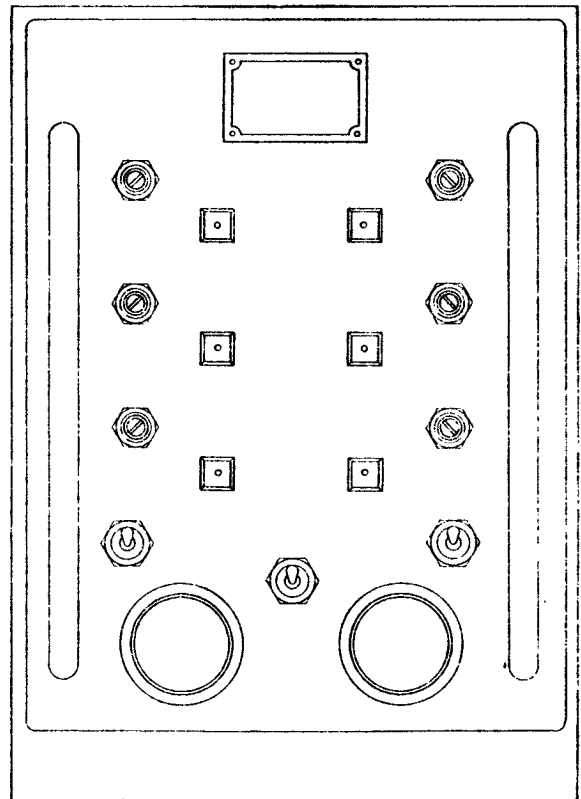


Fig. 5. Pulse generator (range) Type 12408—front view

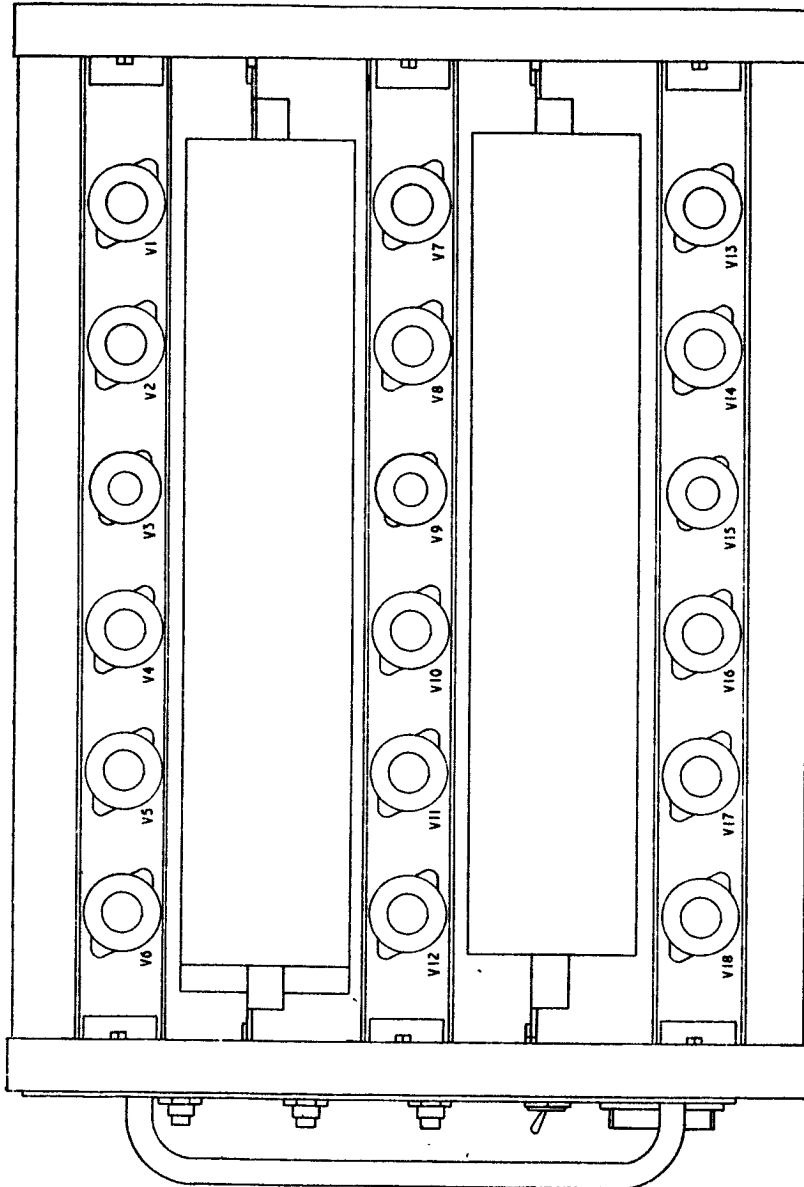


Fig. 6. Pulse generator (range) Type 12408.—side view

### Circuit description

10. As there are three identical circuits in the pulse generator 12408, a description of one is sufficient (fig. 8). The range voltage from the range potentiometer in the control desk is applied to PL1/A. A negative sawtooth from a timebase Type 140 is applied to SKT2. V1A, connected as a diode, clamps the negative sawtooth to be negative going from the positive range voltage (fig. 7a). The time constant of C2 and R2 does not allow perfect reproduction of the sawtooth at V2A grid. This will cause a varying error and to compensate, the range voltage is reduced by the amount of the voltage across R1. V2A conducts with no sawtooth applied, and will continue to conduct, when a sawtooth is applied, until the cathode potential falls allowing current in V2B to turn on and cause a switch over action cutting V2A off. The potential at V2A anode rises to nearly the h.t. + voltage, and will fall again when the sawtooth flyback passes back through earth potential (fig. 7b.) Adjustment of RV1 will vary the change over potential and provide a fine control of the V2A anode square wave initiation time. The leading edge of this square wave is used to determine the timing of the range pulse.

11. The square wave pulse from V2A anode is amplified by V1B. C3 and C4 are included to compensate for stray capacity in the grid circuits of V1B and V3. V3 shapes the pulse to a true square wave, by use of R20 and the grid bias voltage. From

the anode of V3 the square wave is differentiated and applied to the grid of V4A (fig. 7c). The bias of V4A is adjusted by RV2 to allow this valve to conduct during the required portion of the positive differential pip. This control, therefore, alters the amplitude and the width of the pip at the anode of V4B (fig. 7d.) V4A is a cathode follower, and is cathode coupled to V4B.

12. The positive pip output from V4B anode is fed to both halves of V5 connected in parallel. The positive pip output from V5 cathode is fed via C8 and R32 to V6 grid, to give sufficient drive to the output cathode follower, V6, to drive it into grid current. R32 is included to limit the grid current into V6. The output from V6 cathode is a positive pip fed via C9 to a terminated 70 cable. The normal output is a 6 volt positive going pip with a duration of less than 5 microseconds measured at 10% peak amplitude.

### Test switch

13. During normal operating conditions the range marker line on the range/height display is offset slightly to prevent obscuring the target. This is achieved by a resistance network, R11 to R14, which makes the grid of V2B slightly more positive and causes the change-over of V2 to occur earlier. Operation of the test switch to "TEST" will remove this extra grid voltage and allow RV5 to be adjusted to the exact range.

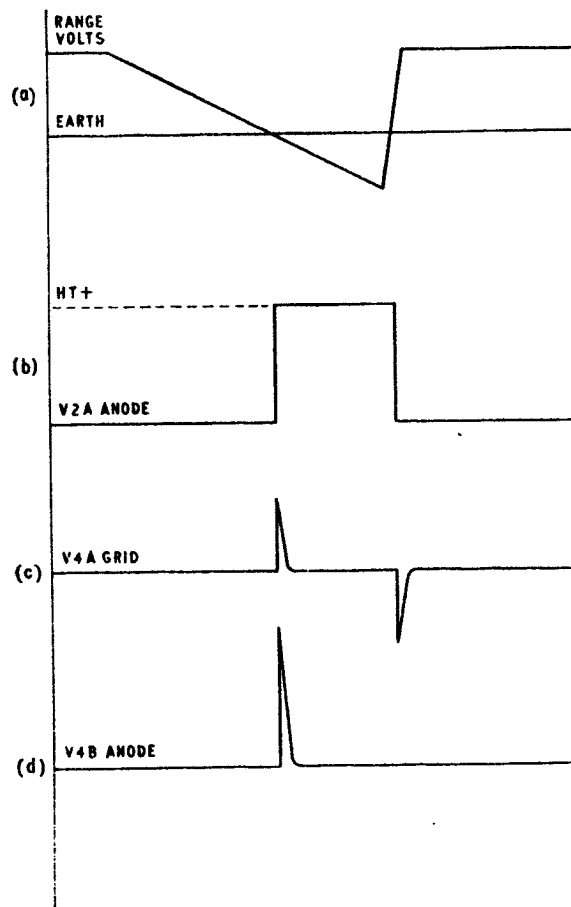
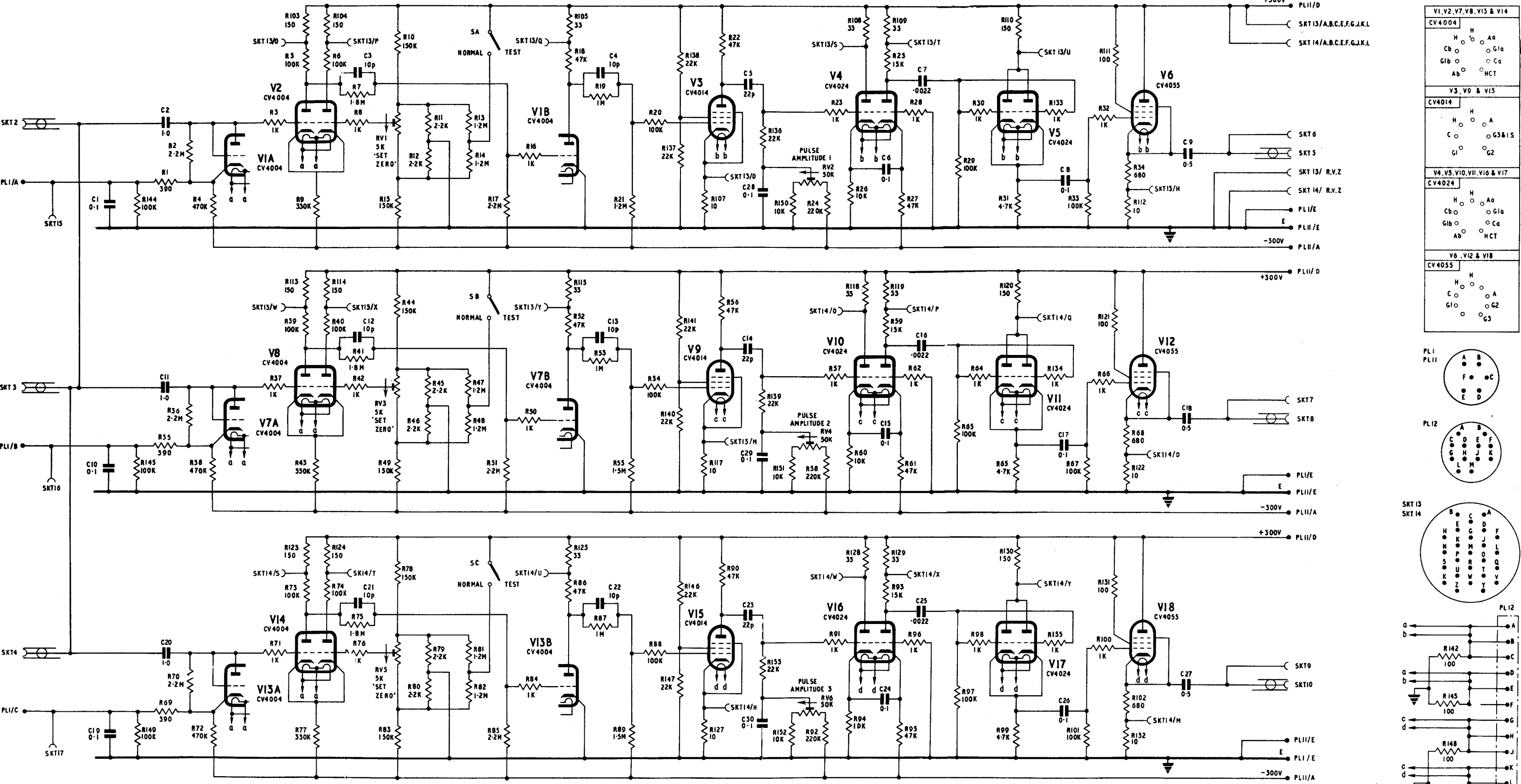


Fig. 7. Pulse generator (range) Type 12408—waveforms





VI, V2, V7, V8, V13 & V14	
CV4004	
V3, V9 & V15	
CV4014	
V4, V5, V10, V11, V16 & V17	
CV4024	
V6, V12 & V18	
CV4055	

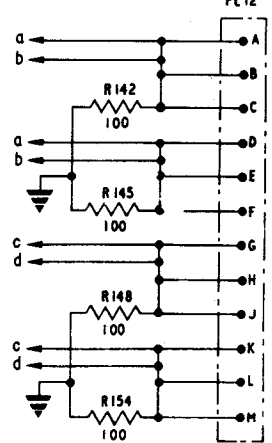
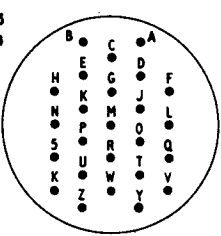
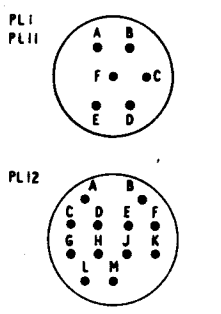


Fig.8

Pulse generator (range) Type I24O8 : circuit

Fig.8

## Appendix 2

### CABINET ELECTRICAL EQUIPMENT

5975-99-957-1622

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#### Introduction

1. The cabinet, electrical equipment is used at sites where a master pulse synchronizing radar is installed. The cabinet provides:—

- (1) A source of master timebase and associated waveforms.
- (2) Suitable (delayed) triggering pulses for all other equipment.

#### General description

2. The cabinet is similar to the rack assembly (timebase) 300 with similar cabling. The differences are two generators, pulse delay fitted in positions 10 and 12, and the cabling between these two generators and the panel (distribution and switching). Fig. 1 identifies interconnecting cable-forms between units and gives unit locations as in fig. 7 within the cabinet. The units are:—

- (1) One panel (distribution and switching) Type 868.
- (2) Two timebases Type 140 to provide 250 Hz 'A' and 'B' master timebase and associated waveforms.
- (3) Two generators, pulse delay 5840-99-957-1620 which provide delayed trigger pulses for other radars.
- (4) Four power units Type 903 (Ref. No. 10K/17131) to provide the power for the two timebase units and the two generators, pulse delay.

#### GENERATOR, PULSE DELAY

##### Introduction

3. The sync. pulse from the Master Pulse Synchronizing Radar must be delayed by  $3930\mu\text{s}$  to provide a  $70\mu\text{s}$  pulse to the station master trigger unit. The master trigger unit must then be delayed by  $3300\mu\text{s}$  to provide a  $680\mu\text{s}$  pulse for other radars. These delayed pulses are generated by the two generators, pulse delay: the  $70\mu\text{s}$  pulse at position 10 and the  $680\mu\text{s}$  pulse at position 12.

##### General description

4. The generator, pulse delay is a timebase unit 140 (Chap. 1) modified to provide a delayed pulse adjustable over the range 3.2 to 3.96 ms. The unit also provides a linear, positive-going sawtooth output and a negative-going square-wave output of the same duration.

5. The modified unit retains the trigger pulse amplifier and the square-wave generator. The sawtooth generator also is retained but with small modifications. The sawtooth paraphase repeater and the radar bright-up generator are removed and a pulse-shaping circuit is added to the clamp trigger generator to form a delay generator.

6. A new front panel is fitted to accommodate the plugs, sockets and controls which remain. The layout of the components in the modified unit is given in fig. 2 to 5.

### Circuit description

7. The circuit diagram of the generator, pulse delay is given in fig. 8 and the associated waveform diagram in fig. 6.

8. The input to the unit appears at SK3 and is applied to trigger pulse amplifier V1. The output from V1 drives square-wave generator V2 to V5. These two stages are identical with those in the timebase unit 140 and are fully described in Chap. 1, para. 24 to 31.

9. The square-wave generator triggers the sawtooth generator which, in turn, controls the square-wave generator and the delay generator. The sawtooth generator operates in a virtually identical manner to the sawtooth generator in the timebase unit 140 (Chap. 1, para. 32 to 39), the differences being:—

(1) The Miller resistor chain R52 to R56 is taken down to a fixed potential of approximately  $-200\text{V}$  and, therefore, the run-down is not adjustable.

(2) The grid potential of V6b is not adjustable; the d.c. levels of amplifier stages V6, V8 and V9 are fixed by the resistor network feeding V6b grid.

(3) The RANGE SET potentiometers RV4 and RV5 become FINE DELAY controls.

10. The first section of delay generator, V16 to V18 is identical with the clamp trigger generator in timebase unit 140 (Chap. 1, para. 45). This

section is triggered by the delayed positive-going edge from V5b cathode and produces a further delayed positive pulse which appears at V18 cathode. Potentiometers RV9 and RV10 provide coarse delay control.

11. The output of V18 is fed to a pulse-shaping and output circuit that includes an input stage V10, a monostable V11, a clipping diode V12, an anti-ringing diode V13 and an output stage V14.

12. The positive pulse at V18 cathode is fed via cathode-follower V10 to V11a grid. The positive excursion of the pulse at V11a grid is limited by V12 to a level dependent on the setting of RV1 (SET PULSE). Adjustment of RV1 varies the width of the output pulse (normally set to  $4.5\mu\text{s}$ ).

13. During quiescence, V11a is off and V11b conducting. The pulse at V11a grid causes V11b to conduct and V11a to cut off, producing a positive-going output pulse at V11b anode. The output pulse terminates when the monostable changes back at the end of the pulse at V11a grid.

14. L2 and C20 improve the r.f. response of the circuit, thereby reducing the rise time of the output pulse.

15. The positive-going pulse at V11b anode is connected to SK6 via cathode-follower V14, which provides impedance matching. The resultant output is a  $16\text{V}$  positive-going  $4.5\mu\text{s}$  pulse delayed by 3.2 to 3.9 ms from the trigger input applied at SK3.

TABLE 1

Pulse delay generator 5840-99-957-1620: component details

#### Resistors (fixed)

Circuit ref.	Value (ohms)	Rating (watts)	Tol. ( $\pm\%$ )	Cat. No.
R1	47k	0.25	10	5905-99-022-2215
R2	330	0.25	10	5905-99-022-1173
R3 deleted				
R4	220k	0.25	10	5905-99-022-3080
R5	33	0.5	5	5905-99-021-5062
R6	6.8k	0.5	5	5905-99-021-5342
R7	10k	0.75	5	5905-99-021-6003
R8	220k	0.75	5	5905-99-021-6723
R9	330	0.25	10	5905-99-022-1173
R10	47k	0.5	5	5905-99-021-6082
R11	47k	0.25	10	5905-99-022-2215
R12	1M	0.25	10	5905-99-022-3164
R13	1k	0.25	10	5905-99-022-2005
R14 and 15 deleted				
R16	1M	0.25	10	5905-99-022-3164
R17	2.2M	0.25	10	5905-99-022-3206
R18	330	0.25	10	5905-99-022-1173
R19	33	0.5	5	5905-99-021-5062
R20	47k	6	5	5905-99-011-3437
R21	3.3k	0.25	10	5905-99-022-2068
R22	47k	6	5	5905-99-011-3437
R23 & R24	330	0.25	10	5905-99-022-1173
R25	33	0.5	5	5905-99-021-5062

TABLE 1 (Cont.)

Circuit ref.	Value (ohms)	Rating (watts)	Tol. (±%)	Cat. No.
R26	47k	6	5	5905-99-011-3437
R27	330	0.25	10	5905-99-022-1173
R28	10k	0.25	10	5905-99-022-2131
R29 & R30 deleted				
R31	680k	0.5	2	5905-99-021-6626
R32	330	0.25	10	5905-99-022-1173
R33	470k	0.25	10	5905-99-022-3122
R34	1.5M	1.5	2	5905-99-021-6668
R35 & R36	33k	0.5	10	5905-99-022-2195
R37	33	0.5	5	5905-99-021-5062
R38	100k	0.5	5	5905-99-021-6122
R39	33k	0.5	5	5905-99-021-6062
R40	330	0.25	10	5905-99-022-1173
R41	33	0.5	5	5905-99-021-5062
R42	4.7k	0.25	10	5905-99-022-2089
R43	33k	0.5	10	5905-99-022-2195
R44 & R45 deleted				
R46	2.7k	0.5	5	5905-99-021-9144
R47	220k	0.5	5	5905-99-021-9282
R48	330k	0.5	5	5905-99-021-6730
R49	2.7k	0.5	5	5905-99-021-9144
R50	470k	0.25	10	5905-99-022-3122
R51	220k	0.75	5	5905-99-021-6723
R52 to R56	500k	0.5	1	10W/19578
R57	220k	0.75	5	5905-99-021-6723
R58, R59, R60 deleted				
R61	330	0.25	10	5905-99-022-1173
R62	4.7k	0.5	5	5905-99-021-5322
R63	150	0.5	5	5905-99-021-5142
R64	220k	0.75	2	5905-99-021-6531
R65	150	0.5	5	5905-99-021-5142
R66	100k	0.5	2	5905-99-021-6451
R67	68k	1	2	5905-99-021-6413
R68	300k	1.5	2	5905-99-021-6557
R69	470k	1.5	2	5905-99-021-6597
R70	22k	0.25	10	5905-99-022-2173
R71	180k	0.25	10	5905-99-022-3071
R72	2.2k	0.25	10	5905-99-022-2047
R73	1k	0.25	10	5905-99-022-2005
R74 & R75 deleted				
R76	330	0.25	10	5905-99-022-1173
R77	33	0.5	5	5905-99-021-5062
R78	33k	6	5	5905-99-011-3433
R79	470k	0.5	5	5905-99-021-6738
R80	1M	0.75	5	5905-99-021-6757
R81	10	0.5	5	5905-99-021-5002
R82 & R83	100	0.25	10	5005-99-022-1110
R84	1.6k	0.75	1	5905-99-021-5687
R85	820	0.5	1	5905-99-021-5616
R86	22k	6	5	5905-99-011-3429
R87	470	0.5	10	5905-99-022-1195
R88	470k	0.5	10	5905-99-022-3123
R89	1k	0.5	10	5905-99-022-2006
R90	10k	0.5	10	5905-99-022-2132
R91 & R92	100	0.5	10	5905-99-022-1111
R93	33k	0.5	10	5905-99-022-2195
R94	100k	0.5	2	5905-99-012-2571
R95	6.8k	4.5	5	5905-99-011-3507
R96 & R97	100k	0.5	2	5905-99-012-2571
R98	1.2k	1	10	5905-99-011-1444

**TABLE 1 (Cont.)**

Circuit ref.	Value (ohms)	Rating (watts)	Tol. (±%)	Cat. No.
R99	100k	0.5	2	5905-99-012-2571
R100	100	0.5	10	5905-99-022-1111
R101	33	0.5	10	5905-99-022-1048
R102	470	0.5	10	5905-99-022-1195
R103	4.7k	0.5	10	5905-99-022-2090
R104	220k	0.5	10	5905-99-022-3081
R105	22k	0.5	10	5905-99-022-2174
R106	220k	1	10	5905-99-011-1499
R107	22k	6	5	5905-99-011-3429
R108	2.2M	0.5	10	5905-99-022-3207
R109	100k	1	10	5905-99-011-1495
R110	470	0.5	10	5905-99-022-1195
R111 to R142 deleted				
R143	330	0.25	10	5905-99-022-1173
R144	33	0.5	5	5905-99-021-5062
R145	22k	1	2	5905-99-021-6294
R146 & R147	33k	1.5	5	5905-99-021-6065
R148, R149 & R150 deleted				
R151	330	0.25	10	5905-99-022-1173
R152	620k	0.75	2	5905-99-021-6619
R153	430k	0.5	2	5905-99-021-6586
R154	100k	0.25	10	5905-99-022-3038
R155	15k	0.5	2	5905-99-021-6252
R156	18k	1	5	5905-99-021-6034
R157	12k	0.75	5	5905-99-021-6013
R158	100k	1.5	2	5905-99-021-6454
R159	22k	0.5	2	5905-99-021-6292
R160	470k	0.75	2	5905-99-021-6595
R161	100	0.25	10	5905-99-022-1110
R162	330	0.25	10	5905-99-022-1173
R163 to R166 deleted				
R167	33k	0.25	10	5905-99-022-2194
R168 to R170 deleted				
R171 to R174	100	0.25	10	5905-99-022-1110
R175	270k	0.25	10	5905-99-022-3092
R176	47k	0.25	10	5905-99-022-2215
R177	22k	0.25	10	5905-99-022-2173
R178	330k	0.25	10	5905-99-022-3101

**Resistors (variable)**

Circuit ref.	Value (ohms)	Rating (watts)	Tol. (±%)	Cat. No.	Function
RV1	50k	1	10	5905-99-027-2410	SET PULSE
RV2 & RV3 deleted					
RV4	1k	1	10	5905-99-027-1605	FINE DELAY 120
RV5	1k	1	10	5905-99-027-1605	FINE DELAY 240
RV6 to RV8 deleted					
RV9	50k	1	10	5905-99-027-2410	COARSE DELAY 240
RV10	50k	1	10	5905-99-027-2410	COARSE DELAY 120

**Capacitors (fixed)**

Circuit ref.	Value ( $\mu$ F except where stated)	Rating (V d.c.)	Tol. ( $\pm\%$ )	Cat. No.
C1	0.01	350	25	5910-99-011-5625
C2 & C3	0.1	350	20	5910-99-011-5506
C4	0.01	350	20	5910-99-011-5552
C5	0.01	350	25	5910-99-011-5625
C6	15pF	750	5	5910-99-011-8301
C7	100pF	750	2	5910-99-011-8321
C8	15pF	750	5	5910-99-011-8301
C9	33pF	750	5	5910-99-011-8309
C10	0.1	350	20	5910-99-011-5506
C11	100pF	750	2	5910-99-011-8321
C12 deleted				
C13	100pF	750	2	5910-99-011-8321
C14	0.005	250	1	10C/20462
C15	33pF	750	5	5910-99-011-8309
C16	2200pF	750	10	5910-99-012-4720
C17	0.1	350	20	5910-99-011-5506
C18 & C19	0.1	350	20	5910-99-011-7818
C20	470pF	750	20	5910-99-012-3413
C21	0.001	350	20	5910-99-012-4479
C22	0.5	350	20	5910-99-011-5511
C23 & C24 deleted				
C25	0.1	200	25	5910-99-011-9827
C26 & C27 deleted				
C28	100pF	750	2	5910-99-011-8321
C29	560pF	350	10	5910-99-012-3952
C30	0.01	350	20	5910-99-011-5552
C31	470pF	750	10	5910-99-012-3949
C32	0.1	350	20	5910-99-011-5506
C33 deleted				
C34 & C35	0.1	350	20	5910-99-011-5506

**TABLE 1 (contd.)****Miscellaneous Items**

Circuit ref.	Description	Type	Cat. No.
L1	Inductor R.F.	2174	5950-99-970-2688
L2	Inductor H.F.	833	10C/18010
PL1	6-way fixed plug	Mk. 4	5935-99-056-0152
PL2	12-way fixed plug	Mk. 4	5935-99-056-0541
SWA	D.P.D.T. Toggle switch (DELAY 120/240)	-	5930-99-051-0304
SK1 & SK2 deleted			
SK3 to SK6	Socket (coaxial)	783	5935-99-972-8281
SK7 & SK8	Socket (Belling Lee T.L.316)	714	5935-99-972-8281
SK9 & SK10 deleted			
SK11 to SK13	Socket (Belling Lee T.L.316)	714	5935-99-911-3896
SK14 & SK15	25-way fixed socket	Mk. 4	5935-99-056-0380

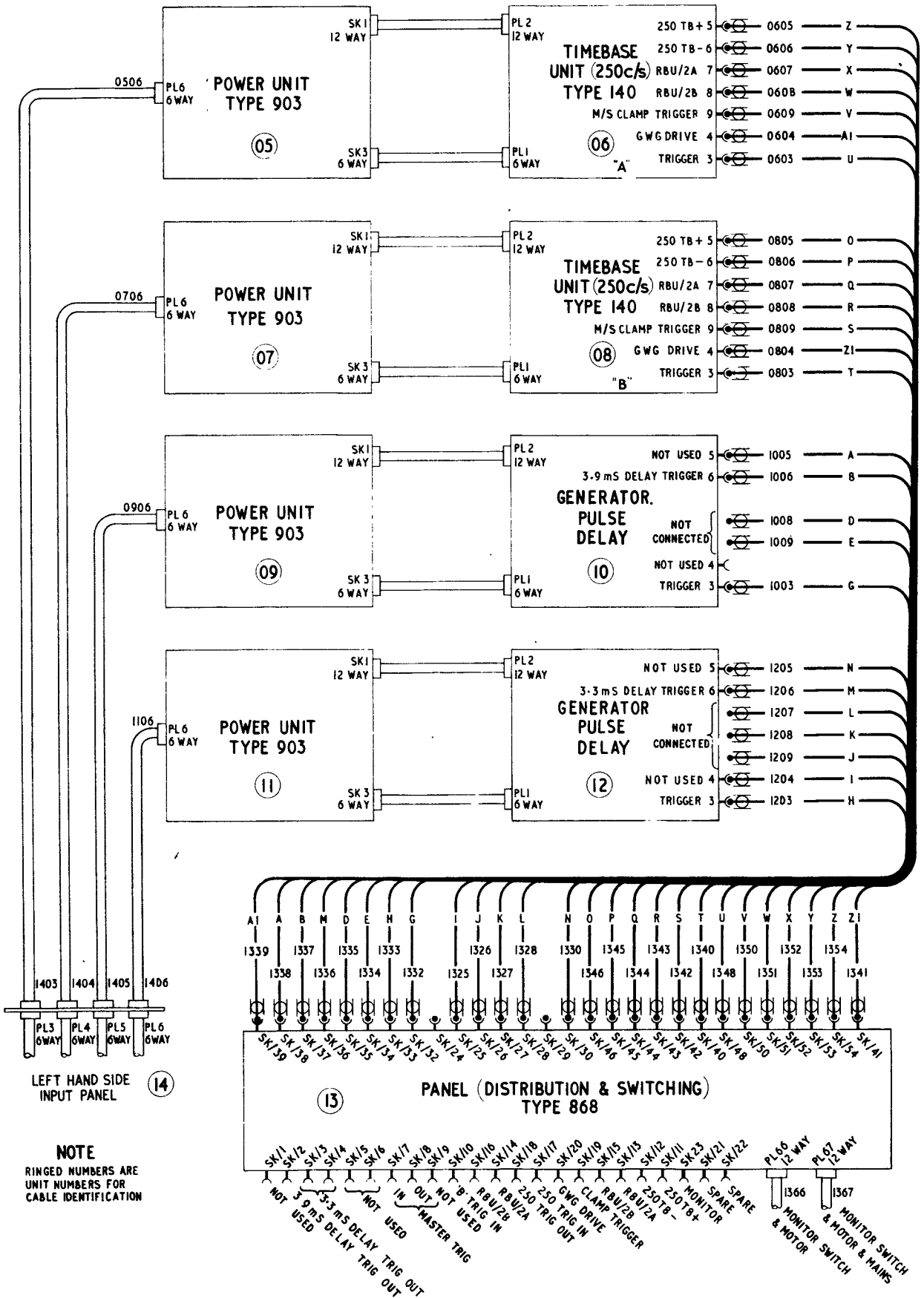
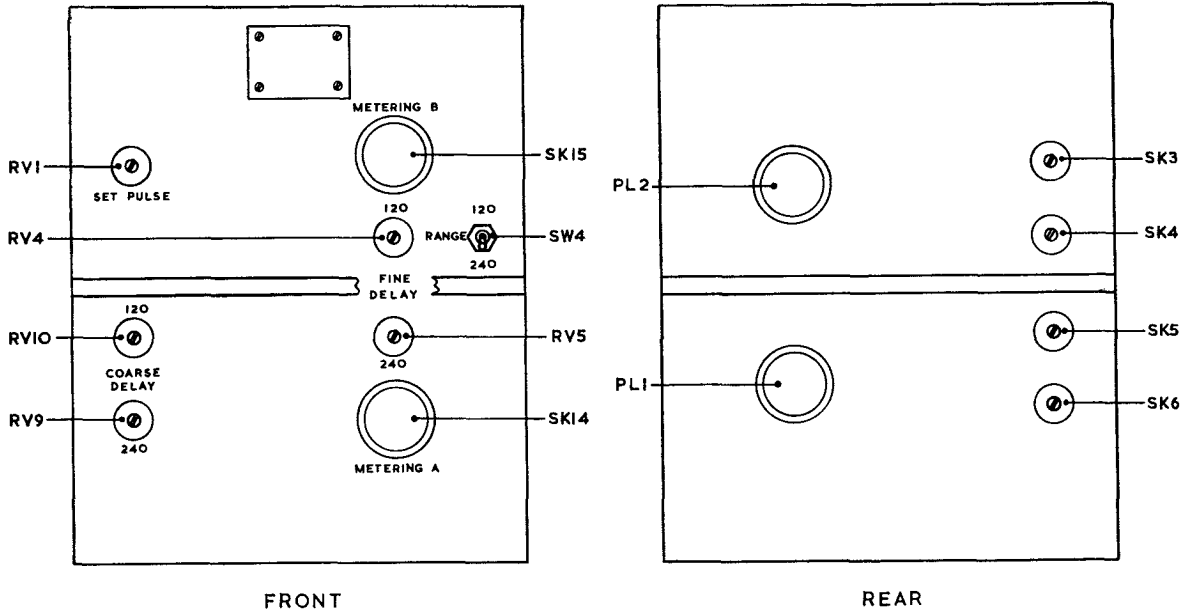
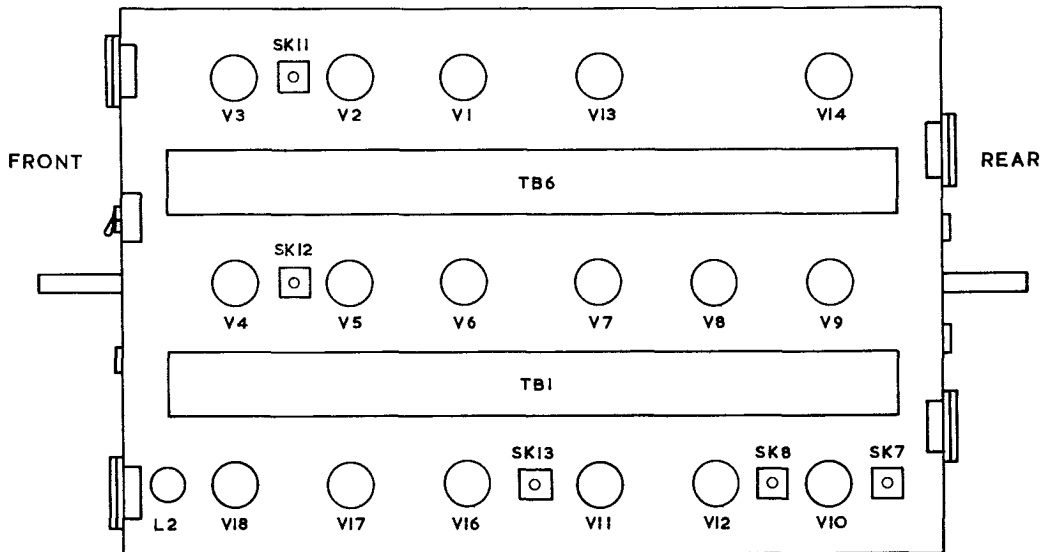


Fig. 1 Cabinet, electrical equipment 5975-99-957-1622: interconnections

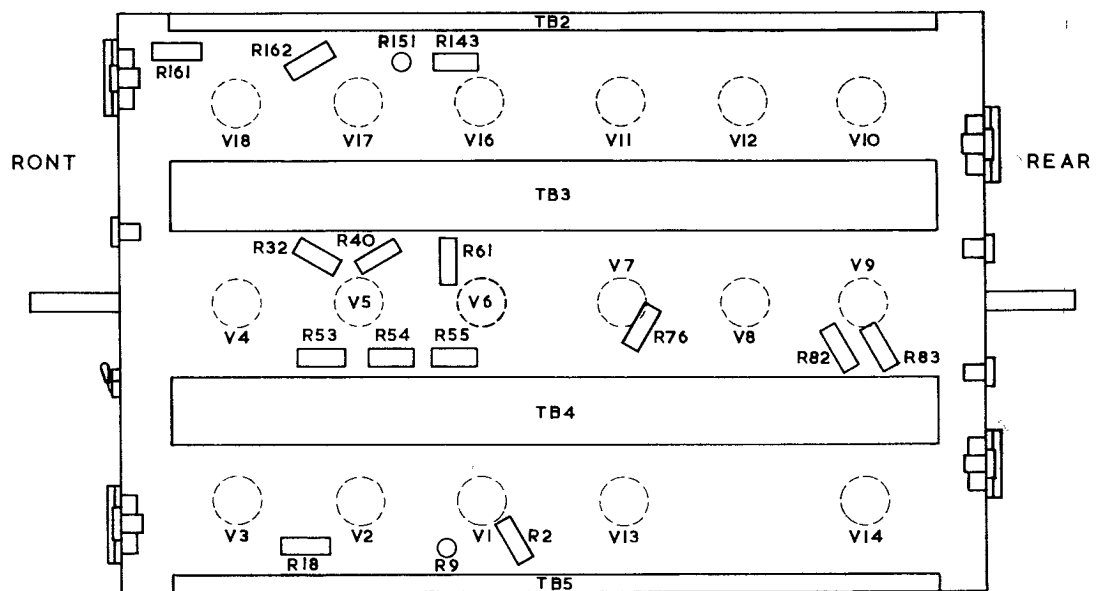


**Fig. 2. Pulse delay generator: front and rear panels**

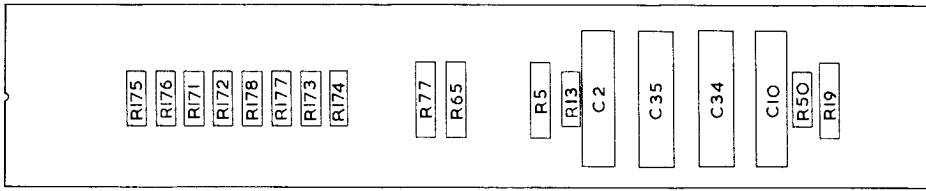


**Fig. 3. Pulse delay generator: over-chassis component location**

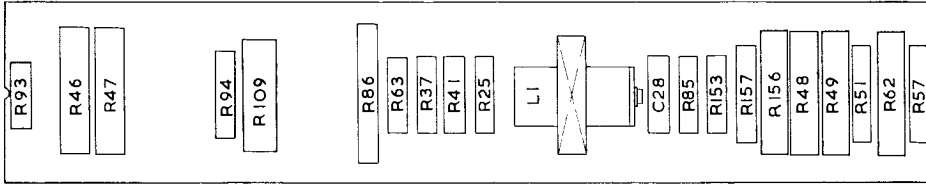




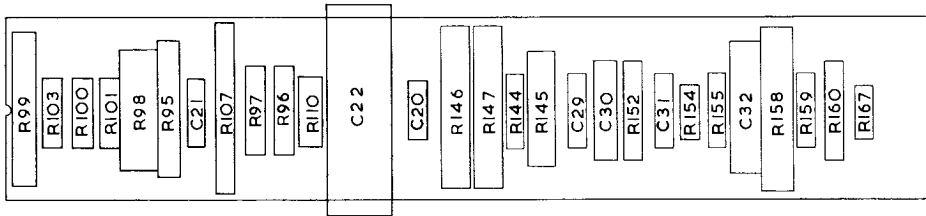
**Fig. 4. Pulse delay generator: under-chassis component location**



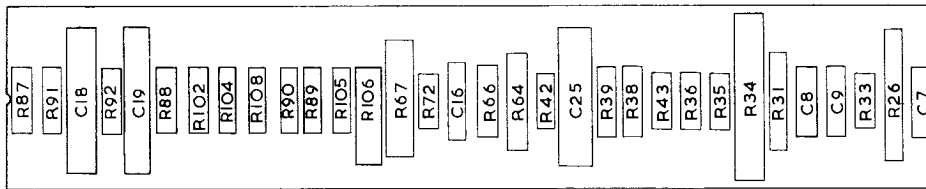
GROUP BOARD TB6



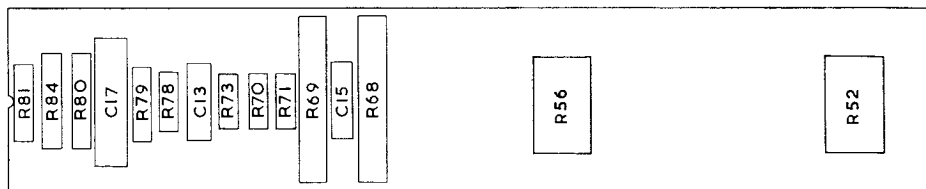
GROUP BOARD TBI



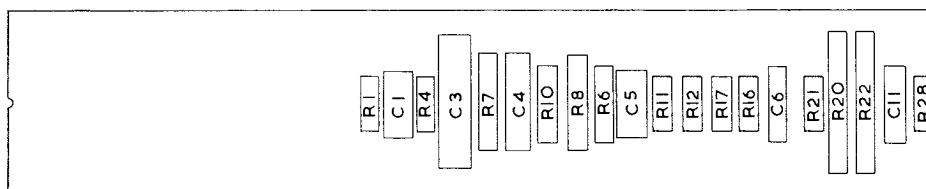
GROUP BOARD TB2



GROUP BOARD TB3



GROUP BOARD TB4



GROUP BOARD TB5

Fig. 5. Pulse delay generator: tagboard layout

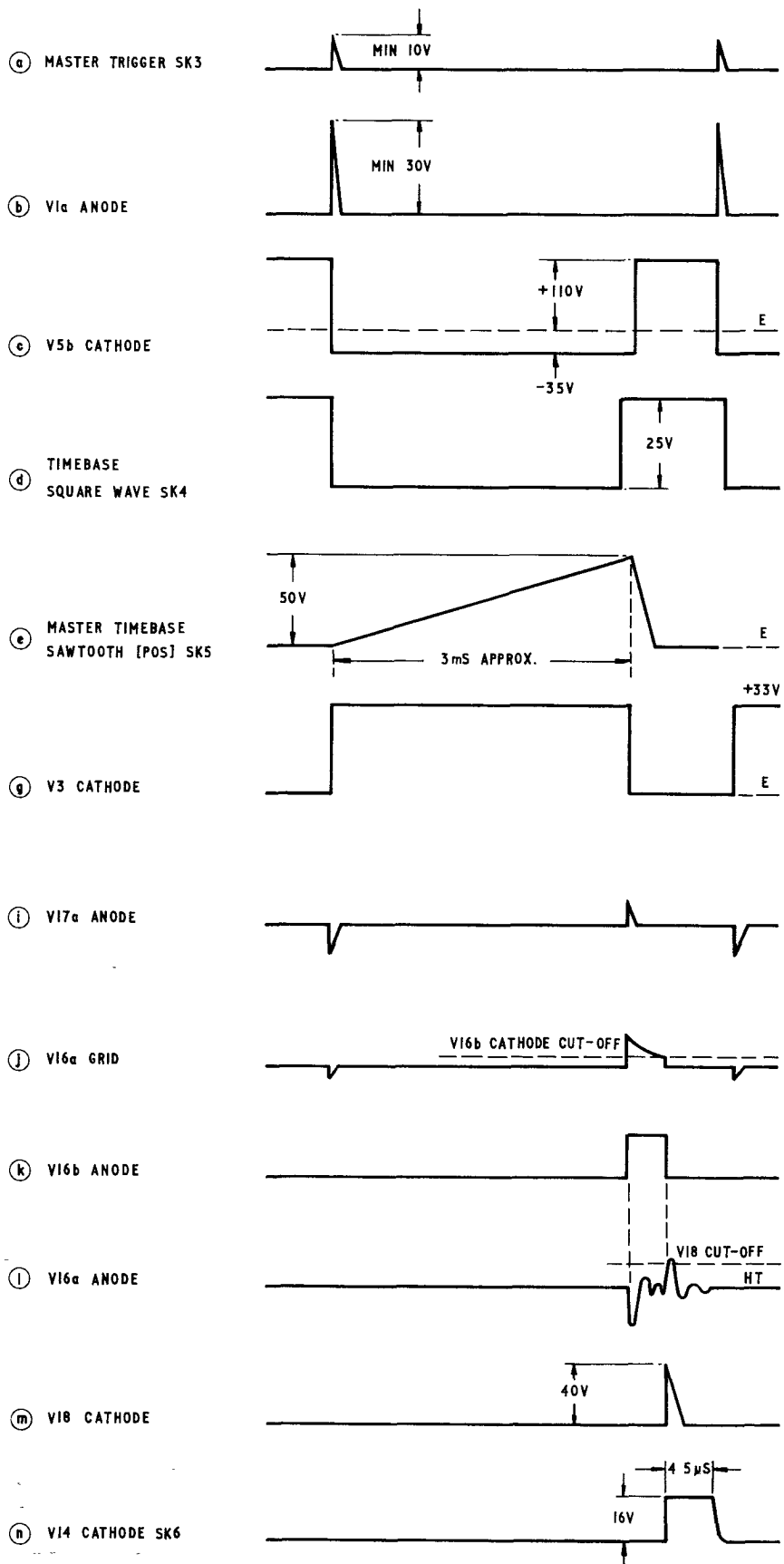
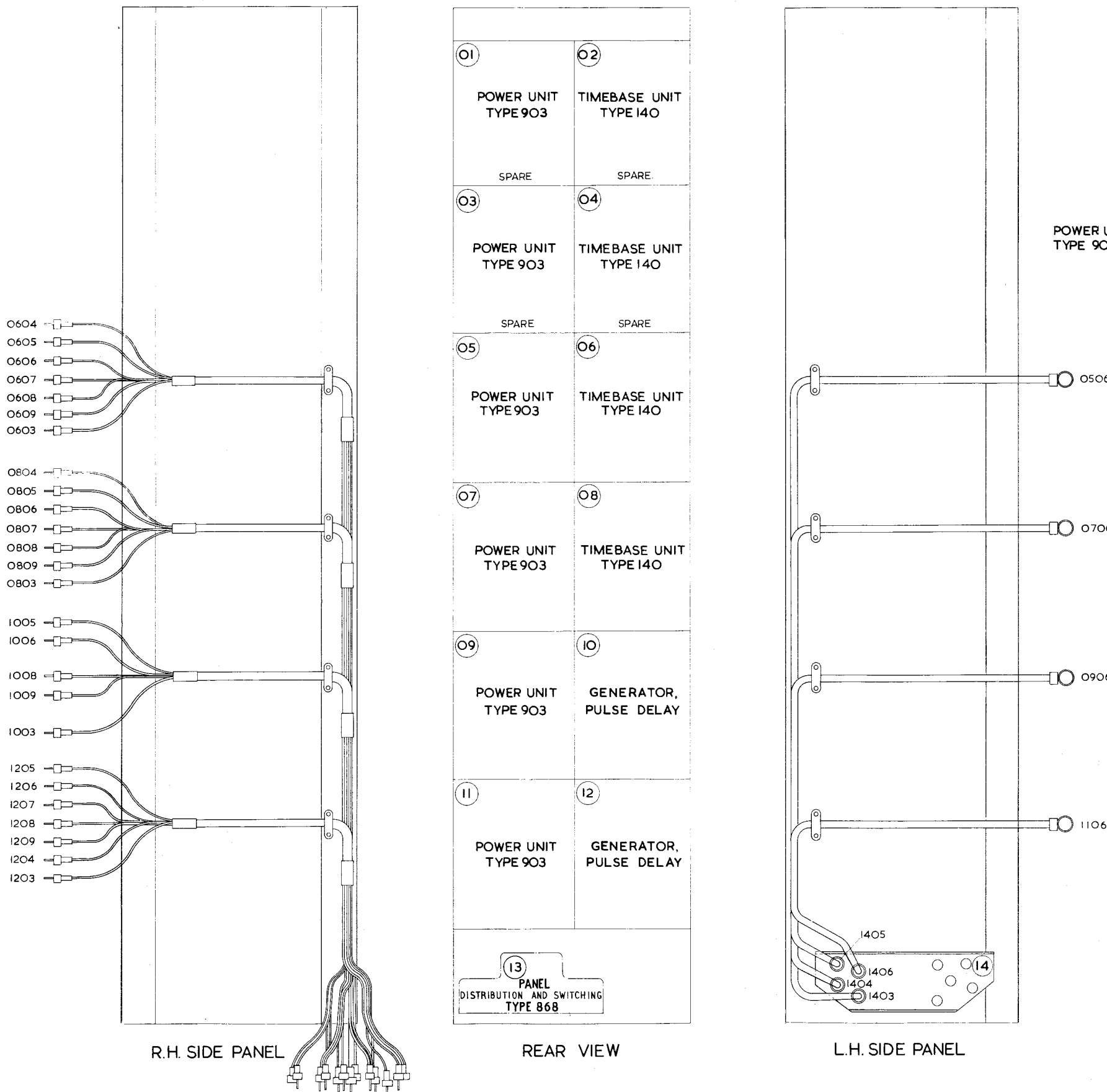


Fig. 6. Pulse delay generator: waveforms



CABLE Nos 1325-1328, 1330, 1332-1346, 1348, 1350-1354.

Fig.7

Cabinet, electrical equipment 5975-99-957-1622: cabling

Fig.7

956/4 712424 428792 430 11/69

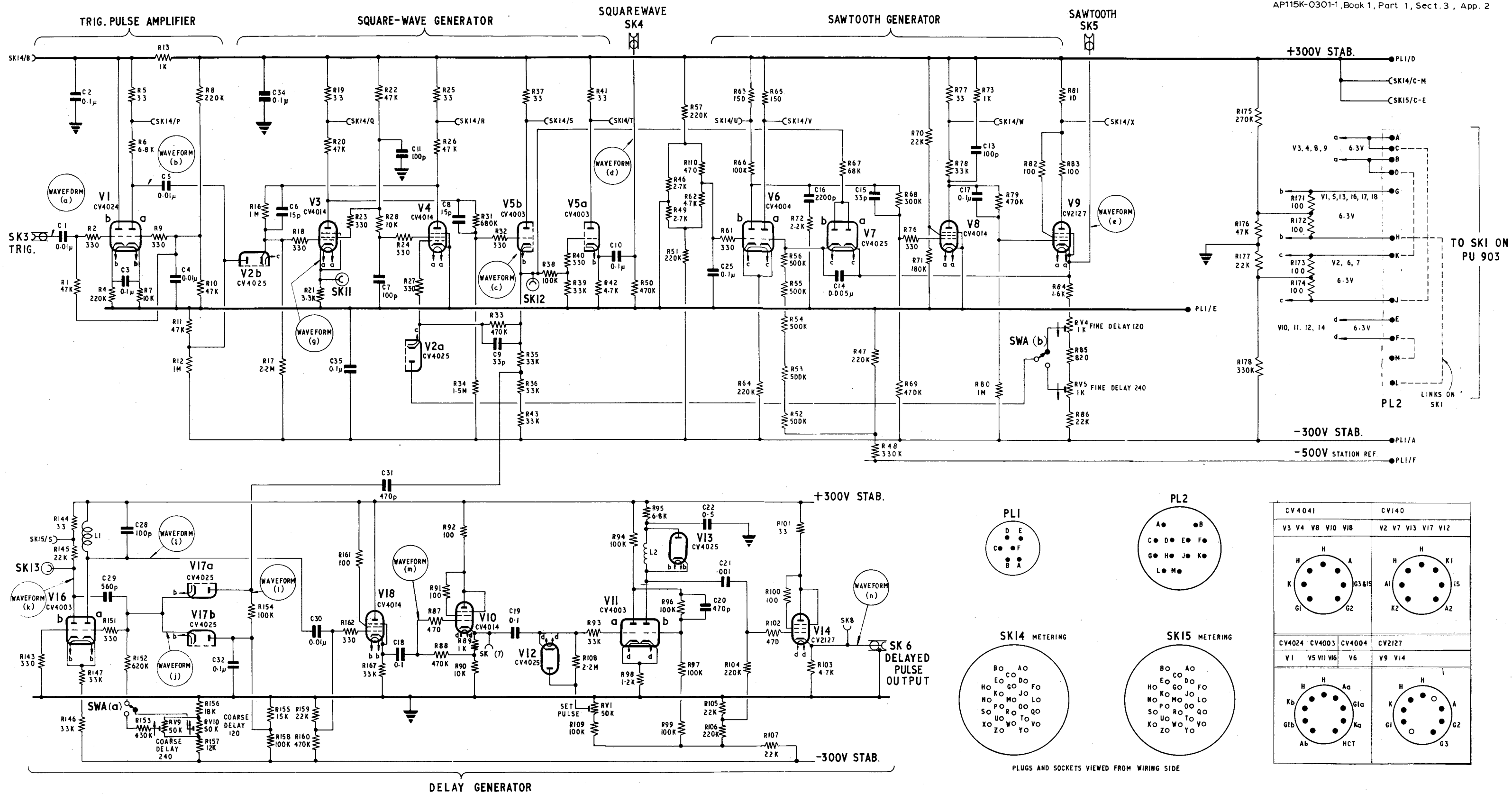


Fig. 8.

Generator pulse delay 5840-99-957-1620: circuit

Fig. 8.

◀Appendix 3▶

PANEL DISTRIBUTION (TEST)

(5840-99-954-8364)

1. The Panel Distribution (Test) 5840-99-954-8364 is a modified version of the Panel (Distribution and Switching) Type 868A described in Appendix 1. The modification includes the addition of a relay RLC1 (5945-99-011-9882) and changes to the wiring, between PL67, the coaxial sockets SK15,

SK29 and SK37, and the switches SWB, SWC and SWD. The circuit changes are shown in fig. 1.

2. The Panel Distribution (Test) forms part of the Type 85 integration equipment.

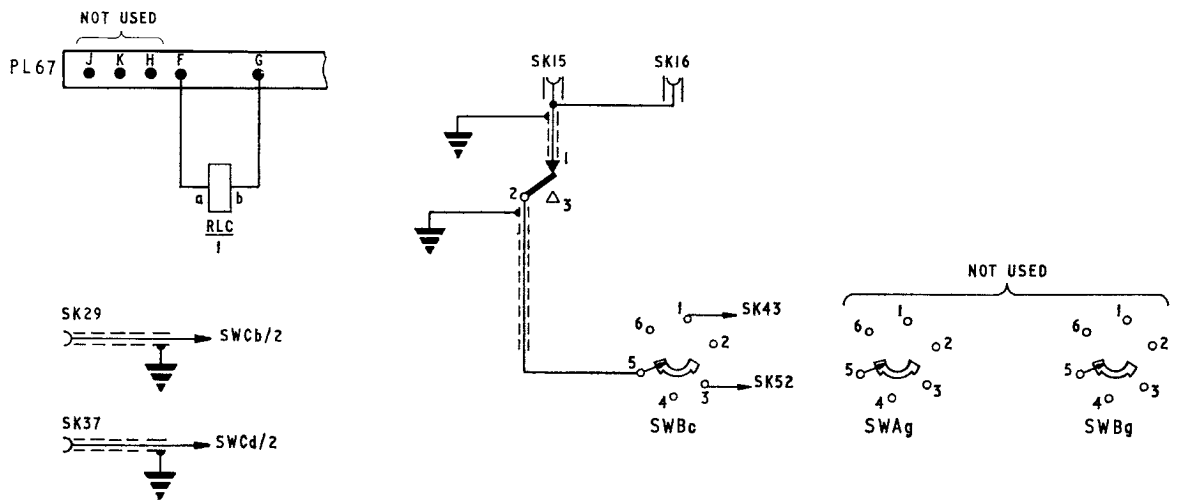


Fig. 1. Panel distribution (test)—scrap circuit

◀Appendix 4▶

PANEL DISTRIBUTION

(5840-99-954-8500)

1. The Panel Distribution 5840-99-954-8500 is a modified version of Panel (Distribution and Switching) Type 868B described in Appendix 1. The modification includes the addition of a relay RLC1 (5945-99-011-9882) and changes to the wiring between PL67, the coaxial sockets SK15,

SK29 and SK37, and the switches SWB, SWC and SWD. The circuit changes are shown in fig. 1.

2. The Panel Distribution forms part of the Type 85 integration equipment.

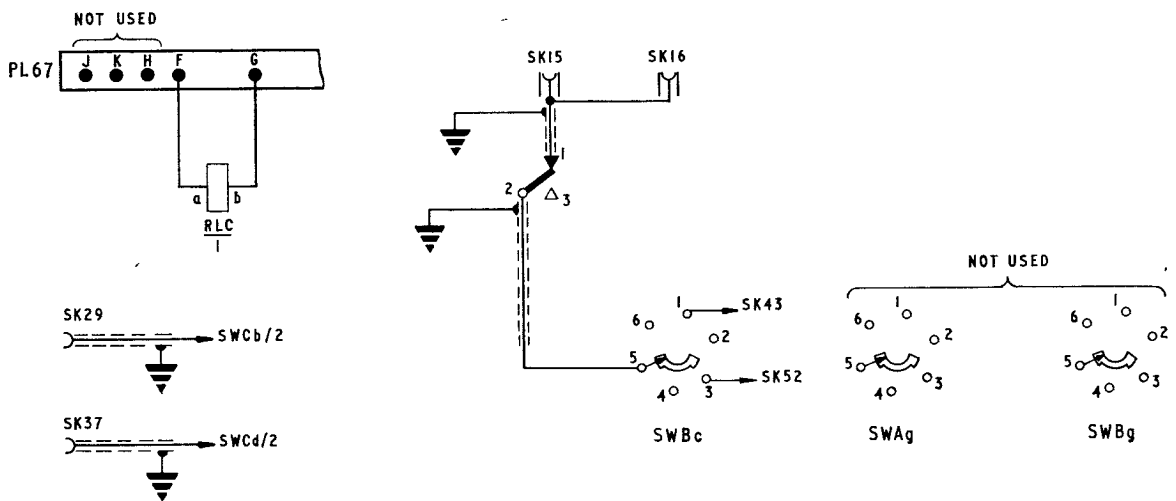


Fig. 1. Panel distribution 5840-99-954-8500—scrap circuit

## ◀Appendix 5▶

**GENERATOR, SWEEP**

(5840-99-954-8339)

1. The Generator (Sweep) 5840-99-954-8339 is a modified version of Timebase Unit 140 described in Chap. 1. The modification includes the replacement of R46 and R49 with resistors of a different value (Table 1) and the replacement of the 120 and 240 RANGE marks on the escutcheon panel with SHORT and NORMAL labels, respectively. This generator forms part of the Type 85 integration equipment.

TABLE 1  
Component changes

Circuit ref.	Value	Rating	Tol.	Ref. No.
R46	33K	1.5W	1%	5905-99-021-6330
R49	160K	1.5W	1%	5905-99-021-6498



## Chapter 2

### RACK ASSEMBLY (RESOLVER MAGSLIP) TYPE 301

#### Addendum

To be read immediately after the list of illustrations.

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## Chapter 2

# RACK ASSEMBLY (RESOLVER MAGSLIP) TYPE 301

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## GENERAL

### Purpose of rack

1. The rack assembly (resolver magslip) Type 301 (A.M. Ref. No. 10D/18667) is a rack centrally located in the radar office, as close as possible to the master timebase rack (RA300), for resolving the master timebase waveforms into X and Y (sine and cosine) components, in accordance with rotational information received from radar search heads on the station. The timebase components, after clamping, are distributed via the head selector racks to all fixed-coil PPI consoles, selecting them no matter where they are installed in the operations building. Any number of PPI consoles can take the same pair of timebase components, so that one selsyn receiver does the work of the considerable number that would be needed (one in each console) with rotating-coil displays. The absence of rotating machinery from the console also results in considerable reduction of size and complexity. The principles of resolution by magslip are given in Chap. 1, Sect. 1 of this Part.

### Contents of rack

2. The rack normally contains three entirely separate *resolver units (magslip)*, referred to as resolvers Nos. 1, 2 and 3 (fig. 1). With each resolver unit (magslip) are associated an *amplifying unit (clamping and distribution) Type 504* and a *power unit Type 904*. At the base of the rack, serving as a junction box for coaxial services entering and leaving, is the *panel (distribution) Type 877*. This panel also contains a remotely operated switch permitting any one of the six timebase component waveforms to be selected and displayed on the oscilloscope in the waveform monitor rack Type 339; it also carries a 230V MAINS power point. Forming part of the rack itself is the *R.H. side input panel*, which has couplers for multicore services entering the rack.

### Allocation of resolvers

3. Ideally, one magslip resolver unit is associated with each search head, from which there is an exclusive selsyn link to the resolver unit. However, unserviceability or extra operational requirements sometimes demand that one resolver unit shall serve two or even three rotation-synchronized search heads. This is quite possible provided the heads all have the same pulse repetition frequency (either 250 c/s or 500 c/s); the selsyn information usually comes from the master head of the group, and as long as the slave heads are closely following the master a reasonably accurate display of information from the slaves may be obtained without separate resolvers. Exclusive resolver units must, however, be reserved for the back-looking and the stop-and-look head.

4. It may happen that the selsyn information from (say) a 250 c/s head fails, but the head remains otherwise serviceable and it is desired to obtain some sort of display from it, even though there is no other 250 c/s resolver available to give appropriate timebase waveforms. When this happens, the selsyn on the stopped 250 c/s resolver may be connected in parallel with the selsyn on a rotation-synchronized 500 c/s resolver,

and service resumed; for this purpose a special cable is being supplied separately with each resolver rack and an emergency selsyn socket is available on every resolver unit in parallel with the normal selsyn input plug (SK11 and PL5, fig. 25).

5. On most stations there are two rack assemblies Type 301 installed, offering a total of six resolver units. Of these, one is for the back-looker, one for the stop-and-look head, one (or more) for ordinary 250 c/s heads and one (or more) for 500 c/s heads. Any spare resolver and associated units are kept with valve heaters alight, ready for use at short notice if any of the operating units should become unserviceable.

6. The interconnections described in this chapter are those for 500 c/s operation of all three resolvers in the rack; any resolver with its amplifying unit may, however, be changed quickly over to 250 c/s operation simply by shifting certain plugs on the panel (distribution) Type 877, so that 250 c/s waveforms are fed into the resolver instead of 500 c/s (*para.* 117). Once a resolver and its amplifying unit have been set up correctly, they will work equally well on either repetition frequency without further adjustment or switching.

### Construction of rack

7. The rack is of standard A.M. pattern, 7 ft. in height and accommodating 19 in. wide units or mounting trays. It has full-length steel doors at front and rear, with automobile-type handles. On fig. 1 the front door has been removed completely from the rack assembly Type 301, but the doors for adjacent racks are visible on either side. All cables for external connections to the rack assembly come up from the cable trunking system under the false floor of the radar office (via adaptor boxes), and enter the rack through holes in its base plate. As in the RA300 (*Chap. 1 of this Section*), air for cooling is blown in at the base from the ventilation system common to all the radar office racks, and extracted at the top after circulating around the rack units.

8. As seen from fig. 1, each magslip resolver unit is mounted alongside its amplifying unit (clamping and distribution) Type 504 on a square, open mounting tray, which is, in its turn, attached to three-draw telescopic runners. Each unit is secured to the tray by four pegs; two at the rear engage in holes in the mounting tray and two at the front in L-shaped slots in a spring-loaded catch. Thus, when the connectors at the rear have been removed, and the mounting tray has been drawn forward to its fullest extent, either unit may easily be removed by pressing the retaining catch outwards, lifting the front pegs out of the L-slots and withdrawing the unit forwards and upwards to free the rear pegs.

9. Each power unit Type 904 extends the full width of the rack and has horizontal flanges at either side; these flanges rest on support channels attached to the runners and are secured to the

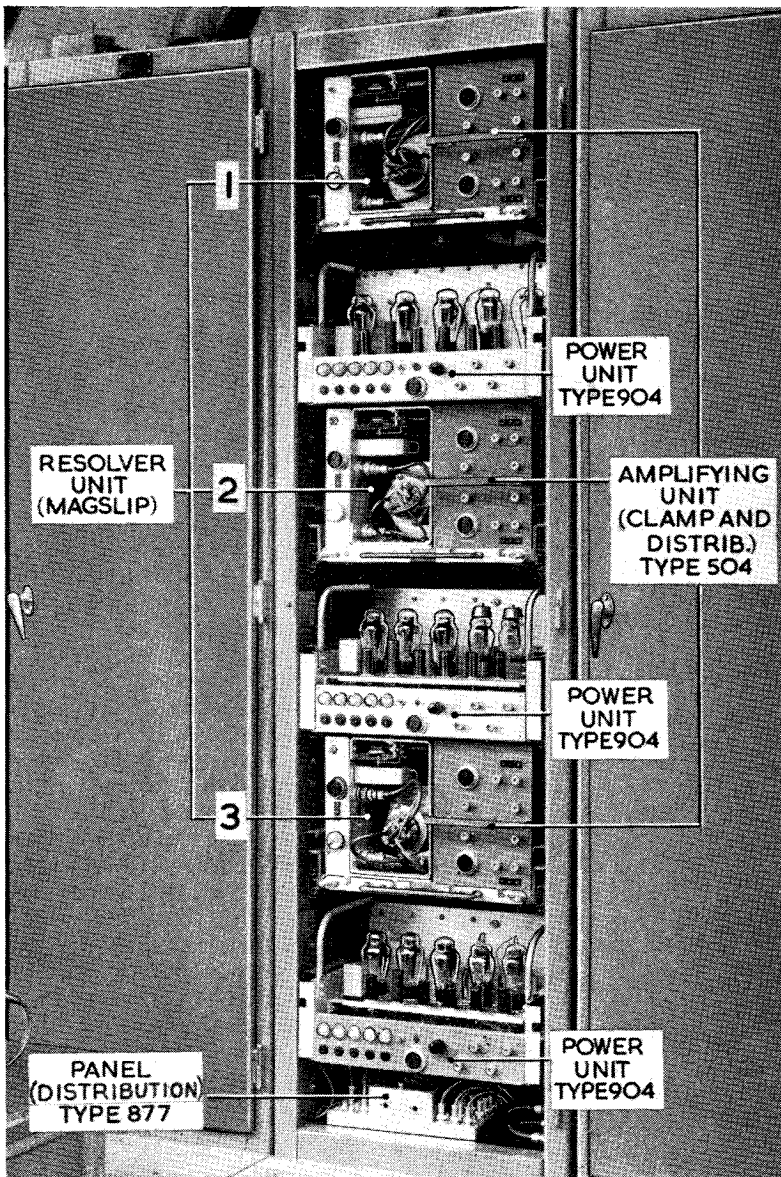


Fig. 1. Rack assembly (resolver magstrip) Type 301—front view

channels by six knurled-headed, captive screws, three at each side. Removal of a power unit from the rack requires two men because of its weight and is effected by disconnecting the cables from the rear, drawing the unit forwards as far as the runners permit, loosening the six captive screws and lifting the unit clear. The panel (distribution) Type 877 is secured at the base of the rack by two captive screws, one of which may be seen at the front in fig. 1.

10. It is quite possible to work on the interior of any of the runner-mounted units without interrupting operation, provided care is taken to avoid electric shock. There is enough slack in the cables to enable any unit to be drawn right forward without unplugging the rear connectors.

#### Setting-up and testing facilities

11. 25-way metering sockets are provided on the fronts of all units containing valve circuits, so that

the multimeter Type 100 may be plugged in for rapid checking of voltages and currents. In addition, key points in the circuits of the resolver and amplifying units are brought out to small sockets on the front panels of these units for monitoring with a CRO. These facilities, together with the waveform monitoring arrangements mentioned in para. 2, mean that correct conditions in the units may easily be set up or checked without interrupting operation or removing anything from the rack. All the preset controls are located on the front panels of the units, and have lock nuts and collets whereby the spindles may be locked in position once the correct settings have been found.

#### Rack cabling

12. The complete rack circuit diagram (fig. 29) shows the electrical interconnection between all units in the rack assembly when all three resolvers are working on 500 c/s. Alterations required to run one or more resolvers on 250 c/s are explained later, in the paragraphs on the panel Type 877. The actual run of the cables, showing relative lengths and cleat positions, is given in the cabling diagram (fig. 30), which shows two side views and a rear view of the cabinet.

#### Cable identification

13. Each end of every cable in the cabinet is marked with a four-figure identification number, as in the other fixed-coil racks. The numbers at each end of any one cable are different, so that reference to fig. 29 is necessary to determine the correct run of the cable. The first two figures of the identification number show the number of the unit (ringed on fig. 29 and 30) to which that cable end goes, and the second two figures show the number of the plug or socket on that unit (preceded by a nought for single-figure PL/SK numbers); to obviate the possibility of confusion between plugs and sockets, all the outlets on any one unit, whether plugs or sockets, are numbered up in one series. Certain sockets are not cabled up at all, in normal operations; they include the metering and monitoring sockets (para. 11) and the emergency selsyn sockets (para. 4).

#### Mk. 4 plug and socket orientation

14. Even where there are two Mk. 4 outlets with the same number of pins, located on the same unit, there is no danger of a connector being inadvertently plugged into the wrong one because the two outlets have been allotted different

moulding positions (*Part 2, Sect. 2, Chap. 1*). These remarks do not, however, apply to the multicore sockets on the rack side panel (unit

No. 14), so special care is needed when handling connectors to that panel to make sure that the right selsyn services go to each resolver.

## RESOLVER UNIT (MAGSLIP)

### INTRODUCTION

15. The resolver unit (magflip) has no Type number, but the A.M. Ref. No. is 10AE/625. As stated in para. 3, one such resolver unit is normally associated with each radar search head on the site.

### Purpose

16. A master timebase waveform at the appropriate repetition frequency is fed into the unit and resolved into two components, the amplitudes of which are proportional to the sine and cosine, respectively, of the angle between the radar beam and due North. The two components are fed out via the associated amplifying unit (clamping and distribution) Type 504 to head selector units, for re-distribution to all consoles which happen to be displaying the responses derived from that particular head. When timebase currents proportional to the resolved components are driven into the CRT fixed deflector coils on these consoles, a radial trace is produced which rotates in synchronism with the radar scanning aerial.

17. The resolver unit (magflip) therefore contains the magflip itself, which is basically a rotary electromagnetic resolver having a stator coil, through which a current corresponding to the master timebase sawtooth is forced by the magflip drive amplifier, and two coils on the rotor with their axes at right-angles to pick up the two components. The magflip rotor is turned by a selsyn receiver, which may be considered as an electric motor turning in exact synchronism with a selsyn transmitter up in the head turning gear. By this means, and the auto-align system explained later in this chapter (para. 35 to 38), the magflip rotor is made to follow exactly the movements of the radar head.

18. Other facilities the resolver unit has to provide are sector switching and trace dimming to prevent CRT screen burn in the event of rotation stopping; these circuits are explained later. Means are also provided for switching off the selsyn and turning the resolver drive assembly by hand, for setting-up and testing.

### CONSTRUCTION

19. The appearance of several resolver units in position in the rack is shown in fig. 1. Fig. 2 gives a closer front view of the whole unit and fig. 3, 4 and 5 are additional views showing the location of all important components on it. The layout of small components on the two group boards is given in fig. 6.

20. The unit is built on a rectangular chassis made of 16-gauge, cadmium-plated steel with a U-shaped guard bracket at each end. The drive unit ◀ (Mechanical) 4936 (A.M. Ref. No. 10AR/2505) ▶ which includes the selsyn motor, gears, switches and magflip, forms a complete sub-unit which is mechanically secured to the chassis by four  $\frac{1}{4}$ -in. BSF fixing bolts, and which is electrically connected to the rest of the resolver unit by free plugs (Mk. 4 and coaxial) mating with fixed sockets on the chassis. On one side of the drive unit, raised from the deck, is the valve mounting channel which carries holders for all seven valves in the unit. Below the valves is group board A (seen in the foreground of fig. 4) which carries some of the small components; the remainder are below the deck (fig. 5). All outlets for normal cabling connections to the unit are located at the rear (R.H side of fig. 5), but the metering socket, the small monitoring sockets and the emergency selsyn socket are at the front.

### Selsyn motor

21. The selsyn motor (or selsyn receiver) is basically an induction motor of a special type, connected by five leads to a similar device (situated up at the radar head) acting as selsyn transmitter, for accurately repeating angular information from one point to the other. The selsyn here is a flange-mounting motor unit Type 113, A.M. Ref. No. 10K/17500 (BTH Type S/1406/B6) and is totally enclosed. The three stator windings are carried in slots in the bore of the yoke and the wires for connection to them are brought out through the end frame, along with the rotor connections. The stator windings are delta-connected and are distributed to give accurately balanced phase voltages and correct flux distribution.

22. The single-phase rotor is wound on an "H" armature fitted to the

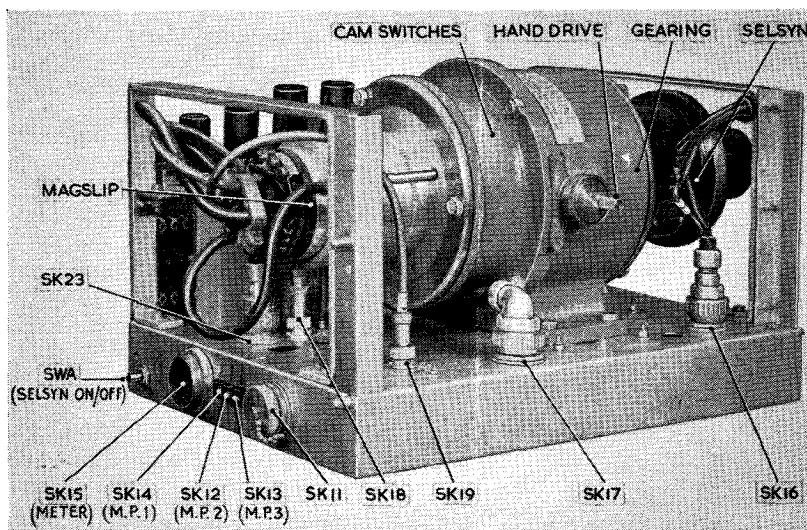
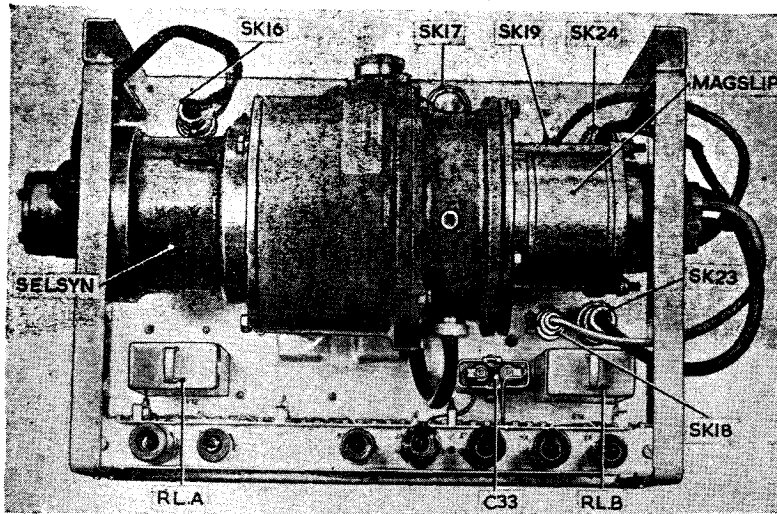
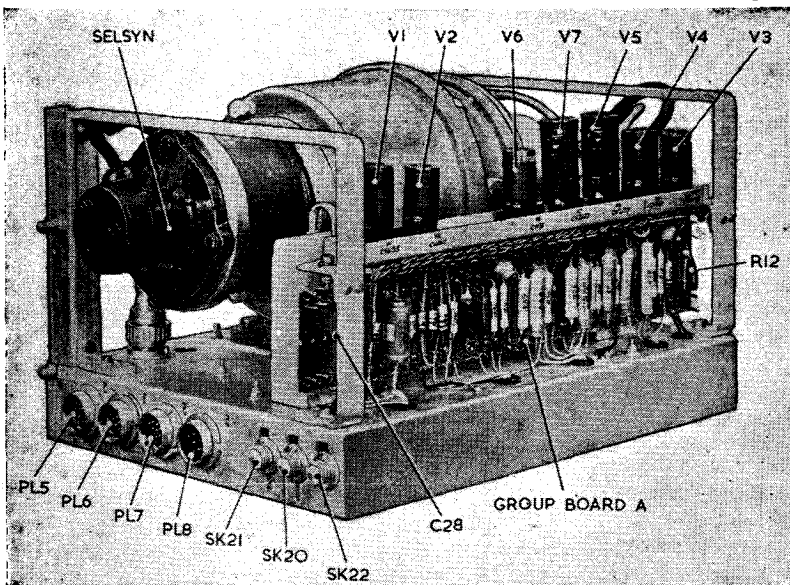


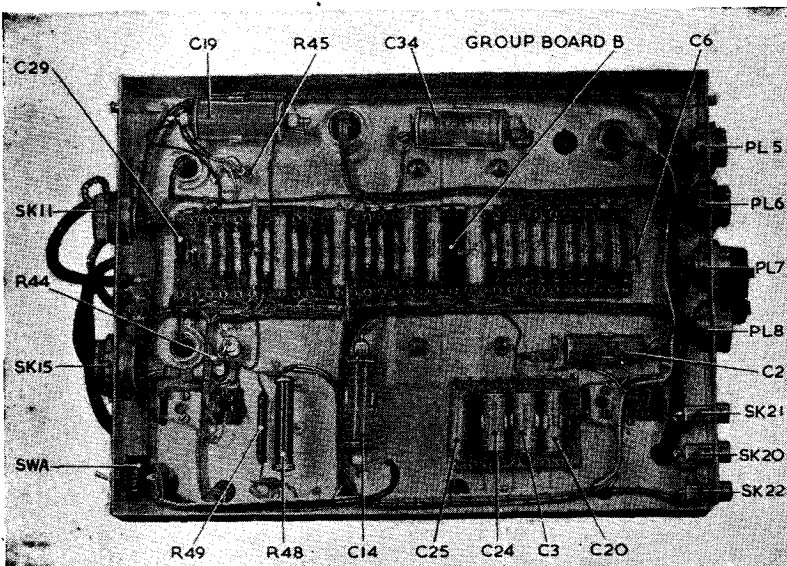
Fig. 2. Resolver unit (magflip)—front view



Note . . . X marks new cable outlet to SK17 (para. 26)  
**Fig. 3. Resolver unit (magslip)—plan view**



**Fig. 4. Resolver unit (magslip)—rear view**



**Fig. 5. Resolver unit (magslip)—under-chassis view**

main shaft, which rotates in precision-type ball bearings specially housed to prevent the entry of dust and grit. On assembly, the bearings are dipped in transformer oil (B.S. 148, grade B.30) and no further lubrication is normally needed during the life of the selsyn. The 230V supply to the rotor goes in via two special silver-graphite, composition brushes (Morgan Link Type S.M.3) and solid silver slippers. These materials are used to secure good electrical connection while minimizing brush friction. The electrical connections are made by flexible pigtails through the slip-ring end frame, near the two brush windows (fig. 4). Brush pressure is maintained by non-adjustable helical springs. The minimum brush length for satisfactory contact is  $\frac{1}{4}$  in.

**23.** Each end frame is secured to the main carcass by four hexagonal headed bolts (three are visible in fig. 4). Three smaller bolts tapped into the inner bearing plates pass through clearance holes in the end frames and the outer bearing cover plates, and the assembly is completed by nuts and spring washers. Views of a dismantled drive unit assembly are given in fig. 7, 8 and 9 of Chap. 2, Sect. 2, Part 2. The item references in the following para. 24 to 29 are to these illustrations.

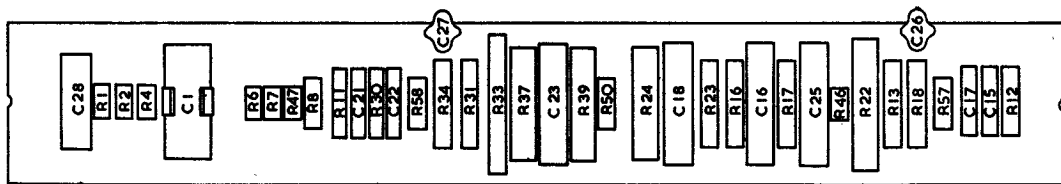
**Selsyn coupling and reduction gearing**

**24.** The selsyn is flange-mounted to the gearbox/switching assembly by a mounting ring having three  $\frac{1}{4}$ -in. BSF bolts (item A) fitting into tapped holes in the gearbox case. The selsyn shaft carries a small 30-leaf pinion (item M) which meshes with a 150-tooth gear wheel (item K) on a layshaft in the gearbox; the layshaft is mounted in ball bearings inside the box. Also on the layshaft is a 25-leaf pinion (not visible on the illustration) which meshes with another 150-tooth gearwheel (item L) on the magslip drive shaft. Thus a step-down ratio of 30:1 is obtained in two stages of 5:1 and 6:1.

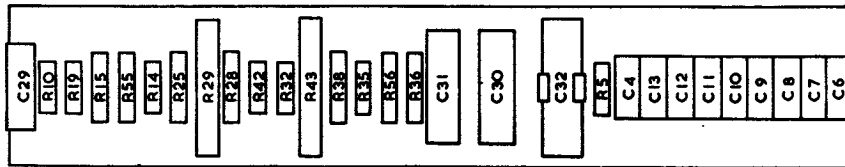
**Hand drive**

**25.** The layshaft also carries a





GROUP BOARD A



GROUP BOARD B

Fig. 6. Resolver unit (magslip)—layout on group boards

bevelled disc (*concealed behind item K on fig. 7*) on which bears a rubber friction drive from the hand drive wheel (*G*). The hand drive is not engaged until the outer knurled ring has been pressed home and twisted clockwise (bayonet action). The whole of the rotating part of the resolver assembly may then be turned by hand, for setting-up, etc. The hand drive may later be disengaged by pressing the knurled ring and twisting counter-clockwise.

**Note . . .**

*The selsyn motor must always be switched OFF before the hand drive is engaged, and must not be switched ON again until the hand drive has been disengaged.*

**Cam switches and magslip coupling**

**26.** The drive shaft from the gearbox extends through ball bearings in the central wall of the casting which separates the gearbox compartment from the cam switching compartment. Two cams are attached to the drive shaft. One, the sector switching cam (*item F, fig. 8*), has a 180 deg. profile, with eight roller-ended switches disposed at equal intervals around it. The other is the

auto-align cam (*item E*) which is actually made up of two separate cams, the relative positions of which are adjustable. The two portions have to be set so that the net result is equivalent to a single cam with a profile of  $94\frac{1}{2}$  deg. There are two roller-ended switches set 90 deg. apart around the cam, so that simultaneous closing of both occurs during only  $4\frac{1}{2}$  deg. of cam rotation. All the leads from the switches come out through the casting in a single form. The illustrations in this chapter and in Chap. 2, Sect. 2, Part 2 are all of a prototype, on which the switch leads come out on the opposite side of the casting from the hand drive. On production models the outlet has been shifted 90 deg. i.e., to the top (*fig. 10 and 12, Chap. 4, of this Sect.*), to give a shorter run to SK17 on the chassis, and the hand drive warning label has been moved two inches out of the way; the construction of the unit is otherwise unaltered.

**27.** On the side of the auto-align cam is a peg (*item D, fig. 8*) which fits into a rubber-lined socket (*item C*) on the magslip coupling plate. The coupling plate is attached to the magslip shaft (*item B*) so that torque from the gearbox is exerted on the magslip rotor.

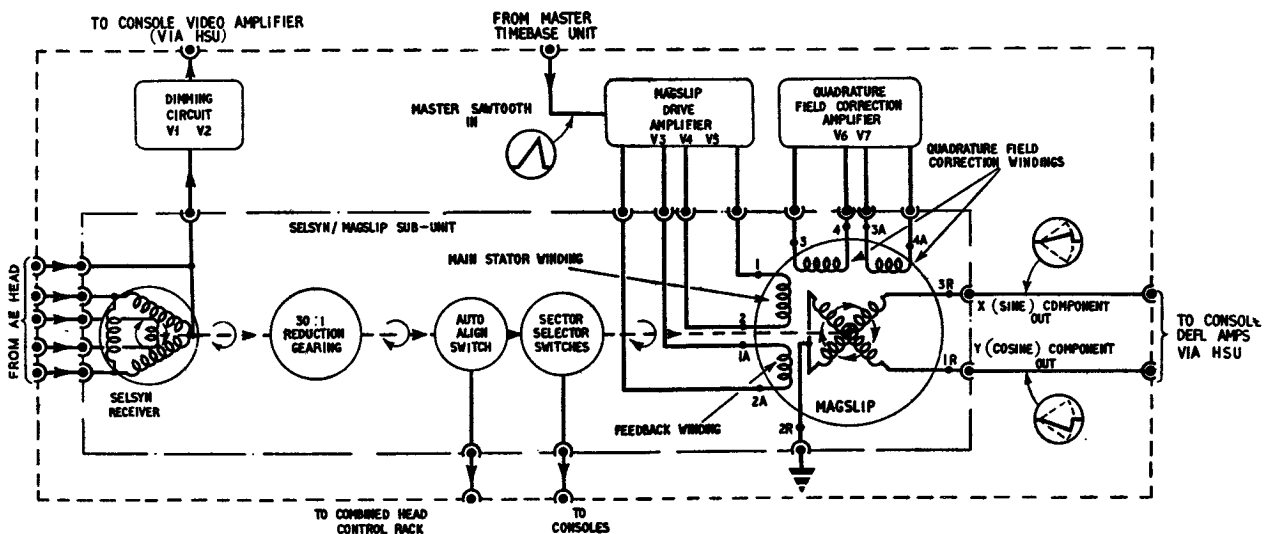


Fig. 7. Resolver unit (magslip)—block diagram

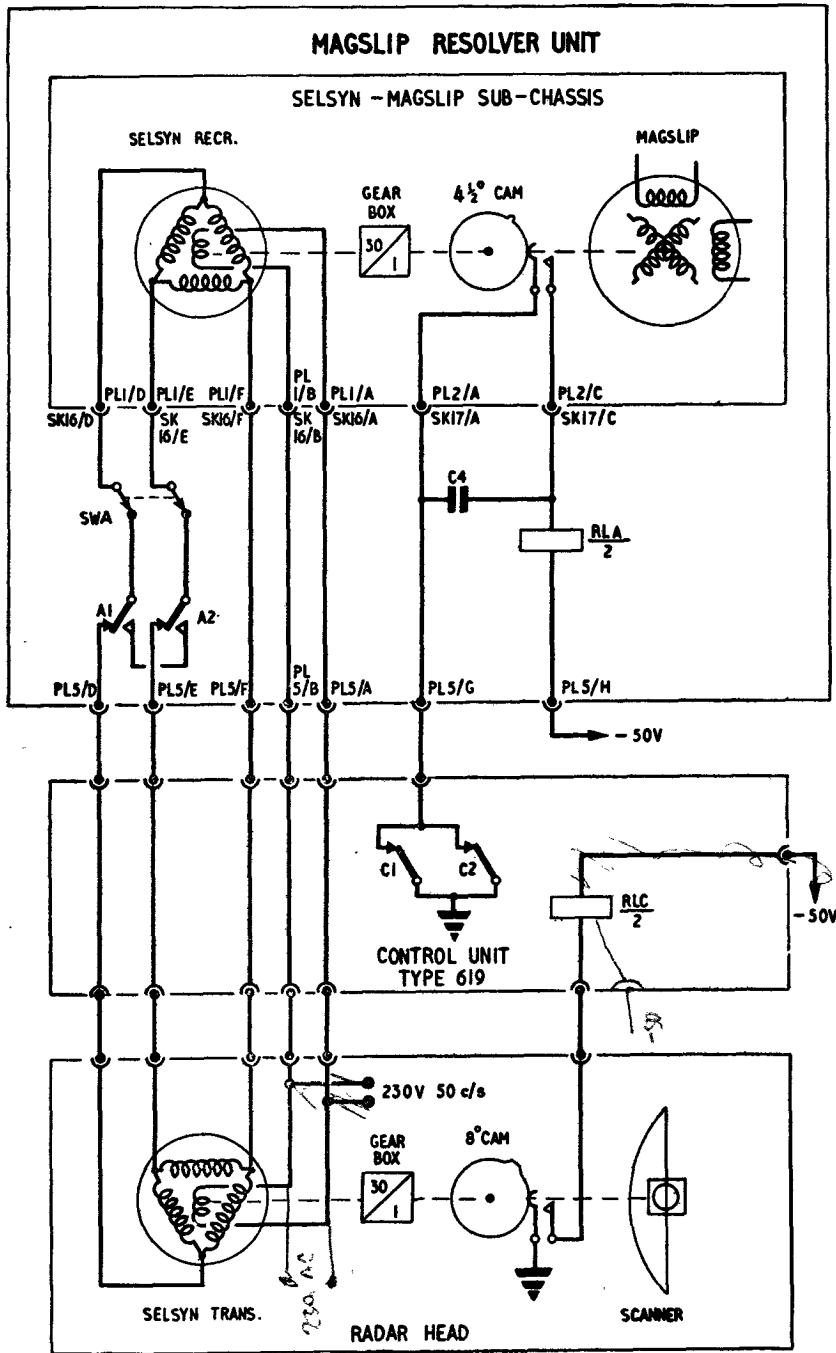


Fig. 8. Auto-align system

looking) head, a reference line engraved on the magslip carcass lies near a line marked "N" on the adaptor. But when the resolver is converted for use with a back-looking head (from which the auto-align impulse comes when it is looking South) the magslip carcass is rotated until the reference line is near a line marked "S" on the adaptor, opposite the "N" line (for fuller instructions see Chap. 2, Sect. 2, Part 2).

**Magslip**

**30.** The magslip unit Type 100, A.M. Ref. No. 10AE/696, is a three inch (nominal diameter) model, otherwise known as resolver No. 2, Mk. 2 (Admiralty pattern 10966, Muirhead catalogue No. MU8511). The colour coding on the standard magslip scheme is brown/yellow (i.e., brown end cover with two yellow spots). The iron stator is fitted with a total of four separate distributed windings, and the leads are brought out separately to numbered tags on the spindle end cover. The allocation of the stator windings is given in the table below.

**31.** The rotor is mounted in pre-loaded bearings and comprises a slotted armature into which are set two distributed rotor windings with one common end. Connections are brought out from the windings via three silvered slip-rings and silver-graphite brushes. The correct brushes for continuous service are Morgan Link Type SM3. No provision is made for lubricating the rotor bearings, as the oil introduced on original assembly is sufficient for three years' service. The leads from the brushes terminate in three small

**28.** The assembly of the magslip and the gearbox casting is shown in more detail in fig. 9, Chap. 2, Sect. 2, Part 2. The standard magslip carcass is made suitable for flange-mounting to the gearbox by the provision of an adaptor frame and a magslip control ring which is secured to the adaptor by two screws. The magslip is then clamped up rigidly to the adaptor by two long bolts and the assembly mounted to the gearbox using a clamp ring and three 1/4-in. bolts (item A).

**29.** The magslip carcass may be moved relative to the control ring through a 180 deg. arc. When the resolver unit is used with a normal (forward-

Tag Number	Wire colour	Function
1	Black	Main input winding
2	Green	
1A	Black	Feedback winding for 1-2
2A	Green	
3	Yellow	Quad. field correction winding
4	White	
3A	Yellow	Feedback winding for 3-4
4A	White	



terminal blocks on the spindle end cover. The numbering of the rotor terminals is as follows:—

Terminal Number	Slip-ring	Wire colour	Function
1R	Outer	Black	Cosine output
2R	Inner	Yellow	Common
3R	Centre	White	Sine output

### CIRCUIT DESCRIPTION

#### General

32. As shown in the block diagram (fig. 7), the electrical circuit of the magslip resolver unit may be considered in seven parts:—

- (1) Selsyn motor circuit
- (2) Auto-align switching
- (3) Sector selection switching
- (4) Magslip
- (5) Magslip drive amplifier
- (6) Quadrature field correction amplifier
- (7) Dimming circuit.

Detailed explanations of these circuits follow; they should be read in conjunction with the complete circuit diagram (fig. 25).

#### Selsyn motor circuit

33. That part of the selsyn circuit located in the magslip resolver unit is shown in fig. 25. The normal selsyn connections come in on PL5, while SK11 is the emergency selsyn outlet (para. 4). The complete circuit of the selsyn link is shown in simplified form in fig. 8. The rotor windings A1/A2 of the selsyn transmitter and the selsyn receiver are connected in parallel to the same 230V 50 c/s supply. Provided SWA (selsyn

ON/OFF) is closed and RLA is not energized, the three delta-wound stators D, E and F, on the receiver selsyn, are connected straight through to the corresponding terminals on the transmitter. Alternating voltages are induced in the transmitter windings, depending on the rotor angle, as the aerial head turns. These voltages are fed through to the stator windings of the receiver selsyn, and set up, in the stator, an alternating field which interacts with the field of the rotor and produces a torque on the rotor until it turns into line. As the rotor in the transmitter is turned, the rotor in the receiver follows the movement within 1 deg., provided it is not too heavily loaded mechanically; but if it has to do too much work in turning, its movements lag behind those of the transmitter.

34. To reduce the torque required from the receiver selsyn and to improve the angular accuracy, the rotations of the radar head are stepped up by a 30:1 gearing before being coupled to the transmitter selsyn, and a corresponding reduction gearing is inserted between the receiver selsyn and the magslip resolver. The main disadvantage of this scheme is that the coupling between the magslip and the gearbox allows the resolver to follow the radar head in any one of 29 wrong modes besides the correct one, even though the selsyns are in perfect synchronism. To overcome this trouble, the auto-align (automatic alignment) system has been introduced.

#### Auto-align system

35. The complete auto-align system involves a cam-operated micro-switch in the radar head, a relay in the appropriate control unit (training) in the combined head control rack, and cam-

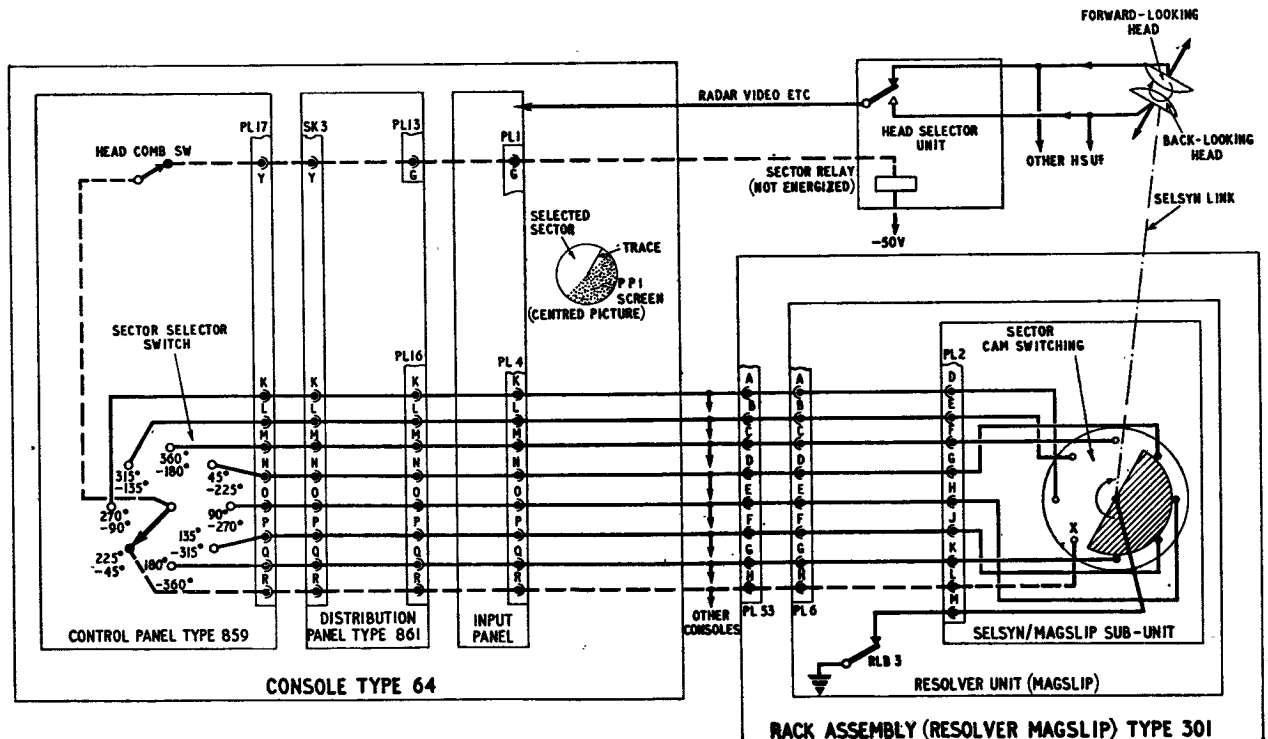


Fig. 9. Sector selection switching

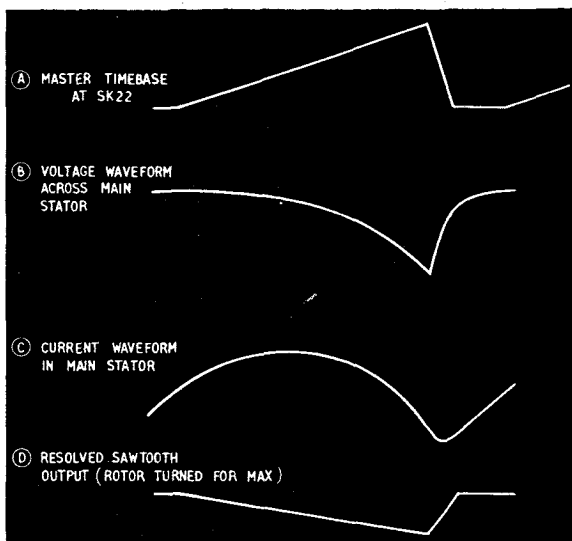


Fig. 10. Magslip waveforms

operated switches and a relay in the magslip resolver unit. Fig. 8 is a simplified circuit of the system; it applies particularly to a Type 14 head with the control unit (training) Type 619, but the principle is just the same on other types of head.

36. The auto-align cam in the Type 14 head is driven off the main aerial pivot mount mechanism and rotates at the same rate as the aerial (the 30 : 1 gearbox only affects the selsyn). The cam closes a microswitch for about 8 deg. of the 360 deg. head rotation, earthing the auto-align lead to the control unit 619 during that 8 deg. and leaving it open during the remaining 352 deg. Meanwhile the auto-align cam in the magslip resolver unit (which may be regarded as a single cam) closes the switch and short-circuits A and C on PL 2 during  $4\frac{1}{2}$  deg. only. If the resolver auto-align cam is properly set up and the resolver is rotating in correct alignment with the radar head, this  $4\frac{1}{2}$  deg. closure occurs within the 8 deg. closure at the head.

37. Thus, as long as mutual alignment remains correct, the closing of the auto-align switch in the resolver unit has no effect on selsyn rotation because RLC in the control unit is energized (the circuit to earth being completed by the 8 deg. cam in the head) so that contacts C1 and C2 (two in parallel for reliability) are open and there is no earth return for RLA. Contacts A1 and A2 therefore remain in the position shown in fig. 8 and normal selsyn rotation is maintained.

38. If, however, alignment becomes incorrect (due, for instance, to a temporary interruption of selsyn services) closure of the auto-align switch in the resolver unit occurs at a time when no earth return is being made, in the head, for RLC in the control unit (i.e., when contacts C1 and C2 are closed). There is now an earth return for RLA, via the auto-align switch and contacts C1-C2, and the relay is therefore energized so that

contacts A1 and A2 change over and short-circuit one selsyn stator. This locks the selsyn rotor and arrests rotation of the magslip and, of course, of the auto-align cam. Consequently, RLA remains energized for the present, keeping the resolver stationary while the head continues to turn. Sooner or later, though, the head comes round to the bearing where its auto-align microswitch closes. When this happens, RLC in the control unit is energized and opens the earth circuit of RLA, so that A1 and A2 change back to their normal positions; normal selsyn rotation then resumes with the resolver back in step with the head.

#### Note . . .

The above system of auto-alignment works well with continuously-rotating heads, but special care is needed with the head allocated for "stop-and-look" operations. On commencing "stop-and-look" operations, or after any temporary interruption of services, the operator must always cause the head to complete at least one complete revolution (to enable the auto-align circuit to pick up) before proceeding with the normal position-laying.

#### Sector selection system

39. Sector selection switching is only in circuit on the resolver unit which is associated with a back-looking head, and then only when combined head operation is being employed by one or more operators. Head-combining means the alternate use of two search heads rotating in rate-synchronism, but 180 deg. apart in space-phase (i.e., one forward-looker and one backward-looker). Radar information is displayed from the forward-looker as it sweeps a chosen 180 deg. sector, and then from the backward-looker as it sweeps the same sector. In this way, improved coverage of the chosen sector is obtained.

40. Fig. 9 is a diagrammatic circuit of the complete system as it concerns one particular console. The change-over of the source of radar video, etc., is done in the console's associated head selector unit in the rack assembly Type 184, where there are four relays with contacts to change over radar video signals, IFF, trigger and RBU (where appropriate) and timebase components. All these are shown for simplicity as one relay (the sector relay) and one contact in the HSU block on fig. 9. To operate these relays at the right times for correct change-over is the function of the sector selection switches in the magslip resolver unit.

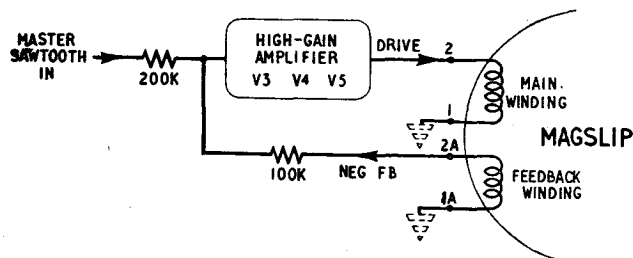


Fig. 11. Magslip drive amplifier—AC see-saw (simplified)

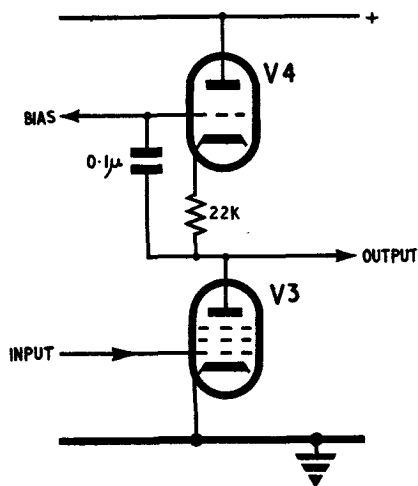


Fig. 12. High-gain amplifier (simplified)

41. The profile of the sector selection cam extends over 180 deg. and there are eight switches arranged at equal intervals round it, so that at any instant the cam closes four of them. The net result is shown in simplified form in fig. 9. For the present explanation the operator of the PPI console is assumed to have selected the 225 deg. - 45 deg. sector for head-combined operations, by setting his SECTOR selection switch to that position and closing his HEAD COMBINING switch on the panel (control) Type 859. The relay in the head selector unit is shown in the normal unenergized position, where it routes signals, etc., from the forward-looker to the console, but when the sector cam comes round to the contact marked X in fig. 9, earth is connected, via the appropriate sector line (shown broken in the diagram) and the SECTOR and HEAD COMB switches, to the HSU relay, energizing the latter and so bringing information from the back-looker instead.

42. The same situation continues while the cam moves past X, i.e., during 180 deg. of cam rotation, but when the trailing edge of the cam leaves X, earth is disconnected from the sector line, the relay in the HSU is released and the console takes information from the forward-looker once more. It will be noted that the sector switching action will not occur if the contact RLB/3 is open. This contact opens when the dimming circuit operates (para. 60), i.e., when normal head rotation stops. This means that if head-combining is in use and the back-looking head ceases to rotate, the change-over relays in the head selector units cannot be energized and the PPI consoles attempting to obtain head-combined display over a chosen 180 deg. sector revert automatically to ordinary 360 deg. display from the forward-looking head only.

43. Although there is normally only one back-looking head on a site, and therefore only one magslip resolver with sector selector switches in action, there is nothing to prevent different PPI operators selecting different sectors for head-combined display, because the sector lines from the one resolver are connected out to all PPI consoles, and information is continuously avail-

able to all head selector banks, both from the forward-looker and the back-looker.

#### Magslip

44. Basically, the magslip may be regarded as a pair of variable-ratio transformers, in which the main input stator winding (terminals 1/2) is the primary and each rotor winding is a secondary. As the rotor is turned by the drive from the selsyn, the inductive coupling between the winding and each secondary varies sinusoidally between a maximum in-phase, through zero, to maximum anti-phase, and so on. As the axes of the two rotor windings are mutually perpendicular, the envelope of sawtooth amplitudes from one is in quadrature to that from the other.

45. In addition to the main stator winding, there are certain auxiliary windings; explanations of these and their associated valve circuits follow later. The voltage waveform obtained across each rotor winding is proportional to the rate-of-change of magnetizing current in the main stator. Since the rotor output has to be a linear sawtooth (waveform (D), fig. 10), the magnetizing current waveform needed in the main stator is complex in shape (waveform (C)); during the sweep period it is parabolic. The stator has resistance as well as inductance, so that the voltage waveform across it is still more complex (waveform B)), consisting, as it must, of waveform (C) with a sawtooth added.

#### Magslip drive amplifier (fig. 25)

46. The function of the magslip drive amplifier is to accept at SK22 the master sawtooth voltage waveform, and to drive into the main stator winding a current waveform (fig. 10 (C)), which will produce a linear sawtooth voltage waveform across each rotor. A system of negative feedback is needed to compare the output waveform with the master sawtooth and to control the drive amplifier so that the output is an exact reproduction of the master waveform. This negative feedback cannot be taken from either of the rotor outputs, because they both vary continuously in amplitude and polarity as rotation proceeds, and vanish entirely twice in each rotation cycle. It is, in fact, taken from a supplementary stator winding, known as the feedback winding (terminals 1A and 2A). The axis of this is parallel to that of the main stator, but the feedback winding has fewer turns. It may be considered

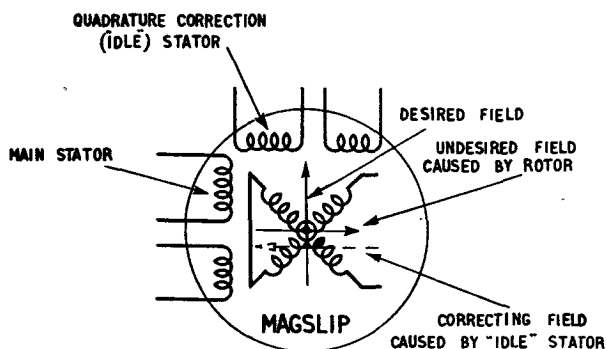
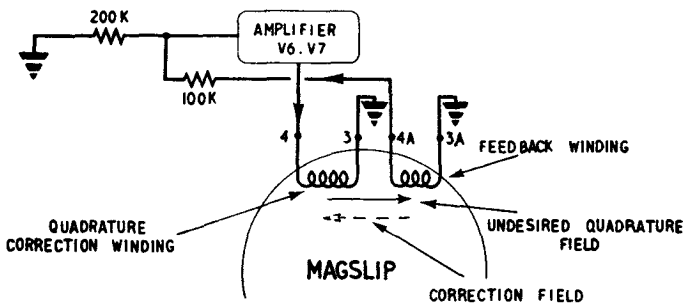


Fig. 13. Quadrature field correction—principle



**Fig. 14. Quadrature field correction amplifier—AC see-saw (simplified)**

to “sample” the operation of the magslip, and if an accurate voltage sawtooth can be produced across the feedback winding, it must also be produced across the rotors.

#### AC see-saw

**47.** The whole drive is arranged, from the AC point of view, as a see-saw amplifier (*fig. 11*), but with the negative feedback arm taken from the auxiliary feedback winding instead of from the actual output. The input arm of the see-saw comes from the master sawtooth input socket SK22. The principle of operation is that, provided the amplifier has sufficiently large gain, it will try to drive into the main stator currents which will produce an accurate anti-phase sawtooth across the feedback winding, and so hold the “pivot” of the see-saw (V3 grid) near earth potential.

**48.** When the rotor is turned to a position of maximum coupling between one rotor winding and the main stator winding, the transformer ratio between the feedback winding and that rotor winding is 1 : 1. Consequently the sawtooth amplitude from that rotor is the same as the amplitude from the feedback winding. Since the see-saw ratio is 100K : 200K (*fig. 11*), i.e.,  $\frac{1}{2}$ , the amplitude across the feedback winding is half that at SK22. When, therefore, the input is the 250 c/s master sawtooth of 50V peak amplitude, the maximum peak amplitude from either rotor is only 25V. Subsequent amplification in the amplifying unit (clamping and distribution) Type 504 is required to restore it to 50V. Similarly, on 500 c/s the maximum peak sawtooth amplitude from either rotor is only  $12\frac{1}{2}$ V. These reductions are introduced to avoid excessive magnetizing current in the magslip main stator.

#### DC feedback

**49.** In addition to the AC feedback loop, DC feedback is included to stabilize the steady operating conditions of the amplifier (including the mean current in the main stator) and to avoid the need for DC SET controls which would have to be reset after every valve change. The stator current is sampled by the 820-ohm resistor R29 (*fig. 25*), and feedback is taken from the top of R29 via R25 (1M) to V3 grid. (R25 is not part of the AC feedback loop, being decoupled by C19.)

#### Amplifier circuit

**50.** The amplifier itself consists basically of a

pentode V3 (CV138), and a high-current pentode V5 (CV2127) connected as a cathode follower to drive the main stator. High gain is required from V3 stage, so, instead of a single resistor, a series triode circuit is used for the pentode load. *Fig. 12* is a simplified diagram of the arrangement, showing only the effective AC circuit.

**51.** The triode V4 (consisting of the two halves of a CV491 strapped as one triode) tries, by cathode follower action, to keep the voltage between its own grid and cathode constant. Since C16 ( $0.1 \mu\text{F}$ ) offers only small reactance at time-base frequency, this means that the triode tries to maintain constant voltage across the 22K resistor (R22) in its cathode circuit, by driving constant current through it and the pentode. As a result the gain of the pentode is very high, being as large as it would theoretically be with a resistive anode load of  $1\text{M}\Omega$  (the approximate AC resistance of the triode), but without the limitation caused by the large HT drop across such a resistor. (Actually, however, the effective load is only about one-third of  $1\text{M}\Omega$ , owing to the resistor chains R16/17 and R23/24 in parallel.)

**52.** Coupling from V3 anode to the cathode follower (V5) grid is AC-coupling (via C18) so far as the sawtooth is concerned, though the DC level is settled by the resistor chain R23/24. The purpose of the screen resistor R49 (18K) is to protect the CV2127 against failure of the CV138; such failure would cause the CV138 anode to rise to +400V (via R16/17) and to raise V5 grid until the anode bottomed and a dangerously large screen current started to flow. However, R49 limits the screen current and restricts the total cathode current to about 45 mA. Protection against HF oscillation round the AC feedback loop is provided by C26, C17 and R57, which give local negative feedback around V3 for HF only.

#### Quadrature field correction amplifier

**53.** The pentodes V6 (CV138) and V7 (CV2127) form a quadrature field correction amplifier. The need for this arises because the current in one rotor winding—the sine winding, say—will itself set up an unwanted magnetic field parallel to the axis of the winding. When the field is parallel to the main stator axis no harm is done, because the feedback circuit automatically corrects any resulting sawtooth distortion. When the sine winding is perpendicular to the main stator, no current flows in the former and no unwanted fields are produced, but at intermediate angles—especially around the 45 deg. positions—the unwanted field has a quadrature component (*fig. 13*) which the feedback circuit cannot take care of (because it occurs at right angles to the main windings), and which causes an angular inaccuracy. To introduce a correcting field which will cancel the unwanted quadrature field, an “idle” stator winding (terminals 3 and 4) has been included, with its axis at right angles to that of the main stator.

**54.** The idle winding has its own feedback winding (terminals 3A and 4A) which picks up any

unwanted quadrature field. Voltages from this feedback winding enter the feedback arm of a see-saw amplifier (*fig. 14*), the circuit of which closely resembles that of the main drive amplifier. However, the input arm, instead of being taken to a sawtooth waveform source, is effectively earthed for AC by C20. The see-saw therefore "compares" any voltages from the feedback winding with zero, and drives such currents into the idle winding as will produce a cancelling quadrature field and thus make the voltage from the feedback winding zero.

**55.** Adequate correction is obtained without exceptionally large gain in the pentode stage V6, so instead of the constant-current triode circuit used in the drive amplifier, a simple 33K resistive load (R33) is sufficient here. Consequently, the resistor values in the DC potentiometer chains around V6 are different from the corresponding values in the drive amplifier. Otherwise, the DC feedback circuit, which stabilizes the operating conditions for both V6 and V7, resembles that for V3 and V5. As for V3, direct negative feedback for HF is included around V6 (C27, C22 and R58) to prevent oscillation.

#### Rotor outputs

**56.** The sawtooth component waveforms emerging from the rotor windings have no settled DC level and so need subsequent clamping as well as times 2 amplification. Damping resistors, R44 and R45 (each 33K) are connected externally across the rotor windings to prevent "ringing" after sharp edges on the timebase waveform. The sine and cosine components are brought out on coaxial leads ending in PL18 and PL19, which plug into SK18 and SK19 on the main chassis. These sockets in turn are connected to SK20 and SK21, from which external cables run to the amplifying unit (clamping and distribution) Type 504, mounted alongside.

#### Dimming circuit

**57.** The dimming circuit (V1a-b and V2b) in the resolver unit releases a dimming relay in the video amplifier of every associated console if trace rotation stops. For its operation the circuit depends on the fact that during normal continuous rotation at, say, 6 r.p.m., the voltage on any one of the three leads to the selsyn stator consists of a 50 c/s sine-wave, amplitude-modulated at 3 c/s (but for the 30:1 step-up in the selsyn link, the modulation frequency would be only 0.1 c/s, i.e., 6 cycles per minute). If

rotation stops, however, the modulation disappears, leaving only a steady 50 c/s sine-wave, the amplitude of which depends on the position of the aerial when it stopped.

**58.** The input to the dimming circuit is taken from one selsyn stator lead (terminal E) and AC-coupled to the grid of the triode V1b (half a CV455). V1b is an infinite impedance detector, which is basically a cathode-follower with a 1  $\mu$ F capacitor (C1) across the load. The reactance of C1 is high to signals at 3 c/s and below, but low to 50 c/s. The operating point of the triode is near cut-off, in a non-linear part of the characteristic, so that a form of anode bend detection takes place, and only the low-frequency envelope appears across C1. The circuit has the usual cathode-follower property of high input impedance, so the selsyn operation is not disturbed by the connection of the detector to one of its stator terminals.

**59.** The rotation waveform envelope across C1 is, in its turn, rectified by a simple half-wave rectifier circuit using the diode V2b, and the negative DC output is DC-coupled to the grid of the triode V1a. The triode grid potential is set so that during rotation the grid is held down below cut-off by the rectifier output; but if rotation ceases, the output disappears and the triode grid rises to the positive potential at the junction of R7/R47, bringing the triode into conduction.

**60.** When rotation ceases and V1a conducts, the relay RLB in its anode circuit is energized and its three normally closed contacts open to perform the following functions:—

- (1) B1 brings the 15K resistor R10 into circuit in series with the relay winding (the relay does not require as much current to hold it on as it does to energize it initially); this limits the dissipation at V1a anode.
- (2) B2 open-circuits the dimming line, which goes out via PL5/J to the head selector units and thence to all consoles displaying the signal from the stopped head. As a result, the dimming relay in the video amplifier of each such console is released and the trace brightness is decreased.
- (3) B3 disconnects the sector selection switches (*para. 42*).

## AMPLIFYING UNIT (CLAMPING AND DISTRIBUTION) TYPE 504

### INTRODUCTION

**61.** The amplifying unit (clamping and distribution) Type 504 (A.M. Ref. 10U/16772) forms part of the rack assembly (resolver magstrip) Type 301. Each amplifying unit is associated with a particular magstrip resolver unit in that rack. The front panel of the unit is shown in *fig. 15*.

#### Purpose

**62.** The unit is designed to accept, from its magstrip resolver unit, the sine and cosine timebase

sawtooth components, to amplify them by a factor of 2, and to clamp them to earth level during the rest period. The clamping process is necessary because the magstrip itself is essentially an AC coupling device, and DC levels are not preserved by it; without clamping, the trace origin on PPI displays would wander about as the amplitudes and polarities of the timebase components varied during head rotation. (*See also Sect. 1, Chap. 1 of this Part.*)

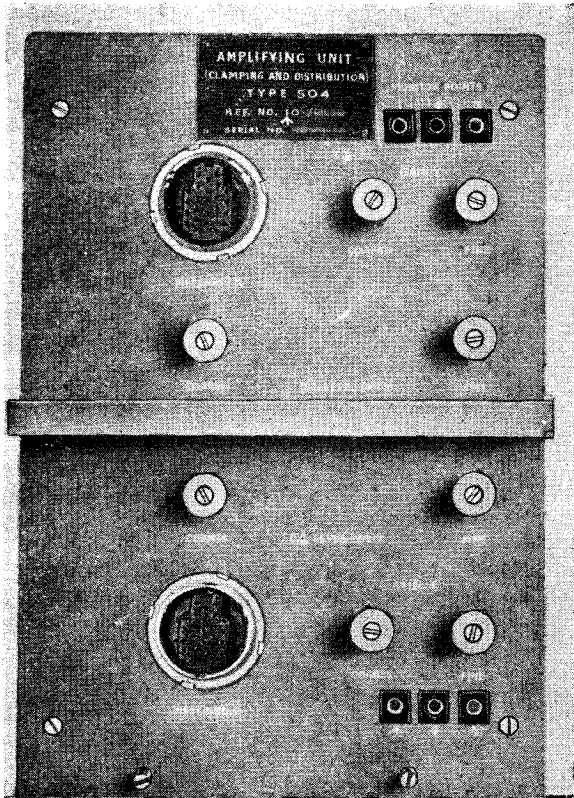


Fig. 15. Amplifying unit (clamping and distribution) Type 504—front view

63. To operate its clamping circuits, the unit has to produce internally the necessary positive and negative clamp waveforms, which are timed from delayed trigger pulses (produced in the master timebase unit) and master trigger pulses (from

the master trigger unit). Finally, the unit has to repeat out the amplified and clamped waveforms to all head selector units. The unit is equally effective for 250 c/s or 500 c/s use, and provided the right trigger pulses are supplied no readjustment or switching is necessary when using the unit on either repetition frequency.

### CONSTRUCTION

64. The unit is constructed on a rectangular framework fitted with the necessary studs to clip into position alongside its magstrip resolver unit on a standard rack mounting tray. The metering sockets, monitor points and preset potentiometers are all mounted on the front panel (fig. 15); but fixed plugs and sockets for power supplies and signal connections are all on the rear panel.

65. There is no fully-decked chassis in the body of the unit; the valveholders, which are all either B7A or B9A types, are set out along three parallel U-shaped valve mounting channels (fig. 16), so that with the unit in the working position the valves are horizontal, and are more readily cooled by the air current coming up from the rack base. The majority of the small components are mounted accessibly on six group boards running nearly the full length of the unit (fig. 16 and 17); the layout of the components on these boards is shown by fig. 18.

### Power supplies

66. The amplifying unit uses three separate heater supplies which come from the associated power unit Type 904 into PL1 on the rear panel. The details are:—

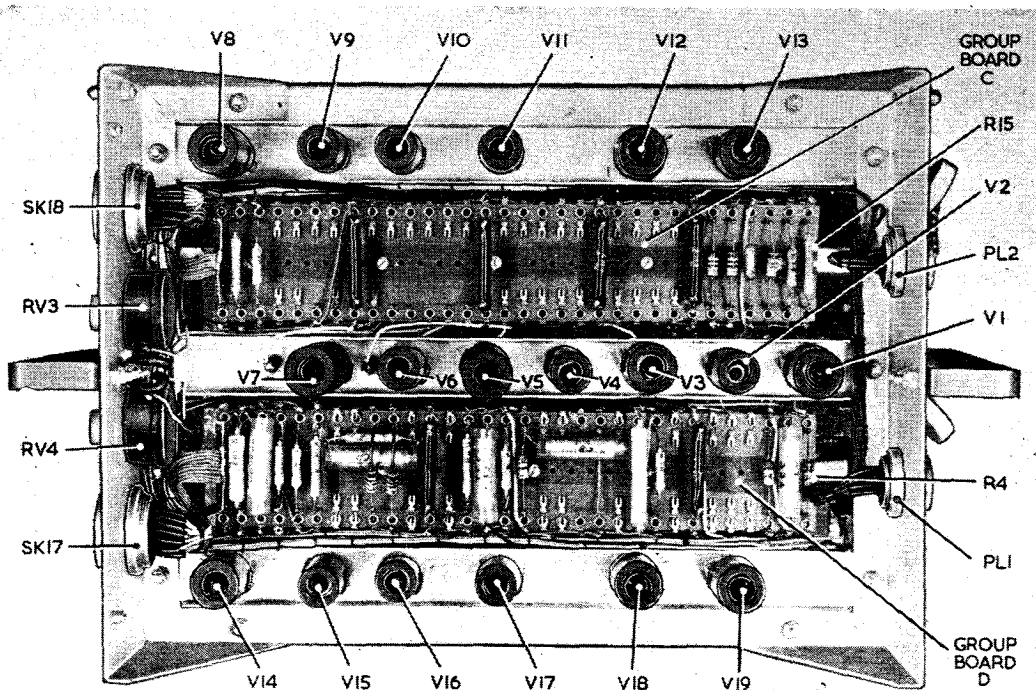


Fig. 16. Amplifying unit (clamping and distribution) Type 504—over-chassis view



- a-a A 4 amp. supply centred to earth level by a pair of  $100\Omega$  resistors.
- b-b Another 4 amp. supply, one side of which is earthed in the power unit.
- c-c This supply is in parallel with a-a.
- d-d A 2 amp. supply held down to a small negative level to prevent hum injection by electronic heater-cathode conduction in the critical clamping diode stages.

67. Stabilized, ripple-free HT supplies at +400V, +300V and -300V also come from the power unit Type 904, and arrive on PL2.

### CIRCUIT DESCRIPTION

#### General

68. The simplified block diagram (*fig. 19*) which also contains a chart of the main waveforms in the unit, shows the principal parts of the circuit to be as follows:—

- (1) Trigger/amplifier and clamp generator.
- (2) Sine amplifier and clamp.
- (3) Sine repeater.
- (4) Cosine amplifier and clamp.
- (5) Cosine repeater.

A more detailed explanation of these circuits follows. Fig. 26 is a complete circuit diagram of the unit.

#### Trigger amplifier and clamp generator

69. That part of the circuit which includes valves V1 to V7 produces the positive and negative clamp pulses, which on 250 c/s are required to start 210  $\mu$ S after the timebase sweep ends (to

allow time for the flyback to finish before the clamp comes on), and to finish exactly at the start of the next sweep. The delayed trigger pulse arriving at SK4 (*waveform f*) is already of sufficient amplitude (40V) to operate the clamp generator; but the master trigger pulse (*waveform e*) may be as small as 10V on arrival at SK3, and requires amplification before application to the clamp generator, to end the clamp.

#### Trigger pulse amplifier

70. A double triode V1 (CV455) is used as the trigger pulse amplifier; the short positive-going pulses from SK3 are applied to the cathode-follower V1a, from which they are cathode-injected into the amplifier V1b across its 10 K $\Omega$  cathode resistor R7. To stabilize the quiescent operating conditions of the pair, both grids are returned to a +50V point at the junction of R10 and R11. The cathode of V1a is thus held near +50V and V1a is nearly cut off, but V1b passes nearly 5 mA. The arrival of a trigger pulse drives V1a cathode positive, and this positive edge, when applied to V1b cathode, cuts off V1b. The resulting 35V positive-going pulse at V1b anode, which is coupled out to the next stage by C5, is practically independent of the original pulse amplitude.

#### Clamp pulse generator

71. The double triode V3 (CV491) is connected in a cathode-coupled bi-stable trigger circuit, which generates the negative clamp pulse. In one stable state—which holds good during the sweep period and the flyback—V3a is conducting, its grid being near earth potential. The diode V2b is just at the point of conduction; its purpose is

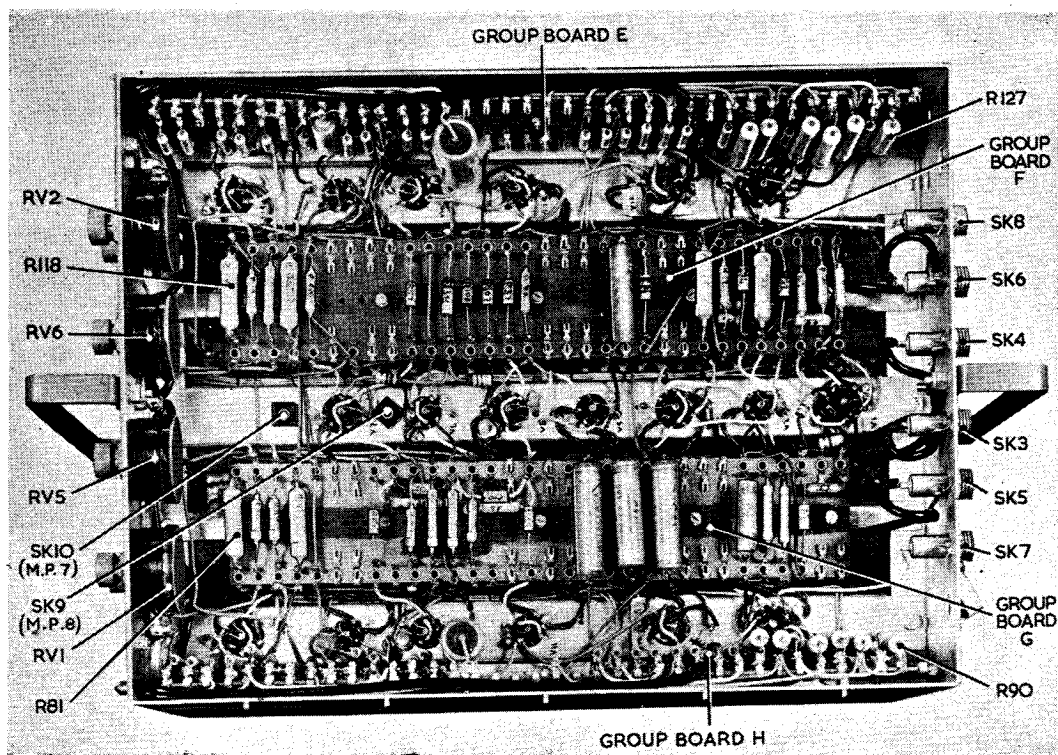


Fig. 17. Amplifying unit (clamping and distribution) Type 504—under-chassis view

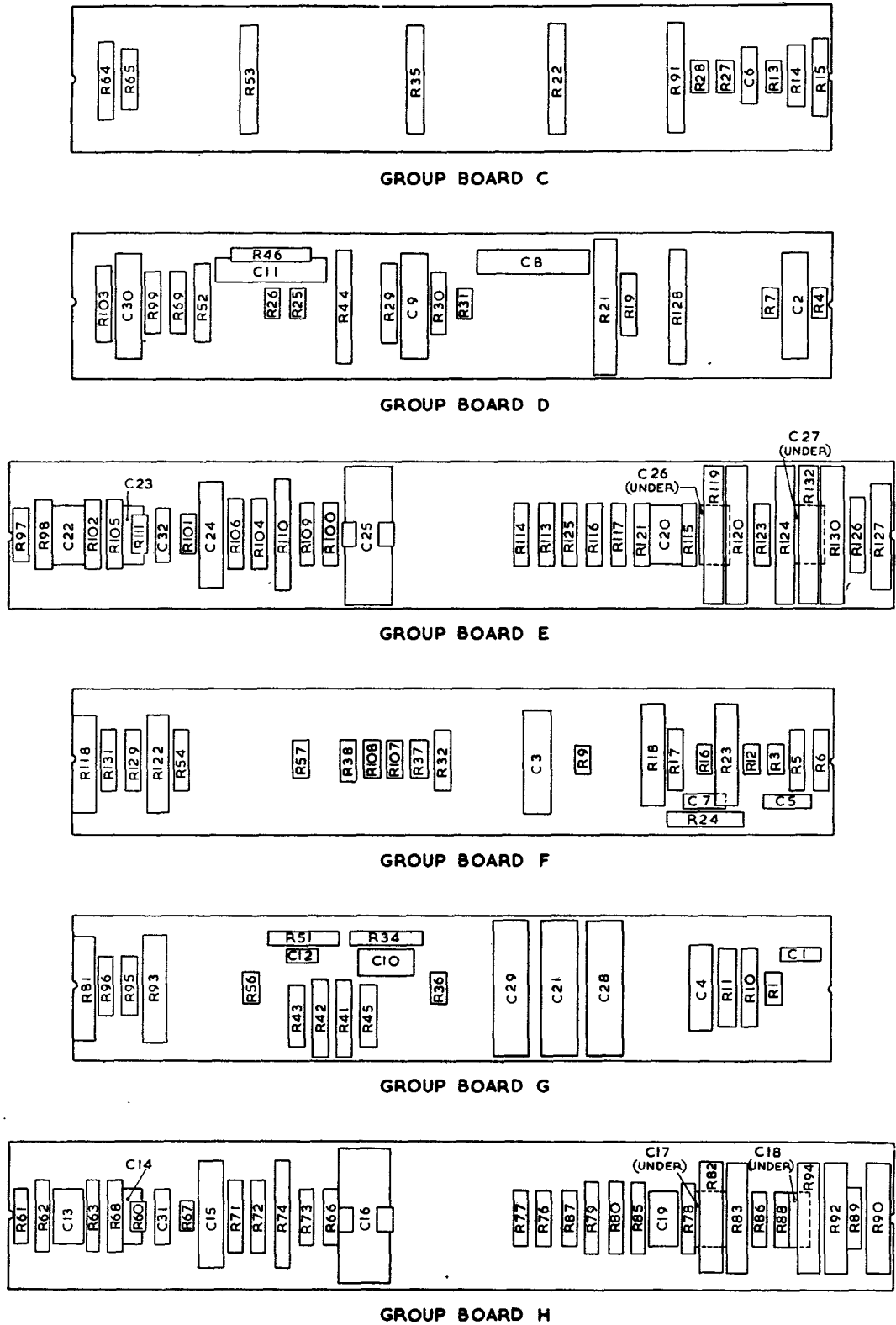


Fig. 18. Amplifying unit (clamping and distribution) Type 504—layout on group boards



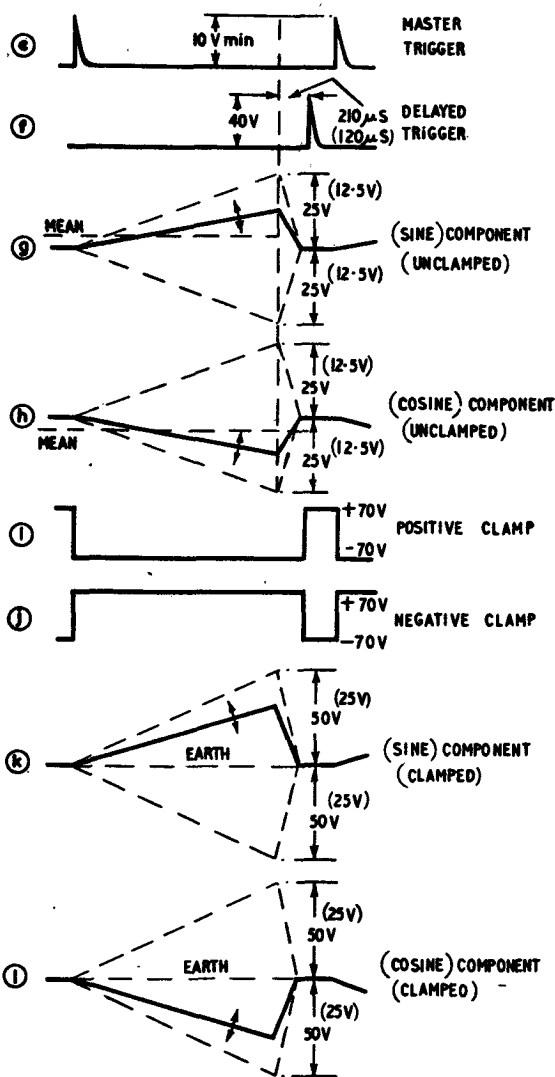
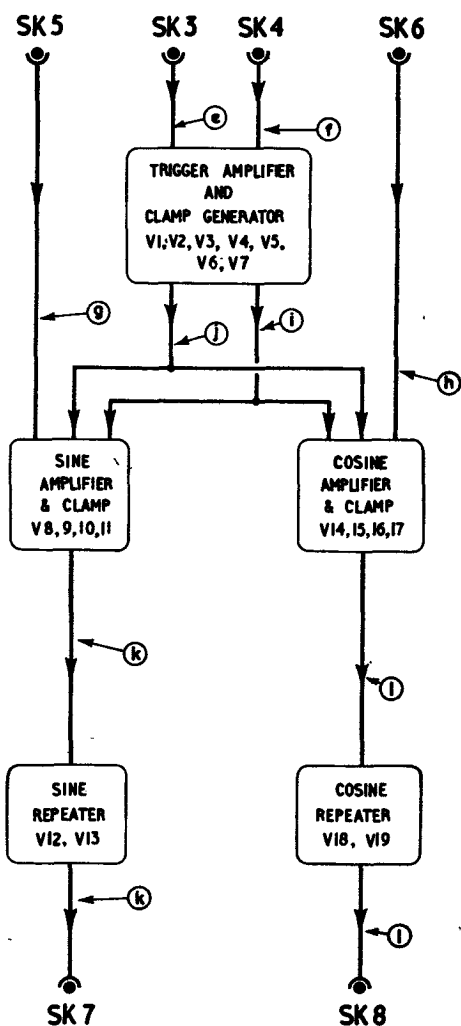
to prevent any stray negative spikes on the trigger input from affecting V3. V3a anode is low (about +200V), and because of the DC cross-coupling R24/R23, V3b grid is also low (about -15V). By cathode-follower action in V3a the common cathode potential is near earth, so V3b is entirely cut off and its anode is up at HT potential. The diode V2a is cut off too, for although its cathode is strapped to V3b grid (-15V), its anode is returned to an even more negative point at the junction R14/R15 (-30V).

**72.** When the 40V positive delayed trigger pulse (waveform *f*) appears at SK4, it is AC-coupled to the anode of V2a which is made to conduct. V3b grid is therefore taken positive, and the common cathode follows it up, cutting off V3a. When this happens V3a anode rises to HT, so V3b grid is held up at a positive voltage, and the cathode with it. The trigger circuit has now changed over, forming at V3b anode the leading edge of the clamp pulse.

**73.** This second stable state persists until the positive-going master trigger pulse—amplified up to 40V—is applied from V1b anode via diode V2b to the grid of V3a. The pulse amplitude is sufficient to switch on V3a, bringing down its anode and V3b grid with it. Consequently the common cathode potential falls back to earth, and the original stable state is restored, forming the trailing edge of the clamp pulse. The rapidity of the changeover on both edges is improved by the 33 pF capacitor C7 shunting the cross-coupling resistor R24.

*Negative clamp cathode-follower*

**74.** Only the negative-going pulse (at V3b anode) is taken out from the trigger circuit, and AC-coupled to the grid of the negative clamp cathode-follower V5 (CV2127). The waveform is DC-restored by the diode V4a so that the top of the waveform is settled just below +70V. The peak-to-peak amplitude at V5 cathode is 140V, so during the clamp period the cathode falls to



**NOTE:** AMPLITUDES AND TIMINGS ARE FOR 250 c/s; THOSE FOR 500 c/s SHOWN IN BRACKETS

**Fig. 19. Amplifying unit (clamping and distribution) Type 504—block diagram and waveforms**

--70V. The output (*waveform j*) is applied to the clamp diodes.

#### Positive clamp see-saw

**75.** To produce the positive clamp pulse is the function of the see-saw amplifier, comprising the pentode V6 (CV138) connected as an amplifier phase-inverter, and the cathode-follower V7 (CV2127). From V5 cathode the negative clamp pulse is applied via the 680 K $\Omega$  input arm R34 to V6 grid. The feedback arm R51 (also 680 K $\Omega$ ) is connected from the amplifier output back to the same grid. Since the see-saw ratio is unity, the positive clamp pulse (*waveform i*) also has a peak-to-peak amplitude of 140V, and the DC conditions are again arranged so that top and bottom are at +70V and -70V respectively.

#### Sine amplifier and clamp

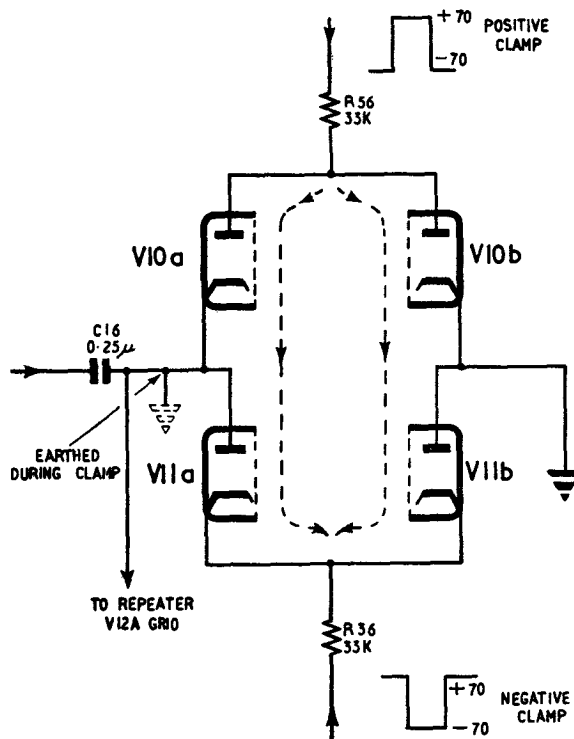
**76.** The see-saw amplifier V8/V9 is included to amplify and phase-invert the sine sawtooth component prior to clamping. DC coupling is used within the amplifier to ensure valve current stability and avoid gain drift over a period of time. The input arm to V8a grid totals over 140 K $\Omega$  (subject to the x GAIN controls RV1 and RV7), and the feedback arm (R68) is 330 K $\Omega$ ; thus the gain from SK5 to V9 anode is about 2 (adjustable by RV1 and RV7).

**77.** V8 is a CV492 double-triode amplifier, cathode-coupled, which provides gain without phase-inversion and with freedom from change of gain due to heater-voltage variations. The waveform is AC-coupled (by C15) from V8b anode to V9 grid, though a DC chain (R67, 60, 68, 71, 72) is included for DC stability.

**78.** V9 is a straightforward pentode amplifier; from its anode come the negative feedback via R68, and the coupling to the clamp diodes and the repeater via C16. The gain of the amplifier is set up by a comparison test with the original master sawtooth.

#### Clamping diodes

**79.** The rest-level part of the sawtooth components has to be held at earth during the clamp period, which extends right up to the start of a new sweep. This clamping is done by the double diodes V10 and V11. Fig. 20 shows how the diodes are connected in a form of bridge. During the non-clamp period the anodes of the top two diodes are at -70V, and the cathodes of the bottom two are at +70V, so all the diodes are cut off and have no effect on the normal sawtooth input via C16 to V12a grid. During the clamp period, however, the top of R56 rises to +70V, and the bottom of R36 falls to -70V; the diodes are switched on, and equal currents of about 2 mA (dotted lines in *fig. 20*) flow down the two arms. The diodes form a Wheatstone bridge with equal arms, and the junction of V10a cathode with V11a anode is held at the same potential as the junction of V10b cathode with V11b anode, i.e. earth. At the end of the clamp period the two clamp waveforms change back



DOTTED LINES SHOW SITUATION DURING CLAMP PERIOD

Fig. 20. Sine clamp diodes

again, the clamp is released and the sweep can start.

**80.** The circuit ensures accurate clamping even if the clamp pulse amplitudes are wrong (they have a tolerance of 10V). Only differences of diode resistances and contact potentials could cause inaccuracy, and such inaccuracy remains constant and may be taken up by DC level set controls later in the circuit.

#### Sine repeater

**81.** The clamped sawtooth sine component is applied direct to the grid of V12a. The double triodes V12 (CV492) and V13 (CV491) form the repeater circuit designed to feed out the sine component (from low impedance source) to as many as 36 head selector units, for re-distribution to consoles. No phase reversal is required, and the gain has to be close to unity.

**82.** The sine repeater, of which *fig. 21* is a simplified circuit diagram, comprises a direct-coupled long-tailed cathode-coupled pair of triodes V12a and b, driving the triode amplifier V13a and the cathode-follower V13b. The requirements of the complete repeater are a linear gain of just over 1, accurate preservation of DC levels with freedom from drift effects, and low output impedance. The drift-free requirement is met by making V12 a *balanced* pair, with equal anode loads. If in this circuit it can be ensured that the drive at V12b grid is the same as the initial

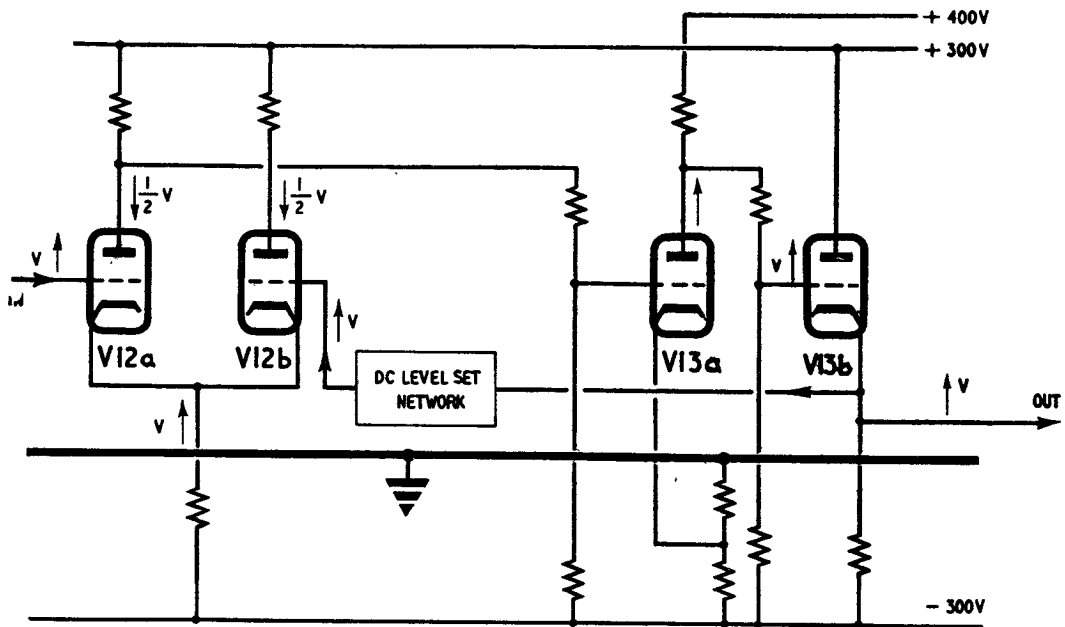


Fig. 21. Sine repeater

input to V12a, then the gain to either anode will be  $1/n$ , where

$$n = \frac{2 \times \text{cathode load}}{\text{anode load}} = 2 \text{ approx. (in the present circuit).}$$

The gain of the subsequent coupling, triode amplifier and cathode-follower has therefore been made about 2 to comply with the requirement for equal drive, the output from the cathode-follower being connected back to V12b as well as to the output socket SK7 (waveform k).

83. The negative feedback from V13b cathode to V12b grid ensures that linearity is maintained, and also takes care of changes in cathode conditions in V13. Similar changes in V12

cathodes cancel each other out because of the common cathode connection.

#### Cosine repeater

84. The circuit of the cosine repeater is identical with that of the sine repeater, and includes similar setting-up controls. The output waveform (l) appears at SK8.

#### Setting-up facilities

85. To ensure accurate PPI presentation, the repeaters have to be set up to give equal sine and cosine DC levels (zero output during the rest period) and equal gain. The procedure for doing this is described in Chap. 2, Sect. 1, Part 2 of this Volume.

## POWER UNIT TYPE 904

### INTRODUCTION

86. The power unit Type 904 (A.M. Ref. 10K/17132) is a general purpose HT and LT power unit, designed initially for use in the rack assembly (resolver magstrip) Type 301, where each such power unit is used in conjunction with a resolver unit (magstrip) and an amplifying unit (clamping and distribution) Type 504.

#### Purpose

87. The unit produces several 6.3V 50 c/s heater supplies for internal and external use, a raw +570V HT supply, and stabilized HT supplies at +400V, +300V and -300V. The maximum currents that may be drawn from the stabilized HT rails without loss of regulation are approximately 50 mA from the +400V, 200 mA from the +300V and 100 mA from the -300V. Some of these supplies are not used in the magstrip resolver rack, but are included for later applications.

88. The -300V stabilizer uses as reference voltage the -500V Station reference supply, and

the two positive stabilizers are in turn referred to the -300V rail. The benefit of this arrangement is that if—in spite of the stabilization—the -300V should drift slightly, the +300V and +400V outputs will move in the opposite direction and so minimize the adverse effect on direct-coupled amplifiers, etc., in the external units.

#### Cut-out and protection

89. A special protection circuit closes down all three HT supplies if any one of them moves more than a few volts away from the nominal value. This provides a safeguard against gross overloads in the external unit as well as against stabilizer troubles. Additionally, ordinary fuses in the mains and HT lines offer protection against overloads, and thermal fuses physically attached to the transformers disconnect the mains from both transformers if either of them should overheat.

#### Construction

90. The power unit is constructed on a rigid

steel chassis which extends the whole width of the rack. To the two side plates are attached U-shaped lifting handles, and outside the side plates are the angle brackets each with three captive screws for attachment to runners. The unit is divided into two halves (front and rear) by a vertical component-mounting panel. Forward of the dividing panel are the valves, relays and smaller components (*fig. 22*); on the front panel itself are all the switches, preset controls, fuses and indicator lamps, and also the 25-way metering socket. Behind the dividing panel are the transformers and chokes and the larger capacitors (*fig. 23*); the plug and socket outlets are on the rear panel, which for *fig. 23* has been swung down through 90 deg.

### CIRCUIT DESCRIPTION

**91.** A complete circuit diagram of the power unit appears in *fig. 27*. In addition to the LT and HT transformers and the positive and negative rectifiers and stabilizers, it shows the cut-out (protection) circuit, and also the circuit of the SET/CHECK/LOAD switch which enables the outputs to be set up and checked before application to the external load.

#### —300V supply

**92.** The —300V supply starts with the 420V–0–420V winding on the HT transformer TR1 feeding V11 (CV378), which is a double-diode with indirectly-heated cathode (5V heater),

connected in a conventional full-wave rectifier circuit. Next comes a single capacitor input filter section C10, L3, C11 which eliminates most of the ripple. A 1 MΩ resistor R56 shunts the filter output; its purpose is to discharge the filter capacitors more rapidly after the power unit has been switched off in the absence of external load. The positive side of the supply has in series a 250 mA cartridge fuse FS5, with an indicator neon LP4 across it to light up when the fuse has blown. The voltage between the two sides of the supply of this stage is about 480V; neither side is yet earthed.

#### —300V stabilizer

**93.** After the fuse comes the series regulator valve and associated circuit; its purpose is to produce a stable and ripple-free 300V supply, the positive pole of which is subsequently earthed. The operation of the stabilizer is easier to comprehend if the earthing of V12 cathode and the positive pole of the output is, temporarily, ignored. (The action of the stabilizer circuit is, of course, just the same whichever pole is subsequently earthed.)

**94.** The regulator valve V12 is a CV345 beam tetrode, triode-connected. The potential drop across it is controlled by its grid voltage, which is governed by the control pentode V13 (CV138). The grid of V13 is returned via R66 to the slider

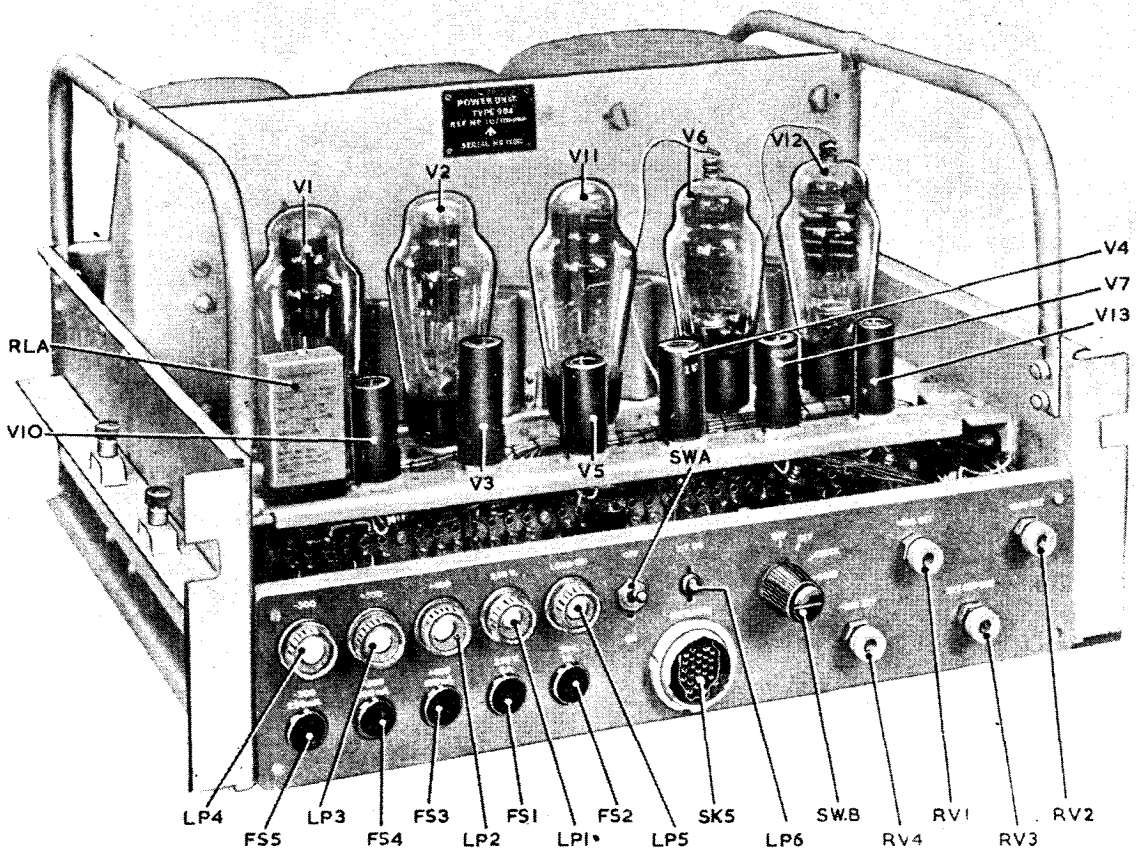


Fig. 22. Power unit Type 904—front view

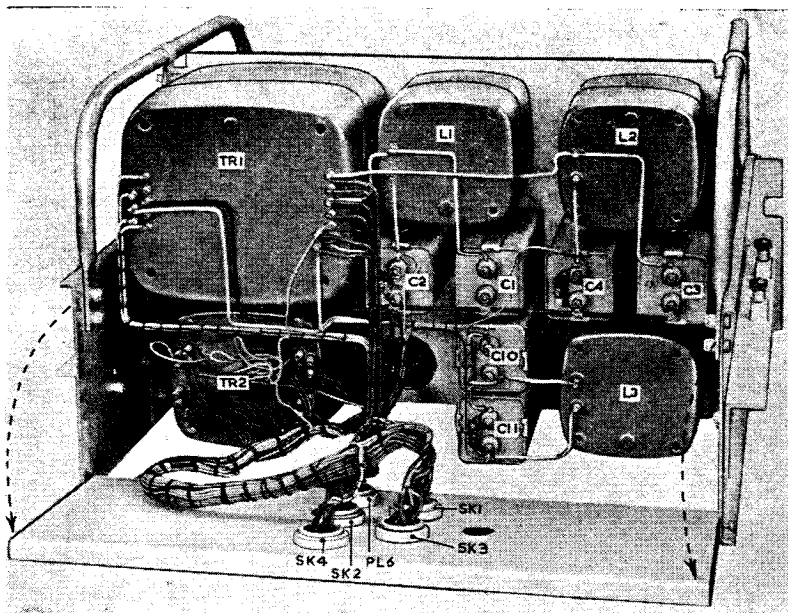


Fig. 23. Power unit Type 904—rear view

of the SET  $-300$  potentiometer RV4, which forms part of a resistance chain connected between the positive pole of this supply and the Station reference voltage of  $-500V$ . Thus a proportion of any fluctuation in the potential difference between these two lines is direct-coupled to V13, at the anode of which an amplified fluctuation appears in the opposite phase; it is then applied to the tetrode grid via a  $4.7 K\Omega$  anti-parasitic resistor R59.

95. The anode load for V13 is in two parts, R60 ( $330 K\Omega$ ) returned to the positive side of this supply, and R61 ( $680 K\Omega$ ) returned to the  $+300V$  line from the  $+300V$  positive regulator. If R60 alone were used, the drop across it could not exceed the grid-cathode voltage of the tetrode (a few volts only), so V13 anode current could not exceed a fraction of 1 mA. Very poor control would be the result of operating so near cut-off; so R61 has been included to provide extra anode current. (The network is equivalent to a single anode load of  $220 K\Omega$  taken to an HT supply of about  $100V$  higher than if R60 alone were used).

96. Extra control for fast fluctuations and ripple is obtained by injecting them straight into V13 grid circuit via C12. Additional compensation for fluctuations—both fast and slow—in the rectifier output is provided by R57, which injects a fraction of such changes into V13 grid circuit, across R67 + R68. Since gain on AC has already been augmented by including C12, less of this additional compensation is needed on AC, so C12 is connected to the junction of R67 and R68.

97. The SET  $-300$  control RV4, which governs the DC condition of V13 and V12 and so sets the regulated output, is adjusted with the aid of the standard metering unit across the output (SK5/T); R73 has been made a 1 per cent. high stability resistor for this reason. The test switch should be turned to the SET position while

setting-up, so that the external load is disconnected and the internal dummy load R83 ( $22 K\Omega$ ) used instead.

#### +570V and +400V supplies

98. The circuit of the rectifier which produces the raw  $+570V$  and stabilized  $+400V$  supplies is similar to that for the  $-300V$ . It incorporates a  $490V-0-490V$  transformer winding feeding the double-diode V1 (another CV378) and the filter section C1, L1, C2. There follows a 100 mA fuse FS3 with its indicator neon LP2. The negative side of the supply is earthed from the start. The voltage here is about  $+570V$ , and is tapped off for external use at this stage.

#### +400V stabilizer

99. The series regulator valve V3 for the  $+400V$  supply is similar to that for the  $-300V$ , but a small pentode (CV2179) is used instead of the CV345 (tetrode) because of the smaller demands made on the  $+400V$  rail.

100. The anode load for the control valve V5 (CV138) is the  $220 K\Omega$  resistor R6. Ideally R6 should be returned to the  $+400V$  stabilized side of the circuit, but this would raise the same difficulty that was mentioned in para. 95, i.e. that the control valve would have to operate very near cut-off and the control obtained would be very poor. R6 is therefore taken to the anode of a boost neon V4 (CV284), which draws current via R4 from the unstabilized side of the supply. The drop across V4 while it is drawing current is a constant  $75V$  at 10 mA, so that V5 gets more HT than would otherwise be the case, without the disadvantages that would arise from using raw unstabilized H.T.

101. The setting of RV1 (SET  $+400V$ ) affects the DC level of V5, and so controls the actual output voltage. When setting-up this potentiometer, the output is measured at SK5/B using the multimeter Type 100. Since the reference voltage for this stabilizer is the  $-300V$  from the other, the latter must always be set-up first.

#### +300V supply

102. The  $+300V$  supply has a separate double-diode rectifier V2 (CV378) connected to the same HT transformer winding as the other positive rectifier. The stabilizer circuit is very similar to that for the  $+400V$ , but no HT boost neon is required for the control valve V7, because the stabilized  $+400V$  supply is available for its HT.

#### Protection (cut-out) circuit

103. The protection valve V10 (CV138) and the protection relay RLA are included to close down all HT supplies entirely if any of the three HT rails moves more than a few volts from its nominal value. As well as protection against stabilizer

faults, this circuit is a safeguard against overload faults in the external unit, since when an exceptionally large current (which may still not be enough to blow the fuses) is drawn from any rail, the associated regulator will be unable to hold up the voltage, and the cut-out will operate.

**104.** The circuit works by keeping RLA de-energized as long as the outputs are correct, and energizing it when they vary, so opening the normally-closed contact A1 and tripping the HT. RLA is a sensitive Carpenter relay, and each of its two 675-ohm coils is in series with a germanium diode CV425 and a limiting resistor. The CV425 has a forward resistance of about 200Ω and a back resistance approaching 60 K. The two relay coil circuits, in which the germanium crystals are connected in opposite senses, are connected in parallel between V10 cathode and earth.

**105.** When all three rails are at exactly their correct values, relative to the -500V ref., and the potentiometer RV3 (SET CUT-OUT) has been correctly adjusted, the values of R48-R51 have been chosen so that V10 cathode rests at earth potential. In this state neither of the germanium diodes is conducting, and all the V10 valve current is drawn from the -50V line via the 12KΩ resistor R43. But if (for example), the +300V now moves positive with respect to the -500V, V10 grid rises proportionately and the cathode starts to rise by cathode-follower action. V9 now conducts and offers a fairly low resistance path to earth via R42 and one winding of the Carpenter relay, so that the greater part of the valve current flows this way and the relay is energized. Likewise, if V10 grid goes down due (for example) to a fall on the +400V rail, the cathode falls and brings the other germanium crystal into conduction, diverting the valve current through the other Carpenter winding and energizing the relay.

**106.** The protection circuit is set up (after the test switch has been turned to SET and the three HT rails have been correctly adjusted) by metering V10 cathode, using the multimeter Type 100 (SK5/E), and turning RV3 until the potential at V10 cathode is zero.

#### Power unit switching

**107.** The ON-OFF switch for the power unit is SWA, a double-pole single-throw toggle switch which brings in 230V 50 c/s mains and -50V for relays, etc. Assuming SWB is in the OFF position, closing SWA brings on the LT transformer TR2 only; LT is fed to internal valves (except rectifiers) and to the external unit, but no HT is produced at this stage.

**108.** The HT is now brought on in three stages, using the four-position wafer switch SWB. This has three wafers, SWBa, SWBb and SWBc, and there are two contact groups on each wafer. On SWBa, contacts 2 to 5 concern the -300V output, and contacts 8 to 10 the relay and lamp

circuit. On SWBb, contacts 3 to 5 relate to the +400V, and contacts 8 to 11 to the +300V. SWBc concerns only the raw +570V output.

#### SET position

**109.** When SWB is turned from OFF to the SET position, earth is connected via contact 8 on SWBa to one side of RLB, the other side of which is connected to the -50V supply. The relay energizes and its contacts close and operate as follows:—

- (1) Contact B1 applies 230V mains to the HT transformer TR1, bringing on the positive and negative rectifiers.
- (2) Contact B2 completes the earth return of the red HT ON lamp LP6, causing it to light.
- (3) Contact B3 routes -50V out via PL6/F to the negative reference rack, there to close a relay which supplies -500V reference voltage back to this unit at PL6/C.

In this switch position the protection circuit is not effective, giving an opportunity to adjust all the SET controls without tripping the HT. So that the stabilizers may be set up under standard conditions, contact 2 on SWBa connects a 22 KΩ 6-watt dummy load R83 across the -300V supply, and contact 8 on SWBb connects a similar load R82 across the +300V. No similar load is connected across the +400V, as this rail is only lightly loaded by the external unit when in use. None of the HT supplies is yet connected out to the external unit.

#### CHECK position

**110.** In the CHECK position of SWB, the 22 KΩ dummy loads stay across the 300V outputs, but the relay circuit is altered. Instead of earth being connected directly to one side of RLB, it now reaches the relay via its own contact B2, the protection contact A1 (provided the protection circuit is in order) and contact 10 on SWBa. So RLB only holds in provided the setting-up has been completed correctly. The CHECK position thus gives an opportunity to confirm that the power unit is in order before any HT is applied to the external load. If RLB drops out at this stage (as indicated by the extinction of LP6), it is necessary to revert to the SET position and make sure the setting-up has been done correctly.

#### LOAD position

**111.** Finally, all being well, SWB is turned to the LOAD position. Here the same relay circuit is maintained as in the CHECK position, so the protection circuit continues to be effective. The remaining contact groups on SWB disconnect the dummy loads from the -300V and +300V supplies, and apply them and the +400V and raw +570V supplies out to the external load instead.

#### Sundry components

**112.** The capacitors C14 to C19 are suppression capacitors, connected across certain switch and

relay contacts to minimize sparking and radiation of interference.

113. The neon lamp LP5 with its 220 K $\Omega$  ballast resistor is connected across the -300V

dummy load R83. On a serviceable power unit LP5 lights up in the SET and CHECK positions of SWB, and provides a useful quick check that the -300V rectifier is working. It does **not** light in the normal (LOAD) position.

### PANEL (DISTRIBUTION) TYPE 877

#### Introduction

114. The panel (distribution and switching) Type 877 (A.M. Ref. 10D/18864) is located at the base of the rack assembly (resolver magstrip) Type 301 (*fig. 1*). Through the panel are routed all the coaxial services between units in that rack and the rest of the radar office. The panel contains a monitor switch that is remotely operated from the waveform monitor rack. By its means any one of the sine and cosine timebase components coming from resolver units in the rack may be selected and examined at the monitor rack. There is also a general-purpose 5-amp. mains socket for a soldering iron or test gear.

#### Construction

115. The unit is constructed in the form of an inverted T, and it is fixed to the base plate of the rack—over the air inlet—by two captive screws at the sides (*fig. 24*). As seen from the front of the rack, the coaxial sockets for external rack connections are on the right horizontal arm of the T,

and those for internal on the left; the mains socket, fuses and switch are at the rear.

#### Circuit description

116. *Fig. 28* is the complete circuit diagram of the panel. It shows how incoming services (master trigger, delayed trigger and master timebase) at both frequencies are each paralleled out to three outlets so that any service is available for any resolver/amplifier group when required.

#### Re-allocation of resolver/amplifier

117. If (for instance) resolver/amplifier group No. 1 is at present operating on 500 c/s, as shown on the rack circuit diagram (*fig. 29*), and it is required to re-allocate the resolver for use with a 250 c/s head, the following alterations have to be made here on the panel Type 877 :—

- (1) Transfer cable 1335 from SK35 to SK32
- (2) Transfer cable 1338 from SK38 to SK27
- (3) Transfer cable 1339 from SK39 to SK26.

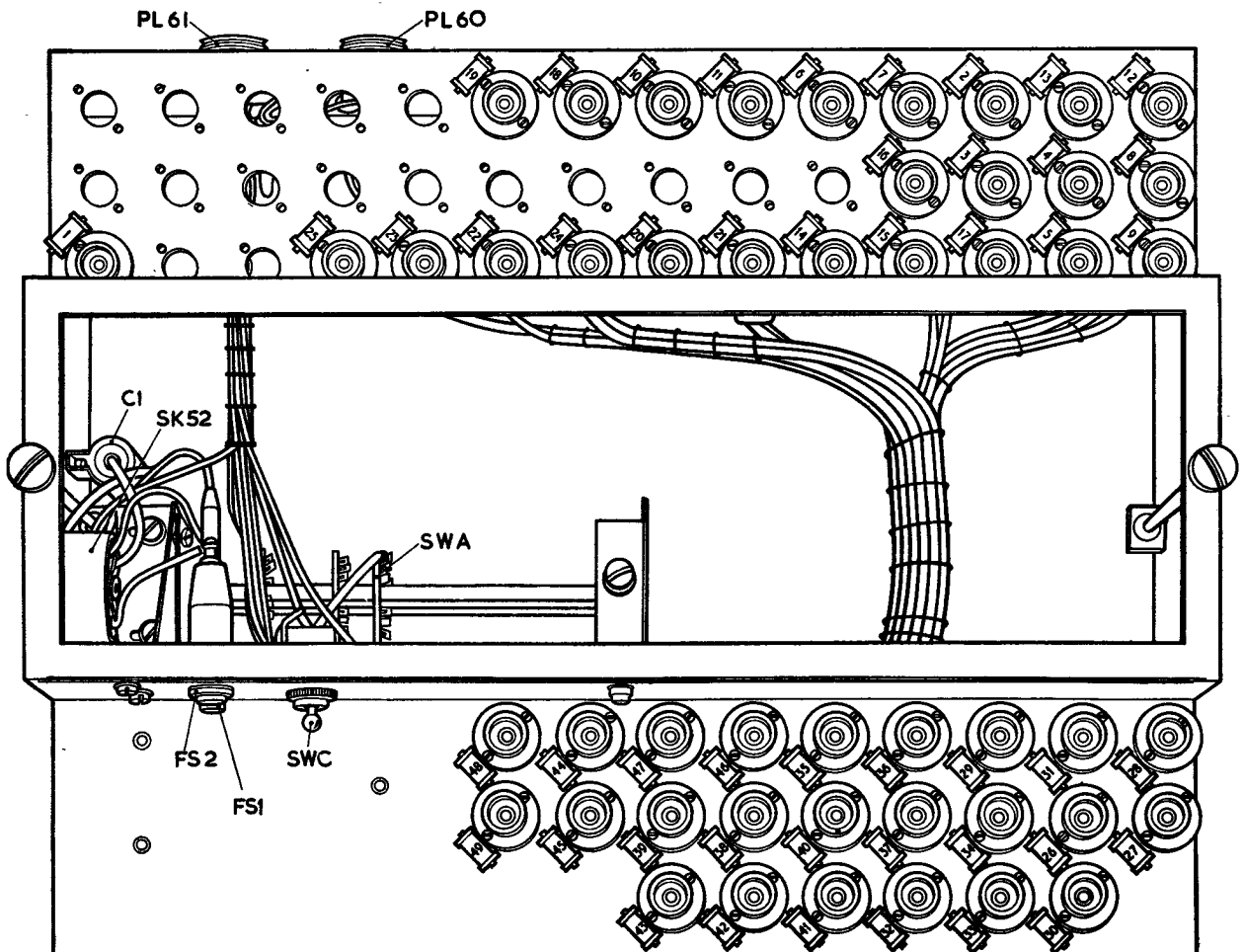


Fig. 24. Panel (distribution) Type 877—top view

It will also be necessary to ensure that selsyn information from the new head is applied to the resolver, but that does not affect this rack assembly.

#### Monitor switch

**118.** The monitor switch is SWA ; its purpose is to select one of the six timebase components passing through this panel, and feed the chosen waveform out via SK1 to the waveform monitor rack. The switch is turned by a rotary actuator (*Ledex*), which is operated by switching lines from the monitor rack entering this panel on PL60 and PL61. In the position shown in fig. 28, earth is connected to one side of the actuator winding via PL61/E, but the actuator cannot energize because  $-50V$  is only being applied from the monitor rack to wiper 1 of SWAa (rear), via PL60/A, and wiper 1 is opposite the blank portion on the switch blade. In this state the waveform from SK41 is fed out to the monitor by SWAc/1.

#### Actuator action

**119.** If now  $-50V$  is applied to wiper 6 (for example) of SWAa (rear), via PL60/F, the actuator is energized and then immediately

released again because its normally-closed contact opens and cuts off its supply. The opening and re-closing of the contact pulls the whole switch round one step by means of a ratchet and pawl device. The actuator is immediately energized again, and the "stepping" action persists automatically until the blank portion of the blade has come round to wiper 6 ; when this is reached no more  $-50V$  can reach the actuator, and the stepping action ceases. Blades on the other wafers of SWA are now in position 6, with the result that the waveform from SK48 is now routed out to the waveform monitor by SWAb.

**120.** The front wafer of SWAa, with the insulated wiper No. 9 and the blank portion on the blade staggered forward one step, has no purpose in this panel, but is part of the standard switch which also figures in more complex applications in other rack assemblies.

#### Note . . .

Tables 1 to 5 are included as an aid to servicing, for identifying connectors and components, and for selecting replacements of the correct ratings.

**TABLE I**  
Rack assembly (resolver magslip) Type 301  
List of input and output connections

#### Note . . .

This list, which applies to initial GCI installations, is issued here for early information only, and may be supplemented or superseded by current Service orders. Full cabling schedules (from which this Table is extracted) will be issued separately to the individual stations.

13 = Panel (distribution) Type 877

14 = Side input panels

R.A. = rack assembly

PL or SK	Type	Location	Moulding position	Pin	Service	Destination	
SK1	Coaxial	13	—	—	Selected waveform	R.A. (waveform monitor) Type 339	
SK2	Coaxial	13	—	—	500 c/s TB IN	R.A. (timebase) Type 300	
SK3	Coaxial	13	—	—	500 c/s TB OUT	Next R.A. 301	
SK4	Coaxial	13	—	—	250 c/s TB IN	R.A. (timebase) Type 300	
SK5	Coaxial	13	—	—	250 c/s TB OUT	Next R.A. 301	
SK6	Coaxial	13	—	—	500 c/s trigger IN	Master trigger unit	
SK7	Coaxial	13	—	—	500 c/s trigger OUT	Next R.A. 301	
SK8	Coaxial	13	—	—	250 c/s trigger IN	Master trigger unit	
SK9	Coaxial	13	—	—	250 c/s trigger OUT	Next R.A. 301	
SK10	Coaxial	13	—	—	500 c/s delayed clamp trig. IN	R.A. (timebase) Type 300	
SK11	Coaxial	13	—	—	500 c/s delayed clamp trig. OUT	Next R.A. 301	
SK12	Coaxial	13	—	—	250 c/s delayed clamp trig. IN	R.A. (timebase) Type 300	
SK13	Coaxial	13	—	—	250 c/s delayed clamp trig. OUT	Next R.A. 301	
SK14	Coaxial	13	—	—	X defl. waveform (sine) from RES. 1	} All head selector racks	
SK15	Coaxial	13	—	—	X defl. waveform (sine) from RES. 1		
SK16	Coaxial	13	—	—	Y defl. waveform (cosine) from RES. 1		
SK17	Coaxial	13	—	—	Y defl. waveform (cosine) from RES. 1		
SK18	Coaxial	13	—	—	X defl. waveform (sine) from RES. 2		
SK19	Coaxial	13	—	—	X defl. waveform (sine) from RES. 2		
SK20	Coaxial	13	—	—	Y defl. waveform (cosine) from RES. 2		
SK21	Coaxial	13	—	—	Y defl. waveform (cosine) from RES. 2		
SK22	Coaxial	13	—	—	X defl. waveform (sine) from RES. 3		
SK23	Coaxial	13	—	—	X defl. waveform (sine) from RES. 3		
SK24	Coaxial	13	—	—	Y defl. waveform (cosine) from RES. 3		
SK25	Coaxial	13	—	—	Y defl. waveform (cosine) from RES. 3		
PL50	6-way (med.)	14	0	A B C D E F	Neutral Line $-500V$ reference 50V $-$ 50V $+$ 50V $-$ neg. ref. control		} Rectifier Type 15
PL51	6-way (med.)	14	0	A-F	As PL50		
PL52	6-way (med.)	14	0	A-F	As PL50		R.A. (neg. ref.) Type 338 R.A. (neg. ref.) Type 338 As PL50 As PL50



TABLE I—cont.

PL or SK	Type	Location	Moulding position	Pin	Service	Destination
PL53	12-way	14	1	A	Sector select 270°-90°	RES. 3 Input panel, PPI consoles, PL4/K Input panel, PPI consoles, PL4/L Input panel, PPI consoles, PL4/M Input panel, PPI consoles, PL4/N Input panel, PPI consoles, PL4/O Input panel, PPI consoles, PL4/P Input panel, PPI consoles, PL4/Q Input panel, PPI consoles, PL4/R
				B	Sector select 315°-135°	
				C	Sector select 360°-180°	
				D	Sector select 45°-225°	
				E	Sector select 90°-270°	
				F	Sector select 135°-315°	
				G	Sector select 180°-360°	
				H	Sector select 225°-45°	
PL54	12-way	14	0	J-M	Spare	RES. 3 From appropriate search head via combined head control rack (F earthed in trunking) Rectifier Type 15 All head selector racks
				A	Rotor A1	
				B	Rotor A2	
				C	—	
				D	Stator D	
				E	Stator E	
				F	Stator F	
				G	Auto-align	
				H	50V —	
				J	CRT dimming line	
				K-M	Spare	
PL55	12-way	14	0	A-M	As PL54 (RES. 2)	As PL54
				A-M	As PL54 (RES. 1)	As PL54
PL56	12-way	14	0	A-M	As PL54 (RES. 1)	As PL54
PL57	12-way	14	1	A-M	As PL53 (RES. 2, if back-looker)	As PL53
PL58	12-way	14	1	A-M	As PL53 (RES. 1, if back-looker)	As PL53
PL60	12-way	13	1	A-M	Monitor switching	R.A. (waveform monitor) Type 339 (direct connector)
PL61	12-way	13	2	A-M	Monitor switching	R.A. (waveform monitor) Type 339 (direct connector)

TABLE 2  
Resolver unit (magslip)—IOAE/625  
Component details

Resistors (fixed)

Circuit ref. (fig. 25)	Value (ohms)	Rating (watts)	Tol. (%)	Inter-serv. ref.
R1	680 K	1/2	10	Z223143
R2	680 K	1/2	10	Z223143
R3	330	1/2	10	Z221173
R4	100 K	1/2	10	Z223038
R5*	150	1/2	5	Z215142
R6	470 K	1/2	10	Z223122
R7	220 K	1/2	10	Z223080
R8	1 M	1/2	10	Z223165
R9	330	1/2	10	Z221173
R10	15 K	4 1/2	5	Z244113
R11*	10	1/2	5	Z215002
R12*	200 K	1/2	1	Z216515
R13*	1 M	1/2	1	Z216655
R14*	51 K	1/2	1	Z216376
R15*	270 K	1/2	1	Z216543
R16*	1 M	1/2	2	Z216659
R17*	680 K	1/2	2	Z216627
R18*	100 K	1/2	1	Z216447
R19*	33	1/2	5	Z215062
R20	100	1/2	10	Z221110
R21	100	1/2	10	Z221110
R22*	22 K	1 1/2	5	Z216045
R23*	390 K	1/2	1	Z216575
R24*	1 M	1/2	1	Z216656
R25*	1 M	1/2	1	Z216655
R26	100	1/2	10	Z221110
R27	100	1/2	10	Z221110
R28*	82 K	1/2	5	Z216112
R29*	820	1 1/2	1	Z215619
R30*	200 K	1/2	5	Z216720
R31*	1 M	1/2	2	Z216659
R32*	33	1/2	5	Z215062
R33	33 K	6	5	Z244141
R34*	100 K	1/2	5	Z216123
R35*	22 K	1/2	5	Z216042

Resistors (fixed)—cont.

Circuit ref. (fig. 25)	Value (ohms)	Rating (watts)	Tol. (%)	Inter-serv. ref.
R36*	220 K	1/2	5	Z216723
R37*	330 K	1/2	5	Z216156
R38*	1 M	1/2	2	Z216659
R39*	820 K	1/2	5	Z216176
R40	100	1/2	10	Z221110
R41	100	1/2	10	Z221110
R42*	10	1/2	5	Z215002
R43*	820	1 1/2	5	Z215235
R44	33 K	1/2	10	Z222194
R45	33 K	1/2	10	Z222194
R46	2.2 M	1/2	10	Z223206
R47	4.7 K	1/2	10	Z222089
R48	6.8 K	10	5	Z244083
R49	18 K	6	5	Z244122
R50	56 K	1	10	Z213324
R51 to R54 deleted				
R55*	1 M	1/2	1	Z216655
R56*	1 M	1/2	2	Z216659
R57	100 K	1/2	10	Z223039
R58	100 K	1/2	10	Z223039

\* High stability

Capacitors

Circuit ref. (fig. 25)	Value µF except where stated	Rating (V.D.C.)	Tol. (%)	Inter-serv. ref.
C1	1	150	25	Z115569
C2	2	150	25	Z115572
C3	1	150	25	Z115569
C4	0.1	150	25	Z115560
C5 deleted				
C6 to C13	0.1	150	25	Z115256

TABLE 2—cont.

Capacitors—cont.

Circuit ref. (fig. 25)	Value $\mu$ F except where stated	Rating (V.D.C.)	Tol. (%)	Stores Ref.
◀C14	0.5	375	5	10C/21408 (Type 7620) ▶
C15	10 pF	350	10	Z123007
C16	0.1	350	20	Z115506
C17	22 pF	350	10	Z123031
C18	0.1	350	20	Z115506
◀C19	1	375	5	10C/21409 (Type 7621) ▶
C20	0.5	150	25	Z115566
C21	10 pF	350	10	Z123007
C22	22 pF	350	10	Z123031
C23	0.1	350	20	Z115506
C24	1	150	25	Z115569
C25	0.1	350	20	Z115506
C26	4.7 pF	500	1/2	Z131167
C27	4.7 pF	500	1/2	Z131167
C28, C29 deleted				
C30	0.1	350	20	Z115506
C31	0.1	350	20	Z115506
C32	0.1	500	20	Z115507
C33	1	600	20	Z112823
C34	1	350	20	Z115632
C35	0.1	350	20	Z115506
C36	1	350	20	Z115632

Miscellaneous items

Circuit ref. (fig. 25)	Description	Type	Stores Ref.
X2	Magslip unit 100 3 in. Magslip resolver No. 2 (Mark 2).	AP10966 (Muirhead Cat. No. M.U.8511).	10AE/696

Miscellaneous items—cont.

Circuit ref. (fig. 25)	Description	Type	Stores Ref.
XI	Motor unit 113 (Selsyn receiver)	BTH S1406B6 (BTH Cat. No 19773).	10K/17500
RLA	2,000 ohm relay, DES 43/3LV.	K3000	Z530216
RLB	2,000 ohm relay, DES 61/3HV.	K3000	Z530293
SWA	Toggle switch (D.P.S.T.).	—	Z510304
PL1*	6-way free plug	Mk. 4	Z560301
PL2*	12-way free plug	Mk. 4	Z560361
PL5*	12-way fixed plug	Mk. 4	Z560150
PL6*	12-way fixed plug	Mk. 4	Z560151
PL7*	12-way fixed plug	Mk. 4	Z560153
PL8*	6-way fixed plug	Mk. 4	Z560541
PL9*	6-way free plug	Mk. 4	Z560300
PL10*	4-way free plug	Mk. 4	Z560290
SK11*	12-way fixed socket	Mk. 4	Z560330
SK12 to SK14.	Socket (Belling-Lee T.L316).	714	10H/19641
SK15*	25-way fixed socket	Mk. 4	Z560380
SK16*	6-way fixed socket	Mk. 4	Z560261
SK17*	12-way fixed socket	Mk. 4	Z560331
PL18,	Coaxial plug	790	10H/19698
PL19.			
SK18 to SK22.	Coaxial socket	783	10H/19861
SK23*	6-way fixed socket	Mk. 4	Z560260
SK24*	4-way fixed socket	Mk. 4	Z560250

\* Moulding position on Mk. 4 plugs and sockets is shown by last digit of Z-number.

TABLE 3

Amplifying unit (clamping and distribution) Type 504—10U/16772

Component details

Resistors (fixed)

Circuit ref. (fig. 26)	Value (ohms)	Rating (watts)	Tol. (%)	Inter-serv. ref.
R1	47 K	1/2	10	Z222215
R2	330	1/2	10	Z221173
R3*	150	1/2	5	Z215142
R4	220 K	1/2	10	Z223080
R5*	33	1/2	5	Z215062
R6*	6.8 K	1/2	5	Z215342
R7	10 K	1/2	10	Z222131
R8	330	1/2	10	Z221173
R9	1 K	1/2	10	Z222005
R10*	470 K	1/2	5	Z216739
R11*	100 K	1/2	5	Z216123
R12	68 K	1/2	10	Z223017
R13	68 K	1/2	10	Z223017
R14*	51 K	1/2	1	Z216376
R15*	470 K	1/2	1	Z216591
R16	270 K	1/2	10	Z223092
R17*	33	1/2	5	Z215062
R18*	22 K	1	2	Z216294
R19*	33	1/2	5	Z215062
R20	330	1/2	10	Z221173
R21*	22 K	1 1/2	2	Z216295
R22	47 K	1/2	5	Z244150
R23*	560 K	1	1	Z216608
R24*	430 K	1/2	1	Z216583
R25				
R26				
R27	100	1/2	10	Z221110
R28	100	1/2	10	Z221110

Resistors (fixed)—cont.

Circuit ref. (fig. 26)	Value (ohms)	Rating (watts)	Tol. (%)	Inter-serv. ref.
R29*	220 K	1/2	1	Z216526
R30	56 K	1/2	1	Z216386
R31	2.2 M	1/2	10	Z223206
R32*	10	1/2	5	Z215002
R33	100	1/2	10	Z221110
R34*	680 K	1/2	1	Z216623
R35	33 K	1/2	5	Z244141
R36	33 K	1/2	10	Z222194
R37	33 K	1/2	10	Z222194
R38	15 K	1/2	10	Z222153
R39	330	1/2	10	Z221173
R40	330	1/2	10	Z221173
R41*	1 M	1/2	1	Z216655
R42*	270 K	1/2	1	Z216543
R43*	13 K	1/2	1	Z216237
R44	33 K	1/2	5	Z244141
R45*	10	1/2	5	Z215002
R46*	470 K	1/2	2	Z216595
R47	330	1/2	10	Z221173
R48	330	1/2	10	Z221173
R49	330	1/2	10	Z221173
R50	330	1/2	10	Z221173
R51*	680 K	1/2	1	Z216623
R52*	560 K	1/2	2	Z216611
R53	33 K	1/2	5	Z244141
R54*	10	1/2	5	Z215002
R55	100	1/2	10	Z221110
R56	33 K	1/2	10	Z222194

TABLE 3—cont.

## Resistors (fixed)—cont.

Circuit ref. (fig. 26)	Value (ohms)	Rating (watts)	Tol. (%)	Inter-serv. ref.
R57	33 K	1	10	Z222194
R58	330	1	10	Z221173
R59	330	1	10	Z221173
R60	1.8 K	1	10	Z222038
R61*	15 K	2	2	Z216252
R62*	120 K	1	1	Z216467
R63*	560 K	2	2	Z216611
R64*	150 K	5	5	Z216715
R65*	150	5	5	Z215142
R66*	150	5	5	Z215142
R67	56 K	10	10	Z223008
R68*	330 K	1	1	Z216559
R69*	56 K	2	2	Z216391
R70	330	10	10	Z221173
R71*	510 K	2	2	Z216603
R72*	680 K	2	2	Z216627
R73*	33	5	5	Z215062
R74	33 K	6	5	Z244141
R75	330	10	10	Z221173
R76*	150	5	5	Z215142
R77*	150	5	5	Z215142
R78*	270 K	2	2	Z216547
R79*	270 K	5	5	Z216727
R80*	390 K	2	2	Z216579
R81*	200 K	1	2	Z216522
R82*	1.5 M	1	2	Z216682
R83*	2.4 M	1	2	Z216676
R84	330	10	10	Z221173
R85*	10 K	5	5	Z216003
R86*	33	5	5	Z215062
R87*	33	5	5	Z215062
R88*	100 K	1	5	Z216125
R89*	4.3 K	1	2	Z215792
R90*	150 K	1	5	Z216136
R91	47 K	6	5	Z244150
R92*	2.2 M	1	2	Z216674
R93*	200 K	1	2	Z216522
R94*	1.5 M	1	2	Z216668
R95*	2.4 K	1	2	Z215731
R96*	2 K	1	2	Z215711
R97*	15 K	2	2	Z216252
R98*	120 K	1	1	Z216467
R99*	150	5	5	Z215142
R100*	150	5	5	Z215142
R101	56 K	10	10	Z223008
R102*	560 K	2	2	Z216611
R103*	150 K	5	5	Z216715
R104*	680 K	2	2	Z216627
R105*	330 K	1	1	Z216559
R106*	510 K	2	2	Z216603
R107	68 K	10	10	Z223017
R108	220 K	10	10	Z223080
R109*	33	5	5	Z215062
R110	33 K	6	5	Z244141
R111	1.8 K	1	10	Z222038
R112	330	10	10	Z221173
R113*	150	5	5	Z215142
R114*	150	5	5	Z215142
R115*	270 K	2	2	Z216547
R116*	270 K	5	5	Z216727
R117*	390 K	2	2	Z216579
R118*	200 K	1	2	Z216522
R119*	1.5 M	1	2	Z216668
R120*	2.4 M	1	2	Z216676
R121*	10 K	5	5	Z216003
R122*	200 K	1	2	Z216522
R123*	33	5	5	Z215062
R124*	100 K	1	5	Z216125
R125*	33	5	5	Z215062
R126*	4.3 K	2	2	Z215792
R127*	150 K	1	5	Z216136
R128	47 K	6	5	Z244150
R129*	2.4 K	1	2	Z215731
R130*	2.2 M	1	2	Z216674
R131*	2 K	1	2	Z215711
R132*	1.5 M	1	2	Z216668
R133 to R138.	330	10	10	Z221173

\* High stability

## Resistors (variable)

Circuit ref. (fig. 26)	Value (ohms)	Rating (watts)	Tol. (%)	Function
RV1	50 K	1	10	Gain X—Coarse
RV2	50 K	1	10	Gain Y—Coarse
RV3	10 K	1	10	DC Level Set X—Coarse
RV4	10 K	1	10	DC Level Set Y—Coarse
RV5	100	1	10	DC Level Set X—Fine
RV6	100	1	10	DC Level Set Y—Fine
RV7	2.5 K	1	10	Gain X—Fine
RV8	2.5 K	1	10	Gain Y—Fine

## Capacitors

Circuit ref. (fig. 26)	Value $\mu$ F (except where stated)	Rating (V.DC)	Tol. (%)	Inter-serv. ref.
C1	.002	350	20	Z115551
C2	0.1	350	20	Z115506
C3	0.1	350	20	Z115506
C4	.01	500	20	Z115546
C5	100 pF	500	10	Z132300
C6	1,000 pF	350	20	Z115623
C7	33 pF	500	10	Z132283
C8	0.1	350	20	Z115506
C9	0.1	350	20	Z115506
C10	15 pF	500	10	Z132073
C11	0.1	350	20	Z115506
C12	15 pF	500	10	Z132073
C13	22 pF	350	10	Z123031
C14	10 pF	350	10	Z123007
C15	0.1	350	20	Z115506
C16	0.25	350	20	Z115589
C17	33 pF	350	10	Z123053
C18	18 pF	350	10	Z123014
C19	47 pF	350	10	Z123070
C20	47 pF	350	10	Z123070
C21	0.1	500	20	Z115507
C22	22 pF	350	10	Z123031
C23	10 pF	350	10	Z123007
C24	0.1	350	20	Z115506
C25	0.25	350	20	Z115589
C26	33 pF	350	10	Z123053
C27	15 pF	350	10	Z123014
C28	0.1	500	20	Z115507
C29	0.1	500	20	Z115507
C30	0.1	350	20	Z115506
C31	1,000 pF	350	20	Z115623
C32	1,000 pF	350	20	Z115623

## PLUGS AND SOCKETS

Circuit ref. (fig. 26)	Description	Type	Stores Ref.
PL1*	12-way fixed plug	Mk. 4	Z560152
PL2*	6-way fixed socket	Mk. 4	Z560541
SK3 to SK8	Coaxial socket	783	10H/19861
SK9 to SK16	Socket (Belling-Lee Type L316).	714	10H/19641
SK17*	25-way fixed socket	Mk. 4	Z560380
SK18*	25-way fixed socket	Mk. 4	Z560380

\* Moulding position on Mk. 4 plugs and sockets is shown by last digit of Z-number.

**TABLE 4**  
Power unit Type 904—10K/17132  
Component details

**Resistors (fixed)**

Circuit ref. (fig. 27)	Value (ohms)	Rating (watts)	Tol. (%)	Inter-serv. ref.
R1, R2	1 M	1	10	Z213339
R3	100	10	10	Z221110
R4	22 K	6	5	Z244129
R5	15 K	10	10	Z222152
R6	220 K	1	10	Z213331
R7	4.7 K	10	10	Z222089
R8*	33	5	5	Z215062
R9	100	10	10	Z221110
R10	68 K	1	10	Z213325
R11	47 K	1	10	Z212263
R12	470 K	10	10	Z223122
R13, R14	10	10	10	Z221002
R15*	330 K	1	2	Z216564
R16*	1 M	1	1	Z216655
R17	100 K	10	10	Z223038
R18, R19	1 M	1	10	Z213339
R20	100 K	10	10	Z223038
R21	33 K	6	5	Z244141
R22	deleted			
R23	100	10	10	Z221110
R24, R25	220 K	10	10	Z213331
R26*	33	5	5	Z215062
R27	4.7 K	10	10	Z222089
R28	100	10	10	Z221110
R29, R30	47 K	1	10	Z212263
R31	470 K	10	10	Z223122
B32, R33	220	10	10	Z221152
R34*	330 K	1	2	Z216564
R35*	300 K	1	1	Z216551
R36	100K	10	10	Z223038
R37	150	4	5	Z243113
R38 to R40	deleted			
R41*, R42*	2.7 K	1	5	Z215294
R43*	12 K	1	5	Z216014
R44	6.8 K	4	5	Z244081
R45	100	10	10	Z221110
R46	22 K	10	10	Z222173
R47	2.2 M	10	10	Z223206
R48*	1 M	1	1	Z216655
R49*	750 K	1	1	Z216631
R50*, R51*	1 M	1	1	Z216655
R52 to R54	deleted			
R55, R56	1 M	1	10	Z213339
R57	220 K	1	10	Z213331
R58	100	10	10	Z221110
R59	4.7 K	10	10	Z222089
R60	330 K	1	10	Z213333
R61	680 K	1	10	Z213337
R62*	33	5	5	Z215062
R63	100	10	10	Z221110
R64	47 K	1	10	Z212263
R65	47 K	1	10	Z212263
R66	470 K	10	10	Z223122
R67	220	10	10	Z221152
R68	330	10	10	Z221173
R69*	470 K	2	2	Z216595
R70*	300 K	2	2	Z216555
R71*	240 K	1	2	Z216540
R72	100 K	10	10	Z223038
R73*	300 K	1	1	Z216551
R74*	330 K	1	2	Z216564
R75	220 K	1	10	Z213331
R76	220	10	10	Z221152
R77	470	10	10	Z221194
R78	220 K	1	10	Z213331
R79	680	10	10	Z221215
R80	220	10	10	Z221152
R81	470	10	10	Z221194
R82	22 K	6	5	Z244129
R83	22 K	6	5	Z244129
R84	680	10	10	Z221215

\* High stability.

**Resistors (variable)**

Circuit ref. (fig. 27)	Value (ohms)	Rating (watts)	Tol. (%)	Inter-serv. ref.	Function
RV1	50 K	1	10	Z272410	+300V SET
RV2	50 K	1	10	Z272410	SET CUT-OUT
RV3	50 K	1	10	Z272410	-300V SET
RV4	100K	1	10	Z272549	+400V SET

**Capacitors**

Circuit ref. (fig. 27)	Value ( $\mu$ F)	Rating (V.DC)	Tol. (%)	Inter-serv. ref.
C1 to C4	4	800	20	Z112529
C5	0.1	500	20	Z115587
C6	1	600	20	Z112823
C7	0.1	500	20	Z115587
C8	1	600	20	Z112823
C9	2	200	20	Z112882
C10, C11	4	800	20	Z112529
C12	0.1	500	20	Z115587
C13, C14	1	600	20	Z112823
C15	3	100	-20, +50	Z145017
C16	0.1	500	20	Z115587
C17	1	600	20	Z112823
C18	3	100	-20, +50	Z145017
C19	1	600	20	Z112823

**Miscellaneous items**

Circuit ref. (fig. 27)	Description	Type	Stores Ref.
LP1 to LP5	Neon lamp	—	X962106
LP6	Filament lamp (50V)	—	X959220
RLA	Relay magnetic (675 ohms +675 ohms).	1339	10F/18105
	6U33		
RLB	2,000 ohm relay, 60/3HV	K3000	Z530187
L1	20 henry choke	LF1153	10C/19297
L2	16 henry choke	LF1138	10C/19262
L3	20 henry choke	LF1153	10C/19297
TR1	Transformer	3144	10K/17340
TR2	Transformer	3145	10K/17341
FS1	Cartridge fuse (5 amp.)	21	10H/11718
FS2	Cartridge fuse (1 amp.)	5	10H/9613
FS3	Cartridge fuse (100 mA)	10	10H/10152
FS4	Cartridge fuse (500 mA)	29	10H/238
FS5	Cartridge fuse (250 mA)	23	10H/107
FS6	Thermo cut-out	Assy. A	10AE/653
FS7	Thermo cut-out	Assy. C	10AE/655
SWA	Toggle switch (D.P.S.T.)	—	Z510302
SWB	Wafer switch	2342	10F/17775
SK1*	12-way fixed socket	Mk. 4	Z560332
SK2*	12-way fixed socket	Mk. 4	Z560333
SK3*	6-way fixed socket	Mk. 4	Z560321
SK4*	6-way fixed socket	Mk. 4	Z560321
SK5*	25-way fixed socket	Mk. 4	Z560380
PL6*	6-way fixed plug	Mk. 4	Z560140

\* Moulding orientation on Mk. 4 plugs and sockets shown by last digit of Z-number.

**TABLE 5**  
**Panel (distribution) Type 877—10D/18864**  
**Component details**

Circuit ref. (fig. 28)	Description	Type	Stores Ref.
SK1 to SK49	Socket (coaxial)	783	10H/19861
PL60*, PL61*	12-pole fixed plug	Mk. 4	Z560151, 2
SK52	3-way, 5A socket	(Crabtree L7170)	5C/1042
FS1, 2	Cartridge fuse, 5A	MOS(A)	{ 10H/11718 Z590112
SWA	Uniselector	4067	10F/17463
SWC	Switch DPST, ON/OFF		Z510306
C1	Capacitor, 0.05, $\mu$ F, 350V, 20 per cent		Z115554
MR1	Resistor unit, (non- ohmic) 50V DC	514	10W/19566

\* Moulding position on Mk. 4 plugs is shown by last digit of Z-number.

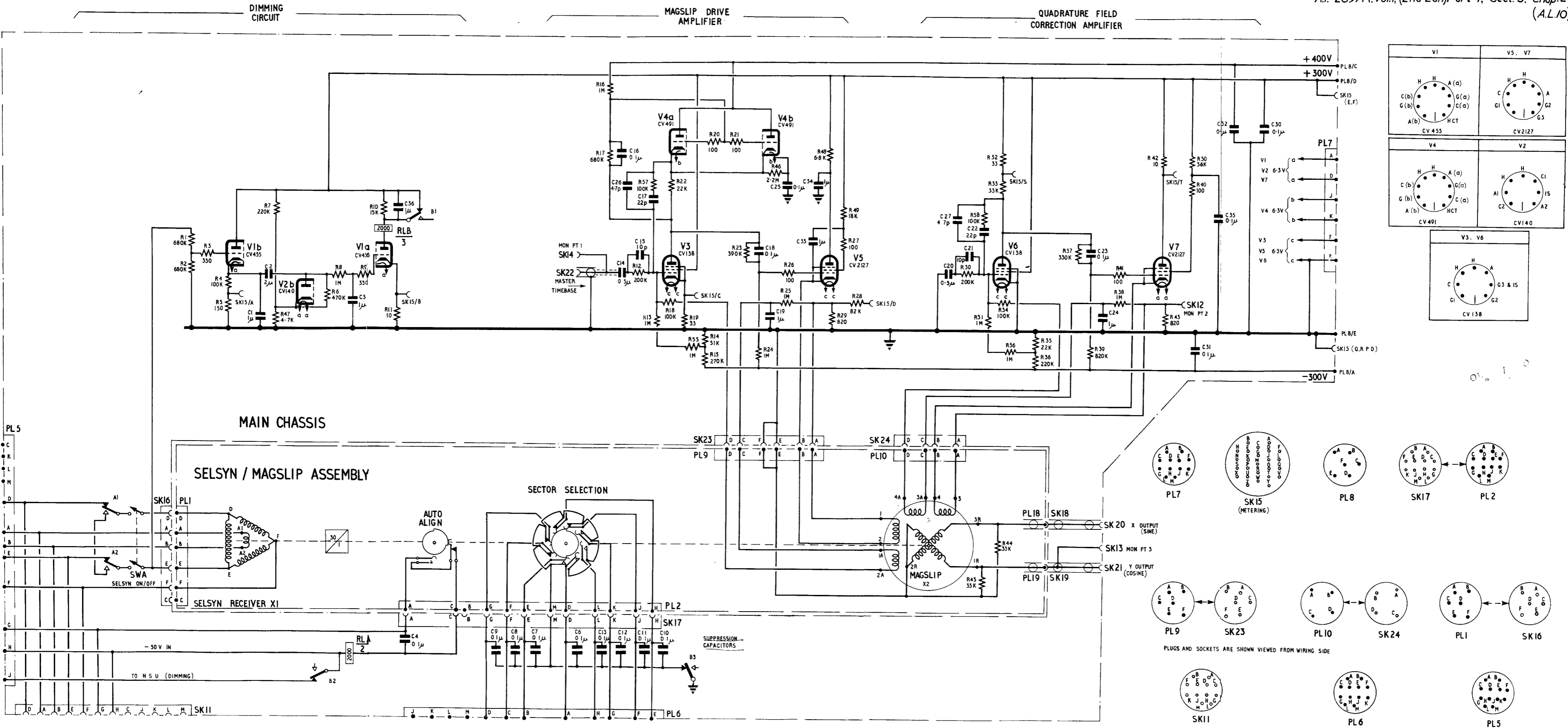


Fig.25 Resolver unit (magslip) - circuit

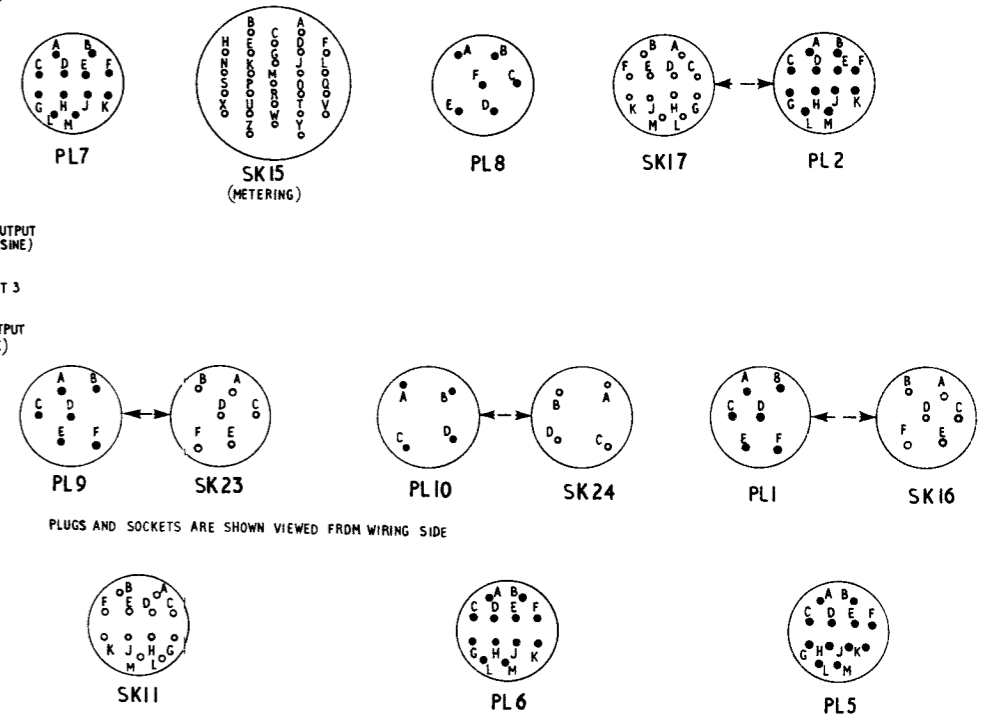
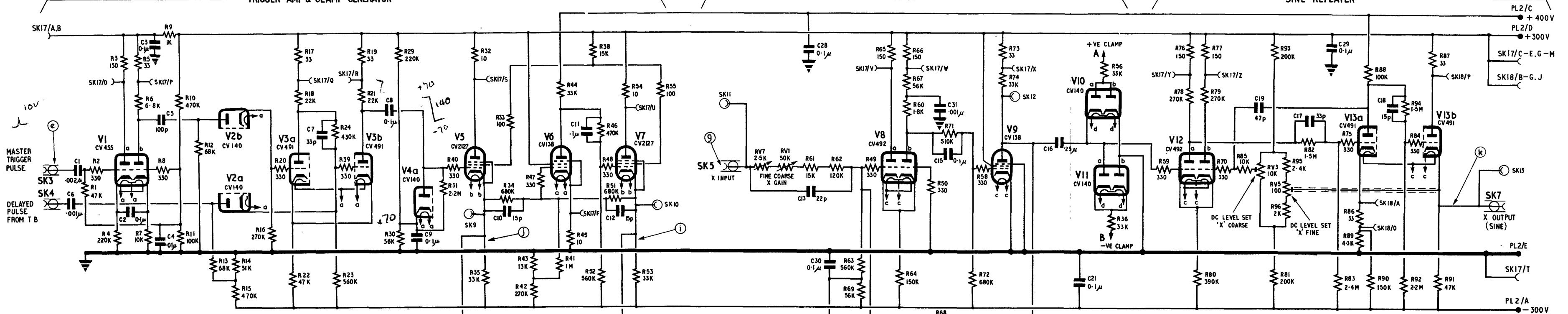


Fig.25 (A.L.10 May 55)

TRIGGER AMP & CLAMP GENERATOR

SINE AMP & CLAMP

SINE REPEATER

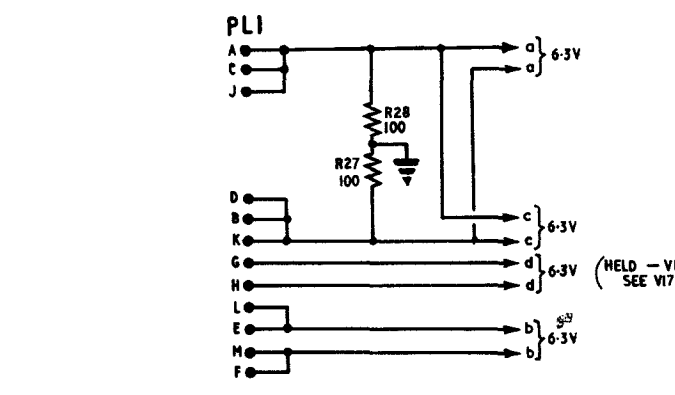


MASTER TRIGGER PULSE  
 DELAYED PULSE FROM T B

PL2/C +400V  
 PL2/D +300V  
 SK17/C-E, G-M  
 SK18/B-G, J

PL2/E  
 SK17/T  
 PL2/A -300V

B -VE CLAMP (V11, V17)  
 A +VE CLAMP (V10, V16)

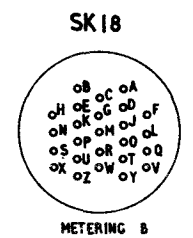
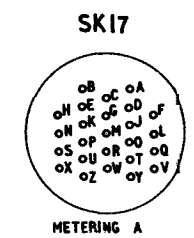


NOTE: RINGED LETTERS REFER TO WAVEFORMS IN FIG. 19

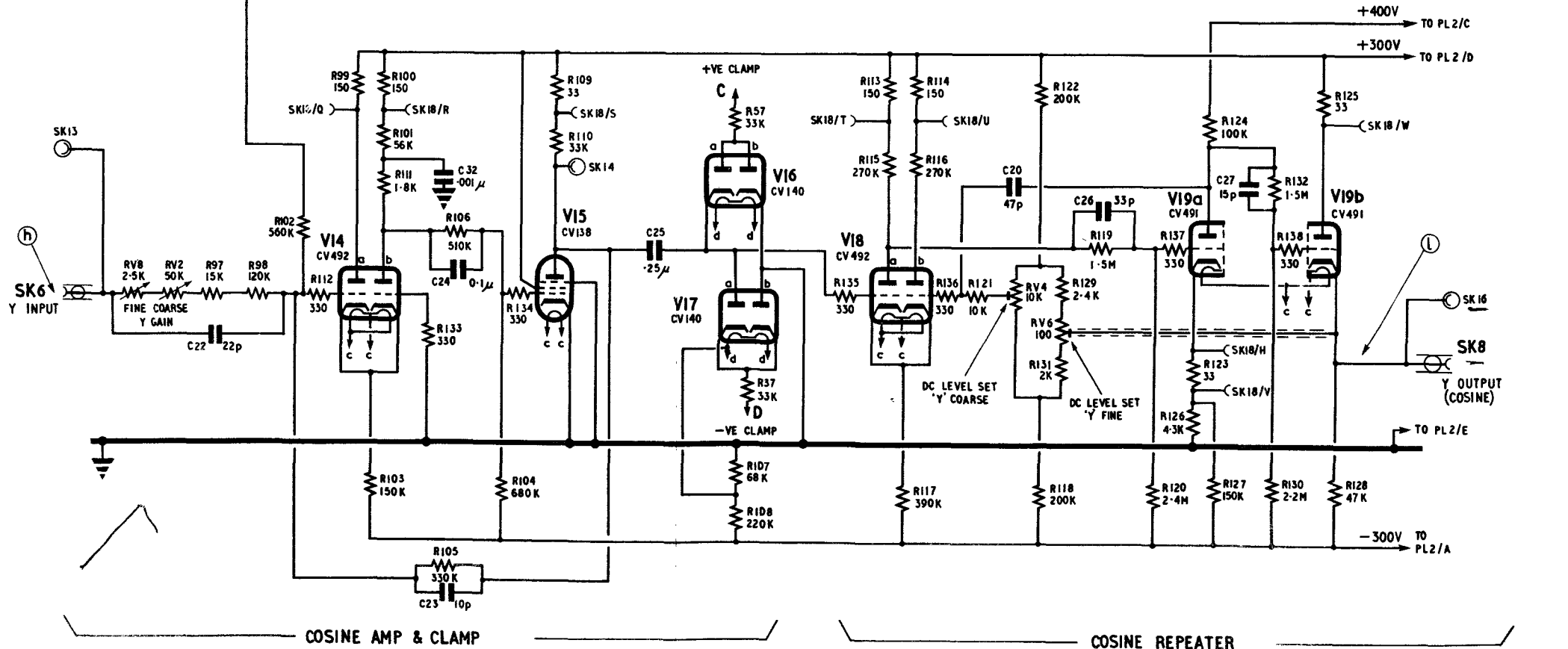
MONITOR POINTS	
1	SK 13
2	SK 14
3	SK 16
4	SK 12
5	SK 11
6	SK 15
7	SK 10
8	SK 9



PLUGS & SOCKETS VIEWED FROM WIRING SIDE



CV138	CV140	CV455	CV491	CV492	CV2127
V6 V9 V15	V2 V4 V10 V11 V16 V17	V1	V3 V13 V19	V12 V18 V8 V14	V5 V7



+400V TO PL2/C  
 +300V TO PL2/D

TO PL2/E  
 TO PL2/A -300V

SK16  
 SK8  
 Y OUTPUT (COSINE)

Fig. 26

Amplifying unit (clamping & distribution) Type 504 - circuit

Fig. 26

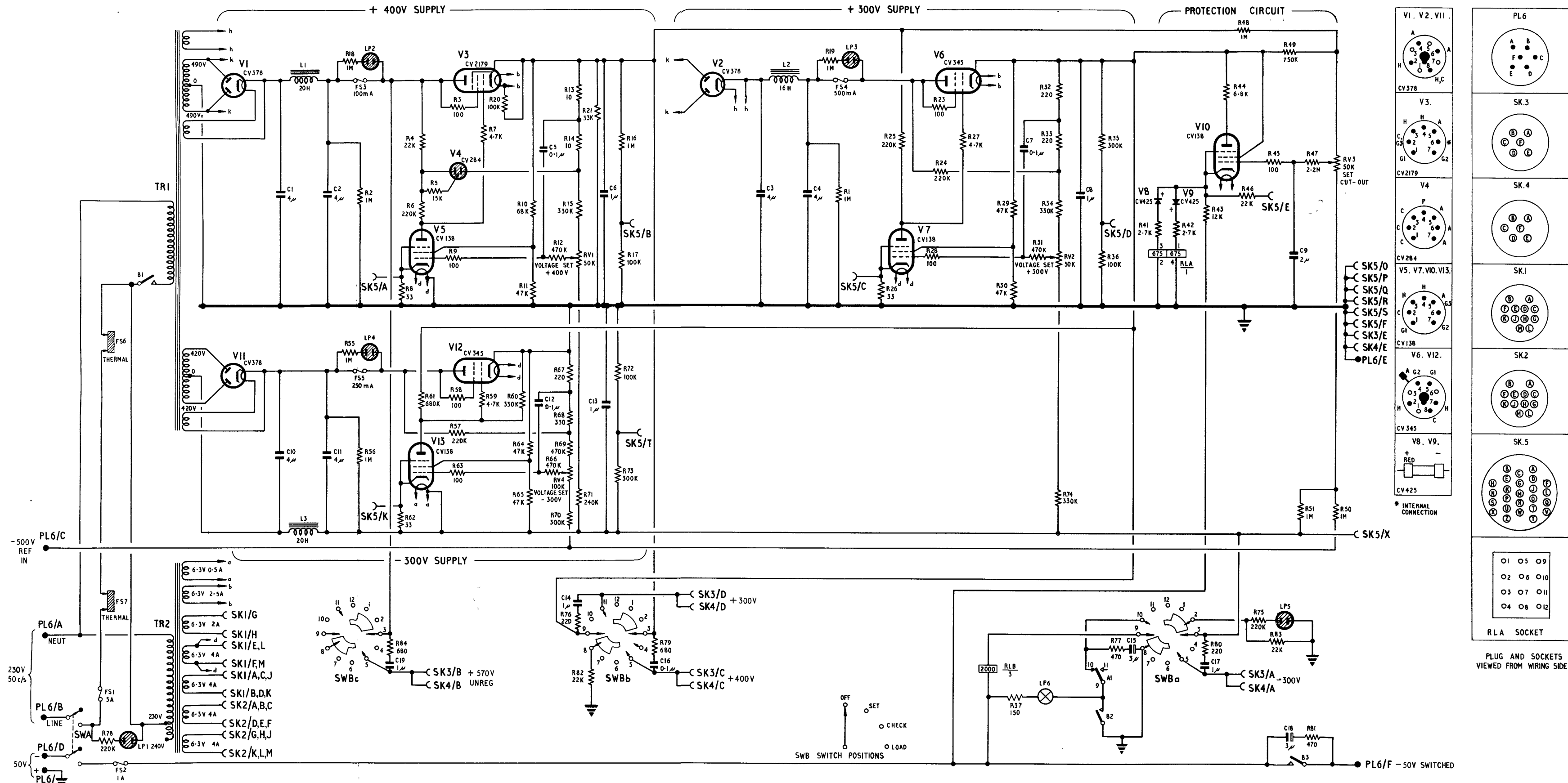


Fig.27

Power unit Type 904 - circuit

Fig.27  
(A.L.10 May 55.)



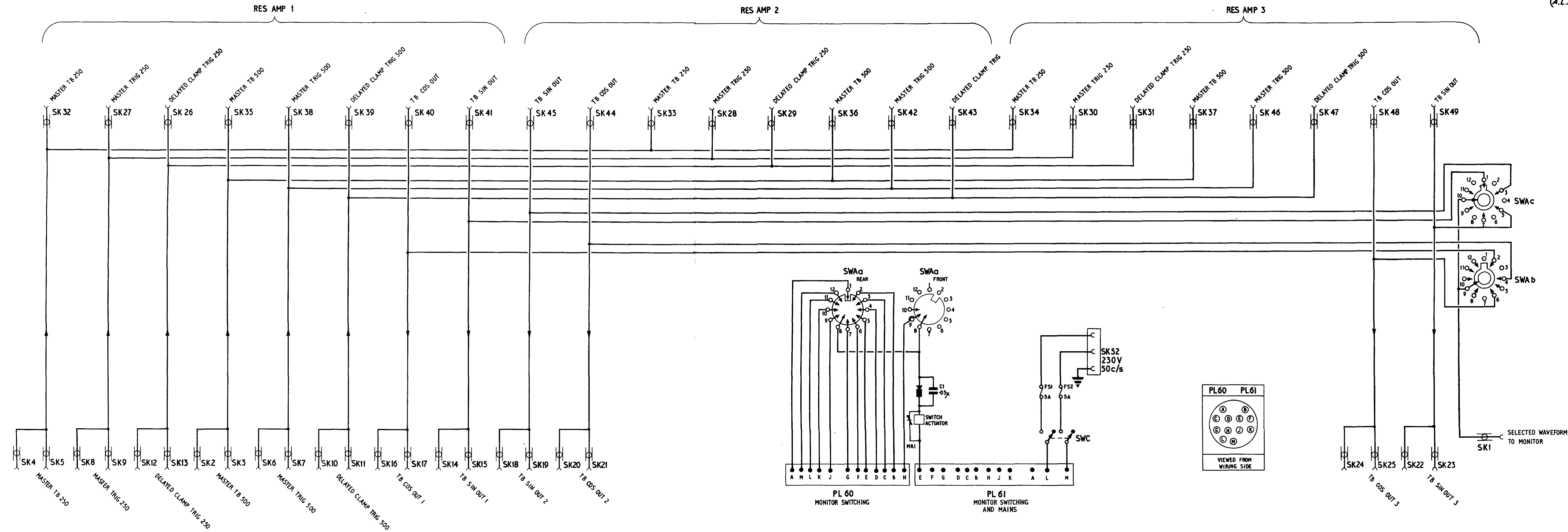


Fig.28

Panel (distribution) Type 877- circuit

Fig.28

(A.L.10 May 55)

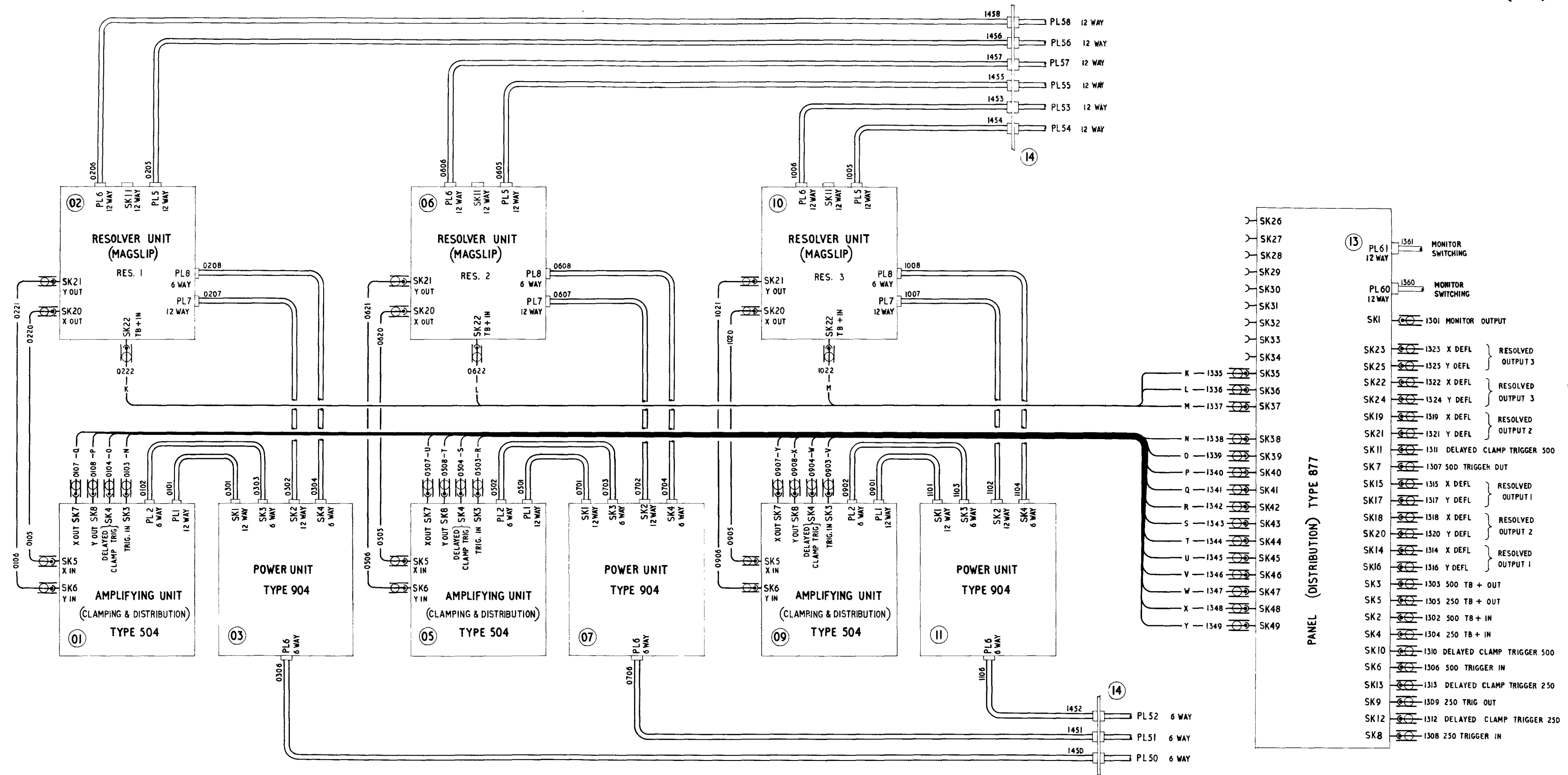
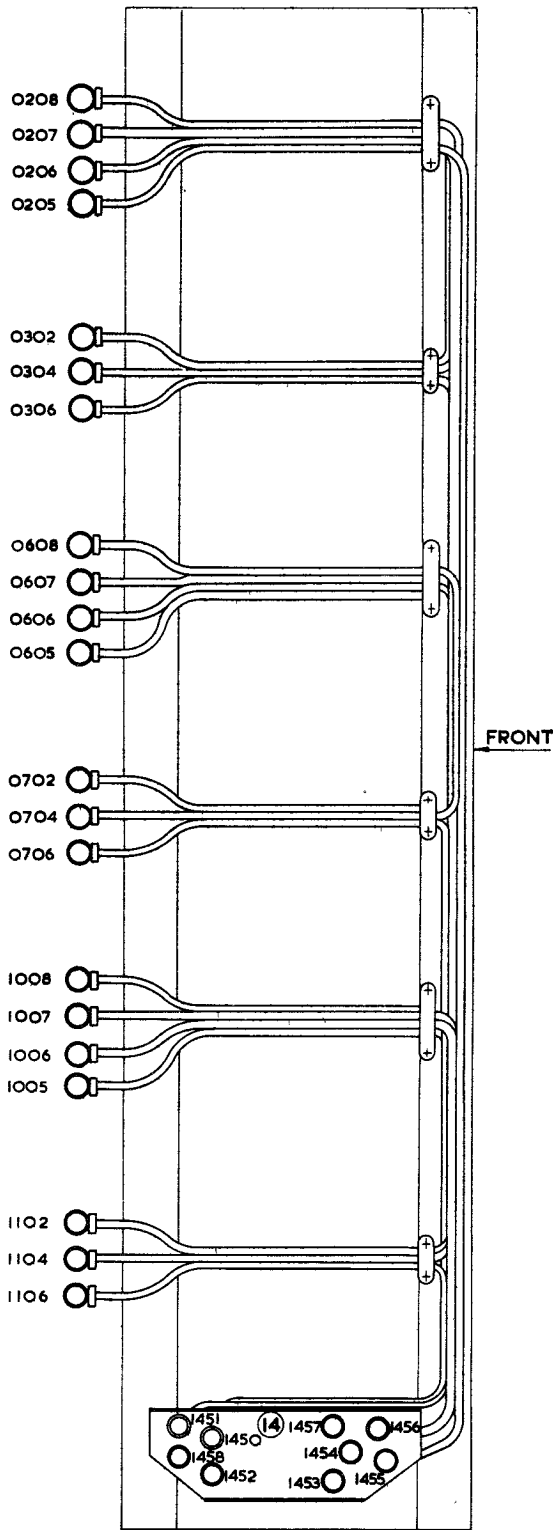
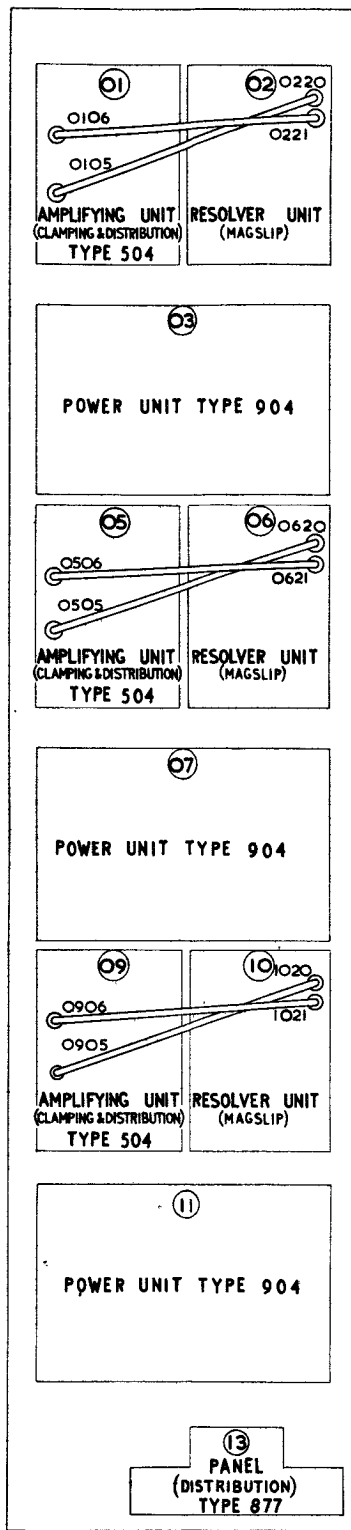


Fig. 29 Rack assembly (resolver magslip) Type 301 — circuit

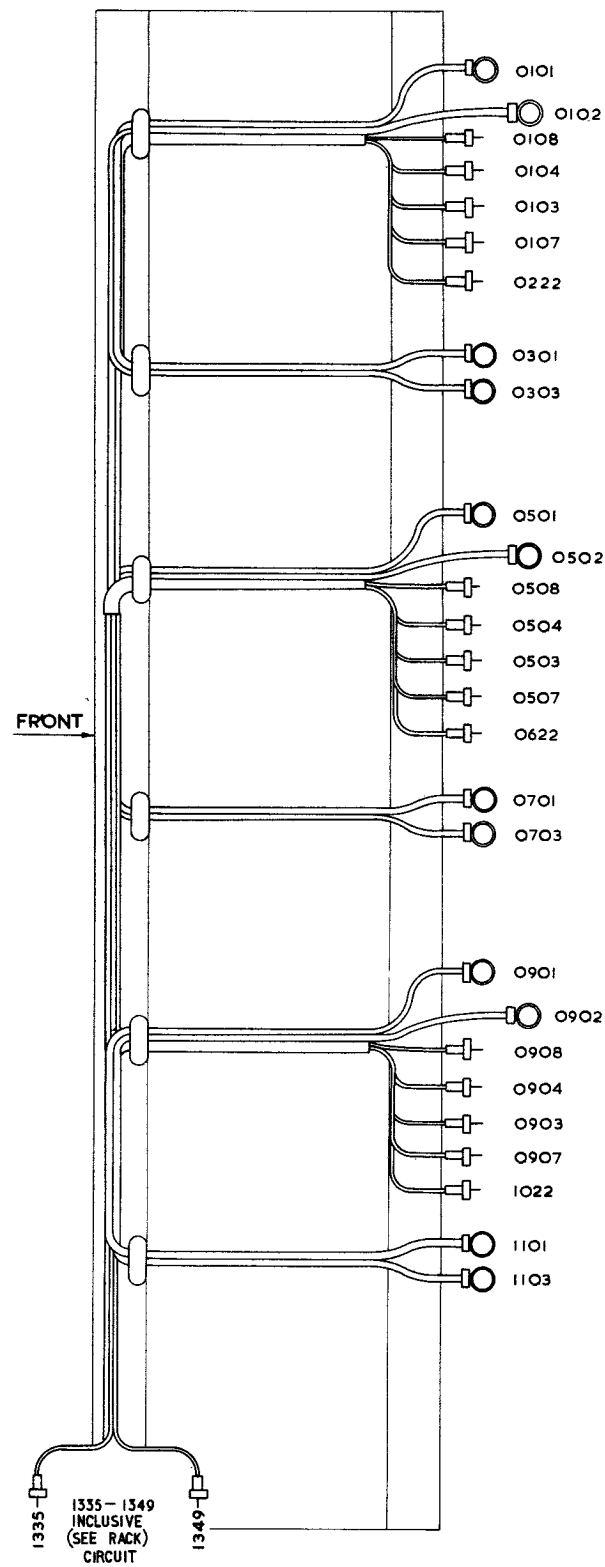
Fig.29  
(A.L.10 May 55)



R.H. SIDE PANEL



REAR VIEW



L.H. SIDE PANEL

Fig. 30 Rack assembly (resolver magflip) Type 30I - cabling

Fig. 30 (AL10, May 55)

## Appendix 1

### RACK (RESOLVER MAGSLIP) TYPE 16357

#### General description

1. The wired frame-works of some rack assemblies Type 301 are referenced to read rack (resolver magslip) Type 16357 (Ref. No. 10D/22739) to obviate re-referencing whenever modifications are made to units housed in them.

2. At stations modified for Phase 1A working the rack (resolver magslip) Type 16357 houses the

following units or their derivatives:—

- (1) Three resolvers (Chap. 2).
- (2) Three amplifying units (clamping and distribution) Type 504 (Chap. 2).
- (3) Three power units Type 904 (Chap. 2).
- (4) Panel (distribution) Type 877.

## Appendix 2

### RESOLVER (MAGSLIP) REF. No. 10AE/2577

#### General

1. Resolver unit (magslip) Ref. No. 10AE/625 is modified to resolver (magslip) Ref. No. 10AE/2577 by replacing capacitor C3, 1  $\mu$ F, 150V d.c.  $\pm 25\%$  N.S. No. 5910-99-011-5569 by capacitor C3, 2  $\mu$ F,

200V d.c.  $\pm 25\%$  N.S. No. 5910-99-011-9839. This modification is to prevent the trace dimming circuit operating at rotating speeds of 0.2 rev/min when the unit is used in conjunction with the H.F.200 height finder in the volumetric scan role.

Appendix 3

PANEL (DISTRIBUTION) TYPE 877A

LIST OF ILLUSTRATIONS

	Fig.
Panel (distribution) 877A—scrap circuit	... 1

General description

1. The panel 877A (fig. 1) is similar to Type 877 with the following exceptions:—

- (1) The 230V 50 c/s mains supply connection PL61/J is paralleled to PL61/L and PL61/K to PL61/M.
- (2) PL61/E earths the external rack 16505 (Sect. 4, Chap. 1).

(3) The feed to PL60/K is +50V from rack selector wafer SA in panel 16504 (rack 16505, Sect. 4, Chap. 4).

(4) The wiring in positions 7, 9, 11 and 12 of SWA front and position 9 of SWA rear is deleted.

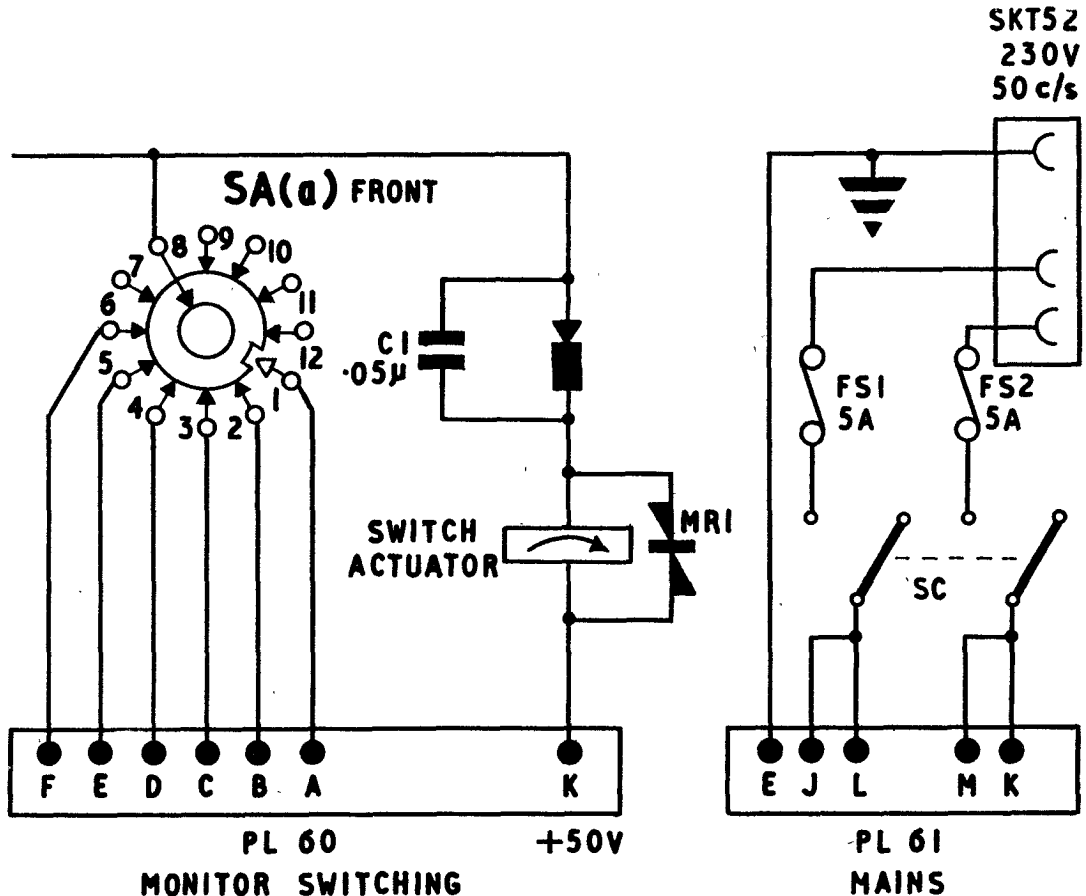


Fig. 1. Panel (distribution)—877A—scrap circuit

Chapter 3

RACK ASSEMBLY (GATING WAVEFORM) TYPE 304 (RA 304) - 10D/18670  
(Completely Revised)

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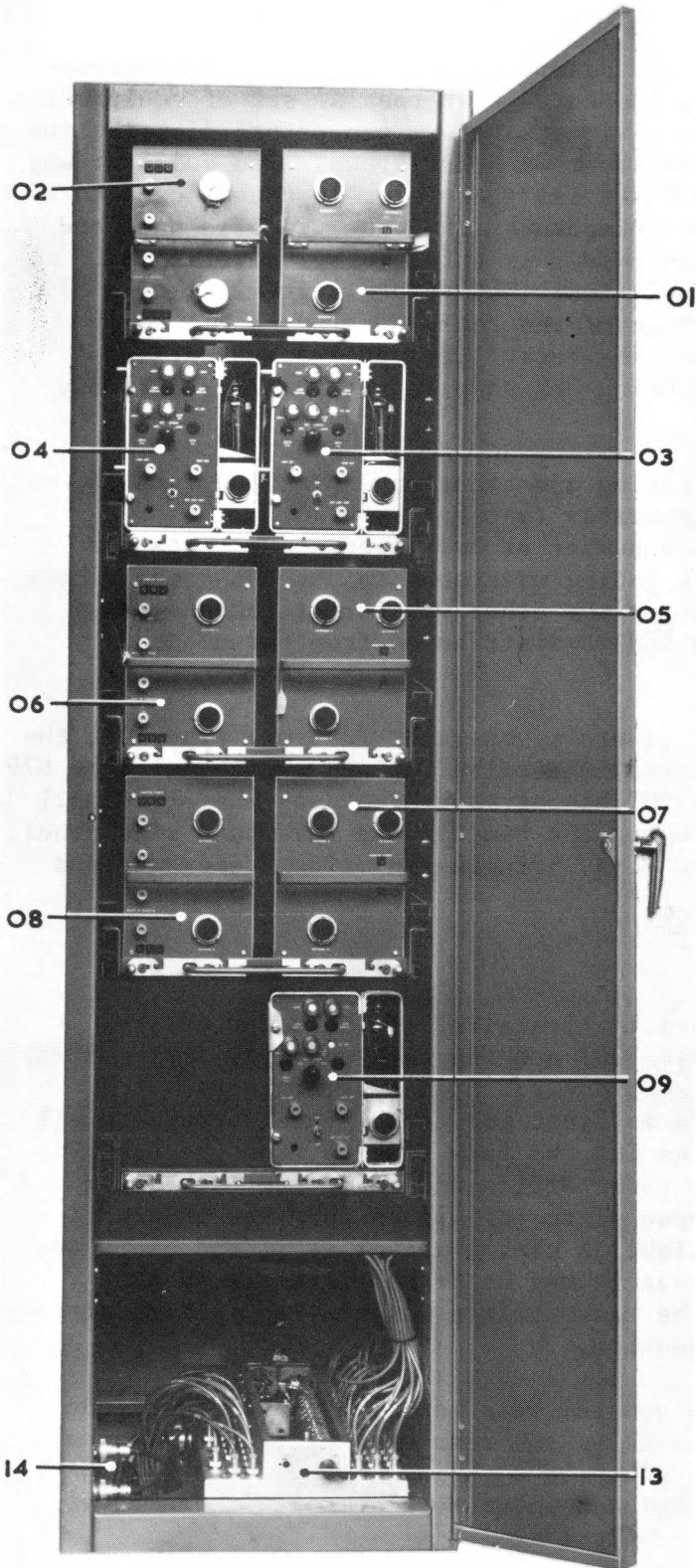
GENERAL

Purpose of equipment

1 The RA304 is a central source of positive and negative gating waveforms, and of certain related waveforms listed later, required in the fixed-coil display system. To distinguish them from the video gating waveforms, produced separately in each fixed-coil PPI console type 64, the services produced by the RA304 should be referred to strictly as deflectional gating waveforms. They are peculiar to the fixed-coil system and are used to effect the change-over in console deflection amplifiers between ordinary (trace period) scanning and special (intertrace period) deflections of the spot. At stations where phase 1A modifications are incorporated the RA304 is replaced by rack (marker sequence) type 4195. A full description of the RA4195 is given in AP 115K-1402-1A.

2 On this rack there is no division of functions between two repetition frequencies, as there is in the master timebase RA300, because all the gating and intertrace display is done at 250 Hz, irrespective of the repetition frequency of the associated radar. In view of the major importance of the gating waveforms to the operation of the azicating consoles, the gating waveform equipment is duplicated to ensure continuous operation in case of failure, the two sets being designated 'A' and 'B'. The standby set is maintained in the operation state and can be brought into use at a moment's notice. In addition a third (cold) set of equipment is normally kept in the same rack for spares.





- 01 Spare distribution unit in storage space.
- 02 Spare waveform generator in storage space.
- 03 Power unit type 903 - 'A'.
- 04 Spare power unit in storage space.
- 05 Distribution unit (gating) - 'A'.
- 06 Waveform generator (gating) type 101 - 'A'.
- 07 Distribution unit (gating) - 'B'.
- 08 Waveform generator (gating) type 101 - 'B'.
- 09 Power unit type 903 - 'B'.
- 13 Panel (Distribution and switching) type 879.
- 14 Left-hand side input panel.

Fig.1 Rack assembly (gating waveform) type 304 - front view.

### Rack units

3 Fig.1 gives a front view of the rack assembly and the key to fig.1 gives the allocation of the units. It will be noted that the 'A' set of equipment forms a complete group of three units, viz:- waveform generator, distribution unit and power unit, while the 'B' set forms another group. The quickest way of restoring services when any unit fails is, therefore, to change over to the other group completely and not to disconnect the unserviceable unit and then replace it by a spare. The change-over is effected by operating a single multi-wafer switch in the panel (distribution and switching) type 879. Through this panel, located in the base of the rack, are routed all the coaxial services entering and leaving the rack. The panel also carries facilities for remote waveform monitoring and sampling at the rack assembly (waveform monitor) type 339.

4 The circuits which generate the gating and other waveforms are located, as the name implies, in the waveform generator (gating) type 101. The distribution unit (gating) provides a number of low-impedance outputs for connecting the positive and negative gating waveforms to the consoles. There is no such system of common outputs for the other waveforms; instead, they are fed to other radar office racks and re-distributed from thence as necessary.

5 More detailed explanation of the waveform generator (gating) type 101, the distribution unit (gating) and the panel (distribution and switching) type 879 follows later. The power unit type 903 has already been described in Chap.1 of this section. The only other item in the rack is the left-hand side panel, which carries two panel-mounting couplers, bringing in mains, reference and relay voltages for the power units.

### Location and construction

6 The rack assembly type 304 is normally installed in the radar office, between one mag slip resolver rack type 301 and the rack assembly (misc. ITBU) type 306. The cabinet, is of the standard 7 ft. high type, internal width 19 in., with full-length steel doors at front and rear, giving access to all units (fig.1). All connecting cables for the rack come up from the trunking system under the false floor of the radar office and enter the rack through a hole in the left-hand side of the base plate (as viewed from the front). To ensure that the cable entry is airtight, a canvas gaiter is fitted below the aperture; the gaiter is corded so that it may be drawn tight around the cables. The rack is connected to the radar office ventilation system, already mentioned in Chaps.1 and 2 of this section.

7 Each unit occupies one half of a square, open mounting tray. Two studs at the rear of each unit fit into holes in the rear member of the tray and two at the front engage in L-shaped slots in a spring-loaded catch assembly. Each tray is bolted to three-draw, telescopic runners so that it can be slid out of the cabinet for servicing the units.

8 Most routine checking and servicing on the units may be completed without removing them from the rack, as metering sockets are provided on the front panels so that the multimeter type 100 may be plugged in for quick tests of circuit voltages and currents. There are also monitoring sockets on the waveform generators and distribution units for checking the waveforms at key points with an oscilloscope. If the entire removal of a unit from the rack proves necessary, its power supplies should be switched off and its cabling disconnected, after which it may easily be removed from its tray by sliding the front catch sideways, lifting the front of the unit upward to release the front studs and then pulling it forward and upward to release the rear studs.

9 The left-hand input panel forms part of the rack. The panel (distribution and switching) type 879 is secured to the rack base plate, over the air inlet hole, by two captive screws.

### Controls

10 Once all external supplies are coming into the rack, including 230V MAINS from the radar office power board, switching on and off is done on the power units type 903 (paras.51-76, Chap.1 of this section). The A/B switch on the panel type 879 is only used when a unit goes unserviceable during operations. The functions of the various preset controls of the units in the rack are given in the circuit descriptions. Instructions for adjusting these controls are given in Chap.2, Sect.1, Part 2.

### Rack cabling

11 The complete rack circuit diagram (fig.15) shows all the electrical inter-connections between the units. All the coaxial services are annotated on fig.15, but there is no room to show all services on the multicore cables; these services may be identified from the circuit diagrams of the separate units. The multicore cables are all metvinsmall types in various sizes while the coaxial cables are Uniradio 32. The actual run of the cables is shown in the cabling diagram (fig.16). Except for the direct connectors between the waveform generators and their distribution units, all the cables run in the forward conduits on the cabinet side panels. All the permanent connections are made at the back of the rack units; sufficient slack has been left on the cables to permit the trays to be withdrawn right forward on the runners without switching off.

### Cable identification

12 As in the other fixed-coil racks, the four figure identification number, with which every cable end is marked, gives the unit number (ringed on figs.15 and 16) and the plug, or socket, on that unit to which the cable must be connected. The first two figures of the identification number give the unit number and the second two the plug, or socket number. Where there are two Mk.4 connectors of the same pattern on the same unit (e.g. SK1 and SK2 on the power unit type 903), they have different moulding orientations (Part 2, Sect.2, Chap.1), making it impossible to connect an incorrect mating component.

External connections to rack

13 The external connections to the rack assembly type 304 depend on the size of the associated radar installation and on current service requirements, so it is impossible to lay down an accurate scheme to cover all stations; reference must be made to the cabling schedule issued individually to each station. As a general guide, table 4 has been extracted from the schedules for one large station, using both repetition frequencies.

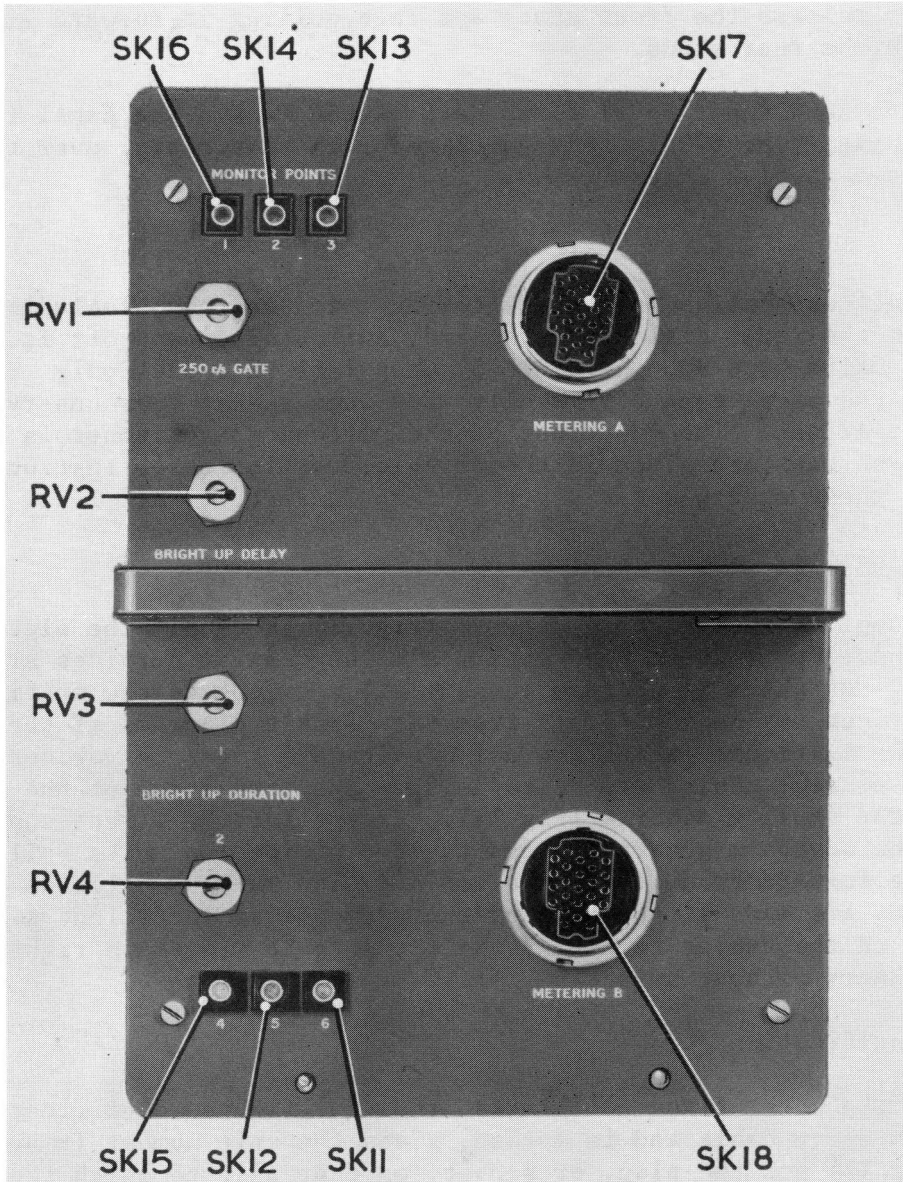


Fig.2 Waveform generator (gating) type 101 - front panel

WAVEFORM GENERATOR (GATING) TYPE 101

Introduction

14 The waveform generator (gating) type 101 (stores ref.10V/16064), or gating waveform generator (GWG), forming part of the RA304, is illustrated in figs.2 to 5. A block diagram is given in fig.6, with annotations referring to waveforms shown in fig.7. Table 1 gives details of components, as an aid to servicing.

Purpose

15 The unit is designed to generate the following five waveforms and pulses, which are used for the intertrace display facility in the fixed-coil display system:

15.1 Positive gating waveform - for console deflection amplifiers, via gating distribution unit (waveform (p), fig.7).

15.2 Negative gating waveform - for console deflection amplifiers, via gating distribution unit (waveform (o)).

15.3 Intertrace bright-up (ITBU) - two outlets for consoles, via rack assembly (misc. ITBU) type 306 (waveform (r)).

15.4 'Second-half' intertrace bright-up ( $\frac{1}{2}$  ITBU), not at present used, but provided for a possible development (waveform (s)).

15.5 Azication generator drive pulse - for rack assembly (azication) type 302 (waveform (q)).

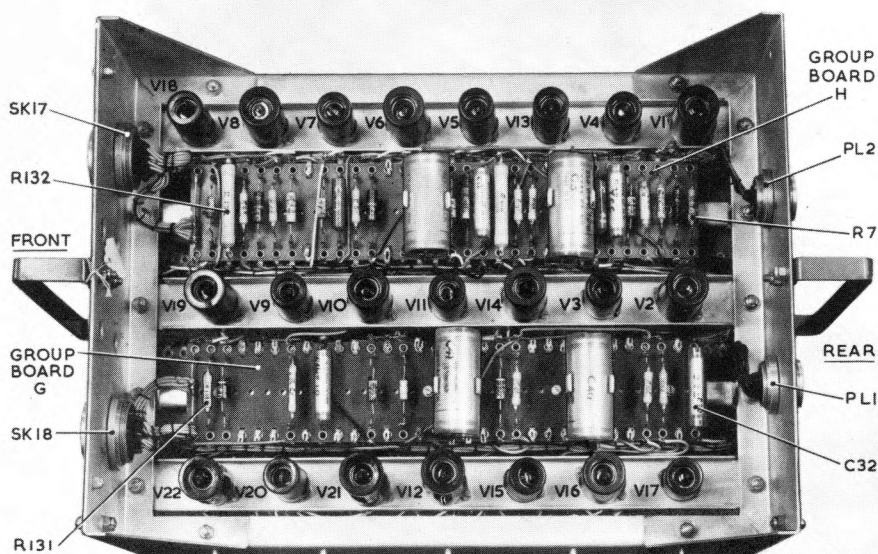


Fig.3 Waveform generator (gating) type 101 - over-chassis view



Timing - normal stations

16 As explained in the introductory chapters in Sect.1 of this part, most stations include both 250 Hz and 500 Hz radar heads, and any PPI console may be required to cope with either frequency. For uniformity, all consoles displaying intertrace markers do so at 250 Hz, whatever the head frequency, but the marker is not displayed until the 500 Hz sweep has been completed. Hence, the positive and negative gating waveforms, (p) and (o), which are used in the consoles to effect the change-over between trace and inter-trace deflections, must start at the end of every other 500 Hz sweep, about half-way through a 250 Hz inter-trace period. The duration of the gating waveforms is required to be about 270  $\mu$ s, leaving 230  $\mu$ s for the spot to re-settle at the trace origin before the start of the next sweep.

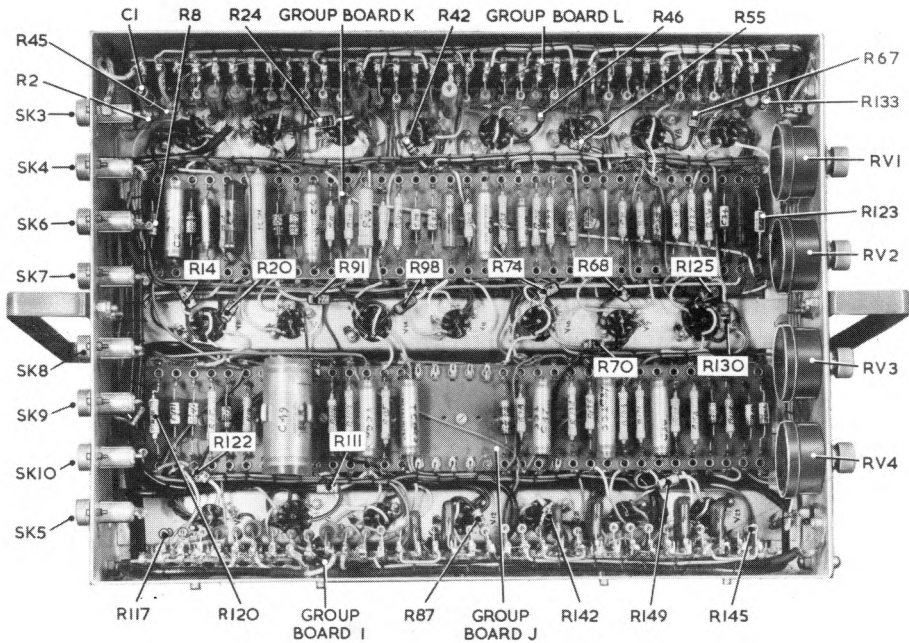
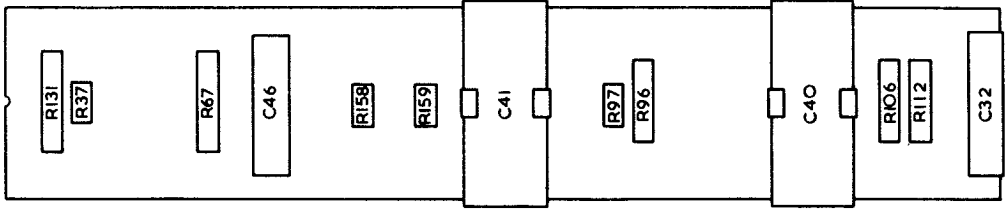
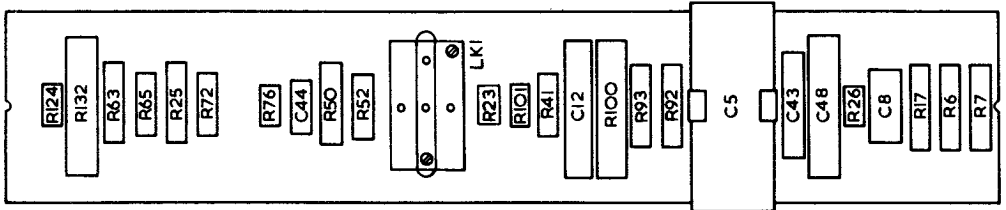


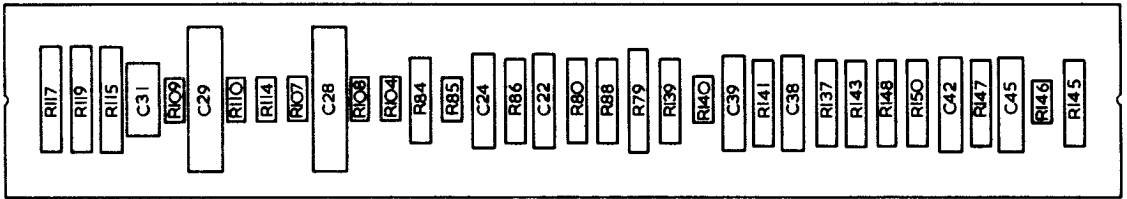
Fig.4 Waveform generator (gating) type 101 - under-chassis view.



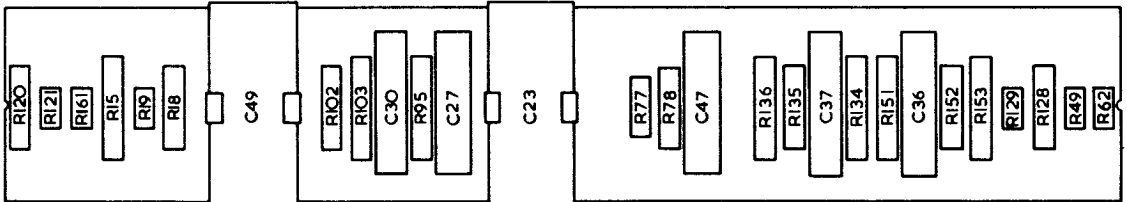
GROUP BOARD G



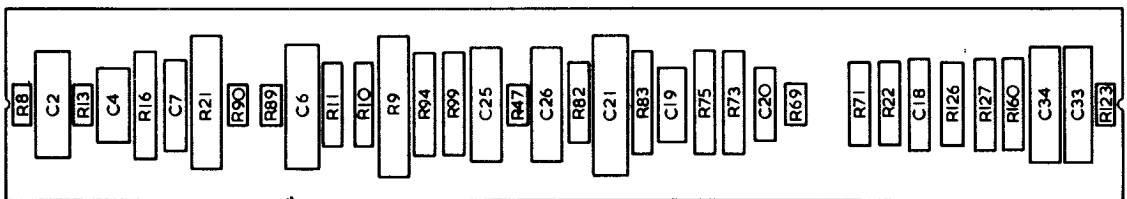
GROUP BOARD H



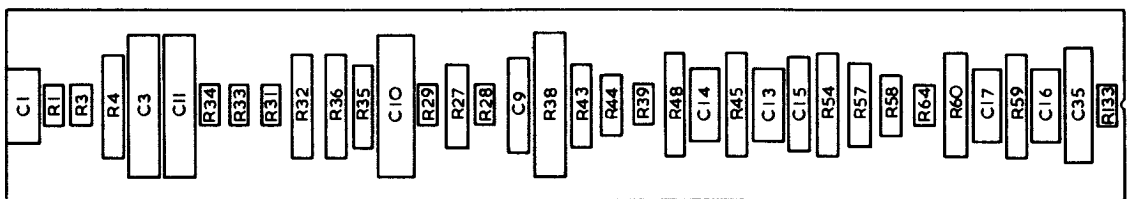
GROUP BOARD I



GROUP BOARD J



GROUP BOARD K



GROUP BOARD L

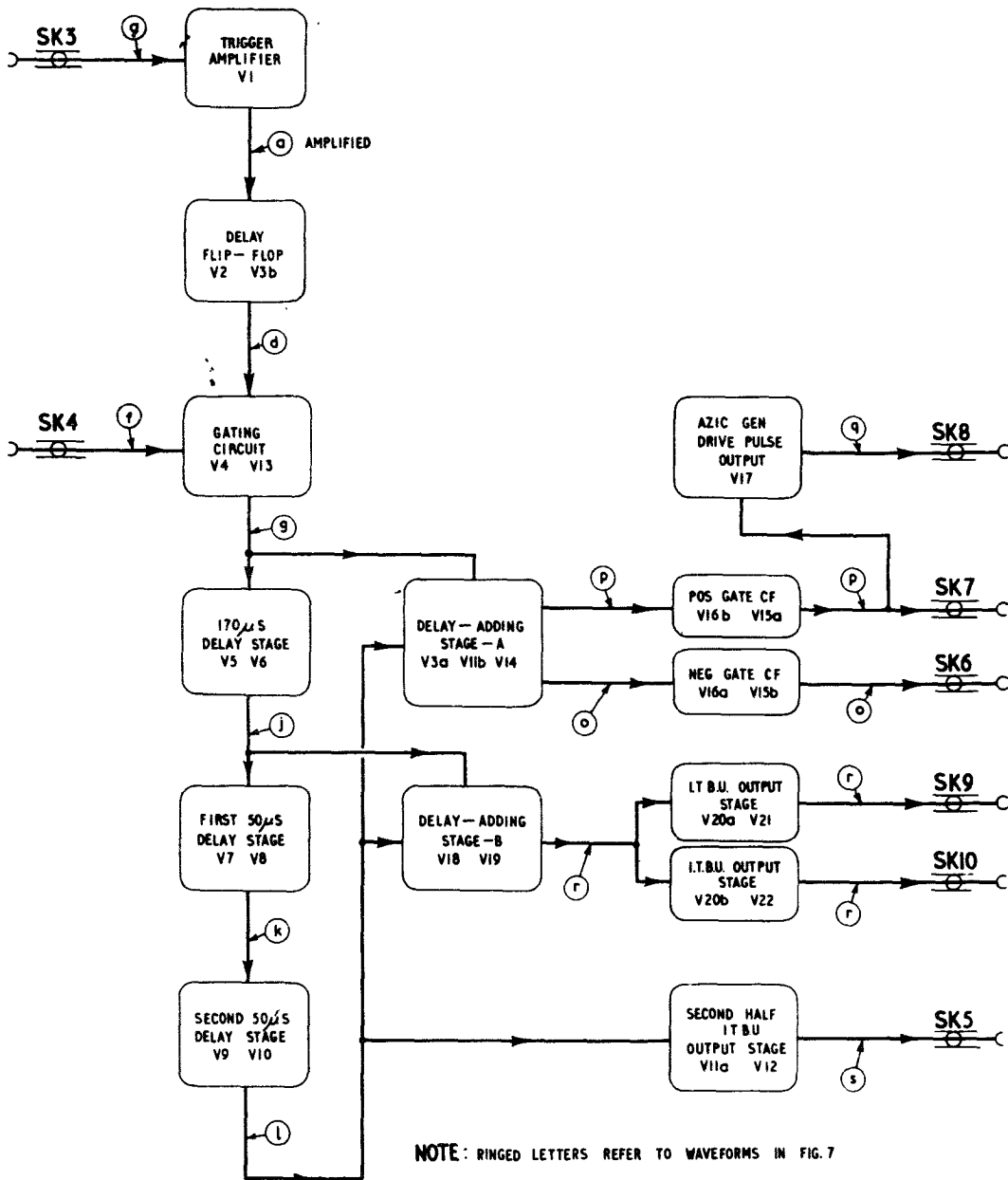


Fig.6 Waveform generator (gating) Type 101 - block diagram

17 The negative-going drive pulse to the azication generator, waveform (q), is required to have the same timing as the gating waveforms, but smaller amplitude. The ITBU waveform (r) has to occupy the last 100 µs of the gating waveforms; the 170 µs delay, after the start of the gating period, gives the spot time to reach the strobe marker position before being brightened up. The 'second-half' ITBU pulse (waveform(s)), not at present used, occupies the last 50 µs of the gating period.



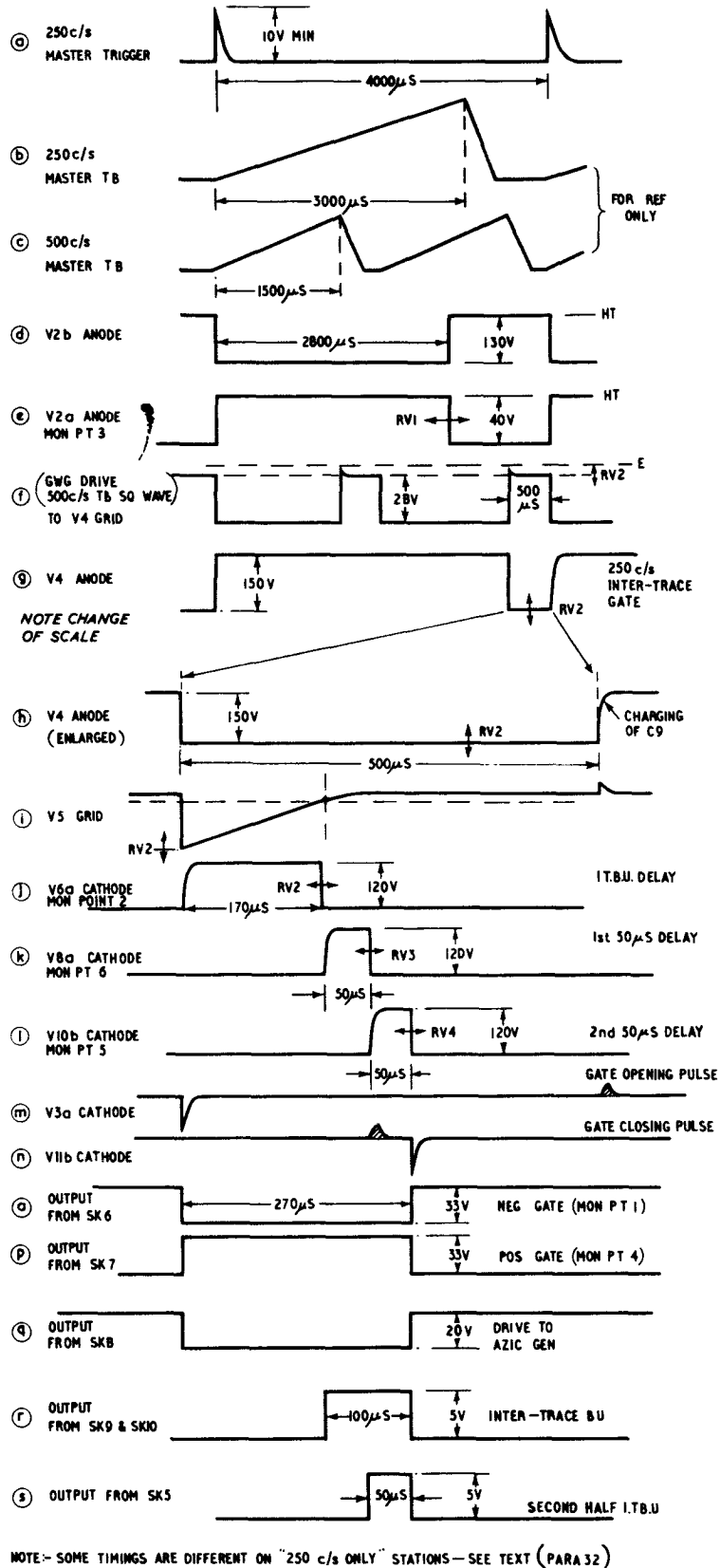


Fig.7 Waveform generator (gating) type 101 - waveforms.

18 The gating waveform generator is never free-running; it is strictly timed from the CWG drive waveform emanating from the master timebase rack, and from the 250 Hz master trigger pulses. The reliable supply of these pulses is therefore essential to the continued generation of gating waveforms and hence to the provision of the intertrace display facilities.

#### Timing - '250 Hz only' stations

19 Some stations are fitted with 250 Hz heads exclusively. Here the intertrace markers are displayed at a repetition frequency of 250 Hz as on normal stations, but are timed from the termination of a 250 Hz timebase sweep, instead of a 500 Hz, because no 500 Hz squarewave is available. The flyback duration on the 250 Hz timebase waveform is twice as long as on the 500 Hz (150  $\mu$ s instead of 75  $\mu$ s) and, as there is often some capacitive breakthrough of the flyback part of the timebase waveform into the console deflection circuits during the intertrace gating period, it is important that the ITBU pulse shall not start to brighten up the intertrace marker until well after the timebase waveform has settled at its rest level. The normal 170  $\mu$ s ITBU delay (para.17) is ample for the 75  $\mu$ s flyback on 500 Hz, but only barely adequate for the 150  $\mu$ s flyback on 250 Hz, especially as component tolerances or slight mis-setting may cause small variations in the timing figures. Hence, on '250 Hz only' stations, the ITBU delay is increased from 170  $\mu$ s to 250  $\mu$ s (by changing a link in the waveform generator). The duration of the ITBU pulse is maintained at 100  $\mu$ s, so that the total duration of the gating waveform is increased to 350  $\mu$ s. As the total intertrace period on 250 Hz averages 1,000  $\mu$ s, there is still ample time (average 650  $\mu$ s), between the end of the ITBU pulse and the start of the next trace, to allow the circuits to settle down. On these '250 Hz only' stations the GWG DRIVE waveform is the 250 Hz TB squarewave instead of the 500 Hz; no master trigger pulses are required by the waveform generator.

#### Construction

20 The unit is assembled on a rectangular 7½ in. x 11 in. x 15½ in. frame which clips into position on its side on the rack mounting tray, alongside its distribution unit. On the front panel (fig.2) are a U-shaped handle, the metering and monitoring sockets and the preset controls. The latter are fitted with collets and locknuts so that, once set up, they may be locked in position to discourage random running adjustments, and to minimize changes due to vibration. At the rear of the unit are fixed plugs for power supplies, and coaxial sockets for all signal services in and out of the unit.

21 The valveholders are disposed along three parallel U-section valve mounting channels (fig.3) and, when the unit is in the working position in the rack, the valve envelopes are horizontal. Most of the small components are located for accessibility on six paxolin group boards which run the full length of the chassis (figs.3 and 4); the layout of the components on these boards is shown in fig.5.

## Power supplies

22 The waveform generator uses six 6.3V 50 Hz heater supplies and stabilized HT supplies at +300V and -300V from the associated power unit type 903. The heater supplies are derived from two transformer windings in the power unit.

## Circuit description

23 Fig.6 is a block diagram of the circuit; it shows the breakdown into successive stages, which are explained in detail below. The description should be read with reference to the chart of waveforms (fig.7) and the complete circuit diagram (fig.12).

## Trigger pulse amplifier

24 The 250 Hz master trigger pulses arriving at SK3 may have an amplitude as small as 10V (waveform (a)), though it will usually be more. For reliable operation of the unit, pulses of at least 30V amplitude are essential, so the double-triode V1 (CV 4024) is included as a trigger pulse amplifier.

25 V1b is connected as a cathode-follower and V1a as a cathode-driven amplifier; coupling between them is through C3 (0.1  $\mu$ F). The circuit is designed to give sufficient gain without phase reversal. The operating conditions of both triodes are fixed by returning both grids to a potential of +60V at the junction of R9 and R10. Due to its cathode resistor R3 (220K), V1b passes only about  $\frac{1}{2}$  mA in the static condition, whereas V1a passes 5 mA (12K cathode resistor R4). When a trigger pulse arrives, V1b is brought momentarily into full conduction, so the common cathode potential rises (C3 coupling) and V1a current is reduced. The resulting amplified positive pulse from V1a anode is passed on to the next stage through C4 (0.01  $\mu$ F).

## Delay flip-flop

26 The purpose of the double-triode V2 (CV4003) together with diode V3B (half a CV4025), is to produce a negative-going squarewave, 2,800  $\mu$ s long (waveform (d)), started by every 250 Hz master trigger pulse. This squarewave is required to gate out alternate 500 Hz timebase squarewaves in the next stage.

27 The double-triode is arranged as a cathode-coupled flip-flop. In the rest condition V2b is cut off and V2a conducts, V2b grid being returned to +30V (at the junction of R10 and R11) via R13, while V2a grid is caught at the potential of V3b cathode (+60V), because this diode draws current through the V2a grid leak R21 (2.7M) from the high positive potential at the slider of RV1 (250 Hz GATE).

28 The leading edge of the 30V positive trigger pulse from V1a drives V2b into conduction, dropping the anode by some 130V. Through C7, V2a grid falls too, so that V2a and the diode V3b are cut off, the anode of V2a rising to HT level. V2b continues to conduct as long as V2a is cut off and the common cathode potential is held at +30V by the V2b grid return via R13.

29 The V2a grid side of C7 starts to charge toward the positive potential at the slider of RV1 at a rate depending on the time constant of C7-R21 and the setting of RV1. After 2,800  $\mu$ s (provided RV1 has been correctly set), V2a grid reaches a sufficiently positive potential for conduction to begin again, through V2a. The double-triode common cathode potential rises and the current through V2b decreases. The consequent rise at V2b anode is fed to V2a grid and cumulative action cuts off V2b to restore the original quiescent state, with the common cathode caught at the +60V potential of the V3b diode cathode. The outcome of the action is the desired negative-going 2,800  $\mu$ s squarewave at V2b anode (waveform (d)) which is passed on to the next stage by C8, and the anti-phase squarewave at V2a anode which may be monitored at SK11 (waveform (e)). The exact setting of RV1 is not critical so long as the gate ends near the middle of the second 500 Hz sweep period.

Gating circuit - normal stations

30 V4 (pentode CV4014) is a coincidence or gating valve; the 250 Hz negative-going 2,800  $\mu$ s waveform from V2b anode is supplied to its suppressor-grid, and the 500 Hz timebase waveform (GWG drive) to its control grid (from SK4). Hence anode current will flow only while neither input is negative. Thus the positive-going part of the timebase squarewave occurring during a 250 Hz sweep does not, thanks to suppressor-grid cut-off, affect the anode, whereas that occurring during the 250 Hz rest period does, and produces a negative pulse there (waveform (g)).

31 To settle the level of the gate waveform at the suppressor grid of V4 with its top at earth, a DC-restoring diode V13b (half a CV4025) follows the AC-coupling from V2b to V4. A similar DC-restorer (V13a) settles the level of the top of the 500 Hz TB squarewave at the control grid of V4 to the negative potential (about 2.5V) determined by the setting of RV2 (BRIGHT-UP DELAY). Without the diode the 28V squarewave would drive the pentode to grid current and self-bias would drive the grid well below earth. With the diode, however, grid current is unable to flow, because the diode conducts first and holds the grid at 2.5V negative. The inclusion of the 22K resistor R34 in series with the input capacitor C11, and the feedback circuit R35-C10 between V4 anode and V13a cathode, permit V13a to act as a limiter for HF inputs, so that positive spikes on the leading edges and slopes on the tops of input waveforms are eliminated at the grid of V4, on account of the voltage drop across R34 when V13A passes current. The resistor R35 between V4 anode and V13a cathode also maintains DC stability in the circuit. The exact level of DC restoration at V4 control grid, which decides the magnitude of the current switched on by the squarewave and thus the amplitude of the waveform (g) at the anode (normally about 150V), is set by the 100 k $\Omega$  potentiometer RV2. This potentiometer provides a fine control for the ITBU delay, but the position of link LK1 is the major factor in controlling the delay time (para.34).

Gating circuit - '250 Hz only' stations

32 On '250 Hz only' stations (para.19) no gating action is required; the CWG drive to SK4 is now the 250 Hz TB squarewave instead of the 500 Hz. No trigger pulses are fed to SK3, the delay flip-flop is inoperative and V4 suppressor grid stays at earth level all the time. LK1 is in the 250  $\mu$ s position, bringing R23 (560K) in circuit in series with R38 (1.5M), to lengthen the re-charge time of C9. This lengthens the slope of the waveform (i) (fig.7) and in this way the ITBU delay generated by the next stage is increased from 170  $\mu$ s to 250  $\mu$ s.

170  $\mu$ s delay stage

33 The pentode V5 (CV4014) and the associated double-triode V6 (CV4089) form a delay stage. Its purpose is to introduce the interval of about 170  $\mu$ s required (on normal stations) between the start of the intertrace gating waveforms and the start of the ITBU pulse. In the quiescent state V5 is conducting, its 1.5 M $\Omega$  grid resistor R38 being returned to the +300V rail (R23 short-circuited by link LK1) but it is not bottomed because the diode-connected triode V6b, with its cathode returned to the 300V negative line via R52, holds V5 grid slightly negative. This is necessary because an output pulse of accurately determined amplitude is required and the bottoming level of different pentodes, or of the same pentode over a period of time, is rather indeterminate. A triode cathode-follower V6A succeeds V5 and from its cathode DC negative feedback is taken via V6b to V5 grid, thus holding the DC output level steady in the quiescent state. The actual level is set by the 100 k $\Omega$  BRIGHT-UP DURATION 1 potentiometer RV3.

34 The negative leading edge of the waveform at V4 anode is applied to V5 grid via the medium time constant C9, R38. It takes the grid sharply below cut-off (waveform (i)) and a positive edge is produced at the anode. At the same time V6b is cut off by the negative swing at its anode (V5 grid). The grid now starts to climb back towards +300V as C9 re-charges via R38 and when cut-off level is reached V5 starts conducting again and a negative edge is produced at the anode. On '250 Hz only' stations the duration of the square pulse at the anode is lengthened by removing LK1 to connect R23 in series with R38. A fine control is provided by adjusting the initial drop to control the current turned on in V4 when it is triggered. This current is decided by the setting of RV2 (BRIGHT-UP DELAY). Similar conditions apply on stations with a p.r.f. of 270 Hz.

35 The subsequent positive edge, terminating the waveform at V4 anode, is lost by conduction in V6b and has no significant effect on the delay stage. The output from V5 is coupled to the cathode-follower V6a via C14 and is fed out to the next stage from V6a cathode (waveform (j)). The amplitude of the waveform at V5 anode depends on the initial steady current through the valve, which is turned off by the input from V4 and which is therefore controlled by the setting of RV3 (BRIGHT-UP DURATION 1). This amplitude decides the delay in the next stage.

36 The curved leading edge of the waveform is due to the charging time of anode and stray capacitances when V5 is cut off. It has no serious effect, since the negative-going trailing edge is the one which is used in the next stage.

37 The 0.01  $\mu$ F capacitor C13, connected from V5 anode circuit down to the DC feedback line to V6b, provides a shortened negative feedback loop for AC and prevents the loop oscillating during the conducting period of V5. There is a danger that the charging of C13 will slow down the leading edge of the pulse at V5 anode to such an extent that the pulse does not reach its full amplitude in the time available, so that the amplitude of the negative edge will be incorrect. This trouble would not arise if V6a were a perfect cathode-follower (i.e., with unity gain), since the pulse at V6a cathode would then be an exact replica of that at V5 anode. Then, if C13 were connected directly between the anode of V5 and the cathode of V6a, the potentials of both its plates would move together, there would be no net charge or discharge and no effect on the pulse shape. Although V6a cannot be a perfect cathode-follower, the same effect has been obtained by connecting C13 to a tap along V5 anode load (junction of R39 and R44), at a point where the pulse is of a sufficiently smaller amplitude to give the desired result.

#### First 50 $\mu$ s delay stage

38 Pentode V7 (CV4014) double-triode V8 (CV4024) and the associated circuit form the next delay stage, which has to provide the 50  $\mu$ s first half of the ITBU period, and which operates in the same way as the previous delay stage (V5 etc.). As before, the delay is set by altering the magnitude of the negative edge coming in from the previous stage; the control concerned is RV3. The output waveform (k) goes on from V8a cathode to the next delay stage.

#### Second 50 $\mu$ s delay stage

39 A further 50  $\mu$ s delay, forming the second half of the ITBU pulse, is furnished by V9 and V10, operating in the same manner as the previous stages. The delay is started by the negative edge from the previous stage and the duration depends on the amplitude of the input. It is set by RV4 (BRIGHT-UP DURATION 2). The output waveform (l) from V10b cathode goes on to the second half ITBU output valve V12, via V11a, and also to both the delay adding stages.

40 The purpose of the delay-adding stage A, which includes the double-triode V14 (CV4003) and the diodes V3a and V11b, is to add together all three delays and produce the gating waveforms, both positive and negative.

41 V14 operates as a bi-stable trigger circuit, that is, a relaxation circuit with two stable conditions, in which rapid change-over from one condition to the other may be brought about by the application of suitable impulses. In one condition, which obtains during the 250 Hz timebase sweep, V14b is conducting, with its grid maintained, through R90, at a potential of +30V, because V3a is not passing current. By cathode-follower action the common cathodes are also at about +30V. Due to this cathode level and to the low potential at V14b anode (coupled to V14a grid by the divider chain R99, R100), V14a is cut off and its anode rests at HT level.

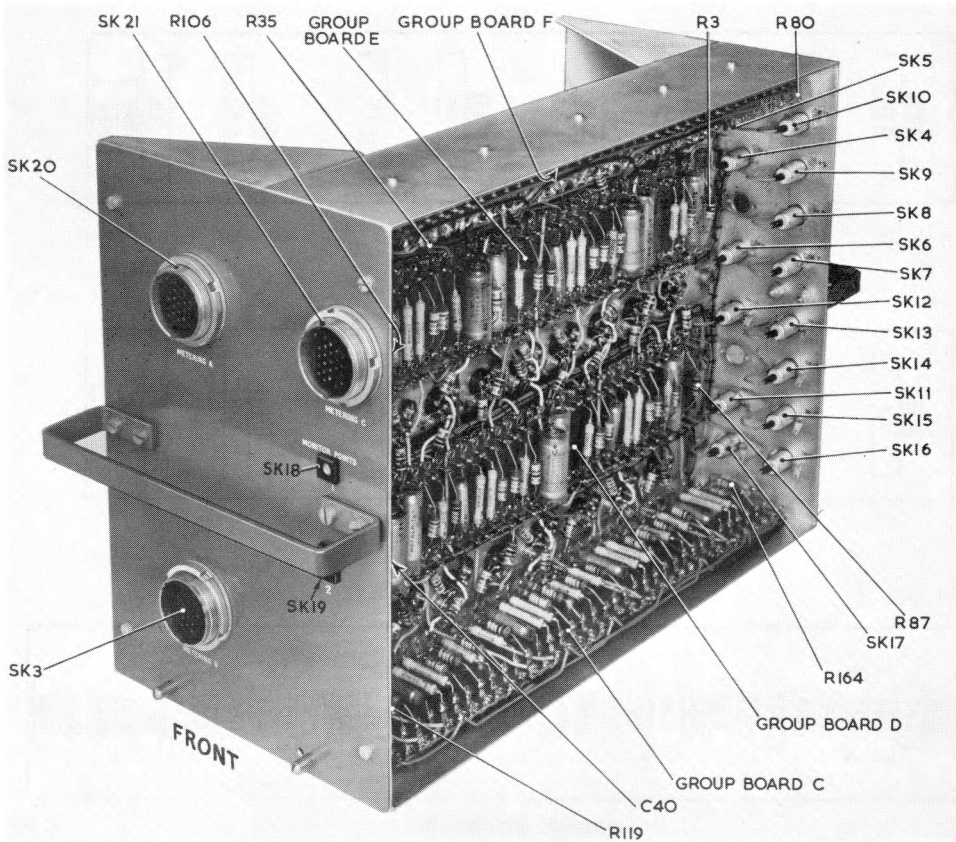


Fig.8 Distribution unit (gating)- general view

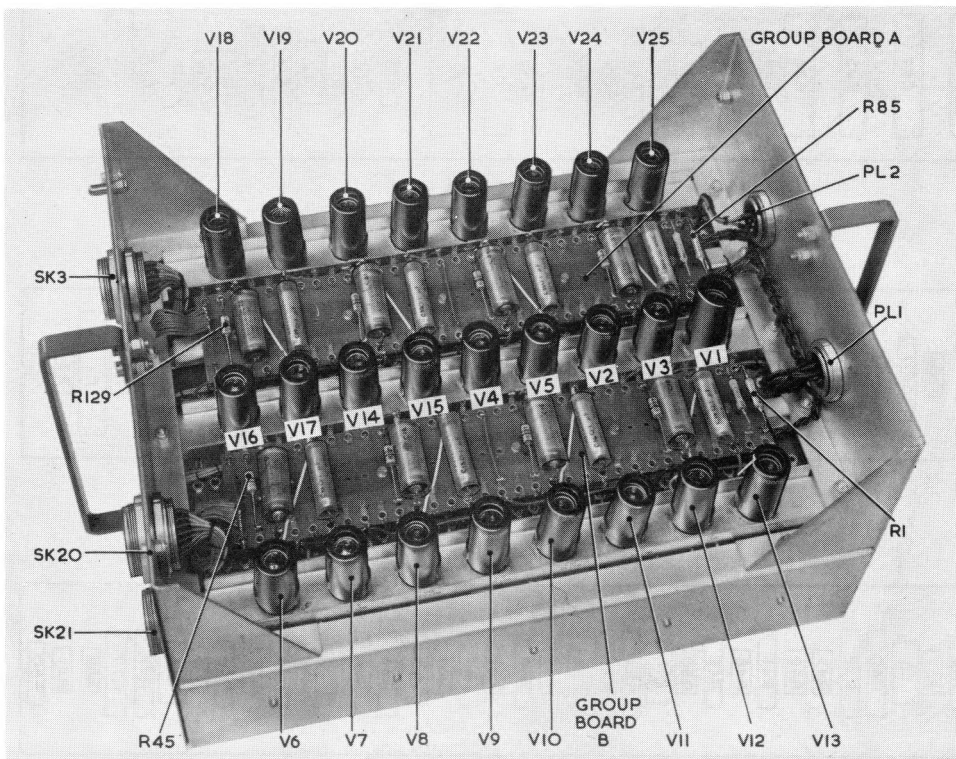
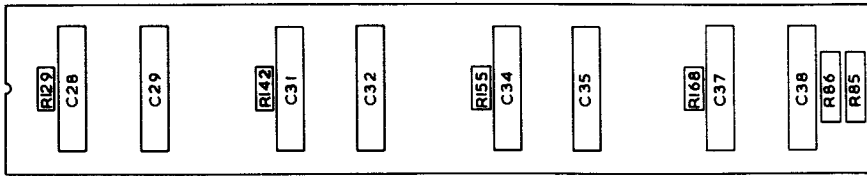
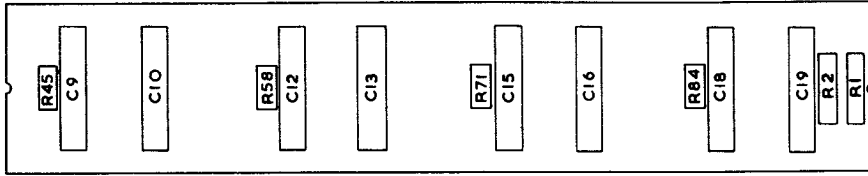


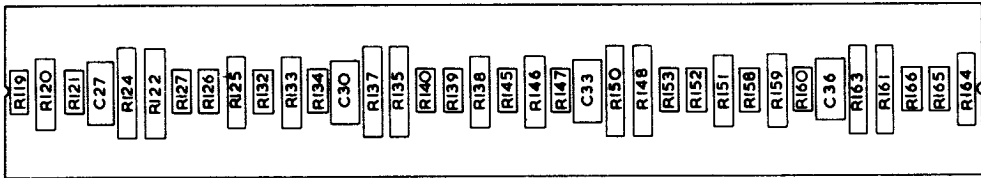
Fig.9 Distribution unit (gating)- over-chassis view



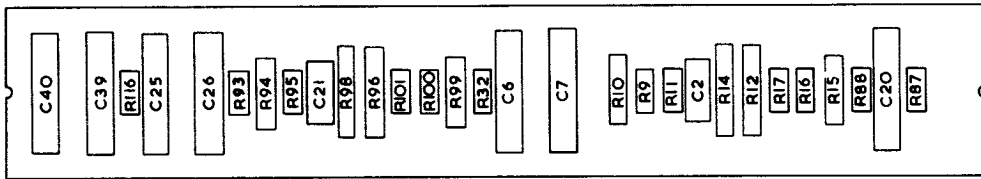
GROUP BOARD A



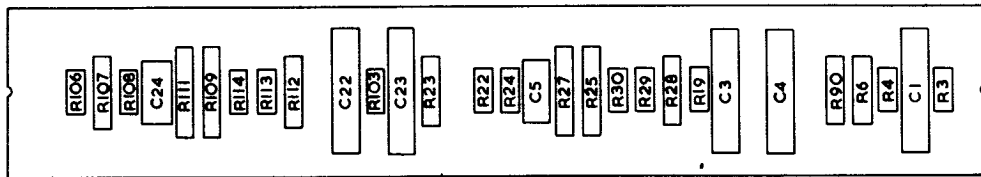
GROUP BOARD B



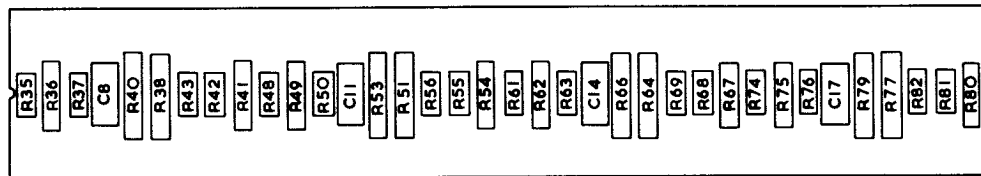
GROUP BOARD C



GROUP BOARD D



GROUP BOARD E



GROUP BOARD F

Fig.10 Distribution unit (gating) - group boards



42 Waveform (h) from V4 anode is applied to the differentiating circuit C43, R89, producing at V3a cathode a train of negative and positive pips (waveform (m)). The negative pip, derived from the leading edge of the input waveform, causes V3a to conduct and thus lowers the potential at V14b grid; the positive pip has no effect. The fall in potential at V14b cathode and the sharp rise at the anode are both applied to V14a and the trigger circuit changes over. In this second stable condition V14b remains cut off because the common cathode is raised to about +60V, following V14a grid, and it is now V14a which is susceptible to negative impulses.

43 To reverse the trigger circuit at the end of the three delays, waveform (l) is brought in from V10b cathode and applied to the differentiating circuit C26, R101, producing at V11b cathode pips as shown in waveform (n). The small positive pip has no effect, because V11b is not conducting, as a result of cathode bias from the +60V line, but the negative pip reverses the trigger circuit by producing a pulse of current through V11b and bringing down V14a grid and the common cathodes, so switching on V14b and restoring the original state. The net result is a 270  $\mu$ s squarewave at each anode of V14, positive-going from V14b (waveform (p)) and negative-going from V14a (waveform (o)). In the exceptional case mentioned in para.19, the duration is 350  $\mu$ s instead of 270  $\mu$ s.

#### Gate cathode-followers

44 The squarewaves from V14 anodes are applied to the cathode-followers V16a and V16b (CV4024), and are fed out from SK7 and SK6, respectively, as the positive and negative gating waveforms. The full amplitude at V14a anode (about 50V) is applied to V16a grid via C27, but since the amplitude at V14b anode is much larger, because of the asymmetrical design of the trigger circuit, the output to V16b grid via C30 is tapped from the V14b anode load at the junction of R93 and R94, where the amplitude is again about 50V. Both waveforms are DC-restored, by the diodes V15a and V15b, to the potential (+30V) at the junction of R103 and R102. This restoration ensures that the cathode-followers will be cut off by the negative portions of the waveforms, so obtaining an accurately defined output. The 33V gating waveforms from SK7 and SK6 do not go straight out to the consoles, but are routed first to the associated distribution unit (gating) in the same rack.

#### Azic. gen. drive output

45 The pentode V17 (CV4014) is connected as a see-saw amplifier, which accepts the 33V positive gating waveform from V16b cathode via C31. The see-saw ratio is 470 k $\Omega$ /820 k $\Omega$ , or about 4/7, so that the amplitude of the negative-going pulse available (at low impedance) from V17 anode is about 20V. This pulse is applied, via C32, to SK8 for supply to the azication rack, where it is used to time the azication sawtooth waveform.

#### Delay-adding stage B

46 In this stage, the double-triode V19 (CV4003) and the double-diode V18 (CV140) may be compared with the valves in stage A (para.40). The purpose of stage B is to add together the two 50  $\mu$ s delays to produce a 100  $\mu$ s ITBU pulse (waveform (r)) correctly timed to start 170  $\mu$ s after the start of the gating waveforms.

47 The circuit is triggered first by the trailing edge of waveform (j), which comes from V6a cathode and is differentiated by C35 and R133 at a time when V19a is conducting. Thus V19a is cut off until the circuit is triggered back 100  $\mu$ s later, when V19b is cut off by the trailing edge of waveform (l) from V10b cathode, differentiated by C33 and R123. In this delay stage, only the positive-going pulse (similar to waveform (r)) from V19a anode is taken out and applied to both the ITBU output stages, V21 and V22.

#### ITBU output stages

48 There are two identical ITBU output stages, using triode-connected pentodes V21 and V22 (CV2127) with the diodes V20a and V20b (CV4025). In the quiescent state the two pentodes are cut off, because their control grids are caught at the negative potential of the diode cathodes. When the positive pulse arrives from V19a anode, the diodes are cut off and the grids of the pentodes start to rise (owing to positive returns via R134 and R151), but the rise is halted and controlled by negative feedback from the anodes via C38, R137 and C42, R150, respectively, so that the amplitude of the output pulses is an accurate 5V.

49 As the cables running from SK9 and SK10 to the ITBU distribution rack are not terminated, there is capacitive loading on the outlets, but this can be handled adequately by the 100 $\Omega$  resistors in each CV2127 cathode circuit. To provide an output pulse of 5V, each CV2127 is required to drive a constant current of 50 mA through its cathode load. To avoid drawing 100 mA from the +300V line during the pulse period, reservoir capacitors C40 and C41 (each 1.0  $\mu$ F) are included in the CV2127 anode circuits. They charge up during the quiescent period and partially discharge, through the valves, during the pulse period. The steady fall of effective HT which results from this partial discharge is compensated by an identical drop at the anodes themselves, effected by suitable choice of the components C38 and C42 in the two feedback arms. By keeping the voltage across R141 (or R147) constant during the pulse, the current driven into the 100 $\Omega$  cathode load is also held constant.

50 There is a tendency for the capacitances across the cathode loads to produce an exponential leading edge on the ITBU pulse. To speed up these leading edges, two capacitors C39 and C45 (0.001  $\mu$ F) have been connected from the output valve anodes to earth. They are charged up to full HT between pulses and they discharge through the valves during the first microsecond of the pulse, providing extra current to charge the cathode-earth capacitances quickly.

#### Second-half ITBU output stage

51 V12, with the diode V11a, forms a constant-current output stage, the circuit of which is identical with that of the ordinary ITBU stages explained in para.48 to 50. The stage is driven by waveform (l) from V10b cathode via R76 (33 k $\Omega$ ), which serves to isolate the output stage from the last 50  $\mu$ s delay stage; the parallel capacitor C44 maintains the wave shape. The output pulse, waveform(s), with an amplitude of 5V like the ordinary ITBU outputs, is available at SK5.

## DISTRIBUTION UNIT (GATING)

### Introduction

52 The distribution unit (gating), stores ref.10D/18917, is associated with the waveform generator (gating) type 101, in the RA304. This unit is required to provide six low-impedance outlets for the positive gating waveform and six for the negative. Each outlet is capable of supplying any number of fixed-coil display consoles, from one up to seven. The pulses are required to be not less than 30V in amplitude and to have edges not longer than 5  $\mu$ s when feeding into a 4,700 pF capacitance.

### Construction

53 In construction and arrangement of valves and tagboards, the unit is very similar to the waveform generator type 101, and is illustrated in figs.8 and 9. The layout of the small components on the group boards is shown in fig.10. There are no preset controls in the unit, but three metering sockets and two monitor points will be observed on the front panel (fig.8). Ratings and other details of components are given in table 2 as an aid to servicing.

### Power supplies

54 HT supplies at +300V and -300V, and four 6.3V 50 Hz heater supplies, come from the same power unit type 903 that supplies the associated waveform generator.

### Circuit description

55 The complete circuit diagram of the distribution unit (fig.13) shows that the positive gate side consists of a triode cathode-follower V1a feeding the waveform to six identical pulse intensifier stages, each of which supplies one positive gate outlet. Similarly, the negative gate side of the unit contains a cathode-follower V1b driving another six pulse intensifiers. The DC grid conditions in V1b are slightly different from those in V1a because of the different polarities of the input waveforms. The outputs from V1a and V1b may be viewed on an oscilloscope at monitor points 1 and 2 (SK18 and SK19), respectively.

### Pulse intensifier action

56 The output stage feeding SK5 (positive gate outlet No.1) may be taken as typical of all twelve pulse intensifiers. It consists basically of a pentode cathode-follower V2, AC-coupled to SK5 via C3. There is considerable self-capacitance across the output due to the mismatched coaxial cables, so although the circuit produces a sharp enough positive edge (when the cable capacitance can charge up through the valve, which is in full conduction), the subsequent negative edge is not sharply reproduced, because the valve is nearly cut off and the cable capacitance has to discharge through V2 cathode load R9 (22 k $\Omega$ ).

57 This slow negative edge is unacceptable for gating purposes, so it is speeded up by providing the pentode valve V3 (CV4014) to discharge the cathode of V2. A 10 k $\Omega$  load R11 is inserted in the anode circuit of V2 and the sharp positive edge, which appears there when the grid is taken negative, is used to drive the grid of V3, the operating condition of which is DC-stabilized by the feedback chain R12, R14. The extra current switched on in V3 is sufficient rapidly to discharge via C4, the cathode of V2 and so speed up the negative edge of the output pulse.

## PANEL (DISTRIBUTION AND SWITCHING) TYPE 879

### Introduction

58 This panel (stores ref.10D/18866) is situated at the base of the RA304. All the coaxial leads linking the rack to the rest of the station pass through the panel. It contains a change-over switch which connects the coaxial services either to gating waveform generator A (and its associated distribution amplifier) or to B. One set of units is normally in action and the other operating under stand-by conditions; by means of the change-over switch, the second set may be brought into use immediately if the first becomes unserviceable.

59 The panel also contains the monitor switches, which are remotely operated from the waveform monitor rack. By means of these switches, any one of the 32 waveforms, produced by the gating waveform generators and their distribution units, may be selected and fed out to the waveform monitor rack for display. There is also a general purpose 5A mains socket (SK58).

### Construction

60 The panel is constructed in the form of an inverted T and it is fixed to the base plate of the rack, over the cooling air inlet, by two long captive screws (fig.11). The coaxial sockets are all on the horizontal arms of the T, those for internal connections being on the right, as seen from the front of the rack, and those for external connections on the left. The mains socket and switch are at the rear.

### Circuit description

61 Fig.14 gives the complete circuit diagram of the panel, which will be explained under two main headings, the change-over switch and the monitor switches.

### Change-over switch

62 The change-over switch is switch A, which has two positions (A and B), selected by the knob at the front of the panel. In the A position of SW.A, the output sockets SK3 to SK18, inclusive, are connected through to gating waveform generator A and its associated distribution amplifier; in the B position, they are connected to the B generator and amplifier. Note that the 250 Hz master trigger pulses and the 500 Hz TB squarewave by-pass the switch, and are applied to both waveform generators all the time. In addition, wafer SW.Aa (front) switches lines to the monitor rack via PL57/F, G, H, which light lamps there to indicate which waveform generator and distribution unit are in use.

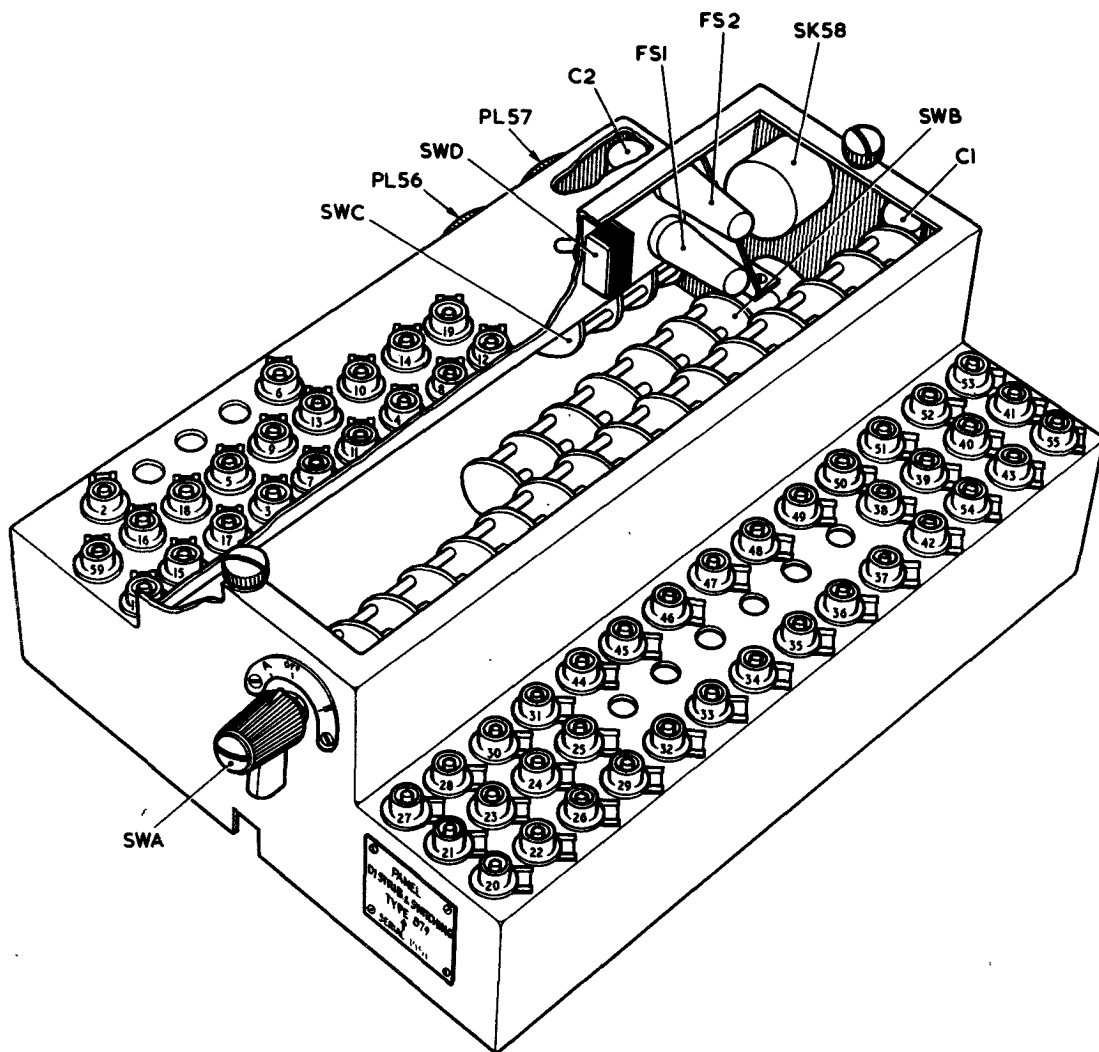


Fig.11 Panel (distribution and switching) Type 879-general view

Monitor switches

63 The monitor switches are SW.B and SW.C. Their purpose is to select any one of the 32 waveforms appearing on sockets SK24 to SK55, inclusive, and to connect the chosen waveform out via SK19 to the waveform monitor rack. The waveforms are divided into three groups, each containing twelve waveforms (allowing four spare positions). The group is selected by SW.C and the waveform within the group by SW.B.

Rotary actuators

64 The actuators for SW.B and SW.C are Ledex rotary selectors (associated with type H wafer switches they are known as uniselector units type 4067). SW.B actuator is controlled by switching lines entering via PL56/A to M, and SW.C actuator by lines entering via PL57/A to C, the common positive return line being on PL57/E. The operation of the actuators is described in para.2, Chap.1, Sect.4 of this part, and the selection of waveforms in Chap.4 of the same section.

TABLE 1 WAVEFORM GENERATOR (GATING) TYPE 101 - COMPONENT DETAILS

(Stores Ref.10V/16064)

Resistors (fixed)

Circuit ref.	Value (ohms)	NS Number
R1	47k	5905-99-022-2215
R2	330	5905-99-022-1173
R3	220k	5905-99-022-3080
R4*	12k	5905-99-022-6013
R5	330	5905-99-022-1173
R6*	6.8k	5905-99-022-5342
R7*	33	5905-99-022-5062
R8	1k	5905-99-022-2005
R9*	100k	5905-99-022-6454
R10*	12k	5905-99-022-6232
R11*	12k	5905-99-022-6232
R12 not fitted		
R13	100k	5905-99-022-3038
R14	330	5905-99-022-1173
R15*	15k	5905-99-022-6023
R16*	68k	5905-99-022-6013
R17*	150	5905-99-022-5142
R18*	33	5905-99-022-5062
R19	10k	5905-99-022-2131
R20	330	5905-99-022-1173
R21*	2.7M	5905-99-022-6191
R22*	22k	5905-99-022-6042
R23*	560k	5905-99-022-6743
R24	100	5905-99-022-1110

TABLE 1 WAVEFORM GENERATOR (GATING) TYPE 101 - COMPONENT DETAILS (continued)

Resistors (fixed)

Circuit ref.	Value (ohms)	NS number
R25*	75k	5905-99-022-6107
R26	2.2M	5905-99-022-3206
R27*	150	5905-99-022-5142
R28	47k	5905-99-022-2215
R29	100k	5905-99-022-3038
R30	330	5905-99-022-1173
R31	10k	5905-99-022-2131
R32*	240k	5905-99-022-6725
R33	1M	5905-99-022-3164
R34*	22k	5905-99-022-2173
R35*	470k	5905-99-022-6590
R36*	1M	5905-99-022-6655
R37	150k	5905-99-022-3059
R38*	1.5M	5905-99-022-6668
R39	820	5905-99-022-1227
R40	330	5905-99-022-1173
R41	27k	5905-99-022-2260
R42	100	5905-99-022-1110
R43*	33	5905-99-022-5062
R44	47k	5905-99-022-2216
R45*	820k	5905-99-022-6639
R46	330	5905-99-022-1173
R47	47k	5905-99-022-2215
R48*	1M	5905-99-022-6655
R49	220k	5905-99-022-3080
R50*	150	5905-99-022-5142
R51 not fitted		
R52	120k	Z213328
R53 not fitted		
R54*	820k	Z216643
R55	100	5905-99-022-1110
R56	330	5905-99-022-1173
R57*	33	5905-99-022-5062
R58	47k	5905-99-022-2216
R59*	820k	5905-99-022-6639
R60*	1M	5905-99-022-6655
R61	330	5905-99-022-1173
R62	220k	5905-99-022-3080
R63*	150	5905-99-022-5142
R64	820	5905-99-022-1227
R65	120k	5905-99-022-3328
R66 not fitted		

TABLE 1 WAVEFORM GENERATOR (GATING) TYPE 101 - COMPONENT DETAILS (continued)

Resistors (fixed)

Circuit ref.	Value (ohms)	NS number
R67*	820k	5905-99-022-6643
R68	100	5905-99-022-1110
R69	1.2k	5905-99-022-2017
R70	330	5905-99-022-1173
R71*	33	5905-99-022-5062
R72	47k	5905-99-022-2216
R73*	470k	5905-99-022-6590
R74	330	5905-99-022-1173
R75*	750k	5905-99-022-6631
R76	33k	5905-99-022-2194
R77	150k	5905-99-022-3329
R78*	150	5905-99-022-5142
R79*	620k	5905-99-022-6619
R80*	160k	5905-99-022-6500
R81	330	5905-99-022-1173
R82*	68k	5905-99-022-6411
R83*	300k	5905-99-022-6555
R84*	150	5905-99-022-5142
R85	1.5k	5905-99-022-2026
R86*	1k	5905-99-022-5641
R87	100	5905-99-022-1110
R88*	100	5905-99-022-5401
R89	47k	5905-99-022-2215
R90	100k	5905-99-022-3038
R91	330	5905-99-022-1173
R92*	150	5905-99-022-5142
R93*	22k	5905-99-022-6292
R94*	36k	5905-99-022-8752
R95*	12k	5905-99-022-6233
R96*	150	5905-99-022-5062
R97	10k	5905-99-022-2131
R98	330	5905-99-022-1173
R99*	1M	5905-99-022-6655
R100*	1.8M	5905-99-022-6671
R101	47k	5905-99-022-2215
R102*	39k	5905-99-022-6072
R103*	330k	5905-99-022-6729
R104	1M	5905-99-022-3164
R105	330	5905-99-022-1173
R106*	33	5905-99-022-5062
R107	4.7k	5905-99-022-2089
R108	4.7M	5905-99-022-3248
R109	4.7M	5905-99-022-3248



TABLE 1 WAVEFORM GENERATOR (GATING) TYPE 101 - COMPONENT DETAILS (continued)

Resistors (fixed)

Circuit ref.	Value (ohms)	NS number
R110	47k	5905-99-022-2089
R111	330	5905-99-022-1173
R112	150	5905-99-021-5062
R113 not fitted		
R114	1M	5905-99-022-3164
R115*	820k	5905-99-021-6751
R116	330	5905-99-022-1173
R117*	470k	5905-99-021-6739
R118 not fitted		
R119*	680k	5905-99-021-6747
R120*	150	5905-99-021-5142
R121	47k	5905-99-022-2215
R122	100	5905-99-022-1110
R123	47k	5905-99-022-2215
R124	100k	5905-99-022-2038
R125	330	5905-99-022-1173
R126*	150	5905-99-021-5142
R127*	56k	5905-99-021-6392
R128*	33	5905-99-021-5062
R129	15k	5905-99-022-2152
R130	330	5905-99-022-1173
R131*	12k	5905-99-021-6233
R132*	1.8M	5905-99-021-6671
R133	47k	5905-99-022-2215
R134*	620k	5905-99-021-6619
R135*	68k	5905-99-021-6411
R136*	300k	5905-99-021-6555
R137*	160k	5905-99-021-6500
R138	330	5905-99-022-1173
R139*	150	5905-99-021-5142
R140	1.5k	5905-99-022-2026
R141*	1k	5905-99-021-5641
R142	100	5905-99-022-1110
R143*	100	5905-99-021-5401
R144	100	5905-99-022-1110
R145*	150	5905-99-021-5142
R146*	1.5k	5905-99-022-2026
R147*	1k	5905-99-021-5641
R148*	100	5905-99-021-5401
R149	330	5905-99-022-1173
R150*	160k	5905-99-021-6500
R151*	620k	5905-99-021-6619
R152*	68k	5905-99-021-6411
R153*	300k	5905-99-021-6555
R154 to R157 not fitted		
R158	47k	5905-99-022-2215
R159	330k	5905-99-022-3101
R160*	1M	5905-99-021-6655
R161	470k	5905-99-022-3122

\*High stability

TABLE 1 WAVEFORM GENERATOR (GATING) TYPE 101 - COMPONENT DETAILS (continued)

Resistors (variable)

Circuit ref.	Value (ohms)	NS number	Function
RV1	100k	5905-99-027-2549	250 Hz GATE
RV2	100k	5905-99-027-2549	IT bright-up delay
RV3	100k	5905-99-027-2549	IT bright-up duration (1)
RV4	100k	5905-99-027-2549	IT bright-up duration (2)

Capacitors

Circuit ref.	Value ( $\mu$ F ex. where stated)	NS number
C1	.01	5910-99-011-5625
C2	0.1	5910-99-011-5506
C3	0.1	5910-99-011-5506
C4	.01	5910-99-011-5625
C5	1	5910-99-011-5632
C6	0.1	5910-99-011-5506
C7	2200 pF	5910-99-012-4192
C8	.01	5910-99-011-5625
C9	330 pF	5910-99-012-3366
C10	0.1	5910-99-011-5506
C11	0.1	5910-99-011-5506
C12	0.1	5910-99-011-5506
C13	.01	5910-99-011-5625
C14	.01	5910-99-011-5625
C15	220 pF	5910-99-012-3288
C16	.01	5910-99-011-5625
C17	.01	5910-99-011-5625
C18	220 pF	5910-99-012-3288
C19	2,700 pF	5910-99-012-4215
C20	.01	5910-99-011-5625
C21	0.1	5910-99-011-5506
C22	.01	5910-99-012-4375
C23	1	5910-99-011-5632
C24	1,000 pF	5910-99-012-4446
C25	22 pF	5910-99-013-2277
C26	220 pF	5910-99-013-2312
C27	0.1	5910-99-011-5506
C28	0.1	5910-99-011-5506
C29	0.1	5910-99-011-5506
C30	0.1	5910-99-011-5506
C31	.01	5910-99-011-5625
C32	0.1	5910-99-011-5506

TABLE 1 WAVEFORM GENERATOR (GATING) TYPE 101 - COMPONENT DETAILS (continued)

Capacitors

Circuit ref.	Value ( $\mu$ F ex. where stated)	NS number
C33	220 pF	5910-99-013-2312
C34	22 pF	5910-99-013-2277
C35	220 pF	5910-99-013-2312
C36	0.1	5910-99-011-5506
C37	0.1	5910-99-011-5506
C38	.01	5910-99-012-4375
C39	1,000 pF	5910-99-012-4446
C40	1	5910-99-011-5632
C41	1	5910-99-011-5632
C42	.01	5910-99-012-4375
C43	220 pF	5910-99-013-2312
C44	150 pF	5910-99-013-2306
C45	1,000 pF	5910-99-012-4446
C46	0.1	5910-99-011-5506
C47	0.1	5910-99-011-5506
C48	0.1	5910-99-011-5506
C49	1	5910-99-011-5632

Plugs and sockets

Circuit ref.	Description	NS number
PL1*	12-way fixed plug	5935-99-056-0153
PL2*	6-way fixed plug	5935-99-056-0541
SK3 to SK10	Coaxial socket	10H/19861
SK11 to SK16	Socket (Belling-Lee)	5935-99-911-3896
SK17*	25-way fixed socket	5935-99-056-0380
SK18*	25-way fixed socket	5935-99-056-0380

\*Moulding position on Mk.4 plugs and sockets is shown by last digit of NS number.

TABLE 2 DISTRIBUTION UNIT (GATING) - COMPONENT DETAILS

(Stores Ref. 10D/18917)

Resistors (fixed)

Circuit ref.	Value (ohms)	NS number
R1*	330k	5905-99-021-6730
R2*	51k	5905-99-021-6087
R3	1M	5905-99-022-3164
R4	22k	5905-99-022-2173
R5	330	5905-99-022-1173
R6*	150	5905-99-021-5142
R7	100	5905-99-022-1110
R8	3.3k	5905-99-022-2068
R9	22k	5905-99-022-2173
R10*	150	5905-99-021-5142
R11	10k	5905-99-022-2131
R12*	620k	5905-99-021-6619
R13	330	5905-99-022-1173
R14*	680k	5905-99-021-6627
R15*	150	5905-99-021-5142
R16	22k	5905-99-022-2173
R17	47k	5905-99-022-2215
R18	100	5905-99-022-1110
R19	4.7M	5905-99-022-3248
R20	100	5905-99-022-1110
R21	3.3k	5905-99-022-2068
R22	22k	5905-99-022-2173
R23*	150	5905-99-021-5142
R24	10k	5905-99-022-2131
R25*	620k	5905-99-021-6619
R26	330	5905-99-022-1173
R27*	680k	5905-99-021-6627
R28*	150	5905-99-021-5142
R29	22k	5905-99-022-2173
R30	47k	5905-99-022-2215
R31	100	5905-99-022-1110
R32	4.7M	5905-99-022-3248
R33	100	5905-99-022-1110
R34	3.3k	5905-99-022-2068
R35	22k	5905-99-022-2173
R36*	150	5905-99-021-5142
R37	10k	5905-99-022-2131
R38*	620k	5905-99-021-6619
R39	330	5905-99-022-1173
R40*	680k	5905-99-021-6627
R41*	150	5905-99-021-5142
R42	22k	5905-99-022-2173
R43	47k	5905-99-022-2215
R44	100	5905-99-022-1110

TABLE 2 DISTRIBUTION UNIT (GATING) - COMPONENT DETAILS (continued)

Resistors (fixed)

Circuit ref.	Value (ohms)	NS number
R45	4.7M	5905-99-022-3248
R46	100	5905-99-022-1110
R47	3.3k	5905-99-022-2068
R48	22k	5905-99-022-2173
R49*	150	5905-99-021-5142
R50	10k	5905-99-022-2131
R51*	620k	5905-99-021-6619
R52	330	5905-99-022-1173
R53*	680k	5905-99-021-6627
R54*	150	5905-99-021-5142
R55	22k	5905-99-022-2173
R56	47k	5905-99-022-2215
R57	100	5905-99-022-1110
R58	4.7M	5905-99-022-3248
R59	100	5905-99-022-1110
R60	3.3K	5905-99-022-2068
R61	22k	5905-99-022-2173
R62*	150	5905-99-021-5142
R63	10k	5905-99-022-2311
R64*	620k	5905-99-021-6619
R65	330	5905-99-022-1173
R66*	680k	5905-99-021-6627
R67*	150	5905-99-021-5142
R68	22k	5905-99-022-2173
R69	47k	5905-99-022-2215
R70	100	5905-99-022-1110
R71	4.7M	5905-99-022-3248
R72	100	5905-99-022-1110
R73	3.3k	5905-99-022-2068
R74	22k	5905-99-022-2173
R75*	150	5905-99-021-5142
R76	10k	5905-99-022-2131
R77*	620k	5905-99-021-6619
R78	330	5905-99-022-1173
R79	680k	5905-99-021-6627
R80*	150	5905-99-021-5142
R81	22k	5905-99-022-2173
R82	47k	5905-99-022-2215
R83	100	5905-99-022-1110
R84	4.7M	5905-99-022-3248
R85*	270k	5905-99-021-6726
R86*	100k	5905-99-021-6122
R87	1M	5905-99-022-3164
R88	22k	5905-99-022-2173
R89	330	5905-99-022-1173

TABLE 2 DISTRIBUTION UNIT (GATING) - COMPONENT DETAILS (continued)

Resistors (fixed)

Circuit ref.	Value (ohms)	NS number
R90*	33	5905-99-021-5062
R91	100	5905-99-022-1110
R92	3.3k	5905-99-022-2068
R93	22k	5905-99-022-2173
R94*	33	5905-99-021-5062
R95	10k	5905-99-022-2131
R96*	620k	5905-99-021-6619
R97	330	5905-99-022-1173
R98*	680k	5905-99-021-6627
R99*	150	5905-99-021-5142
R100	22k	5905-99-022-2173
R101	47k	5905-99-022-2215
R102	100	5905-99-022-1110
R103	4.7M	5905-99-022-3248
R104	100	5905-99-022-1110
R105	3.3k	5905-99-022-2068
R106	22k	5905-99-022-2173
R107*	33	5905-99-021-5062
R108	10k	5905-99-022-2131
R109*	620k	5905-99-021-6619
R110	330	5905-99-022-1173
R111*	680k	5905-99-021-6627
R112*	150	5905-99-021-5142
R113	22k	5905-99-022-2173
R114	47k	5905-99-022-2215
R115	100	5905-99-022-1110
R116	4.7M	5905-99-022-3248
R117	100	5905-99-022-1110
R118	3.3k	5905-99-022-2068
R119	22k	5905-99-022-2173
R120*	33	5905-99-021-5062
R121	10k	5905-99-022-2131
R122*	620k	5905-99-021-6619
R123	330	5905-99-022-1173
R124*	680k	5905-99-021-6627
R125*	150	5905-99-021-5142
R126	22k	5905-99-022-2173
R127	47k	5905-99-022-2215
R128	100	5905-99-022-1110
R129	4.7M	5905-99-022-3248
R130	100	5905-99-022-1110
R131	3.3k	5905-99-022-2068
R132	22k	5905-99-022-2173
R133*	33	5905-99-021-5062

TABLE 2 DISTRIBUTION UNIT (GATING) - COMPONENT DETAILS (continued)

Resistors (fixed)

Circuit ref.	Value (ohms)	NS number
R134	10k	5905-99-022-2131
R135*	620k	5905-99-021-6619
R136	330	5905-99-022-1173
R137*	680k	5905-99-021-6627
R138*	150	5905-99-021-5142
R139	22k	5905-99-022-2173
R140	47k	5905-99-022-2215
R141	100	5905-99-022-1110
R142	4.7M	5905-99-022-3248
R143	100	5905-99-022-1110
R144	3.3k	5905-99-022-2068
R145	22k	5905-99-022-2173
R146*	33	5905-99-021-5062
R147	10k	5905-99-022-2131
R148*	620k	5905-99-021-6619
R149	330	5905-99-022-1173
R150*	680k	5905-99-021-6627
R151*	150	5905-99-021-5142
R152	22k	5905-99-022-2173
R153	47k	5905-99-022-2215
R154	100	5905-99-022-1110
R155	4.7M	5905-99-022-3248
R156	100	5905-99-022-1110
R157	3.3k	5905-99-022-2068
R158	22k	5905-99-022-2173
R159*	33	5905-99-021-5062
R160	10k	5905-99-022-2131
R161*	620k	5905-99-021-6619
R162	330	5905-99-022-1173
R163*	680k	5905-99-021-6627
R164*	150	5905-99-021-5142
R165	22k	5905-99-022-2173
R166	47k	5905-99-022-2215
R167	100	5905-99-022-1110
R168	4.7M	5905-99-022-3248

\*High stability

TABLE 2 DISTRIBUTION UNIT (GATING) - COMPONENT DETAILS (continued)

Capacitors

Circuit ref.	Value ( $\mu$ F)	NS number
C1	0.1	5910-99-011-5506
C2	.01	5910-99-011-5625
C3	1	5910-99-011-5569
C4	0.1	5910-99-011-5506
C5	.01	5910-99-011-5625
C6	1	5910-99-011-5569
C7	0.1	5910-99-011-5506
C8	.01	5910-99-011-5625
C9	1	5910-99-011-5569
C10	0.1	5910-99-011-5506
C11	.01	5910-99-011-5625
C12	1	5910-99-011-5569
C13	0.1	5910-99-011-5506
C14	.01	5910-99-011-5625
C15	1	5910-99-011-5569
C16	0.1	5910-99-011-5506
C17	.01	5910-99-011-5625
C18	1	5910-99-011-5569
C19	0.1	5910-99-011-5506
C20	0.1	5910-99-011-5506
C21	.01	5910-99-011-5625
C22	1	5910-99-011-5569
C23	0.1	5910-99-011-5506
C24	.01	5910-99-011-5625
C25	1	5910-99-011-5569
C26	0.1	5910-99-011-5506
C27	.01	5910-99-011-5625
C28	1	5910-99-011-5569
C29	0.1	5910-99-011-5506
C30	.01	5910-99-011-5625
C31	1	5910-99-011-5569
C32	0.1	5910-99-011-5506
C33	.01	5910-99-011-5625
C34	1	5910-99-011-5569
C35	0.1	5910-99-011-5506
C36	.01	5910-99-011-5625
C37	1	5910-99-011-5569
C38	0.1	5910-99-011-5506
C39	0.1	5910-99-011-5506
C40	0.1	5910-99-011-5506



TABLE 2 DISTRIBUTION UNIT (GATING) - COMPONENT DETAILS (continued)

Plugs and sockets

Circuit ref.	Description	NS number
PL1*	12-way fixed plug	5935-99-056-0152
PL2*	6-way fixed plug	5935-99-056-0541
SK3*	25-way fixed socket	5935-99-056-0380
SK4 to SK17	Coaxial socket	10H/19861
SK18, SK19	Socket (Belling-Lee-316)	10H/19641
SK20*	25-way fixed socket	5935-99-056-0380
SK21*	25-way fixed socket	5935-99-056-0380

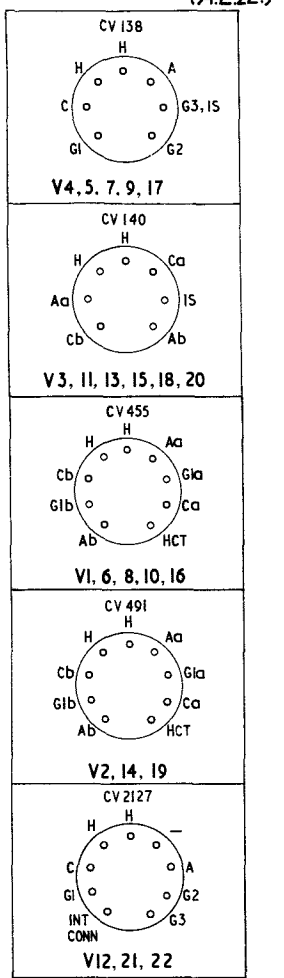
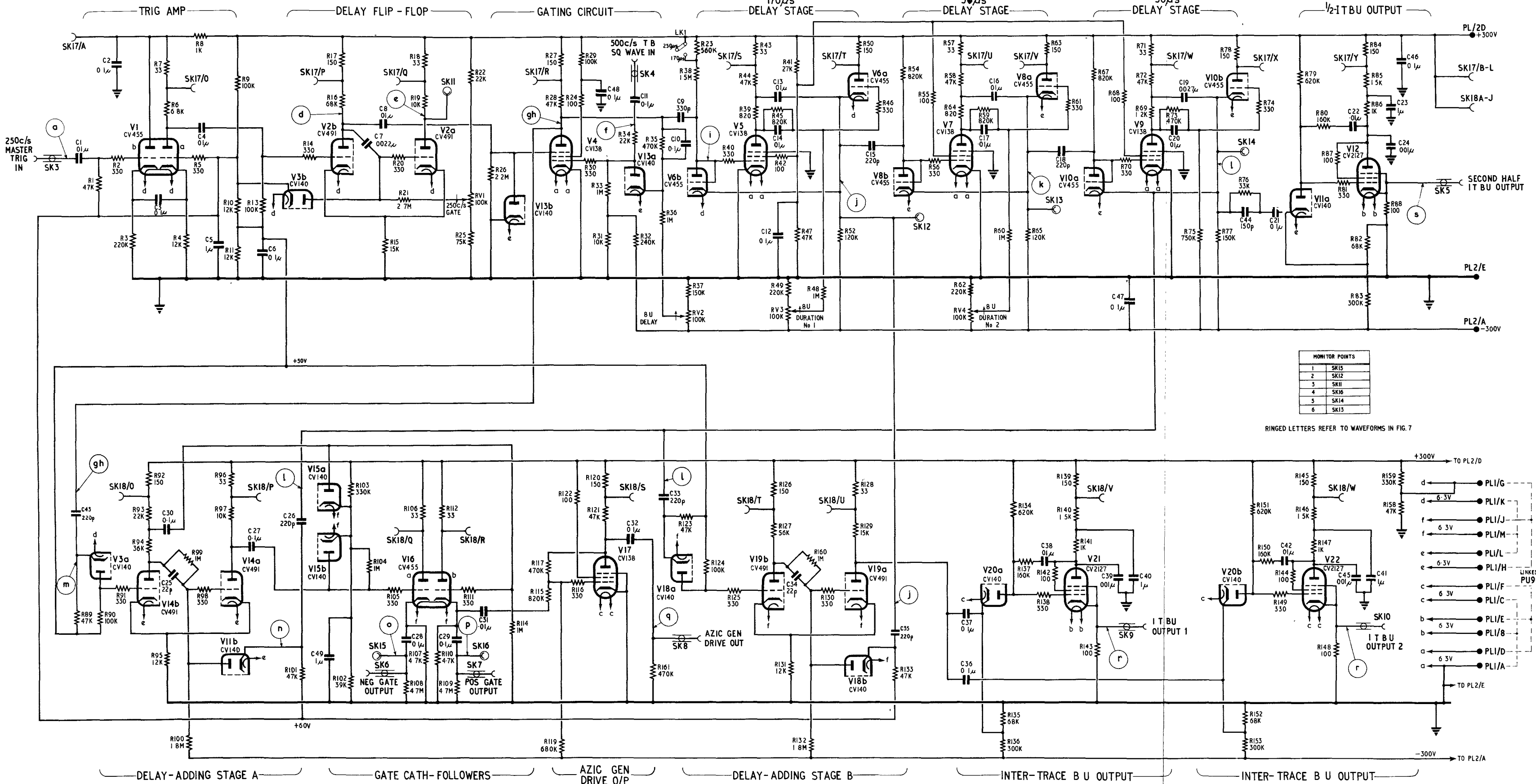
\*Moulding position on Mk.4 plugs and sockets is shown by last digit of NS number.

TABLE 3 PANEL (DISTRIBUTION AND SWITCHING) TYPE 879-COMPONENT DETAILS  
(Stores Ref. 10D/18866)

Circuit ref.	Description	NS number
SK1 to SK55	Coaxial socket type 783	10H/19861
PL56	12-way fixed plug	5935-99-056-0151
PL57	12-way fixed plug	5935-99-056-0152
SK58	5A 3-pole socket (Crabtree L7170)	5C/1042
SK59	Coaxial socket type 783	10H/19861
SW.A	Wafer switch (H) type 2712	10F/17460
SW.B	Uniselector units type 4067	10F/17463
SW.C	(wafer switch H type 4066 and Ledex rotary selector)	10F/17462
SW.D	2-pole ON/OFF toggle switch	5930-99-051-0306
FS1 and FS2	5A fuse link (MOS/A)	5920-99-059-0112
C1 and C2	Capacitor, 0.05 $\mu$ F 350V, 20%	5910-99-011-5554
MR1 and MR2	Resistor unit 514 50V d.c.	10W/19566

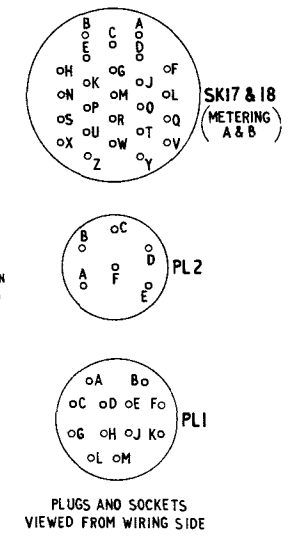
TABLE 4 RACK ASSEMBLY (GATING WAVEFORM) TYPE 304  
LIST OF INPUT AND OUTPUT CONNECTIONS (SEE PARA.13)

PL or SK	Type	Location (Unit No.)	Moulding position	Pin	Service	Destination (RA = rack assembly)
PL1	6-pole (med.)	14	0	A	Neutral 230 50 Hz	Radar office power board
				B	Line for power unit B	
				C	-500V reference	RA (neg. ref.) type 338
				D	50V+	Rectifier type 15
				E	50V-	
				F	50V - neg. ref. control	RA (neg. ref.) type 338 (paired with C)
PL2	6-pole (med.)	14	0	A-F	As PL1, for power unit A	As PL1
PL56	12-pole	13	1	A-M	Monitor control	RA (waveform monitor) type 339 - direct connector
PL57	12-pole	13	2	A-M	Monitor control and lights and mains	RA (waveform monitor) type 339 - direct connector
SK1	Coaxial	13	-	-	250 Hz trigger IN	Master trigger unit
SK2	Coaxial	13	-	-	GWG drive	RA (timebase) type 300.
SK3	Coaxial	13	-	-	+ gate (1)	I/C cabins 1 and 2
SK4	Coaxial	13	-	-	- gate (1)	I/C cabins 1 and 2
SK5	Coaxial	13	-	-	+ gate (2)	I/C cabin 3 and FM
SK6	Coaxial	13	-	-	- gate (2)	I/C cabin 3 and FM
SK7	Coaxial	13	-	-	+ gate (3)	I/C cabin 4 and CC
SK8	Coaxial	13	-	-	- gate (3)	I/C cabin 4 and CC
SK9	Coaxial	13	-	-	+ gate (4)	TT cabin (raid report)
SK10	Coaxial	13	-	-	- gate (4)	TT cabin (raid report)
SK11	Coaxial	13	-	-	+ gate (5)	TT cabin (CHEL/CEW)
SK12	Coaxial	13	-	-	- gate (5)	TT cabin (CHEL/CEW)
SK13	Coaxial	13	-	-	+ gate (6)	Radar office and workshop
SK14	Coaxial	13	-	-	- gate (6)	Radar office and workshop
SK15	Coaxial	13	-	-	Azic. gen. drive OUT	RA (azication type 302)
SK16	Coaxial	13	-	-	$\frac{1}{2}$ ITBU OUT	Not wired
SK17	Coaxial	13	-	-	ITBU No.1 OUT	RA (Misc ITBU) type 306
SK18	Coaxial	13	-	-	ITBU No.2 OUT	RA (Misc ITBU) type 306
SK19	Coaxial	13	-	-	Selected waveform OUT	RA (waveform monitor) type 338
SK59	Coaxial	13	-	-	250 Hz trigger OUT	Not wired



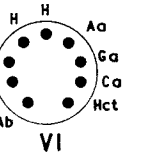
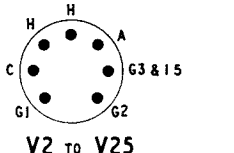
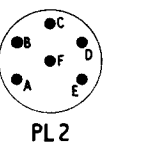
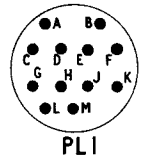
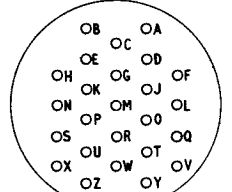
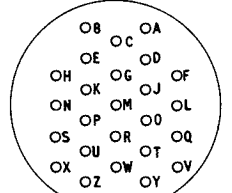
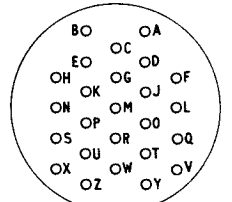
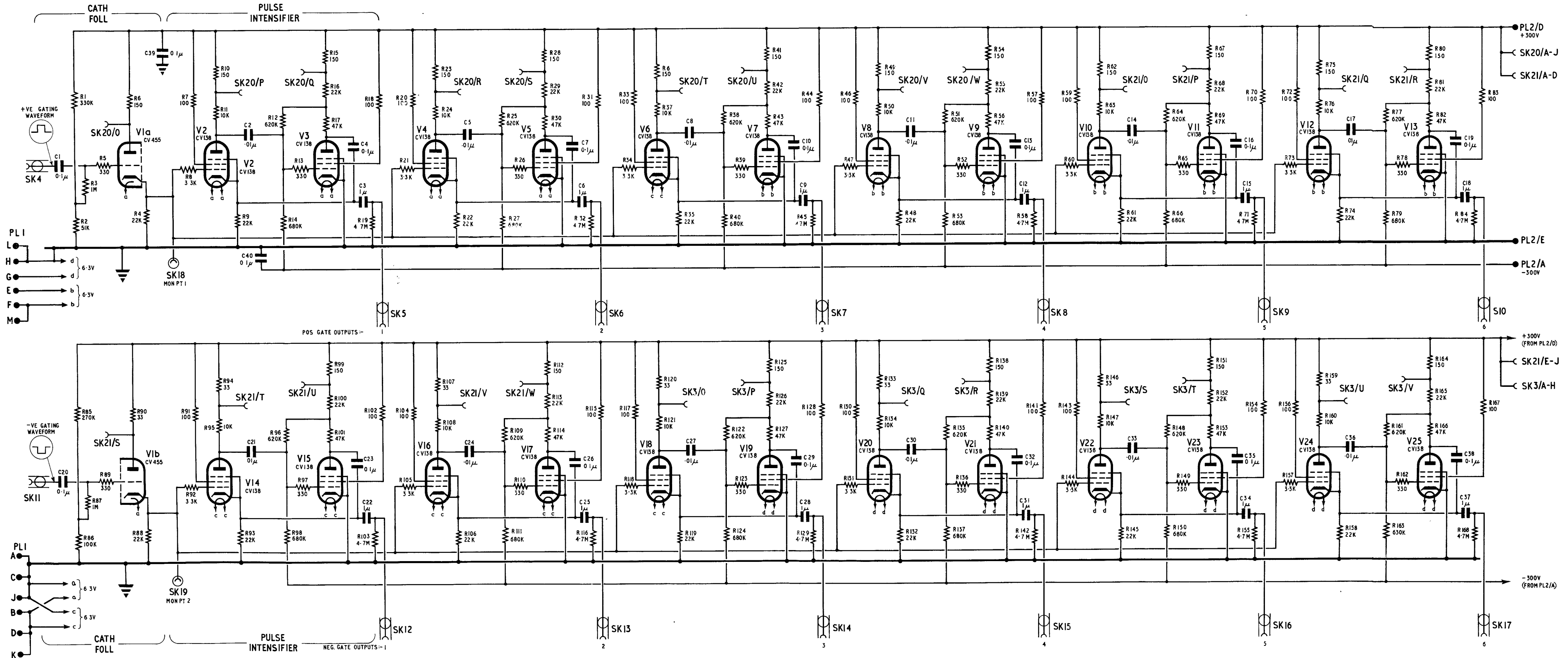
MONITOR POINTS	
1	SK15
2	SK12
3	SK11
4	SK16
5	SK14
6	SK13

RINGED LETTERS REFER TO WAVEFORMS IN FIG. 7



Waveform generator (gating) Type IOI-circuit

Fig. 12 (A.L.22 Apr.56)



PLUGS AND SOCKETS VIEWED FROM WIRING SIDE

Distribution unit (gating) - circuit

Fig. 13

Fig. 13

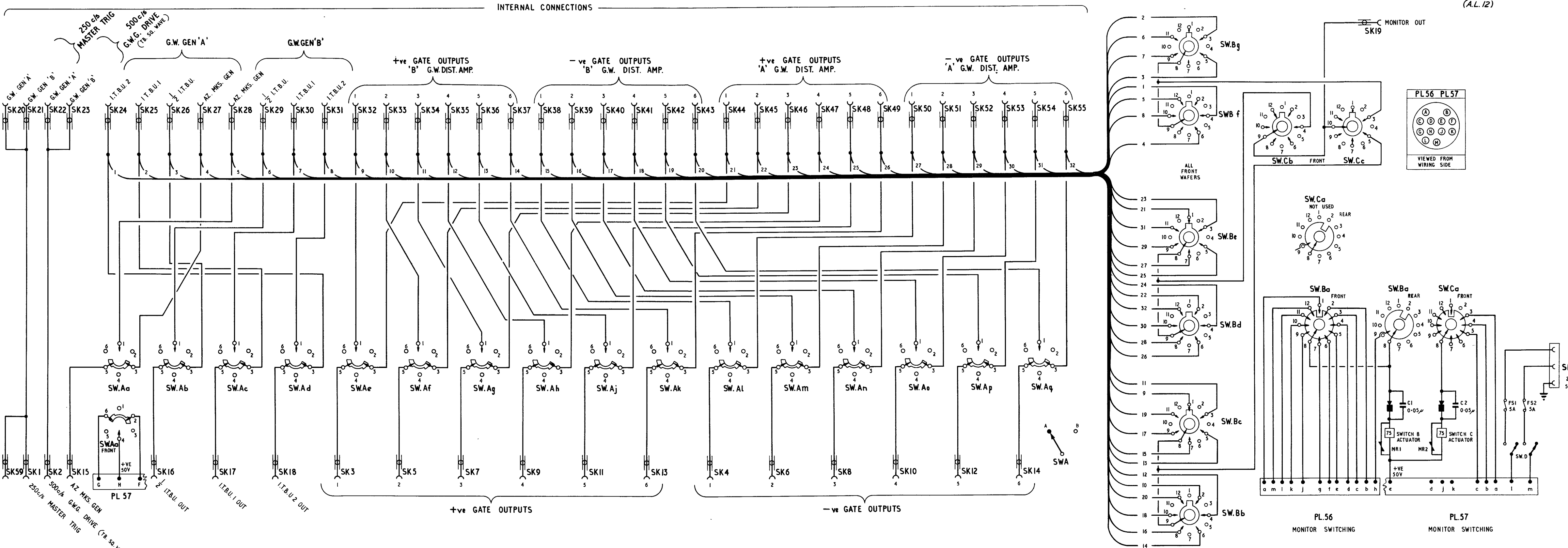


Fig.14

Panel (distribution and switching) Type 879 - circuit

Fig.14

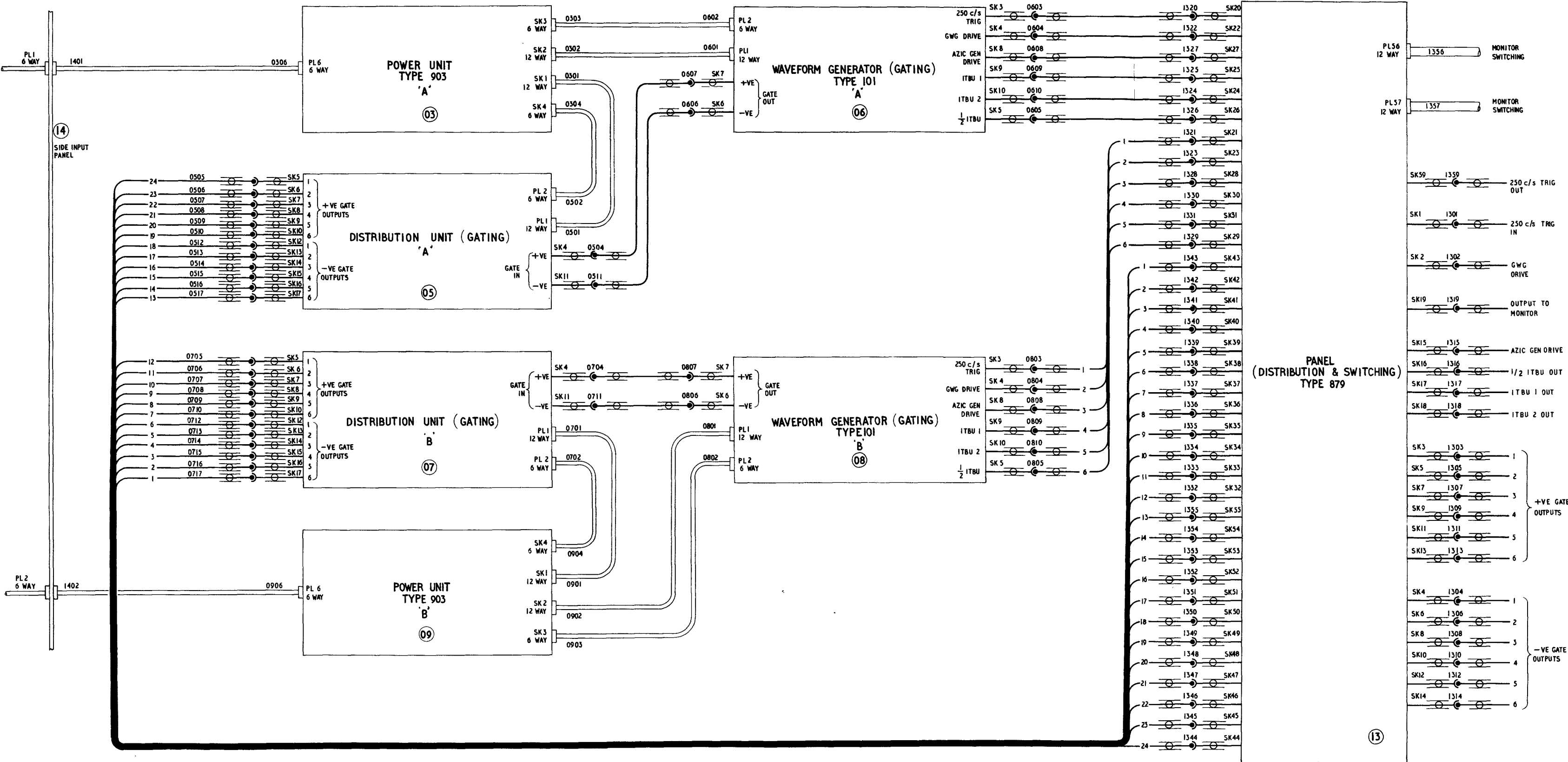
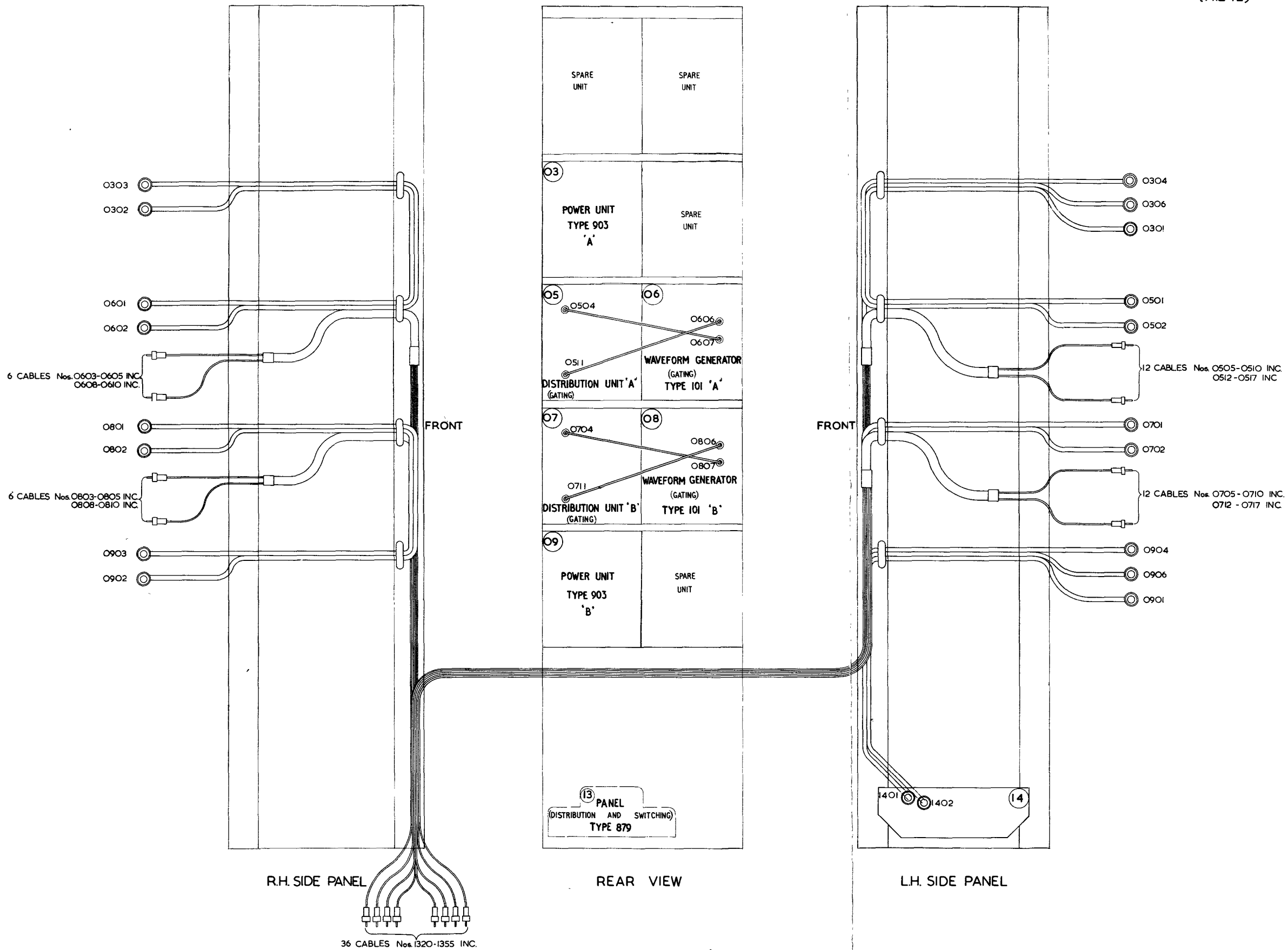


Fig. 15

Rack assembly (gating waveform) Type 304 - circuit

Fig. 15



R.H. SIDE PANEL

REAR VIEW

L.H. SIDE PANEL

36 CABLES Nos. 1320-1355 INC.

Rack assembly (gating waveform) Type 304-cabling

Fig.16

Fig.16

(A.L.12. Jul55)

## Chapter 4

### RACK ASSEMBLY (AZICATION) TYPE 302

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## GENERAL

### Purpose of rack

1. The rack assembly (azication) Type 302 (Stores Ref. 10D/18668) is a set of equipment centrally located in the radar office (*fig. 10, Chap. 2, Sect. 2, Part 2*), for the production and resolution into X and Y components of azication marker waveforms. These component waveforms are then used to produce, on the screen of each fixed-coil "azicating" console, the short line or "azication marker" which indicates to the PPI operator the exact bearing on which the height-finding, Type 13 radar head, under his control, is "nodding." The basic principles of this form of display were outlined in Chap. 1, Sect. 1 of this Part.

### Allocation of units

2. One rack assembly normally contains four entirely separate azication resolver units, each with an associated waveform generator and power unit. The resolvers are referred to as resolver No. 1, No. 2, No. 3 and No. 4. One resolver unit is linked to each height-finding (Type 13) head on the site. Since there may be up to six such heads, a normal radar office installation includes two complete rack assemblies Type 302 ("azication marker generator racks No. 1 and 2"), giving a total of eight azication resolvers.

3. Up to three resolvers (with ancillary units) in each rack are used for ordinary azication resolution. The fourth resolver in rack No. 1 is ruled by rotational information from the master search head (usually the Type 7), and produces a continually rotating azication marker in synchronism with that head. This marker may be displayed on the monitor PPI console and is particularly used when re-synchronizing the rotation of a slave head to that of the master, especially after a period of "stop-and-look" operation. The fourth resolver in rack No. 2 is not used, but is available as a spare for any of the others.

4. Each complete group of associated units, linked to one height-finding head, contains the following three units:—

- (1) *Waveform generator (azication) Type 100*, which receives
  - (a) a DC azication ranging voltage from the RANGE control on the panel (control desk) of the azication operator's console Type 64 (via the rack assembly Type 306), and
  - (b) a 250 c/s drive pulse (negative during part of the inter-trace period) from the gating waveform generator rack (*waveform (q)*) of *fig. 7, Chap. 3* of this Sect.).

In response to these inputs the waveform generator Type 100 produces, and applies to the sine/cos. potentiometer in the azication resolver unit, a master azication sawtooth the DC level of which corresponds to the desired marker range. The waveform generator then receives back from the resolver the separate X and Y components of the azication waveform (with amplitudes dependent on the angular position of the height-finding head), and repeats them out to the associated azicating

console and also to its stand-by console. It should be noted, however, that markers will only be displayed on the console which is receiving inter-trace bright-up pulses (routed by the interlock system in the relay unit (AZ. C/O) Type 192, in the RA306, to the console on which the control desk AZ.MARK key is operated first).

(2) *Resolver unit (azication)* (noType number), which contains the high-precision sine/cosine potentiometer resolver, driven by a selsyn receiver which repeats the angular position of the height-finding head. The unit also contains the auto-align switches and relays which ensure that correct alignment is preserved between the receiver and transmitter selsyns.

(3) *Power unit Type 905*, which supplies LT and HT to the waveform generator Type 100.

5. In addition to the above units, the rack contains one *panel (distribution) Type 878*, which serves as a junction box for services in and out of the rack. Most of the non-coaxial services (including selsyn drive for all resolvers *except* No. 4) to units in the rack do not enter the rack through this panel, but are fed in by way of the couplers on the side input panels, which form part of the rack framework and are not classed as separate units. Selsyn services for resolver No. 4 are exceptional, in that they *are* routed via the panel Type 878, where they are subject to LOCAL or REMOTE switching control, resulting in a small change to the auto-align circuit when the resolver is used for re-synchronizing (*para. 3*). The REMOTE switching facility permits resolver No. 4 to be switched off from the monitor console when it is not actually in use, thus preventing the heavy wear on the sine/cos. potentiometer which would result from prolonged continuous rotation.

### Location and construction of rack

6. The two rack assemblies are situated side-by-side in the radar office (lower floor) of a GCI station, next to the miscellaneous (ITBU distribution) RA306. Each rack is of the standard radar office type, already described in previous chapters of this Section. Fig. 1 gives a view of the front of a rack assembly with the door opened to give access to the controls on the units. The inter-connecting plugs, sockets and cables are accessible at the rear of the units, with the rear door opened.

7. The cables connecting the rack with the rest of the Station come out from adaptor boxes under the false floor of the radar office and enter the rack through holes in the base plate, as in the other fixed-coil equipment racks. The rack is ventilated from the system common to all the racks, already mentioned in the earlier chapters of this Section.

8. The normal location of units in the rack is given in fig. 1 and the accompanying key. The panel Type 878 is retained in the base of the rack by two long captive screws; the remaining units are mounted side-by-side in pairs, on mounting trays fixed to telescopic runners, as described for the RA300 (*Chap. 1 of this Section*).

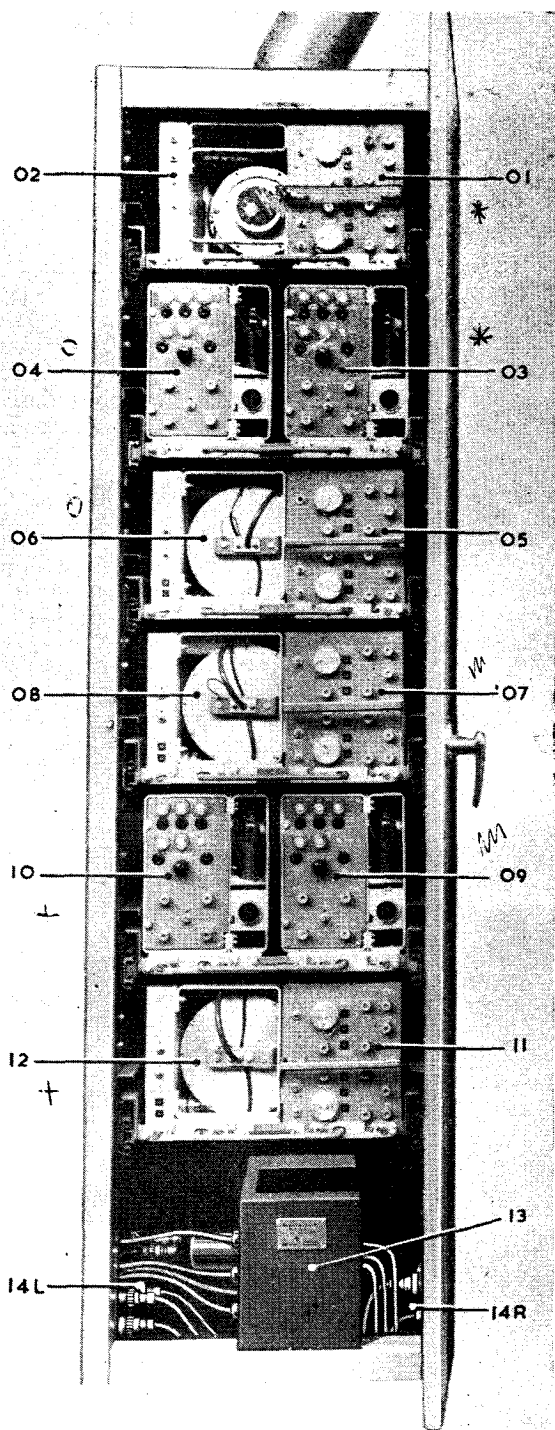


Fig. 1. Rack assembly (azication) Type 302—general view

- 01 WAVEFORM GENERATOR (AZICATION) TYPE 100 (WITH RES. 1)
- 02 RESOLVER UNIT (AZICATION) (RES. 1)
- 03 POWER UNIT TYPE 905 (WITH RES. 1)
- 04 POWER UNIT TYPE 905 (WITH RES. 2)
- 05 WAVEFORM GENERATOR (AZICATION) TYPE 100 (WITH RES. 2)
- 06 RESOLVER UNIT (AZICATION) (RES. 2)
- 07 WAVEFORM GENERATOR (AZICATION) TYPE 100 (WITH RES. 3)
- 08 RESOLVER UNIT (AZICATION) (RES. 3)
- 09 POWER UNIT TYPE 905 (WITH RES. 3)
- 10 POWER UNIT TYPE 905 (WITH RES. 4)
- 11 WAVEFORM GENERATOR (AZICATION) TYPE 100 (WITH RES. 4)
- 12 RESOLVER UNIT (AZICATION) (RES. 4)
- 13 PANEL (DISTRIBUTION) TYPE 878
- 14R SIDE PANEL (R.H.)
- 14L SIDE PANEL (L.H.)

F.S./2

9. Monitor sockets are provided on the front panels of the resolver units and waveform generators, so that an oscilloscope or other test gear may be plugged into key points in the circuits of these units, whilst they are in operation. In addition, 25-way metering sockets are provided on the power units and waveform generators to accommodate the multimeter Type 100 plug, for rapid checking of circuit voltages and currents. These sockets are covered by protective caps (*fig. 2*) when not in use. The most important preset controls (fitted with locking collets) are also accessible on the front panels. Each set of resolver equipment may be switched on separately (once mains are being supplied to the rack from the radar office power board) by switching on the relevant power unit Type 905.

#### Rack cabling

10. All electrical inter-connections between units in the rack assembly are shown in the rack circuit diagram (*fig. 21*). The services carried by coaxial connectors are shown on the diagram, but there is no room to show the services carried by the multicore cables, so the identification of these services must be obtained from the individual unit circuit diagrams given later in this chapter. The grouping of a number of coaxial connectors into one form on *fig. 21* has been done purely to reduce overcrowding on the diagram, and does not correspond to any cableform in the rack. The actual run of the cables, and the positions of the cleats, etc., are shown by the rack cabling diagram (*fig. 22*), which gives a rear view and two side views of the rack. Sufficient free lengths of cable have been left to allow the units to be pulled forward on the runners without disconnecting the cables.

#### Cable identification

11. Each end of every cable in this rack assembly is marked with a four-figure identification number. As in the other fixed-coil equipment racks, the first two figures give the unit number and the second two the plug or socket number.

12. To avoid confusion, the plugs and sockets on each unit are numbered in a single series.

#### Input and output connections

13. Table 5 gives a provisional list of the connections between the rack assembly Type 302 and the rest of the Station. The list may be subject to amendments in the light of later applications.

#### WAVEFORM GENERATOR (AZICATION) TYPE 100 INTRODUCTION

14. The waveform generator (azication) Type 100 (Stores Ref. 10V/16063), forming part of the rack assembly Type 302, is illustrated in *fig. 2, 7* and *8*, with details of group boards in *fig. 9*.

#### Purpose of unit

15. As outlined in para. 4, the unit produces positive and negative master azication waveforms for the azication resolver, and repeats the X and Y components, produced by the resolver, out to

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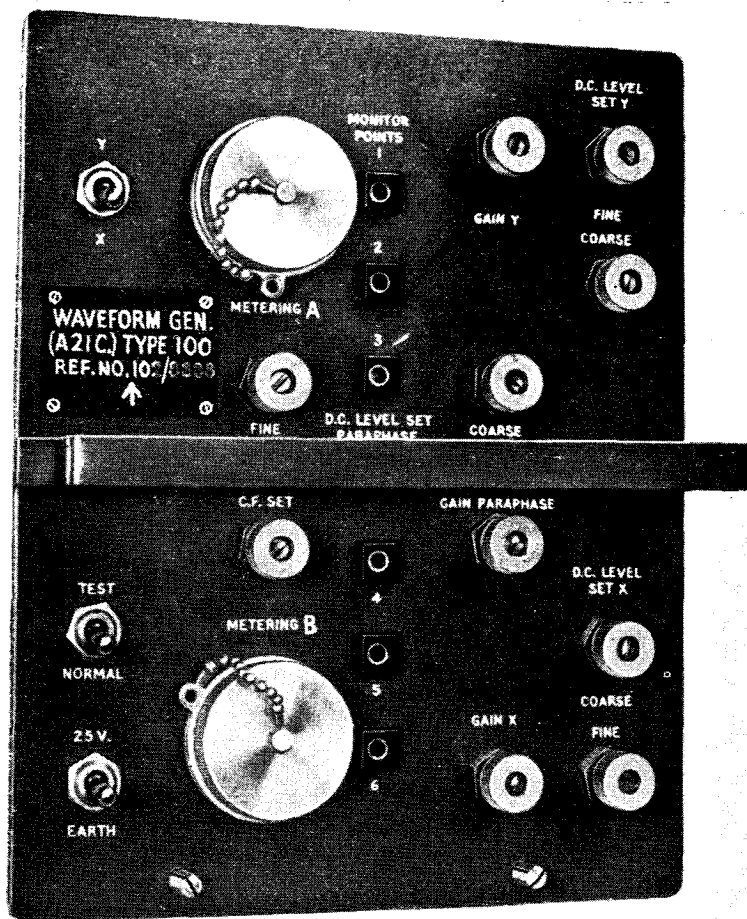


Fig. 2. Waveform generator (azication) Type 100—front panel

the associated azicating console. The DC level of the master azication waveforms (which controls the range from scan centre at which the azication line appears) is governed by the supply of a DC azication ranging voltage from the console itself.

#### Timing of waveform

16. The timing of the small azication sawtooth, which is added to the DC azication ranging voltage by the waveform generator, is controlled by the negative-going drive pulse received from the gating waveform generator rack. On normal stations this drive pulse recurs at 250 c/s, but starts at the end of a 500 c/s timebase sweep and lasts for  $270 \mu\text{s}$  (fig. 7, Chap. 3 of this Section). The azication sawtooth is produced during the whole of this  $270 \mu\text{s}$  period, but only the final  $100 \mu\text{s}$  is brightened up on the PPI display by the ITBU pulse (fig. 3).

#### Construction of unit

17. The waveform generator is constructed on a rectangular framework which clips into position on its side on the standard rack-mounting tray, alongside its associated resolver unit. The test switches, metering sockets, monitor points and preset potentiometers are all mounted on the front panel (fig. 2). Fixed plugs and sockets for power supplies and signal connections are all on the rear panel.

18. There is no fully-decked chassis in the body of the unit; the valve-holders are set out along two parallel U-shaped valve mounting channels (fig. 7), so that, with the unit in the working position, the valves are horizontal. The majority of the small components are mounted on four accessible group boards running nearly the full length of the unit (fig. 8). The layout of the components on these group boards is shown in fig. 9.

#### Power supplies

19. The waveform generator uses two heater supplies, derived from separate  $6.3\text{V}$ ,  $4\text{A}$  windings on TR1 in the power unit Type 905 and reaching the waveform generator via PL2. Pairs of cables (AC, BD, JL and KM) in the multicore connector are in parallel to carry the load. Stabilized and ripple-free HT supplies at  $+400\text{V}$ ,  $+300\text{V}$  and  $-300\text{V}$  also come from the power unit, arriving on PL1.

#### CIRCUIT DESCRIPTION

20. The circuit explanations which follow should be read in conjunction with the block diagram (fig. 4) and the complete circuit diagram (fig. 19). The block diagram shows how the circuit may be considered in five principal parts, viz:—

- (1) Sawtooth generator and cathode follower
- (2) Mixer cathode follower
- (3) Paraphase repeater
- (4) X component repeater
- (5) Y component repeater

The first three come before the sine/cos. pot. resolver, and the other two afterwards. Fig. 4 also gives waveforms, to which reference is made in the following paragraphs.

#### Sawtooth generator and cathode-follower

21. The negative-going drive pulse from the

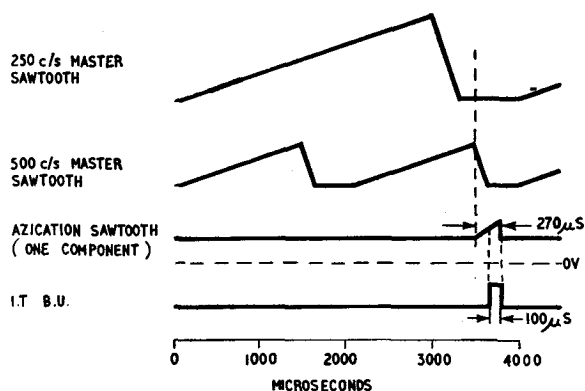


Fig. 3. Azication timing

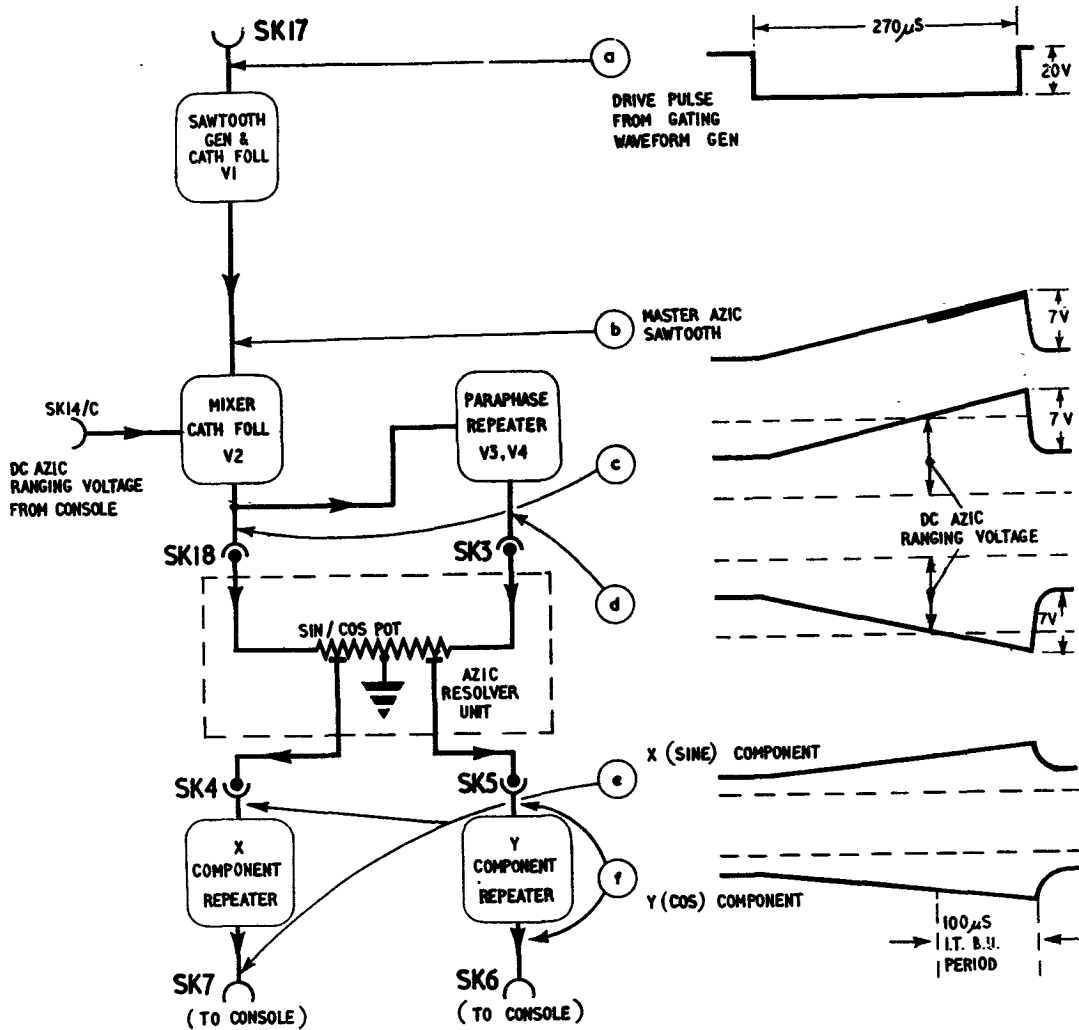


Fig. 4. Block diagram and waveforms

gating waveform generator arrives by coaxial cable at SK17 and is AC-coupled by C14 and R1 to the grid of V1a, which is one half of a double-triode Type CV455. Because of the grid return to HT via R1, V1a is normally conducting and its anode is at a low positive potential. When the grid is driven negative by 20V, at the start of the inter-trace gate period (*waveform (a)*), the valve is cut off. The capacitor C1 ( $0.01\mu\text{F}$ ), between anode and earth starts to charge towards +300V, with a time constant of approximately  $0.01\mu\text{F} \times 1\text{M}\Omega$  ( $C1 \times R4$ ).

**22.** In the period of  $270\mu\text{s}$  before V1a grid is driven positive again, the exponential sweep at the anode (initially almost linear) reaches an amplitude of +7V, but when the valve starts to conduct again, C1 is rapidly discharged, so that the resulting output is a 7V positive-going sawtooth of  $270\mu\text{s}$  duration, coinciding with each 250c/s inter-trace gating pulse (*waveform (b)*). The heavy line on waveform (b) shows the part which is actually brightened on the display by the  $100\mu\text{s}$  ITBU pulse. The sawtooth is AC-coupled,

via C2, to the triode cathode-follower V1b, which has a 15K load R10.

#### Mixer cathode-follower

**23.** From V1b cathode the azication sawtooth is AC-coupled to the mixer cathode-follower pentode V2 (CV138). The waveform has a very low "mark/space" ratio of  $270\mu\text{s}$  to nearly  $4,000\mu\text{s}$  (*fig. 3*), so that it settles down at V2 grid with its base line only a fraction of a volt from the potential to which the  $1\text{M}\Omega$  resistor R13 is returned, at the junction of R12 and R11, which form a potential divider between the positive DC azication ranging input from the console at SK14/C and the negative potential at the slider of RV1 (c.f. SET). RV1 provides for correction to allow for the grid-cathode potential of V2 and for the initial unbrightened part of the azication line, so that R13 appears, in fact, to be returned to the DC azication voltage. The sawtooth and ranging voltages are therefore combined in V2 and the resultant is fed out from V2 cathode to one end of the sine/cos. pot., via SK18.

24. It is essential that, when the ranging voltage is zero, the level of the combined output from V2 cathode shall also be zero, at the centre of the brightened portion of the sawtooth, so the quiescent bias on V2 grid has to be about 3V negative. This condition is set up by adjustment of RV1. To carry out this operation, the RANGE control on the console control desk is turned fully counter-clockwise to zero output and RV1 is then adjusted until the operator is advised, by telephone, from the console, that the azication marker is just threading the scan centre. Subsequent adjustment of RV1 may be needed when setting up for coincidence of H/R STROBE and AZ. MARK RANGE STROBE.

#### Paraphase repeater

25. The double triodes V3 (CV492) and V4 (CV491) form the paraphase repeater, the purpose of which is to repeat accurately, in antiphase, the waveform (including DC component) from V2 cathode, for application to the other end of the sine/cos. pot. winding (the need for antiphase inputs to the two ends of a sine/cos. pot. is explained in *Chap. 1, Sect. 1 of this Part*).

26. The circuit is basically a see-saw amplifier, with a 220K input resistor R17 (in series with a variable component RV3, labelled GAIN PARAPHASE) and a 220K feedback resistor R29 (in series with 15K R30 to ensure that RV3 adjustment is about its centre-point). The 1/1 ratio of the input and feedback resistors gives an output waveform equal in amplitude (though opposite in phase) to the input waveform. V3a and b form a cathode-coupled pair with the advantages of negligible DC drift and independence of heater voltage fluctuations, and providing an output in the same phase as the input. This output, from V3b anode, is DC-coupled to an amplifier phase-inverter V4b and thence to the cathode-follower V4a. The paraphase output from the cathode of this valve goes to the sine/cos. pot. via SK3, while negative feedback over the whole amplifier is taken from the same point, via R29.

#### Facilities for setting-up

27. To ensure that the range of the azication marker is dependent only on the DC azication ranging voltage, it is essential that, when the SK10/SK18 (MONITOR POINT 5) end of RV3 is at earth potential, the cathode of V4a (MONITOR POINT 4, SK11/SK3) is also at zero. If it were not, the range of the marker would drift as the mean level changed with bearing angle. The switches A and B are used to make the adjustment, the procedure being to set SWB to TEST and SWA to EARTH (which earths the SK10 end of RV3), and then to adjust the D.C. LEVEL SET PARAPHASE, COARSE and FINE, controls RV5 and RV4 until V4a cathode is at earth potential also. These controls affect the grid potential of V3b and thus the DC levels throughout the amplifier.

28. It is likewise essential to ensure that when the paraphase inputs are applied to each end of the sine/cos. pot., the centre is at zero potential,

even with the earth connection there removed. With equal inputs, any difference from zero would indicate that the volts drop per inch of winding on either side was unequal, a condition which would give inaccurate resolution. Since the two sides of the winding may, in fact, be not quite equal, the paraphase gain may have to be adjusted just off unity to give a uniform voltage gradient across the potentiometer winding.

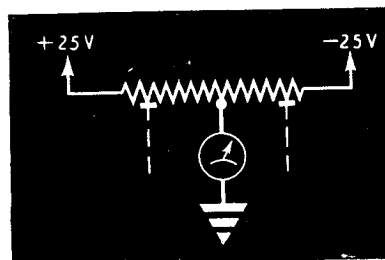


Fig. 5. Paraphase gain check

29. The procedure is to connect a testmeter (e.g. multimeter Type 1) between the sine/cos. pot. centre terminal and earth (*fig. 5*) and, with SWB still at TEST, to operate SWA to the 25V position. This applies +25V to one end of the sine/cos. pot. and also to the paraphase repeater via RV3. This control is adjusted until the testmeter reading is reduced to zero.

#### X and Y component repeaters

30. The resolved components of the azication sawtooth are applied to repeater stages. The double triodes V5 (CV492) and V6 (CV491) repeat the X component, while V7 and V8 provide an identical circuit for the Y component. The function of the X repeater is to accept at SK4 the sine component of the waveform from the sine/cos. pot. and to repeat it out accurately, in phase and with a gain of a little over unity, to the associated console, via SK7. The Y repeater accepts the cosine component at SK5 and repeats it out at SK6.

31. A simplified circuit of the X repeater is given in *fig. 6*. The following description of its operation also applies to the Y circuit, reading V7 for V5 and V8 for V6. The *a* and *b* designations

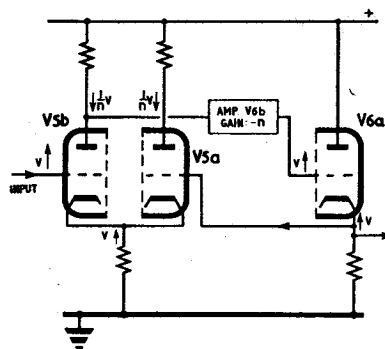


Fig. 6. X component repeater—simplified circuit

correspond with those on the valve bases (fig. 19). The X input is direct-coupled to V5b, which is cathode-coupled to the second half of the Type CV492 double-triode V5a. The V5a grid circuit determines the DC level and gain of the stage, and the output is taken from V5b anode to the triode amplifier V6b by DC coupling. This valve provides negative feedback to V5a grid via C12 (47pF) and is DC-coupled to the second half of the Type CV491 double triode V6a, a cathode-follower feeding the output waveform to the console and also providing negative feedback to V5a. As is usual in DC-coupled circuits, the coupling resistors are by-passed by small capacitors to preserve the waveform shape.

**32.** A circuit of this complexity is necessary because the repeater is required to provide a linear gain of about 1, accurate preservation of DC levels with freedom from drift effects and with low output impedance. By making V5a and b a balanced pair, with equal anode loads, drift effects are cancelled because they produce equal and opposite potentials across the common cathode load. The negative feedback from V6b anode (HF via C12 and DC via the C.F. V6a) to V5a grid ensures linearity and the cathode follower V6a provides a low output impedance. The gain of 1 is a function of V5b and V6b. Assuming equal inputs to V5b and V5a, the common cathode current will be twice the single anode current so that the ratio of voltage output across each anode load to that across the common cathode load will be  $I_a.270K/2I_a.390K = 1/2.9$  approx. Since the cathode voltage is approximately the same as the grid voltage (cathode-follower effect) it follows that the gain at each anode is  $1/2.9$ . The gain of the V6b stage, coupled to V5b anode has accordingly been made  $\times 2.9$  to give an overall gain of  $\times 1$ .

#### *Facilities for setting-up*

**33.** To ensure accurate azication marker positions on the PPI display, the X and Y repeaters have to be set up to give equal DC levels and

equal gain. Equal DC levels are obtained by setting SWB to TEST and SWA to EARTH (thus ensuring zero input to each repeater) and adjusting the D.C. LEVEL SET X, COARSE and FINE controls, and also the D.C. LEVEL SET Y, COARSE and FINE controls, until the outputs at SK7 and SK6 are also zero.

**34.** For equality of gain adjustments, SWB is left on TEST, but SWA is set to 25V. To ensure that the full 25V positive is being applied to the X repeater input, a testmeter is connected between SK15 (MONITOR POINT 2) and earth, SWC is operated to x and the sine/cos. pot. in the azication resolver unit is rotated by hand until the test meter reading is a maximum. As a check, SWC is turned to y and the sine/cos. pot. is rocked for zero reading, which is easier to observe accurately. The potentiometer is then applying the full 25V to V5b grid.

**35.** Next, SWC is reset to x, which applies a proportion of the X repeater output (dependent on the ratio  $R81/R80 + R81$ , i.e. about  $1/1.06$ ) and the testmeter is connected between SK10 (MONITOR POINT 5) and SK15 (MONITOR POINT 2). The 10K GAIN x control RV7 is now adjusted to give zero reading on the testmeter; the circuit conditions then ensure correct gain. This adjustment slightly affects the DC level setting (para. 33) and in practice several successive adjustments are advisable.

**36.** To ensure equal gain in the Y repeater, SWC is operated to Y and the testmeter connections changed to SK15 and earth, after which the sine/cos. pot. is rotated by hand to give maximum Y output. This is checked by switching SWC to x and rocking the potentiometer for minimum reading. The testmeter connections between SK10 and SK15 are then restored and SWC returned to Y. The gain y control RV10 is adjusted for zero reading, and the DC level adjustment is checked.

## RESOLVER UNIT (AZICATION)

### INTRODUCTION

**37.** The resolver unit (azication), (Stores Ref. 10AE/626) forming part of the RA302, is illustrated in fig. 10, 11 and 12. The equipment within the unit consists of the drive unit (mechanical) 4937 (Stores Ref. 10AR/2506) and certain related relays and switches. The associated valve circuits are all in the adjacent waveform generator Type 100. ▶

#### **Purpose**

**38.** The resolver unit, when used as a resolver No. 1, 2 or 3 in the rack, receives rotational information from the associated height-finding (Type 13) head, and applies the information for resolving the master azication waveform from the waveform generator Type 100 into X and Y (sine and cosine) components. These components are fed back to the waveform generator Type 100 to

be repeated out to the associated azicating console. Resolver No. 4 is linked to the master search head (para. 3).

#### **Construction**

**39.** A view of several resolver units in position in the rack is given in fig. 1. Fig. 10 gives a side view and fig. 11 an end view of the receiver selsyn, also showing the coaxial sockets (SK4 to SK7) for making connections with the waveform generator Type 100, and the fixed 12-way selsyn input plug (PL14). The separate end brackets shown in this view have now been replaced by the U-shaped bracket shown in fig. 10. Fig. 12 gives a dismantled view showing the "drive" assembly between the selsyn receiver and the sine/cos. potentiometer. The coupling, gearing, hand drive, auto-align and sector switches and cams are identical with those in the magslip resolver

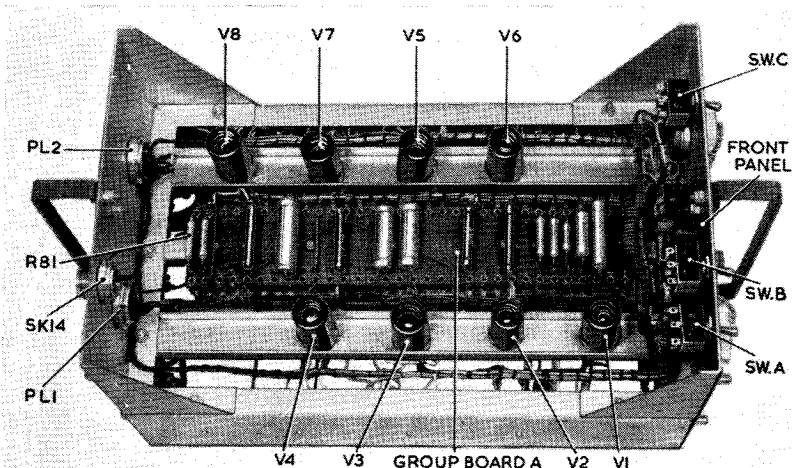


Fig. 7. Waveform generator (azication) Type 100—over-chassis view

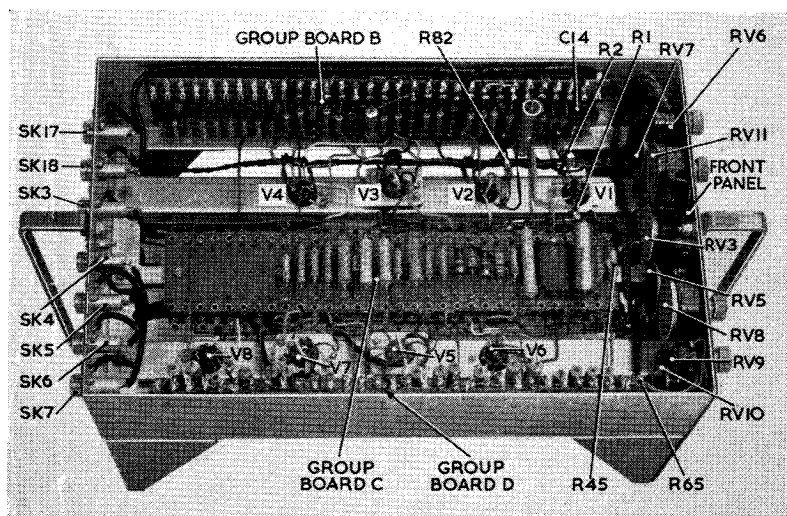


Fig. 8. Waveform generator (azication) Type 100—under-chassis view

unit (RA301), although the sector switches are not used in the azication resolver. Fig. 12 shows a new type coupling which replaces that shown in fig. 8 and 9, Chap. 2, Sect. 2, Part 2.

40. Two alternative types of sine/cosine potentiometer are in use. These are:—

(1) *Colvern type*, shown in fig. 10 and 12, which is a large, high precision form of the ordinary small control potentiometer except that it has two wipers at right-angles and the winding is graduated to give the desired sine/cosine function of input voltage. The total resistance is 25,000 ohms.

(2) *Kelvin & Hughes type*, shown in position 02 on fig. 1. This is an oil-filled potentiometer, only about half the diameter of the Colvern. The winding (total resistance 32,000 ohms) is wound on the "square-grid" principle outlined in Chap. 1, Sect. 1 of this Part.

#### CIRCUIT DESCRIPTION

41. Fig. 13 gives the circuit of the unit. As

noted in para. 39, the sector selector switches are not connected externally. The centre-tap of the sine/cos. pot. is normally earthed (SWA closed), but may be open-circuited for the test explained in para. 29 (see also fig. 5). Monitor points 1 and 2 (SK8 and SK9) are brought out to the front panel (fig. 10) for connecting the testmeter. The remaining parts of the circuit worthy of note, concern the auto-align system, the operation of which varies slightly according to the function of the resolver unit in the rack.

#### Need for Auto-Align

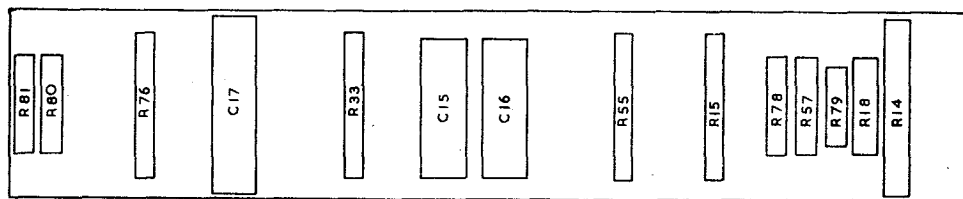
42. The need for the auto-align system arises because, to give greater precision in angle repetition, there is a 30 to 1 step-up gearing between the head turning gear and the transmitter selsyn and a corresponding reduction gearing between the receiver selsyn and the sine/cos. pot. The meshing of the gears permits 29 incorrect relative positions of sine/cos. pot. and aerial head, and only one correct position in which the potentiometer accurately follows the rotation of the head. The auto-align system automatically maintains this correct alignment.

#### Auto-align—Resolvers No. 1, 2 and 3

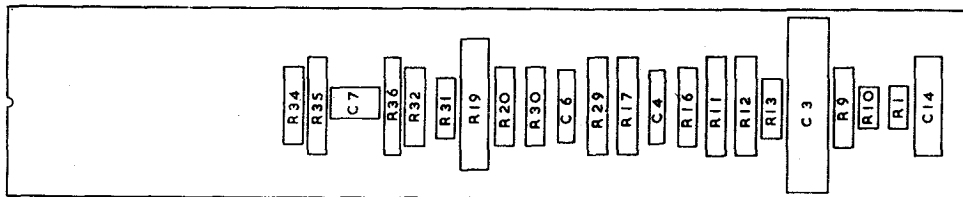
43. When the resolver unit is used for ordinary azication resolution (i.e. resolver No. 1, 2 and 3 positions), leads from PL14 run straight out to the cable trunking system via a plug on the side, input panel (fig. 21). Pins A, B, D, E and F bring in ordinary selsyn services, while G, H and K concern the auto-align system. Pin K is earthed in the trunking, pin H brings in -50V, and from pin G the auto-align lead runs out to the associated Type 13 head. Note particularly that there is no intermediary control unit for Type 13 in the combined head control rack (i.e., there is nothing corresponding with the control unit (training) Type 619, used with the Type 14 head). There is, therefore, an extra relay (RLB) on the azication resolver unit; this is not found on the magstrip (timebase) resolver unit. This extra relay corresponds with the one located in the control unit Type 619 in the Type 14 auto-align system. Apart from this difference, the principle of the system is the same as that outlined in Chap. 2 of this Section, with reference to the rack assembly Type 301.

44. The auto-align cam in the Type 13 head closes a micro-switch during about 8 deg. of the 360 deg. head rotation, earthing the resolver unit auto-align lead (PL14/G) during this 8 deg., and

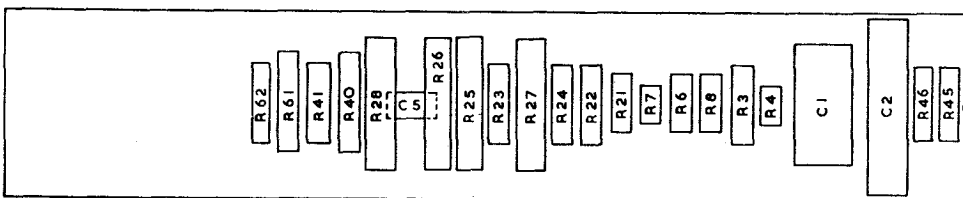




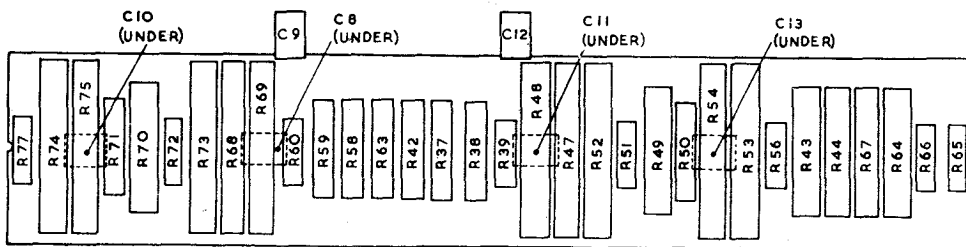
GROUP BOARD A



GROUP BOARD B



GROUP BOARD C



GROUP BOARD D

Fig. 9. Waveform generator (azication) Type 100—group boards

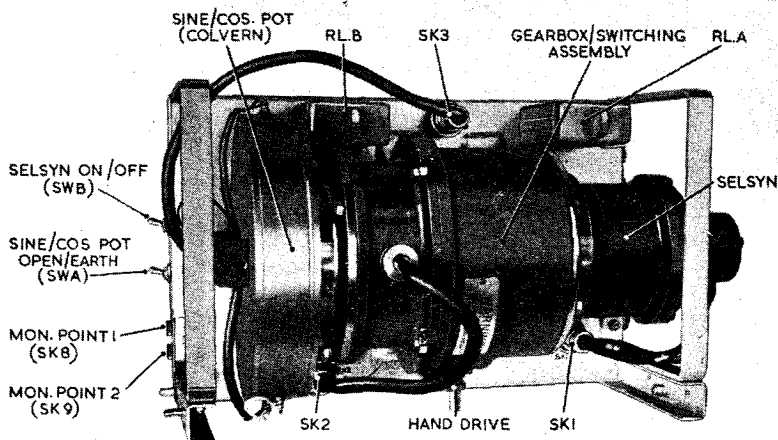


Fig. 10. Resolver unit (azication)—general view

thus operating relay RLB and opening contacts B1 in the auto-align switch leads from PL14/K (fig. 13.).

45. The auto-align cam (actually composed of two adjustable parts) in the azication resolver extends over  $94\frac{1}{2}$  deg.; the two switches (fig. 12) wired in series, operated by the cam, are set 90 deg. apart, so that both are closed simultaneously for only  $4\frac{1}{2}$  deg. of sine/cos. pot. rotation.

46. If alignment between radar head and sine/cos. pot. is correct, the  $4\frac{1}{2}$  deg. closure occurs with in the 8 deg. arc of closure at the head micro-switch. Since cont-



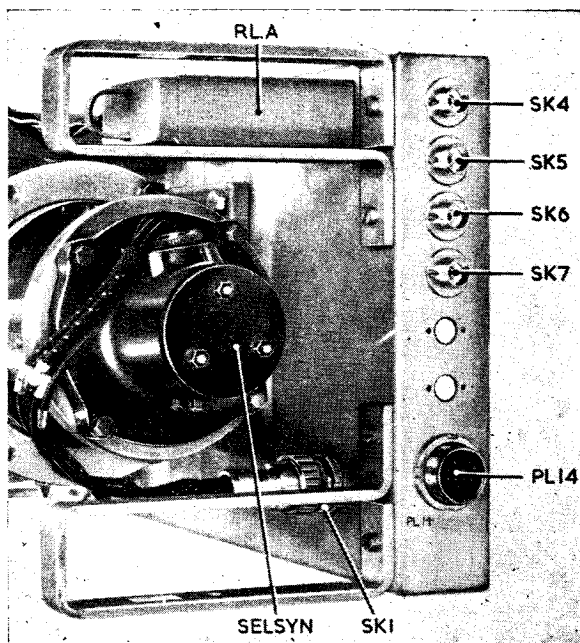


Fig. 11. Resolver unit (azication)—rear view

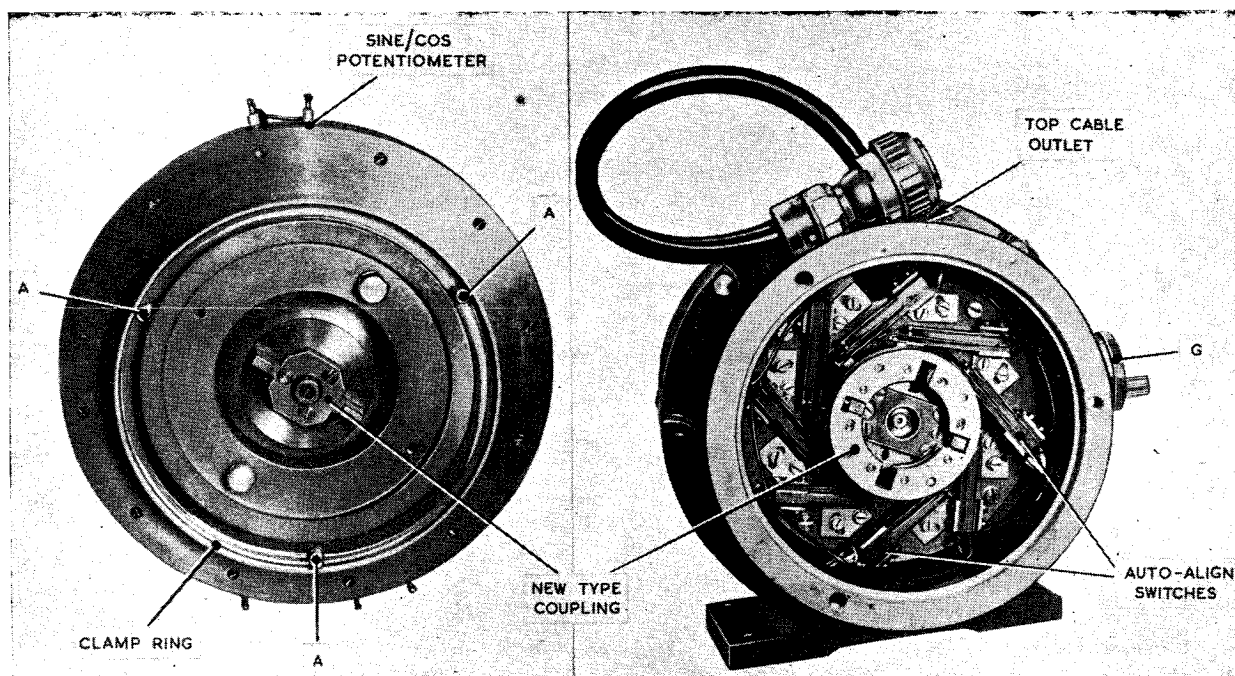
the auto-align cam switches are closed when RLB is not energized and contacts B1 are closed. In this circumstance RLA is energized and contacts A1 and A2 change over and short-circuit one selsyn stator. This locks the selsyn rotor and arrests rotation of the sine/cos. pot. and the auto-align cam. Consequently RLA remains energized until such time as the head comes round to the position in which the micro switch is closed. When this happens contacts B1 open and trip RLA so that normal selsyn rotation is resumed, in correct alignment. SWB permits switching off of the selsyn for manual rotation during setting-up.

**Note . . .**

*This system of auto-alignment makes it essential to rotate the Type 13 head for one complete revolution, to permit the auto-align to operate, after any interruption of services.*

**Auto-align—resolver No. 4.**

48. When an azication resolver is used as resolver No. 4, in association with the master search head (normally Type 7), the operation of the auto-align system is not quite the same. This is because there is, in the combined head control rack, a control unit (training) Type 618, which governs



**KEY**

A  $\frac{1}{4}$  in. BSF  $\times$   $\frac{3}{8}$  in. HEXAGONAL HEAD BOLT

G Hand Drive

Note. See fig. 8, Chap. 2, Sect. 2, Part 2 for old type coupling.

Fig. 12. Resolver unit (azication)—dismantled coupling

acts B1 are open during this 8 deg., the closure of the auto-align cam switches can have no effect; relay RLA remains un-energized and contacts A1 and A2 maintain the ordinary selsyn connection.

47. If, however, alignment becomes incorrect,

the Type 7 rotation, and which contains an auto-align relay, making RLB in the resolver unit redundant. To cope with this, while still retaining the standard resolver unit, the leads from PL14 on resolver No. 4 go out to the cable trunking system *not* via the side panels but via the panel (distribution) Type 878, where the



the external unit, as well as against stabilizer troubles. Additional protection is afforded by ordinary cartridge-type fuses in the mains and HT lines, and thermal fuses mounted on the transformers.

### Construction

53. The power unit construction may be observed in fig. 14 and 15, which show the differences between the Type 905 and the Type 903 (*Chap. 1 of this Section*) Fig. 16 gives the arrangement of small components mounted on the four group boards annotated in fig. 14 and 15.

### CIRCUIT DESCRIPTION

54. A complete circuit diagram of the power unit appears in fig. 20. Since it is basically the same as the power unit Type 903 circuit, the following description is abridged.

#### —300V supply

55. This supply starts with the 400V-0-400V winding on the HT transformer TR1, feeding the

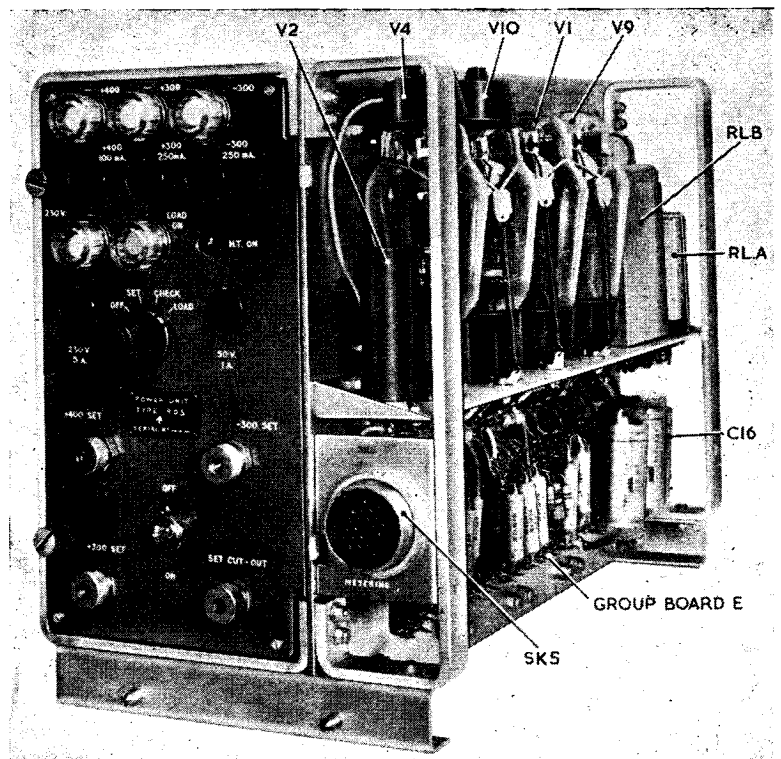


Fig. 14. Power unit Type 905—general view

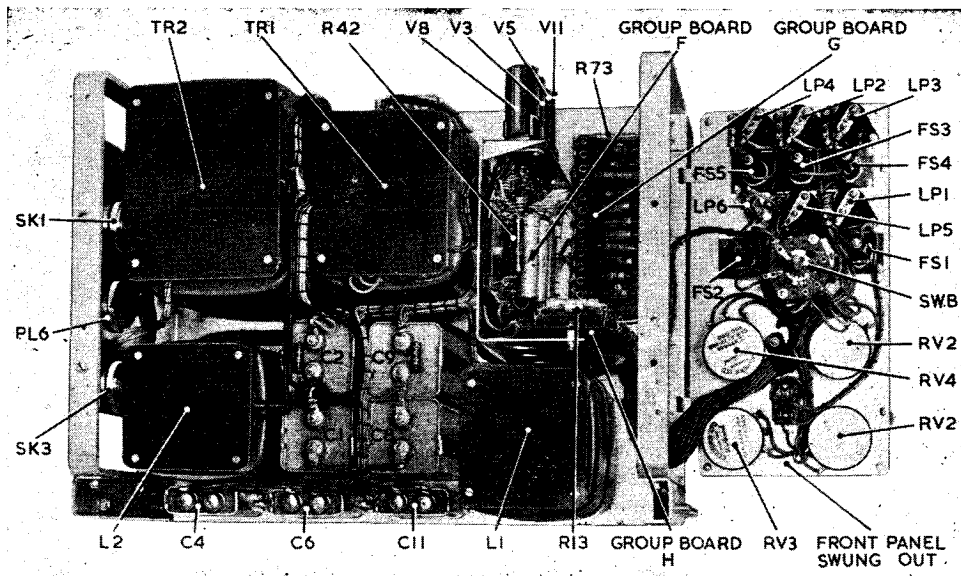


Fig. 15. Power unit Type 905—side view

conventional full-wave rectifier V9. The regulator circuit which follows is identical with that used for the corresponding supply in the power unit Type 903, except that the neon indicator, across the HT fuse, is designated LP4 instead of LP3.

#### Positive supplies

56. The circuit of the rectifier which feeds the +400V and +300V stabilizers is very similar to

that of the —300V rectifier. It incorporates a 500V-0-500V transformer winding feeding the rectifier V1 and conventional filter C1, L1, C2 and discharge resistor R1. The two separate stabilizers are then connected at this stage, instead of the one in the power unit Type 903.

#### +300V stabilizer

57. This is basically the same as the corresponding circuit in the power unit Type 903,

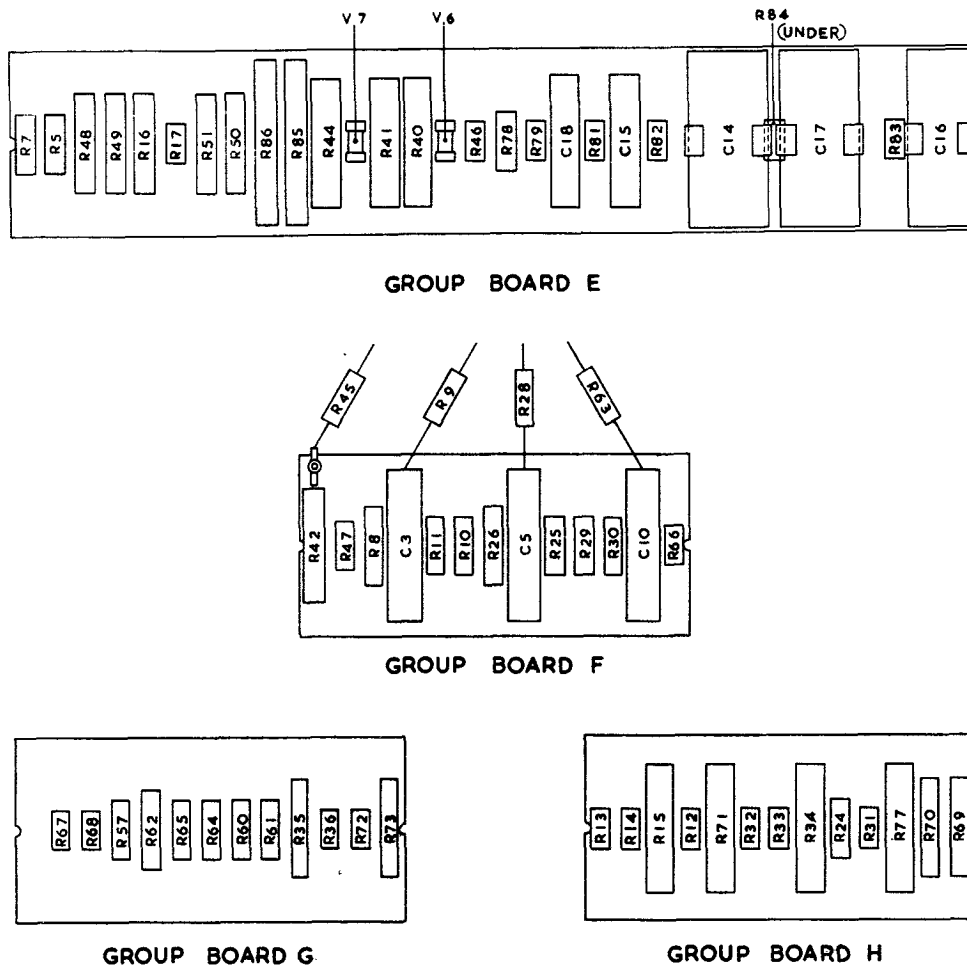


Fig. 16. Power unit Type 905—group boards

except that extra HT for the control valve V5 is derived from the stabilized +400V line.

#### +400V stabilizer

**58.** This circuit follows the same general layout as the other two stabilizers in the unit. The boost HT for the control valve V3 is obtained from the unstabilized side of the supply. Since the drain on this regulator circuit is comparatively low, the stabilizer neon used in the same circumstances in the power unit Type 903 is not required. To nullify any residual AC ripple which may be injected at the grid of V2, a predetermined ripple voltage is tapped from the potential divider R5, R14, R13 and applied to V3 via C3. Similar circuits are used in the +300V and -300V regulators.

#### Protection (cut-out) circuit

**59.** The protection valve V8 operates in precisely the same manner as its counterpart in the power unit Type 903, except that it has reference connections to the +400V, +300V, -300V, -500V reference and -50V relay supplies, instead of just +300V, -500V and -50V. Variations in any of these supplies will trip the cut-out relay by altering the cathode current of V8.

#### Power unit setting-up and switching

**60.** The switching-on procedure for the power unit Type 905 is the same as for the Type 903. The ON/OFF switch SWA brings in the 230V mains (to TR2 only) and the 50V relay supply. With SWB at off, this provides a *standby* position with only the heaters on.

**61.** The HT is now brought on in three stages using SWB, which has additional connections as compared with SWB in the power unit Type 903, to cater for the extra +400V supply; otherwise the three positions SET, CHECK and LOAD, perform the same functions.

#### SET position

**62.** (1) SWB/a contacts 9 and 8 complete the 50V circuit to RLB, which closes the following contacts:

- (a) B2 applies mains to the HT transformer TR1.
- (b) B2 switches on the red LP6 (HT ON).
- (c) B3 routes -50V out to the negative reference rack (via PL6/F); a relay in this rack is operated and -500V returns on PL6/C.
- (d) B4 is not used.
- (2) SWB/a contacts 2 and 3 connect a dummy

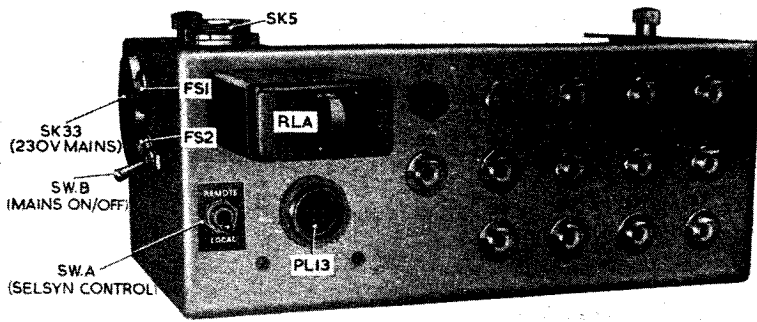


Fig. 17. Panel (distribution) Type 878—general view

lers on the panel Type 878 and are routed out to the associated consoles.

66. The selsyn services for resolver No. 4 are also routed through this panel, where they are subject to the LOCAL/REMOTE selsyn control mentioned in para. 3, and to a small circuit alteration to take care of the different auto-align circuit of resolver No. 4. 230V mains are brought in on the same cable and are available on a 3 pin, 5A socket at the rear of the panel. Pending the

load R86 to the  $-300V$  rail and switch on the neon LP5 (LOAD ON).

(3) SWB/b contacts 9 and 8 connect a dummy load R85 to the  $+300V$  rail.

(4) Since the  $+400V$  rail is only required to supply a low current output the regulator circuit provides sufficient loading for setting-up.

(5) With the multimeter Type 100 plugged into SK5 and switched to FT, BP and DR in turn, the  $-300V$ ,  $+400V$  and  $+300V$  SET potentiometers, respectively, are adjusted to the correct settings.

(6) With multimeter Type 100 switched to ES, the SET CUT-OUT potentiometer is adjusted for zero reading.

**CHECK position**

63. This position retains the dummy loads, but SWB/a contacts 9 and 10 divert the operating circuit of RLB through contact A1 of the protective relay RLA and permit a check that the protective circuit is correctly adjusted.

**LOAD position**

64. This position transfers the outputs from the dummy to the external loads and extinguishes LP5. If the protective circuit operates on LOAD, RLB trip sand LP6 is extinguished to indicate the failure of supplies.

**PANEL (DISTRIBUTION) TYPE 878**

**Purpose**

65. The panel (distribution) Type 878 (Stores Ref. 10D 18865) serves mainly as a junction box for coaxial services entering and leaving the rack assembly Type 302. The 250 c/s drive pulse is received from the gating waveform generator rack Type 304 and distributed to the four waveform generators (azication) Type 100. The resolver rack No. 2 receives the drive pulse via the panel Type 878 of rack No. 1. The outgoing services from the distribution panel are the X and Y (sine and cosine) azication marker components. These come from the waveform generators Type 100 to panel-mounted coup-

introduction of the panel (distribution and switching) Type 4888, there are no facilities for remote selection and monitoring of waveforms at the rack assembly Type 339.

**Construction**

67. The construction of the panel is shown in fig. 17, which is a side view. The heads of the two captive screws which secure the panel to the rack base are at the top of the picture. The mains socket, fuse and switch are on the left.

**Circuit**

68. Fig. 18 is a circuit diagram of the panel. When SWA (SELSYN CONTROL) is in the LOCAL position, RLA is energized and selsyn services go through to resolver No. 4 (where they may be switched ON or OFF by SWB). When SWA is in the REMOTE position RLA is controlled from the monitor console.

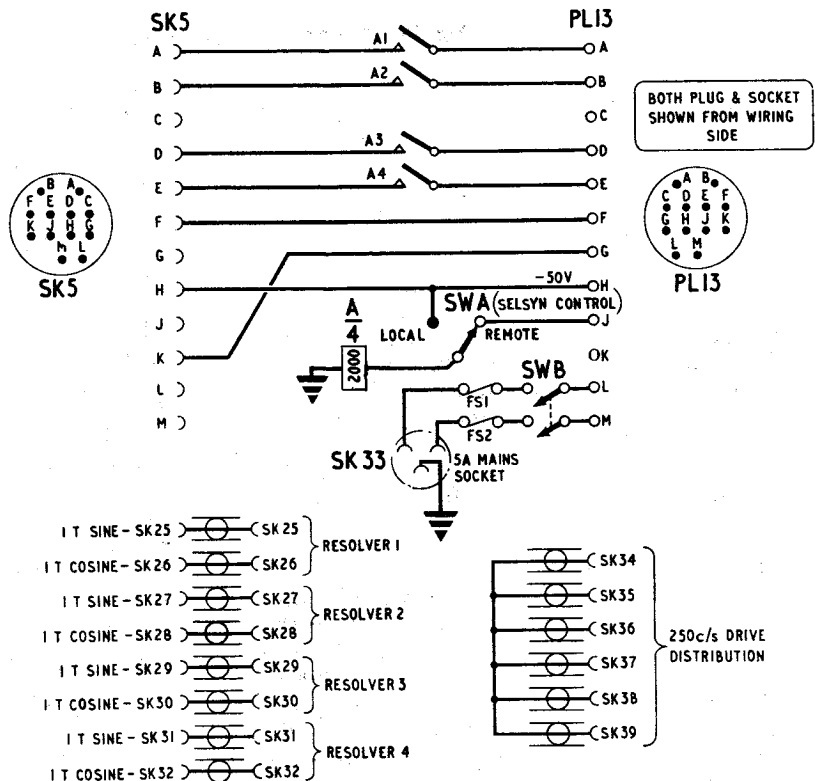


Fig. 18. Panel (distribution) Type 878—circuit

**TABLE I**  
**Waveform generator (azication) Type 100—component details**  
**(Stores Ref. 10V/16063)**

**Resistors (Fixed)**

Circuit Ref.	Value (ohms)	Rating (watts)	Tol. (%)	Inter-serv. ref.
R1	2.2 M	1	10	Z223206
R2	1 K	1	10	Z222005
R3	10 K	1	10	Z222131
R4*	1 M	1	5	Z216181
R5	470	1	10	Z221194
R6	100 K	1	10	Z213327
R7	10 K	1	10	Z222131
R8	1 M	1	10	Z223165
R9*	150	1	5	Z215142
R10	15 K	1	10	Z222152
R11*	620 K	1	5	Z216745
R12*	33 K	1	5	Z216063
R13	1 M	1	10	Z223165
R14*	47 K	1	5	Z216085
R15	68 K	1	5	Z244155
R16*	33	1	5	Z215062
R17*	220 K	1	1	Z216526
R18*	120 K	1	5	Z216130
R19*	220 K	1	5	Z216148
R20*	150	1	5	Z215142
R21	100 K	1	10	Z213327
R22*	150	1	5	Z215142
R23*, R24*	2.4 K	1	5	Z215287
R25*	330 K	1	5	Z216156
R26*	330 K	1	1	Z216560
R27*	330 K	1	5	Z216156
R28*	470 K	1	1	Z216592
R29*	220 K	1	1	Z216526
R30*	15 K	1	1	Z216247
R31	47 K	1	10	Z212263
R32*	33	1	5	Z215062
R33	39 K	1	5	Z244146
R34*	33	1	5	Z215062
R35*	470 K	1	1	Z216591
R36*	390 K	1	1	Z216575
R37*	390 K	1	2	Z216579
R38*	270 K	1	2	Z216547
R39*	150	1	5	Z215142
R40*	270 K	1	5	Z216727
R41*	150	1	5	Z215142

**Resistors (Fixed)**

Circuit ref.	Value (ohms)	Rating (watts)	Tol. (%)	Inter-serv. ref.
R42*	10 K	1	5	Z216003
R43*, R44*	200 K	1	2	Z216522
R45*	2 K	1	2	Z215711
R46*	2.4 K	1	2	Z215731
R47*	2.4 M	1	2	Z216676
R48*	1.5 M	1	2	Z216668
R49*	150 K	1	5	Z216136
R50*	4.3 K	1	2	Z215792
R51*	33	1	5	Z215062
R52*	100 K	1	5	Z216125
R53*	2.2 M	1	2	Z216674
R54*	1.5 M	1	2	Z216668
R55	47 K	1	5	Z244150
R56*	33	1	5	Z215062
R57*	100 K	1	5	Z216123
R58*	390 K	1	2	Z216579
R59*	270 K	1	2	Z216547
R60*	150	1	5	Z215142
R61*	270 K	1	5	Z216727
R62*	150	1	5	Z215142
R63*	10 K	1	5	Z216003
R64*	200 K	1	2	Z216522
R65*	2 K	1	2	Z215711
R66*	2.4 K	1	2	Z215731
R67*	200 K	1	2	Z216522
R68*	2.4 M	1	2	Z216676
R69*	1.5 M	1	2	Z216668
R70*	150 K	1	5	Z216136
R71*	4.3 K	1	2	Z215792
R72*	33	1	5	Z215062
R73*	100 K	1	5	Z216125
R74*	2.2 M	1	2	Z216674
R75*	1.5 M	1	2	Z216668
R76	47 K	1	5	Z244150
R77*	33	1	5	Z215062
R78*	100 K	1	5	Z216123
R79*	27 K	1	5	Z216052
R80*	4.3 K	1	5	Z215318
R81*	68 K	1	5	Z216103
R82	330	1	10	Z221173

\* High stability.

**Resistors (Variable)**

Circuit ref.	Value (ohms)	Rating (watts)	Tol. (%)	Inter-serv. ref.	Function
RV1	50 K	1	10	Z272410	C.F. SET
RV2	<i>not fitted</i>				
RV3	25 K	1	10	Z272301	GAIN PARAPHASE
RV4	1 K	1	10	Z271601	DC LEVEL SET PARAPHASE —FINE
RV5	10 K	1	10	Z272141	DC LEVEL SET PARAPHASE —COARSE

**Resistors (Variable)**

Circuit ref.	Value (ohms)	Rating (watts)	Tol. (%)	Inter-serv. ref.	Function
RV6	100	1	10	Z271301	DC LEVEL SET X—FINE
RV7	10 K	1	10	Z272141	GAIN X
RV8	10 K	1	10	Z272141	DC LEVEL SET Y—COARSE
RV9	100	1	10	Z271301	DC LEVEL SET Y—FINE
RV10	10 K	1	10	Z272141	GAIN Y
RV11	10 K	1	10	Z272141	DC LEVEL SET X—COARSE
RV12	<i>not fitted</i>				

**Capacitors (Fixed)**

Circuit ref.	Value ( $\mu$ F except where stated)	Rating (V.DC)	Tol. (%)	Inter-serv. ref.
C1	.01	350	5	Z124375
C2	0.1	500	20	Z115587
C3	0.1	500	20	Z115587
C4	10 pF	350	10	Z123007
C5	33 pF	500	10	Z132283
C6	10 pF	350	10	Z123007
C7	33 pF	500	10	Z132283
C8	33 pF	500	10	Z132283
C9	47 pF	500	10	Z132289

**Capacitors (Fixed)—contd.**

Circuit ref.	Value ( $\mu$ F except where stated)	Rating (V.DC)	Tol. (%)	Inter-serv. ref.
C10	15 pF	500	10	Z132073
C11	33 pF	500	10	Z132283
C12	15 pF	500	10	Z132289
C13	15 pF	500	10	Z132073
C14	.005	350	20	Z115628
C15	0.1	350	20	Z115506
C16	0.1	350	20	Z115506
C17	0.1	500	20	Z115507

**TABLE I—continued**

**Miscellaneous Items**

Circuit ref.	Description	Type	Stores ref.
SW.A, SW.B, S.W.C.	D.P.D.T. toggle switch	—	Z510304
PL1*	6-way fixed plug	Mk. 4	Z560541
PL2*	12-way fixed plug	Mk. 4	Z560152
SK3 to SK7	Coaxial socket	783	10H/19861
SK8	25-way fixed socket	—	Z560380
SK9 to SK12	Socket (Belling-Lee L316)	714	10H/19641
SK13*	25-way fixed socket	Mk. 4	Z560380
SK14*	4-way fixed socket	Mk. 4	Z560250
SK15, SK16	Socket (Belling-Lee L316)	714	10H/19641
SK17, SK18	Coaxial socket	783	10H/19861

\* Moulding position on Mk. 4 plugs and sockets is shown by last digit of Z-number.

**TABLE 2**

**Resolver unit (azication)—component details  
(Stores Ref. 10AE/626)**

Circuit Ref.	Description	Type	Ref. No
X1	Motor unit (Flange-mounting receiver selsyn)	113 (BTH. S1406/B6)	10K/17500 (BTH Cat. No. 19773)
RV1	Colvern sine/cos. pot	(CLR9602 /BE)	10W/19533
or	Kelvin & Hughes sine/cos.pot (32K)	(SCP4/1)	10W/19408
RLA, RLB	2KΩ, 100V relay	(43/3LV)	Z530216
SWA	S.P.S.T. toggle switch	—	Z510300
SWB	D.P.S.T. toggle switch	—	Z510304
SK1*	Fixed 6-way socket (small)	Mk. 4	Z560261
SK2*	Fixed 12-way socket	Mk. 4	Z560331
SK3*	Fixed 6-way socket (small)	Mk. 4	Z560260
SK4 to SK7	Coaxial socket	783	10H/19861
SK8, SK9	Test socket (Belling-Lee L316)	714	10H/19641
PL11*	Free 6-way plug (small)	Mk. 4	Z560301
PL12*	Free 12-way plug	Mk. 4	Z560361
PL13*	Free 6-way plug (small)	Mk. 4	Z560300
PL14*	Free 12-way plug	Mk. 4	Z560150

\* Moulding orientation on Mk. 4 plugs and sockets is indicated by last digit of Z-number.

**TABLE 3**

**Power unit Type 905—component details  
(Stores Ref. 10K/17133)**

**Resistors (Fixed)**

Circuit ref.	Value (ohms)	Rating (watts)	Tol (%)	Inter-serv-ref.
R1 to R3	1M	1	10	Z213339
R4	100	1/2	10	Z221110
R5	220 K	1	10	Z213331
R6	4.7 K	1/2	10	Z222089
R7	220 K	1	10	Z213331
R8	33	1/2	5	Z215062
R9	100	1/2	10	Z221110
R10	68 K	1	10	Z213325
R11	47 K	1	10	Z212263
R12	470 K	1/2	10	Z223122

**TABLE 3—continued**

Circuit ref.	Value (ohms)	Rating (watts)	Tol (%)	Inter-serv-ref.
R13	470	1/2	10	Z221194
R14	560	1/2	10	Z221206
R15*	330 K	1	2	Z216564
R16*	1 M	1/2	1	Z216655
R17, R18	100 K	1/2	10	Z223038
R19 to R22	not fitted			
R23	100	1/2	10	Z221110
R24, R25	220 K	1	10	Z213331
R26*	33	1/2	5	Z215062
R27	4.7 K	1/2	10	Z222089
R28	100	1/2	10	Z221110
R29, R30	47 K	1	10	Z212263
R31	470 K	1/2	10	Z223122
R32, R33	220	1/2	10	Z221152
R34*	330 K	1	2	Z216564
R35*	300 K	1/2	1	Z216551
R36	100 K	1/2	10	Z223038
R37	150	4/5	5	Z243113
R38, R39	not fitted			
R40*, R41*	2.7 K	1	5	Z215294
R42	6.8 K	4 1/2	5	Z244081
R44*	12 K	1	5	Z216014
R45	100	1/2	10	Z221110
R46	22 K	1/2	10	Z222173
R47	2.2 M	1/2	10	Z223206
R48*	750 K	1/2	1	Z216631
R49* to R51*	1 M	1/2	1	Z216655
R52 to R54	not fitted			
R55, R56	1 M	1	10	Z213339
R57	220 K	1	10	Z213331
R58	100	1/2	10	Z221110
R59	4.7 K	1/2	10	Z222089
R60	330 K	1	10	Z213333
R61	680 K	1	10	Z213337
R62*	33	1/2	5	Z215062
R63	100	1/2	10	Z221110
R64, R65	47 K	1	10	Z212263
R66	470 K	1/2	10	Z223122
R67	220	1/2	10	Z221152
R68	330	1/2	10	Z221173
R69*	470 K	1/2	2	Z216595
R70*	300 K	1/2	2	Z216555
R71*	240 K	1	2	Z216540
R72	100 K	1/2	10	Z223038
R73*	300 K	1/2	1	Z216551
R74 to R76	not fitted			
R77*	330 K	1	2	Z216564
R78	220 K	1	10	Z213331
R79	470	1/2	10	Z221194
R80	220 K	1	10	Z213331
R81	470	1/2	10	Z221194
R82	220	1/2	10	Z221152
R83	680	1/2	10	Z221215
R84	220	1/2	10	Z221152
R85, R86	22 K	6	5	Z244129

\* High stability.

**Resistors (Variable)**

Circuit ref.	Value (ohms)	Rating (watts)	Tol. (%)	Inter-serv. ref.	Function
RV1	50 K	1	10	Z272410	+400V SET
RV2	50 K	1	10	Z272410	+300V SET
RV3	50 K	1	10	Z272410	SET CUT-OUT
RV4	100 K	1	10	Z272549	-300V SET

**Capacitors (Fixed)**

Circuit ref.	Value (μF)	Rating (V.DC)	Tol. (%)	Inter-serv. ref.
C1, C2	4	800	20	Z112529
C3	0.1	500	20	Z115587
C4	1	600	20	Z112823

TABLE 3—continued

## Capacitors (Fixed)—contd.

Circuit ref.	Value ( $\mu$ F)	Rating (V.DC)	Tol. (%)	Inter-serv. ref.
C5	0.1	500	20	Z115587
C6	1	600	20	Z112823
C7	2	200	20	Z112882
C8, C9	4	800	20	Z112529
C10	0.1	500	20	Z115587
C11	1	600	20	Z112823
C12, C13	<i>not fitted</i>			
C14	0.5	500	20	Z115512
C15	3	100	-20, +50	Z145017
C16	0.1	1,000	20	Z115508
C17	0.5	500	20	Z115512
C18	3	100	-20	Z145017

## Miscellaneous Items

Circuit Ref.	Description	Type	Ref. No.
L1	Choke L1195 (16H)	LF 1138	10C/19262
L2	Choke L1274 (20H)	LF 1153	10C/19297
TR1	Transformer L1202	3199	10K/17395
TR2	Transformer L1200	3145	10K/17341
LP1 to LP5	Neon lamp	—	X962106
LP6	Filament lamp	—	X959220
RLA	Relay magnetic, 675 $\Omega$ + 675 $\Omega$ (Carpenter 6U33)	1339	10F/18105
RLB	Relay magnetic, 2,000 $\Omega$	60/3HV	Z530187
SK1*	12-way fixed socket	Mk. 4	Z560332
SK2*	12-way fixed socket	Mk. 4	Z560332
SK3*	6-way fixed socket	Mk. 4	Z560321
SK4*	6-way fixed socket	Mk. 4	Z560321
SK5*	25-way fixed socket	Mk. 4	Z560380
PL6*	6-way fixed plug	Mk. 4	Z560140
SWA	D.P.S.T. toggle switch	—	Z510302
SWB	Wafer switch type H	2176	10F/17465

TABLE 3—continued

## Miscellaneous Items—cont.

Circuit Ref.	Description	Type	Ref. No.
FS1	Fuse link, 5A (MOS/A)	—	Z590112
FS2	Fuse link, 1A (MOS/A)	—	Z590109
FS3, FS5	Fuse link, 250mA (MOS/A)	23	10H/107
FS4	Fuse link, 100mA (MOS/A)	10	10H/10152
FS6, FS7	Thermo cut-out	—	10AE/655

\* Moulding position on Mk. 4 plugs and sockets is shown by last digit of Z-number.

TABLE 4

## Panel (distribution) Type 878—component details (Stores Ref. 10D/18865)

Circuit ref.	Description	Type	Stores ref.
FS1, FS2	Fuse link, 5A (MOS/A)	21	10H/11718
RLA	Relay, 2,000 $\Omega$ , 250V	(29/3HV)	Z530277
SWA	D.P.D.T. toggle switch	—	Z510304
SWB	D.P. ON/OFF switch	—	Z510306
SK5*	12-way fixed socket	Mk. 4	Z560330
PL13*	12-way fixed plug	Mk. 4	Z560150
SK25 to SK32	Coaxial panel coupler (F. & E. Type JS1/BHF)	1107	10H/18473
SK33	3-pin 5A mains socket	Crabtree Type L7170	5C/1042
SK34 to SK39	Coaxial socket	783	10H/19861

\* Moulding position on Mk. 4 plugs and sockets is shown by last digit of Z-number.

TABLE 5

Rack assembly (azication) Type 302  
List of input and output connections

## Note ...

The following list, which applies to initial installations of the fixed coil system, is issued for early information only, and may be supplemented or superseded by current orders. Full cabling schedules will be issued to each station separately.

PL/SK	Type	Pin	Service	Rack unit	Destination (RA. = rack assembly)
<i>Mk. 4 Plugs and Sockets (all moulding position "O")</i> (PL13 on panel (dist.) T.878 : remainder on side panels)					
PL1	6-way (med.)	A	Neutral, 230v 50 c/s	P.U.905 with Res. No. 4	Radar office power board
		B	Line, 230v 50 c/s	P.U.905 with Res. No. 4	Radar office power board
		C	-500v ref.		R.A. (neg. ref.) Type 338
		D	50v -		Rectifier Type 15
		E	50v +		Rectifier Type 15
		F	50v -, neg. ref. control		R.A. (neg. ref.) T.338 (paired with "C")
PL2	6-way (med.)	A-F	As PL1	P.U.905 with Res. No. 2	—
PL3	6 way (med.)	A-F	As PL1	P.U. 905 with Res. No. 1	—
PL4	6-way (med.)	A-F	As PL1	P.U. 905 with Res. No. 3	—
PL6	4-way (small)	A	Spare	—	—
		B	Spare	—	—
		C	DC azic. ranging voltage	W.F.G. 100 with Res. No. 1	R.A. (misc.) Type 306
		D	Spare	—	—



TABLE 5 (continued)

PL/SK	Type	Pin	Service	Rack unit	Destination (R.A=rack assembly)
PL7	12 way	A	A1 Selsyn services	Resolver No. 1	From appropriate height finder head
		B	A2 Selsyn services	Resolver No. 1	From appropriate height finder head
		C	— Selsyn services	Resolver No. 1	From appropriate height finder head
		D	D Selsyn services	Resolver No. 1	From appropriate height finder head
		E	E Selsyn services	Resolver No. 1	From appropriate height finder head
		F	F Selsyn services	Resolver No. 1	From appropriate height finder head
		G	Auto-align	Resolver No. 1	From appropriate height finder head
		H	50v —	Resolver No. 1	Rectifier Type 15
		J	—	Resolver No. 1	—
		K	Earthed in trunking	Resolver No. 1	—
		L	—	Resolver No. 1	—
		M	—	Resolver No. 1	—
		PL8	4-way (small)	A-D	As PL6
PL9	12-way	A-M	As PL7	Res. No. 2	—
PL10	4-way (small)	A-D	As PL6	W.F.G. 100 with Res. No. 3	—
PL11	12-way	A-M	As PL7	Res. No. 3	—
PL12	4-way (small)	A-D	As PL6	W.F.G. 100 with Res. No. 4	—
PL13*	12-way	A	A1 Selsyn services	Resolver No. 4 via Panel (SW) Type 878	Type 7 head via control unit 618
		B	A2 Selsyn services	Resolver No. 4 via Panel (SW) Type 878	Type 7 head via control unit 618
		C	— Selsyn services	Resolver No. 4 via Panel (SW) Type 878	Type 7 head via control unit 618
		D	D Selsyn services	Resolver No. 4 via Panel (SW) Type 878	Type 7 head via control unit 618
		E	E Selsyn services	Resolver No. 4 via Panel (SW) Type 878	Type 7 head via control unit 618
		F	F Selsyn services	Resolver No. 4 via Panel (SW) Type 878	Type 7 head via control unit 618
		G	Auto-align	Resolver No. 4 via Panel (SW) Type 878	Type 7 head via control unit 618
		H	50v —	Resolver No. 4 via Panel (SW) Type 878	Rectifier Type 15
		J	50v — remote control for Res. 4	Resolver No. 4 via Panel (SW) Type 878	Monitor PPI console
		K	—	Resolver No. 4 via Panel (SW) Type 878	—
		L	Neutral 230v 50 c/s	Resolver No. 4 via Panel (SW) Type 878	From PL4
		M	Line 230v 50 c/s	Resolver No. 4 via Panel (SW) Type 878	From PL4
		<i>Coaxial Sockets and Couplers</i>			
SK25	—	—	I.T. sine (X)	Res. 1	Appropriate azicating PPI consoles
SK26	—	—	I.T. cosine (Y)	Res. 1	Appropriate azicating PPI consoles
SK27	—	—	I.T. sine (X)	Res. 2	Appropriate azicating PPI consoles
SK28	—	—	I.T. cosine (Y)	Res. 2	Appropriate azicating PPI consoles
SK29	—	—	I.T. sine (X)	Res. 3	Appropriate azicating PPI consoles
SK30	—	—	I T. cosine (Y)	Res. 3	Appropriate azicating PPI consoles
SK31	—	—	I T. sine (X)	Res. 4	Appropriate azicating PPI consoles
SK32	—	—	I.T. cosine (Y)	Res. 4	Appropriate azicating PPI consoles
SK34	—	—	250 c/s drive pulse	W.F.G.4	—
SK35	—	—	250 c/s drive pulse	W.F.G.3	—
SK36	—	—	250 c/s drive pulse	W.F.G.2	—
SK37	—	—	250 c/s drive pulse	W.F.G.1	—
SK38*	—	—	250 c/s drive pulse out	—	To Azic Resolver rack No. 2
SL39*	—	—	250 c/s drive pulse in	—	R.A. (gating) Type 304

\* Connected thus on resolver rack No. 1 only.

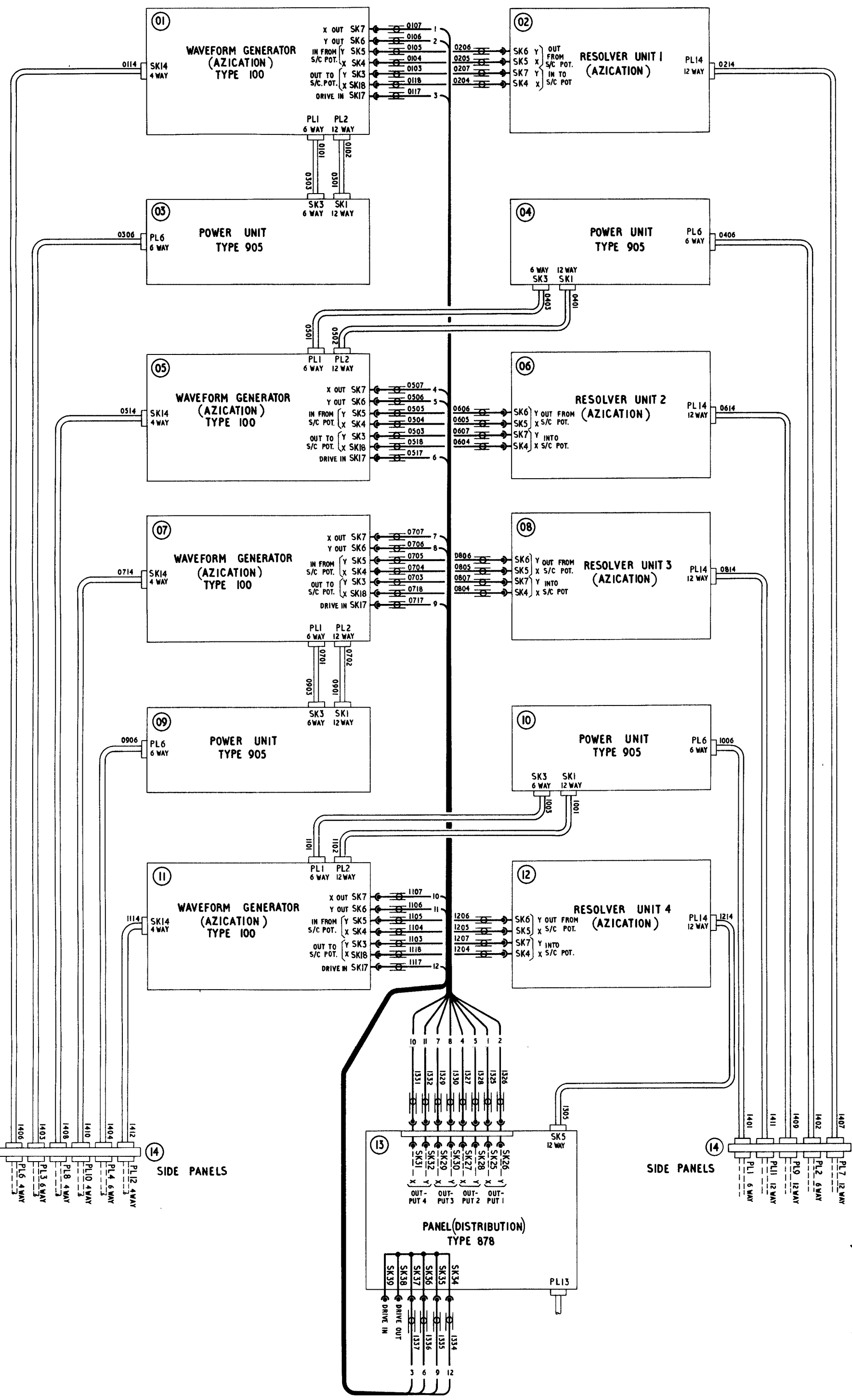
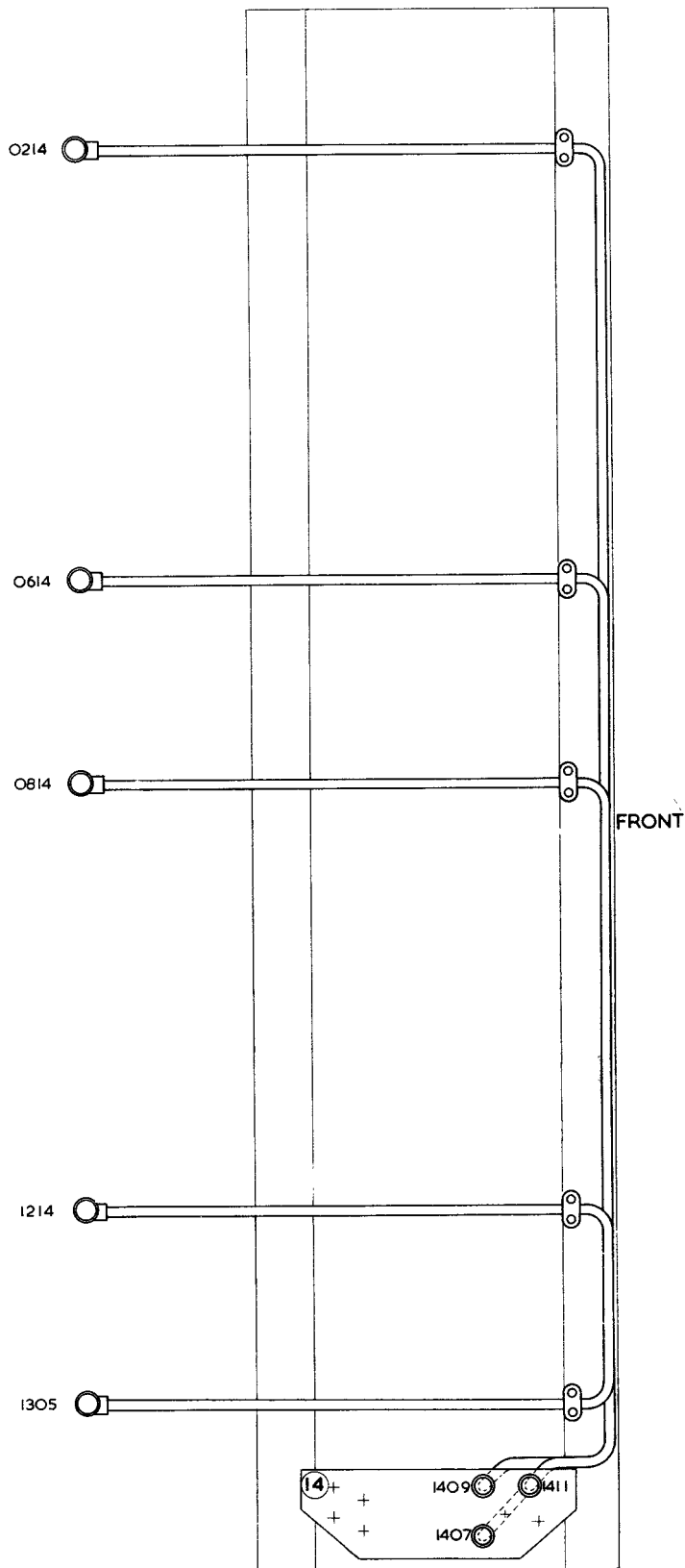


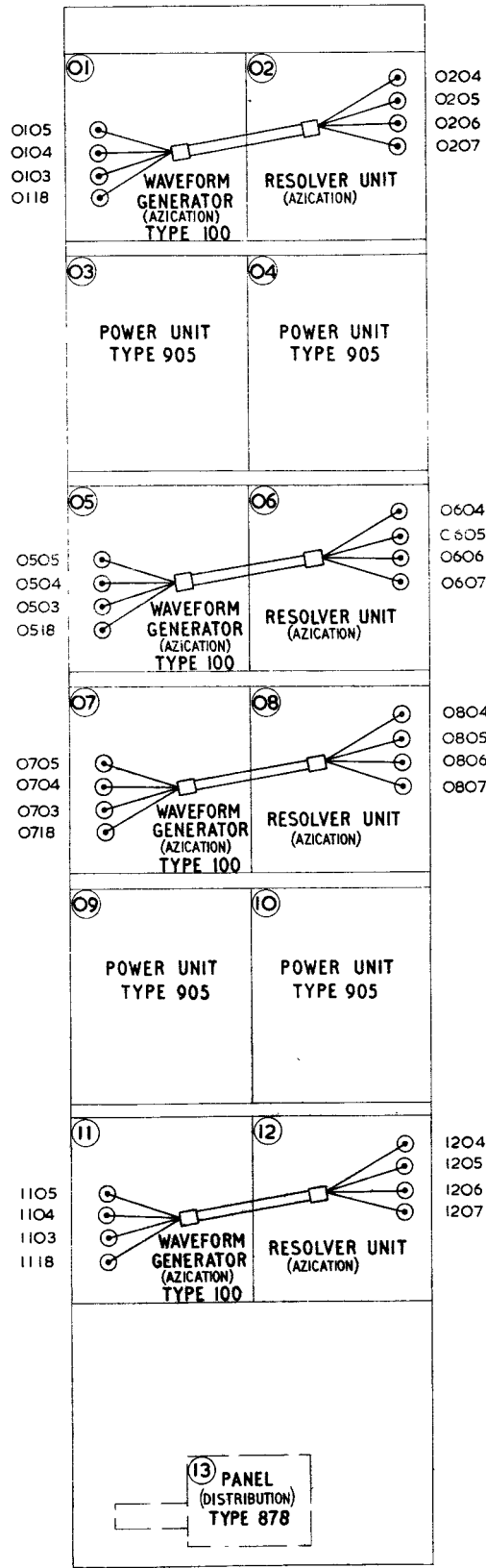
Fig. 21

Rack assembly (azication) Type 302 — circuit

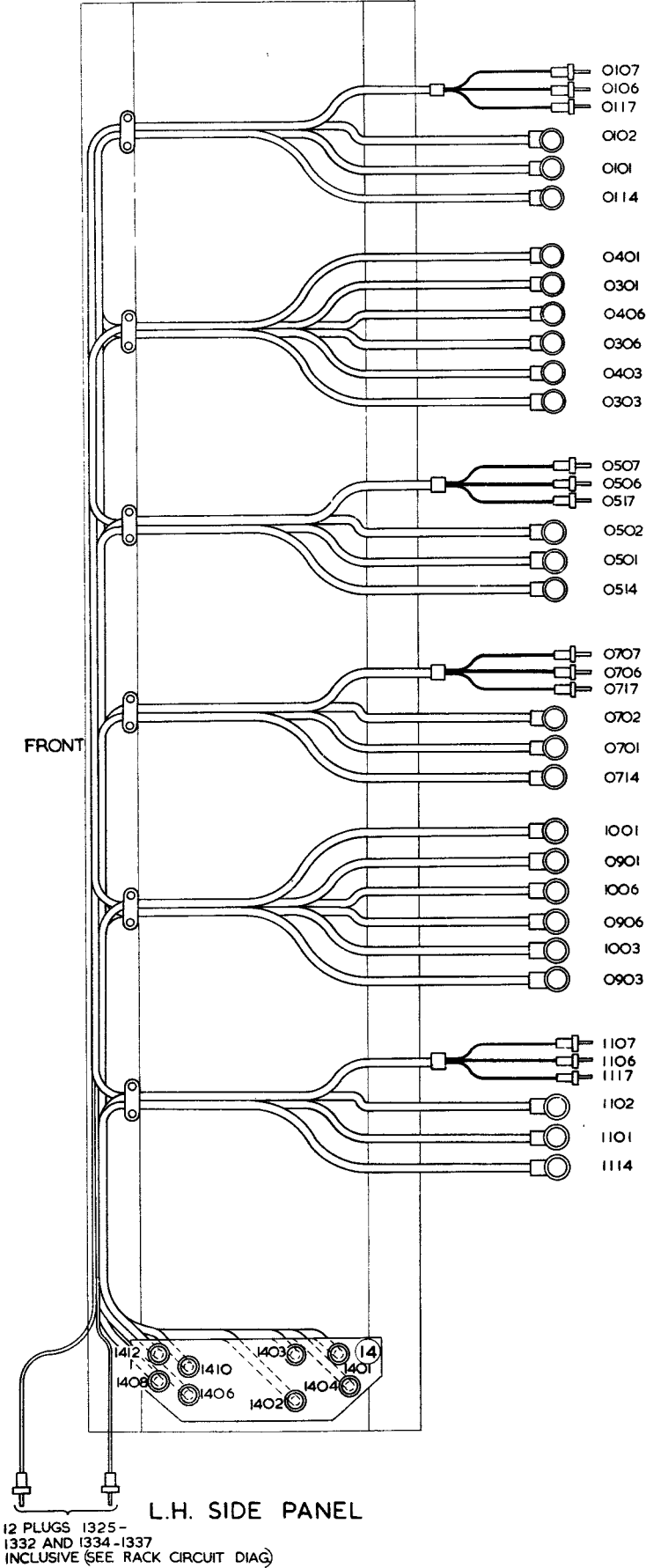
Fig. 21



R.H. SIDE PANEL



REAR VIEW



L.H. SIDE PANEL

12 PLUGS 1325-1332 AND 1334-1337 INCLUSIVE (SEE RACK CIRCUIT DIAG)

Fig.22

Rack assembly (azication) Type 302 - cabling

Fig.22

(A.L.13. Aug. 55)

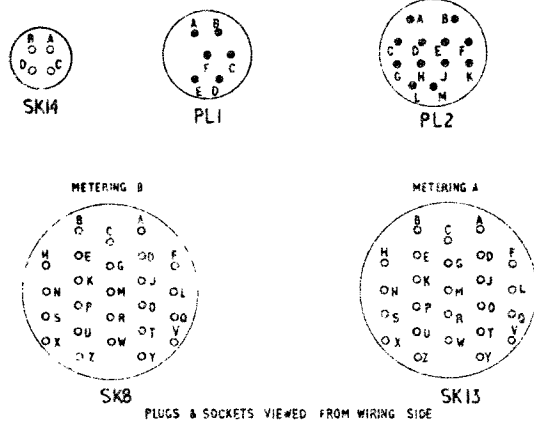
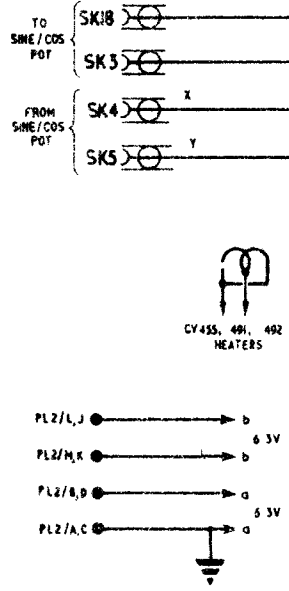
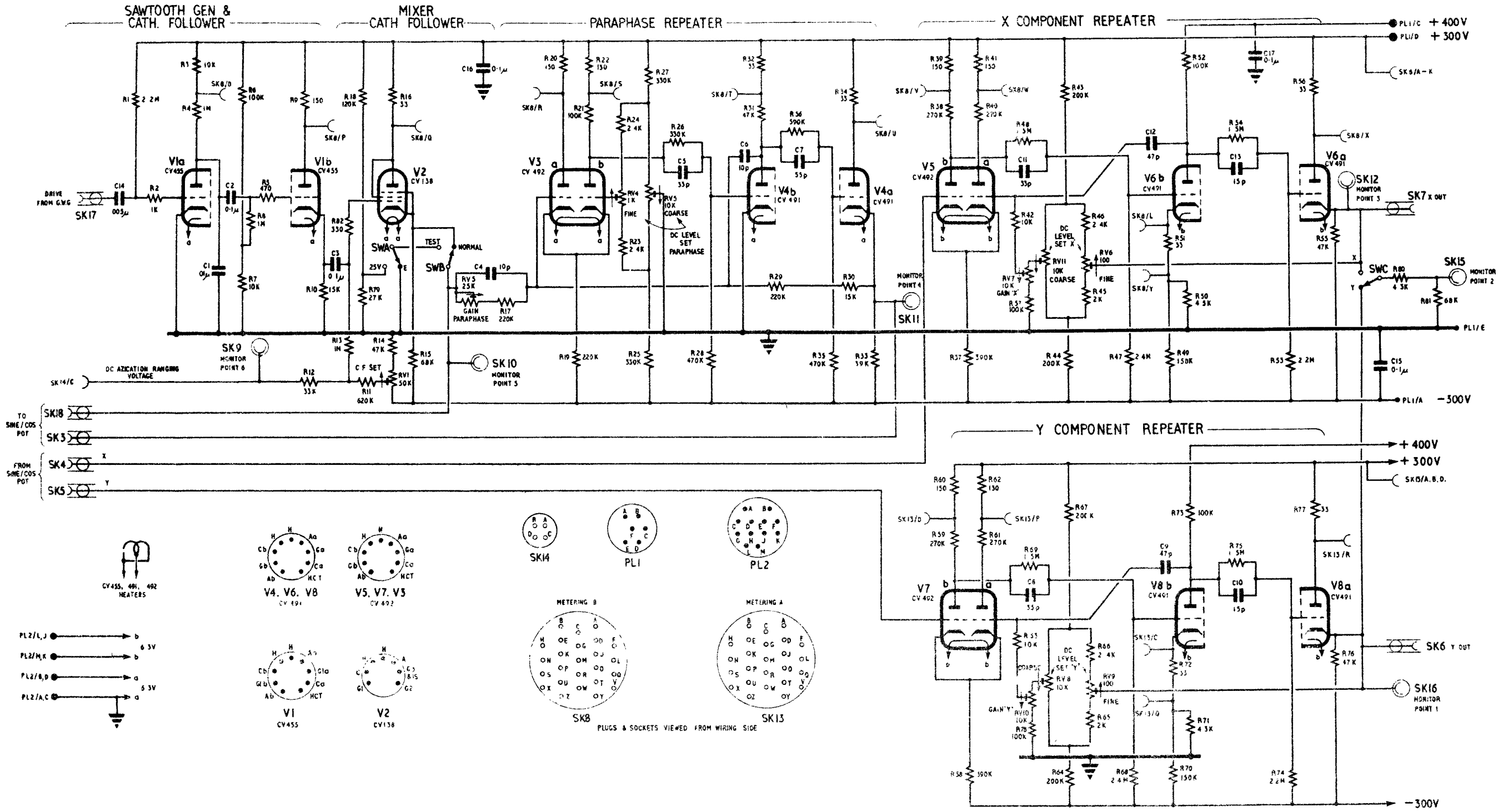


Fig 112  
(AL 13, Aug 55)

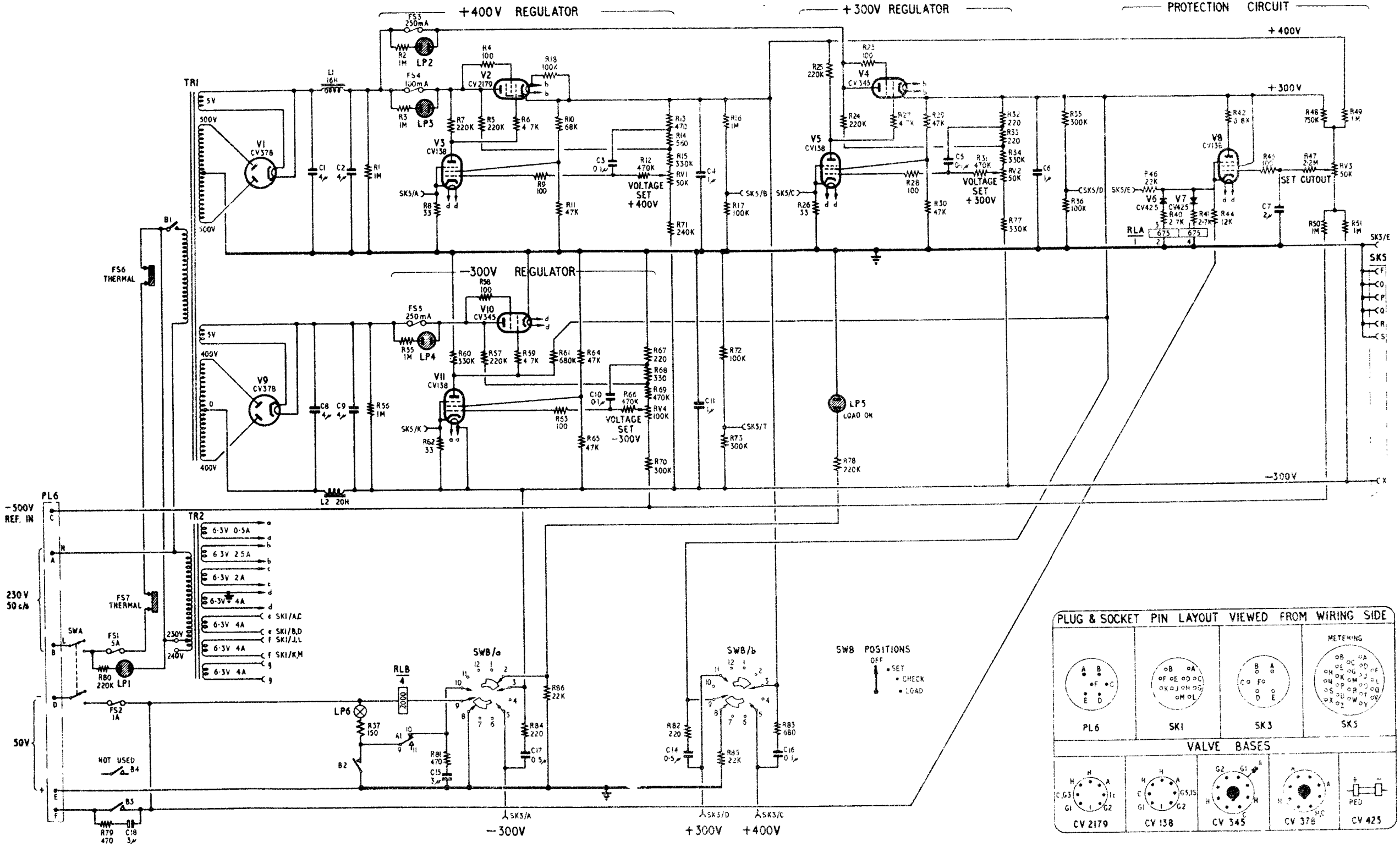


Fig. (11).

(AL13, Aug 55)

## Appendix 1

### RACK (AZICATION) TYPE M2

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#### LIST OF ILLUSTRATIONS

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#### General description

1. At some stations the wired framework of the rack assembly (azication) Type 302 is re-referenced to rack (azication) Type M2 (Ref. No. 10D/22832). This action is to allow greater flexibility in the make-up of units housed in the cabinet, without involving a further re-referencing of the rack assembly.

#### Panel (distribution) Type 878A

2. At stations where Phase 1A modifications are incorporated, the panel (distribution) Type 878 is replaced by the panel (distribution) Type 878A (Ref. No. 10D/22831). The panel 878A (fig. 1) has facilities for four separate drive pulse inputs, instead of one input as in the panel 878, to the four waveform generators (azication) Type 100.

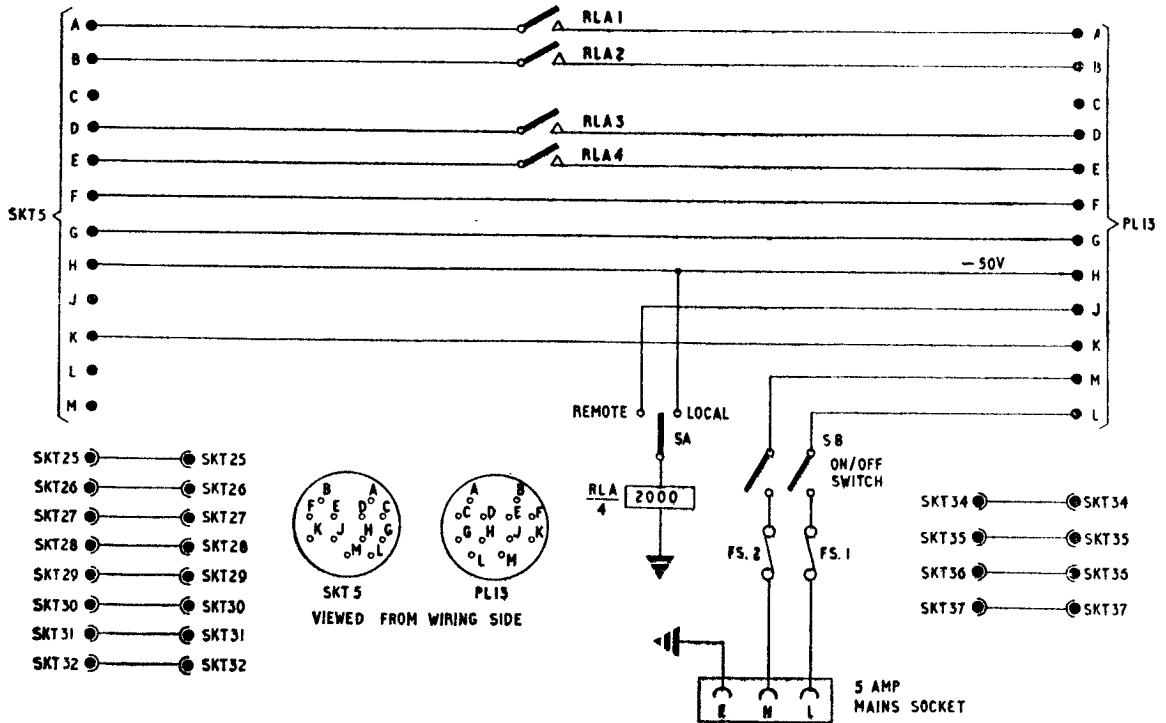


Fig. 1. Panel (distribution) Type 878A—circuit

## Appendix 2

### WAVEFORM GENERATOR (AZIC. MARKER) 100 (ARTIFICIAL ORIGIN)

#### LIST OF CONTENTS

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#### **Introduction**

1. At one site it is necessary to transmit range and bearing co-ordinates to a distant site. These co-ordinates are referred to an artificial point of origin; this is corrected at the remote site.

#### **General**

2. The reference to an artificial origin is achieved by producing a d.c. voltage in waveform generator 100 which is added to the outputs of the sine/cosine repeaters. This d.c. voltage can be preset between +8V and -8V to give offsets of up to 40 miles in any direction, and is switched in or out as required by relays.

## Chapter 5

### RACK ASSEMBLY (MISCELLANEOUS, ITBU) TYPE 306

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## GENERAL

### Purpose of rack

1. The rack assembly (miscellaneous, ITBU) Type 306 (Stores Ref. 10D/18672) is also known as the inter-trace bright-up distribution rack. It is designed as a central unit for the distribution of the inter-trace bright-up waveforms, from the

rack assembly Type 304, to "azicating" PPI consoles Type 64, and also for switching azicating services to and from the relevant standby console when any main azicating console fails.

### Rack units

2. The rack is illustrated in fig. 1. It contains

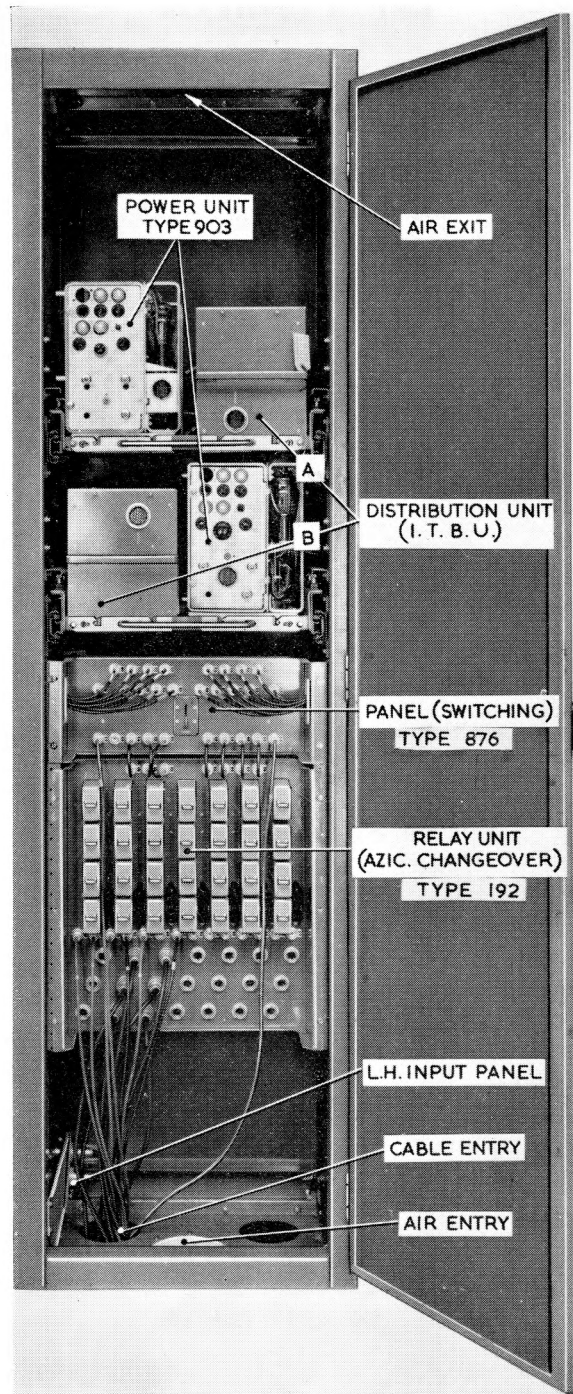


Fig. 1. Rack assembly Type 306—front view

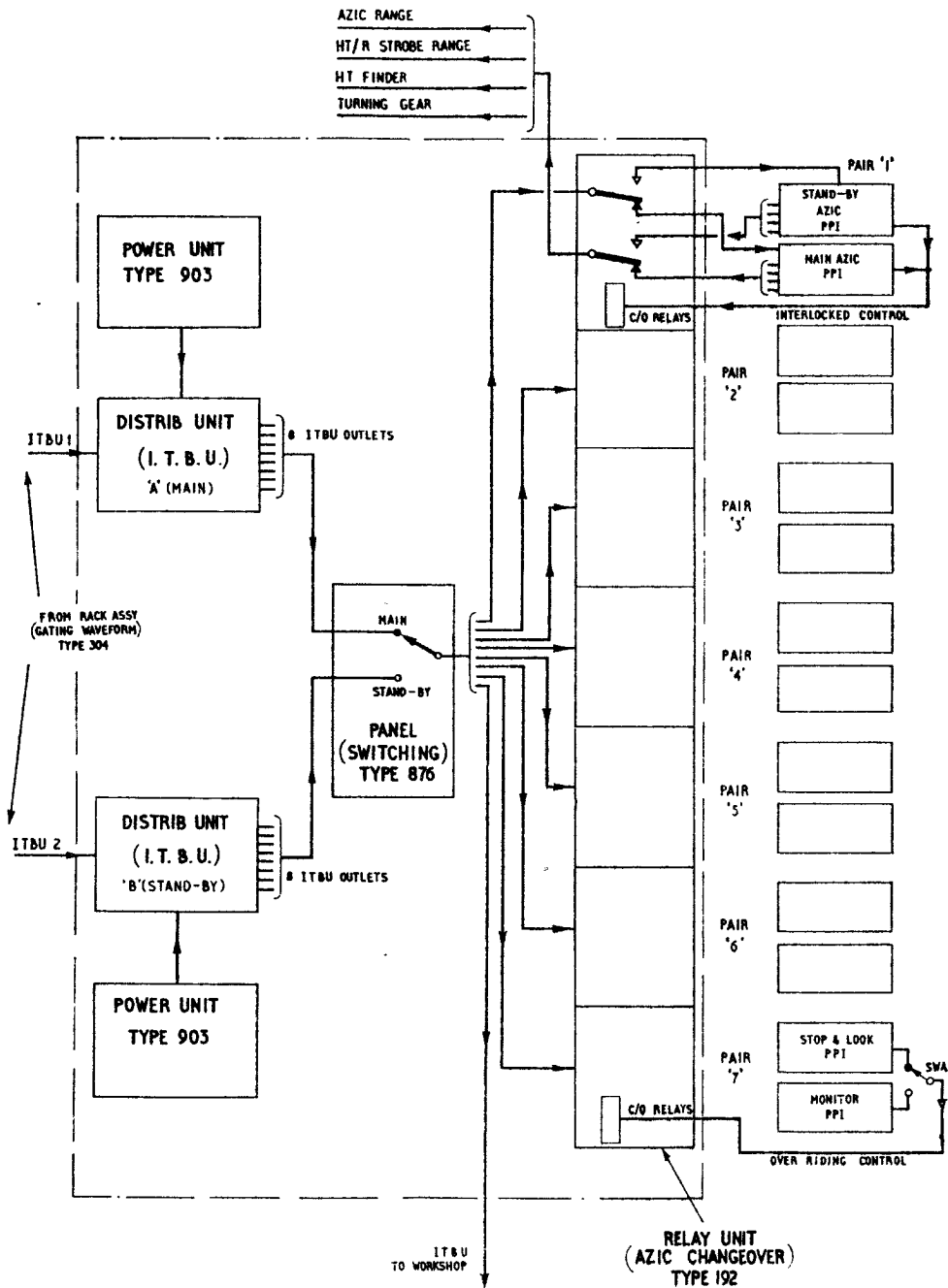


Fig. 2. Rack assembly Type 306—simplified block diagram

two *distribution units (ITBU)*, each with its *power unit type 903*, for supplying HT and LT. ◀To differentiate between the two pairs of units the upper pair (03 and 04) is designated "A" and the lower pair "B". One is normally in use whilst the other is maintained in the fully operational state as a standby. The choice of "A" or "B" units is made by an 8-wafer switch on the *panel (switching) Type 876*▶. The change-over of azicating services between the main and standby consoles is performed by relays in the *relay unit (AZ.C/O) Type 192*. The relays are remotely controlled from the consoles themselves, by an interlock system which is explained in para. 33-35.

#### Outline of circuit

3. The main functions of the rack are indicated in block diagram form in fig. 2. The full circuit is given in fig. 14. Assuming all external supplies are coming in to the rack, each distribution unit is switched on at its associated power unit Type 903 and each receives a separate ITBU input. These inputs are actually via the panel Type 876 but are shown as direct inputs on fig. 2. Each distribution unit then provides eight low-impedance ITBU outputs. ◀The main or standby distribution unit is selected on the panel (switching) Type 876 (A or B) and, of the eight outputs, six are used by ordinary azicating consoles, one by the "stop-and-look" console, and one in the radar workshop.▶

4. Each ordinary azicating console has near it another console which, though normally in use for other operational functions, may quickly be brought into service as an azicating console if the other should fail. The two consoles of the pair are referred to as the *main* and *standby* azicating consoles. The azication marker deflection waveforms are fed to both consoles of the pair all the time (from the appropriate resolvers in the rack assembly (azication) Type 302), but the ITBU pulse is only supplied to one console of the pair, so that the azication marker is only visible on that one. The change-over in ITBU destination is one of the functions of the relay unit (AZ. C/O) Type 192.

5. When a console takes over azicating functions the change-over of control of radar Type 13 turning gear, azication marker, and height/range strobe ranges is also performed by relays in the unit Type 192.

6. There are seven sets of relays in the unit to cater for six ordinary azicating pairs of consoles and for a seventh pair comprising the "stop-and-look" PPI and the monitor PPI in the radar office. Neither of these performs ordinary azicating functions, but each uses an azication-type marker, rotation-synchronized with the master search head. On the "stop-and-look" console the marker is used for guidance when re-synchronizing the "stop-and-look" head to the master, while on the monitor the marker is mainly used as a guide when synchronizing ordinary slave heads to the master, after a shut-

down. One or other of the pair is supplied with ITBU pulses, just as in an ordinary azicating pair, but as the two consoles are in different rooms some distance apart, the ordinary change-over system is not adequate. So for this console pair only (No. 7) there is a switch on the relay unit Type 192 which gives over-riding change-over control either to the monitor or to the "stop-and-look" console (*para. 36*).

7. For a full description of the power unit Type 903, reference may be made to Chap. 1 of this Section.

#### Construction of rack

8. The rack assembly Type 306 is of the standard radar office type already described in Chap. 1 of this Sect. It is usually installed in the radar office next to the rack assembly Type 304 and is coupled to the ventilation system in the same manner as the other racks. The pairs of units (distribution unit and power unit) are mounted side-by-side as already described for RA300 units in Chap. 1 of this Section. Sockets for checking circuit voltages and currents, with the multimeter Type 100, are provided on the front panels on the distribution and power units.

9. The other two principal units, panel (switching) Type 876 and relay unit (AZ.C/O) Type 192, are mounted vertically in the rack, one above the other (*fig. 1*). The flanges on these units are secured to mounting brackets at each side of the rack by  $\frac{1}{4}$  in. BSF screws.

#### Rack cabling

10. The circuit diagram of the rack (*fig. 14*) shows all the interconnections between units in the rack, and also indicates the start of the cables for external connections. Apart from the two connections which bring in supplies for the power units via the L.H. side input panel, all external connecting cables come into the relay unit (AZ.C/O) Type 192.

11. All the interconnections are made either by coaxial cables or by multicore cables of the "metvinsmall" type, terminating on Mk. 4 miniature plugs and sockets. The actual run of those cables forming part of the rack assembly is shown on the cabling diagram (*fig.*

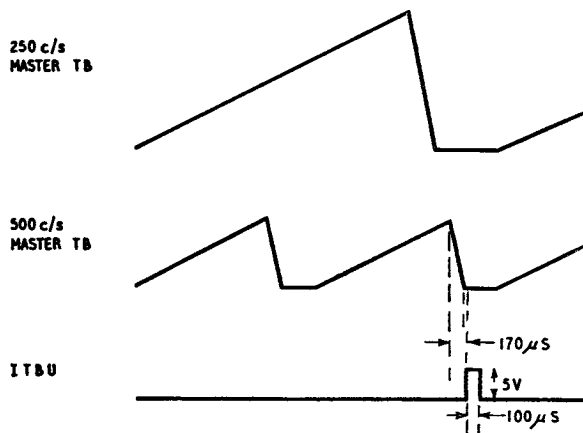


Fig. 3. ITBU timing

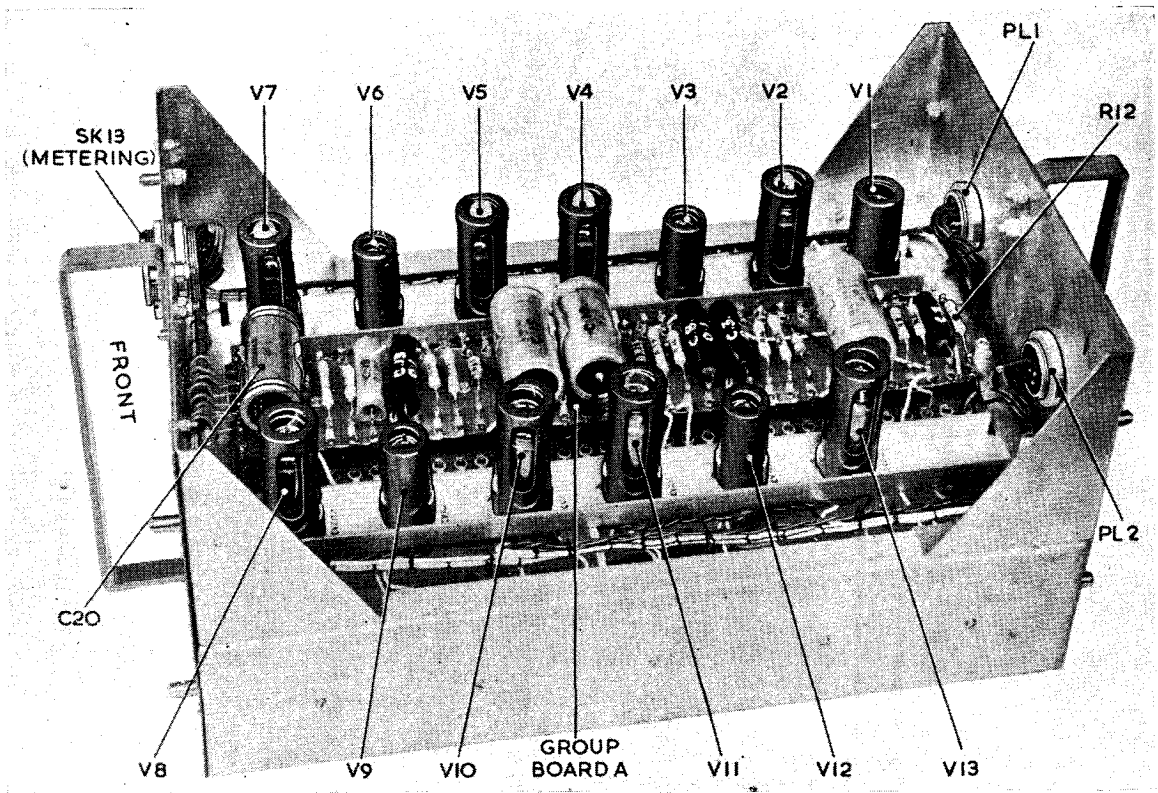


Fig. 4. Distribution unit (ITBU)—over-chassis view

15), which indicates ◀ the routing and the relative lengths of the cables. ▶

12. Every plug and socket on every unit need not necessarily have a cable running to it when the rack is properly cabled up. In particular, the power unit Type 903 caters for applications in

other racks, while the relay unit Type 192 caters for consoles not used on all sites.

*Cabling identification*

13. The destination of each cable end may be decided by reference to the four-figure number marked on it. As in the other fixed-coil equip-

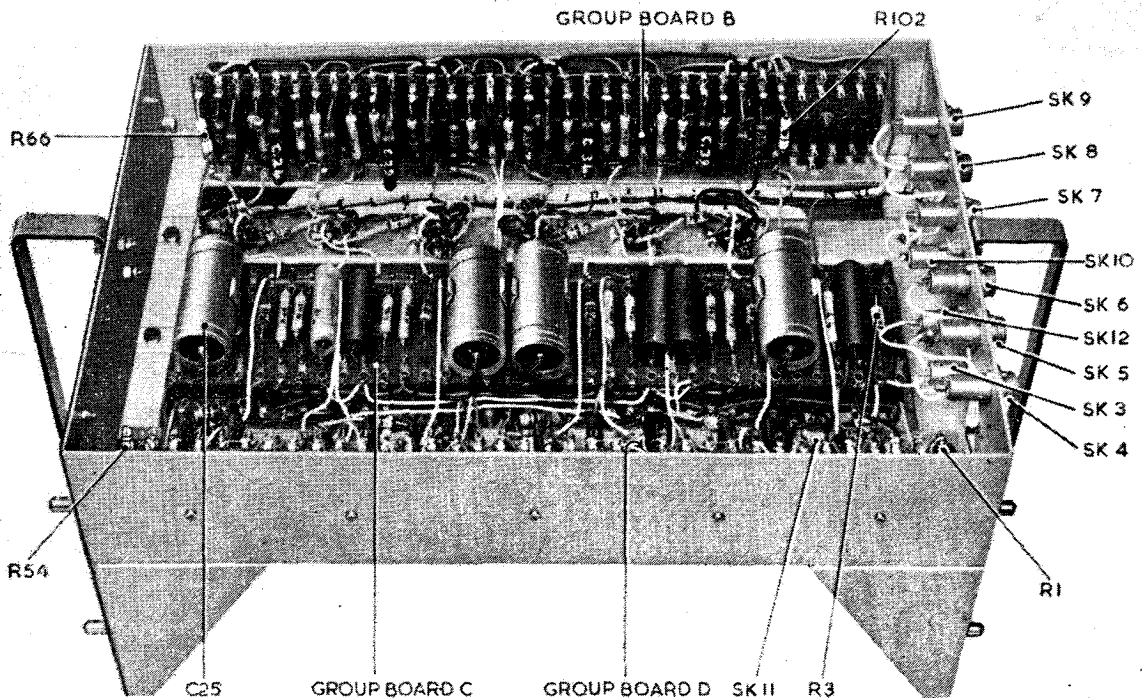
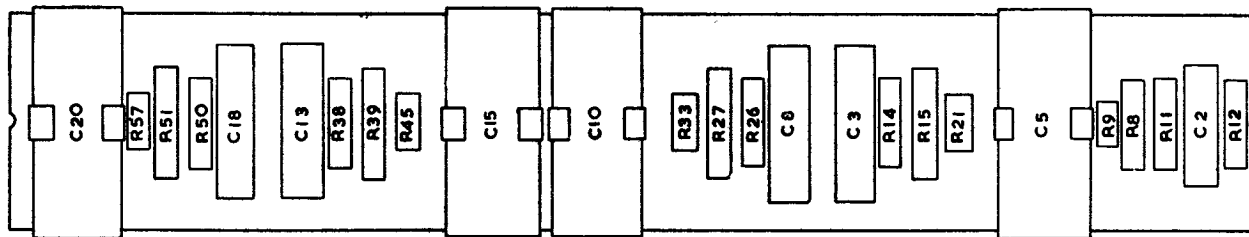
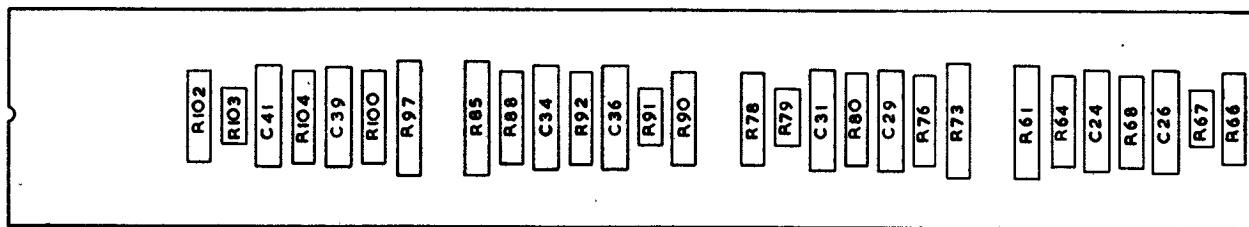


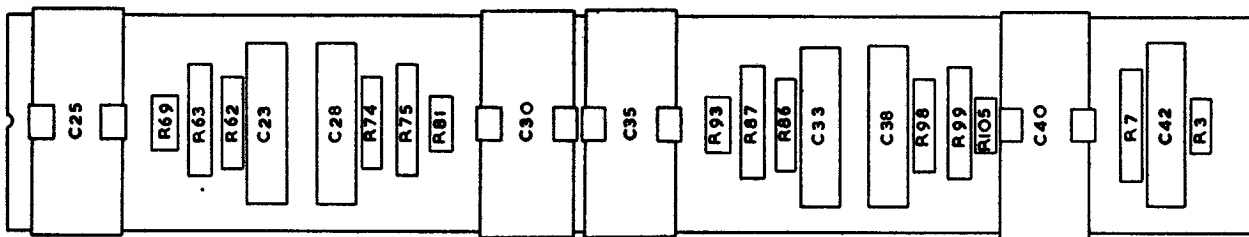
Fig. 5. Distribution unit (ITBU)—under-chassis view



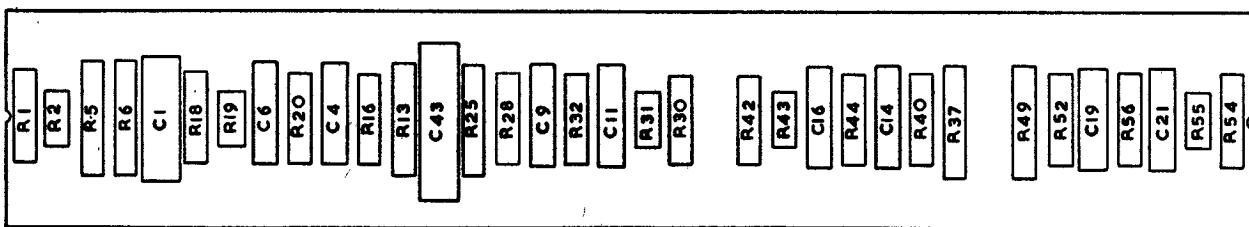
GROUP BOARD A



GROUP BOARD B



GROUP BOARD C



GROUP BOARD D

Fig. 6. Distribution unit (ITBU)—group boards

ment racks, the first two figures give the unit number and the second two the plug or socket number on the unit (*fig. 14 and 15*).

14. A complete list of input and output connections for the rack assembly is given in Table 4. This may be subject to modification but serves as a general guide to the operation of the rack.

**DISTRIBUTION UNIT (ITBU)**

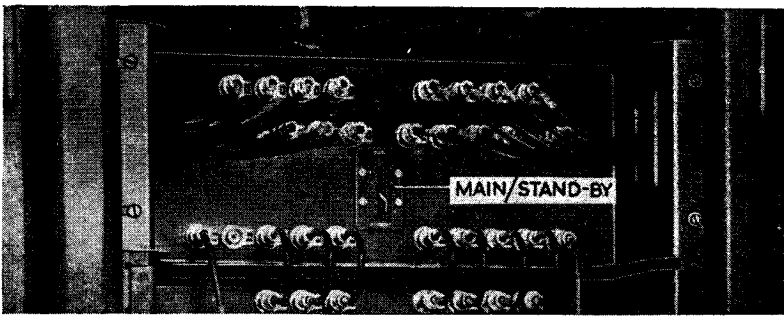
**Introduction**

15: The distribution unit (ITBU), Stores Ref.

10D/18918, forming part of the RA306, consists mainly of a battery of eight identical sections with cathode output stages (to produce eight low-impedance ITBU outputs), all driven by a cathode repeater circuit. The amplitude and timing of the ITBU pulses, in relation to the timebase waveforms at both repetition frequencies, is shown in *fig. 3*.

*Construction of unit*

16. The construction of the unit may be seen in *fig. 4 and 5*. The deep, rectangular steel frame-



**Fig. 7. Panel (switching) Type 876—front view**  
 ◀(the switch is now labelled A/B)▶

work is fitted with studs which secure it to the mounting tray. The chassis is not fully-decked and the miniature valveholders are arranged along two parallel U-shaped mounting channels, so that the valves are horizontal, in the working position. Most of the small components are arranged on group boards running the length of the unit. The layout on these group boards is shown in fig. 6.

**Power supplies**

**17.** The distribution unit takes, from the power unit Type 903, four 6.3V heater supplies (via PL1), as follows:—

- a-a 4A supply, one side earthed here,
- b-b paralleled with supply a-a in power unit,
- c-c 4A supply, one side earthed in power unit,
- d-d 2A supply, one side earthed here.

Stabilized, ripple-free HT supplies, at plus and minus 300V, also come from the same power unit, via PL2.

**Circuit description**

**18.** The complete circuit diagram of the distribution unit is shown in fig. 12. The first part of the circuit, centred on V1, is the cathode repeater, while the rest consists of cathode output stages, as explained below.

**Cathode repeater**

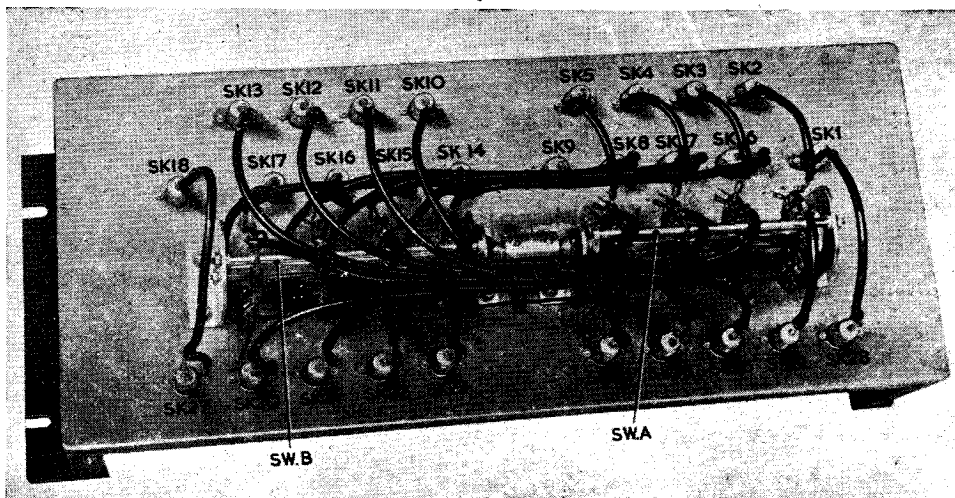
**19.** The ITBU pulse, fed to SK12 from the gating waveform generator rack, has an amplitude of

5V, positive-going, and comes from a source impedance of 100 ohms. The purpose of the double-triode V1 (CV455) cathode repeater circuit is to accept this pulse at appropriately low impedance before amplifying it to 30V to drive the cathode output stages. The input from SK12 is therefore applied direct to the cathode of V1a, which functions as a grounded-grid amplifier, DC-stabilized by the anode to grid connection via R5. The valve is normally passing current, which is reduced by the input pulse, so that an amplified, positive-going pulse appears at the anode. This output is AC-coupled to V1b via C1.

**20.** V1b is also DC-stabilized by its grid connection to the potential divider R7, R8, and is connected as a cathode-follower so that the positive-going output pulse is developed across the cathode load R11 and R12. To make the gain of the repeater largely independent of valve characteristics, the voltage developed across R12 (1.2K) is applied as moderate negative feedback, via C2, to the grid of V1a. The output at V1b cathode is about 30V amplitude and may be monitored at SK11; it comes from a low impedance and is capable of driving the eight output stages in parallel.

**Cathode output stages**

**21.** Since these eight stages are identical, a description of the first (V3a and V2) will serve for all of them. Although V2 may appear to be a cathode-follower, it is strictly a constant-current stage with a cathode output. The real cathode load is a 70-ohm potentiometer (RV2) in the panel (control) Type 859 of the PPI console at the remote end of the coaxial cable plugged into SK3, and the 6.8K resistor R21 is included merely to provide a return for the cathode if the external load is inadvertently disconnected. The function of V2, which is a high current pentode (CV2127), triode-connected, is to drive a constant 70mA



**Fig. 8. Panel (switching) Type 876—rear view**

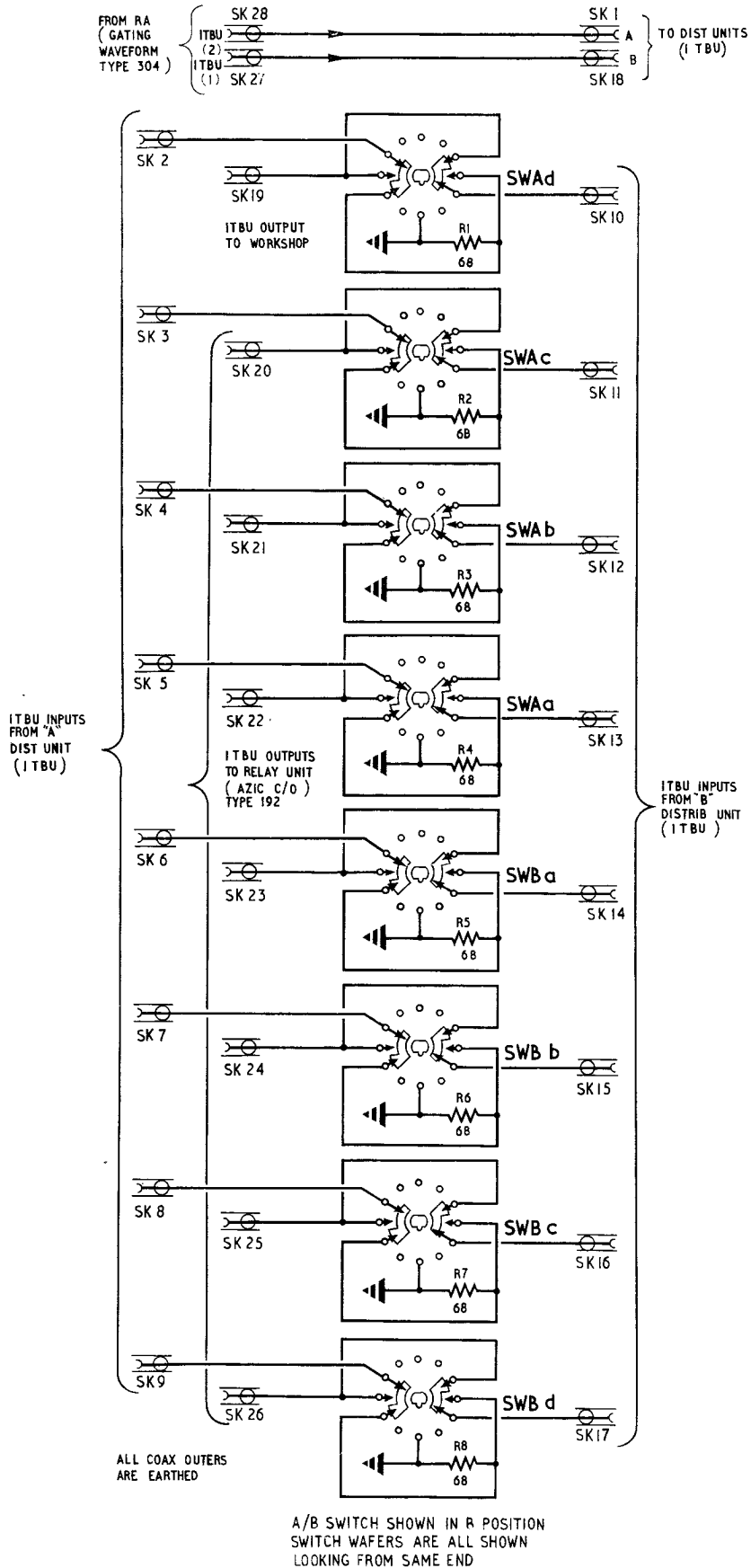


Fig. 9. Panel (switching) Type 876—circuit



current into the 70-ohm load during the ITBU period, and so produce the required 5V pulse.

22. In the quiescent state V2 is cut off because the diode V3a is passing current, and V2 grid is caught at the negative cathode potential of V3a. The 30V ITBU input pulse to V3a cathode, via C3, cuts off this diode and V2 grid is free to rise towards HT potential. V2 comes into conduction and the rise at the grid is limited and controlled by negative feedback from the anode via C4, R16, so that the voltage drop across the 680-ohm anode load R20 is held at a constant 48V during the pulse, thus maintaining the valve current at the required 70 mA whatever the cathode conditions.

23. To avoid drawing 70mA (eight times over) from the HT rail during the pulse the reservoir capacitor C5 ( $1\mu\text{F}$ ) is connected to the junction of R19 and R20 in the anode circuit. This capacitor charges up during the long inter-pulse period and partially discharges during the pulse. This discharge causes a small fall in voltage at the top of R20 which is counterbalanced by an equal fall at the bottom, produced by suitable choice of values for C4, R16, and C6 from V2 anode to earth. As a result the voltage drop across R20 remains constant during the pulse and the constant 70mA valve current is maintained. The metering point SK13/P provides for checking the mean valve current.

#### PANEL (SWITCHING) TYPE 876

##### Introduction

24. The panel (switching) Type 876 (Stores Ref. 10D/18863) is a simple unit for selecting either "A" or "B" distribution unit (ITBU) in the rack assembly Type 306. It is built on a deep U-shaped chassis which mounts vertically in the cabinet (fig. 7), and carries a number of coaxial sockets together with the A/B (main/standby) change-over switch. The complete circuit of the panel is shown in fig. 9. It will be noticed that (purely for convenience of cabling) the original ITBU input pulses pass through this panel on the way to the distribution units, and are not switched.

##### Change-over switch

25. There are, strictly speaking, two change-over switches (SWA and SWB) with four wafers each, but since they are ganged together, they may be regarded as one 8-wafer switch (fig. 8), with alternative positions selected by a lever protruding through the panel. Since the eight wafers are identical, SWAa only is described.

26. An inter-trace bright-up input from the "B" distribution unit (ITBU) arrives at SK13 and one from the "A" unit at SK5. When the switch is in the B position (as shown, fig. 9), the input from SK13 is connected through to SK22, while a  $68\Omega$  dummy load R4 is connected across the other input to simulate actual operating conditions, so that the "A" distribution unit is ready for instant use. When the switch is changed to the A position, the input from SK5 is connected through to SK22 and the dummy load switched to SK13.

#### RELAY UNIT (AZ.C/O) TYPE 192

##### Introduction

27. This relay unit (Stores Ref. 10F/16273), in

the rack assembly Type 306, carries the 28 relays which effect the change-over of azicating functions (including the supply of ITBU pulses) between the *main* and *standby* azicating consoles, as explained in para. 4 and 5.

##### Construction

28. The unit is assembled on a deep U-shaped chassis which is flange-mounted, vertically in the rack (fig. 10), below the panel (switching) Type 876. In fig. 10, two of the change-over relays are illustrated without dust covers to show the relay mounting.

##### Circuit description

29. Reference to the complete circuit diagram (fig. 13) shows that there are seven banks of four relays each. Banks 1 to 6 each operate with an ordinary *main/standby* console pair, whereas bank 7 applies to the *stop-and-look/monitor* pair. Relay banks 1 to 6 therefore have identical circuits, but bank 7 has a small variation due to the inclusion of SWA (para. 36). ◀ The modification shown in dotted lines on fig. 13 applies to equipment at A.T.C.R.U., Sopley, only. It was made to enable communications on voice channel to be routed from the height reader only to the console on which the azication is taking place. ▶

##### Relay bank 1

30. Taking the first relay bank as an example, it may be seen that the services to be changed over are on SK3 and SK4. The key to these services is given in the top right-hand corner of fig. 13. The ITBU input on SK3 comes from SK26 on the panel (switching) Type 876 and is derived from one or other of the distribution units (ITBU) depending on the position of the A/B switch. The inputs on SK4 are derived from external sources as shown in Table 4.

31. SK1 and PL31 provide the corresponding outgoing connections to the *main* console of pair 1, while SK2 and PL32 provide connections to the *standby*. The relays RLAA and RLAB are strapped in parallel and act as one relay, controlled from the *main* console; similarly, relays

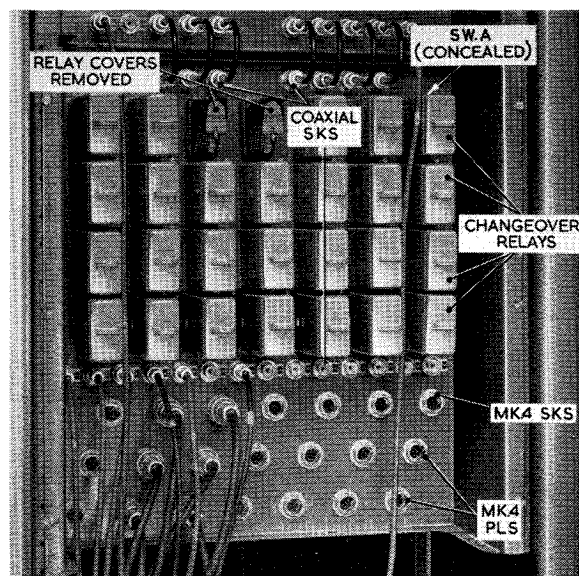


Fig. 10. Relay unit (AZ.C/O) Type 192—front view



RLAC and RLAD are strapped together and are controlled from the *standby* console.

32. In fig. 13 all the relays are shown in the unenergized position. If the azication key on the panel (control desk) of the *main* console is operated,  $-50V$  is applied to PL31/C and the circuit to earth is completed via RLAA, RLAB, contacts AC4 and RL31/E. The relays are energized and the contacts AA1 to 6 and AB1 to 6 change over to make the following connections:—

- (1) *ITBU* input from SK3 is disconnected from the 68-ohm dummy load R1 by the opening of contacts AB4, and connected via AB6 to SK1, feeding the main console Type 64. Contact AB6 is screened from the rest of the relay spring set by the earthed contact AB5.
- (2) *Azication marker range voltage* from main console via PL31/A is connected out to the *waveform generator (azication) Type 100* in the RA302, via SK4/A, by contact AB2. This lead is decoupled by C1 ( $0.5 \mu F$ ).
- (3) *Height/range strobe ranging voltage* arriving at PL31/B from the main console is connected by contact AA3 to SK4/B, feeding the appropriate console Type 61. Simultaneously, contact AA2 breaks the earth connection previously connected to this line to prevent stray pick-up from displaying flashes on the screen of the console Type 61.
- (4) *Turning gear control voltages*, supplied from the control unit (*aerial velocity*) Type 4342

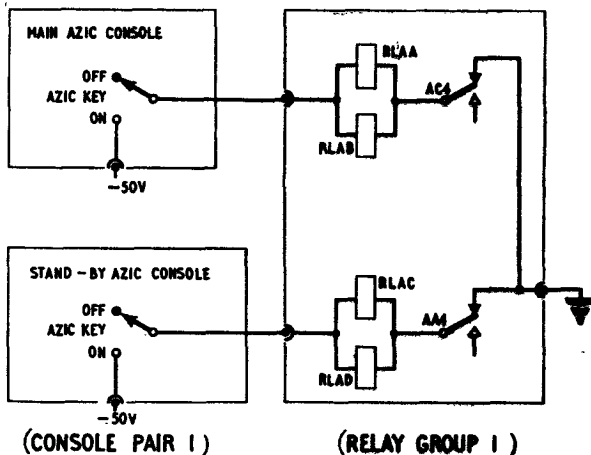


Fig. 11. Interlock system

on the control desk of the main console Type 64 to PL31/D and PL31/F are connected through to the *selector unit Type 100* (for control of the Type 13 height-finding head) via SK4/D and SK4/F, by contacts AA5 and AA6.

- (5) Contact AA4 opens to complete the interlock action described below, ensuring that the azicating facilities cannot be switched on at the standby console.

#### Interlock action

33. Fig. 11 is a simplified diagram of the interlock system. In the state shown neither console is using azicating facilities and both azication keys are in the *off* position.

34. As shown in the diagram, the relay associated with one console of the pair has a normally closed contact in series with the relay associated with the other console. Hence, if the operator of the main console turns his azication key *on*, relays RLAA and RLAB are energized and contacts AA4 open. This prevents RLAC and RLAD from being energized if the azication key on the standby console should be operated later.

35. If the main console becomes unserviceable the operator must first switch off the azication key there (or switch off the whole console, thus removing the  $-50V$  supply and giving the same result) before moving to the standby console. By operating the azication key there he then causes RLAC and RLAD to bring on azicating facilities (*para. 32*) and also to open contacts AC4 so that the main console cannot have the facilities.

#### Relay bank 7

36. On relay bank 7, the change-over requirements are slightly different in that neither turning gear control nor height/range strobe voltages are fed in from the consoles, but the change-over action is just the same as in the relay banks. This action is, however, subject to the operation of SWA, which gives over-riding control to either the stop-and-look PPI or to the monitor PPI (*para. 6*). In the STOP-AND-LOOK position the switch shorts out contact GC4 and completes the operating circuit of RLGA and RLGB from PL43/C to PL43/E, while in the MONITOR position it shorts out GA4 and operates RLGC and RLGD.

TABLE I

Distribution unit (ITBU)—component details  
(Stores Ref. 10D/10916)

#### Resistors (Fixed)

Circuit ref.	Value (ohms)	Rating (watts)	Tol. (%)	Ref. No.
R1*	33	$\frac{1}{2}$	5	Z215062
R2	15 K	$\frac{1}{2}$	10	Z222152
R3	1.5 K	$\frac{1}{2}$	10	Z222026
R4	330	$\frac{1}{2}$	10	Z221173
R5*	750 K	$\frac{1}{2}$	2	Z216635
R6*	1 M	$\frac{1}{2}$	2	Z216659
R7*	1 M	$\frac{1}{2}$	5	Z216757
R8*	47 K	$\frac{1}{2}$	5	Z216082

#### Resistors (Fixed)—cont.

Circuit ref.	Value (ohms)	Rating (watts)	Tol. (%)	Ref. No.
R9	470 K	$\frac{1}{2}$	10	Z223122
R10	330	$\frac{1}{2}$	10	Z221173
R11	33 K	$\frac{1}{2}$	5	Z216062
R12*	1.2 K	$\frac{1}{2}$	5	Z215252
R13*	620 K	$\frac{1}{2}$	2	Z216619
R14*	100 K	$\frac{1}{2}$	2	Z216451
R15*	360 K	$\frac{1}{2}$	2	Z216571
R16*	160 K	$\frac{1}{2}$	2	Z216500

TABLE I—continued

Resistors (Fixed)—cont.

Circuit ref.	Value (ohms)	Rating (watts)	Tol. (%)	Ref. No.
R17	330	1	10	Z221173
R18*	150	1	5	Z215142
R19	1.5 K	1	10	Z222026
R20*	680	1	2	Z215601
R21	6.8 K	1	10	Z222110
R22	100	1	10	Z221110
R23	33 K	1	5	Z244141
R24	<i>not fitted</i>			
R25*	620 K	1	2	Z216619
R26*	100 K	1	2	Z216451
R27*	360 K	1	2	Z216571
R28*	160 K	1	2	Z216500
R29	330	1	10	Z221173
R30*	150	1	5	Z215142
R31	1.5 K	1	10	Z222026
R32*	680	1	2	Z215601
R33	6.8 K	1	10	Z222110
R34	100	1	10	Z221110
R35, R36	<i>not fitted</i>			
R37*	620 K	1	2	Z216619
R38*	100 K	1	2	Z216451
R39*	360 K	1	2	Z216571
R40*	160 K	1	2	Z216500
R41	330	1	10	Z221173
R42*	150	1	5	Z215142
R43	1.5 K	1	10	Z222026
R44*	680	1	2	Z215601
R45	6.8 K	1	10	Z222110
R46	100	1	10	Z221110
R47, R48	<i>not fitted</i>			
R49*	620 K	1	2	Z216619
R50*	100 K	1	2	Z216451
R51*	360 K	1	2	Z216571
R52*	160 K	1	2	Z216500
R53	330	1	10	Z221173
R54*	150	1	5	Z215142
R55	1.5 K	1	10	Z222026
R56*	680	1	2	Z215601
R57	6.8 K	1	10	Z222110
R58	100	1	10	Z221110
R59, R60	<i>not fitted</i>			
R61*	620 K	1	2	Z216619
R62*	100 K	1	2	Z216451
R63*	360 K	1	2	Z216571
R64*	160 K	1	2	Z216500
R65	330	1	10	Z221173
R66*	150	1	5	Z215142
R67	1.5 K	1	10	Z222026
R68*	680	1	2	Z215601
R69	6.8 K	1	10	Z222110
R70	100	1	10	Z221110
R71, R72	<i>not fitted</i>			
R73*	620 K	1	2	Z216619
R74*	100 K	1	2	Z216451
R75*	360 K	1	2	Z216571
R76*	160 K	1	2	Z216500
R77	330	1	10	Z221173
R78*	150	1	5	Z215142
R79	1.5 K	1	10	Z222026
R80*	680	1	2	Z215601
R81	6.8 K	1	10	Z222110
R82	100	1	10	Z221110
R83, R84	<i>not fitted</i>			
R85*	620 K	1	2	Z216619
R86*	100 K	1	2	Z216451
R87*	360 K	1	2	Z216571
R88*	160 K	1	2	Z216500
R89	330	1	10	Z221173
R90*	150	1	5	Z215142
R91*	1.5 K	1	10	Z222026
R92*	680	1	2	Z215601
R93	6.8 K	1	10	Z222110
R94	100	1	10	Z221110
R95, R96	<i>not fitted</i>			
R97*	620 K	1	2	Z216619
R98*	100 K	1	2	Z216451
R99*	360 K	1	2	Z216571
R100*	160 K	1	2	Z216500
R101	330	1	10	Z221173
R102*	150	1	5	Z215142
R103	1.5 K	1	10	Z222026

Resistors (Fixed)—cont.

Circuit ref.	Value (ohms)	Rating (watts)	Tol. (%)	Ref. No.
R104*	680	1	2	Z215601
R105	6.8 K	1	10	Z222110
R106	100	1	10	Z221110

\* High stability

Capacitors (Fixed)

Circuit ref.	Value	Rating (V.DC)	Tol. (%)	Ref. No.
C1, C2	0.05μF	350	20	Z115554
C3	0.1μF	350	20	Z115506
C4	6800pF	350	5	Z124353
C5	1.0μF	350	20	Z115632
C6	1800μF	350	5	Z124124
C7	<i>not fitted</i>			
C8	0.1μF	350	20	Z115506
C9	6800pF	350	5	Z124353
C10	1.0μF	350	20	Z115632
C11	1800pF	350	5	Z124124
C12	<i>not fitted</i>			
C13	0.1μF	350	20	Z115506
C14	6800pF	350	5	Z124353
C15	1.0μF	350	20	Z115632
C16	1800pF	350	5	Z124124
C17	<i>not fitted</i>			
C18	0.1μF	350	20	Z115506
C19	6800pF	350	5	Z124353
C20	1.0μF	350	20	Z115632
C21	1800pF	350	5	Z124124
C22	<i>not fitted</i>			
C23	0.1μF	350	20	Z115506
C24	6800pF	350	5	Z124353
C25	1.0μF	350	20	Z115632
C26	1800pF	350	5	Z124124
C27	<i>not fitted</i>			
C28	0.1μF	350	20	Z115506
C29	6800pF	350	5	Z124353
C30	1.0μF	350	20	Z115632
C31	1800pF	350	5	Z124124
C32	<i>not fitted</i>			
C33	0.1μF	350	20	Z115506
C34	6800pF	350	5	Z124353
C35	1.0μF	350	20	Z115632
C36	1800pF	350	5	Z124124
C37	<i>not fitted</i>			
C38	0.1μF	350	20	Z115506
C39	6800pF	350	5	Z124353
C40	1.0μF	350	20	Z115632
C41	1800pF	350	5	Z124124
C42, C43	0.1μF	350	20	Z115506

Plugs and Sockets

Circuit ref.	Description	Type	Ref. No.
PL1	Fixed 12-way plug	Mk. 4	Z560152
PL2	Fixed 6-way plug	Mk. 4	Z560541
SK3 to SK10	Socket (coaxial)	783	10H/19861
SK11	Banana socket (Belling-Lee Type L316)	714	10H/19641
SK12	Socket (coaxial)	783	10H/19861
SK13	Fixed 25-way socket	Mk. 4	Z560380

TABLE 2  
Panel (Switching) Type 876—component details  
(Stores Ref. 10D/18863)

Circuit ref.	Description	Type	Ref. No.
R1 to R8	Resistor (fixed), 68Ω	1/2W, 10%	Z221089
SWA	Wafer switch type H	2165	10F/17432
SWB	Wafer switch type H	2164	10F/17429
SK1 to SK28	Coaxial socket	783	10H/19861

**TABLE 3**  
**Relay unit (AZ.C/O.) Type 192—component details**  
**(Stores Ref. 10F/16273)**

Circuit ref.	Description	Type	Ref. No.	Circuit Ref.	Description	Type	Ref. No.
SK1, 2, 3, 5, 6, 7, 9, 10, 11, 13, 14, 15, 17, 18, 19, 21, 22, 23, 25, 26, 27	Coaxial socket	783	10H/19861	R1 to R7	Resistor (fixed) 68Ω ½W, 10%	Z221089	
SK4, 8, 12, 16, 20, 24, 28				6-pole fixed socket	Mk. 4	Z560261	C1 to C7
PL31, 33, 35, 37, 39, 41, 43	6-pole fixed plug	Mk. 4	Z560582				All 'A' and 'C' relays
PL32, 34, 36, 38, 40, 42, 44	6-pole fixed plug	Mk. 4	Z560581	All 'B' and 'D' relays	1,000Ω relay, 100V	48/3LV	—
				SWA	D.P.D.T. Toggle switch	—	Z510304

**TABLE 4**  
**Rack assembly (miscellaneous, ITBU) Type 306**  
**List of input and output connections**

Note . . .

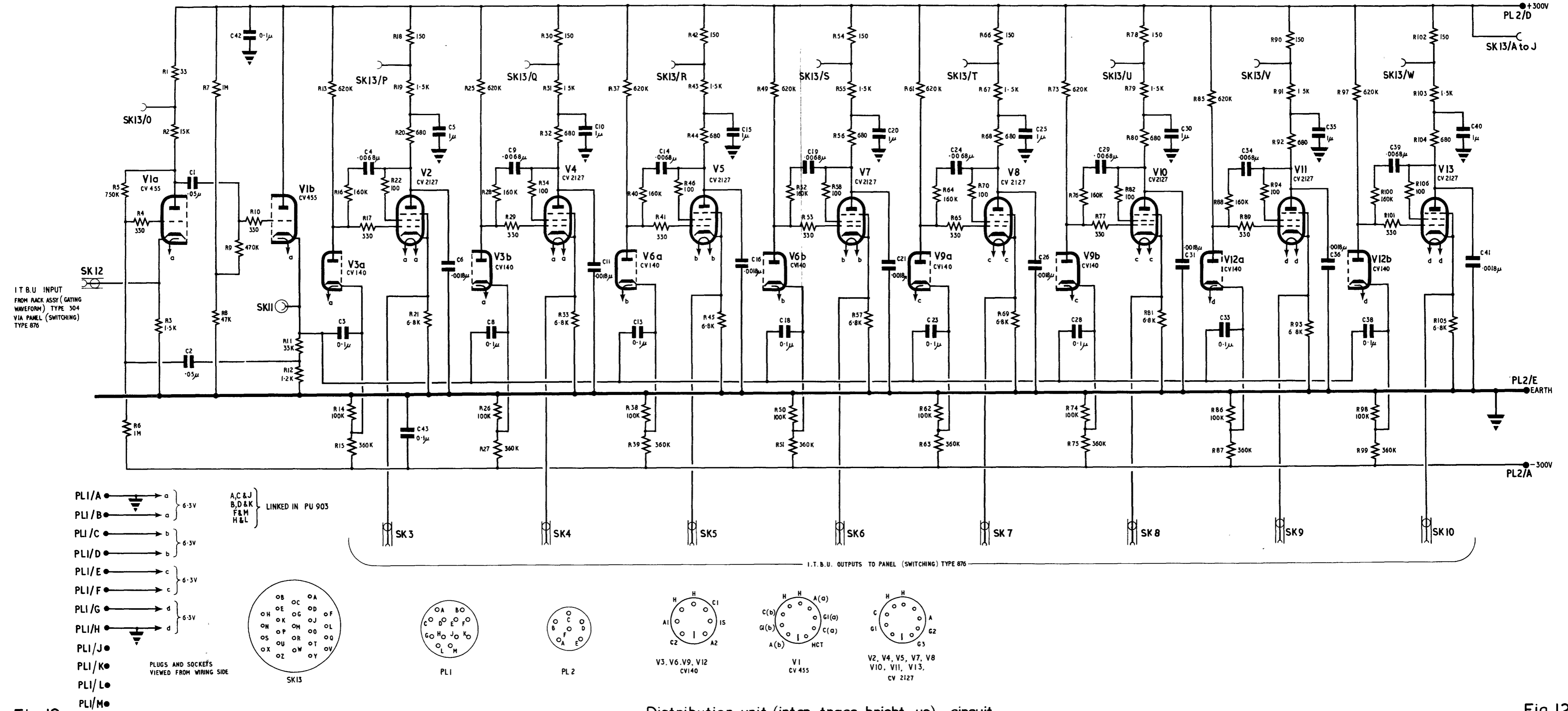
*This list, which applies to initial GC1 installations, is issued here for early information only and may be supplemented or superseded by current orders. Full cabling schedules (from which this table is extracted) will be issued separately to each different class of station.*

For meaning of unit numbers 03 to 09, see fig. 14. R.A. = rack assembly

PL or SK	Type	Location (unit)	Moulding position	Pin	Service	Rack unit involved	Destination	
PL1	6-pole (med.)	09	0	A	Neutral } 230V 50 c/s Line } ('A' power unit) -500v reference 50V - 50V + 50V -, neg. ref. control	05	Radar office power board	
				B				Radar office power board
				C				R.A.(neg. ref.) Type 338
				D				Rectifier Type 15
				E				Rectifier Type 15
				F				R.A. (neg. ref.) Type 338
SK1	Coaxial	08	—	—	ITBU out	08	Azicating console (Main) No. 1	
PL2	6-pole (med.)	09	0	A-F	As PL 1 ('B' power unit)	04	As PL1	
SK2	Coaxial	08	—	—	ITBU out	08	Azicating console (stand-by) No. 1	
SK4	6-pole (small)	08	1	A	Azicating marker ranging voltage	08	R.A. (azication) Type 302	
				B	Height/range strobe ranging voltage		Console Type 61	
				C	—		—	
				D	Turning gear control		Selector unit Type 100	
				E	Earth		Earth tag in trunking	
				F	Turning gear control		Selector unit Type 100	
SK5	Coaxial	08	—	—	ITBU out	08	Azicating console (Main) No. 2	
SK6	Coaxial	08	—	—	ITBU out	08	Azicating console (stand-by) No. 2	
SK8	6-pole (small)	08	1	A-F	As SK4	08	As SK4	
SK9	Coaxial	08	—	—	ITBU out	08	Azicating console (Main) No. 3	
SK10	Coaxial	08	—	—	ITBU out	08	Azicating console (stand-by) No. 3	
SK12	6-pole (small)	08	1	A-F	As SK4	08	As SK4	
SK13	Coaxial	08	—	—	ITBU out	08	Azicating console (Main) No. 4	
SK14	Coaxial	08	—	—	ITBU out	08	Azicating console (stand-by) No. 4	
SK16	6-pole (small)	08	1	A-F	As SK4	08	As SK4	
SK17	Coaxial	08	—	—	ITBU out	08	Azicating console (Main) No. 5	
SK18	Coaxial	08	—	—	ITBU out	08	Azicating console (stand-by) No. 5	
SK19	Coaxial	07	—	—	ITBU out	07	Workshop	
SK20	6-pole (small)	08	1	A-F	As SK4	08	As SK4	
SK21	Coaxial	08	—	—	ITBU out	08	Azicating console (Main) No. 6	
SK22	Coaxial	08	—	—	ITBU out	08	Azicating console (stand-by) No. 6	
SK24	6-pole (small)	08	1	A-F	As SK4	08	As SK4	
SK25	Coaxial	08	—	—	ITBU out	08	Stop-and-look console	
SK26	Coaxial	08	—	—	ITBU out	08	Monitor console	
SK27	Coaxial	07	—	—	ITBU in (1)	07	R.A. (gating waveform) Type 304	
SK28	Coaxial	07	—	—	ITBU in (2)	07	R.A. (gating waveform) Type 304	
SK28	6-pole (small)	08	1	A	Azic Marker ranging voltage	08	R.A. (Azic) Type 302 (for synchronizing resolver)	
				B	—		—	
				C	—		—	
				D	—		—	
				E	Earth		Earth tag in trunking	
				F	—		—	
PL31	6-pole (small)	08	2	A	Azic marker ranging voltage	08	Azic. console (Main) No. 1, PL1/C	
				B	Height/range strobe ranging voltage		Azic. console (Main) No. 1, PL1/A	
				C	Change-over key		Azic. console (Main) No. 1, PL1/V	
				D	Turning gear control		Azic. console (Main) No. 1, PL5/W	
				E	Earth		Earth tag in trunking	
				F	Turning gear control		Azic console (Main) No. 1, PL5/X	

TABLE 4—(continued)

PL or SK	Type	Location (unit)	Moulding position	Pin	Service	Rack unit involved	Destination
PL32	6-pole (small)	08	1	A-F	As PL31	08	As PL31, for Azic. console (stand-by) No. 1
PL33	6-pole (small)	08	2	A-F	As PL31	08	As PL31, for Azic. console (Main) No. 2
PL34	6-pole (small)	08	1	A-F	As PL31	08	As PL31, for Azic. console (stand-by) No. 2
PL35	6-pole (small)	08	2	A-F	As PL31	08	As PL31, for Azic. console (Main) No. 3
PL36	6-pole small	08	1	A-F	As PL31	08	As PL31, for Azic. console (stand-by) No. 3
PL37	6-pole (small)	08	2	A-F	As PL31	08	As PL31, for Azic. console (Main) No. 4
PL38	6-pole (small)	08	1	A-F	As PL31	08	As PL31, for Azic. console (stand-by) No. 4
PL39	6-pole (small)	08	2	A-F	As PL31	08	As PL31, for Azic. console (Main) No. 5
PL40	6-pole (small)	08	1	A-F	As PL31	08	As PL31, for Azic. console (stand-by) No. 5
PL41	6-pole (small)	08	2	A-F	As PL31	08	As PL31, for Azic. console (Main) No. 6
PL42	6-pole (small)	08	1	A-F	As PL31	08	As PL31, for Azic. console (stand-by) No. 6
PL43	6-pole (small)	08	2	A	Azic. marker ranging voltage	08	Stop-and-look console, PL1/C
				B	—		—
				C	Change-over key		Stop-and-look console, PL1/V
				D	—		—
				E	Earth		Earth tag in trunking
				F	—		—
PL44	6-pole (small)	08	1	A-F	As PL43	08	As PL43, for monitor console

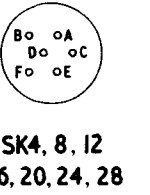
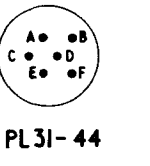


Distribution unit (inter-trace bright-up) - circuit

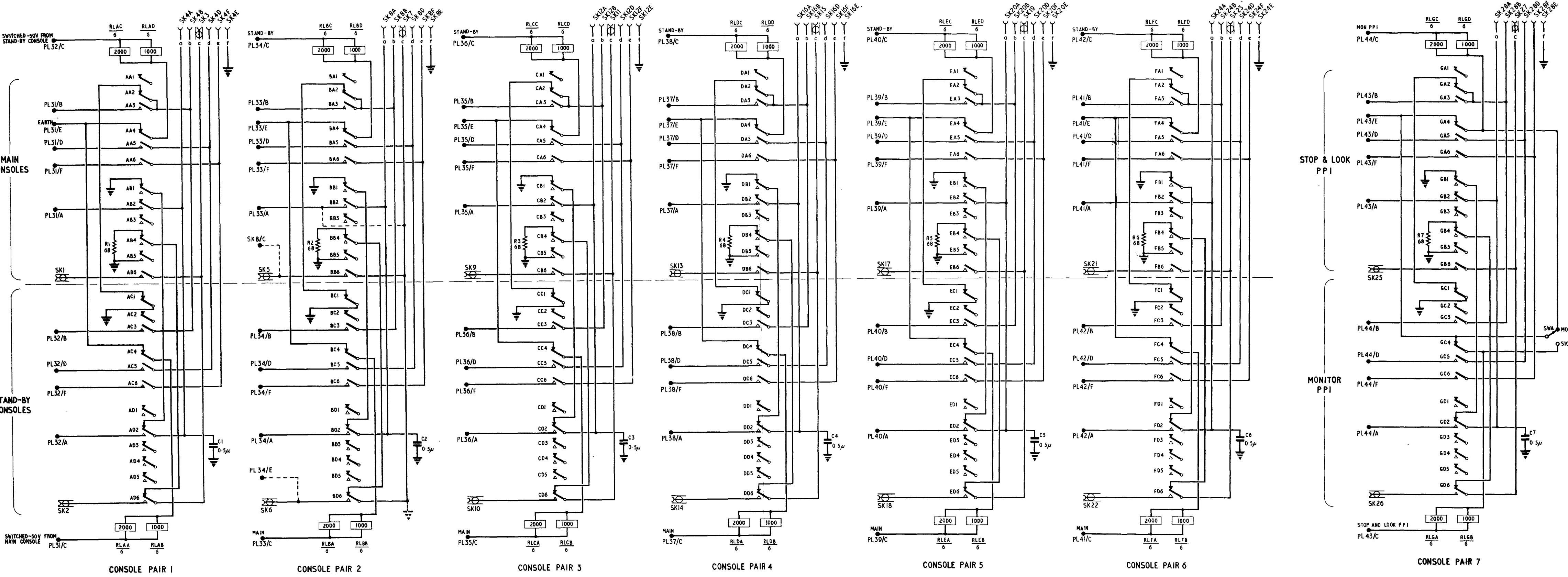
Fig. 12

(A.L13 Aug. 55)

**CODING OF SERVICES**  
 a AZIC MARKER RANGE VOLTAGE  
 b H/R STROBE RANGE VOLTAGE  
 c IT B U  
 d INCHING POT TO TURNING GEAR  
 e INCHING POT TO TURNING GEAR  
 f EARTH



SWA MONITOR  
STOP AND LOOK

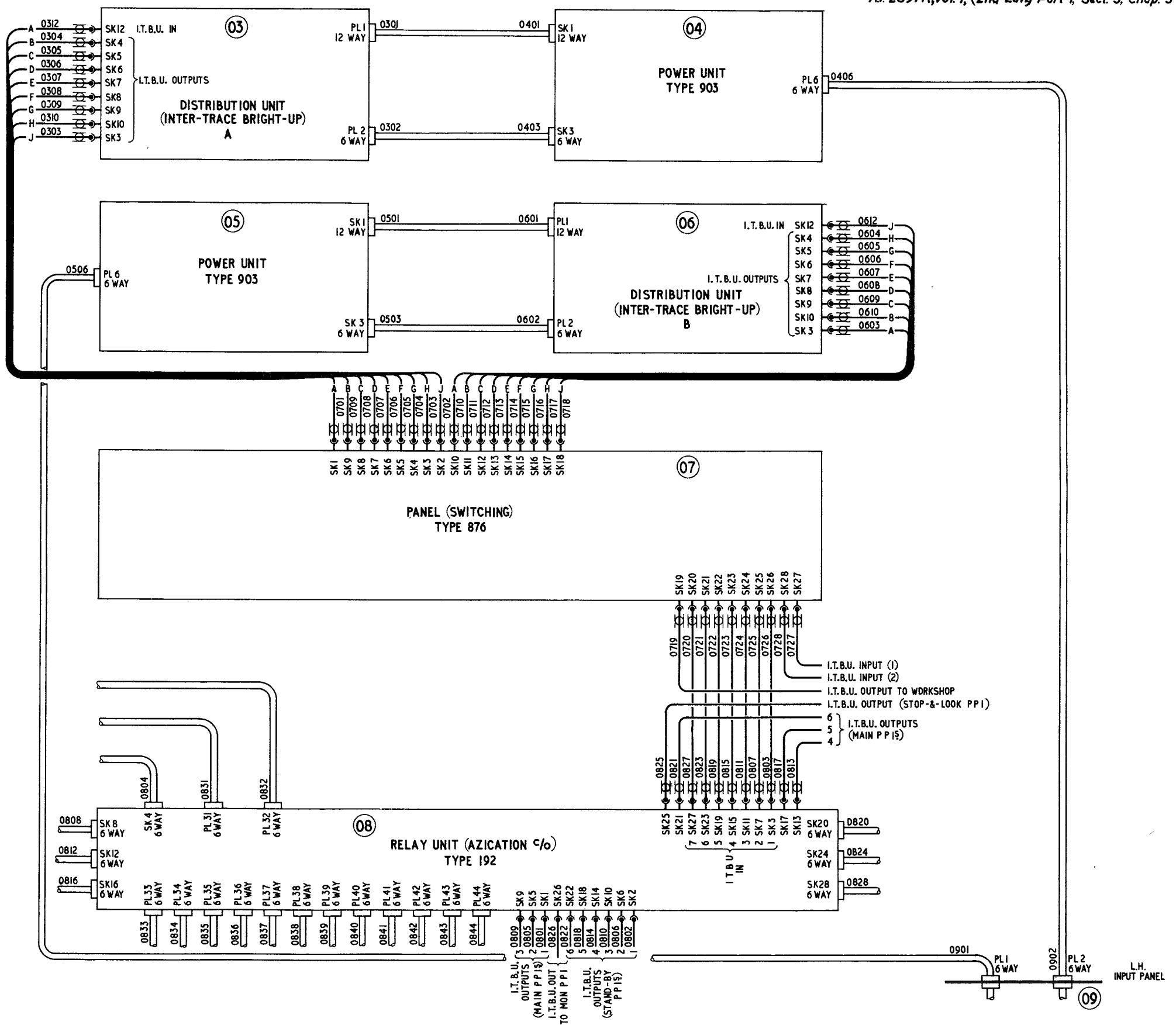


NOTE  
CONNECTIONS SHOWN DOTTED ARE  
USED AT A.T.C.R.M. SOPLEY ONLY

Relay unit (azication c/o) Type 192 - circuit

Fig. 13

Fig. 13



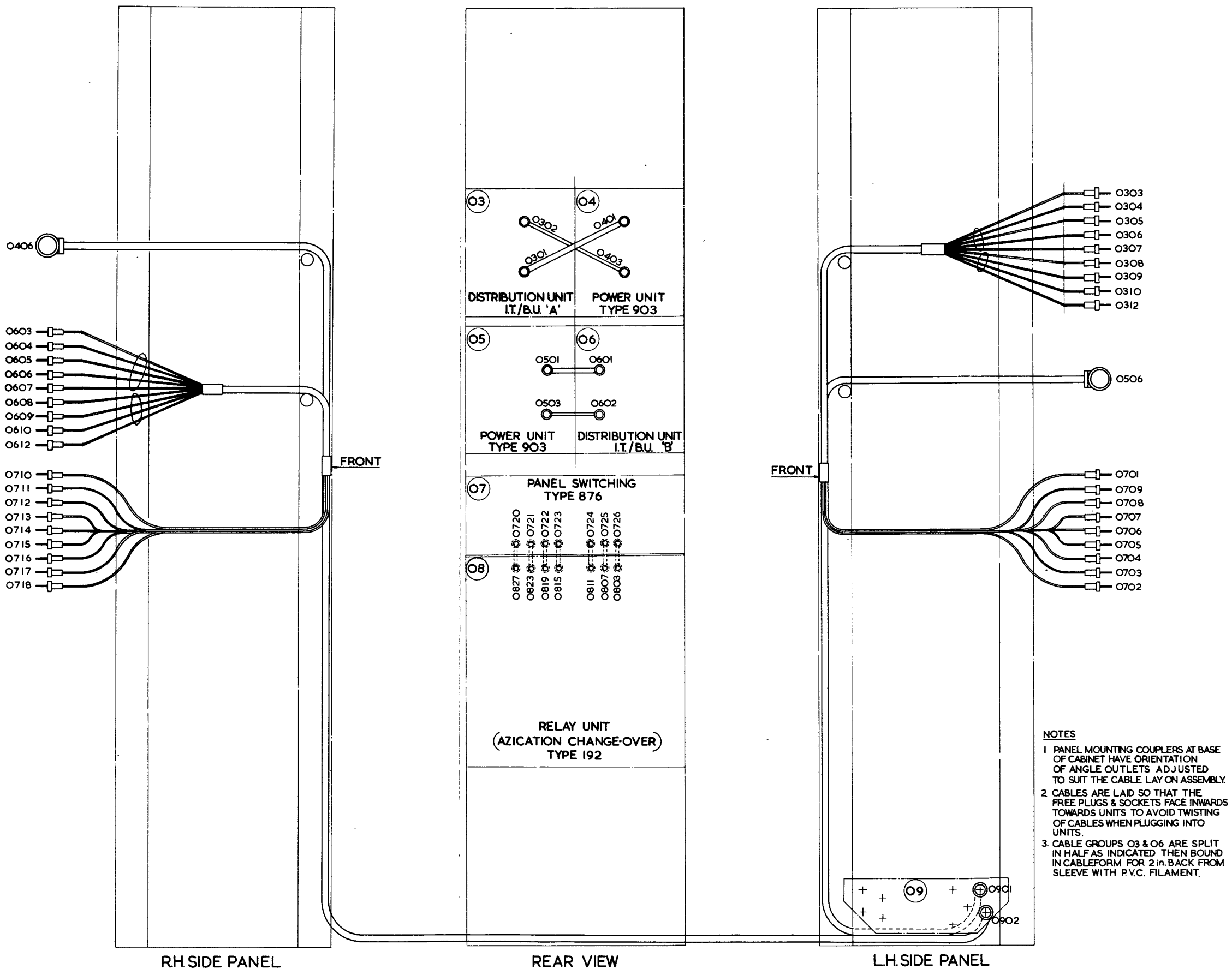
AIR DIAGRAM  
6222 AC/MIN.

ISSUE 1 PREPARED BY MINISTRY OF SUPPLY  
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Rack assembly (misc) Type 306 - circuit

Fig. 14

(A.L.25, Sep. 57)



- NOTES**
1. PANEL MOUNTING COUPLERS AT BASE OF CABINET HAVE ORIENTATION OF ANGLE OUTLETS ADJUSTED TO SUIT THE CABLE LAY ON ASSEMBLY.
  2. CABLES ARE LAID SO THAT THE FREE PLUGS & SOCKETS FACE INWARDS TOWARDS UNITS TO AVOID TWISTING OF CABLES WHEN PLUGGING INTO UNITS.
  3. CABLE GROUPS O3 & O6 ARE SPLIT IN HALF AS INDICATED THEN BOUND IN CABLEFORM FOR 2 in. BACK FROM SLEEVE WITH P.V.C. FILAMENT.

Fig. 15

Rack assembly Type 306-cabling

Fig. 15



Appendix 1

RACK (ITBU DISTRIBUTION AND SWITCHING) TYPE 16503

(Completely revised)

INTRODUCTION

1 At stations where long range working is in operation, and Phase 1A modifications are not incorporated, the rack assembly Type 306 is modified to rack (i.t.b.u. distribution and switching) Type 16503 (Ref. No.10D/22433). Under this modification the rack 16503 consists of a wired framework, into which any of the units associated with i.t.b.u. distribution and switching are fitted.

RACK UNITS

2 The units for which provision is made in the rack are as follows:

2 power units Type 903 (Ref. No. 10K/17131)

2 distribution units (i.t.b.u.) (Ref. No. 10D/18918)

1 panel (switching Type 876 (Ref. No.10D/18863)

1 relay unit (i.t.b.u.) Type 16176 (Ref. No.10F/20357)

A complete description of the relay unit 16176 is available in AP 115K-1401-1  
The other units are described in the foregoing chapter of this publication.



There is room in the rack for up to 30 such relay units, so that up to 150 separate output lines are available, of which there are usually several spare.

3. The highly stable and ripple-free  $-500V$  supply is produced by a power unit (reference) Type 906. To maintain continuity of the supply in the event of power unit failure, there are two such power units in the rack, (known as REF. 1 and REF. 2), and both are normally kept fully switched on. Change-over from the unit in use to the other is effected on the relay unit (change-over) Type 186, either manually, or automatically when the power unit in use fails. The reliable supply of  $-50V$  for relays is essential to the operation of the rack; two such supplies are brought in and change-over between manual or automatic is again effected in the relay unit (change-over) Type 186. Whenever automatic change-over has occurred alarm bells ring as a warning that there is no margin of reserve against a further failure, so that the defective supply (whether  $-50V$  or  $-500V$ ) must be restored without delay. Fig. 2 gives a simplified block diagram of the rack assembly.

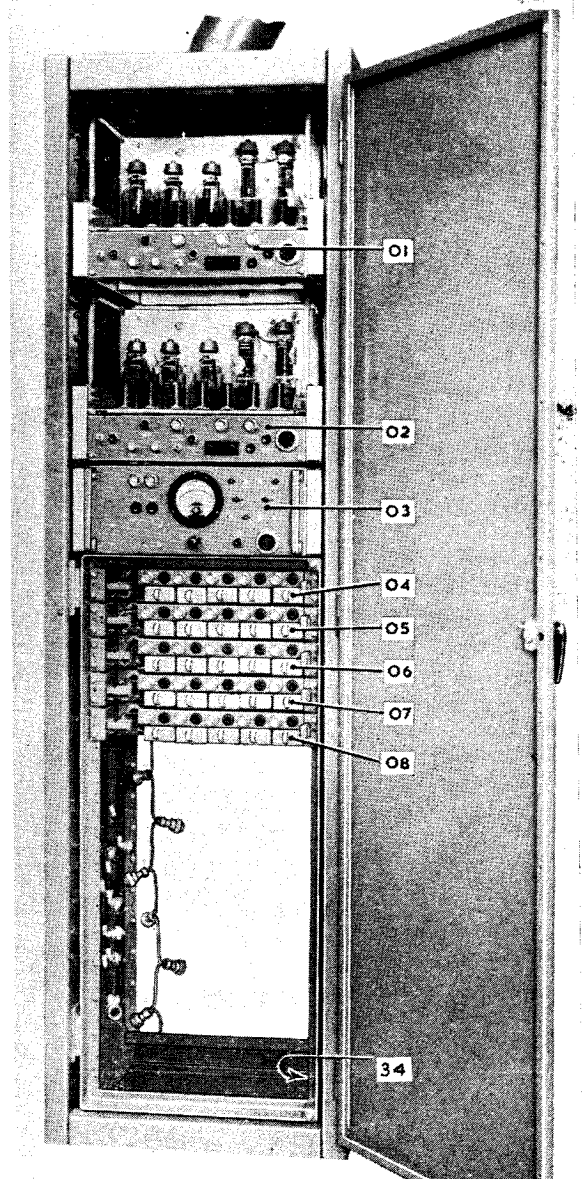
4. More detailed descriptions of the units mentioned above, and an explanation of the change-over action, are given later in this Chapter. The only other item in the rack is the side input panel; it is not a separate unit but is considered as part of the rack assembly, and carries only three panel-mounting couplers on which power supplies are brought in for the power units and the relay unit Type 186.

#### Construction

5. The rack assembly is of the standard radar office dimensions (7ft. high, 19 in. internal width), and has full length doors at front and rear which offer easy access to all units (fig. 1). Cables for external connections enter the rack at its base, and so does air for cooling, which is exhausted at the top. Cabling within the rack runs in conduits in the side panels.

6. Fig. 1 with its key shows the general arrangement of units in the rack. The two power units Type 906, and the relay unit (change-over) Type 186 are each runner-mounted so that they can slide forward out of the rack for servicing. There is enough slack on the connecting cables at the rear to allow this to be done while the units are in operation. For the relay units Type 185, vertical rectangular mounting frames have been fitted at back and front of the rack, to which the desired number of relay units may be attached by their four captive screws each.

7. On the front panels of the power units Type 906 and the relay unit (change-over) Type 186 are metering sockets, which accept the multimeter Type 100 for quick checks of circuit conditions. All pre set controls, fuses, indicator lights and switches are also on the front panels; their significance and use are explained later in this Chapter.



#### KEY TO FIG. 1

- 01 POWER UNIT (REFERENCE) TYPE 906 (REF. 1)
- 02 POWER UNIT (REFERENCE) TYPE 906 (REF. 2)
- 03 RELAY UNIT (CHANGE-OVER) TYPE 186
- 04 to 08 RELAY UNITS TYPE 185
- 34 SIDE INPUT PANEL

Fig. 1. Rack assembly (neg. ref.) Type 338—front view

#### Rack cabling

8. The complete circuit diagram of the rack assembly (fig. 12) shows all the cable interconnections between units. Most of the cables are multicore "metvinsmall" types terminating in Mk. 4 plugs and sockets. The remainder are single connectors ending on unipole plugs (for  $-500V$  interconnections). The actual run of those cables which form part of the cabinet is shown in the cabling diagram (fig. 13).

#### Cable identification

9. In the four-figure identification numbers with

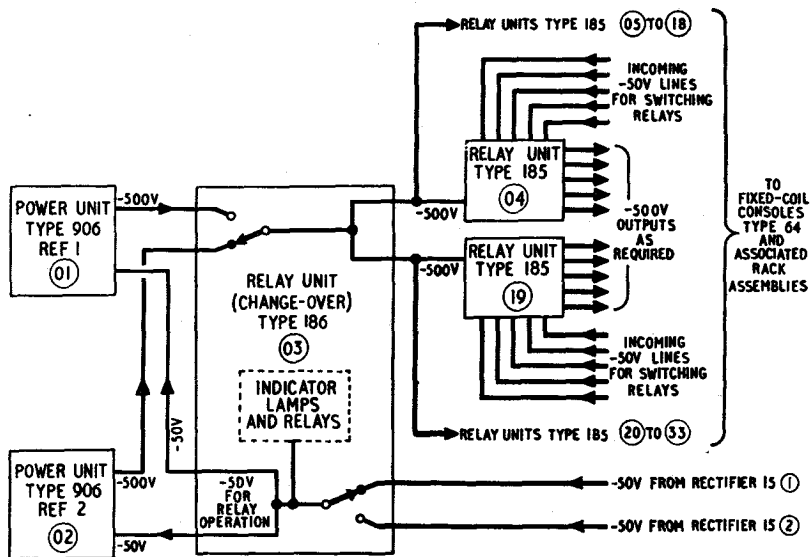


Fig. 2. Rack assembly (neg. ref.) Type 338—block diagram

which every cable end is marked, the first two figures represent the unit to which the cable goes (fig. 1) and the second two figures the plug or socket number on that unit, with the addition of a zero for single-figure PL/SK numbers. For example, the cable which runs from SK2 on the "REF. 1" power unit (unit 01) to PL4 on the relay unit (c/o) Type 186 (unit 03) is marked 0102 at one end and 0304 at the other. As an additional precaution against incorrect cabling up of different plugs or sockets of the same type located on the same unit (e.g. the 6-way plugs on the relay unit Type 186), different moulding orientations (Part 2, Sect. 2, Chap. 1) have been allocated to prevent the insertion of a connector into the wrong outlet on the unit.

**POWER UNIT (REFERENCE) TYPE 906**

**INTRODUCTION**

10. The purpose of the power unit (reference) Type 906, Stores Ref. 10K/17134, is to generate a highly accurate, ripple-free, -500V supply which can feed an external load not exceeding 320 mA. (A further 30 mA are consumed internally). The minimum external load for satisfactory operation of the power unit is 170 mA, and for Stations where the total drain falls below this figure there is a supplementary 3.3K dummy load (R5, in the relay unit Type 186) to bring the load within the optimum region. As an example, a typical negative reference budget, for one large Station, where the total drain with all units on is within the optimum region, is given in Table 1. In estimating the maximum total drain on other types of Station, the totals will have to be adjusted according to the numbers and types of units installed.

11. Within the optimum load range, the specification demands that ripple shall not exceed 5 mV, and that regulation shall be better than 0.1 per cent. (i.e. fluctuations shall not exceed 500 mV.) Experience of several production power units has shown that the actual figures are a good deal better than specification; the regulation is actually within 25 mV. These results have been

achieved by using a stabilizer circuit of more complexity than in the power unit 903/904/905 series. The reference voltage is obtained from a reference neon, as there is no other accurate source of voltage available. A protection circuit, with another reference neon, operates relays and effects automatic change-over if the -500V output strays from its correct value. The protection circuit thus offers "long-stop" protection against defects in the stabilizer circuit.

**Construction**

12. The power unit is illustrated in fig. 3 to 6.

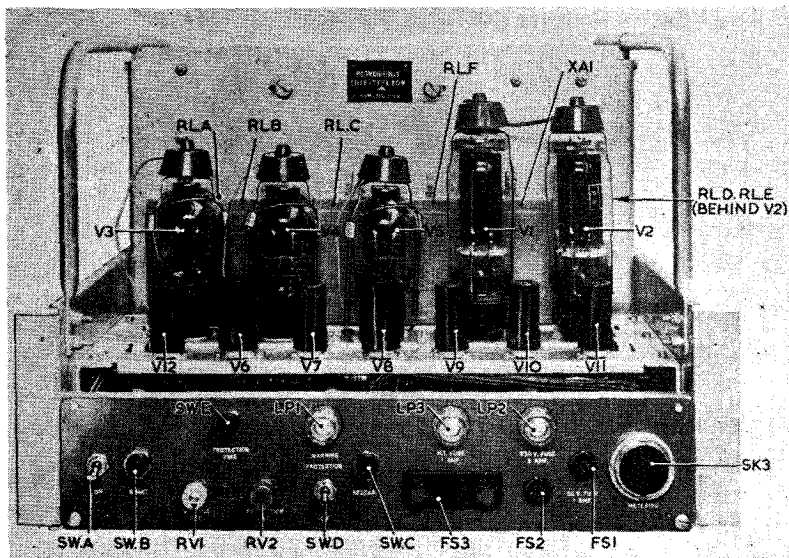


Fig. 3. Power unit (ref.) Type 906—front view

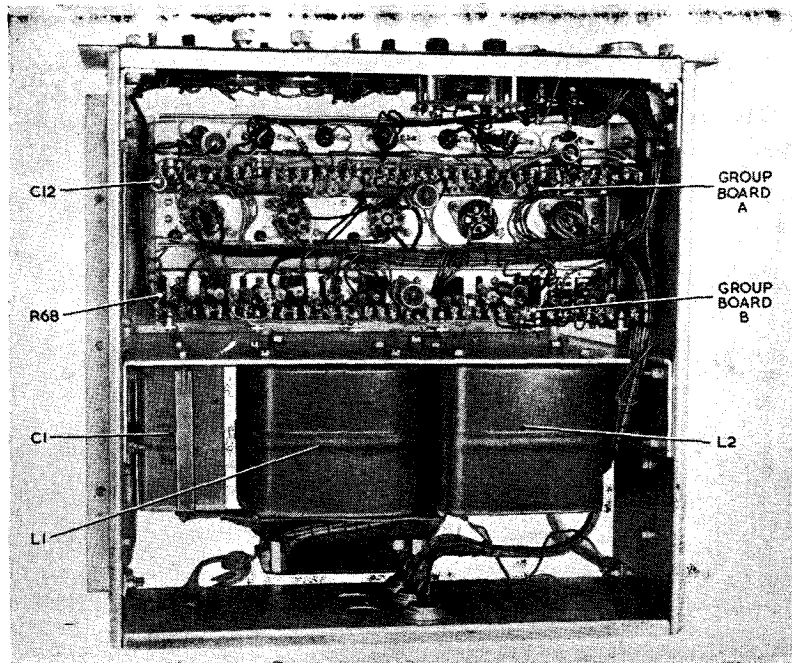


Fig. 4. Power unit (ref.) Type 906—underside

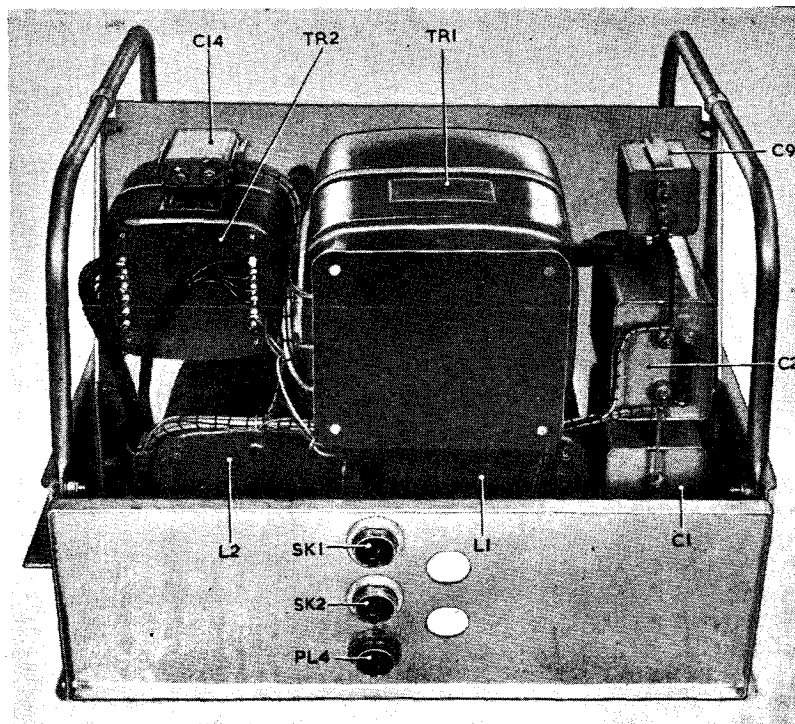


Fig. 5. Power unit (ref.) Type 906—rear view

It is constructed on a rigid horizontal steel chassis which extends the full width of the rack. To the two side plates are attached U-shaped lifting handles (*fig. 3*), and outside the side plates are the angle brackets, each of which bears captive screws for attachment to runners. The unit is divided into two halves (front and rear) by a vertical component mounting panel. Forward

of the dividing panel are the valves, relays and smaller components, and the front panel itself with all the switches, lamps etc. Behind the dividing panel (*fig. 5*) are all the transformers and chokes and the larger capacitors; the plug and socket outlets are on the rear panel. *Fig. 6* shows the layout of the small components on the two group tagboards.

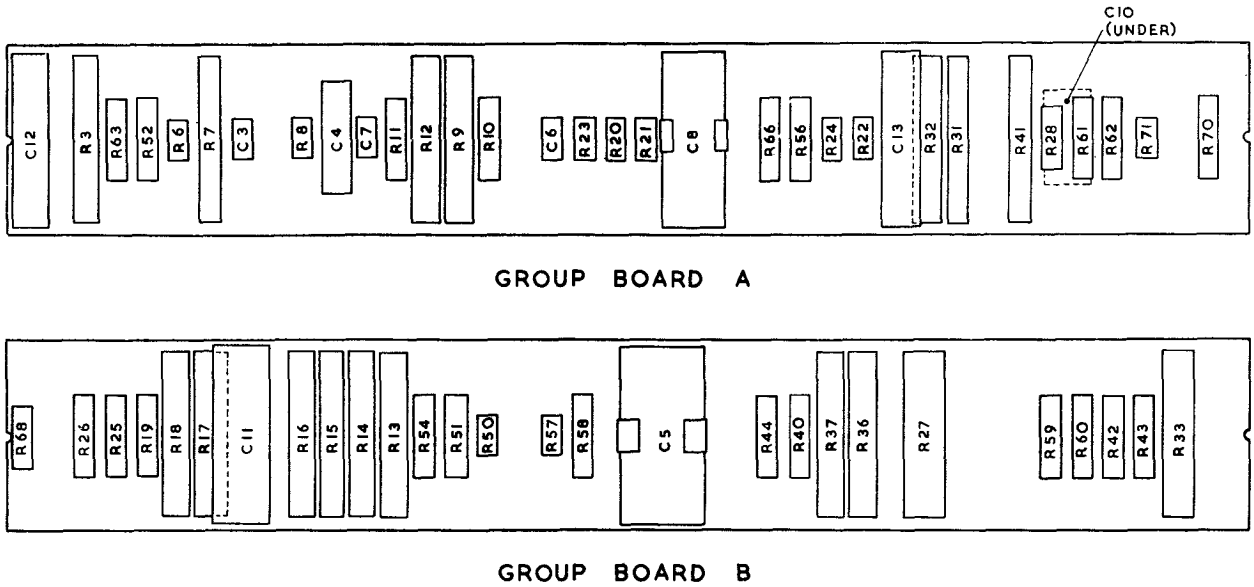


Fig. 6. Power unit (ref.) Type 906—layout on group boards

TABLE I  
Example of —500V reference budget

Number	Unit (P.U.=power unit)	Drain (mA) each	Total (mA)
36	Console Type 64	3.5	126
4	P.U.903 in timebase rack (RA300)	2.0	8
2	V.C.U. in timebase rack*	1.0	2
6	P.U.904 in mag. resolver racks (RA301)	1.0	6
2	P.U.903 in GWG rack (RA304)	1.0	2
8	P.U.905 in azication racks (RA302)	1.0	8
36	250V stabilizer in B.P.S. racks (RA305)	0.5	18
2	P.U.4065 in waveform monitor rack (RA339)	1.0	2
36	I.T. switching units*	1.0	36
6	"Joystick" azication units*	1.0	6
4	Decoder units*	1.0	4
GRAND TOTAL			218 mA

\*Units not fitted in early installations

**CIRCUIT DESCRIPTION**

13. The complete circuit diagram of the power unit is given in fig. 10. Some parts of the relay and switching circuits are closely involved with the relay unit (change-over) Type 186; the combined explanation is given later. The notes which follow are confined to the power pack,

stabilizer and protection circuits, and the switching-on circuits.

**Power pack**

14. There are two mains transformers for the power unit, the HT transformer TR1 and the LT TR2. Thermal fuses FS4 and FS5, attached to TR1 and TR2 respectively, cut off the mains to both transformers if either overheats. An ordinary fuse FS2 (5A) is also included in the mains supply to both transformers.

15. The LT transformer TR2 provides heater supplies for all valves in the power unit (except the rectifiers) and for the thermal delay relay (XA). The ratings are as follows :—

Ref. (fig. 10)	Rating	DC level (approx.)	Valves supplied
a—a	6.3V 1A	—200V	V6
b—b	6.3V 2A	—400V	V8, V10, V11
c1—c2	Strapped windings 6.3V 3A	Earth	V3, V4, V5, XA.
c1—c2		—	—

16. The HT transformer TR1 carries the 960V—0—960V winding to supply the full-wave rectifier circuit, and the 4V 6A winding (*f—f*) for the rectifier directly-heated cathodes. In view of the comparatively heavy load on this power unit (up to 350 mA including 30 mA internal), separate heavy-duty diodes (CV187) are used in a full wave rectifier circuit. A two-section series-inductance filter L1, L2, C1, C2 is used to reduce ripple; the series-inductance type is used to improve the intrinsic regulation of the power pack at the expense of lower output voltage. The chokes are each 10 henries, and the filter capacitors each 4μF. A 0.1 μF capacitor C14 across the first choke L1 minimizes "ringing" in the choke as the diodes cut off and on. A 1

MΩ safety resistor R63 across the filter output is intended to discharge the filter capacitors if the power unit is switched off in the absence of external load.

**17.** At the output from the filter sections the voltage between the two poles is about 650V DC; neither pole is earthed at this stage. The positive side is protected by a 1 amp. fuse FS3, which has an indicator neon LP3 (in series with the ballast resistor R64) across it. The neon does not light unless the fuse has blown.

#### Stabilizer circuit

**18.** The stabilizer circuit includes the regulator valves V3, V4 and V5, and the control valves V8 and V6. The circuit is easier to understand if the earth connection of the positive side of the output is, for the moment, ignored, and if the negative side is imagined to be earthed instead. (The action of the stabilizer is, of course, identical whichever pole of the output is subsequently earthed.)

**19.** V3, V4 and V5 are CV345 beam tetrodes, triode-connected, strapped together (ignoring sundry anti-parasitic resistors) to form effectively one large triode. (This has been necessary because of the heavy current drawn from the power unit.) The voltage drop across the "triode" depends on its grid voltage, which is governed by the control circuit. The 10Ω resistor R69 is inserted in series so that the multi-meter Type 100 may be connected at SK3/L and /Y, to measure the total current through these valves.

**20.** The level of the output may be said to be "sampled" by the potentiometer chain R25, RV1, R26. A proportion of the output is applied to the grid of V8b, which is one half of a double-triode (CV492). The grid of the other half (V8a) is returned to a potential set by the 83V reference neon V7 (CV449); thus the potential sampled from the pot. chain is compared with the reference potential. The current through the neon has to be a certain specified value ( $4\frac{1}{2}$  mA) if the potential across the neon is to remain accurate to its specification, so the chain of resistors feeding it (R14 to R19), comprises a number of small values which will provide the right current.

**21.** The action of the control circuit in the presence of slow fluctuations is straightforward. For example, any rise on the positive line with respect to the negative causes a proportionate rise at V8b grid, and a fall at V8b anode. Thanks to the common cathode resistor R22 for the pair of triodes, there is a corresponding rise at V8a anode. Each anode is DC-coupled to one grid of the double-triode V6, which also has a common cathode load (R7, 47 KΩ). The anode of V6a is connected directly to the positive line, but V6b has a 47 KΩ anode load R6, so an amplified drop appears at its anode. This anode is connected via 4.7 KΩ anti-parasitic resistors to the grids of the regulator valves, so that their impedance is increased, the drop across them

increases, and the level of the positive line is brought down almost to its previous value. The opposite action takes place in the event of a fall on the positive line.

**22.** Advantages of the balanced double-triode circuit employed are:—

(1) Close and accurate stabilization due to the high gain through the control circuit.

(2) Minimum drift due to heater voltage variations; such variations cause drift in the same direction on each cathode of a pair, and so their effects on the control action cancel out.

**23.** The exact DC conditions in the control valve circuits, and thus the actual output level, are set by the 50 KΩ potentiometer RV1 (VOLTAGE SET —500V). The dummy load and the accurate voltmeter required for setting up the level are located in the relay unit Type 186.

**24.** The action described above works equally well for AC fluctuations (i.e. fast changes of output, and ripple). Extra gain for AC is, however, provided by the capacitor C8 (0.1 μF) which feeds such changes direct to V8b grid.

**25.** Due to the high gain through the control circuit, there is a tendency for the whole loop to break into high-frequency oscillation. This is countered by phase-shifted feedback (for HF) from V8b grid to the regulator valve grids, via C3, C4, R8. As an additional precaution, small capacitors C6, C7 shunt the DC coupling resistors R10, R11 to correct the phase shift at HF round the control loop.

#### HT for V6b

**26.** It is desirable that the anode load of V6b should be returned to a steady HT supply, but direct connection to the regulated positive line will not serve because V6b would then have to operate (very inefficiently) near cut-off, to give a voltage drop across the anode load R6 (controlling the grid-to-cathode potential of the regulator valves) small enough to provide the required regulator valve current. To obviate this, the boost neon V12 (CV284) is included; it draws current from the unregulated side of the HT, via R3, and since the drop across it is a steady 70V, it provides a reliable HT for V6b, some 70V higher than would otherwise be available. The voltage drop across R6 can thus be the grid-to-cathode potential of the regulator valves plus 70V, which allows a greater current through V6b and hence more efficient control.

#### Protection circuit

**27.** The protection circuit is designed to switch off the power unit in use, and to effect change-over to the other power unit, if the output of the one in use varies more than 2.5V from the desired —500V. The circuit comprises two pentodes, V10 and V11 (CV138).

**28.** The grid of one pentode (V11) is returned to the slider of RV2, which forms part of a pot. chain extending from earth down to the —500V rail. The grid of the other pentode V10, is held at a

steady 83V above the  $-500V$  rail by the reference neon V9 (CV449). A proportion of the output voltage is thus compared with the 83V reference voltage.

**29.** The anode circuit of each pentode consists effectively of a  $47\text{ K}\Omega$  resistor in series with a Carpenter relay (a sensitive miniature side-stable relay). The major part of the cathode load is common to the two pentodes. In the normal state, when RV2 has been correctly set up and the  $-500V$  output is in order, both pentodes are conducting equally (about 5 mA), and both Carpenter relays are energized; their contacts D1 and E1 are closed and the protection action does not occur.

**30.** If the voltage of the  $-500V$  rail moves more negative, the grid of V11 is taken down and the valve current is reduced, so de-energizing RLE and tripping the protection circuit by opening contact E1 and de-energizing RLC. If on the other hand the output rail moves in a positive direction, the grid of V11 rises, its current increases, and the common cathode potential follows the grid up. In consequence V10 is cut off, de-energizing RLD, opening contact D1, de-energizing RLC and operating the change-over circuit (*para.* 37).

**31.** The protection circuit is set up by connecting the multimeter Type 100 across the anodes of V10 and V11 (at SK3/X, SK3/K), and adjusting RV2 (PROTECTION SET) until there is no voltage difference between them (i.e. the two pentodes are balanced). When approximate balance has been achieved, the PROTECTION FINE button SWE is pressed, reducing the resistance in series with the multimeter and enabling fine adjustment to be made to RV2 for perfect balance. This is essential to ensure that the protection circuit operates equally well for fluctuations in either direction.

#### Switching circuit

**32.** The order of starting up the power unit, and the circuit action, are as follows:—

(1) Close switch A (ON switch), applying mains to the primary of the LT transformer TR2, and so lighting all valve heaters in the unit except the rectifiers. SWA2 switches in the  $-50V$  applied at SK1/B from the relay unit Type 186.

- (2) Press the START button (SWB). This applies  $-50V$  to RLB and energizes it. Its contact B1 closes and holds on RLB (via the contact A2) even after the START button has been released. Contact B2 closes and applies  $6.3V$  from TR2 to the heater element of the  $\frac{1}{2}$  min. thermal delay relay XA.
- (3) After about  $\frac{1}{2}$  min., during which time the valve heaters have had time to warm up, the XA contact changes over and energizes RLA via the 150 ohm resistor R27 (*para.* 37).
- (4) Contact A1 closes the protection line (explained later). Contact A2 changes over, de-energizing RLB and holding on RLA independent of the thermal contact. B2 opens the heater circuit of XA, so that the heater element starts to cool off. Contact A3 energizes RLF, and contacts F1 and F2 apply 230V mains to the primary of the HT transformer TR1, and so start up the  $-500V$  supply. Contact A4 lights a lamp in the relay unit Type 186, showing that this power unit is producing HT.
- (5) During the 1 min. (approx.) when XA is cooling off, the protection line to the relay unit, via A1, C1, is ineffective; during this time there is opportunity to set up the  $-500V$  level and the protection circuit. At the end of the minute, XA changes back, and (provided SWD is closed) the protection line becomes effective, as explained later. If further time is needed for setting-up, SWD (the PROTECTION switch) may be turned to OFF, thus rendering the protection circuit ineffective. As a reminder that the power unit is without the coverage of the protection circuit, the WARNING neon LP1 blinks continuously, with a p.r.f. of about 2 p.p.s. (It operates by the repeated charge of C11 via R40, and discharge via the neon.) When setting-up has been completed, SWD must be restored to ON, so introducing the protection again and extinguishing the neon.
- (6) In the normal state, therefore, the power unit runs with SWA and SWD closed, relays A, C and F energized, and relay B not energized. To switch off the  $-500V$ , without extinguishing valve heaters, it is only necessary to press the RELEASE button (SWC) so that RLA is de-energized. The  $-500V$  may subsequently be restored by pressing the START button again, when the original starting sequence is repeated.

### RELAY UNIT (CHANGE-OVER) TYPE 186

#### INTRODUCTION

**33.** The relay unit (change-over) Type 186, Stores Ref. 10F/16226, illustrated in fig. 7, is used in the rack assembly (negative reference) Type 338 to effect automatic or manual change-over between the two power units (reference) Type 906, and so ensure uninterrupted provision of the important  $-500V$  reference supply. There is also automatic change-over to a second  $-50V$  supply (for relays etc.), if the one in use should fail. The alarm bells (two in parallel for extra

reliability) ring loudly whenever automatic change-over of either supply ( $-500V$  or  $-50V$ ) has occurred, as a warning that there is no longer a supply in reserve. The bells may be silenced by pressing the ALARM RELEASE button on the relay unit. The unit also includes an accurate voltmeter for setting up the power units, and a dummy load for the reserve power unit. The state of the different supplies is shown by a number of indicator lamps.



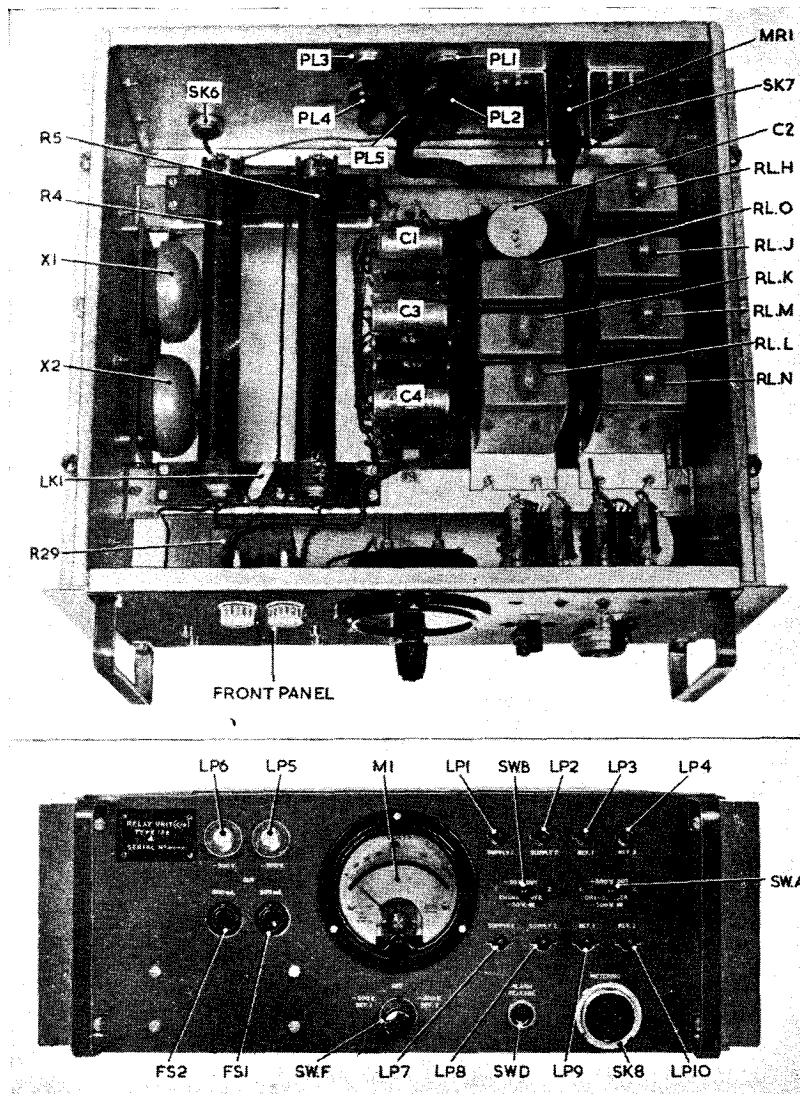


Fig. 7. Relay unit (change-over) Type 186—front panel and top view

#### Construction

34. The unit is built on a 19 in. wide rack-mounting chassis,  $6\frac{3}{4}$  in. deep, with side flanges for attachment to runners by captive screws. The voltmeter, switches and lamps are on the front panel along with the fuses and metering socket. All permanent connections are cabled to plugs and sockets at the rear of the unit.

#### CIRCUIT DESCRIPTION

35. The complete circuit diagram of the relay unit is incorporated in the diagram of the whole change-over system (fig. 11), which also includes skeleton switching circuits of the two power units (Ref. 1 and Ref. 2). In fig. 11 all relays are shown in the unenergized state. The operation of the circuits will be explained (a) in the normal state with two good power units, (b) when one power unit fails and automatic  $-500V$  change-over occurs to the other power unit, (c) when one  $-50V$  supply fails and automatic change-over to the other supply occurs.

#### Normal state

36. When both  $-50V$  supplies are in order and both power units Type 906 have been run up and are working properly, the state of the system is as follows:—

- (1)  $-50V$  SUPPLY 1 enters at PL5/A, and SUPPLY 2 at PL5/B (the positive pole of these 50V supplies is earthed, PL5/E). Lamps LP7 and LP8 are both alight, indicating that both  $-50V$  supplies are in order. Current flows in both the opposing windings of the balanced relay RLL, so it is not energized.
- (2) Depending on the previous change-over history of the system, either  $-50V$  supply may be actually in use. Assuming it is SUPPLY 1, then RLM is energized but RLN is not; contact M2 is open and keeps RLN unenergized ( $-50V$  interlock). Contact M1 connects  $-50V$  from SUPPLY 1 through to the rest of the system via the metal rectifier

- MR1 (*para.* 39 (2)). Contact M3 lights LP1, showing that SUPPLY 1 is the one which is operational. Contact M4 is unused.
- (3) Both  $-500\text{V}$  supplies are in order; that from REF. 1 power unit enters at PL4/F, and that from REF. 2 at PL2/F. Depending on previous change-over history, either may be operational; assume it is REF. 1. In this case RLH is energized, but RLJ is not. Contact H3 ensures that RLJ remains un-energized ( $-500\text{V}$  interlock). Contact C3 in REF. 1 power unit completes the earth return of RLH (while REF. 1 unit is in order, RLC there is energized).
  - (4) Contact H1 applies the  $-500\text{V}$  supply from REF. 1 to both output sockets (SK6 and SK7). Contact H2 lights LP3 to indicate that REF. 1 power unit is operational. Contact J1 is in its unenergized position and connects the REF. 2  $-500\text{V}$  supply to the big  $3\cdot3\text{K}\Omega$  dummy load R4. Contact J2 is open and has no effect. Contact J3 maintains the  $-50\text{V}$  return circuit of RLH.

#### **$-500\text{V}$ change-over action**

**37.** If the system is in the normal state with REF. 1  $-500\text{V}$  supply operational, change-over to REF. 2 supply can occur either automatically (due to trouble in the REF. 1 power unit) or manually. The automatic change-over action is as follows:—

- (1) The protection circuit in Ref. 1 power unit operates and opens either contact D1 or contact E1, de-energizing RLC.
- (2) Contact C3 in the failing power unit opens and disconnects earth from the bottom of RLH.
- (3) RLH is therefore de-energized. Contact H3 now closes and energizes RLJ. Contact J3 opens and keeps RLH off. Contact H1 disconnects the failing REF. 1  $-500\text{V}$  supply from the output sockets and applies it to the dummy load R4 instead. Contact J1 disconnects REF. 2  $-500\text{V}$  supply from the dummy load and connects it to the output sockets. Spark interference during this change-over is suppressed by the components C3, C4, R27, R28. Contact H2 extinguishes LP3, and contact J2 lights LP4, indicating that REF 2 supply is now operational.
- (4) Contact C1 in the failing power unit closes and since SWD/1 and contact A1 there are still closed,  $-50\text{V}$  is applied to PL3/A on the relay unit, energizing RLK.
- (5) Contact K1 changes over and holds on RLK independently of the change-over line. Contact K3 applies  $-50\text{V}$  to the alarm bells, causing them to ring. (They may later be silenced by pressing the ALARM RELEASE, SWD, which de-energizes RLK).
- (6) Contact C2 in the failing power unit closes, short-circuiting the top of RLA there to earth via contact C4 in the other power unit and contact K2 in the relay unit. This releases RLA and trips off the failing power

unit. Contact A1 opens at this stage, but to make sure that the alarm action is completed the  $16\mu\text{F}$  electrolytic capacitor C15 has been included, backed by a  $470\Omega$  resistor (R68), to hold up the  $-50\text{V}$  supply even after A1 has opened. The  $150\Omega$  resistor R27 saves the  $-50\text{V}$  supply from being short-circuited along with RLA.

- (7) Contact C4 opens, ensuring that even if Ref. 2 power unit output subsequently goes wrong no further change-over can take place back to Ref. 1 power unit while Ref. 1 remains unserviceable.
- (8) Contact A4 extinguishes LP9, indicating that REF. 1 power unit is no longer serviceable.

**38.** Manual change-over may be effected by flicking the non-locking key switch SWA to position 2, short-circuiting RLH and producing the same results as in *para.* 37 (3). The  $680\Omega$  resistor R6 saves the  $-50\text{V}$  from being shorted at the same time. The alarm bell circuit does not come into action after manual change-over.

#### **$-50\text{V}$ change-over action**

**39.** If both  $-50\text{V}$  supplies to the rack are satisfactory, and SUPPLY 1 is operational, change-over to SUPPLY 2 can occur either automatically (due to failure of supply 1) or manually. The automatic change-over action is as follows:—

- (1) The cessation of SUPPLY 1 extinguishes LP7, and de-energizes RLM. Contact M2 closes and energizes RLN. Contact N2 opens and keeps RLM off; so when SUPPLY 1 is eventually restored LP7 will light again but RLM will not energize.
- (2) Contact M1 opens and disconnects supply 1 from the input to the system; contact N1 connects supply 2 there instead. The  $-50\text{V}$  supply to relays etc., is held up during the change-over action by the  $250\mu\text{F}$  electrolytic capacitor C2. The system is isolated during the temporary absence of supply by the metal rectifier MR1.
- (3) Contact M3 extinguishes LP1, and contact N3 lights LP2, indicating that SUPPLY 2 is now operational.
- (4) The failure of supply 1 unbalances RLL and it is energized, closing contact L1. The resulting surge of charging current into C1 ( $8\mu\text{F}$  electrolytic) energizes RLO for about half a second, closing contact O1 and energizing RLK. RLO is de-energized again, as soon as C1 is charged sufficiently to drop the voltage across RLO below the operating value.
- (5) Contact K1 changes over and holds on RLK even after contact O1 has opened again. Contact K2 has no importance in the  $-50\text{V}$  change-over action. Contact K3 rings the alarm bells. To stop the bells ringing while action is being taken to restore a reserve supply, the ALARM RELEASE button (SWD) may be pressed, to de-energize RLK.

40. Manual change-over may be made by moving the non-locking key SWB to position 2. This achieves the same result as automatic change-over (*para.* 39) by open-circuiting RLM momentarily; the alarm circuit does not operate.

#### Features of change-over system

41. The following properties of the change-over system are worthy of note:—

- (1) Except that they use the same alarm circuit, the change-over systems for  $-500V$  and  $50V$  are independent. It is possible to use either  $-500V$  unit in conjunction with either  $-50V$  supply.
- (2) In each change-over system, the change-over and indicator lamp action is independent of the alarm bell system, so, even if the alarm circuit goes wrong, change-over will be completed satisfactorily.
- (3) Manual change-over must not be attempted unless the appropriate lamp in the bottom row on the front panel (*fig.* 7) shows that the supply to which change-over is to be made is in fact available.

- (4) It is impossible for *both* reference power units to be switched off even though they are both unserviceable.
- (5) The interlock between the RLC contacts in each power unit ensures that the Station can not work off a defective power unit while there is a good one in the rack.

#### Metering facilities

42. In addition to the normal metering facilities using a multimeter Type 100, whereby the operating currents of the relays may be checked (SK8/T etc.), a Grade 1 voltmeter M1 is included in the relay unit for accurate setting-up of the  $-500V$  supplies. By using the same voltmeter to set up the two supplies it is ensured that the reference voltage remains consistent even after change-over has occurred. M1 is a moving-coil DC meter with its own special series resistor R29; full-scale deflection is  $650V$ , and the scale is expanded around the  $500V$  mark (*fig.* 7). The meter is normally left unconnected by keeping SWF in the OFF position, but when setting up or checking the power units, either supply may be measured by turning SWF to REF. 1 or REF. 2 as required.

### RELAY UNIT TYPE 185

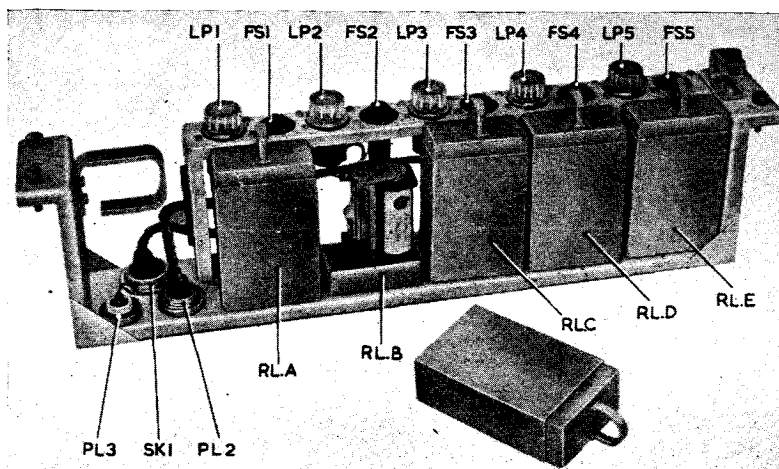


Fig. 8. Relay unit Type 185—general view

#### Purpose

43. The relay unit Type 185, Stores Ref. 10F/16209, is a simple unit containing five relays (*fig.* 8). *Fig.* 9 is the circuit diagram. Each relay switches  $-500V$  out to an external user equipment, via one pin of SK1, when the relay is energized by the application of  $-50V$ , from the user equipment, to the corresponding pin of PL2. When the outlet is not in use, a dummy load (R1 etc.) is connected across the  $-500V$  supply in place of the external load. Dummy loads of  $470 K\Omega$  are used on outlets associated

with external loads around  $1 mA$ , and  $180 K\Omega$  on those around  $3 mA$ .

44. Each outlet is protected by a  $60 mA$  cartridge fuse (FS1 etc.) and each one has a neon lamp which glows when the fuse has blown. The  $-500V$  reference input is looped from one relay unit Type 185 to the next (*fig.* 12). The arrangement of outlets is such that failure of one relay Type 185 will not close down a whole rack assembly or console cabin,

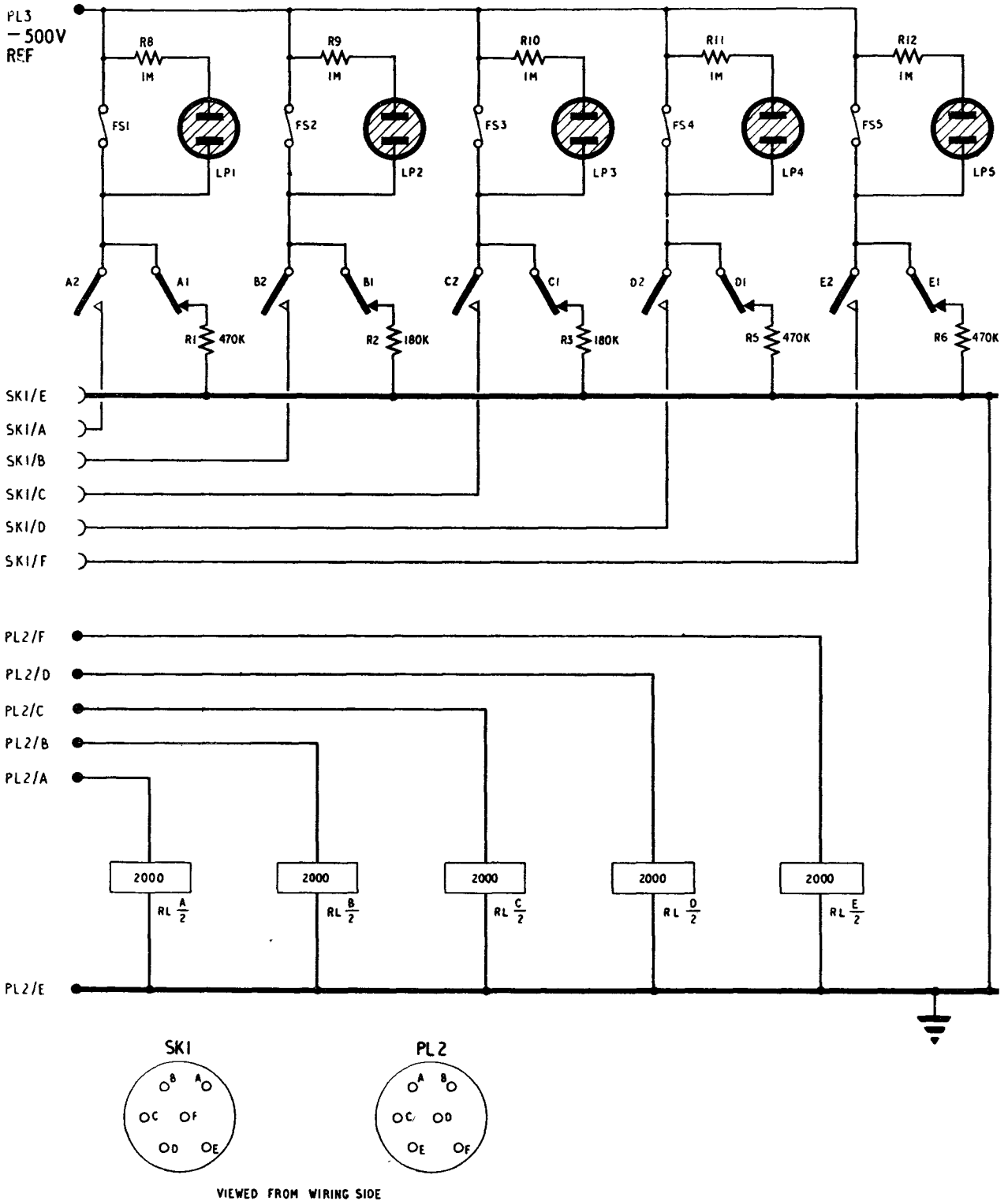


Fig. 9. Relay unit Type 185—circuit

TABLE 2

## Power unit (Reference) Type 906—component details

Circuit ref.	Value (ohms)	Rating (watts)	Tolerance (%)	Ref. No.	Circuit ref.	Value (ohms)	Rating (watts)	Tolerance (%)	Ref. No.
<b>Resistors</b>					R50	100K	$\frac{1}{2}$	10	Z223038
R1, R2	100	$\frac{1}{2}$	10	Z221110	R51*	1M	$\frac{3}{4}$	1	Z216655
R3	18K	6	5	Z244122	R52* to R56*	33	$\frac{1}{2}$	5	Z215062
R4, R5	4.7K	$\frac{1}{2}$	10	Z222089	R57	100K	$\frac{1}{2}$	10	Z223038
R6	47K	$\frac{1}{2}$	10	Z222215	R58*	1M	$\frac{3}{4}$	1	Z216655
R7	47K	6	5	Z244150	R59*, R60*	33	$\frac{1}{2}$	5	Z215062
R8	22K	$\frac{1}{2}$	10	Z222173	R61*	300K	$\frac{3}{4}$	5	Z216729
R9*	1M	$1\frac{1}{2}$	2	Z216661	R62*	47K	$\frac{3}{4}$	5	Z216083
R10*	470K	$\frac{3}{4}$	1	Z216591	R63	1M	1	10	Z213164
R11*	470K	$\frac{3}{4}$	1	Z216591	R64	1M	1	10	Z213339
R12*	1M	$1\frac{1}{2}$	2	Z216661	R65	220K	1	10	Z213331
R13* to R18*	15K	$1\frac{1}{2}$	1	Z216250	R66, R67	2.2M	$\frac{1}{2}$	10	Z223206
R19*	2.4K	$\frac{1}{2}$	1	Z215726	R68	470	1	10	Z211270
R20	220K	$\frac{1}{2}$	10	Z223080	R69	10	6	3	10W/19194
R22	68K	$\frac{1}{2}$	10	Z223017	R70*	4.7K	$\frac{1}{2}$	1	Z215796
R23	10K	$\frac{1}{2}$	10	Z222131	R71	680K	$\frac{1}{2}$	10	Z223143
R24	470K	$\frac{1}{2}$	10	Z223122	R72 to R74	220	$4\frac{1}{2}$	5	Z223129
R25*	1M	$\frac{3}{4}$	2	Z216659	RV1	50K	1	10	Z272410
R26*	180K	$\frac{1}{2}$	2	Z216510	(VOLTAGE SET—500)				
R27	150	10	5	Z243115	RV2	100K	1	10	Z272549
R28	270K	1	10	Z213332	(PROTECTION SET)				
R29	100	$\frac{1}{2}$	10	Z221110	*High stability				
R30	100K	$\frac{1}{2}$	10	Z223038	<b>Capacitors</b>				
R31	47K	6	5	Z244150	C1, C2	4 $\mu$ F	1500	20	Z112834
R32*	56K	$1\frac{1}{2}$	5	Z216095	C3	10pF	500	10	Z132253
R33*	8.2K	$1\frac{1}{2}$	5	Z215355	C4	330pF	500	10	Z132317
R34	—	—	—	—	C5	0.1 $\mu$ F	1000	20	Z115588
R35	100	$\frac{1}{2}$	10	Z221110	C6, C7	10pF	500	10	Z132253
R36*	1.8M	$1\frac{1}{2}$	2	Z216670	C8	0.1 $\mu$ F	1000	20	Z115588
R37*	330K	$\frac{1}{2}$	2	Z216563	C9	1 $\mu$ F	1000	20	Z112162
R38	100	$\frac{1}{2}$	10	Z221110	C10	1.25 $\mu$ F	150	25	Z115563
R39	4.7K	$\frac{1}{2}$	10	Z222089	C11	0.1 $\mu$ F	350	20	Z115506
R40	10M	$\frac{1}{2}$	10	Z223291	C12, C13	0.1 $\mu$ F	500	20	Z115507
R41	47K	6	5	Z244150	C14	0.1 $\mu$ F	1500	20	Z111458
R42*, R43*	220	$\frac{1}{2}$	5	Z215162	C15	16 $\mu$ F	150	-20, +100	Z145121
R44	10M	$\frac{1}{2}$	10	Z223291					
R45	15K	$\frac{1}{2}$	10	Z222152					
R46 to R49	100	$\frac{1}{2}$	10	Z221110					

Circuit ref.	Description	Type	Ref. No.
<b>Miscellaneous</b>			
TR1	Transformer (HT)	3146	10K/17342
TR2	Transformer (LT)	3147	10K/17343
L1, L2	Chokes, LF, 10H, 350 mA	1140	10C/19268
LP1, LP2, LP3	Neon lamps	—	X962106
FS1	Fuse, 1 amp.	5 (MOS(A))	10H/9613
FS2	Fuse, 5 amp.	21 (MOS(A))	10H/11718
FS3	Fuse link, 1A	—	Z590115
FS4	Thermo cut-out	—	10AE/653
FS5	Thermo cut-out	—	10AE/655
RLA	Relay, 2 K $\Omega$	46/3LV	Z530059
RLB	Relay, 2 K $\Omega$	39/3LV	Z530054
RLC	Relay, 2 K $\Omega$	44/3LV	Z530217
RLD, RLE	Relays magnetic (Carpenter 6U7, 330 $\Omega$ )	1343	10F/18126
RLF	Relay, 2 K $\Omega$	57/3HV	Z530111
XA	Relay, thermal delay, $\frac{1}{2}$ min.	117	10F/18148
SWA, SWD	Toggle switch	D.P.S.T.	Z510302

TABLE 2 (continued)

Circuit ref.	Description	Type	Ref. No.
<b>Miscellaneous (cont.)</b>			
SWB, SWC, SWE	Push-button switch	1290	10F/1786
SK1*	6-way fixed socket	Mk. 4	Z560322
SK2*	6-way fixed socket	Mk. 4	Z560321
SK3*	25-way fixed socket	Mk. 4	Z560380
PL4*	6-way fixed plug	Mk. 4	Z560140

\*Moulding position on Mk. 4 plugs and sockets is indicated by last digit of Z number.

TABLE 3

## Relay unit (change-over) Type 186—component details

Circuit ref.	Value (ohms)	Rating (W)	Tolerance (%)	Ref. No.	Circuit ref.	Value (ohms)	Rating (W)	Tolerance (%)	Ref. No.
<b>Resistors (fixed)</b>					R15	1M	1	10	Z213339
R1	10	$\frac{1}{4}$	5	Z217562	R16	680	$\frac{1}{4}$	1	Z217223
R2	10	$\frac{1}{4}$	5	Z217562	R17	150	4.5	5	Z243113
R3	10	$\frac{1}{4}$	5	Z217562	R18	150	4.5	5	Z243113
R4	3.3K	100	5	Z242078	R19	150	4.5	5	Z243113
R5	3.3K	100	5	Z242078	R20	150	4.5	5	Z243113
R6	680	10	5	Z243179	R21	150	4.5	5	Z243113
R7	10	$\frac{1}{4}$	5	Z217562	R22	150	4.5	5	Z243113
R8	10	$\frac{1}{4}$	5	Z217562	R23	150	4.5	5	Z243113
R9	10	$\frac{1}{4}$	5	Z217562	R24	150	4.5	5	Z243113
R10	120	6	5	Z243106	R25	47K	$\frac{1}{2}$	10	Z222215
R11	100K	$\frac{1}{2}$	10	Z223038	R26	51K	$\frac{1}{4}$	5	Z218213
R12	680	10	5	Z243179	R27	220	1	10	Z211266
R13	10	$\frac{1}{4}$	5	Z217562	R28	220	1	10	Z211266
R14	1M	1	10	Z213339	R29	Special, with meter	—	—	—

Circuit ref.	Description	Type	Ref. No.
<b>Miscellaneous</b>			
C1	Capacitor (electrolytic) 8 $\mu$ F	150V ; -20, +100%	Z145279
C2	Capacitor (Type 6440) 250 $\mu$ F	250V ; -20, +50%	10C/18562
C3, C4	Capacitor, 0.1 $\mu$ F	1000V ; 20%	Z115508
FS1, FS2	Fuse link, 500 mA	—	Z590108
LP1 to LP4 LP7 to LP10	Filament lamp	—	X959220
LP5, LP6			
M1	Neon lamp	—	X962106
MR1	M.C. Voltmeter, 0-600V	E. Turner Type 23K	5Q/25115
RLH, RLJ	Metal rectifier	Westinghouse T4A2	10F/17444
RLK	Relay magnetic 2K $\Omega$ Siemens RDJ/6893	1321	Z530056
RLL	Relay magnetic 2K $\Omega$	41/3LV	Z530062
RLM, RLN	Relay magnetic 1K $\Omega$ + 1K $\Omega$	SM3/LV69	Z530059
RLO	Relay magnetic 2K $\Omega$	46/3LV	Z530214
PL1*	Relay magnetic 2K $\Omega$	37/3LV	Z560542
PL2*	6-way fixed plug	Mk. 4	Z560541
PL3*	6-way fixed plug	Mk. 4	Z560542
PL4*	6-way fixed plug	Mk. 4	Z560541
PL5*	6-way fixed plug	Mk. 4	Z560543
SK6, SK7	Unipole fixed socket	1137 (Plessey CZ59498)	10H/18961
SK8*	25-way fixed socket	Mk. 4	Z560380
SWA, SWB	Key switch (non-locking) P.O. T216	1538	10F/2650
SWD	Push button switch	1290	10F/1786
SWF	Wafer switch, H type	2169	10F/17442
X1, X2	Bell, 24V	Gents, Type 396	5A/3989

\*Moulding position on Mk. 4 plugs and sockets indicated by last digit of Z number

TABLE 4

## Relay unit Type 185—component details

Circuit ref.	Description	Type	Ref. No.
R1	Resistor (fixed), 470K $\Omega$	1W, 5%	Z216164
R2, R3	Resistor (fixed), 180K $\Omega$	1½W, 5%	Z216143
R5, R6	Resistor (fixed), 470K $\Omega$	1W, 5%	Z216164
R8 to R12	Resistor (fixed), 1M $\Omega$	¼W, 10%	Z223165
RLA to RLE	Relay magnetic 2K $\Omega$	102/3HV	Z530296
FS1 to FS5	Cartridge fuse, 60 mA	55 (MOS/A)	10H/535
PL1 to LP5	Neon lamp	—	X962106
SK1	6-way fixed socket (med.)	Mk. 4	Z560321
PL2	6-way fixed plug (small)	Mk. 4	Z560581
◀ PL3	Unipole fixed plug, Plessey CZ59596	764	10H/19625 ▶

TABLE 5

## Rack assembly (neg. ref.) Type 338—list of input and output connections

## Note . . .

*This list, which applies to initial GCI installations, is issued here for early information only, and may be supplemented or superseded by current orders. Full cabling schedules (from which this Table is extracted) will be issued to each Station separately.*

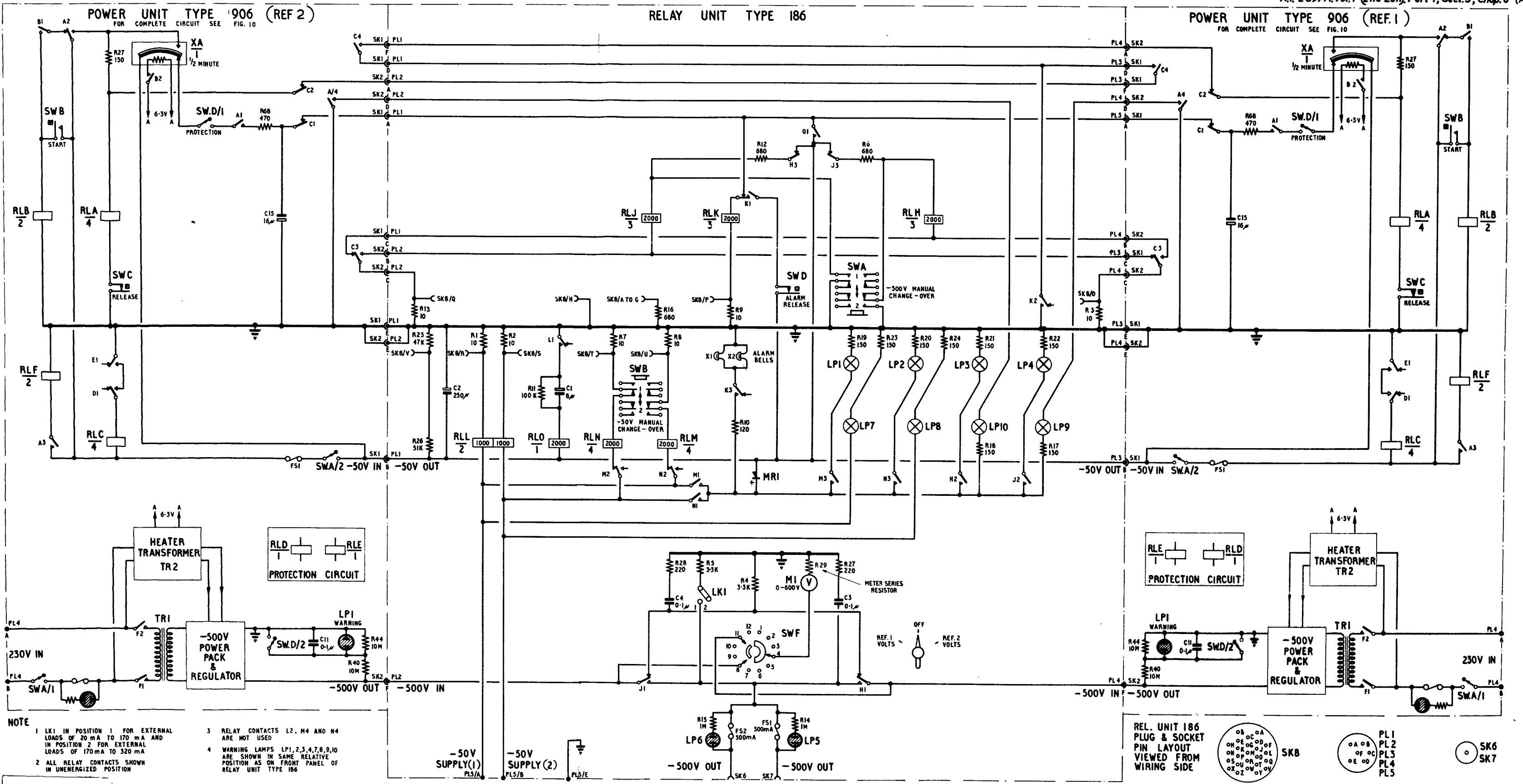
PL or SK	Type	Location (Unit No.)	Moulding position	Pin	Service	Destination	
PL1	6-way (med.)	34	0	A	Neutral Line } 230V, 50 c/s for Ref. 2 P.U.	} Radar office power board	
				B			
				C, D	Earth	—	Earth tag in trunking
				E			
F	—	—					
PL2	6-way (med.)	34	0	A—F	As PL1, for Ref. 1 P.U.	As PL1	
PL3	6-way (med.)	34	3	A	-50V (Supply 1)	} Rectifiers Type 15	
				B			-50V (Supply 2)
				C, D	Earth	—	
				E			
F	—	—					
SK1	6-way (med.)	4	0	A	-500V (1)	Pins A to F on SK1 are paired with corresponding pins on PL2, one pair per outlet, and distributed to various units according to station requirements (see cable schedules)	
				B	-500V (2)		
				C	-500V (3)		
				D	-500V (4)		
				E	Earth		
				F	-500V (5)		
PL2	6-way (small)	4	0	A	-50V switching (1)	See SK1	
				B	-50V switching (2)		
				C	-50V switching (3)		
				D	-50V switching (4)		
				E	Earth		
				F	-50V switching (5)		

## Note . . .

*Connections to SK1 and PL2 on remaining relay units T.185 (units 5-33) are the same as on unit 4.*







**NOTE**

- LK1 IN POSITION 1 FOR EXTERNAL LOADS OF 20 mA TO 170 mA AND IN POSITION 2 FOR EXTERNAL LOADS OF 170 mA TO 320 mA
- ALL RELAY CONTACTS SHOWN IN UNENERGIZED POSITION
- RELAY CONTACTS L2, M4 AND N4 ARE NOT USED
- WARNING LAMPS LP1, 2, 3, 4, 7, 8, 9, 10 ARE SHOWN IN SAME RELATIVE POSITION AS ON FRONT PANEL OF RELAY UNIT TYPE 186

**AIR DIAGRAM**  
6222B/MIN.

Negative reference change-over system

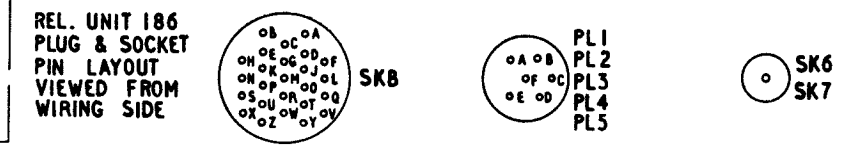
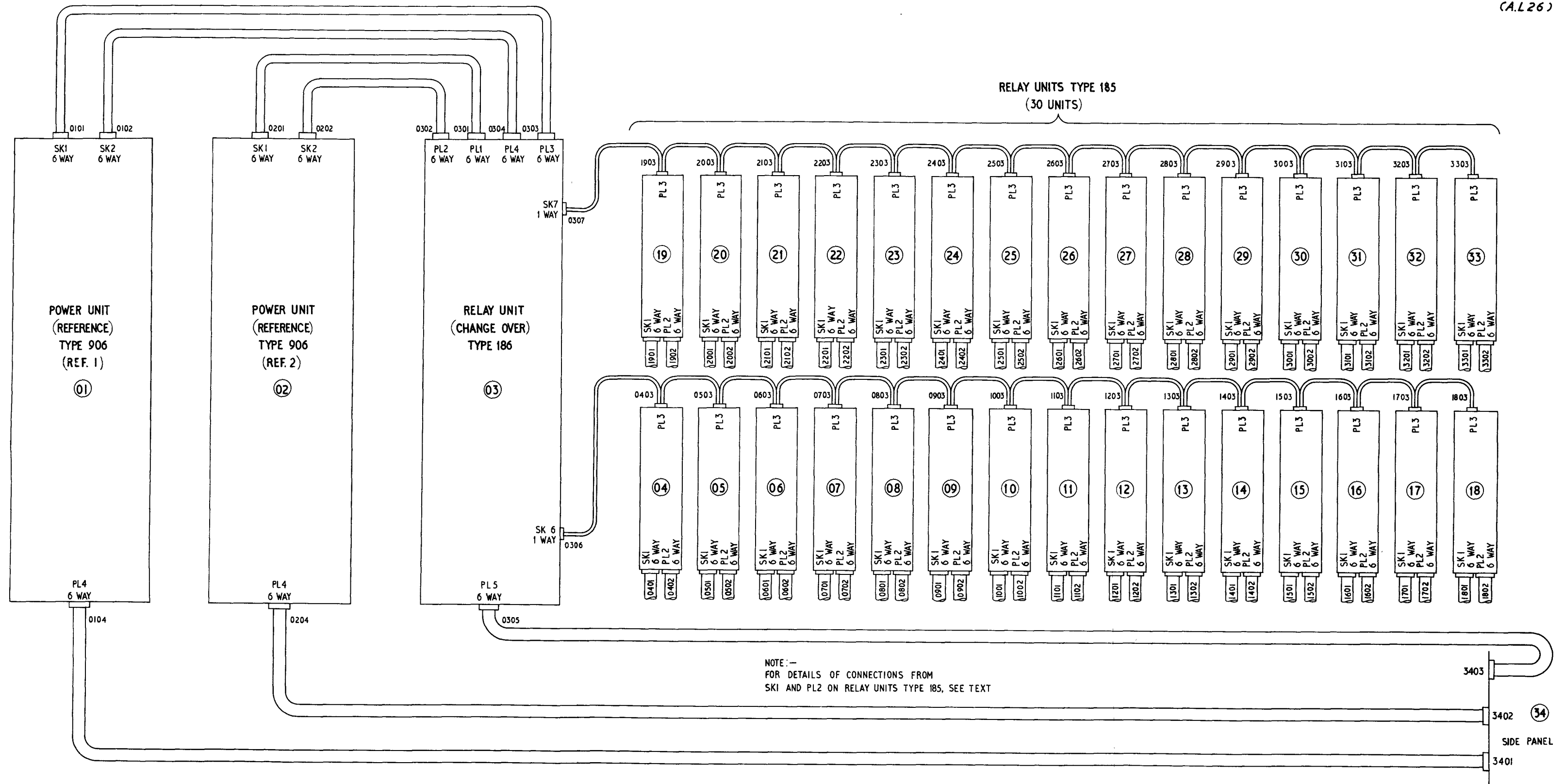


Fig. 11

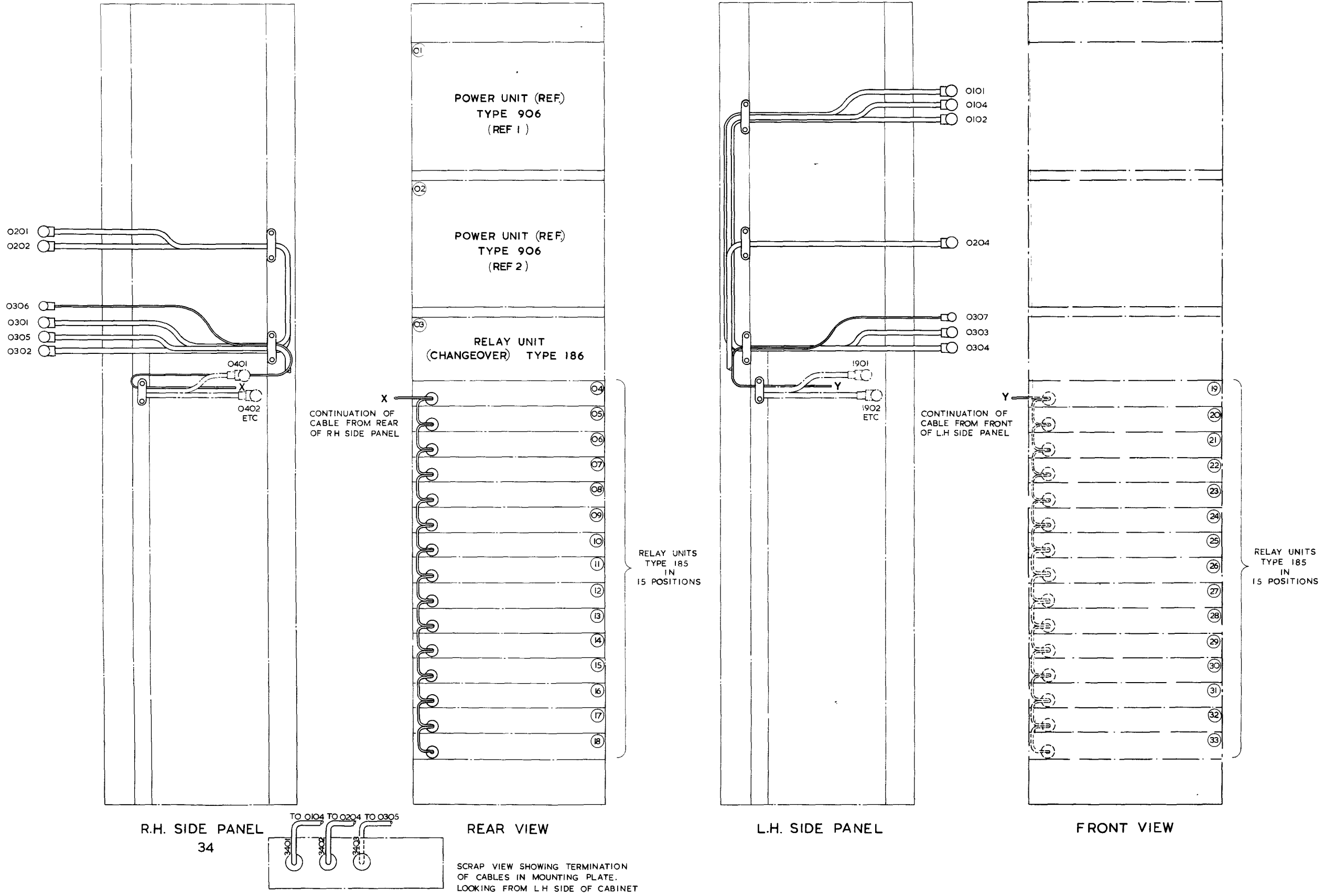


Rack assembly (neg. ref.) Type 338 - circuit

Fig. 12

AIR DIAGRAM  
6222G/MIN.

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



Rack assembly (neg.ref.) Type 338 - cabling

Fig.13  
(A.L.26, Sep.57)

AIR DIAGRAM  
6222H/MIN.  
ISSUE 2 PREPARED BY MINISTRY OF SUPPLY FOR PROLIFIGATION BY AIR MINISTRY

## **Chapter 7**

### **RACK ASSEMBLY (BULK POWER SUPPLY) TYPE 305**

#### **ERRATA**

Para. 41 (3), 45, and Table 7, lines 14 and 15: for modification No. CA.622, read modification No. CA.621.

## Chapter 7

# RACK ASSEMBLY (BULK POWER SUPPLY) TYPE 305

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### GENERAL

#### Purpose of rack

1. The rack assembly (bulk power supply) Type 305 (Stores Ref. 10D/18671), illustrated in fig. 1, is a central source for supplying HT in bulk to fixed-coil PPI display consoles on ground radar Stations. By concentrating the power supply equipment in this way, much of the space, that would otherwise be needed in individual consoles, has been saved, with a consequent valuable

reduction in size. HT is not supplied to any of the radar office racks, as these all contain their own power units.

2. One rack assembly Type 305 can supply any number of PPI consoles from one to six. Thus, on a GC1 Station with thirty three fixed-coil consoles, six rack assemblies are provided. The wiring is normally arranged so that adjacent consoles in any one cabin are never fed from the same bulk

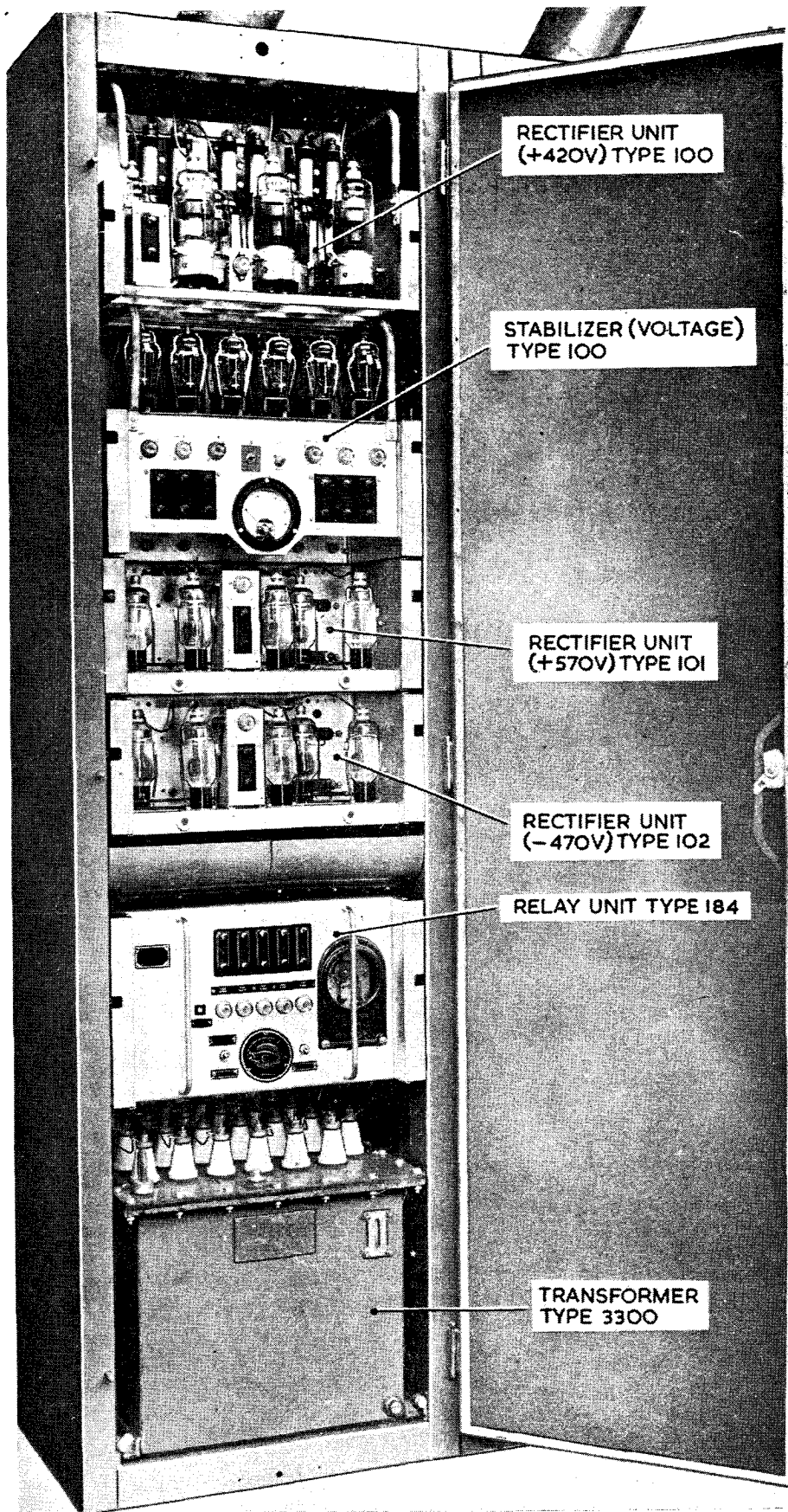


Fig. 1. Rack assembly (bulk power supply) Type 305—front view

power supply rack. As a result, if one rack fails and shuts down the six consoles fed from it, operations may rapidly be resumed on adjacent consoles. Most Stations have one or more extra racks for workshop supplies and spares.

3. The units making up the bulk power supply rack, taken in order from top to bottom, are as follows:—

- (1) *Rectifier unit (+420V) Type 100*—produces a DC supply at a nominal +420V, 6A, which is used both in the rack and in the consoles. In the rack, it is the supply from which six 250V s-abilized outputs are derived in the stabilizer Type 100. In the consoles, the supply is used to provide HT for the EHT generators, and to produce +250V HT in the local voltage stabilizers Type 51, which take 600mA each.
- (2) *Stabilizer (voltage) Type 100*—contains six separate voltage stabilizers (one per console), each producing stabilized +250V HT for the final deflection amplifiers.
- (3) *Rectifier unit (+570V) Type 101*—produces a DC supply at a nominal +570V, 600mA, used in the consoles for focus coil supply and for the production of +400V stabilized HT (in the stabilizer Type 51).
- (4) *Rectifier unit (-470V) Type 102*—produces a DC supply at a nominal -470V, 1½A, which is used in the consoles for the production of -300V stabilized HT (in the stabilizer Type 51).
- (5) *Relay unit Type 184*—contains switches for the rack and relay circuits. These switches have the following functions:—
  - (a) to prevent the rack being switched on at all, until at least one console of the group of six supplied by the rack has been switched on,
  - (b) to delay the application of mains to the main supply transformer (Type 3300), until one minute after the heaters have been switched on,
  - (c) to prevent HT being fed out to any one console until the HT switching line from that console has been completed.

(6) *Transformer assembly* (including the large supply transformer Type 3300). The transformer primary takes three-phase mains and the secondaries apply three-phase AC of appropriate voltages to the different rectifier units, already mentioned in sub-para (1), (3) and (4).

(7) *Base tray and side panels*—form part of the rack assembly and are not classed as separate sub-units; they

carry panel-mounting couplers to provide all the inter-connections between the rack and the rest of the Station.

4. For all the supplies listed in para. 3, there is a common HT neutral line which is earthed in the relay unit Type 184. On all the unstabilized supplies, the output fluctuations under the greatest expected load changes do not exceed five per cent; the worst expected mains variations cause fluctuations not greater than six per cent. Circuit diagrams and further details of the units listed are given later in this chapter. A block diagram is given in fig. 2.

#### Location and construction

5. The bulk power supply racks are located in a row in the radar office. They are of the standard Air Ministry type, 7ft. in height, designed to take 19-in. units, accessible through full-length steel doors at front and rear. Fig. 1 shows the front door open, providing access to all the units.

6. All cables for external connections to the rack come from the Station cable trunking system under the radar office false floor, and enter the rack through holes in the base plate. Like the other rack assemblies, associated with the fixed-coil consoles, the bulk power supply rack is connected to the common ventilation system and cooling air enters at the base and is extracted at the top.

7. Each of the units (1) to (5) (para. 3) is mounted on a pair of telescopic runners, to which it is secured by two captive screws at each side. Any one of these units may be removed from the rack by detaching all connectors from the rear (accessible through the rear door), removing the two fixing screws at the front, pulling the unit forwards on the runners, loosening the side captive screws, and lifting the unit forwards and upwards off the runners. Two men are required for this operation because of the weight of the transformers and chokes. The main supply transformer cannot be removed until its terminals have been disconnected and the two fixing lugs at the bottom

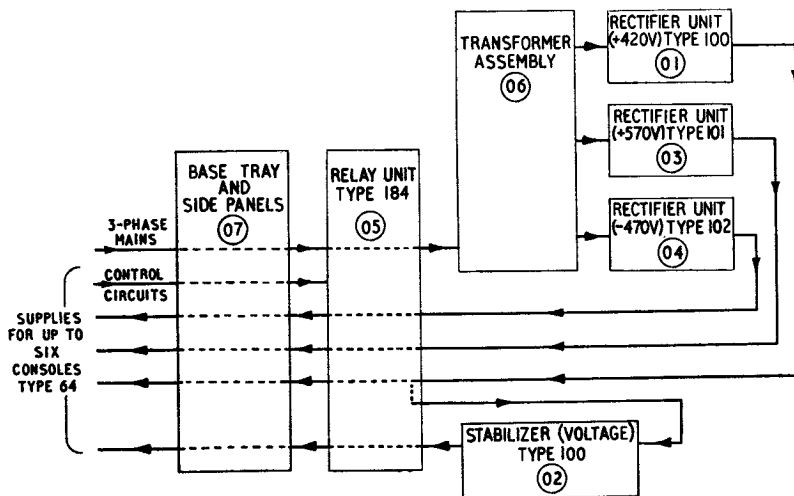


Fig. 2. Rack assembly Type 305—block diagram

corners loosened. The transformer then slides out on runners.

#### Controls

**8.** The ON/OFF switch for the rack is on the front panel of the relay unit Type 184. Since the rack will not come on until an associated console has been switched on, the switch is normally left in the ON position. The voltage or ripple level on the output may be metered using the fixed meter on the front panel of the stabilizer (voltage) Type 100; the selector switch for the meter is on the relay unit Type 184.

**9.** The potentiometers which control the +250V stabilized outputs from the stabilizer (voltage) Type 100 are preset and are not available on the front panel. All fuses have neon indicator lamps across them to facilitate tracing a blown fuse.

#### Rack cabling

**10.** A rack circuit diagram showing the electrical interconnections between all units in the rack assembly is given in fig. 21. The interconnections are made by multicore cables of the *metvinsmall* type, terminating (except in two cases) on Mk. 4 plugs and sockets. Fig. 22 shows the actual run of cables in the cable channels at the sides of the rack assembly.

#### Cable identification

**11.** As with the rest of the fixed-coil equipment, each end of every cable is marked with a four-figure identification number. Since the numbers are different at each end of any particular cable, it is essential to refer to fig. 21 to find the run of the connector. The identification number is the plug or socket number preceded by its parent unit number, with the addition of zeros where necessary to give the standard four-figure code. The relay unit Type 184 provides an exception in that the three-phase mains cable, passing through it from the side input panel to the transformer uses terminals instead of plugs and sockets. Fig. 21 gives the colour-coding of the cores and the numbers of the terminals.

#### Mk. 4 plug and socket orientation

**12.** To avoid the danger of a connector being plugged into the wrong mating component, different internal moulding positions have been allocated to plugs or sockets with the same number of pins, mounted on the same unit. The moulding position is always indicated by the last figure of the inter-services reference number of the component.

#### Six-Phase double-star rectification

**13.** The rectifier units Types 100, 101 and 102,

supplied from the HT transformer Type 3300, all use a three-phase, full-wave rectifier circuit, shown in simplified form in fig. 3. For each rectifier unit there are two secondary star windings on the transformer. Corresponding legs on each star are 180 deg. opposed, so that the output is six-phase (60 deg. spacing). A separate gas-filled diode rectifier is used on each phase and the output ripple is six times the mains frequency (i.e., 300c/s on a normal 50c/s supply, as compared with 100c/s on a single-phase, full-wave rectifier). In addition, when heavy current is drawn from the bulk power supply, the loading on the Station mains is less "choppy" than it would be with single-phase rectifiers, because the effective voltage never falls to zero and the surge current into the smoothing condensers is distributed over six peaks instead of two.

**14.** The waveforms applicable to the simplified circuit are shown in fig. 3 (a) and (b). The AC waveforms at the anodes of rectifiers 1 to 6 are shown at (a), and the positive half cycles are shown at (b). The rectifiers pass current in the order 1, 6, 2, 4, 3, and 5, at the peaks of the positive half cycles.

**15.** To maintain continuity of current through the transformer windings, a reactor, or balance choke, must be inserted between the neutral points of the two stars. The upper DC level on fig. 3 (b), marked "cathode level without balance choke", shows diagrammatically the level of the cathodes if the centres of the two star windings are connected together directly. With this arrangement only one rectifier diode would be conducting at a time, and the output voltage would be high, but with poor regulation.

**16.** With the balance reactor in circuit, providing a choke input to the filter circuit and load negative line, there is a voltage drop across the appropriate half of the reactor as each rectifier passes current, and a lower DC output results (marked "cathode level with balance choke" in the diagrammatic representation in fig. 3(b)). At this lower DC level, the conducting periods of the diodes overlap and give improved transformer utilization with continuity of current and better regulation.

**17.** Since, at any instant, current is flowing through one diode in each secondary circuit, it follows that DC in the two halves of the balance choke is in opposite directions, so that the magnetic fields, due to the current, cancel out. There is thus no possibility of magnetic saturation of the core, which need therefore contain only a relatively small quantity of iron, and the choke itself is of small dimensions.

## TRANSFORMER ASSEMBLY TYPE 185

#### Construction

**18.** The transformer assembly (10K/17957) consists of the transformer itself (transformer Type 3300—10K/17396) together with a cover plate to protect the terminals, a socket mounting bracket for the six-way sockets, and associated fixing screws and wiring. Fig. 4 is a general view

of the transformer in position in the rack; the cover plate has been removed to show the terminals. The two rings, provided for lifting the transformer, are also shown.

**19.** The transformer is oil-immersed in a massive square cast-iron tank. There is an oil level



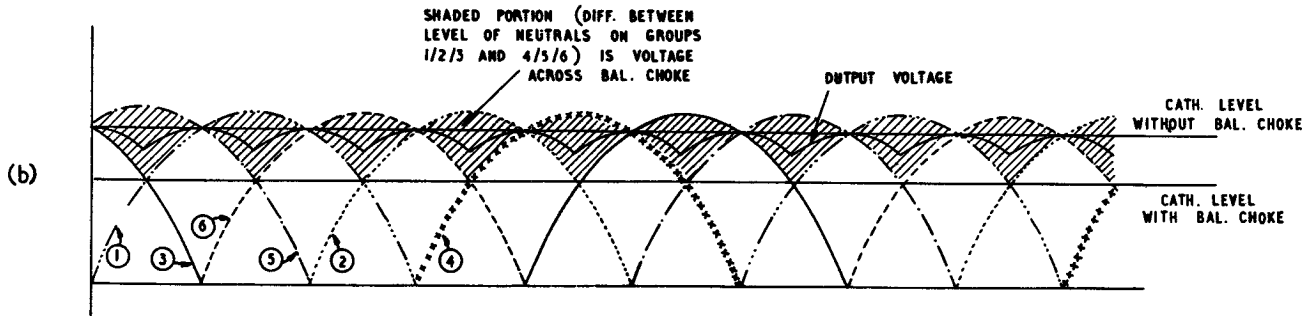
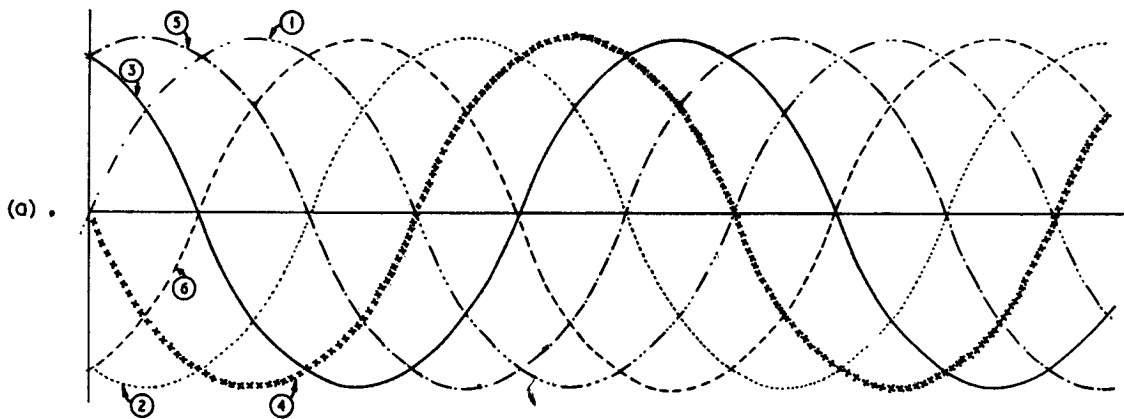
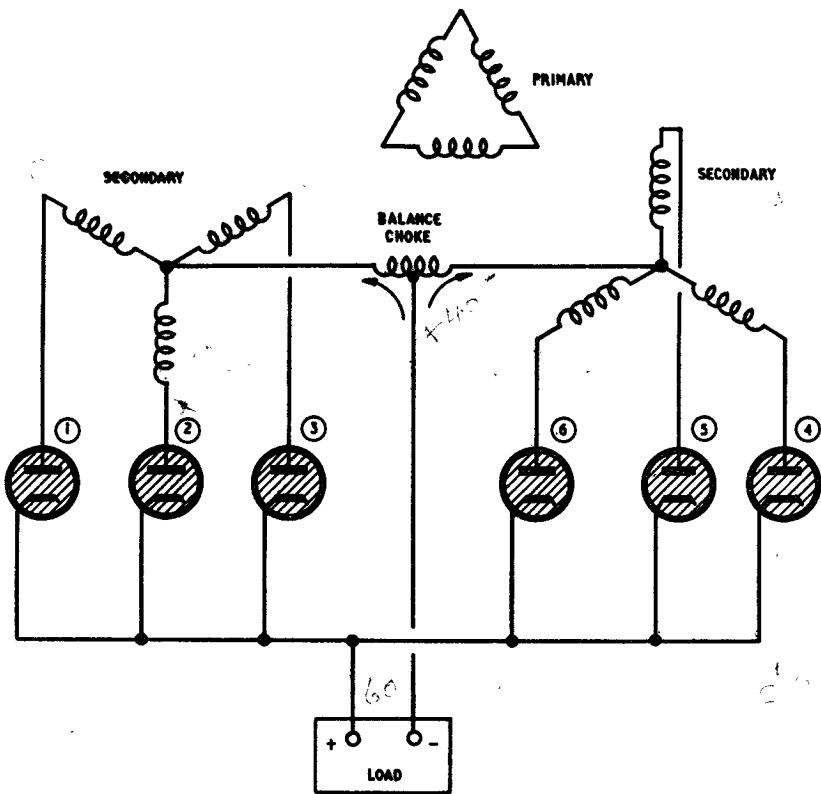
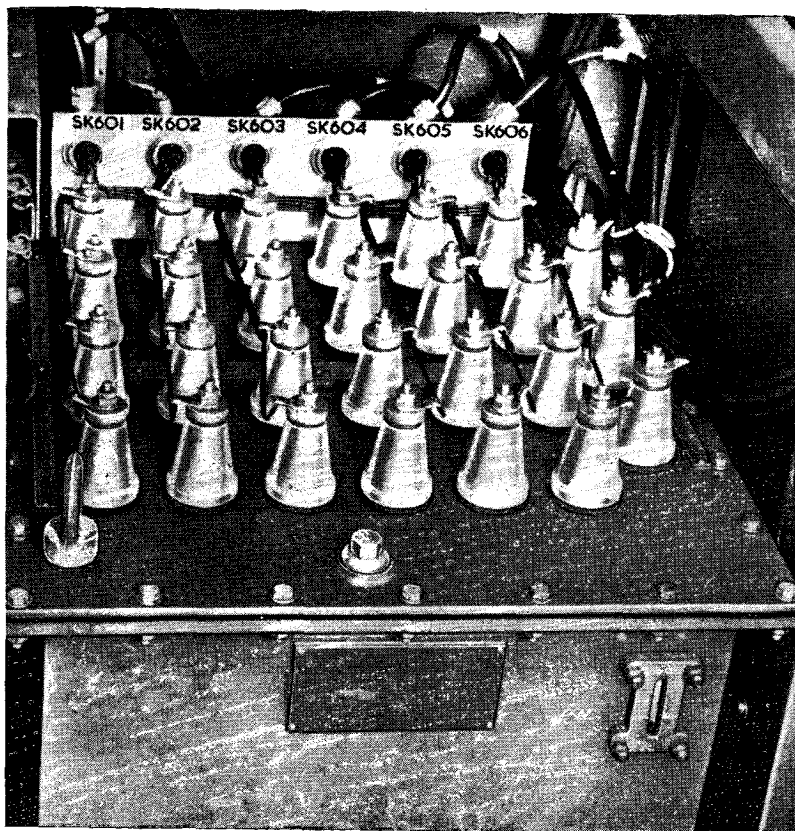


Fig. 3. 3-phase, full-wave rectification—simplified circuit and diagrammatic waveforms



#### KEY TO TERMINALS

(SK601)	(SK602)	(SK603)	(SK604)	(SK605)	(SK606)	
SEC. 1 "N"	SEC. 2 "N"	SEC. 3 "N"	SEC. 3 "N"	SEC. 2 "N"	SEC. 1 "N"	PRIM. "C"
SEC. 1 "C"	SEC. 2 "C"	SEC. 3 "C"	SEC. 3 "C"	SEC. 2 "C"	SEC. 1 "C"	PRIM. "B"
SEC. 1 "B"	SEC. 2 "B"	SEC. 3 "B"	SEC. 3 "B"	SEC. 2 "B"	SEC. 1 "B"	PRIM. "A"
SEC. 1 "A"	SEC. 2 "A"	SEC. 3 "A"	SEC. 3 "A"	SEC. 2 "A"	SEC. 1 "A"	

(for connections, see fig. 5)

**Fig. 4. Transformer assembly—general view**

indicator on the front, and the oil must always be kept up to the level shown by the white line. The correct oil for this transformer is grade B.30. complying with BS.148/33 (*oil insulating, Type O.M.16*, Stores Ref. 34D/102).

**20.** The terminals of the transformer are on porcelain insulators, and their layout is indicated by the key under fig. 4. For their interconnections with the output sockets, and the secondary ratings, see circuit diagram (*fig. 5*). Table 1 lists the sockets on the transformer assembly.

**TABLE I**

**Fixed Mk. 4 6-way sockets on transformer assembly**

Circuit Ref.	Stores Ref.
SK601	Z560320
SK602	Z560320
SK603	Z560321
SK604	Z560321
SK605	Z560322
SK606	Z560322

### RECTIFIER UNIT (+420V) TYPE 100

#### Construction

**21.** This unit (Stores Ref. 10D/18698) is illustrated in fig. 6 and 7. It is divided into two halves by a vertical steel component panel. To the two side plates are attached U-shaped lifting handles, and outside the side plates are the angle brackets, each with three fixing slots for attachment to the runners. The six thyratrons are

mounted in front of the component panel, their bases being staggered across the gaps between the unit framework and a U-section mounting strip, allowing free circulation of air for cooling. The anode-grid capacitors are mounted on the component panel, and the grid-cathode resistors close to each valve base.

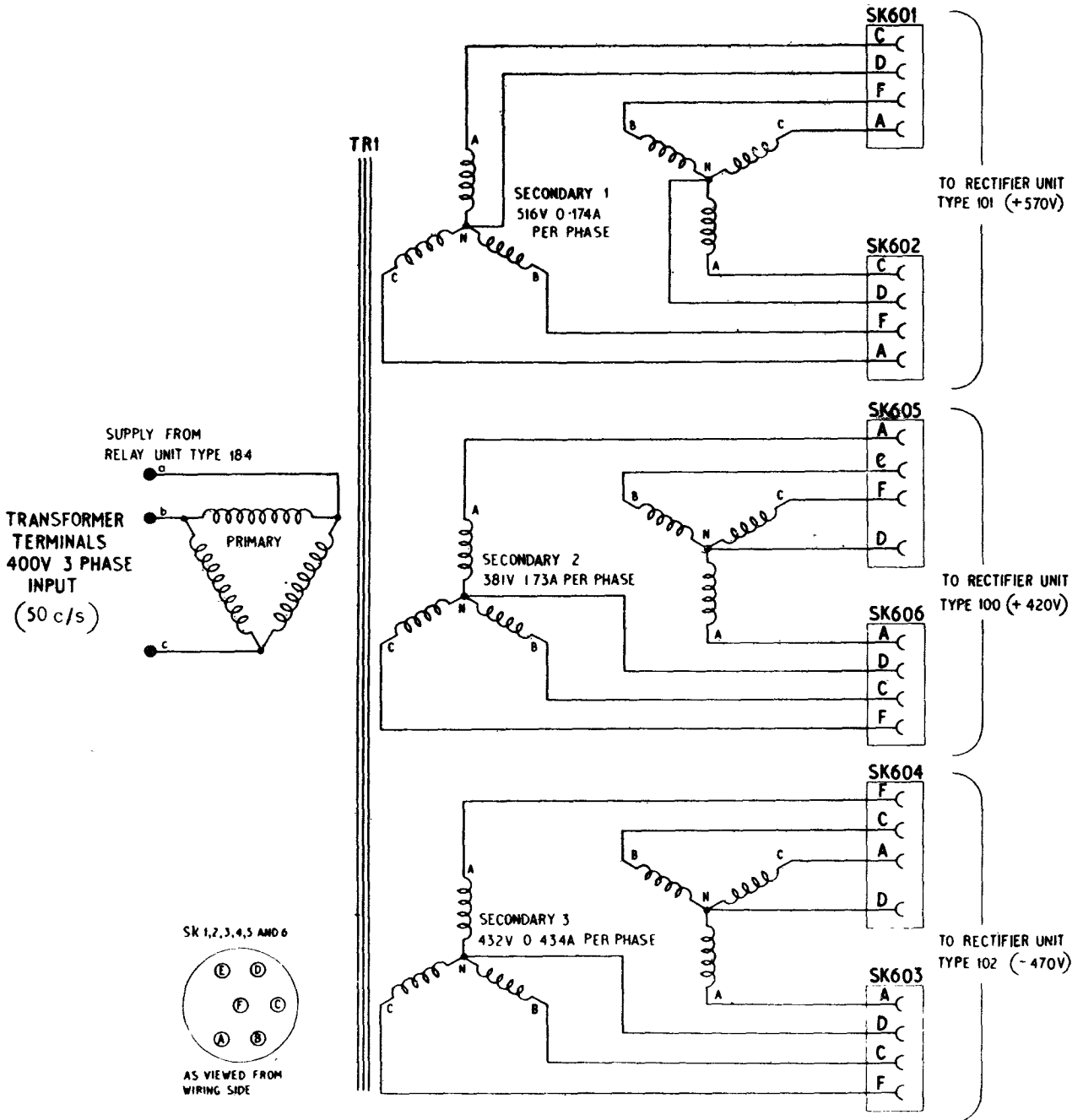


Fig. 5. Transformer assembly circuit

22. Behind the component panel (fig. 7) are the heavy components (chokes and filament transformer), together with the filter capacitors and plug and socket outlets. Table 2 gives a list of the component items as an aid to servicing.

**Circuit**

23. Fig. 8 is the circuit diagram of the rectifier unit. The circuit is similar to that of the basic six-phase double-star rectifier described in para. 13-17, but instead of the diodes of the simple circuit, gas-filled triode thyratrons (CV2210) are used. These are directly-heated, xenon-filled

valves with 2.5V, 12A filaments, and they are capable of delivering a peak anode current of 40A, and of withstanding a peak inverse voltage of 1,500V at the anode.

24. The 50c/s three-phase input for V1, V2 and V3 comes from one of the star windings of secondary 2 (SK605) on the main transformer, via PL102, and the input from the other star winding of secondary 2 (SK606) comes to V4, V5 and V6 via PL101. The two neutral lines of the star windings are linked through the balance choke L1, and the common HT neutral line from

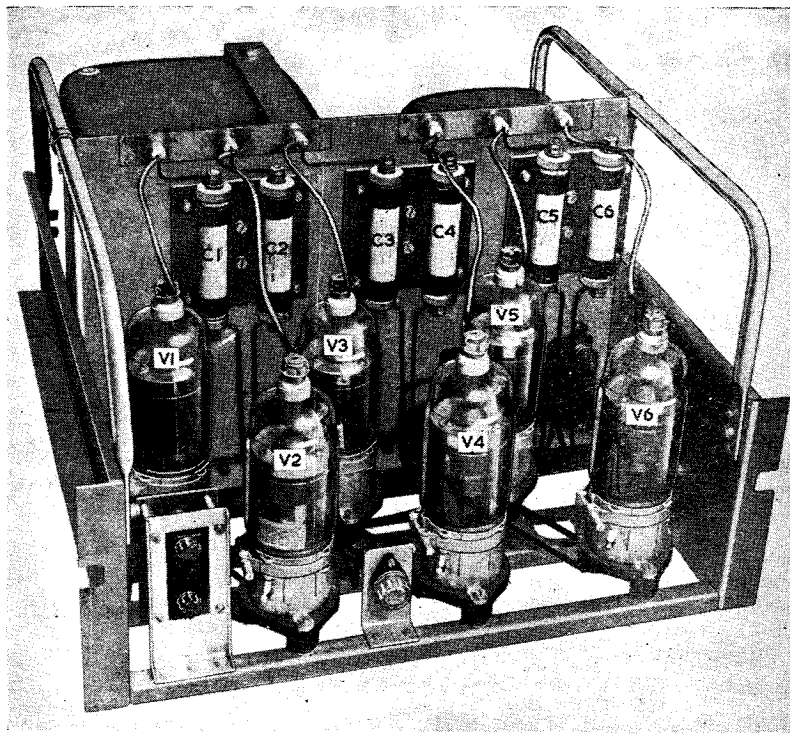


Fig. 6. Rectifier unit (+420V) Type 100—general view

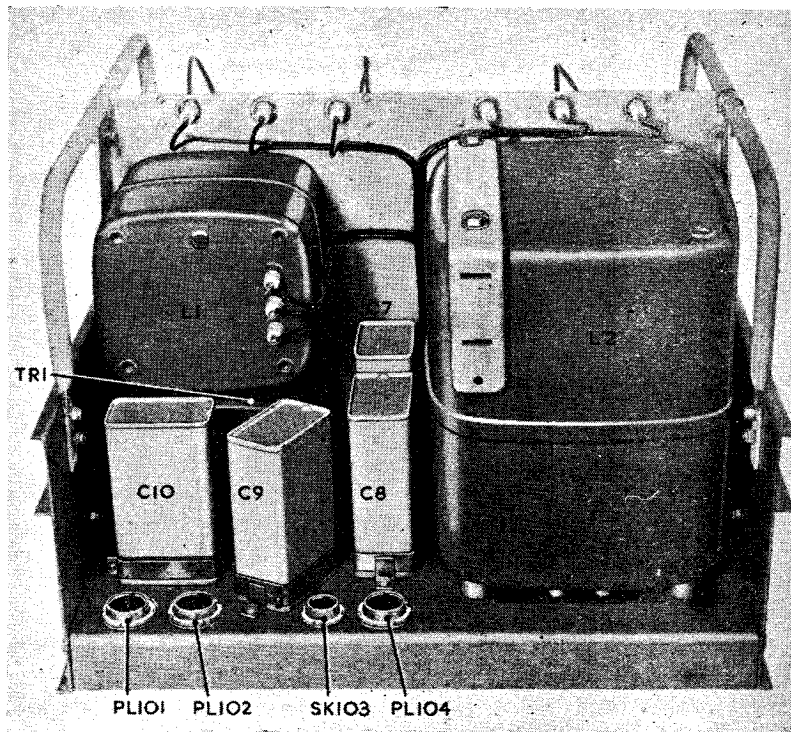


Fig. 7. Rectifier unit (+420V) Type 100—rear view

the centre tap of the choke (negative output pole) is taken via PL104/D to SK502/D in the relay unit Type 184, where it is earthed. The thyatron cathodes are connected to a common positive line and feed a choke-input filter circuit (L2 and C7 to C11). The resistor R8 provides a discharge

path for the smoothing condensers, and the +420V DC output is taken via the 7A fuse FS1 to PL104/A, which feeds SK502/A in the relay unit. The nominal output of the rectifier unit is +420V, 6A, which represents the full load, with six consoles on. With only one console on, the

output rises to about +433V, i.e. the rectifier has a regulation better than 3 per cent over the load range. The ripple level is also less than 3 per cent.

25. Although the Type CV2210 thyratrons are being used only as diodes, the grids cannot be strapped to their respective anodes, because this would reduce the maximum peak inverse voltage that the valves could withstand. Nor can the grids be strapped directly to the cathodes, because this would severely restrict the firing time of the thyratrons. The grids are therefore connected to the anodes by CR networks (R, C1 and R1 for

V1, and so on) so that they are driven positive on positive half cycles, thus ensuring accurate firing of the thyratrons over one third of the cycle. The thyratrons are extinguished when the anode voltages fall below the operating level.

**NOTE:**

If the CV2210 is subjected to mechanical shocks, there is a possibility of portions of the cathode coating becoming detached and causing backfires, which may have serious consequences. Particular care must therefore be taken to avoid rough handling, and spare valves must always be kept in the transit cases in which they are supplied.

Table 2

Rectifier unit (+420V) Type 100-component details

Circuit Ref.	Description	Value	Rating	N.S./Ref. No.
C1 to C6	Capacitors, tubular, fixed, Type 7530	0.01μF	7.5kV	10C/19662
C7 to C11	Capacitors, fixed	8μF	600V	5910-99-011-2825
R1 to R6	Resistors, fixed	22kΩ	¾W	5905-99-022-2174
R7	Resistor, fixed	470kΩ	¾W	5905-99-022-3123
R8	Resistor, fixed	180kΩ	1½W	5905-99-021-6143
R9 to R14	Resistors, fixed	100kΩ	¾W	5905-99-022-3039
TR1	Transformer, Type 2973			10K/17153
L1	Choke, LF, Type 1125			10C/19150
L2	Choke, LF, Type 1126			10C/19151
FS1	Fuse link		7A	5920-99-059-0119
FS2	Thermo cut-out			5930-99-940-2356
LP1	Lamp indicating			6240-99-996-2106
PL101	Plug, 6-way fixed, Mk. 4			5935-99-046-0140
PL102	Plug, 6-way fixed, Mk. 4			5935-99-056-0140
SK103	Socket, 3-way fixed, Mk. 4			5935-99-056-0240
PL104	Plug, 6-way fixed, Mk. 4			5935-99-056-0541

RECTIFIER UNIT (+570V) TYPE 101

**Construction**

26. This unit (Stores Ref. 10D/18699) is very similar in construction to the Type 100 already described (para. 21-22). It is illustrated in fig.9 and 10, and Table 3 gives a list of components.

**Circuit**

27. The circuit diagram is given in fig. 11. It is a straight-forward example of the basic three-phase full-wave rectifier circuit described in para.

13-17. The rectifiers are xenon-filled diodes Type CV1835. This valve is of U.S. origin (3B28) and has a UX4 base. The directly-heated cathode is oxide coated and requires 2.5V, 5A. The peak DC anode current is 2A and the peak inverse voltage is 10kV. The output of the unit with respect to the common HT neutral is approximately +571V on full load (six consoles on), and +588V on minimum load (one console on).

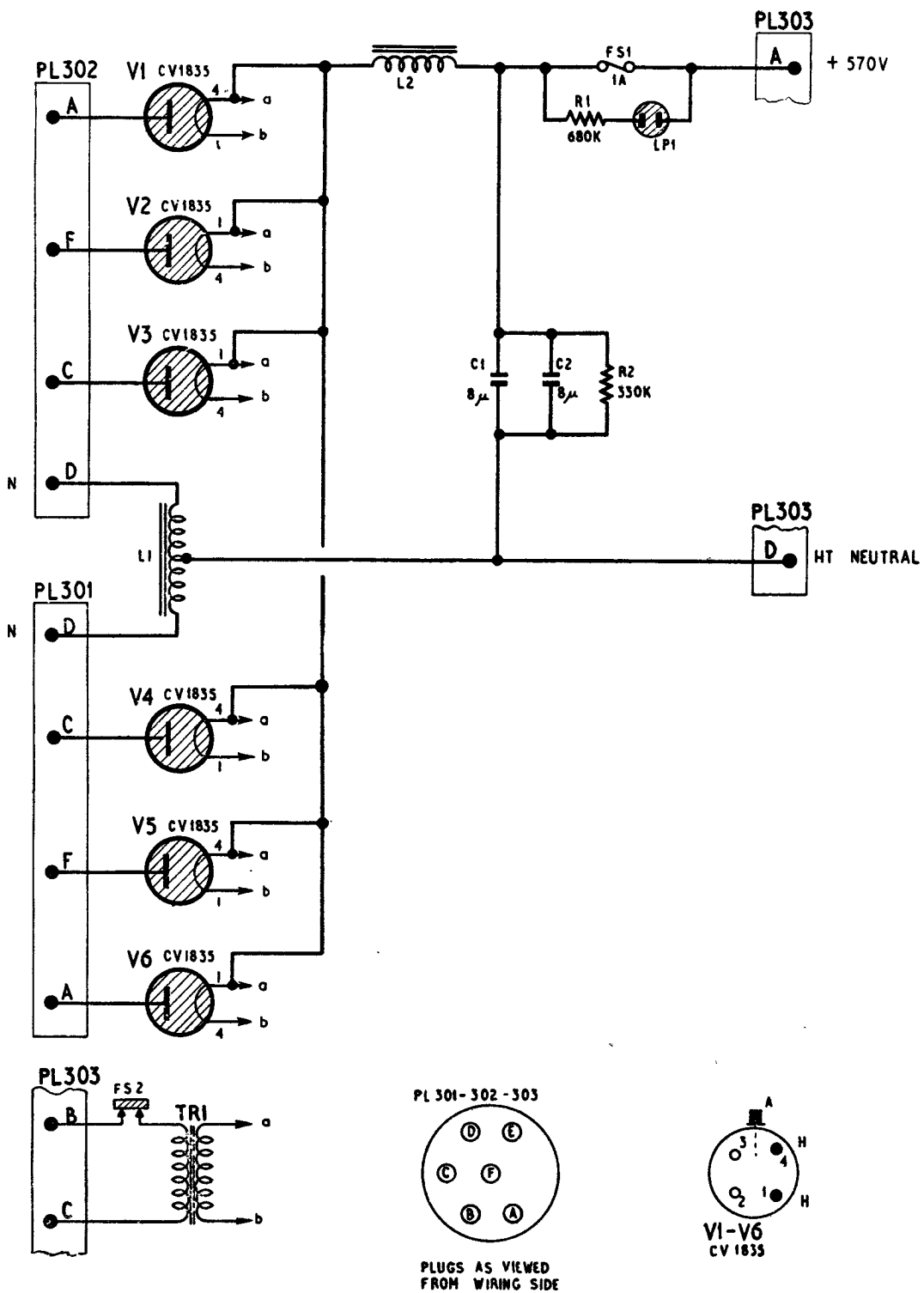


Fig. 11. Rectifier unit (+570V) Type 101—circuit

### RECTIFIER UNIT (−470V) TYPE 102

#### Construction

28. A plan view of this unit (Stores Ref. 10D/18700) is shown in fig. 12. The construction is almost identical with that of the rectifier unit Type 101, and similar components are used (Table 4). The only items not visible in fig. 12 are R1 (concealed behind the fuse assembly at the front) and R2 (under C1).

#### Circuit

29. The circuit (fig. 13) is also very similar to that of the rectifier unit Type 101, except that the output polarity is reversed and some of the components have different values and ratings. The common cathode connection of the rectifier diodes (CV1835) is taken via PL403/D to SK506/D in the relay unit Type 184 to join the common HT

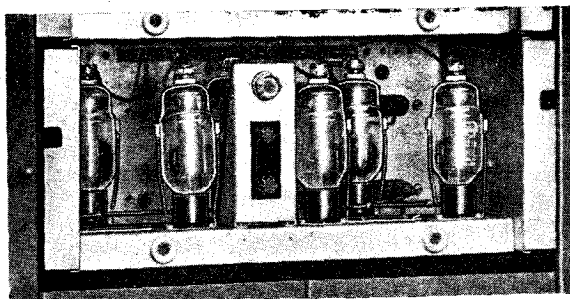


Fig. 9. Rectifier unit (+570V) Type 101—front view

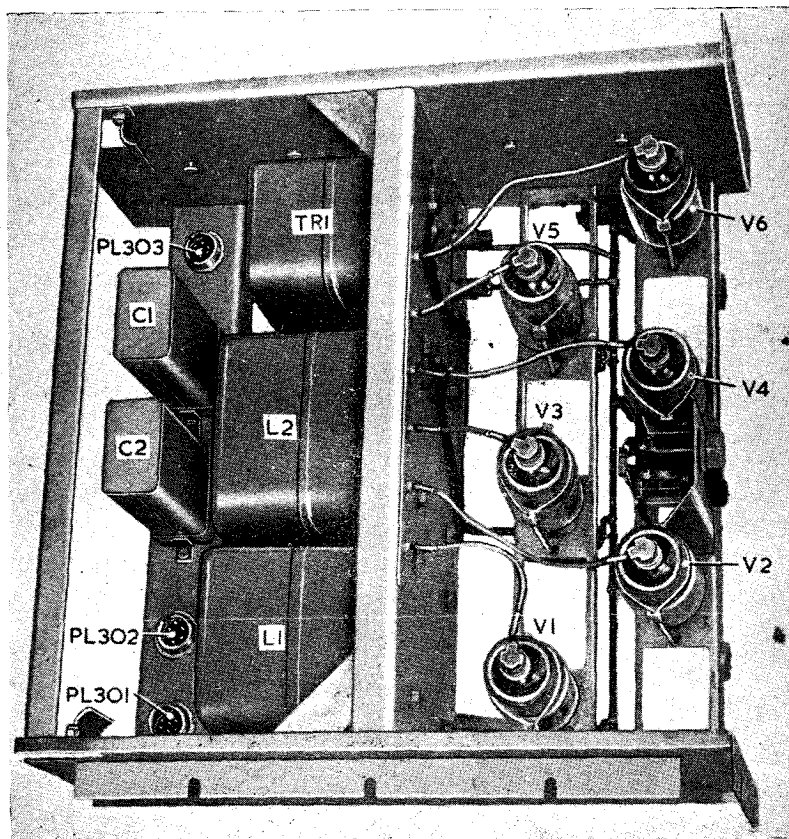


Fig. 10. Rectifier unit (+570V) Type 101—top view

**TABLE 3**  
Rectifier unit (+570V) Type 101—component details

Circuit Ref.	Description	Value	Rating	Tol. per cent	Ref. No.
R1	Resistor, fixed	680K $\Omega$	$\frac{3}{4}$ W	$\pm 10$	Z223144
R2	Resistor, fixed	330K $\Omega$	1W	$\pm 10$	Z213333
C1, C2	Capacitors, fixed	8 $\mu$ F	800V	$\pm 20$	Z112629
TR1	Transformer 2975	—	—	—	10K/17155
L1	Choke LF 1128	—	—	—	10C/19153
L2	Choke LF 1124	—	—	—	10C/19149
FS1	Fuse link	—	1A	—	Z590115
FS2	Thermal cut-out	—	—	—	10AE/655
LP1	Lamp, indicating (5L/648)	—	—	—	X962106
PL301	Plug, 6-way, fixed, Mk. 4	—	—	—	Z560140
PL302	Plug, 6-way, fixed, Mk. 4	—	—	—	Z560140
PL303	Plug, 6-way, fixed, Mk. 4	—	—	—	Z560541

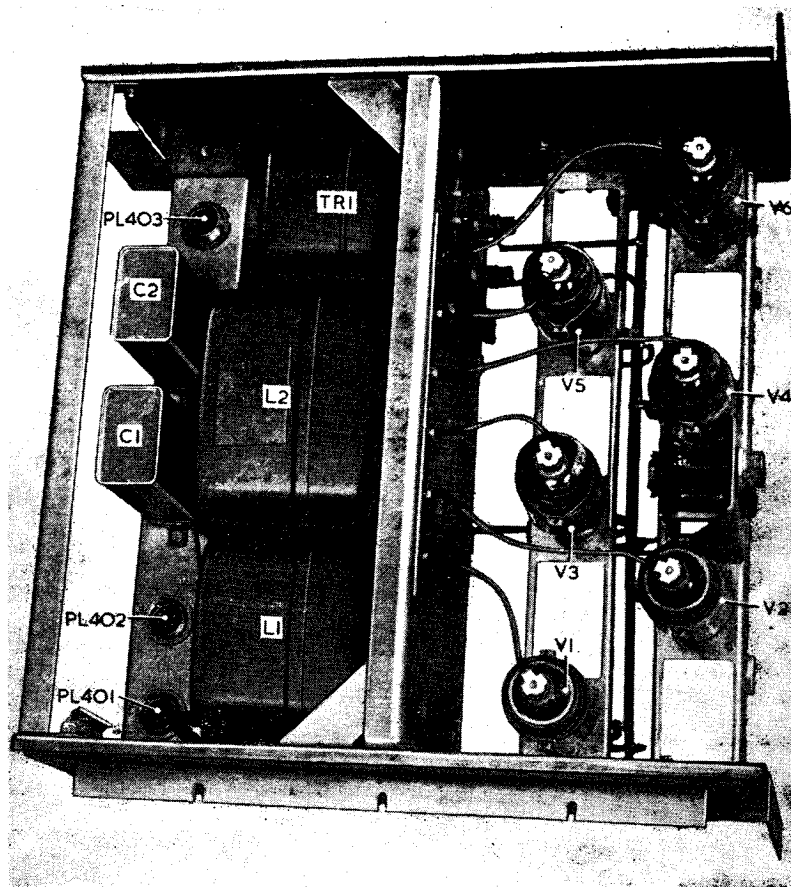


Fig. 12. Rectifier unit (—470V) Type 102—top view

neutral line, which is earthed in the relay unit. The negative output from the rectifier Type 102 is taken from the centre-tap of the balance choke L1, through a choke input filter circuit (L2, C1, C2) and fuse FS1 (2A) to PL403/A which feeds

the console supply lines via SK506/A in the relay unit. The output is —470V on full load (six consoles on), and increases to —487V (approx) on minimum load (one console on). The ripple level is normally less than 3 per cent.

TABLE 4  
Rectifier unit (—470V) Type 102—component details

Circuit Ref.	Description	Value	Rating	Tol. per cent	Ref. No.
R1	Resistor, fixed	470K $\Omega$	$\frac{3}{4}$ W	$\pm 10$	Z223123
R2	Resistor, fixed	220K $\Omega$	1W	$\pm 10$	Z213331
C1, C2	Capacitors, fixed	8 $\mu$ F	600V	$\pm 20$	Z112825
TR1	Transformer Type 2975	—	—	—	10K/17155
L1	Choke 1127	7H	—	—	10C/79152
L2	Choke 1129	1.5H	—	—	10C/19154
FS1	Fuse link	—	2A	—	Z590116
LP1	Lamp, indicating (5L/648)	—	—	—	X962106
PL401	Plug, fixed (10H/19284), 6-way, Mk. 4	—	—	—	Z560140
PL402	Plug, fixed (10H/19284), 6-way, Mk. 4	—	—	—	Z560140
PL403	Plug, fixed (10H/19284), 6-way, Mk. 4	—	—	—	Z560541



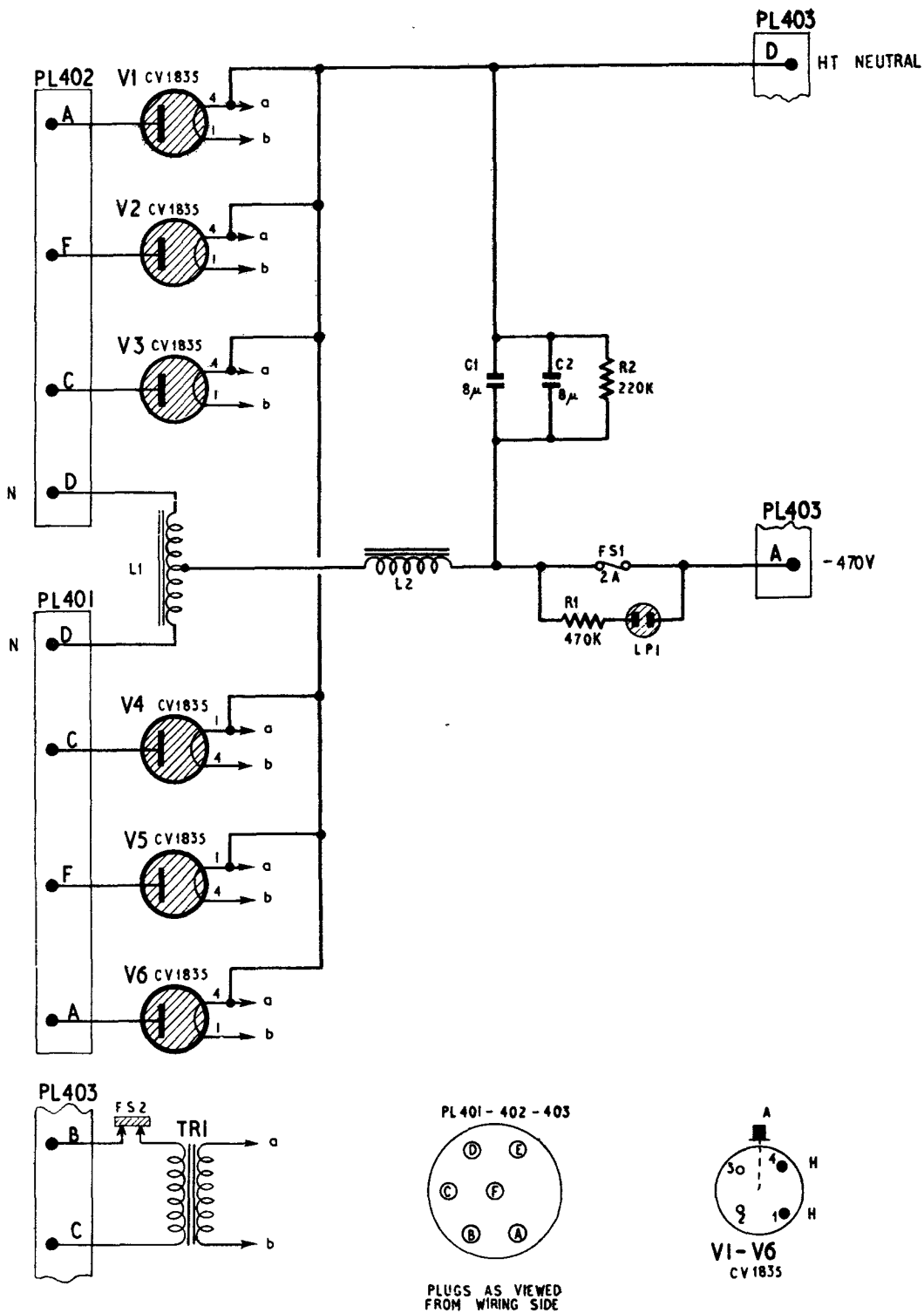


Fig. 13. Rectifier unit (-470V) Type 102—circuit

### STABILIZER UNIT (VOLTAGE) TYPE 100

#### Purpose

30. This unit (Stores Ref. 10D/18697) accepts the +420V supply from the rectifier unit Type 100, via the relay unit Type 184, and produces six separate +250V stabilized outputs. Each output goes to one of the six consoles fed from the bulk power supply rack, and the maximum current

delivered to each, without loss of regulation, is 600mA. The stabilizer unit also has a meter on the front panel, for monitoring the regulator currents within the unit, and also for checking output volts and ripple on all the HT outputs from the rack.

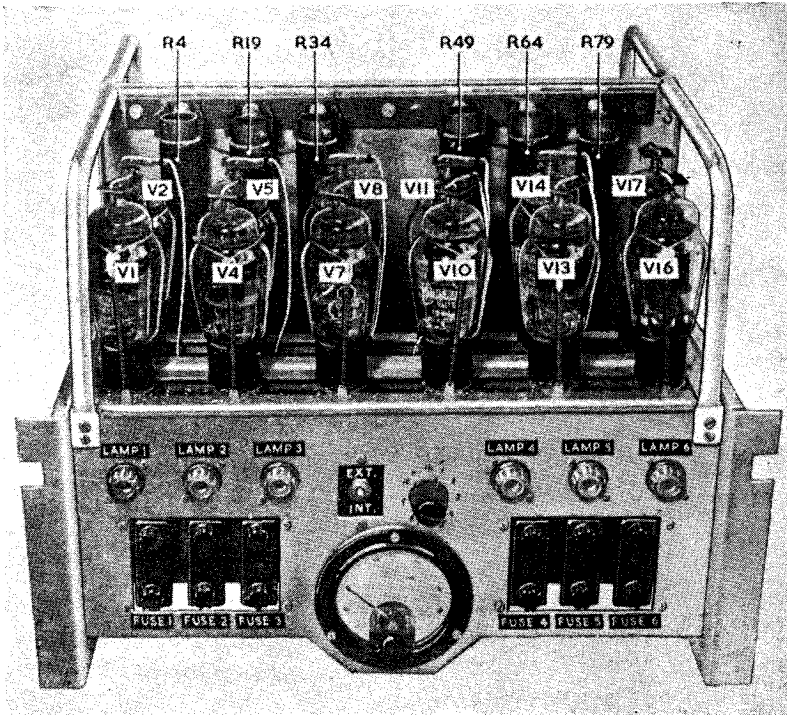


Fig. 14. Stabilizer unit (voltage) Type 100—front view

**Construction**

31. Fig. 14, 15 and 16 are views of a prototype unit; the front panel layout is slightly varied in production models. Broadly, the unit is divided into four quarters by horizontal and vertical partitions. The lower front quarter carries the front panel with the meter and its switches, and the fuse links and neon indicators. Behind the front panel are the CV138 control valves. In the upper front part are the twelve CV345 regulator tetrodes and the six 620Ω, 100W resistors which shunt the regulator valves. In the lower rear section are group boards carrying the small components. The VOLTAGE SET potentiometers project through the centre partition and have locking nuts to secure them after setting up. At the upper rear are the heater transformer TR1 and all the 0.1μF tubular capacitors. Table 5 gives a list of the components.

**Circuit**

32. The circuit diagram of the stabilizer unit is given in fig. 19. The six channels are identical. If the one at the top left of the diagram be taken as an example, V1 and V2 (beam tetrodes CV345, triode-connected) are the regulator valves, and V3 (CV138 pentode) is the control valve. The +420V from the rectifier unit Type 100 comes in at PL203/A (connected to SK503/A in the relay unit). Overload protection is provided by FS1 (1A), which has a neon indicator (LP1) and ballast resistor (R11) across it.

33. Apart from the individual anti-parasitic grid stoppers R7, R8, and the cathode metering resistors R13 and R14, the two tetrodes are strapped in parallel. They do not pass the full load current; approximately 250mA by-passes the tetrodes via the 620Ω 100W resistor R4, while the remaining 250mA (approx.) goes via the tetrodes. The voltage drop across the tetrodes depends on their grid potential, which is governed by the control valve, V3.

34. V3 functions as described at length when dealing with the power unit Type 903 in Chap. 1

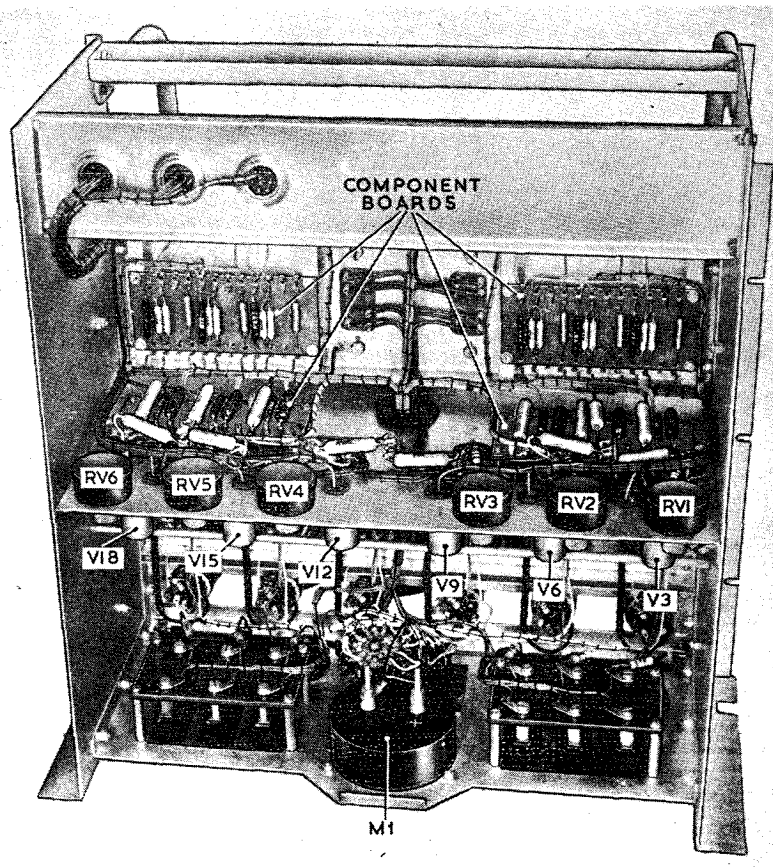


Fig. 15. Stabilizer unit (voltage) Type 100—underside

of this Sect. The 470K grid resistor (R9) is returned to the slider of a 100K potentiometer RV1 (VOLTAGE SET +25.), which forms part of a resistance chain from the +250V output rail down to the -500V reference rail. The anode current of V3, and therefore the voltage across R3, which determines the grid potential of the regulator valves and therefore the output voltage, is determined by the setting of RV1. Any fluctuations of the +250V output are picked up and also applied to V3 via RV1. They are amplified and phase inverted by V3, and applied to the grids of the regulator valves to restore the output to its set value.

35. Since V3 derives its anode current from the unstabilized +420V line it injects a certain amount of AC ripple into the regulator stage, but this is nullified by connecting C2 directly between the +250V line and the anti-parasitic circuit (R91, C19, R92) at V3 grid.

#### Metering

36. For metering the currents in the regulator valves, SWA (EXT./INT.), which is shown in the external position in fig. 19, must be operated to *internal*. The desired valve may then be selected using SWB, which connects the meter M1 across the appropriate cathode resistor. The meter scale is marked 0-300 and the F.S.D. in this instance is 300mA (the meter current is 1 mA). The resistors R103 and R104 (a total of 350Ω) in series with the meter, result in a deflection of 100 divisions with the meter shunted across the 1.5Ω cathode resistor when a regulator valve is passing the normal current of 125mA. The ratio of the anode currents of each pair of valves must

not exceed 2:1, and the sum of the currents in each pair must be within the limits 190 mA to 300 mA (all six consoles supplied by the rack switched on, including HT).

37. For metering the voltages on the six +250V output rails, when setting up RV1 to RV6, SWA must be turned to *external*, to connect the meter to the relay unit Type 184 (SK504/L and K) via PL202/L and K. The relay resistor R39 (220K) is then connected across the meter, which may be used for RIPPLE or VOLTAGE checks as determined by the relay unit switch SWA. Selection of +250V rails is the function of SWB in the relay unit.

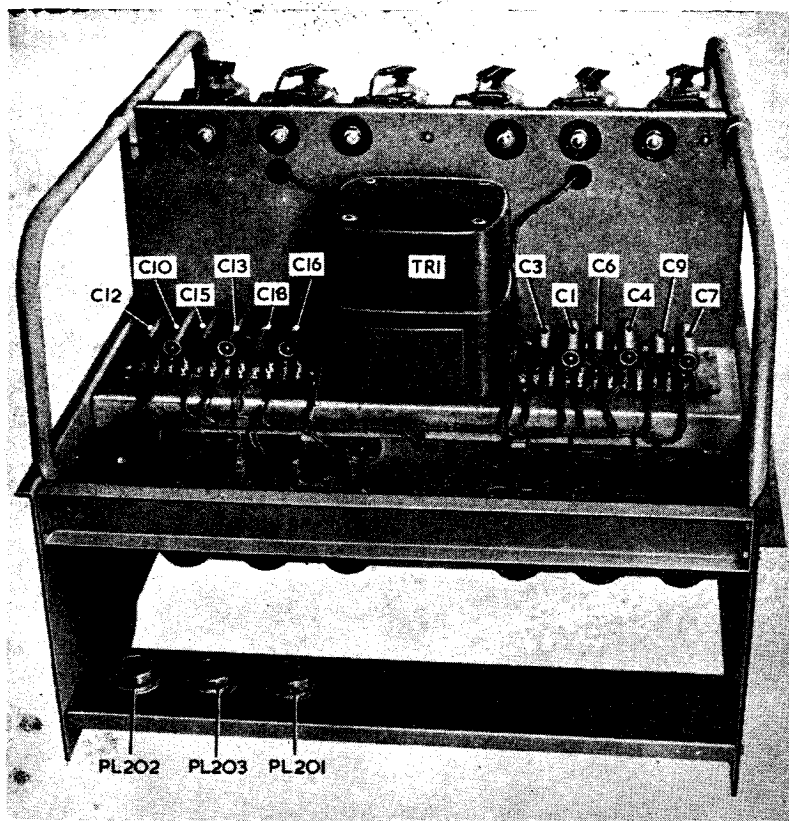


Fig. 16. Stabilizer unit (Voltage) Type 100—rear view

TABLE 5

Stabilizer unit (voltage) Type 100—component details

Circuit Ref.	Description	Value	Rating	Tol. per cent	Ref. No.
R 1, 16, 31, 46, 61, 76	Resistors, fixed	15KΩ*	$\frac{3}{4}$ W	± 5	Z216023
R 2, 17, 32, 47, 62, 77		47KΩ*	$1\frac{1}{2}$ W	± 5	Z216085
R 3, 18, 33, 48, 63, 78		56KΩ*	1W	± 5	Z216094
R 4, 19, 34, 49, 64, 79		620Ω	100W	± 5	Z241264
R 5, 20, 35, 50, 65, 80		100Ω	$\frac{1}{2}$ W	±10	Z221110
R 6, 21, 36, 51, 66, 81		100Ω	$\frac{1}{2}$ W	±10	Z221110
R 7, 22, 37, 52, 67, 82		4.7KΩ	$\frac{1}{2}$ W	±10	Z222089
R 8, 23, 38, 53, 68, 83		4.7KΩ	$\frac{1}{2}$ W	±10	Z222089
R 9, 24, 39, 54, 69, 84		470KΩ	$\frac{1}{2}$ W	±10	Z223122
R10, 25, 40, 55, 70, 85		510KΩ	$\frac{1}{2}$ W	± 2	Z216602
R11, 26, 41, 56, 71, 86		470KΩ	$\frac{3}{4}$ W	±10	Z223123
R12, 27, 42, 57, 72, 87		1MΩ	$\frac{1}{2}$ W	± 2	Z219970

**TABLE 5 (continued)**  
**Stabilizer unit (voltage) Type 100 - component details (continued)**

Circuit Ref.	Description	Value	Rating	Tol. per cent	Ref. No.
R13, 28, 43, 58, 73, 88		1.5Ω	1½W	±10	Z243449
R14, 29, 44, 59, 74, 89		1.5Ω	1½W	±10	Z243449
R15, 30, 45, 60, 75, 90		24KΩ	1W	±5	Z216049
R91, 93, 95, 97, 99, 101		10KΩ	½W	±5	Z216002
R92, 94, 96, 98, 100, 102		330Ω	½W	±10	Z221173
R103		330Ω	½W	±5	Z215182
R104		20Ω	½W	±5	Z215036
RV1 to RV6	Resistors, variable	100KΩ	1W	±10	Z272549
C1, 2, 4, 5, 7, 8,					
C10, 11, 13, 14, 16, 17	Capacitors, fixed	0.1μF	500V	±20	Z115507
C3, 6, 9, 12, 15, 18	Capacitors, fixed	0.1μF	350V	±20	Z115506
C19 to 24	Capacitors, fixed	100pF	500V	±20	Z132300
FS1 to FS6	Fuse links		1A		Z590115
FS7	Thermo-cutout				10AE/655
LP1 to LP6	Lamps, indicating (5L/648)				X962106
TR1	Transformer 2974				10K/17154
M1	Meter		0-300		5Q/25228
SWA	Switch, toggle				Z510583
SWB	Switch, rotary 2-pole, 12-way Type 2177				10F/17466
PL201	Plug, 6-way, fixed (10H/19284), Mk. 4				Z560140
PL202	Plug, 12-way, fixed (10H/19284), Mk. 4				Z560150
PL203	Plug, 6-way, fixed (10H/19284), Mk. 4				Z560541

### RELAY UNIT TYPE 184

#### Purpose

**38.** The relay unit Type 184 (Stores Ref. 10F/16208) serves as the central junction box and switching unit for the bulk HT services. It contains contactors and relays (operated from the six associated consoles) which switch on the rack and also route HT supplies out to the individual consoles.

#### Construction

**39.** The unit is built on a half-decked 19 in. framework. Fig. 17 is a front view and fig. 18 a plan view of the unit. The switches, fuses and neon indicators, and the Venner time-delay relay are on the front, while the plugs, sockets and terminals are on the horizontal deck at the rear. There are two U-shaped handles on the front for pulling the unit out of the racks and lifting it off the runners. Table 7 gives a list of components.

#### Circuit

**40.** Fig. 20 is the circuit diagram of the relay unit. All the relays are shown in the un-energized position, and the rack ON/OFF switch (SWC) is in the OFF position. In this state no -50V is being applied from any of the consoles, to sockets SK513/A to M, and though 230V 3-phase mains are being applied to terminals 1, 2 and 3, they are not yet connected out via 4, 5 and 6 to the main transformer. Similarly, the single-phase 230V mains for heaters are arriving at PL501/A

and B, but are not supplied to the rectifier units because relay RLB is not energized.

**41.** When the rack ON/OFF switch SWC has been closed, nothing happens until -50V is applied from any one of the associated consoles, to pin A, B, C, D, E or F of SK513 (and at the same time to the negative reference rack Type 338). The following changes then take place:—

- (1) Relay RLB is operated directly, the return circuit to the +50V line being made straight to SK513/P.
- ◀ (2) Relay RLL operating coil circuit is completed from SWC via the closed contacts (1 and 2) of relay RLM.
- (3) Contacts RLL/1 open and prevent the immediate operation of contactor RLK when contacts RLC/1 on the time-delay relay operate later (*this sequence depends on the incorporation of modification No. CA.622*).▶
- (4) The -50V, from the console to the rack assembly Type 338, closes a relay there to provide -500V reference to the bulk power supply rack.

**42.** Relay contacts RLB/1 and 2 close and provide the following connections from the 230V single-phase AC input (PL1/A and B), via fuses FS5 and FS4 (shunted by the usual neon indicators and ballast resistors LP5, R8 and LP4, R7):—

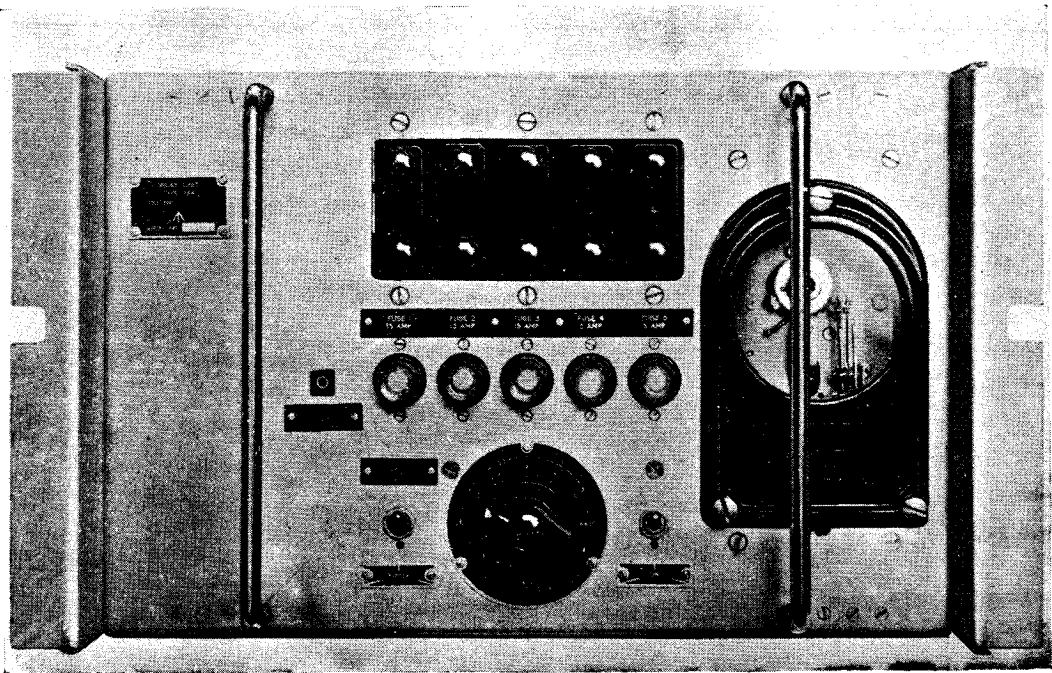


Fig. 17. Relay unit Type 184—front view

- (1) The operating coil of the Venner time-delay relay RLC is energized.
- 2) The 230V AC supply is connected out to the rectifier and stabilizer units, via SK502/B, C (to PL104, rectifier 100), SK504/H, J (to PL202, stabilizer 100), SK505/B, C (to PL303, rectifier 101), and SK506/B, C (to PL403, rectifier 102), thus lighting all valve heaters in the rack, and also lighting the mains supply indicator lamp at the top of the rack, which is connected to SK103/A, B (in parallel with PL104/B, C) in the rectifier 100.

43. After one minute the time-delay relay RLC operates and contacts RLC/1 close to complete the 50V circuit for the operating coil of relay RLM, whose contacts change over (1 and 2 break, while 2 and 3 make) to energize contactor RLA (also via contacts RLC/1). At the same time relay RLL is de-energized by the opening of RLM contacts 1 and 2 but since RLL is slow releasing a few microseconds elapse before contacts RLL/1 close, so contactor RLK is not energized immediately.

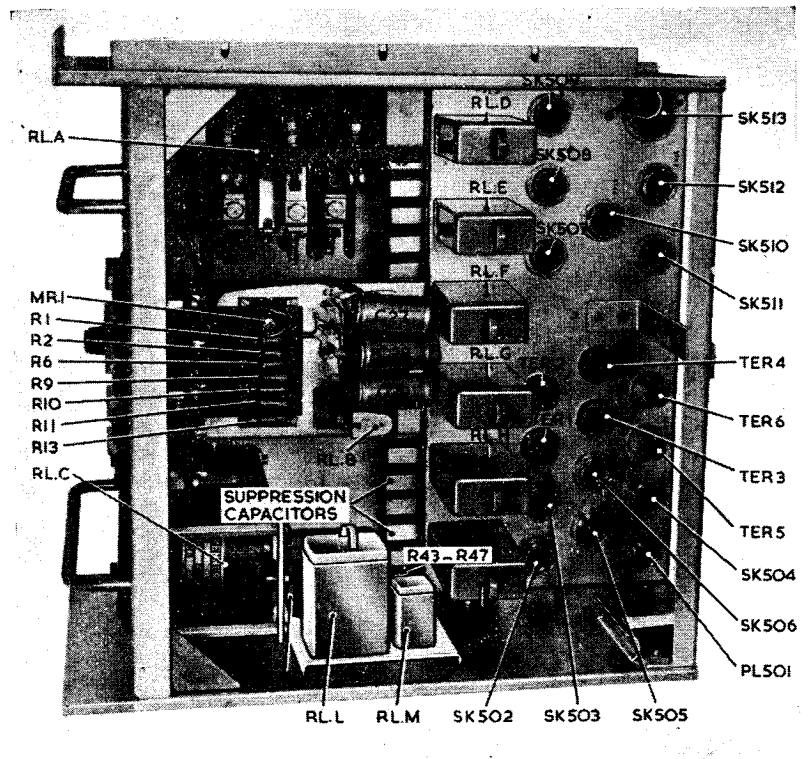


Fig. 18. Relay unit Type 184—top view

44. Contacts RLA/1, 2 and 3 close and feed power out to the three-phase HT transformer via fuses FS1, FS2 and FS3 (15A). These fuses

are shunted by the usual neon indicators and ballast resistors. The 47 $\Omega$ , 6W resistors (R45, R46 and R47), in series with the mains input lines, reduce the switching-on surge which might otherwise blow the fuses. The lag in operation of relay RLL allows time for the dissipation of the surge before contacts RLL/1 close and energize contactor RLK, whereupon contacts RLK/1, 2 and 3 short out the surge limiting resistors.

**45.** Before the introduction of modification No. CA.622, resistors R45, R46 and R47 were apt to overheat after being brought into circuit by a temporary mains failure which tripped RLK but not RLA. The modification ensures that RLA is de-energized by even a momentary mains failure and R45-R47 are not made to carry continuous current.▶

**46.** The rectifier heaters have warmed up during the 1 minute delay provided by RLC, and the rectifier units produce HT as soon as the main transformer is energized. However, no HT supplies are connected out to any console until its HT ON circuit has closed and applied -50V to pin G, H, J, K, L or M of SK513, to energize relay RLD, RLE, RLF, RLG, RLH, or RLJ.

**47.** Taking console No. 1 as an example, -50V is applied to SK513/M (via SK710/M on the right-hand rack side panel) and RLJ is energized.

- (1) Contacts RLJ/1 connect +420V DC out to the console (via SK507/C and SK704/C) and also to the stabilizer (voltage) Type 100 (via SK503/F and PL203/F).
- (2) Contacts RLJ/2 connect +570V DC out to the console (via SK507/A and SK704/A).
- (3) Contacts RLJ/3 connect -470V DC out to the console (via SK507/D and SK704/D).

**48.** As the other consoles are switched on, their associated relays close and make similar connections. The relay contacts are shunted by CR spark suppression circuits.

#### Metering and CRO checks

**49.** The voltage, or the ripple level, on the HT lines may be metered by setting switch SWA to

VOLTAGE or RIPPLE as desired, and selecting the lines by means of SWB. The voltage or ripple reading may then be observed on the meter in the stabilizer Type 100. The INT./EXT. on the stabilizer unit must be set to *external* for these observations (*para. 36*).

**50.** The ripple waveform is rectified by the bridge-connected metal rectifier MR1. On the meter, the permissible NORMAL ripple range is marked by red lines. The 47 $\Omega$  resistor (R1) is effectively across the meter to give the required F.S.D. characteristics. The HT line to be metered is selected by wafer 1 of SWB. The ripple on the HT output lines (with respect to the common earth line) is applied to C27, R40 (-470V), C28, R41 (+420V) and C29, R42 (+570V). SWB/1 selects the AC voltage across R40, R41 or R42 for application to MR1.

**51.** The selected output is also applied to the external monitoring socket SK514, and is shunted by C1 (1 $\mu$ F). Using this socket (connected to CRO terminal A1 and with the CRO properly earthed), the ripple, as observed on the CRO Type 9172 (Cossor Type 1035A), should not exceed 15V peak-to-peak on the +570V and +420V lines, and 10V peak-to-peak on the -470V line (CRO on 15V range). On the +250V supplies the ripple check is carried out on the stabilized lines in the stabilizer Type 100, with CRO A1 to the lower ends of R4, R19, R34, R49, R64 and R79 (*fig. 19*) in turn. The ripple present should not exceed 50mV peak-to-peak (CRO on 50mV range).

**52.** For voltage readings the HT lines are selected by wafers 2 and 3 of SWB. On position 2, SWB/2 selects the -470V line via R9 (300K) while SWB/3 selects the earth connection. For the other positions of SWB, wafer 2 makes the earth connection and wafer 3 selects the live line. Switch contacts on position 3 are left blank and the -470V and +570V connections are on different wafers to prevent arcing. Table 6 gives the meter readings to be expected in VOLTAGE observations, when the voltages are correctly set. The voltage limits are also given where applicable.

**TABLE 6**  
Meter readings

SWB position	RAIL (volts)	LIMITS	METER READING (divisions)
1 (OFF)			
2	-470	466-500	235 (F.S.D. 600V)
3 (BLANK)			
4	+570	558-603	285 (F.S.D. 600V)
5	+250 (1)	—	250 (F.S.D. 300V)
6	+250 (2)	—	250
7	+250 (3)	—	250
8	+250 (4)	—	250
9	+250 (5)	—	250
10	+250 (6)	—	250
11 (fully clockwise)	+420	400-435	210 (F.S.D. 600V)

TABLE 7

## Relay unit Type 184—component details

Circuit Ref.	Description	Value	Rating	Tol. per cent	Ref. No.
Resistors (fixed)					
R1		47 $\Omega$	$\frac{1}{4}$ W	$\pm 5$	Z215081
R2	(not fitted)				
R3, R4, R5		470K $\Omega$	$\frac{3}{4}$ W	$\pm 10$	Z223123
R6	(not fitted)				
R7, R8		220K $\Omega$	$\frac{3}{4}$ W	$\pm 10$	Z223081
R9 to R13		300K $\Omega$	$\frac{3}{4}$ W	$\pm 1$	Z216551
R14, R18, R22, R26, R30, R34		10 $\Omega$	$\frac{3}{4}$ W	$\pm 10$	Z221003
R15, R19, R23, R27, R31, R35	(not fitted)				
R16, R17, R20, R21, R24, R25	}	100 $\Omega$	$\frac{3}{4}$ W	$\pm 10$	Z221111
R28, R29, R32, R33, R36, R37					
R38	(not fitted)				
R39		220K $\Omega$	$\frac{3}{4}$ W	$\pm 10$	Z223081
R40, R41, R42		10K $\Omega$	$\frac{1}{2}$ W	$\pm 10$	Z222131
R43	} removed under modification No CA.622				
R44					
R45, R46, R47		47 $\Omega$	6W	$\pm 5$	Z243066
Capacitors (fixed)					
C1		1 $\mu$ F	150V	$\pm 25$	Z115569
C2	(not fitted)				
C3		1 $\mu$ F	600V	$\pm 20$	Z112823
C4	(not fitted)				
C5, C6		0.25 $\mu$ F	1,000V	$\pm 20$	Z111259
C7		1 $\mu$ F	600V	$\pm 20$	Z112823
C8	(not fitted)				
C9, C10		0.25 $\mu$ F	1,000V	$\pm 20$	Z111259
C11		1 $\mu$ F	600V	$\pm 20$	Z112823
C12	(not fitted)				
C13, C14		0.25 $\mu$ F	1,000V	$\pm 20$	Z111259
C15		1 $\mu$ F	600V	$\pm 20$	Z112823
C16	(not fitted)				
C17, C18		0.25 $\mu$ F	1,000V	$\pm 20$	Z111259
C19		1 $\mu$ F	600V	$\pm 20$	Z112823
C20	(not fitted)				
C21, C22		0.25 $\mu$ F	1,000V	$\pm 20$	Z111259
C23		1 $\mu$ F	600V	$\pm 20$	Z112823
C24	(not fitted)				
C25, C26		0.25 $\mu$ F	1,000V	$\pm 20$	Z111259
C27, C28, C29		0.5 $\mu$ F	1,000V	$\pm 20$	Z111377
FS1, FS2, FS3	Fuse links	—	15A	—	Z590121
FS4, FS5	Fuse links	—	5A	—	Z590118
LP1 to LP5	Lamps, indicating	—	—	—	X962106
RLA	Contactors 4063	—	—	—	10AD/817
RLB	Relay, magnetic (3000Y)	—	—	—	Z530111
RLC	Switch unit, time-delay, 4062 (Venner, Type DS1/M)	—	—	—	10F/17459
RLD to J	Relays, magnetic 1322	—	—	—	10F/17461
RLK	Contactors 4838	—	—	—	10AD/922
RLL	Relay	—	—	—	Z530366
RLM	Relay	—	—	—	Z530040
MRI	Rectifier, metal, 64	—	5mA	—	10D/826
SWA	D.P. Toggle switch	—	3A, 250V	—	—
SWB	Wafer switch 2173, Type H	—	—	—	10F/17458
SWC	S.P. Toggle switch	—	3A, 250V	—	Z510300
PL501	3-way fixed plug, Mk. 4	—	—	—	Z560060
SK502	6-way fixed socket, Mk. 4	—	—	—	Z560321
SK503	6-way fixed socket, Mk. 4	—	—	—	Z560320
SK504	12-way fixed socket, Mk. 4	—	—	—	Z560330

**TABLE 7 (continued)**  
**Relay unit Type 184 - component details (continued)**

Circuit Ref.	Description	Value	Rating	Tol. per cent	Ref. No.
SK505	6-way fixed socket, Mk. 4	—	—	—	Z560322
SK506	6-way fixed socket, Mk. 4	—	—	—	Z560323
SK507	6-way fixed socket, Mk. 4	—	—	—	Z560320
SK508	6-way fixed socket, Mk. 4	—	—	—	Z560321
SK509	6-way fixed socket, Mk. 4	—	—	—	Z560322
SK510	6-way fixed socket, Mk. 4	—	—	—	Z560323
SK511	6-way fixed socket, Mk. 4	—	—	—	Z560324
SK512	6-way fixed socket, Mk. 4	—	—	—	Z560325
SK513	25-way fixed socket, Mk. 4	—	—	—	Z560380
SK514	Socket Type 714	—	—	—	10H/19641

**TABLE 8****Rack assembly (bulk power supply) Type 305—List of input and output connections****Note . . .**

*The following list, which applies to initial installations of a bulk supply rack feeding the full six consoles is issued here for early information, and may be supplemented or superseded by current orders. Full cabling schedules will be issued separately to the individual Station concerned. R.A. = rack assembly.*

*All plugs and sockets are Mk. 4 unless otherwise stated.*

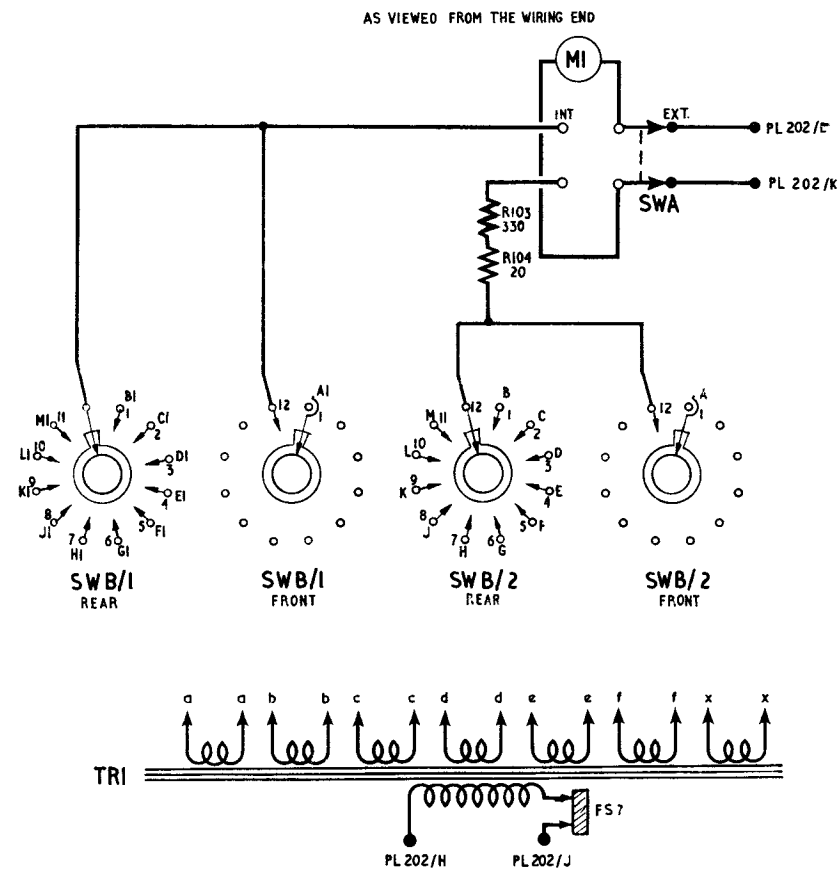
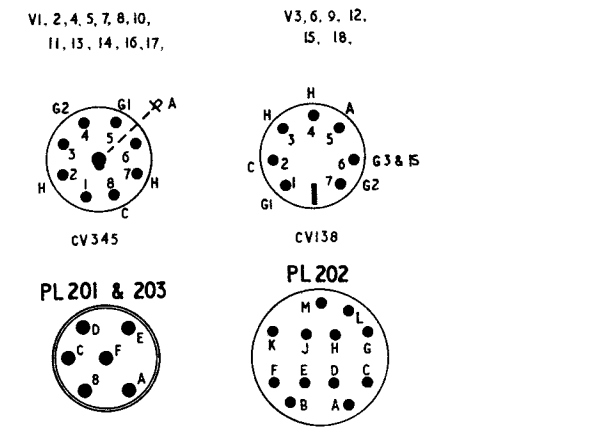
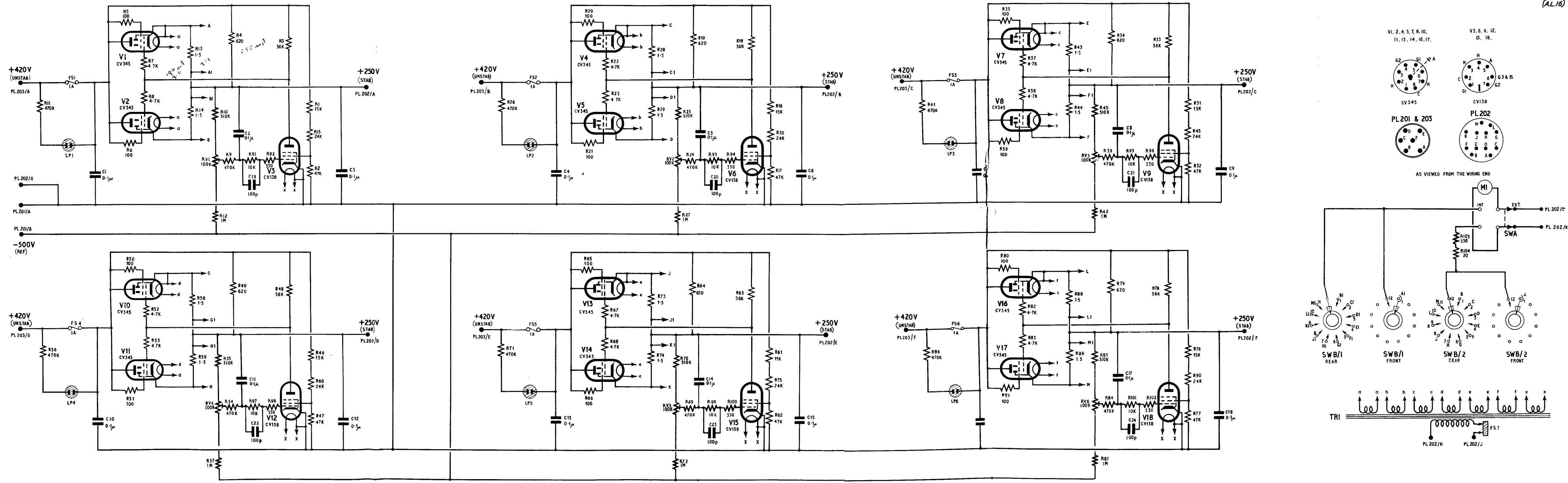
PL or SK	Type	Moulding position	Pin	Service	Destination
PL701	L. & P. A. Ltd. Type 74A 4-pin, 15A, 500V	0	A	— 50c/s 3-phase supply (400V between phases)	Radar office power board
			B		
			C		
			D		
PL702	3-way small	0	A	50 c/s single- phase, 230V	Radar office power board
			B		
			C		
PL703	6-way med.	0	A	Earth —500V reference Spare	Earth tag in trunking R.A. (neg. ref.) Type 338
			B		
			C-F		
SK704	6-way med.	0	A	+570V	PPI console No. 1. Input PL3/Q PL3/S PL3/R PL3/A
			B	+250V stab.	
			C	+420V	
			D	—470V	
			E	Earth	
			F	HT neutral	
SK705	6-way med.	1	A-F	As SK704	PPI console No. 2
SK706	6-way med.	2	A-F	As SK704	PPI console No. 3
SK707	6-way med.	3	A-F	As SK704	PPI console No. 4
SK708	6-way med.	4	A-F	As SK704	PPI console No. 5
SK709	6-way med.	5	A-F	As SK704	PPI console No. 6
SK710	25-way large	0	A	—50V console on-off	PPI console No. 1 (PL3/M) and R.A.338
			B	—50V console on-off	PPI console No. 2 (PL3/M) and R.A.338



**TABLE 8 (continued)**

**Rack assembly (bulk power supply) Type 305—List of input and output connections (continued)**

PL or SK	Type	Moulding position	Pin	Service	Destination
			C	--50V console on-off	PPI console No. 3 (PL3/M) and R.A.338
			D	--50V console on-off	PPI console No. 4 (PL3/M) and R.A.338
			E	--50V console on-off	PPI console No. 5 (PL3/M) and R.A.338
			F	--50V console on-off	PPI console No. 6 (PL3/N) and R.A.338
			G	--50V console HT on-off	PPI console No. 6 (PL3/N)
			H	--50V console HT on-off	PPI console No. 5 (PL3/N)
			J	--50V console HT on-off	PPI console No. 4 (PL3/N)
			K	--50V console HT on-off	PPI console No. 3 (PL3/N)
			L	--50V console HT on-off	PPI console No. 2 (PL3/N)
			M	--50V console HT on-off	PPI console No. 1 (PL3/N)
			N	—	
			O	—	
			P	+50V	Rectifier Type 15 (same unit supplying 50V to six appropriate PPI consoles)
			Q-Z	Spare	



AIR DIAGRAM  
6222A/MIN.  
ISSUE 1 PREPARED BY MINISTRY OF SUPPLY  
FOR PROMULGATION BY AIR MINISTRY

PP8834 567649/4941 3/61 125 C & P Gp. 924 (4)

Stabilizer unit Type 100 - circuit

Fig. 19  
(AL.16, Nov.55)

## Appendix 1

### PANEL (CONTROL) TYPE 890A

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#### Introduction

1. The panel (control) Type 890 is modified to Type 890A by the addition of a toggle switch to the front panel (fig. 1). The Type 890A is operated only in conjunction with units modified for long range timebase working.

2. The additional toggle switch (SWK) is fitted to allow for the monitoring of long range rest level waveforms.

#### Function

3. SWK switches the -50 volts d.c. supply to operate the sequence switch (SWB wafer (a)) in the timebase unit Type 141A.

4. At a selection of rest levels on switches SWA and SWB, on the panel (control) Type 890A, and with SWK selected to LONG RANGE REST LEVELS, sequence 7 on the sequence switch is selected. The sequence 7 circuit provides an increased sampler delay suitable for long range working.

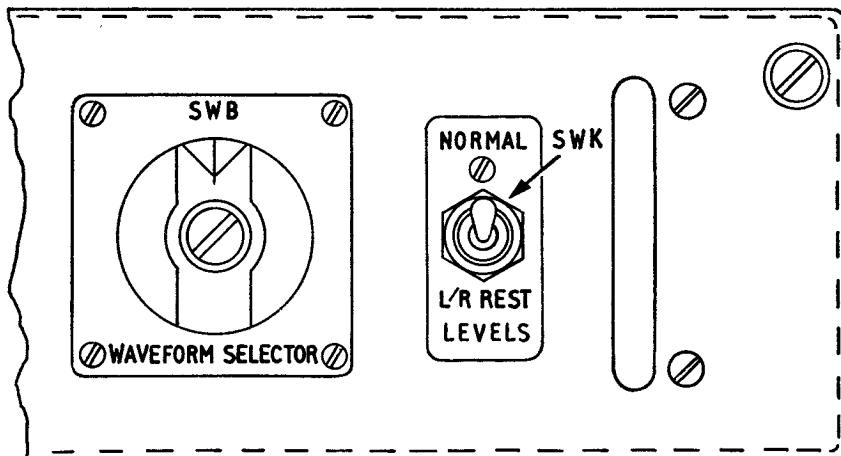
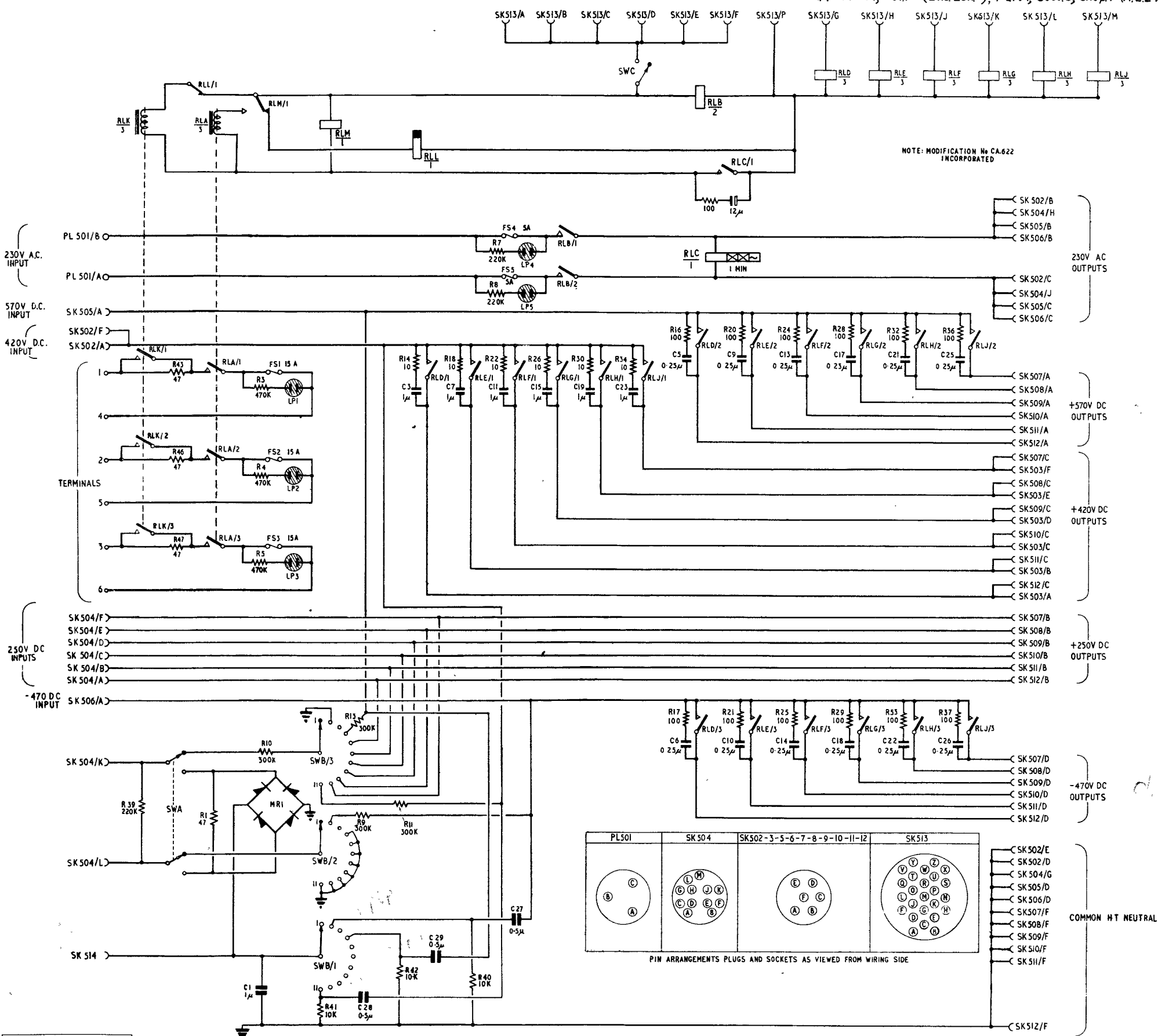


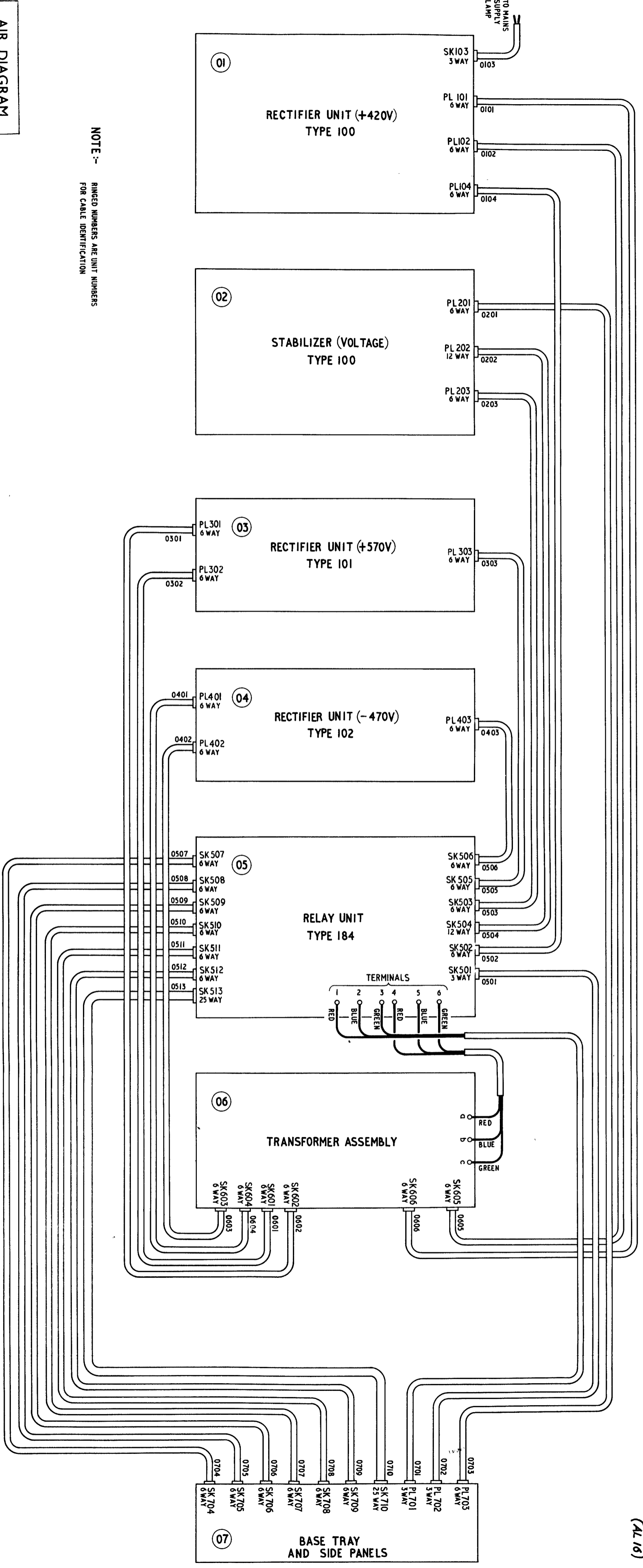
Fig. 1. Panel (control) Type 890A—scrap view



AIR DIAGRAM  
6222C/MIN.  
ISSUE 2 PREPARED BY MINISTRY OF SUPPLY FOR PROMULGATION BY AIR MINISTRY

Relay unit Type 184 - circuit

Fig. 20  
(A.L.24, July 57)



NOTE :- RINGED NUMBERS ARE UNIT NUMBERS FOR CABLE IDENTIFICATION

AIR DIAGRAM  
6222D/MIN.

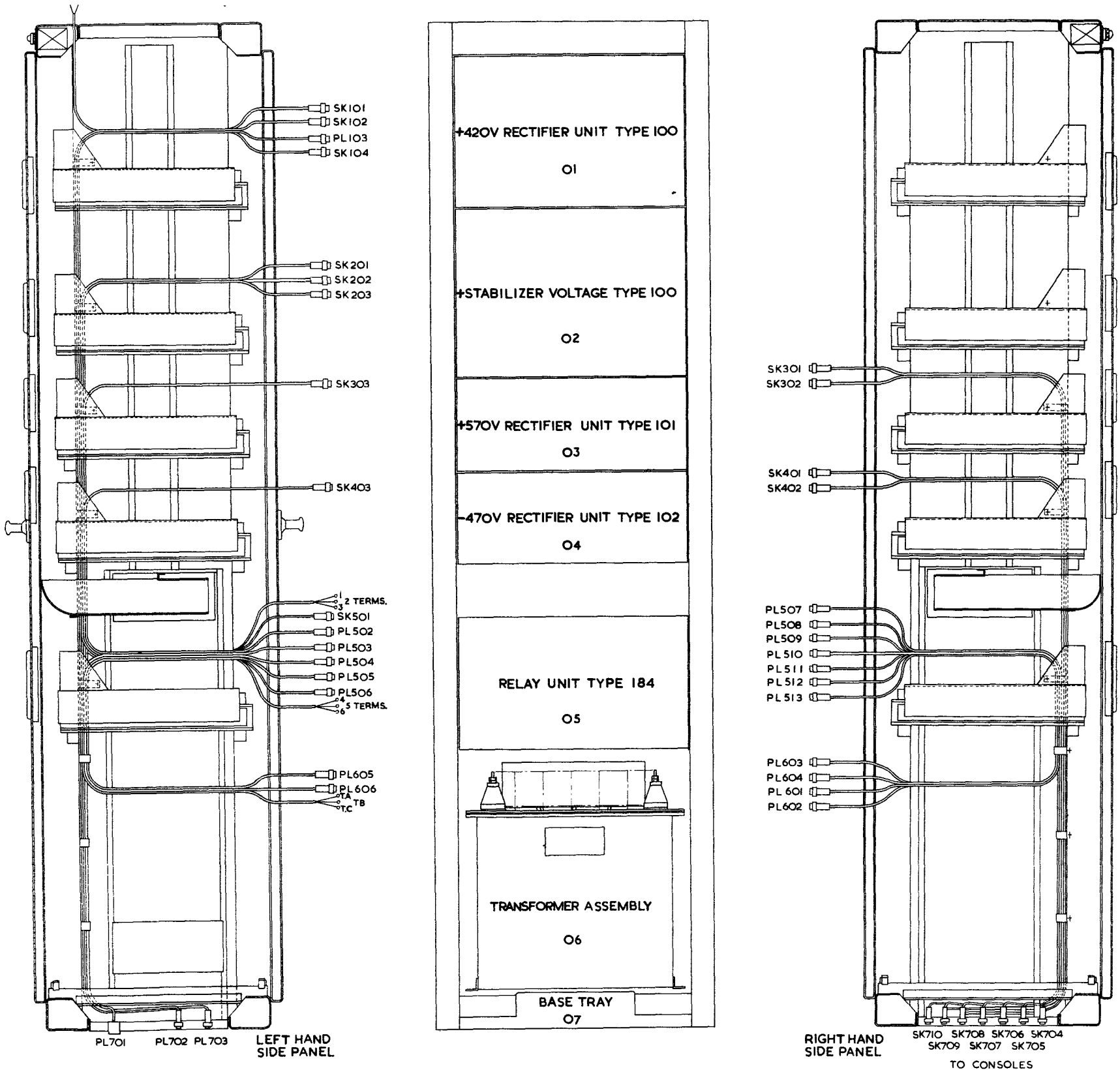
ISSUE 1  
PREPARED BY MINISTRY OF SUPPLY  
FOR PRODUCTIONS BY AIR MINISTRY

PR8834 567649 4941 3:61 125 C & P Cp. 924 (4)

Rack assembly (bulk power supply) Type 305 - circuit

Fig 21

(A.L. 16, Nov. 55)



Rack assembly Type 305, cabling

Fig.22

AIR DIAGRAM  
6222E/MIN.  
ISSUE 1 PREPARED BY MINISTRY OF SUPPLY  
FOR PROMULGATION BY AIR MINISTRY

## **Appendix 1**

### **RELAY ASSEMBLY REF. No. 5840-99-947-1538**

#### **General**

**1.** To permit the temporary integration of radar Type 84 signal processing equipment, relay unit 184 is modified to relay assembly Ref. No. 5840-99-

947-1538 by removing the existing spring set from the left hand side of relays RLD to RLJ and substituting a heavy duty spring set.

## Chapter 8

## CABINET, ELECTRICAL EQUIPMENT, SWEEP

5975-99-953-7535

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### GENERAL

#### Purpose of cabinet

1. The cabinet, electrical equipment, sweep is used in conjunction with the Type 85 radar head to give optional video integration. The cabinet contains facilities for retaining the IFF function while the integrated display is in use.

#### Location and construction

2. The cabinet is located in the radar office and is the standard A.M. type, 7 ft high, 23½ in. wide with full length doors front and rear. External cable connections enter via the underside of the rack from underfloor ducting and connections to all units are made with plugs and sockets. Coded coaxial and multicore cables, also with plug and socket terminations, are used for all inter-unit connections.

3. Cooling air from the ventilation system enters at the base of the cabinet and is withdrawn at the top. The inlet and exhaust pressures are balanced about atmospheric pressure; thus airflow between the cabinet and ventilation system remains constant whether the cabinet doors are open or closed and pressures in other cabinets connected to the ventilating system are unaffected.

#### Function of rack units

4. The location of units is shown in fig. 1 and the block diagram, fig. 2 and 3 is of assistance in understanding the rack function. All units are fully described in subsequent divisions of this chapter.

5. The rack units require +300V and -300V stabilized d.c. supplies and these are provided by the regulators voltage 02 and 03. Unit 04, the generator sweep displaced, accepts resolved sawtooth waveforms from the rack (resolver) 16357 and produces a second timebase to form the basis of the integrated display. The output waveform is fed via a by-pass switch in the panel distribution sweep (unit 10) to the amplifier offset timebase (unit 05), where alternate scans of X and Y sawtooth waveforms are made to provide odd and even-beam timebase outputs, offset from one another by a predetermined angle equivalent to the radar horn displacement. These outputs are fed to the radar head selectors. To enable IFF to operate, the returning composite waveforms from the consoles must have their beam stagger removed and this is achieved by the four generators de-stagger, units 06 to 09. The panel distribution sweep arranges for units 06 to 09 to be by-passed when this function is not required.

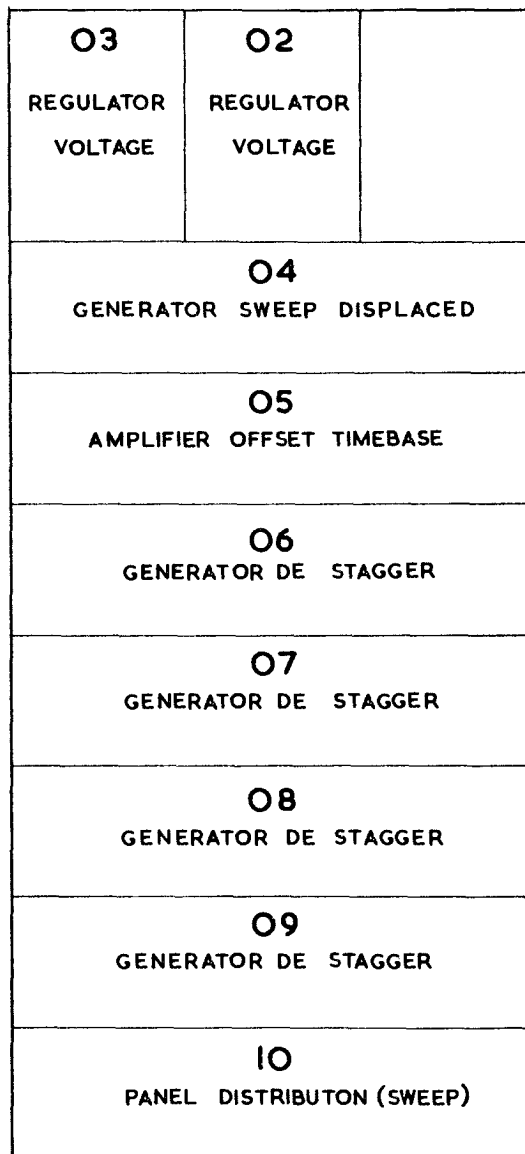


Fig. 1. Location of units

## REGULATOR VOLTAGE

### INTRODUCTION

6. The regular voltage 6110-99-948-8985 provides a number of stabilized d.c. power supplies of +300V and -300V, a maximum of 500mA being available from each polarity. The supplies and earths are connected via multicore cables to various units of the rack.

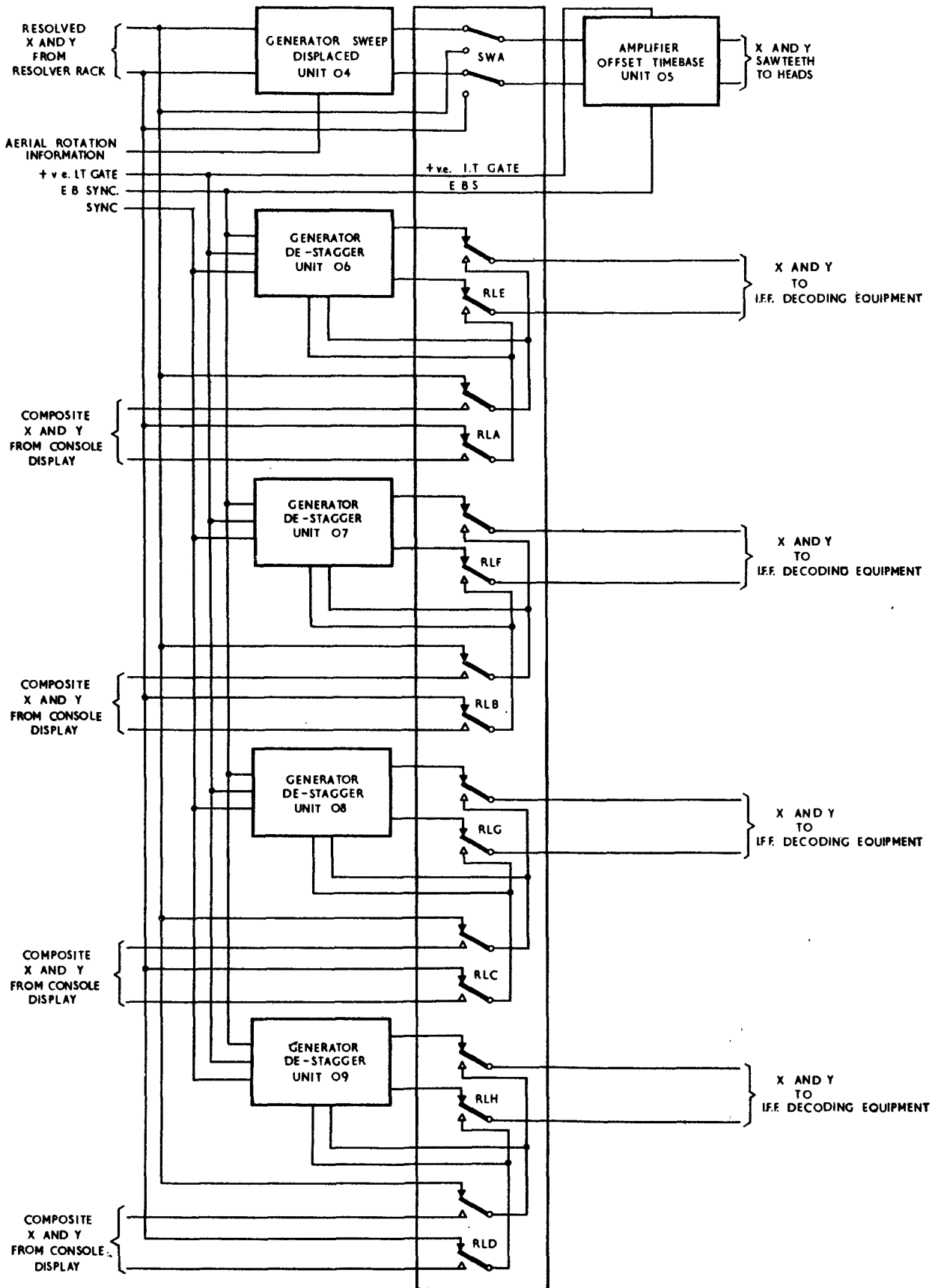


Fig. 2. Signals distribution

### Construction

7. The mechanical basis of the unit is a horizontal chassis fitted with end plates whose upper and lower corners are joined by bracing struts to form a rigid box structure. The high-current tetrodes V1 and V7 are mounted vertically above the chassis and the remaining valves below. All sockets, with the exception of SKT6, are mounted on the rear panel, and all fuses, lamps and switches are on the front panel. Fig. 4 is a general view of the unit and figs. 5 and 6 show component layout.

### CIRCUIT DESCRIPTION

8. Refer to fig. 26. The +300V and -300V stabilizing circuits are mutually dependent in their operation since the stabilized -300V output is used as a reference for detecting variations in the +300V supply. In addition, positive h.t. for the amplifier of the -300V stabilizer is obtained from the +300V output. The -300V stabilizer uses as a reference a -500V stabilized supply derived from an external source via PL5(B) and the -300V circuit is therefore described first.

### -300V stabilizing circuit

9. The -300V stabilized supply is derived from a -425V input to the unit via PL5(F) which is fused by FS2 with LP2 in parallel acting as a fuse failure indicator. The high-current tetrode V7 forms the controlling series element, any variation in the output being detected and amplified by the pentode V5 and fed back via the constant-current pentode V4 to the control grid of V7.

10. The control-grid of V5 is held at a constant potential by the potential divider R29, R65, R30 and the decoupling capacitor C6. Variations in the -300V output of V7 are fed to the cathode of V5 via R37 and the amplified output is d.c. coupled through R28 to the anode of V4. The d.c. potential of V5 anode is too high for direct connection to V7 grid and V4 is arranged to lower this potential without affecting the amplitude of correction voltages. V4 is connected between V5 anode and the -625V line with its grid bias derived from the divider R8, R9 between the -425V and -625V lines. The coupling capacitor C4 minimizes the effect of any hum present on the -625V supply.

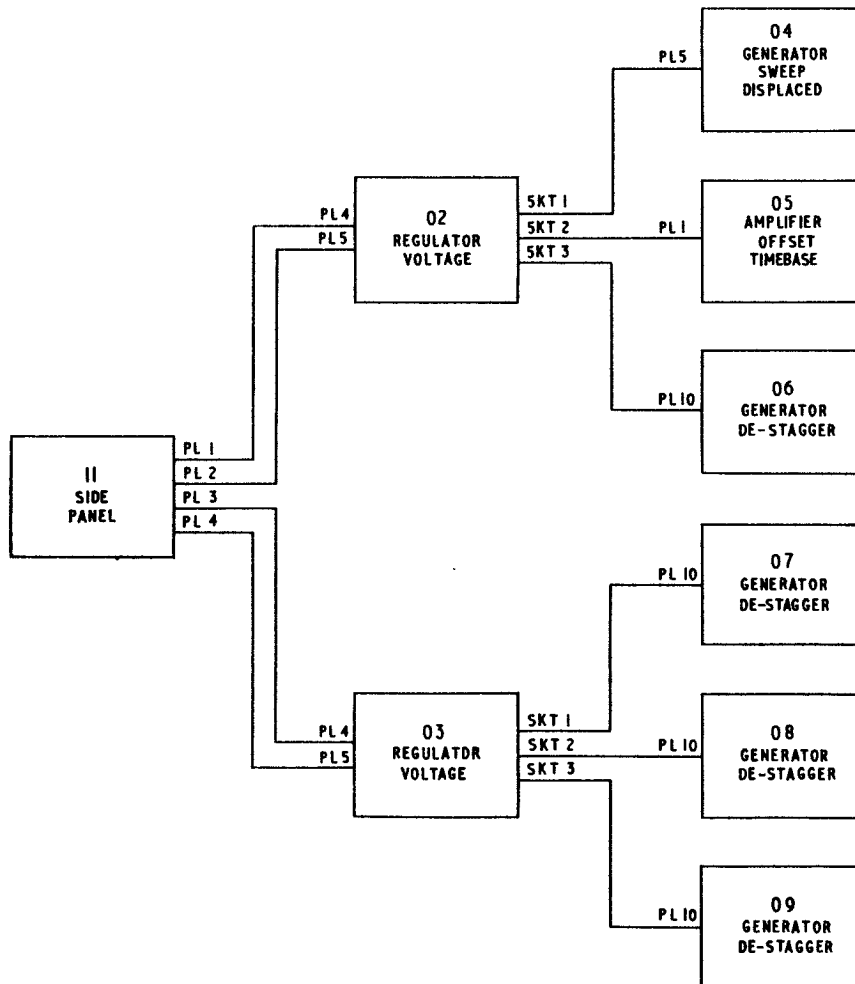


Fig. 3. Power supplies distribution

11. Although the cathode of the error detector and amplifier V5 is effectively connected to the  $-300\text{V}$  output, it is in fact connected in the potential divider R33, R37 which is across the  $-425\text{V}$  input and the  $-300\text{V}$  output. The ratio of R33 to R37 is such that the  $-300\text{V}$  output forms the effective supply. However, should there be any fluctuation in the  $-425\text{V}$  supply, a small proportion of this is fed to V5 cathode thus effecting an appropriate correction to the  $-300\text{V}$  output.

12. The resistors R56, R60 and R68 are dummy loads brought into circuit when one of the unit outputs is not required. This facility is provided by SWB, SWC and SWD in respective conjunction with relays RLC, RLD and RLE.

#### +300V stabilizing circuit

13. The  $+300\text{V}$  stabilized supply is derived from a  $+450\text{V}$  unstabilized input to the input via PL5 (D) which is fused by FS1 with LP1 in parallel acting as a fuse failure indicator. The controlling series element, V1, is of the same type as that used in the  $-300\text{V}$  circuit.

14. Variations in the  $+300\text{V}$  output are detected by V2 which has its control grid connected in the divider chain R20, R21, R22, R64 and R23 across the  $+300\text{V}$  and  $-300\text{V}$  outputs. Any ripple not removed by C1 is passed via C3 to the control grid of V2. Normal variations are passed via R18 and R17 to V2 and thence, via R4, to the control grid of V1.

15. The h.t. supply for V2 is obtained from the stabilized voltage divider R10, V3, R20, R21 between the unstabilized  $+450\text{V}$  input and the stabilized  $+300\text{V}$  output from V1. This chain removes virtually all h.t. fluctuations but as the bottom of the chain is effectively connected to V2 control grid, any residual fluctuation is fed back as a correction voltage to V1.

16. The resistors R55, R59 and R67 are dummy loads brought into circuit in a similar fashion to those used with the  $-300\text{V}$  output.

#### Safety circuit

17. A safety circuit consisting of the pentode V6, diodes MR1 and MR2 and the relay RLA, switches

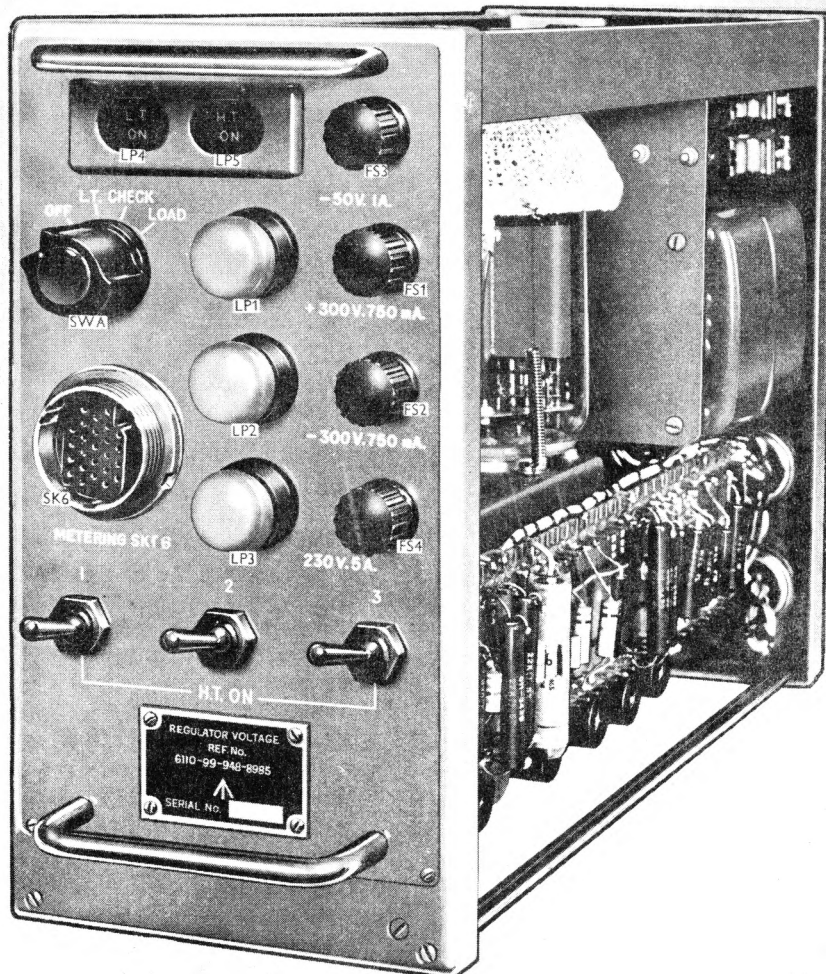


Fig. 4. Regulator voltage 6110-99-948-8985—front view

off the h.t. supplies if the +300V output varies beyond certain limits from its correct value. Since the +300V stabilizing circuit uses the -300V output as its reference voltage, the safety circuit provides a safeguard against failure in either stabilizing circuit. In addition, the safety circuit operates if there are overload conditions in the external circuits which are insufficiently large to blow the fuses but large enough to reduce the output below the accepted limits.

18. V6 is in effect a cathode-follower with diodes MR1 and MR2, and the bipolar relay RLA, in its cathode circuit. The values of R39, R40 and R41 are chosen so that, with the +300V and -300V at their nominal values, the grid bias of V6 is such that its cathode is at earth potential and RLA is de-energized. If the +300V supply becomes more positive V6 control grid will also become more positive. By normal cathode-follower action V6 cathode also becomes more positive and, when a predetermined value is reached, MR1 conducts and RLA is energized. Similarly, if the +300V supply becomes less positive, MR2 conducts and RLA is again energized.

19. Under normal operating conditions SWA is set to LOAD, RLB is energized, RLA is de-energized and a -50V feed is connected to PL4(F) via contacts RLB1 and RLA1. This supply operates external relays controlling the h.t. inputs. If a large output fluctuation occurs, RLA is energized and contact RLA1 breaks the h.t. switching feed to PL4(F), thus switching off the h.t. inputs and connecting the -50V to the control grid of V6 via SWA2, tags 1 and 4. This ensures that following a fault condition the unit remains switched off until it is reset.

### Switching

20. All inputs to the voltage stabilizer are controlled by a -50V supply switched by SWA. SWA is a two bank, four pole, four position switch with positions labelled OFF/L.T./CHECK/LOAD.

21. When SWA is set to L.T. the -50V is switched via SWA1 tags 7 and 8 to control the mains supply system via PL4(C). Additionally a feed passes via SWA2 tags 7 and 8 to a control circuit centred on X1 and to the cathode of V6. RLA is therefore energized by the process described in para. 18.

22. The -50V fed via PL4(C) results in the mains supply of 230V 50 c/s a.c. being fed into the unit via PL4(A) and (B). This supply is fused by FS4 and FS5 (thermal) with a parallel fuse failure indicator, LP3. All heater supplies from the secondary of TR1, also SKT1, 2 and 3, are thus made available, that from terminals f-f being taken to the heater of the thermal delay switch X1. LP4 in parallel with X1 indicates L.T. ON. After a delay of about two minutes, X1 operates and RLB is energized by the -50V feed from SWA2, tag 8. Contact RLB2 breaks the supply to X1 heater;

contact RLB1 operates as a hold-on and in addition makes a -50V connection to SWA1, tag 3. At this stage RLA is still energized and the h.t. ON lamp is off.

23. When SWA is switched to CHECK, SWA1 tag 3 is connected to tag 1 thus supplying -50V to the external h.t. control switches. The following supplies are made available:—

- (1) +450V at PL5(D).
- (2) -425V at PL5(F).
- (3) -500V stabilized at PL5(B).
- (4) -625V at PL5(A).

24. All the valve circuits now reach their stable state, including the safety circuit. RLA is de-energized and the h.t. ON lamp LP5 is lit via RLA1. If LP5 fails to light, it is an indication that the +300V supply is outside the prescribed limits.

25. A metering facility is provided via SKT6 on the front panel and, with SWA in the CHECK position, the following measurements can be made using a multimeter 100:—

- (1) SKT6(E) or (Q) and (S) V6 cathode potential.
- (2) SKT6(D) and (R) +300V stabilized output (via potential divider).
- (3) SKT6(T) and (F) -300V stabilized output (via potential divider).

26. When SWA is set to LOAD the negative side of relays RLC, RLD and RLE is connected via SWA1, tags 10 and 7 to the -50V line. Operation of switches SWB, SWC or SWD connects the positive side of each of the above relays to the +50V supply, closing the appropriate contact in +300V and -300V output lines and connecting both outputs to SKT1, SKT2 or SKT3, according to the appropriate switch. Simultaneously the internal dummy loads are removed. The normally open contact of RLA1 is connected via SWA2, tags 1 and 4 to the control grid of V6 in preparation for holding the safety circuit when required.

27. The functions of SWA are summarized in the following table:—(overleaf).

### Heater supplies

28. Due to the varying cathode d.c. levels of the valves within the voltage regulator, six separate heater supplies are required. These are derived from the mains transformer TR1 and are as follows:—

- (1) a-a supplies 6.3V, .6A to V2 and V6 (d.c. potential at earth).
- (2) b-b supplies 26V, 1.3A to V7 (d.c. potential at -425V).
- (3) c-c supplies 26V, 1.3A to V1 (d.c. potential at +300V).
- (4) d-d supplies 6.3V, .3A to V5 (d.c. potential at -300V).
- (5) e-e supplies 6.3V, .3A to V4 (d.c. potential at -625V).
- (6) f-f supplies 6.3V, 1A to LP4, L.T. ON and to the heater of the thermal delay, X1.

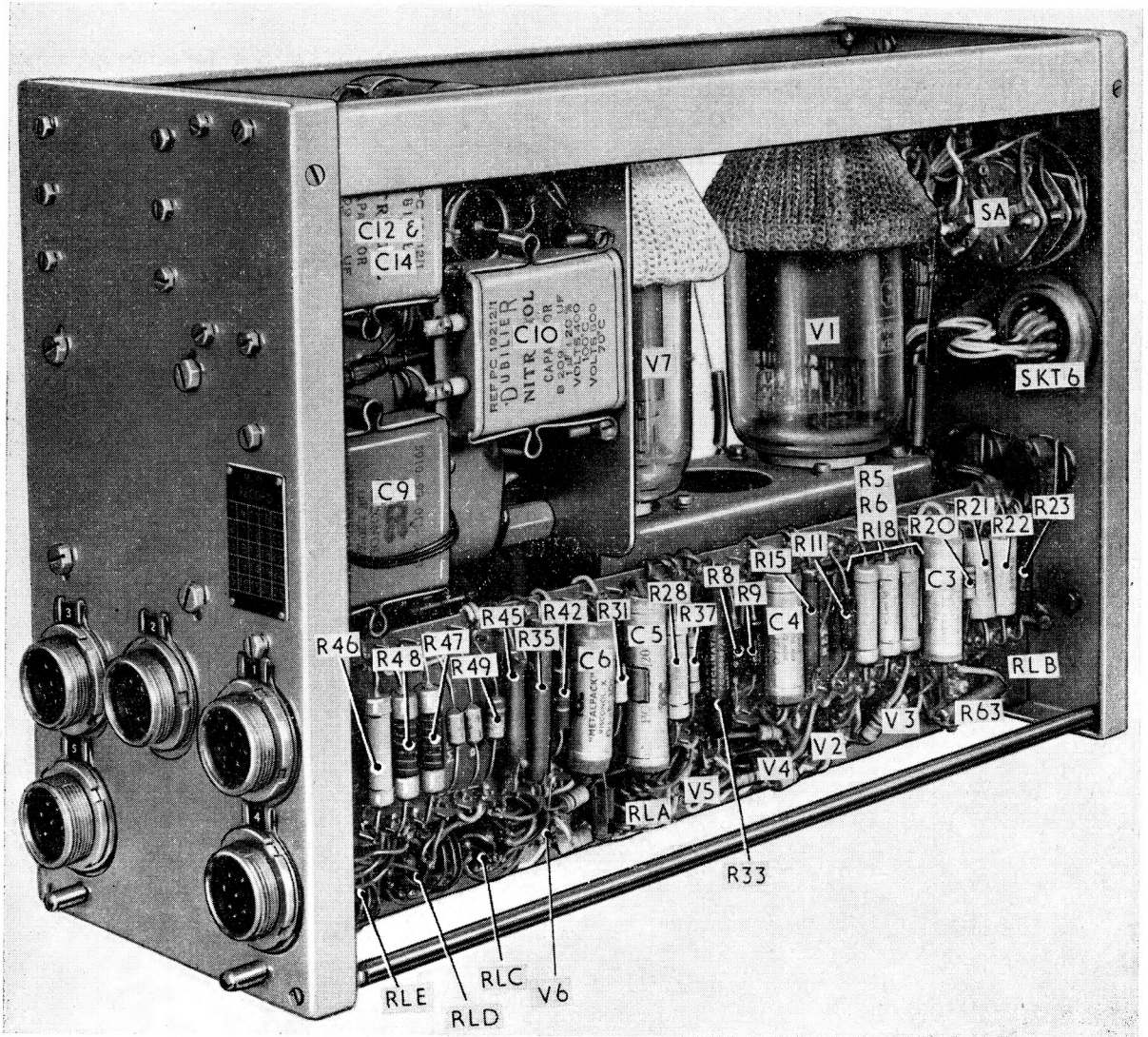


Fig. 5. Regulator voltage 6110-99-948-8985—L.H. view



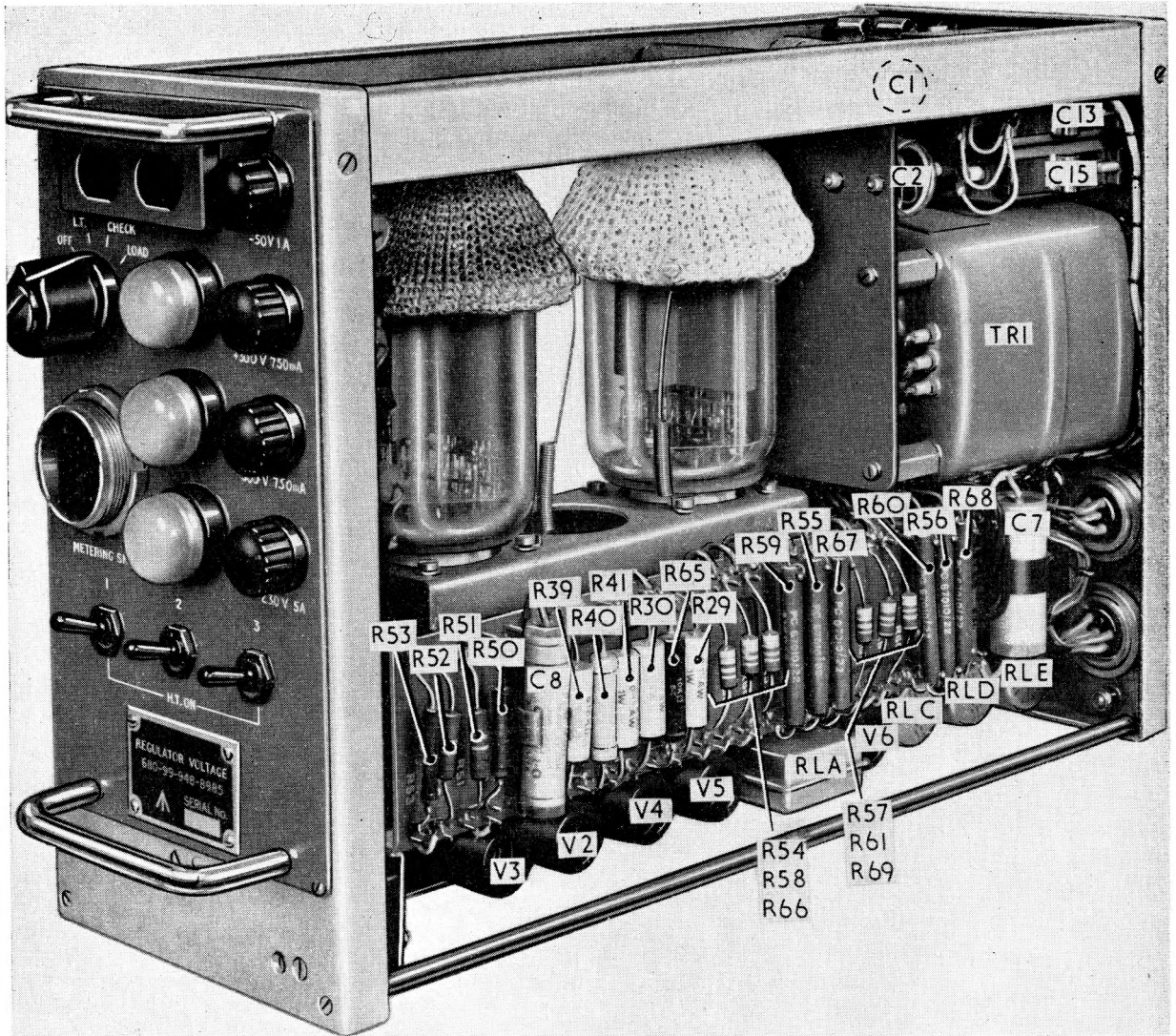


Fig. 6. Regulator voltage 6110-99-948-8985—R.H. view

	SWA 1	SWA 2
L.T.	-50V to PL4(C) (Tags 7 and 8).	-50V to safety circuit (Tags 7 and 8).
CHECK	-50V to PL4(C) (Tags 7 and 8). -50V to PL4(F) (Tags 1 and 3).	-50V to safety circuit (Tags 7 and 8).
LOAD	◀-50V to PL4(C), PL4(F) and RLC, RLD and RLE (Tags 1, 4, 7, 8 and 10).	RLA1(N/O) to V6 grid (Tags 1 and 4) -50V to safety circuit (Tags 7 and 8).

## GENERATOR, SWEEP DISPLACED

### INTRODUCTION

29. The Generator, Sweep Displaced 5840-99-947-6320 is designed to produce a secondary timebase which may be used to provide an integrated display. This timebase is displaced from the main sweep and may be advanced or delayed from it by a small angle.

30. Resolved X and Y sawtooth voltages are brought to the unit and the secondary waveforms derived from these. To obtain a delayed timebase, a small part of the Y voltage is subtracted from the X sawtooth waveform and a small part of the X voltage added to the Y waveform. When an advanced sweep is required these conditions are reversed; fig. 7 illustrates this.

31. Views of the unit from various angles are given in fig. 8 to 11. It is constructed with a rack panel and a back plate which are spaced apart and secured together by angle strips at the four corners. The main and standby amplifiers are both located on the one chassis and occupy the left and right-hand sides respectively. The valve decks are made up of narrow channel-section strips bolted

to brackets riveted to the panel and back plate. Tagboards carrying the small components are bolted to the valve decks.

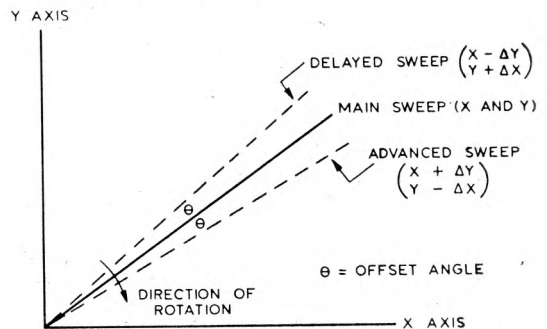


Fig. 7. Production of displaced sweep

32. Slides fitted to the lower sides of the assembly engage with runners in the rack and allow the unit to be fully withdrawn for servicing purposes. Plugs and sockets providing the input and output connections are mounted on the back plate, while fuseholders and indicator lamps in the mains supply lines are located on the front panel.

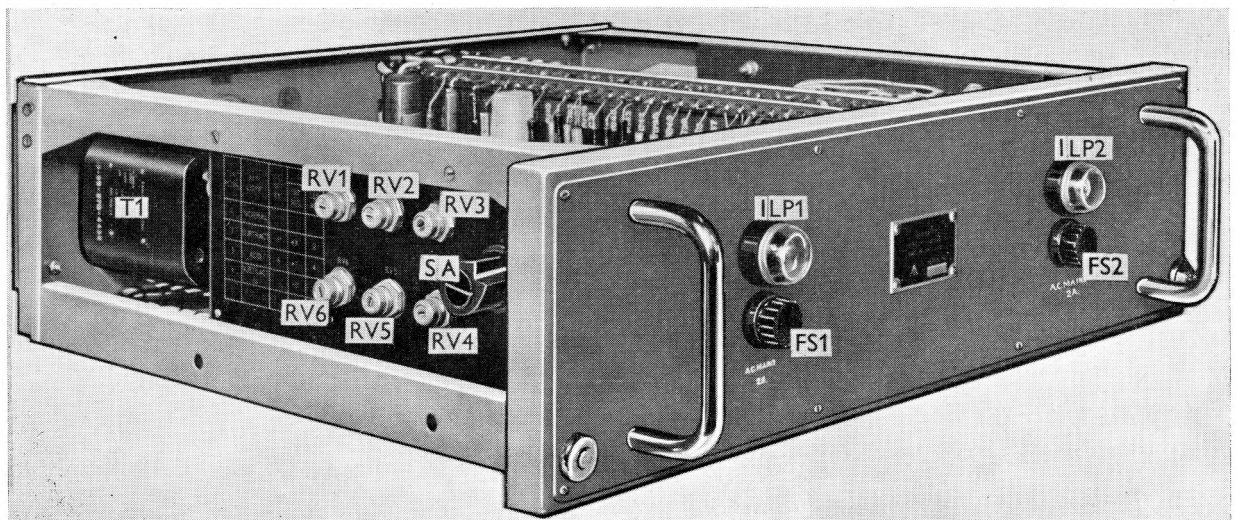


Fig. 8. Generator sweep displaced—front view



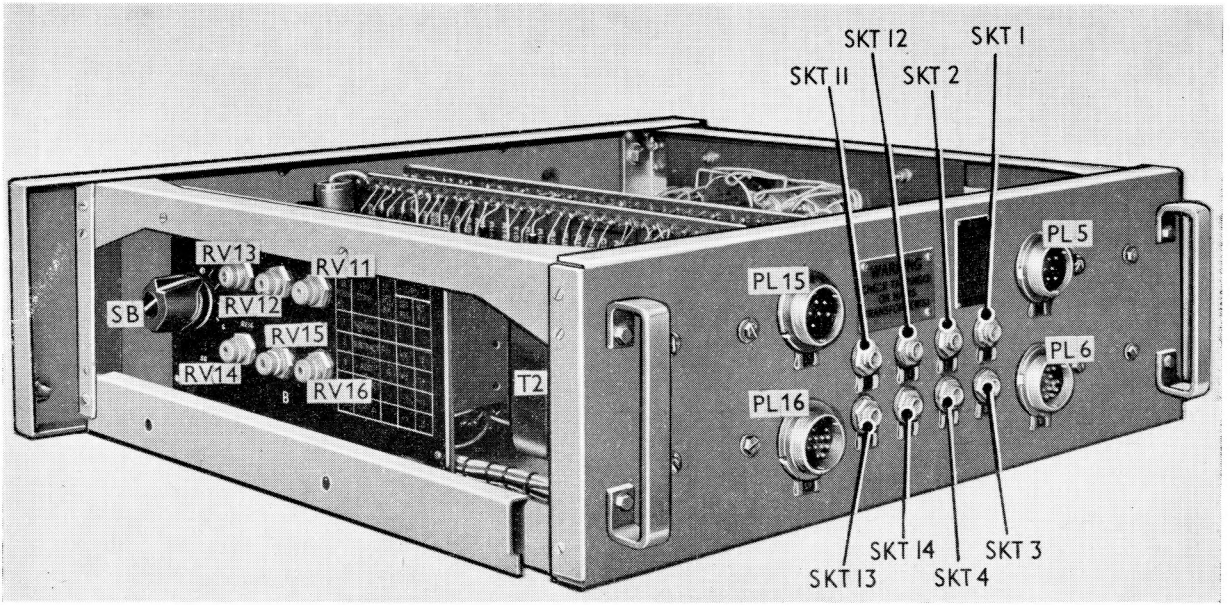


Fig. 9. Generator sweep displaced—rear view

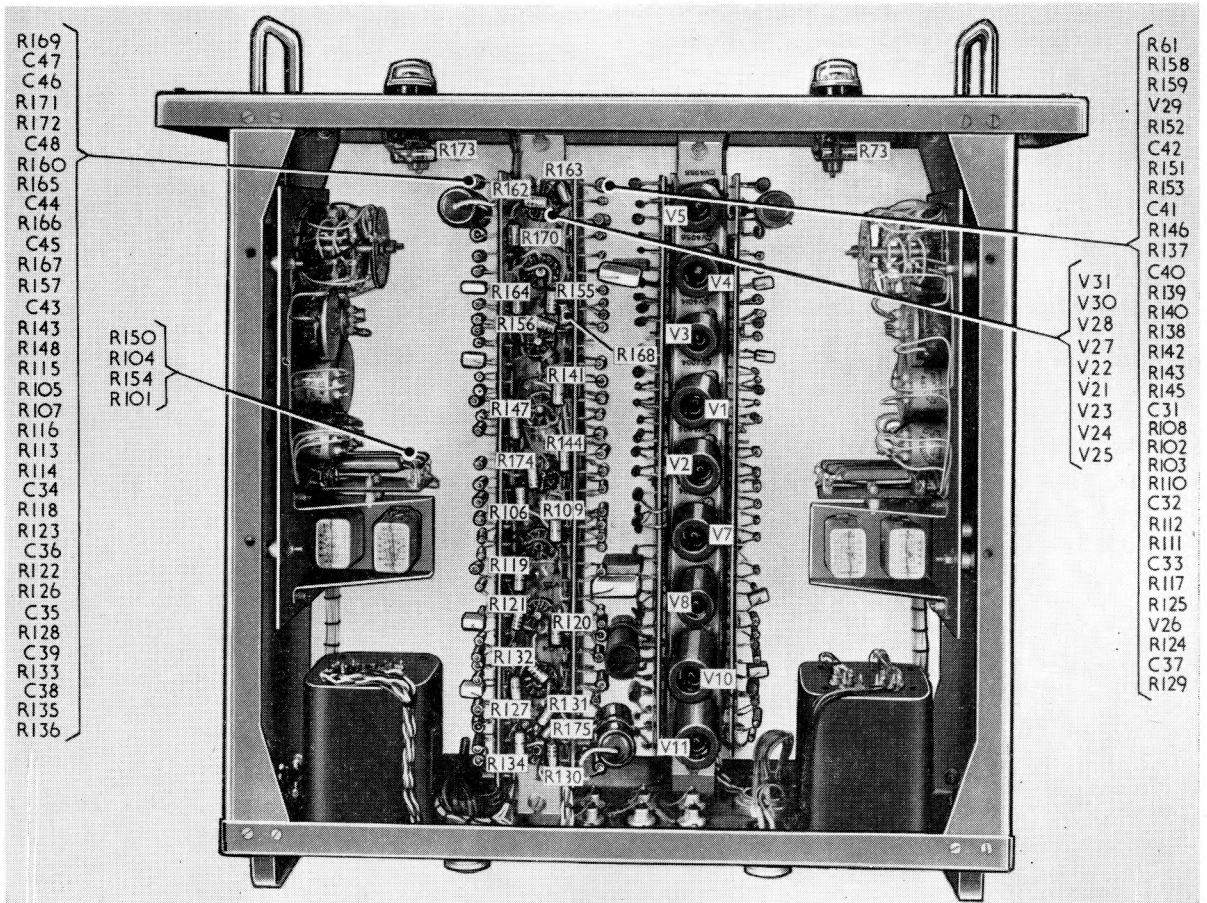


Fig. 10. Generator sweep displaced—top view

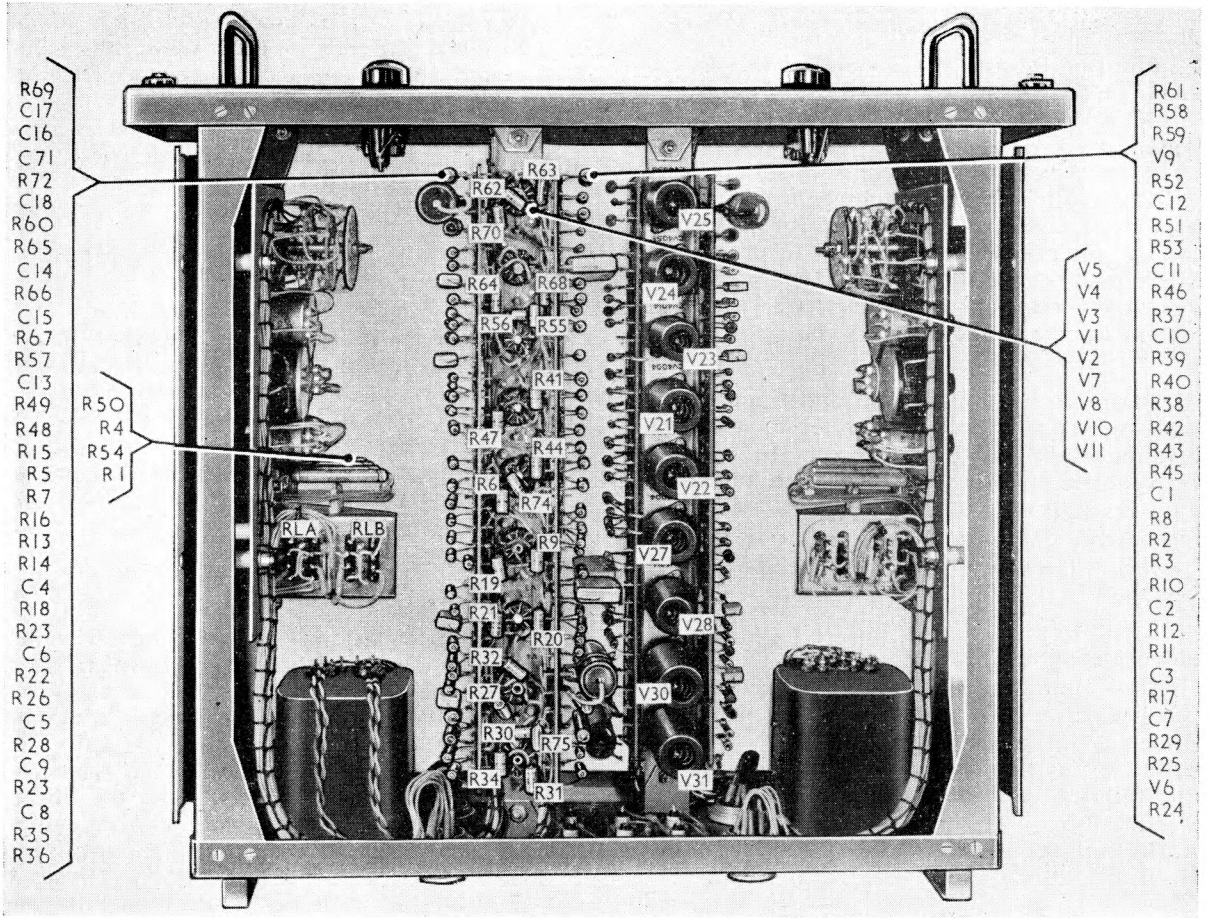


Fig. 11. Generator sweep displaced—under-chassis view

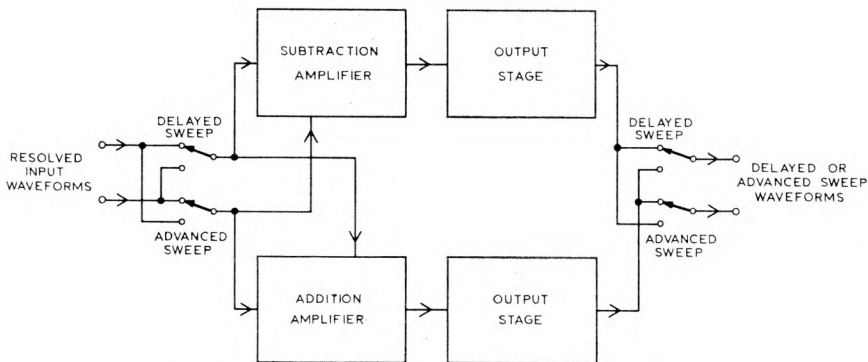


Fig. 12. Generator sweep displaced—block diagram

**CIRCUIT DESCRIPTION**

33. Since the main and standby circuits are identical in all respects yet completely independent of each other, only the circuit with the lower reference numbers, Channel A, is described. Basically, it consists of two feedback amplifiers, one of which performs the function of adding the input voltages while the other subtracts one from the other; delayed or advanced timebases are obtained by switching the input lines to the appropriate ampli-

fier. A block diagram is provided in fig. 12 and a circuit diagram in fig. 27.

**Subtraction amplifier**

34. The subtraction amplifier consists of the cathode-coupled stage of V1A and V1B, which share a high-impedance cathode load V2A, followed by a d.c. coupled amplifier V3 and a White cathode-follower output stage employing

V4 and V5. Feedback is provided through C4 and R18 and taken to the grid of V1B so that it is in opposition to the input voltage on the grid of V1A.

35. Resolved X and Y sawtooth voltages are brought to the unit on SKT1 and SKT2 respectively. With RLA de-energized and SWA in the NORMAL position, the X input is applied to the grid circuit of V1A, RV2 being used to control its amplitude. The  $\Delta Y$  voltage is obtained by applying the Y input across the voltage divider formed by RV3, R13 and R16, the potentiometer being used to obtain the correct fraction of the input. The voltage is taken from across R13 and connected to the feedback line leading to the grid of V1B.

36. Since the  $\Delta Y$  voltage is in opposition to the X voltage on the grid of V1, the resultant output across the anode load R10 represents the X waveform required to produce the delayed timebase. This is inverted by V3 before being passed to the output stage. The d.c. output level is set at 0V by adjustment of RV1 and the waveform fed to SKT3 (X OUT) via contacts RLB1.

#### Addition amplifier

37. The addition amplifier consists of the cathode-coupled stage of V7A and V7B, which share the high-impedance cathode load formed by V2B, followed by a d.c. coupled amplifier V8 and a White cathode-follower stage employing V10 and V11. Feedback is provided through C13 and R57 and taken to the grid of V7B so that it is in opposition to the input voltage on the grid of V7A.

38. With RLA de-energized and SWA in the NORMAL position, the Y input is applied to the grid circuit of V7A, RV4 being used to control its amplitude. The  $\Delta X$  voltage is obtained by applying the X input across the voltage divider formed by RV5, R38 and R40, the potentiometer being used to obtain the correct fraction of the input. With this circuit the two voltages are then both applied to the grid of V7A.

39. The output voltage appearing across the anode load R46 is therefore the result of the sum of the two input voltages less the negative feedback voltage and represents the Y waveform required to produce the delayed timebase. This is inverted by V8 before being passed to the output stage. The d.c. output level is set at 0V by adjustment of RV6 and the waveform fed to SKT4 (Y OUT) via contacts RLB2.

#### Delayed/advanced timebase switching

40. The two relays RLA and RLB are used to obtain a delayed or advanced timebase output. The relays are energized by the application of a 50V d.c. input between PL6(K) and PL6(L). When they are de-energized the input voltages to the amplifiers are as given in the previous text, and the delayed X waveform from the subtraction amplifier appears at SKT3 and the delayed Y waveform from the addition amplifier appears at SKT4.

41. When the relays are energized, the inputs to the amplifiers are changed over by RLA1 and 2 so that the subtraction amplifier receives the Y and  $\Delta X$  voltages and the addition circuit is supplied with the X and  $\Delta Y$  inputs. Waveforms suitable for producing an advanced timebase will now be provided by the amplifiers. However, since the subtraction amplifier is now concerned with the Y waveform, it is necessary to change over the outputs so that they appear at their respective X and Y sockets. This is carried out by the contacts of RLB.

42. Although it has been assumed that the direction of rotation of the timebase is clockwise, this may not always be so. In cases where counter-clockwise rotation is employed, that which has been described as a delayed timebase will, of course, then be regarded as advanced, while that described as advanced will become the delayed version.

#### Power supplies

43. All the heaters of the valves in the Channel A circuit are supplied from transformer TR1 at the rear of the unit. The mains input on PL5(F) (line) and PL5(B) (neutral) is fused at 2A by FS1, which is shunted by indicator lamp LP1. Two secondary windings are used to supply the heaters, one being rated at 6.3V 2.7A and the other at 6.3V 1.8A. The 2.7A winding is earthed and provides the heater current for the majority of the valves. The 1.8A winding, however, supplies V2, V5 and V11, the cathodes of which are at a potential approaching  $-300V$ . To avoid cathode/heater insulation difficulties therefore, this winding is connected to the junction of R74 and R75, which form the voltage divider across the  $-300V$  supply. The stabilized  $+300V$  and  $-300V$  supplies required by the circuit are brought to the unit on PL5(D) and PL5(A) respectively.

#### Monitoring

44. Channel A monitoring switch SWA has three wafers and five operative positions. Wafers SWA1 and SWA2 are concerned with switching the resolved input waveforms to facilitate monitoring, while the third wafer SWA3 is used in conjunction with the associated monitoring unit.

45. When the switch is set at position 1 (NORMAL), all four of the input lines are connected and the delayed or advanced waveforms obtained from the output sockets. In position 2 (GAIN & D.C. SUBTRACT) and 3 (GAIN & D.C. ADD) the  $\Delta X$  and  $\Delta Y$  input lines are earthed. The d.c. output level may then be adjusted to 0V by means of RV1 and RV6 and the gain set correctly by using RV2 and RV4. In positions 4 (SUBTRACT  $\Delta$ GAIN) and 5 (ADD  $\Delta$ GAIN) the X and Y input lines are earthed, enabling adjustment of the  $\Delta X$  and  $\Delta Y$  input voltages to be carried out.



## AMPLIFIER OFFSET TIMEBASE

### INTRODUCTION

46. The Amplifier, Offset Timebase 5840-99-946-8028 is used to compensate for the difference of azimuth angle between the odd- and even-beams of the aerial. Resolved X and Y sawtooth waveforms corresponding to the direction of the odd-beams are accepted by the unit and secondary waveforms produced from these to provide a timebase which is offset from the odd-beam timebase by the required angle. This is then used to represent the even-beam.

47. In order to produce the required offset angle, the even-beam waveform is delayed from the odd-beam waveform by a small amount. This is achieved by the addition of a small change of the X voltage to that representative of the Y axis and by the subtraction of a small change of the Y voltage to that representative of the X axis. An illustration of this is given in fig. 13.

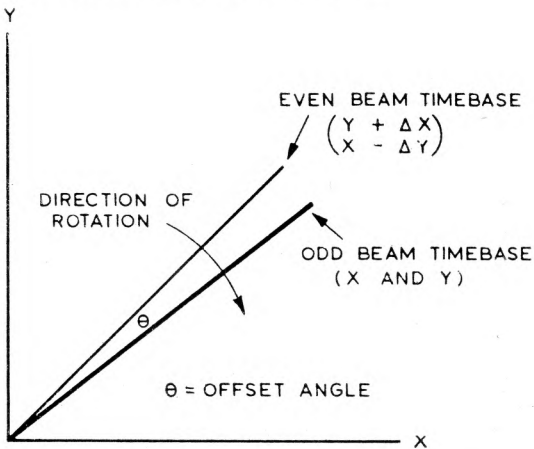


Fig. 13. Production of offset timebase

### Construction

48. Illustrations showing the unit from various angles are provided by fig. 14 to 17. It is constructed as a standard 5 in. deep open-drawer type of assembly, having a rack panel and back plate spaced apart and secured together by angle strips at the four corners. The valve decks are formed of narrow channel-section strips bolted to brackets riveted to the panel and back plate. Tagboards carrying the small components are bolted to the valve decks. Slides, fitted to the lower sides of the assembly, engage with runners in the rack and allow the unit to be fully withdrawn.

49. Fuseholders and indicator lamps are mounted on the front panel, together with monitoring points, while all connecting leads and sockets are mounted at the rear. At one side of the unit a sub-panel is fitted which is used to accommodate a monitoring switch and a group of potentiometers. On the left of this panel a plate is provided to show the function of each of the switch positions.

### CIRCUIT DESCRIPTION

50. The circuit is designed to provide 3 types of output:—

- (1) normal X and Y odd-beam timebase waveforms.
- (2) normal and delayed X and Y waveforms to produce odd-beam and even-beam timebases alternately.
- (3) delayed X and Y even-beam timebase waveforms.

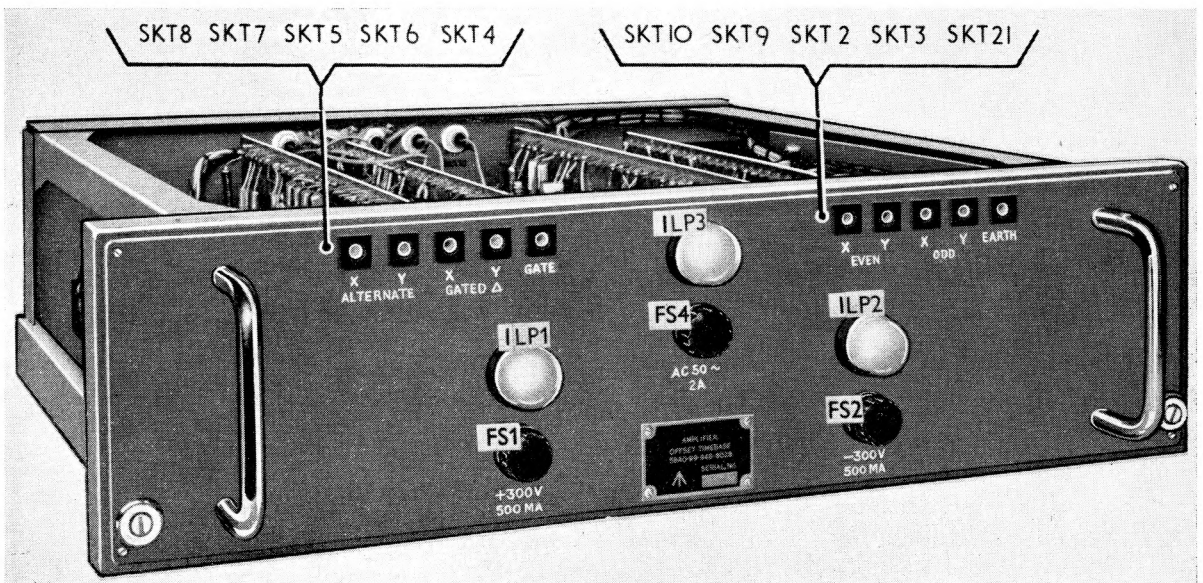


Fig. 14. Amplifier offset timebase—front view

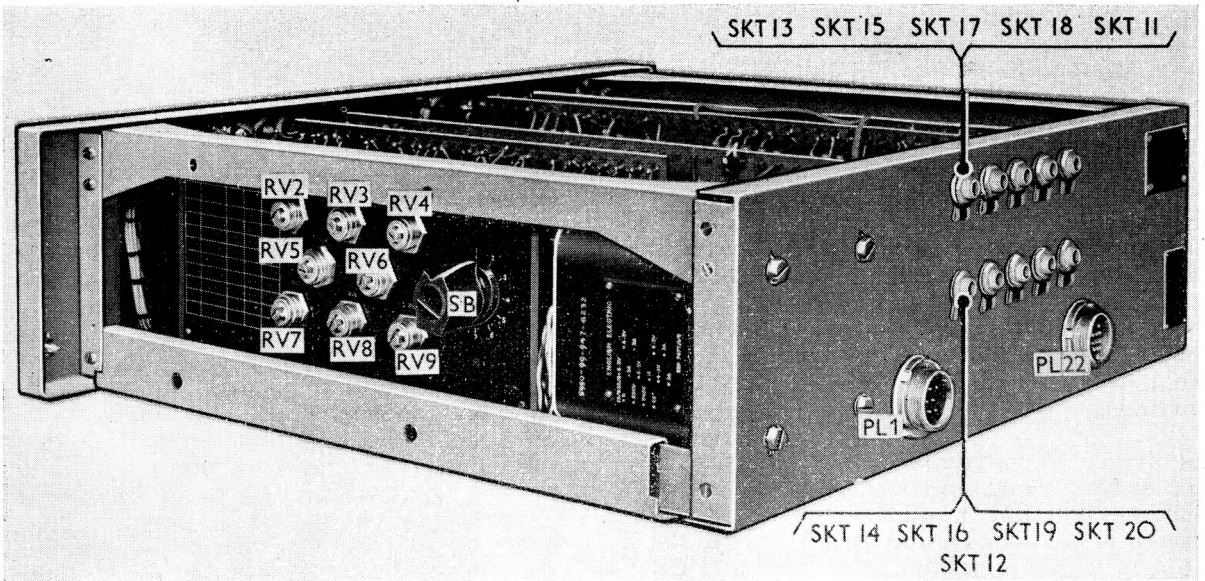


Fig. 15. Amplifier offset timebase—rear (oblique) view

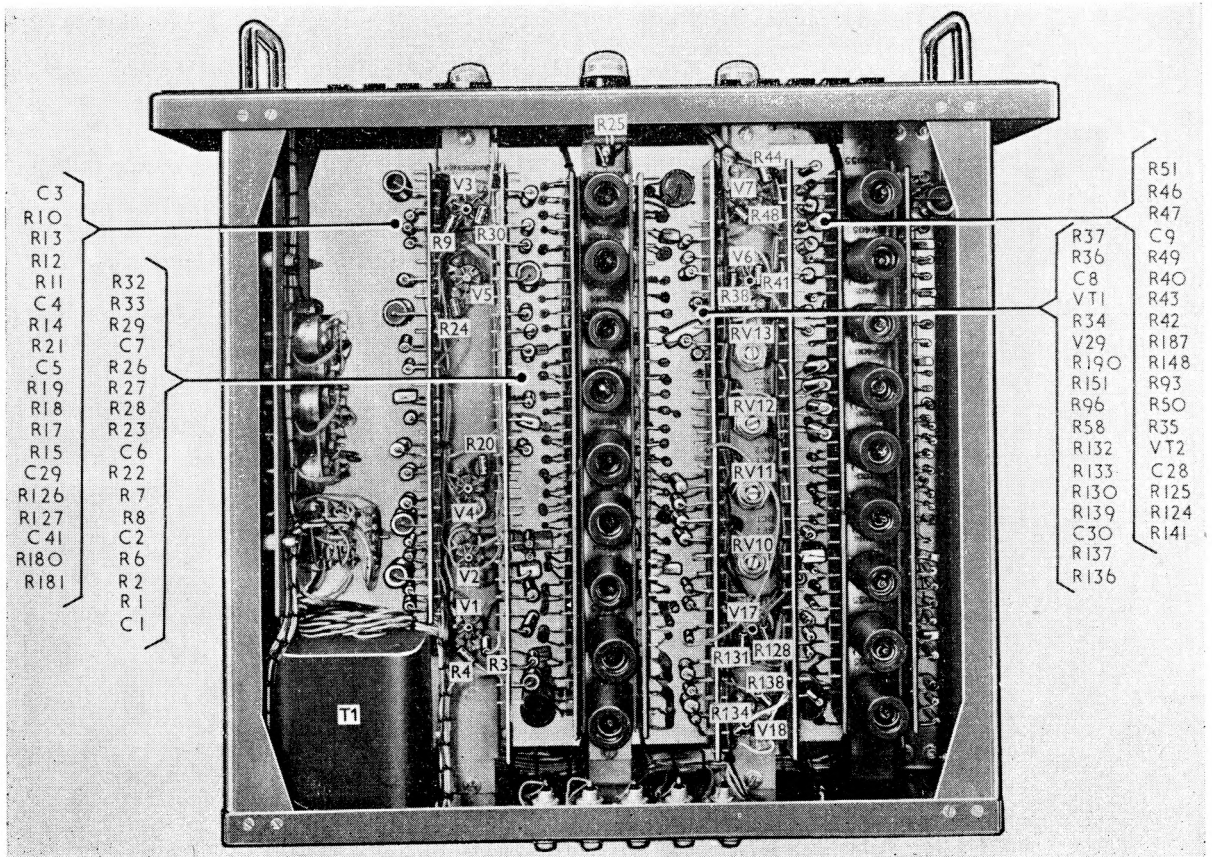
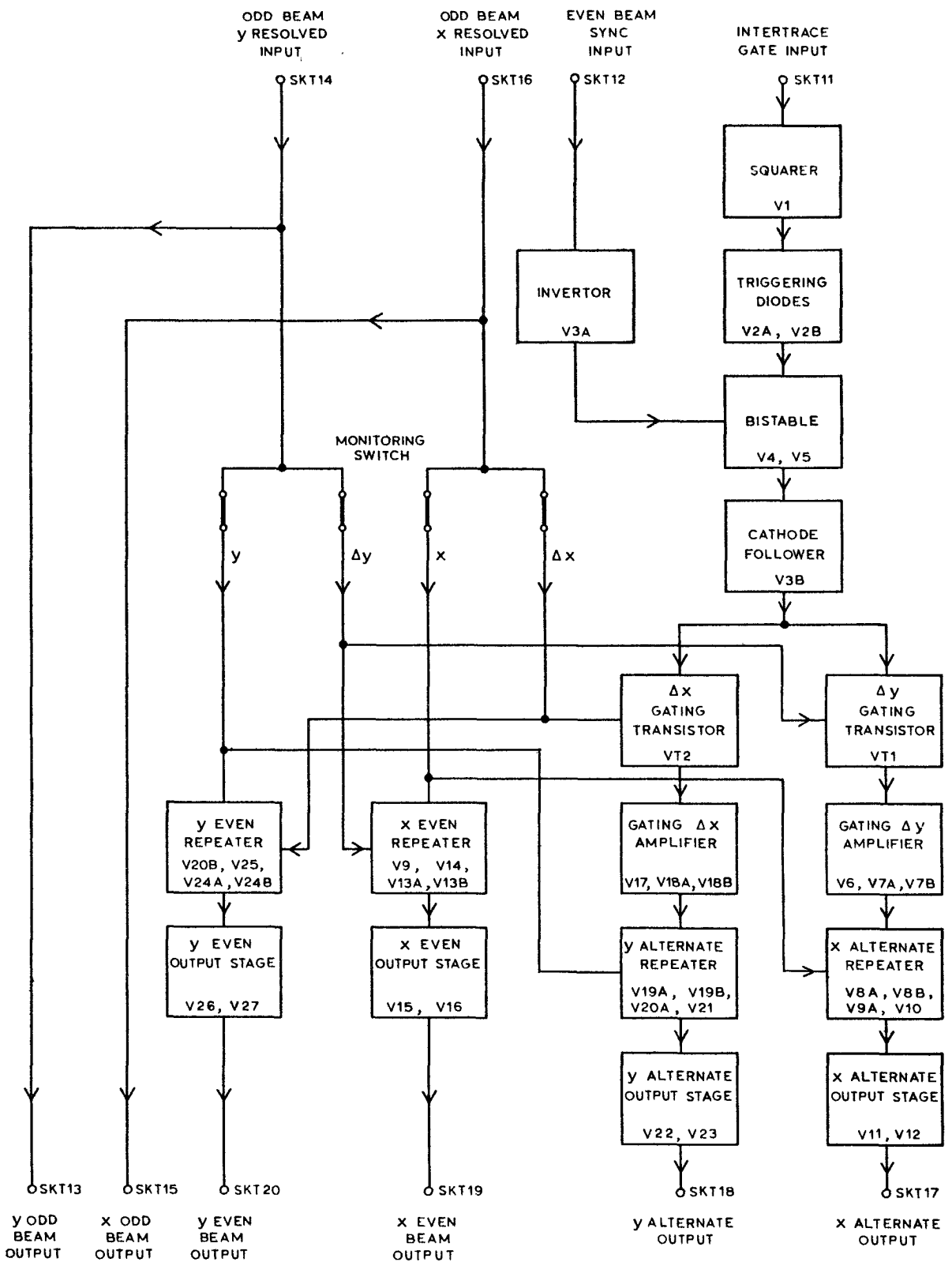


Fig. 16. Amplifier offset timebase—top view







◀Fig. 18. Amplifier offset timebase—block diagram▶

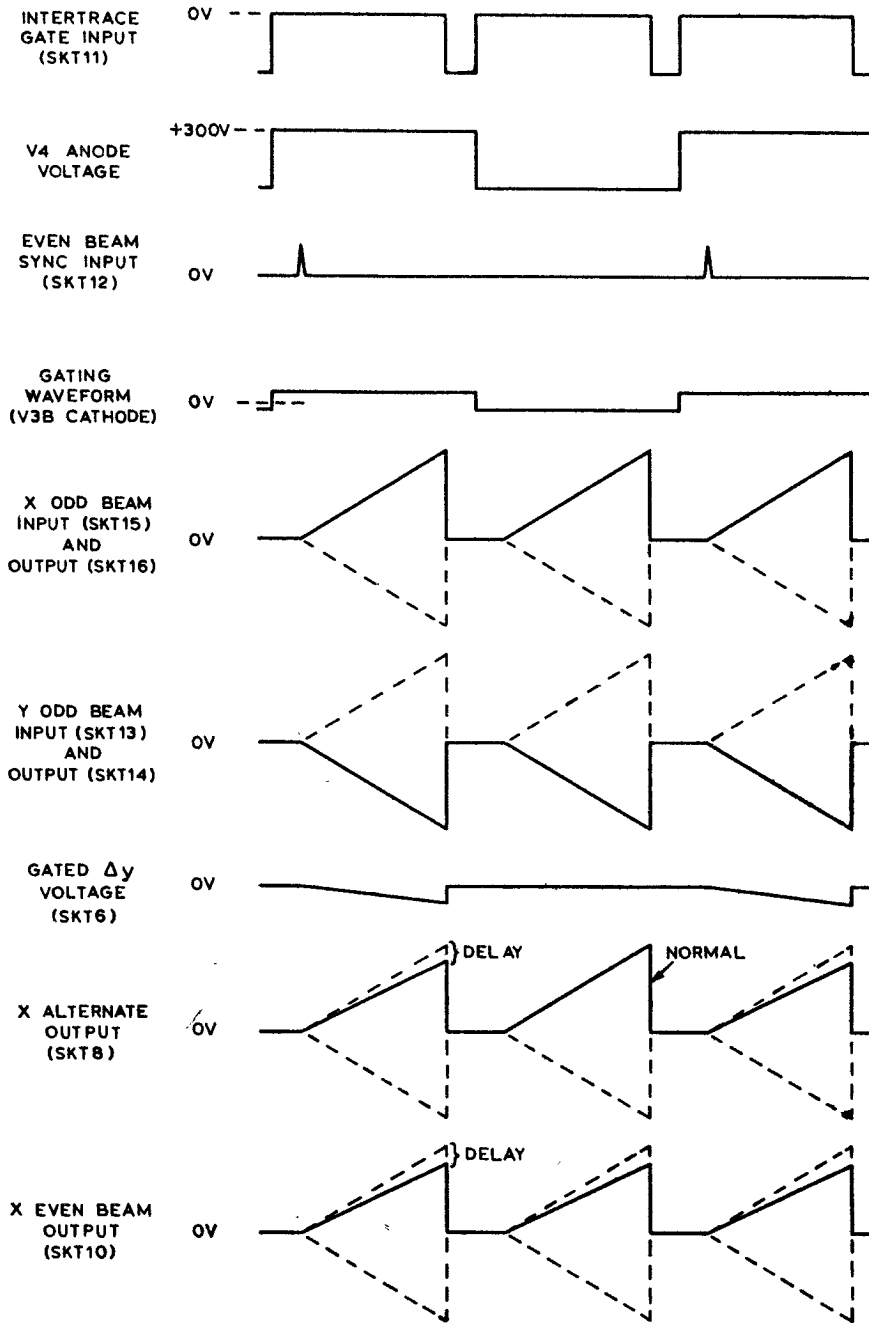


Fig. 19. Amplifier offset timebase—waveforms



### *Gating $\Delta X$ and $\Delta Y$ amplifiers*

**55.** The gating  $\Delta X$  and  $\Delta Y$  amplifiers are required to obtain the correct values and d.c. levels of the  $\Delta X$  and  $\Delta Y$  voltages for combining with the Y and X input voltages respectively. Since the two circuits are identical, only the  $\Delta Y$  amplifier is described here.

**56.** The input to the  $\Delta Y$  amplifier is derived from the odd-beam Y resolved waveform at SKT15 and is routed via the monitoring switch SWB. In order to produce  $\Delta Y$ , the input is developed across the voltage divider formed by R36, R37 and RV2 and the fraction required to represent  $\Delta Y$  obtained by the correct setting of the potentiometer.

**57.** Gating is provided by the transistor VT1 which creates a high or low impedance across the grid circuit of V6. When the gating waveform is negative, the transistor bottoms and clamps the input line to earth so that no output is obtained. With the positive half-cycle of the waveform, the transistor is cut off, so the clamping effect is removed and the input is allowed to pass to the grid.

**58.** Valve V6 is connected as a cathode-follower which shares its cathode load with the first valve of a feedback amplifier stage formed by V7A and V7B. When the transistor conducts, a charge equal to the mean d.c. level of the sawtooth waveform is developed across C8. This biases the input to V6 when the clamp is removed. The feedback stage restores the d.c. component of the sawtooth waveform and maintains the output from V7B at a constant d.c. level. A monitoring point is provided at SKT6.

### *Alternate repeater amplifiers*

**59.** The X and Y sawtooth waveforms are each passed to d.c.-coupled feedback amplifiers having White cathode-follower output stages. To provide the alternate odd or even-beam outputs, the gated voltages are combined with the odd-beam waveforms during alternate cycles. In the case of the X circuit, the  $\Delta Y$  voltage is introduced via the feedback line and, because this is in opposition to the input, subtracts from the odd-beam sawtooth. With the Y circuit, on the other hand, the  $\Delta X$  voltage is connected to the same point as the odd-beam input to the stage so that addition takes place.

**60.** Valves V8A and V8B in the X alternate amplifier are used to carry out the subtracting operation. The X sawtooth waveform is applied to the grid of V8A via RV3 to provide control of its amplitude. The d.c. potential of this grid is determined by the setting of RV10, which controls the mean level of the output. When the  $\Delta Y$  input is gated off, the X waveform is amplified and inverted normally and appears across the anode load R59.

**61.** During the positive half-cycle of the gating waveform, the  $\Delta Y$  voltage is applied to the grid of V8B through R62 and combined with the feedback voltage from the output stage. Owing to the high-impedance common cathode load provided by V9A, the  $\Delta Y$  voltage appears with the feedback at the cathode of V8A in opposition to the X

voltage. The resultant waveform developed across the anode load R59 represents the X voltage required to produce the even-beam timebase. From this stage the alternate odd-beam and even-beam waveforms are passed to the grid circuit of the amplifier V10.

**62.** In the Y alternate amplifier circuit V19A and V19B are connected to a high-impedance common cathode load, as with the X circuit, but the two input voltages are applied to the same grid. The Y waveform is brought to the stage via RV7 to provide control of its amplitude. The gated  $\Delta X$  voltage is connected to the same point via R143 and the sum of the two voltages applied to the grid of V19A.

**63.** When the  $\Delta X$  input is gated off, an odd-beam timebase waveform appears across the load R149, to be followed by an even-beam waveform when the  $\Delta X$  input is gated on. The alternate waveforms are passed to the grid circuit of the amplifier V21 and the mean output level is determined by the setting of RV12, which controls the d.c. voltage at the grid of V19B.

### *Alternate amplifier output stages*

**64.** The output stages of the X and Y alternate amplifiers are designed to provide output voltages varying positively and negatively about zero. Since the two stages are identical, only the X alternate circuit need be described.

**65.** Valves V11 and V12 are effectively in series and the output is obtained from the cathode of V11 through SKT17. The d.c. potential of this point is adjusted to 0V by means of RV10. The waveform from the amplifier stage V10 is applied to the grid of V11 and the voltage developed across the anode load R79 is fed via C17 on to the grid of V12, causing the current through this valve to vary in phase with that through V11. Because of this, the output voltage is enabled to vary positively and negatively about 0V. The feedback loop is completed back to V8B grid via R70 and C13. A monitoring point is provided at SKT8.

### **Production of even-beam waveforms**

#### *Even-beam repeater amplifiers*

**66.** The two even-beam repeater amplifiers combine the  $\Delta X$  and  $\Delta Y$  voltages with the Y and X inputs respectively to provide a series of delayed waveforms for producing the even-beam timebase. The circuits are identical to their counterparts in the alternate amplifiers, described in para. 59 to 63, and the only difference in operation is that the input  $\Delta X$  and  $\Delta Y$  voltages are not gated.

#### *Even-beam output stages*

**67.** The even-beam output stages are identical to the alternate amplifier output stages, described in para. 64 and 65. The even-beam timebase waveforms are obtained from SKT19 and SKT20 and may be monitored at SKT10 and SKT9 respectively.

### **Monitoring**

**68.** Monitoring switch SWB is used to switch the input waveforms for test purposes and to control

the operation of the associated waveform distribution panel. It has three wafers, two of which have contacts at the front and rear, and nine operative positions. Wafers SWB1 and SWB2 control the internal switching of the input waveforms. Wafer SWB3, however, is concerned with the switching of the waveform distribution panel and is included in the description of that unit.

69. Position No. 1 is the normal operational position of the switch and the one in which all outputs are available at their respective sockets. With the switch at positions 2 to 5, however, the  $\Delta X$  and  $\Delta Y$  input lines are earthed and the controls relating to the X and Y input voltages may be adjusted. In positions 6 to 9 the X and Y input lines are earth, enabling the controls concerned with the  $\Delta X$  and  $\Delta Y$  inputs to be set up.

### Power supplies

#### Mains input

70. All heater supplies are obtained from the mains transformer TR1 at the rear of the unit. The 230V 50 Hz mains supply is brought to the unit on PL1(B) (line) and PL1(F) (neutral), the line

being fused at 2A by FS4. The lamp LP3 is shunted across the fuse to indicate its serviceability.

#### Heaters

71. Five secondary windings are provided, four being rated at 6.3V 3A and one at 6.3V 1A. One of the 3A secondaries supplies the heaters of V12, V16, V23 and V27. The cathodes of these valves operate at a d.c. potential of approximately -200V and, to avoid difficulties concerning the cathode/heater insulation, this secondary is connected to the junction of R126 and R127, which forms a potential divider across the -300V supply. Similarly, the 1A heater winding supplies V9 and V20 whose cathodes are at a potential approaching -300V, so this secondary is returned to the junction of R180 and R181, which are also connected across the negative supply.

#### H.T. Supplies

72. A +300V stabilized h.t. supply is brought to the unit on PL1(D) and is fused at 500 mA by FS1. Neon lamp LP1 is shunted across the fuse to indicate its serviceability. The negative rail voltage is provided by a -300V stabilized supply which arrives at the unit on PL1(A) and is fused and indicated in a similar manner to the positive supply.

## GENERATOR DE-STAGGER

### INTRODUCTION

73. The generator de-stagger 5840-99-953-7536 converts the X and Y composite input waveforms containing normal and displaced (odd and even-beam) components into normal X waveforms and normal Y waveforms, suitable for use with IFF. A further facility enables only the odd-beam boundary marks to be displayed on the associated video channel.

### Construction

74. A general view of the unit with component layout is shown in fig. 20. Conventional construction is used with front and rear panels spaced apart with angle struts and valve channels riveted to these panels in a staggered fashion to facilitate servicing. Tagboards are bolted to the sides of the

valve channels, and input and output plugs and sockets are mounted on the rear panel; the front panel carries indicator lamps and fuses, and the selector switch SWA. The complete unit is rack-mounted on runners which allow it to be withdrawn with cables connected for routine measurements.

### CIRCUIT DESCRIPTION

#### General

75. The block diagram fig. 21 indicates that the unit may be considered in three stages. The first stage receives sync. pulses and from these produces a switching waveform for gating the second stage input. Additionally the first stage also gates odd-marks from an odd and even-beam input and provides an output at SKT9.

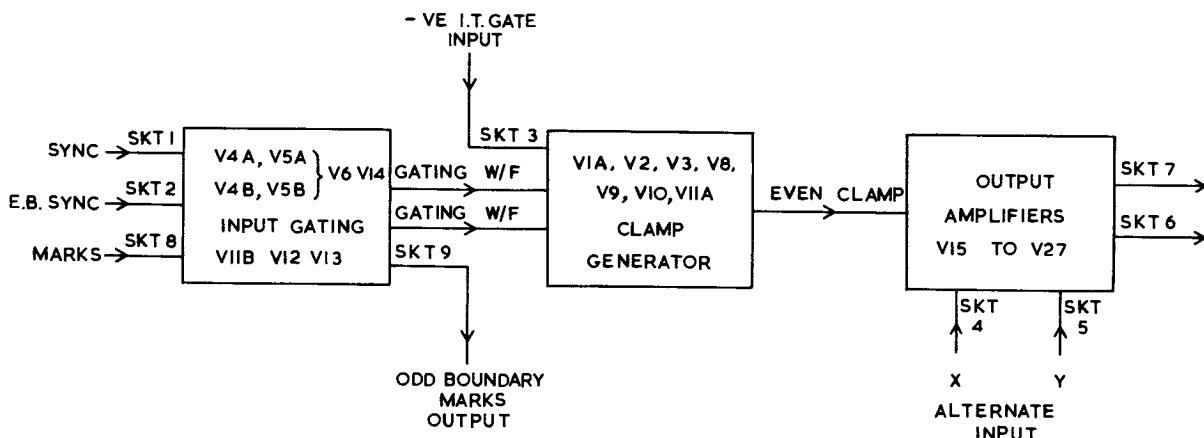


Fig. 21 Generator de-stagger—block diagram

76. The second stage uses the switching waveform from the first stage to select the positive intertrace gate pulse which is then amplified and used to trigger the even-beam clamp generator.

77. The third stage converts X and Y alternate inputs into normal X and Y outputs. This stage is controlled by the even-beam output from the clamp generator in stage 2, so that normal X and Y odd-beam waveforms are generated at SKT6 and 7. Fig. 30 and 31 are circuit diagrams, and waveforms are shown in fig. 22.

#### Production of switching waveform

78. A positive-going timebase sync. pulse (fig. 22) is received by the unit on SKT1 and a positive-going even-beam sync. pulse (fig. 22) at half-normal sync. frequency is received on SKT2. These

pulses are inverted by amplifiers V4A and V4B and applied via triggering diode V5 to the bistable stage formed around double-triode V6. The sync. inputs switch the bistable to produce anti-phase square wave outputs at the same frequency as the even-beam sync. These waveforms are taken to the grids of cathode-followers V14A and B, and their outputs are fed to the intertrace gating circuit.

79. Additionally the output of V14B is also fed to the suppressor of V12 where it controls the odd and even boundary mark input so that only an inverted odd-marks output is produced across R82. This output is fed via triode stage V11B to amplifier/cathode-follower pentode V13. When V12 is quiescent V32 is conducting since its cathode is connected via R88 to the  $-300\text{V}$  line and its anode is connected to the  $+300\text{V}$  line via R87.

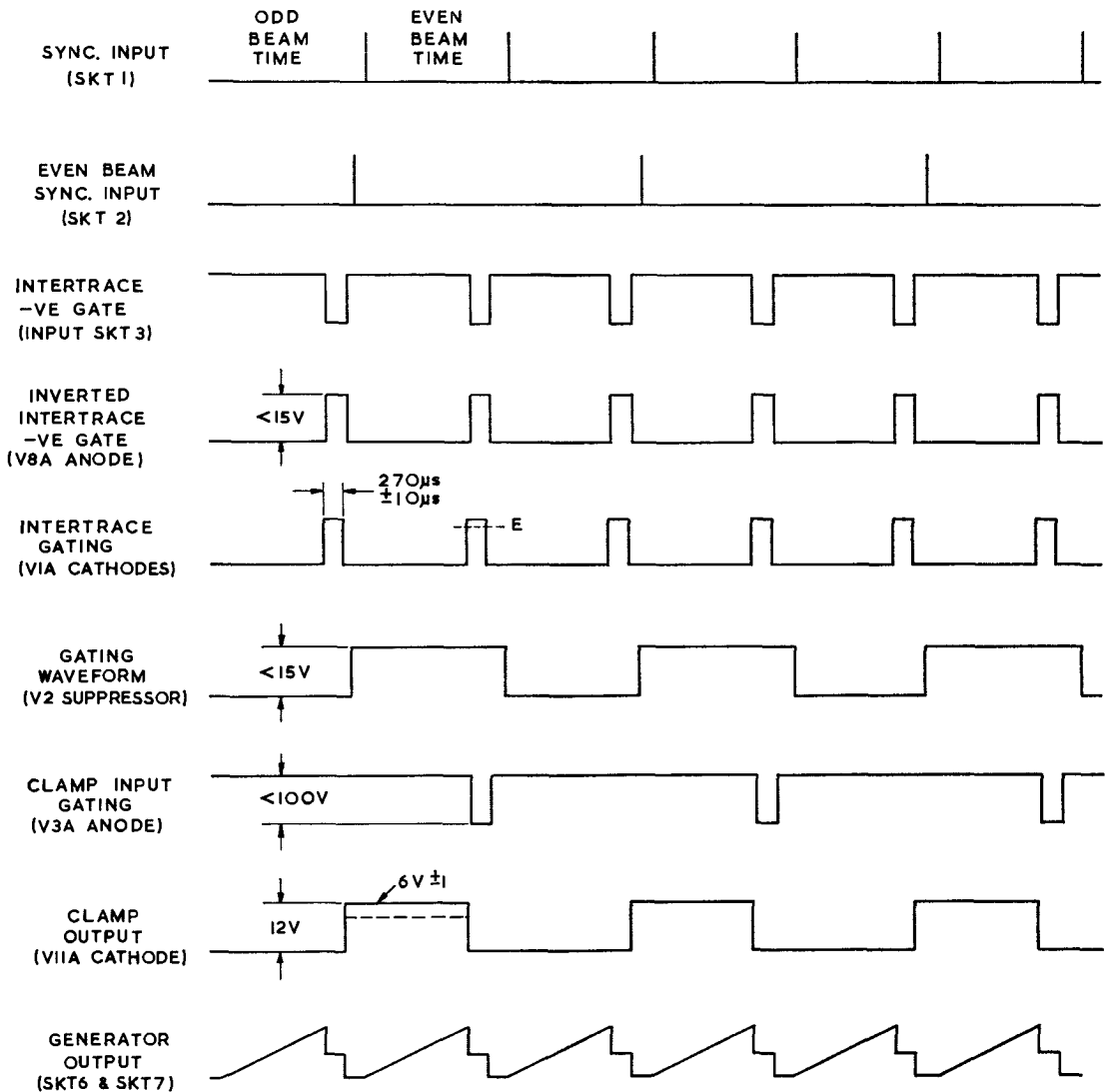


Fig. 22 Generator de-stagger—waveforms

The cathode of the diode would tend to rest at about +4V but the grid current of V11B reduces this to just below 0V. V11B is therefore conducting and V13 is biased off by about -50V from the divider R93, R94 between the -300V line and earth.

**80.** When an odd-mark input to V12 grid coincides with a positive gating pulse on V12 suppressor a negative waveform appears in V12 anode. V32 is cut off and the grid potential of V11B begins to fall toward -300V. At this point V11B and V13 operate as a see-saw amplifier with V13 cathode voltage rising positively and V11B grid held fractionally negative. Odd boundary marks are taken out through SKT9 and trimming capacitor C22 in the feedback loop of the grid of V11B enables the output pulse to be slightly modified to achieve a flat top and sharp edges.

#### Clamp generator

**81.** The clamp generator is a bistable stage, V10A and B, with a triggered diode input stage, V9A and B. During each period of the even-beam sweep, the amplifier V2 is gated on by a switching pulse from V14A. (V1B has no function and V7, with its input from R43, has been removed). The intertrace pulse, obtained from SKT3 via inverter V8 and cathode-follower V1A, produces a negative-going output at V2 anode that is fed to differential amplifier V3. The negative-going pulses from V3 and the inverted timebase sync. pulses from V4A are fed to the cathodes of V9, which in turn, initiate alternate triggering of each half of the bistable V10. A positive-going square wave (fig. 22) at even-beam frequency is obtained from the anode of V10A and taken via cathode-follower V11A to Zener diode V29 which limits the positive excursion of the output voltage to +6V. Diode V30 in series with V29 allows the output to fall below 0V. The output is taken from the junction of V11A cathode and V29 anode and fed to the bases of VT1 and VT2 to gate the odd-beam circuits of the third stage. ▶

#### Even-beam conversion stage

**82.** The even-beam conversion stage employs two amplifiers which add or subtract a preset voltage to the alternate even-beam X and Y inputs and thereby remove any timebase displacement, or stagger. The addition or subtraction process has to be carried out with alternate input cycles and the  $\Delta X$  and  $\Delta Y$  voltages are gated therefore by the output from the clamp generator. The Y alternate input is gated so that during an even-beam input cycle the  $\Delta Y$  voltage is added to the X voltage to produce an odd X output waveform. When the X alternate input is gated during an even-beam input cycle the  $\Delta X$  voltage is subtracted from the Y voltage to produce an odd Y output waveform. During the odd-beam input cycles no gating pulse is present and the alternate odd-beam X and Y inputs are passed straight through the amplifying stage to output sockets SKT6 and 7.

**83.** The input waveform for the  $\Delta Y$  component of the X odd-beam conversion circuit is obtained from SKT5 and brought via the monitoring switch SWA to the input circuit of V22. The  $\Delta Y$  voltage is developed across RV3 ( $\Delta Y$  GAIN), R148 and R149, the fraction required ( $\Delta Y$ ) being determined by adjustment of RV3. Transistor VT2 is controlled by the clamping waveform from V11A applied to its base and gates the input to the grid of V22 so that it is only applied during even-beam cycles.

**84.** V22 is connected as a cathode-follower which shares its cathode load with the first valve of a feedback amplifier stage formed by V23A and B. When VT2 conducts a charge equal to the mean d.c. level of the sawtooth waveform is developed across C38 and this biases the input to V22 when the clamp is removed. The feedback stage resorts the d.c. component of the sawtooth waveform and maintains the output from V23B at a constant d.c. level.

**85.** The addition amplifier consists of the cathode-coupled double triode, each half of which shares the high-impedance load formed by V18B. The added output is taken from the anode of V24A to an amplifier V25 and White cathode-follower V26 and V27. A negative feedback loop is included via C48 and R171 and appears at the cathode of V24A in opposition to the input.

**86.** The X alternate input waveform is obtained from SKT4 via monitoring switch SWA and fed to the control grid of V24A through an amplitude control RV2 (X GAIN). The gated  $\Delta Y$  output from the feedback amplifier V23 is also fed to V24A grid via R162. Thus both the X and  $\Delta Y$  voltages are applied to the V24A grid and the resultant waveform appearing across the anode load is an amplified version of the sum of the two input voltage less the feedback voltage to V24B. This represents the X waveform required to produce an odd-beam timebase during the even-beam cycle of the input. During the odd-beam cycle the  $\Delta Y$  voltage is gated off so that the odd-beam input waveform is merely amplified and inverted by V24 to 27.

**87.** The mean d.c. level of the output from V24A is determined by the setting of RV1 (X D.C.) which controls the standing current through V24. After inversion by V25 the waveform is passed to the grid of V26 which is connected in series with V27. RV1 is adjusted so that the output voltage varies positively and negatively about 0V. A monitoring jack point is provided at TJH.

**88.** The subtraction amplifier is formed by the cathode-coupled double triode V17 each half of which shares the high-impedance common cathode load V18A. The subtracted output is taken from the anode of V17B and fed via a similar output circuit to that used with the addition amplifier to the output at SKT7, although in this case the feedback loop is connected to V17A and appears at the

cathode of V17B in opposition to the input. The Y alternate input is obtained from SKT5 via monitoring switch SWA and fed to the control grid of V17B through an amplitude control RV5 (Y GAIN). The  $\Delta X$  component is derived in a similar way to the  $\Delta Y$  component used with the addition amplifier and is gated by VT1 before being fed via cathode-follower V15 and feedback amplifier V16 to the control grid of V17A. Thus both the  $\Delta X$  and feedback voltages are applied to V17A and the resultant waveform appearing across the anode load of V17B is the difference between the input voltage and the  $\Delta X$  and feedback voltages. This represents the Y waveform required to produce an odd-beam timebase during an even-beam cycle of the input. During the odd-beam cycle the  $\Delta X$  voltage is gated off so that the odd-beam input waveform is merely amplified by V17B, 19, 20 and 21. The d.c. level of the output is set to 0V by adjustment of RV4 (Y D.C.) and the Y odd-beam output at SKT7 varies positively and negatively about that level. A monitoring jack socket is provided at TJE.

#### Power supplies

89. The 230V, 50 Hz mains supply is brought to the unit at PL10(B) and (F) and taken to the primary of heater transformer TR1, the live

side being fused at 2A by FS1 with a fuse failure indicator LP1 connected in parallel. Five 6.3V secondary windings are provided at various current ratings, four being returned to earth and the fifth to a negative d.c. potential from divider R63 and 64. This potential is required by the cathodes of V18, 21 and 27.

#### Monitoring

90. Monitoring facilities are provided by the five-position switch SWA. One wafer is concerned with switching the waveform monitor in an associated rack and the remaining four wafers switch input lines for setting-up and test purposes.

91. With SWA set at NORMAL (position 1) all the outputs are obtainable from their respective sockets and the circuit operates as previously described. In positions 2 (D.C. & GAIN X) and 3 (D.C. & GAIN Y) both input gates are earthed and only the input lines to the X and Y amplifying and output stages are available. This enables the amplifier gains to be measured (X GAIN and Y GAIN) together with the standing d.c. levels (X D.C. and Y D.C.). In positions 4 and 5 the  $\Delta Y$  and  $\Delta X$  adjustments may be set, the X and Y inputs to the amplifiers being earthed. The monitoring points for these settings are in the cathodes of V23B and V16B through sockets T1G and TGD.

## PANEL DISTRIBUTION SWEEP

### PURPOSE

92. The panel distribution sweep (fig. 23 and 24) 5840-99-953-7534 distributes and controls the various services required by the units installed in the cabinet electrical equipment sweep (fig. 25) 5975-99-953-7535. The main facilities provided are as follows:—

- (1) To select displaced or resolved X and Y inputs to the amplifier offset timebase.
- (2) To select either a composite scan waveform or a resolved X and Y waveform as an input to each generator de-stagger.
- (3) To select or bypass the generator de-stagger with either of the inputs in (2) above.
- (4) To select the various monitoring points of the units installed in the cabinet.
- (5) Interconnection of external services with cabinet units.

### Construction

93. The unit is built up as a rigid recessed front panel on which all coaxial sockets, except PL69, are mounted together with a four-pole changeover switch SWA. The front panel is the standard 19 in width and is attached to the cabinet by four captive screws. A small chassis is fixed to the rear of the panel to form a base for the remaining plugs and sockets, the relays, diodes, and Ledex switch SWB. The relays are of the plug-in type secured with spring clips.

## CIRCUIT DESCRIPTION

### General

94. The various switching functions outlined above are described under their function headings in the following paragraphs. Reference to the

circuit diagram fig. 32 will also indicate the following unswitched interconnections:—

- (1) Sync. to generator de-stagger.
- (2) Even-beam sync. to generator de-stagger.
- (3) +ve intertrace gate to generator de-stagger.
- (4) Displaced offset alternate X and Y outputs.
- (5) Displaced offset even X and Y outputs.
- (6) +50V monitor switching lines from each signal processing unit to the monitor rack.
- (7) Aerial rotation information to generator sweep displaced.

### Selection of amplifier offset timebase input

95. Four-pole switch SWA is fed with resolved X and Y waveforms and displaced X and Y waveforms and, depending on operational requirements, may be used to select either of these for feeding to the amplifier offset timebase.

96. Resolved X and Y inputs are connected via SKT57 and 58 to tags 12 and 6 of SWA which in position 1 routes these inputs direct to the generator sweep displaced via SKT1 and 2. The displaced output from the generator is returned to SWA via SKT3 and 4 and routed to the amplifier offset timebase through SKT7 and 8. With SWA in position 2 the resolved X and Y inputs are removed from SKT1 and 2 and looped in conjunction with SWA to SKT7 and 8, and thus the amplifier offset timebase. SKT1, 2, 3 and 4 are not used in position 2. Monitor lines are connected to SKT3 and 4 and in conjunction with SWB the information at these sockets may be fed to the monitor rack.

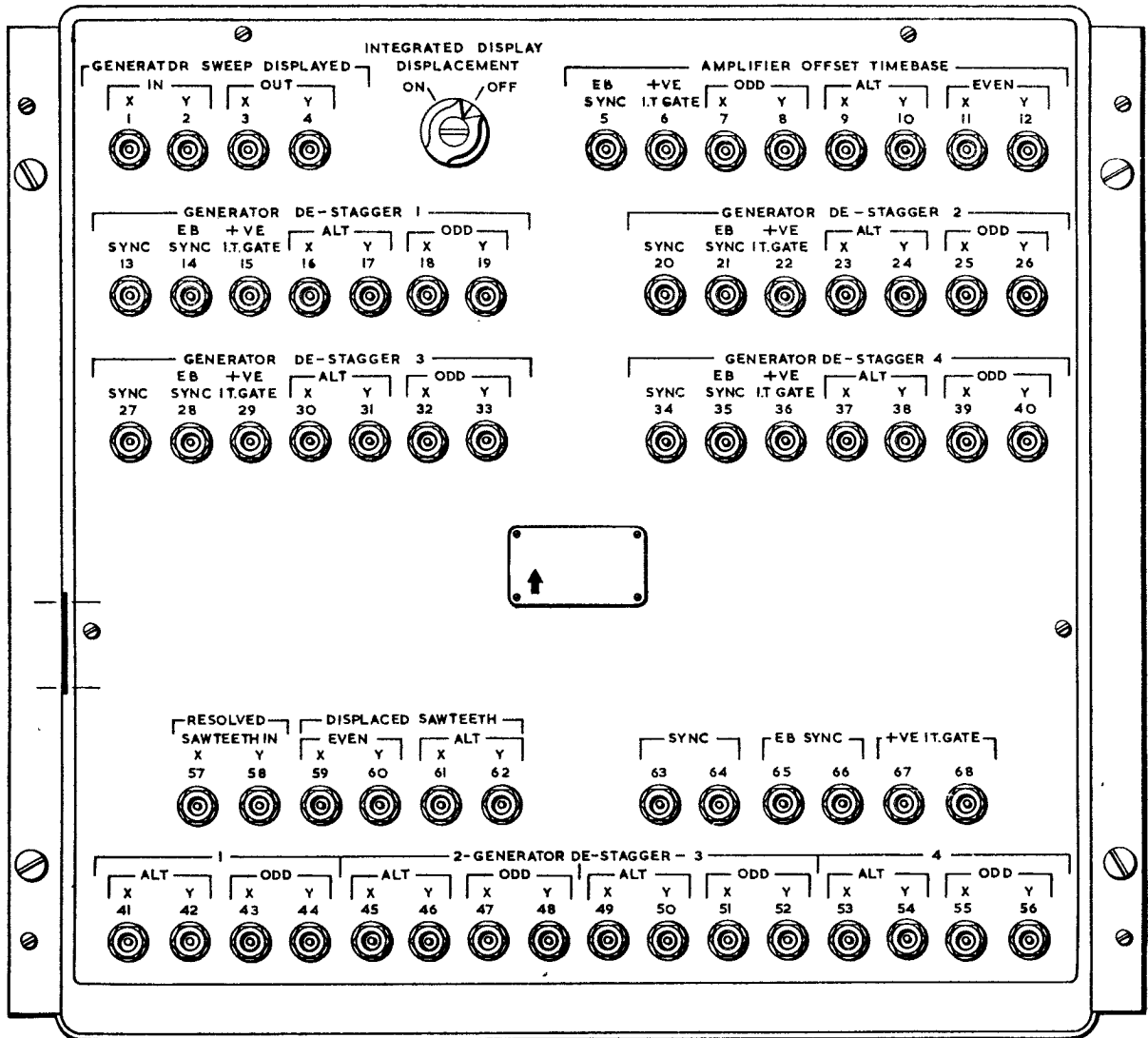


Fig. 23. Panel distribution sweep—front view

### Selection of generator de-stagger input

97. In order to set up the various waveforms within the generator de-stagger a supply of unprocessed resolved X and Y waveforms is required. A changeover relay is therefore inserted in the input line to each generator and the normal composite scan waveform input is fed to one pair of contacts while resolved X and Y waveforms are fed to the other pair. Each relay is energized by the waveform monitor switch on each generator de-stagger.

98. The circuit for each generator is identical and therefore that for unit 06 only is described. Under normal operating conditions alternate composite X and Y scans are received at SKT41 and 42 and passed to RLA1 and RLA2. RLA is normally de-energized and the signals are therefore passed through the relay contacts to the generator de-stagger via SKT16 and 17. When a calibration check is required, SWA on the generator de-stagger is set to one of four positions, all of which connect a +50V feed on bank 1 of SWA to the coil

of RLA via PL11(E) on the generator and SKT72(E) on the panel. The coil is returned to the -50V line at PL76(B) and is thus energized, changing over contacts RLA1 and 2, and connecting the resolved X and Y inputs at SKT57 and 58 to the output sockets, SKT16 and 17.

### Selection of generator de-stagger output

99. The outputs from the generators de-stagger are normally only required when the Type 85 radar head is displayed—when other heads are in use the staggered component is normally absent and the function is therefore superfluous. Changeover relay contacts are incorporated in the output from each generator, one contact being connected to the output from the generator, and the other to a tapping on the generator input line within the distribution panel.

100. The circuit for each generator is identical and therefore that for unit 06 only is described. RLE is normally energized, i.e. the generator is

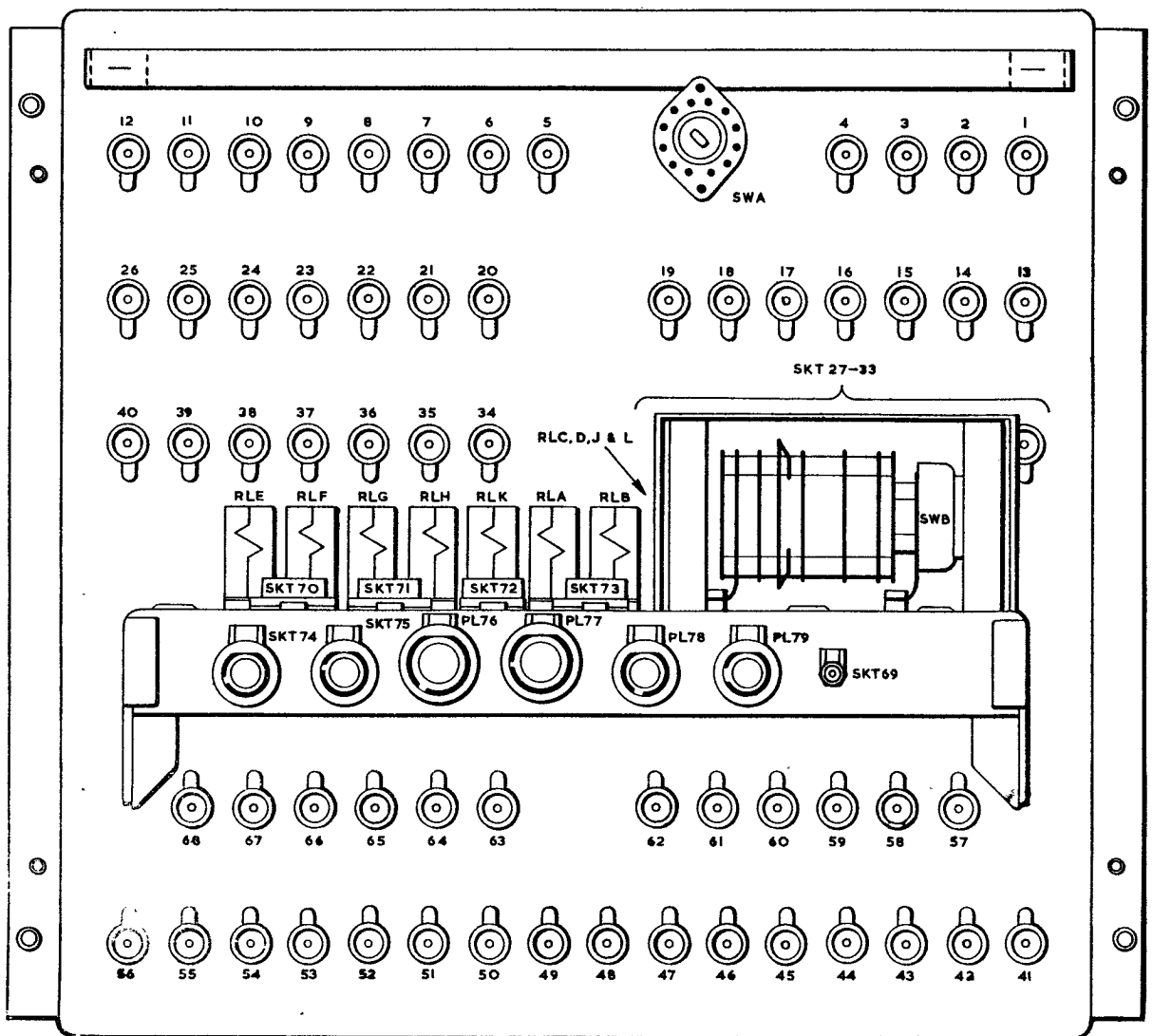


Fig. 24. Panel distribution sweep—rear view and component layout

being used to de-stagger a composite waveform from a console showing a Type 85 display. Under these conditions a +50V feed is selected by the head selector switch on the console, energizing RLE via PL79(A) and returning through PL79(E). The de-staggered X and Y waveforms at SKT18 and 19 are connected via relay contacts RLE1 and 2 to the output sockets SKT43 and 44 and thence to the IFF decoding equipment. When the Type 85 head is not required the head selector switch is moved to another position, removing the +50V feed from RLE. Contacts RLE1 and 2 change-over connecting normal composite X and Y waveforms to SKT43 and 44. A tapping from each generator output line is connected to bank 3 of the monitoring switch SWB.

#### Monitoring

**101.** Remote selection of the output waveforms from units 04 to 09 is carried out by a Ledex switch in conjunction with selector switches on these units, and in the monitor rack. Either the monitor switches on the individual units, or the selector

switch on the monitor rack, may be used to select the required waveform. The selection process is similar, but not identical, for each unit and each process is therefore described under unit headings.

#### Generator sweep displaced

**102.** The switching lines are connected between PL6 on the generator and SKT70 on the panel and when the generator is selected by the unit selector on the monitor rack a +50V feed is brought to bank 3 of the selector switch SWA on the generator. When an X or Y waveform is selected by SWA the +50V feed is fed via SKT70(A) and (B) and relay contacts RLL1 and 2 to the contact ring of the Ledex switch SWB. The switch rotates until the wiper of bank 3 is in the required position where it selects the desired output line from the generator sweep displaced and feeds the signal via RLJ1 and SKT69 to the monitor rack. Relays RLJ and RLL are both de-energized when this facility is being used. When  $\Delta X$  or  $\Delta Y$  monitoring is required a +50V feed is fed to a selector relay in the monitoring rack via the diode V6. The diode eliminates

the possibility of any back feeds in the 50V line reaching the generator sweep displaced.

#### *Amplifier offset timebase*

◀103. The switching lines are connected between PL22 on the amplifier and SKT71 on the panel and when the amplifier is selected by the monitor rack, a +50V feed is made available at PL22(A) on the amplifier, and via switch SWB within the amplifier to PL22(G), thence to SKT71(G) on the panel to energize RLK and open RLK1. Monitoring positions selected by SWB in the amplifier will route the +50V to the Ledex Switch on the panel which will rotate to the required position and select the appropriate line via bank SWB3. When monitoring of  $\Delta$  functions is required, SWB, in the amplifier, breaks the +50V line to RLK, on the panel, closing RLK1 and connecting the +50V to the  $\Delta$  selector relay in the monitor rack. The diode V5 eliminates possible back feeds.▶

#### *Generators de-stagger*

104. The circuit is similar for each generator ◀and that for unit 09 is described. Switching▶ lines are connected between PL11 on the generator and SKT75 on the panel. When the unit is selected on the monitor rack a +50V feed is introduced to the generator at PL11(A) and also to the panel at PL76(A), this latter energizing RLJ and RLL. These relays are not energized when units 07, 08 and 09 are being monitored. When the selector switch SWA on the generator is set to the X or Y positions the +50V is connected to the contact ring of the Ledex switch through RLL1 or 2 and the wiper of SWB4 moves to the required position feeding the desired waveform to the monitor rack via RLJ1 and SKT69. When SWA on the generator is set to either of the  $\Delta$  positions, +50V is connected via PL76 to the  $\Delta$  waveform selection relay in the monitor rack; V1 again serves to eliminate back feeds.



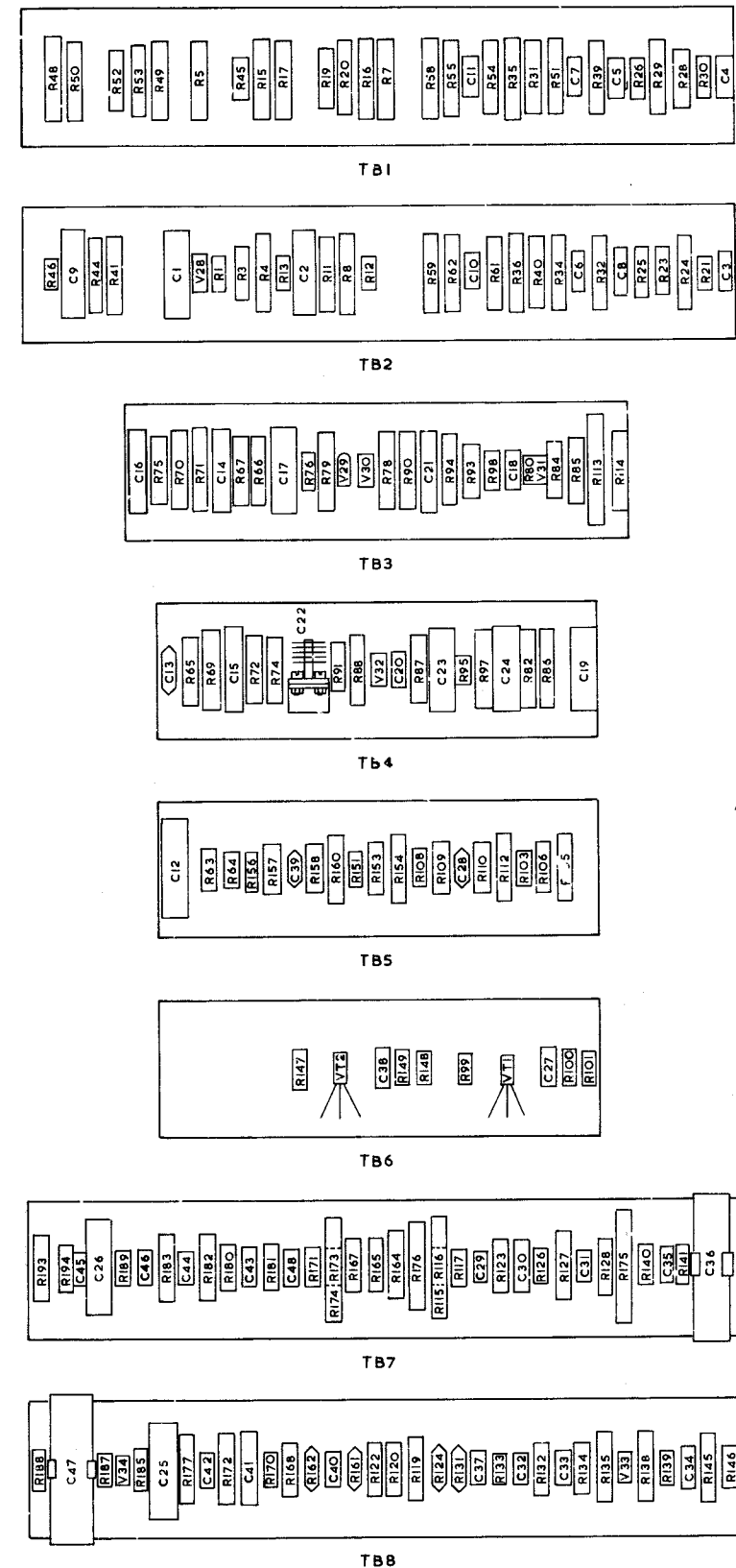
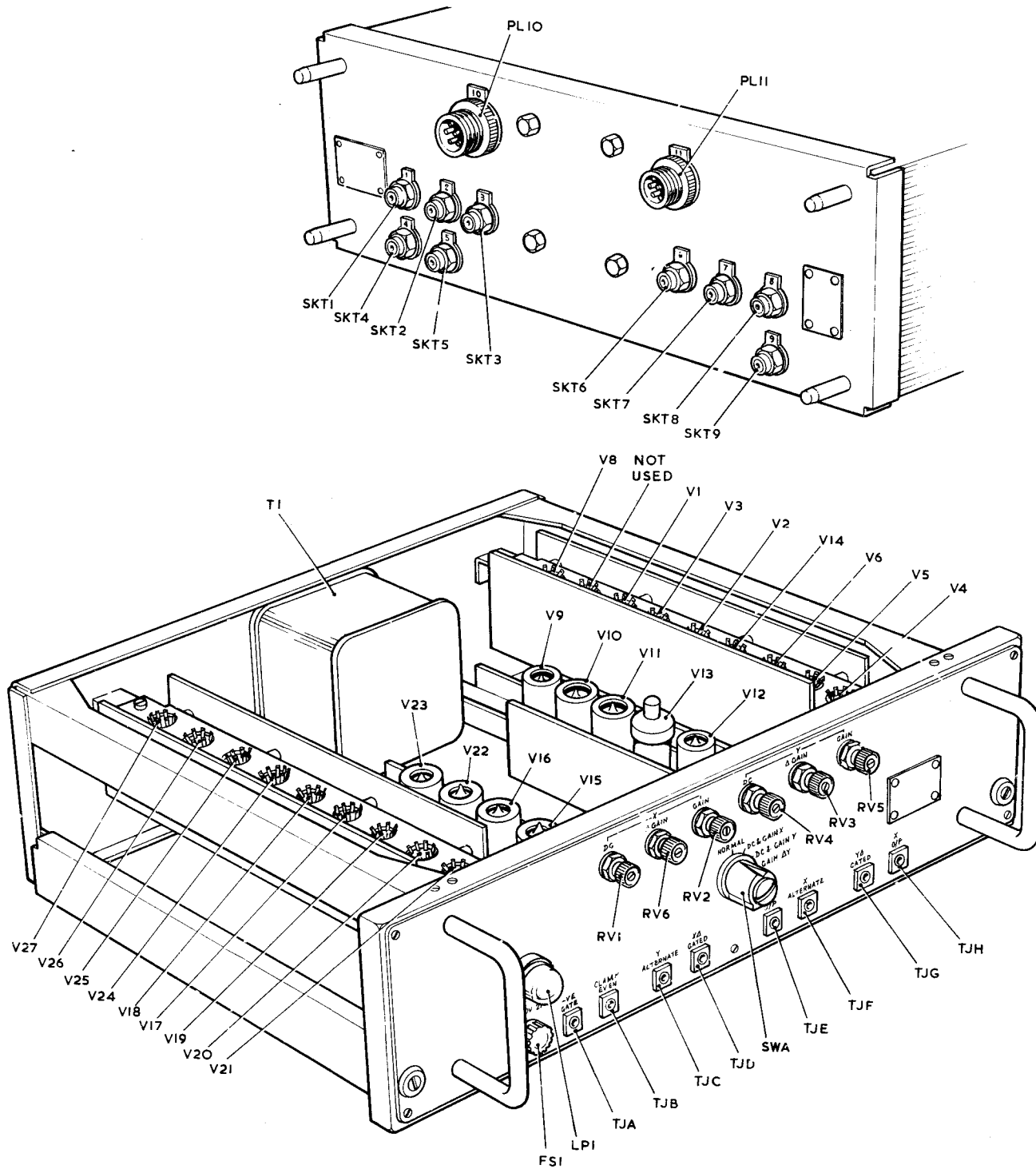
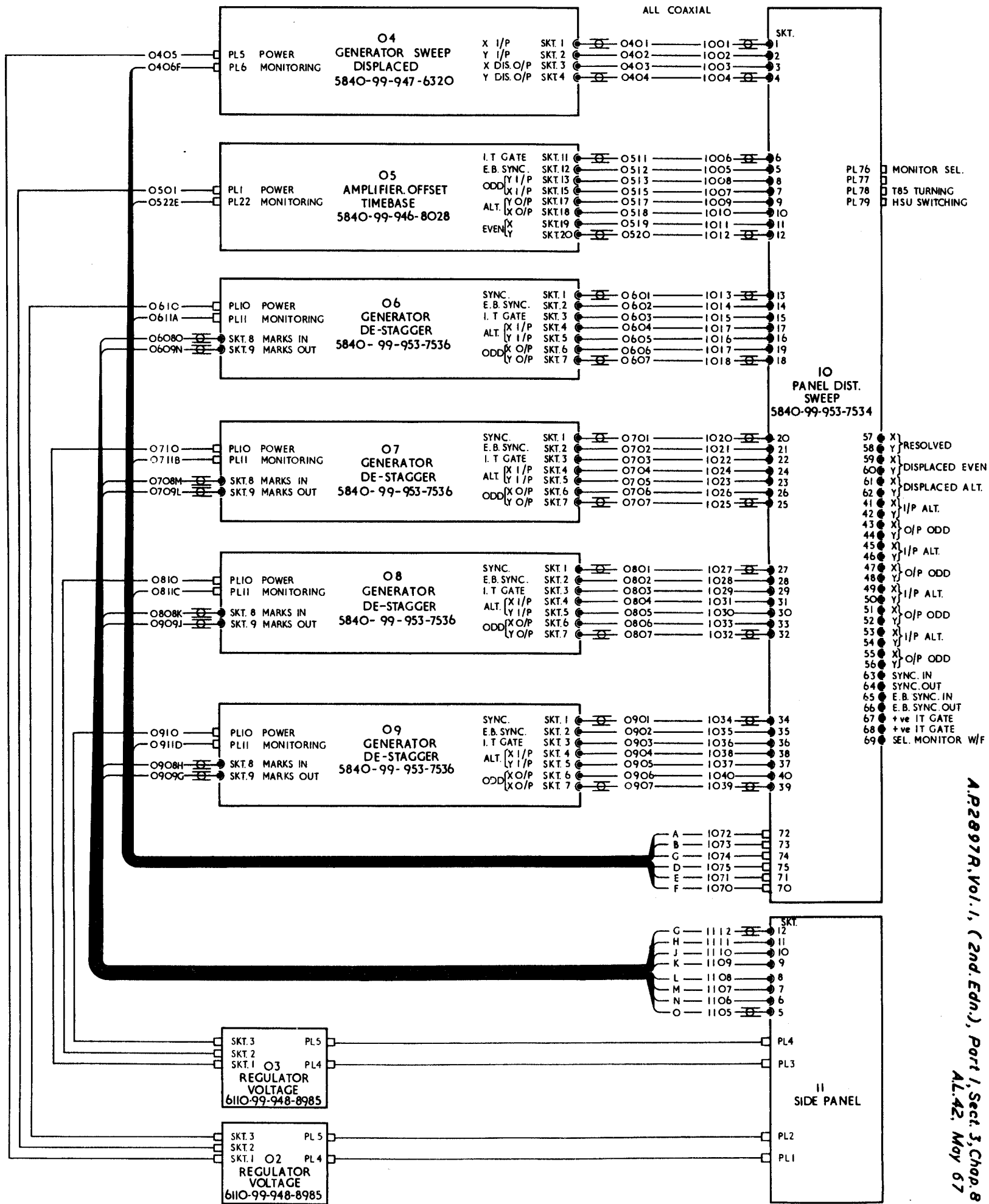


Fig.20

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Generator de-stagger - general view & component layout.

Fig.20



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Fig. 25

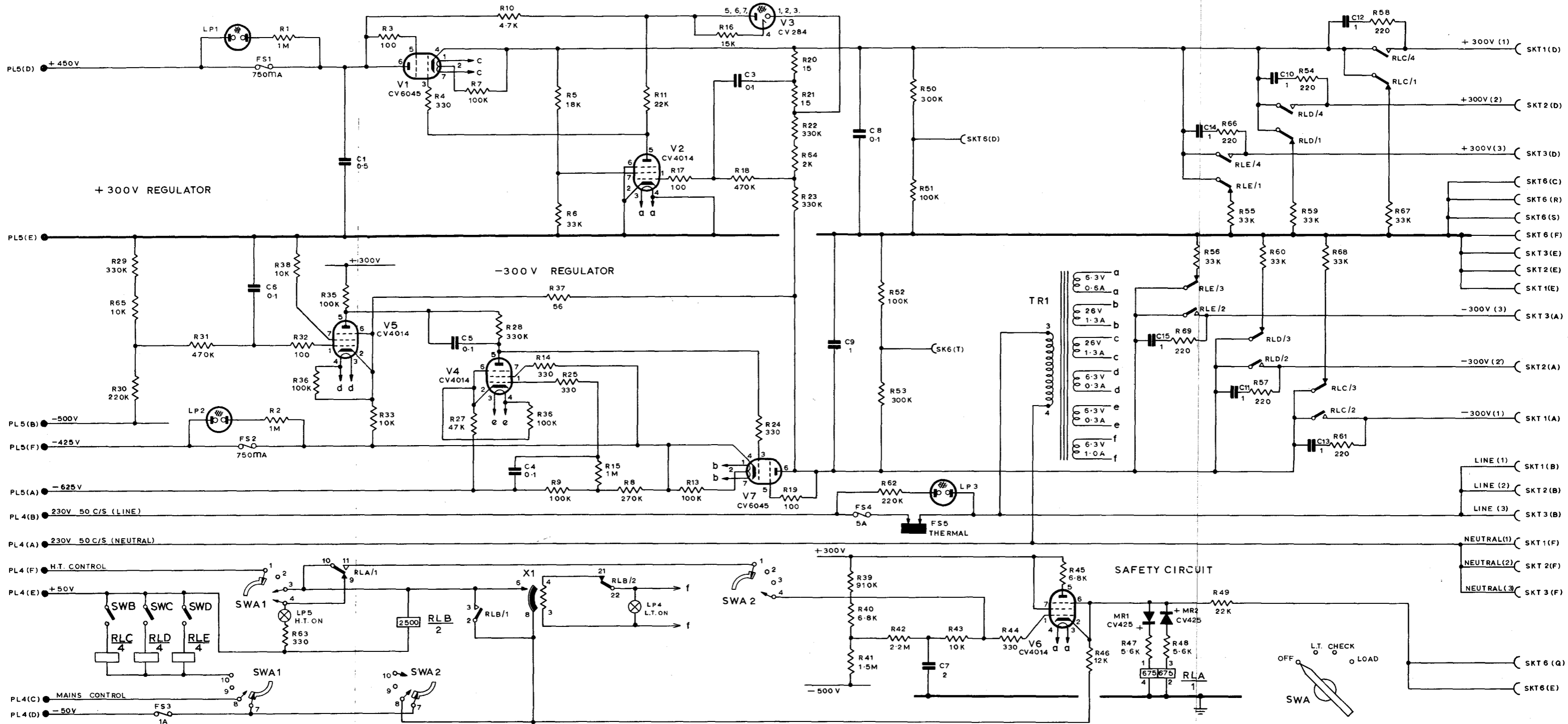
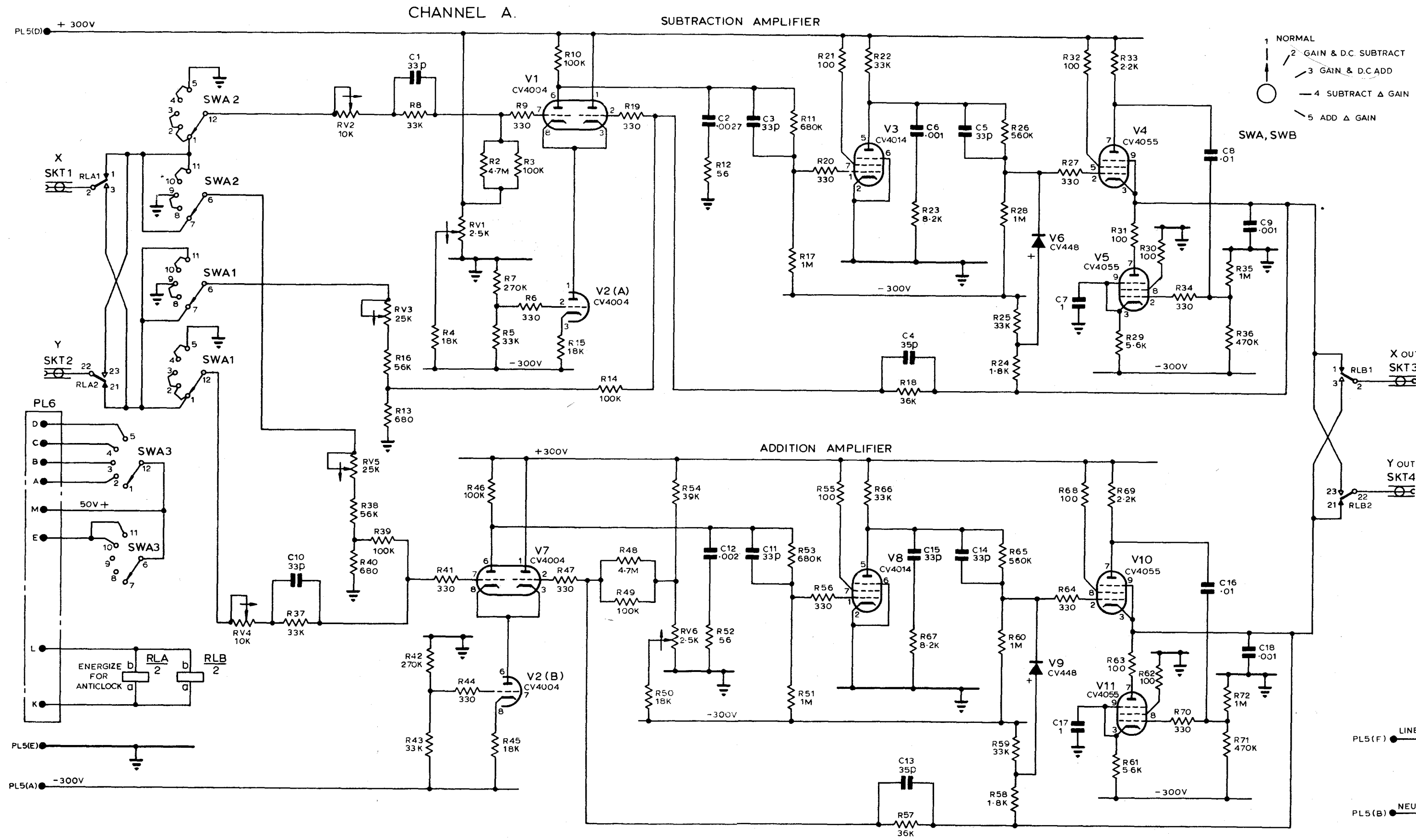


Fig. 26

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Regulator voltage circuit

Fig. 26



CHANNEL 'B' CIRCUIT IS IDENTICAL TO CHANNEL 'A':

COMPONENT REFERENCE

CHANNEL A	CHANNEL B	CHANNEL A	CHANNEL B	CHANNEL A	CHANNEL B	CHANNEL A	CHANNEL B
R1	R101	R39	R139	RV1	RV11	SKT 1	SKT 11
R2	R102	R40	R140	RV 2	RV12	SKT 2	SKT 12
R3	R103	R41	R141	RV 3	RV13	SKT 3	SKT 13
R4	R104	R42	R142	RV 4	RV14	SKT 4	SKT 14
R5	R105	R43	R143	RV 5	RV15		
R6	R106	R44	R144	RV 6	RV16	PL 5	PL 15
R7	R107	R45	R145			PL 6	PL 16
R8	R108	R46	R146	C 1	C 31		
R9	R109	R47	R147	C 2	C 32	ILP 1	ILP 2
R10	R110	R48	R148	C 3	C 33		
R11	R111	R49	R149	C 4	C 34	FS 1	FS 2
R12	R112	R50	R150	C 5	C 35		
R13	R113	R51	R151	C 6	C 36	T 1	T 2
R14	R114	R52	R152	C 7	C 37		
R15	R115	R53	R153	C 8	C 38	SWA	SWB
R16	R116	R54	R154	C 9	C 39		
R17	R117	R55	R155	C10	C 40	RLA	RLC
R18	R118	R56	R156	C11	C 41	RLB	RLD
R19	R119	R57	R157	C12	C 42		
R20	R120	R58	R158	C13	C 43		
R21	R121	R59	R159	C14	C 44		
R22	R122	R60	R160	C15	C 45		
R23	R123	R61	R161	C16	C 46		
R24	R124	R62	R162	C17	C 47		
R25	R125	R63	R163	C18	C 48		
R26	R126	R64	R164	V 1	V 21		
R27	R127	R65	R165	V 2	V 22		
R28	R128	R66	R166	V 3	V 23		
R29	R129	R67	R167	V 4	V 24		
R30	R130	R68	R168	V 5	V 25		
R31	R131	R69	R169	V 6	V 26		
R32	R132	R70	R170	V 7	V 27		
R33	R133	R71	R171	V 8	V 28		
R34	R134	R72	R172	V 9	V 29		
R35	R135	R73	R173	V10	V 30		
R36	R136	R74	R174	V11	V 31		
R37	R137	R75	R175				
R38	R138	R76	R176				

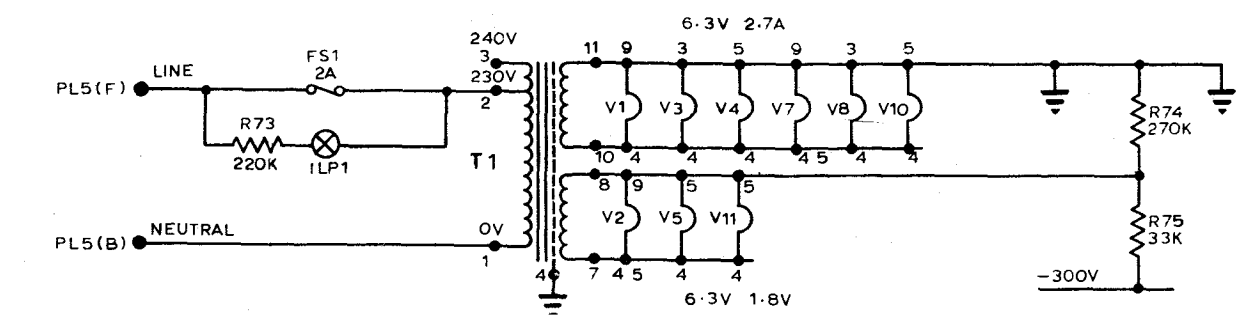


FIG.27

Generator sweep displaced - circuit.

FIG 27

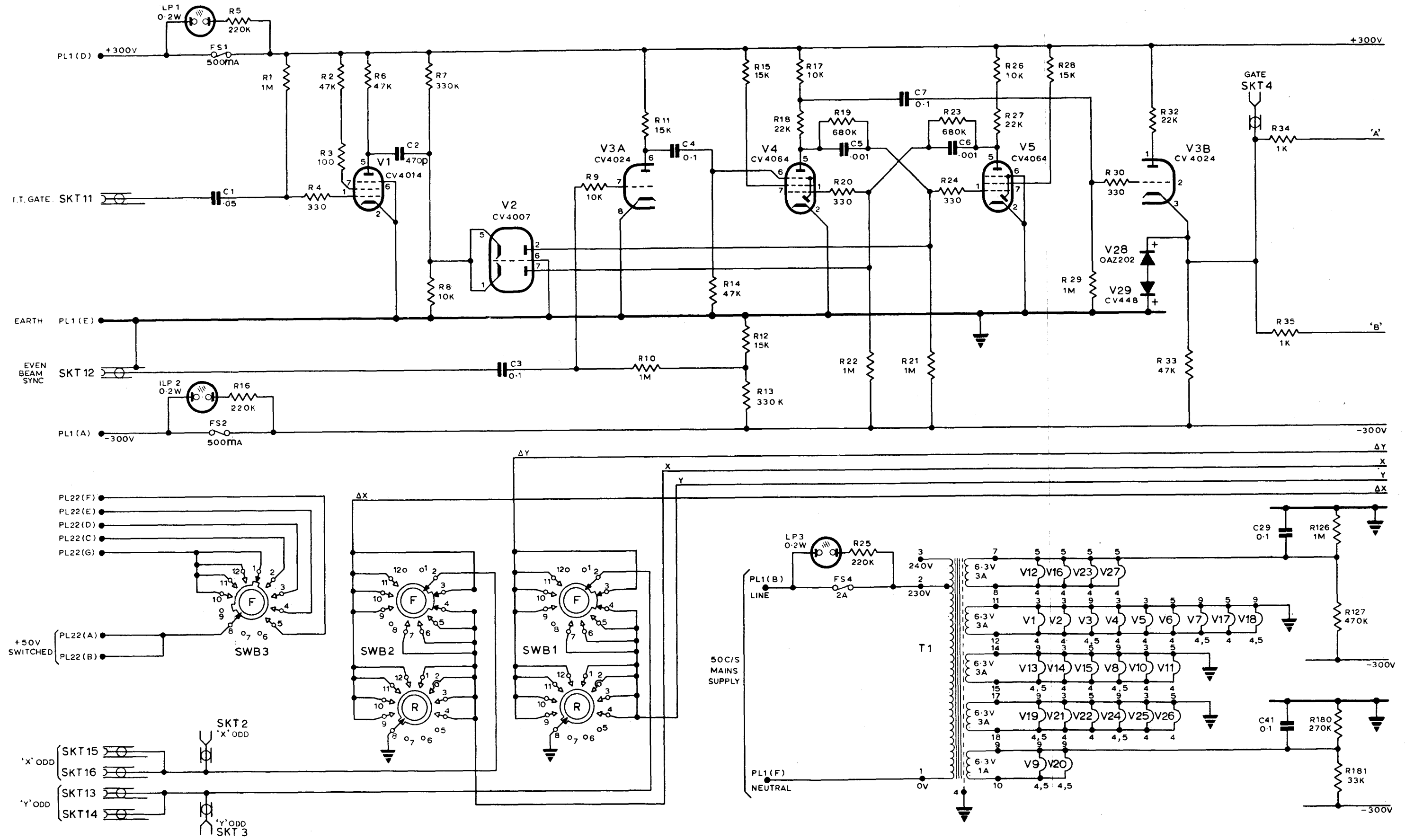


Fig.28

Amplifier Offset Timebase -circuit (1)

Fig.28

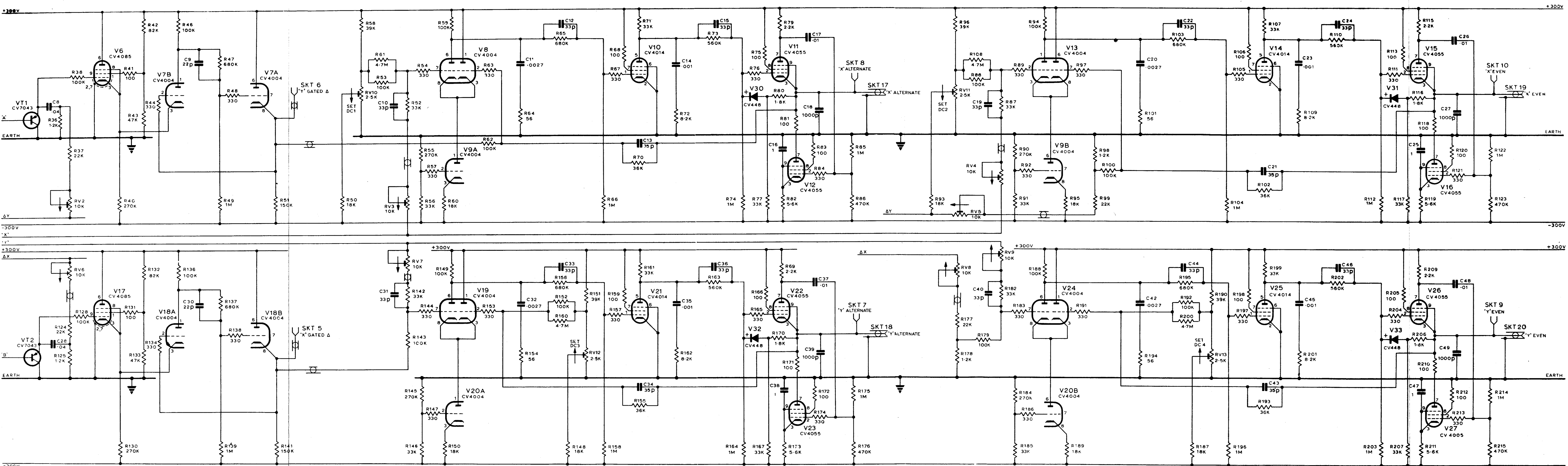
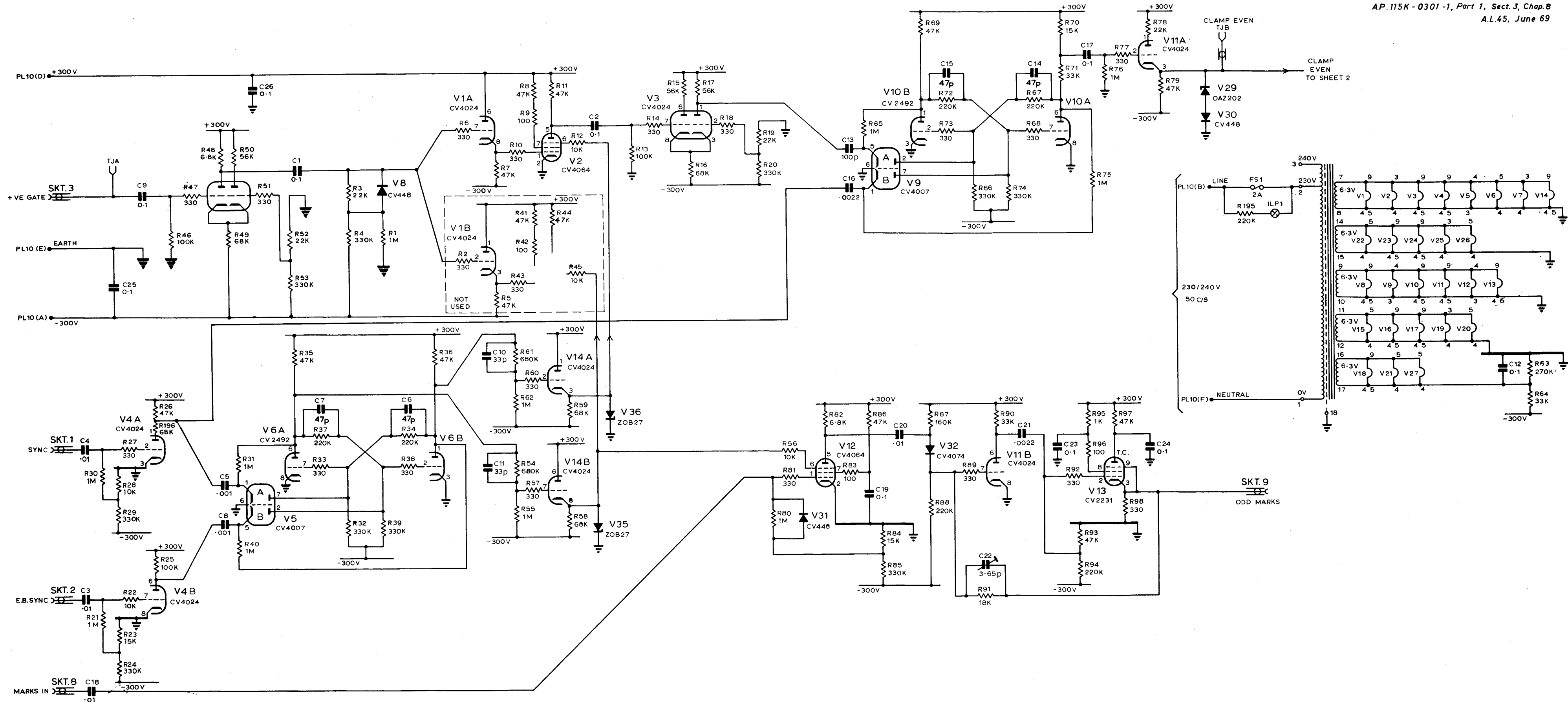


Fig 29

Amplifier Offset Timebase - circuit (2)

Fig 29



GENERATOR DE-STAGGER : CIRCUIT 1

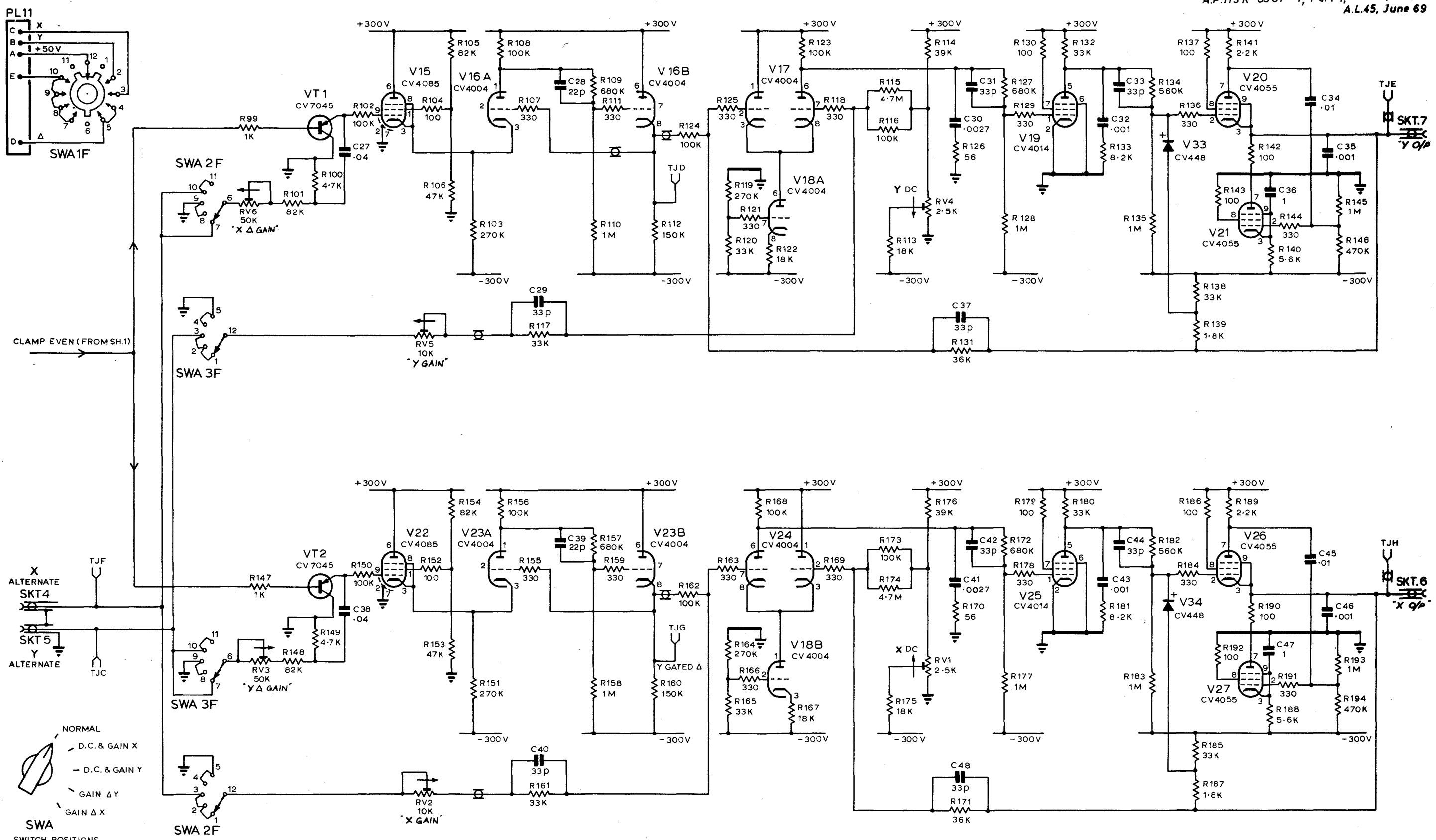


Fig 31

GENERATOR DE-STAGGER : CIRCUIT 2

Fig 31



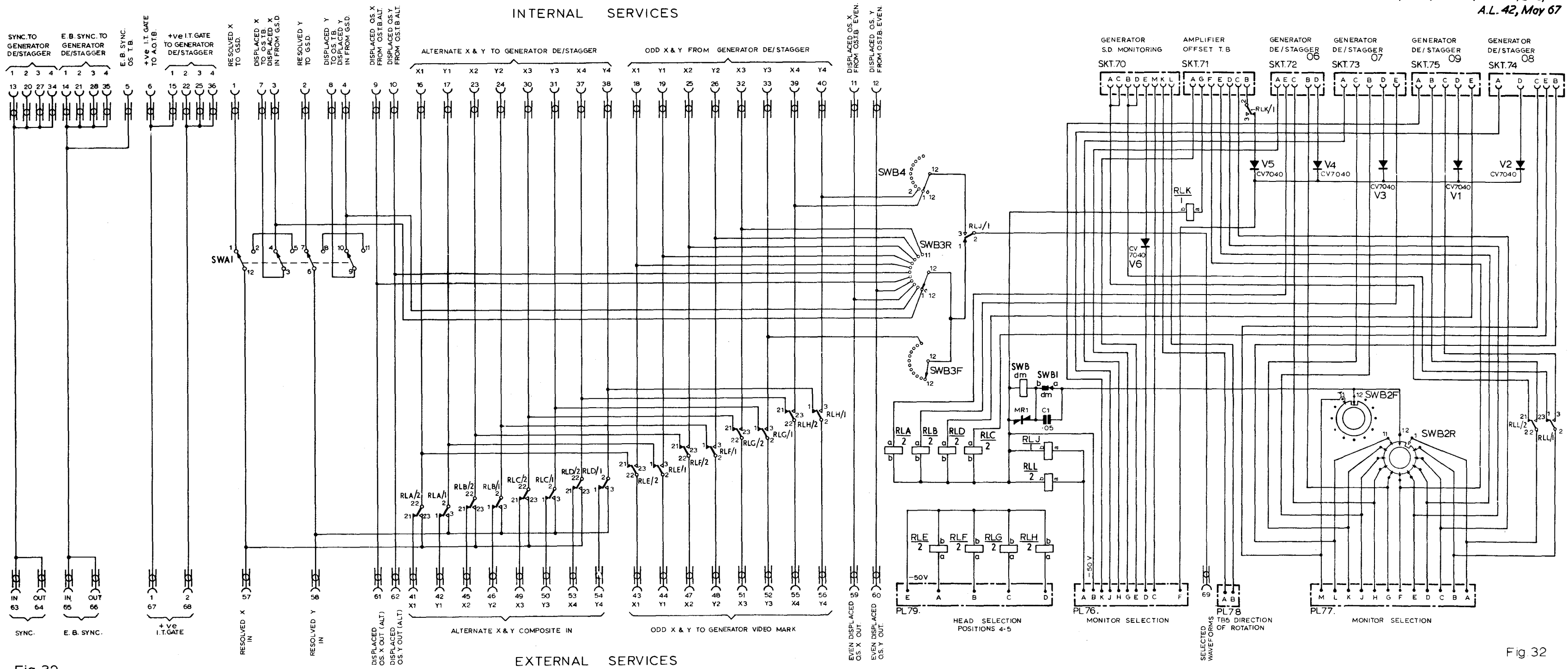


Fig 32

Fig 32. PANEL DISTRIBUTION SWEEP - CIRCUIT.

Fig 32

## **SECTION 4**

# **CIRCUIT DESCRIPTION AND LAYOUT RACK ASSEMBLY (WAVEFORM MONITOR) TYPE 339**

## Chapter 1

## INTRODUCTION AND MINOR UNITS

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## INTRODUCTION

**Purpose of rack**

1. The rack assembly Type 339 is a fixed installation which provides a means of displaying, on its monitor unit, the principal waveforms of the fixed-coil radar office equipment. It takes the form of a standard rack assembly so situated in the radar office that its display can be observed at a convenient range and angle from all the equipments which are being served by it. These equipments are as follows:—

- (1) RA 300—Timebase units Type 140.
- (2) RA 301—Magflip resolver units (two cabinets).

(3) RA 302—Azication marker generator units (two cabinets).

(4) RA 304—GWG units.

(5) RA 184—Head selector units (6 cabinets).

The rack is used for setting-up these equipments and for carrying out certain checks on the waveforms (e.g., measuring the velocity of the timebase waveform from the TB unit Type 140). Except in the case of the head selector racks (in which wander leads are used) and the azication marker generator and resolver (for which instructions will not be published until the design of the associated panel Type 4448 has been finalized) all waveforms are automatically selected, together with the timebase duration, time delays

and degree of amplification required to present the particular waveform (or a sampled portion of it) on the monitor cathode-ray tube. To display waveforms for which no automatic provision is made, the rack may be released from automatic control, similar facilities to those just mentioned being available for manual operation.

2. For automatic operation, the selection of

circuit paths is determined by two switch banks, labelled "A" and "B", respectively, in the control panel of the waveform monitor rack. These switch banks control actuators situated in the distribution panels in the bases of the rack assemblies associated with the fixed-coil PPI display consoles. The actuators (one or more in each rack) select the actual circuit paths in the racks. The 50V D.C. supply is applied to the

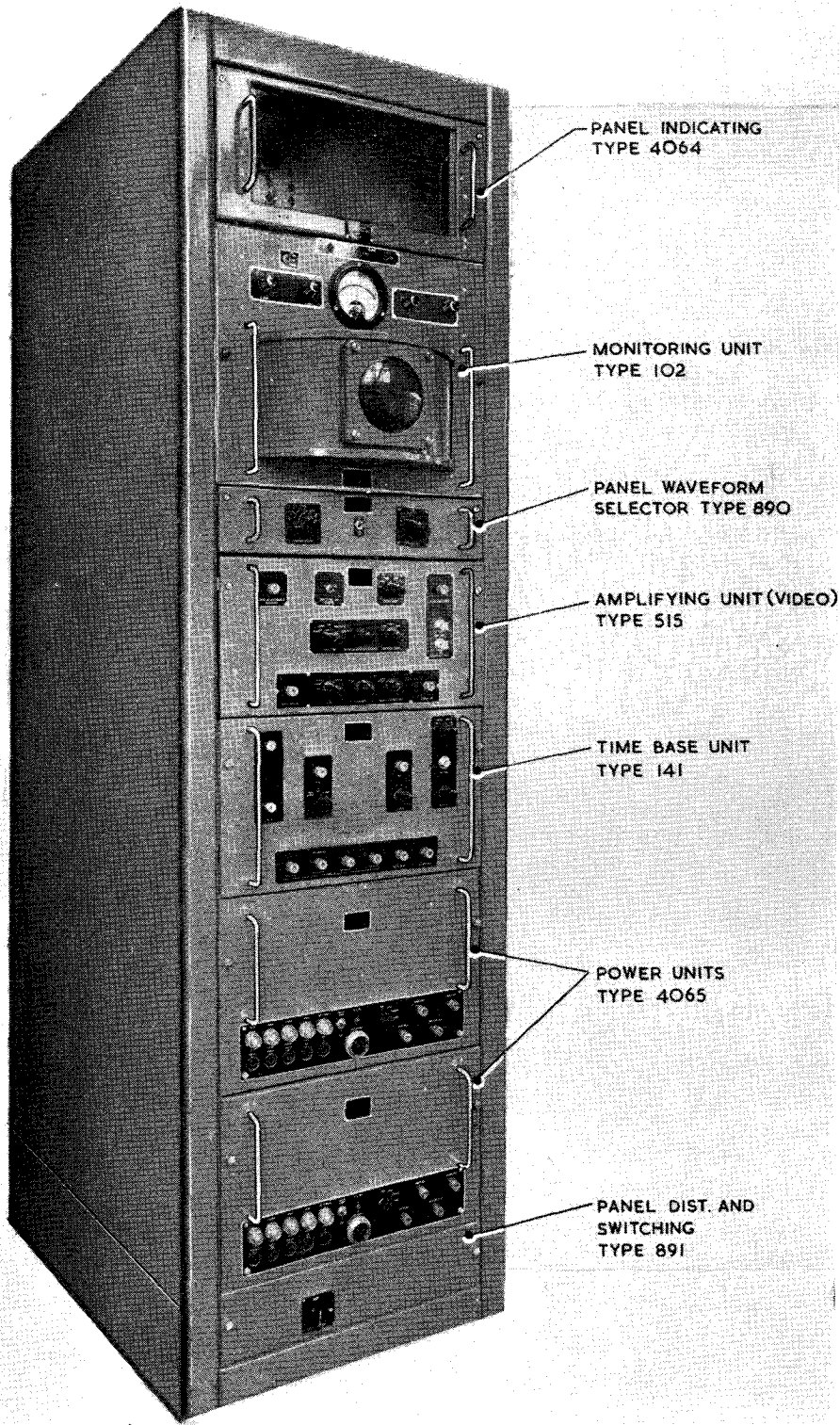


Fig. 1. Rack assembly (waveform monitor) Type 339



operating coil of the actuator from the selector switch, via the actuator switch blade and the actuator switch contacts, which are normally closed. The flow of current through the operating coil turns the armature, and a cam opens the contacts, thereby switching off the current so that the spring-loaded armature turns back and the contacts close again. This operation pulls the whole switch round one step, by means of a ratchet and pawl device. The stepping action continues until the circuit is broken by the gap in the actuator switch blade; the switch then comes to rest in the desired position. A Metrosil and capacitor are connected effectively across the stepping contacts to prevent sparking.

3. The monitor rack contains circuitry to provide the facilities mentioned in para. 1, viz., timebases of various durations, delay circuits, calibration circuits and circuits for different degrees of amplification of video signals. The appropriate circuitry, in the various units of the rack assembly, is selected by actuators controlled from the same two banks of switches mentioned in para. 2.

#### Arrangement of rack

4. The physical arrangement of the monitor rack is similar to that of the other racks associated with the fixed-coil consoles. The basic rack is 7 ft. in height and it accommodates, on sliding runners, the standard 19 in. wide units which make up the rack assembly. The units are interconnected by flexible, screened multiway and coaxial cables, via plugs and sockets at the rear of the rack.

5. All cables for external connections to the rack come from the cable trunking system under the floor of the radar office, and enter the rack through an aperture in the base plate. These connections are made to the panel, distribution, Type 891 and to panel-mounted couplers at the bottom of the rack. Cooling air also enters at the base and is blown through the units before being withdrawn at the top, a single fan being used to promote the circulation of the current of air through all the units in the radar office.

6. The power supplies fed into the rack are:—

- (1) 230V, 50 c/s, from the radar office power board;
- (2) 500V negative reference, from the rack assembly Type 338;
- (3) 50V DC for relay operation, from rectifier Type 15;
- (4) a separate 50V DC supply for operating actuators.

There is also provision for feeding the 50V relay supply out from the rack (via relay contacts in the power units Type 4065) to permit remote switching of the —500V supply in the rack assembly 338. Apart from these supplies the rack is self-contained, with its own power units.

#### Units in rack

7. The units in the rack, reading from top to bottom, are as follows (identification numbers as shown):—

- (01) Panel, indicating, Type 4064 (Stores Ref: 10D/19032).

This unit also contains the EHT power unit, Type 913 (10K/17453), identification number (10).

- (02) Monitoring unit, Type 102 (10T/6156).
- (03) Panel, control (waveform selection), Type 890 (10D/18934).
- (04) Amplifying unit (video) Type 515 (10V/16785).
- (05) Timebase unit, Type 141 (10D/48953).
- (06) Power unit, Type 4065 (10K/17832).
- (07) Second power unit Type 4065.
- (08) Panel, distribution and switching, Type 891 (10D/18935).
- (09) Panel-mounted couplers.

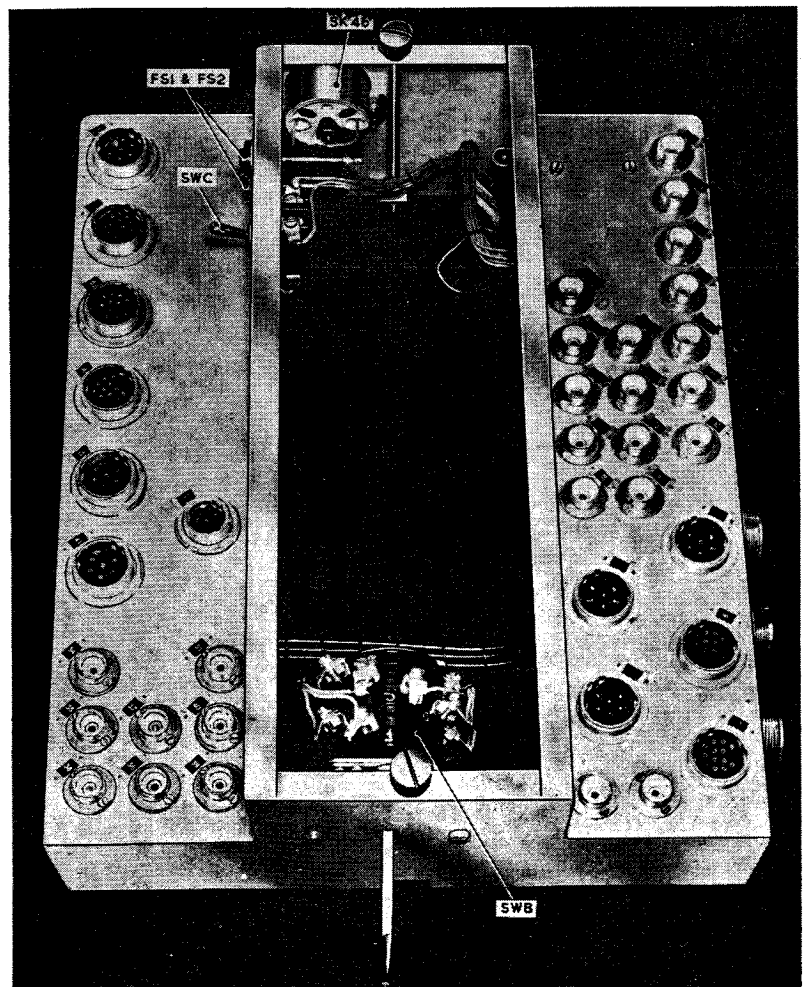


Fig. 3. Panel, distribution, Type 891—top view

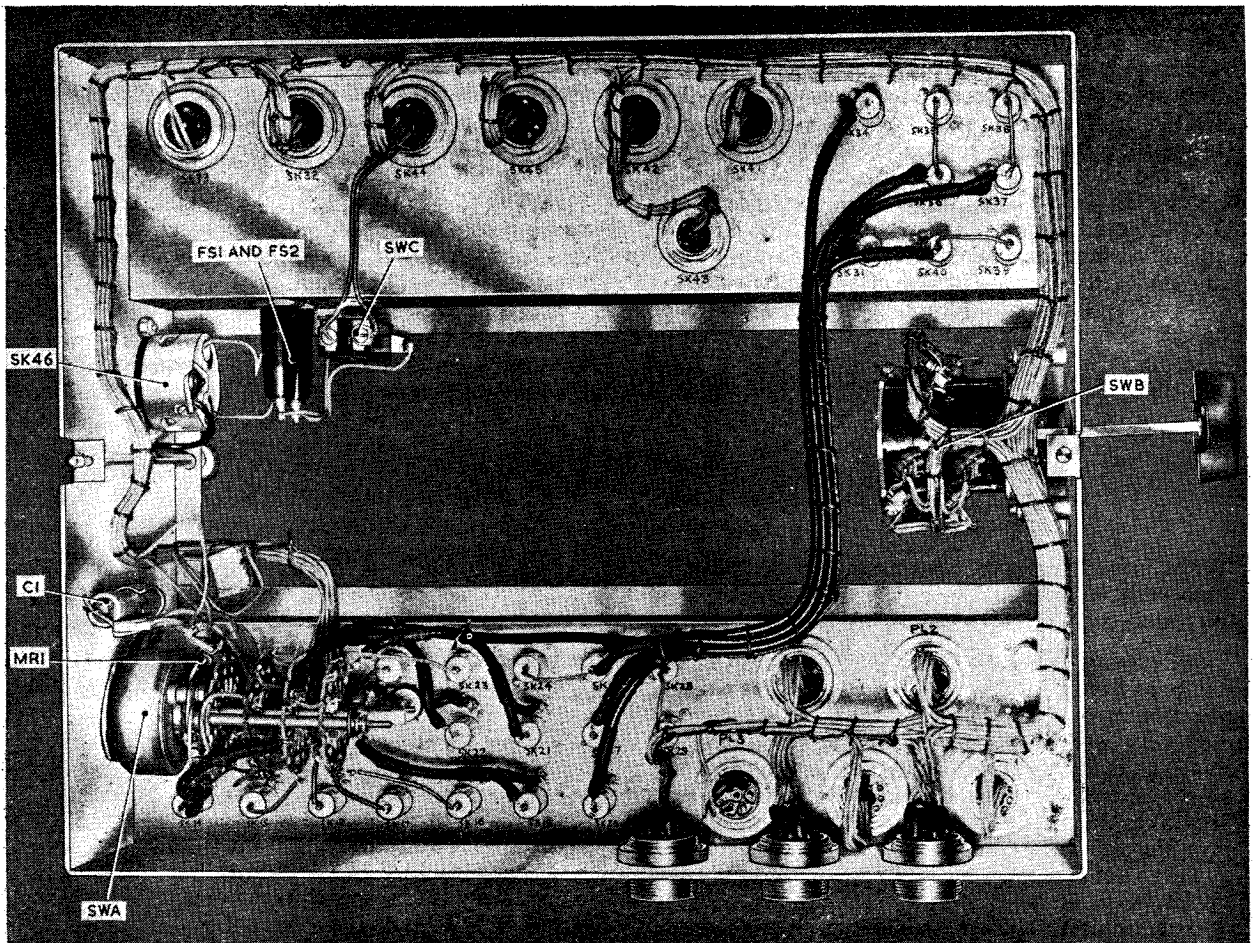


Fig. 4. Panel, distribution, Type 891—underneath view

8. The arrangement of the units in the rack is shown in fig. 1. The units are accessible from the back for servicing (e.g., taking meter readings from the metering sockets at the rear of the units) by opening the rear door. No front door is fitted and the individual units may be withdrawn on their runners when the front panel fixing screws have been released. The units may be removed from the rack entirely by detaching the connectors at the rear, pulling the units forward on the runners, releasing the screws which secure the units to the runners, then lifting the units off the runners. Fig. 2 gives a diagram of the rack assembly, showing the interconnections between the units and the plugs and sockets for external connections.

#### Outline of units

9. This paragraph outlines the functions of all the units in the rack, but the full description is divided into four chapters to simplify the presentation. Thus the remainder of this chapter deals with the simpler units, concerned with inputs to the rack, distribution of signals, display of waveforms and power supplies, while the other chapters describe the timebase and video circuits and the control panel.

(1) *Panel (distribution and switching) Type 891.* This unit accepts the 230V, 50V and reference supplies for use throughout the rack and contains the main isolator switch for the 230V supply. In addition the unit accepts one coaxial lead from each of the twelve associated cabinets; an actuator switch selects one output only for application to the video amplifying unit for eventual display.

(2) *Power units Type 4065.* The lower power unit supplies suitable HT voltages to the video amplifying and EHT units; the upper power unit supplies HT voltages to the timebase unit and additional HT power to the amplifying unit.

(3) *Timebase unit Type 141.* This unit contains trigger selector, delay, timebase and calibrator stages. The delay circuit is used to delay the start of the timebase or to delay the sampling pulse in the amplifying unit Type 515. A circuit is also included to select the eleventh 10-mile pip for accurately initiating the sampling pulse in the amplifying unit. The appropriate trigger, delay and timebase range for the display of a waveform are automatically selected by an actuator switch in this unit. The calibrator produces 10 and 50  $\mu$  sec. blackout markers on the CRT trace.



(4) *Amplifying unit Type 515.* This unit contains not only a DC video amplifier but also circuitry which performs the functions of sampling waveform amplitudes and checking their linearity. The amplifier, when not preceded by the sampling and linearity stages, provides a push-pull output with a gain of 2.5, 10 or 25 on a single-ended input, the appropriate gain being automatically selected to ensure that the selected waveform is displayed at a convenient level on the CRT. The selected signal is fed automatically into the appropriate stage and such services as are required are given with a minimum of manual operation by two actuators and three relays. Two forms of calibration are provided:—

(a) 10-mile pips are mixed in this unit to provide a time scale

and (b) a calibrator which injects fixed known voltage displacements (e.g., 10 mV) is used in conjunction with the sampler stage.

When sampling the amplitude of a positive sawtooth a special slope correction circuit is introduced.

(5) *Panel (control) Type 890.* The two multi-wafer switches SWA and SWB in this unit control the remote and local relays and actuators in order to select the required waveform and to display it correctly. SWA selects either the required cabinet or a large group of waveforms within a cabinet, while SWB selects the individual waveforms. The combination of SWA and SWB ensure that the correct service is provided by the timebase unit and the amplifying unit. The waveforms and services provided are listed on the Perspex label on panel Type 4064.

(6) *Monitoring unit Type 102.* Apart from the 5 in. CRT and its controls, this unit is fitted with a meter which measures the Y shift potential. This potential is fed as a signal into the amplifying unit and hence its variation can be related directly to the amplitude of input waveforms. The meter has, therefore, three scales corresponding to the three levels of video gain, and an indication of the gain being used is provided by one of three lamps on this unit. A feature of the unit is that the CRT is mounted in a rotating turret. The EHT unit Type 913, which supplies +2.2kV and -1800V to the monitor unit, is mounted on the indicating unit chassis for convenience.

(7) *Panel (indicating) unit Type 4064.* As already indicated, this unit accommodates the EHT unit and an edge-lit Perspex label, which details the functions of SWA and SWB of panel Type 890. It also contains three heater transformers for the electronic units of the rack. The label is reproduced in fig. 13. It will be noted that the six lamps at the bottom left-hand corner indicate which of the TB and GWG units are being used.

#### **PANEL, DISTRIBUTION AND SWITCHING TYPE 891**

**10.** This panel is mounted in the base of the rack assembly and is used for distributing the services

entering and leaving the rack assembly. Unlike the other units in the rack it does not pull out on runners. The front panel, shown in fig. 1, is merely a cover plate, secured to the rack framework by two screws. This plate and the control knob of the ON/OFF switch (SWB) must be removed before the Type 891 unit can be taken from the rack.

**11.** Fig. 3 gives a front top view of a unit removed from the rack and fig. 4 gives an underneath view. As in all the illustrations used in these chapters, components to which reference is made in the text are annotated. The photographs are of prototype units which may differ in unimportant aspects from production models (e.g., lack of handles). On production models of the 891 unit all plugs and sockets are clearly marked with their circuit reference numbers and SWA has additional wafers. It will be observed from the illustrations that the unit is secured to the base of the rack by two screws, one at the front and one at the rear, passing through the chassis.

**12.** A circuit diagram of the distribution panel is given in fig. 5. This may be studied in conjunction with the cabling diagram of the rack assembly (fig. 2). All cables coming into the rack, and all cables leaving it, are terminated either by multiway plugs or sockets, or by coaxial plugs, mating with fixed items mounted on the panel. Type 891, with the exception of those cables feeding the four panel-mounted couplers, SK5, SK7, SK9 and SK11 (on unit 09). The actuator controlling leads are thus connected, via panel Type 891 and the panel-mounted couplers, to those racks which are monitored by the rack assembly Type 339, and selected signals are fed back from the monitored racks, via the panel Type 891, to the appropriate destinations in the RA 339. It is convenient to consider the connectors with regard to the services which they carry.

#### **Power supplies**

**13.** The 230V, 50 c/s, the 500V negative reference and the 50V DC control voltages are connected via the distribution panel for power pack operation. Other connections in the unit route the -500V reference to the video unit Type 515, and a second 50V DC supply to the panel (control) Type 890 for operation of the actuators in the rack assembly Type 339 and in the associated rack assemblies.

**14.** The voltages for power pack operation are fed into the panel Type 891 via the 6-pin plugs, PL1, PL2 and PL3. All three plugs carry the 230V, 50 c/s supply, from the radar office power board, on pins (A) (neutral) and (B) (line). On PL1, pins (A) and (B) are connected directly to (M) and (L), respectively, of SK6, feeding the timebase rack Type 300, via PL67 in the distribution panel Type 868, in the base of this rack. The same pins (A) and (B) are also connected, via the ON/OFF switch (SWBa), at the front of the panel Type 891, to (A) and (B) of SK41, feeding the upper power unit Type 4065 (rack reference



number 06). Pins (A) and (B) of PL2 similarly feed (M) and (L) of SK12 directly (supplying PL57 of panel Type 879 in the gating waveform generator rack Type 304), and also feed (A) and (B) of SK42, supplying the lower power unit Type 4065, reference 07, via SWBb.

**15.** On PL3 only pins (A) and (B) are used. They supply mains power, via plugs PL61 in the respective panels Type 877, to the two magstrip resolver racks Type 301, via SK8 (M) and (L), for rack "A", and via SK10 (M) and (L), for rack "B". It may also be noted at this point, that the positive line of the 50V supply to the rack 301 actuators, from the panel Type 890, is carried on SK8(E) and SK10(E). The 230V from PL3 is also available, on a standard 3-pin, 5A socket (SK46), mounted at the rear of the unit (fig. 3 and 4), for rack servicing purposes. Switch C and fuses 1 and 2 are in the circuit for this power point. Finally PL3 supplies power via SWBc (panel 891) to SK43 and SK44 (A and B). SK43 feeds PL5 in the monitoring unit Type 102, where it energizes TR1, the heater transformer for this unit. SK44 is connected to PL1 in the panel, indicating, Type 4064, where pins A and B feed TR1, TR2 and TR3, the heater transformers for the major units in the rack.

**16.** Pin (E) of PL1 carries the positive side of the 50V DC supply (from rectifier Type 15) for relay operation. Connected to SK41(E) it feeds PL1(E) in the power unit 06. PL2(E) similarly feeds PL1(E) in power unit 07, via SK42(E). These positive lines are earthed in their respective power units. The negative lines are carried on pins (D) of the connectors already mentioned, and supply operating current to the power unit relays via the appropriate switches in the power units.

**17.** The -50V outputs from the power units Type 4065, for remote control of the 500V negative reference supply, are routed along pins (F) of the associated connectors, while pins (C) carry the -500V supply (derived from the rack assembly Type 338) to the power units. The reference voltage is also applied to SK33(B) and (C) for application to the video unit Type 515 (pins (B) and (C) of PL1), where the linearity-checking and slope-correction circuits make use of it.

**18.** The 50V DC supply for operating the actuators in the rack assembly 339, and in the associated racks (via switches "A" and "B" in the control panel Type 890), is fed into the distribution panel on pins (D) (*negative*) and (E) (*positive*) of PL4, the other pins on this 6-pin connector being unused. From PL4 the -50V line is fed to PL67 of panel 868 in the timebase rack Type 300 (via SK6(F)), to PL57 of panel 879 in the gating waveform generator rack Type 304 (via SK12(F)), and to the rack 339 control panel Type 890 (via SK32(M)). The positive line is connected via SK44(E) to PL1(E) in the panel

(indicating) Type 4064, for application to the indicating lights LP1 to LP6 (used to show which of the duplicate units in the ancillary racks are in use). It is also connected to one side of the actuator of SWA in the distribution panel Type 891, as well as to the control panel Type 890 (via SK32(E)), where the switches complete the actuator circuits as required.

**19.** In the case of the panel Type 4064 indicating lights, the return circuits (the positive line being common) are carried from PL1, (C), (D), (F), (G), (H) and (J), in the indicating unit, to similarly labelled sockets on SK44 in the distribution panel. Then (C), (D), (F) and (G) are connected to the distribution panel in the rack assembly Type 300, via (G), (H), (J) and (K), respectively, on SK6, while (H) and (J) on SK44 are connected to the distribution panel in the gating waveform rack assembly Type 304, via (G) and (H), respectively, on SK12. The circuits for the appropriate indicator lamps are then completed by actuator contacts in the distribution panels concerned, in response to operating currents from the switches in the panel Type 890.

#### Actuator operating currents

**20.** SWA in the panel Type 891 selects the coaxial socket connected to the rack assembly which is to be monitored, in response to actuator operating current supplied to a selected socket on the 12-way connector SK32, from SWA or SWB in the control panel Type 890, via PL6 in the 890 unit.

**21.** The operating currents for the primary actuators selecting the desired waveform in the chosen rack are routed by SWA or SWB in the panel Type 890 to PL7 in this unit, and thence to SK45 in the 891 unit. Sockets (D), (E), (G), (L) and (M) on SK45 are connected to (A), (D), (E), (B) and (C), respectively, on SK6 for waveform selection in the timebase rack Type 300. Sockets (A), (B), (C) and (H) on SK45 are connected to (A), (B), (C) and (E), respectively, on SK12, for waveform selection in the gating waveform generator rack Type 304. Finally, socket (J) of SK45 is connected to (E) of SK8 and SK10 for waveform selection in the two magstrip resolver racks Type 301 (via plugs PL61 in panels Type 877). For future use in monitoring the two azication resolver racks Type 302, operating current may be applied to SWA in the 891 panel, from the panel Type 890 switches, via SK45 (F) and (K) in the 891 panel. On this panel the switch wafers (b) and (f), using contacts which lead one step on the other wafers, have been added to SWA to make position 12 an operative position, for this future application.

**22.** In addition to the connections routed via the panel Type 891 (*para.* 18, 19 and 21), other connections to complete the primary actuator circuits, or to operate secondary (waveform selection) actuators, are made from the panel Type 890 to the ancillary racks, via the four panel-mounted couplers situated in the base of the

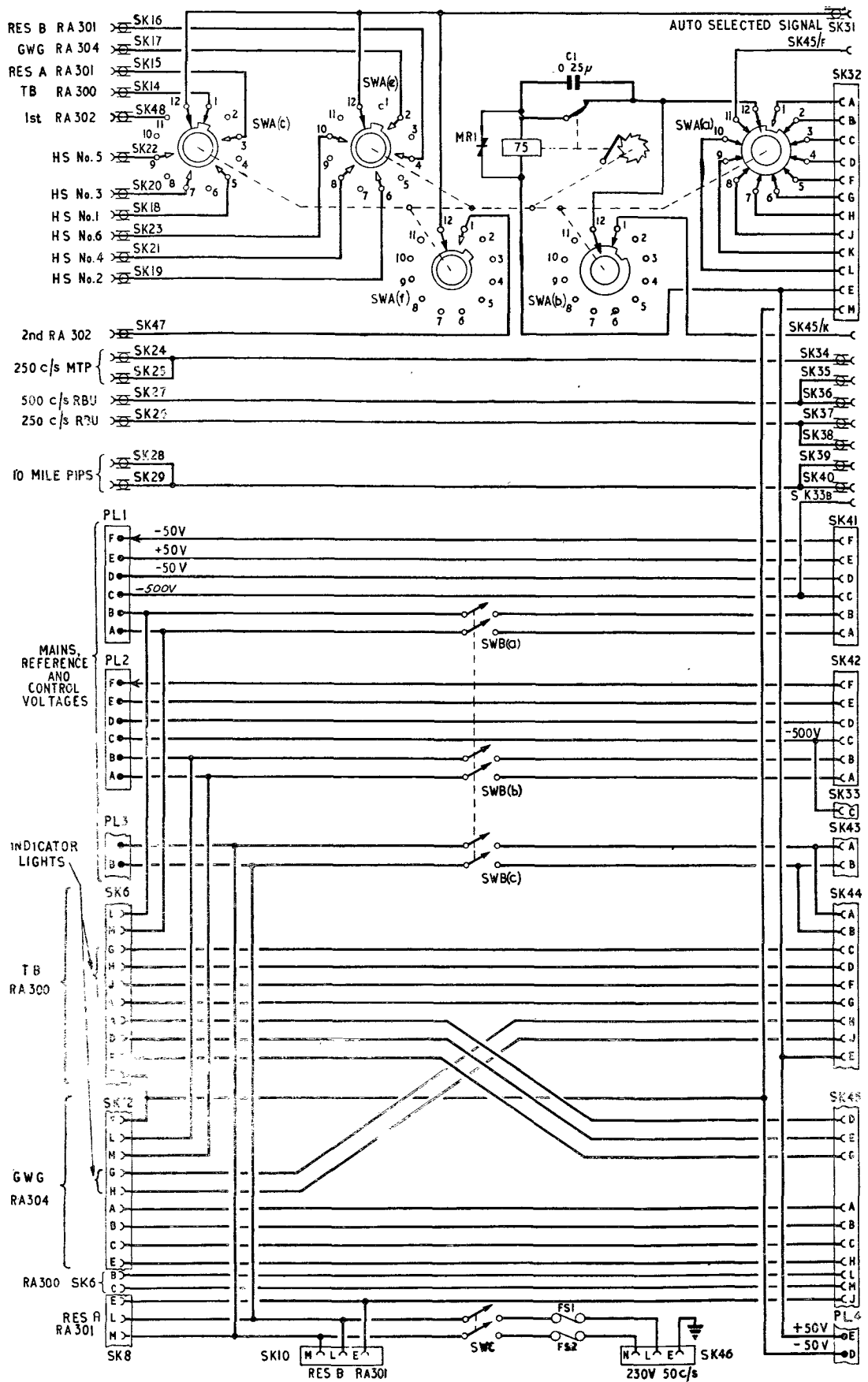


Fig. 5. Panel, distribution, Type 891—circuit

rack Type 339. Thus appropriate contacts on SWB in the panel Type 890 are connected to the 12-way sockets, SK1, SK2, SK3 and SK9, which are linked to panel-mounted couplers, SK11, SK7, SK5 and SK9, respectively. SK11 is connected to PL56 of panel 879 in the RA 304, SK7 to one RA 301 (panel Type 877, PL60) and SK9 to the other, while SK5 is connected to PL66 of panel 868 in the RA 300.

#### Signal connections

**23.** The waveform selected in the rack which is being monitored is returned to the appropriate coaxial socket on the panel Type 891, as indicated in fig. 5, and routed via contacts on SWA (operated as mentioned in para. 20) to SK31, which feeds the signal to SK6 in the video unit Type 515, while the panel Type 890 switching makes provision for the display of the waveform on the monitor cathode-ray tube. Signals leave RA 300 via SK23 on the panel 868 and arrive on SK14 of the panel Type 891. Sockets SK1 in the panels Type 877, rack assemblies 301, similarly feed SK15 and SK16, while SK19 of panel 879 (RA 304) feeds SK17, of panel 891. The wander leads from the head selector racks feed into sockets SK18 to SK23 and provision is made for signals from the rack assemblies Type 302 on SK47 and SK48.

#### Sync. inputs

**24.** Synchronizing waveforms, viz., 250 c/s MTP, 500 c/s BU (from TB 140), 250 c/s BU

(from TB 140), and 10-mile pips (from marker generator unit Type 27) are routed through the panel Type 891 (SK24-25, SK27, SK26 and SK28-29, respectively, connected to SK34, SK35-36, SK37-38 and SK39-40, as shown in fig. 5), to the timebase unit Type 141 (SK34, SK35, SK37 and SK40, feeding the four inputs, in the order given, to SK2, SK4, SK3 and SK6 in the TB 141 unit). The 500 c/s BU, the 250 c/s BU and the 10-mile pips are applied to SK4, SK3 and SK9 in the video unit Type 515, from SK36, SK38 and SK39, respectively.

### POWER UNITS TYPE 4065

#### Introduction

**25.** As indicated in fig. 1 and 2, there are two power units Type 4065 mounted in the rack assembly Type 339. They are situated below the timebase unit Type 141 and are interchangeable, although they are given the numbers 06 and 07 in the rack (*para. 7*) for identification of the cables connected to them.

**26.** Each power unit contains three rectifier and regulator systems within one chassis, to provide three series regulated supplies as follows:—

- (1) +400V with an output up to 70 mA.
- (2) +300V with an output up to 240 mA.
- (3) -300V with an output up to 135 mA.

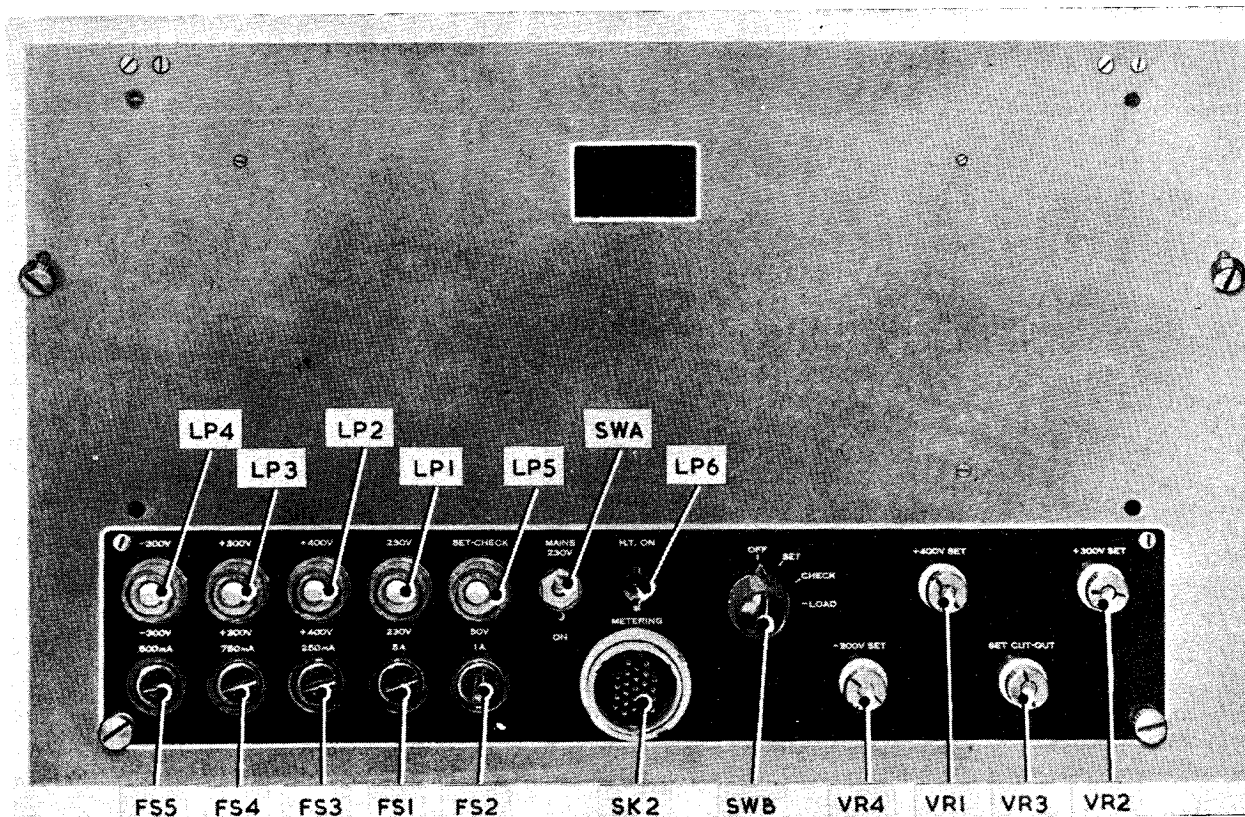


Fig. 6. Power unit Type 4065—front panel

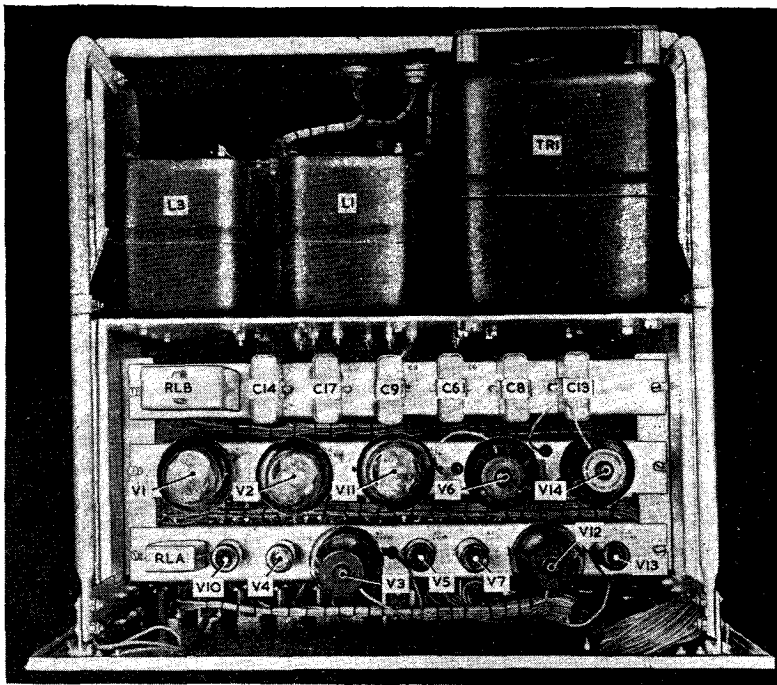


Fig. 7. Power unit Type 4065—plan view

and also supplies the EHT unit Type 913 (PL4) via SK3.

30. Plug PL1 (AC input) and output sockets SK3 and SK4 are at the rear of the power units. In the centre of the front panel of each unit is a metering socket SK2 which facilitates taking test readings.

31. The front panel is illustrated in fig. 6, annotated with the circuit reference numbers of components mounted thereon. A plan view of a power unit is given in fig. 7 and an oblique top view from the rear in fig. 8. Fig. 9 gives a bottom view from the front and fig. 10 shows the component layout of tagboard No. 1, the position of which is shown in fig. 9. Fig. 11 is a bottom view from the rear and fig. 12 a line drawing of the component layout of tagboard No. 2, illustrated in fig. 11. Finally, a circuit diagram is given in fig. 23.

27. The positive supplies are regulated with respect to the  $-300V$  supply, which is controlled by reference to a stable reference potential of  $-500V$ . When the unit is in service, this reference potential is obtained from the rack assembly Type 338 (negative reference supply).

28. A protective circuit is incorporated. This controls the operation of a relay, which will switch off the unit, should the potential of any output be outside certain limits. This ensures that associated electronic circuits in the rack do not give a faulty performance due to incorrect HT levels.

29. In each power unit, the  $230V$ ,  $50$  c/s input is derived from the panel, distribution, Type 891, in the bottom of the rack. On the distribution panel, socket SK41 feeds PL1 of the upper power unit (06), while SK42 feeds PL1 of the lower power unit (07). These connectors also carry into the power units the  $50V$  DC supply for operating the HT relay, and convey out from the units a tapping from this supply for remote control of the  $-500V$  reference supply. The upper power unit supplies the three outputs (*para.* 26) to the timebase unit Type 141 via SK4 (and PL8 on the TB unit), and to the video unit Type 515 via SK3 (and PL10 on the video unit). The lower power unit feeds additional supplies to the video unit (PL11) from SK4,

#### Circuit details

32. The circuitry is similar in principle to that employed in the power units Types 903, 904 and 905, described elsewhere in this A.P., although the physical layouts of the four chassis are different. The front panel MAINS switch (SWA)

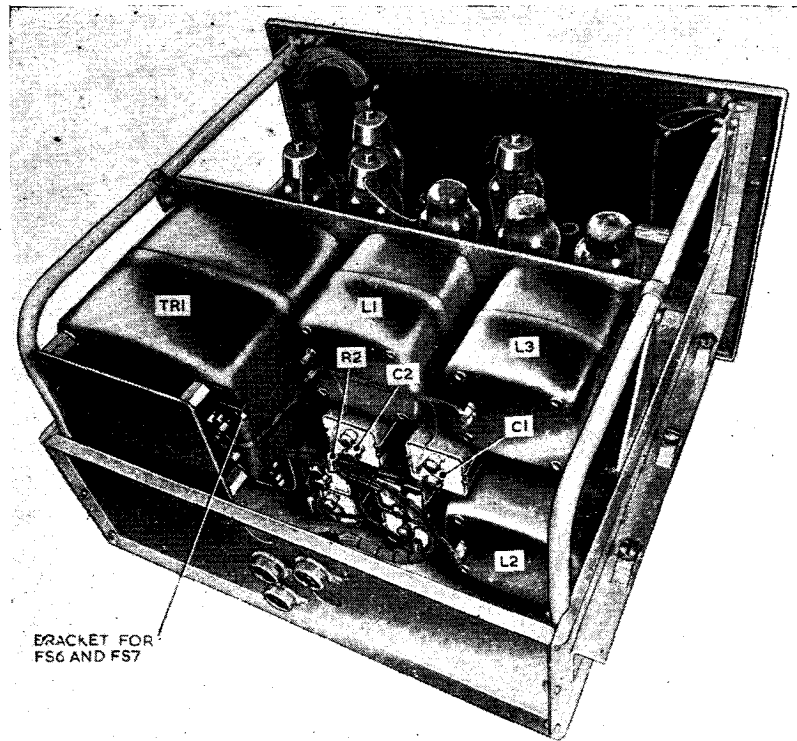


Fig. 8. Power unit Type 4065—oblique top view from rear

is the standby switch. When switched ON, it completes the AC MAINS supply circuit to the heater transformer (TR2), supplying the regulator and protective circuit valves. SWA also completes the 50V negative DC supply circuit to the power unit. The primary circuit of the HT transformer (TR1) is not completed so long as the front panel switch SWB is at OFF.

**33.** Overload protection is afforded to the primary circuits of both TR1 and TR2 by the front panel cartridge type fuse FS1 and the thermo cut-outs FS6 and FS7, which are mounted on a bracket fixed to TR2 (cut-outs not fitted in fig. 8), at the rear of the chassis. The neon indicator lamp LP1, in parallel with FS1, FS6 and FS7, is extinguished when the fuses are intact, but glows when a potential is applied to it, subsequent to one of the fuses becoming open-circuited, thereby drawing attention to the fault.

**34.** With switch B in any position except OFF, the 50V negative DC supply is applied, via fuse FS2 and switch wafer (a), to the operating coil of the GPO type relay RLB. With the relay energized, the various contacts are closed. RLB/1 completes the primary circuit of the HT transformer TR1. RLB/2 applies the 50V supply to the miniature bayonet cap, filament type lamp LP6, mounted on the front panel in series with the current limiting resistor R37, so that the lighting of this lamp indicates the operation of the relay. Finally RLB/3 completes the -50V circuit for remote control of the 500V negative reference supply, between plug pins PL1(D) and PL1(F). R81 and C18 constitute a spark suppression circuit across the contacts.

**35.** When the primary of TR1 is energized, the rectifier valve V1 provides an input to the +400V regulator circuit, while V2 provides the input to the +300V regulator circuit, both rectifiers being

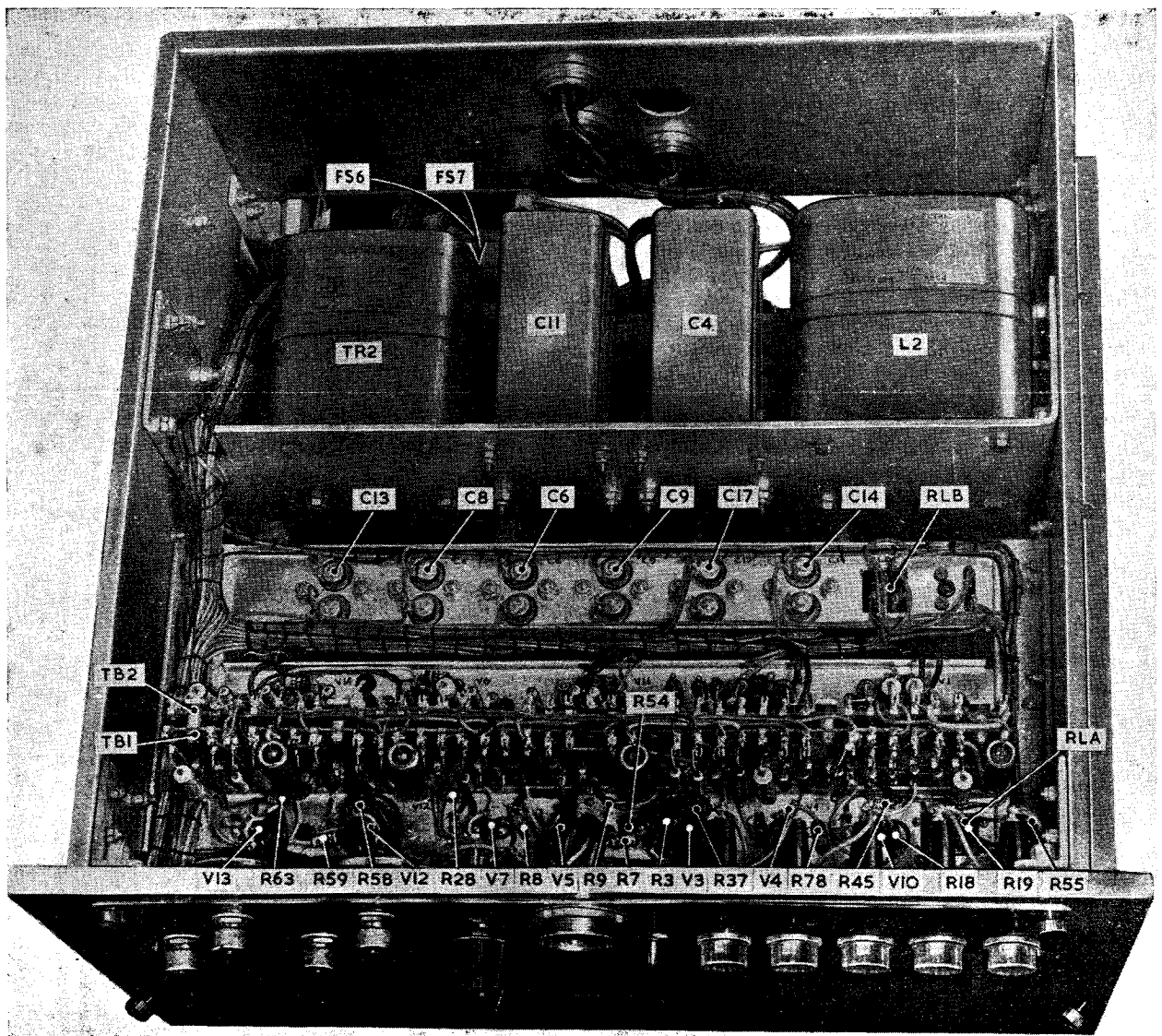


Fig. 9. Power unit, Type 4065—bottom view from front

supplied from the same transformer winding (490-0-490V). A conventional condenser input smoothing circuit is used in each case. The HT fuses FS3 (+400V) and FS4 (+300V) are shunted by the neon lamps LP2 and LP3, respectively, to indicate failure of the fuses.

**36.** A second HT winding on TR1 supplies 470-0-470V to the rectifier valve V11, which provides the input to the -300V regulator circuit, via FS5 and the shunt indicator lamp (neon LP4). Conventional smoothing is again used. The rectifier valves V1, V2 and V11 have anode stoppers (R84 to R89) to limit surge currents. The smoothing is such that the ripple on the unregulated supplies, as observed on a CRO, should be not more than 5V peak-to-peak at the anode of V3 and at the anode of V12, and not more than 15V peak-to-peak at the anode of V6.

#### Regulator circuits

**37.** To ensure stable operation the +400V and the +300V supplies are referred to the -300V supply, which, in turn, is referred to the 500V negative reference. The +400V supply to SK3 (C) and SK4(C), via SWBb, passes through the series regulator valve V3. As is usual in this type of circuit, the impedance of the regulator valve is varied by its control grid potential, which is determined by the voltage drop across the anode load (R6) of a control valve (V5). The initial current through V5 is determined by adjustment of RV1 (+400V SET), which fixes the control grid potential. To achieve optimum regulation, this potentiometer is part of a potential divider between the +400V and -300V lines. Thus any variation in the 400V line is communicated to V5, which produces a counterbalancing effect. For example, any increase in the potential at the cathode of V3 causes increased current through V5, and the resultant negative-going voltage across the anode load is applied as negative bias to the grid of V3, thereby increasing the series impedance of this valve, so that the output voltage remains constant. Grid stoppers are used throughout the regulator circuits to prevent them from responding to parasitic influences.

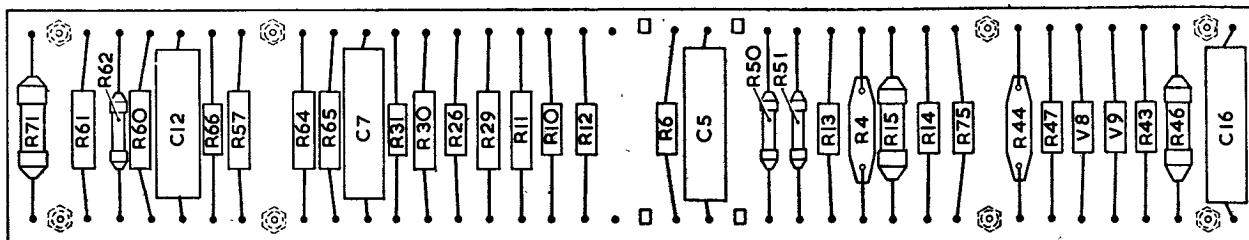
**38.** For stable control operation, V5 must have a steady HT supply. Ideally this should be derived from the regulated +400V line, but since a large anode load R6 (220K) has to be used to give

control voltage variations of the required amplitude at the anode of V5, the use of the +400V supply would give an anode potential so low that the valve would be operating too near cut-off to give efficient control. Accordingly steps are taken to boost the HT supply to V5 by feeding the valve from the unregulated 490V supply via R4. The neon stabilizer valve V4, connected between the junction of R4-R6 and the junction of R14-R15 (at +400V, approx.), maintains a steady 83V voltage drop across itself, when passing current, and the steady potential at the junction of R4 and R6 is 483V (less the small voltage drop across R13 and R14).

**39.** Most of the AC mains ripple (predominantly 100 c/s, from the full wave rectifier V1) is across R4, but residual ripple at the anode of V5 would be sufficient to modulate V3 and so produce hum in the output, if steps were not taken to suppress it. To achieve this suppression, an appropriate value of hum voltage is tapped from the potential divider R4, V4, R14 and R13, at the junction of R14 and R13, and is applied via C5 and R9 to the control grid of V5, to produce antiphase voltages for neutralizing the ripple. Any remaining transient component is by-passed to earth by C6. The circuit is equally effective for neutralizing other rapid fluctuations in the supply voltage. On all regulated outputs the ripple, as observed on an oscilloscope, should be less than 10 mV peak-to-peak amplitude.

**40.** The +300V supply is regulated in a similar manner to the +400V supply, except that two regulator valves (V6 and V14) are operated in parallel to cater for the increased current demand. The boost HT supply for the control valve V7 is derived from the +400V line, while the control grid potential of V7 is derived from RV2 (+300V SET), part of a potential divider between the +300V and the -300V lines.

**41.** The -300V regulator circuit is similar to the other two regulator circuits. The HT supply to the control valve V13 is boosted, as in the other circuits, this time by having a parallel feed, via R61, from the +300V line in addition to the normal feed, via R60, from the earth line. The -v<sub>300</sub> SET potentiometer (RV4) is part of a potential divider between earth and the -500V reference line.



TBI

Fig. 10. Tagboard No. 1—shown in fig. 9



**Functions of switch " B "**

**42.** The four positions of the front panel control switch provide the following facilities :—

- (1) **OFF**—With the MAINS switch (SWA) ON, this is the standby position, with valve heaters on, but HT transformer not energized.
- (2) **SET**—In this switch position the potentiometers RV1 to RV4 may be adjusted as described in the operating instructions in Sect. 2. The switch functions are :—
  - (a) Contacts 8 and 9 on switch B, wafer (a), complete the 50V DC circuit for relay B and the HT transformer (TR1) is energized. LP6 lights up. PL1(F) is energized (−50V), and the −500V supply is connected.
  - (b) Other contacts (2 and 3) on SWB(a) connect the neon indicator LP5, with its associated series resistor R75 and the dummy load R53 between the −300V line and earth. The lamp (labelled SET-CHECK) glows to indicate the presence of the −300V supply.
  - (c) Contacts 8 and 9 on SWB(b) connect a dummy load (R83 and R52 in parallel) across the +300V supply.
  - (d) Other contacts (2 and 3) on SWB(b) connect a dummy load (R82) across the +400V supply.
  - (e) The protective circuit valve passes current as soon as the power supplies come on.
- (3) **CHECK**—this position allows the protective circuit to be tested whilst the power unit is still operating into a dummy load. The make-before-break contacts mentioned in (2) (a) are switched to link contacts 9 and 10 instead of 8 and 9, and RLA /1 is connected in series with RLB/2 in the 50V DC supply circuit to the operating coils of relay RLB. Otherwise all connections remain as in (2).
- (4) **LOAD** :—
  - (a) The 50V DC supply circuit to the operating coils of RLB is still diverted through RLA /1 and RLB/2; so that operation of the protective relay RLA will break the circuit to earth and de-energize RLB, thus disconnecting TR1 from the mains. The switch will then have to be turned back to SET (2) to re-set RLB. If RLA trips during normal operation of the equipment, the relay must not be re-set until the cause of the tripping has been ascertained and remedied.
  - (b) The −300V supply is applied to SK3 (A) and SK4(A), and the dummy load (R53) and LP5 are disconnected.
  - (c) The +300V supply is connected to SK3(D) and SK4(D). The dummy load (R83-R52) is disconnected.

- (d) The +400V supply is connected to SK3(C) and SK4(C). The dummy load (R82) is disconnected.
- (e) Resistance-capacitance suppression circuits are connected across the switch contacts to prevent sparking when the switch is operated from CHECK TO LOAD and vice-versa.

**Protection circuit**

**43.** The valve in this circuit is V10. The circuitry is so arranged that the current through the valve is varied by changes in any of the power supplies. The valve anode and screen grid are connected to the +300V line, and the cathode and suppressor to the −50V line, while the control grid is biased from a potential divider between the +400V, +300V, −300V and −500V lines. The anode current of the valve may be set to a steady value by adjustment of RV3 (SET CUT-OUT), the variable part of this potential divider. This steady value should be such that the cathode of V10 (metering point SK2(E)) is at earth potential, due to the voltage developed across the cathode load R43.

**44.** The protective relay RLA is connected between the cathode of V10 and earth. The relay has two windings, one connected in series with V8 and the current limiting resistor R41, and the other in series with V9 and R42. V8 and V9 are germanium diodes connected in reverse polarity to each other, so that if the cathode potential of V10 goes positive to earth, current passes through V9, but if the potential goes negative, current passes through V8. When the current exceeds the appropriate value, the relay operates and the HT circuit is broken, due to RLA /1 breaking the operating circuit of RLB and so tripping RLB/1. To prevent V10 from responding to switching-on surges, fluctuations at the control grid are smoothed by R47 and C9, but the time constant of these components allows the valve to respond to fluctuations of specified amplitude and duration arising from other causes.

**PANEL, INDICATING, TYPE 4064**

**45.** The selector switch positions and the waveforms selected are listed on the front of the indicator panel (*fig. 13*). The two switch banks in the waveform selector panel are labelled CABINET SELECTOR SWA and WAVEFORM SELECTOR SWB. In the main, SWA determines the feed to SWB, so that SWA may be considered as the primary selector and SWB as the secondary selector.

**46.** Mounted in the lower left-hand corner of the front panel of the indicator unit (viewed from the front) are six indicator lamps (LP1 to LP6). These light up to indicate which of the timebase units, Type 140 (250 c/s and 500 c/s) and Type 101 gating waveform units, in rack assemblies Type 300 and Type 304, respectively, are being used to operate the station. The three units are duplicated (hence the six indicator lamps), and in

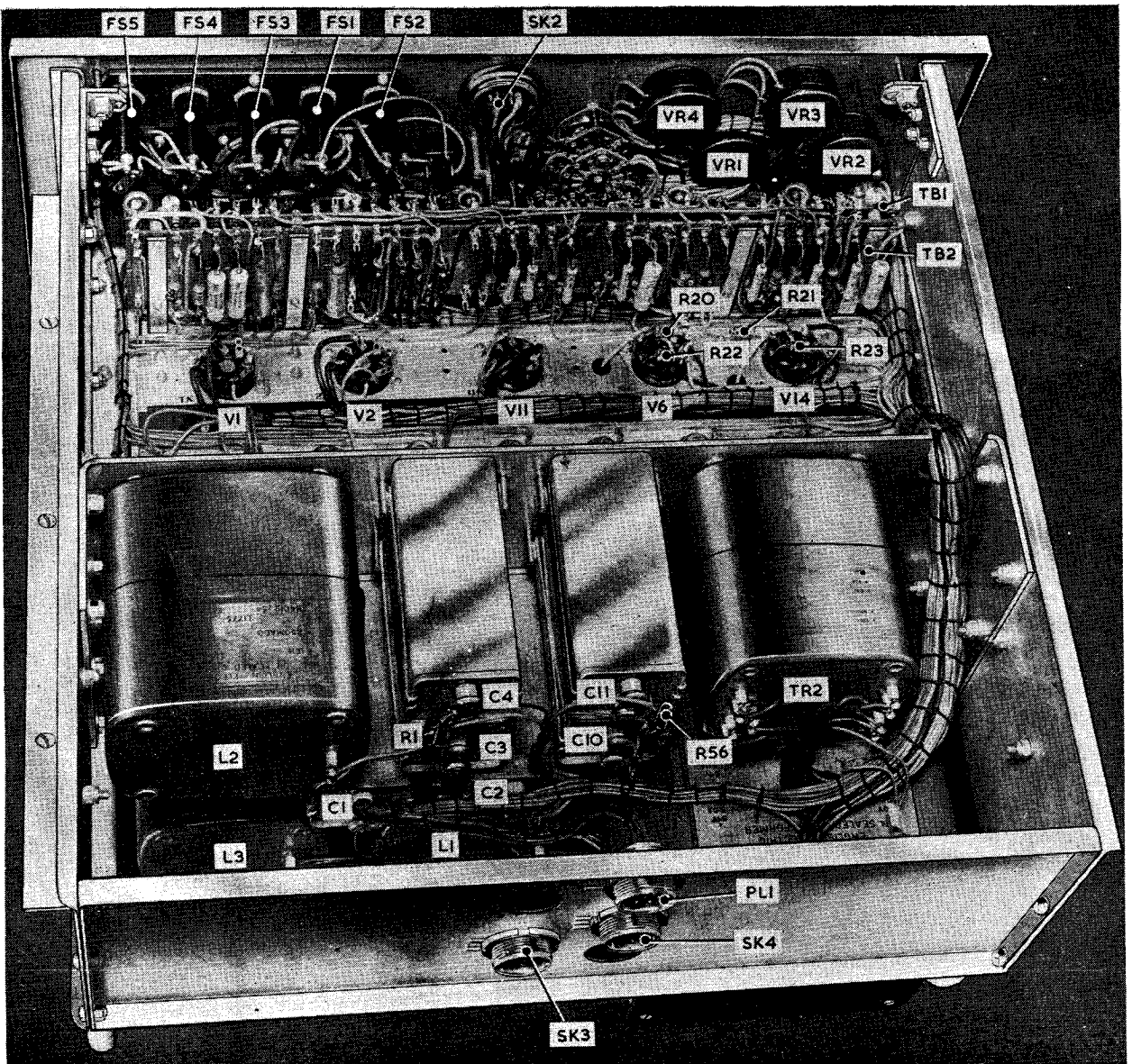


Fig. 11. Power unit Type 4065—bottom view from rear

each case one is referred to as unit "A" and the other as unit "B". One unit is normally in use, while the other is a standby.

for WAVEFORM INSPECTION and SETTING UP. Five festoon lamps (LP7 to LP11), inside the unit, illuminate the engravings by edge lighting of the perspex sheet.

47. The front panel of the indicating unit is a perspex sheet, painted matt black on the inside surface. On this surface are engraved instructions

48. A rear view of the unit is shown in fig. 14 and a circuit diagram in fig. 15. The three transformers (TR1 to TR3) supply the power for

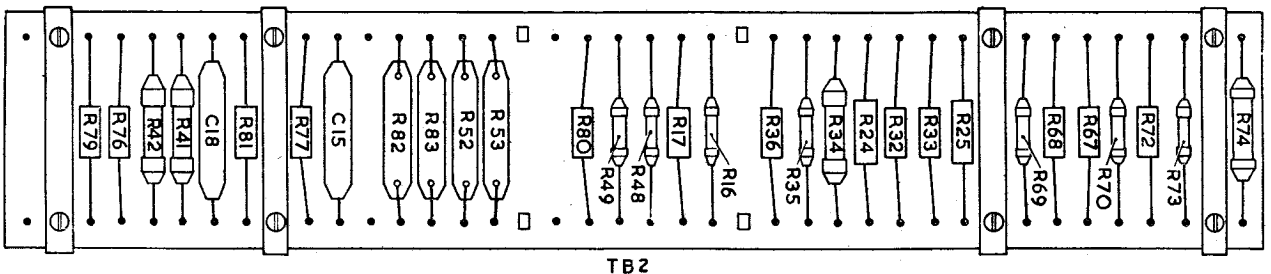


Fig. 12. Tagboard No. 2—shown in fig. 11





the filaments of all lamps and valves in the rack, with the exception of the indicator lamps in the 4064 and 102 units, the CRT, the valves in the power units Type 4065 and the EHT rectifier valves. The voltage and current ratings of each winding, and the units supplied are shown on the circuit diagram.

### EHT POWER UNIT, TYPE 913

49. This unit is self-contained, but is fitted to the indicator unit chassis as a matter of convenience. Fig. 16 gives a side view and fig. 17 a front view of the unit, with the screening cover removed. The circuit is given in fig. 18. It will be observed that V3 is a RF oscillator supplying power to the two half-wave rectifiers V1 and V2, connected in a voltage-doubler circuit, with the centre point earthed. The amplitude of the oscillations can be adjusted to some extent by the setting of RV1, which determines the screen grid potential of V3, and the DC outputs are determined by this amplitude and by the cathode temperature of the rectifiers. The outputs are 2kV at 200 $\mu$  amp. positive, and 1.9kV at 1.1mA, negative. The +2kV output is applied to the rear panel coaxial socket SK1 via the RF filter circuit C2, R1 and C1. The 1.9kV output is similarly applied to SK2 via C4, R2 and C3.

### Adjustment of rectifier heater current

50. The half wave rectifiers V1 and V2 derive their heater supplies from separate windings on the RF transformer L1. The voltages applied to the heaters may be adjusted by varying the reactances of L4 and L3. The tuning slugs of these inductors are adjusted to produce, in the rectifier heaters, a brilliance comparable with that of a similar valve fed from a 4V heater supply, during the initial setting-up procedure.

51. The HT feed to V3 is decoupled by a RF filter circuit C7, L2 and C8, enclosed in a screening can to prevent interference with other units. The heater supply for V3 is derived from transformer TR3 in the indicator unit via socket SK7 at

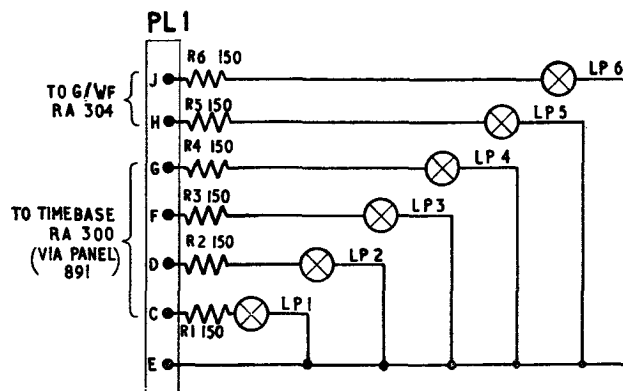
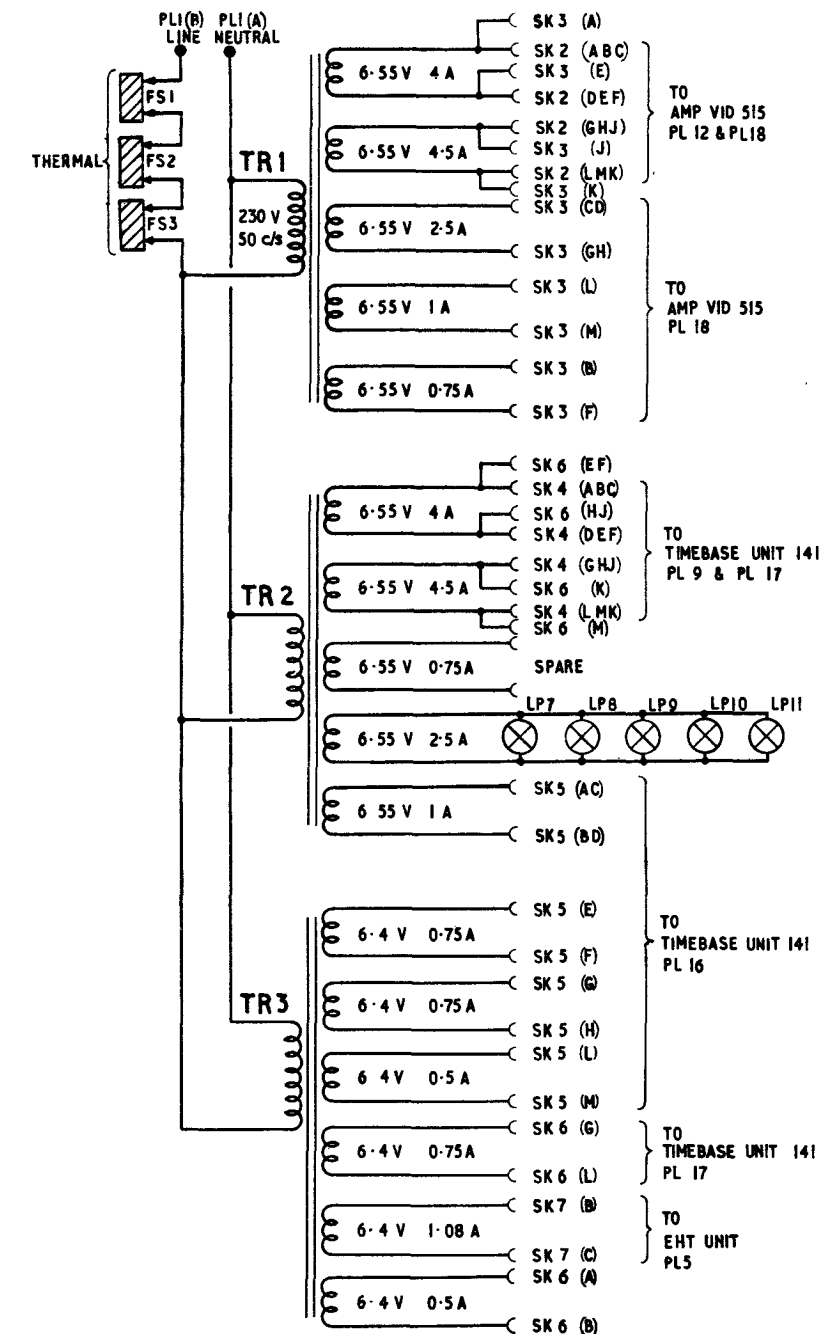


Fig. 15. Panel, indicating, Type 4064—circuit

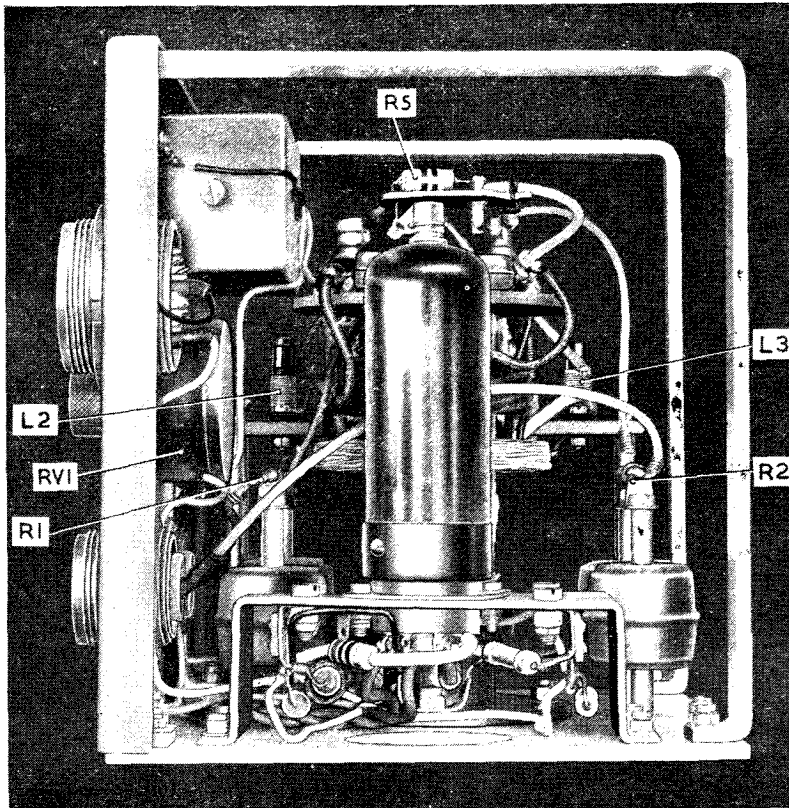


Fig. 16. EHT power unit Type 913—side view

the rear of the indicator panel and plug PL5 at the rear of the EHT unit.

#### MONITORING UNIT, TYPE 102

52. A front view of this unit is given in fig. 19, a rear view in fig. 20 and a plan view in fig. 21. The main item in the unit is the 136 mm. diameter cathode-ray tube, fitted in a swivel mounting so that it may be turned through an arc of approximately 70 degrees. It is thus possible to observe the tube face when using the monitor in making adjustments on any of the fixed-coil rack assemblies. In fig. 20 the safety cap has been removed from the CRT base, to show R9. Transformer TR1 (fig. 21) normally has a protective plate above the terminals.

#### Voltmeter

53. Above the CRT is a voltmeter (M1) with three scales. This instrument is a centre-zero (250-0-250 $\mu$ A) micro-ammeter, converted to read volts by the addition of the series resistors R10 (51K) and R11 (750K). When the toggle switch (labelled PRESS TO READ), in the top left-hand corner of the front panel, is depressed, this meter is deflected by the Y shift voltage, the amplitude of which depends

upon the setting of the front panel Y SHIFT control (RV3), which is situated to the left of the voltmeter. The meter deflection may be used to measure the amplitude of the monitored waveform at the input to the Type 515 video amplifier. The meter scale to be read is automatically indicated by the lighting up of the appropriate METER SCALE indicator lamp above the meter. These lamps are labelled 50v (LP1), 12.5v (LP2) and 5v (LP3) to indicate the scales, which correspond to the three alternative gains (2.5, 10 and 25) available in the video amplifier. The appropriate indicator lamp is supplied with current from switches in the Type 515 unit to show the degree of gain being used.

54. To read the amplitude of a waveform displayed on the CRT screen, the trace may be displaced a distance equal to the waveform amplitude, by operation of the Y SHIFT control. The movement of the meter needle over the appropriate scale then indicates the amplitude of the input waveform. The output waveforms, as displayed on the CRT screen are, of course, subject to the same shift potentials for all video gains, but the meter scales take into account the degree

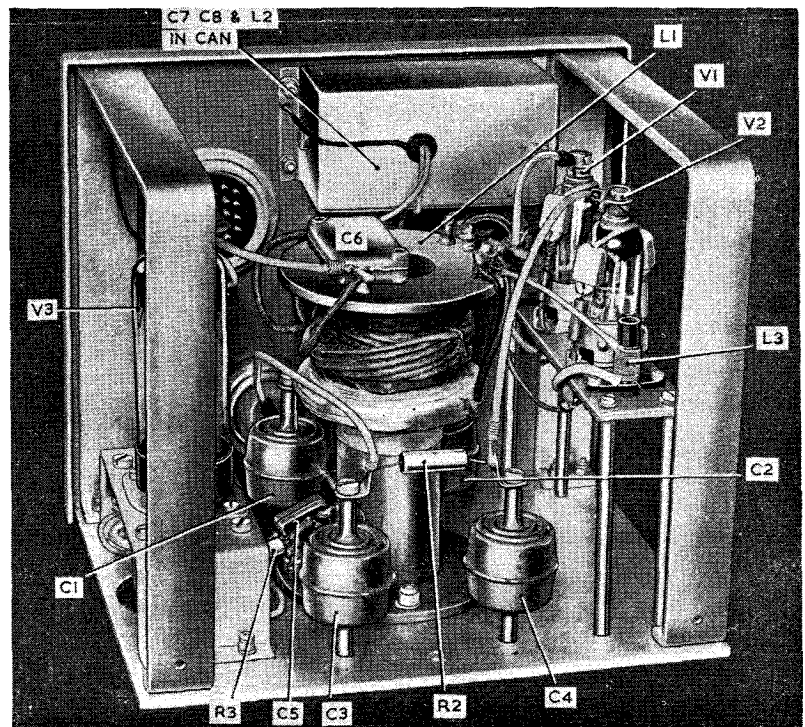


Fig. 17. EHT power unit Type 913—front view

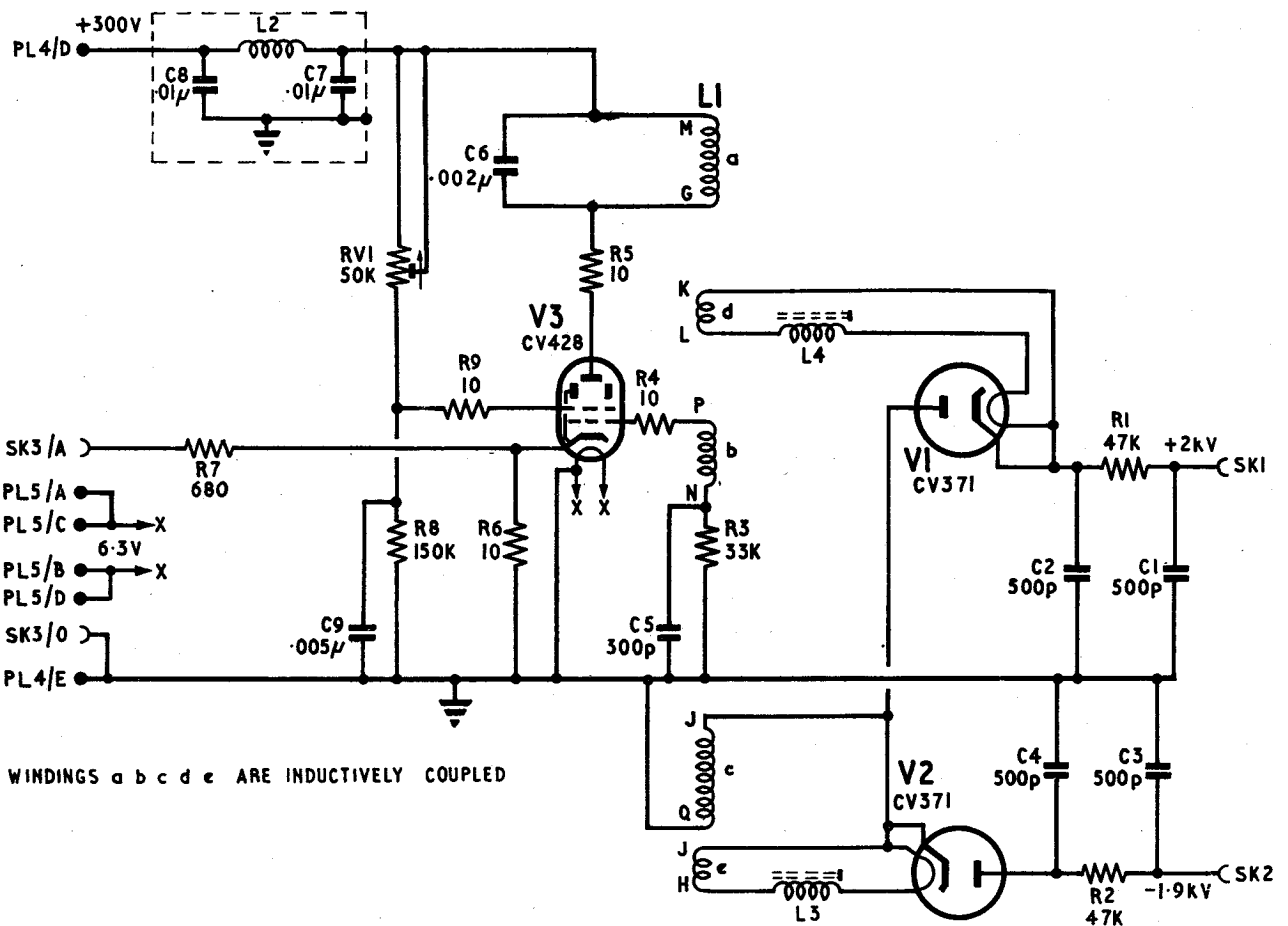


Fig. 18. EHT power unit Type 913—circuit

of amplification that has been used to produce each particular output waveform.

#### CRT controls

55. The remaining front panel controls are the X SHIFT on the left of the panel, and the FOCUS and BRILLIANCE controls to the right. These operate in the circuit of the cathode ray oscilloscope in a conventional manner.

#### Circuit

56. The circuit of the unit is given in fig. 22. The tube is a normal electrostatic type (CV600), with the first and third anodes at earth potential, so that the deflecting plates are earthy. The "gun" is at the negative EHT potential (approaching  $-2\text{kV}$ ) and the accelerator anode is at  $+2\text{kV}$ . These voltages are obtained from the EHT power unit, housed in the indicating unit chassis, via PL2 and PL1, respectively. The focusing potential, applied to the second anode, and the brilliance potential, applied to the grid, are derived in the normal way from a potential

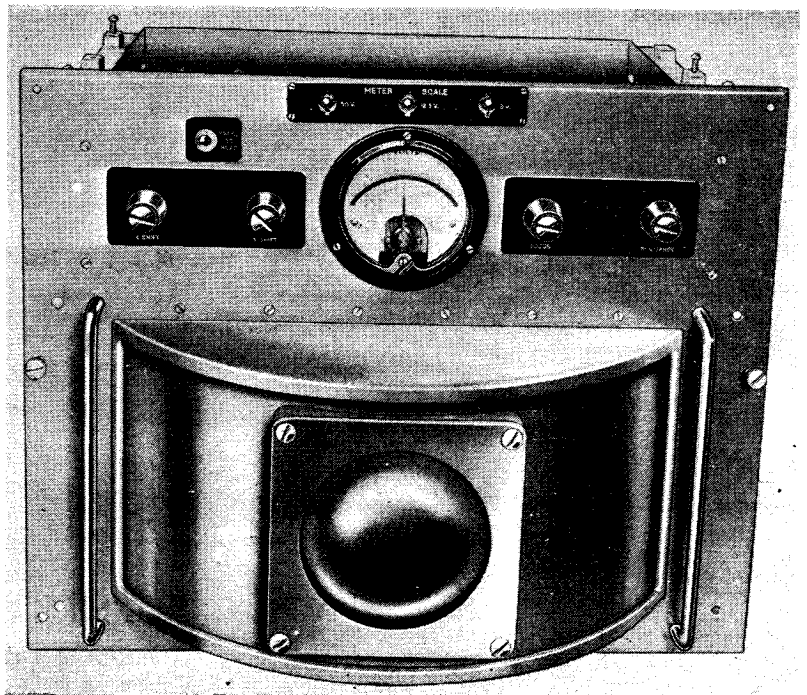


Fig. 19. Monitoring unit Type 102—front view

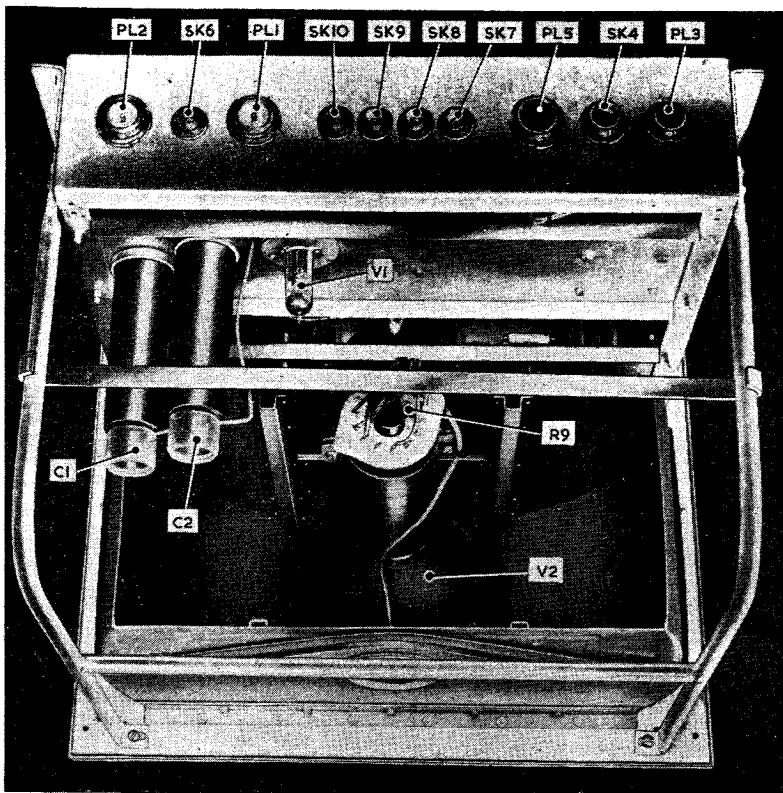


Fig. 20. Monitoring unit Type 102—rear view

divider between earth and negative EHT. The CRT heater, at approximately negative EHT potential, is supplied from the small transformer TR1, mounted in the monitor unit.

57. Timebase and signal voltages, the current for the METER SCALE indicator lamps (LP1 to LP3) and the +300V and -300V potentials for the shift network are supplied to the monitor unit from other units in the rack assembly. Timebase inputs are applied to the X plates from the Type 141 unit via SK7 and SK9. Signal inputs to the Y plates are applied from the video amplifying unit via SK8 and SK10. The +300V and -300V potentials are applied to PL3(D) and PL3(A), respectively, from the timebase unit Type 141.

58. To prevent trapezium distortion and de-focusing, push-pull inputs are applied to both X and Y plates. To this end the X SHIFT control consists of the ganged potentiometers RV4a and RV4b. The single potentiometer Y SHIFT control RV3 also provides a push-pull shift indirectly (*para.* 60). Its use permits the shift voltage to be measured (*para.* 53-54) and it provides a DC input signal for the video amplifier input stage,

via SK4(D) in the monitor unit and PL8(D) in the video unit, for comparison with the selected waveform for amplitude measurement.

59. The shift voltages are not applied directly to the X and Y plates. The X shift potentials reach the deflector plates via the timebase unit, where they provide reference levels for the X1 and X2 DC restorers (V18a and V18b, respectively). Connections are made via PL3(B) and PL3(F) in the monitor unit to SK14(B) and SK14(F) in the timebase unit for V18a and V18b, respectively. The sweep voltages, DC restored to the shift voltages, reach plates X1 and X2 via SK12 and SK13 in the timebase unit, connected to SK7 and SK9 in the monitor unit.

60. The Y shift potentials are derived from the DC amplifiers in the video unit. Adjustment of the Y SHIFT control varies the biasing of the DC amplifiers and results in a shift of the DC reference level of the push-pull output stage. This is applied to the deflector plates Y1 and Y2 via SK13 (Y1) and SK14 (Y2) in the video unit, and SK10 (Y1) and SK8 (Y2) in the monitor unit, so producing a linear push-pull shift, on which the video signal is superimposed.

61. Initially the brilliance level is determined by

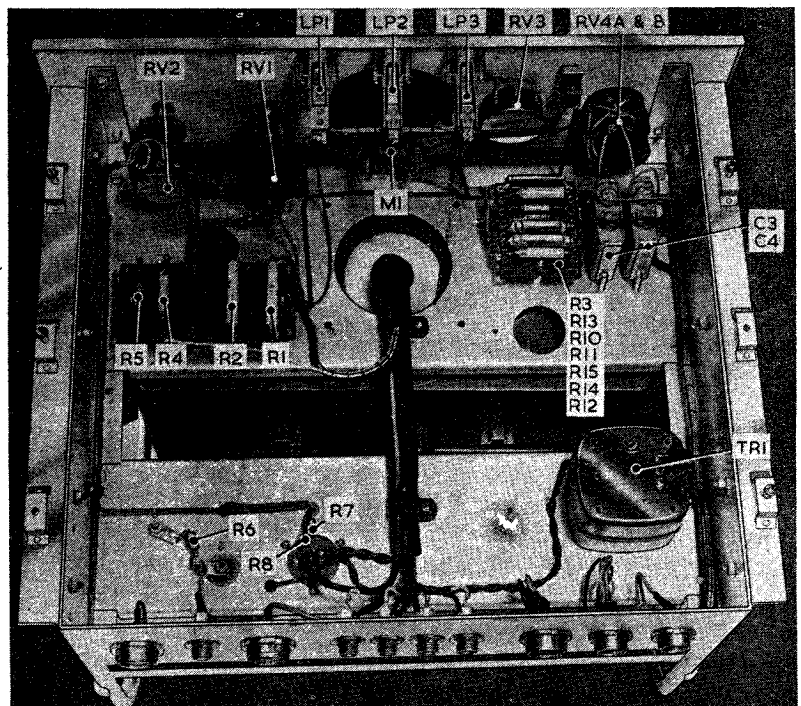


Fig. 21. Monitoring unit Type 102—plan view

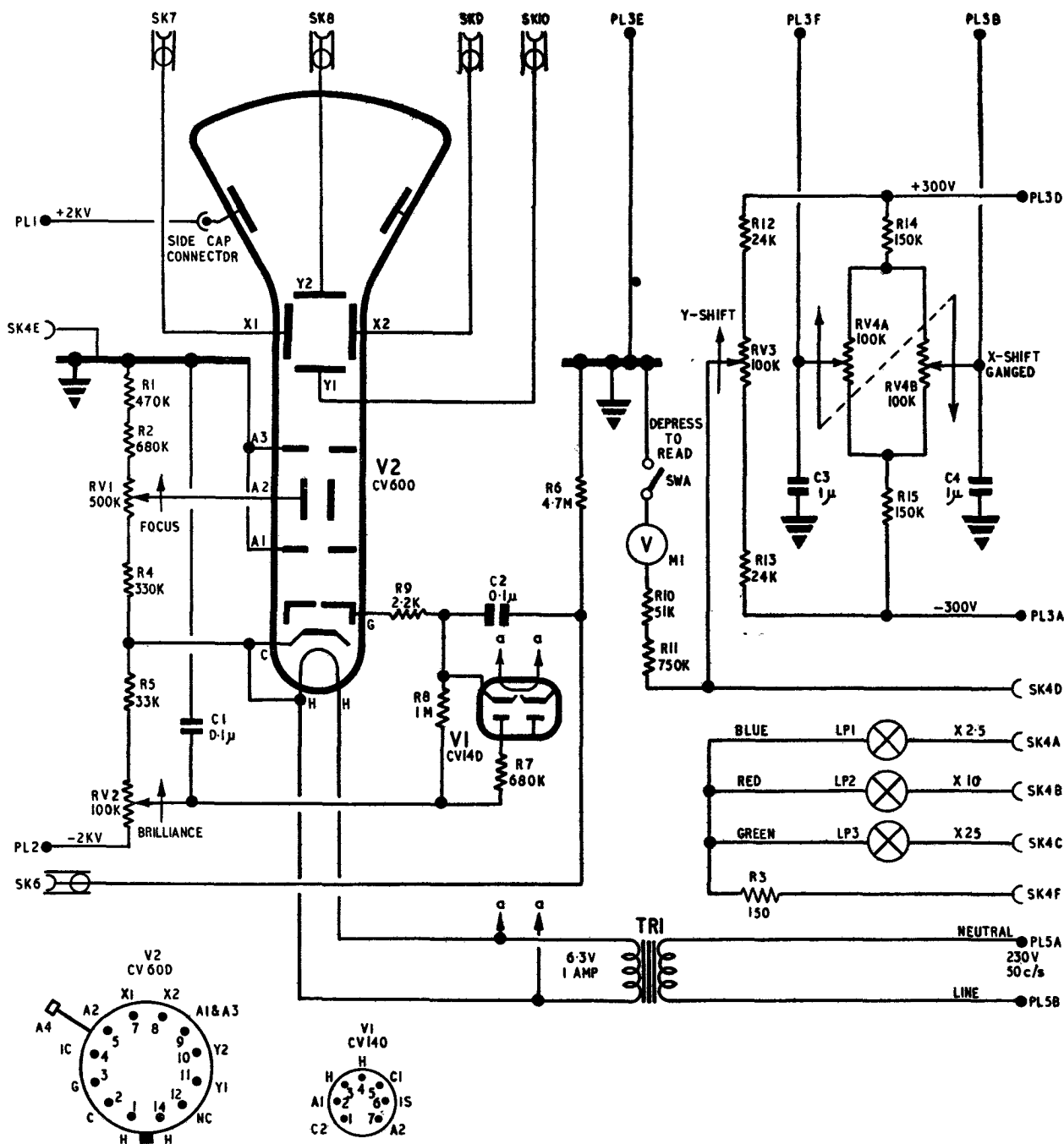


Fig. 22. Monitoring unit Type 102—circuit

the setting of the BRILLIANCE control. A DC restorer (V1—part of a double-diode, Type CV140) is connected on the CRT grid side of the  $0.1\mu\text{F}$  coupling capacitor C2, through which the scan bright-up waveform is applied via SK6 from the timebase unit Type 141. To give some measure of equality in brilliance for different speeds of scan, a compromise has been made in only partially DC restoring the BU pulse. The resistor R7 in series with V1 allows AC coupling

which gives greater effective amplitude to BU pulses of short duration than to pulses of longer duration.

**Note . . .**

The lists of components in Tables 1 to 5, with ratings and tolerances, and the rack cable arrangement in fig. 24, are provided as an aid to servicing.



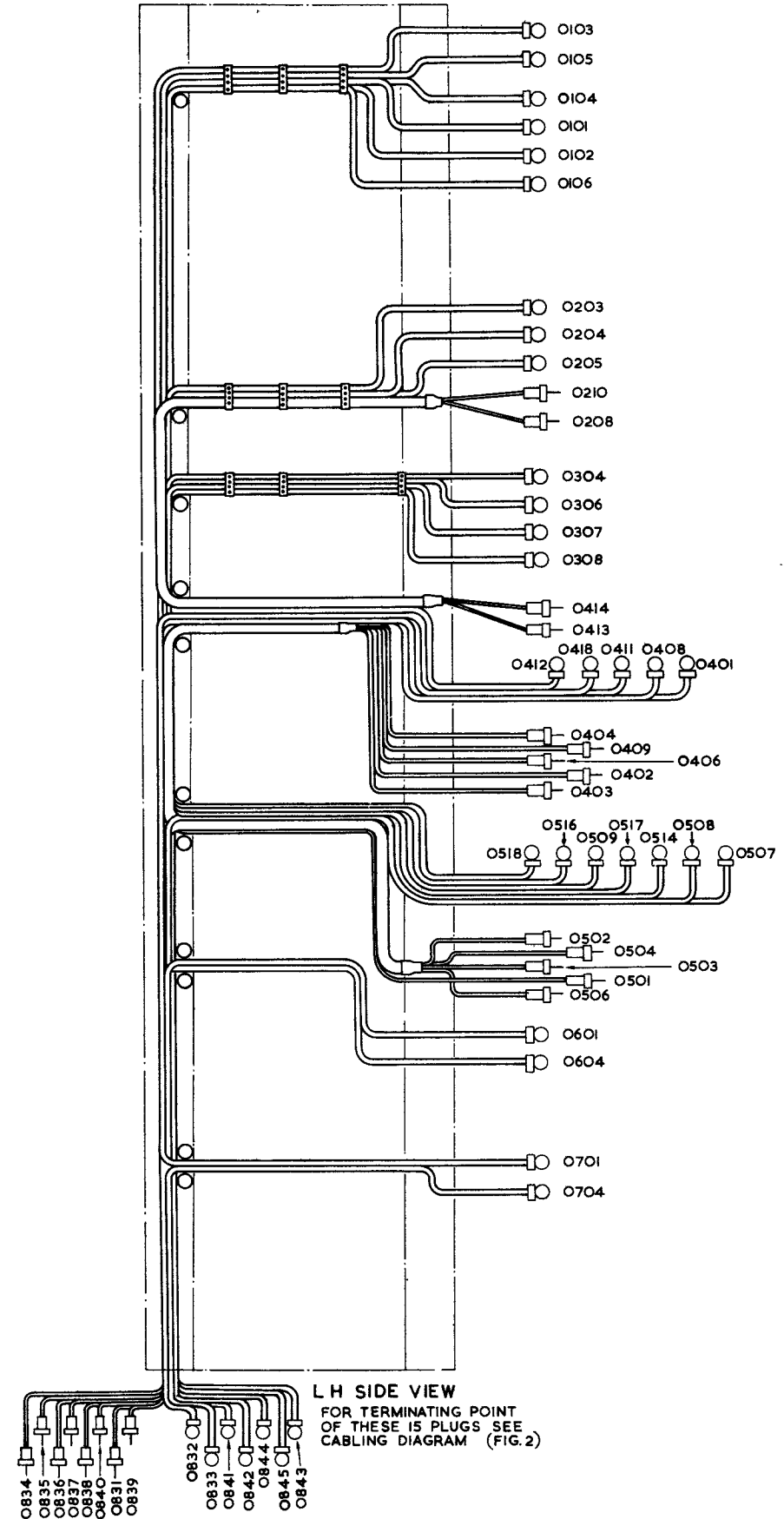
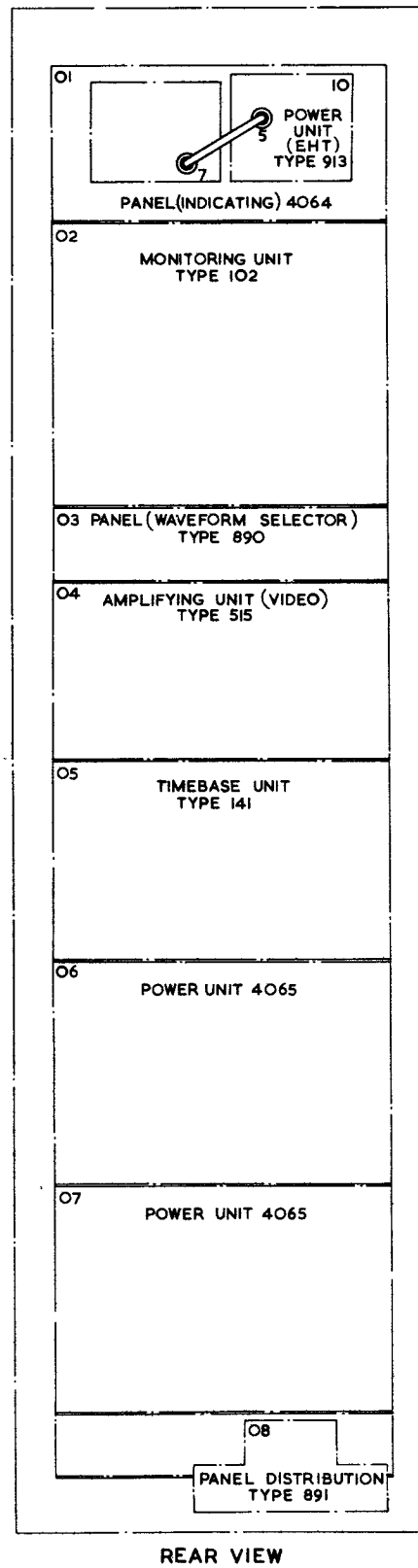
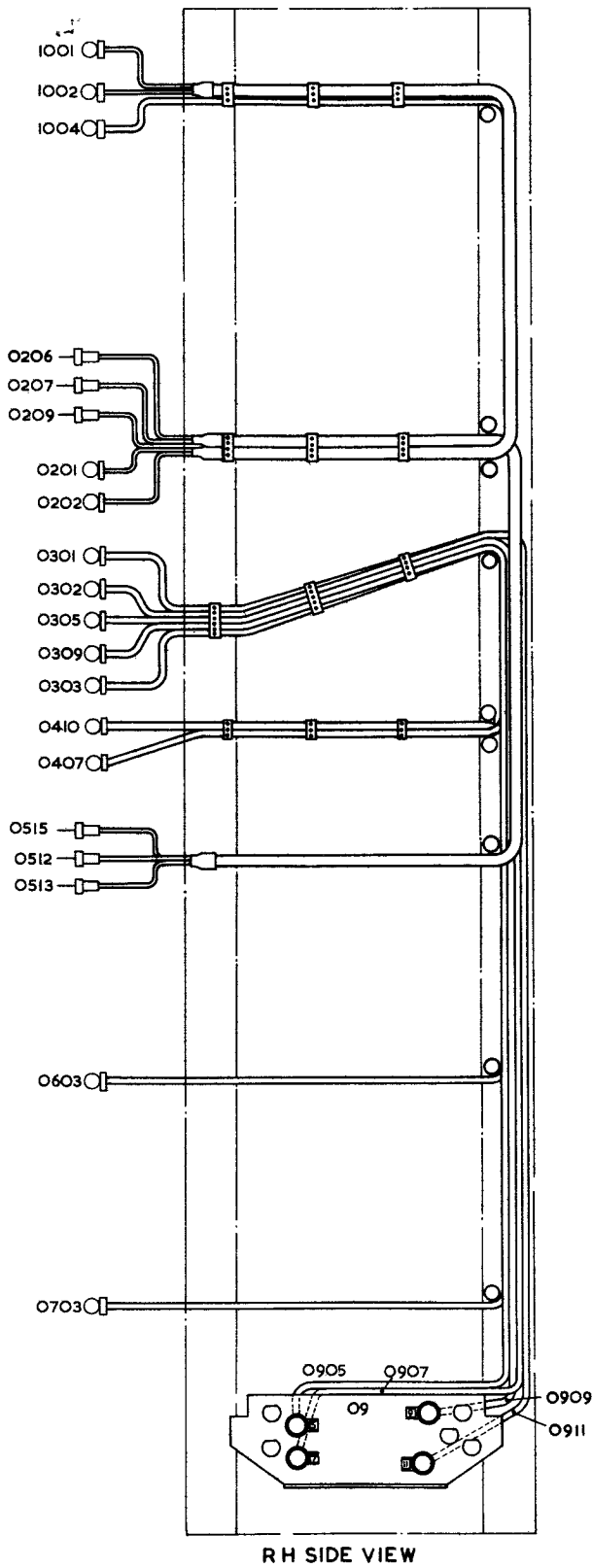


Fig. 24

Rack assembly Type 339 cables

Fig. 24

**TABLE 1**  
**Panel (indicating) Type 4064**  
**(10D/19032)**  
**List of components**

Circuit Ref.	Description	Type	Ref. No.
TR1, TR2	Transformer, heater, L1771	3554	Z2214 (10K/18019)
TR3	Transformer, heater, L1772	3555	Z2218 (10K/18020)
LP1 to LP6	Lamps, filament		X959220
LP7 to LP11	Lamps, filament		X951239
PL1	Plug, 12-way, fixed	Mk.4	Z560150
SK2	Socket, 12-way, fixed	Mk.4	Z560332
SK3	Socket, 12-way, fixed	Mk.4	Z560333
SK4	Socket, 12-way, fixed	Mk.4	Z560334
SK5	Socket, 12-way, fixed	Mk.4	Z560335
SK6	Socket, 12-way, fixed	Mk.4	Z560330
SK7	Socket, 12-way, fixed	Mk.4	Z560331
FS1 to FS3	Fuses, thermo cut-out		10AE/656
R1 to R6	Resistors, fixed, 150 $\Omega$ , 4 $\frac{1}{2}$ W	5% tol.	Z243113

**TABLE 2**  
**Power unit (EHT) Type 913**  
**(10K/17453)**  
**List of components**

Circuit Ref.	Description	Type	Value	Rating	Tolerance (per cent.)	Ref. No.
R1, R2	Resistors, fixed	—	47K	1W	10	Z212263
R3	Resistor, fixed	—	33K	$\frac{1}{2}$ W	10	Z222194
R4, R5	Resistors, fixed	—	10 $\Omega$	$\frac{1}{2}$ W	10	Z221002
R6	Resistor, fixed	—	10 $\Omega$	$\frac{1}{2}$ W	5	Z215002
R7	Resistor, fixed	—	680 $\Omega$	$\frac{1}{2}$ W	5	Z215222
R8	Resistor, fixed	—	150K	1W	10	Z213329
R9	Resistor, fixed	—	10 $\Omega$	$\frac{1}{2}$ W	10	Z221002
C1 to C4	Capacitors, fixed, Erie Type 410	7565	500pF	15KvDC	20	10C/20350
C5	Capacitor, fixed	—	300pF	500VDC	20	Z115621
C6	Capacitor, fixed, TCC Type M4WKO	—	2000pF	2.5KvDC	5	
C7, C8	Capacitors, fixed	—	0.01 $\mu$ F	350VDC	20	Z115552
C9	Capacitor, fixed	—	0.005 $\mu$ F	350VDC	20	Z115628
L1	Inductor (oscillator coil assembly)	—	—	—	—	10AD/851
L2	Inductor (filter choke)	2156	—	—	—	10C/20362
L3, L4	Inductors, variable (heater chokes)	2157	—	—	—	10C/20363
SK1, SK2	Socket, coaxial	1160	—	—	—	10H/20171
SK3	Socket, 25-way, fixed	Mk.4	—	—	—	Z560380
PL4	Plug, 6-way (med.), fixed	Mk.4	—	—	—	Z560541
PL5	Plug, 12-way, fixed	Mk.4	—	—	—	Z560151
RV1	Resistors, variable	—	50K	1W	10	Z272410



**TABLE 3**  
**Monitoring unit Type 102**  
**(10T/6156)**

**List of components**

Circuit Ref.	Description	Type	Value	Rating	Tolerance (per cent.)	Ref. No.
R1	Resistor, fixed	—	470K	1½W	2	Z216597
R2	Resistor, fixed	—	680K	1½W	2	Z216629
R3	Resistor, fixed	—	150Ω	4½W	5	Z243113
R4	Resistor, fixed	—	330K	1W	2	Z216564
R5	Resistor, fixed	—	33K	¾W	10	Z222195
R6	Resistor, fixed	—	4·7M	½W	10	Z223248
R7	Resistor, fixed	—	680K	½W	10	Z223143
R8	Resistor, fixed	—	1M	½W	10	Z223164
R9	Resistor, fixed	—	2·2K	½W	10	Z222047
R10	Resistor, fixed	—	51K	½W	1	Z216376
R11	Resistor, fixed	—	750K	½W	1	Z216630
R12, R13	Resistors, fixed	—	24K	¾W	5	Z216048
R14, R15	Resistors, fixed	—	33K	1½W	5	Z216065
RV1	Resistor, variable	—	500K	¾W	20	Z262551
RV2	Resistor, variable	—	100K	1W	10	Z272557
RV3	Resistor, variable (Colvern CLR5237/264)	11270	100K	2½W	10	10W/19484
RV4	Resistor, variable (Colvern CLR4226/264)	13531	100K + 100K	4W each	10	10W/20208
C1, C2	Capacitors, fixed	—	0·1μF	4KvDC	20	Z116416
C3, C4	Capacitors, fixed	—	1μF	600VDC	20	Z112823
LP1 to LP3	Lamps, filament	—	—	—	—	X959220
TR1	Transformer, heater, L1543	3651	—	6·3V, 1A	—	10K/18026
SWA	Switch S.P.S.T.	2320	—	3A	—	10F/17734
M1	Meter, 250-0-250μA	—	—	130Ω	—	5Q/25244
PL1, PL2	Plugs, coaxial	954	—	—	—	10H/20177
PL3	Plug, 6-way (med.), fixed	Mk.4	—	—	—	Z560542
PL5	Plug, 6-way (small) fixed	Mk.4	—	—	—	Z560080
SK4	Socket, 6-way (small) fixed	Mk.4	—	—	—	Z560261
SK6 to SK10	Socket, coaxial	783	—	—	—	10H/19861

**TABLE 4**  
**Power Unit Type 4065**  
**(10K/17832)**

**List of components**

Circuit Ref.	Description	Type	Value	Rating	Tolerance (per cent.)	Ref. No.
<b>RESISTORS, FIXED</b>						
R1, R2	—	—	1M	1W	10	Z213339
R3	—	—	100Ω	½W	10	Z221110
R4	—	—	22K	6W	5	Z244129
R5	—	—	15K	½W	10	Z222152
R6	—	—	220K	1W	10	Z213331
R7	—	—	4·7K	½W	10	Z222089
R8	—	—	33Ω	½W	5	Z215062
R9	—	—	100Ω	½W	10	Z221110
R10	—	—	68K	1W	10	Z213325

TABLE 4 (continued)

Circuit Ref.	Description	Type	Value	Rating	Tolerance (per cent.)	Ref. No.
<b>RESISTORS, FIXED</b>						
R11	—	—	47K	1W	10	Z212263
R12	—	—	470K	$\frac{1}{2}$ W	10	Z223122
R13, R14	—	—	15 $\Omega$	$\frac{1}{2}$ W	10	Z221011
R15	—	—	330K	1W	2	Z216564
R16	—	—	1M	$\frac{3}{4}$ W	1	Z216655
R17	—	—	100K	$\frac{1}{2}$ W	10	Z223028
R18, R19	—	—	1M	1W	10	Z213339
R20, R21	—	—	4.7K	$\frac{1}{2}$ W	10	Z222089
R22, R23	—	—	100 $\Omega$	$\frac{1}{2}$ W	10	Z221110
R24, R25	—	—	220K	1W	10	Z213331
R26	—	—	33 $\Omega$	$\frac{1}{2}$ W	5	Z215062
R27	—	—	100K	$\frac{1}{2}$ W	10	Z223038
R28	—	—	100 $\Omega$	$\frac{1}{2}$ W	10	Z221110
R29, R30	—	—	47K	1W	10	Z212263
R31	—	—	470K	$\frac{1}{2}$ W	10	Z223122
R32, R33	—	—	220 $\Omega$	$\frac{1}{2}$ W	10	Z221152
R34	—	—	330K	1W	2	Z216564
R35	—	—	300K	$\frac{3}{4}$ W	1	Z216551
R36	—	—	100K	$\frac{1}{2}$ W	10	Z223038
R37	—	—	150 $\Omega$	4 $\frac{1}{2}$ W	5	Z243112
R38 to R40	<i>deleted</i>					
R41, R42	—	—	2.7K	1W	5	Z215294
R43	—	—	12K	1W	5	Z216014
R44	—	—	6.8K	4 $\frac{1}{2}$ W	5	Z244081
R45	—	—	100 $\Omega$	$\frac{1}{2}$ W	10	Z221110
R46	—	—	22K	$\frac{1}{2}$ W	10	Z222173
R47	—	—	2.2M	$\frac{1}{2}$ W	10	Z223206
R48	—	—	1M	$\frac{3}{4}$ W	1	Z216655
R49	—	—	750K	$\frac{3}{4}$ W	1	Z216631
R50, R51	—	—	1M	$\frac{3}{4}$ W	1	Z216655
R52, R53	—	—	22K	6W	5	Z244129
R54	—	—	100K	$\frac{1}{2}$ W	10	Z223038
R55, R56	—	—	1M	1W	10	Z213339
R57	—	—	220K	1W	10	Z213331
R58	—	—	100 $\Omega$	$\frac{1}{2}$ W	10	Z221110
R59	—	—	4.7K	$\frac{1}{2}$ W	10	Z222089
R60	—	—	330K	1W	10	Z213333
R61	—	—	680K	1W	10	Z213337
R62	—	—	33 $\Omega$	$\frac{1}{2}$ W	5	Z215062
R63	—	—	100 $\Omega$	$\frac{1}{2}$ W	10	Z221110
R64, R65	—	—	47K	1W	10	Z212263
R66	—	—	470K	$\frac{1}{2}$ W	10	Z223122
R67, R68	—	—	220 $\Omega$	$\frac{1}{2}$ W	10	Z221152
R69	—	—	470K	$\frac{3}{4}$ W	2	Z216595
R70	—	—	300K	$\frac{3}{4}$ W	2	Z216555
R71	—	—	240K	1W	2	Z216540
R72	—	—	100K	$\frac{1}{2}$ W	10	Z223038
R73	—	—	300K	$\frac{3}{4}$ W	1	Z216551
R74	—	—	330K	1W	2	Z216564
R75	—	—	220K	1W	10	Z213331

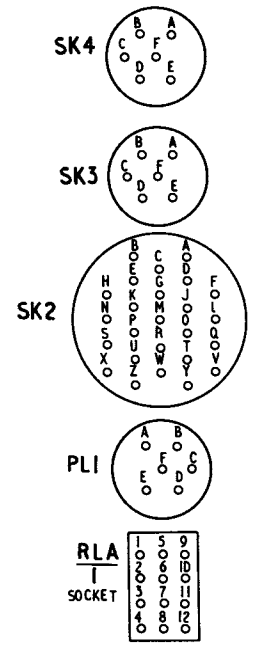
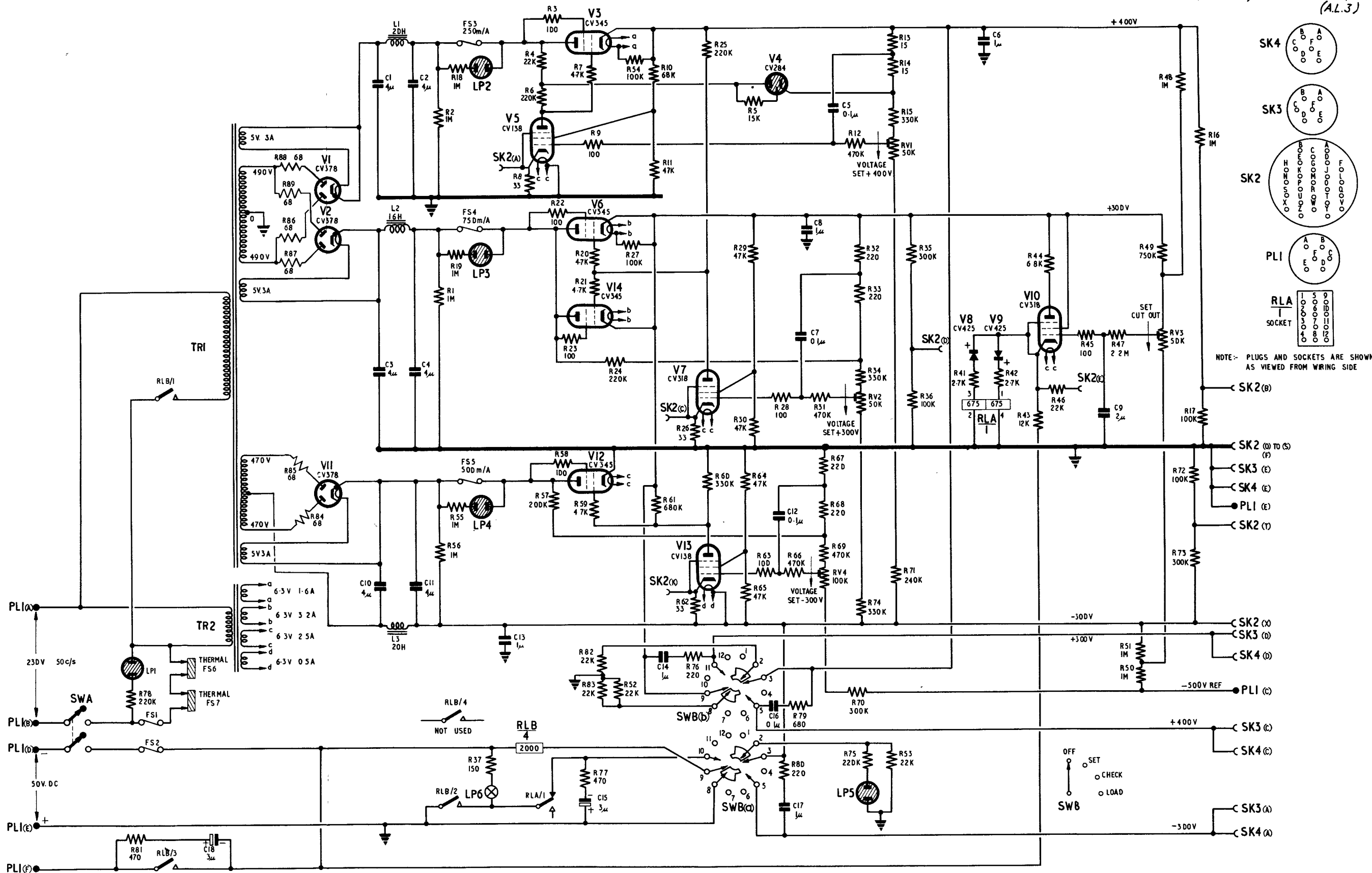
TABLE 4 (continued)

Circuit Ref.	Description	Type	Value	Rating	Tolerance (per cent.)	Ref. No.
<b>RESISTORS, FIXED</b>						
R76	—	—	220Ω	$\frac{1}{2}$ W	10	Z221152
R77	—	—	470Ω	$\frac{1}{2}$ W	10	Z221194
R78	—	—	220K	1W	10	Z213331
R79	—	—	680Ω	$\frac{1}{2}$ W	10	Z221215
R80	—	—	220Ω	$\frac{1}{2}$ W	10	Z221152
R81	—	—	470Ω	$\frac{1}{2}$ W	10	Z221194
R82, R83	—	—	22K	6W	5	Z244129
R84 to R89	—	—	68Ω	6W	5	Z243082
RV1 to RV3	Resistors, variable	—	50K	1W	10	Z272410
RV4	Resistor, variable	—	100K	1W	10	Z272549
<b>CAPACITORS, FIXED</b>						
C1 to C4	—	—	4μF	800VDC	20	Z112529
C5	—	—	0.1μF	500VDC	20	Z115587
C6	—	—	1μF	600VDC	20	Z112823
C7	—	—	0.1μF	500VDC	20	Z115587
C8	—	—	1μF	600VDC	20	Z112823
C9	—	—	2μF	200VDC	20	Z112882
C10, C11	—	—	4μF	800VDC	20	Z112529
C12	—	—	0.1μF	500VDC	20	Z115587
C13, C14	—	—	1μF	600VDC	20	Z112823
C15	Electrolytic	—	3μF	100VDC	-20, +50	Z145017
C16	—	—	0.1μF	500VDC	20	Z115587
C17	—	—	1μF	600VDC	20	Z112823
C18	Electrolytic	—	3μF	100VDC	-20, +50	Z145017
<b>MISCELLANEOUS</b>						
RLA	Relay, magnetic (Carpenter 6U33)	1339	675Ω+675Ω	—	—	10F /18105
RLB	Relay SM3 HV60	—	2K	—	—	Z530187
PL1	Plug, 6-way (med.) fixed	Mk.4	—	—	—	Z560140
SK2	Socket, 25-way, fixed	Mk.4	—	—	—	Z560380
SK3, SK4	Sockets, 6-way (med.) fixed	Mk.4	—	—	—	Z560321
SWA	Switch, D.P.S.T.	—	—	—	—	Z510302
◀ SWB	Switch, wafer, Type H	2317	—	—	—	10F /17730 ▶
FS1	Fuse link, MOS (A)	—	—	5A	—	Z590112
FS2	Fuse link, MOS (A)	—	—	1A	—	Z590109
FS3	Fuse link, MOS (A)	—	—	250mA	—	Z590107
FS4	Fuse, MOS (A)	33	—	750mA	—	10H /321
FS5	Fuse link, MOS (A)	—	—	500mA	—	Z590108
FS6	Thermo-cut-out	—	—	—	—	10AE /653
FS7	Thermo-cut-out	—	—	—	—	10AE /655
◀ L1	Choke, LF, L1274	1153	—	20H	—	10C /19297
L2	Choke, LF, L1775	1190	—	16H	—	10C /20347
L3	Choke, LF, L1776	1191	—	20H	—	10C /20348
TR1	Transformer, HT, L1774	3557	—	—	—	10K /18022
TR2	Transformer, heater, L1773	3556	—	—	—	10K /18021 ▶
LP1 to LP5	Lamps, neon	—	—	—	—	X962106
LP6	Lamp, filament	—	—	—	—	X959220

**TABLE 5**  
**Panel (distribution) Type 891**  
**(10D/18935)**

**List of components**

Circuit Ref.	Description	Type	Value	Rating	Tolerance (per cent.)	Ref. No.
C1	Capacitor, fixed ( <i>amend fig 5</i> )	—	0.05 $\mu$ F	350V DC	20	Z115554
◀ FS1, FS2	Fuse link, MOS (A)	—	—	5A	—	Z590112
SWA	Uniselector unit	4352	—	75 $\Omega$	—	10F / 17718
SWB	Switch (Santon) 6-pole ON/OFF	—	—	10A	—	5A / 4143
SWC	Switch, 2-pole ON/OFF	—	—	5A	—	Z510306
◀ MR1	Resistor unit	514	—	50V DC	—	10W / 19566
PL1 to PL3	Plug, 6-way (med.), fixed	Mk.4	—	—	—	Z560140
PL4	Plug 6-way (med.), fixed	Mk.4	—	—	—	Z560541
SK6	Socket, 12-way, fixed	Mk.4	—	—	—	Z560331
SK8	Socket, 12-way, fixed	Mk.4	—	—	—	Z560333
SK10	Socket, 12-way, fixed	Mk.4	—	—	—	Z560334
SK12	Socket, 12-way, fixed	Mk.4	—	—	—	Z560332
SK14 to SK24	Socket, coaxial	783	—	—	—	10H / 19861
SK25	Socket, coaxial	579	—	—	—	10H / 4953
SK26 to SK29	Socket, coaxial	783	—	—	—	10H / 19861
◀ SK31	Socket, coaxial	783	—	—	—	10H / 19861
SK32	Socket, 12-way, fixed	Mk.4	—	—	—	Z560335
SK33	Socket, 6-way (med.), fixed	Mk.4	—	—	—	Z560321
◀ SK34 to SK40	Socket, coaxial	783	—	—	—	10H / 19861
SK41, SK42	Socket, 6-way (med.), fixed	Mk.4	—	—	—	Z560320
SK43	Socket, 6-way (small), fixed	Mk.4	—	—	—	Z560260
SK44	Socket, 12-way, fixed	—	—	—	—	Z560330
SK45	Socket, 12-way, fixed	—	—	—	—	Z560331
SK46	Socket (Crabtree Type L7170)	—	—	—	—	—
◀ SK47, SK48	Socket, coaxial	783	—	—	—	10H / 19861



NOTE:- PLUGS AND SOCKETS ARE SHOWN AS VIEWED FROM WIRING SIDE

Fig. 23

Power unit Type 4065 circuit

Fig. 23 (A.L.3 Jan. 55)

**Appendix 1****PANEL (DISTRIBUTION) TYPE 891A****LIST OF CONTENTS**

	<i>Para.</i>		<i>Para.</i>
<i>Introduction</i> ... ..	1	<i>General description</i> ... ..	2

**Introduction**

1. On certain stations a  $-50\text{V}$  reference voltage is provided instead of the normal  $-500\text{V}$  reference. To allow for this, the Type 891A version was produced.

**General description**

2. The Type 891A is similar to Type 891 except that in the former a connection is made between PL3(C) and SK33(A), to route the  $-50\text{V}$  reference voltage to the video unit Type 515A.



## Appendix 3

### RACK (MONITOR) TYPE 16505

#### LIST OF CONTENTS

	<i>Para.</i>
<i>Introduction</i> ....	1
<i>General description</i> ....	2
<i>Function....</i> ....	3

#### ILLUSTRATION

	<i>Fig.</i>
<i>Rack (monitor) Type 16505 cabling</i> ....	1

#### Introduction

1. The rack (monitor) Type 16505 (Stores Ref. 10D/22435) replaces the rack assembly (waveform monitor) Type 339, on stations where Phase 1A modifications are incorporated.

#### General description

2. The rack consists of a wired cabinet, into which may be placed any of the panels associated with the function of waveform monitoring. For Phase 1A working the following units may be fitted in the rack:—

Panel (distribution) Type 16506 (Stores Ref. 10D/22436)

Two power units Type 4065 (10K/17832)

Timebase unit Type 141B (10D/22387)

Amplifying unit (video) Type 515C (10U/17472)

Panel (waveform selector) Type 16504 (10D/22434)

Monitoring Unit Type 102 (10T/6156)

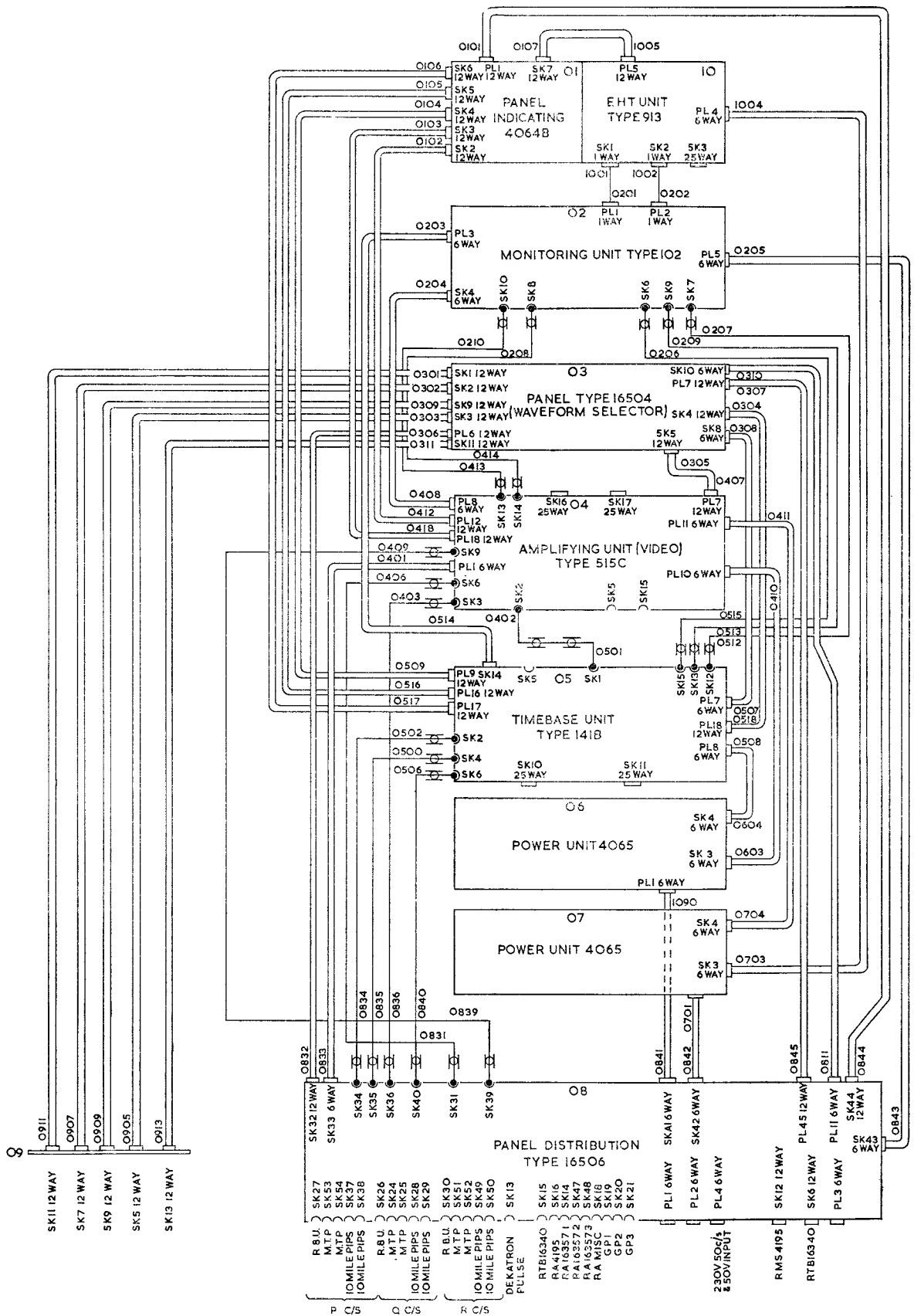
Panel (indicating) Type 4064B (10D/22380)

E.H.T. unit Type 913 (10K/17453)

#### Function

3. When fitted with the named units, the assembly provides a means of displaying on the monitor unit the principal waveforms of the fixed-coil radar office equipment. The function of the assembly is identical with the function of the rack assembly (waveform monitor) Type 339. A block diagram of the racks served by Type 16505 is available under the appendix to Chapter 4 of this Section.





**Fig. 1. Rack (monitor) Type 16505 cabling**

## Appendix 4

### PANEL (DISTRIBUTION) TYPE 16506

#### LIST OF CONTENTS

	<i>Para.</i>
<i>Introduction</i> ....	1
<i>General description</i> ....	2
<i>Actuator function</i> ....	4

#### ILLUSTRATION

	<i>Fig.</i>
<i>Panel (distribution) Type 16506—circuit</i> ....	1

#### Introduction

1. For Phase 1A working, the panel (distribution) Type 891 is replaced by the panel (distribution) Type 16506 (Ref. No. 10D/22436). This panel can be used only in conjunction with other units modified for Phase 1A working. The panel 16506 has an addition Ledex switch for p.r.f. selection.

#### General description

2. The panel 16506 is similar in outward appearance to the panel 891. The plugs and sockets, however, are of a different configuration. A circuit diagram of the panel 16506 is given (*fig. 1*) and may be studied in conjunction with the rack (monitor) Type 16505 cabling diagram, given in Chapter 1, App. 3. All connections to the rack, with the exception of the five panel-mounted couplers, are made through the panel 16506.

3. The voltages for power pack operation are fed into the panel 16506 via the 6 pin plugs PL1, PL2 and PL3. The 50V d.c. supply and the 230V 50 c/s supply are fed into the panel via PL4. The 230V 50 c/s isolation switch SC is mounted on the front of the panel. A 230V supply is available for rack servicing on a standard 5 amp.

3 pin socket SKT46, mounted at the rear of the panel.

#### Actuator function

4. There are two Ledex actuators fitted in the panel, SA and SB. Both of these actuators are fed directly from the positive side of the 50V d.c. supply. The negative side of the supply is controlled by switches in the panel (waveform selector) Type 16504, and is applied to SA and SB actuating wafers through PL11 and SKT32 respectively.

5. SA selects:—(1) R.B.U. at P c/s, Q c/s, or R c/s, and feeds the selected r.b.u. to the amplifying unit (video) Type 515C and the timebase Type 141B.

(2) Ten-mile pips at P c/s, Q c/s, or R c/s, and feeds the selection to the video amplifier 515C and timebase 141B.

(3) Sync. at P c/s, Q c/s, R c/s, or Dekatron pulse, and the selection is fed to the timebase 141B.

6. SB selects the signal to be applied to the video amplifier 515C from the signals available at the associated racks, or from the four wanderleads shown in *fig. 1*.

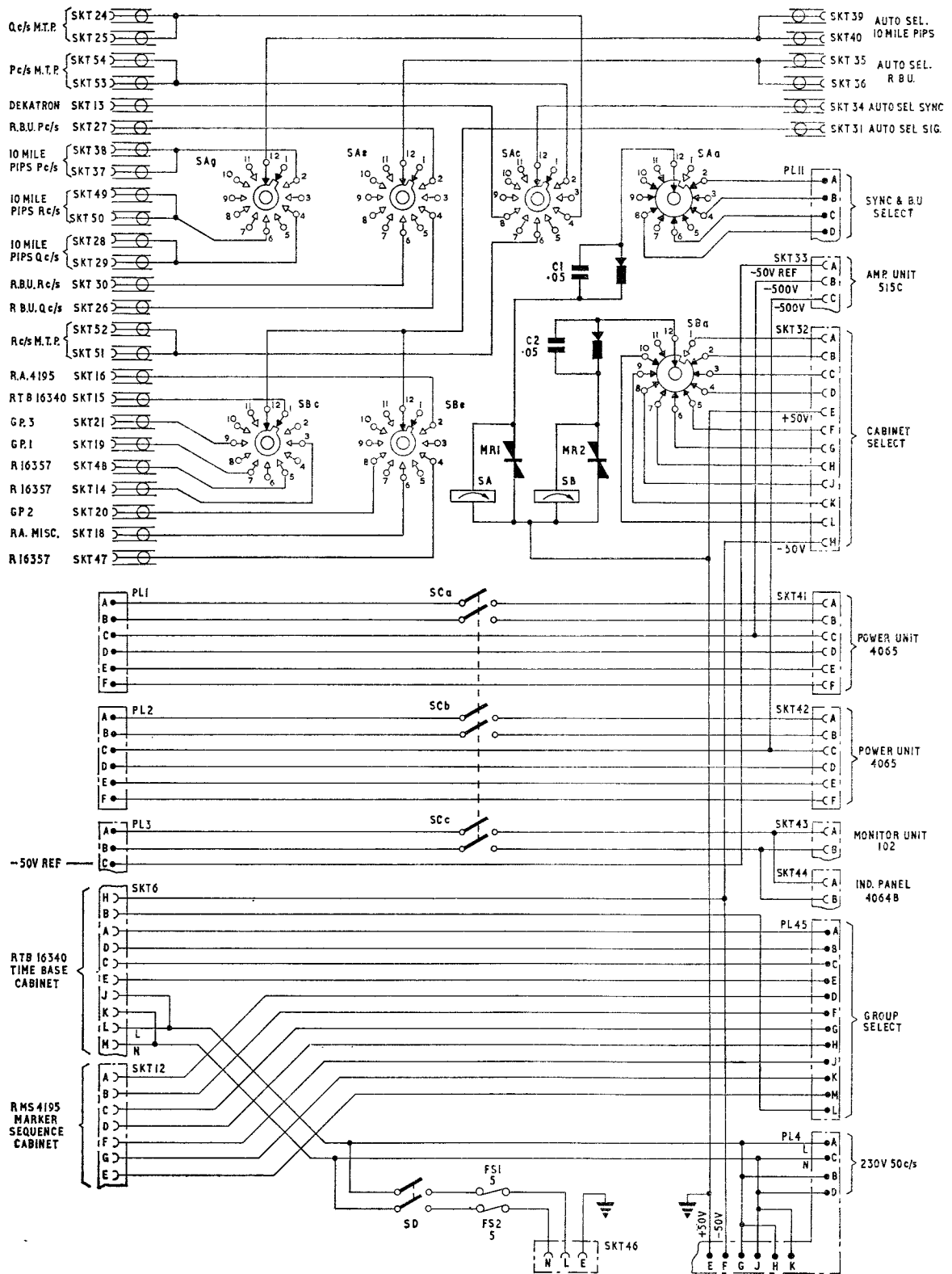


Fig. 1. Panel (distribution) Type 16506—circuit

## Appendix 5

### PANEL (INDICATING) TYPE 4064B

#### LIST OF CONTENTS

	<i>Para.</i>		<i>Para.</i>
<i>Introduction</i> ....	1	<i>General description</i> ....	2

#### ILLUSTRATION

<i>Panel (indicating) Type 4064B—front</i> ....	<i>Fig.</i> 1
---	------------------

#### Introduction

1. The panel Type 4064B is the correct indicator panel for use with the rack (monitor) Type 16505, at stations where Phase 1A modifications are incorporated. The panel supplies all the information relevant to switching positions for operating the panel (control) Type 16504.

#### General description

2. The panel 4064B is similar to the panel 4064 in general appearance, except that the panel 4064B has no indicator lights. The switch position information is, of course, different on the Phase 1A panel.

WAVEFORM SELECTION															
TIMEBASE WAVEFORMS				TIMEBASE WAVEFORMS				GATING WAVEFORMS				RESOLVER WAVEFORMS			
SA	SB	INSPECTION		SA	SB	SETTING UP		SA	SB	INSPECTION & SETTING UP		SA	SB	INSPECTION & SETTING UP	
1	1	UNIT No.1 - 320 MILES		4	1	UNIT No.1 - 320 MILES		7	1	UNIT No.1		13	1 & 2	CABINET No.1	
	2	+VE SAWTOOTH			2	T.B. REST LEVEL			2	GATE 1			3 & 4	RES No.1 X&Y SAWTEETH	
	3	40 MILE PIP			3	SPARE			3	GATE 2			5 & 6	RES No.2 X&Y SAWTEETH	
	4	R.B.U. No.1			4	T.B. VELOCITY			4	1-T BRIGHT UP 1			7-12	RES No.3 X&Y SAWTEETH	
	5	R.B.U. No.2			5	T.B. DURATION			5	1-T BRIGHT UP 2			1-6	REST LEVELS - AS ABOVE	
	6	G.W.G. DRIVE			6	T.B. LINEARITY			6	AZ C1 No.1			7-12	GAINS - AS ABOVE	
		RESOLVER CLAMP TRIGGER			7	SPARE			7	AZ C1 No.2			7-12	LINEARITY - AS ABOVE	
		UNIT No.2 - 240 MILES			8	UNIT No.2 - 240 MILES			8	AZ C2 No.1				CABINET No.2	
	7	+VE SAWTOOTH			7	+VE S-T REST LEVEL			8	AZ C2 No.2			15	1-12	
	8	-VE SAWTOOTH			8	-VE S-T REST LEVEL			9	AZICATION MARKER DRIVE			16	1-12	
	9	R.B.U. No.1			9	T.B. VELOCITY			10	RING				CABINET No.3	
	10	R.B.U. No.2			10	T.B. DURATION			11 & 12	SPARE			17	1-12	
	11	G.W.G. DRIVE			11	Y.B. LINEARITY			8	1-10 DEKATRON WAVEFORMS			18	1-12	
	12	RESOLVER CLAMP TRIGGER			12	PARAPHASE GAIN			11 & 12	SPARE				WANDERLEADS	
		STANDBY UNITS				STANDBY UNITS				UNIT No.2			19	No.1	
2	1-12	SEE SA 1		5	1-12	SEE SA 4		9 & 10	1-12	SEE SA 7&8			1	WAVEFORMS - LOW GAIN	
3	1-12	SPARE		6	1-12	SPARE		11 & 12	1-12	SEE SA 7&8			2	WAVEFORMS - HIGH GAIN	
													3	SET REST LEVELS	
													4	SET AMPLITUDES	
													5-12	SPARE	
														Nos.2-4	
													20-22	1-12	
														SEE SA 19	

Fig. 1. Panel (indicating) Type 4064B—front

**Chapter 2****TIMEBASE UNIT TYPE 141****ADDENDUM**

Directly after the list of illustrations, include the following:—

**LIST OF APPENDICES**

<i>Timebase unit Type 141A</i>	....	....	....	<i>App.</i> 1	<i>Timebase unit Type 141B</i>	....	....	....	<i>App.</i> 2
--------------------------------	------	------	------	------------------	--------------------------------	------	------	------	------------------

**CORRIGENDA**

Para. 45 and Table 1, Capacitors (fixed), item No. 11. The details of C17 only, should be read as follows:

Value (F)	Rating (VDC)	Tolerance (per cent)	Ref. No.
470p	750	10	10C/0123949

### Appendix 6

## PANEL (DISTRIBUTION) TYPE 891B

### LIST OF CONTENTS

	Para.
Introduction ... ..	1
General description ... ..	2

### LIST OF ILLUSTRATIONS

	Fig.
Panel (distribution) Type 891B-- scrap circuit. . .	1

#### Introduction

1. In order to provide rack (waveform monitor) 16339 with facilities for monitoring three rack assemblies (resolver magstrip) 301 or racks (resolver magstrip) 16357, panel (distribution) Type 891 is modified to Type 891B by the addition of a coaxial socket SK50 and a magnetic relay RLA.

at panel (waveform selector) 890B (Chap. 4, App. 3 of this section) relay RLA is de-energized and contact RLA/1 routes the input at SK16 to SWA(c)/4. With RES 3 selected at panel (waveform selector) 890B the -50V supply is connected to SK45/M and relay RLA is energized. Contact RLA/1 then routes the input at SK50 to SWA(e)/4. Resolver rack No. 1 is selected as in the Type 891 panel.

#### General description

2. The circuit changes resulting from this modification are shown in fig. 1. With RES 2 selected

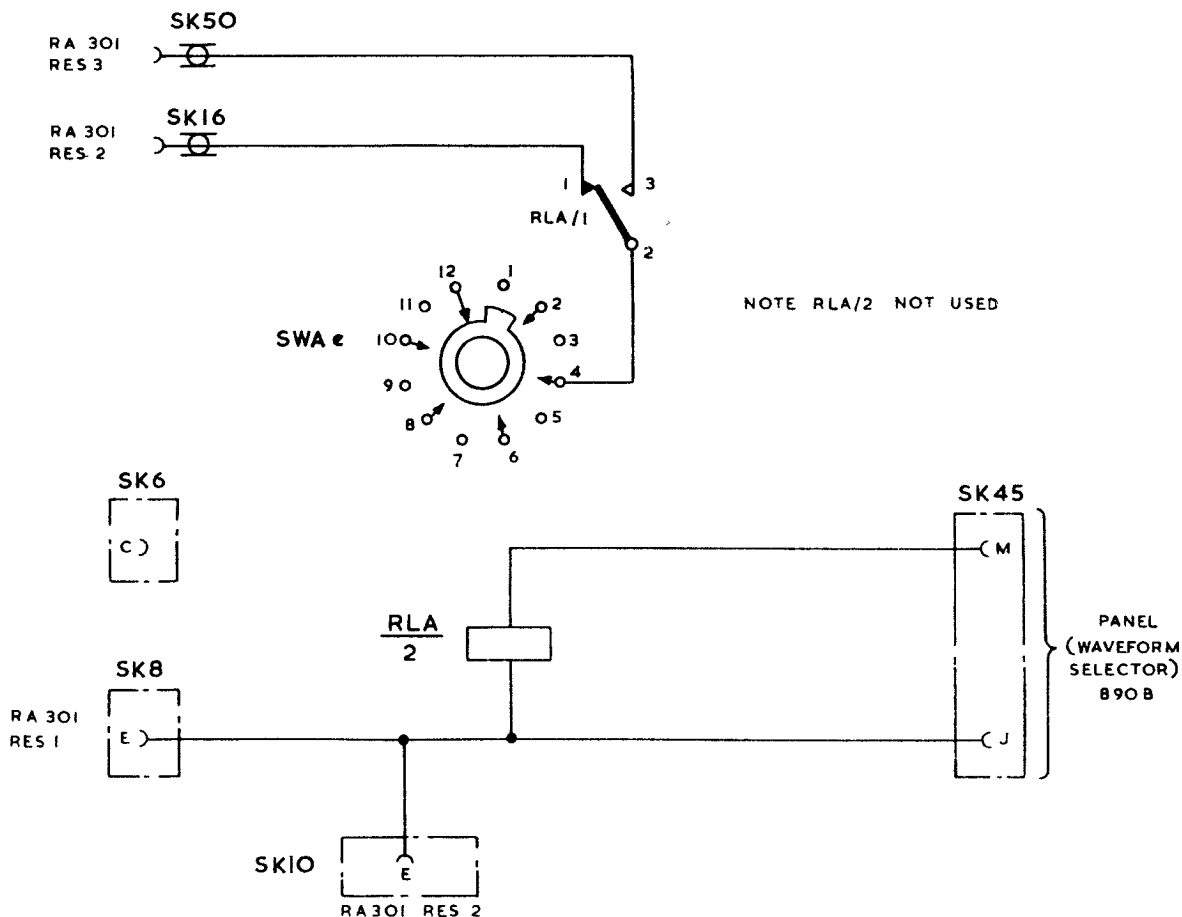


Fig. 1. Panel (distribution) Type 891B—scrap circuit

**Appendix 7****RACK MONITOR TYPE 16339****LIST OF CONTENTS**

	<i>Para.</i>
<i>Introduction</i> .. .. .	1
<i>General description</i> .. .. .	2

**Introduction**

1. The rack assembly Type 339 becomes the rack monitor Type 16339 on certain stations where Phase 1A modifications are incorporated.

**General description**

2. The effect of this modification, CA5026, is to change the equipment label only and the wired cabinet remains technically identical to the rack assembly Type 339.

**Appendix 8****RACK ELECTRICAL EQUIPMENT****5975-99-954-8362****LIST OF CONTENTS**

	<i>Para.</i>
<i>Introduction</i> .. .. .	1
<i>General description</i> .. .. .	2
<i>Function</i> .. .. .	3

**LIST OF ILLUSTRATIONS**

	<i>Fig.</i>
<i>Rack electrical equipment—cabling diagram..</i>	1

**Introduction**

1. The rack monitor 16339 is modified to form the rack electrical equipment 5975-99-954-8362 at certain stations where the integration of radar Type 85 has been carried out.

**General description**

2. The rack is a wired cabinet arranged to perform a waveform monitoring function in conjunction with the following units normally fitted to the rack:—

Monitoring Unit Type 102 (Stores Ref. 10T/6156)  
 Panel (indicator) 5840-99-954-8330  
 Panel (waveform selector) 5840-99-953-7533  
 Amplifier video 5840-99-954-8497

Generator sweep 5840-99-954-8333

Panel distribution 5840-99-953-7532

Power units Type 4065 (2)

(Stores Ref. 10K/17832).

**Function**

3. When fitted with the above-named units, the rack performs a similar function to the rack monitor Type 16339 but in addition facilities are provided for monitoring a cabinet electrical equipment (sweep) 5975-99-953-7535 and an additional rack resolver Type 16357. A cable routing diagram is shown in fig. 1 and a block diagram of the racks served by the rack, electrical equipment is shown in Appendix 3 to Chapter 4 of this Section.



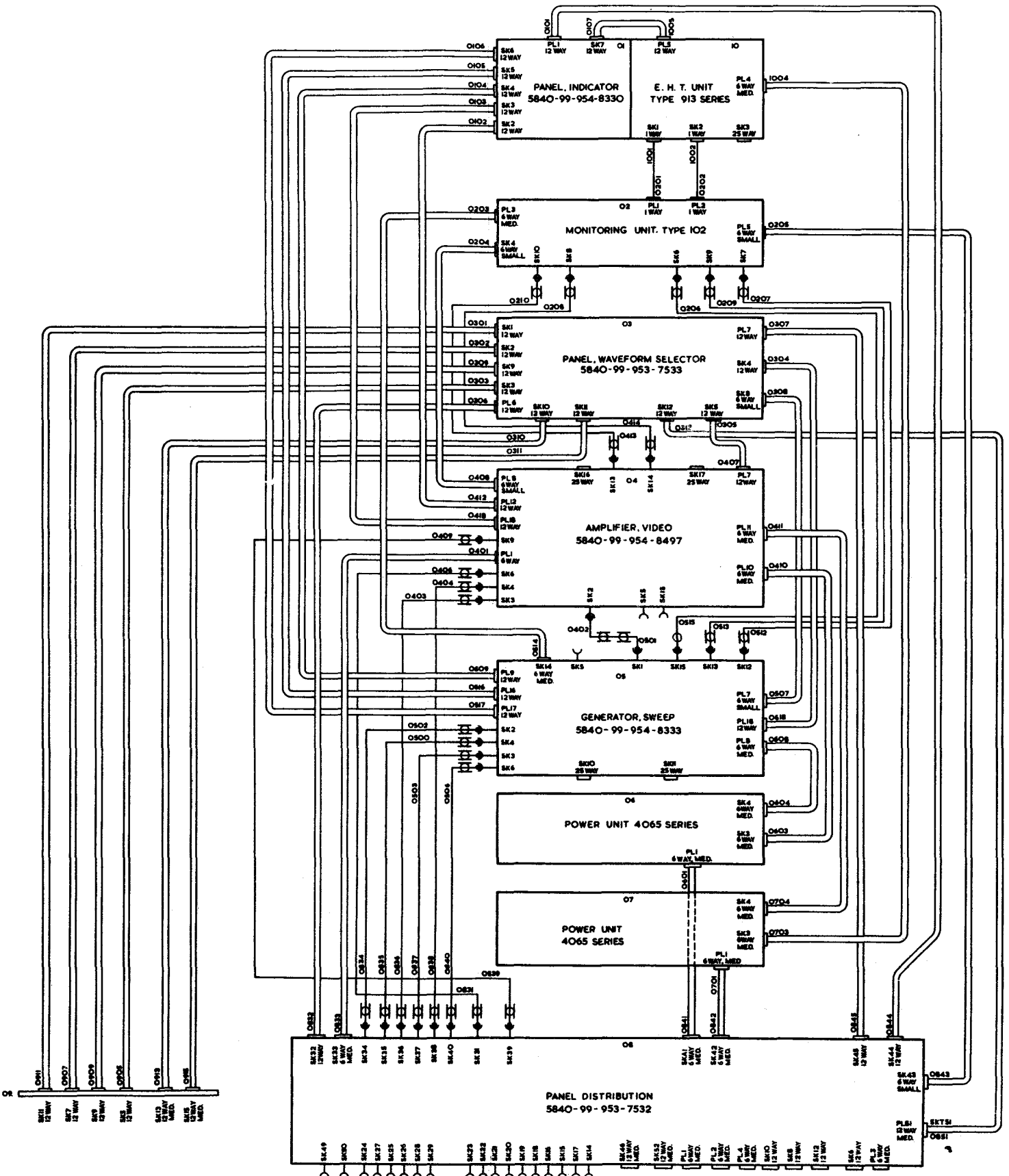


Fig.1 Rack Electrical Equipment 5975-99-954-8362 : cabling diagram.

Fig.1

**Appendix 9**

**PANEL DISTRIBUTION**

**5840-99-953-7532**

**LIST OF CONTENTS**

	<i>Para.</i>
<i>Introduction</i> .. .. .	1
<i>General description</i> .. .. .	2

**LIST OF ILLUSTRATIONS**

	<i>Fig.</i>
<i>Panel distribution—circuit</i> .. .. .	1

**Introduction**

1. At certain stations where the integration of radar Type 85 has been carried out and the rack electrical equipment 5975-99-954-8362 is incorporated, the panel distribution is used.

**General description**

2. The panel is similar in appearance and function to the panel 891 from which it is derived, additional plugs, sockets and wiring being added to facilitate monitoring of a sweep cabinet and an additional resolver rack used with the Type 85 installation. A circuit diagram of the panel is given in fig. 1 which may be studied in conjunction with the associated rack cabling diagram shown in Chapter 1, Appendix 8. All connections to the rack, with

the exception of the six panel mounted sockets, are made via the panel distribution (monitor).

3. The additional services required by the cabinet electrical equipment sweep and the rack resolver are brought to the panel via SK46 and SK52 together with an E.B. sync. source at PL49 and PL50 for use in the sweep generator. Additional connections are also made via the panel-mounted couplers SK13 and SK15 and an additional output socket for the sweep services is provided by PL51. In certain cases the connections between sockets and switches have been rearranged to accommodate additional wiring for the cabinet electrical equipment sweep and the additional rack resolver. The annotated circuit diagram fig. 1 will assist in identifying these connections.

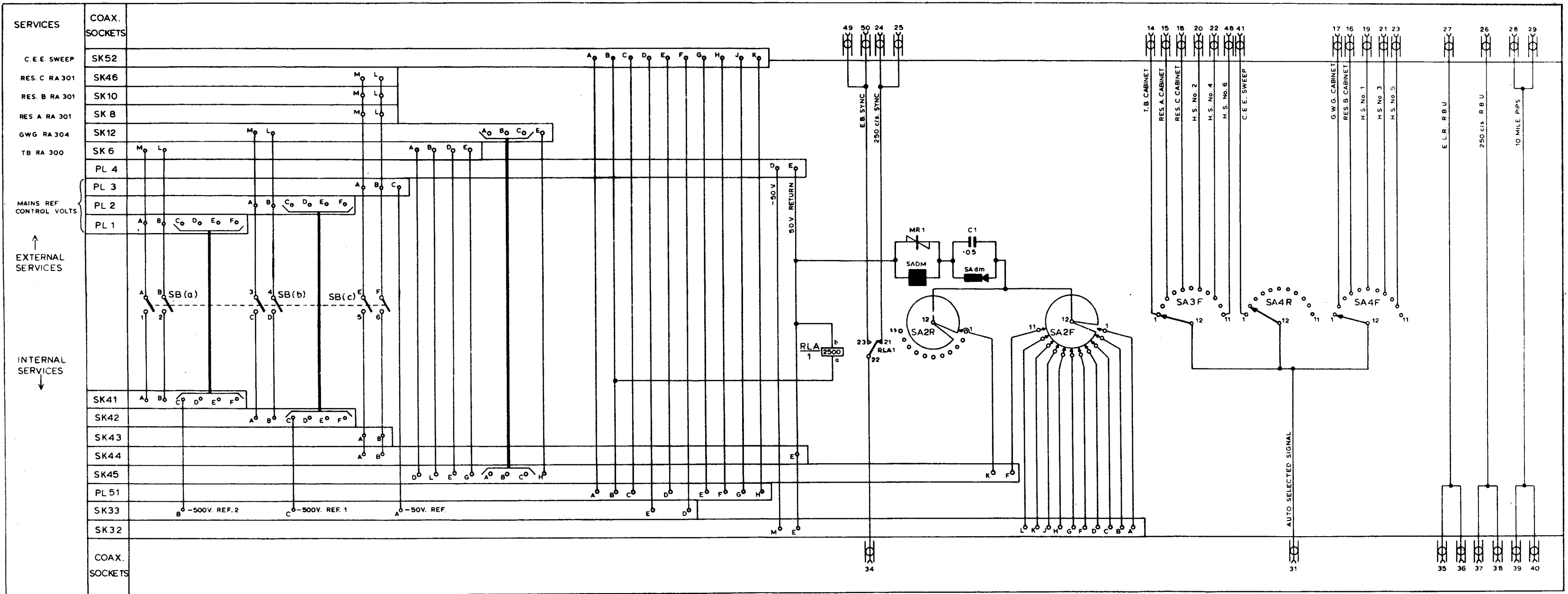


Fig. 1

Panel, distribution 5840-99-953-7532 : circuit

Fig. 1

**Appendix 10**

**PANEL, INDICATOR**

**5840-99-954-8330**

**LIST OF CONTENTS**

	<i>Para.</i>
<i>Introduction</i> .. .. .	1
<i>General description</i> .. .. .	2

**LIST OF ILLUSTRATIONS**

	<i>Fig.</i>
<i>Panel, indicator 5840-99-954-8330—front</i> ..	1
<i>Panel, indicator 5840-99-954-8330—circuit</i> ..	2

**Introduction**

1. The panel, indicator 5840-99-954-8330 indicates the facilities provided by the rack, electrical equipment 5975-99-954-8362 at stations where the integration of radar Type 85 has been carried out.

**General description**

2. The panel is derived from the Type 4064A described in Appendix 2 to this Chapter and from which it differs in having no indicator lamps and in serving to indicate the functions provided by the rack, electrical equipment mentioned above. A view of the front panel is given in fig. 1 and the circuit in fig. 2.

WAVEFORM SELECTION																																																																				
SA	SB	TIME BASE CABINET	SA	SB	TIME BASE CONT'	SA	SB	RESOLVER CABINETS (SEE NOTE BELOW) *	SA	SB	C.E.E. SWEEP																																																									
1	1	ELR 'A'	3	7	NORMAL 'A'	8	1 & 2	CABINET 1	20	1 & 2	GEN. DISPLACED SWEEP																																																									
	2	+VE SAWTOOTH		7	+VE S/T DC. SETTING						8	1 & 2	X & Y SAWTEETH RES. 1	1 & 2	X & Y SAWTEETH (A)																																																					
	3	RES. CLAMP PULSE 2		8	-VE S/T DC. SETTING						9	3 & 4	X & Y SAWTEETH RES. 2	3 & 4	AMP. O.S. TIME BASE																																																					
	4	R.B.U. No.1		9	VELDCITY SETTING						10	5 & 6	X & Y SAWTEETH RES. 3	5 & 6	X & Y SAWTEETH EVEN																																																					
	5	R.B.U. No.2		10	RANGE SETTING						11	7-12	DC SETTING AS ABOVE	7 & 8	X & Y SAWTEETH ALTERNATE																																																					
	6	G.W.G. DRIVE		11	LINEARITY CHECK						12	7-12	LINEARITY CHECKS AS ABOVE	9 & 10	GEN DE-STAGGER																																																					
	7	RES. CLAMP PULSE 1		12	PARAPHASE GAIN						13	1-6	GAIN SETTING AS ABOVE	11 & 12	X & Y SAWTEETH GEN. 1																																																					
	8	NDRMAL 'A'		4	1-5						ELR 'B' AS SA3 SB1-5	10	1-12	CABINET 2	21	1 & 2	1	X & Y SAWTEETH GEN. 2																																																		
	9	+VE SAWTOOTH															7-12	NORMAL 'B' AS SA3 SB7-12	11	1-12	AS SA8 SB1-12	11 & 12	X & Y SAWTEETH GEN. 3																																													
	10	R.B.U. No.1															5	3	1/1T BRIGHT UP No.1	12	1-12	CABINET 3	22	1	2	X & Y SAWTEETH GEN. 4																																										
	11	R.B.U. No.2																							4	1/1T BRIGHT UP No.2	13	1-12	AS SA9 SB1-12	2	GEN. DIS. SWEEP DC. SETTINGS																																					
	12	G.W.G. DRIVE																							5	1/2 BRIGHT UP	14	1	W/F INSPECTION LOW GAIN	3	2	1	3	AMP. O.S.T.B. DC. SETTINGS																																		
1	RES. CLAMP PULSE 1	6	AZ MARK DRIVE			15	2	W/F INSPECTION HIGH GAIN	4	3															1	4							AMP. O.S.T.B. GAIN SETTINGS																																			
2	ELR. 'B' AS ABOVE	7	1/2 BRIGHT UP																							16							3	D.C. SETTINGS	4	4	1	5	GEN. DE-STAG.1 DC. SETTINGS																													
3	NORMAL 'B' AS ABOVE	8	AZ. MARK DRIVE																																			17	4	GAIN SETTINGS	4	5	1	6	GEN. DE-STAG.2 DC. SETTINGS																							
3	1	ELR 'A'	9																																									1/1T BRIGHT UP No.1	18	1	No. 2 AS ABOVE	5	6	1	7	GEN. DE-STAG.2 GAIN SETTINGS																
			2																																									1/1T BRIGHT UP No.2							19	2	No. 3 AS ABOVE	6	2	1	8	GEN. DE-STAG.3 DC. SETTINGS										
			3																																									1/2 BRIGHT UP													20	3	No. 4 AS ABOVE	7	3	1	9	GEN. DE-STAG.3 GAIN SETTINGS				
			4																																									AZ. MARK DRIVE																			21	4	No. 5 AS ABOVE	8	4	1
			5	+VE GATES	22						5	No. 6 AS ABOVE	9	5	1	11																												GEN. DE-STAG.4 DC. SETTINGS																								
6	-VE GATES	23	6	MANUAL OPERATION												10																												6																								
7	+VE GATES																24	7	RESOLVERS	11	7	1																																														
8	-VE GATES																						25	8																																												
9	+VE GATES																										26	9		13	9	1																																				
10	-VE GATES					27	10		14	10															1																																											
11																										28							11		15	11	1																															
12																																						29	12		16	12	1																									

**Fig. 1. Panel, indicator 5840-99-954-8330—front**

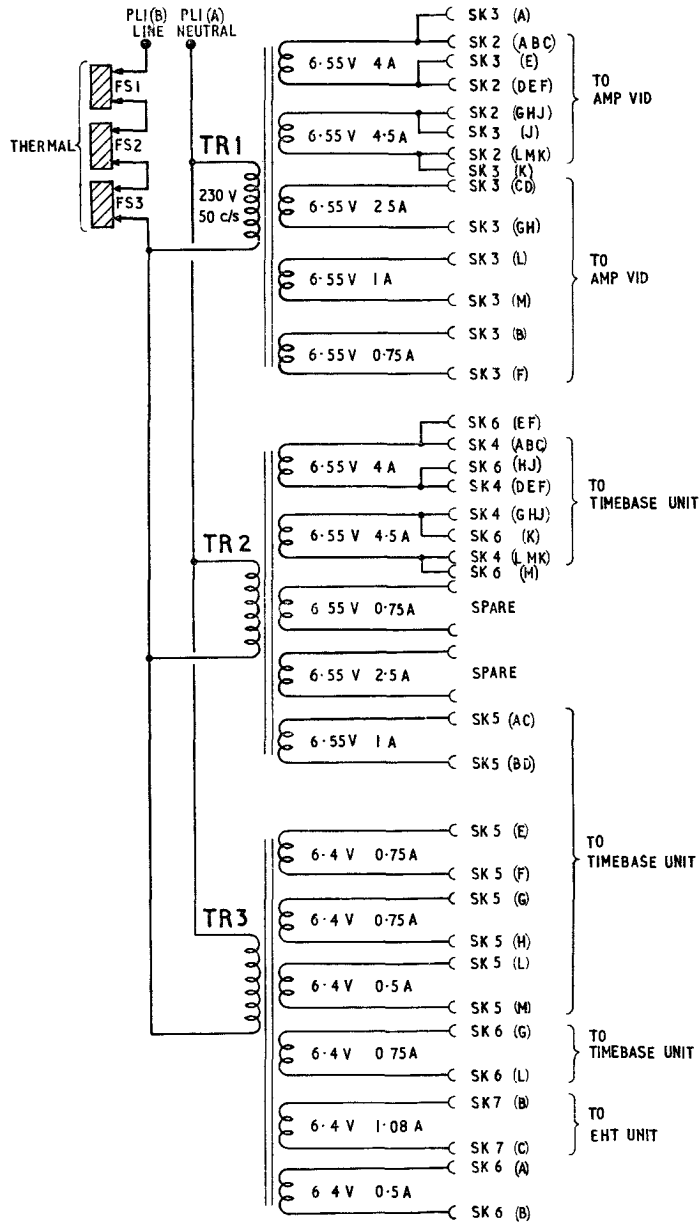


Fig. 2. Panel, indicator 5840-99-954-8330—circuit

### Appendix 11

## PANEL INDICATOR

5840-99-954-8528

1. This panel, used in rack, electrical equipment, 5975-99-956-7666 (App.12) is the Type 4064B (App.5) with different switching information, for switching information, for inspection and setting-up, on the front panel.

WAVEFORM SELECTION																																					
TIMEBASE WAVEFORMS #			TIMEBASE WAVEFORMS #			GATING WAVEFORMS CONT #			C.E.E. SWEEP CONT. #																												
SA	SB	INSPECTION #	SA	SB	SETTING UP #	SA	SB	INSPECTION & SETTING UP #	SA	SB	INSPECTION & SETTING UP #																										
# 1	1	UNIT No 1 - ELR #	# 3	1	UNIT No 1 - ELR #	# 6	1-10	DEKATRON WAVEFORMS	# 15	7 & 8	GENS. DE-STAGGER #																										
	2	+VE SAWTOOTH #		2	T.B. REST LEVEL		11-12	SPARE		9 & 10	X & Y SAWTEETH GEN. 1.																										
	3	40 MILE PIP		3	SPARE		# 7 & 8	1-12		UNIT No 2 #	11 & 12	X & Y SAWTEETH GEN. 2.																									
	4	R.B.U. No. 1		4	T.B. VELOCITY						1 & 2	X & Y SAWTEETH GEN. 3.																									
	5	R.B.U. No. 2		5	T.B. DURATION		# 9 & 10	1-12		UNIT No 3 #	3-12	X & Y SAWTEETH GEN. 4.																									
	6	G.W.G. DRIVE		6	T.B. LINEARITY						1	SPARE																									
	7	RESOLVER CLAMP TRIGGER		7	SPARE		# 11	1 & 2		RESOLVER CABINETS #	2	GEN. DIS SWEEP D.C. SETTINGS																									
	8	UNIT No 2 - NORMAL #		8	+VE S-T REST LEVEL						3 & 4	GEN. DIS SWEEP GAIN SETTINGS																									
	9	+VE SAWTOOTH		9	-VE S-T REST LEVEL						5 & 6	AMP. O.S.T.B. D.C. SETTINGS																									
	10	R.B.U. No 1		10	T.B. VELOCITY						7-12	GEN. DE-STAG 1 D.C. SETTINGS																									
	11	R.B.U. No 2		11	T.B. DURATION						# 12	1-6	CABINET No 1 #	8	GEN. DE-STAG 2 D.C. SETTINGS																						
	12	G.W.G. DRIVE		12	T.B. LINEARITY									9	GEN. DE-STAG 2 GAIN SETTINGS																						
# 2	1-12	RESOLVER CLAMP TRIGGER	# 4	1-12	STANDBY UNITS #	# 13			1-12		# 14	1-12	# 17	10	10	GEN. DE-STAG 3 D.C. SETTINGS																					
															11	GEN. DE-STAG 4 D.C. SETTINGS																					
															12	GEN. DE-STAG 4 GAIN SETTINGS																					
															SEE SA1	# 5	1	GATE 1	# 13	1-12	SEE SA 11	# 14	1-12	# 15	1 & 2	3 & 4	1	WANDERLEADS #									
																											2	No. 1									
																											3	WAVEFORMS - LOW GAIN									
							4	WAVEFORMS - HIGH GAIN																													
							NOTE: SET S.F TO #	APROPRIATE P.R.F.		2																	I-T BRIGHT UP 1	# 14	1-12	SEE SA 12	# 15	1 & 2	# 15	3 & 4	5 & 6	2	REST LEVELS
																																				3	SET AMPLITUDES
																																				4	
																																				5	A.Z.C.1 No 1
																																				6	A.Z.C.1 No 2
7	A.Z.C.2 No 1																																				
8	A.Z.C.2 No 2																																				
9	AZICATION MARKER DRIVE																																				
10	RING																																				
11 & 12	SPARE																																				
# 23	1-12	RESOLVER CLAMP TRIGGER	# 5	1	GATE 2	# 15			1 & 2		# 15	3 & 4	5 & 6	# 18	1	No. 2-4 #																					
															2	SEE SA18																					
							3																														
							4																														
							SEE SA1	# 5		2					I-T BRIGHT UP 2	# 15	1-12	SEE SA 12	# 15	1 & 2	# 15	3 & 4	5 & 6	2	SPARE												
																								3													
																								4													
																								5													
																								6													
																								7													
																								8													
																								9													
10																																					
11 & 12																																					
# 23	1-12	RESOLVER CLAMP TRIGGER	# 5	3	A.Z.C.1 No 1	# 15			1 & 2		# 15	3 & 4	5 & 6	# 22										1	MANUAL OPERATION #												
																								2													
							3																														
							4																														
							5																														
							6																														
							7																														
							8																														
							9																														
							10																														
							11 & 12																														

Fig. 1. Panel indicator 5840-99-954-8528

Appendix 12

RACK ELECTRICAL EQUIPMENT

5975-99-956-7666

(Completely revised)

1 This rack, for certain radar 85 stations, is rack monitor Type 16505 (App.3) with the following units removed:

Panel indicator Type 4064B

Panel (waveform selector) Type 16504

Amplifying unit (video) Type 515C

Timebase unit Type 141B

Panel (distribution) Type 16506

and the following units fitted:

Panel indicator 5840-99-954-8528

App.11

Panel (waveform selector)  
5840-99-954-8905

Chap.4, App.4

Amplifying unit (video)  
5840-99-956-7399

Chap.3, App.5

Generator sweep 5840-99-956-7398

Chap.2, App.4

Panel distribution (monitor) 5840-99-954-8904

App.13

2 Figure 1 overleaf, identifies the internal cableforms.





Appendix 13

PANEL DISTRIBUTION (MONITOR)  
5840-99-954-8904

1 This panel, fitted to rack electrical equipment (5975-99-956-7666: App.12), located at certain Type 85 radar stations, replaces panel distribution Type 16506.

2 The panel is similar to the panel distribution Type 16506, but minor circuit changes, together with the fitting of four additional sockets (SK55 to 59), have been embodied.

3 Figure 1 overleaf is the circuit diagram.

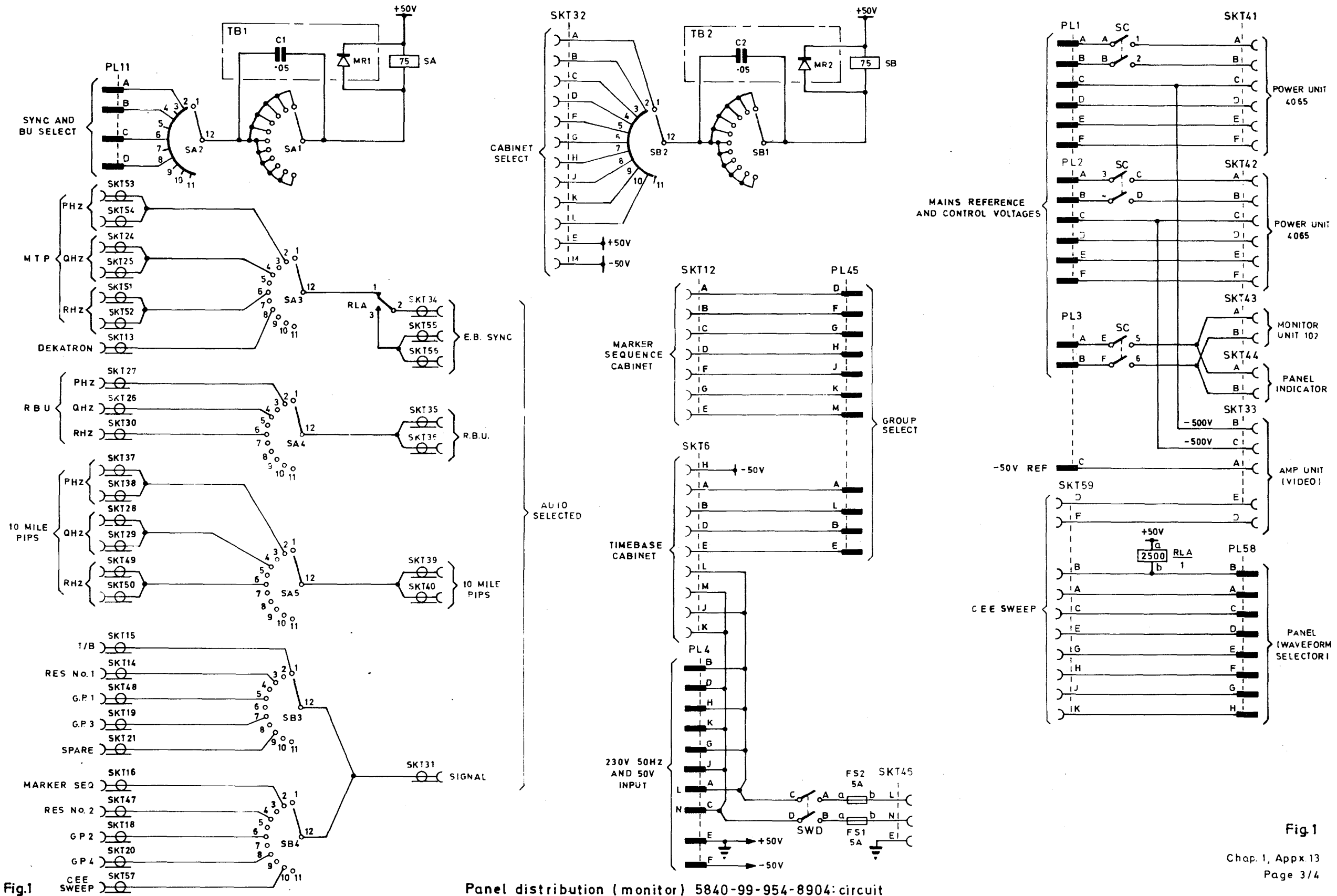


Fig 1

Panel distribution (monitor) 5840-99-954-8904: circuit

Fig.1

## Chapter 2

# TIMEBASE UNIT TYPE 141

### LIST OF CONTENTS

	Para.		Para.
Illustrations	1	Eleventh 10-mile pip selector	38
Function	2	Timebase generator	42
Manual controls	8	Sanatron	43
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### TABLE

Timebase unit Type 141. List of components

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Timebase unit Type 141—front panel	1	TB 141—tagboards shown in fig. 7	8
Timebase unit Type 141—oblique top view from the left	2	Phantastron delay circuit—simplified	9
TB 141—tagboards shown in fig. 2	3	Sanatron time base generator—simplified circuit	10
TB 141—tagboard 7 (see fig. 2)	4	Timebase unit Type 141 trigger and scan waveforms	11
Timebase unit Type 141—view from right	5	TB 141 trigger, bright-up and calibration circuit waveforms	12
TB 141—tagboards shown in fig. 5	6	Timebase unit Type 141—block diagram	13
Timebase unit Type 141—underneath view	7	Timebase unit Type 141—circuit	14

### Illustrations

1. The front panel of this unit is illustrated in fig. 1, oblique top views from the left and right are given in fig. 2 and fig. 5, respectively, while fig. 7 gives an underneath view of the unit.

Further details of the component tagboards, annotated in these illustrations, are given in fig. 3, 4, 6 and 8. Since the photographs are of a prototype timebase unit, slight differences may be apparent between the layout of the tagboard

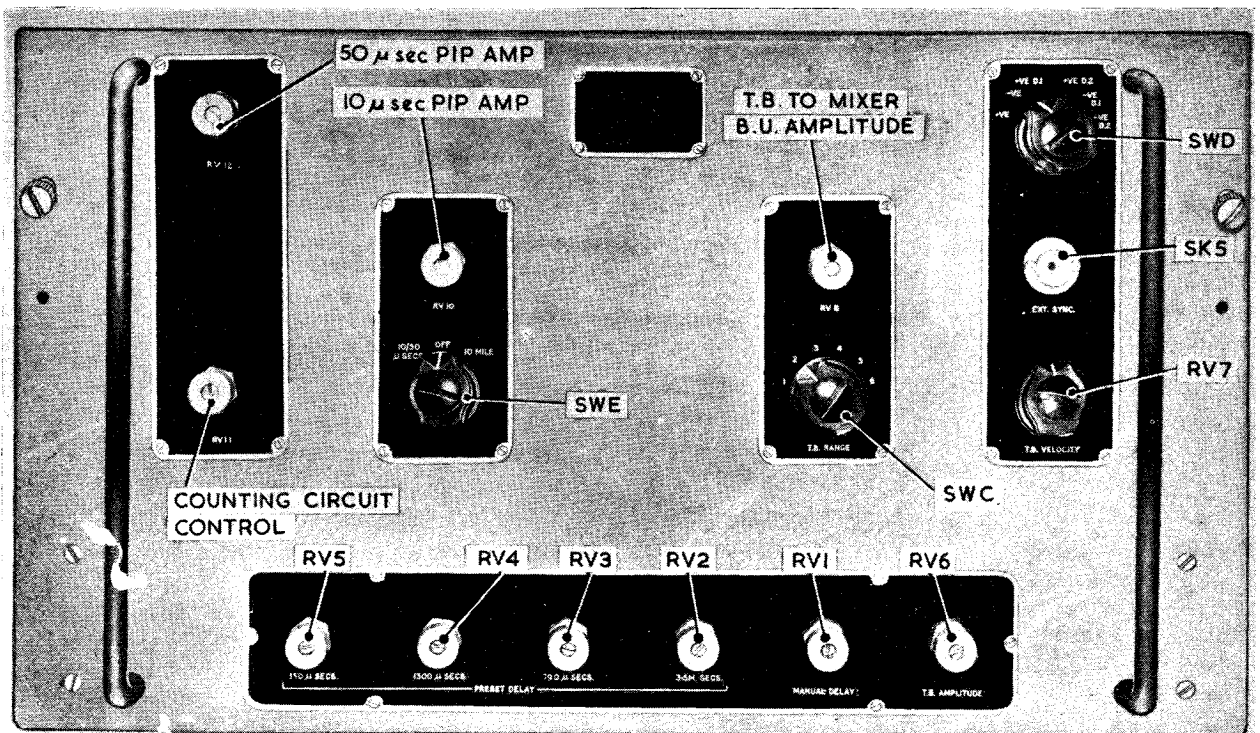


Fig. 1. Timebase unit Type 141—front panel

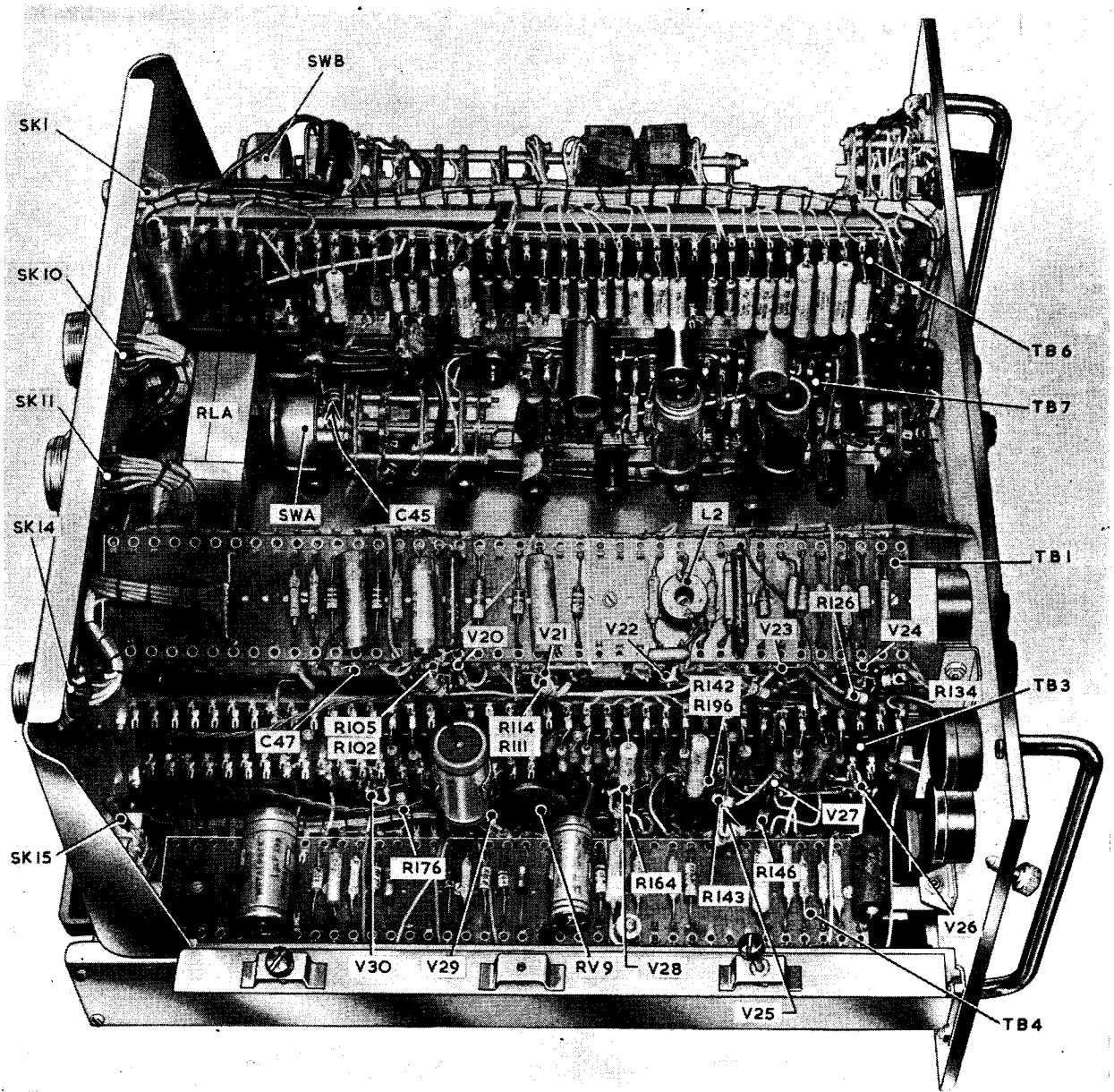


Fig. 2. Timebase unit Type 141—oblique top view from the left

components on the photographs and on the line drawings. In such instances the tagboard drawings are the more accurate. In any case the illustrations are only intended as a guide to the location of components, which may be identified on the actual chassis by the circuit reference numbers, stencilled on or near them, and by checking on the circuit diagram.

**Function**

2. The function of the unit is to provide automatically a timebase which is suitable, both in timing and duration, for the convenient display of waveforms selected from other radar office equipment associated with the fixed-coil display.

3. To achieve this end the unit comprises the following stages:—

- (1) Sync selector and amplifier

- (2) Delay circuit
- (3) Gating circuit for selecting the eleventh 10-mile calibration pip
- (4) Timebase generator
- (5) Calibrator stage

4. The sync selector circuit accepts either the 500 c/s or the 250 c/s bright-up signals from the timebase unit Type 140 in the rack assembly Type 300, or the station 250 c/s master trigger pulse, all supplied via the panel, distribution, Type 891.

5. When in use the delay stage is triggered by the output from the sync selector and it delays either the timebase or the sampler stage of the video amplifying unit Type 515, in the rack. For

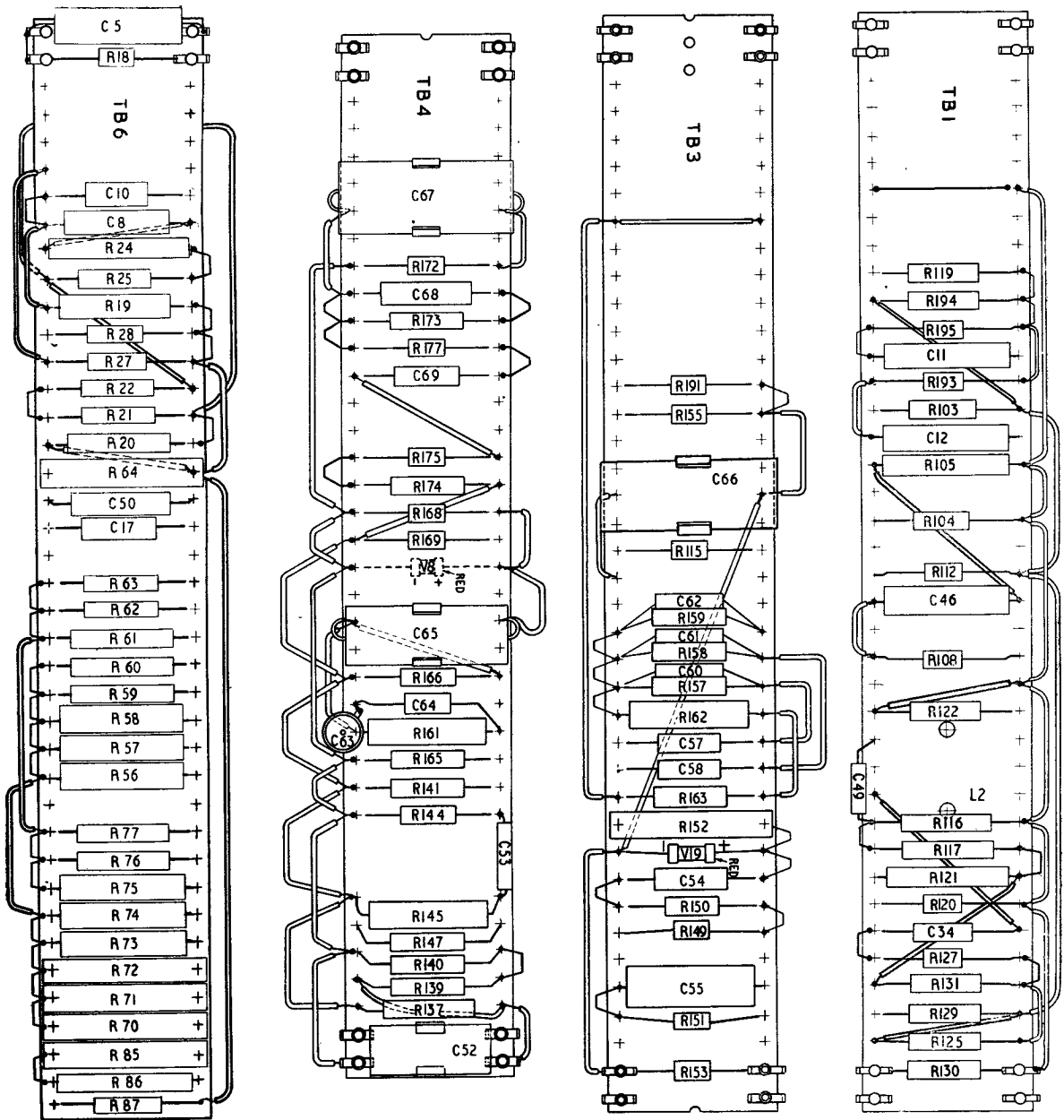


Fig. 3. TB 141—tagboards shown in fig. 2

velocity measurement the eleventh 10-mile pip is selected by a delayed "gate" and used to trigger the sampler.

6. The timebase stage in the Type 141 unit provides push-pull deflection waveforms to the X-plates of the CRT in the monitoring unit Type 102 in the rack, and also triggers the calibrator and bright-up stage to provide either an unmodulated bright-up waveform, or a waveform which combines the bright-up with blackout markers at 10 and 50 microseconds intervals.

7. Interconnection between the circuits, the selection of the required sync input and the con-

nection in the circuits of the components for the required time-constants, are all made through a series of multi-wafer switches. Two of these switches (SWA and SWB) are actuator controlled, for automatic operation, from the waveform selector panel Type 890. Other switches, with front panel controls, are provided, together with a front panel sync input terminal, so that the unit may be released from automatic control and operated manually instead.

**Manual controls**

8. The four, front panel, manual controls and the EXT. SYNC. socket are shown in fig. 1.

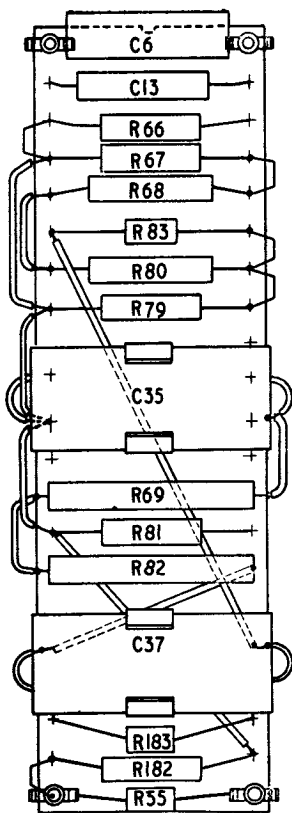


Fig. 4. TB 141—tagboard 7 (see fig. 2)

- (1) Calibration switch (SWE)—left of centre
- (2) T.B. RANGE switch (SWC)—right of centre
- (3) T.B. VELOCITY control (RV7)—lower right
- (4) EXT. SYNC. socket (SK5)—centre right
- (5) External sync selector switch (SWD)—upper right.

9. Also annotated on fig. 1 are the preset potentiometers for determining the delay times and the waveform amplitudes and durations in the various circuits. There are also other preset controls mounted inside the unit. Reference is made to these controls, and to the illustrations which feature them, in those parts of the text dealing with the relevant circuits.

10. As an aid to servicing, test points in the anode or cathode circuits of all the valves are wired to sockets SK10 and SK11 at the rear of the unit. The standard testmeter, multimeter Type 100 (Stores Ref. 10S/16576), is connected across the appropriate metering resistors to give valve current readings, when using the test points.

#### Outline of circuit

11. The full circuit of the timebase unit is given in fig. 14. This is reduced to a block diagram in fig. 13, to illustrate the functions of the various stages, mentioned in para. 3.

12. Referring to the block diagram, it may be observed that the sync amplifier can accept one of four inputs, viz:—

- (1) 250 c/s master trigger pulse via SK2 (SWB positions 4, 5, 8 and 9).
- (2) 500 c/s bright-up via SK4 (SWB positions 7 and 10)
- (3) 250 c/s bright-up via SK3 (SWB positions 6 and 11)
- (4) External sync via SK5 (subject to the operation of SWA and SWD).

13. The output from the sync amplifier V2 is fed, via SWA and SWB (auto) or SWA and SWD (manual), either to a delay stage or direct to the timebase generator. Any one of four delay times may be selected by SWB, on automatic operation, depending upon the waveform under observation. The delay times, which may be adjusted by the preset front panel controls, RV2, RV3, RV4 and RV5, respectively, are:—

- (1) 3.5 M SECS. (SWB position 5)
- (2) 790  $\mu$  SECS. (SWB position 6)
- (3) 1300  $\mu$  SECS. (SWB position 4)
- (4) 350  $\mu$  SECS. (SWB position 7).

14. On manual operation the delay time is adjusted by the preset front panel control RV1 and is applied to the timebase generator via SWD(c). On automatic operation, the delay may be applied to one of three circuits, viz:—

- (1) The timebase generator
- (2) The sampler stage of the video amplifying unit Type 515 (via socket SK1)
- (3) The eleventh 10-mile pip selector stage, which is then used to trigger the video sampler stage.

15. The timebase generator has a range of eight scanning speeds. The capacitors and resistors for the required speed are selected by wafers (h), (j) and (k) of SWB. The timebase waveform is fed to the paraphase amplifier V16-V17 to provide a push-pull output of the required sweep amplitude. The output waveforms are DC restored to the X-shift potentials to maintain the focus and to ensure that the trace starts from the same point on the CRT screen for all ranges. The timebase voltages are fed to the CRT in the monitor unit Type 102 via SK12 and SK13.

16. Calibration markers are displayed on the CRT trace, when required, at 10  $\mu$  sec. intervals, with more prominent markers at 50  $\mu$  sec. intervals. These signals are produced in the calibrator circuit, consisting basically of a 100 kc/s oscillator, pulsed by the timebase bright-up waveform and feeding a shaping circuit. The 10  $\mu$  sec. pips which are produced, are fed to a 50  $\mu$  sec. counting circuit, producing one wider pulse for every five 10  $\mu$  sec. markers. These calibration pips are combined with the timebase bright-up waveform in a mixer stage and the resultant waveform is applied to a cathode follower feeding a bright-up signal to the grid of the CRT in the monitor via SK15 (timebase unit) and SK6 (monitor unit).

**17.** The power supplies for the valve heaters in the timebase unit are derived from the transformers in the panel (indicating) Type 4064, via plugs PL9, PL16 and PL17, some connections on PL9 and PL17 being in parallel to carry the load. The HT power supplies, viz:— +400V, +300V, earth and -300V lines, originate in the upper power unit Type 4065 (06) in the rack and reach the timebase unit via plug PL8.

### CIRCUIT IN DETAIL

**18.** It is not practicable to describe the switch functions in detail at this point since the sequence originates in the waveform selector panel Type 890, yet to be described. Some information on switching is called for, however, so that the block diagram (*fig.* 13) may be studied and fully understood. Reference may also be made to the full circuit (*fig.* 14).

#### Function of main controls

**19.** The main switch functions are given in tables on the circuit diagram. Switches A and B are multi-wafer types, actuator-operated from the waveform selector panel. SWA is the auto-manual changeover switch and SWB the sequence switch. Reference to *fig.* 14 will show the connections to the waveform selector panel (via PL7 and PL18 on the timebase unit) by which the actuating potentials reach the actuator coils. These potentials also operate the relay RLA (with five sets of contacts) to the manual or auto position.

**20.** The block diagram illustrates the function of SWA on changing from auto to manual. SWA(b) changes the sync input connection from the internal 500 c/s or 250 c/s bright-up, or the 250 c/s station master trigger pulse, to the EXT.SYNC. socket. SWA(c) applies the sync pulse either directly or via a manually controlled delay circuit to the timebase generator, subject to the operation of the manual switch D and the relay (RLA3).

**21.** SWD is the switch in the top right-hand corner of the front panel. It is only operative in the manual position of SWA. Wafers SWD(a) and SWD(b) provide a means of routing the synchronizing input from SK5 (EXT.SYNC.) to V1b or V1a, so that a positive or a negative input may be used to produce, at V2 anode, the negative-going pulse required to trigger the timebase generator or the delay circuit, which in turn triggers the timebase. SWD(c) controls the application of the trigger pulse from V2 to either the timebase or the delay circuit.

**22.** The delay time may be adjusted by operation of the preset front panel control MANUAL DELAY (RV1) which is brought into the circuit by operation of RLA1. Two ranges of delay time are provided by SWD(d), when it is connected in the circuit by RLA2. The initial range is determined by the coupling capacitor C8 (560pF) between V4 and V5. Range 2 is provided by connecting C10 (0.002 $\mu$ F) in parallel with C8.

**23.** SWB, the second actuator operated switch, determines the sequence of operations when the unit is under automatic control. SWB(b) and SWB(c) select the appropriate trigger pulse from SK2 (250 c/s master trigger pulse), SK3 (250 c/s BU), or SK4 (500 c/s BU). These pulses are all positive-going, but the BU waveforms are differentiated by C1-R1 and applied to V1a, which uses the trailing edge for triggering, whereas the MTP pulse is applied to V1b. All inputs produce a negative trigger pulse at the anode of V2, where SWB(d) and SWB(e) route the pulse either to the timebase or the delay circuit or both. SWB(f) takes over from the manual SWD(d) in connecting C8, or C8 plus C10, between V4 and V5 to provide the basic delay ranges, while SWB(g) connects the four preset front-panel delay-controls (RV2 to RV5) in circuit, as appropriate.

**24.** SWB(g) also accepts the waveform from the eleventh 10-mile pip selector stage (V9) or the delay output from V5 via RLA3 and supplies the selected trigger pulse to the video sampler stage via SK1.

**25.** The timebase speeds are selected automatically by SWB, wafers (h), (j) and (k). For manual operation, SWB is brought under the control of the front panel TIMEBASE RANGE switch, SWC(a), by operation of RLA5, so that the same circuitry, in the timebase generator, may be used for manual as for automatic control. Operation of switch C supplies current to the actuator of switch B, SWB connections that are not required for manual operation (on wafers (f) and (g)) being open-circuited by RLA1, RLA2 and RLA3, while RLA4 connects the front panel, manual T.B. VELOCITY control in the timebase generator circuit.

**26.** The calibration circuit is manually controlled for all operations of the waveform monitor, insofar as the front panel control SWE allows it to be switched OFF, or to the 10/50  $\mu$  SEC. or 10-MILE positions as required. It is, however, triggered automatically by the time base generator so that the calibration pulses are locked to the CRT trace.

#### Sync amplifier

**27.** This amplifier will accept either positive- or negative-going pulses, but includes a phase discriminating stage (V1) to produce the required negative-going sync pulses at the anode of V2 (*fig.* 11). V1 is a double triode, both halves of which are conducting in the no-signal state, since their cathodes are returned to the negative 300V line, while their control grids are returned to earth. The current through V1a is, however, approximately 6mA (47K cathode bias resistor R8), while that through V1b is approximately 2 mA (120K cathode resistor R4). V1b therefore responds better to positive inputs and V1a to negative inputs. In the no-signal state the sync output valve V2 is biased to cut-off by the control grid connection to a negative potential, the cathode being returned to earth.



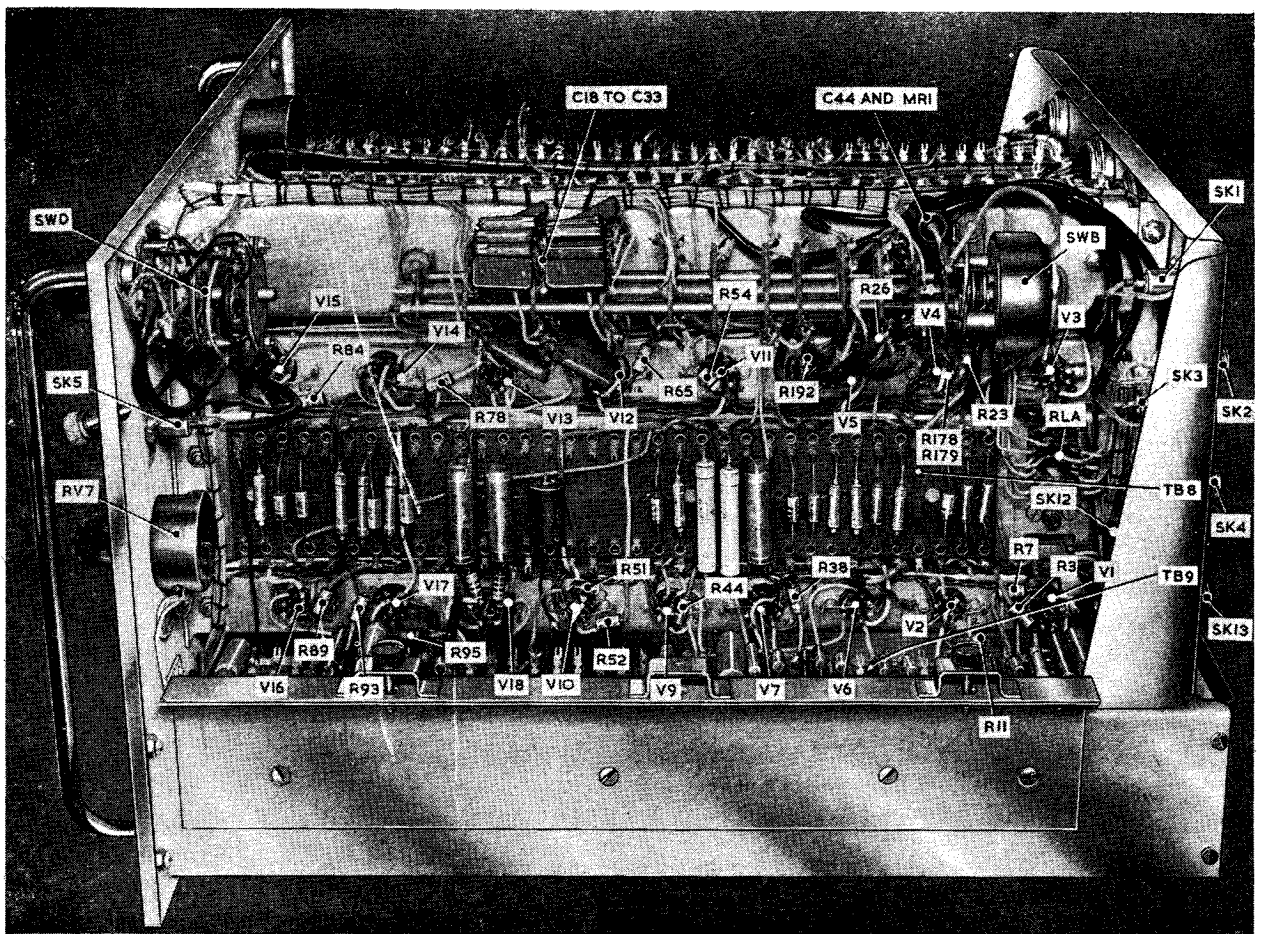


Fig. 5. Timebase unit Type 141—view from right

28. If the input from SK5 (EXT. SYNC.) be considered first (with SWA operated to *manual*—position 2), it will be observed that a positive input is applied to the control grid of V1b on SWD positions 1, 3 and 4, via SWD(a), SWA(b) and C4-R9, differentiation being immaterial in this instance. Meanwhile the input to V1a is earthed via SWA(b) and SWD(b).

29. The positive pulse at the grid of V1b causes the cathode potential of this valve to rise. This potential is applied to the cathode of V1a, via C2, and causes a reduction in the anode current of V1a, so producing a positive-going pulse at the anode. This pulse is applied to V2, where it turns on anode current and gives a negative-going voltage pulse at the anode for application to the appropriate circuitry via SWA(c).

30. With SWD in positions 2, 5 and 6, for a negative input from SK5, the sync pulse is applied to the control grid of V1a via SWD(a), SWA(b) and C1-R1, the input circuit of V1b being earthed via SWA(b) and SWD(b). But for the presence of C2 in the cathode circuit, V1a would act as a cathode follower, most of the output voltage being developed across R8 (47K) and very little across the anode load R2 (6.8K). C2, however,

connects the low output impedance of the cathode follower V1b in parallel with R8, so that degeneration in the cathode circuit is not severe and an appreciable positive-going output voltage is developed across the anode load for application to V2 to produce the negative sync pulse as before.

31. For automatic operation (SWA position 1—*auto*), the master trigger pulse on SK2 is applied to V1b on positions 4, 5, 8 and 9 of SWB, to produce the negative sync pulse as described in para. 29, the input to V1a being earthed. On SWB positions 6 and 11, the 250 c/s BU pulse from the timebase unit Type 140 is applied to V1a; on SWB positions 7 and 10, the 500 c/s BU pulse is applied to V1a, the input circuit of V1b being earthed in both cases. In each instance, the positive-going, rectangular bright-up waveform is differentiated by C1 and R1, so that the leading edge takes the form of a positive pulse and the trailing edge a negative pulse. The positive pulse produces a negative output from V1a having no effect on V2, which is already cut off, but the negative pulse cuts off V1a and gives a positive pulse of voltage across the anode load, to produce the required negative sync pulse at the anode of V2.



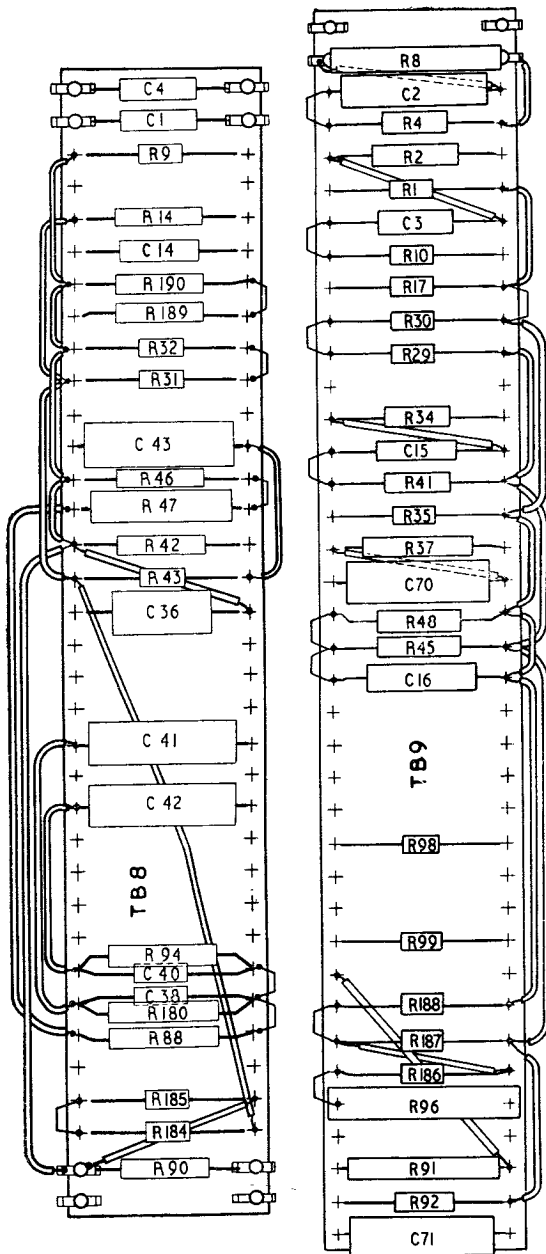


Fig. 6. TB 141—tagboards shown in fig. 5

#### Sync delay phantastron

**32.** For some applications of the waveform monitor, a delay is required, after the arrival of the sync waveform, before the trigger pulse is applied to the associated circuits. This delay is determined by a phantastron circuit, which can provide four delay intervals on automatic operation, viz.: 350  $\mu$  SECS., 790  $\mu$  SECS., 1300  $\mu$  SECS. and 3.5 M SECS., preset by adjustment of the front panel potentiometers RV2 to RV5. For manual operation the delay is adjustable by the preset front panel control RV1. The valves concerned are V3a, V3b, V4 and V5. V5 is the Miller valve, V4 a cathode follower for speeding-up the recharge time of the Miller

condensers, V3a a catching and trigger diode to determine the initial potential of V5 anode and also to trigger the phantastron, while V3b is a similar diode to determine the initial potential at the control grid of V5. A simplified version of the circuit is given in fig. 9, with approximate waveforms indicated.

**33.** Before the arrival of the negative trigger pulse from V2, the conditions existing in the circuit are as follows:—

(1) Anode current in V5 is cut off, due to the suppressor grid being negative to the cathode. The valve Type CV2209 is chosen for this position because of its short suppressor grid base (i.e., it is cut-off with a negative bias of about 10V). The anode is caught at the potential (approx.) of V3a cathode, due to the flow of the anode current of this diode through V5 anode load (R27). This potential is determined by the setting of whichever delay potentiometer is in use.

(2) V5 is passing heavy screen current (6-8 mA) equal to cathode current and there is accordingly a large voltage drop across the screen load (R28-15K).

(3) V3b is passing current because of its anode connection to the positive HT line via R19 (2.2M) and the control grid of V5 (connected to V3b anode) is therefore caught at the potential (approx.) of V3b cathode, connected to the junction of R20 and R21 in the potential divider R20, R21 and R22. Since the suppressor grid of V5 is connected to a less positive point, at the junction of R21 and R22, it is apparent that the cathode potential of V5 (dependent on that of the control grid) is positive to that of the suppressor grid (see sub-para. (1)).

(4) The cathode current of V4 is determined by the cathode load R24 (100K) and the control grid connection to V5 anode.

**34.** With SWB (auto) or SWD (manual) in a position providing delay, the negative pulse (approx. 50V) from V2 is applied to the cathode of V3a, via SWA(c), SWB(d) or SWD(c), and C5. SWB(g) connects V3a cathode to RV4, RV2, RV3 or RV5, respectively, on switch positions 4 (1300  $\mu$  secs.), 5 (3.5 m sec.), 6 (790  $\mu$  sec.) and 7 (350  $\mu$  sec.), while SWB(f) connects C10 (0.002  $\mu$  F) in parallel with C8 (560 pF), via RLA2, between V4 cathode and V5 control grid, on switch positions 4 and 5. With SWA in the manual position, SWD(c) applies the V2 trigger pulse to the delay circuit on positions 3 to 6, two degrees of delay, both preset by RV1, being available. For the longer delay (positions 4 and 6) C10 is connected in circuit by SWD(d) and RLA2.

**35.** The negative pulse causes V3a to draw current through R27 and the pulse is transmitted to the control grid of the cathode follower V4, which relays the pulse to V5 control grid via the

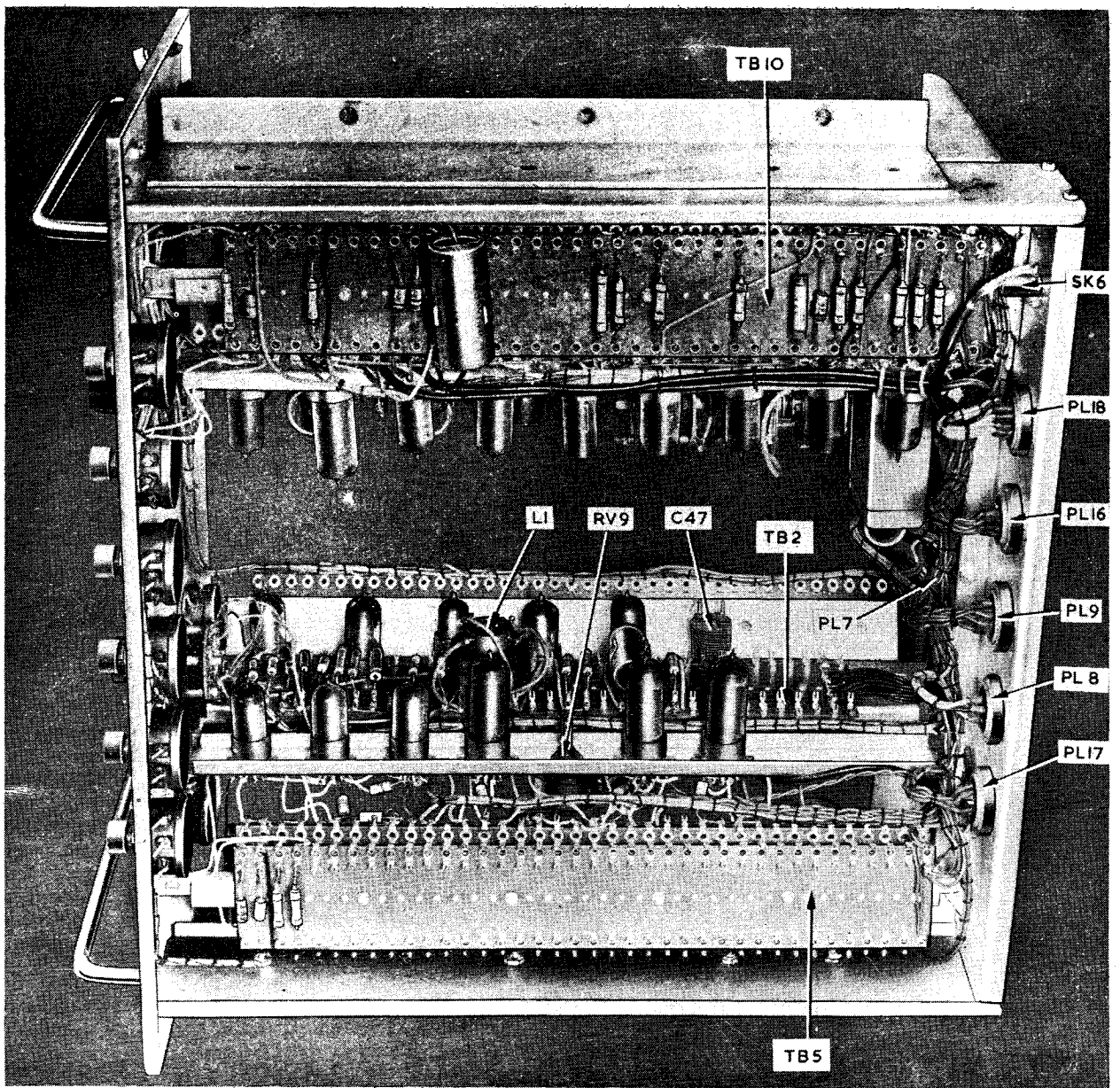


Fig. 7. Timebase unit Type I41—underneath view

feedback condenser C8 (plus C10, when applicable). The diode V3b is cut off and V5 cathode potential is driven negative so that anode current is permitted to flow in V5. Because of current through V4, the feedback condenser is virtually connected between the anode and control grid of V5 (via V4), and the initial drop of anode and grid volts is limited by the feedback action as in a Miller timebase. The voltage drop is, however, greater than in the normal Miller circuit, due to the cathode resistance (R189) degenerating the gain of the Miller valve (V5). The anode run-down then follows, as in the Miller timebase (*A.P.1093E, Chap. 10, Sect. 11*), until the anode voltage "bottoms". The time taken for the run-down to take place depends on the capacitance of the Miller condenser and the initial charge on it, which is determined by the setting of the appropriate delay potentiometer.

36. When the anode of V5 bottoms, the control grid, no longer restricted by Miller feedback, rises towards the  $-300V$  line at the normal time constant of the coupling condenser and grid leak. The cathode follows and biases the suppressor grid so that V5 anode current is cut-off. The initial condition of the control grid being caught by V3b is re-established. Meanwhile, with anode current through V5 cut-off, the anode potential of V5 reverts to its stable value in a time dependent on the time constant of R27 and the stray capacitances of the anode circuit. This rapid return to the stable condition is relayed to V4 control grid and the cathode circuit of this valve follows so that the Miller capacitor is recharged far more rapidly than it would be if it were connected directly to V5 anode.

37. During the period when anode current flows

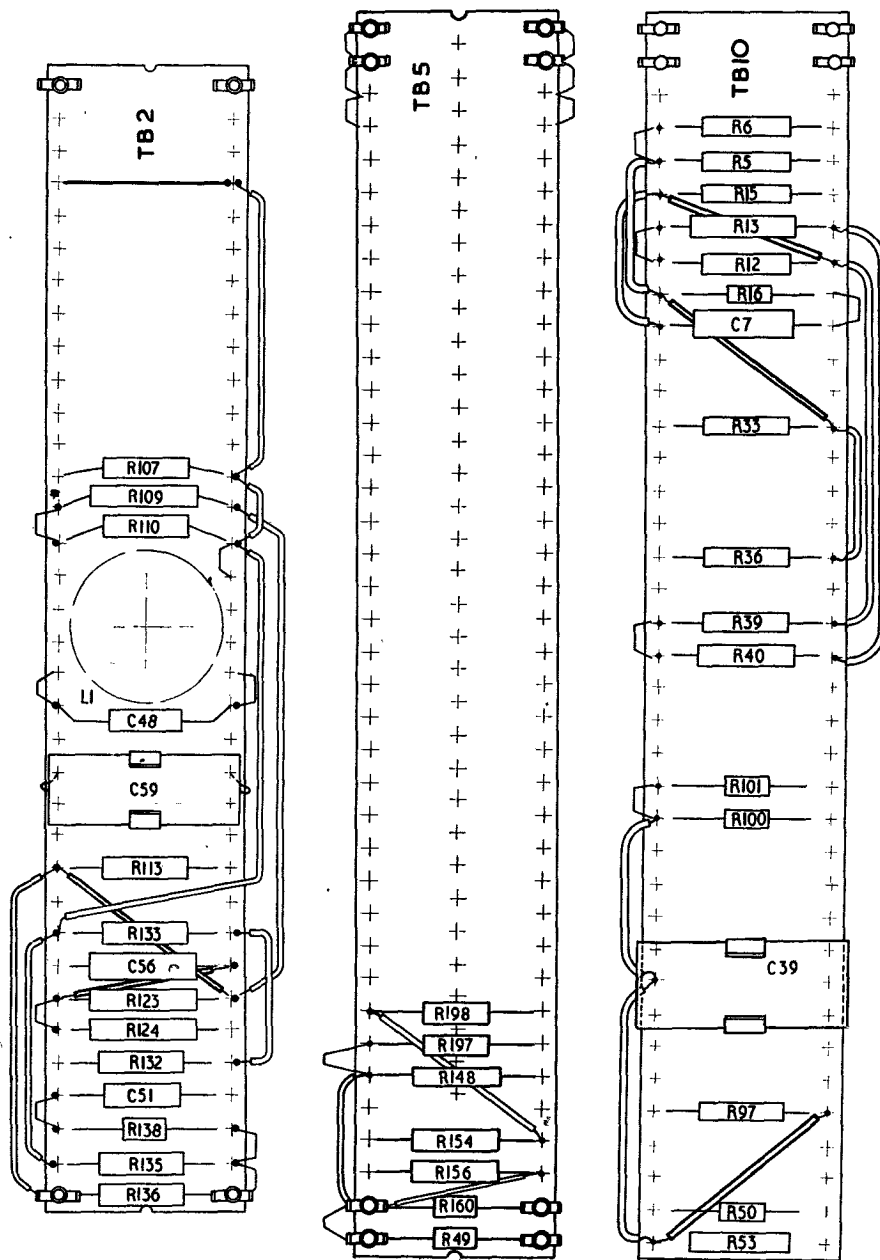


Fig. 8. TB 141—tagboards shown in fig. 7

through V5, the screen grid current of this valve is sharply reduced, producing a positive square wave output across R28. The duration of this waveform (and therefore the delay time, since the trailing edge is used for triggering subsequent stages) are dependent upon the setting of the delay potentiometer in use and the capacitance in circuit. Fig. 12(b) shows the waveform (duration T, amplitude A) related to the delayed bright-up. For manual operation the square wave is fed to the timebase generator via RLA3, C6, SWD(c) and C17. For automatic operation the route is via RLA3, SWB(g), SWB(e) and C17. In automatic use the waveform may also be applied to the eleventh 10-mile pip selector

circuit, via SWB(g) and C14, or to SK1 (sampler trigger) via SWB(g) and C50 (see SWB OPERATION TABLE in fig. 14).

**Eleventh 10-mile pip selector**

**38.** This circuit consists of V6a, V6b, V7a, V7b and V9. Valves V6a and V6b are trigger and limiter diodes, respectively, while V7a and V7b make up a flip-flop for switching V9, which amplifies the 10-mile pips, fed in from socket SK6.

**39.** In the no-signal state, V9 is cut-off, both control and suppressor grids being biased from the negative HT line; V6b is cut-off on account of negative bias on the anode; V6a and V7b are

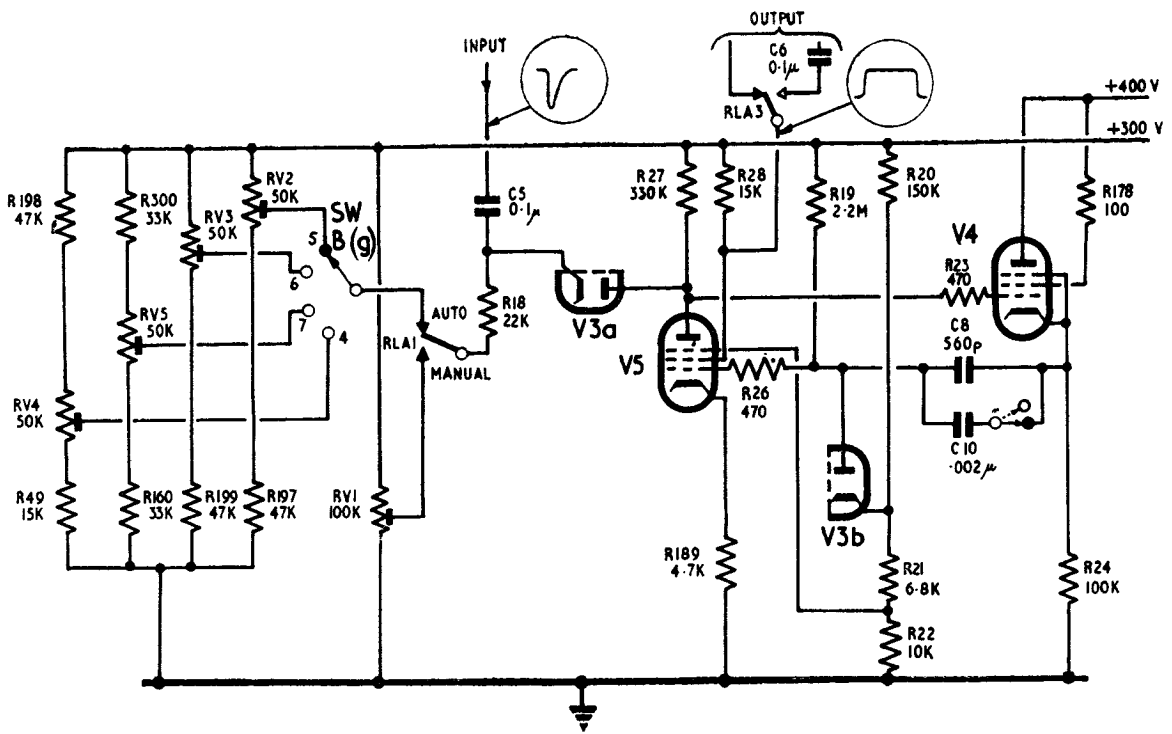


Fig. 9. Phantastron delay circuit—simplified

passing current (connection to positive HT line via R41) and V7a is cut-off by the bias developed across the common cathode load by V7b current.

**40.** On SWB position 4 (delay potentiometer RV4 in circuit) the positive-going square wave from V5 is applied to the timebase generator via SWB, wafers (g) and (e) and to V6a cathode via SWB(g) and C14. The waveform is differentiated by C14-R30, so that the leading edge is applied to V6a as a positive pulse, which has no effect on the circuit. The trailing edge produces a negative pulse at the cathode of V6a and the increased diode current gives a voltage drop across R41, applied as a negative pulse to the control grid of V7b. The fall in anode current through this valve reduces the bias across R35 and turns on the anode current of V7a. The voltage drop across the anode load of this valve is applied to V7b via C15 and the circuit "flips" into its unstable state, with V6a and V7b cut-off and V7a passing current. ◀It remains in this state for a time depending upon the time constant of C15 and R41, and then "flops" back into its stable state, until the arrival of the next trigger pulse. ▶

**41.** The resultant positive-going square wave at the anode of V7b is applied to the suppressor grid of V9 via C70. The amplitude of the waveform is sufficient to bring V9 suppressor grid near to earth potential (V6b prevents it from being driven positive), while the duration of the waveform is between 80 and 160  $\mu$  sec. V9 is thus able to respond to the positive-going input to its control grid for the duration of the gating waveform. RV4 is adjusted so that the gating pulse

embraces the eleventh, and only the eleventh, in each succession of 10-mile pips. This pip therefore produces anode current in V9 and the negative pulse at the anode is applied to the sampler trigger (SK1), via C43, SWB(g) and C50. Fig. 12(o) shows the 10-mile pips as displayed on the Y1 trace of a CRO, together with the gating waveform shown on Y2 trace. Fig. 12(p) shows the output to SK1 with the residual unwanted pips and the selected pip on a small pedestal.

#### Timebase generator

**42.** A simplified version of the timebase circuit is given in fig. 10, with approximate static voltages in brackets and approximate waveforms indicated. This circuit is required to produce a sawtooth output with a velocity and amplitude to suit the waveform under observation. The preset front panel control labelled T.B. AMPLITUDE (RV6) is in circuit on both manual and automatic modes of operation, while the manual control labelled T.B. VELOCITY (RV7) is only in circuit for the manual positions (1 to 3) of SWB.

#### Sanatron

**43.** The valves in the timebase circuit are V10 to V15. Of these V12 and V14 constitute a sanatron type of circuit, using the Miller principle to produce a sawtooth waveform (*A.P.1093E, Chap. 10, Sect. 10*). The selected Miller feedback condenser (C18 to C25), from V12 anode to control grid, and the associated charging resistor (R56 to R63) are connected in circuit for the various timebase speeds by SWB, wafers (j) and (h), respectively. At the same time SWB(k) connects a suitable coupling capacitor and charging resistor to the control grid of V14. This valve controls

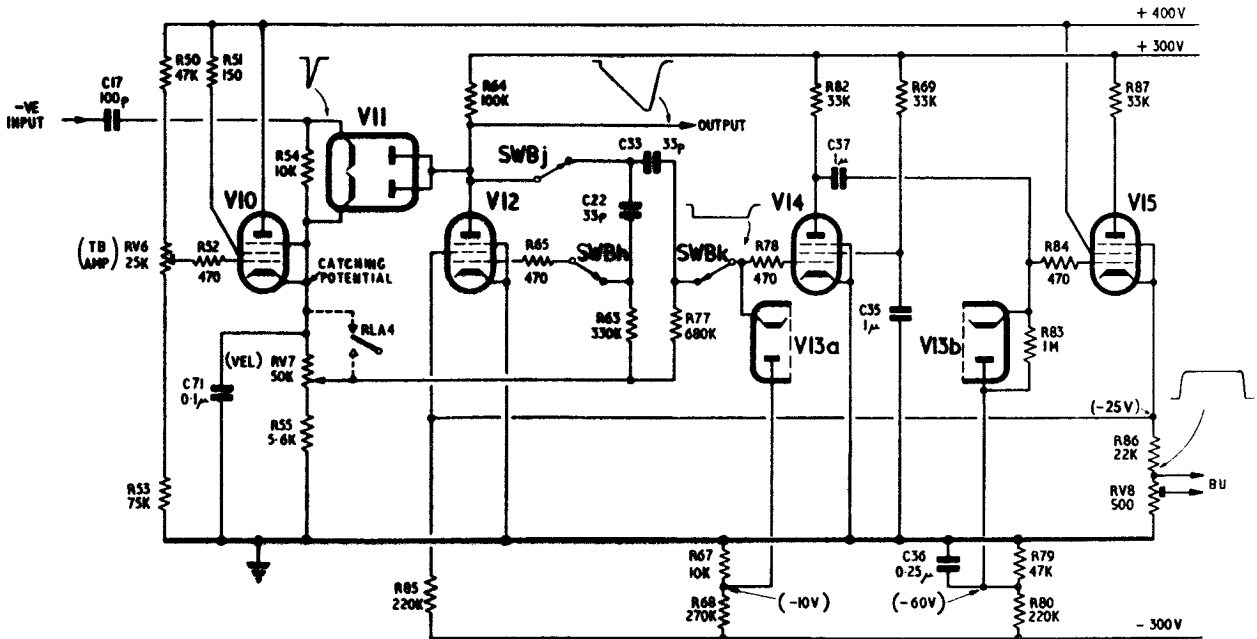


Fig. 10. Sanatron timebase generator — simplified circuit

the Miller valve (V12) through the cathode follower V15, which also provides bright-up outputs to the calibration circuits of the timebase unit. V10 is a cathode follower associated with the T.B. AMPLITUDE and VELOCITY controls and provides a low input impedance for the catching potential applied to the trigger and catching diode V11. V13a is a limiter and V13b a DC restorer for clamping the waveform to predetermined reference levels.

44. In the no-signal state the following conditions exist in the circuit :—

(1) The cathode potential of V10 depends on the setting of the preset front panel control T.B. AMPLITUDE (RV6).

(2) Owing to current through the catching diode V11 and R64 this potential determines the initial voltage at the anode of V12 and is also applied to the grid leaks of V12 and V14. For automatic operation the potential applied to the grid leaks is fixed at the value determined by RV6, but for manual operation it is variable by the front panel control T.B. VELOCITY (RV7).

(3) The control grids of V12 and V14 are held at a potential near to earth, due to grid current, so that the initial charges on the condensers between V12 anode and control grid (e.g. C22 in fig. 10) and between V12 anode and V14 control grid (e.g. C33) depend on the setting of RV6.

(4) V12 anode current is cut-off because the screen grid is biased from the negative HT line via R85 (the connection to V15 cathode providing no drive in the static condition).

(5) V14 is conducting heavily because of the control grid return to a positive potential.

(6) V15 is cut-off, with both the control grid and the cathode negative to earth.

45. With SWD in position 1 or 2 (manual), or SWB in positions 6 to 11 (auto), no delay is introduced and the negative trigger pulse from V2 (approx. 50V amplitude) is applied to the cathode of the upper diode in fig. 10 and 14, via C17 (100pF). In switch positions which introduce a delay before the start of the timebase (SWD 3 to 6 and SWB 4 and 5) the input is the positive-going square wave from V5 screen grid (via RLA3, C6 and SWD(c) on manual and via RLA3, SWB(g) and SWB(e) on automatic). This waveform is differentiated by C17 and R54. Since V11 only responds to negative inputs, it is triggered by the leading edge of the "no delay" waveform and by the trailing edge of the "delay" waveform.

46. The pulse of current through V11 produces a voltage drop across R64 which triggers the sanatron circuit. The negative pulse is applied to the control grid of V14 (e.g. via C33), where it is limited to 10V (approx.) by the bias on V13a (junction of R67 and R68). The positive-going voltage (200V) at the anode of V14 is applied via C37 to the control grid of V15, where it turns on anode current and produces a positive-going voltage across the cathode load (R86 and RV8). This voltage is fed back to the screen grid of V12, so permitting anode current to flow in this valve and establishing the initial sharp voltage drop across R64 commenced by current through V11. The amplitude of this initial voltage step is determined by feedback from V12 anode to control grid (via C22 in fig. 10). The anode rundown follows as the condenser discharges through the valve. The amplitude of the rundown is determined by the initial potential across the condenser,

adjusted by RV6, while the duration depends on the capacitance of the condenser and on the constant current in the associated resistor (e.g., SWB position 1, C22 and R63 give a duration of  $10 \mu \text{ sec.}$ ). On manual applications RV7 acts as a velocity control by varying the potential across the grid leak and so controlling the discharging current of the condenser.

47. Once the run-down at the anode of V12 has commenced, the trigger diode V11 is cut off, because its anode is driven negative to its cathode and the circuit is isolated from the triggering circuit until the timebase waveform cycle has been completed.

48. While V12 is conducting, the grid of V14 is held at minus 10V by V13a. The anode of V14 therefore remains positive, the feed to V15 is DC restored by V13b and the steady positive potential at V15 cathode is applied to V12 screen to maintain anode current through this valve.

49. As soon as the run-down at V12 anode "bottoms", the control grids of V12 and V14 commence to rise towards the potential to which the grid leaks are returned. The rise at V14 grid depends on the time constant of C33 and R77 (fig. 10) and since the negative potential was limited to 10V this grid reaches cathode potential comparatively rapidly. V14 then passes anode current, causing a negative swing at the anode which is relayed by V15 to V12 screen grid, so cutting off anode current in V12. The anode returns exponentially to the catching potential and both V12 and V14 grids rise to take grid current. The square wave at the anode of V14, DC restored by V13b and relayed to V12 screen by the cathode follower V15, ensures the cut-off of V12 when negative and ensures adequate conduction by V12 when positive. The waveform at the cathode of V15 is also applied to the bright-up and calibration circuits to provide BU pulses to the CRT grid in phase with the timebase waveform.

#### Timebase output

50. The negative-going sawtooth waveform at the anode of V12 is applied to the monitor CRT deflector plate X1 via socket SK12. A DC restorer V18a follows the coupling condenser C41 to ensure that the scanning potential remains negative to the X-shift voltage, fed to SK14/B from the monitoring unit Type 102. The negative waveform is also applied to the "see-saw" paraphase amplifier V16 and V17 to produce the positive-going waveform for application to X2 via SK13, V18b being the DC restorer for this waveform.

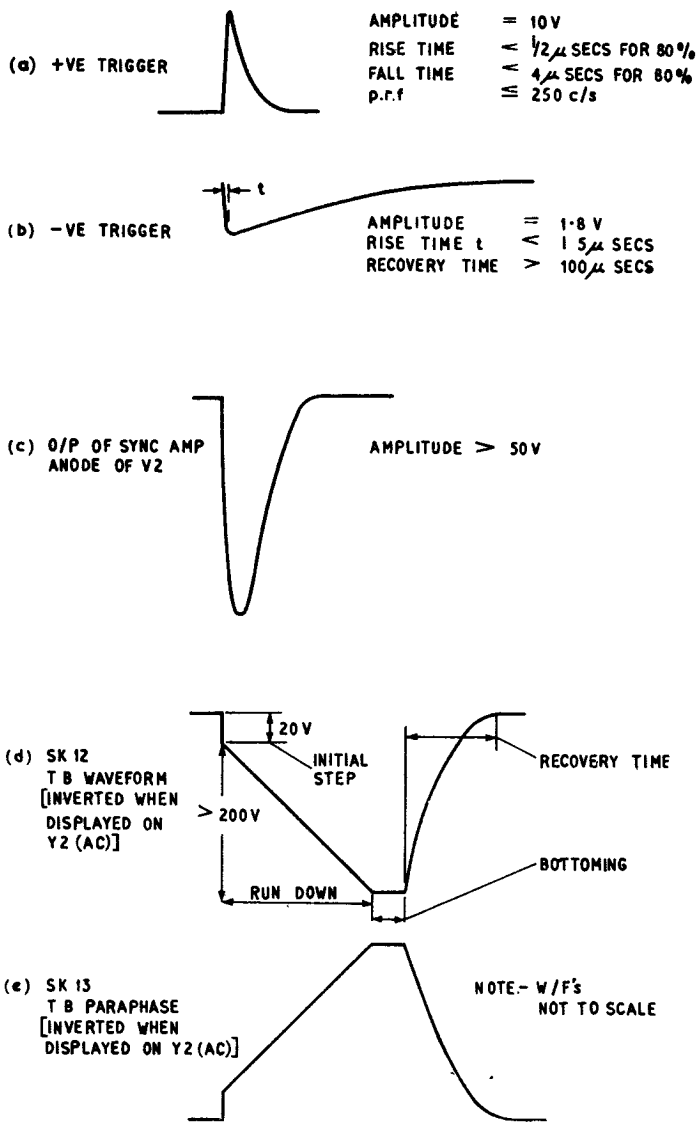


Fig. 11. Timebase unit Type I41 trigger and scan waveforms

51. DC coupling is employed between V12 and V16, and between V16 and V17 to maintain the DC stability of the circuit. In the static condition V16 is passing current because of bias on the control grid, derived from the potential divider R180 and R88 between V12 anode (catching potential) and  $-300\text{V}$ , modified by the coupling to the cathode of V17 via R94. At the same time V17 is near cut-off.

52. The negative-going waveform from V12 anode, applied to the control grid of V16 via R180, with the parallel condenser C38 to preserve the shape of the waveform, produces a positive-going waveform at the anode of V16 and at the cathode of V17. Feedback from V17 cathode to V16 grid via R94 and C40 produces an output equal in amplitude but opposite in phase to the V12 output.

#### Waveforms

53. Fig. 11 shows diagrammatically the waveforms to be expected in the sync and timebase

circuits. The waveforms shown are test waveforms, as displayed on a Cossor oscilloscope Type 1035 but, apart from the trigger pulse to SK5, the same waveforms appear operationally. The reference trigger pulse to SK5 (either waveform (a) with SWD in position 1, 3 or 4, or waveform (b) with SWD in position 2, 5 or 6) is provided by the test set Type 402 (10S 16157). The timing of all waveforms and pips in the TB 141 unit is then taken from this pulse, which is also used to trigger the oscilloscope.

**54.** To display the negative pulse (c) at the anode of V2, this point is connected to terminal A1 on the CRO. Waveforms (d) and (e) are displayed by making an AC connection to the Y2 plate on the CRO. This results in an inversion of the waveforms, which is not shown in the diagrams. All waveforms are shown in the conventional manner with consistent polarity. Fig. 12 shows the waveforms to be expected in the remaining TB 141 circuits.

#### Calibration and bright-up circuits

**55.** The valves in these circuits are V19 to V30. The bright-up waveform from V15 cathode reaches SK15, for application to the monitor CRT grid, via the front panel, preset BU amplitude control RV8, V20a, V28 and V29-V30. The full amplitude of the waveform across RV8 is applied to V20b via C11 (0.1  $\mu$ F) to trigger the calibration oscillator (V21). This valve receives its HT supply via the front panel control SWEa (front of wafer) which only completes the HT circuit in the 10 50  $\mu$  SECS. position of the switch. The remaining valves in the calibration circuit then produce blackout markers at 10  $\mu$  sec. intervals, with more prominent markers at 50  $\mu$  sec. intervals, for mixing with the BU waveform in V28 and subsequent display on the monitor CRT.

**56.** The preset BU input from RV8 is applied to V20a via C12 (0.1  $\mu$ F). In the static condition this valve is biased to near cut-off from the negative HT line (junction of R194 and R119). The positive input produces a negative-going square wave at the anode which is applied to the mixer valve (V28) via the wave shape preserving circuit C59, R159 and C62. Fig. 12(d) shows the waveform. For manual operations the trace-inter-trace ratio (e.g. 4.1 on the fig.), is adjustable by RV7.

**57.** The input valve to the calibration circuit (V20b) is also biased to near cut-off in the static condition, but passes increased current when the square wave arrives on the control grid from V15 cathode. The negative-going square wave at the anode is then applied to V21a via C46, the DC restorer V22a being included to preserve the reference level of the waveform (fig. 12(e)). In the static condition the calibration oscillator is prevented from oscillating, when switched on, by the damping effect of the heavy anode current drawn by the positively biased V21a through the secondary winding of L1. This current is cut-off

by the trigger waveform and V21b is allowed to oscillate. The frequency of oscillation is adjusted to 100 kc/s by the setting of the preset condenser C47. The preset control RV9 provides negative feedback to adjust the amplitude of oscillation to a constant level with a peak-to-peak value of at least 135V (fig. 12(f)). The positions of these controls are shown in fig. 7.

**58.** The 100 kc/s output from V21, lasting as long as the BU waveform from V15, is applied to V23a via C49. V23a is cathode coupled to V23b and both valves are biased from potential dividers across the HT supplies, so that, in the static condition, V23b is passing heavy anode current while V23a is cut-off. The 100 kc/s input to V23a causes this valve to pass current for part of each positive half-cycle. The resultant negative pulses at the anode are applied to the control grid of V23b via C56 and at the same time positive pulses are applied to the cathode across the common load. As a result positive pulses of voltage appear at the anode of V23b as the anode current is interrupted.

**59.** The cessation of current through L2 in the anode circuit of V23b causes the inductance to "ring" and to tend to initiate a train of damped oscillations at its resonant frequency, which is high in comparison with 100 kc/s. However, the presence of the diode V22b in parallel with L2 and the metering resistor R122 permits only the initial positive half-cycle of induced EMF to appear across L2. The succeeding negative half-cycle is dissipated by diode current. The first "pip" occurs during the first quarter cycle of the 100 kc/s waveform, i.e., within  $2\frac{1}{2}$   $\mu$  sec. of the start of the trace (fig. 12(g)).

**60.** Thus each positive half-cycle from the 100 kc/s oscillator V21 produces a positive pip at the anode of V23b, for application to V24a, biased to cut-off in the static condition from the junction of R125 and R131. The negative pulse at the anode of V24a is applied to the phase splitter V24b, which is initially passing heavy current due to positive bias on the grid. V24b then produces a positive pulse at the anode and a negative pulse at the cathode. Due to amplification and clipping in V24a, these pulses take the form of narrow, square-topped pips at 10  $\mu$  sec. intervals (fig. 12(h) and (j)).

**61.** The positive pulses at the anode of V24b are tapped off the slider of the front panel, preset amplitude control RV10 for application to the mixer valve V28, in the 10 55  $\mu$  SECS. position of SWEa (rear of wafer), via the pulse shaping circuit C57, R157 and C60, which maintains the sharp edges of the pulses. The negative pulses at the cathode of V24b are fed to the cathode of the catching and trigger diode V26b associated with the 50  $\mu$  sec. counting circuit.

**62.** Fig. 12 illustrates diagrammatically the waveforms discussed in the preceding paragraphs. Waveform (a) corresponds to (a) in fig. 11 and is





**65.** The negative trigger pulse at the cathode of V26b initiates the phantastron sequence by producing a voltage drop across R149 which is fed back, via the cathode follower V25 and the Miller condenser C53, to the control grid of V27 where it turns on anode current which establishes the negative voltage step at the anode. The rundown at the anode continues until the anode voltage bottoms and anode current ceases. The anode then rapidly reverts to its static condition in a time depending on the time constant of R149 and the stray capacitance in the anode circuit. The cathode follower action of V25 recharges C53 at the same time, at a much quicker rate than if C53 were connected directly between the anode and control grid of V27.

**66.** During the time that anode current is flowing through V27, the screen grid current is greatly reduced and a positive-going square wave output is produced (fig. 12(k)). The duration of this waveform depends on the setting of RV11 and the capacitance of C53 (47 pF). RV11 is adjusted to give a duration of just over 40  $\mu$  sec., so that the circuit is able to respond to every fifth 10  $\mu$  sec. trigger pulse.

**67.** The waveform is differentiated by C54 and R152 and then applied to the negatively biased clipper stage V19. In the static condition this germanium diode is passing current as determined by the setting of the front panel control RV12 (preset). The negative component of the differentiated waveform is by-passed to earth by the diode and, since the trailing edges of the positive pulses aim towards the large negative potential at the slider of RV12 but are caught by the diode at earth, only the peaks of the positive component are passed on to the next stage and sharp, well defined pips are obtained. Thus the control RV12 determines the amplitude of the positive pulses (at 50  $\mu$  sec. intervals and coinciding with the 10  $\mu$  sec. trigger pulses) which are applied via SWEa (rear wafer) and the pulse-shaping circuit C58, R158 and C61 to the mixer stage V28. The 50  $\mu$  sec. waveform is shown in comparison with the 10  $\mu$  sec. triggering waveform in fig. 12(l).

**68.** From the foregoing description it will be apparent that three inputs are applied to V28 (subject to the operation of SWE), viz.:—

(1) A negative-going square wave from V20a. of the same duration as the timebase waveform.

(2) Positive calibration pips at 10  $\mu$  sec. intervals, from V24b (amplitude preset by RV10).

(3) Positive calibration pips at 50  $\mu$  sec. intervals from V19, synchronized with the 10  $\mu$  sec. pips and with an amplitude preset by RV12.

**69.** In the static condition V28 is biased from a potential divider, R161, R162 and R163, between

its anode and HT negative, so that it is passing current and is DC stabilized. This valve stage is an anode follower which adds the three input signals with equal gain, as determined approximately by the equal ratios of R161/R157, R161/R158 and R161/R159. Compensating capacitors are connected across the input arms of the "sec-saw" to ensure faithful pulse and edge response. C63 from V28 anode to grid is for factory use. It is preset to produce a sharp leading edge with no overshoot and should not be touched.

**70.** The V28 output waveform (fig. 12 (m) or (n)) is applied to the "up-and-down" output cathode follower V29-V30 via C65. In the static condition the junction of C65 and R168 is at earth potential, but the arrival of the square wave at the anode of V28 drives the junction positive, the time constant of the circuit allowing it to maintain this potential until the first pulse drives it negative.

**Note . . .**

*The germanium diode V8, shown in the block and circuit diagrams in dotted lines, has been deleted in a recent modification.*

**71.** V29 and V30 are connected in series with respect to the HT supplies (600V between positive and negative lines), so as to provide an output waveform of sufficient amplitude to be effective on the grid of the monitor CRT. In the static condition a small anode current is passing through the valves and the junction of V29 cathode and V30 anode is at a fixed potential. The CRT grid is isolated from this DC potential by the condenser C2 in the monitor unit Type 102, and the initial brilliance of the CRT trace is therefore solely dependent upon the setting of the BRILLIANCE control in the monitor unit. It is normally blacked out in the static condition and is also blacked out operationally during the flyback and intertrace periods and brightened during the scan period. With the 100 kc/s oscillator switched on (SWE to 10 50  $\mu$  secs.) the BU waveform is interrupted by the blackout calibration pulses.

**72.** V29 and V30 form an up-and-down cathode follower. For positive edges applied to the grid of V29 the conventional cathode follower action takes place to charge the cable capacitance on SK15 and to apply a brightup voltage to the CRT grid via SK15 (TB 141 unit) and SK6 (monitoring unit 102). For negative edges, however, any tendency for the cable to remain charged is counteracted by the positive pulses obtained at the anode of V29, which are applied to the grid of V30 (via C69), where they turn on a substantial discharging current. The voltage applied to the CRT grid therefore closely follows the input waveform.

TABLE I

## Timebase unit Type 141 (10D/18933)

## List of components

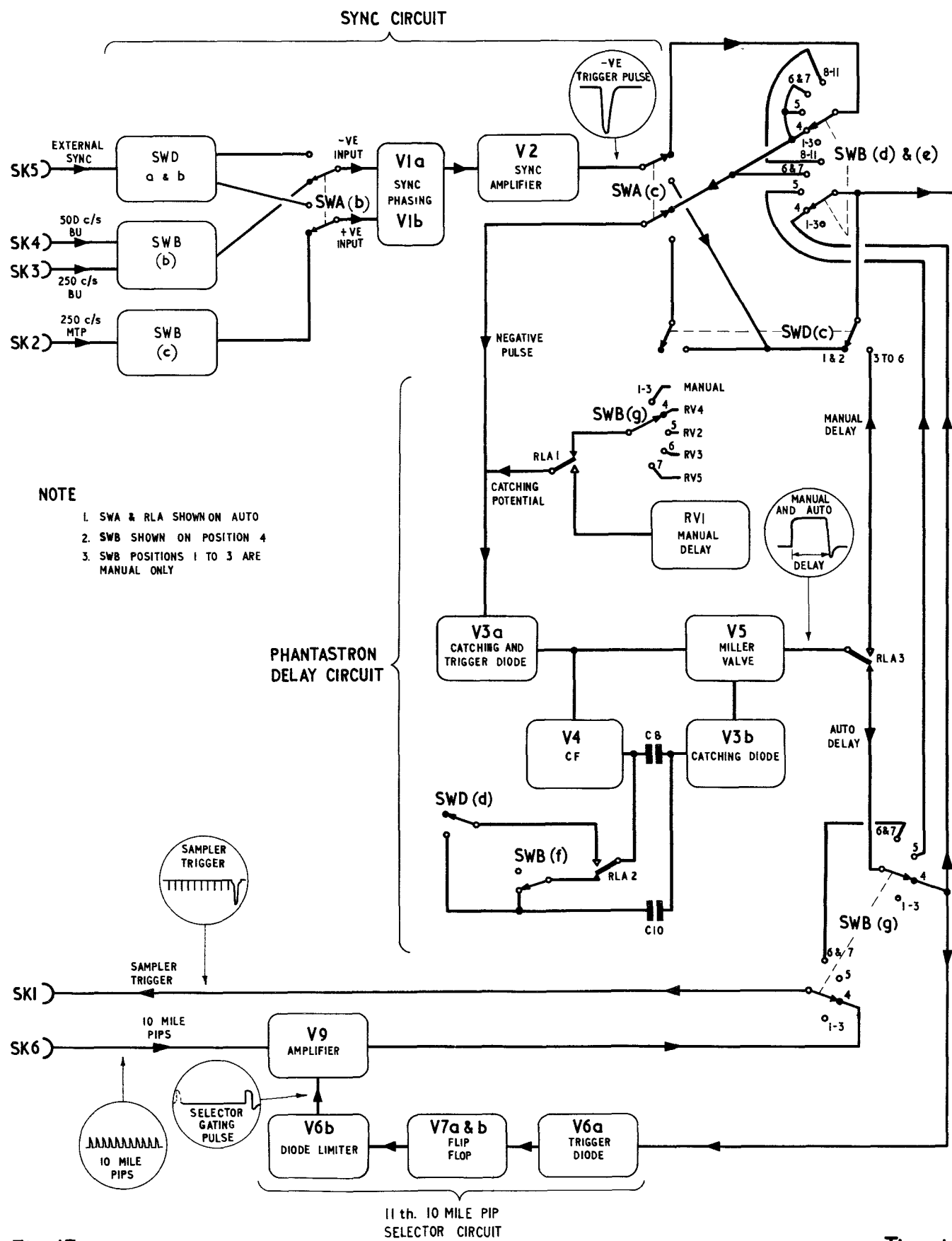
Circuit Ref.	Value (ohms)	Rating (watts)	Tolerance (per cent.)	Ref. No.	Circuit Ref.	Value (ohms)	Rating (watts)	Tolerance (per cent.)	Ref. No.
<b>Resistors, (fixed)</b>					<b>Resistors (Variable)</b>				
R1, R168, R177	470K	$\frac{1}{2}$	10	Z223122	R76, R77	680K	$\frac{1}{2}$	5	Z216747
R2, R21, R110	6.8K	$\frac{1}{2}$	5	Z215342	R79	47K	$\frac{1}{2}$	5	Z216082
R3	330	$\frac{1}{2}$	10	Z221173	R80	220K	$\frac{1}{2}$	5	Z216723
R4	120K	1	10	Z213328	R85	220K	$\frac{1}{2}$	5	Z216149
R5, R6, R15, R25, R42, R87, R97, R122, R129, R133, R141, R148, R182, R190	33	$\frac{1}{2}$	5	Z215062	R86	22K	6	5	Z244129
R7, R45, R115	4.7K	$\frac{1}{2}$	10	Z222089	R88	1M	$\frac{1}{2}$	1	Z216655
R8, R91, R105, R121	47K	6	5	Z244150	R92	22K	$\frac{1}{2}$	10	Z222174
R9, R10, R138, R181	100K	$\frac{1}{2}$	10	Z223038	R94	1M	$\frac{1}{2}$	1	Z216655
R11, R35, R54, R169	10K	$\frac{1}{2}$	10	Z222131	R95	100	$\frac{1}{2}$	10	Z221110
R12	10K	$\frac{1}{2}$	2	Z216212	R96	100K	$\frac{1}{2}$	5	Z216125
R13, R116	330K	$\frac{1}{2}$	2	Z216563	R115	4.7K	$\frac{1}{2}$	10	Z222089
R14	5.6K	$\frac{1}{2}$	5	Z215332	R117	240K	$\frac{1}{2}$	2	Z216533
R16	68K	$\frac{1}{2}$	10	Z223017	R123	270K	$\frac{1}{2}$	2	Z216547
R17, R149, R179, R183, R185, R186, R188, R196	330K	$\frac{1}{2}$	10	Z223101	R124	220K	$\frac{1}{2}$	2	Z216531
R18, R172	22K	$\frac{1}{2}$	10	Z222173	R125	8.2K	$\frac{1}{2}$	5	Z215352
R19, R73, R74, R75, R145, R161, R162	2.2M	1	5	Z216796	R127	27K	$\frac{1}{2}$	10	Z222185
R20, R137	150K	$\frac{1}{2}$	2	Z218753	R132	5.1K	$\frac{1}{2}$	5	Z215327
R22, R140	10K	$\frac{1}{2}$	2	Z216212	R135	51K	$\frac{1}{2}$	5	Z216087
R23, R26, R38, R52, R65, R78, R84, R89, R93, R102, R106, R111, R114, R118, R126, R128, R134, R143, R146, R164, R167, R170, R171, R176, R192	470	$\frac{1}{2}$	10	Z221194	R139	6.8K	$\frac{1}{2}$	2	Z215841
R24	100K	6	5	Z244159	R142, R178	100	$\frac{1}{2}$	10	Z221110
R27	330K	1	10	Z213333	R144, R197, R198, R199	47K	$\frac{1}{2}$	10	Z222216
R28, R104, R150	15K	1	10	Z212257	R147, R189, R194	4.7K	$\frac{1}{2}$	5	Z215322
R29, R31, R83, R98, R99, R108, R193, R195	1M	$\frac{1}{2}$	10	Z223164	R152	68K	$\frac{1}{2}$	5	Z216105
R30	39K	$\frac{1}{2}$	10	Z222206	R153	150K	$\frac{1}{2}$	10	Z223059
R32, R49, R120, R151	15K	$\frac{1}{2}$	10	Z222152	R154, R156	68K	$\frac{1}{2}$	5	Z216102
R33, R36	150	$\frac{1}{2}$	5	Z215142	R160, R200	33K	$\frac{1}{2}$	10	Z222195
R34	330K	$\frac{1}{2}$	10	Z223102	R166	10K	$\frac{1}{2}$	10	Z222132
R37	82K	$\frac{1}{2}$	5	Z216113	R173	470	$\frac{1}{2}$	5	Z215202
R39, R157, R158, R159, R163	680K	$\frac{1}{2}$	5	Z216746	R180	1M	$\frac{1}{2}$	1	Z216655
R40, R59, R60, R61	1M	$\frac{1}{2}$	5	Z216757	R184, R187	680K	$\frac{1}{2}$	10	Z223143
R41	1.5M	$\frac{1}{2}$	10	Z223186	<b>Capacitors (fixed) (F) (VDC)</b>				
R43	6.8K	$\frac{1}{2}$	10	Z222110	C1, C4, C14, C15	200p	500	20	Z115620
R44, R100, R101, R112, R155, R175, R191	1K	$\frac{1}{2}$	10	Z222005	C2, C5, C6, C11, C12, C41, C42, C43, C46, C55, C70, C71	0.1 $\mu$	350	20	Z115506
R46	20K	$\frac{1}{2}$	1	Z216277	C3, C10	0.002 $\mu$	350	20	Z115624
R47	1.1M	1	1	Z216759	C7, C13, C16, C50, C56, C68	0.01 $\mu$	350	20	Z115552
R50	47K	$\frac{1}{2}$	10	Z222215	C8, C20, C23, C28, C29	560p	350	5	Z123475
R51	150	$\frac{1}{2}$	10	Z221131	C9 not fitted				
R53	75K	$\frac{1}{2}$	5	Z216108	C17, C48, C54	100p	500	10	Z132300
R55	5.6K	$\frac{1}{2}$	10	Z222101	C18, C27	1000p	350	5	Z124445
R56, R57, R58	3M	1	5	Z216805	C19, C26	1800p	350	5	Z124124
R62, R63, R119, R131, R136	330K	$\frac{1}{2}$	5	Z215731	C21, C25, C31, C32	100p	350	5	Z123147
R64	100K	$\frac{1}{2}$	5	Z216125	C22, C33	33p	350	5	Z123052
R66, R81, R90, R103, R107, R113, R165, R174	10	$\frac{1}{2}$	5	Z215002	C24, C30	270p	350	5	Z123309
R67, R130	10K	$\frac{1}{2}$	5	Z216002	C34, C49, C51, C57, C58, C69	0.001 $\mu$	350	20	Z115623
R68, R109	270K	$\frac{1}{2}$	5	Z216727	C35, C37, C39, C66, C67	1 $\mu$	350	20	Z115632
R69, R82	33K	6	5	Z244141	C36, C72	0.25 $\mu$	150	25	Z115563
R70, R71, R72	5.6M	$\frac{1}{2}$	5	Z216199	C38, C40	10p	500	5	Z132252
					C44, C45	0.05 $\mu$	350	20	Z115554
					C47 (Variable)	4.8 to 95p			Z160006
					C52	1 $\mu$	150	25	Z115569
					C53	47p	350	5	Z123069
					C59, C65	0.25 $\mu$	350	20	Z115509
					C60, C61, C62	22p	350	5	Z132276
					C63 (Variable)	3 to 30p	70		
					C64	10p	500	10	Z132253

TABLE I (cont.)

Circuit Ref.	Description	Value	Rating	Tolerance (per cent.)	Ref. No.
<b>Miscellaneous items</b>					
SWA	Uniselector unit 6041		75 $\Omega$	5	10F/18197
SWB	Uniselector unit 6032		30·8 $\Omega$	5	10F/18195
SWC	Switch 2344 (Type H)				10F/17777
SWD	Switch 2343 (Type H)				10F/17776
SWE	Switch 2711 (Type H)				10F/18196
MR1, MR2	Resistor unit 514 (metrosil)		50V DC		10W/19566
RLA	Relay magnetic (SM3-LV48))		1000 $\Omega$		Z530060
L1	Inductor, RF, 2545	9·7–14mH		10	10C/21446
L2	Inductor, RF, 2546	550 $\mu$ H	350V DC	20	10C/21447
SK1 to SK6 SK12 SK13 SK15	} Sockets, coaxial, Type 783				10H/19861
SK10, SK11		Sockets, 25-way, fixed, Mk. 4			Z560380
SK14		Socket, 6-way (med.) fixed, Mk. 4			Z560321
PL7		Plug, 6-way (small), fixed, Mk. 4			Z560581
PL8	Plug, 6-way (med.), fixed, Mk. 4			Z560541	
PL9	Plug, 12-way (med.), fixed, Mk. 4			Z560154	
PL16	Plug, 12-way (med.) fixed, Mk. 4			Z560151	
PL17	Plug, 12-way (med.) fixed, Mk. 4			Z560152	
PL18	Plug, 12-way (med.) fixed, Mk. 4			Z560153	

**Note . . .**

*This Table is issued as an aid to servicing. When ordering spares reference should be made to Vol. 3 of this Publication.*



**NOTE**

1. SWA & RLA SHOWN ON AUTO
2. SWB SHOWN ON POSITION 4
3. SWB POSITIONS 1 TO 3 ARE MANUAL ONLY

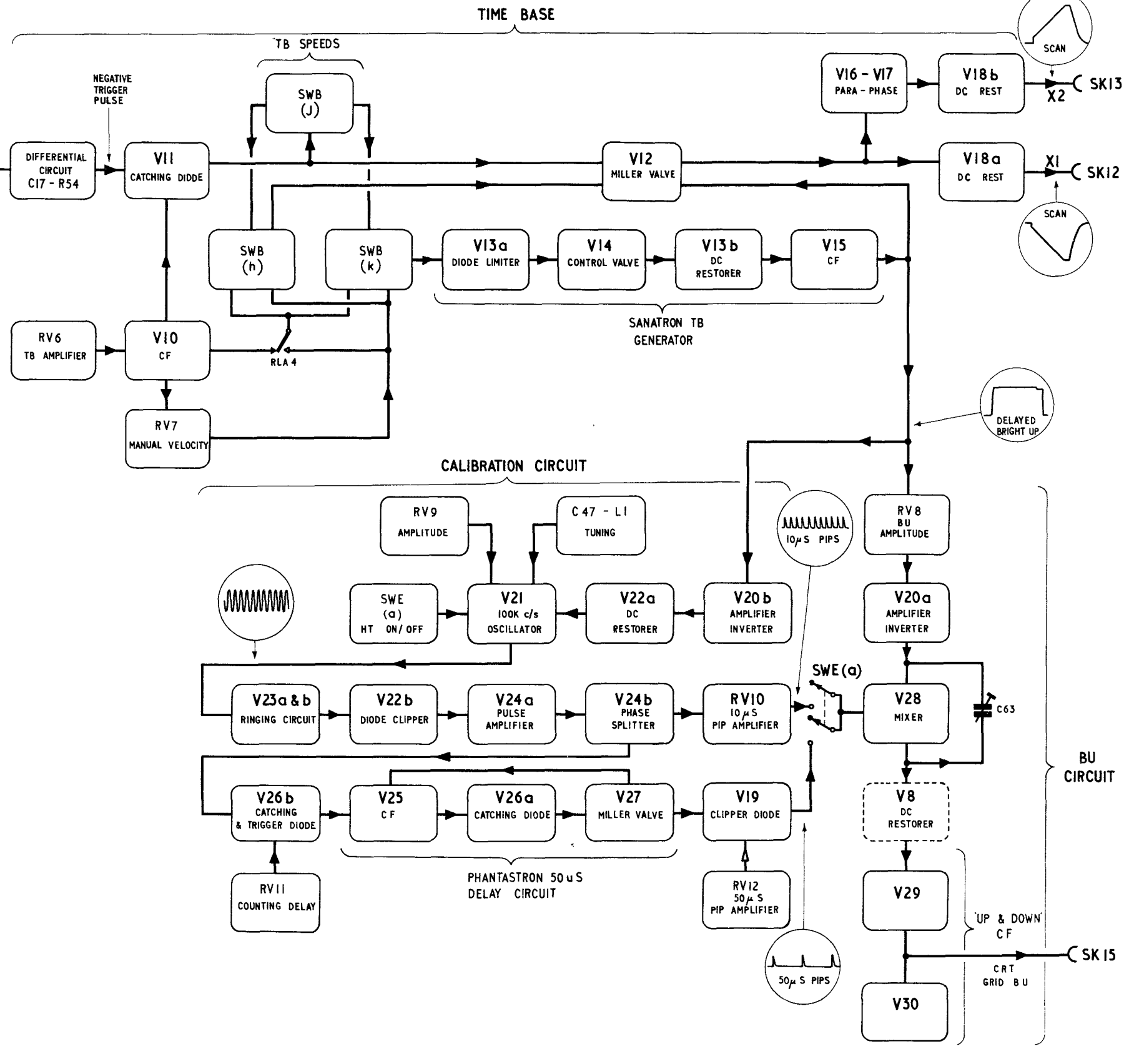
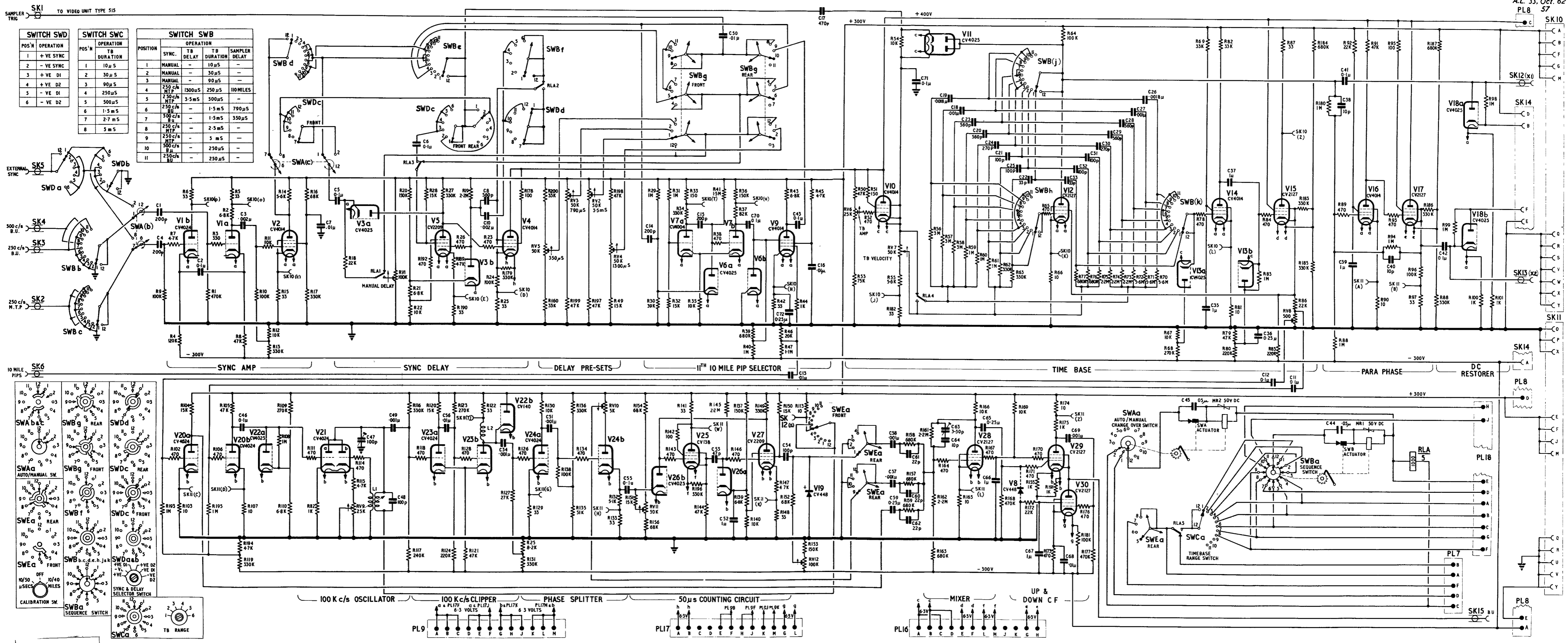


Fig. 13

Timebase unit Type 141 - block diagram

Fig 13

(AL. 4 Mar. 55)



SWITCH SWD		SWITCH SWC		SWITCH SWB				
POS'N	OPERATION	POS'N	OPERATION	POSITION	SYNC.	TB DELAY	TB DURATION	SAMPLER DELAY
1	+ VE SYNC	1	10 μS	1	MANUAL	-	10 μS	-
2	- VE SYNC	2	30 μS	2	MANUAL	-	30 μS	-
3	+ VE D1	3	90 μS	3	MANUAL	-	90 μS	-
4	+ VE D2	4	250 μS	4	250 c/s MTP	1300 μS	250 μS	110 MILES
5	- VE D1	5	500 μS	5	250 c/s BU	3.5 mS	500 μS	-
6	- VE D2	6	1.5 mS	6	250 c/s MTP	-	1.5 mS	790 μS
		7	2.7 mS	7	500 c/s BU	-	1.5 mS	350 μS
		8	5 mS	8	250 c/s MTP	-	2.5 mS	-
		9		9	250 c/s MTP	-	5 mS	-
		10		10	500 c/s BU	-	250 μS	-
		11		11	250 c/s BU	-	250 μS	-

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Timebase unit Type 141 - circuit

Fig. 14

## Appendix 1

### TIMEBASE UNIT TYPE 141A

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	<i>Para.</i>
<i>General description</i> ....      ....      ....      ....	1

#### **General description**

1. The timebase unit, Type 141A is similar to Type 141 with the exception that it provides a suitable sampler delay pulse which enables the rest level of the long range timebase to be correctly set up. It is therefore used in conjunction with units which have been modified for long range timebase working.

2. The difference between Type 141A and Type 141 is that in the former, R200 is 15K,  $\frac{1}{2}$ W,  $\pm 10\%$ , J. S. Ref. No. 5905-99-022-2153; thus the delay period provided by the setting of RV5 is  $600\mu\text{S}$ .

## Appendix 3

### GENERATOR SWEEP

5840-99-954-8333

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	<i>Para.</i>
<i>Introduction</i> .. .. .	1
<i>General description</i> .. .. .	2

#### LIST OF TABLES

	<i>Table</i>
<i>Component changes</i> .. .. .	1

#### Introduction

1. At certain stations where the integration of radar Type 85 has been carried out and the rack electrical equipment 5975-99-954-8362 is incorporated, the generator sweep 5840-99-954-8333 is used.

#### General description

2. The generator is similar in appearance and function to the timebase unit Type 141A from which it is derived, minor component changes being incorporated to adjust the sampling delay for use with long-range working (275 data miles), and to improve overall performance.

3. Detail differences from the Type 141A are the sampler delay adjustment, RV4 mentioned above, whose adjacent fixed resistor is changed to give an effective delay of 2.75 ms. The range adjustment of the associated potentiometers RV2, RV3 and RV5 is also increased, by changing both the fixed and variable components of each potential dividing chain, although the nominal delay in each case remains unchanged. In order to provide a nominal 10 ms timebase for cabinet electrical equipment sweep waveform inspection the values of C18 and C27 in the timebase generator are also increased and to retain the logical switching sequence of the T.B. RANGE switch SWC, minor wiring changes are made at the terminals of this switch. Details of all changes are summarized in the following table.

**TABLE 1**

**Component changes**

Circuit Ref.	T/B Unit 141 Value	Gen. Sweep value	New-J.S. Ref. No.
R53	75 K $\Omega$	56 K $\Omega$	5905-99-021-6093
R49	15 K $\Omega$	33 K $\Omega$	5905-99-021-6063
R160, R197 and R199	33 K $\Omega$ , 47 K $\Omega$ and 47 K $\Omega$	15 K $\Omega$	5905-99-021-6022
C18 and C27	.001 $\mu$ F	.0039 $\mu$ F, 750V	5910-99-012-4728
RV2, RV3 and RV5	50 K $\Omega$	100 K $\Omega$	5905-99-027-2549

In addition to the above component changes connections SWCa/7 and 8 are reversed and appropriate new unit labels are fitted.

## Appendix 4

### GENERATOR SWEEP

#### 5840-99-956-7398

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#### General description

1. This generator sweep, used at certain Radar 85 stations, is the timebase unit Type 141B (App.2) with the following modifications:—

- (1) Eight resistors (R49, R53, R160, R197, R199, R200, R202, R203) have been changed in value.
- (2) R198 has been replaced by a shorting link.
- (3) Two capacitors (C75, C76), two diodes (V32, V33) and relay (RLF) have been added.

#### Circuit description (fig. 4)

2. The range adjustment of potentiometers RV2, RV3, RV4, RV5, RV6, R13, R14, R15 has been

decreased by changing the value of the fixed resistors in each potential dividing chain, thus providing a reduction in scan amplitude control, and an increase in sampling delay (110 miles to 230 miles).

3. In order to provide a nominal 10ms timebase for cabinet electrical equipment sweep waveform inspection, C75 and C76 have been connected to switches SWB (h) and SWB (k) respectively. These additional timebase capacitors are switched into circuit via contacts RLF1 and RLF2. The relay  $\frac{RLF}{2}$  with associated diodes V32 and V33 are connected between PL18 and switches SWB (a) and SWC (a). Wiring changes have been made to switches SWB and SWC.

TABLE 1

Component details

Circuit ref.	Value	Rating	Tolerance (per cent.)	Cat. No.
R160	15K $\Omega$	$\frac{1}{2}$ W	5	5905-99-021-6022
R197				
R199				
R200				
R202 R203				
R49	33K $\Omega$	$\frac{3}{4}$ W	5	5905-99-021-6063
R53	56K $\Omega$	$\frac{3}{4}$ W	5	5905-99-021-6093
C75 C76	1800 pF	750V	5	5910-99-012-4716
RLF	2500 $\Omega$	48V	10	5945-99-011-9882
V32 V33	(CV7040)			5960-99-037-2016



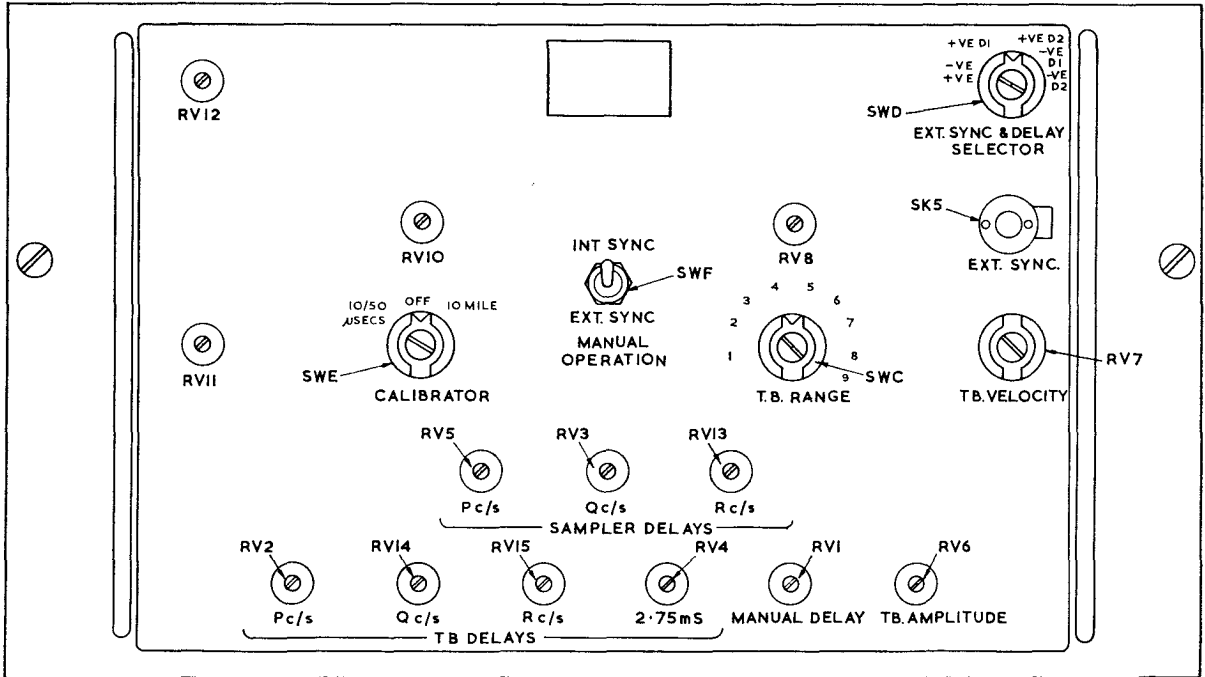


Fig. 1 Generator sweep 5840-99-956-7398 : front panel

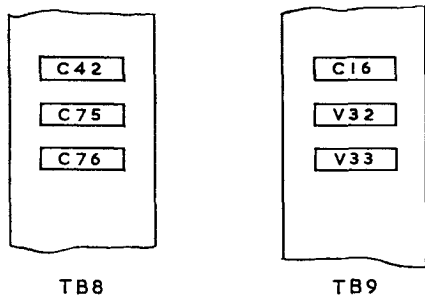


Fig. 2 Generator sweep 5840-99-956-7398 : tag boards : scrap diagram

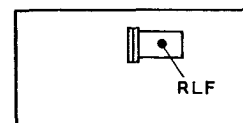
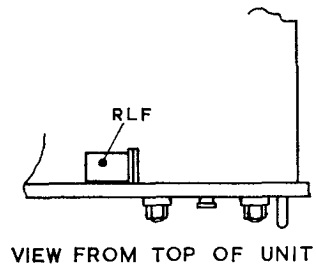
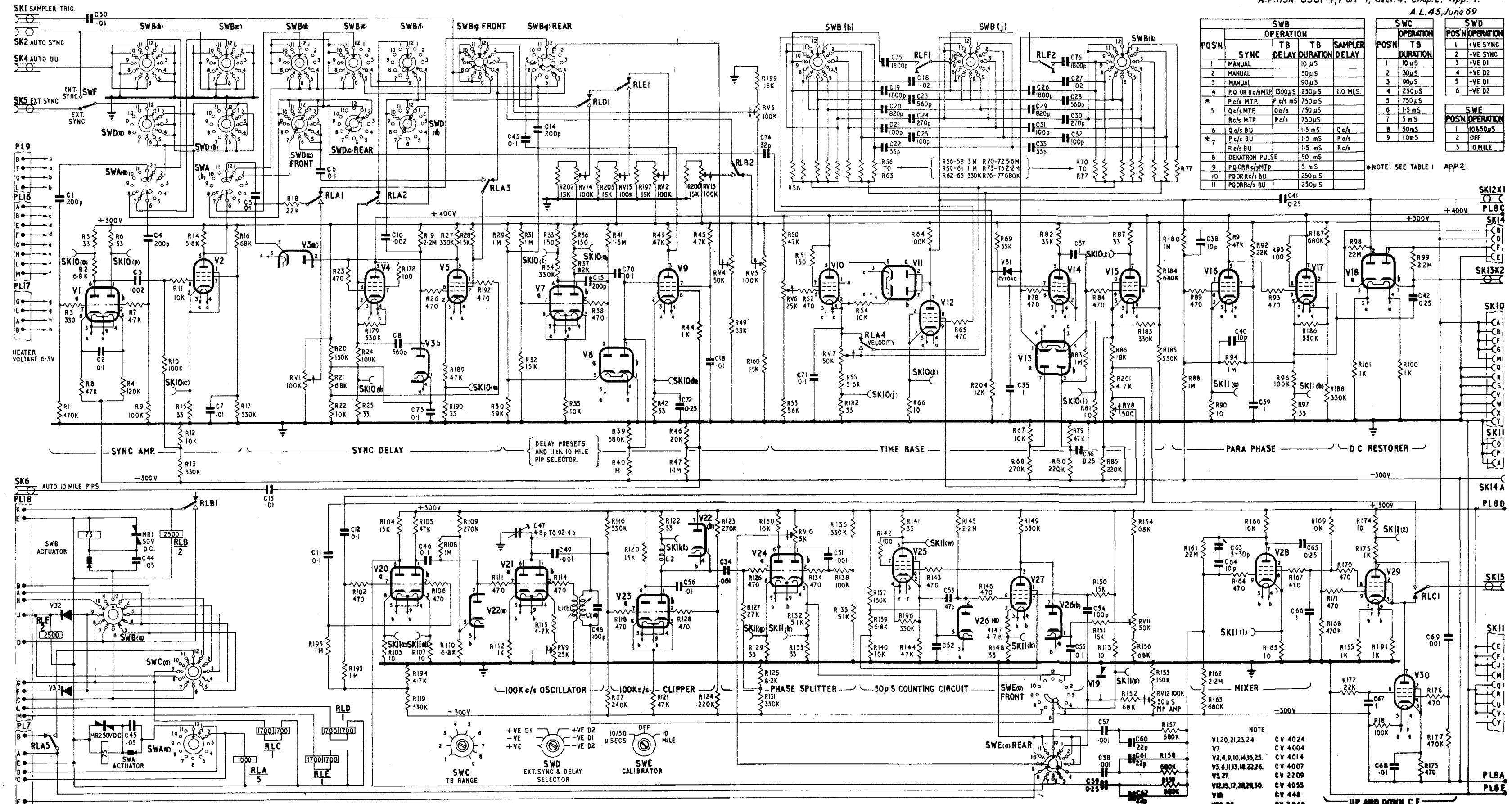


Fig. 3 Generator sweep 5840-99-956-7398 : relay location : scrap diagram



SWB OPERATION				SWC OPERATION		SWD POSN OPERATION	
POS'N	SYNC	TB DELAY	TB DURATION	POS'N	TB DURATION	POS'N	OPERATION
1	MANUAL		10 µS	1	10 µS	1	+VE SYNC
2	MANUAL		30 µS	2	30 µS	2	-VE SYNC
3	MANUAL		90 µS	3	90 µS	3	+VE D1
4	P.Q OR Rc/s MTP	1300 µS	230 µS	4	230 µS	4	+VE D2
5	Pc/s MTP	Pc/s mS	750 µS	5	750 µS	5	-VE D1
6	Qc/s MTP	Qc/s	750 µS	6	1.5 mS	6	-VE D2
7	Rc/s MTP	Rc/s	750 µS	7	5 mS	7	
8	Qc/s BU	1.5 mS	Qc/s	8	30 mS	8	
9	Rc/s BU	1.5 mS	Pc/s	9	10 mS	9	
10	PQ OR Rc/s MTP		5 mS				
11	PQ OR Rc/s BU		250 µS				
12	PQ OR Rc/s BU		250 µS				

\* NOTE: SEE TABLE 1 APP 2

NOTE  
 V1,20,21,23,24 CV 4024  
 V7 CV 4004  
 V2,4,9,10,14,16,25 CV 4014  
 V3,6,11,13,18,22,26 CV 4007  
 V3,27 CV 2209  
 V12,15,17,28,30 CV 4055  
 V18 CV 448  
 V32,33 CV 7048

Fig.4 CA. 5041/2  
D. 712422. 0.428895.11/69. S.W. Ltd.,

Generator sweep 5840-99-956-7398: circuit

Fig.4

## Appendix 2

### TIMEBASE UNIT TYPE 141B

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#### INTRODUCTION

1. The timebase unit, Type 141B meets phase 1A requirements. It is similar to Type 141A but has the following additional facilities:

- (1) It is suitable for use with three different p.r.f.
- (2) The range of timebase durations has been changed; in particular, a 50mS timebase has been added to enable dekatron waveforms to be monitored.
- (3) A switch is provided which enables the

selected station master trigger pulse to be used when the monitor is in the manual condition.

2. Because of the similarity of Type 141B to Type 141A, the following description is written in a comparative sense.

#### General description

3. In order to produce Type 141B from Type 141A the following modifications have been made:

- (1) Six resistors (R86, R98, R99, R197,

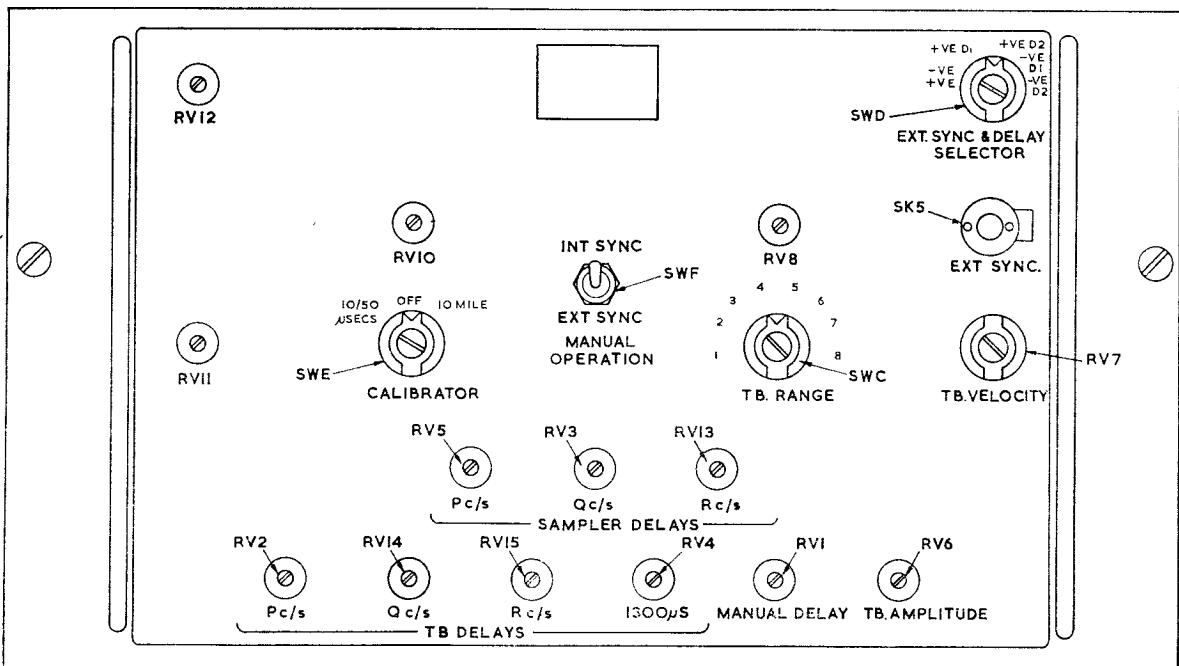


Fig. 1. Timebase unit Type 141B: front panel

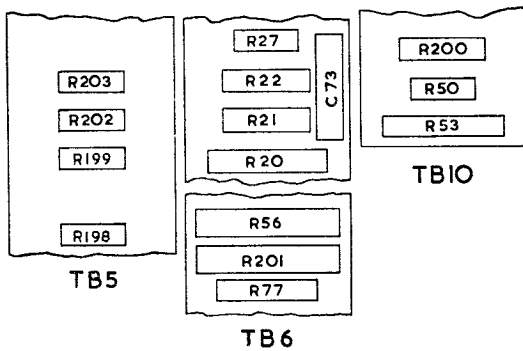


Fig. 2. TB 141B—tagboards: scrap diagram

R199, R200), three potentiometers (RV2, RV3, RV5) and seven capacitors (C17, C18, C20, C27, C29, C41, C42) have been changed in value.

(2) Three resistors (R201, R202, R203), three potentiometers (RV13, RV14, RV15), one capacitor (C73), one switch (SWF) and four relays (RLB, RLC, RLD, RLE) have been added.

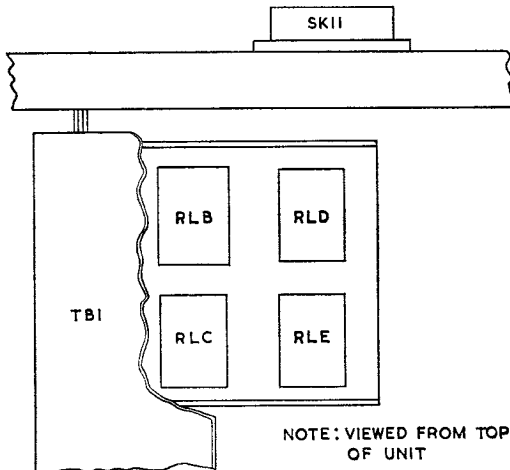


Fig. 3. TB 141B—relay location: scrap diagram

4. Table 2 gives details of these components whilst fig. 1, 2 and 3 show the location of the additional components. It should be noted that R200 is mounted on tagboard TB10.

5. These modifications affect sync selection, preset delays of the sync delay phantastron, time-base duration, and bright-up.

#### Circuit description (fig. 4)

##### Sync selection

6. The required sync and bright-up inputs at SK2 and SK4, respectively, are selected in the panel (distribution) Type 16506.

7. The input at SK2 is 'auto sync' instead of '250 c/s m t p.' Wafer SWD(a) is fed via a manually operated switch (SWF) situated on the front panel; thus as an alternative to the 'ext sync' at SK5, SWD(a) can accept the auto selected station master trigger pulse at SK2, which is conveniently selected by SWF when the monitor is used in the manual condition.

8. The input at SK4 is 'auto b u' instead of '500 c/s b u', and supplies positions 6 and 11 of SWB(b), in addition to positions 7 and 10.

##### Sync delays

9. Timebase delay preset potentiometers RV14 and RV15 are connected into the circuit in a similar manner to RV2, all three are selected by RLD or RLE. The sampler delay potentiometer RV3 is selected in position 6 of SWB; RV5 or RV13 is selected in position 7 of SWB (RV13 in circuit when RLB is energized). Therefore three preset timebase delays and three preset sampler delays are obtainable. These are listed in Table 1.

TABLE 1  
Delay potentiometer selection

SWB position	Relay energized	Potentiometer selected	Delay
4		RV4	1300 $\mu$ S timebase
5		RV2	P c/s timebase
5	RLD	RV14	Q c/s timebase
5	RLE	RV15	R c/s timebase
6		RV3	Q c/s sampler
7		RV5	P c/s sampler
7	RLB	RV13	R c/s sampler

10. The function of RV4 is unchanged. The potentiometers listed in Table 1 are brought into circuit by the action of SWB(g) FRONT and relay contacts RLB2, RLD1 and RLE1. Relay RLB is energized from the panel (control) Type 16504, via PL18(K). The closure of RLB1 feeds the input at PL18(K) to SWB(a); hence SWB is driven to position 7. Contact RLB2 selects RV13/R200. Relays RLD and RLE are also energized from the panel (control) Type 16504 via PL18(L) and PL18(M), respectively. With SWB at position 5 the closure of RLD1 selects RV14/R202; the closure of RLE1 selects RV15/R203. With RLD and RLE de-energized and with SWB at position 5, RLD1 and RLE1 select RV2/R197. Operation of RLB sets SWB to position 7 and also selects RV5/R160, via RLB2. RV3/R199 is selected directly from SWB(g) FRONT in position 6.

11. Capacitor C73 has been added to the cathode circuit of V3(b) to provide a faster delay recovery time. This enables a longer delay to be obtained at the same p.r.f.

#### Timebases

12. To produce timebases of longer duration, certain components have been changed in value. Because of the change of C20 and C30, SWB at position 5 now selects a 750 $\mu$ S timebase; the change of C18 and C27 provides a timebase of 50mS with SB at position 8.

13. Coupling components C41/R98 and C42/R99 have been changed in value to provide a longer time constant for the 50mS timebase.

#### Bright-up

14. To provide a suitable bright-up output for the 50mS timebase, R86 is changed and an additional resistor (R201) is connected into the cathode circuit of V15. The waveform at the junction R86/R201 has a suitable low frequency response, and is fed out via RLC1 (operated) and SK15. Relay RLC is energized when SWB is driven to position 8.

**TABLE 2**  
**Timebase unit Type 141B (10D/22387)**  
**components**

Circuit Ref.	Value	Rating	Tolerance (per cent.)	J.S. Ref. No.
Resistors (fixed)	ohms	watts		
R86	18K	6	5	5905-99-011-3427
R98 } R99 }	2.2M	$\frac{1}{2}$	10	5905-99-022-3207
R197 } R199 }	33K	$\frac{1}{2}$	10	5905-99-022-2915
R200 } R202 } R203 }	33K	$\frac{1}{2}$	10	5905-99-022-2195
R201	4.7K	3	5	5905-99-011-3336
Resistors (variable)				
RV2 } RV3 } RV5 } RV13 } RV14 } RV15 }	100K	1	10	5905-99-027-2549

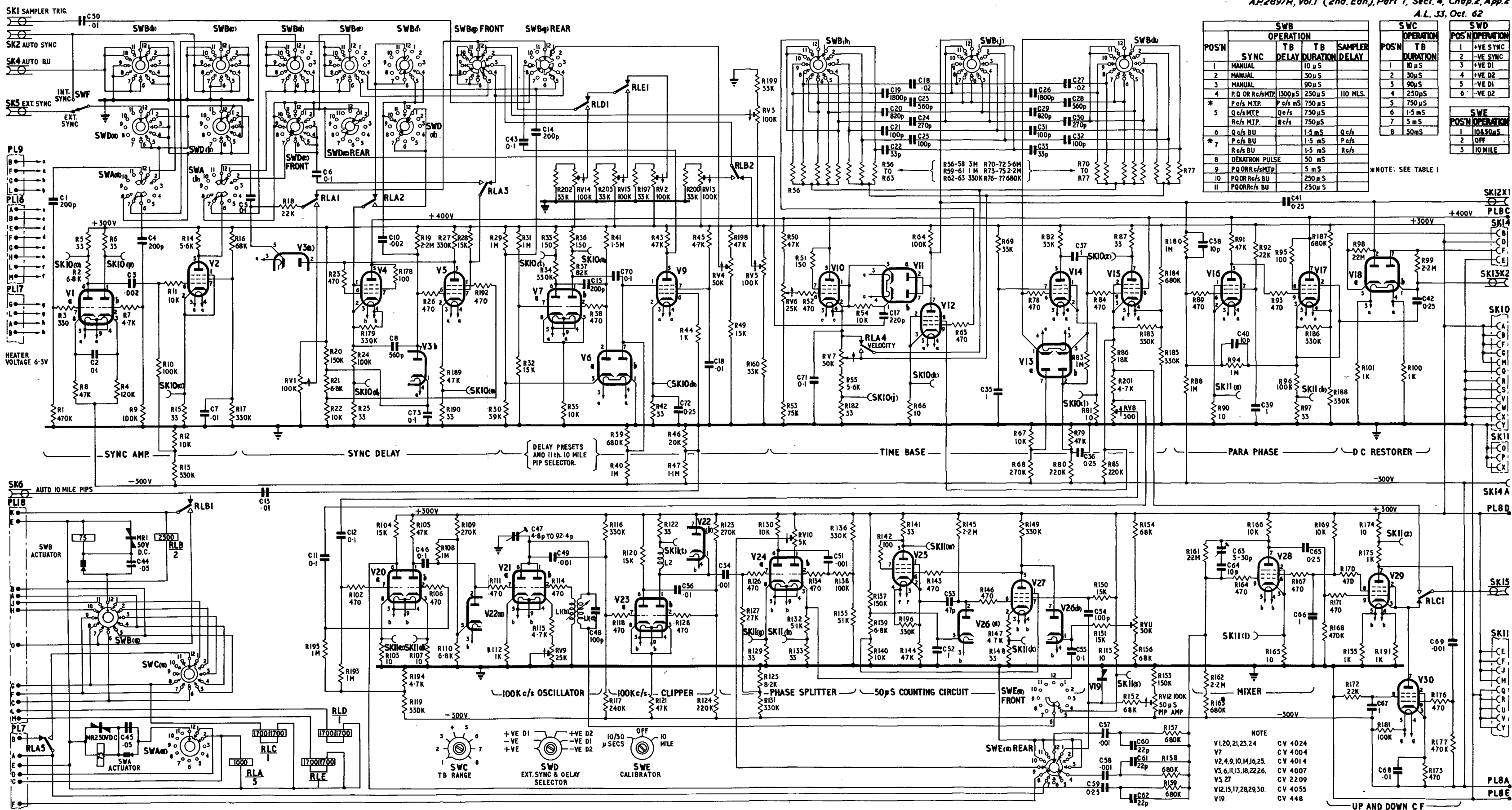
TABLE 2—cont.

Circuit Ref.	Value	Rating	Tolerance (per cent)	J.S. Ref. No.
Capacitors (fixed)				
	(F)	(VDC)		
C17	220p	750	2	5910-99-011-8329
C18 } C27 }	0·02	350	20	5910-99-011-5629
C20 } C29 }	820p	350	5	5910-99-012-3957
C41 } C42 }	0·25	200	20	5910-99-011-9830
C73	0·1	200	25	5910-99-011-9827

Circuit Ref.	Description	Rating	J.S. Ref. No.
Miscellaneous items			
SWF	Switch, toggle, D.P.C.O.		5930-99-051-0583
RLB	Relay magnetic	2500Ω	5945-99-011-9882
RLC } RLD } RLE }	Relay magnetic	1700/1700Ω	5945-99-053-0040

Note . . .

*Details of components not listed are as given for Type 141A.*



SWB OPERATION				SWC OPERATION		SWD OPERATION	
POS'N	SYNC	TB DELAY	TB DURATION	POS'N	TB DURATION	POS'N	OPERATION
1	MANUAL		10 μS	1	10 μS	1	+VE SYNC
2	MANUAL		30 μS	2	30 μS	2	-VE SYNC
3	MANUAL		90 μS	3	90 μS	3	+VE D1
4	P.Q OR Re/MTp	1300 μS	250 μS	4	250 μS	4	+VE D2
* 5	Pc/s MTP	Pc/s	750 μS	5	750 μS	5	-VE D1
	Qc/s MTP	Qc/s	750 μS	6	1.5 mS	6	-VE D2
6	Qc/s BU		1.5 mS	7	5 mS		
* 7	Pc/s BU		1.5 mS	8	50 mS		
	Qc/s BU		1.5 mS				
8	DEKATRON PULSE		50 mS				
9	P.Q OR Re/MTp		5 mS				
10	P.Q OR Re/BU		250 μS				
11	P.Q OR Re/BU		250 μS				

\*NOTE: SEE TABLE I

Fig.4 CA. 5041/2 Timebase unit Type I41B - circuit Fig.4

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## Chapter 3

# AMPLIFYING UNIT (VIDEO) TYPE 515

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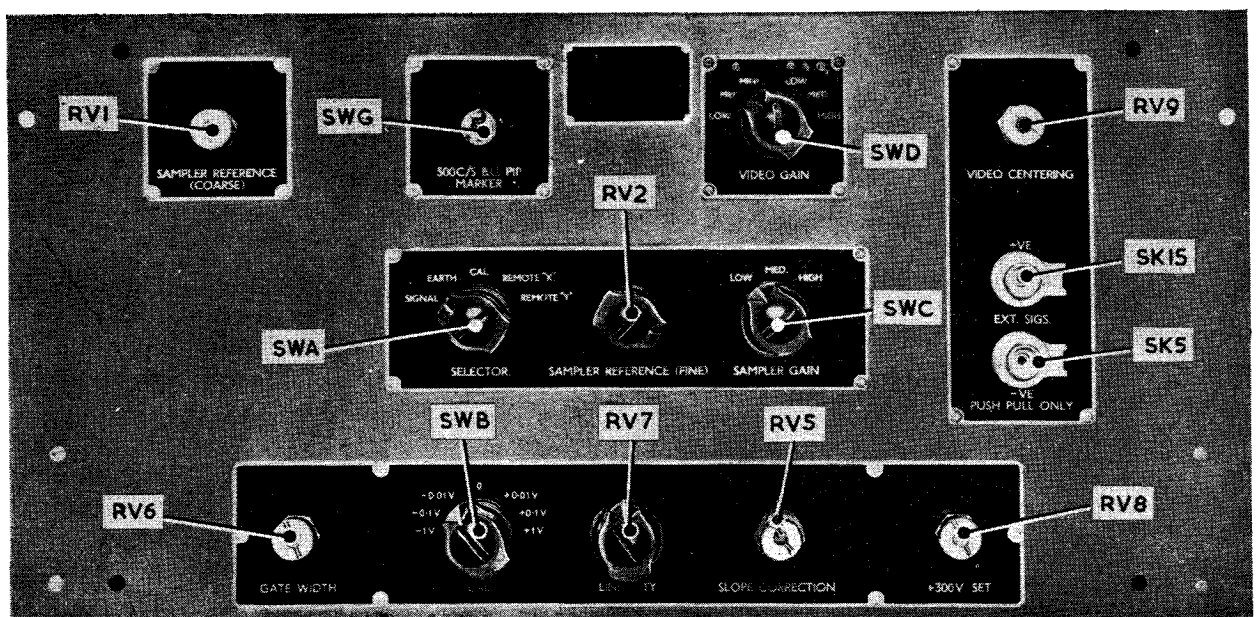
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**Fig. 1. Amplifying unit (video) Type 515 - front panel**



## INTRODUCTION

1. This amplifying unit accepts waveforms from the radar office racks and amplifies them for display on the CRT of the monitoring unit Type 102. The unit is illustrated in fig. 1 to 13. Fig. 18 gives a block diagram and fig. 19 the full circuit diagram. The line drawings which illustrate component and valve layouts merely illustrate the positions and not the sizes and shapes of the components. The photographs are of a prototype unit and, where they do not match up with the line drawings of layout (this is on very minor points only), the line drawings should be followed. On the actual equipment the circuit reference numbers are stencilled on the components, for additional guidance.

### Outline of circuit

2. The circuit may be subdivided into several sections according to function, viz. :—

(1) *The video amplifier* provides DC amplification of, and supplies a push-pull output from all input signals, which may be single-

ended or push-pull. It also converts the input from the Y SHIFT control (monitoring unit Type 102) into push-pull shift potentials. The push-pull outputs are DC coupled to the vertical deflecting plates of the display CRT via SK13 (Y1) and SK14 (Y2), in the 515 unit, and SK10 (Y1) and SK8 (Y2), in the 102 unit. Three differential gains of 2.5, 10 or 25 are available and the selection of the required gain is normally carried out automatically.

(2) *The sampler section* is used to compare the voltage levels of the input signals at a pre-selected time with accurately determined reference voltages. This section comprises :—

(a) *a gated comparison circuit* (V1, V2 and V3) for selecting the required portion of a waveform ;

(b) *the slope correction stage*, switched in circuit to remove the slope resulting from the sampling of a sawtooth

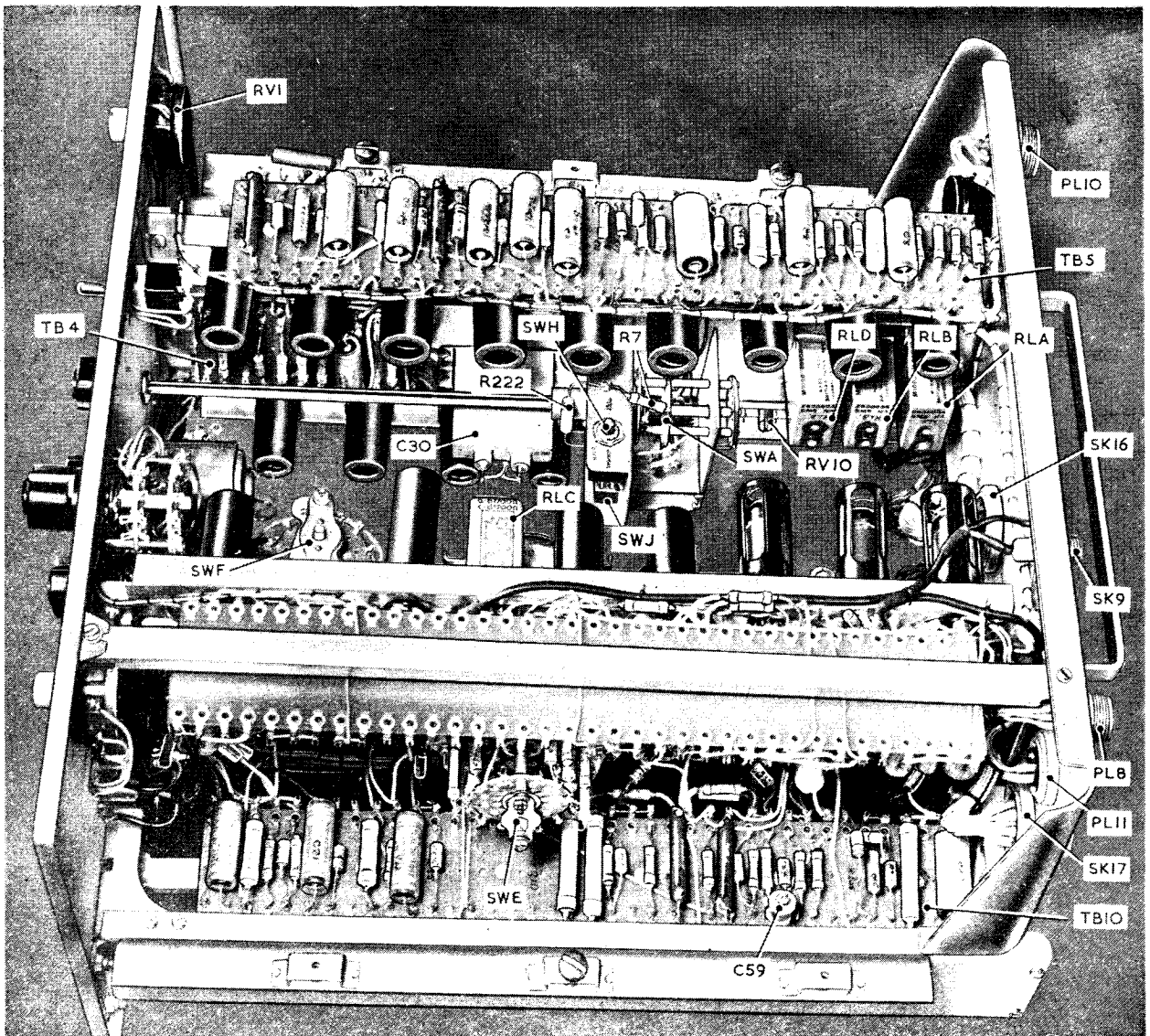


Fig. 2. Amplifying unit Type 515—oblique view from right

(e.g., the positive sawtooth from the timebase unit Type 140 in the rack assembly Type 300) ;

- (c) *the sampler amplifier*, a high-gain differential amplifier, the push-pull outputs of which are connected to the inputs of the video amplifier ;
- (d) *a super regulator stage* for supplying a positive HT supply of 300V to the sensitive stages of the sampler section.

- (3) *The gating waveform generator*, triggered via SK2 by the sampler trigger pulse from socket SK1 on the timebase unit Type 141, ensures that the sampler amplifier will only respond, for a duration of 100µsec., at the preselected time.
- (4) *The linearity checker*, used in conjunction with the sampler and video amplifier, gives an output signal which provides a measure and indicates the nature of non-linearity in sawtooth waveforms.

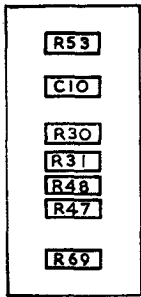


Fig. 3. Amplifying unit Type 515 — tagboard 4

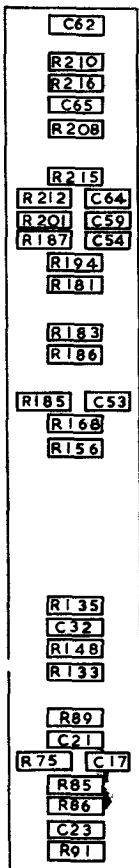


Fig. 4. Amplifying unit Type 515 — tagboard 10

#### Automatic switching

3. The selection of signals from the associated rack assemblies, for application to the input sockets SK6 (AUTO SIG), SK3 (500 c/s BU) and SK4 (250 c/s BU), and the selection of services within the 515 unit are normally carried out automatically by the actuator-operated switches E and F, in response to the settings of the remote selector switches in panel Type 890. However, the unit may be released from such control and used as a video amplifier for single-ended or push-pull signals connected to the external terminal sockets SK5 and SK15 on the front panel, by operating SWF to position 4 (SWA on panel 890 to position 22—MANUAL).

#### Manual controls

4. The front panel of the unit is illustrated in fig. 1. The various controls are annotated with the circuit reference numbers to enable the reader to identify them in the circuit description which follows. In addition there are various preset capacitors which are adjusted when setting up the unit. These are accessible when the unit is withdrawn on its runners from the rack, but they are mainly intended for

factory use and should not normally be adjusted in operational use. Also noteworthy are the tumbler switches SWH and SWJ (*annotated in fig. 2 and fig. 11*) with NORMAL (or operational) and TEST positions, RV10 (*fig. 2 and 11*) and the two preset potentiometers RV3 and RV4, mounted on the rear panel (*fig. 7*).

#### Relays

5. Four relays, RLA, RLB, RLC and RLD, operated from the selector panel Type 890, provide supplementary switching for the different functions of the unit.

#### Plugs and sockets

6. In addition to the front panel external signal sockets, there are eighteen connectors mounted on the rear panel. These are plugs and sockets for linking the unit with the other units in the rack, with the exception of SK16 and SK17 which provide test points for taking meter readings on each valve, as an aid to servicing. Reference should be made to the circuit diagram (*fig. 19*) to identify these points.

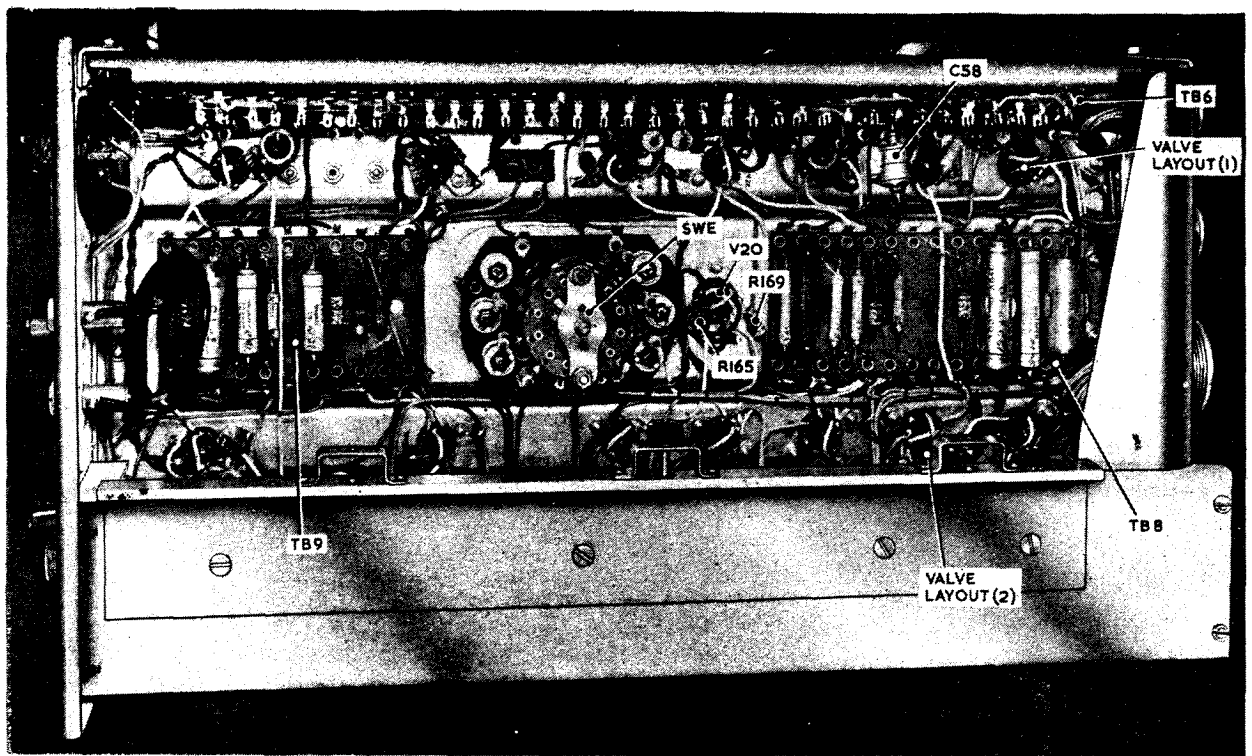
7. The heater supplies for the video valves are taken from the transformer TR1 in the panel Type 4064 (output sockets SK2 and SK3) and reach the valves via plugs PL12 and PL18, some connections on the pairs of connectors being in parallel to carry the load. The HT supplies (+400V, +300V and -300V) arrive on PL10 from SK3 on the upper power unit Type 4065 (06 in the rack) and also on PL11 from SK4 on the lower power unit (07 in the rack). The 50V supplies for actuators and relays are fed in, as appropriate, from SK5 in the panel Type 890, via PL7. The 50V supply, for indicating the degree of gain in use, leaves the 515 unit via connections on PL8 and enters the monitoring unit Type 102 via SK4 for application to the appropriate indicator lamp. Finally, the -500V reference is applied to PL1/B and PL1/C from SK33 in the panel Type 891.

#### CIRCUIT DETAILS

8. In tracing out the circuit, as described in the following paragraphs, reference may be made initially to the block diagram (*fig. 18*) and then to the full circuit diagram (*fig. 19*) when component reference numbers are given in the text.

#### Video amplifier

9. The valves in this section are V18 to V28. Valves V18, V19 and V20 constitute the input differential amplifier, V20 being the common cathode impedance of V18 and V19. Subject to the positions of SWE and SWF (AUTO) and SWD (MANUAL) the circuit accepts single-ended input signals from SK6 (applied to V19), or push-pull signals from the sampler amplifier (V8 to V19 and V9 to V18), on AUTO, or signals



**Fig. 5. Amplifying unit Type 515—right-hand side**

from SK5 ( $\phi 1$ ) and SK15 ( $\phi 2$ ), feeding V19 and V18, respectively, on MANUAL.

**10.** V18 and V19 feed the "see-saw" amplifier V23-V24 via the cathode followers V21 and V22. The two outputs from the see-saw are applied to "up and down" cathode followers V25-V27 and V26-V28, each pair of valves being connected in series across the 600V HT supply to provide a push-pull output of sufficient amplitude to apply to the Y deflector plates of the monitor CRT.

#### Switch functions

**11.** The main switch in the unit is the actuator-operated, nine wafer SWF (*fig. 7 and 11*), the functions of which are summarized, for its seven operational positions, in a table on the circuit diagram. In positions 1 to 3 of SWFg the input from SK6 is routed to relay contacts B1. In position 1 of SWF, RLB is not energized and the signal is applied via contacts B2 to the sampler section (*para. 34*) which also accepts the gating waveform (*para. 29*) via B3. In positions 2 and 3 of SWFj, however, RLB is energized and contacts B1 direct the input signal from SK6 to the linearity checking circuit (*para. 48*), which also accepts the 250 c/s BU input from SK4 on position 2, or the 500 c/s BU input from SK3 on position 3, via SWFh. The output from the linearity checking circuit is then directed via B2 into the sampler section, which is released from control by the gating waveform and given a steady operating bias by the changeover of contacts B3.

**12.** SWFb controls the application of operating current to SWE (*fig. 2, 5, 7 and 11*), the contacts

on the front and rear of SWFb being in parallel to carry the current. SWE then controls the gain of the video amplifier. Thus, on position 1 of SWF (for sampling) the  $-50V$  from PL7/J is routed to SWCa (front and rear contacts again in parallel), the front panel SAMPLER GAIN control, which may be operated manually to give LOW, MEDIUM or HIGH gain. It achieves this by directing the actuating current to SWEa, to operate it to position 3, 4 or 5. Wafers SWEca, SWEba, SWEcb and SWEbb then select the input arms to the video amplifier which give the required gain. Meanwhile, wafers SWFeb and SWFea complete the circuit from the sampler amplifier output to the video amplifier input.

**13.** On positions 2 and 3 of SWFb, SWE is operated to position 5, giving a video gain of  $\times 25$  to the linearity checking signal which is routed from the sampler output to the video amplifier input, via SWFeb and SWFea as in position 1.

**14.** Position 4 of SWF is MANUAL. SWFg is open-circuited, thus isolating the unit from the AUTO SIG input on SK6, while SWFeb and SWFea isolate the video amplifier from the sampler. SWFf completes the circuit from SK5 (front panel EXT. SIGS.) to SWEcb, feeding V19, while SWFc links SK15 to SWDb. This wafer is part of the front panel VIDEO GAIN control. On positions 1 to 3 it completes the circuit from SK15 to SWEca, feeding V18, and provides for push-pull inputs from SK5 and SK15 to V19 and V18, respectively. On positions 4 to 6 (contacts 10 to 12) it disconnects SK15 and connects V18

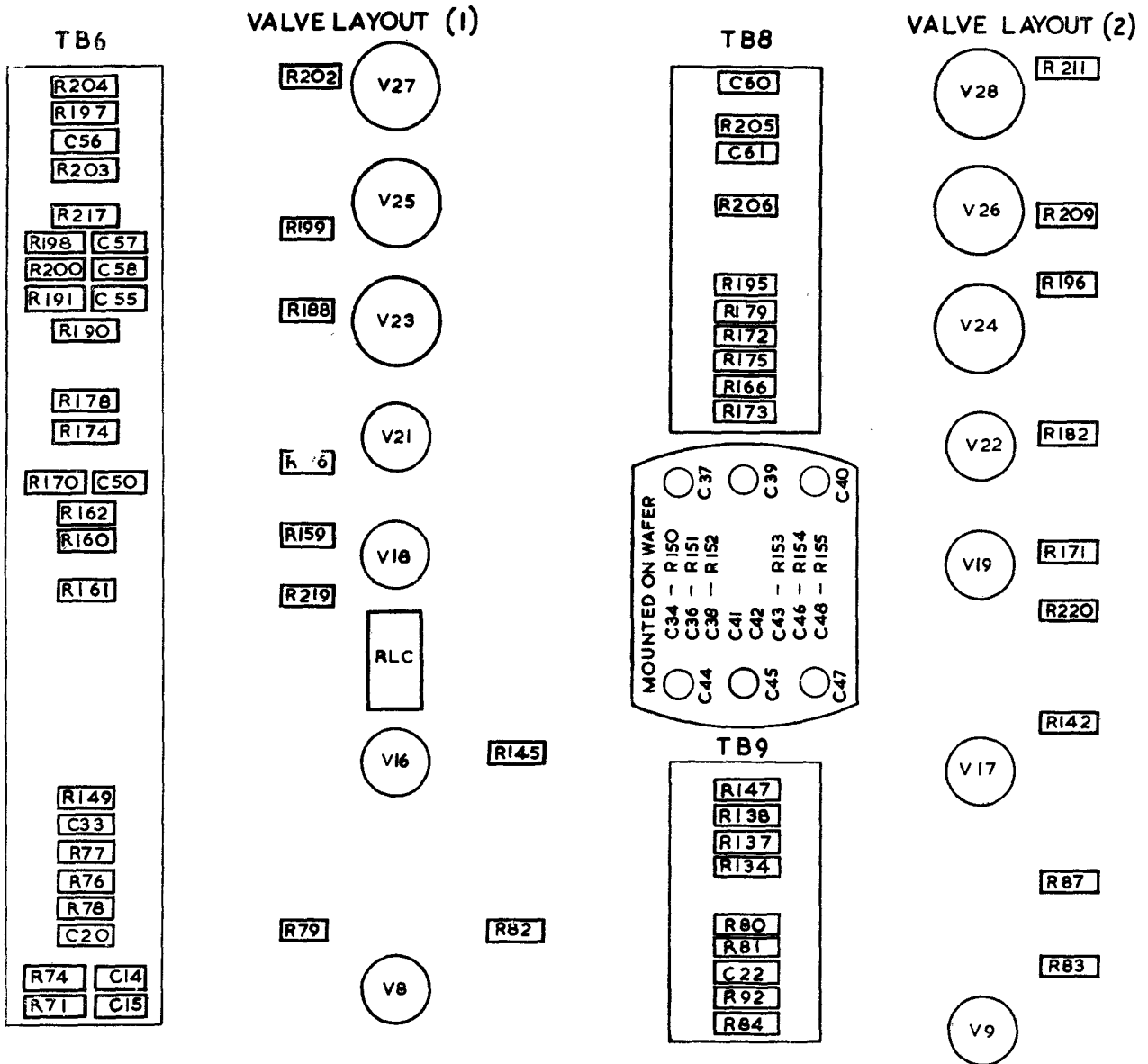


Fig. 6. Component layout of fig. 5

input to position 4 of SWFd which may be earthed, for single-ended inputs to SK5, or connected to the 500 c/s BU input on SK3, via SWG, the front panel 500 c/s BU PIP MARKER. The BU waveform is then differentiated by C33 and R149 to provide a reference point on the monitor CRT trace.

15. Three degrees of gain (LOW, MEDIUM and HIGH) are provided for both push-pull and single-ended inputs to the video amplifier on manual applications, by the six positions of SWD. Wafer *a* (front and rear contacts in parallel) routes the operating current from SWFb to SWEa and so actuates SWEca, SWEba, SWEcb and SWEbb to the required positions.

16. For all applications of the video amplifier, contacts A, B and C on PL8 are in parallel with contacts 3, 4 and 5 respectively on SWEa, so that the appropriate indicator lamp in the monitoring unit Type 102 is lit to show the gain being used.

17. Positions 5 to 8, inclusive, on SWF have no connections, while position 9 provides the wiper contact. In positions 10 to 12 of SWF the single-ended input from SK6 is applied to the video amplifier (V19) via SWF(g). The differentiated 500 c/s BU waveform may also be applied to the amplifier (V18) by closing the toggle switch SWG. SWFb actuates SWE to select the degree of gain required and the remaining wafers of SWF isolate all other circuitry with the exception of

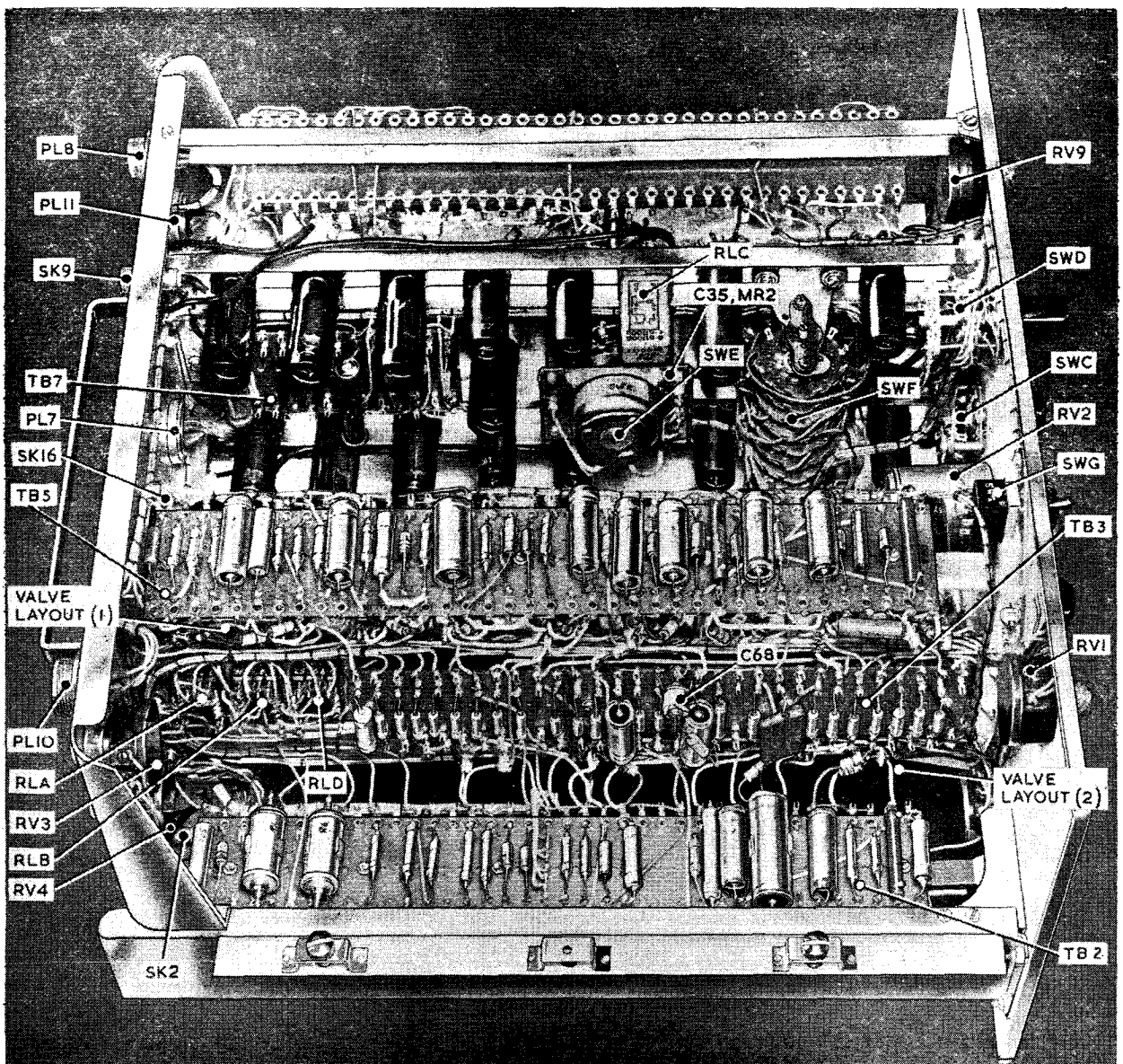


Fig. 7. Amplifying unit Type 515—oblique view from left

relays A, C and D, which are connected to the panel Type 890.

*Function of video amplifier*

18. As already described, SWE provides a choice of three input impedances to the video amplifier. These are CR circuits adjusted to give the required impedance by C44, C45 and C47 for V18 input and by C40, C39 and C37 for V19 input. The circuits of V18 and V19 are identical so that they pass the same current in the no-signal state and produce the same order of gain when receiving a signal. Since they share a common cathode load, however, and since this is the constant current valve V20, an increase in current in one valve is equalled by the decrease in current in the other, so that a differential output results at the anodes of V18 and V19. This is fed back to the respective input arms via the cathode followers V21 and V22 and the ratio of output to input impedance

decides the gain of the see-saw. The output impedances are fixed but the three input impedances give the choice of gain ( $\times 0.5$ ,  $\times 2$  or  $\times 5$  for this stage) resulting from the operation of SWE.

19. Feedback connections are also made from the cathode followers to the strapped control grids of the double-triode V20, via R172 and R175, to maintain the constant current characteristic of this valve. Although the differential outputs from the cathode followers cancel out, the average mean level may tend to vary, but the feedback defeats this tendency and maintains equilibrium. To explain this, let V20 pass increased current; then both V18 and V19 pass more current and relay the voltage drop at their anodes via V21 and V22 to V20, so causing this valve to pass less current and to return to its former state.

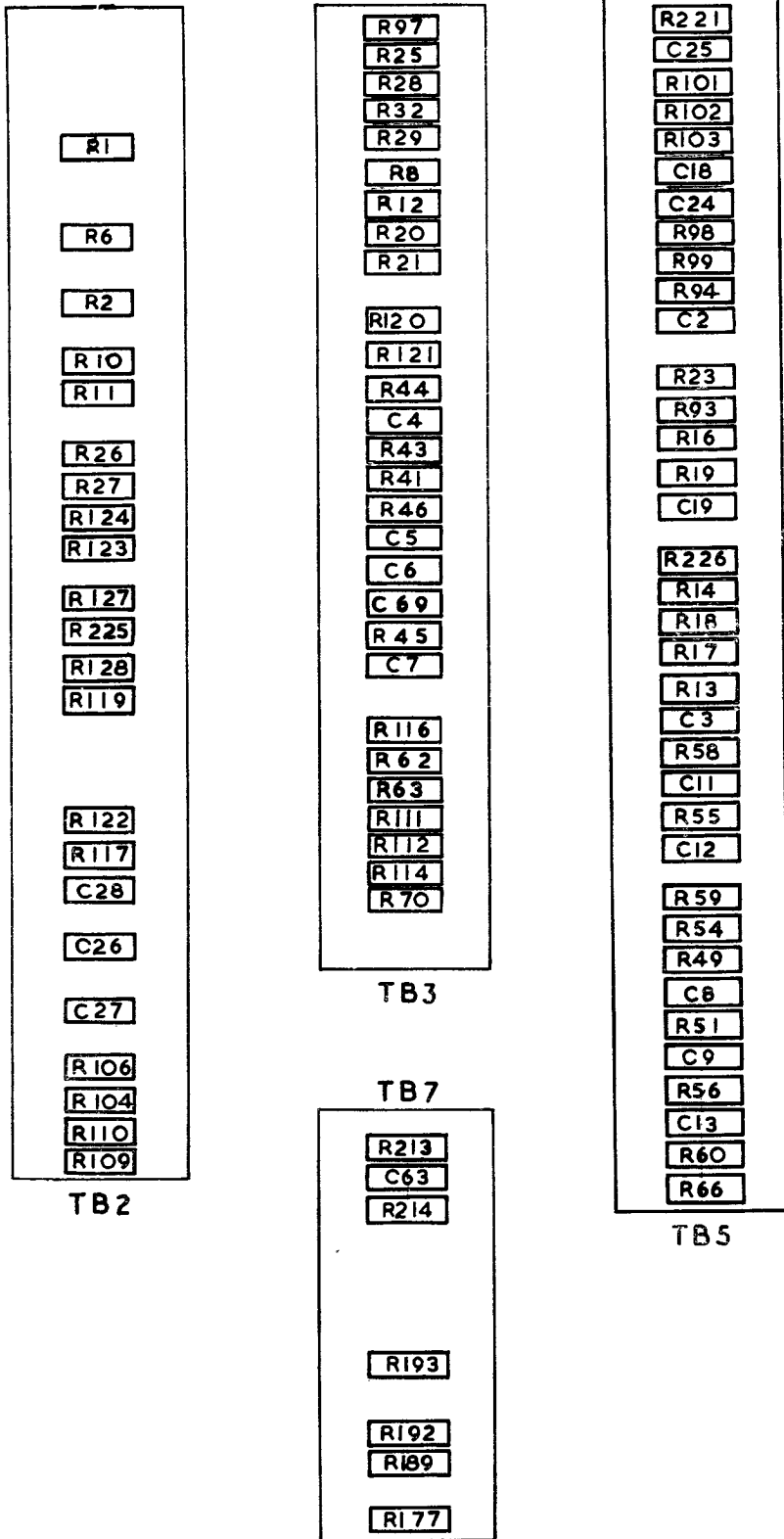


Fig. 8. Tagboards shown in fig. 7

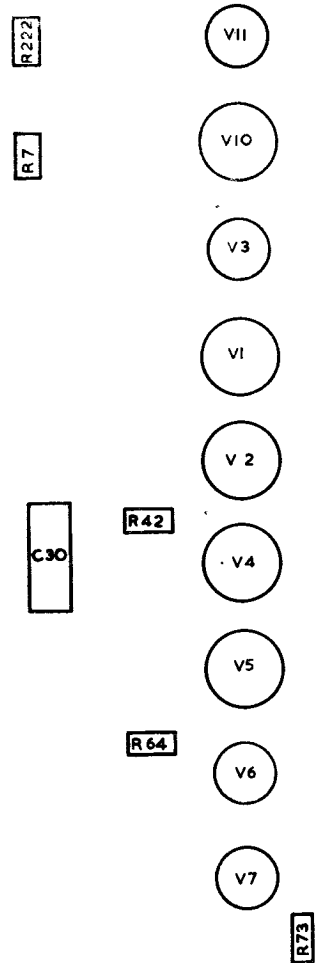


Fig. 9. Valve layout (1) for fig. 7

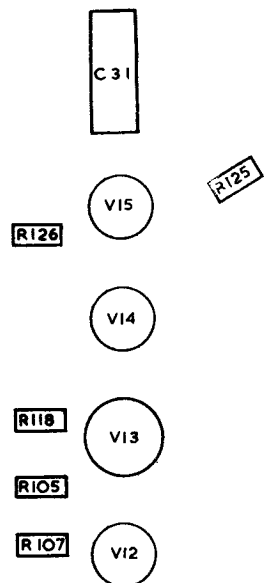


Fig. 10. Valve layout (2) for fig. 7



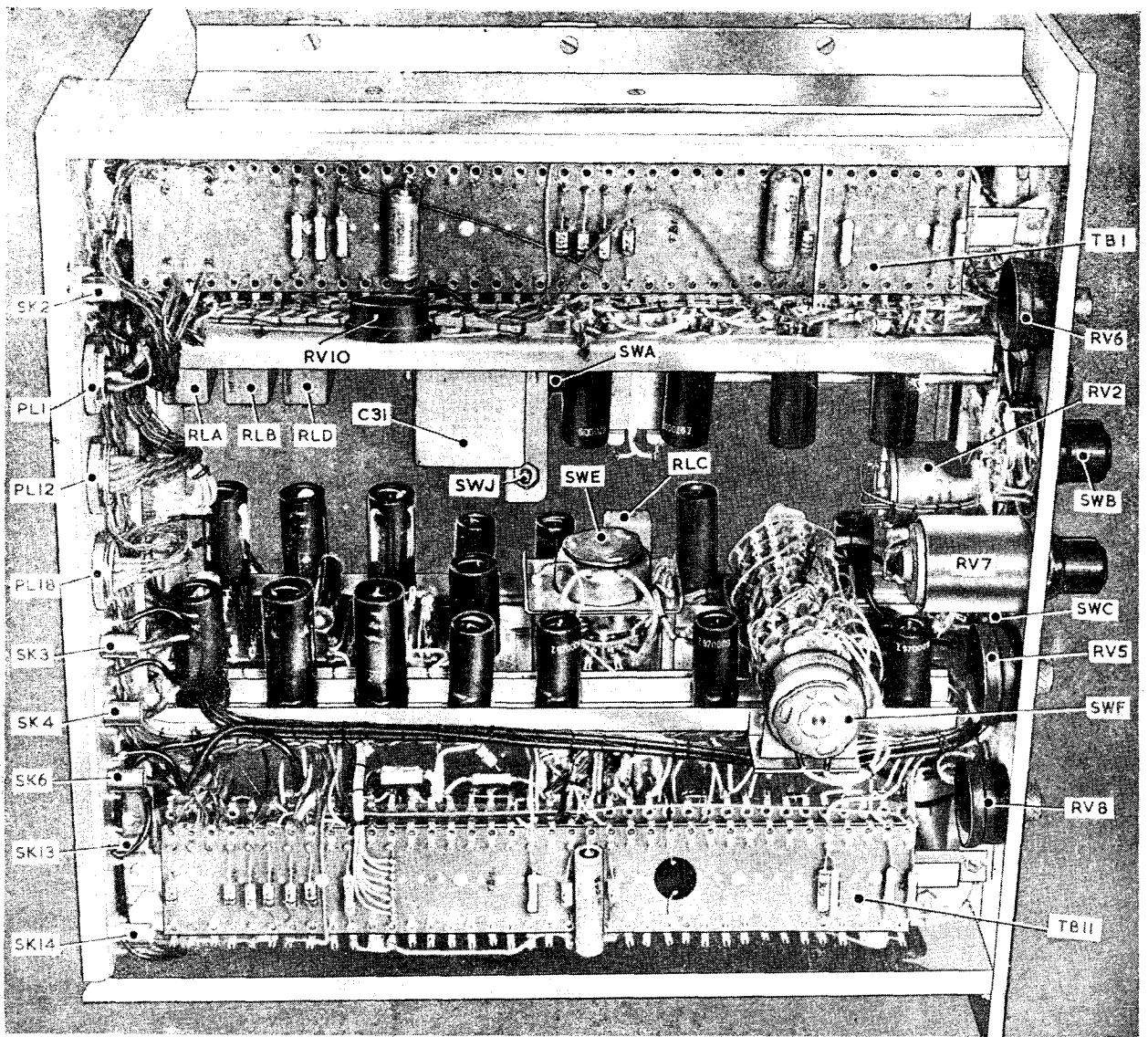


Fig. 11. Amplifying unit Type 515—underneath view

20. The control grid of V18 is connected to the Y SHIFT potentiometer on the monitoring unit Type 102 via R160 and PL8 D. This potentiometer may be used to apply a positive or negative bias to V18 and thus to alter the DC coupling conditions throughout the amplifier, so that push-pull Y-shift potentials are provided at the output terminals SK13 and SK14.

21. The front panel control RV9, labelled VIDEO CENTERING, may be used to apply a similar positive or negative potential to V19, and provides a preset Y-shift control for setting-up purposes. The slider of the control is decoupled by C49.

22. From the cathodes of V21 and V22, inputs are made to V23 and V24, respectively. This stage, coupled with V25 and V26, is also a see-saw amplifier, with R193 as the common cathode load and producing, at the cathodes of V25 and V26, push-pull outputs with a gain

dependent on the output input feedback ratio of R200/R180 and R201/R184. The usual compensating capacitors are connected across the resistance arms.

23. The 10-mile pips from SK9 may be applied to V23, for producing calibration pips on the CRT screen, by operating the CAL switch (SWE) on the front panel of the TB141 unit to the 10 MILE position. Wafer SWEa (rear) of this switch then completes the  $-50V$  circuit, via PL7 F (TB141), SK8 F and SK5 L (panel 890) and PL7L (515 unit) to operate RLC, so closing contacts C1 to connect SK9 to V23 input.

24. Outputs from the anodes of V23 and V24 are taken to the control grids of V25 and V26, respectively, negative feedback from the cathodes of these valves being applied to the control grids of V23 and V24 through the preset CR circuits R200-C58 and R207-C59, which are adjusted during setting-up to produce the required wave-

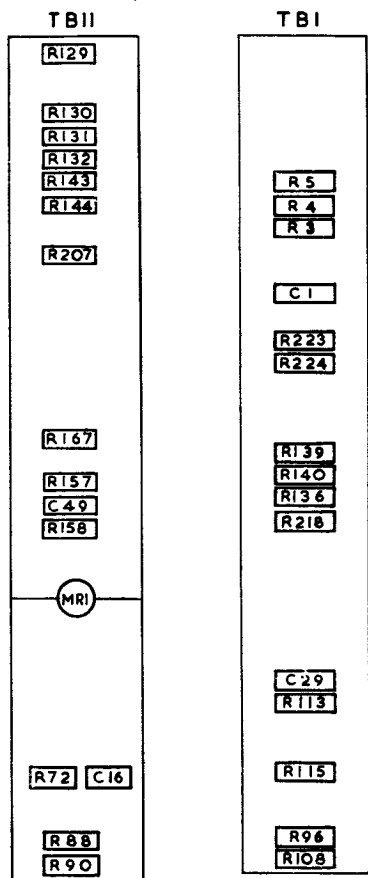


Fig. 12. Tagboards shown on fig 11.

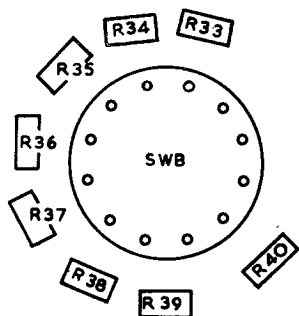


Fig. 13. Components mounted on SWB

form response. The gain of this stage ( $\times 5$ ) gives overall gains of 2.5, 10 and 25 (refer to para. 18 for gain of previous stage).

25. V25 is in series with V27 with respect to the 600V HT supply and is also coupled to it via C56. V26 is similarly connected to V28, with C65 as the coupling capacitor. V25 and V26, in association with their series valves, are up-and-down cathode followers, which produce large amplitude output waveforms for application to the Y deflector plates of the CRT by direct coupling, and at the same time prevent the introduction of distortion due to the self-capacitance of the connecting cables.

26. Thus, a positive input to either V25 or V26 produces a positive potential at the cathode which charges the self-capacitance of the line by normal CF action and so maintains the speed of positive edges.

27. For negative-going potentials applied to the grid of V25 or V26, the tendency for the line to remain charged is defeated by the positive feed from the anode to the control grid of the associated valve, which turns on a substantial current to discharge the line, so maintaining the speed of falling edges of waveforms.

28. The cathode and grid bias resistors of V27 and V28 are decoupled by C60, C62 and C63 to provide constant biasing conditions. Under static conditions equal currents pass through each branch of each stage of the push-pull amplifier. When signals are applied the total amplifier current should still be constant due to the differential effect.

**Gating waveform generator**

29. This section consists of valves V10a, V10b (which constitute a flip-flop) V11a (trigger diode)

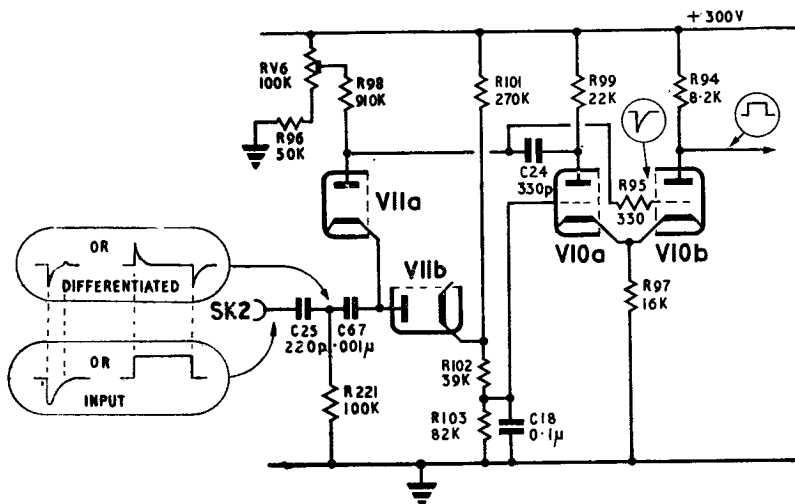


Fig. 14. Gating waveform generator—circuit



and V11b (catching diode). A simplified circuit is given in fig. 14 for easy reference. Diagrams of the waveforms to be expected are incorporated in the drawing.

**30.** In the quiescent state, the following conditions prevail:—

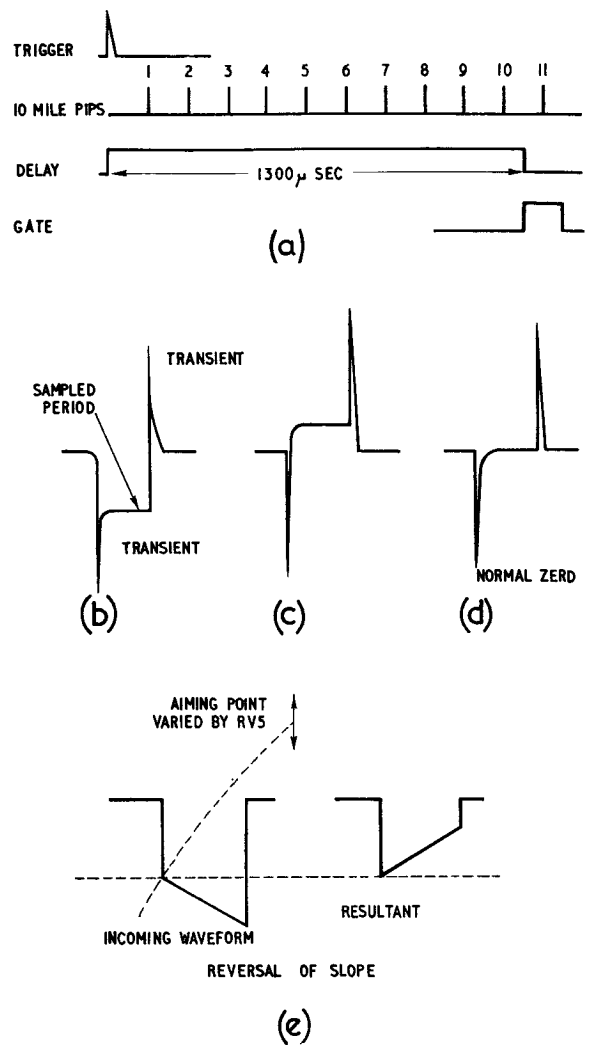
- (1) The two halves of the double diode V11a and V11b are passing current in series, as determined by the relative potentials on the slider of RV6 (front panel preset GATE WIDTH control), and at the junction of R101 and R102.
- (2) V10b is passing current, as determined by the cathode resistor R97 and by its grid potential, caught by the diodes at the potential (approx.) at the junction of R101 and R102.
- (3) V10a is cut off, since its grid is returned to the junction of R102 and R103, a less positive point than that from which V106 grid bias is derived, whilst its cathode potential is determined by the grid potential of V10b.

**31.** The sampler trigger pulse from SK1 in the TB141 unit is applied to SK2 in the video unit. This trigger pulse may be the negative trigger from the eleventh 10-mile pip selector, or the positive square wave from the TB141 V5, for the insertion of delay. This square wave is differentiated by C25 and R221 and the resultant is applied to the junction of V11a cathode and V11b anode. The positive component of the differentiated input waveform momentarily cuts off V11a but has no effect on the equilibrium of the circuit. The negative component, however (or the eleventh 10-mile pip trigger), cuts off anode current in V11b and causes increased current through V11a, thus producing a voltage drop across R98, with C24 and R99 effectively in parallel.

#### Flip-flop

**32.** The grid of V10b is therefore driven sharply negative by the trigger pulse, whilst the grid of V10a is held at a steady positive potential by the charge on C18. The reduced current of V10b through the common cathode load appears as positive bias to V10a; this valve therefore passes increased anode current, to produce across the anode load R99 a voltage drop which is applied as negative bias to V10b. This action is cumulative and V10b is rapidly cut off, so that a positive potential is produced across the anode load R94. The extent of the negative grid movement at V10b, as the circuit "flips" into its unstable state, is dependent on the voltage developed across R99, which in turn depends on the initial grid potential of V10a and on the cathode resistor.

**33.** V10b remains cut off as long as its control grid is held negative by the charge on C24. This depends on the time constant of C24 and the associated resistors RV6 and R98, and also on the setting of RV6, which determines the charging current for C24. As soon as V10b is able to pass current, it biases V10a through the cathode load



**Fig. 15. Amplifying unit Type 515—waveforms**

and a reverse cumulative action takes place. The circuit "flops" back into its stable condition until the arrival of the next trigger pulse. The output from V10b is therefore a positive-going square wave, the duration of which depends on the setting of RV6 (adjusted to give 100 μ sec.). Fig. 15 (a) illustrates the relationship of the trigger pulse to the TB141, the 10-mile pips, the delay pulse produced in the TB141 and the gating pulse produced by V10b.

#### Gated comparison circuit

**34.** This stage of the sampler consists of V1, V2 and V3. On position 1 of SWF the gating waveform is applied to V3 via C2 and the relay contacts B3. The incoming signal, normally a timebase sawtooth (resolved or unresolved), enters on SK6 (AUTO SIG) and feeds into the control grid of V1 via SWFg, relay contacts B1 and B2, SWH and SWAa.

**35.** In the static condition the valves V1 and V2 in the cathode-coupled differential amplifier are cut off, on account of V3, which acts as the common cathode impedance, being prevented from passing current by negative bias on the control grid. The grid is returned to the -300V

line via R16, while the cathode is returned to a less negative point at the junction of R23 and R19.

**36.** For the stage to amplify, the valve V3 must be made to conduct. In the sampling position of SWF (position 1), this is achieved by feeding the gating waveform to the control grid of V3 as mentioned in para. 34. V3 then passes current for the duration of the waveform and enables V1 to respond to the input signal from SK6. For linearity checking (SWF positions 2 and 3) V3 is made to pass current by the closure of relay contacts B3, and for checking paraphase gain in the TB140 units by the closure of contacts D2, which apply a fixed bias.

#### Function of sampler

**37.** When the 100  $\mu$  sec. gating waveform from V10b is applied to the control grid of V1, negative pulses are produced at the anodes of V1 and V2. For setting up a reference voltage is also applied to the grid of V1 from the SELECTOR switch SWA (e.g., EARTH potential with SWAa in position 2) and the potentiometers RV1 (SAMPLER REFERENCE (COARSE)) and RV2 (SAMPLER REFERENCE (FINE)) are adjusted until the pulses are exactly equal. This is achieved by applying the pulses from V1 and V2 to the high gain, sampler differential amplifier, feeding into the video amplifier, and displaying the pulses for comparison, with any difference in amplitude greatly magnified. The adjustment of RV1 and RV2, reducing the displayed difference voltage to a minimum, is known as zeroing the sampler. Fig. 15 (b), (c) and (d) illustrate the waveforms displayed as RV1 and RV2 are adjusted. The direction of the transients cannot be predicted.

**38.** Reference voltages for setting up are provided on positions 2, 4 and 5 of SWAa, labelled EARTH, REMOTE "X" and REMOTE "Y", respectively. Positions 4 and 5 connect in circuit one or other of the rear panel, preset potentiometers RV3 or RV4. These controls cater for stations having remote Type 7 installations, where a deflection voltage is required, corresponding to the distance from the operational building of the remote Type 7 installation. When the sampler has been zeroed (i.e., V1 and V2 pass equal currents during the gating pulse) SWAa is turned to position 1 (SIGNAL) to admit the sawtooth input to the grid of V1 from socket SK6.

**39.** For normal sampling (e.g., sampling rest levels) the relay RLA is de-energized and V1 grid is connected to earth via relay contacts A1 and resistor R2 (47K). R2 is effectively in parallel with the input resistor R1 (22K) to provide an apparent source impedance of 15K. The need for R1 is described later in connection with velocity checking (para. 42). It should be noted that the input impedance of 15K must be maintained for all connections to the grid of V1 to ensure that each connection is affected equally, should grid current flow to a small extent in V1. V2 grid is also connected to the slider of RV2 via 15K (R24) to balance V1. RV10, in the anode circuit of V1 and V2, is used as an addi-

tional preset balance control, to equalize the dynamic gains of V1 and V2. The toggle switch SWH is used when setting up the trimmer condenser C68 (para. 46).

**40.** With SWAa on SIGNAL, V1 responds when the gating pulse arrives at V3, that is, when the sawtooth is at rest level at the end of the inter-trace period. Should the amplitude of the signal be zero (i.e., earth potential or the setting of RV3 or RV4, as appropriate) the sampler will remain zeroed, but if the input signal is not at zero an amplified error is displayed, indicating the extent of the departure from the rest level.

#### Amplitude check

**41.** To enable an assessment of errors in the amplitudes of incoming waveforms to be made (the sampler having been zeroed using the correct reference voltage) SWAa may be operated to position 3 to connect SWBa (CAL.) in circuit. This switch allows specific calibration voltages (viz.: -1V, -0.1V, -0.01V, 0, +0.01V, +0.1V or +1V) to be applied to V1 for comparison purposes. The amplified error can thus be interpreted in terms of the input voltage and adjustment may be made to the unit producing the signal.

#### Velocity check

**42.** For velocity checks, the relay RLA is operated from panel Type 890 and contacts A1 connect the grid of V1 to a potential divider (junction of R3 and R4) between -500V reference and earth (the links LK1a and LK1b make provision for using the -50V reference at some future date). The sampling is now carried out at a point on the sawtooth corresponding to a range of 110 miles, when the voltage of the sawtooth should be 22.9V, but because of the potential divider R1 and R3 to R5, the grid of V1 should be at earth potential when V1 and V2 start conducting. It will be observed that the effective impedance of the input network is again 15K for balanced operation.

**43.** The output from V1 is then a negative-going pulse (due to the gating waveform) with a negative-going sawtooth superimposed, while the output from V2 is a negative-going pulse with a positive-going sawtooth imposed, representing the difference between the grid potentials of V1 carrying the signal and V1 held at earth. The push-pull outputs from V1 and V2 (shown in fig. 15 (e), left and right-hand waveforms, respectively) are fed to bootstrap cathode followers V4a and V4b, respectively, which preserve the shape of the waveform and feed V7 and V6, respectively, in the sampler amplifier.

#### Slope correction circuit

**44.** This circuit is used for velocity measurements with SWAb in position 1 (SIGNAL) and RLA operated so that contacts A2 connect SWAb(7) to the junction of C8 and R49. The circuit is required to align the sampled period with the rest of the CRT trace (V1 and V2 having already

been balanced as described in *para. 37 to 39*). To achieve this, the output from V4a is made to conform with that from V4b, by reversing the slope of the sawtooth component. The broken line on the left-hand waveform in fig. 15 (e) illustrates this reversal. The resultant waveform then coincides with the right-hand waveform in (e).

**45.** The slope correction circuit is shown slightly simplified in fig. 16 for easy reference. It consists of V5a and V5b together with associated components. In the no-signal state both V5b (connected as a diode) and the cathode follower V5a are passing current, SWJ being in the NORMAL position. V5b is held in conduction by the return of its anode, via resistors R51 and R48, to the positive potential at the slider of RV5, the preset, front panel control, labelled SLOPE CORRECTION. Since the cathode of V5b is connected to earth, the grid of V5a (connected to V5b anode) is slightly negative to earth. The cathode current of V5a is therefore high, being determined by the potential to which the cathode is returned (viz.: 300V negative) and the cathode resistor R54 (47K).

*Function of circuit*

**46.** The negative pulse from the cathode of V4a, with its component of slope, is applied via C7 to the anode of V5b and to the grid of V5a. The diode is cut off by the leading edge of the pulse and current from RV5 then flows into C7 as illustrated by the broken line in the left-hand waveform of fig. 15(e). The setting of RV5

controls the charging current and therefore the slope of the waveform, which is adjusted to coincide with the output from V4b (right-hand waveform in fig. 15 (e)). The current flow into C7 is kept linear by the bootstrap effect of V5a feedback, via C10 and R48, and the resultant response is applied via C8 and relay contacts A2 to SWAb, which feeds into the sampler amplifier. SWJ is provided to permit the adjustment of C68, a factory-preset control for balancing the stray capacitances in circuit in the two positions of relay contacts A2.

**47.** When the slope correction circuit is not required (note that the output from the circuit via C8 is not available when SWA is not on SIGNAL), the relay RLA is not operated. The output from V4a is then applied via C6 and contacts A2 to SWAb in the SIGNAL position, or direct to SWAb on its other positions. SWAb then feeds V7 in the sampler amplifier.

**Linearity checking circuit**

**48.** In positions 2 and 3 of SWF the linearity stage of the unit is in circuit, due to the operation of RLB by SWFj. The stage consists of V12, V13, V14a, V14b, and V15. In position 2 of SWFh the 250 c/s BU pulse from SK4 is applied to the control grid of V12. In position 3 the input is the 500 c/s BU from SK3. In both switch positions, wafer SWFg feeds the waveform to be checked from SK6 to the cathode of V14b via relay contacts B1, while the output from the cathode follower V15 is fed to V1 in the sampler stage via contacts B2.

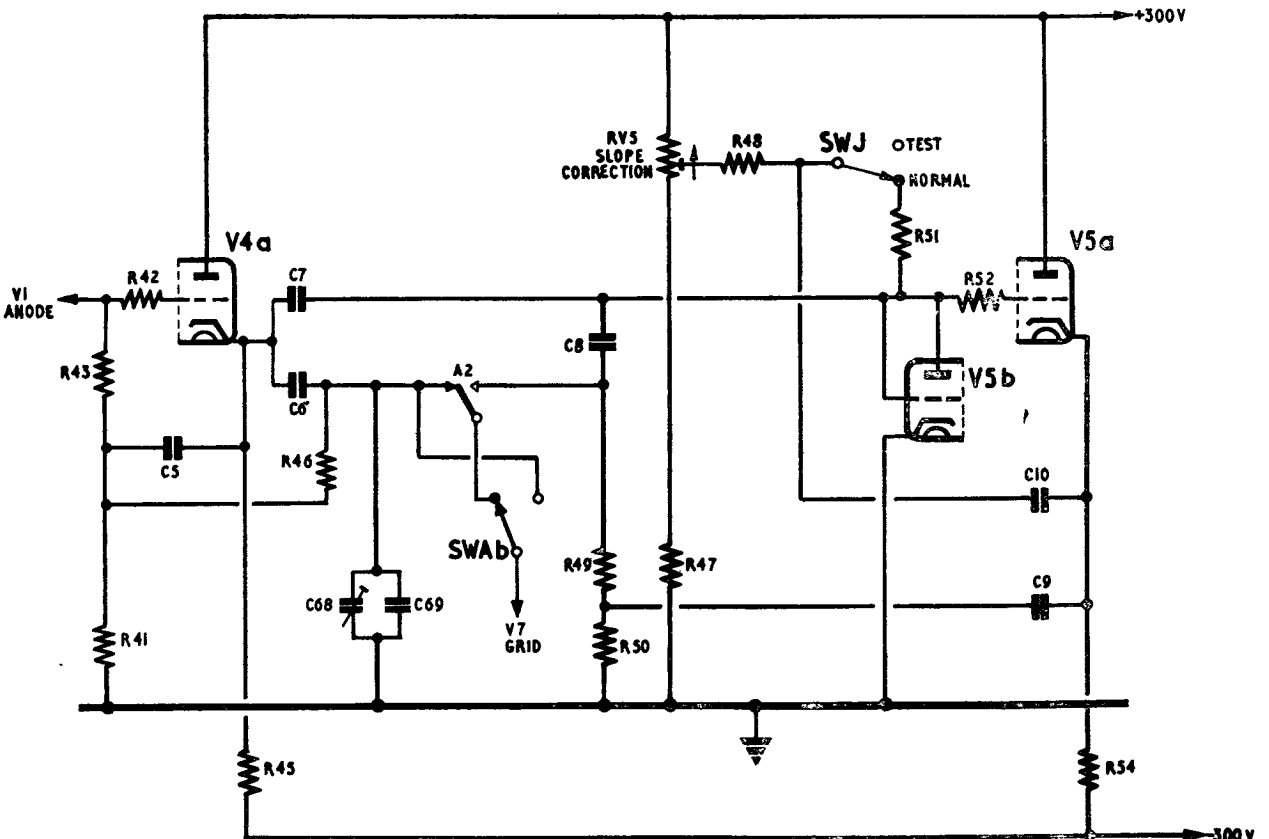


Fig. 16. Slope correction circuit

**49.** The positive-going BU signals are amplified and inverted in V12, which is biased from the potential divider R104 and R106, between the decoupled point at the junction of R109 and R110 in the anode circuit, and the negative HT line. This arrangement gives DC stability of anode current.

**50.** During the inter-trace period, the triode V13a is held in conduction by the positive potential at the junction of R111 and R112, applied to its grid via R113, and current through its cathode load R117, which is returned to the negative HT line. The positive potential at the cathode of V13a then drives current through V14a, the cathode of which is returned to the slider of RV7 (front panel, manual LINEARITY control), part of a potential divider between PL1/B (-500V) and earth. Current also flows through V14b, the cathode of which is returned to earth through the low impedance of the source connected to SK6. Both sides of C30 are at the same potential (near earth) in the no-signal state.

**51.** The negative-going pulses at the anode of V12, corresponding to the BU signals, are applied to V13a control grid, DC restored by the diode-connected V13b to the potential at the junction of R111 and R112. The cathode of V13a follows and both V14a and V14b are cut off, their anodes being driven below earth. At the same time the positive-going input sawtooth from SK6 is applied to the V14b side of C30. Current then flows out of C30 through R119 towards the negative potential at the slider of RV7. This potentiometer is adjusted so that the current flowing out of the condenser ensures that the sawtooth appears only on the input side of C30, i.e., the R119-RV7 side remains at a steady DC level, assuming a perfect sawtooth input. The potential across R119 is therefore constant and the feed to V15 is a steady DC level. Any non-linearity in the sawtooth is, however, amplified by the full gain of the sampler and video amplifiers and appears as a curve on the displayed waveform (fig. 17). Since C30 is virtually being compared with the timebase condensers in the TB140 units, when testing unresolved waveforms, it must have at least the same standard of accuracy. In fact, a better condenser than the one used in the TB140 is being found by the manufacturers for use as C30. If non-linearity is apparent it is therefore assumed, in general, to be due either to

the TB140 condenser, or the TB Miller amplifier (for unresolved waveforms), or to the magstrip units in the resolver cabinets (for resolved waveforms). If, however, the non-linearity of a number of timebase units Type 140 shows a consistent bias, C30 may be at fault. This condenser must never, of course, be replaced by an item differing from the type specified.

#### Sampler amplifier

**52.** The sampler amplifier contains the cathode followers V4a and V4b, the first differential amplifier V6-V7 and the final differential amplifier V8-V9. The output from V8 and V9 is AC-coupled into the video amplifier via C22-R92 and C23-R91, respectively, on positions 1 to 3 of SWF.

**53.** The cathode followers V4a and V4b are bootstrap circuits which ensure that the time-constants of the couplings from the anodes of V1 and V2 are sufficiently long to cause no distortion of flat-bottomed pulses, nor to introduce different slope responses into sawtooth pulses fed from these anodes. For example, the feed from V1 to V4a via C4 and R43, with positive feedback via C5 and R41, makes R43 appear as a large impedance and the time-constant C4-R43 appears correspondingly long.

**54.** V6 and V7 accept the nearly equal pulses from V4b and V4a, respectively, the coupling again being on the bootstrap principle (e.g., the coupling C13, R60, C12 and R56 makes R60 look large). The cathode resistors R65 and R68 help to equalize currents through V6 and V7, while the 1 to 10 ratio of the anode loads to the common cathode load (R66) gives a measure of the attenuation of the in-phase components. The differential component is amplified by a factor of about 8 (i.e., for a difference of 0.1V between the grids of V6 and V7, the change in anode volts is +0.4V and -0.4V).

**55.** The anodes of V6 and V7 are coupled to the final differential amplifier by the input arms R71 and R72, respectively, of a push-pull see-saw. V8 and V9 are stabilized by DC feedback from their anodes to their grid leaks via R76 and R88, respectively, while AC-coupling, via C20 and C21, is employed from the centre points of the see-saw to the grids. The ratio of R74/R71 and similarly R75/R72 establish a differential gain of about 10. The usual compensating capacitors are connected across the resistive arms.

#### Super regulator stage

**56.** For accurate reproduction of waveforms the early stages of the sampler section (V1 to V7) are supplied from an extremely stable HT supply of +300V relative to earth. This is derived from the +400V line and uses the -300V line for reference. The circuit operates in a similar manner to the regulator circuits in the power unit, described in detail in Chap. 1 of this Section.

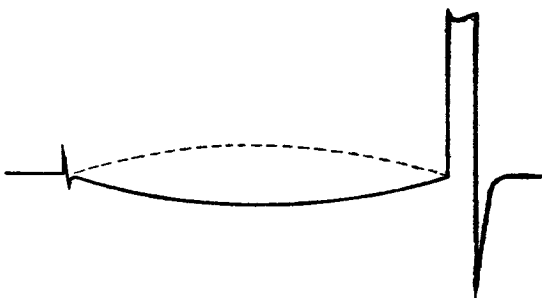


Fig. 17. Linearity checking waveform

**TABLE I**  
**Amplifying unit (video) Type 515**  
**(10U/16785)**

**List of Components**

**Resistors, Fixed**

Circuit Ref.	Description	Type	Value	Rating	Tolerance (per cent)	Ref. No.
R1	Muirhead Type D333	13533	22K	$\frac{1}{2}$ W	0·1	10W/20210
R2, R11			47K	$\frac{1}{2}$ W	5	Z216082
R3			51K	$\frac{1}{2}$ W	5	Z216087
R4, R5			240K	$\frac{3}{4}$ W	1	Z216535
R6	Muirhead Type D333	13534	48K	$\frac{1}{2}$ W	0·1	10W/20211
R7, R8, R24						
R222			15K	$\frac{1}{2}$ W	5	Z216022
R9, R15, R42						
R52, R57, R61,						
R73, R79, R87,						
R95, R100, R105,						
R118, R126, R142,						
R145, R159, R165,						
R169, R171, R176,						
R182, R188, R196,						
R199, R202, R209,						
R211,						
R10			620K	$\frac{3}{4}$ W	5	Z216745
R12, R21			4·7K	$\frac{1}{2}$ W	2	Z215801
R13			100K	$\frac{3}{4}$ W	2	Z216452
R14, R18			2·7K	$\frac{1}{2}$ W	2	Z215741
R16, R91, R92,						
R113, R226			1M	$\frac{1}{2}$ W	10	Z223164
R17, R103			82K	$\frac{1}{2}$ W	2	Z216431
R19			3·9K	$\frac{1}{2}$ W	5	Z215312
R20, R44, R53,						
R58, R62, R69,						
R80, R85, R93,						
R108, R116, R127,						
R161, R167, R177,						
R181,						
R22, R64, R67, R82,						
R83, R107, R120,						
R121, R125, R129,						
R130, R139, R140,						
R143, R144, R146,						
R219, R220			33Ω	$\frac{1}{2}$ W	5	Z215062
R23			100K	1W	5	Z216124
R25, R28			13K	$\frac{1}{2}$ W	5	Z216017
R26, R27			180K	$\frac{3}{4}$ W	5	Z216719
R29, R32			470Ω	$\frac{1}{2}$ W	5	Z215202
R30, R31			22K	$\frac{1}{2}$ W	5	Z216042
R33, R40			330K	$\frac{3}{4}$ W	1	Z216559
R34, R39			910Ω	$\frac{1}{2}$ W	1	Z215626
R35, R38			91Ω	$\frac{1}{2}$ W	2	Z215392
R36, R37, R189,						
R195, R204, R207			10Ω	$\frac{1}{2}$ W	5	Z215002
R41, R43, R46, R49,						
R50, R55, R56,						
R60, R131, R135			470K	$\frac{1}{2}$ W	10	Z223122
R45, R59			100K	$1\frac{1}{2}$ W	5	Z216125
R47			82K	$\frac{1}{2}$ W	5	Z216112
R48			220K	$\frac{1}{2}$ W	5	Z216722
R51, R98			910K	$\frac{3}{4}$ W	5	Z216755
R54			47K	6W	5	Z244150
R63, R70			3·3K	$\frac{1}{2}$ W	5	Z215302
R65, R68			200Ω	$\frac{1}{2}$ W	5	Z215157
R66			33K	6W	5	Z244141
R71, R72, R122			68K	$\frac{1}{2}$ W	2	Z216411
R74, R104, R174,						
R186, R215, R217			1M	$\frac{3}{4}$ W	2	Z216659

TABLE I—(continued)

## Resistors, Fixed

Circuit Ref.	Description	Type	Value	Rating	Tolerance (per cent)	Ref. No.
R75	—	—	1M	$\frac{1}{2}$ W	2	Z216658
R76, R88	—	—	470K	$\frac{1}{2}$ W	5	Z216738
R77, R90	—	—	1M	$\frac{3}{4}$ W	5	Z216757
R78, R89	—	—	4·7M	$\frac{1}{2}$ W	10	Z223248
R81, R86	—	—	47K	1W	5	Z216084
R84, R178, R183	—	—	39K	6W	5	Z244146
R94	—	—	8·2K	$\frac{1}{2}$ W	2	Z215861
R96	—	—	39K	$\frac{1}{2}$ W	10	Z222206
R97	—	—	16K	1W	2	Z216264
R99	—	—	22K	$\frac{1}{2}$ W	5	Z216042
R101	—	—	270K	$\frac{3}{4}$ W	2	Z216547
R102	—	—	39K	$\frac{1}{2}$ W	2	Z216351
R106	—	—	1·2M	$\frac{3}{4}$ W	2	Z216766
R109	—	—	7·5K	1W	5	Z215349
R110	—	—	22K	6W	5	Z244129
R111, R114	—	—	220K	$\frac{3}{4}$ W	2	Z216531
R112	—	—	120K	$\frac{1}{2}$ W	2	Z216471
R115	—	—	330K	$\frac{3}{4}$ W	2	Z216563
R117	—	—	100K	1 $\frac{1}{2}$ W	5	Z216125
R119	—	—	2·2M	1W	2	Z216795
R123, R218	—	—	680K	$\frac{1}{2}$ W	10	Z223143
R124, R132, R141, R221, R224	—	—	100K	$\frac{1}{2}$ W	10	Z223038
R128	—	—	150K	1W	2	Z216492
R133, R134	—	—	390K	$\frac{3}{4}$ W	2	Z216579
R136, R137	—	—	47K	$\frac{1}{2}$ W	10	Z222215
R138	—	—	68K	1W	10	Z213325
R147	—	—	220K	$\frac{1}{2}$ W	10	Z223080
R148	—	—	150 $\Omega$	$\frac{1}{2}$ W	5	Z215142
R149	—	—	68K	$\frac{1}{2}$ W	10	Z223017
R150, R155	—	—	110K	$\frac{1}{2}$ W	1	Z216456
R151, R154	—	—	300K	$\frac{1}{2}$ W	1	Z216550
R152, R153	—	—	1·2M	$\frac{3}{4}$ W	1	Z216764
R156, R160	—	—	4·7M	1 $\frac{1}{2}$ W	1	Z216691
R157, R158	—	—	33K	$\frac{1}{2}$ W	10	Z222194
R162, R168	—	—	22K	1 $\frac{1}{2}$ W	5	Z216045
R163, R164	—	—	620K	$\frac{1}{2}$ W	1	Z216614
R166, R190, R194	—	—	10K	6W	5	Z244098
R170, R185, R198, R212	—	—	560K	$\frac{1}{2}$ W	2	Z216610
R172, R175	—	—	1·8M	$\frac{3}{4}$ W	2	Z216784
R173	—	—	820K	$\frac{1}{2}$ W	2	Z216642
R179	—	—	10K	$\frac{1}{2}$ W	10	Z222131
R180, R184	—	—	160K	$\frac{1}{2}$ W	1	Z216495
R187, R191	—	—	470K	$\frac{1}{2}$ W	2	Z216594
R192	—	—	15K	$\frac{1}{2}$ W	10	Z222152
R193	—	—	10K	10W	5	Z244099
R197, R216	—	—	270K	$\frac{1}{2}$ W	10	Z223092
R200, R201	—	—	1M	$\frac{1}{2}$ W	1	Z216654
R203, R208	—	—	1K	$\frac{1}{2}$ W	5	Z215242
R205, R210	—	—	3·3K	1 $\frac{1}{2}$ W	2	Z215764
R206	—	—	18K	$\frac{1}{2}$ W	10	Z222164
R213	—	—	620K	$\frac{3}{4}$ W	2	Z216619
R214	—	—	160K	$\frac{1}{2}$ W	2	Z216500
R223	—	—	300K	$\frac{3}{4}$ W	1	Z216551
R225	—	—	2·2K	$\frac{1}{2}$ W	2	Z215721
R227, R228	—	—	10K	4 $\frac{1}{2}$ W	5	Z224097

TABLE I—(continued)

Resistors, Variable

Circuit Ref.	Description	Type	Value	Rating	Tolerance (per cent)	Ref. No.
RV1	—	—	10K	1W	10	Z272141
RV2	Colvern Type CLR 2501/264	11273	10K	5W	5	10W/19487
RV3	—	—	10K	1W	10	Z272141
RV4	—	—	10K	1W	10	Z272141
RV5	—	—	100K	1W	10	Z272549
RV6	—	—	100K	1W	10	Z272549
RV7	Colvern Type CLR 2501/264	11274	50K	5W	5	10W/19488
RV8	—	—	50K	1W	10	Z272410
RV9	Colvern Type 5237/263	11275	100K	2½W	10	10W/19489
RV10	—	—	5K	1W	10	Z272005

Capacitors, Fixed

Circuit Ref.	Description	Type	Value	Rating	Tolerance (per cent)	Ref. No.
C1, C3, C4, C5, C8, C9, C10, C11, C12, C18, C20, C21, C22, C23, C27, C28, C29, C32, C49, C61, C63	—	—	0·1μF	350VDC	20	Z115506
C2	—	—	0·02μF	750VDC	20	Z115504
C6, C7, C13	—	—	10,000pF	350VDC	5	Z12743
C14, C17	—	—	6·8pF	500VDC	10	Z132268
C15, C16	—	—	100pF	500VDC	5	Z132185
C19, C60, C62	—	—	1·0μF	150VDC	25	Z115569
C24	—	—	300pF	500VDC	5	Z132316
C25	—	—	220pF	500VDC	10	Z132312
C26	—	—	0·5μF	350VDC	20	Z115511
C30	Muirhead Type B518T	7604	0·005μF	250VDC	1	10C/20462
C31	—	—	1·0μF	600VDC	20	Z112823
C33, C56, C65	—	—	100pF	500VDC	10	Z132300
C34, C48	—	—	47pF	500VDC	5	Z132288
C35, C66	—	—	0·05μF	350VDC	20	Z115554
C36, C46, C54, C55	—	—	27pF	500VDC	5	Z132279

Capacitors variable

Circuit Ref.	Description	Type	Value	Rating	Tolerance (per cent)	Ref. No.
C37, C39, C44, C45, C47, C58, C59, C68	(Capacitors, variable)	—	3–30pF	70VDC	—	Z167006
C38, C41, C42, C43	—	—	15pF	500VDC	5	Z132068
C50, C53, C57, C64	—	—	22pF	500VDC	5	Z132276
C51, C52	—	—	82pF	500VDC	5	Z132297
C67	—	—	0·001μF	350VDC	20	Z115623
C69	—	—	27pF	500VDC	10	Z132280
C70	—	—	68pF	500VDC	10	Z132295
C71	—	—	10pF	500VDC	10	Z132253

Miscellaneous

Circuit Ref.	Description	Type	Value	Rating	Tolerance (per cent)	Ref. No.
MR1	Resistor unit (Metro-Vic metrosil Type 100A) Switch (NSF wafer, Type H)	514	—	50VDC	—	10W/19566
MR2		2718	—	—	—	10F/18604
SWA		—	—	—	—	—

TABLE I—(continued)

## Miscellaneous

Circuit Ref.	Description	Type	Value	Rating	Tolerance (per cent)	Ref. No.
SWB	Switch (NSF wafer, Type H)	2721	—	—	—	10F/18607
SWC	Switch (NSF wafer, Type H)	2719	—	—	—	10F/18605
SWD	Switch (NSF wafer, Type H)	2720	—	—	—	10F/18606
SWE	Uniselector unit (Type H and Ledex rotary Selector)	6056	75Ω	—	—	10F/18608
SWF	Uniselector unit (Type H and Ledex rotary Selector)	6057	48·2Ω	—	—	10F/18609
SWG	Switch CH Type	8373B4	—	3A	—	—
SWH	Switch D.P.D.T.	—	—	3A	—	Z510304
SWJ	Switch S.P.S.T.	—	—	3A	—	Z510300
RLA	} Relays SM5N/4C	—	—	—	—	Z530004
RLB		—	—	—	—	Z530040
RLC	Relay SM8/5	—	—	—	—	Z530040
RLD	Relay SM5N/4C	—	—	—	—	Z530004
PL1	Plug 6-way (med.), fixed	Mk. 4	—	—	—	Z560140
SK2 to SK6, SK9, SK13 to SK15	} Sockets, coaxial	—	—	—	—	10H/19861
PL7		Plug, 12-way, fixed	Mk. 4	—	—	—
P18	Plug, 6-way (small), fixed	Mk. 4	—	—	—	Z560581
PL10	Plug, 6-way (med.), fixed	Mk. 4	—	—	—	Z560541
PL11	Plug, 6-way (med.), fixed	Mk. 4	—	—	—	Z560542
PL12	Plug, 12-way, fixed	Mk. 4	—	—	—	Z560152
SK16	Socket, 25-way, fixed	Mk. 4	—	—	—	Z560380
SK17	Socket, 25-way, fixed	Mk. 4	—	—	—	Z560380
PL18	Plug, 12-way, fixed	Mk. 4	—	—	—	Z560153

## Note . . .

*This table is issued as an aid to servicing. When demanding spares reference should be made to Vol. 3 of this Publication.*



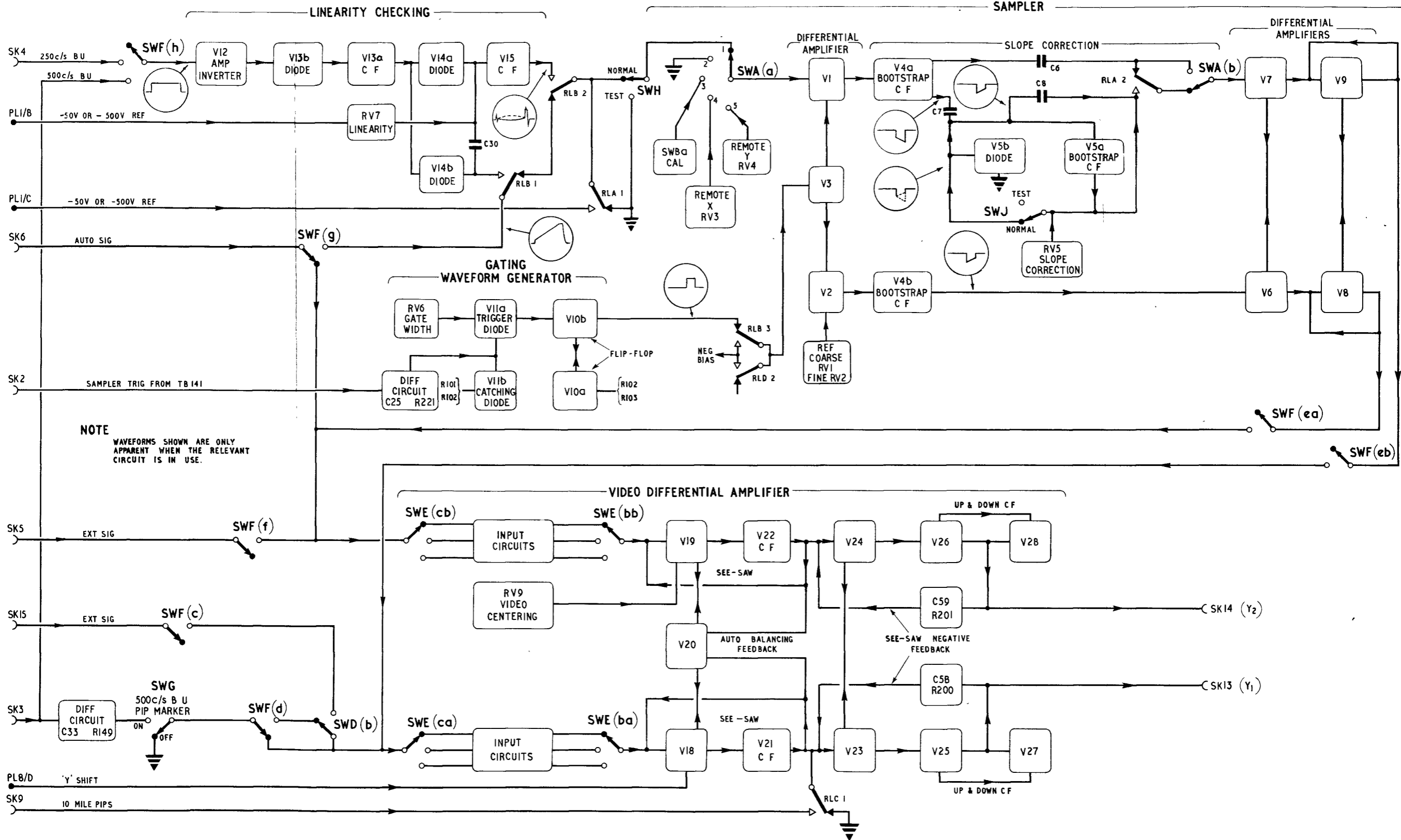


Fig. 18

Amplifying unit (video) Type 515 - block diagram

Fig. 18

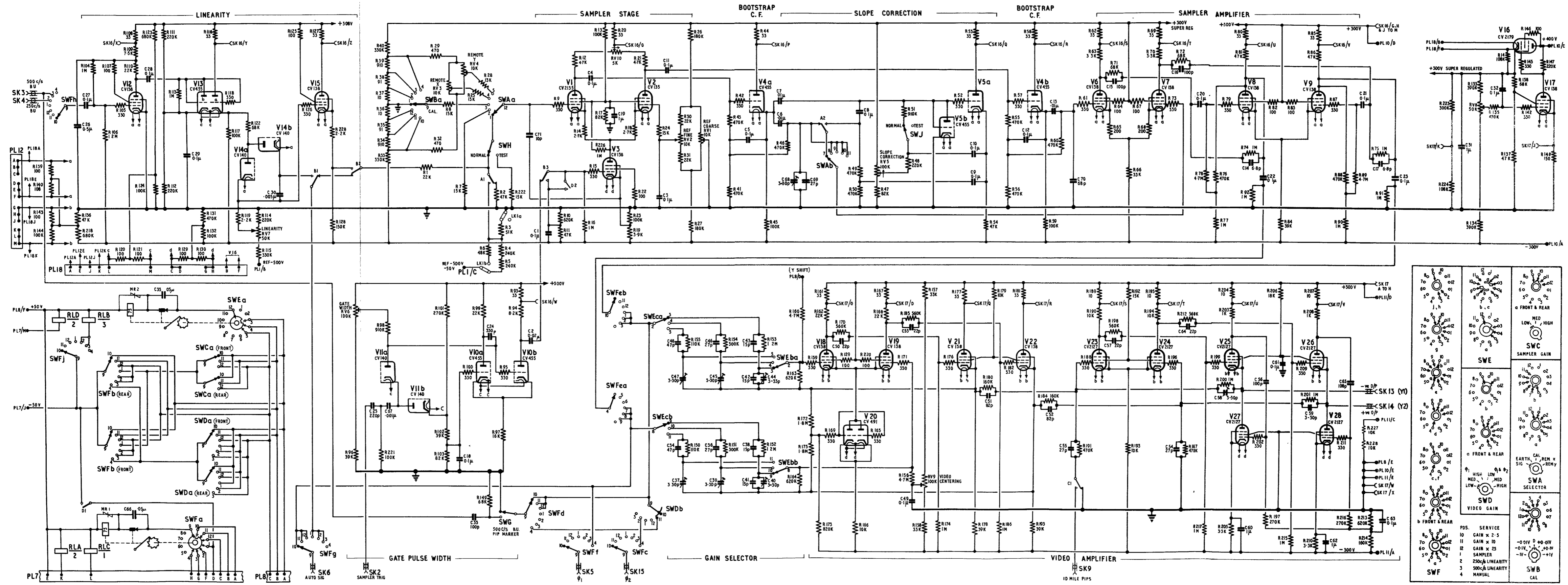


Fig.19

Amplifying unit Type 515-circuit

Fig.19

### Appendix 1

## AMPLIFYING UNIT (VIDEO) TYPE 515A

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#### Introduction

1. The Type 515A was produced to allow for a -50V and -500V station reference supply, and for long range timebase working.

#### General description

2. The Type 515A is similar to Type 515 except that the former has the following modifications to the sampler stage input circuit:

- (1) To maintain the same conditions at VIA grid when either a -50V or -500V

reference supply is used, links are provided which connect either of two potentiometer networks to the input to VIA. The link assembly is shown in fig. 1.

(2) To measure the velocity of both normal and long range timebase waveforms, a manually operated switch is provided which, when set to the L/R TIMEBASE position, connects two additional resistors into the potentiometer networks. The location of the switch (SWK) and label is shown in fig. 2; the location of the two resistors (R232 and R233) is shown in fig. 3.

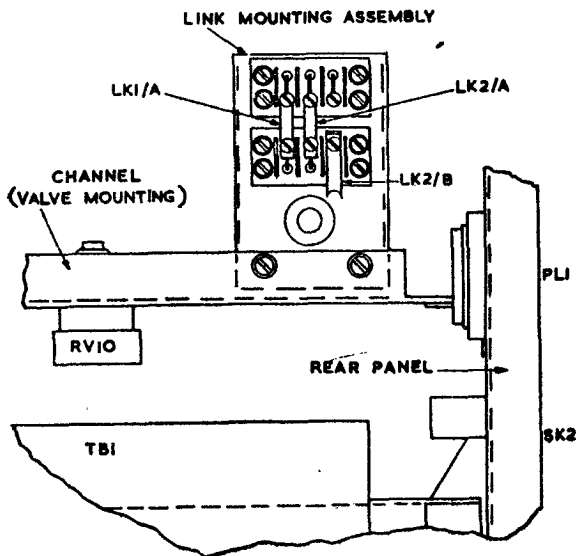


Fig. 1 Link assembly LK1—LK2, amplifying unit (video), Type 515A—scrap diagram.

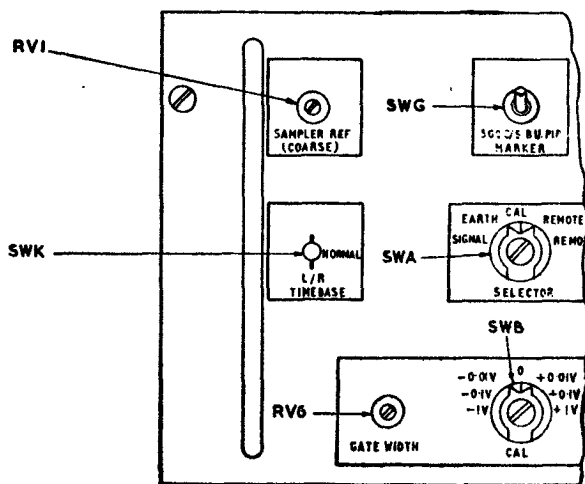


Fig. 2. Amplifying unit (video) Type 515A—front panel—scrap diagram

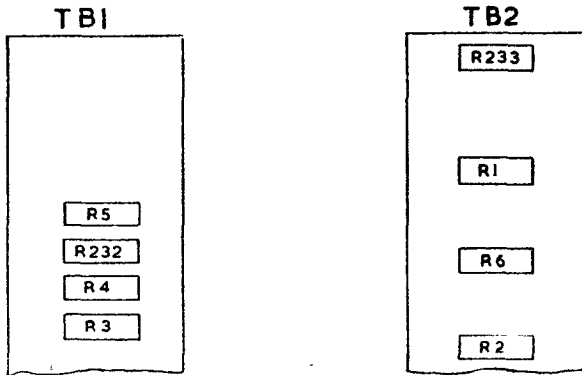


Fig. 3. Amplifying unit (video) Type 515A—tagboards 1 and 2—scrap diagrams

**Circuit description (fig. 4)**

3. For a -500V reference supply, link LK2B is disconnected and links LK1A and LK2A connected. With SWK in the NORMAL position, the circuit operation is identical to that of amplifying unit Type 515 (Chap. 3, Para. 42).

4. Since the potential difference of a long range sawtooth at a point corresponding to 110 miles is only 17.2V, an additional resistor R232 is introduced for long range velocity checks by operating SWK to the L/R TIMEBASE position. This maintains zero potential on VIA grid at 110 miles range.

5. When the unit is required to operate on a -50V reference supply, LK1A and LK2A are disconnected and LK2B is connected. This removes R3, R4, R5 and R232 from the circuit, and

replaces them with R6 and R233; thus the same conditions are maintained at VIA grid with the lower reference voltage. The circuit operation is basically similar to that with the -500V reference supply, R233 being in circuit only when SWK is in the L/R TIMEBASE position. Table 1 gives full details of resistors R232 and R233, the remainder of the components are as given in Table 1 of Chap. 3.

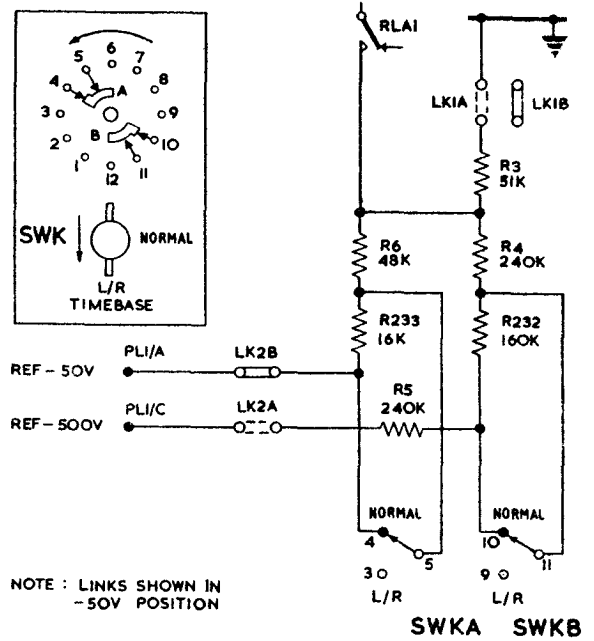


Fig. 4. Amplifying unit (video) Type 515A—scrap circuit

TABLE 1

Amplifying unit (video) Type 515A  
(10U/17440)

Scrap list of Components

Resistors, Fixed

Circuit Ref.	Description	Type	Value	Rating	Tolerance (per cent)	Ref. No.
R232			160K	½W	1	5905-99-021-6495
R233			16K	¼W	0.1	10W/23374

## Appendix 2

### AMPLIFYING UNIT (VIDEO) TYPE 515B

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#### Introduction

1. The Type 515B was produced to allow for long range timebase working at certain stations.

#### General description

2. The Type 515B is similar to Type 515A except

that the former is not provided with links and therefore, can be used only with a  $-500V$  reference supply. Consequently, resistor R233 is omitted, R6 is not used (fig. 1), and only one half of SWK is used. Details of R232 and SWK are as given for Type 515A.

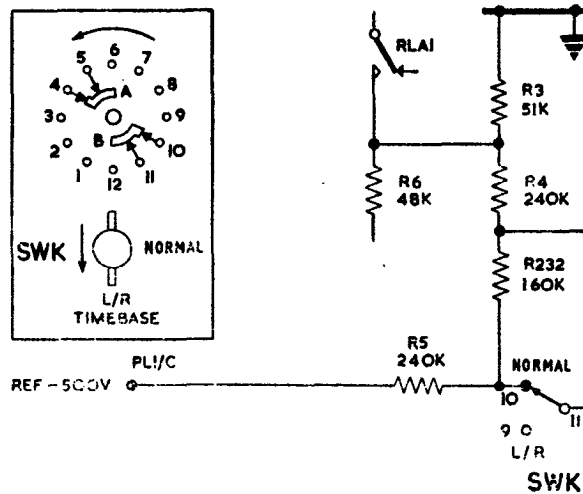


Fig. 1. Amplifying unit (video) Type 515B—scrap circuit

## Appendix 3

## AMPLIFYING UNIT (VIDEO) TYPE 515C

## Introduction

1. The amplifying unit (video) Type 515C (Ref. No. 10U/17472) is used in the rack (waveform monitor) Type 16505 at stations where Phase 1A modifications are incorporated. As the r.b.u. selection in the panel (distribution) Type 16506 is fed to SKT3 only on the video amplifier, SKT4 is connected to SKT3. The 515C also has some small improvements incorporated in the circuitry, as compared with previous versions.

## Component changes

2. The two resistors R102 and R103, in the gating

waveform generator in the video amplifier, are changed in value to 27k and 91k. This change in value increases the sensitivity of the circuit to the eleventh ten mile pip. To compensate for the change in resistance values, C24 is reduced to 180pf.

3. In order to check the linearity of the long range timebase, the range of RV7, the linearity control, is extended to cover the lower velocity of the long range timebase waveform. This is achieved by changing R114 and R115 to 74k and 180k.

TABLE 1

Amplifying unit (video) Type 515C  
10U/17472

## New values of components

Circuit Ref.	Value	Rating	Tolerance (per cent)	Ref. No.
R102	27k	½W	2	5905-99-021-6312
R103	91k	½W	2	5902-99-021-6441
R114	75k	¾W	2	5905-99-021-6422
R115	180k	¾W	2	5905-99-021-6511
C24	180p	750V	2	5910-99-011-8327

## Appendix 4

## AMPLIFIER, VIDEO

5840-99-954-8497

## Introduction

1. At certain stations where the integration of radar Type 85 has been carried out and the rack electrical equipment 5975-99-954-8362 is incorporated the amplifier, video 5840-99-954-8497 is used.

## General description

2. Refer to circuit diagram fig. 1. The amplifier video 5840-99-954-8497 is derived from the Type 515A described in Appendix 1. In order that the velocity of the  $\Delta^1$ ,  $\Delta^2$ , 275 data miles normal and extra long range timebase waveforms can be sampled in the Type 85 installation a number of component changes and additions are made, primary among these being the addition of relays RLD, RLF, RLG and RLH which allow the unit to be controlled by remote switching on the units in the cabinet electrical equipment sweep.

3. In order to maintain the same input conditions to the grid of V1A when sampling the additional amplifier inputs resistors R1 to R8, R24, 25, 28, 33, 40, 222, 232 and 233 have new values and R234,

235, 237, 238, 240 and 241 are added. Contact assembly 1 of RLD, RLF, RLG and RLH is arranged to automatically select the correct input resistor when remote selection is used. Additionally, the triggering of the sampler gate has been improved by modifying the values of R102, R103, C24 and C25.

4. In order to retain the slope correction and linearity checking facilities with 275 data miles = 50V, minor component changes and additions are necessary in those circuits. The values of R48, 51, 110, 112 and 119 are changed and R236, 239, 242 and 243 are added. The contacts of RLD are arranged to select the correct ELR/NORMAL facilities automatically when either of these services is selected on the panel waveform selection, contact RLD/1 eliminating the need for the ELR/NORMAL switch SWK. The coils of RLD and RLH are connected to the normal -50V selection lines to the Ledex actuator SWF and those of RLF and RLG are returned via two additional connections at PL1(D) and (E) to the selector switch in the monitor panel. Relay RLD becomes RLE.

TABLE 1

## Component changes

Circuit Ref.	Drawing or Spec. Ref.	J.S. Ref. No.	Value, etc.
C24	Def. 5133-1	5910-99-012-7121	220 pF $\pm 2\%$ 750V
C25	Def. 5133-1	5910-99-012-7321	470 pF $\pm 2\%$ 750V
R1	E/RAD/A31353 item 3	10W/20210	48 k $\Omega$ $\pm 0.1\%$ $\frac{1}{2}$ W
R2	Def. 5112	5905-99-021-6361	43 k $\Omega$ $\pm 2\%$ $\frac{1}{2}$ W
R3	R30-0031-83	5905-99-955-4767	39 $\Omega$ $\pm 1\%$ $\frac{1}{4}$ W
R4	R30-0031-84	5905-99-194-7211	114 $\Omega$ $\pm 1\%$ $\frac{1}{4}$ W
R5	R30-0031-85	5905-99-106-0383	10 k $\Omega$ $\pm 0.1\%$ $\frac{1}{4}$ W
R6	R30-0031-86	5905-99-194-7210	1.5 k $\Omega$ $\pm 0.2\%$ $\frac{1}{4}$ W
R7, R8, R24, R222	Def. 5112	5905-99-021-6042	22 k $\Omega$ $\pm 5\%$ $\frac{1}{2}$ W
R25, R28	Def. 5112	5905-99-021-6037	20 k $\Omega$ $\pm 5\%$ $\frac{1}{2}$ W
R33, R40	Def. 5112	5905-99-021-6591	470 k $\Omega$ $\pm 1\%$ $\frac{3}{4}$ W
R48	Def. 5112	5905-99-021-6726	270 k $\Omega$ $\pm 5\%$ $\frac{1}{2}$ W
R51	Def. 5112	5905-99-021-6749	750 k $\Omega$ $\pm 5\%$ $\frac{3}{4}$ W
R102	Def. 5112	5905-99-021-6312	27 k $\Omega$ $\pm 2\%$ $\frac{1}{2}$ W
R103	Def. 5112	5905-99-021-6441	91 k $\Omega$ $\pm 2\%$ $\frac{1}{2}$ W
R110	Def. 5111	5905-99-011-3433	33 k $\Omega$ $\pm 5\%$ 6W

TABLE 1-(continued)

Circuit Ref.	Drawing or Spec. Ref.	J.S. Ref. No.	Value, etc.
R112	Def. 5112	5905-99-021-6451	100 k $\Omega$ $\pm$ 2% $\frac{1}{2}$ W
R119	Def. 5112	5905-99-021-6798	2.4 M $\Omega$ $\pm$ 2% 1W
R222	see R7		
▶ R232	R30-0031-78	5905-99-950-8138	39 k $\Omega$ $\pm$ 0.1% $\frac{1}{4}$ W
R233	R30-0031-76	5905-99-950-8139	4.23 k $\Omega$ $\pm$ 0.1% $\frac{1}{4}$ W
R234, R240, R241	R30-0662-50	5905-99-951-8305	14.1 k $\Omega$ $\pm$ 0.1% 2W
R235	R30-0031-80	5905-99-950-8140	4.7 k $\Omega$ $\pm$ 0.1% $\frac{3}{4}$ W
R236	Def. 5112	5905-99-021-6714	150 k $\Omega$ $\pm$ 5% $\frac{1}{2}$ W
R237, R238	Def. 5112	5905-99-021-6022	15 k $\Omega$ $\pm$ 5% $\frac{1}{2}$ W
R239	Def. 5112	5905-99-021-6586	430 k $\Omega$ $\pm$ 2% $\frac{1}{2}$ W
R240, R241	see R234		
R242	Def. 5112	5905-99-021-6032	18 k $\Omega$ $\pm$ 5% $\frac{1}{2}$ W
R243	Def. 5112	5905-99-021-6510	180 k $\Omega$ $\pm$ 2% $\frac{1}{2}$ W
Relay chassis	E/RAD/C95152-B		containing RLE, RLF, RLG, RLH
▶ RLE, RLF, RLG, RLH	RCL 165 SM5A-N97	5945-99-011-9882	2500 $\Omega$



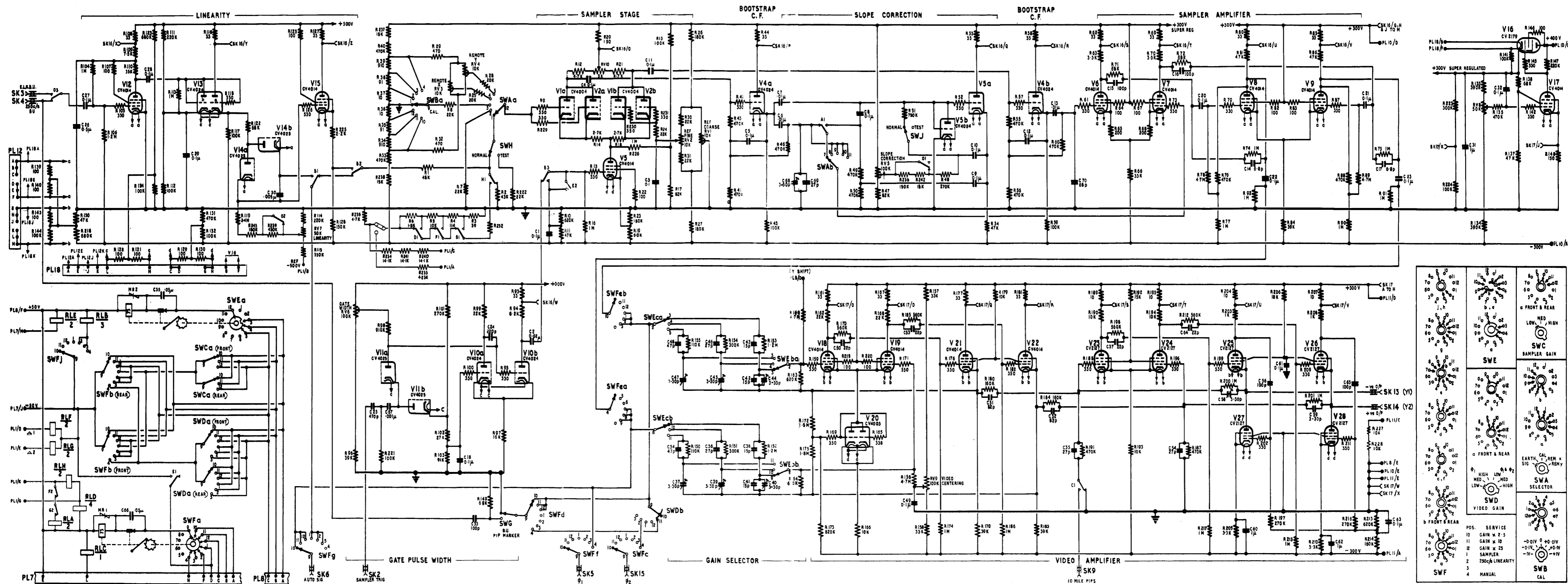


Fig. 1

Mar. 80 (Amdt. 58)

Amplifier, video 5840-99-954-8497: circuit

Fig. 1

## Appendix 5

## AMPLIFYING UNIT (VIDEO)

5840-99-956-7399

1. This amplifying unit is the Type 515C (App 3) with components changed, as listed in Table 1, in order that the velocity of the 275 data miles normal and extra long-range timebase waveforms can be sampled in the Type 85 installation. The additional relays allow the unit to be remotely controlled from the cabinet, electrical equipment, sweep.

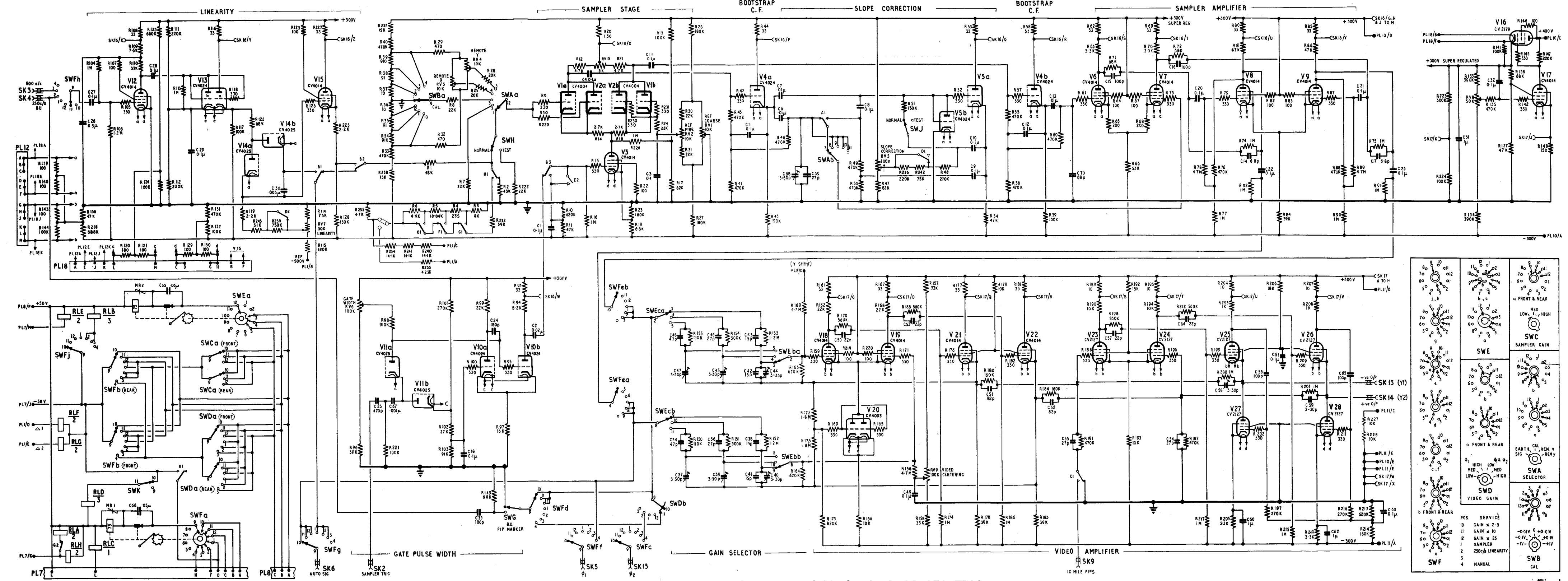
2. To ensure that the same input conditions exist at the grid of V1a when sampling, amplifier

input resistors R1 to R8, R24, R25, R28, R33, R40, R222, R232, and R233 have new values, and additional resistors R234 to R243 inclusive have been incorporated. Relay contact 1 of RLD, RLF, RLG and RLH is arranged to automatically select the correct input resistor when remote selection is used. To retain the slope correction and linearity checking facilities with 275 data miles = 50V, minor component changes and additions are necessary in those circuits. The values of R48, R110 are changed and R236, R239, R242 and R243 are added.

Table 1

## Component changes

Circuit ref.	Drawing or spec. ref.	Cat. No.	Value	Tol.%	Rating
C25	Def. 5133	5910-99-012-7321	470pF	±2	750V
R1	E/RAD/A31353	10W/20211	48K	±0.1	½W
R2	Def. 5112	5905-99-021-6361	43K	±2	½W
R3	R30-0031-87	5905-99-223-3931	80	±1	¼W
R4	R30-0031-88	5905-99-223-3932	235	±1	¼W
R5	R30-0031-89	5905-99-223-3933	18.84K	±0.1	¼W
R6	R30-0031-90	5905-99-223-3934	4.9K	±0.2	¼W
R7, R8, R24, R222	Def. 5112	5905-99-021-6042	22K	±5	½W
R8	See R7				
R24	See R7				
R25, R28	Def. 5112	5905-99-021-6037	20K	±5	½W
R28	See R25				
R33, R40	Def. 5112	5905-99-021-6591	470K	±1	¾W
R40	See R33				
R48	Def. 5112	5905-99-021-6726	270K	±5	½W
R110	Def. 5111	5905-99-011-3433	33K	±5	6W
R222	See R7				
R232	R30-0031-78	5905-99-950-5138	39K	±0.1	¼W
R233	R30-0031-76	5905-99-950-8139	4.23K	±0.1	¼W
R234, R240, R241	R30-0662-50	5905-99-951-8305	14.1K	±0.1	2W
R235	R30-0031-80	5905-99-950-8140	4.7K	±0.1	¾W
R236	Def. 5112	5905-99-021-6723	220K	±5	¾W
R237, R238	Def. 5112	5905-99-021-6022	15K	±5	½W
R238	See R237				
R239	Def. 5112	5905-99-021-6634	750K	±2	½W
R240	See R234				
R241	See R234				
R242	Def. 5112	5905-99-021-6107	75K	±5	½W
R243	Def. 5112	5905-99-021-6381	51K	±2	½W
Relay Chassis	E/RAD/C941152-B				
RLE, RLF, RLG, RLH	RCL 165 SM5A-N97	5945-99-011-9882	2500		



Amplifying unit (video) 5840-99-956-7399

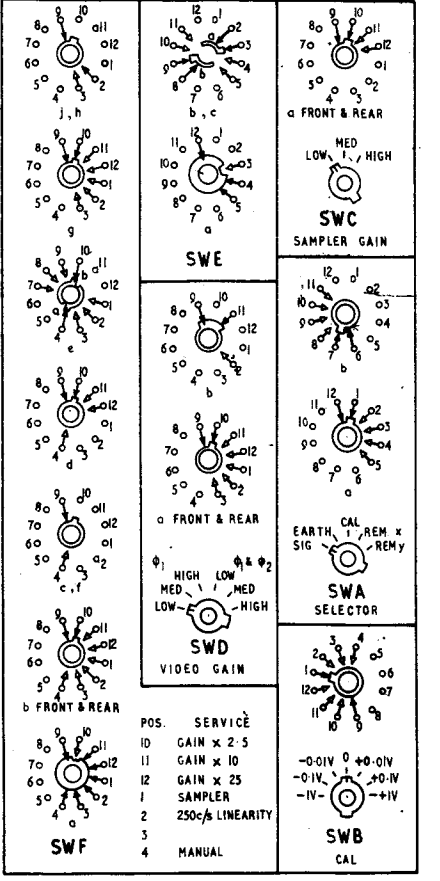


Fig. 1  
Chap. 3 App. 5

Appendix 6  
**AMPLIFYING UNIT (VIDEO)**  
 5840-99-956-7400

1. This amplifying unit is the Type 515B (App 2) with components changed, as listed in Table 1, in order that the velocity of the normal and extra long-range timebase waveforms can be sampled in the Type 85 installation. The incorporation of relays RLD, RLF, RLG and RLH allows the unit to be controlled remotely from the cabinet, electrical equipment, sweep.

**Circuit description**

2. In order to maintain the same input conditions to the grid of V1a when sampling, amplifier input resistors, R1 to R8, R24, R25, R28, R33, R40, R222, R232 and R233 have new values and R234, R235, R237, R238, R240 and R241 are added. Contracts RLD1, RLF1, RLG1 and RLH1 are arranged to select the correct input resistor during remote switching. The values of R102 and R102 have been changed to improve the triggering of sampler gate.

3. In order to retain the slope correction and linearity checking facilities, minor component changes and additions are necessary in those circuits. The values of R48, R51, R110, R112 and R119 are changed and R236, R239, R242 and R243 are added. The contacts of  $\frac{RLD}{4}$  are arranged to select the correct ELR/NORMAL facilities automatically when either of these services is selected on the panel, waveform selection. RLD1 eliminates the need for switch SWK. The coils of  $\frac{RLD}{4}$  and  $\frac{RLH}{2}$  are connected in the normal -50V selection lines to ledex actuator SWF and those of  $\frac{RLF}{2}$  and  $\frac{RLG}{2}$  are returned via two additional connections at PL1(D) and (E) to the selector switch in the monitor panel.

TABLE 1  
 Component changes

Circuit ref.	Drawing or spec. ref.	Cat. No.	Value etc.
C24	PC18804/8	5910-99-012-3935	220 pF ±2 750V
C25	PC18804-12	5910-99-012-3947	470 pF ±2 750V
R1	E/RAD/A31353 item 3		48kΩ ±0.1% ½W
R2	Def. 5112	5905-99-021-6361	43kΩ ±2% ½W
R3	R30-0031-81	5905-99-107-8357	40.5 ±0.1 ½W
R4	R30-0031-82	5905-99-107-8352	172 ±1% ½W
R5	R30-0031-77	5905-99-950-8134	12.35k ±1% ½W
R6	R30-0031-75	5905-99-950-8136	3.623k ±0.2 ½W
R7, R8, R24, R222	Def. 5112	5905-99-021-6042	22kΩ ±5% ½W
R25, R28	Def. 5112	5905-99-021-6037	20kΩ ±5% ½W
R33, R40	Def. 5112	5905-99-021-6591	470kΩ ±1% ¾W
R48	Def. 5112	5905-99-021-6726	270kΩ ±5% ½W
R51	Def. 5112	5905-99-021-6749	750kΩ ±5% ¾W
R102	Def. 5112	5905-99-021-6312	27kΩ ±2% ½W
R103	Def. 5112	5905-99-021-6441	91kΩ ±2% ½W
R110	Def. 5111	5905-99-011-3433	33kΩ ±5% 6W
R112	Def. 5112	5905-99-021-6451	100kΩ ±2% ½W
R119	Def. 5112	5905-99-021-6798	2.5MΩ ±2% 1W
R222	see R7		
R232	R30-0031-78	5905-99-950-8138	39kΩ ±0.1% ¼W
R233	R30-0031-76	5905-99-950-8139	4.23kΩ ±0.1% ¼W
R234, R240, R241	R30-0662-50	5905-99-951-3305	14.1kΩ ±0.1% 2W
R235	R30-0031-80	5905-99-950-8140	4.7kΩ ±0.1% ¾W
R236		5905-99-021-6734	390k ±5 ½W
R237, R238	Def. 5112	5905-99-021-6022	15kΩ ±5% ½W
R239		5905-99-021-6643	820k ±2 ¾W
R242	Def. 5112	5905-99-021-6032	18kΩ ±5% ½W
R243	Def. 5112	5905-99-021-6510	180kΩ ±2% ½W
Relay Chassis	E/RAD/C94152-B		containing RLE, RLF, RLG, RLH
RLE, RLF, RLG, RLH	RLC 165 SM5A-N97	5945-99-011-9882	2500Ω



Appendix 7

AMPLIFYING UNIT (VIDEO) TYPE 515 (Modified)  
Post CA4741/4

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INTRODUCTION

1. The Type 515 amplifying unit (video) fitted in rack assembly Type 16339 was modified by CA4741/4 to make it compatible with the system at ADDC.

GENERAL DESCRIPTION

2. Two resistors, R232 and R233, are additional, otherwise the modified Type 515 is identical to the Type 515 fitted in rack assembly Type 339. The modification enables the unit to be used to set up the velocity of a 0-256 mile timebase waveform.

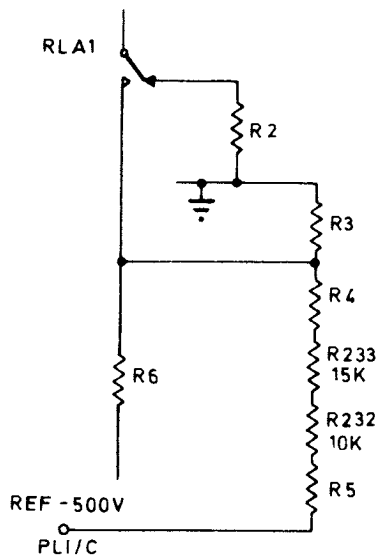


Fig.1 Amplifying unit (video) Type 515 (modified):  
scrap circuit

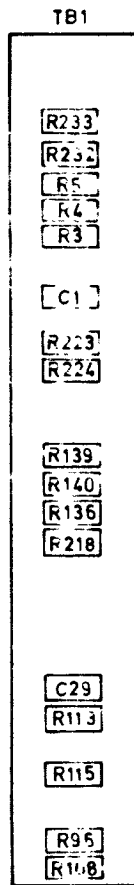


Fig.2 Tagboard TB1 (modified)

Chapter 4

PANEL (CONTROL) TYPE 890

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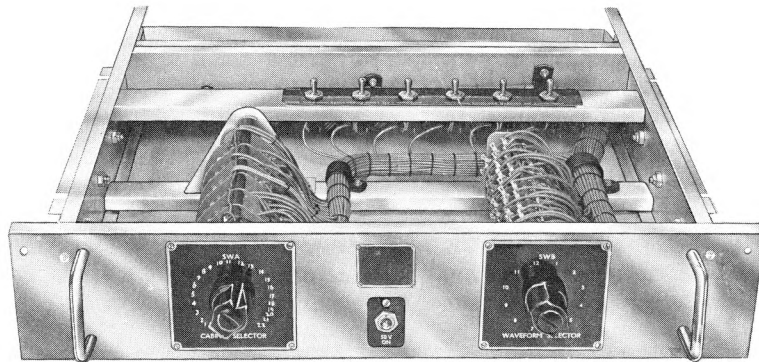


Fig. 1. Panel (control) Type 890—front view

INTRODUCTION

1. As already indicated in Chapter 1 of this Section, the control panel is situated below the monitoring unit Type 102, in the rack assembly Type 339, so that it may be operated conveniently whilst the monitor c.t.o. is being observed. The panel is given the designation 'waveform selector' in fig. 1 and 2 of Chap. 1 to stress its function. In the present chapter, fig. 1 and 2 illustrate the control panel, while fig. 4 gives the circuit. Fig. 3 is a block diagram to show the racks served by the RA339 and to facilitate tracing the interconnections to which reference will be made when describing the functions of the control panel.

2. This panel contains two multiwafer switches (A and B) to give manual control of the selection, not only of waveforms from the associated rack assemblies, but also of the timebase range, of video amplifier gain, and of sampler and trigger facilities inside the rack assembly Type 339, to ensure the correct display of the waveforms. Apart from the initial selection, by manual operation of SWA and SWB, all circuit paths are chosen automatically, except in position 22 of SWA, which releases the RA339 from automatic control, so as to make its functions available for manual operations.



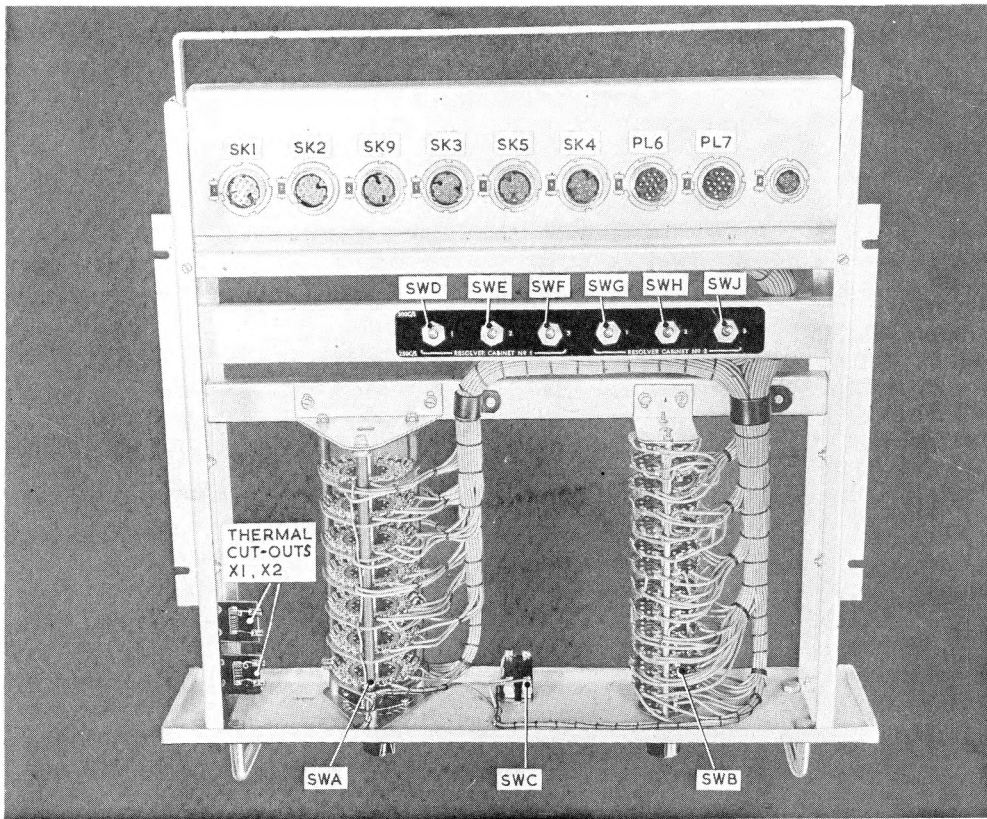


Fig.2 Panel (control) Type 890—top view

### Switch functions

3. SWA and SWB exercise control by directing the 50V d.c. supply to the actuators of switches which make the required connections in the associated rack assemblies. The 50V supply comes from SK32/E (positive) and SK2/M (negative) in the distribution panel Type 891, at the base of the RA339, to PL6/E and M, respectively, in the panel Type 890.

4. The ON/OFF switch (SWC) for this supply is situated in the middle of the front panel of the Type 890 unit (fig. 1). Two thermal cut-outs (X1 and X2) are connected in the 50V negative line to ensure that the actuator solenoids are not damaged by continuous current, due to mechanical jamming and short-circuiting of the actuator contacts.

5. Inside the units are mounted six toggle switches (SWD to SWH and SWJ) which route the 50V actuator supplies when carrying out resolver linearity checks on the two magflip resolver racks Type 301.

6. The functions of the control panel are summarized in fig. 13 of Chap. 1, which illustrates the label forming the front panel of the indicating unit Type 4064. It is convenient to use the same layout as on the label for tracing the sequence of operations in the rack Type 339 and in the associated rack assemblies, following the operation of the switches in the panel Type 890.

7. In practice, of course, the desired waveform may be monitored by switching immediately to the switch positions given on the indicating panel. To illustrate this point, the circuit diagram of the panel Type 890 (fig. 4) shows both SWA and SWB in position 5, monitoring the positive gate output from SK9 of the B distribution unit (gating of the RA304. It should be noted that the rear wafers of SWB lead one step on the front wafers to provide contacts for the twelfth position. To follow the sequences given in the succeeding paragraphs, reference may be made initially to fig. 3 and 4, and then to the circuits of the units that are mentioned.

8. For all automatic operations of the waveform selector panel, SWA(b) (rear) supplies current, via PL6, to SK32 in the panel Type 891, for actuating the signal selector switch (SWA) in this panel (apart from the connections for the future selection of RA302 waveforms, which are via SWA (b) and PL7 in the panel 890, and SK45 in the panel 891). The coaxial line from the appropriate rack is then connected to SK31 (panel 891), feeding the input socket SK6 of the video amplifying unit Type 515.

9. Meanwhile, current for the primary and secondary selection of the desired waveform in the remote rack is supplied via SWA wafers (f) and (h) feeding PL7, and via SWA(d) feeding

- (1) SWB wafers (a) and (b), connected to SK.1 (for RA304),
- (2) SWB wafers (c) and (d), connected to SK.2 (RA301 "A") and SK.9 (RA301 "B"),
- (3) SWB wafers (g), (h), (j) and (k), connected to SK.3 (RA300).

**10.** These connectors on the panel Type 890 feed through to the distribution panels in the bases of the rack assemblies (*fig. 3*), to supply current to the actuators of the waveform selection switches, so that the desired waveform is fed back to the Type 515 video amplifying unit.

**11.** In this unit, control for ensuring the required circuitry and correct degree of gain is provided by contacts on SWA(m) (panel 890), feeding SWB wafers (r) to (w), the outputs from which reach the video unit via SK.5 (panel 890) and PL7 (video unit). The outputs from the video unit, on SK.13 and SK.14, are then applied to SK.10 (Y1) and SK.8 (Y2), respectively, on the monitoring unit Type 102, to provide Y deflection on the CRO.

**12.** At the same time, SWA(g) (rear) feeds current to PL.7/D in the timebase unit Type 141 (via SK.8 in the panel 890) for maintaining this unit in automatic operation, except on position 22, when SWA(n) (front), leading one step on the other wafers, feeds PL.7/C to actuate the timebase change-over switch (SWA) to MANUAL (SWA(o) feeds the 515 unit on MANUAL). The timebase timing and duration, and the other functions of the timebase unit Type 141 are decided by the feed to PL.18 in the timebase unit from SK.4, SWB wafers (l) to (p) and SWA(k) (rear) in the panel Type 890.

**13.** Since, for any one cabinet, the same connectors are used for all automatic monitoring functions, it will suffice to describe in full one sequence of operations to enable the reader to become familiar with the appropriate connections. He will then find it easy to trace the connections for any switch function by referring to the circuit diagrams, and tedious repetition in the text will be avoided.

## WAVEFORM INSPECTION

### Timebase cabinet (RA300)

**14.** Since there are two alternative TB140 units ("A" and "B") for each timebase frequency, SWA must be operated to position 1 to select "A" units and to position 2 to select "B" units. Then SWB positions 1 to 6 select 500 c/s waveforms, while positions 7 to 12 select 250 c/s waveforms, the two frequencies corresponding to timebase ranges of 120 and 240 miles, respectively. The TB140 unit being used for each range is indicated by the lighting up of the correspondingly labelled indicator lamp in the bottom left-hand corner of the panel Type 4064.

### Position A1, B1—500 c/s positive sawtooth

**15.** The selection of circuit paths is considered under four headings:—

#### (1) Signal selection.

The -50V line from PL.6/M (supplied from SK.32/M in the panel Type 891) is connected via SWC and X2 to SWA(b) (rear) which routes the actuator operating current, via PL.6/A, to SK.32/A in the 891 panel, where it feeds SWA. This switch is connected directly to the +50V line and is therefore actuated to position 1. Wafer SWA(c) then selects the incoming signal on SK.14 (connected to SK.23 on panel Type 868 in the base of the rack assembly Type 300) and connects it to SK.31, feeding SK.6 on the video amplifier unit Type 515.

#### (2) Cabinet primary and secondary selection.

SWA(f) in the panel Type 890 applies -50V to PL.7/D, feeding SK.45/D and then SK.6/A in the panel Type 891, connected to PL.67/A in panel 868, where it operates SWD(a) to position 1. Wafer SWD(c) then connects SK.23 to SWC(d) and SWC(e) (via RLA/1), which control the selection of waveforms from both the 500 c/s and the 250 c/s "A" TB140 units. Meanwhile SWA(d) in the panel Type 890 applies the -50V to SWB(g), which feeds SK.3/A, connected to PL.66/A on the distribution panel 868, via the panel-mounted SK.5 at the base of the RA339. SWC(a) (front) in panel 868 is actuated to position 1 and wafer SWC(e) (front) selects the required 500 c/s +TB waveform from SK.38. The actuator circuits of SWD and SWC (panel 868) are completed to the positive side of the 50V supply via PL.67/E, connected to SK.6/E and SK.45/G (panel 891), and then to PL.7/G, fed by SWA(h) in the panel 890.

#### (3) Indicator lights.

LP1, 2, 3 and 4 in the panel Type 4064 have a common +50V line (PL.1/E, supplied from SK.44/E in the panel Type 891). The negative feed for the lamps is derived from SK.6/F (panel 891), connected to PL.67/F (panel 868), which feeds the manual change-over switches A and B, wafers SWA(g) and SWB(g). These switches determine the selection of the TB140 units ("A" or "B") for the 120 and 240 mile ranges, respectively, and the indicator lamps show which units are in use. Thus SWA(g) completes the circuit for LP1 or LP2, as appropriate, via PL.67/G or H, connected to SK.6/G or H and SK.44/C or D (panel 891), feeding PL.1/C or D in the panel Type 4064, to show which unit is in use for the 120 miles range. SWB(g) similarly completes the circuit for LP3 or LP4, via PL.67/J or K, SK.6/J or K, SK.44/F or G and PL.1/F

or G, respectively, to show which unit is being used for the 240 miles range.

(4) *Rack 339 circuit selection.*

(a) *Timebase unit Type 141*—SWA(o) (rear) in the panel 890 applies  $-50V$  to SK.8/D, connected to PL.7/D in the TB141, where it feeds SWA(a), the *auto/manual* change-over switch. The positive side of the supply reaches SWA(a) via PL.18/E, from SK.4/E (panel 890), so that SWA is actuated to the auto position. Meanwhile SWA(k) (panel 890) applies  $-50V$  from SK.8/B (switched supply from SK.8/A, via PL.7/A and B and RLA5 in the TB141 unit) to SWB(l) (panel 890), feeding SK.4/F, connected to PL.18/F (TB141). This completes the circuit for SWB(a) in the TB141 unit, the positive return being to PL.18/E, and SWB is actuated to position 9. SWB(c) then provides the 250 c/s MTP input to the sync circuit, SWB(d) and SWB(e) apply the trigger pulse direct to the timebase generator (no connections being made to the delay circuit), and SWB(h), (j) and (k) make connections to give a timebase duration of 5 m sec.

(b) *Video unit Type 515*—Sub-para. (1) and (2) have already described how the 500 c/s positive sawtooth from the RA300 is applied to SK.6, which feeds SWF(g) in the video unit. The common positive line for the operating coils of SWE and SWF, and for relays A, B, C and D, enters the 515 unit on PL.7/E, fed from SK.5/E (panel 890). The  $-50V$  line is applied by SWA(m), in the panel 890, to SWB(r), which feeds SK.5/A, connected to PL.7/A and SWF(a) in the 515 unit. SWF is actuated to position 10 and SWF(g) feeds the incoming signal from SK.6 to the video amplifier, via the gain selector stage. At the same time  $-50V$  from SK.5/J (panel 890) is applied via PL.7/J to SWF(b) (515 unit), which feeds SWE(a) and actuates it to position 3. Switch wafers SWE(cb) and SWE(bb) select a gain of 2.5 and apply the signal to the video amplifier stage, the output of which is displayed on the monitor CRO. Meanwhile, the  $-50V$  from SWF(b) is also applied to PL.8/A, feeding SK.4/A in the monitoring unit Type 102 and lighting LP1(blue) to indicate that the gain of  $\times 2.5$  is in use. The common return for the three gain indicator lamps (LP1 to LP3) is via R3 and SK.4/F (102 unit) to PL.8/F (515 unit), which is connected to the common positive line on PL.7/E.

*Position A1, B2 to 12*

16. For the inspection of all waveforms from "A" TB 140 units the connections provided by SWA remain the same. Thus the signal input socket (SK.6) on the video amplifier remains connected to SK.23 on panel 868 in the RA300, and SWD in panel 868 remains in position 1, selecting the "A" group of waveforms. SWC in

the panel Type 868 is operated from position 1 to 12 in step with SWB in the panel Type 890, via the connectors already mentioned for position 1, and wafers SWC(d) and (e) select the waveforms in the order given on the indicating panel.

17. Contacts on the panel 890 SWB(l) keep the TB141 circuits on sequence 9 (i.e., 250 c/s MTP, no delay to the timebase and a timebase duration of 5 mS.) except on position 6, which gives sequence 10 (i.e., 500 c/s BU trigger, no TB delay and a TB duration of 250  $\mu$ S). On SWB position 12, wafer SWB(m) provides contacts for sequence 11 (250 c/s BU trigger, no TB delay and a TB duration of 250  $\mu$ S).

18. Contacts on SWB(r) and (s) provide for appropriate amplification of the TB140 waveforms in the video amplifying unit Type 515. Thus the gain of  $\times 2.5$  is used on SWB positions 1, 2, 5, 6, 7, 8 and 12, while  $\times 25$  is used on positions 3, 4, 9 and 10, the appropriate connections being made by SWF and SWE in the 515 unit in response to actuator current supplied via SK.5 (panel 890) and PL.7 (515 unit). No waveform is available on switch position 11.

*Position A2, B1 to 12*

19. SWA contacts for positions 1 and 2 are in parallel, except on wafer SWA(f) (rear) (ignoring the *auto/manual* change-over wafers), so that identical provisions are made for waveforms from "B" TB140 units. These are primarily selected by the contacts on SWA(f), which operate SWD in the panel 868 to position 8, via PL.7/E, SK.45/E, SK.6/D and PL.67/D (*para.* 15 (2)). Wafer SWD(b) then connects SK.23 to the secondary switch wafers SWC(b) and (c), which select the appropriate "B" unit waveform in response to current from panel 890 SWB(g) or (h), via SK.3, SK.5 and PL.66 (*para.* 15 (2)).

**G.W.G. cabinet (RA304)**

*Positions A3 to 5, B3 to 6*

20. Positions 3 to 5 of SWA(h) apply the positive side of the 50V supply to PL.7/H, feeding PL.57/E of the panel Type 879 via the intermediate connectors (*fig.* 3). This provides the common return circuit for the actuators of SWB (secondary selector) and SWC (primary selector) in this unit. Panel 890 SWA(f) feeds PL.7/A, B and C, respectively, on positions 3, 4 and 5, and thus supplies  $-50V$  to PL.57/A, B and C, to operate panel 879 SWC to position 3, 4 or 5. SWC(c) connects SK.19 (panel 879) to SWB(g) and (f) on position 3, and to SWB(b) and (c) on position 5, while SWC(b) connects SK.19 to SWB(d) and (e) on position 4.

21. Meanwhile SWA(b) (panel 890), feeding PL.6/B, actuates the panel 891 signal selector to connect the output from SK.19 (panel 879) to the video amplifier Type 515 input socket. SWA(d) feeds SWB(a) and (b), so that operation of panel 890 SWB from position 1 through to 12 feeds operating current to corresponding contacts on SWB(a) in the panel Type 879. The contacts on the other wafers of this switch

then select the appropriate waveform for application to the waveform monitor.

**22.** On positions 3, 4 and 5, SWA(k) feeds SK.4/B, thus providing timebase sequence 5 for all G.W.G. waveforms. This gives 250 c/s MTP, 3.5 mS timebase delay and 500  $\mu$ S timebase duration. At the same time, SWA(m) provides the required video amplifier conditions. On position 3 it feeds SWB(t) and (u); these wafers make connections for a video gain of  $\times 10$  on positions 3, 4, 5, 9, 10 and 11, and for a gain of  $\times 2.5$  on positions 6 and 12. Similarly SWA(m) feeds the 515 unit (via SK.5/A) on positions 4 and 5 to give a gain of  $\times 2.5$ .

#### Resolver cabinets (RA301)

##### Position A6, B1 to 12

**23.** On position 6 of SWA, wafer (b) feeds  $-50V$  to SWB(e) and (f). Positions 1 to 6 of SWB then feed PL.6/C, while positions 7 to 12 feed PL.6/D, thus operating the signal selector SWA in the panel Type 891 to connect the input from either resolver "A" or resolver "B" to the video amplifier unit.

**24.** Meanwhile SWA(d) feeds SWB(c) and (d), so that SWB positions 1 to 6 feed SK.2 (connected through to PL.60 in panel 877 of RA301 "A"), while SWB positions 7 to 12 feed SK.9 (connected through to PL.60 in panel 877 of RA301 "B"). At the same time the positive return line is completed by SWA(h) to PL.7/J, connected via the panel Type 891 to PL.61/E in both resolver racks. PL.60 and PL.61 are connected to the actuator of SWA in the panel Type 877, which selects the appropriate waveform for application to the monitor rack.

**25.** For the inspection of all resolver cabinet waveforms, the timebase unit Type 141 is maintained on sequence 9 by the feed from SWA(k), contact 6, to SK.4/F. At the same time the video unit gives a constant gain of  $\times 2.5$  because of the feed from SWA(m), contact 6, to SK.5/A.

#### SETTING-UP

**26.** For setting-up, the basic inter-connections are the same as for waveform inspection, with the same switch wafers serving the same units, but greater complexity is introduced into the RA339 timebase and video unit circuits for carrying out the various checks and sampling at different delay intervals.

#### Timebase cabinet (RA300)

**27.** SWA positions 7 and 8 may be compared with positions 1 and 2, in that they result in the selection of the "A" and "B" groups of TB140 unit waveforms, respectively. Thus SWA(b) controls the selection of the RA300 input to the panel Type 891; SWA(f) causes the "A" group to be selected on position 7 and the "B" group on position 8, while SWA(d) feeds SWB(j) and (k) to control the selection of individual waveforms within each group. The positive return line,

from the RA300 actuators, is completed by SWA(h).

#### Position A7, B1

**28.** The "A" 500 c/s positive sawtooth is selected as described in para. 15. To display the *rest level* part of the waveform, SWA(k) feeds SWB (n) and (o), which provide timebase sequence 7 in the TB141 unit on position 1. This gives the 500 c/s BU trigger to the timebase, which is of 1.5 mS duration, and the video sampler stage is triggered after a delay of 350  $\mu$ S.

**29.** At the same time SWA(m) feeds SWB(v) and (w), which feed SK.5/D on position 1. The connection to the video unit, via PL.7/D, actuates SWF to position 1. SWF(b) then feeds  $-50V$  to SWC(a) (SAMPLER GAIN) which may be operated manually to LOW ( $\times 2.5$ ), MED. ( $\times 10$ ) or HIGH ( $\times 25$ ). SWC(a) then feeds SWE(a) and actuates this switch to give the required gain, which is indicated by the lighting up of LP1, LP2 or LP3 in the monitoring unit Type 102.

**30.** Meanwhile, SWF(g) feeds the incoming waveform to V1 in the gated comparison stage, via RLB1, RLB2, SWH and the SELECTOR switch SWA(a). V1 passes current when V3 is pulsed by the gating waveform from V10b, triggered by the delay waveform from the TB141 unit, and any departure from zero of the rest level is amplified by the sampler and video amplifiers before being displayed on the monitor CRO.

#### Positions A7 and 8, B2 to 12

**31.** It is not proposed to go fully into the sequences resulting from all these control switch positions, since they can be traced out on the lines already given. SWA position 8 gives the same sequences as position 7, but displays "B" waveforms instead of "A", and SWB position 2 gives the same sequences as position 1, but displays negative sawtooth rest levels instead of positive.

**32.** SWB(n) provides timebase sequence 4 on positions 3 and 9 for *velocity* checks on 500 c/s and 250 c/s waveforms, respectively. This gives 250 c/s MTP trigger, 1300  $\mu$ S timebase delay, 250  $\mu$ S timebase duration and 110 miles sampler delay. At the same time the feed to SK.5/K and through to PL.7/K (video unit) operates the velocity relay RLA to switch appropriate circuitry into V1 input (RLA1) and to include the slope correction circuit (RLA2). These are described in Chapter 3 of this Section.

**33.** SWB(v) maintains the video unit SWF on position 1 for all sampling operations (i.e., WAVEFORM SELECTOR SWB positions 1 to 3 and 7 to 9).

**34.** For the *TB duration*, *linearity* and *paraphase gain* checks on 500 c/s TB140 units, with SWB on positions 4 to 6, the TB141 sequence switch is actuated to position 8 (SWB(n)), to provide 250 c/s MTP trigger and 2.5 mS timebase

duration. For similar checks on 250 c/s TB140 units, SWB(n) and (o) (positions 10 to 12) give sequence 9 (250 c/s MTP and 5 mS timebase duration).

**35.** On positions 4 and 10 (*duration*) SWB(v) gives video amplifier gain of  $\times 25$ , while on positions 5 and 11 *linearity*  $-50V$  is applied, respectively, to SK.5/G (500 c/s linearity) and SK.5/F (250 c/s linearity). The through connections from these points actuate the video unit SWF to positions 3 and 2, respectively. Position 3 gives a 500 c/s BU input to the linearity checking stage (V12), via SWF(h), while position 2 gives a 250 c/s BU input. At the same time SWF(b) applies actuating current to SWE(a) to give a video gain of  $\times 25$  for both switch positions.

**36.** Finally, for checking *paraphase gain*,  $-50V$  is applied to SK.5/M and PL.7/L on position 6 of SWB(v) and position 12 of SWB(w), with SK.5/M feeding the video unit relay RLD via PL.7/M (video unit), and PL.7/L (panel 890) feeding the RA300 panel 868 relays RLA and RLB via the distribution panel 891. RLD/1 completes the actuating circuit to SWF(a), position 1, so that the video input from SK.6 is applied to the sampler stage (V1) via SWF(g); RLD/2 gives a fixed operating bias to V3. The functions of RLA and RLB are explained in Chap. 1, Sect. 3 of this Part.

#### Resolver cabinets (RA301)

Positions A9 to 11, B1 to 12

**37.** For checking *resolver rest levels* with SWA on position 9, wafers SWA(b), SWA(d) and SWA(f) decide the primary selection of RA301 waveforms, as before (*para.* 23-25), while SWB(c) and (d) control the secondary selection of the waveforms, with SWA(h) providing the positive return line. SWA(k) feeds SK.4/C to provide timebase sequence 6 (250 c/s BU trigger, 1.5 mS timebase duration and 790  $\mu S$  sampler delay), while SWA(m) feeds SK.5/D to provide sampling facilities in the video unit.

**38.** For *amplitude* checks (SWA position 10) the primary conditions are the same and SWA(m) continues to give sampling facilities in the video unit, but SWA(k) makes a connection to SK.4/A (timebase sequence 4), providing 250 c/s MTP, 1300  $\mu S$  timebase delay and 250  $\mu S$  timebase duration, with a sampler delay of 110 miles. A connection is also made to SK.5/K to energize RLA in the video unit, for ensuring correct operating conditions in the sampler. SWB then merely controls the secondary selection of waveforms in the resolver cabinets.

**39.** For *linearity* checks (SWA position 11) the primary and secondary selection of waveforms remains the same, but SWA(k) feeds SK.4/F to provide timebase sequence 9 (250 c/s MTP trigger and 5 mS timebase duration), while SWA(m) feeds SWB(x) and (y), which, in turn, feed the six toggle switches SWD to SWH and SWJ. These may be operated to select SK.5/G for 500 c/s linearity checks, or SK.5/F for 250 c/s linearity checks; the appropriate circuitry is then brought into use in the video amplifying unit Type 515.

#### Head selector cabinets (RA184)

**40.** For monitoring the six head-selector cabinets, SWA is operated from position 12 to 17, inclusive. SWB, positions 1 to 4, then provides displays of the waveforms selected by the RA184 wander leads, which feed into the panel Type 891 in the RA339. Thus SWA(k) feeds SWB(p), which gives timebase sequence 9 on positions 1 and 2, sequence 6 on position 3 and sequence 4 on position 4. Meanwhile SWA(m) feeds SWB(z), which gives a video gain of  $\times 2.5$  on position 1 (*waveform inspection (low gain)*), a gain of  $\times 25$  on position 2 (*high gain*) and which provides sampling conditions on positions 3 and 4 (*rest levels and amplitudes*, respectively).

#### Azication marker cabinets (RA302)

**41.** Although the necessary modifications to the RA302 have not yet been made, to enable monitoring to take place, provision is made for inspecting azication marker waveforms on SWA positions 18 and 19, which make the primary selection of waveforms from rack No. 1 or rack No. 2. SWA(k) then feeds SWB(p) while SWA(m) feeds SWB(z), as for the head selector racks. SWB position 7 (*rest level and gain*) then gives timebase sequence 9 and feeds SK.5/M to operate RLD in the video unit Type 515 and so bring the gated comparison circuit into operation, in the absence of a gating pulse. SWB position 8 (*C.F. set*) gives timebase sequence 5 and a video gain of  $\times 10$ .

#### Manual operation

**42.** Position 22 of SWA releases the RA339 from automatic control. Wafer SWA(n) (front) feeds  $-50V$  to SK.8/C to operate the timebase *auto/manual* change-over switch and wafer SWA(o) (rear) feeds  $-50V$  to SK.5/H to operate the video unit SWF to position 4, which disconnects this unit from the auto signal input socket SK.6 and makes the unit available for manual use, as described in Chapter 3 of this Section.

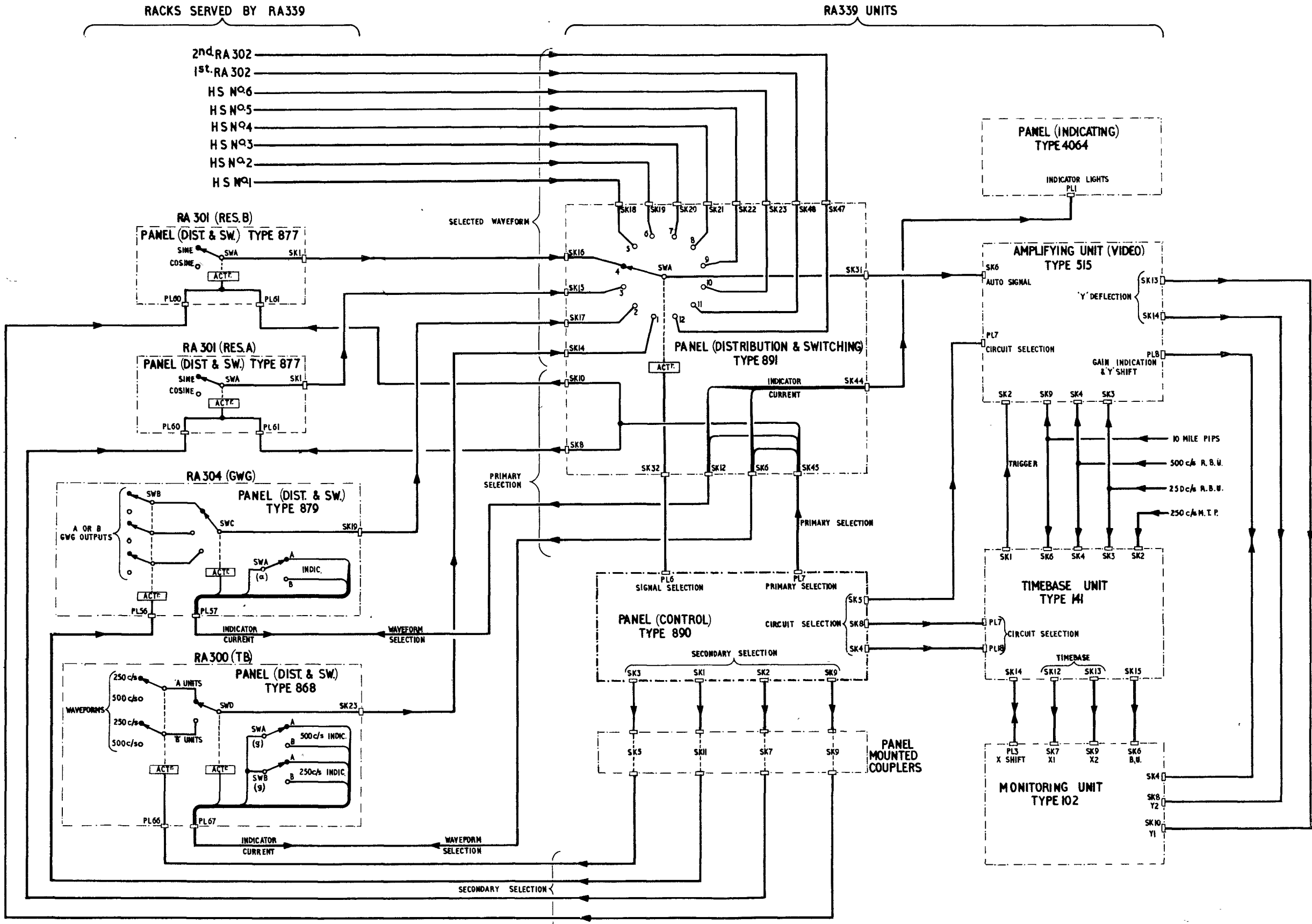
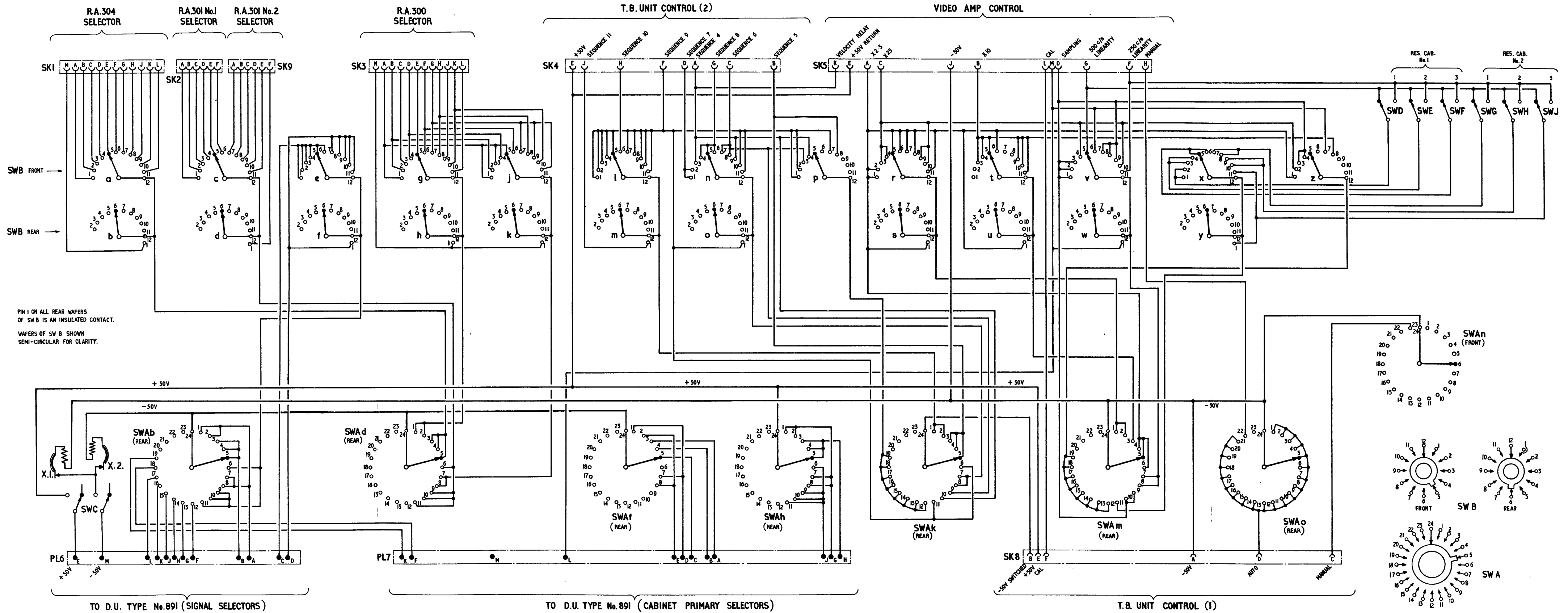


Fig. 3

RA 339 services - block diagram.

Fig. 3





PIN 1 ON ALL REAR WAFERS OF SW B IS AN INSULATED CONTACT. WAFERS OF SW B SHOWN SEMI-CIRCULAR FOR CLARITY.

AIR DIAGRAM 6222AD/MIN. ISSUE 1 PREPARED BY MINISTRY OF SUPPLY FOR PROMULGATION BY AIR MINISTRY PP8834 567649 4941 3/61 125 C & P Gd. 924 (4)

Panel Type 890 - circuit

Fig. 4 (A.L.26, Sep.57)

## Appendix 1

### PANEL (CONTROL) TYPE 890A

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#### Introduction

1. The panel (control) Type 890 is modified to Type 890A by the addition of a toggle switch to the front panel (fig. 1). The Type 890A is operated only in conjunction with units modified for long range timebase working.

2. The additional toggle switch (SWK) is fitted to allow for the monitoring of long range rest level waveforms.

#### Function

3. SWK switches the  $-50$  volts d.c. supply to operate the sequence switch (SWB wafer (a)) in the timebase unit Type 141A.

4. At a selection of rest levels on switches SWA and SWB, on the panel (control) Type 890A, and with SWK selected to LONG RANGE REST LEVELS, sequence 7 on the sequence switch is selected. The sequence 7 circuit provides an increased sampler delay suitable for long range working.

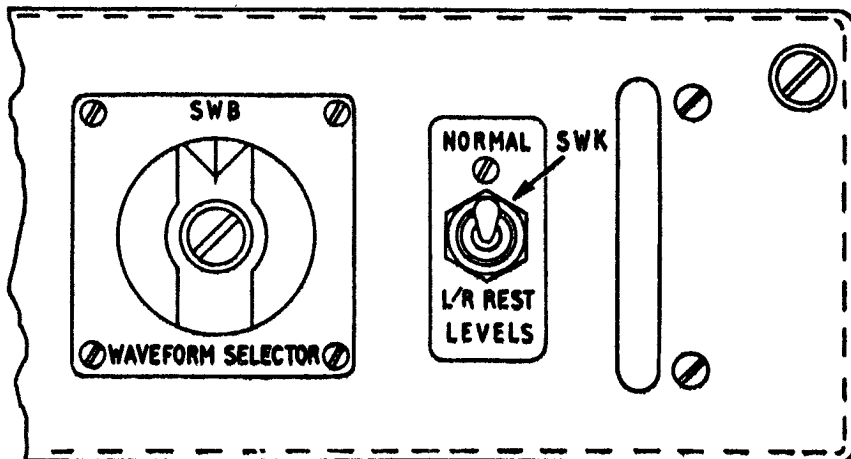


Fig. 1. Panel (control) Type 890A—scrap view



## Appendix 2

## PANEL (WAVEFORM SELECTOR) TYPE 16504

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**Introduction**

1. The panel (waveform selector) Type 16504 (Ref. No. 10D/22434) may be situated immediately below the monitoring unit Type 102, in the rack (monitor) Type 16505, for convenience of operation.

2. The panel (fig. 1) contains three multiwafer switches (SA, SB, and SC) to give manual control of the selection of ; waveforms from the associated rack assemblies, timebase and video amplifier functions, and p.r.f., inside the rack (monitor) Type 16505, to ensure the correct display of the waveforms. Apart from the initial selection, by manual operation of SA, SB, or SC, all circuit paths are chosen automatically, except in position-23 of SA, which releases the rack (monitor) Type 16505 from automatic control, so as to make most of the functions available for manual operation.

**Switch functions (fig. 2)**

3. SA and SB exercise control by directing the 50V d.c. supply to the actuators of switches which make the required connections in the associated rack assemblies. SC operates a Ledex actuator (SA) in the panel (distribution) Type 16506 in the rack (monitor) Type 16505. The 50V d.c. supply comes from SKT32/E (positive) and SKT32/M (negative) in the distribution panel Type 16506, to PL6/E and M, respectively, in the panel Type 16504.

4. The ON/OFF switch (SD) for this supply is situated on the left hand side of the front panel of the Type 16504 unit (fig. 1). Two thermal

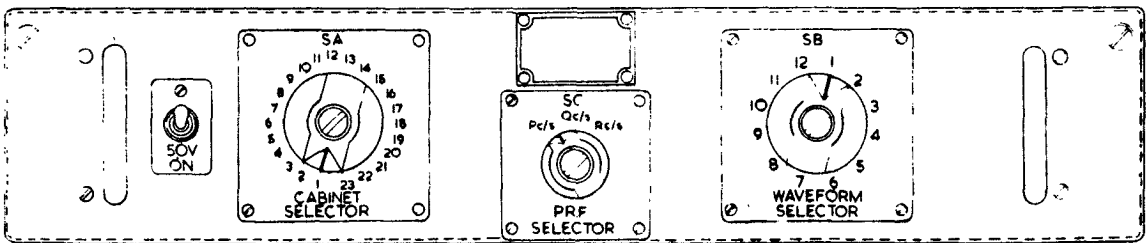
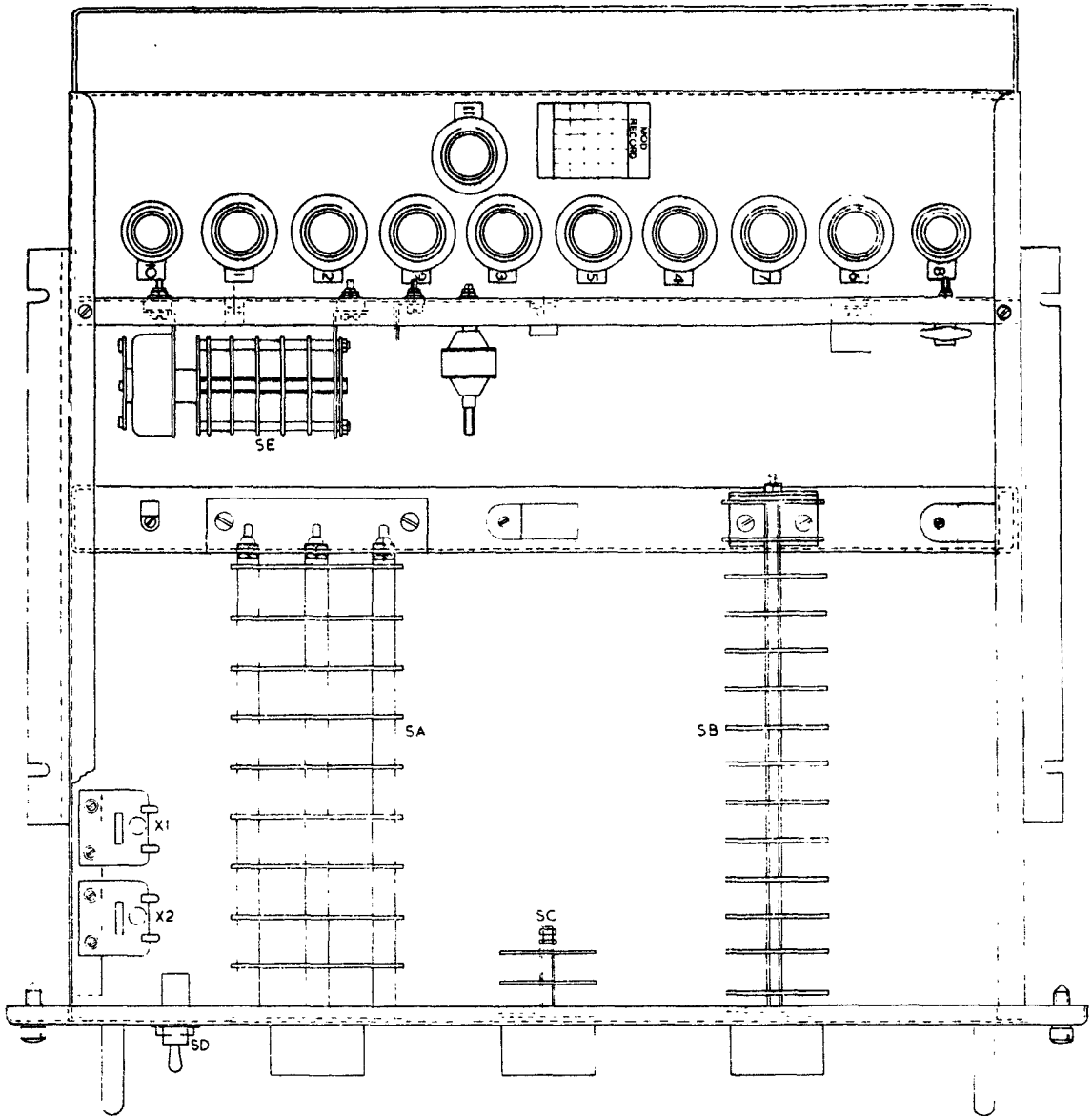
cut-outs (X1 and X2) are connected in the —50V supply to ensure that the actuator solenoids are not damaged by continuous current, due to mechanical jamming or short-circuiting of the actuator contacts.

5. The functions of the waveform selector panel are summarized in Sect. 4, Chap. 1, App. 5, fig. 1, which illustrates the label on the front of the panel (indicator) Type 4064B. It is convenient to use the same layout as on the label for tracing the sequence of operations in the rack (monitor) Type 16505, and in the associated rack assemblies, following the operation of the switches in the panel Type 16504.

6. It should be noted that the rear wafers of SB lead one step on the front wafers to provide contacts for the twelfth position. To follow sequences given in succeeding paragraphs reference should be made to fig. 3 and to the circuits of the units mentioned. For all automatic operations of the panel Type 16504, SA(b) (with this convention wafers a, c, e, g, etc., are front, and b, d, f, h, etc., are rear) supplies current via PL6, to SKT32 in the panel Type 16506 to operate SB. The coaxial line from the appropriate rack is then connected to SKT31 (panel 16506), feeding the input socket SKT6 of the (video) amplifying unit Type 515C.

7. Current for the primary and secondary selection of the desired waveform in the remote rack is supplied via SA wafers (d) and (f) feeding SKT7, and via wafer (h) feeding

(1) SB wafer (a) (b) (c) and (d) connected to SKT3,



**Fig. 1. Panel (Waveform Selector) Type 16504  
Top and Front Views**

- (2) SB wafer (e) and (f) connected to SKT1,  
 (3) SB wafers (g) and (h) which control the  
 Ledex SE. Wafers SE (c) (e) and (g) then feed  
 SKT2, 9 and 11.

8. These sockets, on the panel Type 16504, feed through to the distribution panels in the bases of the rack assemblies, to supply current to the actuators of the waveform selection switches. Thus the desired waveform is fed back to the Type 515C video amplifying unit.

9. In the Type 515C unit, control for ensuring the required circuitry and correct degree of gain, except 'velocity' control which operates in parallel with the 141B velocity control, is provided by contacts on SA (o) feeding SB wafers (s), (t), (u), (v), (w), (x), (3), (aa), (ab) and (ac), the outputs from which reach the Type 515C via SKT5 (panel 16504). The outputs from the video unit on SKT13 and SKT14 are then applied to SKT10(y1) and SKT8(y2) respectively, on the monitoring unit Type 102, to provide Y deflection on the CRT.

10. At the same time, SA(q) feeds current to PL7/D in the timebase unit Type 141B via SKT8 on panel 16504, for maintaining this unit in automatic operation, except in position 23 when SA(q) feeds SKT8/C to actuate the timebase changeover switch (SA in the timebase unit 141B). SA(p), one step behind the other wafers, feeds the Type 515C on manual. The timebase timing and duration and other functions of the timebase Type 141B are decided by the feed from SKT4 (Type 16504), SA wafer (k), SB wafers (j) to (r) and SC (a) in the panel 16504.

11. Since, for any one cabinet, the same connectors are used for all automatic monitoring functions, it will suffice to describe in full one sequence of operations to enable the reader to become familiar with the appropriate connections.

#### Timebase cabinet (RTB16340)

12. There are four timebase units in RTB16340. Two are of Type 140 and two of Type 12269. One of each type is designated 'main' and one is 'standby'. In the panel (distribution and switching) Type 868A or B in the base of RTB 16340, SD selects main/stand by and SC selects waveforms from unit No. 1 and unit No. 2 (i.e. long range and normal). SC selection is obtained through PL66, and SKT3 on the panel Type 16504 from SB wafers (a), (b), (c), and (d). The supply for SD is obtained through PL67, and SKT6, PL45 (panel Type 16506), and SK7 (panel Type 16504) from SA wafer (d).

### TIMEBASE WAVEFORM INSPECTION

#### Position A1, B1.

13. The selection of circuit paths is considered under four headings:—

- (1) *Signal selection.* The —50 volts line from PL6/M is connected via SD and X1 to SA(b) which routes the actuator operating current,

via PL6(A), to SKT32(A) in the panel Type 16506 where it feeds SB. This switch is connected directly to the +50V line and is therefore actuated to position 1. SB wafer (c) in panel Type 16506 selects the incoming signal on SKT15 (connected to SKT23 on the panel Type 868A or B in the base of the rack Type 16340) and connects it to SKT31, feeding SKT6 on the video amplifier Type 515C.

(2) *Cabinet primary and secondary selection.* SA(d) in the panel 16504 applies —50V to SKT7/A, feeding PL45/A and then SKT6/A (in the panel 16506), connected to PL67/A in the panel 868A or B, where it operates SD to position 1. Wafer SD(c) front connects SKT23 (Via RLA1) to SC(d) (front) and SC(e) (front) which control the selection of waveforms from the main unit No. 1 long range timebase Type 12269, and unit No. 2 normal timebase Type 140. At the same time SA(h) in the panel 16504 applies—50V to SB(a), which feeds SKT3/A, connected to PL66/A on panel 868A or B (Via the panel mounted coupler at the base of rack 16505). SC is actuated to position 1, and wafer SC(e) (front) selects the required 'main' long range positive sawtooth from SKT38. The actuator circuits of SC and SD (panel 868A or B) are completed to the positive side of the 50V supply via PL67 E connected to SKT6/E and PL45/E (panel 16506), and then to SKT7/E fed by SA(f) in the panel 16504.

(3) *P.R.F. selection.* The selection of Pc s, Qc/s, Rc s, or Dekatron pulse is determined by SA in panel 16506. SA switch actuator is connected directly to the 50V positive. The negative supply is obtained from panel 16504. SA(m) (panel 16504) applies the 50V negative to SC(c). SC gives manual selection of Pc s, Qc/s or Rc s: Dekatron pulse is automatically selected by SA at positions 8, 10 and 12. SA(k) applies the —50V via SKT10, PL11 (panel 16506) to SA (panel 16506), which will run to the selected position.

(4) *Rack 16505 circuit selection.* (a) Timebase unit 141B. SA(q) in the panel 16504 supplies —50V to SKT8/D, connected to PL7/D in the TB141B where it feeds SA(a), the auto/manual changeover switch. The positive supply reaches SA via PL7/E, from SKT8/E panel Type 16504. SA is therefore actuated to the auto position (1). At the same time SA(k) (panel 16504) applies —50V from SKT8/B (switched supply from SKT8/A via PL7/A and B and RLA5 in the TB141B) to SB(l) (panel 16504) feeding SKT4/F, connected to PL18/F (TB141B). This completes the circuit for SB(a) in the TB141B (the positive return being to PL18/E), and SB is actuated to position 9. SB(c) then provides the auto sync input to the sync circuit, SB(d) and SB(e) apply the trigger pulse direct to the timebase generator

(no connections being made to the delay circuit), and SB(h), (j) and (k) make connections to give a timebase duration of 5mS.

(b) Amplifying unit (video) Type 515C. Subpara. (1) and (2) have already described how the positive sawtooth from the RTB16340 is applied to SKT6 which feeds SF(g) in the video unit. The common positive line for the operating coils of SE and SF, and for relays A, B, C and D, enters the 515C unit on PL7/E fed from SKT5/E (panel Type 16504). The -50V is applied by SA(o) in the panel Type 16504 to SB(t) which feeds SKT5/A connected to PL7/A and SF(a) in the 515C unit. SF is actuated to position 10 and SF(g) feeds the incoming signal from SKT6 to the video amplifier, via the gain selector stage. At the same time -50V from SKT5/J (panel Type 16504) is applied via PL7/J to SF(b) (515C unit), which feeds SE(a) and actuates it to position 3. Switch wafers SE(c) and SE(b) select a gain of X2.5 and apply the signal to the video amplifier stage, the output of which is displayed on the monitor c.r.o. At the same time the -50V from SF(b) is also applied to PL8/A feeding SKT4/A in the monitoring unit Type 102 and lighting LP1 (blue) to indicate that the gain of X2.5 is in use. The common return for the three gain indicator lamps (LP1, LP2, LP3) is via R3 and SKT4/F (102 unit) to PL8/F (515C unit) which is connected to the common positive line on PL7/E.

#### *Position A1, B2 to B12.*

14. For the inspection of all waveforms from 'main' timebase units the connections provided by SA remain the same. Thus the signal input socket (SKT6) on the video amplifier remains connected to SKT23 on panel 868A or B in RTB16340 and SD in panel 866A or B remains in position 1, selecting the 'main' group of waveforms. SC in the panel 868A or B is operated from position 1 to 12 in step with SB in the panel 16504 via the connectors already mentioned for position 1. Wafers SC(d) and (e) select the waveforms in the order given on the indicating panel.

15. Contacts on the panel 16504 SB(l) keep the TB141B circuits at sequence 9 (i.e. auto sync, no delay to the timebase and a timebase duration of 5mS) except at positions 6 and 12 which give a 250µS timebase duration.

16. Contacts on SB(t) and (u) provide for the appropriate amplification of the timebase waveforms in the video amp. 515C. Thus a gain of X2.5 is used at SB positions 1, 2, 5, 6, 7, 8, 11 and 12, whilst X25 is used at positions 3, 4, 9 and 10. The appropriate connections are made by SF and SE in the 515C unit in response to actuator current supplied via SKT5 (panel 16504) and PL7 (515C unit).

#### *Position A2, B1 to B12*

17. SA contacts for positions 1 and 2 are in parallel, except on wafer SA(d) which applies -50V to SKT7/B feeding PL45/B and SKT6/D in the panel Type 16506, connected to PL67/D in the panel Type 868B, operating SD to position

8. Wafer SD(b) then connects SKT23, via RLBI, to the secondary switch wafers SC(b) and (c) which select the appropriate 'standby' unit waveform in response to current from panel 16504 SB(a) or (b) via SK3, and PL66 (Para. 13(2)).

### **TIMEBASE WAVEFORM SETTING UP**

#### *Positions A4 and A5, B1 to B12.*

18. For setting up, the basic inter-connections are the same as for waveform inspection. Position A4 selects 'main' timebase units, and position A5 selects 'standby' units. B1 to B12 selections are the same in both cases. SA(k) feeds SB(n) and (o) to select the appropriate timebase function via SKT4. SA(o) feeds SB(v) and (w) to select the video amplifier function via SKT5. SA(d) selects main or standby units by applying -50V to SD (panel 868B in RTB 16340), via SKT, PL45 and SKT6 on panel 16506, to PL67 on panel 868B. To select unit No. 1 or unit No. 2 timebase (i.e. long range or normal), SB wafers (c) and (d) apply -50V to SC in panel 868B, via SKT3, SKT5, PL66.

### **GATING WAVEFORM INSPECTION AND SETTING UP**

#### *Unit No. 1*

19. *Positions A7 and A8, B1 to B12.* SA(b), the signal selection wafer, applies -50V to SB in panel 16506, via PL6/B and SKT32/B. SB is actuated to position 2, and connects SKT16, the signal feed from the rack, marker sequence Type 4195, to SKT31 and SKT6 (video amplifier Type 515C). Unit No. 1 selection is made by SA(d) applying -50V to SC in the panel (distribution and switching) Type 12271 in the rack marker sequence Type 4195, via SKT7, PL45 and SKT12 in panel 16506, to PL81 in panel 12271. The required signal feed inside the rack 4195 is selected by SB in panel 12271. SB is supplied via PL79, and SKT1 (panel 16504). With SA in position A7, wafer (h) applies the -50V to SB(e) and (f) which feed SKT1. Thus B1 to B10 select different signal feeds in rack 4195. B11 and B12 are spare switch positions. SA(K) feeds SC(a) to manually select the P, Q or Rc/s, gates sequence in the timebase via SKT4. SA(o) feeds SB(x) to select the appropriate video amplifier function via SKT5. Position A8 selects Dekatron waveforms. SA(K) feeds SA in panel 16506, via SKT10 and PL11, operating SA to position 8, to supply the Dekatron pulse to SKT34, then SKT2, the auto sync input on the timebase 141B. SA(o) applies -50V to SKT5/A to provide a video amp selection of X2.5. The -50V applied to SA(K) is via SKT8, PL7 and RLA5 in the timebase 141B. B1 to B12 positions are similar to the A7, B1 to B12 selections.

#### *Unit No. 2 and No. 3*

20. *Positions A9 to A12, B1 to B12.* SA(b) signal selection is identical to unit No. 1 selection. Unit No. 2 or No. 3 selection is made by SA(d) as for unit No. 1. Positions A9 and A10 select No. 2 units, positions A11 and A12 select No. 3 units. Signal selection in the rack 4195 is identical to unit No. 1 selection. Dekatron waveforms are selected in A10 and A12 positions as for unit No. 1 position A8.

## RESOLVER WAVEFORM INSPECTION AND SETTING UP

### *Cabinet No. 1*

21. *Positions A13 and A14, B1 to B12.* SA(b) (signal selection) applies  $-50V$  to SB in panel 16506, via PL6/C and SKT32/C. SB selects SKT14 the signal feed from SKT1 on the panel (distribution and switching) Type 877A in the rack (resolver magstrip) Type 16357. The type of signal fed from SKT1 is determined by SA in panel 877A. SA is operated to select one of six sawtooth waveforms, sine and cosine from each amplifier. The  $-50V$  feed to SA is provided by SE(c) (panel 16504) fed from SA(h). SE is run to the selected position by operation of SB, and is fed from wafers (g) and (h). Thus positions B1 to B6 provide cabinet No. 1 resolver sawtooth signals. Positions B7 to B12 provide the same signals, but in order to display the rest level waveform SA(k) feeds via SB(p) and (q) to SC which selects P, Q, and R rest levels, via SKT4 to timebase 141B, selecting the appropriate timebase functions. SA(o) feeds SB(z) and (aa) to select the appropriate video and function via SKT5. Position A14 differs from position A13 only in respect of the timebase selection. SA(k) via SB(k) and (j) feeds SKT4 to select the timebase function. SA(o) feeds SB(ab) and (ac) to select the video amp function via SKT5. The  $50V+$  switching on SA(f) ensures that SA in only No. 1 resolver cabinet operates.

### *Cabinets 2 and 3*

22. *Positions A15 to A18, B1 to B12.* Positions A15 and A16 are similar to A13 and A14 except that SB (panel 16506) selects SKT47, and SE(e) feeds panel 877A in cabinet No. 2. Positions A17 to A18 are similar to A13 and A14 except that SB (panel 16506) selects SKT48, and SE(g) feeds panel 877A in cabinet No. 3.

### *Wander Leads*

23. *Positions A19 to A22.* The wander leads are numbered 1 to 4 corresponding to SA positions of A19, A20, A21 and A22, respectively. In position A19 SA(b) applies  $-50V$  to SB in panel 16506, via PL6/G and SKT32/G. SB selects SKT18 which is directly connected to wanderlead No. 1; wanderleads 2 to 4 are selected in an identical manner. SA(k) feeds SB(r) to select timebase function via SKT4. SA(o) feeds SB(s) to select video amp function via SKT5.

### *Manual operation*

24. Position 23 of SA releases the rack (monitor) Type 16505 from automatic control. SA wafer (q) feeds  $-50V$  to SKT8/C to operate the timebase auto/manual changeover switch. SA wafer (p) feeds  $-50V$  to SKT5/H to operate SF in the video amplifier 515C to position 4, which disconnects the unit from the auto signal socket SKT6, and makes the unit available for manual use, as described in Chapter 3 of this section.

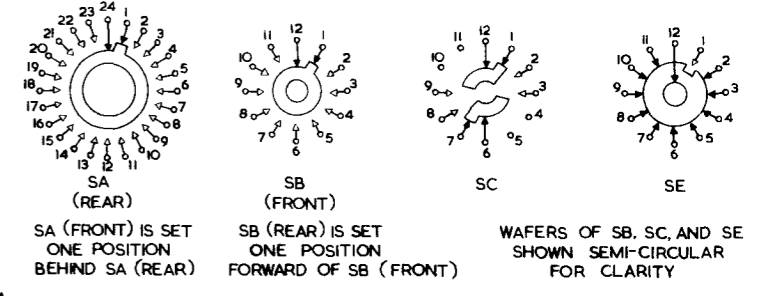
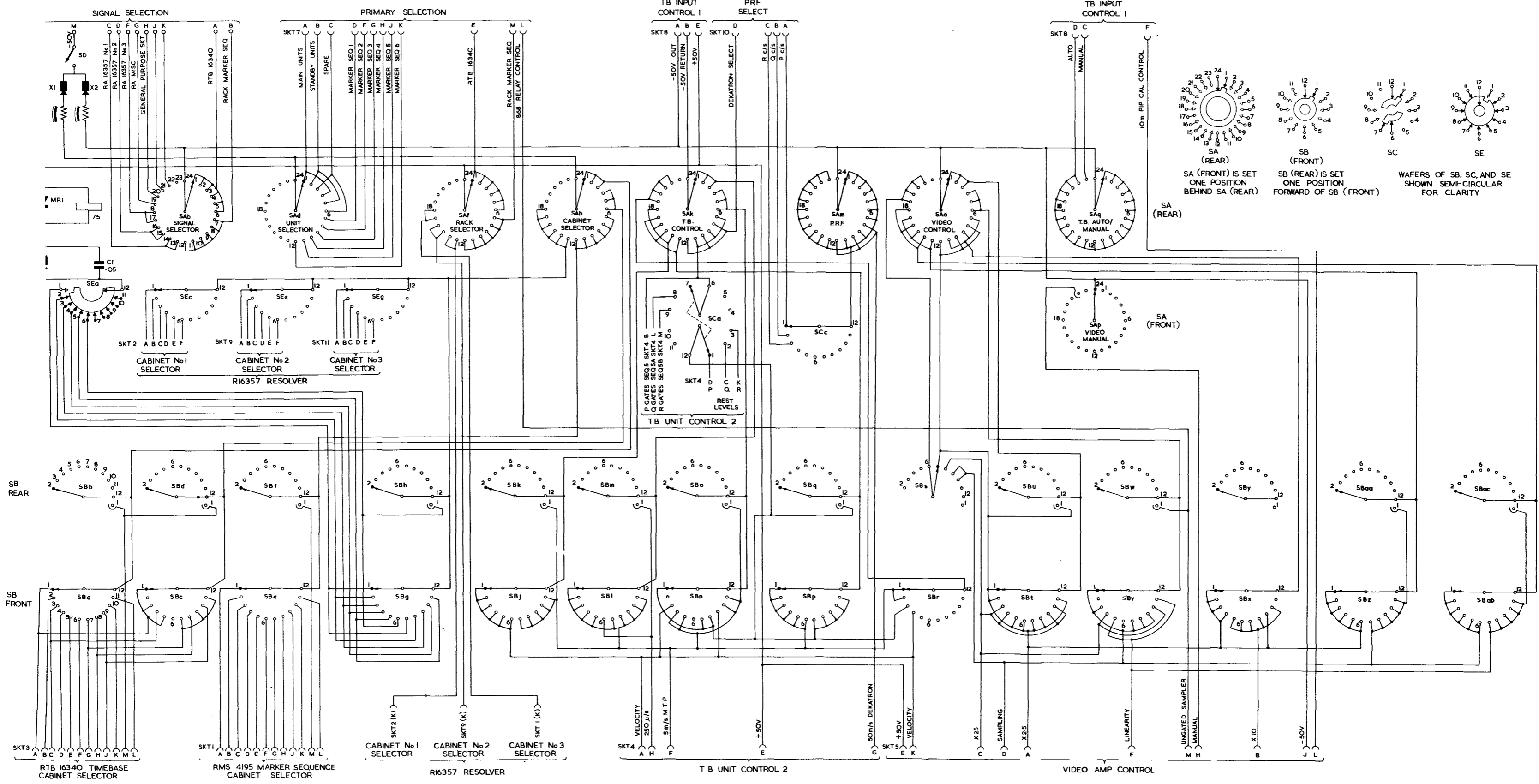


Fig.2

Panel (waveform selector) Type I6504 : circuit

Fig.2

D.7906. c/No.281141. 3/65. S.W.Ltd.

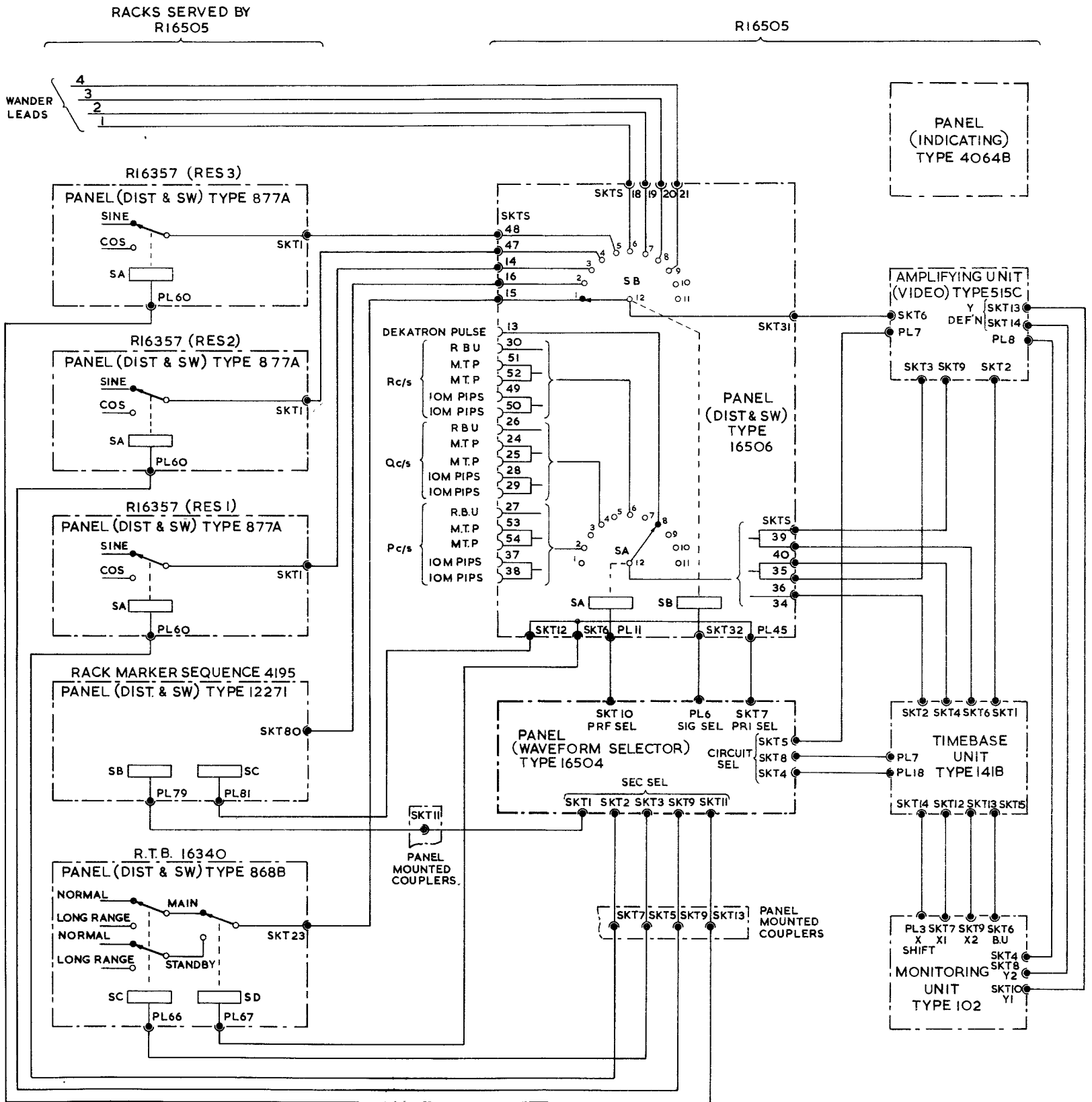


Fig. 3 — Rack (monitor) Type I65O5 : services

### Appendix 3

## PANEL WAVEFORM SELECTOR

5840-99-953-7533

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#### Introduction

1. At certain stations where the integration of radar Type 85 has been carried out and the rack electrical equipment 5975-99-954-8362 is incorporated the panel waveform selector 5840-99-953-7533 is used.

#### General description

2. The panel is similar in design and function to the Type 16504 described in Appendix 2 and a full circuit description is therefore not given. The reader is referred to the services diagram (fig. 3) and the circuit diagram (fig. 2) in this Appendix where salient differences from the Type 16504 are readily apparent. Primary of these is the addition of facilities for switching a further rack, the cabinet electrical equipment sweep, necessitating an

additional Ledex actuator and associated cabling in the waveform selector, the provision of ▲ waveforms at PL1 on the amplifying unit video and an additional panel-mounted coupler SK15. Also provided is a head selector monitoring facility and the p.r.f. selection facility is removed.

3. Provision for these additional services is achieved by increasing the number of banks on the selection actuator, SD, and providing an additional actuator, SC, operating in parallel for the common returns. A NORMAL/ELR switch, SF, permits checking of long-range facilities.

4. The function of the waveform selector is illustrated in Section 4, Chapter 1, Appendix 8, fig. 1, which shows the front of the panel indicator 5840-99-954-8330 used with this unit.



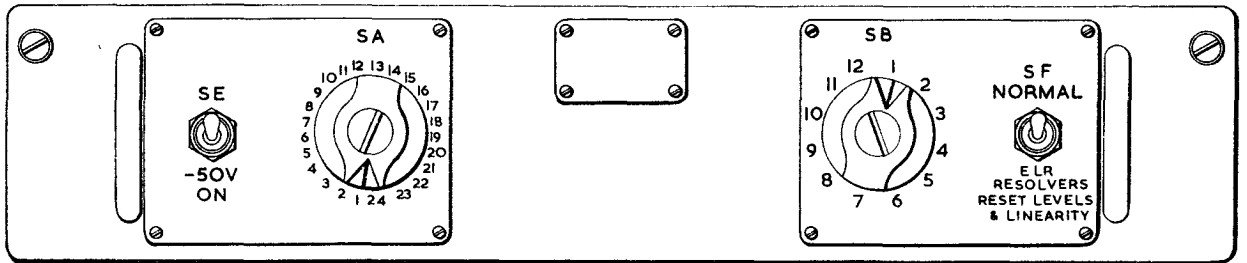
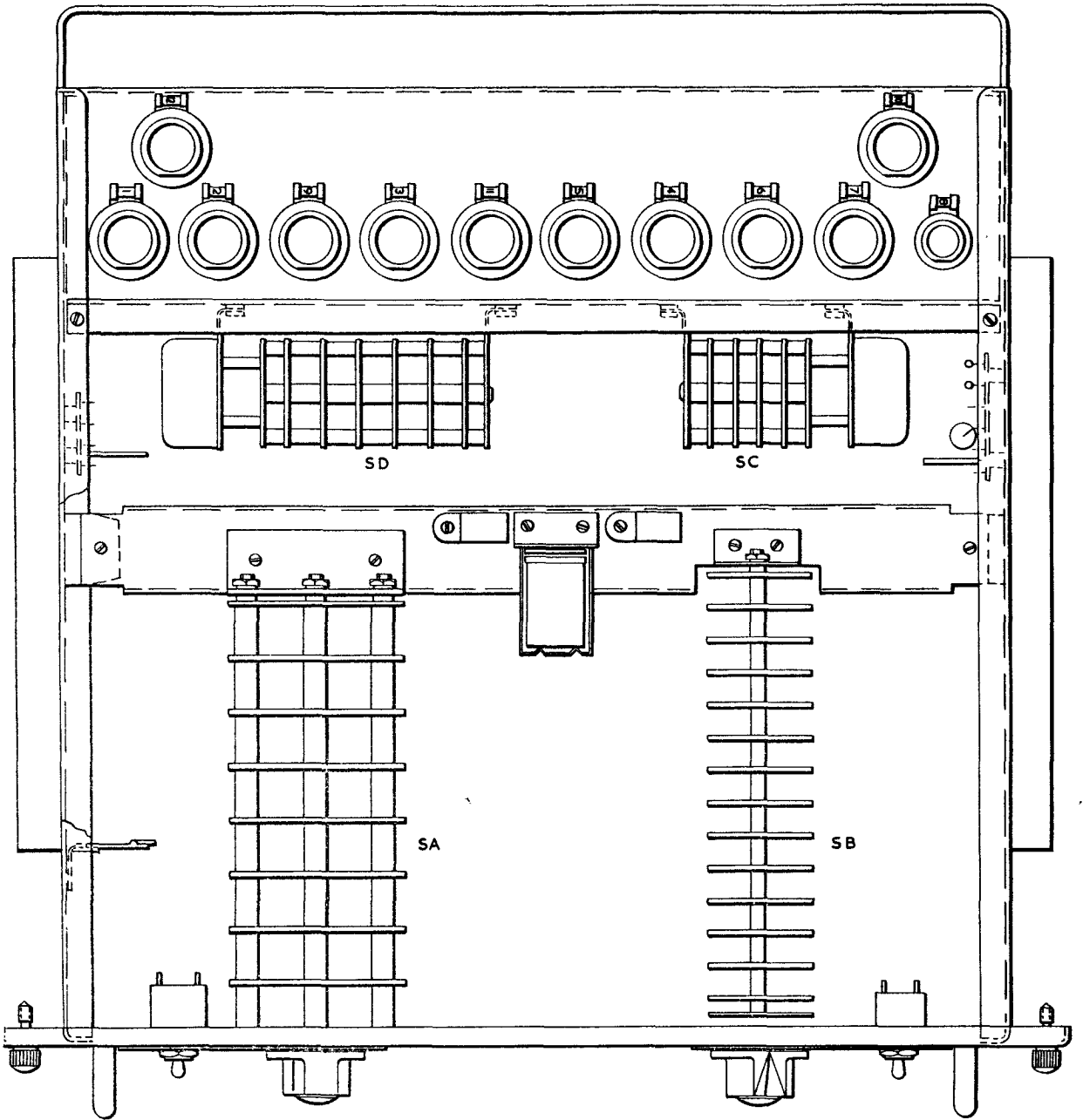


Fig. 1. Panel, waveform selector 5840-99-983-7833-top and front views

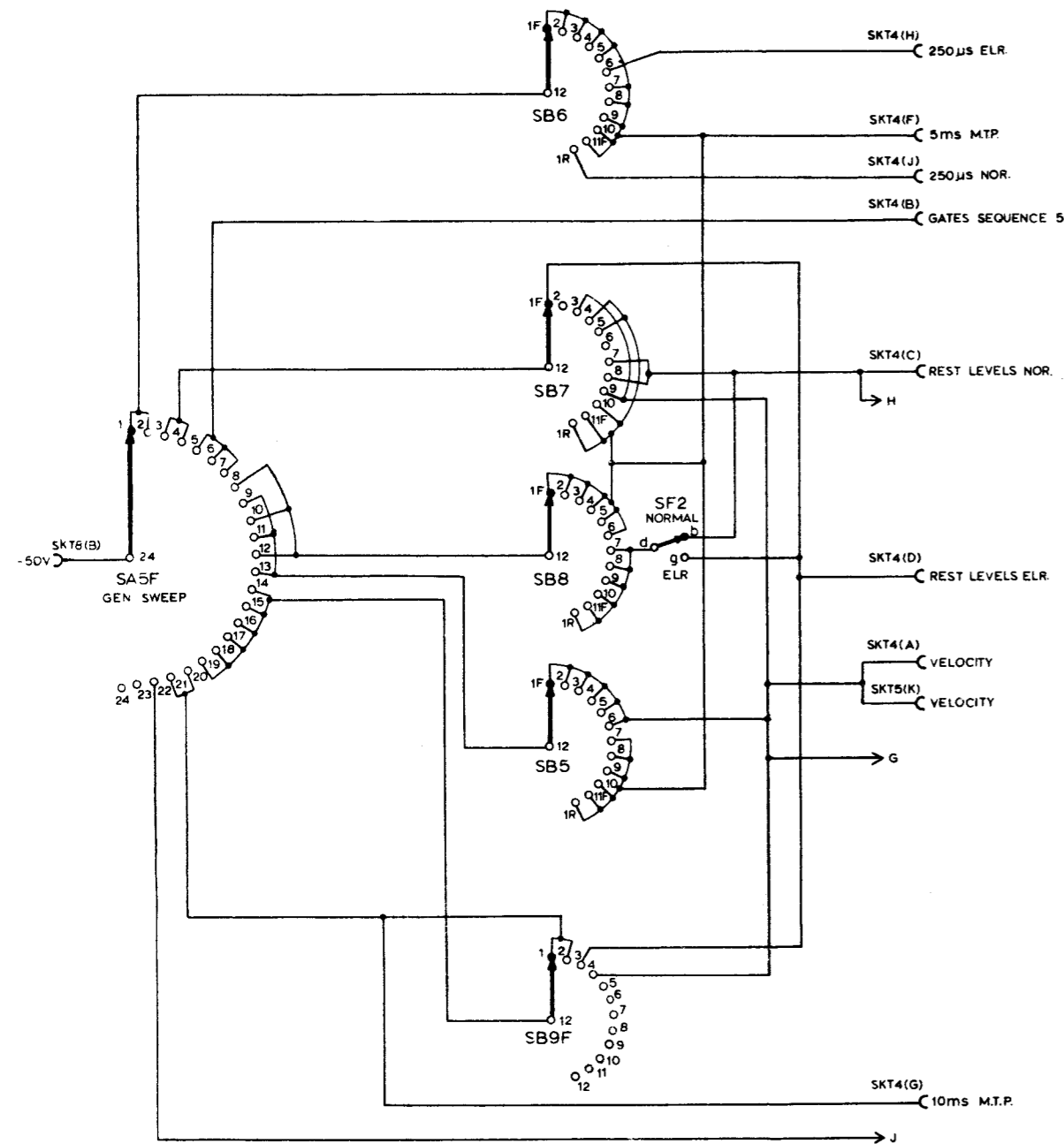
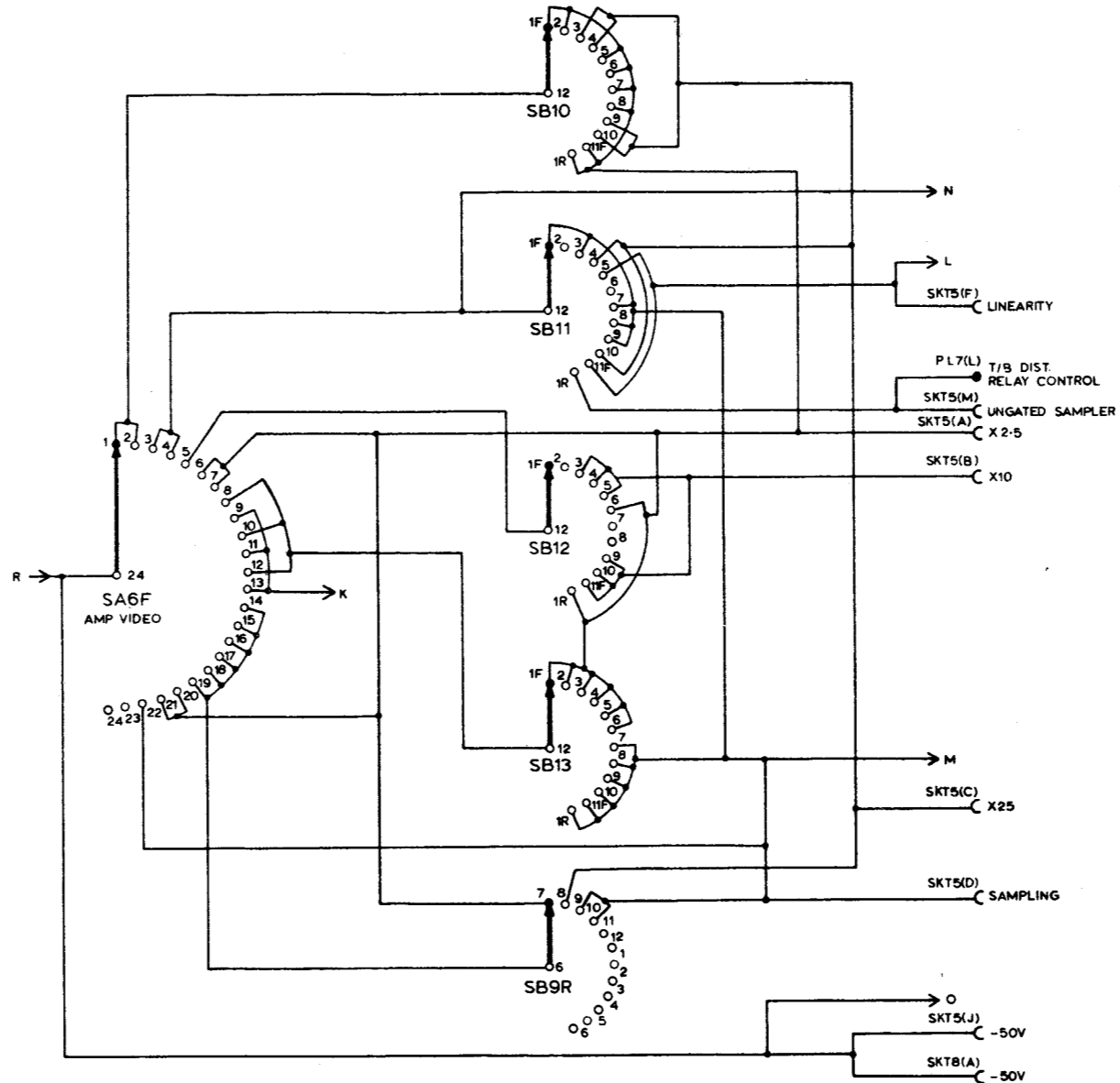


Fig.2



Panel, waveform selector 5840-99-953-7533: circuit

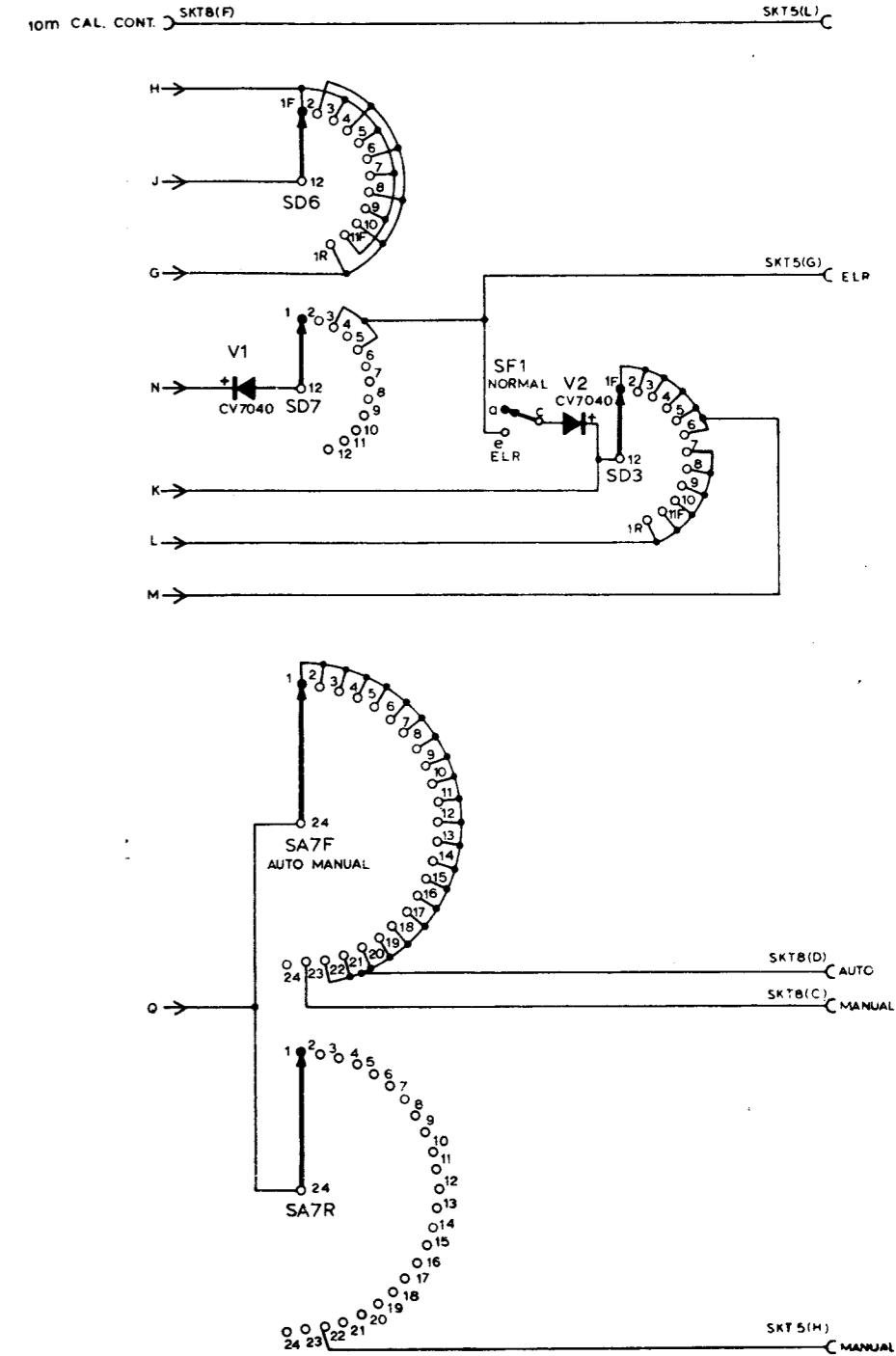


Fig.2

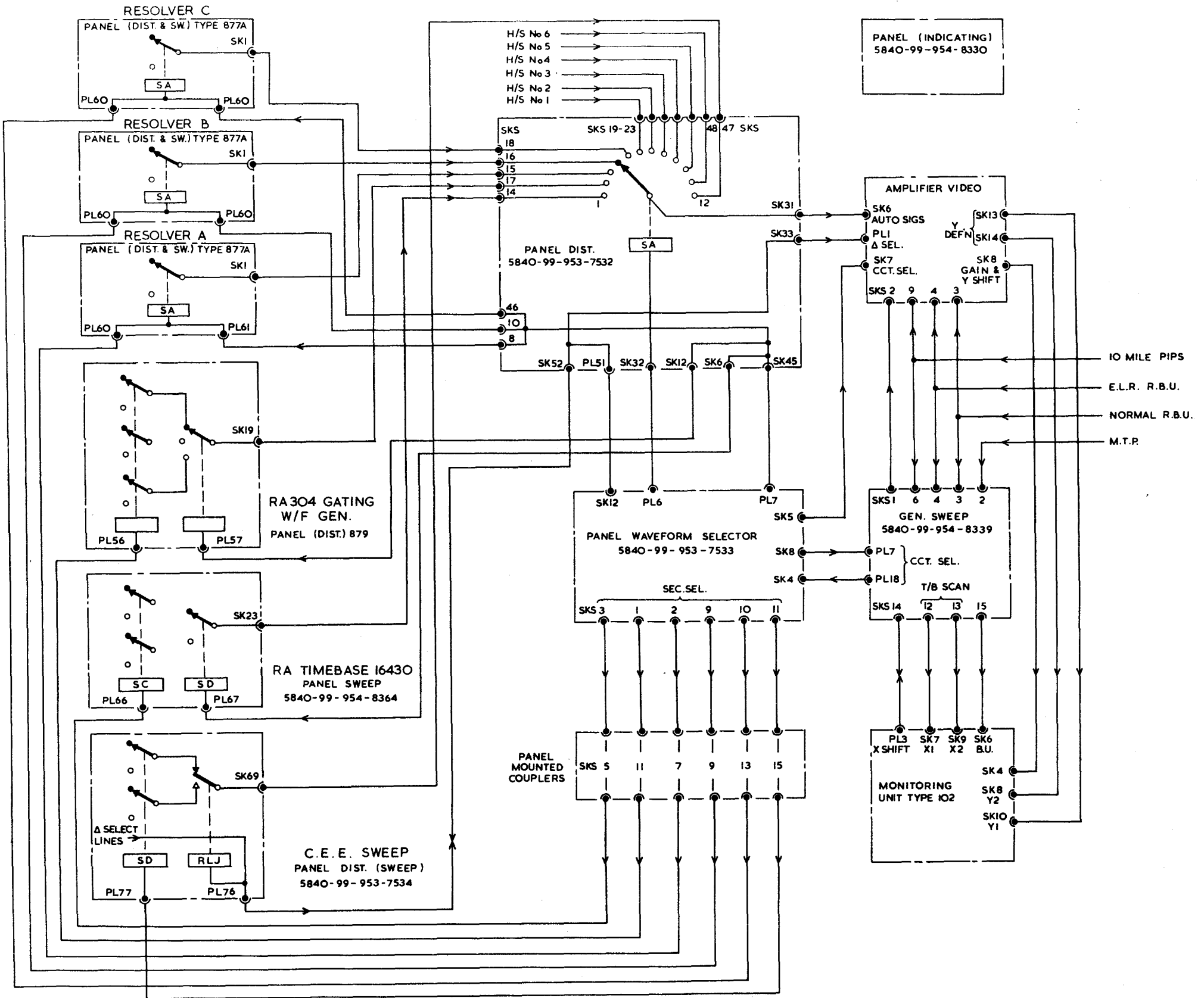


Fig.3

Panel waveform selector 5840-99-953-7533 : services

Fig.3

Appendix 4

PANEL WAVEFORM SELECTOR  
5840-99-954-8905

Fig.	ILLUSTRATIONS	Page
1	Panel (waveform selector) 5840-99-954-8905: plan and front elevation ... ..	3
2	Panel (waveform selector) 5840-99-954-8905: circuit (Part 1) ...	4
	Panel (waveform selector) 5840-99-954-8905: circuit (Part 2) ...	5

INTRODUCTION

1. At certain radar Type 85 stations, where rack electrical equipment 5975-99-956-7666 is fitted, panel waveform selector 5840-99-954-8905 is incorporated.

GENERAL DESCRIPTION

2. The panel is similar in design and function to the panels Type 16504 and 5840-99-953-7533 described in Appendices 2 and 3 respectively. The panel indicating 5840-99-954-8528, used in conjunction with panel -8905, is illustrated in Chap.1, App.11 and shows the switching combinations.

3. Two Ledex actuators are fitted. Additional selection facilities for a cabinet electrical equipment sweep are fitted together with p.r.f. selection. No head selector monitoring or NORMAL/ELR switching facilities are required.

4. The associated units and interconnections are shown in Fig.1, Chap.1, App.12. The services arrangements are similar to those shown in Chap.4, Appendices 2 and 3.

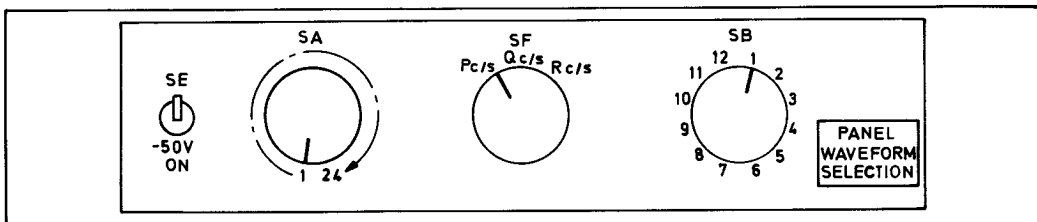
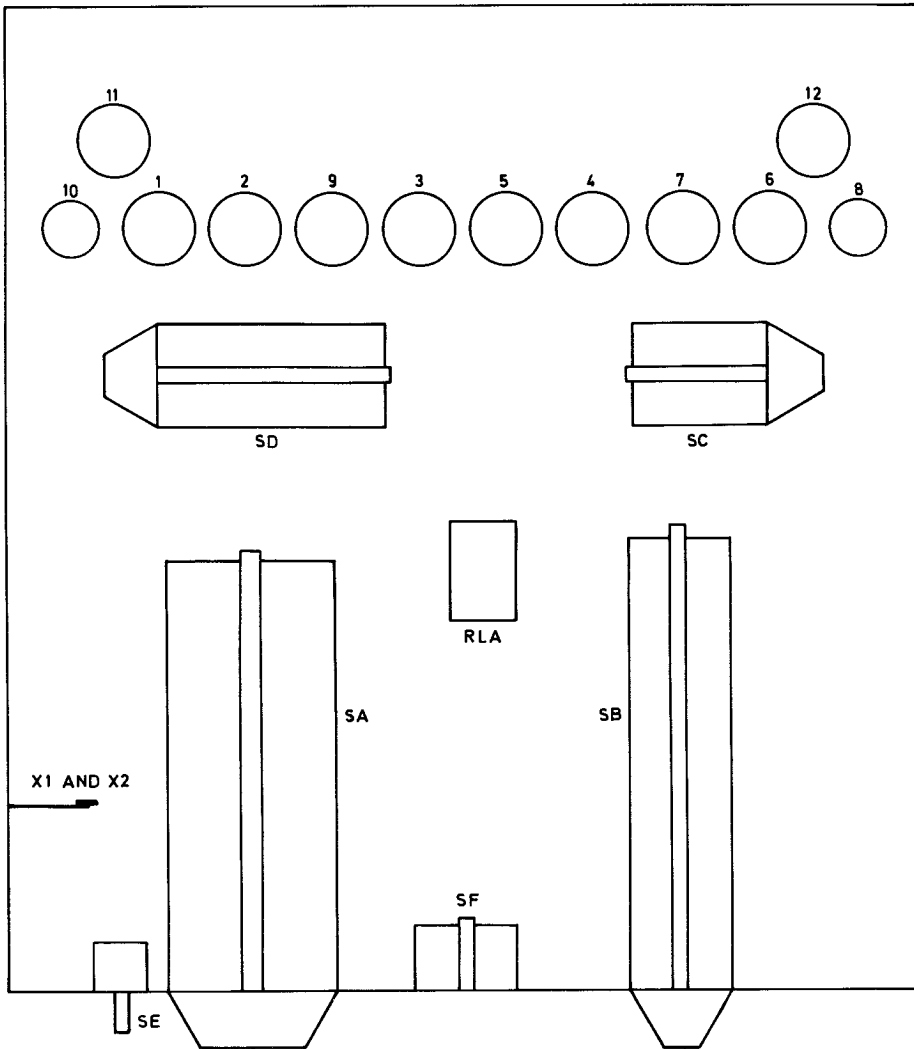


Fig.1.

Panel (waveform selection) 5840-99-954-8905 :  
plan and front elevation

Fig.1.

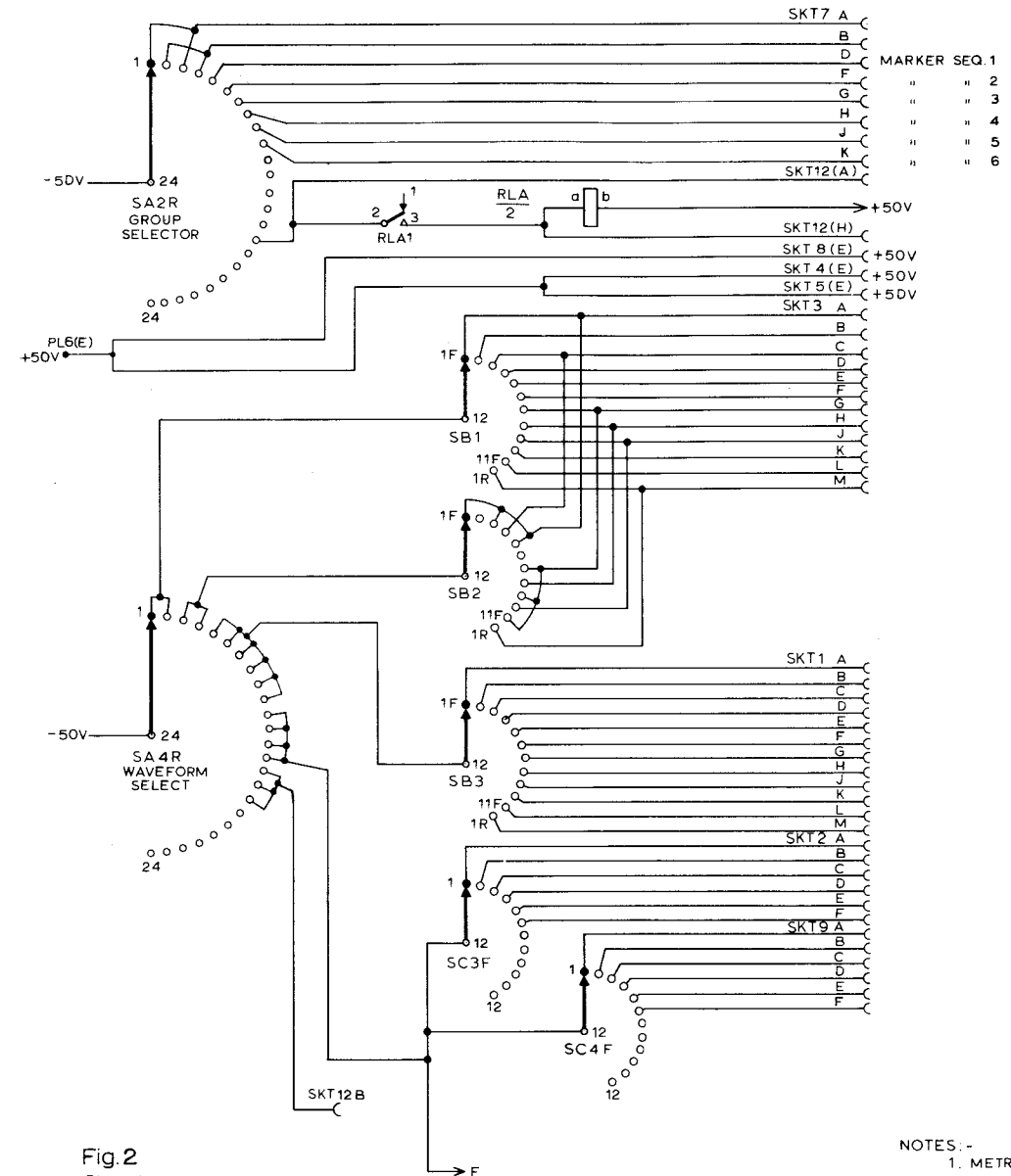
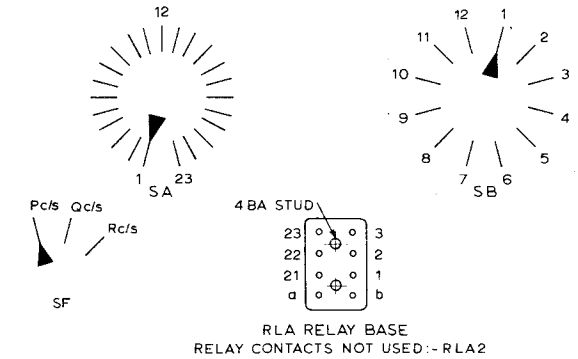
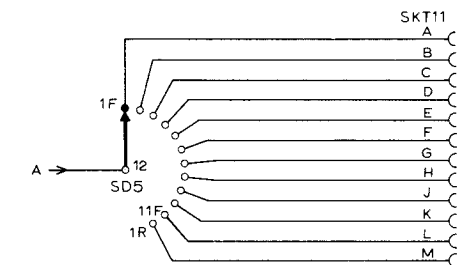
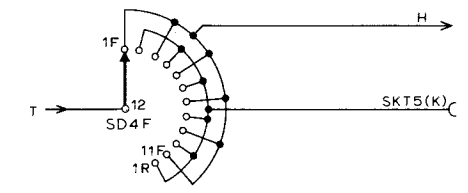
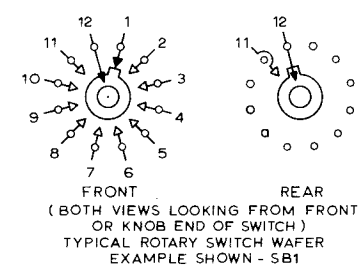
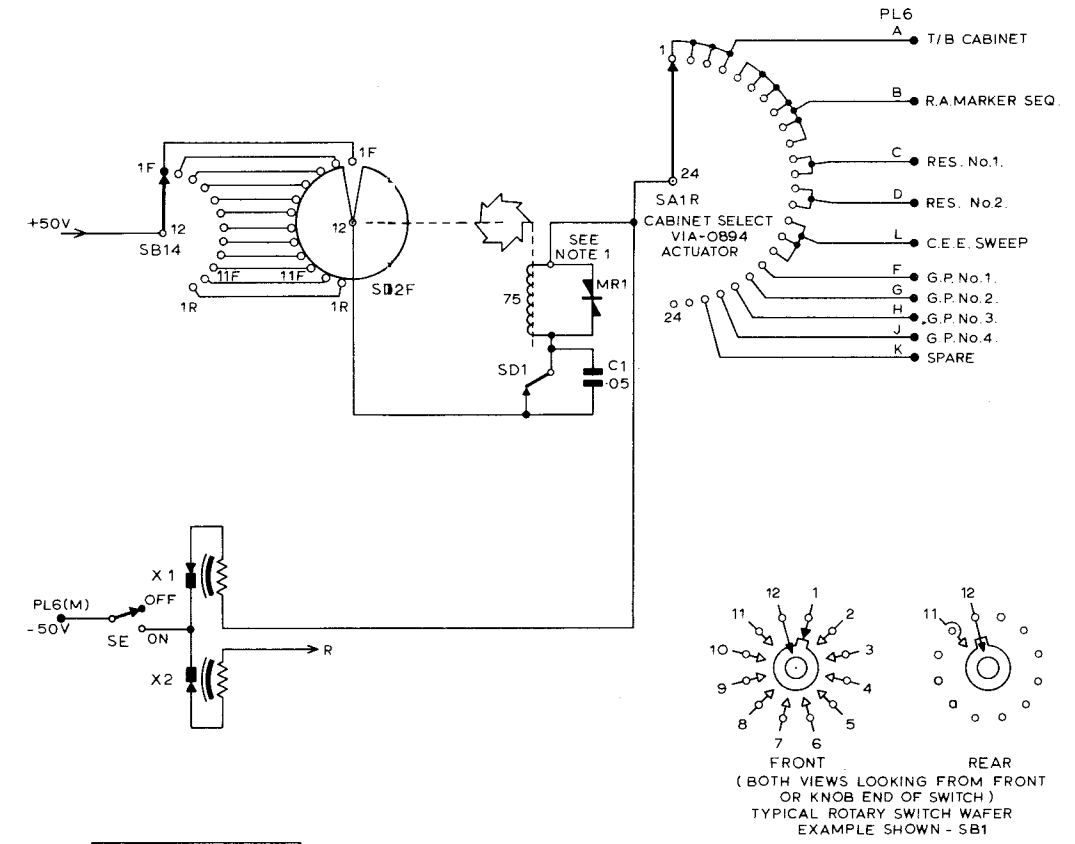


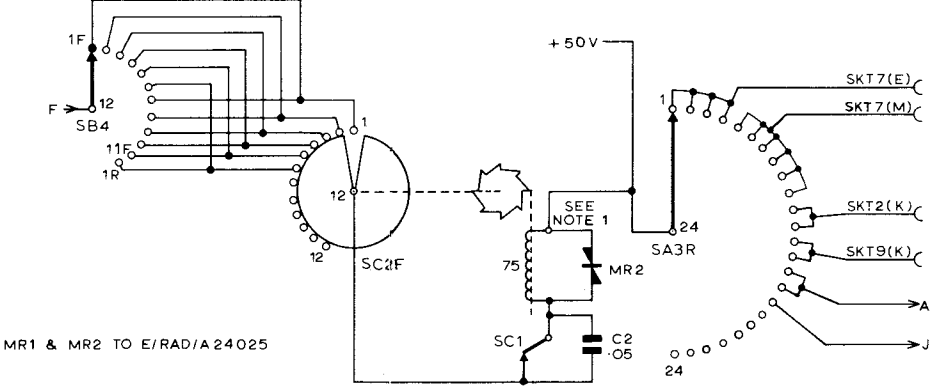
Fig. 2  
Chap. 4  
App. 4, Page 4.



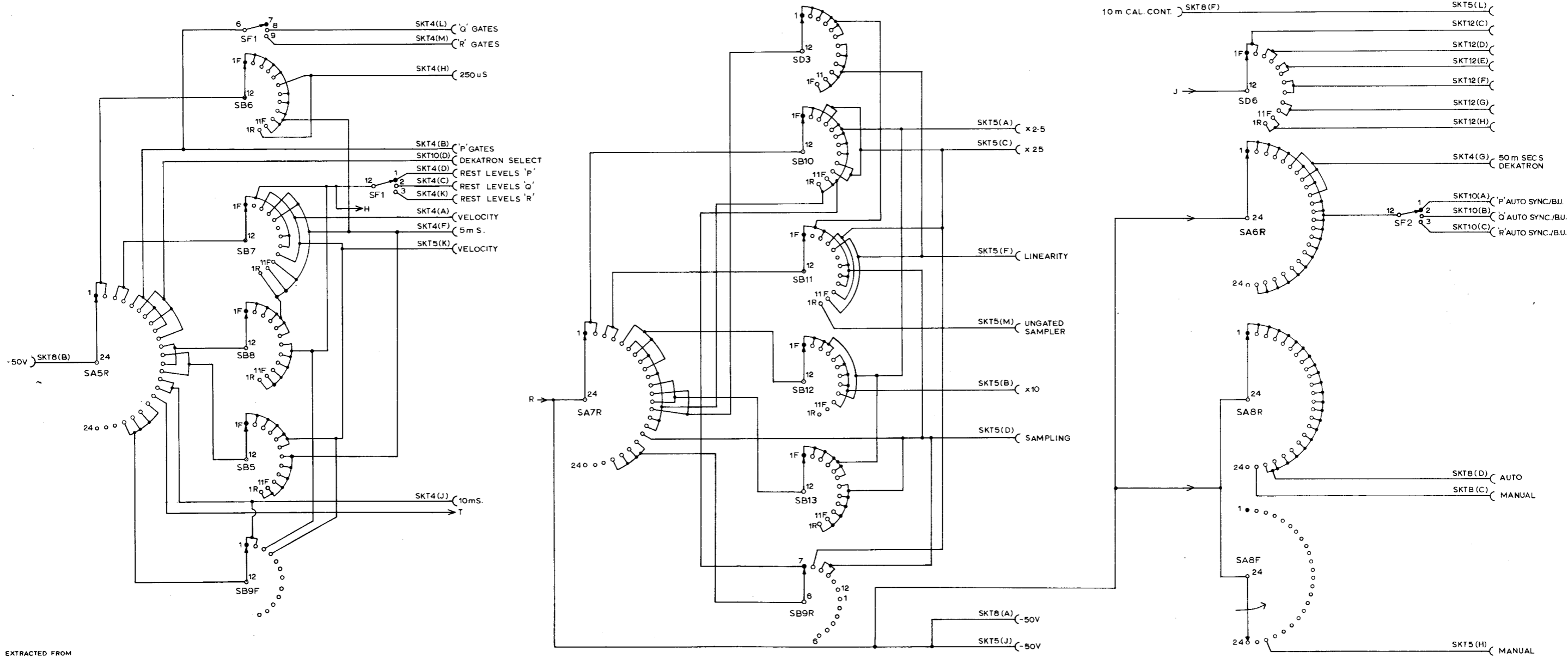
- CONNECTOR DESTINATIONS.
- PL6 - CABINET SELECTOR.
  - SKT 1 - MARKER SEQUENCE CABINET SELECTOR.
  - SKT 2 - RESOLVER CABINET No.1. SELECTOR.
  - SKT 3 - TIMEBASE CABINET SELECTOR.
  - SKT 4 - GENERATOR SWEEP CONTROL 2
  - SKT 5 - AMP VIDEO CONTROL.
  - SKT 7 - GROUP SELECTOR.
  - SKT 8 - GENERATOR SWEEP CONTROL 1
  - SKT 9 - RESOLVER CABINET No.2. SELECTOR
  - SKT 11 - C.E.E. SWEEP SELECTOR
  - SKT 12 - C.E.E. SWEEP CONTROL

Fig. 2

NOTES:-  
1. METROSILS MR1 & MR2 TO E/RAD/A24.025



Panel waveform selection 5840-99-954-8905 : circuit (Part 1)



EXTRACTED FROM  
RS1-2303Z, SH 2, Iss. 3

Fig. 2

AL 53, Nov. 76.

Panel waveform selection 5840-99-954-8905: circuit (Part 2)

Fig. 2

Chap. 4

App. 4, Page 5/6