AIR PUBLICATION

2557A

VOLUME I

3rd Edition,
August, 1949

GEE Mk. 2 AIRBORNE EQUIPMENT

(ARI. 5083)

Prepared by direction of
the Minister of Supply

A. C. Rowlands.

Promulgated by order of
the Air Council

J. H. Barnes.

A I R   M I N I S T R Y

P15231 11/49

GEE Mk. 2 AIRBORNE EQUIPMENT (ARI.5083)

LIST OF CHAPTERS

***Note.**—A list of contents appears at the beginning of each chapter*

P15230 M26082/G1882 11/49 1350 C & P Gp. 1

Chapter 1

INTRODUCTION AND GENERAL DESCRIPTION

LIST OF CONTENTS

LIST OF ILLUSTRATIONS

INTRODUCTION

1. The ARI.5083 is an airborne radar navigational device which, when used within range of associated ground transmitting stations, enables an aircraft navigator to obtain a "fix" of great accuracy at any instant during flight. This publication is concerned with the Gee Mk. 2 equipment, which is the airborne counterpart of the Gee 7000 ground system. For complete information on the general principles of the Gee 7000 system reference should be made to A.P.1093D. A brief summary of the system is given below.

2. The Gee ground system, by emitting pulse signals from synchronized transmitters, each at different geographical positions, lays down a space pattern of intersecting position lines from which a receiving aircraft can obtain an accurate fix.

3. The hyperbolic mesh or "lattice" is produced by radiating from a master station a pulse signal which triggers slave transmitters with predetermined and controlled time delays. Pulses from the master (A) and three slave stations (B, C and D) are received in the aircraft and displayed on a cathode-ray tube along a crystal-controlled and calibrated timebase which can be phased with the transmission. It is therefore possible to measure accurately the difference in time of arrival of the pulses from the slave stations with relation to the pulse signal from the master station.

4. By careful synchronization of the ground stations, the geographical positions of which are known, the time difference of arrival of the pulse signals can be determined for any position within range of the transmitters. Specially prepared "lattice charts" are provided to enable the navigator to plot the interpretation of the cathode-ray tube display and thus obtain an accurate fix.

5. The ARI.5083 is capable of measuring the time intervals between the reception of the A and B, A and C, or A and D pulses and these time intervals when plotted on the prepared chart indicate the position of the aircraft with respect to the ground stations.

6. The B and C slave stations are synchronized to alternate with A pulses from the master station and hence the pulse recurrence frequency of the slave station (250 p.p.s.) is half that of the A station

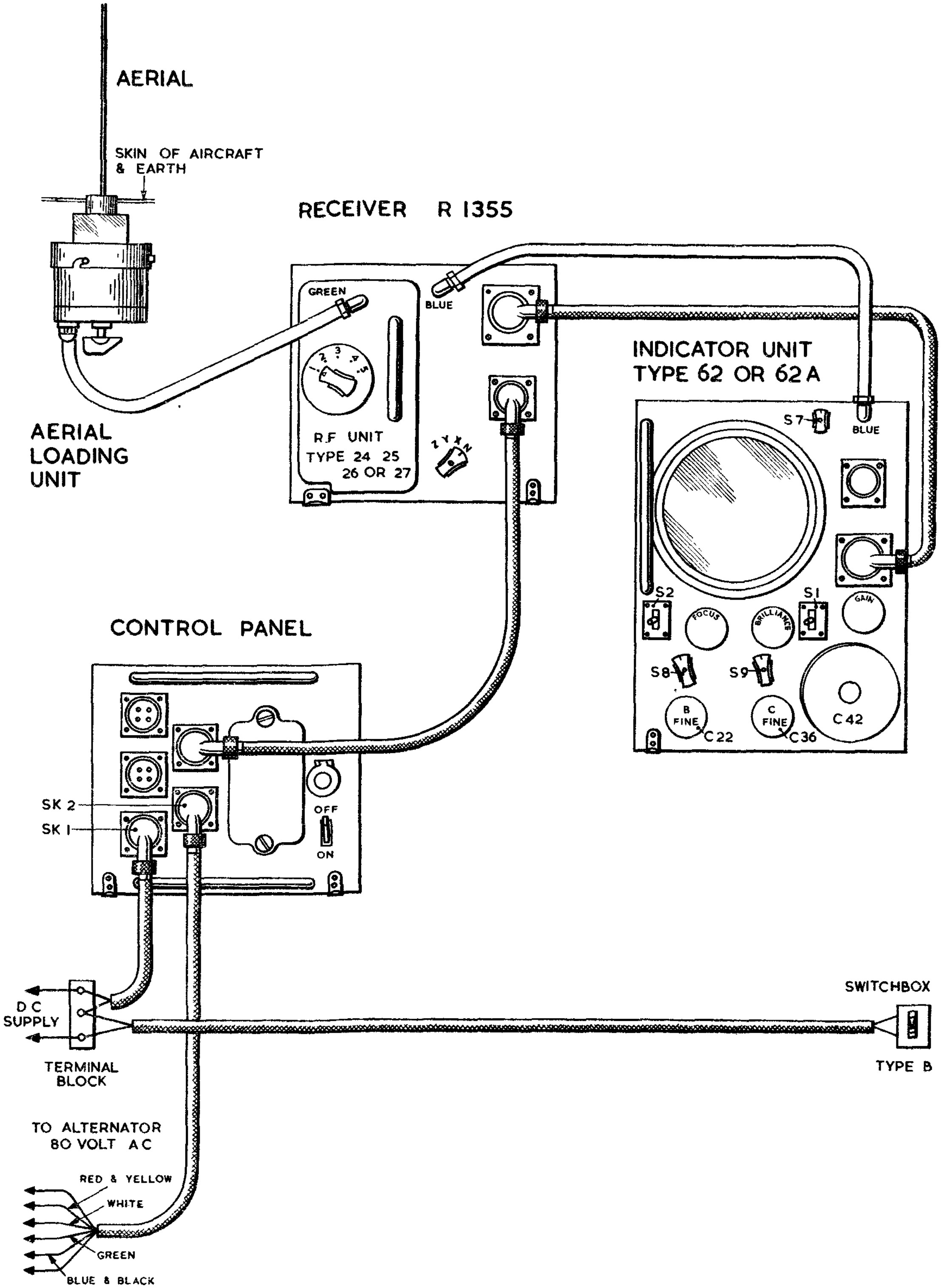


Fig. 1. Interconnection of ARI.5083

(500 p.p.s.). With the master A station, the B and C slave stations are normally sufficient to provide the navigator with enough information to obtain a fix. In certain areas, however (A.P.1093D), because of the acute intersection of the B and C lattice curves, good accuracy of fix is not obtainable. For this reason a third slave transmitter, the D station, is provided for the use of the aircraft navigator over the areas which would otherwise give a low accuracy Gee fix. The method of presentation of these pulses is fully explained in Chap. 2.

7. In this system no transmission from the aircraft is necessary; the installation consists of a superheterodyne receiver and a CRT indicator with the necessary power supplies and aerial system. The CRT display is provided with a calibrated timebase so that the time intervals between pulses can be measured.

GENERAL DESCRIPTION

Complete equipment

8. A typical interconnection diagram of the ARI.5083 is given in fig. 1. The installation consists of the following items:—

(1) Receiver Type R.1355 (10D/13032) fitted with one of the following:—

RF unit Type 24 (10D/1015)
RF unit Type 25 (10D/1016)
RF unit Type 26 (10D/1017)
RF unit Type 27 (10D/1054)

(2) Indicating unit Type 62 (10Q/13000)
or
Indicating unit Type 62A (10Q/37)

(3) Control panel Type 3 (5U/1269)
or
Control panel Type 5 (5U/363)
or
Control panel Type 6 (5U/521)
or
Control panel Type 9 (5U/2548)

(4) Aerial, aircraft Type 329 (10B/16026)

(5) Aerial loading unit Type 51 (10B/16025)

Note . . .
Items (4) *and* (5) *supersede the following:—*
Aerial, aircraft, Type 201 *and loading unit Type* 2.

(6) Connector set Type ARI/5083/- (with suffix letters according to type of aircraft).

(7) Miscellaneous items, such as anti-vibration mounting assemblies, switches, terminal blocks, fuse boxes, cable lengths.

Power supplies

9. A block schematic diagram of the complete equipment is given in fig. 2. Power supplies are obtained from an engine-driven generator of a type according to the type of aircraft in which the installation is fitted. In all cases the output of the generator will be 80 volts AC and of the order of 1,200 watts.

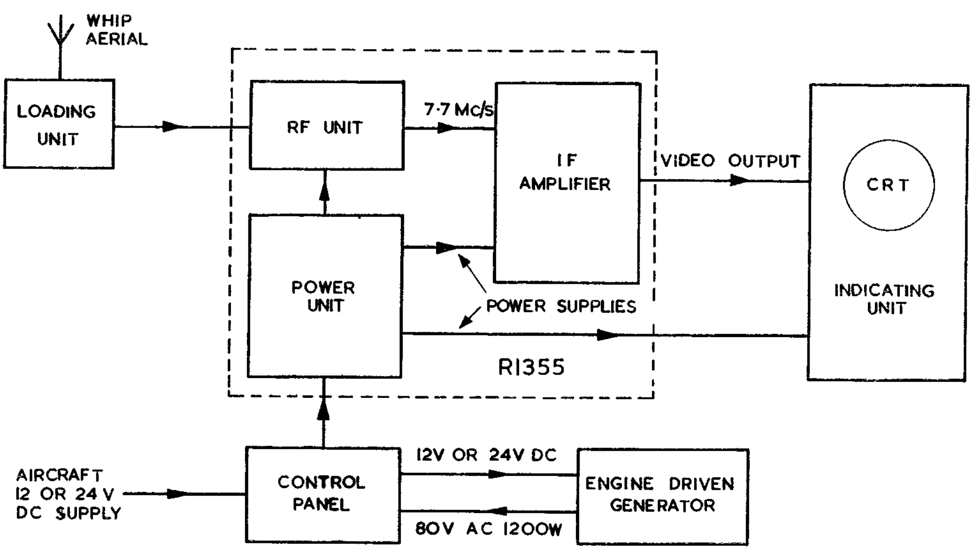


Fig. 2. Block schematic of ARI.5083

Control panel

10. Control panels Type 3 and Type 5 are, in general, the types most frequently installed, but in aircraft fitted with radar equipment additional to Gee Mk. 2, other types of control panel may be employed.

11. The function of the control panel is to stabilize the output of the 80-volt AC generator. The panel incorporates a carbon-pile voltage regulator connected in the DC field circuit of the AC generator, and a suppressor designed to prevent slot ripple in the field being fed to the radar equipment. Complete descriptions of the various control panels are given in A.P.1186D, Vol. 1, Sect. 1.

Radar power unit

12. The 80-volt AC supply is fed to a power unit mounted on a sub-chassis in the receiver R.1355. This power unit supplies HT to all valves in the equipment and EHT to the indicating unit Type 62 or 62A. The heater supplies for the receiver (and RF unit) are also obtained from the power unit. A transformer within the indicating unit supplies heater current for the valves and CRT in that unit. A detailed circuit description of the receiver power unit is given in Chap. 3.

Receiver Type R.1355

13. The superheterodyne receiver R.1355, the circuit layout of which is shown in the block schematic in fig. 3, has three sub-chassis mounted on one main chassis.

(1) RF unit (*para.* 14). This is a "plug-in" unit and may be withdrawn from the main chassis after slackening four captive thumb-screws on the front panel.

(2) Power unit Type 305 (*para.* 12). This is a detachable unit (mounted on the main chassis to the rear of the RF unit) but is not available as an assembled spare.

(3) Amplifying unit Type 182. This is the IF and video amplifier mounted to the right of the RF unit and the power unit. Although detachable, it is not available as an assembled spare.

RF units

14. The frequency range of the receiver R.1355 is covered by the use of four RF units as follows:—

RF unit Type	*Frequency range*
24	20-30 Mc/s
25	40-50 „
26	50-65 „
27	65-85 „

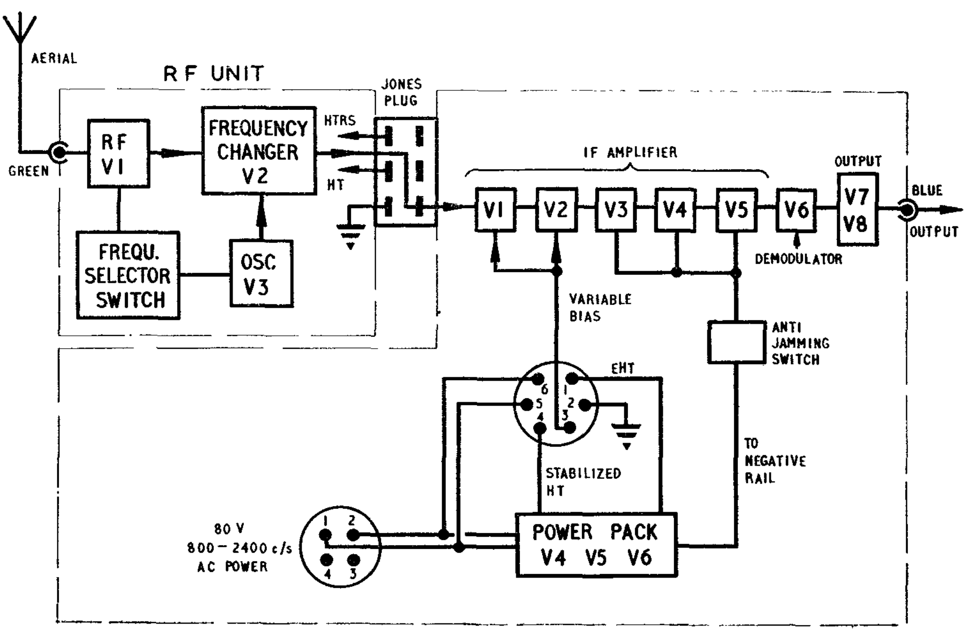


Fig. 3. Block schematic of R.1355

The RF units are interchangeable and are plugged into the receiver chassis according to the frequency band required.

15. RF units Type 24 and 25 operate on any one of five spot frequencies as selected by a switch on the front panel. The following table gives the spot frequencies to which the RF units are normally tuned on leaving the factory.

Switch position	*RF unit* *Type* 24	*Type* 25
1	22 Mc/s	43 Mc/s
2	22·9 ,,	44·9 ,,
3	25·3 ,,	46·79 ,,
4	27·3 ,,	48·75 ,,
5	29·7 ,,	50·5 ,,

Important note . . .

Although the RF units Type 24 and Type 25 are set up during manufacture and reconditioning to the above spot frequencies, it is emphasised that these frequencies are not necessarily used operationally. At the time of writing most Gee chains in use are operating on frequencies within the range of the RF unit Type 24, but not *on the spot frequencies listed above.*

Information on the Gee chain frequencies in current use must be obtained from the appropriate Authority before any attempt is made to set-up the equipment for installation in aircraft.

16. The RF units Type 26 and 27 may be continuously tuned over their frequency ranges (*para.* 14) by a tuning dial mounted on the front panel.

17. Each RF unit comprises a RF amplifier stage, local oscillator and frequency-changing circuit, the complete unit being enclosed in a screening box. The electrical connections to the amplifying unit Type 182 and the power unit Type 305 (*para.* 13) are made via a Jones plug mounted at the rear of the RF unit (*fig.* 3).

Amplifying unit

18. The output from the frequency changing circuit of the particular RF unit is supplied to the amplifying unit comprising a five-stage IF amplifier, demodulator, video amplifier and a cathode-follower output.

Interconnection of R.1355

19. The front panel controls of the receiver (and RF unit) are shown in fig. 1. They have the following functions:—

(1) Pye plug (green). This is the aerial input plug and is located on the RF unit.

(2) Pye plug (blue). This is the receiver output plug and is connected externally with an input plug on the indicating unit.

(3) Tuning control. This is located on the RF unit. On RF units Types 24 and 25 it consists of a 5-position switch, and on RF units Types 26 and 27 a tuning dial with an illuminated scale is provided; a small knob at the lower left-hand of the front panel of Types 26 and 27 is used for trimming.

(4) 4-pin W-plug. This plug is connected externally to the control panel. Pins 1 and 2 supply 80 volts, 1500 c/s (nominal). stabilized AC to the power unit in the receiver. Pins 3 and 4 are not used.

(5) 6-pin W-plug. This plug is connected externally to the indicating unit and its main function is to connect power to the indicating unit from the power unit in the receiver. Pin 3 is used to permit the variable bias to the IF amplifier to be controlled from the receiver gain control. The latter is mounted on the indicating unit front panel for convenience of operation.

(6) Anti-jamming (AJ) switch. This is a four-position selector switch marked N, X, Y and Z. The AJ circuit was designed to counter hostile jamming, but it is often of use when experiencing interference from transmitters in close proximity.

(a) N is the normal position of the switch and is used until jamming is experienced.

(b) X position is selected when railing type jamming is experienced.

(c) Y position is used if the jamming has a low-frequency sine wave modulation superimposed on the railings.

(d) Z position is used for CW jamming and low-frequency amplitude-modulated CW jamming.

20. A detailed circuit description of the receiver R.1355 is given in Chap. 3.

Indicating units Type 62 and Type 62A

21. The indicating units Type 62 and Type 62A are electrically and mechanically interchangeable, the Type 62A being a later design using CV1091 valves in place of certain of the CV1065 valves as used in the Type 62. Other differences are described in Chap. 4.

22. A block schematic diagram of the circuit layout is given in fig. 4. The function

Thus one A pulse and the B pulse appear on one half, and the other A pulse and the C pulse appear on the other half. This effect of "dividing" is obtained by causing the timebase to sweep the tube twice as fast (i.e., 500 c/s) and by applying simultaneously a 250 c/s square wave to the Y-plates, so displacing alternate sweeps.

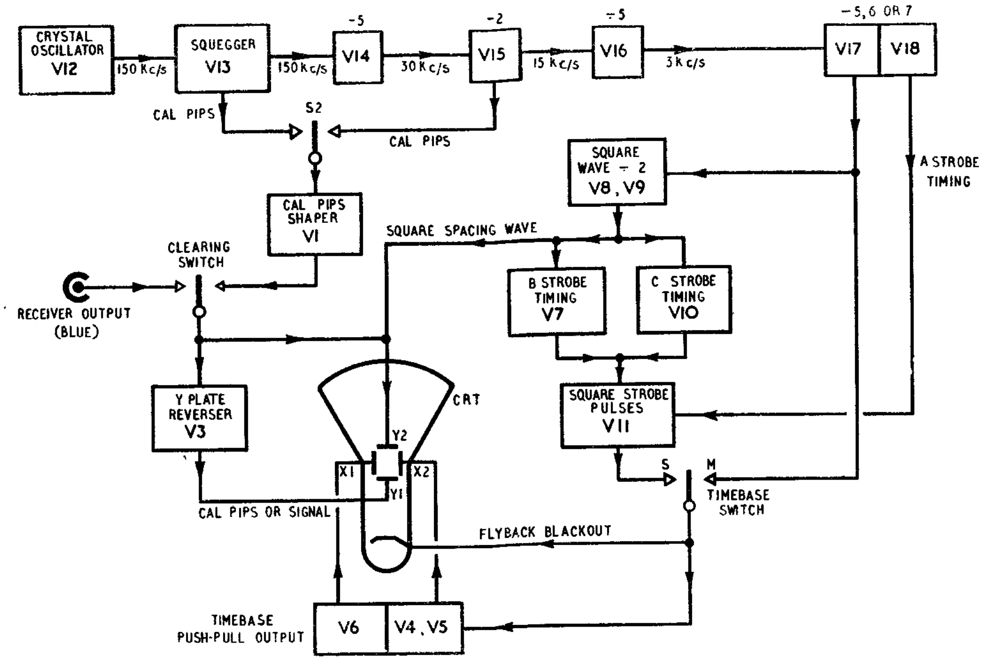


Fig. 4. Block schematic of indicating units Type 62 and Type 62A

of the indicating unit is to display the pulses from the receiver on the cathode-ray tube in a manner most suitable for interpretation by the navigator.

23. There are three timebases; the main timebase which is comparatively slow; the strobe timebase, which is fast and may be selected to cover any part of the main timebase; and the expanded timebase which is still faster than the strobe timebase.

24. In the main timebase position the CRT displays two traces this is explained as follows:—

(1) The pulse recurrence frequency of the A master station is 500 c/s and that of the B and C stations 250 c/s. The frequency of the complete timebase is 250 c/s, so that the CRT displays two A pulses, one B pulse, and one C pulse. The timebase is, in effect, expanded to twice the width of the tube and then "divided" at its mid point (*fig.* 5).

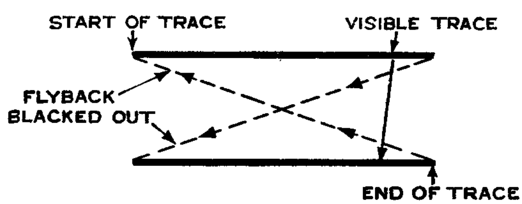


Fig. 5. Gee Mk. 2—main timebase trace

(2) For identification purposes the A station transmits a "ghost" pulse after every fourth main A pulse and this appears as a less brilliant pulse closely following the A pulse on the lower half of the trace.

(3) The D pulse appears on both traces and to distinguish it from the B and C pulses, the D station radiates a double pulse.

Note . . .

A complete description of the appearance of *the double trace and the method of identifying the pulses is given in Chap.* 2.

25. A crystal-controlled oscillator and its associated divider circuit is housed in the indicating unit. The frequency of the oscillator may be controlled within fine limits and it provides a stabilized source of frequency whereby the frequency of the timebase may be synchronized accurately with the ground station. The divider also generates calibration pips which may be fed to the Y-plates of the CRT as required.

26. The controls, switches and plugs listed below and annotated with reference to fig. 1 are features of the front panel on the indicating unit.

(1) Timebase switch. This 3-position switch S2 enables either the main timebase, strobe timebase, or expanded strobe timebase to be selected.

(2) B strobe coarse control S8 and B strobe fine control B FINE which together enable the position of the B strobe timebase to be moved along the first half of the main timebase trace.

(3) C strobe coarse control S9 and C strobe fine control C FINE which together enable the position of the C strobe timebase to be moved along the second half of the main timebase trace.

(4) Fine frequency oscillator control C42. This enables the frequency of the crystal oscillator to be controlled within fine limits.

(5) Clearing switch. With this 2-position switch (S1) either calibration pips or the output of the receiver may be applied to the Y-plates of the CRT.

(6) Focus control for adjusting the focus of the trace on the CRT.

(7) Brilliance control for adjusting the brilliance of the trace on the CRT.

(8) Recurrence frequency switch. This switch S7 controls the division ratio (divide-by-6 or divide-by-7) of the last stage in the dividers. S7 is normally in the divide-by-6 (anti-clockwise) position, and moving it to the divide-by-7 (clockwise) position changes the timebase rate of sweep in the ratio of 7 to 6.

(9) Pye plug coloured blue. This is the receiver output plug by which the output from the receiver is applied to the Y-plates of the CRT.

(10) 6-pin W-plug. The main purpose of this plug is to supply power to the indicating unit. In addition, pin 3 is used as a connection between the IF unit (in the receiver) and the gain control on the indicator.

(11) Gain control. This control enables the gain of the receiver to be controlled from the front panel of the indicator.

27. A detailed circuit description of the indicating unit is given in Chap. 4.

Aerial and loading units

28. Two types of flexible whip aerial have been designed for use with the ARI.5083, although almost all aircraft installations now use the aerial aircraft Type 329. This aerial has a rod 43¾ in. long (rod, aerial, Type 257) with a bayonet mounting which accommodates a loading unit Type 51. The aerial with the loading unit covers all the Gee frequencies in the band 20 to 80 Mc/s.

29. Electrical connection between the aerial and the loading unit is made by an adapter plug Type 587. The feeder from the receiver is coupled to the loading unit by means of a Pye plug and socket.

30. An earlier type of aerial has a 5 ft. whip (rod, aerial, Type 87) fitted with a bayonet type base, and the complete unit is known as the aerial, aircraft, Type 201. This aerial is normally used with the loading unit Type 2.

Loading units Type 51 and Type 2

31. The loading units Type 51 and Type 2 are mechanically similar, but differ in the band of frequencies covered.

32. Loading unit Type 2 is fitted with a five-position Yaxley switch numbered 1 to 5 (*fig.* 6). Position 1 gives a direct connection from the aerial to the feeder line, and is to be used over the band 40 to 51 Mc/s. The series inductance of the lead inside the load-

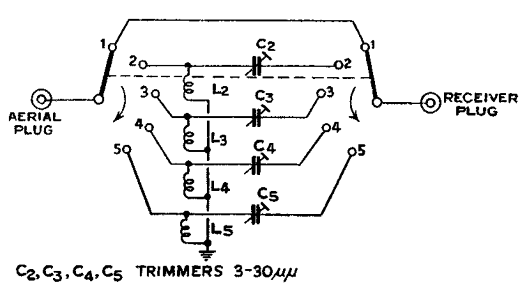


Fig. 6. Loading unit Type 2—circuit

ing unit in this switch position gives a sufficiently accurate impedance match over this range of frequencies. The remaining switch positions, numbered 2, 3, 4, and 5, correspond to the four spot frequencies in the band 22 to 30 Mc/s. Each is provided with a separate matching section to give an impedance match at the spot frequencies required. The trimmer condensers used in the loading units are sealed, and under no circumstances are these seals to be broken.

33. Loading unit Type 51 is for use on the Gee frequencies on the band 20 to 85 Mc/s. Externally it is similar to loading unit Type 2, but differs in its internal mechanical and electrical design, allowing for a total of eight separate switch positions (*fig.* 7).

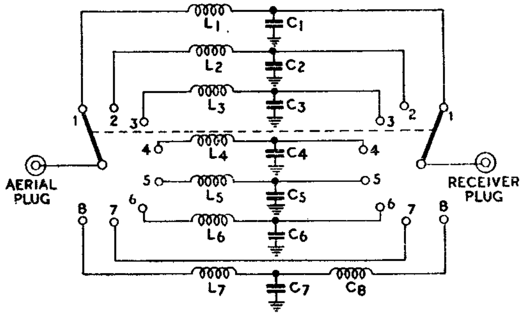


Fig. 7. Loading unit Type 51—circuit

34. The frequency coverage obtainable at each switch position of the loading units is given in the following table:—

Loading unit Type No.	Length of aerial	Switch position	Frequency coverage
51	3 ft. 7¾ in.	1	22·1 to 23·6 Mc/s
		2	23·6 to 25·7 Mc/s
		3	25·7 to 28·0 Mc/s
		4	28·0 to 30·8 Mc/s
		5	42·0 to 47·5 Mc/s
		6	47·5 to 54·5 Mc/s
		7	54·5 to 73 Mc/s
		8	73 to 85 Mc/s
2	5 ft.	1	40 to 51 Mc/s band
		2	22·9 Mc/s spot frequency
		3	25·3 Mc/s spot frequency
		4	27·3 Mc/s spot frequency
		5	29·7 Mc/s spot frequency

P15232 M26083/G1883 11/49 1625 C & P Gp. 1

Chapter 2

OPERATING AND SETTING-UP INSTRUCTIONS

LIST OF CONTENTS

LIST OF ILLUSTRATIONS

OPERATION

1. The following description of the operation of the equipment is of necessity rather comprehensive. In practice, an experienced operator can carry out the alignment of pulses and counting in something less than one minute, and for those requiring a summary of the pulse alignment and counting procedure reference should be made to para. 25 and 26.

Synchronization of indicating unit timebase

2. It is assumed that the RF unit in the receiver has been set to the correct radio frequency for the particular Gee chain in use.

3. With the indicating unit timebase switch (S2, *fig. 1*) in the main timebase position,

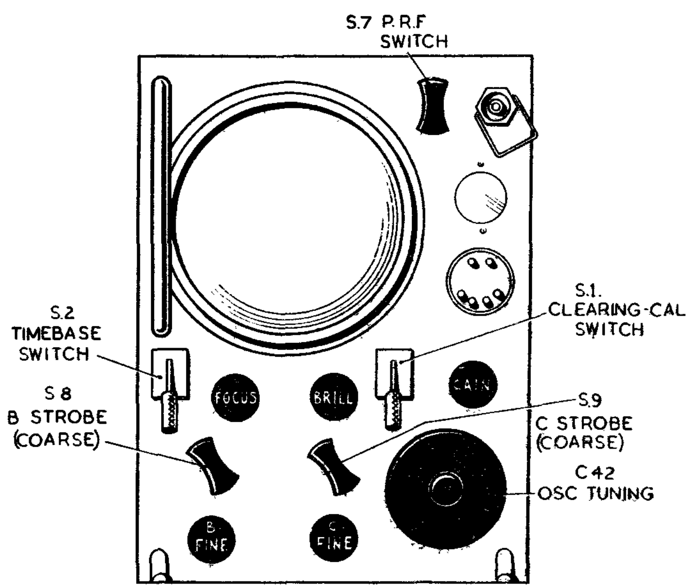


Fig. 1. Panel controls of indicating unit

adjust the focus, brilliance and gain controls to obtain a clear picture. Adjust the oscillator control, C42 (*fig.* 1) until the A pulses (*fig.* 2) from the master station appear one at the beginning of each trace (*para.* 6).

4. Every alternative A pulse (A2) is followed by a less brilliant pulse known as the A ghost pulse (Ag, *fig.* 3). The oscillator control (*para.* 3) must be adjusted so that A2 (followed by Ag) appears on the *lower* trace on the CRT. The A pulses (A1 and A2) will then appear in vertical alignment, and the presentation will be similar to that shown in fig. 2.

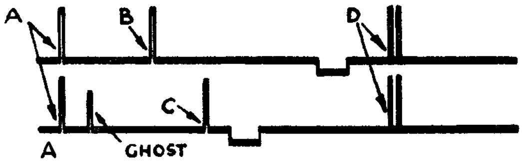
5. Transmission from the first slave or B station is so timed that the received pulses always appear on the top trace at some time interval from the first A pulse (A1, *fig.* 3). The pulse from the second slave station C always appears at some time interval following the A2 (and Ag) pulse. The third slave, or D station, radiates a double pulse with a repetition rate which causes the D signal to appear as a double pulse on both the upper and lower traces of the main timebase, one pair directly beneath the other as shown in fig. 2.

6. Initially, the signals will probably drift across the main timebase, but the oscillator control should be adjusted so that the A1 signal is positioned at the left of the top trace with the A2 signal directly beneath it (*para.* 4). Having positioned the A signals correctly, B and D will always be to the right of A1 on the top trace and C and D will always be to the right of A2 (and Ag) on the lower trace (*fig.* 2). Rapid positioning is possible by first using the "coarse" control of C42 and then the "fine" control for finally ensuring that the A pulses do not drift off the strobed (*para.* 7) sections of the traces.

Pulse alignment

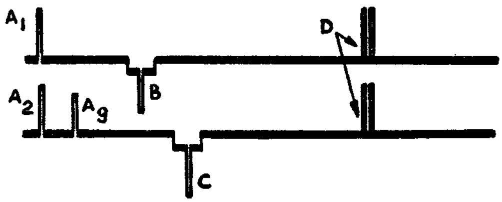
7. The Gee operator is required to measure the distance between A1 and the slave on the top trace and between A2 and the slave on the lower trace. To ensure that this is carried out with the greatest accuracy, four small sections of the main timebase are selected, or strobed, and then amplified (when required) to fill the whole of the CRT screen. The sections of the main timebase to be strobed are, of course, those occupied by the four pulses. There are, therefore, four strobes; two are *fixed* at the left side of the upper and lower traces covering the A pulses, while the B and C strobe markers (*fig.* 2) can be moved

FIG: 2



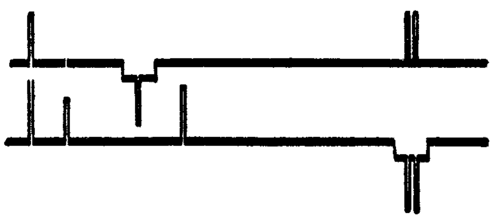
DISPLAY ON MAIN TIMEBASE

FIG: 3



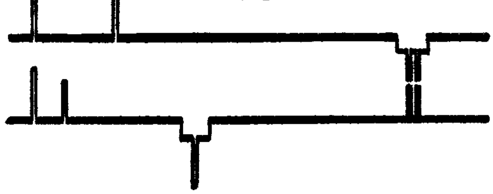
STROBING B & C SIGNALS

FIG: 4



STROBING B & D SIGNALS

FIG: 5



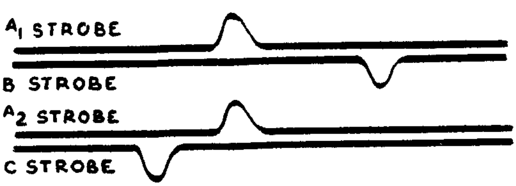
STROBING C & D SIGNALS

along the traces on to the slave pulses by the operator. The positions of the movable strobe markers are indicated by troughs in the upper and lower traces. When the adjustment of the strobe controls place these troughs astride their associated pulses, it will be noted that the slave pulses become inverted, (*fig.* 3).

8. If it is intended to use the B and C slaves, their pulses are strobed on the upper and lower traces respectively. If, however, the D slave is to be used, this must be strobed on the trace which is not being used for the other slave. Thus when B and D are to be used, D is strobed on the lower trace (*fig.* 4), and when C and D are to be used, D is strobed on the upper trace (*fig.* 5).

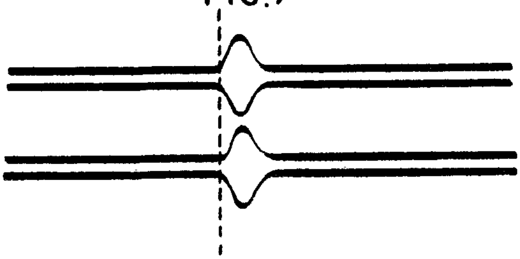
9. Now move the timebase switch S2 to the strobe timebase position. The four traces of the strobe timebase appear, one above the other, as shown in fig. 6. The A pulse appears in each case in the approximate centre of the particular trace with the strobed slave underneath. Adjust the strobe controls until the leading edges of the slave pulses are in vertical alignment with the associated A pulses and note the time. This instant of pulse alignment is the time of the fix which has yet to be resolved. The display will now appear as in fig. 7.

FIG 6



SIGNALS ON STROBE TIMEBASE

FIG.7



ALIGNMENT OF SIGNALS ON STROBE TIMEBASE

10. Any tendency for the pulses to drift is checked by the oscillator tuning control. The FINE B strobe control is used to align the pulses on the upper section of the trace and the FINE C strobe control to align those on the lower.

11. To check, and to ensure the best alignment when the highest possible standard of accuracy is required, the expanded timebase should be used. The pulses should be moved to the left of the strobe timebase using the oscillator tuning control, first to move them, and then to stop drift. The timebase switch is then turned upwards and the expanded strobe timebase thus brought into operation. Final alignment is then made by careful adjustment of the FINE strobe controls, observing the procedure outlined in para. 9.

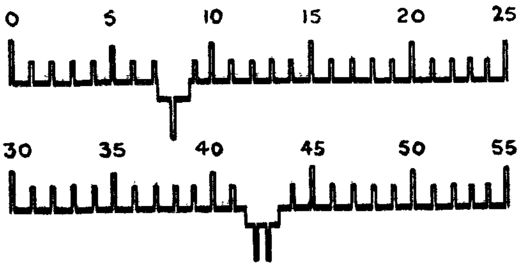
12. To obtain fixes at exact moments of time, such as an even minute, it may be found useful to note when there are several seconds to elapse before the 60th second, and then, by manipulating the FINE controls with each hand, keep the two slave pulses in alignment right up to the exact minute, clearing the signals at that time.

Counting

13. It is now necessary to replace the pulses with calibration pips which are made to appear on the main and strobe timebases by operation of the clearing switch S1. The calibrated timebases are illustrated in fig. 8 and fig. 9. It is most important to note that once the signals have been cleared, neither the coarse nor the fine strobe controls should again be moved until the counting has been completed. If any of these controls are inadvertently moved, the strobe markers will move and false readings will be obtained.

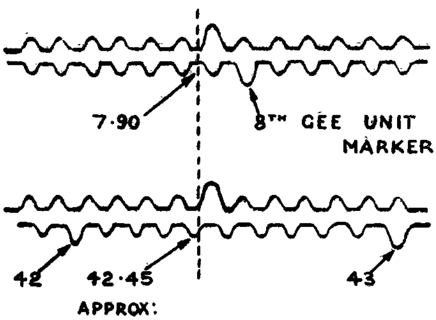
14. There are 25 calibration pips on each trace of the main timebase. Counting from the left to right, the top trace is calibrated from 0 to 25 with each fifth pip wider and of greater amplitude than the others (*fig.* 8). The lower trace is calibrated in a similar manner from 30 to 55 (five pips are lost in each flyback period which, of course, is blacked out). These pips are $66\frac{2}{3}$ microseconds apart, and for convenience this period is called a *Gee unit* of time. Pips on the main timebase are therefore spaced at Gee unit intervals, and pips occurring within the strobe markers are inverted in the same way as the slave pulses when strobed (*para.* 7). The strobe timebase is calibrated with pips which appear at the rate of 10 for each Gee unit, with every tenth pip wider and of greater amplitude than the others.

FIG.8



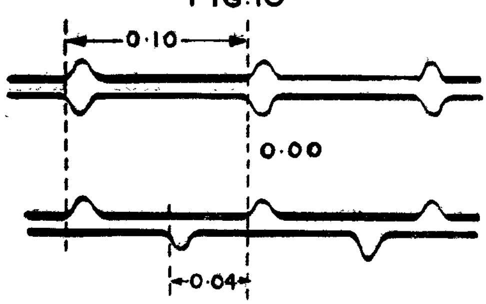
CALIBRATION ON MAIN TIMEBASE

FIG:9



COUNTING ON CALIBRATED STROBE TIMEBASE

FIG:10



INTERPOLATING ON EXPANDED TIMEBASE

15. When counting on the strobe timebase it should be noted that the large calibration pips pointing upwards from the middle of the upper and lower traces (*fig.* 9) are the zero point and the thirtieth calibration pip, respectively, of the main scale. The reading must therefore be taken from that part of the scale immediately below the leading edge of these pips; this is counting to the first decimal place. The whole number calibration pip, pointing downwards in each case, may be easily identified by reference to the main timebase (*fig.* 8).

16. For interpolation of the second decimal place of the reading, it can be seen that this may be estimated anywhere along the strobe timebase, since the spacings are all equal. In fact this interpolation *must not* be done at the centre of the trace because the reference point is a wider calibration pip than the others and tends to give slightly inaccurate second places of decimals. Since this is the case, it can be readily appreciated that when at extreme range or where great accuracy is required, the expanded strobe timebase can be used to obtain a more accurate interpolation. The expanded strobe timebase presents the left-hand ends of the strobes magnified a further five times (*fig.* 10).

17. When the pulses have been aligned, and if high accuracy is required (*para.* 10), the picture presented will be that of the expanded timebase. Since the timebase last in use during alignment is the one giving the highest order of accuracy, it will be convenient to commence counting on that timebase, switching to the three timebases in reverse order, thus obtaining the decimal places first and finding the whole numbers on the main timebase last.

18. In the illustrated example it can be seen that on the top trace in fig. 10 (since the pips are in vertical alignment) the second decimal place will be nought, whereas on the lower trace, the top pips are displaced approximately four-tenths of the distance between the lower pips, giving a second decimal place reading of four.

19. The timebase switch is now put to the strobe timebase position; the picture will then be similar to fig. 9 which shows the reading on the top trace to be just less than a whole number (of Gee-units) that has yet to be identified. Counting back from this number, it can be seen that the fraction of a Gee-unit will be approximately 0·90 (earlier observation of the expanded strobe timebase has shown this to be *exactly* 0·90) and the whole number will be one less than that inverted by the strobe.

20. Switching now to the main timebase (*fig.* 8) it can be seen that the inverted calibration pip on the top trace is the eighth; thus the reading must be 7·90.

21. The timebase switch must now be returned to the strobe timebase position and the reading of the lower trace taken (*fig.* 9). Counting from the left-hand inverted pip, there are four and a half spaces between it and the reference point. From the earlier observation of the expanded strobe timebase it is known that this is 0·44. Again switching to main timebase (*fig.* 8) and remembering that the calibration pip from which the reckoning was made was the left-hand one of the two inverted pips, it can be seen from the main timebase that the correct reading in this case is 42·44.

22. The values of the readings on the two traces having been determined, it is necessary to find the final values with which to enter the lattice charts, taking into account which slave pulses have been used. If the pulse strobed on the upper trace was from the B slave, then the reading is correct at 7·90. If it was from the D slave, then 30 units must be added to give 37·90.

23. The value of the reading on the lower trace is 42·44 irrespective of whether the C or D slave was used.

24. When the values are finally determined, the lattice chart for the particular Gee chain is entered and position lines are plotted giving a fix at their intersection.

Summary of operation in the air

Setting-up

25.

(1) Switch ON at the voltage control panel

(2) Set the receiver anti-jamming switch to N

(3) Switch the RF unit to the appropriate frequency for the Gee chain in use:—

(*a*) RF units, Type 24 and 25. Switch to positions 1 to 5.

(*b*) RF units, Type 26 and 27. Set to approximate frequency and adjust main and fine tuning controls for maximum signals; see also para. 26 (2).

(4) Set the aerial loading switch to the correct position for the frequency in use.

(5) Set switch S7 (*fig.* 1) to ÷ 6 or ÷ 7 position (normally ÷ 6).

(6) After due allowance for warming up, adjust BRILLIANCE and FOCUS controls for sharp, clearly defined traces.

Taking a fix

26.

(1) Switch S2 (*fig.* 1) to the main timebase position. Move clearing switch S1 to show pulses on the main timebase.

(2) Adjust the receiver GAIN control (located on indicating unit) until "grass" just appears on the traces or until pulses are easily seen.

(3) Using the oscillator tuning control (C42, *fig.* 1) drift the pulses along the traces until the A pulses appear at the extreme left of the two traces (with the single pulse A1 on the top trace) and check any further tendency to drift when this condition obtains (*fig.* 2).

(4) With the B and C coarse and fine strobe controls, strobe the wanted slave pulses on the traces (B or D on the upper trace, C or D on the lower trace) (*fig.* 3, 4 and 5).

(5) Switch S2 to the strobe timebase (centre position).

(6) With the FINE strobe controls bring the upper and lower slave pulses into exact alignment directly under the A pulses (now in centre of traces (*fig.* 7)). Check drift with the oscillator control.

(7) Set switch S2 to its upward position and check the alignment on the expanded strobe timebase. Adjust FINE controls if necessary.

(8) NOTE THE TIME (this is the time of the resultant fix) and switch the clearing switch to "calibration pips" (*fig.* 10).

(9) Read off and note the correct second decimal places.

(10) Switch S2 to strobe timebase (*fig.* 9), read off and note the first decimal place of reading on the top trace. Switch S2 to main timebase (*fig.* 8) and note the whole number of the top trace reading. (Add 30 if the signal strobed is the D signal).

(11) Repeat (10) for the reading on the lower trace, remembering that the first calibrations pip on the main timebase lower trace is number 30.

(12) Position lines may now be plotted from the reading taken. The intersection of the lines on the lattice chart will give the fix.

SETTING-UP INSTRUCTIONS

Setting-up in the aircraft

27. Connect up a P.E. set and switch ON at the voltage control panel. Allow a minimum of one minute as a warming up period.

28. Check the 80-volt AC supply from the voltage control panel for stability, with and without load.

29. Check that the receiver is set to the correct frequency for the particular Gee chain to be used and ensure that the AJ switch is in the N position.

30. Set the timebase switch S2 to the downward position (main timebase), the clearing switch S1 to "calibration pips" and check that the pulse recurrence frequency switch S7 is in the normal or divide by 6 (anti-clockwise) position. The normal picture showing 25 calibration divisions with every 5th pip raised should appear on both traces on the CRT. Check that FOCUS and BRILLIANCE controls function correctly.

31. Set the timebase switch to the central position (strobe timebase). The picture should appear normal with 12 to 14 pips on each of the strobe timebases. On the B and C strobes it should be possible to see two "raised" pips on each trace by moving the B and C fine strobe controls. There should be 10 small pips between each pair of "raised" pips counting in one (not both) of these "raised" pips. On the A strobes a "raised" pip should appear at about the centre of the trace.

32. Re-set the timebase switch to main timebase. Check that the zero mark is a "raised" pip. Operate the coarse strobe controls S8 and S9. For each step on the switch the strobe marker should jump about 6½ to 7 small divisions of the main timebase. Check that the markers will move from one end of the trace to the other and that the fine strobe controls operate smoothly. The total rotation of each fine strobe control should cover about 7½ small divisions of the main timebase.

33. Turn the p.r.f. switch S7 to its clockwise position. There should now be 30 small divisions on each trace of the main timebase and the trace length should remain the same to within about one-eighth inch. Re-set the p.r.f. switch to normal.

34. Operate the timebase switch to the expanded strobe timebase position and check that there are about three divisions along the timebase and that the timebases are steady.

35. With the clearing switch S1 in the upward position signals should be received, although it is possible that only one pulse may be visible and that may be drifting along the trace. Check that the receiver pulse (or pulses) may be stopped or caused to drift slowly in either direction by means of the oscillator control C42.

36. Check that the GAIN control operates to increase signal amplitude when turning clockwise and to bring up "noise" on the CRT in the extreme position.

37. If an RF unit Type 24 or 25 is being used, check that the "spot" frequency selector switch is in the required position and the loading unit switch is set accordingly.

38. If an RF unit Type 26 or 27 is fitted, check that the tuning control is set to the required reading (*fig.* 12, 13) and that the loading unit switch is set accordingly.

Setting-up on the bench

39. A test set Type 210 or Type 253, will be required for RF adjustment. Connect up the equipment on the bench in accordance with fig. 1 Chap. 1, omitting the aerial connection until ready to test the receiver. Remove the indicating unit dust cover and check the 80-volt AC supply; make adjustments to the voltage control panel if necessary.

Indicating unit Type 62 or 62A

40. Set the timebase switch S2 to strobe timebase, the clearing switch S1 to "calibration pips" and the p.r.f. switch S7 to "normal". There should be ten small (150 kc/s) pips between every pair of raised pips, counting in one but not both of the "raised" pips.

41. Check the setting of P11 (first ÷ 5 stage). Loosen the locking control of P11 and rotate in one direction until a point is reached where the divider goes out of adjustment and the picture will either jitter or the number of pips will alter from 10 to either 8 or 12. Note the scale setting of P11. Rotate the control in the opposite direction until the divider again commences to jitter or divide by 12 or 8. Note the new scale setting and re-set P11 to a position on the scale midway between the settings noted. Relock the control.

42. Set the timebase switch to main timebase. Set P12 (2nd ÷ 5 stage) in a similar manner to that given in para, 14. The number of minor calibration pips should change from 4 to 5 or 6 (counting one but not both "raised" pips) depending on the setting of P12 Relock control after adjustment.

43. Set P14 (3rd ÷ 6 stage) in a similar manner to that given in para. 14 and 15. For the correct setting there will be twenty-five 15 kc/s pips on each of the main timebase traces as shown in fig. 8. For the setting on either side of this position there will be 20 or 30 pips.

44. Adjust P13 (A strobe position control) until a "raised" pip (zero mark) occurs just at the beginning of the main timebase. Switch to strobe timebase; the "raised" pip on the A strobe timebase should now occur about midway along the trace. If this is not so, readjust P13 and relock.

45. Re-set P14 correctly after the foregoing adjustments are completed and switch the p.r.f. switch S7 to the clockwise position (÷ 7). The main timebase should show thirty 15 kc/s calibration pips instead of twenty-five. Re-lock P14 and set the p.r.f. switch back to normal.

Receiver

46. Throughout the following tests the AJ switch must be maintained in the N (normal) position.

47. Connect a vertical whip aerial together with the corresponding loading unit as used on the aircraft with a length of feeder similar to that of the particular installation.

48. The whip aerial should be mounted on an earthed plate or wire mesh of at least 4 ft. diameter, the tapered end of the whip being well away from surrounding objects.

49. Set up a test set Type 210 or Type 253. Instructions for the use of these test sets are given in A.P.2563J.

50. RF unit Type 24. Check the pre-set frequencies with reference to Chap. 1, para. 15 and the "Important Note" thereto.

51. The frequency selector switch on the aerial-loading unit must be set to the correct range for the frequency being checked. The appropriate trimmers in the three RF compartments and in the aerial loading unit are adjusted to give maximum signals. The location of these trimmers on the RF unit is shown in fig. 11.

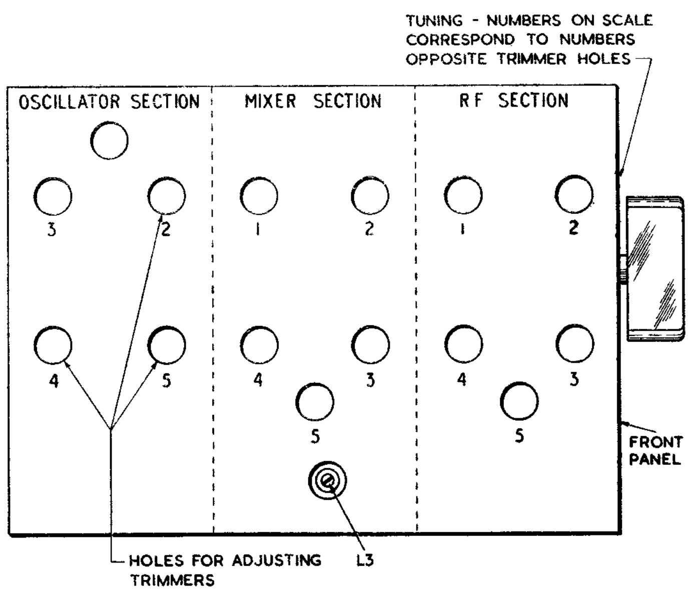


Fig. 11. Trimmer adjustment holes on RF units Type 24 and 25

52. If the signals tend to saturate the receiver, the gain should be turned down so that the exact tuning point can be found. It may be found necessary to break the sealing compound locking the trimmers in position in order to adjust them. After adjustment they should not be resealed as this has been found unnecessary. The RF unit must be removed from the receiver chassis in order to break the sealing.

53. After alignment of the RF stages a check should be made to ensure that any ground stations normally received can be picked up with their usual strength.

54. RF unit Type 25. Check the pre-set frequencies with reference to Chap. 1.

Note . . .

The instructions detailed in the foregoing

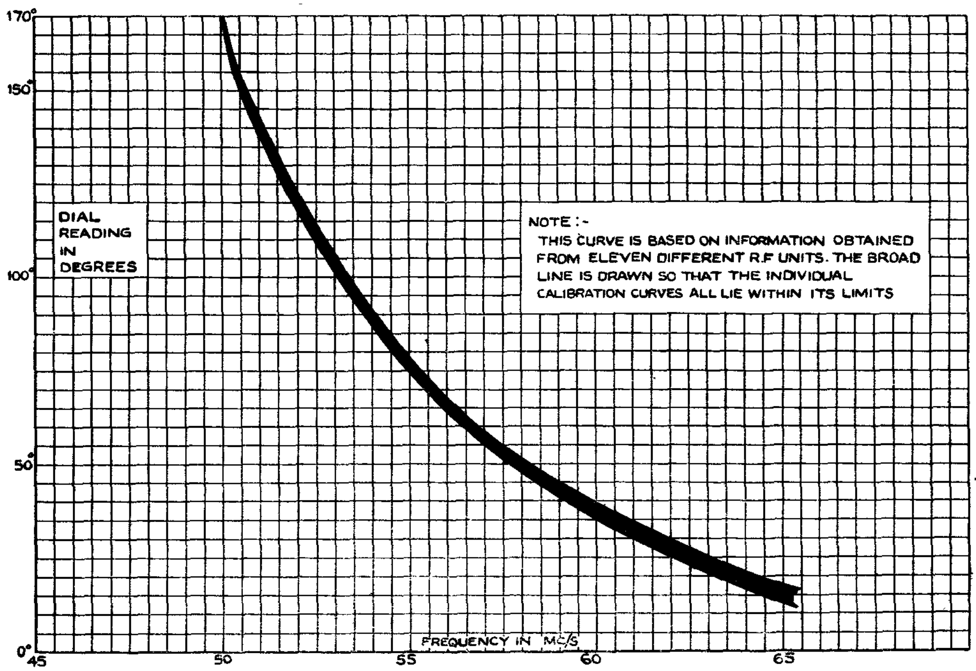


Fig. 12. Calibration curve for RF unit Type 26

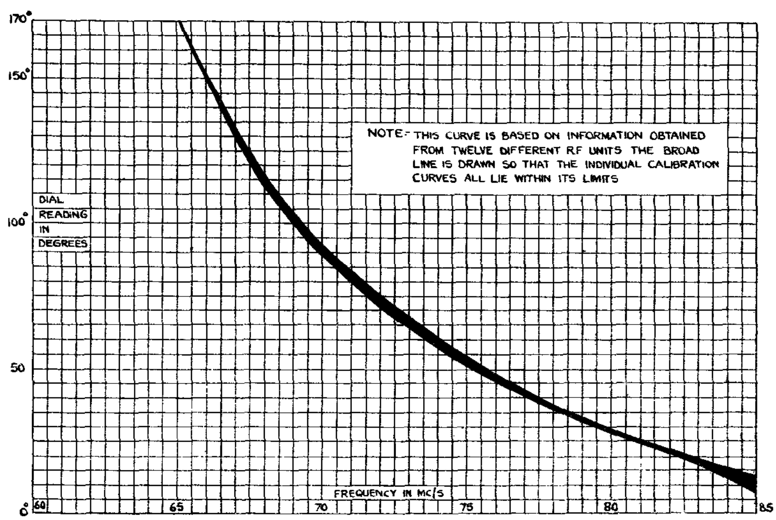


Fig. 13. Calibration curve for RF unit Type 27

paragraphs for RF unit Type 24 similarly apply to the RF unit Type 25.

55. RF units Types 26 and 27. Set the test frequency of test set Type 210 to the value at which tuning is to be checked and leave it at this value.

56. Rotate the tuning dial of the RF unit about the position corresponding to this frequency until the pulses are received at maximum.

57. Check that the dial reading is approximately correct. The tuning curve in fig. 12 gives dial readings against operational frequencies for Type 26, and fig. 13 those for Type 27.

58. Adjust the trimmer knob at the bottom left-hand corner of the RF unit front panel for optimum pulse shape and size. This is best carried out on the strobe timebase. Check that the trimmer is not tuning at one of its extreme positions, as indicated by the marks on the knob and panel.

59. Power unit and IF amplifier circuit. The negative-rail voltage to the anti-jamming circuits should be adjusted as follows:—

(1) Set the gain knob on the indicating unit to zero.

(2) Place the anti-jamming switch in position X or Y.

(3) Adjust P1 in the power unit until the average of the voltages across R22, R30 and R39 in the anode circuits of V3, V4 and 5V, respectively, is 135V.

The operation of the circuit is such that there is automatic compensation for the voltmeter current provided this does not exceed 1 mA. For preference use a test meter Type E or a test meter Type D on the 750 V. range.

(4) Lock P1 in position. Re-check the voltages to make sure that the potentiometer has not been turned during locking.

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Chapter 3

RECEIVER AND RF UNITS – CIRCUIT DESCRIPTION

LIST OF CONTENTS

LIST OF ILLUSTRATIONS

INTRODUCTION

1. The superheterodyne circuit of the receiver R.1355 may be divided into three electrical parts—the RF amplifier, the IF amplifier and video stage, and the power pack. In fact, the main chassis is divided into two sub-chassis, namely, the IF amplifying unit and the power unit. There is also provision on the main chassis for a third sub-chassis, i.e., a plug-in type RF unit.

2. The RF unit is built on a separate sub-chassis and may be plugged into a compartment in the receiver through an entrance in the front panel. Four RF units, each covering a part of the Gee frequency band, are supplied as accessories to the receiver.

3. In the following circuit descriptions of the RF units it will be seen that Type 24 and 25, although covering different parts of the Gee frequency band are almost identical in circuit and construction. Again, Type 26 and 27 are similar in structure with a few electrical differences. The frequency ranges of the RF units are given in Chap. 1.

CIRCUIT DESCRIPTION

RF unit Type 24

4. General views of the RF unit Type 24, with its dust cover removed, are given in fig. 1 and 2. The unit covers the frequency band 20 to 30 Mc/s and can be switched to any one of five spot frequencies within the range.

5. The RF unit forms part of the superheterodyne circuit (*para.* 1) and incorporates an RF amplifier stage, a local oscillator and a frequency-changing circuit. The circuit is given in fig. 3. The RF amplifier employs a CV1065 pentode V1 with a grid coil L1 tuned by the trimmer condensers C3, C5, C7, C9

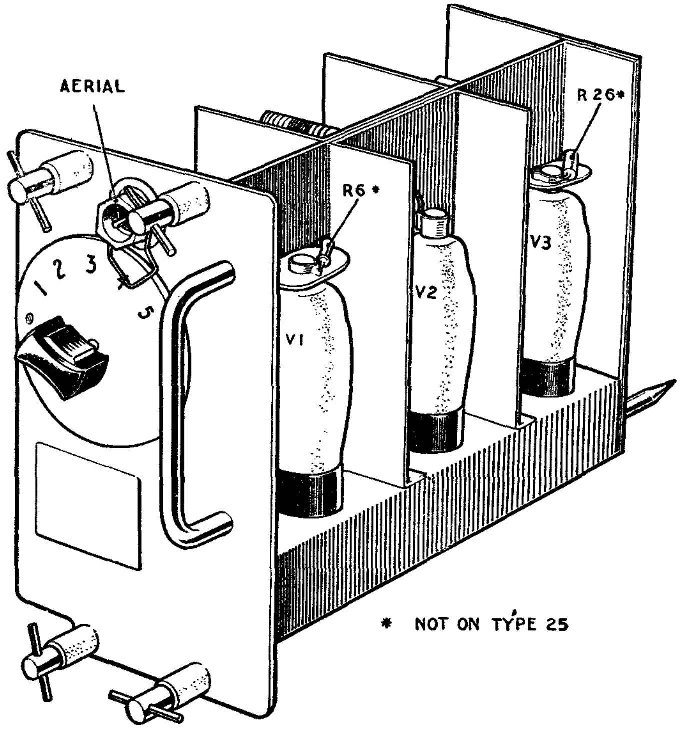


Fig. 1. RF unit Type 24 and 25—panel view

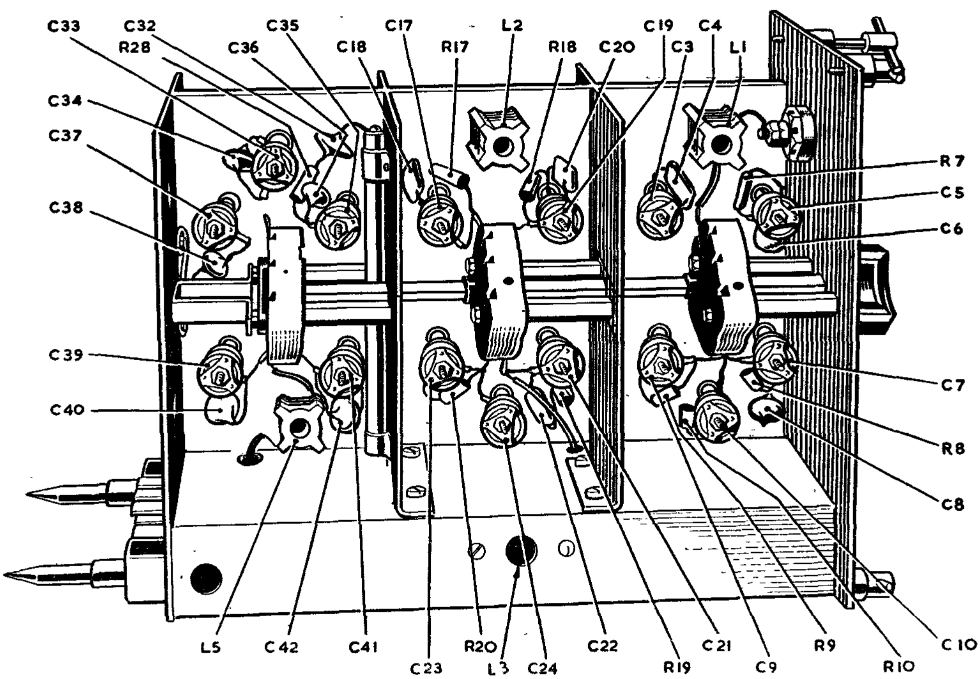


Fig. 2. RF unit Type 24—side view

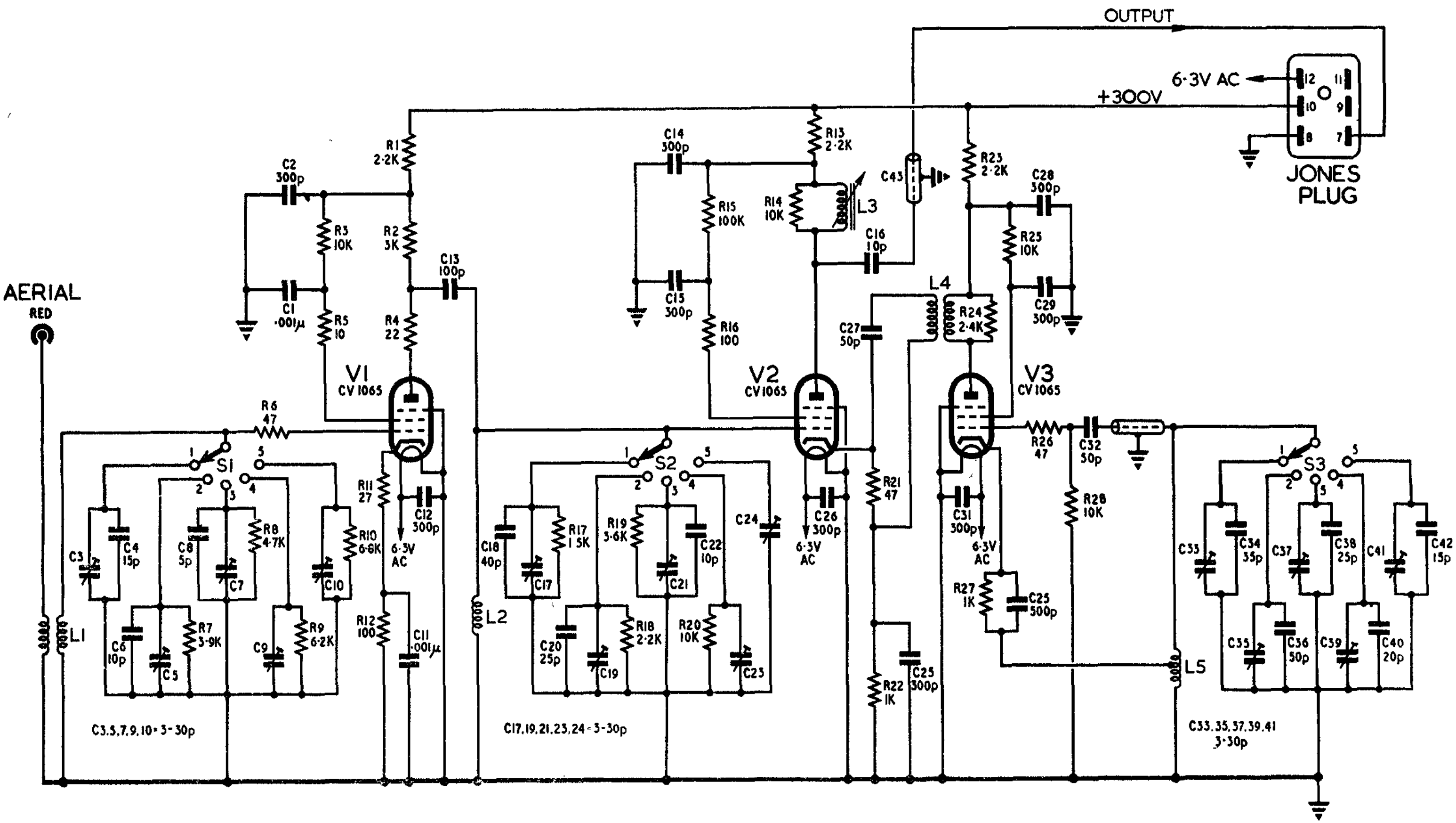


Fig. 3. RF unit Type 24—circuit

and C10, any one of which can be selected by the bank S1 of the frequency selector switch. The aerial feeder is matched in by means of the transformer of which L1 is the secondary winding.

6. The output of the RF stage is fed through the condenser C13 to the control grid of the frequency changer V2, also a CV1065. The grid circuit of V2 is tuned in a similar manner to the grid circuit of V1, the grid coil L2 being tuned by the trimmers C17, C19, C21, C23 and C24 as selected by the bank S2 of the frequency selector switch.

7. The local oscillator V3 has its frequency controlled by the coil L5 and the condensers C34 to C42, the appropriate condenser being selected by the third bank S3 of the frequency selector switch. The oscillator has a Hartley circuit (the cathode of the valve is tapped on to the tuning coil L5). To provide good frequency stability, V3 is electron-coupled, that is, the cathode, grid, and screen grid of the valves form the oscillator, the anode being used only to provide an output to the frequency-changer; the frequency of the oscillator is always above the signal frequency selected by the RF stage.

8. The output from the oscillator to the frequency-changer V2 is fed through the transformer L4, which has a pass-band greater than 10 Mc/s, across the resistor R21 in the cathode circuit of the frequency changer. The oscillator voltage developed across the resistor is about 1 volt RMS.

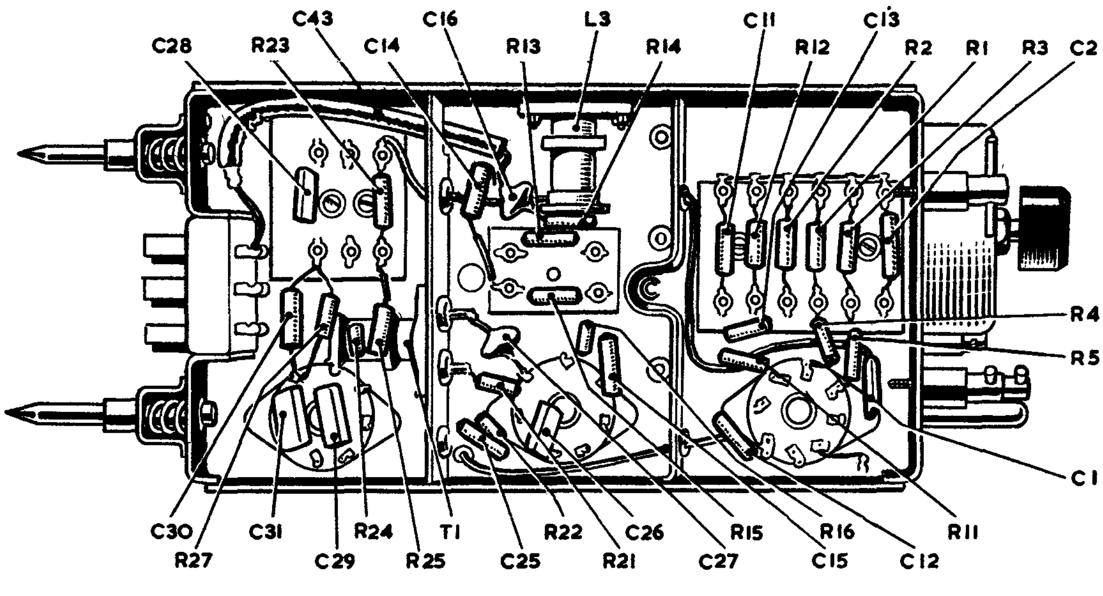
9. The coupling between the frequency-changer and the first stage of the IF amplifier is through the pre-set inductor L3 and the condenser C16 in the grid circuit of the first IF valve; L3 is fitted with an adjustable dust iron core and the circuit is resonated to 7·7 Mc/s, as is the grid circuit of the first IF valve. The annotation C43 (*fig.* 4) represents the capacitance of the co-axial cable to the output. The frequency-changer anode circuit and the first IF grid circuit, together with the concentric tube coupling the units, form a band-pass filter. This coupling is common to all RF units.

Note . . .

The concentric tube is mounted on the main chassis of the receiver and is not a physical feature of the RF unit (*fig.* 15).

RF unit Type 25

10. As can be seen from the circuit diagram in fig. 5, the RF unit Type 25 is electrically similar to the RF unit Type 24. The frequency band of the Type 25 is 40 to 50 Mc/s, the selection of spot frequencies within the band being made with the aid of a five-position switch as in the RF unit Type 24.



NOTE :- R6 AND R26 ARE TOP-CAP RESISTORS ON V1 AND V3

Fig. 4. RF unit Type 24—underside of chassis

11. The oscillator V3 in this case uses a Colpitts circuit, and it also is electron-coupled to the frequency-changing circuit. The damping resistors associated with the switched tuning condensers in the RF unit Type 24 are not necessary in the Type 25 because at these higher frequencies the input resistance of the CV1065 valves provides all the damping required. Illustrations showing the layout of the components of RF unit Type 25 are given in fig. 1, 6 and 7.

RF unit Type 26

12. The RF unit Type 26 illustrated in fig. 8 covers the frequency band 50 to 65 Mc/s; it differs from the two previously described RF units mainly in the fact that continuous tuning is provided over the frequency band (*fig.* 8). A circuit diagram is given in fig. 9. The unit has three valves—RF amplifier V1, a frequency changer V2 and a local oscillator V3. V1 and V2 are CV1136 pentodes and V3 is a CV1137 triode; the CV1065 is unsuitable for use at these higher frequencies.

13. There are three tuned circuits—the RF grid, the frequency changer grid, and the oscillator grid-anode. At these frequencies the valve input resistance is so low that it provides the whole of the damping required on its associated tuned circuit to maintain the necessary bandwidth; but the input resistance of the valve varies rapidly with frequency (as $1/f^2$) and if the variable tuning condenser were connected in parallel with the tuning inductance in the usual way, the combined effect of the change of capacitance over the tuning range would cause the bandwidth of the unit to change by about four-to-one over the band.

14. A variable condenser is therefore connected in series with the tuning inductance, and the two then act as a variable inductance which tunes with the fixed stray capacitances. It can be shown that the bandwidth of such a circuit, damped by a valve input resistance, is practically independent of frequency. All three tuned circuits are of this form.

15. Variable condensers C4, C5 and C32 of the three tuned circuits are ganged (*fig.* 8). The frequency of the oscillator tuned circuit

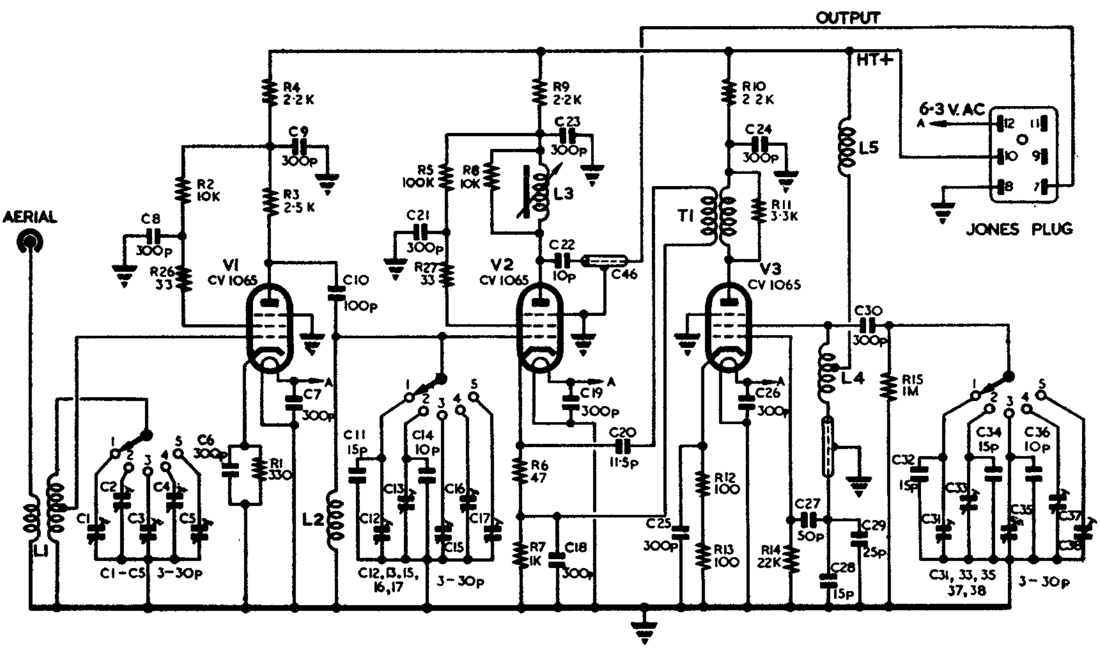


Fig. 5. RF unit Type 25—circuit

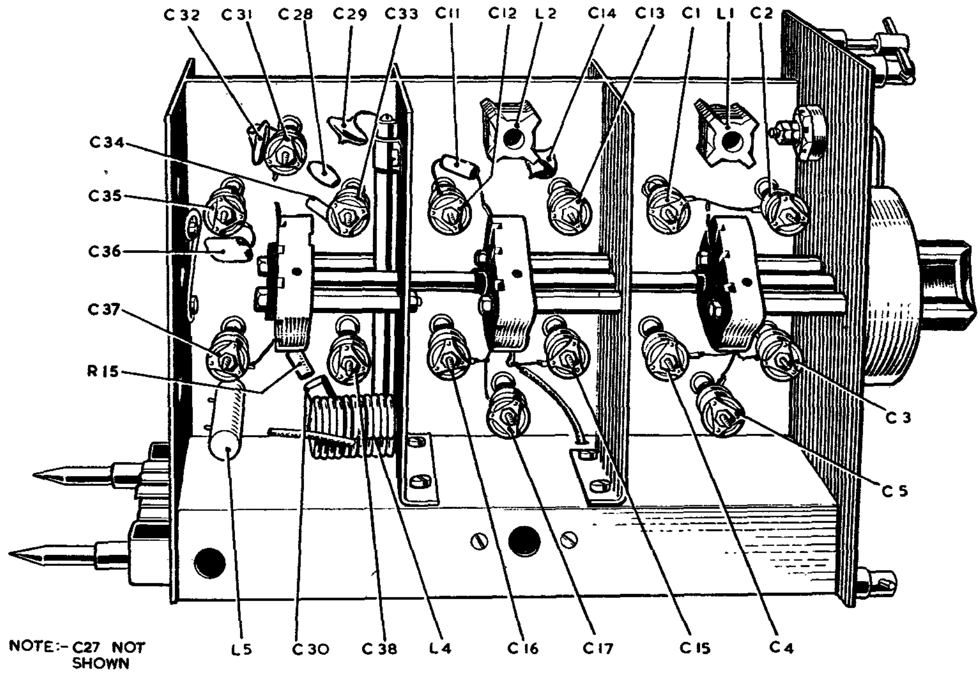


Fig. 6. RF unit Type 25—side view

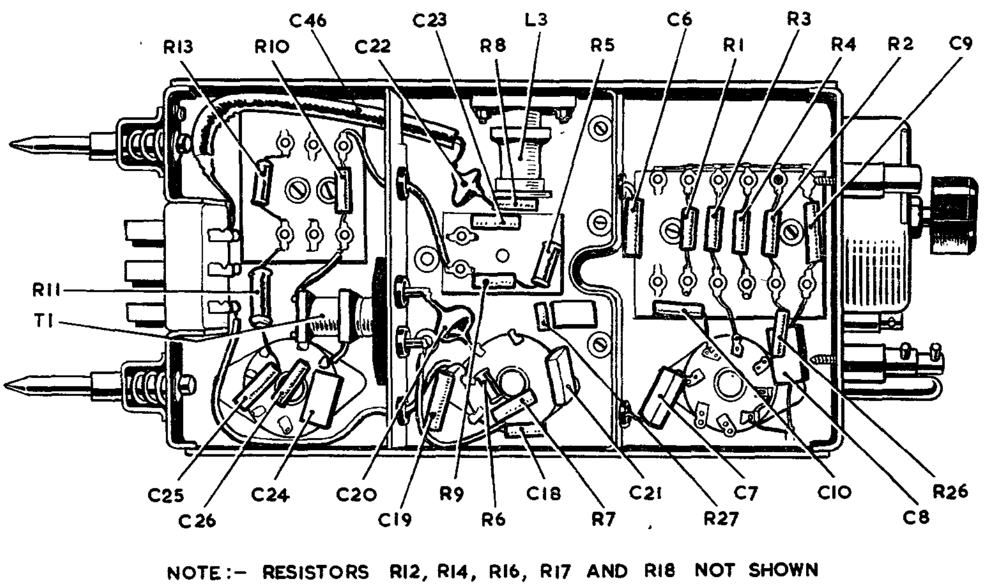


Fig. 7. RF unit Type 25—underside of chassis

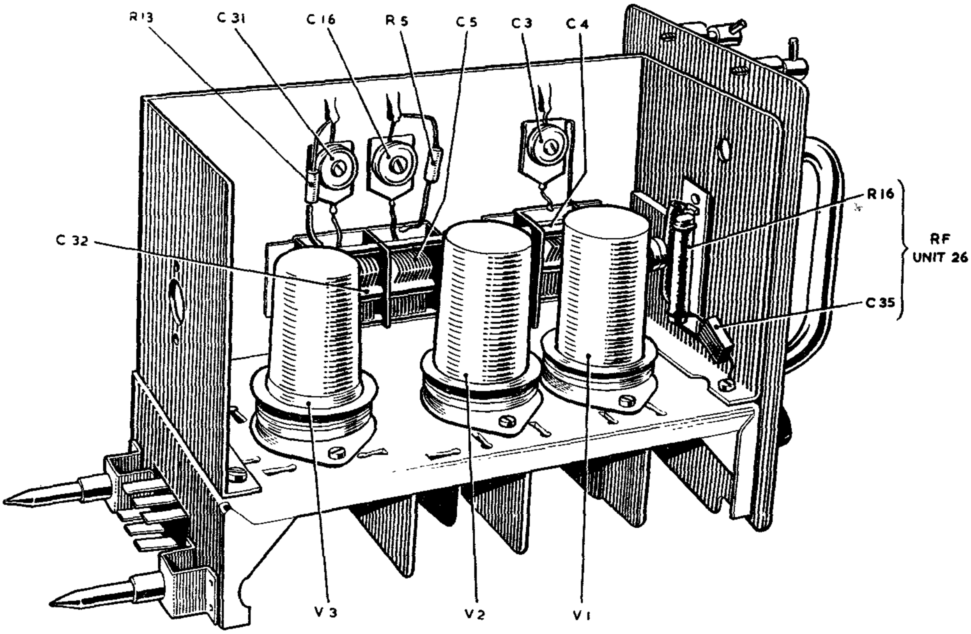


Fig. 8. RF unit Type 26 and 27—side view

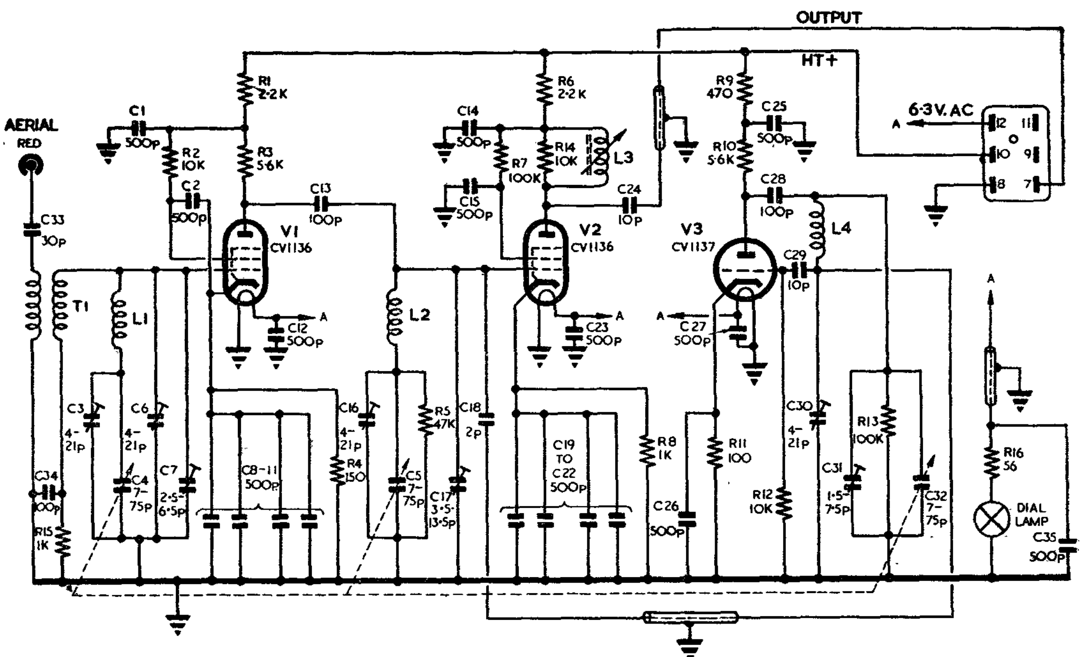


Fig. 9.—RF unit Type 26—circuit

(L4–C32) must remain a constant amount (7·5 Mc/s) above the frequency of the other two tuned circuits as the ganged condenser is rotated; this is accomplished by suitably proportioning the inductances and capacitances. It is essential that the wiring and components of the tuned circuits are not altered in any way as even small changes would upset the ganging of the circuits. The components on the underside of the chassis are shown in fig. 10.

18. The anode circuit of V2 is similar to that of the RF units Type 24 and 25, that is, it forms with the IF amplifier input circuit and the concentric tube (*para.* 9) a band-pass filter.

RF unit Type 27

19. The RF unit Type 27 covers the frequency band 65 to 80 Mc/s continuously, and it differs from the RF unit Type 26 only in the frequency coverage and the values of a number of components. A circuit diagram is given in fig. 11 and an underside view of the chassis is shown in fig. 10.

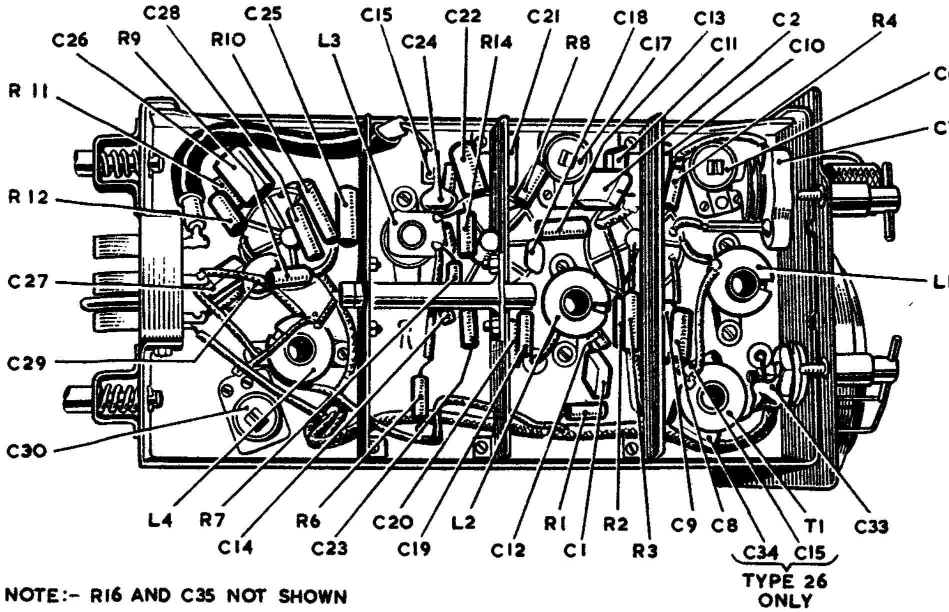


Fig. 10. RF unit Type 26 and 27—underside of chassis

16. The coupling circuit between the aerial input and the first tuned circuit (T1) is designed to match the constant feeder impedance to the varying valve input resistance and to increase the attenuation of any signals at IF frequency coming from the aerial.

17. The oscillator uses a Colpitts circuit and the resonant circuit can therefore be made of the same form as the signal frequency tuned circuits, thus simplifying tracking problems. The oscillator output is fed to the frequency-changer grid through a 10 pF condenser C29 and a screened conduit. The oscillator voltage developed on the frequency-changer grid is about 2 volts RMS.

IF amplifying unit (*fig. 12, at end of chapter*)

20. A circuit diagram of the IF amplifier appears in fig. 12. There are five stages of IF amplification; valves V1 to V5 are RF pentodes (CV1065). The diode V6 is a CV1092 demodulator. The pentode V7 is a video amplifier and V8 is a cathode-follower feeding the output of the receiver to the indicating unit; these are both CV1065 valves. The layout of the IF amplifying unit on the receiver chassis is illustrated in fig. 13, 14 and 15.

21. The grid circuit of V1, consisting of the

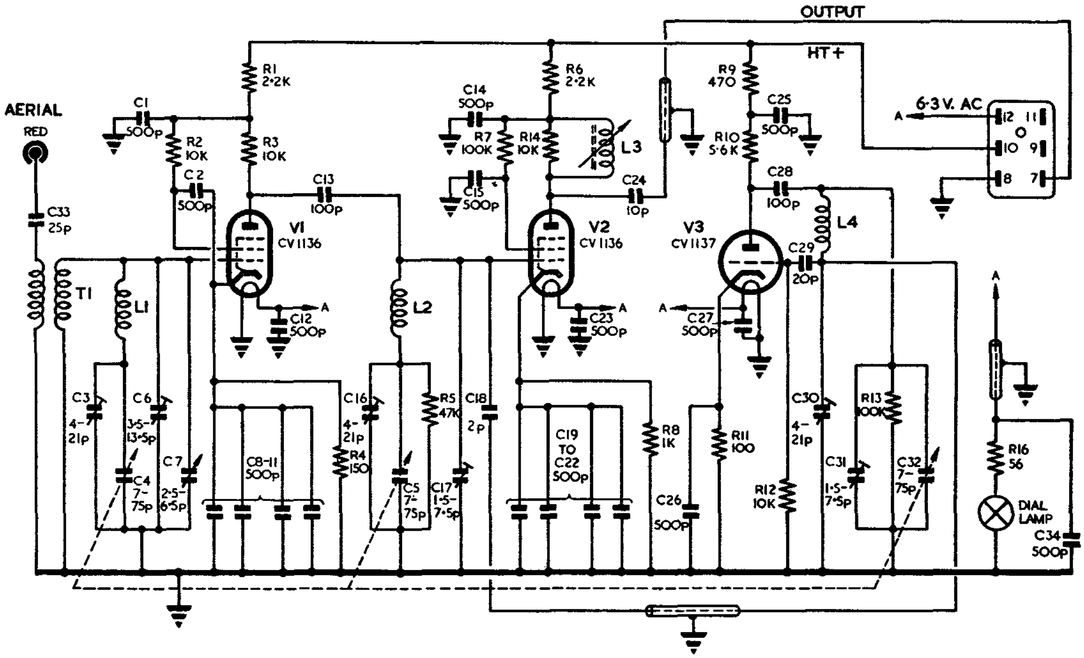


Fig. 11. RF unit Type 27—circuit

pre-set inductor L1 and the coupling condenser C1, forms part of the band-pass coupling between the frequency-changer stage and the IF amplifier, and resonates at 7·7 Mc/s. All the other IF tuned circuits L2, L3, L4, L5 and L6 are peaked at 7·5 Mc/s and the overall curve of the amplifier has a peak at 7·5 Mc/s, the bandwidth being $\pm$ 0·5 Mc/s for 6 dB down measured from the first IF amplifier grid.

22. The first two valves V1 and V2 are provided with variable cathode bias through the resistors R3, R4, R10, R57, R5 and the variable gain control P7 which is situated in the indicating unit. The stages V3, V4 and V5 are fitted with a special "back bias" circuit to enable the signal to be read through jamming. The operation of this circuit is described in para. 25 to 39.

23. An anti-jamming switch in the "back bias" circuit enables certain circuit elements to be adjusted in value to reduce the effects of different types of interference, particularly jamming. The switch has four positions, marked N, X, Y, Z. With the switch in the "normal" position (N) the condensers C15, C23 and C32 are shorted out by the switch contacts S2, S5 and S8 respectively, thus earthing the negative bias supply rail through R18, R19 and R36.

24. In this "normal" position, cathode bias is applied to the valves V3, V4 and V5 through the resistors R17, R27 and R35. An additional dropping resistor R42 is introduced into the screen circuit of V3 and V4 thus limiting the gain of these valves to a suitable operating value. The resistor R5 is introduced in series with the manual gain control (P7) by the open contact S17 thus reducing the maximum overall gain to an operating level. The filter condenser C42 is shorted by contact S11 and the filter circuit C50, R52, C51 and R53, between the video-frequency amplifier V7 and the cathode-follower V8, is shorted by contact S12 (in series with C49).

Function of anti-jamming circuits

25. The anti-jamming (AJ) circuits are selected by the positions X, Y and Z of the ganged switch, each position dealing with specific types of jamming as follows:—

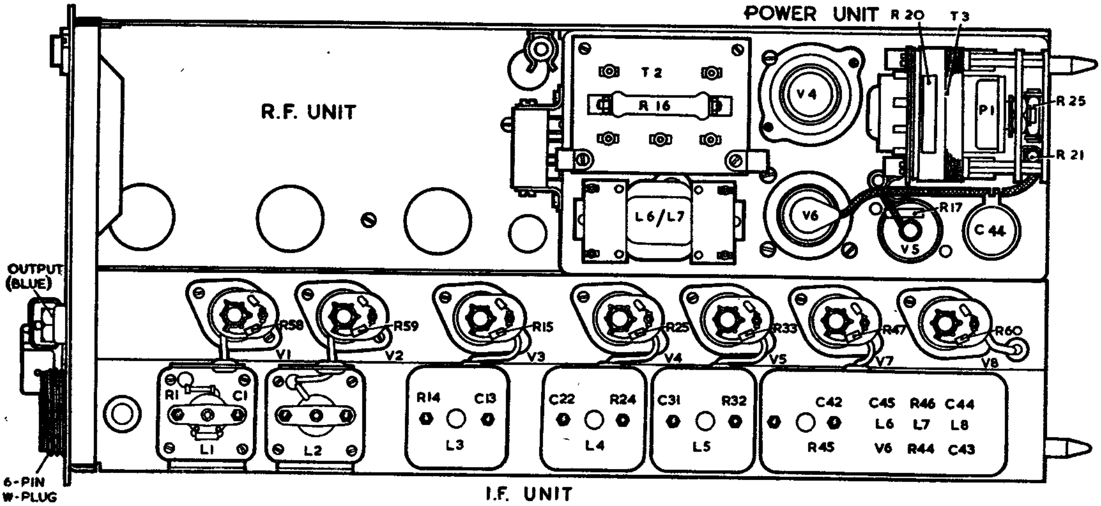


Fig. 13. Receiver R.1355—top of chassis

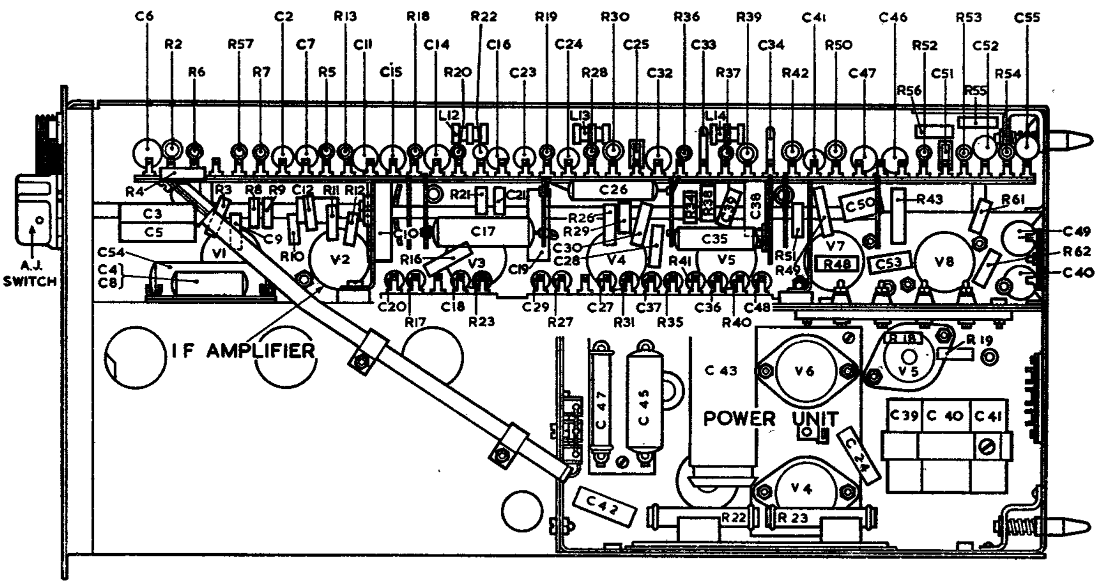


Fig. 14. Receiver R.1355—side of chassis

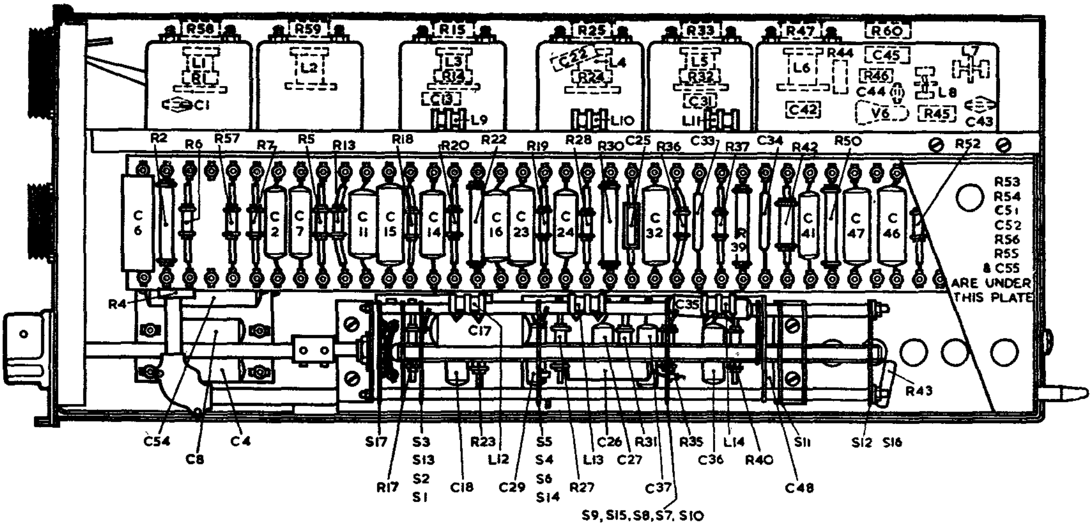


Fig. 15. Receiver R.1355—underside of chassis

Z — CW jamming or low-frequency modulated CW.

X —"Railing" type of jamming.

Y — Used where low frequency sine wave modulation is superimposed on "railing" jamming.

26. In the anode circuit of V3 (*fig.* 11), the resistor R22 (100K) is connected in series with R21 (5K approx.). The junction of these two resistors is connected through L12, R20 and L9 to the lower end of the grid coil L3. The junction of R20 (shunted by C14) and L9 is connected through the 510K resistor R18 to a negative bias rail of approximately 150V or 230V with respect to earth (*para.* 28), dependent upon the position of the AJ switch.

27. The junction of R21 and R22 is decoupled by the condenser C16, and the lower end of the grid coil is decoupled by the condenser C13. Condenser C17 can be switched across C16 and C15 can be switched across C13 (according to the position of the AJ switch) to increase the time constants. The condenser C14 connected across the resistor R20 completes a condenser potentiometer between the grid and anode circuits of V3. The circuit for the valve V4 and the circuit for the valve V5 are almost identical with that for V3 except that values of some of the condensers in the potentiometer chain are different.

28. An additional resistor R41 is connected across the negative-rail supply with the selector switch in position Z. The supply has a poor regulation and the switching in of this resistor drops the voltage from the normal 230V to 150V.

CW jamming

29. Consider the operation of the stage V3 with the anti-jamming switch in position Z, which is the position suitable for dealing with CW jamming or low-frequency modulated CW jamming. The main HT line is 350V positive with respect to earth, whilst the negative-rail is at a potential of 130V negative with respect to earth. The potential at the junction of the resistors R21 and R22 will depend upon the drop in potential across R22, since this has a very much larger resistance than R21. This drop in potential will be determined by the anode current taken by the valve V3.

30. The anode current of V3 with the anti-jamming switch in position Z is 2·3 mA, and this will cause the junction of the resistors R22 and R21 to be at a potential 120V positive with respect to earth. The resistors R20 and R18 are equal in value, so that the grid of V3 will take up a potential mid-way between 120V positive and 130V negative, i.e., 5V negative with respect to earth.

31. The anode-current/grid-voltage curves of fig. 16 will assist the explanation of the operation of the stage. Consider the curve (a) where a small CW jamming signal is applied to the control grid of V3 together with the required pulse signal. The CW signal will tend to drive the grid more positive and make the valve take more anode current. An increase of mean anode current will cause a greater drop in potential across R22, so that the grid will take up a potential more negative with respect to earth. The feedback arrangement thus tries to keep the mean anode current of the valve constant.

32. Fig. 16(b) illustrates the case of a very large CW jamming signal. The bias potential on the grid of the valve is shifted so much negative in the presence of the jamming that the required pulse signal is still able to pass through the valve on top of the jamming signal as shown. The decoupling condensers C16 and C13 in the anode and grid circuits of V3 are sufficiently large to prevent any change in the bias conditions for the duration of the pulse.

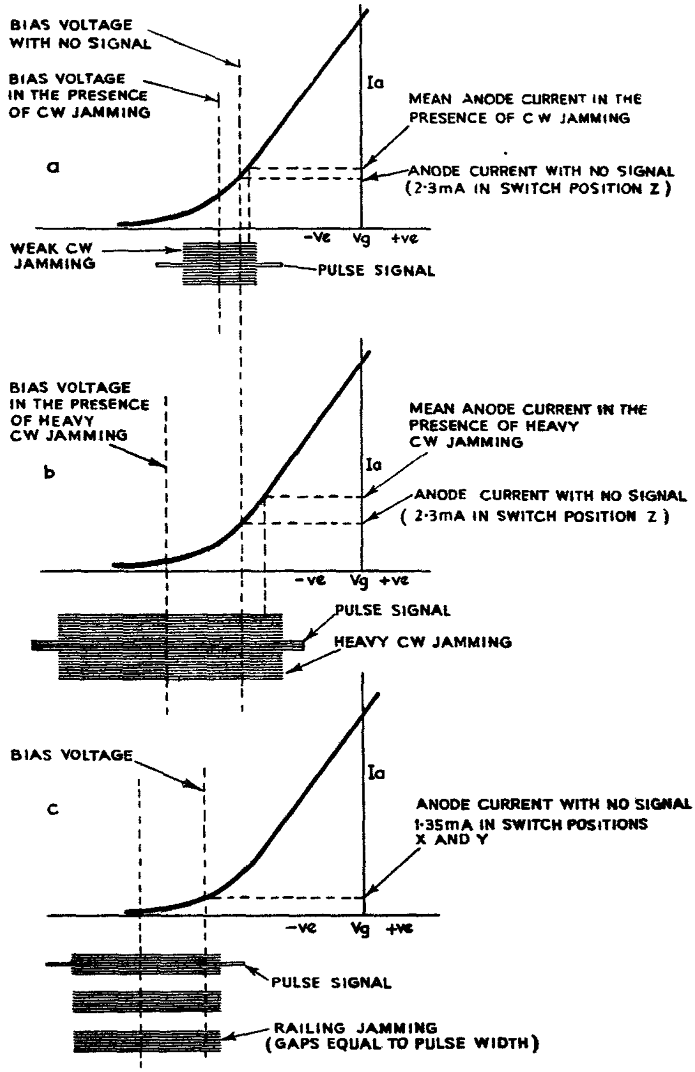


Fig. 16. Operation of back bias in AJ circuits

33. If the jamming signal is CW modulated by a low-frequency sine wave, a waveform similar to the modulation envelope will appear across the anode decoupling condenser C16 since this has a small capacitance and will present a fairly high impedance to modulation frequencies up to about 4 kc/s. This voltage is fed back to the grid circuit through the condenser potentiometer C12 and C13, causing a reduction in the modulation percentage of the jamming signal which gets through the V3 stage. Further reduction in the percentage modulation occurs in the stages V4 and V5. An additional high-pass filter consisting of the condensers and resistors C50, C51, R52, R53 is included between the video-frequency amplifier V7 and the cathode-follower V8 to remove the last traces of ripple.

34. The improvement obtained with this amplifier as compared with a straight receiver in the presence of either pure CW or CW modulated at a very low frequency is of the order of 1000 : 1.

35. The operation of the AJ circuits for a "railing" type of jamming is somewhat different and the diagram of fig. 16(c) helps to explain the action. In the case illustrated the jamming signal consists of square pulses of somewhat greater width than the required pulse signal, separated by gaps of equal width. The anti-jamming switch will be in position X for this type of jamming. This means that the potential of the negative rail will be approximately 230V and the anode current obtained by the valves V3, V4 and V5 will be about 1·35 mA with no signal coming through. Extra condensers (C17 and C15 in the circuit of V3) are switched in on all three back-biased stages, making the time constants long in the anode and grid circuits.

36. During the period of the "railing" pulse the bias applied to the grid of the valve will not change appreciably owing to the large condensers C17 and C15 in the grid and anode circuits. If the required signal pulse happens to occur at the same time as the "railing" pulse, it will be received satisfactorily on top of the "railing" pulse as shown. During the gap in jamming, no signals will be received, but this is not very important unless the jamming is locked to some multiple of the recurrence frequency of the signal and the "gap" happens to occur at the same point as the signal. Normally the recurrence frequency of the jamming will be drifting with respect to the recurrence frequency of the signal pulses and signals will ce received whenever a jamming pulse boincides with a signal pulse.

37. The small amount of the modulation envelope of the jamming signal which comes through the IF amplifier is filtered out from the pulse by C42 and R44. The resistance of R44 is high (1·8M), so that when V6 takes current, the charge accumulated on C42 leaks away very slowly. Thus the voltage across C42 becomes equal to the peak voltage of the "railing" jamming. The diode V6 consequently passes very little of the "railing", but will rectify the signal pulses which are carried unimpaired on top of the "railing".

38. Position Y on the AJ switch is similar to position X, except that the condensers in the grid circuits of the three back-biased stages are reduced in value, permitting some negative feed-back between grid and anode circuits. This position is useful if some low-frequency sine wave modulation is superimposed on the "railing" jamming. The negative feed-back in the back-biased stages,

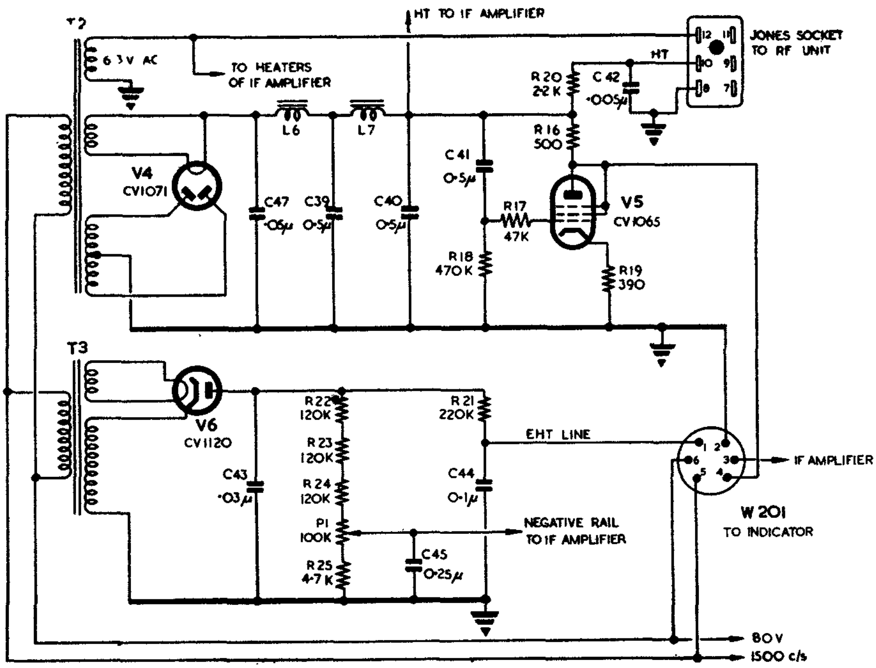


Fig. 17. Power unit—circuit

V3, V4 and V5, helps to reduce the percentage of this modulation, as in the case of CW modulated at low frequency (*para.* 33).

39. The back-bias arrangements will also operate if the jamming signal has a sine wave modulation instead of square pulses, but the improvement will not be so marked as with the square pulse railing jamming, since, due to the waveform of the jamming, there is less time at the peaks during which the desired pulse signals can be received.

Power unit Type 305

40. The power unit Type 305 is a sub-chassis mounted on the main chassis of the receiver. As previously stated, the power unit is removable (in the workshop) but is not available as an assembled spare.

41. Referring to the circuit diagram in fig. 17, the full-wave rectifier V4 supplies HT to the RF unit (via the 6-way Jones socket, of pin 10), the IF amplifier (from the junction R16 and R20) and the indicating unit via the 6-pin W-plug, pin 4 (from the anode of V5). The valve V5 functions as a stabilizer of very low-frequency jitter which is generally present with the normal type of engine-driven generator. It is arranged that some of this ripple is fed to the grid of V5 and the gain is adjusted so that the ripple developed across the anode resistor R16 exactly balances the ripple applied direct from the rectifier V4.

42. The HT supplies are summarized as follows:—

(1) Unstabilized HT to the IF amplifier—335V.

(2) Unstabilized HT to the RF unit—285V.

(3) Stabilized HT to the indicating unit—285V.

Note . . .

The voltages given are on load with a tolerance of ±10 *per cent.*

43. Heater supplies for the R.1355 valves (RF unit, IF amplifier and the stabilizer V5 in the power unit) are provided by a 6·3V winding on the transformer T2 in the power unit.

44. The EHT supply for the indicating unit CRT and the negative rail supply for the IF amplifier is taken from the transformer T3 and the half-wave rectifier V6. The EHT supply is smoothed by the resistor R21 and the condenser C44. The negative rail supply is obtained from the potential divider R22, R23, R24, P1 and R25. Adjustment of the negative rail voltage is by potentiometer P1.

45. The 80-volt AC supply from the control panel is connected to pins 1 and 2 of a 4-pin W-plug (W198) on the front panel of the receiver, from where it is connected to pins 5 and 6 on W201 (also mounted on the front panel of the receiver) and to the primaries of the transformer T2 and T3. Pins 5 and 6 are connected via an external connector and a W-plug and socket of the indicating unit to a transformer T6. The main function of this transformer is to provide heater supplies for the valves in the indicating unit. A schematic wiring diagram of the connections of the W-plugs on the receiver and indicating unit is given in fig. 18.

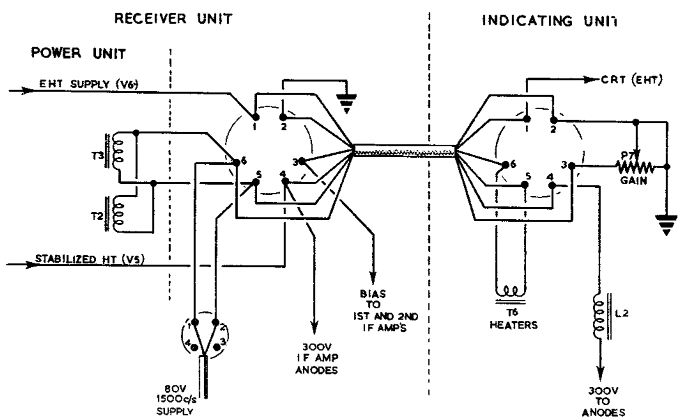


Fig. 18. Schematic wiring diagram of W-plugs on ARI.5083

P15461 M28930/G2369 12/49 1625 C & P Gp. 1

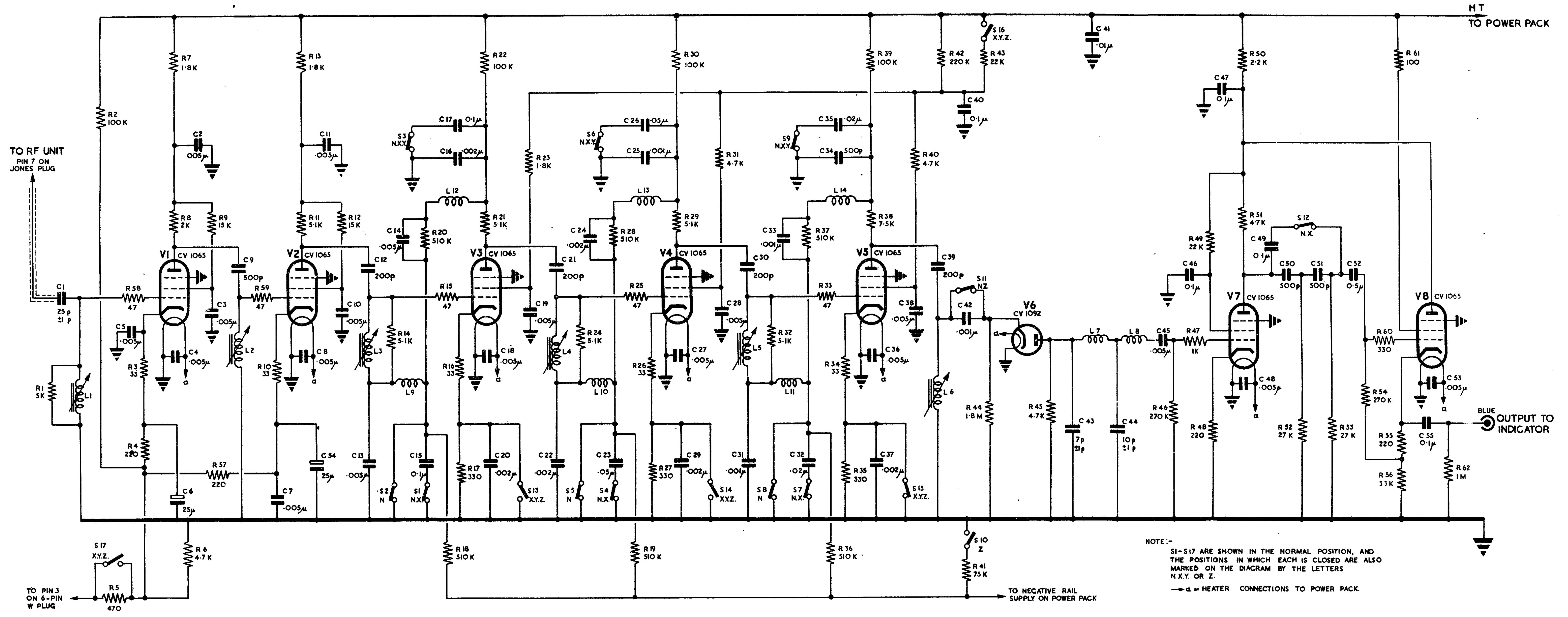


FIG. 12 RECEIVER TYPE R.1355 (IF AMPLIFIER)-CIRCUIT FIG. 12

Chapter 4

INDICATING UNITS TYPE 62 and TYPE 62A —CIRCUIT DESCRIPTION

LIST OF CONTENTS

LIST OF ILLUSTRATIONS

INTRODUCTION

1. As explained in Chapter 1, the indicating units Type 62 and Type 62A are interchangeable. Either may be used in the ARI.5083 without alteration to the particular aircraft installation.

2. There are some electrical and mechanical differences between the two types of indicating unit but in general the performance is identical. In the following paragraphs the circuit of the indicating unit Type 62 is described in detail and this description will suffice for the Type 62A with the exceptions outlined in para. 45 to 60.

3. A complete circuit diagram of the indicating unit Type 62 is given in fig. 1 and 2 (preceding fig. 9 at end of chapter). For the purpose of description the circuit is divided up into three parts, viz., the divider, the strobe timebase, and the main timebase.

Divider unit

4. The first stage in the divider unit is a crystal-controlled oscillator V12 (CV1065). The crystal, which is connected in the grid circuit of V12, has a fundamental frequency of 75 kc/s. Time control of the fundamental frequency is achieved by adjustment of the 50pF variable condenser C42 connected across the crystal and oscillations are maintained by the screen circuit L1, C43. The condenser C42 is provided with a manual "coarse" and "fine" control mounted on the front panel of the indicating unit.

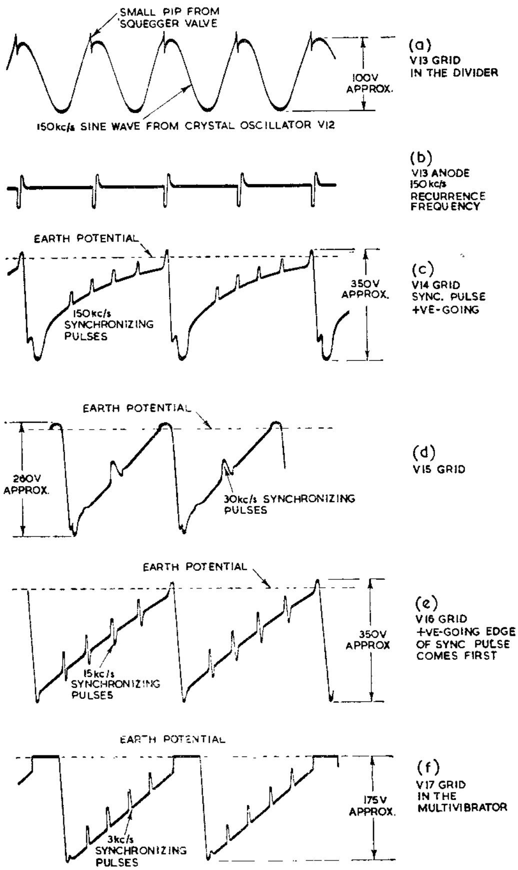


Fig. 3. Divider waveforms

5. In the anode circuit of V12 the transformer T1 is tuned by its pre-set to 150 kc/s, the second harmonic of the crystal frequency. The primary and secondary of T1 are critically coupled to eliminate any trace of the fundamental frequency in the output of V12. The output across the secondary of T1 is a sine wave of amplitude 100-volt peak-to-peak approx., and is applied to the grid circuit of V13 through the condensers C50 and C51.

6. The valve V13 (CV118) is a squegger type of oscillator with the transformer T2 which has two tightly-coupled windings connected to the grid and anode circuits of the valve as shown. The recurrence frequency of the squegger is locked by means of the 150 kc/s sine wave applied to the grid of V13 (*fig.* 3a) so that the output will consist of a series of sharp pulses having a recurrence frequency of 150 kc/s. These are fed to the next stage in the divider (V14) through a winding on transformer T3 which is connected in series with the anode circuit winding of the transformer T2. The divider V14 is another squegger oscillator having a similar arrangement to V13.

7. A potentiometer P11 which forms part of a chain of resistors R70, P11 and R68 from the HT line to earth has its slider connected to the grid resistor R69. The potential to which the grid of V14 is returned is therefore adjustable by means of P11, and this serves to adjust the division ratio of the stage.

8. The mode of operation of the dividers can best be understood by reference to fig. 3 and 4, which show the idealized waveforms obtained at various points in the divider circuit. Consider the valve V14; when the valve has completed one cycle of operation the grid condenser C52 is charged very negative thus cutting off the valve and preventing further oscillation. The grid condenser will now commence to discharge through the grid resistor R69. The synchronizing pulses will appear positive on the grid condenser as shown in fig. 3 (c). Eventually one of the synchronizing pulses will drive the grid sufficiently near zero bias to enable the valve to oscillate.

9. The first half-cycle of this oscillation will drive the grid more positive, but the potential across the grid condenser cannot rise much above earth potential because grid current will flow. The second half-cycle of oscillation will drive the grid negative again and cut off the valve; the whole cycle is then repeated. The setting of the potentiometer P11 controls the rate of discharge of the condenser and thus can be used to set the division ratio (para. 7). Normally this stage is arranged to divide by five, the output frequency being 30 kc/s.

10. In the cathode circuit of V14 the 820-ohm resistor R71 provides synchronizing pulses for the following stage V15. The grid condenser for this stage, C54, is connected to earth in series with R71 so that positive synchronizing pulses (*fig.* 3 (d)) will be injected into the grid circuit. The valve V15 functions in a similar manner to V14 and the waveforms obtained are shown in fig. 3 (e). This stage divides by two and the output frequency is therefore 15 kc/s. No pre-set control is provided.

11. The next stage V16 has a similar circuit, synchronizing pulses being fed in through a third winding on T5 connected in series with the anode circuit winding of the transformer T4. The potentiometer P12 is the pre-set control for the division ratio, and this stage is adjusted to divide by five, the output frequency being 3 kc/s. A multivibrator consisting of the valves V17 and V18 forms the last stage of division. The time constant in the grid circuit of V17 (C61, R85) is much longer than the time constant in the grid circuit of V18 (C62, R86), so that the waveform from the multivibrator is unsymmetrical. Negative synchronizing pulses are derived from a small resistor R80 in the anode of V16 and fed to the grid of V18 through a small condenser C59. The pulses (*fig.* 4 (a)) are amplified by V18 and applied as positive pulses to the grid of V17. The time constants at the two grids may be varied by the potentiometers P13 and P14. The potentiometer in the grid of V18 (P13) controls the width of the narrow positive pulse which appears at the anode (*fig.* 4 (c)). The width of this pulse determines the flyback time of the timebase, and its trailing edge is used to inititiate the "A" strobe timebase. The potentiometer P14 in the grid of V17 controls the recurrence frequency of the multivibrator and is used for setting-up the division ratio.

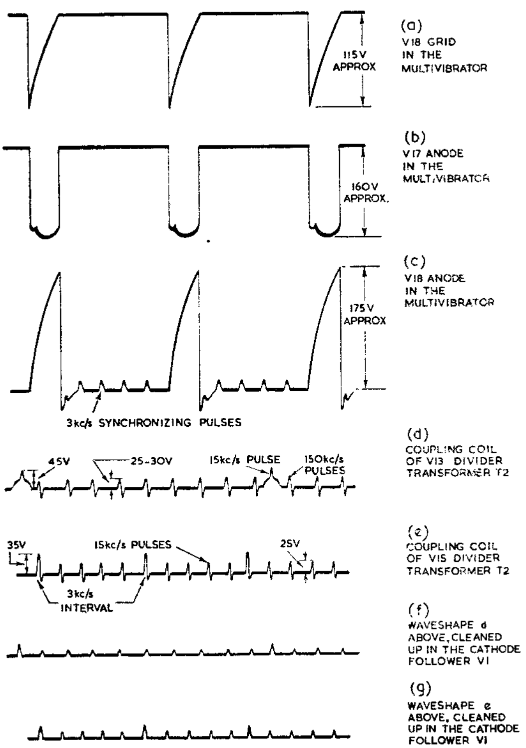


Fig. 4. Multivibrator and calibration waveforms

12. The multivibrator stage V17 and V18 normally divides by six, but can be made to divide by seven by switching in the resistor R89 in series with the normal grid leak R85. This switching is made by the recurrence-frequency switch S7 mounted on the front panel of the indicating unit. Two outputs are taken from the divider to the timebase, namely, from the anodes of V17 and V18; the waveforms obtained are shown in fig. 4.

13. The purpose of the third winding on the transformers T2 and T4 may now be explained. Across the third winding on T2, 150 kc/s calibration pips are produced which it is desired to feed onto the Y-plate of the CRT as calibration markers. It is also desired to raise the amplitude of every tenth 150 kc/s pip to indicate the whole number and to assist in counting. This is accomplished as described in the following paragraphs.

Calibration markers

14. One end of the third winding on T2 is joined to the cathode of V15, the 15 kc/s

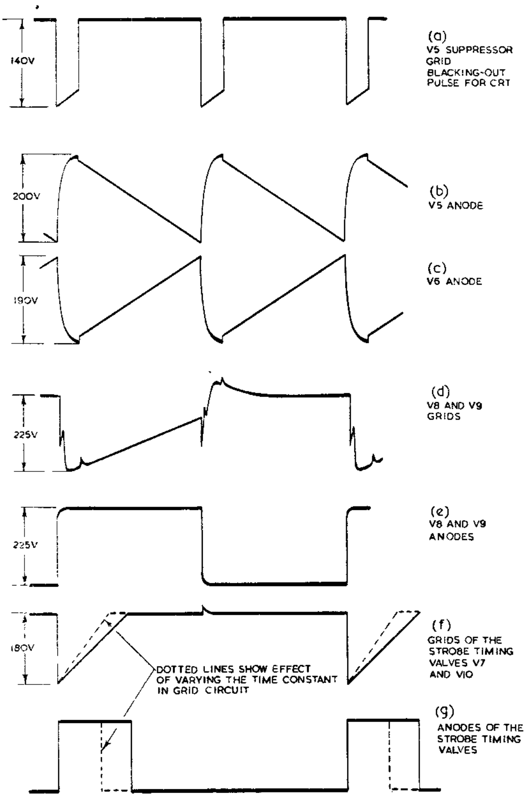


Fig. 5. Main timebase and strobe timing waveforms

stage, and a 200-ohm resistor R74 is connected between cathode and earth. A wide positive pulse is produced across this resistor and the resultant waveform between the free end of the winding on T2 and earth is as shown in fig. 4 (d), where it is seen that every 150 kc/s pip is raised above the others. The third winding on T4 has a similar function, every fifth 15 kc/s pip being raised above the others by means of a pulse across the cathode resistor of V16 (R78); the waveform is as shown in fig. 4 (e). These two waveforms (*fig.* 4 (d) and (e)) are cleaned up in the cathode-follower V1 (according to the position of the contact S2 on the timebase switch), their amplitude is adjusted by the potentiometer P15, and they are applied to the the Y-plate of the CRT as calibration markers—see *fig.* 4 (f) and (g)—via the Y-plate reverser valve V3 (*para.* 37).

Main timebase

15. The operation of the main timebase can best be understood by referring to fig. 5 which gives the waveforms at various points in the circuit. The valves V5 and V6 (*fig.* 1) are used to produce the timebase sweep. In the main timebase position the output from the anode of V17 in the divider is fed to the suppressor grid of V5 through the condenser C58, the switch S5, and the condenser C10. DC restoration is provided at the suppressor grid by means of one half of the double diode V4.

16. The valve V5 has a 100 pF condenser C9 connected between the anode and control grid, and C63 is connected in parallel with C9 by the switch S10. (Refer to paras. on the expanded strobe timebase.) The grid leak R18 is connected via S3 to the slider of the potentiometer P2 which forms part of a chain of resistors comprising P1, R16 and P2 between the HT line and earth. During the short negative pulse input—*fig.* 5 (a)—to the suppressor grid the anode current will be cut off so that the condensers C9 and C63 will charge up the potential of the HT line through the resistor R20 and the grid-to-cathode impedance of V5.

17. At the end of the short negative pulse the suppressor grid is brought up to zero bias again and the anode potential commences to fall. For the first few volts the fall of potential is very rapid as the grid has been at zero bias and is now carried down with the anode to a normal bias (*fig.* 5 (b)). The anode voltage will then fall steadily in a linear fashion as the condensers C9 and C63 are discharged through R18 in such a manner that the grid voltage is kept to the grid-voltage/anode-current characteristic of V5. The next negative pulse causes the condenser C9 and C73 to charge up again to HT potential and the whole cycle is then repeated.

18. Amplitude control of the sweep is carried out by means of the potentiometer P2. Push-pull deflection is obtained by use of the valve V6. The grid of this valve is fed with output from the anode of V5 through the resistor - condenser network shown in fig. 1, R23 and R24 being 250K each. The X-plates of the CRT are DC coupled to the anodes of V5 and V6, the shift being obtained by altering the bias of V6 by means of the potentiometer P3, thus altering the mean potential at the anode. The resistor R22 is connected between the anode of V5 and earth to lower the mean anode potential of this valve, so that the mean anode potential of V6 may be either raised or lowered with respect to that of V5.

19. The spacing between the two traces on the CRT is produced by applying square waveforms to one of the Y-plates of the CRT. The square wave is produced by a multivibrator consisting of the valves V8 and V9 (*fig.* 2). The circuit is so arranged that the multivibrator action takes place between the grids and screens of the two valves; the anodes have load resistors R39 and R47, respectively, from which the outputs are taken. The multivibrator is synchronized from the waveform at the anode of V17 which is differentiated by the condensers C24 and C25 and the resistors R43 and R44, and applied to both grids of the multivibrator. The spacing waveform is taken off the anode of V8 through R38 and P8 and applied directly to the Y2-plate; C23 is an HT blocking condenser. The pre-set potentiometer P8 controls the amplitude of the spacing waveform applied to the Y-plate.

Strobe timebases

20. The two "A" strobe timebases are initiated from the trailing edge of the positive pulse produced at the anode of V18—*fig.* 4 (c). The "B" and "C" strobe time bases are initiated from a timing edge produced at the anodes of V7 and V10—(*fig.* 5 (g).

21. Consider the operation of the valve V7. The grid is connected through one of the condensers C16—C22 to the anode of V8 (*fig.* 2) and so receives a square wave input. The grid-leak R36 has its top end connected to a junction of R53 and R54, two resistors between the HT line and earth; the grid of V7 is thus returned to a point positive with respect to earth. During the positive-going portion of the square wave the grid of V7 will remain at zero bias and the anode voltage will be low. When the square wave goes negative V7 will be cut off but the grid potential will gradually leak back towards zero potential at a rate depending on the time constant (C16 to C22 and R36). Eventually the valve will conduct again. and the grid will remain at zero potential until the next negative-going square wave comes along. The anode waveform will be a square pulse as shown in fig. 5 (g), the width of which is controlled by varying the value of the capacitance in the grid circuit effected by S8 and C22.

22. The strobe timebase is initiated off the back edge of this pulse and can be set to any position between one negative-going and the following positive-going edge of the square wave; it will therefore be possible to move the strobe along one trace of the timebase. Coarse control of the strobe timing is carried out by means of the fixed condensers C16 to C20 which are switched in circuit by means of S8. Fine control is carried out by the variable condenser C22. Both these controls are brought out to the front panel of the indicating unit.

23. The valve V10 works in exactly the same manner as V7, except that its grid is fed from the opposite valve in the square wave generator V9. The strobe timing edge produced at the anode of V10 will therefore occur on the opposite trace to that produced at the anode of V7. Coarse control of the strobe position is carried out by means of the condensers C30 to C34 which are switched in circuit by S9; C36 is the fine control. Both controls are brought out to the front panel of the indicating unit.

24. It is now necessary to convert the timing edges produced at the anodes of V18, V7 and V10 into square pulses of sufficient width to produce the strobe timebase. This is accomplished by the valve V11.

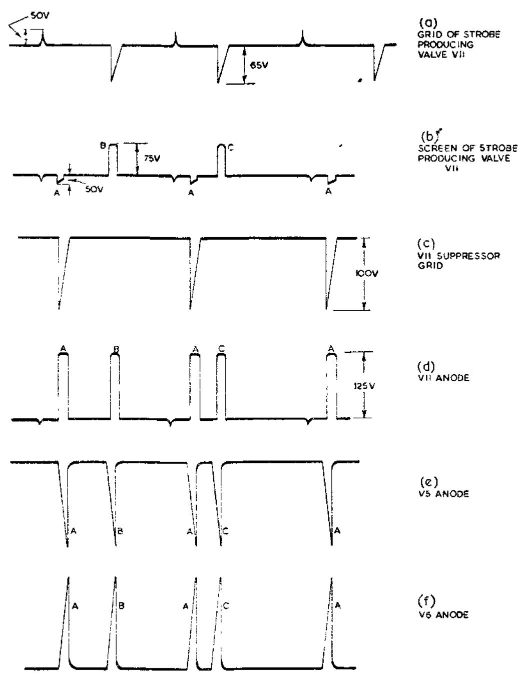


Fig. 6. Strobe timebase waveforms

25. The outputs from the anodes of V7 and V10 are fed to the grid of V11 through the small condensers C39 and C38, respectively. The grid leak R56 has its free end joined to the slider of the potentiometer P10 which is part of a chain of resistors between the HT line and earth consisting of P9, P10 and R55. The grid leak is thus returned to a point which is positive with respect to earth.

26. The output from the anode of V18 is connected to the suppressor grid of V11 through the 300 pF condenser C41 and the stopper resistor R62 which filters out the small 3 kc/s synchronizing pulses which will appear at the anode of V18 (*fig.* 4 (c)). The suppressor grid leak R58 is connected to the slider of the potentiometer P9 which forms part of HT divider. R58 is thus returned to a point positive with respect to earth, but the suppressor grid itself is held at earth potential by means of one of the diodes in the double-diode V4 (*fig.* 1). The negative input signal through C41 must therefore exceed the dropping potential across R62 before it will have any effect on the suppressor grid. Since the 3 kc/s synchronizing pulses have a much smaller amplitude than the wanted input pulses they are filtered out by this circuit.

27. The pulses from the anodes of V7 and V10 are differentiated by means of the small condensers C39 and C38, respectively, and the grid leak R56. The positive-going pulse will be nearly eliminated due to grid current but the negative-going pulse will cut off the valve. The charge on C38 (or C39) will then leak up towards zero and eventually the valve will conduct again. A square pulse (*fig.* 6 (d)) will thus be produced across the anode and screen resistors of V11 (R60 and R61). The width of this pulse will be controlled by the capacity of C38 or C39, the value of the grid leak R56 and the potential to which the grid leak is returned. This latter potential is controlled by means of the pre-set potentiometer P10 which therefore serves to control the width of the square pulse produced at the anode and the screen.

28. The same action takes place at the suppressor grid of the valve through the condenser C41 and the grid leak R58, except that the suppressor grid will have little or no control on the screen of the valve (actually a small negative-going pulse is produced). The potentiometer P9 controls the width of the pulse at the suppressor grid.

29. Thus positive-going square pulses of the correct width for producing the strobe timebase and corresponding to the "B" and "C" strobe positions will be produced at the screen of V11, and positive-going pulses corresponding to the "A", "B" and "C" strobe positions will be produced at the anode of V11. The output from the screen of V11 is fed to a special Y-plate amplifier valve V3, the operation of which is described later (*para.*37). The output from the anode is fed through the switch S5 (one of the contacts on the timebase change-over switch) to the suppressor grid of V5 (*fig.* 1). The suppressor grid is normally cut off by means of the automatic bias provided by C10 and R19.

30. When the positive pulse is applied to the suppressor of V5, the valve will conduct so that the anode potential will fall as described for the main timebase. The rate of fall will be much faster than in the main timebase position because the grid leak R18 is now connected to the potentiometer P1 (through S3) which is at a much higher positive potential with respect to earth than the potentiometer P2; P1 controls the amplitude of the strobe timebase. At the end of the positive pulse on the suppressor grid of V5 the valve is cut off so that the condenser C9 again charges up to the HT potential through the resistor R20. The valve V6 functions as for the main timebase except that the potentiometer P4 now controls the bias of V6 and thus controls the shift.

Expanded strobe timebase

31. The expanded strobe timebase is put into operation by the bank S10 on the timebase switch. This reduces the timebase condenser from 500 pF (C63 + C9) to 100 pF (C9), and speeds up the timebase. Thus when a strobe timebase pulse appears at the suppressor grid the anode potential of V5 falls very quickly until it reaches about 50 volts above earth, it then remains constant until the pulse on the suppressor grid disappears.

Flyback blackout

32. Blackout pulses from the CRT grid are taken from the suppressor grid of V5 through the condenser C13. In the strobe timebase position, positive pulses are applied to the CRT grid to brighten up the tube for the duration of the trace, whilst on the main timebase the negative pulse on the suppressor blacks out the tube during fly-

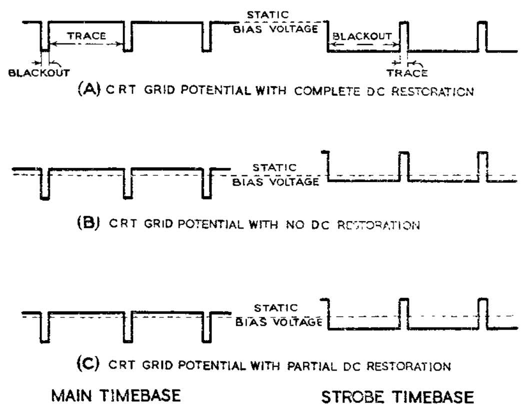


Fig. 7. Partial DC restoration of CRT grid

back. The diode V19 (*fig.* 2) acts as a DC restorer at the grid of the CRT. The DC restoring action is made slightly inefficient by means of the resistor R32 in series with the diode; this tends to equalize the brightness between the main and strobe timebases.

Partial DC restoration of CRT grid

33. The action of the diode V19 and the resistor R32 may be explained with the assistance of the diagram in fig. 7. If V19 were omitted from the circuit i.e., no DC restoration were attempted the mean potential of the CRT grid would be zero as shown in fig. 7 (B); in other words, during the period when no pulses were being received from the suppressor of V5 the potential of the grid would be positive by an amount dependent on the magnitude and width of the negative-going pulse. This means that the trace brightness would depend on the magnitude and width of the blackout pulse.

34. Referring to fig. 7 (A), in the strobe timebase position, the blackout pulse to the CRT is of much longer duration than in the main timebase position. Therefore, with V19 omitted, the positive potential on the grid during the trace would be much higher for the strobe timebase than for the main timebase; so much higher in fact that the strobe timebase would appear brighter than the main timebase in spite of its increased speed of scan.

35. Suppose now that complete DC restoration is attempted, that is, with V19 connected in circuit but with R32 short-circuited. In this case, because of the uni-directional conductivity of the diode the CRT grid could not rise above earth potential and hence the potential during scanning would always be zero. It would follow therefore that the higher speed strobe timebase would be less bright than the main timebase.

36. Consideration of the foregoing indicates that a solution of the problem of maintaining the main timebase at the same brightness of the strobe timebase lies in partially DC restoring the CRT grid; this is done by V19 in conjunction with R32. During the forward scan, when V19 is conducting, the potential drop across R32 ensures that the CRT grid is at a potential above cut-off, but not by the full amount that would obtain if V19 were not present. The value of R32 is chosen so that during the forward scan the CRT grid potential on the strobe timebase is just sufficiently higher than on the main timebase to compensate for the higher speed of scan of the strobe timebase see *fig.* 7 (C).

Y-plate reverser valve

37. Input to the grid of the valve V3 (*fig.* 1) comes either from the receiver output or from the calibration marker valve C1 according to the position of the clearing switch S1. The Y1-plate of the CRT is connected to the anode of V3 through the condenser C5. The output from the receiver which is positive-going, is DC restored by the lower half of the double diode V2. The suppressor grid of V3 is fed with positive-going pulses from the screen of V11 corresponding to the "B" and "C" strobe timebases (*fig.* 6 (b)) through the condenser C8. The suppressor is also connected to the anode of the diode V21 to prevent it being driven positive. The lower end of R14 is connected to a point of the chain of resistors across the negative supply voltage to the CRT, which is at a potential of -80 V with respect to earth.

38. The anode current of V3 is normally cut off by this bias at the suppressor grid, and the valve will only pass anode current for a short period corresponding to the "B" and "C" strobe pulses. The anode of V3 is connected back to the input circuit condenser C3 through the resistors R5 and R6, C4 being a blocking condenser. The second half of the double diode V2 is connected between the junction of R5 and R6 and the grid of V3, and prevents the grid from being driven positive.

39. In the normal position with the anode current to V3 cut off, the signals will pass to the Y-plate through R6 and R5. A signal reaching the Y-plate will be reduced to about two-thirds of its original value. When V3 is operative the signal is phase-reversed by the valve and due to negative feed back through R5 and R6, the resistance values of which are in the ratio of 2:3, the gain is only about two-thirds, i.e., the signal on the anode is equal in size but opposite in sign to the signal when the valve is cut off.

40. The troughs in the main timebase to mark the position of the strobes are produced because a small steady anode current flows in V3 when the valve is brought on by the suppressor grid during the "B" and "C" strobes. This current develops across the resistor R9 a negative pulse equal to the width of the strobe which is fed to the Y-plate.

Power supplies

41. The transformer T6 provides the heater supply for all the valves in the timebase and divider circuits, the CRT, and the DC restoring diode V19. Its primary winding is fed from the 80V AC supply which is applied to the indicating unit through pins 5 and 6 on the 6-pin W-plug mounted on the front panel. The HT supply from the receiver power unit is fed to the indicating unit through pin 4 of the W-plug. Pin 3 feeds the receiver gain control potentiometer P7 mounted on the front panel of the indicating unit. Pin 1 of the W-plug provides the EHT for the CRT, namely −1600 V also from the receiver power unit. The inter-connection wiring of the W-plugs on the receiver and indicating unit is described in Chap. 3.

42. The choke L2 with the condenser C45 prevents any ripple along the HT line to the indicating unit from the receiver in the presence of certain types of jamming.

Summary of valve and potentiometer functions

Valves

43. The following is a list of the valves used in the indicating unit Type 62.

Cct. Ref.	Type	Function
V1	CV1065	Calibration pip shaper—cathode follower
V2	CV1054	DC restorer and clamping diode
V3	CV1065	Y-plate reverser
V4	CV1054	DC restorer and clamping diode
V5	CV118	Timebase generator
V6	CV1065	Timebase generator (push-pull deflection)
V7 V10	CV118 CV118	"B" and "C" strobe timebase initiation timing edges
V8 V9	CV118 CV118	Multivibrator—Producer of square waveform controlling spacing between CRT traces
V11	CV118	Converter of timing edges from V7 and V10 into square pulses of sufficient width to produce strobe timebase
V12	CV1065	Crystal-oscillator with anode tuned to 2nd harmonic of crystal frequency—output 150 kc/s
V13	CV118	Squegger—recurrence frequency 150 kc/s
V14	CV118	Divider (squegger ÷ 5), output 30 kc/s
V15	CV118	Divider (squegger ÷ 2), output 15 kc/s
V16	CV118	Divider (squegger ÷ 5), output 3 kc/s
V17 V18	CV118 CV118	Multivibrator divider (divides by 5, 6 or 7, normally 6)
V19	CV1092	DC restorer. For partial DC restoration at CRT grid
V20	CV1097	Cathode-ray tube
V21	CV1092	Clamping diode. Connected to suppressor of V3

Potentiometers

44. The following potentiometers are fitted.

Cct. Ref.	Engraving	Function
P1	S.T.B. AMP.	Controls amplitude of strobe timebase
P2	M.T.B. AMP.	Controls amplitude of main timebase
P3	M.T.B. SHIFT	Main timebase shift control
P4	S.T.B. SHIFT	Strobe timebase shift control
P8	SPACING	Controls spacing between the two traces on CRT
P9	A STROBE WIDTH	Adjustment of A strobe timebase width
P10	B and C STROBE WIDTH	Adjustment of B and C strobe timebase width
P11	—	Adjusts the division ratio (÷ 5) of the divider V14 (30 kc/s)
P12	—	Adjusts division ratio (÷ 5) of the divider V16 (3 kc/s)
P13	A STROBE POS.	Adjustment of "zero mark" on main and strobe timebases
P14	—	Adjusts the recurrence frequency (÷ 6 or 7) of the multivibrator divider V17-V18
P15	CAL PIPS	Amplitude control of calibration markers

Note: *The above potentiometers are pre-set and are used when setting up the indicating unit during basic servicing*

P5	FOCUS	
P6	BRILLIANCE	
P7	GAIN	Receiver gain control

INDICATING UNIT TYPE 62A

45. The indicating unit Type 62A is similar to the Type 62 except that the chassis layout and circuit have been modified to accommodate CV1091 valves instead of the CV1065 and some of the CV118 valves used in the indicating unit Type 62. The valve types in use are indicated in para. 60.

46. Electrically and mechanically, the two types of indicating unit are interchangeable, and externally the controls are the same. The mechanical changes to the chassis and the circuit changes will be described in the following paragraphs in that order.

Mechanical changes

47. Mechanically, the indicating unit Type 62A is an improvement on the indicating unit Type 62. The potentiometer tray has been divided into two panels which are mounted vertically one on each side of the CRT (*fig.* 8). This reduces heating of the unit and renders the components more accessible. The functions of the potentiometers are identical to that of the indicating unit Type 62 (*para.* 44).

48. The use of L.H. type Morganite potentiometers (P5 and P6), which are considerably smaller thau the normal type of potentiometer, has enabled the focus and brilliance controls to be taken straight through to the front panel without gearing (*fig.* 13).

49. The crystal is moved to the front of the divider chassis, V12 occupying the original crystal position; i.e., the crystal and V12 exchange positions (*fig.* 14). The CV1092 diode V21, has been moved from under the chassis to a position alongside the DC restoration diode, V19 and a diode used to clean up the spacing waveform, V22 (*fig.* 13.)

Circuit changes

50. A complete circuit diagram is given in fig. 9. Electrically, the indicating unit Type 62A conforms to the specification laid down for indicating unit Type 62. Waveforms obtained from a typical indicating unit Type 62A are found to be within 10 per cent., of those obtained from a standard indicating unit Type 62. The lower input capacitance of the CV1091 (8 pF as against

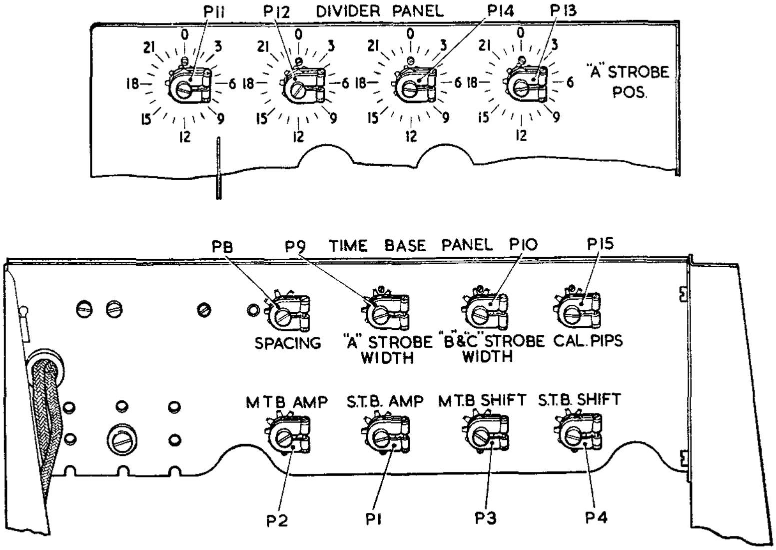


Fig. 8. Pre-set potentiometer panel of indicating unit Type 62A

14 pF for a CV1065) improves the average overall swing of the crystal oscillator by 45 per cent.

51. The division range on the divider potentiometer, together with the time-base amplitude and shift controls, are similar to those on the indicating unit Type 62.

52. The heater current consumption is approximately half that of the indicating unit Type 62 and the transformer T6 is much reduced in size (*fig.* 14). In addition the smaller 1·3 μH choke L2 is adequate to prevent serious ripple passing back from the indicating unit to the receiver.

53. For the indicating unit Type 62A CV118 valves are used for V7, V8, V9 and V10 (*para.* 60) because CV1091 valves proved to be too microphonic and thus gave strobe instability in these positions. To further improve strobe stability the anode loads of V8 and V9 (i.e., R39 and R47 respectively) were increased in value to 150K each, thereby improving the "bottoming" of these anodes, and the grid leaks of V7 and V10 (i.e., R36 and R49) were increased to 1·2 megohms each (temperature stabilized) and taken up to a higher potential by interchanging the value of R53 and R54. In order to avoid an unduly large ratio of screen to anode current, the screen resistors R33 and R52 have been increased to 100K.

54. The values of the resistors forming the resistance chain between the anode of V8 and earth (from which is tapped the spacing waveform) have been changed. In addition V22, which is a CV1092 diode, is introduced to cut off the top of the square wave (which has been distorted by increasing the values of R39 and R47) and so give a clean spacing waveform.

"A" strobe locking

55. A function known as "A" strobe locking is introduced in which the cathode of V17 is tied back to the cathode of V15 thus obtaining a 15 kc/s locking pulse which stabilizes the "A" strobe position and corrects "A" squint; i.e., horizontal misalignment of "A" strobes in certain positions of the "B" and "C" strobes.

56. To do this the time-constant in the grid circuit of V18 is increased by making the value of C62 250pF. This delays the rise of the grid of V18 until the synchronizing pulse arrives from the screen of V17 by amplification of the positive 15 kc/s pulses on the cathode. These are the equivalent to negative pulses on the grid, which is waiting at cathode potential, and thus the 15 kc/s synchronizing pulses shut off V18, and the multivibrator operates. The locked positive-going edge of the waveform at the anode of V17 brings on V18 so fixing the negative-going edge at the anode of V18 (*fig.* 4 (c)). It is from this negative-going edge that the "A" strobe is originated.

57. The "A" strobe potentiometer (P13 in indicating unit Type 62) is now replaced by a fixed resistor R111, and P13 becomes the screen load of V17, with its sliding contact connected to the HT side of C62. This modification prevents any variation in size of the 3 kc/s calibration pips applied to the grid of V17, due to the variation of grid current through R87 when P13 is varied. The introduction of R106 in the cathode tends to make the size of these pips independent of the slope of V18.

58. This method of locking the "A" strobe ensures that there will be no microphonic or drift considerations affecting the "A" strobe; i.e., microphonic valves can be tolerated in the V17 and V18 positions.

59. As the "A" strobe is locked to a 15 kc/s calibration pip, the "A" strobe zero will be displaced towards the right-hand side of the trace on the strobe timebase. This is quite satisfactory as there will be no "A" strobe drift to cause "A" zero to move off the trace.

Summary of valve functions

Valves

60. The following valves are used in the indicating unit Type 62A

Cct. Ref.	Type	Function
V1	CV1091	Calibration pip shaper—cathode follower
V2	CV1054	DC restorer and clamping diode
V3	CV1091	Y-plate reverser
V4	CV1054	DC restorer and clamping diode
V5	CV1091	Timebase generator
V6	CV1091	Timebase generator (push-pull deflection)
V7 V10	CV118 CV118	"B" and "C" strobe timebase initiation timing edges
V8 V9	CV118 CV118	Multivibrator—Producer of square waveform controlling spacing between CRT traces
V11	CV1091	Converter of timing edges from V7 and V10 into square pulses of sufficient width to produce strobe timebase
V12	CV1091	Crystal-oscillator with anode tuned to 2nd harmonic of crystal frequency. Output 150 kc/s
V13	CV1091	Squegger, recurrence frequency 150 kc/s
V14	CV1091	Divider (squegger ÷ 5) output 30 kc/s
V15	CV1091	Divider (squegger ÷ 2) output 15 kc/s
V16	CV1091	Divider (squegger ÷ 5) output 3 kc/s
V17 V18	CV1091 CV1091	Multivibrator divider (divides by 5, 6 or 7, normally 6)
V19	CV1092	DC restorer. For partial DC restoration at CRT grid
V20	CV1097	Cathode-ray tube
V21	CV1092	Clamping diode connected to suppressor of V3
V22	CV1092	Diode limiter. Cleans up spacing waveform from V8 and V9

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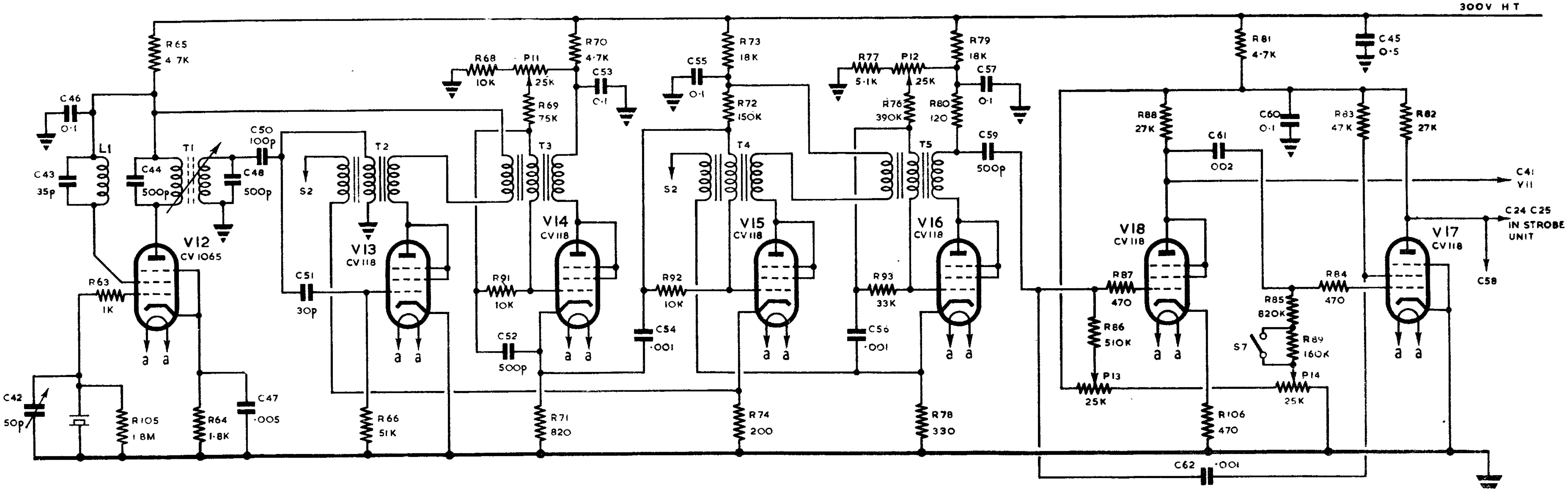
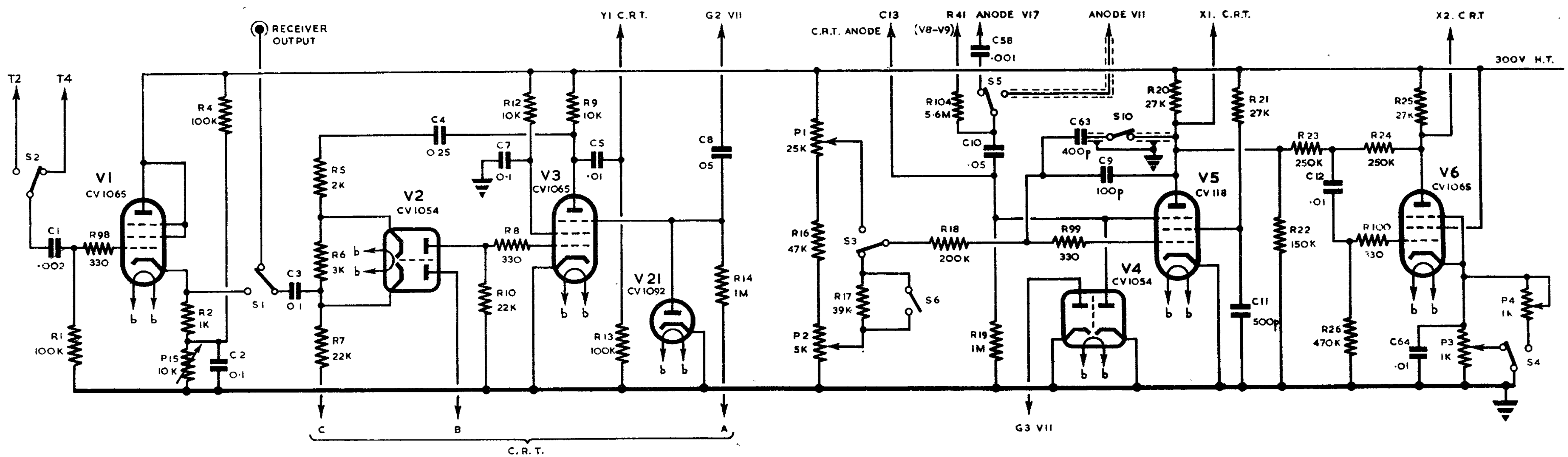


(a) DIVIDER CIRCUIT



(b) MAIN TIME BASE CIRCUIT

FIG. 1 — INDICATING UNIT TYPE 62 — DIVIDER AND MAIN TIMEBASE CIRCUIT

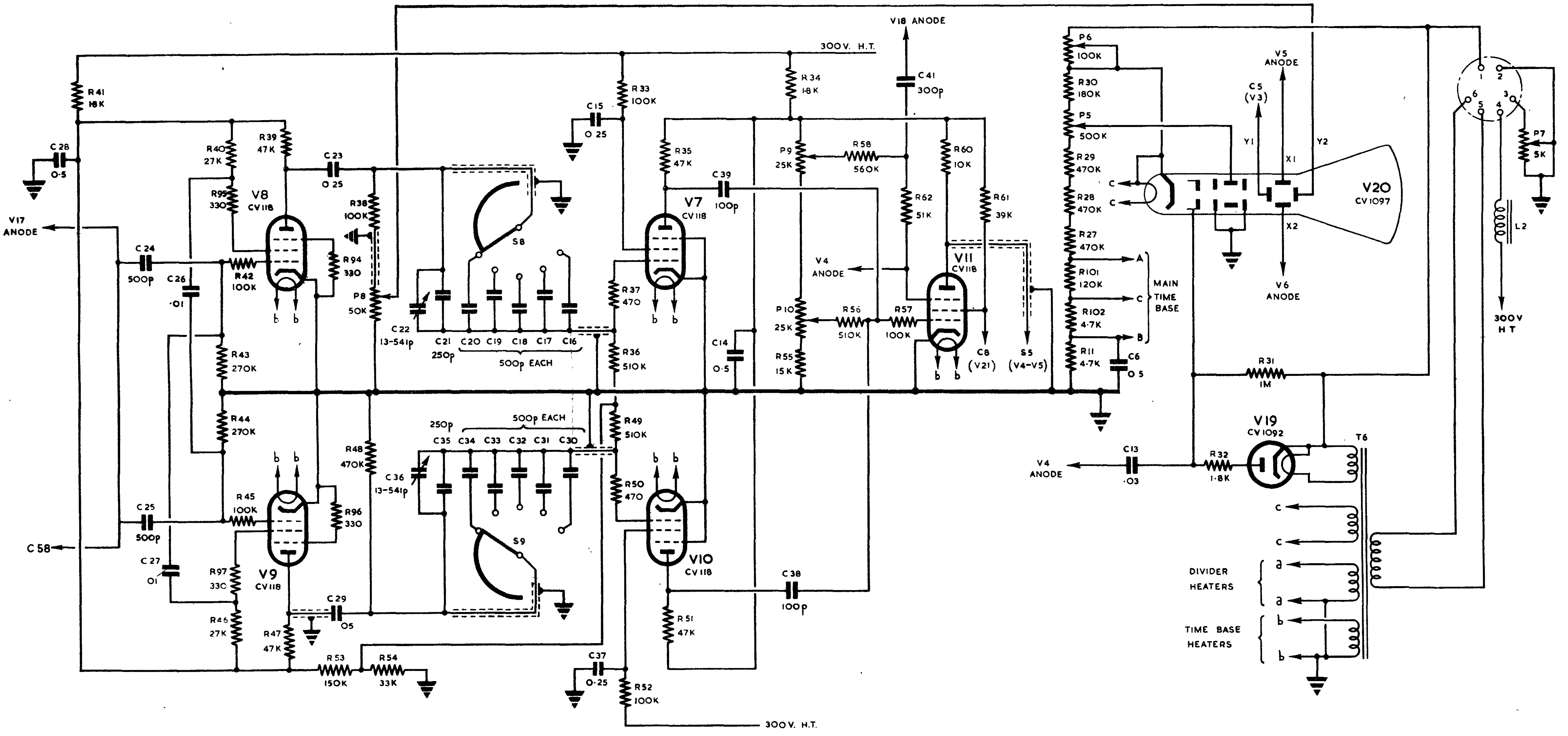


FIG. 2 — INDICATING UNIT TYPE 62 — STROBE TIMEBASE AND C R T CIRCUIT

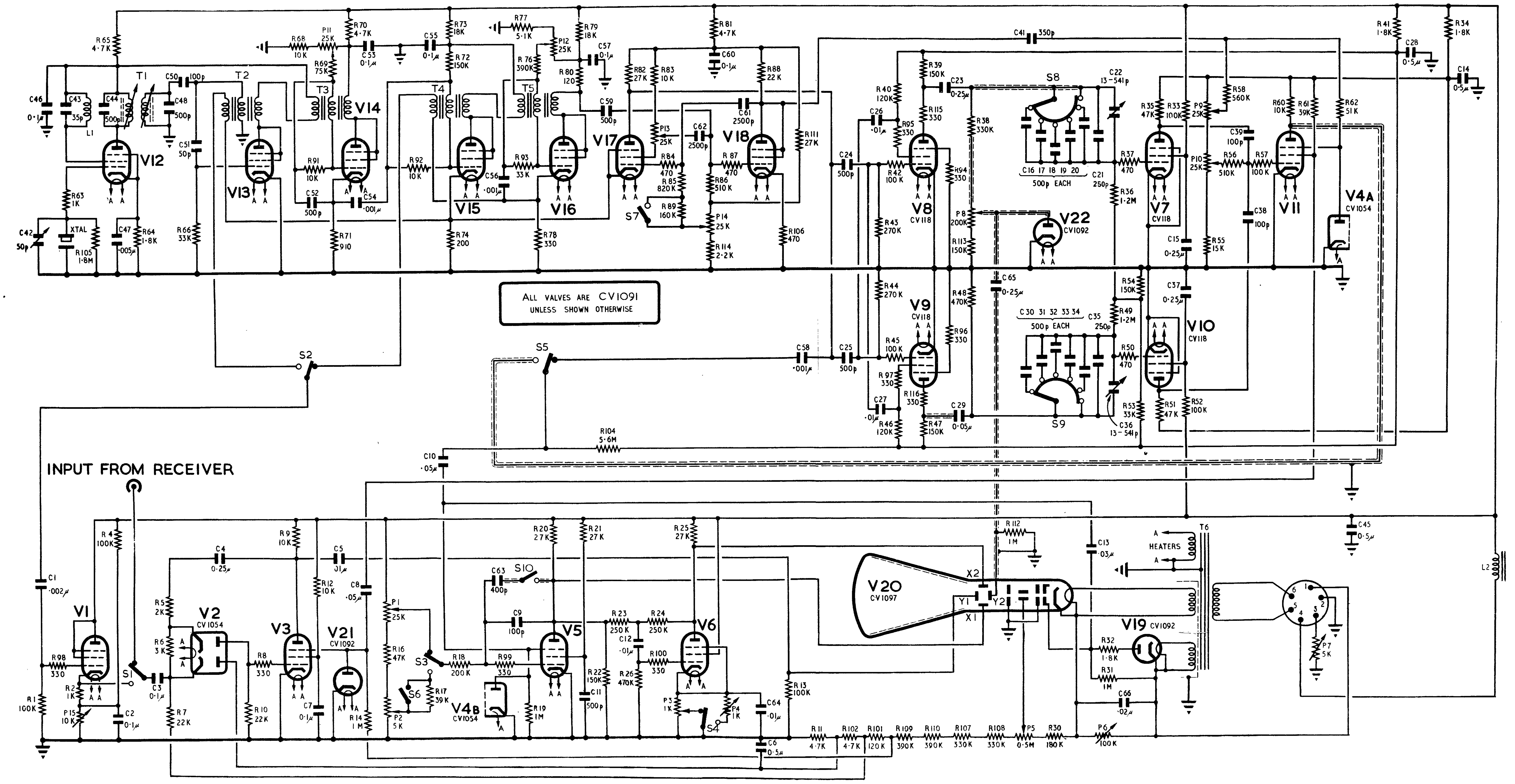


FIG. 9 – INDICATING UNIT TYPE 62A CIRCUIT

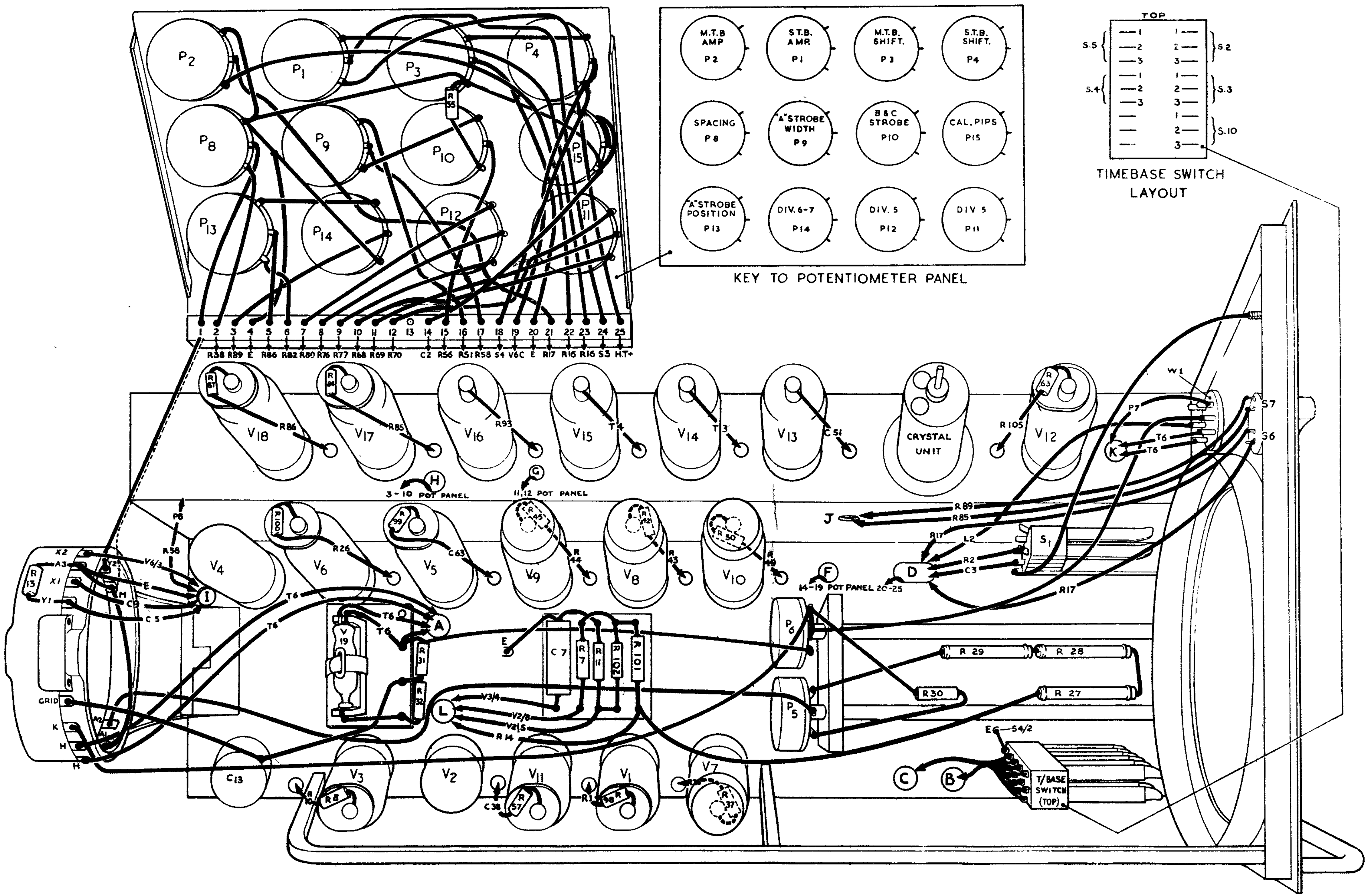
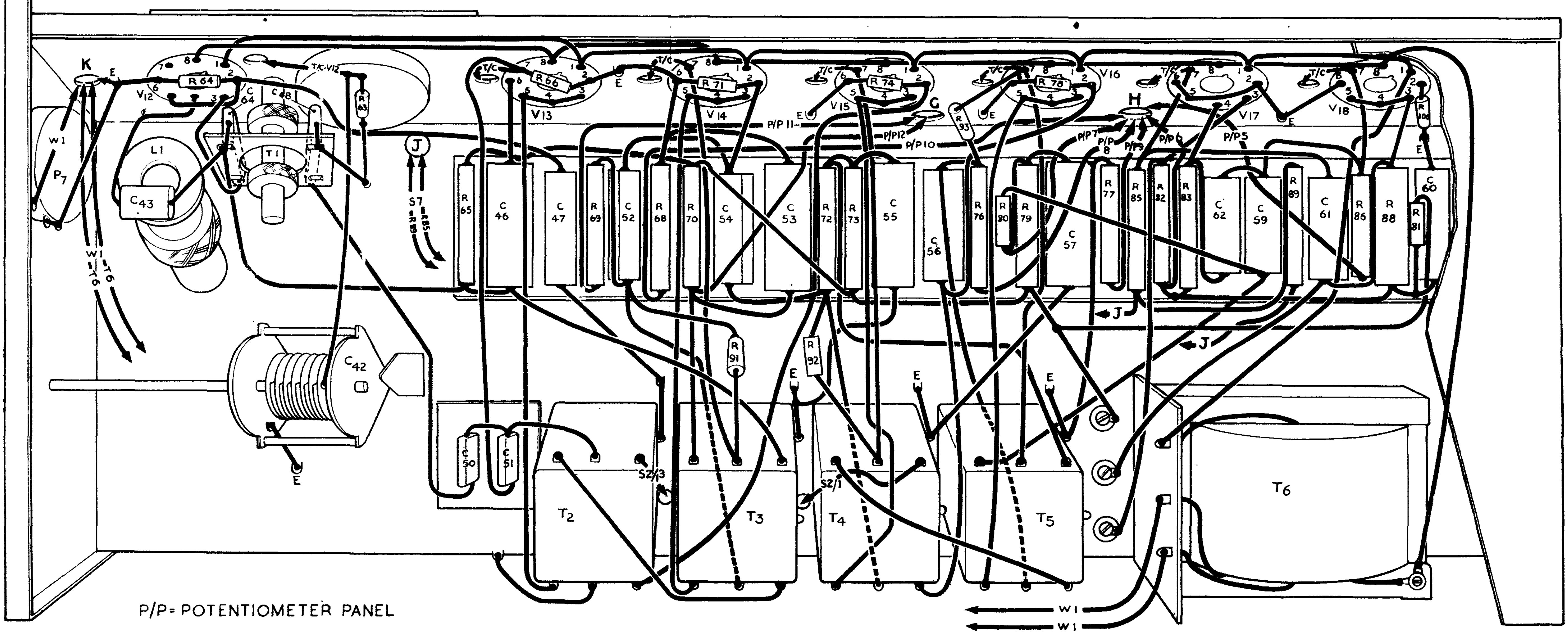


FIG. 10 - BENCH WIRING OF INDICATING UNIT TYPE 62 - TOP OF CHASSIS



P/P = POTENTIOMETER PANEL

FIG. 11 — BENCH WIRING OF INDICATING UNIT TYPE 62 - SIDE COMPARTMENT

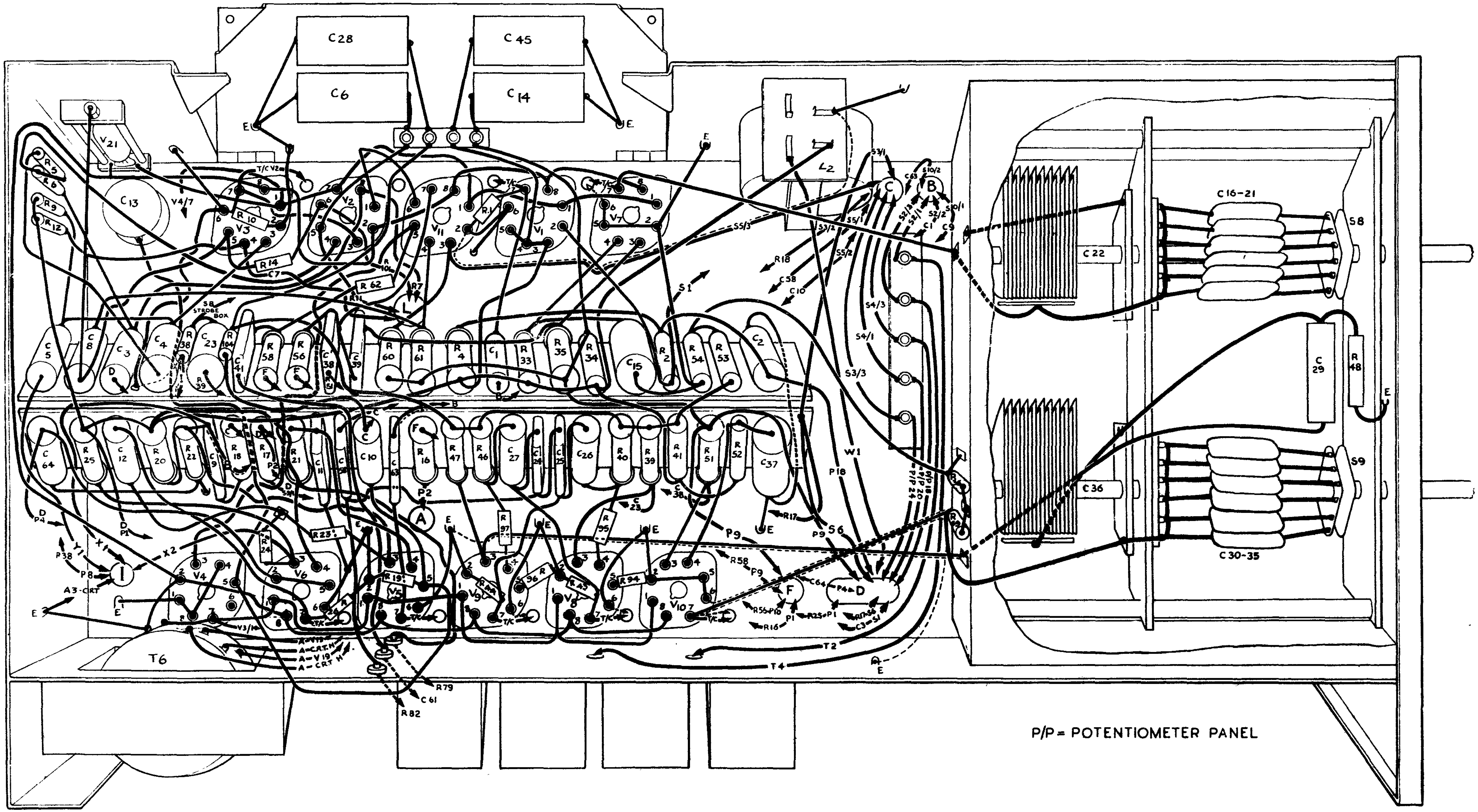


FIG. 12 - BENCH WIRING OF INDICATING UNIT TYPE 62 - UNDERSIDE OF CHASSIS

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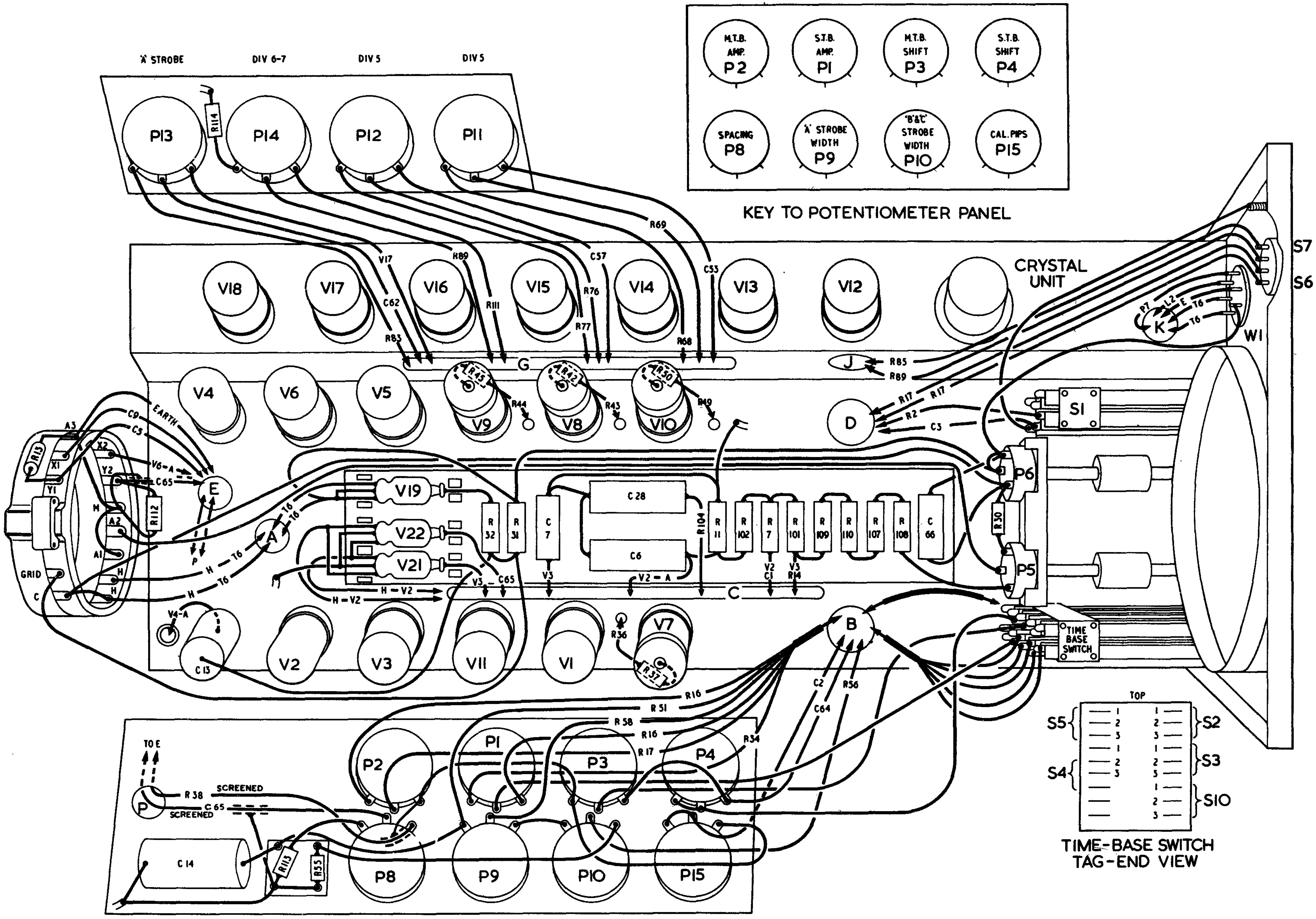

FIG. 13 BENCH WIRING DIAGRAM OF INDICATING UNIT TYPE 62A-TOP OF CHASSIS

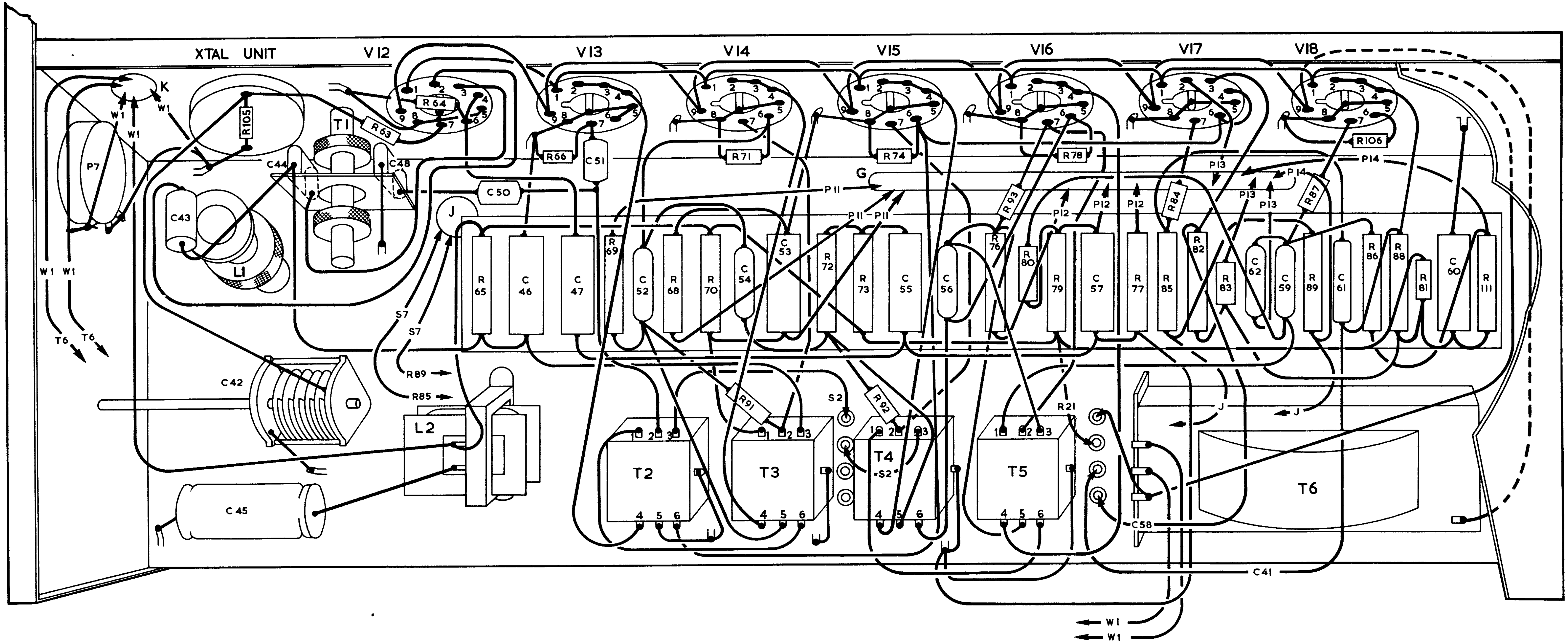

FIG. 14 – BENCH WIRING OF INDICATING UNIT TYPE 62 A — SIDE COMPARTMENT

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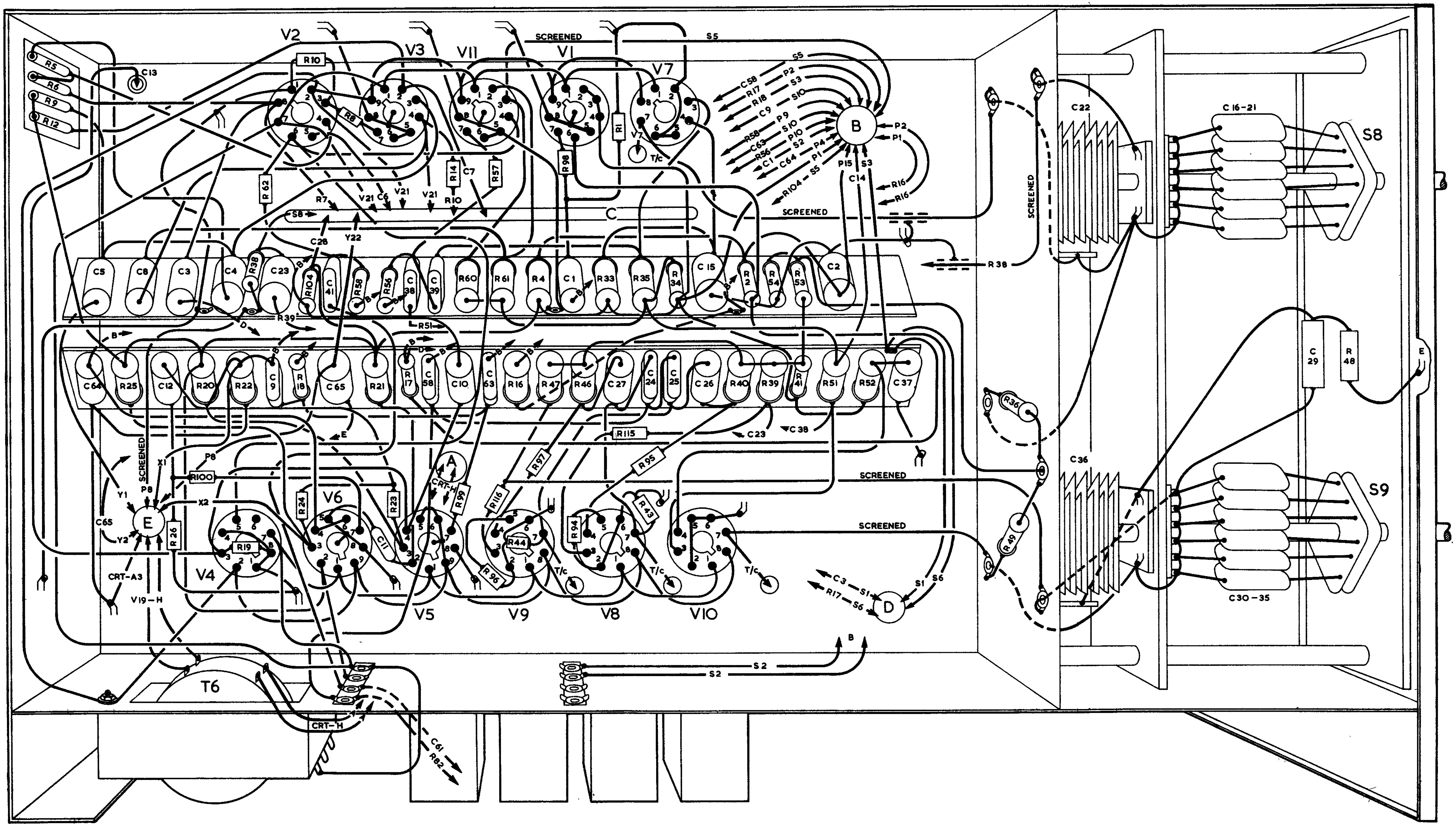

FIG. 15 BENCH WIRING OF INDICATING UNIT TYPE 62A — UNDERSIDE OF CHASSIS

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