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EQUIPMENT, TYPE 7,000 (GROUND)

CHAPTER 12

RECEIVER R 1363 B

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A. Rowlands

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RECEIVER R1363B

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A.L.No.	Amendment made by	Date	A.L.No.	Amendment made by	Date
1	J.M.T. Evans	6/1/44			
3.	Dga Thomas	30/1/45.			

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RECEIVER R1363B

INTRODUCTION

1. The Mk.IIB receiver R1363B is a modified version of the Mk.II receiver R1363. The modifications, besides allowing operation on a number of wavebands and increasing the phasing accuracy, adapt the receiver for use with the Rack Type 36A/(Filter - Comparator - Oscillator).* See S.D.0295, Ch.9. A general view of the receiver is shown in Figure 1. / or type 52

2. The receiver R1363B can be installed at both Slave and Monitor Stations, although some units are not used at the Monitor Station. There is no special monitor version of this receiver as was the case with the Mark I and Mark II receivers.

3. Interchangeable R.F. units are provided so that the receiver may be operated on several wavebands. Anti-jamming circuits are also incorporated in the I.F. amplifier.

4. 230 volt 50 cycle mains are normally used to supply the receiver, but for emergency use a Diesel generator may be employed. The current consumption is 2½ amps.

5. A number of sets will be mounted in "Park Royal" lorries for use as mobile reserves, in case stations are disabled by bombing.

GENERAL DESCRIPTION

6. The purpose of the R1363B is to receive pulses from the Master Station and Slave Stations and display them on a special accurately calibrated time base. When the receiver is installed at a Slave Station a positive locking pulse is sent down a line to the local Slave transmitter. The R.F. pulse radiated by this transmitter is observed on the cathode ray tube together with the other received pulses. A block diagram is shown in Fig.5.

7. By means of controls on the receiver the local pulse can be made to appear in any desired position on the time base relative to the other pulses displayed upon it, i.e. since the length of the time base represents a definite period of time, the interval between the arrival of the Master pulse and the emission of the Slave pulse can be controlled to within a fraction of a microsecond. The operation of setting the Slave pulse in the correct position on the time base is called "phasing". Once the transmitter has been phased correctly, the setting can be automatically controlled by the F.C.O. to within ± 0.01 microseconds. Alternatively the F.C.O. may be manually controlled either from the Monitor Station by means of Remote Control apparatus (see S.D.0295, Ch.13) or by the operator at the Slave Station. The condition in which the F.C.O. operates in chosen by means of a selector key (Remote - Local - Auto) mounted on the control Desk. A second key is provided by means of which the F.C.O. is manually controlled from the receiver. This key is shown in Figure 2 to the left of the selector key.

8. The following units are fitted to R1363B:-

- Receiver Unit (I.F. amplifier with interchangeable R.F.Units)
- Diode Receiver Unit (on same panel as I.F. amplifier)
- Strobe Gain Control Unit
- Filter Input Unit
- Filter Strobe Unit (Filter Gate Unit)
- A.V.C.Unit
- Divider II
- * Divider III
- * Phase Shifter 3
- Phase Shifter 4 (with separate control box)
- Phase Shifter 5 (used with 1.5 mc/s calibration unit)
- Time Base Unit
- 1.5 Mc/s calibration unit
- Cathode Ray Tube Unit (with controls on separate panel)
- Oscillograph Unit ("O" Unit)
- Power Packs: PP1
  - PP2
  - PP3
  - PP5
  - PP6
  - PP7
- Fuse and Indicator Panel

---

* The R1363B MUST be used with an F.C.O. rack

* Not used at Monitor Stations

9. The Units are mounted on a three bay rack as shown in Figure 1. A wooden desk is fitted at a convenient height. The screen of the cathode ray tube is observed through a hole in the desk and certain controls which may require constant attention are also mounted thereon so as to be conveniently near at hand.

10. Each unit has as its basis a Post Office Standard Panel, and in the majority of cases there is a further sub-panel upon which the components are mounted. In some cases, for example the Cathode Ray Tube Unit and Fuse and Indicator Panel, the components are mounted directly on the front panel. Power Packs 1, 2, 3 and 7 have horizontal trays bolted to the rear of the front panel.

11. Many of the component values given on the drawings have large tolerance. In some cases resistances and condensers may not have exactly the same nominal value or rating as is given in this publication: this applies especially to some decoupling condensers, which may have higher capacities than those specified.

12. The approximate maximum dimensions are:-

Height 6 feet 6 inches	Width 6 feet 4 inches
Depth 3 feet 4 inches	The weight is about 15 cwt.

RECEIVER UNIT

13. The Receiver Unit consists of an I.F. amplifier with four interchangeable plug-in R.F.Units covering the following frequency bands:-

R.F. Unit No.32:	20-30 mc/s
R.F. Unit No.31:	40-52 mc/s
R.F. Unit No.26:	50-65 mc/s
R.F. Unit No.27:	65-80 mc/s

The frequency coverages given are approximate only. The overall bandwidth of the receiver is ± 0.5 mc/s at 6 db down each side of resonance. A diode receiver used for receiving the local pulse at Slave Stations is mounted on the same panel as the I.F. amplifier. Figure 3 shows a front view of the receiver panel and Figure 4 a rear view of the same panel. The latter photograph shows an early type of receiver in which terminal blocks were mounted on the I.F. amplifier and Diode receiver in place of the Jones plugs J2 and J3. To make servicing easy a pair of extra flexible leads terminated at each end by 6 pin and 8 pin plugs and sockets are provided so that the complete receiver unit (including Diode Receiver) can be removed from the rack and connected by means of these extension leads to the Jones plugs J2 and J3.

14. R.F.Unit No.31.- The circuit diagram of R.F.Unit No.31, which covers the band from 40 to 52 mc/s approximately, is shown in Figure 6. It contains one stage of R.F.amplification, V1, which is a pentode Type VR65 mounted in the front compartment of the R.F.Unit. V_2, the mixer is also a VR_{65} and is mounted in the middle compartment. The rear compartment contains the oscillator stage V_3 which is another VR_{65}. The output from the oscillator valve is injected into the cathode circuit of V_2 through T_1 which has a band-pass of more than 10 mc/s. The frequency of the oscillator is controlled by L4 and C_{22}, L_5 being an R.F. choke.

15. The inductance L_3 is fitted with an adjustable iron dust core by means of which the coil is tuned to 7.7 mc/s. This coil together with L_1 in the I.F. amplifier (also tuned to 7.7 mc/s) form a band pass coupling of which C_{10} forms the coupling capacity and C_{19} the tuning capacity. C_{19} is the screened lead to the output plug J_1 which is built into the unit. NO ATTEMPT SHOULD BE MADE TO ADJUST THE TUNING OF L_3 UNLESS THE NECESSARY INSTRUMENTS ARE AVAILABLE.

16. R.F.Unit No.32.- The circuit diagram of R.F.Unit No.32 which covers the 20-30 mc/s band is shown in Figure 6. It is similar to No.31. The R.F. tuned circuits are damped by R3, R4 and R_{23}, R_{24}. The mixer stage V_2 is similar to that in R.F.Unit No.31, L4 being the oscillator output transformer. The oscillator stage V_3 is somewhat different. A cathode tap circuit is employed, L_5 being the tuning coil and C_{21} the tuning condenser.

17. R.F. Units Nos. 26 and 27.- The circuit diagram of R.F. Units Nos. 26 and 27, covering 50-65 and 65-80 mc/s respectively are shown in Figure 20. The R.F. and Mixer stages use VR136 (RL7) valves which are special high frequency pentodes having four separate cathode connections to reduce the inductance of the cathode lead. The oscillator valve V_3 is a VR_{137} (RL16) high frequency triode connected in a Colpitts circuit. The R.F. mixer and oscillator circuit are tuned by a three-ganged condenser C_4, C_5, C_{32} with the associated trimming and padding condensers. C7 is an externally adjustable trimmer. The output from the oscillator is applied to the grid of the mixer (V2) via C_{18} together with the R.F. input.

18. I.F.Amplifier.- The circuit diagram is shown in Figure 7 together with that of the Diode Receiver which is mounted on the same panel. There are five I.F. stages, V_1 to V_5, employing VR_{65} valves. V6 is the diode detector type VR92. V7 is a pulse-frequency amplifier and V_8 and V_9 are cathode follower output valves. The grid circuit of V_1 consisting of the variable inductance L_1 and the coupling condenser C1, forms part of the bandpass coupling between the R.F. Unit and I.F. amplifier and is tuned to 7.7 mc/s. All the other I.F. circuits are tuned to 7.5 mc/s .

19. The first two valves V_1 and V_2 are provided with variable cathode bias through the resistances R_3, R_4, R_{57} and the variable resistance (Gain Control) R_{29} mounted on the Strobe Gain Control Unit. Strobe Gain and A.V.C. pulses are also fed on to the cathodes of the first two valves. Stages V_3, V_4 and V_5 are fitted with a special "back bias" circuit to enable the signals to be read through jamming. A switch is

provided to enable certain circuit elements to be altered to deal with different forms of jamming. There are four positions, namely N, X, Y and Z., the operation of which is described in paragraphs 22 to 29.

20. With the switch in position "N" the condensers C_{15}, C_{23} and C_{32} are shorted out by the switch contacts S_2, S_5 and S_8 which also short the negative H.T. line supply to earth. In this position grid bias to V_3, V_4 and V_5 is provided by the resistors R_{17}, R_{27} and R_{35}. A dropping resistance R_{42} is introduced into the screen H.T. circuits of V_3 and V_4 to limit the gain of these stages to a reasonable value. In this position of the switch the resistor R_5 is introduced in series with the Gain Control (mounted on the Strobe Gain Control Unit) to reduce the maximum amplification available, which is unnecessarily large. Strobe Gain pulses are fed in via Pin 3 on the 8 pin Jones plug J2 to cut off the I.F. amplifier for the duration of the B or C strobe upon which the local pulse appears (see para.36 to 42).

21. The filter condenser C_{42} is shorted out in position N, ~~as also is the filter circuit C_{50}, R_{52}, C_{51}, R_{53} between the pulse frequency amplifying stage V_7 and the cathode follower V_8.~~ Outputs are taken from V_8 via P_3 to the Y_1 plate of the C.R.T. through the contacts of the relay (F.S.I) on the Filter Strobe Unit and from V_9 via P_4 to the Filter Input Unit and A.V.C. Unit. Separate cathode followers are used to preserve good pulse shape on the tube by reducing the capacity loading on the output to Y_1.

22. Operation of Anti-Jamming circuits.- Referring to the circuit diagram Figure 7, the anode circuit of V_3 has a resistance R_{22} in series with the normal anode load R_{21}. R_{22} is 100K and R_{21} 5K. The junction point of the two resistors is connected to the bottom end of the grid coil L_3 through the 500K resistor R_{20}. L_9 and L_{12} are R.F. chokes. The bottom end of the grid coil is then connected through another 500K resistor R_{18} to the negative H.T. line which is at 130 or 230 volts negative with respect to earth, depending upon the position of the A-J switch. The junction of R_{21} and R_{22} is decoupled by the condenser C_{16} and the lower end of the grid coil by the condenser C_{13}. Additional decoupling condensers C_{17} and C_{15} are included in the circuit in certain positions of the A-J switch, as shown by the letters on the diagram, to increase the decoupling time-constants. A condenser C_{14} is connected across R_{20}, thus completing a condenser potentiometer between the grid and anode of V_3. The circuits for V_4 and V_5 are similar except that some of the components are of different values.

23. Consider the operation of V_3 with the A-J switch in position Z, which is the position for dealing with C.W. and low-frequency modulated C.W. In this position a resistor R_{41} is connected across the negative rail bias ~~H.T.~~ supply and since the power pack has poor regulation this reduces the voltage from -230 volts to -130 volts approximately. Now the positive H.T. line is at + 350 volts so that the potential at the junction of R_{21} and R_{22} will depend upon the drop in potential across R_{22} due to the anode current of V_3. The current drawn by R_{20} can be neglected. In position Z V_3 draws 2.3 mA and this will cause a drop of 230 volts across R_{22}, thus putting the junction of R_{21} and R_{22} at 120 volts positive. R_{20} and R_{18} are equal so that the grid of V_3 will take up a potential midway between + 120 and -130 volts, which is -5 volts with respect to earth.

24. The Ia - Vg curves of Figure 21 help to explain the operation of the stage. Consider the curve of Figure 21A where a small C.W. jamming signal is applied to the grid of V_3 together with the required pulse signal. The C.W. signal will tend to make the valve take more anode current due to the curvature of the valve characteristic. An increase in anode current causes a greater voltage drop across R_{22} which in turn will make the voltage at the junction of R_{20} and R_{18} more negative with respect to earth. The feedback arrangement thus allows the anode current to increase slightly and this increase automatically increases the negative bias applied to the grid so thst the point on the valve curve about which the input signal and jamming is applied is shifted sufficiently far to the left so that the required pulse signal can pass through the valve. Figure 21B illustrates the case of a very large C.W. jamming signal. It will be seen that the bias volts have been shifted so far negative that the pulse signal is still able to pass through the valve on top of the jamming signal. The decoupling condensers C_{16} and C_{13} are large enough to prevent any change in the bias conditions for the duration of the pulse.

25. If the jamming signal is modulated by a low-frequency sine wave, a waveform similar to the modulation envelope will appear across the anode decoupling condenser C_{16} since this is of comparatively small capacity and so presents 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 C_{14} and C_{13} causing a reduction in the modulation percentage of the jamming signal which passes through V_3. Further reduction in the percentage modulation occurs in V_4 and V_5

26. The operation of the scheme for "railing" jamming is slightly different. Figure 21C will help to explain this. In the case illustrated the jamming signal consists of square pulses of somewhat greater width than the required pulse. The A-J switch should be in position X for this type of jamming. This means that the potential of the negative rail will be approximately -230 volts and the anode current taken by V_3 V_4 and V_5 will be about 1.35 mA each with no signal coming through. Extra condensers (C_{17} and C_{15} in V_3 circuit) are switched in on all three back biassed stages, making the time-constants long in the anode and grid circuits.

27. During the period of the "railing" pulses the bias applied to the grid of the valve will not change appreciably owing to the large condensers in the grid and anode circuits. If the required signal pulse happen to occur at the same time as the "railing" pulse, it will be received satisfactorily on top of the jamming pulse as shown. During the gaps in the jamming no pulses will be received but this is not important unless the jamming is locked to some multiple of the recurrence frequency of the signal. Normally the recurrence frequency of the jamming will drift with respect to the signal, so that signals will be received whenever a jamming pulse coincides with the signal.

28. The small amount of the modulation envelope of the jamming signal which comes through the I.F. amplifier is filtered out by C_{42} and R_{44}. R_{44} is a high resistance so the charge accumulated by C_{42} when V_6 passes current can only leak away slowly. Thus the voltage across C_{42} becomes nearly equal to the peak voltage of the "railings". The diode will therefore pass very little of the jamming but will let through the signals.

29. Position Y on the A-J switch is similar to position X except that the condensers in the grid circuits of the three back biassed stages are reduced in value, allowing some negative feedback to take place between the grid and anode circuits. This position is helpful if some low-frequency modulated C.W. is superimposed upon railing jamming. The back bias arrangements will also operate if the jamming signal has sine wave modulation instead of square pulses, but the improvement will not be so good, as owing to the waveform there is less time at the peaks during which signals can be received.

DIODE RECEIVER

30. The Diode Receiver, which is mounted on the same panel as the I.F. amplifier, is used for receiving the pulse from the local transmitter. It is used in preference to biassing back the I.F. amplifier by strobe gain control because in the latter case only the top of the local pulse is amplified by the receiver, and any jitter or unsteadiness is thus magnified, making accurate phasing difficult. Owing to the absence of tuned circuits distortion of the pulse shape due to frequency discrimination is avoided. Two outputs are taken from the Diode Receiver, one to the cathode ray tube (connected in parallel with the output of V_8 on the I.F. amplifier chassis) and the other to a line running to the transmitter hut so that the rectified pulse may be inspected on a monitor, thus showing the shape of the actual pulse transmitted from the aerial.

31. Referring to the circuit diagram Figure 7, the aerial is brought to a Pye Plug P_7 (shown in the photograph Figure 4) which leads to the cathode of the diode V1. The negative pulse output from the anode is passed through the R.F. filter, C_1, L_1, C_2, L_2 to the grids of V_2 and V_4 via the amplitude controls R_{19} and R_{22}. The latter control is preset and is mounted behind the removable panel.

32. V_2 and V_4 amplify and invert the pulse and pass it to the cathode followers V_3 and V_5, the former being a VR91 valve which feeds the pulse on to the cathode of V_8 in the I.F. amplifier and thence to the cathode ray tube. V_5 is a VT75, the output from which is taken to the line leading to the transmitter hut via the Pye Plugs P_8 and P_{13}.

33. The amplitude of the pulses must always be kept small enough by means of R_{19} and R_{22} to avoid overloading the amplifiers, otherwise distortion will be introduced. The height of the local pulse on the tube should be approximately equal to that of the other received pulses.

34. The time delay experienced by the signals in passing through the I.F. amplifier is about 1.2 microseconds greater than the delay introduced by the Diode Receiver. The exact delay must be determined for each individual receiver and a correction applied to the phasing number.

35. Under certain conditions it may not be possible to receive the transmitter pulse on the Diode Receiver. In this case, the strobe gain control must be adjusted so that the pulse is received on the normal receiver and the amplitude control R_{19} on the Diode Receiver should be turned to zero. In this case the correction factor mentioned in para. 34 should be ignored. Note that since the signal is small, only a small amount of strobe gain ~~control~~ reduction is required, thus no jitter is introduced on the peak of the local pulse.

STROBE GAIN CONTROL UNIT

36. This unit provides a controlled increase or decrease of the gain of the receiver for a period of about 100 microseconds coincident with either the B or C strobe time base. It is effective on both main and strobe time bases. At Slave stations the I.F. amplifier is normally cut off for the duration of either the B or C strobe, upon whichever the local pulse appears, and the local pulse is then received by the Diode Receiver. On some sites however, the diode is not sufficiently sensitive, in which case the gain of the I.F. amplifier must be made just sufficient to receive the local transmitter pulse satisfactorily. At Monitor stations an increase in gain may be required to equalise the amplitudes of the pulses being monitored.

37. The Strobe Gain pulses are applied together with the A.V.C. pulses to the cathodes of V1 and V2 in the I.F. amplifier (fig.7). Thus a positive pulse supplied by the Strobe Gain Control unit reduces the I.F. gain and a negative pulse increases it.

38. The circuit diagram, waveforms and layout are shown in figs.8, 9, and 10 respectively. V1 and V2 (fig.8) form a multivibrator (or "flip-flop") locked to the B or C strobe edge (fig.9A) from the Time Base unit. V1 is normally cut off, but is brought on by the positive pulse (fig.9C) developed in the anode circuit of V2 when the grid of the latter is cut off by the synchronising pulse (fig.9B).

39. When V1 is brought on, a positive pulse (fig.9F) is produced across the cathode load R13 and a similar negative pulse appears at the anode of the valve. These pulses are applied across a variable potentiometer (R12) through an 8 microfarad electrolytic condenser C4. The slider of the potentiometer is connected to the grid of the cathode follower V3 and from the cathode of this valve an output is taken through C8 to the cathodes of the first two valves in the I.F. amplifier, together with the A.V.C. pulses which are fed from the A.V.C. unit directly on to the cathode of V3 in the Strobe Gain unit.

40. The amplitude of the Strobe Gain pulses may be set to any value in between the limits of the positive and negative output from V_1 by adjusting R_{12}, which thus provides a control of Strobe Gain.

41. R_{29} is the normal gain control for the receiver. It is the cathode bias resistor for V_1 and V_2 in the I.F. amplifier and is mounted on the Strobe Gain unit for convenience. R_{28} is in series with R_{29} to prevent the bias from being reduced too much.

42. The heaters on this unit are earthed through a centre-tapped pair of resistors. This helps to prevent hum from being introduced into the output. The heaters of all the other units connected to the same LT supply must of course be unearthed. The HT supply for the Strobe Gain and A.V.C. units is taken from a stabilising valve on P.P.2."

(A.L.1)

43. The Filter Input Unit has two functions

(i) As a gate to prevent unwanted pulses from reaching the Frequency Selector on the F.C.O.

(ii) To produce a clean pulse of constant amplitude and suitable length to operate the crystal filter on the Frequency Selector, irrespective of the amplitude and shape of the pulse received from the Master Station.

It is thus necessary for reliable operation of the F.C.O.

44. The circuit diagram waveform and layout are shown in Figures 11, 12 and 13 respectively.

45. The pulses from the receiver unit are applied to the grid of V_1 through the limiting resistance R_2. These pulses are shown in Figure 12A. V1 is normally biassed off by the resistance network R_6, R_5, R_3 and the input pulses drive the valve into grid current. This produces a negative pulse of about 200 volts amplitude in the anode circuit. The back of this pulse is lengthened by the time constant of R_4 and the stray capacities across it. This time constant is of the order of 3 µs and thus lengthens the pulse as shown in in Figure 12B, as V_2 will not operate correctly if the received pulse is too short.

46. V_2 works with zero bias and has a shorted delay network in its anode circuit. As described in Appendix 2, a waveform as shown in Figure 12C is produced in the anode circuit. The constants of the network are chosen so that the positive and negative pulses produced are each 3½ µs long. The front of the negative pulse (which is not used) corresponds with the rear edge of the pulse shown in Figure 12B, so it is clear that this latter pulse must not be too short. The pulse is made 3½ us long as this is the most effective length for energising the 150 kc/s crystal filter in the Frequency Selector on the F.C.O.

47. V_3 (Type VR116) is the Gate valve. The valve is biassed negatively on the control grid and the suppressor grid is heavily biassed so that the valve is completely cut off on G_3. 500 c/s gate pulses from the Filter Strobe Unit are applied to G_3 so that the cut off bias is neutralised for the duration of this pulse - that is for about 5 us. The position and width of the Filter Strobe Pulse can be adjusted so that it "opens the gate" just before the positive pulse from V_2 arrives ~~at~~ the grid of V_3 and cuts the valve off again on G_3 immediately after the end of the positive 3½ µs pulse. This is shown in Figures 12D and E.

48. The diode V_5 and R_{28} serve to square off the top of the incoming filter strobe pulse. V_3, which is a type VR_{116} valve, has a specially designed suppressor grid which cuts off at about -10 volts. A standing hold off ~~held~~ bias of 20 volts is applied to G_3, and the gate pulse is of considerably greater amplitude. Thus the gate valve is brought on very sharply and when the amplitude of the Filter Strobe pulse exceeds the bias voltage on G_3 the diode V_5 conducts and the excess voltage is then dropped in R_{28}. This gives a square top to the gate pulse and prevents the flow of suppressor current.

49, When the contacts of the relay REL_1 are closed the suppressor grid of V_3 is taken directly to the cathode so that there is no bias on it and the gate is permanently open. The valve then acts merely as an inverting stage.

50. V4 inverts the pulse again. The valve works with a positive bias which removes any kinks which may have been developed in the gate valve. The output from V4 is a square 3½ µs pulse (Figure 12F) which is passed to the Frequency Selector in the F.C.O. and is used to "ring" the crystal.

FILTER STROBE UNIT

51. The purpose of the Filter Strobe Unit is to provide the 500 c/s gate pulse to operate the gate valve V_3 in the Filter Input Unit as explained in para.47 to 49. This allows only those pulses produced from the Master Station signals to pass through and energise the Frequency Selector. The gate pulse is also applied to V_1 in the A.V.C. unit, where it allows only the Master pulses to pass through and operate the A.V.C. circuit.

52. The circuit diagram, waveforms and chassis layout are shown in Figures 14, 15 and 16 respectively.

V_1 and V_2 form a multivibrator circuit, V_2 being normally conducting while V_1 is biassed off by R_1 and R_2. A negative synchronizing pip (Figure 15A) from Divider II is fed on to the grid of V_2. This shuts off the anode current so the anode voltage of V_2 starts to rise as the condenser C_2 charges up through R_8 (Figure 15B). This rise in voltage is communicated to the grid of V_1, making this valve conduct. Therefore the anode voltage of V_1 falls sharply and this fall in voltage is communicated through C_3 to the grid of V_2. Thus a cumulative action is set up and the pulse produced at the anode of V_1 has a sharp front (Figure 15C).

53. When the negative sync. pulse has ended, V_2 remains cut off, due to the negative charge on C_3. This charge leaks away through R_7 and P_1 and when the voltage on the grid end of C_3 has risen to the cut off bias voltage of V_2 the valve starts to conduct. The anode voltage of V_2 falls rapidly ~~as C3 discharges~~ and this fall in voltage is communicated to the grid of V_1 setting up a cumulative action which cuts V_1 off and brings V_2 on sharply, thus giving a steep rear edge to the pulse shown in Figure 15B. This process is repeated every time a negative sync. pip arrives at the grid of V_2.

54. The amplitude of the pulse fed back from V_1 to V_2 can be controlled by P_2. The time taken by C_3 to discharge depends upon the amplitude of this negative pulse, so P_2 provides a coarse control of the multivibrator pulse width. P_1 by controlling the rate of discharge of C_3 provides a fine control.

55. The positive pulse (Figure 15B) from the anode of V_2 is passed to the grid of V_3 through a short time constant circuit C_6 R_{22}. R_{22} is taken to the slider of P_3 so that the positive voltage at the earthy end of R_{22} can be adjusted, thus varying the width of the differentiated pulse (Figure 15D) applied to the grid of V_3. V_3 works with zero bias and so the negative pulse appears at the anode as a square positive pulse of variable width (Figure 15E).

56. Since the position of the Filter Strobe pulse corresponds to the rear edge of the multivibrator pulse, altering the length of the multivibrator pulse by P_2 and P_1 will cause the Filter Strobe Pulse to move along the time base. As shown in Figure 15F and G, it should be set so that it will just cover the received Master Station pulses when they are phased to zero on the time base. The length of the Filter Strobe pulse is set to approximately 5 or 6 microseconds, as required, by P_3.

57. The screen of V_3 is loaded with a 4.7K resistor and is connected to the Y_2 plate of the cathode-ray tube through a small condenser C_{12}. This feeds a small positive pulse on to the Y_2 plate and so produces a shallow "trough" in the time base, corresponding to the position of the Filter Strobe pulse. This helps in the preliminary adjustments to the F.C.O. The two-way changeover relay in the anode circuit of V_3 which was used to allow the Filter Strobe pulse to be inspected is now no longer needed. (A.L.1)

A.V.C.UNIT

58. The circuit, waveforms and layout are shown in Figures 17, 18 and 19. This unit provides Automatic Gain Control on the Master Station pulses. The unit only operates when the Master Pulse is inside the Filter Strobe Gate pulse but for convenience the receiver gain is controlled during the period from the start of the A trace to the end of the step and for an equivalent period immediately below on the C trace.

59. The output from the receiver output valve V_9 is applied to the grid of V_1 in the A.V.C. unit, which is strobed on the suppressor grid by the Gate pulse from the Filter Strobe Unit fed in through C_3. The diode V_2 A prevents the suppressor grid from going positive with respect to cathode, thus squaring the top of the Gate pulse. This arrangement is similar to that employed on V_3 in the Filter Input Unit. The Master Station pulses only (See Figure 18A and B) appear inverted at the anode of V_1 (Figure 18C), their amplitude being controlled by R_7, and charge the condenser C_{14} through V_{2B} to a negative potential nearly equal to the peak amplitude of the pulses. The resistance R_{10} is too high to cause the charge to leak away appreciably between pulses (Figure 18D). This negative potential on C_{14} is applied to the grid of V_3 via the smoothing filter R_{11}, C_5, C_{16}, thus controlling the D.C. anode current of the valve.

60. V_4 and V_5 form a Multivibrator which is locked from a 500 c/s negative synchronising pip from Divider D.II. This pip ~~(Figure 18A)~~ is also used to lock the time base, so it corresponds with the start of the A and C traces of the time base. The multivibrator pulse has a length of about 200 microseconds (adjustable by R_{24}) which is sufficient to cover the step on the time base, allowing for the initial black out period. The Multivibrator gives a positive pulse (Figure 18J) at the anode of V_4. (This anode is connected to the anode of V_3).

61. The standing anode current of V_3 is controlled by the amplitude of the Master Station pulses (see para.59) and so the potential to which the anodes of V_3 and V_4 rise during the multivibrator pulse is controlled by the amplitude of the input signal. In other words, the working H.T. voltage on the anode of V_4 is controlled by the grid voltage on V_3, which is in turn determined by the amplitude of the received pulses. Thus if the amplitude of the Master pulses increases, the bias on V_3 increases, its anode current falls and the anode voltage rises. Therefore the positive pulse on the anodes of V_3 and V_4 due to the multivibrator action will increase in amplitude. Similarly if the amplitude of the input signal falls the amplitude of the pulse on the anode of V_3 decreases.

62. This pulse is fed via the cathode follower V_6 to the cathodes of the first two I.F. valves, thus providing a bias pulse which will maintain the receiver output constant during the reception of the Master Station pulses. Once the amplitude of the pulse on the tube has been set to approximately three quarters of the saturation level by adjusting R_7 on the A.V.C. unit (2 to 3 cm deflection should be allowed), the A.V.C. circuit will maintain it at this level.

63. The upper terminal block on the chassis of the A.V.C. unit carries the connections to the post office keys operating the relays on the Filter Input Unit, Filter Strobe Unit and Calibration Unit (See Table 3).

FINE PHASE SHIFTERS 3 and 4

64. The purpose of the Fine Phase Shifters 3 and 4 (so numbered because they replace the Phase Shifters 2 and 1 respectively used on R1363) is to move continuously by means of handles the phase of the 150 kc/s sine wave from the crystal oscillator on the F.C.O. The inputs to the Phase Shifters are fed in parallel from the oscillator, the output from P.S.4 being taken to D.II and from P.S.3. to D.III.

65. The effect of turning the phase shifter controls is as follows:-

When P.S.4. is turned all the pulses seen on the cathode ray tube move along the time base, since the Time Base Unit is locked to the output from Divider D.II. When P.S.3 is turned, only the local transmitter pulse moves, as this is locked from Divider D.III. The circuit diagram of P.S.4 and 3 are shown in Figures 26 and 27 and the layouts in Figures 30 and 29 respectively. An explanatory Vector Diagram is given in Figure 28. 27

66. P.S.4.- The input from the F.C.O. crystal oscillator is fed into a transformer coil L_1, which is mounted in the control box under the desk (See Figure 2). Two resistors are connected in series across the secondary and the common point is earthed. The output from the coil is connected across two corners of a phase splitting network C_1, L_2, R_3, R_4. This output is represented by AB in Figure 28, and is applied to plates A and B of the special condenser C_9. This condenser has four stator plates and one rotor. The output from the other two corners of the phase splitting network is applied to plates C and D of the condenser C_9. This output is 90 degrees out of phase with respect to the input voltage and is represented by CD in Figure 28.

67. Now for any position of the rotor plate of C_9 (which has no stop to limit its rotation) a certain voltage will be induced upon it from the stator plates. Suppose the rotor is between plates A and D of the stator, rather more under A than under D, then a voltage A1 will be induced upon it from A and also a voltage D_1 lagging by 90 deg. from plate D. The resultant of these two voltages is shown as E_1 in Figure 28. Now suppose the rotor is rotated to lie between D and B. Then, referring to Figure 28, a voltage D_2 will be induced on it from D and a voltage B_2 from B, the resultant voltage being E_2.

68. Similarly when the rotor is further rotated to lie between B and C and C and A voltages E_3 and E_4 respectively will be induced upon it. Thus the effect of manually turning the rotor is to continually alter the phase of the 150 kc/s sine wave induced on the rotor plate with respect to the input signal AB. This voltage is amplified by the valve V_1 and taken out to Divider D.II. via the transformer coil L_4, the primary of which is tuned by C_7. The grid circuit of the valve is similarly tuned by L_3 and C_2.

69. The connections of the phase-splitting network to C_9 in P.S.4 are made so that a clockwise rotation of the knob advances the phase of the 150 kc/s output. This effectively "speeds up" the time base so that the received pulses travel towards the right hand end of the time base.

70. P.S.3.- The operation of P.S.3 is similar to that of P.S.4. The connections to the condenser C_9 are, however, transposed so that a clockwise rotation of the control knob retards the output. Thus a clockwise rotation "slows down" the operation of Divider III so that the local transmitter pulse moves to the right.

71. The control knob of P.S.3. is mounted on the front panel of the unit, whereas the phase shifting condenser and network of P.S.4. are mounted in a separate box under the desk. A microammeter, which is fitted with a flexible lead terminating in a jack, is mounted on P.S.3. and a clock is mounted on the corresponding place on P.S.4. P.S.3 is not used at Monitor Stations.

DIVIDER D.II

72. The purpose of Divider D.II is to produce pulses at 500 c/s rigidly locked in phase to the 150 kc/s sine wave from the F.C.O. crystal oscillator. These pulses are then used to lock the time base. Locking pulses at 500 c/s are also taken from D.II to the Filter Strobe Unit and A.V.C. unit. 150 kc/s pips from D.II are used to produce the 1.5 Mc/s calibration wave from the Calibration Unit and pips at 15 and 150 kc/s from D.II are fed on to the cathode of the C.R.T . to give bright calibration marks.

73. Figure 23 shows the circuit diagram and Figure 24 the waveforms and chassis layout. The input to the divider is a 150 kc/s sine wave of about 5 volts peak to peak amplitude. This is fed into the first valve V_1 through the tuned auto-transformer coil T_1 which has a step-up ratio of 1:10. Since the signal at the grid of V_1 is of greater amplitude than the valve is capable of handling, the anode waveform of this valve is distorted into a square wave with rather sloping sides due to stray capacities across the anode load R_4 (Figure 24B).

74. V_2 is a squegging valve. The square wave from V_1 is fed through a short time constant circuit C_4, R_5 on to the grid so that a positive pip is passed. This makes V_2 draw a pulse of anode current

through T_7 which is connected so that this drives the grid more positive. Grid current is drawn from C_4 and C_6 and the grid of V_2 is driven negative by the joint action of the overswing of the grid voltage due to the oscillatory character of the transformer winding and the discharge of C_4 and C_6 due to grid current. Thus the valve is rapdily cut off and C_4 begins to charge up again. (Figure 24C).

75. The time constant C_4 R_5 is chosen so that the grid voltage has nearly risen to earth potential by the time the next 150 kc/s pip arrives at the grid of V_2. Thus the anode current of V_2 consists of a number of pulses of current very quickly shut off. These pips which are of about $\frac{1}{4}$ µs duration only, are taken as positive pulses from the cathode of V_2 to the squaring valve V_{14} whence they are fed to the cathode of the C.R.T. to provide 150 kc/s bright calibration pips. An output is also taken from the cathode of V_2 to lock the 1.5 Mc/s calibration unit. The cathode waveform is shown in Figure 24D. A more detailed treatment of the blocking (or "squegging") oscillator is given in Appendix 2.

76. V3 is the first divider oscillator stage. This consists of a triode valve arranged as a squegger, the anode and grid circuits being tightly coupled by T_2. V3 is normally biassed off by the voltage on its cathode developed across R_{17}. In the grid circuit C_7 charges up through R_9 and R_{10} and superimposed upon this steady rise in voltage are the 150 kc/s pips from the cathode of V_2. When this voltage has risen sufficiently, V_3 conducts and draws a pulse of current through T_2. This transformer is so connected that the grid is driven more positive and grid current is drawn from C_7.

77. Grid current continues to flow until the grid voltage swings negative due to the joint action of the overswing of the grid voltage caused by the oscillatory character of the transformer windings and the discharge of C_7. The negative voltage on C_7 is rapidly removed by the diode V_{12A} and so the grid end of C_7 is restored to earth potential. C_7 then begins to charge up again through R_9 and R_{10}. The complete cycle of operation is shown in Figure 24E.

78. The voltage on the H.T. end of R_9 can be varied by adjusting P.1. This controls the rate of charging of C_7 and is set so that the arrival of every tenth 150 kc/s pip causes the valve to squegg. Thus V3 produces 15 kc/s pips at its anode locked to the 150 kc/s pips fed on to its grid. The waveform here is shown in Figure 24F. Positive pips can be seen coming from the cathode of V_2 and a negative pip is seen every time V_3 squeggs and draws grid current. To set up the divider stage, this waveform is observed on the Oscillograph Unit and P_1 is adjusted so that one negative pip occurs for every ten positive pips, as shown in Figure 24.0.

79. The valve V4 has two functions: as a buffer to prevent interaction between the two divider stages V_3 and V_5 and as bias regulator for V_3. The bias for V_3 is taken from the cathode of V_4, and the grid of the latter valve is taken to a potential divider R_{15}, R_{16}, P_1 across the H.T. supply. Thus if the H.T. voltage rises, the cathode potential of V_4 rises (being a cathode follower) and hence the hold-off bias of V3 increases. Therefore, since the rate of charging of C7 also increases due to the higher charging voltage, the various factors tend to balance out and the operation of the divider stage is maintained constant over a fairly wide range of H.T. voltage. In fact, the divider will not slip if the H.T. voltage varies by as much as plus or minus 50 volts.

80. The third winding on T_2 feeds positive 15 kc/s pulses through C_{10} and the limiting resistance R_{66} on to the grid of V4. The output from V4 is taken from the cathode (Figure 24J) and is used to synchronise the next division stage (consisting of V_5, V_6 and V_{7A}) the operation of which is similar to that of the first stage. P_2 provides the adjustment of the division ratio, which is 5.

81. The third stage consists of V_8, V_9 and V_{7B}. P4 is the division ratio control which is adjusted to divide by 6. V_{14} is the calibration valve which supplies 150 and 15 kc/s brightening pulses to the cathode ray tube. As described in para.75 150 kc/s positive pips from the cathode of V_2 are fed on to the grid of V_{14}. 15 kc/s pips from T_2 are fed on to the anode (Figure 24 K and L). When the Time Base changeover switch is at "Strobe" or "High Speed" a pair of contacts on the switch short out R_{53} via the terminal Orange 213 so that V_{14} amplifies the 150 kc/s pips on its grid. These then appear at the anode together with the 15 kc/s pips and both are applied to the cathode of the cathode ray tube (Figure 24M). In the "Main" position of the time base switch the contacts are open so that V_{14} is biassed off by R_{53}; thus only the 15 kc/s pips are seen on the trace.

82. The valves V_{10}, V_{11}, V_{12B} and V13 make up the Coarse Phase Shifter. This works in the same way as a divider stage. A potentiometer P_5 fitted with a switch is mounted on the front panel. When this switch is open V_{11} is cut off by the bias voltage across R_{43}, but when the switch is closed V_{11} starts to take anode current and since the grid and anode circuits are tightly coupled by T_5 a cumulative action is set up and the valve squeggs. The squegging frequency is locked by the 15 kc/s pips fed on to the grid of V_{11} via the cathode follower V_{10} so that the coarse phase shifting is regular (Figure 24JJ).

83. The anode waveform (Figure 24KK) consisting of a negative pulse followed by a positive "ring" is passed from the third winding of T5 through the diode of V_{12B}. Only the positive part of this waveform appears at the cathode of the diode, is differentiated by the variable short time constant circuit C_{24}, C_{25}, R_{45} (Figure 24LL) and reaches the grid of V_{13} via the limiting resistance R_{46}. This produces negative pulses (Figure 24 MM) at the anode of V_{13} which are fed to the junction of R_9 and R_{10} through which C_7 is charged. Thus every time the negative pulse from V_{13} arrives the charging of C_7 is checked (Figure 24 NN).

84. C_{24} is adjusted so that the duration of the negative pip from the anode of V_{13} is sufficient to retard the charging of C_7 to such an extent that V3 squeggs after the arrival of eleven 150 kc/s pips instead of ten. This therefore retards the phase of the 15 kc/s pips leaving V_3 by $6^2/3$ µs every time V_{11} fires. The number of times V3 fires per second is determined by the setting of P_5 so the rate of phase shift can be controlled.

DIVIDER D.III

85. The circuit diagram of D.III, which is not used at Monitor Stations, is shown in Figure 25 and the waveforms in Figure 24. The circuit is similar to that of Divider D.II with the following exceptions:-

(i) The 150 kc/s squegging valve V_2 is replaced by a cathode follower with a short time constant C4 R_5 in the grid circuit.

(ii) The division ratio of the second stage is 10 instead of 5, thus giving a 250 c/s output instead of 500 c/s. A fine division control P_3 is provided for the second stage.

(iii) The calibration pip valve (V_{14} in D.II) is not required.

(iv) Three valves V_{16}, V_{15} and V_{14} are provided to produce a pulse of about 400 µs wide and 120 volts amplitude. This is fed through the cathode follower V_{14} to the transmitter hut to trip the transmitter.

86. V_{16} is the Pulse widener. The input from V_8 (Figure 24AA) is applied to the cathode of V_{16} which conducts during the negative part of the cycle and so charges C_{30}. When the negative part of the cycle has ended C_{30} discharges through the high resistance R_{53}. This gives a waveform, shown in Figure 24BB, which cutsoff V_{15} thus producing a 400 µs positive pulse at the anode of this valve. This pulse is then passed to the cathode follower V_{14}.

87. From the cathode of V_{14} an output is taken to a three-position key. With the key in the upper position (OFF) the output is disconnected. In the middle position (INSPECT) a marker pulse is taken through a small condenser C_{35} via a terminal on the Filter Strobe Unit to the Y1 plate of the C.R.T. and in the lower position (SEND) the locking pulse is sent down the line to the transmitter hut.

TIME BASE UNIT

88. The circuit diagram of the Time Base Unit is shown in Figure 31 and the waveforms and chassis layout in Figure 32. The traces produced on the cathode ray tube are shown in Figure 43. There are three different time bases available, the Main, the Strobe and the High Speed Strobe time bases respectively. All are produced by the same unit.

89. Main Time Base.- The appearance of the Main Time Base on the cathode ray tube is shown in Figure 43A. The circuit diagram is shown in Figure 31 where all the contacts of the changeover switch are shown in position M. The 500 c/s input to V1 is taken from Divider II. This input pulse (shown in Figure 32A) is applied to the suppressor grid of V1, which is connected in a Transitron circuit. The positive pip causes V_{2A} to conduct and draw current from C_1, so that at the end of the positive pip C_1 will be negatively charged and as G_3 of V_1 is connected to C_1 this diverts some of the anode current of V_1 to the screen so that the screen voltage falls due to the drop across R_3. The screen is connected to the suppressor via C_3 so that the drop in voltage is communicated back to the suppressor so that a cumulative effect is set up and V_1 is cut off sharply.

90. The condenser C_3 now discharges through R3 and R_4, the rate of discharge being adjustable by R4 ("Square wave") so that the next positive synchronising pulse brings the suppressor voltage above cut off. The process is now reversed and V_1 is brought on sharply. The waveforms at V_1 screen, suppressor and anode are shown in Fig.32B, C and D. It will be seen that a square wave is produced at screen and anode. This square wave is not symmetrical, as the negative going edge is produced by the rear edge of the locking pulse and the positive going edge by the front edge of the pulse, but this assymmetry is not important.

NOTE.- A more detailed explanation of the Transitron is given in Appendix 1.

91. The square wave from the anode of V_1 is fed to the grid of V_6 via C_{15} and the limiting resistance R_{32}. V6 is cut off during the negative part of the square wave so the screen potential is equal to the H.T . voltage but when the positive part arrives the valve conducts and the suppressor voltage falls below cut off due to the Transitron action already described. All the cathode current of the valve flows to the screen, which therefore takes up a very low potential (Figure 32E and F).

92. C_{17} then starts to discharge, the rate of discharge being controllable by R_{71} ("A step, position"). As soon as the suppressor voltage rises above cut off (Figure 32E) the anode starts drawing current so the screen voltage and hence also the suppressor voltage rise sharply. The valve now conducts until the arrival of the negative wavefront from V_1 which cuts V_6 off completely, so that the screen voltage again rises to full H.T. potential. The complete waveform generated on the screen in this manner is shown in Figure 32F. The length of the "step" can be varied by R71 and the amplitude can be adjusted by R72 ("Strobe Space"). This waveform is applied to the Y_2 plate of the cathode-ray tube to produce the stepped double time base.

93. The input to V_{2B} consists of a positive pulse followed by a negative "ring" (Figure 32G). The positive part of this waveform charges C4 through V_{2B} and this charge then leaks away through R_5 which is a high resistance. The time constant R5 C4 is large so that the pulse at the cathode of V_{2B} is longer than the pulse applied to its anode (See Figure 32G and H).

94. V_3 is normally biassed off by the voltage across R_{12}, but the positive pulses developed across R_5 make the valve conduct for about 150 µs. The anode and screen potentials of V_3 therefore fall sharply as C_8 discharges through the valve. When V_3 is again cut off, the anode potential rises slowly as C_8 charges up through R_{10} (Figure 32 I) and the screen potential rises immediately to its original value as shown in Figure 32 J. The anode circuit time constant R_{10}, C_8 is 25,000 µs and C_8 is allowed to charge up through R_{10} for about 1800 us only so the rise in anode potential is nearly linear. The variable resistance R_{66} ("Main T.B.Amp.") controls the potential towards which C_8 charges up when V_3 is cut off and this determines the amplitude of the saw-tooth waveform produced at the anode of the valve. The negative pulse on the screen of V3 (Figure 32J) is taken to the grid of the cathode ray tube and is used to black out the flyback stroke of the time base.

95. The saw-tooth wave generated by V_3 is only of about 15 volts amplitude, so it is therefore amplified by the paraphase amplifier valves V4 and V_5 in order to provide a large enough deflecting voltage to apply to the Y plates of the cathode ray tube. V_4 amplifies the saw-tooth and feeds it to the X_1 plate. A fraction of its output is tapped off by R_{19} and R_{20} and is fed to the grid of V_5, which feeds the X_2 plate. The variable cathode resistor R_{68} ("Paraphase") of V_5 is adjusted until V_5 is giving an output voltage of equal amplitude (but opposite sign) to that given by V_4. (Figure 32K and L).

96. Negative feedback is provided by R_{17} in V4 and R_{23} in V5 in order to improve the linearity. R_{69} provides an X shift control by controlling the mean D.C. level of the output to the X plates. The production of the bright Strobe markers is described in para. 99 and 100.

97. <u>Strobe Time Base.</u>- The strobe time base is produced when all the switch contacts on the circuit diagram (Figure 31) are in position "S". The action of V_1 and V_6 is unchanged. V_7, V_8 and V_9 are the A, B and C strobe producing valves respectively. The input to V_7 is the same as the input to V_6 (Figure 32N) but the output from this Transitron is taken from the anode. When the positive-going square wave is applied to the grid both the anode and screen will start to take current, but since the screen resistance R_{40} is so high (220K) the screen voltage will fall rapidly thus cutting off the suppressor grid and preventing the anode from drawing current until C_{39} has discharged sufficiently (Figure 32.0). The anode waveform (Figure 32P) is thus a negative "spike" coinciding with the arrival of the positive-going edge of the square wave on the grid, a short wait the length of which depends upon the setting of C_{39}, and then, when the condenser has discharged sufficiently to allow the anode to draw current, a square negative pulse lasting until the locking waveform goes negative again. The position of the front of the negative pulse depends upon the setting of C_{39}. ("A Strobe position").

98. V_8 and V_9 operate similarly to V_7 except that the square locking wave applied to the grid of V_9 is taken from the screen of V_1 instead of from the anode, so that this input is effectively in anti-phase. This confines the C strobe produced by V_9 to the lower trace of the time base. The anode waveforms of V_8 and V_9 are shown in Figure 32R and U. The ~~turning~~ of the negative strobe edge B (V_8) is determined by the switch S_3 ("B strobe position coarse") which connects different capacities into the transitron circuit and by the fine control C_{40}. The C strobe edge is similarly controlled by S_4 (coarse) and C_{46} (fine).

99. The outputs from V_7, V_8 and V_9 are differentiated by the condensers C_{31}, C_{30} and C_{26}, each condenser forming a short time constant with R_{62} and R_{78} ("Strobe T.B. period"). The mixed differentiated outputs are shown in Figure 32V. When these are applied to the suppressor grid of V_{10}, which is another Transitron, square negative pulses are produced at the suppressor and screen and smaller positive pulses at the anode, by the usual Transitron action. A condenser C_{27} is connected between anode and grid of V_{10} so that the anode waveform (Figure 32Y) is fed back to the grid thus cutting the valve on and off more sharply. These pulses can be moved along by the coarse and fine position controls so that the A strobe pulse can be set anywhere on the step, the B pulse anywhere on the B trace and the C pulse similarly anywhere on the C trace.

100. The durations of all the strobe pulses are varied by R_{78} ("Strobe T.B. period") which control the discharge time of the condenser C_{32}. The screen waveform of V_{10} (Figure 32X) is tapped down by R_{61} and R_{60} and applied to the cathode of the cathode ray tube. This provides brightening for the strobe time bases to overcome the faintness due to the high speed of writing, and on the Main time base indicates the positions of the strobes by bright markers which can be made to move along the time base by means of the strobe position controls. When the time base switch S_1 is switched to "Strobe" those portions of the main time base lying inside the strobe markers are expanded.

101. V_3 provides the actual deflecting waveform for the strobe time base. In the "strobe" position its cathode is earthed and the grid is taken to H.T. via the leak R_{90}. The square negative strobe pulses from the screen of V_{10} are fed through C_{37} on to the grid of V_3, thus cutting the valve off. This allows C_7 to charge up through R_{10}. The time constant R_{10} C_7 is 500 µs and the valve is cut off for about 80 µs only, so the rise of voltage across C_7 is nearly linear. When V_3 again draws current, at the end of the negative strobe pulse, C_7 is discharged. The time after which V_3 is cut on again is determined by R_{78} ("Strobe T.B. period") which controls the length of the strobe pulses and hence the duration of the strobe time bases.

102. Figure 32Z shows the waveform at the anode of the time base valve V_3. Note that on strobe time base the anode potential of V_3 is held down and "pushed up" to produce the deflecting waveform, whereas on Main Time Base the anode voltage is "pulled down" and then allowed to rise back to its original level. The paraphase amplifiers V4 and V5 work in the same way in the "Main" position except that V_4 has its bias increased by the introduction of R_{18} and R_{67} into the cathode circuit so that it can deal with the positive-going input and V5 has its bias resistor shorted out so that it can handle the negative going input from V_4. (Figure 32 AA and BB). R_{70} is the X shift control which alters the mean D.C. level of the X plates.

103. High speed strobe time base.- An extra fast Strobe Time Base is available with the switch on the upper position. In this case the 0.001 μF condenser C_7 is replaced by C_{38} which is 0.0003 μF thus giving a more rapid sweep as the voltage on the anode of V_3 rises more quickly because of the shorter time constant C_{38} R_{10}. There is no change in the rest of the circuit.

1.5 Mc/s CALIBRATION UNIT

104. The 1.5 Mc/s Calibration Unit provides a fine calibration scale for use on the High Speed Strobe time base. It can give either 1.5 Mc/s pips or sine waves as required. It is locked from the 150 kc/s source feeding Divider II. The phase of the output from the calibration unit can be shifted by means of Phase Shifter 5 which is mounted under the control desk. The scale of the Phase Shifter knob is divided into 10 divisions (each phase shifter is individually calibrated) so that the phasing of any pulse on the time base can be measured to within about 0.0002 or 0.0003 of a division which is 0.01 to 0.02 of a microsecond approximately, by balancing the trough of the sine wave on the peak of a triangular pulse (See Figure 43J). Alternatively a pip can be balanced on the peak of the pulse.

105. The circuit of the Calibration Unit and P.S.5 is shown in Figure 33 and the layout in Figure 34. 150 Kc/s positive pips from the cathode of V_2 in Divider II are fed on to the grid of V_1 via Pye Plug P.II. This valve is biassed back by the voltage developed across the 220K grid leak R_4, due to grid current, (see S.D.0169, Chap.2) instead of by the normal cathode resistor and only the peaks of the input pulses are passed. These make the tuned primary winding of L_1 "ring" at 1.5 Mc/s. The oscillations induced in L_1 decay fairly rapidly between each 150 Kc/s pip, so they are applied through a short time constant circuit C_7 R_8 to the grid of V_2, which has a coil L_2 in its anode circuit which is also tuned to 1.5 Mc/s by C_{11}. This gives a sinusoidal voltage of nearly constant amplitude on the secondary of L_2, whence it is fed to Phase Shifter 5 through the 4 pin plug mounted on the front panel.

106. The operation of P.S.5. is exactly similar to that of P.S.3 and 4. The output from the rotor of the condenser C_2 is fed into an amplifying valve V_3 via the Pye plugs P_{22} and P_{23}. The anode load of V_3 is the tuned circuit L_3 C_{13} C_{17} C_{16}, and this feeds the sine wave to the grid of V_4 through C_{19}. The cathodes of V_3 and V_4 are taken to earth via a pair of contacts on the "Cal.Pips" Post Office key mounted on the desk. In the "OFF" position of this switch (away from operator) these contacts are opened and V_3 and V_4 are biassed off by R_{18}. In the two "ON" positions (Cal. Pips and Sine Waves) the contacts are short-circuited.

107. V_4 has a two-way changeover relay in its anode and screen circuits. This is shown in the unenergised position in Figure 33, in which condition the unit gives 1.5 Mc/s pips. It will be seen that in this case V_4 works with its anode and screen connected together. The anode load is R_{20} and this together with the small condenser C_{25} differentiates the output, giving sharp negative pips which are applied to the Y2 plate of the cathode ray tube. In the sine wave position (switch towards operator) V_4 works as a pentode, the anode load being the transformer coil L_4.

108. The relay is shown in the diagram in the standard symbolic notation, being shown as a rectangle with its D.C. resistance in ohms (2000) written inside. The reference number $\frac{REL1}{3}$ beside it indicates that it is relay No.1 on this particular unit, and has three pairs of contacts designated REL_1 1, REL_1 2 and REL_1 3.

109. No description of the operational method of using this unit is given as the technique is liable to be constantly modified.

CATHODE RAY TUBE UNIT

110. The C.R.T. consists mainly of the various resistance networks for applying the correct working potentials to the cathode ray tube and the input circuits through which the deflecting and brightening waveforms are applied to the appropriate electrodes. The circuit diagram and chassis layout are shown in Figure 35. The following controls are provided:-

(i) Y shift (R11). This controls the standing potential applied to Y_1 and Y_2 increasing the potential applied to one as the other is decreased.

(ii) Astig (R10).- An input from the stabilised H.T. supply from PP_3 is tapped down by R_{10} and applied to A3 and the graphite shield of the tube. By suitably adjusting the voltage the spot astigmatism can be reduced to a minimum and the overall focus of the tube improved.

(iii) Focus (R12).- The spot is focussed sharply by altering the E.H.T. voltage on A2 until best definition is obtained. The settings of "Focus" and "Astig" are mutually interdependent.

(iv) Brilliance (R9).- Brilliance is controlled by varying the bias voltage between grid and cathode of the tube, thus controlling the density of the electron beam.

111. The controls are all mounted on the C.R.T. controls panel immediately above the C.R.T. panel. A diode valve V_1 is mounted on the unit to provide D.C. restoration, which is necessary to keep the brightness of the tube fairly constant on both Main and Strobe time bases.

OSCILLOGRAPH UNIT

112. A small Oscillograph is provided for general monitoring and in particular for setting up the Dividers. The conventional thyratron circuit is shown in Figure 37, together with the chassis layout. It will be seen that the time base speed is adjusted by the selector switch S_1 and the "Velocity" control R_8. In position 1 of the selector a high speed time base is produced by magnetic deflection. L_1 and L_2 being the deflector coils. In switch positions 2, 3, 4 and 5 the time base sweep is obtained by electrostatic deflection. In this case the positive-going saw-tooth on the anode of V_2 is amplified and inverted by V_3 before being fed to the X2 plate of the cathode ray tube.

113. The time base must be synchronised by feeding a signal onto the grid of the thyratron. A valve V1 is provided to amplify the locking signal and to act as a buffer between the thyratron and the circuit under examination. The cathode bias on V_2 may be varied by means of a variable resistance R_{10}. This determines the potential which must be applied to the grid to make the valve strike and thus provides synchronising control.

114. It is necessary to allow the thyratron about a minute in which to warm up before the H.T. is applied. A diode V_5 in series with a relay coil and a resistor is connected between H.T. + and earth. The relay switches H.T. on to the thyratron. When the unit is first switched on V_5 is cold and passes no current so the relay remains open and no H.T . is applied to V_2, but when the valves have warmed up V5 will pass sufficient sufficient current to close the relay and switch H.T. onto the thyratron.

FUSE AND INDICATOR PANEL

115. The Fuse and Indicator (F and I) Panel carries the mains and H.T. switches and fuses with their indicator lamps and the mains voltmeter. The circuit diagram is shown in Figure 39. It will be seen that the neon lamps are arranged so that if a fuse blows the associated lamp is extinguished.

POWER PACKS

116. There are six power packs on the receiver. PP1, PP2, and PP3 are shown in Figure 38, PP5 and PP6 in Figure 40 and PP7 in Figure 41.

117. PP1 supplies E.H.T. for the two cathode ray tubes and also various L.T. supplies. There are two transformers T_1 and T_2 each having E.H.T. winding and three L.T. windings. The E.H.T . windings give supplies of 1,700 volts and 800 volts which are rectified by the diodes V_1 and V_2 respectively. Each supply is smoothed by a resistance and two condensers.

118. PP2 consists of two similar H.T. power packs A and B, which are fed from one transformer which has also three L.T. windings. Each H.T . supply is smoothed by a double filter circuit consisting of two chokes and three blocks of condensers. The second and third set of condensers of PP2 B are mounted on the chassis of PP3 owing to lack of space on PP2. A 500 ohm resistance is in series with L_2 on PP2 A to limit the output [illegible]

A stabilising valve is mounted on P.P.2, which feeds part of the "A" H.T. supply to the Strobe Gain and A.V.C. units. This stabiliser is similar to that on P.P.3, which is described in the next paragraph. The potentiometer R_3 is adjusted for minimum hum on received signals." **(A.L.1)**

output of the power pack with a resistance R2 in its anode circuit. The valve takes a constant drain from the power pack. Consider what happens if the H.T. voltage tends to rise: the rise will be fed on to the grid of V_2 through C7. This makes the valve take more current and so the voltage drop across R2 increases. Thus by suitably adjusting the potentiometer R1 the voltage dropped across R_2 can be made equal to the rise of H.T. voltage, so that the output voltage which is taken from the anode of V_2 remains constant.

120. Similarly if the power pack voltage falls the valve takes less current so there is less drop across R_2. R_4 applies negative feedback to the valve thus increasing the linearity of its characteristic. R_1 is adjusted by observing the High Speed Strobe time base and turning the potentiometer knob until all the time bases are free from jitter. The choke L_3 and condensers C_8 and C_9 are part of the smoothing circuit of PP2 B, being mounted on PP3 because of lack of space on PP2.

121. PP5 supplies H.T. to the Oscillograph Unit, and PP6 provides energising current for the relays on the Filter Input Unit (F.S) Filter Strobe Unit (F.S.I) and Calibration Unit (Cal.pips). No smoothing is needed. The output voltage is about + 100 volts.

122. PP7 supplies H.T . to the Receiver Unit, together with a negative H.T. supply for the anti-jamming circuits. An L.T. winding is also provided. V_1 is the normal H.T. rectifier. V_2 is connected across one half of the secondary winding of T_1 and is arranged to give a negative output which can be set correctly by means of the potentiometer P_1. This negative voltage should be -230 volts in positions X and Y of the anti-jamming switch, measured with a voltmeter consuming not more than 1 mA.

123. **Distribution of Power Supplies.**- The power supplies are distributed as follows:-

PP1	EHT.	2000V 1000V	Main C.R.T. 0 Unit C.R.T.
	L.T.	4V 1A 4V 1A 6.3V 0.25A 6.3V 2.6A	Main C.R.T. 0 Unit C.R.T. V_1 on C.R.T. Unit Valves in 0 Unit
PP2	**H.T.(A)**	**350V**	**Divider D.II** **Filter Input Unit** **Calibration Unit**
		300V (Stabilised)	**Strobe Gain Unit** **A.V.C. Unit**
	H.T.(B)	**350V**	**Diode receiver** **Filter Strobe Unit** **Divider D.III** **Phase shifter 3** **Phase shifter 4** **(A.L.1)**
	L.T.(1) (unearthed)	6.3V 10A	Diode Receiver Strobe Gain Control Unit A.V.C. Unit Filter Strobe Unit
	(2)	6.3V 10A	Filter Input Unit Divider D.II Calibration Unit
	(3)	6.3V 10A	Divider D.III Phase Shifter 3 Phase Shifter 4
PP3	H.T.	300V (Stabilised)	Time Base Unit Astig. Control on C.R.T. Unit
	L.T.	6.3V 3.7A	Time Base Unit
PP5	H.T.	300V.	0 Unit valves
PP6	100V D.C.		Relays on Filter Input Unit (F.S) Filter Strobe Unit (F.S.I) Calibration Unit (Cal.Pips)
PP7	H.T.	350V	I.F. amplifier and R.F. Unit
	Negative Rail	-230V	I.F. amplifier
	L.T	6.3V 6.5A	I.F. amplifier and R.F.Unit

ADJUSTMENT OF DIVIDERS II AND III

124. Connect the terminals "Y1" and "Sync." on the O Unit and also connect the long wander lead to "Y1". "Y2" should be earthed. The waveforms at the various inspection points of D.II, shown in Figure 24 N to Q, are then observed by plugging the wander lead from "Y1" into the inspection point sockets. At I.P.1 on D.II we have the 150 kc/s sine wave from the crystal oscillator on the F.C.O. (Figure 24 N) which may be observed with the condenser switch on the O unit in position 2.

125. Inspection point 2 is used to set up the first divider stage, which divides by 10. The O unit "Velocity" and "Sync" controls are adjusted until a steady picture is obtained and the potentiometer P_1 ("Stage 1 divide by 10") is adjusted until the waveform is as shown in Figure 24.O, that is until there are 10 positive pips between each pair of negative pips. It will be seen that stable operation is obtained over a range of adjustment of the control. The best position is in the middle of this range.

126. This setting should be checked with the Time Base switch in both "main" and "Strobe" positions, as there may be a small difference between the two readings because the calibration valve V_{14} may affect the operation of the first divider stage. All the other stages may be set up in either position of the Time Base switch.

127. Stage 2 divides by 5 and is adjusted by inspecting the waveform at I.P.3. with the O unit switch in position 3. The waveform should be as seen in Figure 24 P. The control for this stage is marked "Stage 2 divide by 5", and should be set to the centre of the range of correct division.

128. Stage 3 is set up by inspecting the waveform at I.P.4 with the 0 unit switch in position 4. The waveform is as shown in Figure 24Q. P4, marked "Stage 3 divide by 6" is set to the centre of the range over which division by 6 is obtained.

129. After adjustment of the division stages the operation of the coarse phase shifter should be checked. Suppose the receiver has been tuned in and that pulses are visible on the time base. Turning the coarse phase shift control to the right, thus switching on V_{11}, should cause the pulses to move in steps of $6^2/3$ microseconds towards the left of the time base. This is because every time V_{11} squeggs, the output of the divider is delayed by $6^2/_3$ microseconds and so the start of the time base, which is locked from D.II, is delayed by the same amount. The speed of travel of the pulses across the time base should increase as the coarse shift control is turned further clockwise, as this increases the frequency of operation of the phase shifter.

130. It may occasionally be necessary to adjust C_{24} so as to ensure correct operation of the coarse phase shifter, which should work at both extremes of the setting of P_1. With the divider controls properly adjusted set P_1 so that the first stage is on the verge of dividing by 11 and check that the coarse phase shifter works satisfactorily. Now turn P_1 until the first stage is about to divide by 9 and again operate the coarse phase shift control. It may be necessary to increase the capacity of C_{24} slightly, to obtain phase shift. This can be done with a small screwdriver. Reliable phase shifting will then be obtained at all settings of P_1.

131. The adjustment of D.III is carried out similarly to the method given in para.124 to 129. The second stage, however, is set to divide by 10 so that the output pulse occurs at 250 c/s instead of 500 c/s. A fine control P_3 as well as the coarse control P_2 is provided for the second stage. The waveform at inspection points 2 to 6 are shown in Figure 24 DD to HH. An inspection point for the 150 kc/s input is mounted inside the removeable front cover, at the top left hand corner.

132. Coarse shift operation should be checked on D.III and this is most conveniently done with the "Tx.Mod." switch on D.III in the "Inspect" position so that a marker pulse from the output valve is fed on to the Y_1 plate of the tube. In this case, the output of the divider is delayed by $6^2/3$ microseconds every time the coarse phase shifter squeggs, so the marker pulse on the tube moves to the right. Adjustment of the coarse phase shifter is the same as for D.II.

ADJUSTMENT OF TIME BASE

133. The appearance of the Main, Strobe and High Speed time bases when correctly adjusted is shown in Figure 43 A, D and E. There are in all seventeen controls and a Post Office key switch on the Time Base Unit of which eleven are preset being mounted behind the removable cover. Immediately under the time base panel is a 1¾ inch panel on which are mounted the Focus, Brilliance, Astigmation and Y shift controls for the cathode ray tube. These should be adjusted before setting up the time base. Figure 43A shows the appearance of the Main Time Base. This consists of two traces, the upper one having a "step" at the beginning. Each trace is calibrated by bright 15 kc/s pips obtained from the first divider stage via V_{14} in D.II. The time interval between these pips is $66^2/3$ microseconds and they should appear about 3/16 inch apart on the tube.

134. It is first necessary to set up the "square wave" control R4. This is mounted on the sub-panel inside the time base unit. By plugging the O Unit inspection lead into inspection point P_2 the square wave at the anode of V_1 can be seen (Fig.32D). If R4 is incorrectly set the two halves of the square wave will not be of equal length and the time base will appear as in Figure 43 B or C. When R4 is correctly set, which should occur over at least 90° rotation, the time base will be as shown in Figure 43A.

135. After setting up the "square wave" stage, the 15 kc/s coarse calibration pips can be checked. These should be about twenty-seven on each trace, the other three being lost in the "black out". After this the "A step" control R_{71} is set up. This varies the length of the step at the beginning of the upper trace and should be set so that there are three coarse calibration pips upon it. The step waveform may be observed at P_6 (Figure 32 F).

136. The spacing between the time base traces (and hence the spacing between the strobe time bases) may be adjusted to a convenient size by varying the amplitude of this step waveform by means of the "Strobe Space" control R_{72}. The amplitude of the main time base can be altered by means of R_{66} ("Main T.B. amp."). This should be set so that the trace just fills the screen of the tube. The deflecting waveform at the anode of V_3 can be seen at P_3 and is shown in Figure 32 I. R_{66} adjusts the amplitude of this saw-tooth.

137. The output from the first paraphase amplifier V_4 may be observed at P_4; the correct waveform is shown in Figure 32K. If the amplifier is overloaded the output will be distorted which will cause the time base to be non-linear. Should this occur the "Main T.B. Amp." control should be used to reduce the input to V_4 until a good saw-tooth is obtained at P_4.

138. At P_5 we have the output from the second paraphase amplifier V_5, as shown in Figure 32 L. The "Paraphase" control R_{68} should be adjusted so as to make the output from V_5 of equal amplitude to the output from V_4. This is best done by removing V_5 and noting the time base amplitude. Then replace the valve and adjust the "paraphase" control until the amplitude of the time base is double its previous value. Also check the operation of R_{69} "Main (X) Shift".

139. Three "Strobe Markers" should be seen on the main time base. These are bright patches which cover about 80 μs (slightly more than the distance between two 15 c/s calibration pips) and their positions are controlled by means of the three slow-motion dials giving fine control of the A, B and C strobes and the switches "B strobe position" and "C strobe position" which give coarse control of the B and C strobes. The A strobe marker can be moved over the A trace, that is the region to the left of the step on the upper trace. The B strobe marker covers the region to the right-hand side of the step and the C strobe marker covers the lower trace. R_{78} "Strobe Period", varies the length of the strobe time bases by controlling the time duration of each strobe. R_{67} ("Strobe amp") varies the length of the strobe time bases by expanding or compressing them without altering the time duration of each.

140. The switch "Strobe Gain Select" (S_2 on the circuit diagram) determines whether strobe gain control is applied to the B or C strobe. The potentiometer R_{94} or R_{53} ("B syn. or C syn.") should be adjusted with receiver gain high enough to see the "noise" and the strobe gain control at minimum, until the strobe gain control unit is synchronised correctly. This control also permits a small variation in the length of the strobe gain control pulse to be obtained.

METER READINGS

141. An 0- 250 microamp meter is mounted on the panel of Phase Shifter 4. It is equipped with a flexible lead and jack plug which can be plugged in to any of the sockets on the units. Each socket is shunted by an accurate wire-wound resistor which is one of three standard values, 15.4, 6.07 or 3.02 ohms. The resistance of the meter is 600 ohms so that a simple calculation shows that the multiplying factors are as follows:-

Shunt	X Factor	Full scale Deflection
15.4	40	10mA
6.07	100	25mA
3.02	200	50 mA

142. A list of nominal current readings for each jack is given in Table 4. The readings may differ slightly in individual receivers. The values given are actual indications on the meter in microamps - to obtain the current reading in milliamps multiply by the multiplication factor and divide by 1000: e.g. a current of 50 microamps through a 15.4 ohm shunt (multiplying factor 40) indicates an actual current of $\frac{50 \times 40}{1000} = 2mA.$

TABLE 4

TYPICAL METER READINGS

Jack No.	Nominal reading				X Factor	Remarks
RECEIVER UNIT	N	X	Y	Z		
H.F.	120	120	120	120	200	
V1 V2	30	100	100	100	100	(Max. gain)
V3 V4 V5	110	40	40	80	100	
V7	180	180	180	180	100	
V8	50	50	50	50	100	(Min. Gain)
V9	40	40	40	40	100	(Min. Gain)
DIODE RECEIVER						
V2 V3	70				200	
V4 V5	100				200	
FILTER INPUT UNIT						
V1	60				40	
V2	110				100	
V3	20				40	(F.S. off)
V4.	200				100	

TABLE 4 (CONTD.)

Jack No.	Nominal reading		X Factor	Remarks
FILTER STROBE UNIT				
V_1	15 to 30		40	(Depending on setting of "F.S. Position")
V_2	75		100	
V_3	170		100	
STROBE GAIN CONTROL UNIT				
V_1	5		40	
V_2	60		100	
V_3	35		200	
P.S.3 and 4				
V_1	120		100	
TIME BASE UNIT				
	Main	Strobe		
V_1	95	95	100	
V_3	60	115	100	
V_4	50	23	40	
V_5	60	100	40	
V_6	180	180	40	
V_7	60	60	40	
V_8	180	180	40	
V_9	180	180	40	
V_{10}	195	205	40	
A.V.C. UNIT				
V_1	30		100	
V_3	100		100	
V_4	45		100	
V_5	40		100	
V_6	5		100	(With A.V.C. operating)
CALIBRATION UNIT				
V_1	20		40	
V_2	60		40	
V_3	60		40	
V_4	150/120		40	(Cal. Pips/Sine wave)
DIVIDER D.II				
V_1	95		100	
V_2	140		40	
V_3	130		40	
V_4	140		40	

TABLE 4 (CONTD.)

Jack No.	Nominal reading		X Factor	Remarks
DIVIDER D.II (CONTD.)				
	Main	Strobe		
V_5	105		100	
V_6	120		40	
V_8	105		100	
V_9	185		40	
V_{10} V_{11}	150		40	
V_{14}	70/120		40	(Main/Strobe T.D.)
DIVIDER D.III				
V_1	85		100	
V_2	95		100	
V_3	130		40	
V_4	130		40	
V_5	95		100	
V_6	140		40	
V_8	95		100	
V_9	200		40	
V_{10}	200		40	
V_{11}	10		40 (Max Coarse Phase Shift)	
V_{14}	155		100	
V_{15}	100		40	

TABLE 1

INTER-UNIT WIRING CHART

NO. ON BLOCK	SLEEVE COLOUR	TO	NO. ON BLOCK	SLEEVE COLOUR
1	Orange		169	Yellow
2	Red		170	Green
3	White		80	Orange
3	White		184	Red
4	Yellow		82	White
5	Green		166	Orange
6	Blue		167	Red
7	Black		168	White
9	Red		23	Red
9	Red		136	Red
13	Blue		19	Blue
13	Blue		140	Blue
14	Black		18	Black
14	Black		141	Black
23	Red		64	Red
25	Orange		58	White
26	Red		57	Red
28	Yellow		115	White
29	Green		40	Blue
30	Blue		136	Red
31	Black		56	Orange
32	White		97	Black
33	Red		192	Black
34	Orange		191	Blue
35	Orange		52	Yellow
36	Red		51	Green
38	Yellow		147	Red
39	Green		97	Black
41	Black		54	Red
42	Black		55	Orange
44	Green		19	Blue
43	Blue		18	Black
45	Yellow		207	Black
46	White		208	Blue
47	Red		152	Black
47	Red		69	Black
48	Orange		68	Blue
48	Orange		153	Blue
49	Black		77	White
49	Black		172	Black
50	Blue		79	Orange
50	Blue		171	Blue
51	Green		39	Black
52	Yellow		88	Blue
53	White		80	Orange
57	Red		178	Red
58	White		179	Orange
59	Yellow		159	Orange
60	Green		160	Red
61	Blue			Mains
62	Black			Mains
70	Orange		230	Green
EARTH PILLAR	WHITE		83	Orange

NO. ON BLOCK	SLEEVE COLOUR	TO	NO. ON BLOCK	SLEEVE COLOUR
EARTH PILLAR	White		186	Orange
74	Green		87	Green
80	Orange		83	Orange
84	Red		144	Green
86	Yellow		120	Green
97	Black		184	Red
98	Blue		183	Orange
99	Green		185	White
104	Black		156	White
106	Green		165	Black
107	Yellow		164	Blue
108	White		161	White
109	Red		162	Yellow
110	Orange		163	Green
115	White		187	Red
118	Black		207	Black
119	Blue		208	Blue
123	Red		210	Yellow
124	Orange		229	Blue
142	Black		207	Black
143	Blue		208	Blue
145	Yellow		232	White
146	White		156	White
147	Red		~~187~~ 234	~~Red~~ Orange
148	Orange		231	Yellow
156	White		169	Yellow
234 ~~187~~	~~Red~~ Orange		210	Yellow
152	Black		214	Black
153	Blue		215	Blue
177	White		56	Orange
189	Yellow		213	Orange
193	Orange		209	Green
219	Red		~~20~~ 37	~~Blue~~ White
219	Red		157	Red

NO. ON BLOCK	SLEEVE COLOUR	TO	PIN NO.	JONES SOCKET NO.
173	Black		1	J2
174	Blue		2	J2
220	Orange		3	J2
53	White		4	J2
217	Yellow		5	J2
176	Yellow		6	J2
175	Green		7	J2
215	Blue		7 & 8	J3
64	Red		9 & 10	J3
214	Black		11 & 12	J3

TABLE 2

INTER UNIT CABLING

NO. ON BLOCK	COLOUR SMALL SLEEVE	COLOUR LARGE SLEEVE	TO	NO. ON BLOCK	COLOUR SMALL SLEEVE	COLOUR LARGE SLEEVE
203	Yellow	White		76	Black	Pink
202	White			72	White	
205	Blue	White		195	White	Blue
202	White			193	Orange	
211	White	White		197	Green	Blue
207	Black			196	Yellow	
212	Red	White		190	Green	Blue
207	Black			186	Orange	
218	White	Blue & White		199	Black	Blue
Earth Screen ~~216~~	~~Green~~			198	Blue	
117	Orange	Orange		190	Green	Blue
EARTH PILLAR	Black			186	Orange	
105	Blue	Orange		188	White	Blue
104	Black			186	Orange	
155	Yellow	Red & Green		203	Yellow	White
156	White			202	White	
22	White	Green		67	Green	Red
20	Green			66	Yellow	
12	Green	Green & Orange		200	Orange	White
11	Yellow			202	White	
114	Yellow	Orange		194	Red	Blue
EARTH PILLAR	Black			193	Orange	
111	Black	Orange		73	Yellow	Pink
EARTH PILLAR	Black			72	White	
75	Blue	Pink		122	White	Brown
EARTH PILLAR	White			118	Black	
75	Blue	Red		158	Orange	Red & Green
72	White			156	White	
65	White			194	Red	
66	Yellow			193	Orange	

NO. ON BLOCK	COLOUR SMALL SLEEVE	COLOUR LARGE SLEEVE	TO	TAPE COLOUR	PYE PLUG NO.
17	Orange	Green		Orange & White	P.19
15	White				
139	Green	Green & Orange		Blue & Red	P.18
138	Yellow				
139	Green	Green & Yellow		Red	P.21
138	Yellow				
206	Black	White		Orange & Blue	P.11
204	Green				
216	Green	Blue & White		Green & Red	P.9
~~214~~ Earth	~~Black~~ Screw				
125	Orange	Brown		Orange & Green	P.10
127	White				
125	Orange	Brown		Blue & Yellow	P.4
127	White				
71	Red	Red		Yellow & Red	P.3
72	White				
114	Yellow	Orange		White & Red	P.12
EARTH PILLAR	Black				

TABLE 2 (CONTD.)

INTER UNIT CABLING

PYE PLUG NO	TAPE COLOUR	TO	TAPE COLOUR	PYE PLUG NO.
P.15	Orange		Orange	P.7
P.16	Black		Black	P.8
P.1	Blue		Blue	P.20
P.14	Green		Green	P.5
P.5	Green		Green	P.6
P.14	Green		Orange	P.15
P.22	Yellow		Yellow	P.23

NO. ON BLOCK	SLEEVE COLOUR	TO	NO. ON PHONE JACK
246	Green		1
245	Yellow		2
243	Red		3
244	White		4
248	Black		4A

TABLE 3

P.O. KEY CONNECTIONS

KEY NO. 198 (REMOTE/LOCAL/AUTO)				
NO. ON BLOCK	COLOUR	TO	LEAF NO. ON KEY	COLOUR OF LEAD
235	Orange		1	White
236	Red		2	Black
237	White		3	Red & Black
238	Yellow		5	Orange & Blue
239	Green		32	Slate
240	Blue		31	Green
241	Black		30	Orange & Red
221	Black		29	Blue & Red
222	Blue		28	Brown & Red
223	Green		27	Blue & White
224	Yellow		25	Red & White
225	White		24	Brown
226	Red		22	Red & Green
227	Orange		21	Red

KEY NO. 216 (LOCAL MANUAL CONTROL KEY)		
LEAF ON KEY NO. 198 (R.L.A)	TO	LEAF ON KEY NO. 216 (L.M.)
29		1
32		6
5		2 & 5

KEY NO.287 (CALIBRATION PIPS)			
NO. ON BLOCK	SLEEVE COLOUR	TO	LEAF ON KEY NO.287 (CAL.PIPS)
228	Black		3, 8, 12 & 17
231	Yellow		9 & 18
232	White		2 & 11

KEY NO.68(A) (FILTER STROBE)			
NO. ON BLOCK	SLEEVE COLOUR	TO	LEAF ON KEY NO. 68(A) (F.S.)
228	Black		2 & 5
229	Blue		3 & 6

KEY NO.68 (B) (FILTER STROBE INSPECTION)			
NO. ON BLOCK	SLEEVE COLOUR	TO	LEAF ON KEY NO. 68(B) (F.S.I)
228	Black		2 & 5
230	Green		3 & 6

APPENDIX I

The Transitron

The 'Transitron' is a single valve circuit depending for its operation on the suppressor grid characteristics of a pentode. Its chief use is to generate a square wave from a synchronising pulse and in this respect the Transitron resembles the better known multivibrator.

Fig.1a shows the effect of variations of suppressor grid potential upon the anode and screen current of a pentode valve, the control grid being supposed to be connected to cathode, and the anode and screen voltages kept fixed. A fall in suppressor grid potential decreases the anode current and increases the screen current, the total valve current remaining approximately constant since this is determined by the control and screen grid potentials.

Suppose that the anode and screen are loaded by means of resistance R_1 and R_2. Fig.1b illustrates typical potential levels to which the electrodes will adjust themselves when the suppressor is at cathode potential, and fig.1c the corresponding levels when the suppressor is below the anode current cut-off point. In fig.1b most of the valve current is passing to the anode so that there is a large drop of potential across the anode load; the screen current is small. In fig.1c the anode current is cut off by means of the suppressor grid so that the anode is at H.T . potential and the whole valve current flows to the screen. The screen potential thus adjusts itself to a very low value and the valve takes only a few milliamps of current, the behaviour of the first three electrodes being similar to that of a triode. During operation the transitron alternates between conditions (b) and (c).

Consider now the circuit of fig.1d and suppose a small negative synchronising pip fed through C_2 to the suppressor grid of the valve. Before the arrival of the pip the valve was in condition (b) with the suppressor at cathode potential, but the synchronising input takes it below cathode level and causes a decrease of anode current and an increase of screen current. The screen potential therefore falls and drives the suppressor grid further negative since they are coupled by means of C_1. This causes a further increase of screen current and a cumulative action is set up which rapidly brings the valve into condition (c) with the anode current cut off and the screen at a low level. The suppressor grid is driven negative to earth by an amount equal to the fall in screen voltage. See fig.1e.

The screen current now discharges C_1 through R_3 and the potential on the suppressor grid rises towards earth. The discharge continues until the suppressor grid potential has risen sufficiently to allow the anode to take current; the screen current then falls allowing the screen potential to rise and carry the suppressor further towards cathode potential. This causes a further reduction in screen current and the action is cumulative. Most of the valve current now flows to the anode and so the anode and screen return to the levels shown in fig.1b. The suppressor grid is driven above earth potential by the sudden rise in screen voltage and the charge on C_1 then leaks away until the grid is again at earth level. The discharge of the condenser is partially effected by the flow of suppressor current. When the suppressor grid has returned to cathode level the cycle is complete and is repeated on the arrival of the next synchronising pip. Negative synchronising pulses arriving before the positive suppressor potential has been removed have no effect.

It will be seen that the anode waveform is a positive square wave and the screen a negative square wave. The width is determined by the discharge of C_1 through R_2 and R_3 and may be varied by adjustment of the suppressor grid leak R_3.

In the circuit of fig.1f the width of the square wave output is varied by adjusting the potential at the end of the grid leak R_3. The more positive this potential, the faster is the initial rate of discharge of C_1 so that the width is reduced by increasing the potential at the end of the leak. See fig.1g.

The transitron action fails if the anode load is so large as to bring the anode potential over the knee of the characteristics, for under these conditions the change in anode voltage affects the anode current and offsets the effect of the variation of suppressor potentials.

The stability of the Transitron may be improved by connecting a diode between suppressor grid and earth. With this arrangement it is also possible to synchronise the valve by means of positive pips as in fig.1j. For suppose the pentode removed, then the positive pip causes the diode to conduct and the condenser C_2 becomes negatively charged by the diode current. At the end of the positive pip the anode of the diode will be negative to earth since C_2 has now charged up. Thus the positive synchronising signal produces a waveform as shown in fig.1k at the anode of the diode. The negative part of this waveform serves to synchronise the transitron. The transitron cycle thus starts from the back edge of the positive synchronising pulse and the relation of the waveforms to the locking signal is shown in fig.1 l.

APPENDIX II

The Blocking Oscillator

Consider the circuit of fig.2a. It will be seen that the anode and grid of valve V_1 are tightly coupled together by means of an iron-cored transformer, the polarity of which is arranged to give positive feedback to the valve.

Suppose the valve cut off by the negative charge on the grid condenser C. The charge leaks away through R and the grid drifts slowly towards cathode potential until eventually the valve starts to conduct. Anode current then flows through the primary of the transformer and the anode potential falls rapidly, an E.M.F. is also induced in the secondary and this carries the grid further positive. A cumulative action is set up which drives the grid well above cathode potential and the anode voltage falls to a low value. The effect of the inductance of the transformer windings is to make the growth of anode current slower than the fall of anode potential; the waveforms are shown in fig.2b. When the grid is positive to cathode, a large grid current flows and negative charge accumulates on the condenser C so that the potential at A falls.

After a time the anode current reaches its maximum value and stops increasing. But the E.M.F. induced in the secondary of the transformer is proportional to the rate of change of anode current so that the positive drive in the grid is reduced and the grid potential falls. This reduces the anode current and the anode potential rises rapidly; at the same time the grid is driven further negative. The valve is thus suddenly cut off so that the anode current falls almost instantaneously to zero and the resulting induced E.M.F. in the primary of the transformer carries the anode far above H.T . potential. At the same time the grid potential is carried below that of A. As the energy stored in the magnetic field of the transformer is dissipated the anode returns to H.T. potential and the grid to the potential at A.

The valve being cut off, the condenser is left with the negative charge accumulated during the conduction period and this leaks away through the resistance R. The discharge of the condenser is exponential and the waveforms at A is shown in fig.2c. The grid waveform is shown in fig.2d and it is seen that during most of the rest period, the grid is at the same potential as Point A. After a time determined by the time constant CR of the grid circuit and also by the extent to which A is initially driven negative, the grid approaches cathode potential and the valve again takes current. The cycle is then repeated.

In the circuit of fig. 2a the grid leak is taken to cathode so that the condenser discharges exponentially towards cathode potential. The valve does not start to draw current until the discharge is almost complete and the rate of rise of potential on the grid is then very slow. The recurrence frequency of the oscillator is therefore unstable. In fig.1e the grid leak is taken to a positive potential V and the potential at A rises exponentially towards this level. The grid reaches cathode potential when the process is only about one-third completed so that the rate of rise of potential at A is still rapid and the stability of the recurrence frequency is improved.

The rate of discharge of C is always proportional to the potential difference between its plates. If the potential V on the grid leak is increased, the discharge is speeded up so the recurrence frequency is increased. Thus a convenient frequency control is obtained by taking the grid leak to the slider of a potentiometer as in fig.2e.

The discharge time of C varies if the potential to which A is driven negative when V_1 conducts changes, is an important source of instability because variations in valve characteristics will affect the amount of grid current collected by the condenser and therefore the initial negative voltage at R. Variations of stray capacity on the grid of the valve, for example, offset the pulse width and so the amount of charge accumulated on the condenser. In order to stabilize the discharge period it is necessary to provide a means of of regulating the potential through which C must discharge and to make it independent of the characteristics of V_1.

If the cathode of V_1 is biassed above earth level as in fig.2g, then a diode V_2 connected across the condenser as shown ensures that the rise of potential at A always starts from earth level. For although during the conduction period of V_1 the heavy grid current may carry A below earth, the diode V_2 returns A to earth as soon as the pulse has finished.

It is now necessary to stabilise the potential E at the cathode of V_1. In the circuit of fig.2g, unless the current through the bleeder R_3, R_2 is large compared with the valve current, the bias E on the cathode will vary if the valve current varies. For example, suppose that V_1 conducts for 3 microseconds in a period of 100 microseconds and that it takes 100 mA when it conducts. Then the mean current is 3 mA. Variations in pulse width or in the peak current will affect this mean current and cause a corresponding charge in E. If the permissible variation of E is 1 volt and the possible variation of valve current is 1 mA., then R_2 must not exceed 1000 ohms. In order to bias the cathode to 60 volts above earth it would therefore be necessary to pass 60 mA. of current through this resistance and such large bleeder currents cannot be provided by a normal H.T. supply. A 'cathode follower' or 'regulating valve' V_3 is therefore introduced as in fig.2h and serves to stabilise the bias on V_2. Since the ouput impedance of the cathode follower is only about 200 ohms, a variation of 1 mA. in the current taken by V_1 will cause only about 0.2 volt change in bias.

In the circuit of fig.2h the recurrence frequency is practically independent of valve characteristics. For the potential E on the cathode of V_1 is determined by the voltage on the grid of V_3, that is by the potentiometer R_4 , R_5. The time required for C to charge up to this voltage is determined by C, the grid leak R_1 and the voltage V determined by P_1 and R_6. These components alone determine the recurrence frequency and can be made of high quality materials. Wire wound resistor and silvered mica condensers are suitable.

APPENDIX III

Delay Network

A delay network may be regarded as an artificial length of transmission line. An electromagnetic wave is propagated down a transmission line with a definite velocity V, almost exactly equal to the velocity of light. Suppose that at time t = o, a positive voltage is suddenly applied to the end of an infinite line as in fig.3a. This rise of voltage travels down the line and reaches a point at distance x from the end at time t = x/V. If the line is of infinite length the process will continue indefinitely.

If at any point P along the infinite line a measurement was made of the instantaneous current and voltage as in fig. 3b, it would be possible to calculate the ratio $E/I = Z$. This ratio represents the effective impedance of the piece of line to the right of P. Suppose now that the line was cut at P and the left-hand portion terminated by an impedance equal to Z. Then the current and voltage at P would be related in just the same way as if the transmission line continued past P and so the waveforms to the left of P are unaffected. Z is called the characteristic impedance of the transmission line, and a piece of line terminated by an impedance Z behaves as though it was of infinite length. Z is purely resistive.

The behaviour of a transmission line is due to the fact that the wires possess distributed inductance and capacity. If L is the inductance per unit length and C the capacity per unit length the impedance is given by $Z = \sqrt{L/C}$ which has the dimensions of a pure resistance.

An artificial line may be produced as in fig.3c by means of lumped inductances and capacities. If we consider first an infinite chain then the behaviour is similar to that of an infinite line, that is, it transmits applied waveforms with a definite velocity. The velocity must now be expressed in 'elements per second' instead of 'meters per second' in accordance with the fact that one element represents a short piece of line. The impedance R is still given by $R = \sqrt{L/C}$ obtained by substituting 'inductance per element' and 'capacity per element' for inductance per unit length and 'capacity per unit length' in the previous formula.

Suppose that it is required to delay a pulse. The pulse may be fed in to one end of a delay network which is terminated at the other end by its characteristic impedance. The waveform travels through the elements and after a definite time arrives at the other end where its energy is completely absorbed by the terminating impedance which simulates a continuation of the network. A delayed but undistorted pulse is therefore produced at this point. The delay, of course depends on the number of elements in the network and on the delay produced by each element.

Consider a typical section element. The succeeding elements may be replaced by the characteristic impedance R of the network as in fig.3f. It is clear that this element will attenuate high frequency components of the applied waveform because C prevents a small impedance at these frequencies. The impedance of L and C becomes equal at a frequency given by $2\pi f_0 = 1/\sqrt{LC}$ and at higher frequencies the impedance of C is small compared with that of L, so that the element attenuates the applied waveform. The periodic time t_0 corresponding to a frequency f_0 is $t_0 = 1/f_0 = 2\pi\sqrt{LC}$ and this is the time required for the current through L to appreciably affect the charge on C. Thus if the waveform applied to the network rises instantaneously as in fig.3g, the output waveform will require about t_0 seconds in which to rise because this is the time required to change the charge on the condenser in the network. The values of inductance and capacity in a delay network must be chosen so as to permit the required rate of rise of the outcoming pulse.

The delay of the element may also be estimated. The back E.M.F. induced in the inductance opposes any sudden rate of change of current and therefore any sudden change of voltage across R. The time required for a major change in the current through L as a result of a change in the voltage applied at A is L/R seconds. Thus if the potential at A rises suddenly we expect a delay of about L/R seconds before the rise of potential at C is complete. It can be shown that the element produces a delay of exactly L/R seconds.

Collecting the previous results:-

Network impedance	$R = \sqrt{L/C}$
Delay per element	$= L/R$ secs $= \sqrt{LC}$ secs
Time of rise of output pulse	$\sim 2\pi\sqrt{LC} = t_0$ secs.

A delay network consists of an aggregate of elements such as those of fig.3f. In practice these are more conveniently wound as in fig.3j, the two end inductances being L/2.

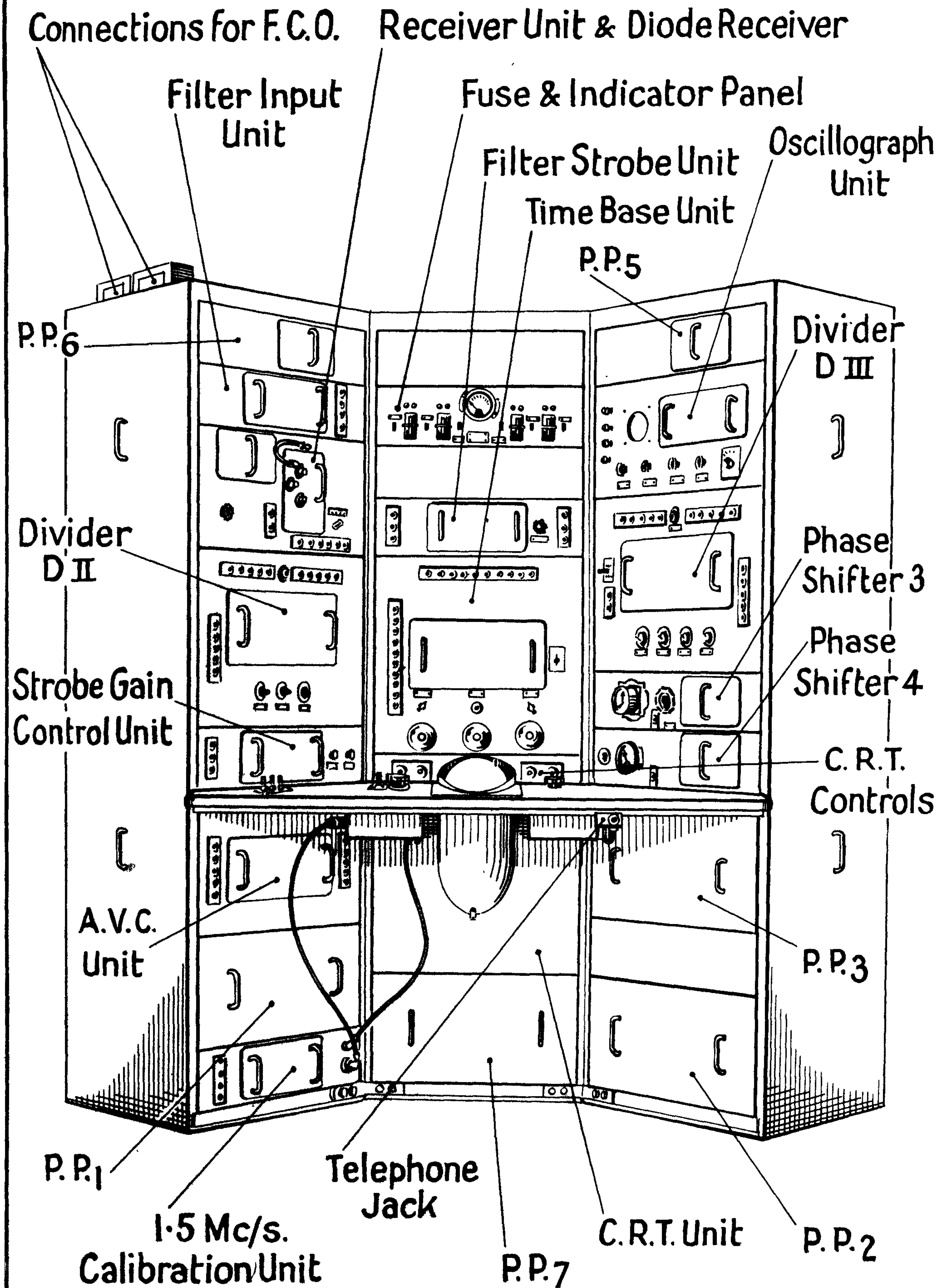
Reflections

Suppose that a delay network is short circuited at one end B as in fig.3 l, and that the potential at the other end A is suddenly raised to V volts above earth. The rise of potential is propagated along the network in the usual way and if there are n elements reaches B after nT seconds, T being the delay produced by each element. Since the network is short circuited at B no potential difference can exist at this point. When the positive going wavefront reaches B it is immediately reflected and inverted and the reflected wavefront starts to travel along the network towards A. The reflected wave is negative going and of the same amplitude as the incident; the two waveforms therefore cancel out at B as is required. The negative going waveform leaves B at time nT and arrives at A after a further nT seconds, just 2nT seconds after the rise of potential at B. The waveform at A is thus a positive square wave of V volts amplitude and 2 nT seconds duration. The potential at B is always zero and at intermediate points the applied and reflected waveforms combine to produce a positive square wave of width less than 2nT seconds. It has been assumed that the returning wavefront suffers no further reflections at A; this is the case if the network is terminated at A by its characteristic impedance.

The reflection of a waveform by a short circuited network or piece of transmission line is similar to the reflection of a ray of light at the surface of a mirror. If P (fig.3m) is a source of light in front of a mirror then a ray such as PR is reflected at R and continues along RS. The ray PN which meets the mirror at right-angles is reflected back along NP. All the reflected rays appear to diverge from a point Q behind the mirror, P and Q are at equal distances from the reflector and Q is called the image of P. Thus an observer in front of the mirror sees what appears to be a second source of light at Q, the light reflected from the mirror seeming to be radiated from the imaginary source.

The method of images may also be used to determine the behaviour of a short circuited line. Imagine the line continued past B to C and that the sections AB and BC both contain the same number of elements. If at the instant t = o the potential at A is suddenly raised to V volts above earth and that at C lowered to V volts below earth, then a positive going wavefront will travel from A towards C and a negative going wavefront from C towards A. These two waveforms both arrive at B at the same instant nT seconds after the start of the wave motion and cancel out. At points in AB the negative going wavefront propagated from C behaves in just the same way as that reflected from B in the circuit of fig.3 1 so that the waveforms at points in AB are just the same as in the previous case of a short circuited network.

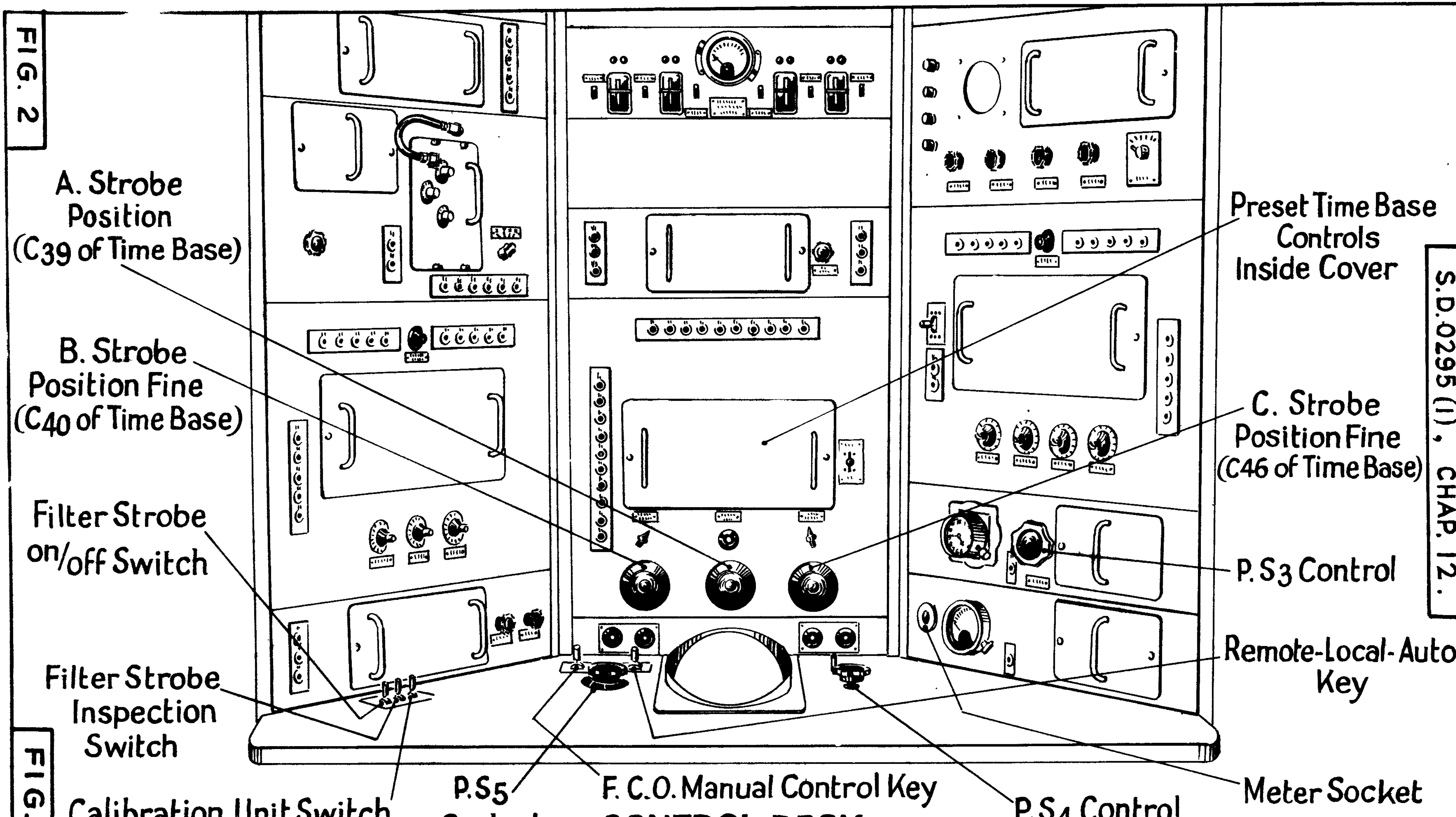
It is seen that a short circuited delay network can be used to produce a pulse of width determined by the constants of the network. A practical circuit is shown in fig.3 o. The network is placed in the anode of a valve and a wide negative square wave is applied to the grid. The front edge PQ of the grid waveform causes a rise AB of anode potential; this is propagated down the network and the reflected wavefront brings the anode potential down along CD. The width of the pulse ABCD is 2nT, the time taken for a wavefront to cross the network twice. The back edge RS of the grid waveform causes a fall EF in anode potential and 2nT seconds later the reflected wavefront returns the anode to its normal level at H. It is seen that the front edge of the positive pulse ABCD coincides with the front edge of the grid waveform but that the width of the pulse depends solely on the constants of the network.



GENERAL VIEW

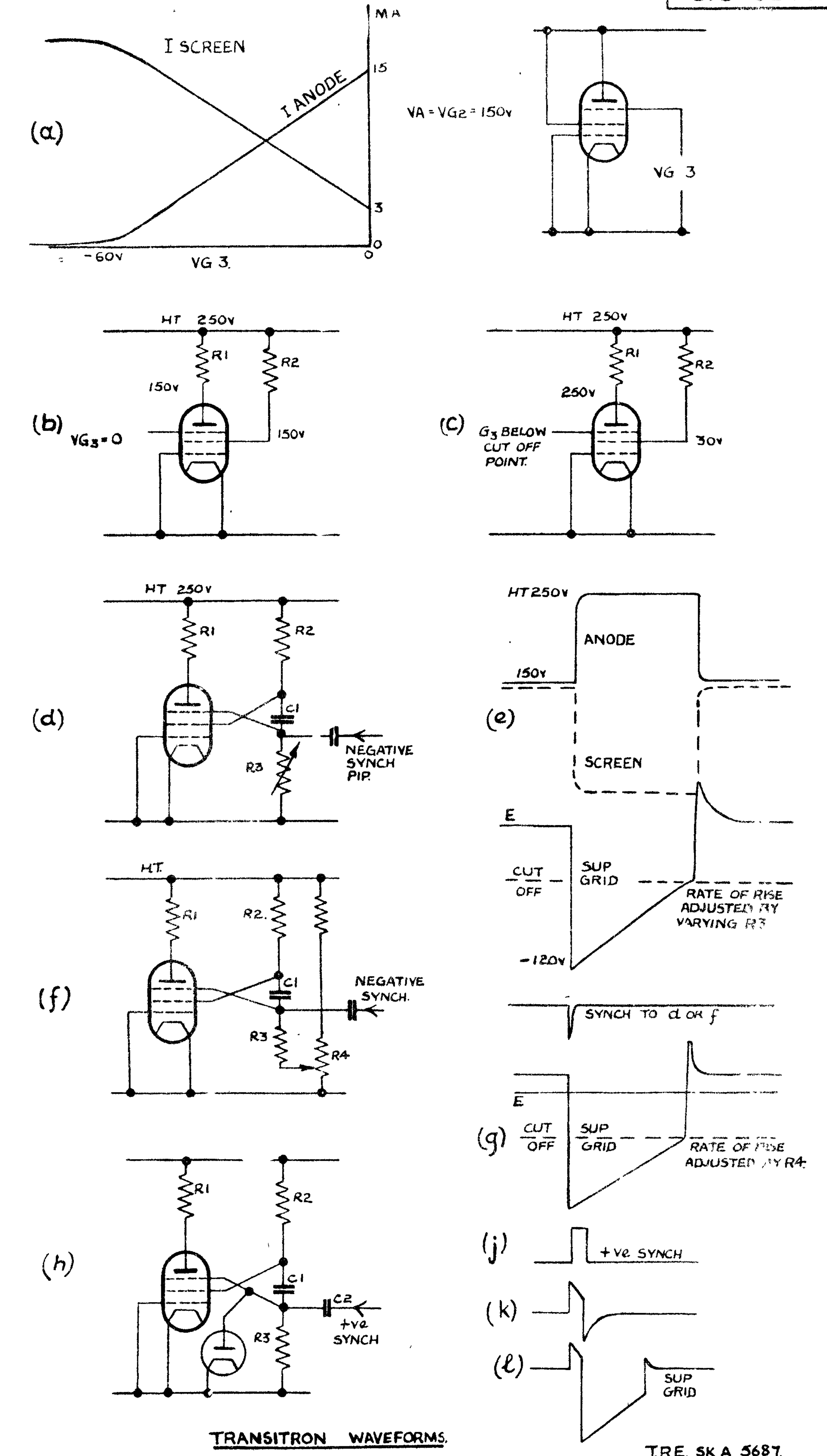
FIG. I

FIG. I

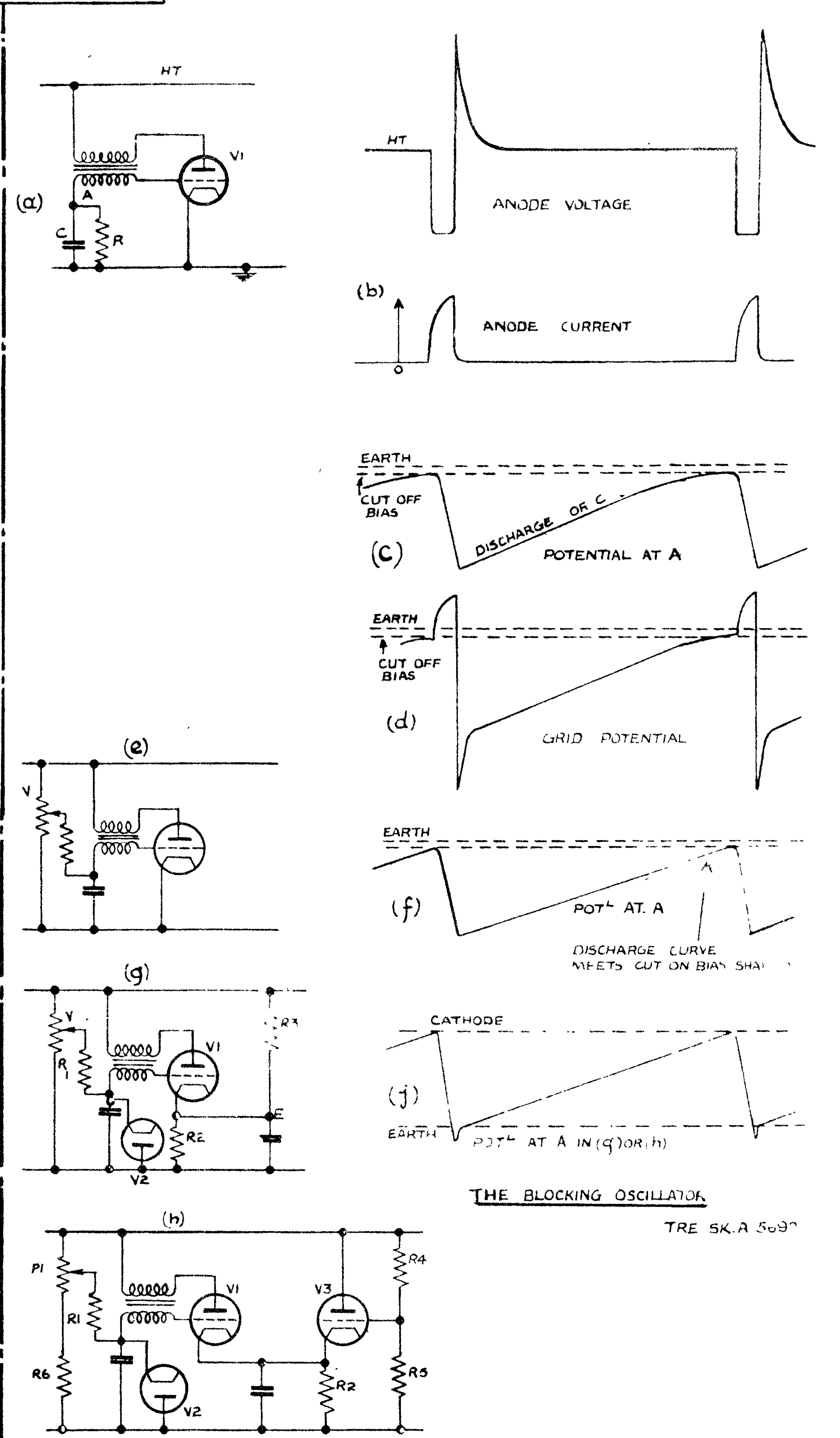


CONTROL DESK

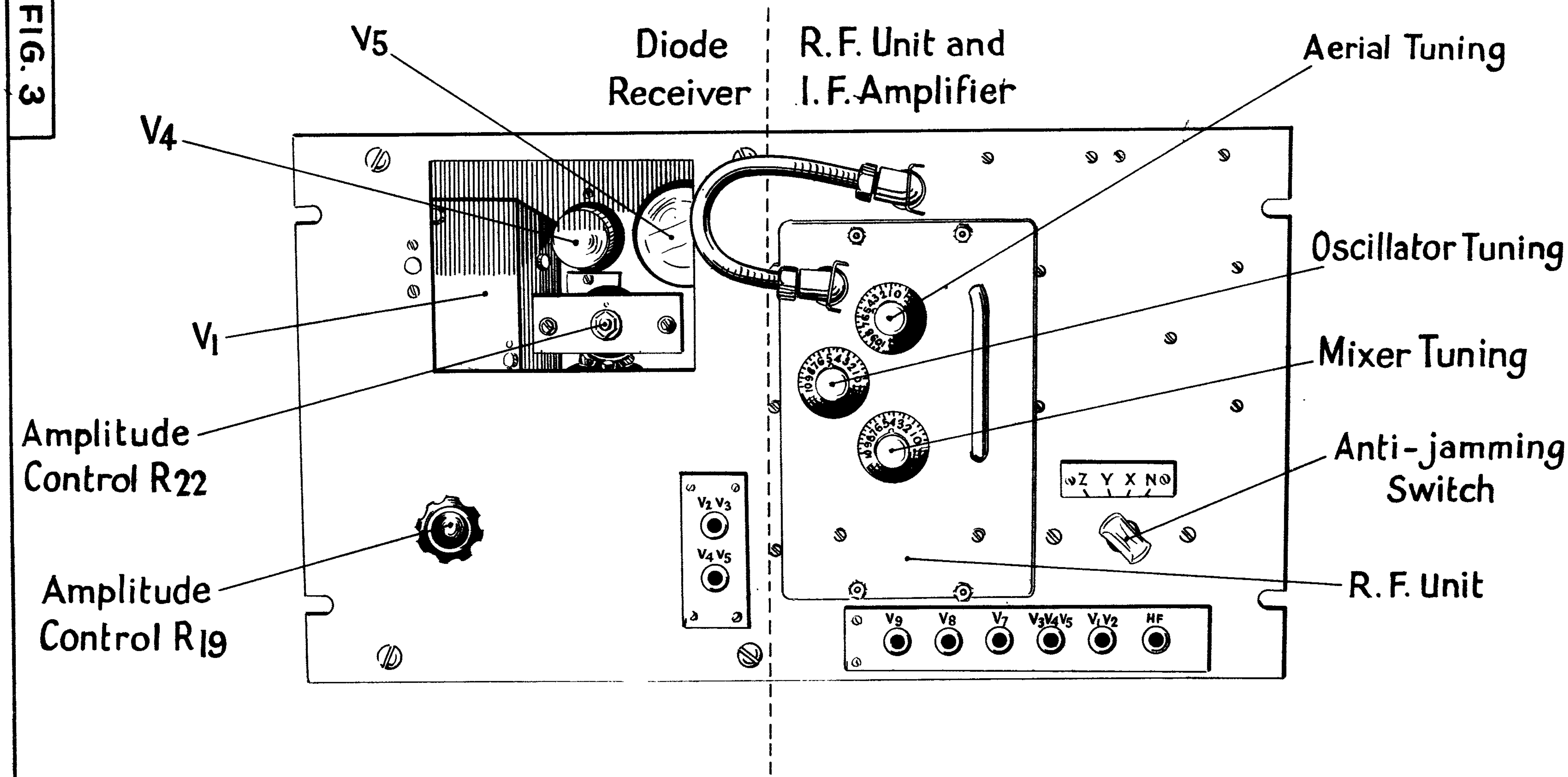
FIG. 2



FIGS. 1-2 APPENDIX I FIG. 1

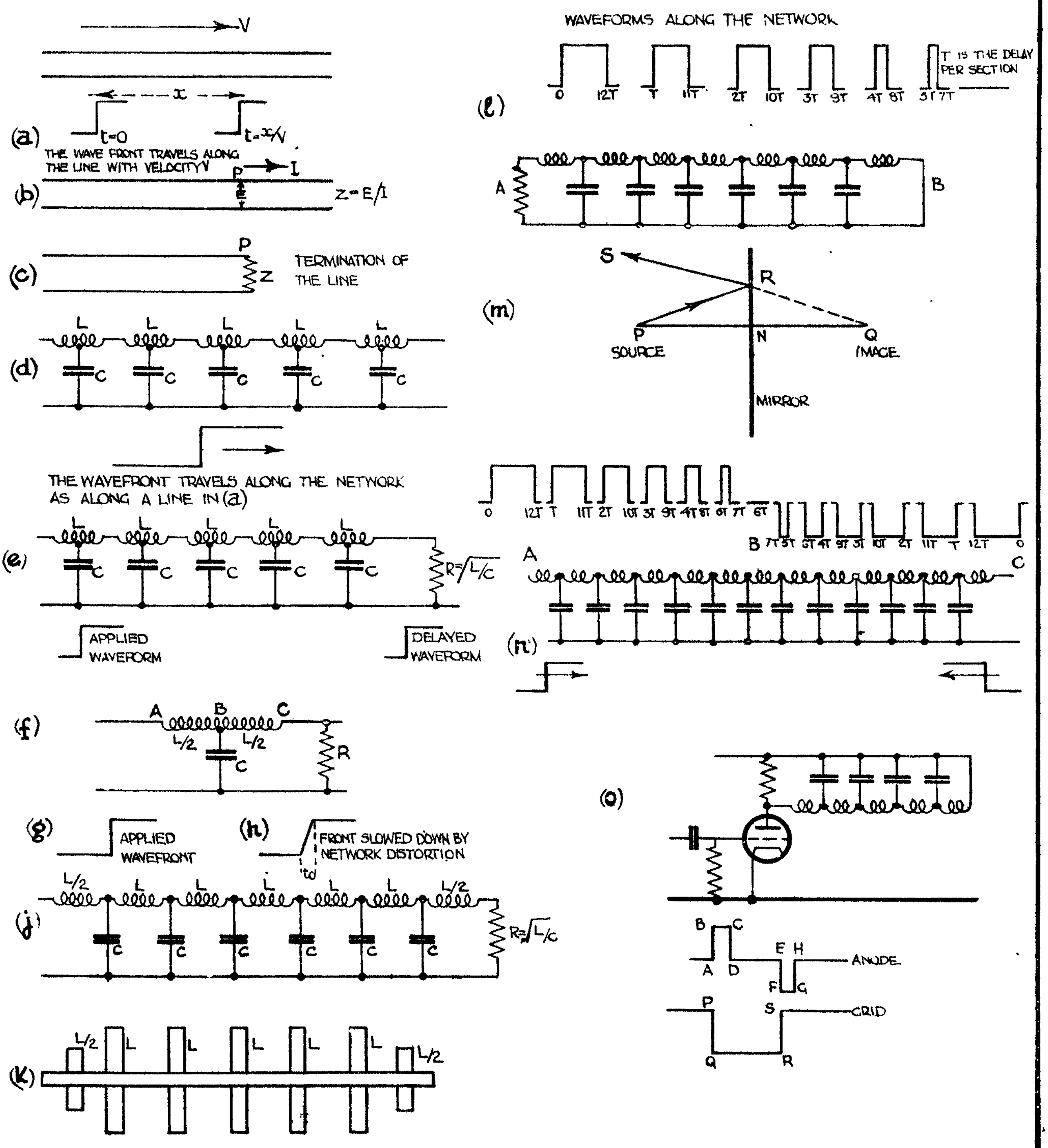


APPENDIX II FIG. 2 FIGS. 1-2



RECEIVER UNIT AND DIODE RECEIVER
Front View

FIG. 3



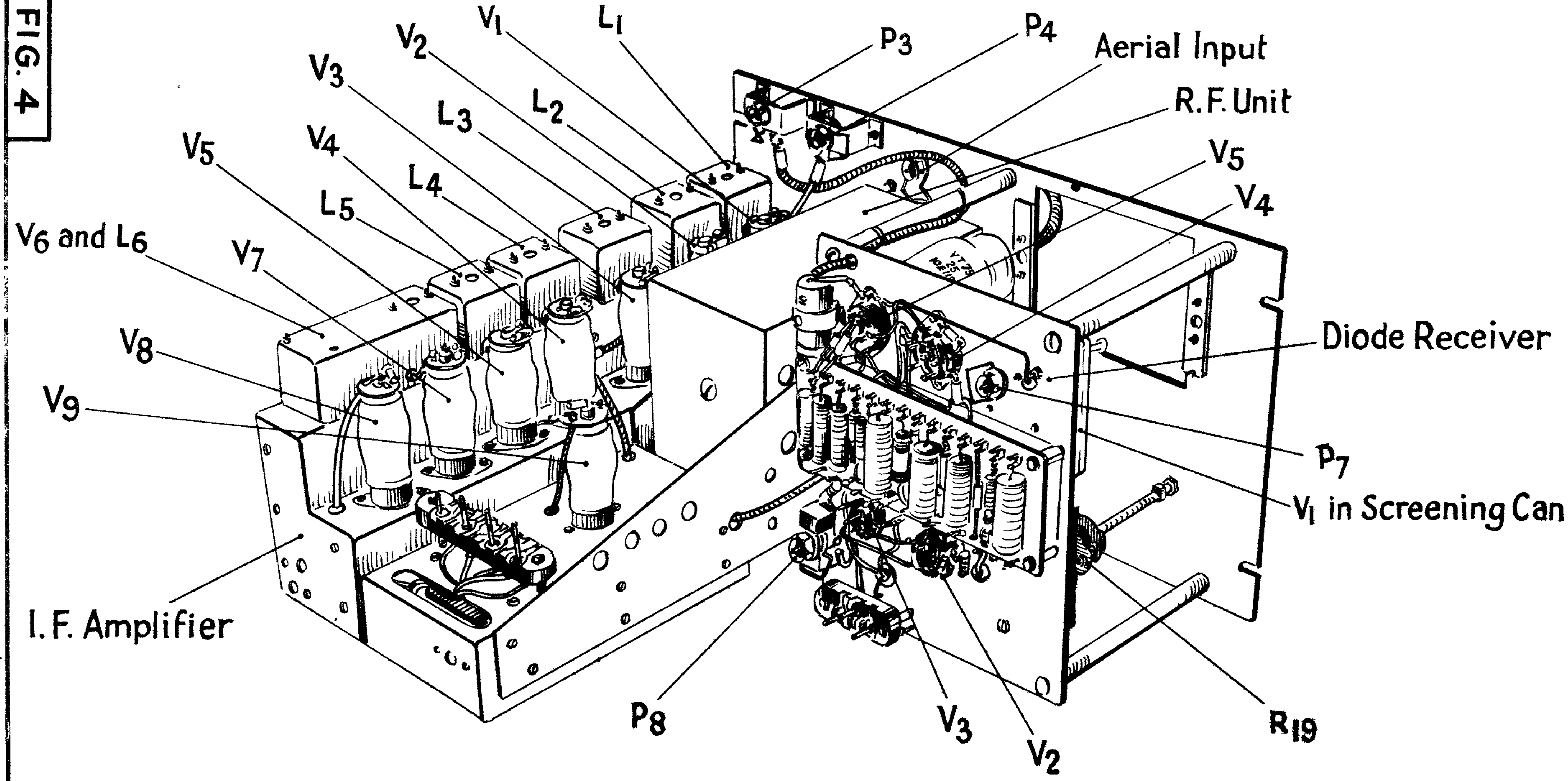
DELAY NETWORK.

APPENDIX III

FIG. 3

FIG. 3

FIG. 4

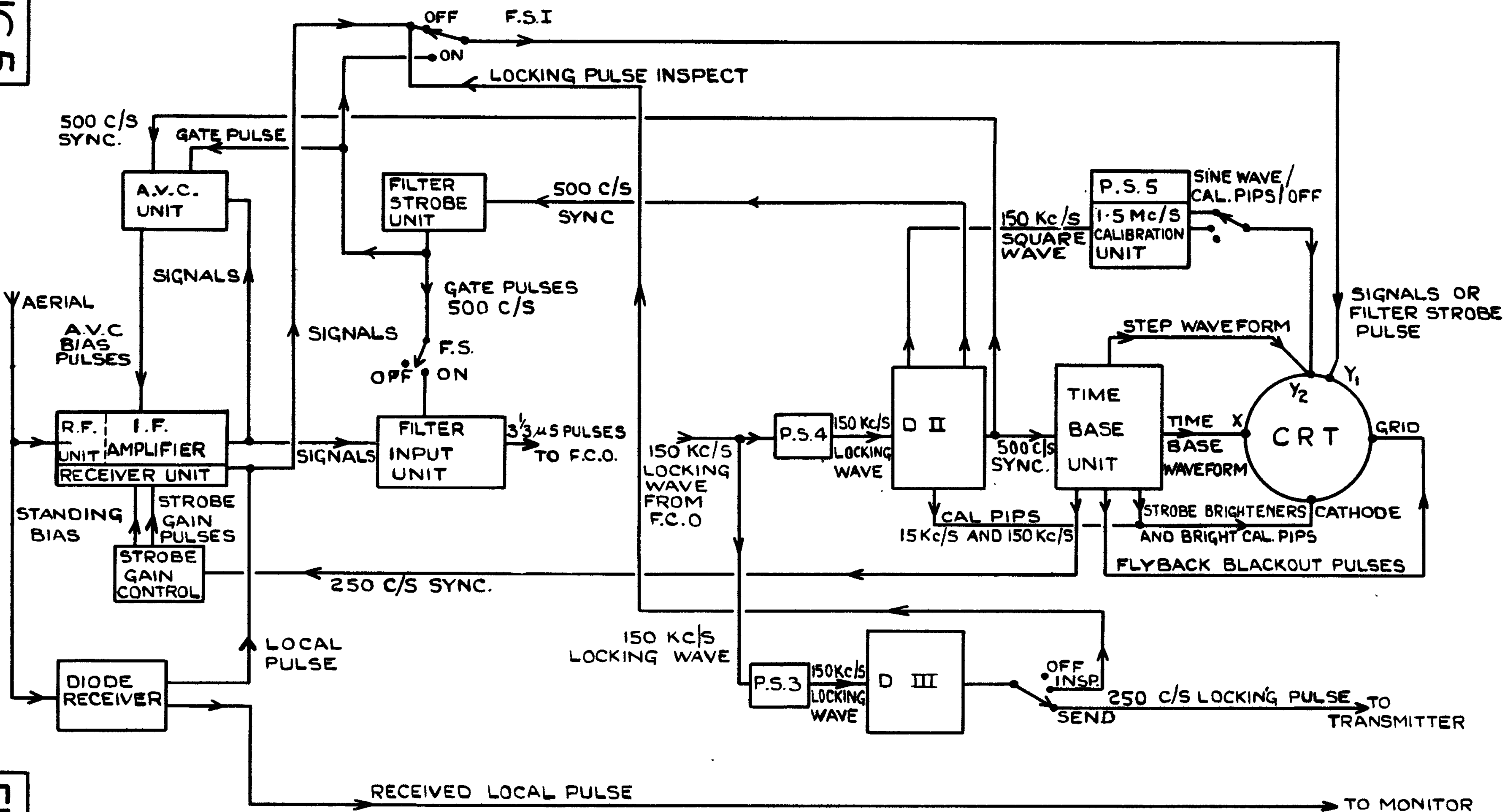


RECEIVER UNIT AND DIODE RECEIVER
Rear View

FIG. 4

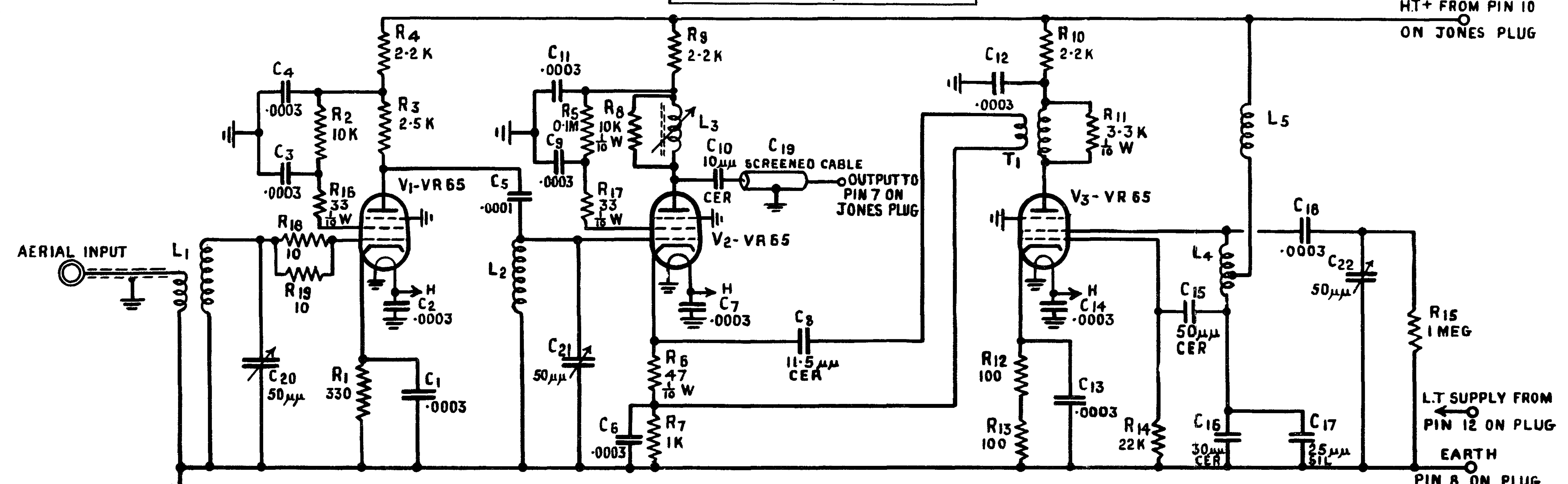
FIG.5

S.D. 0295 (1), CHAP. 12

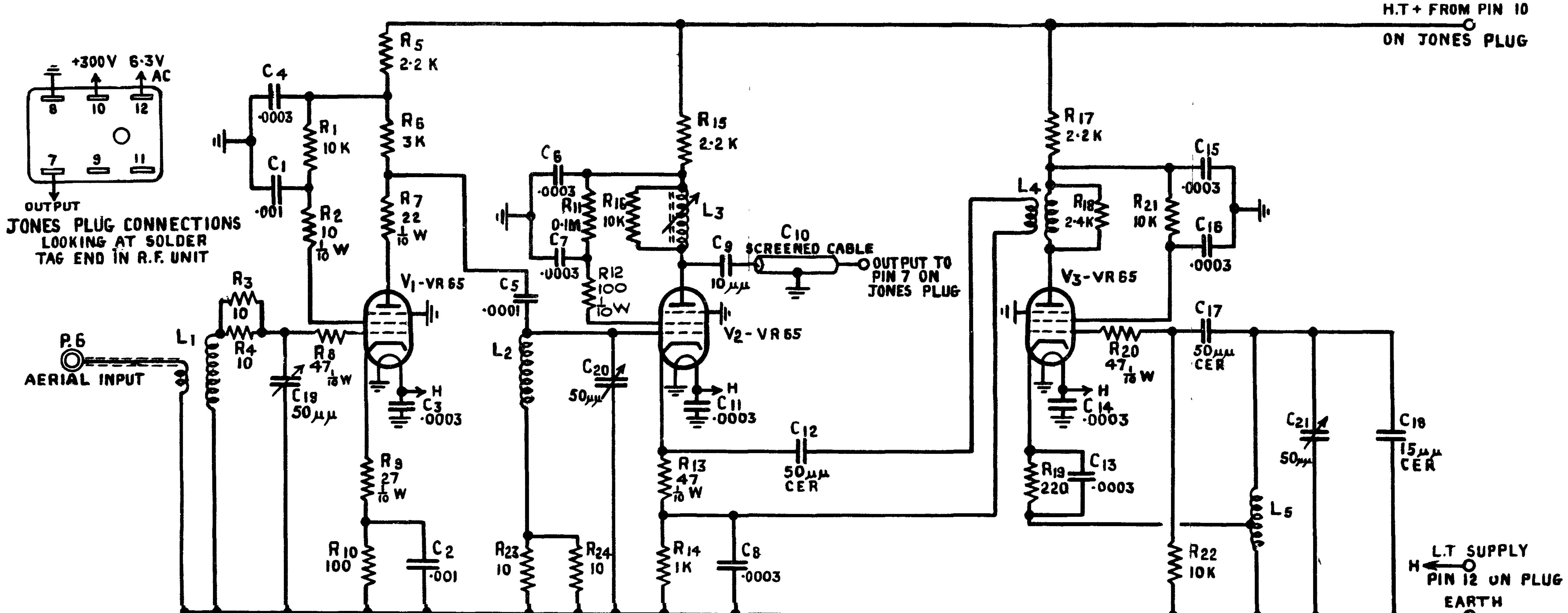


BLOCK DIAGRAM

FIG.5



R.F. UNIT NO. 31

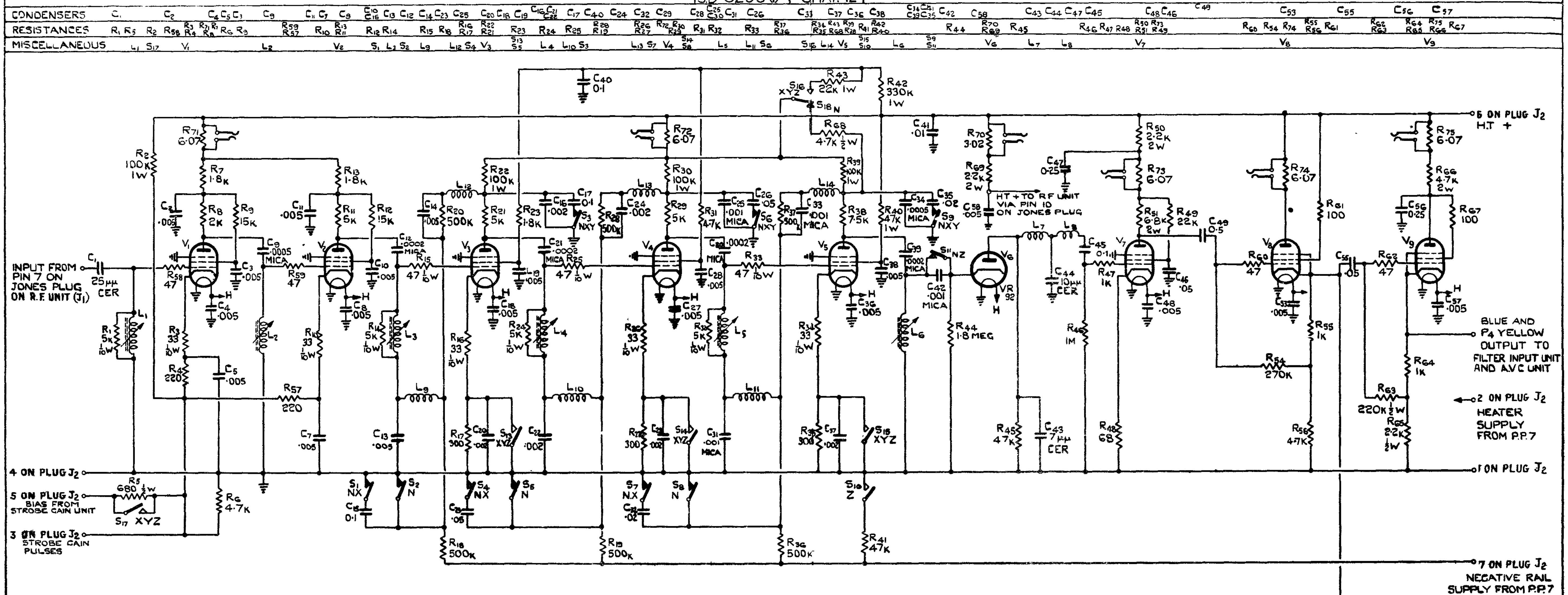


"CER"-CERAMIC DISC TYPE CONDENSER.
"SIL"-SILVERED MICA CONDENSER.
UNSPECIFIED CONDENSERS ARE MOULDED MICA TYPE.
RESISTORS ARE 1/4 WATT TYPE UNLESS STATED.

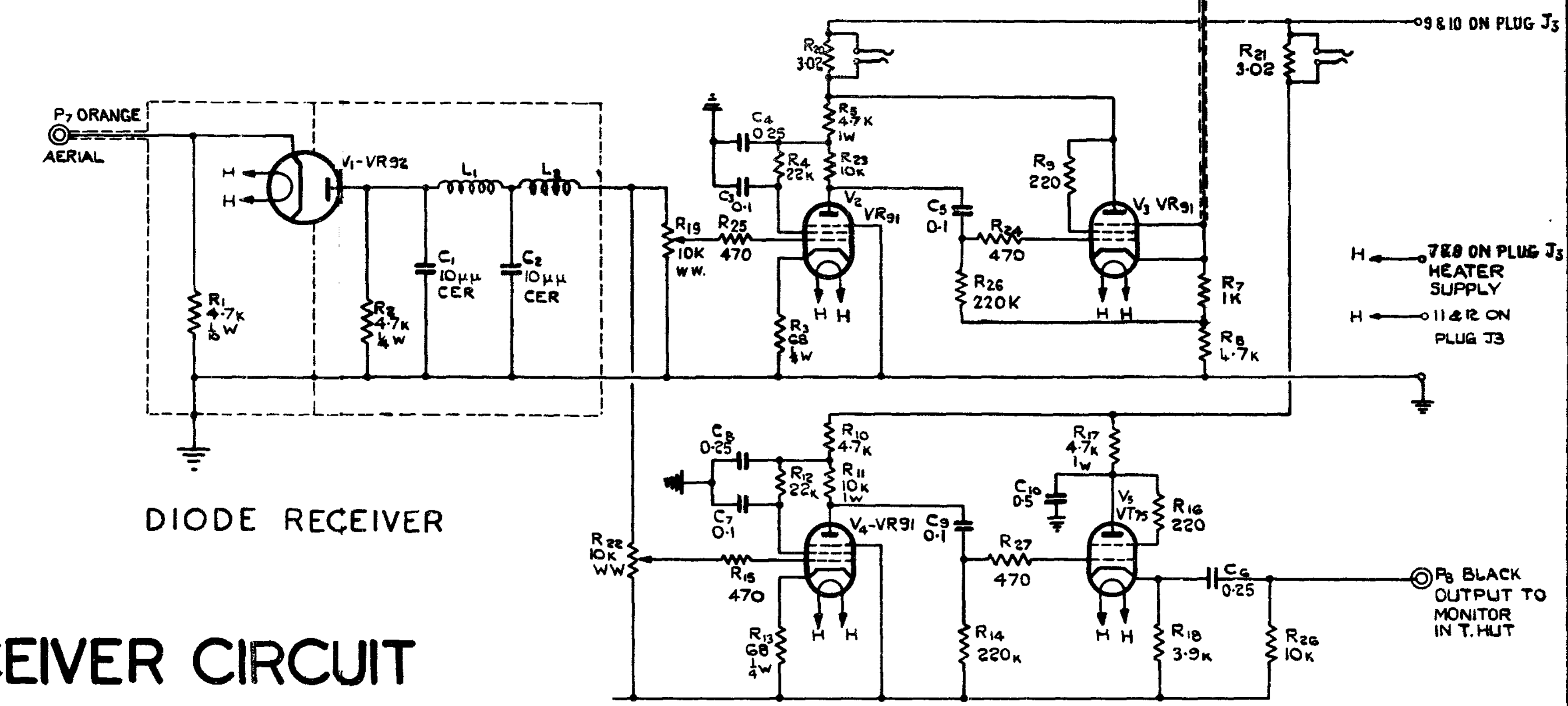
R.F. UNIT NO. 32

FIG. 6

FIG. 6



I. F. AMPLIFIER



DIODE RECEIVER

NOTES:

ALL VALVES TYPE V.R.65 UNLESS OTHERWISE STATED
RESISTORS ¼ WATT TYPE UNLESS OTHERWISE STATED
"CER" CERAMIC DISC TYPE CONDENSER
"MICA" MOULDED MICA TYPE CONDENSER
"W.W." WIRE-WOUND POTENTIOMETER

ANTI-JAMMING SWITCH CONTACTS

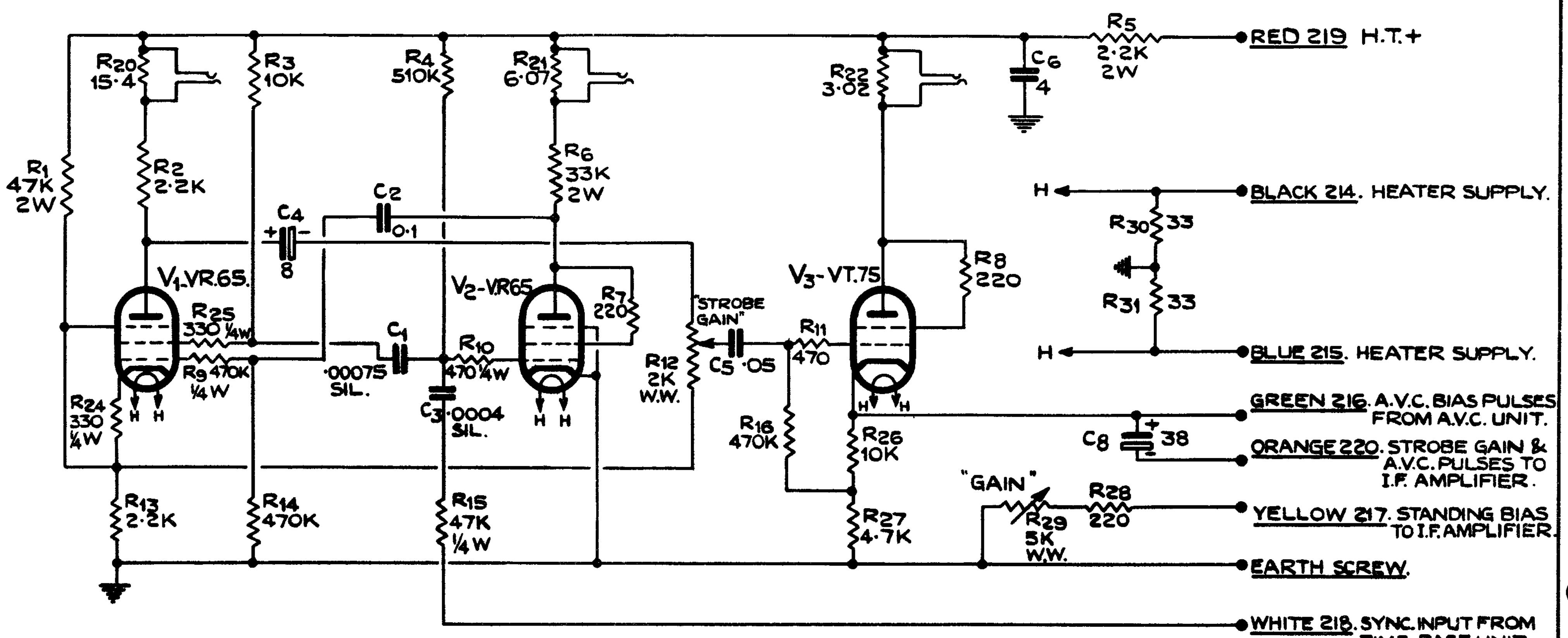
S_1 TO S_{18} ARE SHOWN IN THE "NORMAL" POSITION AND THE POSITIONS IN WHICH EACH ARE CLOSED ARE ALSO MARKED ON THE DIAGRAM BY THE LETTERS "N, X, Y, Z".

WAFER	2			3			4				5	6	2	3	4	6	1	6
SWITCH	S_1	S_2	S_3	S_4	S_5	S_6	S_7	S_8	S_9	S_{10}	S_{11}		S_{13}	S_{14}	S_{15}	S_{16}	S_{17}	S_{18}
N	C	C	C	C	C	C	C	C	C	O	C		O	O	O	O	O	C
X	C	O	C	C	O	C	C	O	C	O	O		C	C	C	C	C	O
Y	O	O	C	O	O	C	O	O	C	O	O		C	C	C	C	C	O
Z	O	O	O	O	O	O	O	O	O	C	C		C	C	C	C	C	O

I.F. AMPLIFIER & DIODE RECEIVER CIRCUIT

FIG. 7

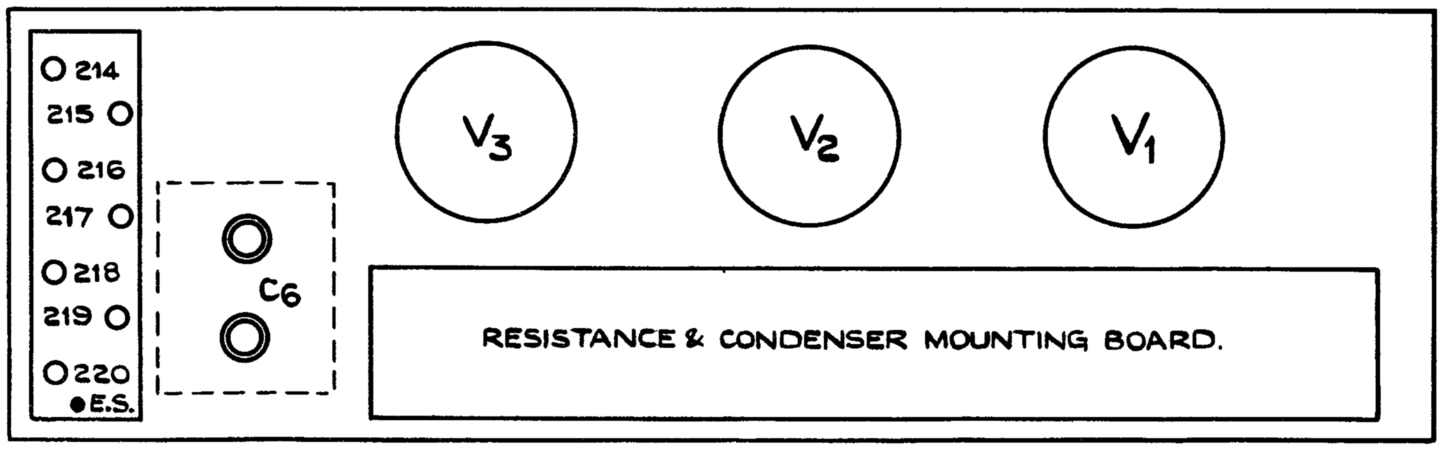
FIG. 7



RESISTORS (EXCEPT METER SHUNTS)
½ WATT TYPE UNLESS STATED.
"SIL". – SILVERED MICA CONDENSER.

FIG. 8. STROBE GAIN CONTROL UNIT – CIRCUIT.

R12 & R29 MOUNTED ON FRONT OF PANEL.



CHASSIS LAYOUT – REAR VIEW.

FIG. 10. STROBE GAIN CONTROL UNIT – LAYOUT.

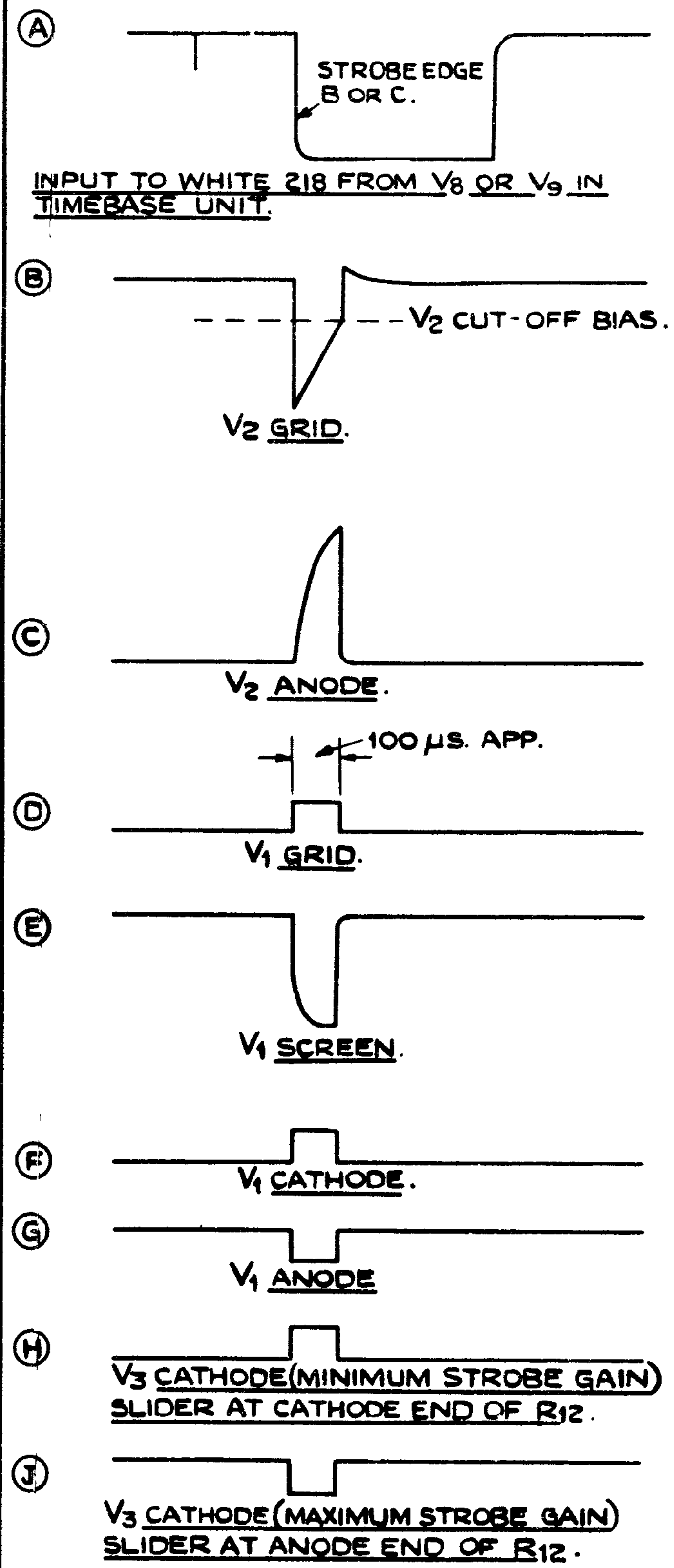
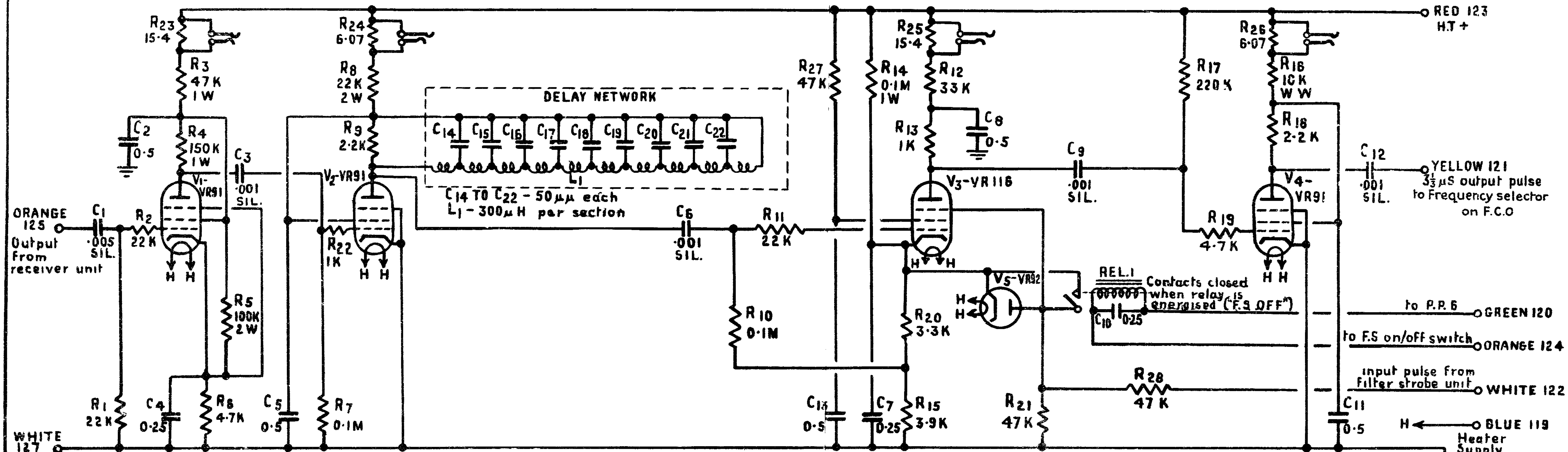


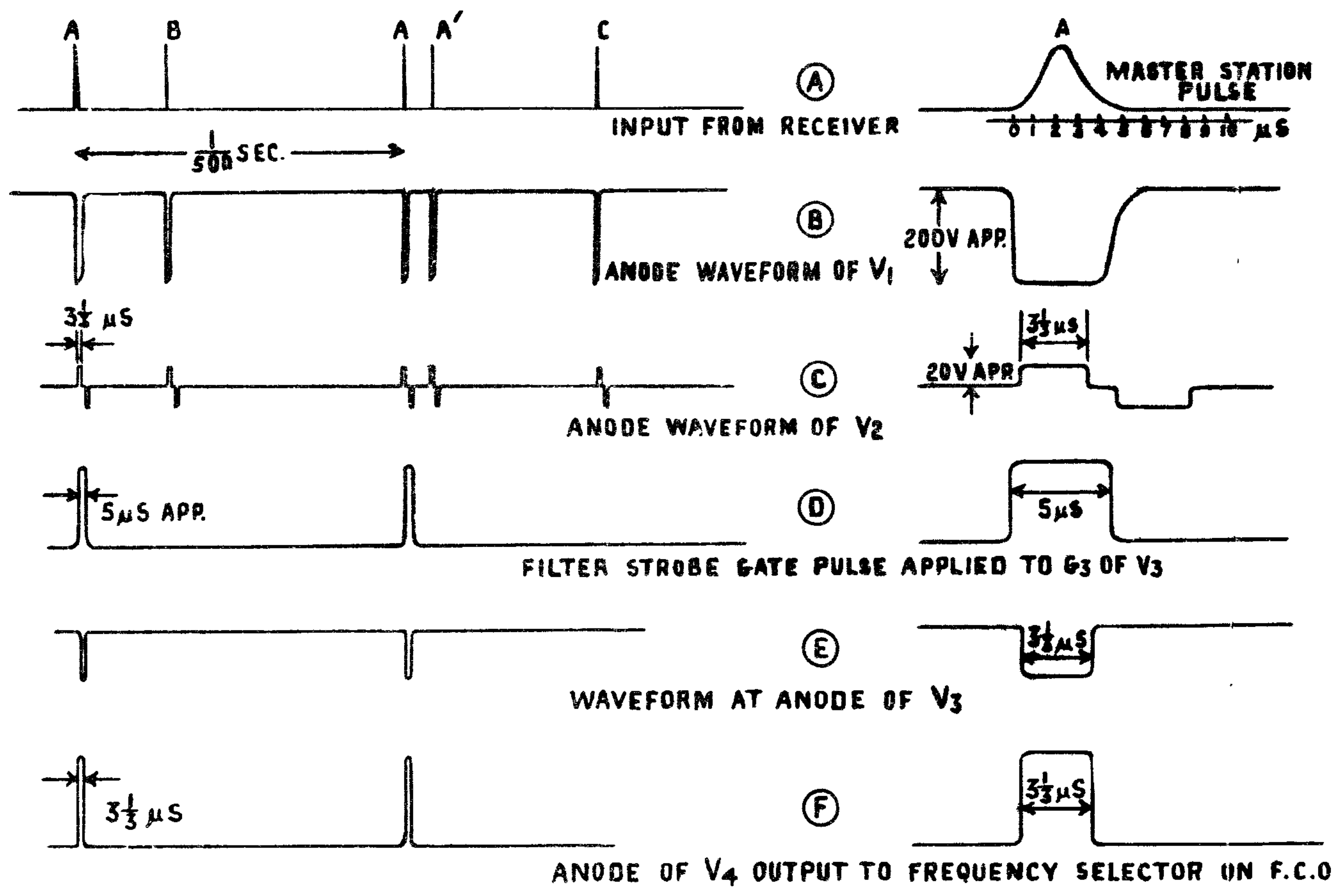
FIG. 9. STROBE GAIN CONTROL UNIT – WAVEFORMS.

FIG. 8, 9 & 10



All resistors (except meter shunts $\frac{1}{2}$ watt type unless stated.
SIL. - Silvered Mica.

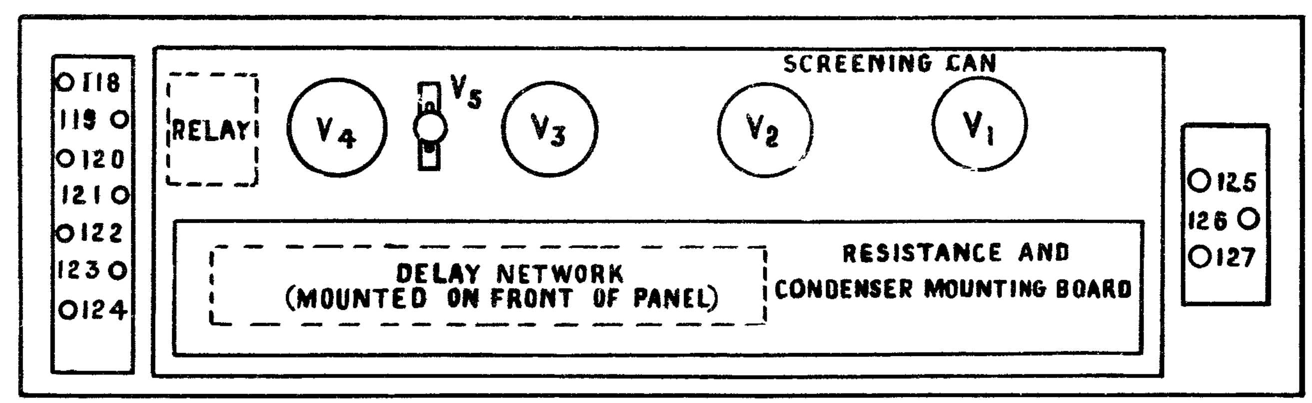
FIG.11 FILTER INPUT UNIT - CIRCUIT



WAVEFORMS

NOTE. Waveforms on the right are expanded views of pictures on left

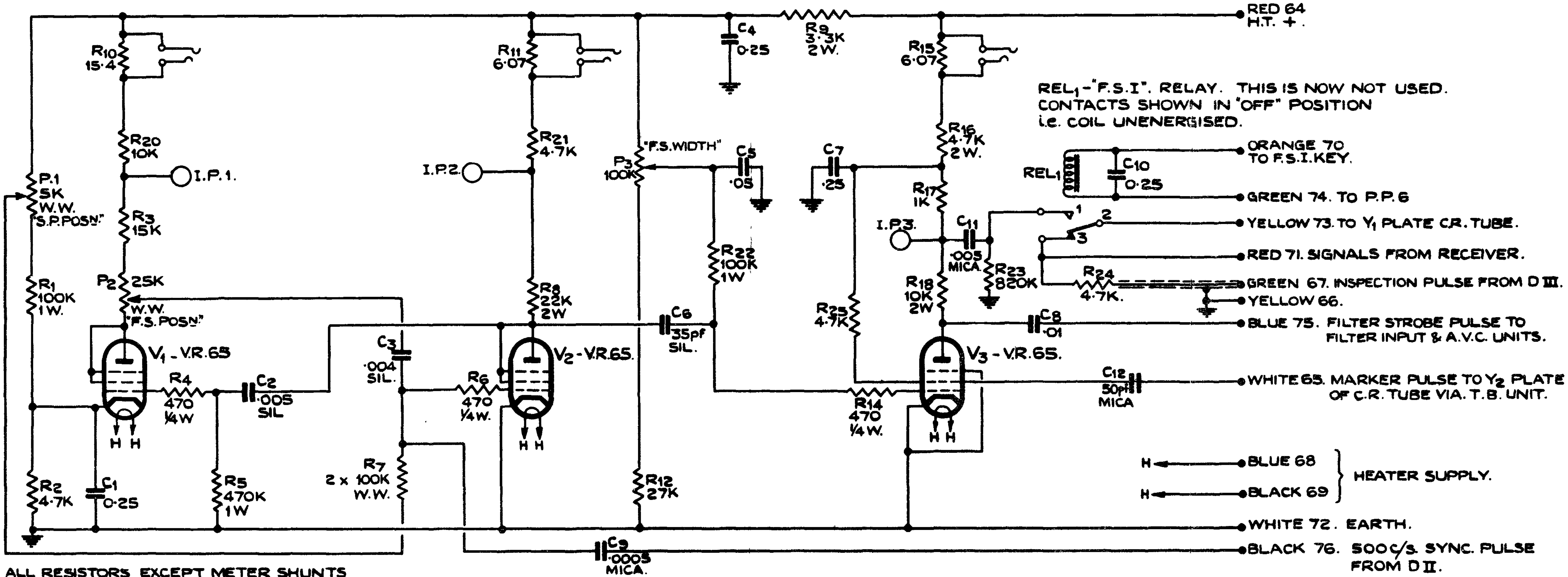
FIG.12 FILTER INPUT UNIT WAVEFORMS



CHASSIS LAYOUT—REAR VIEW

FIG.13 FILTER INPUT LAYOUT

FIGS. 11, 12 & 13



ALL RESISTORS EXCEPT METER SHUNTS
1/2 WATT TYPE UNLESS STATED.
"W.W" - WIREWOUND.
"SIL" - SILVERED MICA.
"MICA" - MOULDED MICA.

FIG. 14. FILTER STROBE UNIT - CIRCUIT.

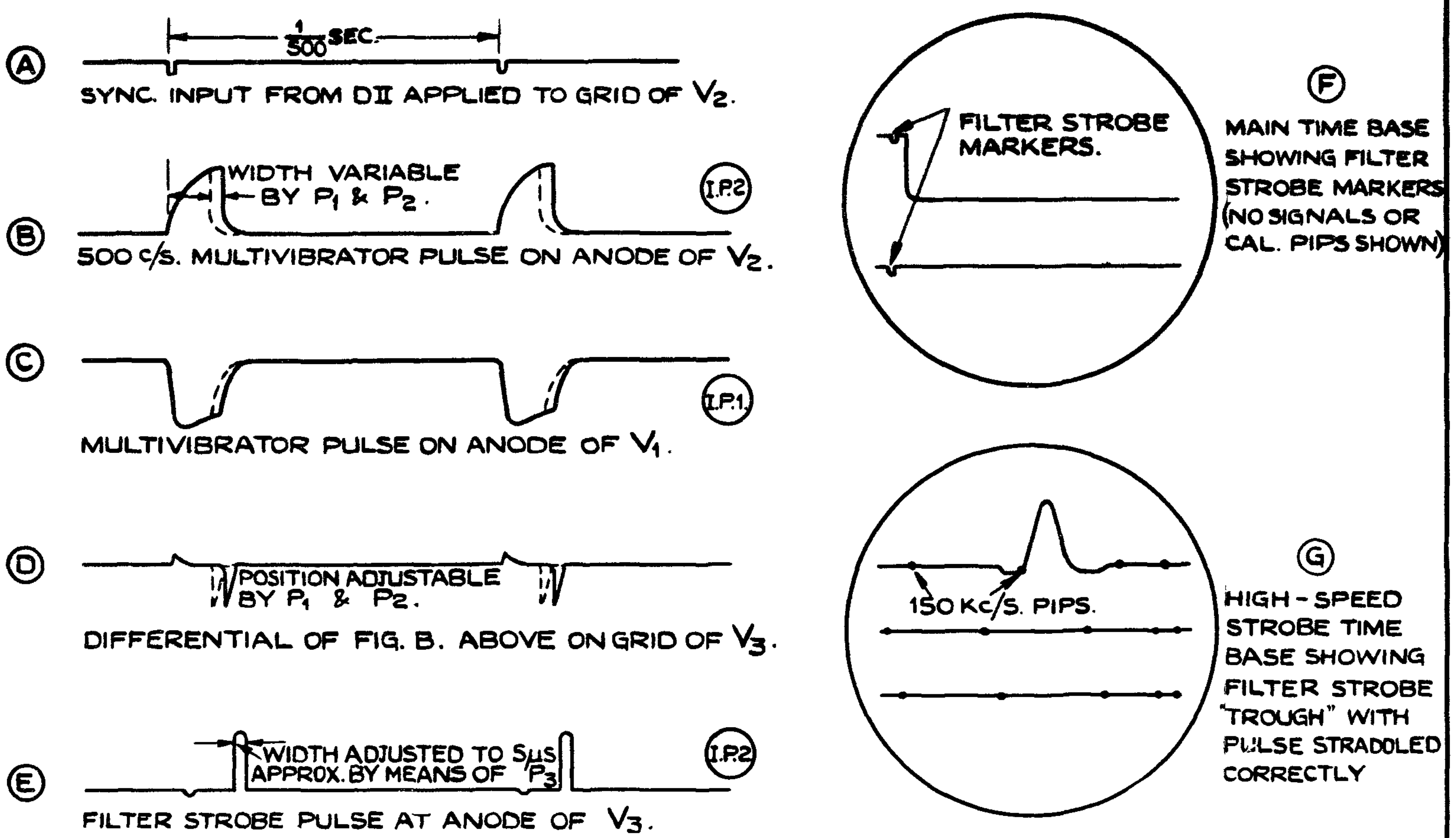


FIG 15 - FILTER STROBE UNIT - WAVEFORMS.

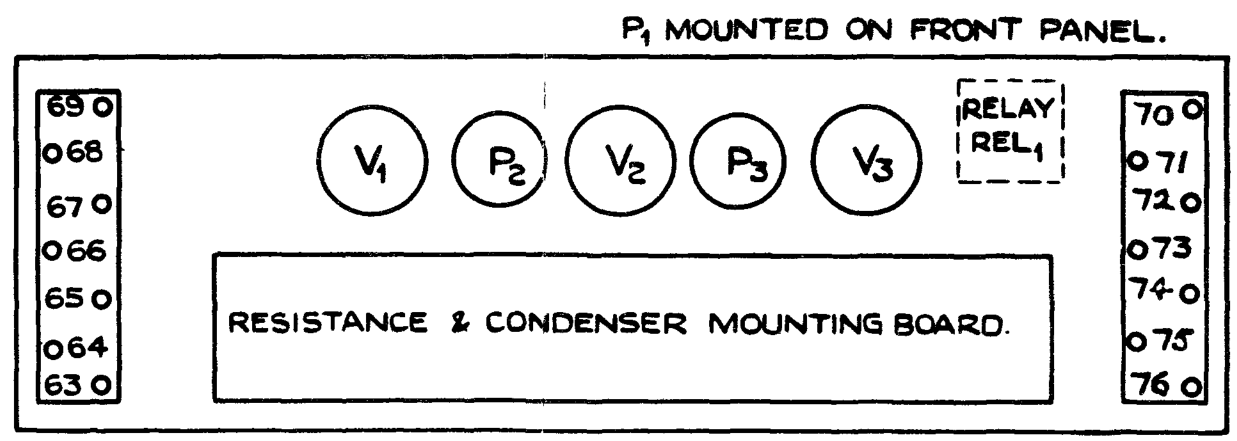


FIG. 16. FILTER STROBE UNIT - LAYOUT. (REAR VIEW)

FIG. 14, 15 & 16.

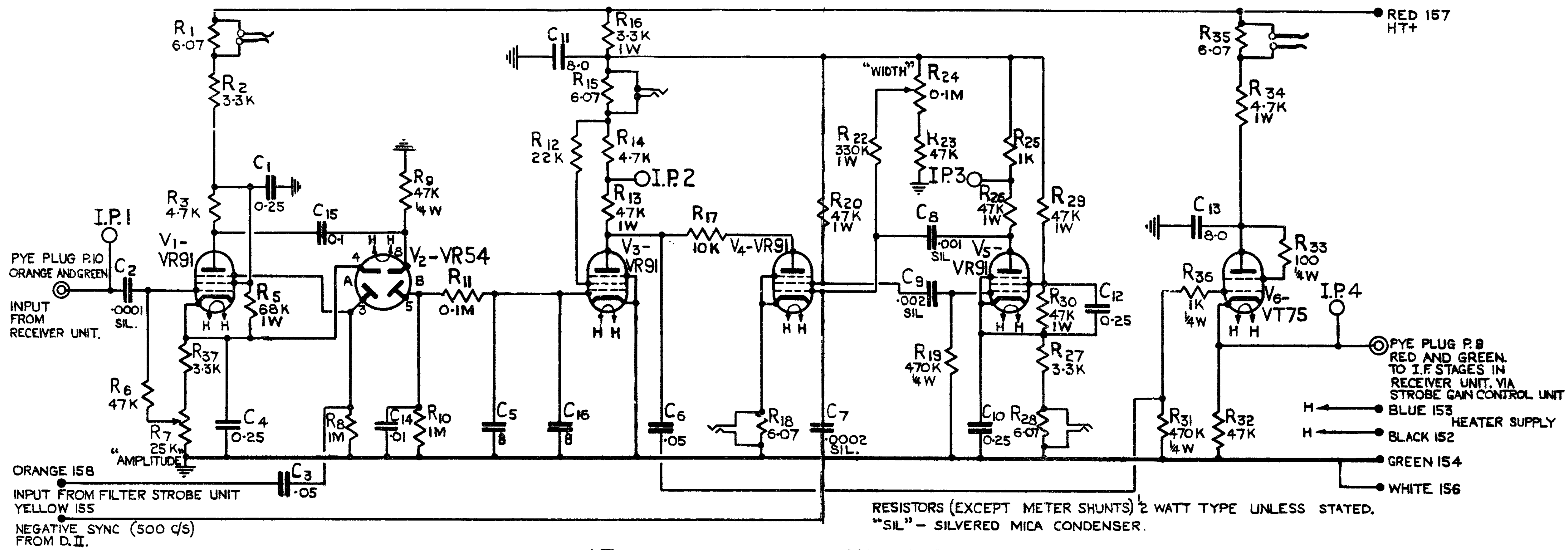


FIG. 17 A.V.C. UNIT CIRCUIT

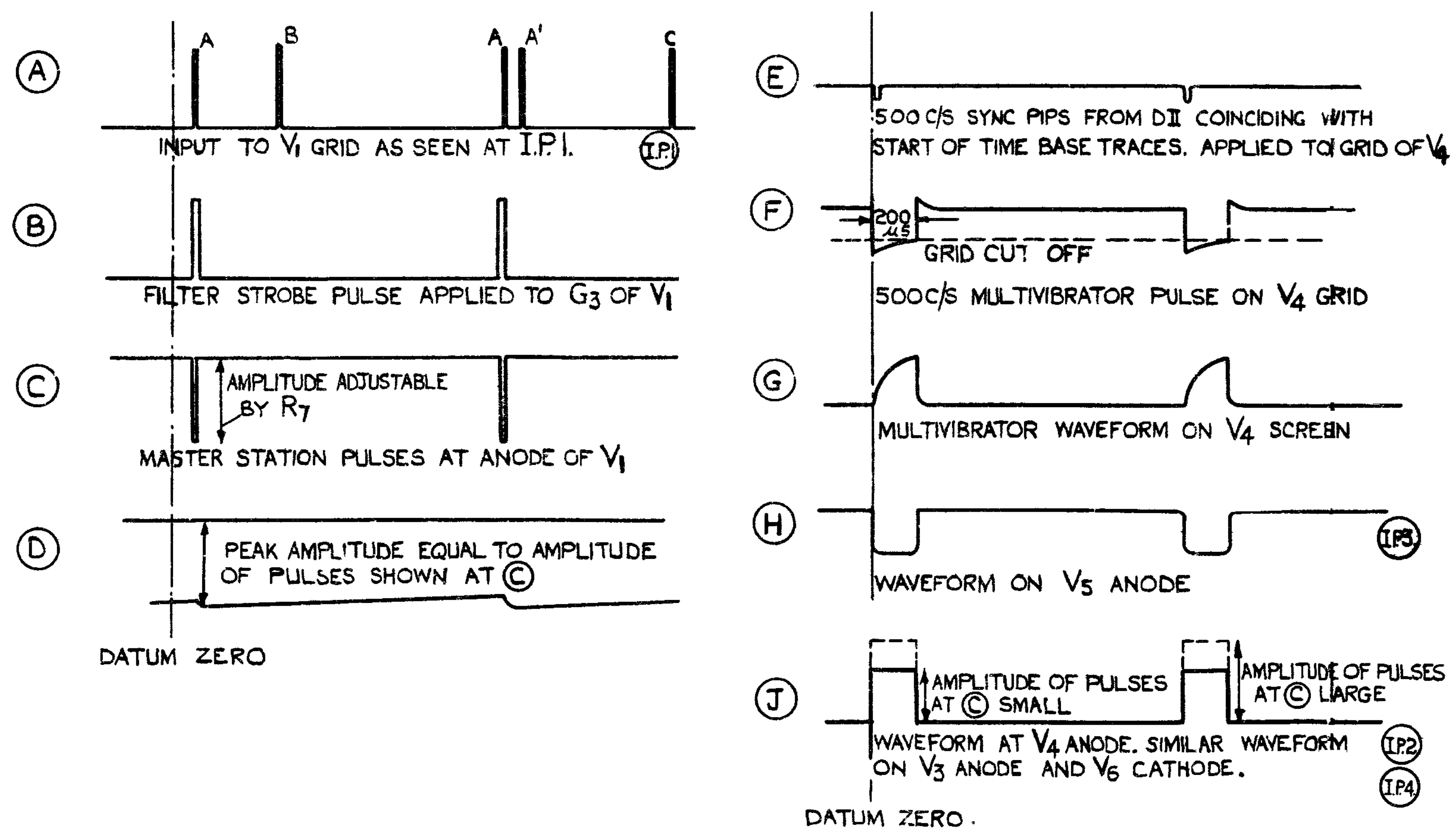
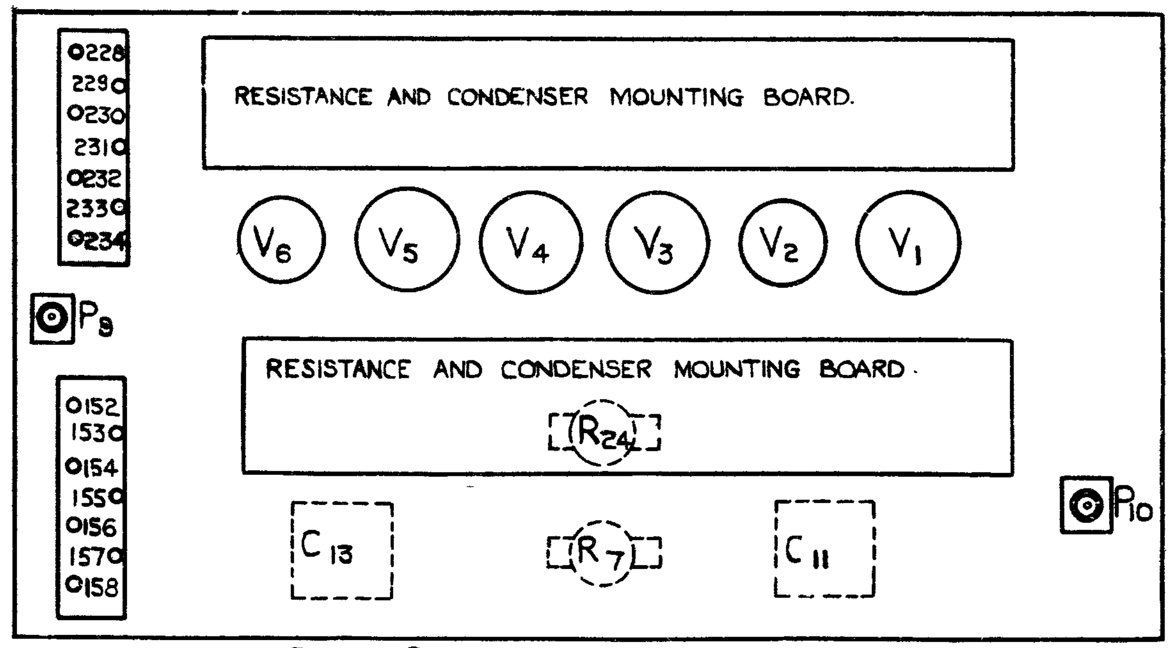


FIG. 18 A.V.C. UNIT WAVEFORMS



R7 AND R24 MOUNTED ON FRONT OF PANEL

FIG. 19 A.V.C. UNIT LAYOUT

FIGS 17, 18 & 19

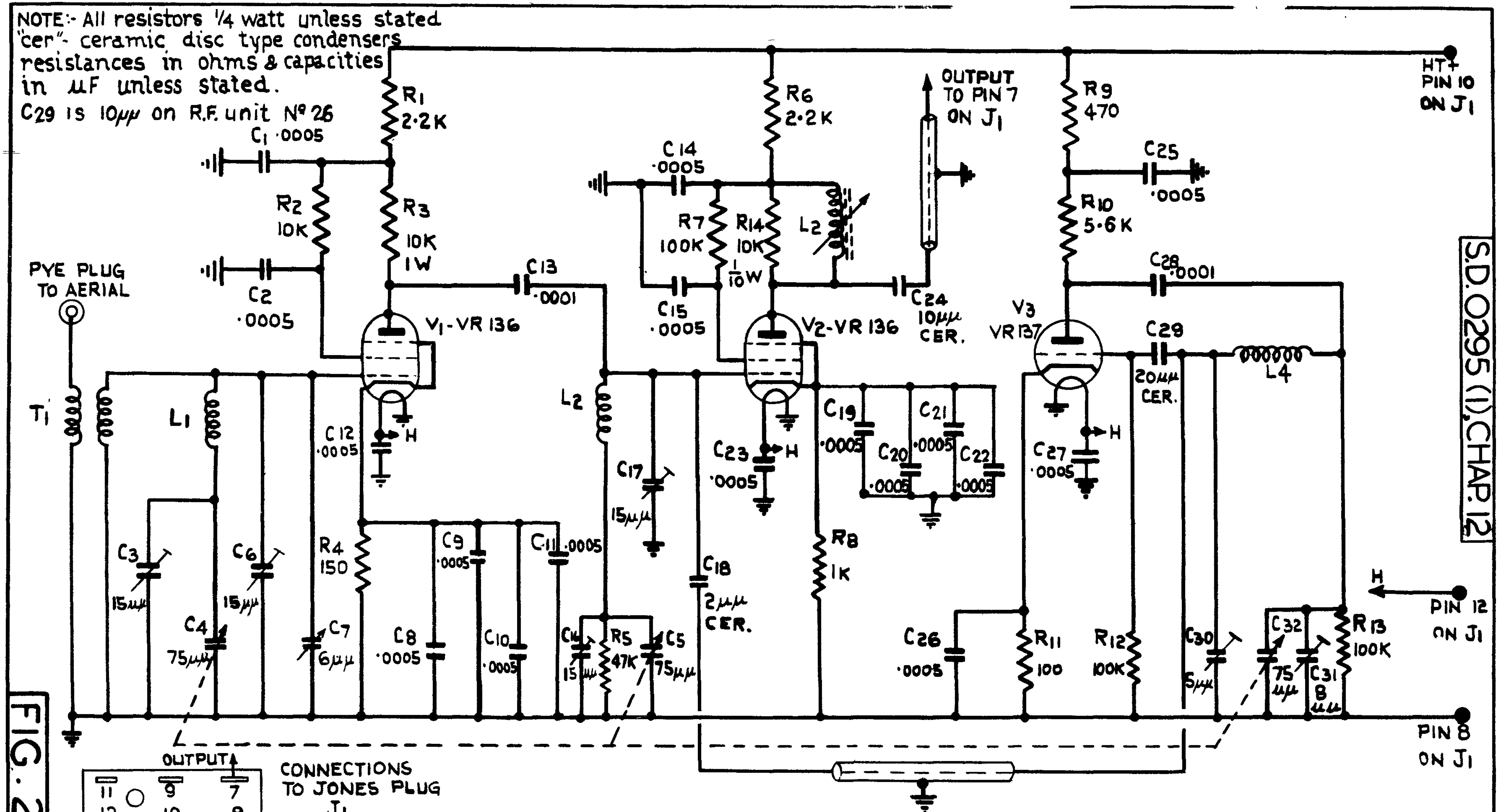
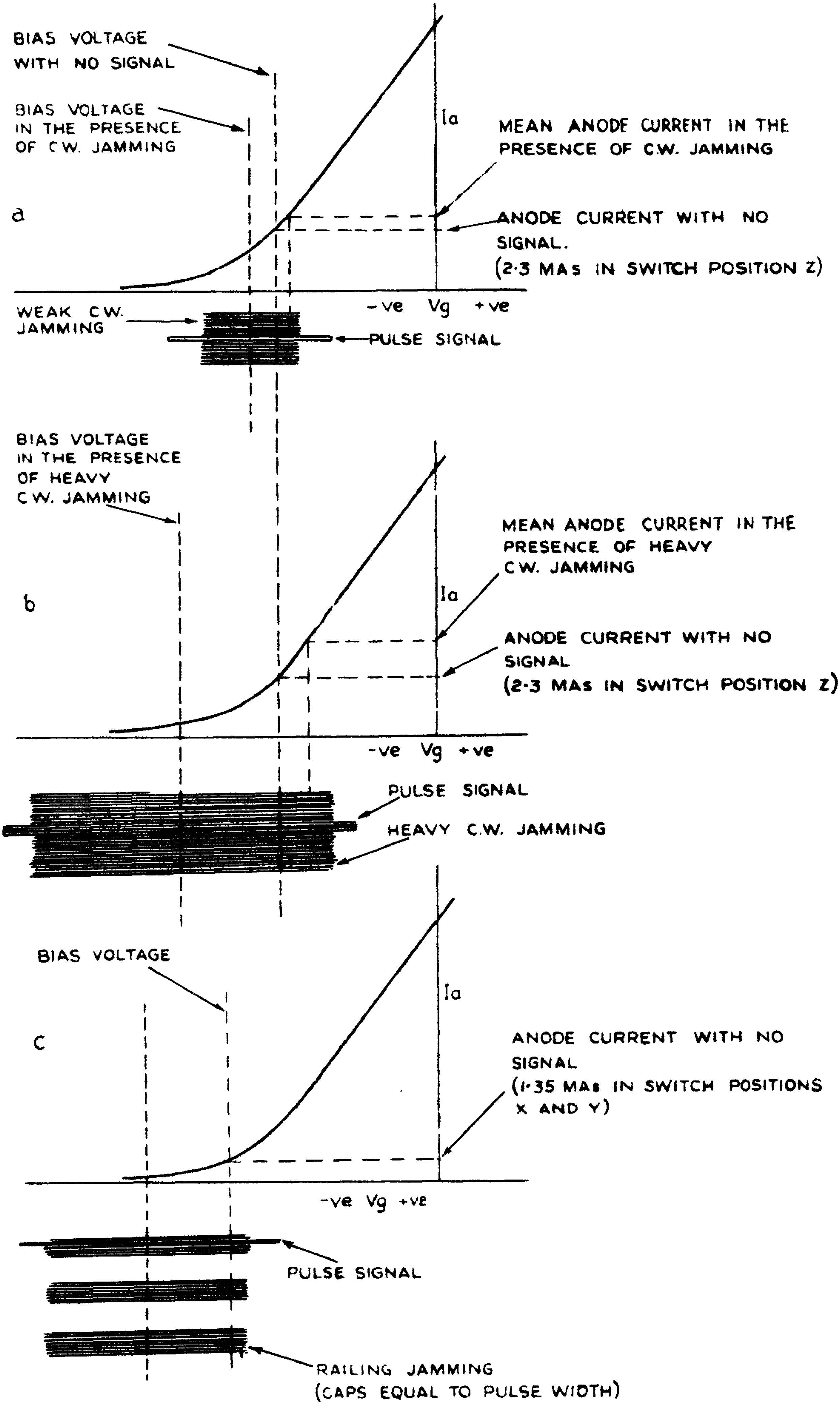


FIG. 20

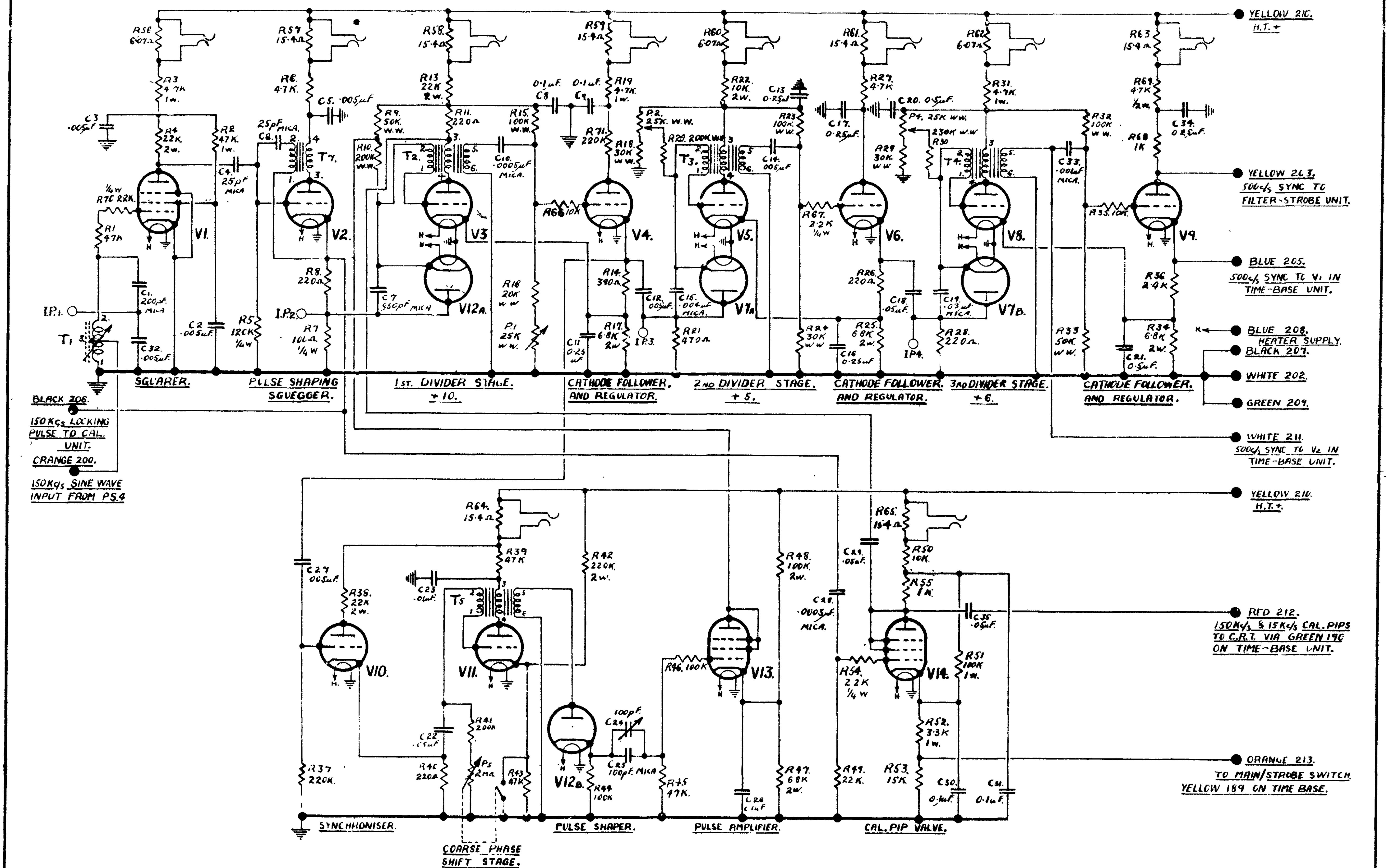
R.F. UNITS Nº 26 AND 27



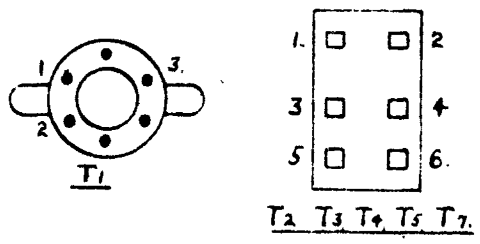
OPERATION OF BACK BIAS I.F. STAGES

FIG. 21

FIG. 21



TRANSFORMER CONNECTIONS



ALL RESISTORS ½ W. UNLESS OTHERWISE SPECIFIED.

W.W. ~ WIRE WOUND. I.P. ~ INSPECTION POINT.

VALVES :- V1, V13, & V14. ~ VR 65.
V7 & V12 ~ VR54.
ALL OTHERS ~ VR66.

FIG.23

DIVIDER II CIRCUIT

FIG.23

02226-1

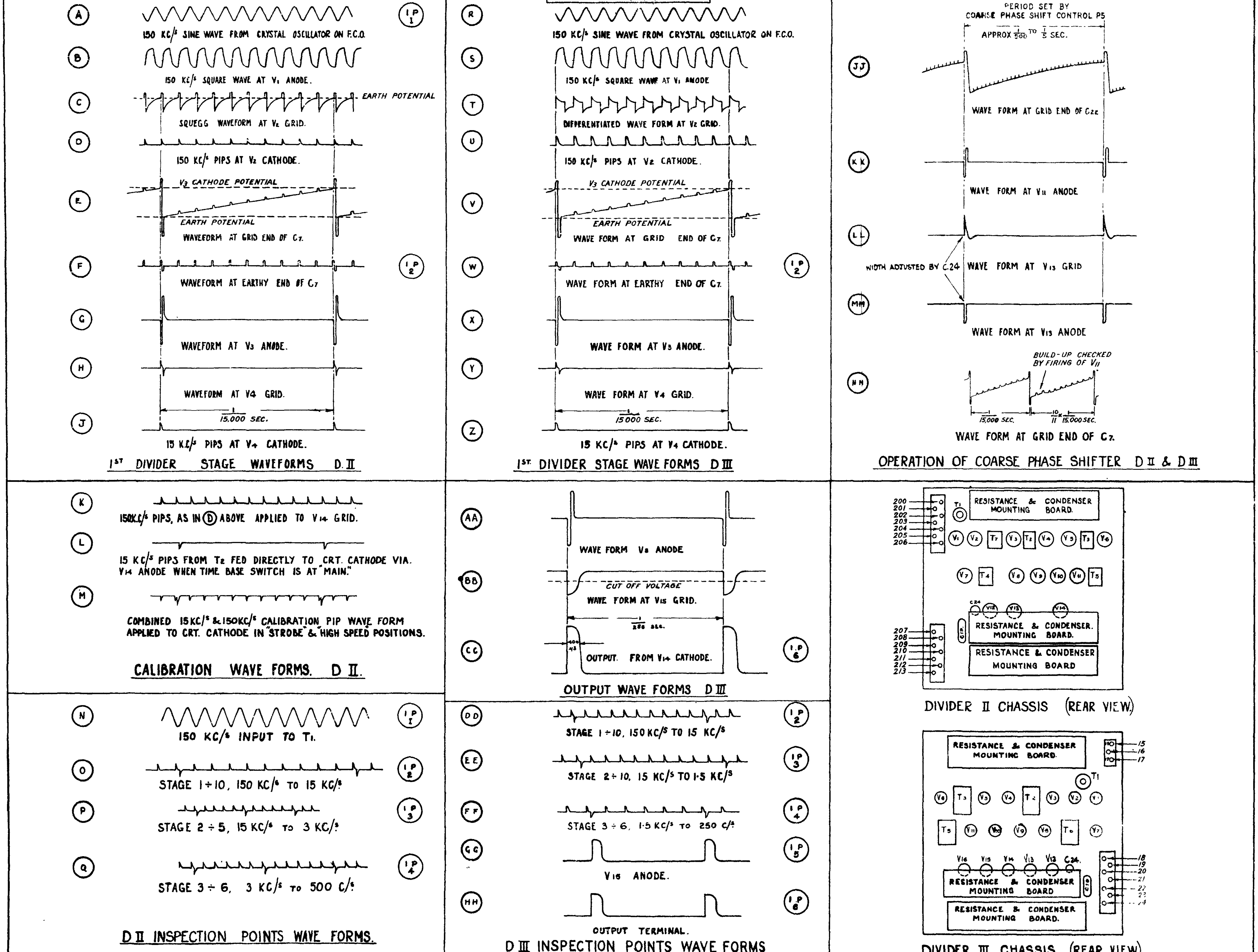
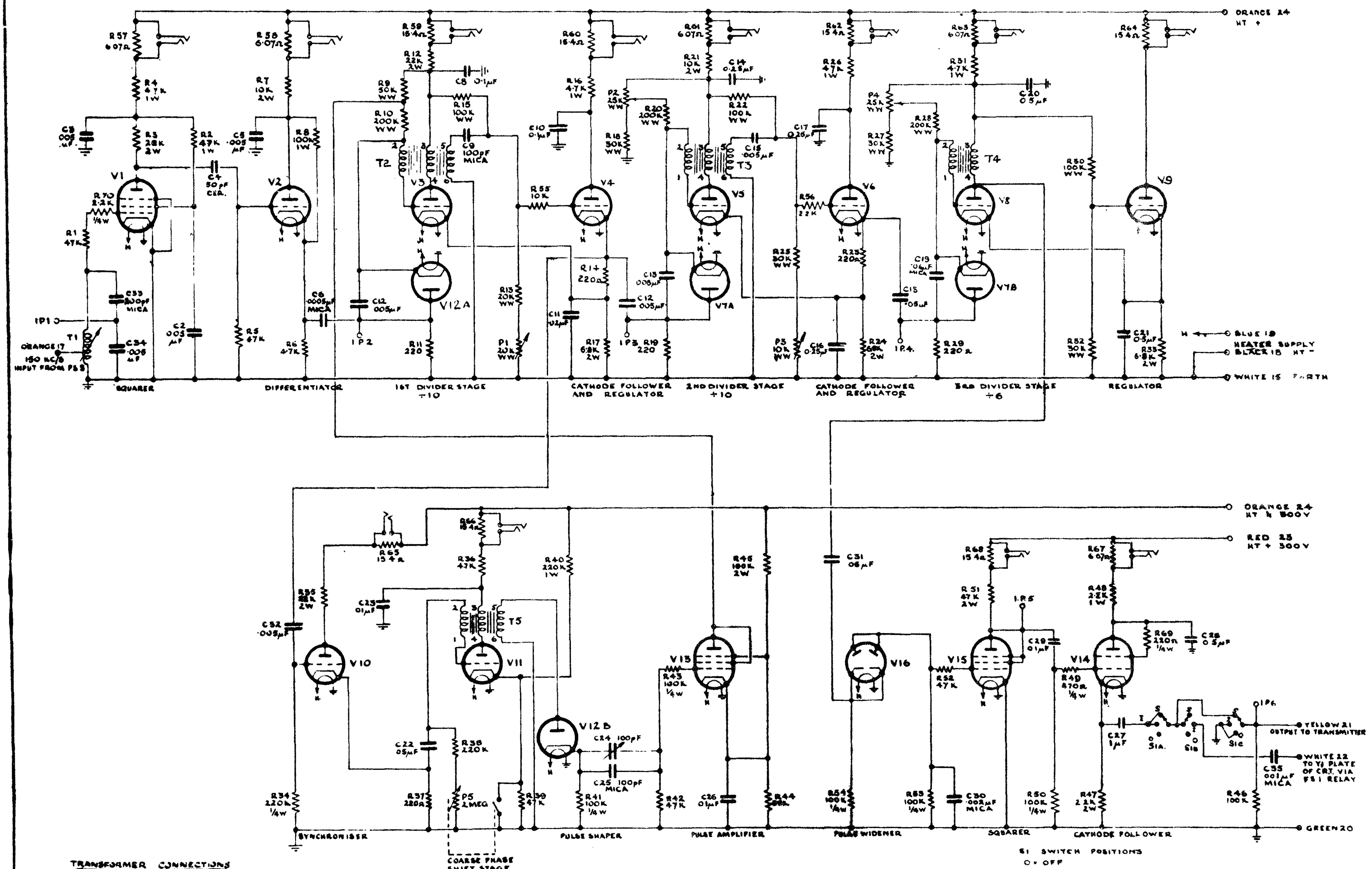


FIG.24 DIVIDER WAVEFORMS FIG.24



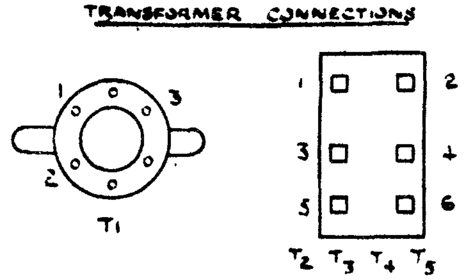
IP - INSPECTION POINT

ALL RESISTORS ½W UNLESS OTHERWISE STATED.

"WW" INDICATES WIREWOUND RESISTOR OR POTENTIOMETER

VALVE TYPES.
V1 V13 V15 — VR 65.
V2, V3 V4 V5 V6 V8 V9 V10 V11. — VR66.
V7 V12 V16 — VR 54.
V14. — VT75.

TRANSFORMER CONNECTIONS



DIVIDER III CIRCUIT

FIG.25

FIG.25

63226-1

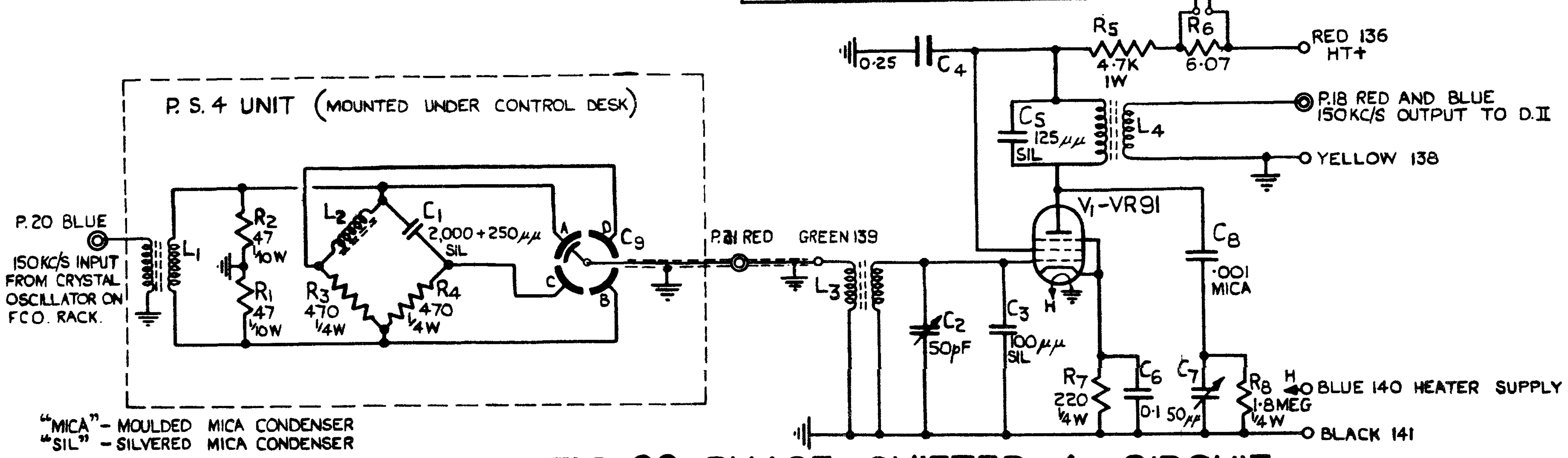


FIG. 26 PHASE SHIFTER 4—CIRCUIT

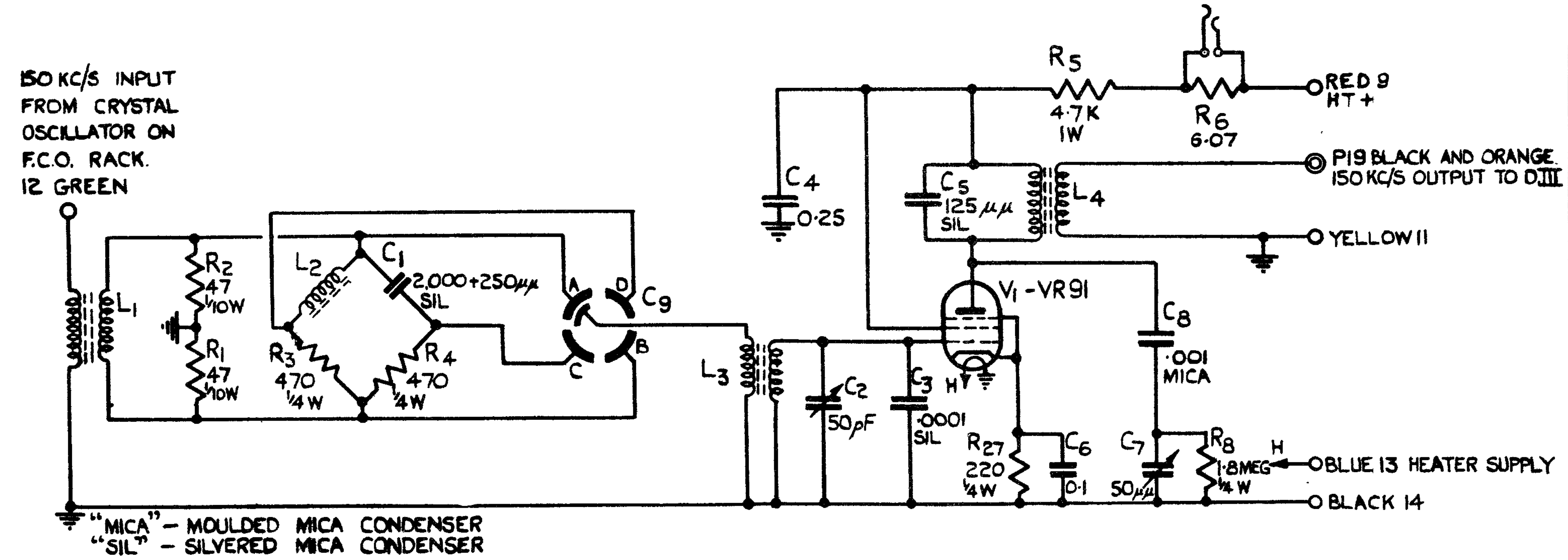


FIG.27 PHASE SHIFTER 3 — CIRCUIT

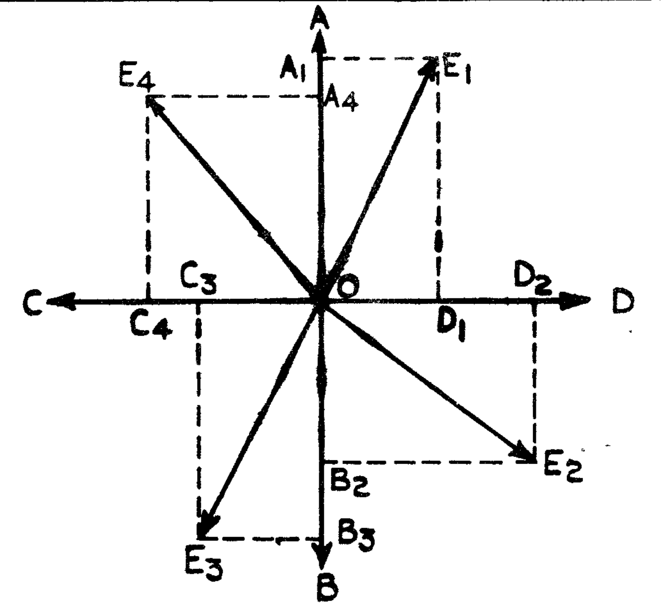


FIG.28 PHASE SHIFTERS — VECTOR DIAGRAM

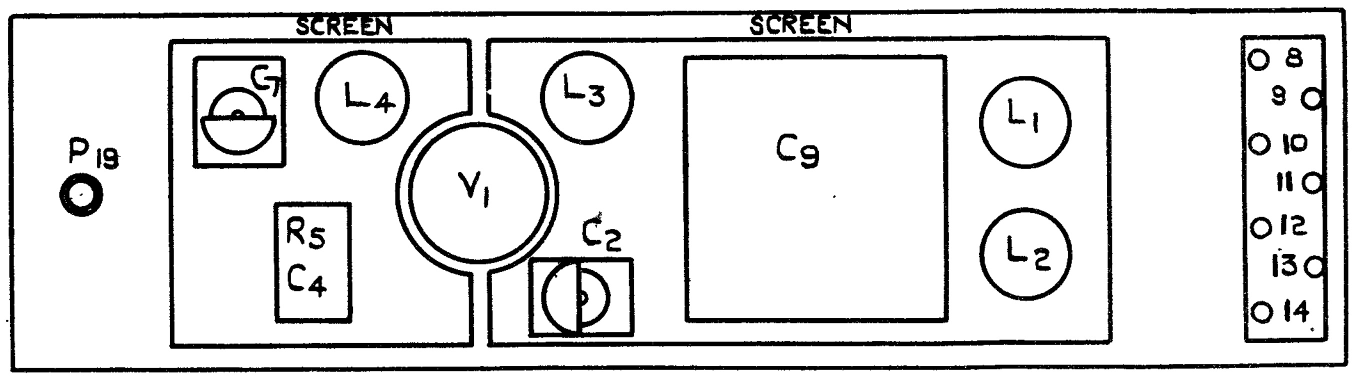


FIG.29 PHASE SHIFTER 3 — LAYOUT

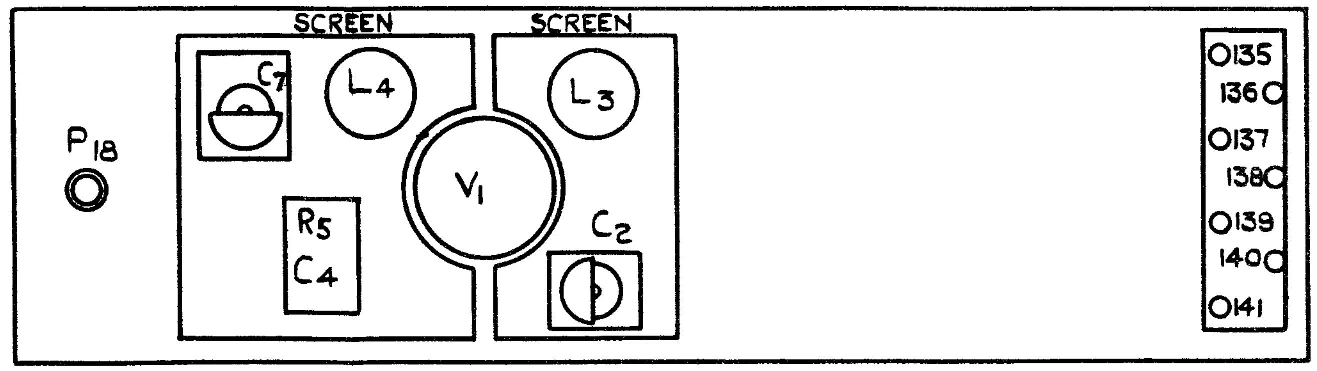
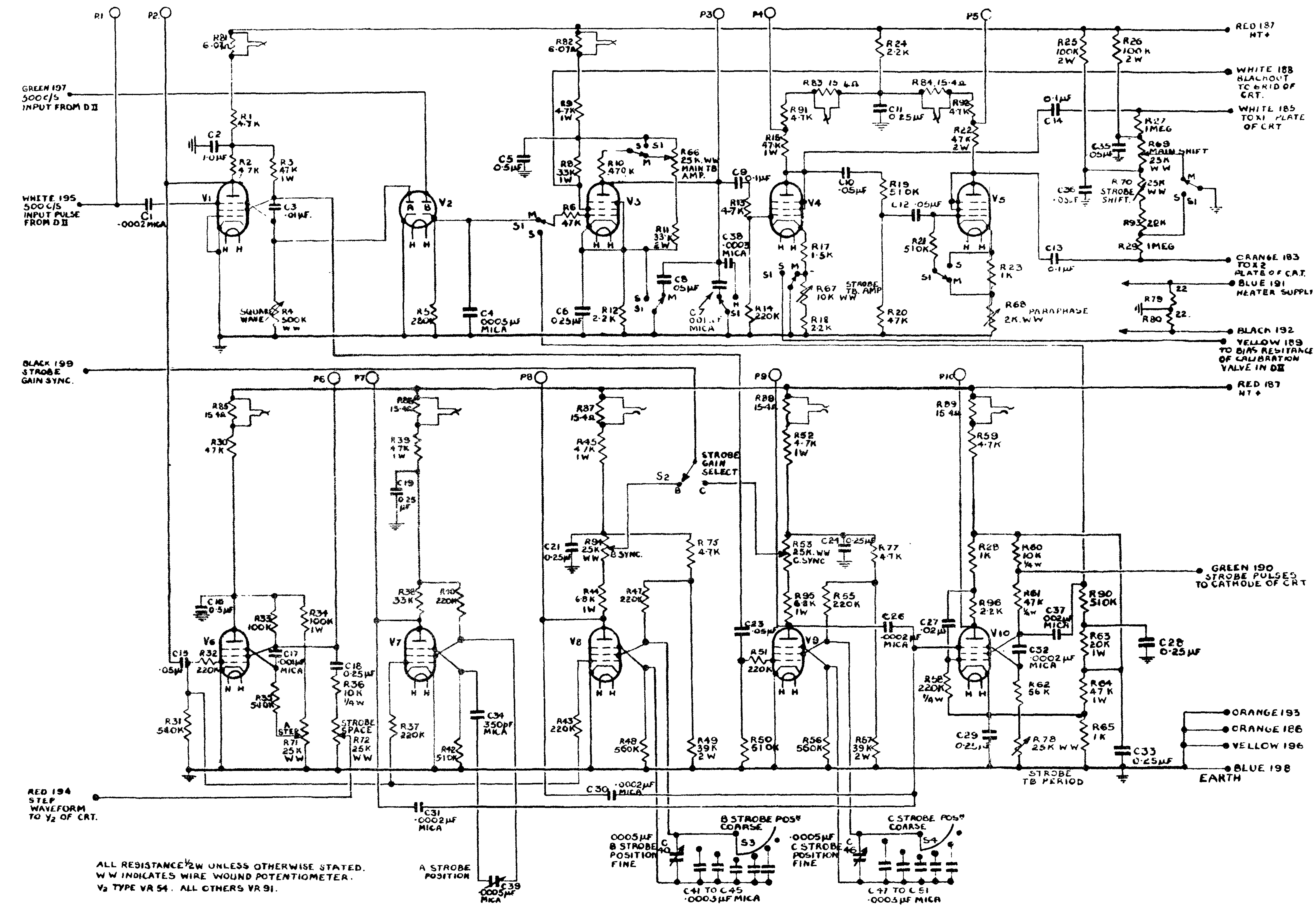


FIG. 30 PHASE SHIFTER 4— LAYOUT

FIGS. 26—30



TIME BASE UNIT CIRCUIT

FIG.31

FIG.31

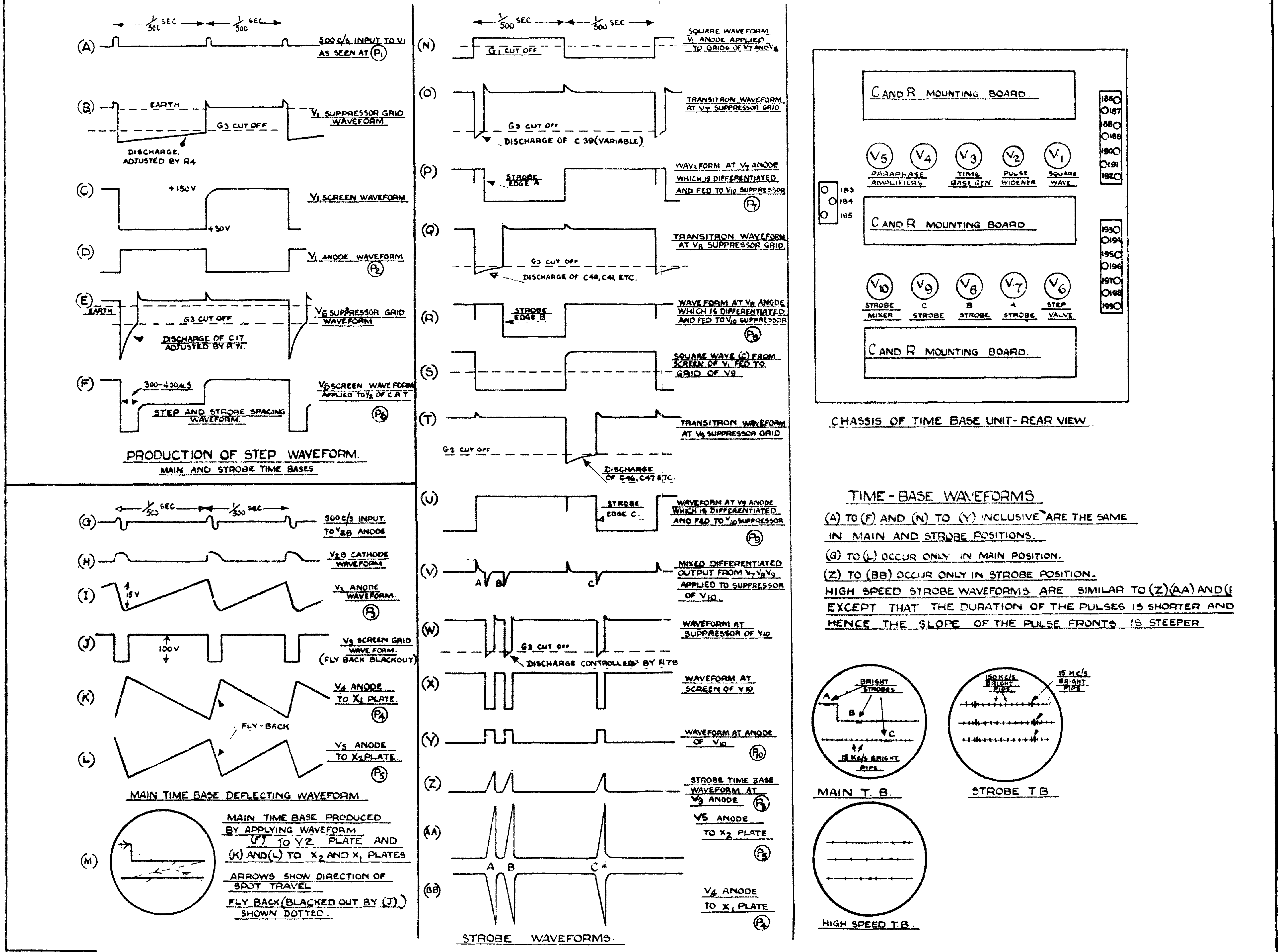
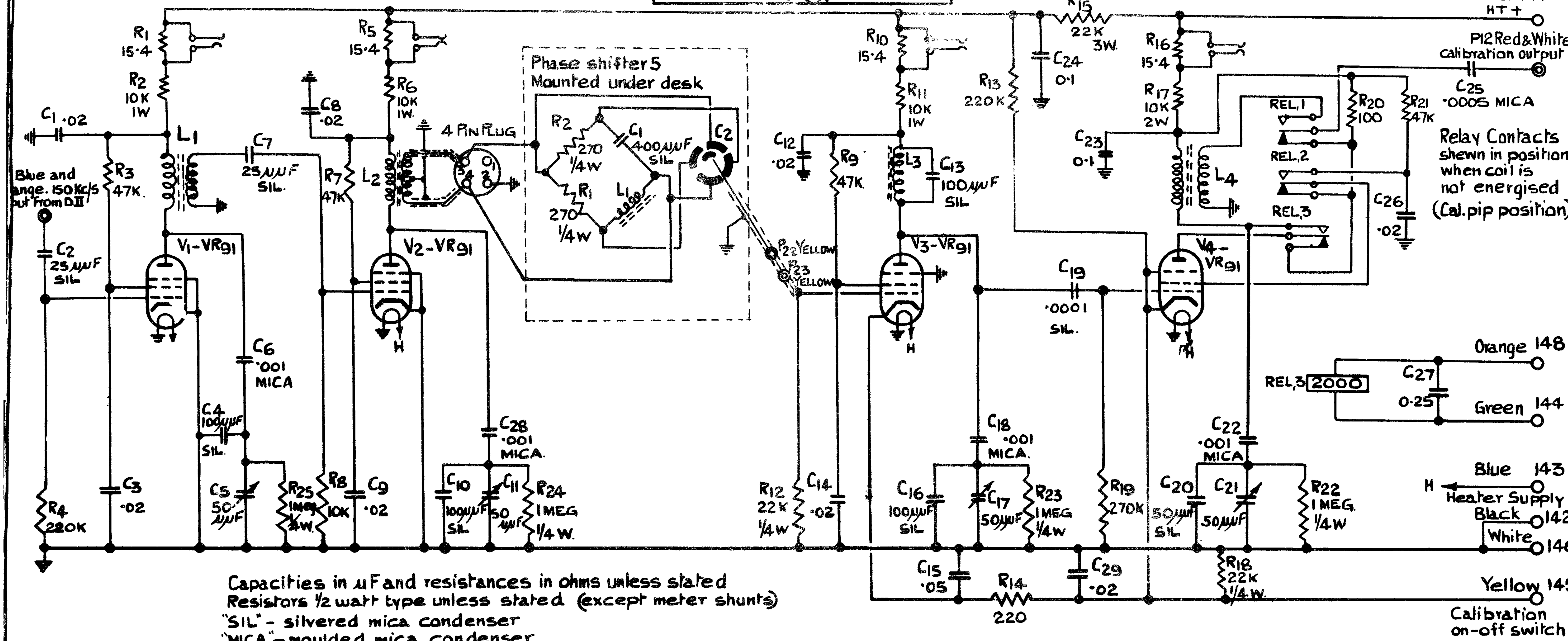
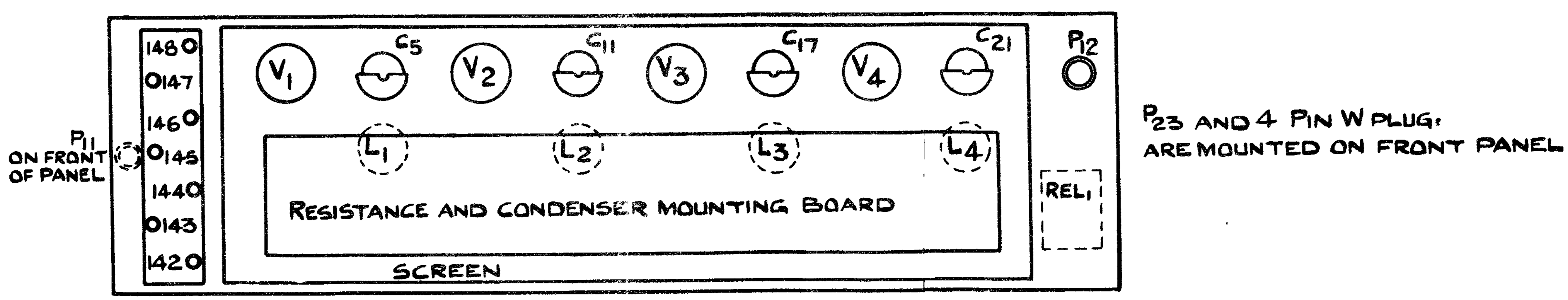


FIG. 32 TIME BASE WAVEFORMS AND CHASSIS LAYOUT FIG. 32



Capacities in μF and resistances in ohms unless stated
Resistors ½ watt type unless stated (except meter shunts)
"SIL" - silvered mica condenser
"MICA" - moulded mica condenser

FIG. 33 1·5 Mc/S CALIBRATION UNIT – CIRCUIT

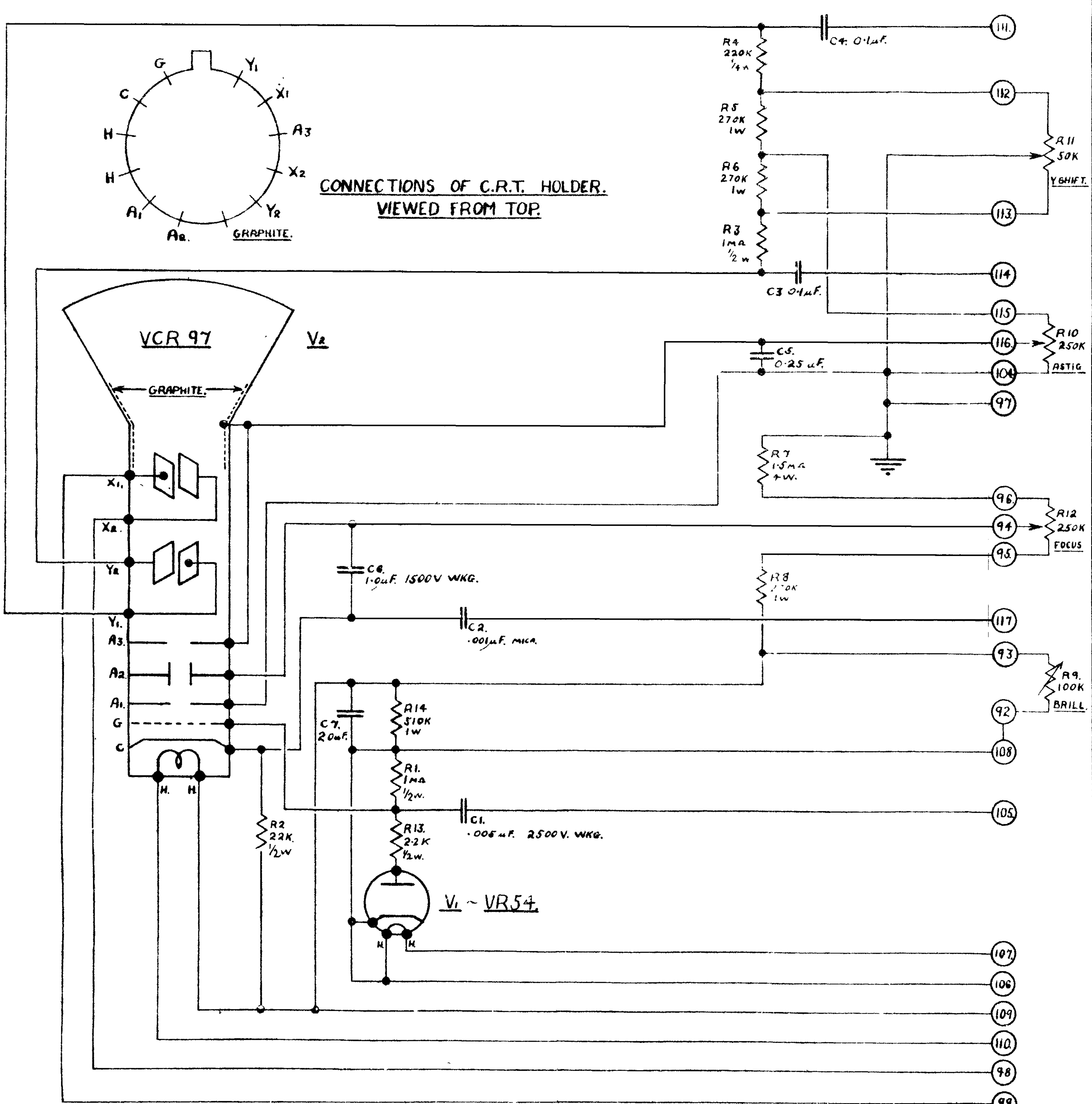


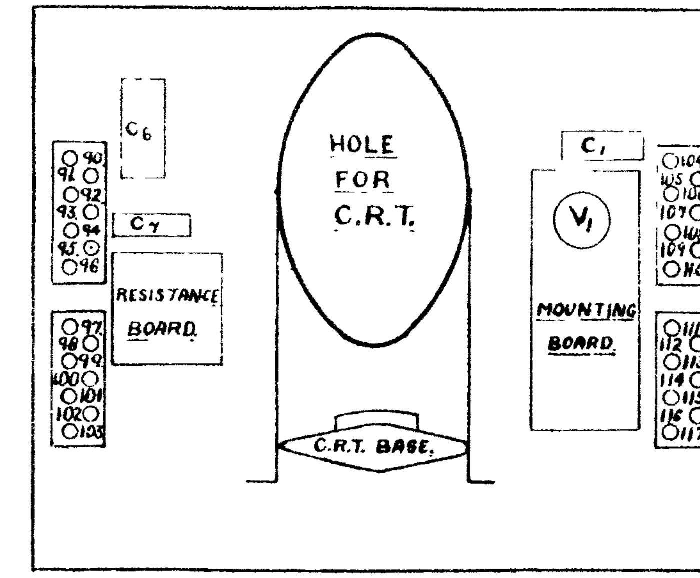
CHASSIS LAYOUT – REAR VIEW

P23 AND 4 PIN W PLUG ARE MOUNTED ON FRONT PANEL

FIG. 34 1·5 Mc/S CALIBRATION UNIT – LAYOUT

FIGS. 33 & 34





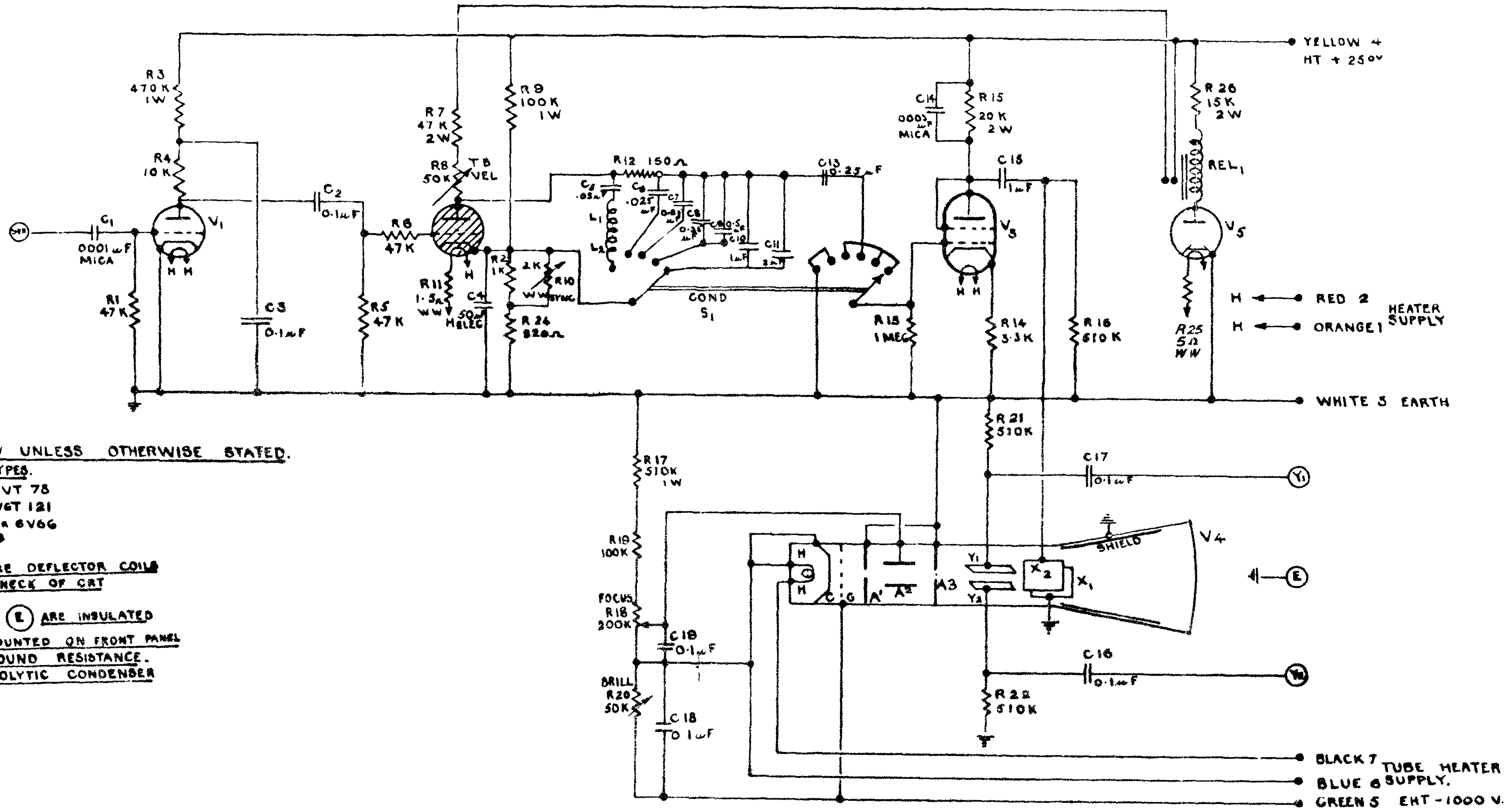
CHASSIS LAYOUT ~ REAR VIEW.

(111) ~ BLACK. PULSES FROM RECEIVER UNIT OR F.6.1.
(112) ~ BLUE
(113) ~ GREEN.
(114) ~ YELLOW. STEP WAVEFORM & 1.5 m/c CAL WAVE
(115) ~ WHITE. H.T. +ve 300V FROM PP3.
(116) ~ RED.
(104) ~ BLACK.
(97) ~ BLACK.
(96) ~ ORANGE.
(94) ~ WHITE.
(95) ~ RED.
(117) ~ ORANGE CAL. PIPS & STROBE BRIGHTENING
(93) ~ YELLOW
(92) ~ GREEN
(108) ~ WHITE. −2000V. E.H.T.
(105) ~ BLUE BLACKOUT. FROM TIME BASE UNIT.
(107) ~ YELLOW } HEATER SUPPLY.
(106) ~ GREEN. }
(109) ~ RED } TUBE HEATER SUPPLY.
(110) ~ ORANGE }
(98) ~ BLUE. } T.B. WAVEFORM.
(99) ~ GREEN. }

R9, R10, R11, R12 } ~ MOUNTED ON BRIGHTNESS & FOCUS PANEL

FIG.35 C.R.T. UNIT CIRCUIT FIG.35

53226-1



RESISTORS ½ W UNLESS OTHERWISE STATED.

VALVE TYPES.

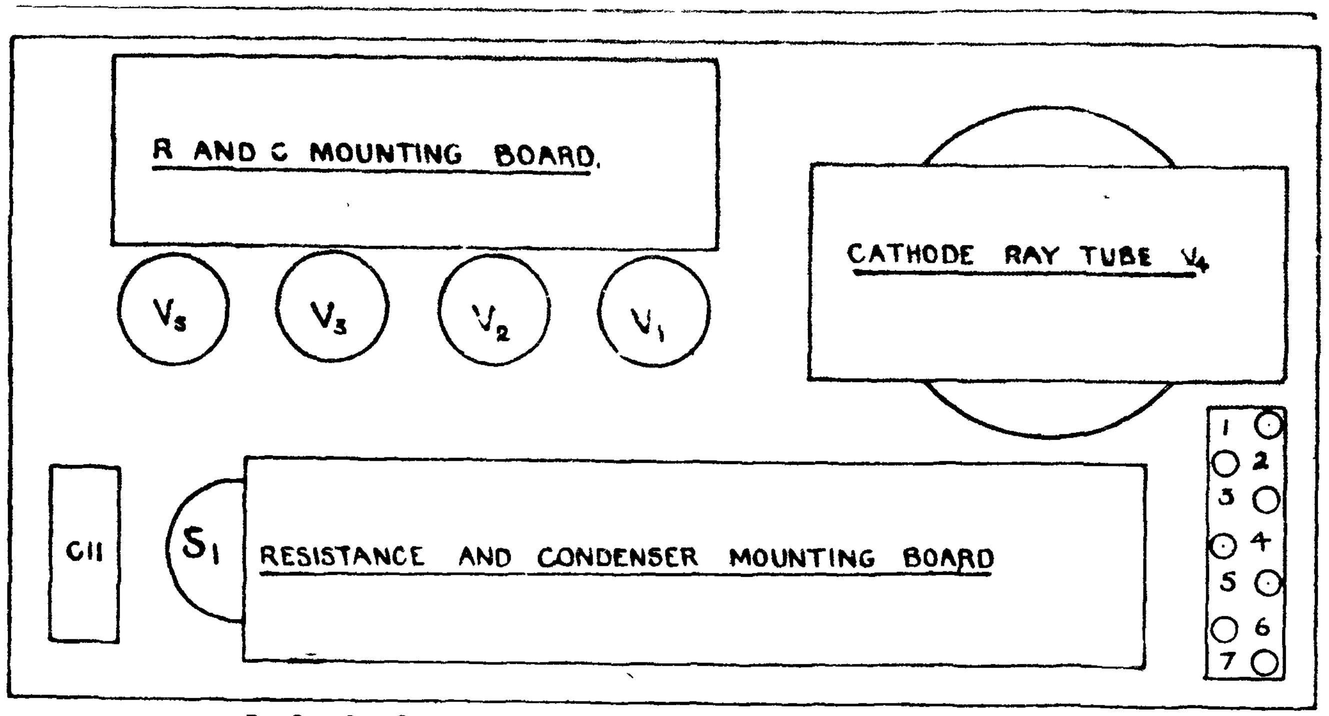
V_1 - H63 OR VT 73
V_2 - T41 OR VGT 121
V_3 - KT63 OR 6V6G
V_4 - VCR 138
V_5 - D42

COILS L_1 L_2 ARE DEFLECTOR COILS MOUNTED ON NECK OF CRT

(SYN) (Y_1) (Y_2) (E) ARE INSULATED TERMINALS MOUNTED ON FRONT PANEL

WW - WIREWOUND RESISTANCE.

ELEC- ELECTROLYTIC CONDENSER



R8 R10 R18 R20 ARE MOUNTED INSIDE FRONT PANEL.

CHASSIS LAYOUT REAR VIEW.

OSCILLOGRAPH UNIT CIRCUIT

FIG 37

FIG.37

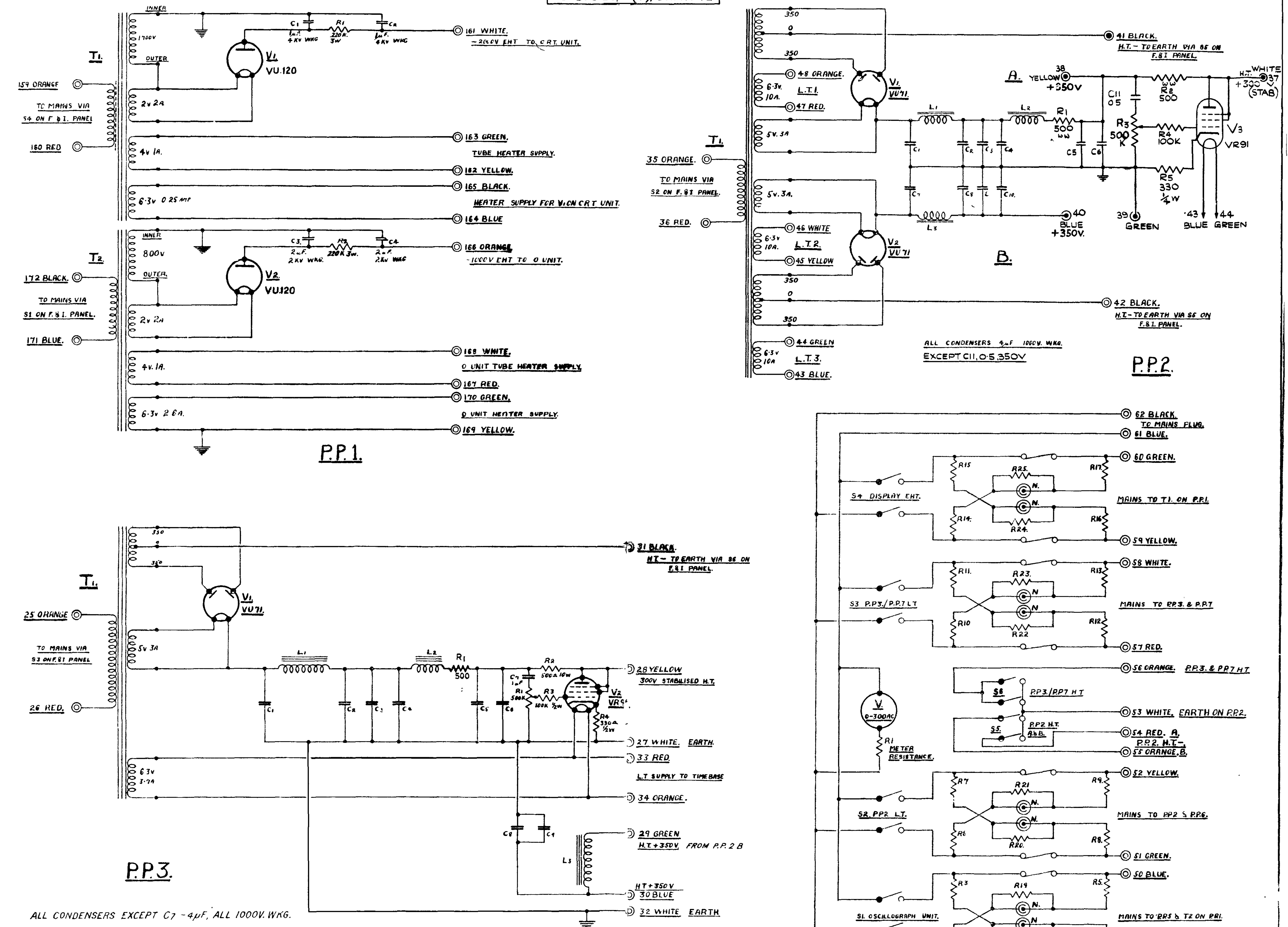


FIG. 38 POWER PACKS P. P. 1, P. P. 2 AND P. P. 3 CIRCUITS

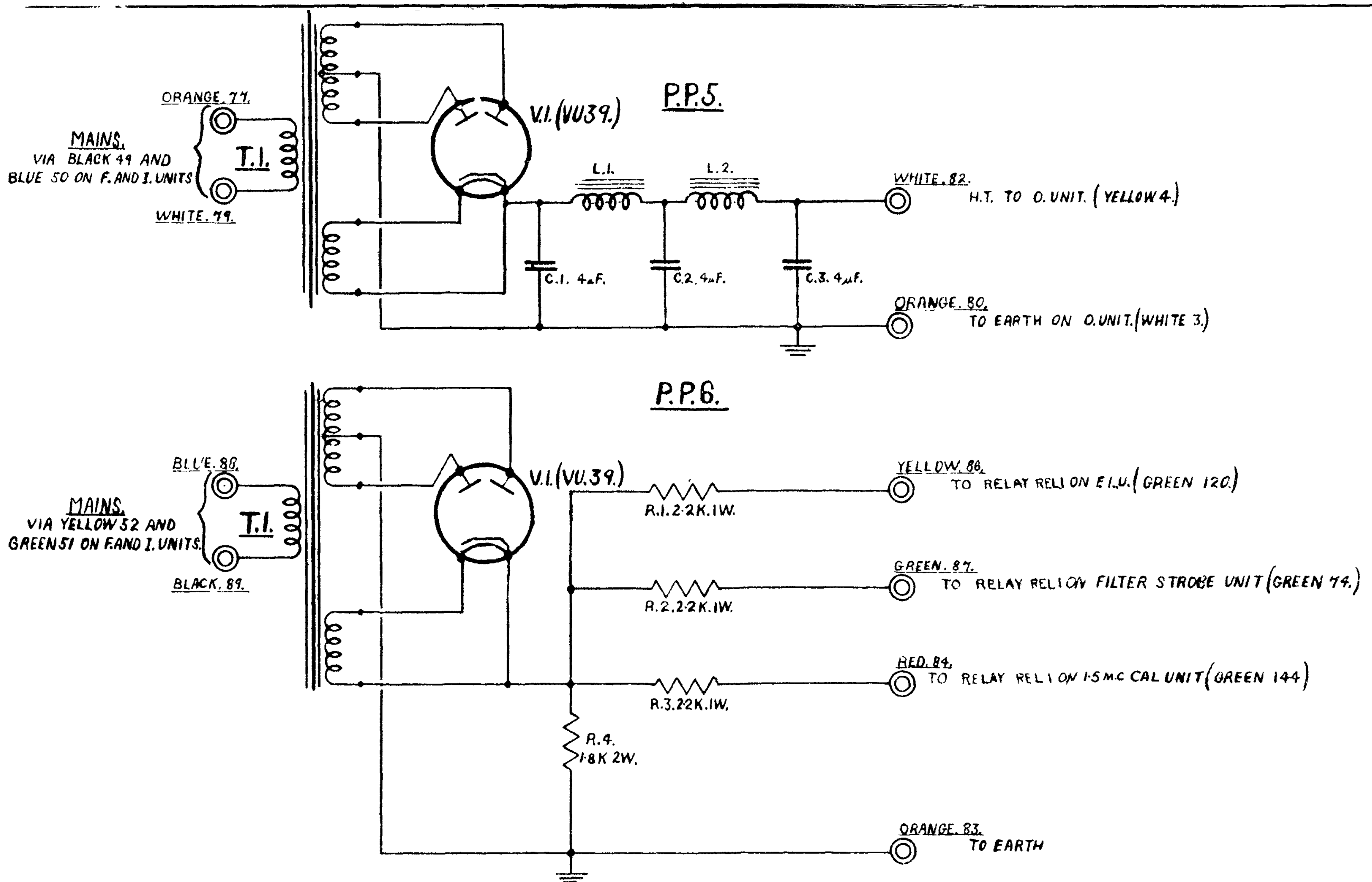
FIG. 39 - FUSE AND INDICATOR PANEL CIRCUIT

N ~ NEON BULBS.
R2 TO R17 ~ 220K ½ W.
R18 TO R25 ~ 1MEG ½ W.

FIGS. 38-39

FIG. 40

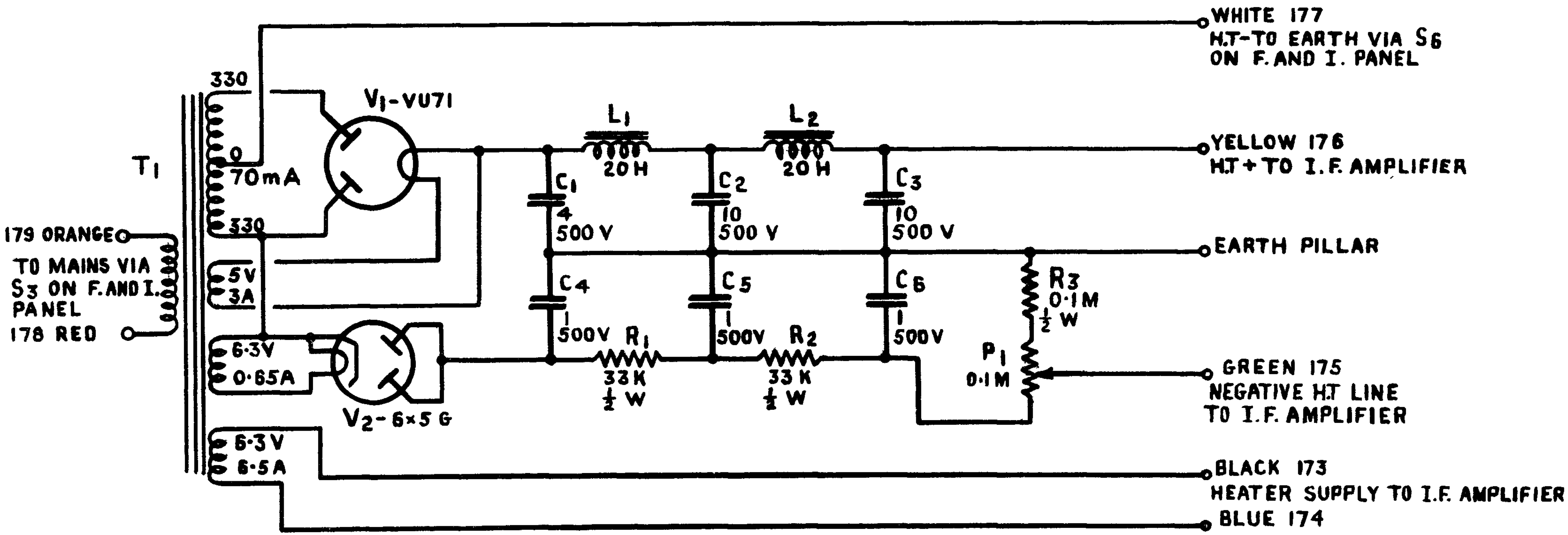
S.D. 0295 (1), CHAP. 12



POWER PACKS P.P.5 AND P.P.6 CIRCUITS

FIG. 40

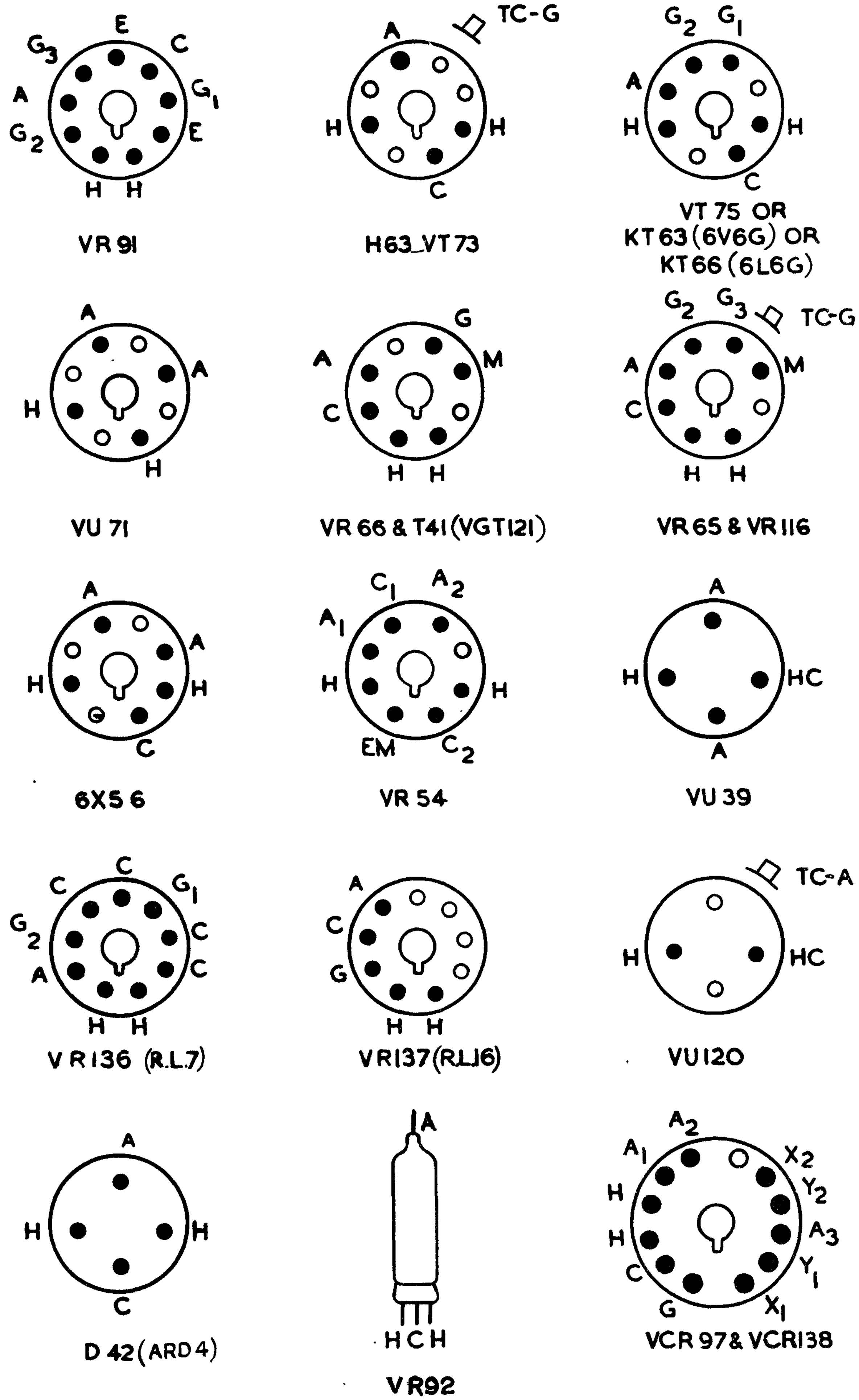
FIG.41



POWER PACK P.P.7 CIRCUIT

S.D.0295, CHAP.12

FIG.41



VALVE BASE CONNECTIONS

FIG. 42

FIG. 42

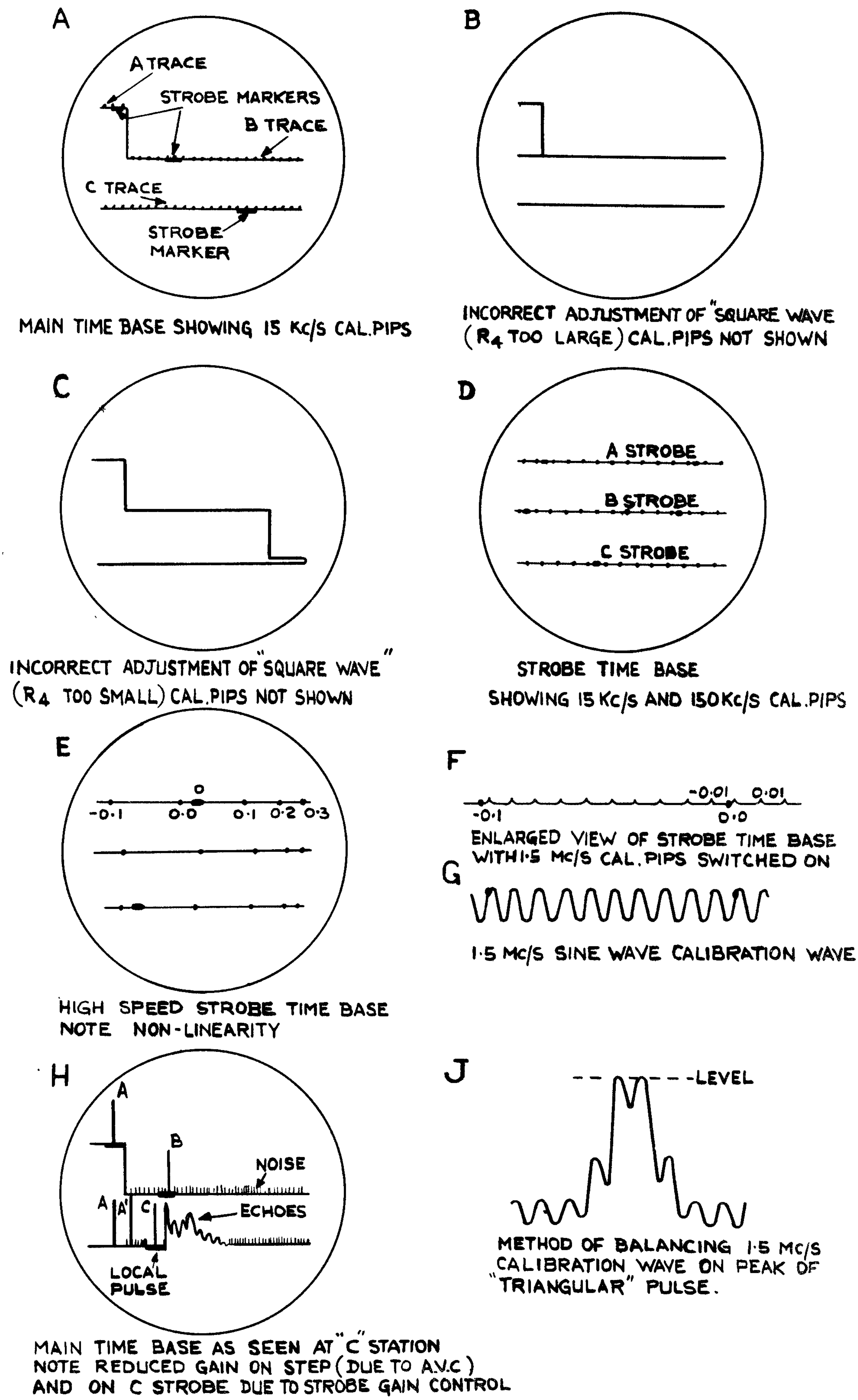
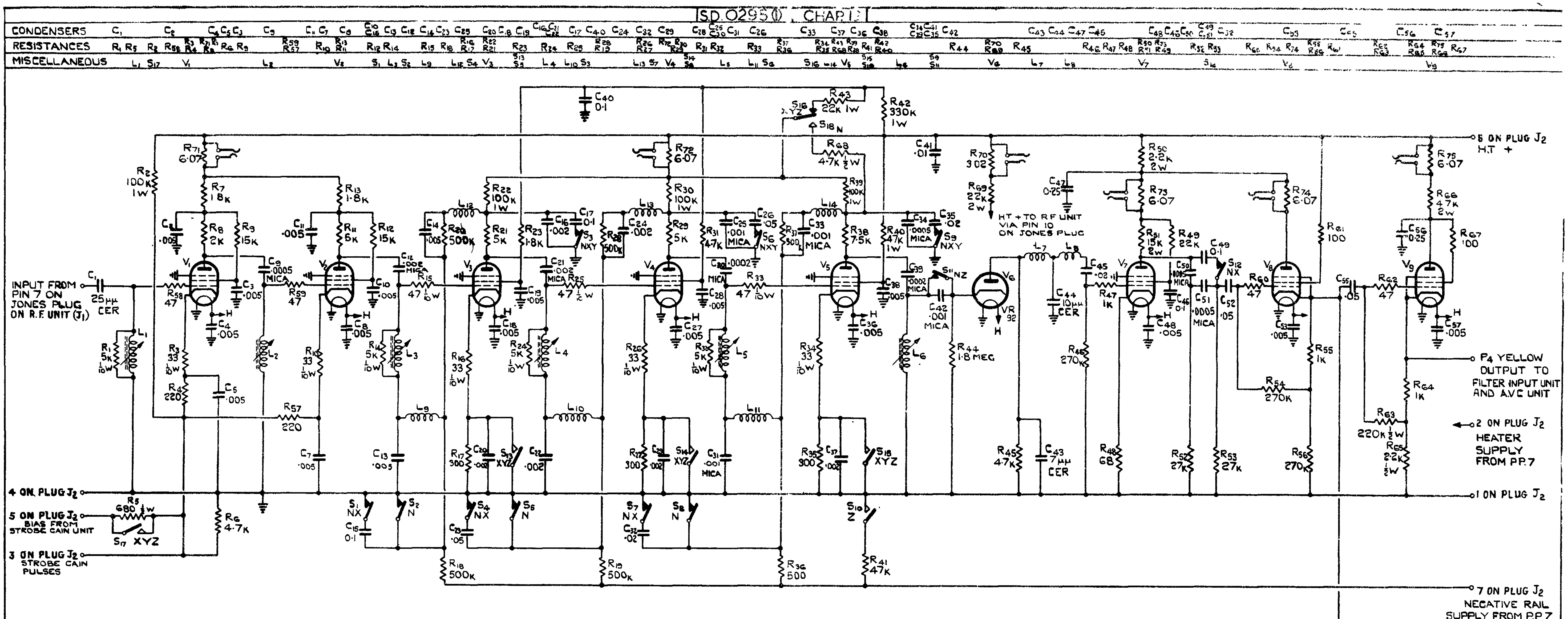


FIG.43 C.R.T. INDICATIONS FIG.43



I. F. AMPLIFIER

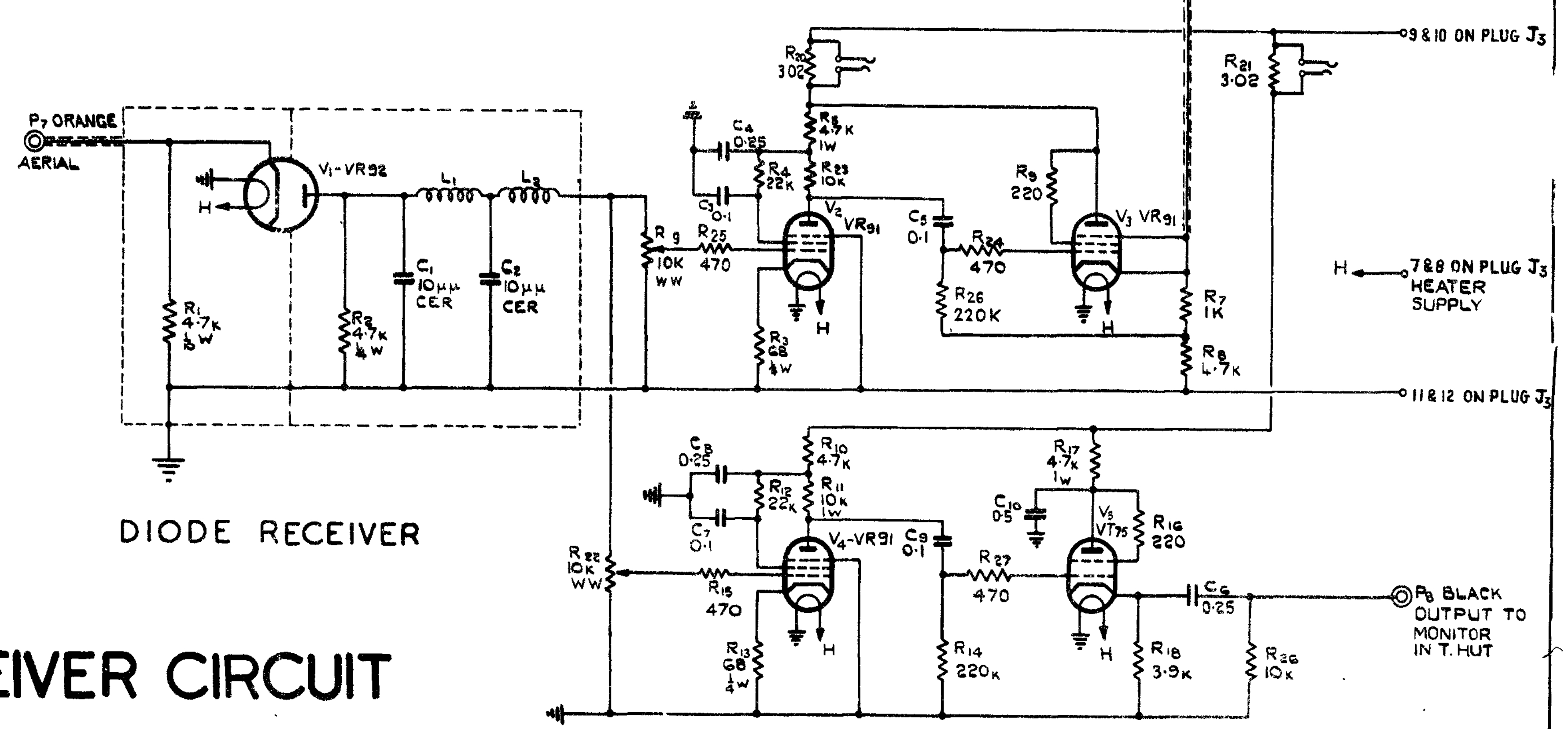
NOTES:

ALL VALVES TYPE VR 65 UNLESS OTHERWISE STATED
RESISTORS ¼ WATT TYPE UNLESS OTHERWISE STATED
"CER" CERAMIC DISC TYPE CONDENSER
"MICA" MODIFIED MICA TYPE CONDENSER
"W.W" WIRE-WOUND POTENTIOMETER

ANTI-JAMMING SWITCH CONTACTS

S_1 TO S_{18} ARE SHOWN IN THE "NORMAL" POSITION AND THE POSITIONS IN WHICH EACH ARE CLOSED ARE ALSO MARKED ON THE DIAGRAM BY THE LETTERS "N, X, Y, Z".

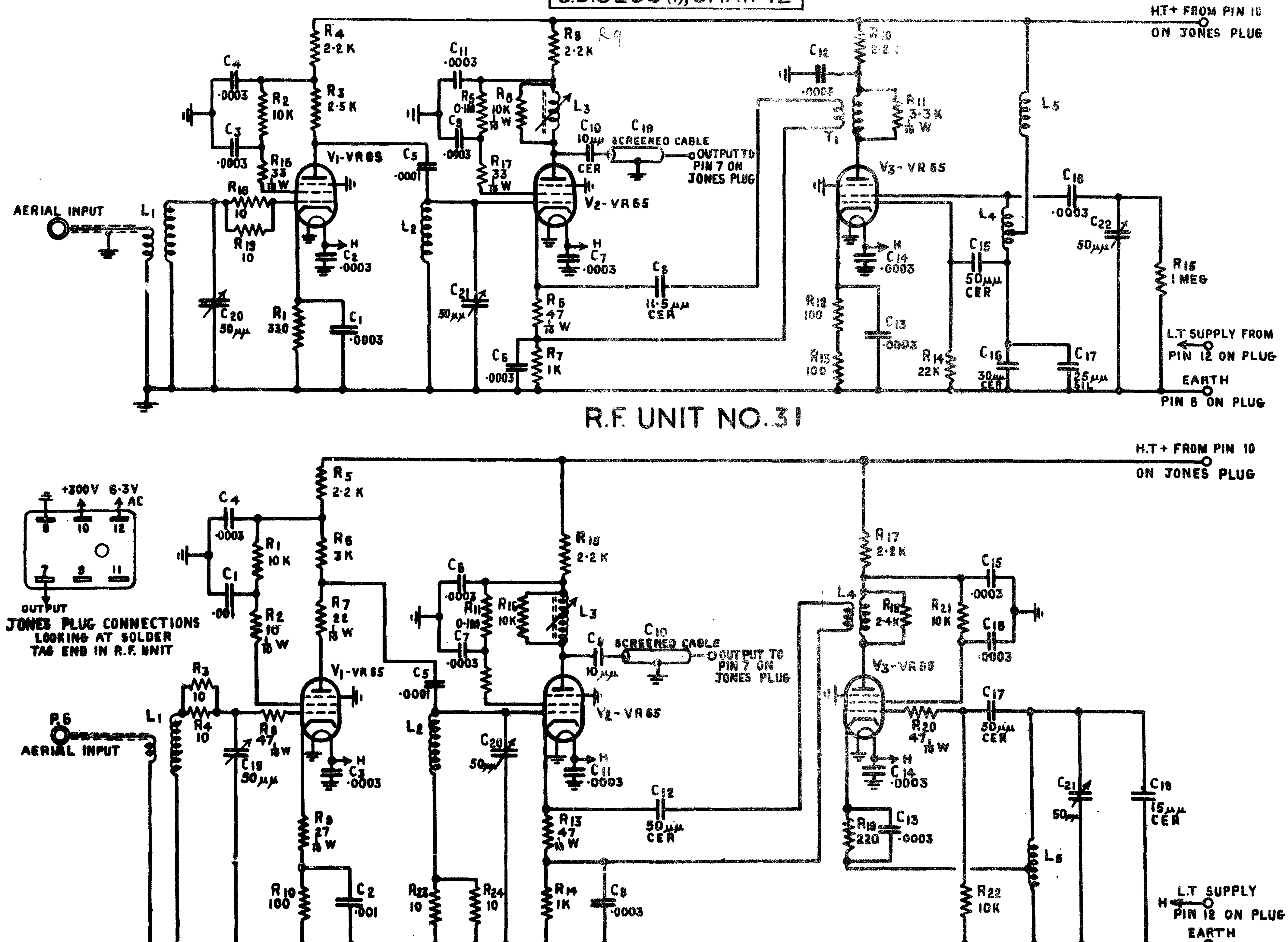
WAFER	2			3			4				5	6	2	3	4	6	1	6
SWITCH	S_1	S_2	S_3	S_4	S_5	S_6	S_7	S_8	S_9	S_{10}	S_{11}	S_{12}	S_{13}	S_{14}	S_{15}	S_{16}	S_{17}	S_{18}
N	C	C	C	C	C	C	C	C	C	O	C	C	O	O	O	O	O	C
X	C	O	C	C	O	C	C	O	C	O	O	C	C	C	C	C	C	O
Y	O	O	C	O	O	C	O	O	C	O	O	O	C	C	C	C	C	O
Z	O	O	O	O	O	O	O	O	O	C	C	O	C	C	C	C	C	O



I.F. AMPLIFIER & DIODE RECEIVER CIRCUIT

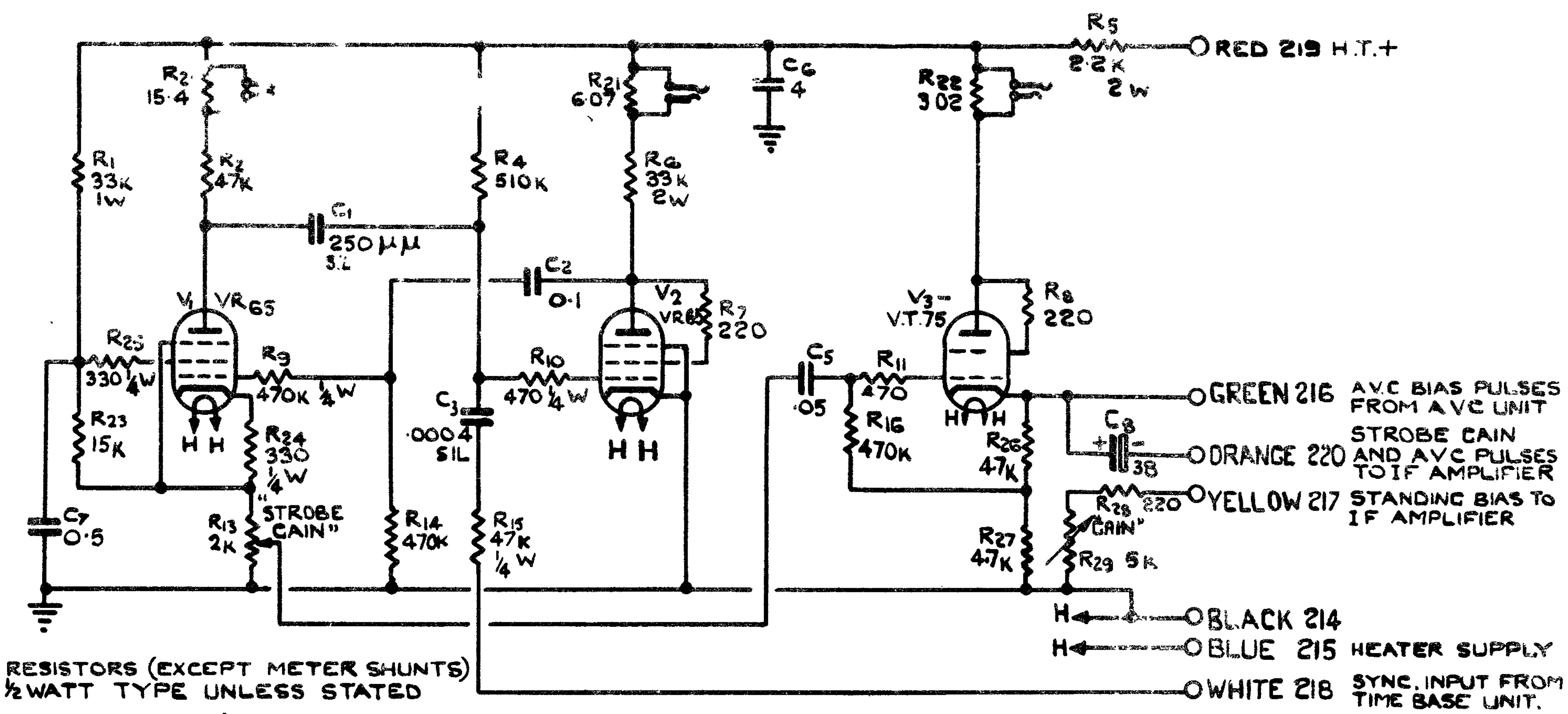
FIG. 7

FIG. 7



"CER"-CERAMIC DISC TYPE CONDENSER.
"SIL"-SILVERED MICA CONDENSER.
UNSPECIFIED CONDENSERS ARE MOULDED MICA TYPE.
RESISTORS ARE ¼ WATT TYPE UNLESS STATED.

FIG. 6

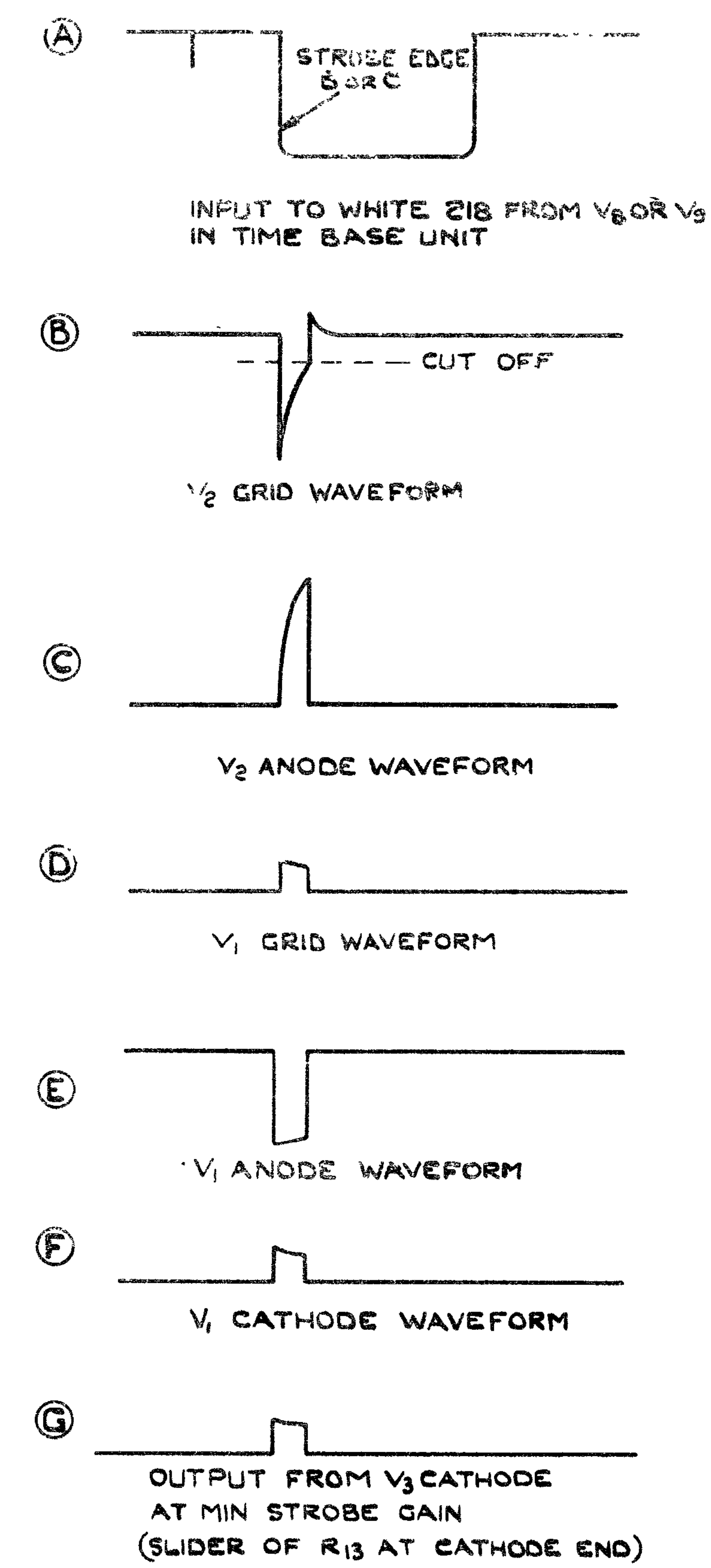


RESISTORS (EXCEPT METER SHUNTS) ½ WATT TYPE UNLESS STATED

CAPACITIES IN μf AND RESISTANCES IN OHMS UNLESS STATED

"SIL" – SILVERED MICA CONDENSERS

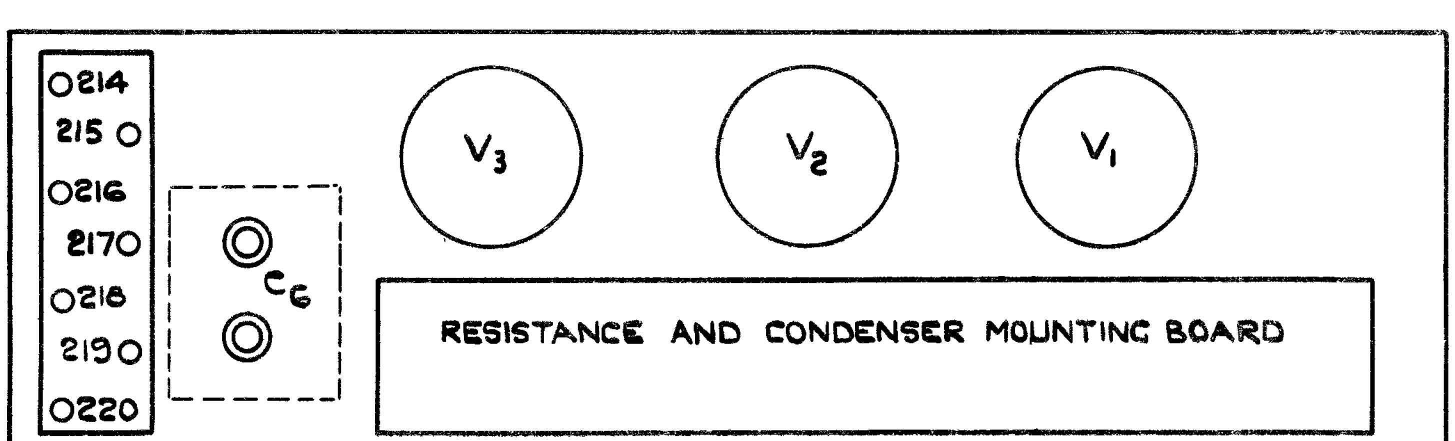
FIG. 8 STROBE GAIN CONTROL UNIT CIRCUIT



WAVEFORMS

FIG. 9 STROBE GAIN CONTROL UNIT

R13 AND R29 MOUNTED ON FRONT PANEL



CHASSIS LAYOUT – REAR VIEW

FIG. 10 STROBE GAIN CONTROL UNIT

FIG. 8, 9 & 10

3226-1

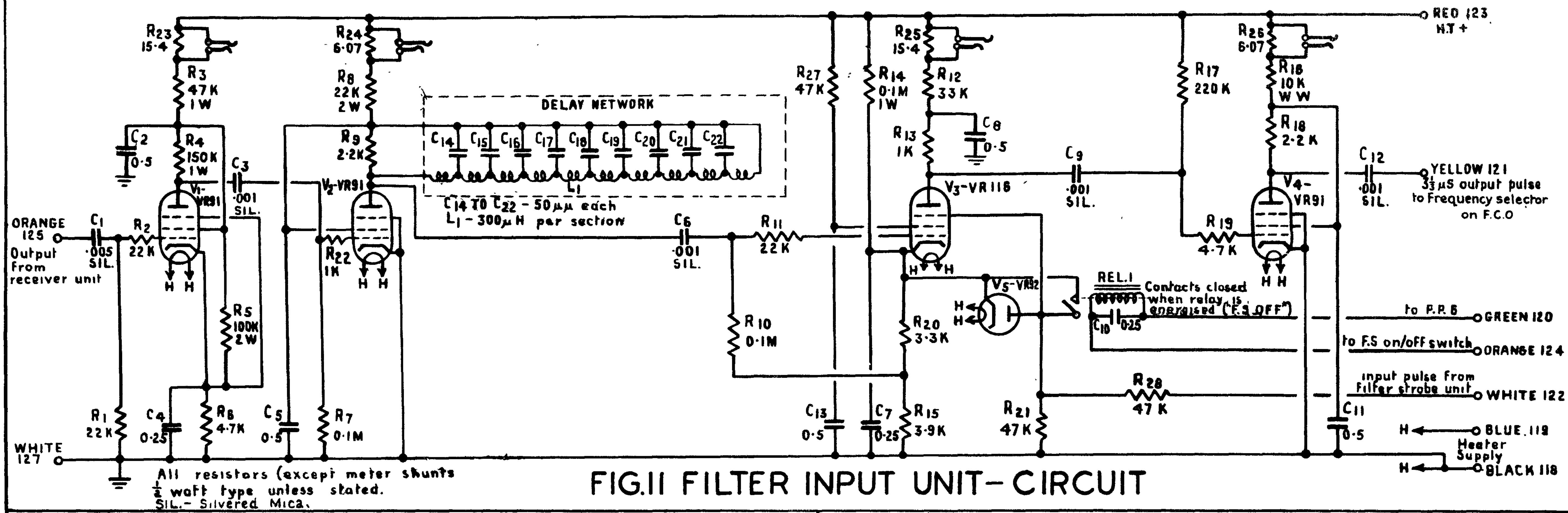
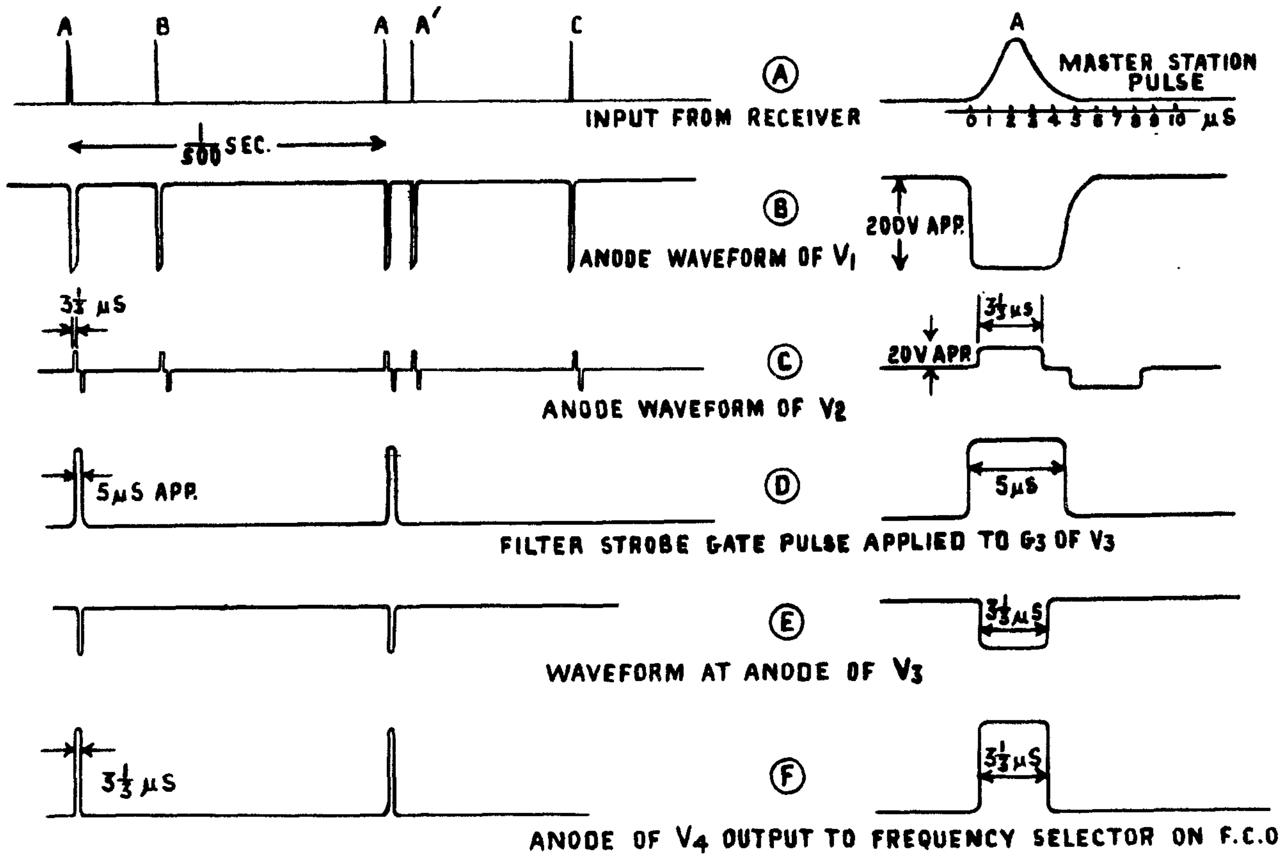


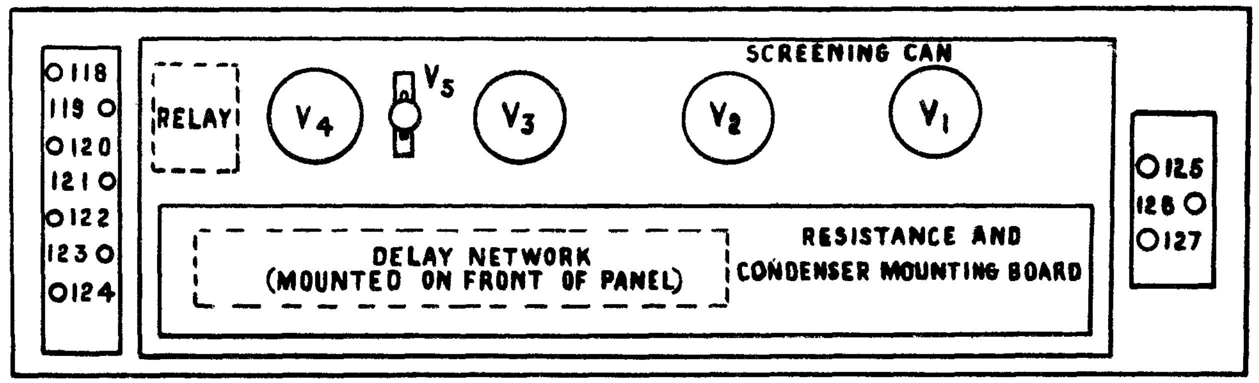
FIG.11 FILTER INPUT UNIT-CIRCUIT



WAVEFORMS

NOTE. Waveforms on the right are expanded views of pictures on left

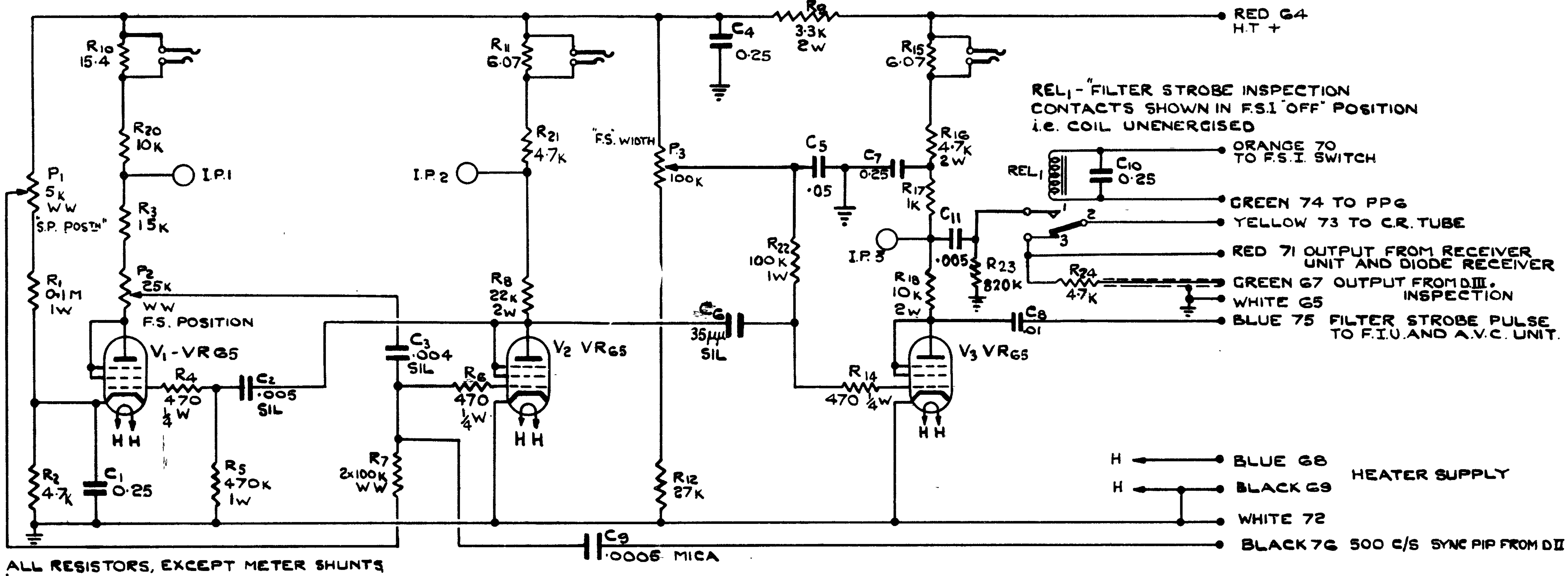
FIG.12 FILTER INPUT UNIT WAVEFORMS



CHASSIS LAYOUT—REAR VIEW

FIG.13 FILTER INPUT LAYOUT

FIGS. 11, 12 & 13



ALL RESISTORS, EXCEPT METER SHUNTS
½ WATT TYPE UNLESS STATED
"W W" - WIREWOUND RESISTOR OR POTENTIOMETER
"SIL" - SILVERED MICA CONDENSER
"MICA" - MOULDED MICA CONDENSER

FIG. 14 FILTER STROBE UNIT

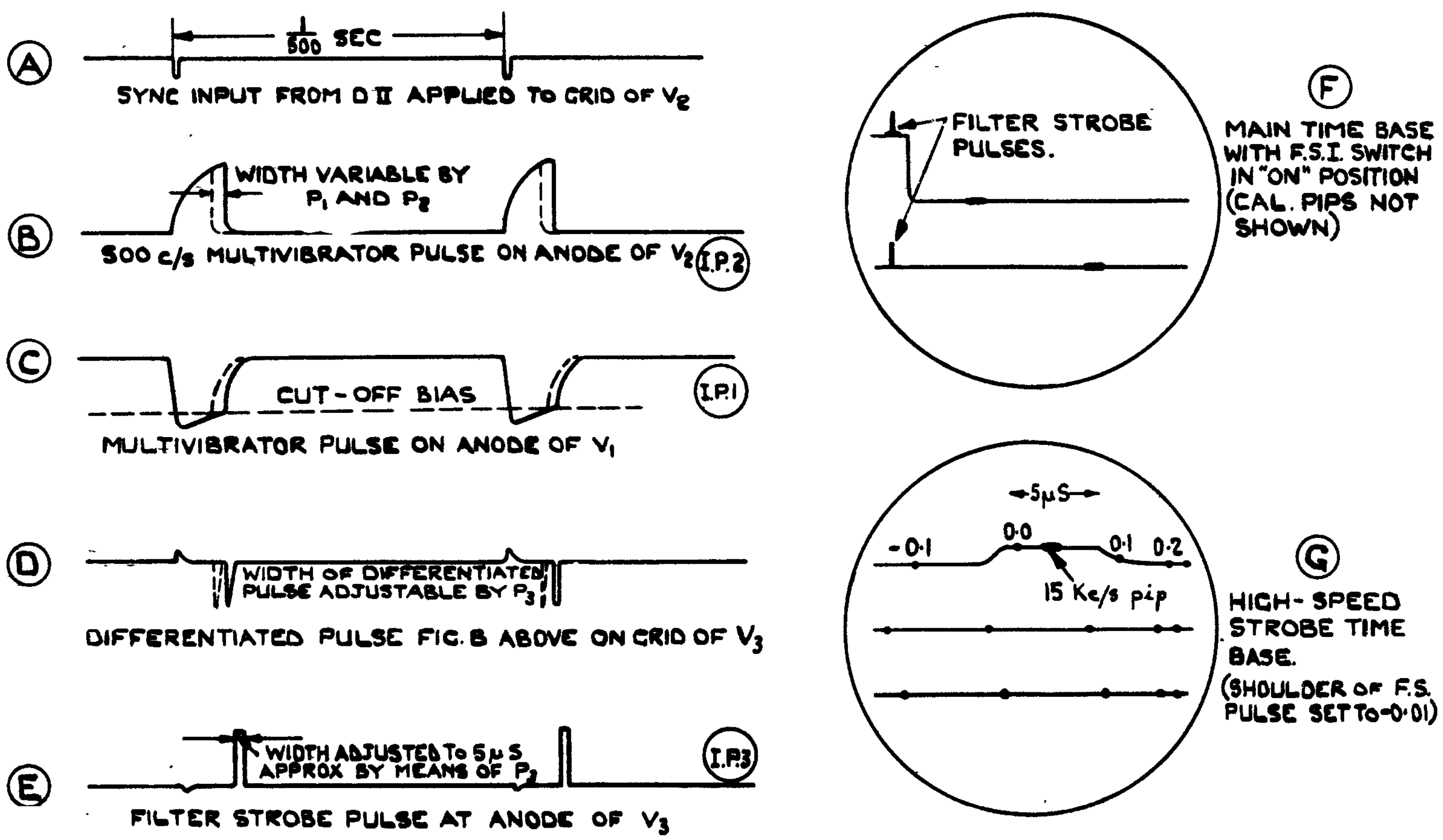
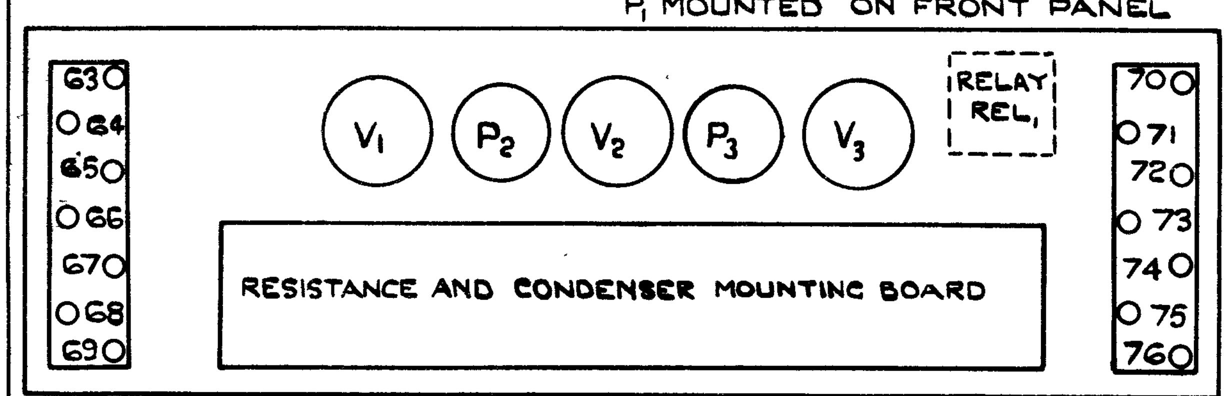


FIG. 15 FILTER STROBE UNIT-WAVEFORMS

P1 MOUNTED ON FRONT PANEL



CHASSIS LAYOUT REAR VIEW

FIG. 16 FILTER STROBE UNIT-LAYOUT

FIG.14 15&16

53846-1

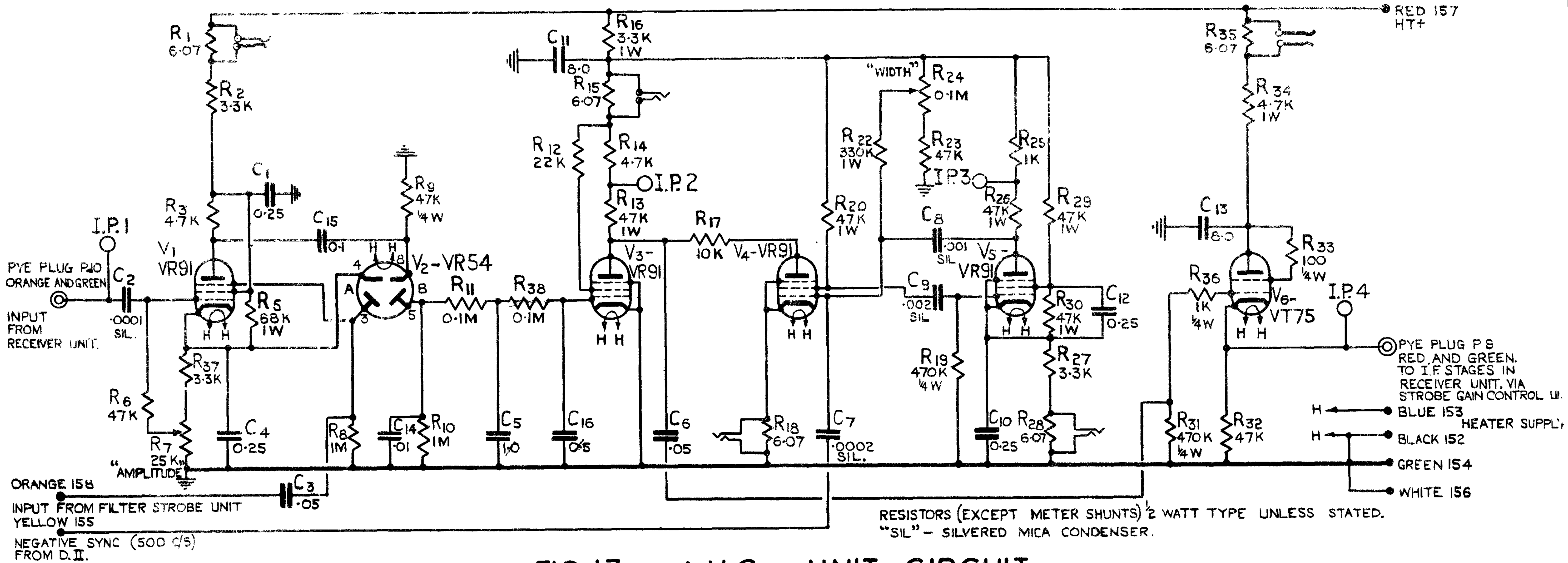


FIG. 17 A.V.C. UNIT CIRCUIT

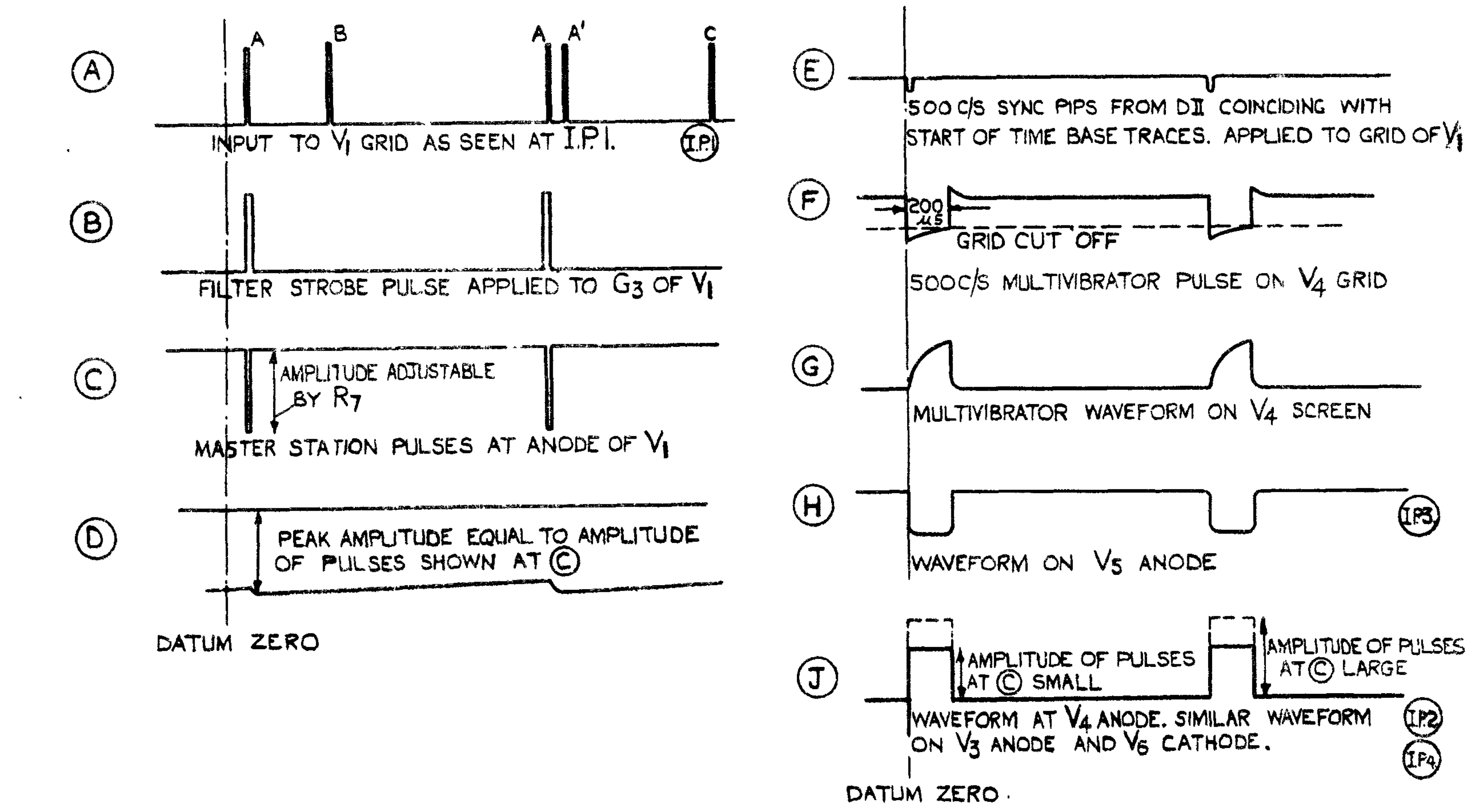
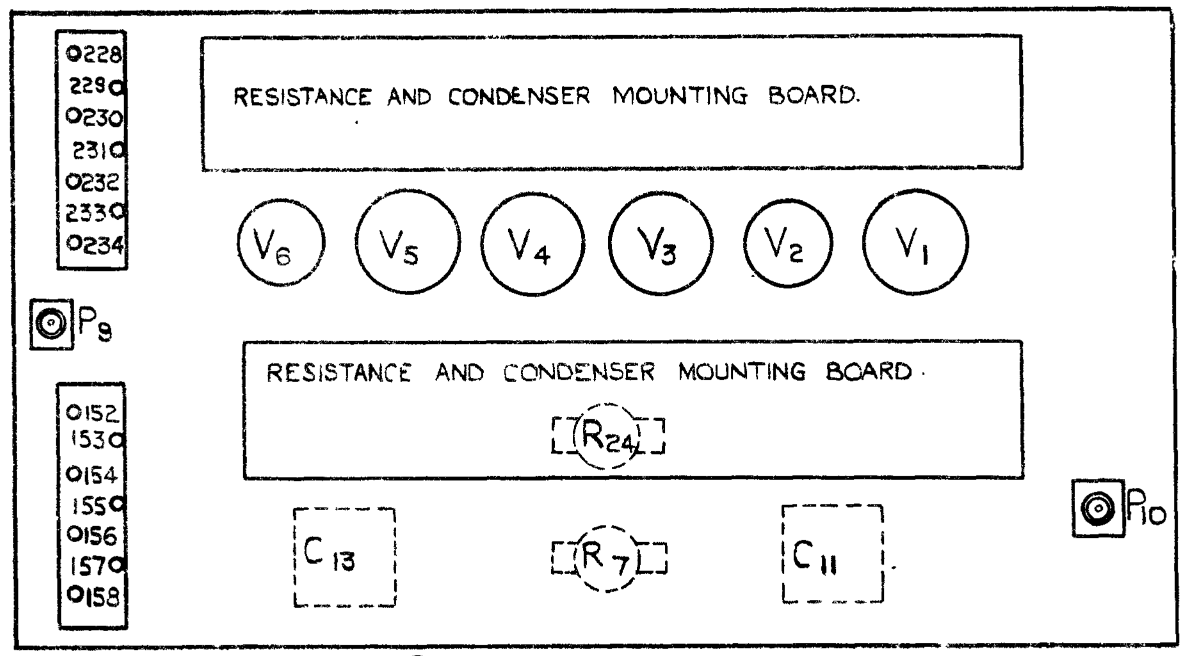


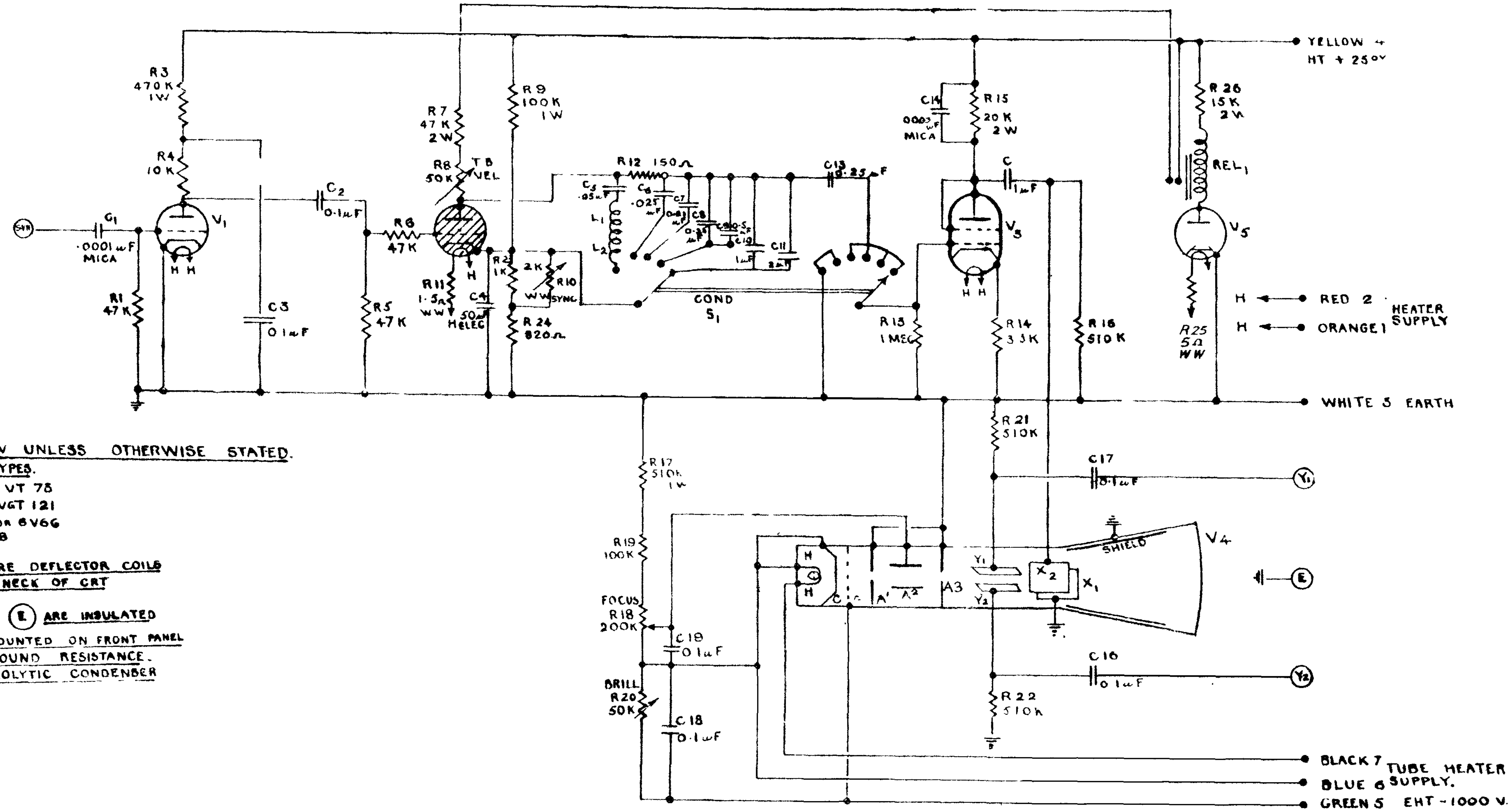
FIG. 18 A.V.C. UNIT WAVEFORMS



R_7 AND R_{24} MOUNTED ON FRONT OF PANEL

FIG. 19 A.V.C. UNIT LAYOUT

FIGS 17, 18 & 19



RESISTORS ½ W UNLESS OTHERWISE STATED.

VALVE TYPES.

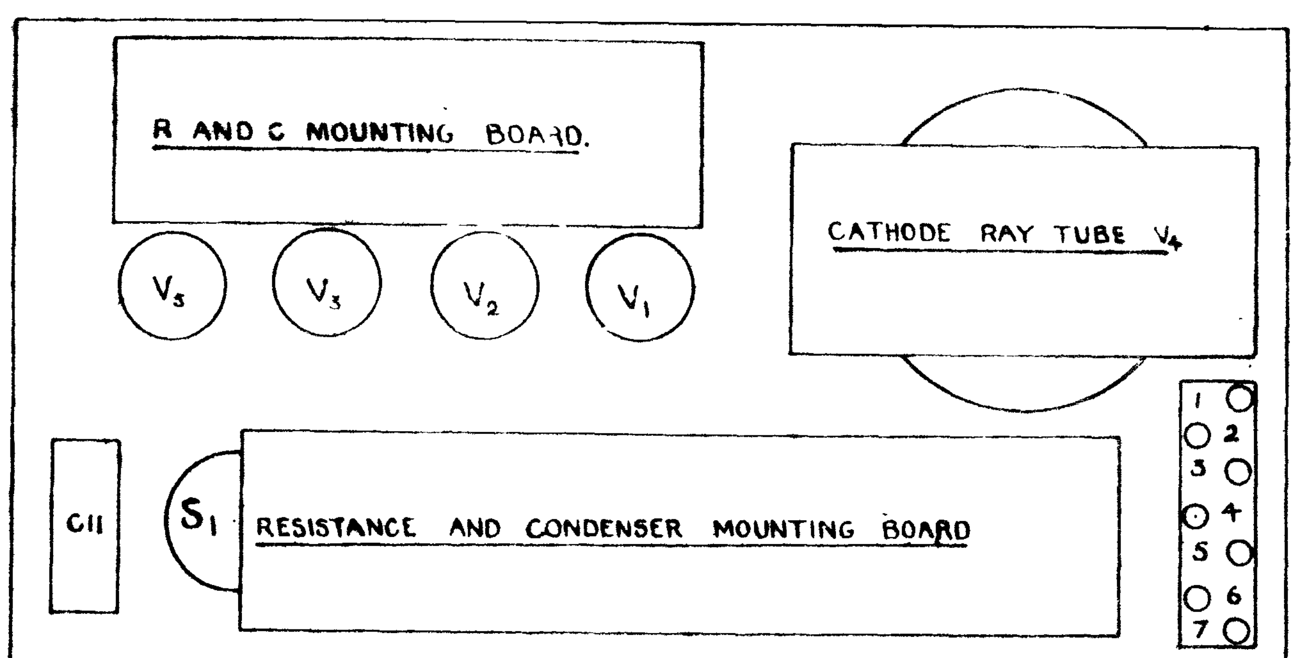
V_1 - H63 OR VT 75
V_2 - T41 OR VGT 121
V_3 - KT 63 OR 6V6G
V_4 - VCR 138
V_5 - D42

COILS L_1 L_2 ARE DEFLECTOR COILS MOUNTED ON NECK OF CRT

(SYN) (Y_1) (Y_2) (E) ARE INSULATED TERMINALS MOUNTED ON FRONT PANEL

WW - WIREWOUND RESISTANCE.

ELEC - ELECTROLYTIC CONDENSER



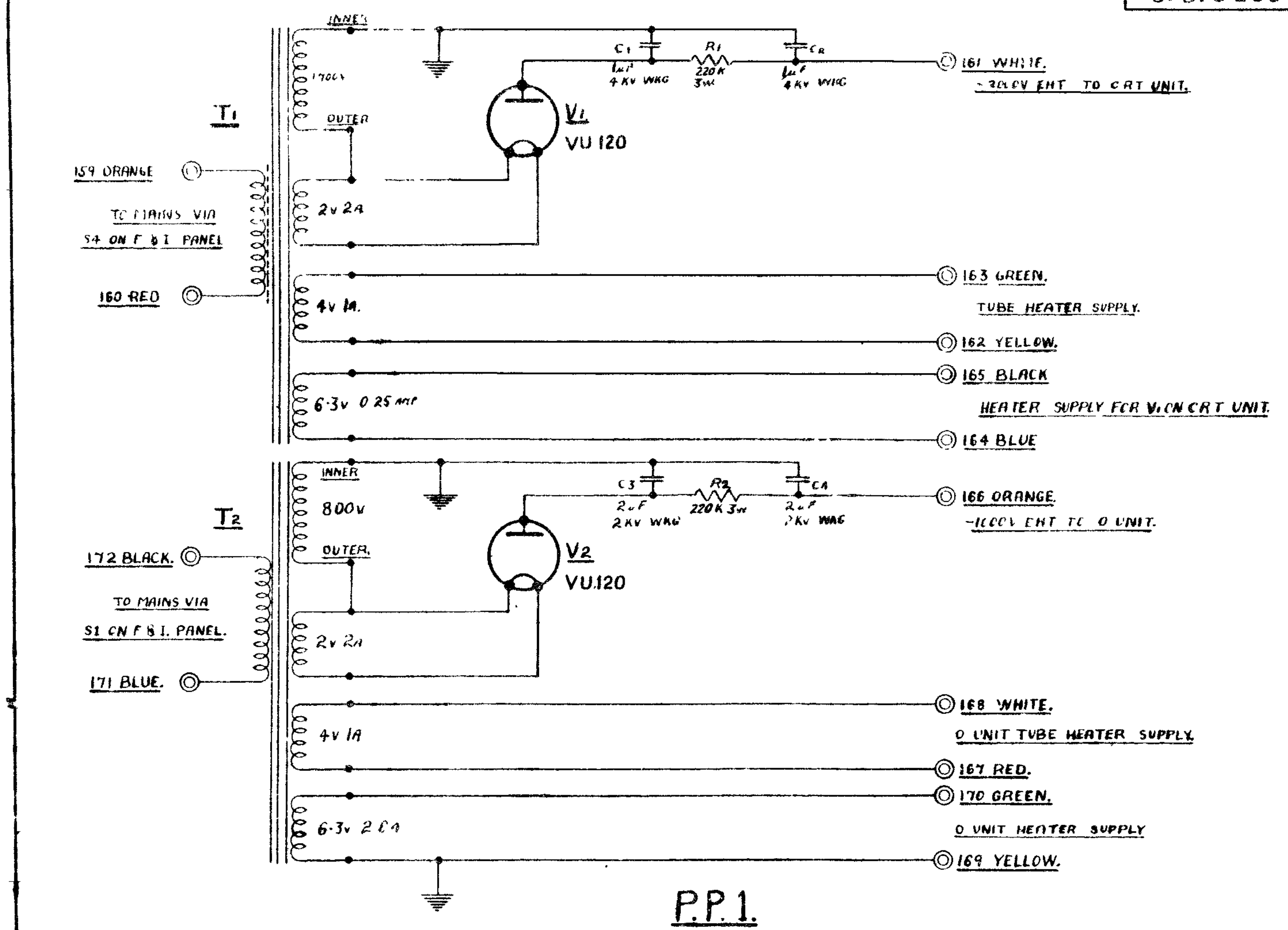
R_8 R_{10} R_{18} R_{20} ARE MOUNTED INSIDE FRONT PANEL.

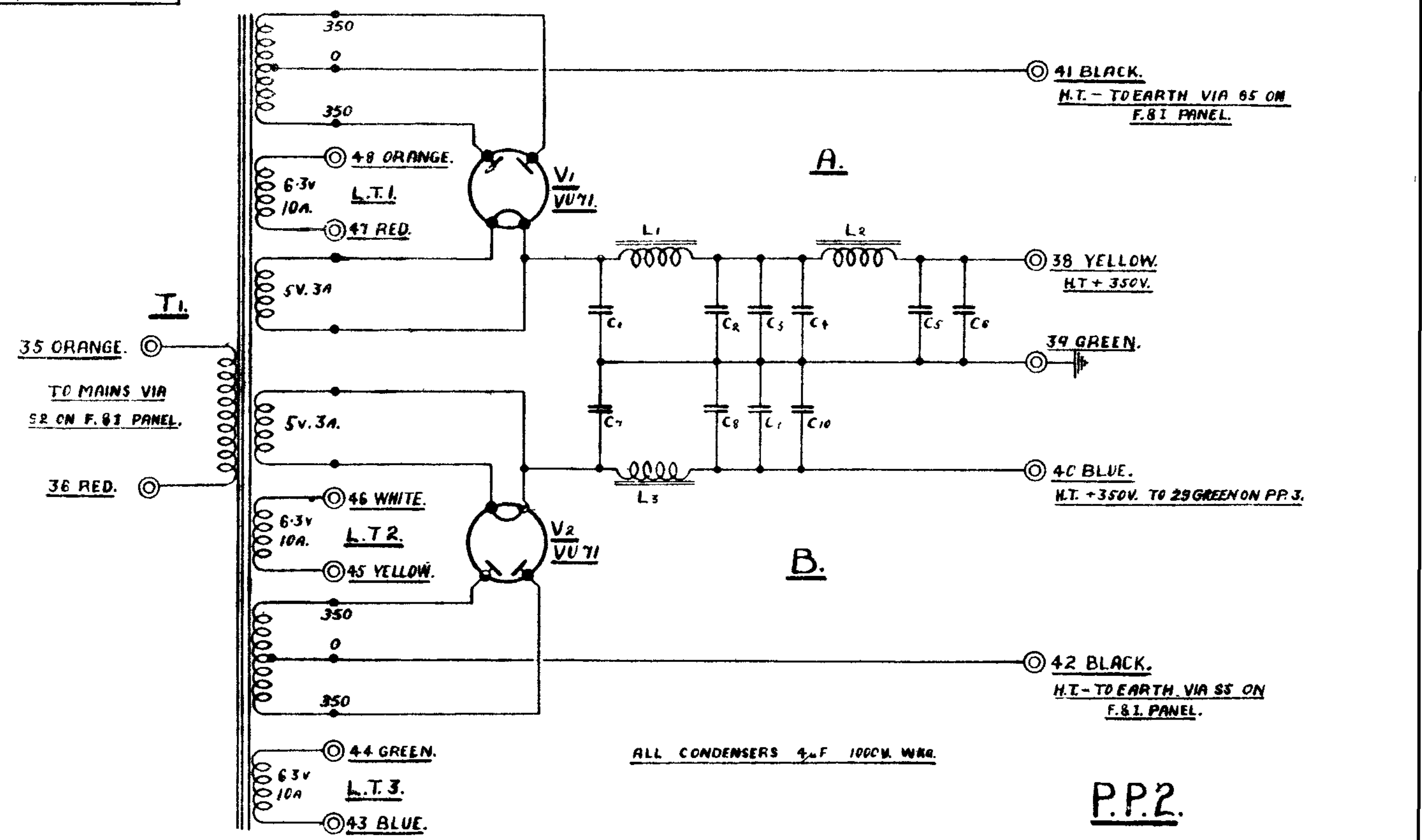
CHASSIS LAYOUT. REAR VIEW.

OSCILLOGRAPH UNIT CIRCUIT

FIG 37

FIG. 37





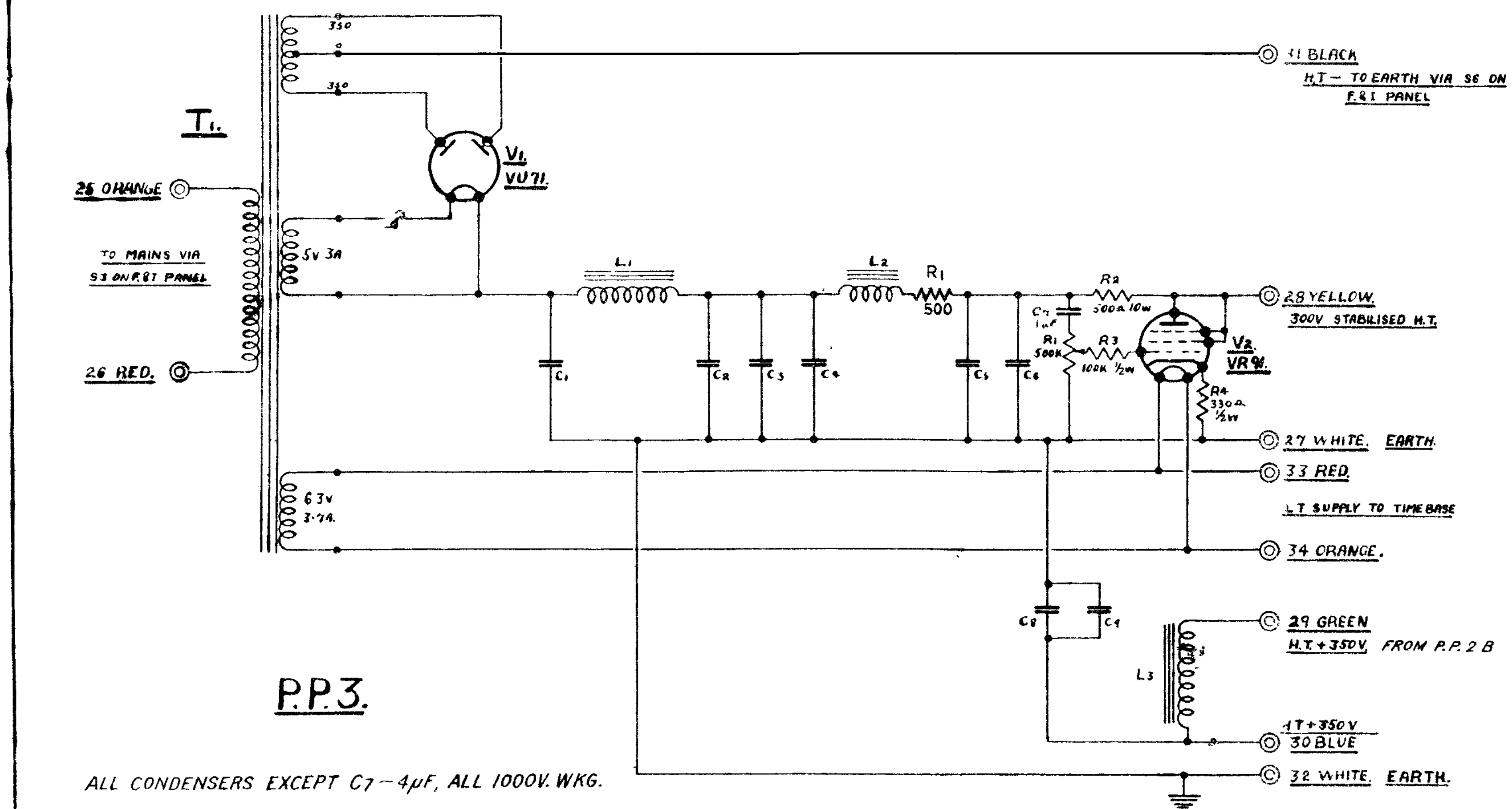


FIG. 38 POWER PACKS P.P.1, P.P.2 AND P.P.3 CIRCUITS

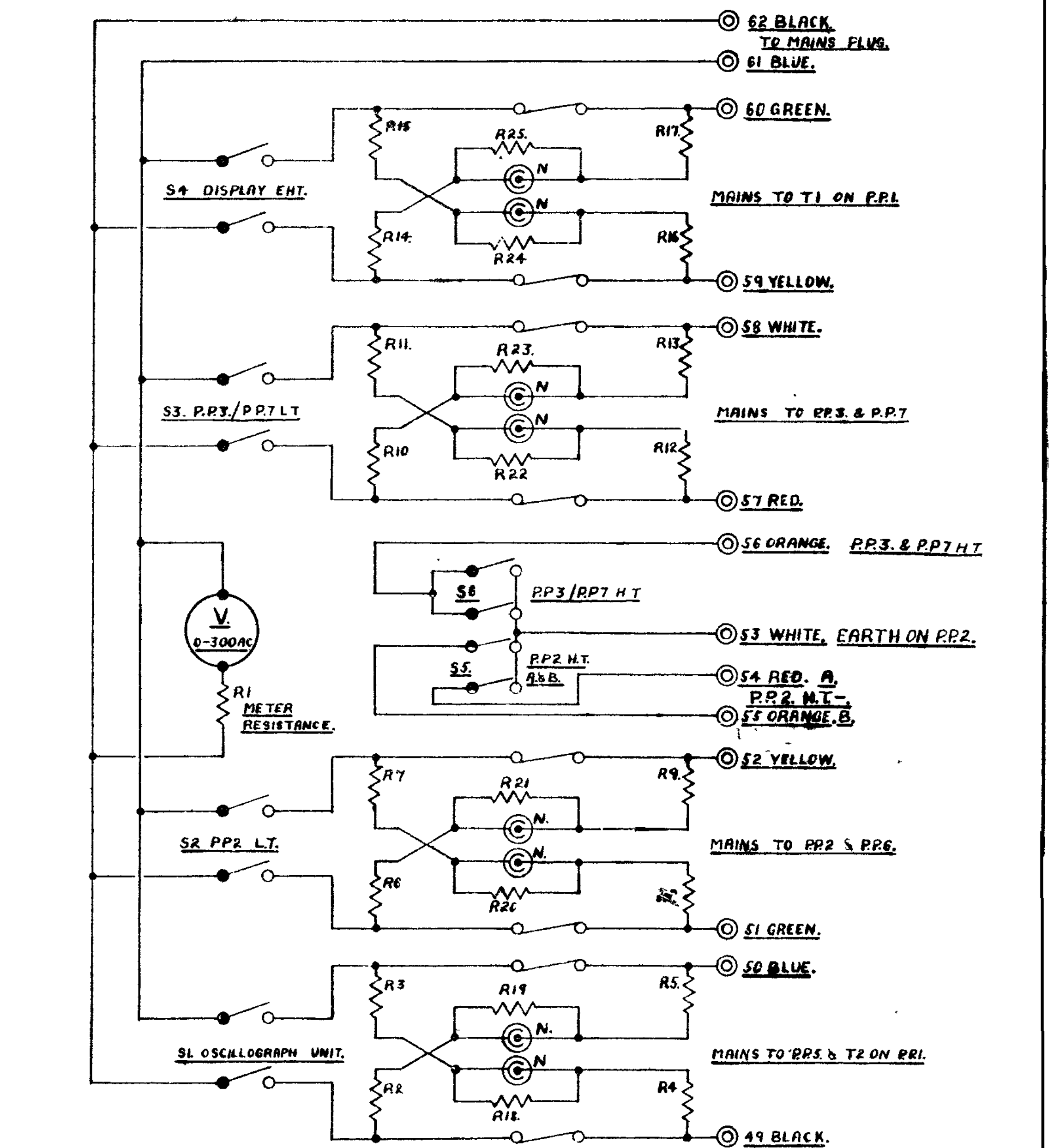


FIG. 39 – FUSE AND INDICATOR PANEL CIRCUIT

N ~ NEON BULBS.
R2 TO R17 ~ 220K ½ W.
R18 TO R26 ~ 1MEG ½ W.

FIGS. 38-39

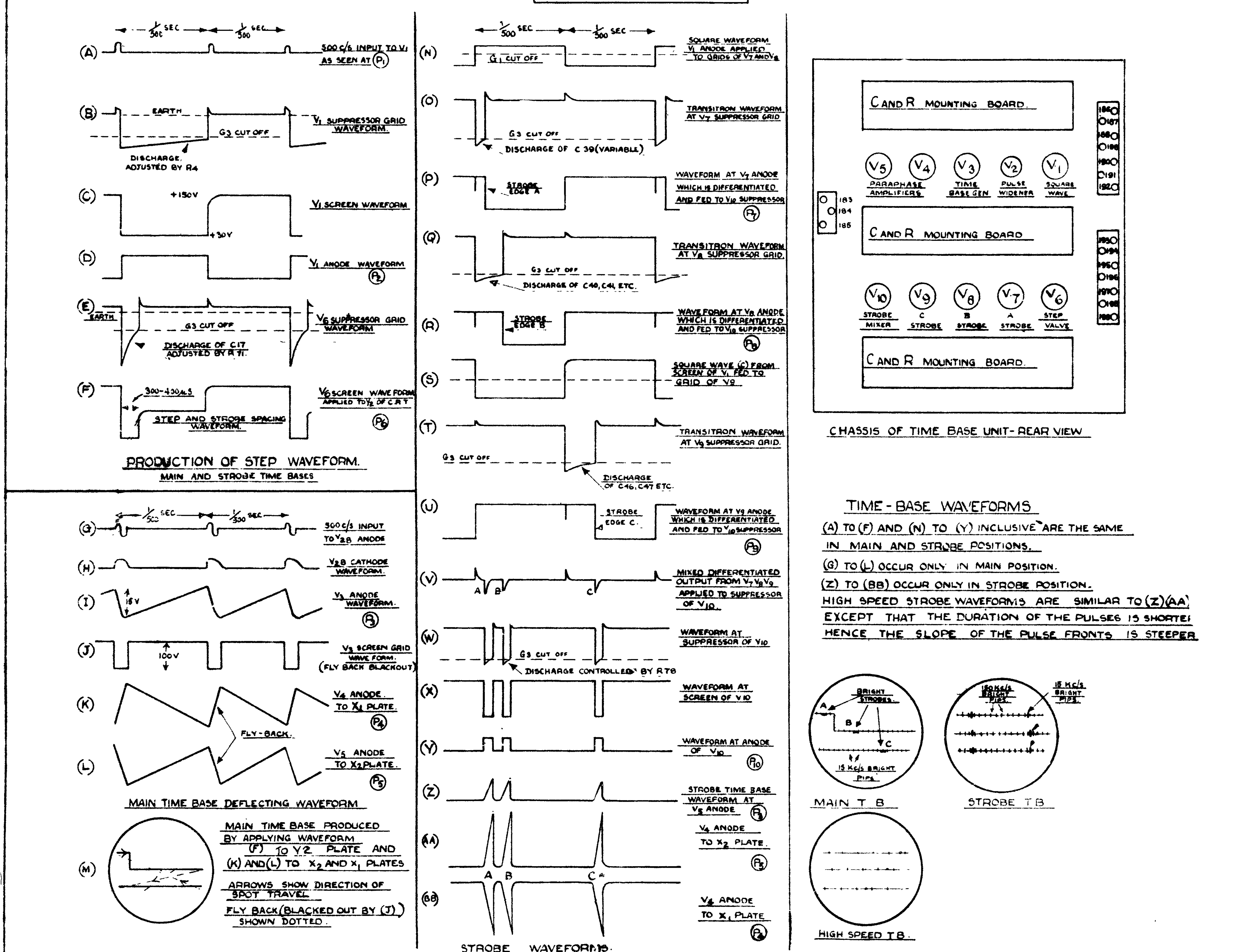
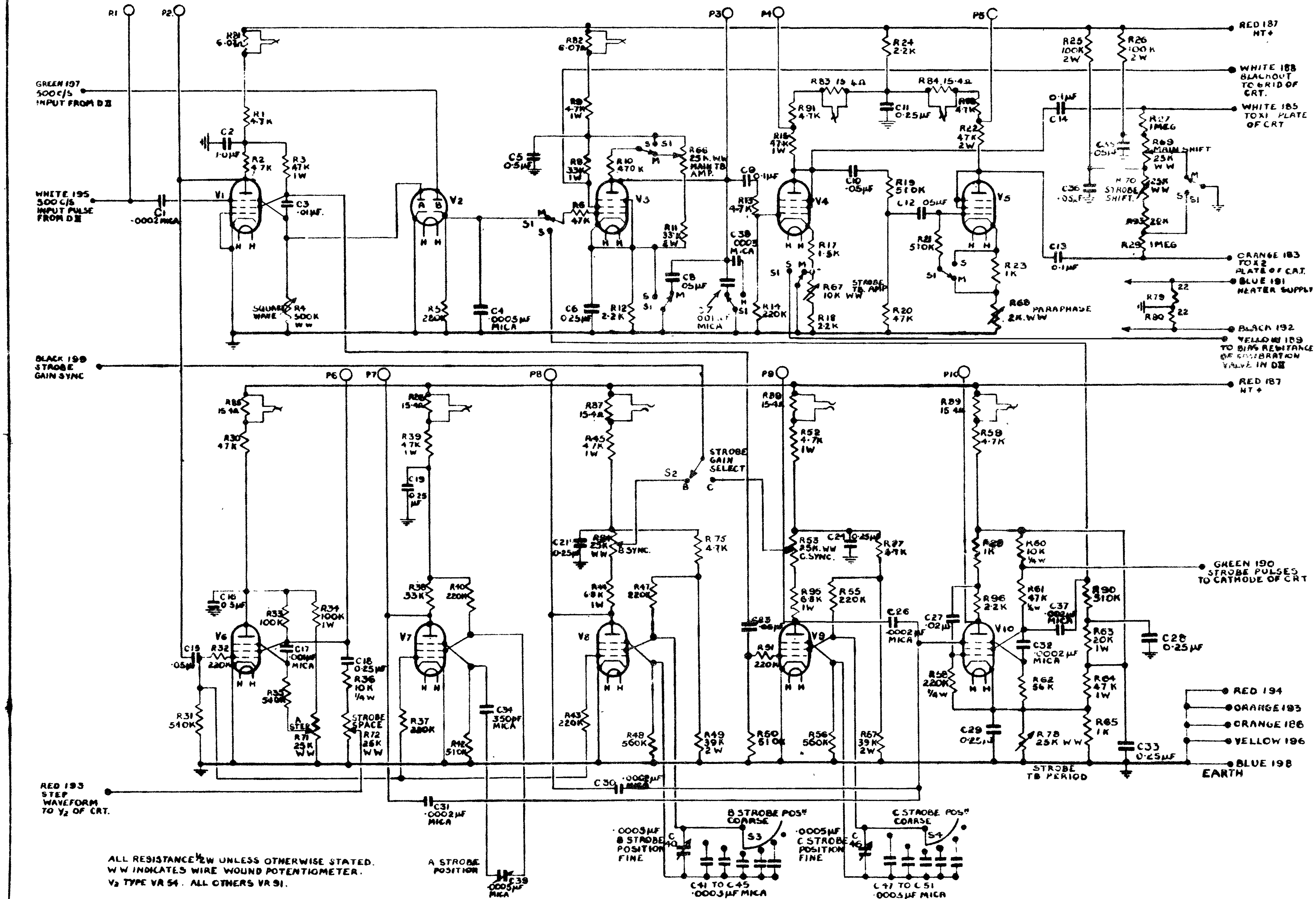


FIG. 32 TIME BASE WAVEFORMS AND CHASSIS LAYOUT FIG. 32

53226-1



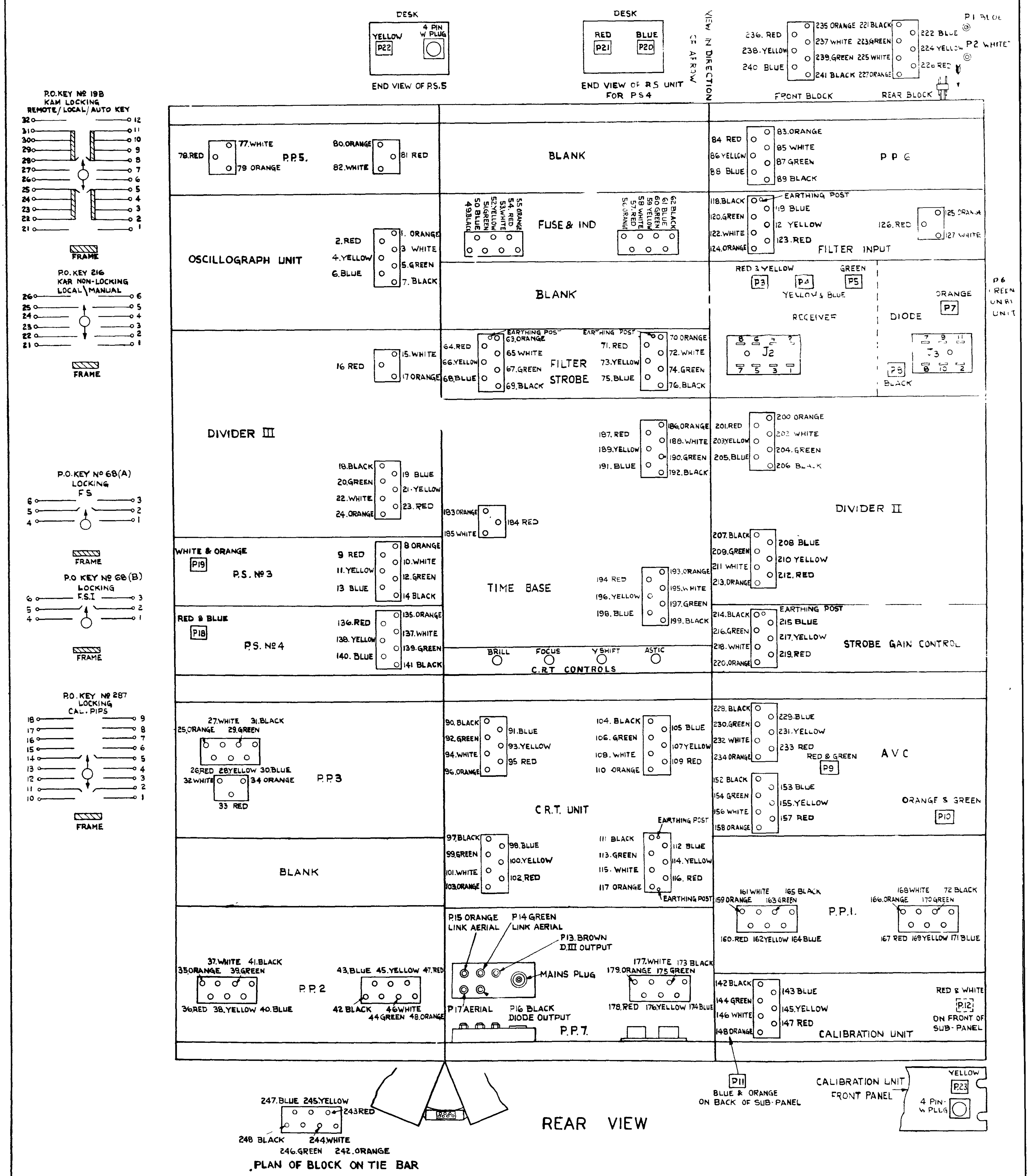
ALL RESISTANCE ½W UNLESS OTHERWISE STATED.
WW INDICATES WIRE WOUND POTENTIOMETER.
V2 TYPE VR 54. ALL OTHERS VR 91.

TIME BASE UNIT CIRCUIT

FIG. 31

FIG. 31

53XX6-1



TERMINAL REFERENCE

FIG.44

FIG.44

52226-1