RESTRICTED
(For official use only)

A.P.2557B
Volume I
FIRST EDITION
October, 1945

GEE Mk. II (Tropical Version)
A.R.I. 5718

Prepared by direction of the Ministry of Aircraft Production

Promulgated by order of the Air Council

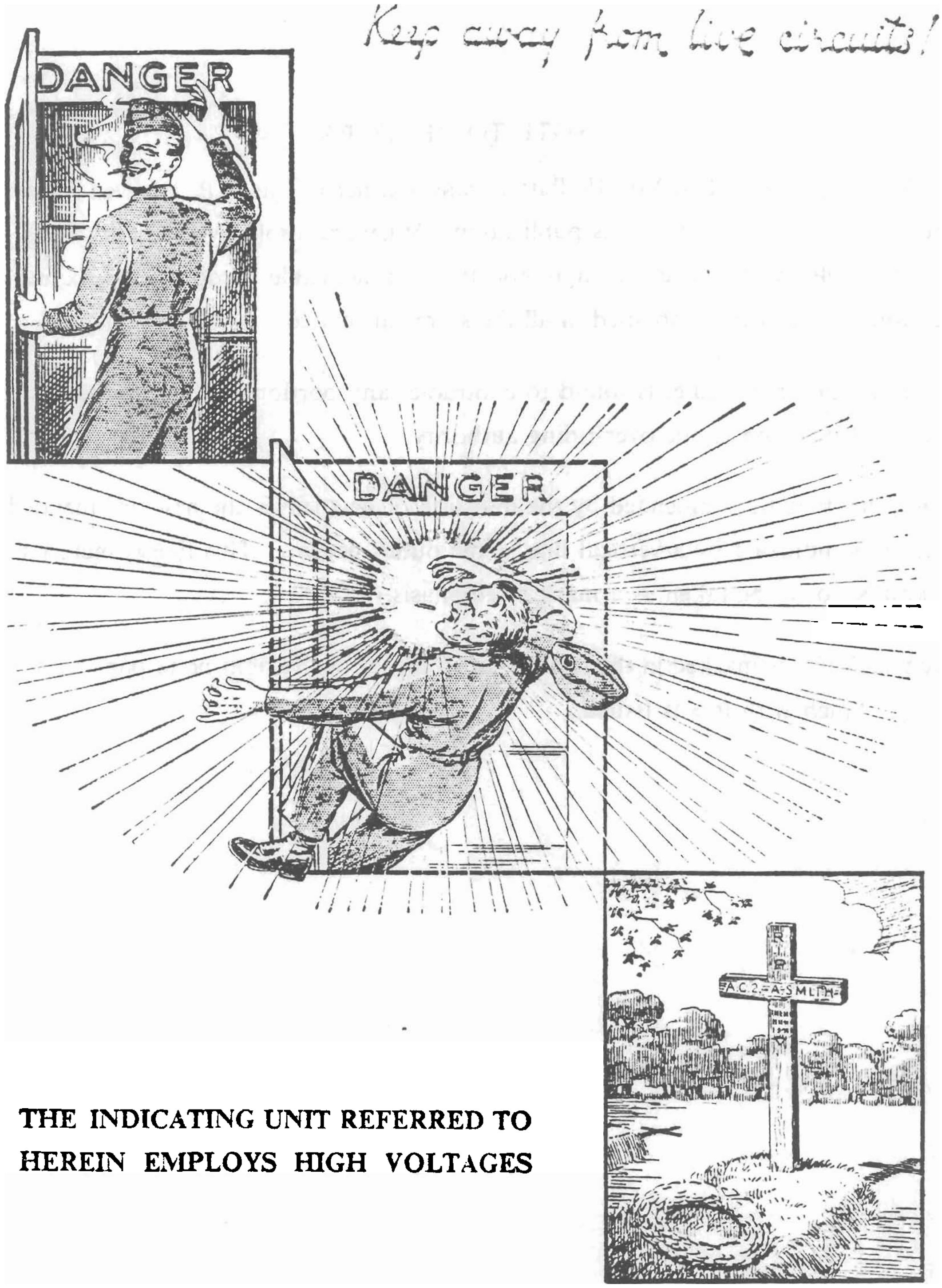
AMENDMENT RECORD SHEET

Incorporation of an Amendment List in this publication is to be recorded by inserting the Amendment List number, signing in the appropriate column and inserting the date of making the amendments.

A.L. No.	Amendments made by	Date
1	R. Gordon	12. 7. 1954

* An Amendment Record Continuation Sheet (R.A.F. Form 2094A) obtainable from A.P.F.S., Kensington will be required when this page is full. Order it now.

LIVE WIRES MEAN—DEAD MEN



THE INDICATING UNIT REFERRED TO HEREIN EMPLOYS HIGH VOLTAGES

NOTE TO READERS

Air Ministry Orders and Vol. II, Part 1 leaflets either in this A.P., or even in some others, may affect the subject matter of this publication. Where possible, Amendment Lists are issued to bring this volume into line, but it is not always practicable to do so, for example when a modification has not been embodied in all the stores in service.

When an Order or leaflet is found to contradict any portion of this publication, the Order or leaflet is to be taken as the over-riding authority.

When this volume is amended by the insertion of new leaves the new or amended technical information is indicated by a vertical line in the outer margin. This line is merely to denote a change and is not to be taken as a mark of emphasis.

Each such leaf is marked in the top left-hand corner of the right hand page with the number of the A.L. which with it was issued.

GEE Mk. II (TROPICAL VERSION) A.R.I. 5718

LIST OF CONTENTS

LIST OF ILLUSTRATIONS

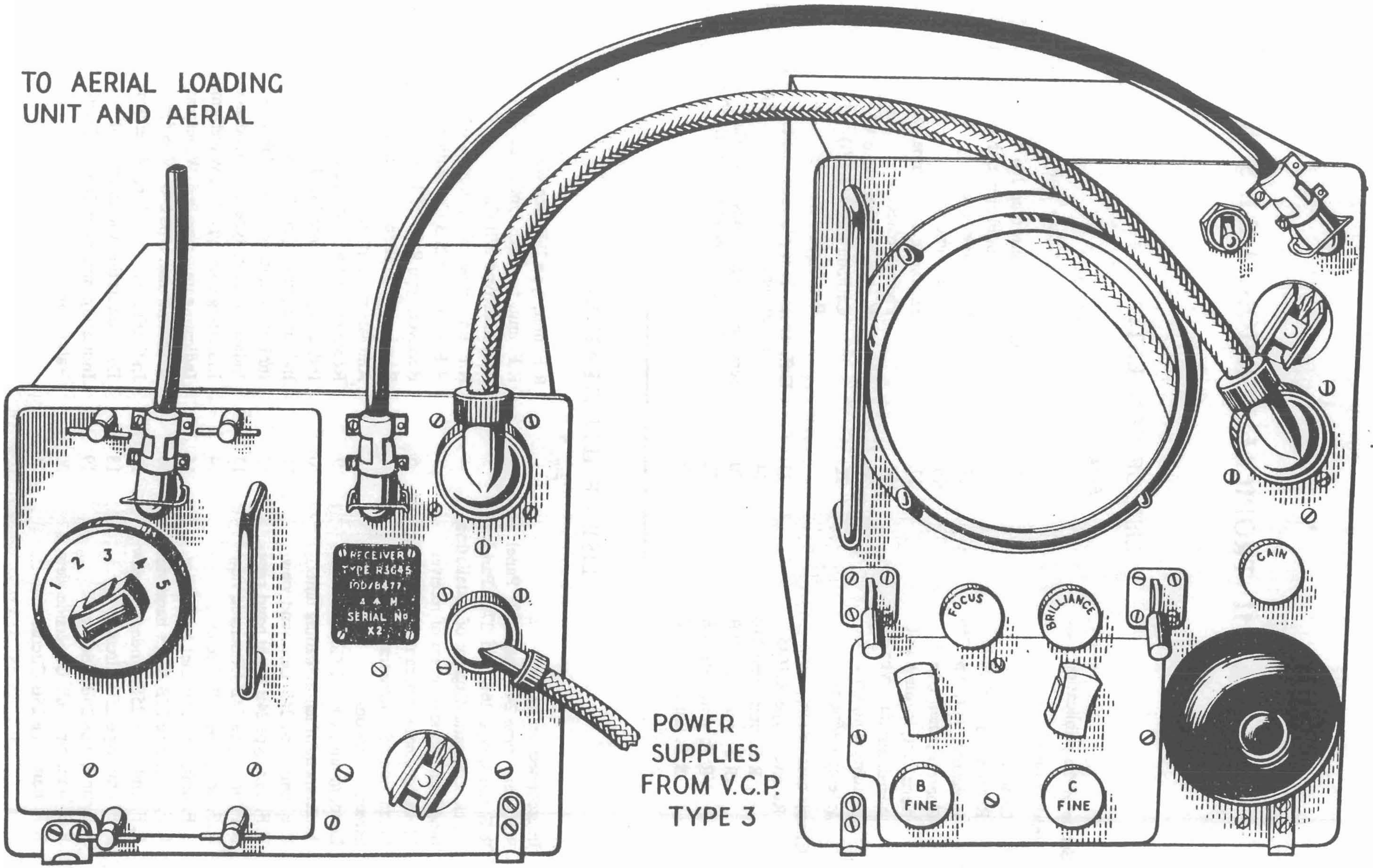


Fig. 1.—Interconnection diagram.

GEE Mk. II (TROPICAL VERSION) A.R.I. 5718

SCOPE OF THE PUBLICATION.

1. This publication describes the tropicalised version of the airborne radar equipment, GEE Mk. II. Essentially it is a redesigned version of GEE Mk. II, which is described in A.P. 2557A, the major changes being in the layout and mechanical design of equipment. For the benefit of readers familiar with existing equipments, the changes effected are summarised in Appendix I.

INTRODUCTION.

General.

2. GEE Mk. II airborne equipment is a radar aid to navigation, the general principles of which have already been fully described in other documents. It is assumed that the reader is fully familiar with the principles of the system.

3. The aircraft installation comprises the units listed in Table I below, being interconnected as shown in fig. 1.

Receiver type R. 3645.

4. The receiver, which employs a superheterodyne circuit, amplifies the pulses received from the ground stations. The amplified signals are fed to the Y plates of the C.R.T. in the indicators.

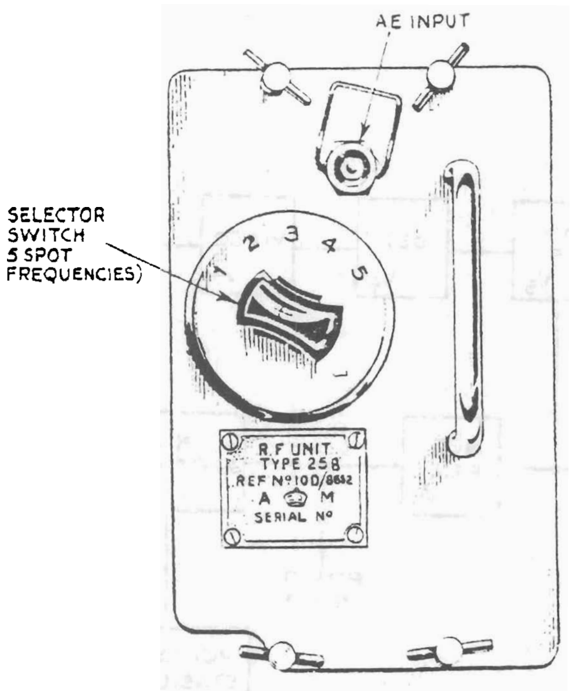


Fig. 2.—R.F. units, type 24B and 25B. Panel view.

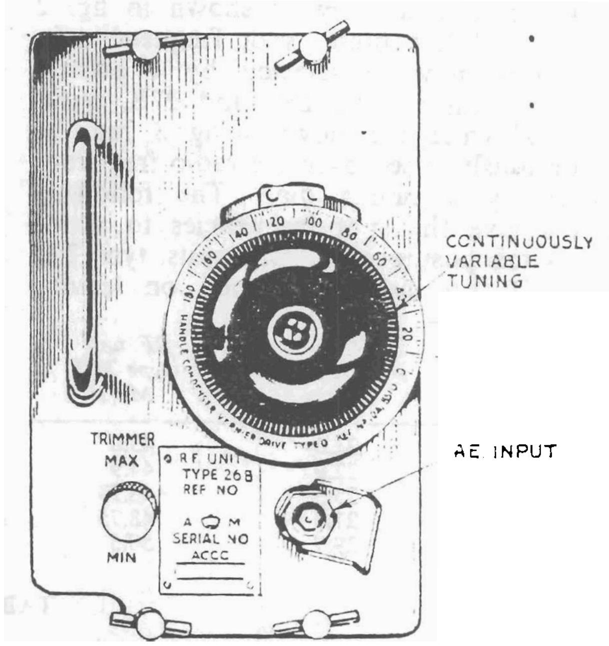


Fig. 3.—R.F. units, type 26B and 27B. Panel view.

5. It consists of three parts ; a detachable R.F. unit ; an I.F. and video frequency amplifier ; and a power unit. The R.F. unit containing the R.F. amplifier, local oscillator, and a mixer valve, is enclosed in a screened box. A Jones plug is provided at the rear of the R.F. unit, and the unit itself is secured to the receiver by four screws at the front ; thus it may be readily removed and a different one covering a different frequency band plugged in.

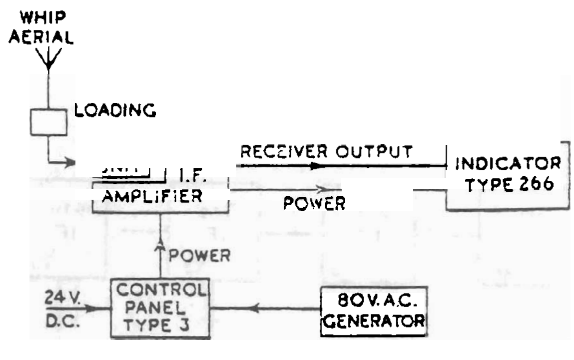


Fig. 4.—Block schematic diagram of installation.

6. Four types of R.F. units are provided. The frequency band which each covers is as follows :—

Band coverage of R.F. units

24B	25B	26B	27B
20-30 Mc/s	40-50 Mc/s	50-65 Mc/s	65-85 Mc/s

7. With R.F. units, type 24B and 25B of which a panel view is shown in fig. 2 any one of five preset spot frequencies in the band may be selected by a switch. The R.F. units, type 26B and 27B, panel views of which are shown in fig. 3, may be continuously tuned over the radio frequency ranges by a tuning dial. The following details give the spot frequencies to which the switch positions on R.F. units, type 24B and 25B are normally tuned on leaving the factory :—

Switch position	*RF. unit type 24B Mc/s*	*RF. unit type 25B Mc/s*
1	22.0	43.0
2	22.9	44.9
3	25.3	46.79
4	27.3	48.75
5	29.7	50.5

8. The remainder of the receiver accommodates a five-stage I.F. amplifier, second detector, video amplifier, and cathode follower output stage on the main chassis ; and on a sub-chassis, a power unit which supplies power to the receiver and the indicator.

TABLE I

Unit	*Stores Ref.*	*Weight*	*Dimensions*		
			Length	*Width*	*Height*
Receiver, type R.3645 ...	10DB/8477	35 lb.	18 in.	9 in.	8 in.
Indicating unit, type 266	10QB/6383	36 lb.	18 in.	9 in.	12 in.
Aerial, aircraft, type 329	10B 16026	—	—	—	—
Control panel, type 3	5U/1269	20 lb.	12 in.	12 in.	12 in.

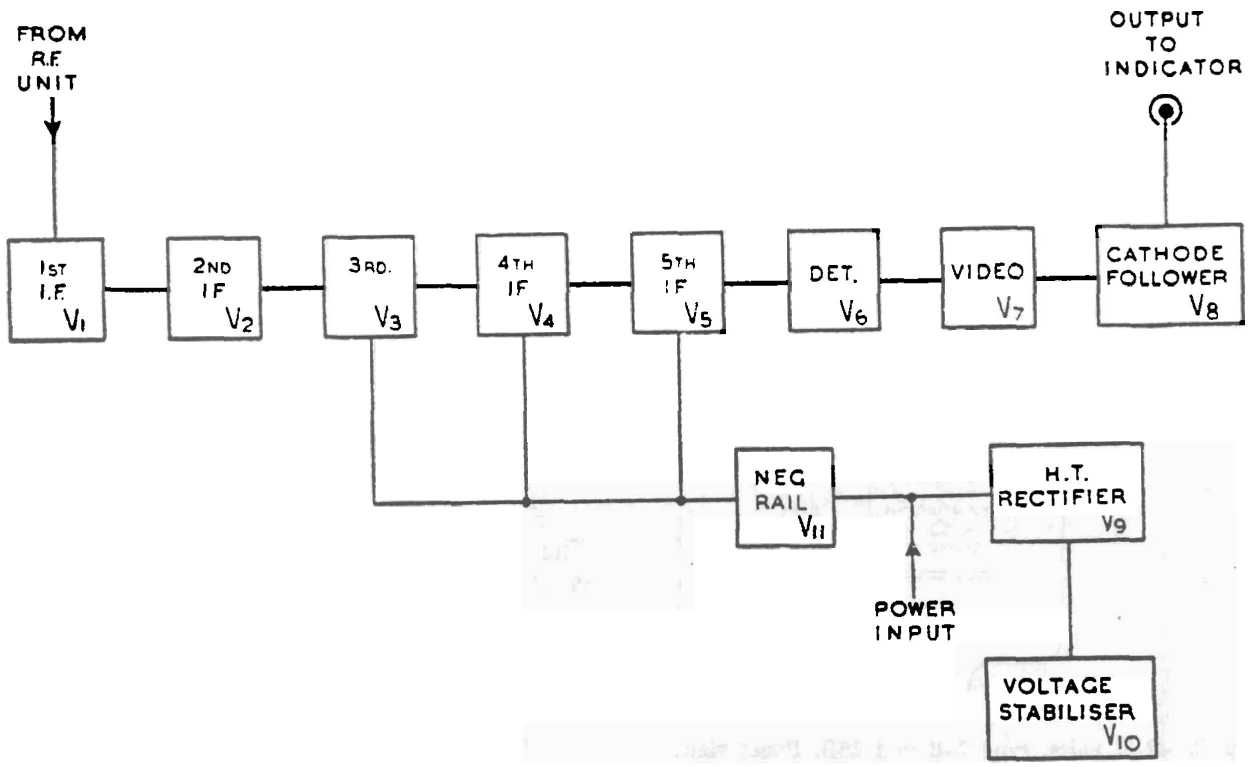


Fig. 5.—Block schematic diagram of receiver.

9. The following controls, sockets, and plugs are provided on the front panel of the receiver ;

(i) *Pye plug coloured green.* The aerial input plug located on the R.F. unit.

(ii) *Pye plug coloured blue.* The receiver output plug, which is connected externally to an input plug on the indicating Unit.

(iii) *Tuning control.* This is located on the R.F. unit. On R.F. units types, 24B and 25B it consists of a five-position selector switch, and on R.F. units, type 26B and 27B a tuning dial with an illuminated scale is provided. A small knob at the bottom left-hand corner of the front panel of R.F. units, type 26B and 27B is used for trimming the aerial input circuit.

(iv) *Anti-jamming switch.* This is a 2-position selector switch, with positions marked " N " and " Z ":—

(a) " N " is the normal position of the switch and is used when no jamming is experienced.

(b) " Z " is selected when jamming is experienced.

(v) *4-pin W plug.* This plug is connected externally to the aircraft alternator, and pins 1 and 2 provide the 80v. 1500 c/s (nominal) supply to the power unit in the receiver. Pins 3 and 4 are not used.

(vi) *6-pin W plug.* This plug is connected externally to the indicating unit and, except for pin 3, provides power for this unit. Pin 3 provides variable bias to the receiver from the receiver gain control on the indicating unit.

10. Further information on the receiver and a circuit description are provided in para. 23 to 54. Fig. 5 shows a block schematic diagram, fig. 14, 18, 21, 24 and 30 circuit diagrams and fig. 11—13, 15—17, 19—20, 22—23 and 27—28 annotated pictorial views of the interior of the receiver. The operation of the anti-jamming circuit is illustrated in fig. 29.

Indicating unit, type 266.

11. The indicating unit is used to display the pulses received from the receiver, on a cathode ray tube, in a manner most suitable for interpretation by the navigator. Three time base circuits are incorporated in the indicating unit and each may be used; the main time base which is comparatively slow; the strobe time base which is fast and may be selected to cover any part of the main time base ; and the expanded strobe time base which is still faster than the strobe time base.

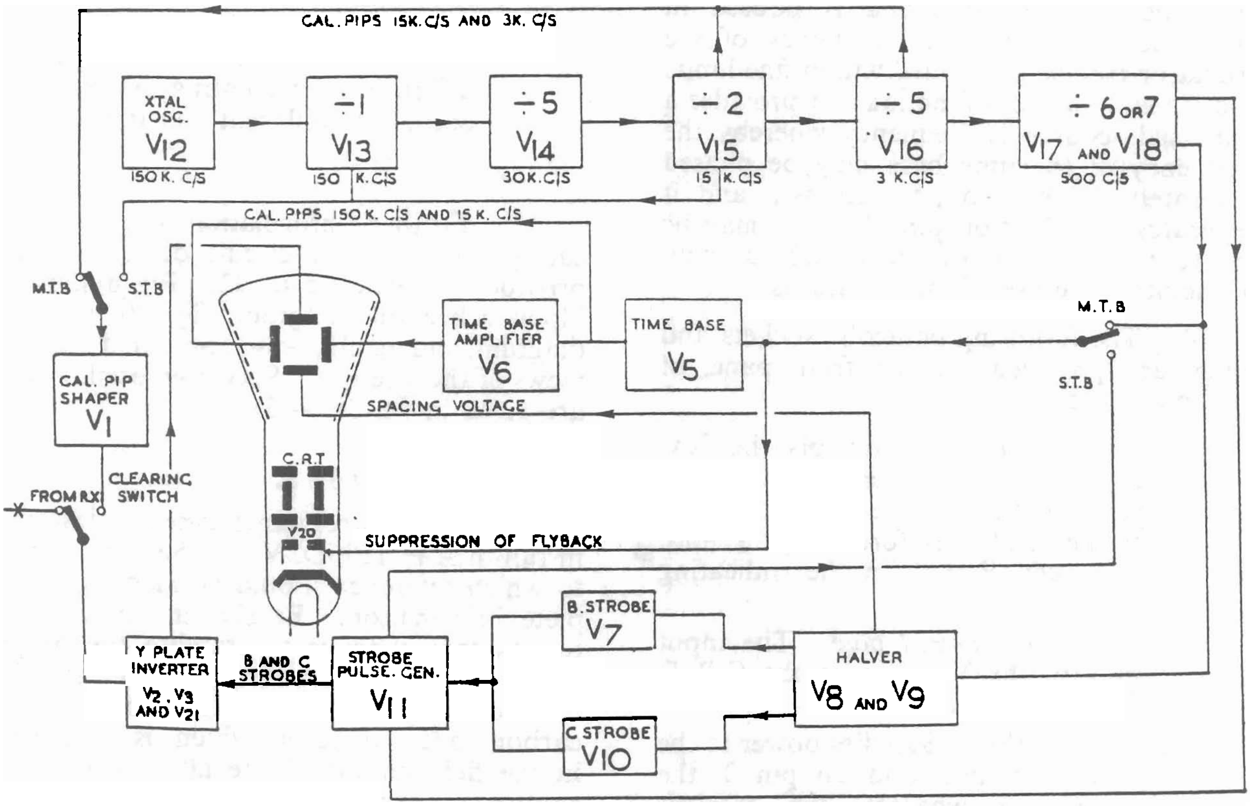


Fig. 6.—Block schematic diagram of indicating unit.

12. Two traces are shown on the C.R.T. in the main time base position. The reason for this may be explained as follows. The pulse recurrence frequency of the "A" master station is 500 c/s and that of the "B" and "C" stations 250 c/s. The frequency of the complete time base is 250 c/s, so the C.R.T. displays two "A" pulses, one "B" pulse, and a "C" pulse. To obtain a time base of greatest length it is in effect, expanded

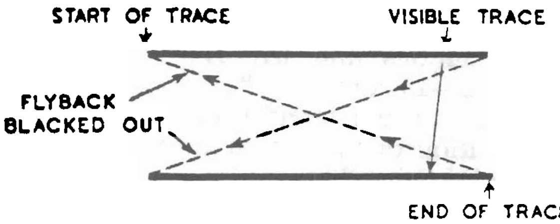


Fig. 7.—Formation of double time base.

to twice the width of the tube and then "divided" at its mid point, see fig. 5. Thus one "A" pulse and the "B" pulse appear on one half, and the other "A" pulse and the "C" pulse appear on the other half. This effect of "dividing" is obtained by causing the time base to sweep the tube twice as fast (i.e. 500 c/s) and by applying simultaneously a 250 c/s square wave to the Y plates so displacing alternate sweeps.

13. A crystal-controlled oscillator and its associated divider circuit is housed in the indicating unit. The frequency of the oscillator may be controlled within fine limits and it has a two-fold function ; it provides a stabilised scource of frequency whereby the frequency of the time base may be phased accurately to the ground stations ; and it generates "calibration pips" which may be fed to the Y plates of the C.R.T. at will, to facilitate the use of the apparatus.

14. The following controls, sockets and plugs are provided on the front panel of the indicating unit.

(i) *E.H.T. switch* — controls the 80v. a.c. supply to the E.H.T. Transformer and the receiver H.T. Transfromer and therefore controls both H.T. and E.H.T. in the indicating unit.

(ii) *Pye plug coloured blue*. The input plug to the Y plates of the C.R.T. from the receiver.

(iii) *6-pin W plug*. Supplies power to the indicating unit, and on pin 3, the connection whereby the receiver gain is controlled at the indicating unit.

(iv) *Gain control*. Enables the gain of the receiver to be varied.

(v) *Clearing switch*. With this 2-position switch either calibration pips generated by the dividers, or the output of the receiver, may be applied to the Y plates of the C.R.T.

(vi) *Time base switch*. This 3-position switch enables either the main time base, strobe time base, or expanded strobe time base to be selected.

(vii) *Focus control* for adjusting the focus of the trace on the C.R.T.

(viii) *Brilliance control* for adjusting the brilliance of the trace on the C.R.T.

(ix) "*B*" *strobe coarse control* and "*B*" *strobe fine control* which together enable the position of the "B" strobe time base to be moved along the "B" main time base.

(x) "*C*" *strobe coarse control* and "*C*" *strobe fine control* which together enable the position of the "C" strobe time base to be moved along the "C" main time base.

(xi) *Fine frequency oscillator control*. This enables the frequency of the master oscillator to be controlled within fine limits.

(xii) *Recurrence frequency switch*. This is provided to give an alternative divider ratio so as to overcome the difficulty of presenting pulses which occur at different recurrency frequency.

15. Further information on the indicating unit and the circuit description are provided in para. 55 to 92. Fig 6 shows a block schematic diagram, fig. 40 a circuit diagram. and fig. 31 — 34, annotated pictorial views of the interior. Specimen oscillograms are given in fig. 35 — 38.

Control panel, type 3.

16. The control panel, type 3 is described in full in A.P. 1186D, Vol. I, Sect. I, Chap. 1 to which reference should be made for complete information. Briefly, the function of the control panel is to stabilise the output of the 80 volts, a.c. generator which supplies a.c. to the equipment. It incorporates a carbon pile regulator which is connected in the field circuit of the alternator, and a suppressor whose function is to prevent the slot ripple in the field from being fed out of the control panel.

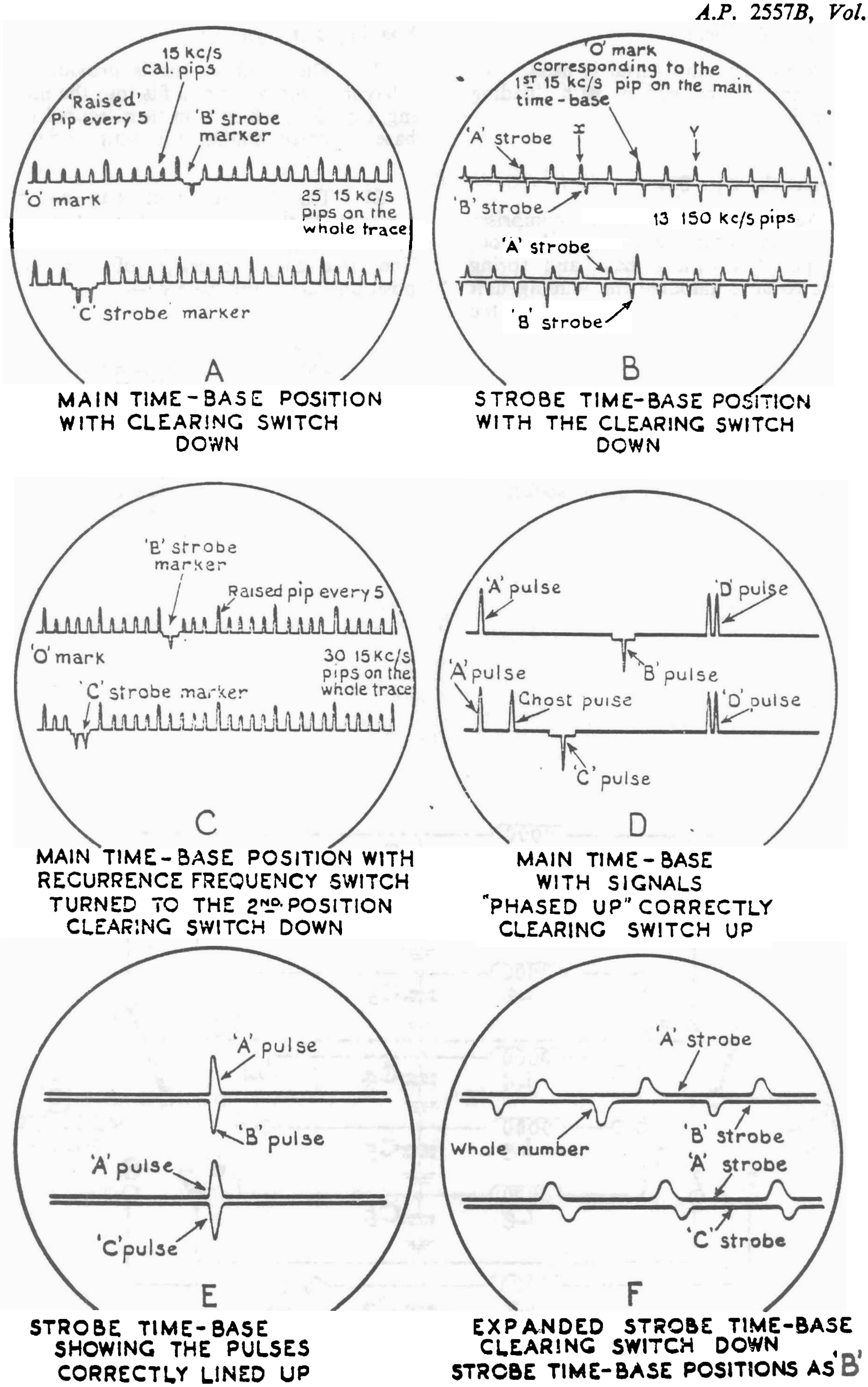


Fig. 8.—Screen indications.

Aerial and loading unit.

17. A rod or whip aerial is used, 3 ft. 7¾ in. long in connection with loading unit, type 51.

Aerial, aircraft, type 329.

18. Aerial, aircraft, type 329 comprises a 3 ft. 7¾ in. whip aerial (namely, rod, aerial, type 257) with a base and spring mounting to accommodate the loading unit type 51. It covers all the frequencies in the band 20 to 85 Mc/s.

19. Electrical connection between the aerial and the loading unit is made by an adaptor, plug, type 587, and the feeder from the receiver is coupled to the loading unit by means of a Pye plug and socket.

Loading unit, type 51.

20. The loading unit is provided with a bayonet slot fixing and fits into the mounting, type 369, which is in turn secured to the base insulator holding the whip aerial.

21. The loading unit has an eight position Yaxley switch in which the switch positions are numbered 1 to 8 respectively. The frequency coverage of the switch positions are given below :—

Switch position	*Frequency coverage*
1	22.1 to 23.6 Mc/s.
2	23.6 to 25.7 Mc/s.
3	25.7 to 28.0 Mc/s.
4	28.0 to 30.8 Mc/s.
5	42.0 to 47.5 Mc/s.
6	47.5 to 54.5 Mc/s.
7	54.5 to 73 Mc/s.
8	73 to 85 Mc/s.

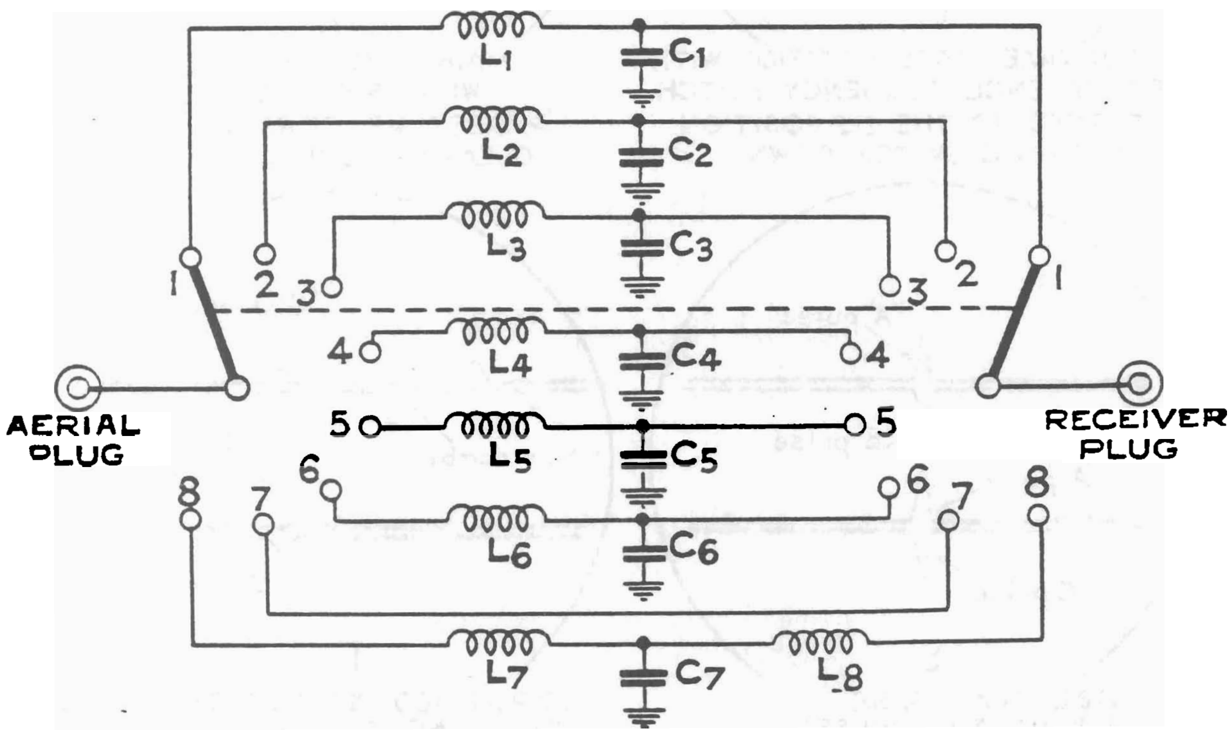


Fig. 9.—Loading unit, type 51 Circuit.

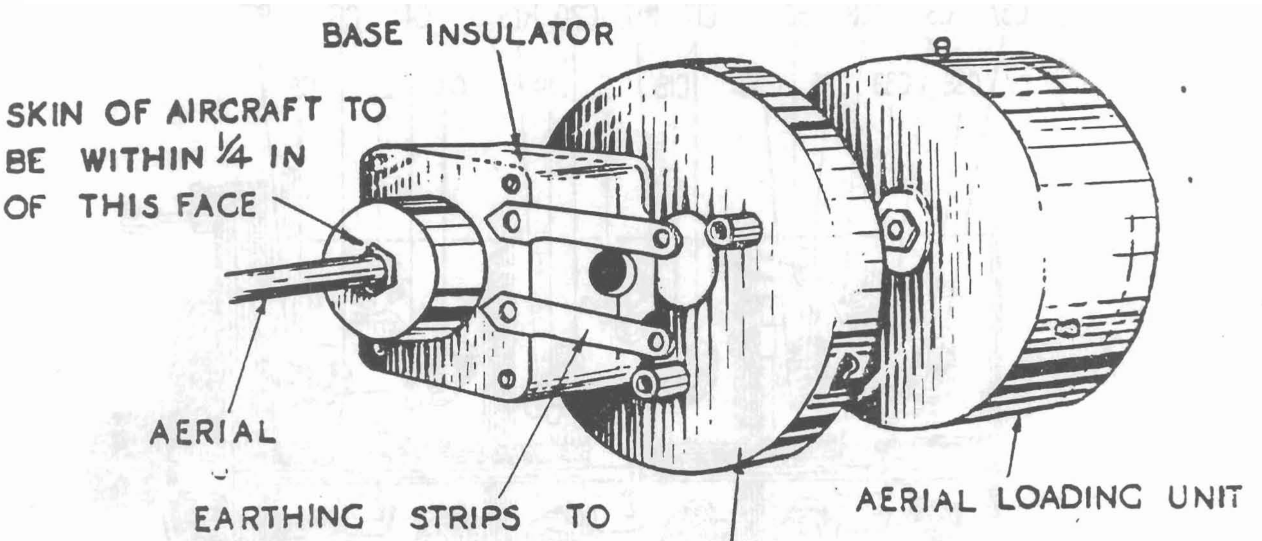


Fig. 10.—Attachment of aerial loading unit.

Interconnections.

22. An interconnection diagram is given in fig. 1 and this together with the colour coding of the plugs and sockets should provide sufficient information to enable the equipment to be correctly installed.

CIRCUIT DESCRIPTION.

Receiver, type R.3645.

23. The circuit diagrams of the R.F. units are shown in fig. 14, 18, 21 and 24 and the remainder of the Receiver in fig. 30. The four R.F. units are described first; the band width of each unit is ± 0.5 Mc/s. at 2 to 3 dB. down.

R.F. unit, type 24B.

24. R.F. unit, type 24B covers the frequency band 20 to 30 Mc/s, tuning to any one of five spot frequencies in this band.

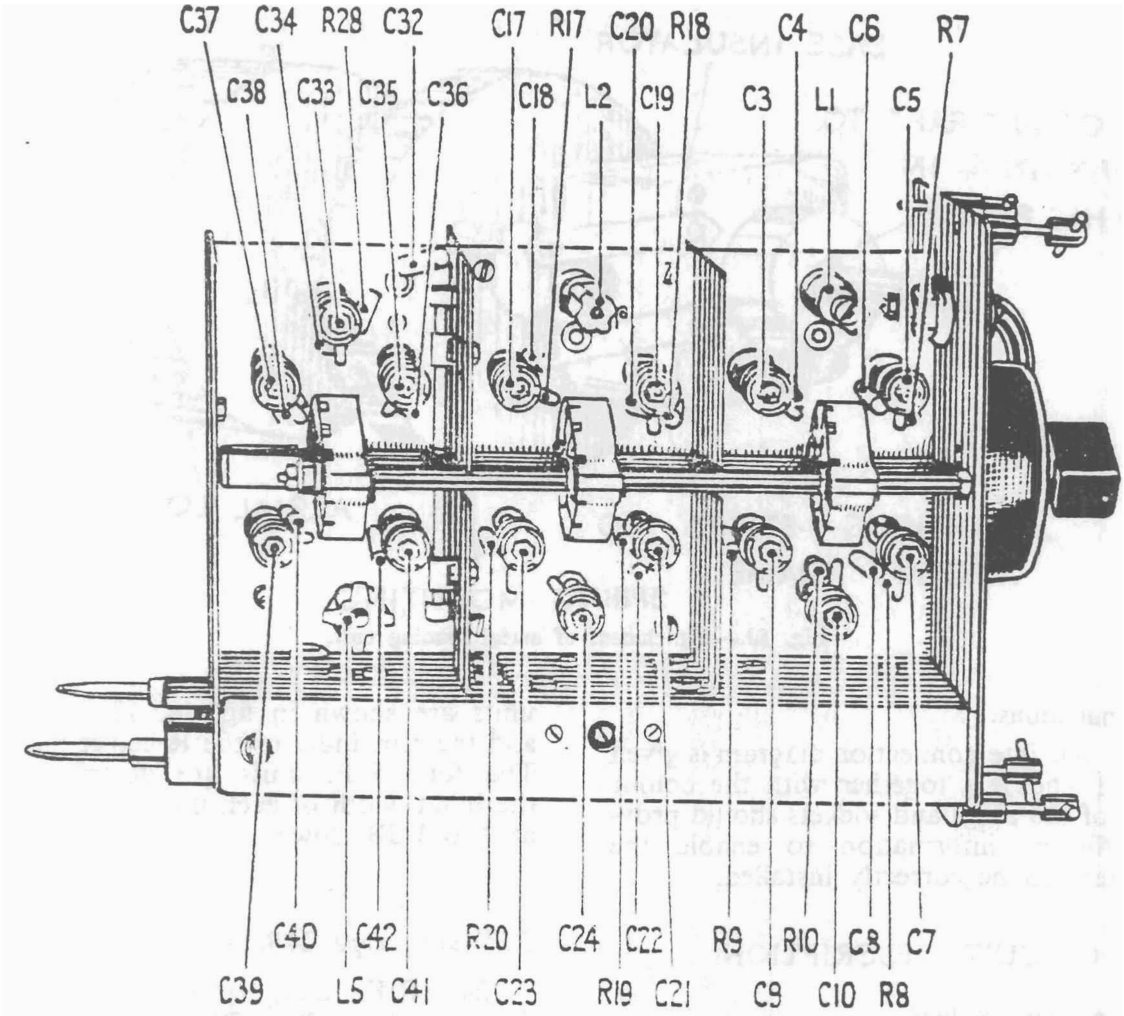


Fig. 11.—R.F. unit, type 24B. Left hand view.

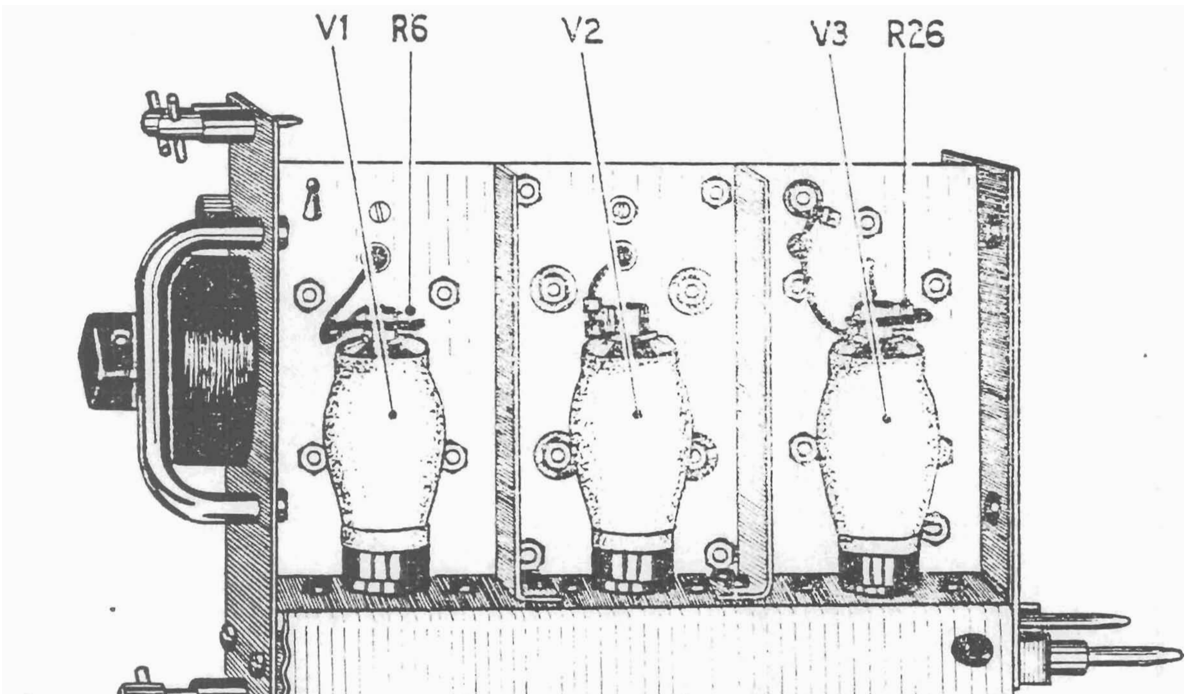


Fig. 12.—R.F. unit, type 24B. Right hand view.

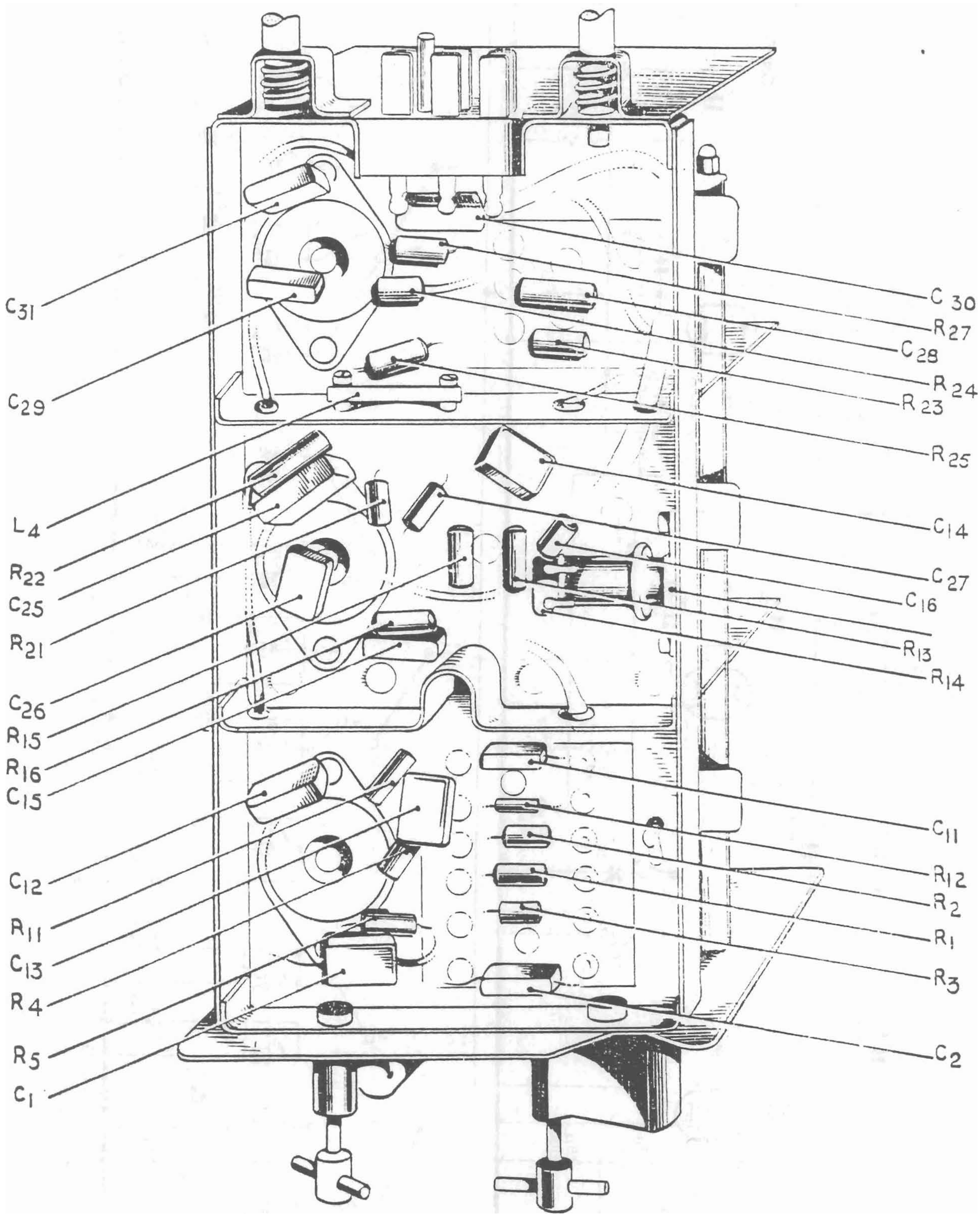


Fig. 13.—R.F. unit, type 24B. Underside view.

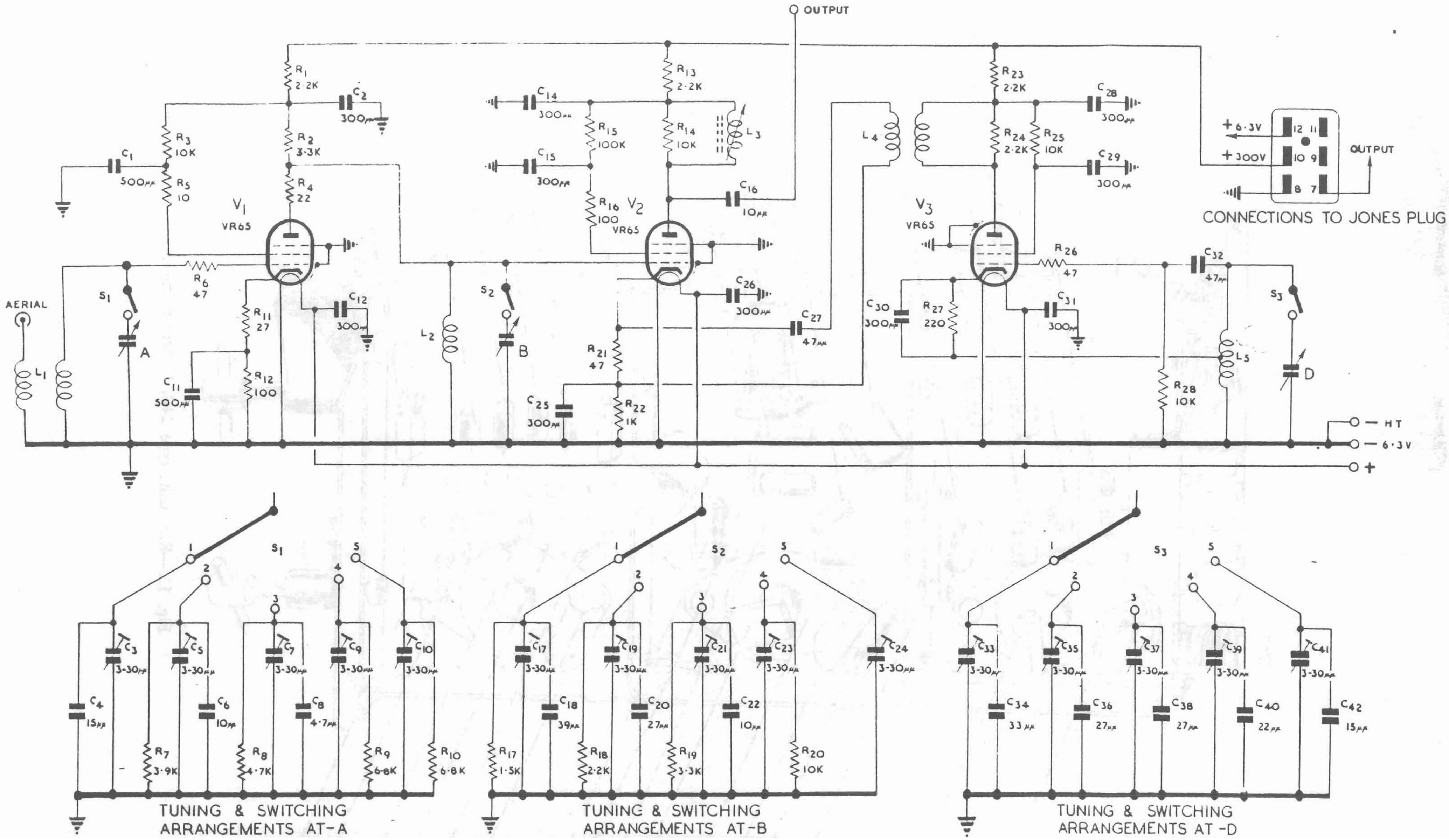


FIG. 14.—R.F. UNIT, TYPE 24B — CIRCUIT

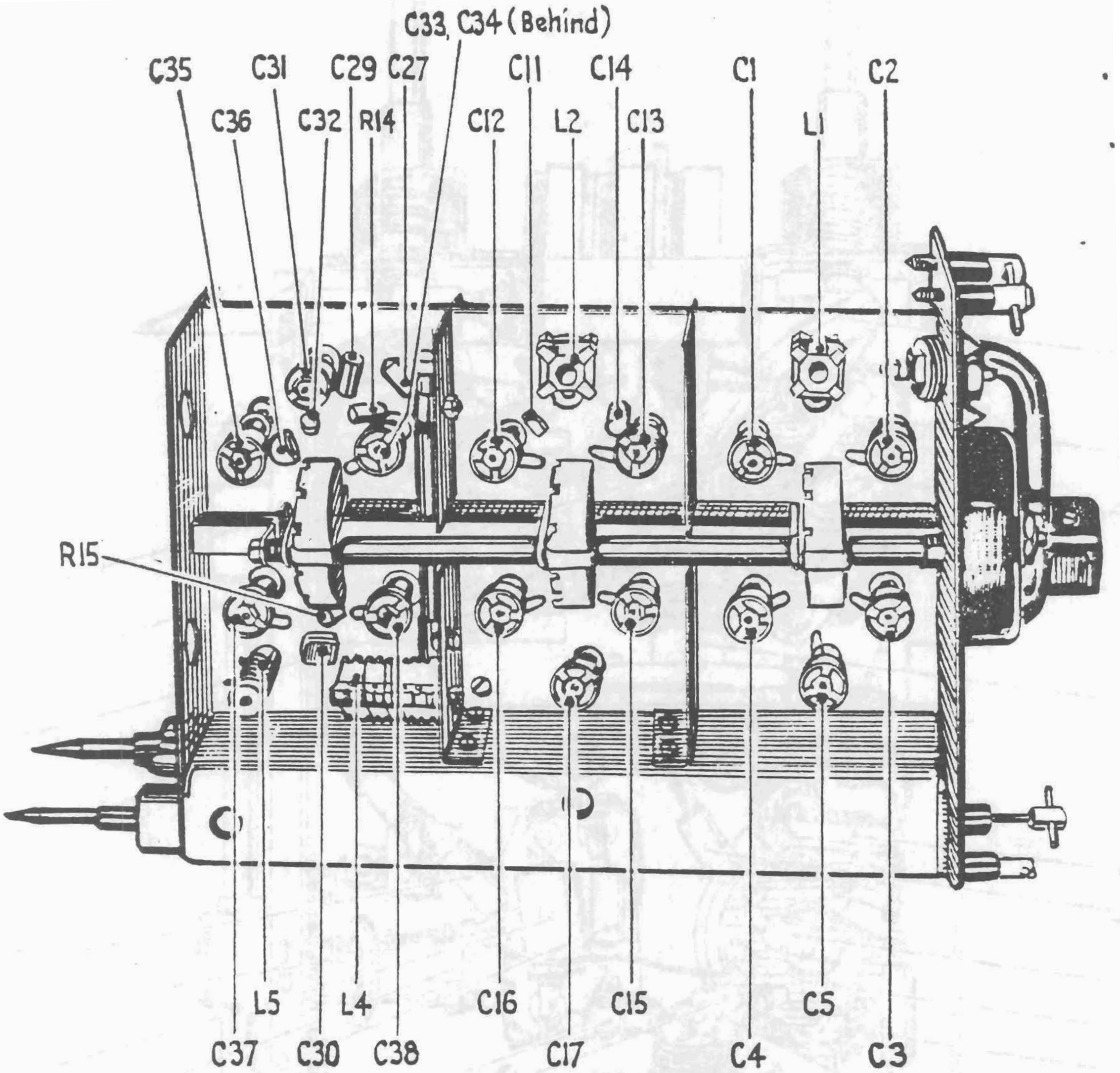


Fig. 15.—R.F. unit, type 25B. Left hand view.

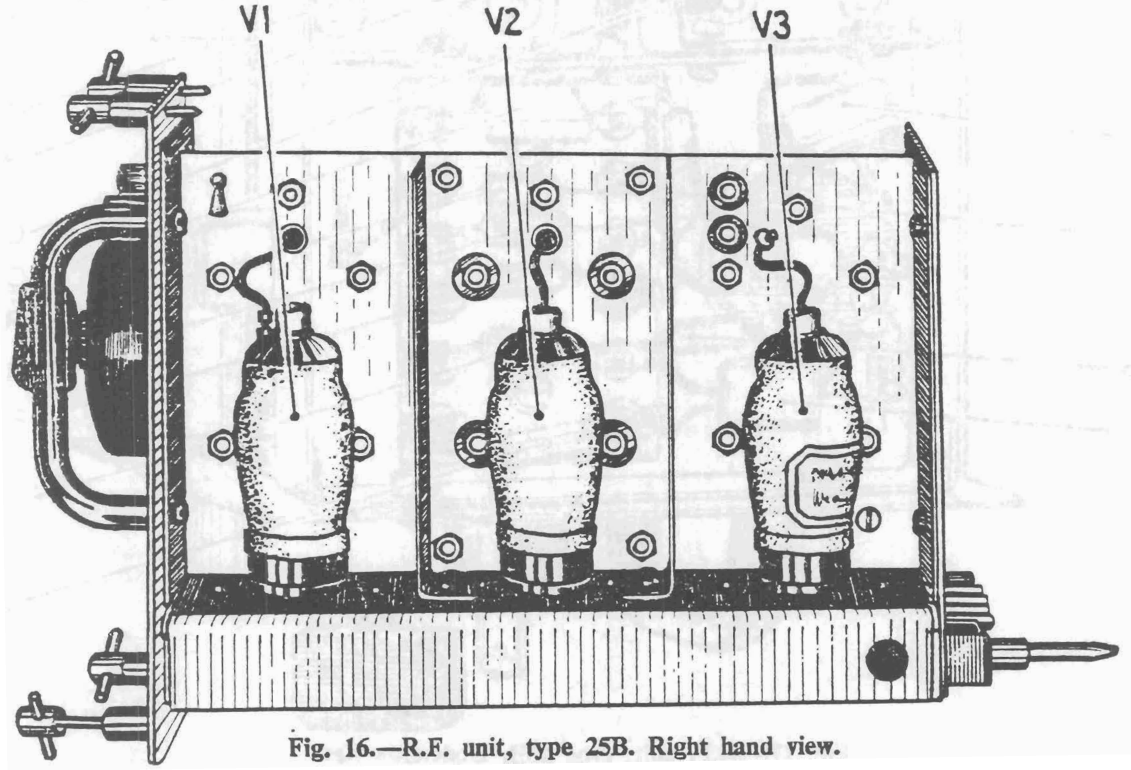


Fig. 16.—R.F. unit, type 25B. Right hand view.

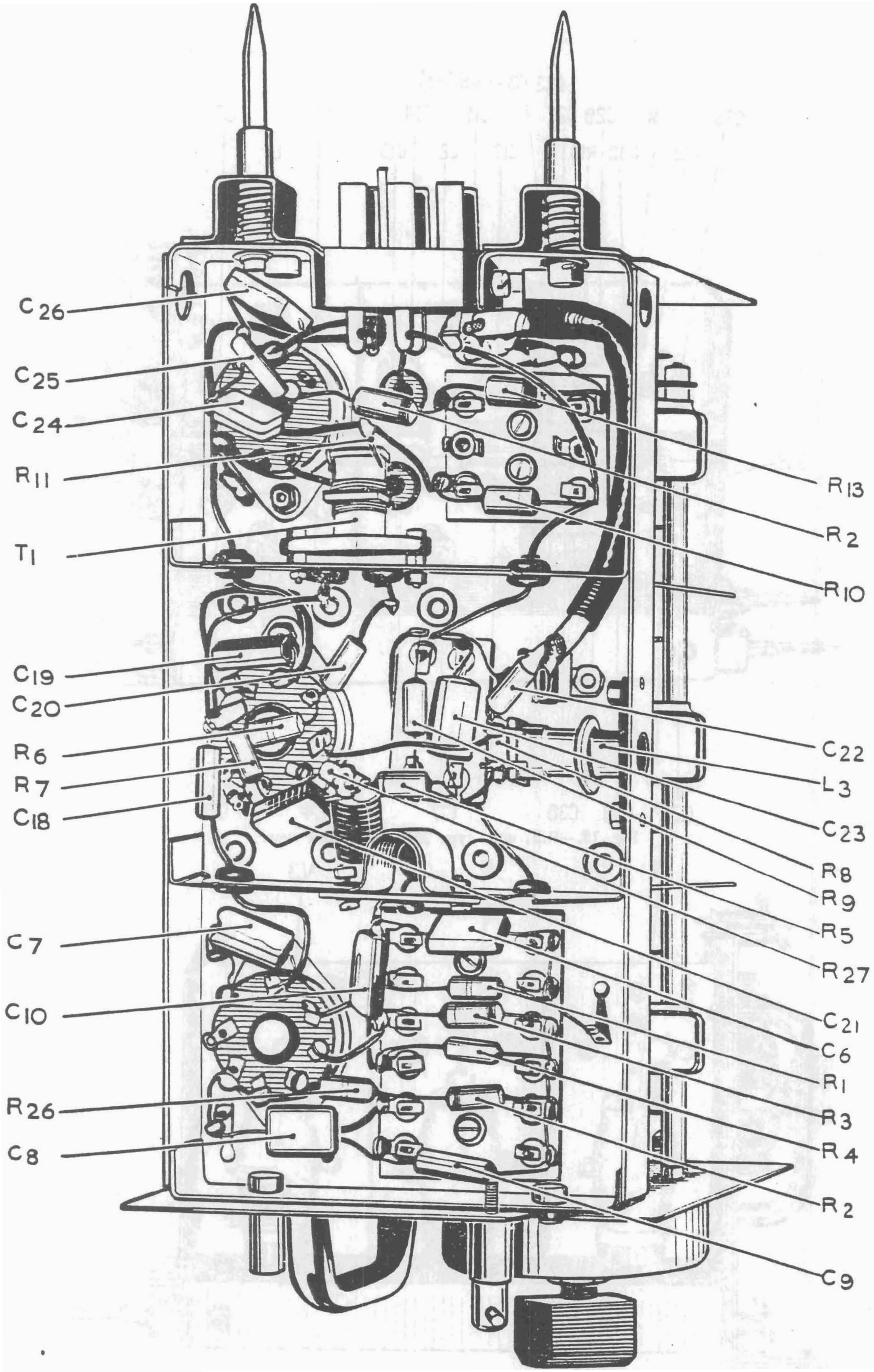


Fig. 17.—R.F. unit, type 25B. Underside view.

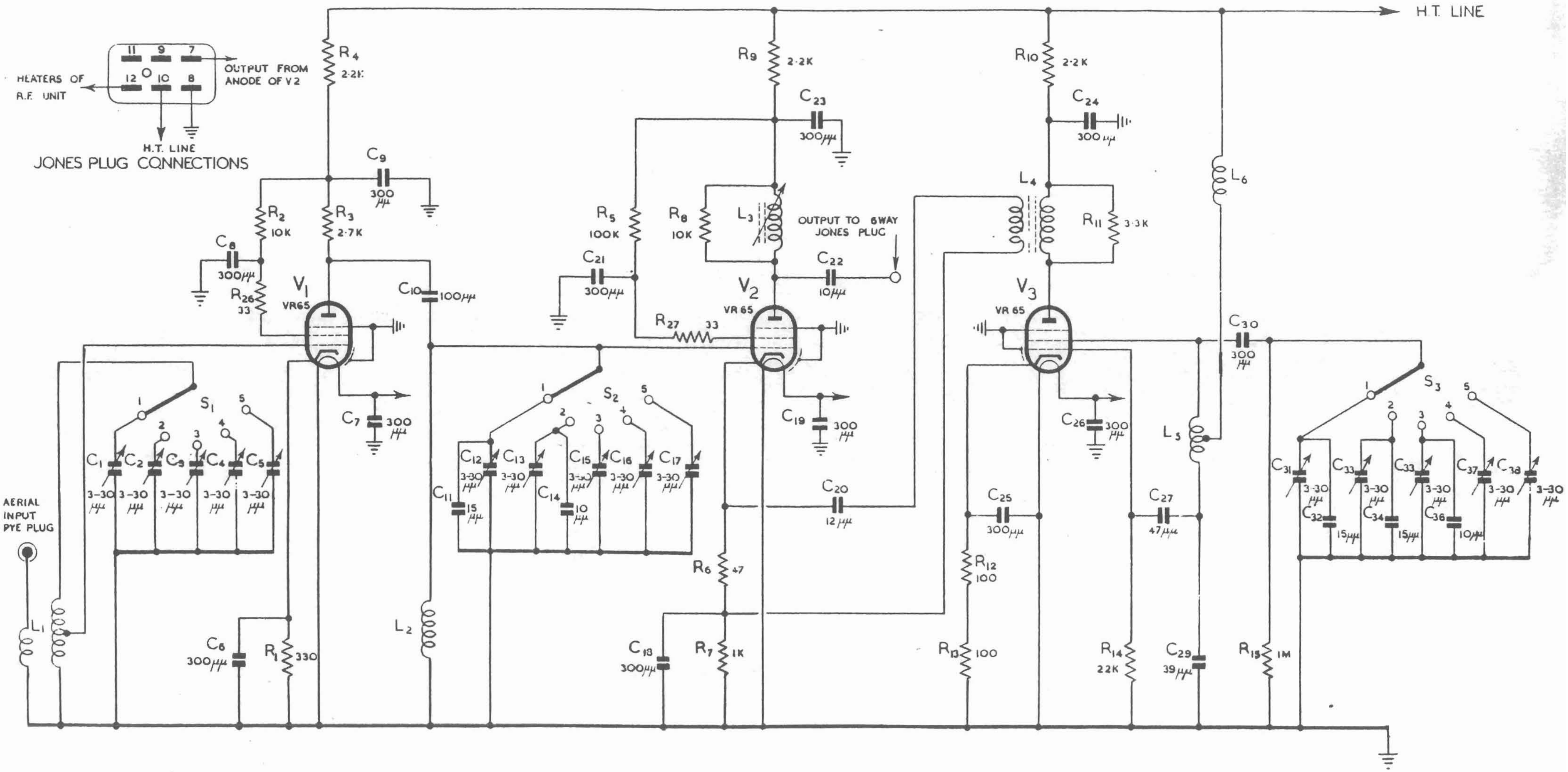


FIG. 18.—R.F. UNIT, TYPE 25B—CIRCUIT

25. It has one stage of R.F. amplification, namely that employing V1 (see fig. 14). The grid inductance (secondary of L1) of V1 is tuned by means of the trimmers C18 to C22, any one of which can be selected by the bank S1 of the spot frequency selector switch. The aerial feeder is matched in by means of the transformer of which L1 is the secondary winding.

26. The output of the R.F. stage is fed through C13 to the grid of the mixer valve V2. The grid circuit of V2 is tuned in a similar manner to the grid circuit of V1, L2 being the tuning inductance. The appropriate trimmers are selected by the bank S2 of the selector switch.

27. The oscillator valve, V3, has its frequency controlled by the inductance L5 and the condensers C33 — 42, the appropriate condenser being selected by the third bank, S3, of the spot frequency selector switch. The oscillator uses a Hartley circuit (the cathode of the valve is tapped on to the tuning inductance), and it is electron-coupled, that is, the cathode, grid, and screen grid of the valve form the oscillator, the anode being used only to provide an output to the mixer ; the frequency of the oscillator is always above the signal frequency. Electron coupling is used because it provides good frequency stability.

28. The output from the oscillator to the mixer is fed through the transformer L4, which has a band pass of greater than 10 Mc/s, into the cathode circuit of the mixer valve V2 across the resistor R21. The oscillator voltage developed across the latter is about 1v. R.M.S. The anode circuit of the mixer is tuned to 7.7 Mc/s by L3.

29. The coupling between the mixer and I.F. amplifier is through the capacitance C16 to the grid circuit of the first I.F. valve. The mixer anode circuit and the first I.F. grid circuit together with the concentric tube coupling the units, form a band pass filter. This coupling is common to all R.F. units.

R.F. unit, type 52B.

30. R.F. unit, type 25B is generally similar to R.F. unit, type 24B, and has a spot frequency selector switch. The frequency coverage is 40 to 50 Mc/s. The circuit differs only in detail from that of R.F. unit, type 24B and the differences become apparent on comparing fig. 18 with fig. 14.

31. The oscillator in this case uses a Colpitts circuit, and it is again electron-coupled to the mixer. The damping resistors associated with the switched tuning condensers in the R.F. unit, type 24B are not necessary in this unit, because, at these higher frequencies, the input resistance of the valves provides all the damping required.

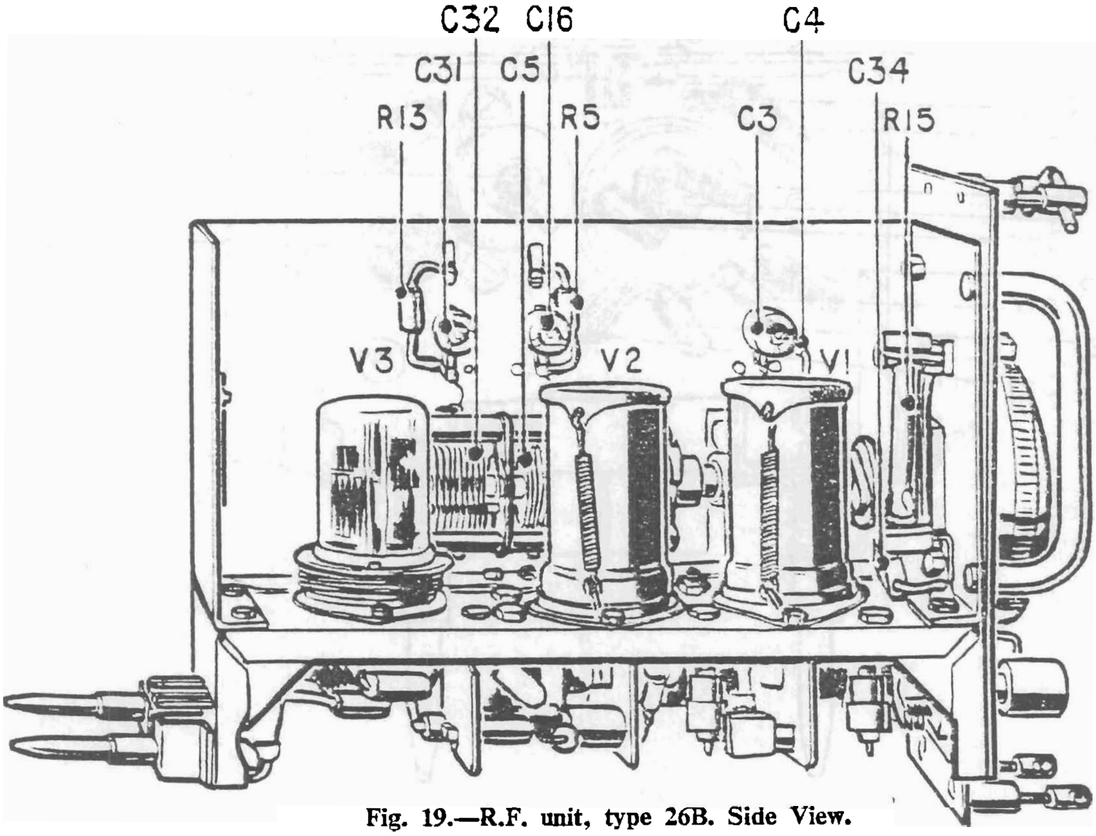


Fig. 19.—R.F. unit, type 26B. Side View.

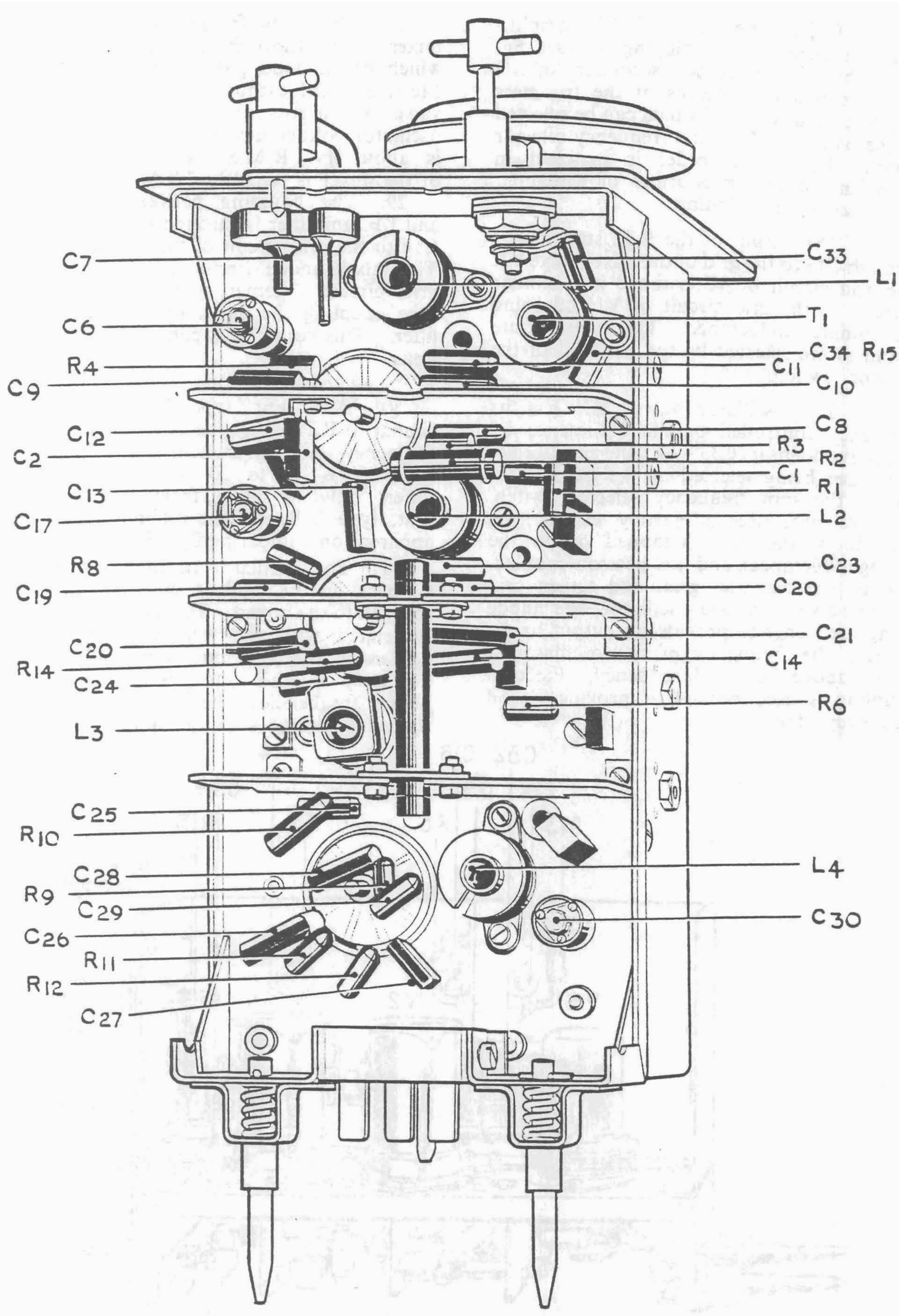


Fig. 20.—R.F. unit, type 26B. Underside view.

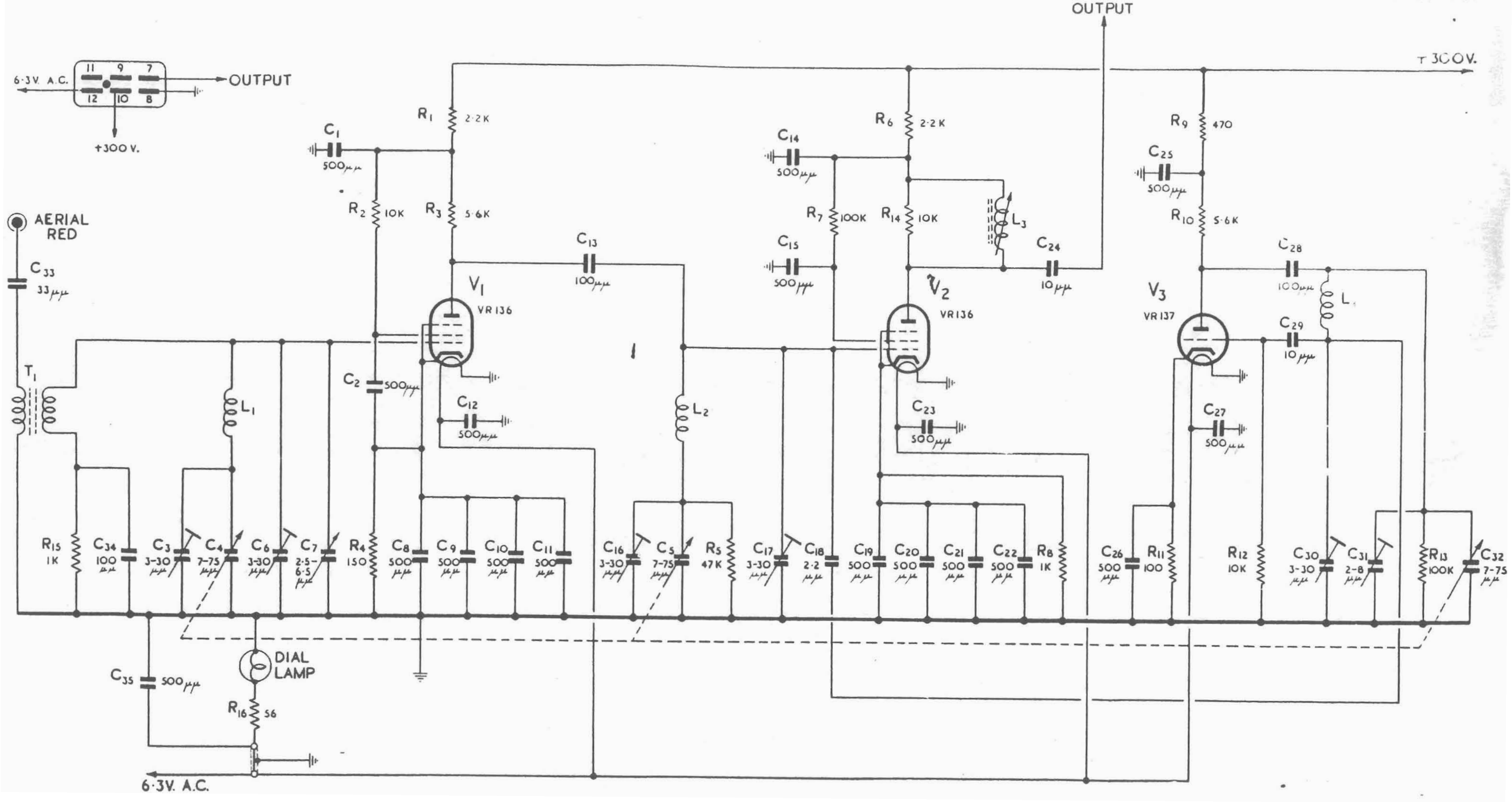


FIG. 21— R.F. UNIT, TYPE 26B — CIRCUIT

R.F. unit, type 26B.

32. R.F. unit, type 26B covers the frequency band 50 to 65 Mc/s; it differs from the two previously described R.F. units mainly in the fact that continuous tuning is provided over the band (see fig. 21). The unit contains three valves; an R.F. amplifying valve (VR136), a mixer valve (VR136) and an oscillator valve (VR137). The VR136 is a pentode and the VR137 a triode, and they are used because the VR65 is unsuitable for use at these higher frequencies.

33. There are three tuned circuits: the R.F. grid, the mixer grid, and the oscillator. At these frequencies the valve input resistance is so low that it provides the whole of the damping required on its associated tuned circuits (as $1/f^2$), and if the variable tuning condenser were connected in parallel with the tuning inductance in the usual way, the combined effect of the change of capacity and resistance over the tuning range would cause the bandwidth of the unit to change by about four to one over the band.

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

35. The three tuned circuits are ganged. The oscillator tuned circuit frequency must remain a constant amount (7.5 Mc/s), above the frequency of the other two tuned circuits as the condenser is rotated; this is accomplished by suitably proportioning the inductances and capacities. It is essential that the wiring and components of the tuned circuits be not altered in any way, as even small changes would upset the ganging of the circuits.

36. The coupling circuit between the aerial input and the first tuned circuit is designed to match the constant feeder impedance to the varying valve input resistance, and to increase the attenuation of any signals at I.F. frequency coming from the aerial.

37. The oscillator uses a Colpitts circuit so that no tap is required on the coil. The resonant circuit can therefore be made of the same form as the signal frequency tuned circuits, thus simplifying tracking problems. The oscillator output is fed to the mixer grid through a 2$\mu\mu$F. condenser and a concentric tube. The oscillator voltage developed on the mixer grid is about 2V. R.M.S.

38. The mixer anode circuit is identical with that of the R.F. units, types 24B and 25B. That is, it forms a band pass filter with the I.F. amplifier input circuit and the concentric tube.

R.F. unit, type 27B.

39. R.F. unit, type 27B covers the frequency band 65 to 80 Mc/s continuously, and it differs from the R.F. unit, type 26 only in the frequency coverage obtained (see fig. 24).

I.F. unit.

40. The circuit diagram is given in fig. 30. There are five stages of I.F. amplification, valves V1 to V5, these being R.F. pentodes, VR65. The diode V6 is a VR 92 and it serves as the second detector. The valve V7 is a video amplifier, and V8 is a cathode follower feeding the output of the receiver to the indicator unit.

41. The grid circuit of V1, consisting of the variable inductance L1 and the coupling capacity C1, forms part of the band pass coupling between the mixer stage and the I.F. amplifier, and resonates at 7.7 Mc/s. All the other I.F. tuned circuits L2, L3, L4, L5 and L6 are peaked at 7.5 Mc/s and the overall curve of the whole amplifier peaks at 7.5 Mc/s, the band width being $\pm$ 0.6 Mc/s for 6 dB down measured from the first I.F. amplifier grid.

42. The first two valves, V1 and V2, are provided with variable bias through the resistance R2, R7 and the variable gain potentiometer which is situated in the indicating unit. The stages V3, V4 and V5 are fitted with special "back bias" circuits to enable the signal to be read through jamming.

43. The two position anti-jamming switch is provided to enable certain circuit elements to be altered to permit the receiver to function in the presence of a modulated C.W. jamming signal. In the "N" position, normally used, the normal anti-jamming circuits, which are described in succeeding paragraphs, are employed and in the "Z" position, a video filter, C31, C32, R45 and R46 is included.

44. The anode circuit of V3 has a resistance R20 in series with a normal load R21, R20 is 100K and R21 is 4.7K. The junction of R21 and R20 is joined to the bottom end of the grid coil through the 510K resistance R16. The lower end of the grid coil is connected through another 510K resistor to a negative H.T. rail of approximately 110 volts.

45. The junction of R21 and R20 is by-passed to earth by the condenser C12 and the lower end of the grid coil is by-passed to earth by the condenser C10. A condenser connected across the resistor R16 completes a condenser potentiometer between the grid and anode circuits of V3. The circuits for the valves V4 and V5 are almost identical with that for V3 except that values of some of the condensers in the potentiometer chain are different.

46. The main H.T. line is 300v. positive with respect to earth, whilst the negative rail is at a potential of 110v. below earth. The potential at the junction of the resistors R21 and R20 will depend upon the drop in potential across R20 since this is a very much larger resistance than R21. This drop in potential will be determined by the anode current taken by the valve V3.

47. The anode current taken by V3 is adjusted to be 2.1 M/a, and this will cause the junction of the resistors R20 and R21 to be at a potential 100 volts positive with respect to earth. The resistances R16 and R17 are equal in value so that the grid of V3 will take up a potential mid-way between 100 volts positive and 110 volts negative, i.e. 5v. negative with respect to earth.

48. The anode current-grid voltage curves of fig. 29 help to explain the operation of the stage. Consider the curve where a small C.W. jamming signal is applied to the grid of V3, together with the required pulse signal. The C.W. signal will tend to drive the grid more positive and make the valve take more anode current. An increase of mean anode current will cause a greater drop in potential across R22, so that the grid will take up a potential more negative with respect to earth. The feedback arrangement thus tries to keep the mean anode current of the valve constant.

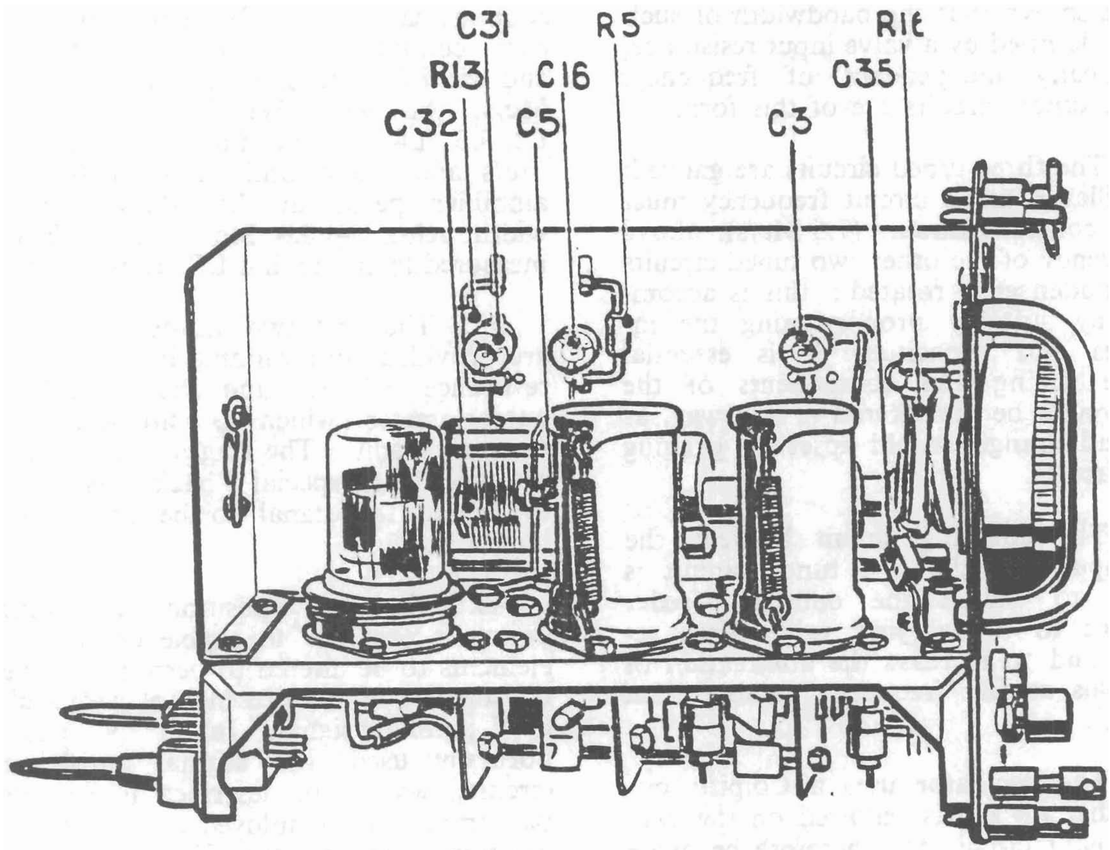


Fig. 22.—R.F. unit, type 27B. Side view.

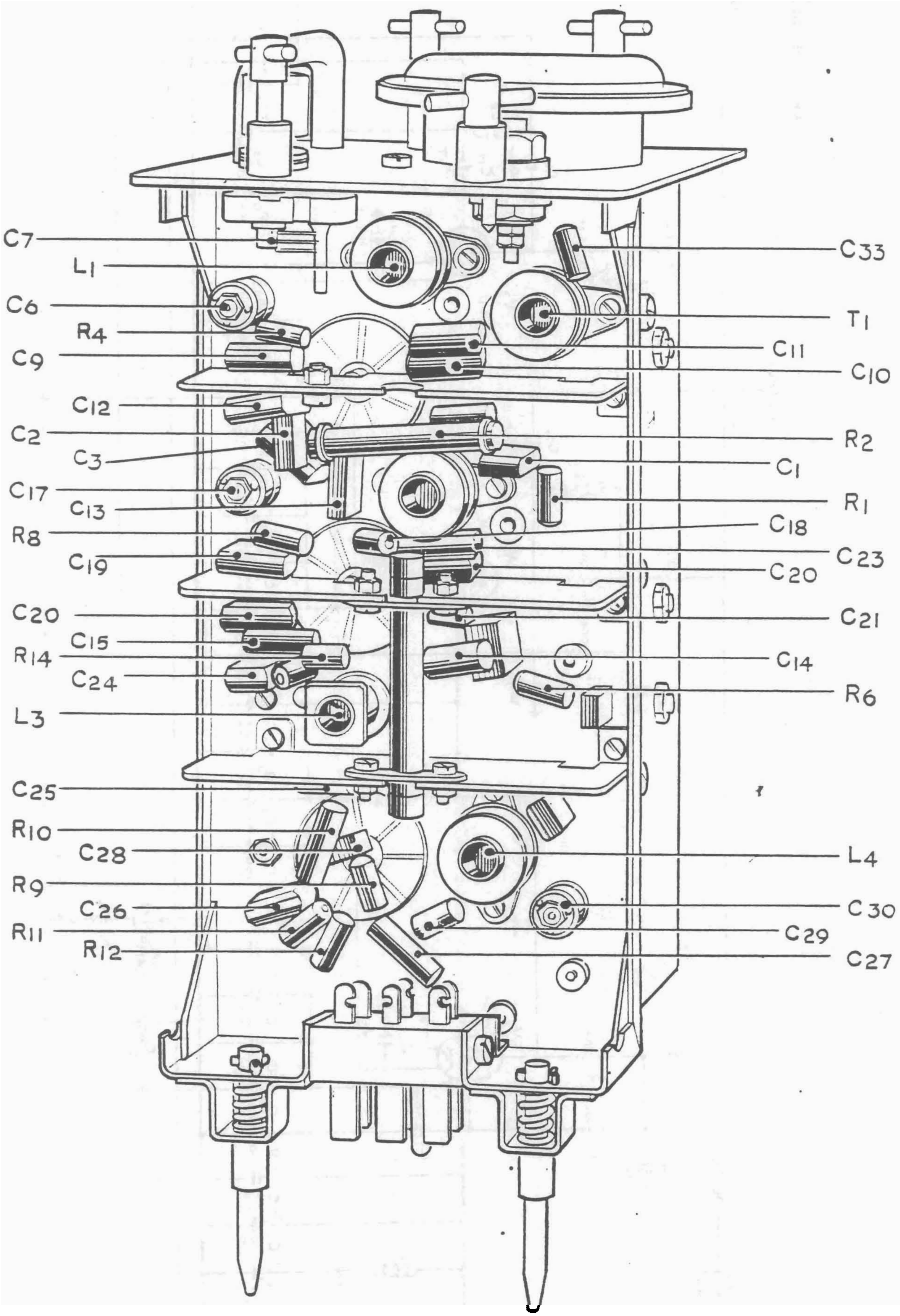


Fig. 23.—R.F. unit, type 27B. Underside view.

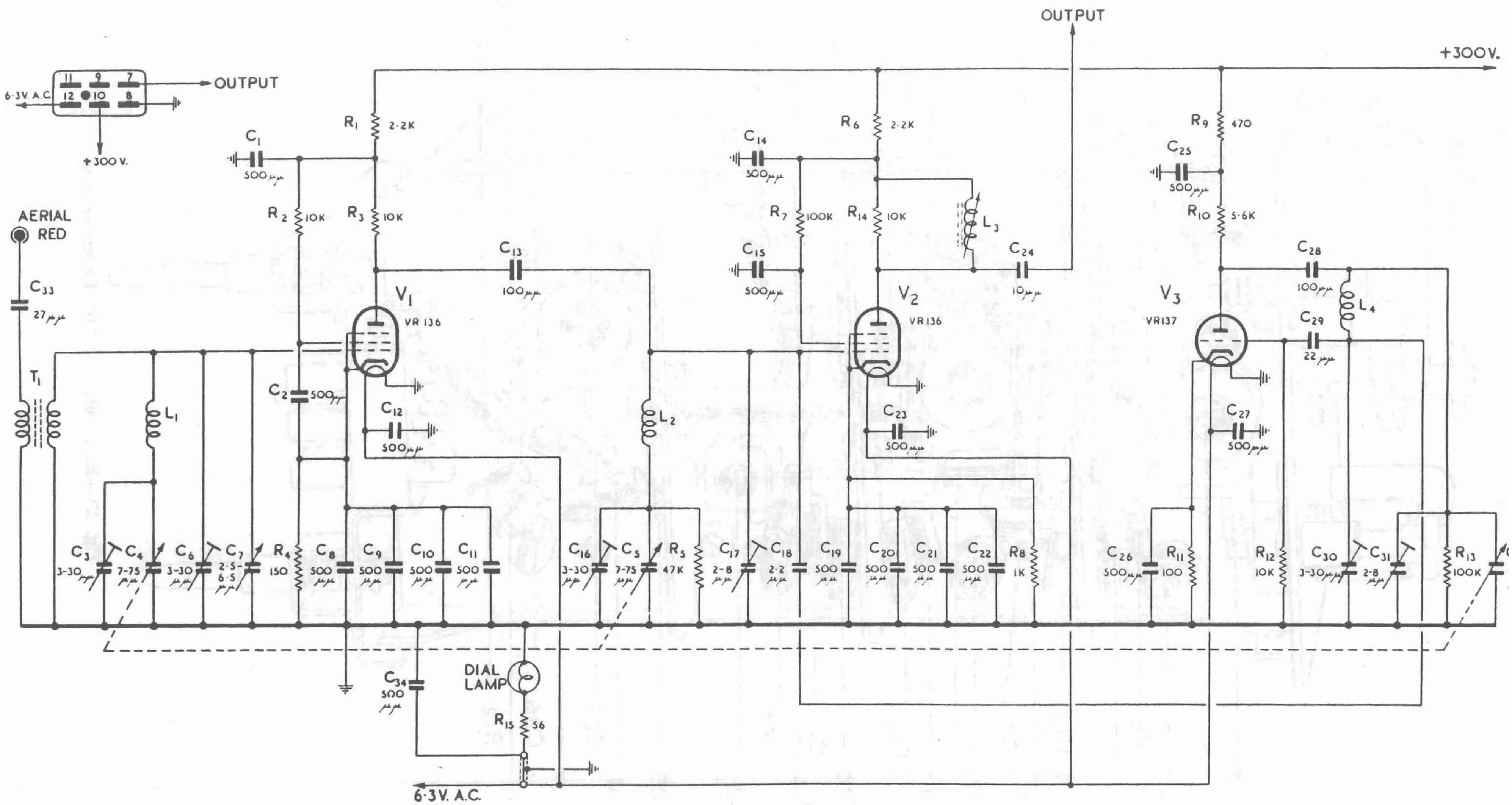


FIG. 24.—R.F. UNIT, TYPE 27B — CIRCUIT

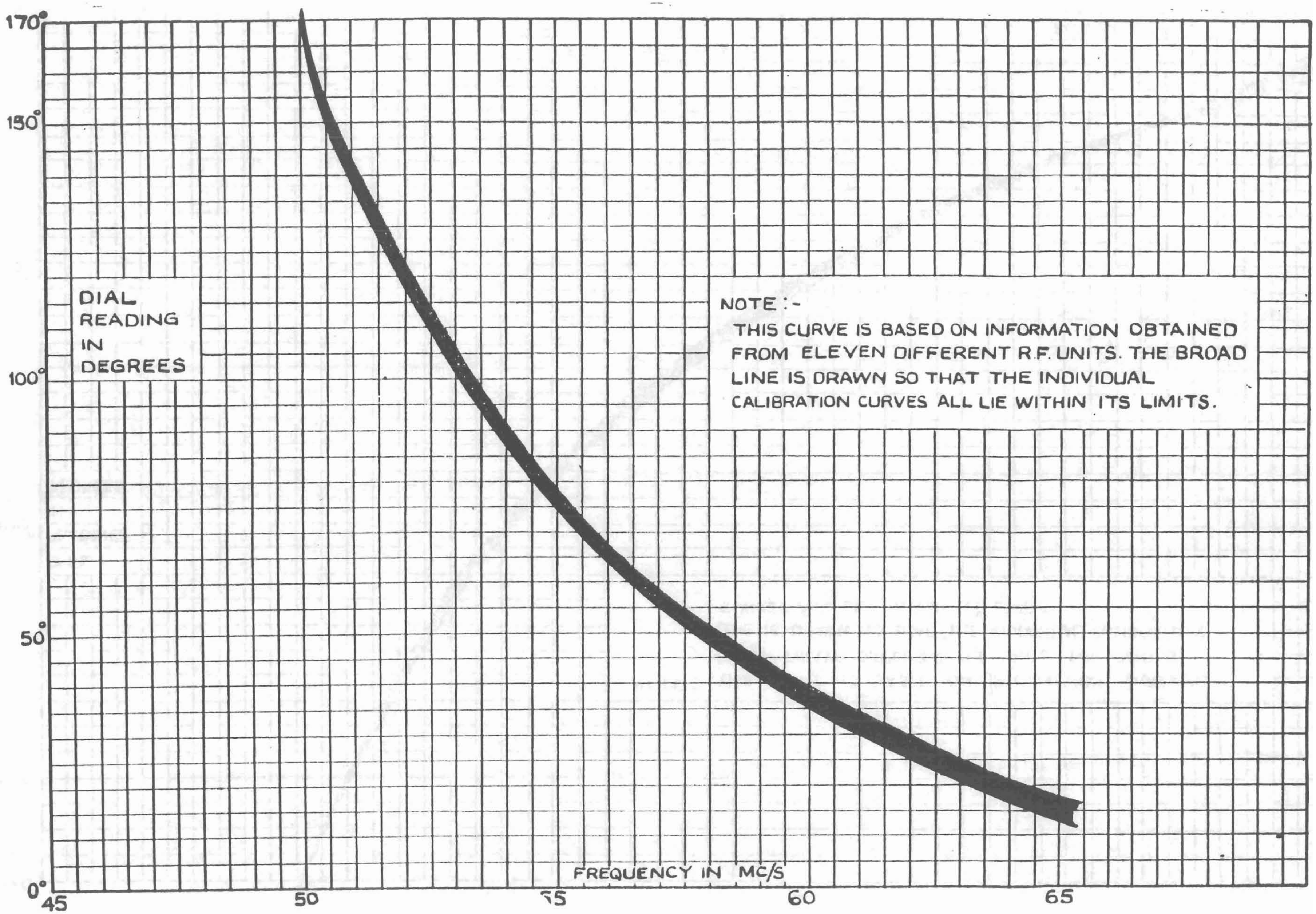


Fig. 25.—R.F. unit, type 26B. Calibration curve.

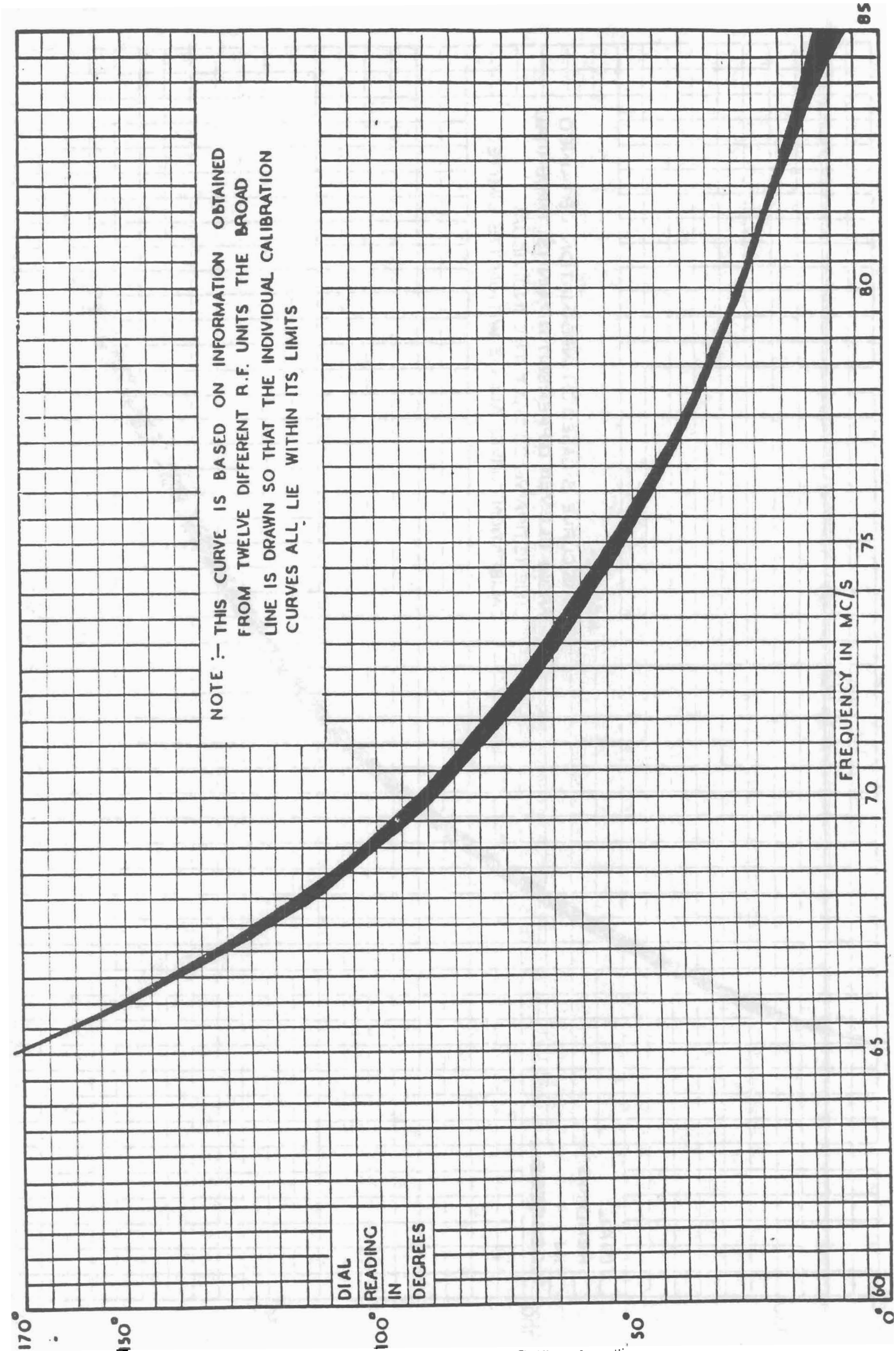


Fig. 26.—R.F. unit, type 27B. Calibration curve.

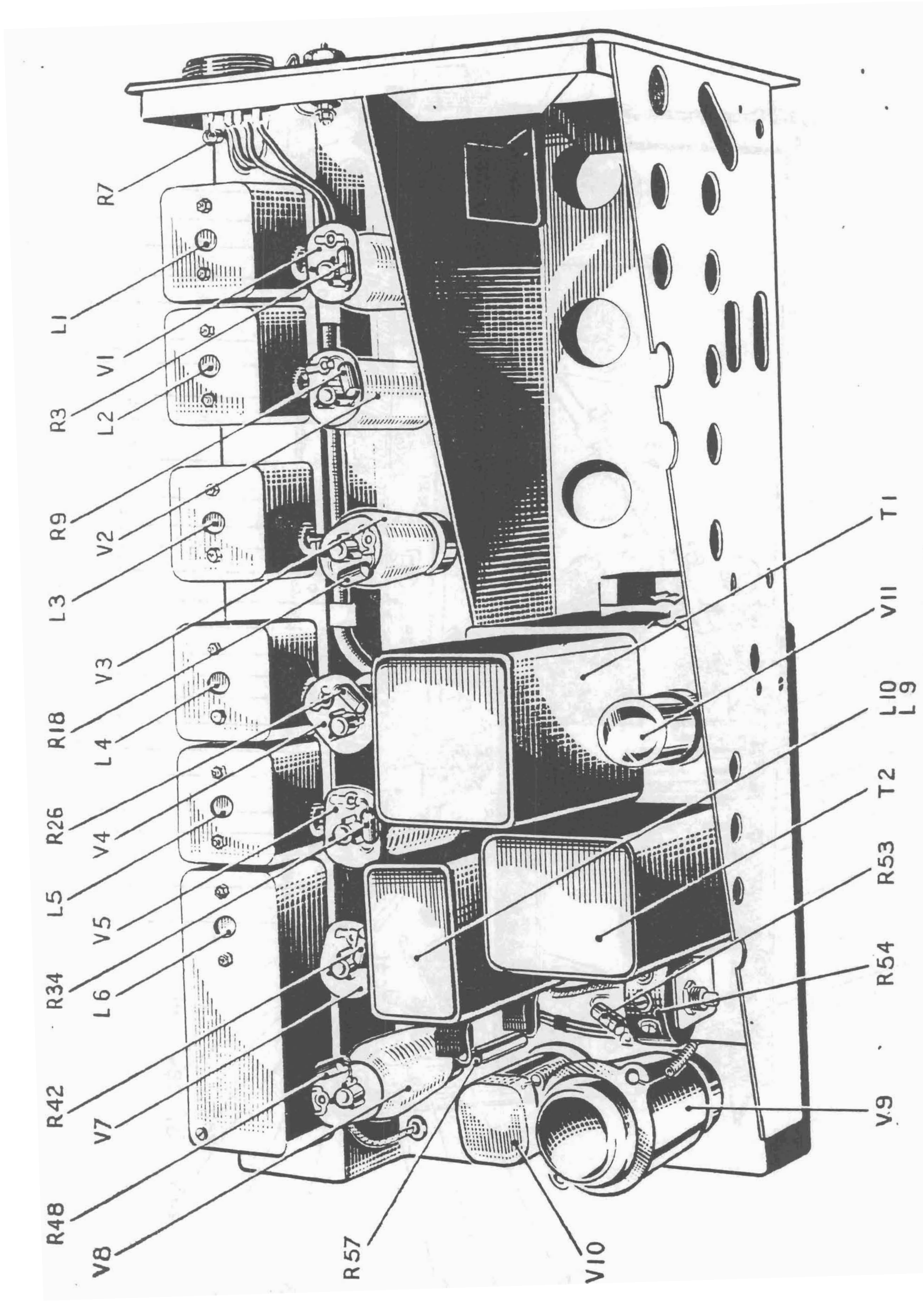


Fig. 27.—Receiver, type R.3645. Top view.

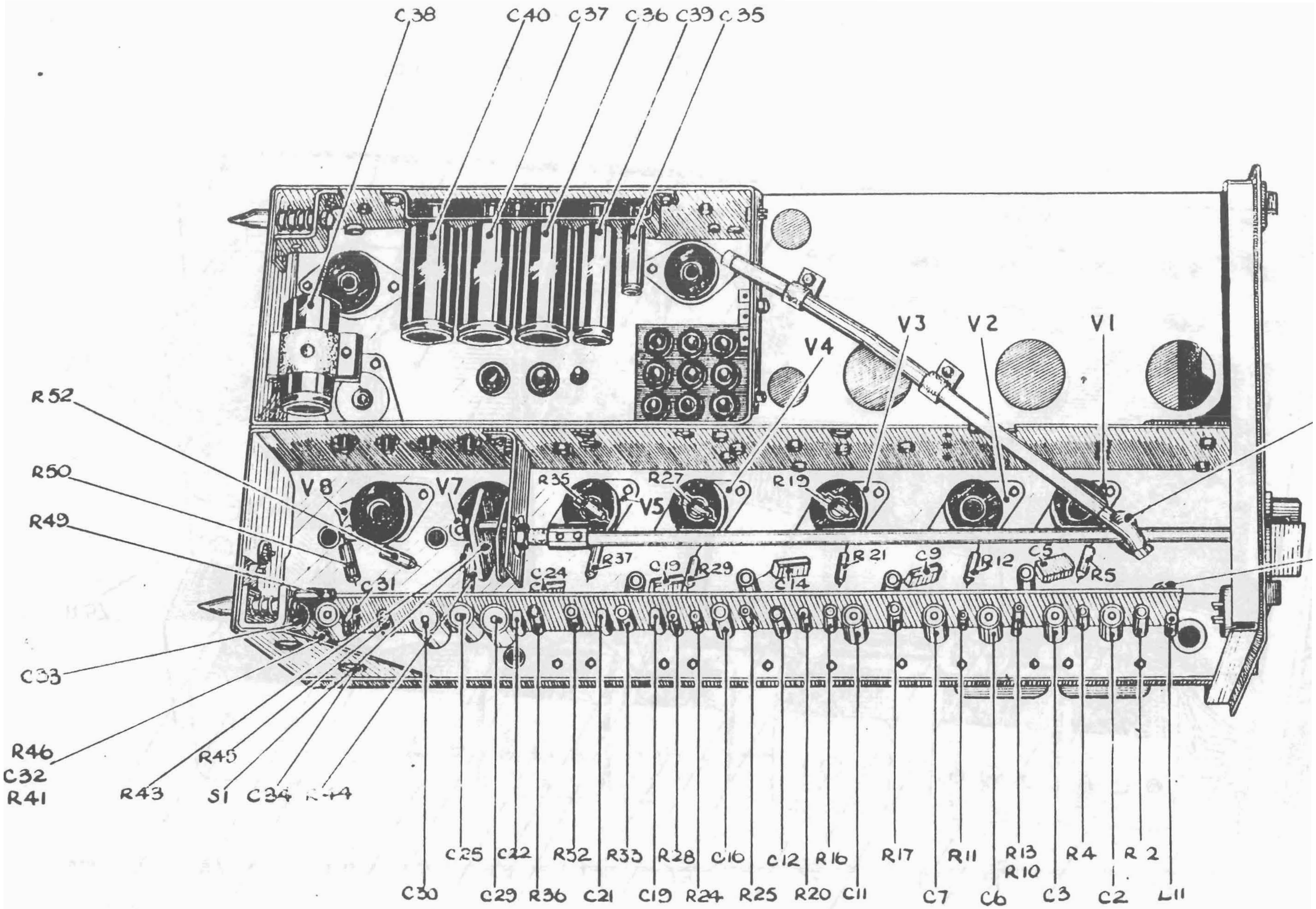


Fig. 28.—Receiver, type R.3645. Underside view.

49. Consider now the curve which illustrates the case of the very large C.W. jamming signal. The bias potential on the grid of the valve is shifted so much negative, in the presence of the jamming, that the required pulse signal is still able to pass through the valve on top of the jamming signal as shown. The decoupling condenser C12 and C10 in the anode and grid circuits of V3 are sufficiently large to prevent any change in the bias conditions for the duration of the pulse.

50. If the jamming signal is C.W. modulated by a low frequency sine wave, a waveform similar to the modulation envelope will appear across the anode decoupling condenser C12, since this has a small capacity and will present a fairly high impedance modulation frequencies up to about 4 kc/s. This valve has a fed back circuit through the condenser potentiometer C11 and C10, causing a reduction in the modulation precentage of the jamming signal which gets through the V3 stage. Further reduction

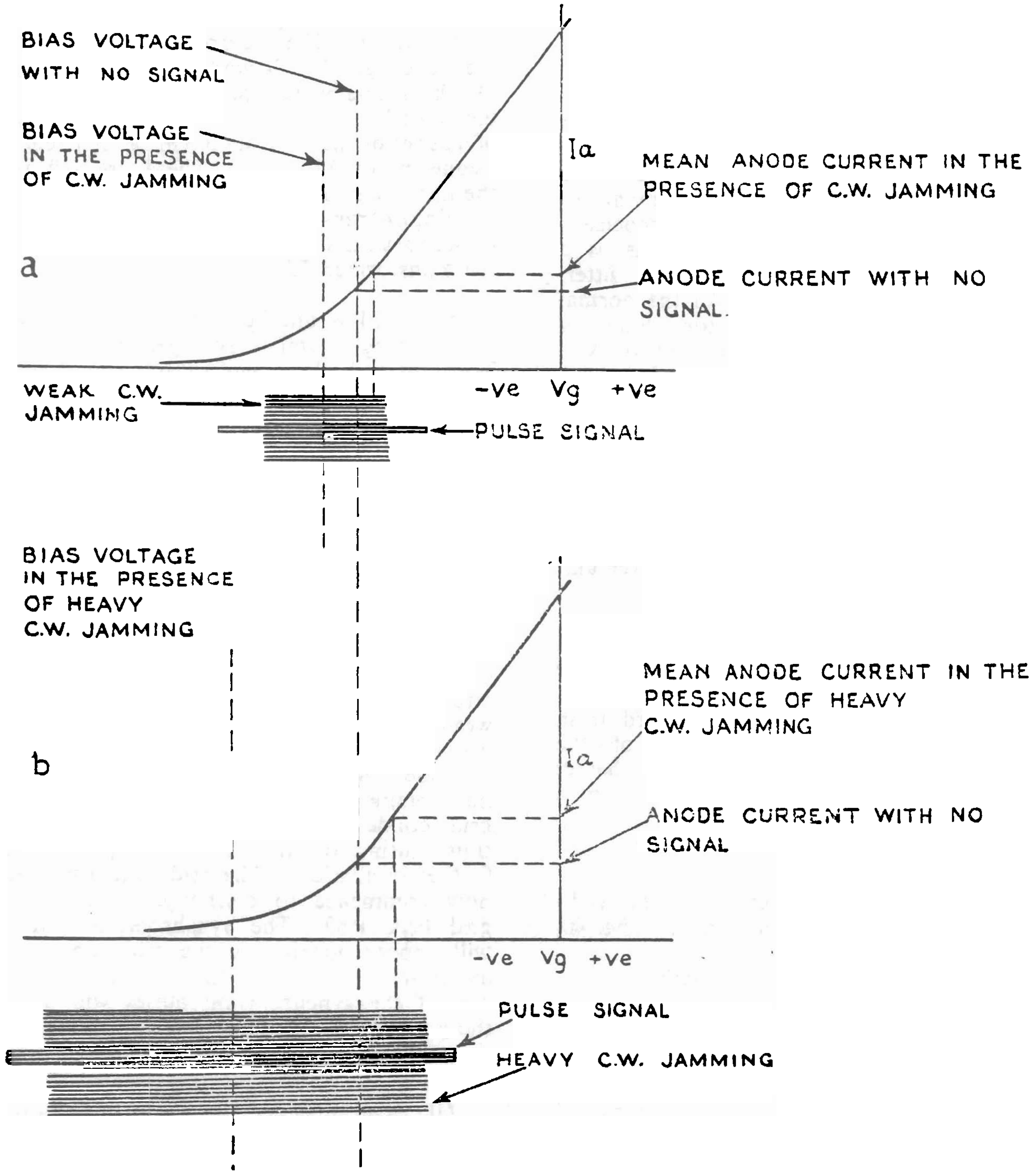


Fig. 29.—Anti-jamming circuits — waveforms.

in the percentage modulation occurs in the stages V4 and V5, and in position " Z " of the anti-jamming switch an additional high pass filter consisting of the condensers and resistances C31, C32, R45 and R46 is included between the video frequency amplifier V7 and the cathode follower V8 to remove the last traces of ripple.

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

Power supply unit.

52. H.T. supply for the equipment is obtained from the transformer T1 and the valve V9, operating as a normal full-wave rectifier. Smoothing is carried out by means of the chokes L9 and L10, and the condensers C36 and C37. The valve V10 acts as a stabiliser against very low frequency jitter, which is generally present with the normal type of engine driven generator. Some of this ripple is fed on to the grid of V10 and the gain is adjusted so that the ripple developed across the anode resistor R57 exactly balances the ripple coming through direct from the power unit.

53. Stabilised H.T. supply from the anode of V10 is fed to the indicating unit through the large 6-pin W plug. Unstabilised H.T. supply is fed to the receiver unit and to the R.F. unit.

54. The negative rail supply is obtained from a tapping on the secondary of the transformer T1 and half-wave rectifier V11. The negative rail supply is obtained from the potential divider consisting of the resistors R53, R54 and R55. The heater supply for the receiver is obtained from a winding of the transformer T2.

Indicating unit, type 266.

55. The circuit diagram of the Indicating unit, type 266 is illustrated in fig. 40.

Crystal oscillator and divider unit.

56. The pentode V12 is the crystal oscillator stage and is a VR91. The crystal has a fundamental frequency of 150 Kc/s and is connected in the grid circuit. The 50$\mu\mu$F variable condenser, C42, is connected across the crystal to give fine control of the frequency. The inductance L1 and condenser C43 form an impedance circuit in the screen circuit to maintain the oscillation. The transformer T1 in the anode circuit has its secondary tuned to 150 kc/s, the crystal frequency. The output across the secondary winding of T1 is a sine wave, having an amplitude of at least 100V. peak to peak, and it is applied to the grid circuit of the valve V13 through a small condenser C50.

57. The valve V13 acts as a " squegger " type of oscillator through the transformer T2, which has two tightly coupled windings connected to the grid and anode circuits of the valve. The recurrence frequency of the "squegger " is locked by means of the 150 kc/s sine wave applied to the grid of the valve V13, so that the output will consist of a series of sharp pulses having a recurrence frequency of 150 kc/s. These are fed to the next stage in the divider, V14, through a winding on transformer T3, which is connected in series with the anode circuit winding of the transformer T2.

58. V14 is another " squegger " oscillator, having a similar arrangement to V13. The grid leak, R69, has its top end joined to the slider of the potentiometer, VR11, which forms part of a chain of resistors VR11 and R68 from the HT line to earth. The potential to which the grid leak is returned, is, therefore, adjustable by means of the potentiometer VR11, and this serves to adjust the division ratio of the stage.

59. The mode of operation of the dividers can best be understood by reference to fig. 35, which shows the waveforms obtained at various points in the divider circuit. (The waveforms are drawn as they would appear on an oscilloscope : during normal operation they are far sharper). Consider the valve V14 ; when the valve has completed one cycle of operation, the grid condenser is charged very negative, thus cutting off the valve and preventing further oscillation. The grid condenser will now commence to discharge through the grid leak R69. The synchronising pulses will appear positive on the grid condenser as shown at (c) on fig. 35. Eventually one of the synchronising pulses will drive the grid sufficiently near zero bias to enable the valve to oscillate.

60. The first half cycle of oscillation will drive the grid more positive, but the potential across the grid condenser cannot rise much above earth potential as grid current will flow. The second half cycle

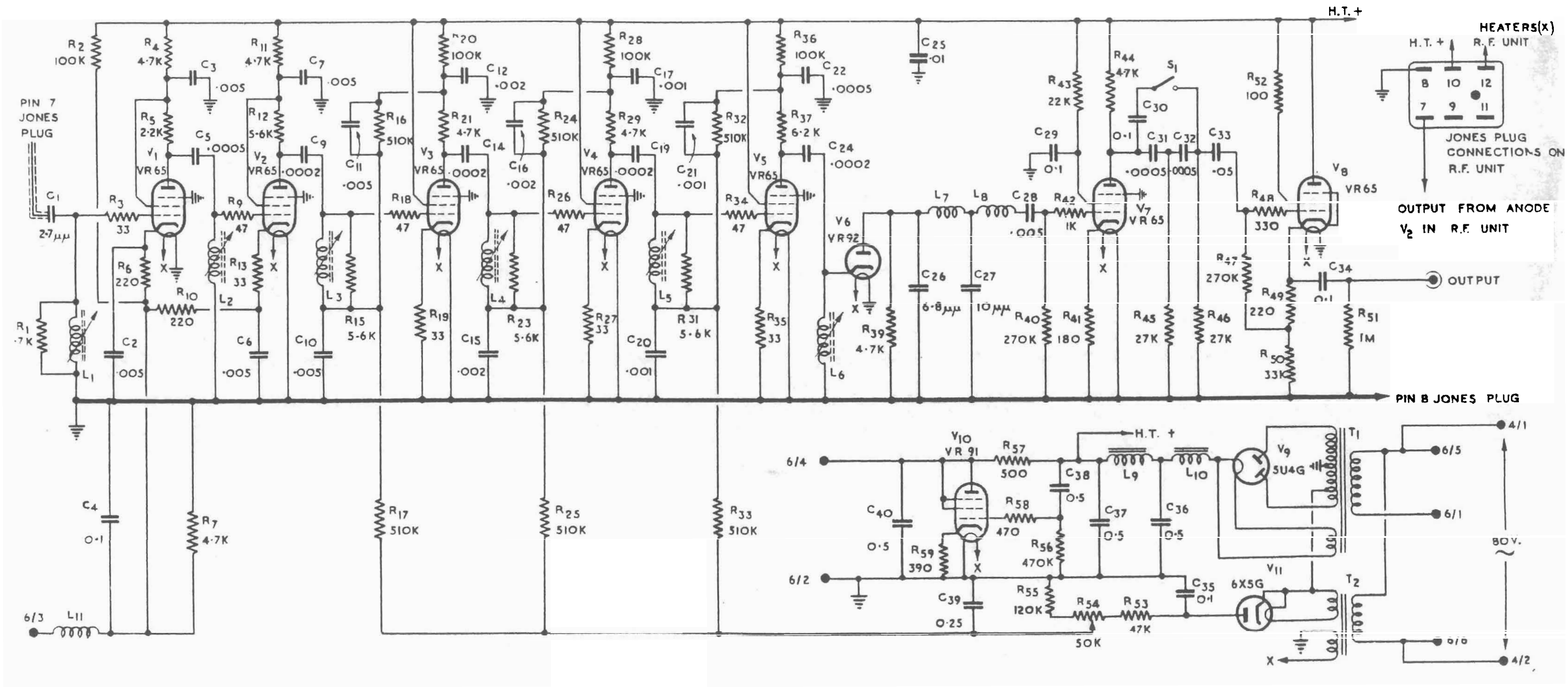


FIG. 30.—RECEIVER, TYPE R.3645—CIRCUIT

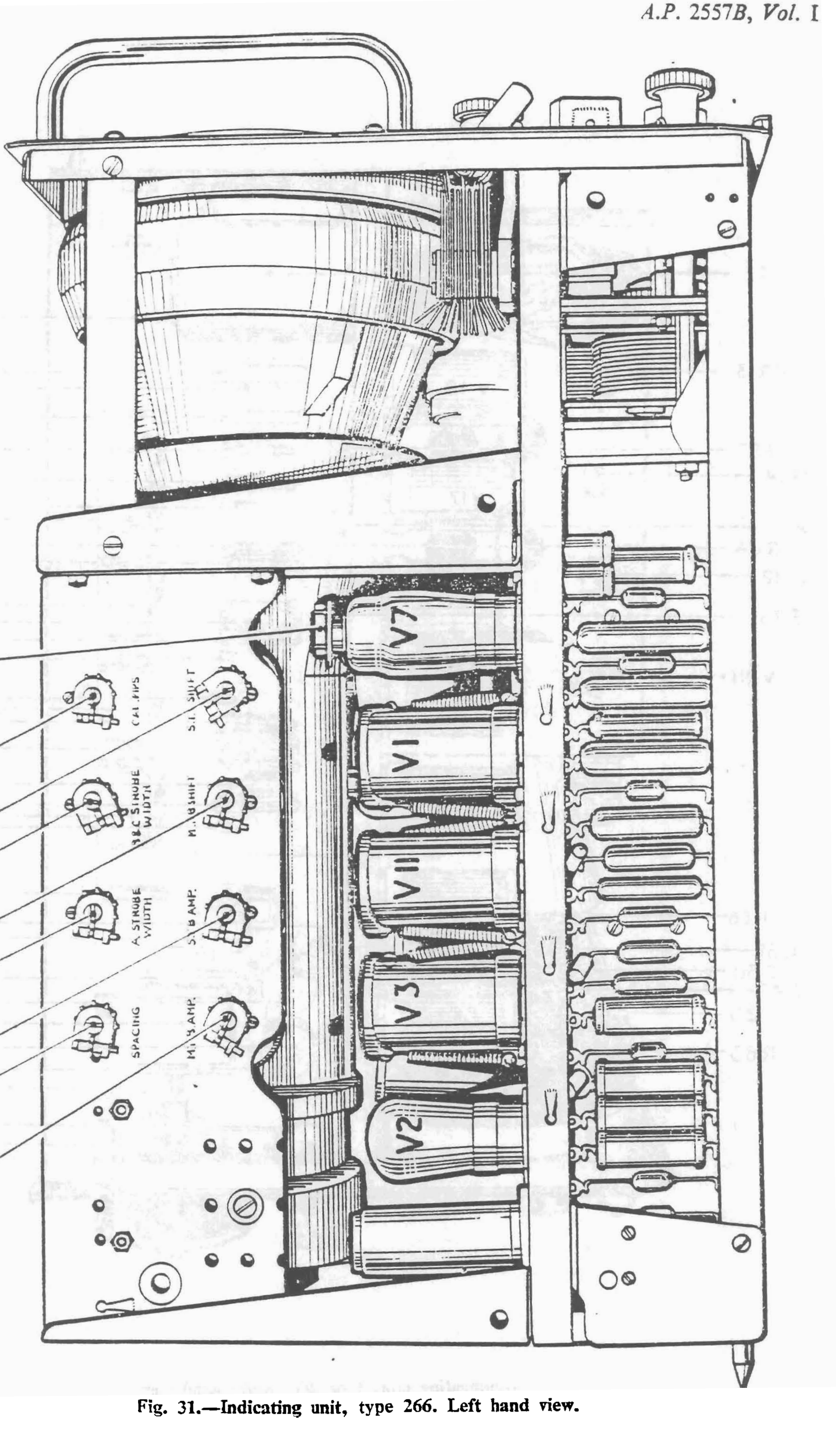


Fig. 31.—Indicating unit, type 266. Left hand view.

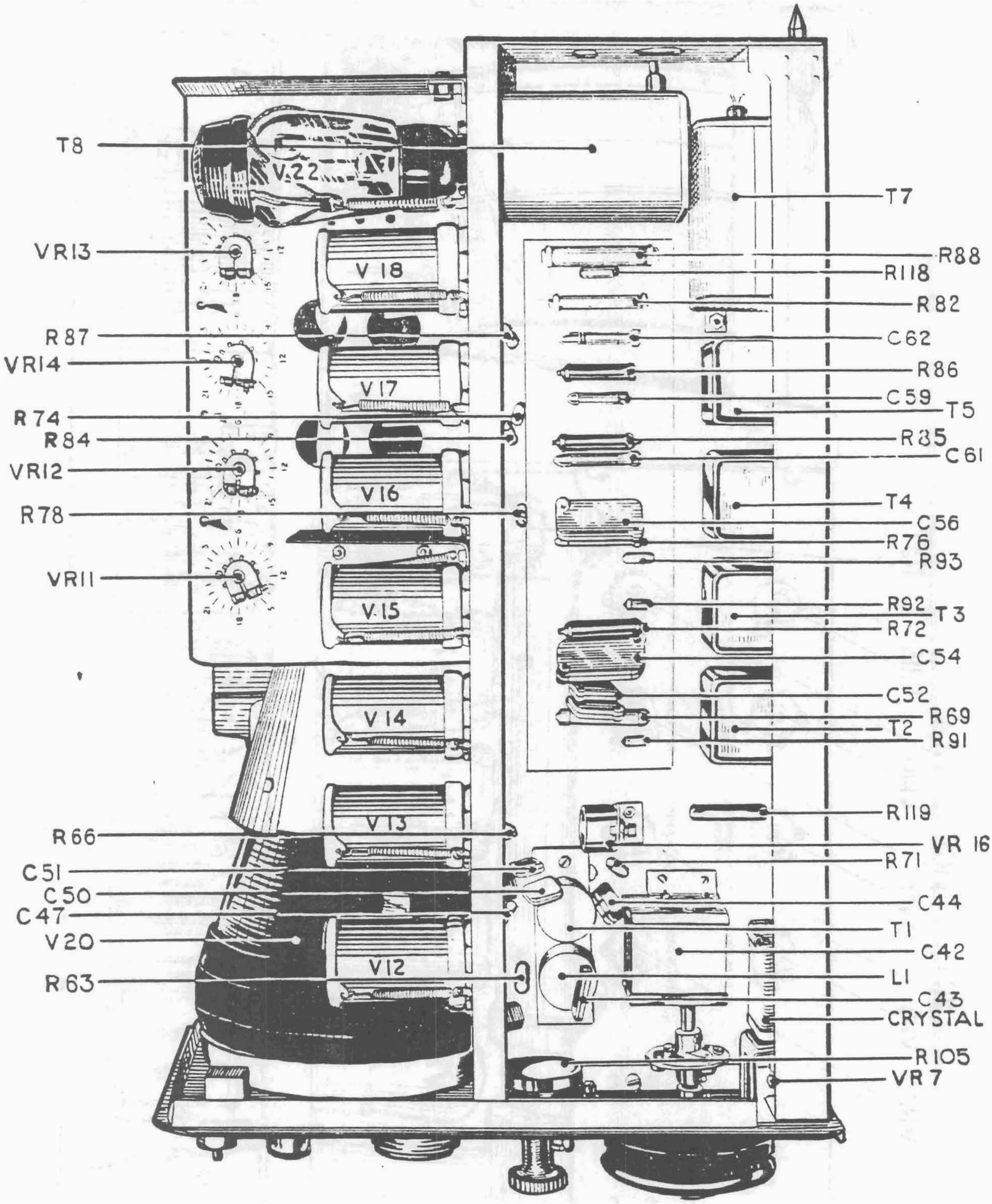


Fig. 32.—Indicating unit, type 266. Right hand view.

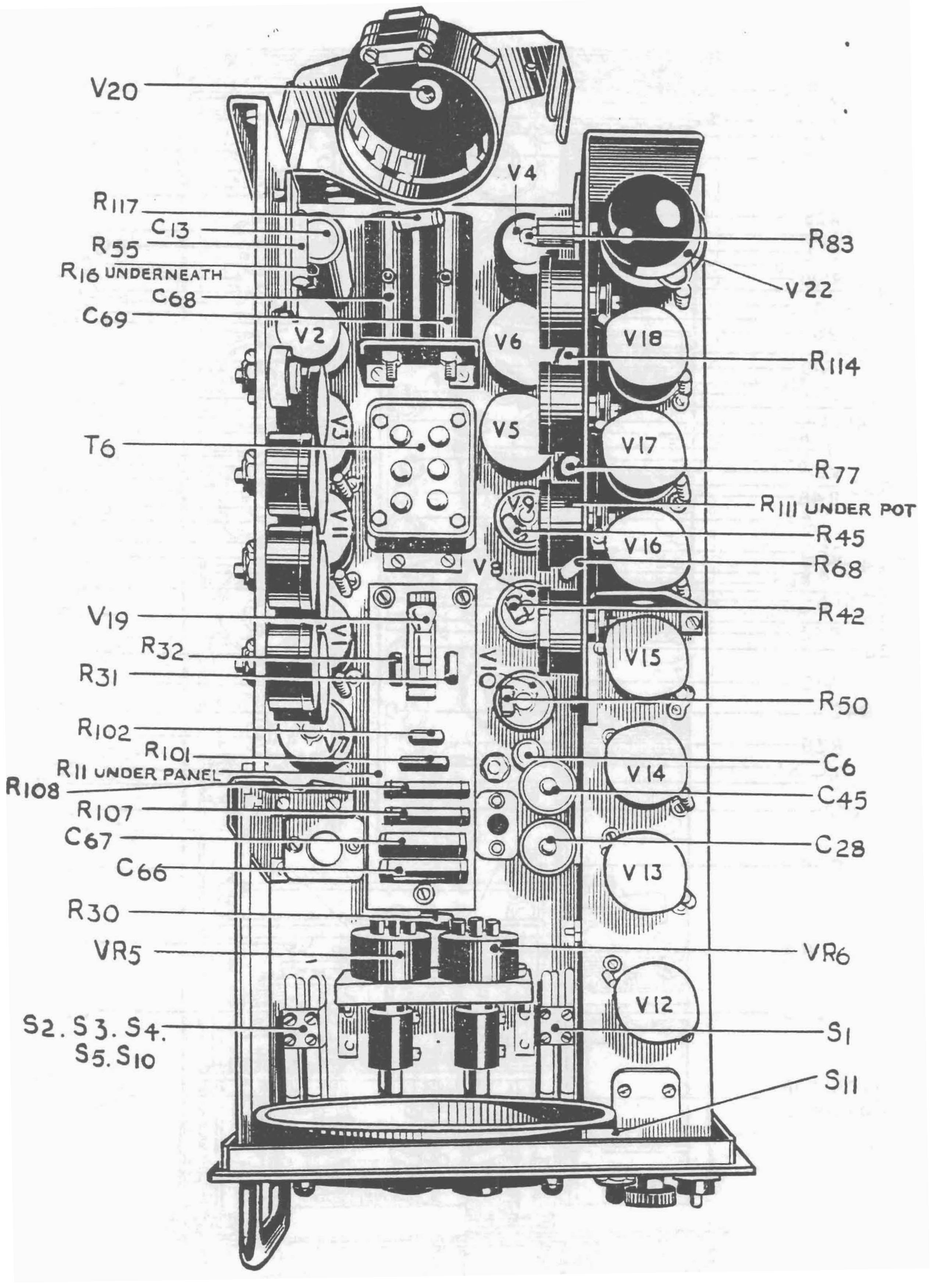


Fig. 33.—Indicating unit, type 266. Top view.

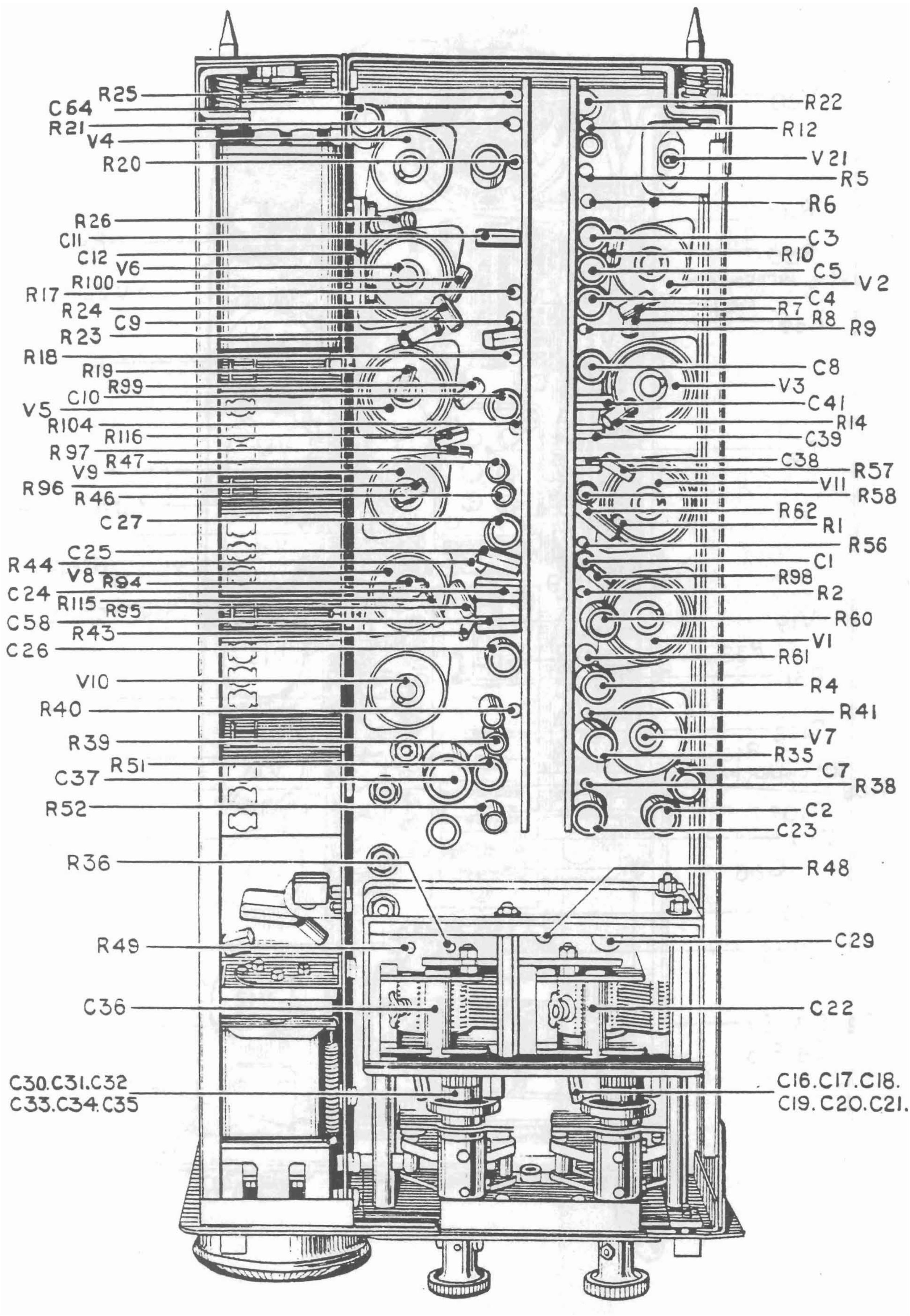


Fig. 34.—Indicating unit, type 266. Underside view.

of oscillation will drive the grid negative again and cut off the valve; the whole cycle is then repeated. The setting of the potentiometer VR11 controls the rate of discharge of the condenser and thus can be used to set the division ratio. Normally this stage is arranged to divide by five.

61. The resistance (R71 and VR16) in the cathode circuit of V14 provides synchronising pulses for the following stage V15, amplitude being governed by the setting of VR16. The grid condenser for this stage, C54, is connected to the slider of this resistance so that positive synchronising pulses will be injected into the grid circuit. The valve V15 functions in exactly the same manner as V14 and the waveforms obtained are shown at (d) in fig. 35. This stage normally divides by two and should not require setting in the normal course of events.

62. The next stage, V16, has a similar circuit, synchronising pulses being fed in through a third winding on the transformer T5, which is connected in series with the anode circuit winding of the transformer T4. The potentiometer VR12 is the preset control for the division ratio, and this stage is adjusted to divide by five.

63. The last stage of division is a multivibrator, consisting of the valves V17 and V18. The time constant in the grid circuit of V17 (C61, R85), is much longer than the time constant in the grid circuit of V18 (C62, R86), so that the waveform from the multivibrator is unsymmetrical. R89 is included by opening the 6/7 switch, S12a, so that the length of the time base in the divide by seven position is the same. Negative synchronising pulses (see fig. 35 (f) are derived from a small resistor, R80, and fed to the grid of V18 through a small condenser C59. The pulses are amplified by V18 and applied as positive pulses to the grid of V17. The control of the time constants at the two grids is carried out by the potentiometers VR13 and VR14. VR13 controls the width of the narrow positive pulse which appears at the anode of V18 and pips are fed on to the cathode of V17 from the cathode load (R74) of V5 to synchronise the back edge of this pulse to a 15kc. pip. The width of this pulse determines the flyback time of the time base, and its trailing edge is used to initiate the "A" strobe time base. The potentiometer VR14 controls the recurrence frequency of the multivibrator and is the control for setting up the division ratio. The output from V17 is taken to the time base and to the spacer multivibrator (V8 and V9). The output from V18 is taken to the strobe mixer valve V11 and the waveforms obtained are shown in fig. 36(g) and 36(h).

64. The purpose of the third winding on the transformers T2 and T4 may now be explained. Across the third winding on T2, 150 kc/s calibration pips are produced, which it is desired to feed on to the Y plate of the C.R.T. to act as calibration markers. It is also desired to raise the amplitude of every 10th 150 kc/s pip to indicate the whole number and to assist in counting.

65. One end of the third winding on T2 is joined to the cathode of V15, the 15 kc/s stage, and a small resistor, R74, is connected between cathode and earth. A wide positive pulse is produced across this resistor and the resultant waveform between the free end of the winding on T2 and earth is as shown in fig. 36(j), every tenth 150 kc/s pip being raised above the others. The third winding on T4 behaves in the same manner, every fifth 15 kc/s pulse being raised up by means of a pulse across the cathode resistor of V16 (R78); the waveform is as shown in fig. 36(k). These two waveforms are cleaned up in a manner described later (see para. 92), and applied to the Y plate of the C.R.T. as calibration markers.

Main time base.

66. The operation can best be understood by referring to fig. 37 which gives the waveforms at various points in the circuit. The valves V5 and V6 in the circuit are used to produce the time base sweep. In the main time base position, output from the anode of V17 in the divider is fed to the suppressor grid of V5 through the condensers C58 and C10. D.c. restoration is provided at the suppressor grid by means of one half of the double diode V4.

67. The valve V5 has a condenser, C9, connected between the anode and control grid. The grid leak R17 is connected to the slider of the potentiometer VR2, which forms part of a chain of resistances VR1, R16 and VR2 between the H.T. line and earth. During the short negative pulse (see fig. 37(a) input to suppressor grid) the anode current will be cut off, so that the condenser C9 will charge up to the potential of the H.T. line through the resistances R20 and the grid to cathode impedance of V5.

68. At the end of the short negative pulse the suppressor grid is brought up to zero bias again and the anode potential commences to fall. For the first few volts the fall of potential is very rapid as the grid has been at zero bias and is now carried down with the anode to a normal bias. The anode voltage will then fall steadily in a linear fashion as the condenser C9 is discharged by current through R17, in such a manner that the grid voltage is kept to the grid voltage — anode current characteristic of V5. The next negative pulse causes the condenser C9 to charge up again to H.T. potential when the whole cycle is repeated. R15 is included when the 6/7 switch S12b is in the divide by seven position to ensure that the time base stays the same length as in the divide by six position.

69. Amplitude control of the sweep is carried out by means of the potentiometer VR2. Push-pull deflection is obtained by using the valve V6. The grid of this valve is fed with output from the anode of V5 through the resistance condenser network shown in the circuit, R23 and R24 being high resistances of equal value. The X plates of the C.R.T. are d.c. coupled to the anodes of V5 and V6, the shift being obtained by altering the bias of V6 by means of the potentiometer VR3, thus altering the mean potential at the anode. The resistance R22 is connected between the anode of V5 and earth to lower the mean anode potential of this valve, so that the mean anode potential of V6 may be either raised or lowered with respect to that of V5.

70. The spacing between the traces is produced by applying a square waveform to one of the Y plates of the C.R.T. The square wave is produced by a multivibrator consisting of the valves V8 and V9. The circuit is arranged so that the multivibrator action takes place between the grids and screens of the two valves, the anodes having load resistances R39 and R47 from which the outputs are taken. The multivibrator is synchronised from the waveform at the anode of V17, which is differentiated by the condensers C24 and C25 and the resistors R43 and R44, and applied to both grids of the multivibrator. The spacing waveform is taken off the anode of V8 through R38 and VR8 and applied directly to the Y2 plate; C23 is a blocking condenser to isolate the H.T. voltage from the Y2 plate. The preset potentiometer VR8 controls the amplitude of the spacing waveform applied to the Y plate.

Strobe time base.

71. The two "A" strobe time bases (see fig. 8) are initiated from the trailing edge of the positive pulse produced at the anode of V18. The "B" and "C" strobe time bases are initiated from a timing edge produced at the anodes of V7 and V10.

72. Consider the operation of the valve V7. The grid is connected through the condenser C16 to C22 to the anode of V8 and so receives a square wave input. The grid leak R36 has its top end connected to an H.T. potential. The grid of V7 is thus returned to a point positive with respect to earth. During the positive-going portion of the square wave the grid of V7 will remain at zero bias and the anode voltage will be low. When the square wave goes negative V7 will be cut off but the grid potential will gradually leak back towards zero potential at a rate depending on the time constant (C16 to C22 and R36). Eventually the valve will conduct again, and the grid will remain at zero potential until the next negative going square wave comes along. The anode waveform will be a square pulse as shown in fig. 37(g), the width of which is controlled by varying the value of the capacity in the grid circuit.

73. The strobe time base is initiated off the back edge of this pulse, and can be set to any position between one negative-going and the following positive-going edge of the square wave: it will therefore be possible to move the strobe along one trace of the main time base. Typical waveforms are given in fig. 38. Coarse control of the strobe timing is carried out by means of the fixed capacities C16 to C20 which are switched in circuit by means of S8. Fine control is carried out by the variable condenser C22. Both these controls are brought out to the front panel of the indicator unit.

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

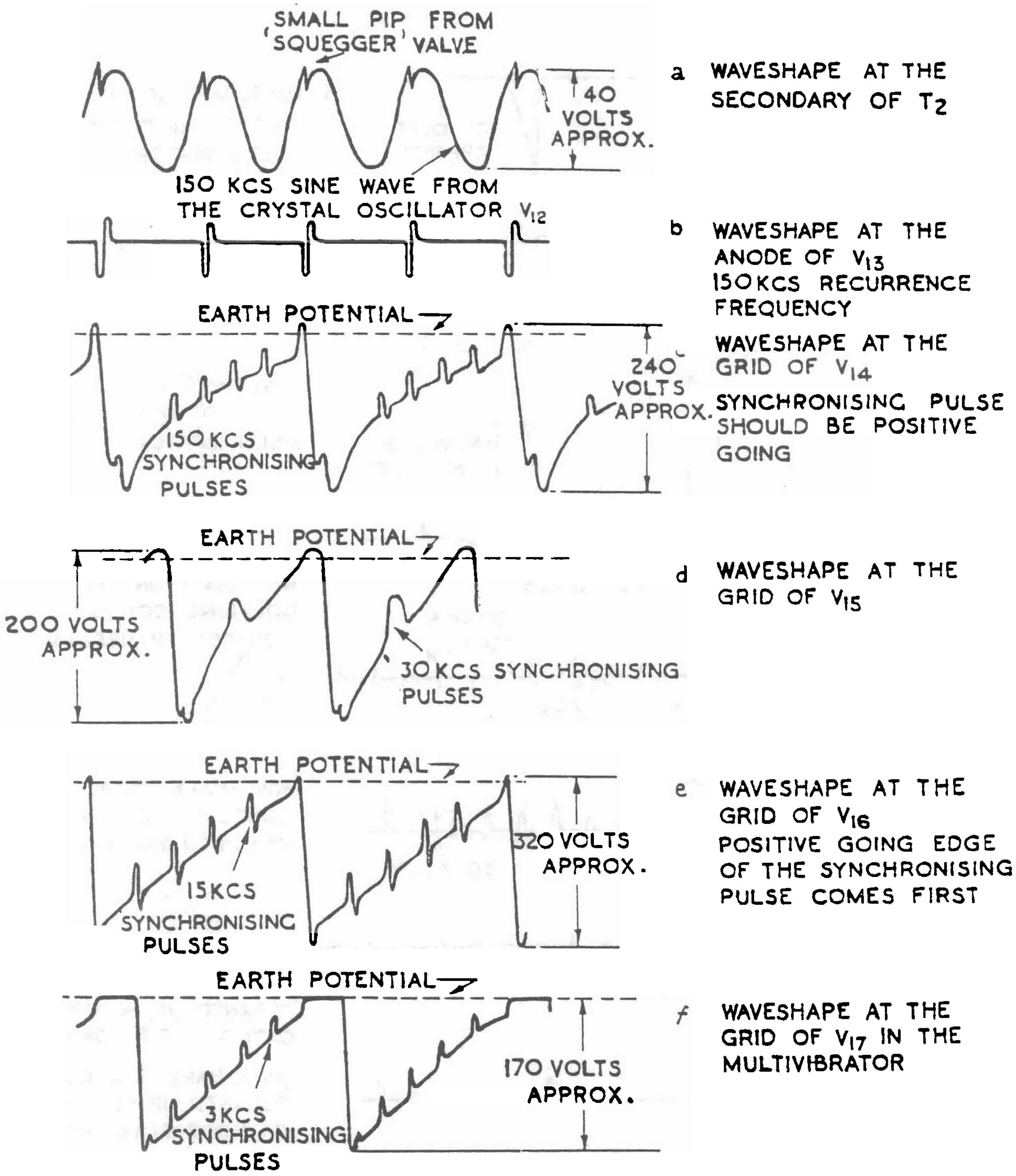


Fig. 35.—Indicating unit, type 266. Waveforms (1).

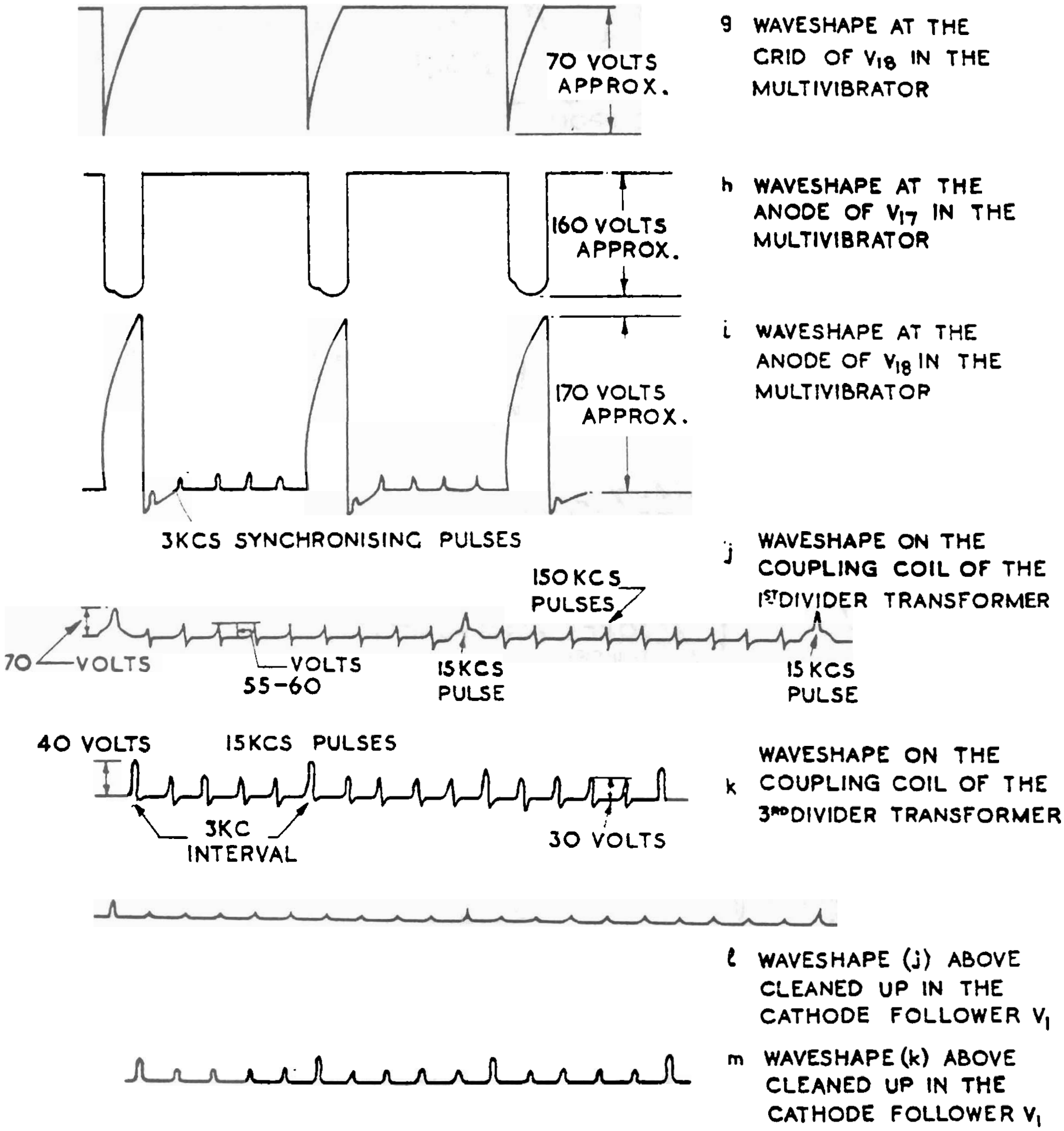


Fig. 36.—Indicating unit, type 266. Waveforms (2).

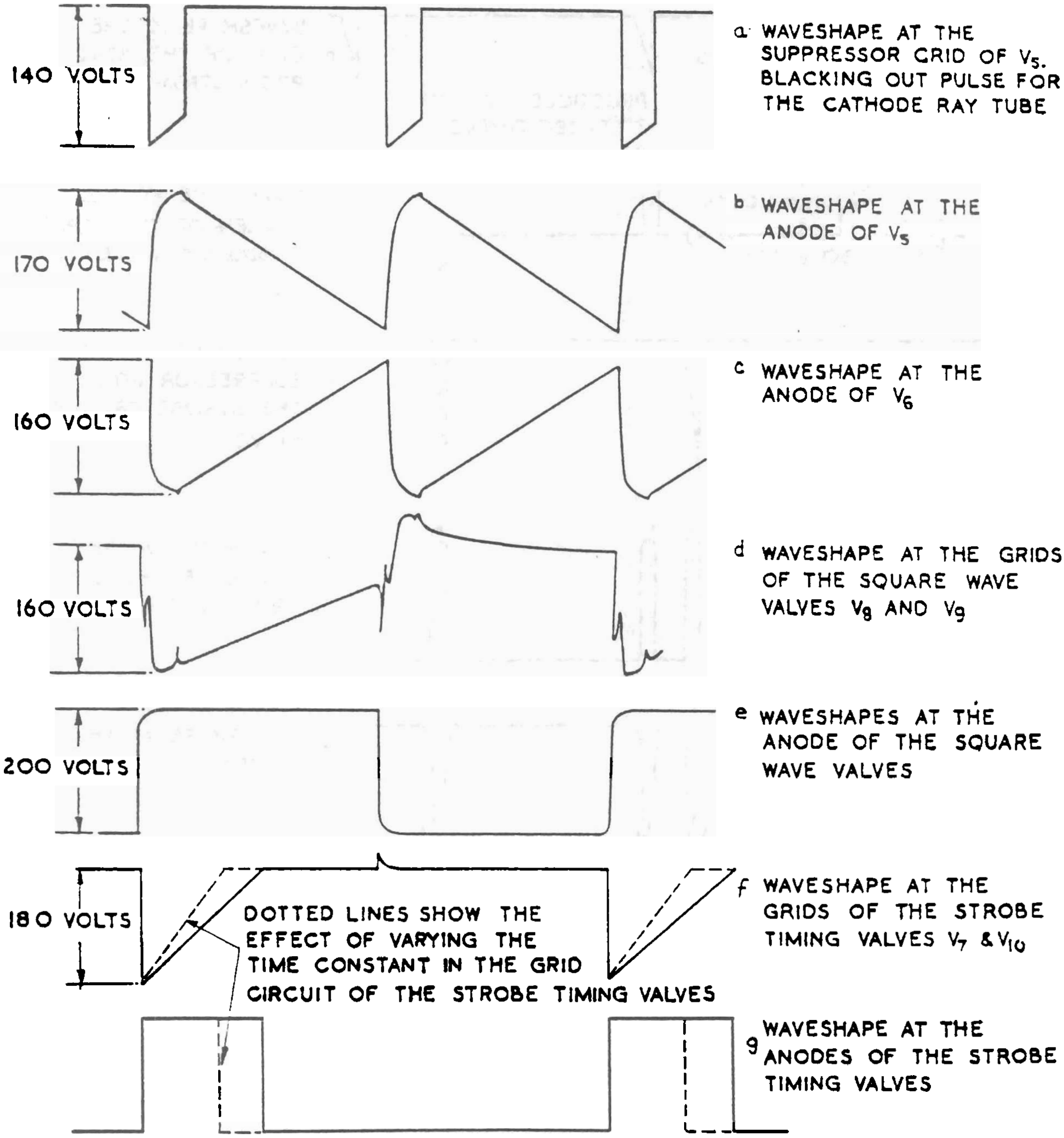


Fig. 37.—Indicating unit, type 266. Waveforms (3).

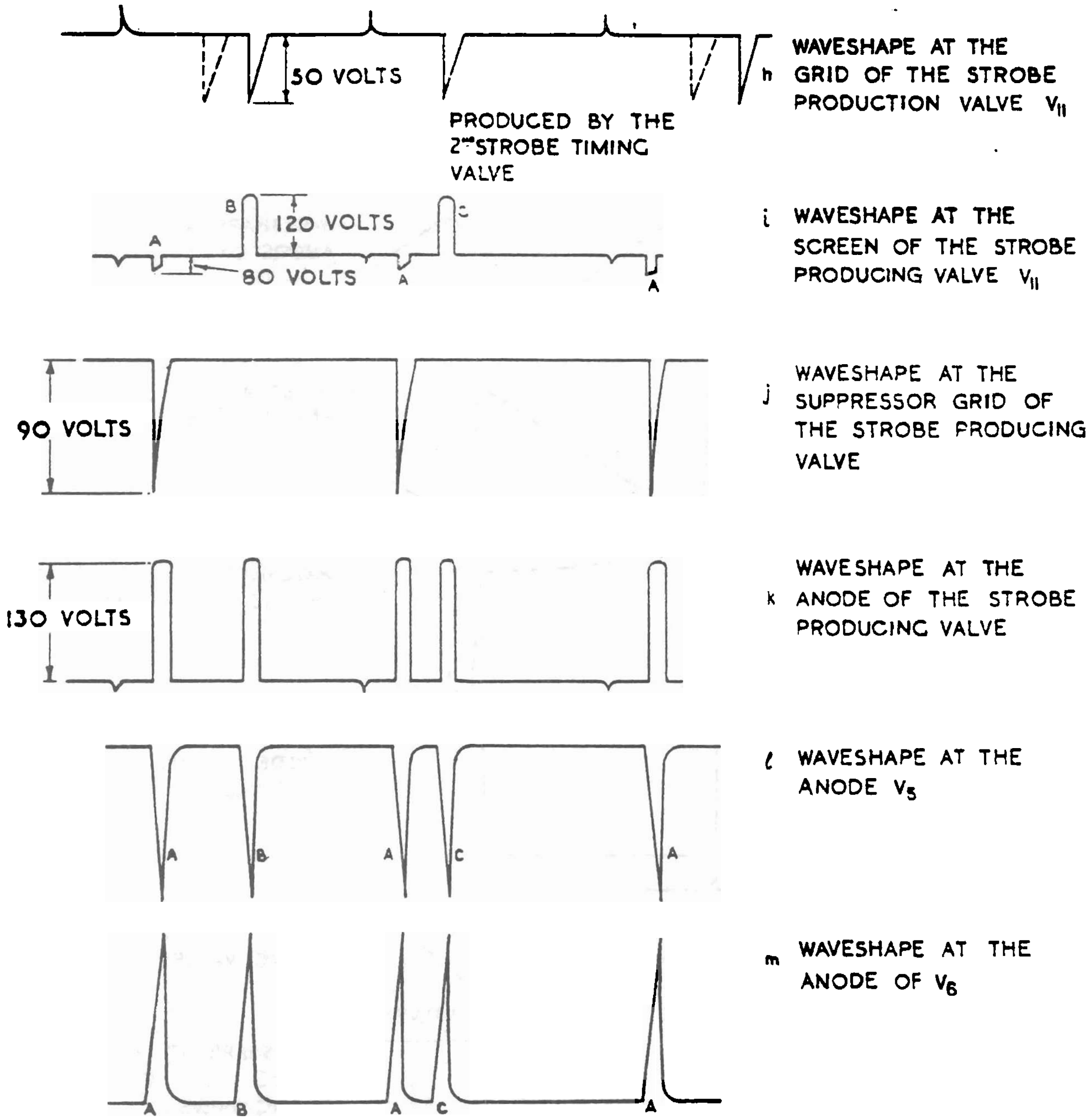


Fig. 38.—Indicating unit, type 266. Waveforms (4).

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

76. The outputs from the anodes of V7 and V10 are fed to the grid of V11 through the small condensers C38 and C39. The grid leak R56 has its free end joined to the slider of the potentiometer VR10 which is part of a chain of resistors between the H.T. line and earth, consisting of VR9, VR10 and R55. The grid leak is thus returned to a point which is positive with respect to earth.

77. The output from the anode of V18 is connected to the suppressor grid of VII through a small condenser C41 and stopper resistance R62. The purpose of this latter resistance is to filter out the small 3 kc/s synchronising pulses which will appear at the anode of V18. The leak to the suppressor grid R58 is joined to the slider of the potentiometer VR9 which forms part of the chain previously mentioned between the H.T. line and earth. The suppressor grid leak is thus returned to a point positive with respect to earth, but the suppressor grid itself is held at earth potential by means of one half of the double diode V4. The negative input signal through C41 must, therefore, exceed the drop in potential across R62 before it will have any effect on the suppressor grid. Since the 3 kc/s synchronising pulses have a much smaller amplitude than the wanted input pulses it is possible to filter them out by means of this circuit.

78. The pulses from the anodes of V7 and V10 are differentiated by means of the small condensers C38 and C39 and the grid leak R56. The positive-going pulse will be nearly eliminated due to grid current but the negative-going pulse will cut off the valve. The charge on C38 (or C39) will then leak up towards zero and eventually the valve will conduct again. A square pulse will thus be produced across the anode and screen resistors of V11 (R60 and R61). The width of this pulse will be controlled by the capacity of C38 or C39, the value of the grid leak R56 and the potential to which the grid leak is returned. This latter is controlled by means of the potentiometer, VR10, which therefore serves to control the width of the square pulse produced at the anode and the screen.

79. The same action takes place at the suppressor grid of the valve through the condenser C41 and the grid leak R58, except that the suppressor grid will have little or no control on the screen voltage of the valve (actually a small negative-going pulse is produced). The potentiometer VR9 controls the width of the pulse at the suppressor grid.

80. Thus positive-going square pulses of the correct width for producing the strobe time base and corresponding to the "B" and "C" strobe positions will be produced at the screen of V11, and positive-going pulses corresponding to the "A," "B" and "C" strobe positions will be produced at the anode of V11. The output from the screen of V11 is fed to a special Y plate amplifier valve, the operation of which is described later (see para. 88). The output from the anode is fed through the switch S5 (one of the contacts on the time base change-over switch) to the suppressor grid of V5. The suppressor grid is normally cut off by means of the automatic bias provided by C10 and R19.

81. When the positive pulse arrives the valve V5 will conduct so that the anode potential will fall as described for the main time base. The rate of fall will be much faster than in the main time base position as the grid leak R17 is now connected to the potentiometer VR1 which is at a much higher positive potential with respect to earth than the potentiometer VR2. VR1 controls the amplitude of the strobe time base. At the end of the positive pulse on the suppressor grid of V5 the valve is cut off, so that the condenser C9 charges up to the H.T. potential again through the resistance R20. The valve V6 functions as for the main time base excepting that the potentiometer VR4 now controls the bias of V6 and therefore controls the shift.

Expanded strobe time base.

82. The expanded strobe time base is obtained by operating the bank S10 on the time base switch. This reduces the grid leak since R18 is now connected across R17 and speeds up the time base. The anode potential of V5 thus falls very quickly when a stroke time base pulse appears at the suppressor grid until it reaches about 50 volts above earth when it stays constant until the pulse on the suppressor grid disappears.

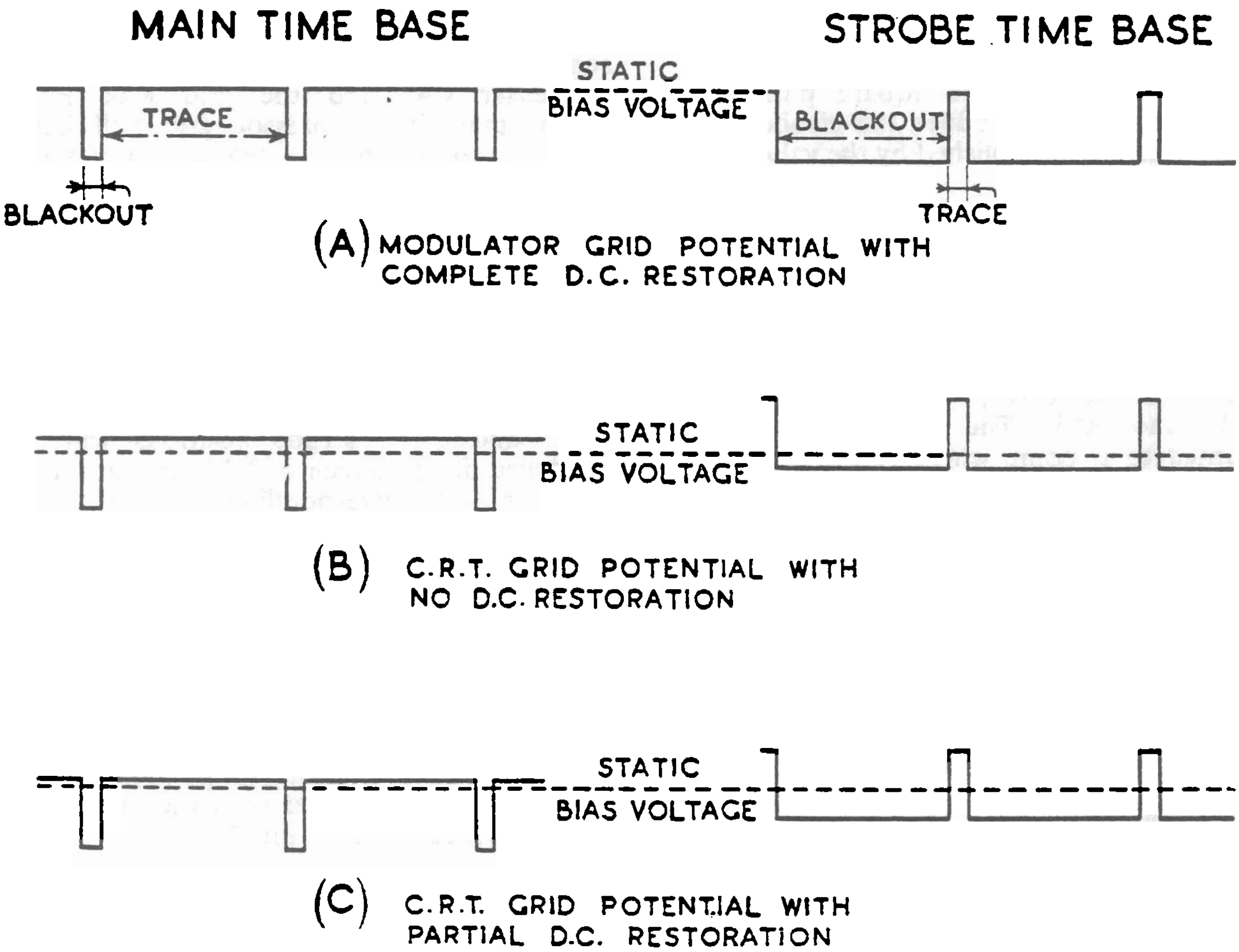


Fig. 39.—D.C. restoration. Indicating unit.

Flyback blackout.

83. Blackout pulses for the cathode ray tube are taken from the suppressor grid of V5 through the condenser C13. On the strobe time base position, positive pulses are applied to the grid of the C.R.T. to brighten up the tube during the trace, whilst on the main time base the negative pulse on the suppressor blacks out the tube during flyback. The diode, V19, d.c. restores at the grid of the cathode ray tube. The d.c. restoring action is made slightly inefficient by means of the resistance R32 in series with the diode ; this tends to equalise the brightness between the main and strobe time bases.

84. The action of the diode V19 and R32 may be explained as follows. If V19 were omitted from the circuit (i.e. no d.c. restoration were attempted) the mean potential of the grid of the cathode ray tube would be zero or, in other words, during the time when no pulses were being received from the suppressor of V5 the potential of the grid would be positive by an amount dependent on the magnitude and width of the negative-going pulse. That is, the trace brightness would depend on the magnitude and width of the blackout pulse.

85. Now in the strobe time base position, the blackout pulse to the cathode ray tube is of much longer duration than in the main time base position (see fig. 39). Therefore, with V19 omitted, the positive grid potential during the trace would be much higher for the strobe time base than for the main time base ; so much higher in fact that the strobe time base would appear brighter than the main time base in spite of its increased speed of scan.

86. Suppose now that complete d.c. restoration were attempted, that is, V19 were connected in circuit but R32 were short circuited. In this case, because of the unidirectional conductivity of the diode the grid could not rise above earth potential and hence the potential during scanning would always be zero. It would follow therefore that the higher speed strobe time base would be less bright than the main time base.

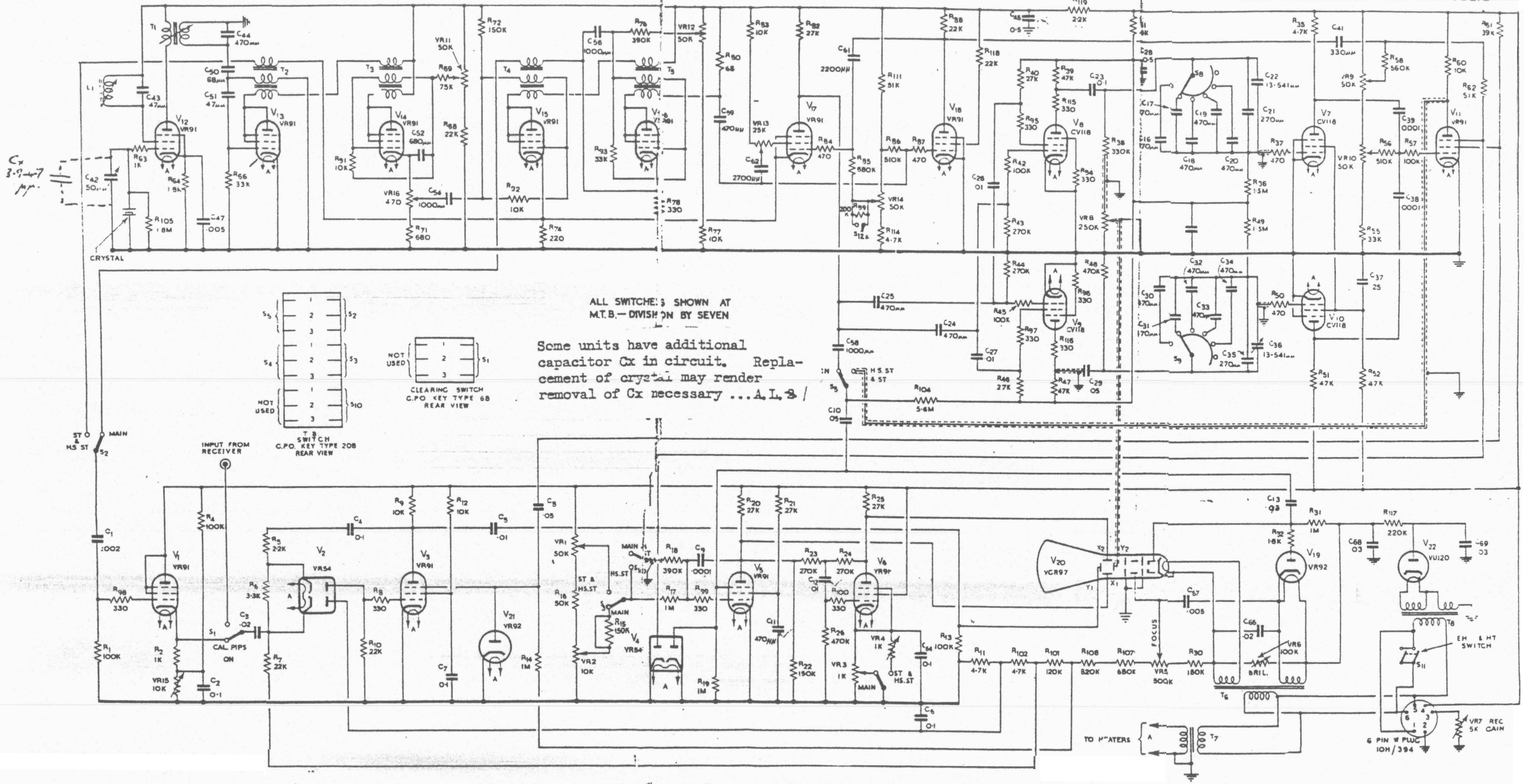


FIG. 40 - INDICATING UNIT, TYPE 266 — CIRCUIT

87. It will be clear from a consideration of para. 83 to 86, that the solution maintains the main time base at the same brightness as the strobe time base by partially d.c. restoring the grid of the cathode ray tube; this is done by V19 in conjuction with R32. During the forward scan, when V19 is conducting, the potential drop across R32 ensures that the C.R.T. grid is at a potential above cut-off, but not by the full amount that would obtain if V19 were not present. The value of R32 is chosen so that during the forward scan the C.R.T. grid potential on the strobe time base is just sufficiently higher than on the main time base to compensate for the higher speed of scan of the strobe time base.

Y plate inverter valve V3.

88. Input to the grid of the valve V3 comes either from the receiver output or from the calibration marker valve V1, according to the position of the clearing switch S1. The Y1 plate of the C.R.T. is connected to the anode of V3 through the condenser C5. The output from the receiver, which is positive-going, is d.c. restored by the lower half of the double diode V2. The suppressor grid of V3 is fed with positive-going pulses from the screen of V11 corresponding to the "B" and "C" strobe time bases (see fig. 38) through the condenser C8 and the resistance R14. The suppressor is also connected to the anode of the diode V21 to prevent it being driven positive. The lower end of R14 is connected to a point on the chain of resistances across the negative supply voltage of the C.R.T., which is at a voltage of —80v. with respect to earth.

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

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

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

Cathode follower (V1).

92. V1, a cathode follower, is incorporated, so that a clean presentation may be made in the display of the calibration pips. Reference to the waveforms in fig. 36 will show that some reference level will be required to remove the irregularity present in the low amplitude portion of the waveforms. V1, which is coupled as a triode is biased on its cathode, from the potential divider R4, VR15, which latter forms the "Cal. Pip Amplitude" control. In its normal working position, V1 is cut off in the absence of a calibration pip and it is arranged that it does not conduct until a pip of amplitude greater than the reference level desired is impressed on the grid. Thus, the irregularities present in the input waveform do not appear in the output.

Power supply.

93. The transformer T7 provides the heater supply for all the valves in the time base and divider circuits. T6 supplies the C.R.T., and the d.c. restoring diode V19. The primary windings are fed from the 80 v. a.c. supply which comes into the indicating unit through pins 5 and 6 on the large 6-pin W plug mounted on the front panel. The H.T. supply is fed to the indicating unit through pin 4 of this same W plug. Pin 3 feeds the receiver gain control potentiometer, VR7, mounted on the front panel of the unit.

94. E.H.T. for the cathode ray tube is provided by transformer T8 in conjunction with the half wave rectifier V22, smoothing being provided by R117 and C68, C69. A switch (S11) is provided to control the H.T. of both the indicating unit and receiver and the E.H.T. of the indicating unit.

APPENDIX I.

DIFFERENCES FROM PREVIOUS VERSIONS OF THE EQUIPMENT

Indicating unit.

1. The E.H.T. supply for the C.R.T. is included in the indicating unit in order to remove the high voltage lead from the cable and W plug.

2. Most of the decoupling to the dividers in the indicating unit has been removed, allowing a smaller H.T. voltage to be employed. To obtain sufficient length of time base the E.H.T. to the C.R.T. has been reduced from 1700 v. to 1450 V. approximately.

3. The strobe unit has been re-designed using ceramic wafer switches, and a new drive for the fine control. The condensers are encased in a sealed plastic box.

4. Components on tag boards have been well spaced to give long leakage paths.

Receiver.

5. The anti-jamming circuits have been re-designed. The I.F. stages now operate as they did in the "Z" position of the receiver R.1355 when the switch is in the "N" position. There is an optional high pass filter in the video stage, which is included when the switch is in the "X" position.

6. The negative rail is now obtained from a separate 6X5G rectifier (V11).

R.F. units.

7. No circuit changes have been made but component changes have been made to ensure tropical stability.

APPENDIX II

SERVICING INSTRUCTIONS FOR GEE Mk. II (TROPICAL VERSION) A.R.I. 5718

LIST OF CONTENTS

DAILY INSPECTION.

Introduction.

1. The daily or pre-flight inspection is carried out by one mechanic. The test gear required comprises only the P.E. set. In many cases other equipments will be carried in the same aircraft, which will necessitate the use of two P.E. sets, and the services of more than one mechanic.

Inspection schedule.

2. Connect up the P.E. set and switch on as required for the particular equipment in use. Allow a minimum of one minute for the equipment to warm up.

3. Check the 80V. supply from the V.C.P. Reading should be 80V. + 1V. Check that the indicator bulb in the V.C.P. is serviceable and that a spare fuse is contained in the appropriate stowage.

4. Set the time base (T.B.) switch to the down position, (main time base), the 6/7 switch to divide by 6 and the clearing switch to "calibration pips." The normal picture showing 25 calibration divisions with every fifth pip raised should appear on the tube face. Check that focus and brilliance controls function.

5. Set the T.B. switch to the central position (strobe time base). The picture should appear normal, with 12 to 14 pips on each of the strobe time bases. On the "B" and "C" strobes it should be posisble to see two raised pips simultaneously by moving the "B" and "C" fine strobe controls. There should be 9 small pips between each pair of raised pips. On the "A" strobes a raised pip should appear to the right of the centre of the scan.

6. Reset the T.B. switch to main time base. Check that the zero mark is a raised pip. Operate the coarse strobe controls. For each step on the switch the strobe marker should jump about 6½ to 7 small divisions of the main time base (M.T.B.) Check that the markers will move from one end of the scan to the other end and that the fine strobe controls operate smoothly. The total rotation of each fine strobe control should cover about 7½ small divisions of the M.T.B.

7. Operate the T.B. switch to the expanded strobe time base (S.T.B.) position and check that there are about three pips along the time base and that the time bases are steady.

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

9. Check that the gain control operates to increase signal amplitude when turning clockwise and to bring up " noise " on the tube in the extreme position.

10. On the receiver, if an R.F. unit, type 24B or 25B is being used, check that the spot frequency switch is in the required position, and the loading unit switch is set to correspond.

11. If an R.F. unit, type 26B or 27B is fitted, check that the tuning control is set to the required reading and that the loading unit switch is set to correspond.

12. The anti-jamming selector should be set to position " N "

13. After disconnection of the P.E. set see that all aircraft cables are replaced on the V.C.P.

14. Check that all cables are in good condition and are connected firmly.

15. Inspect aerial for any sign of damage.

Record keeping.

16. Fill in any records that may be required, e.g. serial numbers of changed units.

PERIODIC INSPECTION.

Introduction.

17. The periodic inspection is a more thorough inspection which will be carried out at regular intervals. These intervals should correspond if possible with the " minor " aircraft inspection. If, however, a unit is found to be faulty and requires repairing it will be necessary to treat it as though it were undergoing its periodic inspection, notwithstanding the fact that the latter may not be due for some considerable time.

Inspection schedule.

18. Remove indicating unit, receiver and voltage control panel from the aircraft for subsequent bench testing and replace them with units which have been thoroughly bench tested. Check that the new units have had all authorised modifications incorporated by reference to the labels on the units.

19. Carry out a full initial installation procedure as laid down in para. 55 to 58.

BENCH TESTING.

Introduction.

20. A test set, type 210 will be required for R.F. adjustment and other items of test gear may be required in the event of faults developing.

21. Inspect both units thoroughly for broken valves, or valves not properly inserted in sockets, for broken wiring and loose connections and for burned or charred parts.

22. Make sure that all authorised modifications have been made on both units, as indicated on the modification labels.

23. See that units are thoroughly clean.

24. Connect up the bench set in accordance with fig. 1, omitting the aerial until ready to test the receiver. Remove the indicating unit dust cover, switch on and check that the supply voltage is 80V. $\pm$ 1 volt. If not, adjust the V.C.P.

Indicating unit, type 266.

25. Set the time base switch to " S.T.B.," the clearing switch to " calibration pips " and the p.r.f. switch to " normal." The picture should appear as in fig. 8, i.e. there should be nine 150 kc/s pips between every pair of raised pips.

26. Check the setting of VR.11 (first divide by 5 stage). Loosen the locking control of VR11 and rotate in one direction until a point is reached where the divider goes out of adjustment and the picture will either jitter or the number of pips will alter from 10 to either 8 or 12. Note

the scale setting of VR11. Rotate the control in the opposite direction until the divider again commences to jitter or divide by 12 or 8. Note the new scale setting and reset VR.11 to a position on the scale midway between the settings noted. Relock the control.

27. Set the time base switch to "M.T.B." Set VR.12 (second divide by 5 stage) in a similar manner to that given in para. 26 above. The number of minor calibration pips should alter from 4 to 5 or 6 (counting one but not both raised pips) depending on the setting of VR12. Set to five pips. Relock control after adjustment.

28. Set VR.14 (third divider stage, divide by 6) in a similar manner to that given in para. 26 and 27 above. For the correct setting there will be twentyfive 15 kc/s pips on each of the main time base traces as shown in fig. 8. For the setting on either side of this position there will be 20 or 30 pips.

29. Adjust VR.13 (" A " strobe position control) until a raised pip (zero mark) occurs just at the beginning of the M.T.B. Switch to S.T.B. when the raised pip on the " A " strobe time base should now occur to the right of the centre along the trace. If this is not so re-adjust VR.13 and relock.

30. Switch the 6/7 switch to divide by seven position. Re-check the setting of VR.14 after performing the above and after setting correctly, relock VR.14 and set the p.r.f. switch back to normal.

31. The following adjustments should only be carried out if necessary :—

32. Adjust VR15 so that :—
  (a) The minor calibration pips on S.T.B. are greater than ⅛ in.
  (b) The minor calibration pips on M.T.B. are greater than 1/16 in.
  (c) Base line between calibration marks shall be clear and free from distortion and all calibration marks clear on both M.T.B. and S.T.B.

33. Adjust VR2 so that the main Time base amplitude is 4 in. ± 1/8 in.

34. Adjust VR1 so that the strobe time base amplitude is 4 in. ± 1/8 in.

35. Adjust VR3 so that the main time bases are central on the tube face.

36. Adjust VR4 so that the strobe time bases are central on the tube face.

37. Adjust VR8 so that the spacing between main time base traces is 1.1/8 in. + 1/8 in.

38. Adjust VR9 to give 11 to 14 150 kc/s pips on "A" strobe traces of S.T.B.

39. Adjust VR10 so that the mean length of the " B " and " C " strobe traces is equal to that of the " A " strobe. The difference in length between the " B " and " C " strobes shall not exceed one minor division. For this test the " B " and " C " strobe markers should be approximately halfway along the M.T.B. The spacing between " A " and " B " strobe traces and between " A " and " C " strobe traces should not exceed 3/32 in.

40. On both M.T.B. and S.T.B. the " B " and " C " strobes must be inverted with respect to the " A " strobes and their amplitude shall be the same as that of the " A " strobes within + 20%. The strobe time bases should not overlap into each other when viewed with receiver noise at full gain.

41. On M.T.B. check that the strobe markers will move from one end of the trace to the other. For each step on the switch the strobe marker should jump about 6½ to 7 small divisions. The total rotation of each fine strobe control should cover about 7½ small divisions.

Receiver, type R.3645 and loading unit, type 51.

General.

42. Throughout the following tests the anti-jamming switch must be kept in the " N " (normal) position.

43. Connect a vertical " whip " serial, (type 257 rod) together with the loading unit, type 51 as used on the aircraft ; the length of feeder cable should be similar to that used in the aircraft. The " whip " aerial should be mounted on an earthed plate or wire mesh screen of at least 4 ft. diameter, the thin end of the whip being well away from surrounding objects.

44. Set up a test set, type 210. Reference should be made to the appropriate document for details of this set and the method of R.F. alignment.

45. The frequency coverage obtainable at each switch position of the loading unit is given below :—

Length of aerial	*Switch position*	*Frequency coverage*
	1	22.1 to 23.6 Mc/s band
	2	23.6 .. 25.7 .. ..
	3	25.7 „ 28.0 „ „
3 ft 7¾ in.	4	28.0 „ 30.8 „ „
	5	42.0 „ 47.5 „ „
	6	47.5 „ 54.5 „ „
	7	54.5 „ 73 ..
	8	73 „ 85 „ „

R.F. unit, type 24B.

.46. Align the unit to the following "spot" frequencies :—

Switch position of R.F. unit	*Frequency Mc/s*	*Tolerance Mc/s*
1	22.0	±0.1
2	22.9	„
3	25.3	„
4	27.3	„
5	29.7	..

The frequency selector switch on the aerial loading unit must also be set to the frequency being checked. The appropriate trimmers in the three R.F. compartments and in the aerial loading unit are adjusted to give maximum signals.

47. If the signals tend to saturate the receiver the gain should be turned down so that the exact tuning point can be found.

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

R.F. unit, type 25B.

49. Align the unit to the following "spot" frequencies :—

Switch position of R.F. unit	*Frequency Mc/s*	*Tolerance Mc/s*
1	43.0	±0.1
2	44.9	„
3	46.8	„
4	48.75	„
5	50.5	„

The instructions detailed and remarks made relating to R.F. unit, type 24B above similarly apply to this unit.

R.F. units, types 26B and 27B.

50. Set the test frequency of test set, type 210 to the value at which tuning is to be checked and leave it at this value.

51. Rotate the tuning dial of the R.F. unit about the position corresponding to this frequency, until the pulses are received at maximum strength.

52. Check that the dial reading is approximately correct, fig. 25 gives dial readings against operational frequencies for type 26B and fig. 26 those for type 27B.

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

Power unit and I.F. amplifier.

54. The negative rail voltage to the anti-jamming circuits should be adjusted as follows :—

(i) Set the gain knob on idicator unit to zero.

(ii) Adjust R54 in the power unit until the average of the voltages across R20, R28 and R36 in the anode circuits of V3, V4 and V5 respectively is 135V.
The operation of the circuit is such that there is automatic compensation for the voltmeter current provided this does not exceed 1 mA. For preference use an Avo-meter (test meter, type D) on the 750V range.

(iii) Lock R54 in position. Re-check the voltages to make sure that the potentiometer has not been turned during locking.

INITIAL INSTALLATION AND ADJUSTMENT IN AN AIRCRAFT.

55. The installation diagram is given in fig. 1. Before installation an equipment would normally be set up fully on the bench, unless it was known that this had already been done at the source of origin of the equipment.

Fixtures in the aircraft.

56. Before connecting the units in the aircraft, carry out the following :—

(a) Check all Pye leads to ensure that the grub screws are tight.
(b) Inspect the aerial system for security.
(c) Ensure that the whip aerial is free from rust. Clean with an oily rag if necessary but do not use emery cloth or similar abrasive material. After cleaning treat the aerial rod with lanolin or vaseline.
(d) Remove the loading unit and using the insulation tester, type A, check that the resistance between the aerial and the air-frame is greater than 10 megohms.

Connection of equipment.

57. The equipment should be connected in accordance with fig. 1, taking care to see that all cables are connected correctly and firmly. In particular, ensure that retaining clips for Pye plugs are correctly fitted and in place.

Initial adjustment.

58. Connect up a P.E. set as indicated in the daily inspection procedure. Check that the regulated voltage is stable by testing on no load and on the Gee load, and that the value is 80V. ± 1V. If necessary change the C.V.P.

59. Carry out a careful and full daily inspection as indicated in para. 1 to 16.

60. On an aircraft engine test, check that the 80V. supply from the V.C.P., after regulation, is stable and that the voltage is 80V. ± 2V.

FAULTS.

61. The following is a brief list of common faults known to develop in the Gee equipment, together with the probable cause of the faults :—

No.	*Symptons*	*Probable causes*
1	No display on C.R.T.	(a) Damage to rectifier V.22. (b) Input condenser (C.69) of smoothing filter on E.H.T. short circuit.
2	No signals.	The Jones plug on the R.F. unit buckles by careless replacement of R.F. unit in I.F. chassis giving bad contact. Some supplies to R.F. unit missing.
3	Unstable strobes.	Faulty valves V7, V10 or V11. Dirty contacts of time-base switch.
4	No signals.	Pye sockets open circuit.
5	Signals drifting very quickly across time-base.	Crystal bumped excessively and knocked out of mounting. No synchronism to T.B. No output from V12 but V13 continues to work at about 150 kc/s. so that T.B. continues.
6	Time-base longer than usual — greater apparent sensitivity of tube.	E.H.T. rectifier V.22 in indicator down in emission or C68 or C69 leaky to lower E.H.T.
7	No display on C.R.T. or display not central.	Wires knocked off C.R.T. base.
8	Similar to fault 5.	Slug tuning 150 kc/s. circuit of V12 badly adjusted. Low or no output from V12 and no synchronism to T.B. *N.B.* Drifting of pulses may in general be due to wrong setting-up of the divider stages.

SUPPLEMENTARY DATA.

Voltage data.

62. All voltages shown are on the assumption that the input voltage is set at 80V R.M.S.

Receiver, type R.3645.

Part of Circuit	Valve	Voltage to Earth: Anode volts	Pin No.	Screen volts	Pin No.	Cathode bias volts	Pin No.	Remarks
R.F. unit, type 24B	V1 V2 V3	215 280 265	3 3 3	220 185 235	4 4 4	2.0 3.2 2.8	2 2 2	H.T. line to unit = 300 volts
R.F. unit type 25B	V1 V2 V3	255 285 265	3 3 3	250 185 300	4 4 4	3.0 3.5 3.2	2 2 2	H.T. line to unit = 300 volts
R.F. unit type 26B	V1 V2 V3	220 270 235	2 2 4	250 190 —	3 3 —	2.0 4.6 1.2	5 5 3	H.T. line to unit = 300 volts
R.F. unit type 27B	V1 V2 V3	180 280 220	2 2 4	250 125 —	3 3 —	1.7 2.0 1.2	5 5 3	H.T. line to unit = 300 volts
I.F. amp	V1 V2 V3 V4 V5 V7 V8	287 285 95 100 90 242 300	3 3 3 3 3 3 3	290 290 300 300 300 235 298	4 4 4 4 4 4 4	5.75 5.8 0.1 0.1 0.1 2.2 37.5	2 2 2 2 2 2 2	H.T. line = 300 volts Gain at minimum

Indicator unit, type 266

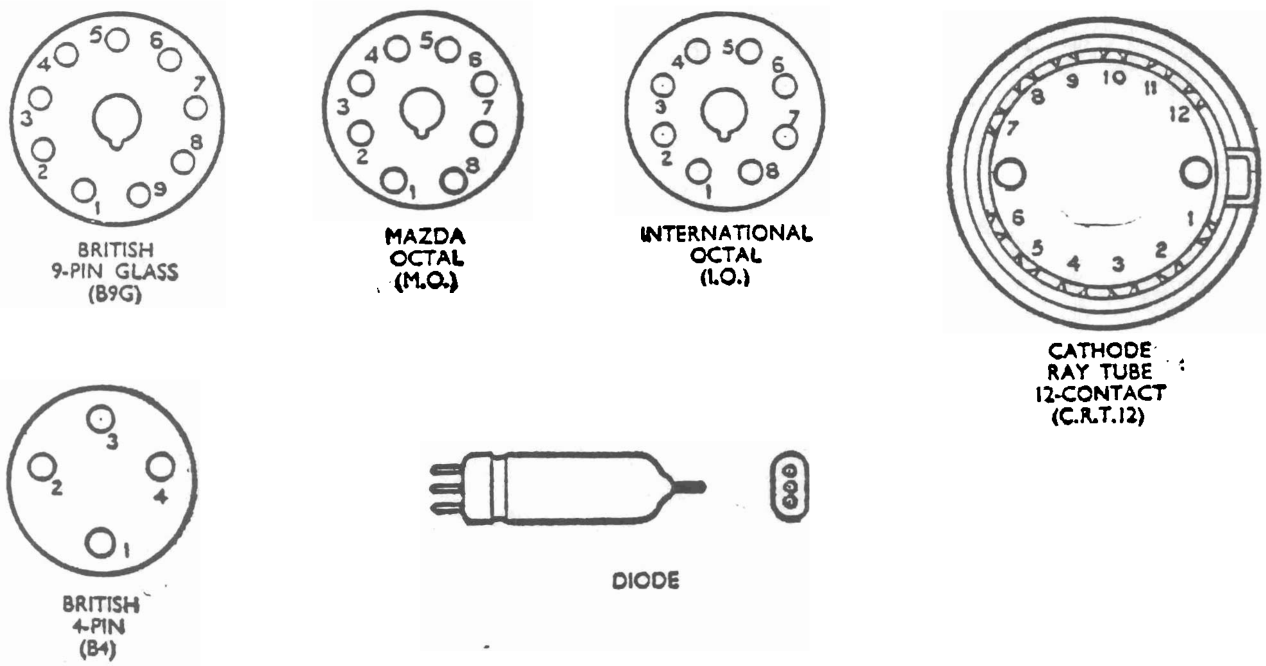
Valve	Voltage to earth: Anode	Pin No.	Screen	Pin No.	Cathode bias	Pin No.	Remarks
V1	240	3	—	—	8.75	6	
V3	240	3	185	2	—	—	
V5	120	3	180	2	—	—	
V6	115	3	240	2	2.5	6	
V7	75	3	65	4	—	—	Stabilised HT = 240 volts
V8	105	3	145	4	—	—	Main time base.
V9	105	3	145	4	—	—	
V10	75	3	70	4	—	—	
V11	145	3	120	2	—	—	
V12	170	3	170	2	4.5	6	
V13	170	3	—	—	—	—	
V14	170	3	—	—	6.0	6	
V15	170	3	—	—	1.5	6	
V16	170	3	—	—	0.5	6	
V17	135	3	142	2	1.5	6	
V18	35	3	95	2	—	—	

In the above table the voltages given are approximate only and may vary by as much as 25% for one equipment to another.

63. H.T. line volts 300 V. ± 10%			Measure from pin 4 of 6 way plug to earth.
Heater voltages in I.F. R.F. units	6.3V. a.c. ± 10% for all valves.		
Negative rail volts :	110V. ± 10%	With A.J. switch in position N.	Measure from slider of R54 to earth.

Waveforms.

64. Typical waveforms giving approximate amplitude are shown in fig. 35 — 38, while fig. 8 shows the various pictures seen on the tube face.



Valve type	*Valve base*	*Connections to pins*												
		1	2	3	4	5	6	7	8	9	10	11	12	T.C
VR91	B9G	H	G2	A	G3	S	C	G1	S	H	—	—	—	—
VR136	B9G	H	A	G2	S†	S†	G1	S†	S†	H	—	—	—	—
VR137	B9G	H	G1	C	A	—	—	—	—	H	—	—	—	—
VR65	MO	H	C	A	G2	G3	S	—	H	—	—	—	—	G1
CV1118	MO	H	C	A	G2	G3	S	—	H	—	—	—	—	G1
CV1054	IO	S	H	A2	C2	A1	—	H	C1	—	—	—	—	—
SU4G	IO	—	F	—	A1	—	A2	—	F	—	—	—	—	—
6X5G	IO	—	H	—	A1	—	A2	H	C	—	—	—	—	—
VU120	B4	—	—	HC	H	—	—	—	—	—	—	—	—	A
VR92	Diode	H	C	H	—	—	—	—	—	—	—	—	—	A
VCR97	CRT12	G	C	H	H	A1*	A2	Coating*	Y2	X2	A3	X1	Y1	—

† Shield internally connected to G3 and C.
* If not internally connected to A3.

Fig. 41. — Valve bases.

T 351 O/r. M 48405 Wt. 14244 /G 2978 800 3/46 S. & Co., Ltd. G7

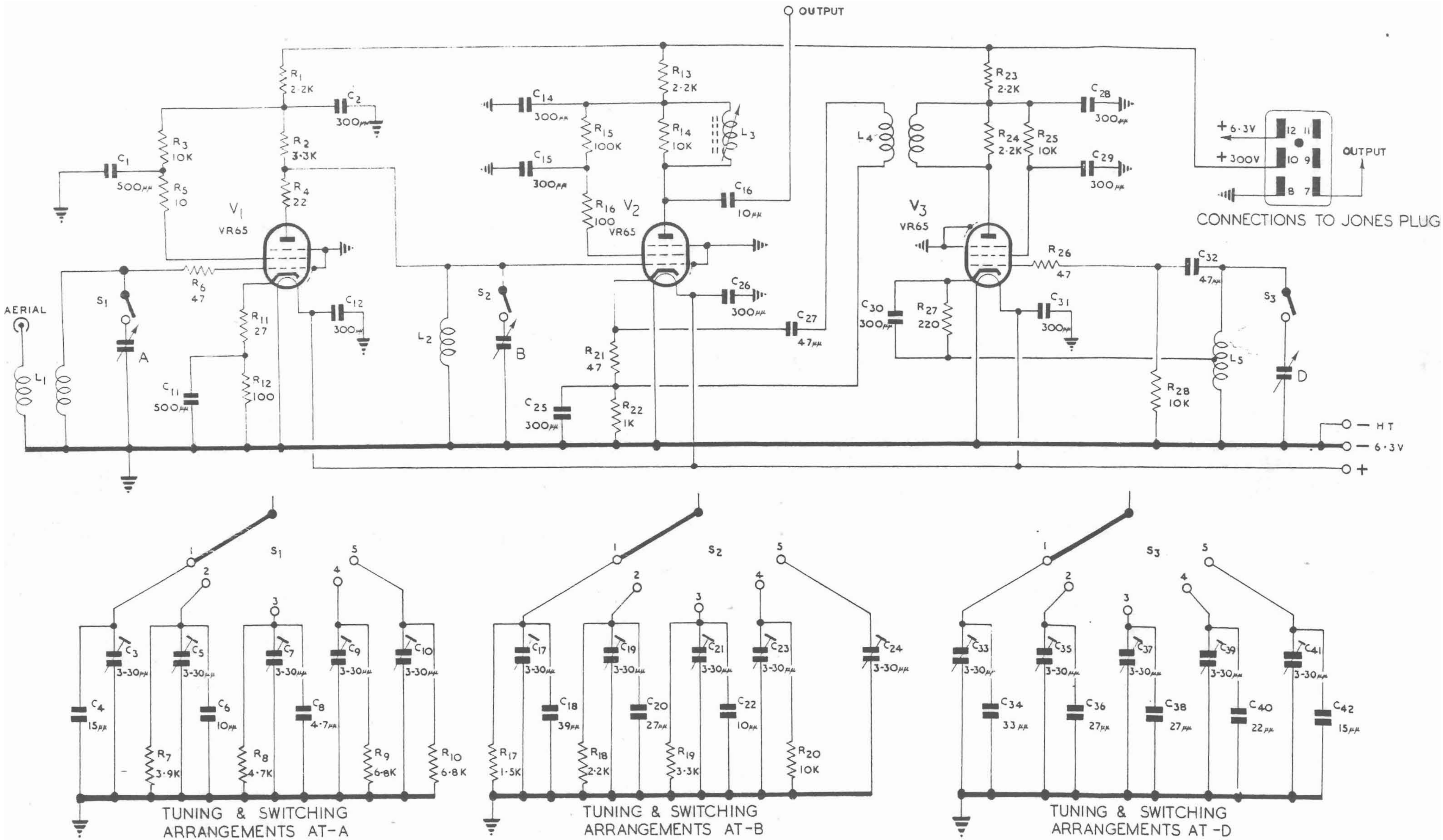


FIG. 14.— R.F. UNIT, TYPE 24B — CIRCUIT