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Delete "(*To be issued later*)" after title of Chap. 1 in the List of Chapters, *write* "A.L.2" in the outer margin of the list, *insert* this chapter, and make an entry in the Amendment Record Sheet at the beginning of the Volume.

SIGNALS

CHAPTER 1

GEE-H MARK II AIRBORNE EQUIPMENT (Tropical)

LIST OF CONTENTS

LIST OF ILLUSTRATIONS

LIST OF ILLUSTRATIONS—*continued*

CHAPTER 1

GEE-H MARK II AIRBORNE EQUIPMENT (Tropical)

ARI.5696

INTRODUCTION

1. This publication covers, as fully as possible, both ARI.5696 which is Gee-H Mark II airborne equipment (tropical) and ARI.5685, Gee-H Mark II (tropical) with automatic computer type 56. The universal indicator type 2 which forms the basis of these main airborne installations, is dealt with in full, detailed layout, waveform and circuit diagrams being provided.

2. Reference to the undermentioned publications will give fuller information on Gee-H principles and operation:—

(1) ARI.5083, Gee Mark II airborne equipment ... A.P.2557A

(2) ARI.5597, Gee-H Mark II airborne equipment ... A.P.2557F

The latter publication covers also ARI.5685 (Gee-H Mark II with automatic computer Type 56) and refers in outline to ARI.5611 (Gee-H Mark II and Rebecca Mark IIU) and ARI.5686 (Gee-H Mark II and Rebecca Mark IIU with automatic computer type 56).

(3) Gee-H transportable equipment A.P.2556C

3. The tropical version of Gee-H Mark II airborne equipment is essentially similar to the non-tropical installation. All tropical units are electrically and physically interchangeable with the non-tropical units. Of the associated equipments used with Gee-H Mark II airborne equipment the automatic computer type 56 (Gee-H Mouse) alone is used with the tropical version and is, therefore, the only associated equipment described in this document.

Facilities provided by the equipment

4. Gee is an aircraft navigational device which may be used for general navigation. Gee-H is used when an accuracy of "fix" at long range, of an order sufficient for blind bombing, is required. These facilities are obtained by adding appropriate units, as listed in para. 30, to the universal indicator type 2.

Note.—Although Gee-H Mark II (tropical) airborne equipment is no longer used in conjunction with Rebecca Mark IIU, the equipment was designed for such use, and references to these functions have had to be made throughout this publication. These functions, however, do not form part of ARI.5696 and ARI.5685, the only installations described.

General principles

5. A brief outline of the principles involved in the Gee, H, Gee-H Mark II and Gee-H Mouse systems is given in the following paragraphs for the benefit of readers who are not familiar with these equipments. A knowledge of these principles is indispensable for the full understanding of the operation of the Gee-H Mark II (tropical) airborne equipment.

Gee system

6. The object of the Gee system is to provide a method of navigation by means of which an aircraft may obtain information as to its location in the area served by the system. The operation of the necessary equipment is founded on the following basic principles:—

(1) The velocity of electro-magnetic waves in air is constant for all practical purposes at approximately 186,240 miles per second.

(2) Pulses of energy of a very high frequency, lasting for a few microseconds, can be radiated into space.

(3) These pulses can be received by suitable equipment and the time interval between the arrival of two successive pulses at any particular point can be measured.

7. Referring to fig. 1, suppose that two transmitters are installed at points A and B, separated by the distance d. Suppose, too, that transmitter A is connected to transmitter B by some link and that it is arranged that when, at a given instant, a pulse is transmitted by A, it is also re-

transmitted by B. The two pulses cannot be transmitted simultaneously since the A pulse must travel to B before it can be retransmitted by B. The time taken for the pulse to travel to B is given by the distance AB divided by the velocity of travel

$$\text{i.e., } t = \frac{AB}{v}$$

This is the minimum time interval between the A and B pulses. A further delay can be arranged between the reception at B of the A pulse and the transmission of the B pulse.

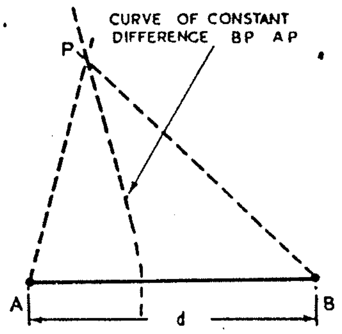

Fig. 1.—Gee principle

8. Now consider an aeroplane situated at P in fig. 1. A pulse emitted by A will arrive at P after an interval t′ depending on the distance AP

$$t' = \frac{AP}{v} = k \times AP$$

where k is the reciprocal of the speed of electro-magnetic waves in air. Similarly, the length of time, t″, taken by the B pulse to travel to P is

$$t'' = \frac{BP}{v} = k \times BP$$

The interval between the arrival of the A and B pulses at P is thus:—

Delay of the B on the A pulse + k (BP — AP)

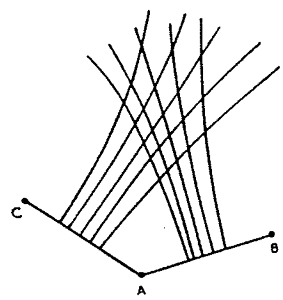

Fig. 2.—Hyperbolic lattice

9. This interval will be measured at P, where P lies on the line AB, or at any point on the curve forming the locus of points satisfying the condition that BP — AP is constant, as shown in fig. 1. Further curves may be drawn for different values of constant path-difference.

10. The employment of two transmitters can only give to the aircraft information that it is at some point on a line, and in order to provide a definite fix position it is necessary to introduce a third transmitter which will be referred to as the C transmitter. This is located in such a position that the lines AB and AC are inclined to one another at a suitable angle, so that the curves associated with the A and B transmitters intersect those associated with the A and C transmitters, forming a lattice as shown in fig. 2.

11. Signals from the three transmitters can provide an aircraft with a definite fix of its position. This is done by means of special maps of the areas served by the systems. A network of lattice curves is drawn on the map representing the lines of constant path-difference between points on the map and the A and B and A and C transmitters. The two sets of curves are printed in different colours.

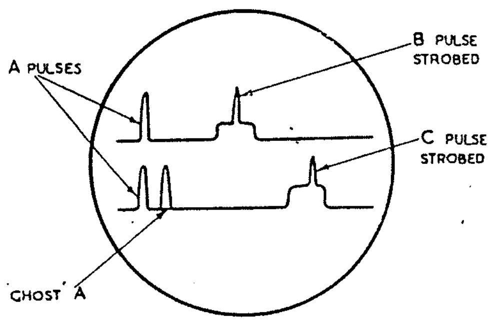

Fig. 3.—Gee indications on CRT

12. To avoid confusion between the B and C transmitter pulses, the C transmitter pulse is always delayed considerably longer than the B pulse. Since the A transmitter triggers the other two transmitters, it is known as the "Master" whilst the other two are called "Slaves".

13. In the aircraft equipment the A, B and C pulses appear on a time trace on the screen of a cathode ray tube as shown in fig. 3. The trace is not one continuous line but is divided into two traces, an upper and a lower. These are calibrated by a series of marks at a frequency of

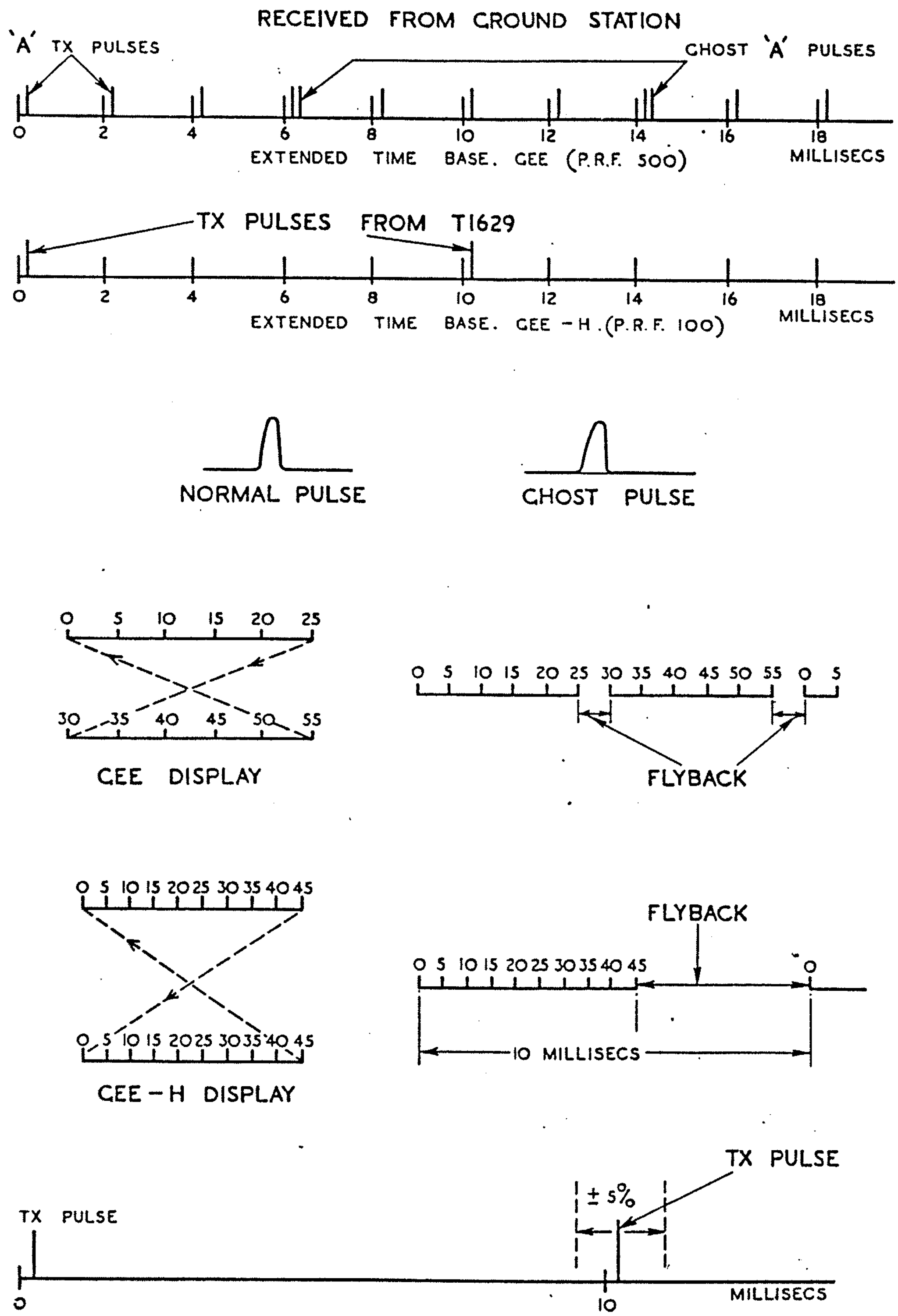

Fig. 4.—Timebase operation for Gee and H

15 kc/s, representing intervals of approximately 66 microseconds. The A and B pulses are made to appear on the upper trace and the A and C pulses on the lower. Since the time traces are calibrated, the interval between the A and B pulses and between the A and C pulses can be measured, and the aircraft fix obtained.

14. The A pulse is seen on each time trace because the pulse repetition frequency of the A transmitter is 500 p.p.s., but the B and C pulses appear on one trace only as the pulse repetition frequency of these transmitters is 250 p.p.s.

15. The C pulse is distinguishable from the B pulse as it follows a "ghost" A pulse. Every fourth pulse of the A transmitter is followed by a second pulse after a delay of 133 microseconds and this pulse, known as the "ghost" pulse, is shown in fig. 3.

H system

16. The H system permits the position of an aircraft to be determined with an accuracy sufficient for blind bombing. The principles of H are entirely different from those of Gee, but the two systems have, in common, the fact that in each case the time interval between pulses is measured and the results transferred to a chart to obtain the required fix. In the H system the aircraft carries an interrogating transmitter which triggers two ground beacons and the time intervals between the transmitted pulse from the aircraft and the reception of the beacon pulses in the aircraft are measured. The positions of these beacons are known and, having found their range by measuring the time of pulse travel, the position of the aircraft is determined.

17. Comparing Gee with H, it will be noted that the position fix obtained with H may be represented as finding the lattice co-ordinates on the chart: but these co-ordinates are no longer hyperbolæ; they are two sets of concentric circles with their centres at the ground beacon stations. The method of use by the navigator (see para. 228 to 232) is, however, the same, the intersection of the measured co-ordinates indicating the position.

18. The Gee indicator is used for H display and the Gee unit is used for calibration, but the measured time taken for the pulse to travel from the aircraft to the beacon and back again represents twice the distance between the aircraft and the beacon. The navigator of an aircraft equipped with Gee-H uses Gee in the normal manner for navigation to the target area and homing back to base, H being used for the target approach and for blind bombing. The different operation of the indicating unit on H compared with Gee is illustrated in fig. 4.

19. One property of the concentric circle lattice system for H is the fact that, for a given absolute accuracy of pulse timing, the range measurement is independent of the absolute range, and the position fix accuracy is therefore constant in a radial direction from the beacon. In the tangential direction the accuracy is proportional to $\frac{1}{\sin\theta}$ (where 2θ is the angle subtended at the aircraft by the two ground beacons) and therefore becomes less accurate with increasing range at ranges much greater than the distance between the ground stations.

20. This represent a considerable increase of accuracy for H compared with Gee. In short, the accuracy of H falls off less rapidly than that of Gee with increasing range, and the accuracy of H is always better than that of Gee for a given accuracy of pulse timing. With H blind bombing the accuracy is preserved to the limit of the range. The table below shows a comparison of the accuracies of the two systems.

System	*Radial inaccuracy proportional to*	*Tangential inaccuracy proportional to*
Gee	$1/\sin^2\theta$	$1/\sin\theta$
H	constant	$1/\sin 2\theta$

In each case 2θ is the angle subtended by the ground beacons at the aircraft.

21. It should be noted that no locking between the ground stations is required for H working as each beacon responds independently of the other and each has its own monitoring section. However, the same problem arises of determining which response displayed on the indicator is

from which beacon, and this is overcome by coding one of the beacons. This takes the form of a periodic sideways jump of the response on the trace and this beacon is known as the interrupted or "I" beacon, the other being the uninterrupted or "U" beacon.

Gee–H Mark II system

22. The Gee–H Mark II system, unlike the Mark I, is not a modified Gee equipment but is an entirely new equipment built up around the universal indicator type 2.

23. The universal indicator type 2 is an indicating system designed to provide Gee, H, Rebecca and Gee–H facilities. It consists of three units:—

Strobe unit type 61
Control unit type 426
Indicating unit type 166

Tropicalised versions of these units are employed in the Gee–H Mark II (tropical) installation:—

Strobe unit type 61A
Control unit type 426A
Indicating unit type 166A

Transmitters and receivers, together with their appropriate aerial systems, may be connected to the indicating unit through junction boxes. The splitting up of the indicating system into these units has been done solely with a view to facilitating installation, and the circuits have been distributed between the units to simplify the controls and to keep at a minimum the quantity of equipment which must be accessible during flight. For this reason it is more convenient to regard the universal indicator type 2 as a whole rather than a number of separate units when considering its electrical operation.

24. It is intended that the equipment shall be used as Gee for normal navigational purposes and as H only when the highest accuracy of fix is required. The Gee pulse repetition frequency is 500 p.p.s., but, to avoid overloading the ground beacons, a much lower pulse repetition frequency must be used for the H system. Suppose that N aircraft were interrogating the H ground beacons simultaneously (i.e. with their pulses interleaving at random) and that the duration of each pulse was T microseconds. Then, in every second, the ground beacons would be pulsing for $500NT/10^6$ seconds. It is clear that under these conditions the ground beacon cannot respond to two aircraft at the same time and, hence, to ensure that the beacon does respond to the maximum number of aircraft pulses, the fraction $500NT/10^6$ must be as small as possible. If this fraction is less than $\frac{1}{5}$ then, on an average, at least four out of every five pulses from each aircraft would elicit a response from the beacon. This has been found to provide a satisfactory indication without overloading the ground beacon transmitter.

25. Control of the fraction, thus enabling a large number of aircraft simultaneously to interrogate the ground beacons, is provided in the strobe unit. By this means the pulse repetition frequency can be reduced from 500 down to between 80 and 250 p.p.s. for H, the normal working repetition being 100 p.p.s.

26. A further problem arises when a number of aircraft interrogate the ground beacons at the same time and the pulse repetition frequency of all the aircraft transmitters is approximately equal. A large number of ground beacon responses appear stationary on each aircraft display. These would confuse the navigator and render the system difficult to use. To obviate this difficulty, the repetition rate for H is jittered, as shown in fig. 4, by introducing an AC waveform from the heater transformer into the timing circuit; hence only the wanted pulse is stationary.

27. The transmitting frequencies of the Gee–H system are as follows:—

(1) 20 to 30 Mc/s
(2) 30 to 45 Mc/s
(3) 45 to 80 Mc/s

Only the receiver frequencies of Gee–H can be varied in the air. The transmitter frequencies have to be set before the aircraft leaves the ground.

Associated equipment

Gee–H Mouse

28. To improve still further the accuracy of Gee–H, the Mouse, an automatic computer, has been developed. This is fully described in Chapter 2.

29. This unit operates the bomb release and takes account of the speed of the aircraft and of the time of bomb fall. To operate it, the time of bomb fall is set up (possibly on the ground before take-off) and a button is pressed as the H pulse passes two warning points during the few minutes before arriving at the bomb release point. The Mouse is equally suitable for use with Gee in areas where the Gee accuracy is high.

GENERAL DESCRIPTION

List of units

30. The Gee–H Mark II (tropical) airborne equipment consists of the following units:—

Unit	*Stores Ref.*	*Dimensions*	*Weight*
(1) Transmitter T.1629A			
(2) Receiver R.3582A	10DB/8373	20″ × 8½″ × 7½″	28 lb.
with			
(*a*) RF unit type 24B	10DB/8651	11½″ × 7½″ × 5″	7 lb.
(*b*) RF unit type 25B	10DB/8652	11½″ × 7½″ × 5″	7 lb.
(*c*) RF unit type 26B	10DB/8653	11½″ × 7½″ × 5″	7 lb.
(*d*) RF unit type 27B	10DB/8654	11½″ × 7½″ × 5″	7 lb.
(3) Indicating unit type 166A	10QB/6370	20″ × 12″ × 8½″	32 lb.
(4) Strobe unit type 61A	10QB/8807	20″ × 13″ × 7¾″	45 lb.
(5) Control unit type 426A	10LB/6299	15″ × 9″ × 5½″	16 lb.
(6) Junction box type 255A	10DB/8394	9″ × 6″ × 3½″	6 lb.
(7) Junction box type 266A	10DB/8396	11″ × 6″ × 3½″	10 lb.
(8) Aerial, transmitter, type 361	10B/16141	—	—
(9) Aerial, receiver, type 329	10B/16026	3′ 7¾″	—
(10) Loading unit type 51	10B/16025	4″ dia. × 3½″	1 lb.
(11) Control panel type 5	5U/363	15″ × 9″ × 8″	17 lb.
(12) Gee–H Mouse	10A/16130	—	—
(13) Filter unit type 190	10P/16017	4¼″ × 5½″ × 2½″	2 lb.

Note.—Junction box type 266A can be replaced by junction box type 256 (Stores Ref. 10A/16104).

31. A block schematic of the Gee–H Mark II (tropical) installation is given in fig. 5 and an interconnection diagram in fig. 6. The position of the units is dependent on the type of aircraft in which they are installed.

Receiver type R.3582A

32. The front panel of Receiver type R.3582A is shown in fig. 7 and a block schematic is given in fig. 8. The receiver employs a superheterodyne circuit which amplifies the signals received from the ground transmitters. These amplified signals are fed to the Y plates of the cathode ray tube in the indicating unit.

33. The RF unit, consisting of the RF amplifier, local oscillator and mixer valves, is enclosed in a screened box which may readily be detached from the main receiver. A Jones plug is provided at the rear of the RF unit and the unit itself is secured to the receiver by four screws at the front. The RF unit may thus be easily removed and a new one substituted.

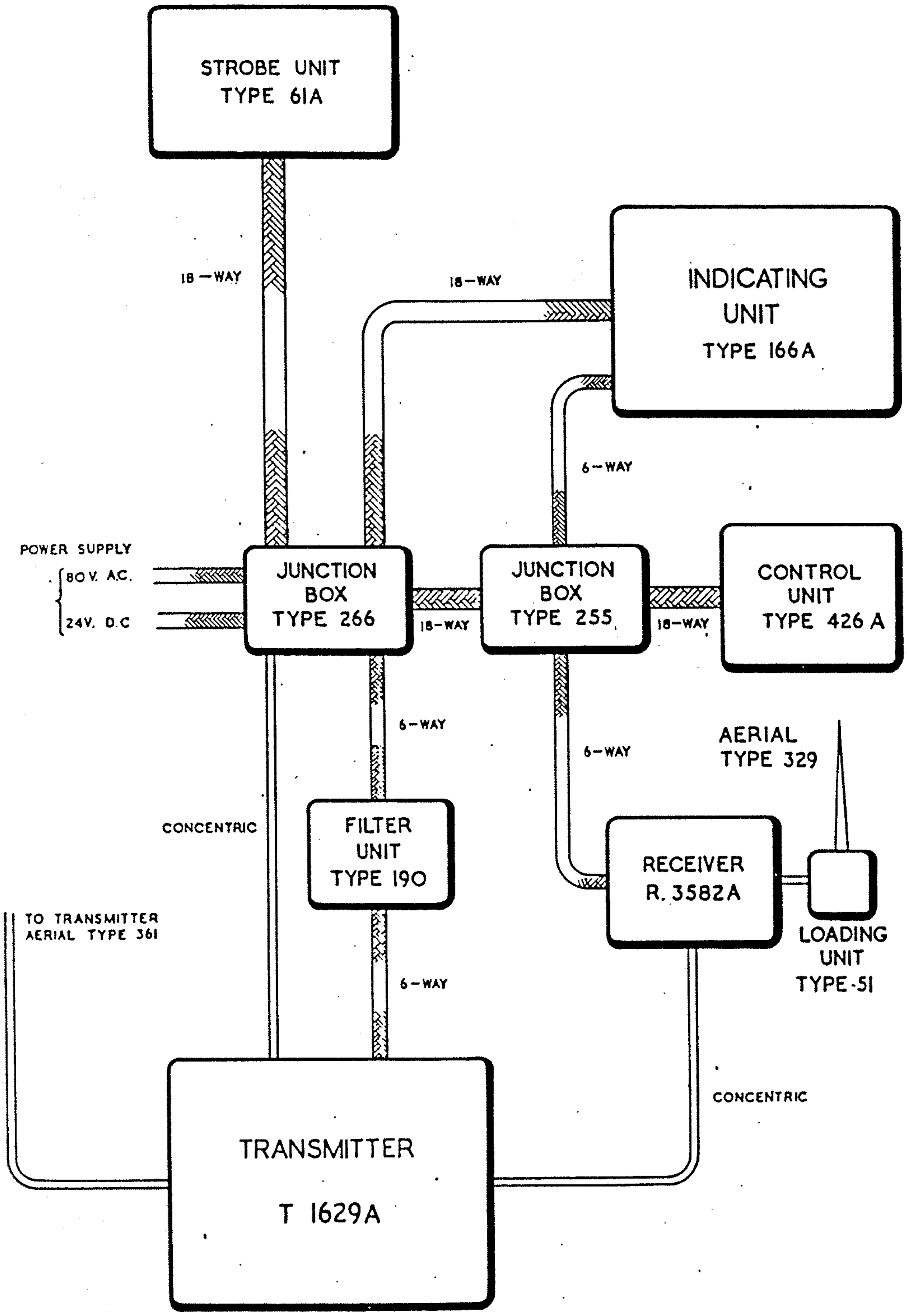

Fig. 5.—Gee-H installation—block schematic

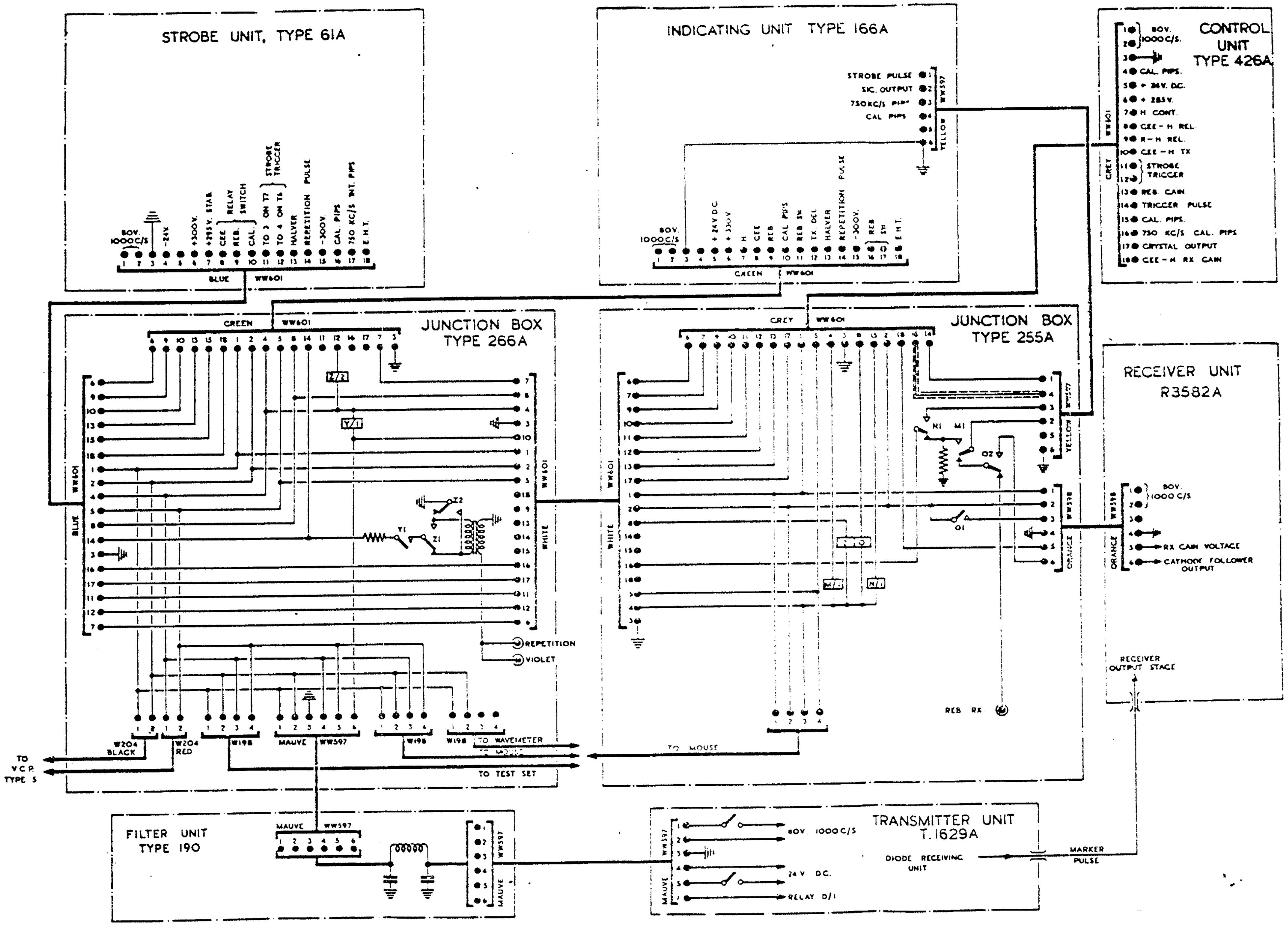

FIG. 6 — INTERCONNECTION DIAGRAM

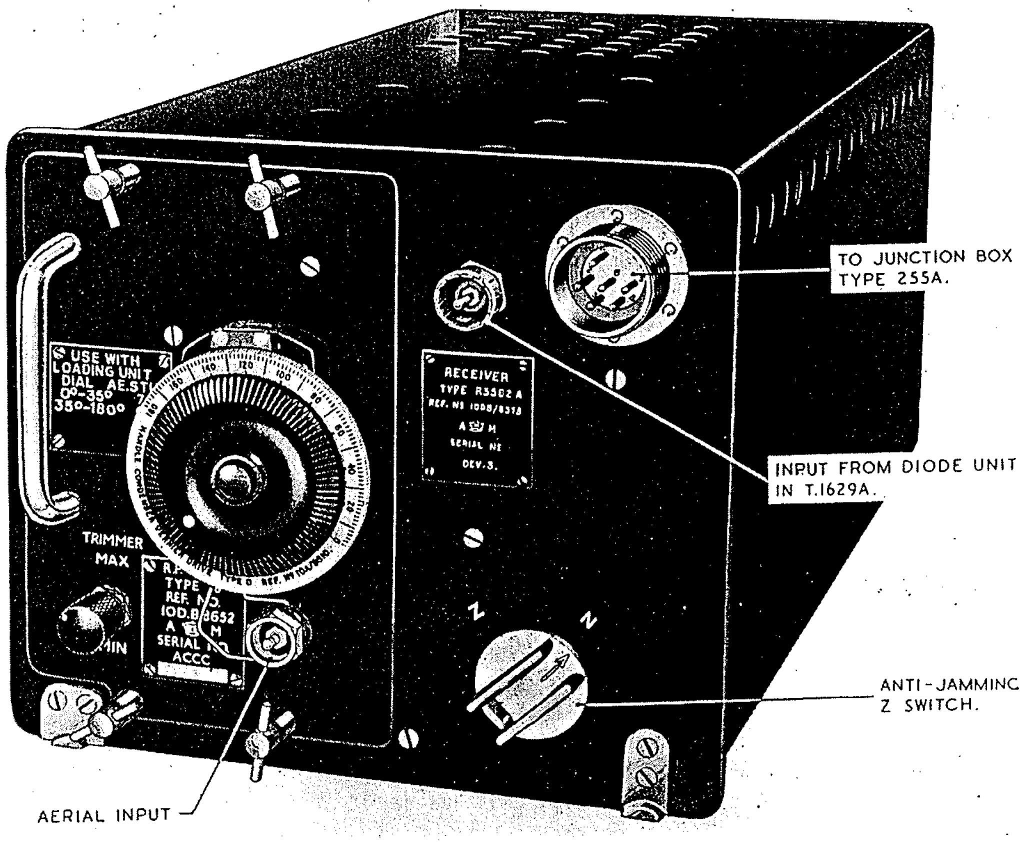

Fig. 7.—Receiver type R.3582A—front panel

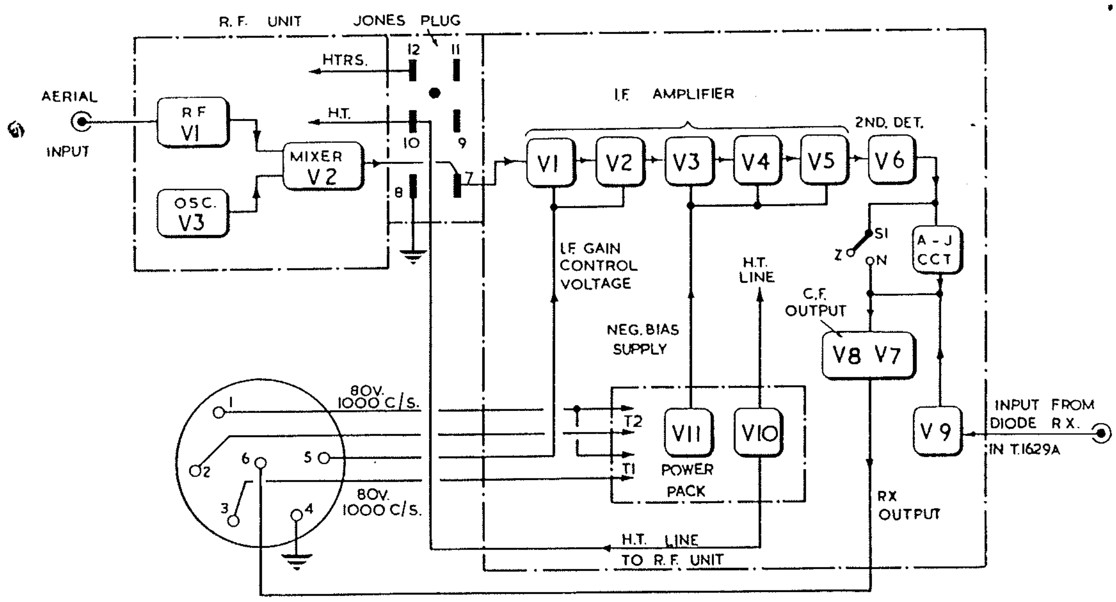

Fig. 8.—Receiver type R.3582A—block schematic

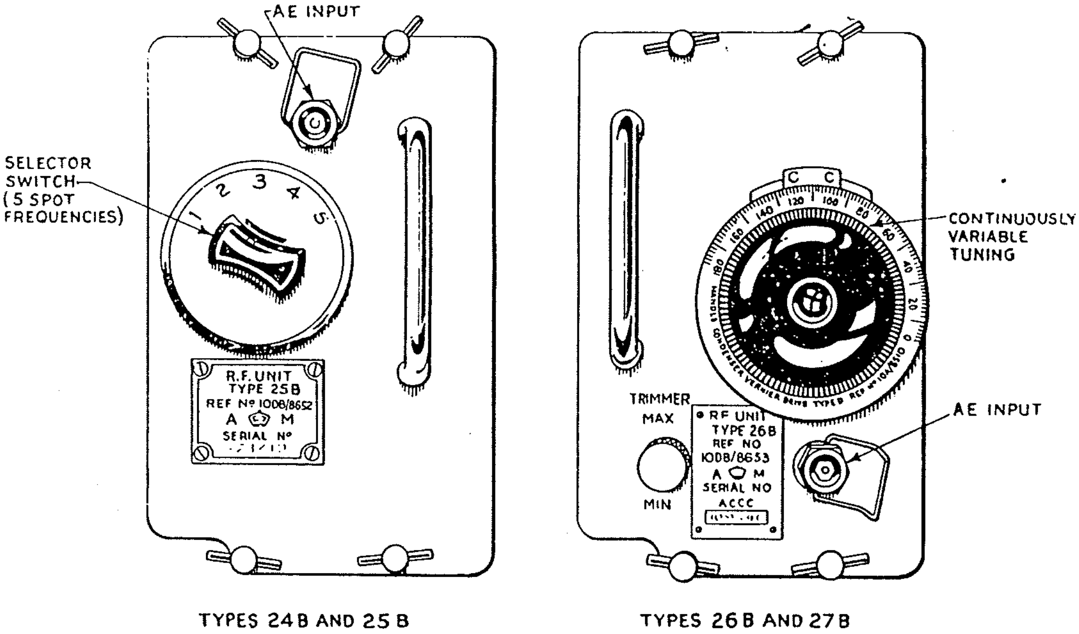

Fig. 9.—RF units—front panels

34. Four interchangeable RF units are provided, each covering a different frequency band. Front panel views of the RF units are shown in fig. 9. The units employed are as follows:—

(1) RF unit type 24B—covering the 20 to 30 Mc/s band
(2) RF unit type 25B—covering the 40 to 50 Mc/s band
(3) RF unit type 26B—covering the 50 to 65 Mc/s band
(4) RF unit type 27B—covering the 65 to 80 Mc/s band

RF units type 24B and type 25B may be set to one of five pre-selected frequencies by a five-position switch, whilst RF units type 26B and type 27B are provided with controls tuning continuously over the frequency bands covered.

35. The spot frequencies to which the RF units type 24B and type 25B are normally tuned are:—

Switch position	*RF unit type 24B*	*RF unit type 25B*
1	22·0 Mc/s	43·0 Mc/s
2	22·9 Mc/s	44·9 Mc/s
3	25·3 Mc/s	46·79 Mc/s
4	27·3 Mc/s	48·75 Mc/s
5	29·7 Mc/s	50·5 Mc/s

36. The remainder of the receiver houses the IF amplifier, the second detector, the cathode-follower output stage and a power unit which supplies power to the whole of the receiver in addition to providing a negative bias supply for the third, fourth and fifth IF valves.

37. The following controls, sockets and plugs are mounted on the front panel of the receiver:—

(1) Pye plug on RF unit. This is the aerial input socket.

(2) Spot frequency switch or tuning control on RF unit. RF units type 24B and 25B are each provided with a five-position switch by means of which any one of the five spot frequencies to which the RF unit is tuned may be selected. RF units type 26B and 27B are provided with continuous tuning controls and trimmer knobs in place of the spot frequency switch.

(3) Single-pole screened plug mounted on main chassis front panel. This feeds the marker pulse from the diode receiving unit in the transmitter T.1629A to the receiver output stage.

(4) 6-pin WW plug. This plug is connected externally to the junction box type 255A. Pins 1, 2 and 3 provide the 80-volt 1000 c/s AC supply from the aircraft generator through the control panel type 5 and junction box type 266A to the power unit of the receiver. Pin 4 is earthed. Pin 5 carries the HT supply to the receiver gain control in the control unit type 426A and pin 6 feeds the receiver output via the junction box type 255A to the indicating unit type 166A.

(5) Anti-jamming switch. This is a two-position selector switch marked N and Z. N is the normal position of the switch and is used when no jamming, CW or otherwise, is being experienced. The Z position brings into circuit a video filter which is helpful in improving the signal response if the jamming signal is sine-wave modulated.

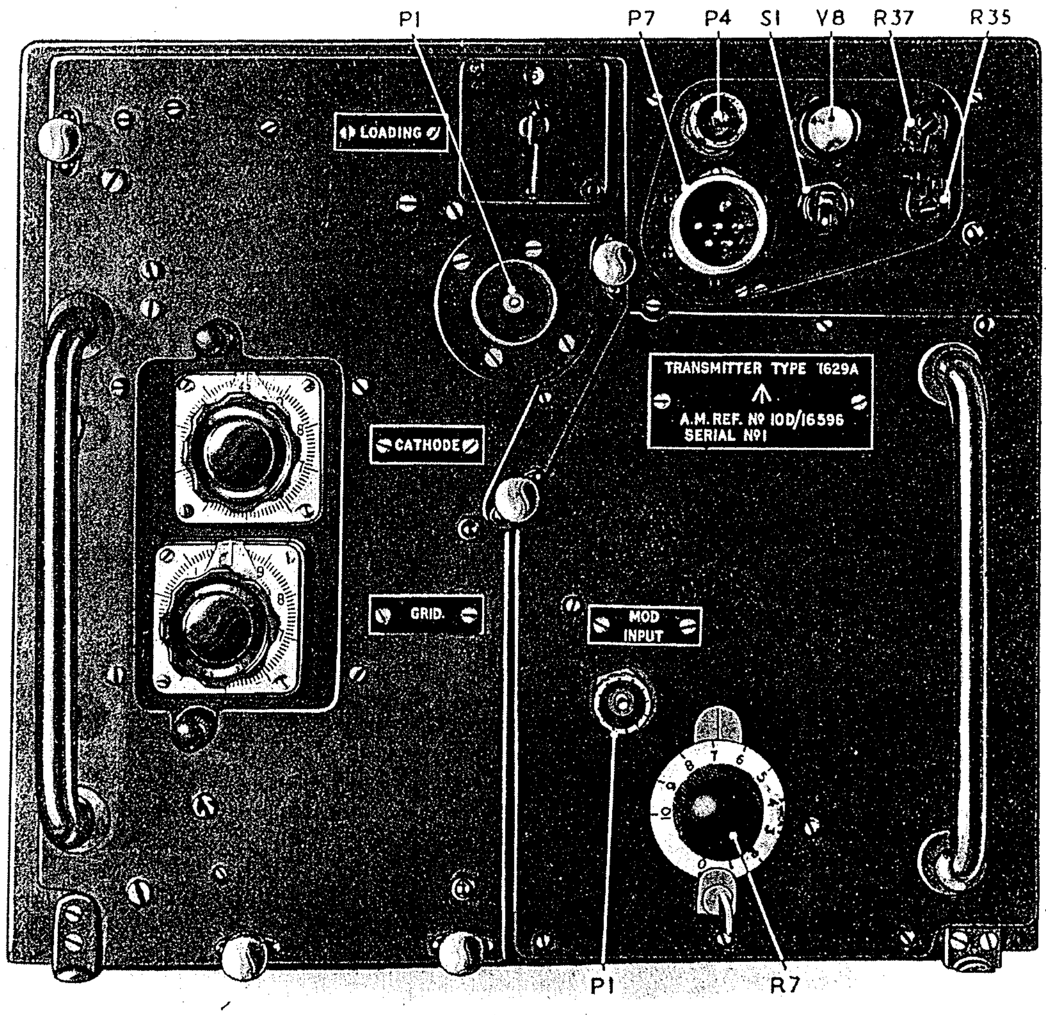

Fig. 10.—Transmitter type T.1629A—front panel

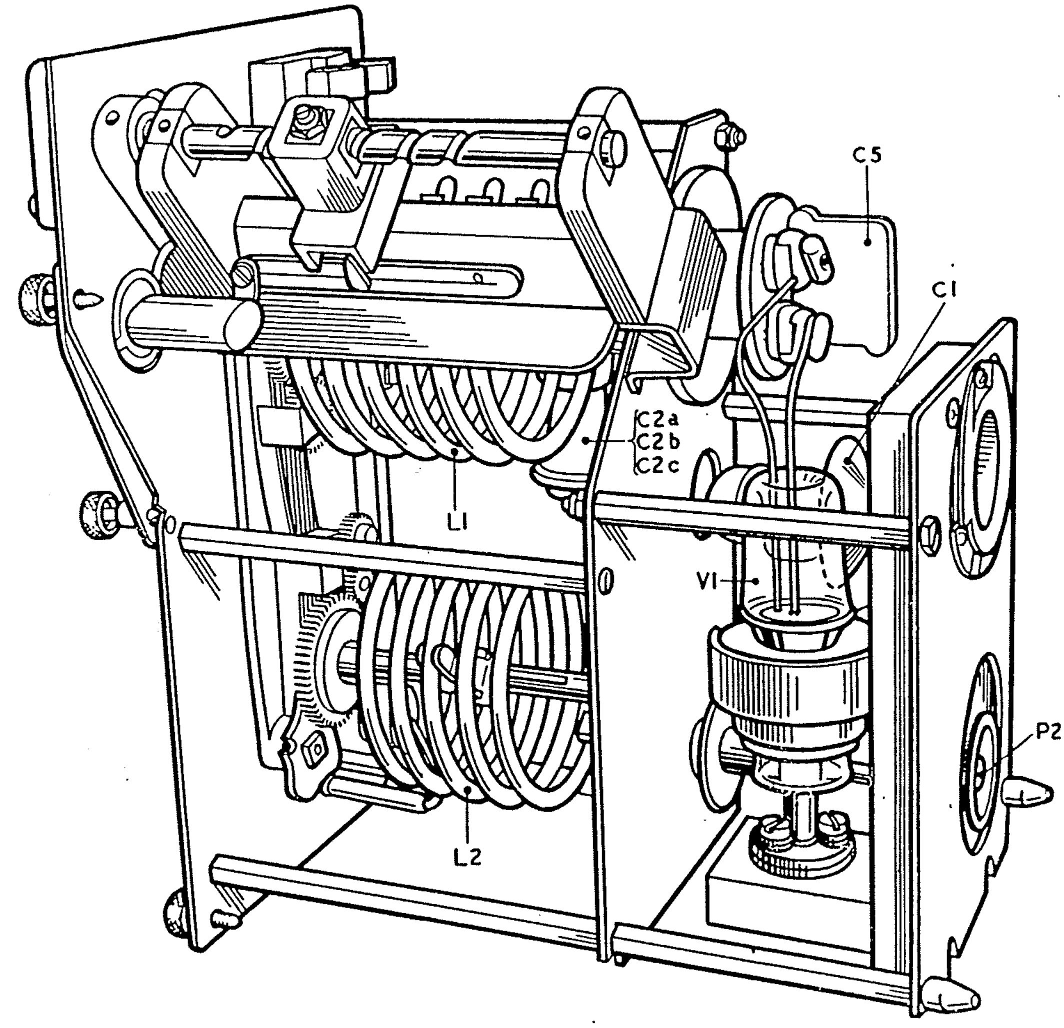

Fig. 11.—Transmitter unit type 116A—general view

Transmitter type T.1629A

38. The front panel of transmitter type T.1629A is shown in fig. 10. It consists of transmitter unit type 116A and modulator type 172A, illustrations of which are provided in fig. 11 and 12 respectively. Transmitter unit type 116A is mounted rigidly to the back of the left-hand position of the front panel of T.1629A and can be easily removed from the main unit.

39. The modulator type 172A consists of the following parts:—

(1) 7 kV power supply
(2) —700 volts and +300 volts power supplies
(3) The main modulator
(4) The sub-modulator (modulator type 214A)
(5) Control circuits
(6) Diode receiving unit

40. Reference to the block schematic diagram given in fig. 13 will make clear the method of working. The sub-modulator (modulator type 214A) is triggered by means of a negative pulse and causes the main modulator to provide a 6 kV pulse of approximately 3 to 4 microseconds width for anode modulation of the transmitting valve. The duration of this pulse is controlled by the charge and discharge of a delay network in the anode circuit of the last sub-modulator valve.

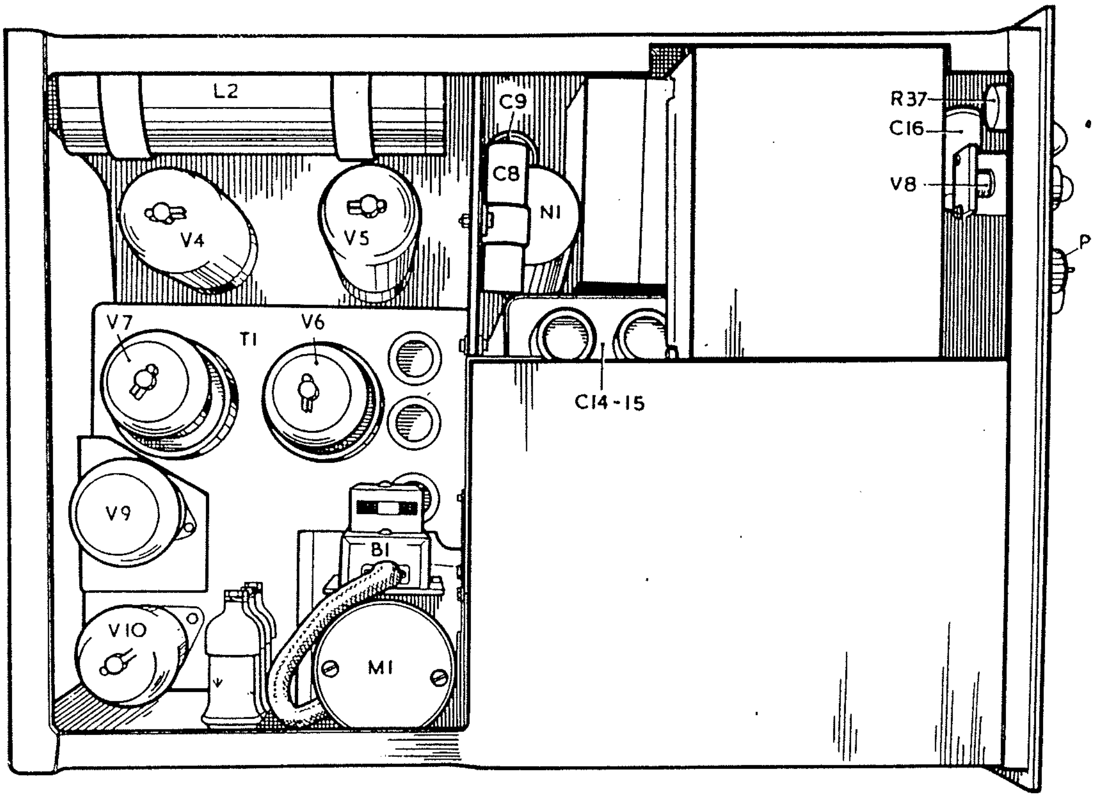

Fig. 12.—Modulator type 172A—general view

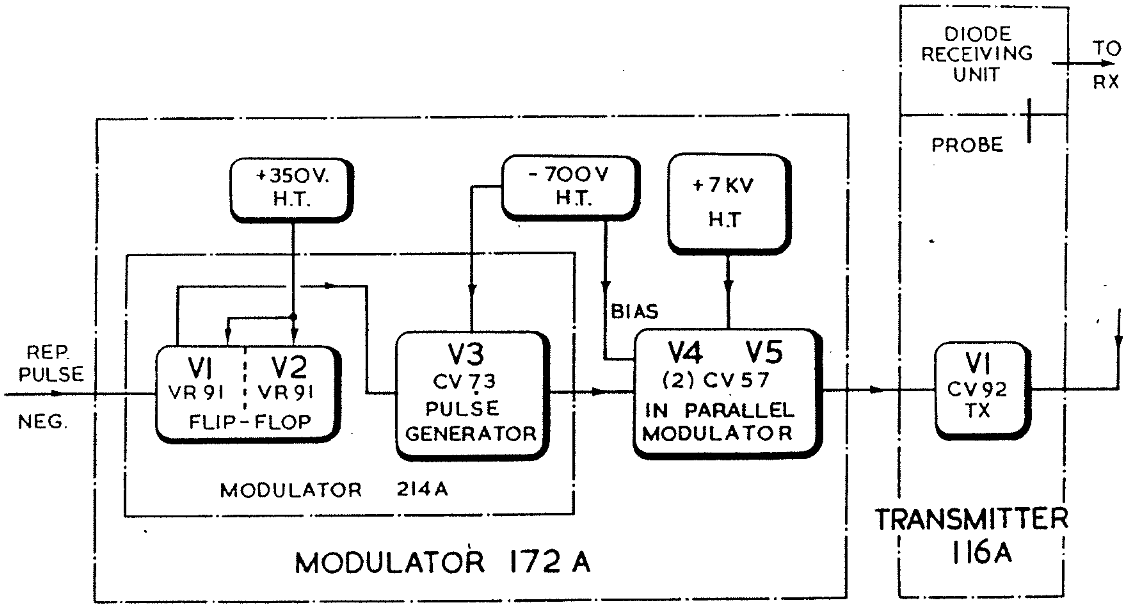

Fig. 13.—Transmitter type T.1629A—block schematic

41. The transmitter frequency is varied by changing the grid and cathode condensers and by altering the tapping points on the grid inductance and the concentric inductance in the cathode circuit. The peak power output is approximately 20 kW. The frequency range covered by the transmitter is from 20 to 80 Mc/s in three bands:—

(1) 20 to 30 Mc/s, using 100 $\mu\mu$F condensers marked C
(2) 30 to 45 Mc/s, using 40 $\mu\mu$F condensers marked B
(3) 45 to 80 Mc/s, using 11 $\mu\mu$F condensers marked A

42. Enclosed in the transmitter unit, but screened from it, is a diode receiving unit. This is connected to a probe within the transmitter and provides a marker pulse for the indicator by rectifying the RF pulse picked up by the probe.

43. The following plugs and controls are mounted on the front of transmitter unit type 116A:—

(1) Cathode tuning adjustment and locking screw
(2) Grid tuning adjustment and locking screw
(3) Loading control for matching the cathode inductance to the aerial system
(4) Single-pole plug for feeding the RF output to the aerial.

44. The following plugs and controls are mounted on the other section of the front panel of the transmitter type T.1629A:—

(1) 6-pin WW plug carrying AC and DC supplies to the unit
(2) Supply switch controlling the AC and DC supplies
(3) Neon warning indicator for main HT supply
(4) Phasing control varying the instant of the start of the transmitter triggering pulse
(5) Single-pole plug for the input triggering pulse to the modulator
(6) Single-pole plug conveying the diode unit output pulse to the receiver type R.3582A
(7) Two pre-set variable resistors forming part of the control circuits of the transmitter type T.1629A.

Universal indicator type 2

45. The tropical version of the indicator consists of three units:—

(1) Strobe unit type 61A
(2) Control unit type 426A
(3) Indicating unit type 166A

By referring to the simplified block schematic diagram shown in fig. 14, it will be seen that it is easier to consider this part of the equipment as a whole rather than unit by unit. With the exception of the halving amplifier in the indicating unit, none of the circuits in this equipment is used for different functions on different positions of the function switch. The only effect of this switch, with the one exception mentioned, is to vary the repetition frequencies or to change the time constants. Hence, when inspecting the waveforms, it is more convenient to use the Gee function only where the repetition frequency is stable. The waveforms may all be monitored on any one of the following indicators, type 60, 60A, 62 and 62A. Alternatively they may be seen by a direct connection to the Y2 plate of a second indicating unit, type 166 or 166A.

46. All the waveforms required are derived from the 150 kc/s crystal oscillator in the control unit. This drives a divider chain and also provides calibration pips for range measurement. The divider has three stages and produces pulses having repetition frequencies of 500 p.p.s. for Gee and 80 to 250 p.p.s. with jitter for H and Rebecca. The repetition frequency for H and Rebecca is normally set for 100 p.p.s.

47. The last divider stage feeds the halver circuit which provides a square waveform, at half the repetition frequency, for timebase spacing and for triggering the strobe circuits. The output of the strobe circuits is then mixed and used to trigger the strobe marker valves and the sanatron timebase.

48. The signals and calibration pulses are fed to the cathode ray tube via a signal reverser circuit to give a back-to-back presentation on the strobe time base and Rebecca main timebase. This circuit is driven by the strobe marker multivibrator for Gee and H and by the Rebecca switch on the Rebecca function.

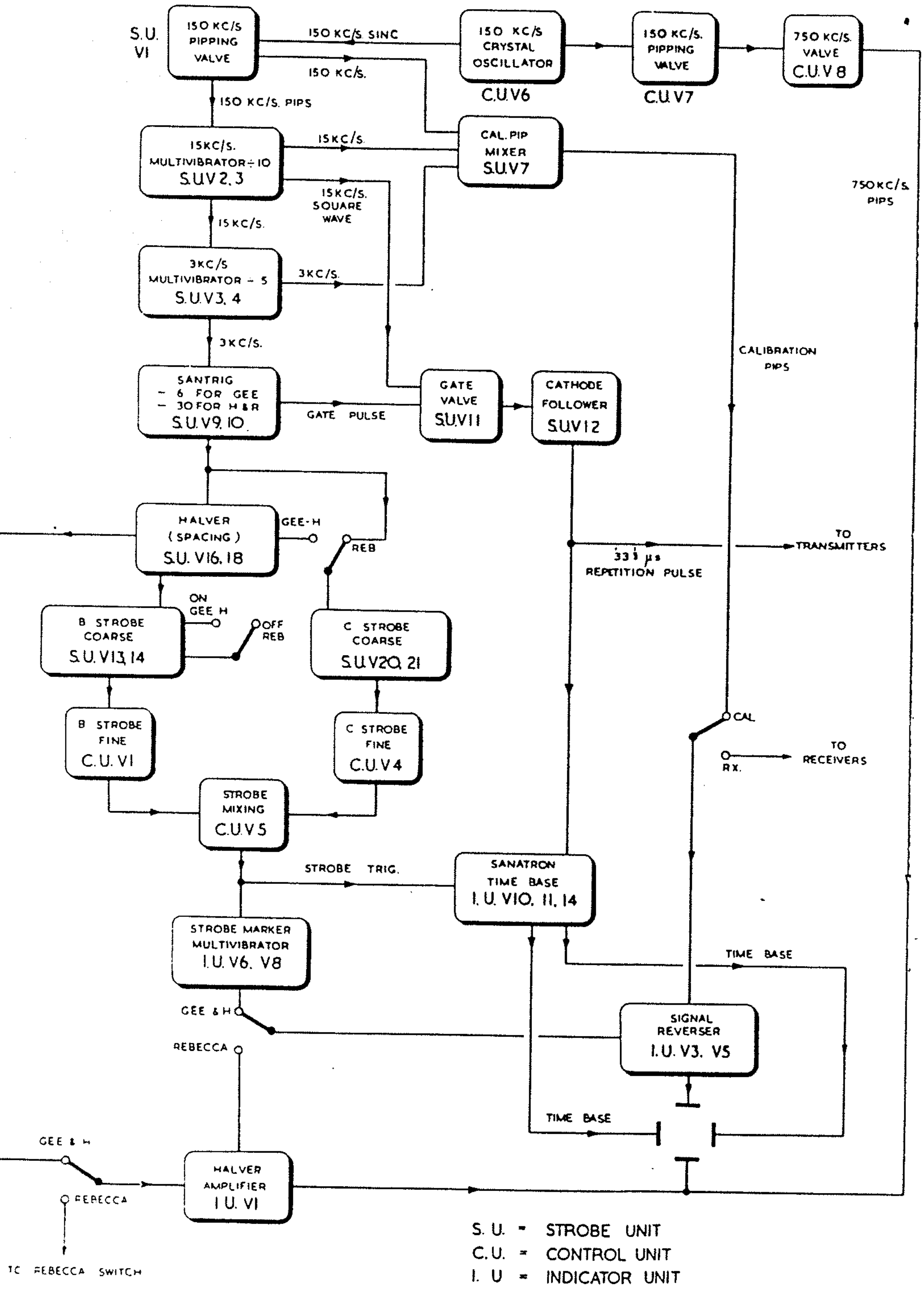

Fig. 14.—Universal indicator type 2—block schematic

49. The square wave from the halver circuit is fed to the cathode ray tube through the halver amplifier on Gee and H. On the Rebecca function the halver amplifier is used to amplify a waveform from the Rebecca switch, this waveform then being fed to the reverser circuit.

50. When installed in the aircraft, it is essential that the control unit type 426A and the indicating unit type 166A are mounted close together in the navigator's compartment, but the strobe unit type 61A may be mounted up to 40 feet away and need not be accessible during flight.

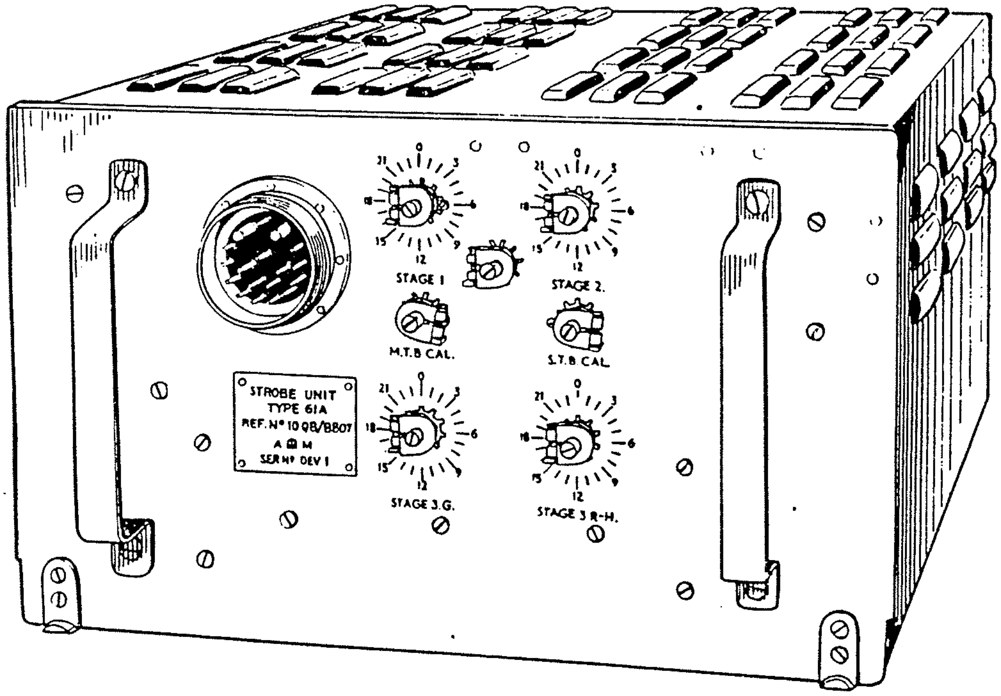

Fig. 15.—Strobe unit type 61A—front panel

51. The following pre-set control and plugs are mounted on the front panel of the strobe unit type 61A (see fig. 15).

(1) 18-way WW plug for connection to junction box type 266A or 256

(2) PR1 } control for first divider stage giving 15 kc/s pulses
(3) PR2 }

(4) PR3 control for second divider stage giving 3 kc/s pulses

(5) PR6 repetition frequency control for Gee

(6) PR7 repetition frequency control for H and Rebecca

(7) PR4 control for main timebase calibration pips

(8) PR5 control for strobe timebase calibration pips

52. Fig. 16 shows a front panel view of the indicating unit type 166A and the various plugs and controls are:—

(1) RANGE switch for 2, 10, 50 and 150-mile strobe timebases

(2) FUNCTION switch for Gee, H or Rebecca

(3) STROBE switch for main or strobe timebase

(4) Doubler button for doubling duration of timebase

(5) LINE SPACE control

(6) Strobe spacing pre-set control

(7) Brilliance control
(8) Focus control
(9) Astigmatism pre-set control
(10) 6-pin WW plug for connection to junction box type 255A
(11) 18-pin WW plug for connection to junction box type 266A or 256

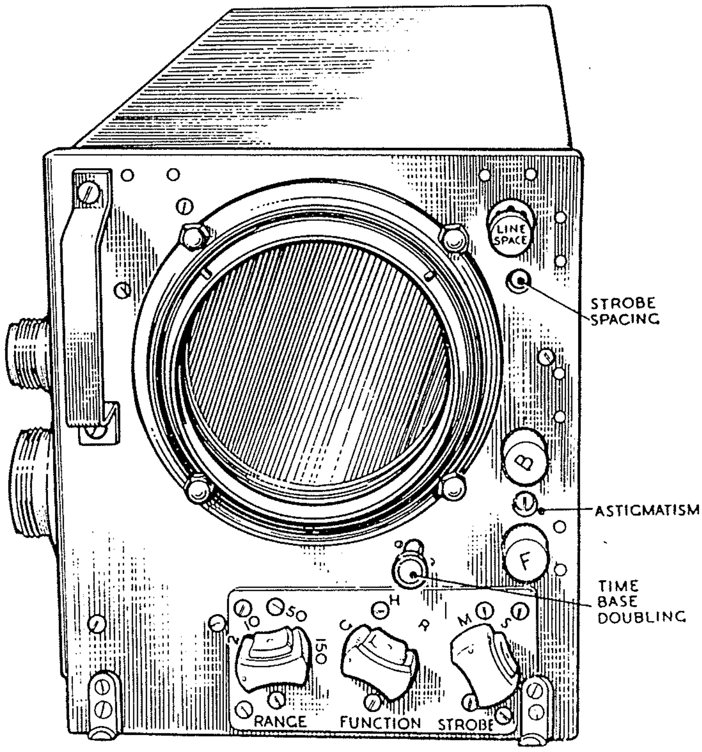

Fig. 16.—Indicating unit type 166A—front panel

53. The front panel of control unit type 426A, which is illustrated in fig. 17, carries the following controls:—

(1) CRYSTAL frequency control, direct and slow motion drives
(2) B FINE strobe control, direct and slow motion drives
(3) C FINE strobe control, direct and slow motion drives
(4) B COARSE strobe control
(5) C COARSE strobe control
(6) Receiver GAIN control
(7) Calibrator pip key for signals or calibration pips
(8) Gee–H transmitter re-setting push button
(9) Gee–H/Rebecca–H push–pull button

An 18-pin WW plug is mounted on the back of the unit for connection to junction box type 255A.

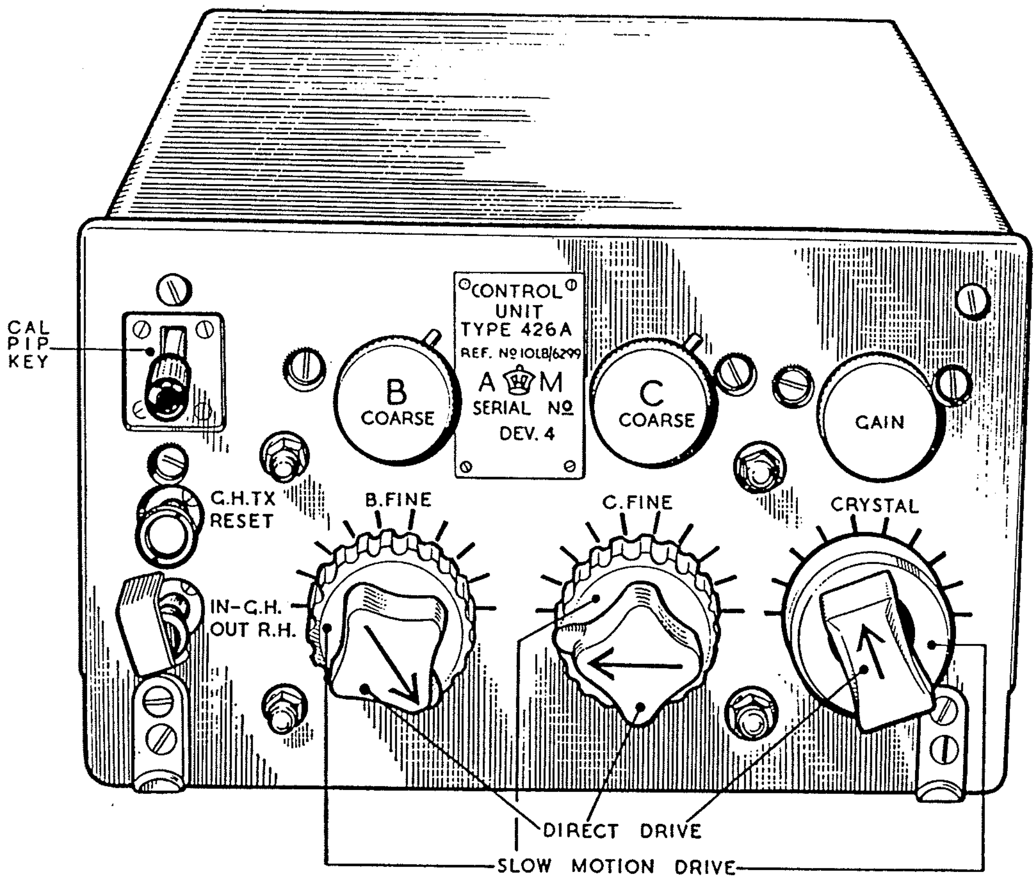

Fig. 17.—Control unit, type 426A—front panel

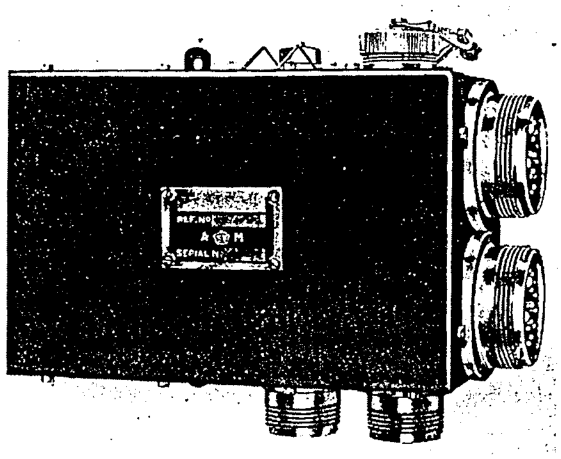

Fig. 18.—Junction box type 255A—general view

Junction boxes

54. Two are required for any one of the installations referred to in this publication. Through them the DC and AC power supplies from the voltage control panel are distributed to the remaining units and other necessary connections are made between units of the installation. Type 255A and

266A are required for Gee and Gee-H installations and are illustrated in fig. 18 and 19, their interconnections being shown in fig. 6. As already stated, junction box type 256 may be substituted for type 266A.

Control panel type 5

55. This panel, a view of which is given in fig. 20, regulates the necessary AC and DC supplies from the aircraft generator and batteries. It is described in A.P.1186D, Vol. I, Sect. 1, Chap. 1. Included in the control panel is a voltage regulator, type EU, which is dealt with in Sect. 2, Chap. 2 of the same publication.

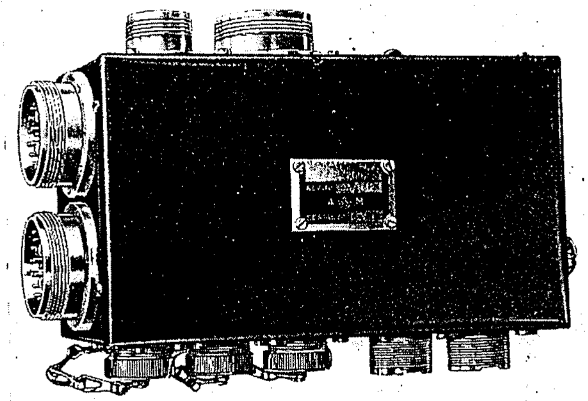

Fig. 19.—Junction box type 266A —general view

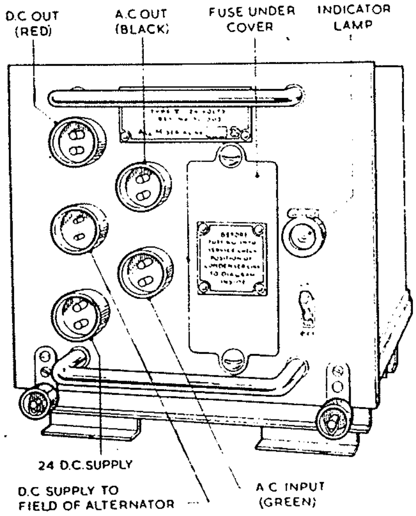

Fig. 20.—Voltage control panel type 5 —general view

Aerials

56. The number of aerials required in the aircraft is dependent upon the actual aircraft installation. For the Gee-H installation two are required, a receiving aerial and a transmitting aerial.

57. The Gee-H receiving aerial consists of aerial type 329 with loading unit type 51. These are used over the entire Gee and Gee-H frequency band, 20 to 80 Mc/s. A view of the loading unit type 51 is shown in fig. 21.

58. The Gee-H transmitting aerial is aerial, aircraft, type 361, which consists of an insulator and ten rods. The insulator is a fixture on the aircraft and the appropriate rod is screwed into the insulator whilst the aircraft is on the ground. Details of the rods are given in the following table:—

Rods, aerial	*Length (excluding 1½" threaded)*	*Frequency in metal-skinned aircraft*
Type 333	10′ 0″	22·9–26·5 Mc/s
Type 332	8′ 8″	26·5–30·5 Mc/s
Type 331	7′ 6″	30·5–35·0 Mc/s
Type 330	6′ 7″	35·0–40·5 Mc/s
Type 341	5′ 7″	40·5–46·0 Mc/s
Type 343	5′ 1″	46·0–52·0 Mc/s
Type 342	4′ 6″	52·0–60·0 Mc/s
Type 329	3′ 11″	60·0–69·0 Mc/s
Type 328	3′ 5″	69·0–78·0 Mc/s
Type 327	2′ 11″	78·0–88·0 Mc/s

Computer, automatic, type 56

59. The computor, automatic, type 56, known as Gee–H Mouse, is an automatic device used to facilitate the operational use of Gee–H as a blind bombing aid. A full description of the device and its operation is given in Chapter 2 of this publication.

CIRCUIT DESCRIPTION

Fundamental circuits

60. Before proceeding with a detailed description of the circuits involved in the Gee–H Mark II airborne equipment, a brief outline of the phantastron, sanatron and santrig basic circuits is given in the following paragraphs as particular applications of these are encountered in the universal indicator type 2 circuits.

The phantastron

61. This circuit is a special case of the Miller fed-back time-constant circuit and can be used in at least two ways:—

(1) As an accurate delay circuit

(2) As a dividing stage.

62. A phantastron circuit suitable for producing a variable delay is shown in fig. 22, together with the waveforms. The triggering input required is a negative-going pulse with a sharp leading edge and of about 25 volts amplitude. Initially the conditions are as follows:—

Voltage on suppressor grid of V2	20 volts
Voltage on cathode of V3	37 volts
Voltage on cathode of V2	41 volts

63. The diode V3 is conducting and therefore the grid of V2 is caught in the region of 37 volts. V2 is a VR 116 which has a short suppressor base, and the suppression voltage therefore prevents the flow of any anode current, the screen taking all the space current. The anode voltage tries to rise to HT potential but is caught by means of the diode V1 and hence the initial value of the anode voltage is determined by the setting of the potentiometer P.

64. The cycle of events which takes place when the phantastron is triggered can be divided into six stages as described in para. 65 to 71 inclusive.

65. *Stage 1.* When a negative pulse is applied to the cathode of V3 via C3 and R8, the anode of V3 (and also the grid of V2) falls. This drop in voltage on the grid of V2 is followed by the cathode of V2, since the cathode load is not decoupled. As the voltage on the cathode of V2 falls, the suppressor grid voltage relative to the cathode rises, and the anode of V2 begins to take current. Thus, owing to the large anode load, the anode voltage falls and V1 is cut off. This drop in anode potential of V2 is transmitted back to the grid of the valve and the grid and anode potentials then fall together until a position of equilibrium is reached in which the control grid is almost cut off.

66. *Stage 2.* The diode V3 is now cut off, and as there is no grid current flowing, the grid of V2 tends to rise to HT potential through R7. This rise in grid voltage causes a fall in the anode voltage of V2 which feeds back through C2 and tends to oppose the rise in grid voltage. As a result of these opposing actions the anode voltage of V2 now falls linearly, its rate of fall depending on the HT potential and the values of C2 and R7.

67. It can be shown that this rate of fall approximates to:—

$$\frac{dVa}{dt} = \frac{-VHT}{C2 \times R7} \text{ secs.}$$

where the CR values are calculated in farads and ohms; accordingly, if C2 is 50 $\mu\mu$F, R7 is 2 Megohms and V HT is 300 volts, then

$$\frac{dVa}{dt} = \frac{-300}{50 \times 10^{12} \times 2 \times 10^{6}} \text{ secs} = 3 \text{ volts per microsecond}$$

68. *Stage 3.* During stage 2, the anode voltage of V2 falls linearly and its grid and cathode voltages rise. This continues until the anode voltage approaches the cathode voltage. The rising grid voltage tends to increase the space current but the falling anode voltage reduces the anode current, and the anode voltage ceases to fall and remains fairly constant. Thus there is little feed-back from the anode to the grid of V2 and the grid rises rapidly towards HT potential at a rate depending upon the values of C2 and R7.

69. *Stage 4.* As the grid and cathode voltages of V2 rise, the voltage on the suppressor grid, relative to the cathode, falls and the anode current is cut off. The anode voltage therefore starts to rise and thus the grid and anode voltages of V2 rise rapidly, both ends of C2 moving together.

70. *Stage 5.* As the grid voltage of V2 rises above 37 volts, the diode V3 starts to conduct and so the grid voltage is held at its original steady value. Since the grid end of C2 cannot rise further, the anode potential of V2 rises exponentially towards HT potential with a time constant (C2 + Cs)R6, where Cs is the sum of the stray capacities from the anode to earth. When the anode potential of V2 reaches the potential on the cathode of V1 this diode conducts and the anode potential of V2 is held at its original steady value.

71. *Stage 6.* The circuit is now quiescent until the next negative pulse is applied to the cathode of V3 when the cycle is repeated. Output waveforms may be taken from the screen or cathode of V2.

The sanatron

72. The sanatron is a development of the phantastron using two valves, one performing the linear run-down associated with the phantastron and being flashed back by the second valve.

73. Reference should be made to the circuit and waveforms given in fig. 23. The valves V2 and V3 are type VR91, V2 being the run-down valve and V3 the flash-back valve.

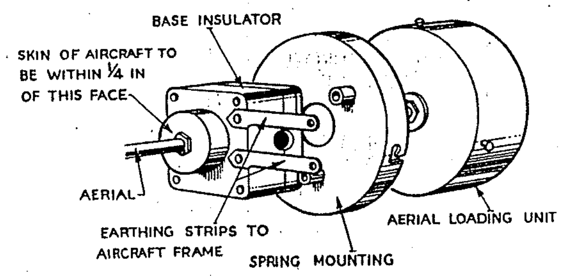

Fig. 21.—Loading unit type 51—general view

74. In the quiescent state V2 and V3 are both drawing grid current since R6 and R7 are returned to + 200 volts. V3 is bottomed (operating below the knee of the *Ia–Ea* characteristic) and therefore V2 is cut off on its suppressor grid as it is DC-connected to the anode of V3 via R8 and R9. Hence the anode of V2 would rise to 300 volts, but is held by the diode V1 at a potentail Vp determined by the setting of the potentiometer P. The screen is now taking all the space current in V2.

75. The circuit may be triggered by:—

(1) A negative pulse of 60 volts amplitude on the suppressor of V3,

(2) A negative pulse of 10 volts amplitude on the grid of V3 through V6,

(3) A negative pulse of 20 volts amplitude on the cathode of V1.

76. In the circuit shown, control-grid triggering is used and when a negative pulse is fed via the diode V6 to the grid of V3, the valve is cut off and the anode rises quickly since R11 is only 15,000 ohms. This sharp rise is transferred, by C5, to the suppressor grid of V2, enabling the

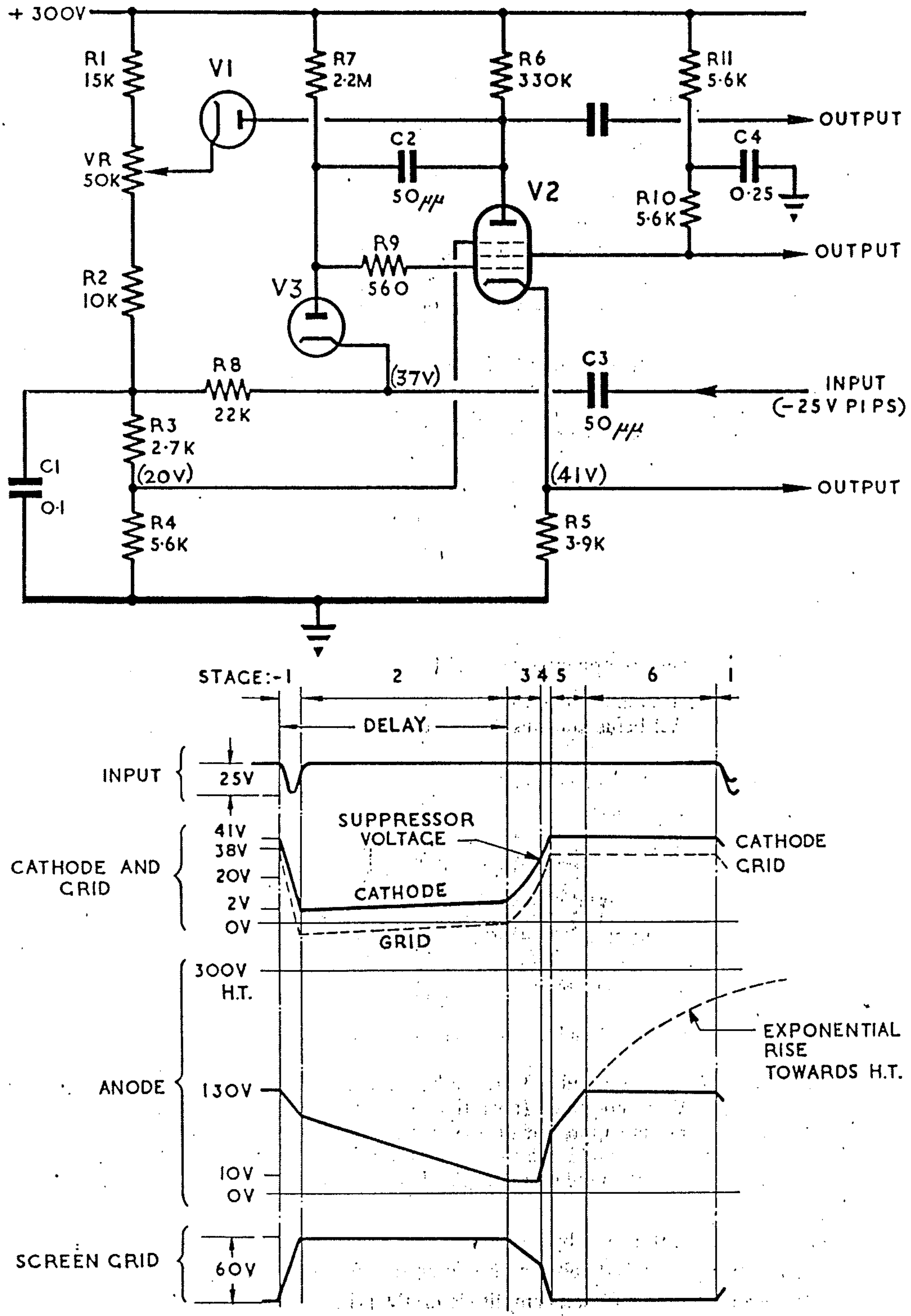

Fig. 22.—Phantastron basic circuit and waveforms

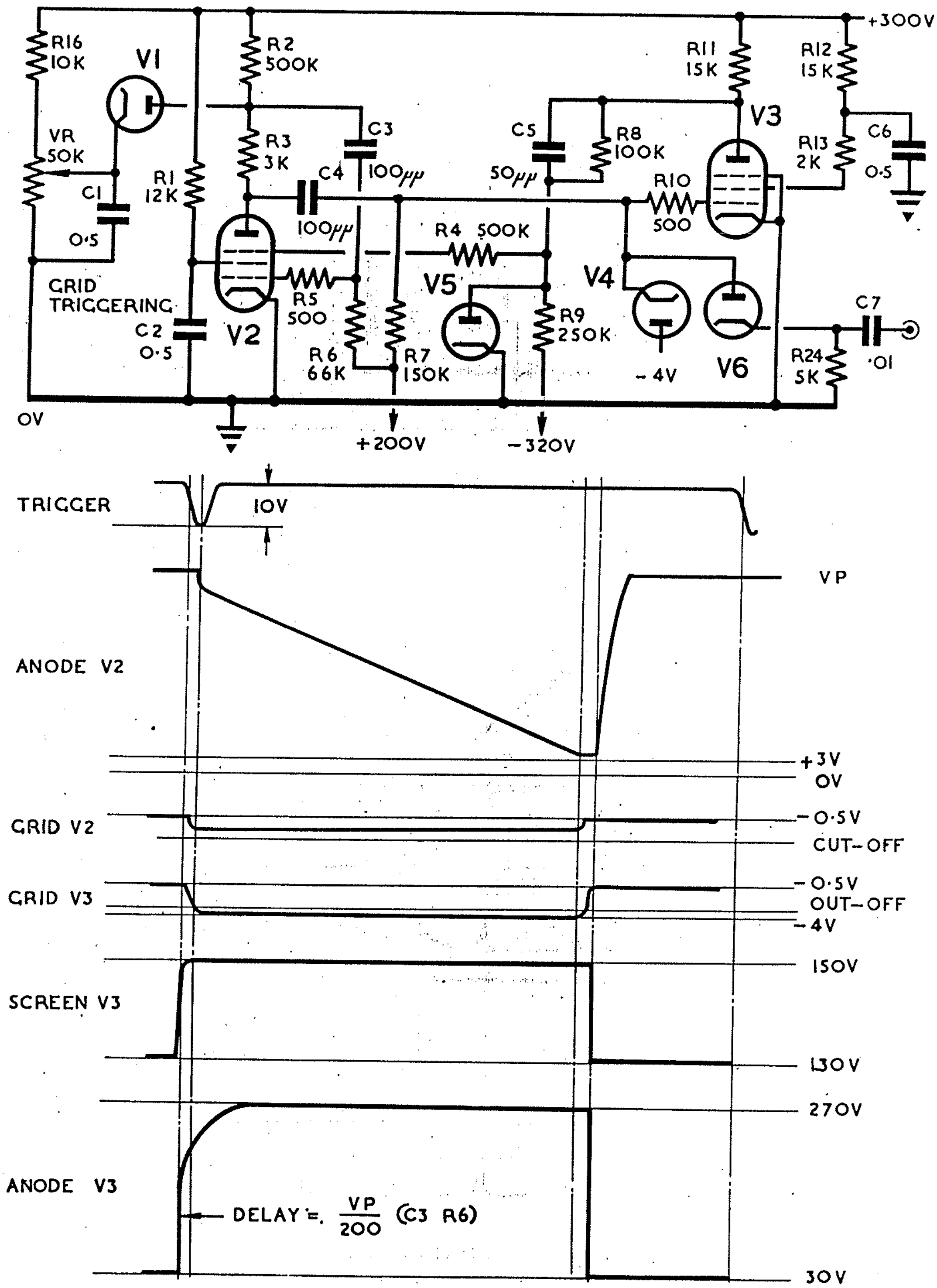

Fig. 23.—Sanatron basic circuit and waveforms

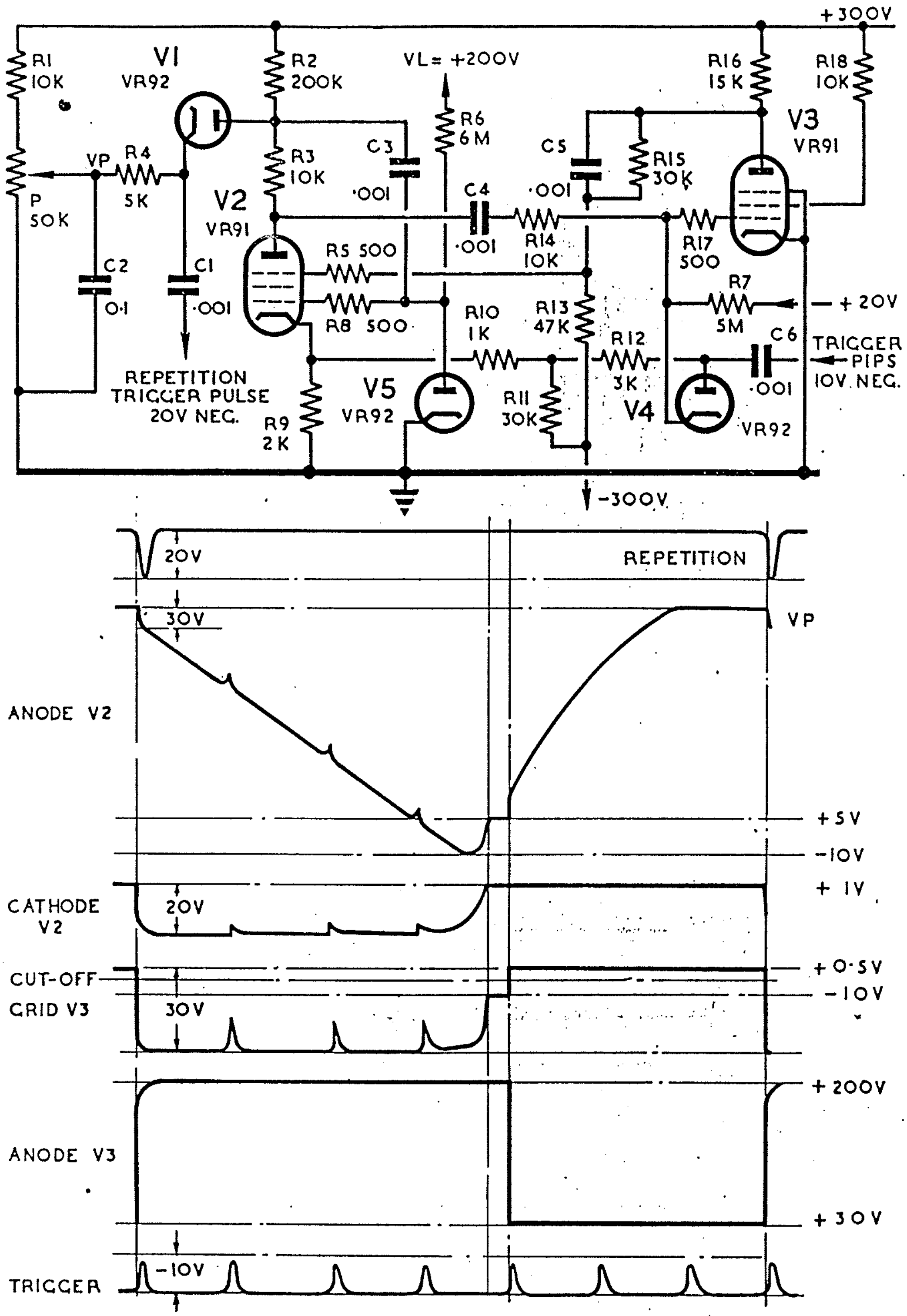

Fig. 24.—Santrig basic circuit and waveforms

anode of V2 to be switched on without appreciable time delay after the initial triggering edge, and current passes through R2 and R3. The anode of V2 falls further than the anode of V1, and since these points are connected to the grids of V3 and V2 by C4 and C3 respectively, the grid of V3 falls further than the grid of V2. The grid of V2 falls almost to cut-off and as it is connected to the anode of V1 by C3, and to ground by the stray capacity, the drop in voltage at the anode of V1 is given by:—

$$\frac{C3 + C \text{ strays}}{C3} \times \text{grid base (approximately)}$$

and is of the order of 6 volts. Therefore the grid of V3 tends to fall by an amount:—

$$6 + R3 \times (\text{Current in R3}) \text{ volts}$$

$$\left\{ \text{Current in R3} = \frac{300 - Vp}{R2} + \frac{200}{R6} \text{ neglecting stray capacities} \right\}$$

and is held by the diode V4 at −4 volts. V3 is now cut off on its control grid. It should be noted that the initial anode drop of V2 is much smaller than in the phantastron, therefore less of the voltage Vp is wasted.

77. C3 now takes current through R6 and the anode of V2 commences its linear run-down. The period of the run-down is equal to

$$\frac{Vp}{200} R6C3$$

During this period the diode V4 holds the grid of V3 at − 4 volts.

78. As the anode of V2 approaches the cathode potential of V2, which is earthed, the anode motion ceases and therefore, since the feed-back stops, the grids of V2 and V3 move upwards. V3 quickly passes the cut-off point and tends to bottom. The anode drop in V3 is transmitted by C5 to the suppressor grid of V2, cutting this valve off on the suppressor and, hence, cutting off the anode current. The cessation of current through R3 causes the anode to rise almost instantaneously thereby switching the grid of V3 hard on. This ensures a rapid cut off on the suppressor grid of V2, R2 then charging up C3 and C4 exponentially towards HT. The anode rises towards HT potential at a time-constant approximately equal to R2 × (C3 + C4 + stray capacity to ground) and is caught at the potential Vp by the diode V1.

79. The circuit is then quiescent until a further triggering pulse is applied. Outputs may be taken from the anode or screen of V3.

80. Comparison with the phantastron reveals the following advantages of the sanatron circuit:—

(1) Much faster rates of run-down may be obtained with the sanatron for given values of Vp. The circuit is then especially valuable for short range timebases.

(2) The circuit does not require valves with short suppressor bases and therefore any pentode with a 60-volt suppressor cut-off may be used.

(3) The initial drop in potential, shown in the anode waveform of the run-down valve, is small and thus does not produce the fast start which a phantastron would cause if used in a timebase circuit.

81. The disadvantage of the sanatron circuit is that it requires two valves and is more complex.

The santrig

82. The santrig is a development of the sanatron circuit having as its object the locking of the flash-back, with a high degree of precision, to one of a series of re-triggering pulses the frequency of which is an integral number of times greater than the repetition frequency. The ranging square wave can therefore be made to select any one of the pulses contained in the period of the repetition by adjustment of Vp and VL (see fig. 24).

83. In the quiescent state the valve V3 is drawing grid current through R7, which is taken to some positive potential. The anode is therefore at a low potential (+30 volts approximately) causing the suppressor grid of V2 to be completely cut off at —130 volts. The anode of V2 is caught by the diode V1 at a potential approximately equal to Vp. The control grid of V2 is held at ground potential by the diode V5 through which the current from R6 is flowing. The cathode of V2, because of its load, R9, follows the grid and rests at a slightly higher potential. The anode of V4 is at —10 volts due to R10 and R11 and so it is cut off.

84. When the circuit is triggered by the negative repetition pulse through C1 and R4, the cathode of V1 falls, and is followed by the anode of this valve. The anode of V2 therefore also falls, to be followed immediately by the control grid of V3 because of the connection through C4. V3 is then cut off on its control grid and its anode rises to +200 volts, rapidly lifting the suppressor voltage of V2, by the connection through C5, to a potential of approximately +5 volts defined by R13 and R15. If required, the suppressor voltage can be prevented from rising above ground potential by a diode limiter connected from suppressor grid to earth. Anode current now flows in V2 causing, across R3, a sudden drop in potential which is transmitted to the grid of V3 through C4. This action is almost instantaneous and results in the anode of V2 falling, followed by its grid, due to C3, and cathode. The cathode attains a negative value because of R9, R10 and R11 as follows:—

When the space current of V2 is less than $\frac{300}{R10 + R11}$, the cathode attains a potential equal to

$$\frac{\frac{300}{R10 + R11} - \text{space current}}{\frac{1}{R10 + R11} + \frac{1}{R9}} \text{ volts}$$

$$= \frac{R9}{R9 + R10 + R11} \times 300 \text{ V when the space current is small}$$

The grid is almost cut off and the anode falls slightly more than the cathode because of R3.

85. The linear run-down commences and lasts for a time approximately equal to

$$\frac{Vp}{VL} R6C3$$

As the anode of V2 approaches the cathode level the screen current increases and the grid voltage rises, followed by the cathode. The anode continues to bottom and since the feed-back action is ceasing, the rate of fall of the anode becomes the rate of rise of the grid. The current through R6 then causes the stray capacity to charge up and the grid of V2 rises to its original level, lifting its anode and cathode.

86. The anode of V4 has now risen to —10 volts due to R10 and R11 and has been followed by the cathode, that is, the grid of V3, which therefore remains cut off at —10 volts. The grid is unable to rise appreciably since the time constant is equal to R7C4 and is very large. When the next positive triggering pulse is applied to the anode of V4, through C6 and R12, the cathode of V4 moves also (the pulse being developed across R14 since the anode of V2 is then a low impedance) and, therefore, the grid of V3 is brought quickly across its grid base. The anode of V3 falls and is followed by the suppressor grid of V2 causing anode current to cease and producing a sharp rise at the anode of V2. This is again transferred to the grid of V3 through C4 and maintains V3 triggered.

87. The anode of V2 then returns towards HT positive with a time constant approximately equal to R2 (C3 + C4 + C strays from anode to ground) until it is held by the diode V1. The circuit is now quiescent until the next repetition pulse is applied.

Receiver type R.3582A

88. The Receiver type R.3582A consists of four interchangeable RF units, the IF amplifier, second detector and video output stages and a power supply.

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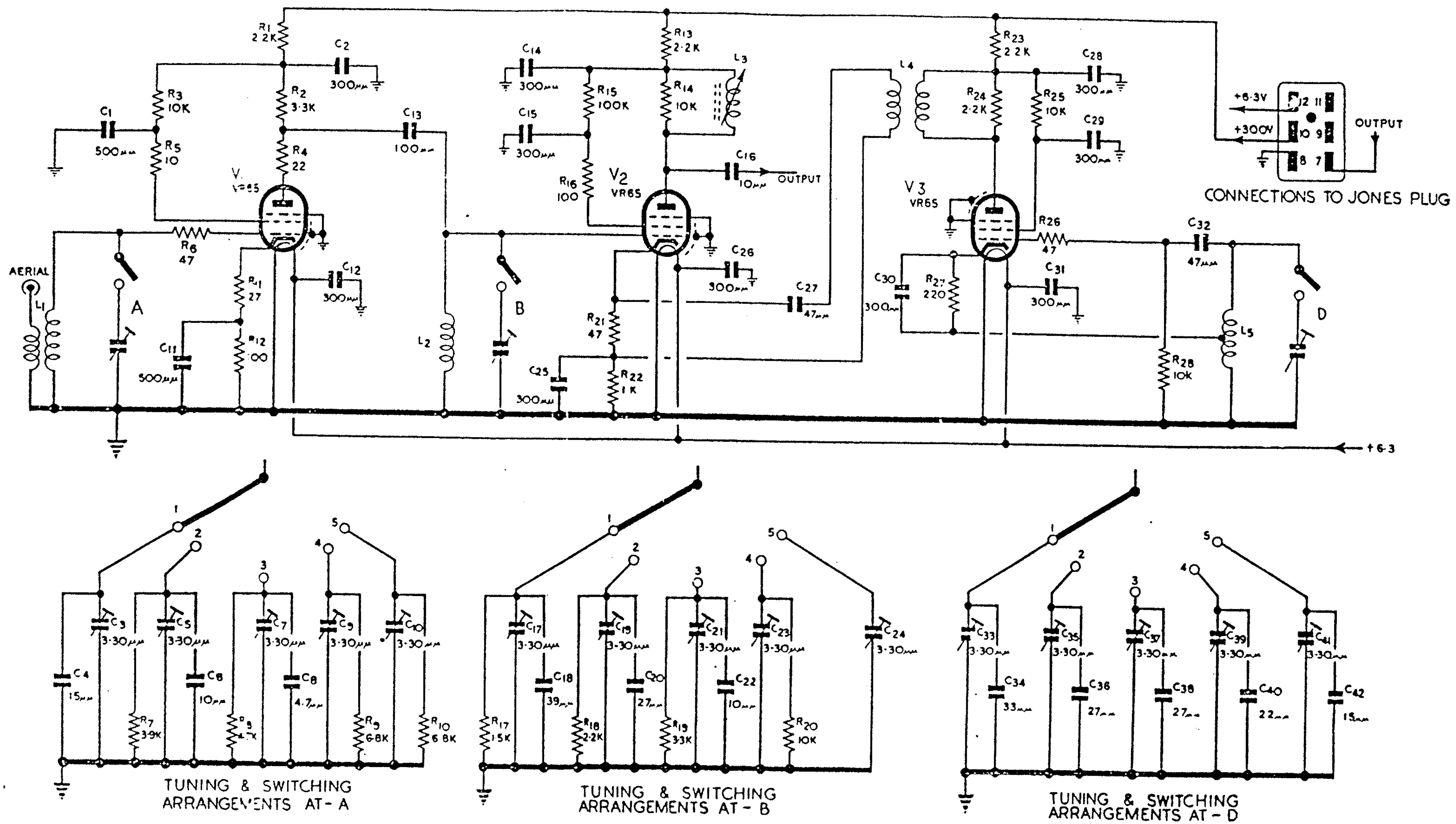

FIG25 R.F. UNIT TYPE 24B – CIRCUIT

FF1822 WT2361/G481 6/47 325 C&P Gp. 959 (4)

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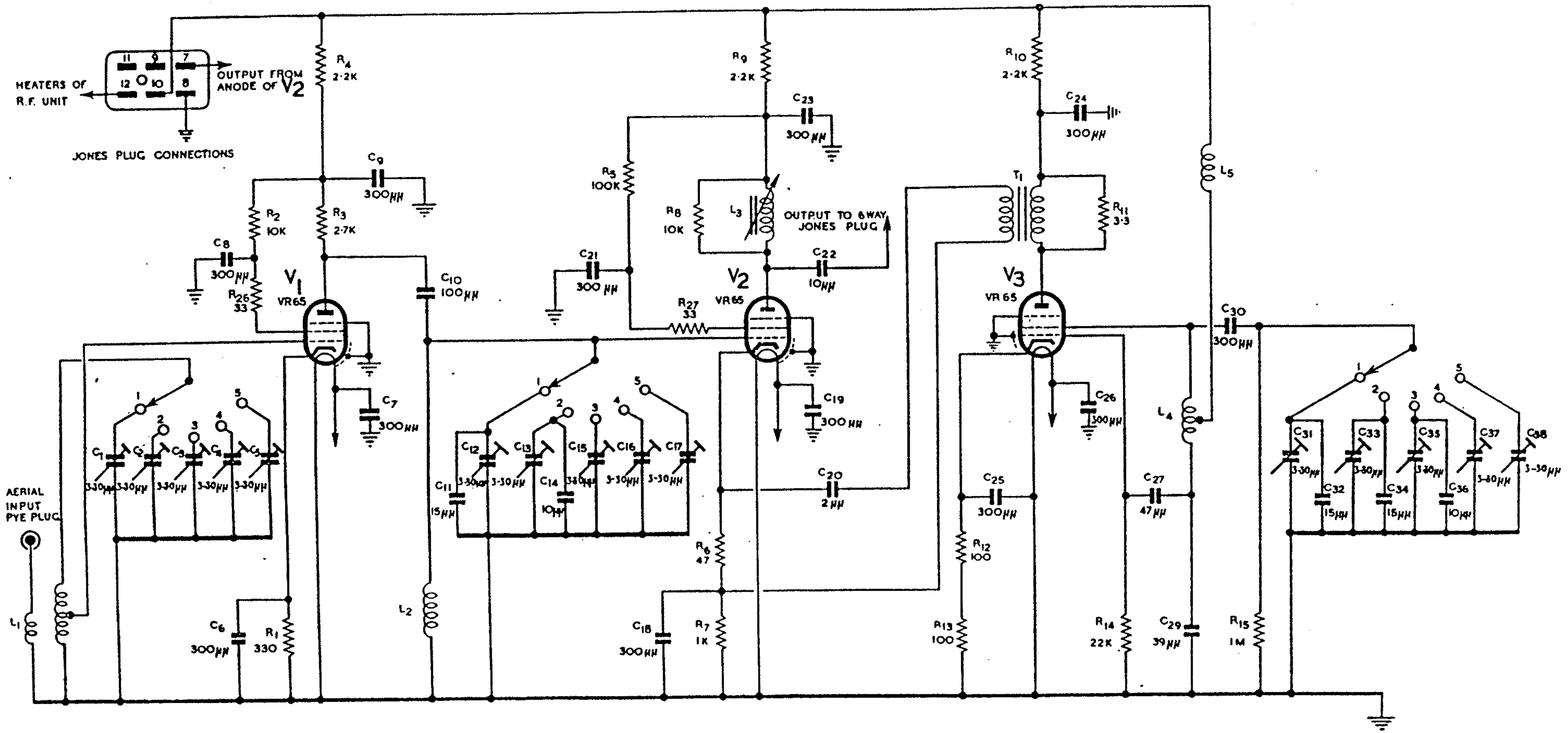

FIG.26 - R.F. UNIT TYPE 25B CIRCUIT.

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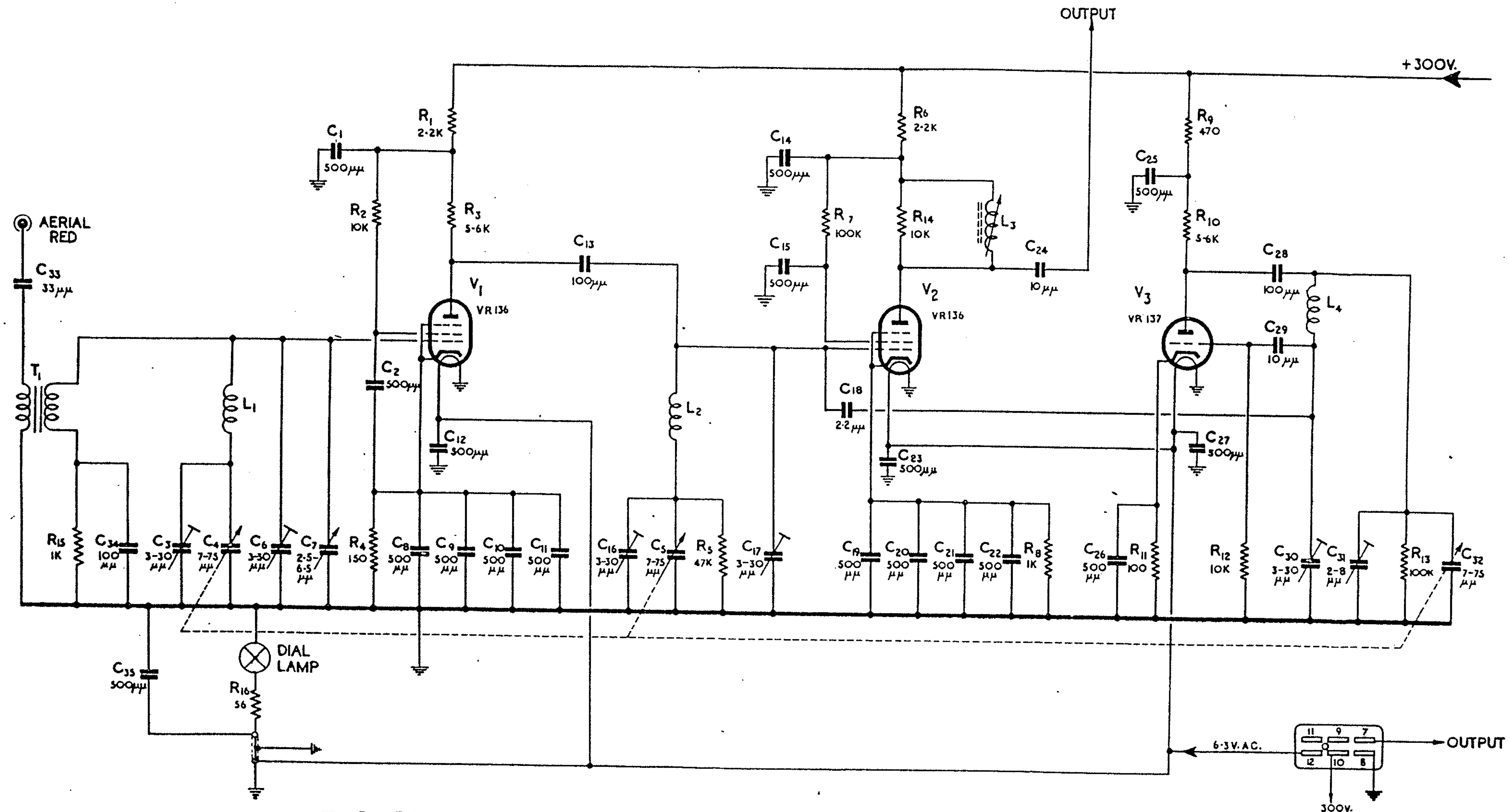

FIG. 27 - R.F. UNIT TYPE 26B — CIRCUIT

M3724/G451 6/47 375 C&P Gp 959 (8)

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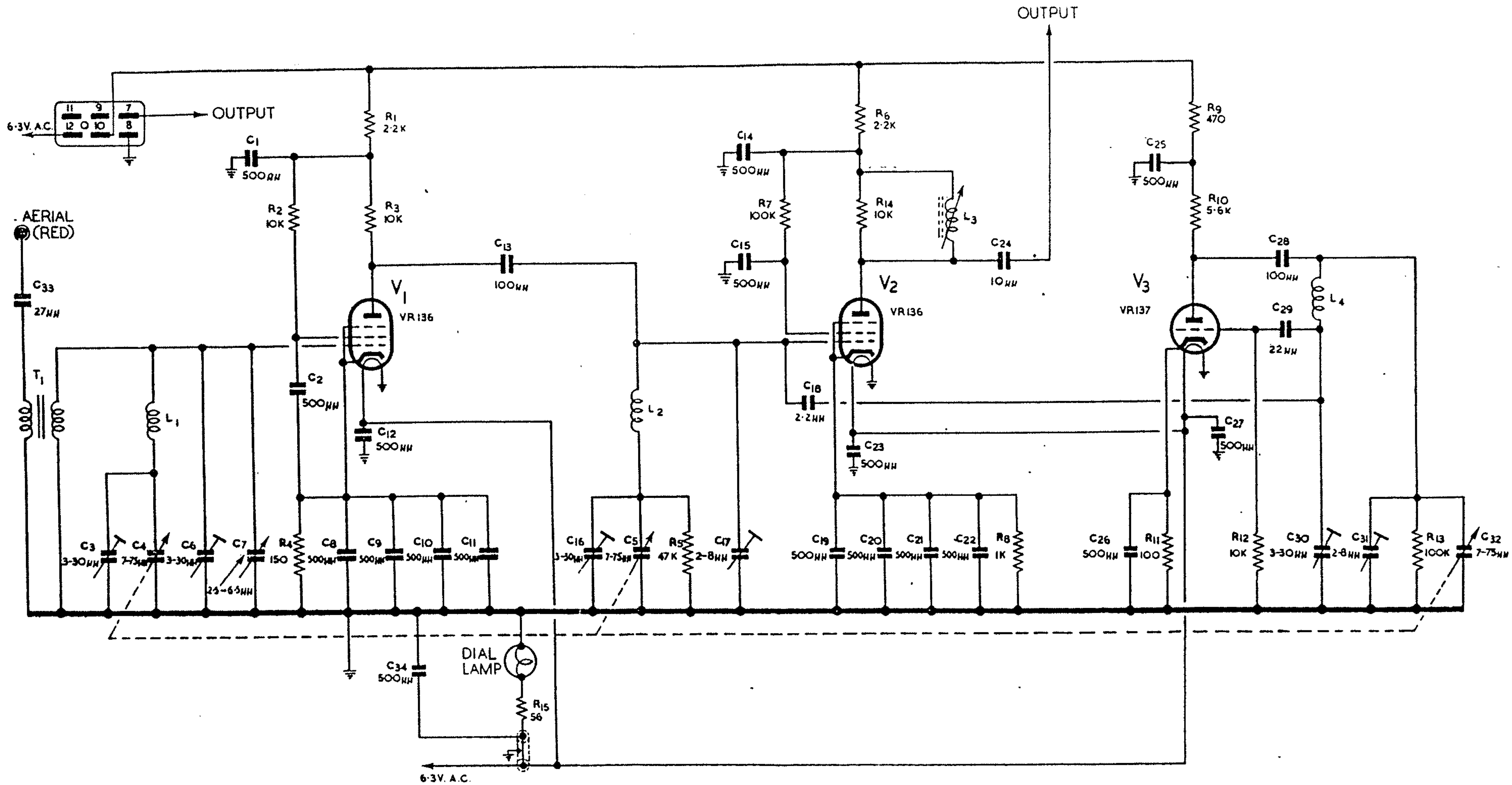

FIG. 28 - R.F. UNIT TYPE 27 B — CIRCUIT.

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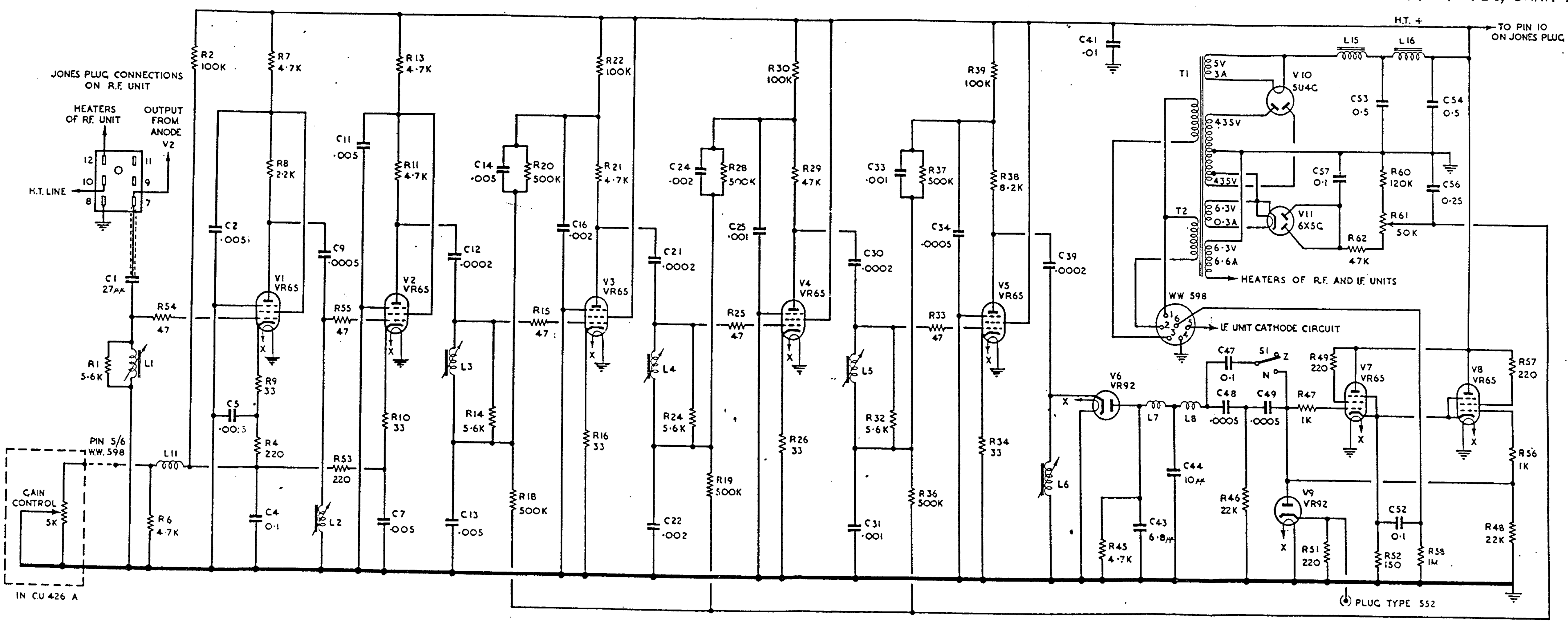

FIG. 29 — RECEIVER R3582A CIRCUIT (LESS R.F. UNIT)

PP4822 W3226/G45 6/47 375 C&P Gp. 959(4)

RF unit type 24B

89. The RF unit type 24B covers the frequency band 20 to 30 Mc/s tuning to any one of five spot frequencies in this range. A circuit diagram is provided in fig. 25.

90. It has one stage of RF amplification, V1, a type VR65. The grid inductance, L1, is tuned by means of the trimmers C3, C5, C7, C9 and C10, any one of which can be selected by the bank A of the spot frequency selector switch. The aerial feeder is matched to the input by the transformer of which L1 is the secondary winding.

91. The output of the RF stage is fed through C13 to the control grid of the mixer valve, V2, the grid circuit of which is tuned in a similar manner to that of V1, L2 being the appropriate inductance. The required trimmer C17, C19, C21, C23 or C24 is selected by the bank B of the selector switch.

92. The oscillator valve, V3, is connected in a Hartley electron-coupled circuit, the frequency of which is controlled by the inductance L5 and the associated trimmers C33, C35, C37, C39 and C41. Any one of these can be selected by the third bank, D, of the selector switch. The cathode, which is returned to a tap on the inductance L5, the control grid and the screen form the oscillatory circuit, the output to the mixer valve being taken from the anode. The frequency of the oscillator is always above the signal frequency. The stability of this oscillator is such that the frequency need be checked only once or twice weekly.

93. The oscillator output is injected, via the transformer L4 which has a pass band greater than 10 Mc/s, into the cathode circuit of the mixer valve, V2, across the resistor R21. The oscillator voltage developed across this load is about 1 volt RMS.

94. The coupling between the mixer and the IF amplifier is through the inductance L3 and the capacity C16 to the grid circuit of the first stage in the IF amplifier. L3 is fitted with an adjustable dust-iron core and the circuit is resonated to 7·7 Mc/s, as is the grid circuit of the first IF valve. The mixer anode circuit and the first IF amplifier grid circuit together with the coaxial cable coupling the units, form a band pass filter. This method of coupling is common to all the RF units and is a capacity in the region of 15 $\mu\mu$F. The overall bandwidth of the complete receiver is approximately $\pm$ 0·5 Mc/s for $-$6dB each side of resonance.

RF unit type 25B

95. This is similar to RF unit type 24B, having a five-position spot frequency selector switch. The circuit differs only in detail from that of the type 24B and the differences are apparent on comparing fig. 26 with fig. 25. The frequency range of this unit is 40 to 50 Mc/s.

96. The oscillator is a Colpitts, electron-coupled to the mixer. The damping resistors associated with the switched tuning capacities in the RF unit type 24B are not necessary in the type 25B, because, at the higher frequencies covered by this unit, the input resistances of the valves provide all the damping required.

RF unit type 26B

97. RF unit type 26B covers the frequency range 50 to 65 Mc/s and differs from the two units previously described mainly in the fact that continuous tuning over the band is provided as shown in fig. 27. The unit contains three valves, an RF amplifier, V1 (type VR136), a mixer valve, V2 (another type VR136) and a triode oscillator, V3 (type VR137).

98. There are three tuned circuits, the RF amplifier grid, the mixer grid and the oscillator. At the frequencies covered by this unit the valve input resistances are so low that they provide all the damping required on the associated tuned circuits to maintain the necessary band width. The input resistance of a valve varies rapidly with frequency (as $1/f^2$) and if the tuning condenser were connected in parallel with the inductance in the usual manner, 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.

99. The variable condenser is therefore connected in series with the 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 in the RF unit type 26B are of this form.

100. The three tuned circuits are ganged. The oscillator frequency must remain constant at 7·5 Mc/s above the frequency of the other two circuits as the condenser is rotated and this is accomplished by suitably proportioning the inductances and capacities. It is essential, therefore, 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. A trimmer condenser, connected across the tuned circuit of the RF amplifier and controlled from the front panel of the unit, allows for slight corrections of the ganging.

101. The coupling 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 intermediate frequency coming from the aerial.

102. The oscillator employs a Colpitts circuit so that no tap is required on the coil. The resonant circuit can thus be made of the same form as the signal frequency tuned circuits, simplifying tracking problems. The oscillator output is injected into the mixer control grid through a 2·2 $\mu\mu$F condenser and a concentric tube, the voltage developed on the mixer grid being about 2 volts RMS.

103. The mixer anode circuit is identical with that of the RF units type 24B and type 25B. That is, it forms, with the IF amplifier input circuit and the connecting coaxial cable, a band pass filter.

RF unit type 27B

104. RF unit type 27B, a circuit diagram of which is given in fig. 28, covers the frequency range 65 to 80 Mc/s with continuous tuning, and differs from the RF unit type 26B only in the frequencies covered.

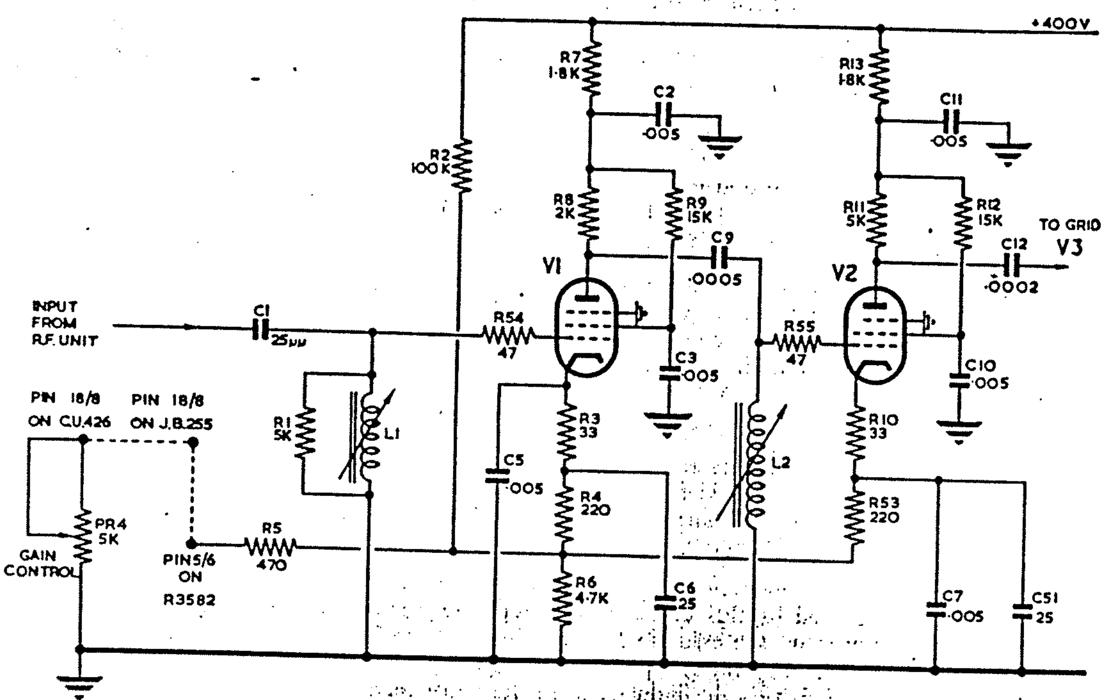

Fig. 30.—IF gain control circuit

IF Amplifier

105. The circuit diagram of this section of the receiver is shown in fig. 29. There are five stages of IF amplification, valves V1 to V5. The diode, V6, is the second detector. V7 and V8 are connected in parallel and form the cathode-follower output stage, feeding the signal output of the receiver to the indicating unit. V9, another diode, by-passes the positive pip of the differentiated signal fed to the grids of V7 and V8. It also serves as a convenient point for introducing the marker pulse produced by the diode receiving unit in the T.1629A.

106. The grid circuit of V1, which consists of the variable inductance L1 and the coupling capacity C1, forms part of the band pass coupling between the mixer stage and the IF amplifier and resonates at 7·7 Mc/s. All the other IF tuned circuits, L2, L3, L4, L5 and L6 are peaked at 7·5 Mc/s and the overall response curve of the whole amplifier peaks at 7·5 Mc/s, the band width being ± 0·5 Mc/s for −6dB, measured from the grid of the first IF amplifier valve.

107. The first two IF amplifier valves, V1 and V2, are provided with variable cathode bias by means of the resistor network R2, R6, R4, R9, R53, R10 and the gain control potentiometer. The variable control is mounted in the control unit type 426A, but is electrically in parallel with R6. The third, fourth and fifth IF amplifier stages, V3, V4 and V5, have a special biasing arrangement which allows the valves to operate so that signals can be read through heavy CW interference.

108. The output of the fifth IF stage is fed across L6 to the cathode of V6, the diode second detector. Negative-going signals are developed across R45, the diode-load resistor, and passed, via the filter and coupling network, to the grids of V7 and V8. The video filter can be switched into, or out of, circuit by a front panel control, and its use results in a considerable improvement in performance when the jamming signal is sine-wave modulated.

109. The last two valves in the IF amplifier, V7 and V8, are connected in parallel and function as a cathode-follower output stage. They are normally biased negatively by the standing current (approximately 15 mA for each valve) through the load resistor R52, and negative-going pulses from the anode of V6 are fed to their grids. Pulses of the same polarity are therefore produced across the cathode load and these are passed to the signal-reverser circuit in the indicating unit type 166A.

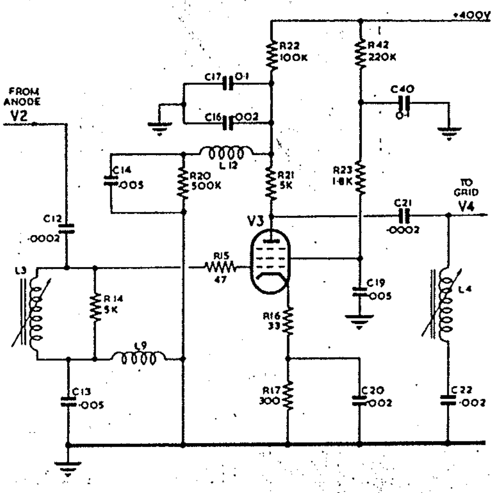

Fig. 31.—3rd, 4th and 5th IF stages

110. *Marker pulse.* To mark the position of the pulse radiated by the transmitter, negative-going pulses from the diode receiving unit in the T.1629A are fed into the receiver. These are produced from the rectified output pulses across the cathode resistor R51 of the diode V9 in the receiver. The pulses are passed through V9 to the output valves V7 and V8 and thence on to the indicating unit. The time position of this marker pulse, and therefore the triggering instant of the transmitter, can be varied over a range of about 40 microseconds by the phasing control in the T.1629A.

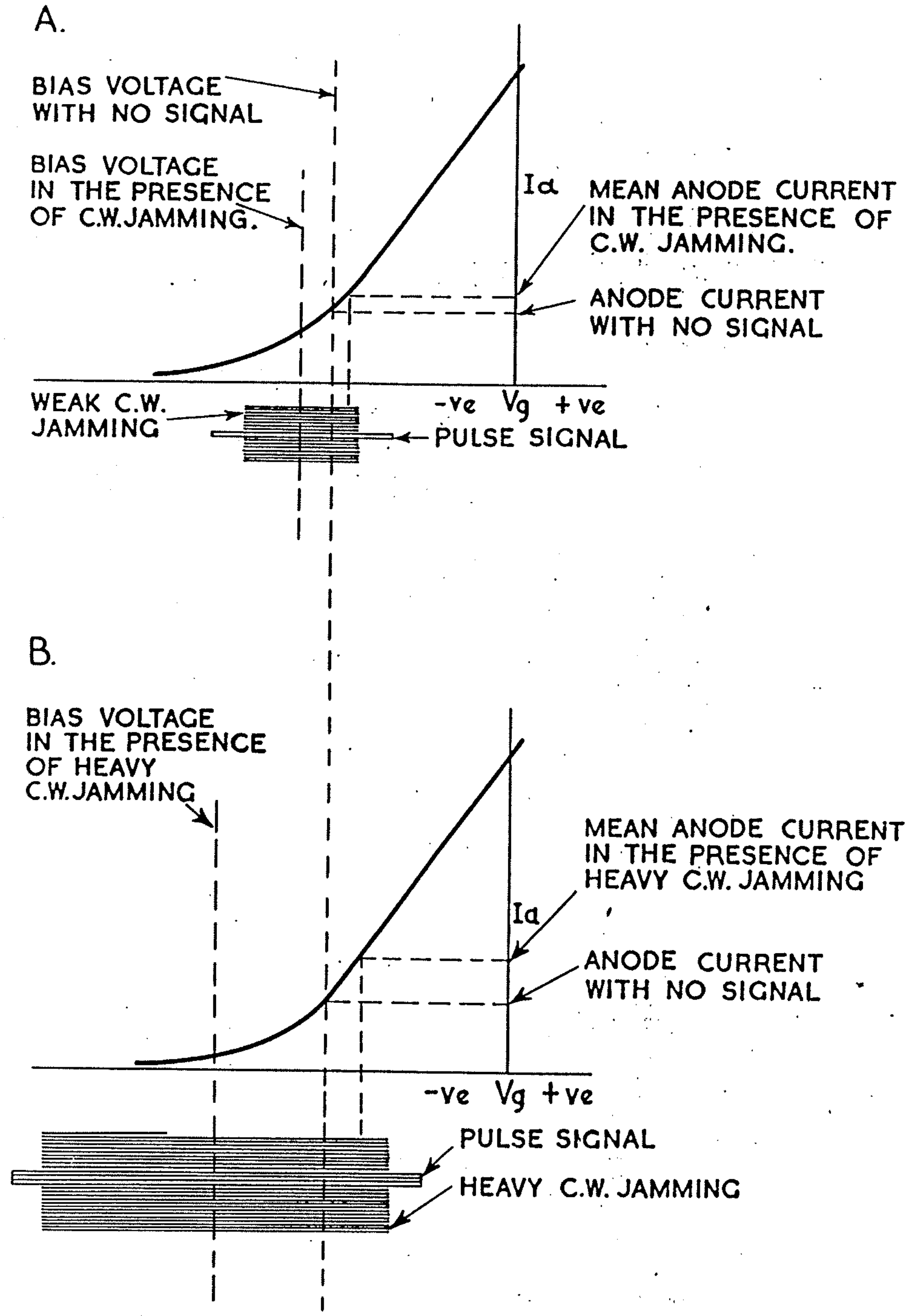

Fig. 32.—Operation of 3rd, 4th and 5th IF stages

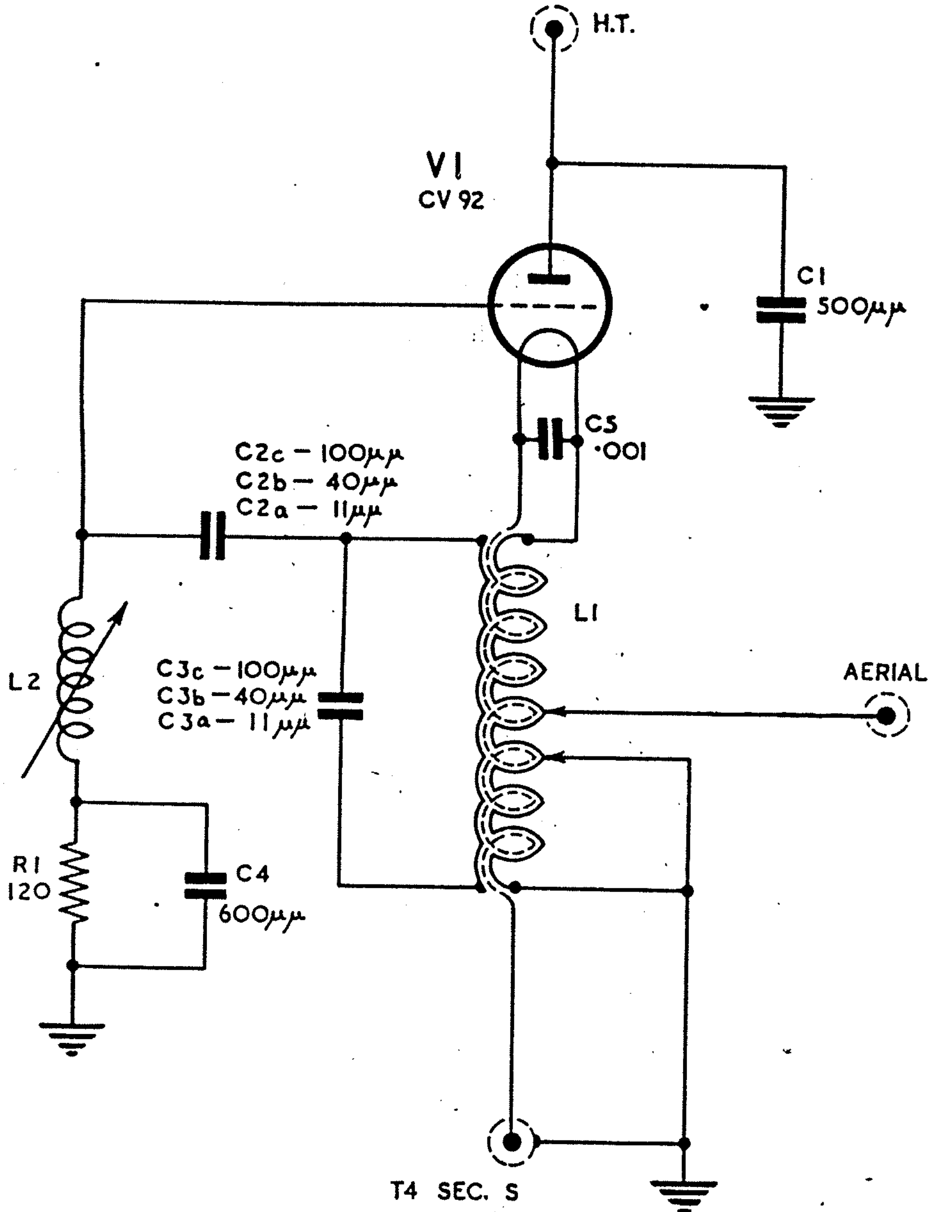

Fig. 33.—Transmitter unit type T.116A—circuit

111. *Anti-jamming system.* Fig. 31 shows the circuit of the third, fourth and fifth IF amplifier valves. The anode circuit of V3 has a resistor, R22, in series with the normal anode load, R21. R22 has a value of 100,000 ohms and R21 a value of 4,700 ohms. The junction of R22 and R21 is joined to the low-potential end of the grid inductance, L3, through the 500,000 ohms resistor R20, and this point in turn is connected through another 500,000 ohms resistor, R18, to the negative supply line via the slider of R61.

112. The voltage of this negative line can be varied between zero and —180 volts by adjustment of the slider of the potentiometer R61, which is in the power unit. Under normal working conditions this will have been set to give a voltage of approximately —100 at the slider.

113. The junction of R22 and R21 is by-passed to ground by the condenser C16 and the "earthy" end of L3 is grounded through the condenser C13. A further condenser, C14, is connected in parallel with R20 thus completing a capacity potentiometer arrangement between the anode and grid circuits of V3.

114. Although the circuit diagram of fig. 31 shows V3 only, the fourth and fifth stages are very similar, the only difference being in the values of the by-pass condensers.

115. Under the conditions stated above the main HT line is approximately 325 volts positive with respect to earth and the negative line is about 100 volts below earth. The potential at the junction of the resistors R22 and R21 will depend upon the drop in potential across R22 since the value of this resistor is much greater than that of R21. The drop in potential will be determined by the anode current taken by V3, which, under normal operating conditions, will be approximately 2·35 mA. The potential at the junction of R22 and R21 will, therefore, be 90 volts positive with respect to earth. The resistors R20 and R18 are equal in value and, as a result, the grid of V3 will take up a potential midway between 90 volts positive and 100 volts negative, that is, 5 volts negative with respect to earth.

116. The anode current/grid voltage curves of fig. 32 help to explain the operation of this stage. Consider the curve of fig. 32a where a small CW jamming signal is applied to the grid of V3 together with the required pulse signal. The CW signal will tend to drive the grid more positive and increase the mean anode current through the valve. This increase in mean anode current will cause a greater potential drop across R22 so that the grid will take up a potential more negative with respect to earth. As a result of these opposing motions the mean anode current of the valve remains practically constant and only the pulse signal is amplified and passed through the amplifier chain.

117. Fig. 32b illustrates the case of a very large CW jamming signal. The bias voltage on the grid of the valve becomes even more negative in the presence of the jamming signal and the required pulse signal is still able to pass through since it rides on top of the jamming signal as shown. The decoupling condensers, C16 and C13, in the anode and grid circuits of V3, are sufficiently large to prevent any change in the bias conditions of the valve for the duration of the pulse.

118. If the CW signal is modulated by a low-frequency sine wave, a waveform similar to the modulation envelope will appear across the anode decoupling condenser C16, since this is a small capacity and will present a fairly high impedance to modulation frequencies up to about 4 kc/s. This voltage is fed back to the grid circuit through the capacity potentiometer C14 and C13, causing a reduction in the modulation percentage of the jamming signal which gets through V3. Further reduction in the percentage modulation occurs in stages V4 and V5.

119. Signal definition is improved still more, in position Z of the anti-jamming switch, by the action of the video filter which reduces the remaining traces of ripple from a low frequency sine wave modulated CW jamming signal.

120. The improvement obtained with the anti-jamming circuit, as compared with a straight receiver, in the presence of either CW or low-frequency modulated CW, is of the order of 2,000 to 1.

121. *Power supplies.* The transformers T1 and T2 provide the necessary HT and heater voltages for the complete receiver. The full-wave rectifier valve, V10, in conjunction with the choke capacity filter, L15, C53 and L16, C54 furnishes HT to the anodes and screens of all valves in the IF unit and to the RF unit through pin 10 on the Jones plug.

122. V11, in conjunction with a tap on the high voltage secondary winding of T1, provides the negative bias supply for the third, fourth and fifth IF amplifier valves. This valve is connected in a half-wave rectifier circuit the output of which is smoothed by the resistance-capacity filter, C57, R62 and C56. The potentiometer R61 is connected from the low-potential end of R62 to ground and permits the negative line potential to be adjusted between 180 volts and zero. For normal operation the potential at the slider arm is set to —100 volts.

Transmitter type T.1629A

123. The transmitter type T.1629A consists of two units, the transmitter unit type 116A and the modulator type 172A. Circuit diagrams are provided in fig. 33 and 36 respectively and the block schematic is shown in fig. 13.

Transmitter unit type 116A

124. The transmitter has been designed for frequency flexibility and covers the range 20 to 80 Mc/s with as few changes as possible. It is designed to cover this range in three bands by changing two condensers in the transmitter circuit for each change of frequency band. The four condensers not in use are housed in the modulator unit. No provision has been made for operation above 80 Mc/s, but, by removing condensers C2 and C3 from the oscillatory circuit, it is possible to extend the range to above 100 Mc/s.

125. The transmitter is a single-ended oscillator employing a high emission low impedance valve, an oxide coated filament type CV92. The circuit is of the Colpitts type, consisting of a grid inductance and the two capacities, grid/cathode and cathode/ground. It is on this tuned circuit that the frequency mainly depends. The cathode inductance serves as a tapped choke for feeding power to the aerial and does not require critical adjustment.

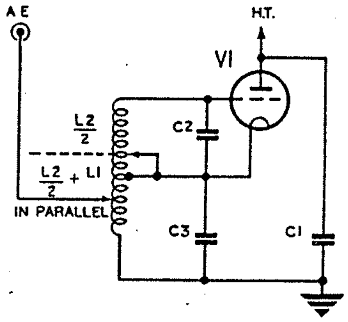

Fig. 34.—Transmitter unit type 116A—simplified circuit

126. The simplified circuit given in fig. 34 shows the similarity of the oscillator circuit to the Colpitts. The grid and cathode inductances are continuously variable by means of wiper contacts and the aerial loading is connected to the cathode inductance L1 by a tapping switch. The cathode inductance is constructed of ¼ inch diameter tubing, the filament supply to the oscillator valve being taken by a wire up the centre of the tube and returned by the tube itself.

127. The frequency of oscillation of the circuit is approximately

$$\frac{1}{2\pi\left\{\left(\frac{L2}{2}+\frac{\frac{L2}{2}\times L1}{\frac{L2}{2}+L1}\right)\frac{C2}{2}\right\}^{\frac{1}{2}}}$$

and the Q of the circuit is given by

$$\frac{R}{\omega\left(\frac{\frac{L2}{2}\times L1}{L1+\frac{L2}{2}}+\frac{L2}{2}\right)}=\frac{\omega C2R}{2}=2\pi f\ \frac{C2R}{2}=\pi f C2R$$

where R is the effective parallel value of the load impedance transferred to the grid circuit. Thus Q is proportional to f so that the bandwidth in megacycles is independent of frequency over the band covered by one set of condensers. Since smaller condensers are used at the higher frequencies the Q does not rise proportionately to the frequency and thus the bandwidth is greater at high frequencies. The pulse consequently rises more quickly. The Q varies in each band from 5 at the lower end to 9 at the upper.

128. Curves of mean dial readings plotted against frequency for three typical transmitters are shown in fig. 35. These curves are accurate to within ±5% of frequency but variations will occur due to tolerances in the condenser values. To avoid variations caused by different lengths of aerial feeder 11 feet is the standard length of feeder wherever possible.

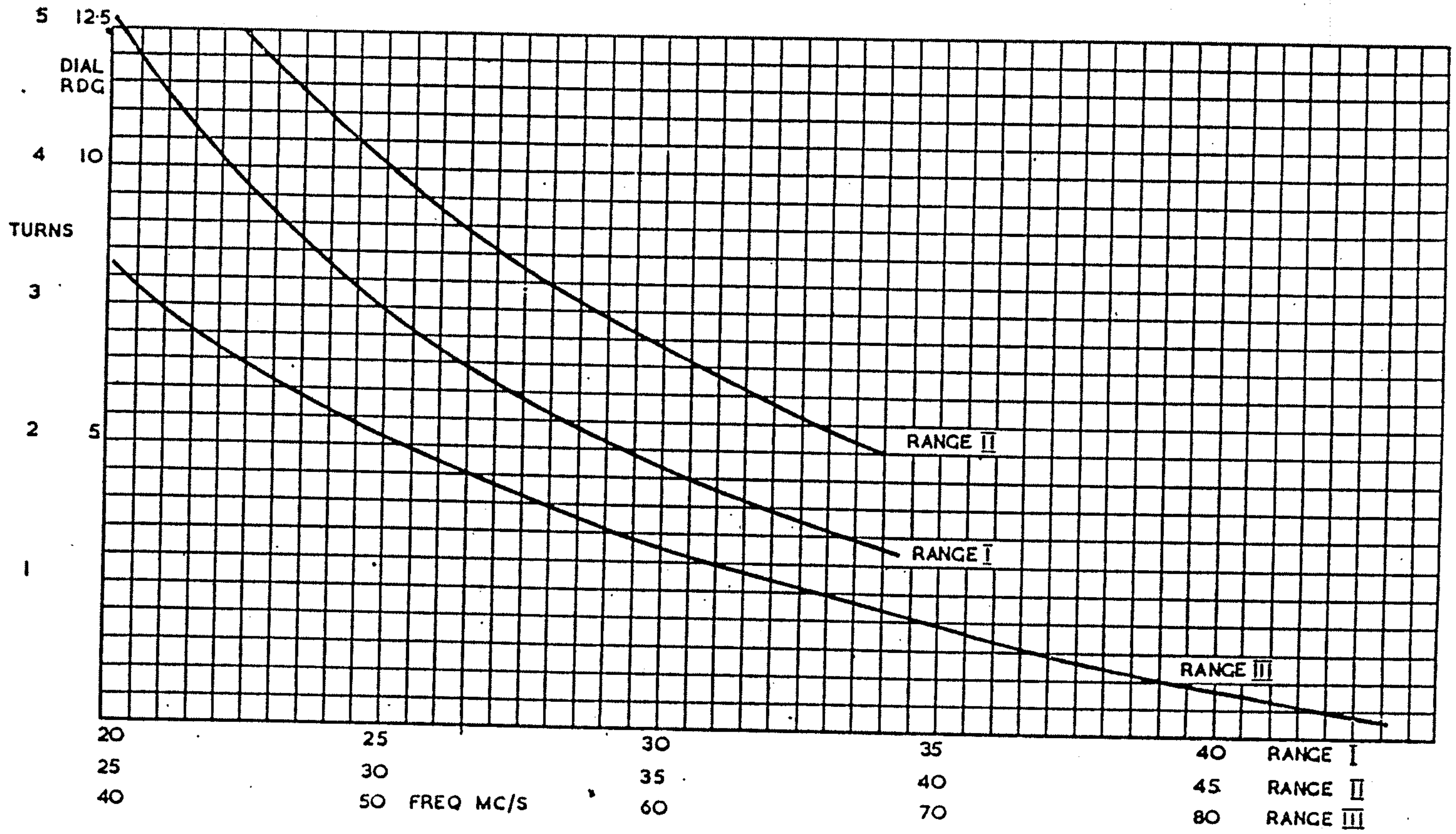

Fig. 35.—Transmitter unit type 116A—calibration curves

129. The transmitter unit is cooled by air blown through the manifold by the blower motor in the modulator unit. No safety devices are associated with this motor and its operation should therefore be checked periodically since failure of the blower may result in damage to the CV92.

130. As the transmitter is designed to work at altitudes up to 35,000 feet, anode modulation is employed. About 54 kW peak modulation is applied to the oscillator anode to give the required power output, and for this a 6 kV 9 amp. pulse is provided by the modulator. The pulse width is 3–4 microseconds.

Modulator type 172A

131. Reference to the block schematic in fig. 13 will show that the modulator unit is sub-divided into two parts, the sub-modulator (modulator type 214A) and the main modulator.

132. The repetition pulse from the strobe unit type 61A is fed to the transformer in the junction box type 266A (or type 256) which differentiates it and, if required, phase inverts the waveform so that the modulator type 214A which is triggered by a negative-going pulse can be operated from either the positive- or negative-going edges of the original repetition pulse. The first two valves of modulator type 214A, V1 and V2, are connected in a flip-flop circuit which produces a positive-going square pulse of 35–40 microseconds duration at the anode of V1.

133. V1 is normally passing a heavy anode current since the suppressor grid is at cathode potential and the control grid is positive. V2 will normally be cut off since the cathode current of V1 produces a positive voltage on the cathode of V2, the grid of which is returned to earth. The application of the negative pulse to the suppressor of V1 cuts the valve off and its anode potential therefore rises. This rise is communicated via C4 to the grid of V2 and this valve begins to draw current producing a fall in the anode potential of V2. The fall is transmitted via C2 to the control grid of V1 keeping this valve cut off. The negative charge on C2 then leaks away until V1 again begins to pass current thus cutting off V2. The circuit then remains quiescent until the next triggering pulse is applied to V1.

134. The duration of the positive pulse at the anode of V1, that is the cut-off time of this valve, can be controlled by varying the potentiometer VR7 forming part of the grid leak of V1, which determines the positive standing voltage applied to the grid of this valve.

135. V3 is normally cut off as the –700 volt supply is fed to its grid and the cathode is approximately 80 volts nearer earth potential. When the positive-going pulse from V1 is fed to the grid of V3 this valve is driven hard for the duration of the pulse and charges up the delay network in its anode circuit. This produces an exponentially rising current waveform at the anode of V3 and a sudden drop in voltage which decreases as the current reaches a maximum and the delay network is charged up. When the positive pulse at the grid of V3 ends, the anode current through the valve is cut off and the delay network discharges raising the grids of V4 and V5 to cathode potential. This causes these two valves to pass a heavy current thereby producing a 6 kV pulse across the inductance, L2, in the cathode circuit, the duration of the pulse being determined by the constants of the delay network. The pulse from V4 and V5 is then fed to the transmitting valve allowing it to oscillate for the required length of time.

136. L2 is damped by R26 and R27 to prevent ringing, and R27 also acts as a load for an inspection point. Information on the use of this point and illustrations of the waveforms to be expected are given in the servicing instructions.

Control circuits

137. On closing the supply switch (shown as S1 in fig. 36) on the front panel of the transmitter type T.1629A all power supplies except the main HT are connected to the equipment. The primary of the transformer T3 which provides the main HT is short-circuited by the relay contacts RE3. When S2 is closed, power is supplied to the relay coil TH/1 and heats a bimetal strip. After a delay of 30 seconds this causes the contacts R.T.H.1 to close, and if the 350-volt supply is normal the relay E/3 is energised. The contacts RE2 then close and at the same time the contacts RE1

open, disconnecting the supply to the thermal relay TH/1. The contacts RE3 also change over maintaining the short-circuit across the primary of T3 through the contacts RA1 and RD1. If the required function is "H" relay D/1 will be energised and the contacts RD1 will change over thus completing the supply to the primary of T3. The voltage-doubler circuit will now provide HT to the modulator valves V4 and V5.

138. If an overload occurs on the main HT supply resulting in excessive current drain, relay C/1 will be energised, closing the contacts RC1 and thus energising the relay A/2. This will cause the contact RA1 to change over, short-circuiting the primary of T3. The contacts RA2 will also close thus maintaining A/2 energised even when C/1 is de-energised and the contacts R.C.1 have opened due to the cutting off of the main HT supply. To restore the main HT it is necessary to de-energise the relay A/2 either by operating the Gee–H transmitter re-setting control in the control unit type 426A or by changing the function for a short period. A neon indicator, V10, is provided to show when the main HT is on.

Diode receiving unit

139. This unit is enclosed in the transmitter but is screened from it. A probe, within the transmitter, is attached to a diode, V11, which rectifies the RF energy picked up, producing a negative-going pulse at the anode. This pulse serves as a marker pulse and is fed to the cathode of V9 in the receiver type R.3582A, mixed with the signals at the grids of V7 and V8 the receiver output cathode-follower stage, and passed to the indicating unit. Adjustment of the phasing control, R7, in the modulator type 172 alters the transmitter triggering instant, and therefore moves the marker pulse along the timebase of the indicating unit.

Power supplies

140. The main HT supply of 7 kV is provided by the transformers T2 and T3 in conjunction with the voltage-doubler circuit formed by the valves V8 and V9. T2 also furnishes the heater voltage for the main modulator valves V4 and V5. The transformers T2 and T3 are wound on a common core.

141. The bias supply for the valves V3, V4 and V5 is produced by the transformer T1 and the half-wave rectifier valve V7. A filter circuit is provided by R30, C12 and C33 and the output is —700 volts.

142. 350 volts for V1 and V2 is supplied by T4 and the half-wave rectifying valve V6 in conjunction with a choke capacity filter. This supply is also used to energise the relay E/3 which controls the main HT supply. Heater voltages for V1, V2, V3, V11 and the transmitter valve are all obtained from T4.

143. It should be noted that the power supplies for the sub-modulator are brought in from the main chassis through a Belling-Lee plug and socket. If the sub-modulator requires servicing it can be detached from the main chassis but a spare lead, terminated at one end by a Belling-Lee plug and at the other by the corresponding socket, should be available as the existing lead is too short to allow power to be fed to the sub-modulator when it has been removed from the main unit.

Universal indicator type 2

144. This consists of control unit type 426A, strobe unit type 61A and indicating unit type 166A. A simplified block schematic of the universal indicator type 2 has already been given in fig. 14.

Control unit type 426A

145. A circuit diagram is provided in fig. 37. All the waveforms required are derived from the 150 kc/s crystal oscillator which, together with the 750 kc/s pip generator is separately illustrated in fig. 38. The 150 kc/s crystal oscillator, V6, employs a crystal unit type 10XC/16 in a Pierce circuit. Oscillation is maintained between the screen circuit which is tuned to approximately 200 kc/s and the grid circuit. The tuned anode transformer T2 steps down the voltage for feeding to the strobe unit type 61A.

146. *750 kc/s pip generator.* A waveform (see fig. 38) is taken from the anode of V6 and fed through C19 to the grid of V7 which is normally biassed negatively. As a result V7 takes pulses of heavy anode current at a repetition frequency of 150 kc/s. This current waveform is rich in harmonics and the transformer T4, tuned to 750 kc/s, is used to select the 750 kc/s harmonic

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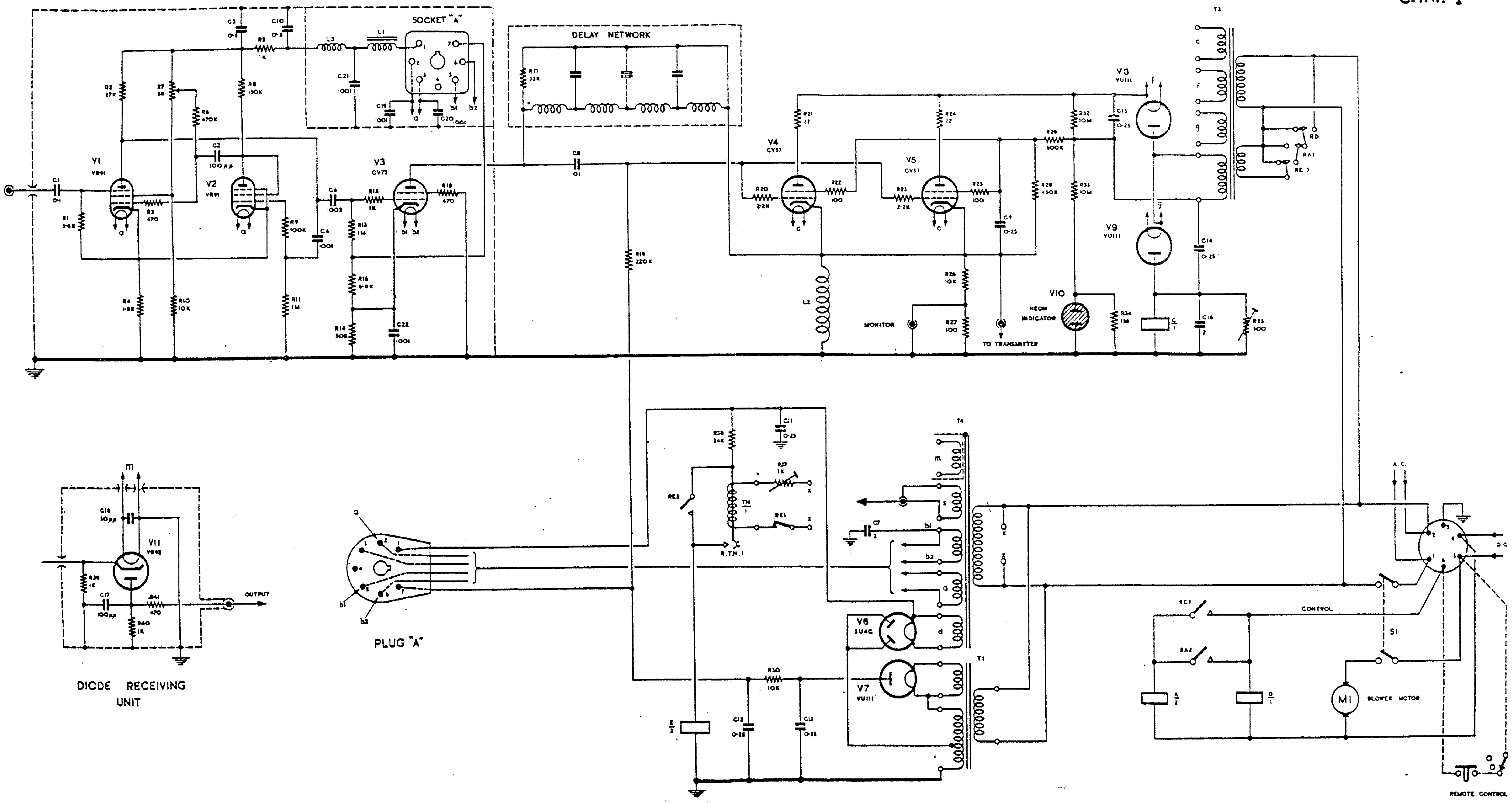

FIG. 36. -MODULATOR UNIT, TYPE 172A, CIRCUIT

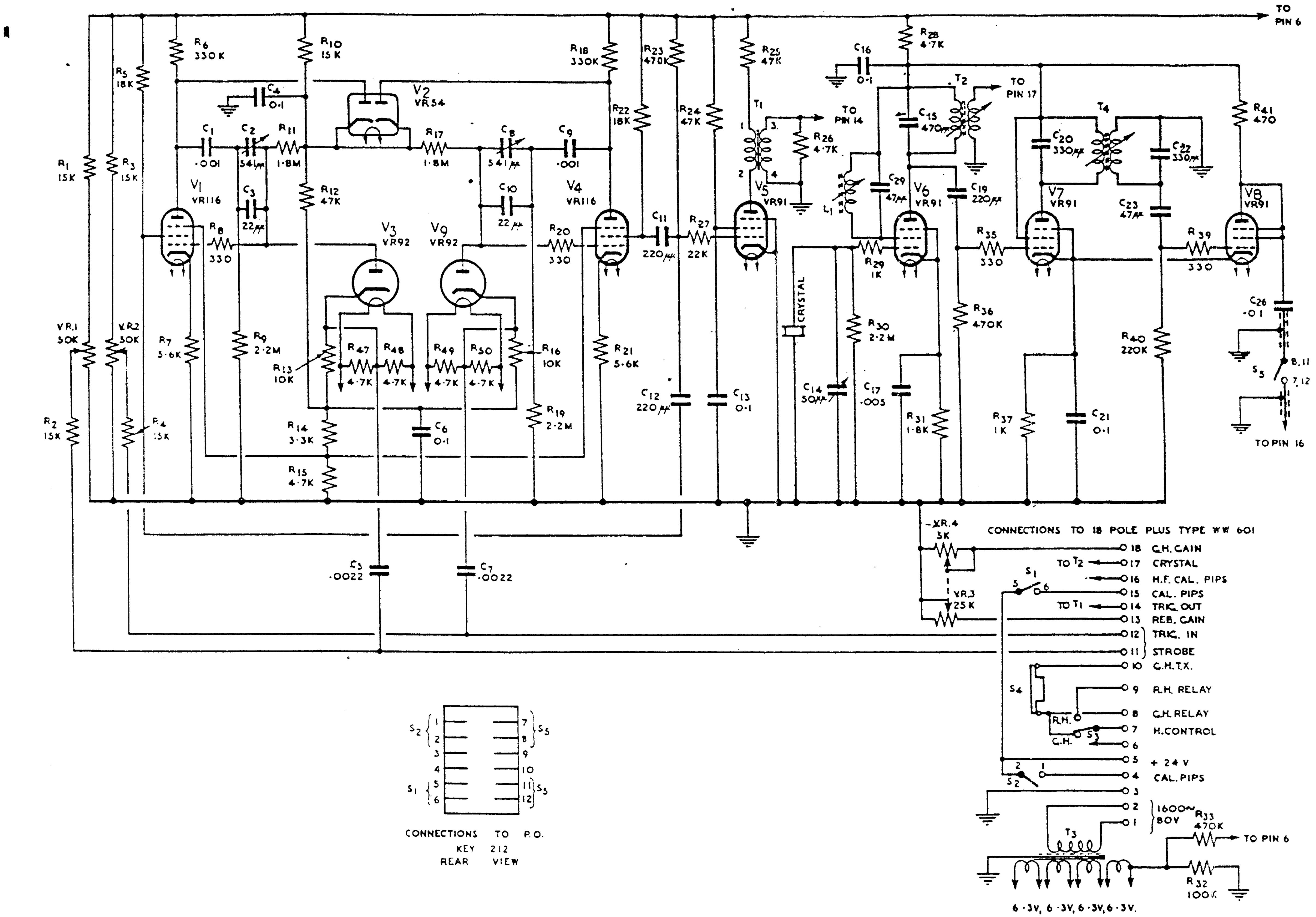

FIG.37 – CONTROL UNIT TYPE 426A CIRCUIT.

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which is fed to the grid of V8 via C23. This valve biases itself back, due to grid current, until only the tops of the 750 kc/s waveform cause anode current to flow. As a result a series of short duration negative-going pips at a frequency of 750 kc/s is generated across the anode load of V8. The ratio of space between pips to pip duration is about 5 to 1 and this waveform is fed through pin 16 of the WW plug on the control unit to the indicating unit type 166A.

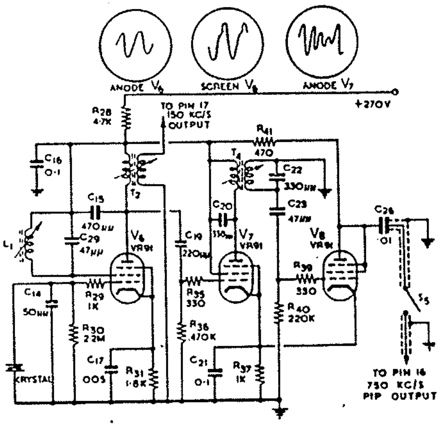

Fig. 38.—Crystal oscillator and 750 kc/s generator circuit

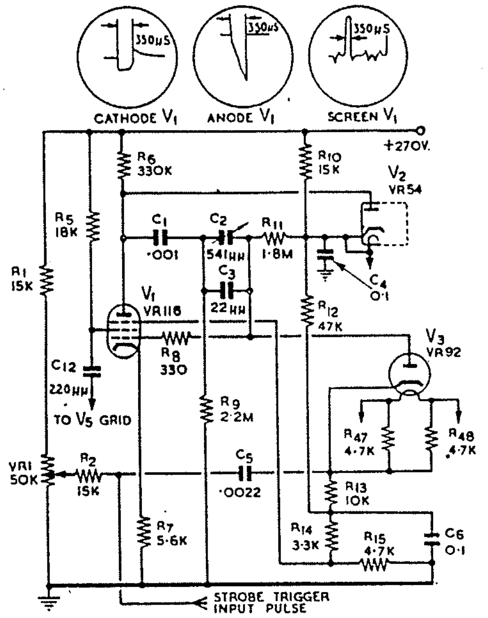

Fig. 39.—Fine strobe phantastron circuit

147. *Fine strobe circuits.* V1 and V4, together with the diodes V2, V3 and V9, constitute the fine strobe timing circuits, that is, the B and C circuits. Each of these strobe circuits is a phantastron triggered by negative pulses on the grid of V1 and V4.

148. The operation of the B fine strobe phantastron is as follows. Reference should be made to fig. 39. With no signal applied to V1 the suppressor potential is approximately +20 volts and that of the grid +40 volts due to the diode V3 conducting. As the VR116 has a short suppressor base no anode current flows under these conditions, the total space current being taken by the screen. The anode potential, therefore, tries to rise to full HT but is held at some value below this by the left-hand section of the diode V2 conducting. When a negative triggering pulse from pin 11 of the 18-way WW plug arrives at the cathode of V3 the anode voltage of V3 and also the grid voltage of V1 fall. This causes the cathode voltage of V1 to fall, the suppressor grid voltage relative to the cathode rises, and the anode then begins to take current. The screen voltage rises and, owing to the large anode load, the anode voltage falls and the diode V2 ceases to conduct. This drop in anode voltage is transmitted back to the grid of V1 via C1 and C2 and the anode and grid voltages then fall together until a position of equilibrium is reached in which the control grid is cut off.

149. Immediately V1 is cut off and as no grid current is flowing, the grid tends to rise towards HT potential through R10 and R11. This rise in grid potential causes a fall in anode potential which, in turn, feeds back through C1 and C2 and tends to oppose the original rise of the grid potential. In practice the anode voltage now falls linearly and the grid and cathode potentials rise. This continues until the anode potential approaches that of the cathode, at which point the rising grid voltage tends to increase the space current, but the falling anode voltage reduces the anode current. The linear run down of the anode potential of V1 is controlled by R6, C1 and C2 and the HT voltage. Since C2 is variable the time of run down can be varied and, in practice, a range of from 60 to 400 microseconds is obtainable.

150. When, due to the falling anode current, the anode voltage approaches the cathode voltage, it becomes practically constant and there is therefore little feed back from the anode via C1 and C2. Thus the grid begins to rise rapidly towards HT potential through R10 and R11.

151. As the grid and cathode rise, the voltage on the suppressor grid of V1, relative to the cathode, falls and the anode current is cut off. Therefore the anode voltage begins to rise and the screen voltage falls since all the space current is now taken by the screen. The grid voltage continues to rise until it reaches +40 volts when the diode V3 starts to conduct and holds the grid potential at its original steady value. The anode continues to rise exponentially to the value at which V2 starts to conduct and is then held at its original steady value. The circuit is now quiescent until the next negative pulse is applied to the cathode of V3 when the cycle is repeated.

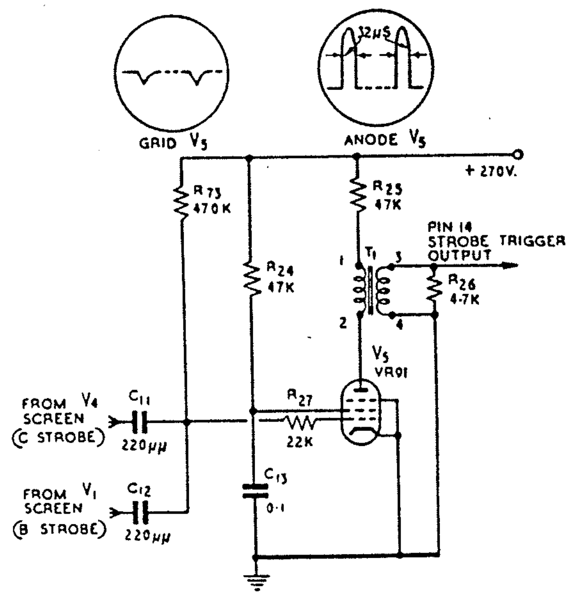

Fig. 40.—Strobe mixing circuit

152. *Strobe mixer circuit.* The screen waveform of V1 shown in fig. 39 is fed via C12 to the grid of V5, the strobe mixing valve. C12 and R23 differentiate the waveform and since V5 is normally conducting heavily due to the positive potential on its grid, only the negative going portions of the waveform have any effect on the anode current of the valve.

153. The operation of the C strobe phantastron, V4, is similar to that of the B strobe phantastron and the screen waveform of V4 is also fed, via C11, to the grid of V5. This valve is therefore cut off at the end of the run down of either phantastron by the negative waveform appearing at its grid. The anode current through T1 is thus broken causing a negative-going pulse to appear across the secondary of the transformer. This waveform has an amplitude of about 25 volts and is fed via pin 14 of the WW plug to trigger the strobe timebase of the indicating unit type 166A.

154. The lead from the strobe unit type 61A which carries the triggering pulse to the phantastron input of V3 is also used to feed the control voltage from VR1 back to the santrig circuit in the strobe unit.

155. *Receiver gain control.* The gain control, which consists of the ganged variable resistors VR3 and VR4, serves for both a Gee–H receiver and a Rebecca receiver. VR3 is a 25,000-ohm potentiometer which short-circuits the screens of the IF valves in the Rebecca receiver to earth as the control is turned anti-clockwise, whilst VR4 is a 5,000-ohm potentiometer which increases the cathode bias on the IF valves in the Gee–H receiver for the same direction of rotation. In practice the Gee–H equipment is no longer used in conjunction with Rebecca Mark IIU.

156. *Calibration pip key.* The calibration pip key, S1 and S2, energises relays in the junction box type 255A for applying the normal calibration pips to the cathode ray tube. It also switches the output from the 750 kc/s calibration pip generator valves, V7 and V8. The full operation of this key is described in para. 209 to 211.

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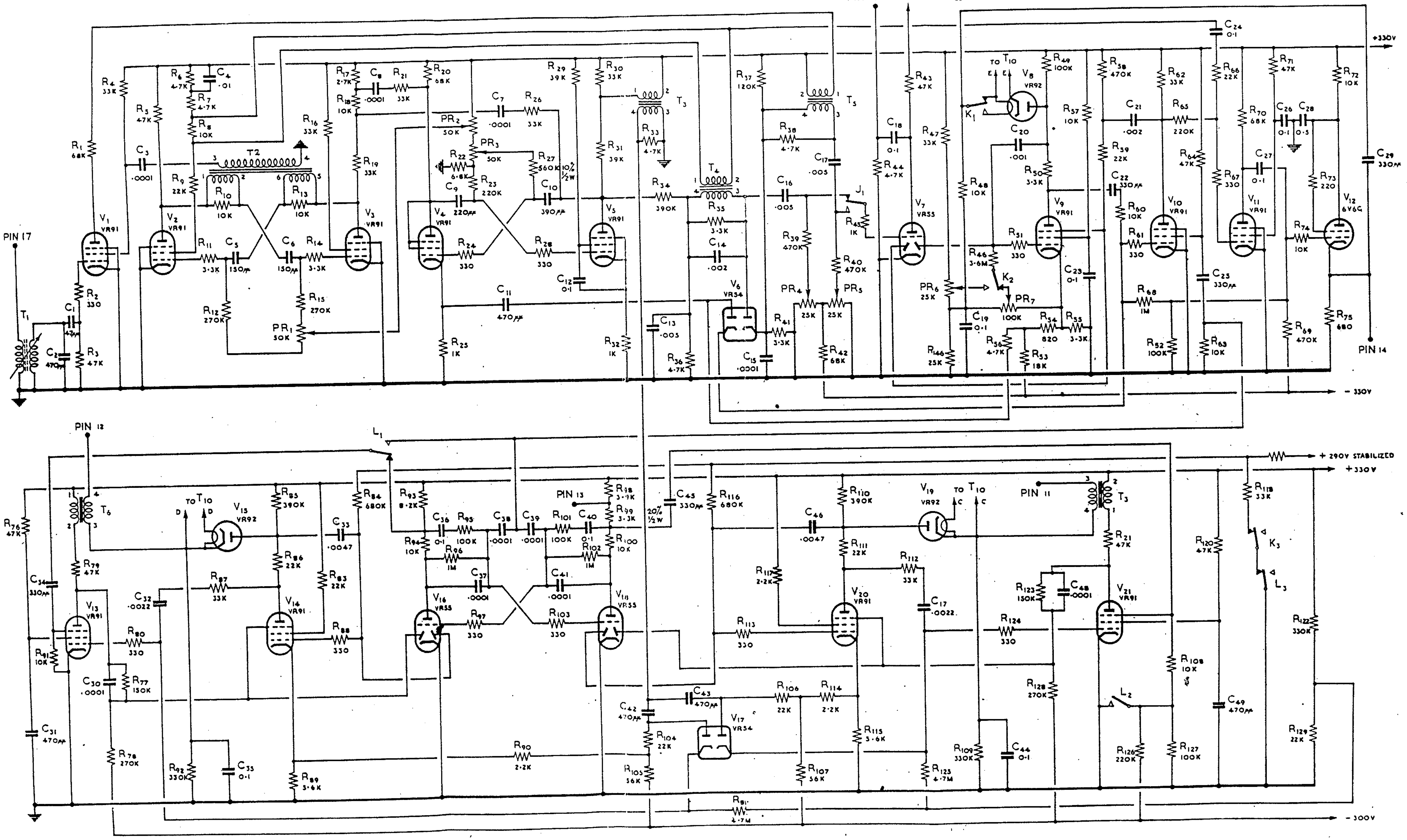

FIG. 41 - STROBE UNIT TYPE 61A (LESS POWER PACK)

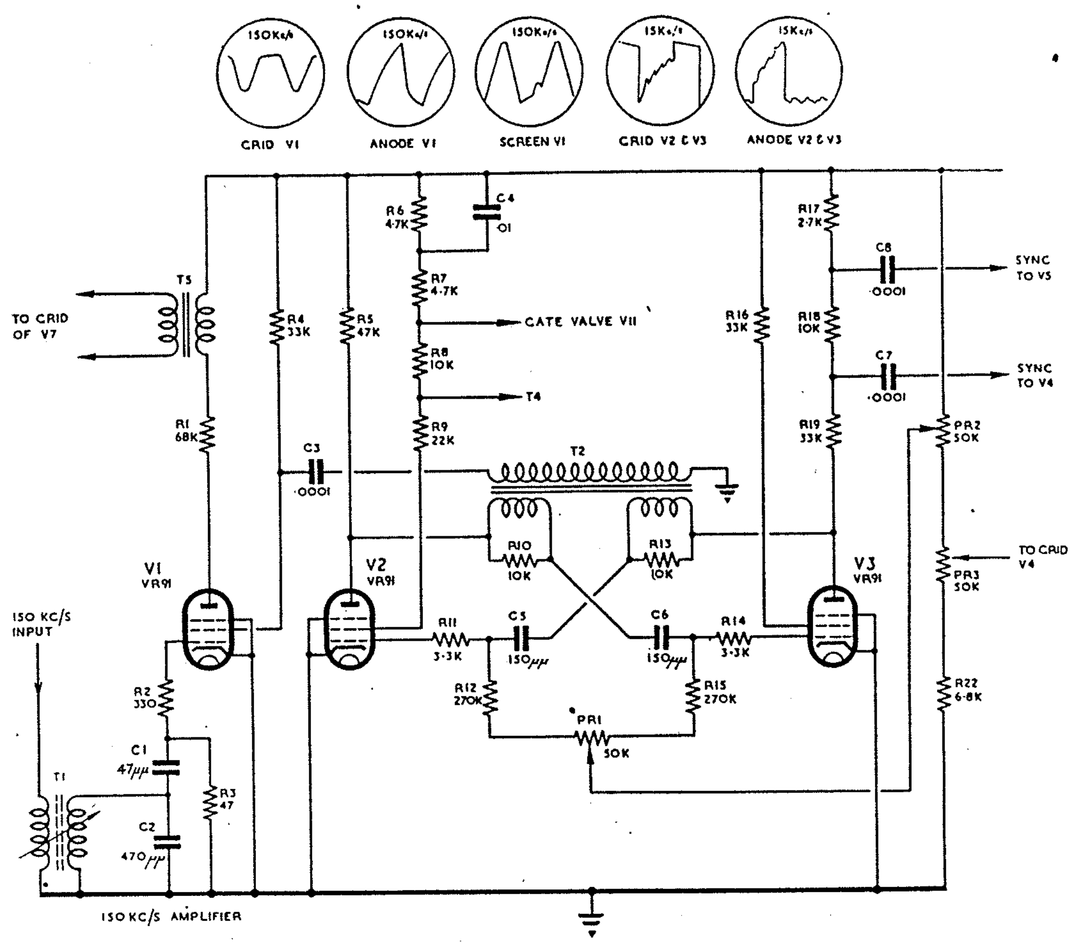

Fig. 42—15 kc/s multivibrator circuit

157. *Rebecca–H/Gee–H button.* The Rebecca–H/Gee–H button, S3, is a push-pull switch determining the particular H function when the functional switch is set to the H position. With S3 set to the Gee–H position and the functional switch set to H the relay O2 in junction box type 255A is energised supplying 80 volts AC to the power unit in the Gee–H receiver R.3582A. The signal output of this receiver in the form of deflection voltages is fed to the indicating unit type 166A via the same junction box. When S3 is set to the Rebecca–H position, with the function switch at H, the main Rebecca relay is energised bringing the Rebecca equipment into operation and connecting the Rebecca signals to the cathode ray tube.

158. *Power supplies.* The transformer T3 supplies all the heater voltages for the valves in the control unit. +285 volts DC from the strobe unit type 61A is fed into the control unit via pin 7 of the 18-way WW plug.

Strobe unit type 61A

159. This unit, in addition to generating a number of waveforms, provides all the HT supplies for the universal indicator type 2 equipment. A circuit diagram of the unit, less the power supply, is given in fig. 41.

160. The 150 kc/s sine wave from the crystal oscillator in the control unit type 426A is fed into the low-impedance primary of the transformer T1 in the strobe unit via pin 17 of the 18-way

WW plug. It is stepped up by this transformer to an amplitude of the order of 100 volts and applied to the grid of V1 bringing the valve very sharply into anode current. The screen waveform of this valve (see fig. 42) is differentiated by T2 to produce synchronising pips for V2 and V3. The anode waveform is differentiated by T5 and provides the 150 kc/s calibration pips.

161. *15 kc/s multivibrator.* V2 and V3 constitute a multivibrator and form the first divider stage. The time-constants consist of C5, R12 and C6, R15, and are so chosen that the output is one-tenth of the input frequency. R12 and R15 are taken to the slider of PR2 which varies the timing and hence the division ratio. PR1 is provided to adjust the two timing circuits for equality. It will not normally require adjustment since it need only be set initially to compensate for component tolerances.

162. The operation of the stage is as follows. Assume that V2 is conducting and V3 is cut off. The grid of V2 will now be rising due to the current through R15 charging up C6. Synchronising pips are being induced in the secondary windings of T2 and since V2 is fully conducting its anode will present an impedance of only a few hundred ohms to the winding connected to C6. As V3 is cut off, however, its anode will present a high impedance and the grid of V2 a low impedance. In this case the synchronising waveform induced in the secondary of T2 connected to C5 will not appear on the grid of V2. The grid of V3 therefore, with synchronising pips superimposed, will rise towards the cut-off point of the valve. PR2 is adjusted so that the fifth synchronising pip causes V3 to conduct, so triggering the multivibrator. The action is then repeated with V3 conducting and V2 cut off, synchronising pips now appearing at the grid of V2 as shown in fig. 42.

163. Waveforms are taken from the screen of V2 to provide 15 kc/s calibration pips and to supply the gate valve, V11, with pulses. The anode load of V3 is tapped to furnish the synchronising waveform required by the 3 kc/s multivibrator, V4 and V5.

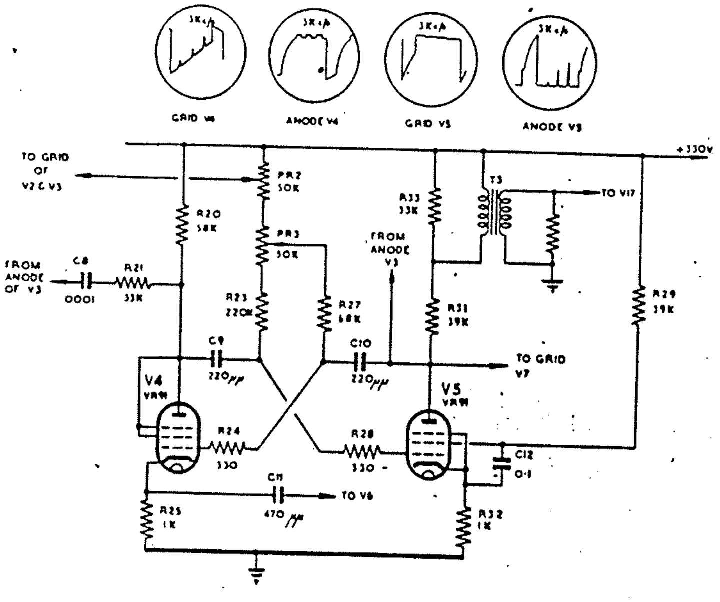

Fig. 43.—3 kc/s multivibrator circuit

164. *3 kc/s multivibrator.* The second divider stage consists of V4 and V5 forming another multivibrator the time-constants of which are C9, R23 and C10, R27. The values selected provide an overall division ratio of five. The potentiometer PR3 is used to control the timing of V4 no provision being made to control V5. The negative-going edge of the waveform from V3 is employed to trigger V4 and V5.

165. In considering the operation of this stage, assume that V4 is conducting and V5 is cut off. The synchronising waveform from the anode of V3 will be differentiated by C8, R21, R20 and by C7, R26, R31 so that negative pulses only appear at the anodes of V4 and V5 coincident in time

with the negative-going edge of the 15 kc/s waveform from the anode of V3 (see fig. 43). The negative pulses from C7 will be fed via C10 to the grid of V4 producing positive pulses at its anode. The first of these will be sufficient to cause V5 to conduct and to trigger the multivibrator. V5 will now be conducting and V4 cut off. Synchronising pips from C8 will be fed via C9 to the grid of V5 and will produce positive pips at the anode. These in turn will be fed back superimposed on the rising grid voltage of V4 and the amplitude of the pip and value of time-constant are so arranged that the fourth pip again triggers the multivibrator. Obviously the amplitude of the pulses at the anodes of V4 and V5 is dependent on the gain of the valves. Negative current feedback is therefore introduced by the un-bypassed cathode resistors R25 and R32 to make the gain less dependent on the characteristics of individual valves.

166. Waveforms are taken from the anode of V5 and the cathode of V4. The former provide 3 kc/s calibration pips and synchronisation for the strobe santrig circuits. The latter are the synchronising pulses for the final divider stage.

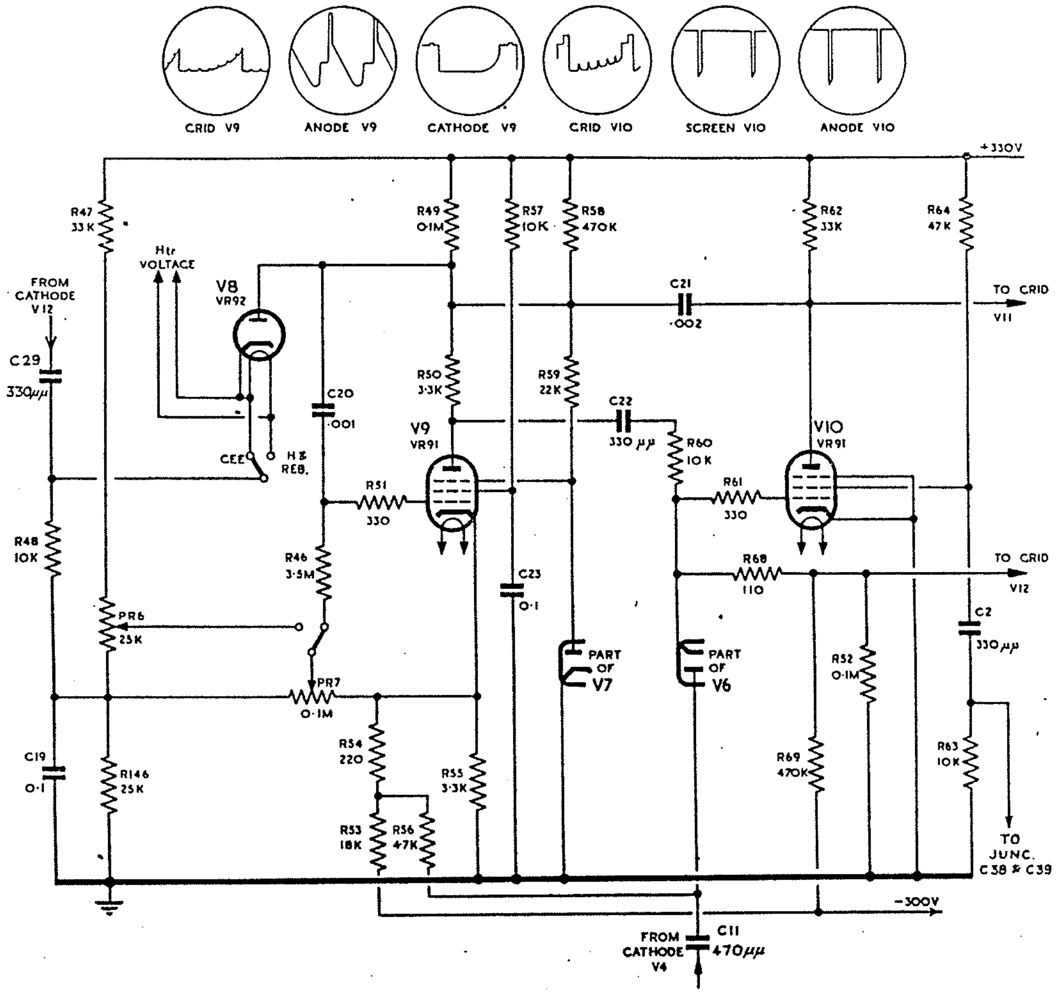

Fig. 44.—Final divider circuit

167. *Santrig divider stage, gate valve and cathode follower.* The final divider stage consists of a santrig circuit formed by V9, V10, V8 and the left-hand section of the double diode V6. The gate valve, V11 and the cathode follower, V12, must also be regarded as forming part of the

divider stage. V10 is the flash-back valve and serves to control the suppressor grid of V9. A waveform from the anode of V10 is also employed to gate one 33½ microseconds pulse from V2 in the gate valve, V11. The anode waveform of V11 is fed to the cathode follower, V12, and thence to the indicating unit type 166A and the transmitter type T.1629A. Synchronising pulses from the cathode of V4 are fed via V6 to the grid of V10 and an output is taken from the screen of V10 to synchronise the halver stage, V16 and V18.

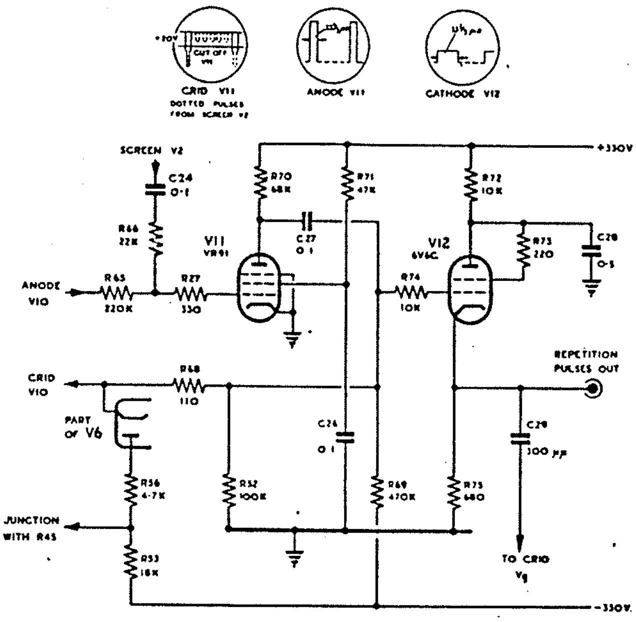

Fig. 45.—Gate valve and cathode-follower circuit

168. The operation of the final divider stage can be more clearly followed by referring to fig. 44. Assuming that V10 has just been cut off the suppressor of V9 will be at earth potential and the anode of V9 will be performing a linear run down. The cathode of V9 will be negative owing to the current through R53, and positive pulses from the cathode of V4 will not be great enough to trigger V10. When the anode of V9 bottoms, the grid will start to rise and the cathode will reach earth potential. The grid of V10 will therefore be raised to about —9 volts by V6 and the next positive pulse through C11 from the cathode of V4 will cause V10 to conduct. The anode voltage of V10 will fall and this fall will be transmitted to the suppressor of V9 cutting the valve off on the suppressor grid. The anode of V9 will then start to rise. The connection from the anode of V9 through C22 to the grid of V10 will serve to maintain the stage triggered at the end of the synchronising pulse to the grid of V10.

169. When V10 is cut off, the potential on the grid of V11, due to the DC connection from the anode of V10, will cause heavy grid current to flow through V11. Negative-going pulses from the screen of V2 are fed to the grid of V11 but are of insufficient amplitude to cut off the valve. These will therefore have no effect on its operation while V10 is cut off. When V10 conducts, however, the potential at the grid of V11 falls considerably and the next negative-going pulse from the screen of V2 is able to cut off V11. Thus the next negative-going pulse from V2, after V10 is triggered, will appear as a positive-going pulse at the anode of V11 and will be fed to the grid of V12. The width of this pulse will be 33½ microseconds since it is a half cycle of the 15 kc/s waveform produced by V2. Meanwhile the anode of V9 will have risen until caught at the potential on the anode of the diode V8. V10 will be held conducting by the current through R68 to the grid of V12 which is now positive. When the pulse from V2 ends the anode of V11 will fall, cutting off V12.

170. The cathode waveform from V12 is differentiated by C29, R48 and R146, the negative pip being fed back through the diode V8 and C22, R60 to the grid of V10 which it cuts off. The anode of V10 rises, switches on the suppressor of V9 and the whole cycle of events is repeated.

171. The different division ratios for Gee and H are obtained by switching the end of the resistor R46 to different voltages by the relay contact B2. Since the division ratio also depends on the anode swing of V9 which in turn is dependent on the potential at which the anode is held by the diode V8, the cathode of the diode is kept at a steady potential for the Gee function. For the H function where the repetition frequency must be jittered, 6·3 volts from the heater supply is injected by the relay contact B1 into the cathode circuit of V8 causing a variation of about 18 volts peak to peak in the anode swing of V9 and a jitter of $\pm 5\%$ on the repetition frequency.

172. *Halver multivibrator*. The halver circuit, consisting of the valves V16 and V18, is a multivibrator which is sensibly aperiodic over the range of repetition frequencies used. C37 and C41 are low capacity condensers to enable the multivibrator to operate quickly from sharp trigger pulses. Once the circuit has been triggered, however, the effective time-constants for the remainder of the cycle are C36, R96 and C40, R102.

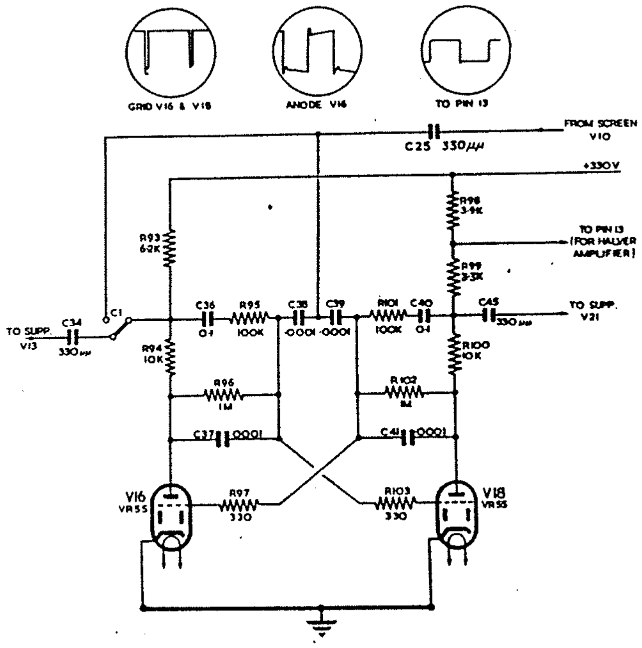

Fig. 46.—Halver multivibrator circuit

173. Reference should be made to fig. 46. Assuming V16 to be conducting, V18 will be cut off and C36 will be charging slowly up to the anode potential of V16 through R96. Before the grid of V18 reaches its cut-off point, a negative synchronising pulse will arrive at the grids of V16 and V18 through C38 and C39. The pulse on the grid of V18 will have no effect since the valve is already cut off, but that on the grid of V16 will cut this valve off and the resulting positive pulse at the anode of V16 will reach the grid of V18 through C37 and cause the valve to conduct. The anode of V18 will then fall, taking the grid of V16 more negative before the end of the synchronising pulse. The cycle of events is now repeated with V18 conducting and V16 cut off. Another synchronising pulse will arrive to trigger the multivibrator before C40 has charged up sufficiently through R102 to allow V16 to conduct.

174. Waveforms are taken from both anodes to trigger the strobe circuits and a waveform from the anode of V18 is taken via pin 13 of the 18-way WW plug to the halver amplifier in the indicating unit.

175. *Coarse strobe circuits*. The coarse strobe timing circuits consist of V19, V20 and V21 forming the B strobe and V13, V14 and V15 which comprise the C strobe. Both are normal santrig

circuits. For the Gee and H functions they are triggered from the anodes of V16 and V18. For Rebecca the relay L operates and L2 opens, cutting off V21 on the suppressor grid whilst L1 transfers the synchronising pulse which is fed to V13, from the anode of V16 to the screen of V10. In this way a single strobe running at the repetition frequency is produced for Rebecca.

176. The operation of the B strobe can be followed by referring to fig. 47. The square wave from the anode of V18 is differentiated by C45 and R108 and fed to the suppressor grid of V21. The negative-going pulse produced from the negative-going edge of the square wave decreases the anode current of V21 generating a positive-going pulse at the anode. This positive pulse is fed across C48 and R123 to the suppressor grid of V20 causing this valve to start passing anode current. A linear run down of the anode voltage now takes place and at the end of this run down one of the 3 kc/s pips from T3 fed through C43 and V17 to the grid of V21 triggers back the circuit.

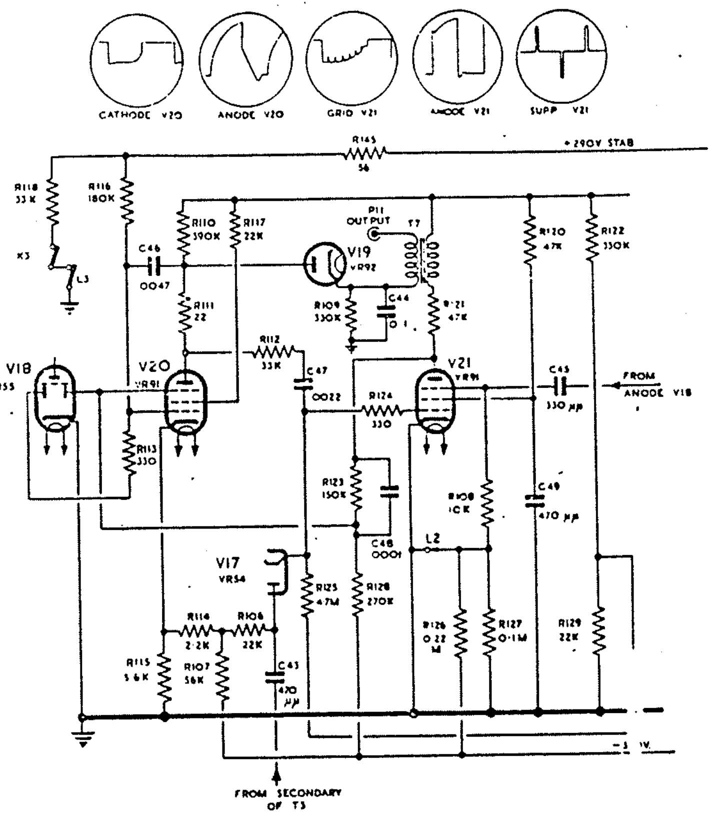

Fig. 47.—Coarse strobe circuit

177. The waveform at the anode of V21 is stepped down and differentiated by T7 whence it is taken to pin 11 of the WW plug and used to trigger the fine strobe circuit in the control unit. The pulse which triggers this is the one corresponding to the flashback of V21 by the pip from T3. As a result no jitter in strobe timing is introduced by the coarse strobe timing circuit.

178. Alteration of coarse strobe timing is effected by varying the anode swing of V20 which, in turn, is accomplished by varying the cathode potential of V19. The DC control voltage for this is produced in the control unit type 426A and is conveyed by the same lead that carries the output waveform from the santrig. The DC potential is developed across C44 in the cathode circuit of V19 and the condenser bypasses the AC component.

179. As the range of strobe travel on the Gee and Rebecca functions is less than that for H the timing leak is taken to a reduced voltage at the junction of R145 and R118. When using the Gee or Rebecca functions a relay is energised and either the K3 or L3 contact opens thereby allowing the potential at the junction of R145 and R118 to reach HT and reducing the range of the strobes. The operation of the C strobe is similar to that of the B strobe circuit.

180. *Calibration pip mixer circuit.* The calibration pips from the first two divider stages are mixed and fed to the grid of V7. The anode waveform of V7 is fed to pin 16 of the WW plug whence the pips are switched to the cathode ray tube in the indicating unit appearing as either intensity or deflection pips. Two types of calibration are provided. For the main timebase 15 kc/s pips are used every fifth pip being slightly greater in amplitude, while for the strobe timebase 150 kc/s pips are employed every tenth pip being of greater amplitude and every fiftieth being slightly larger than the tenths.

181. The 15 kc/s pips for the main timebase are generated in the secondary winding of the differentiating transformer T4. The high potential end of this winding is connected to the grid of V7 via C16 while the earthy end goes to R36 and C13 across which is developed the voltage for increasing the amplitude of every fifth pip. This is achieved by the connection through R34 to the anode of one of the valves of the 3 kc/s multivibrator stage, V5.

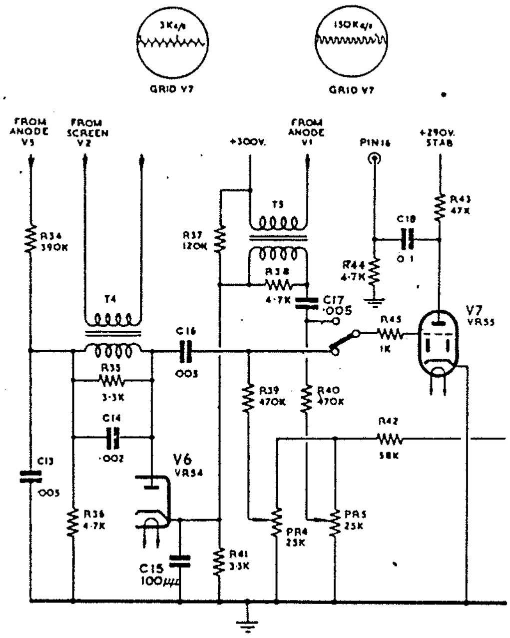

Fig. 48.—Calibration pip mixer circuit

182. The 150 kc/s pips are generated in the secondary winding of T5. The pulses for increasing the amplitude of every tenth pip are obtained by connecting the "earthy" end of this winding to the cathode of the right-hand section of the double diode V6. The main timebase calibration waveform is fed to the anode of this diode and the peaks pass through, appearing as small pips on the cathode. The inductances of the primary and secondary windings of T5 are designed so that the pips occur at the correct instant for increasing the amplitude of a 150 kc/s calibration pip. PR4 and PR5 are for pre-setting the calibration pip height on the main and strobe timebases respectively.

183. *Power supplies.* The power supplies for all the units comprising the universal indicator type 2, exclusive of heater voltages, are derived from the strobe unit. A circuit diagram is given in fig. 49. The transformer T8 in conjunction with the rectifying valve V22 provides a half-wave resistance-capacitance smoothed supply giving approximately 1 mA at $-1{\cdot}6$ kV for the cathode ray tube. T9 has a tapped secondary winding and, together with the rectifying valves V23 and V25, delivers two outputs. The first is a full-wave choke-capacitance smoothed supply of $+310$ volts, stabilized against low frequency ripple by the control valve V24 and is fed to the

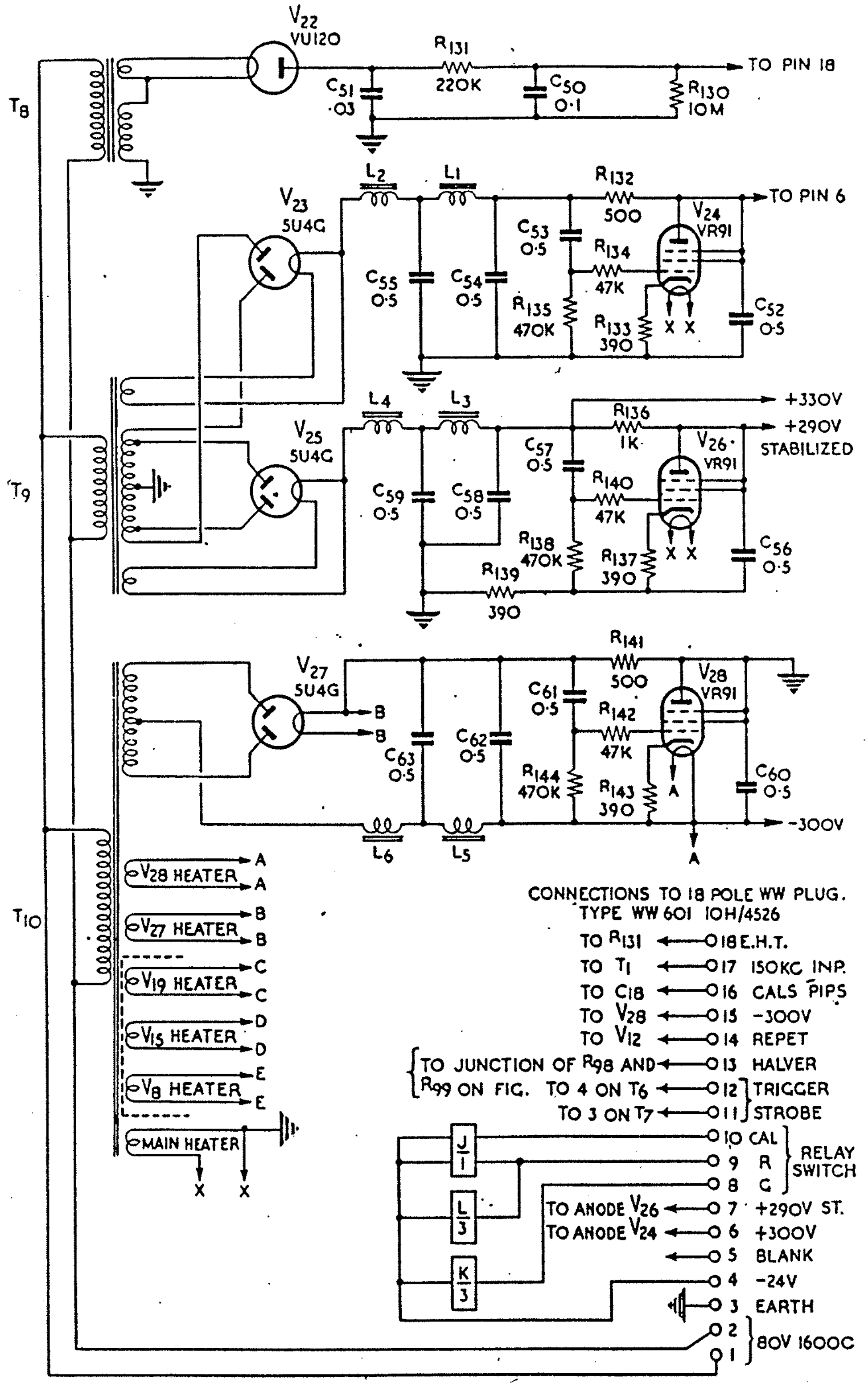

Fig. 49.—Power supplies—circuit

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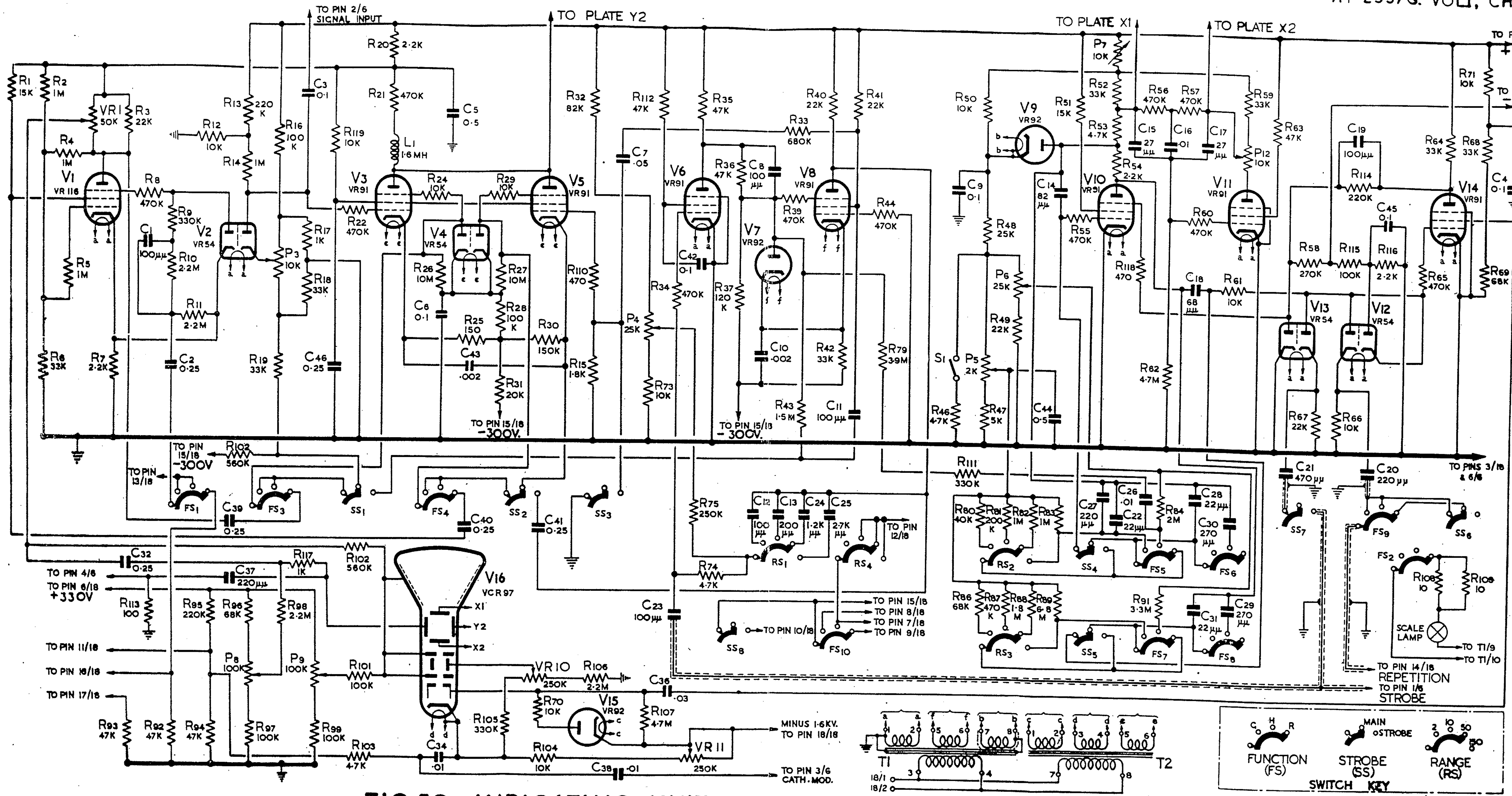

FIG.50.- INDICATING UNIT, TYPE 166A, CIRCUIT

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indicating unit type 166A. The second output is a choke–capacitance smoothed supply providing +310 volts for the strobe unit and also +260 volts stabilized by the control valve V26 for the control unit type 426A. T10 in conjunction with V27 delivers a full wave choke–capacitance smoothed supply stabilized by V28 of −300 volts for the strobe and indicating units. The transformer T10 also supplies heater voltages for all the valves in the strobe unit with the exception of V22, V23 and V25.

184. *Control circuits.* The relays J, K and L which are incorporated in the strobe unit are controlled by the function and strobe switches in the indicating unit type 166A. Relay J is energised on the strobe timebase and Rebecca positions of these switches. It provides strobe timebase calibration pips when energised and main timebase calibration pips when not energised. Strobe calibration pips are required on the main timebase when using the Rebecca function since this timebase can be set to the 10- or 2-mile ranges as well as to slower speeds. Relay K is energised on the Gee function and the operation of the three contacts when the relay is energised is as follows. Contact K1 switches off the jitter on the repetition frequency. K2 changes the repetition frequency to 500 c/s. K3 frees the "earthy" end of R118, thereby reducing the range of the strobes. Relay L is energised on the Rebecca function.

Indicating unit type 166A

185. This unit contains the timebase, reverser circuit, strobe marker circuit and the halver amplifier. The strobe marker circuit drives the reverser circuit and provides the strobe markers whilst the halver amplifier fulfils the function of amplifying and cleaning the spacing waveform before applying it to the cathode ray tube. A circuit diagram of the unit is shown in fig. 50.

186. *Timebase.* The timebase consists of the valves V10, V11 and V14 together with the diodes V9, V12 and V13 in a sanatron circuit. V10 and V14 constitute the sanatron timebase whilst V11 is a phase reverser providing push-pull deflection. The timebase is triggered by the negative-going edge of the repetition pulse arriving via C20 and V12 from V12 in the strobe unit and by the strobe pulses which are fed through C21 and V13 from V5 in the control unit. The timebase amplitude is adjusted by PR7 and the velocity on all functions, except H main timebase, by PR5. The velocity control for the H function is PR6. PR12 is the shift control. The duration in microseconds of the timebase available on different functions is as follows:—

Function	*Main timebase*	*Strobe timebase*			
		2-mile	*10-mile*	*50-mile*	*150-mile*
Gee	1660	17	84	420	—
H	3000 to 6500	17	84	420	—
Rebecca	As for strobe timebase	21	107	535	1660

The time-constants producing this range of speeds are switched by RS2, FS5, FS6 and SS4. The time-constants in the grid circuit of V14 are controlled by RS3, FS7, FS8 and SS5.

187. The circuit operates in precisely the same manner on all functions and the operation on Gee main timebase is described in the following paragraphs. Reference should be made to fig. 51.

188. Assume that the stage is resting in its normal condition with V14 conducting and V10 cut off on the suppressor grid. The anode of V10 will then be positive and the diode V9 conducting. The grid of V10 will be at earth potential drawing grid current.

189. When the repetition pulse arrives via pin 14 of the WW plug it will be differentiated by C20 and R66 and the negative pip will pass through the diode V12 and cut off V14 on its control grid. The anode of V14 will now rise and lift the suppressor grid of V10 causing this valve to pass anode current. V10 performs a linear run down in the normal manner, and as long as the anode of V10 continues to fall, the grid of V14 is held negative through C18. At the end of the run down the grid potential of V14 is raised by the current through R89 and V14 again conducts cutting off V10 on its suppressor grid. After a short period for recovery has elapsed the circuit is again ready for triggering.

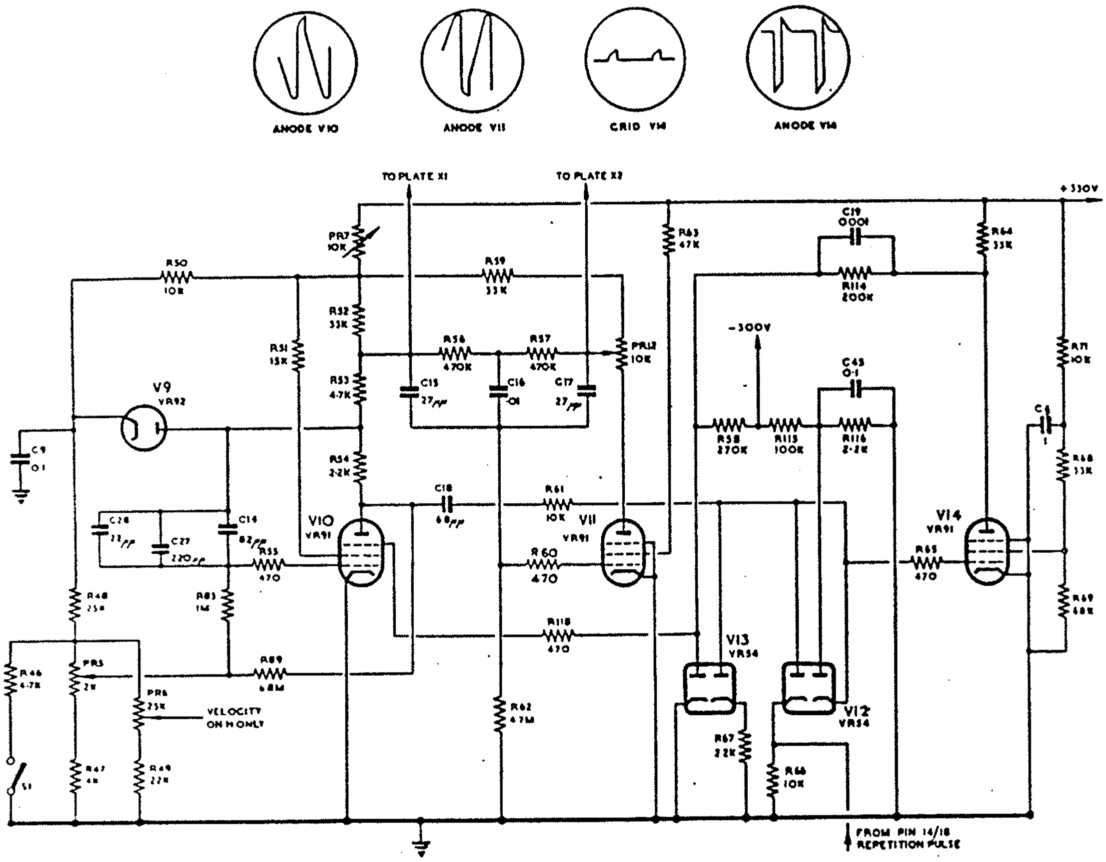


Fig. 51.—Sanatron main timebase circuit

190. The anode waveform of V10 is fed to the grid of V11, the gain of this valve being unity. Thus the anode waveform of V11 is approximately equal in amplitude but of opposite phase to that of V10. C15 and C17 are of sufficiently low value to enable V11 to follow fast waveforms.

191. The switch S1 is provided to double the duration of the timebase by reducing the potential on the grids of V10 and V14. When closed it is possible to see the operation of the halver on the main timebase with both the Gee and H functions. This enables the last divider stage in the strobe unit to be set to the correct division ratio.

192. *Strobe marker multivibrator.* The strobe marker circuit consisting of V6 and V8 is a multivibrator and provides pulses starting at the same time as the B and C strobes and of approximately the same duration. These pulses are used to drive the reverser circuit and are employed as strobe markers on the main timebase. The synchronising pulses from the strobe mixing valve in the control unit type 426A are fed to the grid of V6 via C23. Output waveforms are taken from the anodes of V6 and V8 and also from the screen of V8.

193. A separate diagram of the circuit together with the waveforms is given in fig. 52. The normal condition for the circuit is with V6 conducting and V8 passing a constant cathode current since its grid is at earth potential and its cathode connected to the negative 300 volt supply through R42. The value of this current (about 8 mA) is such as to bring the cathode of V8 approximately to earth potential. During the resting condition of the circuit the suppressor of V8 is cut off and therefore all the cathode current is taken by the screen.

194. When a negative pulse arrives at the grid of V6 through C23 the valve is cut off and the anode rises. The suppressor of V8 now rises to earth potential and most of the cathode current then goes to the anode. The anode potential of V8 therefore falls and the screen potential rises. The time-constants between the anode of V8 and the grid of V6 are selected by the switch section RS1 and the fall in anode potential of V8 is transmitted by them to the grid of V6.

195. At the end of the time determined by the setting of RS1 and PR4, the grid of V6 rises to its cut-off voltage and the valve begins to conduct again cutting off V8 on its suppressor grid. The cathode current of V8 is again taken by the screen producing a negative edge on the screen waveform and a positive edge on the anode waveform.

196. The two pulses of opposite sign at the anode and screen, starting at the same instant, are used to drive the reverser valves V3 and V5 on their suppressors. The connection from the anode of V8 to the suppressor of V5 is a simple AC coupling. The connection from the screen of V8 to the suppressor of V3 is effectively a DC coupling since the resistor R43 is connected to the suppressor of V8 which is always at approximately the same potential as that required for the suppressor of V3. The waveform from the screen of V8 is fed to the grid of V5 via R33, C7 and SS3 for main timebase working and to produce the strobe markers on the trace. The connection from the anode of V6 via R79, R111, C22 and FS5 to the H main timebase circuit is used to accelerate the timebase for the duration of the markers in order to make signals and calibration pips more easily visible.

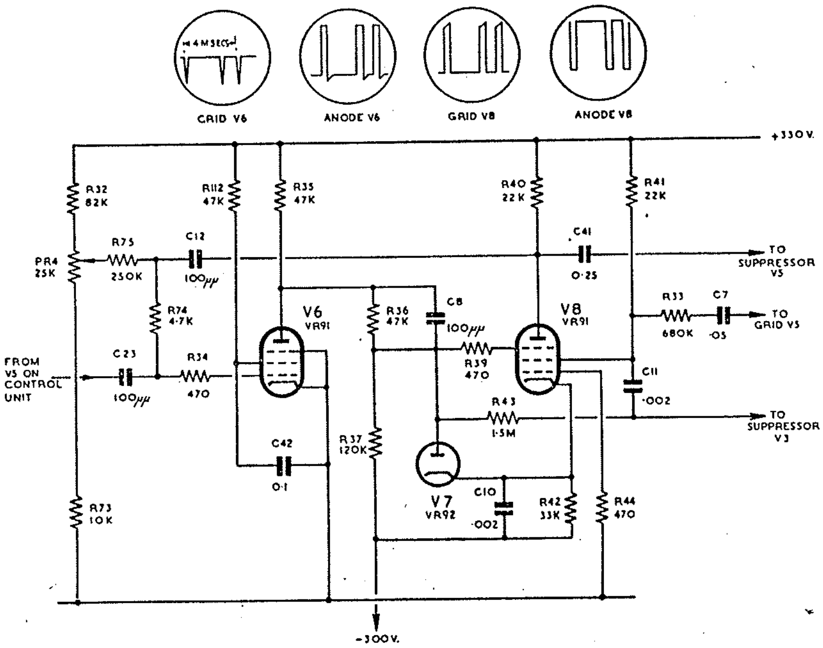


Fig. 52.—Strobe marker multivibrator circuit

197. *Signal reverser circuit.* The reverser circuit consisting of V3, V4 and V5 is employed to reverse the signals on the Gee and H strobe timebase and also on the Rebecca timebases to produce the required back-to-back presentation. On the Gee and H functions the circuit is driven from the strobe marker multivibrator so that the signals are reversed during the B and C strobes. On the Rebecca function the circuit is driven from the Rebecca switch.

198. The circuit takes the form of a long-tailed pair. Reference should be made to fig. 53. The signal input, after DC restoration by the right-hand section of the double diode V2, is taken to the grid of V3, and the strobe markers for main timebase working are fed to the grid of V5. The waveforms for operating the reverser are fed to the suppressor grids of the valves, and V4 prevents these from being driven positive with respect to the cathodes. The output is taken from the anodes of the two valves and fed to the Y2 plate of the cathode ray tube. L1 is an inductance provided to improve the high frequency response of the stage, the gain of which is between 10 and 15.

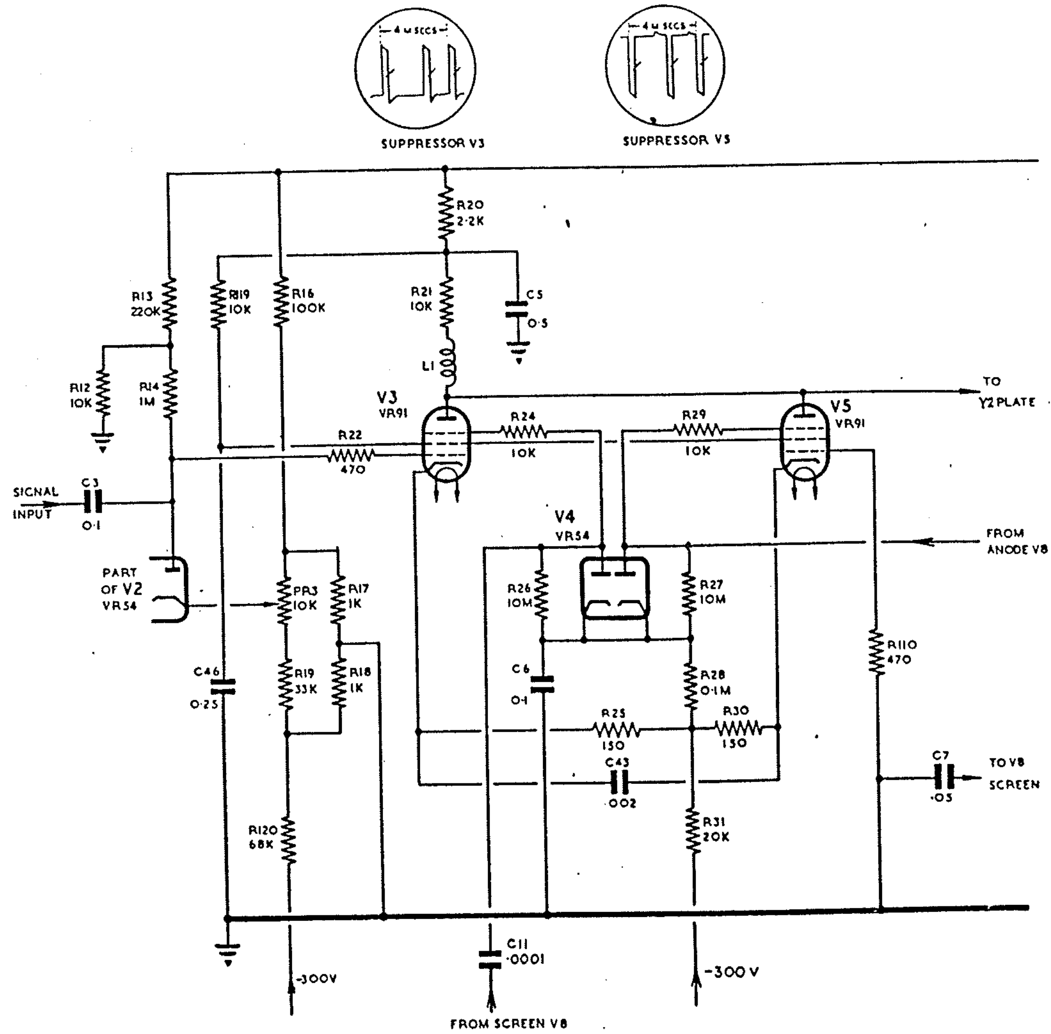


Fig. 53.—Signal reverser circuit

199. Under normal conditions, that is when the signals fed to Y2 are negative producing a deflection to the left or upwards, V3 is cut off on its suppressor grid and V5 is drawing anode current. As the grids of both valves are at earth potential and their cathodes are taken through R31 to the negative HT supply each valve will be taking 6–7 mA of cathode current. Since the gain is equalised by R25 and R30 each valve takes the same current. All the current through V3 is taken by the screen and most of the current through V5 is taken by the anode. Suppose that a small negative pip is now applied to the grid of V3. The current through V3 falls, but if the total current through R31 were to fall the cathode of V5 would become negative with respect to its grid. As a result V5 passes an increased current which balances the decrease of current through V3. A negative pulse therefore appears at the anodes of the two valves due to the increase in current through V5. When the suppressor of V3 is cut on and that of V5 cut off, as occurs during the B and C strobe pulses on the Gee and H strobe timebase and on the Rebecca function when the aerial switch is connected to the starboard aerial, most of the current drawn by V3 goes to the anode and all the current through V5 goes to the screen. Therefore, when the negative pulse is applied to the grid of V3 the anode current of this valve is reduced and a positive pulse appears at the anodes of V3 and V5.

200. On main timebase working a positive pulse from the screen of V8 is applied to the grid of V5 resulting in a negative pulse at the anodes of V3 and V5. In this way the strobe marker takes the form of a square step on the trace and is deflected in the same direction as the signal.

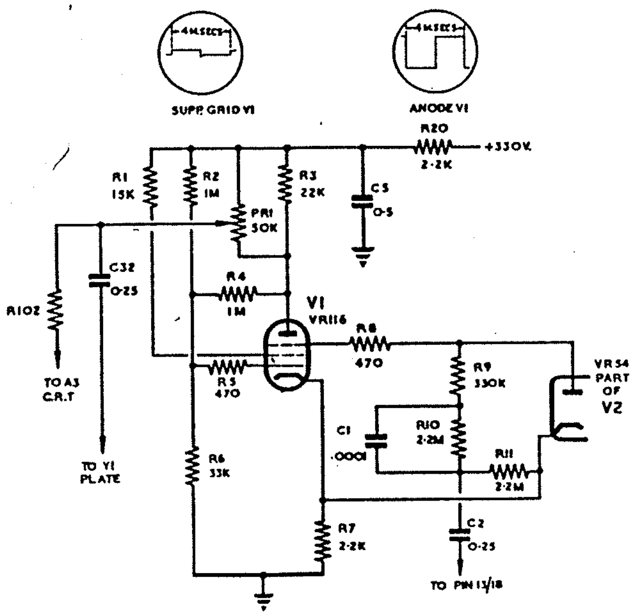


Fig. 54.—Halver amplifier circuit

201. *Halver amplifier.* The halver amplifier, V1, is used on the Gee and H functions to amplify and clean the waveform from the halver circuit in the strobe unit type 61A. On the Rebecca function the halver waveform is not employed and V1 fulfils the purpose of amplifying and cleaning the waveform from the Rebecca switch before applying it to the suppressor grids of the reverser valves. The input and output of the stage are switched for this reason.

202. As will be seen by referring to fig. 54 the grid of V1 is held at about +20 volts with respect to earth and the cathode therefore follows the grid, the total current passed by the valve being approximately 8 mA. When the suppressor grid is at cathode potential this current is shared between the anode and the screen, but when the suppressor is cut off the anode current falls whilst the screen current rises. The application of a square wave to the suppressor grid therefore produces two waveforms of opposite phase, one at the screen and the other at the anode. The resistors R4 and R5 allow the screen and anode currents to balance so that switching the suppressor makes little difference to the total current drawn by the valve.

203. On the Gee and H functions the anode waveform only is used. On the Rebecca function PR1 is set to zero and both screen and anode waveforms drive the reverser circuit.

204. *Cathode ray tube.* The cathode ray tube and its controls are included in the indicating unit type 166A. The tube is supplied with —1·6 kV from the strobe unit. VR11 is the brilliance control varying the cathode potential and VR10 is the focus control for adjustment of the potential on the second anode. Astigmatism control for the tube is provided by PR9 which sets the potential of the final anode with respect to the mean potential of the Y plates. To correct for astigmatism due to the spacing waveform applied to the Y1 plate, a portion of this waveform is fed to the final anode via R102. Intensity modulation calibration pips are fed to the cathode of the tube via C38. The black out waveform from the screen of V14 is DC restored by the diode V15 and applied to the grid of the tube through C36.

205. Relay switching for the other units in the equipment is performed by the switch sections FS10 and SS8. FS10 operates the relays for selecting the different functions and SS8 operates the calibration pip relay in the strobe unit.

206. The transformers T1 and T2 supply heater voltages for all the valves in the indicating unit.

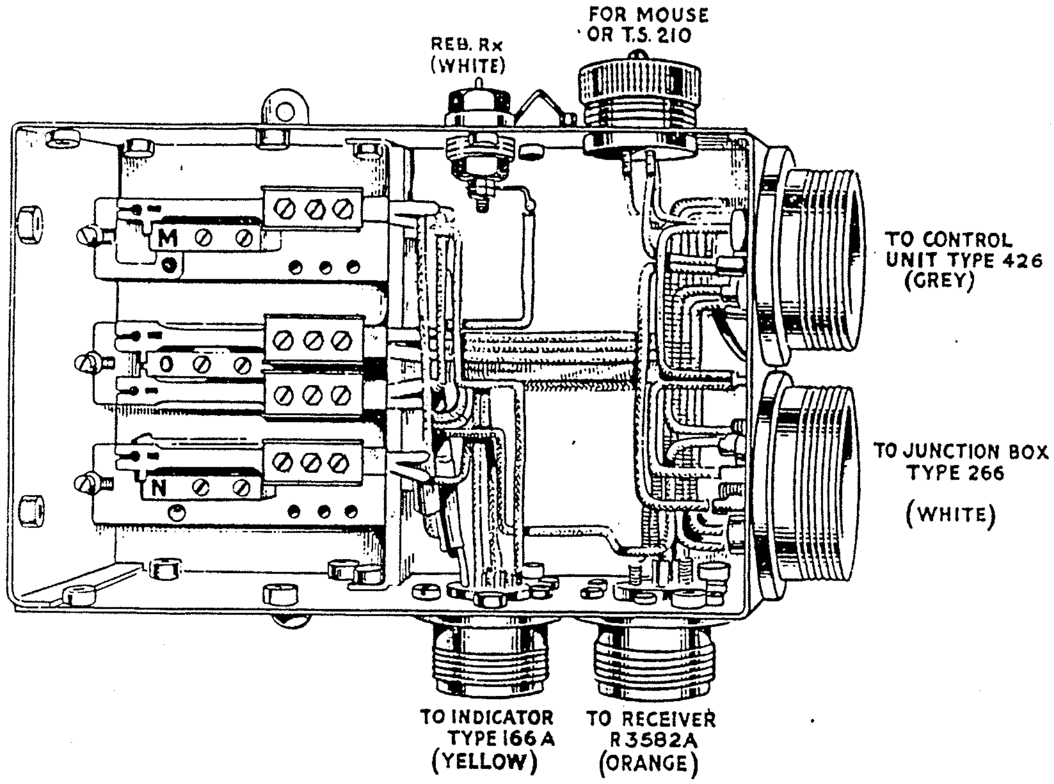


Fig. 55.—Junction box type 255A—interior view

Junction boxes

207. Two junction boxes are required with each installation, type 255A and type 266A for the Gee and Gee-H functions. Junction box type 266A is a simplified version of the type 256 which is used when the Rebecca function is required in addition to Gee and H. It is possible that different aircraft may call for junction boxes having shapes and type and reference numbers different from those described, but the circuit will necessarily be the same.

Junction box type 255A

208. This is used to link the control unit type 426A and the Gee-H receiver type R.3582A to the indicating unit type 166A and to junction box type 266A. It is illustrated in fig. 55 and a circuit diagram is given in fig. 56. Power supplies are connected to the receiver and control unit via this box whilst the receiver output, strobe triggering and calibration pips are fed to the indicating unit. Three relays in the junction box switch the calibration pips and receiver output.

209. Relay M is energised when the calibration pip key on the front panel of the control unit type 426A is depressed closing S2. It switches calibration pips to the reversing circuit in the indicating unit. When this relay is not energised the receiver output from the contact 02 is connected to the indicating unit.

210. Relay N is energised when the calibration pip key is raised closing S1 and in this condition it feeds the calibration pips to the cathode of the cathode ray tube to serve as intensity markers. When the relay is not energised the calibration pips are applied to the indicating unit via the contact N1. The 100-ohm resistance between this contact and earth reduces the amplitude of the pips.

211. The effect of these two relays may be summarised as follows:—

(1) Calibration pip key *down* —Calibration pips shown as deflection of trace

(2) Calibration pip key *central* —Signals on trace with no calibration pips

(3) Calibration pip key *up* —Signals on trace with intensity calibration pips

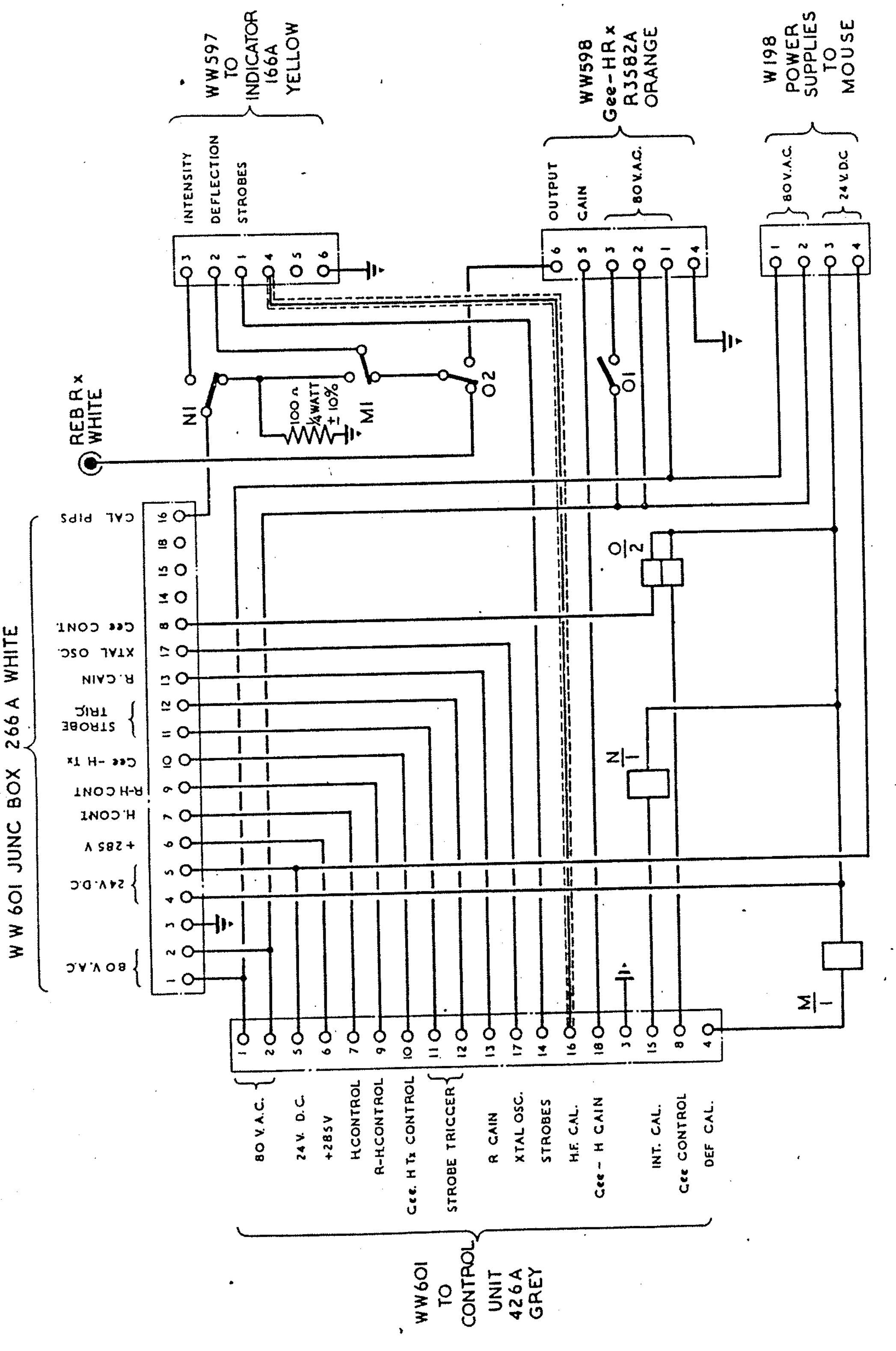


Fig. 56.—Junction box type 255A—circuit

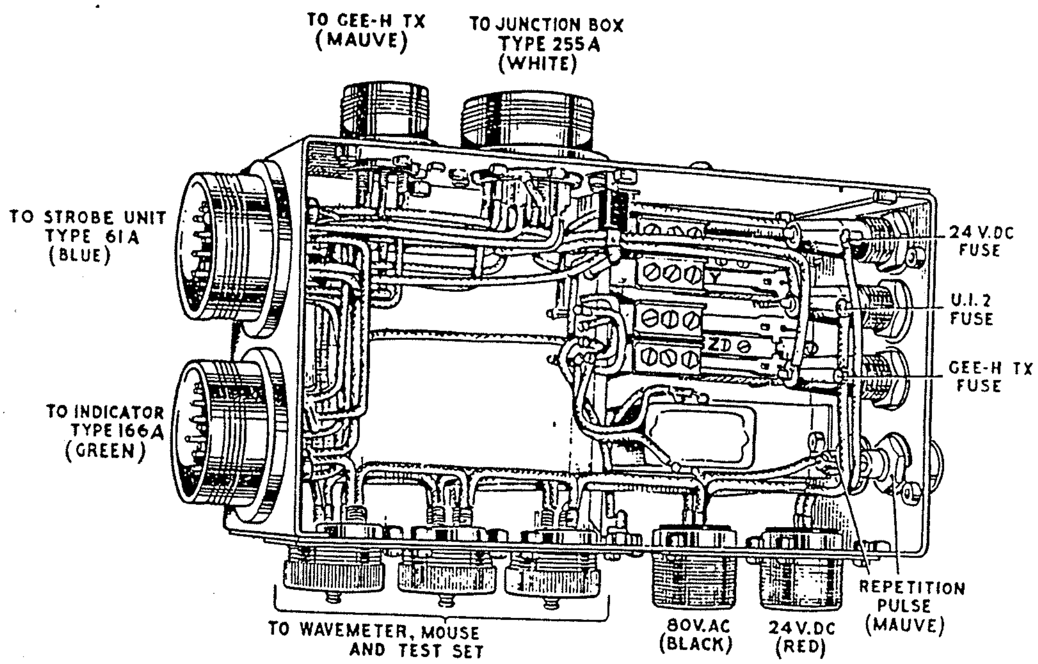


Fig. 57.—Junction box type 266A—interior view

212. Relay O connects the Rebecca receiver when not energised. When energised it switches on the HT in the Gee-H receiver and connects the receiver output to the relay contact M1. There are two coils on relay O one of which is energised on Gee and the other on H through the Gee-H/Rebecca-H key. It is always energised on the Gee and Gee-H functions.

Junction box type 266A

213. This junction box is employed to link up the following units of the installation:—

(1) Strobe unit type 61A

(2) Gee-H transmitter type T.1629A

(3) Indicating unit type 166A

(4) Junction box type 255A

(5) Control panel type 5

(6) Computer, automatic, type 56

It is illustrated in fig. 57 and the circuit diagram is shown in fig. 58.

214. In addition to its function as an interconnection unit, junction box type 266A is provided with plugs for supplying power to a wavemeter and test set for servicing and setting-up. Power to all the units is distributed through this junction box and many of the waveforms and control voltages, including all those to the strobe unit, pass through it. Two relays are mounted in the box and assist in selecting the appropriate function of the installation.

215. Relay Y is controlled by the H button on the control unit. When using the Gee function this relay is not energised and the contacts Y1 are open. On the H function the relay is energised and contacts Y1 close applying the drive pulse to the primary of the differentiating transformer T1 whence it is fed via the plug type 552 to the T.1629A.

216. Relay Z is controlled by sections FS10 and RS4 of the function and range switches in the indicating unit and determines the polarity of the transmitter triggering pulse. When not energised the transmitter is triggered by the rear or negative-going edge of the repetition pulse. In the energised condition contacts Z1 and Z2 reverse the connections to the primary of T1 and the transmitter now triggers from the leading or positive-going edge of the repetition pulse. In the former case the transmitter pulse appears in the centre of the ten-mile timebase and in the latter it appears in the centre of the two-mile timebase.

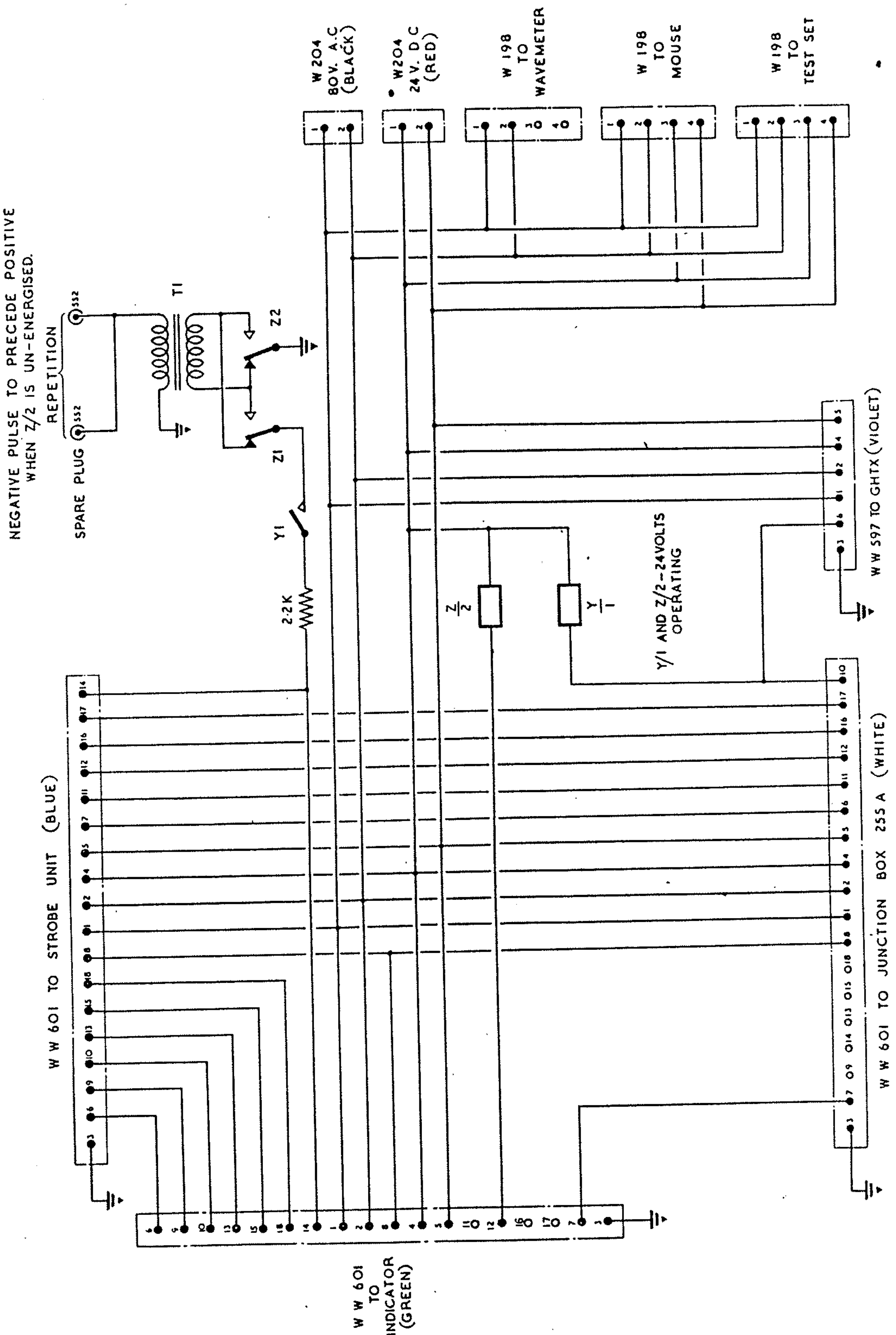


Fig. 58.—Junction box type 266A—circuit

217. If necessary, junction box type 256 can be used to replace the type 266A. It provides the same facilities for Gee and Gee–H operation but includes an additional relay and plugs for connections to a Rebecca equipment.

Filter unit type 190

218. This is illustrated in fig. 59 and a circuit diagram is given in fig. 60. It is a suppressor unit used in all H installations and is inserted between the transmitter and the junction box in the power supply lead. This prevents RF energy being fed back into the common power supply and thence into other units of the installation.

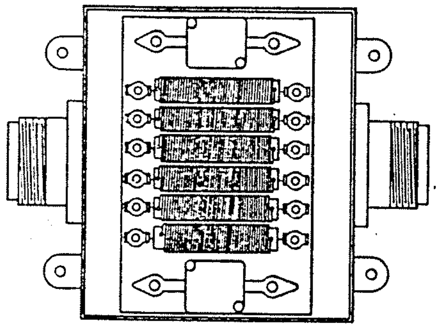


Fig. 59.—Filter unit type 190 —interior view

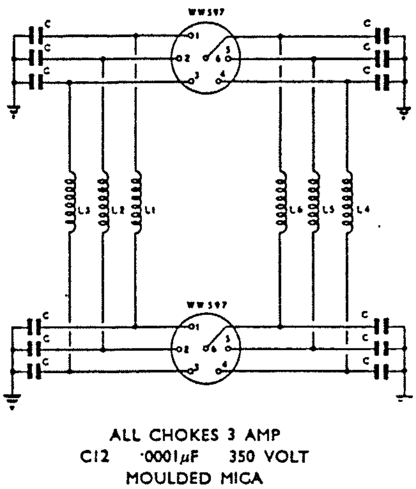


Fig. 60.—Filter unit type 190—circuit

INSTRUCTIONS FOR USE

Installation

219. The layout of the Gee–H Mark II (tropical) installation is clearly shown in fig. 5 and 6 which give the block schematic and interconnection diagrams respectively.

Operation

220. Apart from the control switches on the voltage control panel type 5, the only switches for controlling power supplies to the installation are (1) the supply switch on the transmitter type T.1629A and (2) the FUNCTION switch on the indicating unit type 166A. The normal procedure is to close the switches on the voltage control panel and transmitter unit. Power is then supplied to the appropriate units by setting the FUNCTION switch on the indicating unit to the G (Gee), H or R (Rebecca) position as required, the necessary connections being completed by the relays operated by this switch.

221. An additional switch, the Gee–H/Rebecca–H key (IN–GH. OUT–RH.) on the control unit type 426A determines the appropriate H function.

Operating technique

222. The universal indicator type 2 will not normally be installed in an aircraft for the Gee function alone but Gee will be available when the indicator is installed for other purposes such as Gee–H. A block schematic of the Gee–H installation using the universal indicator type 2 is shown in fig. 5 and the method of obtaining a fix is detailed in the following paragraphs.

223. Allow the pulses to drift on the main timebase until the A pulse falls on the A strobe at the lower end of the timebase with the identification pulse (or ghost A pulse) on the right-hand trace as shown in fig. 61. Stop the pulses with the crystal frequency control.

224. Set the strobes to the 10-mile range and by adjustment of the coarse and fine strobe controls bring the B and C strobes over the appropriate pulses.

225. Switch to strobe timebase when the pulses should be visible. Trim the crystal frequency to make the A pulse stationary at the lower end of the timebase. Bring the B and C pulses into line with the A pulses using the slow motion drives on the fine controls. The traces should now appear as in fig. 62. For extreme accuracy switch to the 2-mile time base and align the pulses accurately as shown in fig. 63.

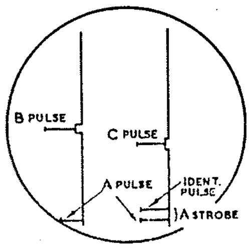


Fig. 61.—Gee main time-base display

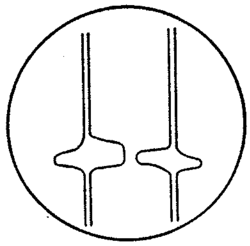


Fig. 62.—Gee or H 10-mile strobe timebase display

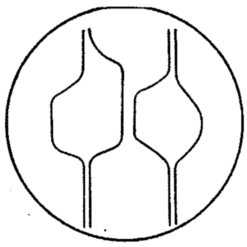


Fig. 63.—Gee or H 2-mile/timebase display

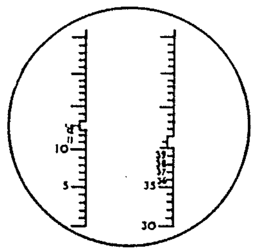


Fig. 66—Method of counting on Gee or H ~~2-mile strobe~~ main timebase

226. Depress the calibration pip key on the control unit. Read the second decimal place as indicated in fig. 64. Switch to the 10-mile strobe timebase and read the first decimal place as shown in fig. 65. Finally switch to the main timebase and read the whole numbers as indicated in fig. 66.

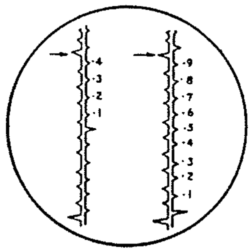


Fig. 65.—Method of counting on Gee or H 10-mile strobe timebase

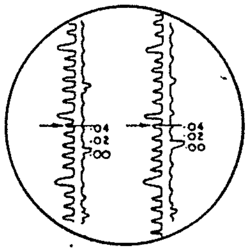


Fig. 64—Method of counting on Gee ~~main timebase~~ 2 mile strobe timebase

Note.—The whole number reading is in a slightly different form from that obtained with the indicating unit type 62 (Gee Mark II) owing to the fact that the zero is at the start of the A strobe instead of being one-half to three-quarters of the way along. The universal indicator type 2 also differs in that signals and calibration pips are not reversed during the strobes when viewed on the main timebase. With Gee Mark II the required whole number pip is the pip inverted by the strobe, but with Gee-H Mark II and other installations using the universal indicator type 2 the required whole number pip is the pip immediately in front of the leading edge of the strobe marker.

227. For homing the above procedure is carried out in the reverse order, the strobes are set accurately to the co-ordinates of the homing point and, keeping the A pulses in position by the crystal frequency control, the aircraft is flown to bring the B and C pulses into alignment. This is normally done by the aircraft moving along a line of constant path difference with one pulse lined up until the other pulse is seen to fall into line.

228. It should be noted that the time traces are normally vertical but in aircraft not using the Rebecca function a horizontal trace may be preferable for Gee and Gee–H and the leads to the cathode ray tube are long enough to enable it to be rotated through 90 degrees.

229. *Gee–H and Rebecca–H.* When the transmitter is operating, the local pulse will be visible on the timebases, the front of the pulse being delayed by 8 to 15 microseconds from the start of the main or A-strobe timebases. The amount of delay can be varied by a pre-set control on the transmitter. When the two beacons of the H chain respond both beacon responses are visible on both traces and the strobes are placed on these as shown in fig. 67.

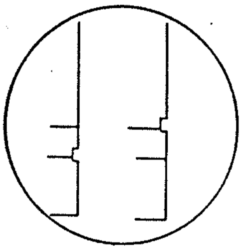


Fig. 67.—H main time-base display

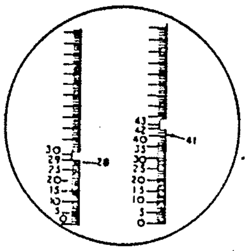


Fig. 68.—Method of counting on H main timebase

230. The strobe timebases are used in exactly the same way as for Gee (see fig. 68, 69 and 70). Fig. 68 shows the method of counting the whole numbers and, as for Gee, the number before the front edge of the strobe marker is taken. It should be noted that the timebase velocity is increased for the duration of the strobe markers, and if there is any difficulty in counting the calibration pips which are closely spaced the strobe timebase length may be set to 50 miles by the range switch when a major calibration pip will be visible on the expanded portion. The whole number reading may be obtained by counting back from this.

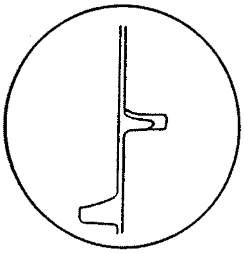


Fig. 69.—Hyperbolic approach on H

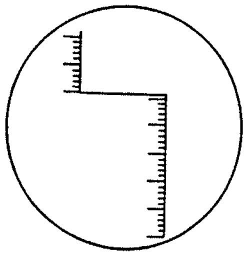


Fig. 70.—Effect of time-base doubling control

231. The 50-mile strobe range may also be useful when the beacon responses are difficult to see on the main timebase since with the strobes set to the 50-mile range the whole length of the main timebase can be scanned by the strobe using the coarse control only. In this way searching can be done on the strobe timebase.

232. When homing to a point, the procedure is as for Gee the strobes being set to the required fix and the aircraft flown along an arc of constant radius from the beacon with one pulse lined up until the other pulse comes into line.

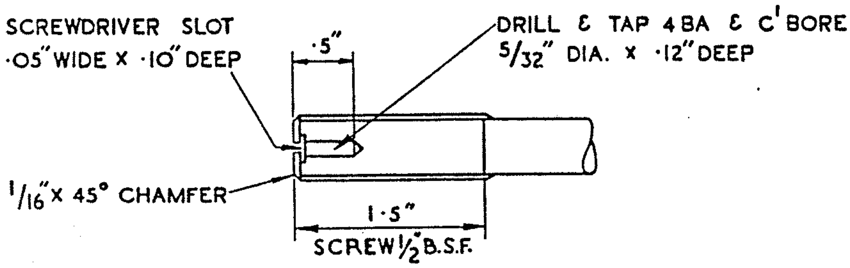
233. A more accurate method which may be employed is as follows. Reduce the timebase spacing to zero and approach with the two beacon responses superimposed, that is along a line of

constant range difference, until these come into line with the A pulse. This method is only suitable when an approach is made from the opposite side of the homing point towards the beacon if the beacon responses are to be brought into line with the A pulses since it will be necessary to begin by using the 10- or even the 50-mile strobe and the transmitter pulse is at the start of these. See fig. 69.

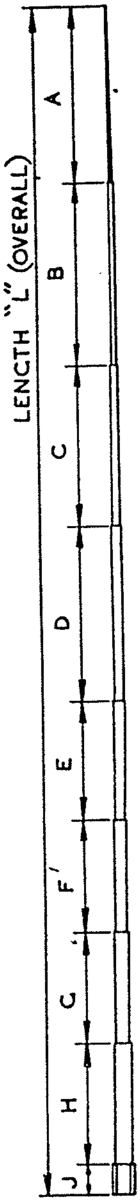
234. *Special points for Gee–H working.* To obtain maximum accuracy, especially at long ranges, it is essential that the 150 kc/s crystal oscillator which provides the calibration pips should be on the correct frequency. This is done by halting the Gee pulses on the Gee function which synchronises the 150 kc/s crystal with the precision standard used at the Gee ground stations. The crystal oscillator control is then left at this setting.

235. An HT overload circuit is provided in the Gee–H transmitter and if this trips, possibly as the result of a flash arc in the transmitting valve, it may be re-set by pressing the Gee–H transmitter reset (G.H. TX RESET) button on the control unit. This button is also of use when there is any doubt whether a pulse seen on the cathode ray tube is the correct beacon response or a spurious pulse since, as long as the button is depressed, the transmitter is off regardless of the state of the overload circuit. Hence, the wanted pulse will disappear when the button is pressed.

236. The frequency of the transmitter is readily adjusted by the three controls on the front panel of the transmitter unit. Owing to the importance of setting the frequency accurately, however, it would be impracticable to change the frequency in the air. In addition it is necessary to replace the aerial for all but small changes in frequency.



ENLARGED VIEW OF SECTION "J"



A.M. TYPE No.	A.M. REF. No.	SECTION	A	B	C	D	E	F	G	H	J	OVER-ALL L
327	10B/16142	LENGTH	–	–	–	9"	7"	7"	6"	6"	1·5"	3'-0½"
		DIAMETER	–	–	–	·25"	·3"	·35"	·40"	·45"	1·5"	
328	10B/16143	LENGTH	–	–	–	13"	8"	7"	7"	6"	1·5"	3'-6½"
		DIAMETER	–	–	–	·25"	·3"	·35"	·40"	·45"	·5"	
329	10B/16144	LENGTH	–	–	10"	9"	8"	7"	7"	6"	1·5"	4'-0½"
		DIAMETER	–	–	·2"	·25"	·3"	·35"	·40"	·45"	·5"	
342	10B/16157	LENGTH	–	10"	8"	8"	8"	7"	7"	6"	1·5"	4'-7½"
		DIAMETER	–	·15"	·2"	·25"	·3"	·35"	·40"	·45"	·5"	
343	10B/16158	LENGTH	–	10·5"	10"	8·5"	8"	8"	8"	8"	1·5"	5'-2½"
		DIAMETER	–	·15"	·2"	·25"	·3"	·35"	·40"	·45"	·5"	
341	10B/16156	LENGTH	–	11·5"	11"	9·5"	9"	9"	9"	9"	1·5"	5'-10½"
		DIAMETER	–	·15"	·2"	·25"	·3"	·35"	·40"	·45"	·5"	
330	10B/16145	LENGTH	–	15"	12·5"	11·5"	10"	10"	10"	10"	1·5"	6'-8½"
		DIAMETER	–	·15"	·2"	·25"	·3"	·35"	·40"	·45"	·5"	
331	10B/16146	LENGTH	17"	15"	12"	10"	9"	9"	9"	9"	1·5"	7'-7½"
		DIAMETER	·1"	·15"	·2"	·25"	·3"	·35"	·40"	·45"	·5"	
332	10B/16147	LENGTH	19·5"	17"	15"	12·5"	10"	10"	10"	10"	1·5"	8'-9½"
		DIAMETER	·1"	·15"	·2"	·25"	·3"	·35"	·40"	·45"	·5"	
333	10B/16148	LENGTH	·23"	20"	17"	14"	11·5"	11·5"	11·5"	11·5"	1·5"	10'-1½"
		DIAMETER	·1"	·15"	·2"	·25"	·3"	·35"	·40"	·45"	·5"	

Fig. 71.—Transmitter aerial type 361

APPENDIX I

Aerials

Transmitter aerial type 361

1. The transmitter aerial consists of an insulator and ten rods, any one of which can be screwed into the insulator whilst the aircraft is on the ground. This aerial has already been described in para. 58 and fig. 71 gives detailed dimensions.

Receiving aerial type 329 and loading unit type 51

2. The receiving aerial type 329 consists of a 5′ 7¾″ whip aerial with a base insulator and a spring mounting which accommodates the loading unit type 51. The aerial is designed to operate on all the Gee frequencies in the band 20–85 Mc/s. Earthing lugs are provided on the insulator base for bonding to the aircraft structure. Electrical connections between the aerial and the loading unit are made by an adaptor plug type 587 and the feeder to the receiver is coupled to the loading unit by a Pye plug and socket.

3. The loading unit is provided with a bayonet slot fixing and fits into the aerial mounting which is secured to the base insulator as shown in fig. 21.

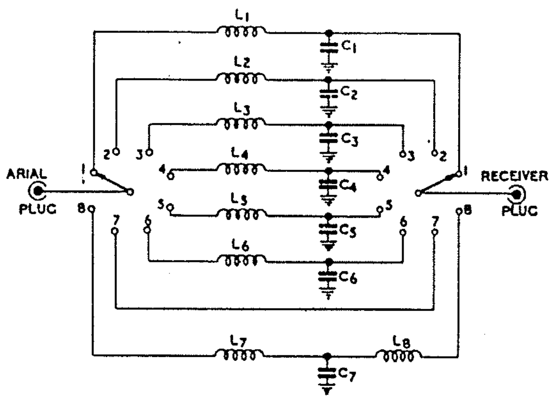


Fig. 72.—Loading unit type 51—circuit

4. The circuit diagram of loading unit type 51 is given in fig. 72. As will be seen, the unit is fitted with an eight-position switch which selects the appropriate inductance and capacitance for each frequency range. The seventh position, however, provides a direct connection from the aerial to the feeder and is used on the range 54·5 Mc/s to 73 Mc/s. The series inductance of the lead inside the unit gives a sufficiently accurate impedance match over this band of frequencies. The remaining switch positions correspond to the frequency bands given in the table below.

FREQUENCY COVERAGE OF LOADING UNIT TYPE 51

Length of aerial — 5′ 7¾″

Switch position	*Frequency band*
1	22·1 Mc/s to 23·6 Mc/s
2	23·6 Mc/s to 25·7 Mc/s
3	25·7 Mc/s to 28·0 Mc/s
4	28·0 Mc/s to 42·0 Mc/s
5	42·0 Mc/s to 47·5 Mc/s
6	47·5 Mc/s to 54·5 Mc/s
7	54·5 Mc/s to 73·0 Mc/s
8	73·0 Mc/s to 85·0 Mc/s

P11638 M32260/G450 7/47 375 C & P Gp. 1

RESTRICTED

AIR MINISTRY

This is A.L. No. 3 to A.P.2557G, Vol. I

Delete "(*To be issued later*)" after title of Chap. 2 in the List of Chapters, *write* "A.L.3" in the outer margin of the list, *insert* this chapter, and make an entry in the Amendment Record Sheet at the beginning of the Volume.

SIGNALS

CHAPTER 2

COMPUTER, AUTOMATIC, TYPE 56

LIST OF CONTENTS

LIST OF ILLUSTRATIONS

INTRODUCTION

1. The computer, automatic, type 56, known as the Gee-H mouse, is an automatic device used to facilitate the operational use of Gee-H as a blind bombing aid.

General principles

2. Blind bombing with the aid of the Gee-H mouse necessitates the use of two warning points both of which must lie on the tracking circle for approaching the target. These warning points are selected before the flight and are chosen so as to make the appropriate allowance for the meteorologically estimated wind over the target. Between the two warning points the aircraft flies along the tracking circle; and between the second warning point and the bomb release point the aircraft flies on a straight and level course, which is tangential to the tracking circle at the second warning point, and which will take the aircraft over the target. The airspeed must be kept constant between the first warning point and the bomb release point.

3. The distance along the tracking circle between the first and second warning points must be equal to the distance between the second warning point and the true range point (TRP), the true range point being defined as the point immediately beneath the aircraft at the instant the bombs strike the ground. The true range point exceeds the target in the direction of the bombing run by an amount known as "trail" as shown in fig. 1. The trail depends on the air resistance to the bomb as it falls freely.

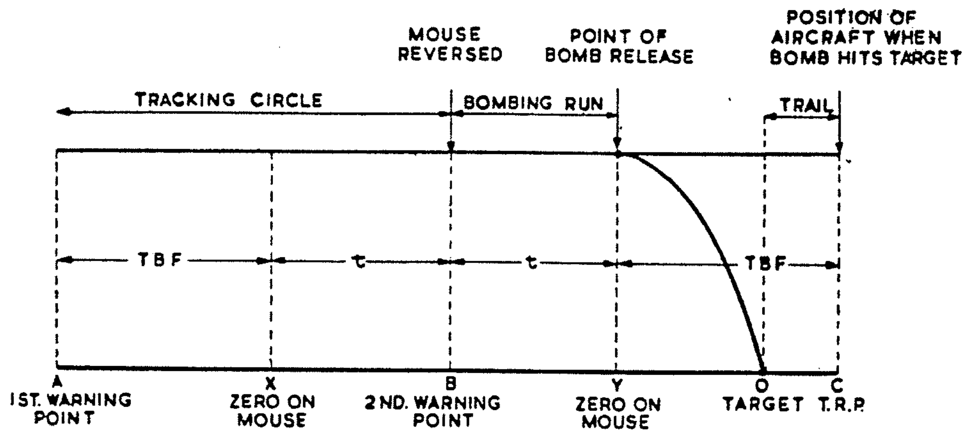


Fig. 1.—Principle of Gee-H mouse

4. The time of bomb fall (TBF) may be determined by the navigator knowing the height of the aircraft, its speed and the bomb ballistics (those properties of the bomb, such as streamlining, which affect its flight through the air). In effect the mouse is a time-measuring device and may be regarded as a stop watch. The time of bomb fall is set up on the watch backwards from zero.

5. The aircraft is navigated, first by Gee and then by Gee-H, to the first warning point. When the aircraft passes this point on the tracking circle the stop watch is started. After a time equal to the time of bomb fall the watch hand passes through zero and continues until the second warning point is reached when the watch is reversed. The watch now runs backwards and when it again reaches zero the bombs are automatically released. By referring to fig. 1 it will be seen that if these operations are correctly carried out the bombs will fall on the target. When started at A the watch reaches zero at X and continues for *t* seconds until the second warning point B is reached. It then runs backwards for an equal time, *t* seconds, to zero at Y when the aircraft is at the bomb release point.

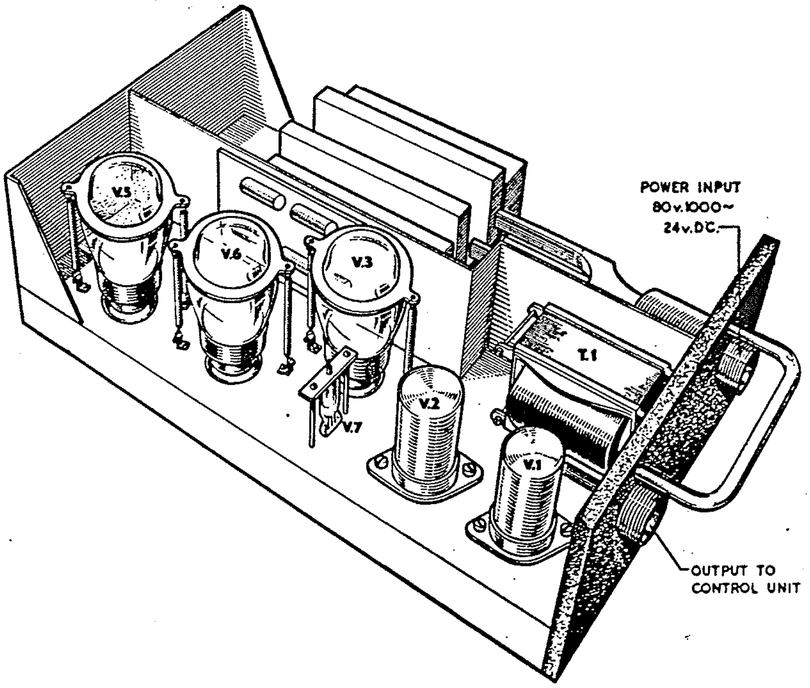


Fig. 2.—Drive unit, type 114—general view

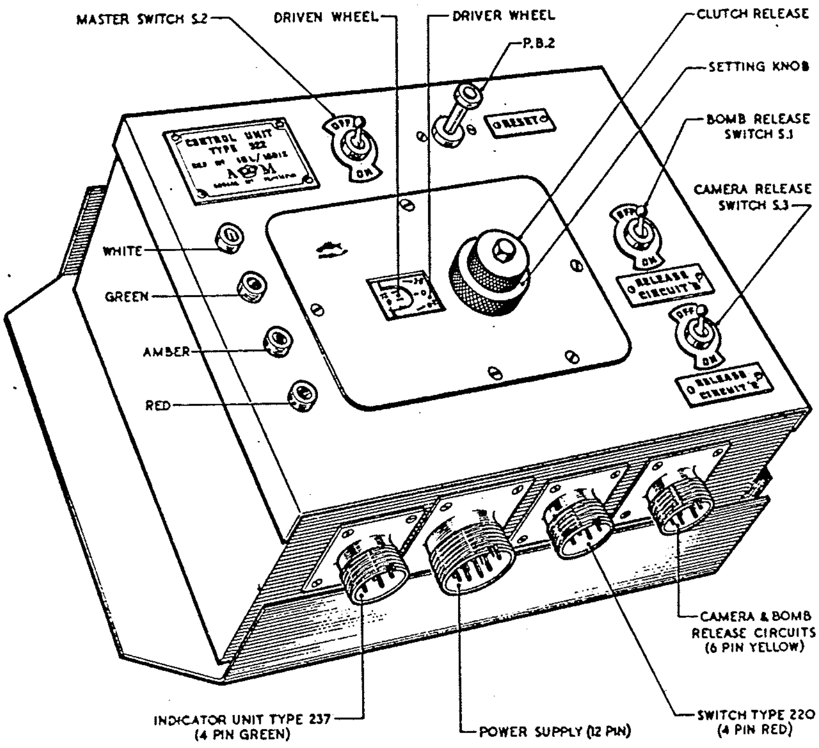


Fig. 3.—Control unit, type 522—general view

GENERAL DESCRIPTION

6. Timing in the automatic computer, type 56, is effected by a tuning-fork controlled oscillator which operates uniselectors. The computer consists of the following units:—

(1) Drive unit, type 114	Stores ref. 10D/16461
(2) Control unit, type 522	Stores ref. 10L/16012
(3) Indicating unit, type 237	Stores ref. 10Q/16032
(4) Switch, type 220	Stores ref. 10F/108

Drive unit, type 114

7. The drive unit, a general view of which is shown in fig. 2, contains the 25 c/s tuning-fork controlled oscillator for driving the motor-operated relay contacts which are housed in the control unit, type 522. The circuit consists of the master oscillator, an amplifier, cathode follower and the associated power supply.

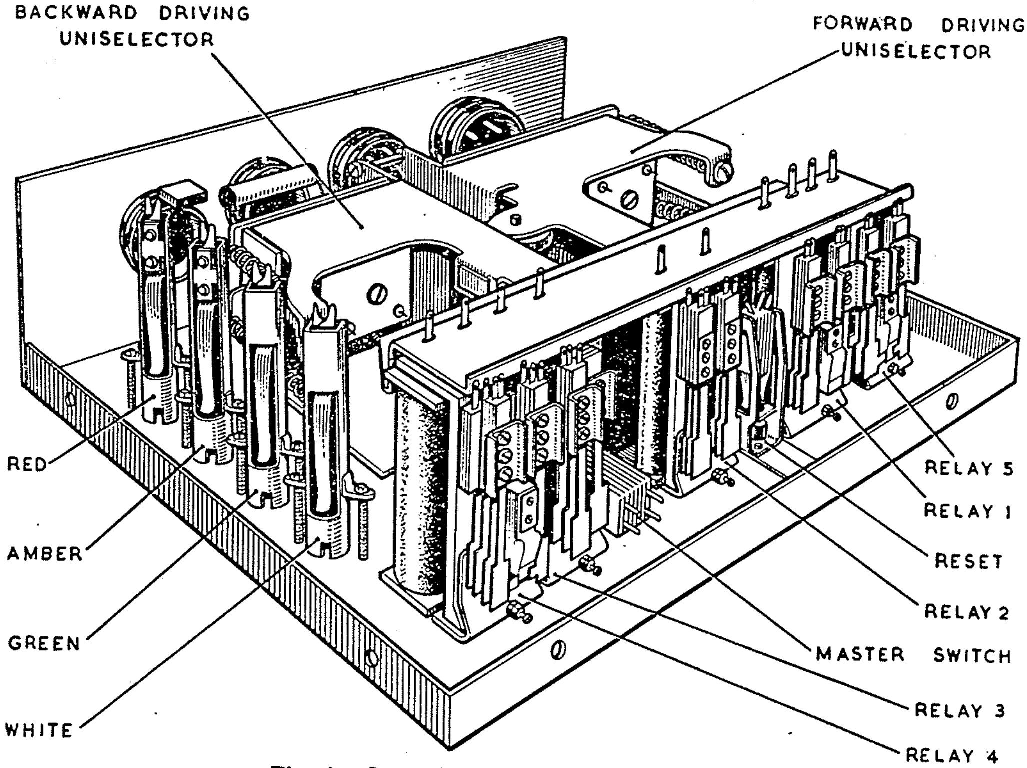


Fig. 4.—Control unit, type 522—interior view

Control unit, type 522

8. This unit, which is illustrated in fig. 3 and 4, contains the two uniselectors, which are operated by the bomb release switch, and the relays which ultimately operate the bomb release gear. It also embodies the control switches and indicating lamps for the Gee-H mouse.

Indicating unit, type 237

9. This is the pilot's indicator and contains three signal lamps coloured white, amber and red respectively. These lamps repeat the indications of the similarly coloured lamps in the control unit, type 522. An illustration of the unit is given in fig. 5. A 4-pin W plug is provided for the connections to the control unit.

Switch, type 220

10. This is the bomb release switch and, as shown in fig. 6, is connected to a length of cable terminating in a socket, type W244, by which the switch is connected to the appropriate plug on the control unit. The assembly forms connector set, type 6230.

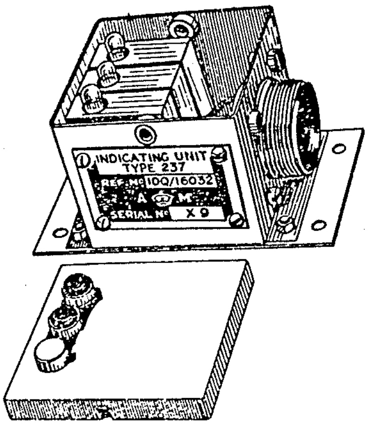


Fig. 5.—Indicating unit, type 237

CIRCUIT DESCRIPTION

Drive unit, type 114

11. A circuit diagram of this unit is given in fig. 7. V1 is the master oscillator and is a tuning-fork-controlled generator of normal design. A portion of the output is fed back in phase to the grid via the network R4, C3 and R2 thus providing AGC. V7 is a limiting diode across the output.

12. The output from V1 is taken from the junction of the potential divider consisting of R5 and R18 to the grid of V2 which is an amplifier.

13. The output from the anode of V2 is taken to the cathode-follower valve V6 and the 25 c/s sine wave appearing at the cathode is fed to pins 5 and 6 of the 12-way W plug on the front panel.

14. A power supply is incorporated, consisting of the transformer T1, the full-wave rectifying valve V5 and the choke-capacitance filter L3 and C6. The neon stabilizer V3 provides a stabilized HT supply of approximately 130 volts for the oscillator valve V1.

Control unit, type 522

15. Details of the mechanical gear train are provided in fig. 8 and the circuit diagram is shown in fig. 9. The operation of the gear train will be considered first.

16. By referring to fig. 8 it will be seen that the forward drive uniselector engages with a ratchet wheel E which has 50 teeth. The ratchet wheel E and the spur wheel A are both fixed to the sleeve F which is free to revolve on the spindle S. The disc J is fixed to the spindle and carries the two pinions C and D which engage with one another and with the spur wheels A and B respectively. The spur wheel B, like A, is similarly fixed to a sleeve H and ratchet wheel G operated by the backward drive uniselector. H is also free to revolve on S.

17. The assembly of A, B, C, D and J forms a differential and its function is to enable the two uniselectors independently to drive the spindle S which carries the timing wheels.

18. It will be seen later that the two uniselectors never act together. Assume that the forward drive uniselector is operating. Its source of supply is 25 c/s AC and the uniselector drives the ratchet E and the spur wheel A at one-half revolution per second. The differential is so designed that, with B fixed, the disc J and the spindle S revolve at one-quarter revolution per second.

19. Similarly, if the forward drive selector is stationary and the backward drive selector operating, the same action occurs in reverse, the spindle S now being driven in the reverse direction at one-quarter revolution per second.

20. One face of a clutch is fixed to the spindle S and the other face to one of two spur wheels which engage with each other. These are known as the driver and driven wheels. A timing control knob is fixed to the driver wheel which is spring-loaded axially so that the clutch is normally engaged and locked in position by the clutch-release knurled head. As a result the driver and driven wheels are normally locked with the spindle S. They may, however, be released from the spindle by unlocking the clutch release and withdrawing the timing control knob axially.

21. The driver wheel is marked on one face from 0 to 4 seconds in steps of 0·2 second and a U-shaped notch is cut out of the wheel at the zero mark. The driven wheel is marked from 0 to 72 seconds in steps of 4 seconds and the teeth ratio of the two wheels is such that the driven wheel rotates 19/18 times as fast as the driver wheel.

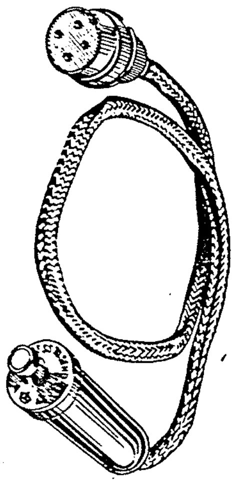


Fig. 6—Switch, type 220

22. As the driver wheel rotates, the notch at zero will ultimately expose a number on the driven wheel. This occurs when the notch is on a line joining the centres of the driver and driven wheels and is behind a small window provided in the front panel of the control unit.

23. Assume that the number 0 is exposed on the driven wheel. Now rotate the driver wheel through one complete revolution in a forward direction and the number 4 will be exposed. This result is obtained because the gear ratio is 19/18 and the driven wheel therefore rotates $1\frac{1}{18}$ revolutions for each revolution of the driver wheel. Since the driven wheel bears 18 equispaced numbers from 0 to 72 in steps of 4, then, if 0 shows at the start, after one revolution of the driver the exposed number will be 4, after two revolutions 8 and so on.

24. For intermediate readings the number seen on the driver wheel is added to the last number appearing on the driven wheel, i.e. after one-and-a-half revolutions 2 will appear on the driver wheel, the driven wheel being concealed from view. The true reading is, however, 6, since the last exposed number on the driven wheel (after one revolution of the driver) was 4, and 2 now shows on the driver. For four-and-a-quarter revolutions of the driver the number will be 17 since, after four complete revolutions, 16 shows on the driven wheel and another quarter revolution will show 1 on the driver.

25. As the driver rotates at one revolution in four seconds the readings obtained from the driver and driven wheels are actual time readings in seconds. Thus the control unit indicates time from 0 to 72 seconds at intervals of 0·04 second by estimating the space between each 0·2 second in fifths.

26. A short rod projects axially from the face of each wheel and closes a timing contact when in the zero position. These two timing contacts are connected in series electrically and hence both are closed simultaneously only when zero is indicated on the driver and driven wheels.

27. It will be seen from fig. 9 that four plugs are provided on the control unit for connections to the other units of the equipment. The 24-volt DC and 25 c/s AC supplies are brought in via the 12-way plug to which is also connected one pole of the master switch S2. The pilot's indicator is connected to P2, the *green* plug, the bomb release button to P3, the *red* plug, and the camera and bomb release mechanism are connected to P4, the *yellow* plug.

28. In considering the operation of the circuit it should be assumed that the master switch S2 is closed and that all the relays are de-energized. The RESET push button PB2 is provided on the front panel for this purpose. Assume now that the bomb release button is depressed, which is done when the first warning point is reached, and consider what occurs while the button remains depressed. The contacts B open and the contacts A close. The coil L1 is energized, closes the hold-on contacts REL 1/A and operates the change-over contacts REL 1/B thus transferring the output of the drive unit from the dummy load R1 to US1, the coil of the forward drive uniselector which commences to rotate. At the same time the *white* signal lamp, SL1, is lit.

29. When the bomb button is released the contacts A open again and contacts B close. Coil L2 is now energized through the contacts REL 1/A thus closing the hold-on contacts REL 2/A and operating the change-over contacts REL 2/B which transfer the bomb release button to the circuit of L3.

30. When the uniselector drives the timing spindle S through zero the two sets of timing contacts are closed simultaneously. Therefore the coil L5/A, which is one of the two coils of relay 5, is energized closing the hold-on contacts REL 5/A. These in turn energize the second coil L5/B lighting the *green* signal lamp, SL2, and closing the contacts REL 5/B enabling L3 to be energized when the bomb release button is next depressed.

31. On reaching the second warning point the bomb release button is again depressed, and contacts A close energizing L3 which closes the hold-on contacts REL 3/A. The change-over contacts REL 3/B operate, thus transferring the drive output from US1 to the backward drive uniselector US2 so reversing the direction of the drive. The change-over contacts REL 3/C also operate, connecting L4 in series with the timing contacts across the 24-volt DC supply. When L3 is energized the *amber* signal lamp, SL3, is lit.

32. When the timing shaft returns to zero the two sets of timing contacts are again closed simultaneously and the coil L4 is energized through the contacts REL 3/C. At the same time the *red* signal lamp, SL4, is lit. The contacts REL 4/B and REL 4/C are closed and, if S3 and S1 are also closed, the bomb release gear and camera are operated.

33. Momentary operation of the reset pushbutton PB2 breaks the 24-volt DC supply and renders all the relays inoperative so that the circuit returns to its initial state.

INSTRUCTIONS FOR USE

34. Ensure that the master ON/OFF switch on the control unit is set to the ON position and that the bomb release and/or camera arming switch is also ON.

35. Operate the RESET push-button switch to ensure that all the relays in the control unit are de-energized. No signal lamp will be lit.

36. Ensure that the correct TBF is set up on the control unit and that the clutch release knob is securely locked.

37. With the aircraft flying on the correct tracking circle depress the bomb release switch once when the first warning point is reached. The *white* signal lamp should light.

38. When the timing mechanism of the control unit passes through zero the *green* pilot lamp will light. Until this occurs it is useless to depress the bomb release switch for the second warning point.

39. With the aircraft still flying on the correct tracking circle depress the bomb release switch once again when the second warning point is reached. The *amber* signal lamp should now light.

40. No further action is required of the navigator. The bombs are dropped automatically and the *red* signal lamp lights at the moment this occurs.

P11770 M34267/G636 7/47 375 C & P Gp. 1

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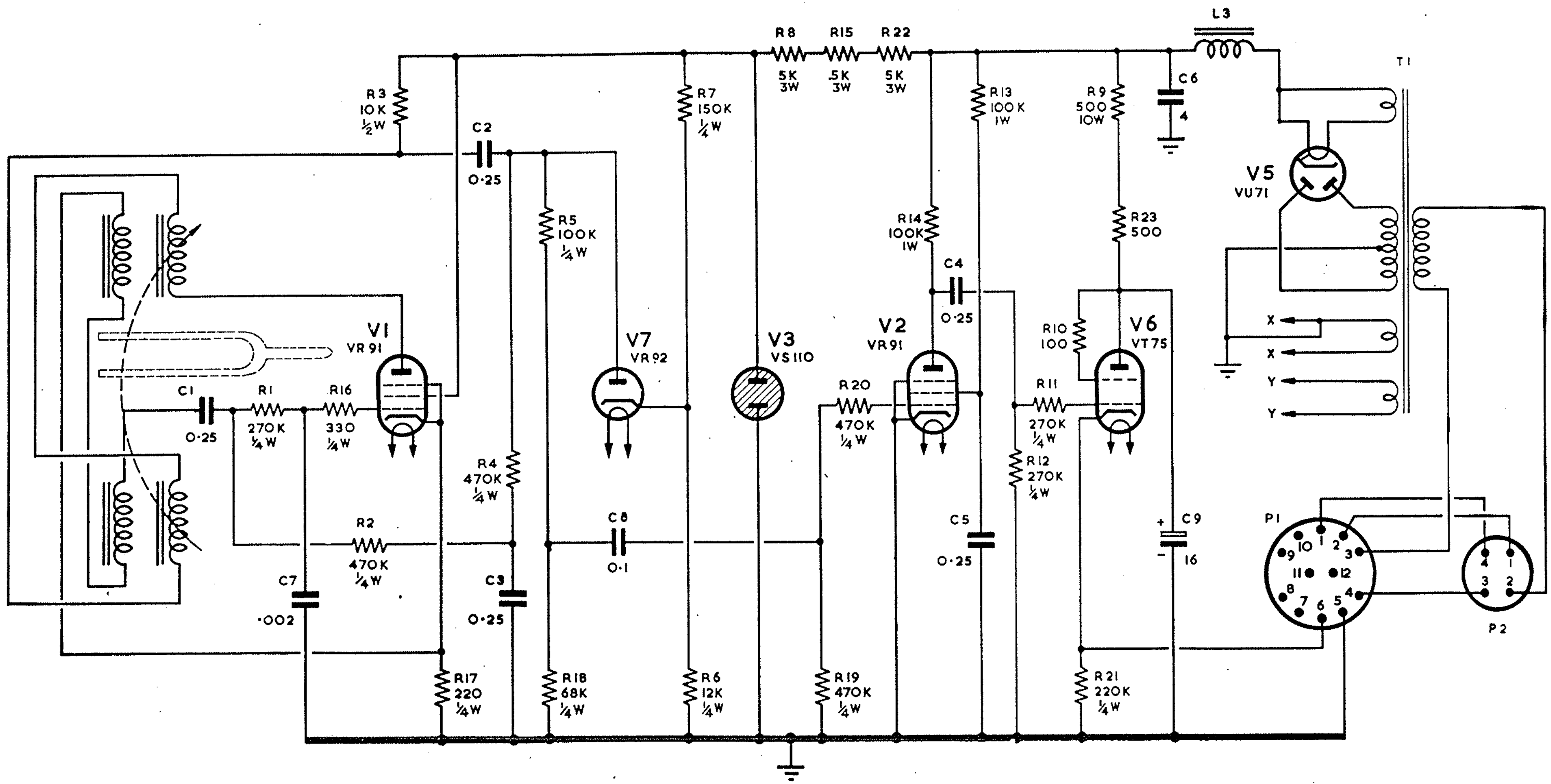

FIG. 7—DRIVE UNIT TYPE 114 —CIRCUIT

PP4857 M34268 Gs37 7/47 375 C&P Gp. 959 (4)

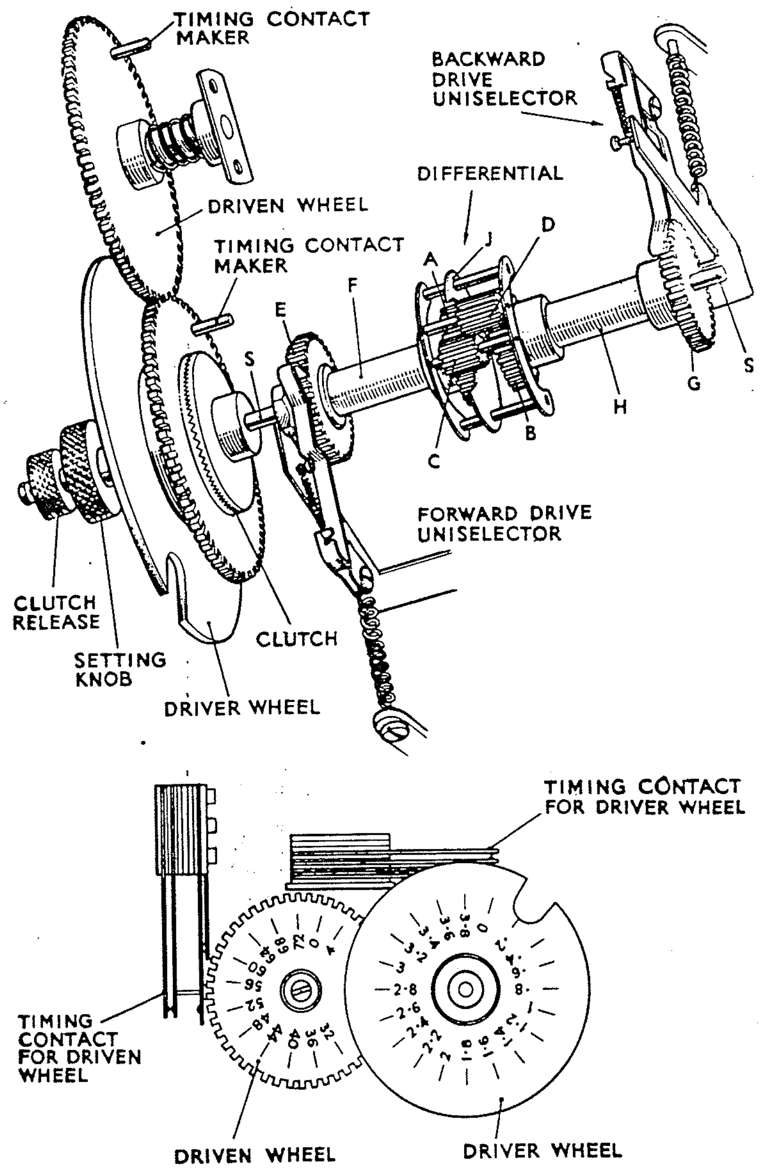

FIG. 8.—CONTROL UNIT TYPE 522

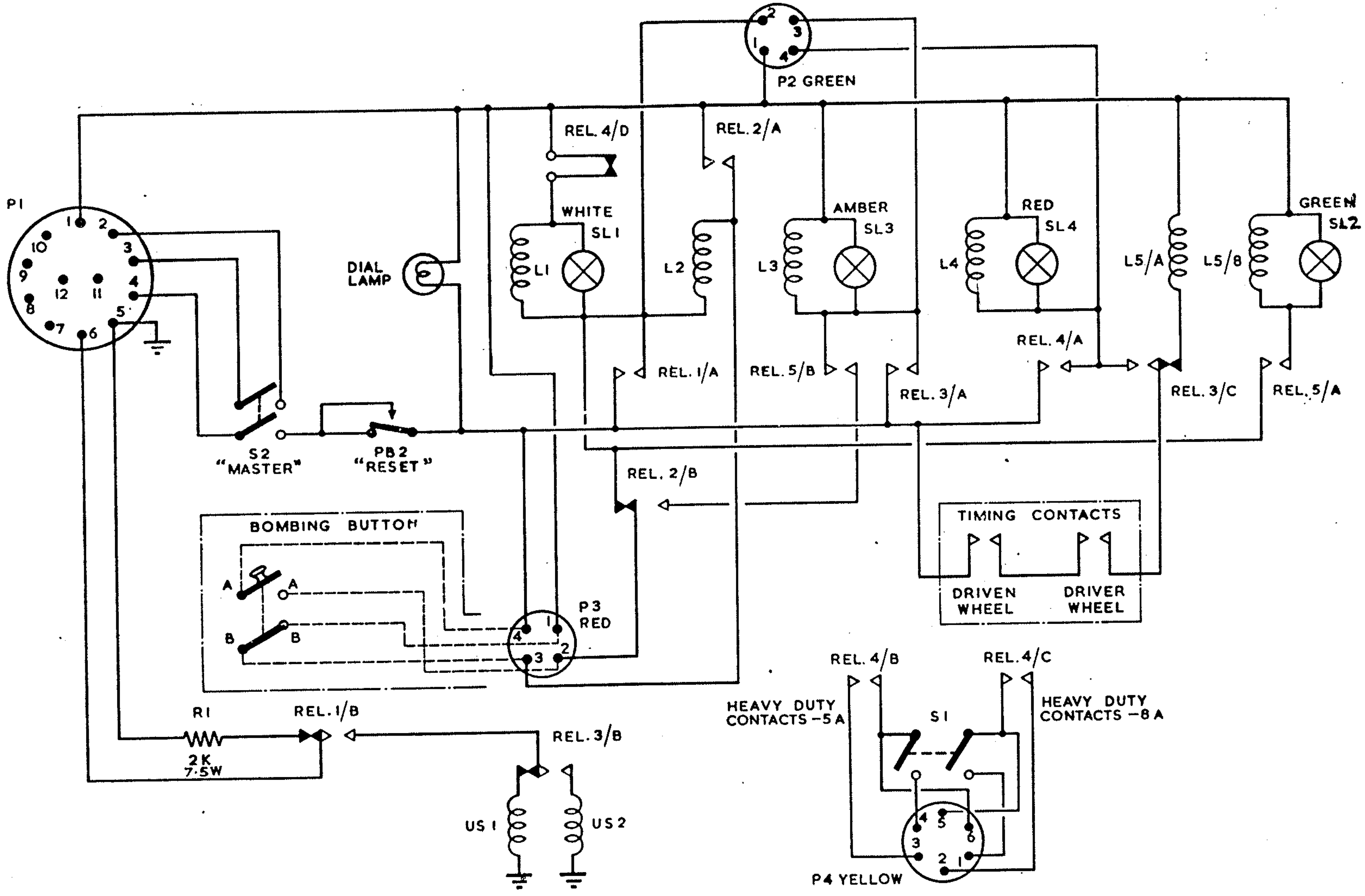

FIG. 9—CONTROL UNIT TYPE 522—CIRCUIT