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AIR MINISTRY

SECTION 2

TRANSMITTER - RECEIVERS

SECTION 2

TRANSMITTER-RECEIVERS

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SECTION 2, CHAPTER 1

TRANSMITTER - RECEIVERS
T.R.9 AND T.R.11

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TRANSMITTER-RECEIVER T.R.9

(Stores Ref. 10A/7917)

INTRODUCTION

1. The transmitter-receiver T.R.9 consists of a two-valve radio-telephony transmitter and a six-valve receiver contained in one case. It has been designed primarily for use in single-seater fighter aeroplanes and is intended to provide two-way communication with the ground over a distance of 35 miles, and 5 miles air to air. The frequency band covered is 6,000–4,300 kc/s, and the entire power supply for both transmission and reception is derived from a dry battery and a secondary cell. As fitted in this particular type of aeroplane the instrument itself is inaccessible to the pilot but is entirely operated by him through a system of remote control.

2. A feature of the receiver is an inter-communication arrangement which can be brought into use when the apparatus is installed in two-seater aeroplanes. The overall dimensions of the instrument are approximately 19½ in. × 13¼ in. × 9½ in., and the weight, including valves, H.T. battery and grid bias batteries, but excluding L.T. battery and remote control, is approximately 44 lb.

3. The principal parts (the receiver unit and the transmitter unit) are housed in a case of canvas covered wood, and from the combined instrument the necessary connections and controls are extended to a convenient position in the pilot's cockpit. At this position are situated the telephones for reception, the microphone for transmission and the remote control with its three handles, operating respectively the send-receive switch, the receiver tuning condenser and the volume control of the receiver.

4. When the send-receive handle on the controller is placed in the "send" position, the aerial and earth are connected to the transmitter, the H.T. and L.T. connections and the microphone connections are made, and the telephones are connected to the transmitter side-tone device. The oscillator valve commences to generate continuous oscillations and when the microphone is spoken into these are modulated at speech frequency, through the medium of the modulator valve, and radiation takes place on a frequency determined by the value to which the transmitter inductances have previously been set, the speaker hearing at the same time his own voice in the telephones.

5. Moving the controller handle from "send" to "receive" changes the aerial and earth connections and H.T. supply from transmitter to receiver, changes the telephone connections from transmitter side-tone device to receiver output and breaks the transmitter filament circuit. (The microphone circuit is completed in both "send" and "receive" positions of the switch and only broken at the intermediate or off position.)

6. The receiver is now ready for reception. Tuning is effected by moving the "tune" handle of the controller which operates three ganged fine tuning condensers giving a variation of one or two hundred kc/s on either side of the "spot" frequency to which the receiver has previously been adjusted. Volume of sound is controlled by means of the "volume" handle on the controller, which varies the voltage applied to the screening grids of the two screen-grid valves in the receiver.

7. If the apparatus is installed in a two-seater aeroplane, and a duplicate telephone and microphone are wired to the second occupant's position, inter-communication can be carried on when the controller handle is in the "receive" position. This is made possible by the provision of a connection from the secondary of the microphone transformer, through a condenser and resistance, to the grid of the second low frequency valve in the receiver. Speech frequencies are thus impressed upon the grid-filament circuit of this valve, amplified and reproduced in both telephones in the output circuit of the last valve.

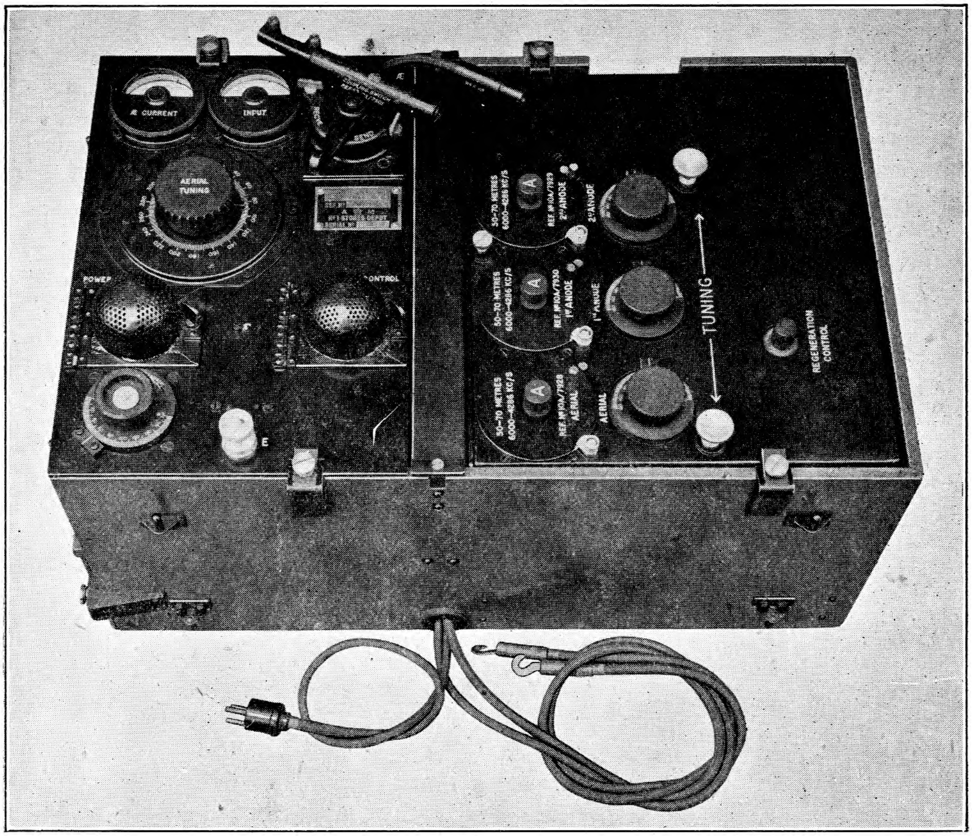


FIG. 1. Transmitter-Receiver T.R.9.

GENERAL DESCRIPTION

Transmitter

8. A theoretical diagram of the transmitter is given in fig. 3, V_1 being the oscillator valve and V_2 being the modulator valve. The aerial circuit can be traced through the ammeter A, condenser C_3, lower portion of the inductance L_1, condenser C_2, filament circuit and earth. The circuit is tuned by means of a tapping S which is rotatable within the coil L_1. The anode circuit of the oscillator valve includes the inductance L_1, and the H.T. supply is *via* the milliammeter MA, the low frequency choke L_4, and the R/F. choke L_3. In the grid circuit of the oscillator valve are the tuning variometer L_2, the grid condenser C_1 and grid leak R_1. The grid and anode circuits are arranged for minimum inductive coupling, R/F. oscillation being maintained by virtue of the inter-electrode capacitance of the valve.

9. The modulator valve V_2 has its anode connected to the junction point of the R/F. choke L_3 and the A/F. choke L_4, choke modulation being employed in the approved manner. The grid circuit of the modulator valve includes the secondary winding of the transformer T and a grid bias battery. Connected across the transformer secondary winding is a condenser C_4 for the purpose of obtaining the desired response characteristic from the transformer.

One side of the primary winding of the transformer is permanently connected to L.T.+, and when the transmitter is in operation the other end of the winding is connected *via* the microphone to L.T.—.

10. The transmitter incorporates a side-tone arrangement which enables the operator to hear, in his head-telephones, the speech as radiated by the transmitter. This circuit can be traced from the anode of the modulator valve through the condenser C_5, and through the telephones to earth.

Receiver

11. A theoretical circuit diagram of the receiver is given in fig. 6. The receiver employs six valves, the first two being screen-grid R/F. These are followed by a detector, two A/F. amplifying valves, and an output valve. Three tuned circuits are employed, each circuit being

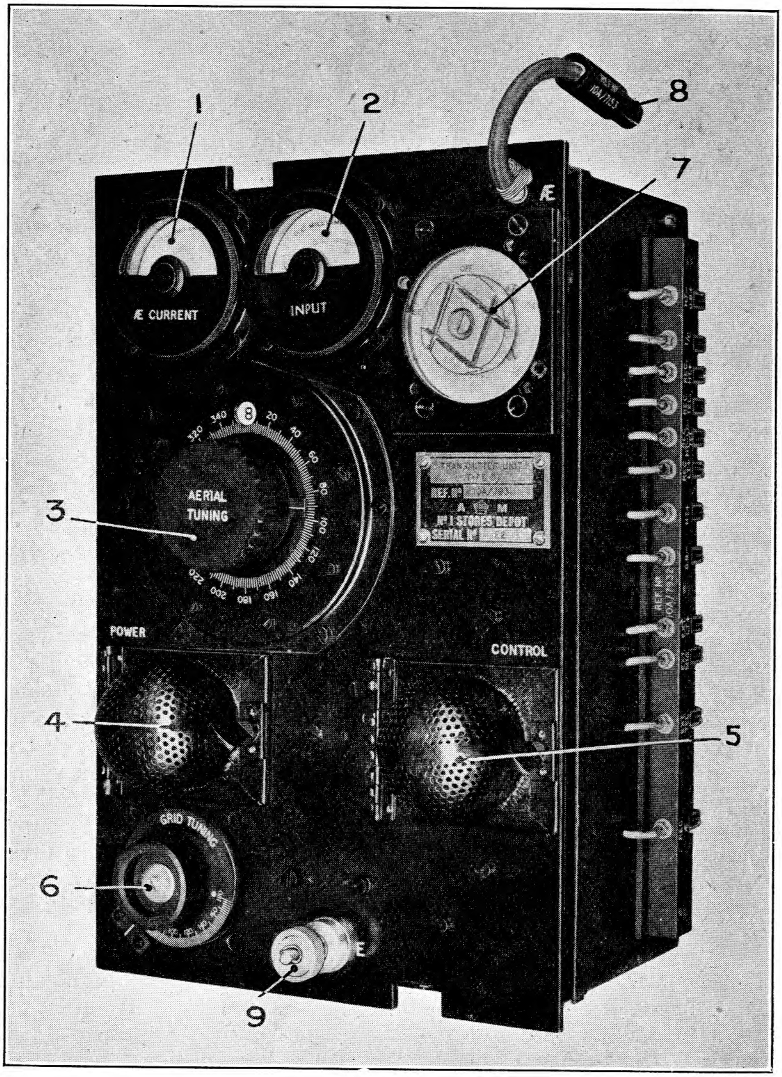
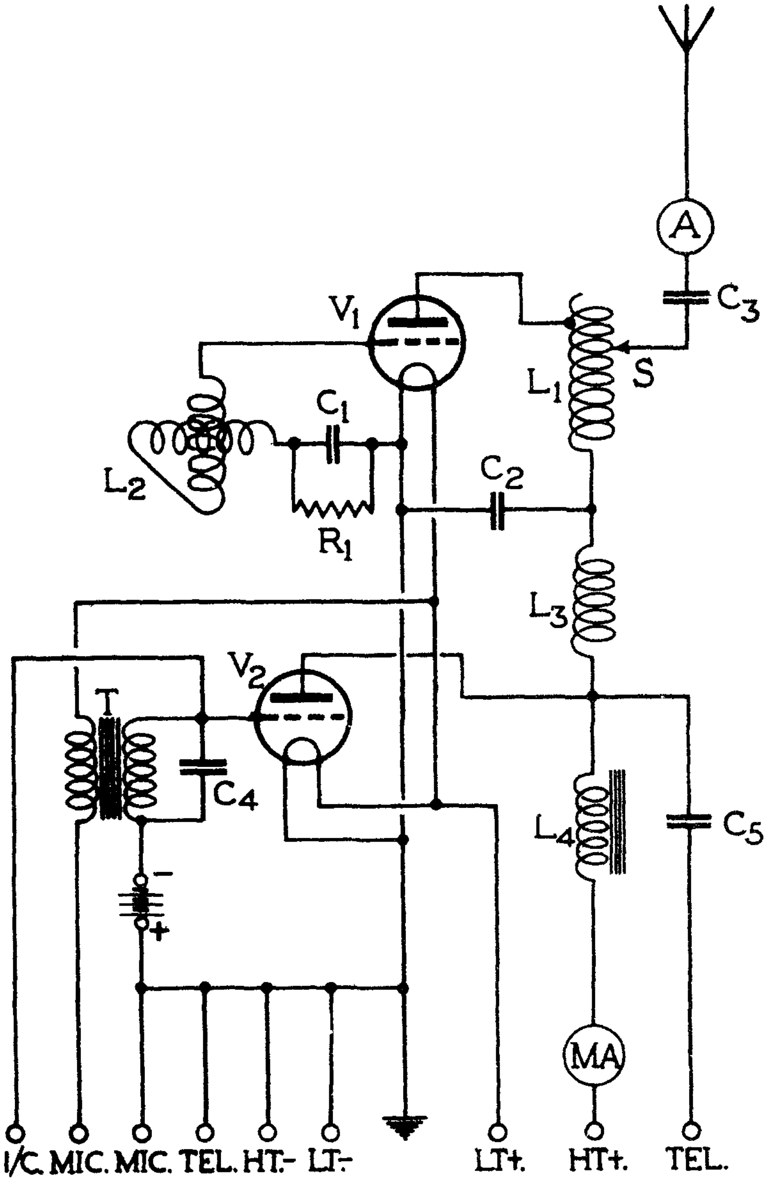


FIG. 2. Transmitter unit removed from case.



CONDENSERS	
C_1	·0002 μF
C_2	·001 μF
C_3	·002 μF
C_4	·0003 μF
C_5	·0005 μF
RESISTANCES	
R_1	45,000Ω

FIG. 3, THEORETICAL CIRCUIT DIAGRAM OF TRANSMITTER UNIT, TYPE. D.

Facing paras. 12-18

(F.1800). Wt. 9053. 4,250. 5/43. Gp.959. FOSH & CROSS LTD.

separately tuned by its individual variable condenser to the " spot " frequency. Across each of these main condensers is connected a small fine tuning condenser and the latter three are ganged together. The aerial is loosely coupled to the grid circuit of the valve V_3 through the condenser C_6, and a static leak R_3 is connected from the aerial side of the condenser to earth. The inductance L_5, which is of the plug-in type, is connected in the grid circuit of the valve and is tuned by the condenser C_7. The condenser C_8 is one of the ganged fine tuning condensers referred to previously in this paragraph. The condenser C_9 is not in use on the 6,000 to 4,300 kc/s range but is connected between two pins on the coil-holder so that it may be brought into use in parallel with other plug-in coils. The negative lead of the valve filament includes the biasing resistance R_4.

12. The screening grid of the valve is fed through the resistance R_5 with which is associated the coupling condenser C_{10}. The resistance is not connected directly to the H.T.+ line but terminates on one of the points of a three-point socket, the other two points being connected to H.T.+ and earth respectively. Variation of the screening grid voltage is accomplished by connecting, by means of a plug, a remote potentiometer device, incorporating a resistance R_6. Movement of a contact over the resistance varies the screening grid voltage. The condenser C_{11} shunts the effective portion of the potentiometer and serves to minimize the noise made when adjusting the potentiometer. The anode circuit of the valve V_3 includes the inductance L_6, which is tuned by means of a main condenser C_{12} and a ganged fine tuning condenser C_{13} in a similar manner to the inductance L_5. The moving vanes of the two variables are earthed to prevent body capacitance effects and, since the inductance is at H.T.+ potential, a blocking condenser C_{14} is inserted in the lead between the condenser and the inductance. A further small fixed condenser C_{15} is connected between the variable condensers and the inductance, for the purpose of opening out the tuning scale. The condenser C_{16} is for a similar purpose to C_9. It is not in use on the 6,000 to 4,300 kc/s band.

13. The anode of the valve V_3 is coupled to the control grid of the valve V_4 by means of the condenser C_{17}. A variable condenser C_{24} is connected between the anode of the valve V_3 and the anode of the valve V_4. This acts as the regeneration control, no other regeneration device being employed.

14. The screening grid of the valve V_4 is fed through the resistance R_9 with which is associated the decoupling condenser C_{18}. The potential of the screening grid is controlled simultaneously with that of V_3. A biasing resistance R_8 similar to R_4 is inserted in the negative filament lead, and a grid leak R_7 is connected between the grid of the valve and earth.

15. In the anode circuit of the valve V_4 is the third plug-in inductance tuned by the condensers C_{19} and C_{20}. The moving vanes are again earthed and a blocking condenser C_{21} is provided to isolate them from the H.T. Scale-opening and packing condensers C_{22} and C_{23}, similar to those on L_6, are provided.

16. The anode of the valve V_4 is coupled to the grid of the detector valve V_5 by means of the coupling condenser C_{25}, and a grid leak R_{10} is connected from the grid to L.T.— for rectification.

17. The anode circuit of the detector valve includes the dropper resistance R_{11}. Two decoupling condensers are associated with this resistance, one C_{26} being connected from the anode end to earth, and the other C_{27} being connected from the H.T. end to earth. The detector anode is coupled to the grid of the first A/F valve by means of the condenser C_{28}, and included in the grid circuit is a stopper resistance R_{12}. The grid of the valve V_6 is taken to a grid bias lead *via* a resistance R_{13}.

18. The anode of the valve V_6 is fed through a resistance R_{14}, which is decoupled by means of the condenser C_{29}. The anode of this valve is coupled to the succeeding grid circuit *via* the coupling condenser C_{30} and the grid of the valve V_7 is connected *via* the resistance R_{15} to the same grid bias tapping as the grid of V_6. A second connection extends from the grid of valve V_7 through a resistance R_2 and condenser C_{32} to a terminal marked I.C. This connection is

provided to enable the valves V_7 and V_8 to be used (in addition to their ordinary function) as amplifiers for inter-communication purposes, speech currents from the microphone being impressed on the grid of the valve V_7 *via* the microphone transformer and the connection referred to above. The amplified speech is reproduced in the head telephones.

19. The coupling between the valves V_7 and V_8 is again by means of resistance-capacitance. The resistance R_{16} in the anode circuit of V_7 has a value of 200,000 ohms and the anode is coupled to the succeeding grid by means of the condenser C_{31}. The grid of the last valve is separately biased, a connection being taken through the resistance R_{17} to a tapping on the grid bias battery. The anode circuit of the last valve includes the low frequency choke L_8, and the telephones are connected from the anode through the condenser C_{33} to earth. A condenser C_{34} is connected from H.T.+ to earth.

CONSTRUCTIONAL DETAILS

Transmitter unit, type D

20. Two views of the transmitter unit are given in figs. 2 and 4 and a bench wiring diagram in fig. 9. All the components of the unit are mounted on the underside of a metal panel which is fitted into a metal screening box. A sub-panel at right angles to the main panel and forming one side of the screening box, carries a row of spring jaw contacts, all connections, with the exception of the aerial and earth, being made through these contacts.

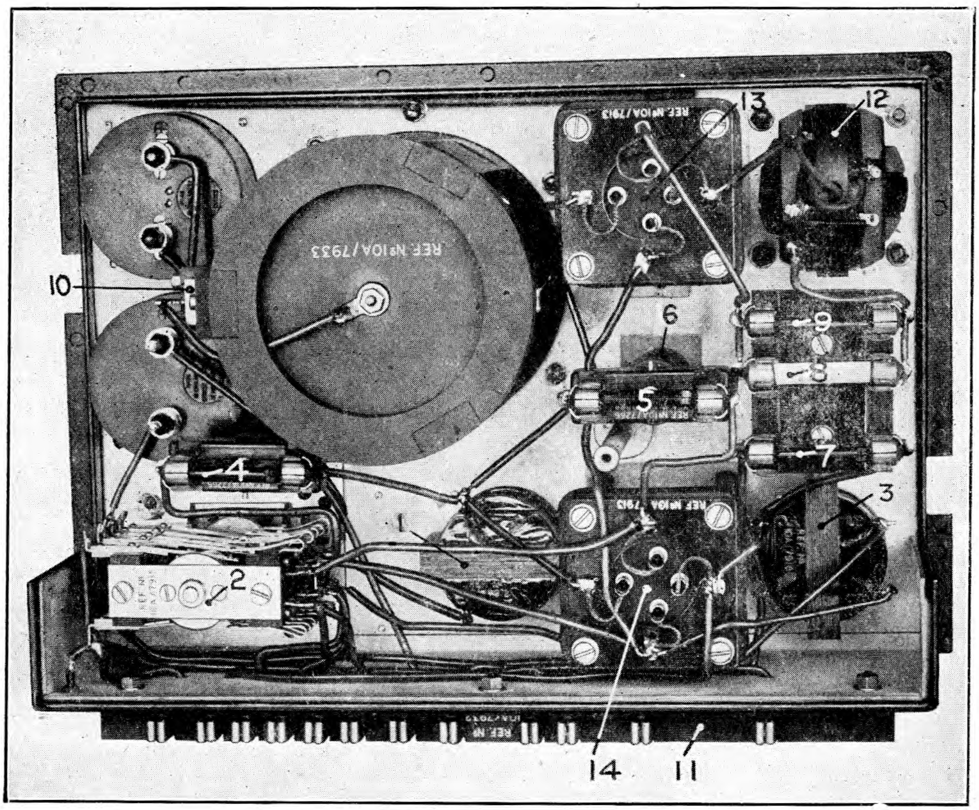


FIG. 4. Transmitter unit, underside view.

21. Referring to fig. 2, which shows the upper face of the panel, the aerial thermo-ammeter (1) reading 0 to ·5 amp., can be seen in the upper left-hand corner, the thermo-couple for the instrument being located inside the ammeter case. Adjacent to this is the H.T. milliammeter (2), which reads 0–30 milliamps. Both instruments are fitted with cover plates, that on the thermo-ammeter being engraved Æ CURRENT and that on the milliammeter INPUT. Immediately beneath the instruments is the aerial coil. This is a helical coil consisting of 17 turns of silver plated copper tube carried in a frame of composite insulating material fixed to the underside of the panel (*see* fig. 4). Projecting through the panel is a handle (3) which operates a variable tapping on the inductance. The variable contact consists of two spring blades mounted on a nut working on a long brass screw fixed in the centre of the coil. The pitch of the screw is similar to the pitch of the coil, and the screw is surrounded by a sleeve of insulating material slotted along its length to allow the contact to move axially. The sleeve turns with the handle and the spring contact thus travels around the turns of the coil. On the face of the panel a dial engraved in degrees is provided and the knob is provided with a pointer. At the zero position of the dial is a small window at which is displayed a number corresponding to the number of complete turns of inductance in circuit. Intermediate settings are read off against the pointer on the 360 degree scale. For example, a setting of 7½ turns would be indicated by a figure 7 at the window and a 180 degree setting of the pointer. The knob is engraved with the words AERIAL TUNING.

22. The valve-holders are carried on pillars on the underside of the panel and are reached through circular apertures cut in the panel. Over these apertures are fitted hinged perforated screening covers (4) and (5) held shut by screw-fasteners. The panel is engraved at the valve position with the words POWER and CONTROL respectively. Immediately beneath the power valve can be seen the handle (6) of the grid variometer. The handle is engraved with a 180 degree scale and the words GRID TUNING. The grid variometer, which is operated by this handle, can be clearly seen at (12, fig. 4). Both stator and rotor are of ebonite, the stator being wound with 20 turns of 26 s.w.g. D.C.C. wire and the rotor with 21 turns of similar wire.

23. Near the top of the panel on the right can be seen the dog coupling (7) of the send-receive switch. This switch is designed for remote control through a detachable coupling. The coupling is shown in position in fig. 1. The switch itself can be seen in the underside view of the panel (2, fig. 4), and the details of the switch are shown in fig. 16. The switch comprises a drum of insulating material housed in a frame, the drum carrying two rows of projecting studs, the two rows being separated around the drum by 90 degrees of arc. The frame carries two rows of spring contacts, one row on each side, and by rotating the drum through 90 degrees one or other set of spring contacts is closed by the projecting studs. In the intermediate or off position all contacts are open.

24. Referring to the simplified diagram of connections in the lower part of the illustration (fig. 16), it will be seen that there are six pairs of contacts on the "receive" side and five pairs on the "send" side. In the send position the aerial is connected (at contact F) to the transmitter through the aerial ammeter. The anode circuits of the transmitting valves are connected (at contact E) to H.T.+. The telephones are connected (at contact D) through the side-tone condenser to the anode of the modulator valve. The transmitter L.T.+ connection is made (at contact C) to the L.T.+ supply, and (at contact A) the transmitter L.T.− filament connection is joined to the L.T.− supply, H.T.− supply, G.B.+, one side of the telephones, one side of the microphone and earth. In the "receive" position the aerial is transferred (at contact F) to the receiver. The H.T.+ and milliammeter connections are transferred to the receiver (contact E). The telephones are transferred (contact D) to the receiver. At contact C the L.T.+ connection to the transmitter is re-established (this is for the purpose of completing the microphone transformer circuit). At contact B the L.T.+ supply is connected to the receiver, and at contact A the filament circuit of the transmitter is broken and the L.T.−, H.T.− and G.B.+ are transferred to the receiver.

25. The only other items to be seen on the front panel are the aerial connection (8, fig. 2), which consists of a flexible lead terminating in a plug connection, and the earth terminal (9) bolted to the metal panel of the instrument.

26. The modulating choke (1) which may be seen adjacent to the switch (2) in fig. 4, comprises a core of " radio metal " stampings with a winding of 4,500 turns of 38 s.w.g. enamel and S.S.C. copper wire. The microphone transformer (3) (near the modulator valve-holder) comprises a core of " radio metal " stampings with a primary winding of 200 turns of 34 s.w.g. enamel and S.S.C. copper wire, and a secondary winding of 8,000 turns of 42 s.w.g. enamel and S.S.C. copper wire.

27. Situated under the panel are three platforms, two of which carry a pair of clips while the third carries three pairs of clips. The clip (4) situated near the switch carries a condenser, type 113 (·0005 μ F), which is connected in series with the telephones across the anode circuit for side-tone purposes. The clip (5) situated on the end of the R/F. choke (6) carries a condenser, type 71 (0·001 μ F), which is connected between the end of the aerial inductance and L.T.—, and acts as a mains oscillating condenser. The third platform carries in the lower clip (7) the grid condenser, type 69 (·0002 μ F), and in the adjacent clip (8) is carried the grid leak (45,000 ohms). In the upper clip (9) is carried a type 70 condenser (·0003 μ F) shunting the secondary winding of the microphone transformer. The aerial blocking condenser (15) is a type 24 (·002 μ F) and is secured to the side of the aerial inductance former. The R/F. choke (6) which can be seen under the mains oscillating condenser consists of a cylindrical former of composite insulating material wound closely with 38 s.w.g. D.S.C. copper wire and has an inductance of approximately 325 mics.

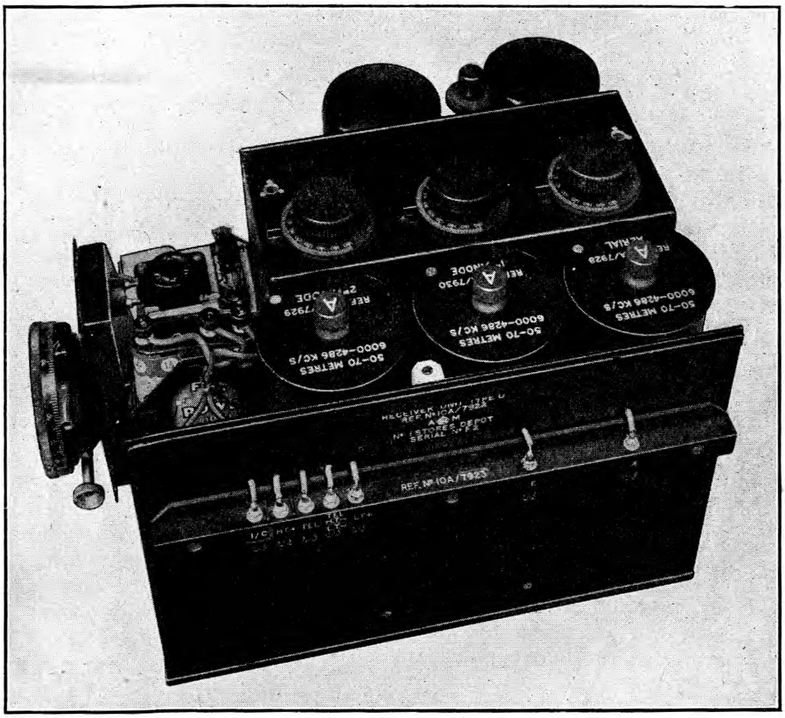
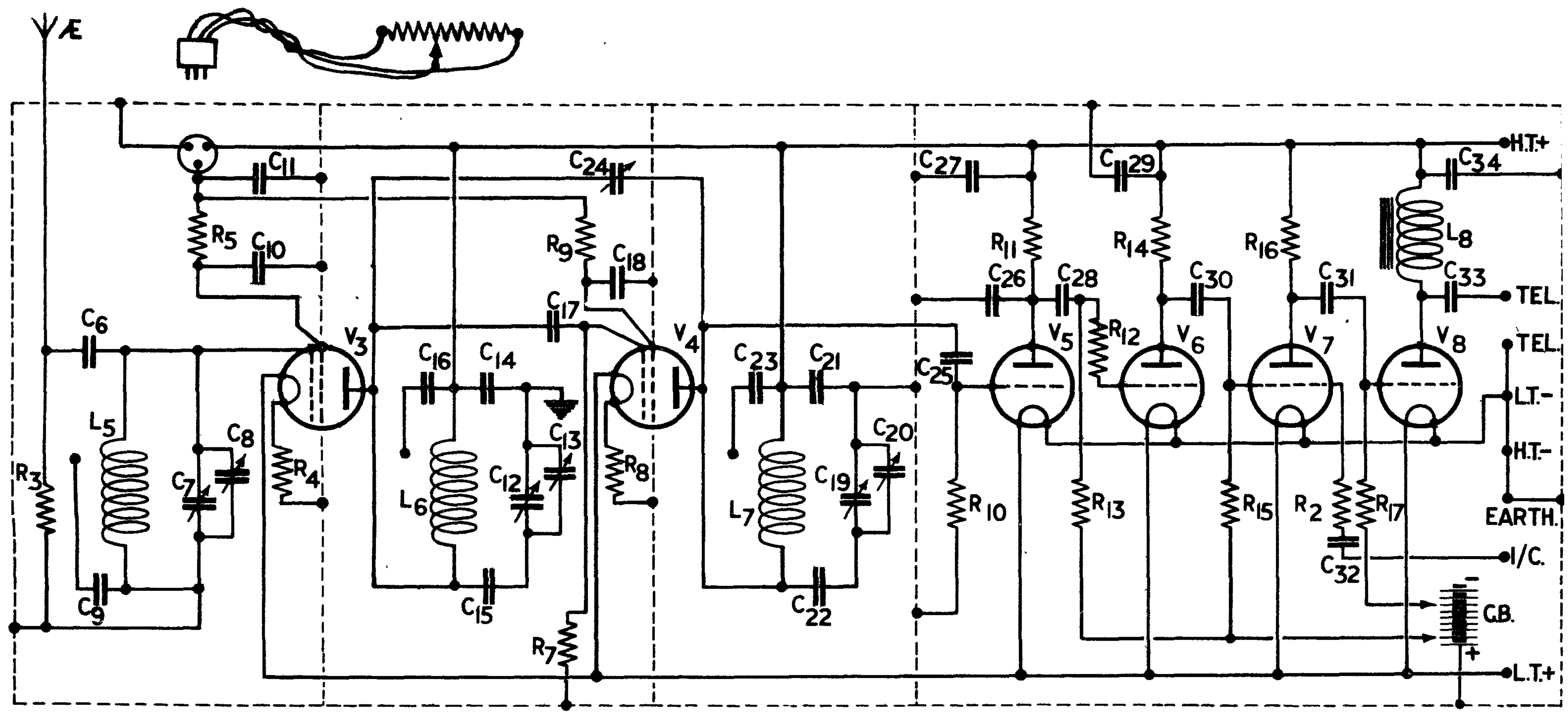


FIG. 5. Receiver unit with coils in position, cover removed.



CONDENSERS µF								RESISTANCES. OHMS			
C_1		C_{10}	·5	C_{19}	·00025 variable	C_{28}	·001	R_1	In transmitter unit	R_{10}	·25 MΩ
C_2	In	C_{11}	·5	C_{20}	·00005 variable	C_{29}	·5	R_2	·5 MΩ	R_{11}	100,000
C_3	Transmitter	C_{12}	·00025 variable	C_{21}	·5	C_{30}	·001	R_3	·5 MΩ	R_{12}	2 MΩ
C_4	unit	C_{13}	·00005 variable	C_{22}	·01	C_{31}	·001	R_4	1·5	R_{13}	1 MΩ
C_5		C_{14}	·5	C_{23}	50 µµF	C_{32}	·0001	R_5	20,000	R_{14}	20,000
C_6	50 µµF	C_{15}	·01	C_{24}	10 µµF variable	C_{33}	·5	R_6	50,000 variable	R_{15}	1 MΩ
C_7	·00025 variable	C_{16}	50 µµF	C_{25}	·0001	C_{34}	2·0	R_7	1 MΩ	R_{16}	200,000
C_8	·00005 variable	C_{17}	·0003	C_{26}	·001			R_8	1·5	R_{17}	1 MΩ
C_9	50 µµF	C_{18}	·5	C_{27}	·5			R_9	200,000		

FIG 6. THEORETICAL CIRCUIT DIAGRAM OF RECEIVER UNIT, TYPE D.

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28. The contact bar (11) on the side of the transmitter is fitted with 12 spring jaw contacts which, when the instrument is fitted into its case, mesh with the 12 knife contacts on a contact bar (*see* para. 36). In the top right-hand corner may be seen the grid variometer (12), and to the left of it the oscillator valve-holder (13). The modulator valve-holder (14) is to the left of the microphone transformer (3).

Receiver unit, type D

29. Three views of the receiver are given in figs. 5, 7 and 8, and in fig. 1 it is shown with its screening cover in position and fitted into the transmitter-receiver. A bench wiring diagram is given in fig. 10. The receiver unit case and screening cover are of metal and the components are fitted above and below a main horizontal panel. The space below the panel which is approximately 2 in. deep is divided into four compartments (*see* fig. 8), and screening boxes are fitted on the top of the panel over the condensers, inductances and screen-grid valves (*see* fig. 5).

30. At right angles to the main panel is the sub-panel, also of metal, carrying seven spring jaw contacts through which all connections are made when the unit is in place in its case. Referring to fig. 7 (cover, valves, and coils removed from the instrument), it will be seen that the condenser box (1) occupies the centre portion of the panel, and the valve-holders and coil-holders are grouped around it. The condenser box houses six variable condensers. Three of these (·00025 μF. each) are mounted with their axes vertical and are independently controlled by three slow-motion handles (2), (3), (4). The other three (·00005 μF. each), which are in parallel with the above, have their axes horizontal and are simultaneously rotated by means of a common spindle (5) and handle (6). This handle is arranged for remote control. The condenser box is divided up into compartments so that the three pairs of condensers are screened from one another, and all the moving vanes of the variable condensers are earthed to the frame. Two ·01 μF. fixed condensers are located inside this box, and are connected as blocking condensers in the lead between the fixed vanes of the anode tuning condensers and the anode inductances. The pair of aerial tuning condensers is connected directly across the aerial inductance without any series condenser.

31. Immediately in front of the condenser box are the three coil-holders. These are of the five-pin type, the pins engaging with sockets on the base of the coils. The coils can be seen in position in fig. 5. On the other side of the box can be seen the two screen-grid valve-holders complete with their screening cases. A felt ring is provided in each of these cases to prevent accidental contact between the metal coating of the valves and the earthed casing. It is important that there should be no contact here as, owing to the inclusion of the 1·5 ohm biasing resistances in the filament circuit, the metal coating is not at earth potential.

32. Mounted on the condenser box, in a position between the two screen-grid valves, is the regeneration control (7). This consists of a small condenser of the " pre-set " type having a maximum capacitance of 10 μμF., and it is connected between the anodes of the two screen-grid valves. As will be seen from fig. 5, the handle of this condenser projects through a small aperture in the screening cover of the receiver. The other valve-holders which are of the standard type are arranged in the following order :—detector (adjacent to the screen-grid valve), first A/F. valve, second A/F. valve and output valve. Between the detector and first A/F. valve is mounted a holder (8) carrying a ·001 μF. condenser. This is connected between the anode of the detector valve and earth. Between the first and second A/F. valve is mounted a holder (9) carrying a 2 megohm resistance which is connected as a " stopper " resistance in series with the grid of the first A/F. amplifying valve. The holder (10) situated near the output valve-holder carries a ·5 megohm resistance. This resistance is in series with the condenser (11), the two being inserted in the inter-communication lead between the grid of the second A/F. valve and the secondary of the microphone transformer. The $4\frac{1}{2}$-volt grid bias battery (12) is also situated here, one of the negative tapping leads from which is taken to the grid of the first and second A/F. valves, the other being taken to the output valve. The three-point socket (13) serves for connecting up

by means of a three-pin plug, the remote volume control. Two of the points of the socket are connected to earth and H.T.+ respectively. The third is connected to the screening grids of the R/F. valves.

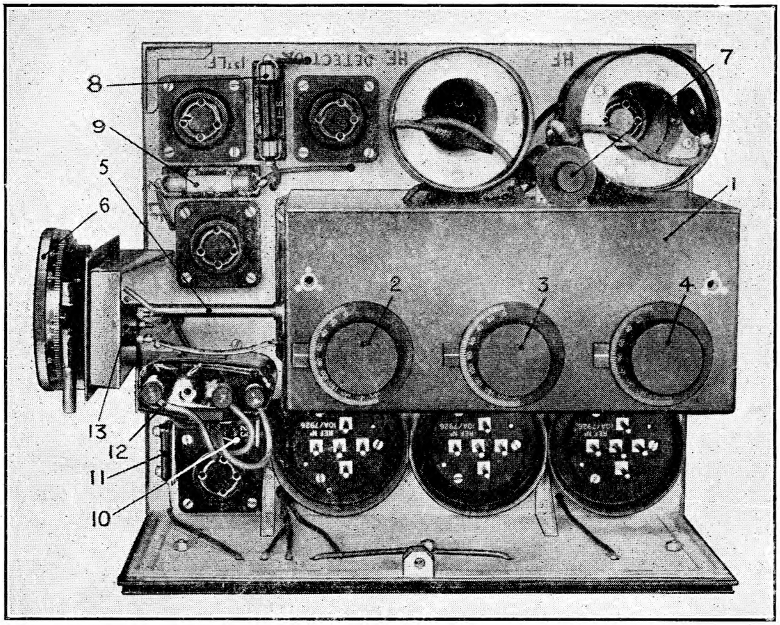

FIG. 7. Receiver unit (cover, coils and valves removed).

33. Referring to fig. 8, which shows the underside of the panel; in the left-hand compartment can be seen the base (1) of the first screen-grid valve-holder, and adjacent to it the 1·5 ohm grid bias resistance (2) which is in series with the L.T.— filament lead. The tin-cased condenser (3), which has a value of ·5 μF., is connected between the screening grid of the valve and earth. The panel (4) carries four clips. In the first clip (5) is a ·00005 μF. condenser connected between earth and the centre pin of the aerial coil-holder, which is intended to function as a packing condenser when such is required across the aerial inductance. The " A " coils have no connection on the centre pin and on this range the condenser is inoperative. The next clip (6) carries a similar condenser which is connected between the grid end of the aerial inductance and aerial. This condenser is the only coupling between the aerial inductance and the aerial. In the next clip (7) is carried a ·5 megohm resistance which is connected from the aerial side of the above-mentioned condenser to earth to act as a static leak. A 20,000 ohm resistance is carried in the next clip (8), and is connected in series with the screening grid of the first valve. At the end of the compartment is the base (9) of the aerial coil-holder.

34. In the adjoining compartment is the base of the second screen-grid valve-holder (10), a similar 1·5 ohm biasing resistance (11) and a ·5 μF. tin-cased condenser (12) connected from screening grid to earth. The tin-cased condenser (13), which also has a value of ·5 μF., virtually completes the oscillatory circuit between the earthed moving vanes of the anode tuning condenser and the high potential end of the anode inductance. Of the four clips on the centre panel the first (14) carries a ·00005 μF. condenser. This is connected to the coil-holder pins in a similar manner to the condenser (5) on the aerial inductance. It is likewise inoperative with the " A " coils. The next clip (15) carries the coupling condenser (·0003 μF.) connected between the anode of the first R/F valve and the grid of the second. The clip (16) carries a 1 megohm resistance which is connected between the control grid of the second R/F. valve and earth. The 20,000 ohm resistance in the next clip (17) is in series with the screening grid of the second valve.

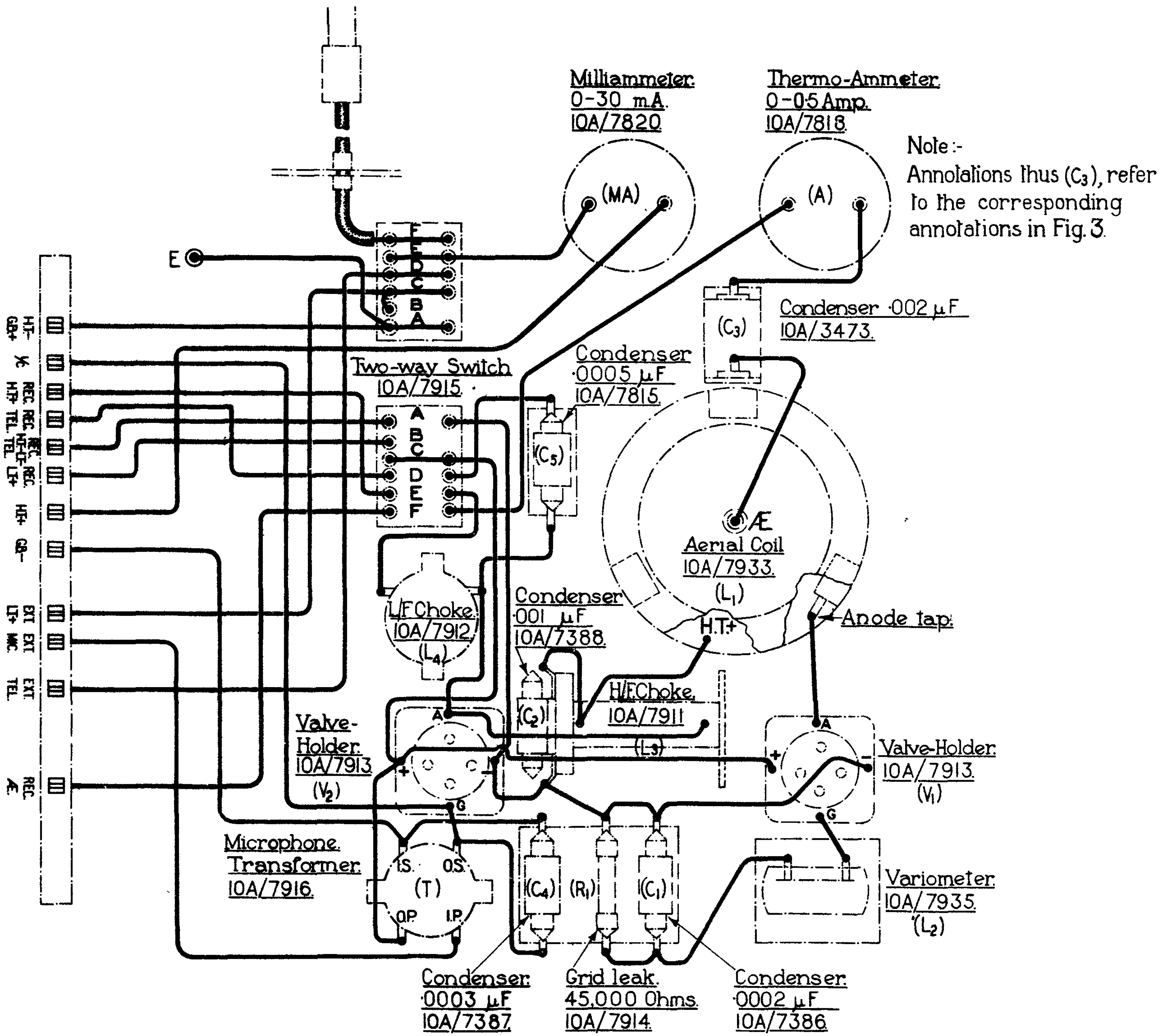

FIG. 9. DIAGRAM OF TRANSMITTER UNIT. TYPE D.

(F.1800). F. & C. LTD.

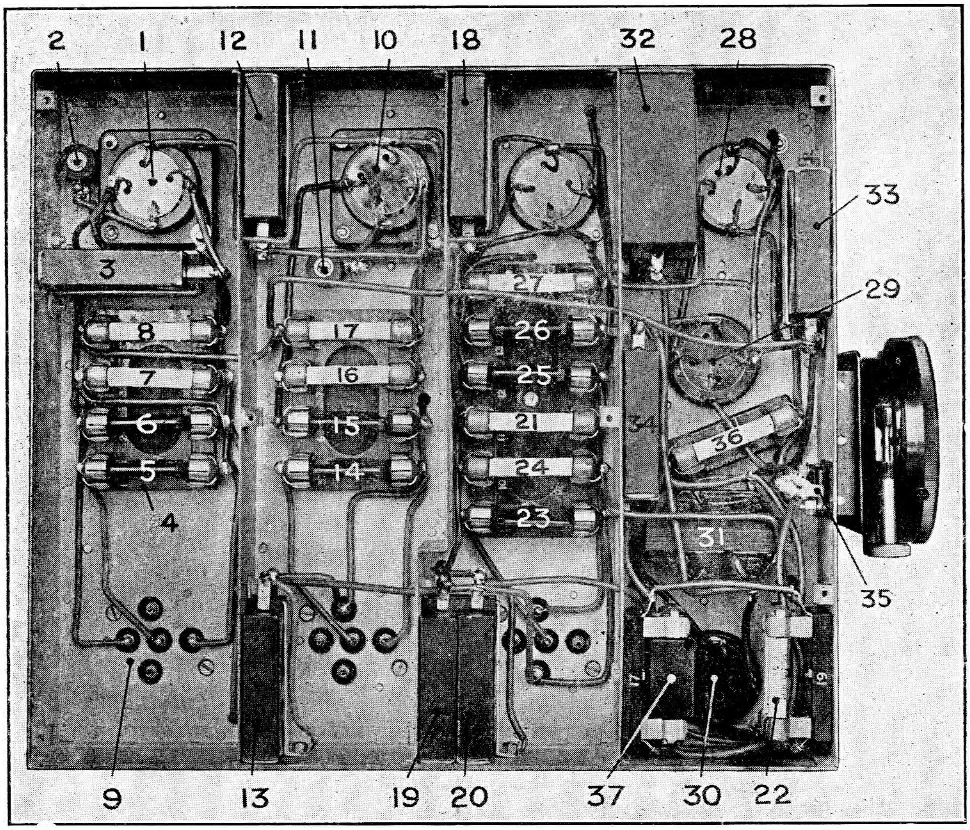

FIG. 8. Receiver unit, underside view.

35. The next compartment contains three tin-cased condensers, each of which has a capacitance of ·5 μF. The condenser (18) near the valve-holder is a series blocking condenser which carries out a similar function to the condenser (13) previously mentioned. The condensers (19) and (20) are joined together at one side and the common connection earthed. The other sides are connected to the high potential ends of the resistances (21) and (22) to act as decouplers. The first clip (23) on the centre panel carries a ·00005 μF. condenser which is connected to the centre pin of the coil-holder in the same manner as the "packing" condensers (5) and (14) previously described. It is inoperative with the "A" coils. The next clip (24) carries a 1 megohm resistance connected in the grid bias lead of the first A/F. valve. The 100,000 ohm resistance (21) is in the anode circuit of the detector valve and the ·001 μF. condenser in the next clip (25) couples the anode of the detector valve to the succeeding grid. The ·0001 μF condenser in the adjacent clip (26) is the detector grid condenser and the ·25 megohm resistance (27) the grid leak.

36. In the right-hand compartment can be seen the bases of the three valve-holders (28), (29), (30) for the A/F. valves and also the output choke (31). Three tin-cased condensers are fitted in this compartment. The condenser (32) in the corner has a capacitance of 2 μF. and is connected as a decoupling condenser from the high potential side of the output choke to earth. Of the other two condensers (33) and (34), each of which has a capacitance of ·5 μF., one is connected from the anode of the output valve to one side of the telephones, the other is connected between the mid-point of the three-way volume control socket and earth. The small condenser (35)

which has a value of ·001 μF., is the coupling condenser between the anode of the first A/F. valve and the grid of the second. The resistance in the holder (36) has a value of 20,000 ohms and is connected in the anode circuit of the first A/F. valve. In the corner of the compartment are two small panels. The one on the left carries a ·001 μF. condenser (37) and a 1 megohm resistance, the former being the coupling condenser between the anode of the second A/F. valve and the grid of the output valve, and the latter the grid resistance in the grid bias lead to the output valve. The panel on the right carries the 200,000 ohm anode resistance (22) of the second A/F. valve and also the 1 megohm resistance in the grid bias lead of the second A/F. valve.

Coils

37. The receiver coils, of which there are three, are shown in position in fig. 5. The three coils form: the aerial inductance, first anode inductance and second anode inductance. They are engraved on their top plates with the words AERIAL, 1ST ANODE and 2ND ANODE respectively and, in addition, with the Stores Ref. No. and the range in metres and kilocycles. As a precaution against incorrect insertion each of the coils has a coloured dimple which corresponds with a similarly coloured dimple on the cover of the receiver. The colour for the aerial coil is red; for the 1st anode, green and for the 2nd anode, yellow. Each coil unit consists of a zinc sprayed aluminium container approximately 2½ in. diameter and 5½ in. long, closed at the top with a circular duralumin cover plate to the centre of which is fitted an ebonite lifting knob. In the other ends of the container is fitted a circular ebonite plate drilled with five holes into which are pressed brass bushes. On the inside face of the ebonite plate are five special phosphor-bronze spring contacts. Inside the metal container is the coil former carried on four short ebonite pillars mounted on the ebonite end plate. The coil former consists of an ebonite tube with external longitudinal flutes. A thread is cut around the former with a pitch of seven turns to the centimetre, and bare tinned copper wire is wound in the groove so formed. The windings of all three coils are similar, *viz.*, fourteen turns of 20 s.w.g., but the connections of the ends of the coils to their bases are different. Fig. 15 shows the three different arrangements of connection for the three coils.

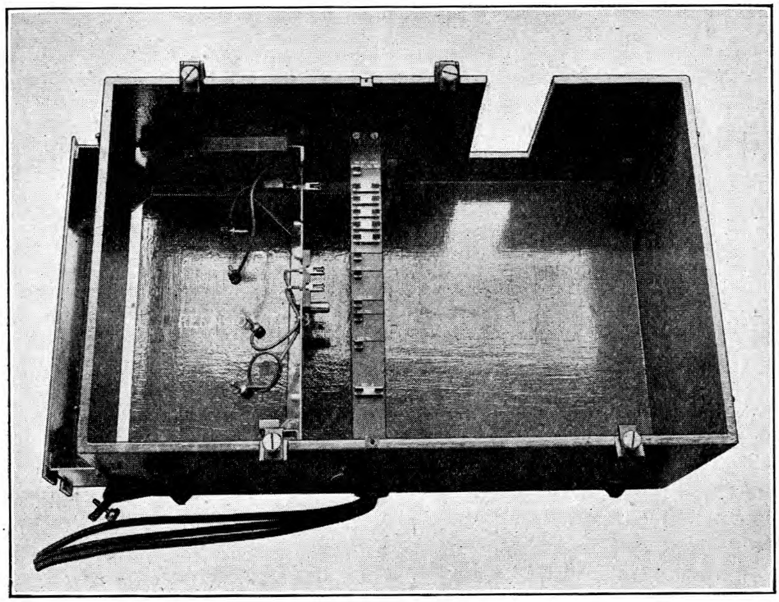

FIG. 11. T.R.9 case, transmitter and receiver units removed.

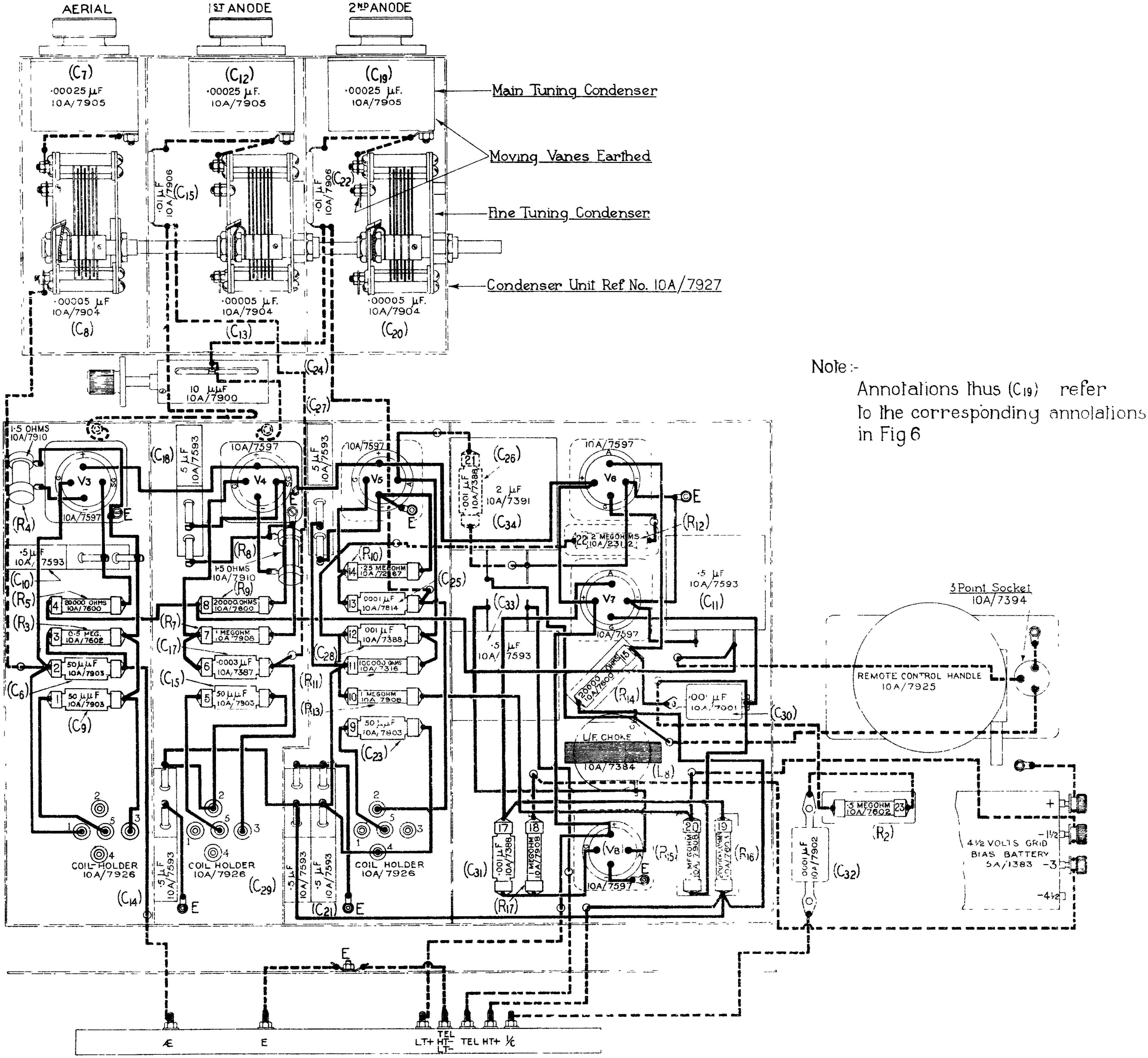

FIG. 10 BENCH WIRING DIAGRAM OF RECEIVER UNIT, TYPE D.

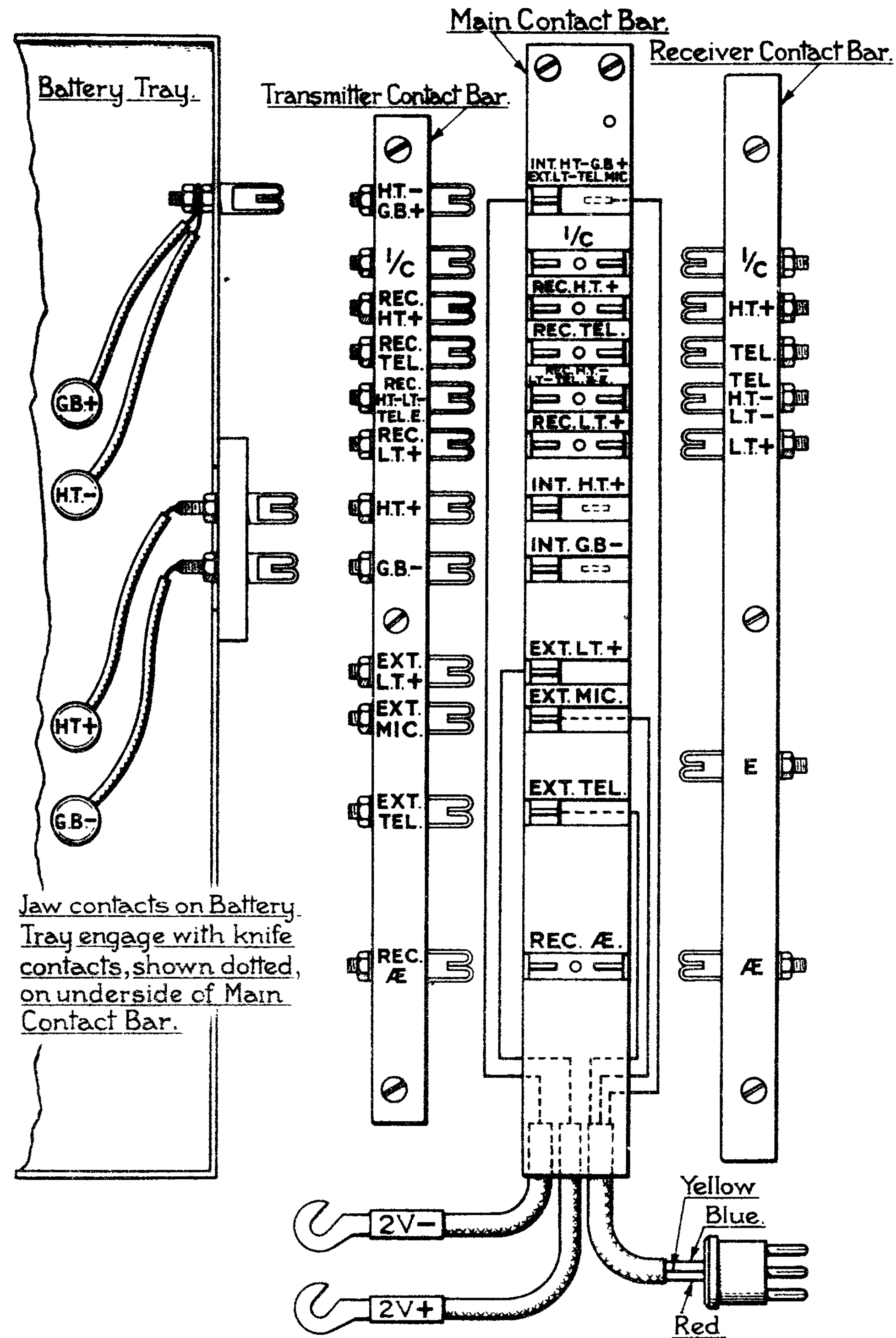

FIG 12 CONTACT CONNECTIONS OF TRANSMITTER, RECEIVER AND BATTERY TRAY WITH MAIN CONTACT BAR

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Case

38. The transmitter and receiver units are housed together in a special case, and are shown in position in fig. 1. In fig. 11 the case is shown with the units removed. It is constructed of wood covered with fabric and painted grey. A main contact bar (fig. 12) is fitted within and from the underside of the contacts flexible connections are taken out through a bush. When the units are in position, spring jaw contacts on each unit engage with the knife contacts on the bar. One end of the case is cut away and a tray is slid in, occupying a position under the transmitter unit. This tray carries the common H.T. battery for the transmitter and receiver and the grid bias battery for the transmitter. By means of four flexible leads terminating in plugs, the batteries are connected up to three spring contact jaws on the tray, and when the tray is in position these three spring jaws engage with three knife contacts on the underside of the main contact bar. The engravings near the various contacts are clearly shown in fig. 12. The transmitter contact bar and receiver contact bar are shown disengaged from the main contact bar, and on the left is the tray withdrawn from engagement. It should be noted that the tray passes under the transmitter contact bar.

Transit case

39. A transit case is provided for carrying the transmitter-receiver. It is constructed from yellow deal painted grey. The dimensions are approximately 1 ft. 9 in. × 1 ft. $3\frac{3}{4}$ in. × $10\frac{3}{4}$ in., and the case accommodates the completely assembled instrument. The hinged lid is securely fastened with screw catches, and two metal carrying handles are provided.

REMOTE CONTROL

40. In single-seater aeroplanes the wireless apparatus is usually installed behind the pilot's cockpit and, to enable the pilot to operate the instruments, remote control apparatus must be employed. The apparatus used for this purpose with the T.R.9 is illustrated in fig. 17. The remote controller (*see* fig. 13) comprises an aluminium casing carrying three handles, two of which operate through a modified form of bowden cable, the other operating electrically. The design is such that the controller may be separated into two units, the mechanical portion (Stores Ref. 10A/7939) and the electrical portion (Stores Ref. 10A/7937). In fig. 13 they are shown assembled as one unit (Stores Ref. 10A/7936). The mechanical portion consists of two rotatable metal plates with portions cut away for lightness. Each plate is operated by a separate handle and the movement of the plates is transmitted to the SEND-RECEIVE switch and receiver condenser by flexible shafts sliding in solid drawn brass tubes. The flexible shaft clamped to one of the plates terminates at its other end on the receiver condenser head and operates this condenser in the manner described in para. 6. Movement of the controller handle from 0 to 180 on the scale causes the ganged condensers on the receiver to rotate through 180 degrees. The flexible shaft clamped to the other plate terminates at its other end on the send-receive switch. The operating handle may be placed in either of three positions marked SEND, OFF, RECEIVE, and is provided with a bolt for locking it in the "Off" position. The operation of the handle moves the barrel of the switch unit into either of its three positions as explained in para. 23.

41. The electrical portion of the controller which provides for remote volume control of the receiver is carried in a moulded cover (*see* fig. 13). Twenty-one fixed resistances are mounted in an ebonite former which is secured to the inside of the cover. The resistances are connected in series (*see* fig. 14), and connections are taken from the junction points to 20 brass contact studs mounted in a ring of composite insulating material. Over these contact studs travels a phosphor-bronze contact brush which makes contact between the contact studs and a slip-ring. The brush is rotated by a moulded handle which is engraved with a 0 to 20-scale, and

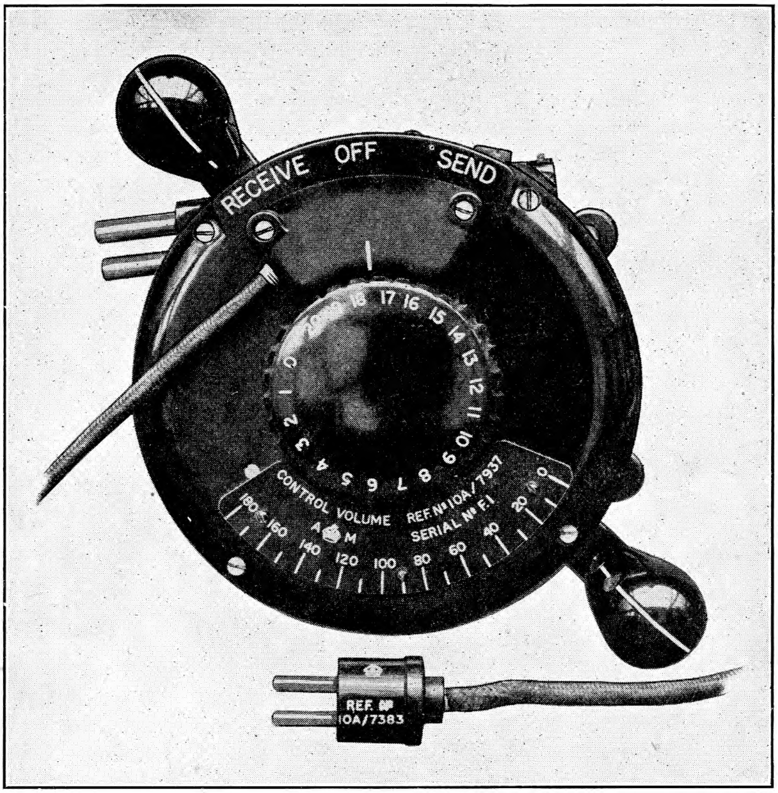


FIG. 13. Remote controller.

a 3-core flexible cable is led into the controller, the three cores being coloured blue, red and yellow. The blue and yellow cores are connected to the ends of the first and last resistances, and the red core to the slip-ring. The other end of the 3-core flexible cable terminates in a 3-pin plug which engages with a socket on the receiver, the yellow lead being thereby connected to H.T.+, the blue lead to H.T.— and the red lead to the screening grids of the two R/F valves. As a result, the total resistance of the controller (57,900 ohms) is connected across the H.T. supply, and the movement of the brush simultaneously varies the potential applied to the two R/F screening grids between approximately 10 and 110 volts.

42. It will be observed that the values of the resistances have been chosen so as to produce a " tapered " control. When the moulded handle is turned in a clockwise direction, the dial reading progressively increases, but the voltage applied to the screening grids increases at first slowly and then rapidly. For the first part of its rotation it passes over resistances of comparatively small value and the voltage drop over these being small (of the order of one volt per 500 ohms), a variation of about 16 volts occurs over the first 10 studs (half the scale). Movement of the handle over the next 5 contacts, however (from 10 to 15), gives an increase of over 20 volts. Over the remainder of the scale an increase of approximately 62 volts results. It will be seen that this arrangement effectively provides for smooth adjustment of the screen grid voltages around the values generally required in operation.

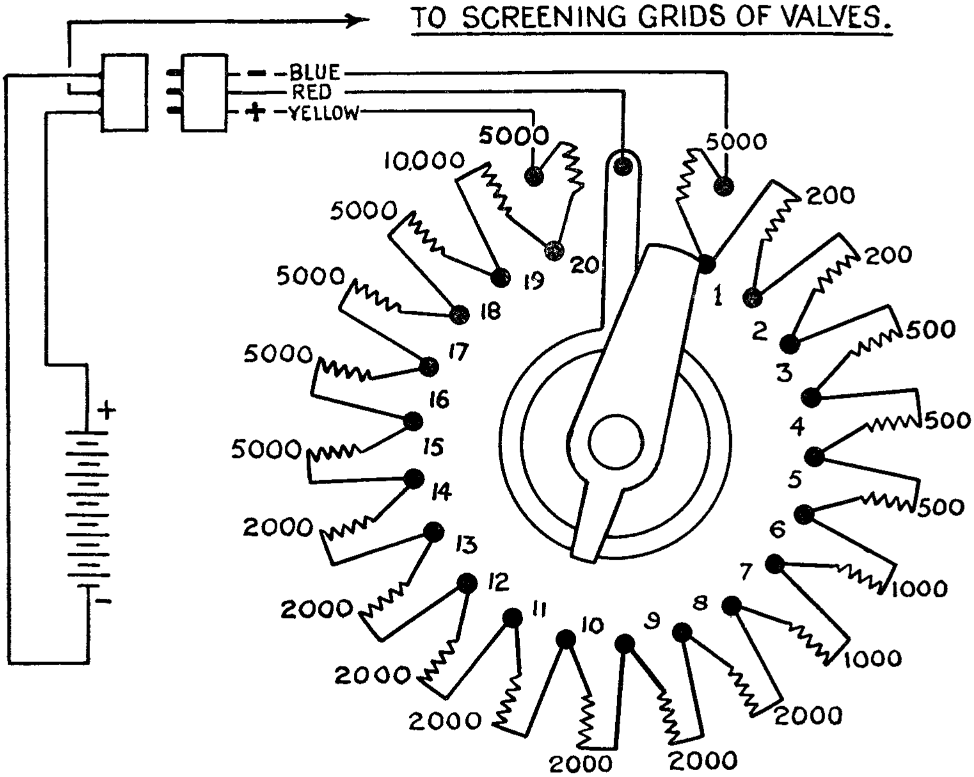


FIG. 14. Diagram of electrical portion of remote controller.

VALVES AND BATTERIES

43. Both oscillator valve and modulator valve in the transmitter are of the same type, *viz.*, V.T.20, having a filament consumption of ·2 amp. at 2 volts. The receiver employs two screen-grid valves (V.R.S.G.18) having a filament consumption of ·15 amp. at 2 volts, a detector valve and two A/F valves (V.R.21) having a filament consumption of ·1 amp. at 2 volts and an output valve (V.R.22) having a filament consumption of ·2 amp. at 2 volts.

44. The current for the transmitter and receiver filaments is supplied from a 2-volt accumulator (Stores Ref. 5A/1387). The H.T. supply for both transmitter and receiver is obtained from a 120-volt dry battery (Stores Ref. 5A/1333) housed in the case of the transmitter-receiver.

45. A maximum load of 15–18 milliamps is imposed upon the H.T. battery when the transmitter is in use. The battery should be tested frequently and, if the reading on load is less than 100 volts, the battery should be replaced. A 15-volt grid bias battery is employed to bias the modulator valve of the transmitter and a 4½-volt grid bias battery is employed to bias the A/F valves and output valve of the receiver. The 15-volt battery is housed with the H.T. battery in the special tray in the transmitter-receiver case, but the 4½-volt battery is accommodated in the receiver itself.

INSTALLATION

46. A typical installation diagram for a single-seater fighter is given in fig. 18. The whole of the apparatus is carried on a tray slid into position on runners and situated behind the pilot's cockpit. The tray complete with instruments and batteries may be withdrawn from the

aeroplane by releasing two bolts which engage with the runners. The H.T. and G.B. batteries for the transmitter and receiver are located in the instrument case.

47. The aerial connection is made by means of a flexible lead on the transmitter terminating in a plug connection. The earth connection is made by means of a flexible connection between a terminal on the panel of the instrument and a spring terminal on the aeroplane frame. A three-core cable terminating in a three-pin plug extends from the instrument and engages with a three-point socket on the aeroplane. From this socket leads are taken to the microphone and telephone circuits. In a two-seater aeroplane duplicate telephone and microphone positions are wired to the socket to allow inter-communication, the receiver being utilized for the inter-communication amplifier.

48. When the send-receive switch is in the " receive " position the microphone is still connected through its transformer to the A/F. amplifying parts of the receiver, speech currents are impressed on the grid of the second A/F. valve and speech is heard in the telephones (which are now in the anode circuit of the last valve) in the same way as the incoming R/T. signals.

49. As will be seen from the illustration, the remote control connections extend from the instrument to a convenient position for operation. They comprise two solid-drawn brass tubes with internal flexible shafts and a metal-braided electrical cable. The two flexible shafts operate the tuning condensers and send-receive switch respectively, and terminate at the instrument in detachable fittings, that at the switch taking the form of a coupling incorporating a rack, and that at the condenser being a condenser-head incorporating special mechanism. The metal-braided electrical cable is in the screen grid control circuit and terminates in a three-pin plug which engages with a three-point socket on the instrument. The remote controller carries three handles, one for each of the above-mentioned controls.

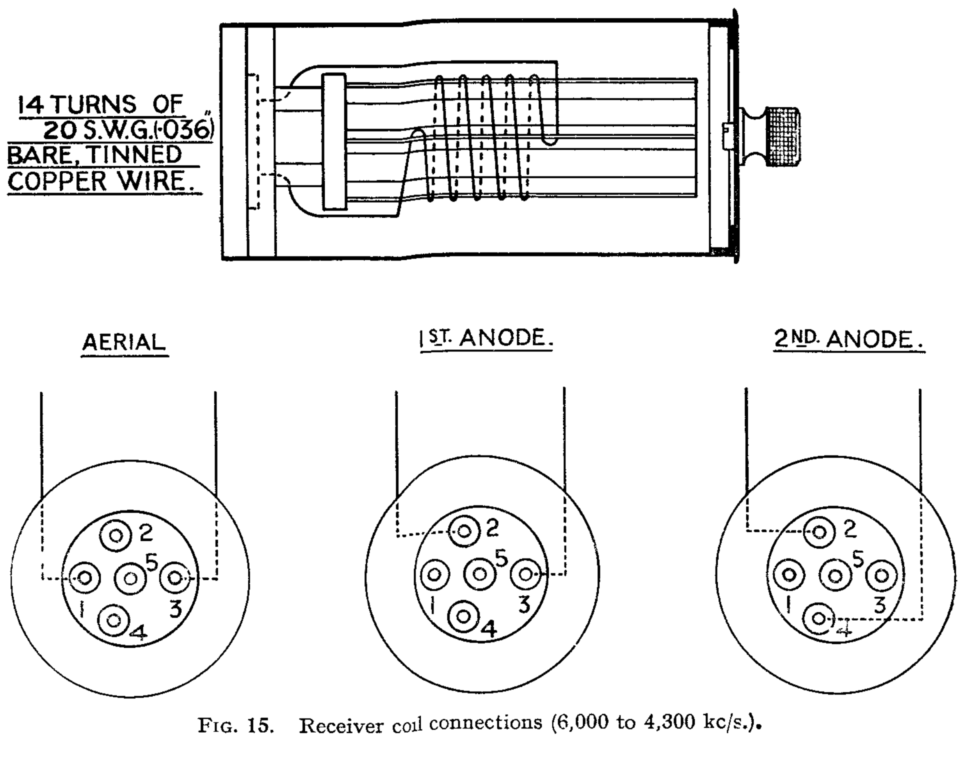
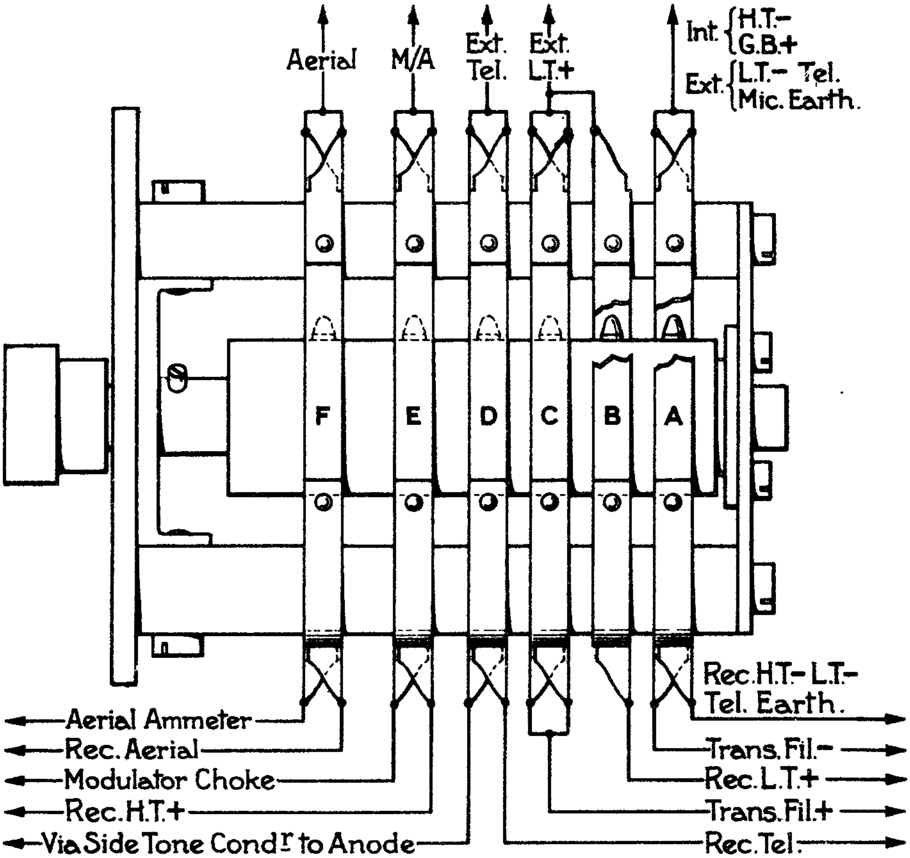
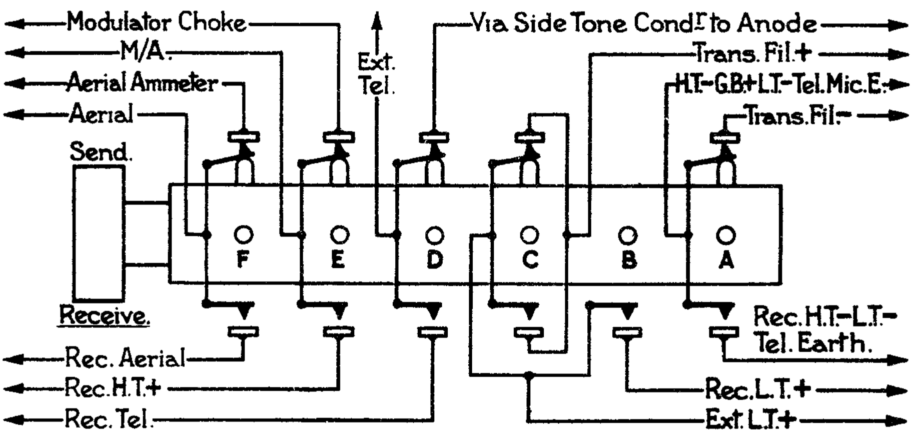


FIG. 15. Receiver coil connections (6,000 to 4,300 kc/s.).



Wiring Diagram.



Simplified Diagram.

FIG. 16, SEND - RECEIVE SWITCH

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OPERATION

Adjustment of the transmitter

50. Wavemeter W.69, described elsewhere in this publication, should be used to adjust the frequency. Place the wavemeter about 6 ft. from the aerial and in such a position that the micro-ammeter on the wavemeter is clearly visible from the cockpit of the aeroplane. Adjust the wavemeter to the desired frequency.

51. Before switching on, adjust the aerial coil and grid variometer on the transmitter to approximately the required frequency. It should be noted that with the grid variometer at maximum the aerial coil should also be at its maximum adjustment, but with the grid variometer at zero the corresponding aerial coil adjustment is about six turns.

52. Set the send-receive switch to SEND and observe the readings on the aerial ammeter and the H.T. milliammeter. The aerial current should be about ·25 amp. and the input 15 to 17 milliamps.

53. Adjust the grid variometer and aerial inductance until a maximum reading is obtained on the wavemeter micro-ammeter. A movement of one of the tuning adjustments should be immediately followed by a corresponding movement of the other. The grid variometer should be adjusted in such a way as to obtain minimum input (as shown on the H.T. milliammeter) and *not* maximum output as shown on the aerial ammeter. This procedure is essential in order to avoid instability. Table 1 gives representative figures of the tuning adjustments of the transmitter when fitted on a " Hart " aeroplane employing a wing-tip-to-tail aerial.

54. The weakest possible coupling between the transmitter and wavemeter should be used in order to avoid overloading of the wavemeter micro-ammeter, and the transmitter must always be tuned to the wavemeter and not *vice versa*.

Table 1

Frequency kc/s.	*Aerial coil turns.*	*Grid variometer degrees.*
4,286	14·0	115
4,700	12·0	90
5,120	10·0	70
5,710	8·0	35
6,010	7·0	30

Adjustment of the receiver

55. The receiver may be tuned by two different methods. The first method is to adjust the transmitter unit of a similar instrument to the required frequency and to tune the receiver directly from this. The second method is to adjust the transmitter of the same, or any similar instrument, to the required frequency, tune an R/T tester or W.39 wavemeter from this and then tune the receiver from the R/T tester or W.39 wavemeter. The two methods are described in full below.

56. To tune the receiver directly from a transmitter, the transmitter unit of another instrument of the same type must first be tuned to the frequency required by the method described above for transmitters. For this purpose it should be set up with a condenser of about 100 micro-microfarads connected between the aerial and earth terminals instead of connecting the aerial. A microphone must be connected up to the transmitter, and with the switch turned to SEND, a constant modulation must be applied. For satisfactory tuning the signal strength received should be adjusted to about strength 5 by moving the transmitter or decreasing its radiation. The receiver is then tuned as follows.

57. Operate the switch of the transmitter-receiver to RECEIVE, turn the volume control to about 15, and set the regeneration control so that the receiver does not oscillate.

58. Set the tuning control to about 105 degrees, that is, to about the middle of its frequency range. Adjust the main tuning condensers (2, 3, and 4, fig. 7) to obtain the maximum signal strength in the telephones connected to the receiver.

59. Turn the regeneration control counter-clockwise until the receiver begins to oscillate, and then turn it back until oscillation just stops. A further adjustment of the main tuning condensers will now be required to obtain maximum strength. The tuning and regeneration should be adjusted alternately until a condition is reached when no further improvement is obtained.

60. Turn the volume control and observe the variation in signal strength. The strength should increase uniformly up to a maximum, which occurs before the control reaches the upper end of its range. Turn the tuning control throughout its range and ensure that the receiver is stable in all positions.

61. Alternatively, the receiver may be tuned by means of the R/T tester, type 1, or the wavemeter W.39. If the tester is used, unit A only will be required. The method is as follows. Set the transmitter unit of the instrument to the frequency required as described above for the adjustment of the transmitter. Place the wavemeter, or the unit A of the tester, close to the transmitter, connect a pair of telephones to it and switch to C.W. Switch the transmitter-receiver to SEND and tune the wavemeter or tester to obtain a zero beat frequency. Without disturbing the setting, switch to T.T. and switch the transmitter-receiver to RECEIVE. Tune the receiver as described in the previous paragraph.

62. These methods have the advantage that all frequencies are set from one wavemeter and their accuracy will therefore depend only on the care taken in the operations. The calibration of the R/T tester should not be used and the calibration of the wavemeter W.39 should be used only if no other standard is available.

PRECAUTIONS AND MAINTENANCE

Transmitter-receiver

63. On the ground the send-receive switch which is embodied in the transmitter-receiver should be locked in the " off " position as a safeguard against the batteries becoming discharged, but immediately before leaving the ground, the handle should be moved to the " receive " position and, except when actually transmitting, it should be maintained in this position so that the apparatus is ready to receive a call. A ground transmission and reception test should be carried out prior to the flight.

64. The low tension battery should be removed for recharging at frequent intervals. The high tension battery, which is a common battery for both transmitter and receiver, should be renewed if the voltage falls below 100 volts when tested on load. Both the H.T. battery and the transmitter grid bias battery are situated in a tray in the interior of the instrument case. To inspect these, it is only necessary to open the door in the end of the case and slide out the tray. Should any difficulty be experienced in withdrawing the tray, see that the plugs which fit into the H.T. and grid bias are not too high. The plugs in question are types 91, 93 and 94, and should the contact pin be greater than the depth of the socket, the plug should be cut down so that when inserted in the socket, the shoulder of the plug will bear against the shoulder of the socket.

65. It is possible to test the voltage of the H.T. battery without withdrawing the tray. For this purpose a simple connecting lead may be made up, which when used in conjunction with test meter, type C (Stores Ref. 10A/8744), enables the voltage of the H.T. battery to be tested in position and on load. A three-pin plug, type 48 (Stores Ref. 10A/7383), is joined by a suitable length of cable (Liflex 4, Stores Ref. 5A/193), being suitable for the purpose, to one plug, type 65 (Stores Ref. 10A/8262), engraved H.T.— and one plug, type 64 (Stores Ref. 10A/8261)

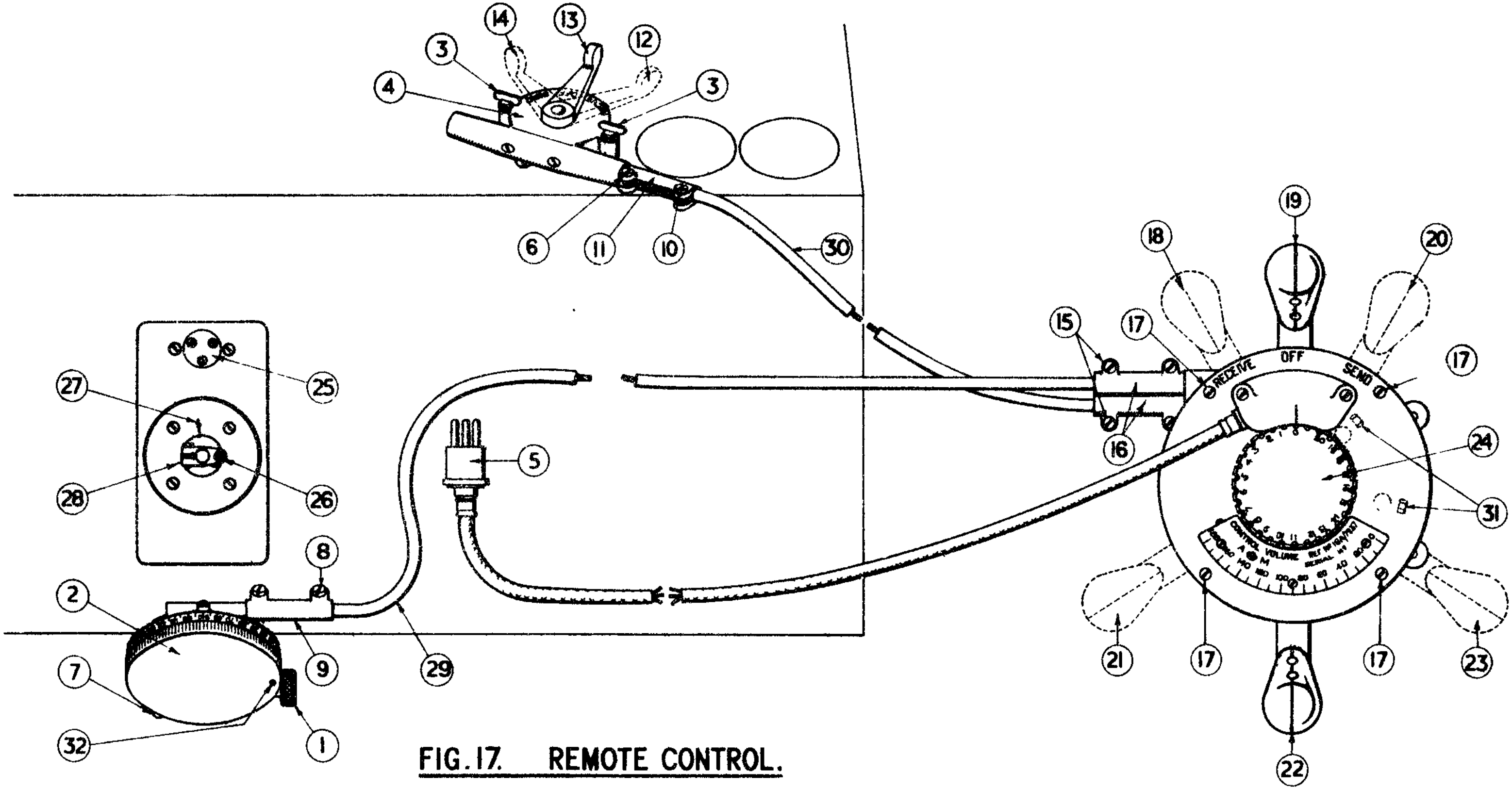


FIG. 17. REMOTE CONTROL.

Facing paras. 66-72

engraved H.T.+. Insert the plugs in the test meter before the three-pin plug is inserted in the volume control socket of the receiver. Care should be taken to see that the send-receive switch is in such a position that the H.T. battery will be " on load " when the test is made.

66. The input current to the transmitter must be carefully checked periodically. With the modulator valve removed, the input to the oscillator should be of the order 7 to 8 mA. With the oscillator valve removed the modulator input should be of the order of 7 to 8 mA., and any variation from these figures must be corrected by careful adjustment of the transmitter grid bias battery.

67. The grid bias battery for the receiver is situated within the receiver and in order to gain access to this it is necessary to remove the cover from the receiver. Periodical checks should be made to ensure that the voltage is normal, and that the plugs are properly fitted. If this battery is faulty, distorted speech, as well as an unduly heavy drain on the high tension battery, will result.

68. As the H.T. milliammeter is connected to the H.T.+ lead in both " send " and " receive " positions of the switch, care should be taken to ensure that the H.T. battery is not subjected even momentarily to any load beyond the capacity of the milliammeter. For this reason the H.T. should be open-circuited when carrying out such operations as inserting screen-grid valves owing to the possibility of the anode lead touching some portion of the earthed case.

69. In single-seater aeroplanes, where during reception the mask microphone is left switched on and where inter-communication is not required, an improvement in the signal-to-noise ratio may be effected by removing the resistance from the clip numbered 23 in the receiver unit, shown at (10) in fig. 7, close to the output valve. The resistance corresponds to R_{18} in fig. 6 and its removal disconnects the inter-communication circuit which otherwise permits the amplified noise from the microphone to reach the telephones. The resistance must be replaced in the clip when the transmitter-receiver is returned to store.

70. The following modification is to be made on all instruments not already modified to prevent the flexible rubber-covered lead connected to the moving part of the regeneration condenser from fouling the moving vanes of the ganged condenser. Remove the receiver unit from the case and take off its cover. Remove the top covers of the two valve cans. Pull out any slack wire left inside the condenser compartment and secure with a light whipping round the wire, close up to the aperture. Arrange the two sets of leads to the regeneration condenser as far apart as possible. Turn the regeneration control knob clockwise till the leads are at the top of their travel and pull any slack wire towards the detector valve. Replace the valve covers and receiver cover and replace the receiver in the case. Reset the regeneration control.

71. When the receiver is being operated on the bench a separate handle, remote control, condenser unit (Stores Ref. 10A/7925) should be used to turn the ganged condensers. This is fitted on to the condenser in the same way as the handle attached to the remote controls.

Remote control

72. It is essential that the remote control mechanism be so adjusted that the controls on the instrument always occupy their correct positions when moved by, and as indicated on, the remote controller. Once set, the adjustment need never be interfered with, the method of coupling to the transmitter-receiver being such that the controls can be disconnected from the instrument, when it is necessary to remove the latter from the aeroplane, without in any way affecting the synchronism. The controls may be disconnected from the instrument in the following way.

73. Referring to fig. 17, slacken the knurled screw (1) and lift the condenser head (2) clear from the condenser. Slacken the screws (3) and remove the switch control (4) from the transmitter. Remove the three-pole plug (5) from the socket (25) on the receiver. When

re-connecting the condenser control, care is necessary to ensure that the head is fitted in the correct manner, *i.e.*, the scale on the head should indicate the correct position of the condenser vanes.

74. The clamp (28) is fitted on the condenser spindle in such a way that when the condenser vanes are at their zero position, the red spot (26) on the clamp is opposite the red spot (27) on the condenser case. When placing the head (2) in position, therefore, it is only necessary to rotate the condenser spindle until the two red spots are adjacent and, before engaging the dog in the head with the clamp, see that the zero graduation on the head is opposite the indicating line. A dimple (32) filled in with red enamel is provided on the top face of the head immediately above the zero graduation. It will be apparent from the position of the clamp (28) that the condenser vanes are at the 90 degrees position. The scale on the head is in the corresponding position and also the handle (22) on the controller. The condenser head is secured in position by means of the knurled screw (1).

75. In order to provide an alternative " lead-in " of the flexible shaft, in the event of the instrument being installed in an awkward position, the head is capable of being fitted in four different positions, 90 degrees apart from one another. A projecting stop pin on the inside of the condenser head prevents incorrect fitting of the head. It can be seated only when this pin is accommodated in one of the four notches cut in the edge of the condenser case. If desired, the clamp screw (1) may be removed and screwed into the reverse end of the clamp to allow access in any one of four different positions of the head.

76. A new system of remote controls known as Types C and D has been introduced for use with subsequent transmitter-receivers. Should it be necessary to install a T.R.9 instrument in an aeroplane equipped with either of these types an additional adaptor known as, " Adaptor, Condenser Coupling " (Stores Ref. 10A/9008) will be required in fitting the condenser control. The adaptor consists essentially of a split-ring clamping device which can be fitted to the condenser unit of the T.R.9 receiver unit, and to which the condenser unit handle of the type C or type D controls can be fitted.

77. As mentioned previously, once the controller flexible shafts have been correctly adjusted, no further adjustments are necessary. The following instructions are given for the information of personnel required to carry out initial fitting.

Initial assembly of send-receive switch

78. Remove the clamp (11) and thread the rack and flexible shaft through it. Hold the handle in its extreme position (14). Insert the rack through the guide and place it in mesh with the quadrant. Push the clamp (11) on the guide up to the shoulder and tighten the screw (6). Push the tube (30) through the clamp to its limit. Withdraw the tube approximately ·05 in. and tighten the screw (10).

Initial assembly of condenser head control

79. Tighten the grip screw (7) and turn the condenser handle (2) clockwise (looking on face) to its extreme position. Hold the condenser handle (2) and push in the flexible shaft to its limit. Now slacken the grip screw (7), push the flexible shaft $\frac{3}{4}$ in. further and again tighten the grip screw (7). Push the tube (29) through the union (9) to its limit. Withdraw the tube approximately ·10 in. and tighten the screw (8).

Initial assembly of controller

80. Remove the screws (17) and lift the volume control and cover. Tighten up the grip screws (31) and hold the handles in their extreme positions (18) and (23). Push in the

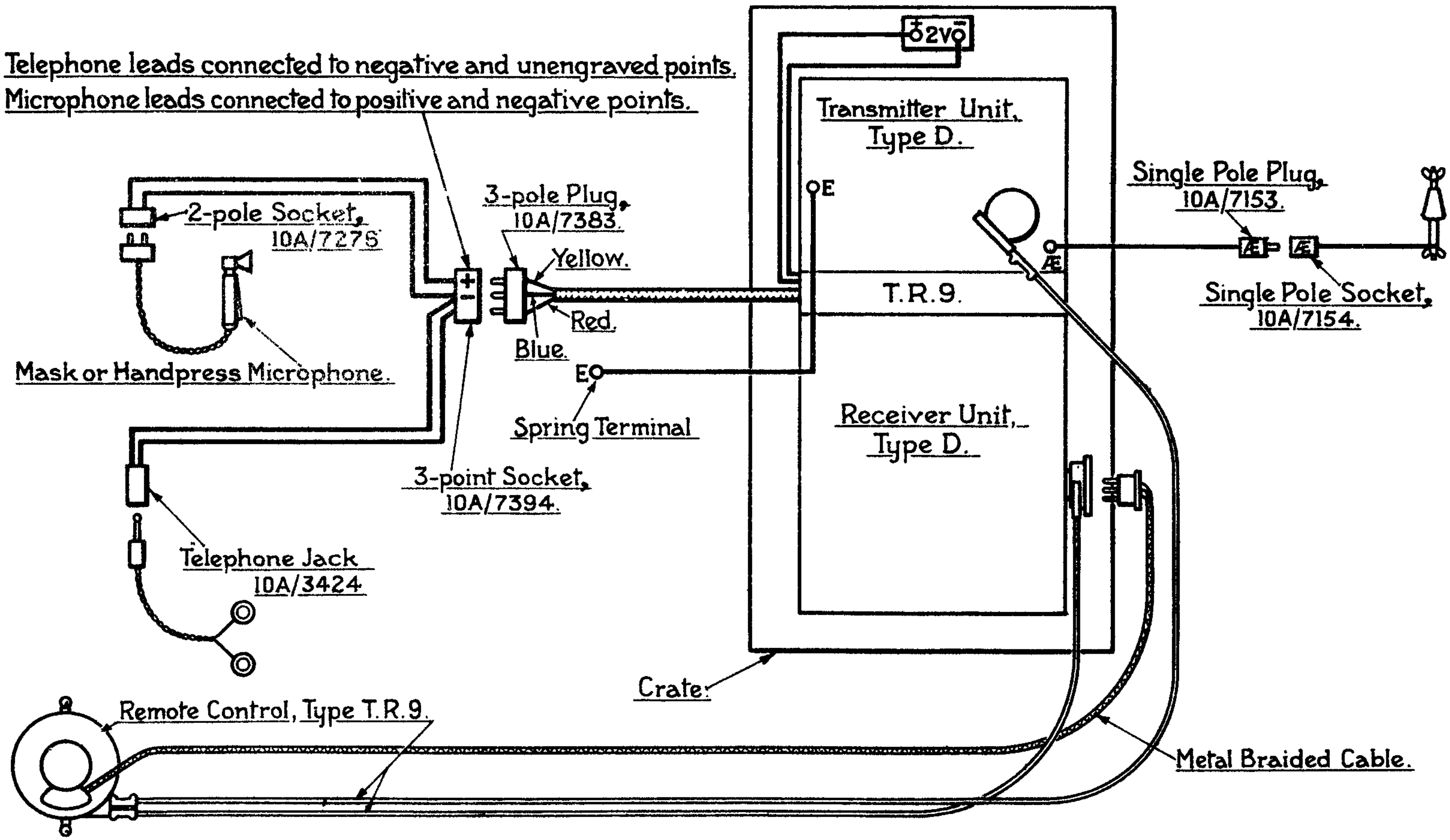


FIG. 18, INSTALLATION DIAGRAM OF TRANSMITTER - RECEIVER T.R.9.

flexible shafts to their limits. Now slacken the grip screws (31), push the flexible shafts $\frac{3}{4}$ in. further and again tighten the grip screws. Push the tubes through the unions (16) to their limits. Withdraw the tubes approximately ·10 in. and tighten the screws (15). Replace the cover and volume control.

To synchronize the " zero " and " off " positions

81. Slacken the screws (15) and slide the tubes a little in the unions (16). Tighten the screws (15).

TRANSMITTER-RECEIVER T.R.11

(Stores Ref. 10A/8099)

82. The transmitter-receiver T.R.11 is similar in general design to the T.R.9, but it has a frequency range of 3,000 to 4,300 kc/s. and an additional facility is provided making inter-communication possible during transmission. It contains the transmitter unit type E (Stores Ref. 10A/8108) and the receiver unit type E (Stores Ref. 10A/8103). The details of the differences are given below.

83. In the receiver the L.T.+ terminal is connected to the filaments of the first four valves only. The positive terminals of the second audio-frequency amplifier and of the output valve are both connected to a terminal on the contact bar designated L.T. + I/C., which takes the place of the earth terminal. The L.T. + I/C. terminal is connected through to a similarly designated terminal on the transmitter unit which is wired to a contact on the send-receive switch. This contact is connected, in the receive position only, to the L.T.+ terminal. Thus during reception the first four valves receive their filament supply through the L.T.+ terminal on the receiver, and the last two valves through the L.T. + I/C. terminals. A 2-pin plug is connected to the L.T.+ and the L.T. + I/C. terminals of the main contact bar, and this is connected to a socket wired to a switch in the bomb-aiming position. By means of this switch the filaments of the last two valves can be supplied independently of the position of the send-receive switch. The H.T. contacts of the switch are so wired that H.T.+ is connected to both receiver and transmitter in both the send and receive positions so that H.T. is available for inter-communication during either reception or transmission. The switch in the bomb-aiming position closes the filament circuit of the last two valves even if the send-receive switch is in the " off " position. It must, therefore, always be switched off when not actually in use.

84. The H.T.— and L.T.— circuits of the receiver are permanently connected to earth through the wiring of the transmitter so as to complete the circuit for inter-communication.

85. In the receiver, the I/C. terminal is connected through the condenser and resistance to the grid of the output valve instead of to the grid of the valve before the last as in the T.R.9. The value of the resistance in this lead is 0·25 megohms instead of 0·5 megohms, and a type 112 condenser (·0001 μF.) is used instead of the type 121 condenser of the same capacitance.

86. The microphone, instead of deriving its supply from the positive lead to the valve filaments, is supplied from the L.T.+ terminal through a separate contact on the switch, which closes the circuit in both the send and receive positions. The telephone connection is not switched from transmitter to receiver, but is permanently connected to the side-tone circuit in the transmitter as well as to the output of the receiver.

87. The plug-in coils for the receiver of the T.R.11 are similar in general construction to those for the T.R.9, but they are designed for the frequency range 3,000 to 4,300 kc/s. (range B) and are marked accordingly. The connections to the pins at the base of the coil are arranged to suit the wiring of the sockets, and differ from those of the T.R.9 coils.

88. An extra resistance of 1,000 ohms (type 124) is mounted beneath the second anode coil, in the third compartment. This is connected in the H.T. lead to the second radio-frequency amplifier, between the H.T.+ terminal and the second anode coil.

89. A resistance, type 113 (20,000 Ω), is mounted below the 3-pin socket for the volume control plug, and is connected in the lead to the positive of this socket. It is thus in series with the volume control potentiometer and limits the range of voltage on the screen grids of the first two valves to that in which stable operation is obtained. It also serves as a protective resistance, limiting the drain on the H.T. battery in the event of the earthing of the volume control potentiometer or leads.

90. The T.R.11 is designed for use with a different system of remote controls, known as the type C or type D, and the coupling on the spindle of the ganged condensers is therefore constructed to fit the condenser unit handle of these controls. The types C and D controls are described in the chapter dealing with T.R.11B.

91. Tuning is carried out exactly as for the T.R.9, except that a wavemeter W.75 will be used instead of the W.69 in tuning the transmitter. Typical settings for the T.R.11 installed in a small aeroplane with an aerial from wing tip to tail are given below :—

Frequency	*Aerial coil*		*Grid variometer*
kc/s.	*turns.*	*degrees.*	*degrees.*
4,388	1	180	60
4,234	2	20	84
4,074	3	20	84
3,898	4	20	100
3,744	5	20	106
3,634	6	20	106
3,525	7	20	118
3,422	8	20	120
3,333	9	20	150
3,242	10	20	160
3,178	11	20	160
3,110	12	20	160
3,046	13	20	180
2,990	14	20	180

92. An auxiliary condenser handle is available for local operation of the fine-tuning condensers either on the bench or in the aeroplane. It consists of a handle with a disc at the end carrying three pins and having two pins in the side of the handle. The three pins at the end, fit into the three holes in the index wheel attached to the end of the condenser spindle, and are used to control the condensers when the remote controls have been taken off. The two pins at the side, fit into holes in the condenser unit handle forming part of the remote controls, and these are used when the remote controls are fitted. One of these pins is detachable and is spring-loaded, so that the auxiliary handle will remain in place when the pins are inserted into the condenser unit handle.

93. A few T.R.11 transmitter-receivers have been modified for the transmission of telegraphy and are known as T.R.11A transmitter-receivers (Stores Ref. 10A/8544). The modification affects the transmitter only and the modified transmitter is known as the transmitter unit, type E (modified) (Stores Ref. 10A/8545). In the modified transmitter a 2-pin socket is fitted on the panel just above the control valve cover. The lead from the modulating choke to the send-receive switch is broken here and the two ends are connected to the tubes of the socket. For normal working a short-circuited plug anchored to the panel by a short length of cord is inserted into this socket and the transmitter then functions exactly the same as the T.R.11. When it is required to transmit C.W. telegraphy the short-circuited plug is taken out and a plug wired up to a transmitting key is inserted in its place.

APPENDIX

NOMENCLATURE OF PARTS

The following list of parts is given for information. In ordering spares for this transmitter-receiver, the appropriate section of AIR PUBLICATION 1086 must be used.

Ref. No.	Nomenclature.	Quantity.	Remarks.
10A/7917	Transmitter-receiver type T.R.9, consisting of :—		See under accessories for coils, etc., required.
10A/7918	Case		Fitted with contact bar, contact bar cover and plug.
10A/7931	Transmitter unit, type D.		
10A/7922	Receiver unit, type D.		
10A/7921	Tray, battery		Fitted with three contacts and four plugs.
	Transmitter unit, type D. *Principal Components.*		
10A/7818	Ammeter, thermo		Reading 0 to 0·5.
10A/7932	Bar, contact		Fitted with 12 contacts.
10A/7911	Choke, H/F., type M.		
10A/7912	Choke, L/F., type G.		
10A/7933	Coil, aerial		Fixed in transmitter.
10A/3473	Condenser, type 24	1	·002 μF, aerial.
10A/7386	,, ,, 69	1	·0002 μF, clip-in type.
10A/7387	,, ,, 70	1	·0003 μF, clip-in type.
10A/7388	,, ,, 71	1	·001 μF, clip-in type.
10A/7815	,, ,, 113	1	·0005 μF, clip-in type.
10A/7934	Cover	1	
10A/7266	Holder	2	For clip-in condensers.
10A/7913	Holder, valve, type E	2	
10A/7820	Milliammeter, type B	1	Reading 0 to 30.
10A/7153	Plug, type 29	1	Aerial.
10A/7914	Resistance, type 98	1	45,000 ohms grid leak.
10A/7915	Switch, type 69	1	Send-receive switch.
10A/7916	Transformer, microphone, type G	1	
10A/7935	Variometer, grid	1	
	Receiver unit, type D. *Principal Components.*		
10A/7923	Bar, contact	1	Fitted with 7 contacts.
10A/7384	Choke, LF., type B	1	Output choke.
10A/7387	Condenser, type 70	1	·0003 μF, clip-in type.
10A/7388	,, ,, 71	3	·001 μF, clip-in type.
10A/7391	,, ,, 74	1	2 μF.
10A/7593	,, ,, 85	8	·5 μF.
10A/7814	,, ,, 112	1	·0001 μF, clip-in type.
10A/7900	,, ,, 119	1	Miniature, variable, tubular.
10A/7901	,, ,, 120	1	·001 μF.
10A/7902	,, ,, 121	1	·0001 μF.
10A/7903	,, ,, 122	4	·00005 μF, clip-in type.
10A/7924	Cover	1	
10A 7925	Handle, condenser unit	1	Remote control.
10A/7926	Holder, coil	3	
10A/7266	Holder, resistance or condenser	4	
10A 7597	Holder, valve	6	
10A/7564	Mounting, resistance and condenser, type 1 ..	2	
10A/7566	Mounting, resistance and condenser, type 3 ..	2	
10A/7907	Mounting, resistance and condenser, type 7 ..	1	
10A/9691	Plug, type 91	1	Engraved G.B. +.
10A/9693	Plug, type 93	1	Engraved — 1½.
10A/9694	Plug, type 94	1	Engraved — 3.

Ref. No.	Nomenclature.	Quantity.	Remarks.
10A/2312	Resistance, type 26	1	2 megohms.
10A/7267	,, ,, 29	1	·25 megohms.
10A/7316	,, ,, 30	1	100,000 ohms.
10A/7600	,, ,, 70	3	20,000 ohms.
10A/7602	,, ,, 72	2	500,000 ohms.
10A/7603	,, ,, 73	1	200,000 ohms.
10A/7908	,, ,, 95	4	1 megohm.
10A/7910	,, ,, 97	2	1·5 ohms, wire wound.
10A/7394	Socket, type 17	1	For remote volume control.
10A/7927	Condenser unit	1	Consisting of 3, type 123; 3, type 124; and 2, type 125.
	Accessories.		
10A/7938	Case, transit.		
10A/7154	Socket, type 10.		
10A/7394	,, ,, 17		Fitted in aeroplane for microphone and telephone connections.
10A/7928	Coil, aerial, Range A		6,000 to 4,300 kc/s for receiver.
10A/7929	,, first anode, Range A		6,000 to 4,300 kc/s for receiver.
10A/7930	,, second anode, Range A		6,000 to 4,300 kc/s for receiver.
10A/7939	Control, remote, switch and condenser.		
10A/7937	,, ,, volume.		
10A/7936	,, ,, T.R.9 complete		Consisting of above two items mounted together.
10A/7501	Coupling, switch		For type B casing and shafting.
	Stores for initial fitting.		
5A/1386	Accumulator, 2 volt, 14 Ah		L.T. for transmitter and receiver.
5A/1383	Battery, dry, 4·5 volts	1	G.B. for receiver.
5A/1338	,, ,, 15 ,, ...	1	G.B. for transmitter.
5A/1333	,, ,, 120 ,, ...	1	H.T. for transmitter and receiver
10A/7738	Valves, V.R.21	3	Receiver.
10A/7813	,, V.T.20	2	Transmitter.
10A/7607	,, V.R. S.G.18	2	Receiver.
10A/7958	,, V.R.22	1	Receiver (output)
10A/7503	Remote control casing, type B	—	$\frac{1}{8}$ in.
10A/7504	Remote control shafting, type B	—	$\frac{1}{8}$ in.
10A/7505	Remote control unions	—	With two screws for type B casing.
10A/8099	Transmitter-receiver type T.R.11, consisting of :—		
10A/8100	Case	1	Complete with contact bar and plugs.
10A/8103	Receiver unit, type E	1	
10A/8108	Transmitter unit, type E	1	
10A/7921	Tray, battery	1	
10A/8099	Transmitter-receiver type T.R.11, consisting of :—		
10A/8100	Case	1	Fitted with contact bar, contact bar cover, and one each type 48 and 52 plugs.
10A/8101	Bar, contact	1	
10A/7920	Cover, contact bar	1	
10A/8103	Receiver-unit, type E	1	
10A/8108	Transmitter-unit, type E	1	
10A/7921	Tray, battery	1	
	Accessories.		
10A/8102	Case, transit	1	

December, 1938

SECTION 2, CHAPTER 2

TRANSMITTER-RECEIVERS
T.R.9B, T.R.9C AND T.R.11B

Contents

List of illustrations

TRANSMITTER-RECEIVERS T.R.9B AND T.R.11B

(T.R.9B Stores Ref. 10A/9507)
(T.R.11B Stores Ref. 10A/9128)

INTRODUCTION

1. The transmitter-receivers T.R.9B and T.R.11B are almost identical instruments and are designed for use in aeroplanes to provide two-way R/T communication with the ground or with another aeroplane. The difference between them is in the frequency at which they operate and in the inter-communication facilities. Each consists of a two-valve radio telephony transmitter and a six-valve receiver contained in one case.

2. The T.R.9B contains the transmitter T.1102 and the receiver R.1103, and the T.R.11B contains the transmitter T.1098 and the receiver R.1099. The T.R.9B is primarily designed for use in single-seater aeroplanes ; in such installations the instrument itself is inaccessible to the pilot and is entirely operated through a system of remote controls. The T.R.11B is primarily intended for use in bombers and is also operated by remote controls. The H.T. supply for both transmission and reception is provided by a battery housed inside the case, and the L.T. supply by an external 2-volt accumulator.

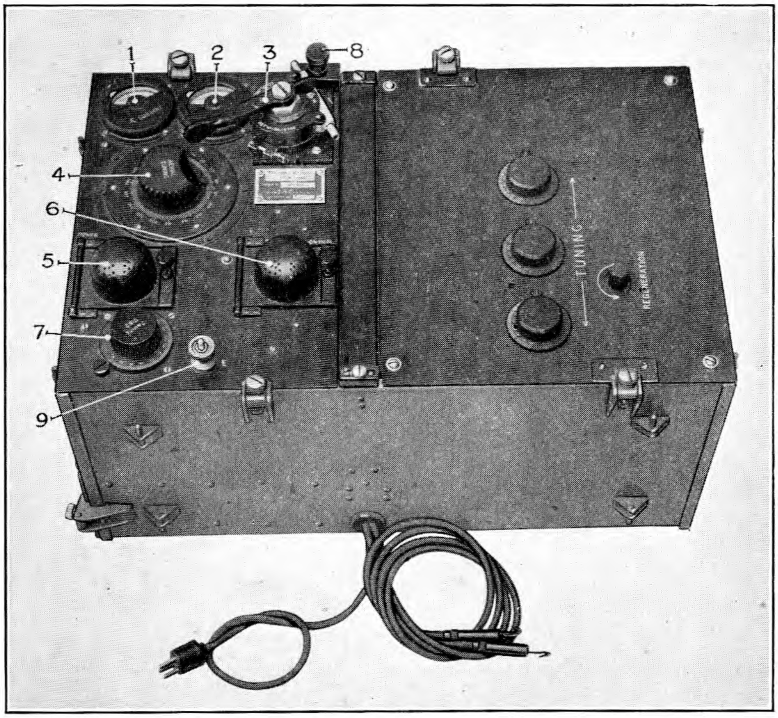


FIG. 1. Transmitter-receiver T.R.9B.

3. Facilities are provided in both instruments for communication between the two occupants of two-seater aeroplanes during reception. In the T.R.11B inter-communication can also be carried out during transmission, but in the T.R.9B this is not possible.

4. The T.R.9B operates at any predetermined frequency between 4,300 and 6,000 kc/s, and the T.R.11B between 3,000 and 4,300 kc/s. Both instruments are designed to give a range of operation to the ground of about 35 miles and to another aeroplane of about 5 miles.

5. The overall dimensions of the instrument are approximately 19½ in. by 13¼ in. by 9½ in. and the weight excluding valves and batteries is 24½ lb. With valves and dry batteries in place the weight is about 36 lb. The complete transmitter-receiver T.R.9B is shown in fig. 1. The T.R.11B is similar but has an additional flexible lead and plug.

6. The receiver unit and the transmitter unit are housed in a metal case, and from the combined instrument the necessary connections and controls are extended to a convenient position in the pilot's cockpit. At this position are situated the telephones for reception, the microphone for transmission, and the remote control with its three handles operating the send-receive switch, the receiver tuning condenser and the volume control of the receiver.

7. When the send-receive switch is in the "Send" position the aerial and earth are connected to the transmitters and the H.T. and L.T. connections and the microphone connections are made. The oscillator valve generates continuous oscillations and when the microphone is spoken into these are modulated at speech frequency, through the medium of the modulator valve, and radiation takes place at a frequency determined by the values to which the transmitter has previously been set, the speaker hearing at the same time his own speech in the telephones.

8. When the send-receive switch is in the "Receive" position the aerial and earth are connected to the receiver, the H.T. supply is again connected up and the L.T. supply is connected to the filaments of the receiver valves. Tuning of the receiver is effected by adjusting the tuning control of the remote controller. This operates the gang of three fine-tuning condensers, which give a small range on either side of the spot frequency to which the receiver has previously been adjusted. The volume of the output is controlled by means of a third handle on the controller, which varies the voltage applied to the screening grids of the two screen-grid valves in the receiver.

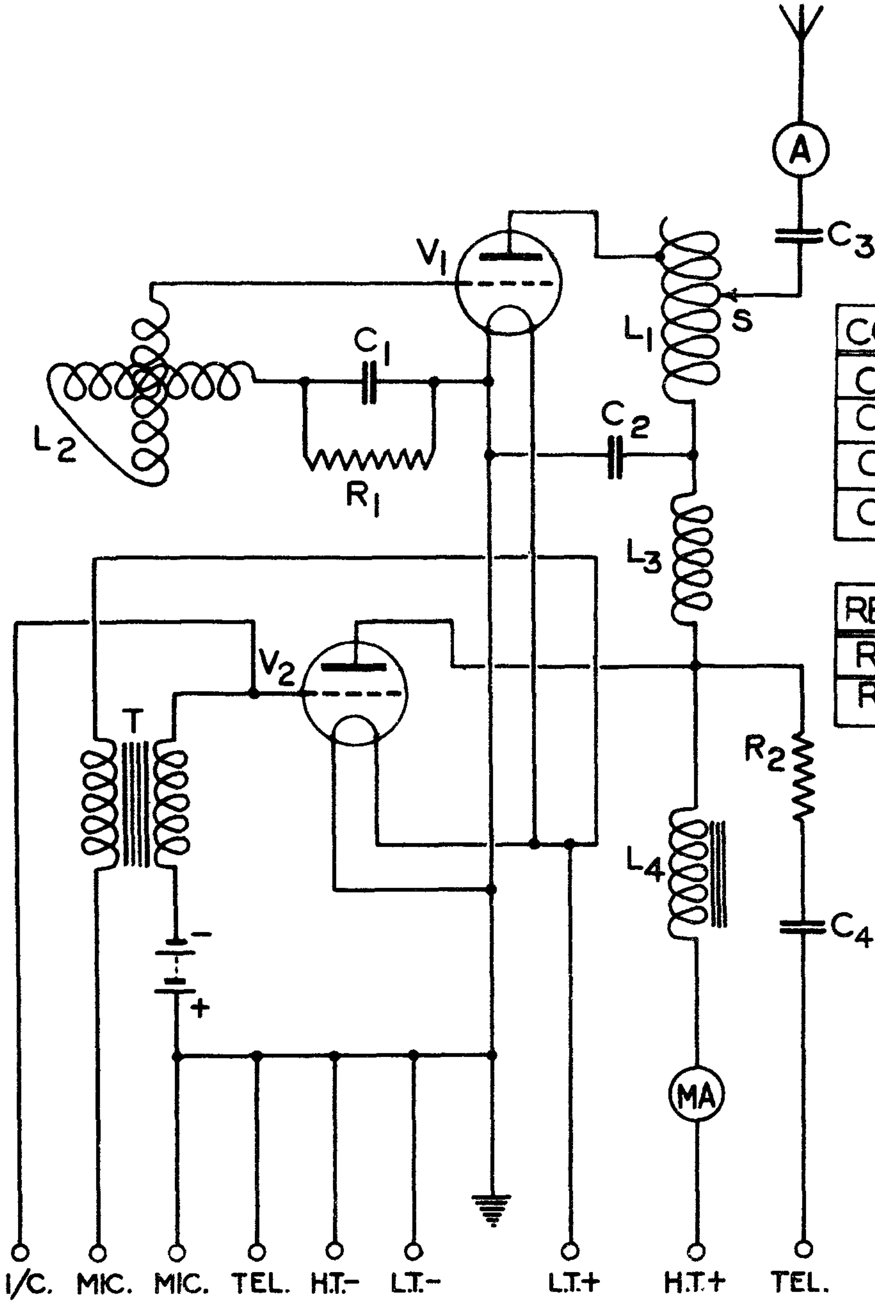
9. When the instrument is installed in a two-seater aeroplane the two microphones are connected in parallel and the secondary winding of the microphone transformer is connected through a condenser and resistance to the second audio-frequency valve of the receiver as well as to the modulator valve of the transmitter. When the last two valves of the receiver are operative, the speech of either occupant is amplified by them and is heard in both telephones, which are connected in parallel to the output of the receiver.

10. To make inter-communication possible during both transmission and reception, the microphone circuit and the H.T. supply to the receiver are connected in both positions of the send-receive switch. In the T.R.11B installation an additional switch at the bomb-aiming position is connected to the L.T. supply lead to the last two valves of the receiver, so that inter-communication may be obtained during transmission by closing this switch and thus rendering the two amplifying valves operative.

GENERAL DESCRIPTION

Transmitter

11. A theoretical diagram of the transmitter is given in fig. 2. V_1 is the oscillator valve and V_2 the modulator valve. The aerial circuit can be traced through the ammeter A, condenser C_3, lower portion of the inductance L_1, and condenser C_2 to filament circuit and earth. The circuit is tuned by means of a tapping S, which is rotatable within the coil L_1. The anode circuit of the



CONDENSER	
C1	·0003 µF
C2	·001 µF
C3	·002 µF
C4	·01 µF

RESISTANCES	
R1	30,000 Ω
R2	250,000 Ω

FIG 2 THEORETICAL CIRCUIT DIAGRAM OF TRANSMITTER UNITS

oscillator valve includes the inductance L_1, and the H.T. supply is *via* the milliammeter MA, the low frequency choke L_4, and the radio-frequency choke L_3. In the grid circuit of the oscillator valve are the tuning variometer L_2, the grid condenser C_1 and grid leak R_1. The grid and anode circuits are arranged for minimum inductive coupling, radio-frequency oscillation being maintained by virtue of the anode-grid capacitance of the valve.

12. The modulator valve V_2 has its anode connected to the junction point of the radio-frequency choke L_3 and the audio-frequency choke L_4, choke modulation being employed in the approved manner. The grid circuit of the modulator valve includes the secondary winding of the transformer T and a grid bias battery. One side of the primary winding of the transformer is connected to L.T.+, and the other end of the winding is connected *via* the microphone to L.T.—.

13. The transmitter incorporates a side-tone arrangement which enables the operator to hear, in his head telephones, the speech as radiated by the transmitter. This circuit can be traced from the anode of the modulator valve through the resistance R_2 and condenser C_4, and *via* the telephones to earth.

Receiver

14. A theoretical circuit diagram is given in fig. 3. The receiver employs six valves. The first two are screen-grid radio-frequency amplifiers, and these are followed by a detector, two audio-frequency amplifying valves, and an output valve. Three tuned circuits are employed, each circuit being separately tuned by its individual variable condenser to the " spot" frequency. Across each of these main condensers is connected a small fine-tuning condenser, and these three are ganged together. The aerial is loosely coupled to the grid circuit of the valve V_3 through the condenser C_6, and a static leak R_3 is connected from the aerial side of the condenser to earth. The inductance L_5 is connected in the grid circuit of the valve and is tuned by the condenser C_8. The condenser C_7 is one of the ganged fine-tuning condensers referred to above. The negative lead of the valve filament includes the biasing resistance R_4.

15. The screening grid of the valve is fed through the resistance R_5 with which is associated the decoupling condenser C_9. The resistance is not connected directly to the H.T.+ line but terminates on one of the points of a three-point socket, of which another point is connected to earth and the third to H.T.+ through the resistance R_{19}. Variation of the screening grid voltage is accomplished by connecting, by means of a plug, a remote potentiometer R_6. Movement of a contact over the resistance varies the screening grid voltage. The condenser C_{10} shunts the effective portion of the potentiometer and minimizes the noise produced by movement of the potentiometer. The anode circuit of the valve V_3 includes the inductance L_6, which is tuned by means of a main condenser C_{12} and a ganged fine-tuning condenser C_{11} in a similar manner to the inductance L_5. A further small fixed condenser C_{14} is connected between the variable condensers and the inductance for the purpose of opening out the tuning scale. The moving vanes of the two variables are earthed to prevent body capacity effects and, since the inductance is at H.T.+ potential, a blocking condenser C_{13} is inserted in the lead between the condenser and the inductance.

16. The anode of the valve V_3 is coupled to the control grid of the valve V_4 by means of the condenser C_{15}. A variable condenser C_{21} is connected between the anode of the valve V_3 and the anode of the valve V_4. This acts as the regeneration control, no other regeneration device being employed.

17. The screening grid of the valve V_4 is fed through the resistance R_9, with which is associated the decoupling condenser C_{16}. The potential of the screening grid is controlled simultaneously with that of V_3. A biasing resistance R_8 similar to R_4 is inserted in the negative filament lead, and a grid leak R_7 is connected between the grid of the valve and earth.

18. In the anode circuit of the valve V_4 is the third inductance L_7, tuned by the condensers C_{17} and C_{18}. The tuning scale is opened out by condenser C_{20}. The moving vanes are again earthed and a blocking condenser C_{19} is provided to isolate them from the H.T.

19. The anode of the valve V_4 is coupled to the grid of the detector valve V_5 by means of the coupling condenser C_{22}, and a grid leak R_{10} is connected from the grid to L.T.— for rectification.

20. The anode circuit of the detector valve includes the resistance R_{11}, and an R/F. by-pass condenser C_{23} is connected between the anode and earth. The detector anode is coupled to the grid of the first audio-frequency valve by means of the condenser C_{24}, and included in the grid circuit is a stopper resistance R_{12}. The grid of the valve V_6 is connected to a grid bias lead through a resistance R_{13}.

21. The anode of the valve V_6 is fed through a resistance R_{14}, and is coupled to the succeeding grid circuit by the coupling condenser C_{25}. The grid of the valve V_7 is connected through the resistance R_{15} to the same grid bias tapping as the grid of V_6. A second connection extends from the grid of valve V_7 through a resistance R_{18} and condenser C_{27} to a terminal marked I/C. This connection is provided to enable the valves V_7 and V_8 to be used, in addition to their ordinary functions, as amplifiers for inter-communication purposes, speech voltages from the microphone being impressed on the grid of the valve V_7 through the microphone transformer and the connection referred to above. The amplified speech is reproduced in the head telephones.

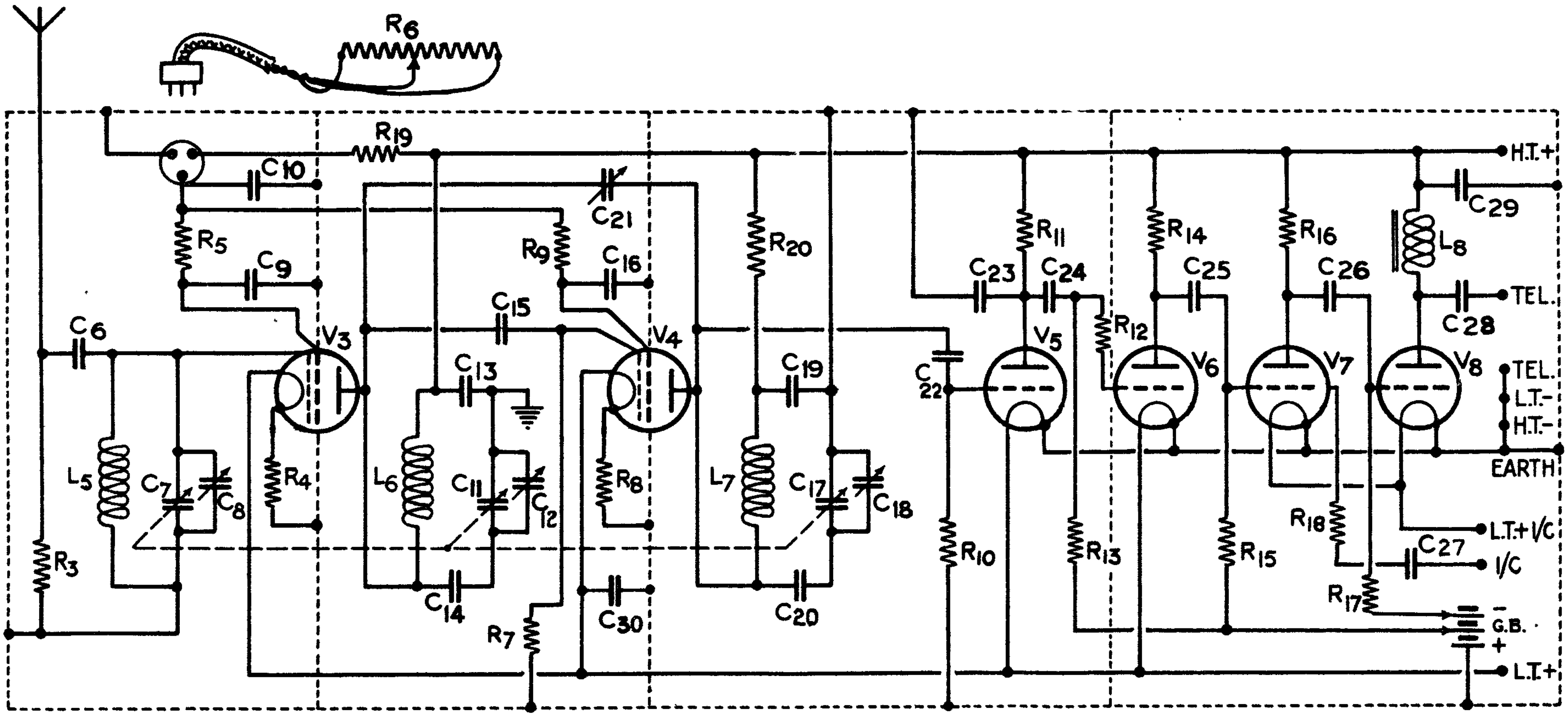
22. The coupling between the valves V_7 and V_8 is again by means of resistance and capacitance. The resistance R_{16} is in the anode circuit of V_7 and the anode is coupled to the succeeding grid by means of the condenser C_{26}. The grid of the last valve is separately biased, a connection being taken through the resistance R_{17} to a tapping on the grid bias battery. The anode circuit of the last valve includes the audio-frequency choke L_8, and the telephones are connected from the anode through the condenser C_{28} to earth. A condenser C_{29} is connected from H.T.+ to earth.

CONSTRUCTIONAL DETAILS

Transmitter unit

23. The transmitter unit and the receiver unit are both contained in the same case as shown in fig. 1, the transmitter being on the left-hand side. The components of the transmitter unit are mounted on the underside of a metal panel. The meters and controls are all mounted on the face of this panel and can be seen in fig. 1. At the top left-hand corner is the ammeter (1) for the aerial current. This is a thermo-ammeter reading from 0 to 0·5 amperes, and the thermo-couple is contained inside the instrument case. Adjacent to this is the H.T. milliammeter (2), which has a range of 30 milliamperes. Both these meters have the lower half of the dial protected with a fixed cover, and over this is a cover which can be turned to protect the upper half. The zero adjuster may be exposed by turning the outer cover. In the top right-hand corner of the panel is the send-receive switch, to which the remote control coupling (3) is attached as shown in the illustration.

24. Immediately below the meters is the aerial coil tuning handle (4) which controls the tapping on the coil, each revolution of the handle moving the contact by one turn. The number of turns in circuit is shown by a number displayed in a small window at the zero position of the graduated scale. The scale is marked in degrees and the inductance reading is thus given by the number representing the whole number of turns and the reading of the pointer on the degrees scale.



CONDENSERS μF

C_1	In transmitter unit	C_{10}	·5	C_{19}	·5	C_{28}	·5
C_2		C_{11}	·000048 variable	C_{20}	·01	C_{29}	2·0
C_3		C_{12}	·000233 variable	C_{21}	10 μμF	C_{30}	·01
C_4		C_{13}	·5	C_{22}	·0001		
C_5		C_{14}	·01	C_{23}	·001		
C_6	·00005	C_{15}	·0003	C_{24}	·001		
C_7	·000048 variable	C_{16}	·5	C_{25}	·001		
C_8	·000233 variable	C_{17}	·000048 variable	C_{26}	·001		
C_9	·5	C_{18}	·000233 variable	C_{27}	·00003		

RESISTANCES OHMS

R_1	In transmitter unit	R_{10}	250.000
R_2		R_{11}	100.000
R_3	·5 MΩ	R_{12}	2 MΩ
R_4	1·5	R_{13}	1 MΩ
R_5	20.000	R_{14}	1 MΩ
R_6	50.000 variable	R_{15}	20.000
R_7	1 MΩ	R_{16}	200.000
R_8	1·5	R_{17}	1 MΩ
R_9	20.000	R_{18}	500.000

FIG. 3, THEORETICAL CIRCUIT DIAGRAM OF RECEIVER UNITS

(F.1800). F. & C. LTD.

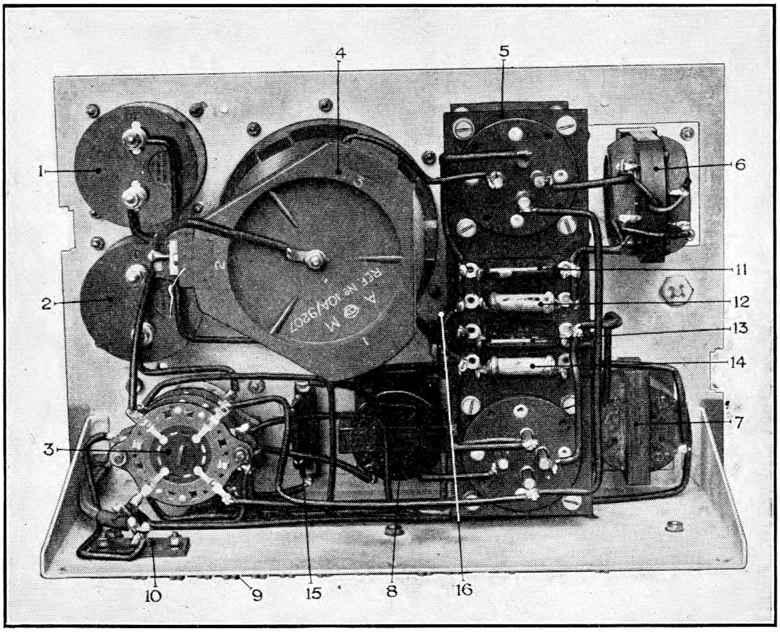


FIG. 4. Transmitter unit, underside view.

25. Below the aerial coil are two doors (5) and (6) giving access to the valves, the power valve being on the left and the control valve on the right. The valves are mounted below the panel, but are inserted through holes and protected by domed perforated covers hinged to the panel and secured by a milled thumb-screw. At the bottom of the panel is the control knob (7) for the grid variometer. A dial attached to the knob carries a scale graduated from 0–180°.

26. The only connections made from the front of the panel are those to the aerial and to earth. In the top right-hand corner of the transmitter is shown the aerial terminal (8). In some models no aerial terminal is fitted, but a flexible lead passes through the panel and terminates in a plug for insertion into a socket connected to the aerial. The earth terminal (9) is mounted directly on the panel.

27. The underside of the transmitter unit is shown in fig. 4. The aerial ammeter and the H.T. milliammeter are seen at (1) and (2), the send-receive switch at (3) and the aerial coil at (4). The valve-holders are mounted on a small panel (5) carried on four pillars, two resistances and two condensers also being mounted on this panel. The grid variometer (6), microphone transformer (7), and modulating choke (8) are mounted directly on the front panel. The contact bar (9) is mounted on an angle plate at the side of the transmitter; it carries twelve spring contacts which engage with the knife contacts on the fixed contact bar when the transmitter is in position. A terminal (10) is used on most of the transmitters issued, for connection of the flexible aerial lead when this passes through the panel.

28. The send-receive switch (3) is built up of three flat units. Each unit consists of an insulating plate with fixed contacts attached to it in the required positions, and a rotating disc in the centre carrying contact points. These points pass through the disc and make contact with a ring or part ring at the back attached to the disc in the same manner as the fixed contacts, and have a projecting soldering lug. A strip attached to the control knob and turning with it passes through a slot in each central disc so that movement of the knob

turns all three discs and the contact points attached to them. The fixed contact points are arranged so that the required connections can be made. The arrangement of the three switch units is shown in fig. 7 and the connection to each terminal is indicated. The upper part of the figure shows the switch in the " receive " position and the lower part in the " send " position. From these figures it will be seen that all the connections shown in fig. 5 are made in the two positions of the switch.

29. The aerial inductance (4) consists of a helical coil of copper tube carried on a frame of insulating material. The tapping contact consists of two spring blades mounted on a nut working on a brass screw fixed in the centre of the coil. The pitch of the screw corresponds to the pitch of the coil and the screw is surrounded by a sleeve of insulating material slotted throughout its length to allow the contacts to move axially. The sleeve turns with the handle and the contacts thus travel along the entire length of the copper tube. The position of the contact on the tube is indicated by the figure and scale reading on the front of the panel as already described.

30. Two condensers (11) and (13) and two resistances (12) and (14) are mounted on the sub-panel (5). The ·0003 μF condenser (11), and the 30,000 Ω resistance (12), are connected in parallel between the grid variometer and the filament of the power valve. The ·001 μF condenser (13), is the main oscillating condenser. The ·25M Ω resistance (14) is connected in series with the ·01 μF condenser (15), mounted on the panel, and the two are in the lead forming the connection to the telephones for side-tone purposes. The radio-frequency choke (16), mounted underneath the sub-panel (5), is connected between the audio-frequency choke and the aerial coil. The bench wiring diagram of the transmitter units is given in fig. 6.

Receiver unit

31. The receiver unit is fitted into the right-hand side of the case as shown in fig. 1. A view of the upper side of the unit with the screening cover removed is given in fig. 8. Nearly all the components are mounted on a metal panel, some being above and some below. The screening box (1) contains the three independent variable condensers (2), (3) and (4) corresponding to the condensers C_8, C_{12} and C_{18} in fig. 3, and the three ganged condensers corresponding to C_7, C_{11} and C_{17} for fine tuning. The condensers (2), (3) and (4) have each a knob and dial marked in degrees from 0–180, which project through the upper panel for adjustment of the frequency range. The screening box is divided into three sections and a ·01 μF condenser, corresponding to C_{20} in fig. 3, is mounted inside the section containing condenser (4). The three coils (5), (6) and (7) are mounted close to the condenser box and each is covered with a screening box. The six valves are also mounted on the upper side of the panel. Valves (8) and (9) are the screened grid valves for radio-frequency amplification, each being in a separate screened compartment. The regeneration control condenser (10) is mounted close to the second valve on the side of the condenser box and has a control knob projecting through the upper panel. The detector valve (11), the two audio-frequency amplifiers (12) and (13) and the output valve (14) are arranged in order. A small side panel (15), of which the front view is shown in fig. 9, carries the socket to which the volume control rheostat is connected and also the socket for the remote tuning control. The 2μF condenser connected between H.T.+ and earth is also mounted behind this panel. The grid bias battery (16) is fitted into clips by the side of the panel supports.

32. The space underneath the panel is about 2 in. deep and is divided by screens into four compartments as shown in fig. 10. In the left-hand compartment, over which the first R/F. valve and the aerial coil are mounted, is a mounting plate (1) carrying a condenser and two resistances. The ·00005 μF condenser couples the aerial to the first tuned circuit, and the adjacent ·5M Ω resistance is connected between the aerial and earth. The other resistance is connected in series with the screen grid. The condenser (2) at the side of the compartment is a decoupling condenser connected between the screen grid and earth. Close to the valve socket is the 1·5 Ω resistance (3), connected in the filament circuit to provide grid bias.

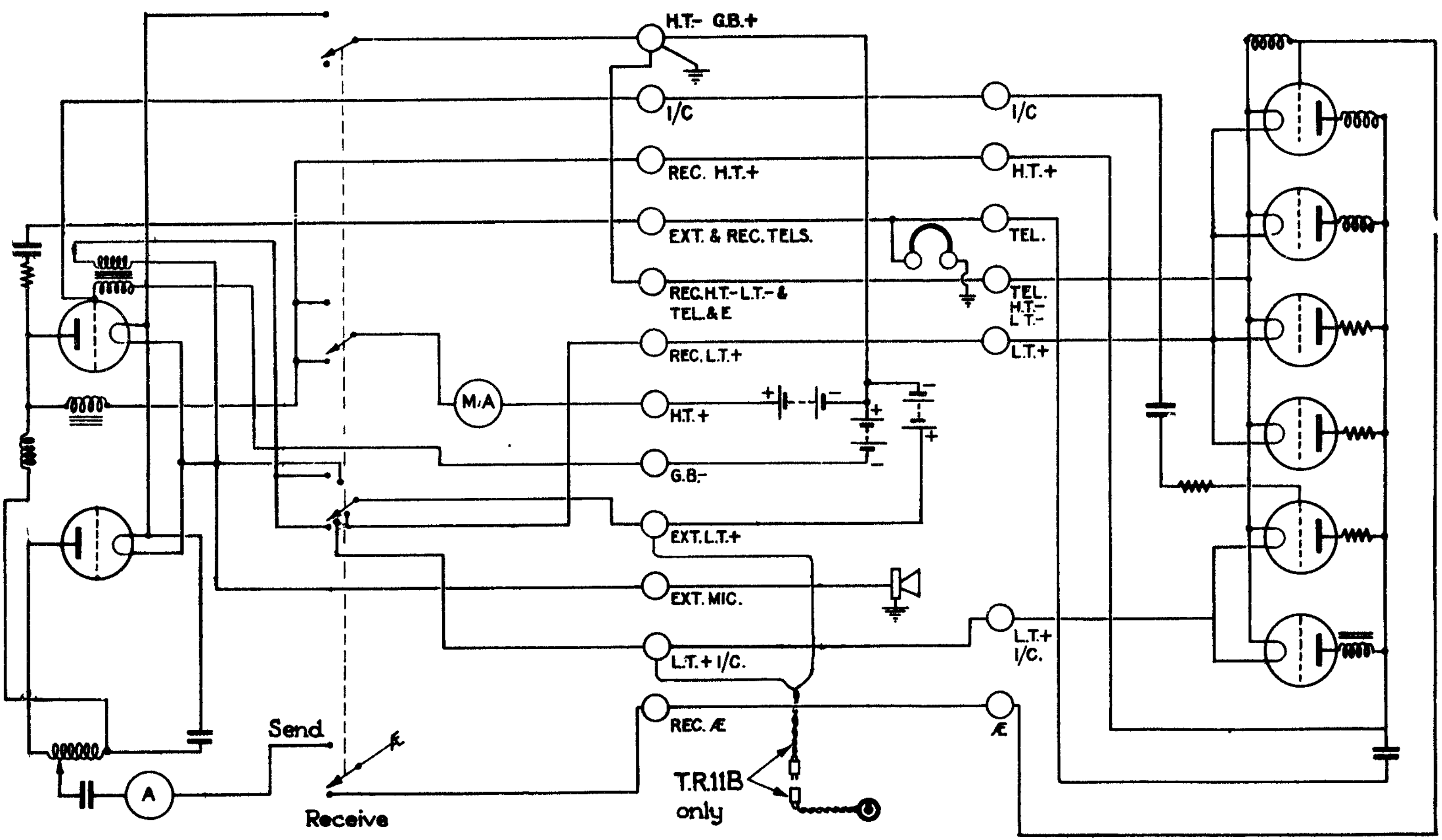


FIG. 5. TRANSMITTER-RECEIVER DIAGRAM
T.R.9B AND T.R.11B

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Note :- Annotations thus (C_4) refer to the corresponding annotations in Fig 2

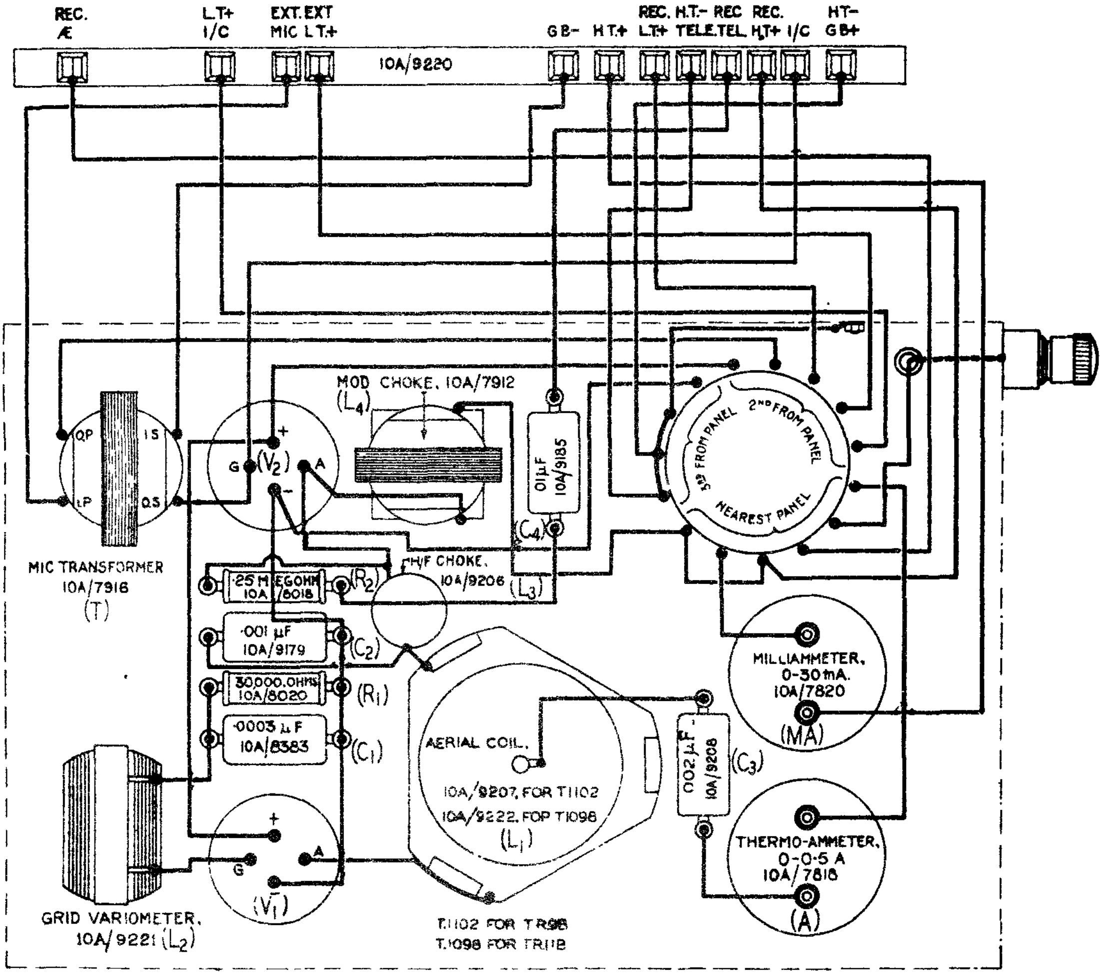

FIG. 6. BENCH WIRING DIAGRAM OF TRANSMITTER UNITS

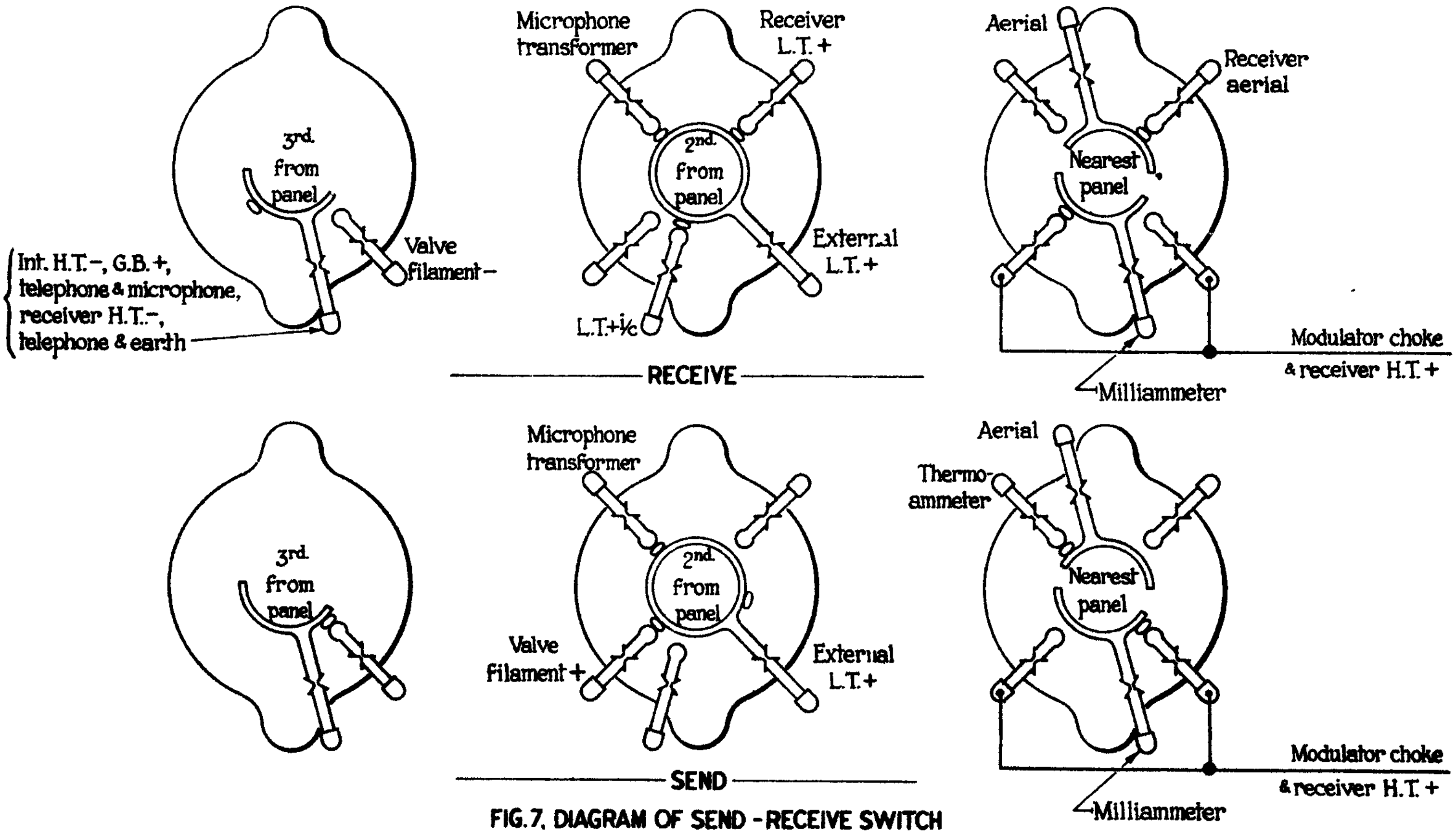

FIG. 7. DIAGRAM OF SEND-RECEIVE SWITCH

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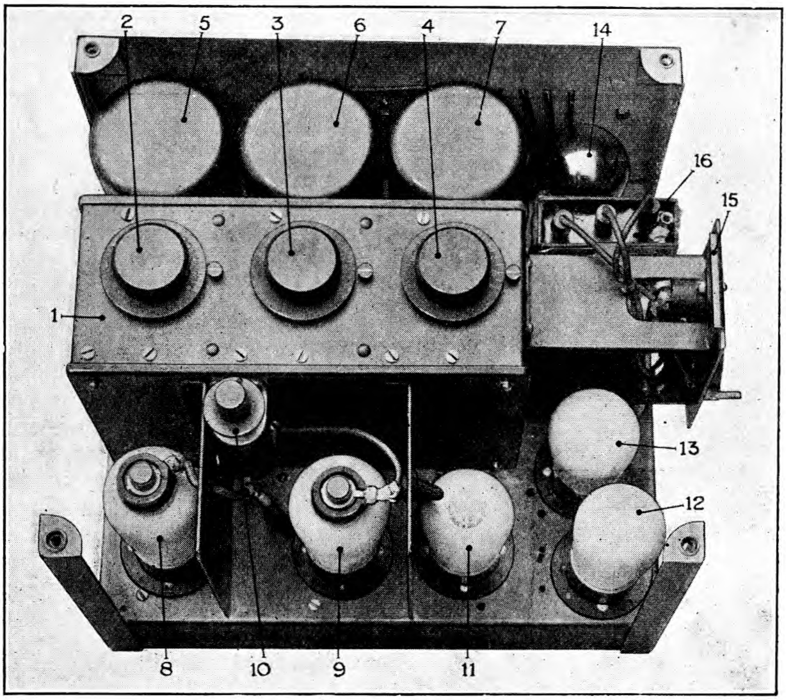

FIG. 8. Receiver, cover removed.

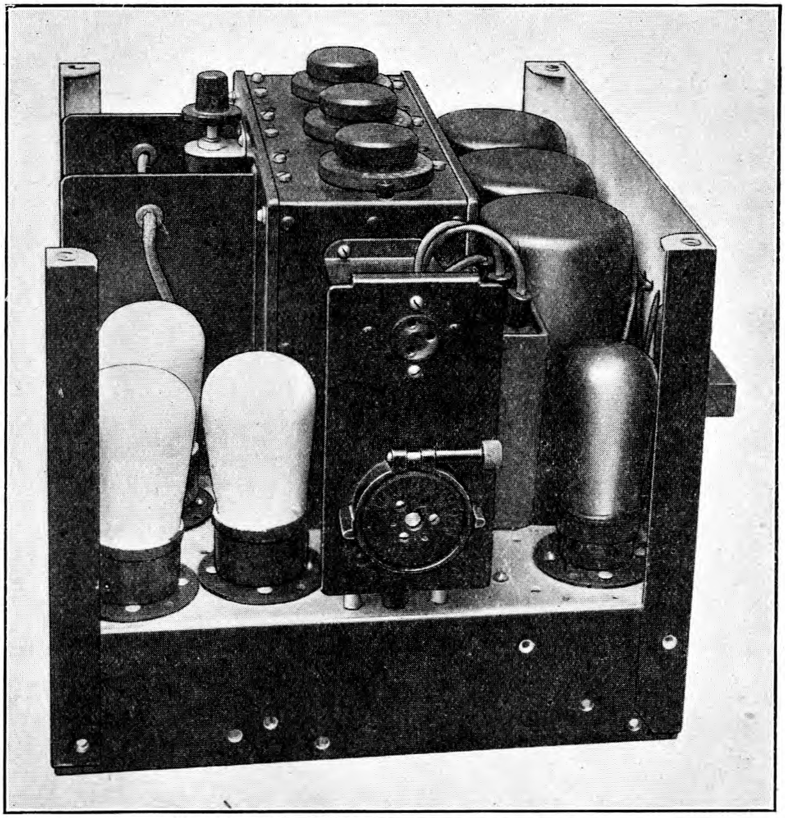

FIG. 9. Receiver, end view, cover removed.

33. In the second compartment the resistance (4) is connected in the same manner for biasing the second valve. The ·5 μF condenser (5), is the decoupling condenser for the second screen grid, and the ·01 μF condenser (6), below this is connected between the positive end of the filament and earth. Three resistances and two condensers are mounted on the insulating plate (7). The first resistance (20,000 Ω) is connected in series with the H.T. supply to the volume control potentiometer. The adjacent resistance (20,000 Ω) is in series with the second screen grid, and the third resistance (1 M Ω) is the grid leak for the second R/F. valve. The condenser next to this (·003 μF.) is the coupling condenser between the first and second valves, and the end condenser (·01 μF.) is the scale-opening condenser in the second tuned circuit. The condensers (8) and (9) (both 0·5 μF.) are the decoupling condenser, connected to the volume control socket, and the blocking condenser in the second tuned circuit respectively.

34. In the third compartment, over which the third tuned coil and the detector valve are mounted, is a mounting plate (10) fixed on the side. Nearest the panel on this plate is a resistance (1 M Ω) in the grid bias lead to the first audio-frequency amplifier. The adjacent resistance (2 M Ω) is connected as a stopper resistance in the grid lead to the same valve. The condenser next to this (·001 μF.) is the coupling condenser between the detector and first audio-frequency valve, and the other condenser (·001 μF.) is connected between the detector anode and earth. The remaining resistance (100,000 Ω) is the decoupling resistance in the H.T. lead to the detector. The mounting plate (11) carries the ·0001 μF. coupling condenser connected between the second radio-frequency amplifier and the detector, and also the ·25 M Ω resistance forming the grid leak of the detector. The mounting plate (12) carries a single resistance (2,000 Ω) in series with the H.T. supply to the second radio-frequency amplifier, and the ·5 μF. condenser (13) is the blocking condenser separating the tuned condensers of the second anode from the H.T. potential.

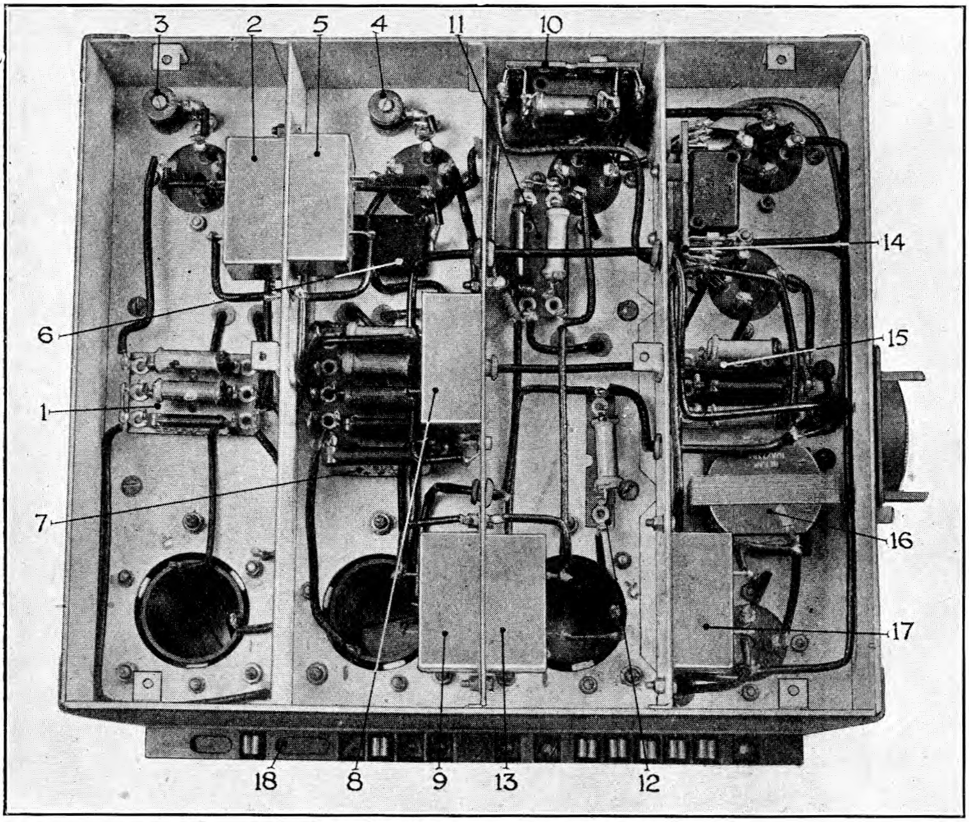

FIG. 10. Receiver, underside view.

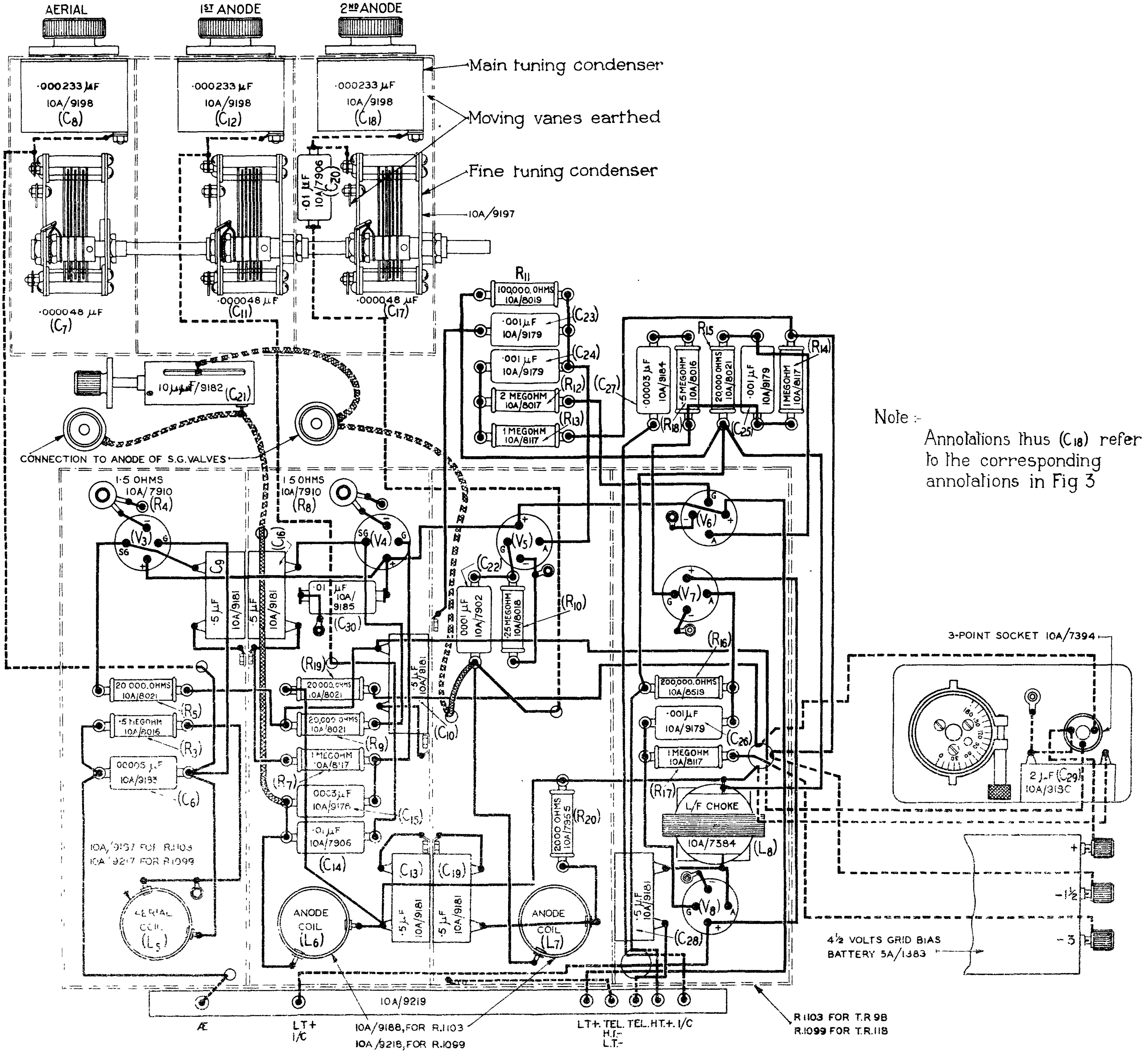

FIG. 11. BENCH WIRING DIAGRAM OF RECEIVER UNITS

35. The right-hand compartment contains the audio-frequency amplifying circuit. The mounting plate (14) fixed to the side carries two condensers and three resistances. The resistance nearest the panel (1 M Ω) is in the grid bias lead to the second audio-frequency amplifier. Next to this is the coupling condenser (·001 μF.) between this and the preceding valve; next is a 20,000 Ω resistance in the H.T. lead to the first audio-frequency amplifier, and at the end are the resistance (·5 M Ω) and condenser (·00003 μF.) connected in series to the grid of the second audio-frequency amplifier to form the input circuit for inter-communication. In the centre of the compartment is a mounting plate (15). The upper resistance on this (200,000 Ω) is in the H.T. supply to the second audio-frequency amplifier. The ·001 μF. condenser couples this valve to the grid of the output valve, and the other resistance (1 M Ω) is in the grid bias lead to the output valve. The audio-frequency choke (16) and the ·5 μF. condenser (17), form the choke-capacitance coupling between the output valve and the telephones.

36. The bench wiring diagram of the receiver unit is given in fig. 11. All the connections to the receiver except those of the remote volume control are made by means of spring contacts mounted on the contact bar (18), which engage with knife contacts mounted on a contact bar fixed in the case.

Case

37. The transmitter and receiver units are housed together in a special case. They are shown in position in fig. 1, and in fig. 12 the case of the T.R.11B is shown with the units removed. The case is of metal and is painted grey. The case of the T.R.9B is similar but the lead and plug on the left are not fitted. A main contact bar, shown in fig. 12, is fitted in the case, and from the underside of the contacts flexible connections are taken out through a bush. When

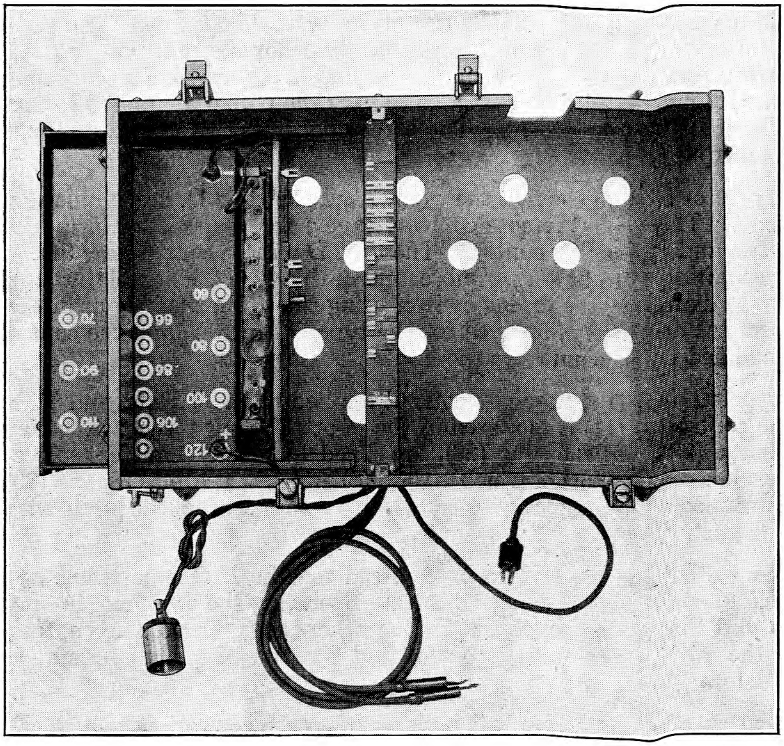

FIG. 12. Case of T.R. 11B.

the units are in position, spring-jaw contacts on each unit engage with the knife contacts on the bar. One end of the case is cut away and a tray is slid in, occupying a position under the transmitter unit. This tray carries the common H.T. battery for the transmitter and receiver and the grid bias battery for the transmitter. By means of four flexible leads terminating in plugs the batteries are connected up to three spring-jaw contacts on the tray, and when the tray is in position these three contacts engage with three knife contacts on the underside of the main contact bar.

38. In fig. 13 the engravings near the various contacts are clearly shown. The transmitter contact bar and receiver contact bar are shown disengaged from the main contact bar, and on the left is the tray also partly withdrawn. The tray passes under the transmitter contact bar.

Transit case

39. A transit case is provided for carrying the transmitter-receiver. It is constructed of yellow deal and is painted grey. The dimensions are approximately 1 ft. 9 in. by 1 ft. $3\frac{3}{4}$ in. by $10\frac{3}{4}$ in., and the case accommodates the complete instrument. The hinged lid is fastened with screw catches, and two metal carrying handles are provided.

REMOTE CONTROLS

40. The T.R.9B and T.R.11B transmitter-receivers are intended for operation by remote controls, and three different adjustments are made by these controls. The send-receive switch and the fine-tuning condensers are each operated by a flexible shaft running in a casing and actuated by a wheel and handle. The volume is regulated by means of a potentiometer connected by a cable to the receiver in such a manner as to vary the potential applied to the screening grids of the two radio-frequency amplifiers. The three controlling handles are mounted in one unit known as the controller.

41. Two types of remote control, the type C and the type D, are standardized for use with these instruments. The type C remote controls have a flexible shaft of $\frac{5}{32}$ in. diameter for both the switch control and the tuning control. The type D remote controls are intended for installations where the shafting is 15 ft. long or more, and in this type the flexible shafting for the switch control is $\frac{3}{16}$ in. in diameter, the tuning control using the $\frac{5}{32}$ in. shafting as in the type C remote controls. Larger casing is therefore used for the type D controls, and the controller and switch coupling are modified to accommodate the larger shafting.

42. The types C and D remote controls, as applied to the T.R.9B and T.R.11B are shown in fig. 14. The controller (11) is mounted in the pilot's cockpit ; the switch coupling (23), condenser unit handle (29) and the plug (26), are fitted to the transmitter-receiver. The flexible shafting (1) runs in a casing, part of which is rigid (8) and part flexible (16) and (30). The shafting consists of a stranded core of steel wire on which is wound a helical tooth wire making about ten turns to the inch.

43. The controller consists of two parts fitted together. One part, known as the Control, switch and tuning, consists of the mechanism for operating the two flexible shafts for the send-receive switch and the tuning condensers. The other part, the volume control, is mounted in the centre of the switch and tuning control and consists of a high resistance potentiometer operated by a knob.

44. The switch and tuning control consists of a case containing two wheels (3) with teeth specially shaped to engage with the helical tooth on the flexible shafting, so that rotation of the wheel moves the shafting in one direction or the other. The longer handle (5) is connected to the

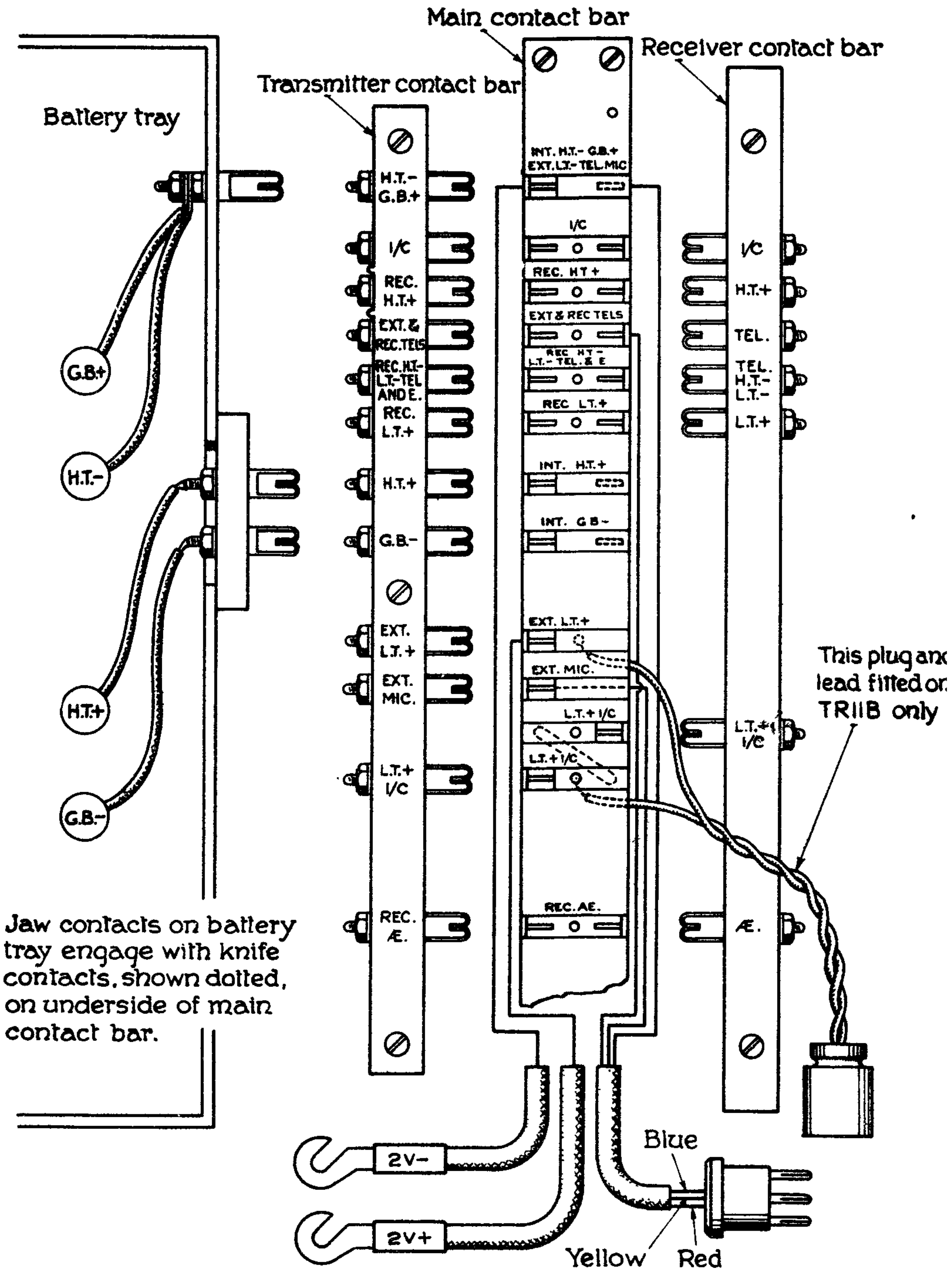

FIG. 13, TRANSMITTER-RECEIVERS T.R.9B AND T.R.11B CONTACT BAR CONNECTIONS

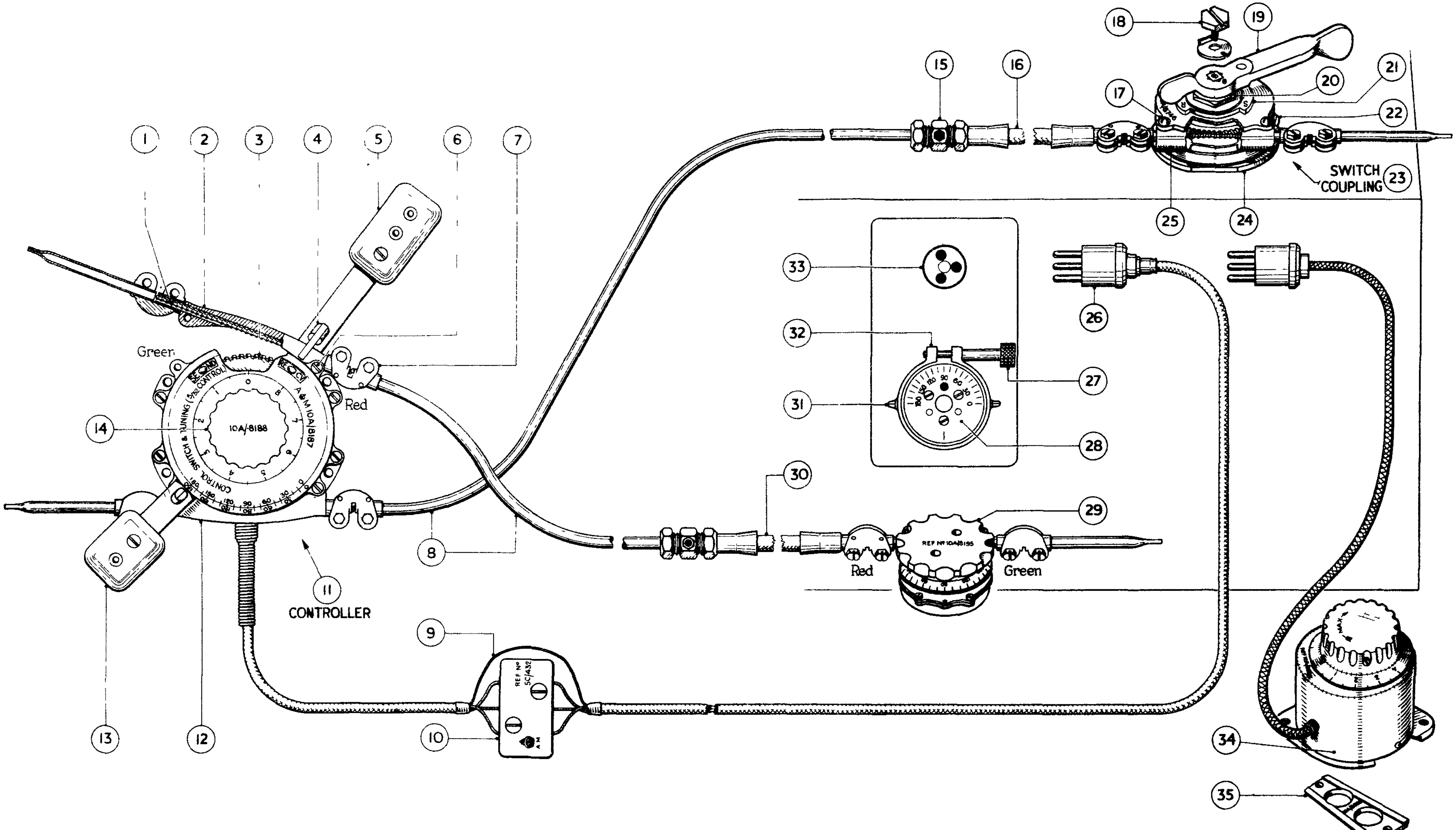

FIG. 14. REMOTE CONTROLS. TYPES C & D, FOR T.R.9B & T.R.11B

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wheel engaging with the flexible shafting in the guide tube (12) and is the control for the send-receive switch. The other handle (13) is connected to the other wheel, and this meshes with the flexible shafting in the guide tube (2). This shafting is connected to the tuning condensers and the handle (13) thus forms the tuning control.

45. Each handle is attached to a lever by a single screw. Three holes are provided in the switch control handle, and two in the tuning control handle, so that adjustment of the effective length of the levers is available. A spring-loaded catch (4) is fitted on the switch control handle. The central position of this handle is the " off " position, and it can be locked in this position by engaging the catch with a notch in the frame.

46. The guide tubes are attached to the body of the controller by two screws each (6), and are arranged so that if one screw is removed and the other loosened the guide tube may be swung away from the toothed wheel and the flexible shaft thus disengaged. The controller may be mounted with either of the handles uppermost, and the engraving is duplicated so that it can be read in either position. The flexible shaft may be arranged to enter either side of the controller, and the two extreme positions of the handle may be allotted for "send" and "receive" to suit the installation. The words SEND and RECV. are engraved on detachable plates which can be interchanged and turned upright to show the positions of the handle for the corresponding positions of the switch in the instrument.

47. The switch coupling (23) also contains a wheel with teeth to engage in the helical winding on the flexible shaft. On the lower end of the spindle carrying this wheel is a dog, which fits over the cross-bar attached to the switch spindle on the instrument. A handle (19) is fitted on to the outer end of the shaft for local operation of the switch and as a local indicator of the switch position. As in the controller, the guide tube (25) is fixed by two screws (17), either of which may be removed to disengage the flexible shaft from the wheel.

48. The switch coupling fits on to a ring adaptor (24) which is attached to the transmitter panel by two 2 B.A. countersunk screws $\frac{1}{4}$ in. long. The sleeve and flange of the coupling are slit and are clamped up on the adaptor ring by tightening the screw (22) which draws up the band round the sleeve. A key inside the sleeve engages in a keyway in the upper edge of the adaptor ring. The ring has eight keyways equally spaced so that the coupling can be secured in any of eight positions on it to allow the casing and flexible shaft to be led up to the instrument at the most convenient angle. The shaft may be led off from either end of the guide tube provided that the controller is arranged accordingly.

49. The handle (19) may be fitted on to the square end of the spindle in any of eight positions, and is secured by the screw (18) with a locking washer. The plate (21) is cut away to form a stop plate and also carries the designations S and R to indicate the "send" and "receive" positions. This plate can also be fixed in eight different positions to suit the position chosen for the handle. It is located by a dowel pin and secured by the nut (20) with its locking washer. The reverse side of the stop plate is also engraved S and R, but in the reverse positions. The reverse engraving will not, however, be required when the coupling is fitted to these transmitters.

50. The condenser unit handle (29) consists of a knob fixed to a spindle turning in the body. A disc is fixed on the other end of the spindle inside the body and carries a single eccentric pin which engages in the largest of the three holes in the index wheel (28) attached to the operating spindle of the gang of fine-tuning condensers. The guide tube for the flexible shafts attached to the body by two screws, in the same way as in the switch coupling, and the flexible shaft meshes with a wheel on the spindle. The sleeve of the body fits inside the split ring (32) fixed to the receiver, and is clamped by the screw (27). The condenser unit handle can be fixed in any position in the ring. A dial engraved with a scale of 0–180° on each half, forms part of the knob. One scale is marked in white and the other in orange, and the two indices (31) register with them. Whichever scale is more easily visible may thus be used. One end of the guide tube is coloured red and the other green, and the ends of the guide tube on the controller are also marked with these colours. The flexible shaft must be led off from the red end of both or the green end of both in order to obtain the correct direction of rotation of the condenser.

51. The rigid casing (8) for the flexible shaft consists of solid-drawn light alloy tubing. The flexible case (16) and (30) is built up of a helix of brass strip over which is a winding of steel wire and another of phosphor-bronze or spring steel wire, and finally, a waterproof covering of varnished cotton braid. The junctions between the casing and the components and between two lengths of casing are made by means of casing unions (7). The free ends of the shafting at the controller, the switch coupling, and condenser unit handle are protected by short lengths of rigid casing fitted to the free ends of the guide tubes by casing unions, and pinched up at the ends.

52. The union consists of two split clips made in one piece, and each clip is clamped up on the casing by means of a screw. A hole is drilled through the union at each end to take a key pin for increased security. These pins are not fitted, however, in the unions at the free ends. Special unions (15) to allow of lubrication are fitted between the flexible and the rigid casing, and along the run of the rigid casing when necessary. These lubricator unions carry a standard grease nipple, and have a union nut at each end. The union nut is tightened up on to a cupped washer inside the body, which is thus flattened out and bites into the tubing.

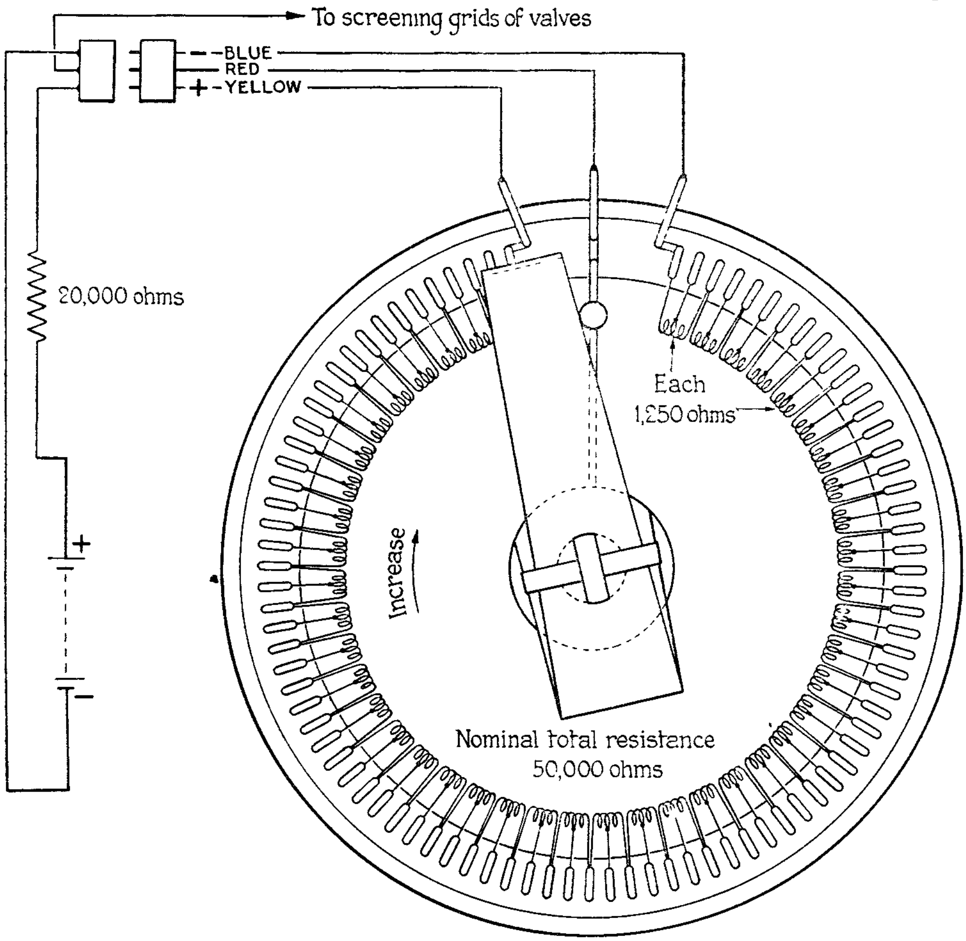
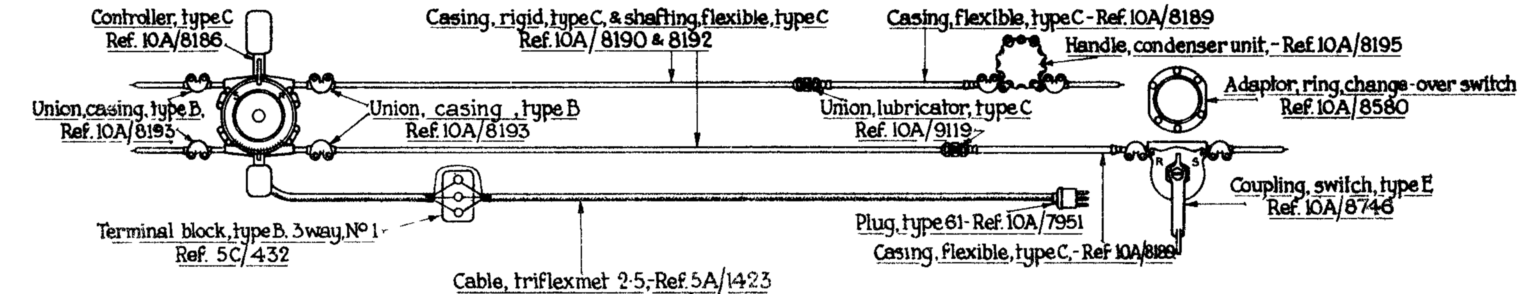
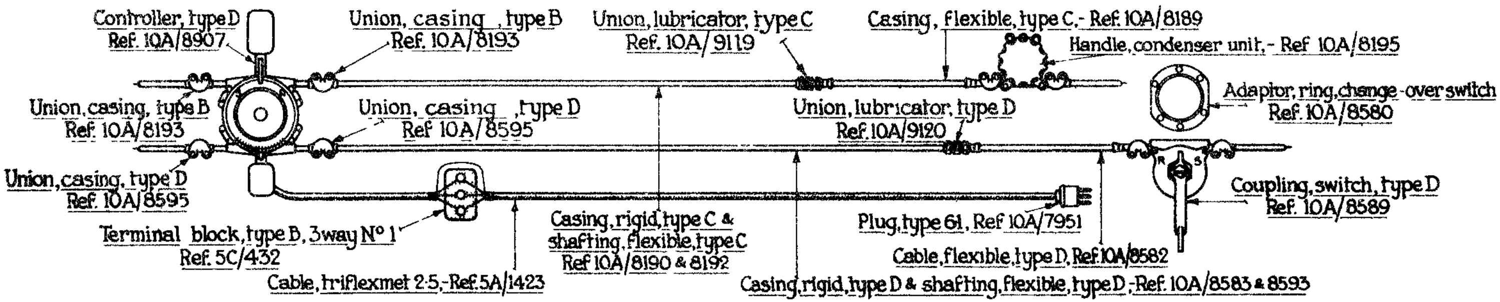


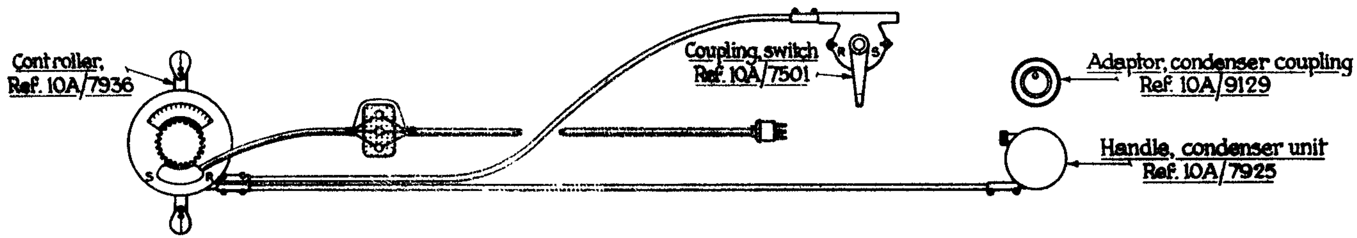
FIG. 15. VOLUME CONTROL CIRCUIT



TYPE C (Condenser & change-over switch shafting 5/32" dia)



TYPE D (Condenser shafting 5/32" dia., change-over switch shafting 3/16" dia. for long runs - 15 ft. or over)



TYPE B (When T.R.9B is fitted in an aeroplane where type B controls are installed, the adaptor, condenser coupling, is required)

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FIG. 16. REMOTE CONTROL COMPONENTS

53. The volume control consists of a high-resistance potentiometer operated by the knob (14). Two different methods of construction are used for the potentiometers in service. One type is built up as an ordinary strip-wound resistance with a contact arm moving over it. The other type consists of a number of resistances connected to contacts on a multiple-contact rotary switch. This type is shown diagrammatically in fig. 15. Forty-four resistances of 1,250 ohms, each with a centre tapping, are mounted round the spindle and connected to the contacts as shown. The ends of this circuit are connected to the H.T. supply with a further resistance of 20,000 ohms in the positive lead, and the contact arm is connected to the screening grids of the valves. The 20,000 ohms resistance connected in series with the potentiometer has the effect of limiting the range of variation of the screen-grid voltage to that required for smooth control of the amplification from a minimum to a maximum.

54. A 2-ft. length of screened three-core cable is supplied with the controller and is connected on installation, to a 3-way terminal block (10). The connections are taken from the terminal block to the three-pin plug (26) for connection to the socket (33) in the side of the receiver. The screening conductors of the two lengths of cable are connected by the bonding wire (9), which is bound to the metal braiding by 30 s.w.g. tinned copper wire soldered in position. In order to test that the bonding is efficient, switch on and tune the transmitter. Rotate the receiver volume control and observe the aerial current. If any change is seen as the volume control is moved, the bonding of the controller probably requires attention. It is important to ensure that the metal sheath of the triflexmet cable is continuous from the controller to the instrument.

55. As the receiver will not function without a potentiometer connected to the socket (33), a type B volume control (34) is provided for use by an observer having access to the transmitter-receiver in a two-seater aeroplane, or for operation of the receiver on the test bench. The type B volume control consists of the potentiometer forming the type A volume control, as used in the controller, fitted into a metal case and having a lead and three-pin plug connected to it. It may be fixed in any convenient position by two screws through a flange; or the wedge plate (35) may be attached to the airframe and the volume control supported on it when easy detachment is required.

56. A key diagram showing the components required for remote control of the T.R.9B and T.R.11B transmitter-receivers is given in fig. 16. The upper sketch shows the type C controls, and the second sketch the type D controls as used with these instruments. In the bottom sketch the type B controls are shown. If these are already installed in the aeroplane they may be used to operate the T.R.9B or T.R.11B. The switch coupling can be attached directly to the plate on the receiver to which the ring adaptor is otherwise fixed. The ring adaptor will not be required, and must be removed. The condenser unit handle requires an adaptor for the type B controls. This adaptor consists of a sleeve, having a spindle carrying two discs, which is adapted to fit into the clamp ring ((32) fig. 14). The inner disc has an eccentric pin to engage in the largest hole in the index plate (28), and the other is arranged to fit the condenser unit handle of the type B controls.

VALVES AND BATTERIES

57. Both oscillator valve and modulator valve in the transmitter are of the same type, *viz.*, V.T.20, having a filament consumption of ·2 amp. at 2 volts. The receiver employs two screen-grid valves (V.R. 18) having a filament consumption of ·15 amp. at 2 volts, a detector valve V.R.27 and A/F. valves (V.R.21) having a filament consumption of ·1 amp. at 2 volts and an output valve (V.R.22) having a filament consumption of ·2 amp. at 2 volts.

58. The current for the transmitter and receiver filaments is supplied from a 2-volt accumulator (Stores Ref. 5A/1387). The H.T. supply for both transmitter and receiver is obtained from a 120-volt dry battery (Stores Ref. 5A/1333) housed in the case of the transmitter-receiver.

59. A maximum load of 15–18 milliamps. is imposed upon the H.T. battery when the transmitter is in use. The battery should be tested frequently and, if the reading on load is less than 100 volts, the battery should be replaced. A 15-volt grid bias battery is employed to bias the modulator valve of the transmitter and a 4½-volt grid bias battery is employed to bias the A/F. valves and output valve of the receiver. The 15-volt battery is housed with the H.T. battery in the special tray in the transmitter-receiver case, but the 4½-volt battery is accommodated in the receiver itself.

TUNING

Transmitter

60. The frequency of the transmitter is adjusted with the use of a wavemeter. The wavemeter W.69 is used for the T.R.9B and the W.75 for the T.R.11B. The method of making the adjustment is as follows :—

61. Erect the wavemeter on the tripod and place it about 6 ft. from the aerial in such a position that the micro-ammeter is clearly visible from the cockpit. Switch on the wavemeter and adjust it to the frequency to which the transmitter is to be set.

62. Before switching on the transmitter set the aerial coil and the grid variometer to give approximately the required frequency. The tables below give representative settings for apparatus installed in small aeroplanes and these may be used as a guide.

63. Turn the switch to SEND and observe the readings on the aerial ammeter and the H.T. milliammeter. The aerial current should be about 0·25 amps. and the input current 15–17 milliamps.

64. Adjust the grid variometer and aerial coil until a maximum reading is obtained on the wavemeter micro-ammeter. The adjustments should be alternated until no further adjustment is necessary. The grid variometer should be adjusted so as to obtain the minimum input, as shown on the H.T. milliammeter and not for maximum output as shown on the aerial ammeter. This procedure is essential in order to avoid instability.

65. The coupling between the transmitter and the wavemeter should be such that the maximum reading obtained on the wavemeter micro-ammeter is about three-quarters of the full scale reading. It may be necessary to move the wavemeter towards or away from the aerial to satisfy this condition.

66. Typical settings for the T.R.9B transmitter unit installed in a small aeroplane with an aerial from wing tip to tail are given below :—

Frequency kc/s.	*Aerial coil turns.*	*Grid variometer degrees.*
4,286	14·0	115
4,700	12·0	90
5,120	10·0	70
5,710	8·0	35
6,010	7·0	30

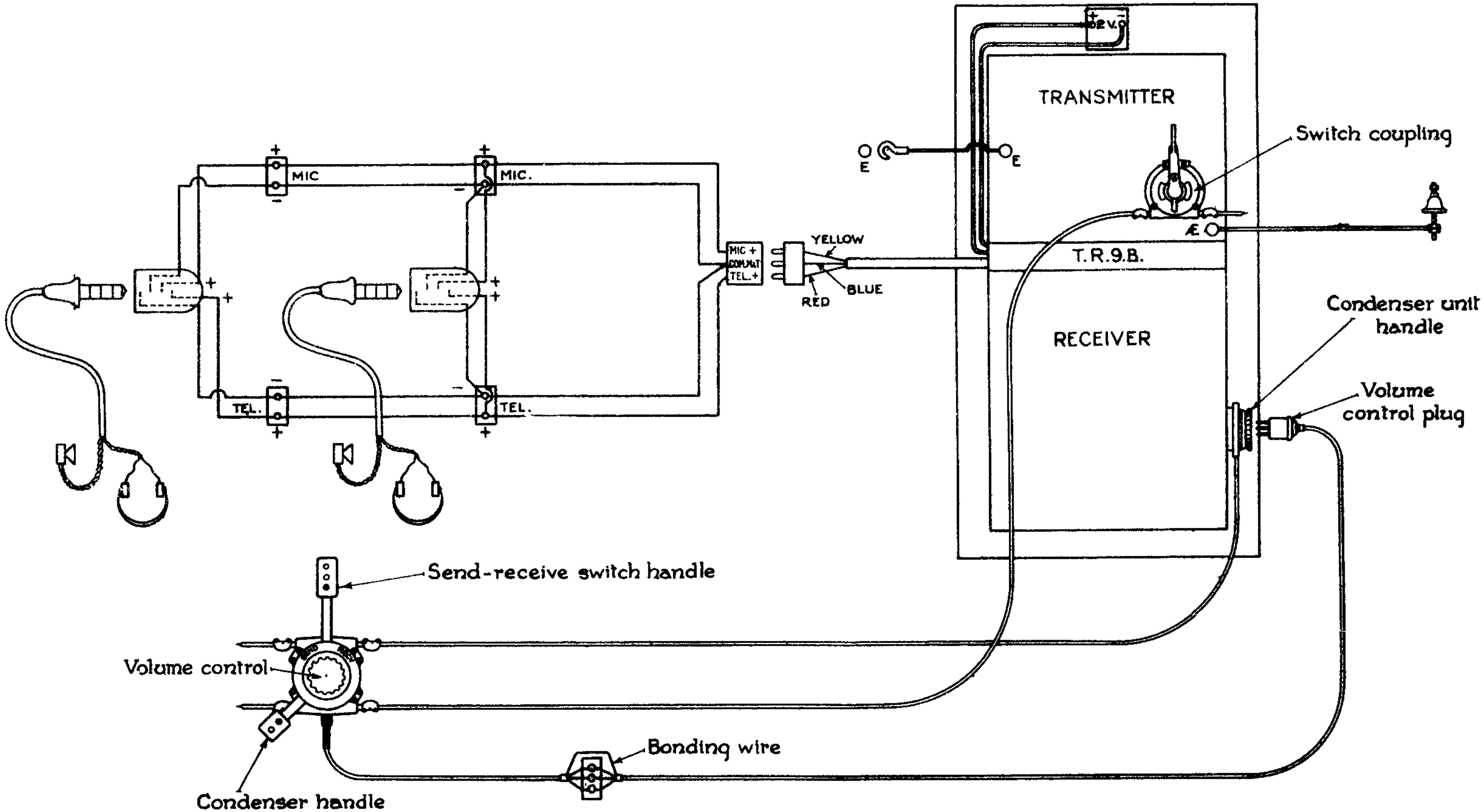

FIG. 17. INSTALLATION DIAGRAM OF T.R.9B.

(F.1800). F. & C. LTD.

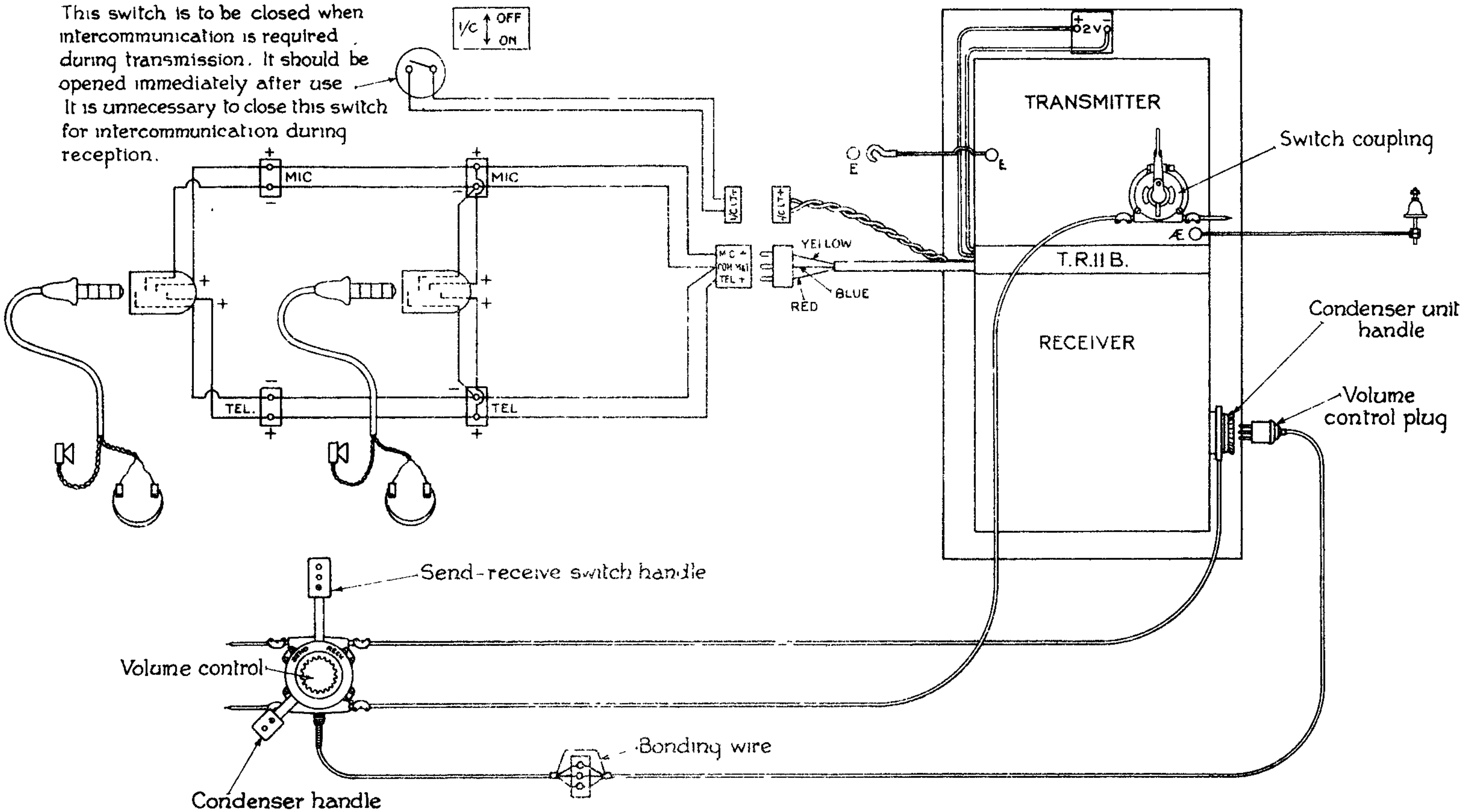

FIG.18. INSTALLATION DIAGRAM OF T.R.11 B.

(F.1800) F. & C. LTD.

67. Typical settings for the T.R.11B transmitter unit installed in a small aeroplane with an aerial from wing tip to tail are given below :—

Frequency kc/s.	*Aerial coil turns.*	*Aerial coil degrees.*	*Grid variometer degrees.*
4,388	1	180	60
4,234	2	20	84
4,074	3	20	84
3,898	4	20	100
3.744	5	20	106
3,634	6	20	106
3,525	7	20	118
3,422	8	20	120
3,333	9	20	150
3,242	10	20	160
3,178	11	20	160
3,110	12	20	160
3,046	13	20	180
2,990	14	20	180

Receiver

68. The receiver may be tuned by two different methods. The first method is to adjust a transmitter of a similar instrument to the required frequency and to tune the receiver directly from this. The second method is to adjust the transmitter of the same or any similar instrument to the required frequency, tune an R/T tester or wavemeter W.39 or W.39A from this, and then tune the receiver from the R/T tester or either wavemeter. The two methods are described in full below.

69. To tune the receiver directly from a transmitter, the transmitter of another instrument of the same type must first be tuned to the frequency required, by the method described above for transmitters. For this purpose it should be set up with a condenser of about 100 micro-microfarads connected between the aerial and earth terminals instead of connecting the aerial. A microphone must be connected up to the transmitter, and with the switch turned to SEND a constant modulation must be applied. For satisfactory tuning the signal strength received should be adjusted to about strength 5 by moving the transmitter or decreasing its radiation. The receiver is then tuned as follows :—

70. Operate the switch of the transmitter-receiver to RECEIVE, turn the volume control to its highest position and set the regeneration control so that the receiver does not oscillate. Set the tuning control to about 105 degrees, that is, to about the middle of its frequency range. Adjust the main tuning condensers (2), (3) and (4) (fig. 8) to obtain the maximum signal strength in the telephones connected to the receiver.

71. Turn the regeneration control counter-clockwise until the receiver begins to oscillate, and then turn it back until oscillation just stops. A further adjustment of the main tuning condensers will now be required to obtain maximum strength. The tuning and regeneration should be adjusted alternately until a condition is reached when no further improvement is obtained.

72. Turn the volume control and observe the variation in signal strength. The strength should increase uniformly over the entire range of the control and the receiver should be stable at all positions. Turn the tuning control throughout its range and ensure that the receiver is stable in all positions.

73. Alternatively, the receiver may be tuned by means of the R T tester, type 1, or the wavemeter W.39. If the tester is used only unit A will be required. The method is as follows :—

74. Set the transmitter of the transmitter-receiver to the frequency required as described under the sub-heading TRANSMITTER. Place the wavemeter, or the unit A of the tester, close to the transmitter, connect a pair of telephones to it and switch to C.W. Switch the transmitter-receiver to SEND and tune the wavemeter or tester to obtain a zero beat frequency.

75. Without disturbing the setting, switch to T.T. and switch the transmitter-receiver to RECEIVE. Tune the receiver as described in the previous paragraph.

76. These methods have the advantage that all frequencies are set from one wavemeter and their accuracy will therefore depend only on the care taken in the operations. The calibration of the R/T tester should not be used and the calibration of the wavemeter W.39 should only be used if no other standard is available.

OPERATION

77. When the aeroplane is on the ground the switch handle of the controller should be locked in the "off" position as a safeguard against wastage of batteries. Immediately before leaving the ground the handle should be moved to the "receive" position and should be maintained in this position, except when transmission is in progress, so that the apparatus is ready to receive a call.

78. Immediately before each flight a test of transmission and of reception should be made, using a fixed aerial. During flight the switch control, the volume control and the tuning are operated as required. Inter-communication is always available during reception. If it is required during transmission on a T.R.11B the switch installed in the bomb-aiming position must be switched on. This brings the last two valves of the receiver into operation and the pilot is thus able to hear the bomb-aimer's speech while he is transmitting. The switch must be turned off immediately after use.

PRECAUTIONS AND MAINTENANCE

Transmitter-Receiver

79. The two-volt accumulator must be removed and charged at frequent intervals and should always be freshly charged before each flight in which the wireless apparatus is to be used. The high tension battery should be periodically tested for voltage. This may be done by withdrawing the battery tray or by removing the cover between the transmitter and the receiver and connecting the voltmeter between the H.T.+ and the H.T.— contacts. If the voltage on load falls below 100 the battery must be renewed. The plugs should be secure in the battery sockets, and care must be taken not to dislodge them in replacing the battery tray. Should any difficulty be experienced in withdrawing the tray, see that the plugs which fit into the batteries are not too high. The plugs in question are types 91, 93, and 94, and should the contact pin be greater than the depth of the socket, the plug should be cut down so that when inserted in the socket, the shoulder of the plug will bear against the shoulder of the socket.

80. A number of instruments have faulty contact bars, so that the H.T. and grid bias batteries are short-circuited as soon as the transmitter unit is put into the case. In order to rectify the defect arising out of the contacts engraved H.T.+ and G.B.— being flush with the left-hand edge of the bar on its lower side, both the contact bar and the contact should be filed, so that the latter does not come within a sixteenth of an inch of the left-hand side of the contact bar.

81. The input current to the transmitter must be checked periodically. With the modulator valve removed the input should be 7 or 8 milliamps. With the oscillator valve removed the input should also be about 7 or 8 milliamps and the tapping of the grid bias battery should be

adjusted if necessary to give this value. The voltage of the grid bias battery should also be checked and the battery replaced if necessary. The modulator valve is normally biased at 7·5 volts, but if the H.T. battery is fresh, it may be necessary to increase the bias to 9 volts. If the H.T. battery voltage is low it is sometimes desirable to drop the bias to 6 volts. The grid bias battery for the receiver is fitted under the receiver panel. Its voltage must be checked periodically and the security of the plugs examined. If this battery is faulty distorted speech as well as an unduly heavy drain on the H.T. battery will result.

82. The H.T. milliammeter is connected between the H.T. battery and the send-receive switch, and is therefore always in circuit. To avoid any possibility of overloading the milliammeter or the H.T. battery, the H.T. circuit should always be broken by withdrawing the battery tray before beginning any repairs or carrying out such operations as renewing valves.

83. In self-excited transmitters such as those in the T.R.9B and T.R.11B the capacitance of the aerial system affects the frequency of the transmission. It is therefore essential that the leads to aerial and earth, and the aerial itself, should be kept as rigid as possible. If frequency variation is experienced these leads should be carefully examined. The earth terminal should make good electrical contact with the airframe, and to this end there should be no paint on the surfaces making contact. The aerial and earth leads should be strapped down to some rigid member, bearing in mind that the aerial lead must not be close to an earthed conductor. The aerial itself must be correctly tensioned, and when a new aerial is fitted the wire should be stretched before it is fixed.

84. An auxiliary condenser unit handle is available for local operation of the fine-tuning condensers either on the bench or in the aeroplane. It consists of a handle with a disc at the end carrying three pins and having two pins in the side of the handle. The three pins at the end fit into the three holes in the index wheel attached to the end of the condenser spindle, and are used to control the condensers when the remote controls have been taken off. The two pins at the side fit into holes in the condenser unit handle forming part of the remote controls, and these are used when the remote controls are fitted. One of these pins is movable and is spring-loaded, so that the auxiliary handle will remain in place when the pins are inserted into the condenser unit handle.

85. Care should be taken to ensure that the two valves (8 and 9, fig. 8) do not touch the metalwork of the chassis. As the valves are of the metallized type, the bias resistance in the negative filament leads (R_4 and R_8, fig. 3) will be short-circuited, if the sides of the valves touch the frame-work.

Remote controls

86. When the remote controls are to be disconnected for removal of the transmitter-receiver from the aeroplane, the switch coupling is removed by loosening the clamp screw and pulling the coupling off the adaptor ring attached to the panel, and the condenser unit handle is removed in a similar manner. The positions at which each of these has been fitted should be noted before they are removed. The volume control plug must also be taken out.

87. When the transmitter-receiver is replaced the switch coupling and condenser unit handle should be fitted in the same position as before unless there is any particular reason for changing them. The correct position for the switch coupling may be determined, if it is not known, by putting both the switch and the handle of the coupling in the "off" position and engaging the dog with the switch cross bar. The key should then fit into the appropriate keyway. Particular attention should be paid to ensure that the switch and coupling are in the same position. Failure to do this may result in the send-receive switch overrunning its stops and damaging the switch type, 102. A switch, type 137, and new stop plate are introduced in later transmitters to minimize the possibility of this failure. The condenser unit handle is not keyed and the correct position must be found by trial.

88. If the shafting has been disengaged from the wheels, or if the position of the switch coupling or condenser unit handle changed, the shafting must be readjusted. When the switch coupling has been fitted in the new position and fixed by tightening the clamp screw, the most convenient position for the handle is then decided on, and the " off " position noted. The stop plate is moved if necessary to correspond with the range of movement decided on for the handle and the handle then fitted. The condenser unit handle is fixed as required and clamped up.

89. The flexible shafting must then be readjusted. The following method is observed in the initial fitting and should be repeated if the shafting has been disturbed. It is assumed that the casing and components are completely assembled.

90. Disconnect the short closed lengths of tubing from the controller and coupling by disengaging the casing unions from the guide tubes. Remove one of the screws fixing each guide tube, slacken the others and swing the tube away from the wheel. Thread the required length of shafting into the casing and push it through until the end is just flush with the free end of the guide tube on the coupling. Turn the handle on the coupling to the position that it would occupy if the shafting were engaged with the wheel and then pulled from the far end. Push the guide tube back into place, meshing the shafting and wheel to the nearest tooth, and screw up the guide tube.

91. Pull the end of the shafting projecting from the controller so as to take up all slack. Turn the handle of the controller to the position it would occupy to pull the shafting as far as possible from the other end and re-fix the guide tube, meshing the shafting and wheel to the nearest tooth. It should now be possible to operate the coupling to either extreme position by movement of the controller handle. When the shafting is pushed away from the controller to its extreme position, the end should be flush with the free end of the guide tube.

92. If there is an intermediate switch coupling for operation of the send-receive switch by the observer, the switch handle of the controller should be placed in the " off " position and locked. The handle of the intermediate coupling should then be turned to the central position and the guide tube pushed into place and screwed up. With the controller handle unlocked it should then be possible to operate the switch to either extreme position by movement of the intermediate handle. Replace the short closed lengths of rigid casing on the free ends of the guide tubes.

93. If in the repair or modification of remote controls it is required to bend the rigid casing, the bending tool supplied for the purpose must be used. The bending tool is of wood and is in the shape of a segment of a circle, with a U-section slot round the edge in which the casing is to be fitted for bending. For the type C rigid casing the tool, bending, type C (Stores Ref. 10A/9006) is used, and for the type D rigid casing the tool, bending, type D (Stores Ref. 10A/9007) is used. In addition, the following precautions must be observed.

94. The cross-section of the casing must not be distorted from the circular form. The appropriate flexible shafting must therefore always be threaded through the casing before the casing is bent. The straight casing adjacent to a bend must be tangential to the bend. The bending tool is to be placed against the casing where the bend is required and the casing bent by hand to the shape of the tool. The bending must be done slowly and without jerks.

TRANSMITTER RECEIVER T.R.9C

(Stores Ref. 10A/10370)

95. Certain modifications have been introduced into the T.R.9B in Fighter Command Units whereby the instrument becomes T.R.9C. Briefly the modifications consist in the introduction of a crystal to stabilize the frequency of the carrier wave. The transmitter unit (T.1102) of the T.R.9B, when modified, will become T.1121 (Stores Ref. 10A/10371). The receiver unit of T.R.9B, *i.e.*, R.1103 (Stores Ref. 10A/9510) will remain unaltered. A modified transmitter unit is illustrated in fig. 19.

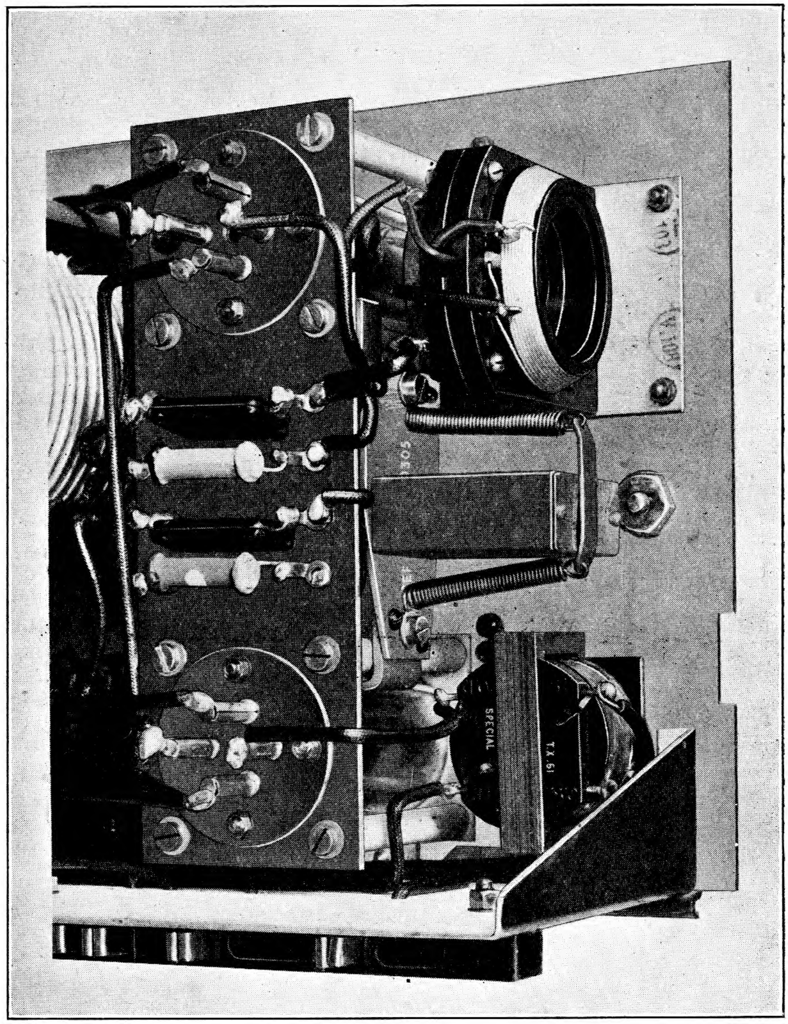

FIG. 19. Transmitter unit of T.R.9C.

OPERATION

Transmitter

96. Turn the aerial tuning control to the zero position and switch on the transmitter. Increase the aerial tuning inductance (noting that the input millamperes are at a maximum) until a position is reached where the input milliamperes are a minimum. The aerial current indicated in the meter will then be a maximum and should be about 0·2 to 0·25 amp. This point is just prior to the non-oscillating point which can be observed by adjusting slowly once or twice and noting that the input rises suddenly and aerial current falls to zero.

97. Having tuned to maximum aerial current (minimum input reading) reduce the aerial inductance approximately 90°. Switch on the microphone and give a loud hoot, speech or whistle, and note that the aerial current increases. If the reduction of 90° on the dial is

insufficient for best aerial current increase, a suitable position near-by can be found by trial and error giving a loud hoot, speech or whistle after each adjustment. If the frequency is towards the lower frequency end of the band, the reduction may be as much as 140°.

98. Should the aerial ammeter fail to rise whilst modulating, check the microphone circuit including the modulator valve. See that the transmitter is in a stable oscillating condition. The aerial ammeter should give steady readings as mentioned in para. 96, when the transmitter is switched off and then on again.

Receiver

99. Turn the volume control in the pilot's cockpit to maximum volume position. Except where it is otherwise stated the volume control must remain in the maximum position during the complete tuning operation. Put the fine tuning control to 90°, i.e. to about the middle of its frequency range. Place a R/T tester, modified for use with a crystal, near the tail plane and switch it on. Switch on the receiver and adjust the three main variable condensers until the modulated signal is heard at maximum strength.

100. To obtain the correct tuning, the weakest possible signal *must* be used and this is to be obtained, not by reducing the volume control, but by closing the lid of the case containing the signal generator and if necessary increasing the distance between the generator and the aeroplane. If during the process of tuning, the signal becomes strong, the distance should be still further increased. Having obtained a weak signal at maximum strength, turn the re-generation control in the direction of the arrow until a position is reached where the receiver begins to oscillate. Note the position and turn back one complete turn. Re-tune the three main tuning condensers for maximum signal. Repeat these adjustments until no further increase in signal strength is obtained.

101. Turn the volume control and note that the strength of signal decreases or increases over the entire range of the control and that the receiver remains stable. With the volume control at maximum, move the fine tuning control throughout its range and note where the receiver is stable. Leave the fine tuning control on the 90° position. Should oscillation occur when carrying out these instructions repeat the whole tuning operation, turning the re-generation control back half a turn more, i.e. 1½ turns.

APPENDIX

NOMENCLATURE OF PARTS

The following list of parts is given for information only. In ordering spares for this transmitter-receiver the appropriate section of AIR PUBLICATION 1086 must be used.

Ref. No.	Nomenclature.	Quantity.	Remarks.
10A/9507	Transmitter-Receiver T.R.9B, consisting of :—		
10A/9512	Case	1	Fitted with contact bar and plug, type 48.
10A/9214	Bar, contact	1	
10A/9172	Cover, contact bar	1	
10A/9511	Transmitter T.1102..	1	
10A/9510	Receiver R.1103	1	
10A/9175	Tray, battery	1	Fitted with 3 contacts and 4 plugs, type 76.
10A/9128	Transmitter-Receiver T.R.11B, consisting of :—		
10A/9213	Case	1	Fitted with contact bar and plugs, types 48 and 62.
10A/9214	Bar, contact	1	
10A/9172	Cover, contact bar	1	
10A/9216	Transmitter T.1098	1	
10A/9215	Receiver R.1099	1	
10A/9175	Tray, battery	1	Fitted with 3 contacts and 4 plugs, type 76.
	Transmitters T.1102 and T.1098. Principal components.		
10A/7818	Ammeter, thermo, 0 to 0·5	1	
10A/9220	Bar, contact	1	Fitted with 12 contacts.
10A/9227	Base, terminal, 1-way	1	Engraved 29.
10A/9206	Choke, R/F., type 34	1	
10A/7912	Choke, A/F., type G	1	
10A/9207	Coil, aerial	1	For T.1102 only.
10A/9222	Coil, aerial	1	For T.1098 only.
10A/9179	Condenser, type 280	1	·001 μF.
10A/9185	Condenser, type 286	1	·01 μF.
10A/9208	Condenser, type 289	1	·002 μF.
10A/8383	Condenser, type 173	1	·0003 μF.
10A/9194	Holder, valve, type R	2	
10A/9195	Plate, guard	2	For valve-holders.
10A/7820	Milliammeter, 0–30, type B	1	
10A/7153	Plug, type 29	1	For aerial lead. May not be used when aerial terminal is fitted.
10A/8018	Resistance, type 110	1	0·25 MΩ.
10A/8020	Resistance, type 112	1	30,000 Ω.
10A/9210	Switch, type 102	1	Multi-contact, rotary.
10A/7916	Transformer, microphone, type G	1	
10A/9212	Variometer, grid	1	For T.1102 only.
10A/9221	Variometer, grid	1	For T.1098 only.
	Receivers R.1103 and R.1099. Principal components.		
10A/9219	Bar, contact	1	Fitted with 7 contacts.
10A/9190	Base, terminal, 1-way..	1	Engraved 16.
10A/9191	Base, terminal, 2-way..	1	Engraved 14 and 15.
10A/9192	Base, terminal, 3-way..	1	Engraved 1, 2 and 3.
10A/9224	Base, terminal, 3-way..	1	Engraved, 22, 23 and 24.
10A/9193	Base, terminal, 5-way..	1	Engraved 4, 5, 6, 7 and 8.

Ref. No.	Nomenclature.	Quantity.	Remarks.
10A/9225	Base, terminal, 5-way	1	Engraved 9, 10, 11, 12 and 13.
10A/9226	Base, terminal, 5-way	1	Engraved 17, 18, 19, 20 and 21.
10A/9189	Can, coil	3	
10A/7384	Choke, A/F., type B	1	
10A/9187	Coil, aerial	1	For R.1103 only.
10A/9217	Coil, aerial	1	For R.1099 only.
10A/9188	Coil, anode	2	For R.1103 only.
10A/9218	Coil, anode	2	For R.1099 only.
10A/7902	Condenser, type 121	1	·001 μF.
10A/7906	Condenser, type 125	2	·01 μF.
10A/9178	Condenser, type 279	1	·0003 μF.
10A/9179	Condenser, type 280	4	·001 μF.
10A/9180	Condenser, type 281	1	2·0 μF.
10A/9181	Condenser, type 282	6	0·5 μF., metal case.
10A/9182	Condenser, type 283	1	Miniature variable.
10A/9183	Condenser, type 284	1	·00005 μF.
10A/9184	Condenser, type 285	1	·00003 μF.
10A/9185	Condenser, type 286	1	·01 μF.
10A/9197	Condenser, type 287	1	Gang of three ·000048 μF. variable air condensers.
10A/9198	Condenser, type 288	3	·000233 μF. variable air condensers.
10A/9194	Holder, valve, type R	6	
10A/9195	Plate, guard	6	For valve-holders.
10A/9196	Plate, guide	6	For valve-holders.
10A/9202	Knob, indicator	3	
10A/9201	Knob, slow motion	3	
10A/9176	Plug, type 76	3	For grid bias battery.
10A/7910	Resistance, type 97	2	1·5 Ω.
10A/7955	Resistance, type 102	1	2,000 Ω.
10A/8016	Resistance, type 108	2	0·5 MΩ.
10A/8017	Resistance, type 109	1	2 MΩ.
10A/8018	Resistance, type 110	1	0·25 MΩ.
10A/8019	Resistance, type 111	1	100,000 Ω.
10A/8021	Resistance, type 113	4	20,000 Ω.
10A/8117	Resistance, type 123	4	1 MΩ.
10A/8519	Resistance, type 145	1	200,000 Ω.
10A/9199	Ring, clamp	1	With screw.
10A/9200	Screw, clamp	1	
10A/7394	Socket, type 17	1	3-pole.
10A/9203	Wheel, index	1	For ganged condenser
	Accessories.		
5A/1333	Battery, dry, 120-volt, type A	1	H.T. for transmitter and receiver (home).
5A/1615	Battery, dry, 120-volt, type B	1	H.T. for transmitter and receiver (overseas).
5A/1338	Battery, dry, 15-volt	1	G.B. for transmitter.
5A/1383	Battery, dry, 4½ volt	1	G.B. for receiver, socket connections.
10A/7938	Case, transit	1	For complete transmitter-receiver.
10A/7813	Valve, V.T.20	2	For transmitter.
10A/7607	Valve, V.R.18	2	Screened grid valves.
10A/7738	Valve, V.R.21	2	A/F. amplifiers.
10A/7958	Valve, V.R.22	1	Output valve.
10A/8239	Valve, V.R.27	1	Detector.
5A/1387	Accumulator, lead-acid, 2-volt, 20 Ah, type B	1	All L.T.

Ref. No.	Nomenclature.	Quantity.	Remarks.
	Remote Controls.		
	Type C Remote Controls		
10A/8186	Controller, type C, consisting of :—		With 2-ft. lead.
10A/8187	Control, switch and tuning		
10A/8188	Control, volume, type A		50,000 Ω.
5A/1782	Wire, T.C., 30 s.w.g.		For binding bonding wire.
10A/8746	Coupling, switch, type E, which fits on to :—		
10A/8580	Adaptor, ring, change-over switch.		
10A/7951	Plug, type 61, with lead		
10A/8195	Handle, condenser unit		
10A/8274	Handle, condenser unit, auxiliary		For local operation of 10A/8195.
10A/8998	Control, volume, type B		Similar to 10A/8188 fitted in a case. For local volume control.
10A/8999	Wedge plate		For mounting 10A/8998.
10A/8190	Casing, rigid, type C		For 10A/8192.
10A/8189	Casing, flexible, type C		For 10A/8192.
10A/8192	Shafting, flexible, type C		$\frac{5}{32}$ in. dia.
10A/8193	Union, casing, type B		For 10A/8190 and 10A/8189.
10A/9515	Pin, key		For 10A/8193.
10A/9119	Union, lubricator, type C		For 10A/8190.
5C/432	Block, terminal, type B, 3-way, No. 1.		
10A/8585	Cleat, type C		For 10A/8190.
10A/9006	Tool, bending, type C..		For installation 10A/8190.
5A/1423	Cable, triflexmet, 2·5		
	Type D Remote Controls		
10A/8907	Controller, type D, consisting of :—		With 2-ft. lead.
10A/8581	Control, switch and tuning, type D.		
10A/8188	Control, volume, type A		50,000 Ω.
5A/1782	Wire, T.C., 30 s.w.g.		For binding bonding wire.
10A/7951	Plug, type 61, with lead.		
10A/8589	Coupling, switch, type D, which fits on to :—		
10A/8580	Adaptor, ring, change-over switch.		
10A/8195	Handle, condenser unit.		
10A/8274	Handle, condenser unit, auxiliary		For local operation of 10A/8195.
10A/8998	Control, volume, type B		Similar to 10A/8188 fitted in a case. For local volume control.
10A/8999	Wedge plate		For mounting 10A/8998.
10A/8190	Casing, rigid, type C		For 10A/8192.
10A/8583	Casing, rigid, type D		For 10A/8593.
10A/8189	Casing, flexible, type C		For 10A/8192.
10A/8582	Casing, flexible, type D		For 10A/8593.
10A/8192	Shafting, flexible, type C		$\frac{5}{32}$ in. dia.
10A/8593	Shafting, flexible, type D		$\frac{3}{16}$ in. dia.
10A/8193	Union, casing, type B		For 10A/8190 and 10A/8189
10A/9515	Pin, key		For 10A/8193.
10A/8595	Union, casing, type D		For 10A/8583 and 10A/8582.
10A/9516	Pin, key		For 10A/8595.
10A/9119	Union, lubricator, type C		For 10A/8190.
10A/9120	Union, lubricator, type D		For 10A/8583.
5C/432	Block, terminal, type B, 3-way, No. 1		
10A/8585	Cleat, type C		For 10A/8190.
10A/8586	Cleat, type D		For 10A/8583.
10A/9006	Tool, bending, type C		For installation of 10A/8190.
10A/9007	Tool, bending, type D		For installation of 10A/8583.
5A/1423	Cable, triflexmet, 2·5		
	Type B Remote Controls		
10A/7936	Controller, consisting of :—		
10A/7939	Control, switch and condenser.		
10A/7937	Control, volume		

Ref. No.	Nomenclature.	Quantity.	Remarks.
10A 7501	Coupling, switch.		
10A/7925	Handle, condenser unit.		
10A/9129	Adaptor, condenser coupling.		
10A/7503	Casing, type B		
10A/7504	Shafting, type B.		
10A/7505	Unions, casing.		
10A/10370	Transmitter-receiver, T.R 9C, comprising :—		
10A/10371	Transmitter T.1121		*See* below.
10A/9510	Receiver R 1103.		
	Transmitter T 1121, comprising :—		
10A/9511	Transmitter T.1102.		
10A 10305	Holder, crystal, type 1	1	

SECTION 2, CHAPTER 3

TRANSMITTER-RECEIVER T.R.1091

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TRANSMITTER-RECEIVER T.R.1091

(Stores Ref. 10A/9275.)

INTRODUCTION

1. This instrument is a combined transmitter-receiver. The transmitter unit and the receiver unit are mounted on a common base-board. Change-over from transmit to receive is made by means of a send-receive switch mounted on the base-board between the two units. The transmitter is capable of radiating C.W., I.C.W., and R/T, and covers the frequency bands 1,222–1,539 kilocycles and 2,000–3,409 kilocycles. The inductances are permanently mounted both in transmitter and receiver, and change of frequency is effected by means of switches. The transmitter unit which is a master-oscillator controlled transmitter, is known as transmitter T.1092. The receiver unit is known as receiver R.1093. The switch unit mounted between them is known as switch unit Type E. Although the transmitter is capable of radiating C.W., I.C.W. and R/T throughout the whole of the frequency bands, reception of C.W. is provided for on the receiver only over the band 2,000–3,400 kilocycles. The overall dimensions of the T.R.1091 are approximately 24 in. × 12 in. × $10\frac{3}{4}$ in., and the weight complete with wired switch unit and valves is $43\frac{1}{2}$ lb.

GENERAL DESCRIPTION

2. In fig. 1 is shown an illustration of the transmitter-receiver T.R.1091. It will be seen that the transmitter is situated on the right and the receiver on the left with a change-over switch between them, the whole being mounted on a shock-absorbing mounting board. On the right-hand side of the receiver are a number of spring jaw contacts, and on the left-hand side of the transmitter a row of similar contacts are provided. A rotor situated in the switch unit is provided with blades, and rotation of the rotor allows engagement with either transmitter or receiver.

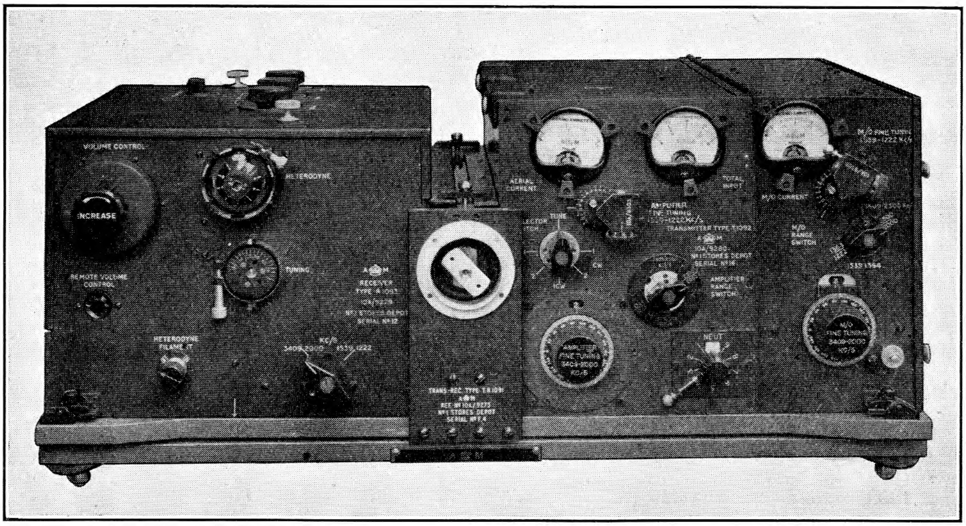
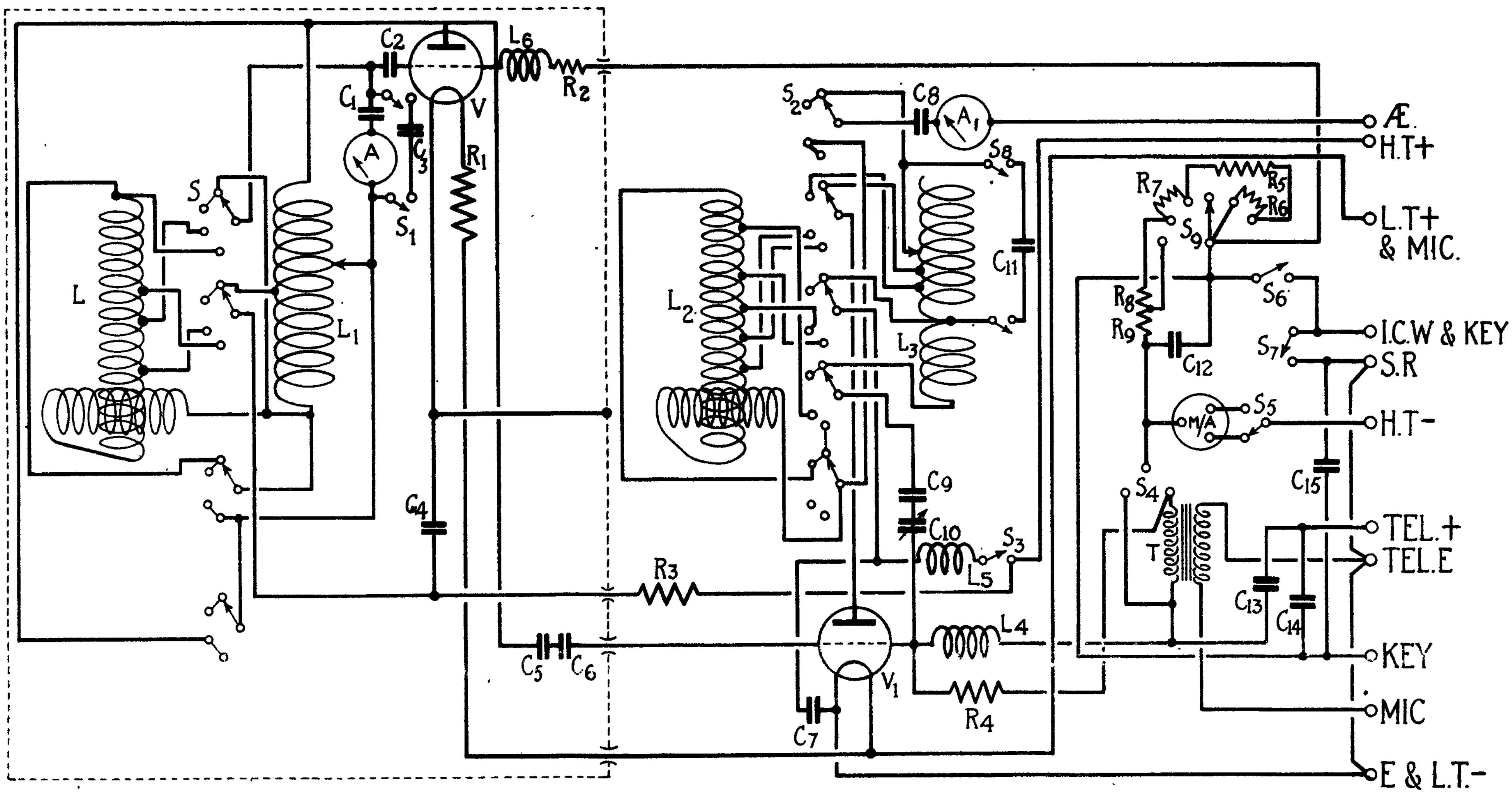


FIG. 1. Transmitter-receiver T.R. 1091, front view.



Condensers	C_9 = ·001 μF	R_2 = 15,000 Ω
C_1 = ·00018 μF	C_{10} = ·00006 μF-Variable	R_3 = 10,000 Ω
C_2 = ·0005 μF	C_{11} = ·000065 μF	R_4 = 500,000 Ω
C_3 = ·000065 μF	C_{12} = ·5 μF	R_5 = 1,800 Ω
C_4 = ·002 μF	C_{13} = ·002 μF	R_6 = 800 Ω
C_5 = ·000025 μF	C_{14} = ·002 μF	R_7 = 600 Ω
C_6 = ·002 μF	C_{15} = ·01 μF	R_8 = 600 Ω
C_7 = ·0004 μF	Resistances	R_9 = 1,200 Ω
C_8 = ·01 μF	R_1 = 1·3 Ω	

FIG. 2. THEORETICAL CIRCUIT DIAGRAM OF TRANSMITTER, T. 1092

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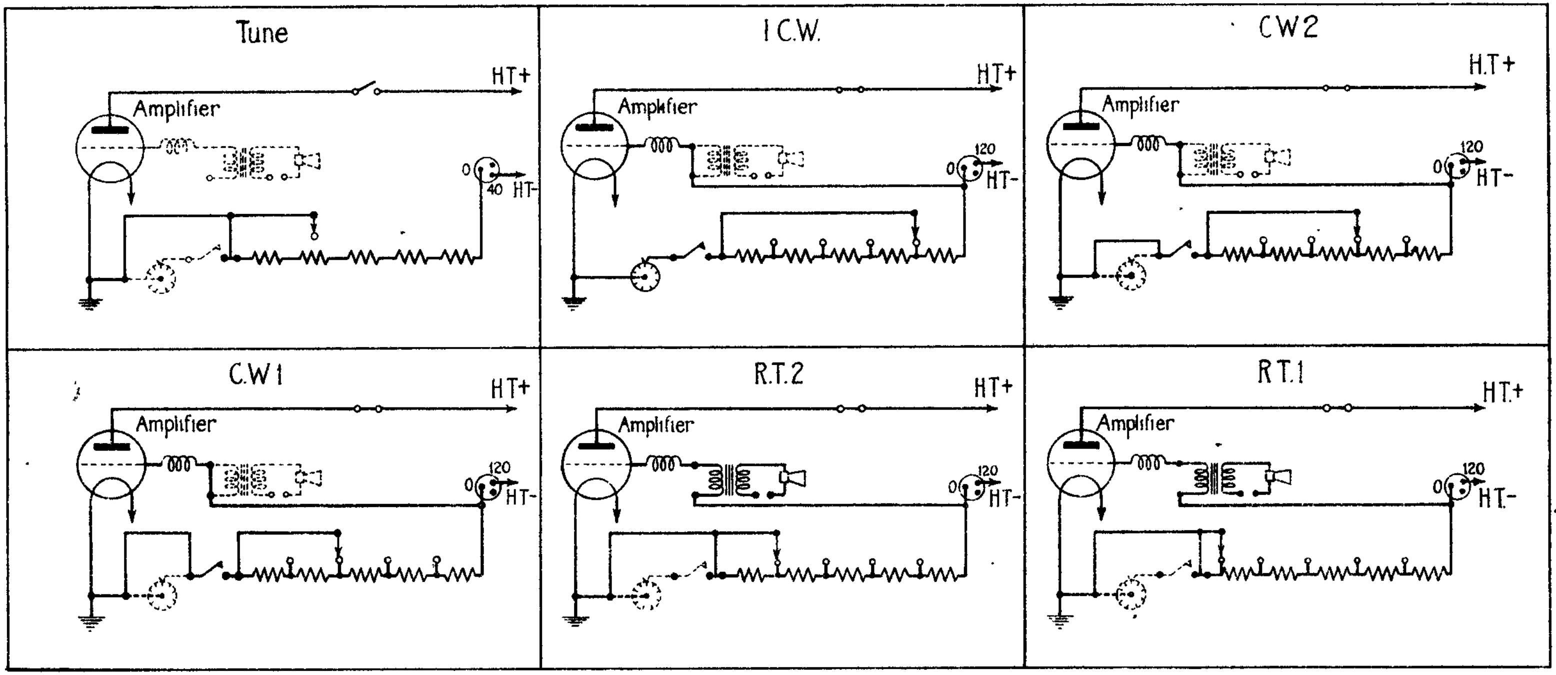

FIG. 4. CIRCUIT CHANGES FOR DIFFERENT POSITIONS OF SELECTOR SWITCH

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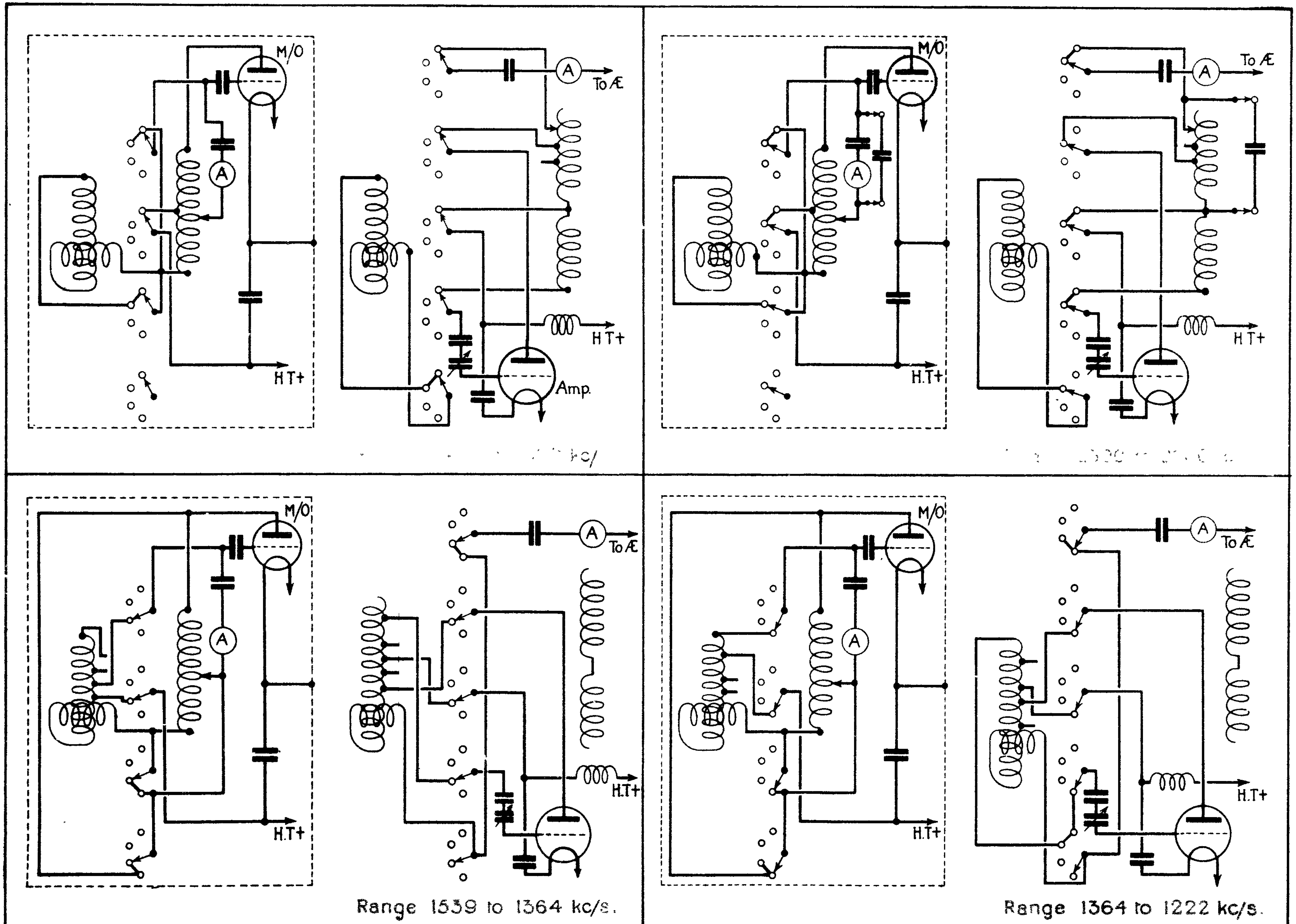


FIG. 3. CIRCUIT CHANGES FOR THE FOUR POSITIONS OF AMP. AND M/O RANGE SWITCHES

Transmitter T.1092

3. Referring to fig. 2 it will be seen that the transmitter comprises a master-oscillator valve V and an amplifier valve V_1. The inductances L and L_1 are the low and high-frequency inductances respectively for the master-oscillator. The inductance L is tuned on the variometer principle. The inductance L_1 is tuned by means of a variable tap. Both of these inductances are fixed in the transmitter but change-over from one to the other is effected by means of the switch S. This switch is a four-pole switch with four positions corresponding to the four frequency bands of the transmitter. It will be seen that in position 1 the inductance L_1 is in use and the inductance L is short-circuited. In position 2 the inductance L is again short-circuited but the switch S_1 is closed and the loading condenser C_3 is connected across part of L_1. In position 3 the short-circuit is removed from the high-frequency inductance, S_1 is opened and the low-frequency inductance short-circuited. In the fourth position the tappings on the high-frequency inductance are altered, the other connections remaining the same as for position 3.

4. A similar switching arrangement is provided in the amplifier circuit, the switches S_2 and S_8 carrying out the changes for the four frequencies. The switch S_2 is a five-pole four-position switch. In position 1 the inductance L_3 is in use and the inductance L_2 is short-circuited. In position 2 the inductance L_2 is again short-circuited but the condenser C_{11} is connected in parallel with L_3. In position 3 the inductance L_2 is in use and L_3 is open-circuited. In position 4 the high-frequency inductance tappings are altered, L_3 still being left open-circuited. The circuit changes for both the master-oscillator and amplifier for the four positions of the range switches are given in fig. 3.

5. The condensers C_9 and C_{10} are connected in series between the grid of the amplifier and the neutralizing winding on either of the coils L_2 or L_3. C_9 is a fixed blocking condenser. C_{10} is the adjustable neutralizing condenser. L_4 is the radio-frequency choke in the amplifier grid circuit. L_5 is the radio-frequency choke in the H.T. feed to the amplifier. R_3 is a resistance in the anode feed to the master-oscillator.

6. The M/O valve is coupled to the amplifier by the condenser C_6, and a further fixed condenser C_5 of small capacitance is introduced for safety purposes. The grid of the M/O is connected through the condenser C_2 to either the high or low-frequency coil depending on the position of the switch S. A filament resistance R_1 is included in the positive filament lead of the M/O valve. A mains condenser C_4 is connected between H.T.+ and earth. The grid of the M/O valve is also connected to the selector arm of the grid bias arrangement through a R/F choke L_6 and a grid leak resistance R_2.

7. In the amplifier valve chamber, C_8 is the aerial blocking condenser and C_7 is the mains condenser, the latter being connected between the positive H.T. feed and the negative side of the filament circuit. A ·5 megohm resistance R_4 is shunted across the grid choke and transformer secondary. A condenser C_{15} is shunted across the contacts engraved S.R. and KEY, while C_{12} is an A/F by-pass condenser connected across the bias resistance.

8. A number of switches S_3, S_4, S_5, S_6 and S_7 are shown at various points in the diagram. These are simultaneously operated by the movement of the handle of the selector switch. S_3 breaks the H.T. feed to the amplifier in the " Tune " position. S_5 changes the milliammeter range from 0–40, to 0–120 milliamps. S_7 short-circuits the interrupter when C.W. or R/T is required. S_6 short-circuits the key when R/T is required. S_4 short-circuits the secondary of the microphone transformer on I.C.W. and C.W. and also opens the grid circuit when on " Tune ". In addition various values of grid bias resistance are selected by the various positions of the switch S_9. The grid bias arrangement is in effect a number of resistances R_5, R_6, R_7, R_8 and R_9 in series connected between H.T.— and L.T.—, and a switch arm short-circuits more or less of these according to the bias required. The grid circuit of the amplifier is connected to the H.T.— end, and the I.R. drop, which varies with the amount of resistance short-circuited, applies the necessary negative bias to the grid of the amplifier. The circuit changes effected by the selector switch for its six positions are shown in fig. 4.

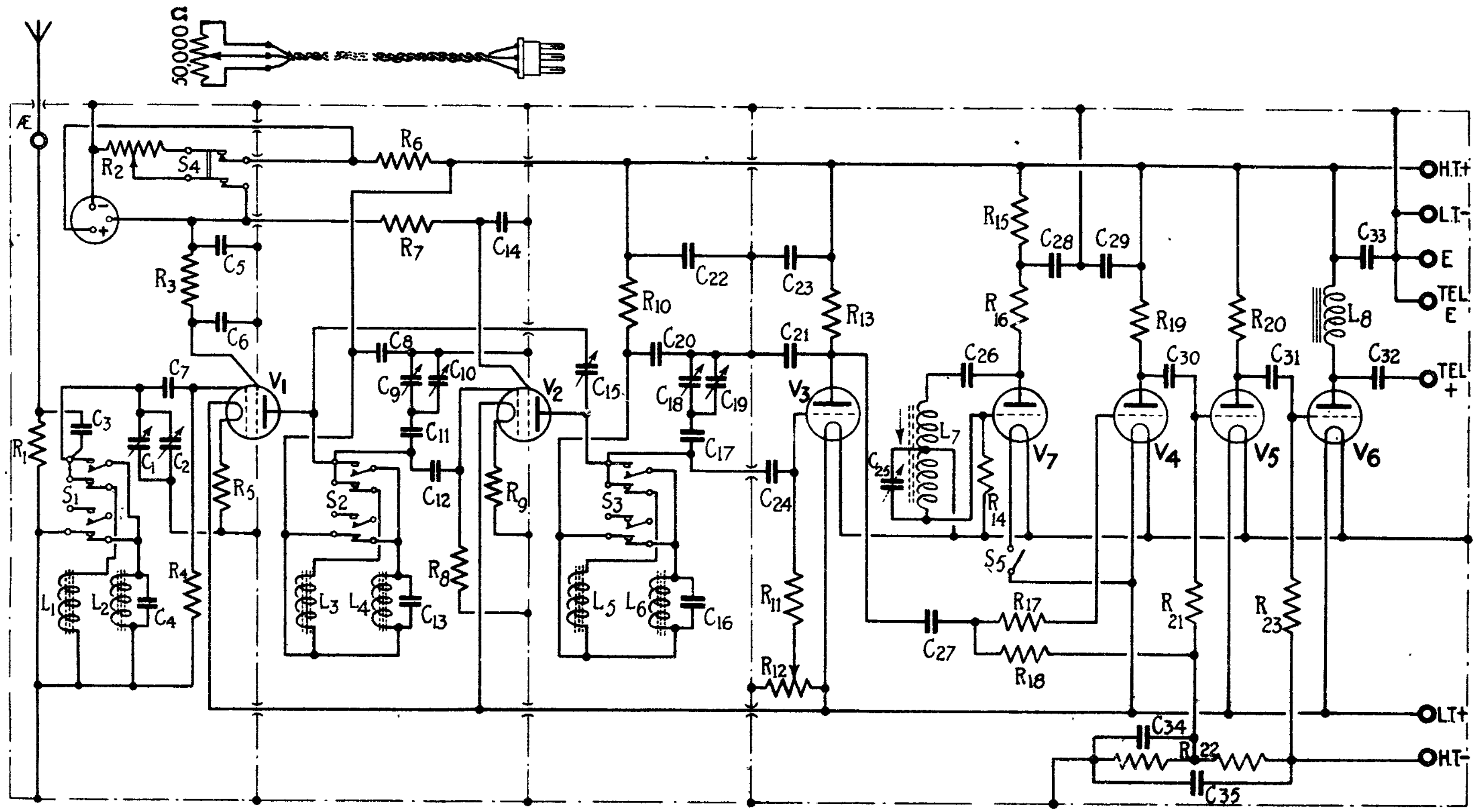
9. It will be seen that two contacts marked TEL. + and TEL. E are provided. These are for the purpose of providing side-tone. When the send-receive switch is in the " send " position the telephones are connected to these two contacts on the transmitter, and as a result the telephones are connected (on R/T) through the condenser C_{13} to the secondary of the microphone transformer T. On I.C.W. the telephones are connected across the key and interrupter in series with the condenser C_{14}. On C.W. the interrupter is of course short-circuited and only key clicks are heard.

Receiver R.1093

10. A circuit diagram of the receiver is given in fig. 5. It will be seen that it consists of a two-stage radio-frequency amplifier, a detector, a separate heterodyne and a three stage audio-frequency amplifier. The three tuned circuits of the radio-frequency amplifier employ iron-cored inductances, and a range switch simultaneously selects the appropriate inductance in each circuit for the required frequency range. The three circuits are separately tuned by three trimming condensers situated on the top of the receiver. Fine tuning is provided by three ganged variable condensers in parallel with the trimming condensers. These may be remotely controlled. A volume control varies the voltage applied to the screen grids of the R/F valves. The audio-frequency valves are resistance-capacitance coupled, and the output valve incorporates choke output. The separate heterodyne employs a variable permeability coil, the inductance of the coil being varied by moving the core. The frequency of the heterodyne and hence the beat note may be remotely controlled.

11. Referring to fig. 5, L_1 and L_2 are the low and high-frequency inductances respectively, which are switched alternatively into circuit by means of the switch S_1, the variable condensers C_1 and C_2 being connected in parallel across the particular inductance in circuit. The condenser C_4 is shunted across the high-frequency inductance, while C_3 is the aerial coupling condenser. The control grid of the screen grid valve V_1 is coupled to the aerial inductance by means of the condenser C_7, and the resistance R_4 is connected between the control grid of the valve and earth. The screening grid is fed through the resistance R_3 and the potential is varied by means of a tapping on the potentiometer resistance R_2, which is connected across the H.T. supply. In order to provide for remote control of the screen grid potential, a 3-point socket is provided into which a 3-point plug is inserted which in turn is connected to a remote potentiometer with a resistance similar to R_2. The socket incorporates a switching device S_4 which is operated by an additional pin on the plug. On inserting the plug the switch is operated and the internal potentiometer R_2 is disconnected. The series resistance R_3 is de-coupled by the condenser C_6, while C_5 is a by-pass condenser connected to the H.T. end of R_3. The resistance R_1 is connected between aerial and earth as a static leak, and the resistance R_5 is a fixed resistance in the filament negative lead.

12. The valve V_2 is coupled to the anode of the preceding valve by means of a condenser C_{12}, the resistance R_8 being connected between the control grid of V_2 and earth. Two inductances L_3 and L_4, the latter having a condenser C_{13} shunted across it, are provided for high and low frequencies respectively. A switching device S_2 changes over from one to the other. The variable condensers C_9 and C_{10} perform a similar function to C_1 and C_2, but in addition a blocking condenser C_{11} is connected between the fixed vanes and the inductance. A further condenser C_8 is connected between the moving vanes of the condensers C_9 and C_{10} and the inductance. The moving vanes are earthed. The screen grid of the valve V_2 is fed through the resistance R_7 and receives its supply from the potentiometer R_2 which supplies the potential to the screen grid of the valve V_1. Between the anode of the valve V_1 and the anode of the valve V_2, is connected a small variable condenser C_{15}, which functions as a reaction condenser. The series resistance R_7 is de-coupled by means of the condenser C_{14}. The inductances L_3 and L_4 are connected direct to H.T.+. The valve V_2 is coupled to the detector valve through the condenser C_{24}.



Condensers	ITEM ON SET						
C_1 = ·00005 μF-Variable		C_{15} = 10 μμF-Variable		C_{30} = ·001 μF	22	R_9 = 1·5 Ω	
C_2 = ·00025 μF-Variable		C_{16} = ·00005 μF	11	C_{31} = ·001 μF	25	R_{10} = 1,000 Ω	12
C_3 = ·00005 μF	1	C_{17} = ·01 μF		C_{32} = ·5 μF		R_{11} = 250,000 Ω	18
C_4 = ·00005 μF	3	C_{18} = ·00005 μF-Variable		C_{33} = 2 μF		R_{12} = 135 Ω - Variable	
C_5 = ·5 μF		C_{19} = ·00025 μF-Variable		C_{34} = ·5 μF		R_{13} = 100,000 Ω	14
C_6 = ·5 μF		C_{20} = ·5 μF		C_{35} = 2 μF		R_{14} = 100,000 Ω	27
C_7 = ·0001 μF	6	C_{21} = ·001 μF	15	Resistances	ITEM ON SET	R_{15} = 50,000 Ω	29
C_8 = ·5 μF		C_{22} = ·5 μF		R_1 = 500,000 Ω	2	R_{16} = 100,000 Ω	30
C_9 = ·00005 μF-Variable		C_{23} = ·5 μF		R_2 = 50,000 Ω - Variable		R_{17} = 2 MΩ	19
C_{10} = ·00025 μF-Variable		C_{24} = ·0001 μF	17	R_3 = 100,000 Ω	4	R_{18} = 1 MΩ	13
C_{11} = ·01 μF		C_{25} = ·0001 μF		R_4 = 500,000 Ω	5	R_{19} = 100,000 Ω	24
C_{12} = ·0003 μF	8	C_{26} = ·001 μF	28	R_5 = 1·5 Ω		R_{20} = 100,000 Ω	21
C_{13} = ·00005 μF	7	C_{27} = ·001 μF	16	R_6 = 20,000 Ω	20	R_{21} = 1 MΩ	23
C_{14} = ·5 μF		C_{28} = 1 μF		R_7 = 50,000 Ω	9	R_{22} = 180 Ω Centre-tapped	
		C_{29} = ·5 μF		R_8 = 500,000 Ω	10	R_{23} = 1 MΩ	20

FIG. 5. THEORETICAL CIRCUIT DIAGRAM OF RECEIVER, R.1093

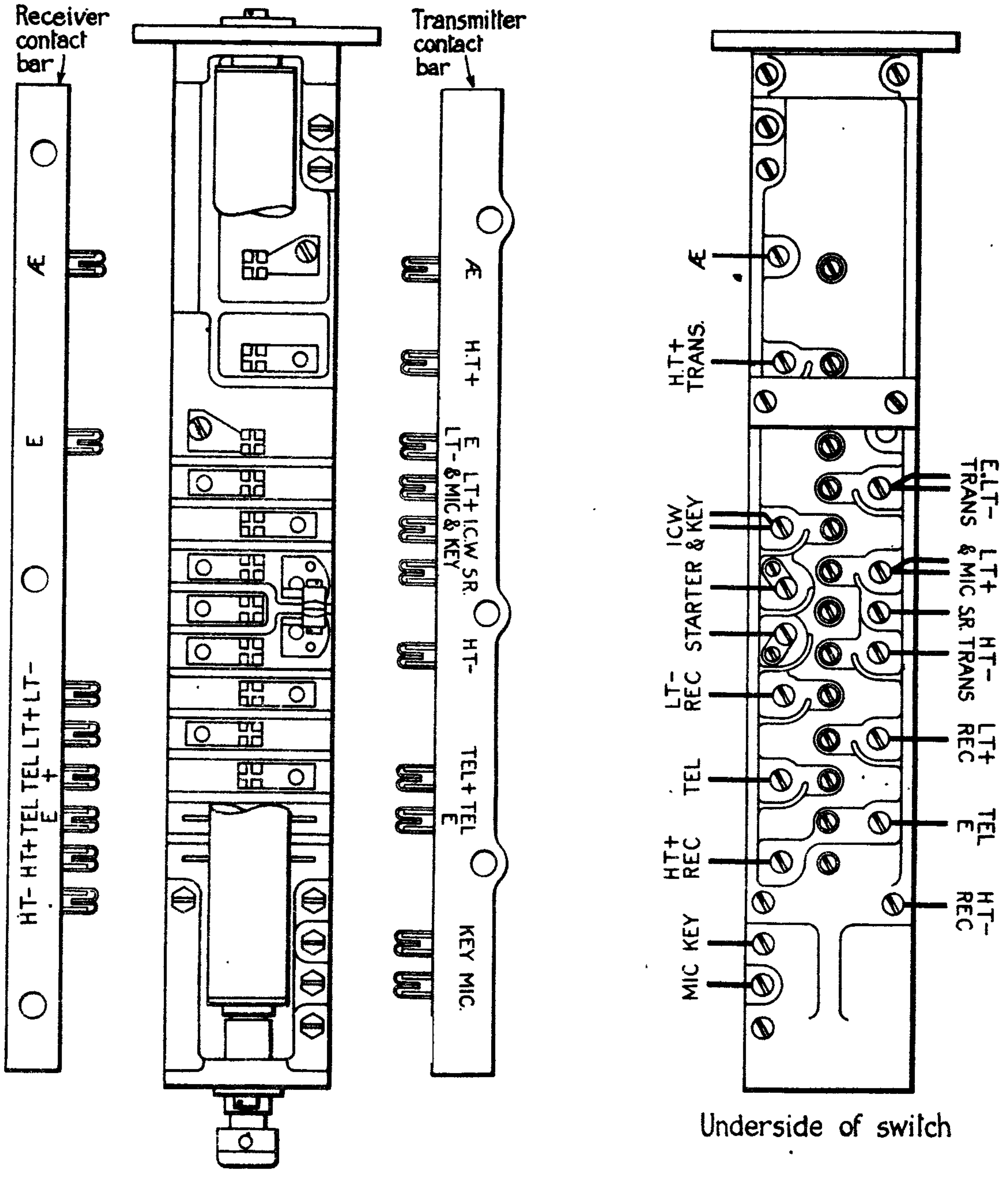


FIG. 6, T.R.1091, SWITCH UNIT TYPE E,
AS WIRED FOR HECTOR INSTALLATION

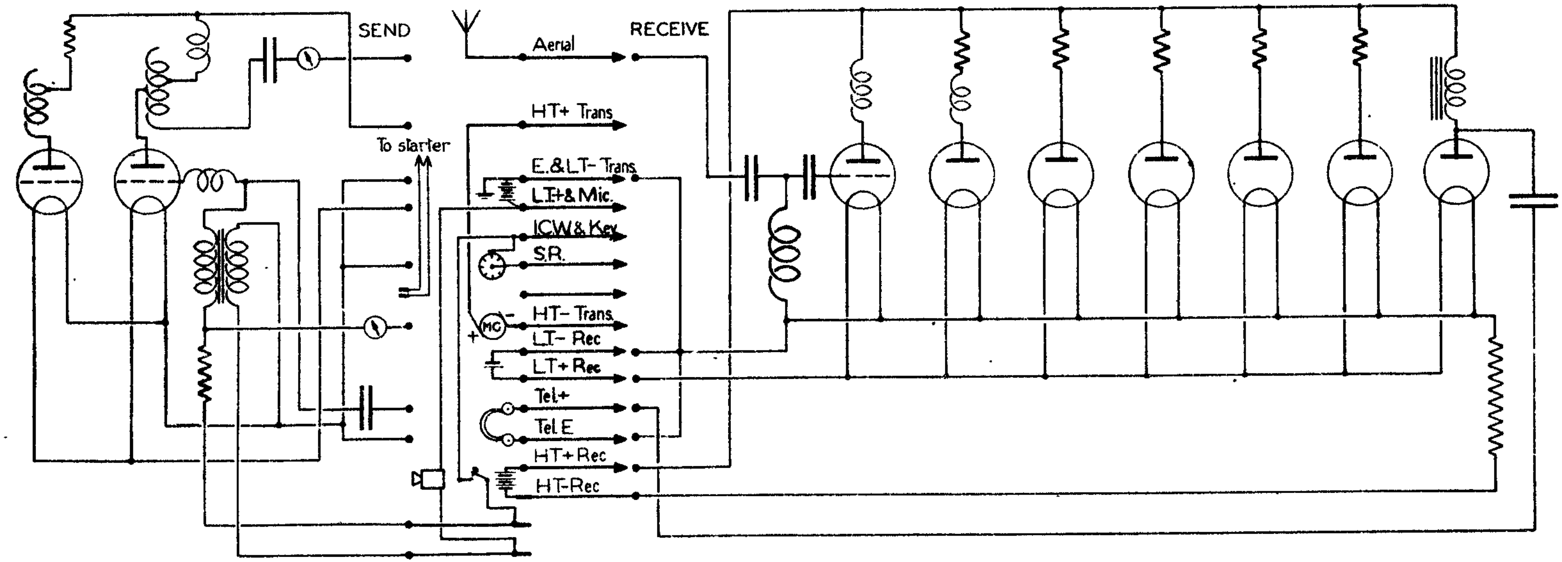


FIG. 7, TRANSMITTER-RECEIVER SIMPLIFIED SEND-RECEIVE DIAGRAM

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13. The grid of the detector valve is connected through the grid leak resistance R_{11} to a potentiometer R_{12}, the resistance of which is connected across the L.T. supply. Anode inductances L_5 and L_6 (high and low-frequency inductances respectively) are switched by means of the switch S_3, and they are connected to H.T. through the resistance R_{10}, the H.T. end of which is connected to earth through the condenser C_{22}. The high frequency inductance L_6 has the condenser C_{16} shunted across it. The moving vanes of the variable condensers C_{18} and C_{19} are connected to earth and the fixed vanes are connected through the condenser C_{17} and the switch S_3 to the appropriate inductance. The connection between the moving vanes and the inductance is made through the condenser C_{20}. No resistance is provided in the detector filament circuit. The anode circuit of the detector is fed from H.T.+ through the resistance R_{13}, which is decoupled by the condenser C_{21}, the by-pass condenser C_{23} being connected between the H.T. side of the resistance R_{13} and earth. The detector is coupled to the valve V_4 by means of the condenser C_{27}, in series with which is the grid stopper resistance R_{17}, the resistance R_{18} being the grid resistance. Bias is applied to the grid of the valve V_4 from a centre-tapping on the resistance R_{22}, the latter being connected between H.T.— and earth.

14. Also associated with this valve is the anode resistance R_{19} and the by-pass condenser C_{29}. The grid of the valve V_5 is coupled to the valve V_4 by means of the condenser C_{30} and the grid is connected through the resistance R_{21} to the centre tapping point of R_{22}. A condenser C_{35} is shunted across R_{22}, while another condenser C_{34} is connected between the centre point of the resistance and earth. The H.T. anode supply to the valve V_5 is through the resistance R_{20}. The valve V_5 is in turn coupled to the output valve through the condenser C_{31}. The grid of the output valve V_6 is connected through the resistance R_{23} to H.T.—. Choke output is employed in the anode circuit of the valve V_6, L_8 being connected in the anode circuit and the telephones being connected in series with the condenser C_{32} between anode and earth. A 2μF condenser C_{33} is connected between H.T.+ and earth.

15. The anode of the heterodyne valve V_7 is connected through the two resistances R_{15} and R_{16} to H.T.+, C_{28} being the de-coupling condenser for R_{15}. A tuned circuit formed by a portion of the inductance L_7 and the pre-set condenser C_{25} is connected in the grid circuit of the heterodyne valve V_7, and the end turns of this inductance are coupled back through the condenser C_{26} to the anode of the valve to maintain oscillation. The inductance is varied and hence the oscillator frequency, by moving the core by means of a handle on the front of the receiver, which may be remotely controlled if desired. R_{14} is a 100,000 ohm resistance connected between grid and filament, to maintain the grid potential at a suitable mean value. A switch S_5 is provided in the filament circuit of the valve. A handle on the front of the receiver operates this switch and is engraved ON and OFF.

Switch unit, type E

16. In order to make the necessary change-over of connections from reception to transmission and *vice versa*, a switch unit is provided. This switch unit comprises a spindle of insulating material carrying contact blades, the spindle being capable of rotation in a frame of insulating material. Spring jaw contacts are carried on both the receiver and transmitter, and the blades on the rotatable element may be engaged with either the transmitter contacts or the receiver contacts by rotating the spindle. An intermediate or " off " position is provided in which the blades are not engaged with either the transmitter or receiver.

17. The connections from the switch unit to the batteries, aerial and earth, etc. (which are changed over from transmitter to receiver by the operation of the switch), are taken out as flexible leads through an opening in the end of the switch unit. Since the arrangement of the installation differs for various types of aeroplane, the switch unit wiring is arranged to suit. In fig. 6 is given an illustration of the switch unit, and also a diagram of the actual connections made for a Hector aeroplane installation. In fig. 7 is given a simplified diagram showing the changes effected in the circuit by the switch.

18. The switch is shown in the receive position. It will be seen that the first blade connects the aerial to the receiver. The next blade engages no spring jaw in this position. The third blade connects up the earth circuit to the receiver. The next five blades make no connection in the receive position. The next two make the filament circuit of the receiver. The next two blades connect the telephones to the output circuit of the receiver, and the next blade closes the H.T.+ circuit to the receiver. The H.T.— to the receiver is permanently connected.

19. When the switch is moved into the "send" position the first blade transfers the aerial to the transmitter. The next blade closes the H.T.+ to the transmitter. Earth and L.T.— are made to the transmitter by the third blade, and the L.T.+ and microphone connections are closed by the fourth blade. The fifth blade (I.C.W. and key) is permanently connected to the key and interrupter, and the sixth blade (S.R.) is now connected to negative filament. The seventh blade closes the starter circuit. The next blade completes the H.T.— circuit to the transmitter. The next two blades (L.T.— Rec., L.T.+ Rec.) are inoperative in the send position. The telephones which are connected across the next two blades are now connected into the side-tone circuit of the transmitter. The last movable blade (H.T.+ Rec.) makes no connection in this position. The two fixed blades at the extreme end which make contact with the corresponding spring jaws on the transmitter, permanently connect the key and the microphone to the transmitter.

Mounting board

20. The mounting board upon which the send-receive switch is fitted consists of two fabric-covered mahogany boards between which four anti-vibration mountings are provided. A hinged lug is provided at each corner of the mounting board. When the transmitter and receiver are placed on the board, the lugs engage projections provided on the right and left-hand side of the transmitter and receiver respectively, and thus secure the instruments at the outer corners. Two retaining clamps are provided on the switch unit, and after the instruments have been placed in position, the clamps are screwed down so as to bear on the top of the contact bars at the side of the transmitter and receiver (*see* fig. 1).

Remote controls

21. The system of remote controls employed on the T.R.1091 is shown in fig. 8. The controller (Stores Ref. 10A/8186) seen in the top left-hand corner of the figure is provided with three controls. The top handle controls the change-over switch and may be left in one of three positions, namely, transmit when in the "S" position, receive when in the "R" position, and "off" when in the intermediate position. The knob in the centre of the controller provides remote volume control, and the bottom handle is for the purpose of tuning the receiver.

22. As can be seen from fig. 8 a switch coupling, a condenser unit handle and a three-pin plug are provided. The switch coupling is connected to the change-over switch handle, the condenser unit handle is connected to the tuning control (3, fig. 16) and the three-pin plug is inserted in the socket (4, fig. 16). When the plug is inserted in the socket a projection on the plug opens a pair of contacts in the receiver and the variable resistance (6, fig. 17) is disconnected. The variable resistance, incorporated in the controller, is introduced into the circuit and movement of the control knob now provides the volume control.

23. The manner in which the remote controls are installed in the aeroplane and the apparatus necessary for coupling them to the receiver are fully described in the chapter dealing with the transmitter T.1083 in this publication. Although the heterodyne condenser knob on the receiver is adapted for remote control, no provision is made for remote control of this in the apparatus shown in fig. 8.

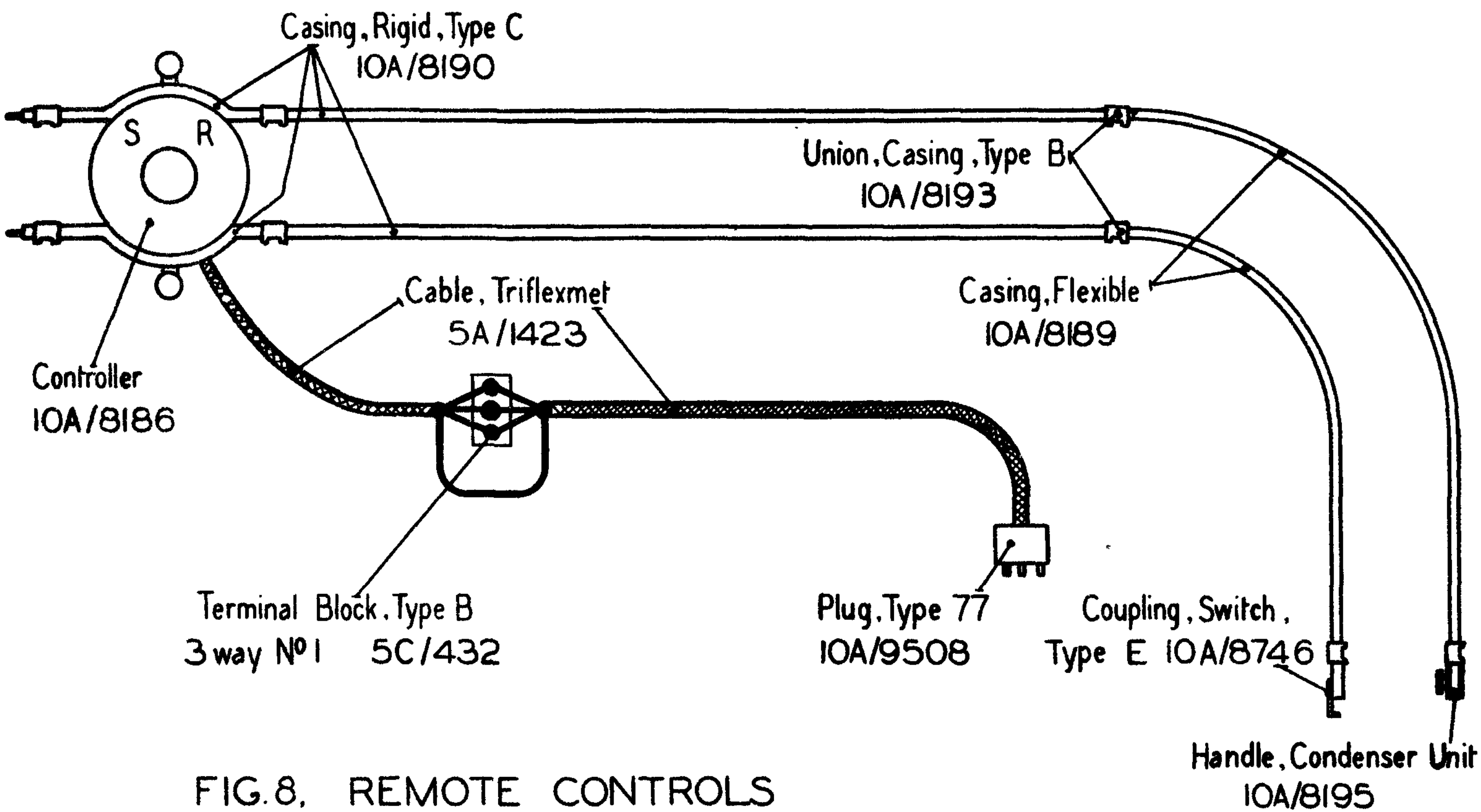

FIG. 8, REMOTE CONTROLS

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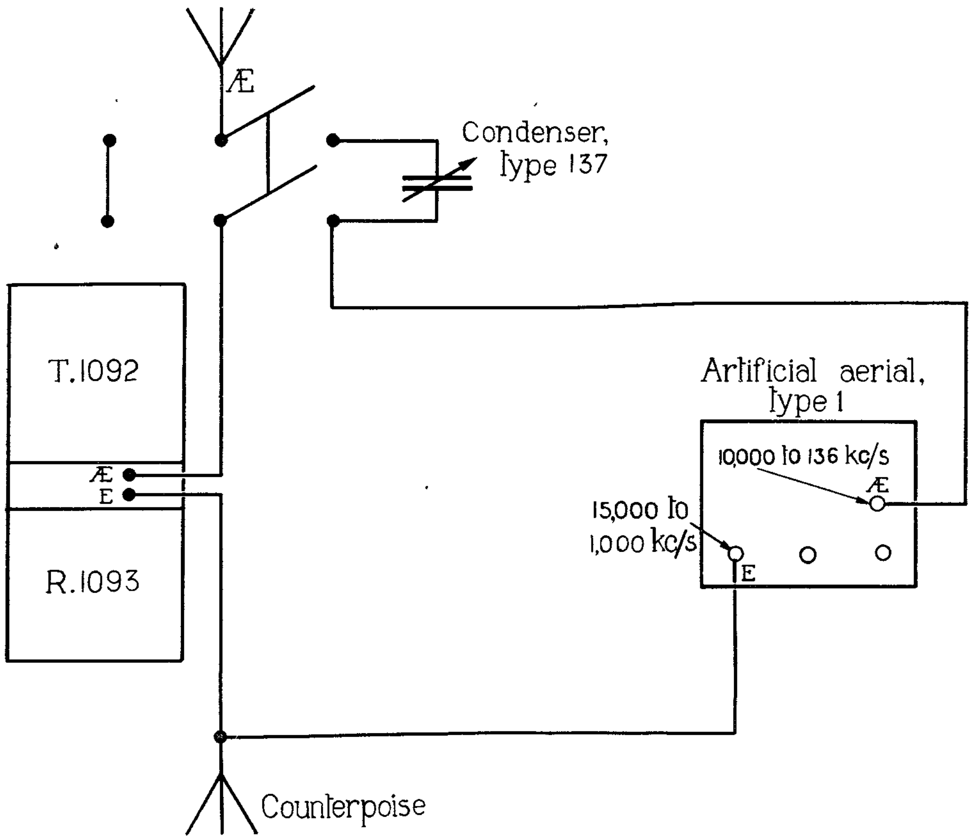


FIG. 9. Listening-testing set.

Testing and listening device

24. In order to provide testing facilities on the T.R.1091 without causing interference with other aeroplanes operating in the vicinity, a device for transmission on reduced power has been developed. It consists of an artificial aerial, Type I, with a change-over switch (Stores Ref. 10A/646) and a variable condenser (Stores Ref. 10A/8042). The arrangement is shown diagrammatically in fig. 9. When the change-over switch is in the left-hand position the aerial terminal of the transmitter is connected to the aerial, and the earth terminal to counterpoise in the usual way, radiation being normal. When the switch is moved into the right-hand position the artificial aerial is connected across the transmitter and the variable condenser is connected in series with the aerial. Radiation is now very much reduced.

25. The method of use may be described in the following way. The switch is first placed in the left-hand position and the transmitter switched on and tuned in the normal way. Next the artificial aerial condenser is set to about 100 $\mu\mu$F., and the variable condenser, type 137, to about $\frac{1}{3}$ of its maximum value. The switch is now moved into the right-hand position, and the artificial aerial condenser adjusted until maximum aerial current is obtained. It is essential when making these adjustments that the selector switch should be moved to an R/T position in order to avoid excessive inputs. A choice of full or reduced radiation can now be made by moving the change-over switch from one position to the other. When receiving, the send-receive switch on the transmitter is moved to " receive " and the D.P.D.T. change-over switch is moved into the left-hand position.

26. If it is desired to make a change in the amount of radiation when using the artificial aerial, an increase can be effected by increasing the value of the condenser, type 137, or a decrease, by decreasing it, but for any change in this condenser, the artificial aerial must be accurately re-tuned.

CONSTRUCTIONAL DETAILS

Transmitter

27. The transmitter unit (T.1092) is housed in a built-up case approximately 11 in. × 11 in. × $8\frac{1}{2}$ in. The case is separated into compartments by a metal screen, the amplifier with its associated equipment being housed at one side of the screen and occupying about two-thirds of the space while the master-oscillator is housed at the other and occupies the remaining third. The oscillator compartment is of metal. The amplifier compartment, with the exception of the hinged lid, is of insulating material.

28. All the controls and meters are mounted on the front of the transmitter. Referring to fig. 10, the three meters can be seen at the top. The thermo-ammeter (1) reads 0–2·5 amps. and is in the aerial circuit. The milliammeter (2) has two scales, 0–40 and 0–120 milliamps., and is in the H.T. feed circuit. The meter is connected up to the selector switch in such a way as to enable the 0–40 scale to be used when in the " tune " position and the 0–120 scale to be used in the R/T, I.C.W. and C.W. positions. The thermo-ammeter (3) reads 0–3 amps. and is connected in the grid filament circuit of the master-oscillator.

29. Beneath the master-oscillator thermo-ammeter is the master-oscillator range switch (4). This is a four-position barrel-type switch, the four positions being engraved on the panel 1,222–1,364 kc/s, 1,364–1,539 kc/s, 2,000–2,500 kc/s and 2,500–3,409 kc/s. The first two engravings (1,222–1,364 kc/s and 1,364–1,539 kc/s) are filled in green and the other two (2,000–2,500 kc/s and 2,500–3,409 kc/s) are filled in yellow. The colours are used to associate them with the appropriate fine-tuning control. The control (5) is the fine tuning for the " green " ranges. The control (6) is the fine tuning for the " yellow " ranges. These two fine tuning controls have the engravings on the panel filled in with the appropriate colour. The upper fine tuning control (5) effects tuning on the 1,222–1,539 kc/s range by moving a rotor within the inductance. The insulated shaft carrying the rotor extends through the panel and carries a gear wheel which is driven by a worm carried in a bracket on the front of the panel. The worm is rotated by means of a milled knob. The bracket also carries a spring-loaded plunger which can be engaged in any one of ten holes drilled around the milled knob. A metal disc, engraved around approximately half its face with the figures 1–13, is attached to the main spindle and this disc reads against a datum line on the panel. The worm wheel makes one complete revolution for each of the divisions on the disc and the barrel of the milled knob is engraved with the figures from 0–9. A rotation of the milled knob through one of its divisions thus moves the rotor coil through approximately $\frac{1}{130}$th of its travel.

30. The lower fine tuning control (6) effects tuning on the 2,000–3,409 kc/s range through a continuously variable tap on the inductance. The shaft which operates the contact on the inductance is extended through the panel and carries a milled control handle engraved 0–360. One revolution of the handle corresponds to a complete turn of the inductance. An additional indicating device shows, at a window in the panel, a figure indicating the number of turns of inductance in the circuit. A locking device is also provided.

31. Similar provision for tuning is made on the amplifier. The switch (7) is the amplifier range switch. It is a similar type of switch to that on the master-oscillator and the engravings are filled in green and yellow as on the master-oscillator switch. The fine tuning device (8) on

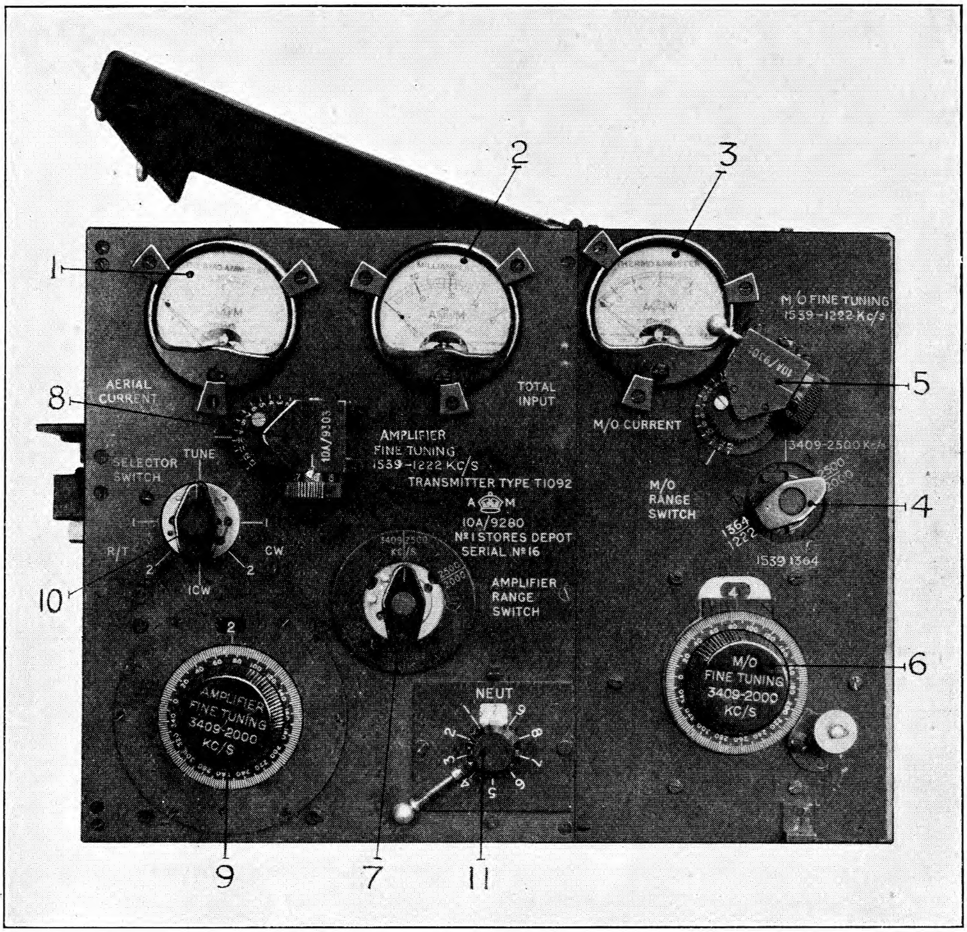


FIG. 10. Transmitter T.1092, front view.

the 1,222–1,539 kc/s range is of similar construction to the control (5) described for the master-oscillator except that no locking device is provided. The fine tuning control handle (9) is similar to the control (6) described for the master-oscillator. No locking device is provided.

32. The only other controls on the panel are the selector switch (10) and the neutralizing condenser control (11). The selector switch is a six-position barrel type switch, and the panel is engraved TUNE, R/T 1–2, I.C.W., C.W. 1–2. In the tune position the amplifier H.T. circuit is broken, the H.T. feed milliammeter is placed on the 0–40 mA range, the key and interrupter are short-circuited and the total grid bias resistance is included. In positions R.T.1 and R.T.2 the key and interrupter are again short-circuited, the microphone circuit is energized, the amplifier H.T. circuit is closed and the H.T. milliammeter is connected on the 0–120 mA range. In the I.C.W. position the secondary of the microphone transformer is short-circuited, the short-circuit is removed from the interrupter and the key, the H.T. feed to the amplifier is completed and the H.T. milliammeter is connected on the 0–120 milliamps range. In the C.W.1 and C.W.2 positions the interrupter is short-circuited, the secondary of the microphone transformer is short-circuited, the H.T. feed to the amplifier is closed and the milliammeter is placed on its 0–120 milliamps range. Different values of grid bias are provided in each of these positions

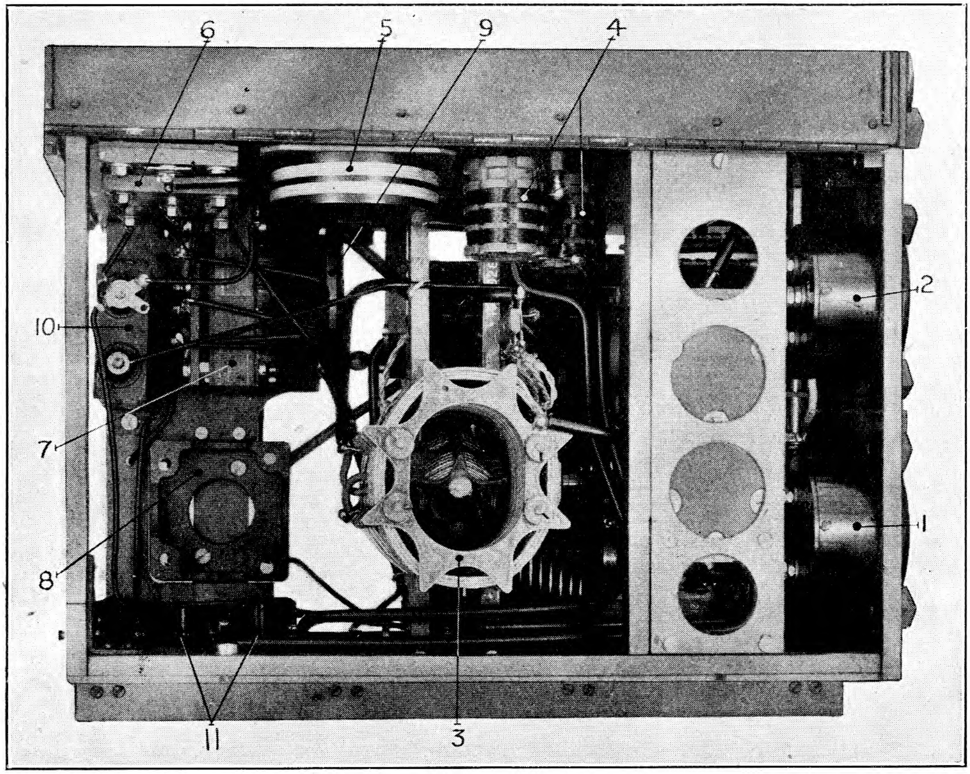


FIG. 11. Transmitter T.1092, plan view.

(*see* fig. 5). The neutralizing condenser control (11) is provided with a serrated knob on the front of the panel. A plate on the panel is engraved with figures from 1–9 and an indicating device shows, at a window, a figure giving the number of complete turns of the knob. A spring-loaded plunger is provided. This is capable of engaging with any one of the ten serrations in the knob in order to lock the condenser in the correct position.

33. Three views of the interior of the transmitter are shown in figs. 11, 13 and 14, and two bench wiring diagrams in figs. 12 and 15. Referring to fig. 11, which is a plan view of the transmitter with the cover raised and two panels removed, the 0 to 2·5 aerial ammeter (1) can be seen in the right-hand bottom corner, while adjacent to it can be seen the 0–40 and 0–120 milliammeter (2) which records the total input. In the centre foreground can be seen the amplifier low frequency coil (3) with its variometer. The two resistances (4) seen above this coil are connected in series and have a value of 50,000 ohms each. They constitute the resistance R_3 in the theoretical circuit diagram fig. 2.

34. The choke (5) seen to the left of these resistances is a high-frequency choke in the H.T.+ circuit, while the condenser (6), adjacent to it, has a value of ·002μF and is connected between the choke and the negative filament lead. In the background can be seen the microphone transformer (7), and beneath it the amplifier valve-holder (8). The choke (9), to the right of the microphone transformer, is the amplifier grid choke and it is connected in the grid circuit of the amplifier valve. The large ·5μF condenser (10) is shunted across the series grid bias resistances. The two condensers (11) in the bottom left-hand corner are each ·002μF ; the

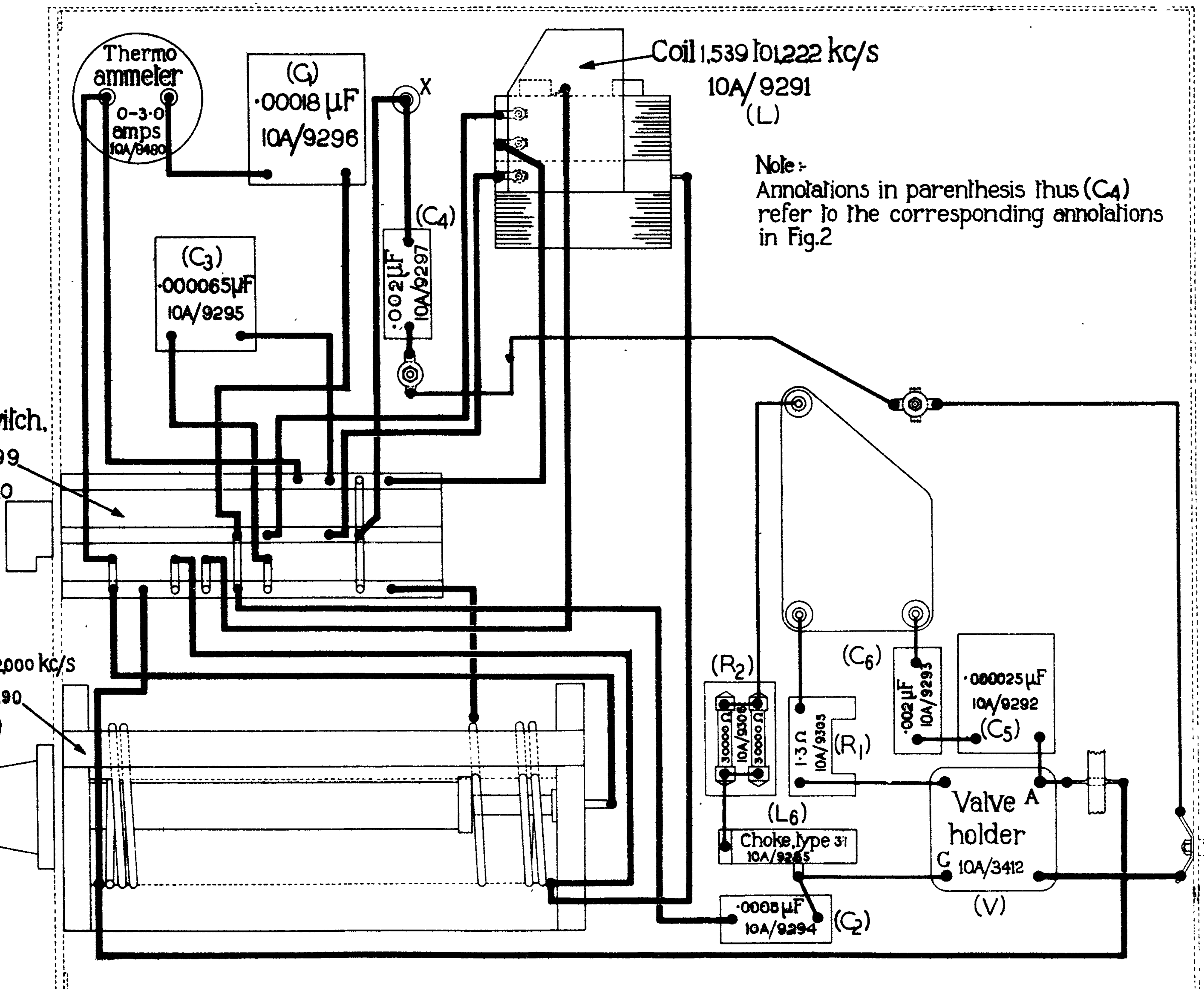


FIG.12, BENCH WIRING DIAGRAM, T.1092 M/O UNIT one on the right is connected across the terminals marked TEL+ and KEY, while the one on the left is connected in series with the telephones between the microphone transformer secondary and earth.

35. Fig. 13 is an inside view of the transmitter showing the components associated with the M/O valve. In the bottom right-hand corner can be seen the M/O valve-holder (1) and two condensers (2) and (3), having values of ·000025μF and ·002μF respectively. These two condensers form the coupling between the M/O and amplifier valve. The ·0005μF condenser (4) is connected in the grid circuit of the M/O valve. The two 30,000 ohm resistances (5) are connected in parallel to give a 1,500 ohm resistance which is connected to the grid of the valve, in series with the choke (6).

36. The M/O high-frequency coil (7) can be seen in the left-hand foreground. The variable tap is connected to one terminal of the 0–3 ammeter. The other terminal of the ammeter is connected through the ·00018μF condenser (8) to the grid circuit of the valve. The coil itself is wound with $\frac{1}{8}$ in. o/d 22 s.w.g. silver plated copper tube on a former of composite insulating material. It has 35 turns wound as a right-hand thread. The variable tap is the usual laminated brush bearing on the inside of the coil. The various tapping points on the coil and its connection relative to the rest of the circuit may be seen in the theoretical circuit diagram fig. 2, and in the bench wiring diagram, fig. 12.

37. Immediately above the coil is the M/O range switch (9). It is capable of being set in any one of four positions, 3,409 to 2,500 kc/s, 2,500 to 2,000 kc/s (yellow), 1,539 to 1,364 kc/s and 1,364 to 1,222 kc/s (green). To the right of the switch can be seen the M/O low-frequency coil (10). The various tapping points from the coil to the range switch may be seen in the theoretical circuit diagram, fig. 2. The single insulated lead (11) on the right of the coil is the connection to the rotor of the coil. The stator of the coil is wound counter-clockwise looking from the rotor end and consists of 11 sections. The first section has $3\frac{1}{2}$ turns, and 4th and 5th sections have 4 turns each and the remainder have 3 turns each. The wire used is 27/38 Litz wire, each

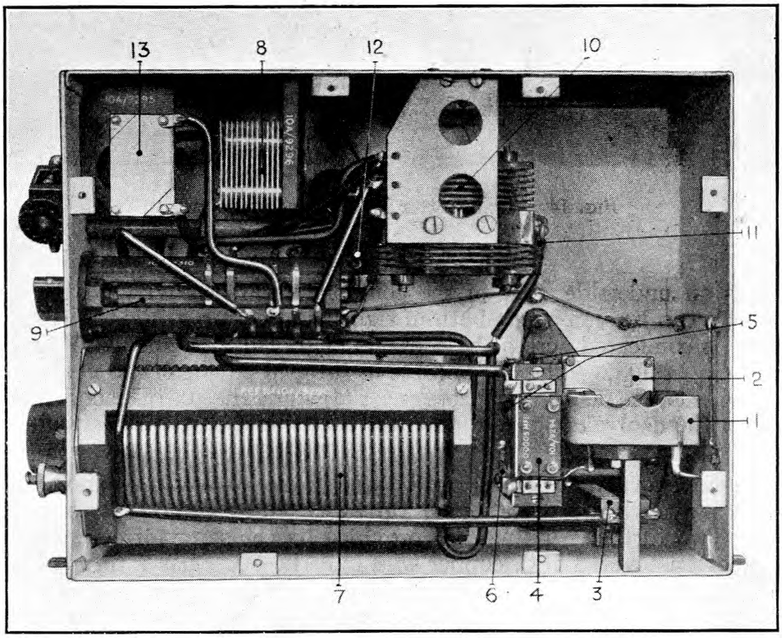


FIG. 13. Transmitter T.1092, viewed from right.

strand being single silk-covered and all 27 strands being double silk-covered. The rotor is wound with 27/40 Litz wire in ten sections. The first four sections have 2 turns per section, the next two have 3 turns per section, and the remaining four have 2 turns per section. The ·002μF condenser (12) which can be seen in the background forms an R/F by-pass for the oscillatory component of the anode current. The ·000065μF condenser (13) seen in the top left-hand corner of fig. 13 is shunted across the M/O inductance for certain frequencies and is represented by C_3 in the theoretical circuit diagram, fig. 2.

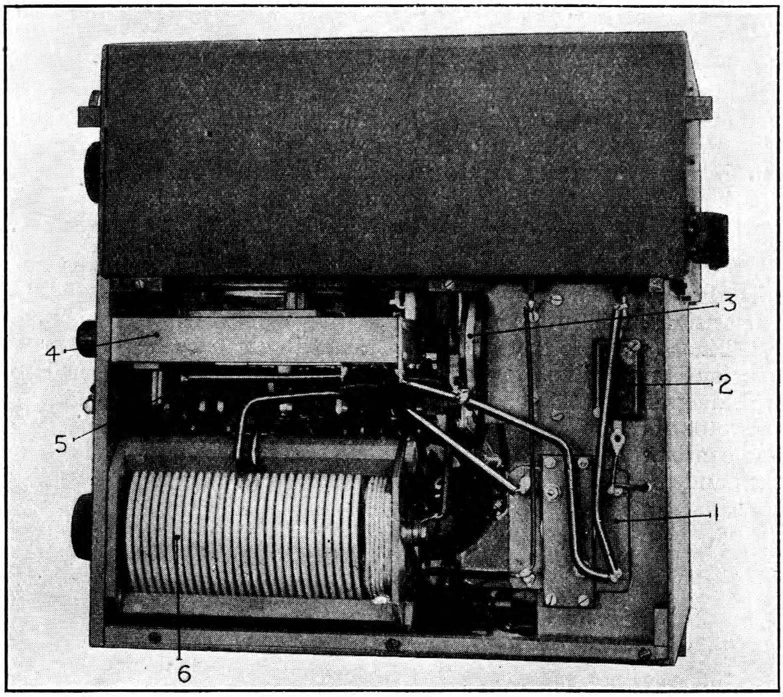


FIG. 14. Transmitter T.1092, underside view.

38. Fig. 14 is an underside view of the components associated with the amplifier valve. The valve-holder (1) can be seen in the bottom right-hand corner, while the ·01μF condenser (2) seen just above it is connected across the contacts engraved S.R. and KEY and is represented by the condenser C_{15} in fig. 2. The choke (3) is in the grid circuit of the valve. In the top left-hand corner can be seen the neutralizing condenser (4) while the ·001μF condenser (5) below it is connected between the neutralizing condenser and a terminal on the range switch.

39. The amplifier short wave coil (6) can be seen in the bottom left-hand corner. It consists of 28 turns of 22 s.w.g. silver plated copper tube $\frac{1}{8}$ in. o/d, wound on a composite insulating material former. Two further windings are provided on the same former. One has 4 turns of 16 s.w.g. double cotton-covered H.C. copper wire and the other has 7 turns of 24 s.w.g. double silk-covered H.C. copper wire. The main coil has a movable tap in the form of a laminated brush which makes contact with the various turns from the inside of the coil. The various connections from the coil may be seen in figs. 2 and 3. The amplifier low frequency coil can be seen in the centre background—this has been referred to in a previous paragraph.

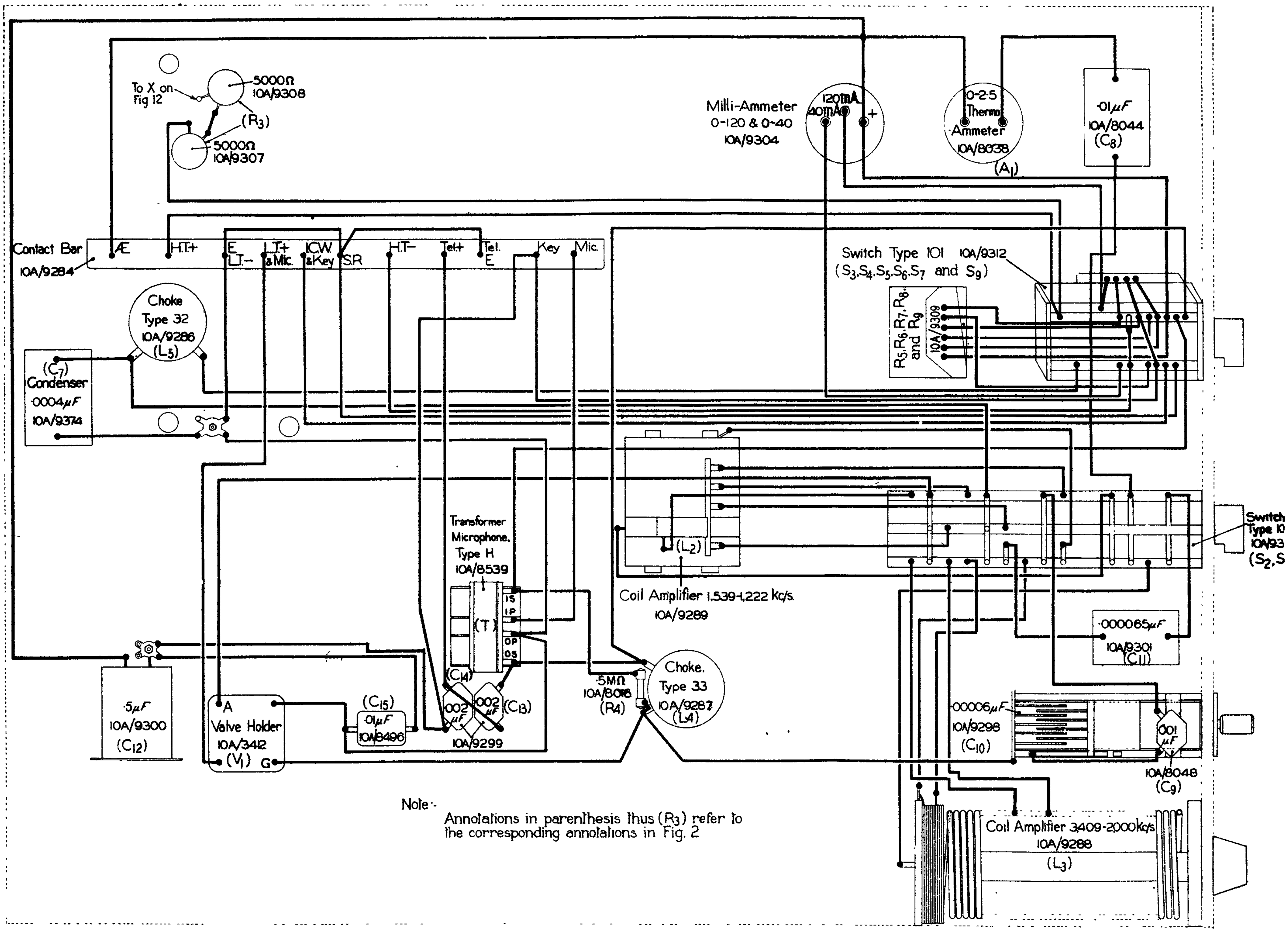


FIG.15, BENCH WIRING DIAGRAM, T.1092, AMPLIFIER UNIT

Receiver

40. Referring to fig. 16, the volume control handle (1) can be seen in the top left-hand corner of the receiver. This consists of a potentiometer device, the moving contact of which is connected to the screen grids of the radio-frequency valves thus giving control of the potential applied thereto. To the right of this is the handle (2) of the heterodyne condenser. This is provided with a coupling which may accommodate a remote control fitting to allow the heterodyne note to be adjusted from a remote position. Coupling is effected by means of a square spring-loaded plunger on the fitting engaging with the squared hole in the centre of the handle.

41. Beneath the heterodyne control is the handle (3) of the ganged condensers which tune the radio-frequency circuits. This is arranged for remote control. To the left of this is a 3-point socket which provides for remote control of volume. The 3-point socket (4) receives a plug which is connected by 3-core flexible cable to a remote potentiometer. In addition to the three electrical connections a fourth hole is provided on the socket and a fourth pin on the plug, the purpose of which is to provide for disconnection of the local potentiometer. This is accomplished by providing a switching device at the rear of the socket so that when the plug is inserted the fourth pin opens the contacts.

42. Near the base of the receiver are situated the heterodyne filament switch (5) and the frequency change switch (6). The former open-circuits the heterodyne valve filament circuit when C.W. is not required. The latter is a multiple switch, the handle of which is carried on the end of a squared spindle which extends to the rear of the receiver. When the handle is rotated three 4-point switches (5, 10 and 16, fig. 19) are operated simultaneously. The first switch is

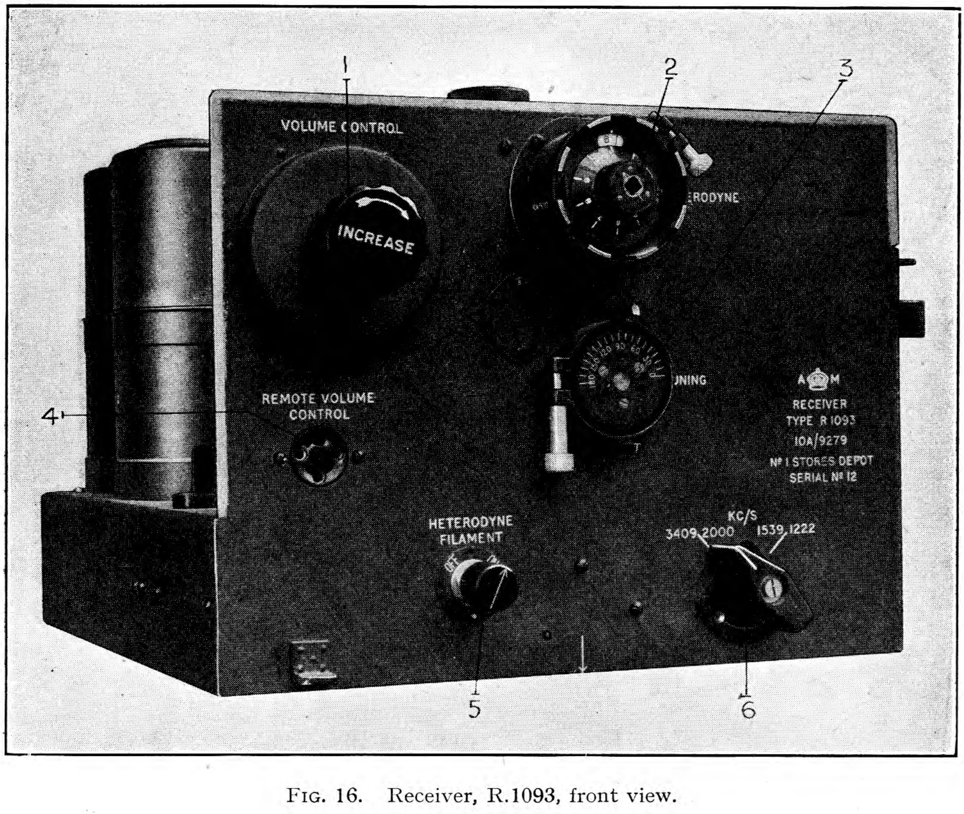


FIG. 16. Receiver, R.1093, front view.

associated with the aerial inductances, the second switch is associated with the anode inductances of the first R/F valve and the third switch is associated with the anode inductances of the second R/F valve.

43. The action of the switch can be explained in the following way. When in the low-frequency position, the inductance is connected across the grid-filament circuit of the first valve and the high-frequency inductance is disconnected. When moved into the high-frequency position, the inductance is connected across the grid-filament circuit, and the low-frequency inductance is short-circuited. In a similar way the anode inductances of the first R/F valve are switched in and out, the low-frequency inductance being short-circuited when the high-frequency inductance is in circuit. The anode inductances of the second R/F valve are switched in a similar manner.

44. Three interior views of the receiver are given in figs. 17, 18 and 19, and a bench wiring diagram in fig. 20. Referring to fig. 17, which is a plan view of the receiver with the cover removed, the two screening cans (1) for the screen-grid valves can be seen in the top right-hand corner. The three valve-holders to the left are the detector (2), 1st A/F (3), and 2nd A/F (4). The unit in the top left-hand corner is the volume control. It consists of a 50,000 ohm variable resistance (6) which is controlled by the handle (1, fig. 16). When the volume is remotely controlled, a plug is inserted in the socket (4, fig. 16) and a pin on this plug opens the contacts of the switch (5), thus cutting out the 50,000 ohm resistance (6) incorporated in the receiver.

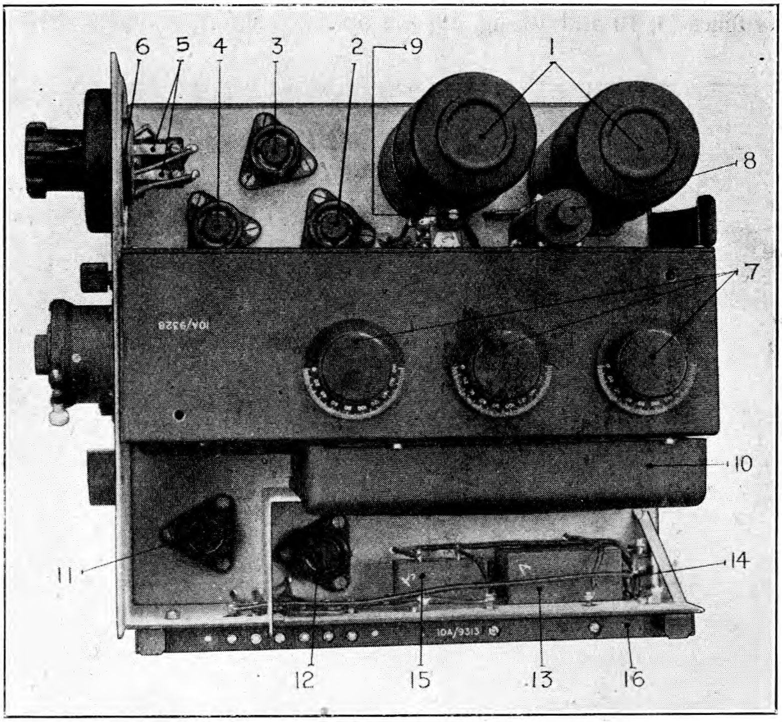


FIG. 17. Receiver R. 1093, plan view.

45. The three tuning knobs (7) project through the cover and control the condensers (C_2, C_{10} and C_{19}, fig. 5). The 0–10 $\mu\mu F$ variable condenser (8) has a control knob which projects through the cover. This condenser is connected between the anodes of the 1st and 2nd R/F

valves. The 135 ohm variable pre-set resistance (9) is connected across the filament leads of the detector valve. The tapping point is connected through a ·25 M Ω resistance to the grid of the same valve.

46. The high-frequency and low frequency coils for the aerial and 1st and 2nd R/F valves are housed under the cover (10). These coils are indicated as L_1–L_2, L_3–L_4 and L_5–L_6 respectively in fig. 5. The cover may be removed for inspection of these coils by undoing four screws. Each of the three high-frequency coils is wound on a former of mica-loaded Trolitol having a dust-iron core. The winding consists of 26 turns of Litz wire, 9/48 enamel double silk-covered copper, giving an inductance of 20 Mics. ± ·5. Each low-frequency coil is wound on a former and core of similar material. The winding consists of 40 turns of Litz wire, 9/48 enamel double silk-covered copper, wound in one slot, the inductance being 60 Mics. ± 1.

47. The valve-holders (11) and (12) are for the heterodyne and output valves respectively. The 2μF condenser (13) is shunted across the centre-tapped 180 ohm resistance (14). One end of this resistance is connected to H.T.— while the other end is connected to earth. The ·5μF condenser (15) is connected between the earthed end and the centre-point of the resistance. The contact bar (16) is provided with 8 spring-jaw contacts engraved, from the right, Æ, E, L.T.—, L.T.+, TEL+, TEL. E, H.T.+ and H.T.—. These contacts engage the appropriate blades on the send-receive switch when the receiver is in position.

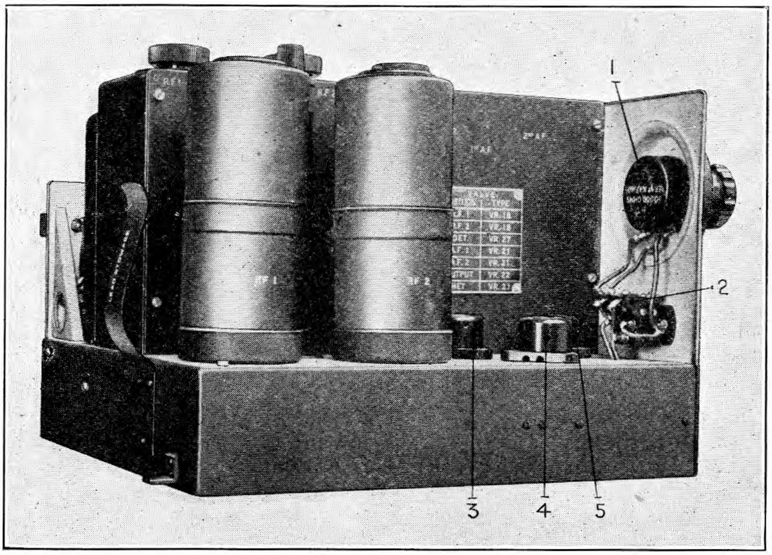


FIG. 18. Receiver R.1093, viewed from the left.

48. Fig. 18 is an inside view of the receiver from the left-hand side, the volume control (1) can be seen in the top right-hand corner and below it the spring contact unit (2) for remote volume control. The three valve-holders (3), (4) and (5) are holders for the detector valve and the 1st and 2nd A/F valves respectively. The screening cans for the 1st and 2nd R/F valves can be seen on the left-hand side appropriately engraved.

49. Fig. 19 is an underside view of the receiver. The components are divided into four groups suitably screened by metal panels on which some of the components are mounted. The group on the left is associated with the 1st R/F valve and comprises a valve-holder (1), a 1·5 ohm resistance (2) in the negative filament lead, two ·5 μF condensers (3) arranged one above the other, a group of resistances and condensers (4) and a frequency change-over switch (5).

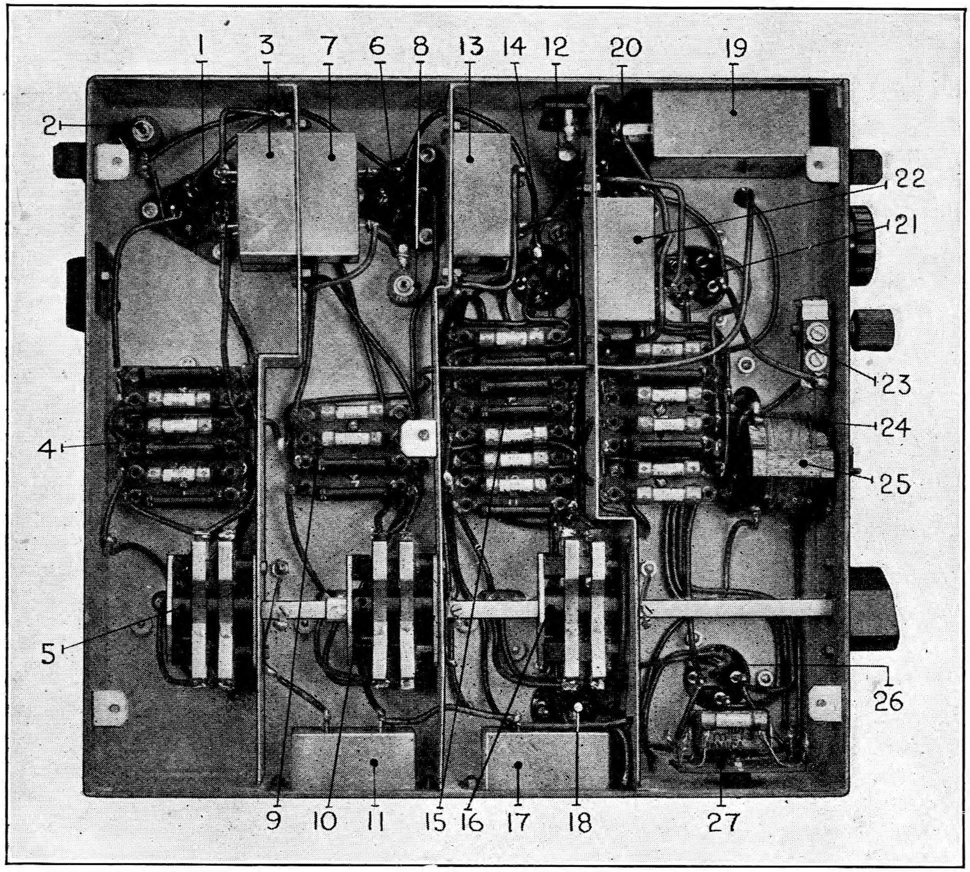
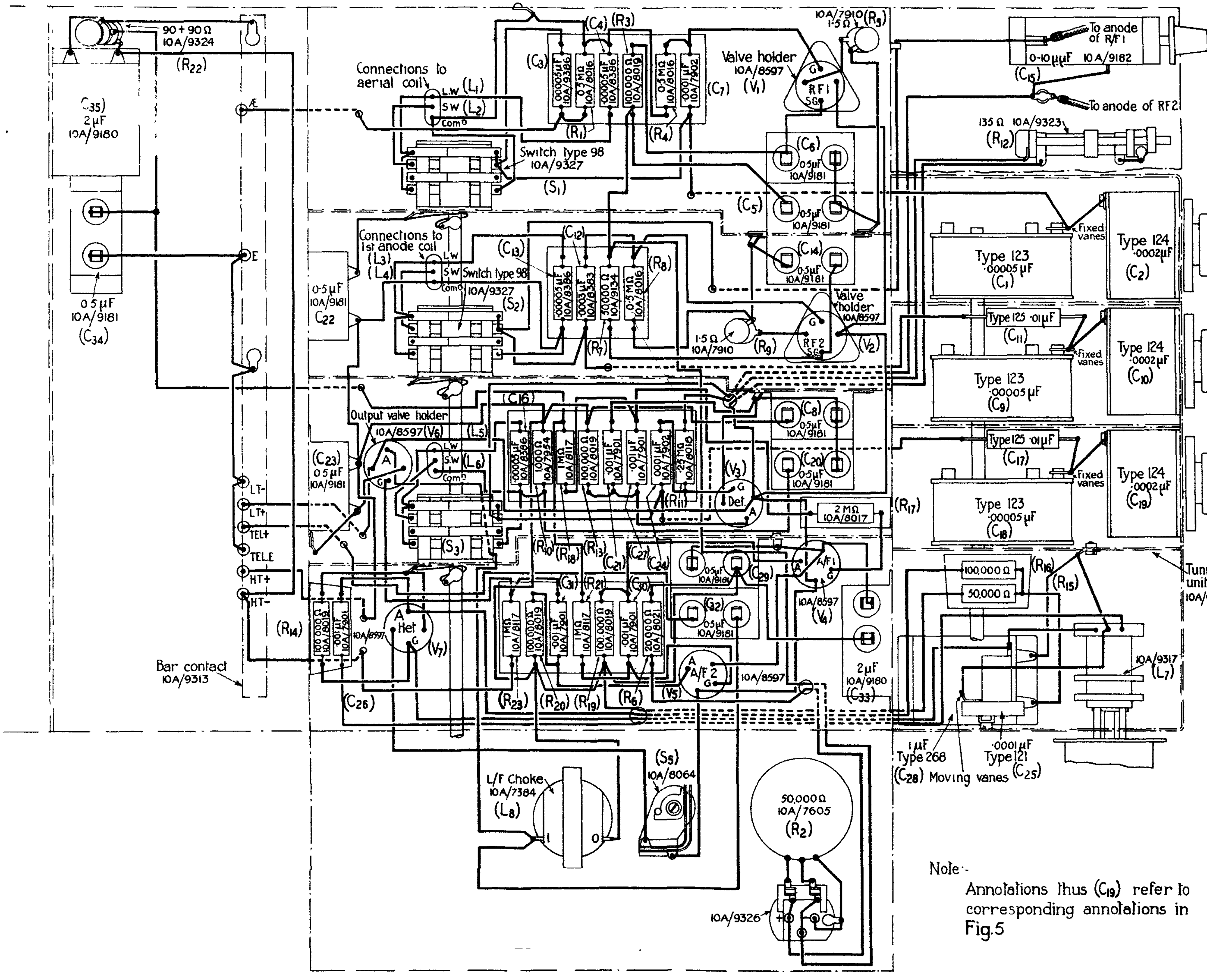


FIG. 19. Receiver R.1093, underside view with the cover removed.

50. Of the two ·5 μF condensers (3), one is connected between one side of the 100,000 ohm resistance R_3 (*see* fig. 5) and earth, and the other ·5 μF condenser is connected between the other side of the resistance and earth. The group of condensers and resistances (4), comprises three resistances and three condensers. These components are numbered from 1 to 6, on their mounting panel, reading from the bottom. The condenser numbered 1 has a value of ·00005 μF and is connected between one terminal of the change-over switch and one side of the ·5 M Ω resistance numbered 2. This is the aerial coupling condenser. The other side of the ·5 M Ω resistance is connected to earth. The condenser numbered 3 has a value of ·00005 μF and is connected across the low-frequency coil (L_2, fig. 5). The next resistance numbered 4 has a value of 100,000 ohms and is the resistance referred to previously connected between the two ·5 μF condensers (3). The resistance numbered 5 has a value of ·5 M Ω and is connected between the grid of the valve and earth. The condenser numbered 6 has a value of ·0001 μF and is indicated by C_7 in the theoretical circuit diagram (fig. 5).

51. The group of components in the second section comprises the 2nd R/F valve-holder (6), a ·5 μF condenser (7) connected between the screen grid and earth, a 1·5 ohm resistance (8) connected in the negative filament lead of the valve, a goup of condensers and resistances (9) numbered from 7 to 10, reading from the bottom, a frequency change-over switch (10) and a ·5 μF. condenser (11) represented by C_8 in fig. 5.



Note:-
Annotations thus (C_{19}) refer to corresponding annotations in Fig. 5

FIG. 20. BENCH WIRING DIAGRAM. R.1093

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52. In the group of condensers and resistances (9), the bottom condenser numbered 7 has a value of ·00005 μF and is connected across the low-frequency coil (L_4, fig. 5). The next condenser numbered 8 has a value of ·0003 μF and is the coupling condenser between the 1st and 2nd R/F valves. The resistance numbered 9 has a value of 50,000 ohms and is connected between the screen grid of the 2nd R/F valve and the centre-point of the volume control. The resistance numbered 10 has a value of 500,000 ohms and is connected in the grid circuit of the 2nd R/F valve. The ·5 μF condenser (11) seen at the bottom is an isolating condenser in the H.T. + lead and is represented by (C_8 in fig. 5).

53. Among the group of components in the third section is a resistance (12) which has a value of 2 M Ω and is the grid stopper resistance for the 1st A/F valve. Of the two ·5 μF condensers (13), which are arranged one above the other, the top one is the R/F by-pass condenser (C_{23}, fig. 5), and the bottom one is the condenser (C_{20}, fig. 5). The detector valve-holder (14) can be seen above a group of condensers and resistances (15). The frequency change-over switch (16) can be seen above the ·5 μF condenser (17) which is the R/F by-pass condenser (C_{22}, fig. 5). While the output valve-holder (18) can be seen between these two last mentioned items.

54. The group of condensers and resistances (15) is numbered from 11 to 18 reading from the bottom. The first condenser has a value of ·00005 μF and is connected across the low-frequency coil (L_6, fig. 5). The 1,000 ohm resistance above it is connected in the anode circuit of the second R/F valve, while the 1 M Ω resistance above it is the grid resistance for the 1st A/F valve. The 100,000 ohm resistance numbered 14 is the anode resistance of the detector valve. The next condenser has a value of ·001 μF and is represented as (C_{21} in fig. 5). The condenser numbered 16 has a value of ·001 μF. and is the coupling condenser between the detector and 1st A/F valve. The next condenser has a value of ·0001 μF and is the coupling condenser between the 2nd R/F valve and the detector. The resistance at the top of the group has a value of ·25 M Ω and is the detector grid leak resistance.

55. The group of components in the last section comprises a 2 μF condenser (19), connected between the high potential side of the A/F choke and earth, the 1st and 2nd A/F valve-holders (20) and (21) respectively, two ·5 μF condensers (22), arranged one above the other, the heterodyne filament switch (23), a group of condensers and resistances (24), an A/F choke (25) connected in the anode circuit of the output valve, the heterodyne valve-holder (26) and a unit (27) consisting of a ·001 μF condenser and a 100,000 ohm resistance.

56. Of the two ·5 μF condensers (22), the bottom one is connected between the anode of the output valve and the terminal engraved TEL+, while the upper one is the R/F by-pass condenser (C_{29}, fig. 5). In the condenser and resistance unit (27), the condenser has a value of ·001 μF and is connected as a fixed reaction condenser between the heterodyne inductance and anode. The resistance has a value of 100,000 ohms and is the grid resistance for the heterodyne valve.

57. In the group of condensers and resistances (24) the bottom resistance has a value of 1 M Ω and is the grid resistance for the output valve. The next resistance has a value of 100,000 ohms and is the anode resistance for the 2nd A/F valve. The condenser above these two resistances has a value of ·001 μF and is the coupling condenser between the 2nd A/F valve and the output valve. The resistance above it has a value of 1 M Ω and is the grid resistance for the 2nd A/F valve. The next resistance has a value of 100,000 ohms and is the anode resistance for the 1st A/F valve. The condenser above this resistance has a value of ·001 μF and is the coupling condenser between the 1st and 2nd A/F valves. The 20,000 ohm resistance above it is connected in the H.T. + lead and is represented by R_6 in the theoretical circuit diagram, fig. 5.

VALVES, GENERATOR AND BATTERIES

58. The transmitter filaments are supplied from four 2-volt accumulators. The H.T. of 1,200 volt is supplied by an 80-watt motor-generator connected to the aeroplane general service

battery. The receiver obtains its L.T. current from a 2-volt accumulator, and its H.T. of 120 volts from a dry battery. The valve used in the master-oscillator stage is a V.T.13C valve. The valve used in the amplifier stage is a V.T.25 valve. Of the seven valves used in the receiver, two are type V.R.18, which are screen-grid valves in the R/F stages, and the detector valve is a type V.R.27. Three type V.R.21 valves are used; two in the A/F stages, and one in the heterodyne stage. One type V.R.22 is used in the output stage.

OPERATION

Transmitter

59. Before commencing to tune the transmitter care should be taken to ensure that the compartment cover on the master-oscillator chamber is screwed down tightly and the send-receive switch placed in the " off " position. During the tuning process the key must never be depressed while the selector switch is being operated. The method of tuning is as follows :—

1·2 to 1·5 Mc/s

60. Connect the appropriate aerial. On this range transmission will normally be carried out on a short trailing aerial of stainless steel. The 200-ft. trailing aerial, partially wound out, must not be used for this purpose since the capacitance to earth of the unused portion is too great. For setting up on the ground the fixed aerial is used. The fixed aerial *may* be used on the lower frequency band in the air (*see* Table 2) with a small loss of performance, and when extreme ranges are not required it may be convenient to do this. The master-oscillator and amplifier range switches should be set to the desired range. It will be observed that this range is split into two bands (on both M/O and amplifier switches), *viz.*, 1·2 to 1·3 and 1·3 to 1·5 Mc/s. The master-oscillator tuning control should now be unlocked and set as nearly as possible to the figures given in the Table. Set the neutralizing condenser to 5·0 and lock it. Set the selector switch to R/T.1.

61. If the send-receive switch is now placed in the " send " position the master-oscillator ammeter should read about one ampere and the milliammeter about 40 to 45 milliamperes. Now unlock the amplifier tuning control and tune this for maximum aerial current, when the milliammeter should read a minimum. The radiated frequency should now be measured by means of wavemeter W.1095. If a note is made as to whether this frequency is above or below that desired, it will facilitate making the correction (up or down) to the tuning of the M/O. Now set the wavemeter to the desired frequency and re-adjust the master-oscillator tuning control, keeping the amplifier in step until the frequency is correct. Lock the controls and set the selector switch for the type of radiation (C.W., I.C.W. or R/T). Since the above adjustments will have been made on the ground with the fixed aerial, a re-adjustment will be required if the short trailing aerial is used in the air. In these circumstances the amplifier must be re-tuned for minimum input. The input and aerial currents for the fixed aerial on the ground will be approximately as follows. For C.W.2, aerial current ·9 to 1 amp., and input 65 milliamps. For R/T 2, aerial current ·5 to ·6 amps., and input 45 milliamps. Slightly higher figures may be expected in the air.

62. Aerial and input currents for the trailing aerial will be approximately as follows. For C.W.2, aerial current ·8 to 1·2 amps., and input 75 to 80 milliamps. For R/T 2, aerial current ·7 to 1·1 amps., and input 60 milliamps.

2 to 3·4 Mc/s

63. For this band the send-receive switch should be placed in the " off " position as before, and the master-oscillator and amplifier range switches set to the desired range. The appropriate aerial should be connected up. On this range the fixed aerial is used. The master-oscillator should be set as nearly as possible according to figures given in Table 7, and the neutralizing condenser set to about 2·0. The selector switch should now be placed in the " tune " position,

and if the send-receive switch is now placed in the "send" position, the master-oscillator ammeter should read about 1·5 to 2 amps. (depending upon the frequency) and the milliammeter about 22 milliamps. Now tune the amplifier so as to obtain a maximum fall in the reading of the master-oscillator ammeter, and then increase the setting of the neutralizing condenser until the master-oscillator ammeter reads about 75 per cent. of the maximum obtained prior to the last operation. Next re-tune the amplifier for a minimum in the master-oscillator ammeter, and then make a further adjustment to the setting of the neutralizing condenser to obtain a maximum in the master-oscillator ammeter. This adjustment should be made with great accuracy. The selector switch should now be placed in the R/T.1 position and the amplifier tuned for minimum input, after which the radiated frequency should be measured to ascertain whether it is above or below that required. The wavemeter should now be set to the required frequency and the master-oscillator tuning adjusted until a maximum deflection is obtained on the wavemeter. After making this adjustment the amplifier should, of course, be re-adjusted for minimum input.

Receiver

64. The receiver should be tuned for R/T in the following way. Open the heterodyne filament switch, and place the range switch in the correct position for the range required (1,222 to 1,539 or 2,000 to 3,409 kc/s). Connect a suitable aerial. The volume control should now be set to *maximum*, the ganged fine tuning condensers set to about 110° and the send-receive switch to "receive". Using the trimmers, gang the R/F circuits by obtaining maximum background noise. The trimmers should be used at one end of their range. Next increase reaction until oscillation occurs. Reduce reaction by about two turns of the condenser knob. A wavemeter giving a modulated signal on the frequency required should now be switched on, and the signal searched for on the trimmers, keeping them approximately in step. When the signal is heard, tune in by means of the ganged tuning control. Now move the wavemeter away until the signal is very weak. The reaction should then be re-adjusted by bringing it up to the oscillation point and taking it two turns back. A final adjustment will now be required on the ganged tuning control.

65. The importance of carrying out the tuning operations as described in the preceding paragraph, i.e., with the volume control at maximum and the wavemeter moved away to produce a weak signal, is emphasized. The reason for this is that the tuning of the receiver is affected by the volume control (the R/F valves are impedances connected across the tuned circuits; these impedances are varied by the volume control) and if the receiver is incorrectly set up with the volume control at a low value, when it is subsequently required to receive a weak signal, the volume control will require to be turned up and (although the gain of the receiver will be increased) the receiver will be mistuned and the signal may be missed.

66. For C.W. reception the receiver should first be tuned as above and then the wavemeter switched over to C.W. and the heterodyne switch on the receiver closed. Search for the signal should now be made entirely on the heterodyne control, the reaction being maintained near its minimum value.

PRECAUTIONS AND MAINTENANCE

67. The send-receive switch is situated on the mounting board between the transmitter unit and receiver unit. The moving blades of the switch mesh in one position with spring jaws on the transmitter and in the other position with spring jaws on the receiver. Care must be exercised when removing either transmitter or receiver from the base-board, and in replacing them, to avoid damage to the switch. When removing or replacing the transmitter the switch should be moved into the "receive" position. When removing or replacing the receiver the switch should be put into the "send" position. The master-oscillator valve should be inspected frequently (say every five to ten hours flying, with the filament switched on). If the valve filament is found

to sag the valve should be discarded. Owing to the comparatively short life of the master-oscillator valve it is important that adequate spares of this valve are available. If no V.T.13 C valve is available, transmission of telegraphy on the higher frequencies is still possible, by allowing the amplifier to self-oscillate. This can be accomplished by setting the neutralizing condenser to either of its extreme positions and choosing the one which gives the better output for a reasonable input. It should be noted that re-adjustment of the tuning will be necessary in these circumstances to regain the desired frequency. In the event of a failure of the V.R.27 valve in the detector stage of the receiver a V.R.21 may be used but the pre-set resistance (9, fig. 17) must be adjusted to suit.

TABLE 1

(Key to Installation Diagram, fig. 21.)

Item No.	Stores Ref.	Nomenclature.	Quantity.	Remarks.
1	10A/9275	Transmitter-receiver T.R.1091		Without valves.
2	10A/9504	Switch unit, type E, complete with plugs and leads.		As wired for Hector aeroplane.
3	5C/430	Block, terminal, type B, 2-way, No. 1 ..	4	
4	10A/7971	Socket, type 29 (combined TEL. MIC) ..	2	
5	10A/7741	Key, morse, type F	2	
6	5A/829	Switch, tumbler, 2 way S.P, No "OFF" position.	1	
7	5A/1362	Cable, L.T., Ducel 4		As required.
8	5A/1358	Cable, L.T., Unicel 4		As required.
9	10A/7439	Socket, type 20 (6 point)	1	
10	10A/7799	Disc, indicating, type M	1	For 10A/7439.
11	10A/8533	Socket, type 42 (4 point)	1	
12	10A/9490	Disc, indicating, type K	1	For 10A/8533.
13	10A/8517	Plug. type 69 (4 point)	1	
14	10A/9189	Disc, indicating, type K	1	For 10A/8517.
15	N.I.V.	Socket, Jacelite, 3 pin, 5-amp.	1	Cat. No. 7170 for 12-V supply.
16	N.I.V.	Plug, Jacelite, 3 pin, 5-amp.	1	Cat. No. 7110 for 12-V supply
17	10A/8533	Socket, type 42 (4 point)	1	
18	10A/9014	Disc, indicating, type G	1	For 10A/8517.
19	5A/1360	Cable, L.T., Unicel 19		As required.
20	5A/1387	Accumulators, 2-V 20 Ah, type B	5	4 for transmitter. 1 for receiver.
21	N.I.V.	Box, accumulator	1	For 5A/1387.
22	10A/7441	Socket, type 21 (7 point)	1	
23	10A/9488	Disc, indicating, type V	1	For 10A/7441.
24	10A/7437	Socket, type 19 (2 point)	1	
25	10A/8120	Disc, indicating, type E	1	For 10A/7437.
26	10A/7532	Motor, generator, 80-watt, type C	1	
27	10A/9011	Condenser, type 256, 1 μF	1	Across M.G. H.T. terminals.
28	5A/917	Cable, H.T., uniplug 12, red braided ..		As required.
29	10A/8262	Plug, type 65 (S.P. H.T. −, battery) ..	1	
30	10A/8261	Plug, type 64 (S.P. H.T. +, battery) ..	1	
31	5A/1333 or 5A/1615	Battery, type A, dry, H.T. 120 volts .. Battery, type B, dry, H.T. 120 volts for overseas use.	1	Stowed in item 32.
32	N.I.V.	Crate, power	1	For H.T. battery and motor-generator.
33	10A/7997	Starter, type A	1	
34	10A/3387	Terminal, 2 B.A., type A, spring type ..	2	For earth.
35	N.I.V.	Crate, bearers and fittings		
36	10A/9000	Plug, type 72 (S.P.), unispark cable	2	
37	10A/4589	Aerial wire, R.4		For fixed aerial.

Fixed wiring shown thus :-
Removable wiring shown thus :-
For key see table 1.

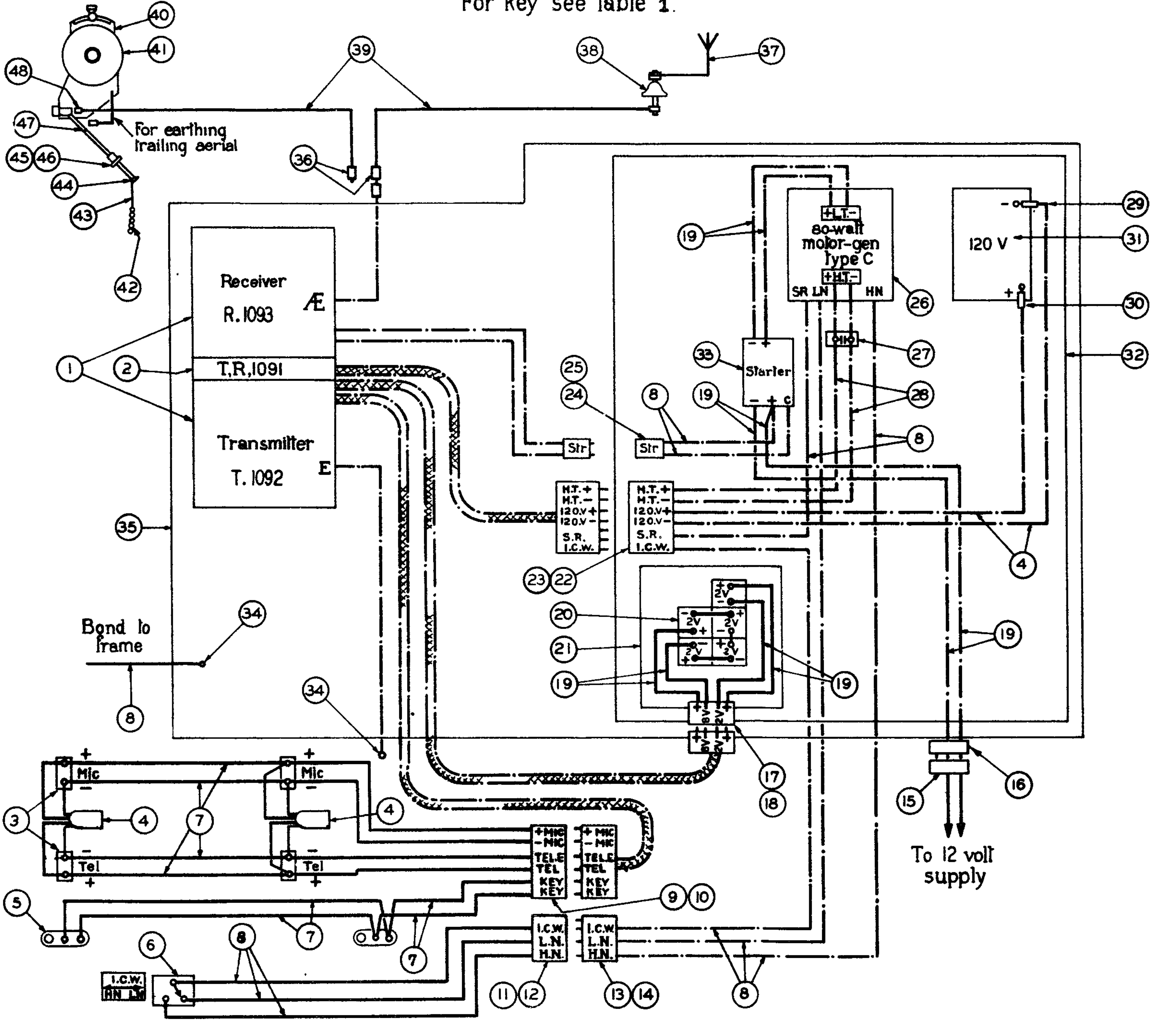


FIG. 21. INSTALLATION DIAGRAM. T.R. 1091 (HECTOR)

TABLE 1—*contd.*

Item No.	Stores Ref.	Nomenclature	Quantity.	Remarks.
38	10A/8093	Aerial insulator, type 16 (lead-in)	1	For fixed aerial.
39	5A/82	Cable, H.T., unispark 7, unbraided ..		For aerial leads.
40	10A/9005	Aerial winch, type 5, frame	1	Complete with earthing lead and socket.
41	10A/9123	Aerial winch, type 5, reel, type B	1	For 10A/9005.
42	10A/7298	Aerial weight, bead, type 1		For trailing aerial.
43	10A/8235	Aerial wire, stainless steel 7/28		
44	10A/8193	Aerial fairlead bush, steel, type 3, flared ..	1	
45	10A/7986	Aerial fairlead bush, insulating	1	
46	N.I.V.	Aerial fairlead clamp	1	
47	10A/7301	Aerial fairlead tube, Dexine, 1 inch	1	For trailing aerial.
48	10A/8531	Socket, type 40 (S.P.)	1	

INSTALLATION

68. An installation diagram is given in fig. 21. It will be seen that, in addition to the aerial and earth leads from the transmitter-receiver, four multi-point plugs are provided. One of these makes the connections to the key, the microphones and the telephones. A second makes the connections for H.T. to the transmitter and receiver and also the I.C.W. switch connections. A third makes the connections for the L.T. to the receiver and transmitter. A fourth provides the connection for starting and stopping the motor-generator, the circuit being closed by a blade on the send-receive switch when the latter is in the " send " position, and opened when in the " receive " or " off " positions. It will be seen that this pair of leads terminates in a two-point plug which is engaged with a two-point socket connected to a Starter, type A.

69. The Starter, type A, is connected to the 12-volt supply through a plug and socket and also to the L.T. terminals of the motor-generator. The starter, which is a device for introducing a resistance in series with the armature and cutting it out at a pre-determined speed, is described in the chapter dealing with transmitter T.1083 in this publication. It will be seen that the three connections, S.R., L.N. and H.N., on the end of the motor-generator are taken through a plug-and-socket connection to the single-pole change-over switch in the bottom left-hand corner of the diagram. The first-mentioned connection (S.R.) is not taken directly to this switch, but is taken through the transmitter in order to bring the interrupter into the H.T. circuit. The I.C.W. note may be selected by means of the switch. The interrupter may of course be short-circuited by the selector switch in the transmitter when C.W. is required. A condenser type 256 is connected across the H.T. leads of the motor-generator.

70. A 4-point jack is provided for each occupant of the aeroplane, one pair of contacts of each jack being wired in parallel to a socket engraved MIC, TEL, KEY, which engages with the corresponding plug on the transmitter. The other pair of contacts are wired in parallel to the telephone connections on the same socket. The 4-way cord connected to the telephones and microphone worn by each occupant terminates in a 4-way plug. When this plug is inserted into the above-mentioned jack, the microphone is connected to the microphone transformer in the transmitter, and the appropriate telephones connected in the output circuit of the receiver or the side-tone circuit of the transmitter, depending upon the position of the send-receive switch. Thus, during transmission, any one of the occupants by speaking into his microphone, may transmit R/T and hear side-tone. During reception the microphone circuit is broken and all the phones are connected in the output circuit of the receiver. A plug-and-socket connection enables either the fixed or the trailing aerial to be used.

TABLE 2

Aerial System : Broad Arrow. Calibrated on the Ground. 1,222 to 1,364 kc/s.

Frequency kc/s.	M/O.	AMP.	Neut. Cond.	C.W.2.		R/T 2	
				Input mA.	Output Amps.	Input mA.	Output Amps.
1,205	9–5	8–3	6–0	64	1·0	45	0·5
1,222	8–5	7–7	6–0	64	1·0	45	0·5
1,240	7–5	6–9	6–0	64	1·0	45	0·6
1,265	6–5	6–0	6–0	64	1·0	45	0·6
1,290	5–5	5–2	6–0	64	1·0	45	0·6
1,328	4–5	4–6	6–0	64	1·0	45	0·6
1,354	3–5	3–7	6–0	64	1·0	45	0·6
1,372	2–5	3–0	6–0	64	1·0	45	0·6

TABLE 3

Aerial System : 20 ft. trailing. 1,222 to 1,364 kc/s.

Frequency kc/s.	M/O.	AMP.	Neut. Cond.	C.W.2.		R/T 2.	
				Input mA.	Output Amps.	Input mA.	Output Amps.
1,205	9–5	9–0	5–0	80	0·8	60	0·7
1,222	8–5	8–0	5–0	80	0·9	60	0·8
1,240	7–5	7–4	5–0	75	0·9	60	0·8
1,265	6–5	6–2	5–0	80	1·0	60	0·8
1,297	5–5	5–6	5–0	80	1·0	60	0·8
1,328	4–5	5–2	5–0	80	1·0	60	0·9
1,354	3–5	4–6	5–0	80	1·0	60	0·9
1,372	2–5	4–0	5–0	80	1·0	60	1·0

TABLE 4

Aerial System : Broad Arrow. 1,364 to 1,539 kc/s.

Frequency kc/s.	M/O.	AMP.	Neut. Cond.	C.W.2.		R/T 2.	
				Input mA.	Output Amps.	Input mA.	Output Amps.
1,353	10–5	10–2	6–0	64	1·0	45	0·5
1,367	9–5	9–6	6–0	64	0·9	45	0·5
1,383	8–5	8–8	6–0	64	0·9	45	0·5
1,413	7–5	8–0	6–0	64	0·9	45	0·5
1,447	6–5	7–1	6–0	64	0·9	45	0·5
1,482	5–5	6–4	6–0	64	0·9	45	0·5
1,515	4–5	5–8	6–0	64	0·9	45	0·5
1,545	3–5	5–0	6–0	64	0·9	45	0·5
1,570	2–5	4–9	6–0	64	1·0	45	0·5
1,600	0–0	4–7	6–0	64	1·0	45	0·5

TABLE 5

Aerial System : 20 ft. trailing. 1,364 to 1,539 kc/s.

Frequency kc/s.	M/O.	AMP.	Neut. Cond.	C.W.2.		R/T 2.	
				Input mA.	Output Amps.	Input mA.	Output Amps.
1,353	10–5	12–3	5–0	80	1·1	60	1·0
1,367	9–5	10–5	5–0	80	1·1	60	1·0
1,383	8–5	9–6	5–0	80	1·2	60	1·1
1,413	7–5	8–8	5–0	80	1·2	60	1·1
1,447	6–5	8–0	5–0	80	1·2	60	1·0
1,482	5–5	7–2	5–0	75	1·1	60	1·0
1,515	4–5	6–3	5–0	70	1·1	60	1·0
1,545	3–5	5–6	5–0	70	1·0	60	0·9
1,570	2–5	5–2	5–0	70	1·0	60	0·9
1,600	0–0	4–6	5–0	70	1·0	60	0·9

TABLE 6

Aerial System : Broad Arrow. Calibrated on the Ground. 2·0 to 2·5 Mc/s.

Frequency kc/s.	M/O.	AMP.	Neut. Cond.	C.W.2.		R/T 2.	
				Input mA.	Output Amps.	Input mA.	Output Amps.
1,910	14–180	22–20	6–8	62	1·3	46	0·9
1,990	13–180	20–100	6–8	62	1·3	46	0·9
2,070	12–180	18–150	6–8	62	1·3	46	0·9
2,160	11–180	16–200	6–9	62	1·4	46	0·9
2,190	10–180	15–200	6–9	62	1·4	46	0·9
2,240	9–180	14–200	6–9	62	1·4	46	0·9
2,310	8–180	13–220	6–9	62	1·4	46	0·9
2,380	7–180	12–240	6–7	60	1·4	46	1·0
2,460	6–180	11–250	6–7	60	1·4	46	1·0
2,500	5–180	10–290	6–7	60	1·4	46	1·0

TABLE 7

Aerial System : Broad Arrow. Calibrated on the Ground. 2·5 to 3·4 Mc/s.

Frequency kc/s.	M/O.	AMP.	Neut. Cond.	C.W.2.		R/T 2.	
				Input mA.	Output Amps.	Input mA.	Output Amps.
2,500	12–180	18–340	6–1	62	1·7	46	1·1
2,540	11–180	17–320	6–1	62	1·7	46	1·1
2,580	10–180	16–290	6–1	62	1·7	46	1·1
2,650	9–180	15–220	6–1	60	1·7	46	1·1
2,700	8–180	14–200	6–1	60	1·7	46	1·1
2,750	7–180	13–140	6–1	60	1·7	46	1·1
2,885	6–180	12–100	5–7	60	1·7	46	1·2
2,940	5–180	11–60	5–7	60	1·7	46	1·2
3,000	4–180	10–40	5–7	60	1·7	46	1·2
3,120	3–180	9–20	5–8	60	1·7	46	1·2
3,260	2–180	7–340	5–8	60	1·7	46	1·2
3,330	1–180	6–300	5–8	60	1·6	46	1·1
3,400	0–340	6–80	5–8	60	1·6	46	1·0

APPENDIX

NOMENCLATURE OF PARTS

The following list of parts is issued for information. In ordering spares for this transmitter-receiver, the appropriate section of AIR PUBLICATION 1086 must be used.

Ref. No.	Nomenclature.	Quantity.	Remarks.
10A/9275	Transmitter-receiver T.R. 1091, consisting of :—		Complete without switch unit.
10A/9276	Board, mounting	1	Fitted with four mountings, anti-vibration, type 3, and 4 feet, ball Ref. Nos. 10A/9277 and 10A/9278 respectively.
10A/9280	Transmitter, type T.1092		Complete without valves.
10A/9279	Receiver, type R.1093..	1	Complete without valves.
	Transmitter T.1092.		
	Principal components :—		
	Ammeter, thermo,		
10A/8480	0 to 3·0, type B	1	
10A/8038	0 to 2·5, type A	1	
10A/9284	Bar, contact	1	Fitted with 11 contacts.
	Choke, H/F		
10A/9285	Type 31	1	
10A/9286	Type 32	1	
10A/9287	Type 33	1	
	Coil		
	Amplifier		
10A/9288	3,409 to 2,000 kc/s	1	Variable,with counting mechanism.
10A/9289	1,539 to 1,222 kc/s	1	With variometer coil.
	Master-Oscillator		
10A/9290	3,409 to 2,000 kc/s	1	Variable with counting mechanism.
10A/9291	1,539 to 1,222 kc/s	1	With variometer coil.
	Condenser		
10A/8044	Type 139	1	·01 μF.
10A/8048	Type 143	1	·001 μF.
10A/8496	Type 188	1	·01 μF.
10A/9292	Type 269	1	·000025 μF.
10A/9293	Type 270	1	·002 μF.
10A/9294	Type 271	1	·0005 μF.
10A/9295	Type 272	1	·000065 μF.
10A/9296	Type 273	1	·00018 μF.
10A/9297	Type 274	1	·002 μF.
10A/9298	Type 275	1	·00006 μF.
10A/9299	Type 276	2	·002 μF.
10A/9300	Type 277	1	0·5 μF.
10A/9301	Type 278	1	·000065 μF.
10A/9374	Type 298	1	·0004 μF.
	Drive		
10A/9302	Slow motion	1	With lock
10A/9303	Slow motion	1	Without lock.
10A/3412	Holder, valve, V.T.13	2	
10A/9304	Milliammeter, 0 to 40 and 0 to 120.. ..	1	Double scale.
	Resistance		
10A/9305	Type 243	1	1·3 ohms.
10A/9306	Type 244	2	30,000 ohms, 1·5-watt, rod type.
10A/9307	Type 245	1	5,000 ohms.
10A/9308	Type 246	1	5,000 ohms.
10A/9309	Type 247	1	5,000 ohms, slab wound.
	Switch		
10A/9310	Type 99	1	Barrel type, multi-contact.

APPENDIX—*contd.*

Ref. No.	Nomenclature.	Quantity.	Remarks.
	Transmitter receiver T.R. 1091—*contd.*		
	*Transmitter T.*1092—*contd.*		
	Principal components—*contd.*		
	Switch—*contd.*		
10A/9311	Type 100	1	Barrel type, multi-contact.
10A/9312	Type 101	1	Barrel type, multi-contact.
	Transformer, microphone		
10A/8539	Type H	1	
	*Receiver R.*1093.		
	Principal components :—		
10A/9313	Bar, contact	1	Fitted with 8 contacts.
	Choke, L/F		
10A/7384	Type B	1	
10A/9314	Coil, L.W.	3	Dust-iron core aerial, 1st and 2nd anode.
10A/9315	Coil, S.W.	3	Aerial, 1st and 2nd anode.
10A/9317	Coil, heterodyne	1	Variable dust-iron core.
	Condenser		
10A/7901	Type 120	5	·001 μF.
10A/7902	Type 121	2	·0001 μF.
10A/8383	Type 173	1	·0003 μF.
10A/8386	Type 176	4	·00005 μF.
10A/9180	Type 281	2	2·0 μF.
10A/9181	Type 282	10	0·4 μF.
10A/9182	Type 283	1	Miniature variable, with screw adjustment.
	Cover		
10A/9321	Bottom	1	
10A/9322	Top	1	
	Holder, valve		
10A/8597	Type L	7	
	Resistance		
10A/7910	Type 97	2	1·5 ohms
10A/7954	Type 101	1	1,000 ohms, ½-watt, rod type.
10A/8016	Type 108	3	·5 M Ω, ½-watt, rod type.
10A/8017	Type 109	1	2 M Ω, ½-watt, rod type.
10A/8018	Type 110	1	0·25 M Ω, ½-watt, rod type.
10A/8019	Type 111	5	100,000 ohms, ½-watt, rod type.
10A/8021	Type 113	1	20,000 ohms, ½-watt, rod type.
10A/8117	Type 123	3	1 M Ω, ½-watt, rod type.
10A/9323	Type 240	1	135 ohms, variable.
10A/9324	Type 241	1	180 ohms, centre tapped.
10A/9134	Type 231	1	50,000 ohms, ½-watt, rod type.
10A/7605	Type 75 .. .. or		50,000 ohms, variable potentiometer.
10A/9505	Type 253 .. .. or	1	50,000 ohms, variable potentiometer.
10A/9506	Type 254		50,000 ohms, variable potentiometer.
	Socket		
10A/9326	Type 46	1	3 pole, with plug operated switch contacts.
	Switch		
10A/8064	Type 70	1	Single pole "on-off" rotary type with gold-silver contacts.
10A/9327	Type 98	3	Barrel type, with four pairs spring contacts.

APPENDIX—*contd.*

Ref. No.	Nomenclature.	Quantity.	Remarks.
	Transmitter-receiver T.R.1091—*contd.*		
	Receiver R.1093—contd.		
	Principal components—*contd.*		
10A/9328	Units, tuning	1	Fitted with :— 1 condenser, type 266, ·001 μF. 3 condensers, type 123, ·0005 μF. 3 condensers, type 124, ·0002 μF. 2 condensers, type 125, ·01 μF. 1 condenser, type 268, 1·0 μF. 1 resistance, type 111, 100,000 ohms. 1 resistance, type 231, 50,000 ohms.
	Accessories		
	Transmitter-receiver, T.R.1091 :—		
10A/9281	Case, transit	1	
10A/9282	Switch, unit, type E Unwired	1	Without plugs and leads.
	Switch unit Wired for :—		
10A/9502	Anson aeroplane		With the appropriate plugs and leads connected for each installation.
10A/9785	Demon aeroplane		
10A/9504	Hector aeroplane		
10A/9747	A.39/34 Westland aeroplane		
	Transmitter T.1092		
	Accessories :—		
	Valve :—		
10A/7510	Type V.T.13C	1	
10A/7312	Type V.T.25	1	
	Receiver R.1093		
	Accessories :—		
	Valve :—		
10A/7607	Type V.R.18	2	For R/F stages.
10A/7738	Type V.R.21	3	For A/F and heterodyne.
10A/9851	Type V.R.22	1	For output stage.
10A/8239	Type V R.27	1	For detector.
	Accessories Installation		Typical for Hector aeroplane, *see* installation diagram, fig. 21.
	Controls, remote, comprising :—		
10A/8189	Casing, flexible, type C		Quantity as required.
10A/8190	Casing, rigid, type C		Quantity as required.
10A/8585	Cleat, type C		For securing casing, rigid to aeroplane structure.
10A/8186	Controller	1	
1B/4178	Gun lubricator, type B	1	For use with 10A/9119.
10A/8195	Handle, condenser unit	1	
10A/9515	Pin, key, type C		For use with unions, casing, type B.
10A/9508	Plug, type 77 (3 pin)	1	Cable, L.T., triflexmet, 2·5, metal braided (8 ft.), to be demanded under 5A/1423.
10A/8192	Shafting, flexible, type C		Quantity as required.
10A/8746	Switch, coupling, type E		For " send-receive ".
5C/432	Terminal block, type B	1	3-way.
10A/8193	Union, casing, type B		Quantity as required.
10A/9119	Union, lubricating, type C		Quantity as required.

SECTION 2, CHAPTER 4

TRANSMITTER-RECEIVER T.R.9.D.

Contents

LIST OF ILLUSTRATIONS

TRANSMITTER-RECEIVER TYPE T.R.9D

Stores Ref. 10D/10470)

INTRODUCTION

1. The transmitter-receiver T.R.9D is designed for use in aeroplanes to provide two-way air-to-ground or air-to-air R/T communication with a higher degree of frequency stability than is obtainable in earlier instruments. It consists of the transmitter T.1119 and the receiver R.1120 fitted into a single case. The H.T. supply for both transmitter and receiver is provided by a single 120-volt dry battery housed in a tray forming a portion of the case. Filament heating supply for both transmitter and receiver is provided by an external 2-volt accumulator.

2. The transmitter-receiver is designed to operate over a frequency range of approximately 4·3 to 6·6 Mc/s, the radiated frequency being stablized by means of a quartz crystal. Two such crystals are incorporated in the transmitter so that either of two predetermined frequencies may be transmitted. Of these one only is used for ordinary R/T communication; this is referred to as the "normal," and the other, on which an unmodulated carrier only is radiated, as the "special" frequency. The range of the R/T communication from air to ground is at least 35 miles, and from air to air at least five miles. In normal circumstances these ranges are usually exceeded.

3. The instrument is primarily intended for use in single-seater fighter aeroplanes, and provision is made for its operation by means of a system of remote controls. When fitted in a single-seater aeroplane, the microphone is disconnected from its transformer when the SEND-RECEIVE switch is in the RECEIVE position. When fitted in a two-seater or multi-seater aeroplane, however, provision may be made for inter-communication between certain members of the crew, using the audio-frequency stage of the receiver as an I/C amplifier. The I/C circuit is operative even if transmission of R/T is actually taking place. This provision is made for tactical purposes which need not be discussed here. During transmission of the "special" frequency, however, the I/C circuit is inoperative.

4. The overall dimensions of the transmitter-receiver, in its case, are approximately 19½ in. by 13¼ in. by 9½ in. The weight excluding batteries, is approximately 28 lb. With valves and dry batteries in place, the weight is about 40 lb. The total weight of the complete installation is further increased to about 67 lb. by the mechanical remote control system for transmitter operation and receiver tuning, and the electrical control system for shifting the frequency from "normal" to "special." The general appearance of the transmitter-receiver is shown in fig. 7.

GENERAL DESCRIPTION

5. The transmitter T.1119 consists of a crystal-controlled oscillator driving an anode-modulated class C radio-frequency power amplifier.

6. Provision is made for the employment of either of two types of microphone, namely the carbon capsule type which has hitherto been generally used with service transmitters, or alternatively, a recently developed electro-magnetic microphone. The advantage of the latter lies in its greater approach to linear operation and consequent reduction of inter-modulation (*see* A.P. 1093, Signal Manual, Part II, Chapter XII). It is however much less sensitive than the carbon microphone, and the audio-frequency stages of the receiver R.1120 are therefore employed to amplify the voice-frequency output of the microphone transformer before application to the input terminals of the modulator valve. When performing the latter function this portion of the receiver is treated as a single unit of the transmitter and referred to as the sub-modulator stage.

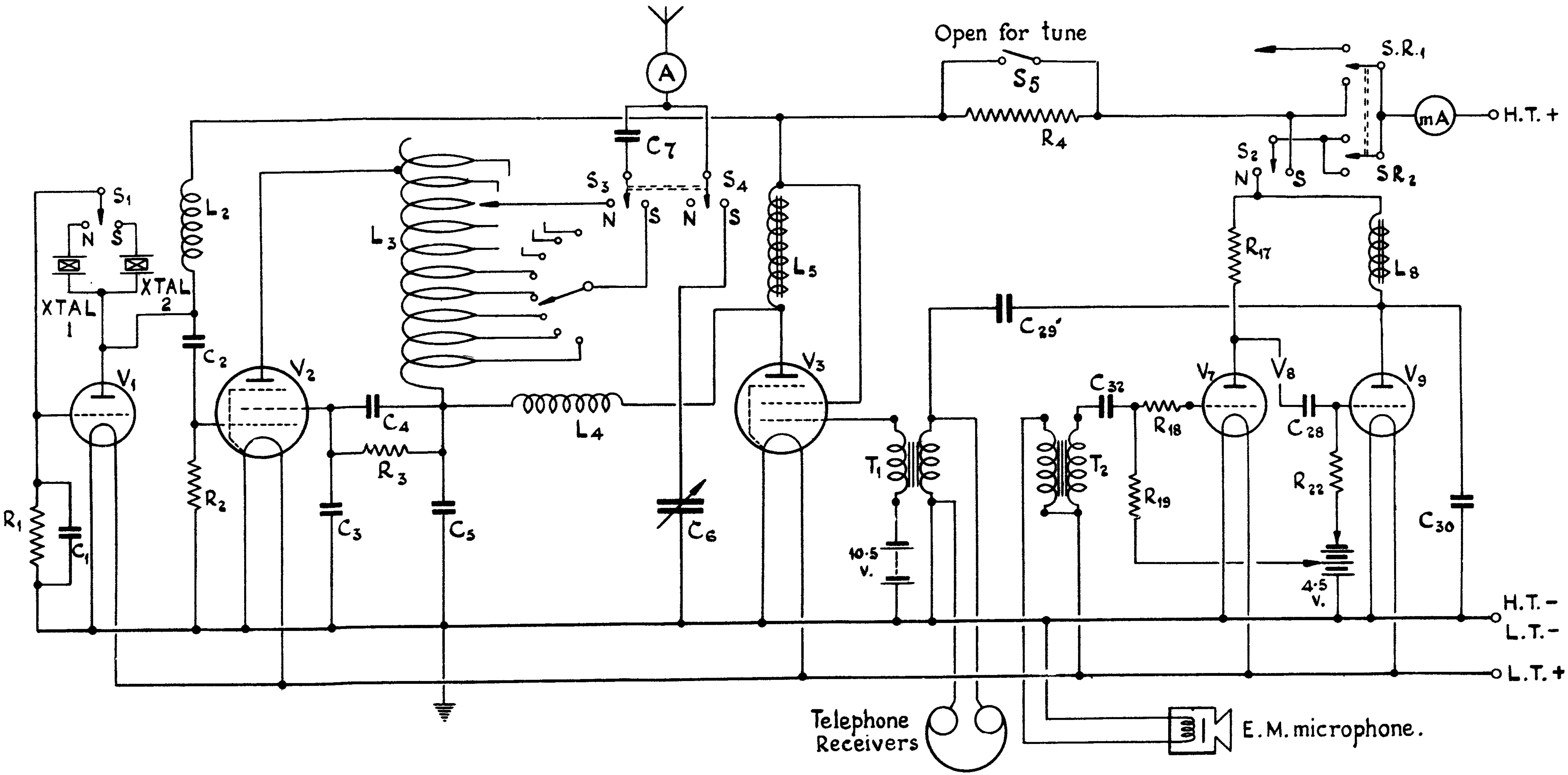
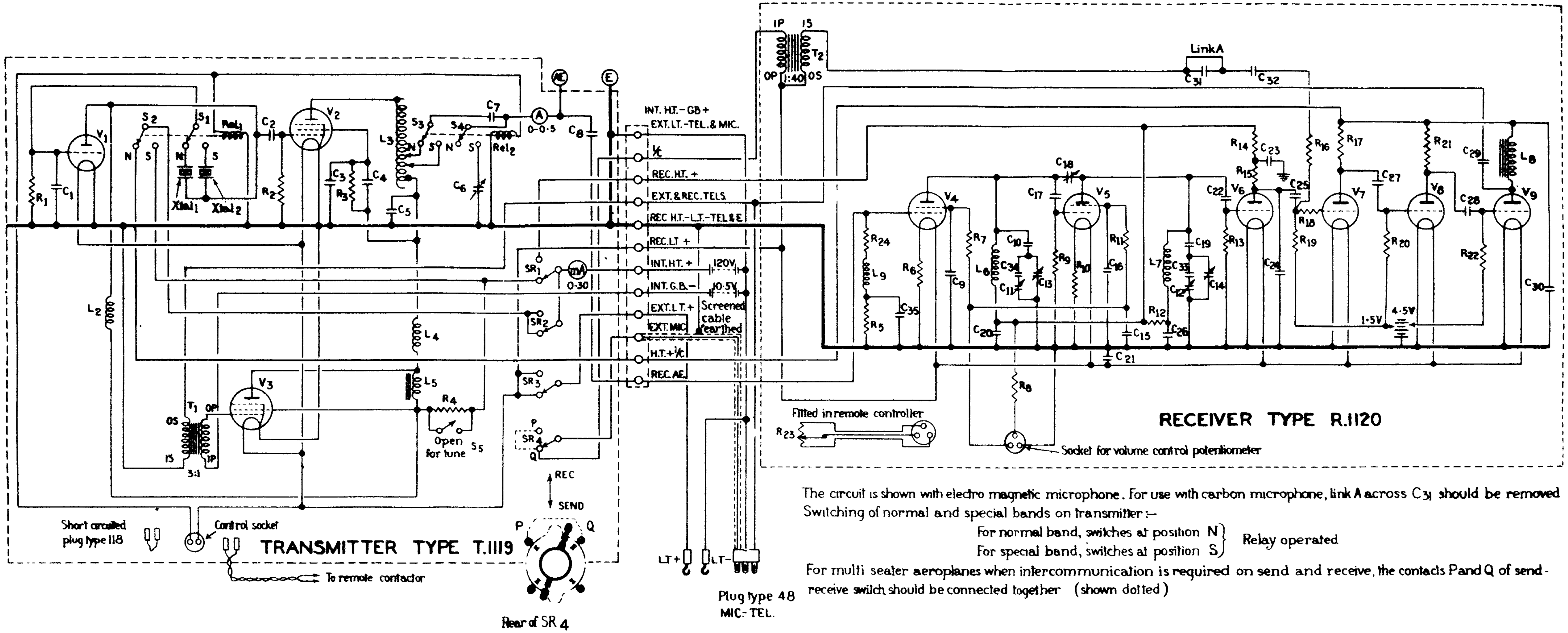


FIG. 1. SIMPLIFIED CIRCUIT DIAGRAM (TRANSMITTING)

CONDENSERS	C1, C2, C3, C4, C5, C6, C7, C8, C35, C9, C20, C34, C10, C11, C13, C17, C18, C16, C21, C15, C26, C19, C33, C12, C31, C14, C32, C22, C23, C25, C24, C27, C28, C29, C30
RESISTANCES	R1, R2, R3, R4, R23, R24, R5, R6, R7, R8, R9, R10, R11, R12, R13, R14, R15, R19, R16, R18, R17, R20, R21, R22
INDUCTANCES	L2, L3, L4, L5, L9, L6, L7, L8
MISCELLANEOUS	V1, S2, S1, REL.1, XTAL1, T1, V3, XTAL2, V2, S3, S4, S5, REL2, SR1, SR2, SR3, SR4, T2, V4, V5, V6, V7, V8, V9



The circuit is shown with electro magnetic microphone. For use with carbon microphone, link A across C31 should be removed

Switching of normal and special bands on transmitter:—

For normal band, switches at position N } Relay operated
For special band, switches at position S }

For multi seater aeroplanes when intercommunication is required on send and receive, the contacts P and Q of send-receive switch should be connected together (shown dotted)

FIG. 2 T.R.9D. THEORETICAL CIRCUIT DIAGRAM

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7. The action of the transmitter will be described with reference to the complete circuit diagram, fig. 2, but the principal features will be more easily understood with the aid of the simplified theoretical diagram, fig. 1. The same notation is employed in both diagrams. The frequency-shifting switches S_1, S_2, S_3, S_4, are, actually, the contacts of a pair of relays, S_1, S_2, being embodied in one relay and S_3, S_4, in the other. These switches are operated simultaneously, since the operating windings are connected in parallel. When the windings are de-energized the contacts are in the normal position and the " normal " frequency is radiated. The windings are energized by a current from the L.T. battery when it is desired to radiate the " special " frequency. The relay operating circuit is closed by a special switching device which is called the remote contactor. The operation of this contactor is dealt with later.

8. Two of the four poles of the SEND-RECEIVE switch enter into the operation of the frequency shifting arrangements, and only these two are included in fig. 1. It will be seen that the pole SR_1 nominally changes over the positive H.T. supply from transmitter to receiver, but the pole SR_2 is connected in such a manner, that, if the SEND-RECEIVE switch is at RECEIVE and the relay operating circuit is completed, the switch S_2 will close an alternative path by which the transmitter receives a H.T. supply, and the " special " frequency is radiated. When the switch S_2 is in the " special " position, the H.T. supply to the sub-modulator stage is interrupted, so that the " special " frequency is invariably unmodulated.

Crystal-controlled oscillator

9. Referring to figs. 1 and 2, it will be seen that the oscillator stage of the transmitter consists of the valve V_1, which receives its H.T. supply through the R/F choke L_2, while the grid bias is maintained at the desired value by the grid condenser C_1 and leak resistance R_1. The frequency of the oscillation is entirely governed by a pre-selected quartz crystal, two of which are fitted, one for the " normal " and one for the " special " frequency. Depending upon the position of the switch S_1 oscillations will always be maintained at one or other of these frequencies, unless the SEND-RECEIVE switch is in the OFF or RECEIVE position. Even if the SEND-RECEIVE switch is at RECEIVE, however, the special frequency is still radiated, whenever the relay windings are energized. No tuned circuit is provided in the master oscillator stage but, in conjunction with the valve inter-electrode capacitance (including that of the crystal and its self-capacitance), the choke L_2 functions as a very flatly-tuned rejector circuit over the whole frequency band covered by the transmitter. The oscillator stage is coupled to the power amplifier stage by the fixed condenser C_2.

R/F power amplifier

10. The power amplifier valve V_2 is a pentode and no neutralization arrangements are necessary to prevent R/F instability. The control grid is maintained at a suitable mean negative potential by the leak resistance R_2. The anode load impedance consists of the aerial tuning inductance L_3, the aerial capacitance, and any other capacitance which may be in parallel therewith. A fixed anode tap is provided for the whole frequency range. The valve obtains its H.T. supply by the series feed system *via* the R/F choke L_4 and the iron-cored speech choke L_5. The screening grid is maintained at a convenient mean positive potential (slightly below that of the anode) with respect to the filament, by the screen feed resistance R_3. The latter is shunted by an audio-frequency by-pass condenser C_4. The R/F potential of the screening grid is maintained at a low level by the radio-frequency by-pass condenser C_3, while the condenser C_5 is the oscillatory mains condenser of the power amplifier stage.

11. Two variable aerial tapping points are provided, the selection being made by the switch S_3. In the " normal " position, the aerial tuning is achieved by a helically-driven rotating contact arm as in the transmitter T.R.9B. In the " special " position, the aerial is connected to any one turn of the aerial coil by means of a sliding contact on the outside of the coil. This contact is moved from turn to turn by a helical thread operated by a suitable control on the front of the panel, fine tuning being effected by the variable condenser C_6. The latter is brought into

circuit by the switch S_1. By this method, the tuning of the " special " frequency is achieved without disturbing the tuning of the " normal " frequency. The remainder of the aerial circuit is comprised by the isolating condenser C_7 and aerial ammeter A.

Modulator

12. A pentode is also employed as the modulator valve V_3. The valve obtains its H.T. supply *via* the speech choke L_5 which is also included in the H.T. circuit of the power amplifier valve. The screening grid of the modulator valve is maintained at a constant positive potential, practically equal to the mean anode voltage. The audio-frequency control-grid excitation is derived from the sub-modulator stage. On speaking into the microphone, audio-frequency voltages are applied by the secondary winding of the transformer T_2 between grid and filament of the valve V_7, which is resistance-capacitance coupled to a valve V_8 (not shown in fig. 1). This valve is coupled in the same way to the audio-frequency power amplifier valve V_9. The anode circuit of this valve contains the iron-cored feed choke L_8, and the load impedance is coupled to the valve by the blocking condenser C_{29}. The load impedance consists of the primary winding of the transformer T_1, with the telephones in parallel therewith. The secondary winding of the transformer is connected between control grid and filament of the modulator valve, and supplies the latter with the required voice-frequency excitation.

Sub-modulator stage

13. The necessity for the inclusion of this stage has already been explained, but it must be realized that the group of three valves, V_7, V_8, V_9, may perform three different functions, namely, an audio-frequency amplifier for normal R/T reception, a sub-modulator stage during transmission, and an inter-communication amplifier where necessary. For the latter purpose, the output A/F voltage must be of the order of 15 volts R.M.S. whereas the grid-filament P.D. required by the modulator valve in order to modulate the carrier to a depth of about 90 per cent., is only about 5 volts. The transformer T_1 therefore has a step down ratio of 3 to 1.

14. Owing to the high gain of the sub-modulator, the wiring of the electro-magnetic microphone must be completely screened, otherwise audio-frequency self-oscillation may occur. In fig. 2, the screening of the internal wiring of the microphone circuit has been indicated, and this screening must be extended to the extension of this lead as a part of the aircraft wiring, and also to the leads of the microphone itself (*see* installation diagram, fig. 18). It will be noted that the winding of the electro-magnetic microphone carries a direct current from the L.T. battery. Although this current is not necessary for its correct performance, this provision permits the substitution of a carbon microphone without any alteration in the wiring of the primary circuit.

15. It is important to note that if a carbon microphone is employed, it is necessary to open the link A which normally short-circuits the condenser C_{31} (fig. 2 only). This condenser is very small compared with C_{32}, with which it is then in series, and the voice-frequency grid-filament voltage of the valve V_7 is correspondingly reduced. The position of this condenser is indicated in fig. 12 and para. 54 dealing with the constructional details.

Switching clock

16. The frequency-shifting relays are operated by means of an automatic switching system, the principal components of which are the master contactor and remote contactor. The operation of this system will be described with reference to fig. 3, which is a theoretical diagram of the operating circuit, and does not purport to show the mechanical detail other than in principle. The installation diagram, fig. 18, should also be referred to. The electrical supply for the switching clock is derived from the general service accumulator battery, which may be either twelve or twenty-four volts.

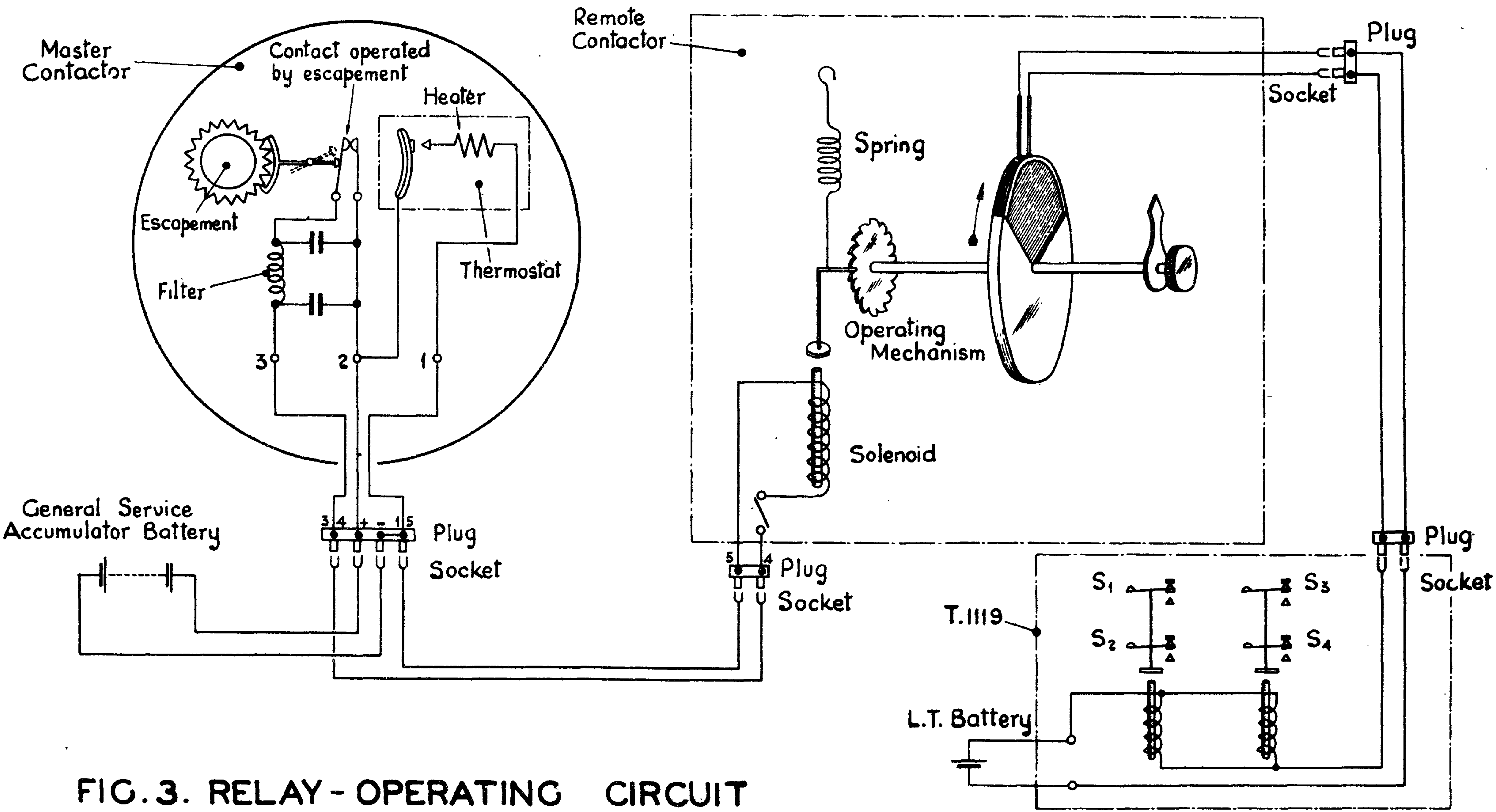

FIG. 3. RELAY - OPERATING CIRCUIT

FIG. 4. Master contactor in case.

17. The master contactor, which is shown in figs. 4 and 5, consists of a spring-driven clock, the escapement of which beats twice per second. Each vibration of the escapement closes an electrical contact, which in turn transmits an electrical impulse to the remote contactor. The latter thus receives electrical impulses at a regular rate of 120 impulses per minute. The case of the master container contains a thermostatically-controlled heating coil, which serves to maintain its interior at a constant temperature irrespective of weather conditions and altitude. An electrical filter circuit of special design is fitted in the base of the contactor in order to minimize interference with radio reception. As a further precaution, the wiring of the switching system is maintained as far away as possible from the telephone and microphone wiring. The master contactor is fitted in a wooden box lined with sponge rubber, and is mounted in the crate by means of a suitable suspension.

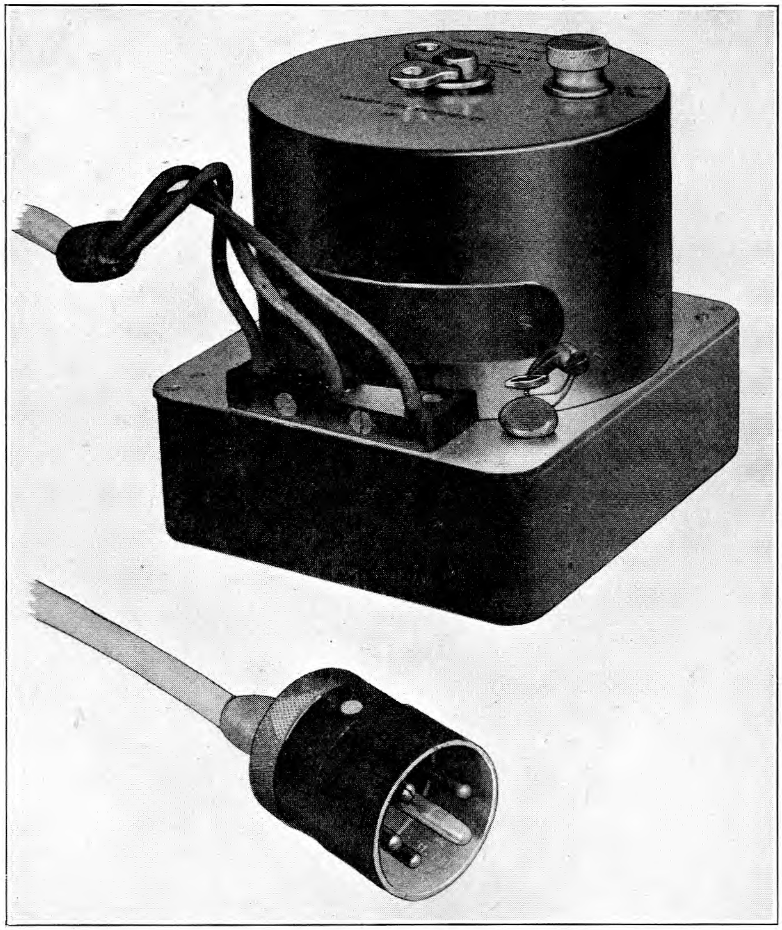

FIG. 5. Master contactor.

18. The remote contactor, shown in fig. 6, incorporates a special form of step-by-step motor, the rotor of which performs one revolution per minute. During 14 seconds of each minute, the rotor causes the closure of an electrical contact and consequent completion of any electrical circuit connected thereto. This circuit is, in the present installation, the 2-volt circuit which includes the operating coils of the frequency-shifting relays.

19. The operation of the remote contactor will be further described with reference to fig. 6 which shows the face of the instrument. The rotor spindle carries a pointer (1) rotating over the dial at a speed of one revolution per minute. On the dial, four lines (2), (3), (4) and (5) are boldly engraved at 0°, 90°, 180° and 270° respectively, and the sector between 0° and 90° is

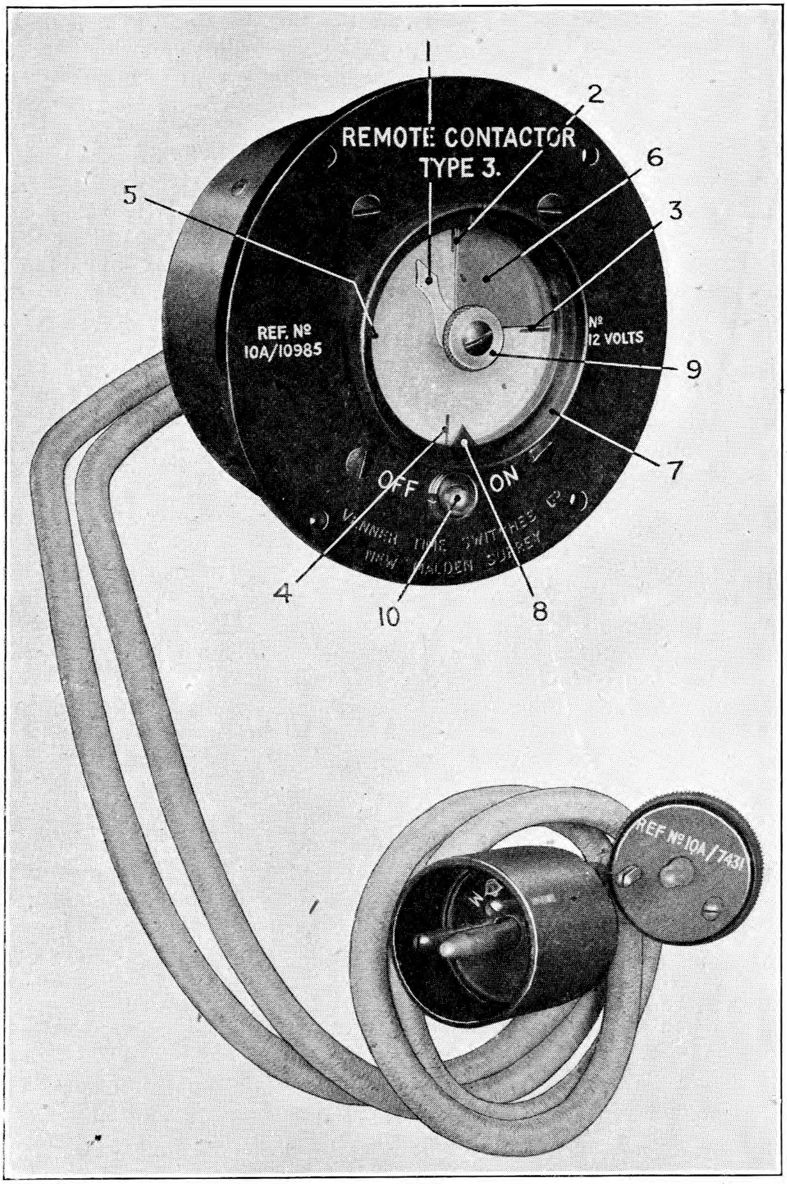

FIG. 6. Remote contactor.

coloured red. External to the front glass cover is an adjustable rubber ring (7) carrying a triangular index (8). The ring may be rotated, and is invariably adjusted to such a position that the index coincides with one of the four lines engraved on the dial. The rotating pointer is beneath the glass cover, but its spindle is extended through the latter and terminates in a milled knob (9), by which the pointer may be set in any desired position relative to the coloured sector. The internal contacts are closed during the time the pointer is traversing the coloured sector.

20. A tumbler switch (10) is fitted beneath the dial, the face plate being engraved to show the ON and OFF positions. This switch completes the circuit from the master contactor to the motor of the remote contactor, and its closure sets the rotor in motion, carrying the pointer with it. Thus, if the tumbler switch is OFF and the adjustable index is set to 270°, the pointer being aligned with it, the following sequence of operations will occur when the tumbler switch is moved to ON. First, the pointer will traverse the sector 270° to 0°; during this interval of 15 seconds the external circuit is open. On reaching 0° the external circuit is closed and remains so for 14 seconds, i.e. while the pointer traverses the red sector. During the next 46 seconds while the pointer moves from 84° to 360°, the external circuit will remain open. The red sector is then traversed again, during which time the external circuit is closed, and so on.

21. Now suppose that in a second installation the tumbler switch is in the OFF position, the adjustable index set to 180°, and the pointer aligned with it. On closing the switch, the pointer traverses the sector 0° to 180° in the first 30 seconds, during which time the external circuit is open. On reaching 0° the external circuit is closed and remains so for 14 seconds, followed by an open-circuit period of 46 seconds and so on. It follows that if the remote contactors in the two installations are both started at the same instant, the external circuit of the second contactor will be closed one second after the external circuit of the first is opened. In a third installation, the initial position of the pointer may be 90°, and in a fourth, 0°. If these four installations are started simultaneously each will transmit its special frequency for 14 seconds in each minute, and the respective transmissions will follow each other with a one-second interval between each.

Receiver

22. The receiver circuit will be discussed with reference to fig. 2. Six valves are employed; the first two, V_4, V_5, are radio-frequency amplifying tetrodes, followed by a detector valve V_6, two audio-frequency amplifying valves V_7, V_8, and a power amplifier valve V_9. The aerial circuit of the transmitter forms the aerial circuit of the receiver also. This is permissible since in practice two-way R/T communication takes place only on the particular "normal" frequency allotted to any aeroplane or formation. The aerial is connected to the grid of the valve V_4 *via* the coupling condenser C_8. A radio-frequency choke L_9, resistance R_{24}, and a resistance R_5 with the condenser C_{35} in parallel, are connected in series between grid and filament.

23. The anode circuits of the valves V_4, V_5, are of similar design. In effect, the well known tuned-anode-capacitance coupling is employed. The tuned circuit between the valves V_4 and V_5 consists of the tuning inductance L_6, with which are associated the condensers C_{10}, C_{11}, C_{13}, C_{34}. Similarly the tuned circuit between the valves V_5, V_6 consists of the tuning inductance L_7 and the condensers C_{19}, C_{12}, C_{14}, C_{33}. The fine tuning condensers C_{11}, C_{12}, are ganged together and operated, either remotely or locally, by a single control. The moving vanes of all the variable condensers are in metallic connection with the case of the receiver in order to prevent the effect of body capacitance, and it is therefore necessary to complete the "tuned anode" circuits by means of blocking condensers C_{10}, C_{19}. A radio-frequency decoupling condenser C_{20} is fitted between the low potential end of the inductance L_6 and the L.T. — line, while the anode circuit of the valve V_5 is decoupled from that of the valve V_4 by a resistance R_{12} and condenser C_{26}.

24. The fixed condensers C_{34}, C_{33} serve to reduce the frequency cover of the fine tuning condensers C_{11}, C_{12}. With these condensers short-circuited, this would be of the order of 200 kc/s on the lower and 1 Mc/s on the higher frequencies; with these condensers in circuit however, the corresponding figures are 40 kc/s and 200 kc/s approximately. A small permanent control grid-bias is provided for each of the radio-frequency amplifying valves by the insertion of resistances R_6, R_{10} in series with their respective L.T. — leads.

25. The screening grids of the valves V_4, V_5 are fed from the H.T. + line *via* the resistances R_7, R_{11}. The condensers C_9, C_{16}, maintain the oscillatory potential of the respective screening grids (with respect to L.T. —) at a very low amplitude. The main feed resistance R_8 is

connected directly to the H.T. + line, and to the centre point of a three-point socket. One of the outer points of this socket is connected to L.T. — and the other to the screen feed resistances R_7, R_{11}. Variation of the screening grid voltage, for the purpose of volume control, is accomplished by connecting an external potentiometer R_{23} to this socket by means of a three-point plug. The condenser C_{15} is connected between the variable tapping on the potentiometer and the L.T. — line.

26. The anode circuit of the valve V_4 is coupled to the control grid of the valve V_5 by the condenser C_{17}. A variable condenser C_{18} is connected between the anode of the valve V_4 and the anode of the valve V_5. This condenser acts as a control of the regenerative amplification. The mean grid potential of the valve V_5 is maintained at the desired value by the grid leak resistance R_9. The anode circuit of the valve V_5 is coupled to the control grid of the detector valve V_6 by the condenser C_{22}, a grid leak resistance R_{13} being also fitted. Its anode circuit includes the load resistance R_{15} and radio-frequency by-pass condenser C_{24}, the latter serving to maintain the input conductance of this valve at a low value. A decoupling resistance R_{14} and decoupling condenser C_{23} are also fitted. The anode load circuit is coupled to the first audio-frequency amplifying valve V_7 by the grid condenser C_{25}, the grid leak resistance R_{19} being connected to the — 1·5 volt tapping on the grid bias battery. A grid stopper resistance R_{18} is interposed between the grid condenser and the control grid of the valve in order to reduce the amplitude of the radio-frequency grid swing. The by-pass condenser C_{24} also contributes to this reduction.

27. The secondary winding of the microphone transformer forms an alternative means of providing a grid-filament excitation for this valve, for the purpose of transmitter modulation and inter-communication where the latter is required. The secondary winding of the transformer is connected in series with the two condensers C_{31}, C_{32}, the former being short-circuited by the link A when an electro-magnetic microphone is used. A resistance R_{16} is also included in this circuit. It will be seen that this arrangement, in effect, prevents the transformer secondary from acting as a low impedance shunt upon the output of the preceding valve V_6 during R/T reception, but does not seriously attenuate the voice-frequency voltages during I/C and modulation. When a carbon microphone is in use, a much greater degree of attenuation is deliberately introduced by the insertion of the condenser C_{31}.

28. The anode circuit of the valve V_7 is coupled to the control grid of the valve V_8 by the condenser C_{27}, a grid leak resistance R_{20} being included. This resistance is also connected to the — 1·5 volt tapping on the grid bias battery. The valves V_8 and V_9 are coupled exactly as are the valves V_7 and V_8, the grid bias for the valve V_9 being — 4·5 volts. The anode circuit of the latter valve includes the iron-cored choke L_8, the coupling condenser C_{29}, and the primary winding of the modulator input transformer T_1. The telephone receivers are connected in parallel with this winding, through the right-hand and centre pins of the three point plug, type 48. The anode circuit is thus of the " choke-filter output " type.

29. The microphone is connected to the primary winding of the microphone transformer *via* the contact EXT/MIC on the contact bar, and the contact Q (figs. 2 and 8) on the rear disc of the SEND-RECEIVE switch, when the latter is at SEND. When this switch is at RECEIVE, however, the microphone is disconnected. The transmitter is always supplied with the connections arranged in this manner. Where it is necessary to provide for I/C to be available when the S.R. switch is at RECEIVE, the service units concerned are responsible that the contacts P and Q are connected by a short link of copper wire, as indicated by a dotted line on an inset diagram in fig. 2. The inset diagram shows the third disc from the panel, viewed from the rear.

H.T. and L.T. supplies

30. Referring to fig. 2 it will be seen that the centre point of the plug, type 48, is in direct connection with the negative L.T. lead, the negative H.T. lead, the transmitter grid bias positive lead, and earth. When the SEND-RECEIVE switch is at either the SEND or RECEIVE positions, the filament circuits, both of transmitter and receiver, are completed by the pole SR_3. When the SEND-RECEIVE switch is at RECEIVE, the R/F and detector valves of the receiver obtain a H.T. supply *via* the terminal REC. H.T. + on the contact bar, but the audio-frequency valves are supplied, *via* the switch S_2 and the contact bar terminal H.T. + I/C, only when S_2 is in the " normal " position.

CONSTRUCTIONAL DETAILS

Transmitter

31. The transmitter T.1119 and receiver R.1120 are both contained in the same case, as shown in fig. 7, the transmitter being on the left. The principal components of the transmitter unit are mounted on the under side of a metal panel. The meters and controls are mounted on the face of this panel and can be seen in fig. 7. At the upper left-hand corner is the H.T. milliammeter (mA) which has a range of 0—30 milliamperes. Adjacent to it is the aerial ammeter (A), which is a thermo-couple instrument reading 0—0·5 amperes ; the thermo-couple is fitted inside the case of the instrument. Both these meters are fitted with a fixed protective

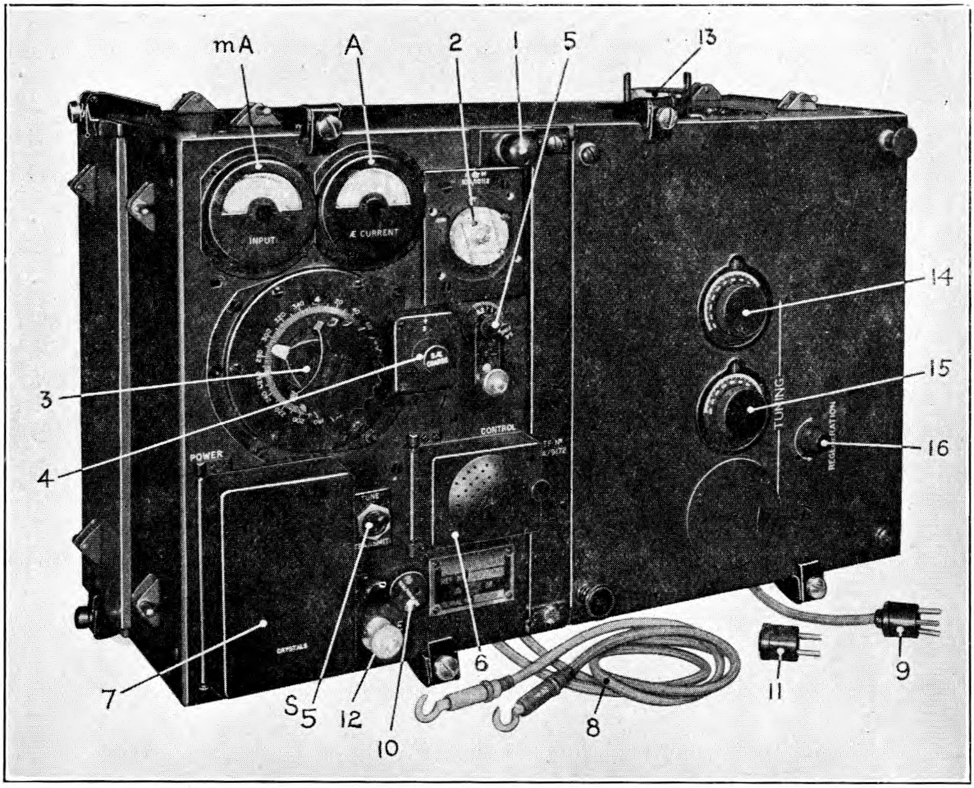

FIG. 7. Transmitter-receiver T.R.9D.

cover over the lower half of the dial, and a rotating cover which can be turned to cover the upper half of the dial when required. The latter operation also exposes the zero adjuster. In the top right-hand corner is the aerial terminal (1). Below this is a slotted switch head (2) which controls the SEND-RECEIVE switch. This slotted head engages with the remote control coupling, and the latter also carries a lever for the local operation of the switch.

32. Immediately below the current meters is the aerial coil. The handle (3) controls a helical spindle mounted along the axis of the coil, by which a moving contact is carried round the turns of the coil. This forms the aerial tuning device for the normal frequency. Each revolution of the handle moves the contact through a complete turn, and the number of turns in circuit is shown by a number displayed in a small window in the zero position of the graduated scale. The latter is marked in degrees, and the setting of this inductance is expressed by a number representing the number of complete turns, followed by the reading of the pointer on the graduated scale, thus, 5,120 represents 5 turns plus 120 degrees.

33. To the right of the "normal" tuning control is another control (4) marked S.AE COARSE. This control rotates a helical spindle, the axis of which is parallel to that of the coil. The rotation of this control causes a sliding brush contact to move from turn to turn of the coil. The number of complete turns in circuit is shown by a number displayed in a window, as in the case of the "normal" tuning control.

34. On the extreme right of the panel is the control head (5) of the fine tuning condenser for the "special" frequency. It is engraved S.AE FINE and carries a rotating disc engraved with an arbitrary scale reading from 0 to 9, with unmarked intermediate lines. In conjunction with a line engraved on the panel, this scale serves to record the fine tuning adjustment for the special frequency. The control is fitted with a locking device of the usual service "scissors" pattern.

35. Below the three aerial tuning controls are two hinged doors. That on the right (6) gives access to the modulator valve, and is marked CONTROL. The larger one on the left (7) gives access to the power amplifier valve, and also to the crystal holders.

36. Between the two doors is a tumbler switch (S_5) the face plate of which is marked TUNE and TRANSMIT. In the latter position this switch short-circuits the limiting resistance in the H.T. + supply to the modulator and amplifier valves. When the switch is at TUNE this resistance is in circuit.

37. The L.T. battery leads are shown at (8), while (9) is a plug, type 48, serving to connect the external telephones and microphone or microphones. One of the two leads entering this plug is the microphone + lead and is screened by metal braiding, while the other is a twin cable consisting of the telephone + lead and the common microphone and telephone lead. All these leads are enclosed in a woven sleeve. The extension of these connections is shown on the installation diagram, fig. 18.

38. Just below the right-hand door is the socket (10) by which the remote contactor is connected to the transmitter. This socket, although assembled as part of the panel, is in effect a socket type 11. The remote contactor, or dummy contactor as the case may be, is connected to this socket by means of a plug, type 34. For tuning purposes on the ground, a short-circuited plug, type 118 (11), is supplied. In order that this plug may be readily identified, its top is painted red. A special stowage place is provided for it in the transit case. Aerial and earth terminals are provided, the former (1) being at the top and the latter (12) at the bottom of the panel.

39. Figs. 8 and 9 give two views of the interior of the instrument and fig. 10 is a bench wiring diagram. Referring to figs. 8 and 9 the milliammeter (mA) and the thermo-ammeter (A) are mounted on the front panel, and adjacent to the latter is the SEND-RECEIVE switch (S.R.). The latter is assembled in three units, each of which consists of a fixed ring of insulating material carrying a number of fixed contacts. The centre of each ring is filled by a rotatable disc, also of insulating material, carrying moving contacts. This disc is rotated through 90° in passing from SEND to RECEIVE, by means of a flat bar which is operated by the externally slotted head of the SEND-RECEIVE switch. The function of the outer of the three units is to complete the circuit through the microphone and microphone transformer, when the SEND-RECEIVE switch is to SEND. If I/C is desired when the SEND-RECEIVE switch is to RECEIVE, as may be the case in multi-seater aeroplanes, the soldering tags P and Q, shown in an inset diagram in fig. 2, must be connected by a short lead of tinned copper wire. The connection must be made by careful soldering, taking particular care not to destroy the electrical efficiency of the existing connection at Q, and that the added connection does not touch any material other than the tags to which it is soldered.

40. One of the two frequency-shifting relays is shown at (1). This is mounted on the side of the case and not on the panel. This relay operates contacts corresponding to the switches S_3 and S_4 in figs. 1 and 2. Below and a little to the left of the SEND-RECEIVE switch is the fine tuning condenser (C_6) for the "special" frequency, its control extending through the panel as shown in the previous diagram. Below it is the speech choke (L_5) (choke L/F. type G).

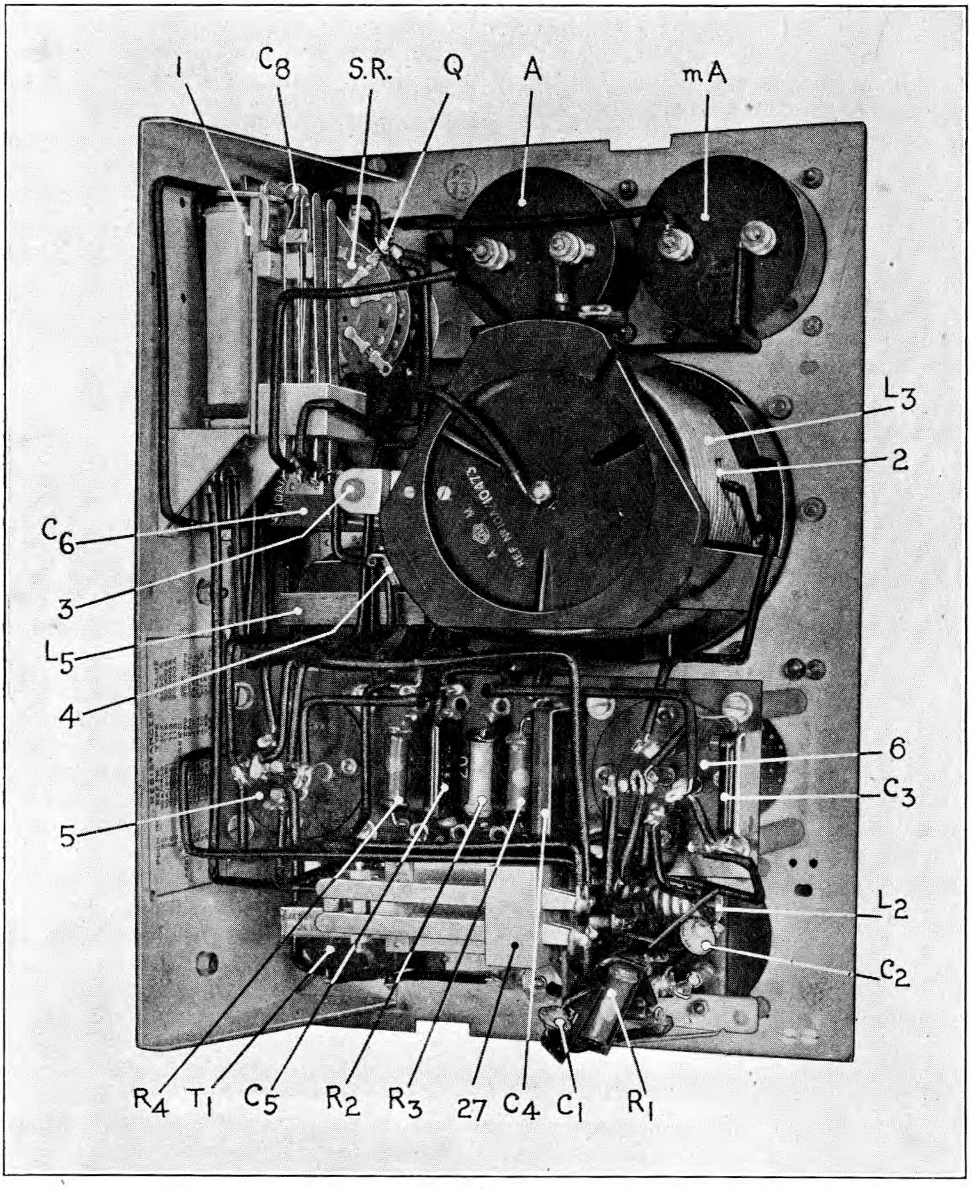

FIG. 8. Transmitter T.1119, rear view.

41. The right-hand centre portion of the interior is occupied by the aerial coil (L_3), which consists of 16 turns of silver-plated copper tubing. The anode tap (2) is fixed, $10\frac{1}{2}$ turns being included between the feeding end of the coil and the tap. Two tuning taps are provided. The first, for the " normal " aerial tuning, consists of a radial arm with a split contact embracing the tubing. This arm is carried round the turns by the action of a screw thread, cut in a shaft, which is mounted in bearings upon the axis of the coil. This shaft is actuated by the control N.AE TUNING. The other tuning tap is actuated by the control marked S.AE COARSE. The same

principle is adopted as in the former instance. The inner end of the threaded shaft is carried by the bearing (3). Its rotation carries one end of a flat spring contact from turn to turn; the other end of this contact bears on a contact bar (4) to which the external connection is made.

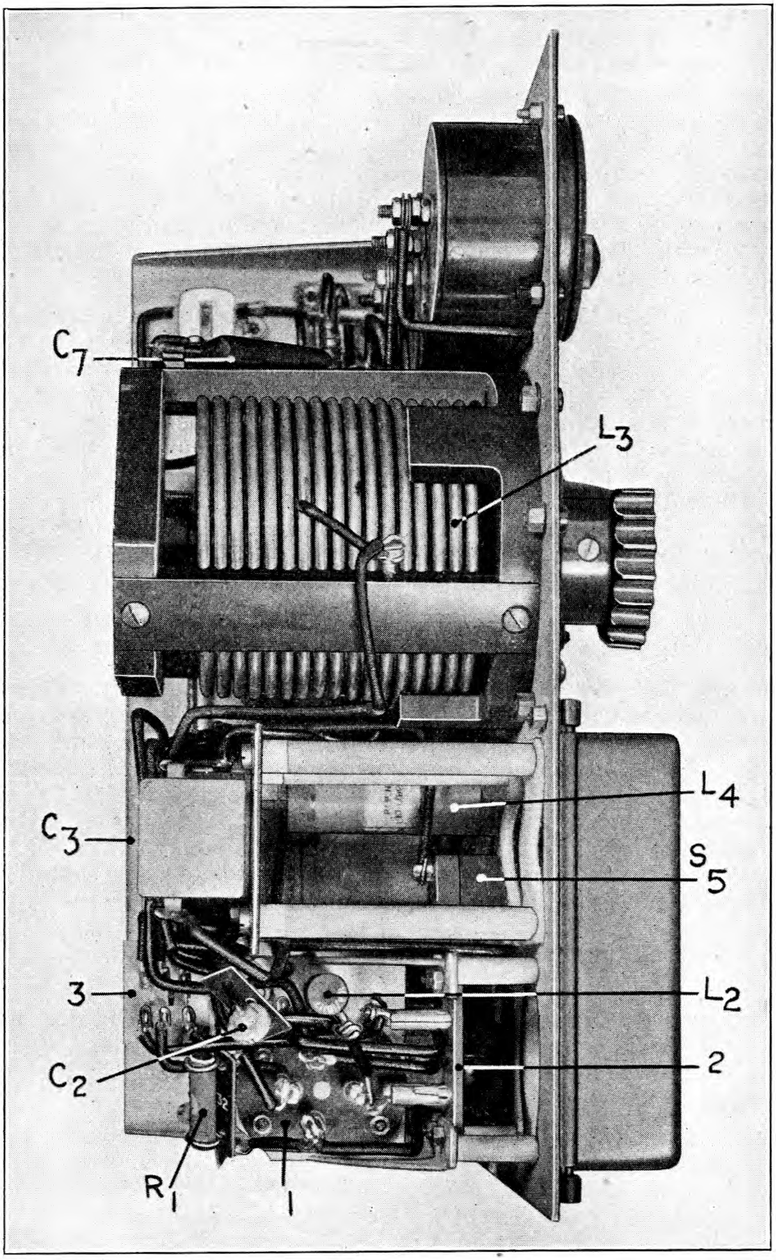

FIG. 9. Transmitter T.1119, side view.

The accurate register of the flat spring, with regard to any particular turn, is maintained by a serrated disc in which a flat spring engages, locking the moving contact in any desired position. Adjacent to the speech choke is a R/F choke, type 34 (L_4, fig. 9 only), which is connected in series with the H.T. supply to the amplifier valve.

42. Below the components already mentioned is a platform of insulating material which carries two valve-holders (5) and (6) for the modulator (control) and amplifier (power) valves respectively. The valves face towards the panel and are accessible through doors in the latter. On the outer side of this platform is mounted a group of condensers and resistances. These components will be dealt with in order from left to right. On the extreme left (R_4) is a resistance of 5,000 ohms which is connected in series with the H.T. supply to the modulator and amplifier valves and may be short-circuited when necessary by the " tune-transmit " switch (S_5, fig. 9). Next to it is the oscillatory mains conductor (C_5). Adjacent to the latter is the grid leak resistance (R_2) for the power amplifier valve. The two components on the right of the shelf are the screen feed resistance (R_3) with its by-pass condenser (C_4). Mounted very near to the right-hand valve-holder (6) is the screen by-pass condenser (C_3).

43. Below the platform is the input transformer (T_1) of the modulator valve, the " tune transmit " switch (S_5) and the R/F choke (L_4) for the amplifier valve. The two latter components can be seen in fig. 9 only. The small coupling condenser (C_2) by which the oscillator is coupled to the amplifier valves is shown in both photographs. The oscillator grid condenser (C_1) and leak resistance (R_1) are mounted near the valve-holder for the oscillator valve (*see* 1, fig. 9). Adjacent thereto are the two crystal holders (2), in which the required crystals may be inserted by opening the door marked POWER. The second relay (3) operating the switches S_1, S_2, of figs. 1 and 2, is mounted in front of these components. The R/F choke (L_2) for the oscillator valve is mounted immediately above the oscillator valve-holder. The condenser (C_8, fig. 8) which couples the aerial to the receiver is situated near to the SEND-RECEIVE switch. The aerial blocking condenser (C_7) is mounted on the upper side of the framework of the aerial coil, and is clearly shown in fig. 9.

Receiver

44. The receiver R.1120 is fitted into the right-hand side of the case as shown in fig. 7, in which (13) is the main tuning control (17) and (18), the pre-set tuning controls and (16) the regeneration control. A view of the upper side of the receiver, with the cover removed, is given in fig. 11. Nearly all the components are mounted upon a metal panel, some above and some below. Above the panel, the screening box (1) contains three compartments, of which only two are used. These contain the two main tuning condensers (C_{13} and C_{14}, fig. 2), the control knobs (2) and (3) of which are brought out through the top of the box, and also the two fine tuning condensers C_{11}, C_{12}, which are ganged together and operated by a single control head. The two fixed band-reducing condensers (C_{34} and C_{33}, fig. 2) are mounted adjacent to their respective fine tuning condensers. In addition, the condenser C_{19} of fig. 2, which acts as an isolating capacitance in the second tuned-anode circuit, is also mounted in this box.

45. A small sub-panel (4) carries the socket, type 17 (5), by which the external volume-control potentiometer is connected to the receiver, and also the control head for fine tuning. A 2μ F condenser (C_{30}) which acts as a mains condenser for the sub-modulator stage, is also housed behind this sub-panel, while the grid bias battery is carried in a spring clip (6) by the side of the bracket which supports the sub-panel.

46. Five of the six valves are grouped on one side of the screening box, the output valve and the two anode circuit tuning inductances (in their screening covers) being arranged on the opposite side. The six valves are mounted on the upper side of the panel. The functions of the various valves are marked on the panel adjacent to the respective valve-holders. The two R/F valves are screened from each other by a metal partition. The regeneration control condenser (C_{18}) is mounted on the side of the screening box, and has a control knob which projects through the cover as shown in fig. 7. The top anode connectors (7), (8), for the first and second R/F valves are connected in circuit by short leads of flexible cable. The detector valve and the two A/F

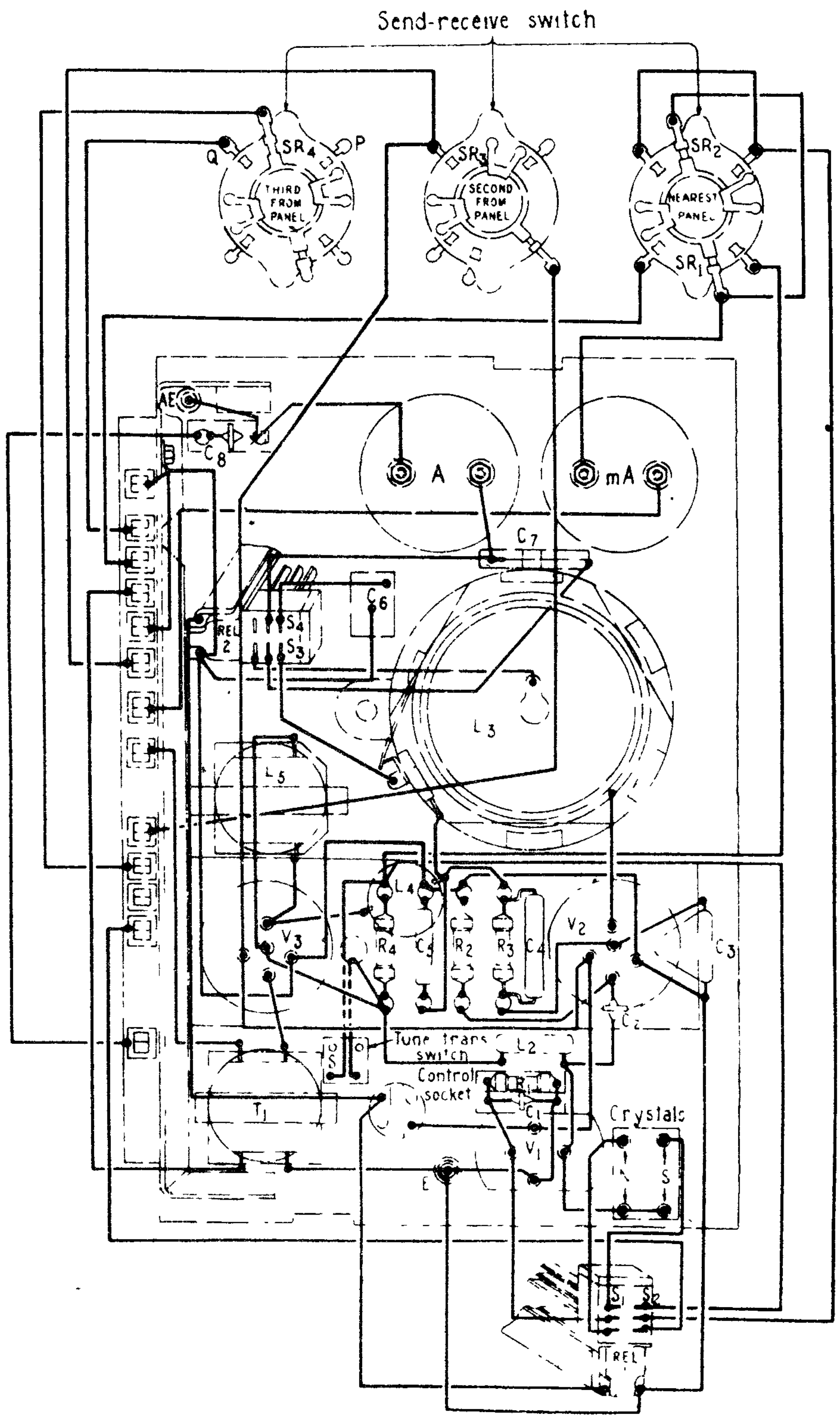

FIG. 10 BENCH WIRING DIAGRAM OF T.1119

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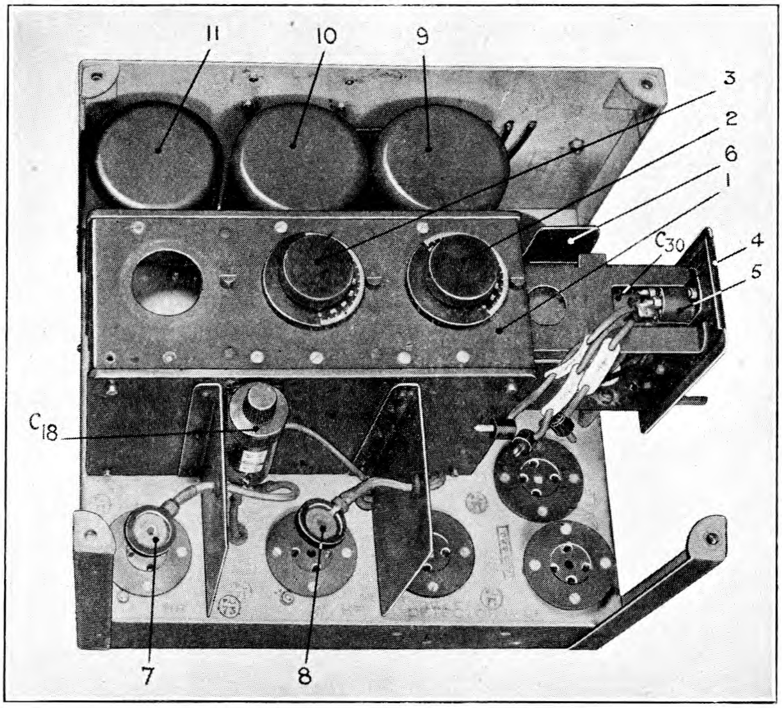

FIG. 11. Receiver R.1120, front view.

amplifier valves, are in the adjacent compartment, separated from the second R/F valve by another metal partition. The tuned anode inductances are enclosed in the screening cans (9), (10), the can (11) being empty.

47. The remainder of the components are fitted below the main panel, the space being about 2 in. deep. It is divided into four bays by means of screening partitions, as shown in fig. 12. For descriptive purposes these will be numbered from right to left, when the contact bar connections are at the top. A bench wiring diagram of the instrument is shown in fig. 13.

48. Referring to fig. 12, the first bay contains the condenser (C_{35}) with a 0·5 megohm resistance (R_2) in parallel. Near these, but mounted upon the inter-bay partition, is the R/F choke (L_9). An insulating platform, fitted to the underside of the main panel, carries two resistances. The first resistance (R_{24}), is of 10,000 ohms. All the above-named components are in the grid circuit of the first R/F valve. The second resistance (R_7), is of 20,000 ohms, and is the screen decoupling resistance for the first R/F valve. The corresponding screen by-pass condenser (C_9), of 0·5μ F, is mounted on the inter-bay partition. The valve-holder (1) carries the first R/F valve, and adjacent thereto is its filament resistance (R_6).

49. In the second bay, the connections for the anode tuning inductance (L_6) of the first R/F valve are brought through a circular orifice. Adjacent thereto, but mounted on the inter-bay partition, is the 0·5μ F condenser (C_{20}), which acts as a decoupling condenser in the first R/F anode circuit. Two other condensers are also mounted on the inter-bay partition, one on each side. On the left is the 0·5μ F condenser (C_{16}), which is the screen decoupling condenser for the second R/F valve, and on the right is a 0·5μ F condenser (C_{15}), which maintains the amplitude of the oscillatory component of screen potential at a low value.

50. An insulating platform (2) in the middle of the bay, and mounted on the underside of the panel, carries the following components, *viz.*, (i) the isolating condenser C_{10}, 0·01μ F, in the

second tuned-anode circuit ; (ii) the anode-grid coupling condenser C_{17}, 0·003μ F ; (iii) the grid leak resistance R_9, 1 M Ω ; (iv) the screen decoupling resistance R_{11}, 20,000 ohms, for the second R/F valve, and (v) the screen feed resistance R_8, 20,000 ohms which is common to the screen circuits of both R/F valves. Below this platform is a 0·01μ F condenser (C_{21}) which is connected across the L.T. supply leads. In the illustration this condenser is partly obscured by the condenser (C_{15}). The valve-holder (3) for the second R/F valve can be seen in the lower part of the bay, with its filament resistance (R_{10}) in proximity.

51. The third bay contains the connections to the base of the second anode-tuning inductance (L_7) and above this, mounted on the right-hand partition, is a 0·5μ F condenser (C_{26}) which, in conjunction with the resistance (R_{12}), of 2,000 ohms, serves to decouple the second tuned-anode circuit from the first. This resistance is carried on a small mounting platform. The 0·5μ F condenser (C_{23}) which is also mounted on the right-hand partition, is the decoupling condenser of the detector valve. The corresponding decoupling resistance (R_{14}), of 20,000 ohms, is suspended by its own wiring in proximity.

52. A small platform (4) near the middle of the bay carries the grid leak resistance R_{13}, 0·25 M Ω, for the detector valve, and also the condenser C_{22}, 0·0001μ F, which couples the anode of the second R/F valve to the detector grid. The valve-holder (5) for the detector valve is also

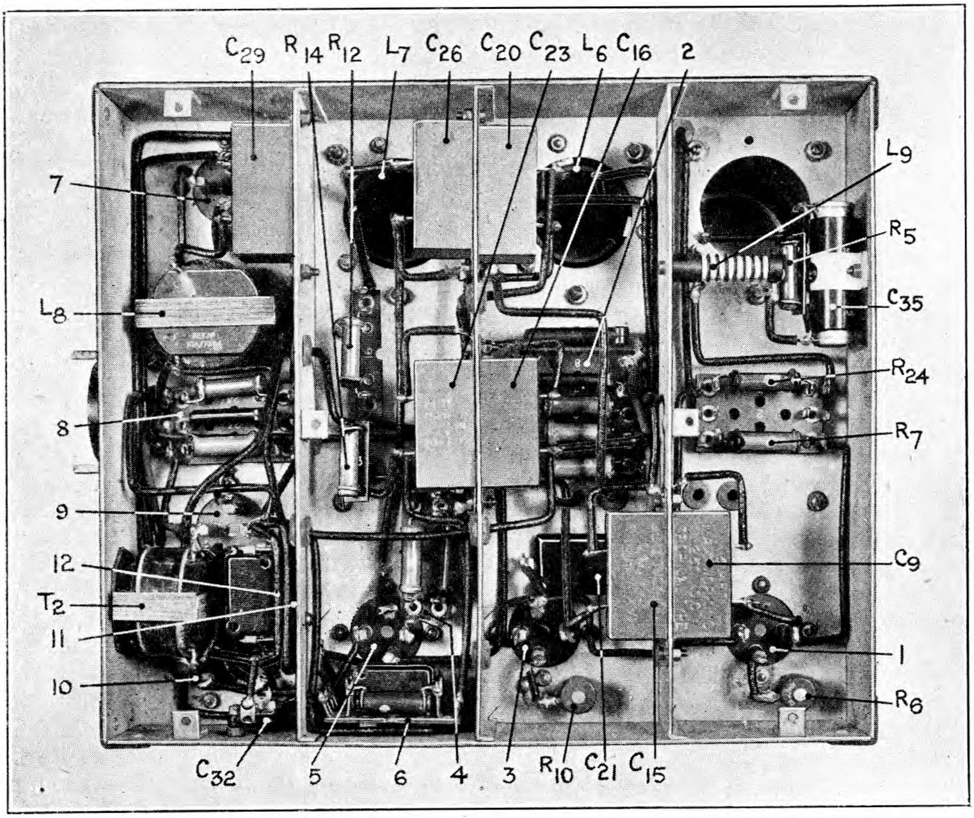

FIG. 12. Receiver R.1120, rear view.

fitted in this bay. On the inside of the case, an insulated platform (6) is fitted, in order to carry a bank of three resistances and four condensers. The components fitted here are (i) the grid leak

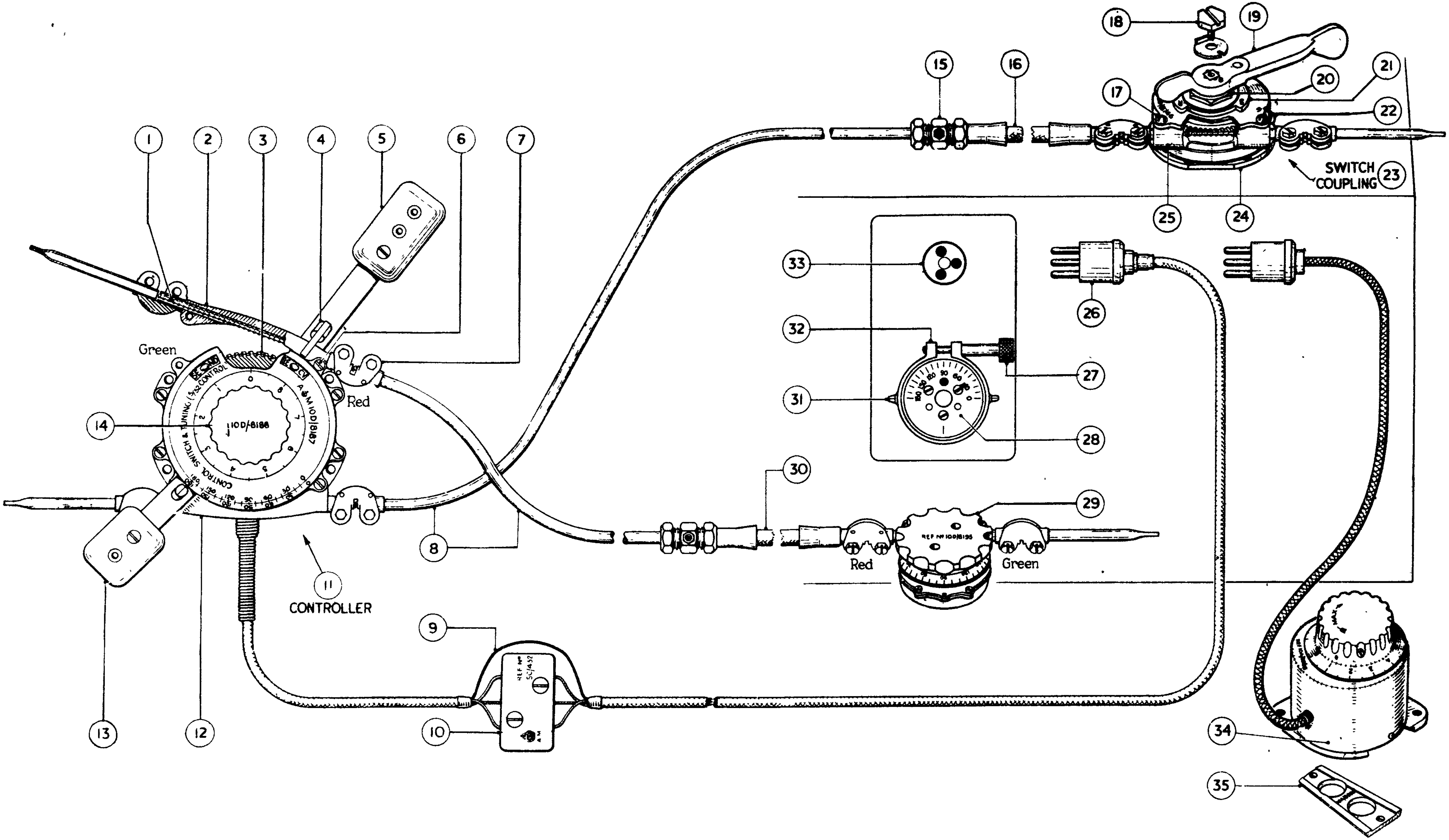

FIG.15. REMOTE CONTROLS. TYPES C & D, FOR T.R.9D

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R_{19}, 1 M Ω, for the detector valve; (ii) the grid stopper resistance R_{18}, of 2 M Ω; (iii) the condenser C_{25}, $0 \cdot 001 \mu$ F, which is the grid coupling condenser between detector and first A/F valve; (iv) the condenser C_{24}, $0 \cdot 001 \mu$ F, which serves as a radio-frequency by-pass in the detector anode circuit, and (v) the anode load resistance R_{15}, 100,000 ohms, in the detector circuit. Only the two upper components can be seen in the diagram.

53. In the fourth bay, in line with the bases of the anode tuning inductances, is the valve-holder (7) for the output valve. On the right-hand partition is a $0 \cdot 5 \mu$ F condenser (C_{29}), which forms part of the choke-filter output circuit of the output valve. Closely adjacent is the output choke (L_8). A mounting plate (8) near the middle of the bay carries (i) the resistance R_{22}, 1 M Ω, which is the grid leak for the output valve, (ii) the grid coupling condenser C_{28}, $0 \cdot 001 \mu$ F, and (iii) the resistance R_{21}, 200,000 ohms, which is the anode load resistance of the second A/F valve. The valve-holder (9) for the latter is in close proximity to the mounting plate, and below this is the valve-holder (10) for the first A/F valve. The microphone transformer (T_2) is mounted on the side of the case and partly obscures the two lower valve-holders.

54. Between the latter valve-holders, fitted on a mounting plate (11) attached to the right-hand partition, is a group of resistances and condensers, arranged horizontally one above the other. In succession from the lower one upwards, these are as follows :—(i) the resistance R_{20}, 1 M Ω, which is the grid leak for the valve V_8; (ii) the grid coupling condenser C_{27}; (iii) the resistance R_{17}, 20,000 ohms, in the anode circuit of the valve V_7; (iv) the resistance R_{16}, $0 \cdot 5$ M Ω, in series with the secondary winding of the microphone transformer, and (v) the condenser C_{31}, $30 \mu\mu$ F also in series with the secondary winding of the microphone transformer. This condenser is, however, normally short-circuited by a link (12) of copper wire.

55. It is most important to observe that the receiver is supplied with this link in position, for use with an electro-magnetic microphone. If a carbon microphone is to be used, this link must be removed, taking care not to reduce the electrical efficiency of the remaining connections to the condenser (*see* para. 111). On the inside of the case, near this bank of components, the $0 \cdot 0002 \mu$ F condenser (C_{32}), is mounted upon a separate support, and it is also in series with the secondary winding of the microphone transformer.

Case

56. The transmitter and receiver units are housed together in a special case. They are shown in position in fig. 7 and in fig. 14 the case of the T.R.9D is shown with the units removed. The case is of metal and is painted grey. A main contact bar (1) as shown in fig. 14 is fitted in the case, and from the underside of the contacts flexible connections are taken out through a bush. When the units are in position, spring-jaw contacts on each unit engage with the knife contacts on the bar. One end of the case is cut away and a tray (2) is slid in, occupying a position under the transmitter unit. This tray carries the common H.T. battery for the transmitter and receiver and the grid bias battery for the transmitter. By means of four flexible leads (3) terminating in plugs the batteries are connected up to three spring-jaw contacts (4) on the tray, and when the tray is in position these three contacts engage with three knife contacts on the underside of the main contact bar.

Transit case

57. A transit case is provided for carrying the transmitter-receiver. It is constructed of yellow deal and is painted grey. The dimensions are approximately 1 ft. 9 in. by 1 ft. 3¾ in. by 10¾ in., and the case accommodates the complete instrument. The hinged lid is fastened with screw catches, and two metal carrying handles are provided.

REMOTE CONTROLS

58. The T.R.9D transmitter-receiver is intended for operation by remote controls, and three different adjustments are made by these controls. The send-receive switch and the fine tuning condensers are each operated by a flexible shaft running in a casing and actuated by a

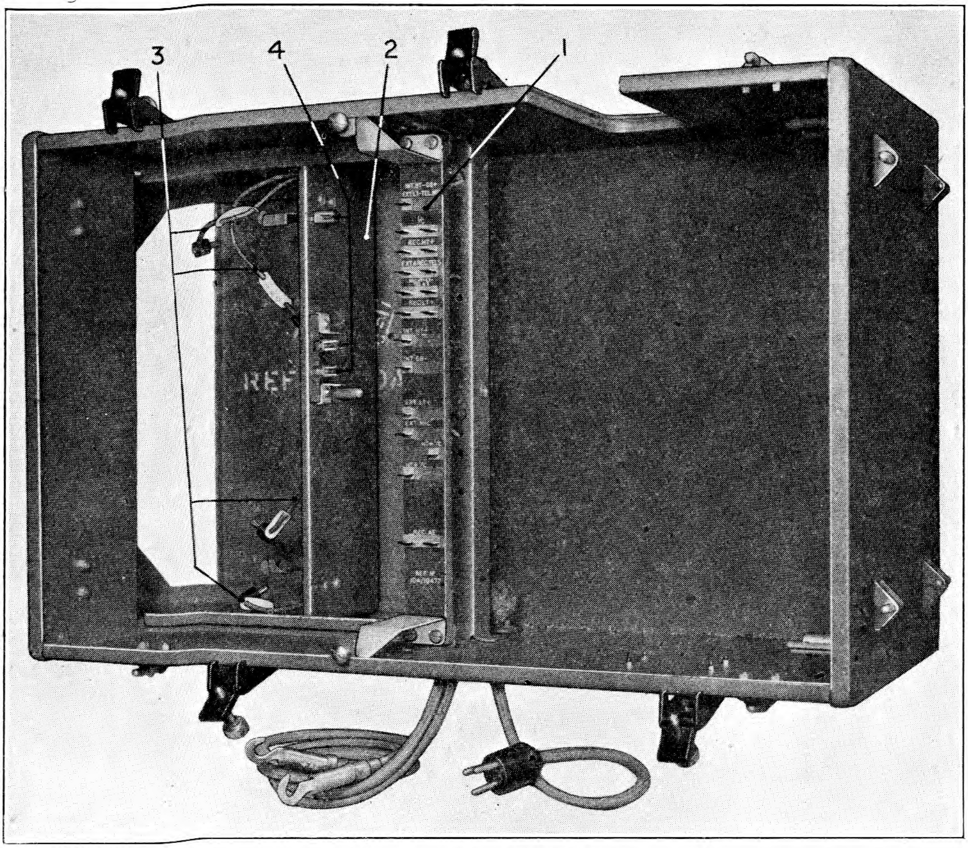


FIG. 14. Case for T.R.9D.

wheel and handle. The volume is regulated by means of a potentiometer connected by a cable to the receiver in such a manner as to vary the potential applied to the screening grids of the two radio-frequency amplifiers. The three controlling handles are mounted in one unit known as the controller.

59. Two types of remote control, the type C and the type D are standardised. The type C remote controls have a flexible shaft of diameter $\frac{5}{32}$ in. for both the switch control and the tuning control. The type D remote controls are intended for installations where the shafting is 15 ft. long or more, and in this type the flexible shafting for the switch control is $\frac{3}{16}$ in. in diameter, the tuning control using the $\frac{5}{32}$ in. shafting as in the type C remote controls. Larger casing is therefore used for the type D controls, and the controller and switch coupling are modified to accommodate the larger shafting.

60. Two types C and D remote controls, as applied to the T.R.9D, are shown in fig. 15. The controller (11) is mounted in the pilot's cockpit ; the switch coupling (23), condenser unit (control) (29) and the plug (26) are fitted to the transmitter-receiver. The flexible shafting (1) runs in a casing, part of which (2) is rigid and part flexible, (16) and (30). The shafting consists of a stranded core of steel wire on which is wound a helical tooth wire making about ten turns to the inch.

61. The controller consists of two parts fitted together. One part, known as the control, switch and tuning, consists of the mechanism for operating the two flexible shafts for the SEND-RECEIVE switch and the tuning condensers. The other part, the volume control, is mounted in

the centre of the switch and tuning control and consists of a high resistance potentiometer operated by a knob.

62. The control, switch and tuning, consists of a case containing two wheels (3) with teeth specially shaped to engage with the helical tooth on the flexible shafting, so that rotation of the wheel moves the shafting in one direction or the other. The longer handle (5) is connected to the wheel which engages with the flexible shafting in the guide tube (12) and is the control for the SEND-RECEIVE switch. The other handle (13) is connected to the other wheel, and this meshes with the flexible shafting in the guide tube (2). This shafting is connected to the tuning condensers, and the handle (13) thus forms the tuning control.

63. The handles are attached to the levers by a single screw each. Three holes are provided in the switch control handle, and two in the tuning control handle, so that adjustment of the effective length of the levers is available. A spring-loaded catch (4) is fitted on the switch control handle. The central position of this handle is the OFF position, and it can be locked in this position by engaging the catch with a notch in the frame.

64. The guide tubes are attached to the body of the controller by two screws each (6), and are arranged so that if one screw is removed and the other loosened the guide tube may be swung away from the toothed wheel and the flexible shaft thus disengaged. The controller may be mounted with either of the handles uppermost, and the engraving is duplicated so that it can be read in either position. The flexible shaft may be arranged to enter either side of the controller, and the two extreme positions of the handle may be allotted for send and receive to suit the installation. The words SEND and RECV. are engraved on detachable plates which can be interchanged and turned upright to show the positions of the handle for the corresponding positions of the switch in the instrument.

65. The switch coupling (23) also contains a wheel with teeth to engage in the helical winding on the flexible shaft. On the lower end of the spindle carrying this wheel is a dog, which fits over the crossbar attached to the switch spindle on the instrument. A handle (19) is fitted on to the outer end of the shaft for local operation of the switch and as a local indicator of the switch position. As in the controller, the guide tube (25) is fixed by two screws (17) either of which may be removed to disengage the flexible shaft from the wheel.

66. The switch coupling fits on to a ring adaptor (24) which is attached to the transmitter panel by two $\frac{1}{4}$ in. by 2 B.A. countersunk screws. The sleeve and flange of the coupling are slit and are clamped to the adaptor ring by tightening the screw (22) which draws the band around the sleeve. A key inside the sleeve engages in a keyway in the upper edge of the adaptor ring. The ring has eight keyways equally spaced so that the coupling can be secured in any of eight positions on it, to allow the casing and flexible shaft to be led up to the instruments at the most convenient angle. The shaft may be led off from either end of the guide tube provided that the controller is arranged accordingly.

67. The handle (19) may be fitted on to the square end of the spindle in any of eight positions, and is secured by the screw (18) with a locking washer. The plate (21) is cut away to form a stop plate and also carries the designations S and R to indicate the send and receive positions. This plate can also be fixed in eight different positions to suit the position chosen for the handle. It is located by a dowel pin and secured by the nut (20) with its locking washer. The reverse side of the stop plate is also engraved S and R, but in the reverse positions. The reverse engraving will not, however, be required when the coupling is fitted to this transmitter.

68. The condenser unit (control) (29) consists of a knob fixed to a spindle turning in the body. A disc is fixed on the other end of the spindle inside the body and carries a single eccentric pin which engages in the largest of the three holes in the index wheel (28) attached to the operating spindle of the ganged fine tuning condensers. The guide tube for the flexible shaft is attached to the body by two screws, in the same way as in the switch coupling, and the flexible shaft meshes with a wheel on the spindle. The sleeve of the body fits inside the split ring (32) fixed to the receiver, and is clamped by the screw (27). The condenser unit control can be fixed in any position in the ring. A dial engraved with a scale of 0—180° on each half, forms part of the knob.

One scale is marked in white and the other in orange, and the two indices (31) register with them. Whichever scale is more easily visible may thus be used. One end of the guide tube is coloured red and the other green, and the ends of the guide tube on the controller are also marked with these colours. The flexible shaft must be led off from the red end of both or the green end of both in order to obtain the correct direction of the rotation of the condenser.

69. The rigid casing (8) for the flexible shaft consists of solid-drawn light-alloy tubing. The flexible case (16) and (30) is built up of a helix of brass strip over which is a winding of steel wire and another of phosphor-bronze or spring steel wire and, finally, a waterproof covering of varnished cotton braid. The junctions between the casing and the components and between two lengths of casing are made by means of casing unions (7). The free ends of the shafting at the controller, the switch coupling, and condenser unit handle are protected by short lengths of rigid casing fitted to the free ends of the guide tubes by casing unions, and pinched up at the ends.

70. The union consists of two split clips made in one piece, and each clip is clamped up on the casing by means of a screw. A hole is drilled through the union at each end to take a key pin for increased security. These pins are not fitted, however, in the unions at the free ends. Special unions (15) to allow of lubrication are fitted between the flexible and the rigid casing, and along the run of the rigid casing when necessary. These lubricator unions carry a standard grease nipple, and have a union nut at each end. The union nut is tightened up on to a cupped washer inside the body, which is thus flattened out and bites into the tubing.

71. The volume control consists of a high-resistance potentiometer operated by the knob (14). Two different methods of construction are used for the potentiometers in service. One type is built up as an ordinary strip-wound resistance with a contact arm moving over it. The other type consists of a number of resistances connected to contacts on a multiple-contact rotary switch. This type is shown diagrammatically in fig. 16. Forty-four resistances of 1,250 ohms, each with a centre tapping, are mounted round the spindle and connected to the contacts as shown. The ends of this circuit are connected to the H.T. supply with a further resistance of 20,000 ohms in the positive lead, and the contact arm is connected to the screening grids of the valves. The 20,000 ohms resistance connected in series with the potentiometer has the effect of limiting the range of variation of the screen-grid voltage to that required for smooth control of the amplification from a minimum to a maximum.

72. A 2-ft. length of screened three-core cable is supplied with the controller and is connected, on installation, to a 3-way terminal block (10). The connections are taken from the terminal block to the three-pin plug (26) for connection to the socket (33) in the side of the receiver. The screening conductors of the two lengths of cable are connected by the bonding wire (9), which is bound to the metal braiding by 30 s.w.g. tinned copper wire soldered in position.

73. As the receiver will not function without the potentiometer connected to the socket (33), a type B volume control (34) is provided for use by an observer having access to the transmitter-receiver in a two-seater aeroplane, or for operation of the receiver on the test bench. The type B volume control consists of the potentiometer forming the type A volume control, as used in the controller, fitted into a metal case and having a lead and three-pin plug connected to it. It may be fixed in any convenient position by two screws through a flange ; or the wedge plate (35) may be attached to the airframe and the volume control supported on it when easy detachment is required.

74. A key diagram showing the components required for remote control of the T.R.9D transmitter-receiver is given in fig. 17. The upper sketch shows the type C controls, and the second sketch, the type D controls as used with these instruments. In the bottom sketch the type B controls are shown. The switch coupling can be attached directly to the plate on the receiver to which the ring adaptor is otherwise fixed. The ring adaptor will not be required, and must be removed. The condenser unit handle requires an adaptor for the type B controls. This adaptor consists of a sleeve to fit into the clamp ring, (32) on fig. 15, with a spindle carrying two discs. The inner disc has an eccentric pin to engage in the largest hole in the index plate (28), and the other is arranged to fit the condenser unit handle of the type B controls.

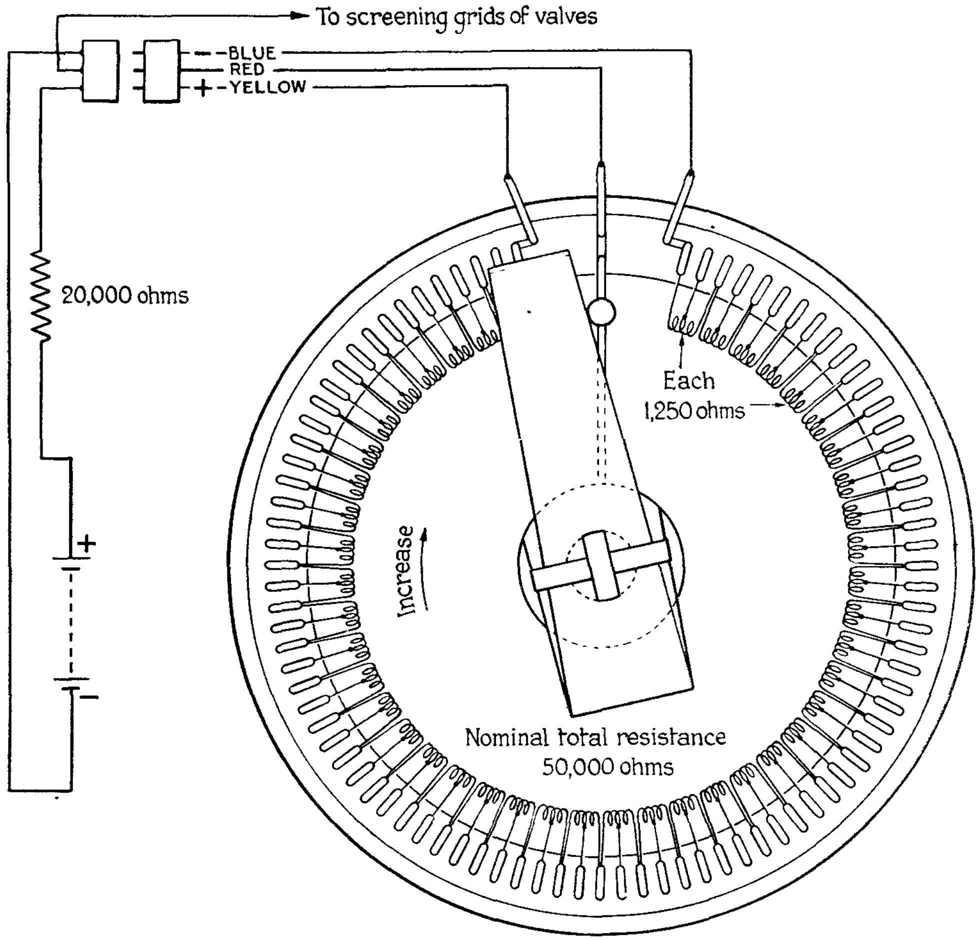


FIG. 16. Volume control circuit.

VALVES AND BATTERIES

75. The valves used in the transmitter are as follows :—In the oscillator stage, a valve V.T.50 is employed. This is a directly-heated triode having a filament rating of 0·1 amperes at 2 volts. It is non-metallized and is fitted with a standard 4-pin base. The maximum H.T. voltage is 150 and it is capable of dissipating 1 watt continuously. The normal anode current is about 3·0 mA. In both modulator and power amplifier stages, the valve is a V.T.51 (Stores Ref. 10E/10946). This is a directly-heated pentode having a filament rating of 0·2 amperes at 2 volts. The maximum H.T. voltage is 150 and it is capable of dissipating 3 watts continuously. The normal anode current is about 9 mA and the screen current about 2·5 mA.

76. The receiver employs two tetrodes, V.R.18, each having a filament current of 0·2 amperes at 2 volts, a detector valve V.R.27 (0·1 ampere, 2 volts), two audio-frequency amplifier valves V.R.21 (0·1 ampere, 2 volts) and a power amplifier valve V.R.22 (0·2 amperes, 2 volts).

77. Since all the valve filaments are heated during transmission, the total load on the L.T. battery is about 1·4 amperes. To this must be added the operating current for the frequency changing delays, and the microphone current, making the total current about 1·6 amperes.

78. The current for the transmitter and receiver valve filaments is supplied by a 2-volt lead-acid accumulator. If a 14 Ah. type B accumulator is fitted, it will serve for about six hours

continuous use, when on the border line of serviceability as defined in R.A.F. Form 480, para. 33. In its earlier life it should of course provide a longer service, but as a precaution, the accumulator should be changed after every operational flight of approximately full duration. Where a 20 Ah. Type B accumulator is fitted, and is on the border line of serviceability, it should provide for 8½ hours continuous flight, but should be changed after every second flight of approximately full duration. The 20 Ah. accumulator will eventually be standardized for use with this installation. The H.T. supply for both transmitter and receiver is obtained from a 120-volt dry battery housed in a tray which is part of the case.

79. A 15-volt dry battery supplies the grid bias voltage for the modulator valve, and a 4½-volt dry battery provides the grid bias voltage for the sub-modulator stage. The former is housed in the transmitter battery tray but the latter is accommodated in the receiver itself.

80. During transmission, the H.T. battery is called upon to give an input current to the transmitter and sub-modulator, amounting in all to about 28 milliamperes. The H.T. battery will therefore require replacement more frequently than in the transmitter-receiver type T.R.9.B. It should be tested frequently, and replaced if the terminal voltage falls below 100 volts on the load.

Installation

81. A typical installation diagram is given in fig. 18. It will be seen that the transmitter-receiver is fitted in a specially designed crate by means of the usual type of suspension. The crate also carries the master contactor and the 2-volt L.T. accumulator. The latter is connected to the transmitter by leads supplied as a part of the transmitter-receiver. The master contactor is fitted with three leads 15 in. long, enveloped in a woven cover and terminating in a plug, type 33. This has 4 pins, marked —, +, 3 AND 4, 1 AND 5. The latter is internally connected to the — pin. The fixed wiring of the master contactor consists of a pair of supply leads from the general service accumulator, which terminates upon the + and — pins of a socket, type 12, into which the plug, type 33, of the master contactor is fitted. The marking of the sockets corresponds to that of the plug. From the terminals 1 AND 5 and 3 AND 4 a pair of leads is carried to a socket, type 19. The input leads of the remote contactor are connected to this socket by a plug, type 51.

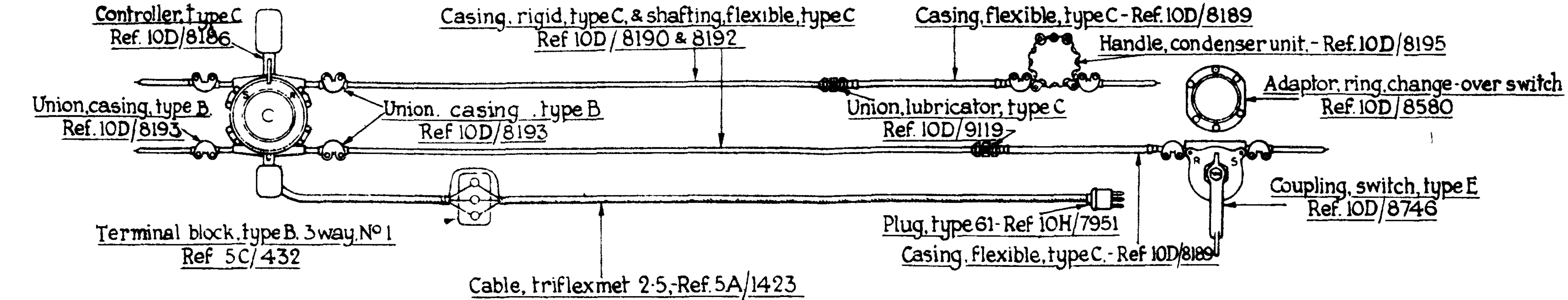
82. The output leads of the contactor are fitted to a plug type 62 which is plugged into a socket, type 19. The fixed wiring of the installation is then carried to a point near the crate and terminates in a plug, type 34, which fits the control socket on the transmitter. A switchbox, type B, is fitted in a convenient position in order that the radiation of the special frequency may be suspended when necessary, without switching off the remote controller and so throwing it out of synchronism.

83. The microphone and telephone leads of the transmitter-receiver terminate in a plug, type 48, which connects up to the fixed wiring *via* a socket, type 17. The fixed wiring, both of the microphone and the telephone circuits, is of metal braided cable (duflexmet 2·5) the braiding being earthed at the ends of each run. Standard sockets, type 29, are fitted for the accommodation of the plug, type 119, fitted to the cord of the mask microphone. The remote controls are also shown in this diagram.

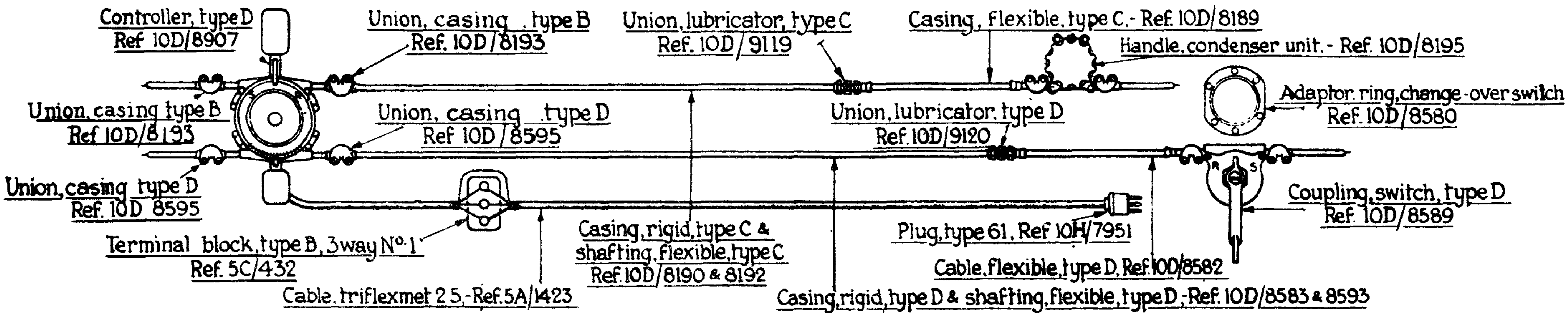
TUNING

Transmitter

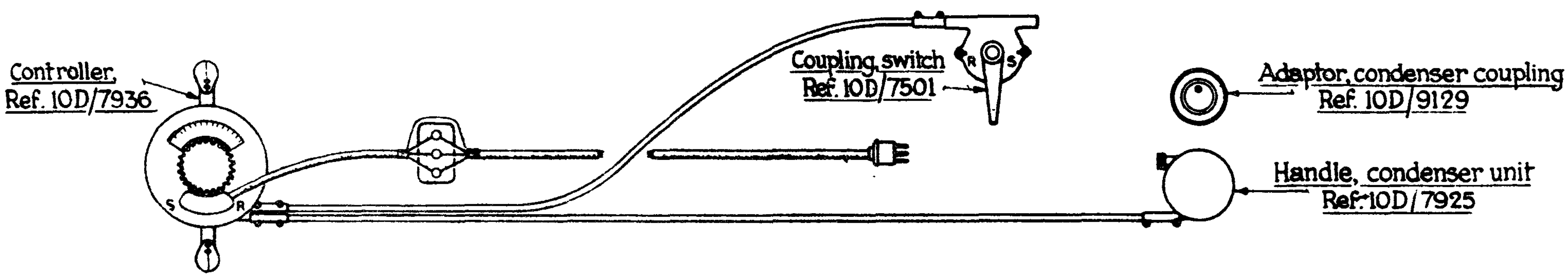
84. Since the oscillator is crystal controlled, no wavemeter is necessary for the tuning of the transmitter. Frequency-control crystals, complete in mountings, have been allocated a separate section in Air Publication 1086 (Priced Vocabulary of Royal Air Force Equipment), to be known as Section 10X. The stores reference number of a crystal is identical with that of its frequency in kilocycles per second. The nomenclature of a crystal complete in mounting, consists of the word " crystal " followed by its frequency expressed verbally, thus 10X/5320, crystal, five three



TYPE C (Condenser & change-over switch shafting 5/32" dia)



TYPE D (Condenser shafting 5/32" dia., change-over switch shafting 3/16" dia. for long runs - 15 ft. or over)



TYPE B (When T.R.9D is fitted in an aeroplane where type B controls are installed, the adaptor, condenser coupling, is required)

FIG. 17. REMOTE CONTROL COMPONENTS

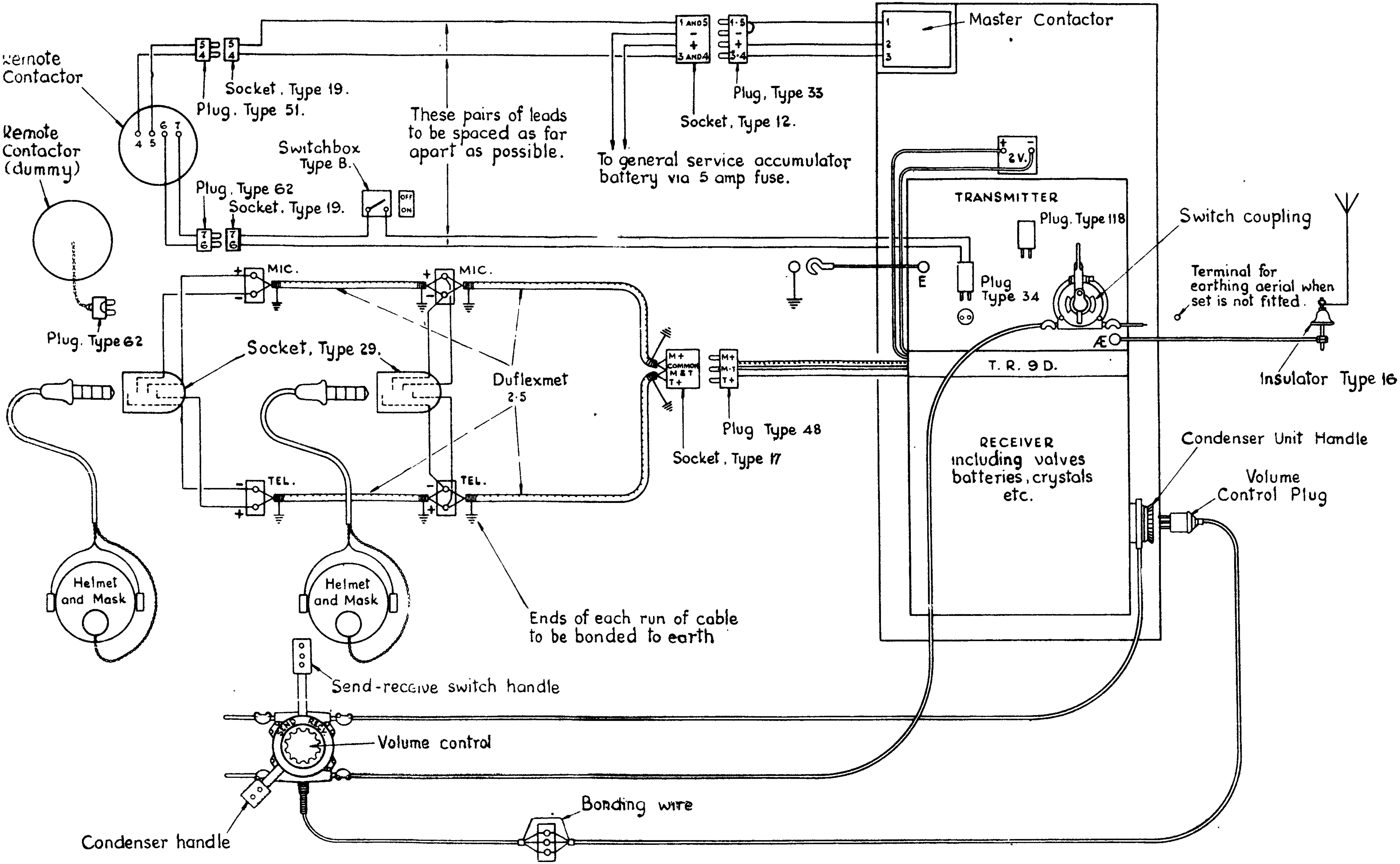


FIG. 18 INSTALLATION DIAGRAM OF T.R. 9D.

(F.1800). F. & C. LTD.

two zero, indicates a crystal having a natural frequency of 5320 kc/s. On no account are crystal mountings to be opened up or repaired by service units or by depots.

85. The procedure for tuning the transmitter to a pair of predetermined (i.e., normal and special) frequencies, is as follows :—

(i) Remove the transmitter from the instrument case.

(ii) Insert a 120-volt H.T. battery and a 15-volt grid bias battery in the battery tray and connect the appropriate plugs. Take particular care that the grid bias is set to −10·5 volts.

(iii) Insert the crystal oscillator valve V.T.50 and replace the transmitter in the case, ensuring that the SEND-RECEIVE switch is in the OFF position and the limiting resistance switch to TUNE.

(iv) Select a pair of crystals of the desired frequencies, ensuring that the "normal" crystal is plugged into the holder N and the "special" crystal into the holder S.

(v) Connect the L.T. leads to the 2-volt accumulator.

(vi) Connect the aerial and earth to the appropriate terminals of the transmitter.

(vii) See that the control socket is unoccupied, so that the relays are in the "normal" position. Ensure that the short-circuited plug, type 118 (red top), is available for use when required.

(viii) Set SEND-RECEIVE switch to SEND. Since the amplifier and modulator valves are not yet in position, only the sub-modulator and oscillator valves will take current. The milliammeter should indicate a feed current of not more than 4·5 mA.

(ix) Insert the short-circuited plug, type 118, in the control socket. This should cause the relays to operate, changing to the "special" position ; observe the feed current. This should not exceed 4·5 mA.

(x) Set SEND-RECEIVE switch to OFF, and remove the short-circuited plug, type 118.

(xi) Insert the amplifier and modulator valves V.T.51.

(xii) Set the SEND-RECEIVE switch to SEND.

(xiii) Adjust the normal aerial tuning inductance to obtain minimum input current. It will be found that the aerial current is very nearly a maximum at this point. The input current should be of the order of 13 mA, and the aerial current should be about 0·13 amperes.

(xiv) Set the limiting resistance switch to TRANSMIT.

(xv) Trim aerial inductance for minimum input as before.

(xvi) Set SEND-RECEIVE switch to OFF.

This completes the tuning of the normal frequency. The special frequency is tuned as follows :—

(xvii) Select a suitable tapping on the aerial coil by means of the control marked S.AE COARSE, and adjust the condenser S.AE FINE to about 4.

(xviii) Return the limiting resistance switch to TUNE.

(xix) Insert red-topped plug, type 118, in the control socket.

(xx) Set SEND-RECEIVE switch to SEND.

(xxi) Adjust S.AE FINE control for minimum input. Unless a definite minimum is obtainable,

(*a*) Put SEND-RECEIVE switch to OFF and

(*b*) try an adjacent tapping on the S.AE COARSE control. The input current should be of the order of 13 mA, and the aerial current should be about 0·13 amperes.

(*c*) When a definite minimum input is observed.

(xxii) Set limiting resistance switch to TRANSMIT and re-adjust S.AE FINE control for minimum input as before.

The special frequency is now correctly adjusted.

(xxiii) Put SEND–RECEIVE switch to OFF and remove red-topped plug, type 118, from control socket.

Note.—When tuning on the bench before installation, an artificial aerial type 3 may be used instead of an aerial and earth. The capacitance should be set to 100$\mu\mu$ F. When re-tuning a transmitter which has been in use previously, the stages (i) to (xi) are omitted, except that appropriate crystals must be inserted as in (iv) if the frequency allocation has been altered.

86. The following table may be used as a guide for preliminary settings of the aerial tuning for both normal and special frequencies.

Crystal frequency kc/s.	Crystal in socket.	Red-topped plug.	N aerial tuning.		S aerial tuning.		Input MA.	Output amperes.
			Turns.	Degrees.	Coarse.	Fine.		
6·6	N	out	5	330	—	—	24	0·25
6·0	N	out	7	100	—	—	24	0·25
5·75	N	out	7	310	—	—	24	0·25
5·3	N	out	9	40	—	—	24	0·25
4·75	N	out	11	20	—	—	24	0·25
4·25	N	out	13	200	—	—	24	0·25
6·66	S	in	—	—	4	2·0	25	0·23
6·0	S	in	—	—	5	2·5	25	0·23
5·75	S	in	—	—	5	8·0	25	0·23
5·3	S	in	—	—	6	8·0	25	0·23
4·75	S	in	—	—	8	5·0	25	0·23
4·25	S	in	—	—	10	5·0	25	0·23

Receiver

87. Since the aerial circuit of the transmitter is the input circuit of the receiver, the transmitter must invariably be tuned to the desired frequency before attempting to tune the receiver. Until a suitable type of crystal monitor is generally available, the receiver may be tuned by means of an R/T tester, Unit A, which has previously been modified in accordance with the instructions contained in A.P.1186/E.36. This modification consists of the introduction of a crystal for stablizing the frequency of the modulated oscillation generated by the R/T tester ; when used in this manner, a valve V.R.21 is used as a modulator and a valve V.T.20 as an oscillator. The R/T tester, Unit A, is set up to the desired frequency as follows. Insert a crystal of the required frequency into the crystal adaptor. Using the telephone plug and lead supplied with the R/T tester, connect a testmeter, type C, to the jack on the instrument panel. Set the testmeter to the 0—30 mA. range, and the R/T tester to transmit T.T. The latter operation completes the filament circuit of both valves and the oscillations will then be initiated. Adjust the variable condenser until the reading of the testmeter is a minimum. This adjustment is critical, but is facilitated by the fact that the setting of the condenser dial in kc/s should agree approximately with the frequency of the crystal. Having determined the condenser setting giving minimum input, increase the condenser reading by 15 kc/s., lock the condenser dial and withdraw the plug of the testmeter. The R/T tester, Unit A, is now radiating a modulated crystal-controlled oscillation.

88. The following instructions are generally applicable, no matter what form of signal generator is used to produce the tuning signal, except where specific reference is made to the R/T tester Unit A.

(i) Turn the volume control potentiometer in the pilot's cockpit to the maximum volume position. Except, as stated in sub-para. (viii), it must be maintained in this position during the whole of the operation of tuning.

(ii) Set the fine tuning control to 90 degrees, *i.e.*, to the middle of its range of movement.

(iii) Place the signal generator near the tail plane. Where a modified R/T tester, Unit A, is used for this purpose, the screening lid should not be securely closed during the preliminary tuning.

(iv) Put SEND–RECEIVE switch to RECEIVE, and adjust the two main tuning condensers until the modulated signal is heard at maximum strength.

(v) Progressively weaken the field strength at the receiver, first by closing and securing the screening cover of the Unit A where used and, if necessary, by removing the unit further from the receiver. In no circumstances should the signal strength be decreased by adjustment of the receiver volume control. Where crystal monitors are available, an attenuator is fitted as an integral component, and this control is used to reduce the field strength instead of the somewhat haphazard method which must be adopted with the R/T tester, Unit A.

(vi) Having attenuated the field at the receiving aerial until signals are barely audible when the receiver is exactly in tune, turn the regeneration control in the direction of the arrow until the receiver commences to oscillate, then turn back one complete turn.

(vii) Re-adjust the two main tuning condensers for maximum signal strength.

(viii) Operate the volume control, ensuring that the strength of signals decreases and increases over the entire range of variation and that oscillation does not set in at any point in the range. Return the control to the maximum position.

(ix) Rotate the fine tuning control over the whole of the range, ensuring that the instrument is stable, and return it to the original position, by observation of maximum signal strength.

(x) Should oscillations set in during the operations described in (viii) or (ix), repeat the whole tuning operation up to (v). In operation (vi) the regeneration control should be turned back $1\frac{1}{2}$ turns from oscillation point instead of 1 turn, then proceed as in (vii), (viii) and (ix).

OPERATION AND MAINTENANCE

General

89. When the aeroplane is on the ground, the switch handle of the controller should be locked in the OFF position as a safeguard against battery wastage. Immediately before leaving the ground the handle should be moved to the RECEIVE position and continuously maintained in this position except when transmission is in progress on the " normal " frequency, so that it is always possible to receive a call.

90. Immediately before each flight a test of transmission and reception should be made. During flight, the SEND–RECEIVE control and volume control are operated as required. If the receiver has been tuned in accordance with the preceding instructions the receiver fine tuning control should not require adjustment during the flight. It is again emphasized that a carbon microphone must not be used unless the shorting link across the attenuating condenser (C_{31} fig. 2) is previously removed (*see* para. 111).

91. Since the aerial circuit of the transmitter also functions, during reception, as the input circuit to the first R/F stage, it is essential that all inter-communicating transmitters shall be

on exactly the same frequency. If this is not the case, the input circuit of the receiver may not be in resonance with a received signal, and the signal strength may be poor.

92. The L.T. accumulator must be removed and charged at frequent intervals. If a 14 Ah. accumulator is fitted, a newly charged one should be installed before each flight in which the wireless apparatus is to be used. Where the 20 Ah. type is fitted, the accumulator should be replaced by a newly charged one after each two flights of approximately full duration.

93. The H.T. battery voltage should be tested periodically. This may be done either by withdrawing the battery tray, or by removing the cover of the contact bar and connecting the voltmeter between H.T. + and H.T. − contacts. If the voltage on load falls below 100 volts the battery must be renewed. The plugs should be secure in the battery sockets and care must be taken not to dislodge them in replacing the battery tray. As already stated the H.T. battery is called upon to supply a total current of about 28 milliamperes.

94. The voltage of the transmitter and receiver grid bias batteries should also be checked periodically, and the security of the plugs attended to. If the voltage of either is low, the modulator or sub-modulator, as the case may be, will take a heavy anode current and transmitted speech will be distorted. A defective receiver grid bias battery will also give rise to distorted speech during reception.

95. On no account should any attempt be made to remove or replace any plug or valve, unless the SEND-RECEIVE switch is in the OFF position, except that the relays may be operated for testing and tuning by the insertion and withdrawal of the plug, type 118, supplied for this purpose.

96. The relays themselves should seldom, if ever, require adjustment, but if this should become necessary it is not to be attempted except by means of the proper tools, which are contained in the kit specified in Section V, Chapter XVI (Ground Station Remote Controls, Table I), of this Air Publication. The relays should operate on the closure of the circuit, *e.g.* by the insertion of the plug, type 118, into the control socket, provided that the terminal P.D. of the L.T. battery is above 1·8 volts. The minimum "break" between any two pairs of contacts should be 0·04 in. On "making" in either direction the contacts should "follow through" for at least 0·02 in.

Master Contactor

97. If any doubt arises as to the accuracy of the master contactor, its regulation should be checked by means of a stop watch Mark VI, which is available for use with this installation. It is not necessary to remove any apparatus from the aeroplane, but the remote contactor must be installed and not the dummy one. The master contactor is fully wound and started by means of the starting knob. At least ten minutes should be allowed for the interior of the clock to attain its working temperature (75° to 80° F.) and for the balance wheel oscillation to settle down to a steady rate. See that the switch of the master contactor is OFF and set the adjustable index to 0°, aligning the pointer to it. Fully wind the stop watch and set it to zero.

98. When ready to take the first or rough check, start the stop watch and simultaneously start the remote contactor by moving the switch to ON. Take the time of 15 complete revolutions. This should take 15 minutes exactly. If, however, it actually takes 15 minutes 0·5 second the master contactor is obviously losing 2 seconds per hour. It is unlikely that the rate of the clock will be so high as this. If it is considerably less, however, it is not possible to check it with accuracy over such a short period as 15 minutes. The remote contactor and the stop watch should therefore be left running for six hours. Suppose that at the end of six hours run, the hand of the remote contactor is 1/10th of a revolution past the index, then the master contactor has gained 1/10th of a minute in six hours, *i.e.* is gaining one second per hour. If the master contactor gains or loses more than this, the accuracy is below the operational requirements of the installation. The object of the preliminary check is to guard against the remote possibility that this is actually a gain of 1 1/10th minute or a loss of 9/10th minute per six hours.

99. For simplicity it has been assumed that the stop watch Mark VI has no rate of gain or loss. The actual rate of the watch should be checked by comparison with a watch of known rate or by wireless time signals. In the latter case, however, it must be remembered that the watch runs for six hours only on a single winding. Since under certain conditions the pilot will use the clock on the instrument panel in conjunction with the radio installation, it is convenient to obtain the relative rates between this clock and the master contactor during the above test. After performing a six-hour test, the L.T. battery should always be replaced by a fully charged one.

Remote controls

100. When the remote controls are to be disconnected for removal of the transmitter-receiver from the aeroplane the switch coupling is removed by loosening the clamp screw and pulling the coupling off the adaptor ring attached to the panel, and the condenser unit handle is removed in a similar manner. The positions at which each of these has been fitted should be noted before they are removed. The volume control plug must also be taken out.

101. When the transmitter-receiver is replaced, the switch coupling and condenser unit handle should be fitted in the same position as before unless there is particular reason for changing them. The correct position for the switch coupling may be determined, if it is not known, by putting both the switch and the handle of the coupling in the OFF position and engaging the dog with the switch cross bar. The key should then fit into the appropriate keyway. The condenser unit handle is not keyed and the correct position must be found by trial.

102. If the shafting has been disengaged from the wheels, or if the position of the switch coupling or condenser unit handle changed, the shafting must be re-adjusted. When the switch coupling has been fitted in the new position and fixed by tightening the clamp screw the most convenient position for the handle is then decided on and the OFF position noted. The stop plate is moved if necessary to correspond with the range of movement decided on for the handle and the handle then fitted. The condenser unit handle is fixed as required and clamped up.

103. The flexible shafting must then be re-adjusted. The following method is observed in the initial fitting and should be repeated if the shafting has been disturbed. It is assumed that the casing and components are completely assembled.

(i) Disconnect the short closed lengths of tubing from the controller and coupling by disengaging the casing unions from the guide tubes.

(ii) Remove one of the screws fixing each guide tube, slacken the others and swing the tube away from the wheel.

(iii) Thread the required length of shafting into the casing and push it through until the end is just flush with the free end of the guide tube on the coupling.

(iv) Turn the handle on the coupling to the position that it would occupy if the shafting were engaged with the wheel and then pulled from the far end. Push the guide tube back into place, meshing the shafting and wheel to the nearest tooth, and screw up the guide tube.

(v) Pull the end of the shafting projecting from the controller so as to take up all slack. Turn the handle of the controller to the position it would occupy to pull the shafting as far as possible from the other end and refix the guide tube, meshing the shafting and wheel to the nearest tooth. It should now be possible to operate the coupling to either extreme position by movement of the controller handle. When the shafting is pushed away from the controller to its extreme position, the end should be flush with the free end of the guide tube.

(vi) If there is an intermediate switch coupling for operation of the SEND-RECEIVE switch by the observer, the switch handle of the controller should be placed in the OFF position and locked. The handle of the intermediate coupling should then be turned to the central position and the guide tube pushed into place and screwed up. With the controller handle unlocked, it should then be possible to operate the switch to either extreme position by movement of the intermediate handle.

(vii) Replace the short closed lengths of rigid casing on the free ends of the guide tubes.

104. If in the repair or modification of remote controls, it is required to bend the rigid casing, the bending tool supplied for the purpose must be used. The bending tool is of wood and is in the shape of a segment of a circle, with a U-section slot round the edge in which the casing is to be fitted for bending. For the type C rigid casing the tool, bending, type C, is used, and for the type D rigid casing the tool, bending, type D and the following precautions must be observed.

(i) The cross-section of the casing must not be distorted from the circular form. The appropriate flexible shafting must therefore always be threaded through the casing before the casing is bent.

(ii) The straight casing adjacent to a bend must be tangential to the bend. The bending tool is to be placed against the casing where the bend is required and the casing bent by hand to the shape of the tool. The bending must be done slowly and without jerks.

Electro-magnetic microphone

105. Periodic inspection of the electro-magnetic microphone should be carried out. The front cover and diaphragm should be removed and any moisture which has condensed on the wax filling or on the diaphragm should be removed with a clean soft white cloth. Before reassembly a thin layer of petroleum jelly should be applied to the rim of the body of the instrument.

106. Tests of microphone resistance, lead screen resistance, insulation resistance and microphone efficiency may be carried out with the following apparatus :—Insulation Resistance Tester, Testmeter, Type A or D, Noise Generator, No. 1, and Condenser, Type 112 or 330. All microphone and telephone connections should be carefully checked before carrying out the tests.

107. Microphone resistance test. Withdraw the microphone-telephone plug and connect the testmeter, on ohmmeter scale, across the microphone contacts on the plug, rings 2 and 3 (counting the tip as ring 1). With the microphone switch at ON, the ohmmeter should read approximately 60 ohms. A faulty microphone will be indicated by a reading which is over 75 or under 45 ohms.

108. Lead screen resistance test. Connect the testmeter between Tel.— (ring 4 of the plug) and the earthing terminal on the back of the microphone. The meter should indicate a very low resistance, less than 1 ohm. A higher resistance indicates a defective screen on the microphone lead.

109. Insulation resistance test. The insulation resistance tester should give a reading of greater than 40 megohms when connected between the following pairs of plug contacts, the microphone switch being in the OFF position :—(i) Mic.+ and Tel.— (rings 2 and 4), (ii) Mic.— and Tel.— (rings 3 and 4), (iii) Mic.+ and Mic.— (rings 2 and 3). If the reading is less than 40 megohms in any of these tests, repeat them after disconnecting the microphone. If these latter tests are satisfactory the fault lies in the microphone which should be tested by connecting the meter in turn between each of the microphone terminals and the earth terminal on the casing. In this way it will be possible to isolate the fault and make any necessary replacements.

110. Microphone efficiency test. Set up the transmitter-receiver T.R.9.D with a condenser, type 112 or 330, connected between the aerial and earth terminals, other connections being removed from these terminals. Insert the microphone plug in its socket, and, with a suitable crystal inserted in the "normal frequency" holder, switch on the transmitter. Tune for minimum anode current. Set the microphone switch to ON and place the front cover of the microphone against the rubber guard strips round the aperture in the noise generator. Note

the current on the aerial ammeter. Switch on the noise generator. The aerial ammeter current should increase by approximately 0·06 amps. If this current does not rise by at least 0·04 amps. the output from the microphone is unsatisfactory.

111. The transmitter-receiver, type T.R.9D, has been designed primarily for use with electro-magnetic microphones, such as microphones, type 19, but when necessary carbon capsule microphones, such as mask microphones, type E, may be used. Since the output voltage from a carbon capsule microphone is considerably greater than that from an electro-magnetic microphone, it is necessary to attenuate the gain of the common amplifier in the receiver portion of the transmitter-receiver. This attenuation is obtained by transferring the grid lead from the secondary to the primary of the microphone transformer, using the primary winding as a choke and dispensing with the transformer as such. Any transmitter-receivers T.R.9D which have been modified as above, cannot be used in conjunction with electro-magnetic microphones.

112. Any instability which may be experienced when using carbon capsule microphones, can be eliminated in the following manner. A lead should be soldered to the common negative terminal of the socket, type 17, and the other end of the lead should be connected to the nearest convenient point on the aeroplane earth system. Any instruments which have been modified, should have the original wiring restored before they are returned to Store.

APPENDIX

NOMENCLATURE OF PARTS

The following list of parts is issued for information only. In ordering spares for this transmitter-receiver, the appropriate section of AIR PUBLICATION 1086 must be used.

Ref. No.	Nomenclature.	Quantity.	Ref. in Fig. 2.	Remarks.
10D/10470 ..	Transmitter-receiver T.R.9D	—	—	
	Consisting of :—			
10D/10531 ..	Case	1	—	Fitted with contact bar Ref. No. 10A/10477, leads and plug type 48.
10A/10477 ..	Bar, contact	–	—	
10A/9172 ..	Cover, contact bar	1	—	
10D/10472 ..	Receiver, type R.1120	1	—	For details, *see* below.
10D/10471 ..	Transmitter, type T.1119	1	—	For details, *see* below.
10A/9175 ..	Tray, battery	1	—	
	Principal components :—			
10A/7818 ..	Ammeter, thermo 0—0·5	1	A	
10A/10474 ..	Bar, contact, type 8	1	—	
10H/9227 ..	Base, terminal	1	—	
10C/9206 ..	Choke, H/F, type 34	1	L_2	
10C/10117 ..	Choke, H/F, type 37	1	L_4	
10C/7912 ..	Choke, L/F, type G	1	L_5	
10D/10473 ..	Coil, aerial	1	L_3	
10C/8009 ..	Condenser, type 132	1	C_3	0·0005 μF.
10C/9179 ..	Condenser, type 280	1	C_5	0·001 μF.
10C/9185 ..	Condenser, type 286	1	C_4	0·01 μF.
10C/9208 ..	Condenser, type 289	1	C_7	0·002 μF.
10C/10394 ..	Condenser, type 404	1	C_2	10 μμF.
10C/10568 ..	Condenser, type 410	2	C_1, C_8	50 μμF, ceramic disc.
10C/10476 ..	Condenser, type 411	1	C_6	Variable, air dielectric.
10F/10111 ..	Head, switch	1	—	
10H/10478 ..	Holder, crystal	1	—	
10H/9615 ..	Holder, valve, type S	2	V_2, V_3	5-pin.
10H/9195 ..	Plate, guard	2	—	For valve-holders.
10H/10479 ..	Holder, valve, type X	1	V_1	4-pin.
10A/7820 ..	Milliameter 0—30	1	—	
10F/10112 ..	Plate, stop	1	—	
10F/10480 ..	Relay, magnetic, type 42	2	REL_1, REL_2.	Telephone type, 2 makes, 2 breaks.
10C/7956 ..	Resistance, type 103	1	R_4	5,000 ohms.
10C/8020 ..	Resistance, type 112	1	R_2	30,000 ohms.
10C/8021 ..	Resistance, type 113	2	R_1, R_3	20,000 ohms.
10H/7276 ..	Socket, type 11	1	—	
10F/10113 ..	Switch, type 137	1	SR_1, SR_2, SR_3, SR_4.	
10F/10338 ..	Switch, type 152	1	S_5	
10A/10497 ..	Transformer, L/F, type 19	1	T_1	
10D/10472 ..	Receiver, type R.1120	1	—	
	Principal components :—			
10A/10475 ..	Bar, contact	1	—	Fitted with 7 contacts.
10H/9190 ..	Base, terminal, 1-way, type A ..	1	—	Engraved 16.
10H/9191 ..	Base, terminal, 2-way	1	—	Engraved 14 and 15.
10H/9192 ..	Base, terminal, 3-way, type A ..	1	—	Engraved 1, 2 and 3.
10H/9224 ..	Base, terminal, 3-way, type B ..	1	—	Engraved 22, 23 and 24.
10H/9193 ..	Base, terminal, 5-way, type A ..	1	—	Engraved 4, 5, 6, 7 and 8.
10H/9225 ..	Base, terminal, 5-way, type B ..	1	—	Engraved 9, 10, 11, 12 and 13.
10H/9226 ..	Base, terminal, 5-way, type C ..	1	—	Engraved 17, 18, 19, 20 and 21.

Ref. No.	Nomenclature.	Quantity.	Ref. in Fig. 2.	Remarks.
10D/9189 ..	Can, coil	3	—	
10C/10117 ..	Choke, H/F, type 37	1	L_9	
10C/7384 ..	Choke, L/F, type B	1	L_3	
10D/9187 ..	Coil, anode	2	L_6, L_7	
10C/7902 ..	Condenser, type 121	1	C_{22}	0·0001 μF.
10C/7906 ..	Condenser, type 125	2	C_{10}, C_{19}	0·01 μF.
10C/8388 ..	Condenser, type 178	1	C_{32}	0·0002 μF.
10C/9178 ..	Condenser, type 279	1	C_{17}	0·0003 μF.
10C/9179 ..	Condenser, type 280	4	C_{24}, C_{25}, C_{27}, C_{28}	0·001 μF.
10C/9180 ..	Condenser, type 281	1	C_{30}	2 μF.
10C/9181 ..	Condenser, type 282	7	C_9, C_{15}, C_{16}, C_{20}, C_{23}, C_{26}, C_{29}.	0·5 μF.
10C/9182 ..	Condenser, type 283	1	C_{18}	Variable.
10C/9184 ..	Condenser, type 285	1	C_{31}	0·00003 μF.
10C/9185 ..	Condenser, type 286	1	C_{21}	0·01 μF.
10C/9197 ..	Condenser, type 287	1	$C_{11}+C_{12}$	Variable.
10C/9198 ..	Condenser, type 288	2	C_{13}, C_{14}	Variable.
10C/10554 ..	Condenser, type 423	1	C_{35}	0·1 μF.
10C/10948 ..	Condenser, type 429	2	C_{33}, C_{34}	20 μμ F, ceramic disc.
10H/9194 ..	Holder, valve, type R	6	V_1, V_5, V_6, V_7, V_8	4-pin.
10H/9195 ..	Plate, guard	6	—	For valve-holders.
10H/9196 ..	Plate, guide	6	—	For valve-holders.
10A/9202 ..	Knob, type 1	2	—	
10A/9201 ..	Knob, type 2	2	—	
10H/9176 ..	Plug, type 76	3	—	For grid bias battery.
10C/7955 ..	Resistance, type 102	1	R_{12}	2,000 ohms.
10C/7957 ..	Resistance, type 104	1	R_{24}	10,000 ohms.
10C/8016 ..	Resistance, type 108	2	R_5, R_{16}	0·5 megohm.
10C/8017 ..	Resistance, type 109	1	R_{18}	2 megohms.
10C/8018 ..	Resistance, type 110	1	R_{13}	0·25 megohm.
10C/7910 ..	Resistance, type 130	2	R_6, R_{10}	1·5 ohms.
10C/8019 ..	Resistance, type 111	1	R_{15}	100,000 ohms.
10C/8021 ..	Resistance, type 113	5	R_7, R_8, R_{11}, R_{14}, R_{17}	20,000 ohms.
10C/8117 ..	Resistance, type 123	4	R_9, R_{19}, R_{20}, R_{22}.	1 megohm.
10C/8519 ..	Resistance, type 145	1	R_{21}	200,000 ohms.
10A/9199 ..	Ring, clamp	1	—	For remote control attachment.
10A/9200 ..	Screw, clamp.	1	—	For Ref. No. 9199.
10A/7394 ..	Socket, type 17	1	—	For remote volume control.
10A/7916 ..	Transformer, microphone, type 51 ..	1	T_2	
10A/9203 ..	Wheel, index	1	—	For remote control attachment.
	Accessories			
5A/1386 ..	Accumulator, lead-acid, 2 V., 14 Ah., type B.	1	—	For L.T. supply, according to operational requirements.
5A/1387 ..	Accumulator, lead-acid, 2 V., 20 Ah., type B.	1		
5A/1383 ..	*Battery, dry, 4½-V.	1	—	G.B. for receiver.
5A/1338 ..	*Battery, dry, 15-V.	1	—	G.B. for transmitter.
5A/1333 ..	*Battery, dry, 120-V.	1	—	H.T. for transmitter and receiver.

* *or appropriate overseas pattern*

Ref. No.	Nomenclature.	Quantity.	Ref. in Fig. 2.	Remarks.
10D/10993	Case, transit	1	—	For complete transmitter-receiver.
10A/10984	Contactor, type 1 *or*	1	—	12-volt, master.
10A/10994	Contactor, type 2	–	—	24-volt, master
10A/10985	Contactor, type 3 *or*	–	—	12-volt, remote.
10A/10995	Contactor, type 4	–	—	24-volt, remote.
10A/10988	Contactor, dummy	1	—	Fitted with plug, type 62.
10X/....	Crystals—units (Quantities and frequencies as required by W/T organisation.)			
10H/10969	Plug, type 118	1	—	2-pole, shorted for ground testing.
5C/543	Switchbox, type B, 1-unit	1	—	
10E/7607	Valve, V.R.18	2	V_4, V_5	R/F. amplifier.
10E/7738	Valve, V.R.21	2	V_7, V_8	A/F. amplifier.
10E/7958	Valve, V.R.22	1	V_9	Receiver output.
10E/8239	Valve, V.R.27	1	V_6	Detector.
10E/10945	Valve, V.T.50	1	V_1	Oscillator.
10E/10946	Valve, V.T.51	2	V_3, V_2	Modulator and R/F. power amplifier.
10A/10989	Microphone, type 19, consisting of :—			
10A/10990	Microphone, type 18	1	—	Electro-magnetic.
10H/10353	Cord, instrument, type Q	1	—	
10H/10991	Plug, type 119	1	—	
—	Remote controls	–	—	*See* Appendix of A.P. 1186, Sect. 2, Chap. 2.

APPENDIX II

TRANSMITTER-RECEIVERS TR9D, TR9F, TR9G, TR9H, TR9J, TR9K and TR9L

FACILITIES AND PRIMARY USES

1. The information contained in the following tables summarises the facilities provided by each of the above quoted Transmitter-receivers and should be of assistance in discriminating between their various applications.

2. Where the Power Unit, type 173, is used in conjunction with the transmitter-receivers, type TR9H, TR9J or TR9K, a double pole ON/OFF switch, type 894 (Stores Ref. 10F/13236), is used in place of the single pole ON/OFF switchbox, type B, shown on Drg. No. A.P.1186/A.167 42, sheet 2.

3. In cases where the abbreviation E.R.S. (electrical remote switching) appears, the relays normally used for switching from "Normal" to "Special" frequency are employed to effect the remote control. Otherwise M.R.C. (mechanical remote control) is used.

Transmitter-Receiver Type	Comprising		Variant of	Additional Facilities provided	Operating Frequency	Method of Control	Primary Use
	Receiver Unit	Transmitter Unit					
TR9D (10D/10470)	R1120 (10D/10472)	T1119 (10D/10471)	—	Nil	Normal and Special	MRC	Single-seater A/C
TR9F (10D/11740)	R1139 (10D/9175)	T1138 (10D/11741)	—	Nil	Normal and Special	MRC	Multi-seater A/C
TR9G (10D/13316)	R1395 (10D/13318)	T1394 (10D/13317)	TR9D	(i) I/C between all members of crew in multi-seater A/C (ii) I/C on "SEND" "Normal" and "RECEIVE" (iii) I/C on SEND "Special" without modulation of carrier wave (iv) I/C without interference from RDF equipment in same A/C	Normal and Special	MRC	Night Fighters (possible application to Naval Fighter A/C)
TR9H (10D/13319)	R1139 (10D/17742)	T1396 (10D/13320)	TR9F	Electrical remote switching of ON/OFF and SEND/RECEIVE	Normal	ERS	Bomber A/C Normal replacement of TR9F
TR9J (10D/13321)	R1398 (10D/13323)	T1397 (10D/13322)	TR9F	(i) ERS of ON/OFF and SEND/RECEIVE (ii) Operation on 2410 kc/s only	2410 Kc/s	ERS	Coastal Command A/C
TR9K (10D/13324)	R1400 (10D/13326)	T1399 (10D/13325)	TR9F	(i) ERS of ON/OFF and SEND/RECEIVE (ii) Transmitter modulation and i/c *without* a separate amplifier (A1134)	Normal	ERS	Small gliders and A/C where no A1134 is fitted

Transmitter-Receiver Type	Comprising		Variant of	Additional Facilities provided	Operating Frequency	Method of Control	Primary Use
	Receiver Unit	Transmitter Unit					
TR9L (10D/13327)	R1402 (10D 13329)	T1401 (10D/13328)	TR9F	(i) ERS of ON/OFF and SEND/RECEIVE (ii) Operation on 2410 Kc/s only (iii) Transmitter modulation and i/c *without* A1134 (iv) Additional 60 volts H.T. supply to transmitter	2410 Kc/s	ERS	Marine craft of Air/Sea Rescue Service

P2535 M35338/374 6/43 13000 C & P **Gp. 1**

CONCISE DETAILS OF
TRANSMITTER-RECEIVER, TYPE T.R.9D

PURPOSE OF EQUIPMENT	Air-borne transmitter-receiver for single seater aircraft
TYPE OF WAVE	R/T
FREQUENCY RANGE	4·3 M/cs to 6·6 Mc/s
FREQUENCY STABILITY	Quartz crystal controlled
CRYSTAL MULT. FACTOR	Fundamental
PERCENTAGE MODULATION	90 per cent
MAXIMUM SENSITIVITY	5 milli-watts output into 20,000 ohm load with 10 micro-volts input at 400 cycles modulated 25 per cent.
SELECTIVITY	—
OUTPUT IMPEDANCE	20,000 ohm, receiver ; variable for transmitter
AMPLIFIER CLASS	Transmitter, Class C ; Receiver, Class A
MICROPHONE TYPE	Carbon or electro-magnetic
VALVES	*Transmitter, T.1119* Oscillator, V.T.50 (Stores Ref. 10E/10945) Modulator, V.T.51 (Stores Ref. 10E/10946) Power-amplifier, V.T.51 (Stores Ref. 10E/10946) *Receiver, R. 1120* R/F (2) V.R.18 (Stores Ref. 10E/7607) Detector, V.R.27 (Stores Ref. 10E/8239) A/F amplifier (2), V.R.21 (Stores Ref. 10E/7738) Power amplifier, V.R.22 (Stores Ref. 10E/7958)
POWER INPUT	28 mA. at 120 volts, H.T. Transmitter L.T. 0·5 amp. at 2 volts Receiver L.T. 0·9 amp. at 2 volts Total operating current, including relays and microphones, 1·6 amp.
POWER OUTPUT	0·27 amp. to 0·29 amp. into average aircraft aerial
STORES REF. NO.	10D/10470
APPROXIMATE OVERALL DIMENSIONS	LENGTH 19½ in. WIDTH 13¼ in. HEIGHT 9½ in.
WEIGHT	Excluding batteries 28 lb. With valves and dry batteries, 40 lb. With remote control equipment, 67 lb.
ASSOCIATED EQUIPMENT	Remote control, type C or D (Stores Ref. 10J/8186 and 10J/8907) Accumulators, 2 v., 20 Ah (Stores Ref. 5A/1387) Battery, dry, 120 v. (Stores Ref. 5A/1333 or Stores Ref. 5A/1615). Battery, dry, 15 v. (Stores Ref. 5A/1338) Battery, dry, 4½ v. (Stores Ref. 5A/1383) Crystal monitor or R.T. Tester, unit A (modified) (Stores Ref. 10S/7185) or R.T. Tester, Type 1, Unit C (Stores Ref. 10S/35)

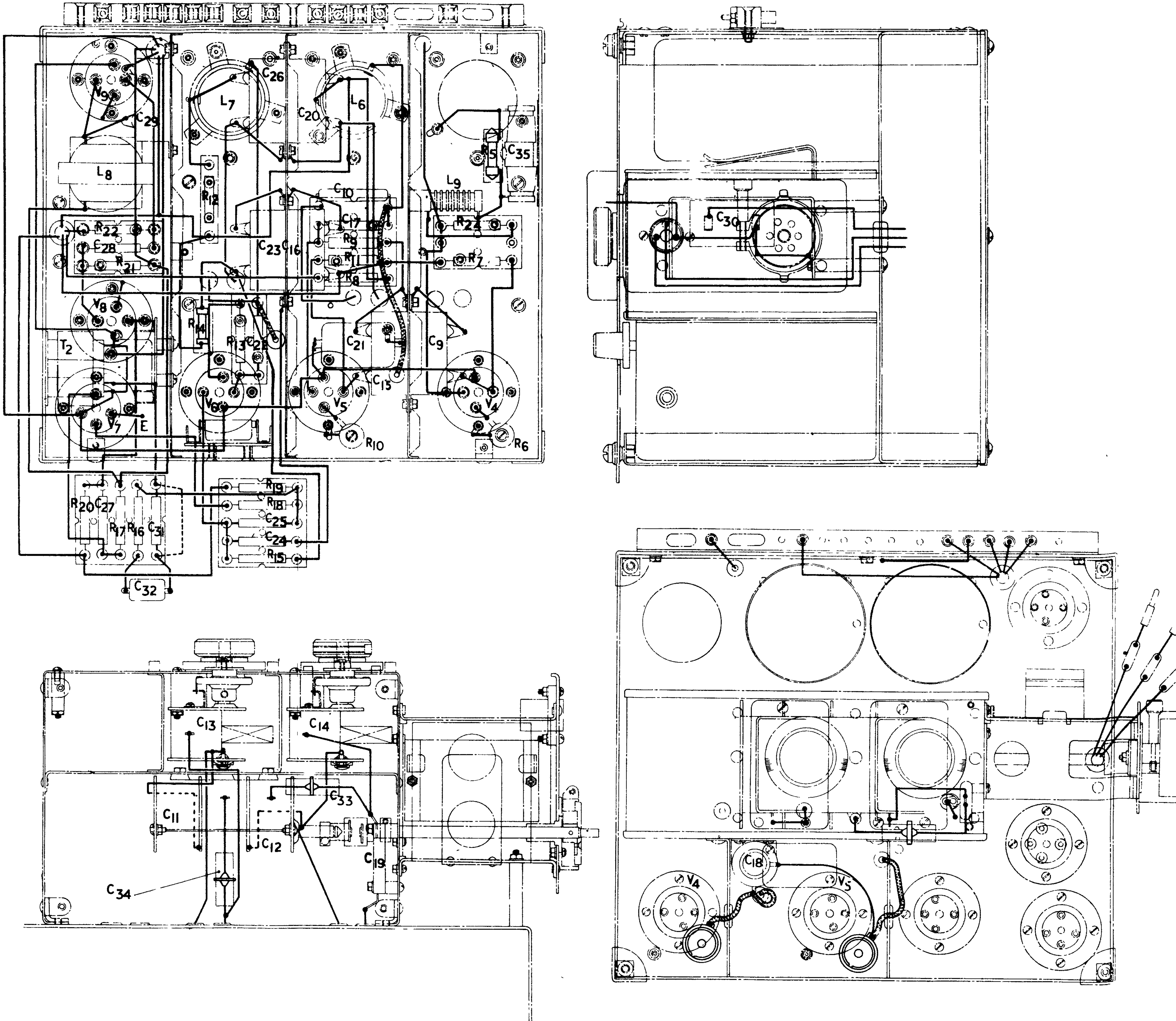


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FIG. 13 BENCH WIRING DIAGRAM OF R.1120

SECTION 2, CHAPTER 5

TRANSMITTER-RECEIVER T.R.9F

Contents

List of Illustrations

(Stores Ref. 10D/11740)

INTRODUCTION

1. The transmitter-receiver T.R.9F is designed for use in multi-seater aeroplanes and should not be used without an amplifier, type A.1134. It affords facilities for modulated transmission on either of two "spot" frequencies which may be selected at will. Provision is also made for inter-communication on both SEND and RECEIVE and for reception at six or seven positions in the aeroplane. Remote control operation may be employed.

2. The transmitter-receiver operates over a frequency range of approximately 6·6 Mc/s to 4·3 Mc/s. Stabilization of frequency is determined by fundamentally-operated quartz crystals and two such controlling elements are incorporated in the instrument.

3. The T.R.9F consists of the transmitter T.1138 and the receiver R.1139 fitted into a single crate. The general appearance of the T.R.9F is shown in fig. 1. The T.1138 is specifically intended for use with the electro-magnetic microphone, type 19, in conjunction with the inter-communication amplifier A.1134. A detailed description of the A.1134 will be found in Sect. 4, Chap. 2 of this

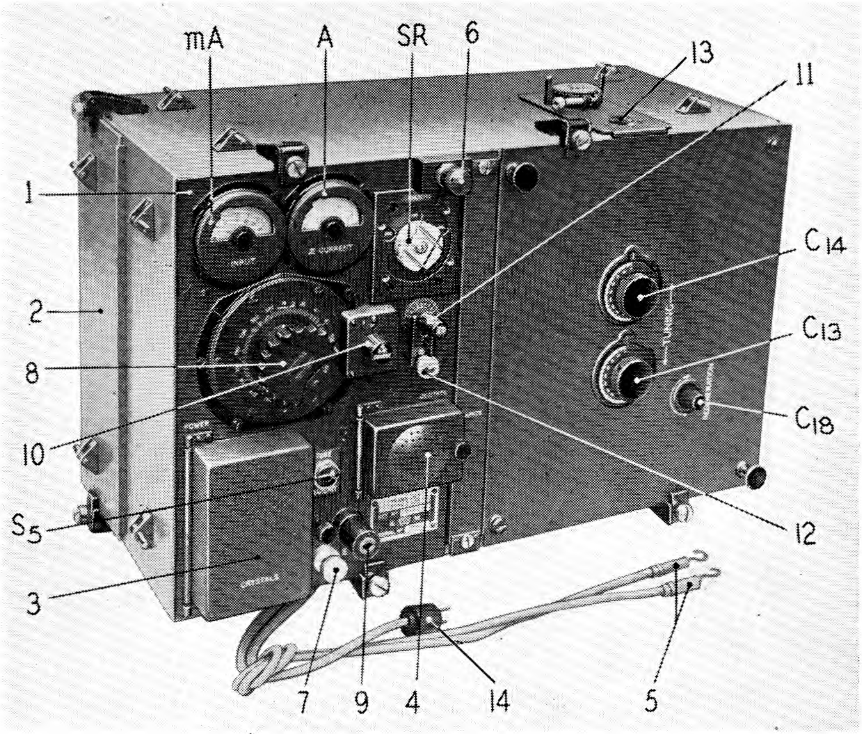

FIG. 1.—THE TRANSMITTER-RECEIVER T.R. 9F.

publication. The transmitter T.1119 which formed part of the T.R.9D, described elsewhere in this publication, also employed the electro-magnetic type of microphone. The essential difference, therefore, between the two transmitter-receivers lies in the circuit rearrangement involved to accommodate the amplifier A.1134. The T.R.9F is battery-operated and both the transmitter and the receiver (*one* frequency only) are pre-tuned prior to flight. The A.1134 uses separate batteries.

4. Having regard to the slight circuital differences between the T.R.9F and that of the T.R.9D, it is not intended to recapitulate either the technical or the operational features which can be found in the chapter on the T.R.9D. Some slight duplication is unavoidable but, in the main, reference should be made to the chapter on the T.R.9D for relevant information.

5. The T.R.9F cannot be used without the A.1134 or equivalent amplifying device to afford the essential microphone gain. Due to the absence of adequate supplies both of the A.1134 and of the microphone, type 19, an "interim" form of the T.R.9F has been evolved for use with carbon granule microphones (*see* paras. 41–44). Reference is also made in this chapter (*see* paras. 45–47) to a modification of the T.R.9F designed for use with a high-impedance H.T. source such as a vibrator unit.

GENERAL DESCRIPTION

6. The transmitter-receiver T.R.9F consists of the transmitter T.1138 and the receiver R.1139. A theoretical circuit diagram of the instrument is given in fig. 2. Briefly, the transmitter T.1138 consists of a crystal-controlled oscillator triode V_1, capacitance-coupled to a radio-frequency amplifying pentode V_2 operated in the Class C condition. The valve V_1 oscillates at one of the two frequencies, NORMAL or SPECIAL, as determined by the fundamental of a quartz crystal selected by switches S_1 or S_2. The action of S_1 and S_2 is controlled by a $Relay_1$ which, acting in conjunction with a second relay provides for the simultaneous selection of tappings, appropriate to the frequencies desired, on an aerial inductance L_3.

7. The modulation of the T.1138 is effected by the familiar choke-control system, an iron-cored choke L_5 being in series with the anodes of V_3 and V_2. The audio-frequency voltages from the electro-magnetic microphones are amplified by means of the A.1134, a separate battery-actuated instrument consisting of two transformer-coupled A/F stages comprising one Class A voltage amplifier triode and one Class B (quiescent push-pull) power amplifier twin-pentode. The modulating output from the A.1134 is transferred to a step-down transformer T_1 which provides for the lesser degree of excitation, that is, compared with the inter-communication output, suitable for the control-grid circuit of a pentode valve V_3. The output from the anode of V_3 modulates the R/F carrier.

8. When electro-magnetic microphones were employed with the T.R.9D the voice voltages from them were applied, *via* a transformer, to the audio-frequency stages of the receiver R.1120 which formed part of that transmitter-receiver. The output from the final stage of the R.1120 was then one of three forms, namely, inter-communication, received signals, or modulating voltages for transfer to the stage V_3 of the transmitter portion. With the T.R.9F and its sub-modulator A.1134 the necessity for the inter-communication and modulating function of the associated receiver A/F stages disappears. The connexion which existed between the final stage of the receiver and the modulating stage of the transmitter is no longer needed but a junction is necessary to provide for the receiver independent H.T. supply. The I/C and telephone circuits now lead externally to the A.1134 and not internally to the transformers T_2 and T_1.

CONSTRUCTIONAL DETAILS

9. The only constructional details illustration of the transmitter T.1138 and the receiver R.1139 shown herein to supplement the illustrations given in the chapter in the T.R.9D is that of fig. 1 which shows the general appearance of the instrument. Bench wiring diagrams of the T.1138 and the R.1139 are given in figs. 3 and 4. The annotational references of fig. 2 have been preserved throughout.

10. Referring to figs. 3 and 4 and comparing them with the corresponding bench-wiring diagrams for the T.R.9D, it will be seen that the leads to the spills I/C and EXT. & REC. TELS on the contact bar have been removed and are now joined together. The lead from the top spill on the relay switch nearer to the oscillator valve has been removed and the remaining two spills have been short-circuited by a wire link. The lead to the spill H.T. + I/C has been removed on the receiver side only and connected to the REC. H.T. + spill.

VALVES AND BATTERIES

11. With the exception of the power amplifier V_9 which is a valve, type VR.118, the valves used in the T.R.9F are identical with those of the T.R.9D. The valve V_9 is biased at 3 volts. The batteries are also as specified for the T.R.9D. The amplifier A.1134 uses separate L.T. and H.T. supplies and therefore does not constitute an additional drain upon the transmitter-receiver power supply. As a precautionary measure, even when using the 20 Ah. 2-volt accumulator, this should be changed after *every* flight of approximately full duration. Subject to certain circuit modifications the T.R.9F may be used with a high impedance H.T. source such as a vibrator unit.

INSTALLATION

12. A typical installation diagram is given in fig. 5. The A.1134 has independent battery supplies when used with the T.R.9F. The amplifier should be installed in such a position that the necessary manipulation of plugs, sockets and key switch can be conveniently performed by the W/T operator.

CONDENSERS	C1, C2, C3, C4, C5, C6, C7, C8, C35, C9, C20, C34, C10, C13, C11, C17, C18, C16, C15, C21, C19, C31, C33, C26, C12, C14, C22, C32, C23, C25, C24, C27, C29, C28, C30
RESISTANCES	R1, R2, R3, R4, R23, R24, R5, R6, R7, R8, R9, R10, R11, R12, R13, R14, R15, R19, R16, R18, R17, R20, R21, R22
INDUCTANCES	L2, L3, L4, L5, L9, L6, L7, L8
MISCELLANEOUS	V1, S2, S1, T1, V3, V2, S3, S4, S5, SR1, SR2, SR3, SR4, T2, V4, V5, V6, V7, V8, V9

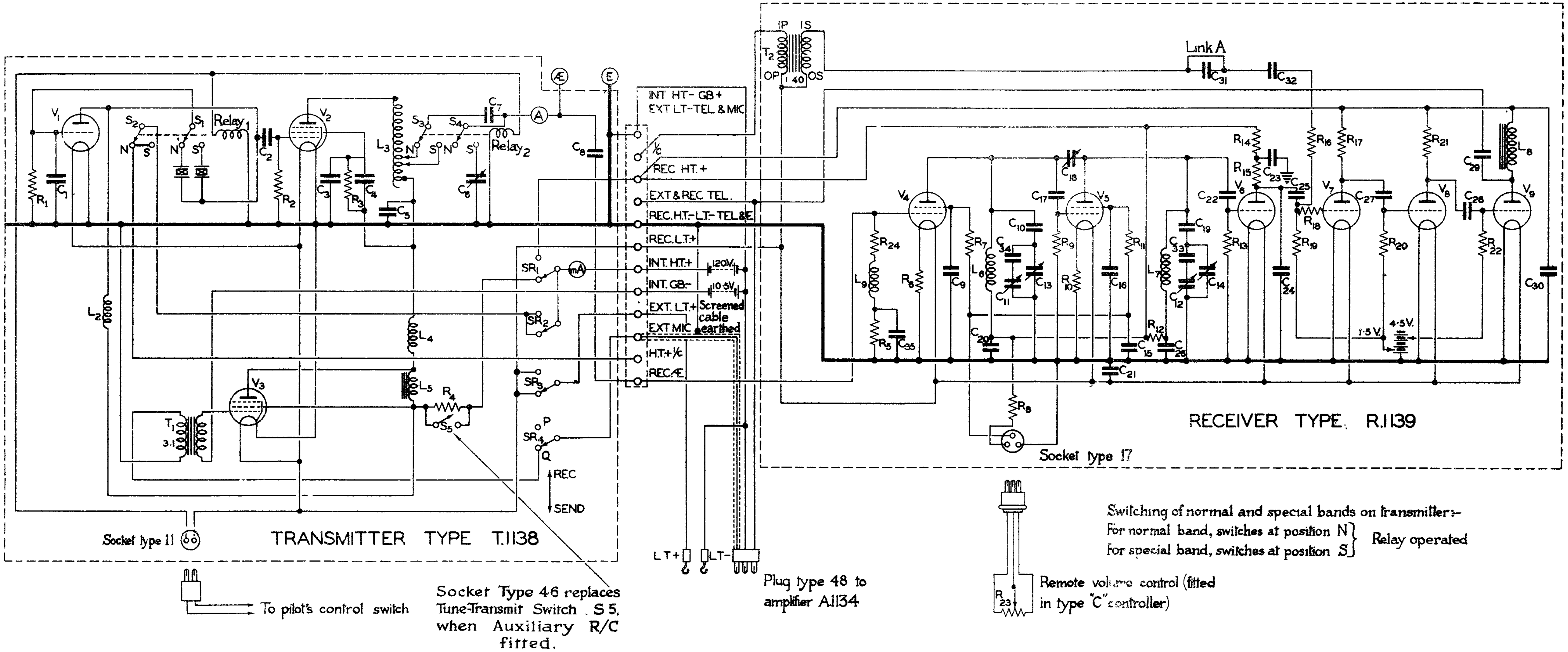

FIG. 2. T.R.9.F. THEORETICAL CIRCUIT DIAGRAM

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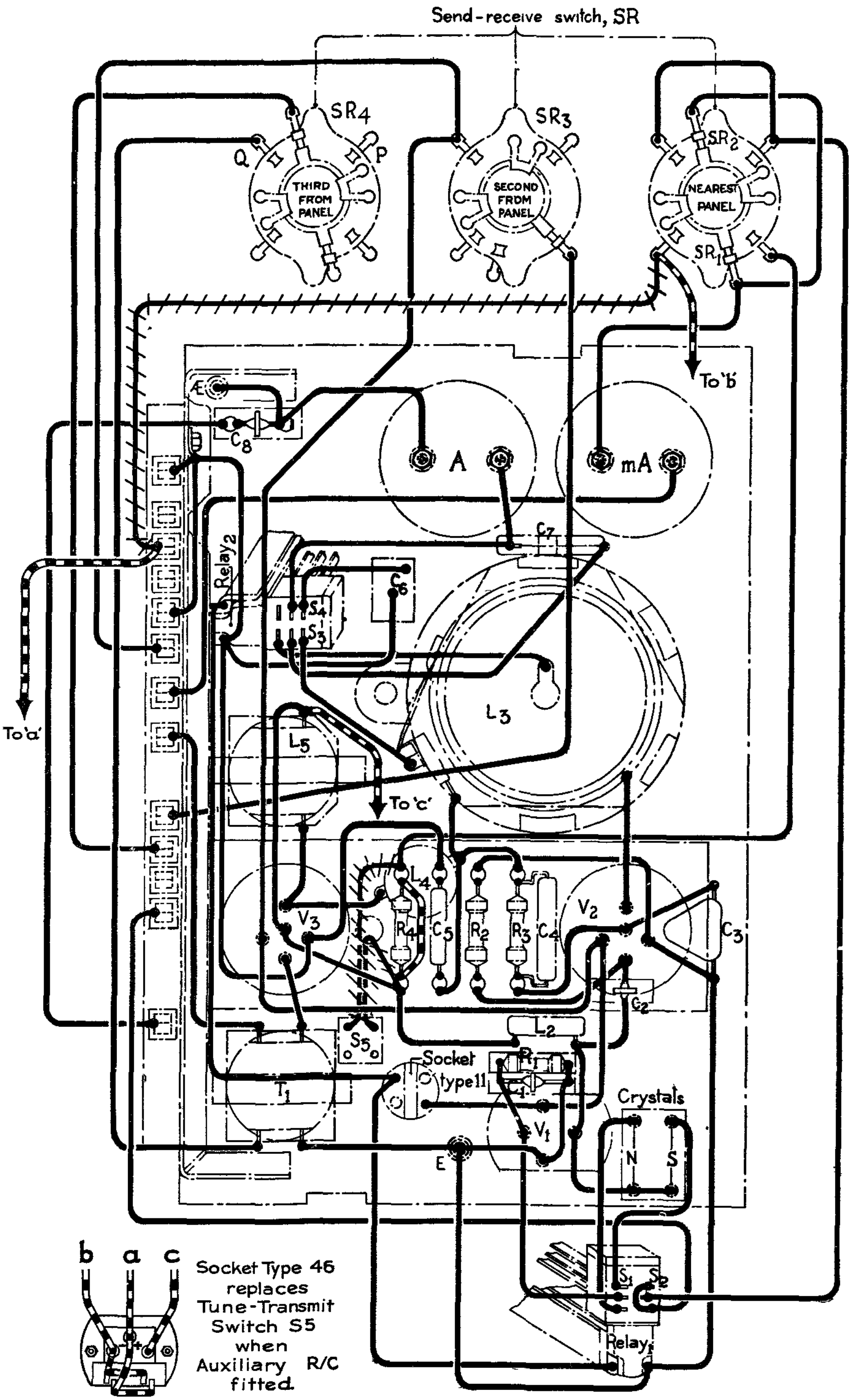

In Installations in which Auxiliary Remote Control is incorporated:– Represents NEW leads; REMOVED leads

FIG.3. BENCH WIRING DIAGRAM OF T.1138.

13. All microphone wiring must be carried out in screened twin-core wire the screen being bonded across wherever a break is made at the terminal points and all screens are earthed. The earth connexion of the A.1134 must be joined to the aeroplane earth or some point connected to it and this may be effected *viâ* the earth of the T.R.9F. The microphone negative must not be earthed when the A.1134 is used.

PRECAUTIONS AND MAINTENANCE

14. The elementary precautions associated with the use of crystal units and the restrictions imposed relative to the dismantling or repairing of them apply to this transmitter-receiver. Care should be taken to insert the correct frequency crystal, as indicated by the reference number, in the appropriate socket N or S.

15. The L.T. accumulators, both of the T.R.9F and the amplifier A.1134 should be recharged after each flight of approximately full duration and the H.T. battery voltage should be tested at the same time. Renewal of the T.R.9F H.T. battery should be made if the voltage on load falls below 110 volts. The H.T. battery of the amplifier A.1134 must be replaced if it has fallen to 100 volts. The correct values for grid-bias voltage are:—the T.R.9F transmitter modulator stage, 10·5 volt negative, the A.1134, 3 volts negative on the primary stage, and 6 volts negative on the output stage.

16. A slight chirp will be heard when the amplifier A.1134 is switched either on or off. This is a transient effect due to the warming-up of the valves and is quite normal. For other relevant notes on precautions and maintenance, reference should be made to the appropriate chapters, namely those on the T.R.9D and the amplifier A.1134, in this publication.

OPERATION

17. The transmitter portion of the T.R.9F is crystal-controlled and is, in consequence, not dependent upon an outside monitor for the frequency determination of its emitted carrier. The service standard type of crystal holder is utilized. An illustration of the T.R.9F showing the front panel controls is given in fig. 1.

Transmitter T.1138

18. The T.R.9F is pre-tuned prior to flight. The transmitter T.1138 *must* be tuned before the receiver R.1139. The procedure to be followed is set out below. Remove the transmitter (1) from the transit case and insert a 120-volt H.T. battery and a 15-volt grid-bias battery in the battery tray (2), connecting the appropriate plugs. Set the grid bias to 10·5 volts negative.

19. Switch OFF the SEND-RECEIVE switch SR and, if fitted, (*see* paras. 33–36) the switch S_5 should be at TUNE. Insert the valve V_1 and replace the transmitter in the transit case. Plug the appropriate crystal into the NORMAL socket, labelled N. Access to the crystal holder and to the holder for the valve V_2 is through the door (3) at the bottom left-hand corner of the instrument. Insert the valves V_2 and V_3 in position. The holder for V_3 will be found inside the smaller door (4). Connect the L.T. leads (5) to the 2-volt accumulator. The tumbler switch, type B, single unit, in the pilot's cockpit should be turned to NORMAL. Connect the aerial (6) and the earth (7) terminals to the appropriate leads. Plug in the Remote Volume control (13) and microphone/telephone lines (14) by means of the plugs and sockets provided.

20. Switch SR to SEND and S_5 to TRANSMIT. Tune by means of the aerial inductance control (8) until the aerial current as read on the ammeter A rises to a maximum. The total anode current on SEND will be in the region of 25 milliamperes. Modulation may now be checked by connecting the amplifier A.1134 to the transmitter and shouting into the electro-magnetic microphone. There should be, approximately, an aerial current increase of 30 per cent.

21. The procedure for tuning the transmitter to the SPECIAL frequency is as follows:—Insert the appropriate crystal into the S position and place SR at SEND. The tumbler switch in the cockpit should be turned to SPECIAL. Alternatively, the two-pole socket (9) can be short-circuited with a length of wire. The switch S_5, if fitted, is turned to TUNE and the control (10) engraved SAE COARSE is adjusted, in conjunction with that (11) marked SAE FINE, until the aerial current as read on A gives a maximum reading (probably about 0·12 amp.). If two settings of SAE FINE are obtained that which gives the lower reading on the ammeter A should be used. The transmitter is then tuned to the SPECIAL frequency and modulation may be tested as for the NORMAL frequency. It may be found necessary, on turning back to the NORMAL, to make some slight adjustment of the control (8) of L_3. The transmitter is now set up on the two frequencies, the one to be transmitted when the pilot's switch is NORMAL and the other when the switch is SPECIAL, both being modulated. Turn S_5, if fitted, to TRANSMIT and the aerial and input currents should rise to the values specified in the table below. Modulation applied should give an approximate rise in aerial current of 30 per cent.

22. For the purpose of bench tuning an artificial aerial, type 3, or a 100$\mu\mu$F condenser, type M may be substituted for the aerial and earth. The capacitance of the artificial aerial should be set to 100$\mu\mu$F. The following table may be used as a guide for preliminary settings. It should be noted that the figures given are applicable to the T.R.9F proper.

Crystal frequency Mc/s	Crystal in Socket	Tumbler switch in pilot's cockpit	NORMAL aerial tuning		SPECIAL aerial tuning		Input mA	Output amperes A
			Turns	Degrees	SAE COARSE	SAE FINE		
6·66	N	OFF	5	350			24	0·23
5·50	N	OFF	9	4			24	0·23
4·25	N	OFF	13	200			24	0·23
6·66	S	ON			4	20	25	0·22
5·50	S	ON			6	8	25	0·22
4·25	S	ON			10	5·5	25	0·22

Receiver R.1139

23. Before setting up the R.1139 it is of primary importance to realize that the volume control affects the tuning and that, in consequence, the receiver should always be set up with the volume control at MAXIMUM. It is essential that the instrument should be monitored to an initially weak signal. An endeavour to set up the receiver on any strong signal, as for example, the signal from a T.1087 at about 500 yards distant and with the volume control set to obviate "swamping", is a sure cause of operational failure.

24. The transmitter T.1138 MUST be tuned before the receiver R.1139. The aerial circuit of the transmitter constitutes the input circuit to the grid of the receiver first H.F. valve so the receiver aerial circuit is already tuned before setting-up takes place.

To set up the receiver with R/T tester, crystal monitor or wavemeter

25. It is useless to set up the R.1139 on any transmission which has not been crystal monitored or referred to a similar standard. If a crystal monitor or wavemeter is used it must be capable of producing a modulated signal. Information on the incorporation of a crystal in the wavemeter, type W.39, or in R/T testers can be found elsewhere in this publication. Preferably the receiver should be set up by the use of the crystal-controlled R/T Tester, type 1, Unit A. Either the crystal from the T.R.9F or one of identical frequency should be used. The tester should be taken inside the aeroplane and placed conveniently close to the T.R.9F. The required degree of attenuation of the tester signal can be obtained by closing the lid which affords effective screening. The emitted signal can be reduced to R1 strength at a maximum gain.

26. Insert the receiver valves and connect the grid-bias battery. The grid-bias voltage for V_7 and V_8 is 1·5 volts and for V_9, 3 volts. Switch off SR before inserting the valves or opening the case. Place the pilot's fine tuning control to its central position. Then switch on the R/T Tester.

27. Rotate the controls of C_{13} and C_{14}, keeping them approximately numerically in step, until a signal is audible. The control of the regeneration condenser C_{18} will probably need adjustment. If the receiver breaks into violent oscillation unscrew the regeneration control until just beyond the point of oscillation and re-tune. The reception of the signal at its best will probably be a matter of trial and error and the R/T Tester lid will be adjusted accordingly. On no account should either volume control or fine tuning control be altered at this stage.

28. When, by adjustment of the tuning and regeneration controls, the receiver is satisfactorily tuned, the regeneration control should be turned back sufficiently to ensure that oscillation does not occur over the entire range of the fine tuning control and the controls of C_{13} and C_{14} readjusted slightly to give maximum strength. The regeneration control must not be moved again.

To set up the receiver with another T.R.9F

29. In default of a proper monitor and providing an instrument can be spared, a T.R.9F should be installed in a ground station for setting up aeroplane receivers. When so used a condenser of about 0·0001μF should be fixed across the aerial and the earth. During the setting-up, modulation may be obtained by inserting a condenser of 0·001μF between the Mic+ and Tel+ contacts.

To set up the receiver with no source of transmission

30. If no source of transmission whatever is available, initial setting-up of R.1139 can be effected but the method demands quiet conditions and some practice. Having first tuned the transmitter so that the aerial circuit is set to the required frequency, place the receiver volume

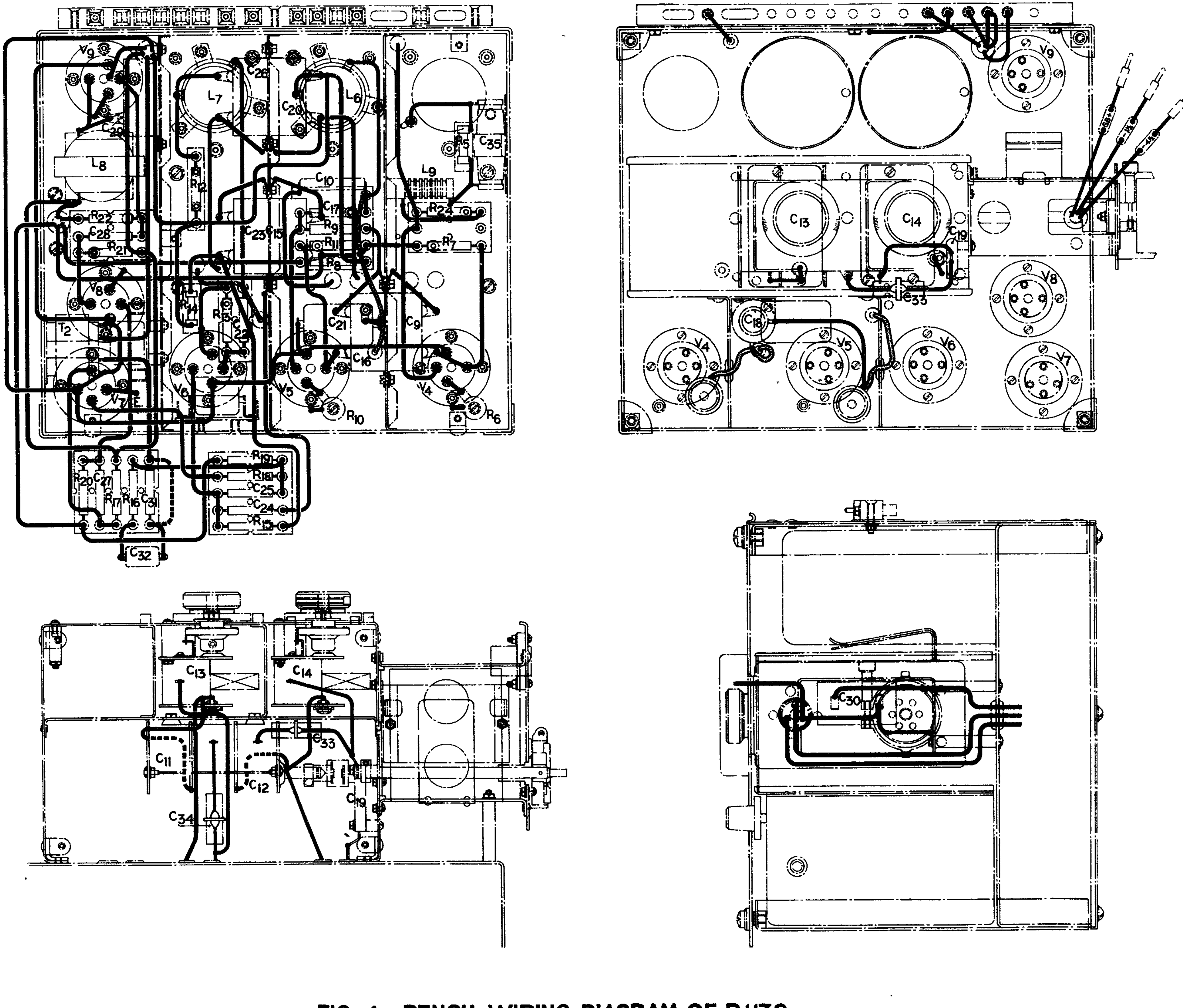

FIG. 4. BENCH WIRING DIAGRAM OF R.1139

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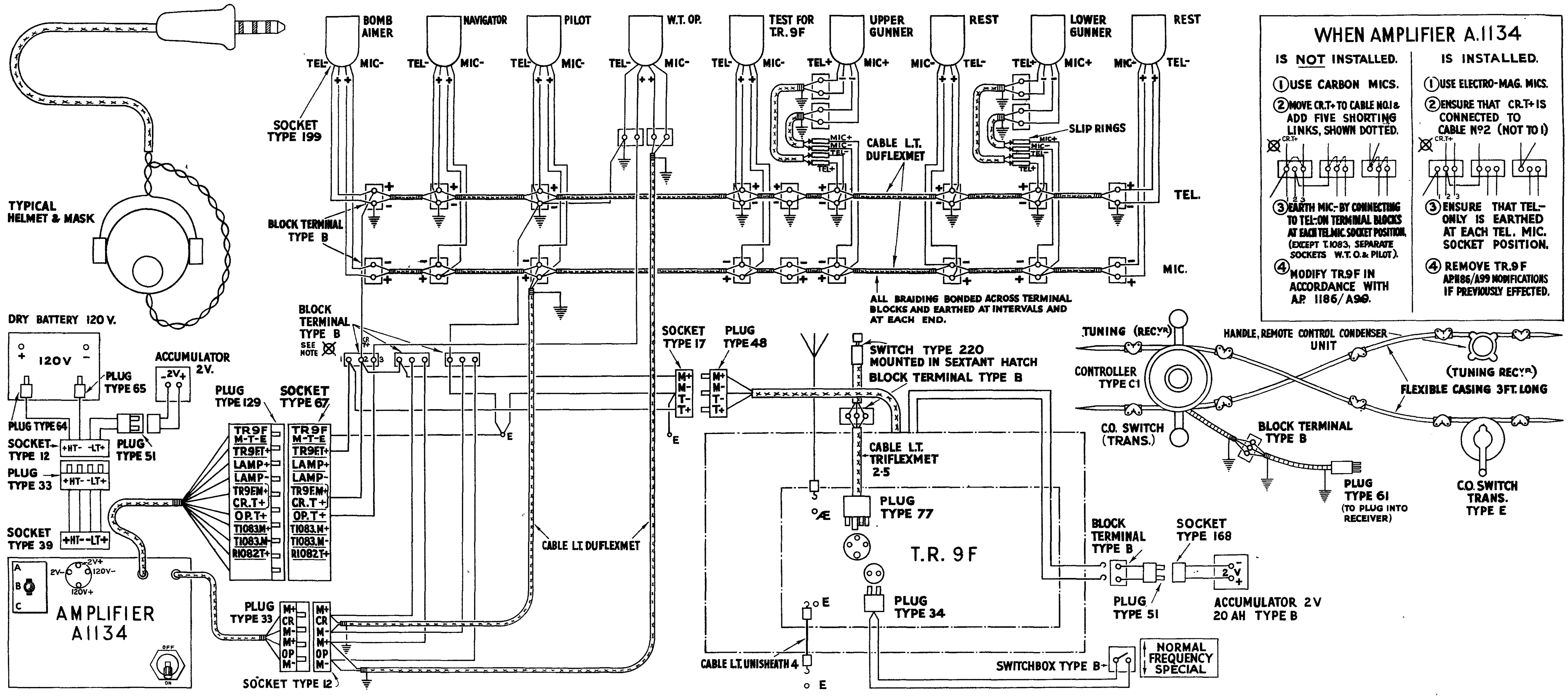

FIG. 5. T.R. 9F. INSTALLATION DIAGRAM

control to MAXIMUM and the fine tuning to the central position. Turn the regeneration control to a position just off oscillation point. Then slowly adjust C_{13} and C_{14}, keeping them in step, until the "mush" background of R.1139 rises to a maximum intensity. As the true tuning is determined by the aerial circuit of the transmitter the aerial inductance control (8, fig. 1) should be rotated to discover whether the intensity increases. If so C_{13} and C_{14} must be readjusted. The two H/F circuits are then tuned to the same frequency as the aerial circuit. It is important that the regeneration control should be set just below oscillation point, a condition which imposes constant readjustment whilst searching. When tuning has been completed it is desirable to turn back the regeneration control one turn.

Operation in the air

31. Normally the pilot has control of the SEND-RECEIVE switch, fine tuning and volume control, which are all mounted together in the controller type C. The tumbler switch which selects one of the two transmitter frequency bands, N or S, is also at this position.

32. When the receiver is used on one frequency only, the fine tuning handle on the controller should not need adjustment as the receiver tuning is determined by the transmitter circuit. A change from one receiver frequency to another can only be made if the receiver is pre-tuned to *both* frequencies and the settings determined and recorded. Such a change would necessitate an adjustment of the fine tuning handle after the new frequency settings had been made.

AUXILIARY "SEND-RECEIVE" REMOTE CONTROL

33. Where it would be inconvenient to fit a manual control, a quick-action auxiliary remote control of the SEND-RECEIVE switching of the T.R.9F is provided in some installations but at one point only. This modification is described in Leaflet A.109 of A.P.1186, Vol. II, Pt. 1. Transmitter—receivers so modified are labelled on the crystal cover (3, fig. 1).

The switch, type 220

34. The auxiliary control is in the form of a small two-way plunger switch, type 220, connected to the T.R.9F by a flexible metal-braided lead and operated by the member of the crew taking SEND-RECEIVE control.

35. The modification entails the bringing out of three leads, H.T. positive supply and the transmitter and receiver H.T. positive feeder lines, *via* a socket, type 46 to a two-way plunger switch, type 220. The socket type 46 replaces the TUNE-TRANSMIT switch S_5, type 77. The L.T. battery is connected to both T.1138 and R.1139 when the manual SEND-RECEIVE switch is placed at either SEND or RECEIVE. With the pilot's control in the RECEIVE position, the H.T. positive is connected to the receiver H.T. positive by means of two spring-loaded contacts in the switch, type 220. On pressing the plunger the H.T. positive is switched from the receiver to the transmitter. If the extension lead plug, type 77, is removed from the T.1138, the spring contacts in the socket, type 46, restore the normal circuit. The modification is shown in fig. 3.

Operation

36. In installations where this auxiliary control is fitted, the manual control may be used in the normal way. To bring the auxiliary control into operation place the manual control to RECEIVE. The manual control must remain in this position whilst the auxiliary is being operated. To change from RECEIVE to TRANSMIT press the switch, type 220. The manual controller has, at all times, master control of switching to TRANSMIT. To switch off the T.R.9F place the manual control switch to the OFF position.

AERIAL MATCHING UNIT, TYPE 9
(Stores Ref. 10A/12025)

37. An aerial matching unit, type 9, has been introduced for use with the T.R.9F to afford effective matching in the case of an aerial system in which the combined length, in feet, of the aerial and earth leads exceeds a value determined by the formula $\frac{200}{f}$, where f equals the operation frequency expressed in megacycles. As an example, the unit should be used for 5·0 megacycles transmission with an aerial system exceeding 40 feet.

38. The aerial matching unit, type 9, consists of a variable condenser of 0·003μF maximum capacitance contained in a well-insulated box. It is mounted close to the aerial terminal of the T.R.9F and is inserted in series with the aerial. Full details will be found in A.P.1186, Vol. II, Pt. 1.

39. To adjust the unit, the SPECIAL frequency should always be tuned first. Set the SPECIAL frequency fine-tuning condenser S.AE FINE (11, fig. 1) to zero degrees and lock in position by means of the knurled locking screw (12). Tune the transmitter to SPECIAL frequency by adjusting the

aerial inductance control (8), using the condenser of the aerial matching unit, type 9, as a fine tuning control. Due to the possibility of obtaining several different LC combinations with this unit in circuit, the optimum reading on the ammeter A can only be determined by trial and error. When the best position is obtained lock the condenser.

40. To tune for the NORMAL frequency use the inductance control (8) only, leaving the matching unit condenser locked in the position arrived at for the SPECIAL tuning. The adjustments for the SPECIAL and NORMAL frequencies are slightly interdependent and it may be necessary to repeat the above sequence of operation for final adjustment.

THE MODIFIED (INTERIM) T.R.9F

41. Reference has been made in this chapter to the "interim" (carbon microphone) T.R.9F evolved for use pending supplies of the A.1134 and the electro-magnetic microphones, type 19. Precise instructions for the modifications necessary are given in Leaflet A.99 of A.P.1186, Vol. II, Part 1.

42. The principal alterations required are to ensure that I/C is obtainable on both SEND and RECEIVE, that modulation is effected on both frequencies, that the transformer T_1 is connected to the output of R.1139 to utilize the amplification of the audio-frequency stages and that the output valve of R.1139 is changed from a V.R.22 to a V.R.118 tetrode (biased to 3 volts negative).

43. The short-circuiting link A across the $30\mu\mu$F condenser C_{31} is removed and the $0{\cdot}002\mu$F condenser C_{32} is short-circuited. A resistance of 250 ohms is connected across the microphone circuit to maintain a minimum load in this circuit. This resistance is connected between the contact on SR_4 which joins to the MIC+ contact and the Earth terminal on the side of the chassis.

44. The same general principles of setting-up, pre-tuning and operation of the transmitter and the receiver apply as for the T.R.9F. In both SEND and RECEIVE positions the L.T. is "made" to all valves so it is advisable to have a stand-by 2-volt accumulator. A careful watch should be kept on the state of the H.T. battery, which must not be permitted to fall below 110 volts on load. Grid-bias batteries should also be periodically checked.

THE T.R.9F MODIFIED FOR USE WITH VIBRATOR UNIT

45. When the T.R.9F is used with a H.T. source of high impedance nature, such as a vibrator unit, certain modifications are necessary to provide stability. These modifications are fully described in the Leaflet A.125 of A.P.1186, Vol. II, Part 1 and entail the fitting of a R/F filter between the detector valve V_6 and the first A/F valve V_7, the decoupling of the first A/F stage and the provision of a permanent load across the primary of the microphone transformer to prevent instability when the microphones are open-circuited.

46. The resistance of 250 ohms to which reference was made in para. 43 is retained in circuit. The resistance R_{17} (fig. 2) is replaced by one of 50,000 ohms, a 20,000 ohm resistance is inserted between R_{17} and R_{21} and a 250,000 ohm resistance is connected between the anode of V_6 and R_{15}. A $50\mu\mu$F condenser is inserted between the high potential end of the 250,000 ohm resistance and earth. A $0{\cdot}5\mu$F condenser is placed between R_{17} and earth.

47. When setting-up, or operating, the T.R.9F so modified, it is essential that the precaution is taken to maintain at least *two* pairs of telephones in the receiver output.

APPENDIX

NOMENCLATURE OF PARTS

The following list of parts is issued for information only. When ordering spares for this transmitter-receiver the appropriate section of AIR PUBLICATION 1086 must be used.

Ref. No.	Nomenclature	Qty	Ref. in fig. 2	Remarks
10D/11740	Transmitter-receiver T R 9F			
	Comprising:—			
10D/11500	Amplifier A 1134	1		*See* A.P.1186, Vol. I, Sect. 4, Chap. 2
10D/11743	Case	1		Fitted with:— 10A/10477, Bar, contact leads and 10H/7383, Plug, type 48
10A/10477	Bar, contact	1		
10A/9172	Cover, contact case	1		
10D/11741	Transmitter, type T.1138	1		For details see below
10D/11742	Tray, battery	1		
10A/9175	Receiver, type R 1139	1		For details see below
	Transmitter, type T 1138			
	Principal components:—			
10A/7818	Ammeter, thermo 0—0·5	1	A	
10A/10474	Bar, contact, type 8	1		
10H/9227	Base, terminal	1		
	Choke,			
10C/9206	H/F, type 34	1	L_2	
10C/10117	H/F, type 37	1	L_4	
10C/7912	L/F, type G	1	L_5	
10D/10473	Coil, aerial	1	L_3	
	Condenser,			
10C/8009	Type 132	1	C_3	0·0005 μ F
10C/9179	Type 280	1	C_5	0·001 μ F
10C/9185	Type 286	1	C_4	0·01 μ F
10C/9208	Type 289	1	C_7	0·002 μ F
10C/10394	Type 404	1	C_2	10 $\mu\mu$ F
10C/10476	Type 411	2	C_1, C_8	50 $\mu\mu$ F
10F/10111	Head, switch	1		
	Holder,			
10H/10478	Crystal	1		
10H/9615	Valve, type S	2		5-pin for V_2 and V_3
10H/10479	Valve, type X	1		4-pin for V_1
10A/7820	Milliammeter 0—30	1		
	Plate,			
10H/9195	Guard	1	2	For valve holders
10F/10112	Stop	1		
10H/9508	Plug, type 77	1		For aux. R/C
10F/10480	Relay, magnetic, type 42	2	$Relay_1$, $Relay_2$	
	Resistance,			
10C/7956	Type 103	1	R_4	5,000 ohms
10C/8020	Type 112	1	R_2	30,000 ohms
10C/8021	Type 113	2	R_1, R_3	20,000 ohms
10C/123	Type 591	1		250 ohms (*see* paras. 43 and 46)
	Socket,			
10H/7276	Type 11	1		
10H/9326	Type 46	1		Replaces S_5 for aux. R/C
	Switch,			
10F/10113	Type 137	1	SR_1, SR_2, SR_3, SR_4	
10F/8142	Type 77	1	S_5	
10A/10497	Transformer, L/F, type 19	1	T_1	

Ref. No	Nomenclature	Qty.	Ref. in fig. 2	Remarks
	Transmitter-receiver T.R.9F (*contd*)			
	Receiver, type R.1139			
	Principal components:—			
10A/10475	Bar, contact	1		
	Base, terminal,			
10H/9190	1-way, type A	1		Engraved 16
10H/9191	2-way	1		Engraved 14, 15
10H/9192	3-way, type A	1		Engraved 1, 2, 3
10H/9224	3-way, type B	1		Engraved 22, 23, 24
10H/9193	5-way, type A	1		Engraved 4, 5, 6, 7, 8
10H/9225	5-way, type B	1		Engraved 9, 10, 11, 12, 13
10H/9226	5-way, type C	1		Engraved 17, 18, 19, 20, 21
10D/9189	Can, coil	3		
	Choke,			
10C/10117	H/F, type 37	1	L_9	
10C/9384	L/F, type B	1	L_8	
10D/9187	Coil, anode			
	Condenser,			
10C/7902	Type 121	1	C_{22}	0·0001 μ F
10C/7906	Type 125	2	C_{10}, C_{19}	0·01 μ F
10C/8388	Type 178	1	C_{32}	0·0002 μ F
10C/9178	Type 279	1	C_{17}	0·0003 μ F
10C/9179	Type 280	4	C_{24}, C_{25}, C_{27}, C_{28}	0·001 μ F
10C/9180	Type 281	1	C_{30}	2 μ F
10C/9181	Type 282	8	C_9, C_{15}, C_{16}, C_{20}, C_{23}, C_{26}, C_{29}	
10C/9182	Type 283	1	C_{18}	Miniature variable
10C/9184	Type 285	1	C_{31}	30 $\mu\mu$ F
10C/9185	Type 286	1	C_{21}	0·01 μ F
10C/9197	Type 287	1	C_{11}, C_{12}	48 $\mu\mu$ F
10C/9198	Type 288	2	C_{13}, C_{14}	0·000233 μ F
10C/10532	Type 421	1		50 $\mu\mu$ F (*see* para. 46)
10C/10554	Type 423	1	C_{35}	0·1 μ F
10C/10948	Type 429	2	C_{33}, C_{34}	20 $\mu\mu$ F
10H/9194	Holder, valve, type R	6		
	Plate,			
10H/9195	Guard	6		For valve holders
10H/9196	Guide	6		For valve holders
	Knob,			
10A/9202	Type 1	2		
10A/9201	Type 2	2		
10H/9176	Plug, type 76	3		Grid-bias battery
	Resistance,			
10C/7955	Type 102	1	R_{12}	2,000 ohms
10C/7957	Type 104	1	R_{24}	10,000 ohms
10C/8016	Type 108	2	R_5, R_{16}	0·5 megohm
10C/8017	Type 109	1	R_{18}	2 megohms
10C/8018	Type 110	2	R_{13}	0·25 megohms (*see* para. 46)
10C/8019	Type 111	1	R_{15}	100,000 ohms
10C/8021	Type 113	5	R_7, R_8, R_{11}, R_{14}, R_{17}	20,000 ohms (*see* para. 46)
10C/8117	Type 123	4	R_9, R_{19}, R_{20}, R_{22}	1 megohm
10C/7910	Type 130	2	R_6, R_{10}	1·5 ohms
10C/8519	Type 145	1	R_{21}	200,000 ohms
10C/11026	Type 400	1		50,000 ohms (*see* para. 46)
10A/9199	Ring, clamp	1		For R/C attachment
10A/9200	Screw, clamp	1		For 10A/9199
10A/7394	Socket, type 17	1		For R.V.C.
10A/7916	Transformer, type 51	1	T_2	
10A/9203	Wheel, index	1		For R/C attachment

Ref. No.	Nomenclature	Qty.	Ref. in fig. 2	Remarks
	Transmitter-receiver T.R.9F (*contd.*)			
	Receiver, type R.1139 (*contd.*)			
	Principal components (*contd*)			
	Accessories:—			
	Accumulator,			
5A/1386	Type B, 2-V., 14 Ah. or	1		According to operational requirements
5A/1387	Type B, 2-V., 20 Ah.	1		
10A/12025	Aerial matching unit, type 9	1		
	Battery,			
5A/1383	*Dry, 4½-V.	1		Receiver grid bias
5A/1338	*Dry, 15-V.	1		Transmitter grid bias
5A/1333	*Dry, 120-V.	1		H.T.
	(*or appropriate overseas pattern)			
10D/10993	Case, transit	1		For complete transmitter-receiver
	Contact,			
10A/10984	Type 1	1		12-volt master
	or			
10A/10994	Type 2	1		24-volt master
10A/10985	Type 3	1		12-volt remote
	or			
10A/10995	Type 4	1		12-volt remote
10A/10988	Dummy	1		Fitted with:— 10H/8118, Plug, type 62
10K/ as required	Crystal unit			
10H/10969	Plug, type 118	1		
5C/543	Switchbox, type B, 1 unit	1		
10F/108	Switch, type 220	1		For aux. R/C
	Valve,			
10E/7607	Type V.R.18	2	V_4, V_5	
10E/7738	Type V.R 21	2	V_7, V_8	
10E/8239	Type V.R.27	1	V_6	
10E/	Type V.R.118	1	V_9	
10E/10945	Type V.T.50	1	V_1	
10E/10946	Type V.T.51	2	V_2, V_3	
10A/10989	Microphone, type 19			
	Comprising:—			
10A/10990	Microphone, type 18	1		Electro-magnetic
10H/10353	Cord, instrument, type Q	1		
10H/10991	Plug, type 119	1		

CONCISE DETAILS OF
TRANSMITTER-RECEIVER T.R.9F

PURPOSE OF EQUIPMENT	For multi-seater aeroplanes
TYPE OF WAVE	R/T
FREQUENCY RANGE	6·6 Mc/s to 4·3 Mc/s
FREQUENCY STABILITY	Quartz crystal controlled
CRYSTAL MULT. FACTOR	Fundamental
PERCENTAGE MODULATION	90 per cent.
MAXIMUM SENSITIVITY	5 milli-watts output into 20,000 ohms load with 10 microvolts input at 400 cycles modulated 25 per cent.
SELECTIVITY	—
OUTPUT IMPEDANCE	Variable-common aerial circuit for transmitter and receiver
AMPLIFIER CLASS	Transmitter T.1138, Class C
MICROPHONE TYPE	Electro-magnetic, type 19 with amplifier A.1134
VALVES	*Transmitter T.1138* Oscillator, V.T.50 (Stores Ref. 10E/10945) Modulator, V.T.51 (Stores Ref. 10E/10946) Power amplifier, V.T.51 (Stores Ref. 10E/10946) *Receiver R.1139* R/F (2) V.R.18 (Stores Ref. 10E/7607) Detector, V.R.27 (Stores Ref. 10E/8239) A/F amplifier (2). V.R.21 (Stores Ref. 10E/7738) Power amplifier V.R.118 (Stores Ref. 10E 88)
POWER INPUT	Approximately 24 mA. at 120 volts H.T. Transmitter, L.T. 0·5 amp. at 2 volts. Receiver, L.T. 0·9 amp. at 2 volts. Total operating current, including relays and microphones, 1·6 amp.
POWER OUTPUT	0·27 amp. to 0·29 amp. into transmitter aerial
STORES REF. NO.	10D/11740
APPROXIMATE OVERALL DIMENSIONS	LENGTH 19½ in. WIDTH 13¼ in. HEIGHT 9½ in.
WEIGHT	Excluding batteries 28 lb. With valves and dry batteries 40 lb. With remote control equipment, 67 lb.
ASSOCIATED EQUIPMENT	Amplifier, A.1134 (Stores Ref. 10U/1150) Microphone, type 19 (Stores Ref. 10A/10989) Battery, dry, 120 v. (Stores Ref. 5A/1333 or 5A/1615) Battery, dry, 15 v. (Stores Ref. 5A/1338) Battery, dry, 4½ v. (Stores Ref. 5A/1383) A Crystal monitor or R.T. Tester, type 1, Unit C (Stores Ref. 10S/35) or R.T. Tester, type 1, Unit A (Stores Ref. 10S/7185) modified

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A.L. No. 28)

SECTION 2, CHAPTER 6

TRANSMITTER-RECEIVER T.R.1148A

Contents

List of Illustrations

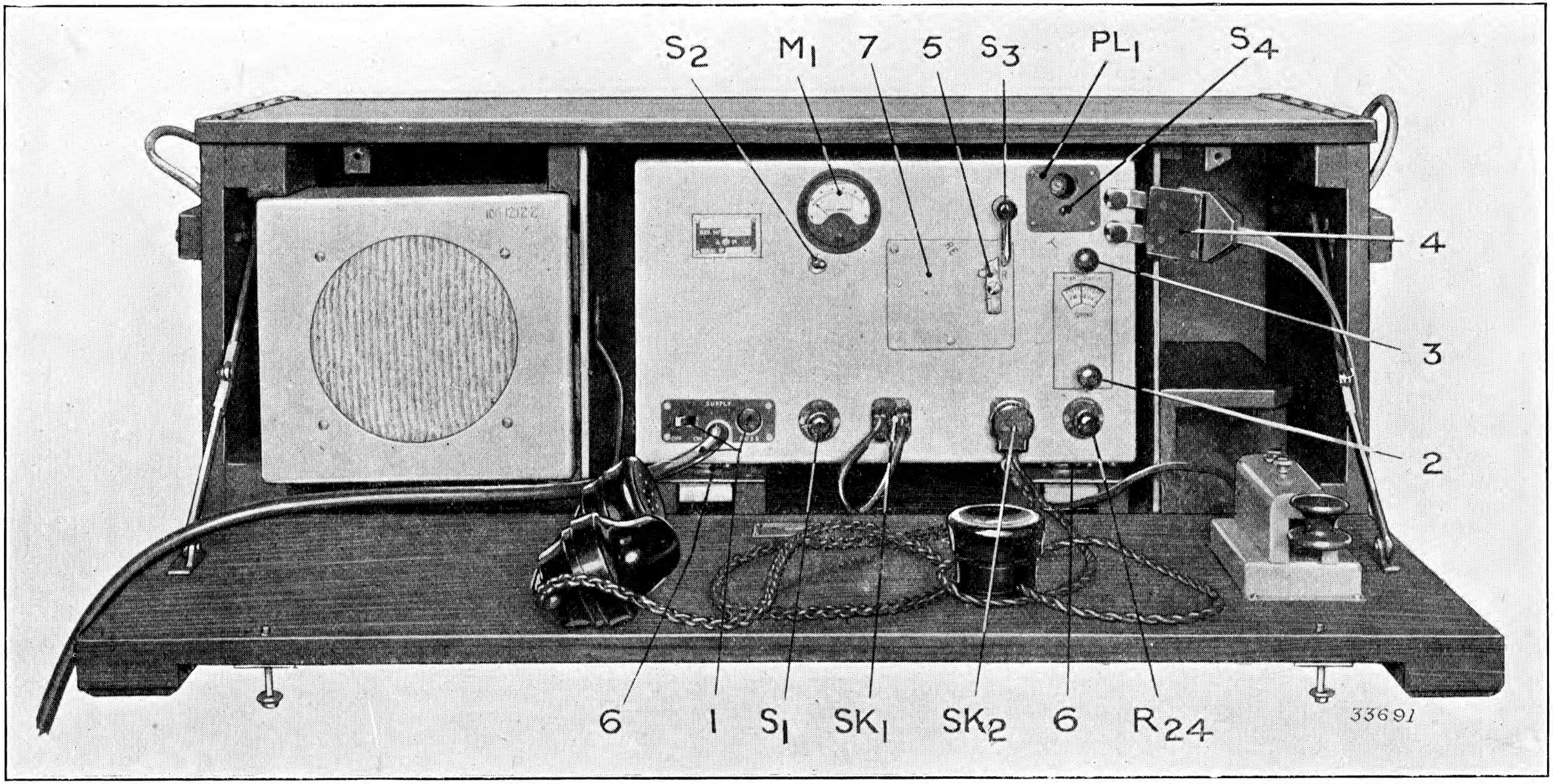


Fig. 1. Transmitter-receiver T.R.1148A.

TRANSMITTER-RECEIVER T.R.1148A

(Stores Ref. 10D/285)

INTRODUCTION

1. This instrument consists of a two-valve transmitter and a three-valve receiver, contained in a single metal case, and covers a frequency range of 60 Mc/s to 65 Mc/s. It is intended for the low power transmission and reception of M.C.W. and telephony over a limited area by shore stations of Balloon Command. The carrier power in the aerial circuit is three to five watts, and under normal conditions, good reception of speech up to a distance of approximately 15 miles can be obtained.

2. A special vertical dipole aerial and mast, together with a wooden transit case, are provided with each instrument. The mast is divided into five sections, and being constructed of metal, acts to a certain extent as a reflector, so that both transmission and reception are partially directional.

3. A telephone handset is provided with each instrument together with an external loudspeaker, which may be plugged into the receiver if desired. Reception by telephone or loudspeaker or both can thus be obtained, the loudspeaker being primarily intended for use as a calling device. The transmitter-receiver and loudspeaker fit into a wooden transit case, from which the equipment can conveniently be operated. Space is also provided for carrying various spare components including valves.

4. The instrument can be operated either from a 6-volt accumulator in conjunction with a power unit, type 41 (Stores Ref. 10K/35) or from A.C. mains with a power unit, type 38 (Stores Ref. 10K/25) and can thus be used as a mobile station or as a fixed station. The two power units are interchangeable, and space is provided inside the metal case to accommodate whichever one may be in use. The power unit, type 38, is designed to work from a mains supply of 110-240 volts, 40-100 cycles.

5. The overall dimensions of the transmitter-receiver are approximately 9 in. by 8½ in. by 15 in. and the weight 44 lb. with either power unit. The dimensions of the wooden transit case housing the instrument and loudspeaker are 36 in. by 12 in. by 13½ in., whilst those of the case for the aerial equipment are 70 in. by 15½ in. by 8 in.

GENERAL DESCRIPTION

Transmitter-receiver

6. A theoretical circuit diagram is given in fig. 2 and it will be observed that a total of five valves is employed, two in the transmitter and three in the receiver. Two acorn type valves are used in the receiver, since compactness is one of the primary considerations.

7. Referring to the transmitter portion, the aerial feeder inductance L_4 is coupled to the anode of the oscillator valve V_2 *via* the inductance L_3, and tuning is effected by means of the variable condenser unit C_{11}, whilst neutralizing is controlled by the small variable condenser C_{10}. A special stabilizing arrangement FS_1 is incorporated, and can be rapidly adjusted to the desired frequency.

8. The oscillator valve is modulated in its anode circuit *via* the transformer T_2 from the modulator valve V_1. Transmission of telephony or M.C.W. can be selected by means of the switch S_1. In the telephony position, the grid of V_1 is connected to the microphone transformer T_1, whilst in the telegraphy position it is connected to the tone generator circuit consisting of the capacitances C_1 to C_4 and the resistances R_1 to R_5.

9. When operating on M.C.W., it will be observed that the key short-circuits the tone generator network during the space position. This method of keying has the advantage that when the signal is being received, the characteristic super-regenerative hiss is suppressed during the spacing period, since the carrier continues to be radiated whilst modulation is not taking place.

10. The switch S_2 connects the meter M_1 in the anode circuit of V_1 or V_2, so that the current of either valve may be measured. A decoupling circuit consisting of the two R.F. chokes L_5 and L_6 and the condensers C_{12}, C_{13} and C_{14} is incorporated in the heater circuit of the two valves.

11. The receiver operates on the super-regenerative principle and consists of one stage of R.F. amplification, a self-quenching detector and a double triode giving a stage of A.F. amplification and output.

12. The first valve V_3 is a R.F. pentode, and has connected to its grid the inductance L_7 *via* the grid stopper resistance R_{17}, whilst tuning is effected by means of the series-gap condenser arrangement C_{15}. A slight flattening of tuning is introduced by the inclusion of the small capacitance C_{16} across L_7, which is variably coupled to the aerial inductance L_8. The anode of V_3 contains a tuned circuit, which consists of the inductance L_{10} and the series-gap condenser unit C_{25}, whilst this arrangement also incorporates a small fixed condenser C_{26} connected across the tuned inductance. The feed to the grid of the succeeding valve V_4 is taken *via* C_{29}. The two condensers C_{15} and C_{25} are ganged and operated by a single tuning control.

13. The detector valve V_4 is a triode, and its anode circuit can be traced through the inductance L_9, the resistance R_{20} and the R.F. choke L_{11}, to one end of the primary of the transformer T_3. The other end of the primary is connected to the variable resistance R_{23}, by means of which the voltage applied to the anode of V_4 can be adjusted. Across the secondary of T_3 is connected the variable resistance R_{24}, which acts as the A.F. gain control, the sliding contact being connected *via* the grid stopper R_{26} to V_5. Both V_3 and V_4 are acorn type valves.

14. The valve V_5 is a double triode, one anode being arranged to give a stage of A.F. amplification, whilst the other supplies the output, *via* the transformer T_4, to the telephone and loudspeaker sockets SK_2 and SK_1 respectively.

15. The three position transmit-receive switch S_3, consisting of seven sections S_{3a} to S_{3g}, interchanges the aerial feeders and H.T. positive supply between the transmitter and receiver, and makes and breaks the energizing current lead to the microphone transformer T_1. It will be seen that when in the " receive " position, as shown, the H.T. supply from pin 2 of the plug P_1 is fed to the receiver by S_{3a}, and the microphone current from pin 3 is disconnected from the primary of the transformer T_1 by means of S_{3b}. Sections S_{3c} and S_{3d} connect the inductance L_8 to the aerial, whilst S_{3e} and S_{3f} short-circuit and earth L_4. In the " transmit " position, the H.T. supply from pin 2 of the plug P_1 is switched over to the transmitter by means of S_{3a}, and the energizing current for the microphone from pin 3 is connected to the transformer T_1 by one side of S_{3b}, whilst the other side connects pin 1 to pin 2 (*see* para. 20). Sections S_{3e} and S_{3f} connect the inductance L_4 to the aerial, L_8 being short-circuited and earthed by S_{3c} and S_{3d}. In the position RE (receive economy), the connections made by the switch are the same as those made in the " receive " position, with the exception that S_{3g} switches off the two transmitter valves by breaking the heater supply from pin 4 of P_1, whilst the three receiver valves still remain in operation.

Power unit, type 41

16. A theoretical circuit diagram of the vibrator unit is given in fig. 3. The unit is driven from a 6-volt accumulator, which also supplies the energizing current for the microphone and the heater current for the valves in the transmitter-receiver. The dropping resistance R_{32} ensures the correct voltage being supplied to the microphone transformer, whilst smoothing is obtained from the choke L_{16} and the electrolytic condenser C_{46}. The fuse F_1, ON/OFF switch S_5 and R.F. choke L_{12}, together with its associated condensers C_{40} and C_{41} are incorporated in one of the L.T. leads.

17. H.T. is obtained from the vibrators VIB_1 and VIB_2 connected to the transformers T_5 and T_6, which have their secondaries connected in parallel and deliver 130mA at 265 volts. Smoothing is effected by means of the two chokes L_{14} and L_{15} and the condensers C_{47} to C_{50}. A further filter arrangement consisting of the R.F. choke L_{13} and the condensers C_{42} and C_{43} is inserted in the H.T. positive output.

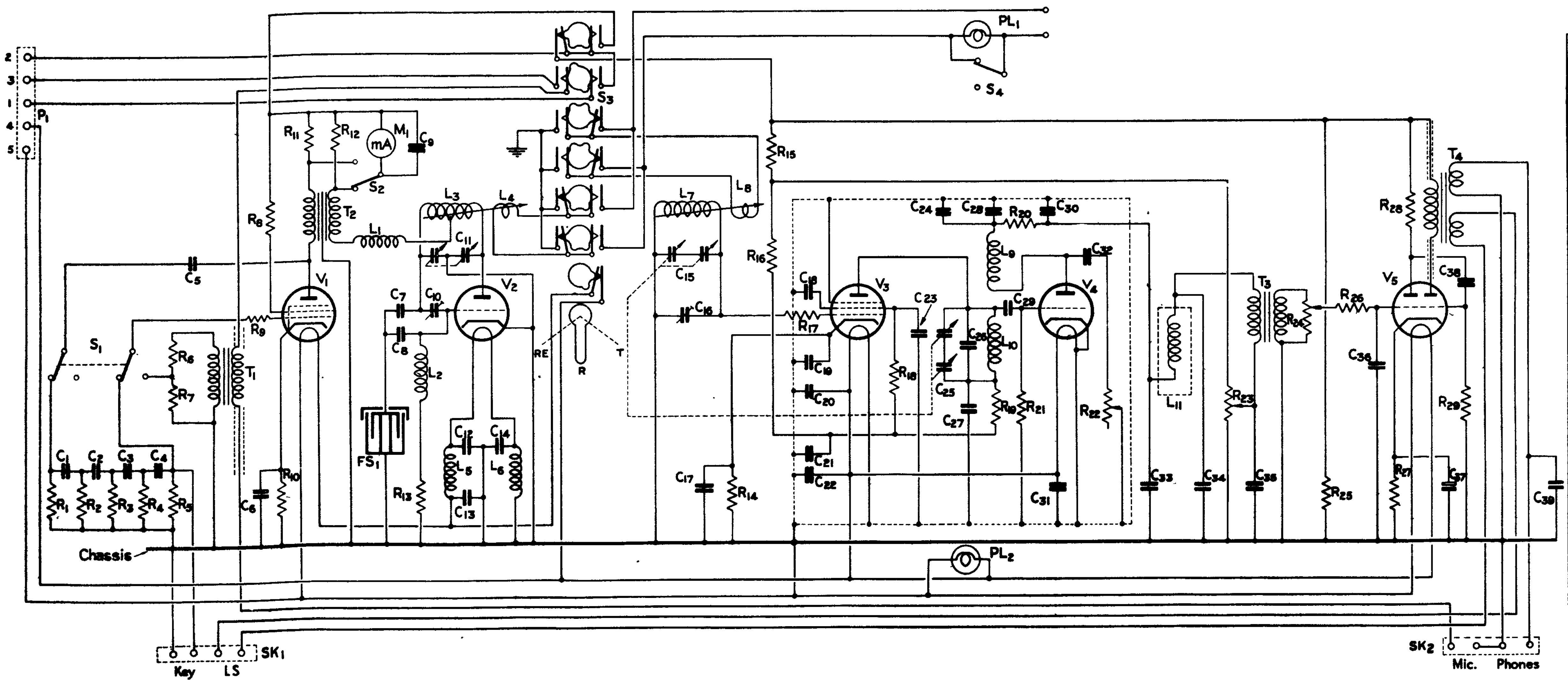
18. When operating the instrument in a vehicle, either the positive or negative terminal of the accumulator may be earthed, and to allow for this, the positions of the two vibrators and the reversing links can be altered, so that the polarity of the electrolytic condensers is preserved.

Power unit, type 38

19. A theoretical circuit diagram of the A.C. mains unit is given in fig. 4, from which it will be seen that a full-wave rectifying valve V_6 is employed. The primary of the transformer T_7 can be adjusted to a mains input voltage of 110 to 240, whilst a fuse F_2 and an ON/OFF switch S_6 are connected in the mains lead. The secondary consists of three windings which supply the filament current for the rectifier, the heater current for all the valves and the H.T. output, which is smoothed by means of the choke L_{17} and condensers C_{52} and C_{52A}. Current for the microphone is also provided by the unit.

RESISTANCES	R_1 R_2 R_3 R_4 R_5 R_6 R_7 R_8 R_9 R_{11} R_{10} R_{12} R_{13} R_{16} R_{14} R_{15} R_{17} R_{18} R_{20} R_{19} R_{21} R_{22} R_{23} R_{24} R_{26} R_{25} R_{28} R_{27} R_{29}
CONDENSERS	C_1 C_2 C_3 C_4 C_5 C_6 C_7 C_8 C_9 C_{10} C_{11} C_{12} C_{13} C_{14} C_{15} C_{17} C_{16} C_{18} C_{19} C_{20} C_{21} C_{22} C_{24} C_{23} C_{25} C_{27} C_{28} C_{26} C_{29} C_{31} C_{30} C_{32} C_{33} C_{34} C_{35} C_{36} C_{38} C_{37} C_{39}
MISCELLANEOUS	P_1 S_1 T_1 SK_1 V_1 S_2 L_1 FS_1 M_1 L_2 L_3 L_5 L_4 V_2 L_6 S_3 L_7 L_8 V_3 PL_1 S_4 L_9 L_{10} PL_2 V_4 L_{11} T_3 V_5 T_4

CONDENSERS	
C_1	0·0016μF
C_2	0·0016μF
C_3	0·0016μF
C_4	0·0016μF
C_5	0·0016μF
C_6	25μF
C_7	4μμF
C_8	16μμF
C_9	0·01μF
C_{10}	TRIMMER
C_{11}	2×30μμF VARIABLE
C_{12}	0·005μF
C_{13}	0·005μF
C_{14}	0·005μF
C_{15}	2×30μμF VARIABLE
C_{16}	30μμF
C_{17}	440μμF
C_{18}	400μμF
C_{19}	0·001μF
C_{20}	400μμF
C_{21}	440μμF
C_{22}	0·0011μF
C_{23}	0·001μF
C_{24}	400μμF
C_{25}	2×30μμF
C_{26}	10μμF
C_{27}	400μμF
C_{28}	440μμF
C_{29}	60μμF
C_{30}	440μμF
C_{31}	320μμF
C_{32}	0·01μF
C_{33}	0·005μF
C_{34}	0·01μF
C_{35}	0·25μF
C_{36}	300μμF
C_{37}	75 + 75μF
C_{38}	0·005μF
C_{39}	0·1μF

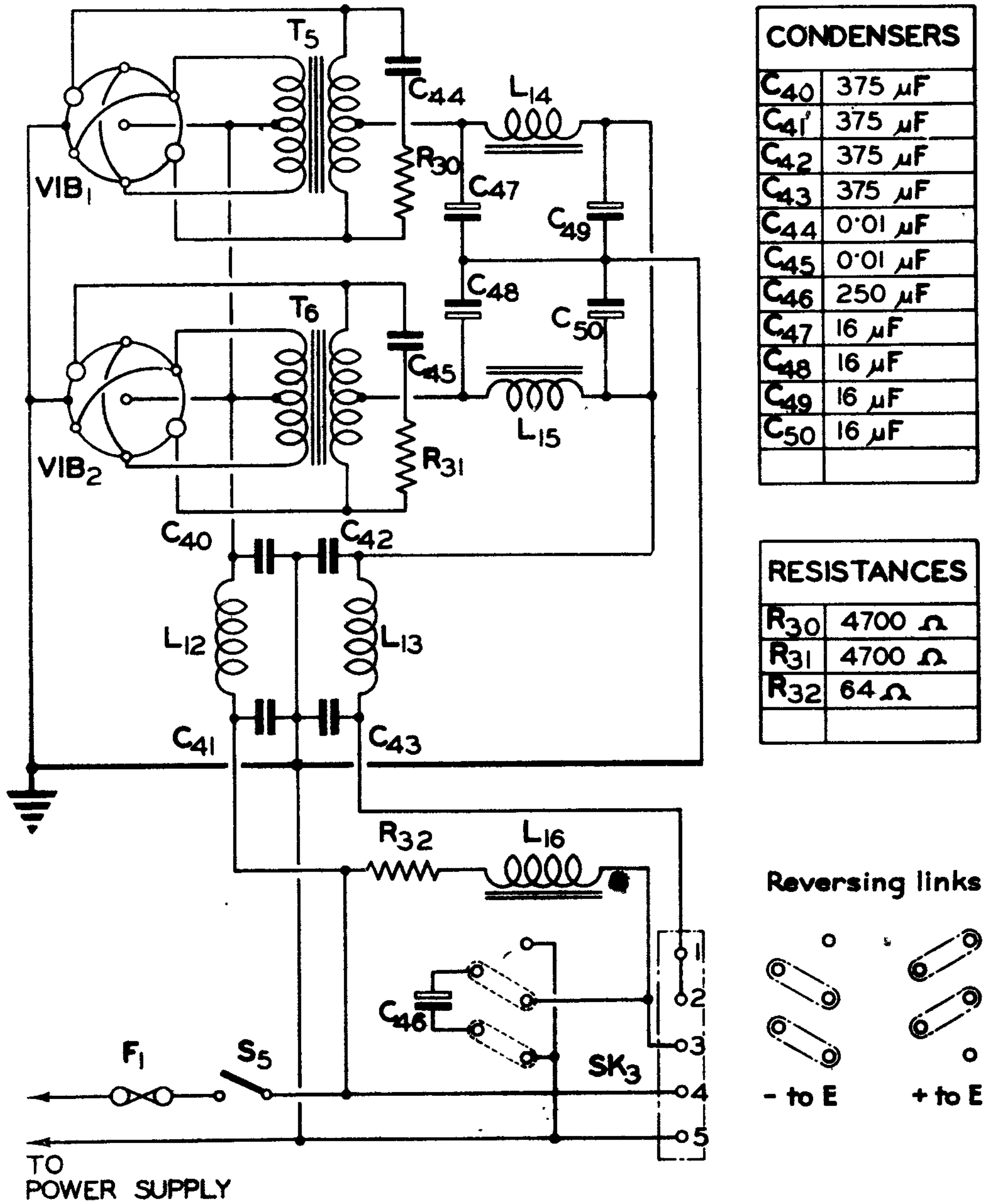


RESISTANCES	
R_1	0·12 MΩ
R_2	0·12 MΩ
R_3	0·12 MΩ
R_4	0·12 MΩ
R_5	0·12 MΩ
R_6	10,000Ω
R_7	10,000Ω
R_8	100Ω
R_9	1,000Ω
R_{10}	195Ω
R_{11}	42Ω
R_{12}	42Ω
R_{13}	2,800Ω
R_{14}	1,200Ω
R_{15}	20,000Ω
R_{16}	0·16 MΩ
R_{17}	100Ω
R_{18}	0·18 MΩ
R_{19}	4,700Ω
R_{20}	1,250Ω
R_{21}	0·56 MΩ
R_{22}	0·1 MΩ VARIABLE
R_{23}	0·1 MΩ VARIABLE
R_{24}	0·2 MΩ VARIABLE
R_{25}	20,000Ω
R_{26}	50,000Ω
R_{27}	600Ω
R_{28}	50,000Ω
R_{29}	0·33 MΩ

T.R. 1148A, THEORETICAL CIRCUIT DIAGRAM

FIG.2

FIG.2



CONDENSERS	
C_{40}	375 μF
C_{41}	375 μF
C_{42}	375 μF
C_{43}	375 μF
C_{44}	0·01 μF
C_{45}	0·01 μF
C_{46}	250 μF
C_{47}	16 μF
C_{48}	16 μF
C_{49}	16 μF
C_{50}	16 μF

RESISTANCES	
R_{30}	4700 Ω
R_{31}	4700 Ω
R_{32}	64 Ω

POWER UNIT TYPE 41, THEORETICAL CIRCUIT DIAGRAM

FIG. 3

FIG. 3

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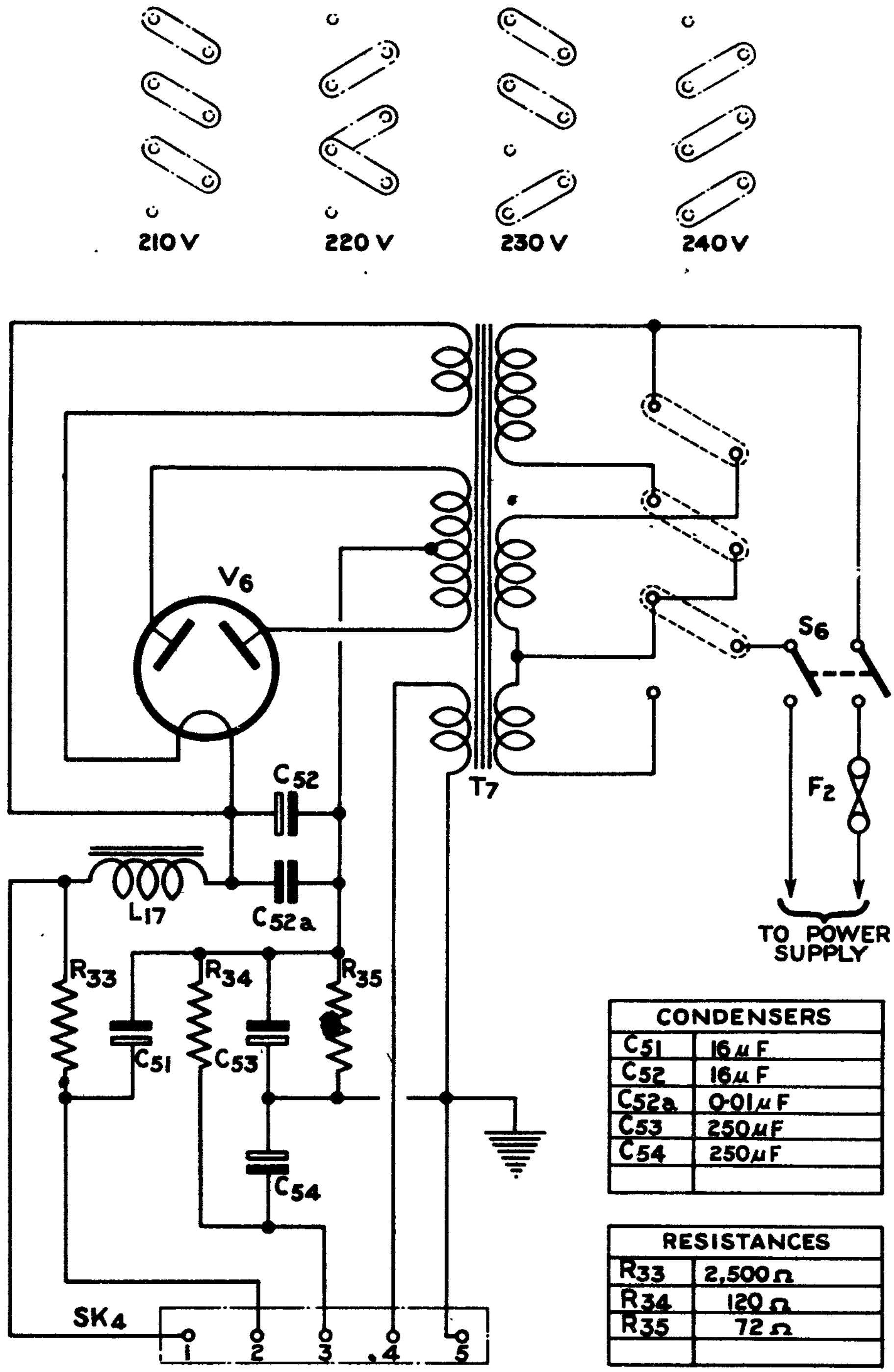


CONDENSERS	
C_{51}	16 μF
C_{52}	16 μF
C_{52a}	0·01 μF
C_{53}	250 μF
C_{54}	250 μF

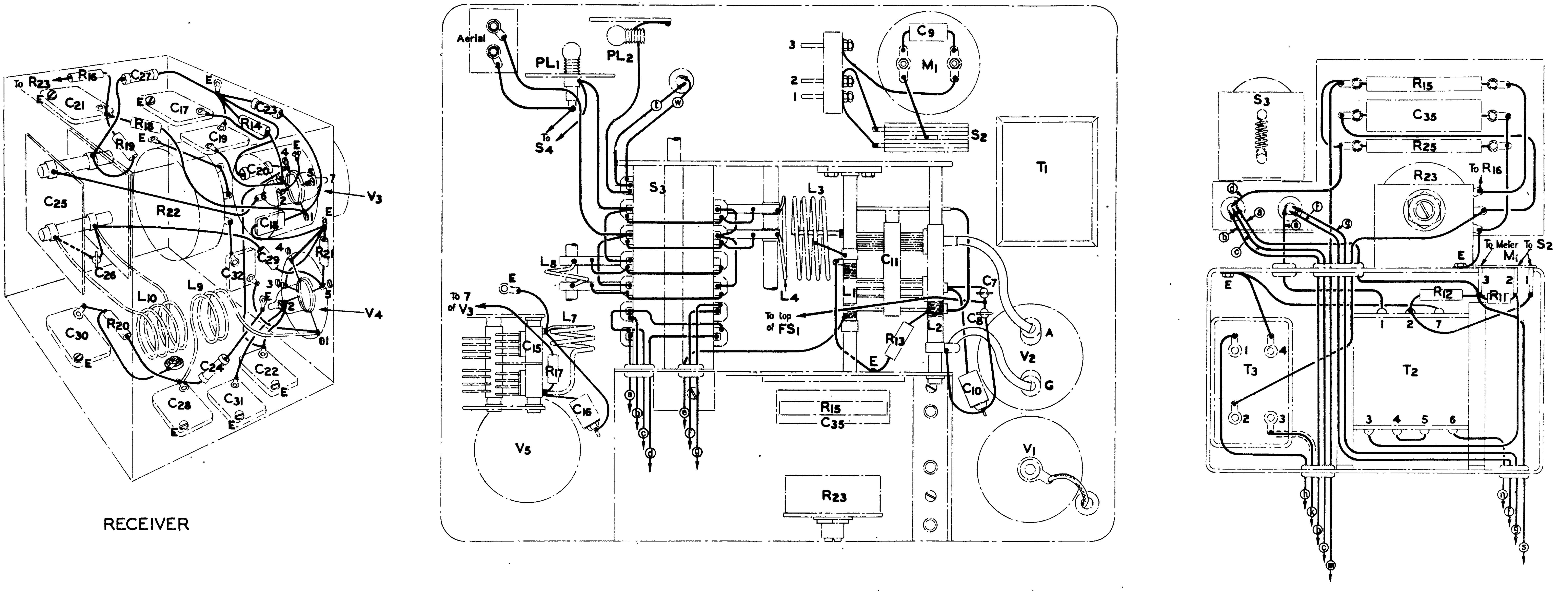
RESISTANCES	
R_{33}	2,500 Ω
R_{34}	120 Ω
R_{35}	72 Ω

POWER UNIT, TYPE 38, THEORETICAL CIRCUIT DIAGRAM

FIG. 4

FIG. 4

(F.1800). F. & C. LTD.

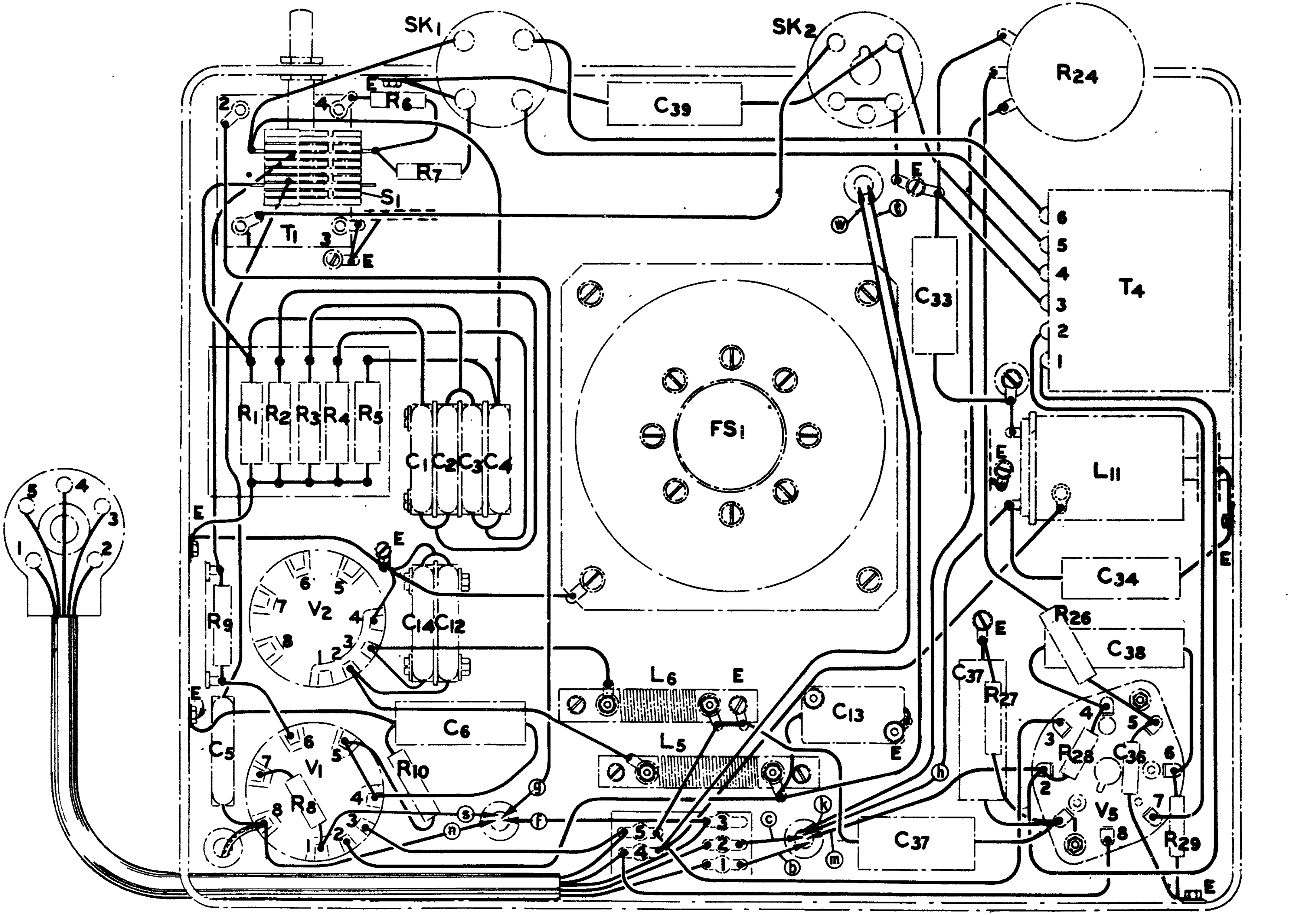


T.R. 1148A, BENCH WIRING DIAGRAM (TOP OF CHASSIS)

FIG. 5

FIG. 5

(F.1800). F. & C. LTD.



T.R. 1148 A, BENCH WIRING DIAGRAM (UNDERSIDE OF CHASSIS)

FIG. 6

FIG. 6

(F.1800). F. & C. LTD.

20. The resistance R_{33} in one of the H.T. positive leads lowers the voltage when the receiver only is in operation. It will be observed that when the switch S_3 (*see* fig. 2) is in the " transmit " position, the H.T. pins 1 and 2 of the plug P_1 are short-circuited, so that R_{33} is no longer in circuit; this arrangement maintains the voltage, which would otherwise drop, owing to the greater drain imposed on the H.T. by the transmitter valves. Sockets 1 and 2 of SK_3 are permanently short-circuited in the vibrator unit, since it is capable of delivering a steady voltage in spite of the extra load placed upon it.

CONSTRUCTIONAL DETAILS

Transmitter-receiver unit, type 2

21. The equipment, complete with loudspeaker, key and all other accessories, fitted in its transit case ready for operation, is shown in fig. 1. Space is provided at the back of the loudspeaker compartment for the storage of certain recommended spares.

22. The transmitter and receiver are mounted on a common chassis and, together with either the vibrator unit or A.C. mains unit, are housed in a plain metal case. The disposition of the controls on the front panel can be seen in fig. 1, whilst a bench wiring diagram of the top of the chassis is given in fig. 5, and one of the underside in fig. 6.

23. Referring to fig. 1, the ON/OFF switch, fuse and power supply cable (1) can be seen in the bottom left-hand corner of the instrument. These three items are attached to the chassis of both types of power unit in identical positions, so that they register with the holes in the front of the case irrespective of which power unit is in use. Next on the right is the switch S_1,marked PHONE/CODE, by means of which the transmission of telephony or M.C.W. can be selected.

24 In the centre can be seen the socket block SK_1 for the key and loudspeaker, the correct positions of which are clearly marked by diagrammatic symbols. Further to the right is the five-pin socket block SK_2 for the telephone handset and additional earpiece.

25. In the bottom right-hand corner is the A.F. gain control R_{24} of the receiver, marked VOLUME, whilst above it can be seen the main tuning knob (2) which operates the two series-gap ganged condenser units C_{15} and C_{25}. The knob (3) marked ANT. COUP, which controls the aerial coupling of the receiver, is situated immediately above the tuning dial.

26. The cable connector (4) on the end of the aerial feeder line is shown connected in position to its two terminals in the top right-hand corner of the instrument. Adjacent to this can be seen the press-button switch S_4, whilst immediately above is the R.F. indicating lamp PL_1. By depressing S_4 the lamp is connected in the aerial circuit and affords a guide as to whether the transmitter is radiating.

27. The transmit-receive switch S_3 is situated to the left of the indicating lamp, and its three positions RE, R and T are clearly marked. It will be observed that a spring-loaded mechanical stop (5) is incorporated. This prevents the control lever of S_3 being swung over to the RE position unless the stop is first rotated by hand in a clockwise direction (*see* para. 53). If, however, it is desired to return from RE to either of the other two positions, the movement of the lever pushes the mechanical stop over to the right-hand side against the spring, after which it will return to its upright position.

28. The anode current of V_1 and V_2 can be measured by means of the meter M_1 in conjunction with S_2 which, when thrown over to the left, provides a reading for V_2, and to the right for V_1. Four fixing buttons (6), two of which are visible, are provided on the underside of the metal case, and register with corresponding keyways cut in two metal sliders fitted in the transit case. These sliders can be seen clearly in fig. 1 pushed back in their grooves and securing the instrument firmly in position.

29. A back view of the components mounted on top of the chassis, is given in fig. 7, from which it will be seen that the receiver portion is on the left-hand side and the transmitter on the right. In the foreground on the left-hand side is the double triode valve V_5, whilst immediately behind is the screening box (1) covering the detector valve V_4, and above this the R.F. pentode V_3. The variable condenser unit C_{15} is ganged by means of a flexible drive to C_{25}, which is situated in the screened compartment behind V_4. On the right-hand side of C_{15} is the inductance L_7, to which L_8 can be variably coupled. Adjacent to V_5 can be seen the intervalve transformer T_3, whilst above it and to the right is the variable resistance R_{23}, which is pre-set so that 100 volts is applied to the anode of V_4.

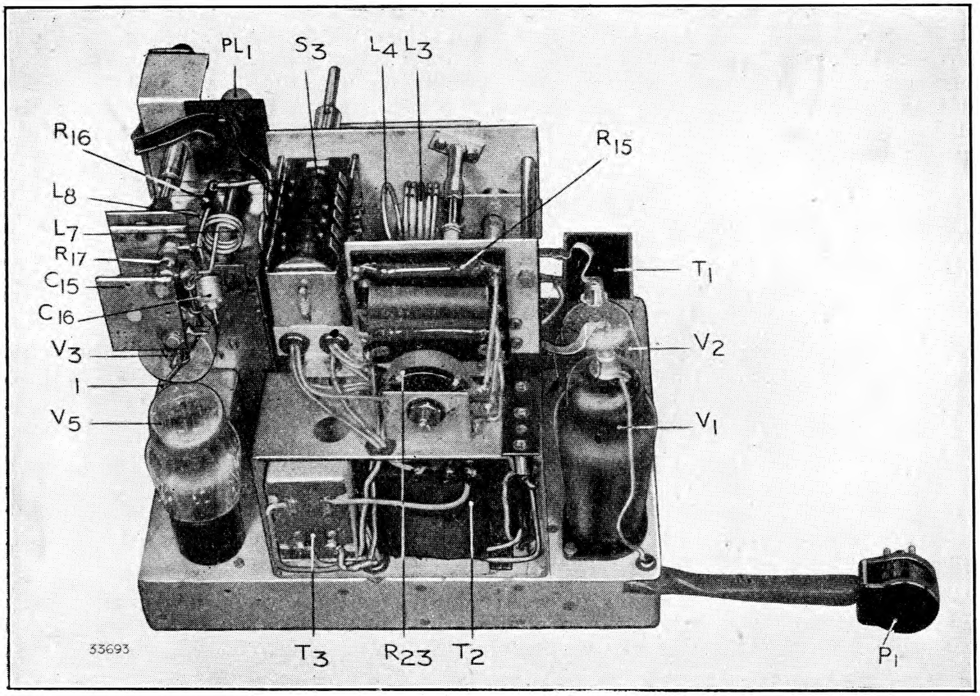


Fig. 7. Chassis removed from case.

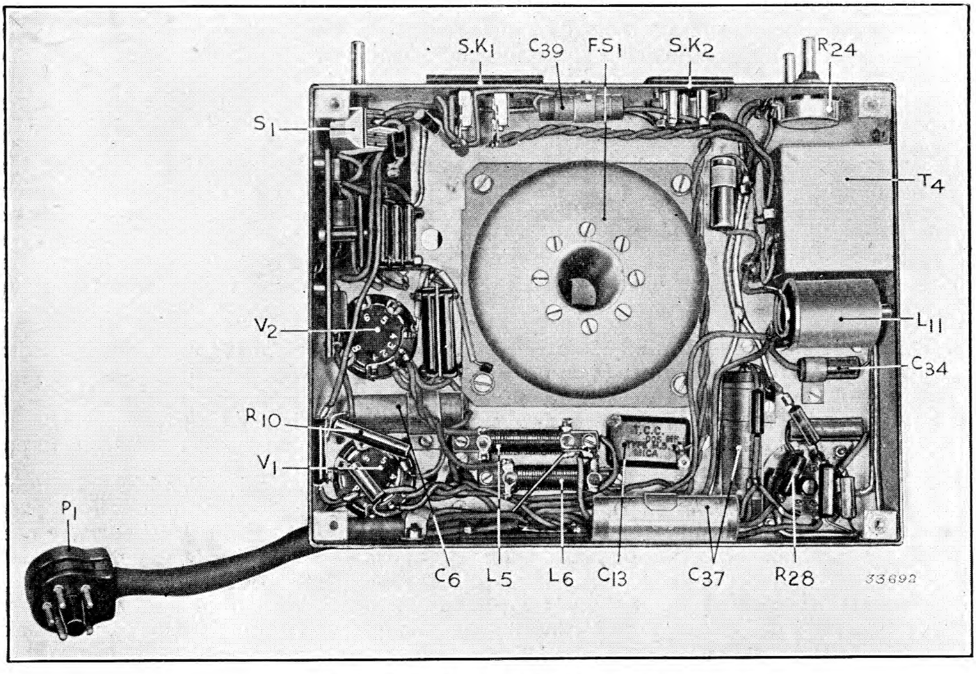


Fig. 8. Underside of chassis.

30. Mounted on the front of the chassis are the R.F. indicating lamp PL_1 and the transmit-receive switch S_3. To the right of this is the aerial inductance L_4 and the anode inductance L_3 of V_2, the coupling between these being variable. The modulator transformer T_2 is mounted below R_{23} and on its right-hand side is the modulator valve V_1. Next to it is the oscillator valve V_2, and on the front of the chassis is the microphone transformer T_1. The 5-pin plug P_1 is for connecting the transmitter-receiver unit to the power unit and carries the supply for the H.T. and the heaters.

31. A view of the underside of the chassis is shown in fig. 8, and the two holders for the transmitter valves can be seen on the left-hand side, whilst above them on the front of the chassis is the PHONE/CODE switch S_1. The variable resistance R_{24} controlling the A.F. gain of the receiver is mounted in the top right-hand corner ; between this and S_1 is the socket block SK_1 carrying the two double-pin sockets for the loudspeaker and key, also the 5-pin socket SK_2 for the telephone handset.

32. Situated on the right-hand side of the chassis is the output transformer T_4, and below it the R.F. choke L_{11} in the anode circuit of V_4. The two R.F. chokes L_5 and L_6 in the heater circuit of the transmitter valves are mounted at the back, whilst in the centre, the base of the frequency stabilizer FS_1 can be seen. Four lugs (one in each corner) drilled and tapped, are provided for fixing the chassis to the metal case.

Power unit, type 41

33. The vibrator unit operates in conjunction with a 6-volt accumulator, and occupies a space next to the transmitter-receiver unit. It is secured in position by means of four fixing screws on the underside of the main metal containing case. The vibrators, VIB_1 and VIB_2, can be withdrawn from their holders and rotated so that their position corresponds with the diagram on top of the unit, according to whether a positive or negative earth supply is being used. Similarly, the reversing links can be reset to agree with the diagram affixed above them. On the right of the reversing links is the 5-pin output socket, to which the plug P_1 from the transmitter-receiver unit is connected.

Power unit, type 38

34. This unit is designed tooperate from A.C. mains, and supplies the necessary H.T. and heater current. It occupies the same space as the vibrator unit and is secured in position by the same four fixing screws. The output sockets for connection to the 5-pin plug from the transmitter-receiver unit, and the mains input adjusting links, are mounted on the back of the bottom compartment.

Aerial system, type 17

35. The mast consists of five sections, each 5 ft. in length, which can rapidly be erected for use. A metal base plate, ground pegs and two sets of guy rope assemblies with tension adjusters are provided. A matching section, two elements, which make up the vertical dipole, and 40 ft. of Lemons' feeder cable complete the equipment, which can be seen set up for use in fig. 9.

INSTALLATION AND OPERATION

Fitting up the aerial

36. The matching section should be inserted through the hole in the lug on the top tube section of the mast, as shown in fig. 9, with the connection box close to the lug. The dipole elements can now be attached, and the matching section rotated so that they are aligned vertically with the mast, after which the clamping screw on the lug may be tightened.

37. The mast sections can now be fitted together with the lower guy rope assembly attached to the second section. The base plate should then be placed on the ground and the mast raised into position, when the ground pegs can be hammered into place and the tension adjusters on the guy ropes tightened.

38. Since the metal mast acts to a certain extent as a reflector, it is preferable to erect it so that the dipole elements are towards the direction in which the receiver lies.

Preliminary adjustments

39. The equipment can now be got ready for operation by letting down the front of the transit case, after unscrewing the two fixing screws along the top. It is assumed that a vibrator unit is in use, so that before connecting up the power supply lead, the instrument must be withdrawn from the transit case by pulling forward the two securing runners underneath the base board, and the back

cover removed after undoing the two fixing screws on the top of the metal case. The positions of the vibrator units and the reversing links must be checked in order to make sure that they correspond with their respective diagrams according to whether a negative or positive earthed supply is to be used. Ascertain that the ON OFF switch on the front of the instrument is in the OFF position, after which the power supply lead can be connected up.

40. If a negative earthed supply is to be used the black lead must be connected to the negative terminal of the accumulator, and the red lead to the positive terminal. If an earth is used, this must be connected to the negative terminal. If, however, the instrument is to operate on a supply, the positive side of which is earthed, the black lead must be connected to the positive terminal and the red to the negative.

41. See that all the valves are in position, and refix the instrument in the transit case, having first replaced the back cover. Make sure that the fuse on the right-hand side of the ON/OFF switch is firmly in position. The cable connector on the end of the aerial feeder line should now be fixed in position under the two terminals as shown in fig. 1, and the telephone handset plugged into its socket SK_2, whilst the loudspeaker and tapping key may be connected up to SK_1 if required. The transmit-receive switch S_3 should be turned to the position marked R, since this enables the supply unit to become stable on the lighter load of the receiver, rather than switching it immediately on to the heavier load of the transmitter.

42. If the power supply is obtained from the A.C. mains unit, the same instructions will apply, though the only precaution necessary with regard to the unit itself is to make sure that the links on the voltage adjustment strip are correctly set to the mains input.

To receive

43. The ON/OFF switch should now be moved over to the ON position, and a period of between one and two minutes allowed for the heaters to warm up. Turn the receiver volume control R_{24} (*see* fig. 1) in a clockwise direction until the characteristic hiss of a super-regenerative receiver is heard. Turn the tuning control knob (2) until a signal is received, or alternatively, if it is known that the signal which it is required to receive is being radiated, tune to this. Reference can be made, if necessary, to the calibration chart on the back of the cover plate (7) below S_3. Adjust the aerial coupling control (3), immediately above the tuning scale, for the best results, and rotate R_{24} until the required signal strength is obtained.

To transmit

44. First turn the transmit-receive switch to the position marked T, and check that the transmitter is radiating as indicated by a glow from the R.F. indicator lamp PL_1, when the push button S_4 is depressed. It is important to note that before operating S_4 it is necessary to move the PHONE/CODE switch S_1 to the PHONE position.

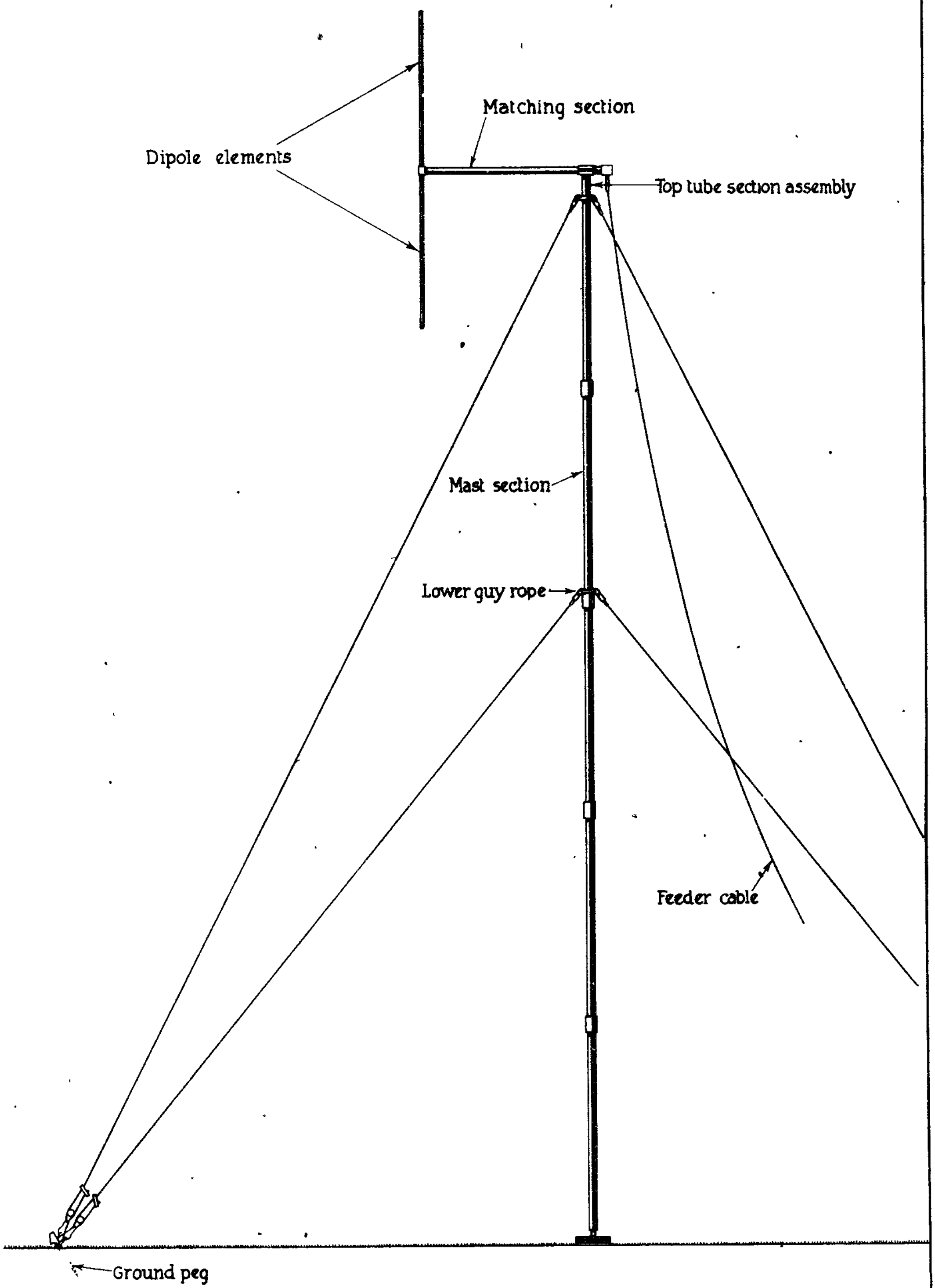
45. The anode current of the modulator valve should be checked by moving the switch S_2 over to the left, when a reading of the meter M_1 of approximately 60mA should be obtained. The PHONE/CODE switch S_1 should now be turned to the required position, when the transmitter will be ready for operation. It will be observed that the indicator lamp PL_1 normally remains short-circuited, since it is intended solely for checking purposes, and that it is brought into circuit only when S_4 is depressed.

Tuning of the transmitter

46. The instructions in the following paragraphs apply if it is desired to alter the frequency of the transmitter, or if it is considered that the variable circuits require re-alignment.

47. The cover plate (7) below S_3 must be removed by undoing the three fixing screws. This exposes the adjustable element of the frequency stabilizer FS, whilst in the top left- and right-hand corners of the aperture, the screwdriver adjustment for the oscillator anode tuning C_{11} and the aerial coupling can be seen.

48. A view of the frequency stabilizer FS_1 is given in fig. 10, and before making any adjustments the large milled-head screw (1) must be released. This screw serves the double function of a handle for rotating the top of the stabilizer, and a clamping device when the correct setting has been obtained. Adjustment to the desired position can now be made, by reference to the calibration curve on the back of the cover plate.



AERIAL MAST ASSEMBLY

FIG. 9

FIG. 9

(F.1800). F. & C. LTD.

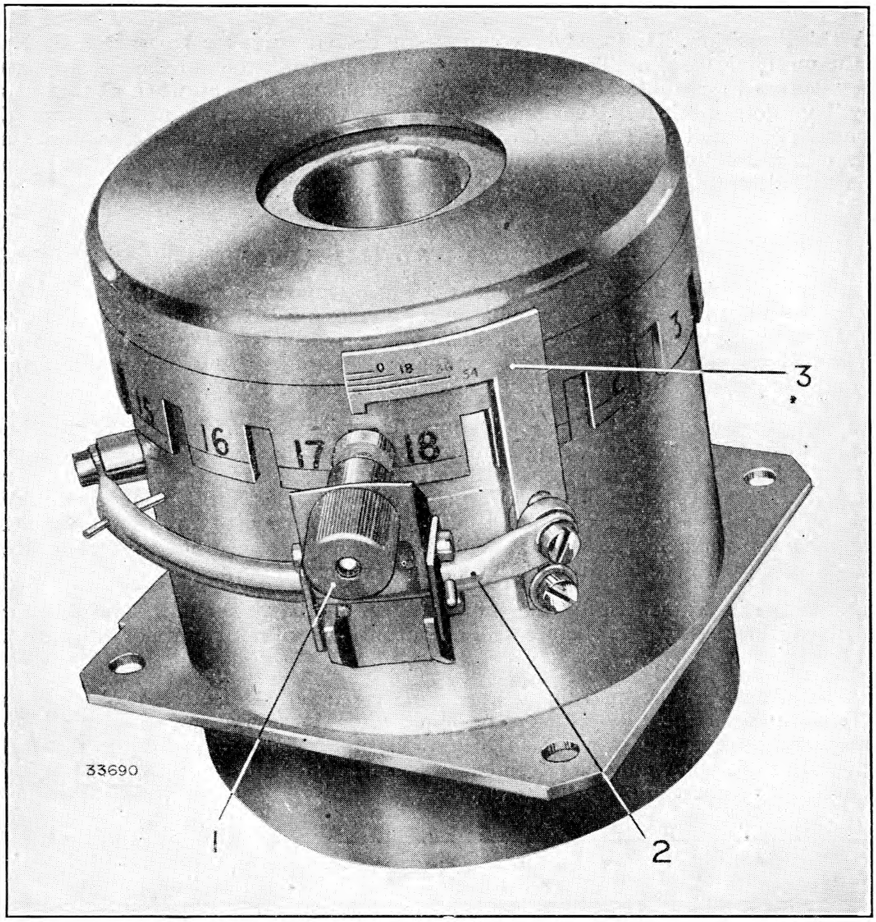


Fig. 10. Frequency stabilizer.

49. The top element is rotated by moving the head of the screw (1) into one of the notches and sliding the unit along the rail (2). The number of complete turns of the rotatable head is indicated on the line scale (3), there being eighteen notches to one complete turn. The number of each notch is engraved on its right-hand side, so that when the screw (1) has been inserted into the correct notch and the unit moved along the rail towards the right until the stop is reached, this number will be immediately below the line scale.

50. The milled-head screw should now be tightened so that the top element is clamped firmly in position, and the transmit-receive switch S_3 put in the position marked T.

51. The locking screws alongside the aerial coupling adjustment and the anode tuning adjustment C_{11} must be slackened, and the meter switch S_2 moved over to the right-hand position. Slacken off the aerial coupling in a counter-clockwise direction and adjust C_{11} until a dip in the reading of the oscillator anode current is observed on M_1. Now turn C_{11} again in a counter-clockwise direction until the meter shows a reading of approximately 40mA, and tighten up the aerial coupling until maximum glow is obtained from the indicator lamp PL_1 with S_4 depressed.

52. Small adjustments to C_{11} and the aerial coupling should be made alternatively to obtain maximum current in the aerial feeder as indicated by PL_1. When the transmitter is correctly tuned, the oscillator anode current should be between 40mA and 50mA. The locking screws for C_{11} and the aerial coupling must now be tightened up and the cover plate replaced.

Stand-by receive

53. A third position, RE (receive economy), of the transmit-receive switch S_3, is available on releasing the mechanical stop. This position switches off the heaters of the two transmitter valves, and is intended to be used for the economy of accumulator current when the instrument has to "stand-by" for long periods. The loudspeaker should be connected up, and immediately upon receipt of a call, S_3 should be set to the position R in order that the transmitter valves may have time to warm up in readiness for the reply. During normal two-way communication, the mechanical stop prevents the transmitter valve heaters being unintentionally switched off.

PRECAUTIONS AND MAINTENANCE

54. On each occasion that the instrument is set up for operation with a vibrator power unit it is most important to check the accumulator supply for positive or negative earth, and to make sure that the vibrator units and reversing links are correctly positioned. Failure to do this may result in severe damage to the electrolytic condensers. If an A.C. mains power unit is being used, ascertain that the voltage adjustment links are set to the mains input.

55. In order to replace the tuning scale lamp PL_2, it is necessary to remove the chassis from its metal case by unscrewing the four fixing bolts on the underside. Should it be necessary to take out the two acorn valves V_3 and V_4, the tops of their screening boxes must be removed after having first withdrawn V_5. The valves should be firmly gripped by the glass tip and gently eased out of their holders, at the same time taking care not to disturb the position of any of the wiring. The same remarks apply when replacing, and care should be exercised to see that the valves are the correct way round—that is, with the long portion inside the screening box.

56. Should the instrument fail altogether, the fuse in the power unit should be examined and a new one fitted if necessary. If there is still no output, the vibrator units or valve, as the case may be, should be replaced.

57. Should, however, the instrument appear only partially defective, a check should be made of the H.T. voltages on the valves, and this should afford some indication as to where the trouble lies. Voltages will be found to vary slightly with individual receivers, but the following table provides a guide as to what may be expected. Measurements must be made with a high-resistance voltmeter and a fully charged 6-volt accumulator.

Transmitter (with S_3 in position T)				
Valve	Anode	Screen	Bias	Heater
Modulator V_1 .. .. (unmodulated)	215	225	11	5·5
Oscillator V_2	220	—	—	5·5
Receiver (with S_3 in position R)				
R/F Stage V_3	60	30	0·9	5·7
Detector V_4	100	—	—	5·7
A/F Stage V_5	200	—	5	5·7
Output Stage V_5 ..	260	—	—	—

If an A.C. mains unit is used, the voltages will be slightly higher than those given in the table.

APPENDIX

NOMENCLATURE OF PARTS

The following list of parts is given for information only. When ordering spares for this transmitter-receiver, the appropriate section of AIR PUBLICATION 1086 must be used.

Ref. No.	Nomenclature	Qty.	Ref. in fig. 3	Remarks
10D/285	Transmitter-receiver, type T.R.1148A			
	Comprising :—			
5A/1091	Accumulator, type B	1		For use with 10K/35 if required.
10B/288	Aerial system, type 17	1		
10D/82	Case, transit	1		
10D/83	Case, transit, accumulator	1		
10B/158	Case, transit, aerial system, type 9	1		
10A/12125	Handset, telephone, type 2	1		P.O. pattern.
10F/127	Key, morse, type K	1		
10U/7	Loudspeaker, type 9	1		
10K/35	Power unit, type 41	1		6-volt supply.
10K/25	Power unit, type 38	1		A.C. supply.
10A/12123	Receiver, telephone, head, type 12	1		P.O. pattern.
10D/354	Transmitter-receiver unit, type 2	1		
	Aerial system, type 9			
	Principal components :—			
10B/212	Aerial tube assembly	1		Containing central feeder and connecting box.
10B/205	Block, connecting	2		
10B/202	Dipole	2		
10B/378	Feeder	1		Dr. Lemon's feeder wire.
10B/386	Guy-rope assembly	1		Fitted with 3 stays, mast, type 2.
10B/375	Mast, lower section	1		Tubular.
10B/376	Mast, intermediate section	3		Tubular.
10B/377	Mast, upper section	1		Tubular, fitted with 3 stays, mast, type 3.
10B/206	Peg, ground	3		
10B/203	Plate, base	1		
10B/208	Ring	6		For connecting guy-rope assembly to pegs, ground.
10B/380	Stay, mast, type 2	3		21 ft. long.
10B/385	Stay, mast, type 3	3		30 ft.
	Power unit, type 41			
	Principal components :—			
10C/845	Choke, R.F., type 77	1	L_{16}	200μH.
10C/846	Choke, L.F., type 55	2	L_{14}, L_{15}	8 H.
	Condenser :—			
10C/842	Type 855	8	C_{44}, C_{45}, C_{47}, C_{48}, C_{49}, C_{50}	0·01μF., 4 in series-parallel.
10C/843	Type 856	4		16μF. electrolytic.
10C/844	Type 857	1	C_{46}	250μF. electrolytic.
10K/38	Filter unit, type 4	1		Fitted with 1 choke, type 78, and 1 choke, type 79 (L_{12} and L_{13}).
10H/269	Fuse, type 31	1	F_1	15 ampere, cartridge.
10H/1111	Holder, fuse, type 25	1		Panel mounting.
10A/12225	Plate, reversing	1		

Ref. No.	Nomenclature	Qty.	Ref. in fig. 3	Remarks
	Transmitter-receiver, type T.R.1148A —(*contd.*)			
	Power unit, type 41 (*contd.*)			
	Principal components (*contd.*)			
	Resistance :—			
10C/848	Type 850	1	R_{32}	64 ohms.
10C/1646	Type 1,646	2	R_{30}, R_{31}	4,700 ohms.
10F/239	Switch, type 261	1	S_5	S.P. ON/OFF.
10A/12224	Transformer, type 155	2	T_5, T_6	Vibrator transformer.
	Accessories :—			
10H/268	Clip, type 7	2		25-ampere battery clip.
10A/12124	Vibrator unit, type 2	2	VIB_1, VIB_2	6-volt.
	Power unit, type 38 :—		Ref. in	
	Principal components :—		fig. 4	
10C/2643	Choke, L.F., type 91	1	L_{17}	6 H.
	Condenser :—			
10C/843	Type 856	2	C_{51}, C_{52}	16μF., electrolytic.
10C/2637	Type 1,259	1	C_{51A}	0·01μF.
10C/844	Type 857	2	C_{53}, C_{54}	250μF., electrolytic.
10H/10269	Fuse, type 13	1	F_2	2-ampere, cartridge.
10H/376	Holder, fuse, type 13	1		Panel mounting.
10H/640	Holder, valve, type 87	1	V_6	8-side contact, moulded.
	Resistance :—			
10C/1501	Type 1,501	1	R_{35}	72 ohms.
10C/1502	Type 1,502	1	R_{34}	120 ohms.
10C/1215	Type 1,215	1	R_{33}	2,500 ohms.
10H/211	Socket, type 99	1	SK_4	5-way with centre guide-hole.
10F/111	Switch, type 223	1	S_6	D.P. ON/OFF.
10A/12552	Tapping panel	1		Fitted with adjustable links.
10K/177	Transformer, type 296	1	T_7	Input voltage 110, 130, 220, 240, 50 cycles.
	Accessories :—			
10E/379	Valve (Mullard AZ.2)	1	V_6	Side contact base.
	Transmitter-receiver unit, type 2 :—			
	Principal components :—		Ref. in	
	Choke R.F. :—		fig. 2	
10C/717	Type 72	1	L_1	
10C/718	Type 73	1	L_2	
10C/719	Type 74	2	L_5, L_6	
10C/721	Type 76	1	L_{11}	100μH.
	Condenser :—			
10C/728	Type 814	1	C_8	16μμF.
10C/729	Type 815	1	C_7	4μμF.
10C/730	Type 816	1	C_{10}	Ceramic trimmer.
10C/731	Type 817	1	C_{11}	2 × 30μμF.
10C/10875	Type 491	3	C_{12}, C_{13}, C_{14}	0·005μF.
10C/733	Type 819	1	C_6	25μF., electrolytic.
10C/734	Type 820	5	C_1, C_2, C_3, C_4, C_5	0·0016μF.
10C/2930	Type 1,407	1	C_{25}	2 × 30μμF.
	Type	1	C_{15}	2 × 30μμF.
10C/2972	Type 1,427	1	C_{27}	400μμF.
10C/737	Type 823	1	C_{33}	0·005μF.
10C/738	Type 824	1	C_{34}	0·01μF.
10C/739	Type 825	1	C_{35}	0·25μF.
10C/11076	Type 503	1	C_9	0·1μF.

Ref. No.	Nomenclature.	Qty.	Ref. in fig. 2.	Remarks.
	Transmitter-receiver, type T.R.1148A —(*contd.*)			
	Transmitter-receiver unit, type 2—(*contd.*)			
	Principal components—(*contd.*)			
	Condenser—(*contd.*)			
10C/743	Type 829	1	C_{16}	30μμF.
10C/2561	Type 1,208	1	C_{29}	60μμF.
10C/10629	Type 440	1	C_{32}	0·01μF.
10C/745	Type 831	1	C_{36}	300μμF.
10C/16	Type 572	1	C_{26}	10μμF.
	Inductance :—			
10C/722	Type 44	1	L_3	
10C/723	Type 45	1	L_4	
10C/724	Type 46	1	L_7	
10C/725	Type 47	1	L_8	
10C/726	Type 48	1	L_{10}	
10C/727	Type 49	1	L_9	
5A/	Lamp, 2 volt, 0·1 amp.	1	PL_1	R.F. indicator lamp.
5A/1428	Lamp, 6 volt, 0·04 amp.	1	PL_2	Scale lamp.
10A/12213	Milliammeter, type C	1	M_1	Moving coil, 0–100 mA.
	Resistance :—			
10C/747	Type 885	1	R_{13}	2,800 ohms.
10C/748	Type 886	1	R_{10}	195 ohms.
10C/749	Type 887	5	R_1, R_2, R_3, R_4, R_5	0·12 megohm.
10C/750	Type 888	2	R_{11}, R_{12}	42 ohms.
10C/751	Type 889	1	R_{14}	1,200 ohms.
10C/752	Type 890	1	R_{18}	0·18 megohm.
10C/753	Type 891	1	R_{19}	4,700 ohms.
10C/754	Type 892	1	R_{21}	0·56 megohm.
10C/755	Type 893	1	R_{20}	1,250 ohms.
10C/758	Type 896	2	R_{15}, R_{25}	20,000 ohms.
10C/760	Type 898	1	R_{29}	0·33 megohm.
10C/11678	Type 512	1	R_9	1,000 ohms.
10C/53	Type 561	2	R_8, R_{17}	100 ohms.
10C/11687	Type 521	1	R_{28}	50,000 ohms.
10C/27	Type 544	2	R_6, R_7	10,000 ohms.
10C/763	Type 901	1	R_{16}	0·16 megohm.
10C/764	Type 902	1	R_{23}	0·1 megohm, variable.
10C/765	Type 903	1	R_{24}	0·2 megohm, variable.
10C/766	Type 904	1	R_{22}	0·1 megohm, variable.
10D/173	Stabilizer	1	FS_1	Frequency stabilizer.
	Switch :—			
10F/503	Type 450	1	S_3	Transmit-receive switch.
10F/182	Type 255	1	S_1	PHONE/CODE switch.
10F/183	Type 256	1	S_2	Meter switch.
10F/504	Type 451	1	S_4	R.F. indicator press switch.
	Transformer :—			
10A/12216	Type 150	1	T_2	Modulation transformer.
10A/12217	Type 151	1	T_1	Microphone transformer.
10A/12218	Type 152	1	T_3	A.F. transformer.
10A/12219	Type 153	1	T_4	Telephone transformer.
	Accessories :—			
10E/130	Valve (Mullard TV.05/12)	1	V_2	Oscillator.
10E/131	Valve (Mullard E.L.50)	1	V_1	Modulator.
10E/.32	Valve (Mullard 4672)	1	V_3	R.F. amplifier.
10E/133	Valve (Mullard 4671)	1	V_4	Detector.
	Valve (Mullard ECC31)	1	V_5	A.F. and output.

(63125-1) Wt. 9053/2459 3,500 & 750 5/43 Hw. G.371 (TS 5532)

SECTION 2, CHAPTER 7

TRANSMITTER-RECEIVER T.R.1150

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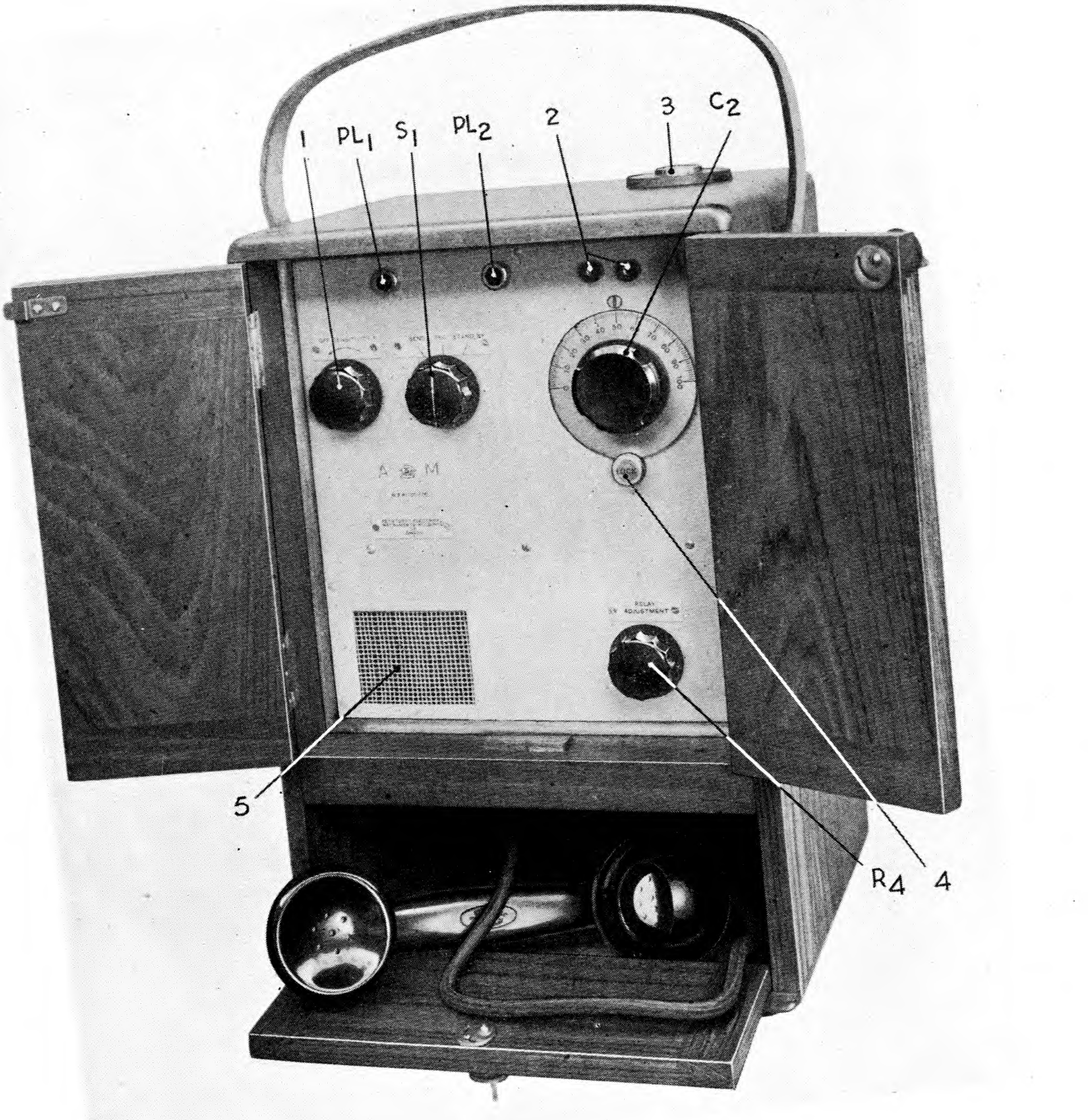
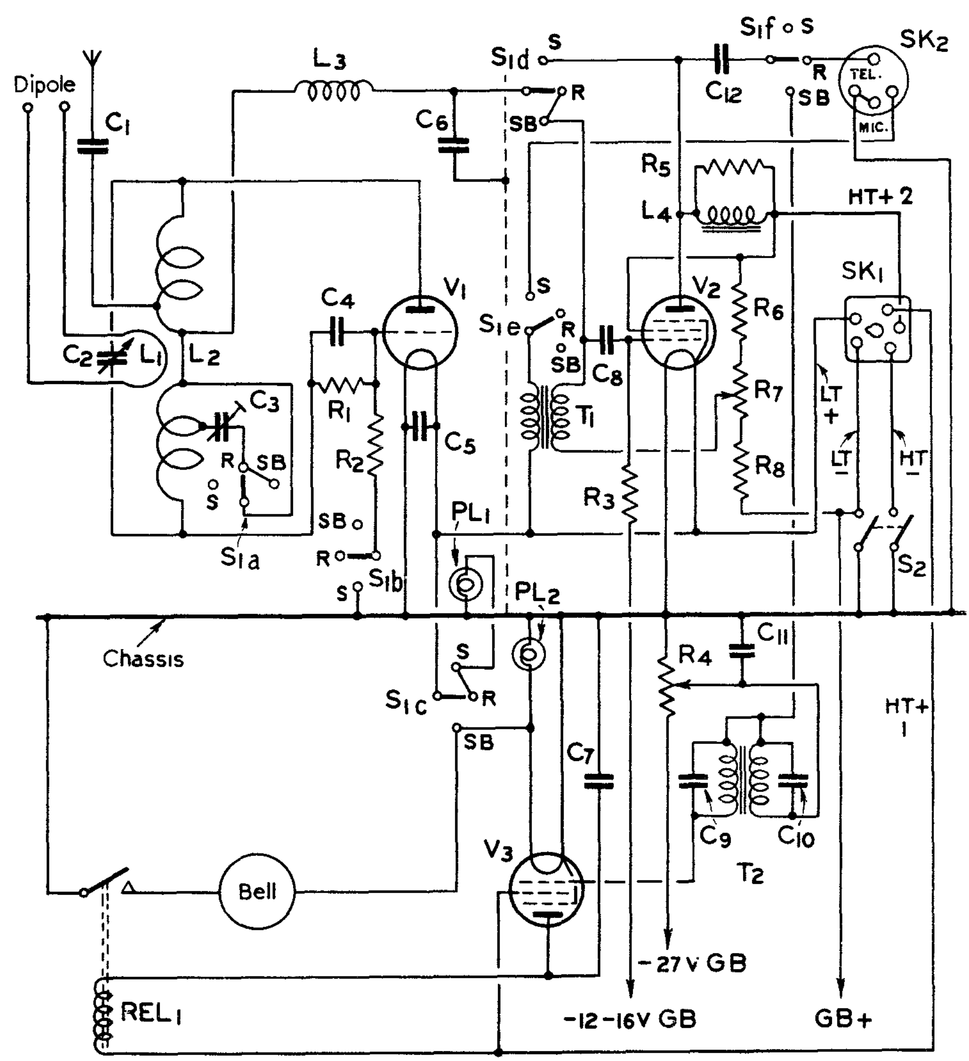


FIG. 1.—TRANSMITTER-RECEIVER T.R.1150



CONDENSERS				RESISTANCES	
C_1	·002 μF	C_9	·0005 μF	R_1	750,000 Ω
C_2	25 μμF Var.	C_{10}	·002 μF	R_2	10,000 Ω
C_3	30 μμF Trimmer.	C_{11}	0·1 μF	R_3	0·5 MΩ
C_4	·0003 μF	C_{12}	·01 μF	R_4	100,000 Ω Var.
C_5	·006 μF			R_5	10,000 Ω
C_6	·004 μF			R_6	25,000 Ω
C_7	1·0 μF			R_7	50,000 Ω Var.
C_8	0·1 μF			R_8	25,000 Ω

FIG. 2 T.R. 1150, THEORETICAL CIRCUIT DIAGRAM FIG. 2

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TRANSMITTER-RECEIVER T.R.1150

(Stores Ref. 10D/78)

INTRODUCTION

1. The T.R.1150 is designed for two-way communication between drifters of Balloon Command over a distance of not more than three miles, and operates on a frequency of 60 Mc/s. The transmitter-receiver, which is portable, derives its power supply from batteries, the accumulator and H.T. battery being carried in an external transit case, whilst the grid bias batteries are fitted inside the instrument.

2. Three valves are employed, two of which are used for transmitting or receiving, and the third, which is introduced into the circuit when standing-by, operates a calling bell by means of a relay.

3. The instrument is housed in a teak cabinet, measuring 16 in. by $10\frac{1}{4}$ in. by $8\frac{3}{4}$ in., fitted with two hinged doors on the front, a removable back and a leather strap for transit purposes. Space is provided at the bottom for the grid bias batteries and a telephone handset. The case for the accumulator and H.T. batteries is also constructed of teak, and measures $26\frac{1}{8}$ in. by $10\frac{1}{8}$ in. by $12\frac{1}{4}$ in.

4. Two types of aerials can be utilized. The first, which is a quarter-wave rod type and screws into a bush mounted on the top of the cabinet, is intended for use under conditions where the period of operation is likely to be short and speed of installation is essential; the second, which is a dipole and can be fitted between any two convenient points, should be used where the establishment of the station will be either permanent or cover a period of known duration.

GENERAL DESCRIPTION

5. A theoretical circuit diagram is given in fig. 2, and it will be seen that only the valves V_1 and V_2 are used for transmitting or receiving, according to the position of the SEND/RECEIVE switch S_1. The valve V_3 is brought into operation in the STAND-BY position of S_1 and is coupled to V_2. As the anode current rises, the relay REL_1 closes and causes the bell to ring. The valve V_1 is a triode, whilst the other two are pentodes.

Transmit

6. In the SEND position, the dipole aerial inductance L_1 is coupled to the anode of the oscillator valve V_1 *via* the inductance L_2, which is tuned by means of the variable condenser C_2, whilst the rod aerial is connected directly to a tapping point on L_2 through the series condenser C_1. The bottom end of L_2 is connected to the grid of V_1 *via* the condenser C_4, across which is placed the resistance R_1, whilst R_2 is connected to the chassis by means of section S_{1b} of the SEND-RECEIVE switch, and the pilot light PL_1 is illuminated by section S_{1c}. A R.F. by-pass condenser C_5 is incorporated across the filament of V_1.

7. The oscillator valve V_1 is modulated in its anode circuit from the valve V_2, and one end of the primary of the microphone transformer T_1 is switched to the handset socket SK_2, whilst the other end is connected to L.T. positive, which provides the necessary energizing current for the microphone. The H.T. positive supply to the anode of both valves is fed through the A.F. choke L_4, across which is the resistance R_5, the feed to V_1 being obtained through the R.F. choke L_3, by means of S_{1d}, and by-passed by the condenser C_6. The supply to the screen-grid of V_2 is drawn directly from the maximum battery voltage, whilst bias is obtained from a separate battery and is applied to the grid through the resistance R_3.

Receive

8. In this position of the switch S_1, the valve V_1 functions as a super-regenerative detector and V_2 as an A.F. amplifier. The aerial arrangements remain unchanged, whilst R_2 is disconnected from the chassis by means of S_{1b}, and S_{1a} introduces the trimmer condenser C_3 across a portion of the inductance L_2. The purpose of this trimmer is for balancing the aerial circuit, in conjunction with the variable condenser C_2, so that the setting of C_2 remains the same both for transmitting and receiving. This means that two-way communication can be held merely by the movement of the switch S_1, no adjustment to the tuning being necessary. The output from V_1 is switched, by means of S_{1d}, to the grid of the succeeding valve V_2 *via* the coupling condenser C_8, and, at the same time the H.T. supply to the anode of V_1 is fed through the potential divider consisting of the three series resistances R_6, R_7 and R_8, the secondary of the microphone transformer T_1, and the R.F. choke L_3. Of the three series resistances, R_7 is variable and controls the voltage applied to the anode and consequently the sensitivity of this stage.

9. The H.T. supply to the anode and screen-grid of the valve V_2 remains unchanged, but the output is switched, by means of S_{1f}, through the coupling condenser C_{12} to the handset socket SK_2 and thus to the earpiece. It will be seen that the ON/OFF switch S_2 makes and breaks the connection between the chassis and L.T. negative and H.T. negative.

Stand-by

10. The circuit arrangements of the two valves V_1 and V_2 remain fundamentally the same in this position of the switch S_1 as in the RECEIVE position, the only difference being in the pilot light switching and the introduction of the third valve V_3, in conjunction with the relay REL_1 and the bell.

11. The L.T. positive feed is removed from the pilot light PL_1 by means of S_{1c} thereby switching it off, and is moved over to PL_2 and the filament of the relay valve V_3, both of which are then switched on. At the same time one end of the bell induction coil is also connected to the L.T. positive supply, whilst the other end is connected to L.T. negative through the chassis and the ON/OFF switch S_2.

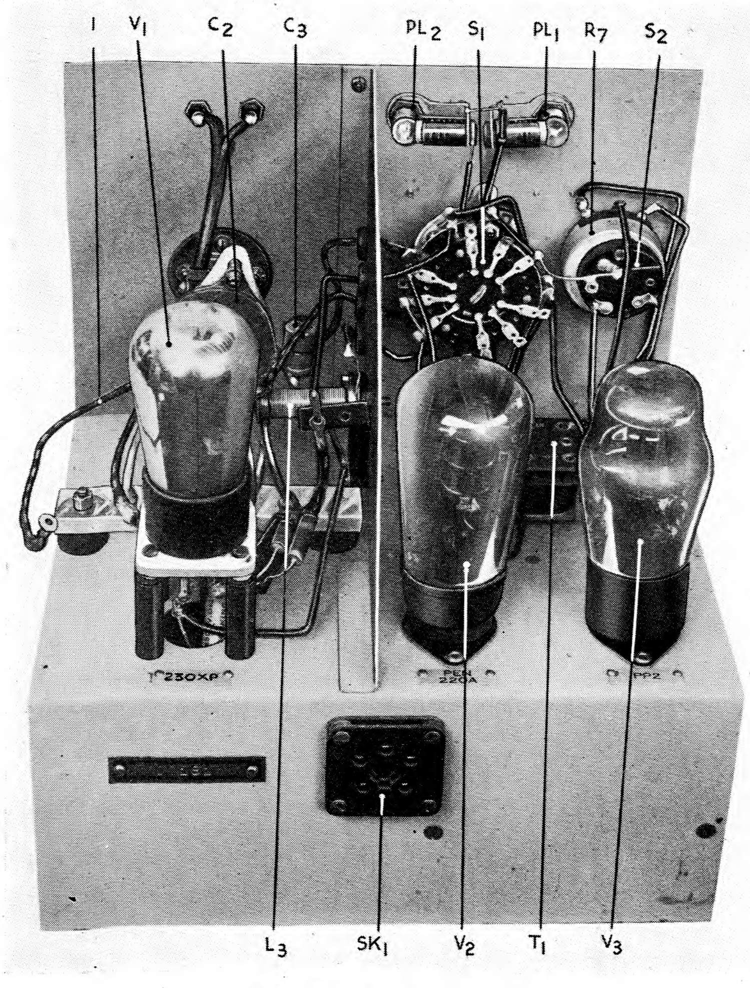


FIG. 3.—TOP OF CHASSIS

12. The output from the valve V_2 is transferred by means of S_{1f}, from the 4-pin socket SK_2 to the grid of V_3 *via* the inter-valve transformer T_2, through which bias is applied and the voltage controlled by the variable resistance R_4. The H.T. supply to the valve is obtained *via* the socket SK_1 from a tapping point H.T. +1 in the batteries, the feed to the screen-grid being taken direct and that to the anode passing through the coils of the relay REL_1 and by-passed by means of the condenser C_7. When the bias voltage adjustment has been correctly set by means of the resistance R_4, so that the relay just remains inoperative, a received signal will produce a rise in anode current, which, passing through the relay coils will cause the relay to operate, thus ringing the bell.

CONSTRUCTIONAL DETAILS

13. A general view of the instrument showing the controls on the front panel is given in fig. 1. the knob (1), which operates the combined variable resistance R_7 and ON/OFF switch S_2, can be seen in the top left-hand corner, and next to it is the SEND/RECEIVE switch S_1, with the pilot lights PL_1 and PL_2 above. The two sockets (2) for the dipole aerial are mounted in the right-hand corner of the panel, and the rod aerial screws into the bush (3) on the top of the cabinet. The space at the bottom houses the telephone handset which plugs in to the 4-pin socket SK_2 mounted at the back of the compartment.

14. The control for the tuning condenser C_2 is situated below the dipole sockets, and includes a locking device (4), consisting of a metal ring which screws against the scale plate of the condenser and holds it in position after the correct setting has been obtained. The relay adjustment R_4 is mounted in the bottom right-hand corner, whilst the wire gauze (5) in the opposite left-hand corner allows the ringing of the bell to be heard distinctly.

15. Two further views are given; fig. 3 showing the components mounted on top of the chassis and fig. 4 giving a view of the underside, whilst a bench wiring diagram can be seen in fig. 5. Referring to fig. 3, the valve V_1 and the variable condenser C_2 will be observed in the left-hand compartment together with the trimmer condenser C_3 and R.F. choke L_3. The lead (1) is the rod type aerial feed, and can be seen disconnected from the bush mounted on top of the cabinet.

16. The valves V_2 and V_3 are situated in the right-hand compartment, also the switch S_1 and the combined variable resistance R_7 and ON/OFF switch S_2, which are mounted on the front panel. Above these are the two pilot lights PL_1 and PL_2, whilst the microphone transformer T_1 can be seen below. The 5-pin socket SK_1 on the back of the chassis is for connection to the external accumulator and H.T. supply.

17. The components mounted on the underside of the chassis are shown in fig. 4, the choke L_4 and intervalve transformer T_2 being visible on the left-hand side. The relay REL_1 is mounted on the right-hand side and the relay adjustment control R_4 on the front panel. The screw (2) on the relay is for adjusting the armature gap. The bell (1) is "floated" on rubber, instead of being fitted directly to the chassis, in order to damp out vibration and prevent microphony when it rings.

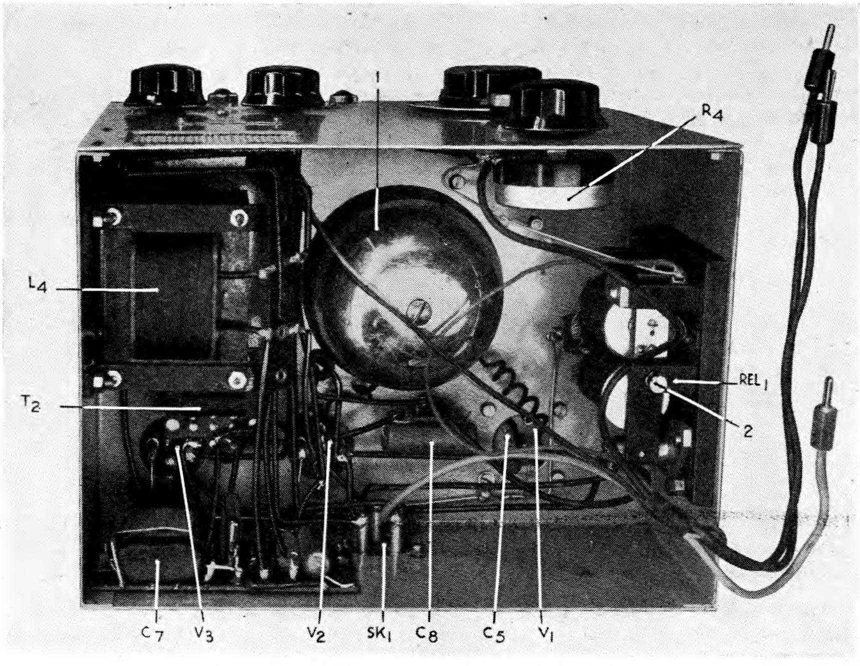
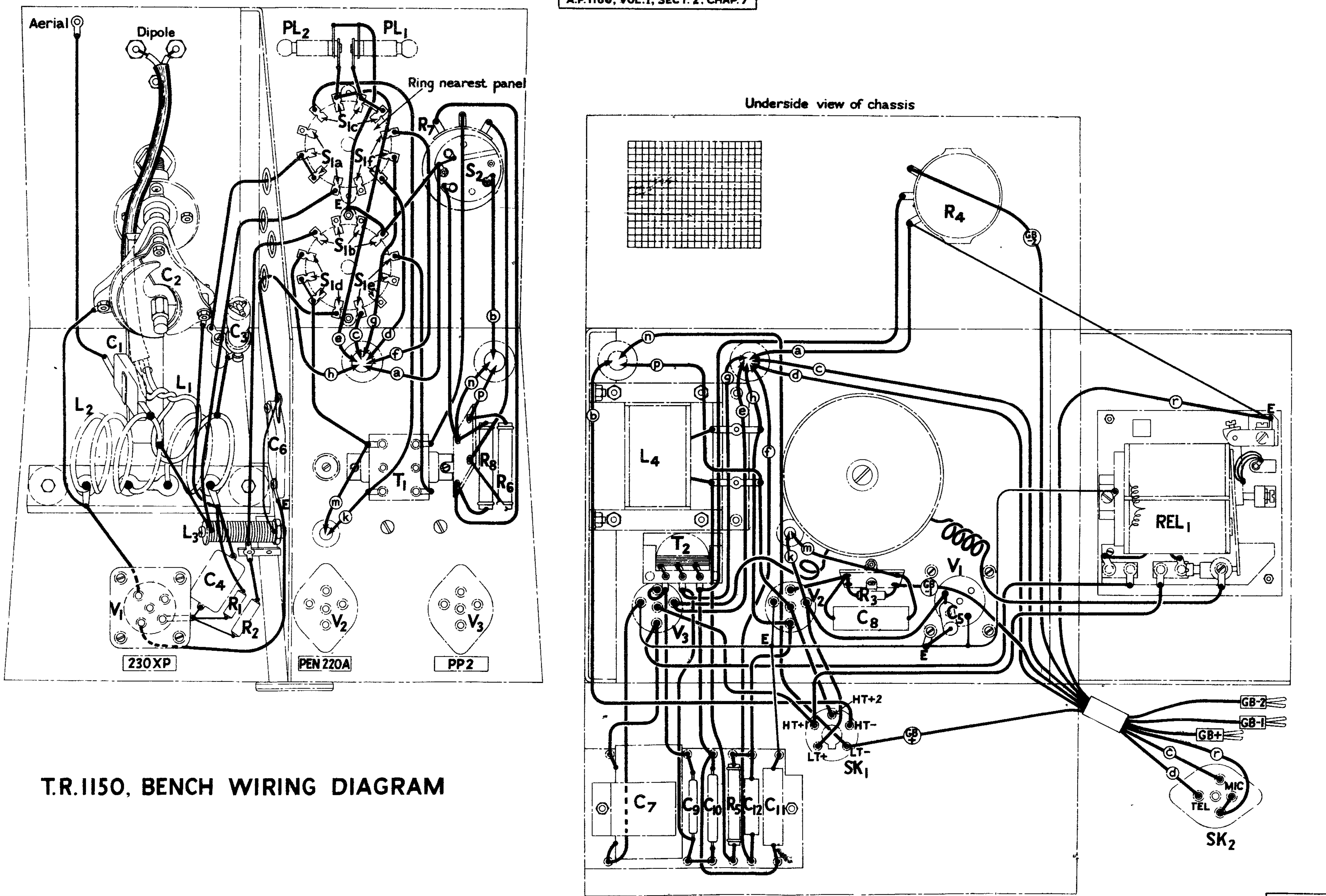


FIG. 4.—UNDERSIDE OF CHASSIS

18. Space is provided in the battery box for the dipole aerial, but the rod type of aerial which consists of four sections of approximately 1 ft. each in length, is carried separately. The sections fit one over the other, and the aerial can be assembled in a matter of a few seconds.



T.R.1150, BENCH WIRING DIAGRAM

FIG. 5 FIG. 5

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27. A test for the radiation of R.F. energy can be made by inserting between the turns of the inductance L_2, a loop of wire approximately one inch in diameter with a 3·5-volt, 0·3-amp. bulb in series with the ends, and a glow from the bulb will indicate whether radiation is taking place. Stiff covered wire should be used, and the device supported on a strip of insulating material.

28. If trouble is experienced when receiving, a voltage test should be carried out with the switch in the RECEIVE position, and a reading of approximately 150 should be obtained on the anode and screen of the valve V_2, whilst the anode volts of V_1 should vary between 16 with the SENSITIVITY control at minimum and 40 at maximum. The H.T. consumption of the two valves may be checked and should be approximately 18 milliamps.

29. In the case of the relay failing to close, the H.T. on the anode of the valve V_3 may be tested and should be approximately 90 volts with 100 volts on the screen. The H.T. current drawn by V_3, and flowing through the relay coils can be ascertained by removing the two valves V_1 and V_2 from their holders, and inserting a milliammeter in the H.T.+1 lead. This current will vary with different positions of the RELAY ADJUSTMENT, from 0 with the control turned fully clockwise to 17 milliamps turned fully counter-clockwise. The armature gap adjustment provided on the relay itself, should be set to close at from 3 to 5 milliamps. It is possible that the bell may fail to ring owing to the hammer jamming against the stop inside or to seizing of the armature contacts and examination with the gong removed will indicate the fault.

30. Inspection should be made to ensure that all valve pins are a good fit in their respective holders, switch contacts are making properly, plugs fixed securely to the end of their leads and all wires firmly soldered in position. When taking voltage and current consumption readings, it is very important to make sure that the accumulator, H.T. and grid bias batteries are in good condition.

APPENDIX

NOMENCLATURE OF PARTS

The following list of parts is given for information only. When ordering spares for this transmitter-receiver, the appropriate section of AIR PUBLICATION 1086 must be used.

Ref. No.	Nomenclature	Qty.	Ref. in fig. 2	Remarks
10D/78	Transmitter-receiver, type T.R.1150			
	Principal components:—			
10D/123	Bell			
10D/152	Bush, aerial, connecting	1		
10C/400	Choke, A.F., type 38	1	L_4	
10C/401	Choke, R.F., type 66	1	L_3	
	Condenser			
10C/426	Type 697	1	C_7	1 μF
10C/512	Type 744	3	C_8, C_{11}, C_{13}	0·1 μF
10C/513	Type 745	1	C_9	0·0005 μF
10C/429	Type 700	2	C_1, C_{10}	0·002 μF
10C/514	Type 746	1	C_{12}	0·01μF
10C/516	Type 748	1	C_2	25 $\mu\mu$F, variable
10C/517	Type 749	1	C_5	0·006 μF
10C/518	Type 750	1	C_6	0·004 μF
		1	C_4	0·0003 μF
10C/504	Type 751	1	C_3	30 $\mu\mu$F, trimmer
10D/153	Coupler	1		Flexible
10D/151	Coupling, unit, type 8	1	L_2	Coil assembly
	Holder, valve			
10H/303	Type 46	2		5-pin
10H/304	Type 47	1		4-pin
	Knob			
10A/12074	Type 22	3		12-sided, black
10A/12075	Type 23	1		Tuning, engraved 0–100
10A/12133	Lampholder, type 8	2		
10F/144	Relay, magnetic, type 83	1	REL_1	
	Resistance			
10C/525	Type 796	1	R_4	100,000 ohms variable
10C/27	Type 544	2	R_2, R_5	10,000 ohms
10C/526	Type 797	1	R_7	50,000 ohms variable, with double switch
10C/527	Type 798	2	R_6, R_8	25,000 ohms
		1	R_1	0·75 M ohms
10C/528	Type 799	1	R_3	0·5 M ohms
	Sockets			
10H/211	Type 99	1	SK_1	5-pin battery
10H/278	Type 117	2		
10F/143	Switch, type 229	1	S_1	2-bank, 3-pole, 3-way
	Transformer			
10K/12134	Type 128	1	T_2	Intervalve
10K/12135	Type 129	1	T_1	Microphone
	Accessories:—			
5A/867	Accumulator, No. 1, Mk. 4	1		2-volt, 90 ampere-hours
5A/1893	Batteries, dry, 9-volt	3		Grid bias
5A/2255	Batteries, dry, 54-volt	3		High tension
10D/88	Case, transit, battery	1		
10H/212	Connector, type 186	1		5-way battery, fitted with plugs, type 163
10B/287	Dipole, aerial	1		
10A/12033	Head set, combined type 1			
5A/361	Lamps, filament	2	PL_1, PL_2	3·5 volts
	Plug			
10H/214	Type 165	2		Single-pole, red
10H/215	Type 164	2		Single-pole, black
10H/216	Type 166	1		Single-pole, engraved —1
10H/217	Type 167	1		Single-pole, engraved —2

Ref. No.	Nomenclature	Qty.	Ref. in fig. 2	Remarks
	Transmitter-receiver, type T.R.1150—*contd.*			
	Accessories—*contd.*			
	Plug—*contd.*			
10H/218	Type 168	1		Single-pole
10H/213	Type 163	2		5-pole
10H/223	Type 169	1		4-pole
10B/286	Rod, aerial, type 9	1		
10H/211	Socket, type 99	1		5-pin
	Valve			
	(Cossor 230 XP)	1	V_1	
	(Tungsram PP2)	1	V_3	
10E/10946	Type V T.51	1	V_2	

SECTION 2, CHAPTER 8

TRANSMITTER-RECEIVERS T.R.1196 AND T.R.1196A

Contents

List of Illustrations

CONCISE DETAILS OF

TRANSMITTER-RECEIVERS T.R.1196 AND T.R.1196A

PURPOSE OF EQUIPMENT	Airborne equipment designed primarily for F.A A. It may be applied to multi-seater aeroplanes by incorporating amplifier A 1134 or other suitable instrument. Embodies transmitter unit, type 22, receiving unit, type 25, either chassis assembly, type 7 with power unit, type 87, or chassis assembly, type 8, with power unit, type 104.
TYPE OF WAVE	R/T and M.C.W.
FREQUENCY RANGE ...	4·3 Mc/s to 6·7 Mc/s in maximum of four "spot" frequency channels
FREQUENCY STABILITY ...	Quartz crystal controlled.
CRYSTAL MULT. FACTOR ...	Fundamental operation in transmitter, type 22. Plus or minus 460 kc/s off frequency channel in the super-heterodyne receiver, type 25, for local oscillator.
PERCENTAGE MODULATION	100 per cent.
MAXIMUM SENSITIVITY ...	Input of 10 micro-volts modulated 50 per cent. at 1,000 c/s—output 40 to 60 milliwatts into 20,000 ohms Less than 10 per cent distortion for output of 140 milliwatts into 8,000 ohms, that is, 3 pairs of telephones.
SELECTIVITY	6 kc/s bandwidth for 6 db attenuation. 30 kc/s bandwidth for 40 db attenuation
OUTPUT IMPEDANCE ...	50 ohms for 3 pairs of 150 ohms telephones 200 ohms for 3 pairs of 600 ohms telephones 8,000 ohms for 3 pairs of 20,000 ohms telephones } Regulation assisted by negative feedback to prevent excessive rise with fewer telephones in use.
AMPLIFIER CLASS	Class C in transmitter output stage, anode modulated.
MICROPHONE TYPE ...	Electro-magnetic, type 21 or type 26 (Stores Ref—10A/11994 and 10A/12571).
VALVES	*Transmitter unit, type 22.* Crystal-controlled oscillator pentode V. R. 91 (Stores Ref—10E/92) Output tetrode, V.T.501 (Stores Ref—10E/389). Modulator pentode V.T 52 (Stores Ref—10E/11398). *Receiving unit, type 25.* R F. and I F. pentodes V.R 53 (Stores Ref—10E/11399) Frequency-changer octode V.R.57 (Stores Ref—10E/11403) A G C first A F and microphone amplifier pentode, V. R. 56 (Stores Ref—10E/11402) Double diode-triode output and 2nd microphone amplifier V R 55 (Stores Ref—10E/11401).
POWER INPUT	*Transmitter* 250 volts. 60 mA, H.T.; 6·3 volts, 1·3 amp.; heaters. *Receiver* 275 volts, 35 mA, H.T.; 6·3 volts, 1·2 amp.; heaters *Total input* from aeroplane supply to rotary transformer.—5 amps at 13 volts or 2·5 amps. at 26 volts.
POWER OUTPUT	0·4 amp to 0·6 amp into "small" (100 $\mu\mu$ F) type aerials as used with transmitter-receivers T.R 9D and T R 9F Given resistance 5 ohms, power is between 0·8 watts and 1·8 watts
STORES REF No	T.R 1196, 10D/325; T.R.1196A, 10D/369.
APPROXIMATE OVERALL DIMENSIONS	LENGTH 18 in. WIDTH 11 in HEIGHT $7\frac{1}{2}$ in Fixing centres in base identical with T.R 1133 and T.R 1143
WEIGHT	36 lb including cables and the controller, electric, type 4
ASSOCIATED EQUIPMENT...	Controller, electric, type 4 (Stores Ref.—10J/22) Crystal unit, type A, 8 off (Stores Ref.—10X/ as required). Connector set, type according to installation Amplifier A 1134, (certain installations Stores Ref—10U/1150). Receiver telephone, head, type 32, 150-ohm impedance (Stores Ref.—10A/13466). Receiver telephone, head, types 16, 17, or type C, 20,000 ohm -impedance (Stores Ref.—10A/8543). 600-ohm impedance telephones, types unspecified (U S A). Contact cleaner (Stores Ref—1H/6).

TRANSMITTER-RECEIVERS T.R.1196 AND T.R.1196A

(Stores Ref. 10D/325 and Stores Ref. 10D/369)

INTRODUCTION

1. The transmitter receivers T.R.1196 and T.R.1196A are multiple channel R/T and M.C.W. instruments operating on fixed frequencies in the band from 4·3 Mc/s to 6·7 Mc/s and are designed for use in aircraft. A maximum of four "spot" frequencies may be preset prior to flight. Stabilization of frequency by quartz crystal-control is provided in the transmitter and receiver.

2. The transmitter receiver is intended to be worked into a short capacitative aerial (100$\mu\mu$F) of a maximum length of 28 ft. giving a telephony air-to-ground range of 50 miles at an altitude of 2,000 ft., with an air to air range of 30 miles. When used in certain types of aircraft it may be necessary to load the aerial either inductively or capacitatively in order to cover the specified band of frequencies.

3. A push button remote control unit affords facilities for the frequency selection in flight. In addition, the controller incorporates a three-way key switch for TRANSMIT RECEIVE-RECEIVER ATTENUATION, an OFF button and a two pin socket for a PRESS-TO-TRANSMIT plug, if desired, to override the TRANSMIT switch. The receiver attenuation is variable and is used to reduce, up to a maximum of 20 db, in the absence of a signal.

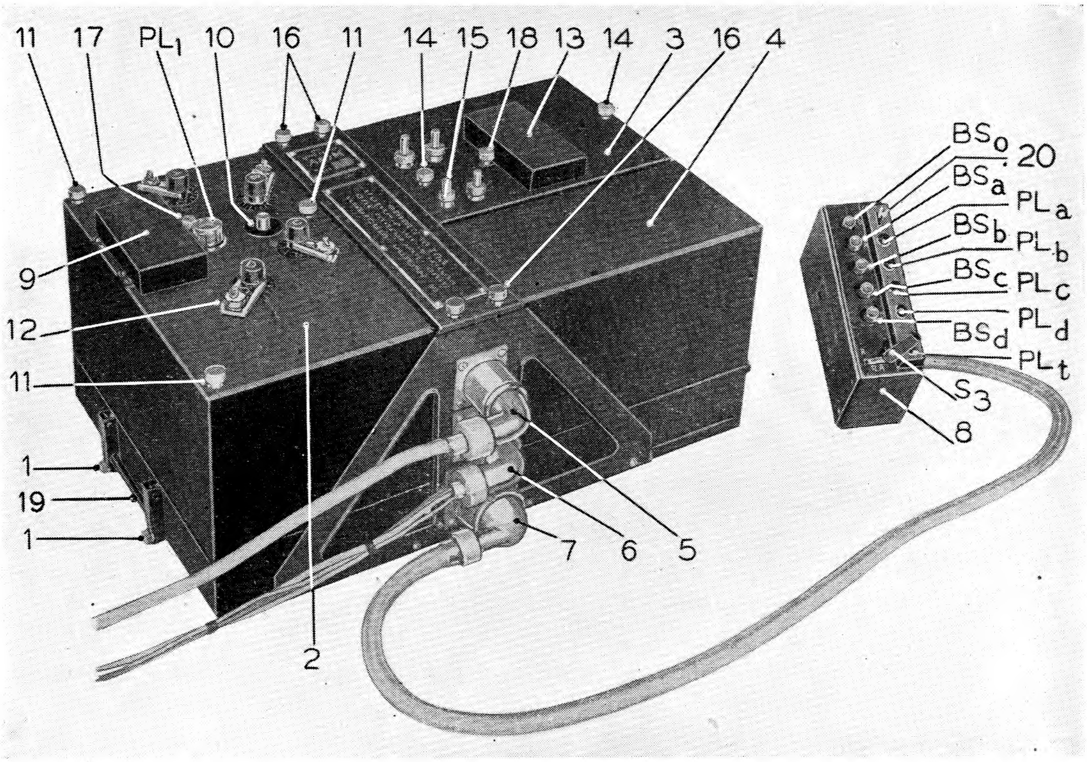


FIG. 1.—THE TRANSMITTER-RECEIVER T.R.1196 WITH THE CONTROLLER, ELECTRIC, TYPE 4

4. The transmitter receivers each consist of a main mounting chassis carrying three quickly detachable units which are—the transmitter unit, type 22, the receiving unit, type 25 and either the power unit, type 87 (24-volt), or the power unit, type 104 (12-volt). The former power unit forms part of the T.R.1196 and the latter of the T.R.1196A. The transmitter and receiver units for the two types are identical. The main mounting chassis has a transverse centre section carrying all plugs and sockets required for connexion between units and to external apparatus. For the T.R.1196 this is the chassis assembly, type 7 (24-volt) and for the T.R.1196A, the 12-volt assembly, type 8.

5. The transmitter circuit consists of a crystal controlled oscillator pentode stage, working on the crystal fundamental frequency, a modulator pentode stage and a R.F. amplifier tetrode stage. The transmitter output circuits are used as input tuned circuits for the receiver. A key operated relay transforms the modulator to a selective positive feed back oscillator for tone modulation.

6. The receiver circuit comprises a variable-μ pentode R.F. amplifier, an octode frequency-changer amplifier, the triode portion of which acts as a local oscillator, crystal controlled, a variable-μ pentode intermediate frequency amplifier at a frequency of 460 kc/s, a pentode automatic gain control (A.G.C.) amplifier, a pentode first A.F. amplifier and a double-diode-triode output stage. The A.F. stages of the receiver are also used as a microphone amplifier to provide sub-modulation of the transmitter and I/C by electro-magnetic microphones, type 21 or type 26 used at three positions in the aircraft. Where an increased number of positions is required to be served, the amplifier A.1134, or other suitable instrument, may be used as an alternative I/C amplifier. Slight link changes permit the use of 150-ohm, 600-ohm, or 20,000-ohm impedance telephones.

7. The power supplies for the transmitter-receiver are derived from a power unit incorporating a three commutator rotary transformer with input and output smoothing components. The power unit, type 87, has a nominal 24-volt input and the power unit, type 104, an input of 12-volts nominal The input to the power unit is derived from the aircraft general electrical system. The power output into "small" or $100\mu\mu F$ (of the order of 28 ft.) aerials will be approximately 0·8 to 1·8 watts.

8. The general appearance of the transmitter-receiver together with the control unit, and the leads to the aircraft electrical supply, microphone and telephone is shown in fig. 1. The overall dimensions of the complete instrument are, approximately, 18 in. wide by 7½ in. high by 11 in. deep and the total weight including the controller electric, type 4, but without cables, is approximately 40 lb.

GENERAL DESCRIPTION

The transmitter unit, type 22

9. A theoretical circuit diagram of the transmitter unit, type 22, is given in fig. 2. An indirectly-heated pentode valve V_1, is connected as a cathode-coupled oscillator, the frequency of which is determined by one of four quartz crystals X_a, X_b, X_c or X_d.

10. A cathode bias resistance R_3 provides for an initial negative biasing of the valve. A choke L_1 prevents the crystal from being short-circuited at radio frequency. The series condensers C_3 and C_2 constitute the grid to earth capacitance for the valve V_1. A regenerative effect is introduced to the cathode through the junction of C_2 and C_3 and is determined by the value of C_2. A resistance R_1 is a grid leak and a resistance R_{12} is an anti-parasitic resistance in the grid circuit.

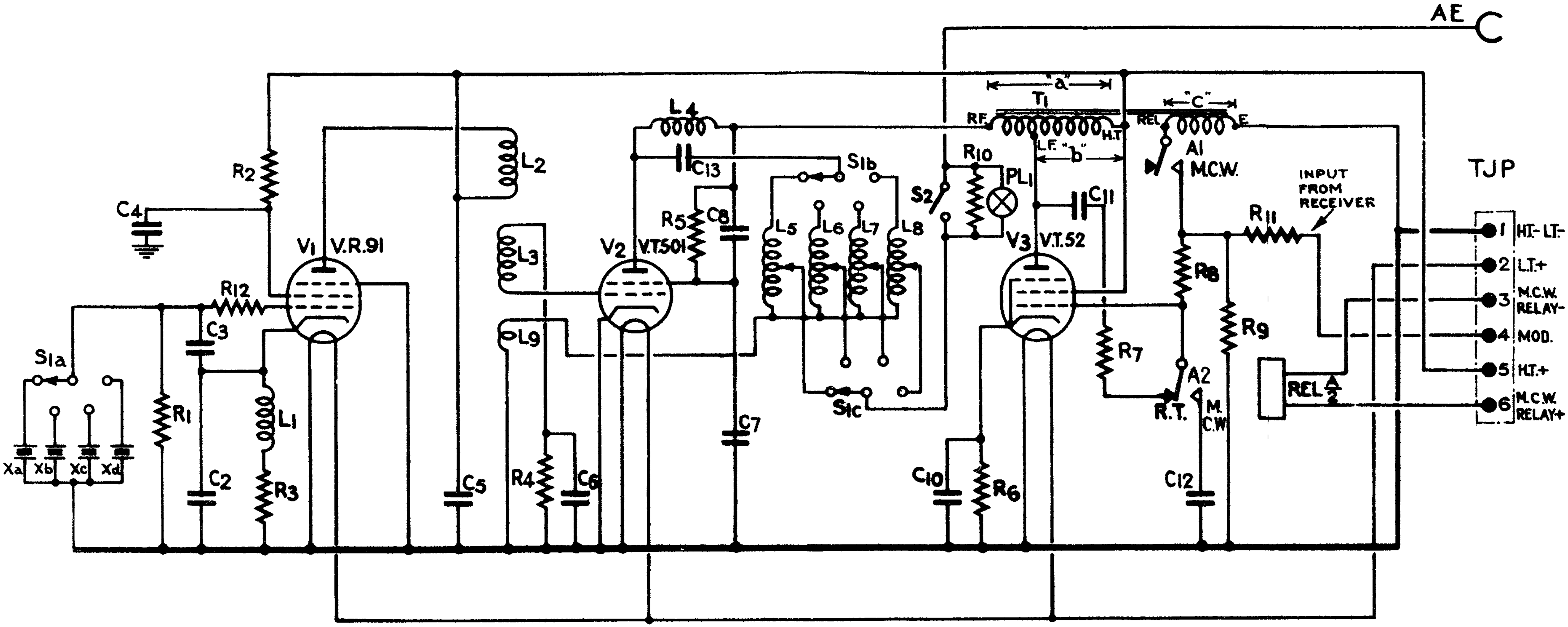
11. The screen voltage for V_1 is reduced to a suitable value by a resistance R_2, the necessary decoupling to earth being brought about by a condenser C_4. The anode voltage is fed through an anode load coil L_2 the H.T. line being decoupled by a condenser C_5.

12. The coupling between the valve V_1 and an amplifying tetrode valve V_2 is *via* the anode coil L_2 and a grid coil L_3, the combination affording a band-pass arrangement having a sufficiently wide characteristic to accommodate the whole range of frequencies operated. This design consideration obviates the use of four separate tuned anode circuits for V_1 and an adequate drive voltage is supplied to the grid of V_2 between the frequency limits of 4·3 Mc/s and 6·7 Mc/s.

13. Higher power conversion efficiency is obtained by operating the valve V_2 as a class C amplifier. Sufficient anode-grid capacitance exists in V_2 to make it desirable to provide for some degree of neutralization under the variable drive conditions. This is provided by a single turn loop L_9 used between the lower ends of the coils L_5, L_6, L_7 and L_8 and earth and coupled inductively to the secondary winding L_3, of the R.F. transformer. Satisfactory modulation is given at all frequencies at which the grid drive exceeds, approximately, 40 volts peak, a bias of 40 volts being approximately twice the cut-off bias at normal anode and screen voltages. Any reduction in the grid drive volts will cause the valve to operate less efficiently and not under the class C condition required. A complete discussion of class C operation can be found in A.P.1093, Chapters IX and XI. Grid bias is provided by a self-bias resistance R_4 which acts as a leak in the grid-rectification system constituted by R_4 and C_6.

14. To provide for efficient power transference between the amplifier output and the aerial circuit four preset coils L_5, L_6, L_7 and L_8 are provided. These are coils of the continuously variable type and the shunt capacitance for each is, in effect, represented almost entirely by the aerial system. The coils L_5, L_6, L_7 and L_8 are selected by a 2-bank switch ganged to a further bank which selects the appropriate crystal. The crystal selector portion is S_{1a}, the anode end selector for the coils, S_{1b}, and the Ae tap end selector S_{1c}. The aerial current is normally between 0·4 amp. and 0·6 amp.

C4 C2 C3	C5	C6	C13 C8 C7	C10		C11	C12		CONDENSERS
R1 R12 R2 R3	R4		R5	R10 R6		R7	R8 R9 R11		RESISTANCES



CONDENSERS			
C2	100 μμF	C8	0·01 μF
C3	20 μμF	C10	1 μF
C4	·01 μF	C11	0·01 μF
C5	0·01 μF	C12	0·0003 μF
C6	300 μμF	C13	0·001 μF
C7	0·005 μF		

RESISTANCES					
R1	100,000 Ω	R6	500 Ω	R11	2,000 Ω
R2	20,000 Ω	R7	500,000 Ω	R12	200 Ω
R3	250 Ω	R8	50,000 Ω		
R4	100,000 Ω	R9	500,000 Ω		
R5	20,000 Ω	R10	10 Ω		

THE TRANSMITTER UNIT, TYPE 22, CIRCUIT DIAGRAM

FIG. 2 FIG. 2

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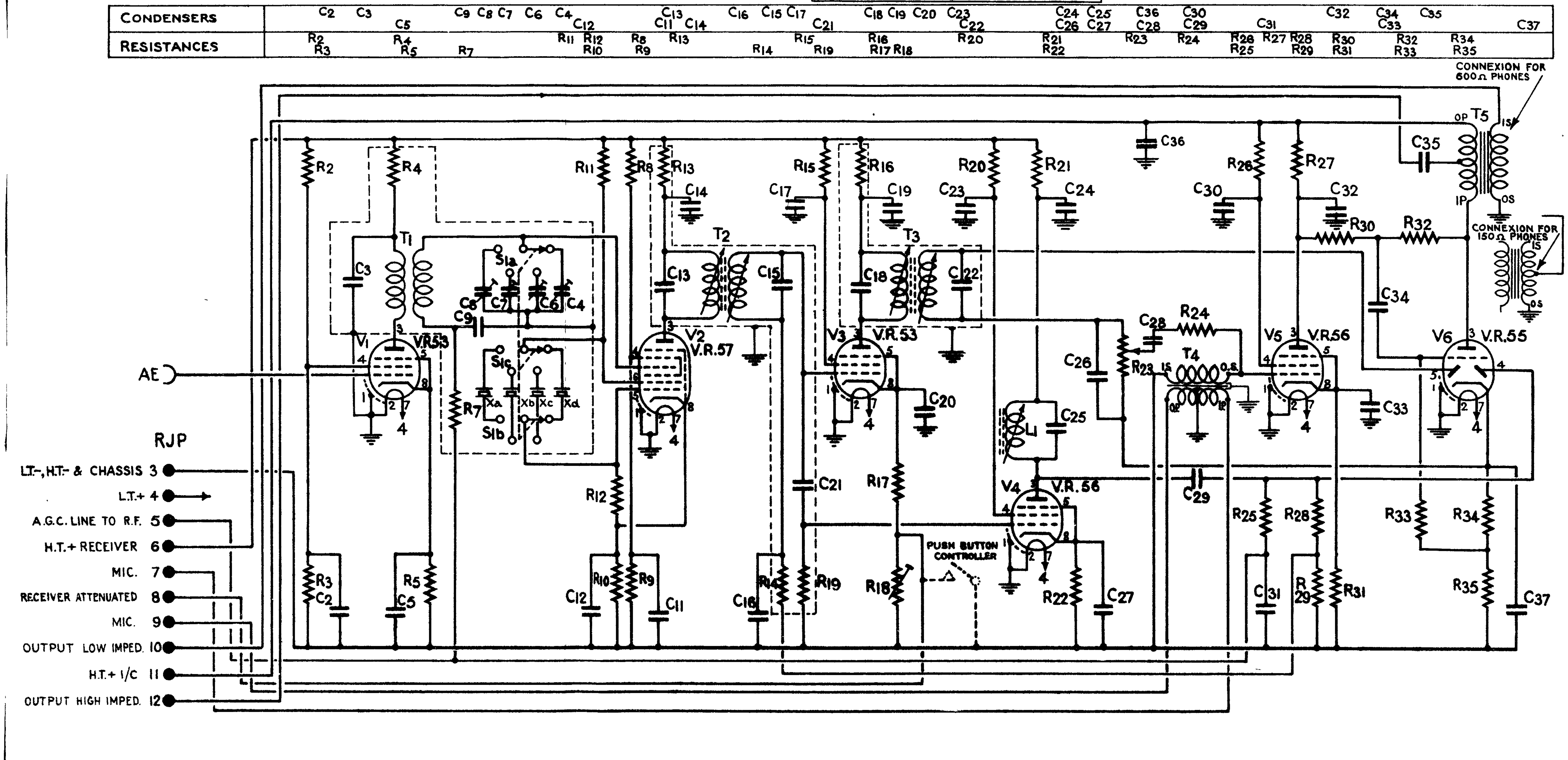


THE RECEIVING UNIT, TYPE 25, CIRCUIT DIAGRAM.

CONDENSERS		RESISTANCES	
C2	0·01µF	R2	0·1MΩ
C3	0·01µF	R3	0·2MΩ
C4	100µµF	R4	2,000Ω
C5	0·01µF	R5	400Ω
C6	100µµF	R7	0·1MΩ
C7	100µµF	R8	0·1MΩ
C8	100µµF	R9	0·1MΩ
C9	0·01µF	R10	400Ω
C11	0·01µF	R11	50,000Ω
C12	0·1µF	R12	50,000Ω
C13	150µµF	R13	2,000Ω
C14	0·1µF	R14	1MΩ
C15	150µµF	R15	0·1MΩ
C16	0·1µF	R16	2,000Ω
C17	0·1µF	R17	200Ω
C18	150µµF	R18	5,000Ω
C19	0·1µF	R19	0·5MΩ
C20	0·1µF	R20	0·2MΩ
C21	100µµF	R21	5,000Ω
C22	150µµF	R22	500Ω
C23	0·1µF	R23	0·5MΩ
C24	0·1µF	R24	0·5MΩ
C25	200µµF	R25	1MΩ
C26	200µµF	R26	0·25MΩ
C27	0·1µF	R27	60,000Ω
C28	0·01µF	R28	1MΩ
C29	100µµF	R29	0·25MΩ
C30	0·1µF	R30	0·1MΩ
C31	0·1µF	R31	800Ω
C32	500µµF	R32	0·5MΩ
C33	0·1µF	R33	1MΩ
C34	0·01µF	R34	600Ω
C35	0·5µF	R35	600Ω
C36	0·1µF		
C37	2µF		

FIG. 3

FIG. 3

15. An aerial circuit resonance indicator consists of a pilot lamp PL_1. The pilot lamp is shunted by a resistance R_{10} and is brought into operation by a plunger-operated break switch, S_2. The coupling condenser C_{13} affords the necessary blocking for H.T.

16. To the control grid of a pentode valve V_3, a sub-modulation input is applied from the receiver A.F. stages *via* a resistance R_8. When using R/T the contacts A.2 of a magnetic relay REL $\frac{A}{2}$ complete a negative feedback channel from the anode of V_3 through a condenser C_{11} and a resistance R_7. In order to obviate any tendency to self-oscillation in the final valve of the receiver, due to the interlocking of the circuit with this stage of the transmitter, a resistance R_{11} is included between the top end of R_8 and the modulation input from the receiver at the TJP_4 point of the transmitter Jones plug TJP.

17. To provide a tone modulation for M.C.W., when keying the transmitter, the valve V_3 is arranged as a selective positive feedback oscillator, the feedback voltage being obtained from a special winding "c" on a modulation transformer T_1, the modulation frequency being determined by the constants of a resistance R_9, the inductance of the winding "c" and a condenser C_{12}. The modulation transformer T_1 has a ratio of 1 to 1·25 (winding "b" to winding "a") and through it the output from the anode of V_3 is applied to the anode and screen of the valve V_2.

18. The simultaneous modulation of anode and screen of V_2 in the system employed provides for a more approximately linear modulation by maintaining a constant ratio of voltage between the two electrodes. Two R.F. by-pass condensers C_7 and C_8, in series, form a potential divider, feeding the screen. The values of C_7 and C_8 are so chosen that they maintain the correct voltage ratio at all modulating frequencies.

19. When the key is closed the supply circuit to the magnetizing coil of the relay REL $\frac{A}{2}$ is completed and the negative feedback circuit through C_{11} and R_7 is broken. This provides for 100 per cent. modulation of from 800 to 1,500 c/s. Connexion to the chassis assembly is made by two plugs, Ae for the aerial and TJP, the transmitter Jones plug, consisting of six points — TJP_1 for L.T. negative, H.T. negative and earth; TJP_2 for L.T. positive; TJP_3 for M.C.W. relay REL $\frac{A}{2}$ negative; TJP_4 for modulation input from receiver; TJP_5 for H.T. positive and TJP_6 for relay REL $\frac{A}{2}$ positive.

The receiving unit, type 25

20. The circuit of the receiving unit, type 25, is of the super-heterodyne type and is shown in fig. 3. The R.F. input to the control grid of an indirectly-heated pentode valve V_1 is capacitance-coupled by a small condenser C_1 which is included in the chassis assembly unit. A resistance R_1, also in the chassis assembly unit, applies the automatic gain control for the stage V_1. The grid circuit tuning of this stage utilizes the transmitter output coils L_5, L_6, L_7 and L_8, which are continuously variable and are adjusted to resonance with the individual channel crystals employed in the transmitter.

21. A screen H.T. dropping resistance is R_2. A similar function for the anode is performed by a resistance R_4 incorporated in the screened container for a R.F. transformer T_1. The output of V_1 is inductively coupled by the transformer T_1 to the control grid of the pentode portion of an octode valve V_2. The cathode circuit includes a fixed bias resistance R_5 and a by-pass condenser, C_5. The valve V_1 has a variable-μ characteristic and this R.F. amplifying stage results in a reduction in noise level and an improvement in image ratio.

22. The secondary winding of the transformer T_1 is tuned by a preset condenser as selected by a bank S_{1a} of a four-way switch S_1. The condenser is C_4, C_6, C_7 or C_8, according to the particular "spot" frequency, coded A, B, C or D, selected. The theoretical considerations involved in the choice of "tuned secondary" circuit in preference to the tuned anode or "tuned primary" methods of R.F. inter-valve coupling can be found, together with the relevant mathematical treatment, in A.P.1093, Chapter XI.

23. The input to the control grid of the pentode portion of the frequency changer-amplifier valve V_2 is mixed with a local oscillator voltage derived from the triode constituted by the common cathode 8, control grid 5 and grid 6, which, is, virtually, the anode for the oscillator. The H.T. voltage dropping resistance for the pentode anode 3, is R_{13}, for the screen, R_8; the A.V.C. bias resistance is R_7. The H.T. voltage for the oscillator grid 6 is dropped by R_{11} the value of which is sufficiently high to obviate the necessity for a R.F. choke. The bias for the cathode 8 is fixed by R_{10} and R_{12} is a grid leak from grid 5.

24. The frequency of the local oscillator component is determined by the fundamental frequency of a quartz crystal which, selected by a bank of the four-way switch S_1, is connected between the grid 6 and the grid 5. This oscillator is, in effect, a conventional anode-to-grid crystal oscillator

in which the crystals X_a, X_b, X_c or X_d are substituted for the tuned anode circuit. Oscillator feedback is derived from grid-to-cathode capacitance of the valve. A condenser C_{12} decouples the cathode circuit for the I.F. voltages.

25. The local oscillations are electronically-coupled to the input signal within V_2 and frequency changing to 460 kc/s is effected. The two frequencies "beat" at 460 kc/s and, due to the non-linear action of the stage, voltages at the beat frequency appear in the anode circuit. As an example, if the received signal frequency, for which the instrument is tuned, is 5,500 kc/s, the receiver local oscillator crystal employed would have a fundamental frequency of either 5,040 kc/s or 5,960 kc/s, that is, differing from the input frequency by plus or minus 460 kc/s.

26. The amplified I.F. output from the anode 3 of the valve V_2 is coupled to the control grid of a subsequent pentode valve V_3 by a R.F. tranformer T_2. The windings of T_2 are designed to give optimum coupling, and, in practice, bring about an attenuation, by 3 db, of signals plus or minus 3·0 kc/s removed from the I.F. and of 20 db for a total bandwidth of 30 kc/s (plus or minus 15 kc/s.). For the complete I.F. amplifier, incorporating two such transformers, the attenuation figures are 40db for 30 kc/s and 6 db for 6 kc/s total band width. The windings of T_2 are tuned by screwdriver adjustment of the iron dust cores and both are shunted by condensers, C_{13} and C_{15}, which are of equal capacitance. The anode resistance for the amplifier portion of V_2 is R_{13}, the circuit being by-passed by a condenser C_{14}. The resistance R_{13}, a filter resistance R_{14} (*see* para. 38) with a grid coupling condenser C_{21} and resistance R_{19}, are contained within the screening can of the transformer T_2.

27. The valve V_3 is a variable-μ pentode. Coupling between V_3 and the succeeding stage, which is the diode portion of the double-diode-triode valve V_6, is by means of a R.F. transformer T_3, similar in characteristic to the transformer T_2. The anode resistance for V_3 is R_{16} which is contained in the screening can of the transformer, the H.T. being by-passed by a condenser C_{19}. Cathode bias to V_3 is fixed by a resistance R_{17} or a conjunction of R_{17} with a series variable resistance R_{18} as will be explained in para. 39. The screen voltage is reduced by a resistance R_{15} and by-passed by a condenser C_{17}. The cathode suppressor grid circuit is by-passed by C_{20}.

28. The signal voltage across the secondary of T_3 is injected at the first diode 5 of the valve V_6 and is rectified by the diode portion, the resultant A.F. component appearing across a load resistance R_{23}. This resistance is a preset potentiometer and is shunted by a condenser C_{26}. The audio voltages developed across R_{23} are coupled, through a resistance R_{24}, to the control grid of a first A.F. pentode valve V_5. The resistance R_{24} and a condenser C_{28} constitute part of the A.C. load of the valve V_5, the condenser C_{28} isolating the biasing system of V_5 from that of V_6. The secondary winding of the microphone transformer T_3 is connected between the grid of V_5 and earth.

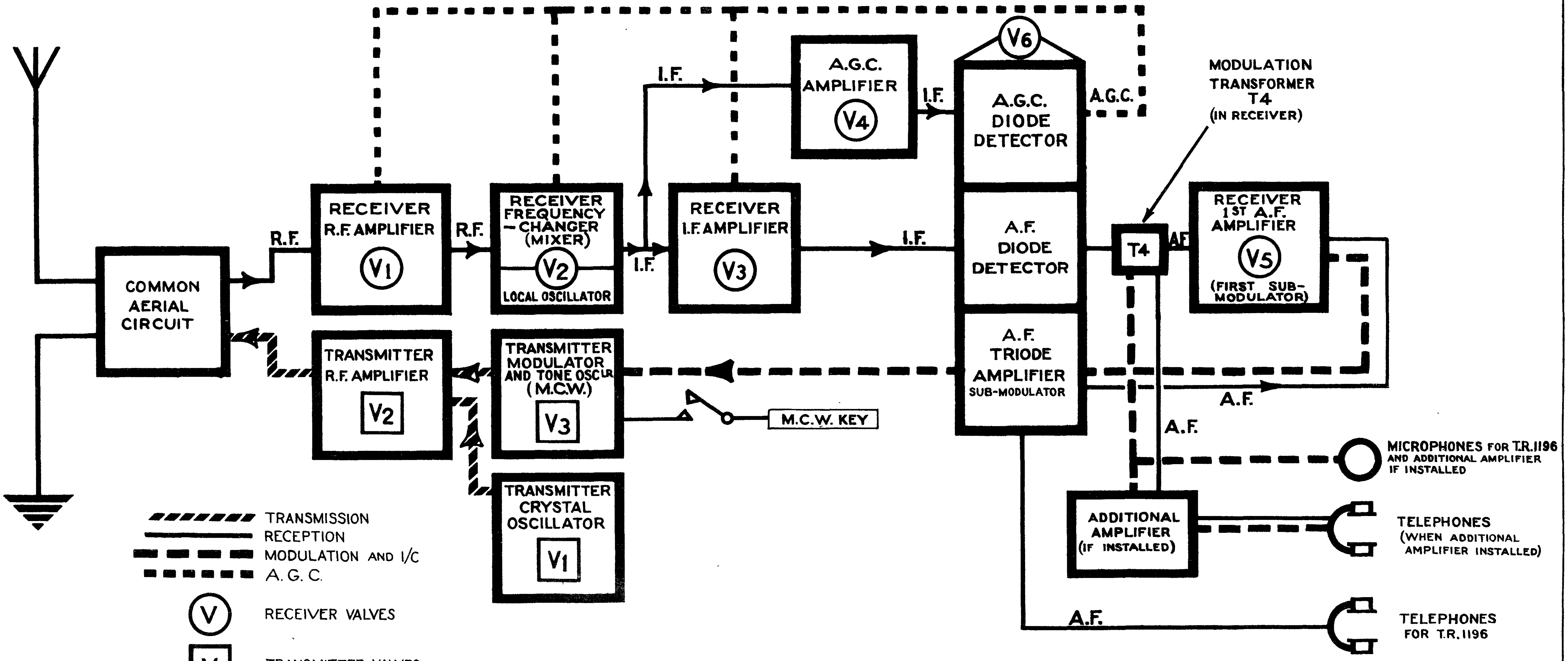
29. The microphone is approximately matched to R_{24} by the transformer T_4 and the microphone terminals RJP_7 and RJP_9 of the receiver Jones plug RJP, provide receiver output at microphone level when a separate I/C amplifier is used. It is therefore possible to connect a suitable amplifier, such as the A.1134, to these terminals providing radio signals at an increased number of positions without risk of any undesirable interaction effects due to the output circuit of the receiver and of the amplifier being common.

30. The valve V_5 is cathode biased by a resistance R_{31} by-passed by a condenser C_{33}. The screen H.T. dropping resistance is R_{26} and, for the anode, R_{27}. The function of V_5, as an A.F. amplifier for receiver signals, is supplemented by its use as a microphone amplifier, the microphone input being provided at terminals $RJSK_9$ and $RJSK_7$ in the chassis assembly.

31. The valve V_5 is resistance-capacitance coupled to the output A.F. amplifier, which is the triode portion of the double-diode-triode V_6, through a resistance R_{30}, a condenser C_{31}, and a grid leak resistance R_{33}. The grid leak R_{33} is returned to a tapping on the output valve bias resistance constituted by R_{34} and R_{35}. Cathode bias is fixed by a resistance R_{34} and a condenser C_{37} decouples the system.

32. A condenser C_{32}, shunted across the anode-to-earth voltages of the valve V_5, serves to attenuate the higher audio frequencies. Negative voltage feedback is provided in this final amplifier stage by a resistance R_{32} and this is injected in opposition to the voltage from V_5 through the grid condenser C_{34}. Partial compensation for the varying load conditions brought about by the connexion of more than one pair of telephones is, by means of this feedback, rendered possible, the A.F. output voltage remaining reasonably constant.

33. An output transformer T_5 has a tapped primary and, in conjunction with a condenser C_{35}, this provides for high impedance telephones and for modulation. The secondary winding of T_5 is an alternative output to be used, as a whole, with 600-ohm impedance telephones; a tapping on this secondary winding can be used to accommodate telephones of 150-ohm impedance. The output impedance for maximum undistorted output rates at 50 ohms for three pairs of 150-ohm telephones, at 200 ohms for three pairs of 600-ohm telephones and at 8,000 ohms for the same number of 20,000-ohm telephones.



T.R. 1196, BLOCK SCHEMATIC DIAGRAM

FIG. 4

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34. The utilization of the stages V_5 and V_6 in the dual capacity of receiver A.F. amplifier and sub-modulator for the transmitter, necessitated independent H.T. positive circuits for R.F. and A.F. supply. When the A.F. portion of the receiver is used with the microphone the R.F. H.T. supply is switched out of circuit through the action of a TRANSMIT-RECEIVE relay in the chassis assembly, this relay being, in turn, governed by the T/RA/R key switch in the controller unit.

Automatic gain control

35. In order to avoid the necessity for the remote means of controlling volume, amplified delayed A.G.C. has been included in the design. In conjunction with the negative feedback applied to the stages V_5 and V_6 a level output of plus or minus 4 db. is maintained with signal variations of from 5 microvolts to 100 millivolts and load variations from one to three pairs of telephones.

36. A portion of the I.F. signal appearing across the secondary of T_2 is coupled, through a condenser C_{21}, to the control grid of a pentode valve V_4 which is the A.G.C. amplifier. An amplified signal appears across a resonant circuit comprising an adjustable iron dust core coil L_1 and a condenser C_{25}. This circuit is tuned to the I.F. of 460 kc/s and the LC ratio is so adjusted that possible variations in the anode to earth capacitance of the valves used for the V_4 stage are compensated. This compensation is effected by arranging that the shunt condenser C_{25}, for L_1, has twice the capacitance of similarly employed condensers for the secondary windings of T_2 and T_3 respectively, the inductance of L_1 accordingly being halved.

37. The amplified I.F. signal across L_1 is applied *via* a condenser C_{29} to the second diode (4) of the valve V_6 and rectification takes place, the resultant D.C. component appearing across a load resistance constituted by R_{28} and R_{29} in series. This rectifying action is, however, delayed until the peak voltage on the second diode exceeds the delay voltage of approximately 10 volts. This delay voltage is due to the voltage drop across the series resistance R_{34} and R_{35} and is produced by the triode anode current of V_6. The receiver remains at full gain until the carrier signal strength approaches 5 microvolts, while from 10 microvolts upwards the output is kept practically constant. A block schematic diagram showing the interdependence of the transmitter and receiver and embodying the A.G.C. system is given in fig. 4.

38. If the A.G.C. voltage were applied only to the R.F. and frequency changer stages an inadequate degree of control would be obtained. The use of a separate A.G.C. amplifier, however, renders it possible to control the I.F. amplifier which is situated at a point in the network at which the control voltage is tapped off. This point is selected in such a way that an almost level characteristic is obtained. This condition is brought about by applying half the D.C. control voltage to V_3 from the potential divider R_{28}, R_{29}. The bias for the stage V_3 is taken in a series feed circuit from the junction of R_{28} and R_{29}, through a filter circuit consisting of R_{14} and C_{16}, to the secondary of T_2 and thence to the grid of V_3. The condenser C_{16} also by-passes the R.F. components from the lower end of T_2 secondary to earth. The control grid of the pentode portion of V_2 is similarly biased by R_7 with C_9 by-passing the circuit. The control grid of V_1 is shunt fed, the resistance R_1 being the grid leak As mentioned in para. 20, R_1 and the blocking condenser C_1 are contained in the chassis assembly and the tuned circuit in the transmitter unit.

Attenuation

39. As indicated in para. 27, the resistance R_{17} provides standing bias for the valve V_3 and a preset variable resistance, R_{18}, in series with R_{17}, is short-circuited at the remote controller when the key switch is in the R (Receive) position. When the switch is moved to the central position RA, the resistance R_{18} is connected in series with R_{17} thereby reducing the V_3 stage gain by an amount depending upon its setting. When the whole of the resistance of R_{18} is employed the reduction in gain is approximately 20 db. This reduces the background noise present in the absence of a signal, permitting clear I/C and a warning when a signal is received.

40. The connexions between the receiver and the chassis assembly are effected by means of an aerial plug Ae and a Jones plug RJP consisting of ten points which are—RJP_3, L.T. negative, H.T. negative and chassis earth; RJP_4, L.T. positive; RJP_5, A.G.C. line to R.F. that is to Al contact of the transmit-receive relay REL $\frac{A}{2}$ (para. 48); RJP_6, receiver H.T. positive; RJP_7, microphone; RJP_8, receiver attenuation; RJP_9, microphone; RJP_{10}, low impedance output; RJP_{11}, I/C H.T. positive and RJP_{12}, high impedance output.

The chassis assembly types 7 and 8, with controller, electric, type 4

41. The electrical system associated with the selector switch system for the TR.1196 is contained in the chassis assembly, type 7, designed for 24-volt operation. A similar chassis assembly, the type 8, is used with the T.R.1196A for 12-volt operation. The controller, electric, type 4, is exterior to this assembly. A theoretical circuit diagram of the two assemblies is shown in fig. 5. The circuit of the controller is incorporated on this diagram.

42. A maximum of four frequency channels, within the specified limits of from 4·3 Mc/s to 6·7 Mc/s are selected by the controller button-operated switches BS_a, BS_b, BS_c and BS_d, associated with the frequency channels A, B, C and D. A fifth button switch BS_o causes a starting relay REL $\frac{B}{1}$ to break the connexion to the power unit in the positive line. A three-position key switch S_3 gives positions for transmit (T), receive (R) and receiver attenuation (RA).

43. When any one of the buttons is pressed and one of the switches BS_a, BS_b, BS_c or BS_d made, a circuit is closed at the switch contacts whilst the OFF switch BS_o is mechanically rejected. The relay REL $\frac{B}{1}$ is energized. The power lines from the aircraft electrical supply, *via* a plug P_3, are completed through the contacts Bl of REL $\frac{B}{1}$ to the power unit Jones type socket points $PJSk_9$ and $PJSk_{10}$ and the rotary transformer is started.

44. A secondary result of pressing one of four buttons and so closing the OFF contacts of BS_o is to make the circuit, which includes a motor Mo_1, to which is ganged the frequency channel selector switch mechanism. This circuit includes the off-normal contacts F, the motor selector switch S_4 with a ganged cam S_{4a}, the make-and-break contacts Cl of the selector motor and the driving magnet REL $\frac{C}{1}$. A filter circuit consisting of a resistance R_2 and a condenser C_2 bridges the contacts Cl.

45. Reference to fig. 5 will show that at any one time, three sets of contacts are made to the motor selector switch S_4. If one of these corresponds to the button depressed in the controller the power supply to the driving magnet REL $\frac{C}{1}$ is made and the motor Mo_1 is caused to turn.

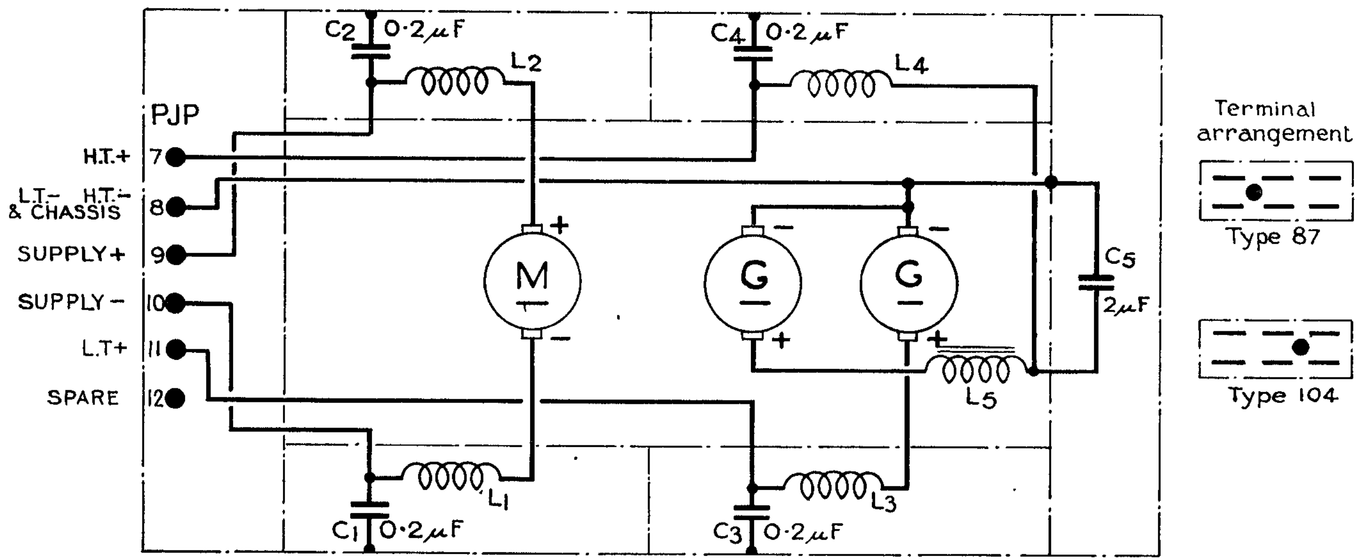
46. The electrical circuit is broken, momentarily, every 90 degrees of angular turn, by the opening of the contacts F by the cam S_{4a}. The motor Mo_1, will, however, continue to turn until the selector switch S_4 arrives at a position at which the contact wired to the depressed button switch is open-circuited at the same time as the contacts F open. When this happens the motor stops and the circuit is completed to an indicator lamp PL_a, PL_b, PL_c or PL_d corresponding to the selected frequency channel A, B, C or D.

47. Pressing a further button will release the button already down and will provide an alternative circuit for the supply to the coil of the driving magnet REL $\frac{C}{1}$. This causes the motor again to turn until the selector switch S_4 arrives at the new position determined by the button used. Spring-loaded dog-clutches turn the selector switches of the transmitter and receiver to the positions necessary to bring the frequency channel A, B, C or D components and crystals into circuit. Bridging tags SA, SB, SC, SD provide for links which may be removed should less than four channels be required for operational reasons. This obviates the selection of non-set-up channels should the buttons associated with them be accidentally pressed. In this event the selector motor will not follow the normal sequence of operation but will remain at its original position, that is, on the set-up channel for which the button was previously pressed.

48. A transmit-receive relay REL $\frac{A}{2}$ has one set of standard contacts, A2, for H.T. positive switching and a separate set, A1, for disconnecting the A.G.C. circuit, to the receiver valve V_1, when transmitting. The H.T. switching contacts are arranged to complete the H.T. supply circuit to the transmitter, the line being formed from the power unit *via* the power unit Jones socket point $TJSk_5$, when the coil of REL $\frac{A}{2}$ is energized. This occurs when the relay power circuit is completed at the controller key switch S_3 position T. At the same time the H.T. supply, *via* $PJSk_7$, contacts A2 and $RJSk_6$, to the R.F. portion of the receiver is disconnected. The switch position T also brings into circuit a pilot lamp PL_t.

49. Moving the key switch S_3 to the R or RA positions reconnects the H.T. supply to the receiver and disconnects the transmitter by the operation of contacts at RA position; the equipment is left in the receive (R) state but intercommunication is facilitated by a reduction of background noise in the absence of a carrier (*see* para. 39). High or low impedance telephones can be used, provision being made for a connecting link on a three-spill tag board. A two-point plug P_5, on the controller, type 4, is fitted with a socket to which a push-button may be connected by suitable cable for remote control of TRANSMIT-RECEIVE switching.

50. Connexions to the chassis assembly are made by a two-point W-plug P_3 for the aircraft electrical supply, a six-point W-plug P_4 for the microphones, telephones and MCW key and a 12-point



THE POWER UNIT TYPE 87, OR TYPE 104, CIRCUIT

FIG.6

W-plug P_2 for the controller, type 4. The transmitter connector is a six-point Jones socket TJSk having the following sockets:—$TJSk_1$, H.T. and L.T. negative and earth; $TJSk_2$, L.T. positive; $TJSk_3$, M.C.W. relay negative; $TJSk_4$ modulation; $TJSk_5$, H.T. positive and $TJSk_6$ M.C.W. relay positive.

51. Connection to the receiver is made *via* a ten-point Jones socket RJSk with the points:—$RJSk_3$, L.T. and H.T. negative and chassis earth; $RJSk_4$, L.T. positive; $RJSk_5$, A.G.C. line to R.F.; $RJSk_6$, H.T. positive; $RJSk_7$ microphone; $RJSk_8$, receiver attenuation, $RJSk_9$, microphone; $RJSk_{10}$, low-impedance output; $RJSk_{11}$, H.T. positive and I/C; $RJSk_{12}$, high impedance output.

52. The connexions to the power unit are made *via* the six-point Jones socket PJSk mating with the power unit Jones plug PJP. The points are:—$PJSk_7$, H.T. positive; $PJSk_8$, L.T. and H.T. negative and chassis earth; $PJSk_9$, supply positive; $PJSk_{10}$, supply negative and $PJSk_{11}$, L.T. positive, with $PJSk_{12}$ spare.

Power unit, types 87 and 104

53. The theoretical circuit diagram of the power units, type 87 and type 104, is shown in fig. 6. The unit consists of a three-commutator rotary transformer with its associated smoothing systems. The power unit is connected to the chassis assembly by a 6-point Jones plug PJP —The two units differ in respect of the rotary transformer windings but are identical in suppressor and filter components. They are continuously rated to give 30mA (receiver) with intermittent rating up to 65mA (transmitter). The rotary transformer has a permanent magnet field system.

54. The aircraft general electrical supply is fed to the power unit through the plug contacts PJP_9, positive, and PJP_{10}, negative. A R.F. choke is incorporated in each circuit with a condenser by-passing the circuit to earth. These chokes and condensers comprise screened suppressor unit combinations which are L_2 and C_2 and L_1 and C_1. Similar units L_3 and C_3 are in the L.T. output positive circuit and form part of the H.T. positive system (L_4 and C_4). A simple parallel rejector circuit consists of a choke L_5 and a condenser C_5 in the H.T. system. The output contacts are — PJP_{11}, L.T. positive; PJP_8, L.T. and H.T. negative and PJP_7, H.T. positive with PJP_{12} spare.

CONSTRUCTIONAL DETAILS

55. A general arrangement view of the T.R.1196, showing the controller, type 4, and cables to the transmitter-receiver is shown in fig. 1, and a plan view of the instrument, with covers removed, is shown in fig. 7. Two views of the chassis assembly are shown in fig. 8 and fig. 9. The transmitter unit, type 22, is shown, with covers removed, in fig. 10, whilst fig. 11 is a view of the chassis underside. For clarity of illustration the screened tuning unit has been removed from the chassis in the view of the receiving unit, type 25, which is shown in fig. 12, the chassis underside being depicted in fig. 13 and fig. 14. The construction of the I.F. transformers is shown in the view of fig. 15. The chassis underside of the power unit is shown in fig. 16, a plan view of the instrument, with cover removed, forming part of fig. 7. The power unit base contains all components other than the rotary transformer.

56. The three units can be easily withdrawn from the main chassis assembly by means of handles which are secured, when the instrument is assembled, by captive knurled headed screws (1, fig. 1). The handle (19) of the transmitter unit is visible in fig. 1. Each unit is separately screened by mild steel boxes, or covers, cadmium or zinc plated internally and stove enamelled black externally. The position of the units is indicated on fig. 1 as (2) for the transmitter, (3) for the receiver and (4) for the power unit.

57. Connexions to the transmitter-receiver are made by cable connectors through W-type plugs and sockets. The top plug (5) is a two-point connexion from the aircraft general electrical supply accumulators, the centre six-way plug (6) accommodates the microphone, telephone and M.C.W. key leads from a junction box and the bottom, 12-way plug (7) is joined to the controller, type 4 (8). In this illustration the controller is shown with the anti-glare mask fitted over the pilot lamps for night operation. The blue shield is brought into operation by a switch (20).

58. On the upper surface of the instrument, as shown in fig. 1, can be seen the cover (9) through which the transmitter crystal units are inserted and the resonance indicating lamp PL_1 with its associated switch button (10). The captive knurled headed screws (11) secure the transmitter cover and the locks (12) serve to fix the aerial circuit trimmer tuning controls in position when set up on the "spot" frequencies.

59. The cover (13) is used to insert the receiver local oscillator crystal units, which are plus or minus 460 kc/s off the frequency of the transmitter crystals to which the transmitter-receiver is set up. The cover release screws of the receiver are indicated at (14) and the screwdriver adjusting and locking mechanism associated with the receiver R.F. transformer T_1 secondary are shown at (15). The four top plate release screws for the chassis assembly are indicated at (16). This plate carries the engraved label of instructions for setting up the equipment.

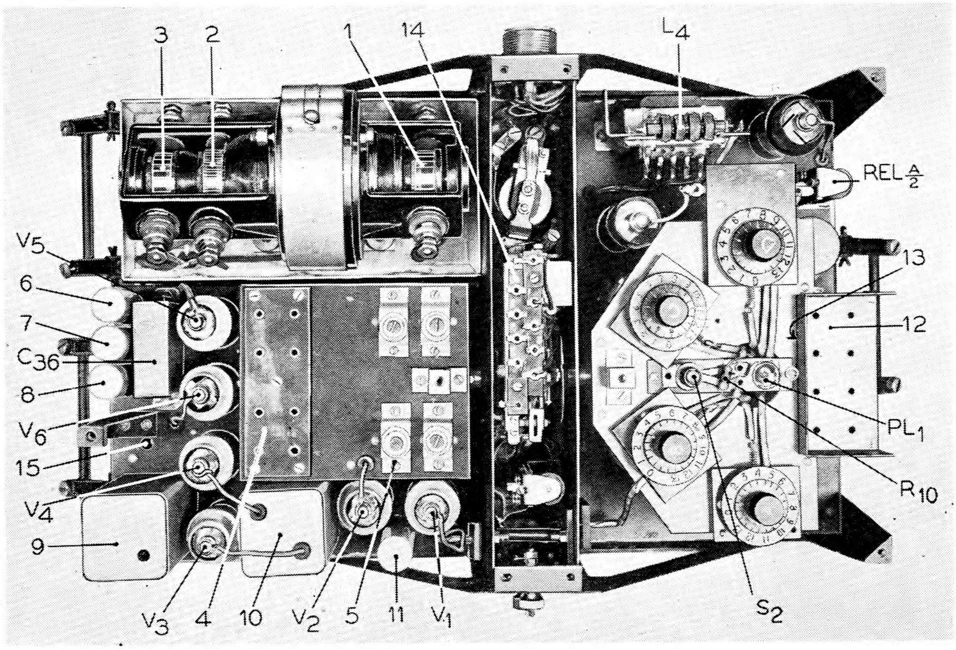


FIG. 7.—PLAN VIEW OF T.R.1196 WITH COVERS REMOVED

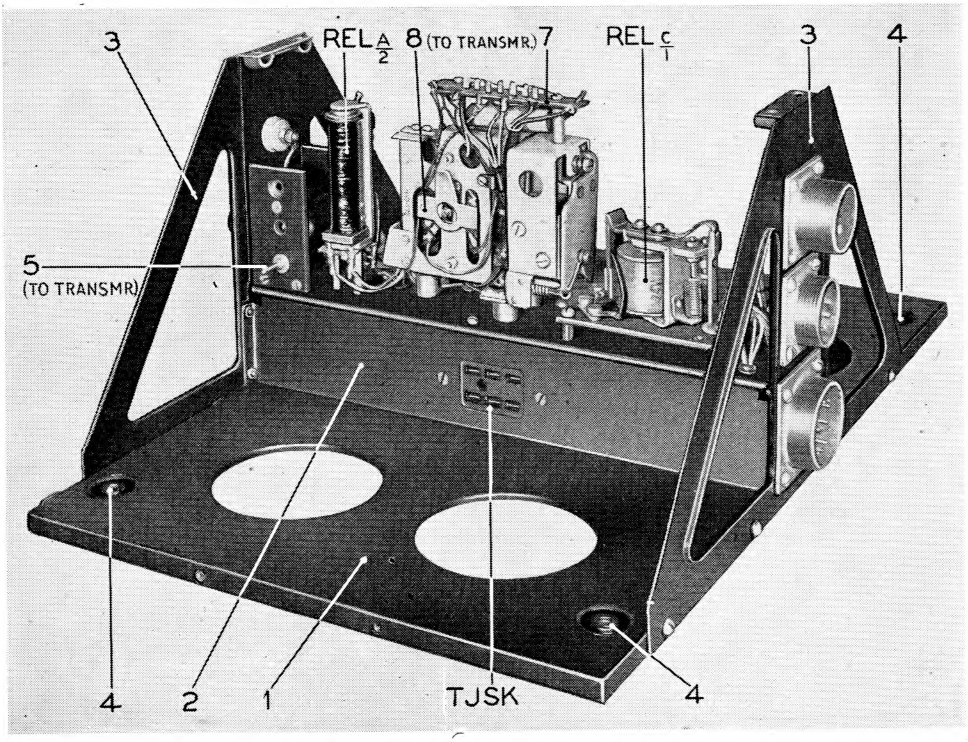


FIG 8.—CHASSIS ASSEMBLY, FROM LEFT-HAND SIDE

60. The plan view of fig. 7 shows the units in position. The three commutators of the rotary transformer are:—input (1), H.T. (2) and L.T. (3). The receiver crystal sockets are on a small panel (4) and adjacent to this is the platform (5) carrying the four screwdriver adjustments for the receiver condensers C_4, C_5, C_6 and C_8. The three cans (6), (7) and (8) in the receiving unit each contain three condensers of the value of 0·1μF. The can (6) contains C_{30}, C_{31} and C_{33}, (7) contains C_{20}, C_{24} and C_{27} whilst (8) has C_{17}, C_{19} and C_{23}. The first I.F. transformer T_2 can is (9) and the second I.F. transformer T_3 can is (10). The condenser can (11) of the receiving unit accommodates C_{12}, C_{14} and C_{16}.

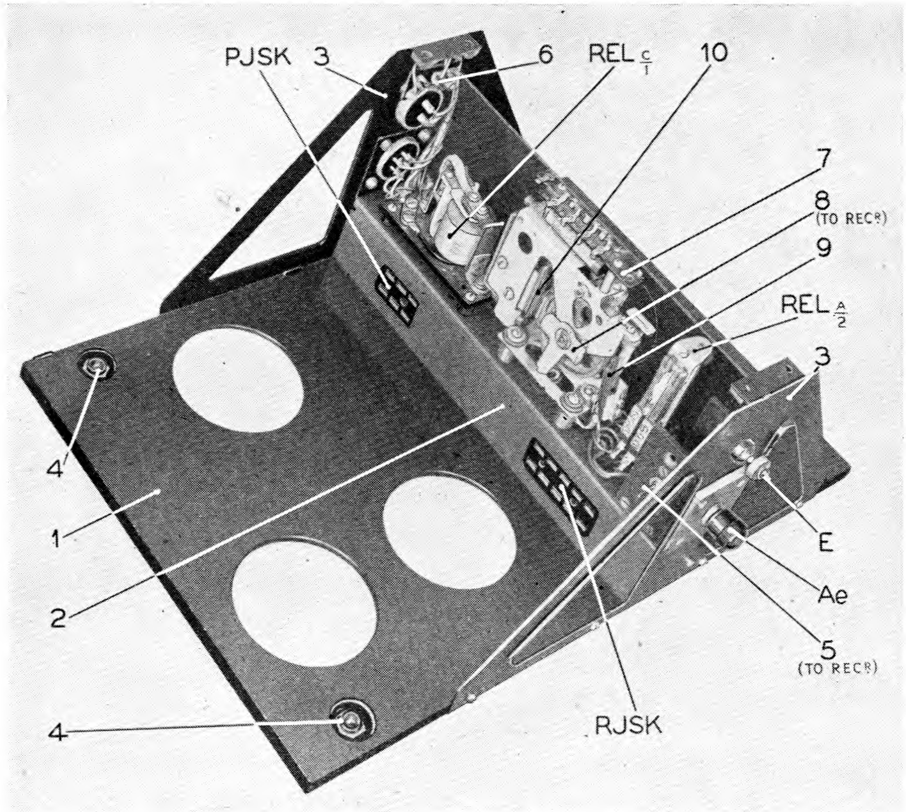


FIG. 9.—CHASSIS ASSEMBLY, FROM RIGHT-HAND SIDE

61. The bracket (12) containing the sockets for the transmitter crystals is sign-written with the ranges A, B, C and D on the return edge (13) and against each pair of sockets. The aerial circuit tuning coils each have two scale discs the outer of which is engraved 0 to 13 and the inner, or vernier, 0 to 10. The switch button of S_2 is engraved "PRESS TO TUNE".

62. The construction of the chassis assembly, type 7 or type 8, can be seen in the view presented in fig. 8 and fig. 9. The chassis assembly is constructed of 20 s.w.g. sheet steel and consists of a shallow inverted dish (1) construction forming a base plate, and has a raised transverse channel section (2) carrying all the plugs and sockets required for connexions between units and to apparatus external to the transmitter-receiver. The side members are strengthened by triangulated webs (3). On these side members are mounted the W-type sockets seen in fig. 8 and the aerial and earth terminal, seen in fig 9.

63. Four ¼ in. B.S.F. threaded bushes (4) are mounted on lugs underneath the base for fixing the equipment in aircraft. A detachable cover plate, secured by 6 B.A. screws, may be removed to enable inspection of the Jones sockets and wiring underneath the transverse centre section. The annotations of fig. 8 and fig. 9 are similar. The floating location pins (5) engage with sockets on the transmitter (1, fig. 10) and receiver (1, fig. 12). The tag board (6) for high and low impedance telephones is shown in fig. 9. The links are engraved and, when issued, are arranged for high impedance telephones.

64. Four pairs of soldering tags coded SA, SB, SC and SD are mounted on an insulated panel (7). These are bridged when the equipment is set up for four channel operation. Should less than four channels be required it is only necessary to remove the appropriate link, or links, to prevent the selector motor operating due to the accidental pressing of an unused channel button in the controller, type 4.

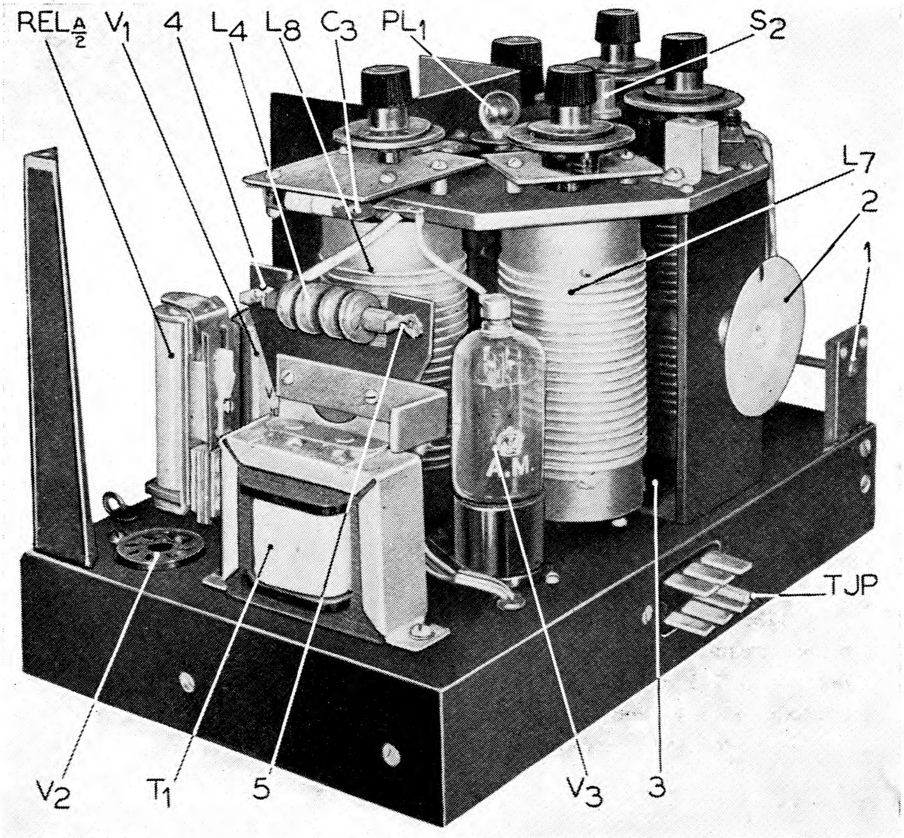


FIG. 10.—TRANSMITTER UNIT, WITH COVER REMOVED

65. Spring-loaded dog clutches (8) actuated by the selector motor MO_1 turn the selector switches of the transmitter and receiver to the position necessary to bring into circuit the components and crystals associated with the tuning channels. The T/R relay REL $\frac{A}{2}$ has one set of contacts for H.T. positive switching and a separate set for aerial changeover. The OFF-NORMAL contacts (9) are shown in fig. 9.

66. In the illustration of the transmitter unit, fig. 10, can be seen the slotted circular metal disc (2) which projects from the inner side of the unit and engages with the dog clutch (8, fig. 8). The selector motor shaft is double ended and drives a similar disc (2, fig. 12) on the receiving unit. The valve V_2 has been removed, in this illustration, to afford a better view of the M.C.W. relay REL $\frac{A}{2}$. The transmitter coils L_5, L_6, L_7 and L_8 are space wound on cylindrical formers with closed ends through which are secured, by set screws, bakelized fabric spindles. Bearings for the spindles lead off the end connexions of the coils and enable them to be rotated by turning the engraved knobs.

67. The tapping adjustment of the coils L_5, L_6, L_7 and L_8 is obtained, through rotation, by means of a small grooved wheel connector, free to move in a vertical plane along a circular guide rod mounted parallel to the coil and held in position at each end by small helical rings (1, fig. 11).

In this manner suitable aerial matching to the output circuit is arranged. As practically the whole of the shunt capacitance to this circuit is represented by the aerial, an efficient transfer of power from the anode of the transmitter output valve V_2 is effected.

68. The base fixing lugs (2) of the transmitter underside are indicated in fig. 11, in which illustration can be seen the accessible manner in which components are mounted to facilitate checking and replacement. From the receiver chassis view, fig. 12, the R.F. amplifier and tuning unit has been removed and is shown (as an interior view) at the side of the main chassis. The operation of removal is effected by the withdrawal of four screws (3) and by unsoldering four connectors (4) which lead through the rubber grommets (5) on the main chassis. The underside of the crystal sockets (6) is shown. The remaining annotations of main components can be found in fig. 7.

69. Two views of the under-chassis arrangement of the receiver are shown in fig. 13 and fig. 14. The adjustment port (1) for R_{23} is indicated in the former. The construction of the two I.F. transformers T_2, T_3 is illustrated in fig. 15. The anode connector (1) leads to the top cap of the frequency-changer V_2 whilst the connector (2) joins to the grid top cap of the I.F. amplifier V_3. The under-chassis view of the power unit is shown in fig. 16, a typical suppressor unit (1) has been included, the R.F. choke (2) and paralleled condensers (3) being indicated. The corresponding suppressors shown in the chassis are:—input negative (4), input positive (5), L.T. positive (6) and H.T. positive (7).

VALVES AND POWER SUPPLIES

70. The following valves are used in the transmitter-receivers T.R.1196 and T.R.1196A:—

Transmitter unit, type 22

V_1 crystal oscillator 9-pin glass base pentode valve, V.R.91 (Stores Ref. 10E/92)

V_2 output octal base tetrode valve, V.T.501 (Stores Ref. 10E/389)

V_3 modulator and octal base pentode valve, V.T.52 (Stores Ref. 10E/11398).

Receiving unit, type 25

V_1 and V_3 variable-μ pentode valves, R.F. amplifier and I.F. amplifier, V.R 53 (Stores Ref. 10E/11399).

V_2 octode frequency changer valve V.R.57 (Stores Ref. 10E/11403)

V_4 pentode A.G.C. amplifier valve V.R.56 (Stores Ref. 10E/11402)

V_5 pentode 1st A.F. and microphone amplifier valve V.R.56 (Stores Ref. 10E/11402)

V_6 double-diode-triode output and 2nd microphone amplifier valve V R.55 (Stores Ref. 10E/11401).

All the receiver valves are fitted with international octal bases.

71. The power supplies are derived from the aircraft general electrical system accumulators through either the power unit, type 87 (nominal 24 volts) for the T.R.1196A or the power unit, type 104 (nominal 12 volts) for the T.R.1196. The H.T. consumption of the transmitter is 60 mA at 250 volts and the heater consumption is 1·3 amp. at 6·3 volts. The total H.T. consumption of the receiver, at full gain, does not exceed 35 mA at 250–275 volts whilst the heater consumption is 1·2 amp. at 6·3 volts. The H.T. consumption of the microphone amplifier alone is 10 mA. The power input is approximately 5 amps. at 13 volts or 2·5 amps. at 26 volts for the 12-volt and 24-volt installations respectively.

INSTALLATION

72. A typical installation diagram is shown in fig. 17. Depending upon the type of aircraft involved, the transmitter-receiver may be fitted to a vertical bulkhead as an alternative to the normal horizontal position. In either eventuality it is secured by four ¼ in. B.S.F. bolts, and fixing centres are 14 in. by 9·5 in. The threaded ¼ in. bushes can be seen, annotated (4), in figs. 8 and 9.

73. The position chosen for fixing should ensure that the minimum length of lead-in wire to the aerial terminal is necessary. A good earth connexion bonded to the aircraft frame is essential. The multi-way cables connecting the aircraft general electrical supply, the microphones, telephones and remote controller will depend upon the aircraft installation and the position in which the equipment is installed. It is important, however, that sufficient clearance above the controls, tuning indicator and crystal covers should be allowed to permit adjustment when needed. A minimum of three inches clearance should be left, at either end, to enable the individual units to be removed, when necessary, by means of the hinged handles. Similarly, sufficient hand-room clearance must be allowed at the side for connecting the W-type sockets to their plugs on the chassis assembly.

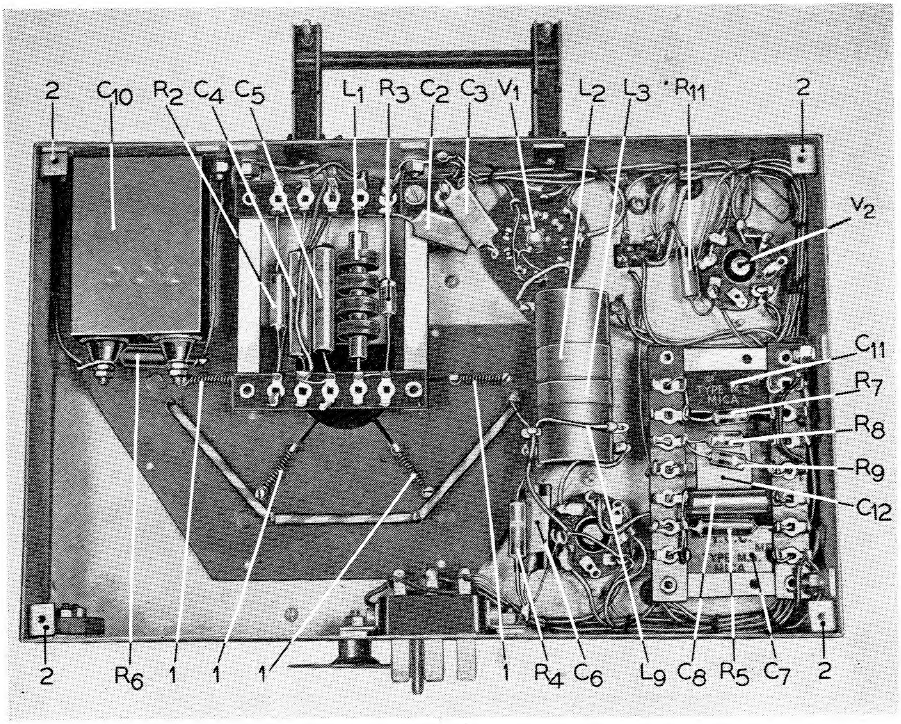


FIG. 11.—TRANSMITTER UNIT, UNDERSIDE OF CHASSIS

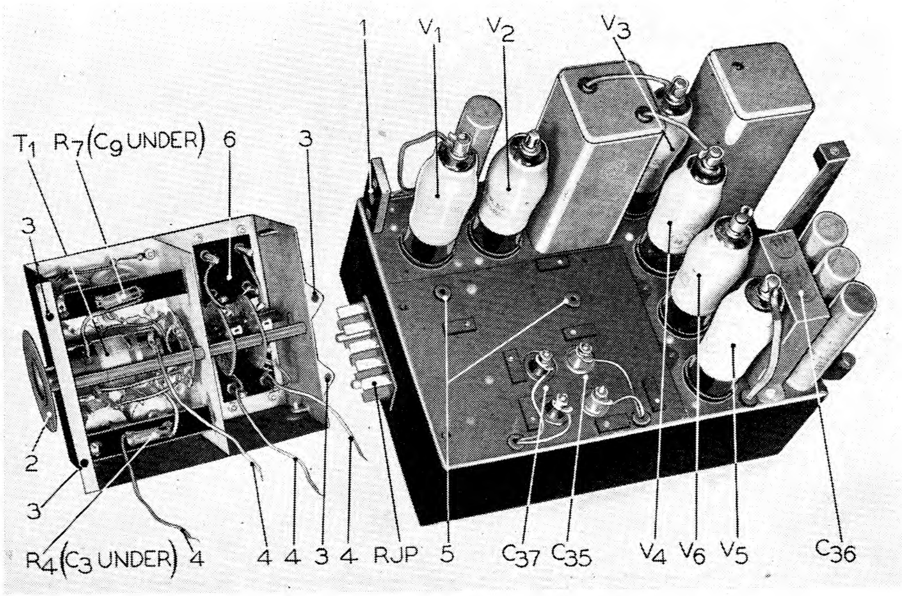


FIG. 12.—RECEIVING UNIT, AND INTERIOR OF TUNING UNIT

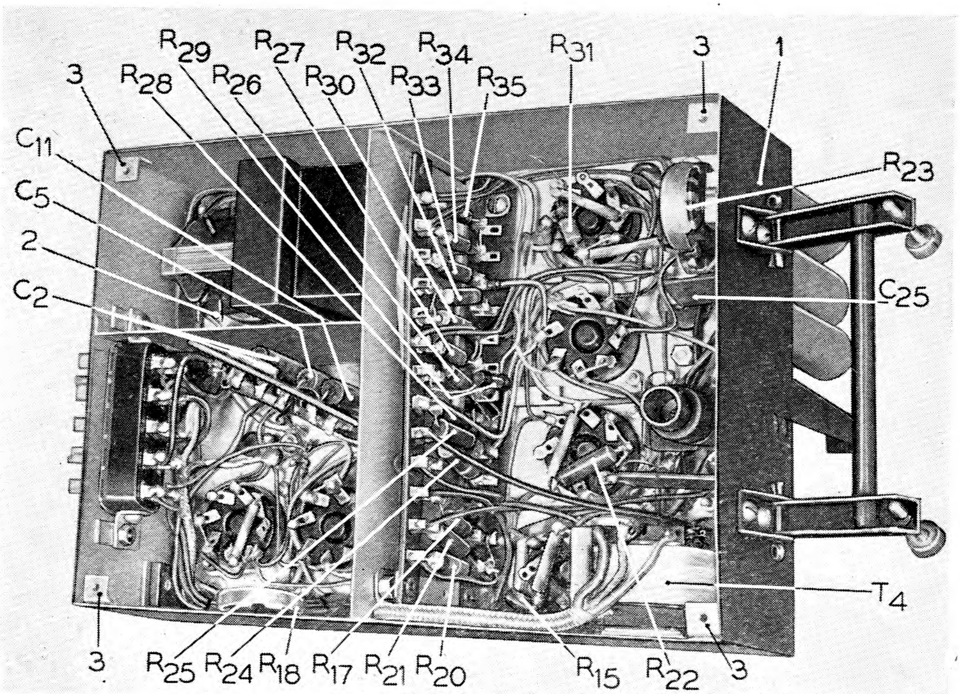


FIG. 13.—RECEIVING UNIT, UNDERSIDE OF CHASSIS

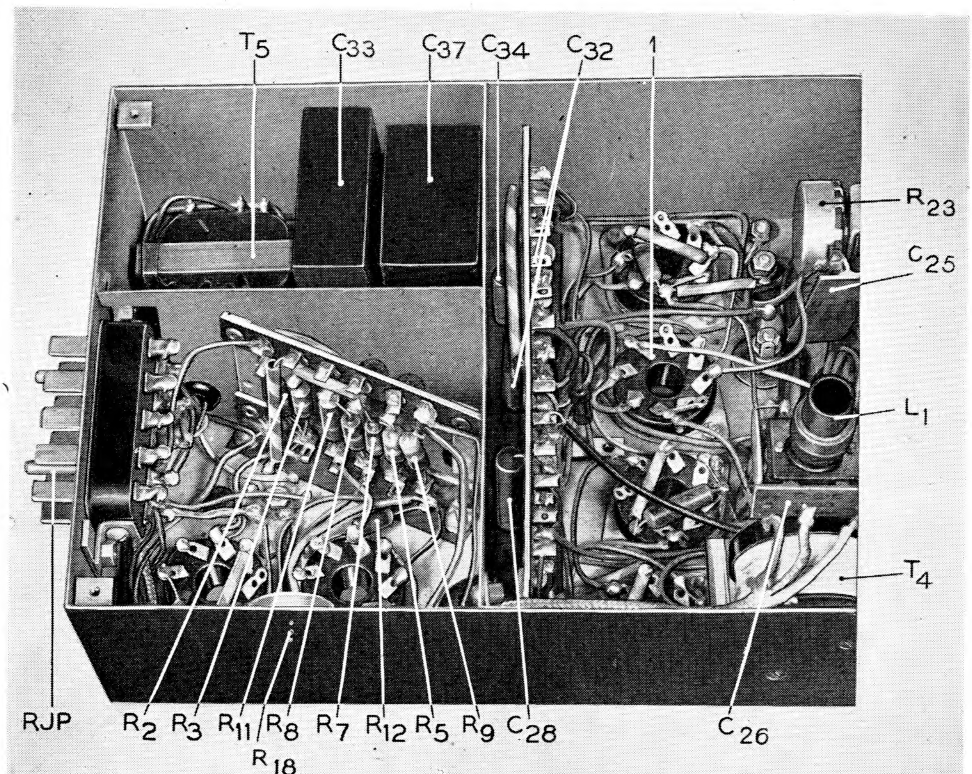


FIG. 14.—RECEIVING UNIT, UNDERSIDE OF CHASSIS FROM LEFT-HAND SIDE

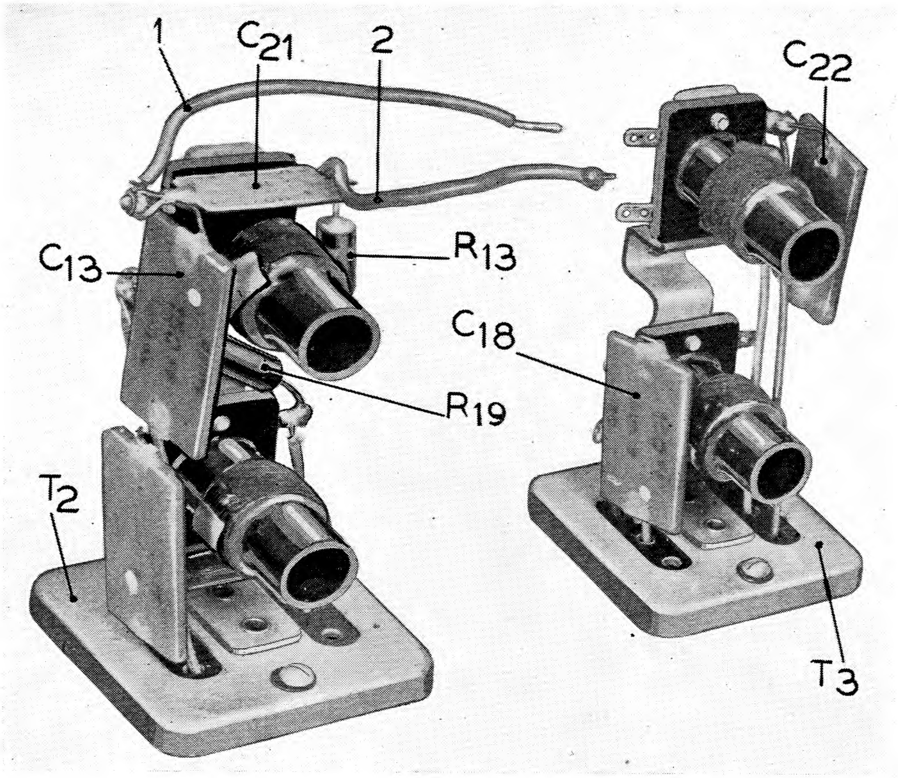


FIG. 15.—I.F. TRANSFORMERS WITH CANS REMOVED

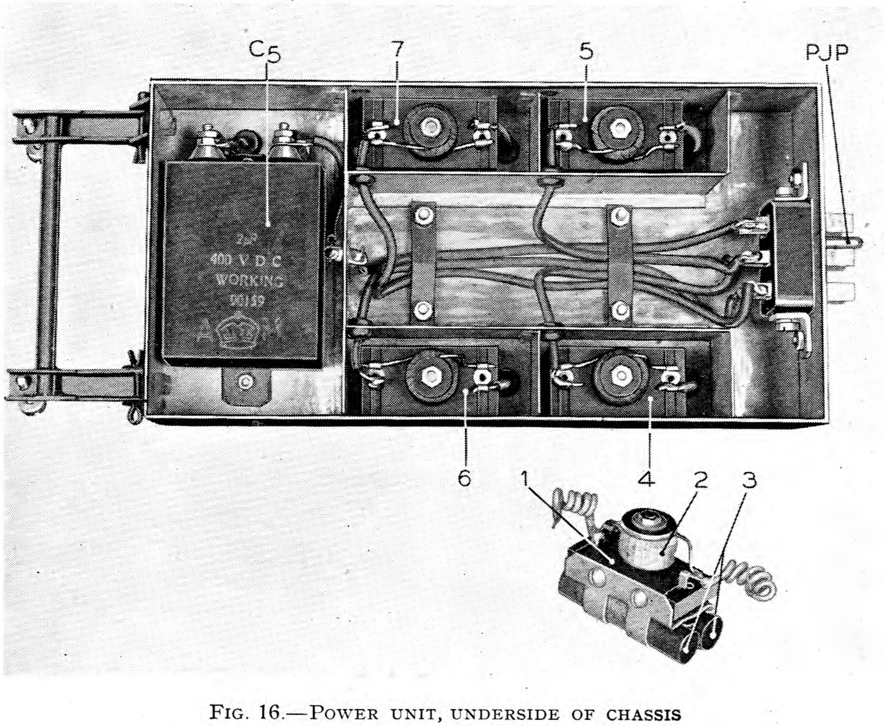
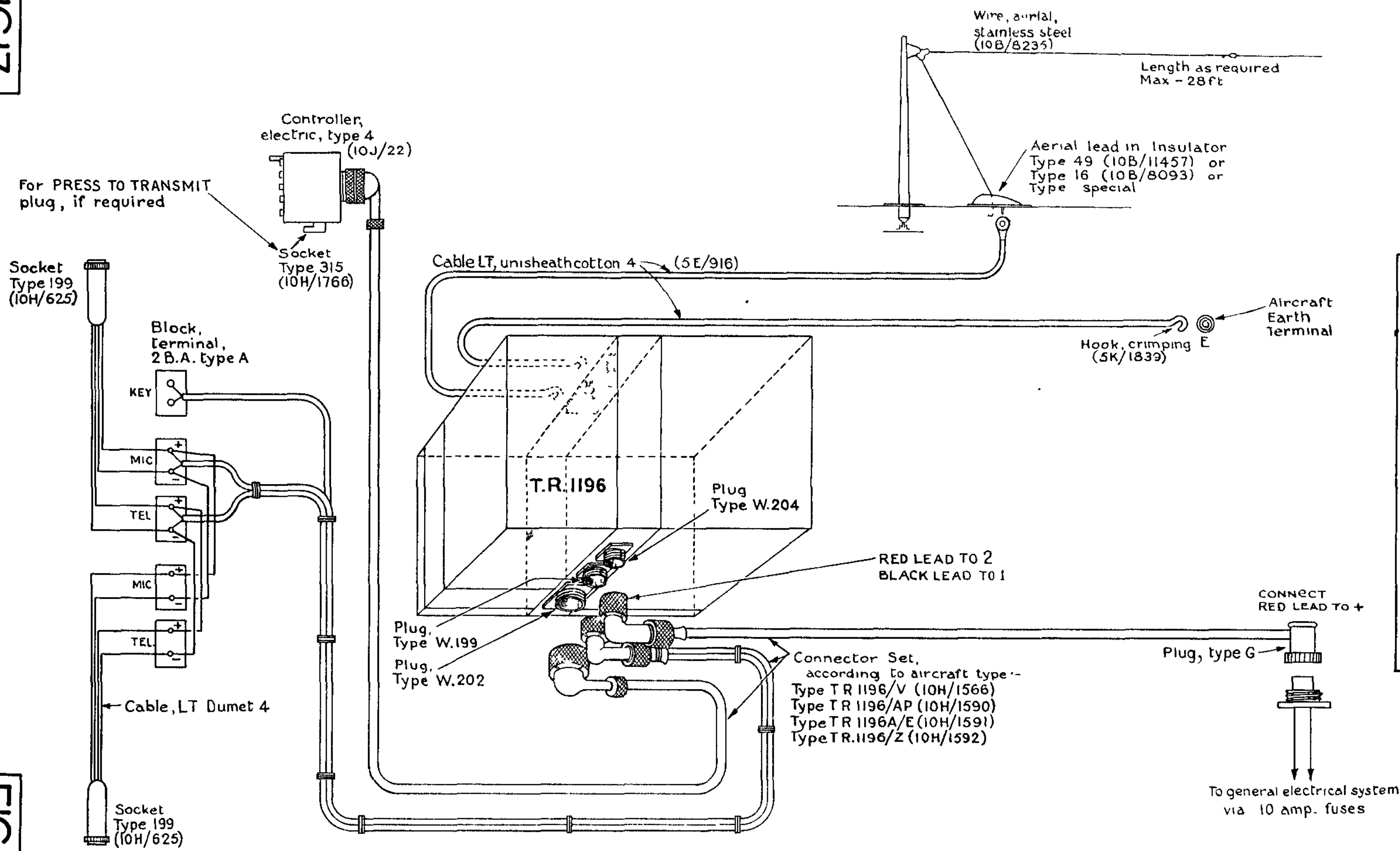


FIG. 16.—POWER UNIT, UNDERSIDE OF CHASSIS

FIG.17



TYPICAL INSTALLATION DIAGRAM

FIG.17

74. Two points may be mentioned here relative to the responsibility of installation. Firstly, as the instrument may be used with three types of telephones, that is with impedance of 150 ohms, 600 ohms and 20,000 ohms, the appropriate soldering operations should be carried out. A phone tag board engraved HIGH and LOW will be found in the chassis assembly (6, fig. 9). A short length of wire connects either of the end tags to that in the centre and connexion should be made according to the type of telephones to be used. Should 150-ohm impedance telephones be required a further soldering connexion should be made (retaining the LOW connexion on the tag board) to the receiver transformer T_5. Referring to fig. 13, unsolder the connexion from the receiver Jones plug RJP_{10} at the transformer IS tag and reconnect to the spare tag (2). For this operation the base plate must be removed by means of the screws which fit into lugs (3). The circuit diagrams of fig. 5 and fig. 3 show, in insets, the tag board and transformer connexions for each type of telephone. The 150-ohm impedance telephones are the receiver telephones, head, type 32, and the 20,000-ohm may be type 16 or 17 or type C. The 600-ohm types are, at the time of writing, not included in the vocabulary, A.P.1086.

75. Secondly, the channels to be used for transmission are governed by soldered tag connexions on the small panel (7, figs. 8 and 9, or 14, fig. 7) in the chassis assembly. These are engraved SA, SB, SC and SD and the tags corresponding to the channels not required should be removed.

76. In installations requiring I/C service to more than three positions it is necessary to instal an amplifier A.1134 or other suitable instrument. Should this eventuality arise instructions for installation will be promulgated.

OPERATION

77. Study of these operational notes will be assisted by reference to the illustrations specified. As the equipment is used on "spot" frequencies no actual adjustment of a tuning nature other than operation of the button switches is undertaken in flight. The transmitter-receiver is preset on the ground.

78. The transmitter-receivers are supplied with all valves inserted and the first operation should be to ensure that all top cap leads are securely contacting. Referring to fig. 1, the steps to be taken to dismantle the apparatus for valve substitution, inspection or servicing are as follows. Remove the transmitter unit (2) from the main chassis by means of the handle (19) which is secured by captive knurled headed screws (1). A firm equalized pull will withdraw the transmitter from the chassis assembly Jones socket and floating "aerial" pin. Three captive screws (11) secure the transmitter cover. Release these and open the four locking devices (12) which hold the trimmer control knobs A, B, C and D. The cover may now be withdrawn. If valve substitution is necessary, insert the valves, connect top caps and replace the cover, securing the screws. Re-insert the transmitter in its position in the main chassis using the guiding lugs as an indication. Push well home and secure the captive screws of the handle.

79. The receiving unit (3) is similarly equipped with a withdrawal handle. Treatment of this unit depends upon the type of telephones and the frequency channels to be used. Whilst this may be regarded as an installation responsibility a check-up on the telephone and channel connexions as specified in paras. 74 and 75 should be made before replacing the unit. The receiver attenuation resistance R_{18} (*see* fig. 13) should be preset prior to installation, according to the operational circumstances in which the transmitter-receiver is desired to be used (*see* para. 87).

80. The W-type socket-ended connectors should now be attached to the plugs as shown in fig. 1, and the sleeving screwed tight. The top connector (5) leads to the aircraft electrical system, the centre connector (6) to the junction box from which connexion is made to the M.C.W. key and to the external amplifier if used. The bottom connector (7) leads to a W-type plug on the controller unit (8). The aerial and earth terminals can be seen in fig. 9. The earth lead is attached to an aircraft earth terminal suitably positioned and bonded to the airframe structure.

To set up the transmitter

81. The crystals appropriate to the channel frequencies to be operated are inserted *via* the door (9, fig. 1) on top of the transmitter. The transmitter functions on crystal fundamental frequency and the crystals are to be selected according to the stores reference number which represents the frequency, expressed in kilocycles, to which the quartz plate is ground. For instance, should the desired operational frequency be 5 Mc/s, the stores reference of an appropriate crystal would be 10K/5000. Should less than four channels be needed for operation a note should be made of the channel reference letters used. The crystal cover should be securely fastened by the captive screw (17).

82. The output circuit corresponding to the desired frequency channels should now be adjusted. Move the switch S_3 in the controller, to position T (TRANSMIT) and select the frequency channel to be set up by pressing the appropriate button switch BS_a, BS_b, BS_c or BS_d. This operation rejects the OFF-normal button switch BS_0. Next, press the PRESS-TO-TUNE button (10) retaining

pressure whilst adjusting the control knob A, B, C or D, corresponding to the channel being set up, until the resonance indicator lamp PL_1 attains maximum brilliance. With the switch S_3 in the T position the pilot lamp PL_t in the controller will also glow.

83. Some indication of the direction in which the control has to be turned to arrive at the resonant position may be seen from the position of the counting device since frequencies near the higher limit (6·7 Mc/s) of the band will necessitate the coil tapping moving towards the maximum number, 13. The converse holds for crystals near the lower limit of the band, 4·3 Mc/s, when the tapping will approach 0. Final adjustment for lamp brilliance and resonance is made by the inner scale, engraved 0 to 10. A rough check may be made to ensure that the transmitter is modulated; whilst speaking into the microphone the brilliance of PL_1 should increase.

To set up the receiver

84. To set up the receiver insert crystals, *via* the door (13). These crystals should differ from the selected channel frequencies by plus or minus 460 kc/s. Refer to the note made of the channels selected (*see* para. 81) before inserting the holders into position. As an example, should the transmitter crystal frequency for channel A be 5 Mc/s, a crystal, the stores reference of which is 10X/4540 or 10X/5460, should be utilized for channel A of the receiver.The receiver crystal door is securely locked by a captive screw (18).

85. Set the controller key switch S_3 to position R (RECEIVE) then each channel selector button BS_a, BS_b, BS_c or BS_d should be pressed in turn and the corresponding preset condenser (15) engraved A, B, C or D, corresponding to C_4, C_5, C_6 and C_7 of fig. 4, should be separately adjusted. These condensers are of the screwdriver adjusted type and are equipped with knurled locking knobs. The adjustment should be made for maximum 'noise' output. In this way the receiver may be set up without the aid of measuring instruments.

86. It is now necessary to preset the built-in volume control R_{23} the screwdriver adjustment of which is situated on the withdrawal end of the receiver (1, fig. 13). In order to obtain the maximum benefit from the attenuating circuit of the I.F. amplifier V_3 (R_{18}) it is essential to avoid operating the L.F. amplifiers V_5 and V_6 at a higher level than is necessary thus avoiding limiting due to overloading. To ensure this, the following procedure should be followed. During ground testing, switch to the R (RECEIVE) position and, in collaboration with the ground station, ascertain the minimum setting of R_{23} at which adequate volume is obtained. Normally it will be found that adequate output is obtained when R_{23} is set at three-quarters of a turn in the clockwise direction. Its adjustment will not affect the gain of the microphone amplifier. No adjustment of the volume level is needed during operation since the A.G.C. system maintains the output voltage constant, within plus or minus 2 db, for a variation of from 10 microvolts to 100 millivolts.

87. After the equipment has been adjusted, as outlined in the foregoing paragraphs, the key in the controller, type 4, is moved to the central position (RA) and the preset resistance R_{18} control (*see* fig. 14) should be adjusted to a point at which background noise produced by the receiver will allow the I/C system to be used.

88. The A.F. amplifier output supplies side tone to points on the installation where telephones are connected. When it is desired to use M.C.W. a morse key is attached to the junction box to which tags 3 and 4 of the chassis assembly W-plug P_4 are connected and a tone-modulated (800 c/s to 1,500 c/s) carrier is used. Pressing the key actuates the M.C.W. relay REL $\frac{A}{2}$ in the transmitter when the key switch S_3 of the controller is in the T position. When it is desired to override the transmitter key a plunger-operated switch should be wired to the plug P_5 mounted at the end of the controller nearer to the OFF button. This gives a PRESS-TO-TRANSMIT condition.

89. Should I/C only be required the key switch S3 is moved to the RA (RECEIVER ATTENUATION) position, that is, central, and one of the channel buttons should be pressed to reject the normal OFF button BS_0. The apparatus takes approximately 30 seconds to reach an operating temperature.

PRECAUTIONS, MAINTENANCE AND REPLACEMENT PROCEDURE

90. The variable controls of the transmitter-receiver are reduced to a minimum and this obviates the necessity for continual check on the alignment of the units. Generally, adjustments will only be necessary when changing the frequency of any of the four channels. However, it may be advisable, occasionally, to check the settings of the transmitter output circuit coils by testing them to see whether alterations of the adjustment increases the brilliance of the indicator lamp PL_1.

91. When set up the transmitter trimmers should be locked (12, fig. 1). The preset trimmers in the receiver should not need any readjustment provided they are initially correctly set up and securely locked (15, fig. 1).

92. In no circumstances should any attempt be made to dismantle the crystal unit should fracture be suspected and it is not intended that repairs to this unit should be carried out at stations. When fracture or other fault is suspected, replacement of the crystal unit must be made and the faulty unit returned through the usual channels in accordance with the routine procedure.

93. When either the transmitter unit or the receiving unit is removed or both units are removed, from the instrument for adjustment or repair, it is possible that the discs located on the ends of the selector switch shafts may be accidentally turned out of alignment with the dog clutch and, on re-assembling they may not engage. It is therefore necessary, after replacing, to turn the selector motor through 360 deg. by pressing the button switch preceding that corresponding to the original position. For instance, if the last button pressed, before dismantling, should be BS_a, it is now necessary to press BS_d. This will cause the motor to turn through 270 deg. Then press the next button in sequence (BS_a), which is the button corresponding to the original channel, and this brings about a further 90 deg. of angular turn.

94. In the event of the transmitter output coils being withdrawn this may be done by unscrewing two lug screws situated at the top and bottom of the coil former. One of these screws (the lower) may be seen on Coil C and is indicated (3) on fig. 10. It is very essential, however, that care should be taken in re-assembling the coil, and fig. 18 indicates the correct position for the connecting contact washer at the bottom of the coil assembly.

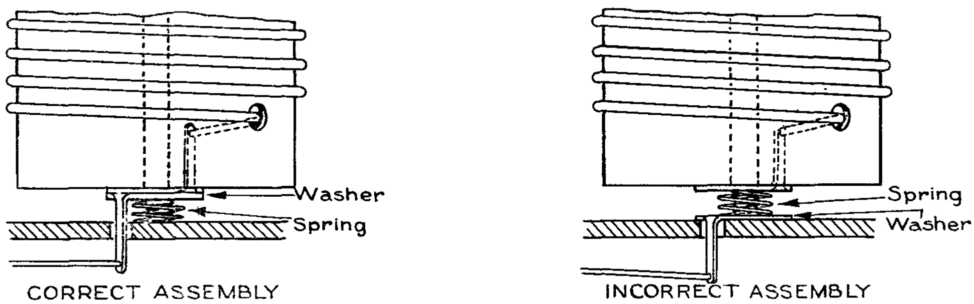


FIG 18 —COIL ASSEMBLY DIAGRAM

95. Sluggish operation of the channel selecting motor will usually indicate that the OFF-NORMAL contact F (9, fig. 9) and/or the driving motor make-and-break contacts Cl (10, fig. 9) require cleaning. These contacts are both accessible when the transmitter and receiving units are removed from the chassis assembly. The tool to be used for contact cleaning is a contact cleaner, type 1 (Stores Ref. 1H/6) as this does not abrade the contact points.

96. In the event of complete failure of the transmitter-receiver a quick test of the H.T. voltage may be made by removing the top cover of the chassis assembly and measuring, with a suitable meter, the H.T. voltage at the standard set of contacts on REL$\frac{A}{2}$, the T/R relay.

97. A useful aural indication of the effect of switching to TRANSMIT may be obtained by noting the change in note level made by the power unit generator. Should the note fall due to the transmitter load it is an indication that the H.T. feed to that unit is being made. This test eliminates the possibility of faults in switching-on of the inter-connexion between transmitter and power unit.

98. Valve substitution in both transmitter and receiving units is carried out after removing the top covers as indicated in the operation notes to this chapter. Care should be taken to switch OFF when the change is being made. Special precautions should be taken to ensure that the pins of the transmitter valve V_1 type V.R.91, are properly aligned before applying any pressure.

99. Only one test can be made for H.T. voltage on the transmitter unit with the top cover removed, and that is the anode and screen voltage to the valve V_3, type V.T.501. This test can be taken at the end of the choke L_4. The point is indicated as (4) on fig. 10. A test at the opposite end (5) will give the anode voltage only of V_3.

100. Since all the top cap connexions of the valves in the receiving unit are control grids, no H.T. tests are possible without removing the chassis from the mounting unit and testing with an independent power supply. The normal methods of trouble location as indicated by instrument

performance will apply. A check of the A.F. portion will be possible using a microphone and telephones of known reliability. Assuming the A.F. tests indicate that this part of the receiver is in order, tests will have to be made for faults located in the R.F. or I.F. portions.

101. A suitable signal generator (see para. 103) and audio output meter are necessary to carry out realignment of the I.F. transformers and the A.G.C. amplifier anode circuit. This alignment can only be done with the chassis removed from the chassis assembly since the A.G.C. voltage to the controlled valves must be disconnected when realigning the I.F. transformers. This can more easily be done by disconnecting the second diode of the valve V_6 (1, fig. 14) as it is undesirable to remove the A.G.C. amplifier V_4 since its capacitance will have some effect upon the trimming of the secondary of the transformer T_2. The alignment of the I.F. must only be attempted by properly authorized and equipped units.

102. After lining-up the I.F. transformer, the second diode of V_6 may be reconnected and with a signal of 1 millivolt at 450 kc/s applied to the control grid of V_2, the iron dust core of L_1 should be adjusted (15, fig. 7) to give minimum dip as indicated on the output meter.

103. It is important to note that with the crystal control of both transmitter and receiver the centre of the I.F. pass-band must be located exactly on 460 kc/s and realignment should not be attempted unless a signal generator is available which has been checked against a frequency standard and is known to be accurate to plus or minus 0·5 kc/s at 460 kc/s.

104. As the rotary transformer of the power units has a permanent magnet field system no attempt should be made to remove the armature, as this would result in loss of magnetism. The rotary transformer should be replaced as a unit whenever failure occurs. The bearings are grease-packed and should require no attention. Although specifically intended for generators Section V, Chapter 1, of A.P. 1095 applies equally to this apparatus.

105. The necessity for absolute cleanliness, particularly of the commutators and brush gear cannot be too often stressed. The use of abrasives for commutator cleaning is an extreme method, the use of rag, sparingly soaked in cleansing fluid, such as petrol, being the safer treatment.

106. The brushes are supplied with contact faces already shaped to the commutator. The following list gives the appropriate brushes, with stores references, used with the different types of rotary transformer.

Power unit	Rotary Transformer	Brush (Stores Reference)	
		H.T.	L.T.
Type 87 ...	Type 52 (Stores Ref 10K/568) ...	10K/570	10K/569
	Type 258 (Stores Ref 10K/270) .	10K/566	10K/565
Type 104 ...	Type 51 (Stores Ref 10K/567)	10K/570	10K/569
	Type 257 (Stores Ref 10K/269)	10K/566	10K/565

APPENDIX

NOMENCLATURE OF PARTS

The following list of parts is issued for information only. When ordering spares for the transmitter-receivers the appropriate section of AIR PUBLICATION 1086 must be used.

Ref. No.	Nomenclature	Qty	Ref in figure	Remarks
10D/325	Transmitter-receivers, T R 1196 and T.R 1196A	1		
	Comprising:—			
10D/550	Chassis assembly, type 7	1		T R 1196
10D/551	Chassis assembly, type 8	1		T R 1196A
10K/201	Power unit, type 87	1		T R 1196
10K/238	Power unit, type 104	1		T.R 1196A
10P/11	Receiving unit, type 25	1		T.R 1196 and T.R.1196A
10R/23	Transmitter unit, type 22	1		T.R.1196 and T.R.1196A
	Chassis assembly, type 7	1	Fig 5	T.R 1196 (24-volt)
	Principal components—			
10H/1150	Aerial plug unit	1		
	Fitted with—			
10C/4323	Condenser, type 2229	1	C_1	50 $\mu\mu$ F
10C/11384	Resistance, type 480	1	R_1	1 megohm
	Plug			
10H/392	Type W.199	1	P_4	6-pole panel mounting
10H/395	Type W.202	1	P_2	12-pole panel mounting
10H/397	Type W.204	1	P_3	2-pole panel mounting
	Relay magnetic			
10F/719	Type 256	1	REL^{A}_{2}	
10F/679	Type 246	1	REL^{B}_{T}	Starting
10D/373	Selector-drive unit	1	MO_1	24-v step by step motor
	Fitted with—			
10C/10165	Condenser, type 386	1	C_2	0·1 μ F
10D/501	Clutch	2		
10C/6455	Resistance, type 6455	1	R_1	5 ohms
	Socket			
10H/11615	Type 69	1	RJSk	10-pole
10H/1450	Type 303	2	TJSk, PJSk	6-pole
	Terminal			
10H/7227	Type C	1	Ae	
5A/472	Instrument, single, 4 B.A.	1	E	
	Power unit, type 87		Fig 6	T R 1196
	Principal components—			
10K/637	Base	1		
10C/2098	Choke, type 60	1	L_5	
	Condenser			
5C/1735	Type	8	C_1, C_2, C_3, C_4	0·1 μ F (2 off each)
10C/4510	Type 2336	1	C_5	2 μ F
10K/638	Cradle	1		
	Cover			
10K/641	Bottom	1		
10K/640	Top	1		
10H/1523	Plug, type 360	1	GJP	6-pole
10K/568	Transformer, rotary, type 52	1		
	or			
10K/270	Transformer rotary, type 258	1		
	Receiving unit, type 25	1	Fig 3	T.R 1196 and T.R.1196A
	Principal components—			
10H/1151	Aerial socket unit	1		Single-pole
10A/12865	Cap, valve, type 12	6		
10C/3424	Choke. R F., type 161	1	L_1	I.F 460 kc/s
	Condenser			
10C/9755	Type 332	5	C_2, C_5, C_{11}, C_{28}, C_{34}	0·01 μ F
10C/288	Type 652	1	C_{37}	2 μ F
	or			
10C/4568	Type 2378			
10C/961	Type 893	4	C_{12}, C_{14}, C_{16}, C_{17}, C_{19}, C_{23}, C_{20}, C_{24}, C_{27}, C_{30}, C_{31}, C_{33}	0·1 μF + 0·1 μF + 0·1 μF
	or			
10C/4571	Type 2381			
10C/4325	Type 2230	1	C_{32}	0·0005 μF

Ref. No.	Nomenclature	Qty	Ref. in. figure	Remarks
	T.R.1196 and T.R.1196A *(contd.)*			
	Receiving unit, type 25 *(contd.)*			
	Principal components *(contd.)*—			
10C/4326	Type 2231	1	C_{25}	0·0002 μF
10C/4327	Type 2232	1	C_{26}	0·0002 μF
10C/4329	Type 2234	1	C_{29}	0·0001 μF
10C/4330	Type 2235	}		
	or	1	C_{36}	0·1 μF
10C/4569	Type 2379	}		
10C/4331	Type 2236	}		
	or	1	C_{35}	0·5 μF
10C/4570	Type 2380	}		
10A/12870	Disc, coupling	1		
10H/493	Holder, valve, type 73	6		International octal
10H/308	Plug, type 185	1	RJP	10-pole
10C/1725	Potentiometer, type 1725	1	R_{23}	0·5 megohm
	Resistance			
10C/9134	Type 231	1	R_{11}	50,000 ohms
10C/11381	Type 477	1	R_{12}	50,000 ohms
10C/11384	Type 480	3	R_{14}, R_{25}, R_{26}	1 megohm
10C/11499	Type 487	2	R_2, R_7	100,000 ohms
10C/11666	Type 499	2	R_5, R_{10}	400 ohms
10C/11670	Type 504	1	R_{21}	5,000 ohms
10C/11673	Type 507	2	R_3, R_{20}	200,000 ohms
10C/11674	Type 508	1	R_{24}	0·5 megohm
10C/11682	Type 516			5,000 ohms
10C/11688	Type 522	1	R_{27}	60,000 ohms
10C/6	Type 540	1	R_{22}	500 ohms
10C/818	Type 924	2	R_8, R_9	100,000 ohms
10C/6226	Type 6226	3	R_{31}, R_{34}, R_{35}	600 ohms
10C/6441	Type 6441	2	R_{28}, R_{33}	1 megohm
10C/6662	Type 6662	1	R_{15}	100,000 ohms
10C/6870	Type 6870	1	R_{32}	0·5 megohm
10C/6871	Type 6871	1	R_{29}	0·25 megohm
10C/6872	Type 6872	1	R_{17}	200 ohms
10C/7313	Type 7313	1	R_{18}	5,000 ohms var.
10D/382	Tuning unit, type 69	1		
	Fitted with—			
	Condensers			
10C/9755	Type 332	2	C_3, C_9	0·01 μF
10C/4321	Type 2226	4	C_4, C_6, C_7, C_8	0·0001 μF var.
	Resistance			
10C/1018	Type 1018	1	R_7	100,000 ohms
10C/6662	Type 6662	1	R_4	2,000 ohms
10F/536	Switch, type 471	3	S_{1a}, S_{1b}, S_{1c}	Wafer S P 4-way
	Transformer			
10K/245	Type 363	1	T_4	Microphone, 40 : 1
10K/246	Type 364	1	T_5	A F output
10K/241	Transformer unit, type 29	1	T_2	
	Fitted with—			
	Condenser			
10C/4328	Type 2233	2	C_{13}, C_{15}	0·00015 μF
10C/4329	Type 2234	1	C_{21}	0·0001 μF
	Resistance			
10C/11674	Type 508	1	R_{19}	0·5 megohm
10C/1018	Type 1018	1	R_{13}	2,000 ohms
10K/242	Transformer unit, type 30	1	T_3	
	Fitted with—			
10C/4328	Condenser, type 2233	2	C_{18}, C_{22}	0·00015 μF
10C/1018	Resistance, type 1018	1	R_{13}	2,000 ohms
	Valve			
10E/11399	Type V.R 53	2	V_1, V_3	
10E/11401	Type V.R.55	1	V_6	
10E/11402	Type V.R.56	2	V_4, V_5	
10E/11403	Type V.R.57	1	V_2	
	Transmitter unit, type 22	1	Fig 2	T R 1196 and T.R 1196A
	Principal components—			
10H/1151	Aerial-socket unit	1		Single-pole
10H/12865	Cap valve, type 12	2		
10C/2054	Choke, H F. type 86	2	L_1, L_4	

Ref. No.	Nomenclature	Qty.	Ref. in figure	Remarks
	T.R.1196 and T.R.1196A (*contd.*)			
	Transmitter unit, type 22 (*contd.*)			
	Principal components (*contd.*)—			
	Condenser			
10C/9755	Type 332	3	C_4, C_5, C_8	0·01 μF
10C/10512	Type 379	1	C_{13}	0·001 μF
10C/10551	Type 420	1	C_3	20 μμF
10C/10832	Type 482 or	1	C_{10}	1 μF
10C/4572	Type 2382			
10C/11486	Type 537	1	C_2	0·0001 μF
10C/244	Type 635	1	C_{11}	0·01 μF
10C/499	Type 737	1	C_7	0·005 μF
10C/4323	Type 2228	2	C_6, C_{12}	0·0003 μF
10A/12870	Disc, coupling	1		
	Holder, valve			
10H/379	Type 62	1		9-pin for V_1
10H/493	Type 73	2		Octal base for V_2, V_3
	Indicator, visual tuning	1		
	Fitted with—			
5A/1117	Lamp filament, 2-v.	1	PL_1	Resonance indicator
10C/6875	Resistance, type 6875	1	R_{10}	10 ohms
	Inductance type 183	1	L_2, L_3	Band-pass
10H/1523	Plug, type 360	1	TJP	6-pole
10F/720	Relay, magnetic, type 257	1	$REL\frac{A}{2}$	250-ohm, 1 c/o, 1 m.
10A/13094	Retainer, valve, type 19	1		
	Resistance			
10C/8019	Type 111	1	R_1	100,000 ohms
10C/8021	Type 113	1	R_5	20,000 ohms
10C/11379	Type 475	1	R_2	20,000 ohms
10C/11381	Type 477	1	R_8	50,000 ohms
10C/11499	Type 487	1	R_4	100,000 ohms
10C/11668	Type 502	1	R_{11}	2,000 ohms
10C/11674	Type 508	2	R_7, R_9	0·5 megohm
10C/34	Type 551	1	R_{12}	200 ohms
10C/1156	Type 1156	1	R_6	500 ohms
10C/1862	Type 1862	1	R_3	250 ohms
10F/536	Switch, type 471	3	S_{1a}, S_{1b}, S_{1c}	Wafer S.P. 4-way
10K/247	Transformer, type 365	1	T_1	Modulation 1 : 1·25
	Valve			
10E/92	Type V.R.91	1	V_1	
10E/11398	Type V.T 52	1	V_3	
10E/389	Type V.T 501	1	V_2	
	The following items are included in the tuning coil section of the transmitter—			
10R/37	Coil aerial	4	L_5, L_6, L_7, L_8	
10R/38	Contact, wheel	4		
10A/13261	Dial, revolution indicator	4		
	Knob			
10A/13263	Type 108	1		
10A/13264	Type 109	1		
10A/13265	Type 110	1		
10A/13266	Type 111	1		
	Rod			
10R/59	Aerial coil	4		
10R/40	Contact wheel	4		
10A/13262	Sheave assembly	4		
10R/41	Spring, tension, contact	4		
10R/50	Washer, spring	4		
	Chassis assembly, type 8		Fig. 5	T.R.1196A (12 volt)
	Principal components—			
	As chassis assembly, type 7, except—			
10D/373	Selector-drive unit	1		Substituted for 10D/550
	Fitted with—			
10C/10165	Condenser, type 386	1	C_2	0·1 μF
10D/501	Clutch	2		
10C/6069	Resistance, type 6069	1	R_1	1 ohm

Ref. No.	Nomenclature	Qty.	Ref. in figure	Remarks
	T.R.1196 and T.R.1196A (*contd*)			
	Power unit, type 104		Fig. 6	T R.1196A
	Principal components—			
	As power unit, type 87, except—			
10K/567	Transformer, rotary, type 51	1		Substitute for 10K/568
	or			
10K/269	Transformer, rotary, type 257	1		Substitute for 10K/270
	Accessories—			Common to all installations
	Block, terminal, type B, No. 1	4		2-way
5E/916	Cable, L T. unisheathcotton 4	As required		Aerial and earth lead
	Cable end			
5K/911	Eye type 4 B.A.	1		
5K/1839	Hook type crimping 2 B.A.	3		
10D/678	Case, transit			
10K/ as required	Crystal units	8		4-transmitter, 4 receiver
	Insulator			
10B/8093	Type 16	1		Aerial lead-in
	or			
10B/11457	Type 49	1		Aerial lead-in, dome shaped glass
	or			
	Special	1		Aerial lead-in
10B/8994	Type 18	1		Aerial strain type, tail fitting
10B/9121	Insulator, type 18, strand	1		
10F/7741	Key, morse, type F	1		
5K/1072	Sleeve, identification	3		
10H/625	Socket, type 199	1		Telephone microphone, jack type
5K/1058	Terminal, instrument spring, type No. 2 B.A.	1		Earth
10B/8235	Wire, aerial			Stainless steel
	Accessories—	As required		Peculiar to individual aeroplanes
10H/1566	Connector set			
	Type T.R.1196/V	1		"Firefly", 24-volt
	Comprising—			
	Connector			
10H/895	Type 360/1	1		Form 4, 12-way
10H/896	Type 361/1	1		Dumet 4 and Ducel 4
10H/897	Type 362/1	1		Dumet 19
10H/1590	Type T.R.1196/AP	1		"Fulmar", 24-volt
10H/1591	Type T.R 1196A/E	1		"Swordfish", 12-volt (Torpedo trainer only)
10H/1592	Type T R 1196/Z	1		"Blackburn" No. 11/40, 24-volt
10J/22	Controller, electric, type 4	1	Fig. 5	Press button operated
	Fitted with—			
10A/10495	Cap, lamp, type 1	5	PL_a, PL_b, PL_c, PL_d, PL_t	
10F/11777	Handle, switch	1		
10H/11661	Jack, lamp, type 1	5		
10A/11562	Knob, type 12	5	BS_a, BS_b, BS_c, BS_d, BS_e	
10J/63	Mask, lamp, type 3	1		
	Plug			
10H/395	Type W.202	1	P_1	12-pole
10H/1917	Type 384	1	P_5	2-pole
10H/1766	Socket, type 315	1		2-pole
	Switch			
10F/11564	Type 166	1	S_3	T/RA/R
10F/776	Type 596	1		
	Accessories—			
5L/1141	Lamp, filament, 12 v.	5		Jack type, P O. No. 2A
	or			
5L/1638	Lamp, filament, 24 v.	5		Jack type, P.O No. 2A

SECTION 2, CHAPTER 9

TRANSMITTER-RECEIVER T.R.1161

List of Contents

List of Illustrations

CONCISE DETAILS OF TRANSMITTER-RECEIVER T.R.1161

PURPOSE OF EQUIPMENT	To provide two-way C.W. communication on multi-seater aeroplanes. Primarily designed for the Fleet Air Arm.
TYPE OF WAVE	C.W.
FREQUENCY RANGE	3 to 7 Mc/s.
FREQUENCY STABILITY	Transmitter and receiver ±0·1 per cent. at altitudes up to 40,000 ft. and temperature variations from +30° C. to −30° C. Normal conditions ±0·03 per cent.
CRYSTAL MULT. FACTOR	
PERCENTAGE MODULATION	
MAXIMUM SENSITIVITY	2 μV. into dummy AE of 100 μμF in series with 10 signal/noise of at least 12 db.
SELECTIVITY	Not less than 3 kc/s wide 6 db. down. Not greater than 30 kc/s. wide 60 db
OUTPUT IMPEDANCE	
AMPLIFIER CLASS	
MICROPHONE TYPE	A.M.
VALVES	Transmitter V.T.60 2 (Stores Ref. 10E/11441) Oscillator doubler and power amplifier. Receiver V.R.91 5 (Stores Ref. 10E/92) R.F. amplifier, 1st oscillator frequency control, I.F. amplifier, C.W. oscillator, output 6K8G 1 (Stores Ref. 10E/406) Frequency changer. V.R.53 1 (Stores Ref. 10E/11399) I.F. amplifier. V.R.55 1 (Stores Ref. 10E/11401) Tone oscillator and signal and A.V.C. rectifier. Power unit V.S.68 1 (Stores Ref. 10E/11449) Stabiliser.
POWER INPUT	Transmitting condition—key down 150 watts. Transmitting condition—mean power 125 watts. Receiving condition, 110 watts.
POWER OUTPUT	Not less than 10 watts when working into 10 ohms and 100 μμF. artificial aerial. Input voltage 26 at battery input plug.
STORES REF. No.	10D/256.
APPROXIMATE OVERALL DIMENSIONS	LENGTH 16¼ in. WIDTH 13½ in. HEIGHT 8¼ in.
WEIGHT	51 lb.
ASSOCIATED EQUIPMENT	Control unit (Stores Ref. 10L/31) Cables.

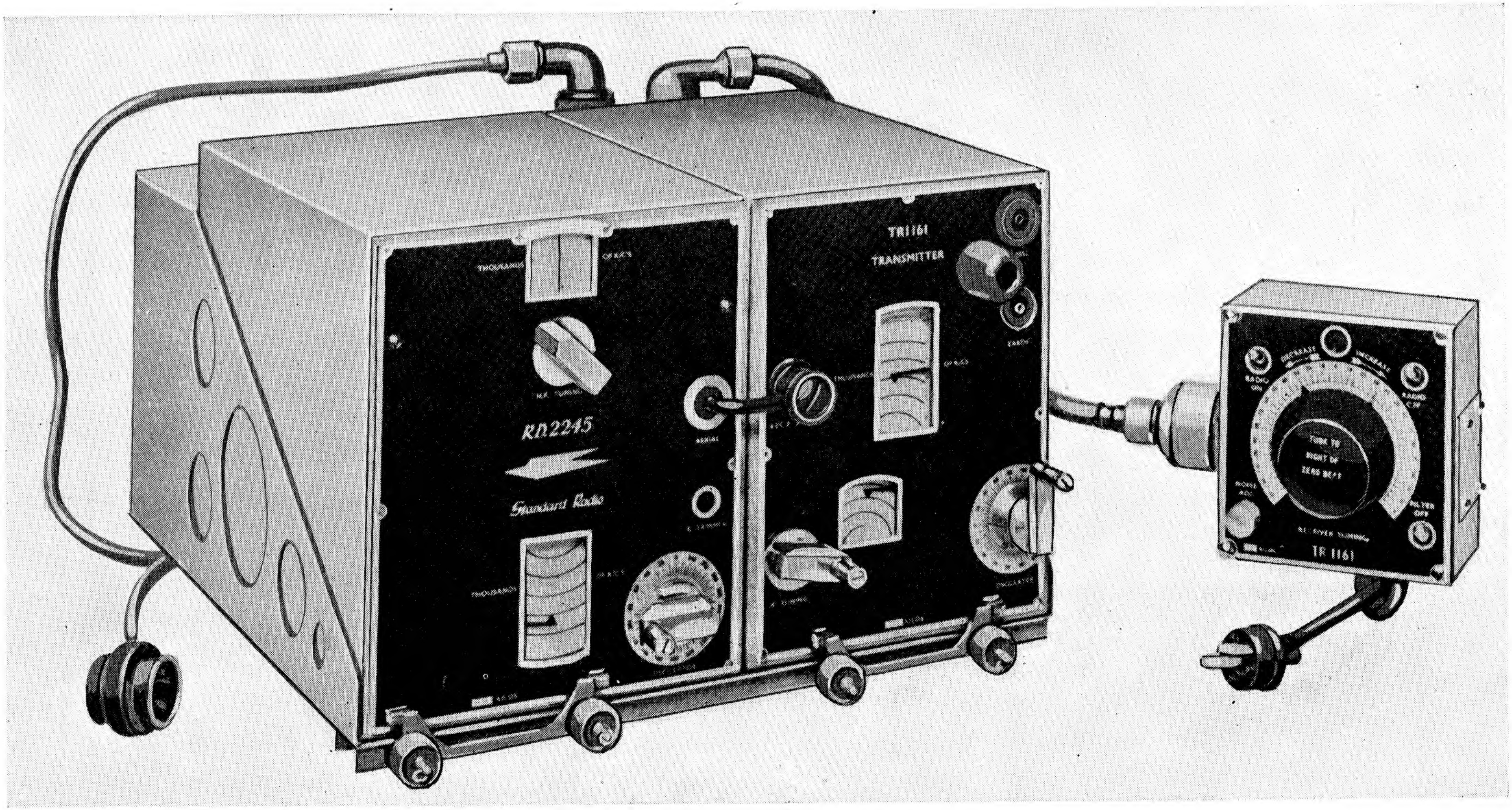


FIG. 1.—GENERAL VIEW OF T.R.1161 EQUIPMENT

SECTION 2, CHAPTER 9

TRANSMITTER-RECEIVER T.R.1161

(Stores Ref. 10D/256)

INTRODUCTION

1. The transmitter-receiver T.R.1161 is a self-contained equipment designed to provide two-way C.W. communication on multi-seater fighter aircraft. Primarily intended for the Fleet Air Arm it operates in the 3 to 7 Mc/s band. Any frequency within the stated band may be preselected, and, if the controls are accessible, fr quency can be changed during flight. The control of all operations, such as switching on, keying and trimming the receiver, is effected by a remote control located conveniently near the operator; the main unit, therefore, can be situated where it is accessible when the aeroplane is on the ground but not necessarily in the air Features of the design are high stability and setting accuracy, the circuit elements being temperature compensated.

2 The equipment consists of two main units—(i) the main assembly, comprising the transmitter, receiver and power supply and (ii) the remote control unit. The two units are interconnected by one cable and two "W" plugs.

3. The transmitter comprises two stages, namely, an oscillator doubler stage and a power amplifier stage. The oscillator valve is employed in a circuit of the electron-coupled type with a Colpitts tuned circuit.

4 The receiver is an eight-valve superheterodyne using an intermediate frequency of 550 kc/s, provision being made for the electrical fine tuning of the frequency of the local oscillator section of the frequency changer from the remote control.

5. Power supply is obtained from a rotary transformer operating from the aeroplane general services. The secondary of the transformer provides two outputs—12 volts for the L.T. and 350 volts for the H.T. The input required is 24 volts.

6. The power output from the transmitter is 10 watts into the aerial circuit. The sensitivity and signal-noise ratios are such that under normal conditions an unmodulated signal of 1 to 2 micro-volts into an aerial of 10 ohms $100\mu\mu F$ will give an output of at least 50 mW. with a signal/noise ratio of 12 db

7. The dimensions of the main unit are $8\frac{1}{4}$ in. high by $13\frac{1}{2}$ in. wide by $16\frac{1}{4}$ in. long. The control unit measures $4\frac{7}{8}$ in. by $4\frac{9}{16}$ in. by $2\frac{1}{4}$ in. The total weight is 51 lb., exclusive of cabling. A view of the complete equipment is given in fig. 1. It should be noted that in the circuit diagrams and photographs which follow, the annotational references are upwards for each unit.

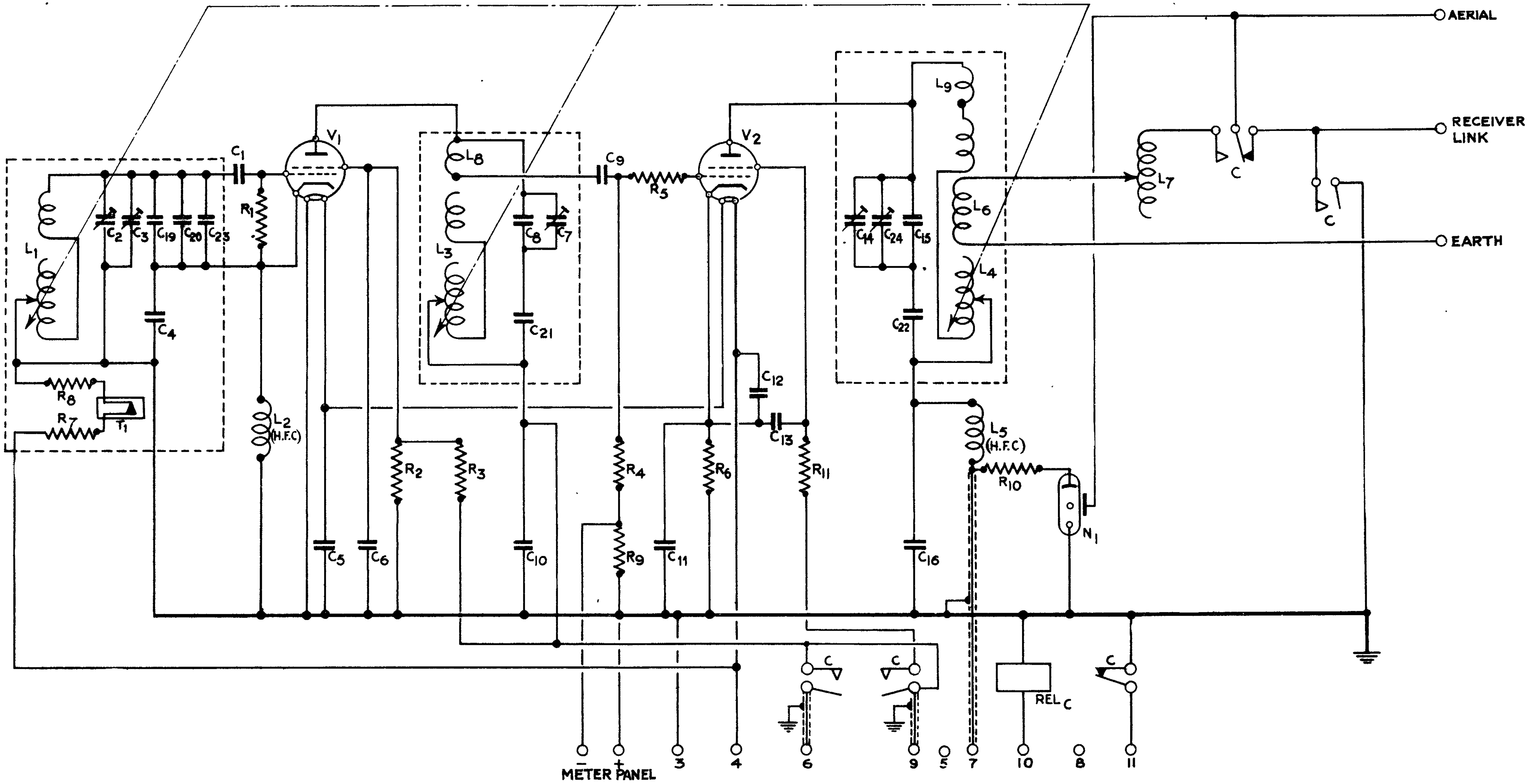
GENERAL DESCRIPTION

Transmitter

8. A theoretical circuit diagram of the transmitter is given in fig. 2 and it will be seen that it consists of an oscillator-doubler stage and a power amplifier stage. The circuit of the oscillator valve V_1 is of the electron-coupled type with a Colpitts tuned circuit consisting of condensers C_2, C_3, C_4, C_{19}, C_{20} and C_{23} and inductance L_1 connected between the screen grid and control grid, *via* condensers C_1 and C_6. A further tank circuit, consisting of C_7, C_8 and C_{21} and inductance L_3, tuned to double the oscillator frequency, is employed in the anode circuit so as to obtain adequate output and reduce pulling of the oscillator to the minimum. In order to compensate for temperature variations and reduce frequency drift to a minimum, the oscillator tuning circuit is made up of positive and negative temperature coefficient condensers. In addition, the oscillator inductance L_1 and condensers are enclosed in a screened can which is heat insulated; this compartment is also provided with a thermostatically controlled heater R_7, R_8 and T_1 to maintain the chamber at a temperature of approximately 30° C. Power for the heater is obtained from the 12 volt secondary winding of the rotary transformer unit.

9. The oscillator valve V_1 is coupled to the power amplifier V_2 by the condenser C_9 and the resistances R_5, R_4 and R_9. The anode tank circuit of the amplifier C_{14}, C_{15}, C_{22} and C_{24} and coil L_4 is tuned to the same frequency as the anode circuit of the oscillator. The grid bias supply for the power amplifier valve is obtained from the rectified grid current *via* the grid leak R_4 and R_9.

10. The three tuned circuits (oscillator, oscillator anode and harmonic generator, and power amplifier anode) are mechanically coupled, but are at the same time electrically screened from one



CONDENSERS	
C_1	200 µµF
C_2	3-20 µµF
C_3	3-20 µµF
C_4	1300 µµF
C_5	·01 µF
C_6	·01 µF
C_7	3-20 µµF
C_8	135 µµF
C_9	50 µµF
C_{10}	·01 µF
C_{11}	·01 µF
C_{12}	·01 µF
C_{13}	·01 µF
C_{14}	3-20 µF
C_{15}	150 µµF
C_{16}	·01 µF
C_{17}	———
C_{18}	———
C_{19}	1,000 µµF
C_{20}	SEE PART LIST
C_{21}	1,000 µµF
C_{22}	1,000 µµF
C_{23}	315 µµF
C_{24}	3-20 µµF

RESISTANCES	
R_1	20,000 Ω
R_2	20,000 Ω
R_3	50,000 Ω
R_4	15,000 Ω
R_5	50 Ω
R_6	150 Ω
R_7	9 Ω
R_8	9 Ω
R_9	50 Ω
R_{10}	10 MΩ
R_{11}	300 Ω

FIG.2

TRANSMITTER CIRCUIT DIAGRAM.

FIG.2

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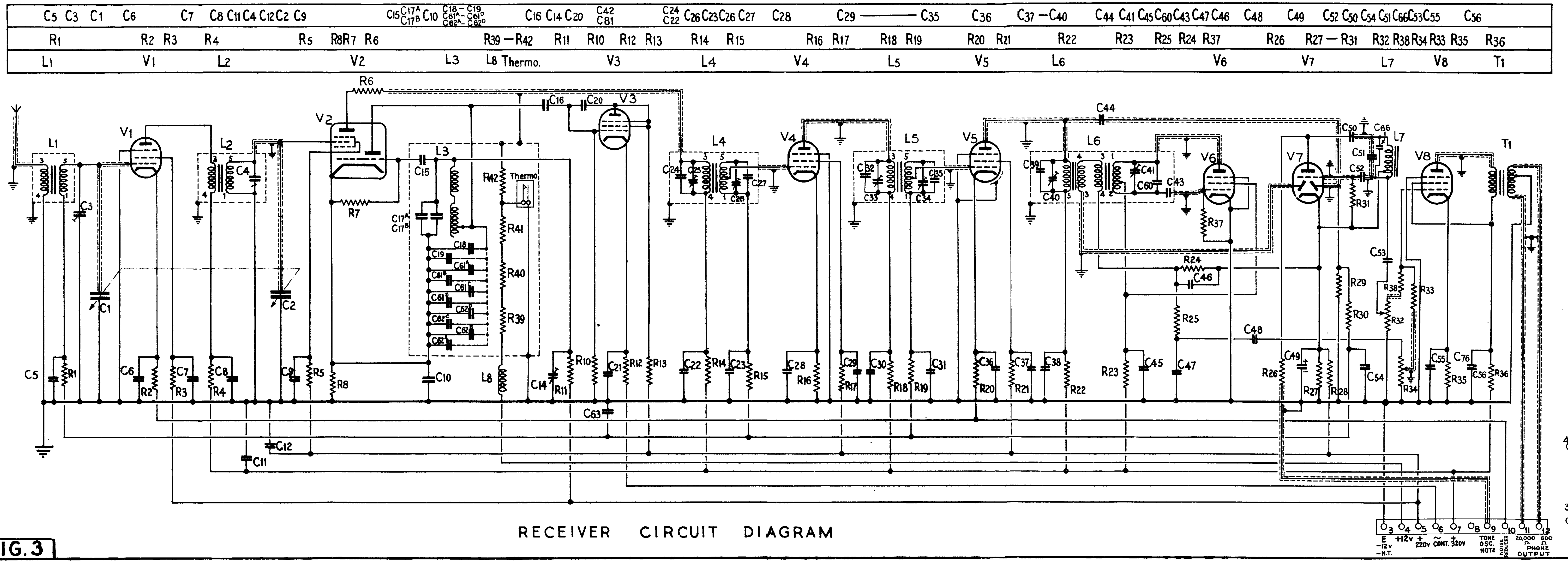

RECEIVER CIRCUIT DIAGRAM

FIG. 3

CONDENSERS			
C 1	TUNER	C35	115 μμF
C 2	TUNER	C36	0·1 μμF
C 3	3-25 μμF	C37	0·1 μμF
C 4	12-42 μμF	C38	0·1 μμF
C 5	0·1 μF	C39	115 μμF
C 6	0·1 μF	C40	12-42 μμF
C 7	0·1 μF	C41	12-42 μμF
C 8	0·1 μF	C43	50 μμF
C 9	0·1 μF	C44	20 μμF
C 10	0·1 μF	C45	0·1 μF
C 11	0·1 μF	C46	0·0002 μF
C 12	0·1 μF	C47	0·0001 μF
C 14	3·5–25 μμF	C48	0·1 μF
C 15	0·00025 μF	C49	8 μF
C 16	50 μμF	C 50	0·1 μF
C 17A	500 μμF	C 51	0·15 μF
C 17B	440 μμF	C 52	0·05 μF
C 18		C 53	0·001 μF
C 19		C 54	0·1 μF
C 20	50 μμF	C 55	25 μF
C 21	0·1 μF	C 56	0·1 μF
C 22	0·1 μF	C 57	0·1 μF
C 23	0·1 μF	C 60	320 μμF
C 24	115 μμF	C 61A	100 μμF
C 25	12-42 μμF	C 61B	80 μμF
C 26	12-42 μμF	C 61C	40 μμF
C 27	115 μμF	C 61D	20 μμF
C 28	0·0005 μμF	C 62A	100 μμF
C 29	0·1 μF	C 62B	80 μμF
C 30	0·1 μF	C 62C	40 μμF
C 31	0·1 μF	C 62D	20 μμF
C 32	115 μμF	C 63	0·1 μF
C 33	12-42 μμF	C 64	0·02 μF
C 34	12-42 μμF	C 65	0·02 μF
		C 66	0·015 μF

RESISTANCES	
R 1	100,000 Ω
R 2	300 Ω
R 3	1,000 Ω
R 4	15,000 Ω
R 5	50,000 Ω
R 6	100 Ω
R 7	50,000 Ω
R 8	500 Ω
R 10	5,000 Ω
R 11	15,000 Ω
R 12	100 Ω
R 13	25,000 Ω
R 14	50,000 Ω
R 15	100,000 Ω
R 16	500 Ω
R 17	50,000 Ω
R 18	50,000 Ω
R 19	100,000 Ω
R 20	500 Ω
R 21	100,000 Ω
R 22	50,000 Ω
R 23	25,000 Ω
R 24	¼ MΩ
R 25	50,000 Ω
R 26	220,000 Ω
R 27	10,000 Ω
R 28	30,000 Ω
R 29	50,000 Ω
R 30	25,000 Ω
R 31	¼ MΩ
R 32	½ MΩ
R 33	50,000 Ω
R 34	½ MΩ
R 35	300 Ω
R 36	10,000 Ω
R 37	50,000 Ω
R 38	150,000 Ω
R 39	4 Ω
R 40	4 Ω
R 41	4 Ω
R 42	300 Ω

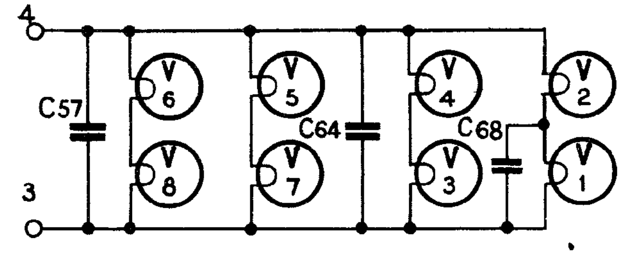

FIG. 3

another to prevent interaction and give maximum stability. The inductance of each of these coils is the same, each being split up into two mutually coupled portions, one with thick wire which is always in circuit and the other with a thinner wire on which a roller contact can be moved to provide a variation of the inductance in circuit.

11. The aerial circuit, which is tuned by the inductance L_7, is inductively coupled by means of the small coupling coil L_6 to the amplifier tank circuit. This coupling coil is situated between the variable and fixed parts of the amplifier coil. The aerial circuit is designed to work into an aerial of which the effective capacitance is not less than 70 $\mu\mu$F. at 3 Mc/s and not more than 200 $\mu\mu$F. at 7 Mc/s. The effective resistance of the aerial may be between 1 and 10 ohms. These capacitances correspond to a short fixed aerial approximately 10 ft. long or to a fairly long fixed aerial 25 ft. in length, the limiting factor being that the aerial tends to become resonant when its length is equal to a quarter of the operating wavelength.

12. An R.F. indicator is mounted on the front panel, to check the radiation of the transmitter. This also indicates whether H.T. is applied to the final stage. The indicator takes the form of a small neon lamp mounted near the aerial terminal. The lamp has a D.C. polarising voltage applied to it from the 350-volt H.T. supply through R_{10}, fig. 2. The intensity of glow of the lamp is greatest at the low-frequency end of the band, so that its brightness is no indication of the amount of R.F. power being radiated. The indicator is, however, sufficiently sensitive to tune the transmitter. The transmitter is keyed by making and breaking the H.T. supply to the screen and anode of the oscillator valve and the screen of the power amplifier

Receiver

13. Eight valves are employed in the receiver in a superheterodyne circuit which is given in fig. 3. The intermediate frequency used is 550 kc/s. The valve sequence is as follows:—

V_1, H.F. amplifier; V_2, frequency changer; V_3, 1st oscillator frequency control; V_4, I.F. amplifier, V_5, I.F. amplifier, V_6, C.W. oscillator, V_7, tone oscillator, signal and A.V.C. rectifier; V_8, output.

14. In the aerial circuit is a trimming condenser C_3 which, within normal limits of aeroplane antennae, permits of the antenna circuit being tuned to resonance. The H.F. transformer design is essentially a compromise between gain and selectivity and the constants are chosen to give maximum stage gain consistent with minimum detuning errors. Condensers C_1 and C_2 are ganged, so that the input and output circuits of V_1 are tuned simultaneously.

15. The frequency-changer valve V_2, fig. 3, is operated at maximum gain and, in conjunction with the beating oscillator, converts the received signal to 550 kc/s. The triode portion of this valve employs a Colpitts type oscillator. To ensure constancy of the oscillator circuits, which would vary with change of temperature, resulting in frequency drift, the components of this stage are contained in a screened box lagged with cork and the heat supplied by R_{39}, R_{40} and R_{41} is controlled by a thermostatic relay. Compensation for changes of ambient temperature is also afforded by a combination of ceramic and mica insulation for the tuning condensers C_{17a}, C_{17b}, C_{18}, C_{19}, C_{61} and C_{62}. The frequency drift, due to change of coil inductance with change of temperature, is thus reduced to an amount which, under normal operating conditions, is within the audible range and occurs over a minimum period of time.

16. The first oscillator frequency control valve, V_3, has its cathode brought out to a variable resistance R_4 in the remote control unit, which enables the amplification of the valve to be varied and, in conjunction with the associated circuits, C_{20}, R_{10} and R_{13}, varies the input impedance between C_{16} and earth. This impedance, which is mainly capacitive, is connected *via* C_{16}, between the oscillator anode of V_2 and the chassis, so that, as the gain of V_3 is changed, the frequency of the beating oscillator also varies. The amount of control is small, but the frequency deviation obtainable is sufficient to compensate for slight drift or inaccuracy of dial setting. Too wide a control is not desirable, as it would make the location of a particular signal difficult because of the additional number of signals received with wider frequency variation.

17. The intermediate-frequency amplifier, which is tuned to 550 kc/s., employs five tuned circuits in cascade, viz. L_4, L_5 and L_6 together with the associated tuning condensers, as indicated in the circuit diagram. The amplifier valves are V_4 and V_5. To overcome the variation of input impedance due to change of grid-cathode capacitance, the grid circuits of V_4 and V_5 are connected across only a part of the total coil and, in addition, each tuned circuit is loaded with fixed capacitance, leaving a small ceramic condenser to tune these circuits to resonance. The tuning condensers are C_{25}, C_{26}, C_{33}, C_{34} and C_{40}. The temperature coefficient of the I.F. tuning capacitances is selected to give the minimum frequency drift and thus improve gain stability.

18. Slight negative feedback reduces the gain of the amplifier valve V_4, and this improves stability, reduces noise and makes for a better automatic gain control characteristic. The feedback, or degeneration, in this stage is due to a particular choice of the cathode by-pass condenser, C_{28}

19. The oscillator valve V_6, and part of L_6 which works only at a fixed frequency, is compensated against frequency drift and, therefore, with compensated oscillators and a scale specially designed for high setting accuracy, the receiver may be set to any frequency within its range with the certainty that the signal will be heard.

20. The output of the I.F. amplifier is fed into one of the diodes of V_7 *via* the coupling windings L_6 and the C.W. oscillator is injected in series with the I.F. amplifier output. The resultant audio-frequency voltage, due to detection, appears across the diode load R_{24} and filter condenser C_{46} and is fed, *via* a low-pass filter R_{25}, C_{47}, to the grid of the output valve V_8 where R_{34} functions as an audio-frequency volume control.

21. The valve V_7 also functions as a side tone oscillator on "Transmit" in the following manner With the transmitter key depressed, H.T. voltage is placed between terminal 9 (marked Tone Osc. in the circuit diagram) and chassis. This causes the triode portion of V_7, together with the associated circuits L_7, C_{51}, C_{50}, and C_{52}, R_{31}, to oscillate at a frequency of approximately 850 cycles. This audio-frequency tone appears across C_{53} and chassis *via* the side tone output volume control R_{32}.

22. The output valve V_8, is operated for maximum gain and the transformer T_1 serves to isolate the headphones from D.C. H.T. and to provide matching into an impedance of 7,000 ohms, corresponding to high resistance phones, or into low-resistance phones approximating to 200 ohms impedance.

23. The automatic gain control circuit in the receiver is derived from the rectified carrier output from the diode circuit of V_7. This voltage appears across R_{29} and is fed *via* the low-pass filter R_{30}, C_{54} to controlled valves V_5, V_4 and V_1. The time constant of the A.V.C. system is determined principally by R_{30}, C_{54}, C_{63} and the associated decoupling resistances and condensers of the controlled stages. Resistances R_{27} and R_{28} form a voltage delay network to ensure that the rectified bias voltage across R_{29} does not come into operation until a certain carrier strength is reached. A by-pass condenser C_{49} short-circuits the tone oscillator voltage developed across R_{27}; complete control of side tone output is, therefore, *via* R_{32} only.

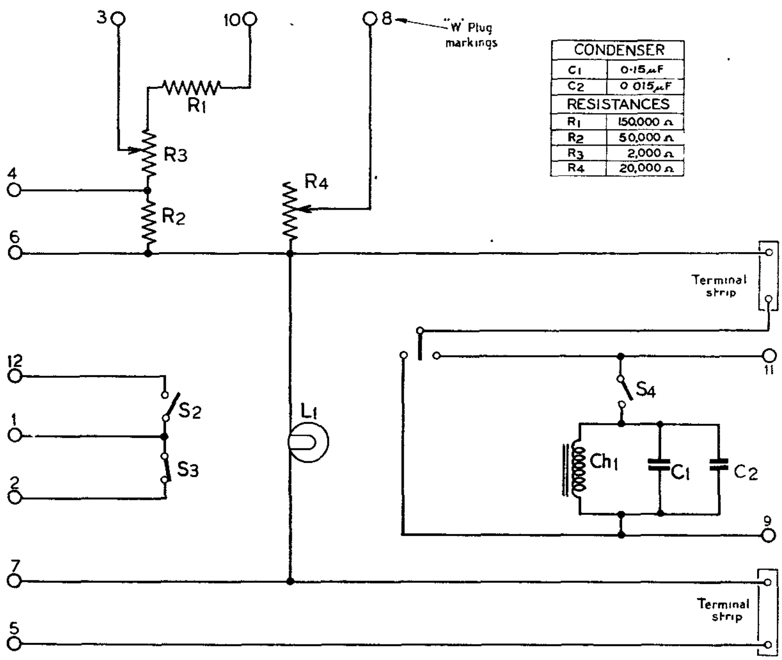

FIG. 4.—CONTROL UNIT CIRCUIT DIAGRAM

Control unit

24. The circuit diagram of the control unit is given in fig. 4. Reference to this will show that the phone output may be connected *via* S_1 between terminal 6 (earth) and either terminals 11 or 9, according to the output impedance required. Across these terminals is connected a note filter circuit (Ch_1 and C_1 (fig. 4)), which resonates at approximately 850 cycles but gives a sharp cut-off to frequencies either side of the resonant frequency. The filter may be switched out of circuit by S_4.

CONDENSERS				RESISTANCES			
C_{29}	2 µF	C_{33}	0·1 µF	R_{12}	1 MΩ	R_{16}	2000 Ω
C_{30}	2 µF	C_{34}	2 µF	R_{13}	1 MΩ		
C_{31}	2 µF	C_{35}	·002 µF	R_{14}	1 MΩ		
C_{32}	2 µF	C_{36}	25 µF	R_{15}	1000 Ω		

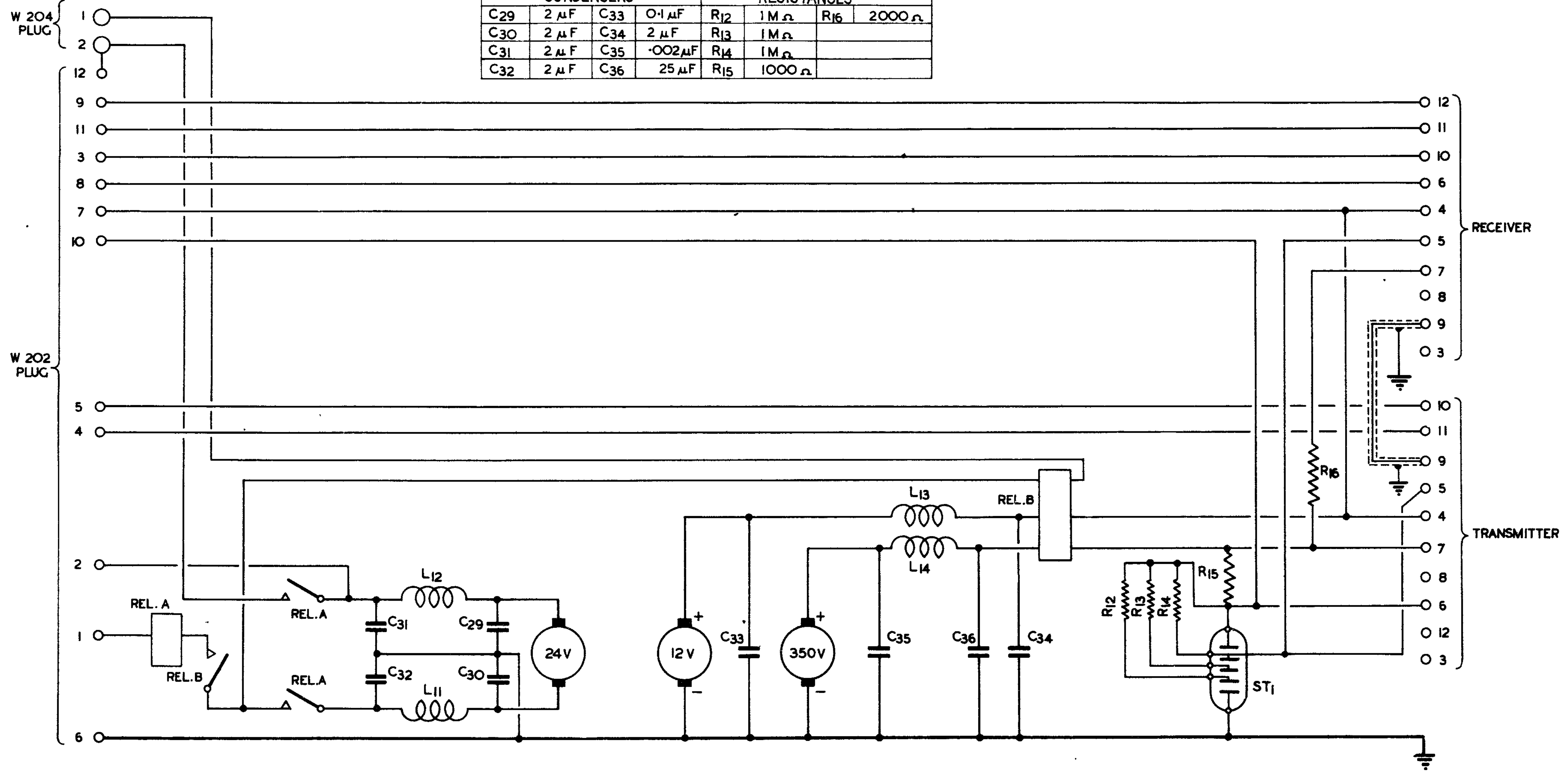

FIG. 5

POWER UNIT CIRCUIT DIAGRAM

FIG.5

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25. Noise reduction is effected by a variable resistance R_3 This resistance which gives control of sensitivity is connected *via* terminal 10 to the cathodes of V_1 and V_5 through the series resistances R_1 and R_{20} of the receiver (fig. 3). The condensers C_{11}, C_{12} and C_{63} tie the interconnecting service leads to the chassis at R.F. potential.

26. Break-in keying is achieved by muting the receiver during keying intervals. It will be seen by reference to fig. 4 that R_2 is in series with R_3 to the chassis so that on TRANSMIT, R_2, which is connected to the SEND-RECEIVE relay in the transmitter, is open-circuited and additional bias is switched into the cathodes of valves V_1 and V_5 of the receiver, thus desensitising it. In addition, the aerial terminal of the receiver is short-circuited to chassis. These operations are arranged to occur before the H.T is connected to the transmitter by special adjustment of the change-over relay.

Power supply

27. The rotary transformer which supplies all power for the equipment has a 24-volt input derived from the aeroplane general services. The circuit is given in fig. 5. The outputs are 12-volts L.T. and 350 volts H.T. Filtering arrangements are included in both input and output leads; the input comprises L_{11}, L_{12}, C_{29} C_{30}, C_{31} and C_{32}; the 12-volt output L_{13}, C_{33} and C_{34} and the 350-volt output by L_{14}, C_{35} and C_{36}. The 350-volt output is applied direct to the power amplifier of the transmitter and through dropping resistances to the receiver anodes and a stabilo-volt stabilising valve ST_1 to provide two stabilised supplies—one at 270 volts for the transmitter oscillator valve (anode and screen) and power amplifier screen, and the other at 220 volts for the receiver screen supplies.

28. The overload relay has three windings which are connected in series with the input and output of the rotary transformer: if the current in any of these circuits exceeds the safe limit, the relay operates and opens the energizing circuit of the starter relay, thus shutting down the entire equipment. It is designed to operate on the following loads:—

(i) Input short circuit

(ii) 12-volt secondary, 4-5 amps.

(iii) 350-volt secondary, 450 mA.

It does not, however, protect against short circuits in the smoothing networks on the secondary side.

CONSTRUCTIONAL DETAILS

General

29. A view of the complete transmitter-receiver T.R.1161, split up into its component units, is given in fig. 6. It will be seen that it consists of an assembly comprising the transmitter, the receiver and the power supply unit, each of which is easily detachable from a mounting tray. The latter is a light-gauge sheet steel wedge-shaped tray designed for mounting on six shock absorbers which will each carry 8 lb., and the units can be released by unscrewing four knurled clamping nuts at the front and turning the two adjacent knobs on the transmitter and receiver to a vertical position, when the transmitter and receiver can be withdrawn by means of the extractor handles. The power unit can be removed by pulling up the two plunger type catches, turring through 90° and then releasing the two Dzus catches.

Transmitter

30. The transmitter consists of a shallow rectangular chassis on the upper side of which are mounted a three-gang coil assembly, the aerial coil, the valves and the front panel, as will be clearly seen by reference to fig. 7. In this view the three-gang coil assembly can be seen on the right, the aerial coil on the front left-hand corner behind the front panel and the valves behind this. A Jones plug for connection to the rotary unit is at the back of the chassis.

31. On the underside of the chassis are the screened compartments containing the oscillator components, the circuit components and the keying relay. The chassis is made of a light gauge sheet steel cadmium plated and welded. On the right-hand side is a step 1½ in. deep and 3 in. wide. The whole assembly fits into a light-gauge steel case and is fixed by a single Dzus fastener at the rear The overall dimensions are 10 in. by 6 in by 8 in.

32. The three-gang coil assembly has a box-form base of light-alloy inside which is a horizontal shaft carrying the spiral gears for driving the three coils The gear ratio between the horizontal shaft and the coils is 2·53 to 1. The three main tuning inductances are each mounted vertically on the base. The bottom bearing is a ball race fixed in an adjustable housing on the casting. Four cast aluminium pillars support the end plate which carries the top bearing of each coil, which is a plain brass bush. The coil spindle is hollow and the end of the coil is brought through it to a slip ring to which contact is made by a spring wire. The tuning condensers are mounted on brackets fixed to the end plates.

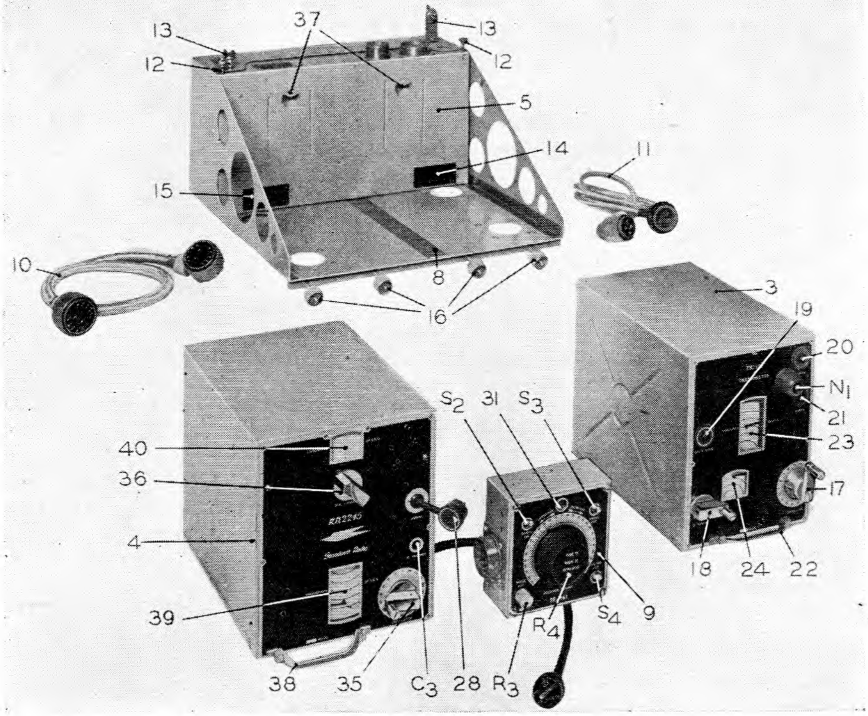

FIG. 6.—DISSEMBLED VIEW OF T.R.1161 EQUIPMENT

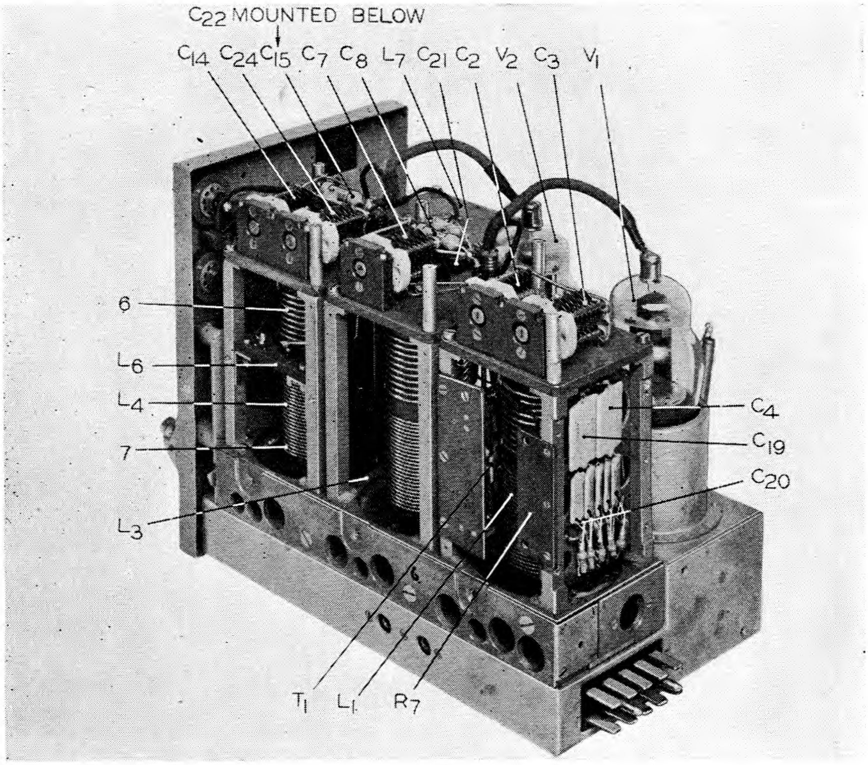

FIG. 7.—VIEW OF TRANSMITTER REMOVED FROM ITS CASE

33. The three coils are each screened with rectangular sheet aluminium boxes, the box covering the oscillator coil being lagged with cork encased in silk in order to maintain a constant temperature. On the sides of two of these cans are mounted the adjustable valve retaining flaps.

34. The coils consist of two mutually coupled inductances, one made of thick wire which is always in circuit, and the other of thinner wire, the number of turns in circuit being variable by means of a roller contact. The three coils are identical.

35. The front end of the horizontal driving shaft is geared to a 5 in. diameter scale. At the back of this scale is cut a scroll in which the radial change of the last ½ in. is greater than the remainder A guide pin runs in the scroll and is connected to a system of links which operate the pointer and stop mechanism. When the guide is at the end of the scroll, the stop mechanism comes into operation by means of the link movement which causes a lever to engage on a stop on the horizontal shaft. This spiral scale gives a high degree of setting accuracy as it corresponds to a scale approximately 50 in. in length.

36. The aerial coil is a complete assembly in itself. It consists of a light U-shaped casting which carries a horizontal shaft driving the vertical aerial coil by gears having a gear ratio of 1·2 to 1. The bearings are similar to those of the three-gang assembly, the stop being on the coil. The total length of the aerial scale is 14 in.

37. The front panel is fixed to the chassis by the pull-out handle and screws. Mounted on the panel are a neon radiation indicator lamp and the three sockets for the aerial, earth and receiver link.

38. Behind the panel are mounted the two small dials, the larger one for the oscillator tuning on the three-gang coil assembly and the small one for the aerial tuning. Both dials are calibrated in kilocycles. In order to obviate damage to the coil if undue force is used when the coils have reached the stop positions, the knobs are fitted with a slipping clutch which will re-engage upon reversal of rotation.

Receiver

39. The receiver is contained in a light steel box. A view of it removed from this is given in fig. 8. The front panel is secured to the case by a spring catch located at the rear of the case.

40 The main chassis (42) fig. 8 consists of a light steel box structure flanged and ribbed to give mechanical stability. A light angle framework (45) protects the components on the upper side and permits of the receiver being placed on its back to obtain easy access to the components on the underside. A central steel partition passes down the centre of the chassis which provides screening between the H.F. and I.F circuits and also increases the mechanical rigidity.

41. The front panel is secured to the chassis by means of the pull-out handle and screws. There are two cut-outs in it through which the oscillator and H.F. tuning dials can be observed.

42. The H.F. coils are of the iron dust type and are mounted in a framework within their cans. The coils are tuned by means of variable ceramic condensers mounted just below the tops of the coil cans. The variable H.F. oscillator coil, L_3, fig. 3, is mounted in a removable aluminium box, (41) fig. 8, at the lower left-hand side of the chassis. This coil is of the variable inductance type and consists of a wound former which can be rotated by a handle; this causes a carriage bearing the variable tapping point contact to move up and down the coil, contact being made by the drive pulleys with the winding on the former. The carriage is located in an angular plane by a guide rail which engages the guide blocks forming part of the carriage assembly.

43. The block of ceramic or silvered mica condensers for the purpose of adjusting the temperature drift of the coil is mounted on the side of the coil can opposite to the guide rail. The lead-out from the back of the coil is taken via spring wires which contact the slip ring on the rear spindle. A thrust spring is fitted to eliminate end play.

44. The oscillator scale is driven by a split gear mounted on the oscillator coil spindle, special precautions having been taken to eliminate back lash. The scale is of spiral form and it has an effective length of 55 in. allowing of a high degree of setting accuracy being obtained.

45. The H.F. circuits are tuned by the two gang condensers C_1 and C_2; the scale is mounted directly on the spindle, as a high setting accuracy for these circuits is not necessary. Undesired movement of the condenser is prevented by means of a friction disc and spring.

46. The two preset potentiometers for adjustment of L.F. volume and side tone volume are mounted adjacent to the ganged condensers on the top of the chassis.

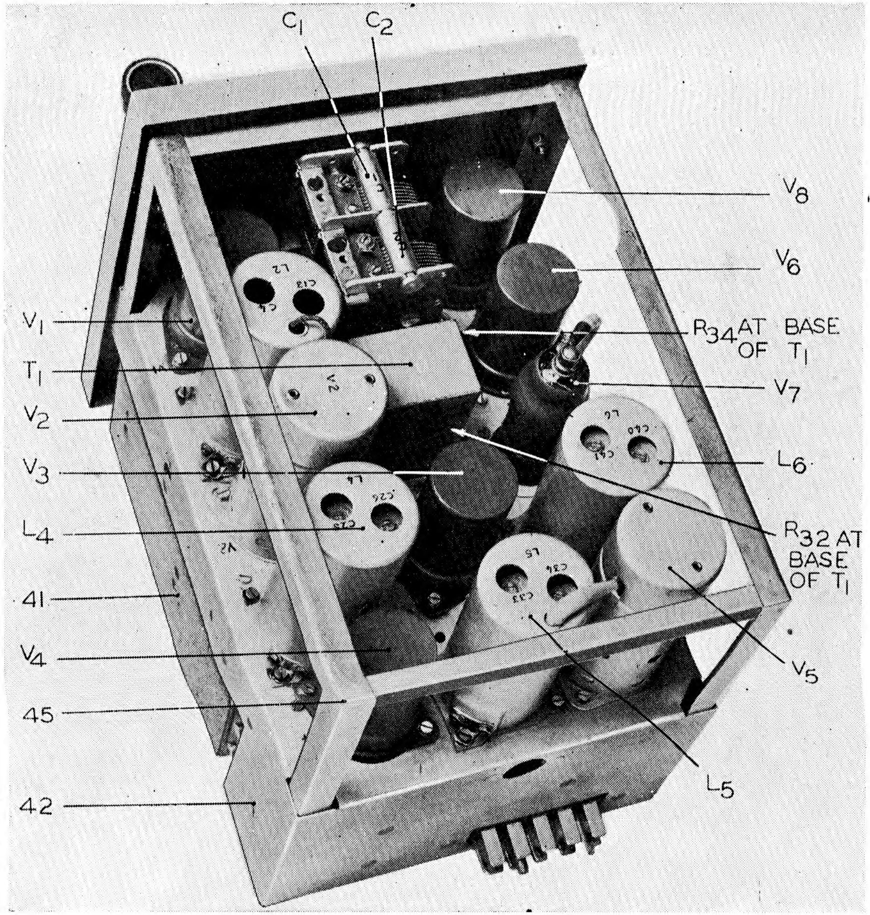

FIG. 8.—VIEW OF RECEIVER REMOVED FROM ITS CASE

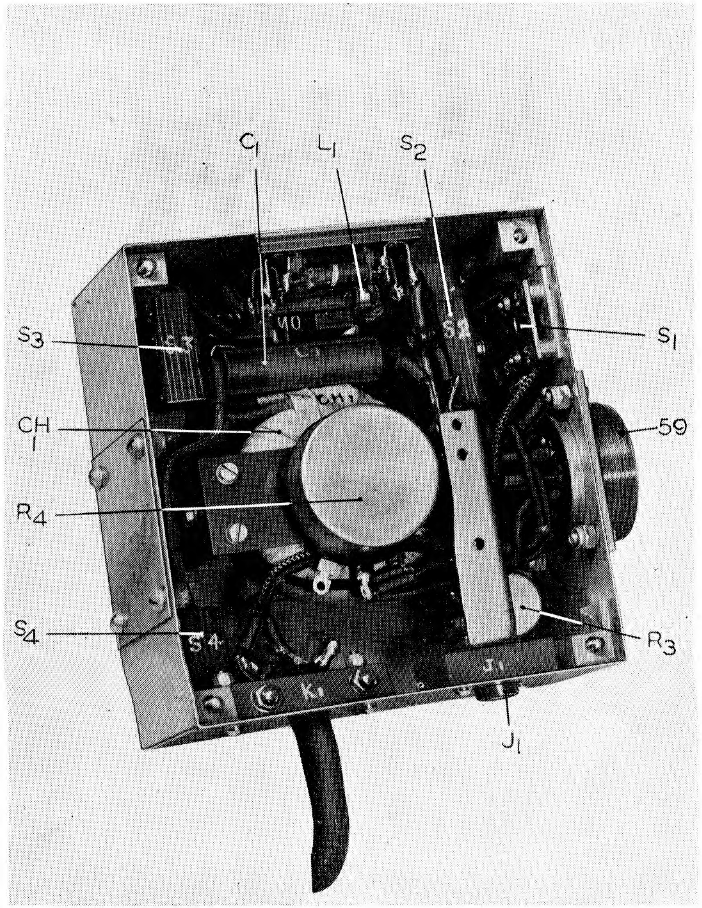

FIG. 9.—VIEW SHOWING INTERIOR OF CONTROL UNIT

47. The V.R.91 valves are held in their sockets by spring steel clips, V.R.55 and V.R.53 (V_5, V_7) by screwed on valve caps, and the 6K8G (V_2) by an internal spring in the cap, which holds ears in the cap in engagement with straps mounted on the adjacent coil cans.

Control unit

48. The control unit consists of a rectangular metal box 4½ in. long by 4⅞ in. wide and 2½ in. high with a detachable back plate which is slightly larger than the box to permit of mounting by three external screws. A view of this unit is given in fig. 9.

49. On the front panel of the control unit are the RADIO ON switch, RADIO OFF switch, ON indicator window, RECEIVER TUNING (fine frequency control), NOISE ADJUSTMENT control and FILTER ON-OFF SWITCH (audio frequency). The headphones and key leads are brought out at the bottom of the unit. All connections are made to a 12-point "W" plug into which fits the 12-point socket from the power supply unit.

50. Keying is effected by a contact on the aerial changeover relay in the transmitter. This performs the following operations in the sequence given; earths the receiver aerial, desensitizes the receiver, changes the aerial from receiver to transmitter, causes the triode section of the double-diode triode valve to oscillate at approximately 850 cycles on the side tone, applies H.T. to the transmitter oscillator anode and screen of the power amplifier.

Power supply unit

51. A rear view of the power supply unit is given in fig. 10. The chassis of this unit has a raised platform at the rear, on the top of which is mounted the rotary transformer, the voltage stabilizer and the various chokes and condensers employed in the smoothing circuit. These smoothing elements are mounted as near as possible to the rotary transformer, the latter being near the L.F. end of the receiver when the units are assembled on the main tray.

52. The rotary transformer is completely screened when in position. It is fixed to a small sub-tray which bolts on to a shallow sub-chassis. It has three commutators—a 24-volt input (primary) and 12-volt and 350-volt secondaries. The machine is shunt wound, the field winding being connected across the 24-volt input. A fan is fitted at the end of the shaft for cooling purposes.

53. On the underside of the platform are mounted the starter relay, the overload relay, the receiver socket, the transmitter socket and the various resistances, condensers, etc. indicated in the circuit diagram (fig. 5).

54. At the top of the chassis are mounted the control unit cable plug, the battery cable plug and the catch knobs and catches. The rotary unit is approximately 13 in. long by 6 in. deep by 7 in. high. A panel is provided on the long side, on the bottom of which are fitted the sockets for receiving the plugs on the transmitter and receiver; on the top are two W plugs for connection of the battery and control cables. When removed from the main tray the rotary unit is in the form of sub-chassis and panel, the enclosure being completed when in position in the main assembly.

VALVES AND POWER SUPPLY

55. The complete equipment incorporates eleven valves, one of which is a Stabilovolt stabilizer valve; one neon lamp and an indicator lamp.

56. The transmitter has two valves, an oscillator doubler and a power amplifier, both of which are type V.T.60.

57. The receiver employs eight valves; V_1, the R.F. amplifier is a type V.R.91; V_2, the frequency changer, a type 6K8G; V_3, 1st oscillator frequency control, a type V.R.91; V_4 and V_5, I.F. amplifiers, types V.R.91 and V.R.53; V6, C.W. oscillator, type V.R.91; V_7, tone oscillator, and signal and A.V.C. rectifier, type V.R.55; V_8, output, type V.R.91.

58. The stabilizer Stabivolt valve incorporated in the power unit is a type V.S.68.

59. Power is obtained from the 24-volt aeroplane battery which drives the rotary transformer giving two separate outputs of 12 volts and 350 volts. Conversion to 12-volt operation may be made by changing the rotary transformer.

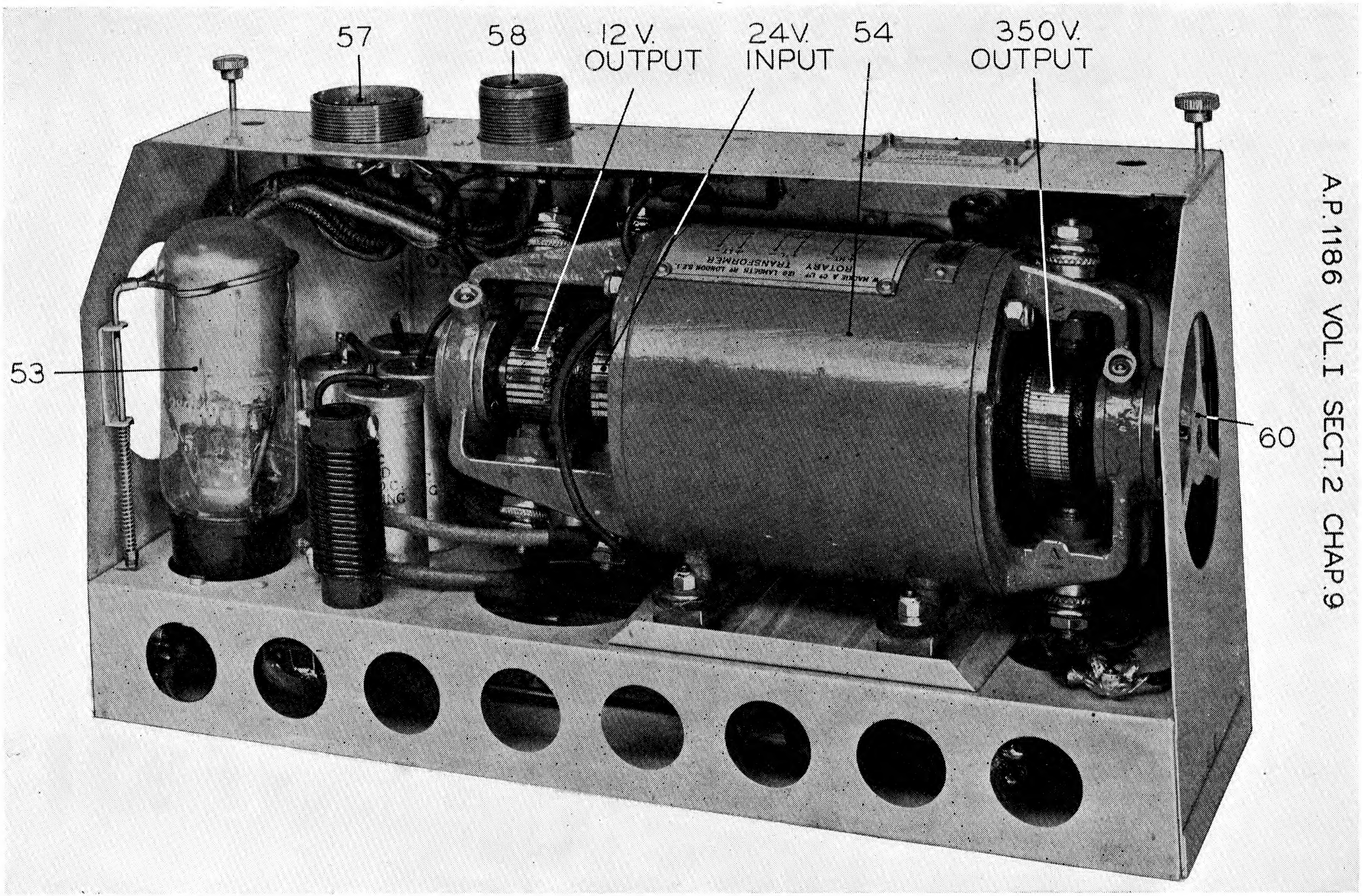

FIG. 10.—VIEW OF POWER SUPPLY UNIT

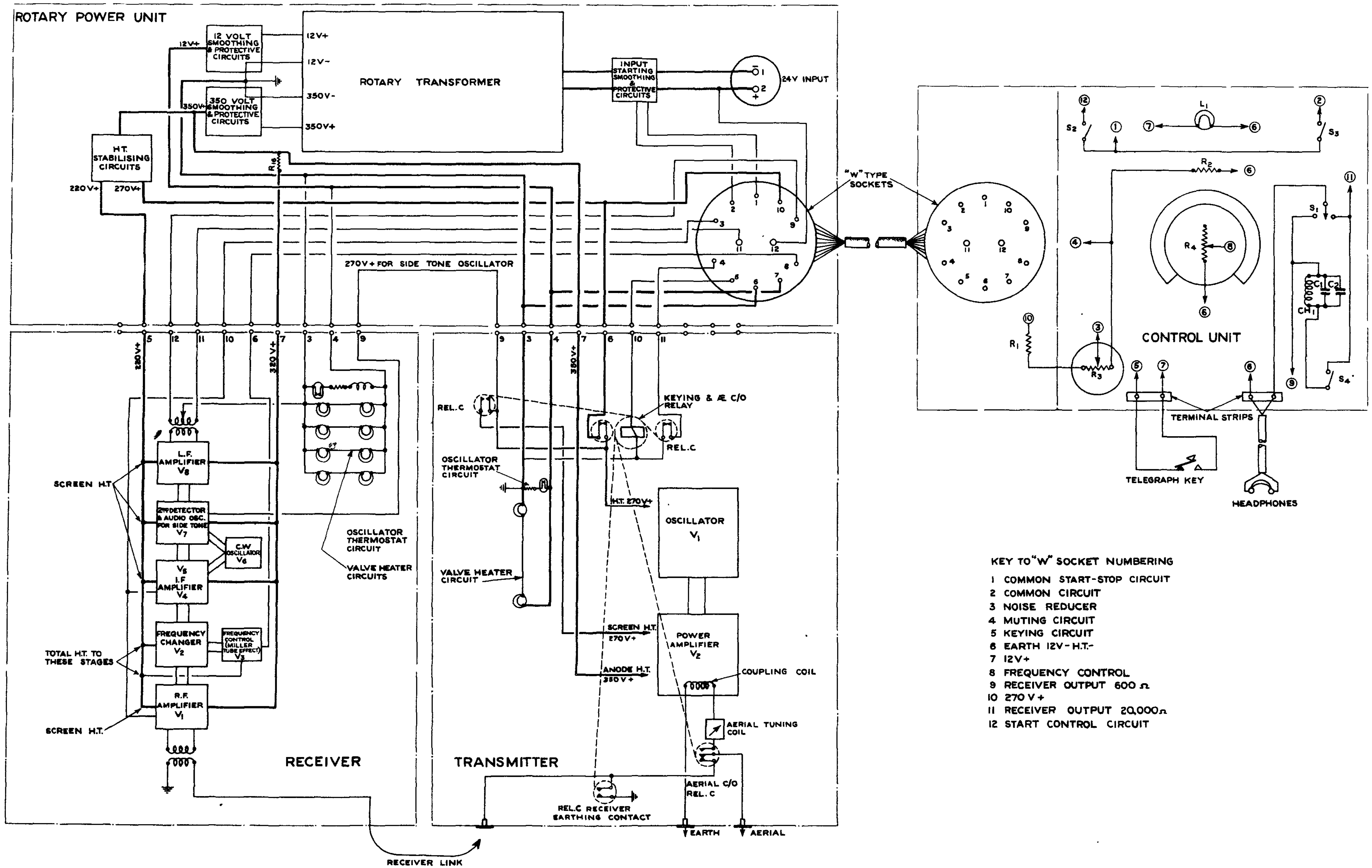

FIG. 11 SIMPLIFIED SCHEMATIC DIAGRAM FIG. 11

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OPERATION

General

60. The controls on the T R.1161 are as follows.—

Transmitter	Oscillator tuning Aerial tuning Oscillator stage trimmers Harmonic generator stage trimmer
Receiver	Oscillator tuning H.F. tuning Aerial trimmer Side-tone volume Low-frequency volume
Control unit	Noise adjusting control Fine control of frequency for receiver Note filter On-off switches

61. A preliminary check should be made of the equipment by removing the units from their cases and seeing that the valves are in their correct positions and properly secured by their retaining clips. The transmitter and receiver are removed by undoing the Dzus fastener at the back of the case above the Jones plug.

62. A check should be made that the Stabivolt stabilising valve is in position in the transformer unit, and also that the lamp is in its holder behind the indicating window in the control unit. It is essential to ensure that the 200-ohm or 7,000-ohm strap is correctly connected in the control unit according to the type of phones used. Access is obtained to the strap by removing the back of the case.

Connecting up

63. Assembly of the units on the main tray should be carried out as follows:—

(i) Slide the rotary transformer into position, first having lifted the knurled knobs at each end. When the unit is in position, give the knobs a turn and do up the two Dzus fasteners which hold the unit on the tray.

(ii) Slide the transmitter into position on the right-hand side of the tray and secure in place by the two knurled knobs (16, fig. 6) over the handle (22) on the front.

(iii) Slide the receiver into position on the left-hand side and secure as with the transmitter.

(iv) Fix the control unit to the side of the receiver or at a remote point according to the installation.

(v) Fit the two interconnecting cables, the larger (10), from the rotary unit to the control unit and the smaller (11), from the rotary unit to the battery.

(vi) Connect the aerial, earth and receiver link (28).

Adjustment of L.F. and side tone control

64. The L.F. and side tone controls should be set to give a convenient output in the following manner. Place the receiver, without the case, into position on the power unit. Start up the aeroplane engine. Switch on, using the ON switch on the control unit. Tune in to a convenient signal. Set the noise reducer to maximum, i.e. fully clockwise. Adjust L.F. VOLUME to a convenient level (this should be done with the phones over the ears to simulate operating conditions). Depress the transmitting key and adjust SIDE TONE VOLUME control to give a convenient level.

65. With the key up, switch on, set the noise adjuster to maximum, set the H.F. and oscillator dials to the same frequency anywhere in the band (preferably at H.F. end). Trim the A.E. trimmers, using tool supplied, for maximum noise.

Tuning the transmitter

66. The equipment is switched on by pressing the RADIO ON button on the control unit. The rotary transformer will start up, the indicator lamp (31) on the control unit will light up and the aerial neon indicator (N1) will strike with a faint glow. Allow half-a-minute for the equipment to warm up.

67. Turn the oscillator tuning knob (17) and the aerial tuning knob (18) to the required frequency. Press the telegraph key, when the neon indicator will glow more brightly indicating that R.F. power is being radiated. If an R.F. ammeter be inserted in the aerial circuit, the current indicated should be 0·7 to 1·1 amps.; this will vary slightly with frequency and aerial capacitance.

68. When the equipment is being worked into a non-standard aerial, the method of lining up is as follows. Switch on the equipment and allow it to warm up for at least half-a-minute, when a faint glow will be observed in the neon indicator. Set the oscillator knob to the desired frequency. Press the key down and tune the aerial tuning knob for maximum glow or, if an aerial ammeter is inserted, for maximum current. The amount of current will vary according to frequency and aerial characteristics.

Tuning the receiver

69. In tuning the receiver, the following operations should be carried out. Referring to fig. 6, the note filter (S4) is switched to OFF, the frequency control (R4) on the control unit set to 0 degrees and the noise adjuster (R3) to maximum, i.e. fully clockwise. The equipment is then switched on with the key up. Oscillator tuning (35) and H.F. tuning (36) are set to the frequency required as marked on the dials. If an interfering signal is experienced, the note filter should be switched in and the frequency control on the control unit adjusted. The maximum output of the side tone is too great for one pair of phones and the side tone volume control should be adjusted accordingly.

70. The audio-frequency output due to the signal is also too great for normal use and this control should be adjusted so that the level is above ordinary cabin noise. It is important to note that when a good signal-to-noise ratio exists, and the output under such conditions is too great, the L.F. volume control must be turned back, and not the noise reducer control. The setting of the noise reducer will give the best operating compromise between high noise level during deep fading and a steady output from the receiver. If the control is turned back, the peak value of noise and signal will be reduced at the expense of greater fluctuations in output level consequent upon fading; in brief, the automatic gain control action will not be so good. The foregoing remarks are of importance, for with the noise reducer set at a maximum there is little audible difference between signals of some 1 to 2 μ V. to values some half-a-million times as great.

71. The note filter will be of use in eliminating beat notes that would normally pass through the audio-amplifier and produce interference. Some reduction in audio level will be experienced, but by a small movement of the frequency control, the desired signal may be peaked at the resonant frequency of the note filter and thus give greater output than the interfering signal. When "listening out", the note filter must be switched out of circuit and used only when interference is experienced.

72. The peak response of the filter is arranged to coincide with the resonant frequency of the telephones and thus the aerial loss with filter in is less than that measured with the telephones out of circuit.

73. The frequency control should always be set to 0 degrees upon setting the receiver up to any required frequency, thus ensuring that the desired signal is within the range of the electrical control provided. The control knob is engraved "Tune to right-hand of zero beat". The reason is that on initial receiver alignment the beat note is arranged to give slightly greater output on the high frequency or INCREASE side on the control dial. The difference will not be noticeable except in the case of a very weak signal.

Separating units

74. To separate the equipment into its various units it is necessary to follow a certain sequence of operations which is detailed below.

(i) Extract plugs from items (19), (20) and (21) fig. 6 from the front panel of transmitter. Item (19) will remain attached to receiver panel by a short length of connector.

(ii) Align knobs (18) on transmitter and (35) on receiver in a vertical position.

(iii) Unscrew the four knurled knobs (16) to maximum extent (these will then swing down below the level of the mounting tray surface) and release withdrawing handles on transmitter (22) and receiver (39).

(iv) Grip appropriate handle and pull steadily with a slight sideways shake.

(v) Detach control (10) and battery cables (11) by unscrewing wide knurled collar.

(vi) Twist two wing-type Dzus catches (13) through 90° counter-clockwise and lift up hinge plates.

(vii) Lift two plunger type catches (12) and turn through 90° when they will remain in the up position, releasing plungers which project from the base of the power supply unit into holes in the mounting tray. The power unit can now be slid forward like a drawer, using the finger plates (37), in the front panel.

75. It is most important that the power unit should not be withdrawn with the power cable in position owing to the danger from high voltage contacts and the rotating fan. (60, fig. 10).

76. The control unit is detached from its back plate by unscrewing the four large screw heads in the corners of the front panel. These screws cannot be entirely removed.

77. The final operation is the removal of the box covers (3) and (4) from the transmitter and receiver. At the rear of the two boxes is a slotted Dzus fastener head which should be rotated through 90° counter-clockwise. This will release the box cover from the chassis which can now be extracted.

Transmitter adjustment

78. Maintenance will have to be carried out from time to time on the transmitter, such as the replacement of the thermal control relay, valves and neon lamp, and the cleaning of the roller taps on the coils. These matters are dealt with below.

79. The coils are respectively the amplifier, the harmonic generator or doubler, the oscillator and the aerial coil. The first three are screened by rectangular cans.

80. From these cans the following leads project; one from the amplifier can to the anode cap of the first valve and one to the aerial terminal immediately above the back of the neon indicator lamp in the front panel, from which it can be released by the terminal screw; from the harmonic generator can to the anode of the second valve. There are no leads from the oscillator.

81. On the right-hand face of each of the three cans there are holes through which the trimmer condensers can be adjusted by means of the special tools provided.

82. The coil cans are removed in the following manner:—

(i) Unfasten hook on valve retaining flap.

(ii) Unscrew two countersunk screws on top of coil cans.

(iii) Unscrew single countersunk screw in lug at base of coil can on right-hand side.

(iv) Remove lid of amplifier coil can.

(v) Slide coil screen up over coil, feeding projecting leads back through the holes.

83. The setting of the tapping rollers on the coils must on no account be disturbed.

84. The valves are removed by unhooking the spring-loaded hook from the valve retaining flap on the side of the can, when the valve can be withdrawn. This retaining flap is adjustable in the event of an oversize valve being supplied.

85. To remove the thermal control relay, it is necessary to locate the relay in the oscillator coil mounted on its panel on one of the corner supporting pillars. The screws holding the panel must be removed and the panel withdrawn gently to the limit of the connecting wires. The glass tube containing the relay is slipped out of the spring clip and its connections unsoldered from the tags on the panel.

86. It is important not to displace the roller contact from the preselected position on the coil. Cleaning, therefore, must be done with carbon tetrachloride applied with a camel-hair brush.

87. The neon indicator lamp is removed by unscrewing the knurled moulded lamp cover and releasing the lamp by pushing in and giving a half-turn.

Receiver adjustment

88. Maintenance to the receiver will include replacement of valves, and the thermal control relay mounted in the H.F. oscillator coil, and cleaning of the contacts.

89. The VR.91 valves are held in their holders by a spring steel clip and it is essential that both prongs on the clip be depressed simultaneously. A special tool is provided for this operation. Valve V_2 is released by depressing the top cap of the valve screen against a spring contained in the cap and then rotating the latter until the arms on the side of the cap clear the straps mounted on the adjacent coil cans. V_5 and V_7 are removed by first removing the grid clip connection and then unscrewing the upper portion of the valve can.

90. To remove the front panel and mask assembly and obtain access to the scale mechanism, the following parts have to be dissembled in the sequence given:—

(i) H.F. tuning knob,

(ii) oscillator tuning knob,

(iii) vernier scale pointer disc,

(iv) aerial lead from block at rear of front panel,

(v) withdrawing handle securing nuts,

(vi) two 4 B.A. round-headed screws towards top of front panel.

91. Before replacing the front panel fixing screws check that there is a $\frac{1}{32}$ in. gap between the underside of the chassis and the inside of the lip at the bottom of the front mask in order to ensure that the flange of the receiver case will correctly engage the tip of the front panel. Check that the knob fixing screws engage the holes in the spindles and that the vernier disc slot engages pin in oscillator coil spindle.

92. When removing the H.F. oscillator coil to replace the thermal control relay, or clean the contacts, it is important to note that this assembly has been carefully adjusted for temperature regulation and scale calibration and adjustment must be strictly limited to the above. The front panel and mask must first be removed. Next remove the five external connections to the coil which are connected to tags at the rear end. Remove the four fixing screws securing the coil box to the chassis. The box may be opened by removing the five countersunk screws in the lid.

93. To remove the thermostat, unsolder its connections at the adjacent tags, slacken off the four supporting bracket screws in the side of the can and slide the brackets outwards, thus releasing the thermostat from its fixings. The contact carriage should not be further dismantled or the correct contact pressures will be spoilt. A small amount of light non-freeze oil may be placed on the rear shaft and slip ring contacts but not on the moving carriage contact arm guide rails and operating wheels, or noisy operation will result.

94. When replacing the H.F. oscillator coil, reassemble the thermostat, taking care to assemble the felt washers between the ends of the thermostat and the supporting brackets. Then rotate the thermostat so that the flat surfaces of the springs point towards the centre line of the coil former. Slide the supporting brackets inwards to grip lightly the ends of the thermostat and tighten the fixing screws. Reconnect the thermostat and replace lid of box, then replace and fasten the coil on the chassis. The coil screws should be slipped down to the bottom of the slots, i.e. so that the gear wheels are out of mesh, and lightly secured in this position. The external connections are now replaced.

95. In order that the calibrated scale may be set in the correct relation to the sliding contact of the oscillator coil, it is essential that the two gears are correctly meshed in the following manner:—

(i) Rotate the oscillator coil spindle fully counter-clockwise.

(ii) Slack off the coil fixing screws and slide the coil upwards so that the gears mesh together in such a way that the marked tooth on the small gear wheel meshes between the two marked teeth on the large wheel. (This should ensure that in this fully counter-clockwise position of the oscillator coil spindle, the end mark of the outer spiral of the scale lines up with the scale pointer);

(iii) the depth of meshing of the gears should be adjusted so that there is always slight backlash, but his should not exceed 0·020 in. at the tips of the teeth;

(iv) tension the backlash spring by moving the free half of the gear towards the coil, rotating it counter-clockwise by ten teeth and allowing it to come forward again into mesh with the large wheel.

PRECAUTIONS AND MAINTENANCE

96. The aerial tuning and oscillator knobs of the receiver and transmitter units of the T.R.1161 equipment are of a special type. They are so designed that if undue force is used when the coils have reached their stop positions, the knob disengages and will not drive the shaft. This condition occurs when the scroll dials are at the extreme centre position or the extreme outer position as indicated by the pointers. If forced, the knobs will slip suddenly and rotate with a clicking noise but if the direction of rotation is reversed the knob will engage again.

97. To remove these knobs, it is necessary to rotate the knob until a small hole behind the handle is visible. There are two "click" positions only, and in one of these the slot of a grub screw is visible down the hole. If this screw is released the knob can be removed from the shaft but this should only be done if the knob is broken or damaged and fails to drive the dials and coils, or if access to the receiver oscillator coil is required.

Power unit adjustments

98. The parts of the power unit which may need attention are; the carbon brushes and commutators of the rotary transformer, replacement of the neon voltage stabiliser, relay contacts and inspection of the plug-in sockets.

99. The rotary transformer is mounted on a separate plate which is held by two hexagon slotted screws just above the coil of the overload relay and also two countersunk screws on the front panel of the unit. If these screws are removed and the connections to the brushes are released, the transformer can be withdrawn.

100. The brushes are removed by unscrewing the knurled terminal caps. When replacing the brushes it is important that they should be returned to their holders in the same position in every way. The commutators should be cleaned with carbon tetrachloride.

101. The voltage stabiliser can be removed by lifting the retaining ring and, when clear of the glass envelope, swinging it to the left.

102. The relay contacts should be cleaned only by competent personnel as relay adjustment is specialised work.

Periodic inspection

103. Periodic inspection of the T.R.1161 equipment is desirable in order to ensure reliable and consistent operation. Below is given a schedule of periodic inspection and tests which should be carried out.

104. *Daily.*—

(i) Check fully the operation of the transmitter into an artificial load of 10 ohms and 100$\mu\mu$F.

(ii) Check connections to the aerial system and the aerial insulators for security.

(iii) Check telegraph key and headphone connections.

Receiver operation should be checked in the following manner:—

(i) Rotate noise adjuster on the control unit fully clockwise and check that receiver noise can be heard and that this noise varies with variation in position of the control.

(ii) Remove receiver aerial plug from transmitter socket and check that the receiver noise decreases.

(iii) Press telegraph key and check that side-tone note can be heard.

(iv) Set both dials on receiver to 3·3 Mc/s. Then rotate receiver tuning knob on control unit and check that pitch of note heard varies as this control is rotated in either direction.

105. *After 10 hours flying time.*—

(i) Check engagement of all plugs and sockets.

(ii) Remove all units from the tray according to the instructions already given (para. 74) and inspect for loose components, connections, nuts, screws, etc.

(iii) Inspect power supply unit. Clean commutators with carbon tetrachloride and, if pitted, with fine glass paper; emery cloth must not on any account be used. Check that brushes are bedding down properly and that all connections are secure. Remove any dust.

(iv) Ensure that the valves of all units are fully engaged in their sockets and that the retaining clips and anode and grip caps are in position.

(v) Check all shock absorbers for wear.

(vi) Examine aerial wire for frayed strands and bonding of cables.

106. *After 30 hours flying time.*—

(i) Inspect the two socket panels on the power supply unit and ensure that the spring contact is not misplaced.

(ii) Check the grid drive to the power amplifier and also the power output.

107. The grid drive should be greater than 1·6 mA and the aerial current should be 0·7 to 1·1 amp. into an artificial aerial of 10 ohms and 100 $\mu\mu$ F. If these figures are not obtained, check the battery voltage.

Fault location

108. Three charts are given in figs. 12 and 13 for the purpose of fault location. One of these is for the transmitter, another for the receiver and the third for the power supply. They are in the form of geneological trees, the various symptoms of failure being shown at the top; the method of tracing through is to follow the various branches according to the nature of the trouble. These charts cannot take the place of systematic tests with the use of suitable apparatus but they will assist in locating a fault to a particular circuit or component, and should suffice to trace most of the troubles that are likely to develop.

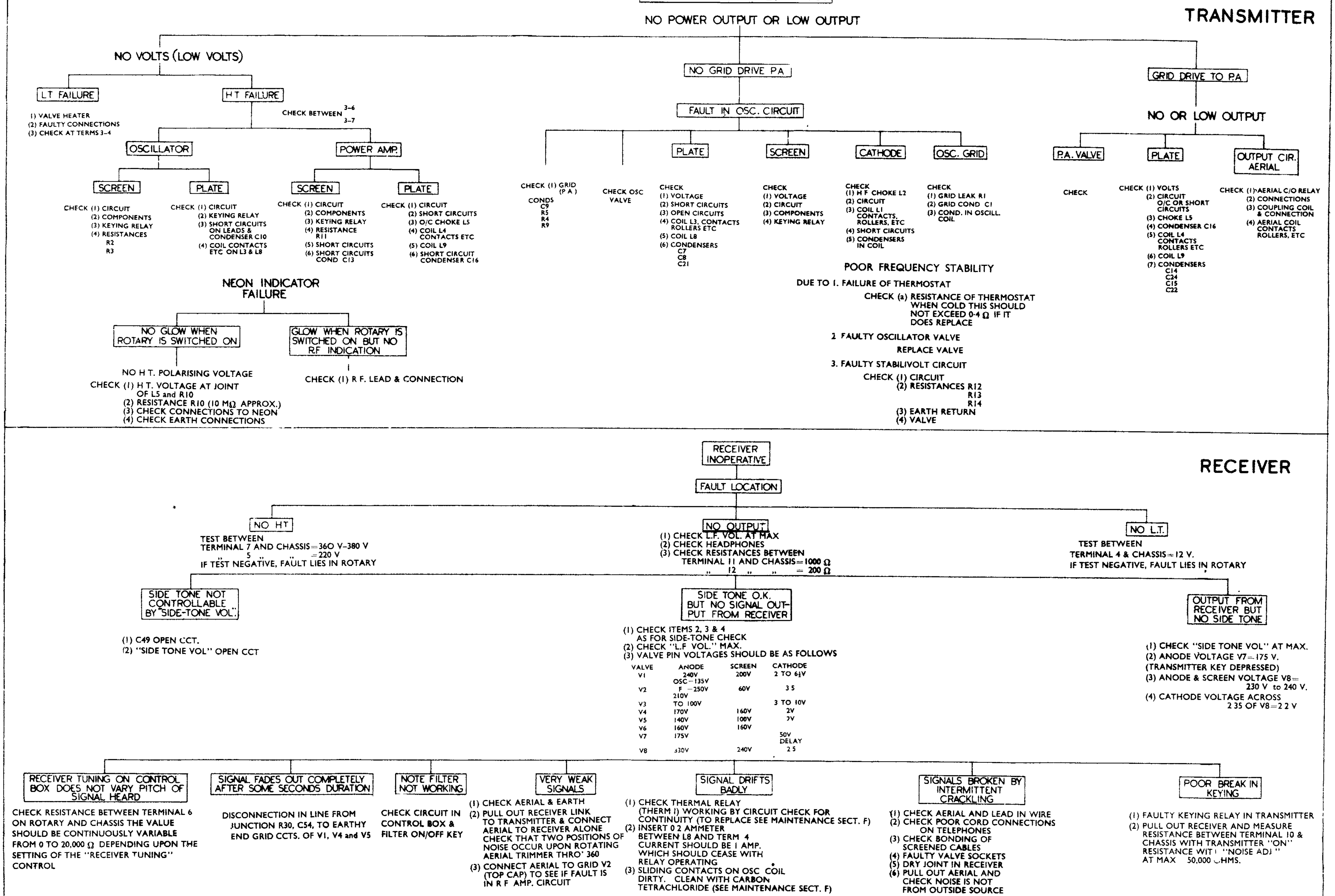

FIG. 12 FAULT LOCATION CHART FIG. 12

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NO OR LOW VOLTAGE OUTPUT

(1) 12 VOLT

CHECK

(1) INPUT VOLTS
(2) INPUT VOLTS AT ROTARY TERMINALS (PRIMARY)
(3) 12 VOLT AT ROTARY TERMINALS
(4) CHOKE L.13
(5) VOLTAGE (12V) AT INPUT OF RELAY "B" & EARTH
(6) VOLTAGE (12V) AT OUTPUT OF RELAY "B" & EARTH
(7) VOLTAGE AT TERMINAL 4 OF BOTH TRANS. & REC. JONES SOCKETS

(2) 350 VOLT. H.T. TRANSMITTER 320 VOLT. H.T. RECEIVER

CHECK

(1) INPUT VOLTS
(2) INPUT VOLTS AT ROTARY TERMINALS (PRI)
(3) VOLTAGE AT 350 VOLT TERMINALS OF ROTARY
(4) CHOKE L. 14
(5) VOLTAGE AT INPUT (350V) OR RELAY "B" & EARTH
(6) VOLTAGE AT OUTPUT (350V) OR RELAY "B" & EARTH
(7) VOLTAGE AT TERMINAL 7 ON TRANSMITTER JONES SOCKET
(8) RESISTANCE R16
(9) VOLTAGE AT TERMINAL 7 ON RECEIVER JONES SOCKET

(3) 270 VOLT STABILISER FOR TRANSMITTER

CHECK

(1) VOLTAGE ON 350V SUPPLY (TERM. 7 ON TRANSMITTER)
(2) VOLTAGE AT INPUT TO STABILOVOLT
(3) RESISTANCES R12, R13, R14 & R15
(4) SHORT CIRCUITS & WIRING

(4) 220 VOLT STABILISER FOR RECEIVER

CHECK

(1) VOLTAGE ON 270V SUPPLY
(2) TERMINAL 4 ON STABILOVOLT
(3) TERMINAL 5 ON RECEIVER
(4) RESISTANCE R12, R13, R14 & R15

FAILURE TO START

(1) CABLE FAULTS

CHECK

(1) ALL CABLES
(2) PLUGS & SOCKETS SCREWED "HOME"

(2) INPUT CIRCUIT

CHECK

(1) BATTERY VOLTS
(2) BATTERY CABLE
(3) VOLTAGE AT BATTERY PLUG
(4) VOLTAGE BETWEEN OVERLOAD RELAY "B" (HALFTURN) & TERMINAL 2 ON BATTERY PLUG
(5) VOLTAGE ON COIL OF STARTING RELAY "A"
(6) VOLTAGE AT INPUT OF ROTARY
(7) BRUSH CONTACTS
(8) FIELD WINDING CONNECTIONS

(3) CONTROL CIRCUIT

CHECK

(1) VOLTAGE BETWEEN INPUT TERMINAL 2 ON BATTERY PLUG & ENERGISING WINDING ON RELAY "A" (SIDE CONNECTED TO RELAY "B" CONTACT)
(2) CHECK THAT OVERLOAD RELAY CONTACT IS MADE
(3) CHECK CONNECTION OF ENERGISING WINDING OF RELAY "B" IN THE CONTROL CABLE PLUG ON THE ROTARY UNIT

(4) CONTROL UNIT

CHECK

(1) CONTROL UNIT CABLE
(2) "ON" SWITCH (CONTACT SHOULD MAKE WHEN OPERATED)
(3) "OFF" SWITCH (CONTACT SHOULD BE MADE TILL OPERATED)
(4) CHECK CONNECTIONS

FIG. 13 FAULT LOCATION CHART—POWER SUPPLY CIRCUIT

FIG. 13

APPENDIX

NOMENCLATURE OF PARTS

The following list of parts is issued for information only. When ordering spares for this equipment the appropriate section of AIR PUBLICATION 1086 must be used.

Ref. No.	Nomenclature	Qty.		Remarks
10D/256	Transmitter-receiver T.R.1161	1		
	Consisting of:—			
10L/31	Control unit	1		
10K/69	Power unit	1		
10P/1	Receiver	1		
10R/2	Transmitter	1		
	Cables	2		
	Control unit		Ref. in fig. 4	
	Principal components—			
	Choke			
10C/3258	Type 230	1	Ch.1	
	Condenser			
10C/4428	Type 2294	1	C_1	0·15 μ F.
10C/4429	Type 2295	1	C_2	0·015 μ F.
10C/	Lamp			
	Type	1	L_1	12 V. 3 watt
	Resistance			
10C/1592	Type 1592	1	R_1	150,000 ohms, ½ W.
10C/27	Type 544	1	R_2	10,000 ohms, ½ W.
10C/1973	Type 1973	1	R_3	2,000 ohms, pot.
10C/1800	Type 1800	1	R_4	20,000 ohms, pot.
	Switch			
	Type	1	S_1	
	Type	1	S_2	Normally "off"
	Type	1	S_3	Normally "on"
10F/662	Type 525	1	S_4	On-off
	Power unit		Ref. in fig. 5	
	Principal components —			
	Choke			
10C/3009	Type 139	2	L_{11}, L_{12}	
10C/3013	Type 141	1	L_{13}	
10C/2999	Type 140	1	L_{14}	
	Condenser			
10C/3324	Type 1630	4	C_{29}, C_{30}, C_{31}, C_{32}	2 μ F. 50 V. D.C.
10C/3086	Type 1492	1	C_{33}	0·1 μ F. 350 V. wkg.
10C/3324	Type 1630	1	C_{34}	2 μ F. 50 V. D.C.
10C/10391	Type 401	1	C_{35}	0·002 μ F. 2,200 V. test
10C/3091	Type 1497	1	C_{36}	25 μ F. electrolytic 500 V. wkg.
	Relay			
10F/534	Type 230	1	REL. A	Starter
10F/533	Type 299	1	REL. B	Overload
	Resistance			
10C/11093	Type 466	3	R_{12}, R_{13}, R_{14}	1 megohm, ⅓ W.
	Type	1	R_{15}	1,000 ohms (2–2,000 ohms in par.)
10C/2984	Type 111	1	R_{16}	2,000 ohms (2 to 1,000 ohms in series)
	Valve			
10E/11449	Type VS.68	1	St. VI	Stabilovolt
	Receiver		Ref. in fig. 3	
	Principal components			
	Condenser			
10C/3085	Type 1491	1	C_1, C_2	2-gang
10C/3084	Type 1490	1	C_3	3 to 25 $\mu\mu$ F. ceramic
	Type	1	C_4	12 to 42 $\mu\mu$ F. ceramic
10C/3087	Type 1493	8	C_5, C_6, C_7, C_8, C_9, C_{10}, C_{11}, C_{12}	0·1 μ F.

Ref. No.	Nomenclature	Qty.	Ref in fig. 3	Remarks
	Receiver (*contd*)			
	Principal components (*contd*)			
	Condenser (*contd.*)			
10C/3299	Type 1608	1	C_{14}	3·5 to 25 $\mu\mu$ F.
	Type	1	C_{15}	0·00025 μ F.
10C/11485	Type 536	1	C_{16}	50 $\mu\mu$ F.
	Type	2	C_{17a}, C_{17b}	500 $\mu\mu$ F. 440 $\mu\mu$ F.
10C/11485	Type 536	1	C_{20}	50 $\mu\mu$ F. mica
10C/3087	Type 1493	3	C_{21}, C_{22}, C_{23}	0·1 μ F 350 V. wkg.
	Type	1	C_{24}	115 $\mu\mu$ F. ± 1 per cent.
	Type	2	C_{25}, C_{26}	12–42 $\mu\mu$ F.
	Type	1	C_{27}	115 $\mu\mu$ F
	Type	1	C_{28}	0·0005 μ F.
10C/3087	Type 1493	3	C_{29}, C_{30}, C_{31}	0·1 μ F.
	Type	1	C_{32}	115 $\mu\mu$ F.
	Type	2	C_{33}, C_{34}	12 to 42 $\mu\mu$ F.
	Type	1	C_{35}	115 $\mu\mu$ F. ± 1 per cent.
10C/3087	Type 1493	3	C_{36}, C_{37}, C_{38}	0·1 μ F.
	Type	1	C_{39}	115 $\mu\mu$ F. ± 1 per cent.
	Type	2	C_{40}, C_{41}	12 to 42 $\mu\mu$ F.
10C/11485	Type 536	1	C_{43}	50 $\mu\mu$ F.
10C/3927	Type 1996	1	C_{44}	20 $\mu\mu$ F.
10C/3087	Type 1493	1	C_{45}	0·1 μ F
10C/8388	Type 178	1	C_{46}	0·0002 μ F
10C/7902	Type 121	1	C_{47}	0·0001 μ F.
10C/3087	Type 1493	1	C_{48}	0·1 μ F
10C/3317	Type 1623	1	C_{49}	8 μ F.
10C/3087	Type 1493	1	C_{50}	0·1 μ F.
10C/4428	Type 2294	1	C_{51}	0·15 μ F. ± 1 per cent
10C/3316	Type 1622	1	C_{52}	0·05 μ F.
10C/7901	Type 120	1	C_{53}	0·001 μ F.
10C/3087	Type 1493	1	C_{54}	0·1 μ F.
10C/3318	Type 1624	1	C_{55}	25 μ F. electrolytic 12 V.
10C/3087	Type 1493	2	C_{56}, C_{57}	0·1 μ F.
	Type	1	C_{60}	320 $\mu\mu$ F. ± 2 per cent.
	Type	1	C_{61a}	100 $\mu\mu$ F. ± 2 per cent.
	Type	1	C_{61b}	80 $\mu\mu$ F. ± 2 per cent.
	Type	1	C_{61c}	40 $\mu\mu$ F. ± 2 per cent.
	Type	1	C_{61d}	20 $\mu\mu$ F ± 2 per cent.
	Type	1	C_{62a}	100 $\mu\mu$ F. ± 2 per cent.
	Type	1	C_{62b}	80 $\mu\mu$ F. ± 2 per cent.
	Type	1	C_{62c}	40 $\mu\mu$ F. ± 2 per cent.
	Type	1	C_{62d}	20 $\mu\mu$ F. ± 2 per cent.
10C/3087	Type 1493	1	C_{63}	0·1 μ F. 350 V. wkg.
	Type	2	C_{64}, C_{65}	0·02 μ F. 450 V. wkg.
10C/4429	Type 2295	1	C_{66}	0·015 μ F.
	Inductance			
	Type	1	L_1	
	Type	1	L_2	
	Type	1	L_3	
	Type	1	L_4	
	Type	1	L_5	
	Type	1	L_6	
	Type	1	L_7	
	Type	1	L_8	
	Relay			
	Type	1	THERM. 1	Thermostat
	Resistance			
10C/1562	Type 1562	1	R_1	100,000 ohms, ¼ W.
10C/1619	Type 1619	1	R_2	300 ohms, ½ W.
10C/11678	Type 512	1	R_3	1,000 ohms, ½ W.
10C/11683	Type 517	1	R_4	15,000 ohms, ½ W.
10C/7829	Type 7829	1	R_5	50,000 ohms, ½ W.
10C/953	Type 561	1	R_6	100 ohms, ½ W.
10C/6185	Type 6185	1	R_7	50,000 ohms, ¼ W.
10C/1865	Type 1865	1	R_8	500 ohms, ¼ W.
10C/6183	Type 6183	1	R_{10}	5,000 ohms, ¼ W.
10C/1971	Type 1971	1	R_{11}	15,000 ohms ± 5 per cent 7 W.

Ref. No.	Nomenclature	Qty.	Ref. in fig. 3	Remarks
	Receiver (*contd.*)			
	Principal components (*contd*.)			
	Resistance (*contd*.)			
10C/953	Type 561	1	R_{12}	100 ohms, ½ W.
10C/1972	Type 1972	1	R_{13}	25,000 ohms ± 5 per cent 7 W.
10C/7829	Type 7829	1	R_{14}	50,000 ohms, ½ W
10C/1562	Type 1562	1	R_{15}	100,000 ohms, ¼ W.
10C/1865	Type 1865	1	R_{16}	500 ohms, ¼ W.
10C/6185	Type 6185	2	R_{17}, R_{18}	50,000 ohms, ½ W.
10C/1562	Type 1562	1	R_{19}	100,000 ohms, ¼ W.
10C/1865	Type 1865	1	R_{20}	500 ohms, ½ W
10C/6115	Type 6115	1	R_{21}	100,000 ohms, ½ W.
10C/7829	Type 7829	1	R_{22}	50,000 ohms, ½ W.
10C/1756	Type 1756	1	R_{23}	25,000 ohms, ½ W.
10C/1116	Type 1116	1	R_{24}	¼ megohm, ¼ W.
10C/6185	Type 6185	1	R_{25}	50,000 ohms, ¼ W.
		1	R_{26}	220,000 ohms, ¼ W.
10C/1015	Type 1015	1	R_{27}	10,000 ohms, ½ W
10C/10140	Type 368	1	R_{28}	30,000 ohms, ½ W.
10C/7820	Type 7829	1	R_{29}	50,000 ohms.
10C/1756	Type 1756	1	R_{30}	25,000 ohms, ½ W
10C/1116	Type 1116	1	R_{31}	¼ megohm, ¼ W
10C/1734	Type 1734	1	R_{32}	½ megohm pot
10C/6185	Type 6185	1	R_{33}	50,000 ohms, ¼ W
10C/1734	Type 1734	1	R_{34}	½ megohm pot.
10C/1619	Type 1619	1	R_{35}	300 ohms, ¼ W.
10C/1015	Type 1015	1	R_{36}	10,000 ohms, ½ W.
10C/6185	Type 6185	1	R_{37}	50,000 ohms, ¼ W.
	Type	1	R_{38}	150,000 ohms, ¼ W.
	Type	3	R_{39}, R_{40}, R_{41}	4 ohms ± 5 per cent., 5 W.
10C/1619	Type 1619	1	R_{42}	300 ohms ± 10 per cent., ½ W
	Transformer			
	Type	1	T_1	
	Valve			
10E/92	Type V.R.91	1	V_1	
10E/405	Type 6K8G	1	V_2	
10E/92	Type V.R.91	1	V_3	
10E/92	Type V.R.91	1	V_4	
10E/11399	Type V.R.53	1	V_5	
10E/92	Type V.R.91	1	V_6	
10E/11401	Type V.R.55	1	V_7	
10E/92	Type V.R.91	1	V_8	
	Transmitter		Ref. in fig. 2	
	Principal components.—			
	Coil			
	Type	1	L_1	
10C/2054	Type 86	1	L_2	
	Type	1	L_3	Harmonic producer
	Type	1	L_4	Output
	Type	1	L_5	
	Type	1	L_6	
	Type	1	L_7	Aerial loading
	Type	1	L_8	
	Type	1	L_9	
	Condenser			
	Type	1	C_1	200 $\mu\mu$ F
	Type	2	C_2, C_3	3–20 $\mu\mu$ F.
	Type	1	C_4	1,300 $\mu\mu$ F. ± 1 per cent. 1,000 V. D.C. test
10C/3055	Type 1465	2	C_5, C_6	0·01 μ F.
	Type	1	C_7	3–20 $\mu\mu$ F.
	Type	1	C_8	135 $\mu\mu$ F. ± 1 per cent.
	Type	1	C_9	50 $\mu\mu$ F. ceramic cap type
10C/3055	Type 1465	2	C_{10}, C_{13}	0·01 μ F.
10C/2835	Type 1394	2	C_{11}, C_{12}	

Ref. No.	Nomenclature	Qty.	Ref. in fig. 2	Remarks
	Receiver (*contd.*)			
	Principal components (*contd.*)			
	Condenser (*contd*)			
	Type	1	C_{14}	3–20 $\mu\mu$ F.
	Type	1	C_{15}	160 $\mu\mu$ F.
10C/3055	Type 1465	1	C_{16}	0·01 μ F.
	Type	1	C_{19}	1,000 $\mu\mu$ F. $\pm$ 1 per cent 1,000 V. D.C. test
	Type	1	C_{20}	100, 75, 50 and 25 $\mu\mu$ F. +315, 100 100, 75, 50 and 25 $\mu\mu$ F. 250 $\mu\mu$ F.
	Type	2	C_{21}, C_{22}	1,000 $\mu\mu$ F. $\pm$ 5 per cent
	Type	1	C_{23}	100 $\mu\mu$ F. (2)
	Type	1	C_{24}	3–20 $\mu\mu$ F.
	Neon lamp			
10E/484	Type 15	1	N_1	Bayonet cap
	Relay			
	Type	1	T_1	
10F/599	Type 241	1	REL. C	
	Resistance			
10C/1717	Type 1717	1	R_1	20,000 ohms, 5 W.
10C/1718	Type 1718	1	R_2	20,000 ohms, 10 W.
10C/1719	Type 1719	1	R_3	50,000 ohms, 10 W.
10C/1721	Type 1721	1	R_4	15,000 ohms, 5 W.
10C/1111	Type 456	1	R_5	50 ohms, $\frac{1}{3}$ W.
10C/1720	Type 1720	1	R_6	150 ohms, 5 W.
	Type	2	R_7, R_8	9 ohms, 5 W.
10C/1111	Type 456	1	R_9	50 ohms, $\frac{1}{3}$ W.
10C/1618	Type 1618	1	R_{10}	10 megohms, $\frac{1}{4}$ W
10C/6422	Type 6422	1	R_{11}	300 ohms, 5 W.
	Valve			
10E/11441	Type V.T.60	2	V_1, V_2	

SECTION 2, CHAPTER 11

TRANSMITTER-RECEIVER T.R.1304

Contents

List of illustrations

CONCISE DETAILS OF
TRANSMITTER–RECEIVER T.R.1304

PURPOSE OF EQUIPMENT	R.T. communication on any one of four crystal-controlled frequencies
TYPE OF WAVE	
FREQUENCY RANGE	Transmitter: 3–10 Mc/s. Receiver 2–12 Mc/s any 1·9 to 1 band
FREQUENCY STABILITY	Better than 0·004 per cent for L.T. variation of 10 to 14·5 volts and better than ± 180 parts 10^6 between + 30° C. and – 30° C.
CRYSTAL MULT. FACTOR	
PERCENTAGE MODULATION	
MAXIMUM SENSITIVITY	Signal noise ratio greater than 10 db. with 5 μV. modulated 30 per cent at 1,000 c/s into an aerial of 5 ohms 100 μμF. giving an output of 10 μW. into 10,000 ohms.
SELECTIVITY	
OUTPUT IMPEDANCE	
AMPLIFIER CLASS	A–B push-pull
MICROPHONE TYPE	Electro-magnetic
VALVES	Transmitter: Crystal oscillator, type 6F6G. R.F. amplifier, type 58/300B. Receiver: R.F. amplifier, type 6U7G. Frequency changer, type 6K8G. 1st I.F. amplifier, type 6U7G. 2nd I.F. amplifier detector and A.V.C. rectifier, type 6B8G. Amplifier: Pentode, type 6U7G, double triode, type 33A/100A, double triode, type 33A/100A
POWER INPUT	200 watts (max.)
POWER OUTPUT	3 watts
STORES REF. No.	10D/611
APPROXIMATE OVERALL DIMENSIONS	LENGTH 16¾ in. WIDTH 14 in. HEIGHT 9¾ in.
WEIGHT	50 lb. (exclusive of cables)
ASSOCIATED EQUIPMENT	Remote control unit Junction box Cables

TRANSMITTER–RECEIVER T.R.1304

(Stores Ref. 10D/611)

INTRODUCTION

1. The T.R.1304 is a transmitter-receiver designed for use in aircraft. The equipment is a self-contained remote-controlled transmitter and receiver and comprises a single main unit, remote-control unit, junction box and interconnecting cables. These units are shown in the general view, fig. 1, which illustrates the main unit shown in the centre, the junction box on the left and the remote control at the right.

2. The main unit comprises the transmitter, receiver, audio unit, rotary transformer, aerial change-over and a multiple junction box to which all interconnecting cables are connected. The unit is provided with a cover and is mounted on a shock absorber. Interconnecting cables are of the Breeze type, fitted with Breeze plugs and sockets.

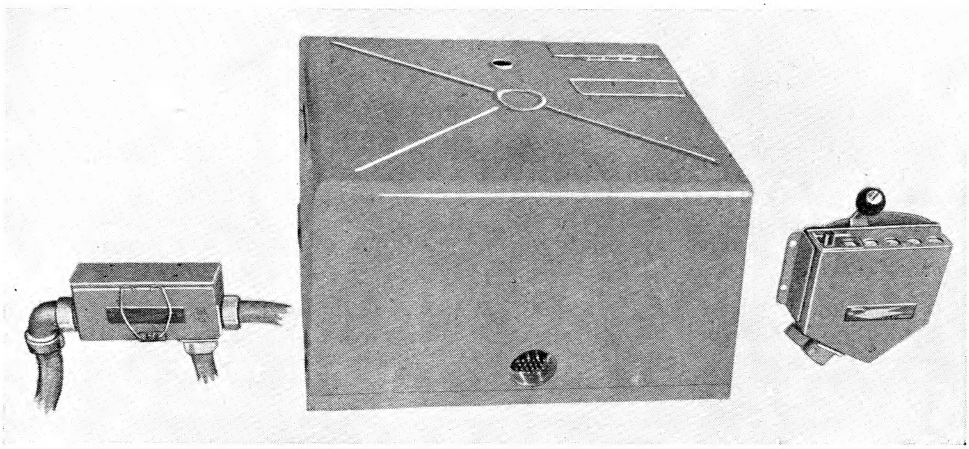


FIG. 1.—TRANSMITTER-RECEIVER T.R.1304

3. The apparatus provides for R/T communication on any one of the crystal controlled frequencies. Those on the transmitter may be located anywhere within the band 3 to 10 Mc/s. The four crystal-controlled frequencies for the receiver cover from 2 to 12 Mc/s., the ratio of the extremes of the band, however, being limited to 1·9 to 1.

4. Frequency selection for both transmitter and receiver is simultaneously controlled by a single lever on the remote control, but this lever may be duplicated in order to provide separate control for each should this be necessary. Signal lights situated in the control box indicate the spot frequency in use and also the position of the send-receive switch.

5. The carrier power available from the transmitter is in excess of three watts (based on a load of 100 $\mu\mu$ F and 5 ohms). The receiver has a sensitivity such that an input of 5 microvolts modulated to a depth of 90 per cent will result in more than 200 milliwatts being delivered to the headphone circuit, the volume level of which is variable by preset adjustment.

6. An audio amplifier is provided which serves for modulation of the transmitter and also provides audio amplification for the receiver. An electro-magnetic microphone is employed in order to secure maximum intelligibility.

7. The equipment is designed to operate from a 12- or 24-volt battery. The dimensions of the main unit are approximately 16¾ in. by 9¾ in. deep and the weight, exclusive of the cables, is 50 lb. Fig. 2 shows the circuit of the complete equipment.

8. In the following description of the equipment the annotational references are from 1 upwards for each unit but in order to simplify identification the figure number to which a reference relates is given where necessary.

GENERAL DESCRIPTION

Transmitter

9. A theoretical circuit diagram of the transmitter is given in fig. 3 and it will be seen that it comprises a two-stage unit consisting of a crystal-controlled master oscillator, V_1 and a R.F. amplifier, V_2. Valve V_1 in the first stage is a pentode valve with the crystal connected between anode and control grid. Coupling between this valve and the R.F. amplifier valve is by means of the choke L_5. The R.F. amplifier valve is also a pentode valve and its anode is connected to the output circuit. As will be seen from the diagram, fig. 3, the output circuit consists of a plug-in coil with two continuously variable taps (of the roller type) connected to the anode and aerial.

10. Four crystals are provided for the master oscillator circuits, one for each of the four spot frequencies, and there are four corresponding aerial output circuit coils; any one pair of crystal and coil can be selected by the ganged switch S_1 operated by the step-by-step mechanism, the switch S_{1e} cutting out the unused coils. In order to check the master oscillator drive to the output, a 2-pin. socket is provided wired across R_6 into which a grid meter may be inserted.

Receiver

11. Reference to the circuit diagram of the receiver, fig. 4, will show that it is a four-valve superheterodyne employing the following valves:—

V_1—R.F. amplifier stage	pentode
V_2—Frequency changer	heptode
V_3—1st I.F. amplifier	pentode
V_4—2nd I.F. amplifier detector and A.V.C. rectifier	double diode pentode

12. The input circuit to the R.F. valve, V_1, consists of a coil L_1 shunted by the trimmer condensers C_3, C_4, C_5 and C_6, any one of which may be selected by the switch S_{2c}. The anode of this valve is coupled through the H.F. transformer L_2 to the mixer, or frequency changer, valve V_2. The first and second grids of V_2 function as grid and anode of a triode and an oscillator circuit is formed by connecting across them any one of the four crystals X_1, X_2, X_3 or X_4, the particular crystal required being selected by the switch S_{2a}.

13. Four trimmer condensers C_{10}, C_{11}, C_{12} and C_{13} are placed between the fourth grid and earth of V_2 and any one of these may be selected by the switch S_{2b}. The switches, S_{2a}, S_{2b}, S_{2c} and S_{2d}, for the selection of any one crystal and any one trimmer condenser from each of the two groups are part of one switch assembly which is driven by the step-by-step mechanism.

14. The resultant I.F. from V_2 is amplified in turn by V_3 and the screen portion of V_4, rectification being carried out by one of the diodes in this valve. The remaining diode functions as an A.V.C rectifier

Audio-frequency amplifier

15. The audio-frequency unit, a theoretical circuit diagram of which is shown in fig. 5, employs three valves. V_1 is a pentode valve, V_2 is a double triode and V_3 also is a double triode. During transmission all three valves are employed, but for reception the first two stages only are used. When the transmitter is in operation the output from the microphone, which is balanced about earth, is fed via a shielded cable into the fully shrouded microphone transformer T_1, the output of which is matched to 250,000 ohms across the grid of V_1, a pentode valve. The anode of the valve is transformer coupled by the transformer T_2 to the control grids of the double-triode V_2 operating in class A–B push-pull. The grid windings of V_2 are loaded with 50,000 ohms each side and the valve draws no grid current. The anode circuit of V_2 is coupled by a transformer, T_3, to another double triode V_3 which is the same type as V_2. The grids of the valve V_3, are loaded with 5,000 ohms each side and are driven into grid current. Valve V_1 derives its grid bias from the cathode resistance R_9, but the cathodes of V_2 and V_3 are connected direct to L.T.+. The third valve V_3, is coupled to the transmitter by the modulation transformer T_4.

16. The first and second stages of the audio-frequency amplifier also function when the receiver is in operation. The output from V_4 (fig. 3) is taken to a separate winding (terminals 3 and 4) on T_1 (fig. 4) the output to the headphone circuit being taken from a special winding on T_3 (terminals 9 and 10).

17. The output of the side-tone circuit can be varied by changing the value of the side-tone attenuator R_{10} (fig. 5). Experience has shown that the present level of 80 mW. (100 per cent tone modulation) is correct when a normal type of helmet is used in the orthodox type of fighter aircraft.

Power supply unit

18. The theoretical circuit diagram of the power supply unit is given in the complete circuit diagram fig. 2.

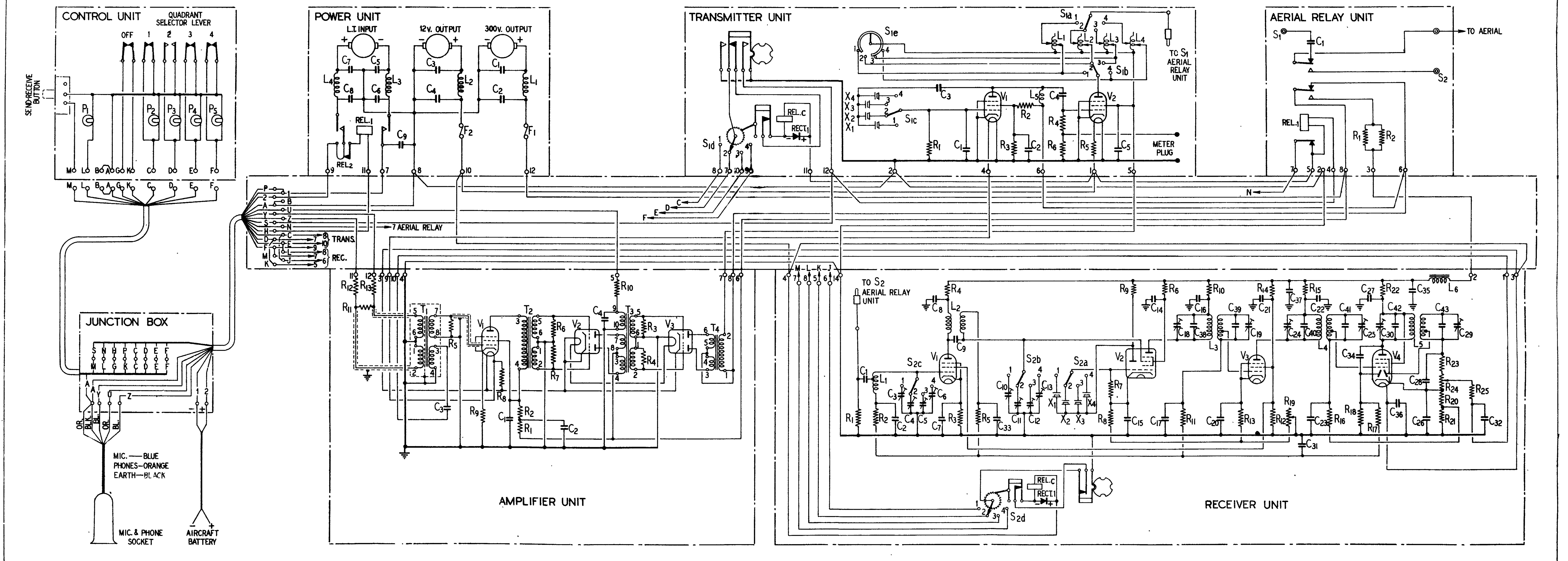


FIG. 2

T.R. 1304, CIRCUIT DIAGRAM

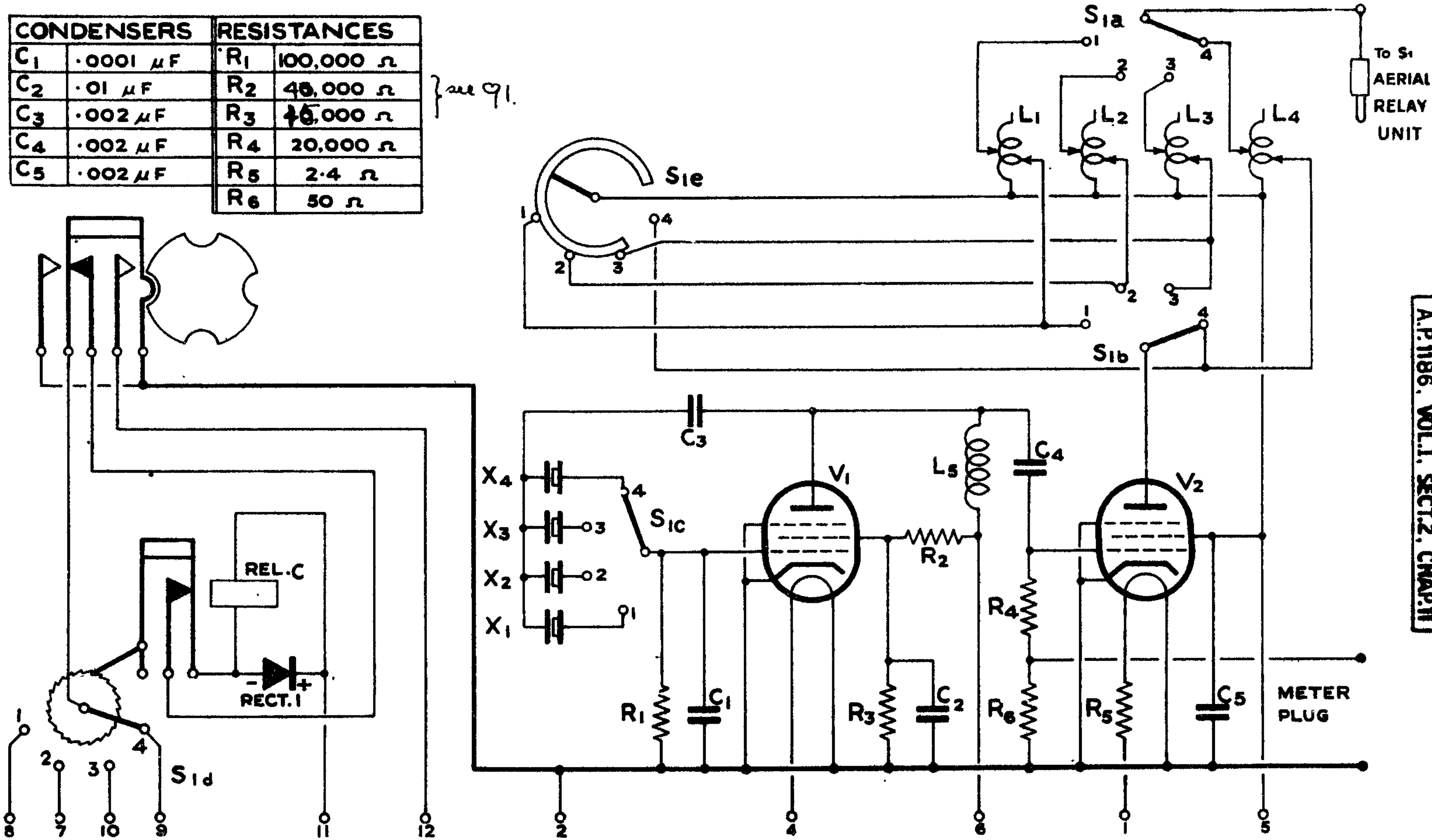
FIG. 2

REPRINT PP2150 M28881/2459 4/43 4250 C & P Gp. 959(4)

FIG. 3

CONDENSERS		RESISTANCES	
C_1	·0001 μF	R_1	100,000 Ω
C_2	·01 μF	R_2	40,000 Ω
C_3	·002 μF	R_3	15,000 Ω
C_4	·002 μF	R_4	20,000 Ω
C_5	·002 μF	R_5	2·4 Ω
		R_6	50 Ω

} see 91.

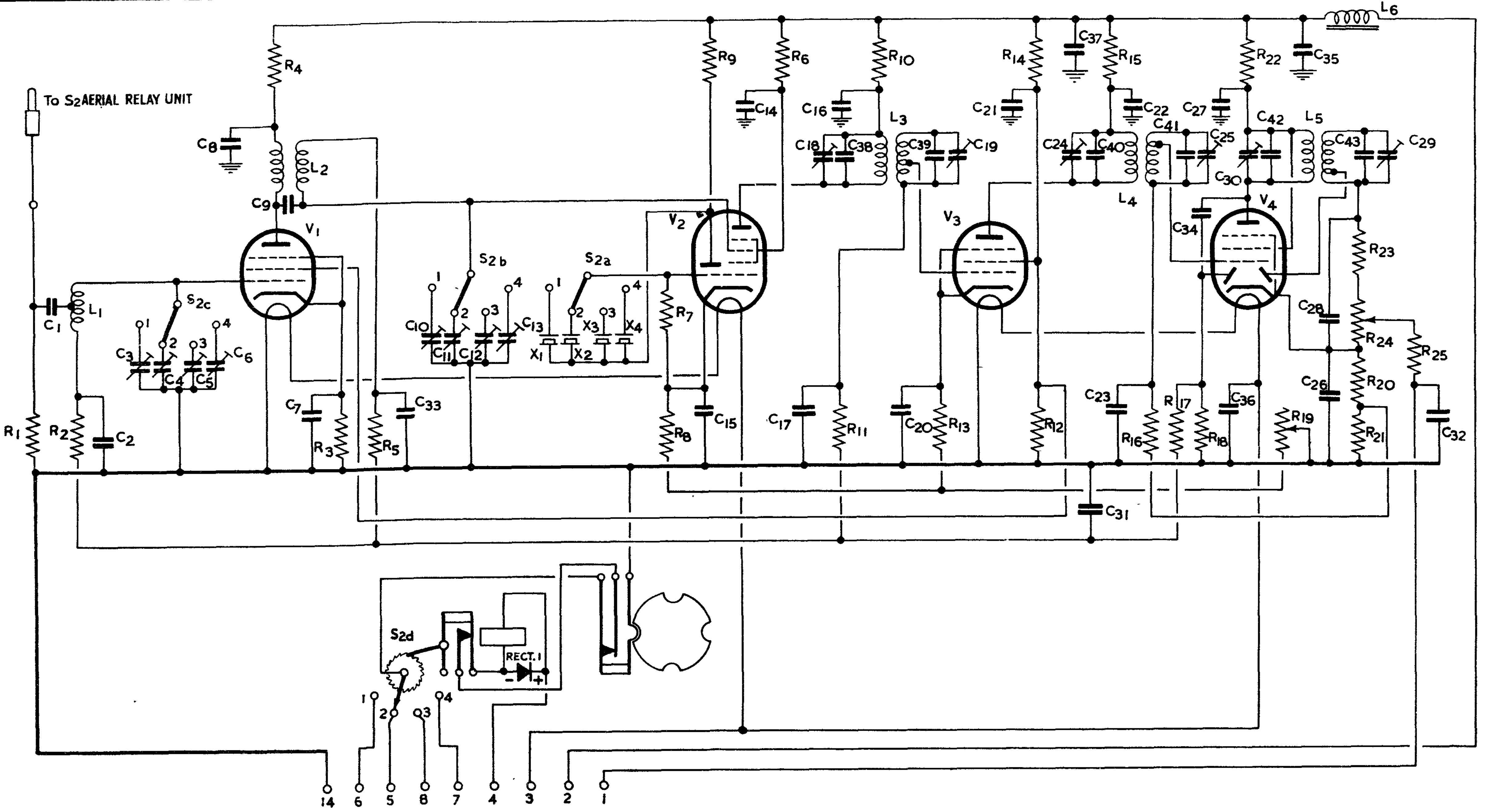


A.P. 1186, VOL. I, SECT. 2, CHAP. 11

TRANSMITTER CIRCUIT DIAGRAM

FIG. 3

C1 C2 C3 C4 C5 C6 C8 C9 C7 C33 C10 C11 — C13 C15 C14 C17 C18 C16 C38 C20 C39 C19 C21 C37 C24 C40 C31 C23 C22 C41 C25 C34 C27 C36 C30 C42 C35 C28 C26 C43 C29 C32	CONDENSERS
R1 R2 R4 R3 R5 R7 R8 R9 R6 R11 R10 R13 R14 R12 R15 R16 — R18 R22 R19 R23 R20 R24 R21 R25	RESISTANCES
L1 S2c V1 L2 S2b S2d X1 — X4 V2 L3 V3 L4 V4 L5 L6	MISCELLANEOUS



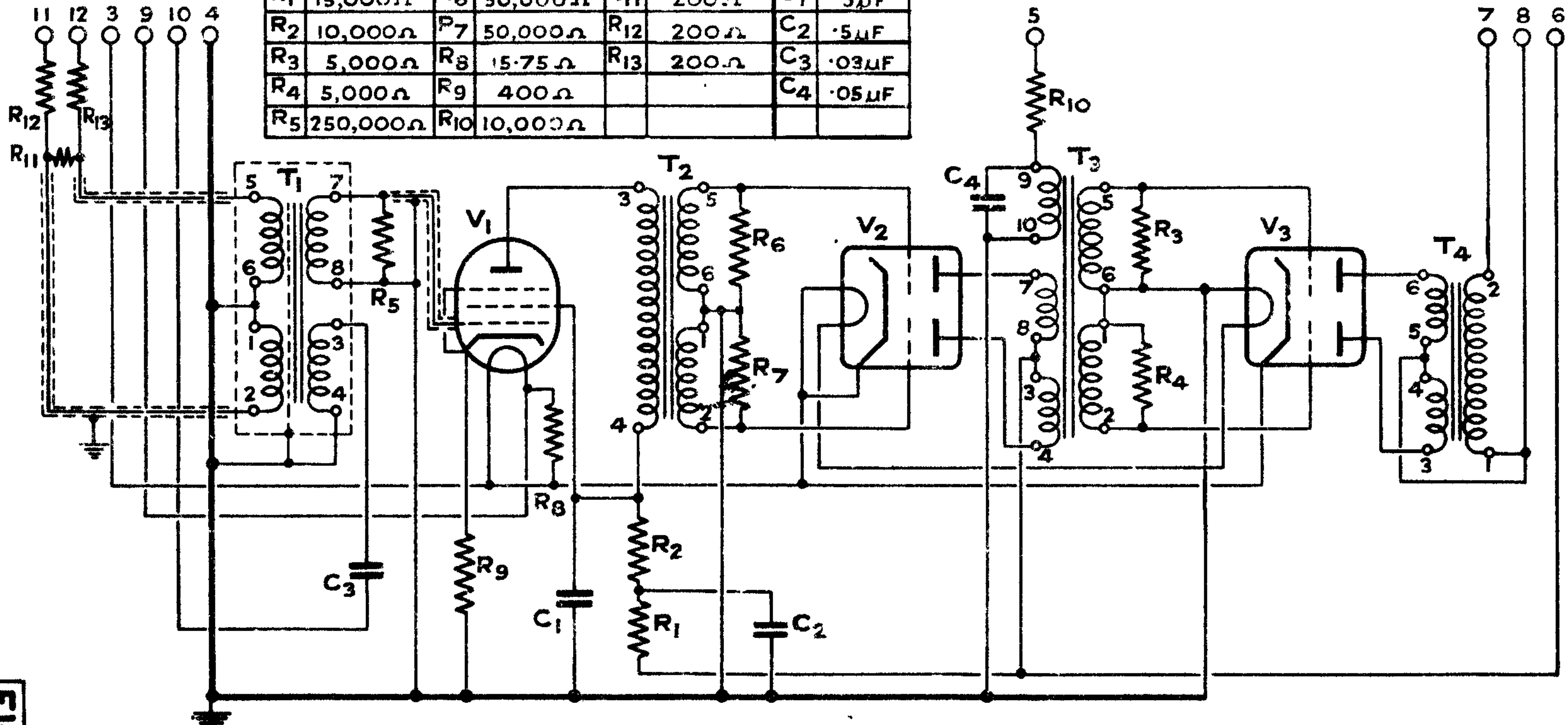
CONDENSERS			
C1	·0001 μF	C20	·1 μF
C2	·1 μF	C21	·1 μF
C3	7-110 μμF	C22	·1 μF
C4	7-110 μμF	C23	·1 μF
C5	7-110 μμF	C24	15-45 μμF
C6	7-110 μμF	C25	15-45 μμF
C7	·1 μF	C26	·1 μF
C8	·1 μF	C27	·1 μF
C9	3 μμF	C28	·0001 μF
C10	7-110 μμF	C29	15-45 μμF
C11	7-110 μμF	C30	15-45 μμF
C12	7-110 μμF	C31	·01 μF
C13	7-110 μμF	C32	·00005 μF
C14	·1 μF	C33	·1 μF
C15	·1 μF	C34	50 μμF
C16	·1 μF	C35	
C17	·1 μF	C36	·1 μF
C18	15-45 μμF	C37	·01 μF
C19	15-45 μμF	C38-C43	100 μμF

RESISTANCES			
R1	2 MΩ	R14	20,000 Ω
R2	500,000 Ω	R15	10,000 Ω
R3	500 Ω	R16	100,000 Ω
R4	10,000 Ω	R17	1 MΩ
R5	100,000 Ω	R18	1 MΩ
R6	50,000 Ω	R19	POT.
R7	25,000 Ω	R20	1,000 Ω
R8	500 Ω	R21	5,000 Ω
R9	50,000 Ω	R22	5,000 Ω
R10	10,000 Ω	R23	250,000 Ω
R11	100,000 Ω	R24	POT.
R12	50,000 Ω	R25	15,000 Ω
R13	500 Ω		

RECEIVER CIRCUIT DIAGRAM

FIG. 4

REPRINT PP2150 M28881/2459 4/43 4250 C & P Gp. 959(4)



R_1	15,000Ω	R_6	50,000Ω	R_{11}	200Ω	C_1	·5μF
R_2	10,000Ω	R_7	50,000Ω	R_{12}	200Ω	C_2	·5μF
R_3	5,000Ω	R_8	15·75Ω	R_{13}	200Ω	C_3	·03μF
R_4	5,000Ω	R_9	400Ω			C_4	·05μF
R_5	250,000Ω	R_{10}	10,000Ω				

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AMPLIFIER CIRCUIT DIAGRAM

FIG. 5

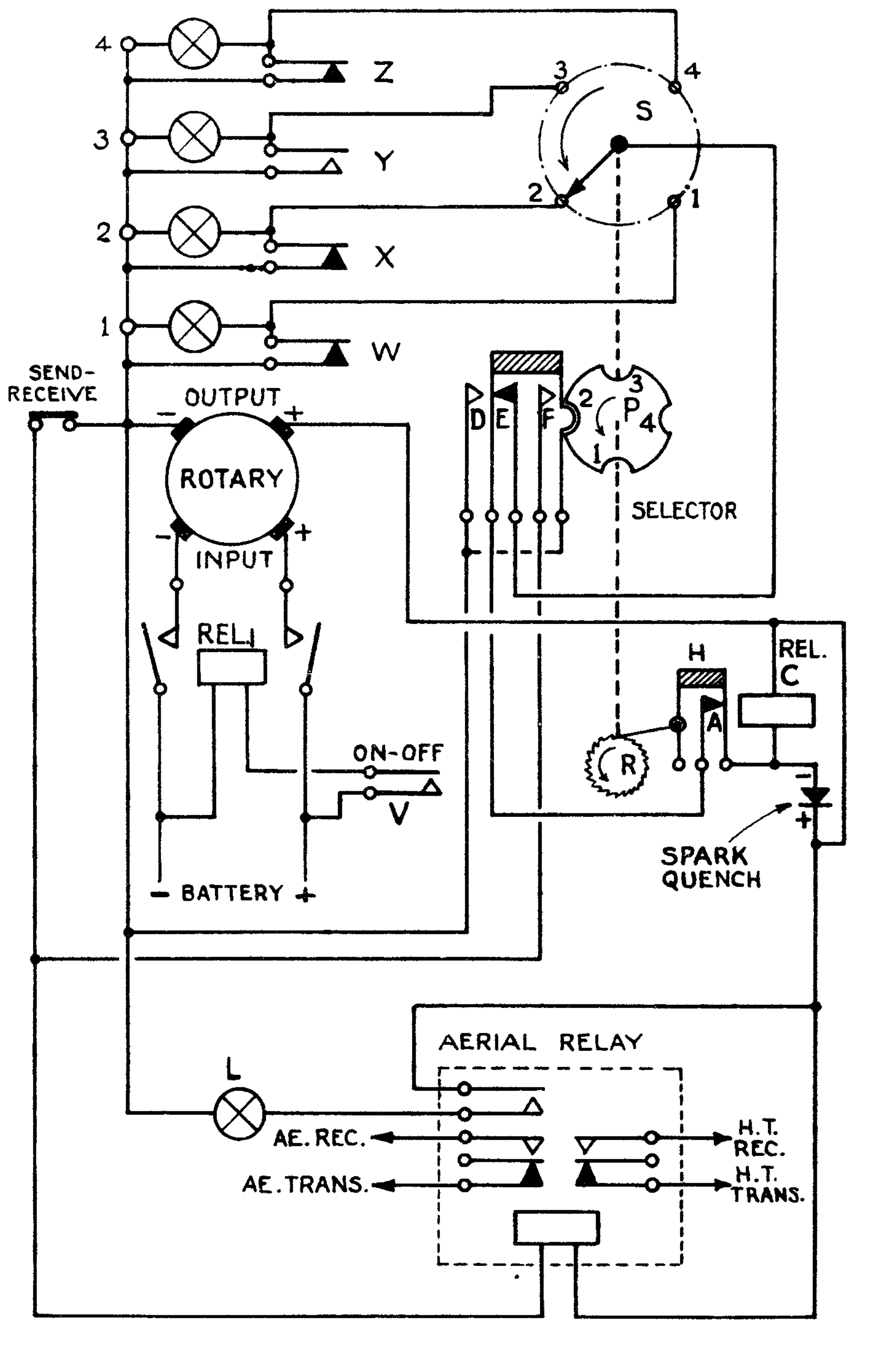

FIG. 6 CONTROL CIRCUITS - SIMPLIFIED DIAGRAM FIG. 6

REPRINT PP2150 M28881/2459 4/43 4250 C & P Gp. 959(4)

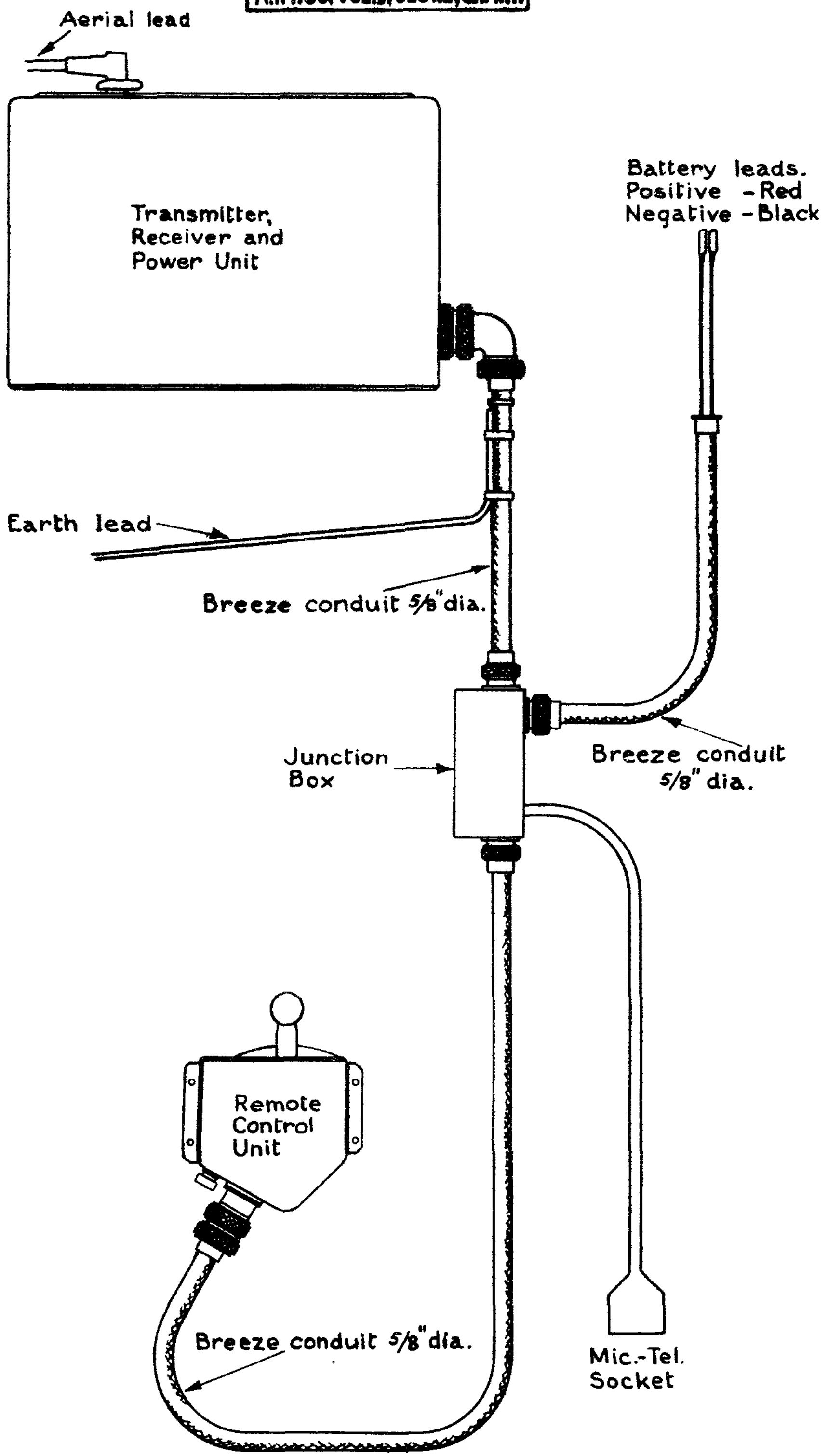

FIG. 7 INSTALLATION DIAGRAM FIG. 7

19. All the power necessary for operating the entire equipment is obtained from this unit which is mounted on the main chassis. The principal component of this unit is a rotary transformer which is driven from the aircraft battery. Change from 12-volt to 24-volt operation or *vice-versa* is made by changing the rotary transformer, and it is only necessary to slide this out from the main unit and replace it with the alternative type.

20. The rotor of the transformer is fitted with three commutators—one for the L.T. input from the aircraft battery, and the other two for outputs of 12 volts and 300 volts respectively. Each circuit includes full R.F. smoothing for all windings and smoothing for L.F. ripple in the output windings. As will be seen from the theoretical circuit diagram, the smoothing arrangements consist of chokes in series with each winding and the input and output leads have condensers shunted across them. Complete screening is effected by enclosing the unit and its associated circuits in a metal case. Cooling is by means of a fan fitted to one end of the rotor. Fuses are provided in both input and output circuits.

21. Overload and starting relays are fitted. One of these REL. 2 is of the thermal type, designed to protect the machine against a sudden heavy overload or a prolonged small overload. The starter relay (REL. 1) is of the magnetic type and operates contacts in both input leads.

Remote control system

22. A simplified circuit diagram of the remote-control system is given in fig. 6. In both transmitter and receiver there are similar control mechanisms which operate in parallel when a single-lever control on the control unit is used.

23. The operation of the system can be most easily understood by taking a specific example and for this purpose it will be assumed that it is required to set the equipment in operation in position 3 of the control. This position on the actual control lever will be apparent from the photograph shown later (fig. 15). The lever is first moved to this position and this movement performs two functions.

(i) When moved from the OFF position, the pair of contacts V shown in the simplified diagram (fig. 6) are closed.

(ii) As the lever passes through each position, it momentarily opens a contact associated with the position (W, X, Y or Z), finally keeping open, in the instance being considered, the contact for position 3(Y).

24. The closing of contact V applies voltage from the aircraft battery to the coil of the relay (REL. 1), the contacts of which close and apply volts to the input of the rotary transformer.

25. As the rotary transformer comes up to speed, it builds up L.T. output volts which are applied to the operating coil C of the selector mechanism, through the circuit from "Rotary+", "Coil C", "Contact A", "Contact E", "Selector arm S" (which may be in any position, but is assumed for the purpose of this explanation not to be in position 3) and "Contact X" in the control unit, back to "Rotary−."

26. The coil C is energised and operates the arm H; when this has moved, contact A is broken, thus releasing the arm H which, being spring loaded, returns to its normal position, at the same time moving the ratchet wheel R one tooth. Ratchet wheel R, cam P and selector switch S are all on the same shaft and therefore move in unison.

27. The movement of cam P breaks contact E and makes D, with the result that the circuit to coil C is now through contact D and not through the selector arm and control unit.

28. Arm H continues to advance the ratchet wheel R a tooth at a time until the cam P arrives at the next notch, when contact D is again broken and contact E made, transferring the circuit to coil C back through the selector arm and control unit.

29. If the switch arm should be in position 3, which corresponds to the position selected by the arm of the control unit, the negative path is through a lamp, because the contacts which normally short circuit it are open. The resistance of the lamp is high in comparison with that of the coil C and therefore the major part of the voltage is developed across it, with the result that coil C is not energised to a sufficient extent to operate H, and R ceases to rotate.

30. If, however, the switch arm had not been in position 3, the negative path would have been directly through the control unit and the next impulse would have moved the cam P out of the notch and the sequence would have been repeated until such time as it fell into the correct notch. The selector switch S is therefore automatically rotated until it takes up the correct position as set up on the control unit.

Send-receive change-over

31. Change-over from SEND to RECEIVE or *vice versa* is effected by a push-button on the control unit which makes the change every time it is pressed and released. The switch which this

button operates is closed in the RECEIVE position and completes a circuit from the rotary transformer output to the operating coil of relay 1 of the aerial relay unit shown in the complete circuit diagram fig. 2.

32. This relay has three sets of contacts which switch:—

(i) The aerial from the receiver to the transmitter.

(ii) H.T. from the receiver to the transmitter.

(iii) Lights lamp L on the control unit when in the SEND position.

33. In the RECEIVE position the relay is energised. To change over to SEND, the switch is broken, the relay de-energised and the aerial and H.T. are transferred from the receiver to the transmitter and the lamp L is lighted.

34. During the process of changing frequency, the aerial and H.T. are automatically put on to the receiver. This precaution is effected as follows:—During the change-over, cam P, fig. 6, is not resting in a "home" position and contact F is therefore closed, thus energising the aerial relay 1 of the aerial relay unit regardless of the position of the SEND-RECEIVE switch.

Aerial relay unit

35. The theoretical circuit diagram of the aerial relay unit is given in fig. 2. It consists of a coil-operated relay, with suitable contacts, which performs the following:—transfers the aerial from receiver to transmitter, transfers the H.T. supply from receiver to transmitter and, removes the H.T. from the final stage of the audio-frequency amplifier. These operations can, of course, be reversed when changing from TRANSMIT to RECEIVE. This unit also contains the breakdown resistances R_1 and R_2 which reduce the H.T. from 300 volts to 200 volts on RECEIVE. A meter adaptor is provided for checking aerial current. An approximate value of 0·9 amp. into a 5 ohms 100 $\mu\mu$ F aerial should be obtained.

CONSTRUCTIONAL DETAILS

General

36. A view of the complete transmitter-receiver with the outer case removed is given in fig. 8. The metal cover (*see* fig. 1) is secured by spring clips at (1) and when this is removed the five units—transmitter, receiver, audio-amplifier, power unit and aerial change-over unit, are accessible.

37. All these units are mounted on the main chassis to which they are secured by locking bars and studs. On the left of the chassis is the receiver unit (2) and attached to this, at the right, is a case containing the selector mechanism. On the right is the audio-frequency amplifier (3). Behind these units from left to right are the aerial relay unit, the transmitter (4) and the rotary transformer unit (5), the last named having a detachable cover, secured by screws, thus permitting easy access to the interior which in addition to the rotary transformer and its associated equipment also houses the starting relay.

Transmitter

38. A view of the transmitter is given in fig. 9. On the upper part of the chassis are mounted the anode and aerial tuning coils L_1, L_2, L_3 and L_4 and situated below these are the cases (1), containing the crystals. The valve V_1 at the front is the crystal controlled master oscillator and valve V_2, at the rear is the R.F. amplifier. Sockets (2) are provided on the front of the chassis into which a grid meter may be inserted in order to check the master oscillator drive to the output. Devices for adjusting the aerial and anode coils are indicated at (3). A view of the underside of the transmitter is given in fig. 10.

Receiver

39. A general view of the receiver is given in fig. 11. On the front of the receiver chassis holes are provided for access to the aerial (C_3 to C_6) and H.F. (C_{10} to C_{13}) trimming condensers and L.F. and H.F. volume controls. Above these are the four cases (X_1 to X_4) containing the crystals for the four spot frequencies. The valves are at the rear, each being contained in its separate can provided with spring retained covers. From left to right, the valve sequence is H.F. amplifier, (V_1); frequency changer, (V_2); 1st I.F. amplifier, (V_3); 2nd I.F. amplifier, detector and A.V.C., (V_4). In front of the valves are the tuning inductances L_1, L_2, L_3, L_4. At the extreme right is the case (1) containing the selector mechanism. The underside of the receiver is given in fig. 12.

Audio-frequency amplifier

40. An exterior view of the audio-frequency amplifier unit is given in fig. 13. The main components, which include the microphone (T_1) and modulation (T_4) transformers and the three valves, are mounted on the top of the chassis. The valves, two of which are the same type as clearly shown, are the penultimate amplifier (V_1), the modulator (V_2) and the microphone amplifier (V_3). On the left is the plug assembly for connection to the main chassis.

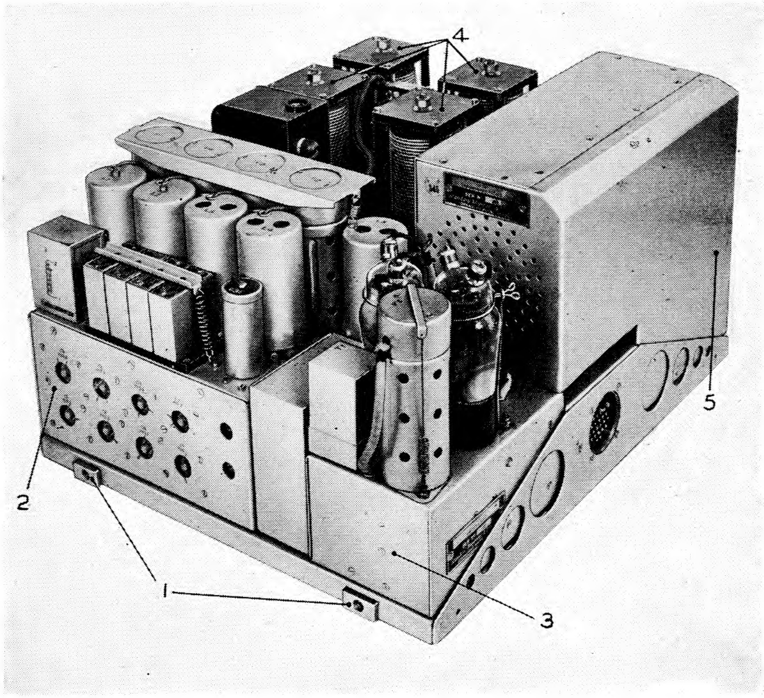

FIG. 8.—VIEW OF MAIN UNIT

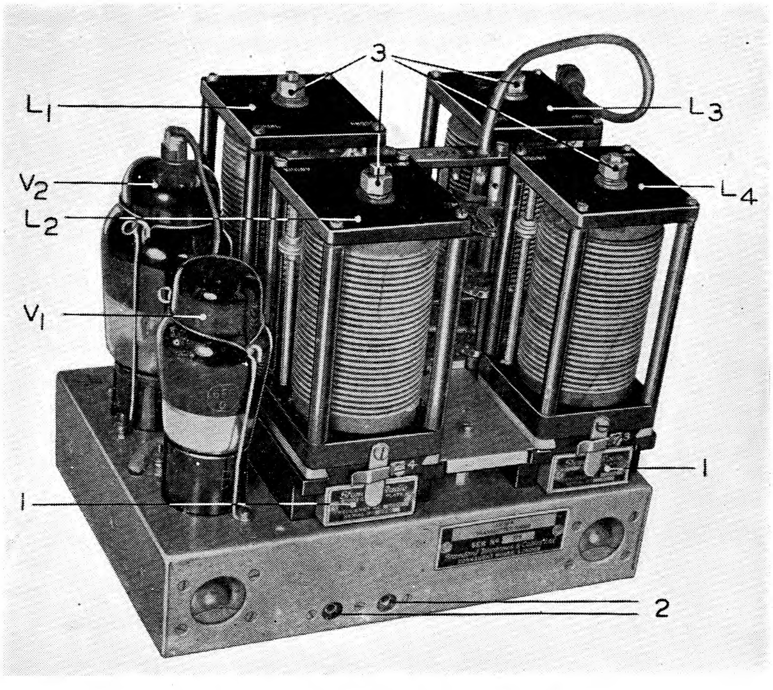

FIG. 9.—VIEW OF TRANSMITTER

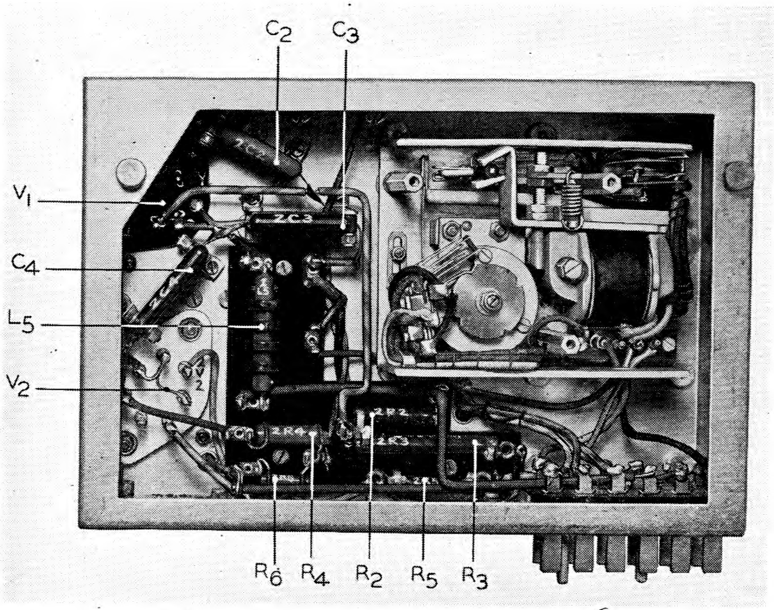

FIG. 10.—VIEW OF UNDERSIDE OF TRANSMITTER

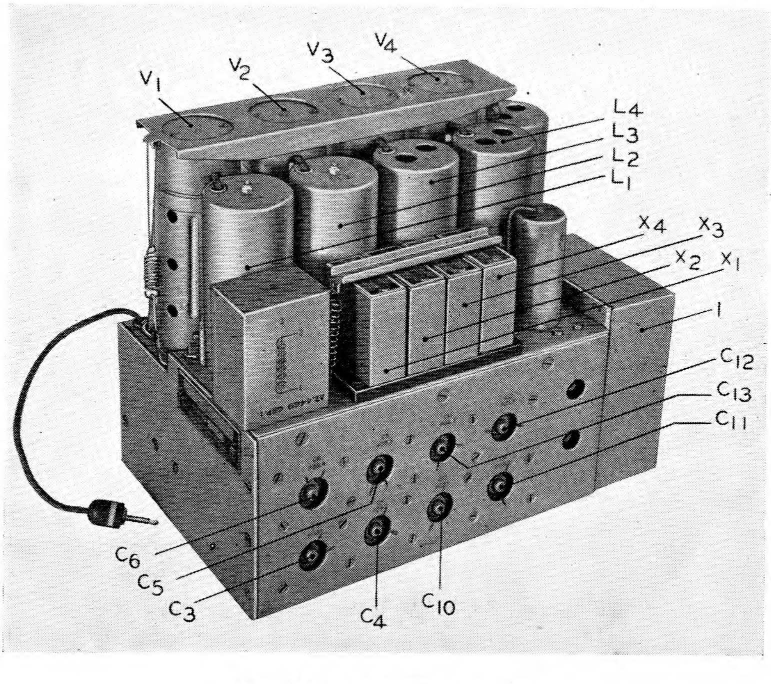

FIG. 11.—VIEW OF RECEIVER

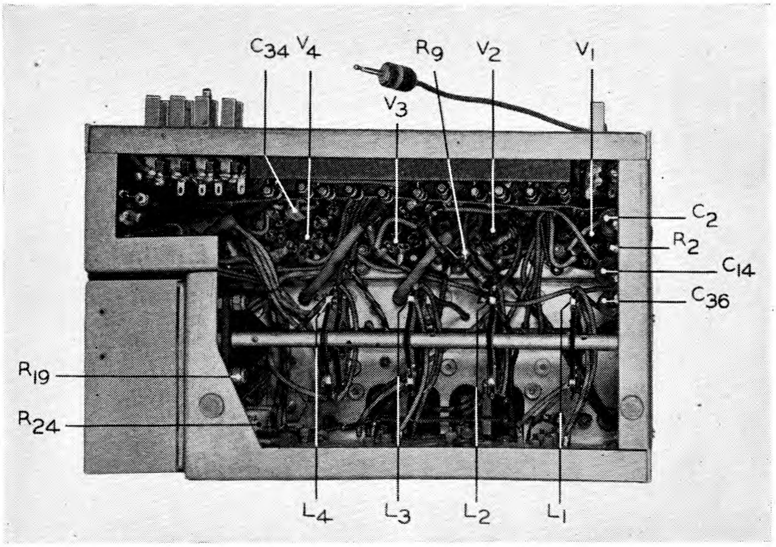

FIG. 12.—VIEW OF UNDERSIDE OF RECEIVER

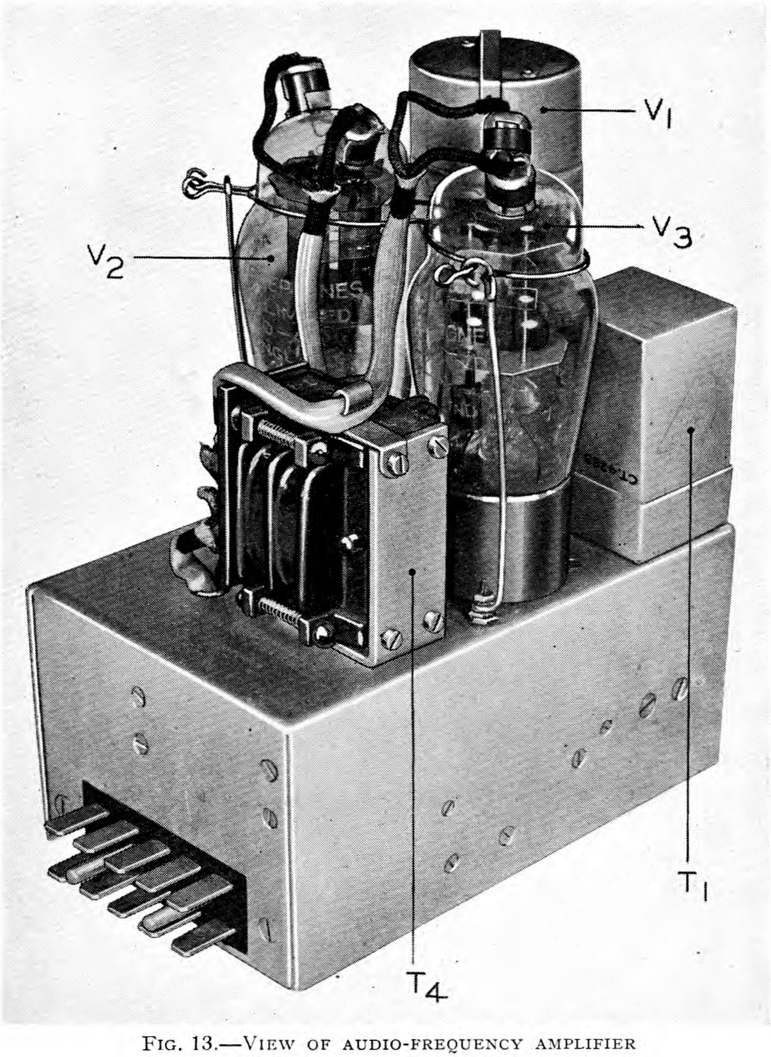

FIG. 13.—VIEW OF AUDIO-FREQUENCY AMPLIFIER

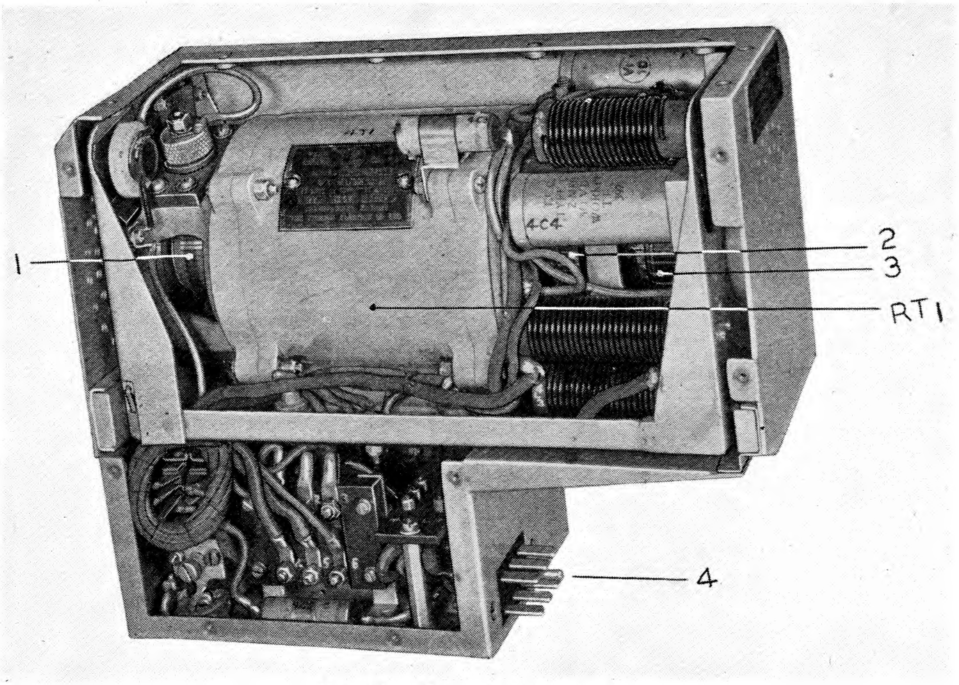

FIG. 14.—VIEW OF POWER UNIT

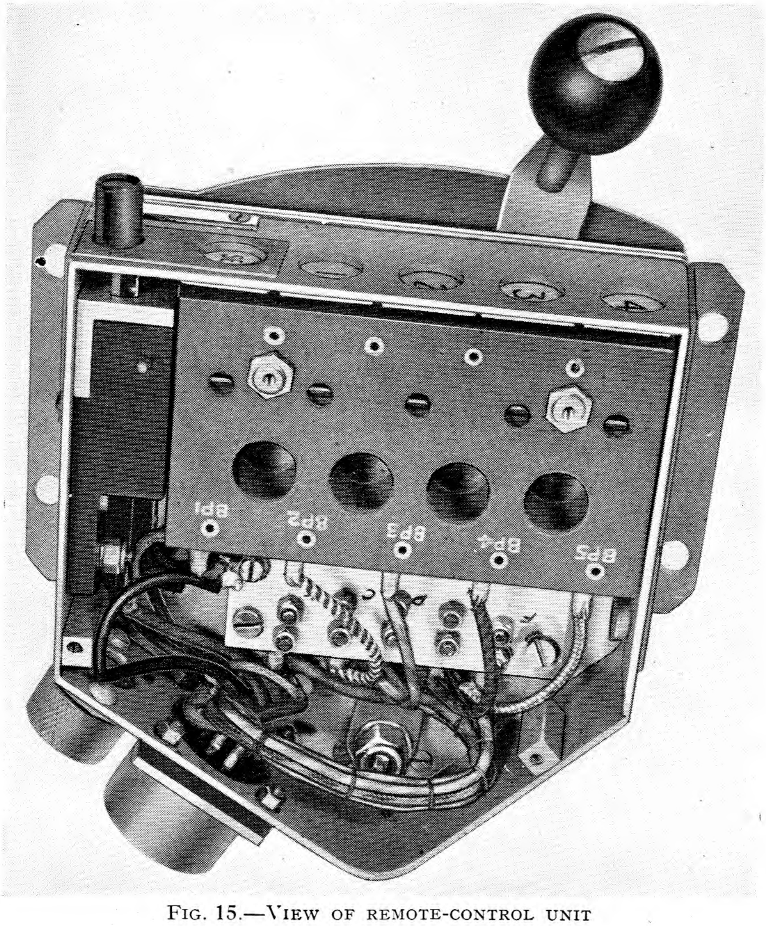

FIG. 15.—VIEW OF REMOTE-CONTROL UNIT

Power supply unit

41. Referring to fig. 14, which is a view of the interior of the power unit and its associated equipment, it will be seen that this is contained in a ventilated metal case with the rotary transformer RT_1 approximately in the centre, the H.F. filter on the extreme left and the L.F. smoothing for ripple at the right. In the compartment below is situated the starting relay. H.T. output is taken from the commutator (1) on the left, L.T. output from the inner commutator (2) on the right and the L.T. input is made at the outer commutator (3). The plugs for connection to the main chassis (4) project from the bottom compartment at the right. Incorporated in the power supply unit is an overload cut-out in the form of a thermal relay.

Remote control unit

42. The remote control switch unit is contained in a metal case which is entirely separate from the main unit to which it is connected by Breeze cable. A view of this is given in fig. 15. By removing four screws from the outer side of the control unit, this may be removed and access obtained to the whole of the interior. Removal of two screws from the external face and two screws from the lower part of the lamp assembly enables this to be withdrawn at the end of its connecting wires. To withdraw the lamps it is necessary to remove the external cover plate from the unit and slide the windows sideways in their slots. The lamps may then be withdrawn lengthwise from their sockets.

Selector mechanisms

43. The selector mechanisms are mounted, one on the transmitter and one on the receiver. They may be inspected in position by removing three small screws in the cases. If it is necessary to remove the complete mechanism, the three hexagon pillars which secure them to the rest of the unit should be removed.

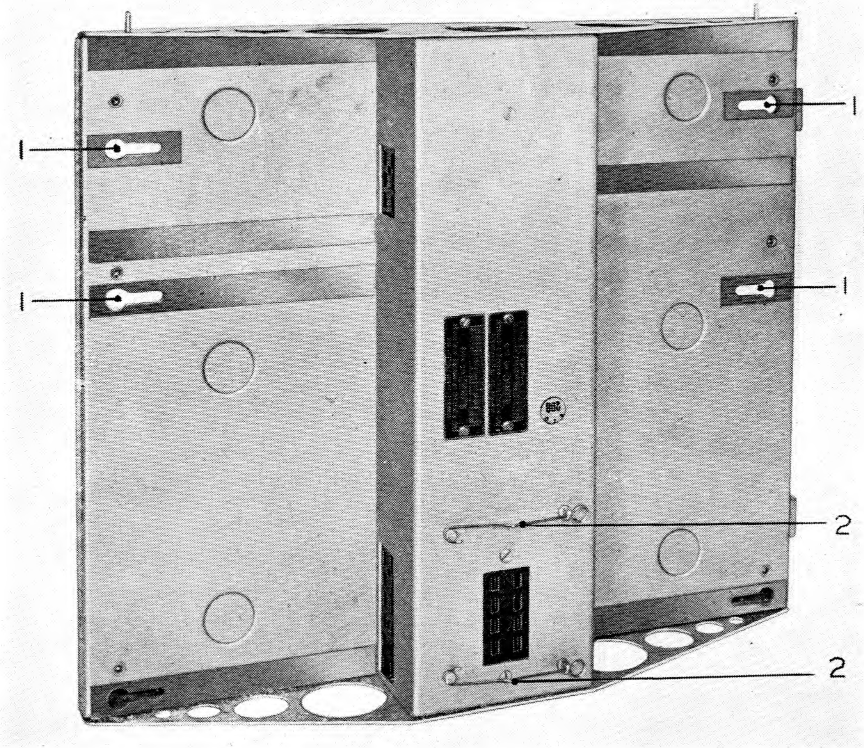

FIG. 16.—VIEW OF UPPER SIDE OF CHASSIS

Main chassis

44. The transmitter, receiver, audio-amplifier, and rotary transformer units are secured in position on the main chassis by locking studs and bars underneath the chassis. These bars can be seen at (1) in fig. 16. The aerial relay unit is retained in position by wire clips (2). The aerial leads from the transmitter and receiver are inserted into two sockets in the side of the aerial relay unit—the transmitter lead in the red socket and the receiver lead in the white socket.

VALVES AND POWER SUPPLY

45. The complete equipment incorporates nine valves, eight crystals and five lamps. The transmitter has two valves—a crystal oscillator type—6F6G pentode valve and a R.F. amplifier type—5B/300B.

46. The receiver employs four valves.—V_1 the R.F. amplifier is a type 6U7G pentode valve; V_2 the frequency changer, is a heptode, type 6K8G; V_3 the first I.F. amplifier is a pentode type 6U7G; and V_4 the second I.F. amplifier, detector and A.V.C. rectifier is a double diode pentode type 6B8G.

47. The audio-frequency amplifier has three valves.—V_1 is a valve type 6U7G, V_2 and V_3 are both double triodes, type 33A/100A.

48. The eight crystals employed—four in the transmitter and four in the receiver—are all of the same type. For transmitting and receiving on the same frequency, the receiver crystal is 470 kc/s. (I.F. frequency) below that of the transmitter crystal.

49. The rated power characteristics of the rotary transformer for the power supply are as follows:—

(i) When connected to a 12-volt supply the 12-volt machine will deliver:—

120 mA. at 300 volts 3 amp. at 12·6 volts	Transmit
50 mA. at 300 volts 3·5 amp. at 12·6 volts	Receive

(ii) When connected to a 24-volt supply the 24-volt machine will deliver:—

120 mA. at 300 volts 3 amp. at 13·1 volts	Transmit
50 mA. at 300 volts 3·5 amp. at 13·1 volts	Receive

50. It should be noted that the H.T. volts in the "Receive" condition are dropped to 200 by means of resistors contained in the aerial relay unit.

OPERATION

General

51. The units should be prepared for use according to the following instructions.

Transmitter

52. Plug in the valves and ensure that the retaining clips are in their correct positions. Insert the crystals in their appropriate sockets. The highest frequency crystal is normally situated in No. 1 socket and the other crystals follow in order of descending frequency. Care should be taken that the corresponding output coil is plugged in above each crystal. If there are different types of output coil included with the equipment, it should be remembered that the higher frequency coils will have fewer turns and greater spacing. It is necessary that the rollers are seated on the coil turns and not between them and that the retaining turn buttons are correctly in position.

Receiver

53. Plug in the valves according to the references marked on the chassis as follows:—V_1, 6U7G; V_2, 6K8G; V_3, 6U7G; V_4, 6B8G. Connect the grids and fit the retaining strip. The crystals should then be inserted in the same relative positions as for the transmitter, i.e., starting with the highest frequency in No. 1 holder. The crystal frequency is the output frequency less the I.F.

Audio-frequency amplifier

54. Plug in the 6U7G valve in the socket marked V_1 and place a screening can over it. Insert the two 33A/100A valves in the other two sockets and secure the anode clips in place. These clip leads are of such lengths that they reach the correct caps, and they should not be strained to fit any other.

Rotary transformer unit

55. Check that the H.T. and L.T. fuses are in their correct positions and that the screening box lid is firmly secured in place.

Main chassis tra

56. Fix the cover plate to the trough beneath the tray and then place the five units—transmitter, receiver, audio-frequency unit, rotary transformer unit and aerial relay unit in their respective positions. The aerial relay unit is retained by wire clips and the other units by locking studs and bars underneath the chassis. Plug the aerial leads from the transmitter and receiver into the two sockets in the side of the aerial relay unit—the receiver lead into the white socket and the transmitter lead into the red socket.

Connecting-up

57. The main chassis should now be placed in the aeroplane and the main cable inserted in the Breeze socket and screwed up. An aerial tuning meter is plugged into the aerial socket on the aerial relay unit and the aerial lead is inserted into the socket on the top of the meter. The earth lead is cut as short as possible and connected to the appropriate terminal on the frame of the aeroplane. For the purpose of preliminary tuning the lid should not be placed on the chassis.

58. Connect the battery cable to the battery. On moving the selector lever on the control unit from the OFF position, the rotary transformer should start up, the valves light, and the step-by-step mechanisms on the transmitter and receiver move round and come to rest in the corresponding positions, whereupon the signal light on the control unit will light up.

TUNING

Transmitter

59. Switch the equipment over to SEND on channel 1. Release the coil locking nut and place both tapping wheels at the top of the coil; rotate counter-clockwise until an indication is obtained on the aerial meter. Adjust the anode tap up or down for maximum output, retuning each time an adjustment is made. The anode tap must be as near the top of the coil as possible, consistent with maximum aerial current. If it is suspected that the crystal oscillator is not functioning, insert the grid current meter, mounted on the special plug provided, into the socket on the side of the transmitter. This will give a direct indication of drive.

60. To check modulation, plug in the headphone unit to the appropriate socket and speak into the microphone on "send" and note if the aerial current increases slightly and whether side tone is heard in the phones.

Receiver

61. Normally, the H.F. circuit of the receiver will have been carefully tuned for the frequencies specified and provided that the crystals have been inserted in the correct sockets, the trimmer condensers C_{10} to C_{13} should not be touched. The aerial circuit trimmer condensers C_3 to C_6 will have been tuned for an aerial capacity of 100 $\mu\mu$ F. in the laboratory and will probably require some slight adjustment. There are several methods of final tuning adjustment dependent upon the equipment available.

62. Should it be necessary to tune the H.F. circuits on noise, the following procedure is necessary to ensure tuning the correct channel. The trimmer, upon inspection, will be found to have a red line and a black line which, on rotation to coincide with a zero line, represent the high frequency or the low frequency end of the band respectively. Beginning with the condenser set on the black line (lower frequency end of the band), rotate slowly until a noise peak is heard. This is the second channel position. Ignore this and continue rotation until the second peak is found. This is the correct position and should be carefully tuned. In the case of a signal close to the lower end of the band, it might be found that only one noise peak can be located, in which case this may be assumed to be correct.

63. For tuning on output, if any type of output meter is available which can be substituted for the headphones, the two circuits may be tuned for maximum reading in the meter. It is not recommended that tuning be done on a basis of maximum speech level in the headphones. All tuning should be carried out with the aerial correctly connected.

64. Finally, in two-seater installations, check that speech in one microphone is heard in the other pair of headphones. Close down the equipment, disconnect the connection to the main chassis, withdraw, replace the lid of the equipment and return to position with the aerial current meter in place. Lift the two flaps in the lid above the transmitter and check the four transmitter output coils for tuning; some slight readjustment may be necessary owing to the presence of the lid. When maximum aerial current has been obtained, lock the coils with the hexagon locking nut, switch off and remove the aerial meter. Then replace the aerial in its normal socket and close the two flaps.

65. The equipment is now ready for operation, provided that all the leads are connected and the headphones plugged into the appropriate socket. Before the battery is connected, the control lever on the control unit should be in the OFF position.

66. To start up the equipment, move the control lever from its OFF position to the channel on which it is desired to transmit and receive. The signal light opposite to this position will light up, indicating that the wave-change switches have reached their correct positions. A short warming up period should be allowed.

67. The small button at the rearmost edge of the control unit changes over the equipment from RECEIVE to SEND or *vice versa*. When the equipment is set for transmitting, the white window marked SEND is illuminated red. Pressing the SEND-RECEIVE button and releasing it again, changes over from one operating condition to the other. It is not necessary to hold the button down for transmission; this is only necessary when a special "Press to talk" button is supplied.

68. If the equipment has been arranged for independent control of receive and transmitter communication channels, a control unit having two knobs of different colours will be fitted. The right-hand knob controls the starting and stopping of the equipment and the transmitter frequency, while the left-hand knob controls the receiver frequency only. The receiver knob is inoperative in its OFF position.

69. The provision of an external SEND-RECEIVE switch, which is wired into the control box, in no way affects the control of the equipment; it is used in place of the button fitted to the control unit.

70. Should the equipment be operated on an excess voltage for too long a period it is automatically protected by the operation of the thermal overload relay. It is still possible to use the equipment when the input voltage is excessive. Should the relay operate during communication, the equipment must be switched off for a period of not less than half a minute.

PRECAUTIONS AND MAINTENANCE

General

71. The transmitter-receiver is carefully aligned before going into service and it is most important, therefore, that the tuned circuits are not interfered with in any way except by competent personnel equipped with adequate apparatus. Repairs, adjustments and tests for faults should only be made when they are obvious and can be carried out with simple tools which are normally available.

72. *To remove units from main tray.*—

(i) Remove the dust cover by undoing the four holding catches.

(ii) Release both locking bars which are situated on the underside of the tray.

(iii) Withdraw the unit about ¾ in., when the locking studs may be disengaged from the tray and the unit lifted out.

73. *To remove valves and coils from transmitter.*—The valves are retained by wire clips which can easily be unlocked. The screws securing these clips should not be removed.

74. The coils are provided with dovetail shaped bases and are held in position by a twin-button catch. When the catch is turned the coils can be slid forward. The catch serves the double purpose of securing the coil and retaining the crystal case in the compartment below.

75. *To remove valves and crystals from receiver.*—The valves in the receiver unit are all held in place by springs inside the valve can caps, which in turn are held in place by a spring-retained channel placed over the tops of the four cans. The crystal holders are secured by a similar device and when this is pulled forward, the crystal cases can be pulled upwards.

76. One side of the chassis is hinged to permit of inspection and servicing and it can be opened by removing the single countersunk screw at each end of the chassis.

77. *To remove valves from amplifier.*—The valves of the amplifier unit are retained by wire clips and anchored cams and can readily be removed by releasing these.

78. *To remove rotary transformer.*—The cover of the rotary transformer unit is removed by taking out the screws round its edge. Disconnection of the five leads from the terminal panel, which connects to the upper part of the unit, will permit the whole upper deck carrying the rotary transformer to be withdrawn. The sub-panel at one end of the rotary transformer, carrying certain of the smoothing components, is hinged, allowing it to be tilted back for complete removal of the machine should this be necessary.

79. *To replace fuses.*—Access to the fuse panel may be had through the hole in the bottom of the complete power supply unit. A 500-mA. fuse is fitted in the H.T. holder and a 10-amp. fuse in the L.T. holder.

Periodic inspection

80. *Daily.*

(i) Check fully the operation of the equipment.

(ii) Check connections of the aerial system.

(iii) Check aerial insulators for security.

(iv) Check engagement of plugs and sockets on all units.

(v) Check microphone and headphone cords for loose connections or damage.

(vi) Check that remote control lever operates correctly.

81. *After every ten hours flying time.*—

(i) Clean the rotary transformer commutators with carbon tetrachloride and ensure that the brushes are bedding down properly and the pigtail connections are secure.

(ii) Clean the wiping contacts in the remote control unit.

(iii) Check that all units are securely locked in place on the main tray.

82. *After every 25 hours flying time.*—

(i) Remove all units from the main chassis and inspect for loose connections, screws, nuts and components.

(ii) Put a few drops of non-freezing oil on the selector relay oiling wicks (transmitter and receiver).

(iii) Check all relay contacts for burning or dirt.

(iv) Examine all earth connections for loose or dry joints.

(v) Examine valves and ensure that pins are a tight fit in sockets.

(vi) Examine all shock absorber mountings.

(vii) Check all currents for which jacks are provided and log.

(viii) Examine aerial wire for frayed or broken strands.

(ix) Clean all plug contacts and check for good electrical connection inside plugs.

(x) Check the bonding of all cables, including screening to engine and spark plugs.

(xi) Clean all cams.

(xii) Check signal-to-noise ratio on the receiver.

(xiii) Check power output and percentage modulation of the transmitter.

Location of faults

83. The following paragraphs indicate the faults which are most likely to develop and the manner of locating them without the use of special apparatus.

84. *No output from transmitter on one frequency.*—

(i) Check that crystal is oscillating by the use of the grid meter. If no reading is obtained, substitute another crystal.

(ii) Examine rollers on coil and if dirty clean with carbon tetrachloride. Ensure that rollers rest on the coil turns and not between.

85. *No output or low output on all transmitter frequencies.*—

(i) Check L.T. and H.T. voltages.

(ii) Examine all battery and rotary transformer connections. Check voltages at valve sockets.

(iii) If no H.T. voltage, check fuse.

(iv) If H.T. voltage present, check by measuring the feed current which should be approximately 120 mA.

(v) Clean all plugs and contacts with carbon tetrachloride and ensure that they are mechanically sound.

(vi) Check valves by substitution.

86. *No output from receiver on one frequency.*—

(i) Check crystal by substitution.

(ii) Examine all switch and plug contacts.

(iii) Check condensers for the inoperative frequency.

87. *No output or low output from receiver on all frequencies.*—

(i) Check fuse.

(ii) Ensure that volume control is not set at minimum.

(iii) Check all voltages at valve sockets.

(iv) Check all valves by substitution.

(v) Examine wiring for loose or dry joints. Wiring or components must not be disturbed in any way whatever, otherwise misalignment and serious loss of performance will result.

88. *Faulty operation of audio-frequency unit when input from microphone circuit or output from receiver is correct.*—

(i) Check valves by substitution.

(ii) Check continuity of transformers.

(iii) Check continuity of screened leads and examine for short circuits between inner conductor and sheathing.

89. *Remote control.*—Clean dirty contacts with carbon tetrachloride. Ensure that all contacts have a good follow when operated by hand. Lubricate moving parts with non-freeze oil. Do not interfere with the adjustment of the step-by-step mechanism and associated relays. Failure of the SEND window to light indicates that either the aerial relay is not operating, or that the lamp or lamp circuit is faulty. The operation of the SEND-RECEIVE switch can be checked by removing the lamp mounting bank from the control unit and verifying that the switch closes in the RECEIVE position.

90. *Rotary transformer unit.*—Failure of the rotary transformer to start may be due to:—

(i) Insufficient battery voltage.

(ii) Dirty commutator or bearings.

(iii) Short circuit in secondary.

In the last case the excessive current taken by the rotary transformer on starting up will operate the thermal relay connected with the primary circuit and the machine will be immediately shut down; it will not start again until the relay has cooled down.

Damage to crystals—over-excitation

91. Trouble has been experienced resulting in damage to crystals due to over-excitation. The screen potential on the oscillator valve should therefore be reduced. This can be done by changing over the two resistances R_2 and R_3 (fig. 3) so that R_2 = 40,000 ohms and R_3 = 15,000 ohms. This will not affect the efficiency of the transmitter.

92. Filter condensers C_4, C_5, C_6, C_7, and C_8 in the power unit (fig. 2) which were 2μF in later models are 1·5μF 50-volt working. **(A.L.52)**

APPENDIX

NOMENCLATURE OF PARTS

The following list of parts is issued for information only. When ordering spares for this equipment the appropriate section of AIR PUBLICATION 1086 must be used.

Ref No	Nomenclature	Qty.	Ref. in fig 2	Remarks
10D/611	Transmitter-receiver T.R 1304			
	Consisting of —			
10F/1029	Aerial relay unit	1		
10U/96	Amplifier	1		
10L/65	Control unit	1		
10A/1388	Junction box	1		
10K/646	Power unit	1		
10P/46	Receiver	1		
10F/13005	Selector unit	1		
10R/62	Transmitter	1		
5E/81	Cables	3		
	Aerial relay unit			
	Principal components —			
	Condenser			
10C/3055	Type 1465	1	C_1	0·01 μF, 2,200 V D C test
	Relay			
10F 13006	Type 347	1	REL 1	
	Resistance			
10C/7178	Type 7178	2	R_1 R_2	5,000 ohms
	Amplifier		Ref. in fig 5	
	Principal components —			
	Condenser			
10C/8007	Type 130	2	C_1, C_2	0·5 μ F, 350 V working
10C/4902	Type 2594	1	C_3	0·03 μ F, paxolin
10C/4119	Type 2118	1	C_4	0·05 μ F, paxolin
	Holder, valve			
10H/1154	Type 132	3		
	Resistance			
10C/1721	Type 1721	1	R_1	15,000 ohms
10C/1736	Type 1736	1	R_2	10,000 ohms
10C/6397	Type 6397	2	R_3, R_4	5,000 ohms, ½ W.
10C/6982	Type 6982	1	R_5	250,000 ohms, ⅓ W.
10C/1301	Type 1301	2	R_6, R_7	50,000 ohms, ⅓ W
10C/7224	Type 7224	1	R_8	15·75 ohms
10C/6994	Type 6994	1	R_9	400 ohms, ⅓ W.
10C/1736	Type 1736	1	R_{10}	10,000 ohms
10C/1175	Type 1175	3	R_{11}, R_{12}, R_{13}	200 ohms, ⅓ W.
	Transformer			
	Type	1	T_1	
	Type	1	T_2	
	Type	1	T_3	
	Type	1	T_4	
	Valves			
10E/627	Type 6U7G	1	V_1	
10E/629	Type 33A/100A	2	V_2, V_3	
	Control unit		Ref. in fig. 2	
	Principal components:—			
	Lamp			
5L 1141	Type P O 2A	5	P_1, P_2, P_3, P_4, P_5	12 V.
	Power unit			
	Principal components —			
	Condenser			
	Type	1	C_1	0·002 μ F, 2,200 V D C. test
10C/4652	Type 2437	1	C_2	1 μ F, 350 V. working
10C/3086	Type 1492	1	C_3	0·1 μ F, paxolin
10C/3324	Type 1630	5	C_4, C_5, C_6, C_7, C_8	2 μ F, 50 V D C working
	Type	1	C_9	1 μ F, paxolin
	Fuse			
10H/238	Type 29	1	F_1	500 mA
10H/13034	Type 88	1	F_2	10 A
	Inductance			
	Type	4	L_1, L_2, L_3, L_4	
	Relay			
10F/534	Type 230	1	REL.1	
10F/1030	Type 15	1	REL 2	Thermal

Ref. No.	Nomenclature	Qty	Ref. in fig. 5	Remarks
	Transmitter receiver T.P.1304 (*contd.*)			
	Power Unit (*contd*)			
	Principal components (*contd.*)			
	Transformer			
10K 650	Type 53	1	T.R.1	Rotary
	Receiver			
	Principal components:—		Ref. in fig. 4	
	Condenser			
10C/10749	Type 459	1	C_1	0·0001 μ F
10C/10165	Type 386	1	C_2	0·1 μ F, paxolin
10C/4705	Type 2476	4	C_3, C_4, C_5, C_6	7–110 $\mu\mu$ F
10C/10165	Type 386	2	C_7, C_8	0·1 μ F, paxolin
	Type	1	C_9	3 $\mu\mu$ F, disc type
10C/4705	Type 2476	4	C_{10}, C_{11}, C_{12}, C_{13}	7–110 $\mu\mu$ F trimmers
10C/10165	Type 386	4	C_{14}, C_{15}, C_{16}, C_{17}	0·1 μ F paxolin
	Type	2	C_{18}, C_{19}	15 $\mu\mu$ F–45 $\mu\mu$ F trimmers
10C/10165	Type 386	4	C_{20}, C_{21}, C_{22}, C_{23}	0·1 μ F paxolin
	Type	2	C_{24}, C_{25}	15 $\mu\mu$ F–45 $\mu\mu$ F trimmers
10C/10165	Type 386	2	C_{26}, C_{27}	0·1 μ F paxolin
10C/10749	Type 459	1	C_{28}	0·0001 μ F
	Type	2	C_{29}, C_{30}	15 $\mu\mu$ F–45 $\mu\mu$ F
10C/9755	Type 332	1	C_{31}	0·01 μ F paxolin
	Type	1	C_{32}	0·00005 μ F
10C/10165	Type 386	1	C_{33}	0·1 μ F paxolin
10C/8386	Type 176	1	C_{34}	50 $\mu\mu$ F ceramic
	Type	1	C_{35}	350 V. working
10C/10165	Type 386	1	C_{36}	0·1 μ F paxolin
10C/9755	Type 332	1	C_{37}	0·01 μ F paxolin
10C/4705	Type 2476	6	C_{38}, C_{39}, C_{40}, C_{41}, C_{42}, C_{43}	100 $\mu\mu$ F silvered mica
	Crystal,			
	Type	4	X_1, X_2, X_3, X_4	Frequency as specified
	Holder, valve			
10H/1154	Type 132	4		
	Inductance			
	Type	2	L_1, L_2	Tuning coil
	Type	1	L_3	Tuning coil
	Type	1	L_4	Tuning coil
	Type	1	L_5	Tuning coil
10C/5007	Type 409	1	L_6	Choke 3·2 H. 40 mA, 360 ohms
	Resistance			
10C/7011	Type 7011	1	R_1	2 megohms, $\frac{1}{3}$ W
10C/7022	Type 7022	1	R_2	500,000 ohms, $\frac{1}{3}$ W.
10C/6118	Type 6118	1	R_3	500 ohms, $\frac{1}{3}$ W.
10C/6343	Type 6243	1	R_4	10,000 ohms, $\frac{1}{3}$ W.
10C/1900	Type 1500	1	R_5	100,000 ohms, $\frac{1}{3}$ W.
10C/6005	Type 6005	1	R_6	50,000 ohms, $\frac{1}{3}$ W.
	Type	1	R_7	25,000 ohms, $\frac{1}{3}$ W.
10C/6118	Type 6118	1	R_8	500 ohms, $\frac{1}{3}$ W.
10C/6005	Type 6005	1	R_9	50,000 ohms, $\frac{1}{3}$ W.
10C/6343	Type 6343	1	R_{10}	10,000 ohms, $\frac{1}{3}$ W.
10C/1900	Type 1500	1	R_{11}	100,000 ohms, $\frac{1}{3}$ W.
10C/6005	Type 6005	1	R_{12}	50,000 ohms, $\frac{1}{3}$ W.
10C/6118	Type 6118	1	R_{13}	500 ohms, $\frac{1}{3}$ W.
10C/1899	Type 1899	1	R_{14}	20,000 ohms, $\frac{1}{3}$ W.
10C/6343	Type 6343	1	R_{15}	10,000 ohms, $\frac{1}{3}$ W.
10C/1900	Type 1500	1	R_{16}	100,000 ohms, $\frac{1}{3}$ W.
10C/1198	Type 1198	2	R_{17}, R_{18}	1 megohm, $\frac{1}{3}$ W.
10C/7455	Type 7455	1	R_{19}	Potentiometer
10C/7202	Type 7202	1	R_{20}	1,000 ohms, $\frac{1}{3}$ W.
10C/7181	Type 7181	1	R_{21}	5,000 ohms, $\frac{1}{3}$ W.
10C/10898	Type 443	1	R_{22}	5,000 ohms, $\frac{1}{2}$ W.
10C/6982	Type 6982	1	R_{23}	250,000 ohms, $\frac{1}{3}$ W.
10C/6998	Type 6998	1	R_{24}	Potentiometer
10C/6985	Type 6985	1	R_{25}	15,000 ohms, $\frac{1}{3}$ W.
	Valves			
10E/622	Type 6U7G	1	V_1	
10E/405	Type 6K8G	1	V_2	
10E/622	Type 6U7G	1	V_3	
10E/406	Type 6B8G	1	V_4	

Ref. No.	Nomenclature	Qty.	Ref in fig. 4	Remarks
	Transmitter receiver T R.1304 (*contd.*)			
	Selector unit		Ref. in fig. 2	
	Principal components:—			
	Rectifier			
	Type	1	W_1	
	Transmitter		Ref. in fig. 3	
	Principal components.—			
	Condenser			
10C/7902	Type 121	1	C_1	0·0001 μF
10C/8496	Type 188	1	C_2	0·01 μF
10C/8010	Type 133	3	C_3, C_4, C_5	0·002 μF 2,200 V. D.C. test
	Crystal, type A	4	X_1, X_2, X_3, X_4	Frequency as specified
	Holder, valve,	2		
10H/353	Type 59	1		
10H/1154	Type 132	1		
	Inductance			
	Type	4	L_1, L_2, L_3, L_4	
10C/2360	Type 104	1	L_5	H.F. choke, 1·25 μH
	Resistance			
10C/1818	Type 924	1	R_1	100,000 ohms, ⅓ W.
10C/7175	Type 7176	1	R_2	15,000 ohms
10C/6425	Type 6425	1	R_3	40,000 ohms
10C/8021	Type 113	1	R_4	20,000 ohms, ½ W.
10C/7177	Type 7177	1	R_5	2·4 ohms
10C/1758	Type 1758	1	R_6	50 ohms, ⅓ W.
	Valve			
10E/346	Type 6F6G	1	V_1	
10E/628	Type 5B300B	1	V_2	

SECTION 3

RECEIVERS

SECTION 3

RECEIVERS

LIST OF CHAPTERS

APPENDIX 3

RECEIVERS, Types R.1155C, D, E, F, L, M, and N

1. The above-mentioned receivers are all variants of the basic R.1155 series. The receivers R.1155C and L have certain circuit modifications which will be promulgated in due course. The remaining receivers, with the exception of R.1155M, differ from the basic type only so far as the casing material is concerned.

2. The following list of receivers, stores reference numbers and basic types from which developed, is supplied for reference:—

Receiver type	*Stores Ref. No.*	*Basic type*	*Comments*
R.1155C	10D/1105	R.1155B	Modified for H.F.D/F. Primarily intended for Coastal Command.
R.1155D	10D/1331	R.1155	Steel case.
R.1155E	10D/1332	R.1155A	Steel case.
R.1155F	10D/1333	R.1155B	Steel case.
R 1155L	10D/1477	R.1155B	75–200 Kc/s range replaced by 1·5–3·3 Mc/s range for A.S.R. launches. Aluminium case.
R.1155M	10D/1597	R.1155A	For use in ground schools only. These are R.1155A receivers which, for certain reasons, have been rejected as unfit for other use
R.1155N	10D/1667	R.1155L	Steel case. With modified extended ranges for A.S.R. launches as in R.1155L.

P4264 M /137 6/44 13000 C & P Gp. 1

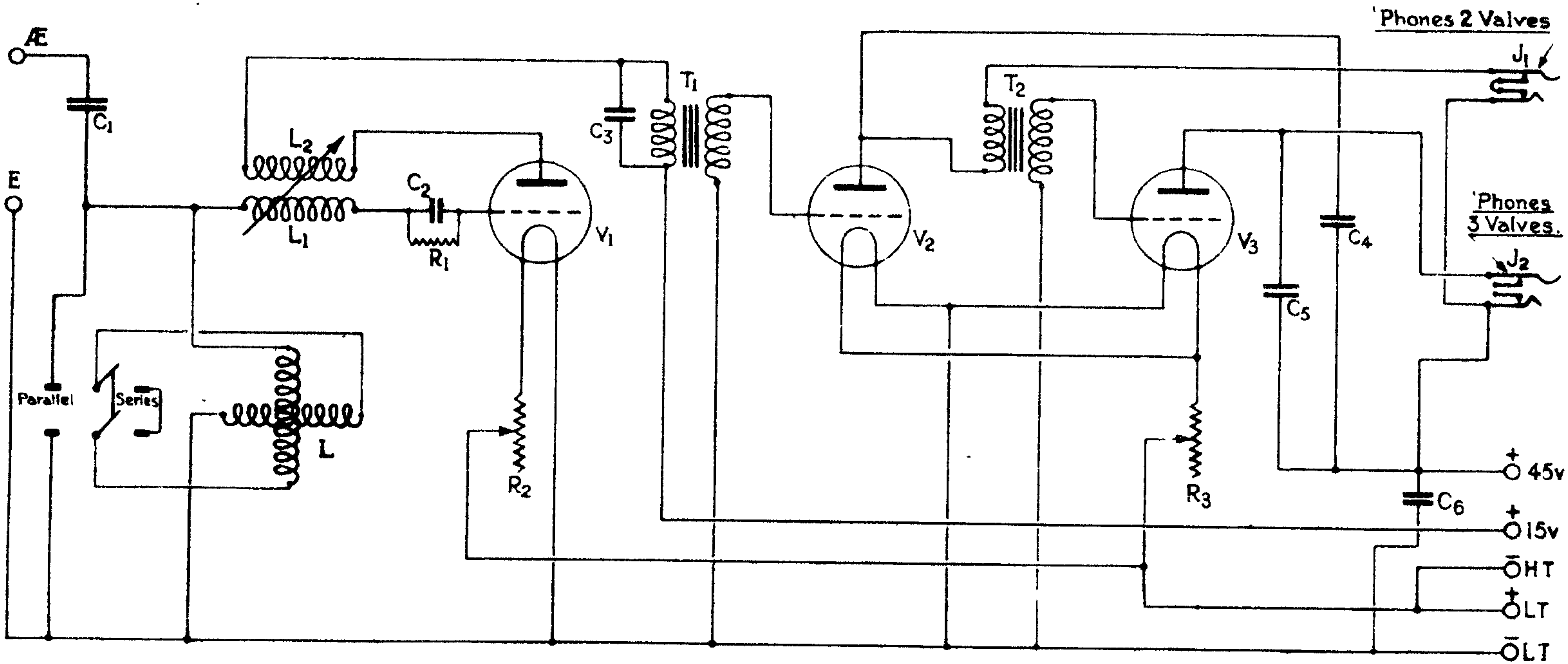

FIG. 1. THEORETICAL DIAGRAM.

SECTION 3, CHAPTER 1

RECEIVER R.54 AND RECEIVER R.54A

Contents

List of Illustrations

RECEIVER R.54

(Stores Ref. 10A/7211)

INTRODUCTION

1. This instrument has been designed to serve as a portable ground receiving station and is intended for the reception of wireless signals transmitted from aircraft engaged in artillery co-operation. The main purpose of the instrument is, therefore, to receive I.C.W. transmissions from the transmitter unit of an army co-operation aircraft. The receiver is, however, also suitable for the reception of R/T and C.W. The range of frequencies covered by the instrument is approximately 1,000 to 500 kc/s (300 to 600 metres).

2. The instrument consists of a three-valve receiver, with an arrangement for cutting out the third valve when not required. It is housed in a case which also contains all the necessary equipment for the complete receiving installation. The complete equipment is known as Receiver R.54. The receiver unit itself is known as Receiver R.55.

3. The equipment includes the following apparatus :—One carrying case for the receiver and installation (Case, carrying, R.54, Stores Ref. 10A/7213), containing the following :—

(i) Receiver R.55 complete (Stores Ref. 10A/7229).
(ii) H.T. battery (three 15-volt units).
(iii) L.T. battery (two 1·5-volt cells or accumulator).
(iv) One pair of telephone receivers complete.
(v) One watch-holder.
(vi) Four valves, type V.R.17 (or suitable valves when accumulator is used).

4. The case complete with the apparatus detailed above is shown in fig. 3. The case itself is described in para. 13.

GENERAL DESCRIPTION

5. The receiver employs three valves of the dull emitter type, the filament current for which is provided by dry cells or alternatively by accumulators. From an examination of the theoretical circuit diagram shown in fig. 1 it will be seen that the tuning of the aerial circuit is carried out by means of a variometer L, the windings of which may be connected in series or parallel by means of a two-position switch. A spring clamp is mounted on the panel, so that the variometer dial can be clamped in any desired position. The aerial condenser C_1 is connected in series with the variometer on the aerial side.

6. The grid coil L_1 is connected between the aerial circuit and the grid condenser C_2, and to this coil is coupled the reaction coil L_2 in the anode circuit of the valve V, the coupling being variable. Grid leak rectification is employed, the grid leak being connected across the grid condenser in the usual way. The H.T. connections are brought out to three flexible leads, terminating in 6 B.A. claw type terminals. Identification sleeves are fitted to these, marked H.T.—, 15V+ and 45V+, respectively. Terminals marked L.T.+ and L.T.— are provided on the panel for the low tension connections. The filament rheostats are connected in the positive lead, and the negative lead is earthed.

7. The detector valve V_1 is transformer-coupled to the first amplifying valve V_2 by means of the transformer T_1, the primary of which is shunted by the condenser C_3. Two rheostats R_2 and R_3 are included in the positive filament leads of the valves, R_2 controls the filament voltage of V_1 whilst R_3 controls the filament voltage of both V_2 and V_3.

8. The valve V_2 is coupled to the output valve by the transformer T_2. Two telephone jacks J_1 and J_2 are provided in order that the telephones may be plugged into either the second or third valve position. The two condensers C_4 and C_5 act as R/F by-pass condensers. C_5 shunts the telephone jack J_2, and C_1 shunts both the telephone jacks and the primary winding of T_2. The R/F by-pass condenser C_6 is connected across H.T.+ and L.T.—.

9. A feature of the receiver is the low H.T. voltage required for efficient working. This is to some extent due to the method of reaction employed and is a considerable advantage in an instrument designed for portability.

10. From fig. 1 it will be observed that the circuit employed is essentially simple and straightforward, with the exception of the arrangement of the reaction coupling. Instead of the reaction being applied to the aerial tuning inductance, an un-tuned grid coil L_1 is used for this purpose. The coils L_1 and L_2 are so disposed that the coupling effect is the reverse of that generally used for reaction. For this reason the effect of loosening the coupling is to increase reaction and of tightening the coupling to suppress it.

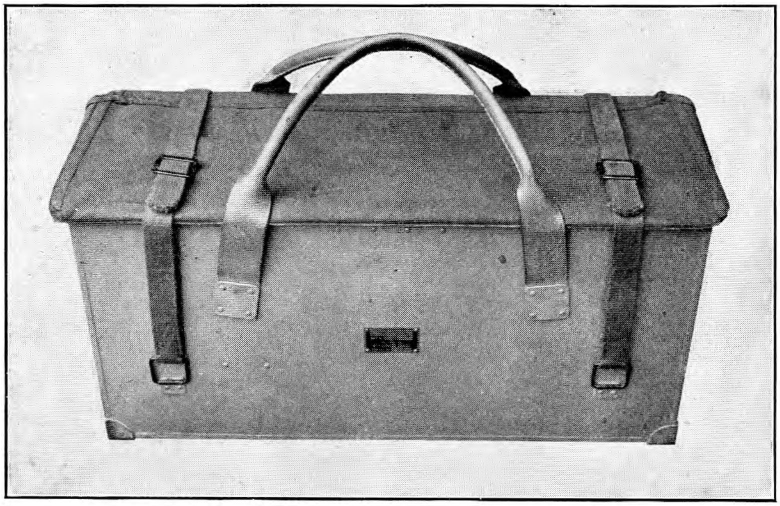

FIG. 2. Carrying case closed for transport.

11. The arrangement of the circuit is such that the valve is normally working in its most sensitive state, namely, in a regenerative but non-oscillatory condition. This condition, together with complete control of reaction, is obtained by the use of the reversed anode coil. The theoretical aspect of the principle employed is capable of more than one explanation, but the main features are as follows :—Suppose that two coils are connected, one in the grid and one in the anode circuit of any valve and that the impedances of the two coils are approximately equal. Now, if a condenser is connected across the two coils, the valve will oscillate, even if the two coils are not inductively coupled. If now the coils are inductively coupled so that the reactive effect assists the primary oscillations, these will be stimulated. On the other hand, if the coupling is reversed the tendency to oscillate is reduced.

12. This latter condition obtains in the circuit of the receiver R.54. The coils L_1 and L_2 have approximately the same impedance and coupling is furnished by the interelectrode capacitance of the valve, etc. From the foregoing it is clear that the circuit is prone to self-oscillation, but that the oscillations are suppressed by virtue of the reverse coupling. The valve is thus just maintained in a non-oscillatory condition when the coupling is adjusted to give optimum signal strength.

CONSTRUCTIONAL DETAILS

13. Various views of the receiver are given in figs. 2, 3, 4, 5 and 6, and a bench wiring diagram in fig. 9. The receiver with the cover folded is illustrated in fig. 2, whilst the waterproof cover is shown raised in fig. 3. The latter is the normal position for the cover when operating. The receiver unit is shown installed in the case (1) in fig. 4. The case is made of metal-covered plywood and is divided into three compartments. The left-hand compartment houses the receiver with its H.T. batteries and spare valve, the two smaller compartments on the right house the dry batteries for the L.T. supply and the canvas bag containing the receiver telephones. The approximate dimensions of the receiver are 22 in. × 11 in. × $8\frac{1}{2}$ in. and the weight including all batteries is $39\frac{1}{2}$lb.

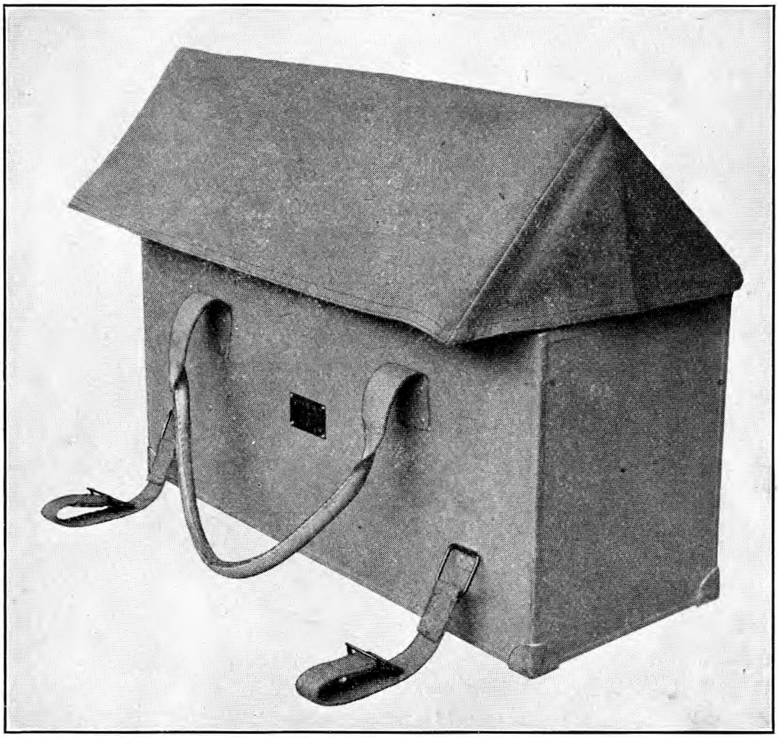

FIG. 3. Carrying case open with flap down.

14. The waterproof cover (2) is folded above the lid of the case, which is held open by the watch-holder (3), hinged to the middle partition. When closed the lid of the case is secured by the webbing straps (4), two leather straps (5) being provided for carrying purposes. The receiver unit may be removed from the case after undoing two screws.

15. Referring to fig. 5 which is a view of the receiver unit withdrawn from the case, mounted on the panel (1) which is made of an insulating material are the following components. The filament rheostat levers (2) and (3) for the detector valve and A/F stages respectively, the telephone jacks (4) and (5), the two securing screws (6) and (7), reaction control (8), earth and aerial terminals (9) and (10) respectively, series-parallel switch (11), and aerial variometer control (12). Beneath the main unit is the container (13) which houses the H.T. battery (14) and spare valve (15).

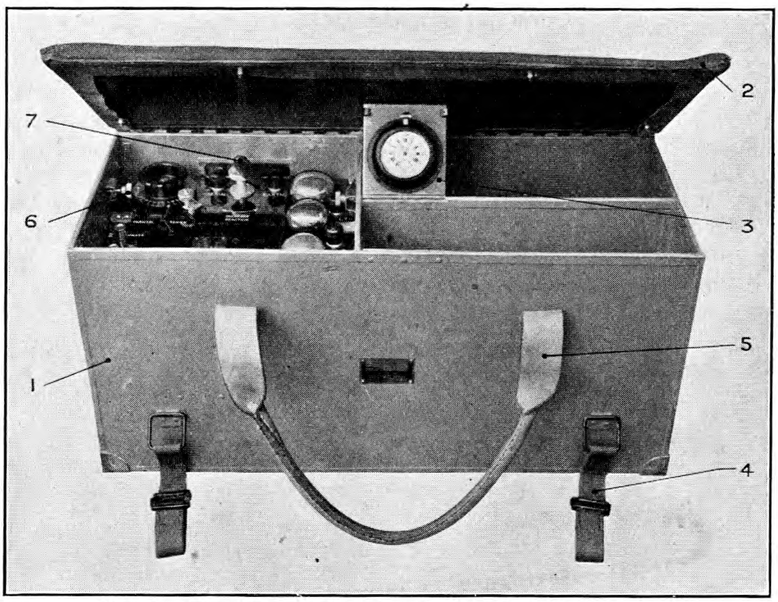

FIG. 4. Receiver complete in carrying case with lid open.

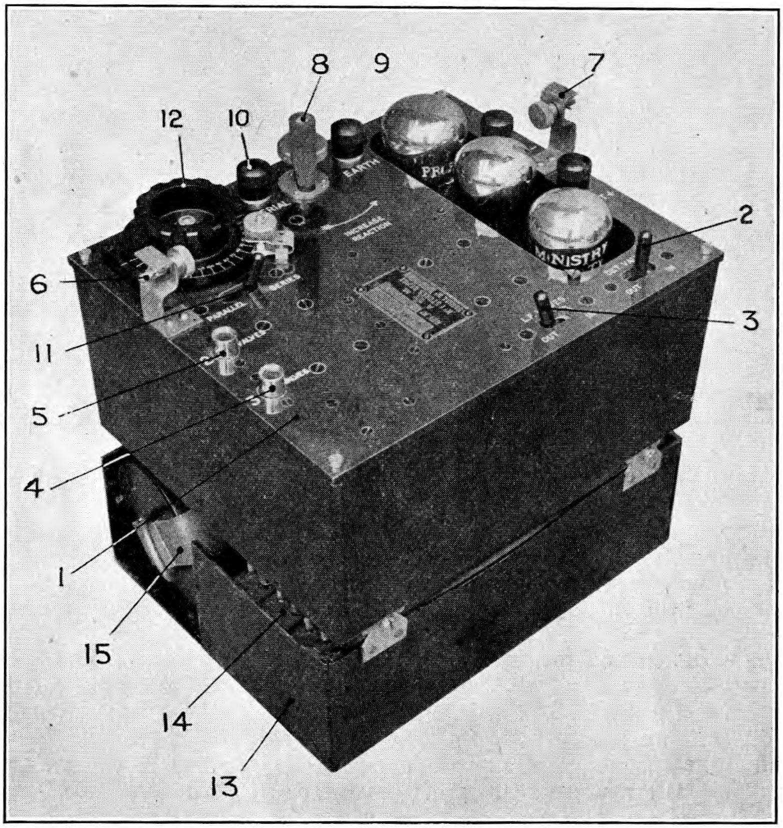

FIG. 5. Receiver removed from carrying case.

16. The aerial variometer comprises two insulating formers. The outer former or stator is wound with 100 turns of 32 s.w.g. d.s.c. copper wire. The rotor winding consists of 134 turns of 34 s.w.g. d.s.c. copper wire. The flexible connections to the rotor consist of ribbons of phosphor bronze, two or three turns of which are taken round the rotor spindle. The variometer scale is marked every 10° from 0° to 180°. The reaction control consists of the knob (8, fig. 5) which swings the anode, or reaction coil (8, fig. 6), so that it can be tightly or loosely coupled to the grid coil (7, fig. 6). The anode coil and grid coil are exactly similar, being wound on insulating formers. Each is wound with 225 turns of 34 s.w.g. d.s.c. copper wire to an inductance of 1,000 mics.

17. The underside of the panel is illustrated in fig. 6. The three valve-holders (1), (2) and (3) are on the left, (1) being the detector valve-holder. The iron-cored transformer (4) couples the detector valve to the first A/F stage. The two filament rheostats (5) and (6) are mounted in front of the valve-holders. The grid coil (7) and anode coil (8) may be seen behind the transformer.

18. The aerial variometer (9) may be seen in the right-hand corner and near it is mounted the aerial series condenser (10). The coupling transformer between the first and second A/F stages is mounted near the telephone jacks (12) and (13). The $\cdot 5\ \mu F$ condenser (14) is represented by C_6 in fig. 1. The three terminals (15), (16) and (17) are connected respectively to H.T.—, 15V+and 45V+.

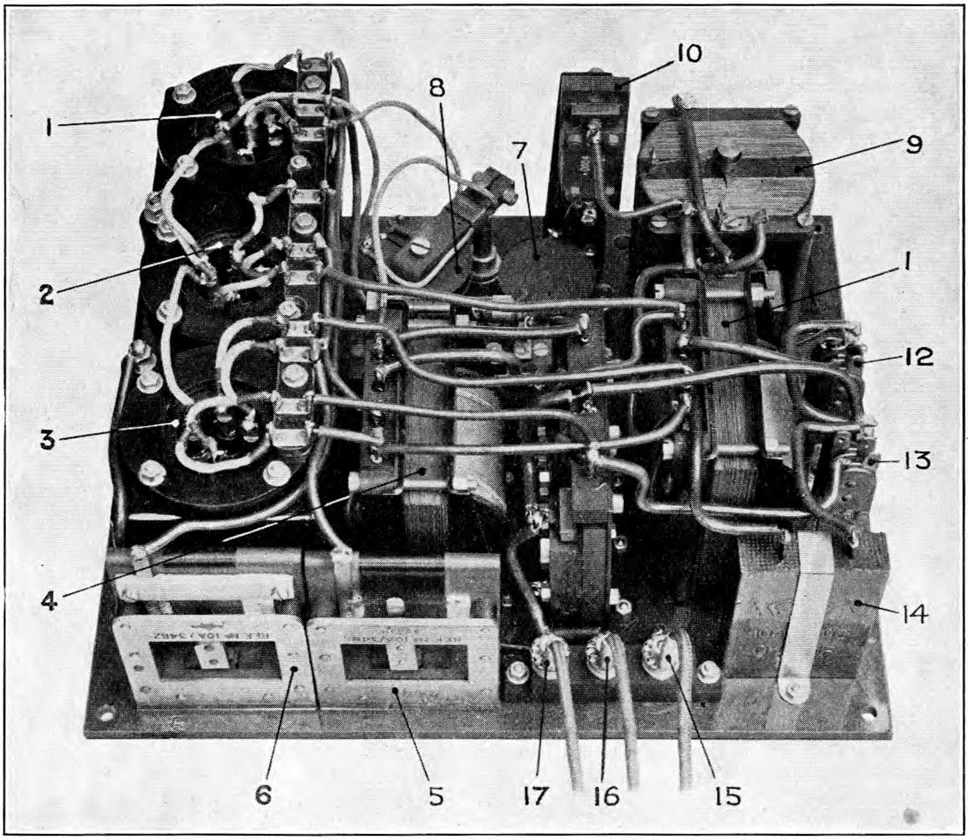

FIG. 6. Underside of panel.

OPERATION

19. Fig. 8 shows different aerial arrangements. When using the loop arrangement shown in fig. 8B, the loop should be tuned by means of a parallel variable condenser, as shown. If it is desired to use a coupled circuit arrangement, as shown in fig. 8A, a variable condenser is again necessary.

20. When an aerial of the open loop type is required, it will be found, as a general rule, that a 3-ft. square wooden frame wound with 50 ft. of aerial wire gives best average results. The frame should, if possible, be raised about 8 ft. from the ground. This arrangement is shown in fig. 8C.

21. With this receiver it is important that the length of aerial indicated (*i.e.*, 50 ft.) should never be exceeded. Consistently good results cannot be obtained with aerials of great length and large capacitance. The capacitance of aerials suitable for use with this receiver should not be greater than about ·0004 μF.

22. A 12-ft. portable mast which has been designed especially for use with portable ground receiving stations, and which may be employed with the receiver R.54, is illustrated in figs. 7 and 10.

23. This mast is known as " Mast, combination, for battery ground stations " and consists of five metal sections which, when fitted together and erected, form the entire aerial and earth system for the receiver. The lower section, which is of steel, is provided with a spike so that it can be driven into the ground. The other four sections, which are of brass and are provided with male and female sockets, are then built up above this. An insulating bush is fitted in the top of the earth section. The upper portion of the mast (consisting of four sections, one of which is provided with a 4 B.A. terminal) thus forms the aerial and is entirely insulated from the lower section which forms the " earth ". A No. 0 B.A. terminal is provided on the lower section.

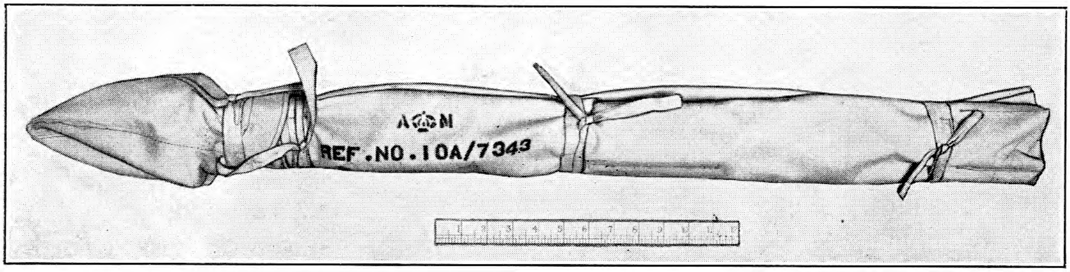

FIG. 7. Combination mast, packed for transport.

24. A heavy steel collar is fitted to the top of the earth section to prevent damage when driving it into the ground and a rubber cover (Stores Ref. 5C/174) is provided on the first aerial section to prevent water reaching the insulated socket and causing a failure of the insulation between aerial and earth. The lower, or earth, section of the mast is galvanized and the other four sections are painted grey except at the socket joints, which are left bright so as to ensure good electrical conductivity.

25. As can be seen from the illustration, the mast, when dismantled, is housed in a canvas bag and packed for transportation purposes. The complete mast is very light in weight owing to the fact that all sections are tubular.

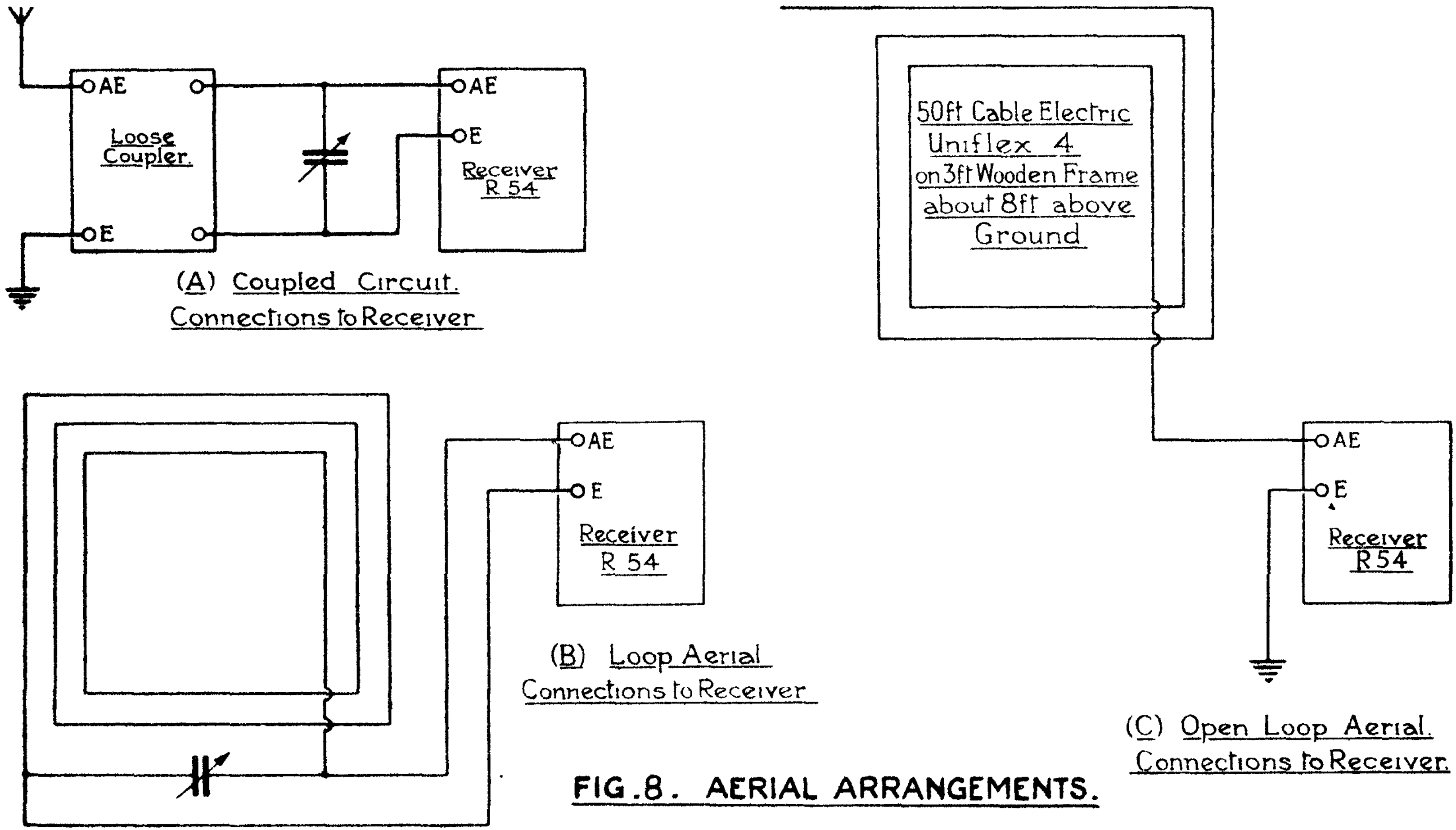

FIG. 8. AERIAL ARRANGEMENTS.

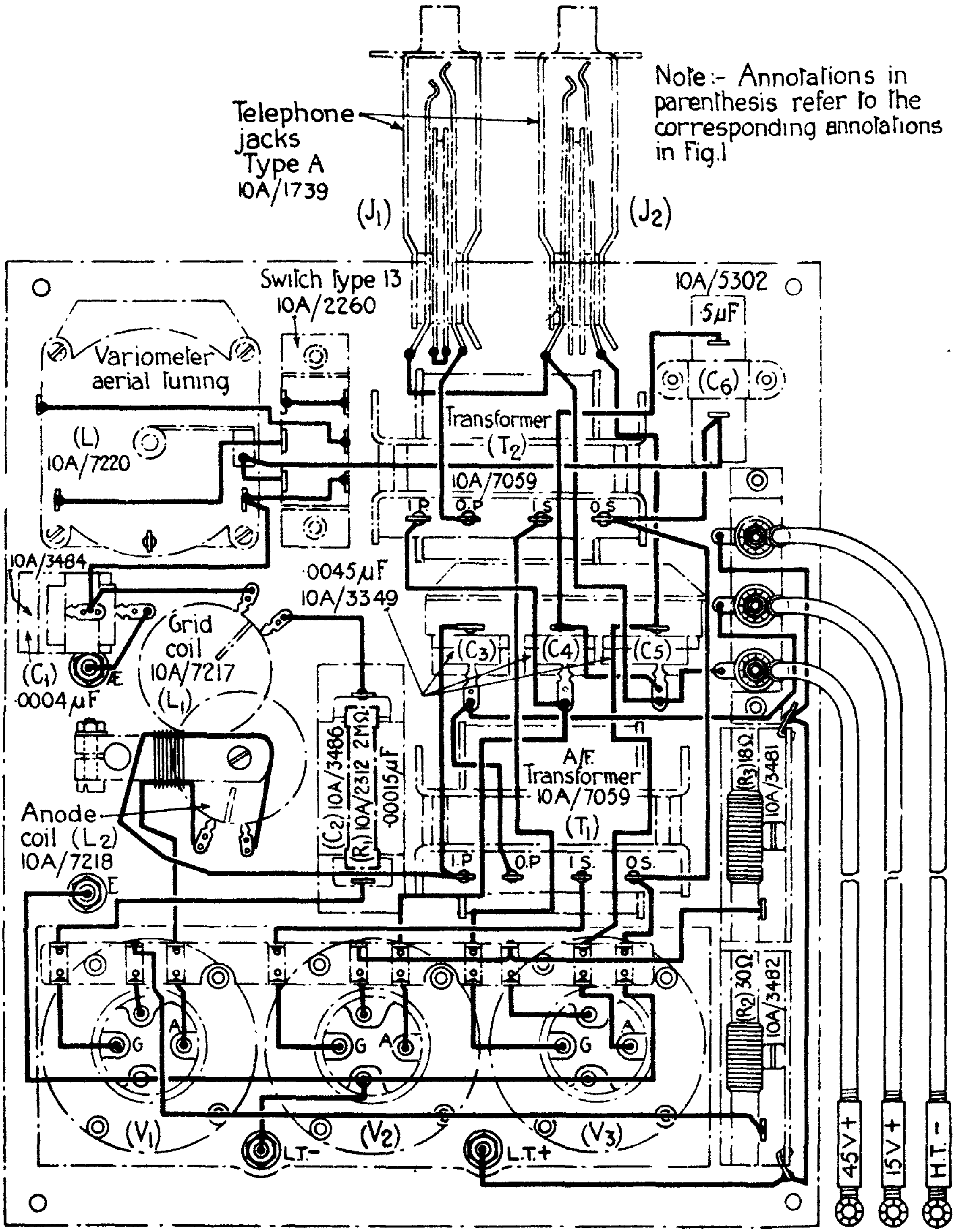

FIG. 9, BENCH WIRING DIAGRAM R54

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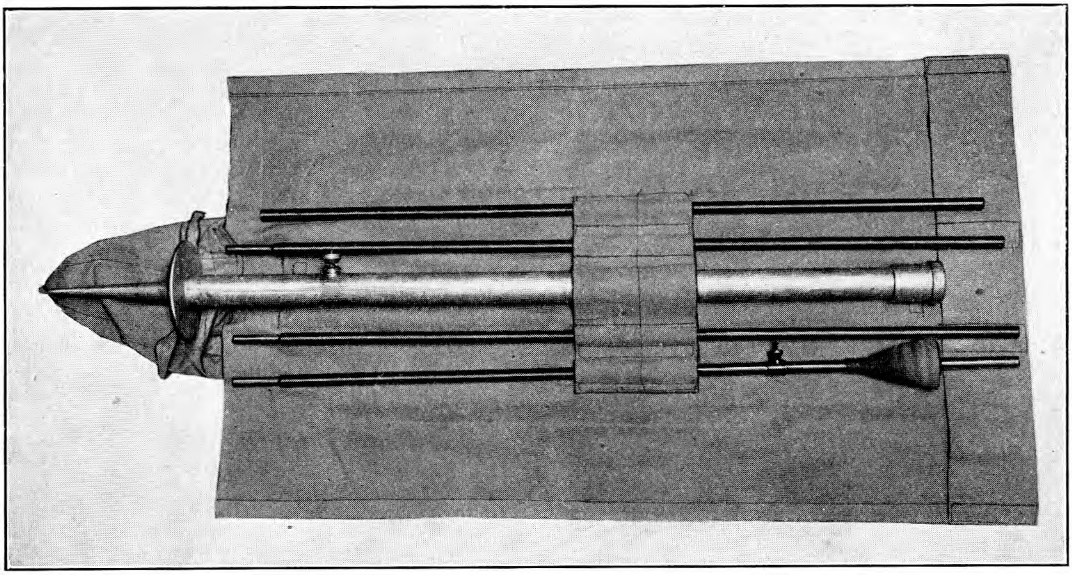

FIG. 10. Combination mast, dismantled.

26. No special instructions are necessary for the use of this combination mast beyond drawing attention to the fact that the aerial system thus formed will not have a very large capacitance, and the aerial tuning adjustments will thus be somewhat higher, and aerial damping somewhat less, than with the type of aerial previously described.

27. The procedure in operating the receiver is as follows :—Connect up the aerial and earth, as shown in fig. 8C or to the combination mast described above, and plug the telephones into jack marked 3 VALVES. Set the series-parallel switch to PARALLEL. Adjust the reaction coupling until the receiver oscillates. Decrease the reaction until oscillations just cease. Tune the receiver to the desired frequency by means of the aerial variometer. If the frequency cannot be reached with the switch in the PARALLEL position, set the switch to SERIES and re-tune. (The change from parallel to series or *vice versa* is usually made near the middle of the frequency range.) Re-adjust the reaction until optimum signal strength is obtained, *i.e.*, the signals are loud and clear, free from distortion or oscillation. Lock the variometer dial in the desired position by means of the spring clamp.

28. It may be found that signals are coming in so strongly that the amplification can be reduced. In this case the plug should be withdrawn from the 3-valve jack and plugged into the 2-valve position. It should be noted, however, that the third valve, although not now in use, is still lit.

PRECAUTIONS AND MAINTENANCE

29. The valves must be removed from their sockets and stowed in the felt-padded valve container when the receiver is not in use. Valves should not be kept in their valve-holders during transit.

30. As the system of reaction control used with this receiver differs from that usually employed, special care should be taken when making adjustments. The efficient working of the receiver depends entirely on the proper use of reaction. When making adjustments the receiver must not be allowed to oscillate continuously.

APPENDIX

NOMENCLATURE OF PARTS

The following list of parts is issued for information. In ordering spares for this receiver, the appropriate section of AIR PUBLICATION 1086 must be used.

Ref. No.	Nomenclature.	Quantity.	Remarks.
10A/7211	Receiver R.54 :—		
	Comprising,		
10A/7212	Bag, telephone	1	
	Case,		
10A/7213	Carrying	1	
10A/7214	Spare valve	1	
10A/7219	Container, battery and spare valve case	1	
6A/269	Holder, watch	1	
10A/7229	Receiver, type R.55	1	For details, *see* below.
	Receiver, R.55 :—		
	Principal components,		
10A/7215	Case	1	
10A/7216	Chamber valve	1	
	Coil,		
10A/7217	Anode	1	
10A/7218	Grid	1	
	Condenser,		
10A/3486	Type 8	1	$\cdot 0015\ \mu F$.
10A/3484	Type 13	1	$\cdot 0004\ \mu F$.
10A/3349	Type 32	3	$\cdot 0045\ \mu F$.
10A/5302	Type 43	1	$\cdot 5\ \mu F$.
10A/7221	Holder, valve, type B	3	
10A/1739	Jack, telephone, type A	2	
	Resistance,		
10A/3481	Type 6	1	18Ω, variable.
10A/3482	Type 7	1	30Ω, variable.
10A/2312	Type 26	1	2MΩ, 1-watt.
10A/2260	Switch, type 13	1	
10A/7059	Transformer, L/F, type B	2	
10A/7220	Variometer, aerial tuning	1	
	Accessories,		
5A/50	Battery, dry, 15-volt	3	
5A/1374	Cell, inert No. 2	2	
10A/7342	Mast, combination, comprising,	1	12-ft. mast, aerial and earth.
10A/7343	Bag, canvas	1	
10A/7344	Base	1	With terminal.
	Section mast,		
10A/7345	Upper	3	
10A/7346	Lower	1	With terminal.
10A/7232	Valve, type V.R.17	4	One spare.
10A/9548	Receiver R.54A :—		
	Comprising,		
10A/7212	Bag, telephone	1	
	Case,		
10A/7213	Carrying	1	
10A/7214	Spare valve	1	
10A/7219	Container, battery and spare valve case	1	
6A/269	Holder, watch	1	

Ref. No.	Nomenclature.	Quantity.	Remarks.
	Receiver R.54A—*contd.*		
	Comprising—*contd.*		
10A/9549	Receiver, type R.55A	1	For details, *see* below.
	Receiver R.55A:		
	Principal components:		
10A/7215	Case	1	
10A/7216	Chamber, valve	1	
	Coil,		
10A/9550	Anode	1	
10A/9551	Grid	1	
	Condenser,		
10A/3486	Type 8	1	·0015 μF.
10A/3484	Type 13	1	·0004 μF.
10A/3349	Type 32	3	·0045 μF.
10A/5302	Type 43	1	·5 μF.
10A/7221	Holder, valve, type B	3	
10A/1739	Jack, telephone, type A	2	
	Resistance,		
10A/3481	Type 6	1	18Ω, variable.
10A/3482	Type 7	1	30Ω, variable.
10A/2312	Type 26	1	2MΩ, 1-watt.
10A/2260	Switch, type 13	1	
10A/7059	Transformer, L/F, type B	2	
10A/9552	Variometer, aerial tuning	1	
	Accessories,		
5A/50	Battery, dry, 15-volt	3	
5A/1374	Cell, inert No. 2	2	
10A/7342	Mast, combination, comprising,	1	12-ft. mast, aerial and earth
10A/7343	Bag, canvas	1	
10A/7344	Base	1	With terminal.
	Section mast,		
10A/7345	Upper	3	
10A/7346	Lower	1	With terminal.
10A/7232	Valve, type V.R.17	4	One spare.

SECTION 3, CHAPTER 2

RECEIVER R.1082

Contents

List of Illustrations

RECEIVER R.1082

(Stores Ref. 10A/8415)

INTRODUCTION

1. The receiver R.1082 has been designed for use primarily in conjunction with transmitter T.1083. The frequency bands covered are 111 kc/s to 15 Mc/s. These bands are covered by a number of plug-in coils. Both modulated and unmodulated reception is provided for and

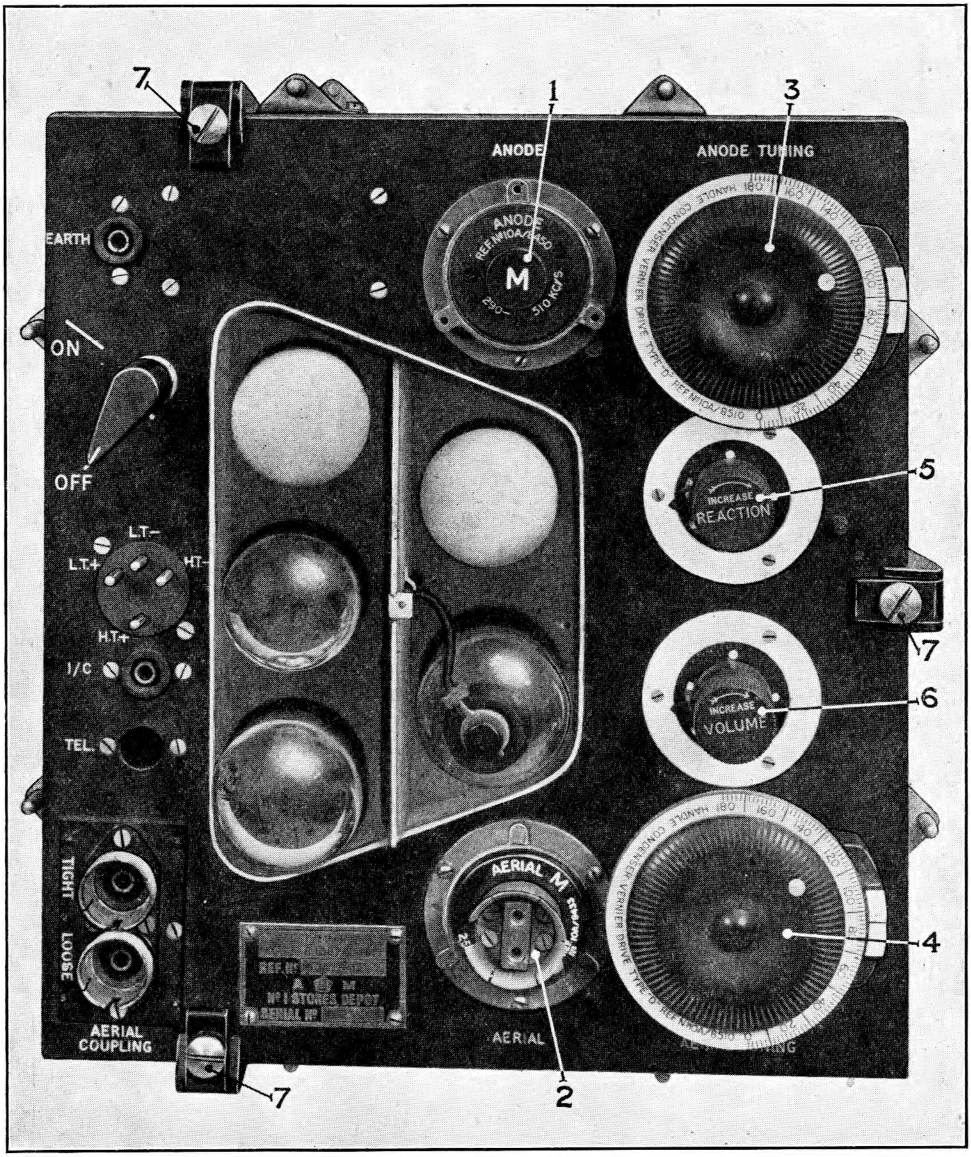

FIG. 1. Plan view of receiver.

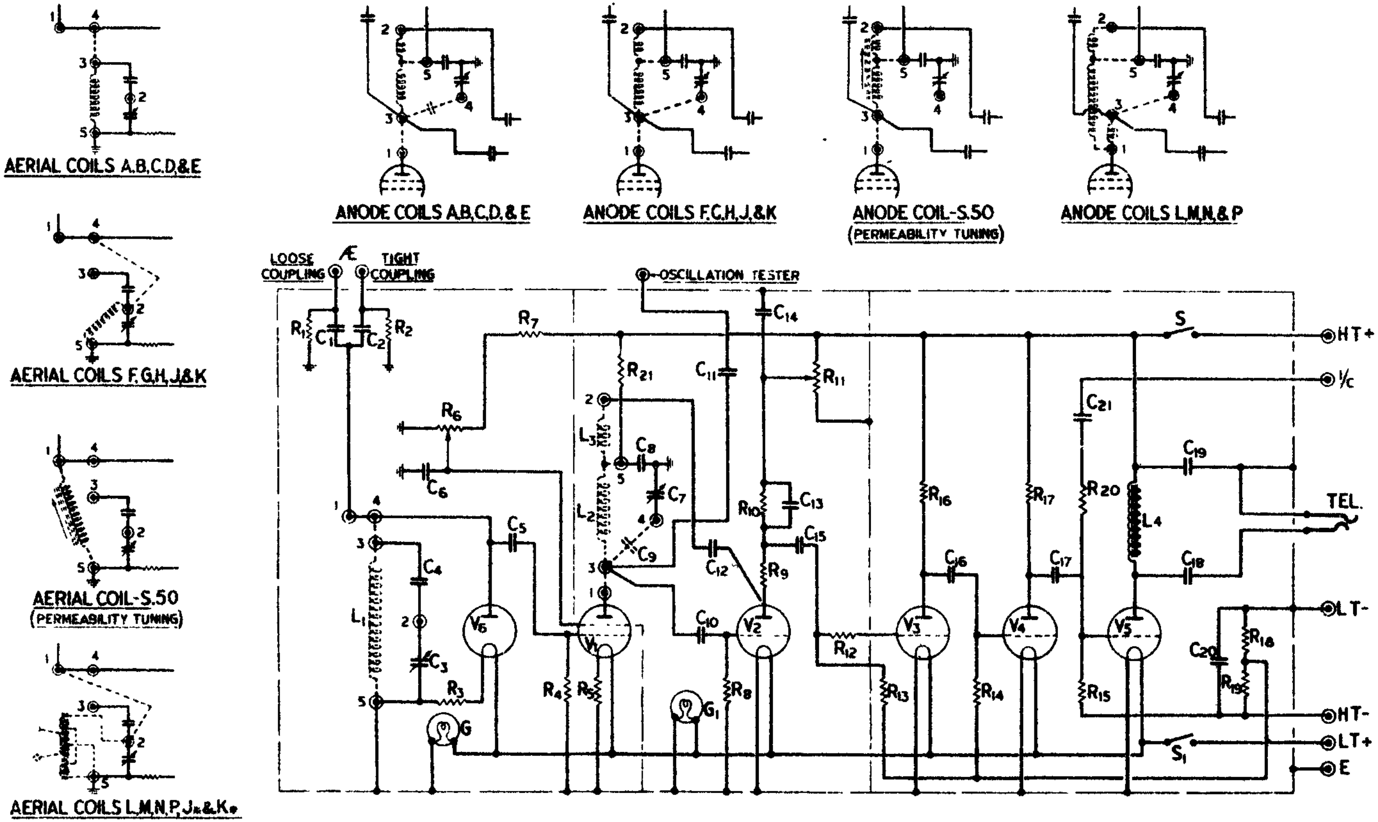

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FIG. 2, THEORETICAL CIRCUIT DIAGRAM, R1082

CONDENSERS		
REF	VALUES	No. ON SET
C_1	10 µµF	1
C_2	·00005 µF	2
C_3	0003 µF (VARIABLE)	-
C_4	0002 µF	6
C_5	0002 µF	7
C_6	0 5 µF	-
C_7	·0003 µF (VARIABLE)	-
C_8	0·5 µF	-
C_9	·0002 µF IN ANODE COILS A TO E	-
C_{10}	·0001 µF	13
C_{11}	10 µµF	10
C_{12}	·0005 µF	14
C_{13}	001 µF	18
C_{14}	2 0 µF	-
C_{15}	0005 µF	16
C_{16}	001 µF	22
C_{17}	001 µF	25
C_{18}	2 0 µF	-
C_{19}	4 0 µF	-
C_{20}	2 0 µF	-
C_{21}	100 µµF	28
RESISTANCES		
R_1	0·5 MΩ	3
R_2	0 5 MΩ	4
R_3	0 75 Ω	-
R_4	0 5 MΩ	8
R_5	1·5 Ω	-
R_6	·05 MΩ (VARIABLE)	-
R_7	0·1 MΩ	9
R_8	0·25 MΩ	12
R_9	0 02 MΩ	15
R_{10}	0·1 MΩ	17
R_{11}	0·05 MΩ (VARIABLE)	-
R_{12}	1 0 MΩ	20
R_{13}	2 0 MΩ	19
R_{14}	0·5 MΩ	23
R_{15}	2·0 MΩ	26
R_{16}	0·1 MΩ	21
R_{17}	0 2 MΩ	24
R_{18}	150 Ω	-
R_{19}	150 Ω	-
R_{20}	0·5 MΩ	27
R_{21}	5,000 Ω	

arrangements are also incorporated to enable the transmitter and receiver to be used for inter-communication in the aeroplane. The approximate dimensions of the receiver are $10\frac{1}{2}$ in.$\times$ $11\frac{1}{2}$ in.$\times$9 in., and the weight including coils and valves is $14\frac{1}{2}$ lb.

2. A 5-valve circuit is employed, comprising a screen-grid R/F amplifying valve, detector, two audio-frequency amplifying valves and an output valve. Provision is made for listening-through by connecting up the receiver, through a condenser unit, to the transmitter. A feature of the receiver is the provision of facilities for Direction Finding in conjunction with a D/F loop and a sense unit.

3. Over the range 4,286 to 6,000 kc/s a special form of aerial and anode coil is used. Each of these coils consists of an inductance, the value of which is varied by inserting or withdrawing a movable element in the coil.

GENERAL DESCRIPTION

Receiver

4. A theoretical circuit diagram of the receiver is given in fig. 2, from which it will be seen that five valves only are employed for reception, V_1 being a screen-grid radio frequency amplifying valve, V_2 a detector valve, V_3 and V_4 audio-frequency amplifying valves and V_5 an output valve. The valve V_6 is a diode connected across the input circuit to provide a damping resistance to safeguard the receiver when transmission is in progress. The valve is biased negatively so that during normal reception it is inoperative, but becomes a low resistance shunt when the input voltage rises above a predetermined value.

5. Two alternative aerial connections are provided, one of which connects the aerial inductance to the aerial through a small capacitance C_1 whilst the other connects up the aerial through a larger capacitance C_2, thus giving a choice of aerial coupling, the former " loose " and the latter " tight ". Both aerial terminals are provided with leak resistances R_1 and R_2 to prevent the possible accumulation of heavy static charge on the aerial.

6. The aerial and anode inductances are of the plug-in type, the arrangements shown in the theoretical diagram being those in use for the frequencies from 15,000 to 6,000 kc/s (coils A, B, C, D and E). The alternative arrangements for the other frequencies are shown (aerial coils) on the left and (anode coils) above. Referring to the diagram, the aerial inductance L_1 is tuned by means of the variable condenser C_3 in series with the fixed " spreader " condenser C_4, the aerial inductance being coupled to the valve V_1 by means of a fixed coupling condenser C_5. A grid leak resistance R_4 is provided on the control grid of the valve V_1 and the grid bias resistance R_5 is included in the negative filament lead of this valve. The potential of the screen-grid of this valve is controlled by means of the adjustable contact on the resistance R_6 which is in series with the resistance R_7 across the H.T. supply. A decoupling condenser C_6 is connected from the variable contact to earth. The anode circuit of the valve V_1 includes the inductance L_2 which is tuned by means of the condenser C_7 in series with the blocking condenser C_8 and the spreader condenser C_9, the moving vanes of the condenser C_7 being earthed to avoid hand capacitance effect. An oscillation testing pin in an insulated bushing on the panel of the set is connected through a small condenser C_{11} to the anode end of the inductance L_2. The testing pin provides a means of ascertaining whether the receiver is oscillating or not. If the valve is generating oscillations a click will be heard when the testing pin is momentarily touched with the finger.

7. Coupling between the screen-grid Valve V_1 and the detector valve V_2 is by means of a condenser C_{10}, the grid leak R_8 being connected from the grid of the detector valve to the negative L.T. The anode of the detector valve is fed through two resistances R_9 and R_{10} and the anode voltage is controlled by the potentiometer R_{11}, the latter being decoupled by means of the condenser C_{14}. From the anode of the detector valve a connection is taken through the fixed condenser C_{12} to a reaction coil L_3 wound on the same former as the anode inductance coil L_2. Reaction is controlled by means of the potentiometer R_{11}.

8. Resistance-capacitance coupling R_{10}—C_{15} is employed between the detector valve and the first audio-frequency valve, the resistance R_{10} being shunted by the by-pass condenser C_{13} to obtain reaction feed-back. A grid stopper resistance R_{12} is included in the grid circuit of the valve V_3 in order to prevent R/F voltages from being applied to the audio-frequency amplifier, and the valve is biased through the resistance R_{13}. The valves V_3 and V_4 are also resistance-capacitance coupled by means of the resistance R_{16} and capacitance C_{16}, and bias for the valve V_4 is obtained through the resistance R_{14}. The valves V_4 and V_5 are resistance-capacitance coupled by means of the resistance R_{17} and capacitance C_{17}, bias being applied to the output valve V_5 through the resistance R_{15}. Choke capacitance output L_4—C_{18} is employed. The resistance R_{18} and R_{19} in series are connected between the L.T. and H.T. negative terminals to provide automatic bias for the audio-frequency and output valves, half of the p.d. being tapped off to the grids of the valves V_3 and V_4 and the full p.d. being applied to the grid of the output valve. A condenser C_{20} to by-pass audio-frequency is provided across the resistances.

9. In order to enable intercommunication to be employed a connection is made through a resistance R_{20} and condenser C_{21} from the grid of the valve V_5 to a socket on the panel. This socket receives a plug which is connected to the secondary of the microphone transformer in the transmitter. Speech from the microphone is therefore reproduced in the head telephones connected to the receiver.

10. Since the receiver is intended to be connected up so as to provide for " listening through " during the intervals in transmission the possibility of the generation of excessively high currents and voltages in the aerial inductance coil and high voltages on the grid of the R/F. valve must be guarded against. It is for this reason that the valve V_6 is connected across the input of the receiver. It will be seen that a resistance R_3 is included in the negative filament lead which causes a permanent negative bias to be applied to the anode. For normal reception the value of this bias is such as to make the valve virtually an infinite resistance having no effect upon the sensitivity. The application of excessive voltages such as those set up by the transmitter causes the anode to become positive and the valve to act as a low resistance shunt across the receiver.

Coils

11. For frequencies between 7,000 and 785 kc/s the aerial and anode circuits are changed. The changes effected in the aerial circuit are shown on the left (aerial coils F. G, H, J and K). It will be seen that the only difference here is the omission of the fixed spreader condenser, this no longer being necessary on these lower frequencies. The changes effected in the anode circuit are shown above (anode coils F, G, H, J and K). As in the aerial circuit the only change is the omission of the small condenser which was in series with the variable condenser.

12. For the frequencies between 111 and 785 kc/s the aerial and anode circuits are again changed. The changes in the aerial circuit are shown on the left (aerial coils L, M, N, P, J* and K*). The aerial inductance is now an iron-cored coil tuned by means of a variable condenser (the fixed spreader condenser being omitted). On the aerial inductance is wound a coupling winding with centre point earthed. The ends of the coupling winding are brought out to socket connections to enable a screened loop to be brought into use for D/F on these frequencies. The changes effected in the anode circuit are shown above (anode coils L, M, N and P). The fixed spreader condenser is omitted and the tuned inductance is split into two portions, the anode being tapped at the junction point of the two portions.

13. Over the frequency range 4,286 to 6,000 kc/s a special form of aerial and anode coil is used, employing " permeability " tuning. As will be seen from the diagram of the aerial coil S.50 on the left and the anode coil S.50 above, the tuning condensers are not used, but tuning is effected by varying the inductance value by alteration of the position of a movable core. The inductance of the aerial coil is capable of being varied between approximately 9 and 27 microhenrys and the anode coil between approximately 12 and 16 microhenrys. Two switches S and S_1, operated simultaneously, are provided in the H.T. and L.T. circuits and two panel lights G and G_1 are connected across the filament circuit.

Listening-through

14. The receiver is provided with a listening-through arrangement. This consists of a unit of moulded material (4, fig. 3) provided with three connections. Two of these connections are taken to the transmitter, and one to the receiver. When they are connected in this way a fixed condenser incorporated in the unit is connected between the receiver and transmitter inductances, and the aerial is connected to one side of the condenser. It will thus be seen that, when transmission is in progress, the operator will be able to listen-in during pauses in his transmission owing to the permanent coupling of the receiver through the listening-through condenser to the aerial. There is a further important effect arising from this listening-through arrangement. During reception, the transmitter aerial inductance (tuned to the same frequency) is connected to the receiver aerial inductance, resulting in an increase of sensitivity and selectivity beyond those normal to the receiver. It will be apparent from the foregoing that background noises during transmission would nullify any advantages derived from this, and therefore it is essential that the generator should be as noise-free as possible. The smoothing unit (Stores Ref. 10A/8525) shown in fig. 12 is therefore employed.

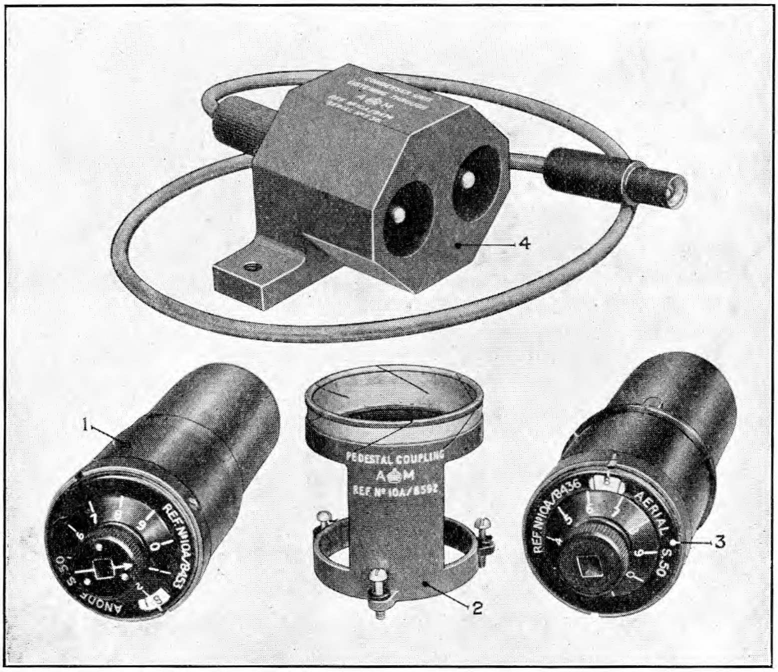

FIG. 3. Listening-through unit, permeability coils and pedestal coupling.

15. Listening-through is not possible when transmitting R/T. On telegraphic transmission it is only applicable when transmission and reception is being carried out on the same frequency. Searching is not practicable when listening-through. If it is desired to make use of the advantages accruing from the use of the transmitter aerial coil, and neither transmission nor searching is contemplated, it is important to ensure that the send-receive switch is in the "receive" position in order to avoid waste of L.T. current on the transmitter valve filaments.

16. Owing to the use of plug-in connections on the listening-through unit, it is possible to rearrange the connections to give "free receiver". By removing the milled aerial plug

from the unit and mating it with the milled socket, the receiver is connected directly to the send-receive switch, and operation of the switch now merely changes the aerial from transmitter to receiver or *vice versa.*

17. When the receiver is connected up *via* the listening-through unit, and transmission is in progress, R/F voltages will be developed across the transmitter aerial coil and applied *via* the listening-through condenser to the receiver input circuit. To avoid damage to the receiver a limiting valve is employed. This is a diode connected across the receiver input circuit. During alternate half cycles it acts as a low resistance across the receiver input, and any energy which the latter has accepted from the transmitter is harmlessly dissipated at the limiter valve anode. This protection is afforded only when the receiver switch is on. In order to ensure that the valve does not damp the receiver during normal reception, a small negative bias is applied to the limiter valve.

Direction finding and sense unit

18. Provision is made for direction finding over the frequencies 111 to 1,500 kc/s, where the receiver is used in an aeroplane. A screened D/F loop aerial is shown in fig 13. It will be seen that it may be connected to the sense unit by a length of metal-braided cable terminating at each end in a plug, type 101. Each of these plugs is provided on the side with a projection. A 2-pin socket is provided on the D/F loop and a 2-pin socket on the sense unit. The projections on the plugs fit into the slot provided in the metal screens surrounding the sockets and ensure the correct polarization of the D/F loop with respect to the receiver. The sense unit is also provided with a socket to receive the aerial plug, type 68. A single-pole plug on the sense unit engages the aerial socket of the receiver and the 2-pole socket plugs into the socket on the aerial coil. The connections to the aerial coil may be seen from an examination of fig. 10 (coils L, M, N, P, J* and K*).

19. The operation of taking an ordinary D/F bearing resolves itself into the simple process of identifying and tuning in a suitable transmitter and, with the loop connected to the receiver, rotating the loop whilst listening in simultaneously. The strength of the signal heard in the telephones will vary as the loop is rotated, and at two points in every revolution of the loop, the signal will fall to a minimum. It will be found that the two readings at which these minima occur are separated by 180°. One of these is the bearing and the other the reciprocal of the bearing.

20. The ambiguity of 180° can be resolved by dead reckoning. It may also be resolved by obtaining a second bearing of the same transmitter a few minutes later or by obtaining a bearing of another transmitter. In order to resolve this ambiguity at the same time as the bearing is taken, however, sense finding arrangements are provided.

21. The method of determining sense may be described in the following way. Having obtained two minima as described in para. 19, the sense aerial is connected up through an adjustable resistance to the receiver whilst retaining the loop aerial connection. This has the effect of altering the polar diagram from figure-of-eight form (two minima and two maxima) to a cardioid form (single minimum). This sense minimum, however, is not located with sufficient accuracy to be employed for an actual bearing but it does enable the ambiguity between the bearing and its reciprocal to be resolved, because it always has a relation of $\pm 90°$ to the bearing. Further, this sign may be pre-determined for a given installation.

Remote controls

22. The arrangement of the remote controls for the T.1083–R.1082 installation is shown in Fig. 4. The " control, switch and tuning " (1) has two handles, the upper one being engraved SEND-RECEIVE and the lower one being engraved TUNING. Movement of these handles is transmitted, through flexible shafts sliding in casings (2) to the send-receive switch (3) on the transmitter and the tuning control (4) on the receiver respectively. The internal flexible shaft (5) comprises a core of stranded steel wire on which is wound a spiral " tooth " wire, making approximately 10 turns to the inch.

23. In the controller is a " gear wheel " (6) which engages with the spiral tooth winding so that rotation of the gear wheel moves the shaft backwards or forwards in the casing. On the send-receive switch and tuning control of the instrument are coupling units similarly provided with gear wheels which are engaged with the spiral windings on the flexible shafts. The movement of the flexible shafts thus rotates these gear wheels operating the send-receive switch and tuning controls. The remote controls are permanently installed in the aeroplane and means are provided for easily releasing them from the instruments when the latter are removed from the aeroplane.

24. The outer casing is of solid drawn light aluminium alloy for the greater part of its length but the portion (7) near the instrument is flexible, being constructed from a spiral brass strip, over which are two windings, one of steel wires and one of phosphor bronze or spring steel, with an outer weatherproof covering of cotton braid treated with transparent varnish. The junctions between the rigid and flexible casing are made by unions (8).

25. The switch coupling consists of an aluminium body in which is a gear wheel, the spindle of which projects carrying an exterior handle (9). On the underside of the gear wheel is a dog coupling which engages with the fitting on the end of the send-receive switch spindle. The body of the switch coupling is provided with a split-ring and clamping bolt (10) and when fitting the switch coupling to the transmitter the dog is engaged with the fitting on the send-receive switch spindle and the body is secured to an adaptor ring (11) on the transmitter by means of the split-ring and clamping bolt. Provision is made for alternative positions of the switch coupling to suit possible different angles at which the remote control shafts may enter. It is positioned by a projection on the underside of the switch coupling body which may be engaged in any one of 8 slots around the periphery of the adaptor ring. The handle may also be fitted in any one of 8 positions by undoing a slotted screw, removing the handle from the squared spindle and refitting.

26. Remote control of the tuning on R.1082 is accomplished by varying the inductance of the anode permeability tuning coil S.50. A square hole is provided in the movable element of the coil. In this is engaged a square spindle (12) carried in the coupling tuning which is, in turn, fitted on the pedestal coupling (13) fitted to the receiver. The coupling tuning is secured to the pedestal coupling by means of a split-ring and coupling bolt (22). A gear wheel (20) in this coupling is rotated by the to-and-fro motion of the flexible shaft, causing the core to be inserted or withdrawn according to the direction of rotation. A spring plunger device (14) on the top of the coupling provides a means of disengagement. This disengagement is effected by depressing the plunger, after which the knob is rotated to obtain the correct tuning and then released. Operation of the remote tuning control, which has been previously set in a central position, now varies the tuning either side of a given point.

27. To facilitate manufacture, the knob, on both the anode and aerial coil, is provided with a square hole. It is, however, impossible to connect the remote control to the aerial coil as the pedestal coupling cannot be secured to the panel fitting of the aerial coil, since the lugs on this panel fitting have deliberately been left un-drilled.

28. At one or more intermediate points on the send-receive shafting, provision may be made, by means of additional switch couplings, to operate the send-receive switch. One of these (21) is provided with a remote switch (Switch, type 89) which is a simple on-and-off switch connected up to the motor-generator starting switch to ensure that the motor-generator starts up whenever the send-receive switch is placed in the send position and is stopped when the switch is placed in the receive or off position.

29. It is essential that the remote control mechanism be so adjusted that the controls on the instrument always occupy their correct positions when moved by, and as indicated on, the remote controller. The method of adjusting the controls is described in the following paragraphs.

30. At the instrument end, the dog of the switch coupling is engaged with the send-receive switch fitting and the body of the switch secured to the adaptor ring by tightening up the clamping bolt. The switch is placed in the " send " position and the handle correctly positioned with respect to the indicating plate. The handle may be removed from the spindle by undoing the screw (15) and fitted in any one of eight positions. The indicating plate may be removed by undoing the nut (16) and refitted in any one of sixteen positions.

31. The intermediate switch coupling should now be disengaged from the internal shafting by undoing one of the screws (17) and swinging away the body of the switch coupling. Leaving this disengaged, the controller end should now be set by undoing one of the screws (18) and swinging away the body of the controller so that the internal shafting is disenaged from the gear wheel. The control send-receive handle is now moved into the " send " position, but before re-engaging the wheel with the internal shafting the latter should be tensioned by grasping the projecting end in the hand and pulling. Whilst maintaining the shafting in tension the body of the controller should be swung back again into position so that the gear wheel is again engaged with the flexible shafting and the screw (18) re-inserted. The intermediate switch coupling may now be placed in the " send " position, the wheel engaged with the shafting and the screw (17) re-inserted. Rotation of the controller handle should now result in the rotation of the send-receive switch and the intermediate switch coupling. To obtain correct synchronism a further slight adjustment may be necessary on the intermediate switch coupling. This may be made by locking the controller handle in the intermediate or " off " position with the catch (19) in the slot provided. If on examination the intermediate coupling switch is found not to be exactly central, it should be disengaged and the wheel rotated a tooth or so either way to bring it exactly to off, and then re-engaged. It is important to check that the position of the switch, type 89, coupled to the underside of the intermediate switch coupling is correct. In the " send " position it should be closed. In the " off " and " receive " positions it should be open. Two leads are taken from this switch to the starter, type A, which is a relay starting switch for the motor-generator.

32. The relay starting switch consists of two electro-magnetic switches, one being double-pole and the other single-pole, and a resistance element of ·22 ohm. When the switch, type 89, is closed the solenoid operating the double-pole switch is energized from the 12 volt aircraft supply. Both contacts close, and the supply is connected across the motor-generator (the resistance being in series with the L.T. armature) and the motor-generator starts up. The solenoid of the single-pole switch is connected across the L.T. armature of the motor-generator and as the motor-generator speeds up the voltage across the armature increases. When it reaches about 8 volts, the single-pole switch closes and short-circuits the series resistance element thus allowing the motor-generator to run up to full speed. To stop the motor-generator the switch, type 89 is opened. This de-energizes the solenoid of the double-pole switch breaking both sides of the supply to the motor-generator.

33. The tuning handle on the controller is provided with devices for disengagement similar to those on the send-receive handle. The adjustment is facilitated by the provision of the spring plunger device on the receiver coupling tuning. It is only necessary to fit the pedestal coupling on the receiver and the coupling tuning on this with the square spindle on the latter engaged in the square hole in the movable element of the coil. Now ensure that the internal shafting is positioned so as to allow for rotation of the gear wheel on the coupling tuning over the full travel of the tuning handle.

34. Final adjustments of the tuning control are made with the receiver in operation. The tuning handle on the controller is set to the central position. The spring plunger on the receiver is depressed, disengaging the spindle from the gear wheel, and allowing the spindle to turn freely and rotate the movable element of the coil until the correct tuning is obtained. The plunger is now released causing the spindle to be re-engaged with the gear wheel. Movement of the controller tuning handle now gives variation of the tuning on either side of a given frequency. It is important when installing the shafting to ensure that the flexible portion is cleated up as near the instrument as possible. If this is not done movement of the outer flexible casing takes place and unnecessary friction is produced when the controls are moved.

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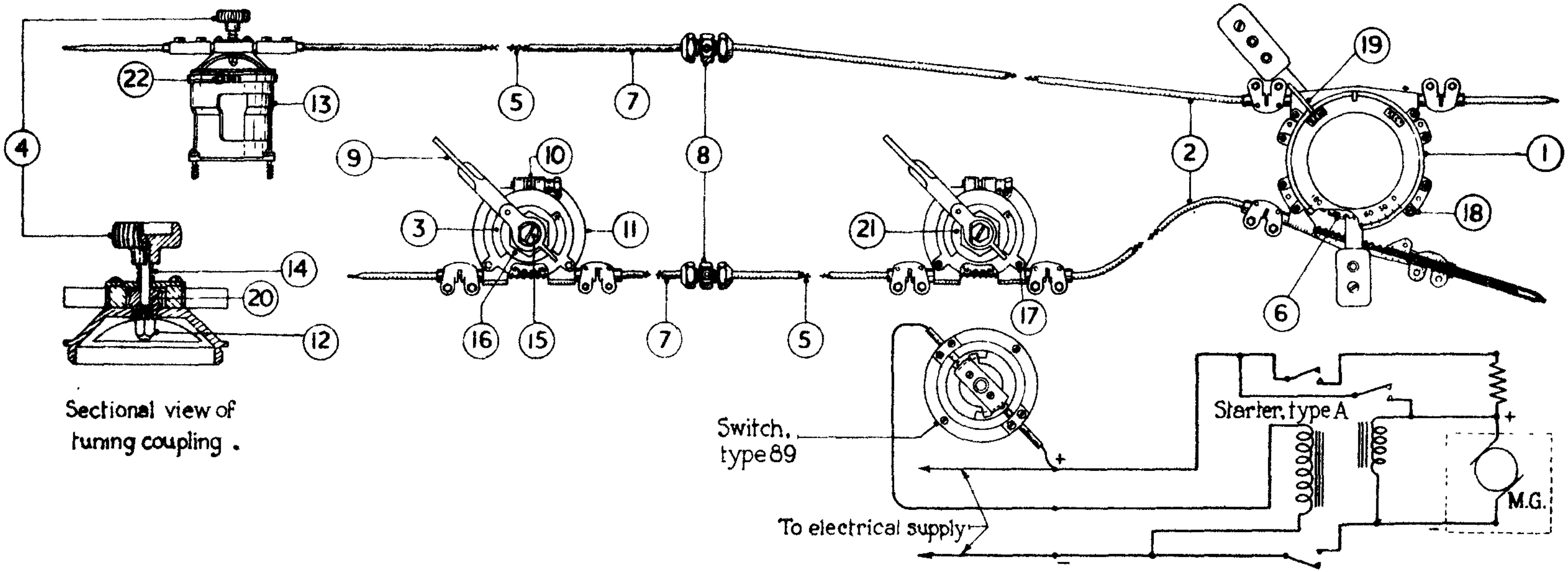

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FIG. 4, REMOTE CONTROLS

CONSTRUCTIONAL DETAILS

Receiver

35. Four views of the receiver are given in figs, 1, 5, 6 and 7, and a bench wiring diagram in fig. 8. Fig. 1 is a view of the front panel and figs. 5, 6 and 7 are views of the interior of the receiver showing the disposition of the various components. The receiver is housed in a case of canvas covered wood, the components being mounted on a metal panel to the underside of which are fitted metal screens. The receiver may be lifted from the case after loosening the three clamping screws (7) shown in fig. 1. The controls of the anode and aerial tuning condensers incorporate fine tuning devices. Referring to fig. 1, the anode tuning control (3) is disposed in the top right-hand corner, while the aerial tuning control (4) is disposed in the bottom right-hand corner. Between these are the reaction control (5) and the volume control (6). The holder into which the anode coil (1) is plugged, carries a flanged fitting on to which is secured the pedestal coupling (2, fig. 3) for the remote permeability tuning control. A similar flanged fitting is provided on the panel at the aerial coil (2) position but the flange is not drilled and tapped, no provision for remote control being required here. It should be noted that although the anode and aerial permeability coils are each provided with a squared hole in the top, only the anode coil is intended to be remotely controlled. On the left of the panel in fig. 1 can be seen the earth socket, the on-off switch, the L.T. and H.T. supply socket connection, the i/c socket, the telephone jack, and the aerial socket. The anode and aerial coil-holders, with a coil M in position, can be seen adjacent to the anode and aerial tuning controls respectively, while five of the valves can be seen grouped together in the centre of the panel. Referring to fig. 5, which is an interior view of the receiver, a number of resistances and condensers (1) are shown grouped together in the top right-hand corner. A similar group (2) can be seen on the left-hand side, while the

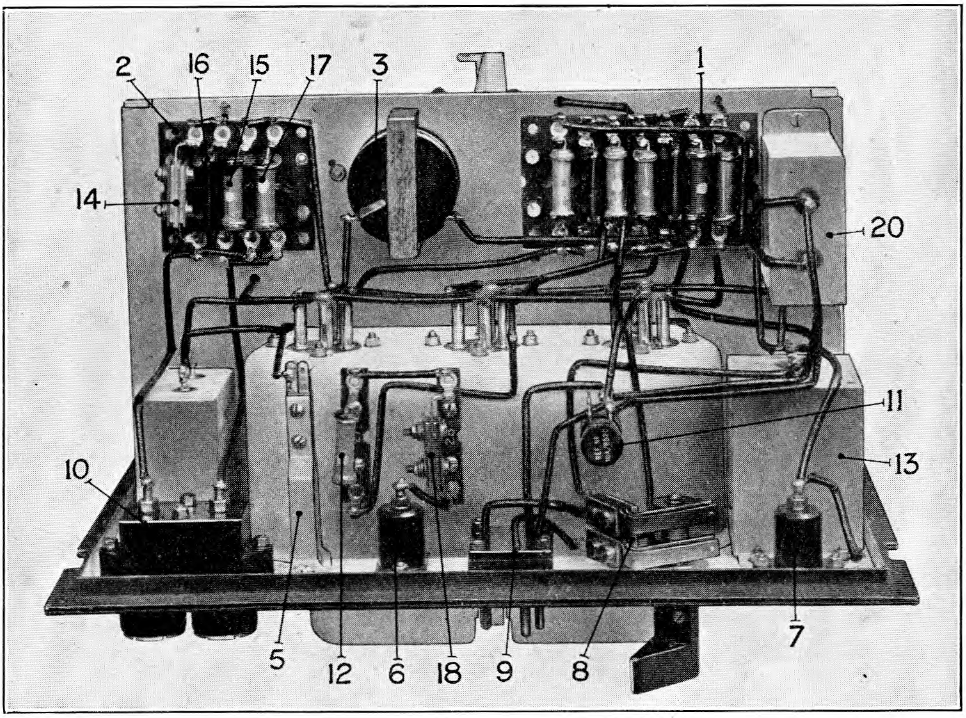

FIG. 5. Interior of receiver.

A/F choke (3) is mounted between (1) and (2). Below these components can be seen three valve-holders (4), telephone jack (5), i/c and earth sockets (6) and (7) respectively, the combined L.T. and H.T. switch (8), and L.T. and H.T. plug connection member (9). The aerial coupling socket (10) can be seen in the left-hand bottom corner, while the condenser immediately behind is the condenser C_{18}, shown in the theoretical circuit diagram fig. 2. This condenser is connected from the anode of the valve through the telephone jack to earth. The resistance unit (11) above the switch (8) is connected between the L.T.—and the H.T.—. The condenser (18) and resistance (12) which have values of 100 $\mu\mu$F and ·5M Ω respectively, are connected in series with the i/c socket, while the condenser (20) is connected directly across the resistance unit (11).

36. The group of condensers and resistances (1) referred to above, includes a resistance of 2 megohms, shown on the extreme left of the group. This resistance constitutes the grid bias resistance for the output valve. The condenser and resistance adjacent to this have values

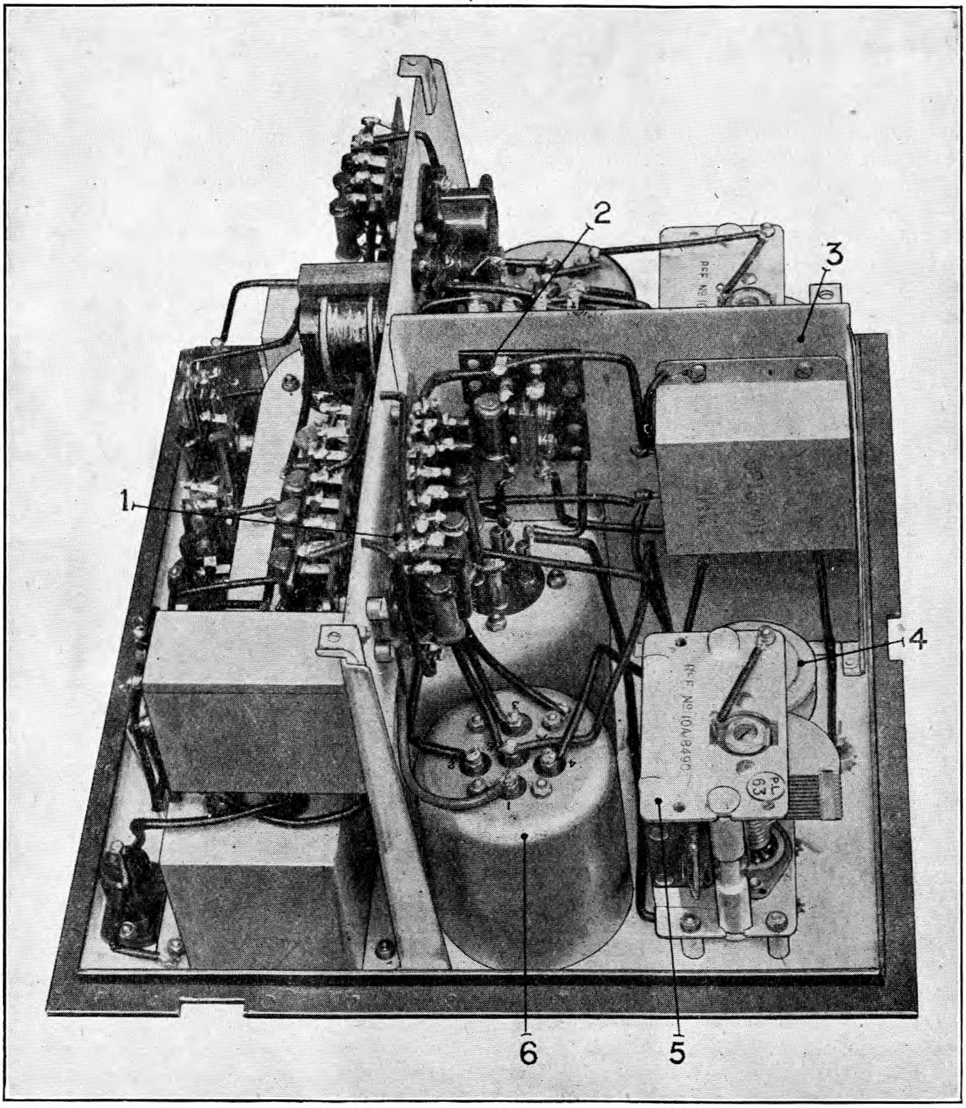

FIG. 6. Interior of receiver—right-hand side.

of ·001μF and 200,000 ohms respectively and form the resistance-capacitance coupling between the output valve and the second A/F amplifying valve. The next resistance which is the third from the left in the group has a value of ·5 megohm and is the grid bias resistance for the second A/F amplifying valve. The condenser adjacent to this resistance has a value of ·001μF, and forms with the 100,000 ohms resistance next to it, the resistance-capacitance coupling between the two A/F amplifying valves. The last resistance on the extreme right of the group (1), has a value of 1 megohm and constitutes a grid-stopper resistance in the grid circuit of the first A/F amplifying valve.

37. The group of condensers and resistances (2) on the extreme left consists of a condenser (14) having a capacitance of 10μμF, a resistance (15) having a value of ·5 M Ω, a condenser (16) having a value of ·00005μF, and a resistance (17) having a value of 5 M Ω. The two condensers provide a means of obtaining alternative aerial coupling, either tight or loose, whilst the resistances shunted across them prevent the possible accumulation of static charges. Two separate sockets (10) are provided for aerial connections, the one on the left being connected to the condenser (14) shunted by the resistance (15) to provide loose coupling, and the socket on the right being connected to the condenser (16) shunted by the resistance (17) to provide tight coupling.

38. The telephone jack (5) is connected through the 2μF condenser seen immediately behind the aerial sockets to the anode of the output valve. The plug (9) is provided with four legs, which are the L.T. + and — and the H.T. + and — connections. The L.T. + is connected through the lower arm of the switch (8) to the valve filaments, whilst the H.T.+ is connected through the upper arm of the switch to the anode circuits. The L.T.— is connected to one end terminal of the resistance unit (11) and the H.T.— is connected to the other end terminal of the same unit. The earth socket (7) is connected to the metal panel. The 4μF condenser (13) is the condenser represented by C_{19} in the theoretical circuit diagram, fig. 2, and is connected between the H.T. + switch and earth. The A/F choke (3) seen in the upper part of fig. 2, is connected in the anode circuit of the output valve.

39. Referring to fig. 6, the anode coil-holder, anode tuning control, the detector valve-holder and various units of condensers and resistances can be seen in the foreground on the right. Behind the screen can be seen the limiter valve-holder and the tops of the aerial coil-holder and aerial tuning condenser. The group of condensers and resistances (1) comprises a resistance of 2 M Ω (in the foreground of the group) through which is provided the grid bias for the first A/F amplifying valve. The condenser and resistance next in order have values of ·001μF and ·1 M Ω respectively, the resistance being in the anode circuit of the detector with the condenser connected across it. The condenser in the centre of the group has a value of ·0005μF, and is the coupling condenser between the detector and first A/F amplifying valve. The resistance which can be seen third from the rear end of the group has a value of 20,000 ohms and is connected in the anode circuit of the detector valve. The condenser second from the rear has a value of ·0005μF and is connected between the anode of the detector valve and the terminal 2 of the anode coil-holder. The last condenser in the group is connected between the grid of the detector valve and the terminal 3 of the anode coil-holder. It has a value of ·0001μF and forms the coupling between the screen-grid valve and the detector valve.

40. The resistance-condenser unit (2) mounted on the front of the screen (3) consists of a ·5 M Ω resistance which is connected between the control grid of the screen-grid valve and earth, while the condenser, which has a capacitance of 10μμF, is connected between an oscillation testing pin and the anode end of the inductance L_2 shown in the theoretical circuit diagram, fig. 2. The large 2μF condenser seen on the right-hand top corner of the screen is a decoupling condenser connected across the potentiometer (4), a part of which can be seen behind the variable condenser (5) which has a value of ·003μF and which tunes the inductance in the anode circuit of the screen-grid valve.

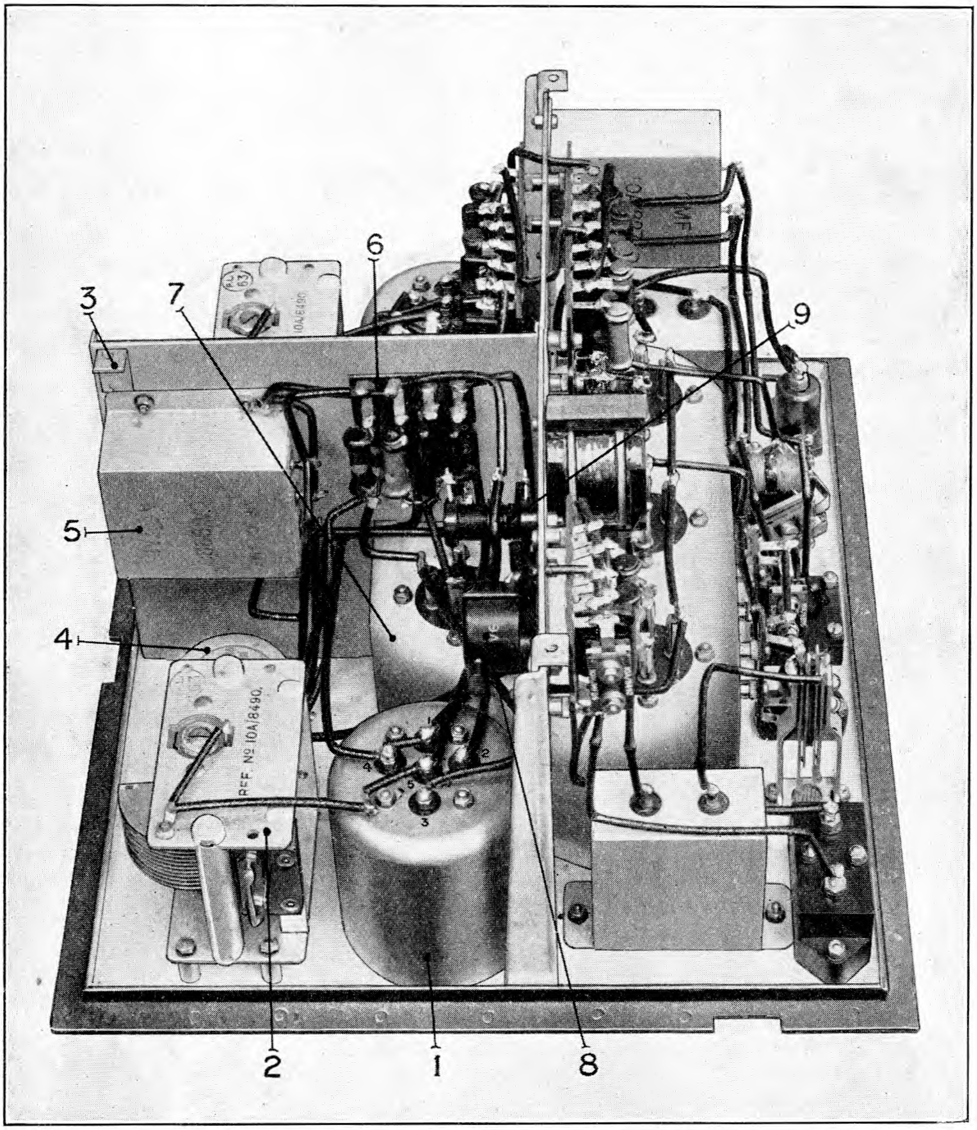

FIG. 7. Interior of receiver—left-hand side.

41. The anode coil-holder (6) seen in the foreground of fig. 6, provides a means of interchanging the anode coils which are of the plug-in type. The five terminals of the coil-holder which may be seen in the figure, and which are engraved 1–5, are connected up externally as follows :—The terminal 1 is connected by a flexible lead to the anode of the screen-grid valve, the terminal 2 is connected through a ·0005μF condenser to the anode of the detector valve, the terminal 3 is connected through a ·0001μF condenser to the grid of the detector valve, terminal 4 is connected through a ·0003μF variable condenser to earth, and the terminal 5 is also connected through a ·5μF condenser to earth.

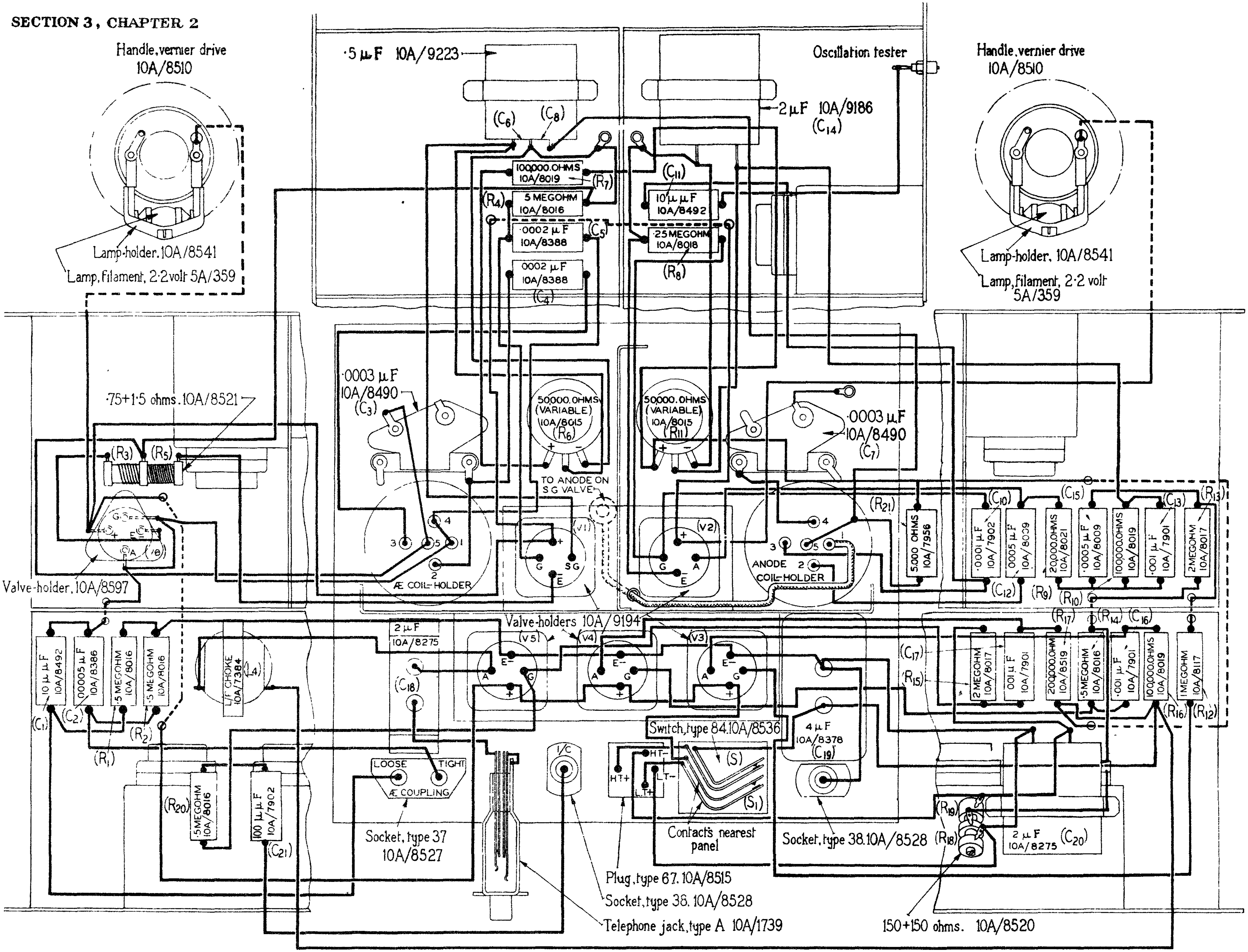

FIG. 8, BENCH WIRING DIAGRAM, R.1082

42. Fig. 7 is an inside view of the receiver showing the components mounted on the rear of the two screens shown in figs. 5 and 6. The aerial coil-holder (1) is shown in the foreground and adjacent to it the aerial tuning condenser (2). Behind the condenser can be seen the top of the variable resistance (4) and immediately above this, the condenser (5) which will be referred to again later. To the right of the condenser is a unit of condensers and resistances (6) and immediately below this unit can be seen the screen-grid valve-holder (7). Above the valve-holder and to the right can be seen the valve-holder (8) for the limiter valve, close to which the resistance unit (9) is mounted.

43. The resistance-condenser unit (6) comprises two resistances and two condensers. The first resistance on the left has a value of ·1 M Ω and is connected in the H.T. circuit in series with the variable resistance (4) which has a value of 50,000 ohms. The next resistance from the left is the grid leak resistance for the screen-grid valve and it has a value of ·5 M Ω. The condenser next to this resistance is the coupling condenser between the aerial inductance and the screen-grid valve, its value being ·0002μF. The condenser seen on the extreme right-hand side of the group has a value of ·0002μF, and is the fixed spreader condenser for tuning the aerial inductance.

44. The variable condenser (2) shown in the foreground of fig. 7 has a capacitance of ·0003μF, and is connected in the aerial circuit. This condenser, connected up in series with a fixed " spreader " condenser, tunes the aerial inductance. The movable vanes of the variable condenser are earthed to avoid hand capacitance effect. The driving control, not shown in this figure but which may be seen in fig. 1, incorporates fine tuning devices. The condenser (5) shown immediately behind and above this variable condenser in fig. 7, is actually a unit comprising two condensers of ·5μF each, mounted in one case and provided with a common central connecting lug. One half is included in the anode coil circuit while the other half is connected to the variable resistance controlling the potential of the screen-grid valve.

45. The limiter valve-holder (8) is shown mounted above the anode coil-holder (1). Near the valve-holder (8) can be seen a resistance unit (9), which consists of two resistances wound on the same bobbin, one has a value of ·75 Ω and the other a value of 1·5 Ω. The ·75 Ω resistance is included in the negative side of the limiter valve filament circuit and causes a permanent negative bias to be applied to the anode. The 1·5 Ω resistance is included in the negative side of the filament circuit of the screen-grid valve.

46. In the right-hand foreground of the figure can be seen the aerial coil-holder (1). This coil-holder, like the coil-holder (6, fig. 6) is provided with five terminals engraved 1 to 5, as can be seen on the upper part of the holder. On the coil-holder, the terminal 1 is connected externally with the terminal 4. The terminal 2 is connected to the terminal 3 *via* the fixed spreader condenser shown on the extreme right in the group (6), and also to the terminal 5, which is the centre terminal on the coil-holder, *via* the variable condenser (2). The internal connections of the various terminals are, of course, dependent on the particular coil that is plugged in, details of which may be seen in the theoretical circuit diagram (fig. 2).

Coils

47. The receiver is provided with a set of anode and aerial coils of the plug-in type, some of which can be seen stowed away in their carrying case, fig. 11. There are fourteen anode coils engraved A, B, C, D, E, F, G, H. J, K, L, M, N and P, covering the ranges 15,000 to 111 kc/s. There are also fourteen aerial coils engraved as above, covering the same ranges as the anode coils but with an additional two coils J* and K*. The tops of the aerial coils are coloured red and the tops of the anode coils are coloured green. All the anode coils and the aerial coils engraved A to K inclusive are similar in appearance, while the aerial coils engraved L. M. N, P, J* and K* are different, owing to the fact that they are provided with a D/F coupling socket. Four of these aerial coils can be seen on the right-hand side of the second row in fig. 11. Two further coils, similar in appearance and engraved S.50, are provided for the anode and aerial circuit. These coils have permeability tuning, the inductance of the winding being altered by means of a movable core.

48. Each coil consists of an ebonite former enclosed in a tube of synthetic-resin varnish-paper board. A metal cover provided with a knob is fitted to the top of all the coils, except the aerial coils L, M, N, P, J* and K*, where the D/F coupling is provided, and an ebonite base with five contact sockets is fitted to the bottom. The ebonite former is wound to the appropriate value of inductance for the frequency covered. The internal connections are illustrated in fig. 9 (anode coils) and in fig. 10 (aerial coils). The various external connections to the respective coil-holders are also shown.

Anode coils

49. The anode coils A, B, C, D and E cover the ranges 15,000 to 6,000 kc/s. As previously stated, each coil is wound on an ebonite former enclosed in a tubular shield. A ·0002μF condenser is connected across the sockets (3) and (4). The sockets (3) and (1) are short-circuited. All the anode coils A, B, C, D and E, have similar internal connections, but the windings are different for each coil. The internal connections are clearly shown in fig. 9.

50. The anode coil A, range 15,000 to 12,200 kc/s, is provided with two windings, one of 4 turns of 22 s.w.g. bare tinned copper wire connected between the sockets (3) and (5), starting at (3) and finishing at (5), and a second winding between the sockets (5) and (2) starting at (5) and finishing at (2), having 9 turns of 22 s.w.g. bare tinned copper wire.

51. The anode coil B, covering the range 12,200 to 9,500 kc/s, has two windings, one starting at (3) and finishing at (5) and consisting of 5 turns of 24 s.w.g. double cotton-covered copper wire, and the other starting at (5) and finishing at (2) and having 8 turns of 24 s.w.g. double cotton-covered wire.

52. The anode coil C, covering the range 9,500 to 8,500 kc/s, has two windings, one starting at (3) and finishing at (5) and consisting of 6 turns of 24 s.w.g. double cotton-covered copper wire, and the other starting at (5) and finishing at (2) and having 8 turns of 24 s.w.g. double cotton-covered wire.

53. The anode coil D, which covers the range 8,500 to 7,000 kc/s, consists of two windings ; one winding starts at (3) and finishes at (5) and has 8 turns of 24 s.w.g. double cotton-covered wire, and the other winding, which starts at (5) and finishes at (2) has 9 turns of 24 s.w.g. double cotton-covered wire.

54. The anode coil E, which covers the range 7,000 to 6,000 kc/s, consists of two windings ; one winding starts at (3) and finishes at (5) and has 11 turns of 24 s.w.g. double cotton-covered wire, and the other winding starts at (5) and finishes at (2) and has 10 turns of 24 s.w.g. double cotton-covered wire.

55. The group of anode coils F, G and H, covering the ranges 6,000 to 1,500 kc/s, will be considered next. As shown in fig. 9, the internal connections will be the same for each of these coils, the windings, of course, being different. The sockets (4) and (3), and (3) and (1), are short-circuited. The windings on the anode coil F, which covers the range 6,000 to 4,000 kc/s, consist of one which starts at the socket (3) and finishes at (5) having 14 turns of 24 s.w.g. double cotton-covered wire, and a second winding which starts at (5) and finishes at (2) having 12 turns of 24 s.w.g. double cotton-covered wire. The coil G, which covers the range 4,000 to 2,500 kc/s, has two windings, one of which starts at (3) and finishes at (5) and has 20 turns of 24 s.w.g. double cotton-covered wire, and the other which starts at (5) finishes at (2) and has 10 turns of 24 s.w.g. double cotton-covered wire. The windings of the anode coil H, which covers the range 2,500 to 1,500 kc/s, consist of one winding which starts at (3) and finishes at (5) and has 30 turns of 30 s.w.g. double silk-covered copper wire, and a second winding which starts at (3) finishes at (5) and has 20 turns of 30 s.w.g. double silk-covered copper wire.

56. The anode coils J and K, covering the range 1,500 to 785 kc/s, and illustrated in fig. 9, each have the sockets (1) and (3), and (3) and (4), short-circuited. Each coil has a winding (B) starting at socket (3) and finishing at socket (5), and another winding (C) starting at socket (5) and finishing at socket (2). The winding (B) for the coil J which covers the range 1,500 to

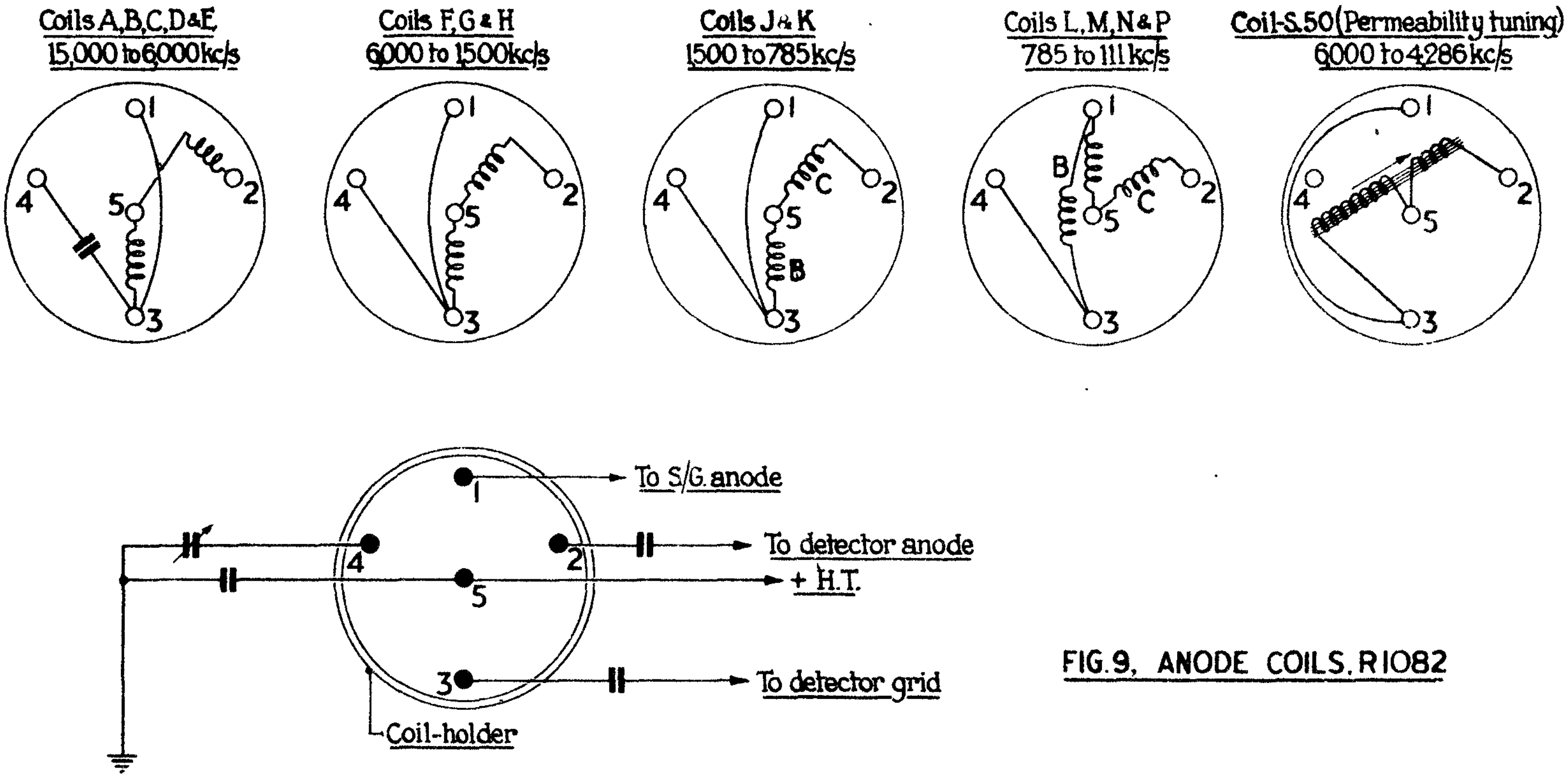

FIG. 9, ANODE COILS, R1082

1,200 kc/s, has 60 turns of 30 s.w.g. double silk-covered copper wire wound in the groove " B " to an inductance of 69 ± 4 mics. The winding (C) has 27 turns of 30 s.w.g. double silk-covered copper wire wound in groove " C " to an inductance of 38 ± 2 mics. The coil K which covers the range 1,200 to 785 kc/s, has a winding (B) of 80 turns of 30 s.w.g. double silk-covered copper wire wound in groove " B " to an inductance of 128 ± 7 mics, and a winding (C) of 37 turns of 30 s.w.g. double silk-covered wire wound in groove " C " to an inductance of 73 ± 4 mics.

57. The anode coils L, M, N and P covering the ranges 785 to 111 kc/s, illustrated in fig. 9, are each provided with two windings, one (C) between the sockets (5) and (2) starting at (5) and finishing at (2), and one (B) between the sockets (3) and (5), starting at (3) and finishing at (5). A tapping is taken off at a point along this latter winding and connected to the socket (1). Each coil has the sockets (3) and (4) short-circuited by a piece of 20 s.w.g. bare tinned copper wire. The coil covering the ranges 785–470 kc/s, has a winding (B) of 165 turns of 36 s.w.g. double silk-covered copper wire tapped at 50 turns from the end (3) and wound in the groove " B " to an inductance of 514 ± 12 mics, and a winding (C) of 48 turns of 36 s.w.g. double silk-covered copper wire wound in the groove " C " to an inductance of 111 ± 7 mics. The coil M, covering the range 470 to 280 kc/s, has a winding (B) of 250 turns of 36 s.w.g. double silk-covered copper wire tapped at 130 turns from the end (3) and wound in the groove " B " to an inductance of 1,329 ± 20 mics. The winding (C) of this coil has 72 turns of 36 s.w.g. double silk-covered copper wire wound in the groove " C " to an inductance of 254 ± 7 mics. The coil N, covering the range 280 to 170 kc/s, has a winding (B) of 400 turns of 40 s.w.g. double silk-covered copper wire tapped at 300 turns from the end (3) and wound in the groove " B " to an inductance of 3,333 ± 3 mics. The winding (C) has 80 turns of 40 s.w.g. double silk-covered copper wire wound in the groove " C " to an inductance of 328 ± 8 mics. The coil P, covering the range 170 to 111 kc/s, has a winding (B) of 650 turns of 42 s.w.g. double silk-covered copper wire tapped at 450 turns from the end (3) and wound in the groove " B " to an inductance of 8,718 ± 50 mics. The winding (C) for this coil has 80 turns of 42 s.w.g. double silk-covered copper wire wound in the groove " C " to an inductance of 367 ± 9 mics.

Aerial coils

58. A similar set of plug-in coils is provided for the aerial circuit, each coil having the same mechanical structure internally, but provided with different windings according to the different ranges covered. The aerial coils A, B, C, D and E, covering the ranges 15,000 to 6,000 kc/s, are each provided with a winding between the sockets (3) and (5), the winding starting at (3) and finishing at (5). The sockets (3) and (4) are short-circuited. Double cotton-covered copper wire is used for the windings for each of these coils. The winding for the coil A, which covers the range 15,000 to 12,200 kc/s, has 4 turns of 24 s.w.g. Coil B, which covers the range 12,200 to 9,500 kc/s, has 5 turns of 24 s.w.g. Coil C, which covers the range 9,500 to 8,500 kc/s, has 6 turns of 24 s.w.g. Coil D, covering the range 8,500 to 7,000 kc/s, has 8 turns of 24 s.w.g., and coil E, covering the range 7,000 to 6,000 kc/s, has 10 turns of 24 s.w.g. The connections referred to above are diagrammatically illustrated in fig. 10.

59. The group of aerial coils F, G, H, covering the ranges 6,000 to 1,500 kc/s, are each provided with a winding between the sockets (2) and (5), starting at (2) and finishing at (5). The terminals (2) and (4) are short-circuited. Double cotton-covered copper wire is used for the windings in each of these coils. The coil F, which covers the range 6,000 to 4,000 kc/s, has 12 turns of 24 s.w.g. The coil G, covering the range 4,000 to 2,500 kc/s, has 20 turns of 24 s.w.g., and the coil H, covering the range 2,500 to 1,500 kc/s, has 32 turns of 30 s.w.g. A diagram of connections for these three coils is shown in fig. 10.

60. The aerial coils J and K, covering the ranges 1,500 to 1,200 kc/s and 1,200 to 785 kc/s, respectively, are each provided with a winding (B) starting at the socket (2) and ending at the socket (5). The sockets (2) and (4) are short-circuited. The windings for both coils are made up of double silk-covered copper wire. The coil J, covering the range 1,500 to 1,200 kc/s, has a winding of 63 turns of 30 s.w.g., wound in the groove (B) to an inductance of 70 ± 3 mics. The coil K, covering the range 1,200 to 785 kc/s, has 80 turns of 30 s.w.g., wound in groove " B " to an inductance of 133 ± 7 mics.

61. The aerial coils L, M, N and P, covering the ranges 785 to 111 kc/s, each consist of a special bobbin and core mounted on pillars of synthetic-resin varnish-paper board, enclosed in a tube of similar material and fitted with contact sockets. At the top of each coil is fitted a monel metal cap and screen, and a socket-holder of synthetic-resin varnish-paper board carrying two brass sockets for external connections. An additional winding or coupling is provided, as can be seen in fig. 10 (aerial coils) which enables the coils to be used either for ordinary working or, when used in conjunction with an external coil in the aeroplane, for D/F purposes. This additional winding or coupling coil is centre-tapped to earth. Each coil is also provided with a winding between the sockets (5) and (2). This winding is made up in halves, one half starting at (5) and the other half starting at (2). The " finish " ends of the halves are joined together after the windings have been adjusted, so that the inductance of each half is as nearly equal as possible. The coupling winding for each coil is wound in halves side by side. The " start " of each half is joined to the socket (5), after the adjustment of the windings to the correct inductance. The " finish " of each half is connected to the sockets provided for accommodating the D/F loop. In addition, the sockets (1) and (2) are short-circuited. A monel metal screen surrounds the D/F sockets and it is provided with five slots which are each ·03 in. wide and one slot which is ·25 in. wide and ·5 in. deep. A projection on the D/F loop plug fits into this slot and thus ensures the correct polarization of the loop in relation to the coupling coil. The coils are so assembled that the wide slot in the screen is in the correct position relative to the locating screw provided on the side of the coil body.

62. Two additional coils J* and K*, covering the same ranges as the aerial coils J and K, *viz.*, 1,500 to 1,200 kc/s and 1,200 to 785 kc/s, respectively, have D/F windings similar to the aerial coils L, M, N and P. These two coils have been provided in order to extend the frequency range over which D/F may be used. In future each set of coils will comprise anode coils A, B, C, D, E, F, G, H, J, K, L, M, N, P, and aerial coils A, B, C, D, E, F, G, H, J, K, L, M, N, P, J* and K*.

63. The windings of aerial coils L, M, N, P, J* and K* are made up of double silk-covered copper wire, the number of turns of course being different. The coupling winding for the coils L, M, N, P, have approximately 32 turns per side of 38 s.w.g., the total inductance of both halves being 168 ± 7 mics. The coupling winding for both coils J* and K* have approximately 14 turns of 34 s.w.g. per side, the total inductance of both halves being 40 ± 3 mics.

64. The winding between the sockets (5) and (2) on the coil L which covers the range 785 to 470 kc/s, consists of 50 turns of 38 s.w.g. per side, the total inductance being 330 ± 8 mics. The coil M covering the range 470 to 280 kc/s, has a similar winding of 87 turns of 38 s.w.g. per side, having a total inductance of 935 ± 11 mics. The winding on the coil N which covers the range 280 to 170 kc/s, has 150 turns of 38 s.w.g. per side and a total inductance of 2,590 ± 22 mics. The winding on the coil P which covers the range 170 to 111 kc/s, has 250 turns of 38 s.w.g. per side and a total inductance of 7,000 ± 30 mics.

65. The two coils J* and K*, which cover the ranges 1,500 to 1,200 and 1,200 to 785 kc/s respectively, are each provided with a winding between the sockets (5) and (2), made up of 38 s.w.g. double silk-covered copper wire. The winding on the coil J* has 24 turns per side and a total inductance of 72 ± 2 mics, and the coil K* has 33 turns per side, having a total inductance of 135 ± 3 mics.

66. In addition to the thirty coils described above, two special aerial and anode tuning coils, engraved S.50, are provided. These coils are of variable inductance. The core is arranged to slide through the bobbin carrying the windings, and adjustment is effected by means of a lead screw operated by a knob fitted at the top of the coil. Each coil is provided on the top with a device to indicate the position of the core. The anode coil only is arranged for operation by mechanical remote control, the knob being provided with a square hole to accommodate the coupling control mechanism. The core consists of a cylindrical plug of Polyiron, fitted with an inner sleeve of brass, through which the operating screw passes. The plug is concentric with the exterior and it is greased to provide smooth easy movement within the ebonite coil former. Both coils are arranged to cover the range 6,000 to 4,286 kc/s.

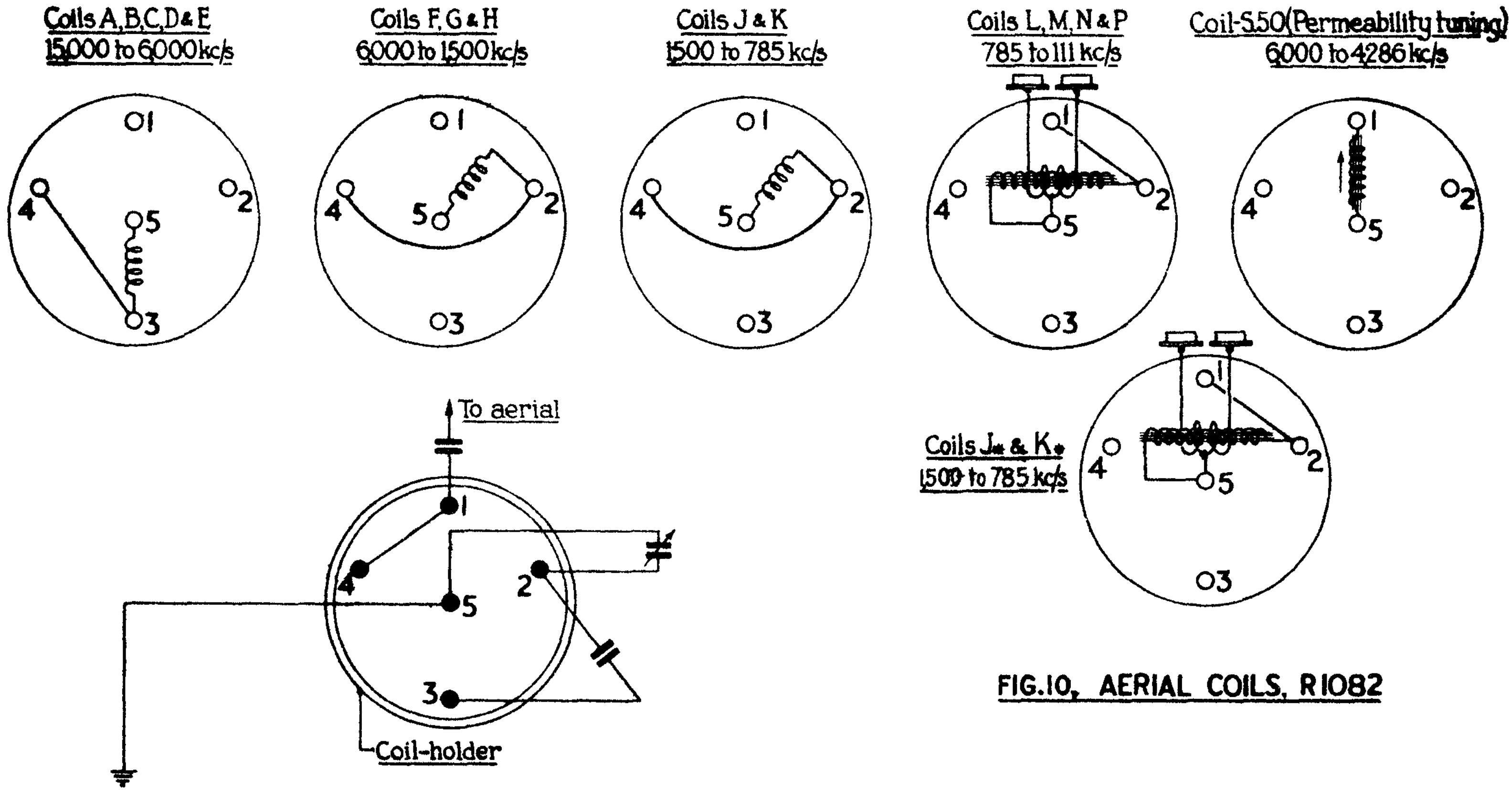

FIG.10, AERIAL COILS, R1082

Facing paras. 61-66.

FIG. 11. Receiver coils in carrying case.

67. The anode permeability tuning coil is connected up internally as shown on the extreme right in fig. 9, one winding being connected between the sockets (2) and (5) and another winding being connected between the sockets (5) and (3). The sockets (1) and (3) are short-circuited. The winding between the sockets (2) and (5) has 10 turns of 24 s.w.g. double silk-covered copper wire. The winding between the sockets (5) and (3) has 28 turns of 24 s.w.g. double silk-covered copper wire. Both windings are close-wound, any remaining space being filled up with waxed sailmaker's twine. The movable core is common to both windings.

68. The aerial tuning coil, S.50, which covers the range 6,000 to 4,286 kc/s has only one winding, connected up as shown in the diagram on the extreme right in fig. 10. The winding is connected up between the sockets (1) and (5) and consists of 26 turns of 22 s.w.g. double cotton-covered copper wire close-wound on the bobbin, any remaining space being filled with waxed sailmaker's twine.

Sense unit

69. The unit is carried on the top of the receiver and is brought into circuit by means of plug-and-socket connections. When inserted it introduces a change-over switch into the D/F loop connections and a 3-pole switch into the fixed aerial connection. The change-over switch enables the loop connections to be reversed and is engraved BEARING and RECIPROCAL. The three-position switch enables the fixed aerial to be connected up directly, or through an adjustable resistance or disconnected altogether. It is engraved TRAFFIC, SENSE and D/F.

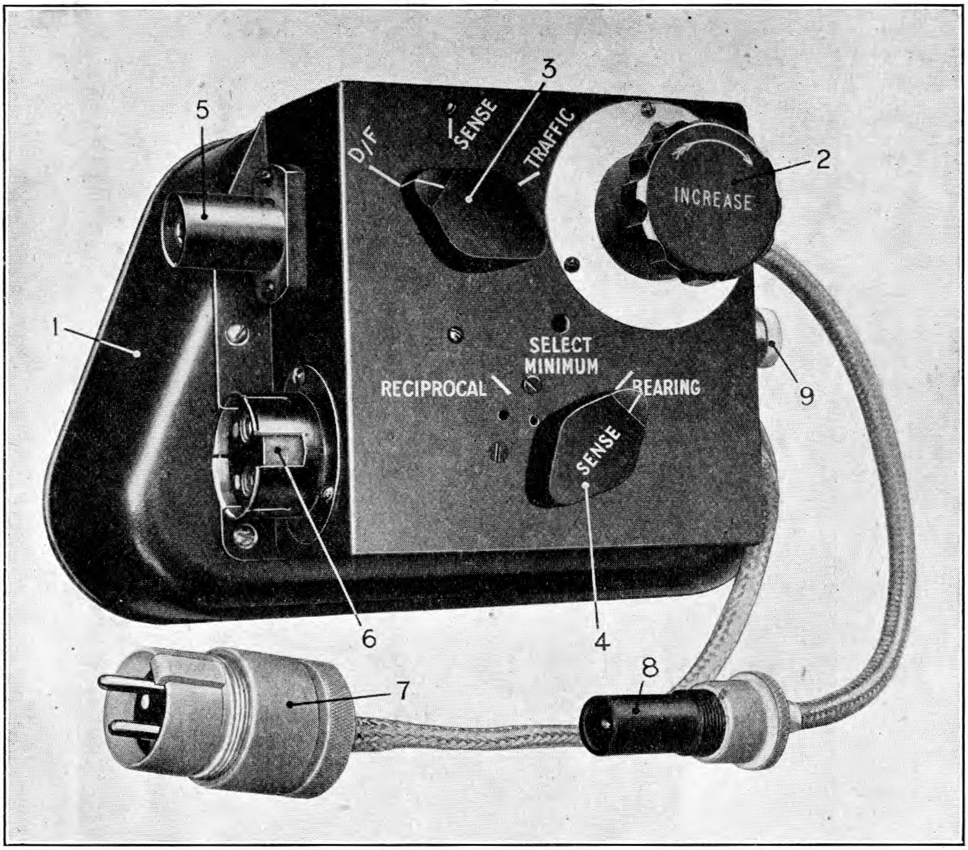

FIG. 12. Sense unit.

70. The sense unit is illustrated in fig. 12. The cover (1) is the normal valve cover of the receiver and the sense unit is secured to it by four screws, one in each corner. The control (2) for the adjustable resistance is mounted in the top right-hand corner and near it is a three-position switch (3) suitably engraved. The change-over switch (4) enables the loop connections to be reversed.

71. The aerial lead which terminates in a plug, type 68, fits into the socket (5). The D/F loop is connected by a plug, type 101, with the socket (6). The plug (7) fits into the socket provided on the receiver aerial coils and has a projection to ensure correct engagement. The single-pole plug (8) is fitted into the aerial socket of the receiver. An earth terminal (9) is provided on the side of the sense unit. When the unit is connected up in this manner the switches may be operated to effect the circuit changes mentioned above.

VALVES AND BATTERIES

72. The receiver employs one V.R.18 screen-grid valve (2 volts 0·15 amp.) in the R./F. stage, a V.R.27 valve (2 volts, ·1 amp.) in the detector stage, two V.R.21 valves (2 volts, ·1 amp.) in the first and second audio-frequency stages, a V.R.22 valve (2 volts ·2 amp.)

in the output stage and a V.U.33 valve (2 volts, ·4 amp.) as the damping or limiting valve. The low tension supply for the receiver is obtained from a 2-volt accumulator, and the high tension supply is obtained from a 120-volt H.T. battery. The grid bias is " automatic."

INSTALLATION

73. In fig. 13 is given a typical installation diagram showing receiver R.1082 used in conjunction with transmitter T.1083. The H.T. and L.T. supply reaches the receiver through a 4-point socket which engages with a 4-point plug on the receiver. In the crate is situated the 120-volt H.T. battery and 2-volt accumulator for the receiver and the 8-volt accumulator for the transmitter filaments. The receiver is permanently earthed by means of a plug-and-socket connection, and a connection is taken from the aerial socket of the receiver to the listening-through unit situated on the transmitter. This unit is connected to the transmitter in such a way that the receiver is connected to the transmitter inductance through a small condenser. The receiver being connected up through a condenser whilst the transmitter is actually in operation, enables the operator to listen between pauses in the transmission without having to operate the change-over switch.

74. For D/F work the screened loop and fixed aerial are connected up to the receiver through the sense unit. Switches on the sense unit enable the necessary change of connections to be made. A connection between the transmitter and receiver enables the audio-frequency amplifying portion of the receiver to be utilized for telephonic communication between the occupants of the aeroplane. This is accomplished by providing a 4-point jack at each position, one pair of contacts of each jack being wired in parallel to a microphone plug engaging with a socket on the transmitter, and the other pair of contacts being wired in parallel to a telephone plug engaging with a socket on the receiver. The 4-way cord connected to the telephone and microphone worn by each occupant terminates in a 4-way plug. When this plug is inserted in the above-mentioned jack, the microphone is connected to the microphone transformer in the transmitter and the telephone is connected in the output circuit of the receiver. Thus, during transmission, any one of the occupants, by speaking into his microphone, may transmit R/T and during reception he may speak through the receiver to the other occupants.

75. The remote control apparatus provides for operation of the send-receive switch and also provides, when required, a means of varying (from the pilot's seat) the tuning of the anode inductance of the receiver when on the 4,286 to 6,000 kc/s band.

OPERATION AND ADJUSTMENT

Receiver

76. Plug in the aerial and anode coils for the required wavelength. The appropriate coils may be selected by referring to table I. See that the aerial and earth plugs are inserted and that the H.T. and L.T. supply plug is in position. Plug in the telephones and put the battery switch into the on position.

77. Set the volume control to maximum and if C.W. reception is required increase reaction until oscillation commences. If a C.W. signal is being received, oscillation of the receiver will be indicated by a heterodyne note. If there is no incoming signal, a finger should be momentarily placed on the oscillation testing pin. A click indicates that the receiver is oscillating. The receiver normally has a quiet background, and a low " noise level " does not indicate that the receiver is faulty or insensitive.

78. Tune the receiver with the aerial and anode condensers. The anode tuning is sharp and the aerial tuning relatively flat. Searching, especially on the higher frequencies, should be carried out by means of the slow motion anode tuning dial, the aerial circuit being subsequently brought into tune. When receiving weak I.C.W. signals on the high frequency band, the volume

control is set to maximum and a high degree of reaction is employed. Under these conditions correct tuning of the aerial circuit will be accompanied by a tendency of the receiver to oscillate. When this indication (that the two circuits are in tune) is obtained, reaction should be reduced.

79. When a strong signal is being received, an increase in selectivity can be obtained by first reducing the signal strength by means of the volume control, and then increasing the strength by means of the reaction control. Care must be exercised in using the reaction handle that excessive reaction does not occur. This will be indicated by a loud howl. The volume control should be used to limit very strong C.W. signals as otherwise there is a possibility that the local oscillations may be " pulled into step " with a consequent loss of the heterodyne note.

80. Maximum sensitivity for the reception of weak C.W. signals is obtained when reaction is reduced to the lowest value which will maintain oscillation. A final slight adjustment to the tuning controls should be made after this reduction. For very strong signals the alternative (loose coupled) aerial terminal should be used to obtain maximum selectivity. A re-adjustment of the aerial tuning condenser will be necessary after changing.

81. The method of setting the permeability tuning coil for remote control of tuning (anode only) is dealt with under " Remote Control ".

Direction finding

82. With the T.1083–R.1082 installation the listening-through unit should be connected up for " free receiver " and the send-receive switch placed in the " receive " position.

Bearing

83. Identify and tune in a suitable transmitting station with the switch in the " Traffic " position. Disconnect the fixed aerial from the receiver. Move the T.D.S. switch to D/F. Swing the loop through 360° observing where the two minima occur. When using the remote indicator always read from the yellow pointer. Very broad minima should not be used if another suitably located transmitter can be selected which will give better results. It should be borne in mind that the broader the minima the less will be the accuracy. Having obtained satisfactory minima carefully note the mid-point of one. This may be either the bearing or its reciprocal.

Determination of sense

84. Proceed as above and after having noted the reading obtained, swing the loop so as to bring the sense pointer into the position previously occupied by the yellow pointer (or when using the loop without remote control, until the red engraving on the loop reads the figure obtained from the white scale), re-connect the *fixed* aerial (the trailing aerial *must not* be used) and turn the switch to SENSE. Now reverse the connection of the loop by means of the switch provided on the sense unit, repeatedly changing over and observing the change in signal strength from one position to the other. The variable resistance incorporated in the sense unit and connected in series with the fixed aerial may require adjustment to produce the maximum change.

85. The reversing switch is engraved in white characters at one position BEARING, and at the other RECIPROCAL. If the minima occurs at BEARING then the figure noted (*see* para. 83) is the bearing. If the minima occurs at RECIPROCAL then the figure is the reciprocal.

PRECAUTIONS AND MAINTENANCE

86. When a new receiver and valves are put into use the L.T. should be connected to the receiver through an ammeter. Each valve should then be inserted separately and the filament current checked. The H.T. should be connected through a milliammeter, each valve inserted separately, and the anode current checked.

87. A check should be made to ensure that the volume control gives smooth control of anode current in the screen-grid valve. There should be a smooth control of the detector anode current when the reaction control is operated. Lack of volume control can usually be traced to a faulty screen-grid valve.

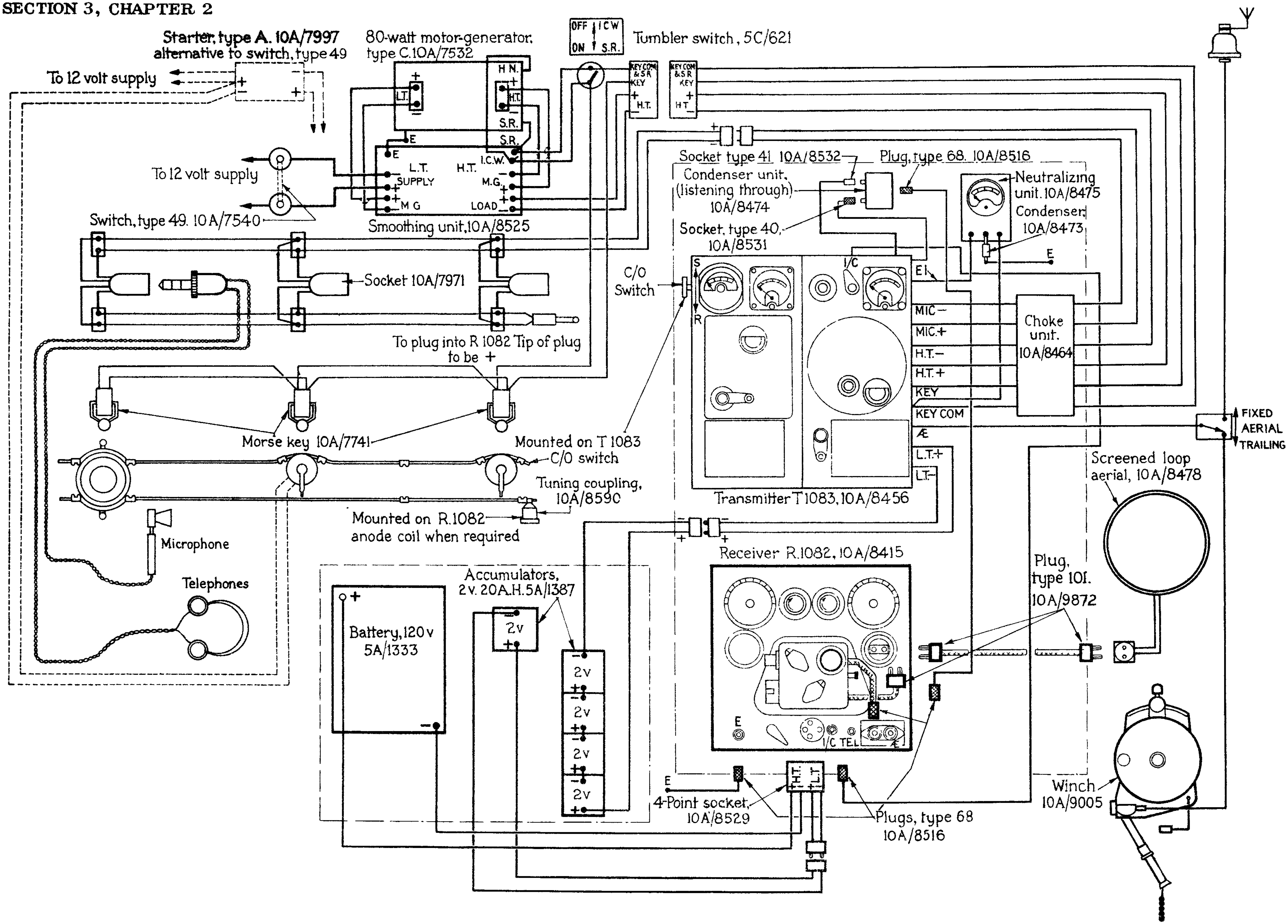

FIG. 13. INSTALLATION DIAGRAM

Facing paras. 73-87.

P.1894

88. In the event of a failure of the automatic bias resistor, a new one may be improvised by winding each half non-inductively with 38 s.w.g. d.s.c. Eureka wire to a value of 150 ohms. In the event of a failure of the screen-grid valve, and no other is available, temporary reception may be obtained by removing the valve cover and attaching the aerial direct to the anode connection of the screen-grid valve. It should be noted that listening-through will not be possible with this arrangement.

89. Possible causes of a noisy receiver may be traced to :—a microphonic valve ; the metallizing of the valve may be touching the screen ; a faulty potentiometer. By packing cotton wool round the valves, the first two faults may be remedied. Noises when listening-through may be traced to :—a faulty smoothing unit, dirty commutators and ill-fitting brushes on the motor generator failure to break smoothing unit earth connection when listening-through at high frequencies.

90. Care should be taken to prevent denting of the metal valve cover, as this may cause the cover to touch the valves and possibly damage them.

91. The low tension battery should be removed for re-charging at frequent intervals. The high tension battery should be changed if the voltage falls below 100 volts, measured on load.

92. When the receiver is put out of use for any length of time, it must be switched off by means of the switch provided. Disconnection of the L.T. accumulator is not sufficient as there would then still be a potentiometer load on the H.T. battery.

93. To test a limiter valve, tune the receiver on the bench to a steady weak signal and withdraw the limiter. An increase of signal strength indicates a faulty limiter, which must be changed. The test should be made frequently, say at every 10-hour inspection, or gradual deterioration of the receiver performance may otherwise pass unnoticed.

94. No attempt should be made to change valves without first placing the H.T.—L.T. switch in the off position. This is especially important in respect of the screen-grid valve. The flexible connection to the anode of the screen-grid valve is provided with an insulated termination, but it is possible for the metal portion of this to make contact with earth (e.g. the screen or the metal coating of the valve) and so cause a short-circuit if the H.T. has not been previously broken. As the automatic bias resistance is connected between H.T.— and earth there is a danger of the resistance being damaged and possibly burnt out in the event of such a short-circuit occurring. Damage to the automatic bias resistance would also occur in the event of an accidental earth on the positive terminal of the H.T. battery. It is important to note that in this latter event damage would result irrespective of the position of the L.T.—H.T. switch, and if the accidental earth remained on for any appreciable time, the resistance would almost certainly be burnt out.

TABLE 1

Anode and aerial coil ranges

Anode Coils.	Aerial Coils.	Frequency range in kc/s.	
A	A	15,000 to 12,200	
B	B	12,200 to 9,500	
C	C	9,500 to 8,500	
D	D	8,500 to 7,000	
E	E	7,000 to 6,000	
F	F	6,000 to 4,000	
G	G	4,000 to 2,500	
H	H	2,500 to 1,500	
J	J	1,500 to 1,200	
K	K	1,200 to 785	
L	L	785 to 470	With D/F coupling.
M	M	470 to 280	With D/F coupling.
N	N	280 to 170	With D/F coupling.
P	P	170 to 111	With D/F coupling.
	J*	1,500 to 1,200	With D/F coupling.
	K*	1,200 to 785	With D/F coupling.
S.50	S.50	6,000 to 4,286	Permeability tuning.

APPENDIX

NOMENCLATURE OF PARTS

The following list of parts is issued for information. In ordering spares for this receiver the appropriate section of AIR PUBLICATION 1086 must be used.

Ref. No.	Nomenclature.	Quantity.	Remarks.
10A/8415	Receiver R.1082		Complete without coils and valves.
	Principal components :—		
	Case		
10A/8416	Inner	1	Screening.
10A/8417	Outer	1	Wood.
10A/7384	Choke, L/F, type B	1	
	Condenser		
10A/7901	Type 120	3	0·001 μF.
10A/7902	Type 121	2	0·0001 μF.
10A/8009	Type 132	2	0·0005 μF.
10A/8275	Type 164	2	2·0 μF.
10A/8378	Type 168	1	4·0 μF.
10A/8386	Type 176	1	0·00005 μF.
10A/8388	Type 178	2	0·0002 μF.
10A/8490	Type 182	2	0·0003 μF, variable.
10A/8492	Type 184	2	10·0 $\mu\mu$F.
10A/9223	Type 291	1	0·5+0·5 μF, paper dielectric in metal case.
10A/9186	Type 292	1	2·0 μF, paper dielectric, metal case.
10A/8418	Cover, valve, screening	1	Fitted with engraved range plate and tuning log plate.
10A/8510	Handle, condenser, vernier drive, type D	2	
	Holder, valve		
10A/8597	Type L	1	4-pin with triangular mounting flange.
10A/9194	Type R	5	4-pin.
10A/9195	Plate, guard	5	For valve-holders.
10A/9196	Plate, guide	5	For valve-holders.
10A/1739	Jack, telephone, type A	1	
10A/8515	Plug, type 67	1	
	Resistance		
10A/7956	Type 103	1	5,000 ohms.
10A/8015	Type 107	2	0·05 Ω variable.
10A/8016	Type 108	5	0·5 M Ω.
10A/8017	Type 109	2	2·0 M Ω.
10A/8018	Type 110	1	0·25 M Ω.
10A/8019	Type 111	3	0·1 M Ω.
10A/8021	Type 113	1	0·02 M Ω.
10A/8117	Type 123	1	1·0 M Ω, $\frac{1}{2}$-watt, rod type.
10A/8519	Type 145	1	0·2 M Ω, $\frac{1}{2}$-watt, rod type.
10A/8520	Type 146	1	150 Ω plus 150 Ω, wire wound bobbin.
10A/8521	Type 147	1	0·75 Ω plus 1·5 Ω, wire wound bobbin.
	Socket		
10A/8527	Type 37	1	2-way, for panel mounting.
10A/8528	Type 38	2	Single pole, for panel mounting.
10A/8536	Type 84	1	D.P., on-off rotary type, with gold-silver contacts.

Ref. No.	Nomenclature.	Quantity.	Remarks.
	Receiver R.1082—*continued.*		
	Accessories :		
	Case, transit :		
10A/8420	28 coils	1	
10A/8419	6 coils	1	
10A/8421	Receiver	1	
	Coil, aerial :		
10A/8422	Range A	1	12,200–15,000 kc/s.
10A/8423	Range B	1	9,500–12,200 kc/s.
10A/8424	Range C	1	8,500– 9,500 kc/s.
10A/8425	Range D	1	7,000– 8,500 kc/s.
10A/8426	Range E	1	6,000– 7,000 kc/s.
10A/8427	Range F	1	4,000– 6,000 kc/s.
10A/8428	Range G	1	2,500– 4,000 kc/s.
10A/8429	Range H	1	1,500– 2,500 kc/s.
10A/8430	Range J	1	1,200– 1,500 kc/s.
10A/9580	Range J*	1	1,200– 1,500 kc/s, with D/F socket.
10A/8431	Range K	1	785–1,200 kc/s.
10A/9581	Range K*	1	785–1,200 kc/s, with D/F socket.
10A/8432	Range L	1	470–785 kc/s, with D/F socket.
10A/8433	Range M	1	280–470 kc/s, with D/F socket.
10A/8434	Range N	1	170–280 kc/s, with D/F socket.
10A/8435	Range P	1	111–170 kc/s, with D/F socket.
10A/8436	Range S.50	1	4,286–6,000 kc/s. Permeability tuning coil.
	Coil, anode :		
10A/8439	Range A	1	12,200–15,000 kc/s.
10A/8440	Range B	1	9,500–12,200 kc/s
10A/8441	Range C	1	8,500– 9,500 kc/s.
10A/8442	Range D	1	7,000– 8,500 kc/s.
10A/8443	Range E	1	6,000– 7,000 kc/s.
10A/8444	Range F	1	4,000– 6,000 kc/s.
10A/8445	Range G	1	2,500– 4,000 kc/s.
10A/8446	Range H	1	1,500– 2,500 kc/s.
10A/8447	Range J	1	1,200– 1,500 kc/s.
10A/8448	Range K	1	785– 1,200 kc/s.
10A/8449	Range L	1	470– 785 kc/s.
10A/8450	Range M	1	280– 470 kc/s.
10A/8451	Range N	1	170– 280 kc/s.
10A/8452	Range P	1	111– 280 kc/s.
10A/8453	Range S.50	1	4,286–6,000 kc/s. Permeability tuning coil, arranged for remote control.
	Valve		
10A/7607	V.R.18	1	Screen-grid, 2 V, 0·15 amp, in R/F stage.
10A/7738	V.R.21	2	2 V, 0·1 amp, in A/F stage.
10A/7958	V.R.22	1	2 V, 0·2 amp, in output stage.
10A/9829	V.U.33	1	Limiter, 2 V, 0·4 amp.
10A/8239	V.R.27	1	2 V, 0·1 amp, in detector stage.
	Accessories, installation :		
5A/1387	Accumulator, 2 V, 20 Ah.	1	For use with R.1082.
10A/8487	Aerial, screened loop	1	For D/F with R.1082.
5A/1615 or 5A/1333	Battery, dry, 120 V	1	To suit location. For use with R.1082.
	Controls, remote, comprising :		
10A/8580	Adaptor, ring, change-over switch		On which a switch, coupling, type E, is mounted.

Ref. No.	Nomenclature	Quantity.	Remarks.
	Receiver R.1082—*continued.*		
	Controls, remote, comprising—*continued.*		
10A/8189	Casing, flexible, type C		
10A/8190	Casing, rigid, type C		
	Cleat, type C		For securing casing rigid to aeroplane structure.
10A/8187	Control switch and tuning, type C ..		
10A/8592	Coupling, pedestal		For remote control of coil, anode, S.50, on R.1082.
10A/8590	Coupling, tuning		For remote control of coil, anode, S.50, on R.1082.
10A/4178	Gun, lubricator, type B		For use with 10A/9119.
10A/9515	Pin, key, type C		For use with unions, casing, type B.
10A/8192	Shafting, flexible, type C		
10A/8745	Switch, type 89		Mounted on underside of switch, coupling.
10A/8746	Switch, coupling, type E		For " send-receive ".
10A/8193	Union, casing, type B..		Quantity as required.
10A/9119	Union lubricating, type C		Quantity as required.
5A/359	Lamp, filament, 2·2 volt, miniature, festoon.	2	Dial light.
10A/8541	Lamp-holder	2	
10A/7532	Motor-generator, type C, 80 watt ..	1	For use with T.1083.
	Plug		
10A/8118	Type 62..	1	2-pin, for use with T.1083.
10A/8516	Type 68..	3	For use with R.1082.
10A/8517	Type 69..	1	4-point, for use with T.1083.
10A/9872	Type 101	2	For use with R.1082.
	Socket		
10A/7437	Type 19..	2	For use with T.1083.
10A/8529	Type 39..	1	4-pole, circular body, for use with R.1082.
10A/8533	Type 42..	1	4-point, for use with T.1083.
10A/7997	Starter, automatic, type A	1	Alternative to 10A/7540.
5C/621	Switch, tumbler	1	I.C.W.-C.W.
	Unit, condenser		
10A/8473	Earth	1	Combined condenser and resistance.
10A/8474	Listening-through	1	Combined condenser and plug and socket connectors.
10A/8475	Neutralizing	1	Consisting of one each 0–5 thermo-ammeter and type 86 switch and lamp socket.
10A/8525	Unit, smoothing	1	
10A/11120	Sense unit	1	

CONCISE DETAILS OF RECEIVER R.1082

PURPOSE OF EQUIPMENT	Air-borne receiver for use with T.1083. Used for D/F and I/C
TYPE OF WAVE	C.W., I.C.W. and R/T reception
FREQUENCY RANGE	111 kc/s to 15 Mc/s.
FREQUENCY STABILITY	Not applicable
CRYSTAL MULT. FACTOR	Not applicable
PERCENTAGE MODULATION	Not applicable
MAXIMUM SENSITIVITY	5 milliwatts from maximum 25 microvolts input 400 cycles modulated 40 per cent.
SELECTIVITY	—
OUTPUT IMPEDANCE	20,000 ohms
AMPLIFIER CLASS	Class A
MICROPHONE TYPE	Not applicable
VALVES	R/F amplifier V.R.18 (Stores Ref 10E/7607) Detector V.R.27 (Stores Ref. 10E/8239) A/F amplifier (2) V.R.21 (Stores Ref. 10E/7738) Output amplifier V.R.22 (Stores Ref. 10E/7958) Limiting valve V.U.33 (Stores Ref. 10E/9829)
POWER INPUT	H.T. 120 v., 13 mA max. L.T. 1·15 amp., 2 volts.
POWER OUTPUT	5 milliwatts (under test conditions)
STORES REF. NO.	10D/8415
APPROXIMATE OVERALL DIMENSIONS	LENGTH 10½ in. — WIDTH 11½ in. — HEIGHT 9 in.
WEIGHT	14½ lb. including coils and valves
ASSOCIATED EQUIPMENT	Accumulator, 2 v. 20 Ah. (Stores Ref. 5A/1387) Aerial, screened loop (Stores Ref. 10B/8487) Battery, dry, 120 v. (Stores Ref. 5A/1615 or 5A/1333) Control, remote, type 3 (Stores Ref. 10J/9521)

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SECTION 3, CHAPTER 3

RECEIVER R.1084

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List of Illustrations

RECEIVER R.1084

(Stores Ref. No. 10A/8301)

INTRODUCTION

1. The Receiver R.1084 is a general purpose ground station receiver, the frequency range of which is 120 to 20,000 kc/s, and reception of both modulated and unmodulated signals is possible over the whole of the range. The receiver is of the supersonic-heterodyne type, thirteen valves being employed. Provision is made for using the receiver as a " straight " receiver when desired. In fig. 3 is given a circuit diagram of the receiver from which it will be seen that the essentials are a radio-frequency amplifier, a supersonic-frequency amplifier and an audio-frequency amplifier and output stage.

FIG. 1.—Receiver with lid open.

2. A separate radio-frequency oscillator is provided to beat with the signal frequency and produce the supersonic-frequency. This oscillator is coupled to the first detector through an isolator or buffer valve, the latter being necessary to prevent coupling between the radio-frequency amplifier and the oscillator in order that the tuning of the oscillator shall not be affected.

3. A heterodyne oscillator is coupled to the last stage of the S/F amplifier to enable C.W. signals to be received by the beat method. The frequency of the oscillator can be adjusted within narrow limits to provide a correct beat note.

4. The anode circuit of the first detector and the anode circuits of the four S/F. amplifying valves are each provided with alternative tuned circuits adjusted to the same frequency but having different characteristics. By means of a switch situated at the top of each coil unit one or other of these circuits can be switched in as required. As there are five circuits of this type, the selectivity of the supersonic-frequency amplifier can be varied between wide limits. The characteristics of the circuit are so arranged that there is little change in the gain of the amplifier when switching over from the high selectivity circuit to the low selectivity circuit.

5. The second detector is coupled to one stage of audio-frequency amplification followed by an output valve. The coupling between the second detector and the audio-frequency valve may be either resistance-capacitance or by an audio-frequency filter circuit tuned at 1,000 cycles. A switch enables either form of coupling to be used as required. The audio-frequency valve and the output valve are resistance-capacitance coupled, and a choke-capacitance output circuit is provided. The output circuit is suitable for a high resistance load such as the standard high resistance telephones.

6. The tuning inductances of the receiver consist of plug-in coils, the radio-frequency circuits and the radio-frequency oscillator each having eleven coils to cover the frequency range. The four supersonic-frequency circuits, second detector and heterodyne oscillator circuits all have interchangeable coils providing alternatives of 40 and 167 kc/s.

7. On the front of the receiver the following controls are provided. A single control operating the three ganged main tuning condensers for tuning the three radio-frequency circuits to the signal frequency. (Three trimming condensers are provided in the receiver. These are pre-set but usually require re-adjustment when the coil units are changed.) To the right of this is a condenser control for the radio-frequency oscillator. This enables the radio-frequency oscillator to be adjusted to produce a resultant frequency similar to that to which the supersonic-frequency amplifier is tuned. Fine tuning is also provided on this. Near the R/F. oscillator a variable tuning condenser is also provided to control the heterodyne oscillator. This enables variation to be made in the audio-frequency note.

8. Three volume control potentiometers are provided; one for the radio-frequency valves, one for the supersonic-frequency amplifying valves, and one on the control grid of the isolator or buffer valve. Normally the latter gives control of the radio-frequency oscillator.

9. In order to allow for possible variation in the characteristics of detector valves, a pre-set bias adjustment is provided so that the particular valve can be made to give the best rectification for weak signals. This adjustment finds its greatest utility when the receiver is operating as a "straight" receiver. When the receiver is used as a superheterodyne the grid bias on the detector valve is not critical.

10. The change from superheterodyne to "straight circuit" is effected by moving two switches. These cut out the supersonic-frequency amplifier, and the receiver then consists of two radio-frequency stages, detector, audio-frequency and output stages and a separate heterodyne oscillator. The separate heterodyne function is performed by the valve circuit which previously acted as R/F oscillator.

11. When the R.1084 is used in conjunction with ground station transmitters, a modification has been introduced whereby R/F side-tone is provided. The modification consists essentially of re-wiring the three potentiometers so as to introduce an external potentiometer. A six-pin plug (Stores Ref. 10A/9618) has been introduced into the circuit (*see* fig. 5). Four pins are used for H.T. and L.T. One is engraved S.T. and is the junction point of the three potentiometers, and the remaining pin is engraved E and is connected to the receiver chassis. A side-tone unit, type F (Stores Ref. 10A/11834), has been devised consisting of a potentiometer and a switch engraved SEND and RECEIVE. In the "receive" position the potentiometer is short-circuited and the normal R/F and S/F bias is applied. In the "send" position the switch removes the

short circuit, introduces the potentiometer and, in addition, switches on the transmitter H.T. supply and closes the circuit for the microphone and pilot lamp. This modification applies to all receivers R.1084, both in service and in store. Future contracts of the receiver will also be modified.

12. An output limiter (Stores Ref. 10A/10520) has been provided for use with the receiver. It consists of a metal box in which are mounted four metal rectifiers, a switch and a telephone jack. It should never be used on R/T owing to the large amount of distortion produced, its use being confined to C/W.

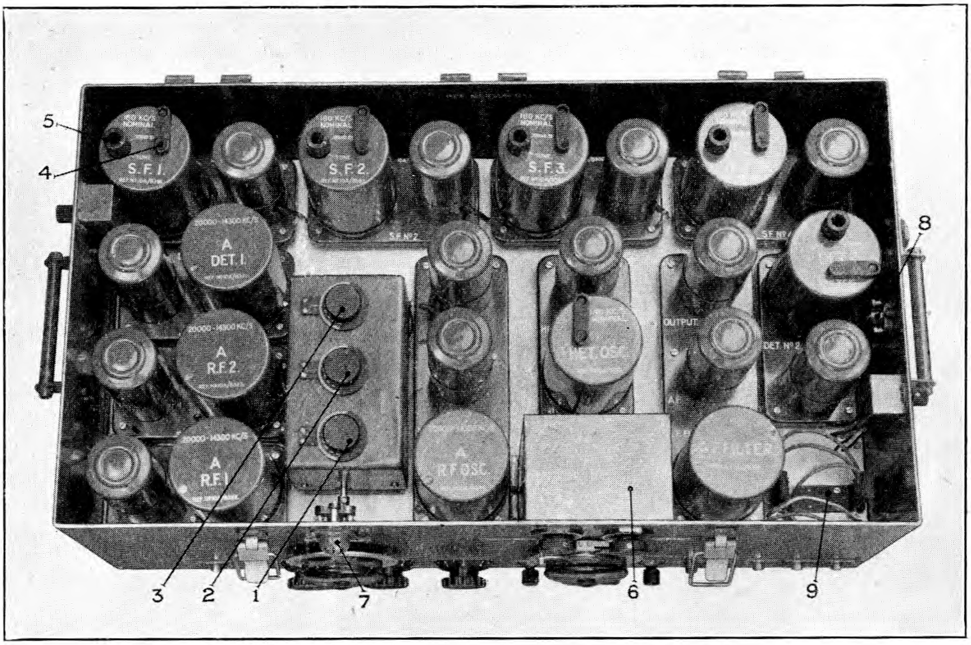


FIG. 2.—Plan view of receiver.

GENERAL DESCRIPTION

Receiver

13. The Receiver R.1084 functions on the supersonic-heterodyne principle. A theoretical circuit diagram of the receiver is given in fig. 3. V_1 and V_2 are the radio-frequency valves, V_3 the first detector valve, V_4, V_5, V_6 and V_7 the supersonic-frequency valves, V_8 the second detector valve and V_9 and V_{10} the audio-frequency and output valves respectively. The isolator valve V_{11} couples the radio-frequency oscillator valve V_{12} to the first detector. The heterodyne oscillator V_{13} is coupled to the last stage of the supersonic-frequency amplifier.

14. It will be observed that there are three aerial terminals provided. When terminal AE 1 is used, a small condenser C_1 is in circuit between the aerial and the aerial inductance L. When the terminal AE 2 is in use, the condenser is cut out. Aerial terminal AE 3 provides a coupling connection to the aerial inductance for use with a dipole aerial. The inductance L is tuned by means of the condenser C_4, across which is a trimming condenser C_5. The control grid of the variable-mu screen-grid valve V_1, is coupled to the aerial inductance by means of the condenser C_3, and is connected through the resistance R_1 to the potentiometer R_{55}. The anode circuit

of the valve V_1 includes the inductance L_1, which is fed with H.T. through the resistance R_4. The inductance is tuned by the condenser C_8 and the trimmer C_9. The moving vanes of the condensers are earthed and the blocking condenser C_{10} is inserted between the end of the inductance and earth.

15. The tuned circuit L_1C_8 is coupled to the succeeding valve by means of the condenser C_7, and the control grid of this valve is connected, in a similar way to that of V_1, through a resistance R_5 to the potentiometer R_{55}. The screen grids of valves V_1 and V_2 are connected through resistances R_2 and R_6 to H.T. positive, a voltage dropping resistance R_7 being included in this circuit. The arrangement of the circuit L_2C_{13} is similar to the preceding one except that the grid of the valve V_3 is connected through the resistance R_{11} to the grid bias resistance R_{12}. From the inductance a connection is taken to the anode of the isolator valve. Valves V_3, V_4, V_5, V_6 and V_7 have alternative anode circuits, one or other of which may be selected by means of a switch mounted on the unit. For example in the anode circuit of V_3 the inductance L_3 is shown switched into the circuit. The inductance is shunted by a fixed condenser C_{17} and a trimmer condenser C_{16}—C_{19} being a blocking condenser. When the switch is moved to the alternative position the circuit is completed through the inductance L_4 which is shunted by the condenser C_{18} and the resistance R_{16}.

16. The anode circuits of the remaining valves V_4, V_5, V_6 and V_7 have exactly the same circuits. The screen grids of the four valves are connected to the resistances R_{19}, R_{26}, R_{32} and R_{38} respectively and H.T.+ through the resistance R_{39}. The resistances are decoupled by the condensers C_{21}, C_{25}, C_{39} and C_{45}. The anode circuits of the valves are fed with H.T. through the resistances R_{23}, R_{27}, R_{34} and R_{40}. A single potentiometer R_{31} provides the grid bias for all four valves through the resistances R_{17}, R_{29}, R_{30} and R_{36}.

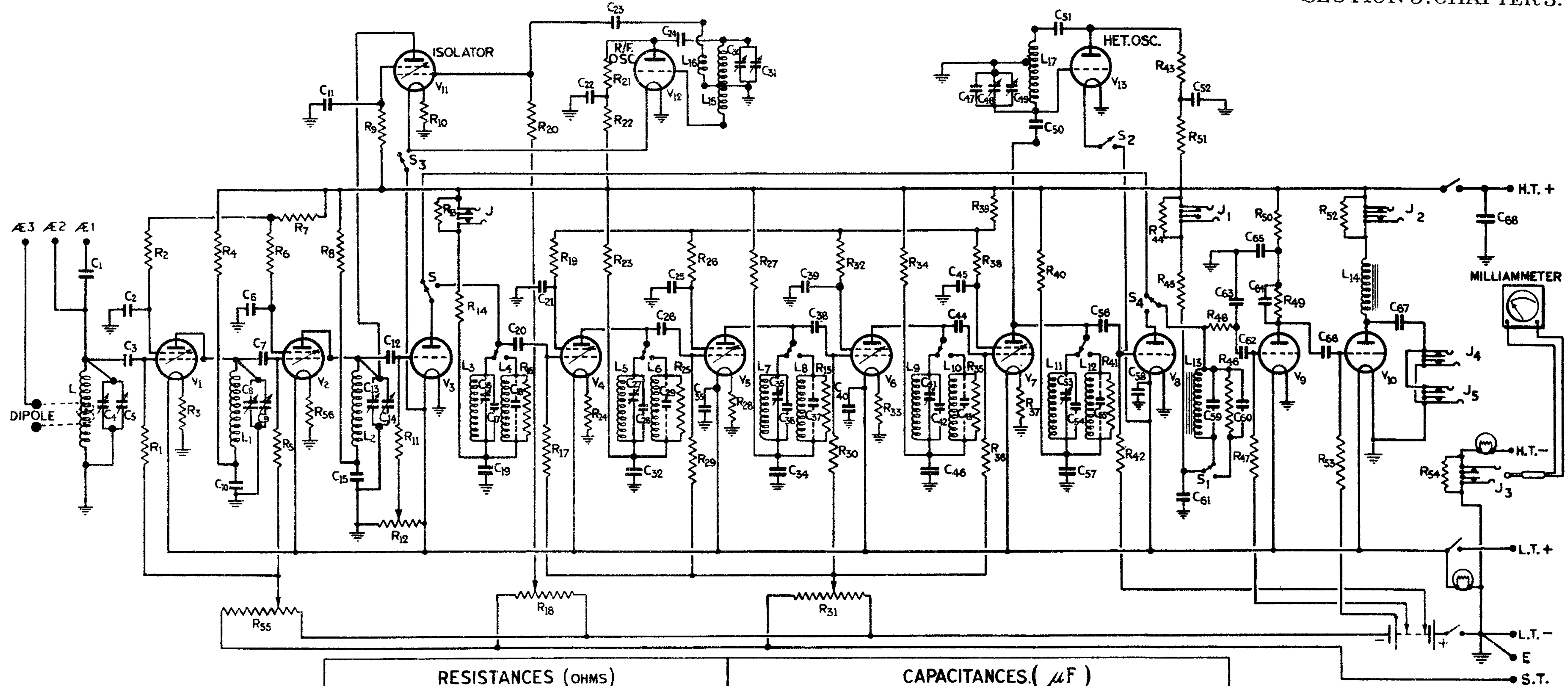
17. The anode circuit of the valve V_8 includes an iron-cored inductance L_{13} shunted by the condenser C_{59}. By movement of the switch S_1 however, resistance R_{46}, shunted by the condenser C_{60}, is substituted for the inductance. Grid bias for the valves V_8, V_9 and V_{10} is provided from a grid bias battery. The grid of valve V_8 is connected through the resistance R_{47} and the grid of valve V_{10} is connected through resistance R_{53} to the appropriate tappings on the battery.

18. The anode circuit of the valve V_9 is connected to H.T.+ through the resistances R_{49} and R_{50}. The latter is decoupled by the condenser C_{65} and the former is shunted by the condenser C_{64}. The anode of the valve is coupled to the succeeding valve by the condenser C_{66}. The anode of the output valve V_{10} is connected to H.T. positive through the iron-cored choke L_{14}. A telephone jack J_2, shunted by the resistance R_{52}, provides an easy means of measuring the H.T. current taken by this circuit. Telephone jacks J_4 and J_5 are connected from earth through a fixed condenser C_{67} to the anode of the valve.

19. The inductance L_{17} in the circuit of the heterodyne oscillator valve V_{13} is coupled through the fixed condenser C_{50} to the anode of the valve V_7. The inductance is tuned by a fixed condenser C_{47} across which is a pre-set condenser C_{49} and the small variable condenser C_{48} which is controlled by a knob on the front of the panel. H.T. is fed through the resistances R_{51} and R_{43} in series. C_{52} is the decoupling condenser for R_{51}. A filament switch S_2 is provided in the L.T.+ lead.

20. The radio-frequency oscillator valve V_{12} employs an inductance L_{15} tuned by the variable condenser C_{30}, the latter being shunted by a small fine tuning condenser C_{31}. The valve is coupled through the isolator valve V_{11} to the first detector. C_{24} is the grid-anode coupling condenser. V_{12} is coupled to V_{11} by the condenser C_{23}. The H.T. is fed to the valve through the resistances R_{22} and R_{21} in series. Grid bias for the isolator valve V_{11} is obtained from the variable resistance R_{18}. The grid of the valve is connected to R_{18} through the resistance R_{20}. The screen grid of V_{11} is connected to H.T.+ through the resistance R_9. A filament switch S_3 controls the L.T. supply for the valves V_{11} and V_{12}.

21. In the anode circuit of the valve V_3 is a two-position switch S which enables the anode circuit to be coupled to the succeeding valve *via* the condenser C_{20}, or connected to a screened connection which is taken along to a similar switch S_4 in the grid circuit of the valve V_9. It is



RESISTANCES (OHMS)							
R_1	250,000	R_{15}	20,000	R_{29}	250,000	R_{43}	10,000
R_2	40,000	R_{16}	20,000	R_{30}	250,000	R_{44}	12·5
R_3	1·5	R_{17}	250,000	R_{31}	50,000	R_{45}	2,000
R_4	1,000	R_{18}	50,000	R_{32}	40,000	R_{46}	20,000
R_5	250,000	R_{19}	40,000	R_{33}	1·5	R_{47}	250,000
R_6	40,000	R_{20}	250,000	R_{34}	1,000	R_{48}	100,000
R_7	60,000	R_{21}	10,000	R_{35}	20,000	R_{49}	100,000
R_8	1,000	R_{22}	5,000	R_{36}	250,000	R_{50}	20,000
R_9	250,000	R_{23}	1,000	R_{37}	1·5	R_{51}	20,000
R_{10}	1·5	R_{24}	1·5	R_{38}	40,000	R_{52}	10
R_{11}	250,000	R_{25}	20,000	R_{39}	100,000	R_{53}	250,000
R_{12}	135	R_{26}	40,000	R_{40}	1,000	R_{54}	2·0
R_{13}	12·5	R_{27}	1,000	R_{41}	20,000	R_{55}	50,000
R_{14}	101,000	R_{28}	1·5	R_{42}	250,000	R_{56}	1·5

CAPACITANCES (μF)									
C_1	·00005	C_{15}	·02	C_{29}	·0002	C_{43}	·0002	C_{57}	·25
C_2	·25	C_{16}	·0005	C_{30}	·0005	C_{44}	·0002	C_{58}	4·0
C_3	·0005	C_{17}	·01	C_{31}	·00001	C_{45}	·25	C_{59}	·2
C_4	·0005	C_{18}	·0002	C_{32}	·25	C_{46}	·25	C_{60}	·0002
C_5	·0002	C_{19}	·25	C_{33}	4·0	C_{47}	·004	C_{61}	·5
C_6	·25	C_{20}	·0002	C_{34}	·25	C_{48}	·00025	C_{62}	·001
C_7	·00005	C_{21}	·25	C_{35}	·0005	C_{49}	·0005	C_{63}	·0002
C_8	·0005	C_{22}	·5	C_{36}	·01	C_{50}	·0001	C_{64}	·0003
C_9	·0002	C_{23}	·0002	C_{37}	·0002	C_{51}	·001	C_{65}	·5
C_{10}	·02	C_{24}	·001	C_{38}	·0002	C_{52}	·5	C_{66}	·001
C_{11}	·5	C_{25}	·25	C_{39}	·25	C_{53}	·0005	C_{67}	2·0
C_{12}	·00005	C_{26}	·0002	C_{40}	4·0	C_{54}	·01	C_{68}	2·0
C_{13}	·0005	C_{27}	·0005	C_{41}	·0005	C_{55}	·0002		
C_{14}	·0002	C_{28}	·01	C_{42}	·01	C_{56}	·0002		

Note :- Condensers C_{18}, C_{29}, C_{37}, C_{43} and C_{55} are used only for S/F coils on 40 kc/s.

FIG. 3. THEORETICAL CIRCUIT DIAGRAM, RECEIVER R.1084

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Facing paras 15-21

thus possible, in one position of the switches, as shown in the diagram, to couple V_3 to V_9 through the screened lead. The supersonic amplifier is thus cut out and the receiver functions as a " straight " receiver. In the other position of the switches, the superheterodyne circuit is restored.

22. The potentiometer R_{18} is a control on the grid of the isolator valve (*see* para. 11). The potentiometer R_{31} is a control on the grids of the four supersonic-frequency valves V_4, V_5, V_6 and V_7.

23. The resistance R_{12} is a wire-wound variable resistance (135 ohms) fitted on the underside of the base and operated by means of a key inserted through an aperture in the side of the receiver case. Its purpose is to vary the grid bias on the first detector valve V_3.

24. Jacks J, J_1, J_2 and J_3 are provided in the anode circuits of valves V_3, V_8 and V_{10} and also in the main H.T. line. The jacks are shunted by resistances and, when the milliammeter is plugged in, the reading obtained must be multiplied by the figure engraved near the appropriate jack.

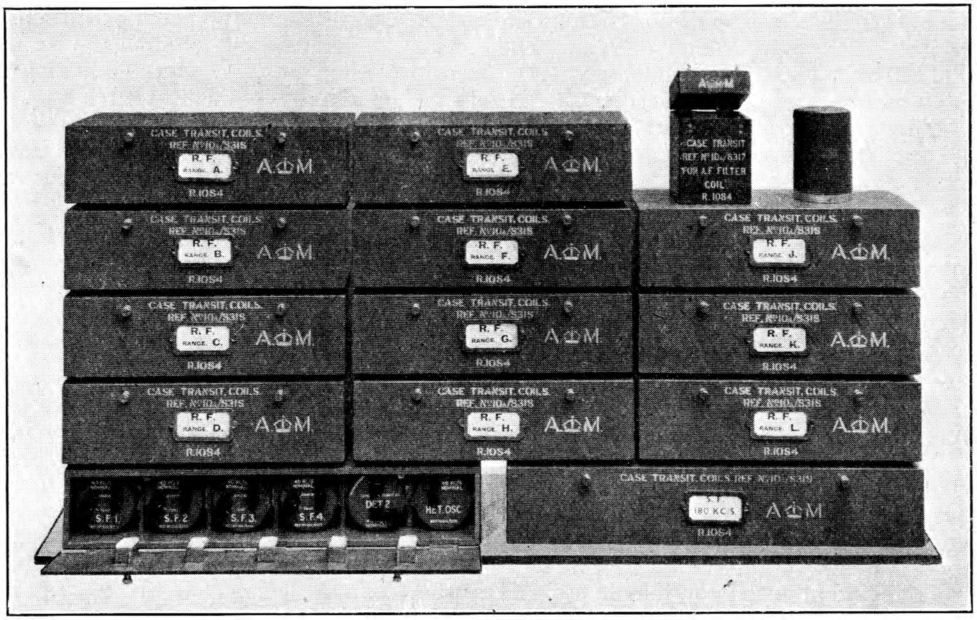

FIG. 4.—Coils in cases.

Coil units

25. A set of coil-carrying cases, for stowing the coils when not in use, is provided with the receiver, and the complete set is shown in fig. 4. There are fourteen cases altogether. The two larger cases in the lower part of the illustration house the 40 and 180 kc/s. alternative supersonic-frequency coils. Although the S/F coils are marked as 180 kc/s, the actual frequency is 167 kc/s, future reference to the coils as 180 kc/s will therefore apply to the engraving on the coils. In the illustration the lid of the left-hand one is shown open and, reading from left to right, the coils are S/F.1, S/F.2, S/F.3, S/F.4, DET. 2 and HET. OSC. The smaller cases above, of which there are eleven, house the radio-frequency coils, the Det. No. 1 coils and the radio-frequency oscillator coils for all the ranges A to L. The audio-frequency filter coil is shown standing near its carrying-case in the upper right-hand part of the illustration. All the cases are provided with labels, and the lids are conveniently arranged so that, when the cases are stacked up near the operating desk in the manner shown, easy access is obtainable.

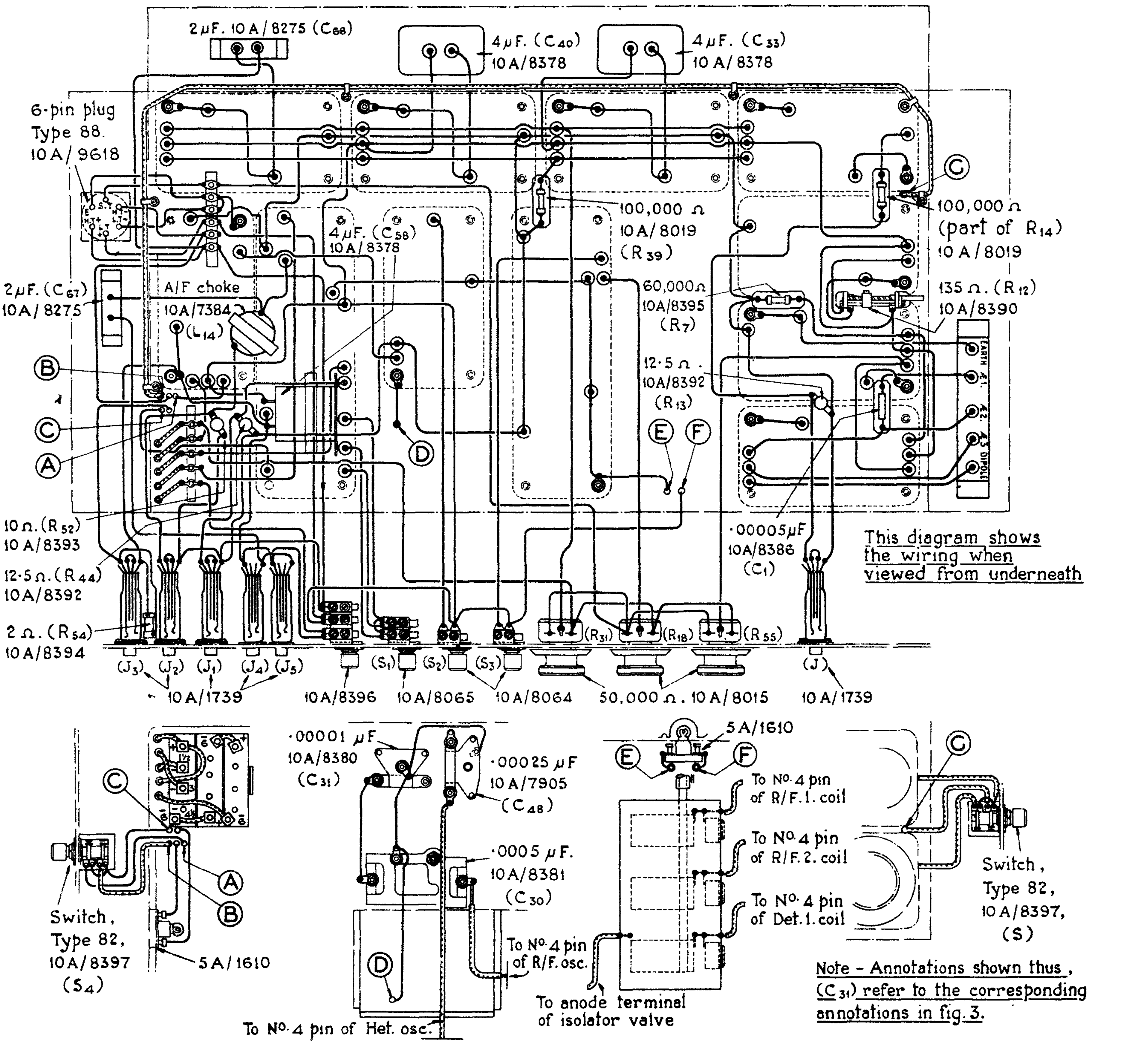

FIG. 5. BENCH WIRING DIAGRAM

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32. All the S/F. coils, the Det. No. 2 coil and the heterodyne oscillator coil are provided with pre-set condensers in a moulding on the top of their covers. These condensers are adjusted to give the correct frequency before the coils are sent out to service. One set is adjusted to a nominal frequency of 40 kc/s and the other is adjusted to a nominal frequency of 180 kc/s. The S/F. coils and the Det. No. 2 coils are also provided with a switch for changing over the inductance of the coils to vary selectivity. The switch (5) and sealed pre-set condenser (4) can be seen on the S/F. unit in the rear left-hand corner of the receiver.

33. Two miniature-screw lamp-holders are provided on the receiver. The holder on the front panel which is fitted with a perforated protection cover (7) accommodates a two-volt lamp. This lamp is illuminated when the filament circuit is switched on and acts as a pilot lamp. The holder (8) carries a 6-volt lamp. It is connected in the negative H.T. lead and serves as a fuse to open the H.T. circuit in the event of a short-circuit.

34. Three 6-volt grid-bias batteries are connected in the clips (9) in the right-hand front corner of the receiver. The three batteries are connected in series by means of the short jumper-connections provided. The five flexible leads terminating in plugs which are brought through the base at this point are marked +, POTR., OUTPUT, A/F., DET. The leads marked + and POTR. are connected to the positive and negative terminals respectively of the battery. The " output " lead is plugged into −3, the " A/F." into −1·5 and the " Det." into the top of the positive socket (zero grid-bias).

35. In fig. 6 the wiring of the units is clearly shown, and in fig. 7 the internal connections of the coils for the various frequencies are given. The external connections in the coil-holders into which the coils are plugged are also given in this illustration.

BATTERIES AND VALVES

36. The L.T. for the receiver is obtained from a 2-volt accumulator. The grid-bias is obtained from three 6-volt grid-bias batteries, and 120 volts is required for H.T. Where the supply is D.C. a 120-volt Milnes H.T. alkaline accumulator should be used for H.T. Where the supply is A.C., an A.C. mains H.T. unit should be used. The H.T. may of course be obtained from a dry battery, but as the H.T. consumption of the receiver is of the order of 25 milliamps, this method of supply must be regarded as an emergency one. If dry batteries are used, two batteries (Stores Ref. No. 5A/1333 or 5A/1615) should be wired in parallel.

37. For stages R/F.1, R/F.2, Buffer, S/F.1, S/F.2, S/F.3 and S/F.4, V.R.28 valves are used. For R/F oscillator, S/F oscillator and A/F.1, V.R.21 valves are used. For Det. 1 and Det. 2, V.R.27 valves are used. The output valve is a V.R.22.

OPERATION

38. Since the receiver is capable of a very high degree of selectivity, some experience is necessary before the full advantages are obtained. Setting up should be done very methodically and in a definite sequence. As experience is gained by constant operation, the indications of wrong adjustments will be easily interpreted and the correct adjustments quickly made. The following sequence of operations should be observed in all cases so as to ensure that the best results are obtained from the receiver.

39. Check the H.T. and L.T. voltages. Plug in the earth and aerial, check the grid-bias battery voltages and ensure that the plugs are inserted in the correct sockets. Check all the valves and see that the correct valve is inserted. When used, see that the correct S/F coils are in position. For frequencies between 20 Mc/s and 600 kc/s use the 180 kc/s S/F coils and for frequencies between 600 and 120 kc/s use the 40 kc/s S/F coils. Set the switches on all S/F coils to TUNE. From the chart in the lid ascertain which range of coils is required and insert these, ensuring that they are placed in their correct positions. Each coil is provided with a coloured

dimple which corresponds to a dimple on the unit to which it belongs. A reference to fig. 2 will show the correct positions for a set of 180 kc/s S/F coils and a set of range A coils which cover the frequency 20 to 14·3 Mc/s.

40. It is important to have a clear understanding of the manner in which the various aerial arrangements should be used. When a normal aerial and earth system is used, the aerial should be connected to the socket engraved AE 1 and the earth to the socket engraved EARTH. The socket engraved AE 2 is suitable only for a small low-capacitance aerial such as for example a vertical rod. If a dipole is used (ranges A, B, C and D) connections must be made to the socket engraved AE 3 and the one adjacent to it, engraved DIPOLE. When using a quarter-wave aerial, it should be connected to AE 3 and the dipole socket should be linked to the earth socket and earthed.

41. When using a normal aerial and earth on ranges J and L (350–600 and 120–200 kc/s), the socket engraved AE 3 should be used for the aerial connection. It is important to remember, however, that when the other ranges are in use there is no direct connection provided between AE 3 and the aerial coil (coils E, F, G, H and K have no connection whatsoever to AE 3). If, for example, range J or L coils have been in use and a change is made to, say, range K, the aerial must be inserted in AE 1 before reception is possible.

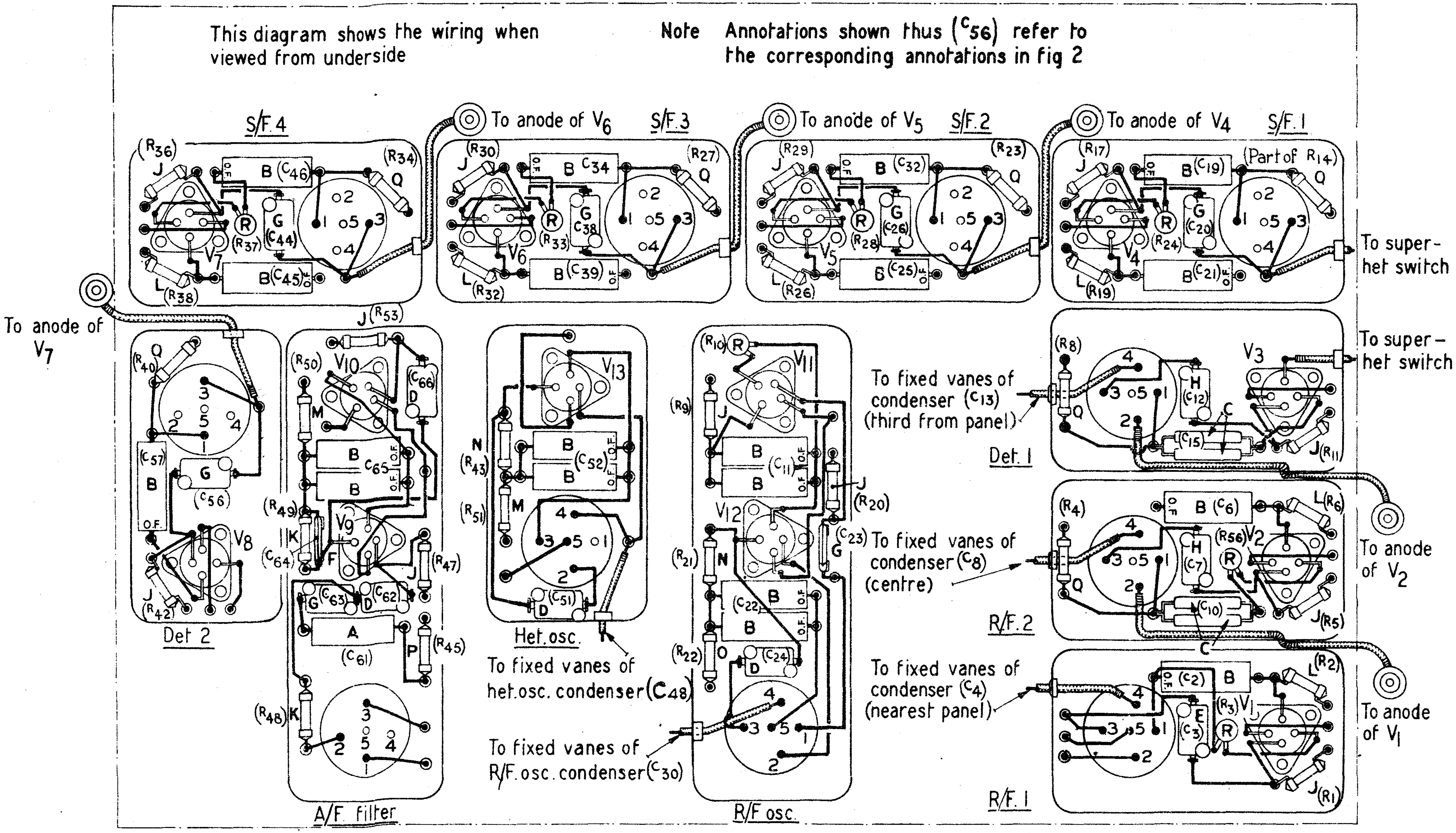
42. A point of some importance in connection with the tuning charts in the calibration book, may be mentioned here. When using the receiver as a superheterodyne, the R/F oscillator full-line curve is used to set up the R/F oscillator. It should be realized that this curve is not the actual frequency calibration of the R/F oscillator, but a curve showing the settings required on the R/F oscillator condenser in order to produce, when combined with the signal frequency, the beat or supersonic frequency of the S/F amplifier.

43. As a first measure the instrument may be operated as a "straight" receiver to obtain familiarity. In the following paragraphs all annotations refer to figure 1. Assuming it is desired to receive R/T or M.C.W. signals on 1,500 kc/s, the following procedure should be adopted. Insert the G range coils, connect aerial to AE 2 and earth to terminal engraved EARTH. Ensure that the H.T. and L.T. supply is correct and also that all valves, coils and plugs are making good contact. Set the two superhet switches on the side of the receiver to OUT ; set the R/F oscillator filament switch (8) to OUT ; the heterodyne oscillator filament switch (9) should be set to OFF and the A/F filter (10) to OUT. Switch on H.T. and L.T. at (11).

44. Referring to the R/F curve on the left-hand side of the chart for range G, set the second and third R/F trimmers (19) and (20) respectively to 80°, and the main ganged condenser control (1) to the point on the curve which corresponds to 1,500 kc/s, approximately 50°. The receiver is now tuned to approximately 1,500 kc/s. A search for the signal can now be made if the R/F volume control (5) is put to maximum and the R/F oscillator condenser control (1) is varied on either side of its pre-determined setting. When the signal is received, all the trimmers should be adjusted to give a maximum signal, ensuring that they are accurately tuned.

45. If a C.W. signal is required on this frequency, the R/F oscillator filament (8) should be switched on and, without any further adjustment of the R/F side of the receiver, the R/F oscillator (2) should be adjusted to 135° as read from the dotted line on the chart for 1,500 kc/s. Fine tuning can be carried out on the R/F oscillator fine tuning control (3).

46. If it is desired at this stage to use the receiver as a superheterodyne on this frequency of 1,500 kc/s, set the two superhet switches on the side of the receiver to IN, insert the 167 kc/s S/F coils in position and set all the coil switches to TUNE. Put the filter (10) to OUT, set the HET. OSC. filament switch (9) to OFF, switch R/F oscillator filament (8) on. Set the R/F volume control (5) to maximum, the R/F oscillator volume control (6) to maximum, and the S/F volume control (7) about 6. Plug a pair of telephones into one of the jacks (13) engraved OUTPUT, and plug the milliammeter into the jack (16) engraved TOTAL MA. Providing everything is normal, a reading of between 20 and 25 mA should be obtained. It should be



	CONDENSERS	
	Value μF	Stores Ref
A	·5	10A/8007
B	·25	10A/8382
C	·01	10A/7906
D	·001	10A/7901
E	·0005	10A/8009
F	·0003	10A/8387
G	·0002	10A/8388
H	·00005	10A/8386

	RESISTANCES	
	Value Ω	Stores Ref.
J	250,000	10A/8018
K	100,000	10A/8019
L	40,000	10A/7973
M	20,000	10A/8021
N	10,000	10A/7957
O	5,000	10A/7956
P	2,000*	10A/7955
Q	1,000	10A/7954
R	1·5	10A/7910

Valve-holders, Stores Ref — 10A/8597

FIG. 6, WIRING DIAGRAM OF UNITS

Facing paras 40-46

noted here that the milliammeter reading must be multiplied by 50 and, furthermore, that the figure for total milliamps given in para. 57 will not be obtained, as some of the valves are switched off.

47. Set the R/F oscillator condenser control (2) to 120°, as obtained from the full line on the right-hand side of the chart, and set the three R/F trimmers (18), (19) and (20) to about 80°. Switch on the heterodyne oscillator filament switch (9) and search for the signal on the R/F oscillator fine tuning control (3). When the signal is heard, re-adjust the heterodyne oscillator control (4) to give the desired note. It should be noted that, when operating the instrument as a " straight " receiver, the R/F oscillator behaves as a heterodyne oscillator and, on superheterodyne, as a frequency-changer oscillator.

48. It is essential to ensure that the three R/F trimmers are accurately tuned. It sometimes occurs that if the aerial is large, the first trimmer fails to tune and this necessitates a reduction of capacitance in the main R/F condenser so that more capacitance may be obtained on the trimmers till all three trimmers are tuneable. The S/F volume control should be adjusted to give the required signal level. When the receiver is finally tuned, the R/F oscillator fine tuning condenser should now be approximately 80° to 100°. The reason for this is that any frequency variation of the received signal may be compensated for by this fine tuning control.

49. To adjust the heterodyne note correctly, switch off the heterodyne oscillator filament switch (9) and tune in to the signal " mush " only. When this has been done, switch on the heterodyne oscillator and, while listening to a C.W. signal, use the heterodyne oscillator tuning control (4) to adjust the note to 1,000 cycles or whatever note is most suitable from an operational point of view.

50. Should interference be experienced during reception of C.W. signals on either the high or low frequency bands, with the S/F's at TUNE, and insufficient selectivity is obtained, the introduction of the A/F filter will greatly increase the discrimination of the receiver. It should be borne in mind that this A/F filter is tuned to 1,000 cycles and, as its band width is only some 200 cycles, care must therefore be taken to adjust the heterodyne note to approximately 1,000 cycles. This A/F filter will also be found very effective in reducing extraneous noise during reception. It must not on any account be used for signals other than C.W.

51. The reception of R/T transmissions which are crystal controlled may be satisfactorily obtained with the 180 kc/s S/F coils at TUNE. If, however, the transmission is not crystal controlled, in order to cope with any frequency variation of the transmitted carrier, some or all the S/F coils may be put to STAND-BY. The setting of the S/F coil switches will therefore depend on the transmission conditions, and, in some cases, S/F 2 may be at TUNE while S/F's 3 and 4 are at STAND-BY or *vice versa*. It should be noted however that S/F1 and Det. 2 must always be at TUNE. When receiving R/T, the heterodyne oscillator and A/F filter must be off. The regulation of the volume is a matter of individual preference, but it should be remembered that the receiver was designed for telephones and not for a loud-speaker.

PRECAUTIONS AND MAINTENANCE

52. Faults in the receiver can be easily detected or avoided by routine checking. A record should be kept of the various battery readings, the anode current readings in each of the jack positions, and the dates upon which new valves are put into service. The L.T. accumulator should never be allowed to fall below 1·8 volts. The H.T. voltage should never be below 100 or above 130 volts and the total voltage of the three grid-bias batteries should never be below 15 volts, i.e. 5 volts per battery.

53. It is advisable for units to make a weekly check on all batteries and ensure that the following points are observed : The L.T. battery terminals should be clean. The lugs on the ends of the receiver leads should be soldered and should be large enough to ensure good surface contact at the battery terminals. As the L.T. current is of the order of 2 amperes, a serious

voltage drop is likely to occur in the leads unless suitable precautions are taken. The leads should therefore be as short as possible and of a sufficient current carrying capacity; Uniflex 19 (Stores Ref. 5A/86) is recommended for this purpose.

54. The H.T. leads should be short and neatly installed. Straggling leads are quite unnecessary. The "crocodile" clips generally used on the end of the H.T. leads are made of iron and are liable to corrosion. It is therefore not enough merely to wrap the H.T. lead around the clip, nor to secure it with a screw—the lead must be soldered to the clip.

55. The grid-bias plugs should fit securely in the battery sockets; the plugs are provided with split ends and these should be opened out to ensure a good fit. It is essential to ensure that the correct grid-bias tappings are made. The first A/F valve should have 1·5 volts negative; the output valve should have 3 volts negative. Each grid-bias unit should be checked to ensure that the voltage is 6 volts, and finally the total voltage should be checked. Although the foregoing points may appear trivial, it should be borne in mind that, with a sensitive receiver like the R.1084, these points become necessary for satisfactory operation and it is essential that they are carried out.

Checking of valves

56. A simple and comprehensive method of checking all the valves in the receiver may be carried out by means of the milliammeter supplied with each instrument. Switch on H.T. and L.T. Set the two superhet switches on the sides of the receiver to IN. Set the filter, heterodyne oscillator, and R/F oscillator switches (10, 9, 8, fig. 1) to IN. Set the three volume controls to maximum.

57. Plug the milliammeter into the right-hand jack position, which corresponds to J_3, fig. 6. The milliammeter will indicate the total H.T. current taken by the valves, and a reading of between 0·4 and 0·6 should be obtained. This reading must be multiplied by 50, which gives a total anode current of between 20 and 30 mA. Next plug the milliammeter into the output jack (second from the right). A reading of between 0·4 and 0·6 should be obtained; this reading is multiplied by 10 to get an anode current of between 4 and 6 mA for the output valve (V_{10}, fig. 2). The third jack from the right is connected to the second detector valve (V_8, fig. 2). A direct reading of between 0·2 and 0·25 should be obtained which, when multiplied by 8, gives between 1·6 and 2·2 mA. Now plug the milliammeter into the jack on the left-hand side of the receiver, and a direct reading of between 0·08 and 0·1 should be obtained, which when multiplied by 8 gives between 0·64 and 0·8 mA approximately as the anode current taken by the first detector valve (V_3, fig. 2).

58. It will be seen that up to this stage three valves have been checked individually. Now plug the milliammeter into the jack engraved TOTAL MA, i.e. the jack on the right-hand side, and remember that all readings on the milliammeter must be multiplied by 50. Switch off the R F oscillator filament. A reduction of about 5 mA in the reading of the milliammeter shows that the valves (V_{11} and V_{12}, fig. 2) are normal. Now switch off the heterodyne oscillator filament when a reduction of 3 mA in the milliammeter reading will indicate that the heterodyne valve (V_{13}, fig. 2) is normal. If the setting of R/F volume control (the one on the left) is now varied, the reading on the milliammeter should also vary by about 3 mA, showing that the two R/F valves (V_1 and V_2, fig. 2) are taking anode current. If the central volume control is varied, the isolator valve (V_{11}, fig. 2) may be tested and a reduction of about 1 mA obtained. Variation of the S/F volume control, i.e. the right-hand one, will indicate if the four S/F valves are normal. A variation of approximately 2 mA may be expected when this control is varied between maximum and minimum. Finally, remove the valve near the front of the receiver from the unit engraved AF. FILTER; a reduction of 0·5 mA in the reading will indicate that the A/F amplifier valve (V_9, fig. 2) is normal.

59. By this method it is possible to check seven valves individually and the remaining six in groups of two and four, i.e. the two R/F valves and the four S/F valves respectively. It is possible to check these valves individually by removing the pig-tail connection to the top of

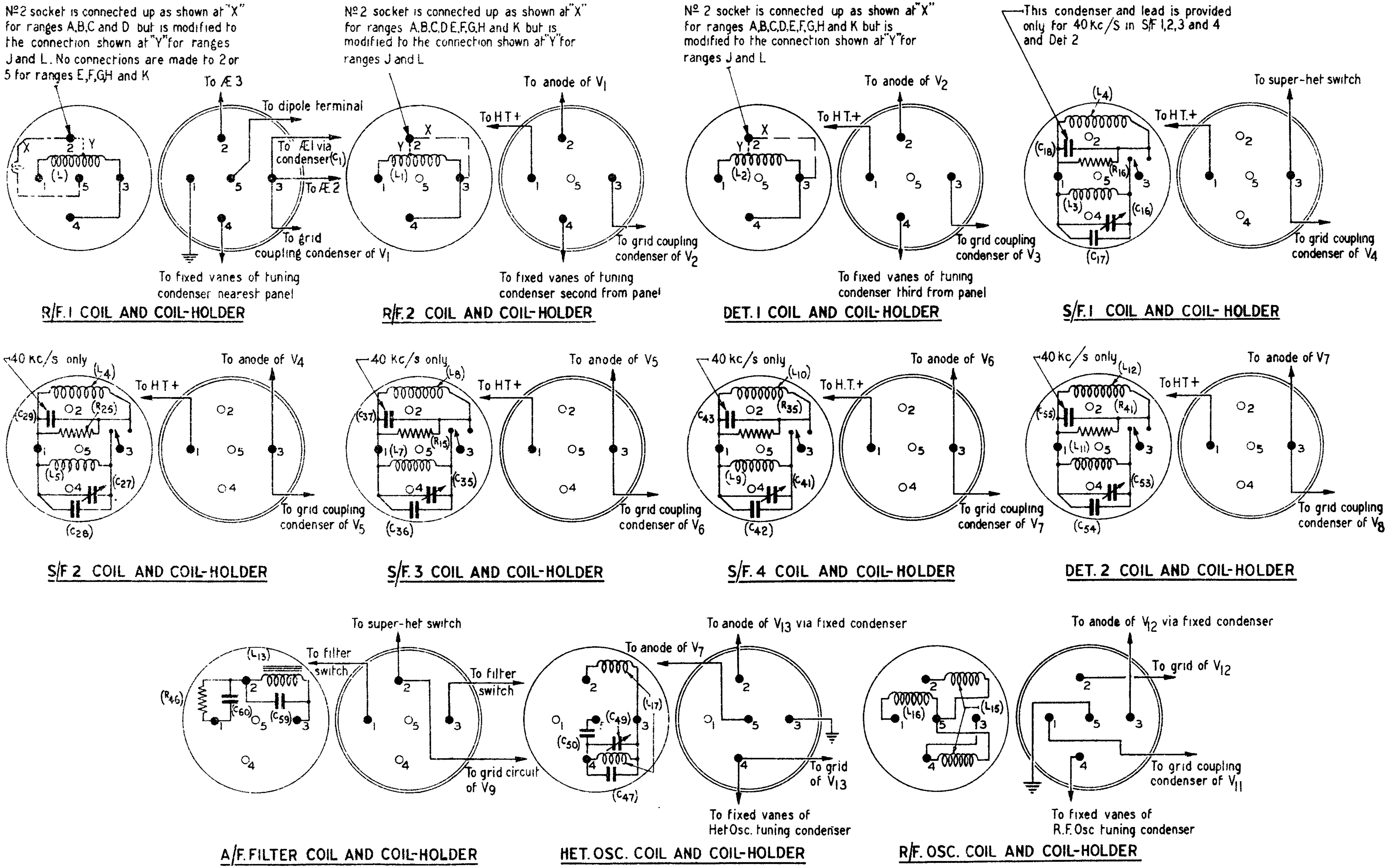


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FIG. 7. COIL AND COIL-HOLDER CONNECTIONS

the valve, when a deflection should be observed in the milliameter if the valve is taking anode current. It will be seen therefore that a quick check can be made on all the valves in the receiver and if a valve is suspected it can be easily isolated and replaced if necessary.

60. It should be borne in mind that the life of the valves is limited. The average life is approximately 1,000 hours and the requisite spares must therefore be carried. If any difficulty should be experienced in obtaining spares some improvisation may have to be resorted to. For example, a V.R.27 valve may be used in place of a V.R.21. A V.R.21 valve may be used in the Det. 1 or Det. 2 position. Either a V.R.21 or a V.R.27 valve may be employed in place of the V.R.22 but, since the results will be indifferent and distortion will be experienced, the use of this is deprecated. In the event of a V.R.28 valve not being at hand, a V.R.18 valve is recommended until replacements are available.

61. The coils and valves should be tested to ensure that they are making good contact in their holders. Dirty contact pins may be cleaned with carbon tetrachloride or benzol. In this connection it should be mentioned that it is not enough merely to test the valves with the milliammeter, they should also be inspected to ensure that the glass envelopes are secure in their bases. This is important in the case of the V.R.28 valves, as a loose envelope impairs the earthed screening effect of the valve.

62. The springs on the coil contacts are liable to break and, in the event of a coil having a broken contact spring, the spring should be replaced at once. Apart from the broken spring causing inefficient contact, the broken parts may quite easily cause a short-circuit. If the coils are removed from the receiver and then given a shake, a broken spring will be made apparent by a rattling noise.

63. Remove the coil from the receiver ; mark the paxolin base and cover so as to ensure correct reassembly. Remove the three screws from the base of the coil and withdraw the screening cover. The broken spring contact will be obvious on inspection. If spares are available the broken spring must be replaced. However, it is possible that the spring may break on a contact which does not form part of the circuit, in which case it is only necessary to remove the broken parts and then re-assemble the coil. If no spares are available, then the contacts should be examined and a spring removed from a contact which is not connected in the coil circuit, and placed over the contact which is in the coil circuit. This is easily done by grasping the spring with a pair of round nosed pliers.

64. In the event of a broken contact spring on any of the S/F coils, some further precautions are necessary. If, on shaking one of the S/F coils, a rattle is heard indicating a broken spring, proceed as follows :—Break the seals on the top of the coil over the trimming condenser and the retaining screw ; remove both these screws and the ebonite strip. Now replace the screw on the trimming condenser (the large one). This is done in order that the washer will not get lost or displaced. Remove the four screws at the base of the coil. Hold the container in one hand and carefully push the " tune-stand-by " switch with the other when the coil will come out. After repairing the assembly, replace the coil in the container and insert the four screws round the base. Hold the coil upright and remove the condenser adjusting screw ; replace the ebonite strip and retaining screw, and finally replace the condenser screw. The coil will require re-aligning before it is sealed again. For the method of doing this, reference should be made to para. 70, *et seq.*

65. A simple test to ensure that the R/F side of the receiver is functioning normally, may be made by utilizing the input circuit thermal agitation noise in the following manner. Since the first circuit noise on the R.1084 is easily obtained on a frequency between 4 to 6 Mc/s, insert range D coils in the appropriate positions, and use the 180 kc/s range in the S/F, DET. 2 and HET. OSC. positions. Remove the aerial, set the HET. OSC. switch to off, and the filter switch to off. Set the superheterodyne switches to in, and the R/F volume control and R/F oscillator volume control to maximum. Set the R/F oscillator filament switch to on ; switch on the H.T. and L.T. supplies. Plug a pair of headphones into the socket provided (jacks J_4 or J_5, fig. 2).

Now tune the receiver accurately, using the controls (1 and 2, fig. 1) and also the R/F trimmers (18, 19 and 20, fig. 1). Bring the S/F volume control up till a healthy set noise is heard in the headphones. Now remove the R/F 2 coil, when the set noise in the headphones will be considerably diminished. Insert the coil again and the set noise should come back as before, proving the R/F side is normal.

66. When the receiver is tuned and the R/F oscillator and isolator valves are functioning normally, there will be a decrease in background noise if the R/F oscillator filament switch is opened. No decrease of background noise, when this switch is opened, indicates the possibility of a faulty valve in either of these positions.

67. To test for continuity in the S/F stages, switch each S/F coil in turn from TUNE to STAND-BY when a well-defined " click " should be heard in the headphones when changing over. If crackling noises are produced or there is a marked diminution of background noise a fault is indicated. If the " click " is not well defined, the valve may be defective or the switch contacts may be dirty. If there is a marked diminution of background noise, or the noise ceases altogether, the coil should be examined for a broken pig-tail connection or a broken switch spindle. Crackle during the switching operation may indicate a partially broken pig-tail connection or dirty contacts.

68. Among the symptoms of faulty volume control resistances are : Lack of proper control, possible abnormal anode currents, and noisy operation during control. If the trouble is traced to a faulty resistance associated with a volume control, a spare one should be fitted. In the event of no spares being available, a resistance, type 75 (Stores Ref. 10A/7605), may be used as a temporary measure.

69. A reduction in H.T. voltage below the stipulated figure may cause certain R/F oscillators to fail at the lower frequency end of a range, particularly range E. On such occasions the interchange of valves, type V.R.21, may show an improvement. The combination of valves to be aimed at, is that which will permit the greatest reduction in H.T. volts before failure to oscillate. When the receiver fails at the lower frequency end of range E, the R/F oscillator valve should be suspected. Alternative valves, type V.R.21, may be tried, or, if it will cover the desired frequency, the next lower range may be used. The best method of ascertaining whether the R/F oscillator valve is oscillating, is from the extra noise it introduces when the receiver is tuned.

Re-alignment of S/F coils

70. It has been found that the fixed and pre-set condensers included in the 180 kc/s, S/F and Det. 2 coils of the receiver are liable to variation of capacitance due to ageing. These variations are irregular and, in addition to alteration of the nominal frequency of each individual coil, the gain of the complete supersonic-frequency amplifier may be affected. It is therefore essential that the setting of the pre-set condensers should be checked, and if necessary adjusted at intervals. This re-alignment of the S/F stages should be carried out by units to receivers in service at intervals not exceeding twelve months. Since the necessity for re-aligning the S/F coils became apparent, experience has shown that more than one method is possible. Since the method laid out in the following paragraphs has proved most satisfactory in practice, it is to be adopted in future whenever the necessity for re-aligning the S/F coils should arise.

71. Inspect and check the L.T., grid-bias and H.T. batteries and connections and ensure that the voltages are correct. Check the valves and ensure that they are functioning normally. Test the R/F side of the receiver, examine the coils and ensure that their connections are mechanically and electrically sound. Test the S/F coils for continuity of circuit on both " tune " and " stand-by " positions. Finally ensure that all the controls are working smoothly and freely. Switch off the H.T.

72. Remove the aerial connection to the receiver. Insert range D coils, and a set of 180 kc/s S/F coils in the receiver ; put all S/F coil switches to TUNE and insert the L range R/F oscillator coil. Plug the 0–1 mA milliammeter into the Det. 2 position. Switch on H.T. and L.T. Set the filter to IN, when an increase of Det. 2 anode current should be observed. Set the heterodyne

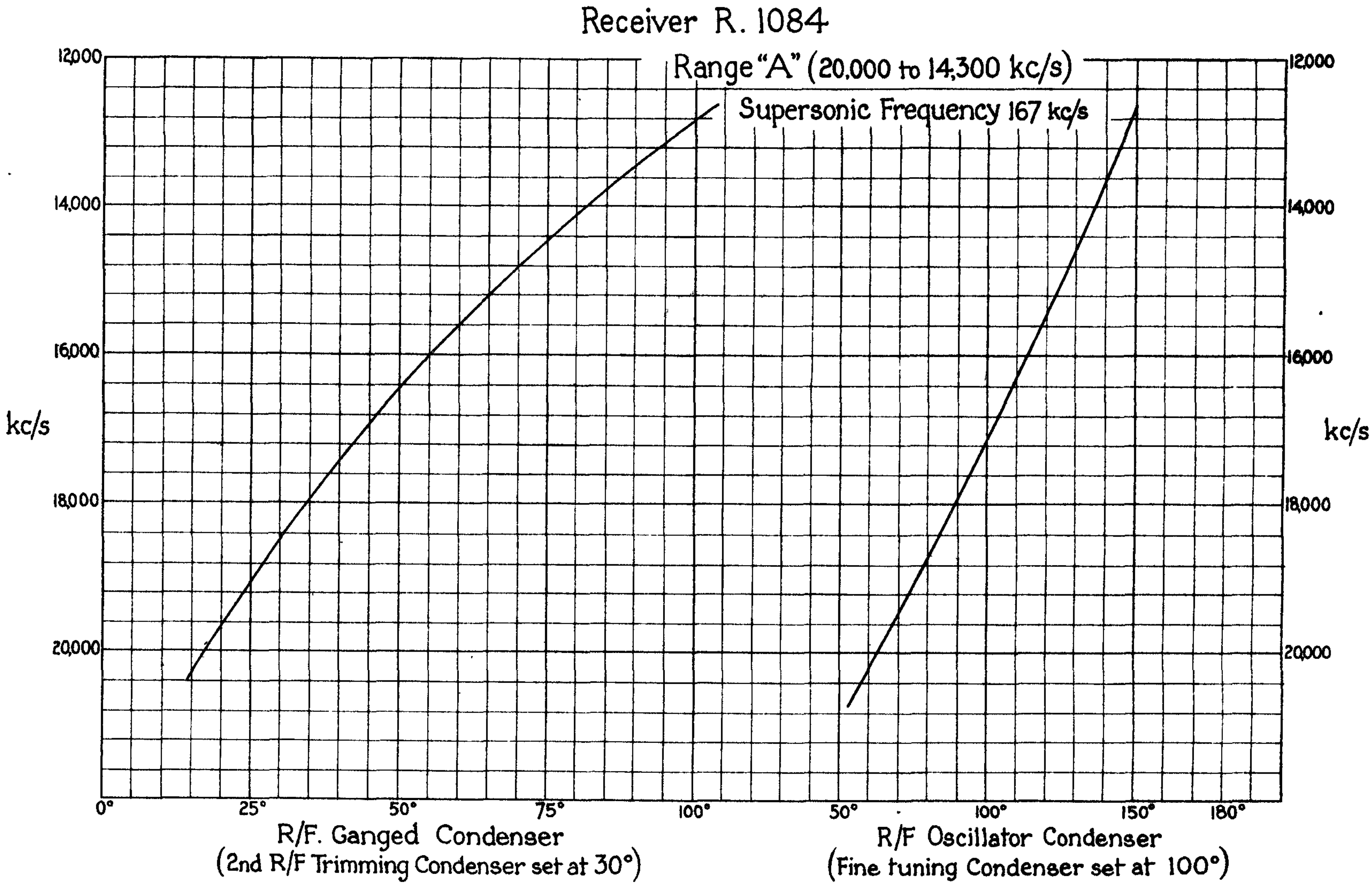

FIG. 8, TYPICAL CALIBRATION CHART

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Facing paras. 66-72.

oscillator filament switch to OFF ; set the R/F oscillator filament switch to ON, and the two superheterodyne switches to IN. Set the R/F volume control and R/F oscillator volume control to maximum (*see* para. 11). Increase the S/F volume control till a dip is indicated in the reading of the milliammeter. Adjust the R/F oscillator condenser control until a minimum reading is obtained. Re-adjust the S/F volume control until a reading of 0·4 mA is obtained on the milliammeter. This reading is chosen to ensure that the S/F amplifier is stable. Now carefully re-tune the R/F oscillator condenser to obtain a minimum reading on the milliammeter and adjust the S/F volume control again, if necessary to give a reading of 0·4 mA.

73. With the R/F oscillator set to give a minimum reading with all S/F coils on TUNE, as set out in the previous paragraph, proceed to re-align the circuits as follows : (It should be noted that once the R/F oscillator is set it should not be moved from this position, and a frequent check should be made to ensure this.) Break the seals (larger ones) on S/F.1, S/F.2, S/F.3, S/F.4 and Det. 2. Start on S/F.2 and set its switch to TUNE, ensuring that the remaining four are on STAND-BY. Adjust the pre-set condenser of S/F.2 to give a minimum reading on the milliammeter, and adjust the S/F volume control if necessary to give a reading of 0·4 mA. Now set the switch on S/F.2 to STAND-BY. Proceed to S/F.3, put its switch to TUNE, ensuring that the remainder are at STAND-BY, adjust the pre-set condenser of S/F.3 to give a minimum reading, adjust the S/F volume control to 0·4 if necessary, finally return the switch on S/F.3 to STAND-BY. Repeat these operations for S/F.4, Det. 2 and S/F.1 in this order. Finally re-seal the coils with sealing-wax or Chatterton's Compound.

74. If, during the re-aligning process, it is found that one or more trimmers have reached the limit of their travel in either direction, i.e. " all in " or " all out ", and still do not tune, it will then be necessary to readjust the R/F oscillator. Leave the trimmer in its extreme position, re-adjust the R/F oscillator control to give a minimum reading, and then leave it at this new setting. Now proceed to re-align the remaining coils to this new frequency, carrying out the procedure as in the previous paragraphs, and keeping to the same sequence as near as possible. If, during this re-aligning process, it is found that one trimmer is " all in " and on proceeding to another coil its trimmer does not tune when the trimmer is " all out ", this coil should be replaced by one from another set. It may not be necessary to return the coil to Store as unserviceable, since it may possibly line up with another set of coils.

75. Once any particular set of S/F coils has been re-aligned in any particular receiver, it is to be used for that receiver *only*, and should be marked in some convenient manner to ensure the correct association. No re-alignment of the 40 kc/s range is anticipated, as the band covered is fairly wide, and re-alignment of the coils will not give very greatly improved results.

APPENDIX

NOMENCLATURE OF PARTS

The following list of parts is issued for information only. When ordering spares for the receiver the appropriate section of Air Publication 1086 must be used.

Ref No	Nomenclature.	Quantity	Remarks.
10A/8301	Receiver, type R 1084		Complete without valves, batteries and coils.
	Principal components :—		
10A/8302	Book, calibration	1	
10A/8303	Case	1	
10A/7384	Choke, L/F, type B	1	
	Condenser :—		
10A/7905	Type 124	1	0·0002 μF.
10A/8275	Type 164	2	2·0 μF.
10A/8378	Type 168	3	4·0 μF.
10A/8380	Type 170	1	0·00001 μF.
10A/8381	Type 171	1	0·0005 μF
10A/8386	Type 176	1	0·00005 μF
10A/8389	Handle, condenser, vernier drive, type C	1	
10A/1739	Jack, telephone, type A	6	
5A/1610	Lampholder, miniature	2	Batten type.
10A/8304	Lens, magnifying	1	
10A/8400	Plug, type 66	9	Single pole, battery plug.
10A/9618	Plug, type 88	1	
	Resistance		
10A/8015	Type 107	3	50,000 ohms, variable.
10A/8019	Type 111	2	100,000 ohms, ½-watt rod type.
10A/8392	Type 141	2	12·5 ohms, wire wound bobbin.
10A/8393	Type 142	1	10 ohms, wire wound bobbin.
10A/8394	Type 143	1	2 ohms, wire wound bobbin.
10A/8395	Type 144	1	60,000 ohms, ½-watt rod type.
10A/8390	Type 140	1	135 ohms, variable, with lead screw motion.
10A/8391	Key, operating	1	For item 10A/8390
	Switch :—		
10A/8064	Type 70	2	Single pole "on-off" rotary type.
10A/8065	Type 71	2	2 position, double-pole, rotary type.
10A/8396	Type 81	1	3-pole "on" and "off" rotary type
10A/8397	Type 82	1	Similar to type 71, but different label.
10A/8305	Unit, Detector 1	1	Fitted with :— 1 holder, valve, type L 1 resistance, type 101 (1,000 Ω) 1 resistance, type 110 (250,000 Ω). 2 condensers, type 125 (0·01 μF). 1 condenser, type 176 (0·00005 μF).
10A/8306	Unit, Detector 2	1	Fitted with :— 1 holder, valve, type L. 1 resistance, type 101 (1,000 Ω). 1 resistance, type 110 (250,000 Ω). 1 condenser, type 172 (0·25 μF). 1 condenser, type 178 (0·0002 μF)

Ref. No.	Nomenclature.	Quantity.	Remarks.
	Receiver, type R.1084—*contd.*		
	Principal components—*contd.*		
10A/8307 ..	Unit, S/F. No. 1, engraved S.F.1. ..	1	Fitted with 1 holder, valve, type L. 1 resistance, type 97 (1·5 Ω). 1 resistance, type 101 (1,000 Ω). 1 resistance, type 105 (40,000 Ω). 1 resistance, type 110 (250,000 Ω). 2 condensers, type 172 (0·25 μF). 1 condenser, type 178 (0·0002 μF).
10A/8308 ..	Unit, S/F. No. 2	1	Identical with 10A/8307, but engraved S/F.2
10A/8309 ..	Unit, S./F. No. 3	1	Identical with 10A/8307, but engraved S/F.3.
10A/8310 ..	Unit, S./F. No. 4	1	Identical with 10A/8307, but engraved S/F.4.
10A/8311 ..	Unit, heterodyne oscillator	1	Fitted with :— 1 holder, valve, type L. 1 resistance, type 104 (10,000 Ω). 1 resistance, type 113 (20,000 Ω). 1 condenser, type 120 (0·001 μF). 2 condensers, type 172 (0·25 μF).
10A/8312 ..	Unit, A/F amplifier and filter	1	Fitted with :— 2 holders, valve, type L. 1 resistance, type 102 (2,000 Ω). 2 resistances, type 110 (250,000 Ω). 2 resistances, type 111 (100,000 Ω) 1 resistance, type 113 (20,000 Ω). 2 condensers, type 120 (0·001 μF) 1 condenser, type 130 (0·5 μF). 2 condensers, type 172 (0·25 μF). 1 condenser, type 173 (0·0003 μF) 1 condenser, type 178 (0·0002 μF).
10A/8313 ..	Unit, R/F. No. 1	1	Fitted with :— 1 holder, valve, type L. 1 resistance, type 97 (1·5 Ω) 1 resistance, type 105 (40,000 Ω). 1 resistance, type 110 (250,000 Ω). 1 condenser, type 132 (0·0005 μF). 1 condenser, type 172 (0·25 μF).
10A/8314 ..	Unit, R/F, No. 2	1	Fitted with :— 1 holder, valve, type L. 1 resistance, type 97 (1·5 Ω). 1 resistance, type 101 (1,000 Ω). 1 resistance, type 105 (40,000 Ω). 1 resistance, type 110 (250,000 Ω). 2 condensers, type 125 (0·01 μF). 1 condenser, type 172 (0·25 μF). 1 condenser, type 176 (0·00005 μF).

Ref. No.	Nomenclature.	Quantity.	Remarks.
	Receiver, type R.1084—*contd.*		
	Principal components—*contd.*		
10A/8315 ..	Unit R/F, oscillator	1	Fitted with :— 2 holders, valve, type L. 1 resistance, type 97 (1·5 Ω). 1 resistance, type 103 (5,000 Ω). 1 resistance, type 104 (10,000 Ω). 2 resistances, type 110 (250,000 Ω). 1 condenser, type 120 (0·001 μF). 4 condensers, type 172 (0·25 μF). 1 condenser, type 178 (0·0002 μF).
10A/8316 ..	Unit, tuning	1	Fitted with :— 1 Triple ganged 0·0005 variable condenser. 3 condensers, type 124 (0·0002 μF).
	Accessories :—		
5A/1119 ..	Accumulator, 2-V, 90 Ah.	1	For L.T.
5A/1251 ..	Battery, dry, 6-V.	3	For grid bias.
	Case, transit,		
10A/8320 ..	Receiver	1	
	Case, transit, coils,		
10A/8317 ..	1-coil	1	For A/F filter.
10A/8318 ..	4-coil	Quantity to suit ranges covered.	For 2 R/F coils, 1 Det. 1 and 1 R/F oscillator.
10A/8319 ..	6-coil		For 4 S/F coils, 1 Det. 2 and 1 HET. oscillator.
10A/8569 ..	Case, transit, milliammeter	1	For 10A/8398.
	Coils :—		
	Range A	—	20,000 to 14,300 kc/s.
10A/8321 ..	Det. 1	1	
10A/8322 ..	R/F 1	1	
10A/8323 ..	R/F 2	1	
10A/8324 ..	R/F oscillator	1	
	Range B		14,300 to 10,700 kc/s.
10A/8325 ..	Det. 1	1	
10A/8326 ..	R/F. 1	1	
10A/8327 ..	R/F. 2	1	
10A/8328 ..	R/F. oscillator	1	
	Range C		10,700 to 6,000 kc/s.
10A/8329 ..	Det. 1	1	
10A/8330 ..	R/F. 1	1	
10A/8331 ..	R/F. 2	1	
10A/8332 ..	R/F. oscillator	1	
	Range D		6,000 to 4,290 kc/s.
10A/8333 ..	Det. 1	1	
10A/8334 ..	R/F. 1	1	
10A/8335 ..	R/F. 2	1	
10A/8336 ..	R/F. oscillator	1	
	RangeE		4,290 to 2,500 kc/s.
10A/8337 ..	Det. 1	1	
10A/8338 ..	R/F. 1	1	
10A/8339 ..	R/F. 2	1	
10A/8340 ..	R/F. oscillator	1	
	Range F		2,500 to 1,600 kc/s
10A/8341 ..	Det. 1	1	
10A/8342 ..	R/F. 1	1	
10A/8343 ..	R/F. 2	1	
10A/8344 ..	R/F oscillator	1	

Ref No.	Nomenclature.	Quantity.	Remarks.
	Receiver, type R 1084—*contd.*		
	Accessories—*contd.*		
	Coils—*contd.*		
	Range G		1,600 to 1,000 kc/s.
10A/8345 ..	Det. 1	1	
10A/8346 ..	R/F. 1	1	
10A/8347 ..	R/F. 2	1	
10A/8348 ..	R/F. oscillator	1	
	Range H		1,000 to 600 kc/s.
10A/8349 ..	Det. 1	1	
10A/8350 ..	R/F. 1	1	
10A/8351 ..	R/F. 2	1	
10A/8352 ..	R/F. oscillator	1	
	Range J		600 to 350 kc/s.
10A/8353 ..	Det. 1	1	
10A/8354 ..	R/F. 1	1	
10A/8355 ..	R/F. 2	1	
10A/8356 ..	R/F. oscillator	1	
	Range K		350 to 200 kc/s.
10A/8357	Det. 1	1	
10A/8358	R/F. 1	1	
10A/8359	R/F. 2	1	
10A/8360	R/F. oscillator	1	
	Range L		200 to 120 kc/s.
10A/8361 .	Det. 1	1	
10A/8362	R/F. 1	1	
10A/8363	R/F. 2	1	
10A/8364 .	R/F. oscillator	1	
		1	
	180 kc/s.		
10A/8365 ..	Det. 2	1	Each coil fitted with :—
10A/8366	S/F. 1	1	1 resistance, type 113 (20,000 Ω).
10A/8367 .	S/F. 2	1	1 condenser, (0·00025 μF).
10A/8368 ..	S/F. 3	1	1 condenser, (0·004 μF).
10A/8369 ..	S/F. 4	1	1 two-way switch.
10A/8370 ..	Heterodyne oscillator .. .	1	Fitted with :— 1 condenser, type 177 (0·00001 μF). 1 condenser, (0·0002 μF). 1 condenser, (0·00025 μF).
	40 kc/s		
10A/8371 ..	Det. 2	1	Each coil fitted with :—
10A/8372 ..	S/F. 1	1	1 resistance, type 113 (20,000 Ω)
10A/8373 ..	S/F. 2	1	1 condenser, (0·01 μF).
10A/8374 ..	S/F. 3	1	1 condenser, (0·0005 μF).
10A/8375 ..	S/F. 4	1	1 condenser, type 178 (0·0002 μF). 1 two-way switch.

Ref. No.	Nomenclature.	Quantity.	Remarks.
	Receiver, type R 1084—*contd.*		
	Accessories—*contd.*		
	Coils—*contd.*		
10A/8376 ..	Heterodyne oscillator	1	Fitted with :— 1 condenser, type 121 (0·0001 μF). 1 condenser, (0·004 μF). 1 condenser, (0·0005 μF).
10A 8377 .	A/F. filter	1	A/F. filter coil 10A 8001, fitted with :— 1 resistance, type 113 (20,000 Ω). 1 condenser, type 120 (0·001 μF). 1 condenser, type 205 (0·2 μF).
5A/1434 ..	Eliminator, H.T. battery, type A ..	1	
5A/1117 ..	Lamp, filament, 2-V, clear	1	
5A/1428 ..	Lamp, filament, 6-V, 0·24-watt ..	1	Used as a fuse.
10A/8402 ..	Lead, milliammeter	1	Fitted with plug, type 1.
10A/8398 ..	Milliammeter, 0–1	1	2½-in. dial, desk type.
10A/7153 ..	Plug, type 29	4	
	Valves		
10A 7738 ..	Type V.R 21	3	R/F. oscillator, S/F. oscillator and A/F.1.
10A/8329. ..	Type V R 27	2	Det. 1 and Det. 2.
10A/7958 ..	Type V.R 22	1	Output.
10A/8399 ..	Type V.R.28	7	R/F.1, R/F.2, Buffer, S/F.1, S/F.2, S/F.3, and S/F.4.
10A/10520 ..	Limiter, receiver, output		
	Principal components :—		
10A/1739 ..	Jack, telephone	1	
10A/488 ..	Plug, type 1	1	
10A/10521 ..	Rectifier, metal H 2	2	
10A/10522 ..	Rectifier, metal H.5	2	
10A/10523 ..	Switch, type 138	1	2-pole, 2-way, and " off."

SECTION 3, CHAPTER 4

RECEIVER R.1080

Contents

List of Illustrations

RECEIVER, R.1080

(Stores Ref. 10A/8291)

INTRODUCTION

1. This is a 6-valve super-heterodyne receiver of commercial make (*see* fig. 1) intended for the reception of meteorological broadcast on R/T. The receiver is intended for A.C. mains or battery operation, the change from one form of supply to the other being made by means of a switch. When batteries are employed the supply plug is withdrawn and the batteries are connected to terminals located on the chassis of the receiver. The receiver is adjusted to give reception from a given transmitter and the tuning control covers a band of 10 kc/s only.

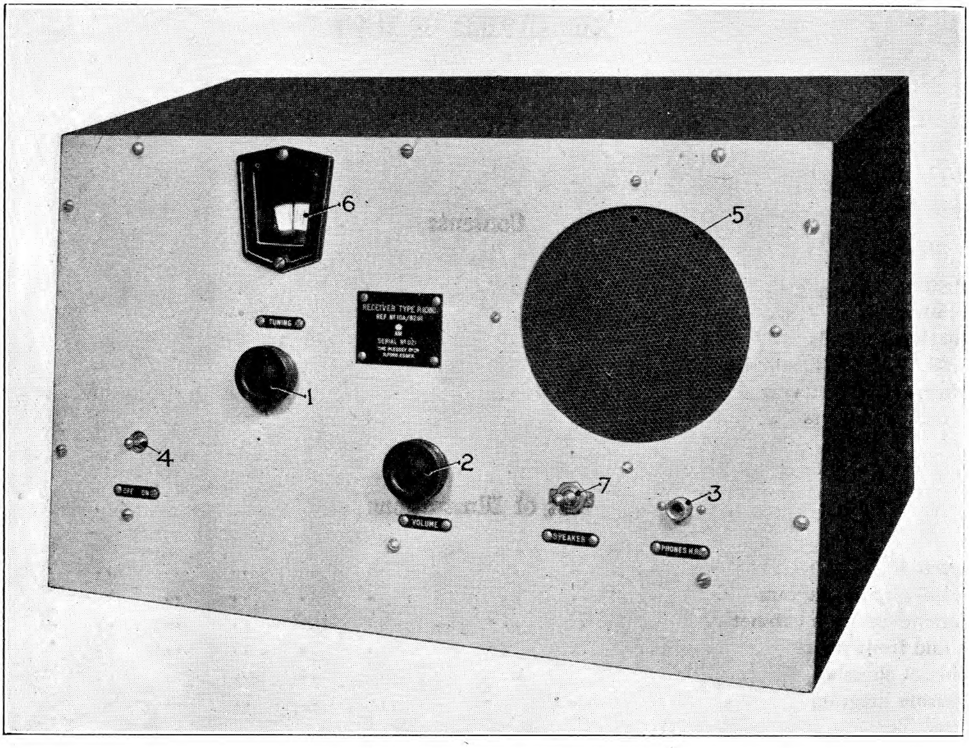
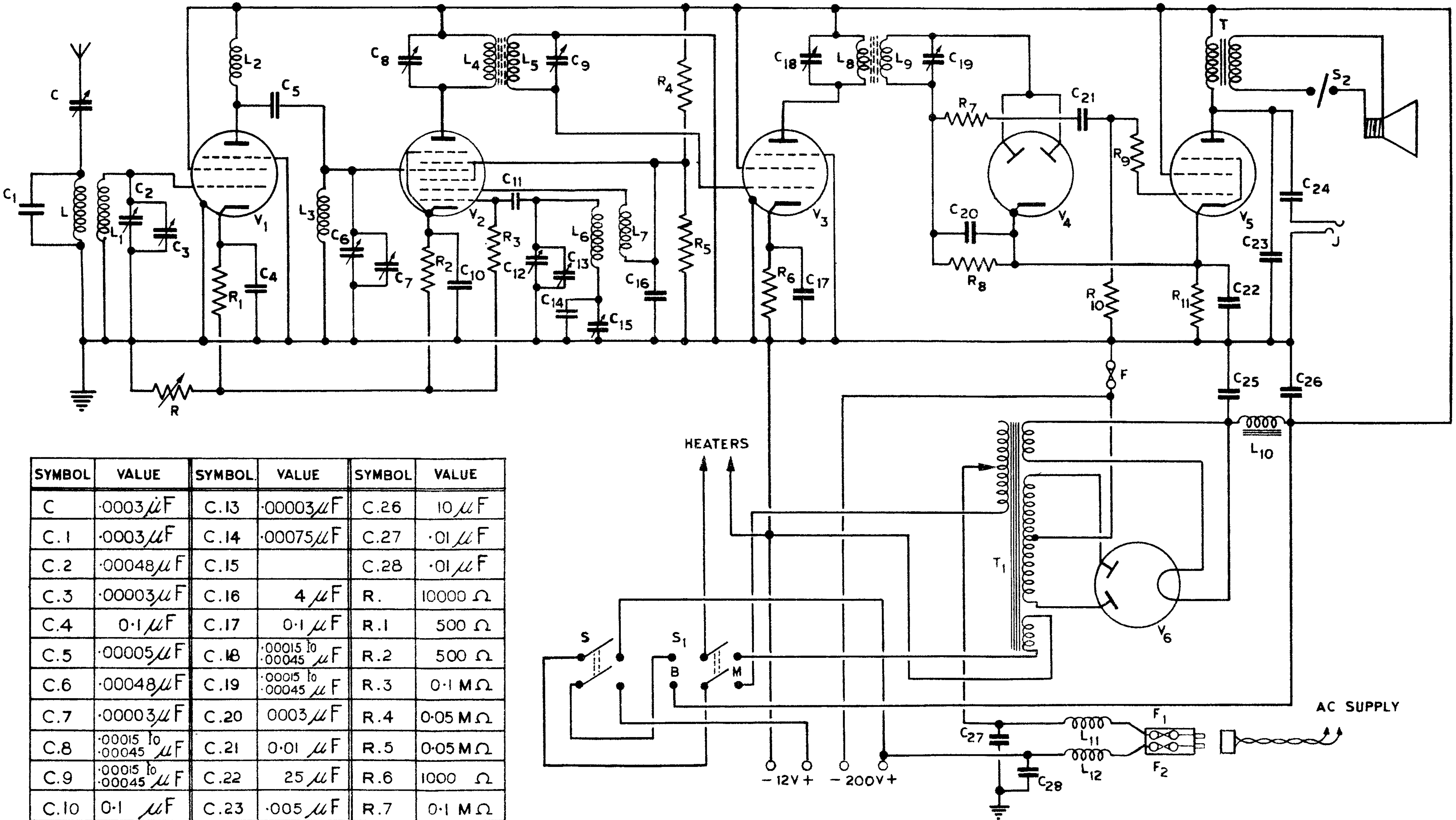


FIG. 1. Receiver R.1080.

2. A loud speaker is incorporated in the receiver and arrangements are also made for using head telephones, a switch being provided to switch off the loud speaker when telephones are in use.

GENERAL DESCRIPTION

3. The receiver is built into a metal chassis, the mains transformer, ganged tuning condensers, inductance coils and valves being located on the top of the chassis, and the resistances, condensers, etc., under the chassis. The chassis is enclosed in a metal cabinet, the front panel of which



SYMBOL	VALUE	SYMBOL	VALUE	SYMBOL	VALUE
C	·0003 μF	C.13	·00003 μF	C.26	10 μF
C.1	·0003 μF	C.14	·00075 μF	C.27	·01 μF
C.2	·00048 μF	C.15		C.28	·01 μF
C.3	·00003 μF	C.16	4 μF	R.	10000 Ω
C.4	0·1 μF	C.17	0·1 μF	R.1	500 Ω
C.5	·00005 μF	C.18	·00015 to ·00045 μF	R.2	500 Ω
C.6	·00048 μF	C.19	·00015 to ·00045 μF	R.3	0·1 MΩ
C.7	·00003 μF	C.20	0003 μF	R.4	0·05 MΩ
C.8	·00015 to ·00045 μF	C.21	0·01 μF	R.5	0·05 MΩ
C.9	·00015 to ·00045 μF	C.22	25 μF	R.6	1000 Ω
C.10	0·1 μF	C.23	·005 μF	R.7	0·1 MΩ
C.11	·0001 μF	C.24	·005 μF	R.8	0·5 MΩ
C.12	·00048 μF	C.25	6 μF	R.9	0·1 MΩ
				R.10	0·5 MΩ
				R.11	1000 Ω

FIG. 2 THEORETICAL CIRCUIT DIAGRAM

carries the loud speaker. The ON–OFF switch, the volume control spindle and tuning control project through the front panel. The tuning control consists of a knob which rotates the ganged condensers through about 12°.

4. Referring to the theoretical diagram fig. 2, it will be seen that the circuit employed is a superheterodyne. The valve V_1 is an R/F pentode, V_2 is the frequency changer, V_3 is a second R/F pentode operating at the supersonic frequency, followed by the diode rectifier valve V_4 which is coupled to the output pentode V_5. The valve V_6 is the rectifier from which the H.T. supply for the anode circuits is taken.

5. The aerial circuit includes the inductance L shunted by the fixed condenser C_1. In series with this circuit is a small variable condenser C which is initially set to a value which will provide the correct aerial coupling. The inductance L_1 is tuned by the condenser C_2 across which is the trimming condenser C_3. This tuned circuit, which is of the band-pass filter type , is connected between the control grid of the R/F pentode V_1 and earth. Bias is applied to the grid by connecting the resistances R_1 and R between cathode and earth. The former resistance has a fixed value but the latter is variable and serves as a volume control. The anode circuit of the valve includes the choke L_2, and coupling to the succeeding tuned circuit L_3 C_6 is by means of the fixed condenser C_5. The tuned circuit is connected between the control grid of the valve V_2 and earth, bias being provided by means of the resistances R_2 and R connected in the cathode-earth circuit.

6. The frequency changer valve V_2 is an octode which is virtually a triode and an R/F pentode in series. The cathode and the two electrodes adjacent to it comprise the triode, the first element acting as the grid and the second as the anode.

7. In this triode, it will be seen that between the grid and earth is a tuned circuit L_6 C_{12} which is inductively coupled to the inductance L_7 in the anode circuit, thus performing the function of an oscillator. The frequency of the generated oscillations, owing to the tuning of L_6 C_{12}, differs from the signal frequency by a given amount.

8. Since the potential of the anode of the triode portion is fluctuating at oscillator frequency and the electrode is " perforated ", the positive potential of the screen (adjacent to it) will cause electrons to pass into the space between the screen and the control grid of the R/F pentode portion of the valve. The potential of the control grid is varying at signal frequency and there will be a varying repulsion at signal frequency producing a space charge pulsating with two components. From this space charge or virtual cathode, electrons will be drawn by the action of the anode of the octode, in series with which is the circuit L_4 C_8 tuned to a frequency corresponding to the difference between the signal frequency and oscillator frequency. It only now requires the assumption of suitable non-linear characteristics to see that the anode current of the octode will contain among other oscillatory components one which has a frequency equal to the difference between the signal and oscillator frequencies. The resistances R_4 and R_5 form a voltage dividing arrangement to give the necessary potential to the screens.

9. The three condensers C_2, C_6 and C_{12} are all ganged and operated by a common handle so that the grid circuits of the first two valves are simultaneously tuned to the signal frequency, and at the same time the oscillator frequency is correctly related to the signal frequency. The condenser C_{14} and the trimming condenser C_{15} are provided to maintain correct " tracking ", i.e. proper relationship of the oscillator and signal frequencies throughout the tuning range.

10. The circuit L_5 C_9 is also tuned to the intermediate frequency and is connected between the control grid of the valve V_3 and earth. The grid of this valve is suitably biased by means of the cathode resistance R_6, and the anode circuit includes the inductance L_8 which is tuned by means of a condenser C_{18} to the intermediate frequency.

11. In series with the tuned circuit L_9 C_{19} and the diode rectifier V_4, is the resistance R_8, across which is connected, in series with C_{21} and resistance R_7, the grid-cathode circuit of the output valve V_5. A grid " stopper " resistance R_9 is included in series with the control grid of V_5, and a leak resistance R_{10} is connected between here and earth. The necessary bias is applied to the valve by means of the resistance R_{11} in the cathode connection.

12. In the anode circuit of the valve is the primary of an output transformer T. The secondary winding is connected through a switch S_2 to the speech coil of the permanent magnet loud speaker. Provision is made for connecting high-resistance telephones, a telephone jack J in series with a condenser C_{24} being connected between anode and earth.

13. The rectifier valve V_6 is of the full wave type. The anodes are fed with A.C. from the secondary of a transformer T_1 with a tapped primary winding. Two other secondary windings are provided one giving a four-volt heater supply for the rectifier and the other a 13-volt heater supply for the other valves in the receiver. The tappings on the primary windings of the transformer enable it to be connected to any A.C. supply between 100 and 130 and between 205 and 260 volts, and the transformer will function on any periodicity between 40 and 100 cycles. The chokes L_{11} and L_{12} together with the condensers C_{27} and C_{28} are provided to filter out R/F disturbances which may be brought in on the power mains.

14. A feature of the receiver is the switching device which enables it to be changed over for battery operation, the switch S_1 disconnecting the transformer and enabling a 12-volt battery to be employed for filament supply, and a 200-volt battery for H.T. supply.

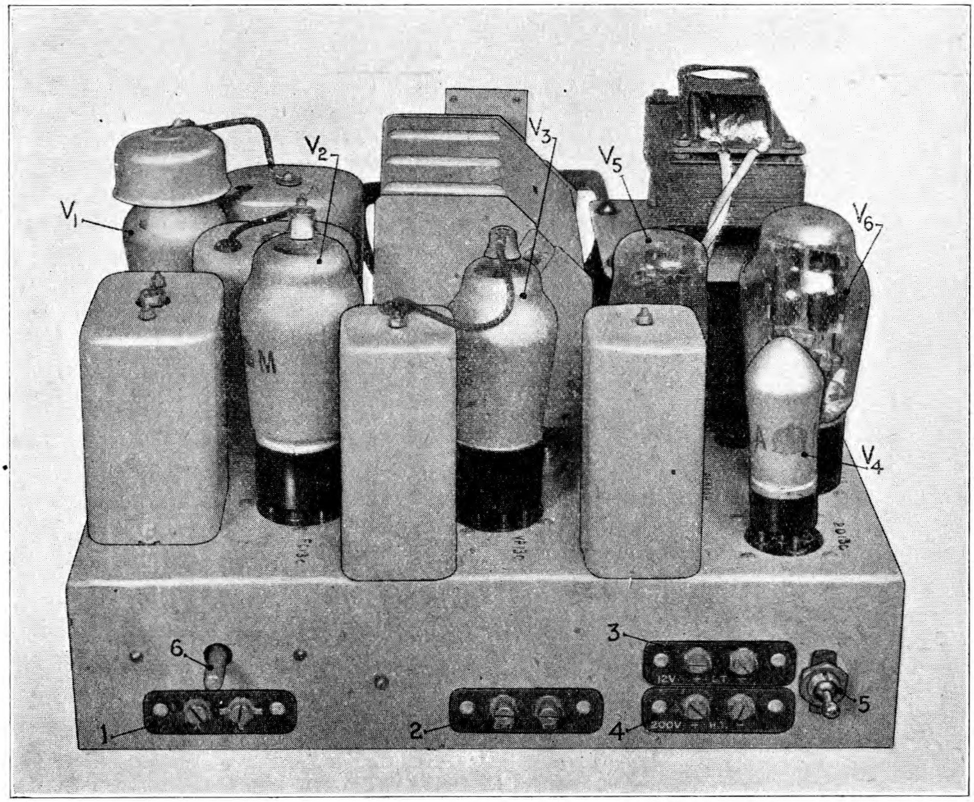


FIG. 3. Chassis removed from cabinet.

CONSTRUCTIONAL DETAILS

15. Four views of the receiver are given in figs. 1, 3, 4 and 5 and a bench wiring diagram in fig. 6. Referring to fig. 1, which shows the front of the receiver, the tuning controls (1) rotate the ganged tuning condensers through a slow motion drive. The amount of travel of the

ganged condenser spindle is limited by stops to about 12° and this movement is indicated by a pointer on a scale (6). The movement corresponds to approximately half a turn of the knob (1). The volume control handle (2) operates the variable resistance (1, fig. 5). This corresponds to the resistance R in fig. 2. The telephone jack (3) is permanently connected in series with the condenser (4, fig. 4), across the anode-cathode circuit of the output valve. The loud speaker (2, fig. 4) is mounted behind the grill (5, fig. 1). The speech coil of the loud speaker is connected in series with the switch (7). This switch may be seen at (3, fig. 4). The ON–OFF switch (4) breaks both H.T. and L.T. connections. It is mounted on the front of the chassis (5, fig. 4) and the knob projects through a clearance hole in the panel.

16. Referring to fig. 4 the flexible lead (7) is connected to the earth terminal (6) and the flexible leads (8) are connected to the loud speaker terminals (2, fig. 3) on the rear of the chassis. The other terminals of the receiver can also be seen in fig. 3. The aerial and earth terminals (1) can be seen beneath the series aerial condenser spindle (6), and on the right of the chassis

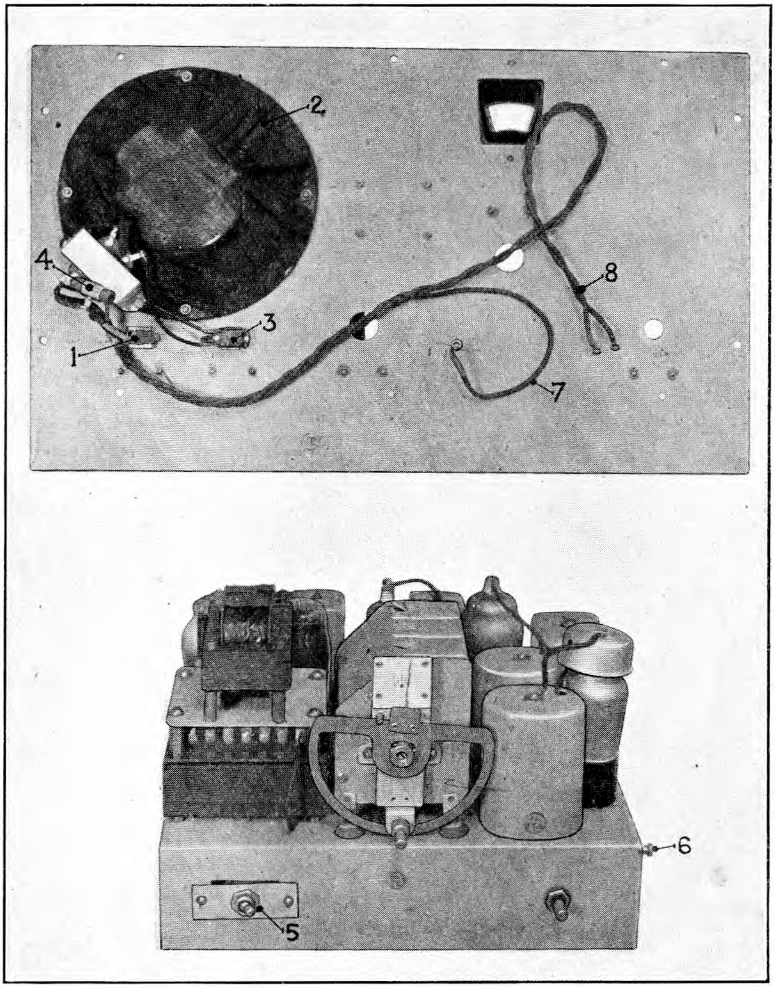


FIG. 4. Chassis and front panel.

are the L.T. and the H.T. terminals (3) and (4) respectively for use with batteries. The switch (5) on the extreme right is the " battery-mains " switch. This is a double pole two-way switch. One of the poles changes over the H.T. supply connection and the other changes over the L.T. connection. The switch can also be seen at (5, fig. 5) and the way in which it is wired may be seen from an examination of fig. 2.

17. The annotations on the valves in fig. 3 are similar to those used in the theoretical diagram fig. 2. V_1 is the first R/F pentode ; V_2 is the frequency changer ; V_3 is the second R/F pentode operating at intermediate frequency ; V_4 is the diode rectifier ; V_5 is the output pentode and V_6 is the H.T. rectifying valve. In fig. 5 is given a view of the underside of the receiver, and in fig. 6 a bench wiring diagram, but they must be regarded as typical and not exactly applicable to any one receiver, since modification during production has resulted in receivers differing from one another.

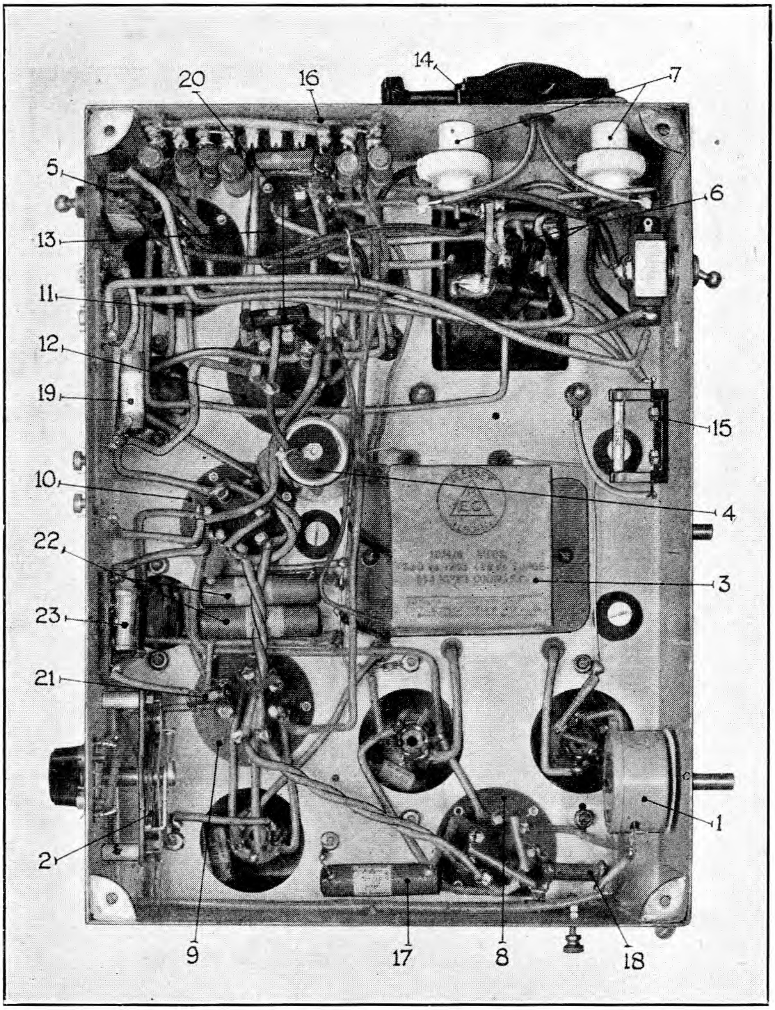
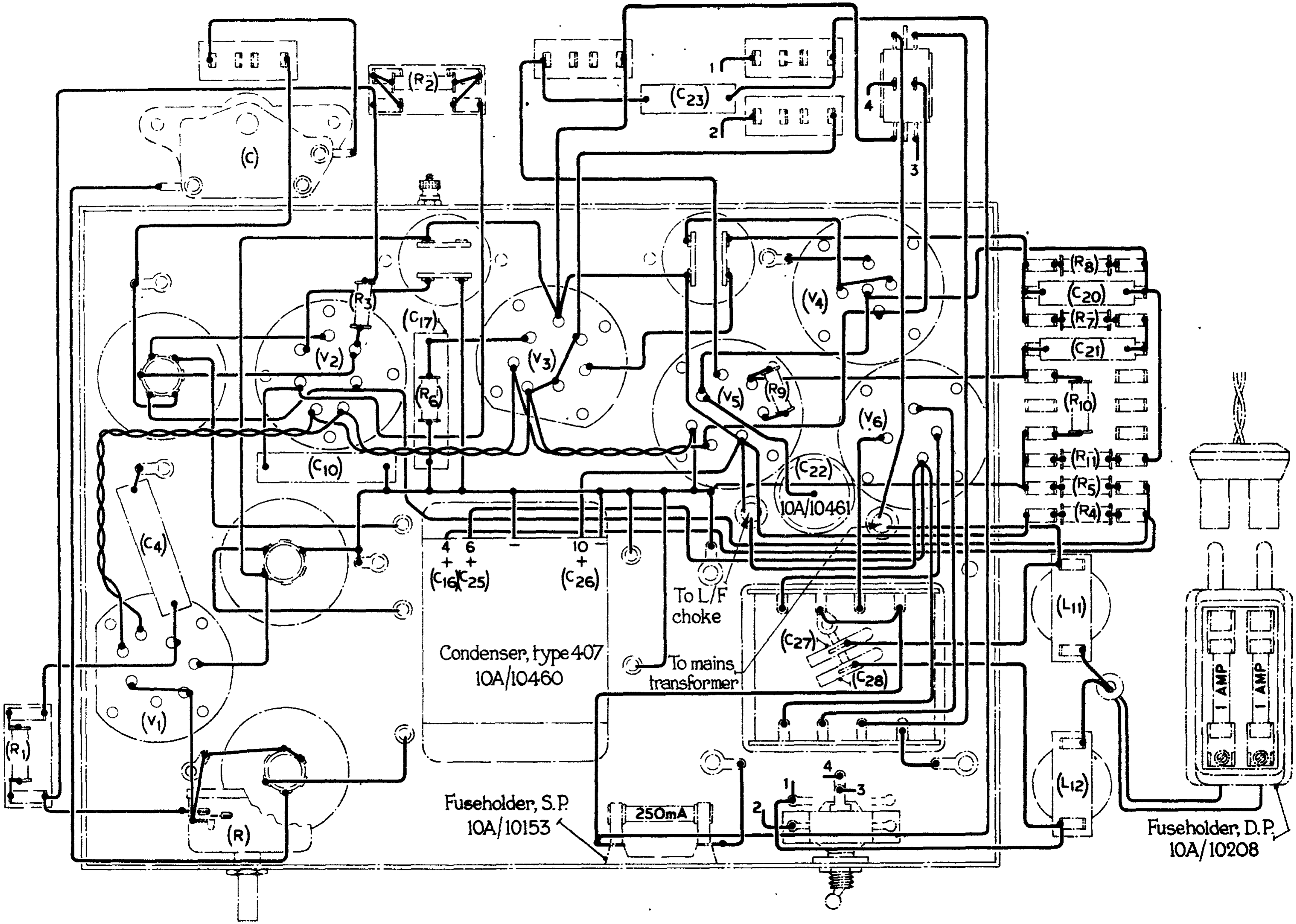


Fig. 5. Underside of chassis.



NOTE : Annotations in parenthesis, for example (C_{26}), refer to the corresponding annotations in Fig. 2

P.1894.

FIG. 6, BENCH WIRING DIAGRAM

18. Among the modifications which have been made to the receiver since production may be mentioned the following. The cardboard container (3, fig. 5) originally housed one of each of the following condensers : 10 μ F, 6 μ F, 4 μ F and 25 μ F. The receiver shown houses the 10 μ F, the 6 μ F and the 4 μ F condensers in the cardboard container but the 25 μ F is in a cylindrical metal case (4). Leaflet B11, A.P.1186, Vol. II, authorizes this change in components in the event of breakdown occurring with the original arrangement. The recommended method of mounting the 25 μ F condenser, however, is on the side of the chassis and not in the position in which it is shown in the receiver illustrated in fig. 5. These four condensers correspond to those marked C_{26}, C_{25}, C_{16} and C_{22} in the theoretical diagram (fig. 2). Condensers C_{26} and C_{25} are smoothing condensers in the rectifier circuit ; C_{16} is connected between the screen of the frequency-changer and earth and C_{22} is connected across the cathode resistance of the output valve.

19. Another modification (*see* A.P.1186/B9) is the provision of the main and H.T. fuses referred to in para. 29. The mains (1 amp.) fuses are located in the combined plug-and-socket and fuse-holder fitting (14). The H.T. fuse-holder (15) carries a 250-mA fuse and it is connected between the H.T.— connection and chassis. Originally the receiver was wired up with the H.T.— and L.T.— terminals connected together and joined to the centre point of the H.T. secondary and chassis. With the modified wiring the centre-point of the H.T. secondary winding is connected to the H.T.— terminal, and the 250-mA fuse is wired between this common point and chassis. The L.T.— terminal is not connected to H.T.— but is connected directly to chassis. A direct chassis connection is also taken from the end of the 13-volt heater winding remote from the " Battery-Mains " switch. The earth terminal of the receiver is connected to the chassis. The main bank of resistances and condensers is mounted on the holder (16) seen at the top left-hand corner of fig. 5. From left to right the units are as follows. The first is a resistance of ·5 megohm and corresponds to R_8 in fig. 2. It is connected between the diode cathode and the preceding valve. The condenser adjacent to this has a value of ·0003 μ F and is shunted across the ·5 megohm resistance. This condenser corresponds to C_{20} in the theoretical circuit diagram. Next to this is a resistance of ·1 megohm which is connected between the control grid of the output pentode and the diode. It corresponds to R_7 in the theoretical circuit diagram and is in series with the ·01 μ F condenser adjacent to it (C_{21}, fig. 2). Next to this is the resistance (R_{10}, fig. 2) which has a value of ·5 megohm. It is connected between the grid of the pentode output valve and earth. The 1,000 ohms bias resistance next in line is in the cathode circuit of the pentode output valve. It corresponds to R_{11} in the theoretical diagram. The two resistances at the extreme right both have similar values (·05 megohm) and are connected in series across the H.T. supply as a voltage dividing arrangement to provide the potential for the screen of the frequency changer. These resistances are designated R_5 and R_4 in the theoretical circuit diagram.

20. In the right-hand corner may be seen the R/F chokes (7) and the condensers (6) on the supply side of the mains transformer. These can be identified as L_{11}, L_{12}, and C_{27}, C_{28}, in fig. 2 The underside of the valve-holders may be clearly seen in fig. 5. The first R/F pentode is inserted in the valve-holder (8), the frequency changer in the valve-holder (9), the second R/F pentode in the valve-holder (10), the diode in the valve-holder (11), the output pentode in the valve-holder (12) and the rectifier in the valve-holder (13).

21. The 0·1 μ F condenser (17) is connected across the 500 ohms bias resistance (18) in the cathode circuit of the first valve. The 0·1 μ F condensers (22) are the shunt condensers across the bias resistances (23) in the cathode circuits of the second and third valves. One of these resistances has a value of 500 ohms and the other a value of 1,000 ohms. They correspond to R_2 and R_6 of the theoretical circuit diagram. The 0·1 megohm resistance (21) is the bias resistance of the oscillator grid of the frequency changer. The ·005 μ F condenser (19) is connected in the output valve circuit between anode and earth, and the 0·1 megohm resistance (20) is the " stopper " resistance in the grid circuit of the output valve.

VALVES AND H.T. AND L.T. SUPPLIES

22. Commercial valves are used in the receiver. Two V.P.13.C valves (Stores Ref. 10A/10526) are used, one in the first stage and one in the third stage. An F.C.13.C valve (Stores Ref. 10A/10527) is used in the second or frequency changer stage, and a 2.D.13.C valve (Stores Ref. 10A/10528) is used as a diode rectifier in the fourth stage. A Pen. 13.C valve (Stores Ref. 10A/10529) is used in the output stage, and an I.W.3.A valve (Stores Ref. 10A/10530) is used in the H.T. rectifier.

23. Normally the receiver will be run from A.C. mains, no battery of any kind being required. If A.C. is not available a 12-volt accumulator is used for L.T. supply, and an accumulator battery, such as a Milnes H.T. alkaline accumulator, for H.T. Dry battery H.T. supply is not likely to be economical owing to the heavy H.T. consumption. Where D.C. mains are available, a rotary convertor (Stores Ref. 10A/8291) may be used for the H.T. supply.

OPERATION AND PRECAUTIONS

24. The mains transformer is suitable for any frequency between 40 and 100 cycles and for any voltage between 100 and 130 or between 205 and 260. To adjust the receiver to different mains voltages remove the front panel complete, when the mains tappings will be found marked on the front of the mains transformer. To remove the front panel it will first be necessary to undo the small setscrews on the knobs of the tuning and volume controls, and withdraw the knobs. The loud speaker together with its switch comes away with the panel, but three flexible leads remain connected between the panels and chassis. These are sufficiently long to enable the panel to be laid beside the cabinet. Care is required to ensure that tension is not applied to these leads.

25. To change a valve or make any other adjustment it will be necessary to remove the chassis from the cabinet. This may be done by unscrewing the four screws on the underside. A portion of the cabinet is cut away to allow the choke to pass when withdrawing the chassis from the cabinet. The position of the valves may be seen from an examination of fig. 3.

26. The receiver as supplied for service is adjusted for reception on 245 kc/s. If for any reason, such as a change in the frequency of the transmission, it is required to re-adjust the receiver, the main condenser drive can be rotated to enable the receiver to be tuned to the new frequency. When authority is given to make such a change it may be carried out in the following way. The two grub screws securing the drive should be slacked off and the ganged condenser spindle rotated by means of the screwdriver slot in the end, until the required transmission is tuned in (volume control at a high setting). Keeping the main spindle in this position the drive should be set so that the pointer occupies the mid-position on the scale. The grub screws should then be tightened up. The high setting of the volume control, when carrying out this adjustment, ensures that any de-tuning which occurs as a result of variations of volume control will not be disadvantageous, i.e. de-tuning may occur for a strong signal (volume control at low), but it will be unimportant. Detuning will not occur on a weak signal (volume control at high) when correct tuning is important.

27. A series aerial condenser is fitted at the rear of the chassis. This should be turned fully clockwise and normally left in this position. If, however, interference should occur from a powerful transmission on a nearby channel, the control should be rotated in a counter-clockwise direction until the interference disappears. It may be necessary to increase the volume control setting to compensate for loss of signal strength. Change-over from mains to battery operation is made by the switch situated at the rear of the chassis. Before connecting either A.C. mains or batteries to the receiver make sure that this switch is in its correct position. It is engraved M and B. The former is the position for mains operation and the latter is the position for battery operation.

28. Two sets of terminals are provided at the rear of the chassis for connection of the batteries. One set is engraved —LT+12V and the other is engraved —HT+200V. See that the mains plug is withdrawn before connecting up batteries. In no circumstances are mains and batteries to be connected up together.

29. Three fuses are provided in the receiver. Two of these are located in a combined fuse-holder and plug-and-socket, mounted on the side of the receiver. One-ampere cartridge fuses (Stores Ref. 10A/9613) are used here. The other fuse is located underneath the chassis in the negative lead. It consists of a 250-mA cartridge fuse (Stores Ref. 10A/10209).

30. It should be noted that the metal coating of the frequency changer valve is not at earth potential owing to the presence of the bias resistance. Care should therefore be exercised that the coating is not allowed to come into contact with the metal work of the chassis or any earthed conductor.

APPENDIX

NOMENCLATURE OF PARTS

The following list of parts is issued for information only. All the parts of the receiver have not been listed but only those spares for which reference numbers have been allocated. In ordering spares for this receiver the appropriate section of AIR PUBLICATION 1086 must be used.

Ref. No.	Nomenclature.	Quantity.	Remarks.
10A/8291	Receiver, type R.1080		
10A/10460	Condenser, type 407	1	
10A/10461	Condenser, type 408	1	
10A/10209	Fuse, cartridge 250-mA	1	
10A/9613	Fuse, cartridge 1 amp	2	
10A/10153	Holder, fuse S.P.	1	
10A/10208	Holder, fuse D.P.	1	
	Accessories :—		
10A/8291	Convertor, rotary, 60-watt	1	For use with D.C. mains.
10A/10526	Valve, V.P.13 C	2	First and third stages.
10A/10527	Valve, F.C.13 C	1	Frequency changer.
10A/10528	Valve, 2 D.13.C	1	Diode.
10A/10529	Valve, Pen. 13.C	1	Output.
10A/10530	Valve, I W. 3.A	1	Rectifier.

SECTION 3, CHAPTER 5
RECEIVER R.1100

Contents

List of Illustrations

RECEIVER R.1100

(Stores Ref. 10A/9476)

INTRODUCTION

1. The receiver, type R.1100, has been designed for use as a self-contained portable ground receiving station and is intended primarily for use in Army Co-operation units, in which service it will ultimately replace the receiver type R.54. The principal function of the receiver is the reception of wireless signals from aeroplanes engaged in artillery reconnaissance, but provision has also been made for its employment in the reception of signals between the wireless tender and aeroplanes engaged in tactical reconnaissance. It is capable of receiving C.W., M.C.W., or R/T signals and has two frequency ranges, namely 1,200–1,500 kc/s for artillery reconnaissance, and 2,000–3,000 kc/s for the reception of signals relating to tactical reconnaissance.

2. The instrument consists of a three-valve superheterodyne receiver, fitted into a carrying case which provides for the stowage of all ancillary equipment including batteries, together with certain spares and stationery, but excluding the portable mast, which is not described in this chapter. The approximate overall dimensions are as follows:—23 in. long by 13 in. high by 10 in. wide, and the weight complete for service is 58½ lb. The carrying case is provided with flexible handles, which enable the receiver to be carried by one man for short distances. It is intended, however, that the receiver should normally be carried by two persons, each holding one of the flexible handles. It is constructed for use under both ordinary and tropical climatic conditions, and can be operated with the lid held wide open on a check chain, or semi-closed and protected from rain by its weather-proof hood. Again the receiver itself can be withdrawn from its carrying case and used as a separate receiving instrument.

GENERAL DESCRIPTION

3. The receiver has been designed to operate with a mast aerial, Stores Ref. 10B/7342 as described in Section 3, Chapter 1 of this publication, or, as an alternative, with 50 ft. of wire suspended as an aerial, at a height not exceeding 12 ft. above the ground. It is a three-stage superheterodyne receiver and comprises a combined first detector and beat oscillator or frequency changer employing a heptode mixing valve. This is followed by an intermediate frequency amplifier, and the last stage is a combined leaky grid detector and output valve. A simplified circuit diagram in which only the essential elements of the circuit have been shown, is given in fig. 1.

4. It will be seen that the aerial is coupled to the tuned aerial circuit L_2–C_1 by a small pre-set condenser C_{28} and the coil L_1. One of two tuned aerial circuits may be used by means of a selector switch, according to the frequency band it is desired to receive.

5. For each of the two frequency bands a separate parallel-fed oscillator circuit is also employed. One of these L_6–C_5 is shown. The aerial and oscillator tuning condensers C_{10} and C_{11} are ganged together and the common spindle carries a tuning scale which is calibrated approximately in kilocycles per second. The anode circuit of the frequency-changer valve V_1 is tuned to the intermediate frequency by the circuit L_9–C_{14} and is coupled to the I/F amplifier valve V_2 by the condenser C_{16}.

6. The intermediate frequency amplifier valve V_2 is a pentode. Its anode circuit is similar to that of the mixing valve and it is coupled to the grid of the detector valve by the condenser C_{20}. A reaction winding L_{11} is coupled to the tuning coil, in order to produce local oscillations for the purpose of heterodyne reception.

7. The final stage functions as a grid detector, but since the valve is a pentode a considerable amplification of the audio-frequency waveform is obtained. The impedance of the valve V_3 is matched to the impedance of the telephones by means of the stepdown auto-transformer L_{13}. A centre tap on L_{13} is coupled to the telephone jacks J_1 and J_2 by means of the output condenser C_{25}.

8. The reaction winding L_{11} referred to in para. 6 is connected between the anode and filament of the detector valve, a pre-set condenser C_{22} being connected in series with it in order to serve as a reaction "throttle" control. This circuit is only completed when the switch S_5 is closed on the C.W. side. When this circuit is open, that is, the switch is on the MOD side, only M.C.W. or R/T reception is possible.

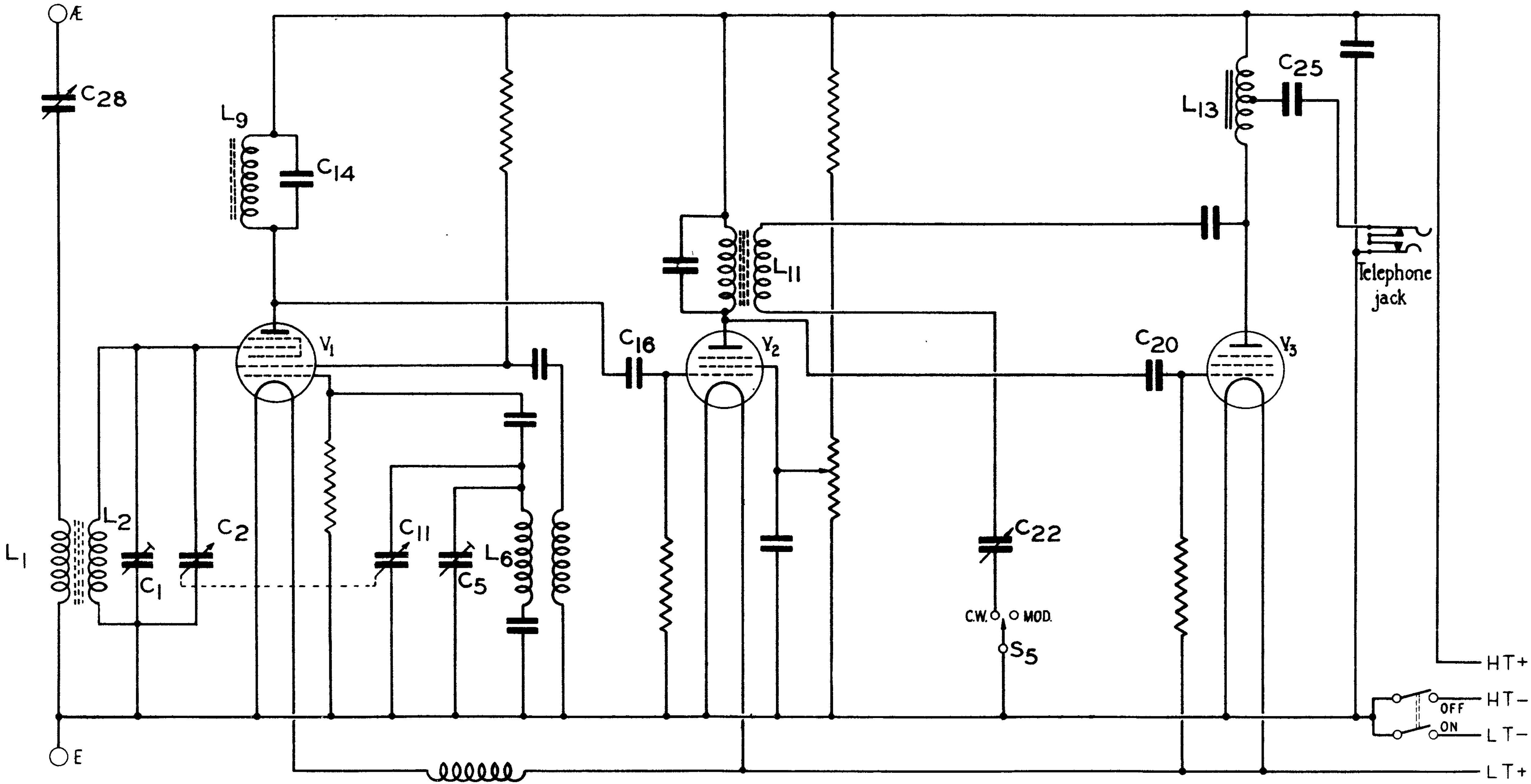


FIG. 1 SIMPLIFIED CIRCUIT DIAGRAM

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C_{28}, C_1 to C_7, C_8, C_9, C_{10}, C_{11}, C_{12}, C_{13}, C_{15}, C_{14}, C_{16}, C_{17}, C_{18}, C_{27}, C_{19}, C_{20}, C_{21}, C_{22}, C_{23}, C_{25}, C_{24}, C_{26}	Condensers
R_1, R_2, R_3, R_4, R_6, R_{11} to R_{15}, R_5, R_7, R_{10}, R_8, R_9	Resistances
L_1 to L_8, L_{12}, L_9, L_{10}, L_{11}, L_{13}	Inductances
S_2, S_1, S_3, V_1, V_2, S_4, M, S_5, V_3, S_6	Miscellaneous

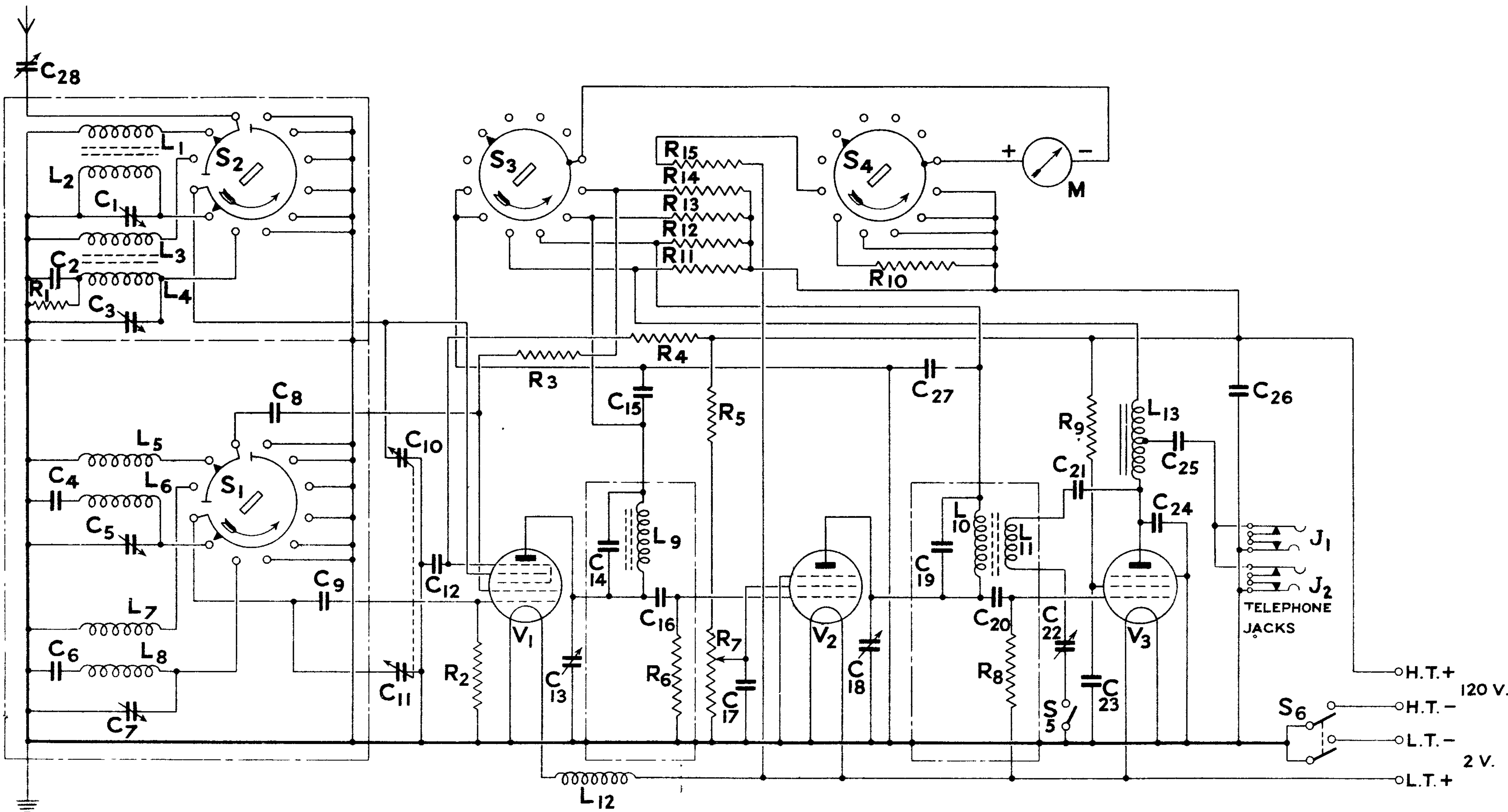

FIG. 2. RECEIVER R.1100 —— THEORETICAL CIRCUIT DIAGRAM

9. The manner in which C.W. reception is accomplished may be described in the following way. When the switch is placed in the C.W. position the last stage oscillates at a frequency of approximately 465 kc/s. In order to produce audible beats it is now only necessary to ensure that the generated supersonic frequency differs from this by some suitable frequency. When the tuning control is varied slightly, there is a small change in the I/F frequency produced in the anode circuit of the frequency-changer valve. Since the last stage is oscillating at 465 kc/s, a beat note will be produced in the telephones which is equal to the difference between this change in I/F and 465 kc/s. Thus an intermediate frequency of 466 kc/s would produce an audible note of 1,000 cycles per second.

10. The switching arrangements for the two groups of frequencies, as well as details of the circuits for measuring certain voltages and currents, are shown in the theoretical circuit diagram, fig. 2. The four wafer-contact type selector switches, S_1, S_2, S_3 and S_4 are ganged. The control which operates the four switches has eight positions, of these, two are used to select the desired frequency band by means of the two sets of tuned circuits. The other six are used in conjunction with a small moving coil meter which measures the following circuit operating values:—

(i) Oscillator anode current, in non-oscillating condition, V_1. Io.A. (A)

(ii) Modulator anode current, V_1. Im.A. (A)

(iii) Anode current, V_2. Ia. (B)

(iv) Anode current, V_3. Ia. (B)

(v) High tension battery voltage, H.T.V. (C)

(vi) Accumulator voltage, L.T.V. (B)

11. The aerial is coupled to the tuned aerial circuit by a small pre-set trimmer condenser C_{28} and (depending upon the frequency band selected) by an inductive coupling made up of either of the following groups:—the 1,200–1,500 kc/s frequency band by the inductances L_1, L_2, the latter tuned by the pre-set trimmer condenser C_1; or the 2,000–3,000 kc/s frequency band by the inductances L_3, L_4, the latter in series with a padder condenser C_2 and shunt resistance R_1. This circuit L_4–C_2–R_1 is tuned by the pre-set trimmer condenser C_3.

12. The switch S_1 controls the respective parallel-fed oscillator circuits (i) for the 1,200–1,500 kc/s frequency band, the inductances L_5 and L_6 and padder condenser C_4, aligned by the pre-set trimmer condenser C_5 (ii) for the 2,000–3,000 kc/s frequency band, with the inductances L_7 and L_8 and padder condenser C_6, aligned by the pre-set trimmer condenser C_7. Aerial and oscillator circuits are tuned respectively by the ganged tuning condensers C_{10} and C_{11}.

13. Reference should also be made to fig. 3 which shows the valve connections and annotations. The heptode valve V_1 combining the function of first detector and beat oscillator has its filament fed through the R/F choke L_{12}. The valve V_1 is coupled to the two parallel-fed tuned oscillator circuits, by the condensers C_8 and C_9. Oscillator bias is obtained by means of the grid leak R_2. The screen grids 3 are maintained at earth potential with respect to R/F by the condenser C_{12}. The grid 1 is maintained at positive potential by the feed resistance R_3. The screen grids 3 are fed through the resistance R_4, by-passed to earth through C_{12}. The signal voltage from the tuned aerial circuit is connected directly to the top cap. The anode 7 of the valve is connected directly to the tuned circuit C_{14}–L_9 of the 1st I/F stage. This stage contains a coupling condenser C_{16} and leak resistance R_6, which are directly connected to grid 2 of the valve V_2, which is an intermediate frequency amplifier. Potential is applied to the anode of V_1 through the meter shunt resistance R_{13}, which is connected to the H.T. supply.

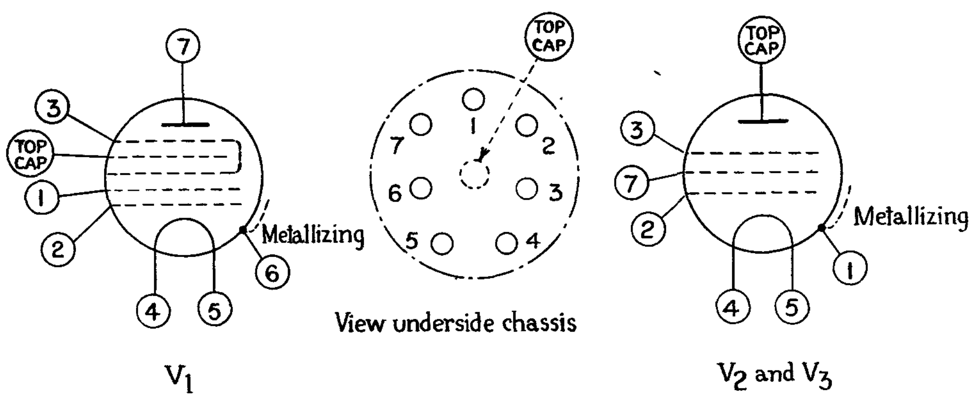

Fig. 3.—Valve diagram

14. The I/F amplifier valve V_2 is a pentode and, as indicated in para. 13, has its control grid connected to the 1st I/F stage. A variable positive potential is applied to the screen grid 7 by the volume control R_7 which is connected in series with R_5 to H.T.+. A by-pass condenser C_{17} is connected across the moving portion of the volume control R_7 and earth. The suppressor grid 3 is connected to earth. The anode of the valve is connected, through the top cap, to the tuned circuit of the 2nd I/F stage and through a pre-set trimmer condenser C_{18} to earth. The 2nd I/F stage contains a coupling condenser C_{20} and bias resistance R_8 (the latter connected to L.T.+.), which are coupled to grid 2 of the valve V_3. Potential is applied to the anode of the I/F valve through the meter shunt resistance R_{12} which is connected to the H.T. supply. The 2nd I/F stage also contains a coupling coil L_{11}, which is referred to in para. 15.

15. The output valve V_3 is also a pentode and combines the function of detector and audio-frequency amplifier. As indicated in para. 14, its control grid 2 is connected directly to the 2nd I/F stage. The screen grid 7 is by-passed to earth through the condenser C_{23} and is connected to H.T.+ through the feed resistance R_9. The suppressor grid 3 is connected to earth. A condenser C_{24} is connected to the anode of V_3 and earth and acts as a tone control. The reaction coil L_{11}, which is a part of the 2nd I/F stage unit referred to in para. 14, is coupled to the anode of V_3 *via* the condenser C_{21}. This circuit is completed through a pre-set trimmer condenser C_{22} and switch S_5 (MOD C.W.) forming a reaction circuit to produce local oscillations for C.W. heterodyne reception. The anode of this valve is also connected to an audio-frequency output choke L_{13} and through the meter shunt R_{11} to H.T.+. The telephone jacks J_1 and J_2 are connected to a tapping on the output choke L_{13} by means of the coupling condenser C_{25}. A smoothing condenser C_{26} is shunted across the H.T. supply.

16. The switches S_3 and S_4 connect the meter M in the desired circuit, as indicated in para. 10. These switches form part of a Yaxley switch which comprises a set of four ganged-wafer contacts S_1, S_2, S_3 and S_4, which are operated by a single control handle on the front of the operating panel. The switch S_5 (MOD C.W.) is a two-position ON-OFF switch operated by a small knurled knob on the control panel. The switch S_6 provides for switching on and off the negatives of both L.T. and H.T. supply. Two telephone jacks J_1 and J_2 provide for the connection of two pairs of telephone receiver head sets.

CONSTRUCTIONAL DETAILS

17. The receiver and its associated equipment is contained in a weatherproof carrying case which is provided with a canvas hood and carrying straps. A view of the receiver in its carrying case, closed for transport, is given in fig. 4. This carrying case is constructed of wood with metal

FIG. 4.—CARRYING CASE, CLOSED FOR TRANSPORT.

reinforcement at the joints and double metal reinforcement at the corners. The lid, in the form of a hood, has similar metal reinforcement and metal sides. It is hinged at the back with a rainproof strip hinge extending the whole width of the case. Two metal snap lock clips are located on the front to fasten the lid. A canvas flap folds back and is fastened to the lid by seven screws on the front and by two straps and studs on opposite sides of the lid. When it is not in use as a weather hood, it is retained in the folded position by two press studs on the top of the lid. Fig. 5 shows the carrying case open with the hood in position for wet weather operation. Two webbing carrying straps are fixed by universal fastenings to the front and back of the carrying case. The overall dimensions of the carrying case are approximately $22\frac{3}{4}$ in. by $12\frac{1}{2}$ in. by $9\frac{1}{2}$ in.

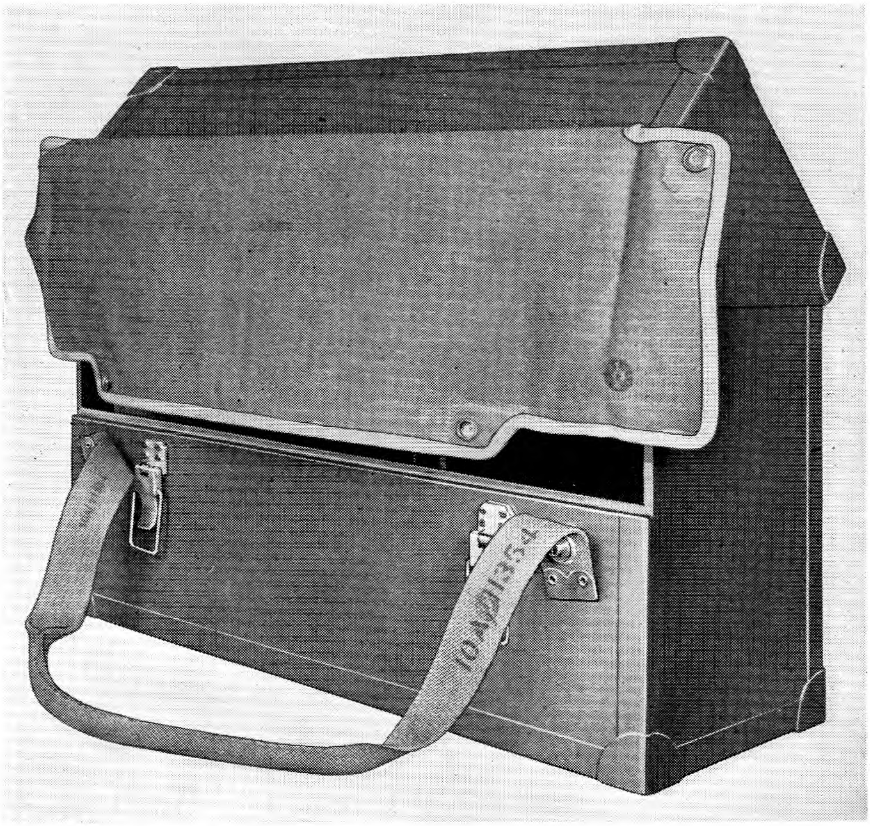

FIG. 5.—CARRYING CASE, OPEN FOR WET WEATHER OPERATION.

18. Referring to fig. 6, which is a view of the receiver with the carrying case open, the fittings in the lid may be seen. These comprise a chain (1) to limit the opening of the lid and a hinged arm (2) on which to rest the lid when operating either with or without the canvas weather hood down. Both the chain and the hinged arm can be seen on the right-hand side in the carrying case. The hinged arm is shown folded down. An instruction sheet (3) with a wiring diagram and certain operating instructions is secured to the inside of the lid. A clip (4) is also provided in front of the sheet at the lower centre engraved FOR BATTERY OPERATOR'S CARD.

19. To the left of the carrying case may be seen the receiver (7) secured in position by the two anti-vibration mountings (5) and (6). The H.T. battery is carried under the receiver and is held in position by a metal clip.

20. The container (8) seen on the right of the case is divided into three compartments. The one seen in the illustration is provided for the stowage of the telephones. Two compartments are provided under the lid (9) for the L.T. accumulators. The one on the left is for a spare and the one on the right for the accumulator being used. A pair of leads (10) connect the accumulator to the receiver. These leads pass under the container which can be removed from the case. Three spare valves are housed under the container. Two bushed holes (11) on the left of the case provide access for the aerial and earth connections.

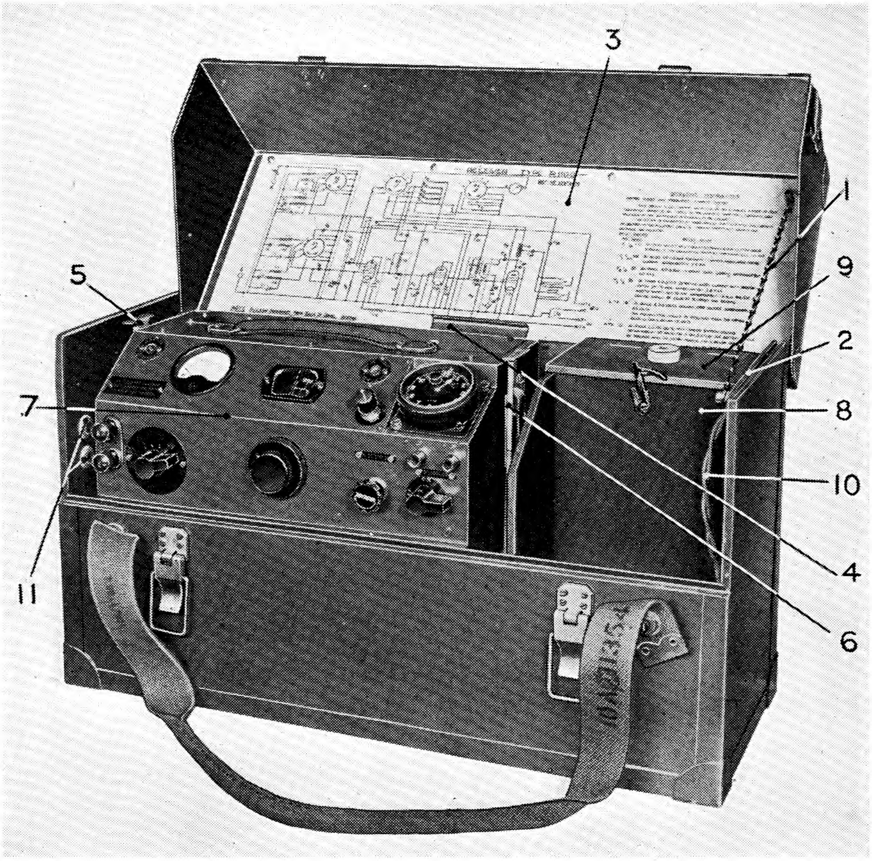

FIG. 6.—CARRYING CASE OPEN, SHOWING RECEIVER.

21. The receiver which is shown withdrawn from its carrying case in fig. 7 has a sheet aluminium-alloy chassis, which is built into a case made of the same material. This case is fitted with two brackets (1) and (3) at the lower edge of each side, which engage in guides on the receiver suspension frame when the receiver is placed in the carrying case. An upper bracket (5), located towards the top of each left and right-hand side of the case engages the pillar spring grips which fasten the receiver into the carrying case. At the back and located at the upper extreme corners are two metal-shod rubber anti-vibration pips which rest against the back of the carrying case and prevent the receiver jarring against the case when in transit. A rim (10) at the front fills the space between the receiver case and the carrying case without limiting the anti-vibration features of the suspension of the receiver in the carrying case. This rim (10) can be seen immediately above the two pairs of battery leads (13) on the front of the receiver case in the illustration.

22. The receiver, as will be seen in fig. 7, is oblong in shape with a sloping portion in front. Its overall dimensions are about 13½ in. by 7½ in. by 7½ in. The controls are situated on the front, partly on the middle vertical portion and partly on the sloping portion. The vertical middle portion above the rim (10) contains at the left, the aerial and earth terminals, the handle (7) and the engraved position plate of the switch S_1, S_2, S_3 and S_4. The fine and coarse tuning control knobs (4) of the ganged condensers C_{10} and C_{11} are in the central position, the volume control operating knob (2) being on their right. Sockets J_1 and J_2 for telephone receivers, the control handle (9) and the engraved position plate of the switch S_4, complete this portion of the front panel.

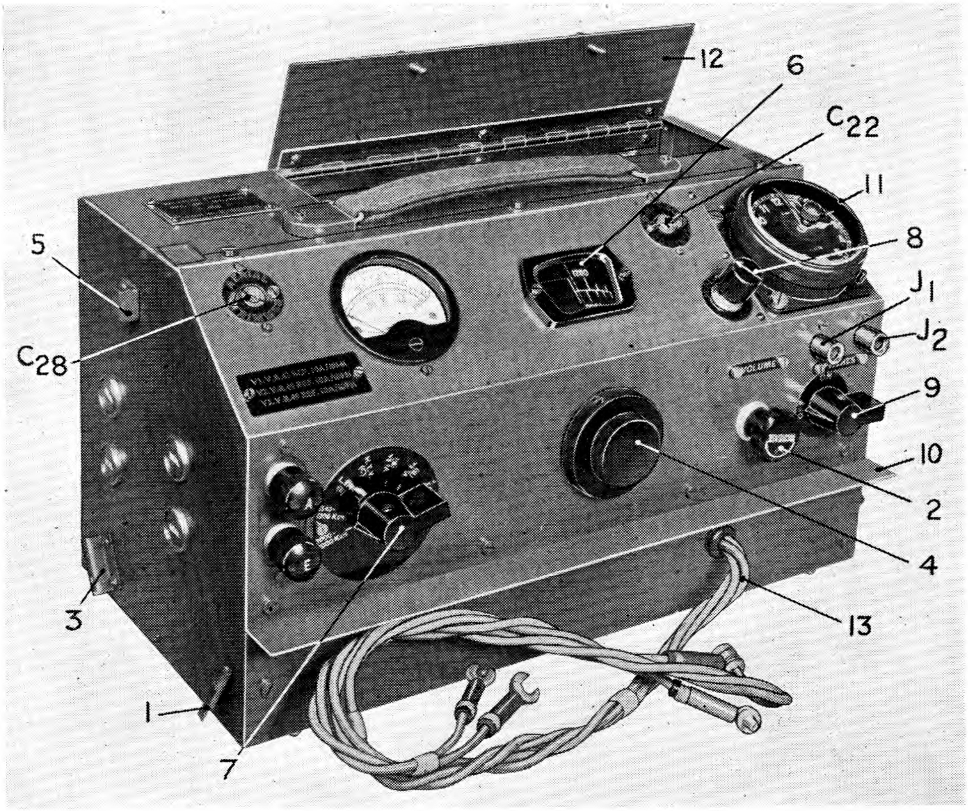

FIG. 7.—RECEIVER REMOVED FROM CARRYING CASE.

23. Below the rim and almost under the volume control knob (2) is situated a bush through which the H.T. and L.T. leads (13) pass. On the sloping portion of the receiver are mounted the aerial trimmer condenser C_{28} on the left and the C.W. OSC control condenser C_{22} on the right. About the centre may be seen the dial of the moving coil meter and the scale (6) of the tuning dial of the ganged condensers C_{10} and C_{11}. On the right of the panel are the operating knob (8) of the MOD. C.W. switch, and a clock (11). The latter is mounted in a sunken portion to the extreme right in full view of the operator. A label indicating the three valves which are used in the receiver, their types and stores reference numbers is at the lower left. This completes the whole equipment of the operating panel.

24. On the top of the receiver case is a hinged door (12) which gives access to the valves. It is secured by two captive knurled fastening screws. A name plate and carrying strap complete the top fixtures. The four seals, indicated on the left-hand side of the receiver, cover the slots of the pre-set condensers C_1, C_3, C_5 and C_7. The receiver metal case is painted Air Force blue. All controls are black with white filled indicating engraving. The labels are black with brass finish lettering. The single exception is the meter which has a white face with black indicator and lettering.

25. The receiver case forms the screen of the receiver and it comprises two portions. The front, both vertical and sloping desk portions, is built on to the receiver chassis. The bottom, back, top and two sides are made up into a box unit and are detachable. This portion is attached to the chassis and front of the receiver by eight nickel-plated screws, which, when unscrewed, enable the receiver case to be removed entirely from the chassis and control panel, giving access to the interior of the receiver.

26. The chassis which is built up of sheet aluminium alloy, together with the front of the receiver case, have mounted upon them the whole of the components of the receiver. A bench wiring diagram is given in fig. 10 and should be used in conjunction with the interior illustrations of the receiver. A view looking from the back into the receiver with the case

screen removed is given in fig. 8. It will be seen that starting from the left and mounted on the back of the vertical portion of the front panel are the two telephone jacks J_1 and J_2 wired in parallel. Beneath these are the ON-OFF switch S_6 and immediately to the right of this switch the volume control potentiometer R_7. This resistance is wound on a former and enclosed in a metal case. The coarse and fine tuning control (3) and tuning dial (5) of the ganged condensers C_{10} and C_{11} are in the centre. The condensers themselves are mounted on the top of the chassis behind these controls. To the extreme right is mounted the clicking device of the switches S_1, S_2, S_3 and S_4 with contact wafers S_3 and S_4 immediately in front. The flat control rod which actuates these switches, after passing through the contact wafers S_3 and S_4 enters into the sheet-aluminium box to be seen to the right of the chassis.

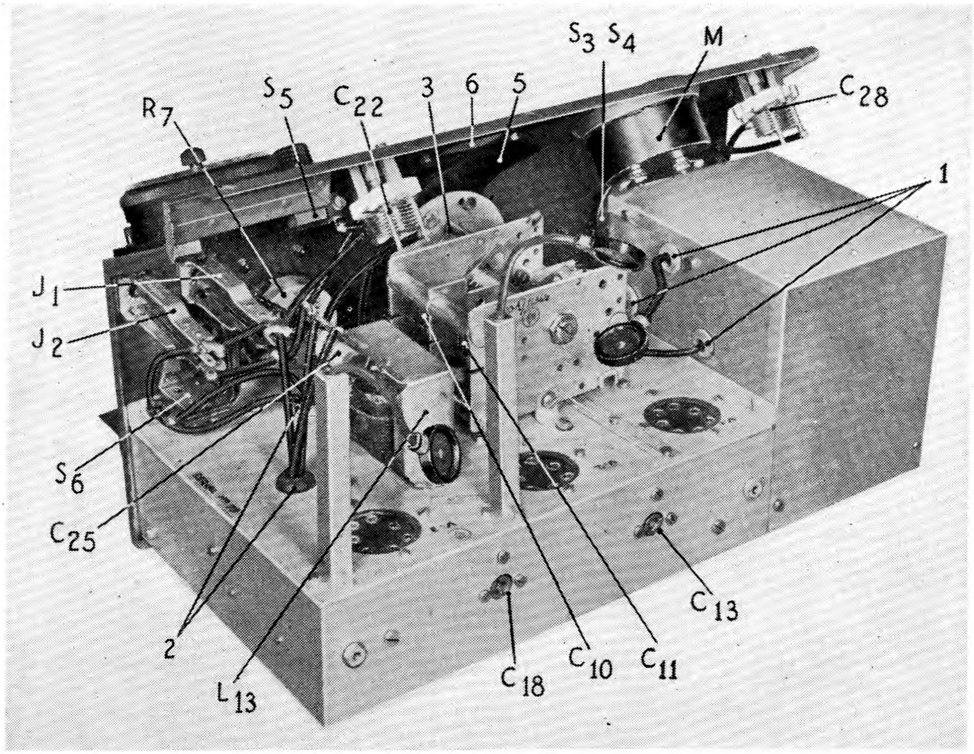

FIG. 8.—INTERIOR OF RECEIVER.

27. Behind the sloping desk portion of the front panel and near the upper edge are the two condensers, aerial trimmer C_{28} and C.W. OSC control C_{22}. Below the latter is mounted the MOD C.W. switch S_5. In the centre is the window (6) for the tuning dial of the ganged condensers C_{10} and C_{11} and to the right of this the moving coil meter M.

28. The chassis is attached to the lower portion of the vertical front panel. It is box-shaped with a top and two sides. It is about $2\frac{1}{4}$ in. high and has mounted on the top the ganged tuning condensers C_{10}, C_{11}. Behind these it is cut away to take their dial (5). Two angle strips are fixed to the top of the chassis immediately under the ganged condensers to stiffen the bedding of the condensers. Mounted immediately to the left will be found the auto-transformer L_{13} which carries a terminal strip at its top left edge. The condenser C_{25} is mounted upon this terminal strip. The three valve-holders for the valves V_1, V_2 and V_3 are mounted beneath three holes cut in the chassis towards the rear edge. Aluminium pillars positioned immediately to the left of each of the valve sockets V_2 and V_3 carry the top cap connectors for the valves. Two bushes (2), one in front of the potentiometer R_7 and one beside the choke L_{13}, carry the connecting leads from the components on the top of the chassis to those on the underside.

29. Three bushes (1) are provided on the side of the box which may be seen on the right-hand side of the receiver. The connections to the two tuning condensers C_{10} and C_{11} and the top connector for the valve V_1 are taken through these bushes. On the right-hand side of this box are the adjusting slots for the condensers C_1, C_3, C_5 and C_7. At the back is a bush through which the lead to the aerial trimmer condenser C_{28} passes. Also two mountings for the switch contact wafers S_3 and S_4, and their flat control rod.

30. The underside of the chassis is shown in fig. 9. In this view the box screen is at the left and is formed into two compartments. The first, in the foreground of the illustration, houses the oscillator coil assembly which consists of the inductances L_5, L_6, L_7 and L_8 wound on a former with the condensers C_4 and C_6 mounted on a strip of insulation material at the top. Litz winding is employed for the two inductances L_6 and L_8. This compartment also contains the wafer contact switch S_1 and the two condensers C_5 and C_7. The latter are mounted upon the left-hand wall of the box and are capable of adjustment through the sides of the receiver container. Two condensers C_8 and C_9 are mounted behind the wafer switch.

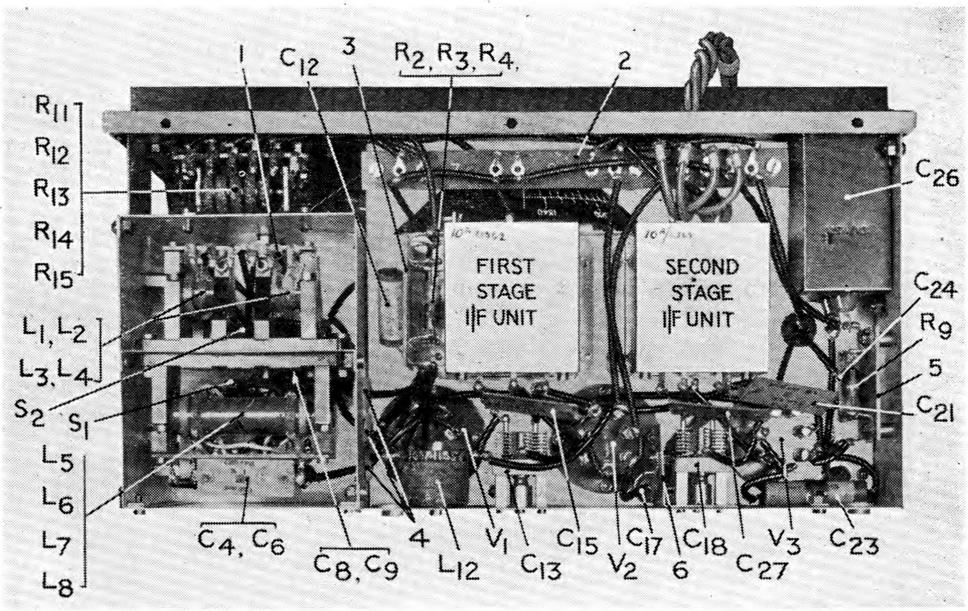

FIG. 9.—INTERIOR OF RECEIVER, SHOWING UNDERSIDE OF CHASSIS.

31. The second compartment houses the aerial coil assembly which consists of the inductances L_1, L_2, L_3 and L_4 wound on a former with a terminal strip at the top. Litz winding is employed for the two tuned inductances L_2 and L_4. This former is mounted back to back with the former of the oscillator coil assembly upon the wall which divides the compartments. This compartment also contains the wafer contact switch S_2, mounted behind the switch S_1, and the two condensers C_1 and C_3 mounted upon the left-hand wall of the box in similar positions to the condensers C_5 and C_7 of the oscillator coil compartment. The condensers C_5 and C_7 may be adjusted through the sides of the container. Three bushes (4) provide access for leads to this compartment. Mounted outside the box and upon the wall nearest the front panel is the meter shunt former with the shunt resistances R_{11}, R_{12}, R_{13}, R_{14} and R_{15} wound upon it.

32. Centrally situated in the main chassis will be found the 1st and 2nd stage I/F units each contained in a screened box. The one on the left is the 1st stage and contains the inductance L_9, condensers C_{14} and C_{16} and the resistance R_6. The one on the right is the 2nd stage and contains the inductance L_{10}, condensers C_{19} and C_{20}, the resistance R_8 and the coupling coil L_{11} of the local oscillator. Between these and the front panel a strip of insulation material (2) is mounted on pillars and carries eleven double connectors. On the back of this strip the resistances R_5 and the meter shunt resistance R_{10} are mounted.

To the left of the first stage I/F unit a square of insulating material (3) is mounted on a bracket and carries the condenser C_{12} and resistances R_2, R_3 and R_4. In the extreme right-hand corner against the front panel the condenser C_{26} is fitted. To the right of the 2nd stage I/F unit a square of insulation material (5) is mounted on pillars against the right-hand side of the chassis and supports the condenser C_{24} and resistance R_9.

33. The three holders for the valves V_1, V_2 and V_3 have their connectors on this side of the chassis. Between the valve-holders for the valves V_1 and V_2 and mounted on the side of the chassis is the condenser C_{13}, and similarly between the valve-holders for the valves V_2 and V_3, the condenser C_{18}. The latter is mounted on a sheet-aluminium angle plate (6) which supports the condenser C_{17}. The condenser C_{23} is clamped to the side of the chassis immediately in front of the valve-holder V_3. The inductance L_{12} is mounted on the side of the chassis above the holder for the valve V_1, and three condensers C_{15}, C_{21} and C_{27} are directly connected in their respective circuits on the 1st and 2nd stage I/F units.

34. The wiring of the receiver is in accordance with the bench wiring diagram (*see* fig. 10), braided cable, in silk insulation, directly soldered to the various connection points being used. In order to reduce the effects of vibration and to maintain the circuit capacitances constant, all the wiring is carried out in the shortest possible runs, and is secured in position wherever movement may be likely. All screws, nuts and similar connecting media are locked with shellac varnish.

35. The H.T. and L.T. leads are made up in red twin twisted pairs. Their lengths are sufficient to enable the receiver to be removed from the carrying case and to be stood down beside it without disconnecting the H.T. and L.T. batteries. Both the H.T. and L.T. leads are directly connected to their appropriate terminals in the chassis, through the bush at the lower right of the front of the receiver. The L.T. leads terminate in spade terminals with identification sleeves marked L.T.+ and L.T.—. The H.T. leads terminate on locking plugs with similar identification sleeves marked H.T.+ and H.T.—. In each case the markings are in red for positive and black for negative.

36. Immediately inside the valve inspection flap and attached to the back of the case is a label inscribed with position numbers, stores references, resistance and capacitance values. These refer to position numbers of certain components to be found on the chassis and refer to the values of the resistances and condensers at these positions. In the event of it being necessary to replace any of the units referred to, the position number is of value in locating the unit and replacing it. As an example, reference to fig. 9 will show that on the terminal strip (2) the figures 7 and 8 are engraved. These indicate the position of the resistances R_{10} and R_5 respectively, which are mounted at the back of this terminal strip. All resistances not specifically mentioned as otherwise constructed are of the rod type, and have the standard resistance colour code.

VALVES AND BATTERIES

37. The valves required for this receiver are fitted into their respective sockets to be found situated at the back of the receiver, access to which may be obtained by opening a hinged flap secured by two captive knurled screws. The valves are three in number and their holders are marked from left to right V_1, V_2 and V_3. The valves, particulars of which are to be found in the appendix, are fitted as follows:—

V_1 socket, fitted with a V.R.43 valve.
V_2 socket, fitted with a V.R.49 valve.
V_3 socket, fitted with a V.R.49 valve.

The valves must be fitted into their correct sockets. The top connector for the valve V_1 will be found hanging from a bush in the wall of the box screen, and the top connectors for each of the valves V_2 and V_3 are supported by pillars adjacent to their respective valves. When the top connectors are fitted the screening caps should be pushed well over each valve. The hinged flap of the case covering the valves may then be closed and its locking screws tightened. Spare valves are carried in the compartment beneath the battery box.

38. Two accumulators are used with this receiver. They are 2 volt 20 ampere-hour and are housed in the wooden box to be found at the right of the receiver. One is a spare and occupies the left-hand receptacle, whilst the one in use is at the right. The accumulators are connected to the receiver by means of two labelled leads. The high tension battery is 120 volt and is housed beneath the receiver to which it is connected by means of the labelled leads provided. These leads have locking plugs attached to prevent them from working loose.

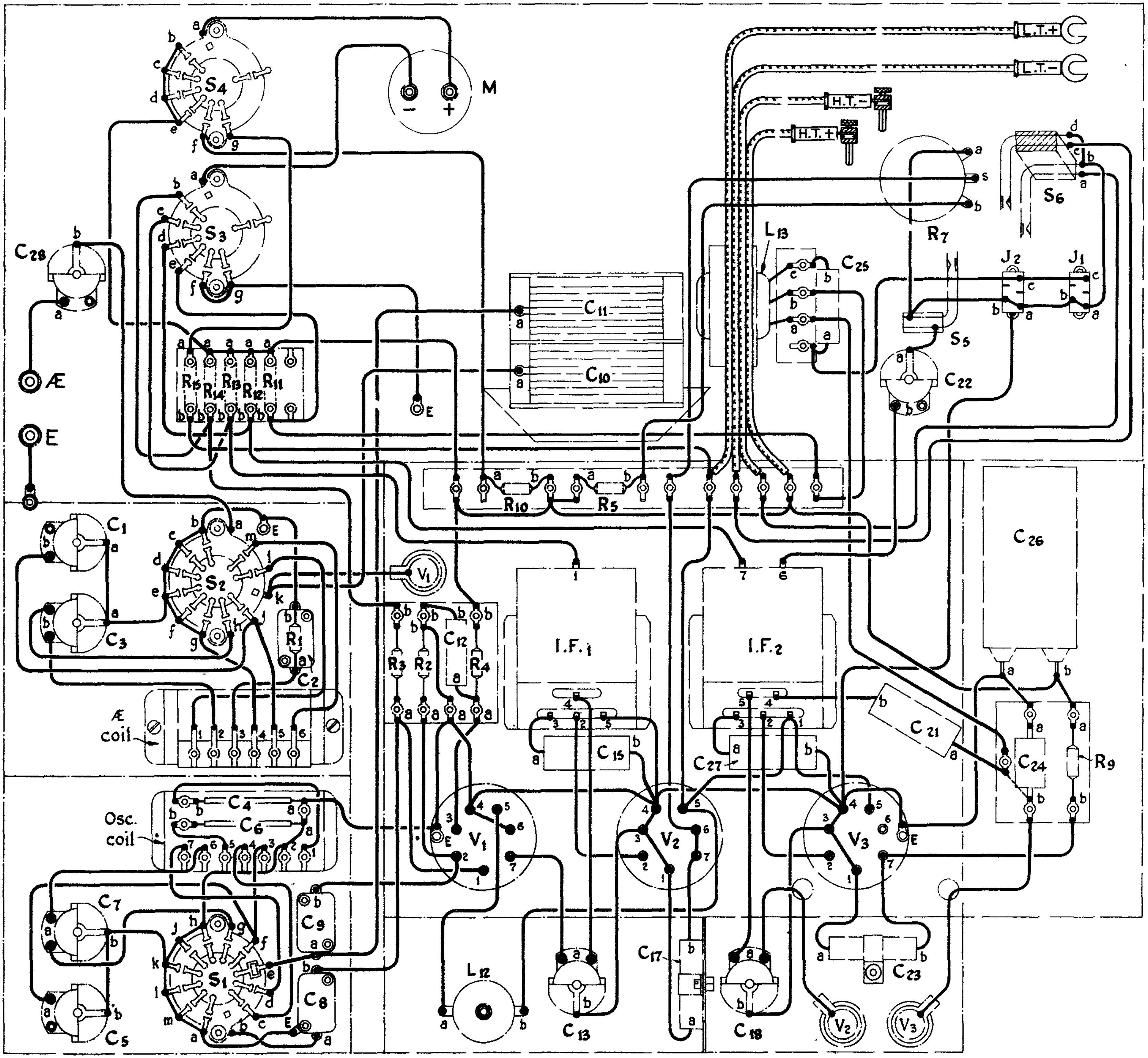

FIG. 10. RECEIVER R.1100 — BENCH WIRING DIAGRAM

OPERATION

39. The whole equipment at this stage should be checked over. Having ensured that all the accessories and their connections have been correctly made, and the accumulator and high tension battery connected, the ON-OFF switch (9, fig. 7) should be put in the ON position. The accumulator, high tension battery voltage and the valve currents should be checked over in accordance with the instructions given in the lid of the receiver on the bakelized instruction chart, making use of the selector switch (7). Place the ON-OFF switch in the OFF position.

40. It is desirable that the receiver should be operated as a complete receiving unit before being taken out for service in the field. This includes the reception of signals on both frequency bands. The same routine should be adopted as for operation in actual field service conditions.

41. To operate the receiver, place it in a convenient position relative to the aerial and earth connecting leads. Remove about one inch of the covering from the end of each of the aerial and earth connecting leads, baring the metallic conductors. Pass the leads through the two bushes to be found on the left-hand side of the carrying case and connect the bared ends of the aerial and earth connecting leads to the terminals marked A and E respectively, the aerial connecting lead to the terminal marked A, and the earth connecting leads to the terminal marked E. Plug a pair of telephone receivers into either of the two sockets marked TELEPHONES. If there is more than one listener the second pair of telephone receivers should be inserted into the remaining socket. Both pairs of telephones and both telephone sockets should be used when testing the equipment.

To receive Telephony and M.C.W.

42. The range selector switch (7, fig. 7) should be set to the frequency range to be received 1,540–1,200 kc/s, or 3,000–2,000 kc/s, the MOD C.W. switch (8) turned to MOD, and the battery switch (9) turned to ON. The volume control knob (2) should be turned fully clockwise. The required signal may then be tuned in by rotating the larger of the two tuning condenser knobs (4) and when the signal becomes audible, a finer adjustment can be made with the smaller knob. Final adjustment to comfortable signal strength should be made by rotating the volume control knob (2) counter-clockwise.

To receive C.W.

43. The range selector switch (7) should be set to the frequency range to be received, 1,540–1,200 kc/s or 3,000–2,000 kc/s, the MOD C.W. switch (8) turned to C.W., and the battery switch (9) turned to ON. The volume control knob (2) should be turned fully clockwise. The required signal may then be tuned in by rotating the larger of the two tuning condenser knobs (4) and when the signal becomes audible, a finer adjustment can be made with the smaller and outer knob. Final adjustment to comfortable signal strength should be made by rotating the volume control knob (2) counter-clockwise.

44. Tuning should always be made critical at optimum signal strength with the volume control turned fully clockwise. Any decrease in signal strength desired should be made by counter-clockwise rotation of the volume control and not by de-tuning. Care should be taken, however, when the batteries are in their best condition, that the circuit does not break into oscillation with maximum clockwise rotation of the volume control, and a point of say 50 per cent to 75 per cent of maximum should be used under such conditions. This avoids unnecessary interference.

45. While these operational adjustments are being carried out, the following additional adjustments should be made to the trimmer condenser if necessary. These small condensers are adjusted by inserting a wide bladed screw-driver into the upper or locking collar slots and releasing the locking collar by a counter-clockwise turn. The actual condenser adjustment is best made with a narrow blunt-ended screw-driver inserted into the central deeper slot and rotated carefully clockwise and counter-clockwise until the correct tuning is obtained. The locking collar is then re-locked by a firm clockwise turn to prevent any further movement of the condenser due to vibration.

Aerial trimmer

46. The AERIAL TRIMMER condenser C_{28} is not critical and has to be adjusted to optimum value to suit the aerial in use. It need only be altered when the aerial is changed. It is adjusted as described above and this is best carried out by operating the instrument on both ranges of frequency and for the MOD and C.W. The correct position is the average of each.

C.W. OSC Control

47. The oscillation control condenser C_{22} is adjusted until the valve V_3 is just oscillating. This is indicated by an audible beat note in the telephone receivers or by a sudden reduction in the anode current of the valve V_3 as read on the meter, if the switch is set to read V^3IA (B). The frequency of the beat note can be altered to suit the operator by varying the tuning control (4) by a small amount either way.

48. When these tests are completed, the ON-OFF switch (9) should be put in the OFF position. This is important and should be carried out on each occasion in order to reduce any unnecessary drain on the batteries. The receiver should now be ready for service in the field. Receivers should never be *stored* with batteries and accumulators in position.

PRECAUTIONS AND MAINTENANCE

49. Failure to receive signals, or inadequate reception of signals, may be caused either by incorrect operation of the receiver or by a failure in the functioning of the receiver or its accessories. The former is eliminated by practice in the proper handling of the receiver. The latter involves an examination of the equipment and can be divided into two categories, namely, the inspection and tracing of simple faults, and the tracing and repair of actual breakdown. The first of these two categories should be routine procedure for every operator, whilst the second can only be undertaken by repair depot personnel.

50. One of the causes of inadequate reception or total failure to receive signals may be attributed to run down accumulators and faulty connections. The accumulators can and should be checked regularly by means of the meter provided. They have a minimum approximate life of 100 hours, with daily use of about 8 hours per day. If low, or no readings are obtained on the meter and there is reason to believe that the accumulator is reasonably well charged and the high tension battery has not been on long or continuous service, the connections to both accumulator and high tension battery should be examined, cleaned and reconnected. Intermittent results when testing can be traced by shaking each lead in turn, carefully watching the meter whilst so doing. Complete lack of continuity, indicated by no reading on the meter, can only be traced by use of an ohmmeter or lamp and battery, each lead being tested separately for continuity. Both intermittent and discontinuity faults may occur in the cords of telephone receivers and they can be traced by similar methods.

51. The care and maintenance of accumulators is dealt with in A.P.1095 (Electrical Equipment Manual). In this connection special attention should always be given to keeping accumulators clean and dry, especially at the vents. The terminals should be cleaned and all corrosion removed. They must be kept free of acid and safeguarded from corrosion by being lightly smeared with vaseline.

52. The volume control should always work silently and produce continuous variations in signal strength. The local oscillator should give a regular variation throughout the whole range of the trimmer condenser C_{22}.

53. Valve pins should be inspected to ensure a really good contact fit in each socket, including the top connectors. Valves should be pushed well into their sockets and top connectors tightly screwed on. The spare set of valves should be tried in place of those in position on the set. Valves screening caps should always be fitted and pushed well down over each valve.

54. Crackling noises and fading are sometimes due to atmospheric conditions. If the noises show no marked diminution when the aerial is disconnected the fault lies within the receiver and its equipment.

55. If the receiver fails to function correctly after all these tests have been applied, it will be necessary to remove it from the carrying case and partially to dismantle it, then to test and inspect the wiring and components in detail. This necessitates more or less test bench conditions and is best undertaken in a repair depot.

APPENDIX

NOMENCLATURE OF PARTS

The following list of parts is issued for information only. All the parts of the receiver have not been listed but only those spares for which reference numbers have been allocated. In ordering spares for this receiver the appropriate section of AIR PUBLICATION 1086 must be used.

Ref No	Nomenclature	Qty	Refer to fig. No. 2	Remarks
10A/9476	Receiver, type R.1100			
	Principal components:—			
10A/11355	Case			Fitted with 2 anti-vibration mountings
	Choke:—			
10C/11358	H/F. type 61	1	L.12	
10C/11359	L/F. type 36	1	L.13	
6A/579	Clock, aircraft Mk II			
	Coil assembly			
10D/11360	Aerial	1		
10D/11361	Oscillator	1		Fitted with C_4, 1160 $\mu\mu F$ C_6, 241 $\mu\mu F$
10D/11362	I/F, 1st stage	1		Fitted with L_9, C_{14}, 100 $\mu\mu F$ C_{16}, 100 $\mu\mu F$ R_6, 1M Ω
10D/11363	I/F, 2nd stage	1		Fitted with L_{11}, C_{19}, 100 $\mu\mu F$ C_{20}, 100 $\mu\mu F$ R_8, 2M Ω
	Condensers:—			
10C/8009	Type 132	1	C_2	0·0005 μF
10C/9755	Type 332	2	C_{17} and C_{12}	0·01 μF
10C/10165	Type 386	1	C_{23}	0·1 μF
10C/11271	Type 512	1	C_{25}	0·02 μF
10C/11364	Type 516	6	C_3, C_7, C_{13}, C_{18}, C_{22} and C_{28}	50 $\mu\mu F$
10C/11365	Type 517	2	C_1 and C_5	25 $\mu\mu F$
10C/11366	Type 518	1	C_{10} and C_{11}	15 to 97 $\mu\mu F$ ganged
10C/11369	Type 521	1	C_8	0·0005 μF. Two units in parallel
10C/11370	Type 522	1	C_9	0·00025 μF
10C/11371	Type 523	1	C_{26}	2 μF
10D/11373	Contact—wafer meter range	2	S_3 and S_4	8-contact non-shorting
10D/11374	Contact—wafer wave range	2	S_1 and S_2	12-contact, shorting
	Switches:—			
10F/11387	Type 161	1	S_5	Single pole, cam operated, engraved MOD C.W.
10F/11388	Type 162	1	S_6	2-pole, cam operated, engraved ON-OFF
10A/11375	Dial, tuning	1		
10A/11376	Drive, slow motion type 8	1		
10A/11372	Guards, contact type G	3		
10H/9756	Holder, valve, type U	3		
	Plate	3		
10H/9772	Guide	3		
10H/1739	Jack, telephone, type A	2	J_1 and J_2	
	Meter:—			
10A/11377	Type 2	1	M	2in dial, flush 0—1·5 mA 0—3·0 volts 0—150 volts
10A/11386	Shunt	1		For meter comprising R_{11}, R_{12}, R_{13}, R_{14} and R_{15}

NOMENCLATURE OF PARTS—*continued.*

Ref. No.	Nomenclature	Qty.	Refer to fig No. 2	Remarks
	Plug:—			
10H/9112	Type 82	1		
10H/9113	Type 83	1		
	Resistance:—			
10C/11378	Type 474	1	R_7	50,000 Ω
10C/11379	Type 475	1	R_3	20,000 Ω
10C/11380	Type 476	1	R_4	70,000 Ω
10C/11381	Type 477	1	R_5	50,000 Ω
10C/11382	Type 478	1	R_{10}	150,000 Ω
10C/11383	Type 479	1	R_2	250,000 Ω
10C/11384	Type 480	2	R_1, R_6	1M Ω
10C/11499	Type 487	1	R_9	100,000 Ω
10H/7227	Terminal, type C	2		4 B.A.
	Accessories:—			
10D/10832	Case, carrying	1		Fitted with accumulator container, battery clamp, receiver suspension frame, canvas hood, 2 carrying straps, and 4 anti-vibration mountings, type 12.
5A/1387	Accumulator, lead-acid, 2 volt, 20 ampere-hour, type B	2		One in use and one spare
5A/1615	Battery, dry 120 volt, type B	1		
	Receiver telephone:—			
10A/8542	Receiver telephone head 1,750 ohm, type B	4		2 telephones per head receiver
10A/10155	Headband, type B	1		
10H/117	Cord instrument, type A	2		
	Valve:—			
10E/10541	V.R.43	2	V_1	One in use and one spare
10E/10931	V.R.49	4	V_2, V_3	Two in use and two spare
Form 398	Log book			Form 398
Form 776	Battery operator's card			Form 776
10D/11349	Clamps, battery			
10D/11350	Containers, accumulator			
10D/11351	Frames, mounting, type 5			
10D/11352	Hoods, canvas			
10A/11353	Mountings, type 12			
10D/11354	Straps, carrying			
10A/11356	Anti-vibration mountings, type 37			

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SECTION 3, CHAPTER 6

RECEIVERS, TYPES R.1155, R.1155A, AND R.1155B

WITH Appendix on R1155C, D, E, F, L, M & N. AL 60

Contents

List of illustrations

CONCISE DETAILS OF RECEIVERS, TYPES R.1155, R.1155A and R.1155B

PURPOSE OF EQUIPMENT	Designed for use in aircraft with transmitters of the T.1154 type. Communications and D/F. Super-heterodyne circuit with I.F. 560 kc/s., B.F.O. 280 kc/s. R.1155A and R.1155B embody interference suppressor circuits. All instruments incorporate A.V.C. and manual volume control
TYPE OF WAVE	C.W., M C.W., and R.T.
FREQUENCY RANGE	18 Mc/s. to 3 Mc/s. and 1·500 kc/s. to 75 kc/s. with gap between 600 kc/s. and 500 kc/s.
FREQUENCY STABILITY	Not applicable
CRYSTAL MULT. FACTOR	Not applicable
PERCENTAGE MODULATION	Not applicable
MAXIMUM SENSITIVITY	Input of 12 micro-volts at 210 kc/s. gives output in excess of 50 milliwatts Input of 6 micro-volts at 16 Mc/s. gives an equivalent output
SELECTIVITY	Approximately 4 kc/s. to 6 kc/s. total bandwidth for 6 db attenuation
OUTPUT IMPEDANCE	5 000 ohms
AMPLIFIER CLASS	Not applicable
MICROPHONE TYPE	Not applicable
VALVES	Visual D/F switching, triode-hexodes, two V.R.99 (Stores Ref. 10E/277). R.F. amplifier, variable-mu pentode, V.R.100 (Stores Ref. 10E/278) Frequency-changer, triode-hexode V.R.99 (Stores Ref. 10E/277), I.F. amplifier, variable-mu pentode, two V.R. 100 (Stores Ref. 10E/278) A.V.C. and B.F.O., double diode triode, V.R.101 (Stores Ref. 10E/280) Speech diode, visual meter limiter and output double diode triode, V.R.101 (Stores Ref. 10E/280) Visual meter switching, double triode, V.R.102 (Stores Ref. 10E/279) Cathode ray tuning indicator, V.T.103 (Stores Ref. 10E/305)
POWER INPUT	Supplied by L.T. power unit used for T.1154 L.T. Input to unit, type 34, 10·3 v., 24 amp. D.C.; output, 7 v., 13 amp. D.C. and 217 v., 110 mA, Input to unit, type 35, 18·5 v., 12 amp. D.C.; output as for type 34 Overall input approx. 247 watts, type 34; 222 watts, type 35 Overall input to receiver, approx. 114 watts
POWER OUTPUT	Max. 100 milliwatts into 5,000 ohms impedance
STORES REF. NO.	R.1155, 10D/98; R.1155A, 10D/820, R.1155B, 10D/13045.
APPROXIMATE OVERALL DIMENSIONS	LENGTH $16\frac{7}{16}$ in. — WIDTH $9\frac{3}{8}$ in. — HEIGHT $11\frac{5}{8}$ in.
WEIGHT	25 lb. 14 oz. with valves
ASSOCIATED EQUIPMENT	Transmitter, type T.1154 (Stores Ref. 10D/97) and associated types Visual indicator, type 1 (Stores Ref. 10Q/2) Impedance matching units, type 12 (Stores Ref. 10A/12248) or type 13 (Stores Ref. 10A/12245) or type.15 (Stores Ref. 10A/12247) L.T. power unit, type 34 (Stores Ref. 10K/19), type 35 (Stores Ref. 10K/20), type 34x (Stores Ref. 10K/61), type 34A (Stores Ref. 10K/13065) or type 35A (Stores Ref. 10K/20) Resistance unit, type 47 (Stores Ref. 10C/2221) or type 52 (Stores Ref. 10C/2295) Aerial loop, type 3 (Stores Ref. 10B/10594) or aerial loop, type 1 (Stores Ref. 10B/8478) Aerial switch unit, type J (Stores Ref. 10F/126) or aerial plug board (Stores Ref. 10H/681)

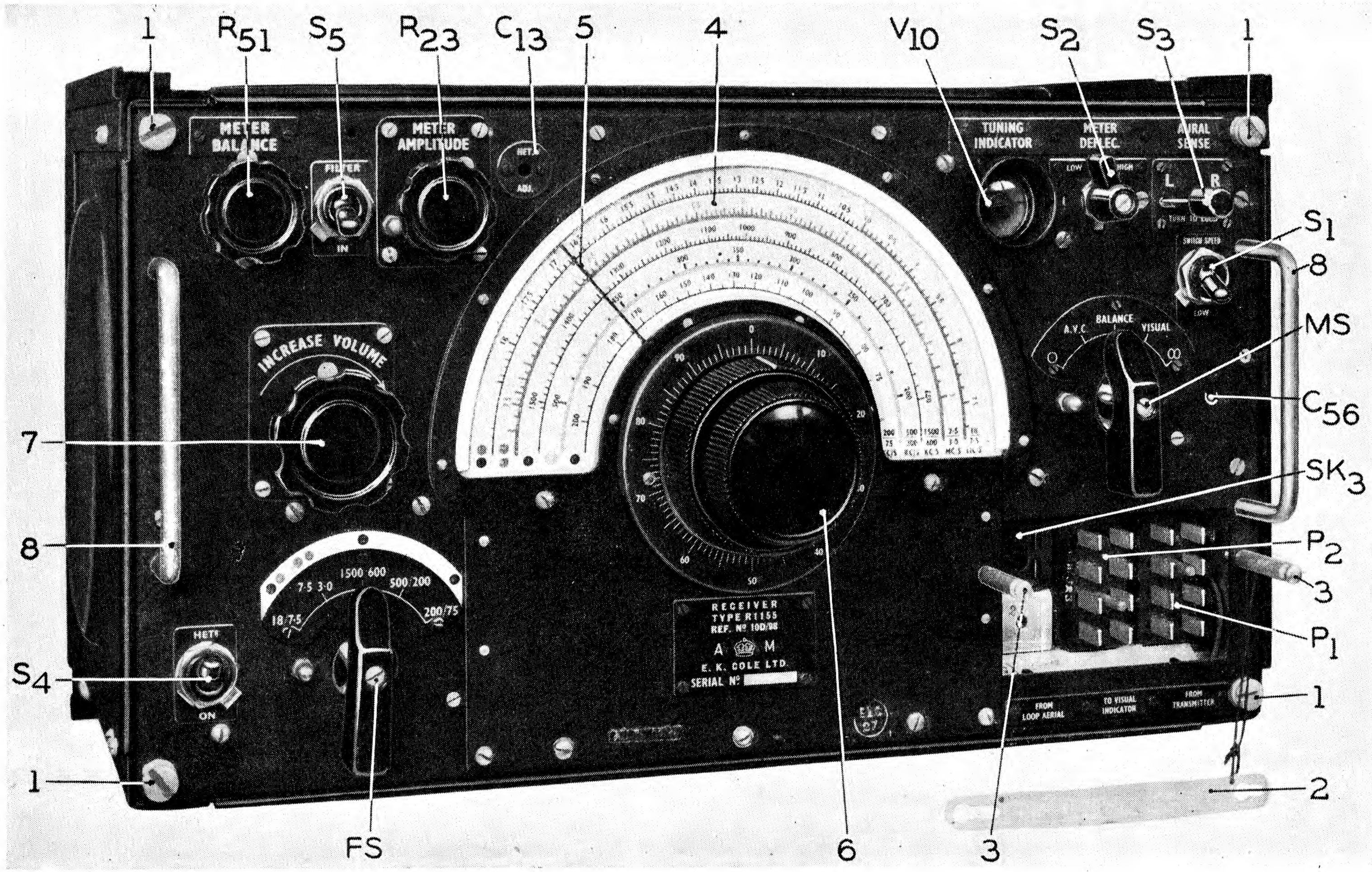


FIG. 1.—THE RECEIVER R.1155

RECEIVERS, TYPES R.1155, R.1155A AND R.1155B

INTRODUCTION

1. The receivers of the type R.1155 have been designed for use in aircraft in conjunction with transmitters of the T.1154 group described in Sect. 1, Chap. 7 of this publication. The receiver, type R.1155 (Stores Ref. 10D/98) is the parent type; the R.1155A (Stores Ref. 10D/820) and R.1155B (Stores Ref. 10D/13045) are equipped for employment in circumstances in which R.F. interference may be experienced. It is expected that, ultimately, the type R.1155A will become standardised and will incorporate the additional filter circuits of the R.1155B.

2. The receiver covers the bands of frequencies from 18·5 Mc/s to 3 Mc/s. and from 1,500 kc/s to 75 kc/s with a gap between 600 kc/s and 500 kc/s. The coverage is effected in five ranges:—

RANGE 1	(H.F.)	18·5 Mc/s to 7·5 Mc/s.
RANGE 2	(H.F.)	7·5 Mc/s to 3·0 Mc/s.
RANGE 3	(M.F.)	1,500 kc/s to 600 kc/s.
RANGE 4	(M.F.)	500 kc/s to 200 kc/s.
RANGE 5	(M.F.)	200 kc/s to 75 kc/s.

Tuning is of the uni-control type, the scales appropriate to the RANGES being colour coded and, where applicable, the colour coding of the T.1154 RANGES is adopted. It should be noted that the term RANGES is used in this Chapter as a convenient method of avoiding repetition of the frequency bands. The receiver controls are not engraved with the term.

3. Provision is made for the reception of modulated and of unmodulated signals and, on D/F, or, in certain circumstances for communications, for direction-finding. The receiver is a D/F or communications receiver on the M.F. RANGES 3, 4 and 5 and a communications receiver on the H.F. RANGES 1 and 2. The determination of bearings in D/F and of "homing" course are made in conjunction with a visual indicator, type 1. Bearings may be taken aurally. Sense of bearings can be determined aurally or visually.

4. The receivers may be worked on either fixed or trailing aerials for communications and on a suitable loop aerial, such as the loop aerial, type 3, for D/F. Aerial switching is, however, interlocked with that of the associated transmitter, and an exterior common switching device, such as the aerial switching unit, type J, or an aerial plug board, is used. The fixed aerial is normally between 25 ft. and 65 ft. long overall, including the lead-in, 45 ft. being, approximately the optimum length. The trailing aerial is 200 ft. long. The D/F loop aerial, type 3, has a nominal inductance of 100 μ H and self-capacitance of 20 $\mu\mu$ F.

5. The receiver uses ten valves and is based on a super-heterodyne circuit. The communications circuit has one R.F. stage, a frequency-changer stage, two intermediate frequency amplifier stages, a combined beat frequency oscillator (B.F.O.) and automatic volume control (A.V.C.) stage, with a combined second detector, visual meter limiter and output stage. The I.F. is 560 kc/s and the B.F.O. oscillator frequency is about 280 kc/s. A visual tuning indicator shows correct tuning. The D/F circuit arrangements incorporate a visual direction-finding system in which two triode hexode valves electronically switch the fixed aerial into phase and anti-phase, or 90 deg. lead or lag, relationship to the loop aerial at a pre-determined frequency. A meter switching valve synchronously switches the rectified output to a visual indicator, type 1. A limiter valve, already mentioned, automatically controls the input to the visual indicating meter.

6. The I.F. selectivity of the receiver is, approximately, 4 kc/s to 6 kc/s band width for an attenuation of 6 db. The two I.F. stages have either A.V.C. or manual gain control according to the position of a master switch. The sensitivity is such that the input of 12 microvolts at 210 kc/s gives an output in excess of 50 milliwatts and at 16 Mc/s an input of 6 microvolts has an equivalent output. A maximum working output of approximately 100 milliwatts is obtainable when working into a 5,000-ohm impedance.

7. The L.T. and H.T. power for the receiver, when airborne, is obtained from a rotary transformer power unit driven from the aircraft general electrical system. This power unit is also used for the supply of L.T. to the associated transmitter and may be the power unit, type 34 (nominal input D.C. 12 volts) or type 35 (nominal input D.C. 24 volts). Derived types of these units such as the type 34A, 34X and 35A may also be used. When utilized for ground training purposes it is customary to employ power units, type 114 or type 115 in conjunction with the 230-volt, 50 c/s A.C. mains. These units are described in Sect. 6, Chap. 18 of this publication.

8. The overall dimensions of the receiver are, approximately, 16$\frac{7}{16}$ in. by 9$\frac{3}{8}$ in. by 11$\frac{3}{8}$ in. The weight of the instrument, with valves, is 25 lb. 14 oz. The receiver R.1155 is shown in the illustration of fig. 1.

GENERAL DESCRIPTION

9. A schematic diagram of the receiver is shown in fig. 2. A complete theoretical circuit diagram of the receivers R.1155, R.1155A, and R.1155B is given in fig. 3. The simplified communications circuit diagram in fig. 4, a simplified visual D/F circuit diagram in fig. 10 with the switching diagrams of figs. 11, 12 and 13, should materially assist towards an understanding of the circuits. The annotational references of fig. 3 have, as far as possible, been preserved throughout the simplified diagrams.

10. Both the fixed aerial, F.Ae., and the trailing aerial T.Ae. are connected to the receiver *via* an exterior aerial switching device and the transmitter. The aerial switching is described in Sect. 1, Chap. 7, of this publication, in connexion with the transmitter T.1154. The correct aerials for reception on the H.T., M.F. or D/F RANGES are selected by a frequency range switch and a master selector switch. The trailing aerial is used on all M.F. RANGES, the fixed aerial being used for the H.F. RANGES and also for SENSE determination on D/F. When the aerial selector switch is in the D/F position, ordinary reception may be obtained if desired.

11. The frequency range switch selects the five frequency RANGES. In this chapter it is designated as FS. The wafers associated with this switch are, for the purpose of clarity, dispersed on the theoretical circuit diagram of fig. 2 and for easier identification the annotation FS prefixes each wafer. The individual wafers are shown as "wf," "wr," "xf," "xr, "yf," "yr," "zf," and "zr," these references being included as subscripts to FS. Thus, the section "wr" of FS is annotated as "FS_{wr}." The "f" and "r" subscripts refer to "front" and "rear," respectively, of the wafer sections.

12. The general functions of the switch FS are to select the appropriate aerial (*see* para. 10), to select the correct RANGE coils of the grid and anode circuits, to select the correct grid and anode circuit oscillator coils and to regulate the grid bias for the R.F. amplifier, frequency-changer and I.F. stages on the H F. RANGES in order to preserve constant amplification. The individual wafers are "w," loop aerial input, "x," aerial to grid of R.F. valve, "y," anode of R.F. valve and "z," grid and anode coils of the oscillator of the frequency changer valve. These are shown, with contact details, on fig. 2.

13. The master selector, functional, or operational switch, is a five-position switch and is designated in this chapter as MS. The wafers are annotated in a manner similar to that described for the switch FS. These are the sections "af," "ar," "bf," "br," "cf," "cr," "df," "ef" and "er," shown on fig. 2. The section "a" controls visual meter, manual and A.V.C. volume control switching, section "b" switches the fixed and trailing aerial circuits with M.F. biasing, section "c" is associated with the L.F. switching valve used for D/F, section "d" deals with the communications aerial input and section "e" switches loop and dummy aerial, the latter for circuit balancing purposes.

14. The five positions of the switch MS are:—

(i) OMNI (⊙) or plain reception. The gain of the R.F. amplifier, frequency-changer and I.F. stages is controlled, manually, by a potentiometer $R_{8(1)}$, the A.V.C. being out of circuit.

(ii) A.V.C. This position gives A.V.C. with the manual control of the A.F. input to the output stage by means of a potentiometer $R_{8(2)}$.

(iii) BALANCE (for visual D/F). This is for the purpose of matching the circuits and valves V_1 and V_2 associated with the visual indicator.

(iv) VISUAL D/F. The twin needle indicator and associated circuits, including valves V_1, V_2 and V_9 are switched into circuit. In this position A.V.C. is provided.

(v) FIGURE-OF-EIGHT (∞) which represents aural D/F. In this position bearings can be taken on aural "nulls" (zero signals), using a hand-switch S_3 for the determination of sense. The R.F. gain is manually controlled, A.V.C. being disconnected.

The communications circuit, R.1155

15. Referring to the schematic diagram of fig. 2, it will be seen that the communications circuit commences at the R.F. amplifier valve V_3, the valves V_1 and V_2 being used for visual switching in the D/F circuit. The valve V_3 is an aligned grid variable-mu pentode and, in the simplified communications circuit diagram of fig. 4, it is shown as the basis of a R.F. amplifier stage.

16. Before studying the main circuit in fig. 3, it is desirable to understand the plug and socket arrangements of the receiver and the connexions to the various points. Looking at the front panel of the instrument, the socket P_3 is engraved FROM LOOP AERIAL, the central plug P_2 TO VISUAL INDICATOR and the right-hand plug P_1 FROM TRANSMITTER.

17. The Table A overleaf gives the connexions to the individual points of the plugs and socket. The style of connector cable with its end connexions, is also set out. The first plug, or socket, mentioned is that which is connected to the receiver.

18. The aerial is capacitatively coupled to the grid circuit of the R.F. amplifier valve V_3. A condenser C_{100} is in the trailing aerial (T.Ae) circuit and a condenser C_{102} does similar service in the fixed aerial (F.Ae) circuit.

19. For convenience in studying the theoretical circuit diagram of fig. 3, a complete coil and choke table is given as an Appendix I to this chapter. The inductance values of the various components are included in this Appendix.

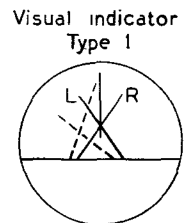
20. The trailing aerial is connected through the switch section MS_{bf}, the condenser C_{100}, switch sections MS_{df} and FS_{xr} to the coils L_4, L_5 or L_6, the aerial coils for the M.F. RANGES 3, 4 or 5, whence *via* the switch section FS_{xr} connexion is made to a variable condenser C_{84} and the control grid of the variable-mu pentode valve V_3. The variable-mu characteristic permits control of volume by means of grid bias variation and full automatic volume control can be applied without distortion on normal signals. The valve V_3 is actually tetrode connected.

21. The fixed aerial is connected through the switch section MS_{bf}, condenser C_{102}, sections MS_{df}, FS_{xf} and the H.F. RANGES 1 or 2, coils L_2 and L_3, through switch FS_{xr} to the control grid of V_3. These coils are also tuned by the condenser C_{84} which forms part of a ganged assembly including an anode circuit tuning condenser C_{83} and an oscillator circuit condenser C_{82}.

22. The resistances R_{62} and R_{63} in series across the fixed and trailing aerials, are joined to earth at their junction. These resistances afford a drain path for static charges. A condenser C_{40} is a blocking condenser enabling the moving vanes of the tuning condenser C_{84} to be earthed and is, together with a resistance R_{45}, part of the A.V.C. system (*see* paras. 43 to 49). Small trimmer condensers are connected across the coils and their tuning condenser C_{84}. These are the condensers C_{61} (with a fixed condenser C_{110} in parallel) for L_2, C_{60} for L_3, C_{59} for L_4, C_{58} for L_5 and C_{57} for L_6.

23. The screen grid voltage for V_3 is decoupled by a resistance R_{43} forming part of a virtual potentiometer composed of R_{43}, R_{44} and R_1. A condenser C_{95}, in conjunction with another condenser C_{39}, by-passes the circuit to earth. The resistance R_1 is by-passed by a condenser C_1. The earth is tapped in at a positive point across the H.T. supply. Bias for the control grid of the valve V_3 is obtained from a resistance network in the A.V.C. circuit (*see* paras. 43 to 49). The cathode is not automatically biased by a resistance but the A.V.C. resistance network is returned to a point 3·6 volts negative with respect to the cathode. This point is taken from the junction of resistances R_3 and R_4 in series and parallel with R_1 and it provides for standing bias on V_3 during no-signal periods.

VALVE TYPES							
V1	VR.99	V4	VR.99	V7	VR.101	V10	V1 103
V2	VR.99	V5	VR 100	V8	VR.101		
V3	VR.100	V6	VR.100	V9	VR 102		



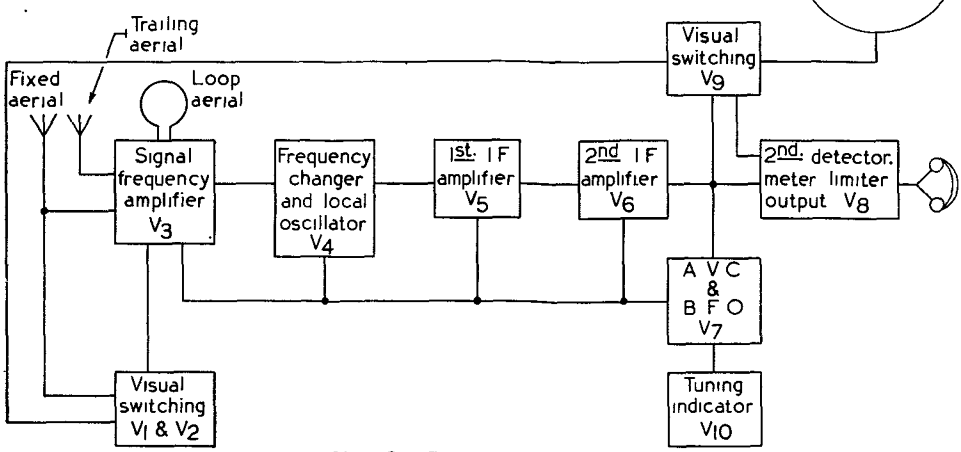


FIG. 2.—SCHEMATIC DIAGRAM

TABLE A

PLUGS, SOCKET AND CONNECTORS FOR R.1155

SINGLE RECEIVER WITH VISUAL INDICATOR, TYPE 1

Points	SOCKET P_3 FROM LOOP AERIAL	PLUG P_2 TO VISUAL INDICATOR		PLUG P_1 FROM TRANSMITTER
1	—	To V.I. terminal A (GREEN)		F.Ae (H.F. RANGES)
2	—	To V.I. terminal D (RED)		T.Ae. (H.F. RANGES)
3	—	To V.I. terminals B, C (BLUE)		L.T.+
4	—	To V.I. screening earth		L.T.— and screen earth
5	—			H.T.+ through interlock
6	—			Telephone+
7	—	WHEN TWO INDICATORS FITTED		H.T.+ 220–v.
8	—	Points		H.T.—
13	Earth	1	To V.I. terminal A (Green)	—
14	Earth	2	To V.I. terminal D (Red)	—
15	MS_{ef} contact 5 and loop	3	To V.I. terminal F (Blue)	—
16	MS_{ef} contact 11 and loop	4	To V.I. screening earth	—
	CONNECTOR Plug, type 209 Dulocapmet No. 1 Socket, type 63 or Cable end eye (to matching unit).	CONNECTOR Socket, type 137 Trimet 4 Cable end eye		CONNECTOR Socket, type 137 Octocoremet No. 2 Plug, type 210

SINGLE RECEIVER WITH TWO VISUAL INDICATORS

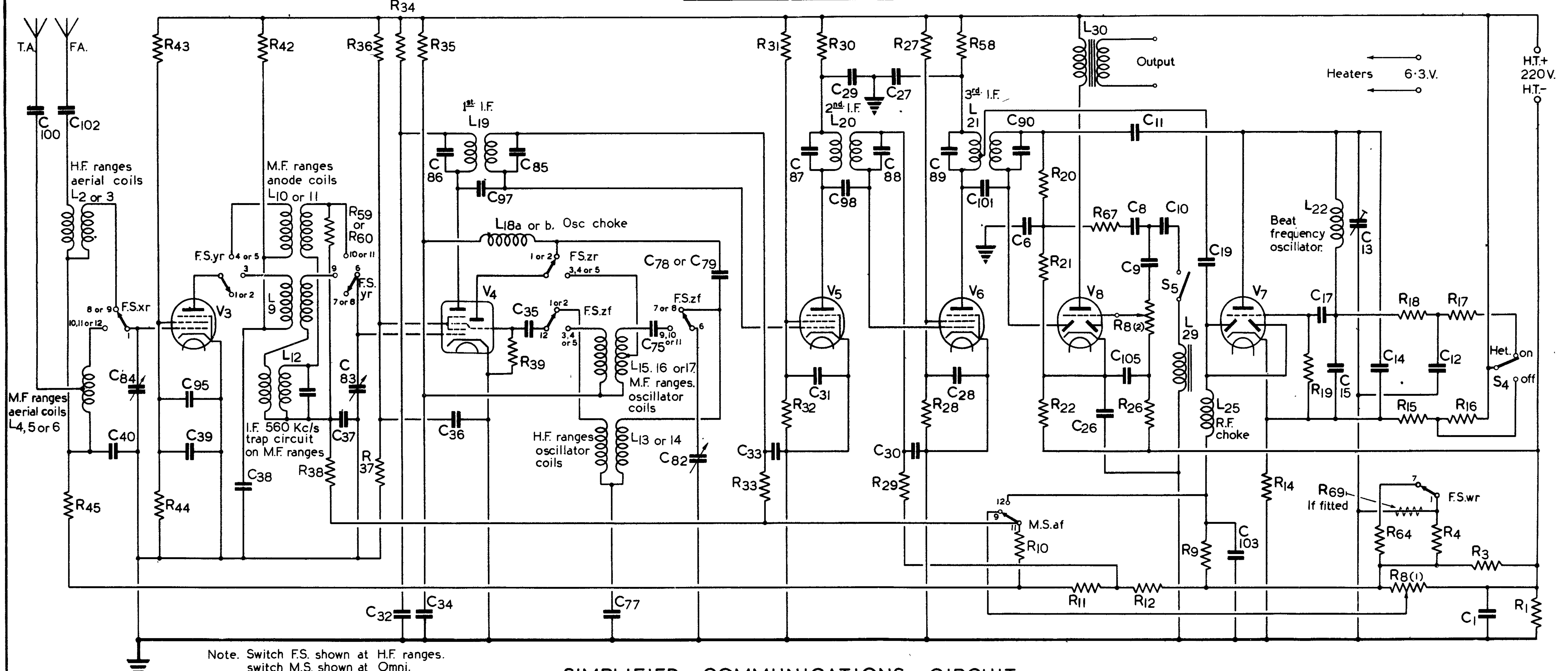
As above

As above but with, additionally:
CONNECTOR
Between visual indicators
Cable end eye,
Trimet 4,
Cable end eye
TERMINAL CONNEXIONS

First V.I.	Colour	Second V.I.
B	Green	A
C	Red	D
F	Blue	BC

TWO RECEIVERS (ONE NAVIGATOR-OPERATED) WITH 2 INDICATORS
W.T. OPERATOR RECEIVER

Socket P_3	Plug P_2	Plug P_1
DUMMY SOCKET BLOCK INSERTED		As above
		CONNECTOR As above



SIMPLIFIED COMMUNICATIONS CIRCUIT

FIG. 4

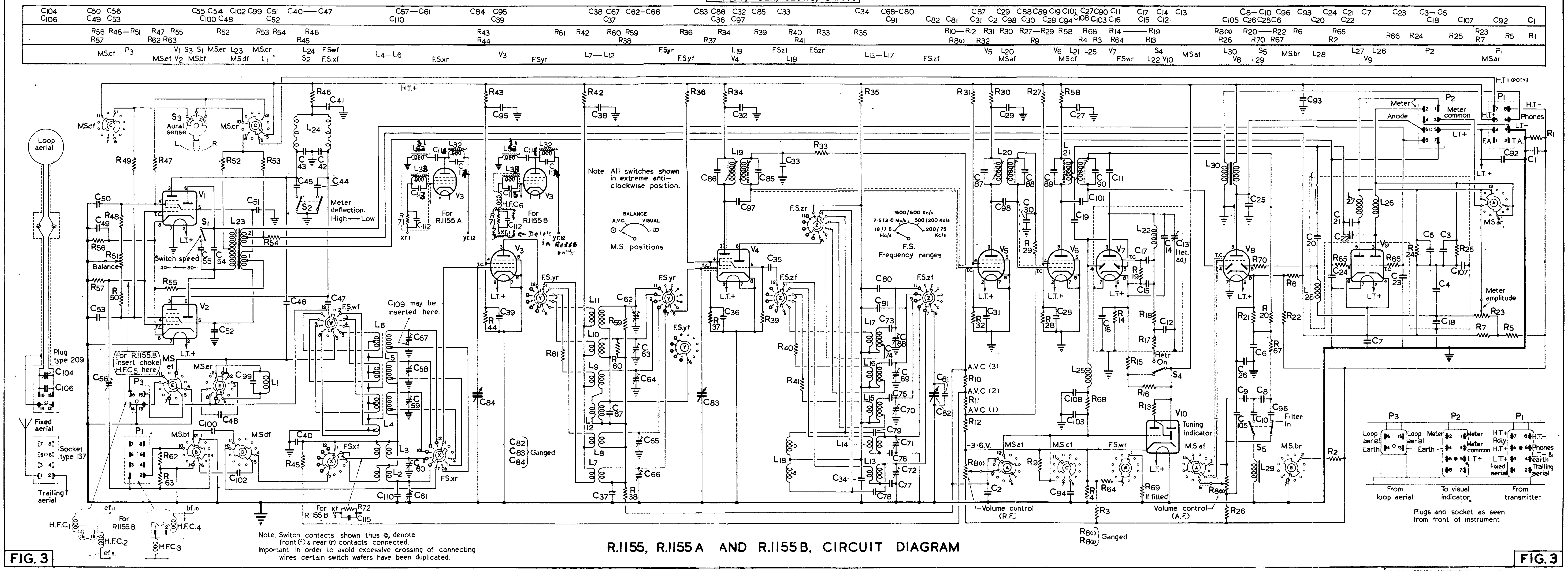


FIG. 3 R.1155, R.1155A AND R.1155B, CIRCUIT DIAGRAM FIG. 3

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This table should be read in conjunction with fig. 3

COMPONENT LIST FOR R.1155, R.1155A AND R.1155B

CONDENSERS

Annotation	Value	Stores Ref.	Type
C_{1}*	2·5μF	10C/960	892
C_{2}	2 × 0·1μF	10C/961 or	893
		10C/3399	1662
C_{3}†	2·5μF		
C_{4}†	~~2·5μF~~ 1.6	10C/962	894
C_{5}†	2.5 ~~1·0~~μF		
C_{6}	0·0001μF	10C/963 or	895
		10C/2155	995
C_{7}	0·005μF	10C/964	896
		10C/4256	2201
C_{8}	0·001μF	10C/965	897
C_{9}	0·001μF	10C/965	897
C_{10}	0·004μF	10C/966	898
C_{11}	0·0001μF	10C/963 or	895
		10C/2155	995
C_{12}	0·1μF	10C/967	899
C_{13}	75μμF	10C/968	900
		(1st 1,000)	
	60μμF	10C/3129	1525
		(after)	
C_{14}	1,600μμF	10C/969	901
		(2 off)	
C_{15}	4,550μμF	10C/2005	917
C_{16}	0·5μF	10C/970 or	902
		10C/3401	1664
C_{17}	0·0001μF	10C/2006	918
C_{18}	0·005μF	10C/964 or	896
		10C/4256	2201
C_{19}	0·001μF	10C/651	782
C_{20}	0·005μF	10C/964 or	896
		10C/4256	2201
C_{21}	0·005μF	10C/964 or	896
		10C/4256	2201
C_{22}	0·005μF	10C/964 or	896
		10C/4256	2201
C_{23}	0·005μF	10C/964 or	896
		10C/4256	2201
C_{24}	0·005μF	10C/964 or	896
		10C/4256	2201
C_{25}	0·001μF	10C/651	782
C_{26}	0·1μF	10C/961	893
C_{27}	0·1μF	or	
C_{28}	0·1μF	10C/3399	1662
C_{29}	0·1μF	10C/961	893
C_{30}	0·1μF	or	
C_{31}	0·1μF	10C/3399	1662
C_{32}	0·1μF	10C/961 or	893
C_{33}	0·1μF	10C/3399	1662
		with C_{36}	
C_{34}	0·1μF	10C/967	899
C_{35}	0·0002μF	10C/972 or	904
		10C/2719	1322
C_{36}	0·1μF	with C_{32}, C_{33}	
C_{37}	0·1μF	10C/967	899
C_{38}	0·1μF	10C/967	899
C_{39}	0·1μF	10C/3399	893
C_{40}	0·1μF	10C/967	899
C_{41}	0·1μF	with C_{49}, C_{50}	
C_{42}	25μμF	10C/2007	919
C_{43}	25μμF	10C/2007	919
C_{44}	240μμF	10C/2008	920
C_{45}	240μμF	10C/2008	920
C_{46}	80μμF	10C/2009	921
C_{47}	80μμF	10C/2009	921
C_{48}	200μμF	10C/2010	922
		10C/961 or	893
C_{49}	0·1μF	10C/3399	1662
C_{50}	0·1μF	with C_{41}	

Annotation	Value	Stores Ref.	Type
C_{51}	0·1μF	10C/961	893
C_{52}	0·1μF	or	
C_{53}	0·1μF	10C/3399	1662
C_{54}	0·04μF	10C/973 or	905
		10C/4257	2202
C_{55}	0·5μF	10C/970 or	902
		10C/3401	1664
	max.		
C_{56}	8–115μμF or	10C/974 or	906
	8–105μμF	10C/3402	1665
C_{57}	4–40μμF		
C_{58}	4–40μμF		
C_{59}	4–40μμF	10C/3173	Unit
C_{60}	4–40μμF		type 34
C_{61}	4–40μμF		
C_{62}	4–40μμF		
C_{63}	4–40μμF		
C_{64}	4–40μμF	10C/3173	Unit
C_{65}	4–40μμF		type 34
C_{66}	4–40μμF		
C_{67}	2,000μμF	10C/2011	923
C_{68}			Unit
C_{69}	4–40μμF	10C/3174	type 35
C_{70}			
C_{71}	5–40μμF	10C/976	908
C_{72}	5–40μμF	10C/976	908
C_{73}	93μμF	10C/2012	924
C_{74}	255μμF	10C/2013	925
C_{75}	537μμF	10C/2014	926
C_{76}	1,670μμF	10C/2015	927
C_{77}	6,170μμF	10C/2016	928
C_{78}	20μμF	10C/10948	429
C_{79}	15μμF	10C/978	910
	10μμF	10C/977	909
C_{80}		(1st 1,000)	
	25μμF	10C/3027	1439
		(after)	
C_{81}	15-cms.	10C/978	910
C_{82}	Ganged	10C 584	770
C_{83}	tuner	(1st 1,000)	
C_{84}		10C/3028	1440
		(after)	
C_{85}	300μμF	10C/2017	929
C_{86}	300μμF	10C/2017	929
C_{87}	300μμF	10C/2017	929
C_{88}	300μμF	10C/2017	929
C_{89}	600μμF	10C/971	903
C_{90}	300μμF	10C/2017	929
C_{91}	40μμF	10C/853	858
C_{92}*	2·5μF	10C/960	892
C_{93}	4·0μF	10C/979	911
C_{94}*	1·0μF	10C/960	892
C_{95}	0·5μF	10C/970 or	902
		10C/3401	1664
C_{96}	0·02μF	10C/2000 or	912
		10C/4258	2203
C_{97}	2μμF	10C/2001	913
C_{98}	2μμF	10C/2001	913
C_{99}	100μμF	10C/2006	918
C_{100}	200μμF	10C/2010	922
C_{101}	4μμF	10C/2002	914
C_{102}	0·001μF	10C/651	782
C_{103}	0·005μF	10C/964 or	896
		10C/4256	2201
C_{104}	75μμF. var.	10C/968	900
C_{105}	0·1μF	10C/2003	915
C_{106}	65μμF	10C/2649	1265
C_{107}	0·1μF	10C/2003	915

Annotation	Value	Stores Ref.	Type	Annotation	Value	Stores Ref.	Type
C_{108}	0·0002μF	10C/972 or 10C/2719	904 1322	C_{111}‖	160$\mu\mu$F	10C/4923	2613
				C_{112}‖	30$\mu\mu$F	10C/4922	2612
C_{109}‡	10 cms.			C_{113}‖	160$\mu\mu$F	10C/4923	2613
C_{110}	40$\mu\mu$F	10C/853	858	C_{114}‖	8$\mu\mu$F	10C/3860	1949

NOTES

* $C_1 + C_{92} + C_{94}$ Block † $C_3 + C_4 + C_5$ Block ‡ In early receivers ‖ In R.1155A and R.1155B

RESISTANCES

Annotation	Value in ohms	Stores Ref. No.	Type	Annotation	Value in ohms	Stores Ref. No.	Type
R_1	2,000 or	10C/1001	1,001	R_{37}	22,000	10C/1010	1,010
	4,700			R_{38}	100,000	10C/993	993
R_2	1,200	10C/1002	1,002	R_{39}	56,000	10C/1008	1,008
R_3	1,200	10C/1002	1,002	R_{40}	1,500	10C/1082	1,082
R_4	120	10C/1003	1,003	R_{41}	1,500	10C/1082	1,082
R_5	1,000	10C/11667	500	R_{42}	2,200	10C/691	875
R_6	1,500	10C/124	592	R_{43}	27,000	10C/1006	1,006
R_7	270	10C/1505	1,505	R_{44}	22,000	10C/1010	1,010
R_8(1)	50,000	} 10C/1000	1,000	R_{45}	100,000	10C/993	993
R_8(2)	500,000	} dual pot.		R_{46}	1,500	10C/1082	1,082
R_9	2 M	10C/1004	1,004	R_{47}	27,000	10C/1006	1,006
R_{10}	150,000	10C/11382	478	R_{48}	6,800 or	10C/991	991
R_{11}	150,000	10C/11382	478		3,300	10C/1464	1,464
R_{12}	27,000	10C/1005	1,005	R_{49}	27,000	10C/1006	1,006
R_{13}	1 M	10C/11384	480	R_{50}	6,800 or	10C/991	991
R_{14}	1,000	10C/11667	500		3,300	10C/1464	1,464
R_{15}	30,000	10C/1007	1,007	R_{51}	20,000 pot.	10C/999	999
R_{16}	27,000	10C/1006	1,006	R_{52}	6,800	10C/991	991
R_{17}	1,500	10C/1082	1,082	R_{53}	560,000	10C/992	992
R_{18}	10,000	10C/777	906	R_{54}	56,000	10C/1008	1,008
R_{19}	56,000	10C/1008	1,008	R_{55}	56,000	10C/1008	1,008
R_{20}	56,000	10C/1008	1,008	R_{56}	240	10C/995	995
R_{21}	470,000	10C/989	989	R_{57}	560,000	10C/992	992
R_{22}	1,000	10C/11667	500	R_{58}	2,200	10C/691	875
R_{23}	20,000	10C/998	998	R_{59}	220,000	10C/648	855
	(min. 6,000)			R_{60}	220,000	10C/648	855
R_{24}	22,000	10C/1010	1,010	R_{61}	1,200	10C/1081	1,081
R_{25}	22,000	10C/1010	1,010	R_{62}	2·2 M	10C/996	996
R_{26}	100,000	10C/993	993	R_{63}	2·2 M	10C/996	996
R_{27}	27,000	10C/1006	1,006	R_{64}	200 or	10C/1634	1,634
R_{28}	22,000	10C/1010	1,010		100	10C/2006	918
R_{29}	100,000	10C/993	993	R_{65}	10,000	10C/11671	505
R_{30}	2,200	10C/691	875	R_{66}	10,000	10C/11671	505
R_{31}	27,000	10C/1006	1,006	R_{67}	22,000	10C/1278 or	1,278
R_{32}	22,000	10C/1010	1,010			10C/1010	1,010
R_{33}	100,000	10C/993	993	R_{68}	56,000	10C/1008	1,008
R_{34}	2,200	10C/691	875	R_{69}	100	10C/2006	918
R_{35}	22,000	10C/1010	1,010	R_{70}	1,000	10C/11667	500
R_{36}	27,000	10C/1006	1,006	R_{71}*	150,000		

NOTES

R_1 normally 2,000 ohms but in certain receivers 4,700 ohms.

R_{64} is 100 ohms if R_{69} (100 ohms) fitted.

R_{48}, R_{50} are 6,800 ohms but in certain receivers 3,300 ohms.

* In R.1155A and R.1155B.

TABLE A—(*Contd.*)

NAVIGATOR-OPERATED RECEIVER

SOCKET P_3	PLUG P_2	PLUG P_1
Points and connector detail as for single receiver (above)		CONNECTOR Socket, type 299 Dumet 7 (to power unit) Plug, type 336 Ducel 4 (to telephones) Terminal block B (2-way) Unicel 4 (to aerial) Cable end eye

The connexion points are numbered in accordance with the above table and are shown, as viewed from the back, in fig. 3.

24. The incorporation, before the frequency-changer, of the R.F. amplifier stage, represented by the valve V_3 and its associated circuits, leads to an increase in the signal-to-noise ratio and to an improved image ratio or suppression of second channel interference. It also prevents the frequency-changer from overloading and obviates any tendency to cross modulation which would otherwise develop.

25. The anode circuit of the valve V_3 is inductively coupled to the grid circuit of a frequency-changer valve V_4. Operation of the switch FS, through its section FS_{yr}, brings into the anode circuit of V_3 and the grid circuit of the valve V_4, one of the RANGE coils L_7, L_8, L_9, L_{10} or L_{11}, which are R.F. transformers tuned in their secondary circuits by a condenser C_{83} forming part of the three-ganged assembly with C_{82} and C_{84}. The use of a tuned secondary circuit brings about a greater stage gain with increased stability and is generally preferred to a circuit in which a tuned primary is used.

26. The grid circuit coils of the assemblies L_7, L_8, L_9, L_{10} and L_{11} are, further, "trimmed" by variable condensers C_{66}, C_{65}, C_{64}, C_{63} and C_{62}. The M.F. RANGES 3, 4 and 5 are also equipped with an accurately adjusted common rejector circuit consisting of a coil L_{12} and a fixed condenser C_{67}. This combination constitutes a frequency filter tuned to the I.F. of 560 kc/s. The circuit eliminates the possibility of instability due to I.F. feedback *via* the circuits of V_3 either at the low frequency end of RANGE 3 or at the high frequency end of RANGE 4.

27. In the absence of the filter circuit L_{12} and C_{67}, should the impedance of the tuned grid circuits of L_9, L_{10} or L_{11} become appreciably near, or actually equal to, that of the I.F., feedback might occur, either due to the direct influence of the stray field in the circuit itself, or by the amplification of the valve V_3. The inclusion of the circuit of L_{12} and C_{67} causes the impedance of the grid circuit of the valve V_4 to fall very sharply at the I.F. thereby preventing feedback due to either of the causes mentioned above.

28. The valve V_4 is a triode hexode and combines the functions of a first detector and a R.F. oscillator. The incoming signal frequency, amplified by the stage V_3, is admitted at the signal grid of the hexode portion of V_4. The screen grids are internally joined and form a screening electrode for the internal injector grid which is directly connected to the grid of the triode portion of V_4. The triode portion is the R.F. oscillator and this functions at a frequency which is, at all times, greater than the signal frequency by 560 kc/s. The signal and oscillator frequencies are "mixed" electronically within the valve V_4 and the resultant difference frequency of 560 kc/s appears in the anode circuit of the hexode portion. A complete theoretical discussion of the super-heterodyne principles can be found in Chapter XI of A.P.1093.

29. The screen grid of the valve V_4 derives its H.T. voltage through a resistance R_{36} which forms part of a potentiometer composed of R_{36}, R_{37} and R_1 across the supply. The condenser C_{36} serves to decouple the circuit from the common cathode, which is at earth potential. A grid condenser for the triode, or oscillator portion, is C_{35} and a resistance R_{39} is a grid leak. The oscillator circuit consists of a tuned anode circuit loosely coupled to an untuned grid circuit. The grid circuit is switched, according to the RANGE, by the switch section FS_{zf} and embraces the primary windings of the transformers L_{13}, L_{14}, L_{15}, L_{16} or L_{17}. A condenser C_{37} is a blocking condenser and a resistance R_{38} a decoupler. These components are the counterpart of C_{40} and R_{45} mentioned in para. 22.

30. The oscillator anode circuit, switched by the switch sections FS_{zr} and FS_{zf}, consists of the secondary windings of L_{13} L_{14}, L_{15}, L_{16} or L_{17}, all of which are tuned by a condenser C_{82}. On the RANGES 3, 4 and 5 the anode is tap connected, through the switch section FS_{zr}, from the secondary of the coil L_{15}, L_{16} or L_{17} whilst on RANGES 1 and 2 the anode is coupled through separate small R.F. choke coils L_{18a} or L_{18b}. The choke coils are of such a value and arrangement that, with the stray capacitance across them, they resonate at a frequency just below the lowest frequency in their respective bands.

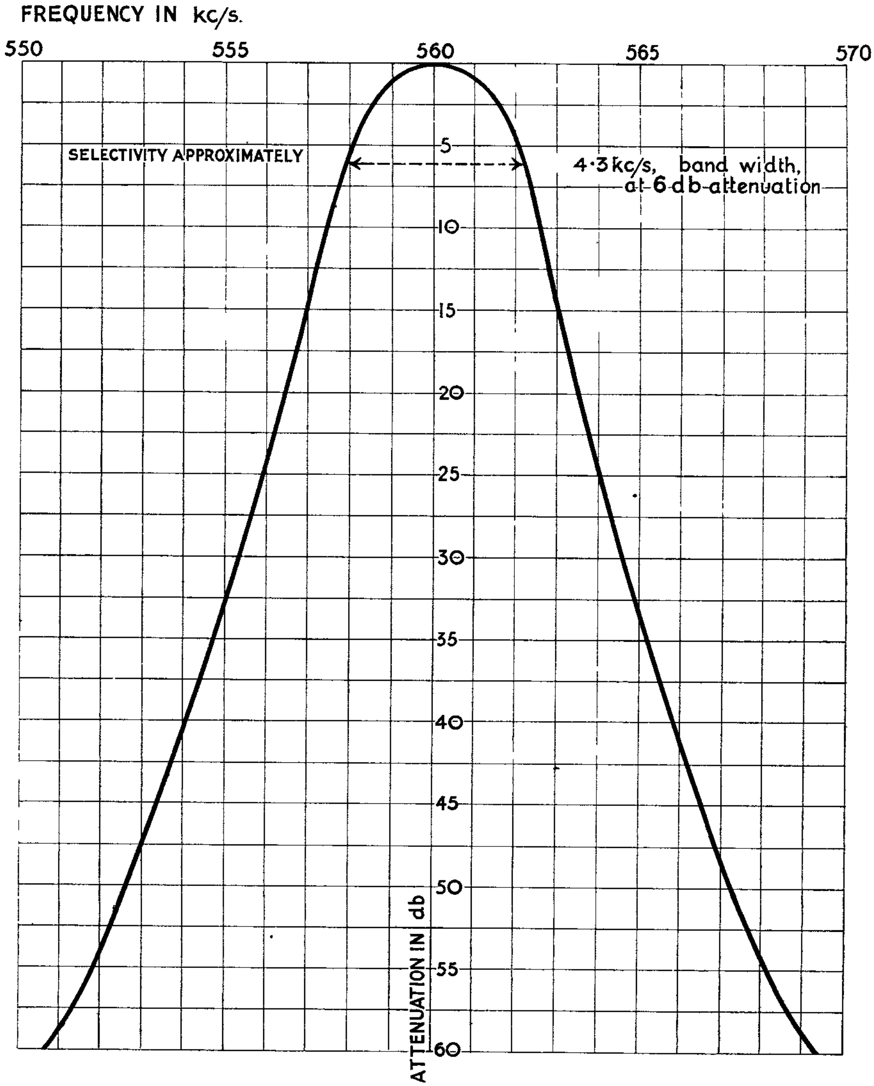


FIG. 5.—I.F. RESPONSE CURVE

31. The combination of L_{18a} or L_{18b}, with the condensers C_{78} or C_{79}, provides for the maintenance of the correct coupling between the anode and the tuned circuit throughout the frequency band. The design of the circuit is calculated to give a high degree of frequency stability on the H.F. RANGES, particularly in the obviation of initial frequency drift due to changes in valve constants either during the heating-up process or caused by replacements. There is, in consequence, a greater retention of calibration accuracy than in more conventional circuit arrangements.

32. Stability is materially assisted in the oscillator circuits also, by the incorporation of fixed condensers, which, in conjunction with trimmer condensers, keep the oscillator tuning at a constant difference from the incoming signal tuning circuits. These condensers are identified as C_{77}, C_{76},

C_{75}, C_{74} and C_{73} and they decrease the maximum capacitance of the tuning condenser C_{82}. The absolute minimum capacitance of C_{82} is determined by the small fixed condenser C_{81} which is effective over all RANGES; pre-set trimmer condensers C_{68} to C_{72} determine the lower limits for each RANGE. A condénser C_{31} is a R.F. by-pass or decoupler for all RANGES.

33. The receiver includes two stages of I.F. amplification employing three band-pass coupling units. The peaked nature of these coupling units is shown in the response curve of fig. 5, the selectivity of the I.F. circuits being of the order of a bandwidth of from 4 kc/s to 6 kc/s for an attenuation of 6 db, and about 8·5 kc/s bandwidth for an attenuation of 20 db. Very little mutual inductive coupling exists between the tuned circuits of the band-pass units, the coupling being effected by the small condensers C_{97}, C_{98} and C_{101}. The coils are adjusted to the I.F. of 560 kc/s by means of dust-iron cores, there being no adjustable capacitance across the coils.

34. The anode of the hexode portion of the valve V_4 is joined to the primary of the 1st I.F. transformer L_{19}, the connexion to the H.T. positive being made from the opposite end of the primary winding through a decoupler resistance R_{34}. The circuit is decoupled by a condenser C_{32}. A fixed condenser C_{86} is across the primary winding of L_{19}, C_{85} occupying a similar position for the secondary winding. The I.F. transformer is by-passed to earth through a condenser C_{33} and decoupled, for biasing purposes, by a resistance R_{33}.

35. The I.F. amplifier valves V_5 and V_6 are aligned grid variable-mu pentodes. The I.F. transformer units between V_5 and V_6 and between V_6 and the subsequent stage V_8 are similar to that of the V_4–V_5 stage. The second I.F. unit comprises the primary and secondary windings of L_{20} with the coupling condenser C_{98} and the fixed condensers C_{87} and C_{88}. The third I.F. unit is composed of L_{21}, a coupling condenser C_{101} and the fixed condensers C_{89} and C_{90}.

36. The output from the I.F. amplifier valve V_6 which passes through the I.F. transformer unit L_{21}, is taken to one diode of an indirectly-heated double diode triode common cathode valve V_8. The diode acts as a second detector, the triode section functioning as the output valve. Another function of the valve V_8 will be dealt with later in this chapter (*see* para. 59).

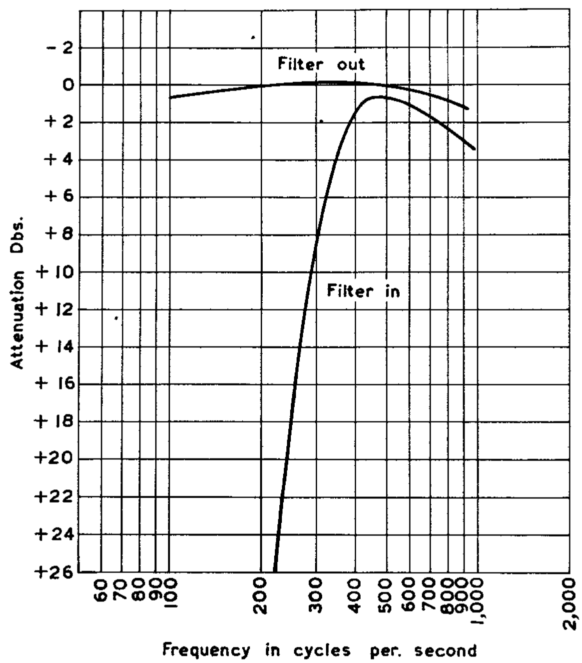


FIG. 6.—L.F. FILTER CHARACTERISTICS

37. The rectified voltage from the diode detector is developed across a resistance R_{21}. A resistance R_{20}, in conjunction with a condenser C_6, forms part of a R.F. filter system to prevent R.F. being passed to the A.F. circuit. A condenser C_{26} with C_1 decouples the cathode. The A.F. passes through a network comprising R_{67} and two series condensers C_8 and C_9 to a potentiometer $R_{8(2)}$, the variable contact of which is connected to the grid of the valve V_8. Before the potentiometer $R_{8(2)}$ there is a L.F. filter "T" network composed of the condensers C_8 and C_9 with a condenser C_{10}, passing from their junction, to an A.F. choke coil L_{29} and earth.

38. The A.F. filter network, which may be switched in or out of circuit by a switch S_5, prevents the greater proportion of the frequencies below 300 c/s from reaching the volume control $R_{8(2)}$ and the output stage. The filter removes part of the aircraft electrical and ignition noises. The diagram of fig. 6 gives the A.F. filter characteristics. The attenuation of 300 c/s is approximately 9 db and below that frequency the curve drops 1 db, for, approximately, every 5 c/s. It is a test requirement for this filter that not less than 21 db attenuation takes place at 200 c/s.

39. The voltage developed across $R_{8(2)}$ is admitted *via* the grid of V_8, the anode impedance of which is the primary of an output transformer L_{30}, by-passed to earth by a condenser C_{25} and connected directly to the H.T. positive input terminal. A condenser C_{105} and resistance R_{26} decouple the cathode bias resistance R_{22} in the triode section of V_8.

Gain control of communications receiver (manual)

40. The R.F. gain of the valves V_3, V_4, V_5 and V_6 is controlled by the application of varying degrees of grid bias to their respective grids and is manually effected by the potentiometer $R_{8(1)}$. When the master switch MS is in the OMNI position the grid of the output valve V_8 is joined through section MS_{af} to the top end, that is, further from the H.T. negative, of the A.F. volume control $R_{8(2)}$ and the variable slider is out of circuit. The full A.F. voltage is therefore applied to the grid of V_8. The automatic volume control (A.V.C.) system is inoperative.

41. With the switch at OMNI the circuits are:—

(i) A fixed potentiometer R_{10}, R_{11} and R_{12} is connected, through the switch contacts MS_{af}, to the slider of the manual gain control $R_{8(1)}$.

(ii) The A.V.C. diodes (strapped together) of V_7 are connected, through the load resistance R_9, to a point 3·6 volts negative along the resistances R_3 and R_4, the rectified voltage across R_9 operating the tuning indicator V_{10}.

(iii) On RANGES 1 and 2 the switch FS_{WT} connects R_{64} and R_{69} (if fitted) across R_4 to reduce the minimum bias voltage and also the delay on the operating voltage of the indicator V_{10}.

42. The chassis is, approximately, 30 volts positive with respect to H.T. negative. The method by which this figure and that of the 3·6 volts negative, previously mentioned, are assessed may be rendered less obscure by the diagram of fig. 7. It is convenient to consider potentiometer networks across the supply, an example of which is R_{43}, R_{44}, chassis and R_1. The effective resistance of these circuits, having regard to the switch positions, gives a basis for calculation. Effective resistance should not be confused with the values appearing on the component table shown on fig. 3.

43. The resistance R_1 has, at a minimum, $R_3 + R_4$ in parallel with it and these form a potential divider so that 26·4 volts are across R_3 and 3·6 volts across R_4. The manual volume control $R_{8(1)}$ is connected across R_3 and any voltage between $-3{\cdot}6$ and -30 can be applied to V_5 and V_4 for grid bias. This voltage is broken down by means of the fixed potentiometer R_{10}, R_{11} and R_{12} for connexion to V_6 and V_3 (*see* fig. 7).

Automatic volume control

44. Automatic control of the gain of the valves V_3, V_4, V_5 and V_6 is effected by the strength of the received signals when the master switch MS is in the A.V.C. position. Manual control of the A.F. from the second detector diode of V_8 to the output valve, that is, the triode of V_8, is also provided from the potentiometer $R_{8(2)}$. The controls of $R_{8(1)}$ and $R_{8(2)}$ are ganged for simplification of operation and the joint front panel control is labelled VOLUME CONTROL. The position of the master switch MS determines which of the potentiometers is operative:—OMNI for $R_{8(1)}$, A.V.C. for $R_{8(2)}$.

45. The received signal which is applied to the grid of the R.F. amplifier valve V_3, detected and frequency-changed at V_4, is amplified at I.F. by V_5 and V_6. The amplified I.F. voltage appears across the primary winding of the third I.F. transformer L_{21}. This primary winding is tapped and a proportion of the R.F. voltage is led to the strapped diodes of the indirectly-heated double diode triode valve V_7. Rectification takes place and the rectified current flows through a series R.F. choke coil L_{25}, a resistance capacitance filter and decoupling circuit composed of R_{68} and the condensers C_{108} and C_{103}.

46. At A.V.C., BALANCE and VISUAL, the switch MS_{af} disconnects the slider of $R_{8(1)}$ and connects the fixed potentiometer network R_{10}, R_{11} and R_{12} across R_9, the A.V.C. diode (V_7) load which has a delay of –3·6–V due to the drop across R_4 in series with R_3. On RANGES 1 and 2 this delay is reduced to —2·4–V by switching R_{64} (and R_{69}, if fitted) across R_4. The rectified current flows through R_{10}, R_{11} and R_{12}, with R_9 in parallel, back to the cathode *via* R_4. The

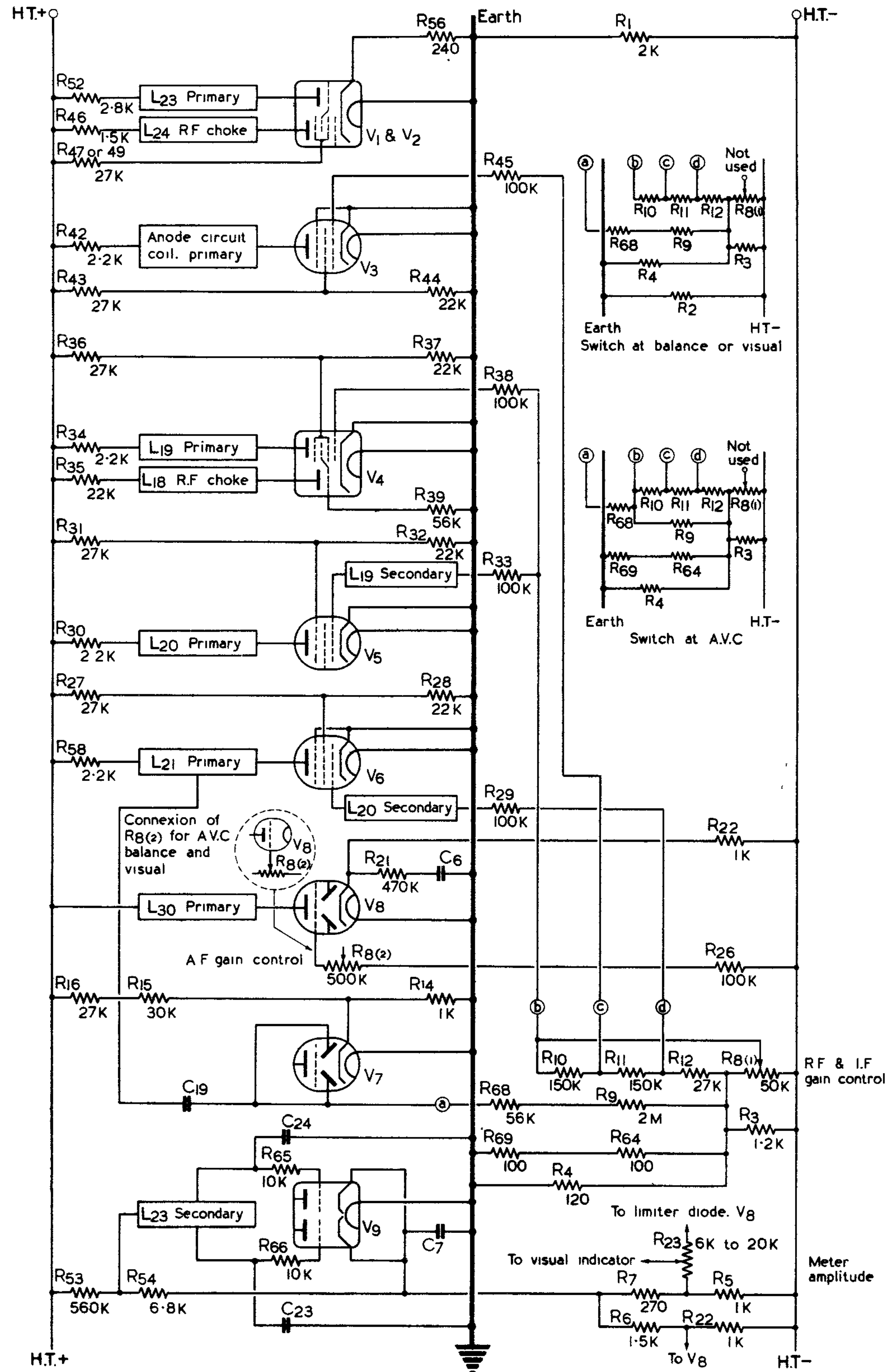


FIG. 7 BIASING AND FEED ARRANGEMENTS FIG. 7

voltage developed across R_9 and the network R_{10}, R_{11} and R_{12} is divided to suit V_3 and V_6. On BALANCE and VISUAL, C_{94} is shunted across R_9 to give a longer time constant and reduce the flicker of V_{10}.

47. The R.F. amplifier valve V_3 receives approximately one half the full value of the biasing voltage, through the line A.V.C.2, tapping the junction of R_{10} and R_{11}, and the grid-return circuit includes the resistance-capacitance circuit of R_{45} and C_{40} preventing back-coupling between V_3 and V_4, V_5 and V_6 and has a time-constant which is much longer than the lowest incoming signal frequency and which has been previously mentioned. The frequency changer V_4 and the first I.F. amplifier V_5 receive full A.V.C. bias voltage from the top end of the resistance R_{10} through the line A.V.C.3 and decoupling combinations R_{38}–C_{37} and R_{33}–C_{33} respectively. The second I.F. valve V_6 receives approximately one-tenth of the bias volts through the circuit R_{29}–C_{30}.

48. The A.V.C is subjected to a voltage delay of approximately 13 volts, that is, it does not come into operation until the received carrier reaches the pre-determined level of strength, represented by the 13 volts. This delay is partially accomplished by running the cathode of V_7 positive with respect to its diode by means of resistances R_{14} and R_{15} which are connected with R_{16} between H.T. positive and earth. An additional resistance R_{16} is introduced on C.W. to reduce this delay voltage. The full delay voltage is a composition of the voltage produced here and the standing bias on the R.F. valves (*see* para. 50). The voltage delay assists in giving an A.V.C. characteristic which, for a change in input signal of 80 db results in a change in output of approximately 8 db.

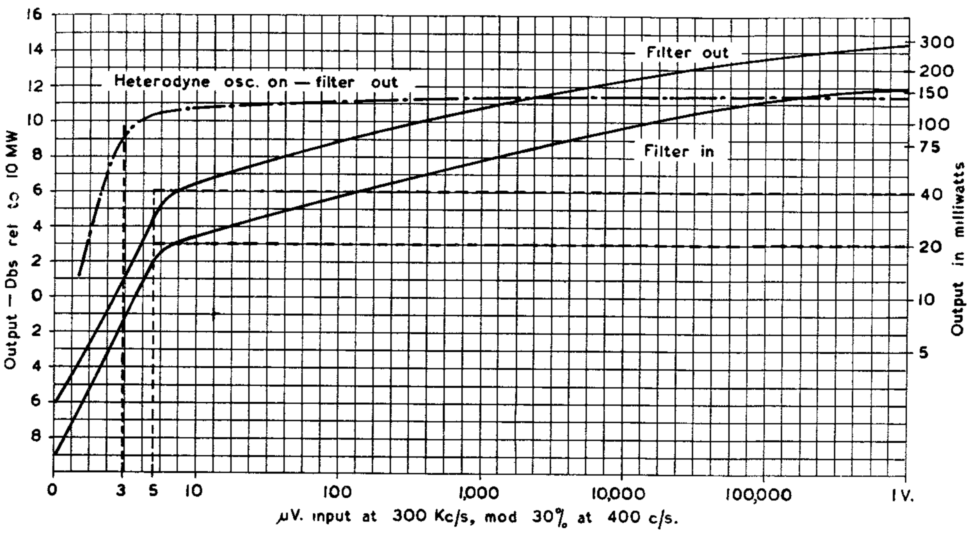


FIG. 8.—A.V.C. CHARACTERISTICS

49. The A.V.C. characteristic curves of fig. 8 are taken on an input of from 1 μ volt to 1 volt (10^6 μ volt) and show an output in decibels with an arbitrary zero at 10 milliwatts. The curves show the output plotted against input voltages at 300 kc/s, modulated 30 per cent. at 400 c/s. No curve is given for a "no control" condition, that is, with A.V.C. removed, but it is indicated by the steep straight portions of the curves which show a slope of approximately 16 db for 10 times the voltage. The effect of the A.V.C. is to level off the curves, at inputs above 5 μ volt, to a slope of approximately the same input voltage as with the filter IN but the slope is a trifle less steep. The heterodyne oscillator ON curve, with filter OUT, is practically level and comes into operation at a lower input voltage. The A.V.C. action is clearly defined by the sharp bend in all curves. There is nowhere any indication of excessive modulation rise. The input/output characteristics of the receiver are shown in fig. 9. These are taken for R.F. sensitivity, with or without the L.F. filter in circuit, and the carrier input of 300 kc/s is modulated 30 per cent. at 400 c/s. Since this description was written a fresh specification provides for 210 kc/s, 10 mW at 100 μV and 32 mW at 104 μV.

50. As mentioned in para. 22 in connexion with the R.F. amplifier valve V_3 none of the A.V.C. controlled valves are automatically biased by cathode resistances. To preserve a standing bias on the cathode during no-signal periods, therefore, the resistance network of R_{12}, R_{11} and R_{10} is returned to a point (R_3) which is 3·6 volts negative with respect to the cathodes. On RANGES 1 and 2 (H.F.

this standing bias is reduced to approximately 2·5 volts in order to preserve reasonably constant amplification over the five RANGES. On these RANGES the resistances R_{64} and R_{69} are included in the circuit.

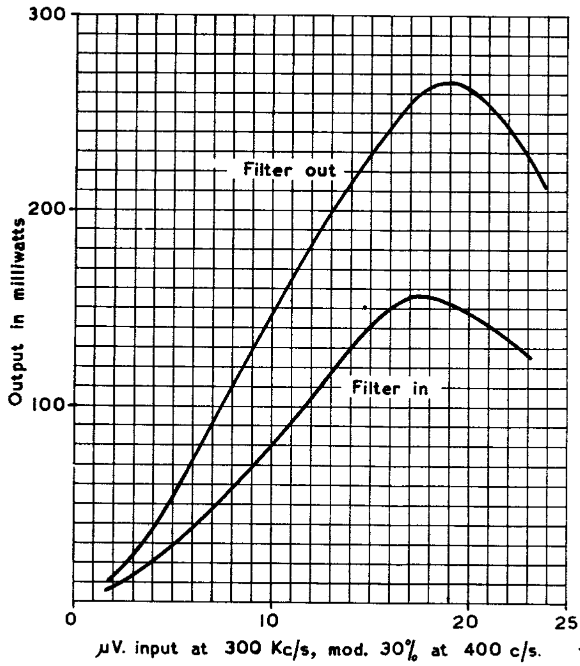


FIG. 9.—INPUT/OUTPUT CHARACTERISTICS

Beat frequency oscillator

51. In addition to providing the A.V.C. the valve V_7 also acts as a beat frequency oscillator, the triode section of the valve being used for this purpose. The oscillatory circuit consists of a coil L_{22} and the condensers C_{14} and C_{15} in the Colpitt's arrangement, the anode and grid circuits being capacitance coupled. A variable pre-set condenser C_{13} enables the beat frequency to be adjusted by means of screwdriver control to a variation of approximately 3 kc/s. The grid condenser is C_{17} and a grid-leak resistance R_{19} gives the grid its correct negative potential. The oscillatory circuit is tuned to approximately half the I.F., that is, to 280 kc/s and the second harmonic is used to heterodyne the incoming signal. The use of second harmonic prevents "pulling" of the two oscillations into synchrony which would give no resultant A.F. note. A peak voltage of, approximately, 42 volts is produced and this gives optimum heterodyne.

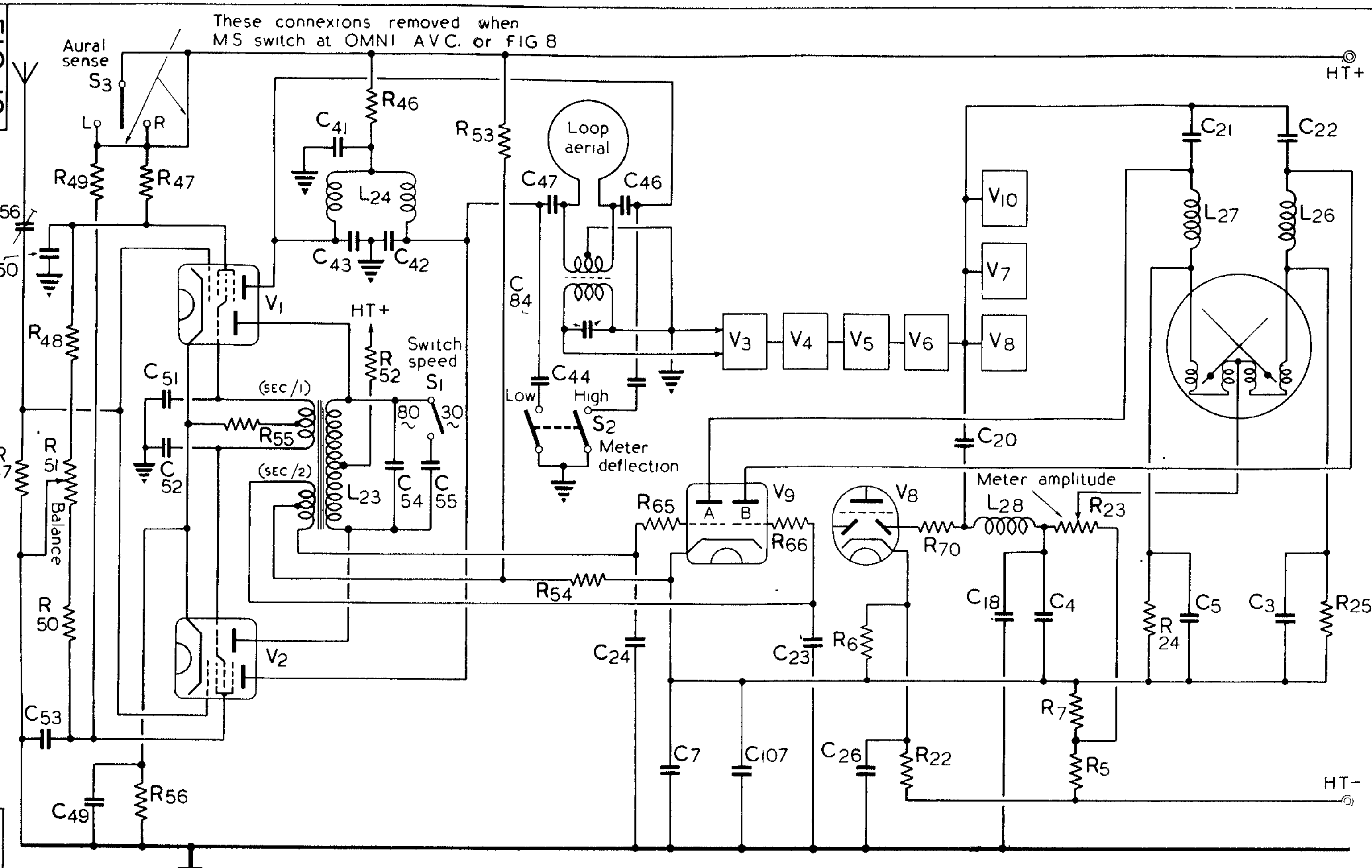
52. The H.T. for the oscillatory circuit is fed in series with the tuning coil L_{22}, R_{17} and C_{12}, forming a decoupling circuit, and R_{18} a choke to R.F. The condenser C_{15} provides for the 180 degrees out-of-phase grid/cathode voltage. The output from the oscillator is coupled *via* C_{11} to the signal diode of V_8 where it mixes with the I.F. signals, the resultant A.F. beat being produced across the diode load R_{21}–C_6.

The tuning indicator

53. Correct tuning of the receiver is indicated by means of a cathode ray indicator V_{10}. The indicator gives a varying shadow angle on a fluorescent anode, the angle of light being dependent upon the voltage developed across the resistance R_9 which is the diode load on OMNI (*see* paras. 41 to 43). The anode of the triode portion of V_{10} is connected to H.T. positive through a resistance R_{13} the grid being fed from the voltage developed across R_9. A potential difference thus exists between the fluorescent anode and the triode anode. The greater the difference in potential between these anodes, the greater the deflection of the electronic stream.

54. The deflection of the electronic stream is brought about by a wire which is in the direct path of the stream. This wire is adjacent to the fluorescent anode but slightly off-centre from it, and is joined to the anode of the triode section. In the absence of a signal the voltage drop through R_{13} makes the wire negative with respect to the fluorescent anode repelling the electronic stream and producing a V-section. When a strong signal is received, the control grid becomes more negative with consequent reduction in the triode anode current and of the voltage across R_{13}. This

FIG. 10



SIMPLIFIED CIRCUIT DIAGRAM OF VISUAL D/F

FIG. 10

in turn causes a smaller potential difference between the two anodes, and the electron stream will be repelled less, giving a smaller V. The direct bombardment illuminates a greater part of the fluorescent anode and a greater part of the indicator will be coloured green.

The D/F circuits

55. The frequency ranges covered by the R.1155 for D/F purposes are primarily the RANGES 3, 4 and 5, covering from 1,500 kc/s to 75 kc/s. Provision is also made for D/F reception on the RANGE 2, from 7·5 Mc/s to 3 Mc/s. The change from the communication circuit to the D/F circuit is made by means of the switch MS, the OMNI or plain reception and A.V.C. positions of which have already been described. A simplified circuit diagram of the visual D/F system is shown in fig. 10.

56. The following operations can be performed with the receiver when coupled to a suitable D/F loop:—

(i) Determination of bearings of a selected transmitting station either visually or aurally with sense discrimination.

(ii) Homing on to a transmitter by the visual method, in which the loop is set athwartship (except in special circumstances) and the course determined by the point of intersection of the twin needles on the centre line of the scale.

57. Primarily, the receiver has been designed to work in conjunction with the loop aerial, type 3, which has a nominal inductance of 100 μ H and self-capacitance, when installed, of 20 $\mu\mu$ F. In order to effect a match between this aerial and the receiver, that is, to adjust the total impedance of loop and lead to the receiver adjustment, a small pre-set condenser C_{104} is provided, built into the loop lead terminating plug, parallel, in certain conditions, to the fixed condenser C_{106} shunting the loop. The condenser C_{106} is of small capacitance (65 $\mu\mu$ F) and is included in circuit only when the total loop and lead capacitance is too small to enable tuning by C_{104} alone to be effected. Referring to fig. 3, it will be seen that the loop is connected through the switch sections MS_{ef}, MS_{er} and the frequency range switch section FS_{wf} to the input circuit of V_3.

58. Suitable impedance matching units are provided for use with types of loop aerial other than the type 3, to enable the input tuned circuits to gang correctly with the other tuned circuits. These, are, normally, the impedance matching units, types 12, 13 or 15 and the application will be dealt with later in this chapter (paras. 136 to 142).

59. A general picture of the electron switching system should be obtained before commencing a study of the details of the circuits. D/F is accomplished by using:—

(i) Signals received on a loop aerial.

(ii) Signals received on a vertical aerial, and

(iii) A twin-needle visual indicator meter or

(iv) Aural methods.

60. The use of a loop aerial, or its electrical equivalent, is a fundamental feature of D/F and depends upon the fact that the E.M.F.'s induced in the vertical sides and, consequently, the resultant E.M.F. from the loop, is determined by the angle of the plane of the loop relative to the path of the transmitted wave. When the plane of the loop is at right-angles to the direction of the distant transmitter no signal is heard. The signals received upon the vertical aerial are unaffected by direction so that when the two aerial systems are operated together it will be seen that the resultant produces a cardioid polar diagram of reception.

61. The vertical aerial E.M.F.'s are injected into the loop aerial E.M.F. and, dependent upon whether they are in phase or in anti-phase with the instantaneous voltages of the loop, become additive to or subtractive from the loop voltages. This phasing process is brought about by a system of electronic switching which may occur either at a frequency of 30 c/s or of 80 c/s. The conjoint loop and vertical aerial E.M.F.'s are amplified and, finally, rectified. The rectified D.C. is then applied, synchronously with the original switching, by another electronic switch, alternately to the two moving coils of a visual indicator and drives the indicator needles up or down in accordance with the greater or lesser E.M.F.'s determined by the proportion of the loop aerial E.M.F.'s (resulting from the orientation of the loop) to the practically constant E.M.F.'s of the vertical aerial.

62. The twin needle indicator is a positive method of providing ON COURSE direction through the action of the differential currents upon the needles. The aural D/F methods are standard practice and are not complicated by the electronic switching processes referred to in the previous paragraph.

63. The switching of the visual indicator is accomplished by electronic means on what is known as the "switched heart" principle. The indirectly-heated triode hexode valves V_1 and V_2 switch the fixed aerial with relation to the loop at a predetermined frequency. A double triode valve,

referred to as the meter switching valve, switches the rectified output to the visual indicator. The two operations are synchronized. A limiter valve automatically controls the input to the indicating meter. The simplified diagrams of figs. 10, 11, 12 and 13 will assist in an understanding of the operations.

64. The expression "switched heart" is based on the typical cardioid reception polar diagram arising from a conjoint vertical aerial and loop aerial system. For convenience, polar diagrams of a loop aerial (A) system ("figure of eight") alone, a vertical aerial system (B) alone ("circle") and resultants from differing proportions in amplitude of the received waves (C), (D) and (E) are shown in the diagram of fig. 14.

65. Upon the reception of signals the E.M.F.'s of the fixed and loop aerial systems are 90 deg. out-of-phase. The application of the fixed aerial voltages to those of the loop aerial must, ultimately, however, be either in phase or in anti-phase. The essential phase-opposition is brought about by the valves V_1 and V_2 operating according to the well-known push-pull procedure. The necessary switching of V_1 and V_2 is controlled by a L.F. oscillatory system which is described in paras. 69 to 73.

66. Whilst the fixed aerial original signal is subjected to a phase-splitting process in V_1 and V_2, the original angular difference $\pm$ 90 deg. between the voltage and that of the loop aerial, would still persist were the phase-restoring condensers C_{46} and C_{47} not incorporated in the circuit to bring the signals into phase and anti-phase.

67. The resultant potentials, that is, fixed aerial with loop aerial, ultimately appear across the variable condenser C_{84}, which is part of the tuned aerial circuit, and are amplified and finally rectified in the normal manner.

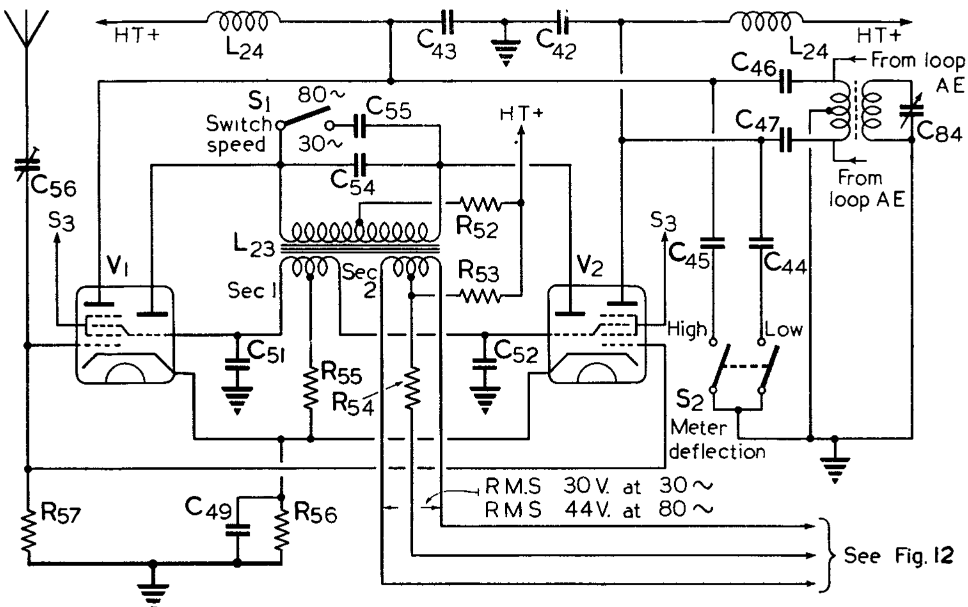


FIG. 11.—L.F. OSCILLATOR SWITCHING CIRCUIT

68. The visual circuit of the receiver consists of three principal valves, V_1, V_2 and V_9, together with one of the diodes of the valve V_8. The fixed aerial component is capacitance coupled to the joined input grids of the hexode portions of the indirectly heated triode-hexode valves V_1 and V_2. The coupling condenser is the pre-set variable condenser C_{56} which provides for an initial installation, adjustment of the amount of fixed aerial input to the switching valves. The resistance R_{57} is the grid return of V_1 and V_2.

L.F. switching oscillator for D/F

69. The triode portions of the valves V_1 and V_2 are connected to form a push-pull L.F. oscillator the frequency of which is internally injected into the hexode section of the valves. The oscillator frequency is determined by the inductance of the primary winding of a L.F. transformer L_{23} directly connected between the anodes of the triodes in conjunction with two condensers C_{54} and C_{55}. Switching

is provided, by means of S_1, to incorporate either C_{54} alone, in the oscillatory circuit, giving a frequency of 80 c/s, or to include C_{54} and C_{55} in parallel, giving a frequency of 30 c/s. The necessity for the two frequencies is explained in paras. 75 and 76.

70. The push-pull oscillator circuit brings about a condition in which the mutual inductive excited oscillator grids of V_1 and V_2 are in anti-phase. This is brought about by the phase-splitting process rendered possible by the centre-tapped secondary winding SEC_1 of L_{23}. Two equal voltages, 180 deg. out-of-phase are fed to the triode grids of V_1 and V_2. The hexode anodes are connected differentially to the loop aerial circuit through the condensers C_{47} and C_{46}. Thus, when V_1 is amplifying and V_2 is not amplifying, anode current flows in one sense with respect to the loop whilst if V_2 is amplifying and V_1 not amplifying the current flows in the opposite sense.

71. At each valve, during the positive half-cycle, the oscillator grids are held at a uniform and slightly positive value. Grid current through the resistance R_{55} causes the oscillator grid to become only slightly positive due to the injector connexion and this positive voltage holds the hexode gain practically constant. During the negative half-cycle the full secondary voltage is applied to the oscillator grids. Due to the reservoir condenser C_{52} or C_{51} the negative volts block the hexode portions, rendering them inoperative for a longer period than would, normally, be the case during the negative half-cycles, thus bringing about a sharp cut-off.

72. Two condensers C_{51} and C_{52} have a value of capacitance which does not permit an appreciable negative charge to be built up due to rectifying action by the grids. These condensers by-pass to earth any R.F. voltages which might appear on the grids. The H.T. positive is series fed *via* the centre-point of the primary winding of L_{23}, R_{52} acting as a R.F. choke and voltage dropper for the anode. The voltages to the screens are dropped by the potentiometers R_{47}, R_{48} and R_{51} and R_{49}, R_{50} and R_{51}. The screens are by-passed to earth by C_{50} and C_{53}.

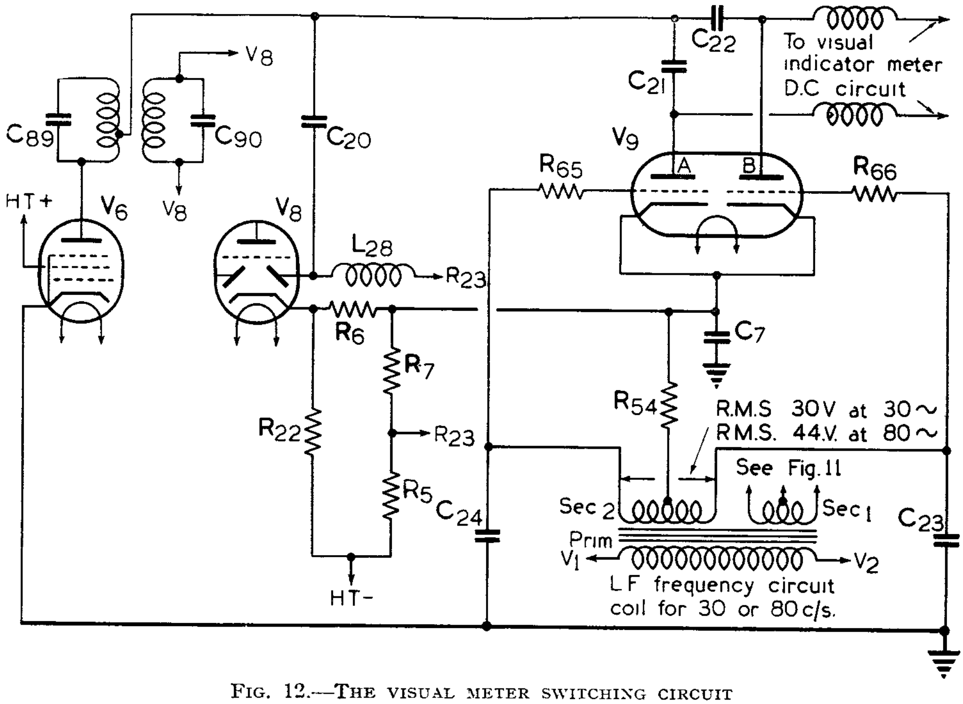


FIG. 12.—THE VISUAL METER SWITCHING CIRCUIT

73. A resistance R_{56} is a cathode biasing resistance for the valves V_1 and V_2 and is by-passed by a condenser C_{49}. The resistance R_{57} affords a grid return for the mixer valves. The potentiometer R_{51}, having two equal resistances R_{48} and R_{50}, one on either side of it, in the screen circuit of V_1 and V_2, is used to balance the screens to earth. The potentiometer R_{51} is referred to later in this chapter (para. 94).

74. The combined potential differences (loop and fixed) across the condenser C_{84} are taken to the control grid of the valve V_3 and, following the sequence of the communications circuit, through the valves V_4, V_5 and V_6, are ultimately applied to the anodes of an indirectly-heated double-triode valve V_9 from a tapping on L_{21} *via* C_{21} or C_{22}. The anodes A and B (fig. 10) of V_9 act as diode

anodes and the valve functions as an electronic switching device by means of which the L.F. switching voltage from a second secondary winding SEC_2 of the oscillator transformer L_{23} is utilized to provide simultaneous switching of the receiver output to the visual indicator.

75. As indicated in fig. 12, the voltage from L_{23} which may be approximately 30 volts R.M.S. at 30 c/s or 44 volts peak at 80 c/s is applied to the two grids of the valve V_9. The resistances R_{54} and R_{53} form a potentiometer to put a positive voltage between the grid and cathode of V_9, reducing the valve impedance and increasing its sensitivity.

76. Whenever the fixed aerial voltage is switched by the action of the valves V_1 and V_2 there must, necessarily, be some interruption of the received signal at the time of phase reversal. The process of switching actually implies a condition in the valves V_1 and V_2 analogous to Class C amplifier operation, that is, that the valve working point is considerably beyond cut off. The negative pulses of grid voltages are high and the sudden phase reversal, causing cessation in the individual valves, tends to produce momentarily excessive harmonics with consequent wave distortion. This is reflected in the received signal as a "wobble" which is least noticeable when the axis of the loop is pointing in the direction of the transmission, that is, when the amplitude of the loop received signal is sufficiently high to tend to override the fixed aerial signal at the moment of phase reversal.

77. Interference with intelligibility of R.T. signals is negligible when the switching frequency is 30 c/s. For telegraphy, however, 30 c/s is too low a switching frequency and arrangements have, therefore, been made to provide an oscillator frequency of 80 c/s. As mentioned in para. 69, the L.F. oscillator frequency is determined by the primary winding of the transformer L_{23} and either the condenser C_{54} alone, for 80 c/s, or the condensers C_{54} and C_{55} in parallel, for 30 c/s. The frequency change is accomplished by the switch S_1.

Meter deflection sensitivity

78. The "sharpness" of D/F bearing is determined by the relative amplitude of the fixed aerial voltage to that of the loop aerial. Variation of the fixed aerial voltage with respect to that of the loop will therefore make it possible to adjust for a high degree of sensitivity to change of direction. As will be seen from the polar graph D of fig. 14, a displacement of a few degrees in the loop direction brings about a given change from maximum to minimum signals whereas, from graph E it will be appreciated that a considerably greater angular displacement is required to bring about the same change from maximum to minimum signals.

79. The valves V_1 and V_2, with their associated circuits, are electrically balanced to provide for equal gain during their respective operative half cycles. Variation of the fixed aerial voltage input to the valve grids would result in a reduction in the gain of the valves but would also reduce the signal to valve noise ratio. The amplitude of the fixed aerial voltage introduced into the loop aerial circuit has therefore been reduced by the introduction of two condensers C_{43} and C_{42} which may be switched between the anodes of V_1 and V_2 and earth by means of the ON–OFF switch S_2 which is the METER SENSITIVITY SWITCH. The sensitivity is HIGH when the switch S_2 is ON.

80. When the switch S_2 is ON and the two condensers C_{44} and C_{45} are in circuit, maximum deflection of the visual indicator occurs when the loop aerial is offset from the true bearing by a small amount. When taking bearings by the visual method therefore, the switch S_2 should be closed. When the switch S_2 is open and C_{44} and C_{45} are out of circuit, maximum deflection does not take place until the loop is off-set by a considerably greater number of degrees. This condition is used for "homing" as the "blunting" of direction sensitivity enables an approximate COURSE to be maintained without the strain of constant search and correction imposed by the sharper indication obtaining when the switch S_2 is open.

The visual indicator, type 1

81. The visual indicating meter is of the twin needle type giving an ON COURSE indication by the intersection of two needles on the centre line of a scale. The position of the point of intersection is dependent upon the amount of current passing through the circuits associated with each needle. The presence of signal voltages automatically ensures that the point of intersection of the two needles lies on the working part of the scale. The no-signal condition is shown by a complete collapse of the needles. The indicator is dealt with in greater detail in paras. 195 to 198.

82. A certain advantage attaches to the use of a twin-needle indicator when compared with the single needle indicating instrument. In the latter type the ON COURSE signal is indicated when the needle is at the central position, that is, no current is flowing through the meter. There is, in consequence, no means of determining, visually, whether the needle is actually giving the ON COURSE indication or whether its condition arises from failure of current through cessation of the signal or failure to receive. A simplified visual meter switching diagram is shown in fig. 13.

83. Referring to fig. 13 the combined diode and switch action of the valve V_9 is presented in simplified form. Rectification of the signal impulses takes place at the anodes of V_9 and, as previously indicated, these may be regarded as diode anodes. The grids of V_9 alternately accept the L.F. oscillator switching voltage and the diodes are rendered conducting, or non-conducting, accordingly as the grids pass through positive or negative half cycles.

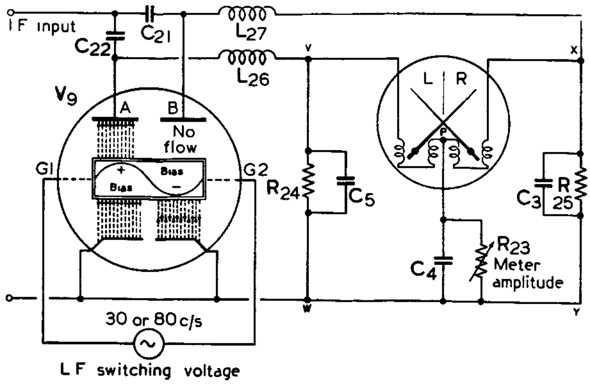


FIG. 13.—SIMPLIFIED VISUAL METER SWITCHING CIRCUIT

84. The grids of V_9 are represented as G_1 and G_2 and an idealized waveform is attached to them. This is, of course, merely conventional and does not represent the true condition. It will be seen that when the grid wave is in the positive half cycle the electronic flow is maintained between anode and cathode of the valve V_9. When G_1 or G_2 is biased strongly negative the through current flow ceases. When either of these grids is biased slightly positive the current flow exists and the diode is operative. In synchronization with the reversal of phase in V_1 and V_2 so the application of the L.F. switching voltages to the grids G_1 and G_2 takes place.

85. The I.F. voltage from the secondary winding of L_{21} is applied to the anodes A and B of the valve V_9 and, according to the condition of G_1 and G_2, it is rectified by the unilateral conductivity of the diode action. The effect of this rectified voltage upon the circuits associated with the visual indicator meter is described in the subsequent paragraphs.

86. The sections A and B of the valve V_9 pass current in quick succession (either 30 or 80 c/s) at values which are dependent upon the voltages resulting from the switched heart mentioned in para. 63. The condensers C_5 and C_3 become charged through the voltages developed across the anode load resistances R_{24} and R_{25} to values proportional to the mean currents in the sections A and B respectively.

87. The condensers C_5 and C_3 will tend to discharge through the coils of the visual indicator meter *via* the variable resistance R_{23}. When the charges are equal, that is when the current in sections A and B is equal, the indicator needles rise by an equal amount and intersect on the centre scale of the meter. If the charges in C_5 and C_3 are unequal, the needles rise to different heights giving intersection to left or right according to which section is passing the greater current.

88. Additionally, however, when the charges are unequal, current will pass from the point of greater charge to that of lesser charge in such a manner as to emphasize the deflection of the needle, bringing about a greater differential movement. As the resistance R_{23} is variable, the values of the currents can also be varied with the result that the height at which the needles intersect is controllable.

89. In the diagram of fig. 13 the potential points are indicated by V, X, Y, W and P. When C_3 and C_5 charges are equal, the potentials between XY and VW are equal. The potential at P is equal to those of X and V. The potential at P remains practically constant under all conditions and it is this fact which assists the condition mentioned in para. 88.

90. The necessity for the variable resistance R_{23} is imposed by the potential action of the A.V.C. system. It follows that, due to A.V.C. when the loop aerial is rotated from the ON COURSE position, one needle of the visual indicator would remain steady whilst the other would move downwards. The output from V_1 and V_2 always affects the same section of V_9, that is V_1 supplies section A of V_9, and V_2 supplies section B. If the loop aerial is rotated OFF COURSE, therefore, V_1 supplies a larger signal to section A than V_2 supplies to section B. The A.V.C. will hold the larger signal but cannot control the weaker signal. One needle therefore would remain in its original position whilst the other would fall.

The diode limiter valve V_8

91. That the sections A and B of valve V_9 operate alternately and in synchronization with the L.F. oscillator switch of V_1 and V_2 has already been explained. Through the condensers C_{21} and C_{22} the I.F. is fed to the valve V_9 and the D.C. switched-output flows through the R.F. chokes L_{27} and L_{26} to the meter indicating circuit. A delay bias is applied between the cathode and the anodes of V_9 in order to prevent them from delivering a current and raising the meter needles, due to noise output of the receiver in the absence of a signal.

92. Through a condenser C_{20} from the secondary winding of L_{21} a proportion of the L.F. voltage is taken to one diode of the double-diode triode V_8, the second detector and output valve already dealt with in its communications circuit application. The rectified output from V_8 flows *via* a "swamp" resistance R_{70}, and a R.F. choke L_{28} to the variable resistance R_{23}. The circuit is decoupled by the condensers C_{18} and C_4 in parallel and by-passed from R.F. by C_{18}. The cathode of V_8 is biased through a resistance R_{22}. Any current injected at R_{23} tends to drive both needles downwards without interfering with the differential action of the circuit. The normal A.V.C. arrangements of the receiver are not sufficient to keep the intersection point of the needles on the scale for the possible range of signal variation.

93. The limiter delay voltage is supplied across the resistances R_6 and R_7 in series and is adjusted to be approximately 4 volts. It does not come into action until the peak voltage applied to the common points C_{20}, C_{21} and C_{22} exceeds the delay voltage. This limiter deals with input changes up to 80 db and is so adjusted as to make it impossible, given correct setting of R_{23}, for the point of intersection of the needles to move off the scale. A small positive bias potential is given to the grids of V_9 by the resistances R_{53} and R_{54} and this, by lowering the working impedance of the anode circuit, greatly increases sensitivity. This positive bias also reduces the effect of any difference in impedance between the diodes A and B circuits of V_9.

94. Accuracy of indication depends upon the balance of the two input switching valves V_1 and V_2 and all associated circuits throughout the receiver. Between the screens of V_1, V_2 and earth there is a balancing circuit consisting of the potentiometer formed by R_{47}, R_{48} and R_{51}, R_{49}, R_{50} and R_{51}. The variable portion of this is R_{51}. When the meter switch MS is in the BALANCE position the loop aerial is disconnected and is earthed by MS_{ef}. A suitably matched dummy loop consisting of a coil L_1 with a condenser C_{99} is connected in place of the loop aerial.

95. As the dummy loop does not pick up signals any side deflection of the visual indicator needles, when the dummy is in circuit, is due to lack of symmetry in the circuit. In order to balance out this lack of symmetry the potentiometer R_{51} is adjusted until the point of intersection of the indicator needle coincides with the centre scale line.

Visual sense

96. The direction of movement of the visual indicator needle reflects the angle of the plane of the loop aerial relative to the path of the incident wave. Now, orientation of the loop so that one side of it is nearer to the distant transmitter than is the opposite side brings about a current condition (due to phase difference in the two sides) in which increased current is indicated in the needle corresponding to the nearer side. Supposing the loop to be swung off course to the RIGHT. The aircraft must go to the left to return to its course and the increased current is indicated by the LEFT movement of the needles because the LEFT side of the loop is nearer to the transmitter *if the aircraft is travelling towards the transmitter*. If the transmitter is astern the indication is, of course, reversed.

Aural D/F "figure-of-eight"

97. For aural D/F using the conventional "figure-of-eight" polar reception diagram shown, in fig. 14, for the loop aerial, the fixed aerial is disconnected in the FIGURE-OF-EIGHT position of the master switch MS_{bf}. The H.T. to the L.F. oscillator L_{23} is disconnected by the switch MS_{cr} rendering the meter switching circuits of V_9 inoperative. The A.V.C. system is changed to manual control by MS_{af} and MS_{cf} (*see* paras. 41 to 43).

98. Consideration of the polar diagram will show that two aural "nulls" exist for any given station, resulting in an ambiguity of 180 degrees. Application of fixed aerial voltage by means of a three-position switch S_3 gives a cardioid polar graph and enables the correct minimum to be selected. The spring-loaded switch S_3 applies H.T. to the screens of one or the other of the hexode portions of V_1 or V_2 thus coupling the fixed aerial through to the loop circuit. Sense determination is described in para. 182.

Receiver R.1155A

99. The receiver, type R.1155A, is a modified form of the R.1155 with which it is interchangeable. It incorporates arrangements designed to prevent interference from certain M.F. broadcasting stations the carrier frequency of which approximates to the receiver I.F. of 560 kc/s. It is possible

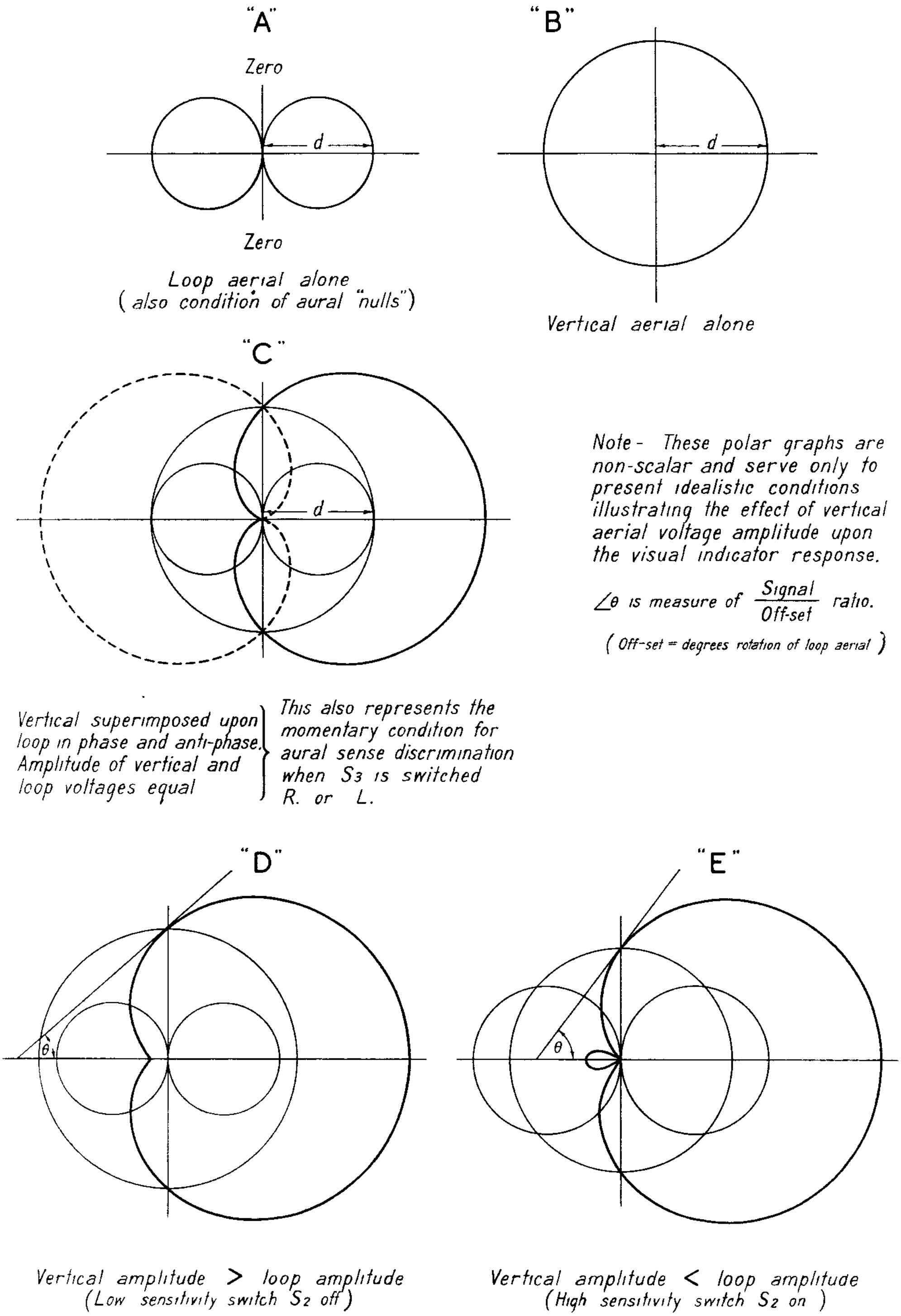


FIG. 14

POLAR DIAGRAMS

FIG. 14

that this instrument will eventually become the standard receiver and will incorporate the suppression units at present associated with the R.1155B (paras. 103 and 104). These notes describe the R.1155A in its existing limited form.

100. The arrangement comprises three assemblies which are the grid rejector circuit, the anode rejector circuit and the anode acceptor circuit. These three assemblies are shown inset in the theoretical circuit diagram of fig. 3 which gives only that portion of the R.1155 circuit affected by their inclusion.

101. The grid rejector circuit is included in the grid circuit of the R.F. valve V_3 from the top end of the variable condenser C_{84} and the aerial circuit coils to the grid of V_3. The circuit consists of a coil L_{33} with a parallel fixed condenser C_{113}. In series with the rejector circuit there is the added impedance of a condenser C_{112} having a resistance R_{71} of 150,000 ohms in parallel. This circuit minimises the additional capacitance to earth produced by the addition of the filter and associated wiring.

102. The anode rejector circuit between the anode of V_3 and the switch section FS_{yr}, which switches the anode coil primaries of this stage, consists of a coil L_{32} with a parallel fixed condenser C_{114}. The anode acceptor circuit consists of a condenser C_{111} and a coil L_{31} in series between the anode of V_3 and the chassis earth.

Receiver R.1155B

103. The receiver, type R.1155B is a modified form of the R.1155 and whilst incorporating the arrangements designed to prevent interference by broadcast transmitters whose carrier frequencies approximate to the I.F. of 560 kc/s it has, in addition, six R.F. choke coils all introduced at the points indicated in the inset in fig. 3. These chokes are designed to filter the unwanted frequencies from transmitters utilizing a V.H.F.

104. In order to bring about a condition of maximum impedance in respect of the R.F. chokes they have been designed to represent an electrical $\frac{\lambda}{2}$. In the circuit diagram of fig. 16 they are annotated generally, as HFC. The choke HFC_4 is in series with the trailing aerial and the choke HFC_3 is in series with the fixed aerial. The chokes HFC_1 and HFC_2 are in series with the loop aerial leads. In the common grid circuit of the L.F. switching valves V_2 and V_1, the choke HFC_5 is inserted. The choke HFC_6 is incorporated in the grid circuit of the valve V_3 and is, in series with the grid M.F. rejector circuit and the resistance-condenser combinations C_{112}–R_{71}. A condenser C_{115} shunted by a resistance R_{72} is connected between the switch contact 3 of FS_{xf} section and the primary of L_3.

CONSTRUCTIONAL DETAILS

Receiver R.1155

105. The control panel of the receiver, type R.1155 is shown in fig. 1. Other illustrations of the R.1155 are given in fig. 15, which is a view of the upper deck of the chassis, and fig. 16 which shows the chassis underside view. The composite diagram of fig. 17 gives the location of components. To facilitate search this diagram has been "gridded" and a reference table is provided.

106. The containing box of the receiver is easily removed by loosening the four screws indicated as (1) on fig. 1 and by pulling on the handles (8). The box is mounted on special rubber anti-vibrational suspension units, which are known as the mounting, type 54. This method of mounting is also used when the receiver is back mounted. All cable connexions to the receiver are terminated in plugs and sockets which are non-reversible and non-interchangeable. Cables are, wherever possible, metal braided, the braiding being earthed to reduce interference from external sources. The receiver containing box and chassis and panel are of metal construction, being earthed to the main bonding system of the aircraft.

107. Referring to fig. 1, the metal strip (2) is a retaining strip by means of which the cable connector plug and sockets are secured to the receiver by means of the metal posts (3). The calibrated tuning dial (4) which differs as to type in certain models (*see* Appendix 2) shows the frequency to which the receiver is tuned by a pointer (5). The tuning control (6) has two speeds, direct drive (outer knob) and 100 : 1 slow-motion gearing (inner knob) for vernier tuning. The exact point of resonance is indicated on the tuning indicator V_{10}, located to the right-hand side of the tuning scale. The tuning control (6) is coupled to a three-gang condenser comprising C_{82}, C_{83} and C_{84}.

108. The tuning scale is divided as follows:—

RANGE 1 18·5 Mc/s to 7·5 Mc/s. The scale colouring refers to the dial colouring on the transmitter of the T.1154 group. Ranges not covered by the transmitter are engraved BLACK. The part of the scale marked 10 Mc/s to 7·5 Mc/s refers to RANGE 1 on the transmitters T.1154, T.1154A and T.1154B, and is coloured BLUE. The scale is marked in divisions of 100 kc/s.

RANGE 2 7·5 Mc/s to 3 Mc/s. From 7·5 Mc/s to 5·5 Mc/s the scale is coloured BLUE referring to RANGE 1 on the T.1154. The portion coloured RED corresponds to the transmitter RANGE 2. Scale divisions are marked every 50 kc/s.

RANGE 3 From 1,500 kc/s to 600 kc/s. This is engraved BLACK and marked every 10 kc/s.

RANGE 4 From 500 kc/s to 200 kc/s. This is coloured YELLOW corresponding to RANGE 3 on the transmitter. Scale divisions are marked every 10 kc/s.

RANGE 5 From 200 kc/s to 75 kc/s. This is engraved BLACK and marked every 5 kc/s.

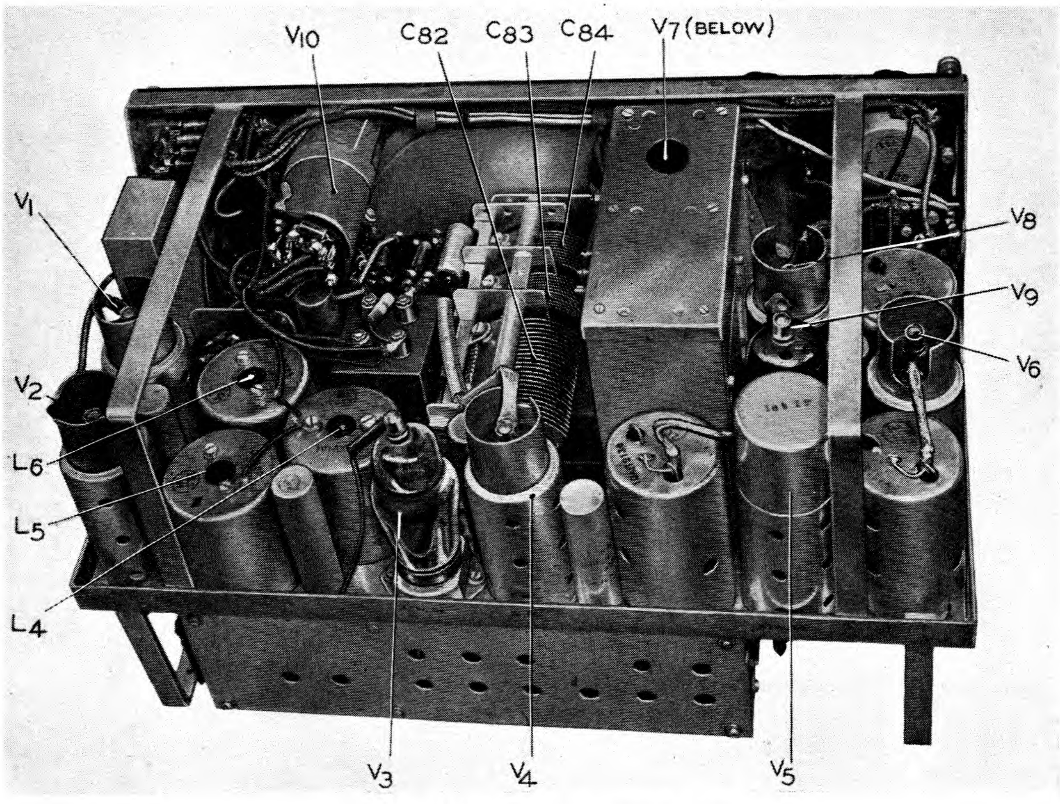


FIG. 15.—R.1155 CHASSIS, UPPER DECK

109. The five-wafer master switch (MS), type 234, has five positions which are as follows:—

OMNI (⊙)—The R.F. and I.F. gain is manually controlled by $R_{8(1)}$ which is represented by the control (7). The control (7) actuates $R_{8(1)}$ in this position of the master switch but brings a ganged potentiometer $R_{8(2)}$ into circuit in the A.V.C. position (*see* below). The knob (7) is rotated clockwise and is engraved INCREASE VOLUME.

A.V.C.—The R.F. and I.F. gain is automatically controlled. This position is used for W.T. reception and for back-tuning between transmitter and receiver.

BALANCE—For balancing the visual indicator before using D/F. This position is used in conjunction with the adjustment of the meter balance control R_{51}.

VISUAL—For visual D/F "homing" by the pilot.

FIGURE-OF-EIGHT—For aural D/F reception on "null" signals, using the switch S_3 (L–R) for sense discrimination.

110. The frequency range switch FS is at the lower left-hand side of the tuning scale and selects the five frequency RANGES. Its five positions are engraved with the numerical band coverage and there is a supplementary colour-coded scale. It is composed of one switch, type 368 for oscillator wafer, one switch, type 369 for anode wafer, one switch, type 370 for aerial wafer, and one switch, type 371 for the loop aerial wafer.

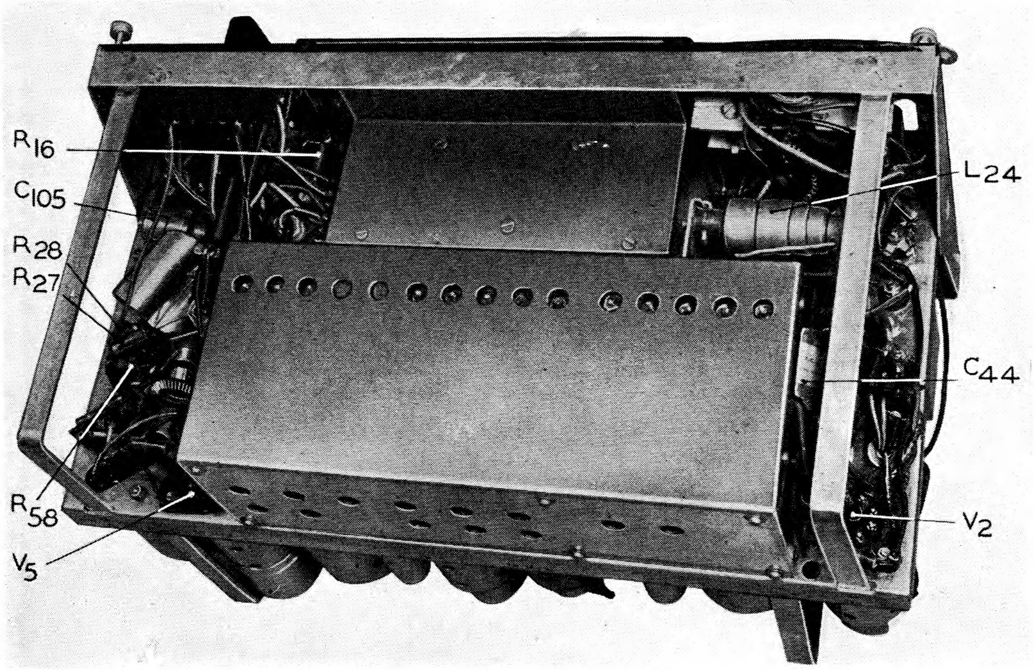


FIG. 16.—R.1155 CHASSIS, UNDERSIDE

111. The remaining front panel controls include the L.F. filter switch S_5, the meter amplitude control of R_{23}, the heterodyne switch S_4, the meter sensitivity switch S_2, type 235, and the meter frequency switch S_1. The switches S_1, S_4 and S_5 are single-pole switches of the type 152.

112. The aural sense switch S_3 has three positions and is spring-loaded to allow it to revert to the centre position when not normally held to the left or to the right. It is of the type 239. Screwdriver adjustment is provided, on the panel, for the B.F.O. circuit of V_7 by C_{13} which is of the type 1525. The condenser C_{13} near to the meter amplitude control R_{23} is adjustable between capacitance limits of from 5 $\mu\mu$ F to 60 $\mu\mu$ F.

113. The degrees of fixed aerial input to the switching valves V_1 and V_2 and thence to the loop aerial, are adjusted, when the receiver is installed, by means of C_{56} which is found below S_1 and is of the screwdriver, adjustable, type 906, from 8 $\mu\mu$ F to 115 $\mu\mu$ F.

114. The panel is attached to a metal tray, braced top and bottom, by right-angle strips returned to the panel upper and lower edges. The strips provide an equalising fit into the receiver container. The upper deck plan view in fig. 15 shows the chassis with valves in position. For the purposes of this illustration the screening container of the valve V_3 has been removed. The disposition of the components can be seen in the location diagram of fig. 17.

115. An underside view of the chassis is given in fig. 16. The aerial circuit, anode circuit and local oscillator coils, associated condensers, resistances, and the wafers, wr–wf, xr–xf, yr–yf and zr–zf of the frequency range switch FS are contained inside the large screening case at the bottom of fig. 16. Fifteen ports can be seen near the top edge of this container and, reading from left to right, they are the adjustment ports for the trimmer condensers C_{69}, C_{70}, C_{68}, C_{71}, C_{72}, C_{63}, C_{64}, C_{65}, C_{62}, C_{66}, C_{59}, C_{60}, C_{61}, C_{58} and C_{57}.

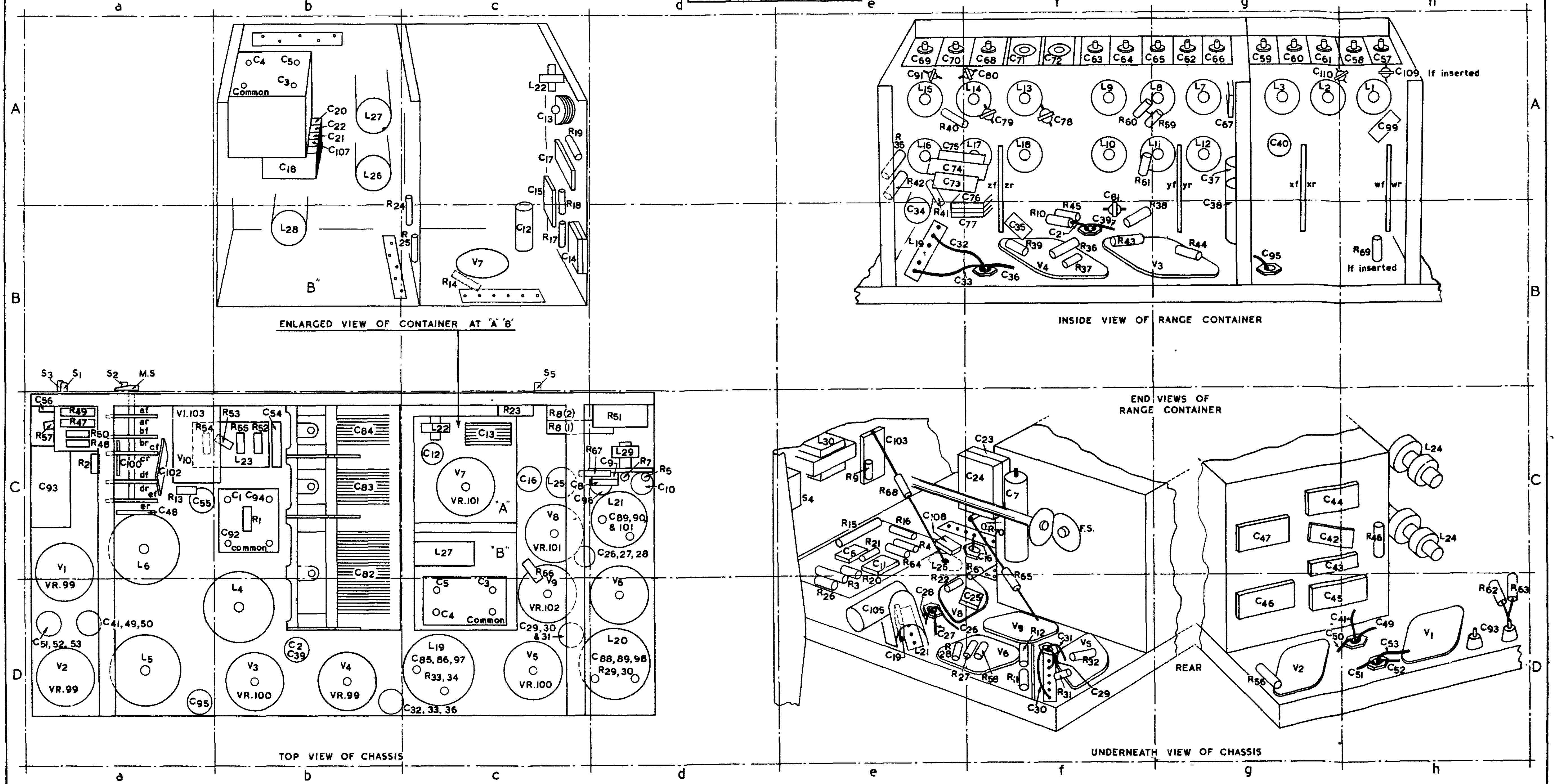
116. The location of components on the underside of the chassis and within the screening can is shown in detail in fig. 17. Part of the interior of the H.F. coils and components container is shown in fig. 19.

FIG. 18.—R.1155B CHASSIS UPPER DECK

Receivers R.1155A and R.1155B

117. The additional filtering components included in the receivers, types R.1155A and R.1155B are shown in the two illustrations, figs. 18 and 19. These illustrations are, actually, chassis upper deck and chassis underside views of the R.1155B and show the complete arrangements for suppression of M.F. broadcasting and V.H.F. interference. There is only a limited number of receivers in service containing M.F. suppression only and as the components with one exception are, physically, in the same relative positions in both types it would be superfluous to give illustrations for both.

118. Referring to fig. 18 the screening can (1), mounted over the three D/F aerial coil assemblies on the upper side of the deck, contains the rejector filter unit, type 44, comprising a coil L_{31}, type 393, with a condenser C_{111}, type 2,613. In the R.1155A this can also contains a condenser C_{112}, type 2,612 and a resistance R_{71}, type 7373. In the R.1155B these two components are located in the H.F. coil box under the deck and are connected between the choke HFC_6 and the switch section xr. The choke HFC_5 connected between the vertical aerial tuning condenser C_{56} and the control grids of V_1 and V_2 is mounted on a bracket adjacent to the top caps of V_1 and V_2. The illustration of fig. 19 shows the H.F. coil box removed. The positions of the suppressor components are indicated.



COMPONENTS LOCATION DIAGRAM

FIG. 17

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This table should be read in conjunction with fig. 17

COMPONENTS LOCATION (GRID REFERENCES)

Component	G. R.	Component	G. R.	Component	G. R.	Component	G. R.
C_{1}	Cb	C_{29}	Dc	C_{57}	Ah	C_{85}	Dc
C_{2}	Db	C_{30}	Dc	C_{58}	Ah	C_{86}	Dc
C_{3}	Ab, Dc	C_{31}	Dc	C_{59}	Ag	C_{87}	Dd
C_{4}	Ab, Dc	C_{32}	Db	C_{60}	Ag	C_{88}	Dd
C_{5}	Ab, Dc	C_{33}	Db	C_{61}	Ag, Ah	C_{89}	Cd
C_{6}	Ce	C_{34}	Be	C_{62}	Ag	C_{90}	Cd
C_{7}	Cf	C_{35}	Bf	C_{63}	Af	C_{91}	Ae
C_{8}	Cd	C_{36}	Db	C_{64}	Af	C_{92}	Cb
C_{9}	Cd	C_{37}	Ag, Bg	C_{65}	Af, Ag	C_{93}	Ca, Dh
C_{10}	Cd	C_{38}	Ag, Bg	C_{66}	Ag	C_{94}	Cb
C_{11}	Ce	C_{39}	Bf, Db	C_{67}	Ag	C_{95}	Da
C_{12}	Bc	C_{40}	Ag	C_{68}	Af	C_{96}	Cd
C_{13}	Ac, Cc	C_{41}	Da	C_{69}	Ae	C_{97}	Dc
C_{14}	Bc	C_{42}	Cg, Ch	C_{70}	Ae, Af	C_{98}	Dd
C_{15}	Ac	C_{43}	Cg, Ch	C_{71}	Af	C_{99}	Ah
C_{16}	Cc	C_{44}	Cg, Ch	C_{72}	Af	C_{100}	Ca
C_{17}	Ac	C_{45}	Dg, Dh	C_{73}	Ae, Af	C_{101}	Cd
C_{18}	Ab	C_{46}	Dg	C_{74}	Ae, Af	C_{102}	Ca
C_{19}	De	C_{47}	Cg	C_{75}	Ae, Af	C_{103}	Ce
C_{20}	Ab	C_{48}	Ca	C_{76}	Be, Bf, Af	C_{104}	Plug type
C_{21}	Ab	C_{49}	Da	C_{77}	Be, Bf		209
C_{22}	Ab	C_{50}	Da	C_{78}	Af	C_{105}	De
C_{23}	Ce, Cf	C_{51}	Da	C_{79}	Af	C_{106}	Plug type
C_{24}	Ce, Cf	C_{52}	Da	C_{80}	Af		209
C_{25}	De, Df	C_{53}	Da	C_{81}	Bf	C_{107}	Ab
C_{26}	Cd, Cc	C_{54}	Cb	C_{82}	Db, Cb	C_{108}	Ce
C_{27}	Cd, Cc	C_{55}	Ca	C_{83}	Cb	C_{109}	Ah
C_{28}	Cd, Cc	C_{56}	Ca	C_{84}	Cb	C_{110}	Ag

RESISTANCES

R_{1}	Cb	R_{19}	Ac	R_{37}	Bf	R_{55}	Cb
R_{2}	Ca	R_{20}	Ce, De	R_{38}	Bf	R_{56}	Dg
R_{3}	Ce, De	R_{21}	Ce	R_{39}	Bf	R_{57}	Ca
R_{4}	Ce	R_{22}	De	R_{40}	Ae	R_{58}	Df
R_{5}	Cd	R_{23}	Cc	R_{41}	Ae	R_{59}	Af, Ag
R_{6}	Cf, Df	R_{24}	Ac, Bc	R_{42}	Ae	R_{60}	Af
R_{7}	Cd	R_{25}	Bc	R_{43}	Bf	R_{61}	Af
R_{8}	Cc	R_{26}	De	R_{44}	Bg	R_{62}	Dh
R_{9}	Ce	R_{27}	Df	R_{45}	Bf	R_{63}	Dh
R_{10}	Bf	R_{28}	De	R_{46}	Bf	R_{64}	Ce
R_{11}	Df	R_{29}	Dd	R_{47}	Ca	R_{65}	Cf, Df
R_{12}	Df	R_{30}	Dd	R_{48}	Ca	R_{66}	Cc
R_{13}	Ca	R_{31}	Df	R_{49}	Ca	R_{67}	Cd
R_{14}	Bc	R_{32}	Df	R_{50}	Ca	R_{68}	Ce
R_{15}	Ce	R_{33}	Dc	R_{51}	Cd	R_{69}	Bh (if used)
R_{16}	Ce	R_{34}	Dc	R_{52}	Cb	R_{70}	Cf
R_{17}	Bc	R_{35}	Ae	R_{53}	Cb		
R_{18}	Ac, Bc	R_{36}	Bf	R_{54}	Ca		

COILS AND CHOKES

L_{1}	Ah	L_{9}	Af	L_{17}	Ae, Af	L_{25}	Ce, Cd
L_{2}	Ag, Ah	L_{10}	Af	L_{18}	Af	L_{26}	Ab
L_{3}	Ag	L_{11}	Af, Ag	L_{19}	Dc, Be	L_{27}	Ab, Ce
L_{4}	Db	L_{12}	Ag	L_{20}	Dc, Dd	L_{28}	Bb
L_{5}	Da	L_{13}	Af	L_{21}	Ce, De	L_{29}	Cd, Cc
L_{6}	Ca	L_{14}	Af, Ae	L_{22}	Ac	L_{30}	Ce
L_{7}	Ag	L_{15}	Ae	L_{23}	Cb		
L_{8}	Af, Ag	L_{16}	Ae	L_{24}	Ch		

VALVES

V_{1}	Ca, Da, Dh	V_{4}	Db, Bf	V_{6}	Dd, Cd, De,	V_{8}	Cc
V_{2}	Da, Dg	V_{5}	Dc, Df		Df	V_{9}	Cc, Dc, Df
V_{3}	Dd, Bf, Bg			V_{7}	Bc, Cc	V_{10}	Ca

SWITCHES

S_{1}	Ca	S_{3}	Ba	S_{5}	Bc	F.S.	Af to Ah
S_{2}	Ba	S_{4}	Ce	M.S.	Ca		

VALVES AND POWER SUPPLIES

119. The accompanying TABLE B gives a list of the valves used in the receivers, types R.1155, R.1155A and R.1155B, showing their respective function, type and Stores Reference number.

TABLE B

R.1155 VALVE LIST

Ref. in fig. 2	Function	Type	Stores Ref. No.
V_1, V_2	Visual D/F switching	Triode-hexode, V.R.99	10E/277
V_3	R.F. amplifier	Aligned grid variable-mu pentode, V.R.100 (tetrode connexion)	10E/278
V_4	Frequency-changer	Triode-hexode, V.R.99	10E/277
V_5, V_6	I.F. amplifiers	Aligned grid variable-mu pentode, V.R.100 (tetrode connexion)	10E/278
V_7 V_8	A.V.C. and B.F.O. Second detector, visual meter limiter and output	Double diode triode, V.R.101	10E/280
V_9	Visual meter switching	Double triode, V.R.102	10E/279
V_{10}	Tuning indicator	V.I.103	10E/305

All the above valves are fitted with international octal bases. A diagram of the base connexions is given in fig. 20.

120. The receivers R.1155 were originally issued with the valve positions marked with trade nomenclatures. Later issues of the receivers are marked with the standard A.M. V.R. numbers as indicated in the table of para. 119. To remove the difficulty arising when it is necessary to fit spare valves marked in one system into a receiver marked in the other system a valve identification label (Stores Ref. 10D/580) has been prepared. Instructions for affixing this label to the screening box of the valve V_7 and its associated components are contained in the leaflet A.P.1186/B.48–W.

121. The sequence of operations for affixing the valve label is as follows:—

(i) Remove the receiver from its outer screening case.

(ii) Identify the flat screening box immediately behind the front panel and adjacent to the tuning condensers. Remove the four fixing screws in the centre of the top screening plate.

(iii) Use shellac varnish (Stores Ref. 33A/511) to fix the label to the rear inside face of the receiver can in the most suitable position for reading.

(iv) Apply a thin coat of shellac varnish over the label.

(v) Replace the receiver in its outer screening case.

122. Due to restricted space in early issues of the receiver, difficulty may be experienced in removing the B.F.O. valve V_7 without altering the adjustment of the B.F.O. tuning condenser C_{13}. Originally this condenser was a type 900 but this has been replaced by a type 1525 and no difficulty will be experienced in removing, or inserting, the valve V_7.

123. The procedure to be followed when removing V_7 is as follows:—

(i) Remove the receiver from its outer case by withdrawing the four screws from the front panel.

(ii) Remove the top cover of the oscillator unit, type 18, by withdrawing the six screws securing it. The valve V_7 and condenser, type 900, C_{13} will now be exposed.

(iii) Using a suitable screwdriver, rotate the condenser, type 900, until the moving vanes are fully engaged with the fixed vanes. The valve can now be readily removed and replaced without fouling the condenser.

(iv) Replace the top cover of the oscillator unit and place the receiver in its outer case.

The procedure for setting up the B.F.O. is laid down in para. 165.

124. Certain valves, supplied as spares for this receiver, are too large in diameter to go into the screening cans as originally supplied. To overcome this difficulty the cans are now being manufactured without the longitudinal stiffening ribs. Where, however, it is found that the original cans remain, units have been instructed by the leaflet A.P.1186/B.43–W to remove the ribs on all valve screening cans so that in the event of oversize valves being issued the cans may be ready to accommodate them. The method to be adopted is to remove the can from the receiver and, placing it on a round bar or pipe of suitable diameter, gently beat out the ribs from the outside.

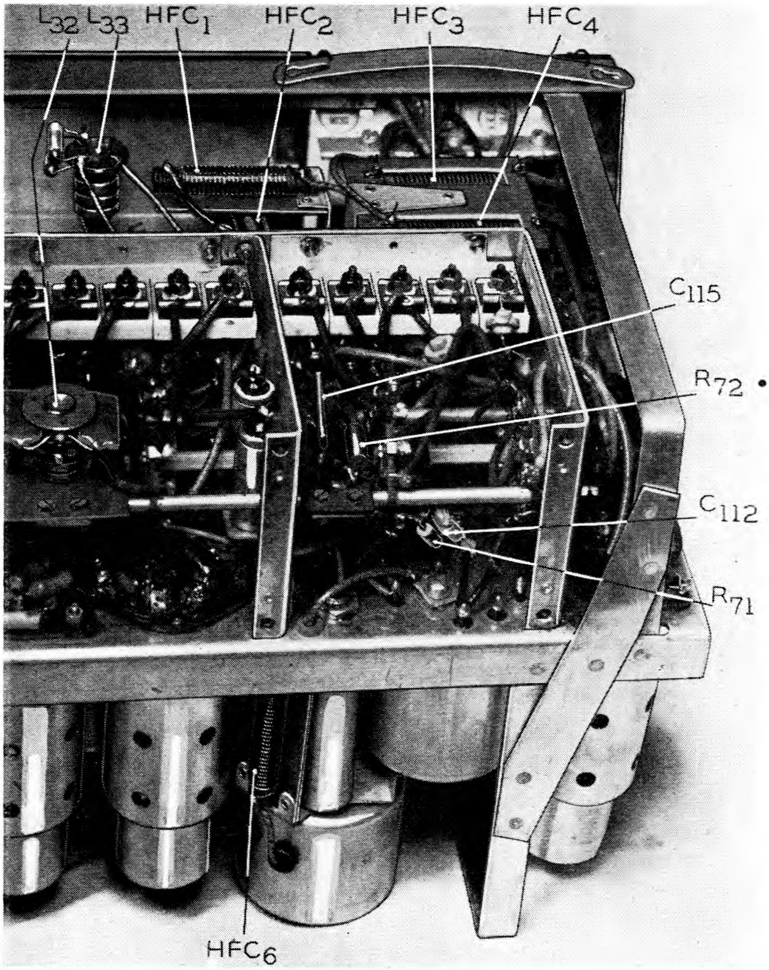

FIG. 19.—R.1155B CHASSIS UNDERSIDE

125. When the R.1155 is used solely as a communications receiver, the visual D/F switching and meter valves V_1, V_2 and V_9 are removed to conserve power. Whilst the valves V_1, V_2 and V_4 are all of the same type V.R.99, it is not advisable to change a "low" V_1 or V_2 with V_4 to obtain balance but it is permissible to replace V_4 with either V_1 or V_2 to obtain communications if V_4 is faulty. In certain operational circumstances an additional receiver is installed for the exclusive use of the aircraft navigator for D/F purposes. A type of metallized valve (V_1, V_2) is in course of production and this must *not* be used in the V_4 socket due to the metallizing pin being used as a connecting pin at H.T., the metallized grid lead then touches the valve metallizing and short-circuits the H.T. to chassis. Instructions will be issued in due course.

126. A small padded valve stowage box (Stores Ref. 10E/542) is provided for use, where necessary, for carrying spare valves and it is desirable to carry one V.R.101, and one V.R.100 for the receiver.

127. The power supplies for both L.T. and H.T. of this receiver are derived from a power unit incorporating a three-commutator compound wound rotary transformer driven off the aircraft general electrical system. The power unit, which may be either the type 34 (Stores Ref. 10K/19) of the type 35 (Stores Ref. 10K/20), is described in detail in Sect. 1, Chap. 7 of this publication. The power units, types 34A and 35A which are improved versions of these units are also described therein.

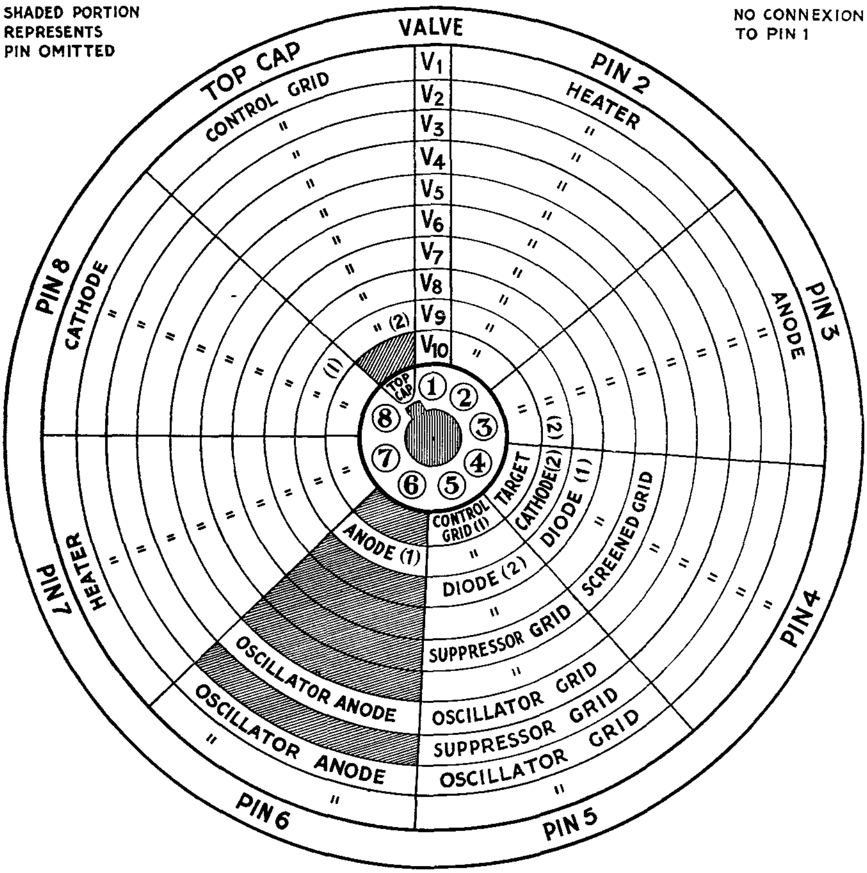

FIG. 20.—VALVE CONNEXIONS

128. The power unit is used in common with the transmitter and supplies the L.T. for that instrument. The accompanying TABLE C gives the power unit types and details.

TABLE C

R.1155 ASSOCIATED POWER UNITS

Type	Stores Ref. No.	Input D.C.		L.T. — Outputs — H.T.				Rated Watts
		Volts	Amps.	Volts	Amps.	Volts	mA.	
34	10K/19	10·3	24	7	13	217	110	115
35	10K/20	18·5	12	7	13	217	110	115
34A	10K/13065	10·3	24	7	13	217	110	115
35A	10K/13066	18·5	12	7	13	217	110	115

The receiver D.C. feed varies according to the master switch position ranging from 48 mA at OMNI with volume control at a minimum to 69 mA or more at BALANCE or VISUAL with maximum setting of volume control.

129. The aircraft electrical supply is connected to the L.T. power unit through a resistance unit, type 47 (Stores Ref. 10C/2221), or type 52 (Stores Ref. 10C/2295), for the type 34 and type 35 respectively. This resistance unit is adjusted to maintain the filament voltage between 6 volts and 7·8 volts and to compensate for the voltage alteration between the charge and no-charge condition of the aircraft batteries. It is dealt with in detail in Sect. 1, Chap. 7 of this AIR PUBLICATION.

INSTALLATION

General

130. The following notes upon the installation of the receiver duplicate, to some extent, the installation paragraphs included in Sect. 1, Chap. 7, of this AIR PUBLICATION upon the transmitter T.1154. This is unavoidable due to the interdependence of the transmitter and receiver when used as airborne equipment. A typical installation diagram is given in fig. 21. When it is realized that the transmitter is the main focal point of the wiring any initial confusion is dispelled. The power unit connectors plug into the transmitter, also the fixed and trailing aerials and connexions from the receiver.

131. In laying out the equipment in the aircraft the receiver is placed in the most convenient position for operation and where possible it is at desk level. The transmitter is mounted above, or to one side of the receiver. The tuning scales of the receiver are easily visible and the controls are accessible to the operator. The coloured click-stop dials on the transmitter are in an accessible position and visible without effort on the part of the operator.

Receiver position

132. The receiver is normally positioned horizontally. If space is limited it may be mounted vertically. The receiver is mounted on suspension fittings, mounting, type 54, and as these fittings will be 90 deg. out when the receiver is mounted vertically, a sponge rubber pad, mounting, type 55, may be positioned between the table and the bottom of the receiver. The receiver may be either table mounted or back mounted depending upon the aircraft layout.

133. From 1½ in. to 2 in. is left between the receiver and the table or between the transmitter and the receiver (if mounted one above the other) to permit freedom of movement for the suspension fittings. Clearance around the receiver and transmitter should be sufficient to allow for removal and replacement of plugs and sockets and of the chasses themselves. The transmitter case retaining screws will also be accessible. The equipment is not provided with internal illumination and is put in such a position that the natural illumination is good. For night work artificial illumination is provided and this is easily adjustable for direction and intensity.

Power unit position

134. The H.T. and L.T. power units, the latter of which is used to supply the receiver, are positioned in an accessible position. Complete instructions on the installation of the power units power cables and fuses, the L.T. dropping resistances, types 47 and 52, and the positioning of apparatus with respect to the aircraft compass, are given in Sect. 1, Chap. 7 of the AIR PUBLICATION dealing with the transmitter T.1154 group. The receiver should be at least 24 in. from the compass and the visual indicator at least 18 in. to guarantee negligible interference.

Aerial switch position

135. The aerial switching unit, type J or the aerial plug board, which is the temporary alternative to the switch unit, is positioned between the transmitter and the aerial lead-in points so that the "run" of the aerial leads is clean and short, but accessible for easy operation. Complete instructions upon the switch unit, the aerial plug board, internal aerial leads and other relevant detail are given in the transmitter chapter previously mentioned.

D/F loop aerial and impedance matching units

136. The D/F circuits of the receiver have been arranged to work with a D/F loop, type 3, which has a nominal inductance of 100 μ H and a self-capacitance, when installed, of 20 $\mu\mu$ F. When loops, having constants widely differing from these figures, are used, it is necessary to use an impedance matching unit with a series or shunt coil between receiver and loop.

137. Two small condensers C_{106} and C_{104}, the latter adjustable, are contained within the plug, type 209 (Stores Ref. 10H/433) which connects the D/F loop to the receiver. The condenser C_{104} should be adjusted for maximum sensitivity. The fixed condenser C_{106} should be wired in circuit only if the length of low-loss cable between loop and receiver is less than 12 ft. The position of the adjustment of C_{106} can be seen on the diagram of the plug, type 209, in fig. 22. The screwdriver used for adjusting C_{104} should have an insulated shaft to prevent short circuiting to the receiver metal casing. A suitable tool is the tool, tuning (Stores Ref. 10A/11421).

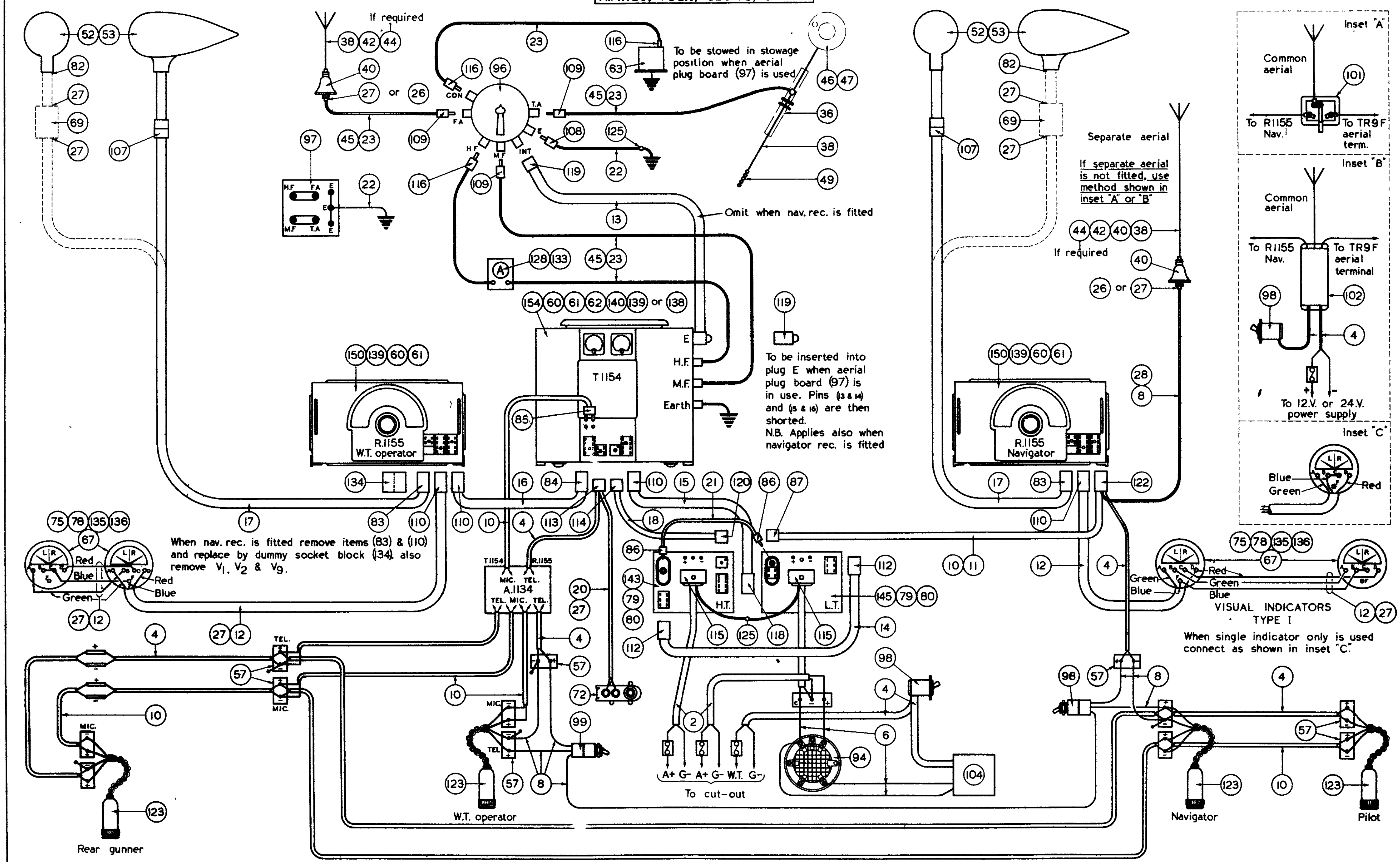

FIG. 21

TYPICAL INSTALLATION DIAGRAM

FIG. 21

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Item No.	Stores Ref. No.	Description
GENERAL WIRING		
2A	5E/1364	Cable L.T. Ducel 19 Cellse. braided or
2B	5E/1365	Cable L.T. Ducel 37 metal braided
4	5E/1362	Cable L.T. Ducel 4 Cellse. braided
6A	5E/1360	Cable electric L.T. Unicel 19 Cellse. braided or
6B	5E/1361	Cable electric L.T. Unicel 37 Cellse. braided
8	5E/1358	Cable electric L.T. Unicel 4 Cellse. braided
10	5E/1328	Cable electric L.T. Dumet 4 metal braided
11	5E/1348	Cable electric L.T. Dumet 7 metal braided
12	5E/1351	Cable L.T. Trimet 4 metal braided
13	5E/1353	Cable L.T. Quadramet 4 metal braided
14	5E/2069	Cable electric Sextocoremet
15	5E/2067	Cable electric Octocoremet No. 1
16	5E/2068	Cable electric Octocoremet No. 2
17	5E/2033	Cable electric H.F. Dulocapmet No. 1
18	5E/758	Cable H.T. Uniplugmet No. 1
20	5E/916	Cable L.T. Unisheath 4 red braided
21	5E/130	Cable L.T. Unisheath 7 unbraided
22	5E/	Cable L.T. Uniflex 19 red braided
23	5E/82	Cable H.T. Unispark 7 unbraided
26	5A/912	Cable end eye type O.B.A.
27	5A/911	Cable end eye type 4 B.A.
28	5A/910	Cable end eye type 6 B.A.
31	5A/1810	Cable end hock type crimping Uniflex cable
34	5A/1073	Sleeve identification Uniflex cable
W.T. FIXED EQUIPMENT		
36	Special	Ae. frld. com. with lghtn. arrt. type C
38	10B/8235	Ae. wire stainless steel
40A	10B/8093	Ae. insulator type 16 (lead in) or
40B	10B/11457	Ae. insulator type 49 (lead in)
42A	10B/8097	Ae. insulator type 17 (strain) or
42B	10B/8994	Ae. insulator type 18 (strain)
44	10B/9121	Ae. insulator type 18 (shroud)
45	10B/468	Ae. insulator type 177
46	10B/9005	Ae. winch type 5 frame
47	10B/9123	Ae. winch type 5 reel type B
49A	10B/7298	Ae. weight bead type No. 1 or
49B	10B/7706	Ae. weight bead type No. 2
52	10B/8478	Ae. loop type 1 or
53		Ae. loop type 3. Group to suit a/c
57	5C/430	Block terminal type B 2 way No. 1
58	5C/432	Block terminal type B 3 way No. 1
60	10A/12427	Block mounting type 1
61	10A/12428	Block mounting type 2
63	10C/564	Condenser type 764
67	10Q/2	Indicator visual type 1
69	10A/12148	Impedance matching unit type 12 or
69A	10A/12247	Impedance matching unit type 15
72	10A/7741	Key morse type F
73	Special	Label
75A	Special	Lamp holder or
75B	10A/13078	Lamp holder type 61
78	10A/12954	Mounting anti vibration type 119
79	10A/12421	Mounting type 51
80	10A/12422	Mounting type 52
82	10H/9872	Plug type 101
83	10H/433	Plug type 209
84	10H/434	Plug type 210
85	10H/451	Plug type 217
86	10H/8516	Plug type 68
87	10H/1518	Plug type 358
92	10A/12436	Plate anchorage type 1
94A	10C/2221	Resistance unit type 47
94B	10C/2295	Resistance unit type 52
96	10F/126	Switch unit type J or
97	10H/681	Aerial plug board
98	5C/543	Switch box type B 1 unit
99A	10F/11714	Switch type 170 S.P.C.O. or
99B	5D/531	Switch 2 amp. miniature S.P.C.O.
101	10H/1276	Switch type 9 S.P. 2 way or
102A	10F/752	Relay type 265 (12–v.) or
102B	10F/725	Relay type 258 (24–v.)
104A	10F/493	Relay type 219 LONDEX or
104B	10F/494	Relay type 220 LONDEX
106	10H/8531	Socket type 40
107	10H/11051	Socket type 63
108	10H/319	Socket type 135
109	10H/320	Socket type 136
110	10H/322	Socket type 137
112	10H/427	Socket type 168
113	10H/428	Socket type 169
114	10H/429	Socket type 170
115	10H/431	Socket type 171
116	10H/422	Socket type 172
117	10H/423	Socket type 173
118	10H/424	Socket type 174
119	10H/425	Socket type 175
120	10H/435	Socket type 176
122	10H/1498	Socket type 299
123	10H/2206	Socket type 359
125	5A/1058	Terminal 2 B.A. type A spring type
W.T. REMOVABLE EQUIPMENT		
128A	10A/12227	Ammeter H.W. 0–4 amps. type A or
128B	10A/12667	Ammeter thermo 0–4 amps. type C
131	10E/542	Box valve stowage
133	10A/12674	Cover protective
134	10H/1938	Dummy sockets block
135	5C/462	Lamp instrument
136A	5L/1150	Lamp filament 12-v. or
136B	5L/1898	Lamp filament 24–v.
138	10A/12423	Mounting type 53
139	10A/12424	Mounting type 54
140	10A/12425	Mounting type 55
143A	10K/13063	Power unit H.T. type 32A or
143B	10K/13064	Power unit H.T. type 33A
145A	10K/13065	Power unit L.T. type 34A or
145B	10K/13066	Power unit L.T. type 34B
150	10D/98	Receiver R.1155 (or R.1155A or R.1155B)
154A	10D/97	Transmitter type T.1154 or
154B	10D/99	Transmitter type T.1154A
154C	10D/196	Transmitter type T.11548 or
154D	10D/198	Transmitter type T.1154C

TYPICAL CONNECTOR SET INSTALLATION

(*Note.*—This installation is typical and refers only to the SUNDERLAND type aircraft)

KEY TO BASIC TYPE NOS. AND FUNCTION

541	Power Unit H.T. to Power Unit L.T.	543	Power Unit H.T. to Transmitter	545	Switch Unit, type J to Transmitter "D/F"	547	Receiver (Nav.) to Power Unit L.T. Only required when 2 Receivers fitted
542	Transmitter to Receiver	544	Power Unit H.T. to Transmitter	546	Loop Aerial, type 3 to Receiver	548	Used in place of Switch Unit, type J and also when 2 Receivers are installed

Aircraft Type Indentification Letter and Connector Set	Comprising Connector Set		Fitted with									References in Figure
						Socket			Plug			
	Stores Ref. No.	Type	Stores Ref. No.	Cable type	Length	Stores Ref. No.	Type	Qty.	Stores Ref. No.	Type	Qty.	
Sunderland Mk. II and Mk. III "A"	10H/1634	541/1	5E/2069	Sextocoremet	1′ 3″	10H/427	168	2				14, 112
Fitted with single receiver	10H/1635	542/1	5E/2068	Octocoremet No. 2	3′ 2″	10H/322	137	1	10H/434	210	1	16,110, 84
	10H/1636	543/1	5E/2067	Octocoremet No. 1	3′ 0″	10H/322	137	1				15, 110
Connector Set Type T.1154/ R1155						10H/424	174	1				118
	10H/1637	544/1	5E/758	Uniplugmet No. 1	3′ 6″	10H/429	170	1				18, 114
(Stores Ref. 10H/1556)						10H/435	176	1				120
	10H/1638	545/1	5E/1353	Quadramet 4	1′ 10″	10H/425	175	2				13, 119
	10H/1639	546/1	5E/2033	Dulocapmet No. 1	13′ 8″	10H/11051	63	1	10H/433	209	1	17, 107, 83
	10H/1718	548/1	5E/1362	Ducel 4	6′ 0″	10H/425	175	1				119
Fitted with extra Receiver R.1155 for D/F.	Items 10H/1634, 10H/1635, 10H/1636 and 10H/1718 as above. Item 10H/1637 is 4′ 0″ not 3′ 6″											
	10H/2317	545/3	5E/2033	Dulocapmet No. 1	6′ 6″	10H/11051	63	1	10H/433	209	1	17, 107, 83
Connector Set Type T.1154/2 R.1155/A	10H/1640	547/1	5E/1348	Dumet 7	25′ 0″	10H/1498	299	1	10H/1518	358	1	11, 122, 87
(Stores Ref. 10H/1735)			1328	Dumet 4	25′ 0″							10
			1362	Ducel 4	9′ 6″							4
Conversion of Single Recr. Instn.	Item 10H/2317 (below) replaces Item 10H/1639 when converting to two Receiver installation											
To Two Recr. Instn.	10H/2317	545/3	5E/2033	Dulocapmet	6′ 6″	10H/11051	63	1	10H/433	209	1	17, 107, 83
Connector Set Type T.1154/R. 1155/Convn./A	10H/1640	545/3	5E/1328	Dumet 4	25′ 0″	10H/1498	299	1	10H/1518	358	1	10, 122, 87
(Stores Ref. 10H/1986)			5E/1328	Dumet 7	25′ 0″							11
			5E/1362	Ducel 4	9′ 6″							4

The following items refer to 14 connectors without reference Nos.:—

Stores Ref. No.	Cable	Approx. length	Ref. in fig.	Sockets			Ref. in fig.	Plugs			Ref. in fig.
				Stores Ref. No.	Type	Qty.		Stores Ref. No.	Type	Qty.	
5E/82	Unispark 7	21′ 0″	23	10H/8531	40	1	106	10H/451	217	1	85
5E/86	Uniflex 19	6′ 0″	22	10H/319	135	2	108				
5E/916	Unisheath 4	6′ 0″	20	10H/320	136	4	109				
5E/1328	Dumet 4	4′ 0″	10	10H/322	137	1	110				
5E/1349	Ducel 19	5′ 0″	2	10H/428	169	1	113				
5E/1351	Trimet 4	14′ 0″	12	10H/431	171	2	115				
5E/1362	Ducel 4	4′ 0″	4	10H/422	172	4	116				
				10H/423	173	2	117				

The following items refer to 15 connectors without reference Nos.:—

5E/82	Unispark 7	19′ 0″	23	10H/8531	40	1	106	10H/8531	68	2	86
5E/86	Uniflex 19	6′ 0″	22	10H/319	135	2	108	10H/451	217	1	85
5E/916	Unisheath 4	7′ 0″	20	10H/320	136	4	109				
5E/1328	Dumet 4	9′ 0″	10	10H/322	137	1	110				
5E/1349	Ducel 19	4′ 0″	2	10H/428	169	1	113				
5E/1362	Ducel 4	10′ 0″	4	10H/431	171	2	115				
5E/1351	Trimet 4	28′ 0″	4	10H/422	172	4	116				
5E/130	Unisheath 7	3′ 0″	21	10H/423	173	2	117				

The following items refer to 2 connectors without reference Nos.:—

5E/1351	Trimet 4	18′ 0″	4	10H/322	137	1		Replaces Receiver to Indicator connector
5E/130	Unisheath 7	3′ 0″	21	10H/8531	68	2		Connector between power units

138. The procedure for matching the receiver input to the capacitance of the loop aerial lead is as follows:—

(i) Set the aerial switch, type J, to D/F. (If the aerial plug board is in use set plug FIXED AE. to group marked H.F.) No D/F interlock is provided to prevent transmission with the receiver in the D/F position and care must be taken to avoid this condition (*see* also A.P.1186, Sect. 1, Chap. 7, on the aerial plug board). Set the receiver master switch MS to FIGURE-OF-EIGHT.

(ii) Tune receiver to suitable signal on RANGE 3 at the 1,500 kc/s end of the scale, and turn the loop to position giving MAXIMUM signals in the telephones.

(iii) Adjust the trimmer condenser C_{106} to the position which gives maximum signals. Observe the tuning indicator V_{10} for minimum shadow during this operation.

(iv) Remove the loop plug, type 209, from the receiver and note the position of the rotor plates in the condenser C_{106}. If it is found that the plates are in a position between maximum and minimum capacitance, that is, at about 90 deg., the adjustment is satisfactory and the plug should be replaced.

(v) If it is found that the rotary plates are fully meshed it is an indication that insufficient capacitance adjustment is obtainable and additional capacitance should be added by removing the insulated covering from the leads, running the insulated covering from the leads across the paxolin strips from the lower pair of tags to the top pair of tags and by soldering the leads to the middle pair of tags adjacent to the leads.

(vi) If examination shows that the rotor plates are in the position of minimum capacitance it is an indication that too much capacitance is in circuit. The additional capacitance of the fixed condenser C_{104} should be removed by reversing the procedure outlined in (v) above. Unsolder the connecting wires from the middle pair of tags and cover the wires with suitable insulation to prevent contact with the middle pair of tags.

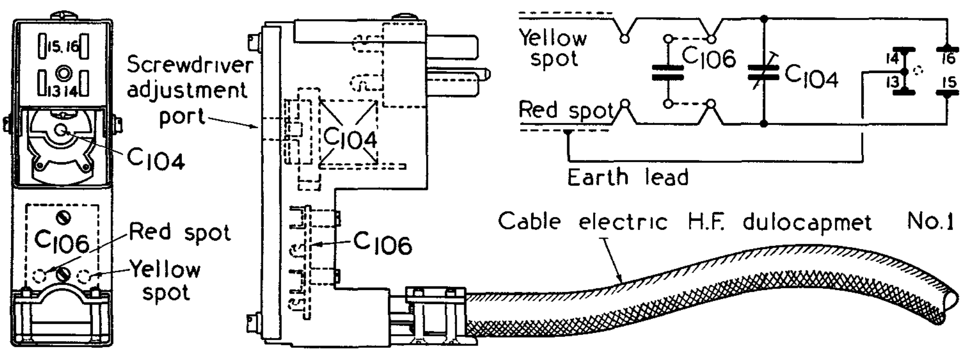


FIG. 22.—THE PLUG, TYPE 209

139. When the loop aerial, type 1, is installed, an impedance matching unit, type 12, is used. When the receiver is installed on Hampden aircraft fitted with the retractable loop, an impedance matching unit, type 13, is used. When installed in aircraft fitted with the Bendix type loop, a matching unit, type 15, is used.

140. The position of the impedance matching unit, with the maximum permissible length of cable between the loop and the receiver, is clearly indicated in the installation schedules, a typical specimen of which is included in the diagram fig. 21. The lengths between loop and matching unit, when installed, and between matching unit and receiver must, naturally, depend upon the position of the matching unit. In paras. 141 to 143 general principles governing the positioning are given.

141. On installations using the loop aerial, type 3, the length of cable connector dulocapmet No. 1, fitted with plug, type 209, and socket, type 63, should not be less than 6 ft., or more than 20 ft. On installations using the loop aerial, type 1, the length of cable connector dulocapmet No. 1 should not be less than 5 ft. or more than 18 ft. The matching unit should, preferably, be as near to the loop as possible.

142. The position of the matching unit, when the Hampden retractable loop is used, should be as near to the loop as possible and the position of the unit affects the maximum permissible length of cable. The length of dulocapmet No. 1 between the loop and the receiver should not be less than

4 ft. If the matching unit is not more than 7 ft. from the receiver a maximum total length of 22 ft. from loop to receiver is permissible. If the unit is not more than 3 ft. from the loop, the cable should not exceed 18 ft., total length, from loop to receiver.

143. When the Bendix loop is installed the matching unit, type 15, should be, preferably, as near as possible to the receiver. The length of dulocapmet between loop and receiver should not be less than 4 ft. If the matching unit is not more than 6 ft. away from the receiver, the total length of cable from receiver to loop should not exceed 20 ft. If the unit is not more than 2 ft. from the loop, the total length of cable between receiver and loop should not exceed 17 ft.

Fixed aerial input

144. The amount of fixed aerial input to the switching valves V_1 and V_2 and hence to the loop aerial circuit, is adjusted, on installation, by inserting a screwdriver into the small port on the right-hand side of the master switch MS. This is indicated on fig. 1 as C_{56}. Once adjusted, the condenser needs no further attention. An insulated screwdriver should be used in order to avoid the possibility of short-circuiting the trimmer to earth.

145. The following procedure should be followed:—

(i) Set the aerial switch, type J, to D/F. (If plug board in use set plug marked FIXED AE to group marked HF, *see* para. 138(i).) Set the Meter deflection sensitivity S_2 to HIGH.

(ii) Tune the receiver to a suitable signal on RANGE 4 and rotate the loop to a position which gives the MINIMUM signals in the telephones. The signal selected should be one the bearing of which remains constant. This may be checked by turning the master switch MS to VISUAL and noting that the needles of the visual indicator remain steady on the bearing. It is advisable, also, that the volume control R_8 should be adjusted to give the lowest possible signal strength, consistent with accurate observation, during this and other adjustments.

(iii) Set the receiver master switch to BALANCE and adjust balance control of R_{51} and meter amplitude control R_{23} to a position which causes the visual indicator needles to intersect along the white centre line on the dial face.

(iv) Return the receiver master switch MS to FIGURE-OF-EIGHT and rotate the loop 30 deg. from the position previously obtained for (ii) above.

(v) Operate the aural sense switch S_3 to L and R and hold the switch to the side which gives the weaker signal.

(vi) With the aural sense switch held in the position selected as at (v) adjust the trimmer C_{56} so that zero or minimum signals are obtained. Observe the tuning indicator V_{10} during this operation as correct adjustment is indicated by maximum shadow.

The visual indicator, type 1

146. It is usual to install two visual indicators, type 1, one on the pilot's instrument panel for "homing" purposes and the other in a convenient position for the operator of the receiver and D/F loop. These indicators are provided with a dim, but independent, illumination so that they may be used at night. The indicators are mounted on a sprung panel, or otherwise protected against jars and vibrations, as the movements are extremely fragile. The methods of wiring to the visual indicator when either one or two of these instruments is installed are shown as part of the typical installation diagram, fig. 21.

147. The mounting, anti-vibration, type 119, is used with the visual indicators, and filament lamps, jack, type G.P.O. No. 3 (12-volts) or G.P.O. No. 3 (24 volts) with lampholders, type 61, are provided when required. The following points should be noted when fitting the visual indicators:—

(i) The instruments are mounted in the retaining strap so that they are suspended horizontally. The side brackets of the mounting, type 119, are adjusted as necessary. A minimum clearance of $\frac{1}{32}$ inch is allowed between the face of the instrument and the rubber cushion of the mounting.

(ii) Not less than 9 in. of loose cable is left between the indicator and the first cable fixing point.

(iii) The instrument retaining strap is tightened by means of a screw.

Setting up the D/F loop

148. The polarity of the leads connecting the visual indicators to the receiver must be correct as indicated in fig. 21. This must be carefully checked. Similarly, the connexions from the receiver to the D/F loop should be checked. If the loop, type 3, is used and has been installed with the

red end of the cradle toward the rear and the cursor reading at 180 deg. on the black marking of the scale ring, then the sense of the visual indicators should be correct. If a D/F loop, other than the type 3, is used it should be stated quite clearly on a label in the aircraft how the loop scale must be adjusted so that the sense is correct.

149. The following procedure should be adopted to ensure that the sense is correct:—

(i) Turn the master switch MS to FIGURE-OF-EIGHT. Tune the receiver to any signal in RANGES 3 or 5. This signal should be definitely identified and its relative position, with respect to the aircraft, known.

(ii) Set the loop to the approximate bearing of the station and finally adjust for minimum or zero signal to give the exact relative bearing.

(iii) Turn the meter deflection sensitivity switch S_2 to LOW. Hold the aural sense switch S_3 to R and reduce the loop scale reading. The signals should rise in strength.

(iv) If the signals decrease in strength it will indicate that the installation has been incorrectly made and the loop and associated circuits should be checked.

(v) The above test should be repeated with the master switch MS at VISUAL. If sense is correct, the visual indicator meter needles will swing to the right.

After installation of a new apparatus, when making a test flight, the routine for visual D/F sense discrimination should be carried out in order to determine whether the loop connexions are actually correct. It is necessary to check on a station, the position of which, relative to the aeroplane, is known.

Loop centre tap

150. The receiver is designed to work on loops having no centre tap. As the receiver aerial coils are centre-tapped to earth, the loop centre tap is unnecessary. Since it is possible that the tap may have been removed with new installations a check should be made as follows:—

(i) Remove loop plug at receiver and connect a test meter, type E across contacts 15 and 16 using the OHMS range. This should give a low resistance reading.

(ii) A reading should then be taken from contact 15 or 16 to 14 and 13. Open circuit should be indicated.

(iii) If a reading is obtained at (ii) it indicates that the loop has not had the centre tap removed, or that one side is earthed. The necessary action as indicated in para. 151, should be taken in these circumstances.

(iv) Adjust the loop lead capacitance (*see* para. 138).

Checks of sense, vertical aerial input and loop lead capacitance should always be applied as a matter of routine after any repair or replacement of items in the loop aerial or visual meter circuits.

151. The following is the sequence of operation, as laid down in the leaflet A.P.1186/E.62–W, for the removal of the loop centre tap:—

(i) Remove the fabric seating strips from around the centre seam of the streamlined housing.

(ii) Remove and retain the six screws securing the tail and centre section of the housing.

(iii) Withdraw the tail portion of the housing. The loop winding will now be exposed.

(iv) Identify the loop winding inner terminations and remove the connexion from one winding termination, inner, to the metal centre piece.

(v) Remove the connexion from the other winding termination, inner, to the spill on the corner fixing screw.

(vi) Connect the winding terminations, inner, by a short length of 18 s.w.g. tinned copper wire (Stores Ref. 5E/1779) encased in insulating tubing, grade E (Stores Ref. 5F/1910).

(vii) Disconnect the loop plug from the receiver and using a test meter, type E, check the loop circuit as follows:—

(*a*) Plug the negative lead into the OHMS socket and connect the test meter between the loop winding and earth. The test meter should remain undeflected.

(*b*) Connect the test meter across the loop winding outer terminations and it should register full-scale deflection.

(viii) Replace the tail piece of the loop housing and secure it by the six screws.

(ix) Re-seal the centre seam, using 2-in. wide tape (Stores Ref. 32B/409), approximately 10 ft. and special adhesive, bostik No. 103 (Stores Ref. 10C/590).

Navigator-operated receivers

152. In certain aircraft an additional receiver is installed for the exclusive use of the navigator for D/F purposes. The D/F loop is then connected to the navigator-operated instrument and the existing loop connector is deleted and a new connector fitted, the length varying to suit individual installations. The typical installation diagram of fig. 21 includes this navigator-operated receiver.

153. The D/F loop which is normally connected to the communications receiver is now connected to the navigator-operated receiver and the D/F valves are removed from the communications receiver in order to conserve the electrical supply. The existing loop connector is dispensed with and a new connector fitted, the length of this varying to suit individual installations.

154. The visual indicator, previously located and wired in a position accessible to the W/T operator, is removed and mounted at the navigator's station, a suitable connector being used. The visual indicator is connected to the navigator-operated receiver. The visual indicator provided for the use of the pilot will remain. A dummy socket, Stores Ref. 10H/1938, is provided for the purpose of blanking out the D/F loop and visual indicator connexions on the communications receiver. Existing remote controls may have to be repositioned or deleted and where no remote controls exist these may have to be provided.

155. To provide for sense indication a fixed aerial is required for use with the navigator-operated installation. For this purpose it is necessary to employ a separate fixed aerial. In certain circumstances it may be necessary to utilise one of the existing fixed aerials and a change-over switch.

156. In order to provide for any difficulty which might arise over signal identification, means is provided to enable signals to be switched from the navigator back to the W/T operator. This is accomplished by means of two switches, type 170, suitably wired. One switch is controlled by the navigator whilst the other is controlled by the W/T operator. When the navigator's switch is set to the D/F position his telephones are connected to the output of the additional receiver. Should it be necessary for the W/T operator to identify the signal, the operator's switch is set also to the D/F position. Normal I/C facilities are established when the switches are set to the I/C position.

157. The modifications to the power unit, to enable the additional power for the navigator-operated receiver, entail the fitting of a relay unit to the L.T. power unit and a single pole socket to the H.T. power unit. These modifications are described in the appropriate sub-section of Sect. 1, Chap. 7 of this publication.

158. It has been found that in certain navigator-operated receivers, type R.1155, some valves are not connected to the H.T. supply. This is due to the omission of a lead between pins Nos. 5 and 7 of the socket, type 299, which is fitted at the receiver end of the cable between the L.T. power unit and the receiver. If, upon examination, the socket, type 299, is found deficient in this respect, the procedure as laid down in the leaflet A.P.1186/B.58.W should be followed:—

(i) Withdraw the socket, type 299, from the receiver and remove its cover.
(ii) Connect a 1 in. length of 18 s.w.g. tinned copper wire, encased in grade E insulating tubing, between pins No. 5 and No. 7.
(iii) Replace the cover of the socket.
(iv) Replace the socket in the receiver.

Prevention of frequency drift

159. Cases have occurred of excessive frequency drift in the beat frequency oscillator of the R.1155. This has been traced to (i) the overheating of the fixed silver mica condensers in the B.F.O. compartment causing alteration of capacitance and (ii) the presence of sulphur from the sorbo pad used to prevent the valve V_7 from touching the lid. The modification consists of drilling a ventilation hole in the B.F.O. compartment lid with replacement of the valve identification label. The procedure detailed in the leaflet A.P.1186/B.54.W is as follows:—

(i) Withdraw the receiver from its case.
(ii) Remove the lid of the B.F.O. compartment situated immediately behind the front panel, by withdrawing the six securing screws.
(iii) Remove the sorbo pad from the inside of the lid.
(iv) Cut a hole $1\frac{1}{4}$ in. dia. in the B.F.O. compartment lid, the centre of the hole being directly above the valve top cap, that is, approximately 1 in. from the long edge and $1\frac{7}{8}$ in. from the short edge of the lid.
(v) Refit and secure the lid to the compartment.
(vi) Readjust, if necessary, the frequency of the trimmers as described in para. 165.

(vii) Use shellac varnish to fix the valve identification label to the rear inside face of the receiver case in the most suitable position for reading.

(viii) Apply a thin coat of shellac varnish over the label.

(ix) Replace the receiver in its case.

Power units

160. Installation instructions in connexion with the power units and the full procedure for adjustment of the resistance unit, type 47 (12-volt) or type 52 (24-volt) which is connected between the aircraft electrical supply and the L.T. power unit, supplying the receiver L.T. and H.T., can be found in the chapter on the transmitter, type T.1154, Sect. 1, Chap. 7 of this publication.

OPERATION

General

161. The operation of the R.1155 will be facilitated by reference to fig. 1 which shows the front panel controls, plugs and socket. An initial necessity is that the operator should satisfy himself that all valve top cap connectors are making secure contact. The plugs and socket should be securely engaged and the retaining bar (2) should be in position on the posts (3) provided. The receiver socket and plugs are grouped at the bottom right-hand corner and, from left to right, they are:—Socket P_3, "FROM LOOP AERIAL"; plug P_2, "TO VISUAL INDICATOR"; plug. P_1 "FROM TRANSMITTER."

162. For communications reception the fixed aerial is normally used on the H.F. RANGES 1, 18·5 Mc/s to 7·5 Mc/s, and 2, 7·5 Mc/s to 3·0 Mc/s; the trailing aerial is used for the M.F. RANGES 3, 1,500 Mc/s to 600 Mc/s, 4, 500 Mc/s to 200 Mc/s and 5, 200 Mc/s to 75 Mc/s. By operation of the aerial selector switching unit, type J, or the aerial plug board, the fixed or trailing aerial can be used on all RANGES. This ensures continuity of communication should one of the aerials become unserviceable. For D/F the fixed aerial and loop aerial are used. D/F reception, using visual and aural methods, is available on all RANGES except RANGE 1. The operator should ensure that the correct matching unit, for the type of loop aerial being used, is installed, as specified in paras. 133 to 136. He should be familiar with the RANGE coverage and colour code associated with it. The sequence of RANGES 1 to 5 corresponds to the five positions of the frequency switch reading from left to right.

Main controls

163. The receiver has three main communication controls:—

(i) The tuning control (6) with direct frequency calibrated dial (4), the frequency being indicated by a pointer (5) on the full-vision scale. The front knob has direct drive and the inner knob is the vernier adjustment. The exact point of resonance is shown by the narrowest shadow indicated on the tuning indicator V_{10}. The scale colour code is based on that of the transmitter, type T.1154, frequencies outside the transmitter RANGES being indicated in BLACK (*see* para. 108).

(ii) The frequency range switch FS selects the desired RANGE 1 to 5.

(iii) The master switch MS has five positions:—

"OMNI"—(⊙) Manual control of H.F. and I.F. ($R_{8(1)}$). Used for W/T reception and transmitter-receiver inter-tuning, that is, using receiver as a monitor.

A.V.C.—Automatic control of H.F. and I.F. gain. Manual control of L.F. gain ($R_{8(2)}$). Used for R.T.

BALANCE—For balancing visual indicator before using D/F.

VISUAL—For visual D/F and "homing."

FIGURE-OF-EIGHT (∞) For aural D/F.

164. The receiver secondary controls are:—

(i) INCREASE VOLUME (R_8)—Adjusts input to grid of V_8 when MS is at A.V.C. and adjusts bias of H.F. and I.F. when MS is at OMNI and FIGURE-OF-EIGHT. The knob is rotated clockwise.

(ii) HETERODYNE SWITCH (S_4)—Switches in the B.F.O. valve V_7 for W/T reception.

(iii) METER AMPLITUDE (R_{23})—Varies height of visual indicator needles when setting up to D/F balance. May also be used for occasional adjustment of the needles on weak signals.

(iv) METER BALANCE (R_{51})—Adjusted with MS at BALANCE and must not be adjusted with MS at any other position. Balance is indicated when the two needles of the visual indicator intersect along the centre line.

(v) METER SENSITIVITY SWITCH (S_2)—Effects maximum deflection of visual indicator needles at 25 deg. off course for "homing" purposes (LOW) or maximum deflection of 10 deg. off minimum when taking bearings by visual indicator (HIGH).

(vi) METER FREQUENCY SWITCH (S_1)—Causes L.F. switching oscillator (V_1 and V_2) frequency to be either 80 c/s (HIGH) for W/T, or 30 c/s (LOW) for R.T.

(vii) AURAL SENSE SWITCH (S_3)—Spring loaded. Used for sense determination when aural D/F reception is employed.

(viii) FILTER SWITCH (S_5)—Used to eliminate the switching frequency when monitoring visual D/F and for elimination of aircraft electrical noises.

Setting up heterodyne oscillator

165. To bring the B.F.O. valve V_7 into operation when receiving W/T the switch S_4 is used. It is first necessary to set up the heterodyne oscillator and this is accomplished as follows:—

(i) Turn the aerial selector switching unit, type J, to the position M/F on FIXED or, if using and aerial plug board, FIXED AE. TO M/F.

(ii) Put the transmitter master switch to STAND BI and the receiver master switch MS to A.V.C.

(iii) The frequency range switch FS should be at RANGE 3 and a convenient C.W. transmitting station tuned in until the minimum shadow is seen in the tuning indicator V_{10}.

(iv) Now switch on the heterodyne, using S_4.

(v) Insert a screwdriver into the HET.ADJ. port of C_{13} and slowly adjust the condenser until an audible note is heard in the telephones. A variation of approximately 3 kc/s can be effected and the note should be adjusted to the required frequency.

Back-tuning

166. In the absence of a crystal monitor the back-tune method can be used to facilitate the setting up of the transmitter "spot" frequencies. The receiver frequency range switch FS is set to the RANGE in which the required transmitter frequency occurs. Set the receiver to the required frequency and set the master switch to OMNI. Set volume control R_8 about half-way.

167. With the transmitter master switch at TUNE, press the morse key and swing the master oscillator dial until maximum signal strength, that is minimum shadow, is indicated in the tuning indicator V_{10}, adjusting the receiver volume control R_8 as necessary. Adjust the transmitter output in the normal manner and recheck the M.O. tuning by reference to the receiver tuning indicator V_{10}. Send a series of dots and observe flicker in V_{10}.

168. It will be realized that it is possible to set up the receiver exactly to a click-stopped "spot" frequency on the transmitter by means of back-tuning. The transmitter should be tuned, using the M.O. calibration, to the correct frequency. Set the receiver FREQUENCY RANGE switch to the required RANGE in which transmitter frequency occurs. Set the receiver master switch to OMNI with volume control half-way. Set the transmitter master switch to TUNE, press key and adjust receiver, tuning for minimum shadow as shown in V_{10}. N.B.—If the edges of light on the tuning indicator overlap during tuning operations, reduce the volume control. If shadow cannot be reduced, increase volume control.

Normal communication

169. The aerial switching unit, type J, is turned to NORMAL (when using aerial plug board FIXED AE. to H/F, TRAILING AE. to M/F). The transmitter master switch is at STAND BI. Turn up the receiver volume control until background noise is heard. Put the receiver master switch MS to OMNI and V_{10} should show a green light. Turn the receiver frequency range switch FS to the required RANGE and adjust the receiver frequency, first by the outer tuning knob (6) and finally by the inner fine-tuning knob. If working C.W., switch ON the heterodyne by S_4. Whilst sending signals a 1,200 c/s side-tone should be heard in the telephones. Listening-through can be tested, with the morse key up, by listening for signals or receiver background noise. The tuning indicator V_{10} will flicker to dots and dashes when transmission is taking place if the receiver is tuned to the same frequency as the transmitter.

Heavy atmospheric interference

170. In heavy static, or thunder conditions, the fixed and trailing aerials should be earthed. This condition is met by turning the aerial selector switching unit, type J, to EARTH (when using an aerial plug board, FIXED and TRAILING AE. TO EARTH). Reception is still possible,

using RANGES 2 to 5, in conjunction with the loop aerial. Turn the frequency range switch FS to the required RANGE. Turn the master switch MS to FIGURE-OF-EIGHT and tune in the signal. Rotate the loop aerial to the position of maximum strength, noting the V_{10} shadow. Adjust the volume control (7).

D/F bearings with visual indicator

171. Frequency RANGES 3, 4 and 5 (occasionally 2) are used. Only the BLACK scale on the loop should be used. First, turn the aerial selector switch to D/F or, if using aerial plug board TRAILING AE. on M/F and FIXED AE. on H/F. If an aerial plug board is fitted, care must be taken by the operator to see that the transmitter switch is at STAND-BI and that the key is not pressed. Turn the transmitter master switch to STAND-BI and the receiver frequency range switch FS to the required RANGE. Turn the receiver master switch to OMNI.

172. Tune in the signal as for normal communication and adjust volume (7) to a low level. Turn the receiver master switch to BALANCE. Adjust the visual indicator needles by METER BALANCE control R_{51} so that they intersect exactly along the centre line on the dial face. If necessary, adjust the needles to a suitable working height by rotating the METER AMPLITUDE control R_{23}. Turn the METER SENSITIVITY switch S_2 to HIGH.

173. Turn the METER FREQUENCY switch S_1 to HIGH for W/T or LOW for R.T. Switch FILTER S_5 to IN. Readjust balance by METER BALANCE control R_{51}. Turn the master switch MS to VISUAL. The indicator needles should now operate. Turn the loop aerial to position at which the indicator needles intersect along the centre line on the dial face.

174. Check for sense by reducing the scale reading of loop. If indicator needles swing to the RIGHT, sense is correct. If to the LEFT, sense is incorrect. When sense is correct, turn the loop back to the position on BLACK SCALE to which needles intersect along the centre line on the dial face, and note reading. If sense is incorrect, rotate through 180 deg. to determine bearings. The routine may be easily remembered by the RRR rule:—Reduce reading; Right deflection; Right sense.

"Homing," using visual indicator

175. The sequence of operations detailed in paras. 171 to 173, up to that in which the master switch MS is turned to VISUAL, should be carried out prior to the following. The loop is then set to loop scale reading zero, that is, athwartship. The meter deflection sensitivity switch S_2 is positioned at LOW and the master switch MS to BALANCE. The balance is readjusted by R_{51} and the switch MS put to VISUAL. The pilot should now be asked to alter course until the needles intersect along the centre line on the visual indicator dial face. There may be occasions when it is not known whether the "homing" transmitter lies ahead or astern of the aircraft, and sense discrimination must then be carried out as described herein.

176. After the aircraft has been set to a course which causes the needles to intersect on the centre line the course is off-set a few degrees to the left; if the station is ahead, the needles will intersect on the right; if the station is astern, the needles will intersect on the left and the course should be altered to 180 degrees. This sense discrimination may, if desired, be carried out by reducing the scale reading by, say, 10 deg. instead of altering the aircraft's course. Sense will be indicated in the same manner.

177. Care should be taken to ensure that the loop is restored to zero after sense determination. During "homing," balance should be checked every ten minutes. If necessary, make adjustments to the meter amplitude by R_{23} and re-check the balance after this operation.

178. It should be remembered that "homing" by visual indication is only in the nature of an "aid to navigation" and that normal navigation should not be neglected whilst it is being used. The aircraft should, for example, be prevented from drifting if there is a cross wind. The homing method, when properly used, will always bring the aeroplane to the source of transmission, but unless the standard navigational methods are observed, the course flown may be increased beyond the point-to-point distance due to wind, speed and direction.

179. A method of off-setting the loop to the fore-and-aft line of the aircraft in order to traverse a true point-to-point course is possible, but this is dependent upon very accurate information as to cross wind, speed and direction. When flying over the home station the indicator needles will collapse for a few seconds indicating that the station is directly below. After passing the station the sense will reverse and if the instructions given are observed the course of the aircraft can be reversed until the station is again directly below. When homing on a keyed transmitter, it is necessary to note that the indicator needles collapse symetrically down the centre scale as the distant transmitter is keyed. If the needles collapse assymetrically it will indicate that signals are being received with

interference and resulting false indication of course. When homing, signals should be monitored from time to time to ensure that the desired frequency is not subject to interference.

Aural D/F

180. When using the aural method of D/F the fixed aerial is disconnected, the loop being the sole source of signal pick-up. The L.F. oscillator, incorporated in V_1 and V_2 and the meter switching circuits of V_9, are inoperative. Volume control is effected manually, the A.V.C. system being out of circuit.

181. The operational routine is as follows:—The aerial selector switching unit is turned to D/F or, when using the aerial plug board the positions TRAILING AE. on M.F. and FIXED AE. ON H.F. should be used. The range switch FS is turned to the required range and the master switch MS to OMNI. The meter deflection switch S_2 is placed at LOW and the required signal tuned in. The volume control (7) is then readjusted and the tuning re-checked on the tuning indicator V_{10}.

182. The master switch MS is then turned to the FIGURE-OF-EIGHT position, the loop is swung to the position of MINIMUM signal and the volume control adjusted to obtain a zero. The loop scale reading for this zero signal should be observed. To check for sense, reduce the scale reading of the loop, putting the sense switch S_3 to the R position. If the signal strength rises the sense is correct. If the signal strength decreases the sense is wrong, and the loop should be turned through 180 deg. and the zero signal setting noted. The L and R positions of S_3 permit the operation of V_1 or V_2 by applying H.T. to the screens. This, of course, brings in the fixed aerial signals for application to the loop aerial circuit.

PRECAUTIONS AND MAINTENANCE

Ground testing

183. The following procedure should be adopted for ground testing the R.1155. Having set the aerial switching unit to the NORMAL position the range switch FS should be placed at either RANGE 1 or RANGE 2. The master switch MS is then positioned at either OMNI or A.V.C. Having turned the transmitter master switch to STAND-BI the L.T. power unit should start up and, in a few seconds, the tuning indicator should glow. The telephones are then inserted and the reception of signals checked.

184. To receive in the M.F. RANGES 3, 4 and 5 the aerial switching unit is set to the position engraved M.F. ON FIXED AERIAL. If a check of D/F reception is made the aircraft should be clear of all metal obstructions such as hangars, before verifying sense of bearings. To carry out this test the aerial switching unit should be placed to D/F. With the aerial switching unit in this position or in the EARTH position, the H.T. power unit should remain inoperative in all positions of the transmitter master switch.

185. On installations fitted with the aerial plug board, the fixed aerial socket must be connected to the H/F plug in order to receive on the H.F. RANGES 1 and 2. To receive on the RANGES 3, 4 or 5, the fixed aerial socket should be connected to the M.F. plug. When using visual D/F, it should be remembered that the aerial plug board does not break the H.T. power unit relay circuit in any position and therefore the transmitter master switch MUST be kept at STAND-BI.

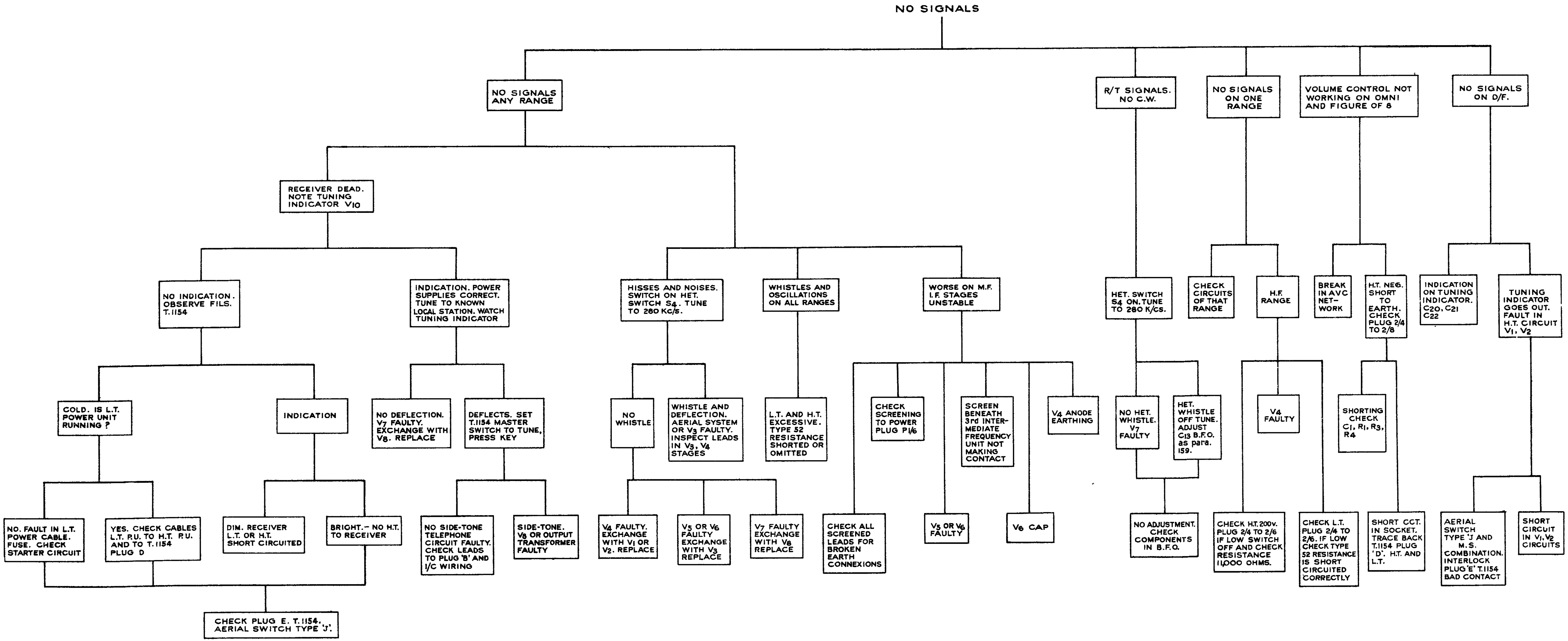
186. When the aeroplane nominal supply is 12 volts the minimum permissible voltage with the L.T. power unit running is 10·5 volts. When the aircraft supply is 24 volts the minimum permissible voltage with the L.T. power unit running is 21 volts. A high resistance voltmeter should be used to check these figures. The minimum filament voltage permissible for normal functioning of the receiver is 5·7 volts. If reception fails or signals are weak, when the filament voltage is between 5·7 volts and 6 volts, the frequency changer valve V_4 should be replaced.

Starter trolley batteries

187. As the current drawn by the T.1154–R.1155 equipment will discharge the aircraft batteries very rapidly, ground tests are to be carried out using the larger batteries on a starter trolley. It is usual for equipment to be so arranged that plugging in the trolley starter service leads to the normal point, automatically isolates the aircraft starter accumulator and connects the W/T equipment to the trolley accumulator.

Visual indicator meter unserviceable

188. Should either of the visual meters be rendered unserviceable, operation can be carried out with a single instrument. The windings are connected in series and connexions A, B, C and D on the unserviceable meter should be short-circuited to enable the serviceable meter to operate.



COMMUNICATION CIRCUITS — TROUBLE LOCATION CHART

FIG. 23

FIG. 23

REPRINT PP2150 M28881/2459 4/43 4250 C & P Gp. 959(4)

D.C. RESISTANCE TABLE

Component	Test Points	Resistance ohms
I.F. Coils		
L_{19} prim.	V_4 anode to R_{34}, C_{32}	2 approx.
sec.	V_5 grid to R_{33}, C_{33}	2 approx.
L_{20} prim.	V_5 anode to R_{30}, C_{29}	2 approx.
sec.	V_6 grid to R_{29}, C_{30}	2 approx.
L_{21} prim.	V_6 anode to R_{58}, C_{27}	2 approx.
sec.	V_7 diode to R_{20}, C_{11}	2 approx.
B.F.O. Coil		
L_{22}	Fixed plates C_{13} to R_{18}	5
Anode chokes V_1, V_2		
L_{24}	V_1 anode to R_{46}, C_{41}	550
L_{24}	V_2 anode to R_{46}, C_{41}	550
Visual meter chokes		
L_{26}	V_9 diode to C_3, R_{25}	130
L_{27}	V_9 diode to C_5, R_{24}	130
Limiter diode choke		
L_{28}	V_8 limiter diode to C_4, R_{23}	130
A.V.C. choke		
L_{25}	V_7 diode to C_{108}, R_{68}	130
L.F. filter choke		
L_{29}	S_5 to earth	2020
Output transformer		
L_{30}, prim.	V_8 anode to pin 5, power plug P_1	1528
L_{30}, sec.	P_1 pin 6 to earth	1063
A.F. oscillator trans.		
L_{23}, prim.	V_1 osc. grid to V_2 osc. grid	800
L_{23}, sec.	V_1 osc. grid to V_2 osc. grid	355
L_{23}, 2nd sec.	R_{65}, C_{29} to R_{66}, C_{23} or across P_2 pins 7 and 8	331
Aerial circuit		
Range 1 input	V_3 grid to C_{40} junction	Less than 1
Range 2 input	V_3 grid to C_{40} junction	Less than 1
Range 3 input	V_3 grid to C_{40} junction	2

Component	Test Points	Resistance ohms
Range 4 input	V_3 grid to C_{40} junction	6
Range 5 input	V_3 grid to C_{40} junction	57
Loop input circuit	Tested between C_{46} (switch end) and C_{47} (switch end)	
Aerial circuits		Less than 1 to earth
V_4 input circuits	V_4 grid to C_{37}, R_{38} junction	
Range 1	Switch to R_1	Less than 1
Range 2	Switch to R_2	Less than 1
Range 3	Switch to R_3	3·5
Range 4	Switch to R_4	11·0
Range 5	Switch to R_5	78·0
V_4 osc. circuit	V_4 osc. grid C_{35} (zf contact 12) to joint R_{35}, C_{34}	
Range 1	Switch to R_1	Infinity
Range 2	Switch to R_2	Infinity
Range 3	Switch to R_3	1,600
Range 4	Switch to R_4	1,650
Range 5	Switch to R_5	0·5
H.F. Ranges 1 and 2	FS zf12 to zf6	0·5
Ranges 3, 4, 5	FS zf12 to zf6	Infinity
Oscillator anode coil		
Range 3	C_{34}, R_{35} to C_{75}	2·5
Range 4	C_{34}, R_{35} to C_{74}	4·5
Range 5	C_{34}, R_{35} to C_{73}	8·5
Oscillator anode coils tap check		
Range 1	FS zr6 to C_{35} or zr.12	Infinity
Range 2	FS zr6 to C_{35} or zr.12	Infinity
Range 3	FS zr6 to C_{35} or zr.12	1,600
Range 4	FS zr6 to C_{35} or zr.12	1,600
Range 5	FS zr6 to C_{35} or zr.12	1·5

VOLTAGE TESTS, ETC.

Measure	Test Points	Voltage and Resistance
L.T. volts	Withdraw meter plug P_2 Measure across contacts 4 and 5	6 to 7·5 v.
H.T. volts	Measure across contacts 4 and 6	200 v. approx
Standing bias on V_3, V_4, V_5 and V_6	Remote end of R_{12} and chassis Vol. control to OMNI max. position	—3 v. M.F.
	Remote end of R_{12} and chassis Vol. control to OMNI max. position	—1·5 v. H.F.
Output transf. L_{30}	Withdraw meter plug P_2 Measure between pin 6 and C_{93}	1,528 ohms
D.C. resistance across H.T.+ across H.T.—	Withdraw meter plug P_2 Measure between pin 6 and chassis	11,000 ohms
A.F. oscillator	Withdraw plug P_2 Measure between pins 7 and 8 using A.C range of AVOMETER	28 v. at 30 c/s 35 v. at 80 c/s

COLOUR CODE

Wiring Red, H.T. positive; Yellow, H.T. negative; Blue, L.T. positive; Black, earth; Green grids

SWITCHES

w is aerial input
x is grid V_3
y is anode V_3
z is grid and osc. V_4

189. Water or dampness will affect the readings on the visual meters if allowed to remain on the terminals of the instrument. The back of the meters should therefore be wiped dry before use. Periodical observations should be made to check that the pilot's and operator's visual meters are giving approximately equal readings. If not approximately equal the pair should be tested against a known serviceable meter and the faulty instrument replaced. When carrying out these checks the receiver master switch MS should be in the BALANCE position.

Trouble location

190. Simple trouble location charts, figs. 23 and 23A, are included and these should be of assistance in the rapid localizing of faults. They are given as indicative only. Various circuit continuity tests are also included for the checking of burnt-out or deteriorated components. A necessary preliminary to the rapid solution of difficulties is a familiarity with the location of the various components and this will be materially assisted by the location diagram of fig. 17.

Test apparatus

191. Ground tests of the R.1155 are normally carried out by means of the test rig, type 22. For the use of civilian repair organizations and maintenance units for bench testing, a special test set, type 65, is provided. This is, however, not a normal service issue. By means of this unit all the test conditions necessary for communications and D/F reception can be simulated and are easily selected for each particular test by means of switches. The unit, type 22, comprises a single panel carrying the visual indicator, four switches for selecting the test conditions, four plugs for connecting the unit to the receiver and power supplies, and terminals for the connexion of the signal generator, output meter and telephones. The test set, type 65, is described in Sect. 5, Chap. 18 of this publication.

THE IMPEDANCE MATCHING UNITS, TYPE 12, TYPE 13, AND TYPE 15

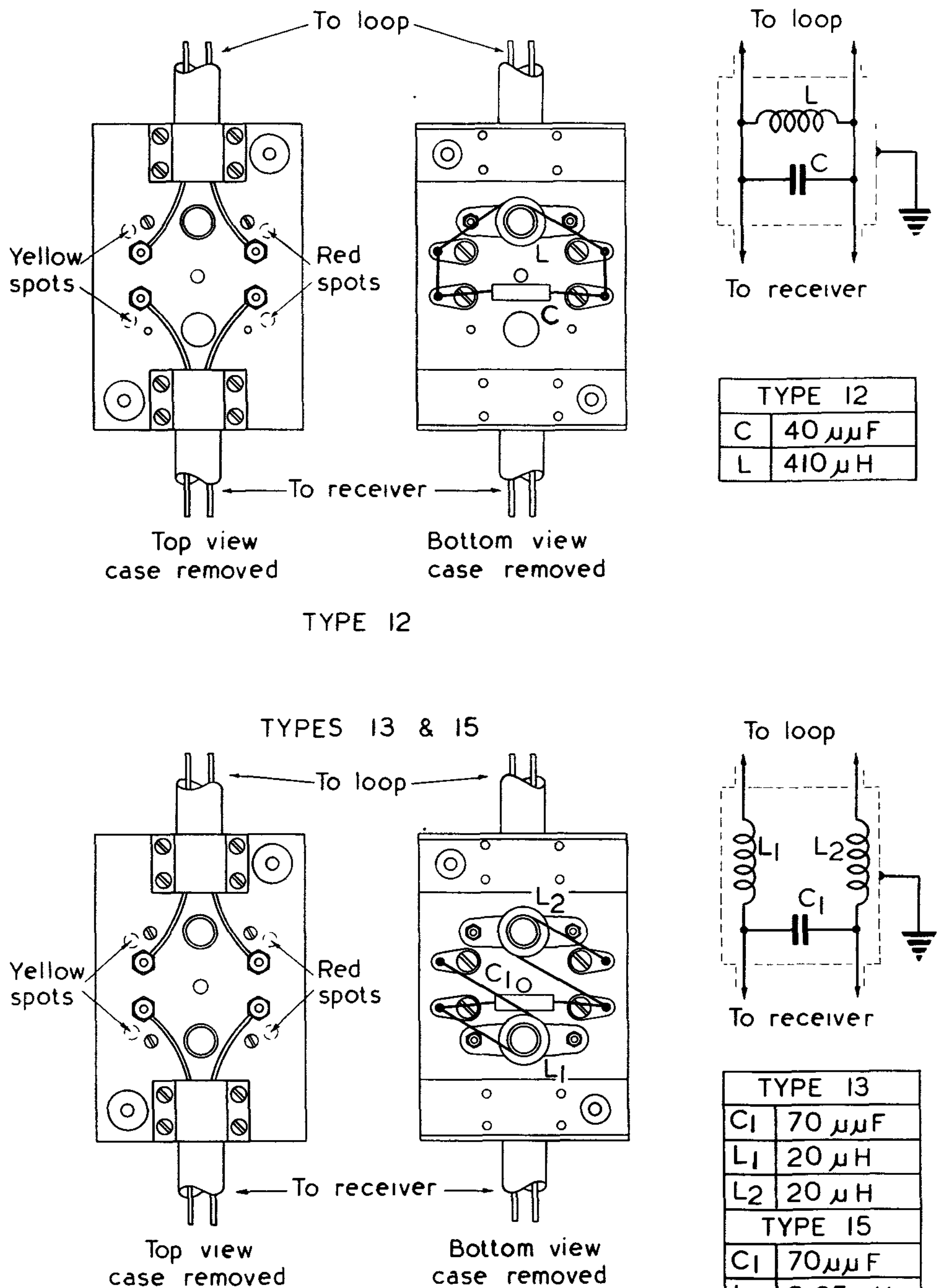
192. The R.1155 is designed for use with the D/F loop aerial, type 3, which has an inductance value of approximately 100 μ H and a self-capacitance of 20 $\mu\mu$ F. Should the inductance placed across the loop terminals differ appreciably from this value, the input tuned circuit will not gang correctly with the other tuned circuits. As the receiver is required for use with loop aerials of widely differing values of inductance from the type 3, a matching unit is necessary with these loops. The impedance matching units, type 12 (Stores Ref. 10A/12248), type 13 (Stores Ref. 10A/12245) and type 15 (Stores Ref. 10A/12247) have been designed for application as indicated in para. 139. The matching unit consists of a small metal box containing a panel of bakelized liner carrying four terminals to which are connected the dulocapmet No. 1 screened cables from the loop and to the receiver. The matching coils and condensers are also mounted on this panel. The unit weighs 11¾ oz.

193. The theoretical circuits and constructional details of the matching units are shown in fig. 24. The matching unit circuit depends upon whether it is required to reduce the inductance of the loop or to increase it. If a reduction in value is required a shunt unit (type 12) is used. This consists of one matching coil L with a condenser C both in shunt across the twin leads of the loop. If an increase in value is necessary the series units (types 13 and 15) are used. To preserve the symmetry of the loop two series coils L_1 and L_2, of equal inductance, are connected, one to each lead from the loop to the receiver. A condenser C_1 is connected in shunt across the receiver leads. The condenser brings the total capacitance of the circuit to the correct value.

194. The unit condenser C, type 12, has a capacitance of 40 $\mu\mu$ F and the coil L consists of 150 turns of 38 d.s.c. wire on a former and is adjusted by a dust iron screwed core to 410 μ H. The unit condenser C_1, type 13, is 70 $\mu\mu$ F and the coils L_1 and L_2 each consist of 29 turns of 30/48 litz wire adjusted to 20 μ H. The corresponding values for components of the unit, type 15, are 70 $\mu\mu$ F and 8·25 μ H. The four terminals are colour-coded by indicator spots of red and yellow and it is essential that due regard should be paid to these when fixing the cable ends.

THE VISUAL INDICATOR, TYPE 1

195. The visual indicator, type 1 (Stores Ref. 10Q/2) consists essentially of two D.C. milliammeter movements mounted side by side. The windings, which are connected in series, each have a resistance of 500 ohms. The current sources applied to opposite ends of the conjoint winding produce deflection of heavily damped indicator needles in opposite sense. The intersection of the indicator needles follows a straight line between zero and 90 microamps current. Approximately 2·4 microamps are required to produce one degree scale deflection. The visual indicator is shown in the diagram of fig. 25.



TYPE 12	
C	40 μμF
L	410 μH

TYPE 13	
C1	70 μμF
L1	20 μH
L2	20 μH
TYPE 15	
C1	70 μμF
L1	8·25 μH
L2	8·25 μH

THE IMPEDANCE MATCHING UNITS, TYPES 12, 13 & 15

FIG. 24

FIG. 24

196. The visual indicator is contained in a circular metal screening case of, approximately, 3¼ in. diameter. The depth of the casing may vary in different models but the overall maximum depth is 3⅝ in. The instrument weighs 1 lb. 7 oz. Its general appearance is shown in the drawings of fig. 25 and a theoretical circuit forms part of fig. 13.

197. The indicator is fixed in position through four fixing lugs of 0·187 in. dia. and a space of 4·12 in. dia. by 4 in. deep should be allowed behind the panel for an anti-vibrational mounting. Five terminals, nominated A., B., C., D. and F., are mounted on the rear of the indicator. The terminal F. is a binding post for securing the cable. The connexions of terminals A., B., C. and D. differ according to the number of indicators installed. The normal connexions are shown in the installation diagram of fig. 21.

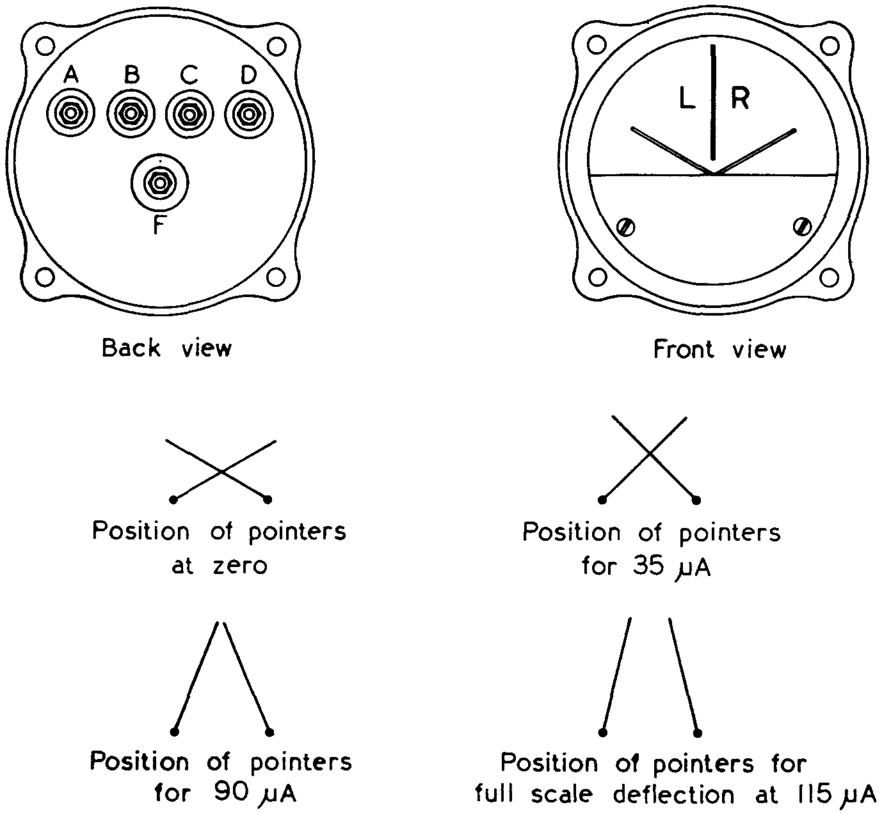


Fig. 25.—The visual indicator, type 1

198. The mounting, anti-vibrational, type 119 (Stores Ref. 10A/12954) has been introduced for use with the visual indicator. The lampholder, type 61 (Stores Ref. 10A/13078), lamp, filament, 12 volts, jack type, G.P.O. No. 3 (Stores Ref. 5L/1150) and lamp, filament, 24 volts, jack type, G.P.O. No. 3 (Stores Ref. 5L/1898) are also used when required. The equipment required and the installation procedure are detailed in para. 147 and is the subject of leaflet A.P.1186/E entitled Indicators, visual, type 1 (Stores Ref. 10Q/2)—Mounting, type 119 (Stores Ref. 10A/12954)—Introduction.

APPENDIX 1

R.1155 COILS AND CHOKES

Ref. in fig. 3	Function	Value *in situ*
L_1	Dummy loop coil	109μH
L_2	Aerial coil, RANGE 1	Sec. 0·74 μ H
L_3	Aerial coil, RANGE 2	Sec. 5·64 μ H
L_4	D/F coil, RANGE 3	Sec. 158 μ H
L_5	D/F coil, RANGE 4	Sec. 1462 μ H
L_6	D/F coil, RANGE 5	Sec. 11, 426 m H
L_7	Anode coil, RANGE 1	Sec. 0·77 μ H
L_8	Anode coil, RANGE 2	Sec. 6·21 μ H
L_9	Anode coil, RANGE 3	Sec. 163 μ H
L_{10}	Anode coil, RANGE 4	Sec. 1374 μ H
L_{11}	Anode coil, RANGE 5	Sec. 10·5 m H
L_{12}	I.F. trap or filter coil	Sec. 40 μ H
L_{13}	Oscillator coil, RANGE 1	Sec. 0·7 μ H
L_{14}	Oscillator coil, RANGE 2	Sec. 5·83 μ H
L_{15}	Oscillator coil, RANGE 3	Sec. 70·6 μ H
L_{16}	Oscillator coil, RANGE 4	Sec. 248 μ H
L_{17}	Oscillator coil, RANGE 5	Sec. 699·2 μ H
L_{18}	Oscillator choke coil	(*a*) RANGE 1, 18·8 μ H† (*b*) RANGE 2, 102·3 μ H†
L_{19}	1st I.F. coil assembly	Pri. 244·5 μ H Sec. 251·0 μ H
L_{20}	2nd I.F. coil assembly	Pri. 250·5 μ H Sec. 251·5 μ H
L_{21}	3rd I.F. coil assembly	Pri. 132 μ H Sec. 254·5 μ H
L_{22}	Beat frequency—oscillator coil	272 μ H
L_{23}	Switching oscillator transformer assembly	Pri. 27 μ H Sec. 1, 1·82 μ H Sec. 2, 1·44 μ H
L_{24}	R.F. choke assembly	290 m H
L_{25}	R.F. choke assembly (screened)	6·7 m H
L_{26}	R.F. choke assembly (screened)	6·7 m H
L_{27}	R.F. choke assembly (screened)	6·7 m H
L_{28}	R.F. choke assembly (screened)	6·7 m H
L_{29}	A.F. choke assembly	200 H**
L_{30}	Output transformer (1·75 : 1)	Pri. 14 H Sec. 4·5 H

† Measured off chassis.

* Measured at 1,000 c/s. with no D.C.

** Measured at 150 c/s.

APPENDIX 2

NOMENCLATURE OF PARTS

The following list of parts is issued for information only. When ordering spares for these receivers the appropriate section of AIR PUBLICATION 1086 must be used.

Ref. No.	Nomenclature	Qty.	Ref. in fig. 3	Remarks
10D/98	Receivers, types R.1155, R.1155A and R.1155B			
	Principal components			
10D/508	Case	1		
	Choke, H.F.			
10C/583	Type 71	1	L_{24}	250 μ H, 637 ohms, D.C.
10C/2019	Type 83	3	L_{26}, L_{27}, L_{28}	250 μ H, 637 ohms, D.C.
10C/2186	Type 94	1	L_{25}	250 μ H, 637 ohms, D.C.
10D/157	Coil unit, R.F.	1		For first 1,000 receivers only
	Fitted with:—			
	Coil			
	Aerial	3	L_1 to L_3	RANGES 1 to 2 and "dummy"
	Anode	6	L_7 to L_{12}	RANGES 1 to 5 and I.F. trap
	Oscillator	6	L_{13} to L_{18}	RANGES 1 to 5 and anode choke
	Condenser unit			
10C/3173	Type 34	2	C_{57} to C_{61}, C_{62} to C_{66}	4 to 40 $\mu\mu$ F trimmer
10C/3174	Type 35	1	C_{68} to C_{70}	4 to 40 $\mu\mu$ F trimmer
	Condenser			
10C/10948	Type 429	1	C_{78}	20 $\mu\mu$ F
10C/853	Type 858	1	C_{91}	40 $\mu\mu$ F
10C/965	Type 896			
	or	2	C_7, C_{18}	0·005 μ F
10C/4256	Type 2201			
10C/967	Type 899	4	C_{37}, C_{38}, C_{34}, C_{40}	0·1 μ F
10C/972	Type 904	1	C_{35}	0·0002 μ F
10C/976	Type 908	2	C_{71}, C_{72}	5 to 40 $\mu\mu$ F trimmer
10C/977	Type 909	1	C_{80}	10 $\mu\mu$ F
10C/978	Type 910	1	C_{79}	15 $\mu\mu$ F
10C/2003	Type 915	1	C_{105}	0·1 μ F
10C/2006	Type 918	1	C_{99}	100 $\mu\mu$ F
10C/2007	Type 919	2	C_{42}, C_{43}	25 $\mu\mu$ F
10C/2008	Type 920	2	C_{44}, C_{45}	240 $\mu\mu$ F
10C/2009	Type 921	2	C_{46}, C_{47}	80 $\mu\mu$ F
10C/2011	Type 923	1	C_{67}	2,000 $\mu\mu$ F
10C/2012	Type 924	1	C_{73}	93 $\mu\mu$ F
10C/2013	Type 925	1	C_{74}	255 $\mu\mu$ F
10C/2014	Type 926	1	C_{75}	537 $\mu\mu$ F
10C/2015	Type 927	1	C_{76}	1,670 $\mu\mu$ F
10C/2016	Type 928	1	C_{77}	6,170 $\mu\mu$ F
	Resistance			
10C/648	Type 855	2	R_{59}, R_{60}	220,000 ohms
10C/691	Type 875	1	R_{42}	2,200 ohms
10C/993	Type 993	1	R_{38}	100,000 ohms
10C/1081	Type 1,081	1	R_{61}	1,200 ohms
10C/1082	Type 1,082	3	R_{17}, R_{40}, R_{41}	1,500 ohms
10C/1278	Type 1,278	1	R_{35}	22,000 ohms
	Switch			
10F/154	Type 368	1	FS_{zf}, FS_{zr}	Oscillator wafer
10F/155	Type 369	1	FS_{yf}, FS_{yr}	Anode wafer
10F/156	Type 370	1	FS_{wf}, FS_{wr}	Aerial wafer
10F/157	Type 371	1	FS_{xf}, FS_{xr}	Loop aerial wafer
10D/380	Coil unit, R.F.	1		After 1st 1,000 receivers
	Fitted with:—			
	Coil			
	Aerial	3	L_1 to L_3	RANGES 1, 2 and "dummy"
	Anode	6	L_7 to L_{12}	RANGES 1 to 5 and I.F. trap
	Oscillator	6	L_{13} to L_{18}	RANGES 1 to 5 and anode choke

Ref. No.	Nomenclature	Qty.	Ref. in fig. 3	Remarks
	Receivers, types R.1155, R.1155A and R.1155B (*contd.*)			
	Principal components (*contd.*)			
	Coil unit, R.F. (*contd.*)			
	Fitted with (*contd.*)			
	Condenser unit			
10C/3173	Type 34	2	C_{57} to C_{61}, C_{62} to C_{66}	4 to 40 $\mu\mu$ F trimmer
10C/3174	Type 35	1	C_{68} to C_{70}	4 to 40 $\mu\mu$ F trimmer
	Condenser			
10C/10948	Type 429	1	C_{78}	20 $\mu\mu$ F
10C/853	Type 858	1	C_{91}	40 $\mu\mu$ F
10C,965	Type 896			
	or	2	C_7, C_{18}	0·005 μ F
10C/4256	Type 2201			
10C/967	Type 899	4	C_{37}, C_{38}, C_{34}, C_{40}	0·1 μ F
10C/972	Type 904	2	C_{35}, C_{108}	0·0002 μ F
10C/976	Type 908	2	C_{71}, C_{72}	5 to 40 $\mu\mu$ F trimmer
10C/978	Type 910	1	C_{79}	15 $\mu\mu$ F
10C/2003	Type 915	1	C_{105}	0·1 μ F
10C/2006	Type 918	1	C_{99}	100$\mu\mu$ F
10C/2007	Type 919	2	C_{42}, C_{43}	25 $\mu\mu$ F
10C 2008	Type 920	2	C_{44}, C_{45}	240 $\mu\mu$ F
10C/2009	Type 921	2	C_{46}, C_{47}	80 $\mu\mu$ F
10C/2011	Type 923	1	C_{67}	2,000 $\mu\mu$ F
10C/2012	Type 924	1	C_{73}	93 $\mu\mu$ F
10C/2013	Type 925	1	C_{74}	255 $\mu\mu$ F
10C/2014	Type 926	1	C_{75}	537 $\mu\mu$ F
10C/2015	Type 927	1	C_{76}	1,670 $\mu\mu$ F
10C/2016	Type 928	1	C_{77}	6,170 $\mu\mu$ F
10C/3027	Type 1,439	1	C_{80}	25 $\mu\mu$ F
	Resistance			
10C/648	Type 855	2	R_{59}, R_{60}	220,000 ohms
10C/691	Type 875	1	R_{42}	2,200 ohms
10C/993	Type 993	1	R_{38}	100,000 ohms
10C/1081	Type 1,081	1	R_{61}	1,200 ohms
10C/1082	Type 1,082	3	R_{17}, R_{40}, R_{41}	1,500 ohms
10C/1278	Type 1,278	1	R_{35}	22,000 ohms
	Switch			
10F/154	Type 368	1	FS_{zf}, FS_{zr}	Oscillator wafer
10F/155	Type 369	1	FS_{vf}, FS_{yr}	Anode wafer
10F/156	Type 370	1	FS_{wf}, FS_{wr}	Aerial wafer
10F/157	Type 371	1	FS_{xf}, FS_{xr}	Loop aerial wafer
	Coil, D/F.			
10D/161	Range 3	1	L_4	1,515 kc/s. to 600 kc/s.
10D/162	Range 4	1	L_5	502 kc/s. to 198 kc/s.
10D/163	Range 5	1	L_6	202 kc/s. to 74 kc/s.
	Condenser			
10C/10948	Type 429	1	C_{78}	20 $\mu\mu$ F
10C/584	Type 770	1	C_{82}, C_{83}, C_{84}	Var. 3-ganged (1st 1,000 receivers)
10C/651	Type 782	3	C_{19}, C_{25}, C_{102}	0·001 μ F
10C/853	Type 858	1	C_{91}	40 $\mu\mu$ F
10C/760	Type 892	1	C_1	2·5 + 2·5 + 1·0 μ F (or 10C/3399)
10C/961	Type 893			
	or	6	C_{26} to C_{28}; C_{29} to C_{31}; C_{32} + C_{33} + C_{36}; C_{41} + C_{49} + C_{50}; C_{51} to C_{53}; C_2 + C_{89}	0·1 + 0·1 + 0·1 μ F
10C/3399	Type 1662			
10C/962	Type 894	1	$C_3 + C_4 + C_5$	2·5 + 2·5 + 1·0 μ F
10C/963	Type 895			
	or	2	C_6, C_{11}	0·0001 μ F
10C/2155	Type 995			
10C/964	Type 896			
	or	8	C_7, C_{18}, C_{20} to C_{24}, C_{103}	0·005 μ F
10C/4256	Type 2201			
10C/965	Type 897	2	C_8, C_9	0·001 μ F
10C/966	Type 898	1	C_{10}	0·004 μ F
10C/967	Type 899	5	C_{12}, C_{34}, C_{37}, C_{38}, C_{40}	0·1, μ F
10C/968	Type 900	1	C_{104}	75 $\mu\mu$ F, trimmer
10C/969	Type 901	2	C_{14}	800 $\mu\mu$ F (2 off) = 1,600$\mu\mu$ F

Ref. No.	Nomenclature	Qty.	Ref. in fig. 3	Remarks
	Receivers, types R.1155, R.1155A and R.1155B (*contd.*)			
	Principal components (*contd.*)			
	Condenser (*contd.*)			
10C/970	Type 902			
	or	3	C_{16}, C_{55}, C_{95}	0·5 μ F
10C/3401	Type 1664			
10C/971	Type 903	1	C_{89}	600 μμ F
10C/972	Type 904			
	or	2	C_{35}, C_{108}	0·0002 μ F
10C/2719	Type 1322			
10C/973	Type 905			
	or	1	C_{54}	0·04 μ F
10C/4257	Type 2202			
10C/974	Type 906			
	or	1	C_{56}	8 to 115 μμ F, trimmer
10C/3402	Type 1665			
10C/976	Type 908	2	C_{71}, C_{72}	5 to 40 μμ F, trimmer
10C/977	Type 909	1	C_{80}	10 μμ F (1st 1,000 receivers)
10C/978	Type 910	1	C_{79}	15 μμ F
10C/979	Type 911	1	C_{93}	4 μ F
10C/2000	Type 912			
	or	1	C_{96}	0·02 μ F
10C/4258	Type 2203			
10C/2001	Type 913	2	C_{97}, C_{98}	2 μμ F
10C/2002	Type 914	1	C_{101}	4 μμ F
10C/2003	Type 915	2	C_{105}, C_{107}	0·1 μ F
10C/2005	Type 917	1	C_{15}	4,550 μμ F
10C/2006	Type 918	2	C_{17}, C_{99}	100 μμ F
10C/2007	Type 919	2	C_{42}, C_{43}	25 μμ F
10C/2008	Type 920	2	C_{44}, C_{45}	240 μμ F
10C/2009	Type 921	2	C_{46}, C_{47}	80 μμ F
10C/2010	Type 922	2	C_{48}, C_{100}	200 μμ F
10C/2011	Type 923	1	C_{67}	2,000 μμ F
10C/2012	Type 924	1	C_{73}	93 μμ F
10C/2013	Type 925	1	C_{74}	255 μμ F
10C/2014	Type 926	1	C_{75}	537 μμ F
10C/2015	Type 927	1	C_{76}	1,670 μμ F
10C/2016	Type 928	1	C_{77}	6,170 μμ F
10C/2017	Type 929	5	C_{85}, C_{86}, C_{87}, C_{88}, C_{90}	300 μμ F
10C/3027	Type 1,439	1	C_{80}	25 μμ F after 1st 1,000
10C/3028	Type 1,440	1	C_{82}, C_{83}, C_{84}	Var. 3 ganged after 1st 1,000
10C/3129	Type 1,525	1	C_{13}	5 to 60 μμ F var.
10C/3860	Type 1,949	1	C_{114}	8 μμ F (R.1155A and R.1155B)
10C/4922	Type 2,612	1	C_{112}	30 μμ F (R.1155A and R.1155B)
10C/4923	Type 2,613	2	C_{111}, C_{113}	160 μμ F (R.1155A and R.1155B)
	Condenser unit			
10C/3173	Type 34	2	C_{57} to C_{61}, C_{62} to C_{66}	4 to 40 μμ F trimmer
10C/3174	Type 35	1	C_{68} to C_{70}	4 to 40 μμ F trimmer
10A/12684	Drive, slow-motion, type 13	1		
	Holder, valve			
10H/326	Type 51	10		American octal (1st 1,200 receivers)
10H/326	Type 51	9		After 1st 1,200 receivers
10H/493	Type 73	1		After 1st 1,200 receivers
10P/13005	Filter unit, type 44	1		Grid rejector (R.1155A)
	Fitted with:—			
10C/4838	Coil, type 393	1	L_{31}	
	Condenser			
10C/4922	Type 2,612	1	C_{112}	30 μμ F.* In H.F. coil box, R.1155B
10C/4923	Type 2,613	1	C_{111}	160 μμ F
10C/7373	Resistance, type 7373	1	R_{71}	150,000 ohms.* In H.F. coil box R.1155B

Ref. No.	Nomenclature	Qty.	Ref. in fig. 3	Remarks
	Receivers, types R.1155, R.1155A and R.1155B (*contd.*)			
	Principal components (*contd.*)			
10P/13006	Filter unit, type 45	1		Anode rejector (R.1155A and B)
	Fitted with:—			
10C/4839	Coil, type 394	1	L_{32}	
10C/4923	Condenser, type 2,613	1	C_{113}	160 $\mu\mu$ F
10P/13007	Filter unit, type 46	1		Anode acceptor (R.1155A and R.1155B)
	Fitted with:—			
N.I.V.	Coil	1	L_{33}	
10C/3860	Condenser, type 1,949	1	C_{114}	8 $\mu\mu$ F
10D/164	Output unit, type 4	1		
	Fitted with:—			
	Choke L.F.	1	L_{29}	
	Condenser			
10C/965	Type 897	2	C_8, C_9	0·001 μ F
10C/966	Type 898	1	C_{10}	0·004 μ F
10C/2000	Type 912			
	or	1	C_{96}	0·02 μ F
10C/4258	Type 2,203			
	Resistance			
10C/11667	Type 500	1	R_5	1,000 ohms
10C/1505	Type 1,505	1	R_7	270 ohms
10V/1	Oscillator unit, type 18	1		
	Fitted with:—			
10C/2019	Choke, R.F., type 83	3	L_{26} L_{27}, L_{28}	
	Condenser			
10C/962	Type 894	1	C_3, C_4, C_5	2·5 + 2·5 + 1·0 μ F
10C/964	Type 896			
	or	5	C_{20}, C_{21}, C_{22}, C_{23}, C_{24}	0·005 μ F
10C/4256	Type 2201			
10C/967	Type 899	1	C_{12}	0·1 μ F
10C/968	Type 900	1	C_{13}	75 $\mu\mu$ F (1st 1,000 receivers)
10C/969	Type 901	2	C_{14}	800 $\mu\mu$ F (2 off) = 1,600 $\mu\mu$ F
10C/2005	Type 917	1	C_{15}	4,550 $\mu\mu$ F
10C/2006	Type 918	1	C_{17}	100 $\mu\mu$ F
10C/3129	Type 1,525	1	C_{13}	5 to 60 $\mu\mu$ F (after 1st 1,000 receivers)
10C/3129	Holder, valve, type 51	1		
	Resistance			
10C/11667	Type 500	1	R_{14}	1,000 ohms
10C/777	Type 906	1	R_{18}	10,000 ohms
10C/1008	Type 1,008	1	R_{19}	56,000 ohms
10C/1010	Type 1,010	1	R_{32}	22,000 ohms
10C/1082	Type 1,082	1	R_{17}	1,500 ohms
10H/323	Plug, type 194	2	P_1, P_2	Power and meter
	Resistance			
10C/11382	Type 478	2	R_{10}, R_{11}	150,000 ohms
10C/11384	Type 480	1	R_{13}	1 megohm
10C/11667	Type 500	3	R_5, R_{14}, R_{22}	1,000 ohms
10C/1505	Type 505	2	R_{65}, R_{66}	10,000 ohms
10C/124	Type 592	1	R_6	1,500 ohms
10C/648	Type 855	2	R_{59}, R_{60}	220,000 ohms
10C/691	Type 875	4	R_{30}, R_{34}, R_{42}, R_{58}	2,200 ohms
10C/777	Type 906	1	R_{18}	10,000 ohms
10C/989	Type 989	1	R_{21}	470,000 ohms
10C/991	Type 991	3	R_{48}, R_{50}, R_{52}	6,800 ohms (or 10C/1464)
10C/992	Type 992	2	R_{53}, R_{57}	560,000 ohms
10C/993	Type 993	5	R_{26}, R_{29}, R_{33}, R_{38}, R_{45}	100,000 ohms
10C/995	Type 995	1	R_{56}	240 ohms
10C/996	Type 996	2	R_{62}, R_{63}	2·2 megohms
10C/998	Type 998	1	R_{23}	20,000 ohms, var.
10C/999	Type 999	1	R_{51}	20,000 ohms, pot.
10C/1000	Type 1,000	1	$R_{8(1)}$ and $R_{8(2)}$	0·5 megohm + 50,000 ohms
10C/1001	Type 1,001	1	R_1	2,000 ohms
10C/1002	Type 1,002	2	R_2, R_3	1,200 ohms
10C/1003	Type 1,003	1	R_4	120 ohms
10C/1004	Type 1,004	1	R_9	2 megohms

Ref. No.	Nomenclature	Qty.	Ref. in fig. 3	Remarks
	Receivers, types R.1155, R.1155A and R.1155B (*contd.*)			
	Principal components (*contd.*)			
	Oscillator unit, type 18 (*contd.*)			
	Resistance (*Contd.*)			
10C/1005	Type 1,005	1	R_{12}	27,000 ohms
10C/1006	Type 1,006	6	R_{16}, R_{27}, R_{31}, R_{36}, R_{43}, R_{47}	27,000 ohms
10C/1007	Type 1,007	1	R_{15}	30,000 ohms
10C/1008	Type 1,008	6	R_{19}, R_{20}, R_{39}, R_{54}, R_{55}, R_{68}	56,000 ohms
10C/1010	Type 1,010	7	R_{24}, R_{25}, R_{28}, R_{32}, R_{35}, R_{37}, R_{44}	22,000 ohms
10C/1081	Type 1,081	1	R_{61}	1,200 ohms
10C/1082	Type 1,082	4	R_{17}, R_{40}, R_{41}, R_{46}	1,500 ohms
10C/1278	Type 1,278	1	R_{67}	22,000 ohms
10C/1464	Type 1,464			
	or	2	R_{48}, R_{50}	3,300 ohms
10C/991	Type 991			
10C/1505	Type 1,505	1.	R_7	270 ohms
10C/1634	Type 1,634	1	R_{64}	200 ohms
10C/7373	Type 7,373	1	R_{71}	150,000 ohms
10H/327	Socket, type 138	1	Sk_3	Loop socket
	Switch			
10F/10338	Type 152	3	S_4, S_1, S_5	S.P. c/o. Het.; speed, filter
10F/158	Type 234	1	MS	5 wafer, 5 position
10F/159	Type 235	1	S_2	D.P. c/o. meter deflection
10F/163	Type 239	1	S_3	S.P. D.T. aural sense
10F/154	Type 368	1	FS_{zf}, FS_{zr}	Oscillator wafer
10F/155	Type 369	1	FS_{yf} FS_{yr}	Anode wafer
10F/156	Type 370	1	FS_{xf}, FS_{xr}	Aerial wafer
10F/157	Type 371	1	FS_{wf}, FS_{wr}	Loop aerial wafer
10K/12136	Transformer, type 130	2		I.F.
	Fitted with:—			
	Condenser			
10C/2001	Type 913	1	C_{97} or C_{98}	2 $\mu\mu$ F
10C/2017	Type 929	2	C_{85}, C_{86} or C_{87}, C_{88}	300 $\mu\mu$ F
	Resistance			
10C/691	Type 875	1	R_{34} or R_{30}	2,200 ohms
10C/993	Type 993	1	R_{33} or R_{29}	100,000 ohms
	or, as alternative			
	Transformer			
10K/12136	Type 130			
	and	1		As above
10K/251	Type 366			
	Fitted with:—			
	Condenser			
10C/2001	Type 913	1	C_{97}	2 $\mu\mu$ F
10C/2017	Type 929	2	C_{85}, C_{86}	300 $\mu\mu$ F
	Resistance			
10C/691	Type 875	1	R_{34}	2,200 ohms
10C/993	Type 993	1	R_{33}	100,000 ohms
10K/12137	Transformer, type 131	1		3rd I.F. coil assembly
	Fitted with:—			
	Condenser			
10C/971	Type 903	1	C_{89}	600 $\mu\mu$ F
10C/2002	Type 914	1	C_{101}	4 $\mu\mu$ F
10C/2017	Type 929	1	C_{90}	300 $\mu\mu$F
10K/12138	Transformer, type 132	1	L_{23}	30 c/s. transformer assembly
	Fitted with:—			
	Condenser			
10C/973	Type 905			
	or	1	C_{54}	0·04 μF
10C/4237	Type 2202			
	Resistance			
10C/991	Type 991	1	R_{52}	6,800 ohms
10C/992	Type 992	1	R_{53}	560,000 ohms
10C/1008	Type 1,008	2	R_{54}, R_{55}	56,000 ohms
10K/12139	Transformer, type 133	1		

Ref. No.	Nomenclature	Qty.	Ref. in fig. 3	Remarks
	Receivers, types R.1155, R.1155A and R.1155B (*contd.*)			
	Accessories			
10D/315	Case, transit	1		
	Valve			
10E/277	Type V.R.99	3	V_1, V_2, V_4	
10E/278	Type V.R.100	3	V_3, V_5, V_6	
10E/280	Type V.R.101	2	V_7, V_8	
10E/279	Type V.R.102	1	V_9	
10E/305	Type V.I.103	1	V_{10}	
10Q/2	Indicator, visual, type 1	2		

A complete installation schedule is included in Sect. 1, Chap. 7 of this AIR PUBLICATION

APPENDIX 3

RECEIVERS, Types R.1155C, D, E, F, L, M, and N

1. The above-mentioned receivers are all variants of the basic R.1155 series. The receivers R.1155C and L have certain circuit modifications which will be promulgated in due course. The remaining receivers, with the exception of R.1155M, differ from the basic type only so far as the casing material is concerned.

2. The following list of receivers, stores reference numbers and basic types from which developed, is supplied for reference:—

Receiver type	*Stores Ref. No.*	*Basic type*	*Comments*
R.1155C	10D/1105	R.1155B	Modified for H.F.D/F. Primarily intended for Coastal Command.
R.1155D	10D/1331	R.1155	Steel case.
R.1155E	10D/1332	R.1155A	Steel case.
R.1155F	10D/1333	R.1155B	Steel case.
R.1155L	10D/1477	R.1155B	75–200 Kc/s range replaced by 1·5–3·3 Mc/s range for A.S.R launches. Aluminium case.
R.1155M	10D/1597	R.1155A	For use in ground schools only. These are R.1155A receivers which, for certain reasons, have been rejected as unfit for other use
R.1155N	10D/1667	R.1155L	Steel case. With modified extended ranges for A.S.R launches as in R.1155L.

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SECTION 3, CHAPTER 7

BLIND APPROACH RECEIVERS, R.1124A AND R.1125A

Contents

List of Illustrations

List of Illustrations—*continued*

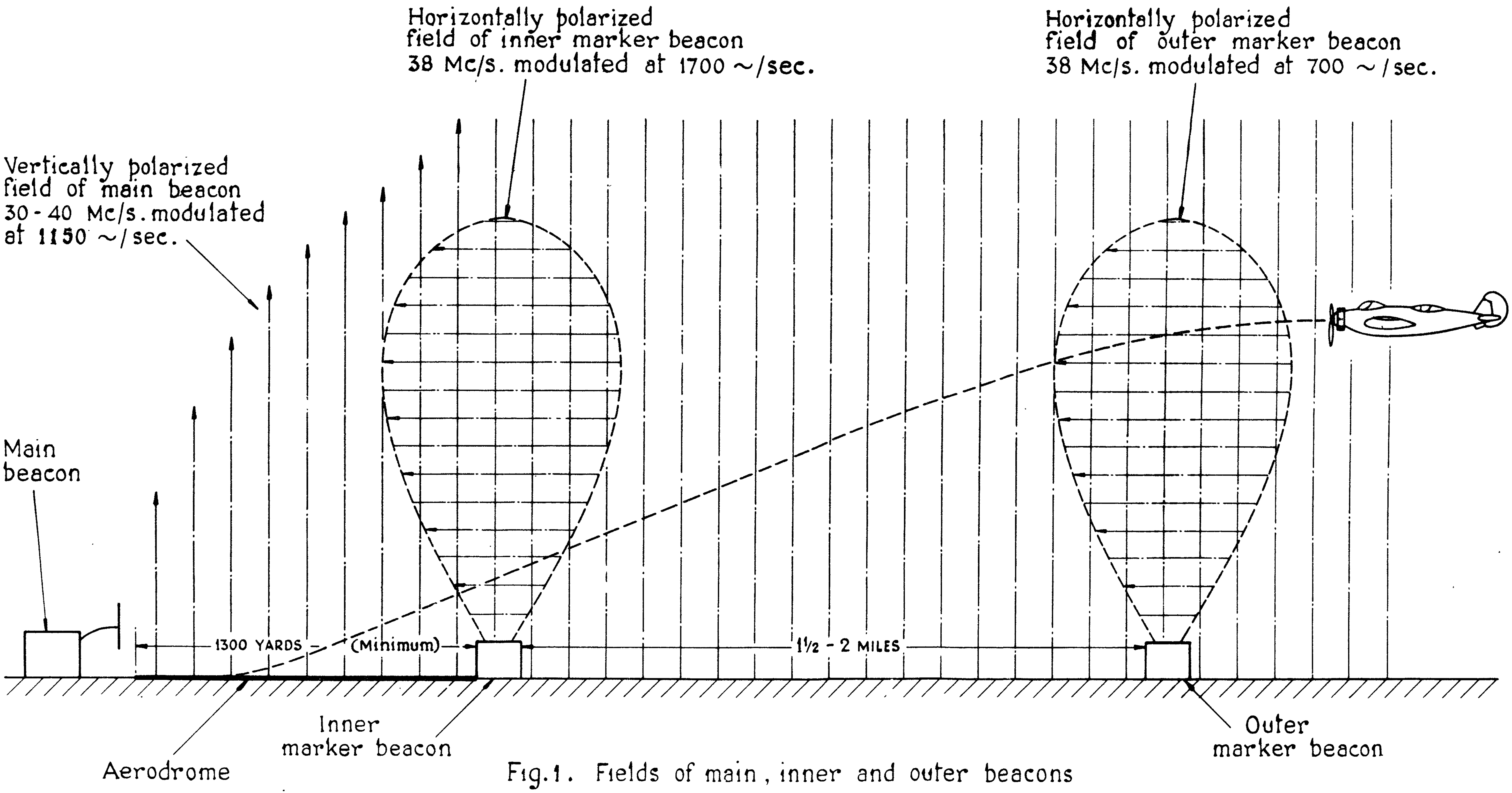

Fig. 1. Fields of main, inner and outer beacons

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BLIND APPROACH RECEIVERS, R.1124A AND R.1125A

INTRODUCTION

General

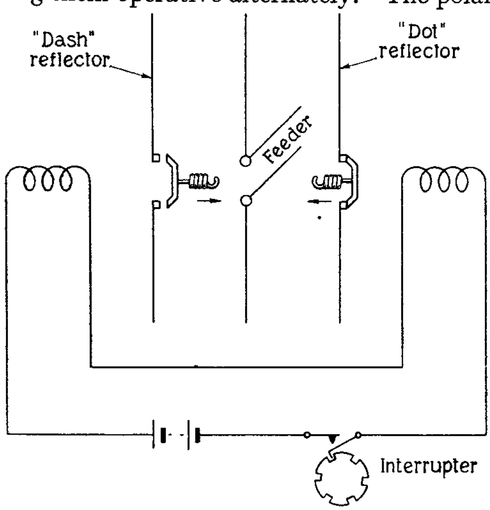
1. The blind approach receiving equipment is designed for installation in aeroplanes to enable the pilot, in conditions of poor visibility, to take up the correct approach track to an aerodrome fitted with the blind approach beacon, and to maintain this course until the moment of landing. In addition to course indication, provision is made for the reception of marker beacon signals indicating the distance of the aeroplane from the aerodrome boundary at two particular instants during the approach. A full description of the methods of using blind approach apparatus is given in A.P. 1751, Blind Approach, Pilot's Handbook.

Nature of received signals

2. The transmission system of the blind approach beacon will be dealt with in Section 1, Chapter 9 of this Air Publication, but before dealing with the receiving apparatus it is necessary to appreciate the nature of the signals to be received.

3. The transmitting apparatus comprises three entirely independent radiators, *viz.* (i) the outer marker beacon, (ii) the inner marker beacon and (iii) the main beacon. Both marker beacons are situated on the approach track, the inner marker beacon near the edge of the landing run-way and the outer marker beacon about 2 to 3 miles outside the run-way on the approach side. The radiation from these beacons is horizontally polarized and is chiefly concentrated in the upward direction. The same radio frequency (38 Mc/s) is radiated by each, the radiation of the outer is modulated to a depth of about 90 per cent. at a frequency of 700 c/s, and that of the inner to the same depth but at a frequency of 1,700 c/s. Fig. 1 shows the fields to be detected in pictorial form.

4. The main beacon is situated outside the inner edge of the run-way. The aerial system consists of a vertical dipole energized by the main transmitter and two reflector dipoles placed one on each side of the energized dipole as shown pictorially in fig 2. A relay-operated switch is located at the mid-point of each reflector. The two relays are operated by the keying system in such a manner that when the circuit of one reflector is completed the other is open, rendering them operative alternately. The polar diagram of the main beacon therefore oscillates



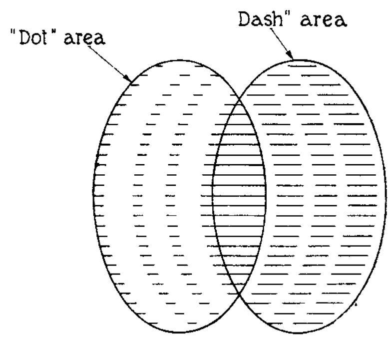


FIG. 2. Switching of reflectors.

to the right and left of the approach track, as shown in fig 3. The duration of the successive switching impulses is such that an aeroplane to the left of the approach track receives a succession of increments of field strength, having a duration of $\frac{1}{8}$ sec., separated by intervals of $\frac{7}{8}$ sec., while an aeroplane to the right of the approach track receives a succession of increments of field strength having a duration of $\frac{7}{8}$ sec., separated by intervals of $\frac{1}{8}$ sec. These increments of field strength are superimposed upon a "steady" field strength, which depends upon the distance from the transmitter, the height and other factors. Along the correct course, however, the field strength is unchanged by switching from one reflector to the other.

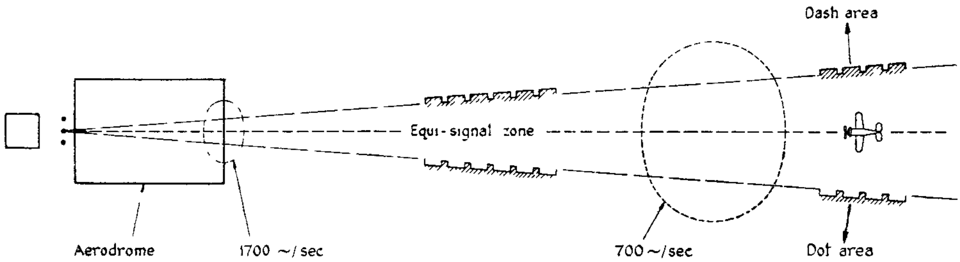


FIG. 3. Marker and Course Signals.

5. The radiation from the main transmitter is modulated at a frequency of 1,150 c/s. After rectification, the aural signal received in an aeroplane flying on the correct approach track is an unbroken note of 1,150 c/s. If to the left of the track, modulated dots of $\frac{1}{8}$ sec. duration, and if to the right, modulated dashes of $\frac{7}{8}$ sec. duration, are received (*see* figs 2 and 3). In addition to aural indications, visual indications are given by the course meter.

Receiving equipment

6. The receiving equipment is designed to operate from a 12-volt battery, the power consumption being approximately 85 watts. The weight of the complete equipment, with the exception of the battery, is 80 lb. Dimensions and weights of individual components will be given in the paragraphs dealing with the constructional details.

7. The equipment consists of several units, namely :—

(i) The main beacon receiver, type R.1124 or R.1124A. These differ only in the constructional details of certain connecting cable joints (*see* para. 92). Type R.1124 was an early version, and the screw connections for the Breeze plugs and sockets had an American thread. Subsequent models, designated R.1124A, were provided with cable connections that had an English thread. Both are 6-valve superheterodyne receivers operating in the band 30·5 to 40·4 Mc/s.

(ii) The marker beacon receiver, type R.1125 or R.1125A. These receivers are again electrically identical but differ in construction as explained in sub-para. (i) above. Both employ a two-valve circuit consisting of a detector with regenerative amplification followed by an A/F amplifying stage.

(iii) The power supply unit, which contains a dual purpose rotary transformer for L.T. and H.T. supplies to the main and marker beacon receivers, together with certain filter systems. A relay for remote switching control is also incorporated.

(iv) The control unit, which provides for the operation of the equipment, switching on, selecting the correct frequency, volume adjustment, etc.

(v) The main junction box, in which the leads from various units are interconnected. This facilitates the rapid and easy removal of any of the other units for test or replacement.

(vi) The visual indicator, which is a small instrument designed for dashboard mounting. It gives course indications by means of a pointer, while two neon lamps show when the inner and outer marker beacons respectively are being flown over. A glide path indicator is also incorporated in this instrument (*see* para. 9).

(vii) The remote control cable mechanism, which is fitted in order that the frequency of the main beacon receiver may be selected by the pilot.

(viii) The vertical aerial (and loading coil, if fitted), which supplies the main beacon receiver with its R/F input, *via* a special co-axial feeder.

(ix) The horizontal dipole aerial, which supplies the marker beacon receiver with its R/F input, *via* a special type of feeder.

(x) The interconnecting cables, which are enclosed in Breeze metallic screening hose and are fitted with special types of plug, which engage with sockets on the various instruments.

GENERAL DESCRIPTION

Visual indicator

8. Before dealing with the action of the main beacon receiver, the visual indicator will be briefly described. This is an assembly of two moving coil micro-ammeters, one of which is the course meter and the other the glide path meter. The movement of the former is in the horizontal and that of the latter in the vertical plane. The scale of the course meter is marked L and R for left and right respectively ; these letters indicate the direction of turn to bring the aeroplane on to the correct track. The scale of the glide path indicator is arbitrarily marked.

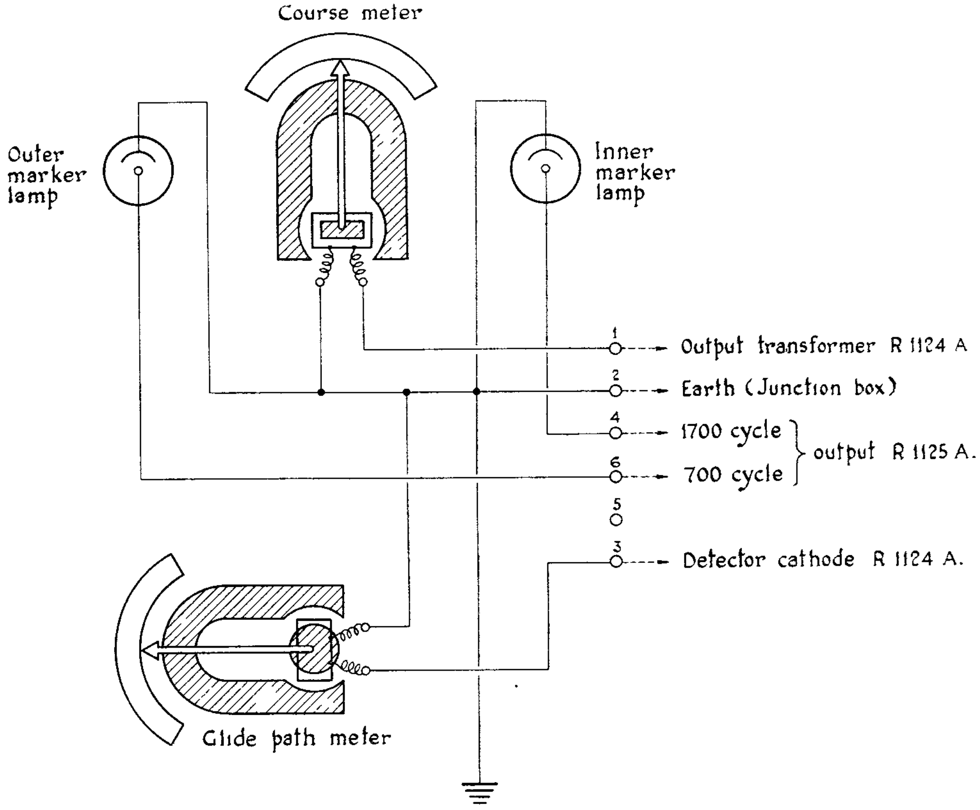


FIG. 4. Visual indicator circuit.

In addition to the two meters, two neon lamps are incorporated. These are operated by the marker beacon receiver through two A/F filters tuned respectively to 700 c/s and 1,700 c/s. The flashing of each neon lamp is an indication that the corresponding marker beacon is being flown over.

9. The action of the glide path meter is that of an ordinary D.C. micro-ammeter. It is operated by the D.C. space current of the detector valve of the main beacon receiver. This current is (very nearly) directly proportional to the R/F input to the valve. Thus the glide path meter may be regarded simply as a field strength meter graduated in arbitrary units.

10. The action of the course meter is somewhat different. The coil is wound on a metal former, but the fixed iron core, instead of being cylindrical as in ordinary moving coil micro-ammeters, consists of a comparatively narrow bar (*see* Fig. 4). This has the effect of concentrating the magnetic field into the middle of the gap between the pole pieces as shown.

11. If a short sharp impulse of current passes through the coil, when the latter is in its normal position and the pointer is reading zero, the coil is deflected to right or left according to the direction of this impulse. As soon as the coil starts to swing, however, it moves into a considerably weaker field. Two effects are then of importance :—(i) since the metal former is also moving in only a weak field, the currents induced in it are of small magnitude and the movement is practically undamped. Even a very small impulse of current may therefore cause a large deflection ; (ii) while the coil is moving through the weak field, a second short pulse of current in the opposite direction will have only a small tendency to cause the coil to deflect in the opposite direction, compared with the effect of the first pulse, which occurred when the coil was situated in a strong field.

12. If a current wave of the form shown in fig. 5 (L. or M.) is applied to the meter, the first impulse will cause the coil to be deflected to the left or right. The second impulse tends to cause the coils to be deflected in the opposite direction but actually has little or no effect because it occurs at a time when the coil is moving through only a weak field. Thus the effect of the whole wave is to cause the coil to deflect to the left or right, and to return to its normal position under the control of the spiral springs. As the coil returns to the normal position it re-enters the concentrated portion of the field, and the movement becomes heavily damped owing to the current induced in the coil former, and is practically dead beat in coming to rest.

Receiver R.1124A

13. The receiver R.1124A employs six valves of the indirectly-heated type, arranged in a superheterodyne circuit (shown in fig. 6) and comprises a pre-selector R/F amplifier V_1, a frequency changer V_2, two intermediate-frequency amplifiers V_3 and V_4, an anode-bend second detector V_5 and an output valve V_6 which operates the course meter only.

14. The main beacon signals are received on a vertical aerial which is connected to the receiver by a co-axial cable transmission line terminating in a plug which engages a socket on the receiver.

15. The " live " member of the socket is connected to the inductance L_1 by means of a tap by which the input impedance is approximately matched to the line impedance. The control grid of the R/F amplifier valve V_1 is connected to the input circuit *via* the condenser C_1 and through leak resistance R_1 to the grid bias control line. A condenser C_2 is connected between the latter and earth. The inductance L_1 is tuned to any one of six pre-determined frequencies by the pre-set variable condensers CT_1 to CT_6.

16. The anode circuit of the valve V_1 is coupled to the fourth grid of the frequency changer valve V_2 by the tuned radio-frequency transformer L_2. The primary winding is tuned to the signal frequency by one of the pre-set condensers CT_7 to CT_{12}, and the secondary winding by one of the pre-set condensers CT_{13} to CT_{18}. The whole arrangement therefore constitutes a radio-frequency band-pass filter (*see* Signal Manual, Part II, A.P.1093, Chapter XII).

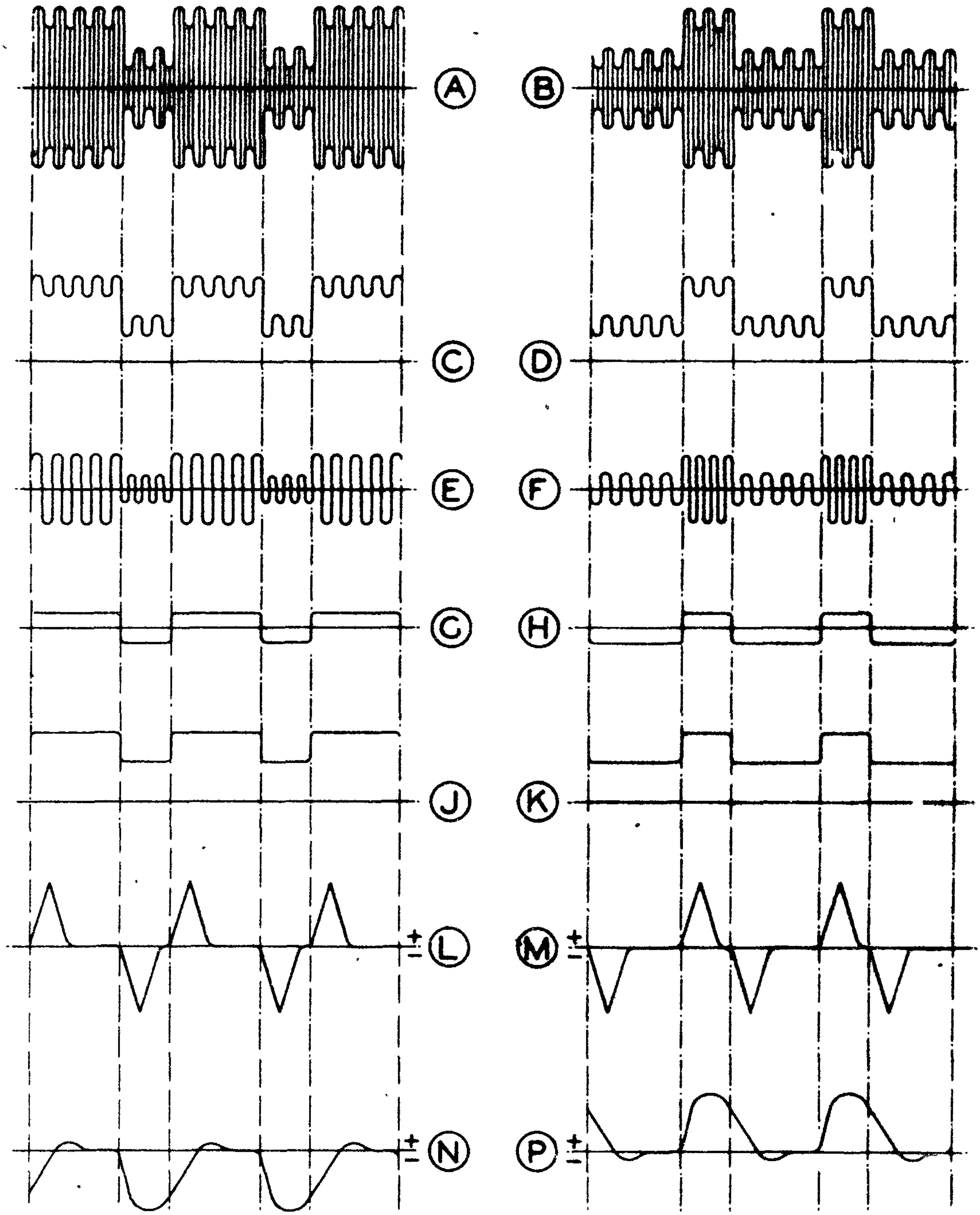


FIG. 5. RECEIVER R.1124 A — WAVEFORMS

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C_2 C_1 · C_3 CT_7-CT_{12} CT_1-CT_6 · C_4 C_{27} C_9 CT_{13}-CT_{18} · C_6.CT_{25}.C_7 C_8.C_{18}.C_5 · C_{10} CT_{26} CT_{19}-CT_{24} · C_{11} CT_{27} · C_{12} · C_{13} CT_{28} · C_{31} CT_{29} · C_{14} · C_{15} CT_{30} · C_{26} C_{32} · C_{25} C_{24}.C_{16} · C_{17} · C_{19} · C_{20} C_{23} · C_{30} · C_{28} C_{29} · C_{21} C_{22}	Condensers
R_3 R_1 · R_4 · R_{16} · R_9.R_{17}.R_6 · R_8 R_5 · R_7 · R_{10} · R_{11} · R_{12} · R_{13} · R_{14} · R_{15} · R_{20} · R_{28} · R_{21} R_{22} · R_{25}.R_{24}.R_{23} · R_{29} · R_{27} · R_{26}	Resistances
L_1 · L_2 · L_4 L_3 · L_5 · L_6	Inductances
S_1 · S_2 V_1 · S_3 · V_2 · S_4 S_5 · V_3 · V_4 · V_5.T_1 · W_3 W_1 · W_2. [illegible] T_2	Miscellaneous

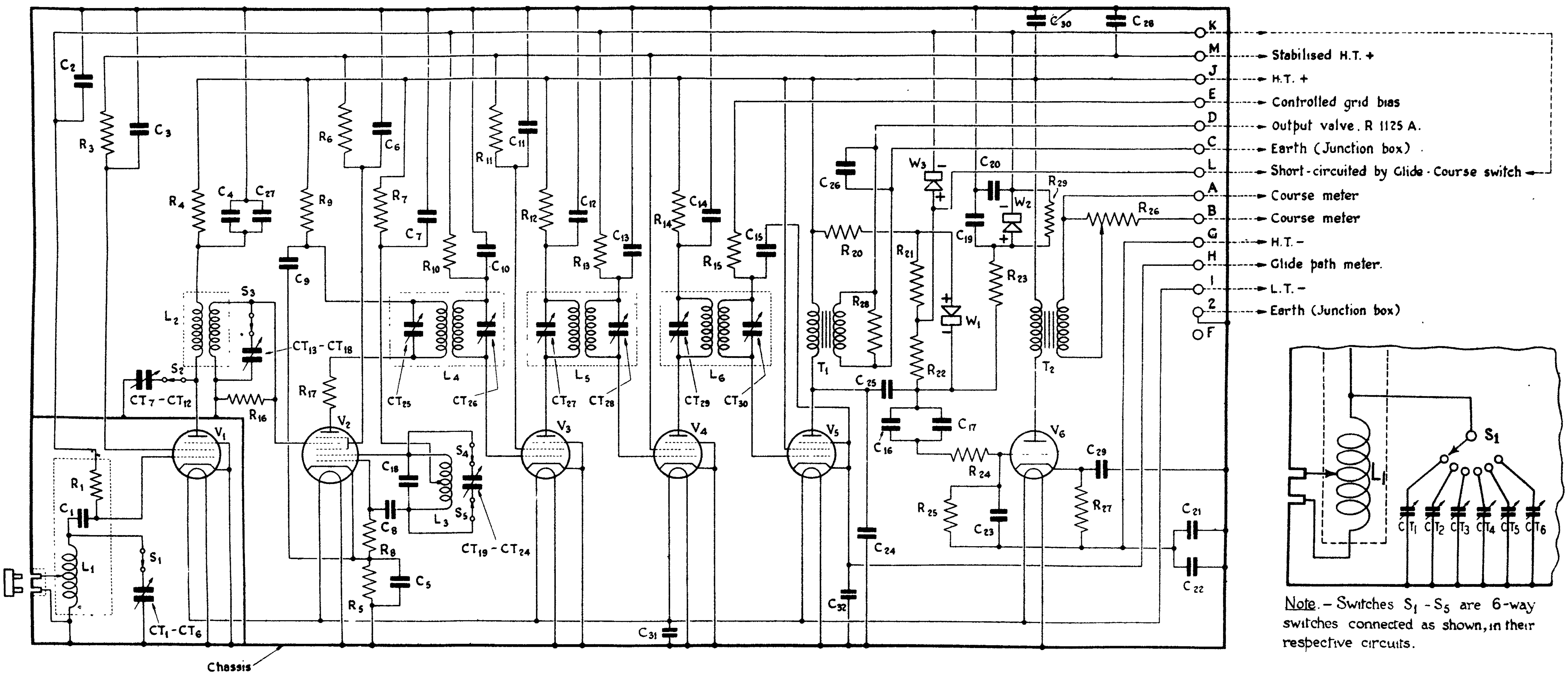

FIG.6. RECEIVER R.1124 A — THEORETICAL CIRCUIT DIAGRAM

Note.—Switches S_1-S_5 are 6-way switches connected as shown, in their respective circuits.

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17. The frequency changer valve V_2 is a heptode. An oscillatory circuit consisting of an inductance L_3, condenser C_{18}, and one of the pre-set condensers CT_{19} to CT_{24}, is connected between the first grid (oscillator control) and second grid (oscillator anode), the H.T. feed being taken through the de-coupling resistance R_7 with its associated condenser C_7 to the centre point of the coil so that the circuit functions as a Hartley oscillator. Automatic control grid bias is provided by the resistance R_5 and by-pass condenser C_5. The oscillator grid bias is of the " leaky " type and is provided by the resistance R_8 and condenser C_8.

18. The frequency-changing process is briefly described in Signal Manual, Part II. A.P.1093, Chapter XI. The anode current of the heptode contains, among others, an oscillatory component at the designed intermediate frequency, which is approximately 7 Mc/s. This frequency is amplified by the two succeeding stages, the first consisting of the tuned R/F transformer L_4 and valve V_3, and the second consisting of the tuned R/F transformer L_5 and valve V_4.

19. Valves V_3 and V_4 are R/F pentodes. The cathode of each is earthed, and grid bias is derived from the grid bias control line *via* de-coupling resistances R_{10} and R_{13} and the respective secondary windings of the R/F transformers L_4 and L_5. De-coupling condensers C_{10} and C_{13} are associated with the de-coupling resistances. The output of the intermediate frequency stages is applied to the control grid circuit of the second detector valve V_5 *via* a tuned R/F transformer L_6.

20. The usual de-coupling resistances R_3, R_6 and R_{11} and condensers C_3, C_6 and C_{11} are associated with the screens of valves V_1, V_2 and V_3. The anodes of valves V_1, V_2, V_3 and V_4 are de-coupled by resistances R_4, R_9, R_{12} and R_{14} and associated condensers C_4+C_{27}, C_9, C_{12} and C_{14} respectively. The anode and screen H.T. supplies are shunted by reservoir condensers C_{30} and C_{28} respectively. The H.T.—line is connected through condenser $C_{21}+C_{22}$ to earth.

21. The three intermediate frequency transformers L_4, L_5 and L_6 are tuned by means of pre-set condensers mounted in the transformers themselves. They are correctly adjusted during manufacture and should not be interfered with. If their setting is disturbed, it is a matter of considerable difficulty to re-align the intermediate frequency stages, even if proper equipment is available.

22. The valve V_5 is a radio-frequency pentode, operated as a lower-anode-bend detector. The grid bias voltage is derived from the control unit *via* de-coupling resistance R_{15} and condenser C_{15}, but not from the common grid bias line supplying valves V_1, V_3 and V_4. Part of the mean space current of this valve is used to operate the glide path meter.

23. The A/F transformer T_1, the secondary of which is shunted by resistance R_{28} and condenser C_{26}, feeds part of the output of the valve V_5 to the output valve of the marker beacon receiver, and thence to the telephone receivers. A small portion of the A/F output current, however, flows in the path C_{25}, R_{22}, R_{21}, R_{20}, which is in parallel with the primary winding of the transformer T_1. A metal rectifier W_1 is shunted across a portion of this circuit in order to provide an automatic gain control voltage for the valves V_1, V_3 and V_4, and also to produce a waveform suitable for operating the course meter.

24. Before describing the remainder of the circuit it is necessary to appreciate the nature of the signal received under various conditions. When the aeroplane is flying on the correct track the signal is a steady carrier, modulated at 1,150 c/s. The detector valve V_5 rectifies this and its anode current may be resolved into three components, *viz.*: (i) a radio-frequency component which is by-passed by the condenser C_{24}, and need not be considered further; (ii) a steady D.C. component which is above the no-signal value; (iii) an A/F component of 1,150 c/s; the greater part of this component passes through the primary winding of the output transformer T_1, setting up a secondary voltage which is passed to the telephones *via* the A/F stage of the marker beacon receiver. A portion of the A/F component flows in the path C_{25}, R_{22}, R_{21}, R_{20}, a metal rectifier W_1 being connected in shunt with R_{21} and R_{22}. This rectifier suppresses one-half of the voltage wave across these resistances so that a uni-directional

pulsating P.D. is set up across the resistance R_{22}, with the polarity indicated in fig. 9 by the conventional signs. This pulsating P.D. is applied between the cathode line (*via* resistance R_8 in the control unit) and the automatic gain control line. The resistance R_{23}, the metal rectifier W_2, and the condensers C_{19} and C_{20} are inserted in order to provide a time delay circuit and smooth out the 1,150 c/s pulsations, and by this means a steady bias voltage is applied to the grids of valves V_1, V_3 and V_4. A third rectifier W_3 connected between the A.G.C. line and the junction of resistances R_{21} and R_{22} ensures a low resistance path for grid current from valves V_1, V_3 and V_4 back to the negative bias line without affecting the time constant of the control circuit. A medium impedance triode valve V_6 is employed in the output stage, which functions as a D.C. amplifier for the course meter only. Automatic grid bias for this valve is provided by R_{27} and C_{29}.

25. Referring to fig. 5, when the aeroplane is to the left or right of the correct track, the received signal is chopped into short intervals of alternately strong and weak carrier, as shown in A or B. After rectification by the valve V_5, the anode current of the latter contains a R/F component by-passed by condenser C_{24}, and an A/F component super-imposed upon the D.C. component (C and D). This waveform may again be resolved into an A/F component (E or F) (which is applied to the telephones *via* the marker beacon receiver) a rectangular wave (G or H) and an average steady value. Owing to the presence of the components R_{23}, W_2, C_{19}, C_{20} only the latter is applied to the A.G.C. line. The presence of the capacitance $C_{16}+C_{17}$ prevents any direct current from flowing in the filter circuit C_{16}, C_{17}, R_{24}, R_{25}, C_{23}. The waveform reaching the grid of the output valve V_6 is, therefore, as shown in G or H. This grid receives a negative bias from the cathode resistance R_{27} which is associated with a by-pass condenser C_{29}. The anode current of this valve will therefore vary in the manner shown in J or K. This current flows in the primary winding of the output transformer T_2 and will set up a secondary E.M.F. proportional to the rate of change of the primary current. The latter quantity is plotted in L and M. The secondary current will be proportional to this and will therefore possess the same waveform, so that diagram L or M may therefore be taken to represent the current which flows in the moving coil of the course meter. The diagrams N and P show the movements of the course meter pointer which kicks with the first pulse received. The effect of the return pulse is almost suppressed by the non-linear friction characteristic and non-linear field of the meter, as explained in paras. 10 to 12. It will now be appreciated that when the aeroplane is to the left of the track the pointer will move from zero to the right and back to zero, while when on the right of the track, it will move from zero to the left and back to zero, repeating this movement synchronously with the frequency of the keying rhythm, *viz.* once per second. The pre-set potentiometer R_{26} controls the amount of signal passed to the course meter.

Receiver R.1125A

26. A theoretical circuit diagram of this receiver is given in fig. 7. It consists of a simple cumulative-grid detector with anode voltage controlled Reinartz reaction, followed by an A/F output stage which feeds the receiving telephones and also the inner and outer marker beacon neon lamps in the visual indicator. Both marker beacons operate on a frequency of 38 Mc/s, the outer being modulated at 700 c/s and broken into dashes, while the inner is modulated at 1,700 c/s and broken into dots. These signals are received on a horizontal dipole aerial AE fitted on the aeroplane and are fed to the receiver *via* a junction box and a screened cable with two inner conductors. At the receiver, the output from the cable is coupled to the tuned input circuit of the detector valve V_1 by means of the balanced primary winding of the R/F transformer L_3.

27. The input circuit is tuned to the marker beacon frequency by the pre-set condenser C_1. The circuit is connected to the grid of the valve *via* the condenser C_2 and leak resistance R_1, the required reactive feedback from the resistance R_2 in the anode circuit being *via* the condenser C_3. The resistance R_3 is the principal anode load, the A/F voltages set up across this component being applied to the grid of the succeeding valve V_2 *via* the condenser C_4 and the primary winding of the auto-transformer T_1. Reaction is controlled by the potentiometer R_4 which varies the H.T. supply voltage to the detector valve.

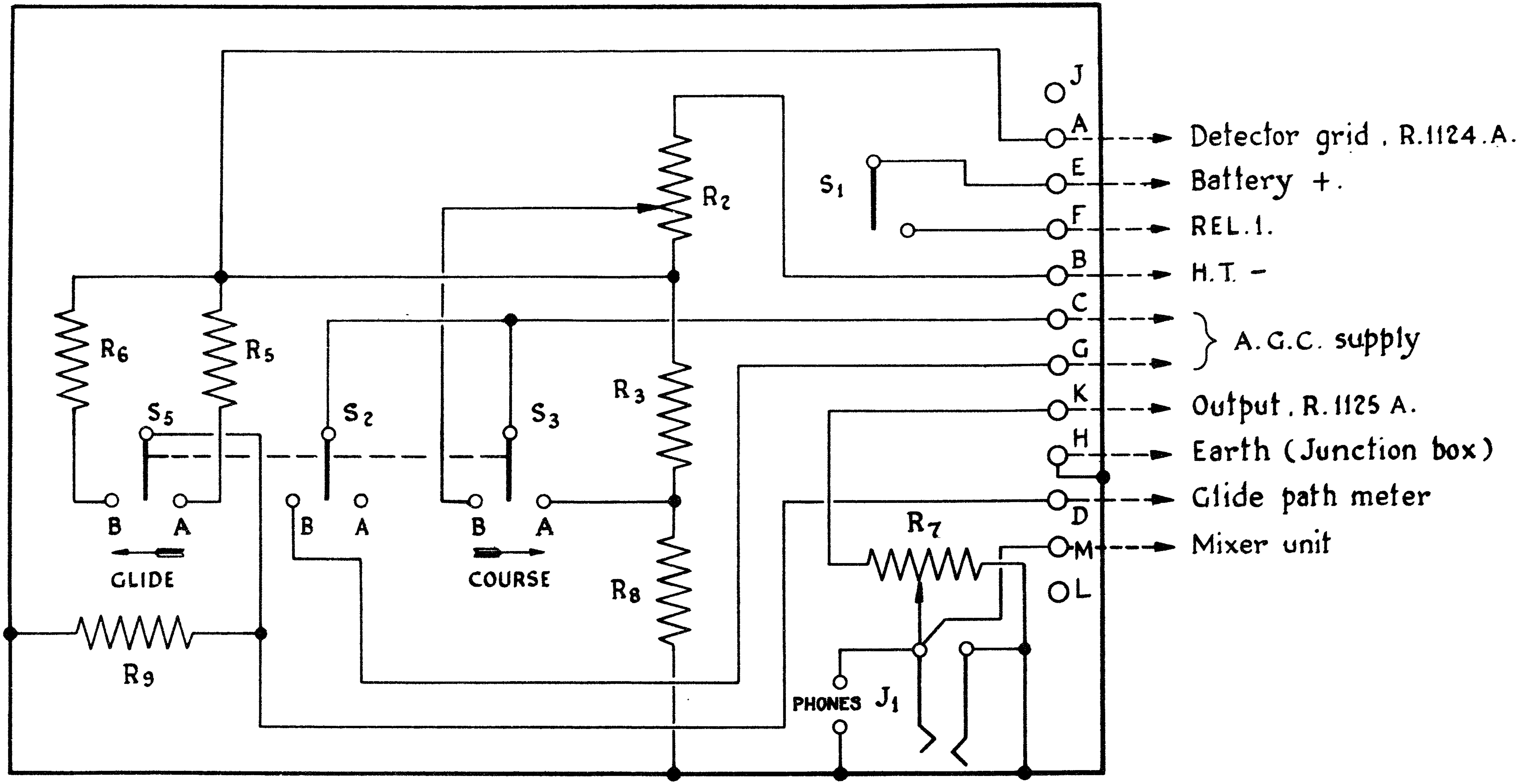

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FIG. 8. CONTROL UNIT — THEORETICAL CIRCUIT DIAGRAM

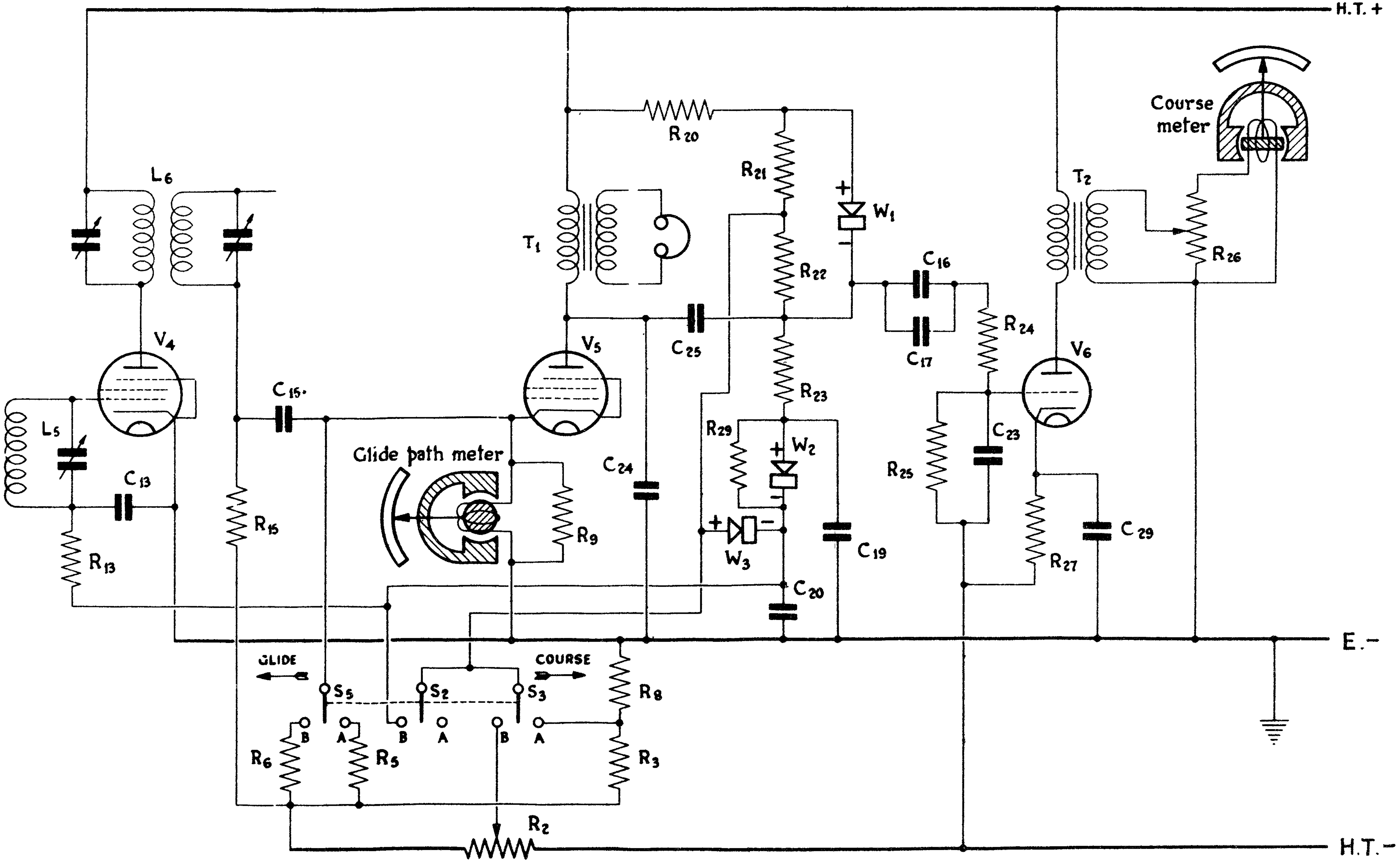

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FIG. 9. GLIDE AND COURSE — SKELETON CIRCUIT

28. The A/F output from the detector valve of the main beacon receiver is also fed to the primary of the auto-transformer T_1 through the resistance R_{11}.

29. The output valve V_2 is a pentode, its auxiliary grid being maintained at a mean steady potential slightly below that of the anode by the feed resistance R_{10}, with which a R/F by-pass condenser C_{10} is associated. The valve derives its A/F input voltage from the secondary winding of the auto-transformer T_1. Automatic grid bias is applied by the resistance R_7 shunted by the A/F by-pass condenser C_5.

30. The anode circuit includes the primary winding of the output transformer T_2. This transformer has three secondary windings. The middle one supplies the telephone receivers. The other two supply the neon lamps of the visual indicator, the upper, *via* the A/F filter L_2—C_8, tuned to 700 c s, for the outer marker and the lower, *via* the A/F filter L_1—C_6, tuned to 1,700 c/s, for the inner marker. Two pre-set potentiometers R_5 and R_6 associated with by-pass condensers C_9 and C_7 respectively, provide an adjustable priming voltage for the neon lamps.

31. The receiver is fitted with two sockets, one for the engagement of the screened transmission line to the plug of the aerial circuit, and the other for the Breeze interconnecting cable plug.

Control unit

32. A theoretical circuit diagram of the control unit is given in fig. 8. The controls are as follows :—

(i) The ON-OFF switch. This is the switch S_1 on the theoretical circuit diagram ; it controls the battery current through the starter relay REL_1 in the power unit.

(ii) The frequency selector switch. This operates a bowden cable mechanism and remotely controls the switches S_1, S_2, S_3, S_4, S_5 (fig. 6), in the main beacon receiver, so selecting the desired frequency.

(iii) The " service " switch. This has two positions, engraved COURSE and GLIDE respectively ; it controls the grid bias circuits of the main beacon receiver. When this switch is in the COURSE position, the grids of the valves V_1, V_3 and V_4 receive an automatic gain control voltage from the rectifier W_1 (fig. 6) as explained in para. 25. When in the GLIDE position, the automatic gain control line is short circuited and the grid bias of the valves V_1, V_3 and V_4 is controlled by means of a potentiometer.

(iv) The manual gain control. This is the potentiometer just referred to, and is denoted by R_2 on the theoretical circuit diagram.

(v) The volume control. This is a potentiometer (R_7, fig. 8) connected directly across the receiving telephones for the adjustment of the general signal level.

33. Referring to fig. 8, the service switch operates the three switches S_2, S_3 and S_5, the two former being ganged. Terminal C, which is connected to the moving members of both, is connected externally to the junction of the resistances R_{21} and R_{22} in the main beacon receiver. In the COURSE position S_2 is open and S_3 is at A, so that this junction is connected to the junction between R_3 and R_8.

34. The resistances R_8, R_3 and R_2 are in series between the cathode and the H.T.— line, so that the initial bias (*i.e.* irrespective of that due to rectification of the A/F signal by W_1) is that due to the volts drop across R_8.

35. When the service switch is in the GLIDE position, switch S_2 is closed and S_3 is at B. The junction of R_{21} and R_{22} in the main receiver is then connected to the tapping point on the potentiometer R_2, giving manual control of the amplifier gain, while the A.G.C. line is short circuited. Fig. 9 is a skeleton circuit diagram showing the interconnection between the main receiver, visual indicator and control unit with the alternative positions of the service switch.

36. The switch S_5 is independent of the switches S_2 and S_3 although operated simultaneously. In effect, it varies the resistance of the path between the cathode of V_5 and negative H.T. and so diverts a larger or smaller amount of the space current of this valve from the moving coil of the glide path meter. The latter is also permanently shunted by the resistance R_9 in the control unit.

Power unit

37. A theoretical circuit diagram of the power unit is given in fig. 10. The principal component is a rotary transformer of the permanent magnet field type, which is driven from the 12-volt general service accumulator of the aeroplane. This rotary transformer provides both the L.T. (heater) supply and the H.T. supply for the receivers R.1124A and R.1125A.

38. The 12-volt supply is connected, through the main junction box to the motor commutator of the machine, *via* one pair of contacts on the relay REL_1. The winding of the relay is also energized from the general service accumulator, through the switch S_1 on the control unit. By this means, the supply cables, which carry a heavy current, are kept as short as possible and the distance between the control unit and the remainder of the equipment does not affect the terminal P.D. at the motor terminals. Except as stated above, the accumulator is not connected to the blind approach equipment.

39. On closing the switch S_1 in the control unit, the lower contacts of the starter relay close the circuit through the motor armature winding, a R/F choke L_5 being connected in series in the positive lead and a similar choke L_6 in the negative lead. Two condensers C_7 and C_8 are connected in series across the motor brushes, the mid-point being earthed. The assembly L_5—C_7, L_6—C_8 forms a filter which prevents interference with the R/F portion of the equipment.

40. The H.T. armature winding is connected to the main junction box through a R/F filter system consisting of the condensers C_3, C_4, the R/F chokes L_2, L_3, and the condensers C_5, C_9, each pair of condensers being connected in series and the mid-point earthed. A fuse F_1 is fitted in the positive H.T. lead. The H.T. circuit is completed by the relay REL_1, when the winding is energized by the closure of the switch S_1 in the control unit. The anode supplies are fed to the respective receivers *via* the iron-core choke L_4, a condenser C_6 being connected from the out-going H.T. supply lead to earth. The screen voltages for the receiver R.1124A, and the detector anode voltage for the receiver R.1125A are fed *via* the resistances R_1 and R_2. The neon lamp N_1 functions as a voltage stabilizer.

41. The negative brush of the L.T. armature is connected to the main junction box *via* the R/F choke L_1 a condenser C_2 being connected between the L.T.—brush and earth. It should be noted that the L.T. + brush is connected directly to earth. A condenser C_1 is connected between the out-going L.T. — lead and earth. The condensers and choke enumerated form a R/F filter.

Aerial for receiver R.1124A

42. This is a short retractable vertical aerial for reception of the main beacon signals. It is connected to receiver R.1124A by a flexible co-axial feeder. If the feeder has to exceed 20 ft. in length a small loading coil is connected between the aerial and the feeder in order to provide better matching of the aerial and line impedances.

Aerial for receiver R.1125A

43. This is a dipole aerial mounted horizontally on the aeroplane for reception of the horizontally-polarized signals from the marker beacon transmitters. It is connected to receiver R.1125A by a screened feeder with two inner conductors. To match the aerial and feeder impedances, a tuned circuit, housed in the junction box for the screened feeder, is connected between the dipole elements. The feeder is tapped to two points on the inductance symmetrically disposed about the centre.

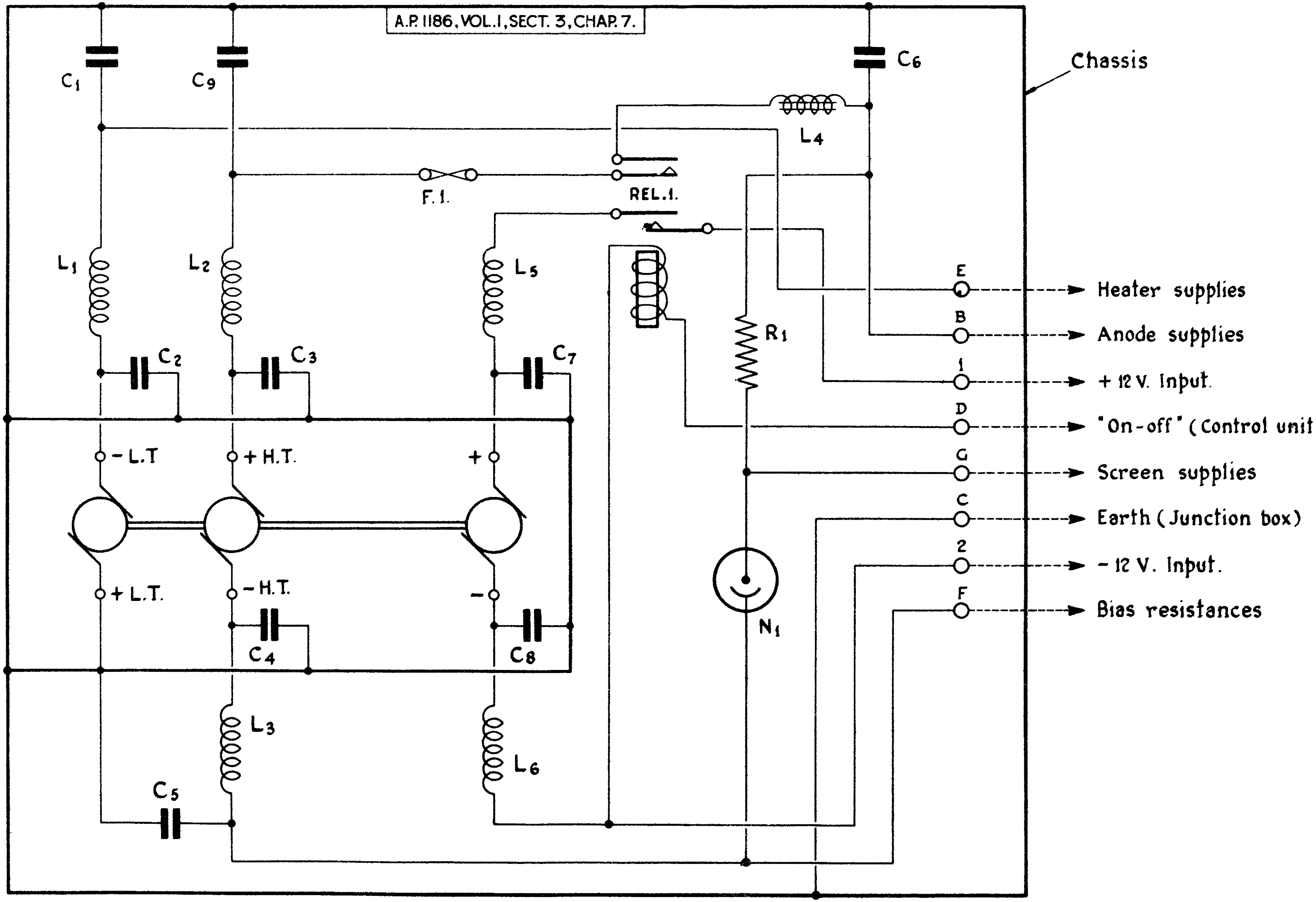

FIG. 10. POWER UNIT — THEORETICAL CIRCUIT DIAGRAM

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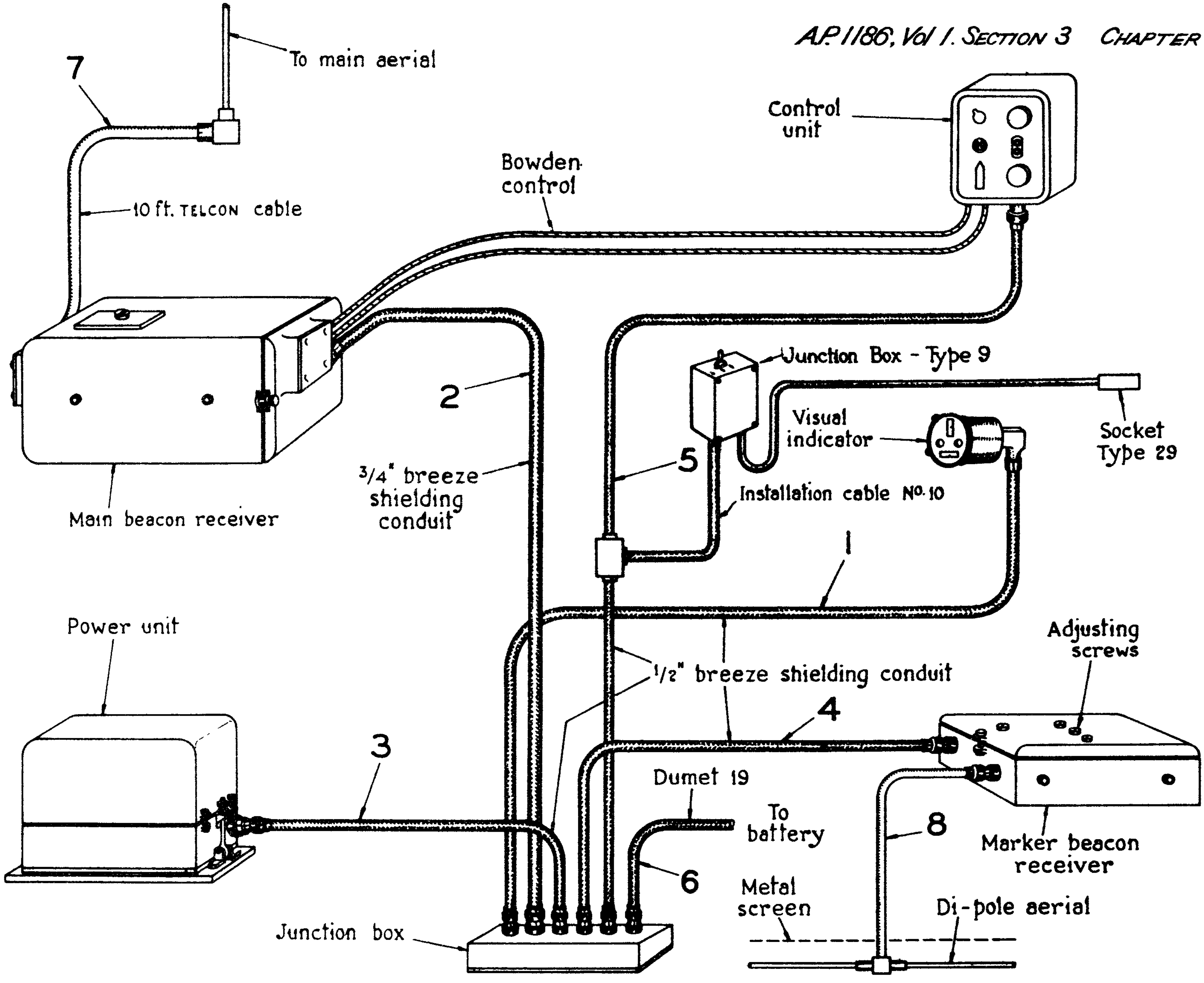

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FIG. 11. INSTALLATION DIAGRAM

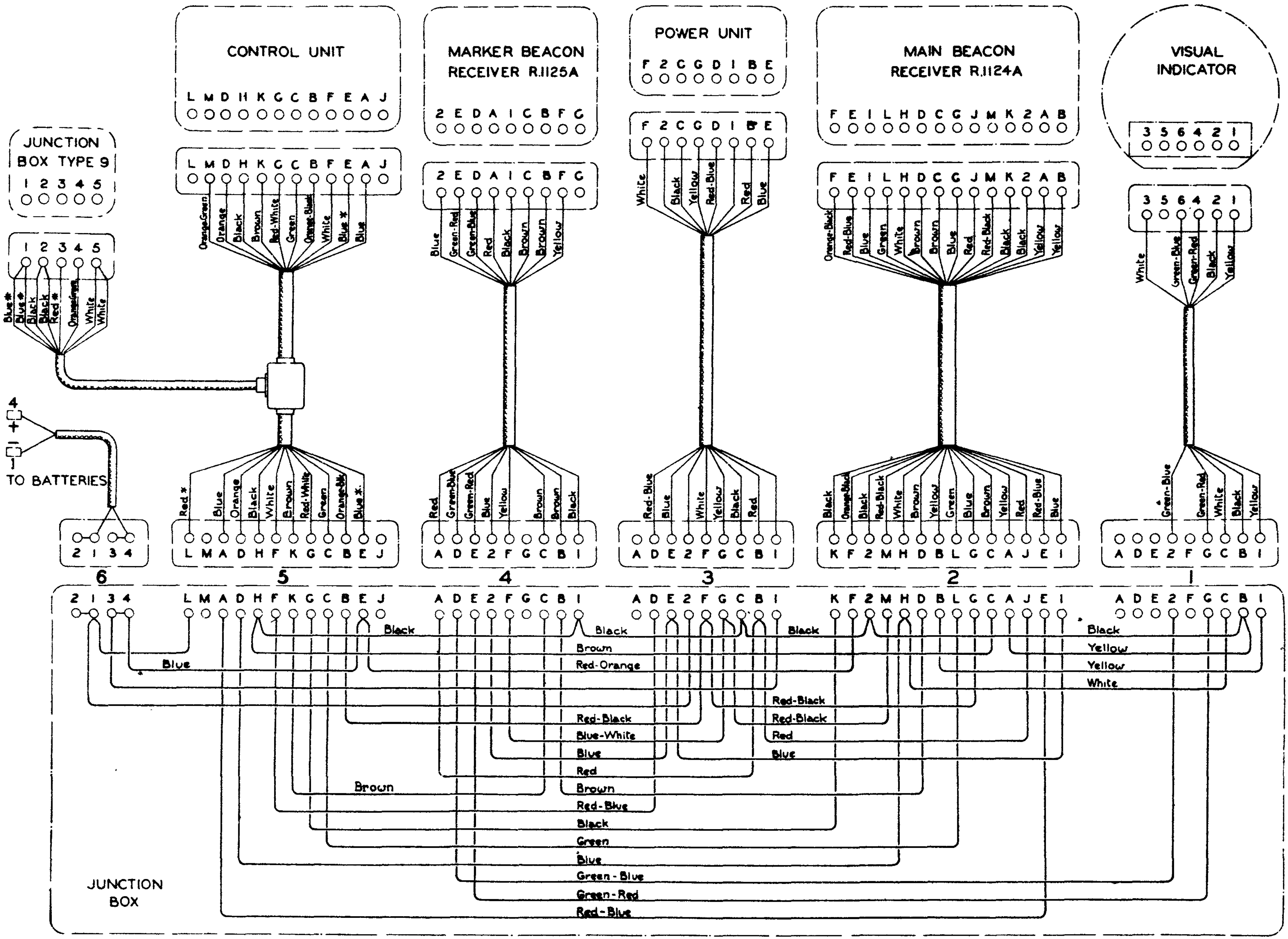

FIG. 12. JUNCTION BOX AND CABLE COLOUR CODE

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Junction box and cables

44. The power supply connections for the receivers, and the various interconnections between the units of the equipment are made through a junction box. These connections are shown in fig. 11. The junction box has six Breeze sockets with which are engaged the Breeze interconnecting cables from the visual indicator, receiver R.1124A, power unit, receiver R.1125A, control unit and 12-volt battery respectively. The cable colour code, terminal designations and internal junction box connections are indicated in fig. 12.

CONSTRUCTIONAL DETAILS

Visual indicator

45. Front and back views of the visual indicator are shown in figs. 13 and 14 respectively. Referring to fig. 13, (1) is the course meter and (2) its white indicating line which moves horizontally towards the marks R (right) or L (left) if the aeroplane is not on the correct approach track. The glide path meter (3) has an uncalibrated vertical scale (4).

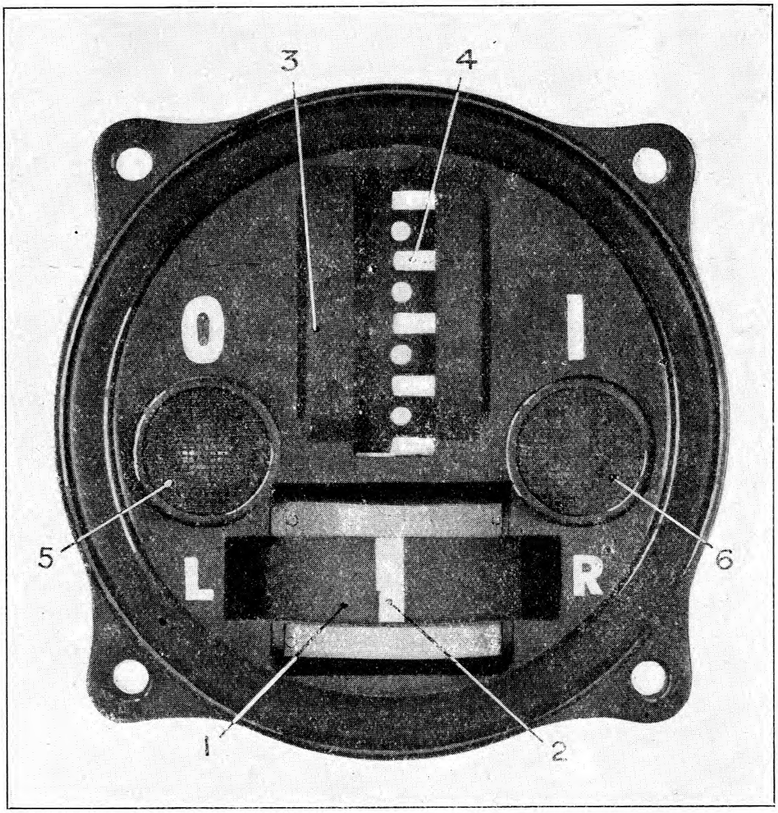

FIG. 13. Visual indicator, front view.

46. Two neon signal lamps are visible through the windows (5), (6) marked O (outer) and I (inner) respectively. The first flashes while the outer marker beacon is being crossed, and the second while the inner marker beacon is being crossed. The scales and the designations L, R, O, I are self-luminous.

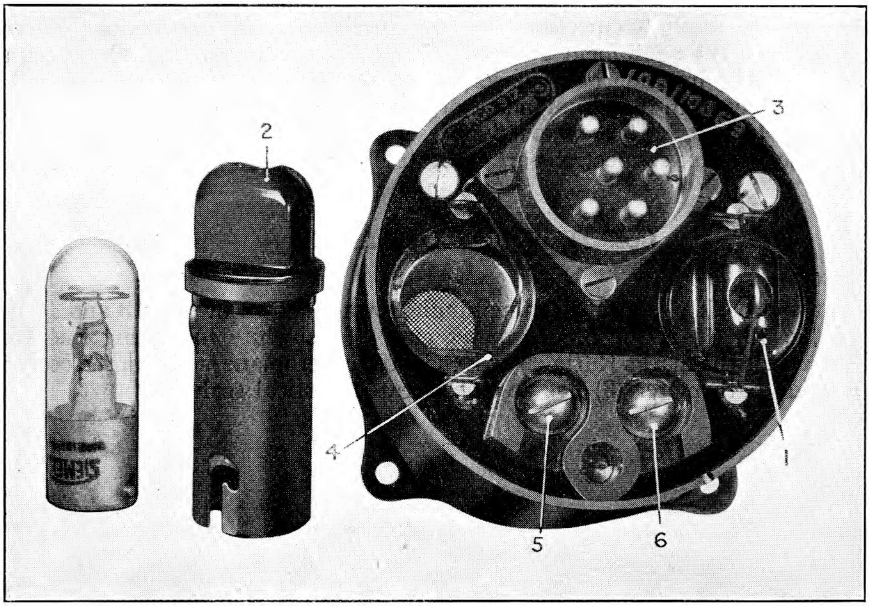

FIG. 14. Visual indicator, back view.

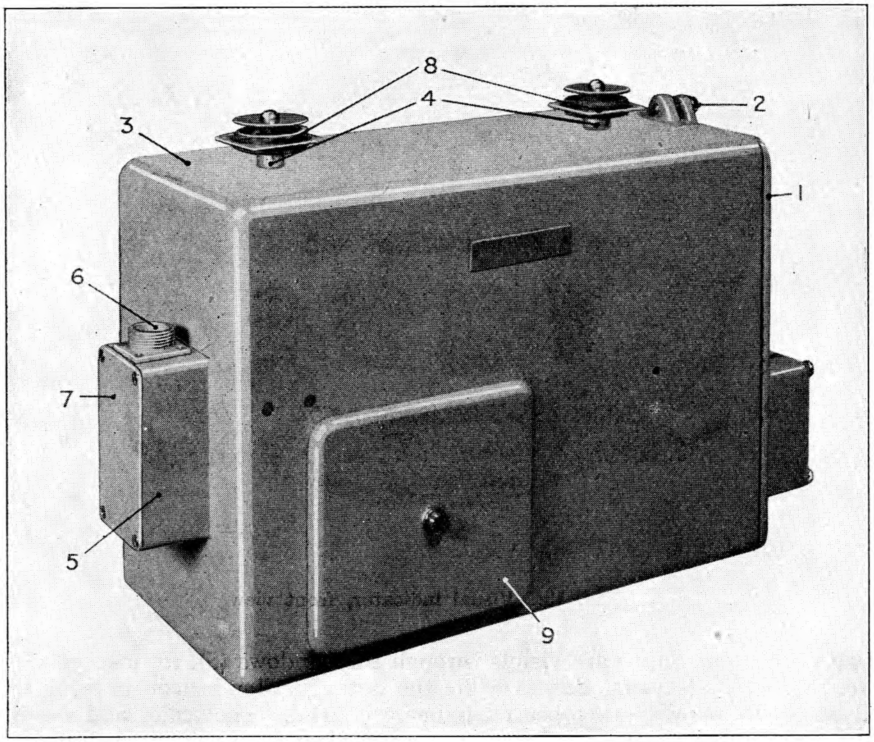

FIG. 15. Receiver R.1124A, exterior view.

47. At the rear of the instrument, illustrated in fig. 14, are the neon lampholders (1) and (2), which may be withdrawn by pushing aside a locking spring (4) and pulling the holder in an axial direction. A six-way screened socket (3) is provided for the plug on the cable from the junction box. This plug is normally a special right-angle plug fitting supplied with the installation cabling, but in certain installations a straight-through plug fitting is supplied. Extra internal lighting is provided for by a removable 12-volt, 3-watt lamp which is connected to the terminals (5) and (6). These may be wired to the dashboard lighting system of the aeroplane, if required.

Receiver R.1124A

48. Fig. 15 shows an exterior view of receiver R.1124A. The components of the receiver are carried by the cover plate (1) on the right which is clamped by screws (2) over the end of a cast aluminium box (3). A rubber gasket is interposed between the box and the cover plate. The box (3) is provided with eight tapped bosses, two of which (4) are shown, and four anti-vibration fixing plates for attachment thereto, two of which (8) are shown. An extension (5) on the left, houses the sockets (6) for the co-axial aerial cable connection and is provided with a removable inspection cover (7). A further removable cover (9) on the front face gives access to the frequency setting trimming condensers.

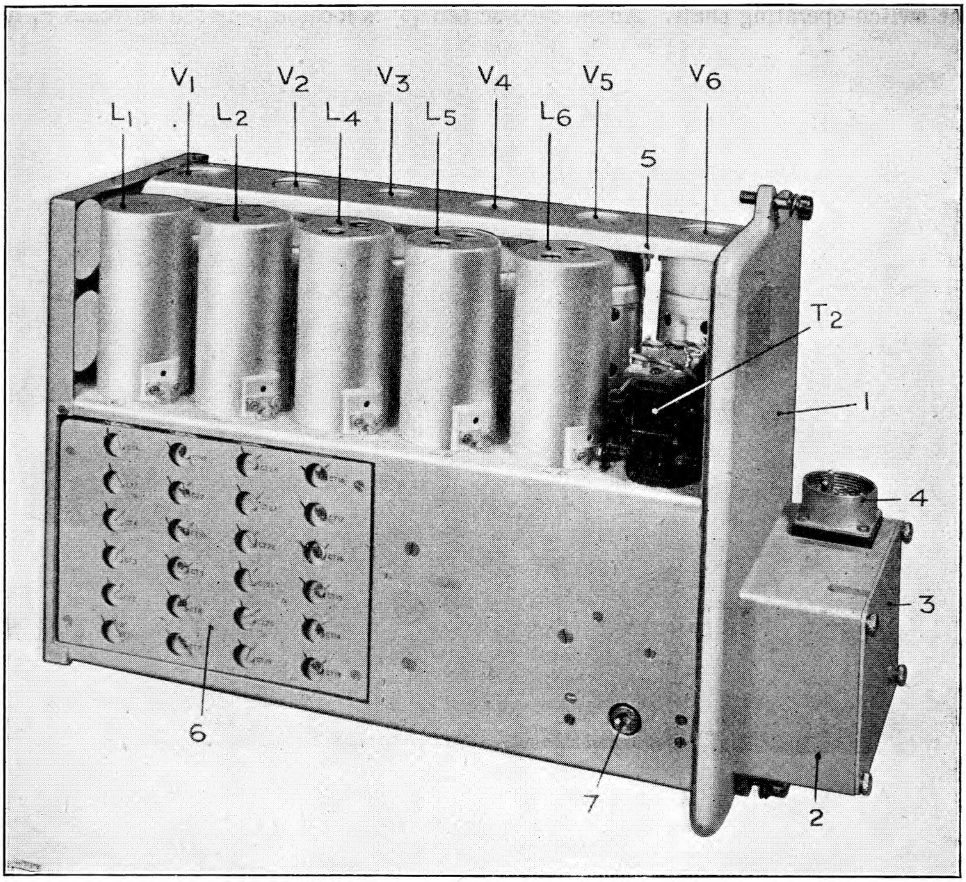

FIG. 16. Receiver R.1124A, removed from housing.

49. A general view of the receiver, removed from its housing, is given in fig. 16. On the right will be seen the supporting cover plate (1) which bears an extension (2) provided with a removable inspection cover (3). The extension houses the power cable socket (4) and the driven assembly of the remote control system.

50. The receiver chassis is divided into two compartments by a platform on the upper side of which are mounted the screened inductances L_1, L_2, L_4, L_5, L_6, the output transformer T_2, and the valves V_1 to V_6. The valve screening boxes are retained in position by a bar (5) held down by springs engaging hooks on the valve platform. The valves are prevented from leaving their holders by spring-pressed pads in the lids of the screening boxes.

51. The adjusting screws of trimming condensers CT_1 to CT_{24} are visible through holes in a removable portion (6) of the front wall of the chassis. A hole in the main front wall gives access to the adjusting screw (7) of the course meter amplitude adjusting potentiometer (R_{26}, fig. 6). A special trimming tool (13, fig. 19) is provided for trimming this receiver and receiver R.1125.

52. An underside view of the receiver is given in fig. 17 and a bench wiring diagram in fig. 18. In fig. 17 some of the frequency setting trimming condensers will be seen behind a sub-panel (1). Carried in front of this panel is the oscillator coil and the switch assembly comprising the switches S_1 to S_5 arranged for ganged control by the shaft (2) leading to the remote control mechanism. A flexible spring coupling (3) is interposed between the shaft (2) and the switch-operating shaft. An earthed screen (4) is located between switches S_1 and S_2.

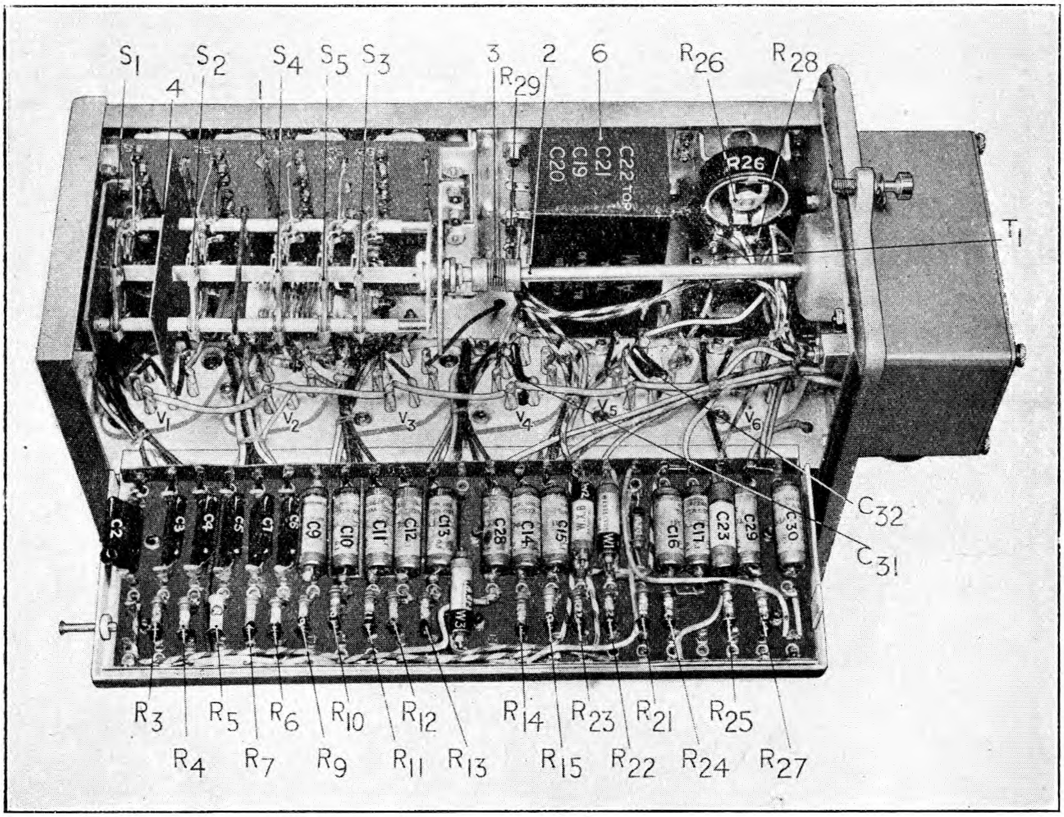

FIG. 17. Receiver R.1124A underside view.

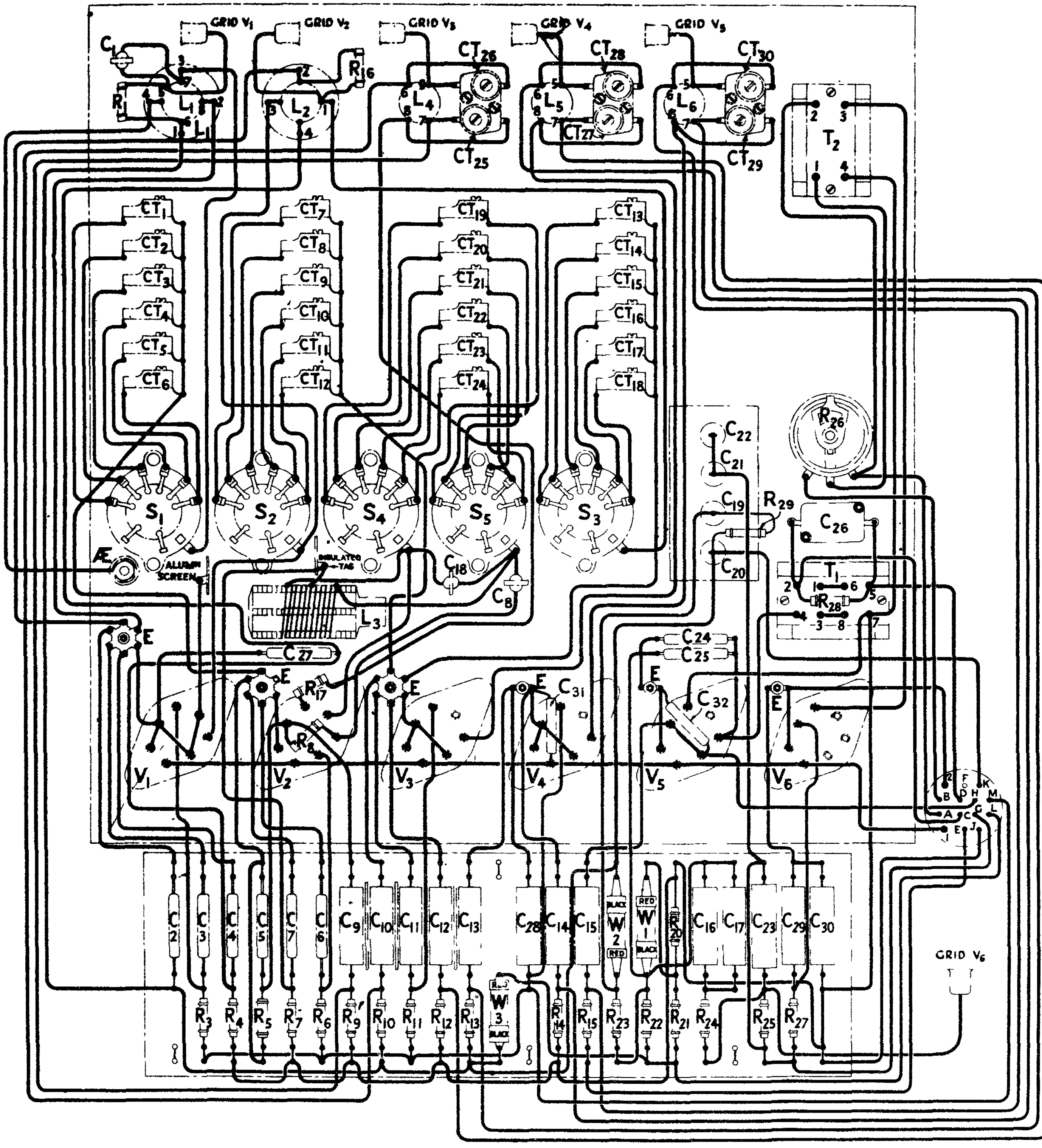

FIG. 18 RECEIVER R.1124A, BENCH WIRING DIAGRAM

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53. Behind the shaft (2) are the potentiometer R_{26} associated with the course meter, the output transformer T_1, and a condenser pack (6) containing condensers C_{19} to C_{22}. The underside of the valve holders may be seen behind the hinged component board (5) which is shown swung down from its normal position in which it forms part of one wall of the receiver. The board (5) carries most of the smaller components, which are arranged in two rows. Referring to the upper row, on the left-hand side may be seen five moulded mica condensers C_2, C_3, C_4, C_5, C_7 and C_6, each of which has a capacitance of $0{\cdot}002\mu$ F. In the centre may be observed the eight tubular paper condensers C_9, C_{10}, C_{11}, C_{12}, C_{13}, C_{28}, C_{14} and C_{15} each of which has a capacitance of $0{\cdot}1\mu$ F. Immediately to the right of these may be seen the two Westectors W_2 and W_1, and the 10,000-ohm resistance R_{20}. Five tubular paper condensers are mounted on the right-hand side of the upper row. The condenser C_{23} has a capacitance of $0{\cdot}01\mu$ F and C_{16}, C_{17}, C_{29} and C_{30} have a capacitance of $0{\cdot}1\mu$ F each. The lower row comprises eighteen resistances, which are divided into two sections by the Westector W_3. The left-hand section consists of R_3, 1,000 ohms; R_5, 300 ohms; R_7, 2,000 ohms; R_6, 10,000 ohms; R_9, 1,000 ohms; R_{10}, 10,000 ohms; R_{11}, 1,000 ohms; R_{12}, 1,000 ohms and R_{13}, 10,000 ohms. The right-hand section comprises R_{14}, 1,000 ohms; R_{15}, 2,000 ohms; R_{23}, 5 megohms; R_{22}, 500,000 ohms; R_{21}, 10,000 ohms; R_4, 1,000 ohms; R_{25}, 1 megohm, and R_{27}, 1,000 ohms.

54. The aerial connection and the earth connection for the instrument are made automatically when the receiver chassis is placed in the outer box. This is accomplished by the provision in the outer box of two internally-projecting pins which fit into corresponding sockets in the receiver chassis. The earth pin is made of sufficient strength to give mechanical alignment and support as well as electrical contact.

Receiver R.1125A

55. Fig. 19 is a view of the exterior of receiver R.1125A with the special trimming tool (13) beside it. It consists of a split cast aluminium case having a deep portion (1), in which is mounted the receiver equipment, and a lid (2). The two parts are clamped together by screws (3) and (4), a rubber gasket being interposed. The lid contains four screws (5), (6), (7), (8), the first of which

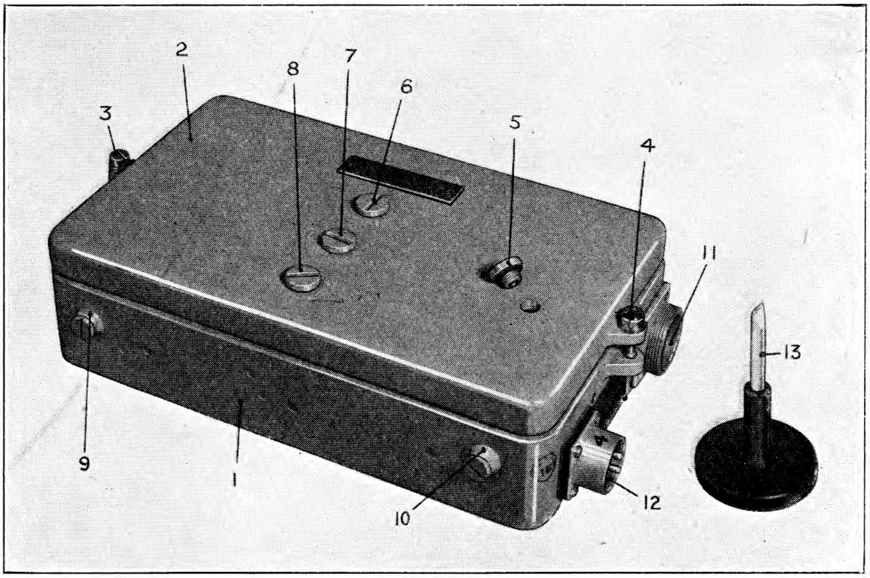

FIG. 19. Receiver R.1125A, exterior view.

is shown removed. These screws permit access to the pre-set controls of the receiver which are operated by an insulated screwdriver (13). It is essential that the controls be adjusted with the lid in position.

56. Tapped suspension bosses (9) and (10) are provided on both sides of the case, the two on the rear side not being visible. The case also carries a special two-way socket (12) for the interconnection cable plug.

57. A view of the interior with the valves removed is shown in fig. 20 and a bench wiring diagram in fig. 21. In fig. 20 may be seen the valve holders V_1 and V_2 mounted on right-angle brackets (1) attached to the base. Each of these brackets is fitted with a spring-retaining harness (2) which holds the valves in position. On the right adjacent to the dipole feeder entry (3) and interconnection cable entry (4) is the grid inductance L_3 and its pre-set trimmer C_1. Between the valve positions is a metal bridge carrying the pre-set reaction potentiometer R_4

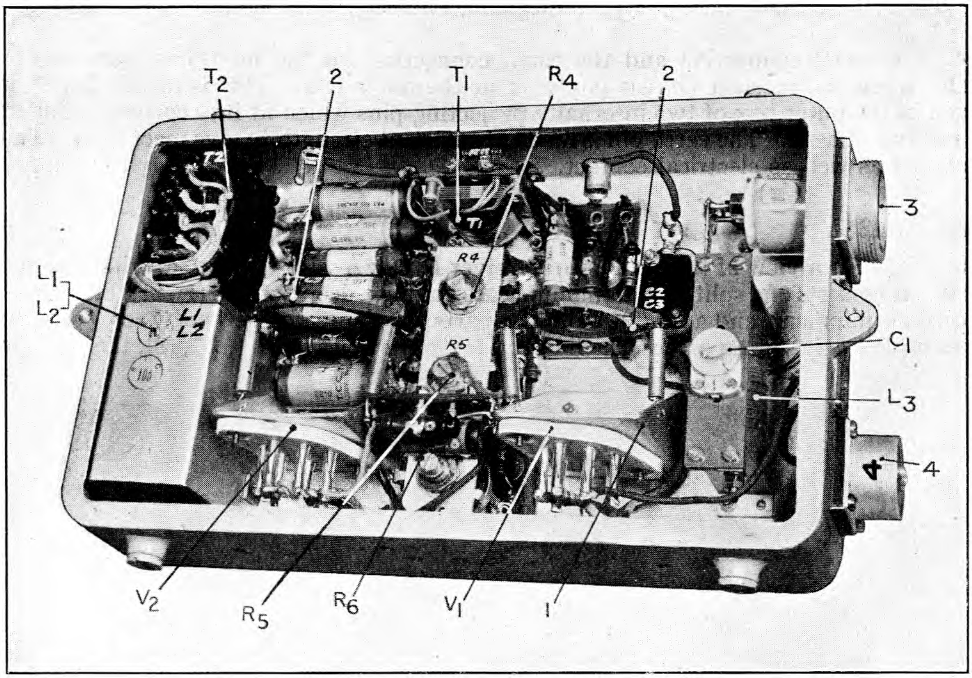

FIG. 20. Receiver R.1125A, interior view.

and the pre-set potentiometers R_5, R_6 for adjusting the polarizing voltage on the neon indicators. All these pre-set controls are accessible through holes in the lid. The intervalve coupling transformer T_1 is seen in the upper left-hand corner and the marker beacon filter inductances L_1 and L_2 in the lower.

58. The remaining resistances and condensers are arranged on sub-panels underneath the valve positions. The slip-on connections to the top caps of the valves will be seen supported by their connecting wires. These caps should be removed from the valves before attempting to remove the valve-retaining harness.

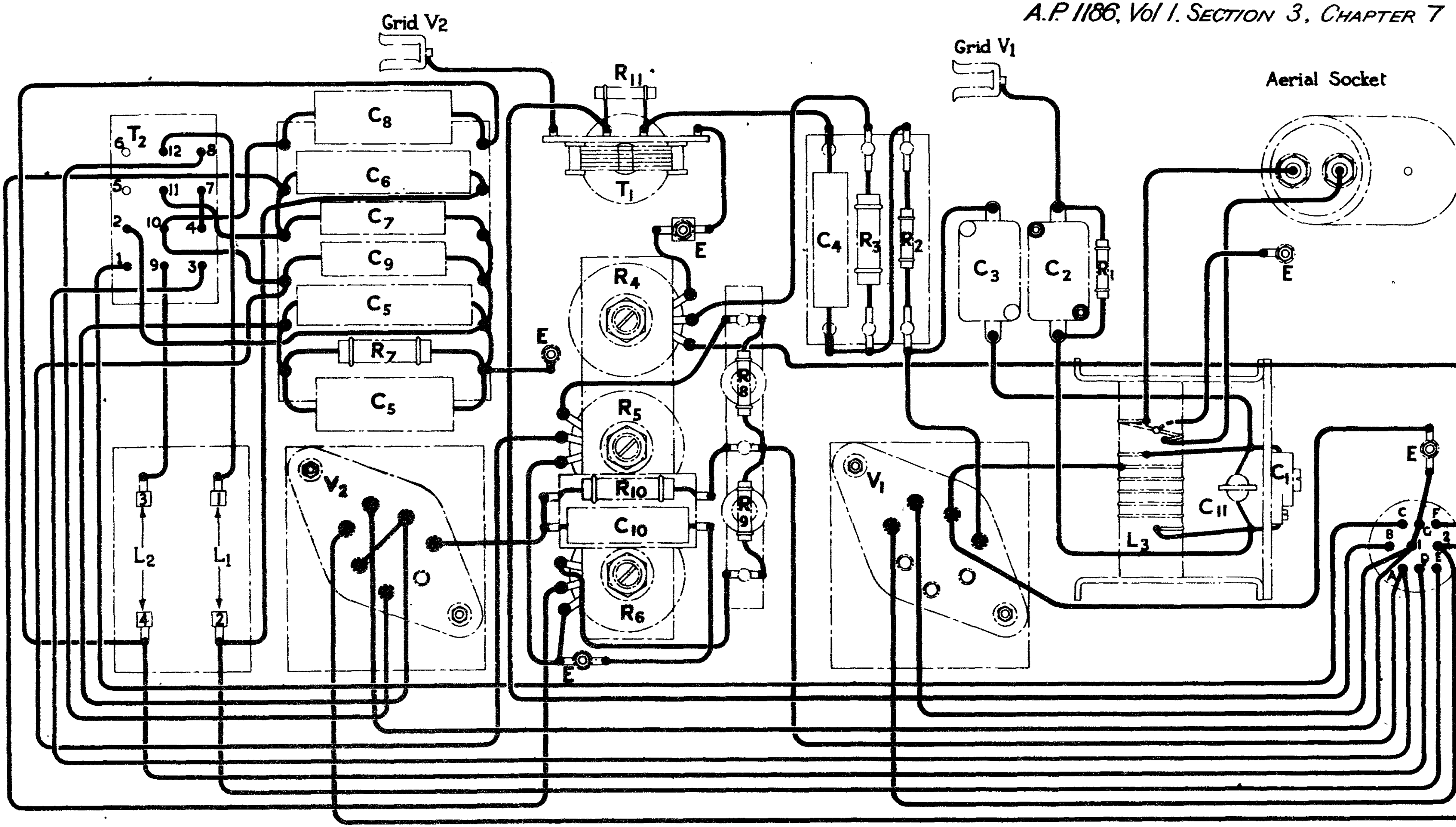

FIG. 21. RECEIVER R.1125 A, BENCH WIRING DIAGRAM

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Control unit

59. Fig. 22 shows a front view of the control unit from which the whole equipment is controlled by the pilot. All the apparatus in the unit is mounted on the detachable cover (1) which is secured to the base-plate (2) by captive screws at the corners. The joint is sealed by a rubber gasket. In the centre is the ON-OFF switch (3), (S_1 of fig 8) also the telephone sockets (4). At the bottom are the selector (5) operating the frequency control switches in

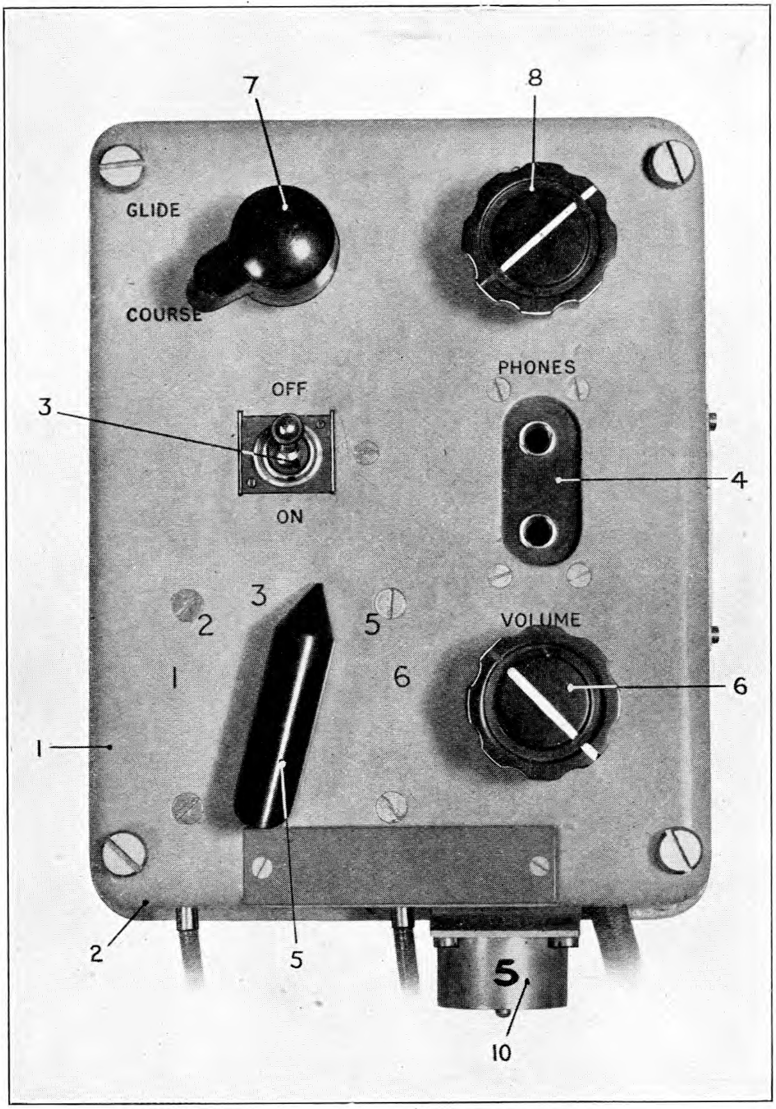


FIG. 22. Control unit, front view.

R.1124A through the remote control mechanism and the telephone volume control (6). At the top are the GLIDE-COURSE control (7) which operates the ganged two-way switches S_2, S_3, S_5 (fig. 8) and the glide control (8) which operates the potentiometer R_2 in the same figure. The socket (10) for the interconnecting cable is attached to the bottom of the cover (1).

60. Fig. 23 shows an interior view of the unit and fig. 24 a bench wiring diagram. In fig. 23, at the top may be seen the switch assembly S_2, S_3, S_5 and the potentiometer R_2. On the right is the switch S_1 and also the driving gear of the remote control which can be removed by withdrawing four screws from the face of the unit after removing the handle of the selector

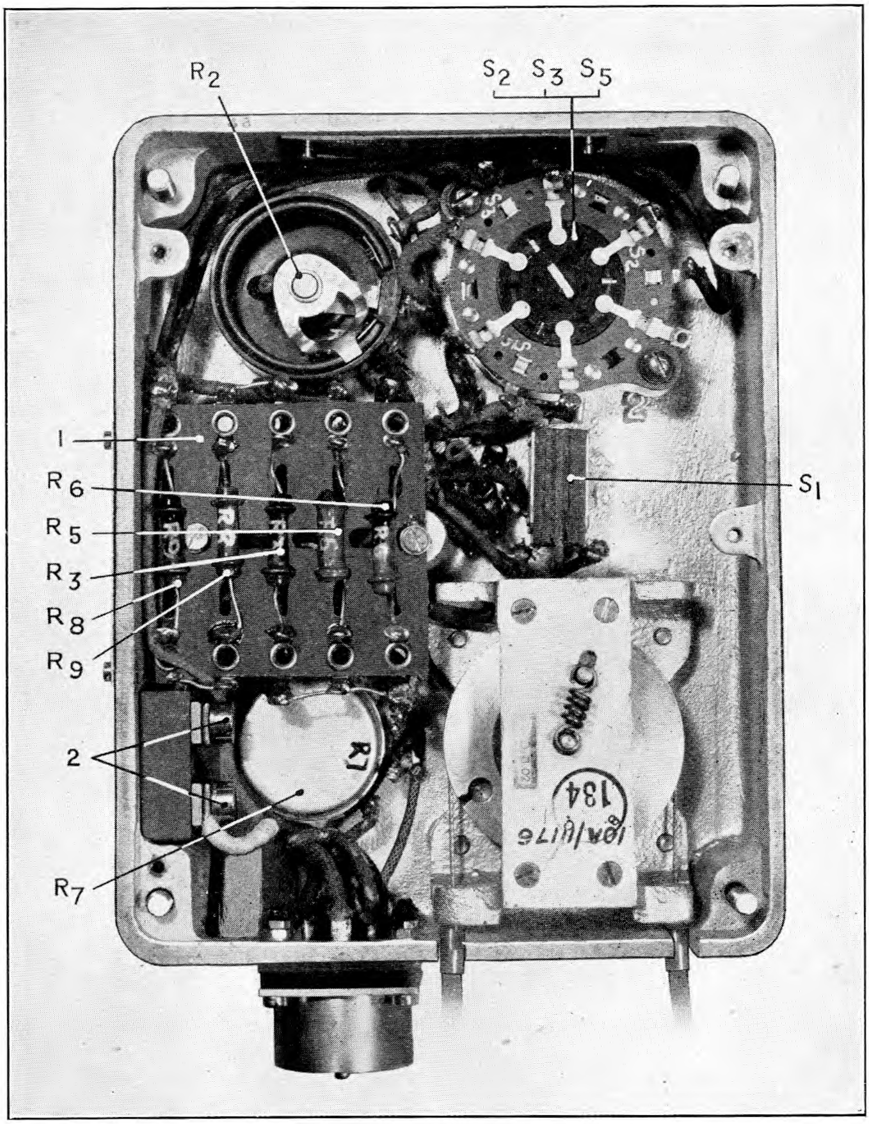


FIG. 23. Control unit, interior view.

(5, fig. 22). On the left are the telephone sockets (not visible) under the sub-panel (1) carrying resistances R_6, R_5, R_3, R_8 and R_9, the alternative telephone terminals (2) and the volume control R_7. The interior components are protected by a synthetic varnish paper board cover, which is not shown in fig. 23.

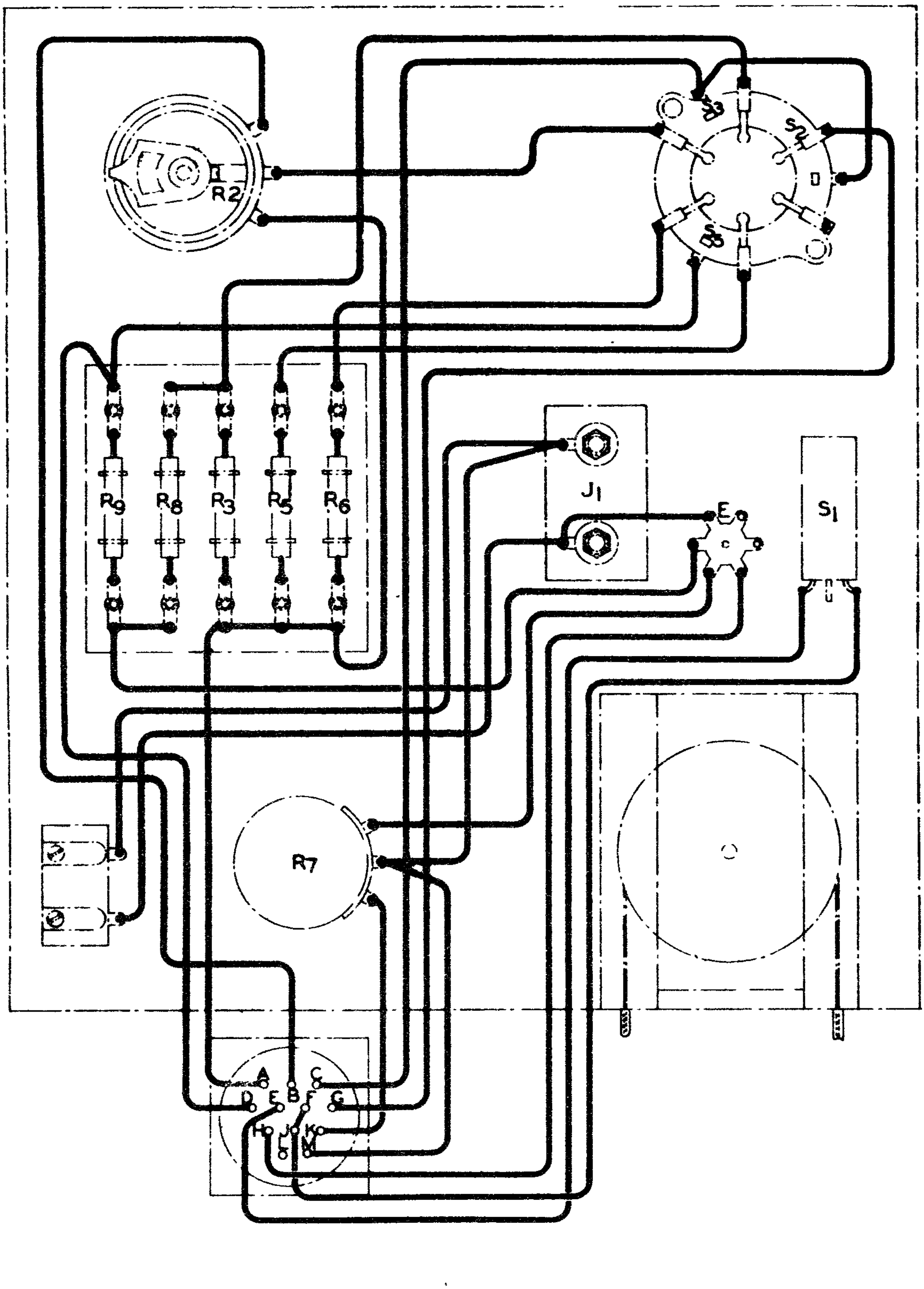


FIG. 24. CONTROL UNIT - BENCH WIRING DIAGRAM

Power unit

61. A view of the exterior of the power unit is shown in fig. 25. A cast aluminium box (1) is provided with two covers; the top cover (2) is held down by captive screws (3) and the base cover (4) is secured in position by countersunk screws. Rubber gaskets of circular section seal the joints between the covers and the box. These covers not only protect the internal components, but also provide an electrical screen which shields the receivers from short wave radiation from the rotary transformer. The power cable connection (5) is attached to the end of the box. The main assembly may be easily detached from the wooden baseplate (6) by releasing the swing bolts (7).

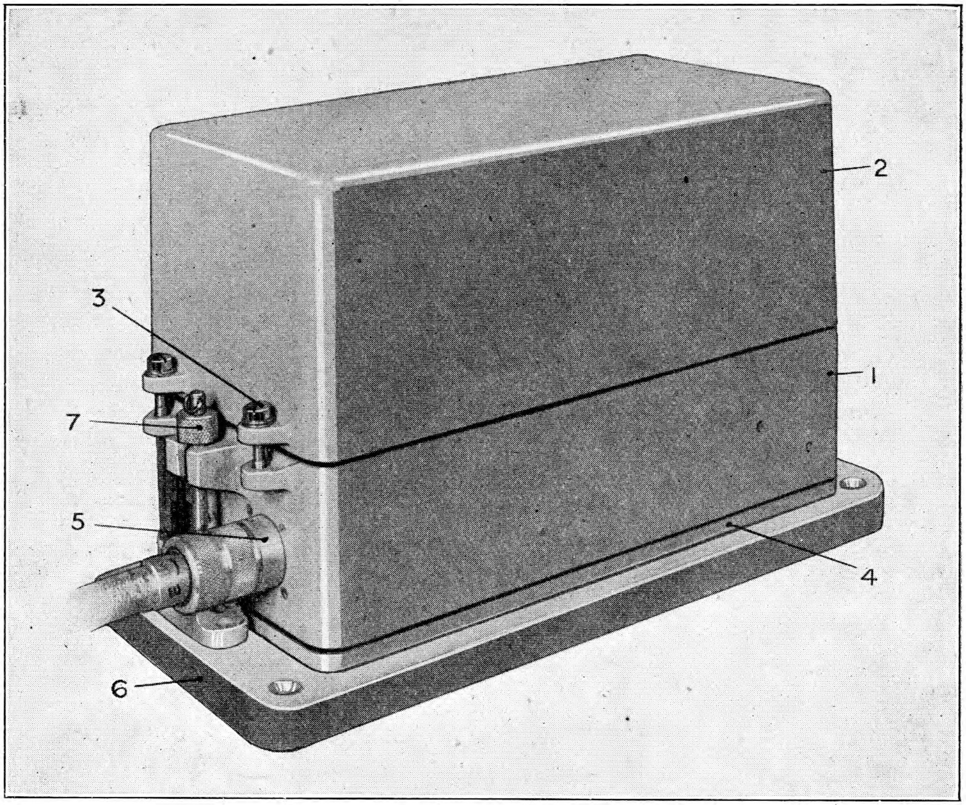


FIG. 25. Power unit, exterior view.

62. An interior view of the upper compartment is shown in fig. 26 and a bench wiring diagram of the complete unit in fig. 27. The rotary transformer (2, fig. 26) is mounted on top of the box (1) on rubber cushioned supports (3). The machine is of the permanent magnet field type. The innermost 13-volt L.T. output winding is brought out to the commutator (4) on the extreme right. The next winding is the motoring winding designed to run on a nominal 11-volt input and is brought out to the commutator (5) on the extreme left. The outermost 200-volt H.T. output winding is brought out to the other right-hand commutator (6). The machine runs at a speed of 5,000 r.p.m.

63. Arranged round the rotary transformer are the R/F chokes L_1, L_2, L_3, L_5, and L_6, of which L_1, L_2 and L_6 may be seen in the illustration. On the left are the starter relay REL_1

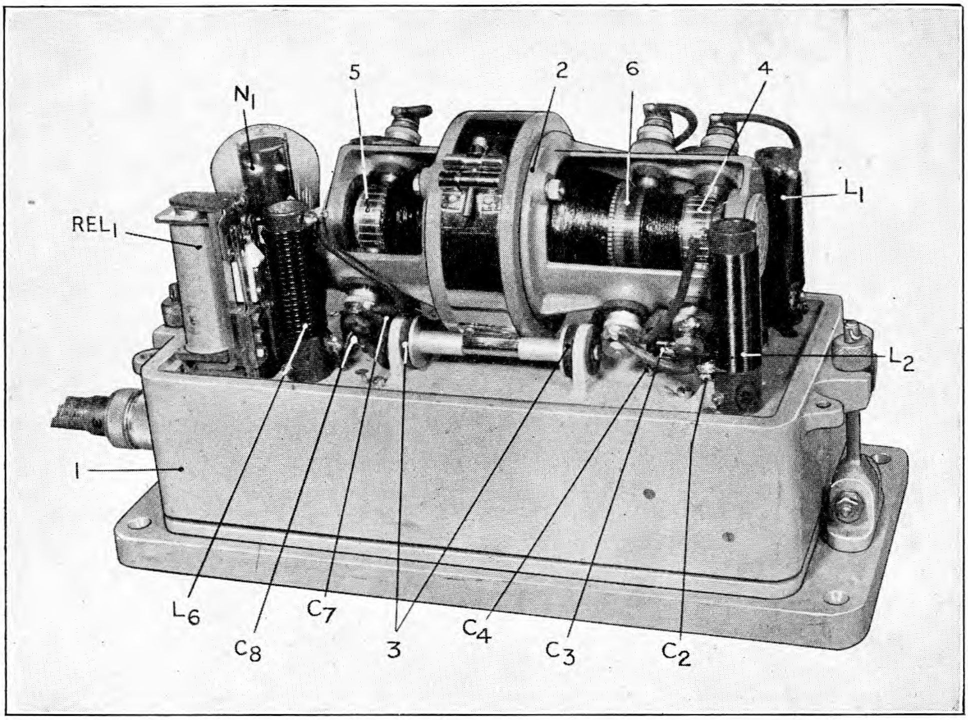


FIG. 26. Power unit, interior view, upper compartment.

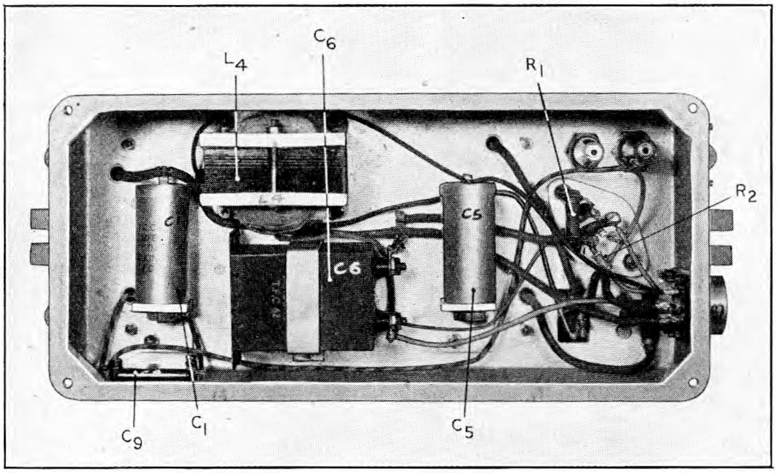
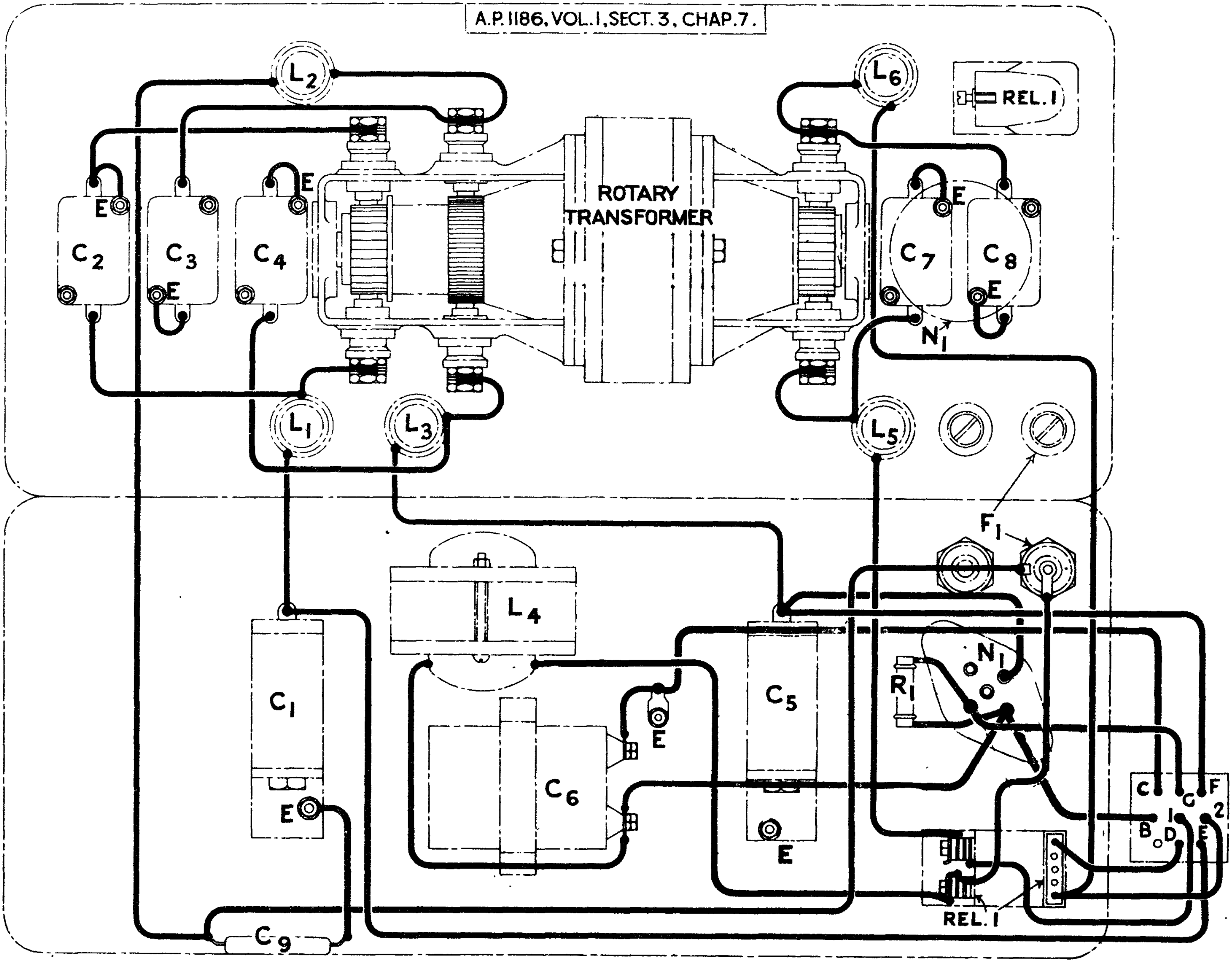


FIG. 28. Power unit, interior view, lower compartment.

PLAN



VIEW OF UNDERSIDE

FIG. 27. POWER UNIT, BENCH WIRING DIAGRAM.

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and the neon voltage regulator N_1. Behind N_1, but not visible, are two fuse-holders one of which carries a spare fuse. The filter condensers C_2, C_3, C_4, C_7 and C_8 may be seen beneath the armature.

64. An interior view of the lower compartment is shown in fig. 28. The H.T. smoothing choke L_4 and condenser C_6, the R/F filter condensers C_1, C_5 and C_9 and the H.T. feed resistances R_1 and R_2, are housed in this compartment. The bases of the relay, fuse-holders, neon stabilizer and Breeze socket will also be seen in the figure.

Aerial for receiver R.1124A

65. The vertical retractable aerial for the main beacon signal is shown in fig. 29. It consists of a length of ¾-in. stainless steel tube (1). When fully extended the tube projects 32 in. above the skin of the aeroplane. The top end of the tube is fitted with a small closing cap which may be removed by withdrawing a countersunk screw at the top. At the lower end the tube is provided with a handle (2). The aerial is retracted by giving the handle a quarter-turn in the

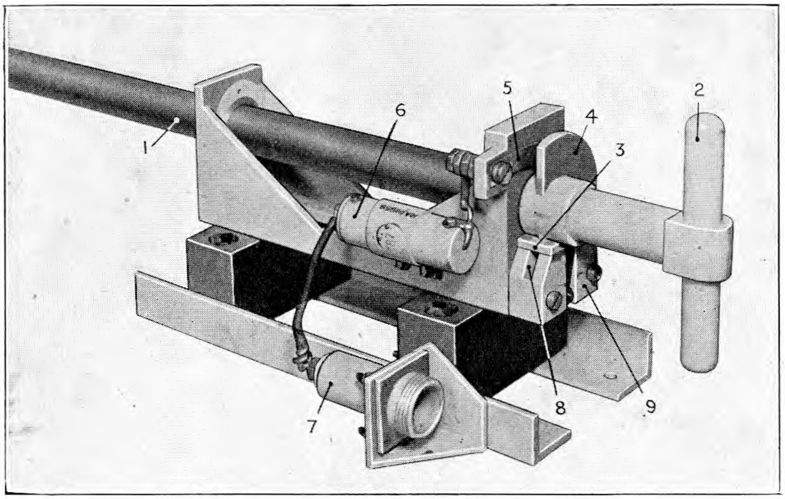

FIG. 29. Aerial for receiver R.1124A.

counter-clockwise direction against the stop (3) and pulling it straight down. The cut-away disc (4) on the aerial tube provides a slip-ring for the brush (5) which is connected through the loading coil (6) to the mechanically reversible output socket (7). The disc (4) provides also a locking device by entering the passage (8) in the supporting bracket (9) and being retained in the operating position by a " click " device. A clip is provided in the aeroplane to hold the handle when the aerial is in the retracted position.

Aerial for receiver R.1125A

66. The dipole aerial for the marker beacon signals may be one of two alternative types:—

(i) For mounting outside the fuselage of an aeroplane having a metal skin. Referring to figs. 30 and 31 which illustrate the complete dipole aerial assembly and an enlarged view of the junction box respectively, the aerial consists of two aligned ¼-in. copper tubes, each approximately 39 in. long, enclosed in ebonite tubes (1) and (2) the outer ends of which are closed by caps, (3) and (4) respectively, of streamlined form. These tubes are supported horizontally under the fuselage by streamlined brackets (5) and (6)

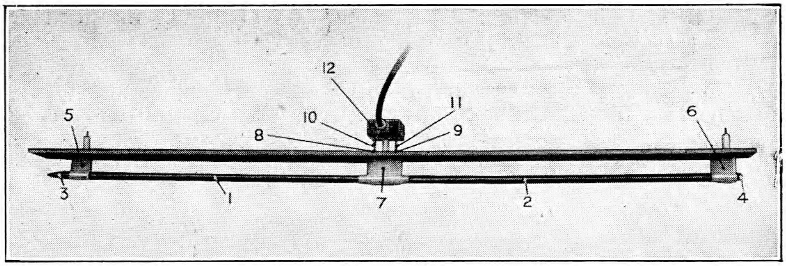

FIG. 30. Aerial for receiver R.1125A.

near their outer ends. The inner ends are clamped inside a similar bracket (7). The inner ends of the aerial proper are extended vertically upwards through the skin of the aeroplane to terminate in sockets (8) and (9). Two plugs (10) and (11) project from the underside of the junction box (12) and engage the sockets (8) and (9). Inside the junction box (*see* fig. 3) is the inductance (1) and pre-set condenser C_1 forming the tuned matching circuit. A socket (2) on the rear wall provides connection to the plug on the screened feeder leading to receiver R.1125A. In this type of installation the metal skin of the aircraft acts as a reflector for the dipole aerial.

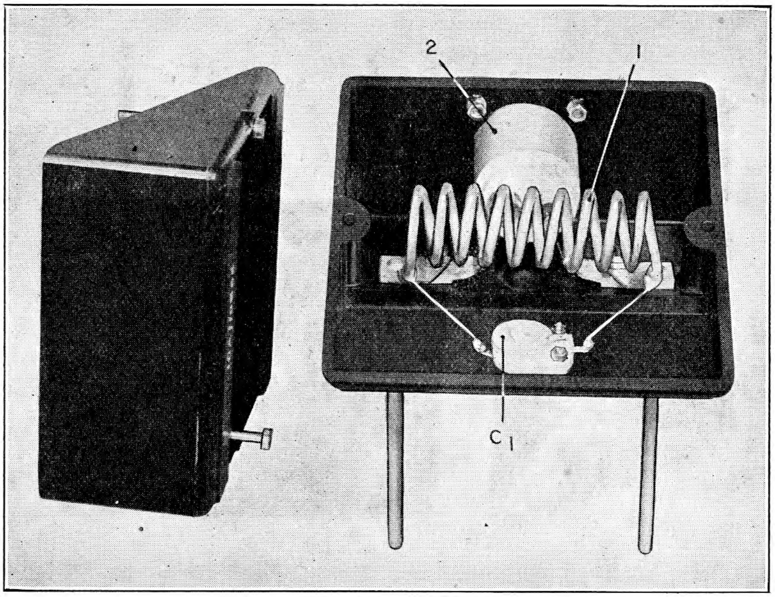

FIG. 31. Dipole junction box, interior view.

(ii) For mounting inside the skin of the aeroplane. This type is intended mainly for use on fabric covered aeroplanes and is a similar assembly, but the dipole conductors are unenclosed and mounted on insulators. Behind the aerial rods, and at a distance between $2\frac{5}{8}$ in. and 6 in., is a metallic reflector screen, at least $8\frac{1}{2}$ in. wide, bonded to the aeroplane at three points at least. This is provided by the constructor.

Junction box

67. Fig. 32 shows the junction box with some of its associated cables. It consists of a cast aluminium box (7), closed by a sheet metal cover (8) which acts as a mounting base. Six Breeze sockets (1 to 6), for the visual indicator, receiver R.1124A, power unit, receiver R.1125A, control unit and battery supply respectively are mounted on the cover (8). Each unit is thus separately removable from the installation for servicing.

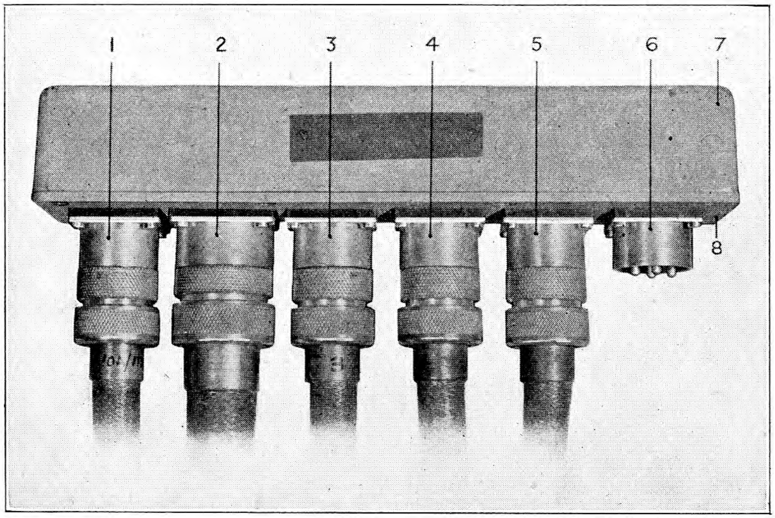

FIG. 32. Junction box.

REMOTE CONTROL

General

68. The mechanical remote control, for coupling the frequency selector switch on receiver R.1124A to the control unit operating member, is a bowden control with positive actuation in both directions. It is compensated for stretch in the cables by a spring-loaded differential gear at the driven end. Both the driving and driven units are readily detachable from the control unit and receiver R.1124A respectively. The complete control is supplied as a separate functioning assembly correctly wound and tensioned and adjusted to give the correct relative angular positions between the driving knob and the switch arm.

Driving assembly

69. Fig. 33 shows the complete control assembly, the working parts being removed from their housings, and the special adjusting tool. The driving assembly consists of an alloy casting (1) supported from the front of the control unit by four screws (2). Mounted on the driving shaft (3) are the manual control handle (4) and an aluminium drum (5) bearing two grooves (6) round which are wound the operating cables in opposite directions. The cables are anchored by soldered brass cylindrical ends housed in transverse holes in the drum (5), from which they may be removed when the cable is slackened off. The non-adjustable nipples (7) of the bowden outer casings are housed in recesses in the casting (1). The drum is located and restrained in one of six selectable positions by a " click " roller (8) engaging a steel cam member (9) mounted on the shaft (3).

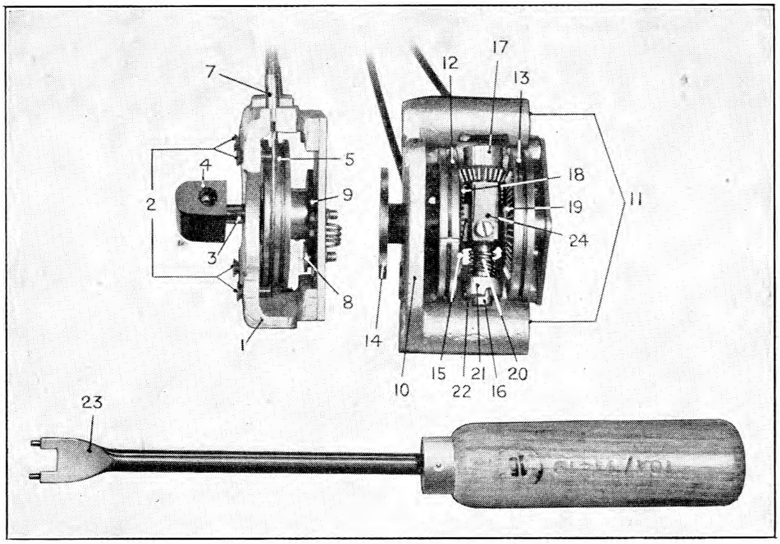

FIG. 33. Remote control assembly.

Driven assembly

70. The driven assembly consists of an alloy casting (10) with passages (11), through which holding bolts on receiver R.1124A are adapted to pass. The two incoming bowden wires pass in opposite directions over two separate pulleys (12) and (13) running independently on the main shaft. The main shaft carries the switch-operating disc (14) and a mounting (15) for a transverse shaft (16) on which is mounted a bevel planet pinion (17). The pinion (17) engages bevel gears (18) and (19) to which the pulleys (12) and (13) respectively are attached.

71. When operated normally, the whole differential gearing, described above, and the operating disc (14) rotate about the axis of the main shaft. The differential gear is provided to maintain a constant tension on both cables without upsetting the position of disc (14). For this purpose, the transverse shaft (16) bearing the pinion (17) is constrained, by a spring (20), to rotate in such a direction as to wind up the cables on pulleys (12) and (13) through the gears (18) and (19). The spring (20) is anchored at one end to the mounting (15) and at the other to an annular castellated member (21) engaging a pin (22) passing through the shaft (16). The tension on the spring (20) may be adjusted by rotation of the member (21) with the special tool (23).

72. Also attached to the shaft (16) is a ratchet gear which is engaged by two spring-pressed pawl members, the spring (24) of one of these members is visible in fig. 33. The ratchet mechanism enables the spring tension adjustment to be made without special means for securing the shaft (16), while it is free from the spring restraint.

73. The switch-operating disc has two slots which are asymmetrically placed so that they can engage in only one way with two pins projecting from a disc on the end of the switch-driving shaft in receiver R.1124A. When supplied, the remote control is set up and tensioned to give the correct operative relation between the driving knob and the switch arm.

Adjustments

74. It will sometimes be found necessary to dismantle the remote control system, *e.g.* when the cables are to be passed through a space too small to allow the passage of the driving or

driven assemblies. Should this be necessary do not release the spring (20) but adopt the following procedure. Lock the differential gear by screwing the locking plate provided to the member (21). The locking plate extends outside and over the pulleys (12) and (13) to prevent rotation of member (21) and the pinion (17). Slacken off the cable-adjusting nipples and remove the cables from the grooves in the drum (5) in the driving unit. The cables may then be completely withdrawn from this unit, installed in the required space and replaced on the drum. The adjusting nipples should then be tightened until all the slack is taken out of the cables and finally the locking plate should be removed.

75. Should it become necessary at any time to release the tension on the spring (20), the following procedure should be followed after reassembling the control. Remove slackness in the cables by rotating the pulleys (12) and (13) in opposite directions. Tension the spring (20) by depressing the member (21) with the special tool and giving it one complete turn in the clockwise direction. Finally allow the member (21) to rise and engage the pin (22) passing through the transverse shaft (16).

76. The correct alignment between the control handle (4) and the switch-operating disc (14) may be checked by placing the handle (4) in the fourth position. In this position the slot in disc (14) which is adjacent to the face of the casting (10) bearing the cable anchorages should be at right-angles to this face. When the disc (14) is viewed directly, the cables being on the left, the other slot will be seen to be slightly below the diameter upon which the first slot lies.

VALVES

77. Indirectly heated valves are used for both receivers R.1124A and R.1125A. In receiver R.1124A, the R/F amplifier (V_1) and two I/F amplifiers (V_3 and V_4) are type V.R.106. The frequency changer valve (V_2) is type V.R.107, the second detector valve (V_5) is type V.R.108 and the output valve (V_6) is type V.R.109. In receiver R.1125A the detector valve (V_1) is type V.R.109, and the output valve is type V.R.108. The neon stabilizer tube in the power unit is a type V.S.110.

INSTALLATION

78. A typical layout of the installation, which varies for different aeroplanes, is shown in fig. 11. Receiver R.1124A is usually housed in a metal crate. Either the crate or the receiver is mounted on a system of shock absorbers. Two of these shock absorbers will be seen screwed to two of the receiver mounting bosses in fig. 15. In some cases the receiver will fit the suspension provided in alternative positions. The position selected should be that which allows the cover plate over the trimming condensers to be more readily accessible for removal.

79. Receiver R.1125A is usually mounted in the same crate as receiver R.1124A. In large machines it may be arranged to be mounted aft of this position to reduce the length of the high frequency feeder connecting it to the dipole aerial. As with receiver R.1124A it should be provided with a shock-absorber mounting and access to the four trimming port screws should be readily obtainable.

80. The power unit is stowed either on the crate or on an adjacent portion of the aeroplane. The stowage consists of a platform on which are mounted the quick-release wing bolts. A spring suspension is unnecessary in view of the internally provided shock-absorber mounting of the rotary converter. The top cover should be readily removable without having to remove the whole unit from its platform. Subsequent stowage of any material which would prevent this should be avoided. When the aeroplane is in level flight, the rotary converter shaft should be horizontal, as its bearings have no provision for taking end-thrust. Before use, it should be verified that the armature of the starting relay is working freely, that the neon stabilizer tube is correctly in place, and that the H.T. fuse is intact and in position.

81. The control unit is mounted, by screwing the base-plate to the stowage provided, within reach of the pilot's seat and usually on the port side of the cockpit. To obtain access to the securing screws, detach the body of the unit from the base-plate by loosening the four fixing screws in the body.

82. The blind approach equipment is linked up with the aeroplane radio installation by means of a mixer unit known as junction box, type 9; this mixer unit consists of an aluminium alloy box containing a P.O. key switch, a 1 : 1 ratio A/F transformer, a 5-pin Breeze plug and a 4-way connector. A flexible 4-core cable is usually connected between the junction box and a 4-way terminal box fitted on the aeroplane.

83. Referring to fig. 34, it will be seen that the switch S_1 is provided with three positions. These are engraved INTER-COMM, MIX, and BLIND APPROACH respectively. Simplified diagrams, which explain the action of the switch, are given at B, C and D. This switching arrangement enables the pilot to select signals from either the blind approach receiver or the aeroplane inter-communication arrangements. In the intermediate position the output from these two sources is mixed by means of the transformer T_1.

84. The six-way junction box may be mounted on the crate or on extension brackets. In some installations a separate stowage, suitably marked, is provided on the aeroplane. The empty box is screwed to the stowage. Do not attempt to remove or replace the cover plate bearing the sockets, with the cable plugs in position in the sockets. When replacing the cover plate see that the interconnecting wires on the back are not trapped between the plate and box.

85. It is essential to ensure an efficient earthing connection between the junction box and the metal portions of the aeroplane or the aeroplane earthing system when the aeroplane is of non-metallic construction. If the unit is mounted in a crate, the paint on the brackets and on the contiguous surface of the junction box should be scraped away to ensure electrical continuity.

86. The visual indicator, which is a delicate instrument requiring careful handling, is normally mounted in the aeroplane dashboard. The Breeze socket behind the instrument is usually engaged by a right-angle plug on the instrument leads. In some cases a straight-through plug is fitted. The Breeze cable is threaded behind the dashboard to the point where it connects with the instrument. When auxiliary dial lighting is necessary, the two independent terminals on the back of the indicator are connected to the dashboard lighting system to operate a 12-volt lamp within the instrument. There is no connection between these terminals and the other circuits of the indicator.

87. The remote control bowden cables should be installed with great care to avoid sharp bends. The system will not operate satisfactorily if this precaution is neglected and, should operation be possible, undue wear and a liability to breakdowns will result. With the driven assembly removed from the receiver R.1124A, the coupling plate on the switch should be easy to turn with the fingers, and it should be possible to feel the switch arms passing the various contacts. The remote control will not operate satisfactorily if these conditions do not obtain.

88. The two angle-aluminium brackets on the main aerial, feeding receiver R.1124A, are screwed, through the holes provided, to a stowage in the form of a bracket or fitting containing four fixing holes. When the aerial tube is first passed through the gland provided in the skin of the aeroplane or if it is subsequently necessary to withdraw the tube through this gland, the closing cap must be removed by taking out the countersunk screw at the top. A clip is provided in the aeroplane for securing the handle when the aerial is in the retracted position. The socket on the aerial assembly terminating the co-axial feeder is reversible and may be fitted to face either outboard or inboard depending on the relative positions in the aeroplane of the aerial and its associated receiver R.1124A.

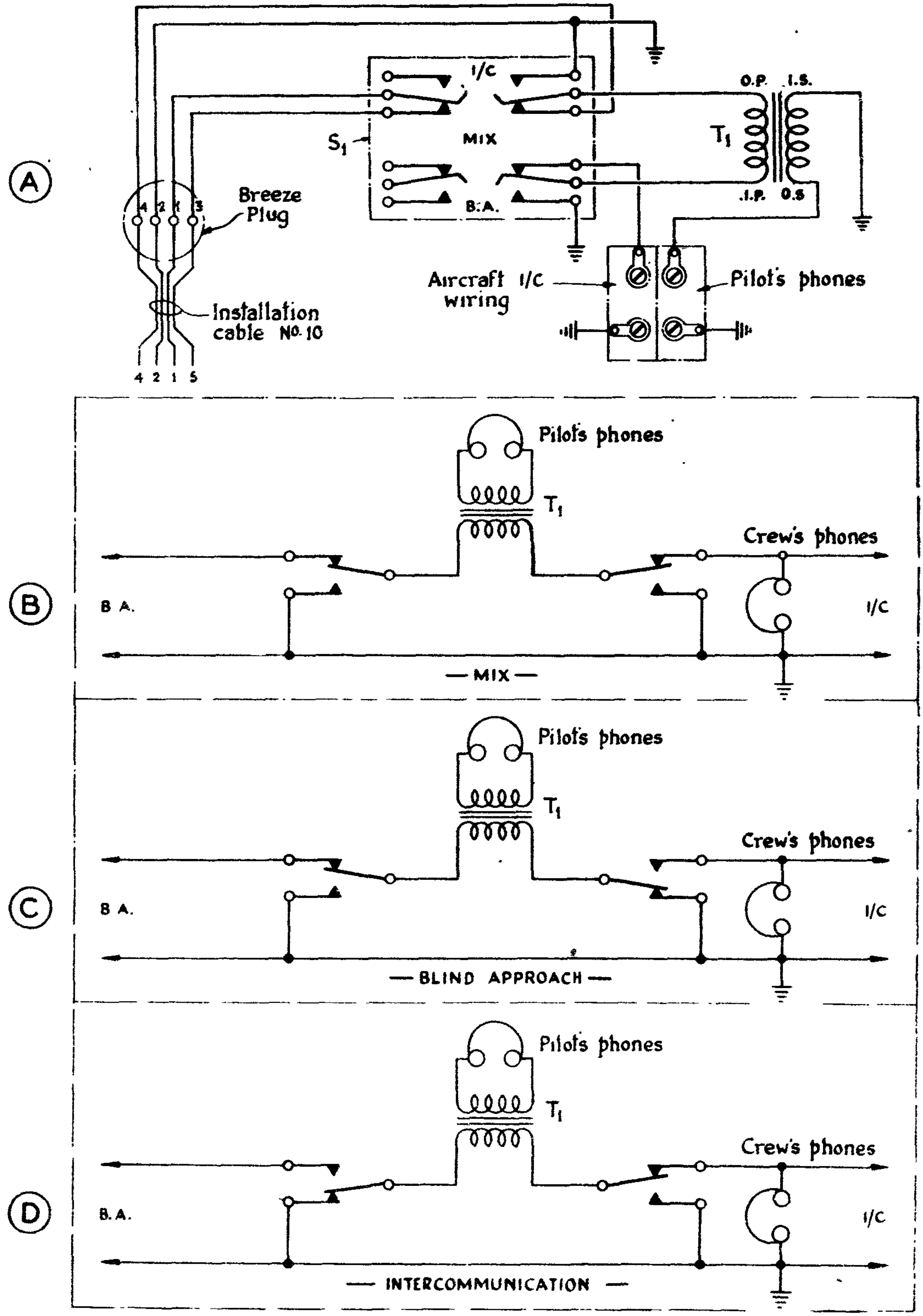

FIG. 34. JUNCTION BOX, TYPE 9, THEORETICAL CIRCUIT DIAGRAM

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89. The enclosed type of dipole aerial for receiver R.1125A is mounted under and outside the fuselage, the supporting brackets each being secured to a suitable anchorage, care being taken that not more than one-third of the total length of each tube is allowed to overhang. The associated junction box, containing the matching circuit, is clamped by a central bolt to a seating provided inside the aeroplane, the metal prongs on the underside of the box engaging with the turned-up portions of the aerial tubes. The holes in the floorwalk or lining of the aircraft through which the aerial tubes or their extensions pass should be at least $\frac{3}{4}$ in. diameter and their edges must be clear of the conductors.

90. With the unenclosed type of dipole aerial, the supports are screwed below the false floor of the aeroplane with the turned-up portions projecting to port or starboard. The associated junction box is mounted on its side with the socket facing upwards. This arrangement avoids obstruction of the floor of the machine and prevents damage to the junction box. The reflector screen should be thoroughly bonded in at least three positions. An area at least 7 ft. long and 1 ft. wide of the fabric immediately below the aerial should be kept free from metallic dope; clear or pigmented dope only should be applied to this area.

91. In both types of dipole aerial installation, care should be taken to earth the feeder socket by a 16 s.w.g. tinned copper wire connected from the soldering connection on the socket to the nearest suitable earth connection on the aeroplane.

92. The cables interconnecting the various units, except the aerial feeders and battery leads, consist of colour coded flexible leads protected by Breeze metal braided hose. The hose between the junction box and receiver R.1124A is $\frac{3}{4}$ in. internal diameter. The other cables are carried in hose of $\frac{1}{2}$ in. internal diameter. All the cables terminate in numbered plug connections which fit correspondingly numbered sockets on the appropriate units. It should be noted that some of the earlier installations have American threads on the plugs and sockets; later installations are provided with British threads. In order to differentiate between the two systems, it is suggested that, in the American installation, a red spot approximately $\frac{1}{4}$ in. diameter should be painted on the plugs and sockets at both ends of each cable run. The continuity of the earthing system depends upon the locking rings on the ends of the connectors, and care should be taken that these are screwed home tightly.

93. The battery lead is a dumet 19 cable. The single co-axial feeder connecting the main aerial and receiver R.1124A is a Telcon 5C cable. The double screened feeder connecting the dipole aerial and receiver R.1125A is a Telcon 12D cable.

ADJUSTMENT AND OPERATION

General

94. When the equipment has been installed in the aeroplane, and before adjustment, check the following points :—

(i) The aeroplane battery is correctly connected to the appropriate cable and is capable of maintaining an output of 7 amperes at 12 volts at the junction box terminals RT (fig. 32).

(ii) The valves in receivers R.1124A and R.1125A are in working order and correctly inserted.

(iii) The neon tube stabilizer and H.T. fuse are inserted in the power unit.

(iv) The aerials are connected to their appropriate receivers.

(v) The Breeze interconnections are in their correct positions and screwed home properly.

95. A test oscillator and an A.C. voltmeter are required for the alignment of the equipment. The Universal Avometer is suitable for the purpose. It should be set to a position in the " A.C. Volts " range that gives the maximum reading. This will usually be the second position, *i.e.* 75V or on some models, 120V. The A.C. voltmeter will function as an output meter, and it should be connected across the telephone terminals. Tuning should only be effected by means of the insulated trimming tool provided. In order to avoid any inaccuracy due to slight changes in frequency during the warming up period, it is advisable to switch on the apparatus at least 30 minutes before the adjustments are made.

Alignment of receiver R.1124A

96. Turn the pre-set course meter control (R_{26}) fully counter-clockwise and replace the receiver in its case. Set the frequency selector switch in the control unit to position 1, the service switch in the same unit to COURSE and the adjacent volume control for maximum volume (fully clockwise).

97. Connect up and switch on the test oscillator, tuning it to the desired frequency on the first receiver position. Set the modulation to 1,150 c/s. and bring the oscillator close to the aeroplane. Connect the A.C. voltmeter across the headphone sockets in the control unit and plug a pair of headphones into the cord socket. Switch on the equipment by means of the switch S_1 in the control unit. Listen for a slight residual hum in the headphones and verify that the rotary converter in the power unit is operating.

98. Remove the tuning panel cover of receiver R.1124A and turn the four condensers marked CT_1, CT_7, CT_{13} and CT_{19} to the approximate positions required. This can be found by taking the distance between the two marks on the sheet metal cover over each trimmer as the frequency range covered, *i.e.* 30·5 to 40·5 Mc/s, and mentally dividing it to get the spot frequency required.

99. Trimmer CT_{19} should now be carefully adjusted with the trimming tool until the signal heard in the headphones is a maximum, the slight amount of de-tuning caused by the tool being compensated for by a slight additional movement in the counter-clockwise direction. The remaining trimmers CT_1, CT_7 and CT_{13} should now be readjusted. For the final tuning the test oscillator should be so far removed from the aeroplane that the output shown by the Avometer does not exceed 10 volts on the 75V. A C. range with no telephones connected. The signal strength is thus kept below the value necessary to operate the A.G.C., and accurate tuning adjustments may be made. The final tuning must never be done with the course-glide switch in the "glide" position, since under these conditions the tuning of the receiver is affected by signal strength.

100. The other five spot frequencies are set up in a similar manner by means of the remaining groups of trimmers, *e.g.*, position 2, trimmers CT_2, CT_8, CT_{14} and CT_{20}. Finally, replace the cover over the trimmers and screw firmly home.

Alignment of receiver R.1125A and dipole aerial

101. Set the test oscillator to generate 38 Mc/s with 1,700 c/s modulation, and bring it close to the aeroplane. The test oscillator aerial should be placed in such a position that it is parallel and opposite to the dipole aerial in the aeroplane. Remove the tuning-port screws in the cover of receiver R.1125A. Before attempting to adjust the aerial trimmer, it will first of all be necessary to advance the reaction control, taking care that the receiver does not go into oscillation. Adjust the aerial trimmer C_1 and the trimmer across the coupling coil in the dipole aerial junction box to give maximum signal. Now adjust the reaction control until maximum output is shown by the output meter. Note the reading and reduce reaction until about half the maximum reading is shown. This adjustment will generally provide adequate marker sensitivity, but test flights will be necessary to determine the degree of sensitivity required. The reaction control must never be set at the threshold of oscillation, as, although the H.T. supply is stabilized, a variation in the L.T. voltage may cause the receiver to oscillate, resulting in loss of marker signals. All these controls interlock to a certain extent, and it is advisable to repeat this procedure in order to obtain optimum settings and a clear note.

102. The dipole aerial should be so balanced that reception on either half of the dipole is of equal intensity. This can be checked by earthing the sides of the aerial alternately at the junction box, and noting the deflection produced by the test oscillator in the output meter. The coil in the junction box may be balanced by springing the turns together or apart.

103. Now switch off the oscillator and turn the two neon lamp controls (R_5 and R_6) until a glow appears in both the visual indicator lamps. Turn them in a clockwise direction through an angle of about 20°, until the lamps are extinguished. Switch on the oscillator again. The inner marker indicator lamp should now light, and a 1,700 c/s tone should be heard in the headphones. Change the modulation of the test oscillator to 700 c/s. The outer marker indicator lamp should now light, the inner should be extinguished and a 700 c/s tone should be heard in the headphones. Finally, replace the cover on the junction box and the tuning-port screws in the cover of the receiver R.1125A.

Flight testing

104. In addition to the above adjustments, a check on the width of the beam should be carried out. The beam is usually adjusted at the transmitter to have an angular width of between 3° and 5°. Thus, with an angle of 4½° the beam should be 1½ miles wide at a distance of 20 miles from the transmitter. The aeroplane should be flown at a constant air speed directly across the beam at a distance of 20 miles from the transmitter and a height of about 3,000 ft. The air speed should be noted and the time in seconds elapsing between the disappearance of the "dots" and the appearance of the "dashes." The observation should be repeated by flying back across the beam at the same air speed after turning the aeroplane through 180°, and the mean of the two times taken. This figure when multiplied by the speed in m.p.h. and divided by 3,600 should give approximately 1½ miles if the receiving equipment is reproducing the beam width properly.

105. The correct functioning of the course meter should be checked and, if necessary, the meter movements should be reduced by means of the control (R_{26}) on receiver R.1124A, which should then be locked. The neon lamp controls (R_5, R_6) in receiver R.1125A may require readjustment to produce the best indications when flying over the marker beacons.

106. A note should be made of the most suitable position for the glide path gain control (R_2) on the control unit, when switching to GLIDE on passing over the outer marker beacon, at 1,000 ft. This position should be such that at the outer marker beacon the glide path meter reading is near the bottom of the scale and that it does not go over to full scale on any normal approach or landing. If interference from the engine is noticed, adequate steps should be taken for suppression at the source.

PRECAUTIONS AND MAINTENANCE

107. Immediately after its initial installation and before every flight in which the blind approach equipment is to be used, care should be taken that all valves are in an efficient condition and correctly inserted, the H.T. fuse is in position, the vertical and horizontal aerials are connected, and the Breeze interconnections between the various units and the main junction box are in their correct positions and screwed home. The supply voltage from the general service accumulator should be checked at the terminals RT of the junction box (*see* fig. 12). It should be not less than 12 volts while supplying a current of 7 amperes.

108. The equipment should be kept clean, dust may be removed either by wiping with a soft dry cloth or by means of a blast of dry air. All securing nuts and bolts and the Breeze connection plugs should be examined periodically for tightness. All contacts should be kept clean and free from grease.

109. The power unit should be removed from the aeroplane periodically. The commutators should be cleaned with a piece of clean linen, and the brushes examined to see that they are correctly bedded down and free to slide in the brush holders. They should not, however, be disturbed unnecessarily. If it is necessary to remove any brush, it should be carefully replaced in exactly the same position, otherwise it will take a long time to bed down again owing to the extremely light spring pressure employed in this machine.

110. On no account whatever must the armature be removed from the machine, otherwise the magnetism of the field magnet will be seriously impaired and the machine will be rendered useless.

111. All bonding connections on the aeroplane should be tested periodically for continuity. Faulty bonding may cause an excessive noise level in the telephones and irregular operation of the visual indicator.

112. The fit of the valve pins in their sockets should be checked whenever any unusual noise develops. If necessary the pins should be opened slightly with a thin-bladed knife. Valve sockets should be cleaned out with a wooden dowel.

113. If the signal fades out after the receiver has been in operation for one or two hours, it is usually an indication that the L.T. supply is failing. This may be due to a faulty or run-down accumulator. A similar effect may be noticed if the receiver has been incorrectly tuned owing to the tuning adjustments being made before the valves have reached a stable operating temperature. It is therefore necessary that the receiver should be switched on for about 30 minutes before tuning, as a frequency drift of 50 kc/s takes place during this period.

114. Intermittent or rough signals may be caused by breaks or badly soldered joints in the aerial feeder cables, but if key-clicks are present in the equi-signal zone and the beam edges are indistinct, the transmitter may be at fault.

115. The glide path meter normally reads about half scale when the glide-course switch is in the COURSE position. If the pointer of the glide path meter rises to the top of the scale when the aeroplane is close to the transmitter *e.g.* after the inner marker has been passed, the A.G.C. system may be defective. A fault in the A.G.C. system, which would result in a wide equi-signal zone and indistinct beam edges, may be due to a defect in one of the controlled valves *i.e.* V_1, V_3 or V_4. New valves should be inserted, one by one, until the faulty valve is discovered.

116. If the trouble persists after new valves have been substituted, it may be due to faulty insulation between the A.G.C. line and earth. The insulation may be tested with a megger in the following manner. The Breeze cabling should be disconnected from the receiver, and the glide-course switch put in the COURSE position. The resistance between the cable socket V or K and earth may now be measured. If this test proves satisfactory the valves V_1, V_3 and V_4 should be removed from the receiver, and the rectifiers W_3 and W_4 disconnected. The insulation resistance between the Breeze pin V or K and the chassis should now be measured.

117. After flying over the main beacon transmitter at a low altitude, the signal should cut out for about 20 seconds. If the period is abnormally prolonged, the receiver should be examined to ensure that the resistance R_{29} has been included.

118. If difficulty is experienced in tuning the receiver because of a change in capacitance when the pressure on the trimming tool is removed, a new trimmer should be fitted.

119. A faulty neon stabilizer may cause a sudden change in signal strength during flight. It is essential to ensure that the neon stabilizer in the power unit will strike under all conditions, especially with no signal, and with the glide-course switch in the COURSE position. If it fails to function correctly, a new stabilizer should be fitted.

APPENDIX

NOMENCLATURE OF PARTS

The following list of parts is issued for information only. When ordering spares for this equipment the appropriate section of AIR PUBLICATION 1086 must be used.

Ref. No.	Nomenclature.	Qty.	Ref. in Fig. 11	Remarks.
	Blind approach receiving equipment :—			
	Consisting of :—			
	Aerial, aircraft :—			
10B/10861	Type 1	1	—	External dipole. For Hampden, Whitley, Wellington, Harrow, London, Blenheim, Gladiator, Battle, Anson, Halifax, Botha, Beaufort and Defiant.
	or			
10B/10862	Type 2	1	—	Internal dipole. For Hurricane, Oxford and Beaufighter.
10B/10865	*Type 3	1	—	Retractable—fitted with contactor for length reduction on Oxford, Blenheim, Wellington, Anson, Hampden, Whitley, London, and Harrow.
	Box, junction :—			
10A/11842	Type 7	1	—	Main junction box.
10A/11986	†Type 9	1	—	Mixer for outputs.
	Connector :—			
10H/26	Type 103	1	1	For Halifax.
	or			
10H/27	Type 104	1	1	For Anson.
	or			
10H/28	Type 105	1	1	For Hurricane.
	or			
10H/29	Type 106	1	1	For Oxford.
	or			
10H/30	Type 107	1	1	For Battle and Gladiator.
	or			
10H/31	Type 108	1	1	For Spitfire.
	or			
10H/32	Type 109	1	1	For Botha.
	or			
10H/33	Type 110	1	1	For Blenheim, Whitley and London
	or			
10H/34	Type 111	1	1	For Hampden and Harrow.
	or			
10H/35	Type 112	1	1	For Albatross.
	or			
10H/36	Type 113	1	1	For Wellington.
	or			
10H/37	Type 114	1	1	For Beaufort.
	or			
10H/38	Type 115	1	2	For Blenheim.
	or			
10H/39	Type 116	1	2	For Hurricane, Oxford and Spitfire.
	or			
10H/40	Type 117	1	2	For Gladiator, Albatross and Beaufort.
	or			
10H/41	Type 118	1	2	For Wellington and Anson.
	or			
10H/42	Type 119	1	2	For Whitley, Harrow and Halifax.
	or			

* This item is not required when T.R. 1133 is fitted.

† This item is required only for Blind Approach /T.R.9 installations in bombers.

APPENDIX—*contd.*

Ref. No.	Nomenclature.	Qty.	Ref. in Fig. 11	Remarks.
	Blind approach receiving equipment :—(*contd.*)			
	Consisting of :—(*contd.*)			
	Connector :—(*contd.*)			
10H/43	Type 120 . . . . *or*	1	2	For Hampden and Botha.
10H/44	Type 121 . . . . *or*	1	2	For Battle and London.
10H/45	Type 122 . . . . *or*	1	3	For Hurricane, Oxford and Blenheim.
10H/46	Type 123 . . . . *or*	1	3	For Anson, Battle, London and Spitfire.
10H/47	Type 124 . . . . *or*	1	3	For Wellington.
10H/48	Type 125 . . . . *or*	1	3	For Hampden, Albatross and Halifax.
10H/49	Type 126 . . . . *or*	1	3	For Whitley and Harrow.
10H/50	Type 127 . . . . *or*	1	3	For Beaufort.
10H/51	Type 128 . . . . *or*	1	3	For Gladiator.
10H/52	Type 129 . . . . *or*	1	3	For Botha.
10H/53	Type 130 . . . . *or*	1	4	For Anson and Harrow.
10H/54	Type 131 . . . . *or*	1	4	For Blenheim, Hampden, Halifax and Botha.
10H/55	Type 132 . . . . *or*	1	4	For Beaufort.
10H/56	Type 133 . . . . *or*	1	4	For Hurricane, London and Spitfire
10H/57	Type 134 . . . . *or*	1	4	For Gladiator and Albatross.
10H/58	Type 135 . . . . *or*	1	4	For Oxford and Battle.
10H/59	Type 136 . . . . *or*	1	4	For Wellington.
10H/60	Type 137 . . . . *or*	1	4	For Whitley.
10H/61	Type 138 . . . . *or*	1	5	For Anson.
10H/62	Type 139 . . . . *or*	1	5	For Oxford, Halifax and Botha.
10H/63	Type 140 . . . . *or*	1	5	For Hurricane.
10H/64	Type 141 . . . . *or*	1	5	For Hampden and Gladiator.
10H/65	Type 142 . . . . . . *or*	1	5	For Battle.
10H/66	Type 143 . . . . *or*	1	5	For Whitley, London, Harrow and Beaufort.
10H/67	Type 144 . . . . . . *or*	1	5	For Blenheim.
10H/68	Type 145 . . . . *or*	1	5	For Albatross.
10H/69	Type 146 . . . . *or*	1	5	For Wellington.
10H/73	Type 148 . . . . *or*	1	5	For Spitfire.
10H/11174	Type 46 . . . . *or*	1	7	For Hurricane and Gladiator.

APPENDIX—*contd.*

Ref. No.	Nomenclature.	Qty.	Ref. in Fig. 11	Remarks.
	Blind approach receiving equipment :—(*contd*.)			
	Consisting of :—(*contd.*)			
	Connector :—(*contd.*)			
10H/11182	Type 51	1	7	For Oxford and Botha.
	or			
10H/11190	Type 57	1	7	For Blenheim and Spitfire.
	or			
10H/11216	Type 61	1	7	For Anson.
	or			
10H/11224	Type 67	1	7	For Battle, Hampden and London.
	or			
10H/11237	Type 74	1	7	For Wellington.
	or			
10H/11253	Type 83	1	7	For Whitley.
	or			
10H/11316	Type 87	1	7	For Harrow.
	or			
10H/11653	Type 96	1	7	For Halifax.
	or			
10H/70	Type 147	1	7	For Albatross and Beaufort.
	or			
10H/11175	Type 47	1	8	For Hurricane.
	or			
10H/11183	Type 52	1	8	For Oxford and Gladiator.
	or			
10H/11217	Type 62	1	8	For Anson and Halifax
	or			
10H/11225	Type 68	1	8	For Battle.
	or			
10H/11238	Type 75	1	8	For Wellington and Albatross
	or			
10H/11246	Type 79	1	8	For Hampden.
	or			
10H/11254	Type 84	1	8	For Whitley.
	or			
10H/11262	Type 86	1	8	For Blenheim, London and Beaufort.
	or			
10H/11317	Type 88	1	8	For Harrow.
	or			
10H/11797	Type 99	1	8	For Botha.
	or			
10H/74	Type 149	1	8	For Spitfire.
10H/187	*Type 150	1	—	For Hurricane.
	or			
	*Type	1	—	For Spitfire.
10H/188	*Type 151	1	—	For Hurricane.
	or			
	*Type	1	—	For Spitfire.
10H/189	*Type 152	1	—	For Hurricane.
	or			
	*Type	1	—	For Spitfire.
10H/190	*Type 153	1	—	For Hurricane.
	or			
	*Type	1	—	For Spitfire.
			Ref. in Fig. 8	
	Controls, remote, Type F :—			
10D/11184	Assembly No. 1	1	—	For Oxford and Spitfire. Length 4 ft.
	or			
10D/11192	Assembly No. 2	1	—	For Blenheim. Length 12 ft. 1 in.
	or			
10D/11218	Assembly No. 3	1	—	For Anson. Length 2 ft. 7½ in.
	or			
10D/11226	Assembly No. 4	1	—	For Battle. Length 3 ft 3 in.
	or			

*These items required for Hurricane and Spitfire only.

APPENDIX—*contd.*

Ref. No.	Nomenclature.	Qty.	Ref. in Fig. 8	Remarks.
	Blind approach receiving equipment :— (*contd.*)			
	Consisting of :—(*contd.*)			
	Controls, Remote, Type F :—(*contd.*)			
10D/11255	Assembly No. 5	1	—	For Whitley. Length 11 ft. 7 in
	or			
10D/11263	Assembly No. 6	1	—	For London and Wellington. Length 5 ft. 1 in.
	or			
10D/11318	Assembly No. 7	1	—	For Harrow. Length 12 ft. 10 in.
	or			
10D/11418	Assembly No. 8	1	—	For Gladiator, Hurricane and Halifax. Length 7 ft.
	or			
10D/11810	Assembly No. 9	1	—	For Beaufort. Length 13 ft. 7 in.
	or			
10D/48	Assembly No. 10	1	—	For Hampden and Botha. Length 7 ft. 6 in.
	Control unit :—			
10A/11841	Type 6	1	—	
10A/11456	*Type 12	1	—	
10A/10863	Indicator, visual	1	—	
	Power-unit :—			
10A/11840	Type 5	1	—	12 V. input.
	or			
10A/11853	Type 12	1	—	24 V. input.
10D/5	Receiver R.1124A	1	—	
10D/6	Receiver R.1125A	1	—	
	Switch-unit :—			
10F/13	†Type F	1	—	Aerial and telephone switch, 12 V. operated.
	or			
10F/14	†Type G	1	—	Aerial and telephone switch, 24 V. operated.
10A/11841	Control unit, Type 6 :—			
	Principal components :—			
10H/11265	Connector, telephone	1		
	Resistances :—			
10C/11105	Type 450	1	R_3	150Ω ⅓ watt.
10C/11109	Type 454	1	R_2	400Ω, potentiometer.
10C/11110	Type 455	1	R_7	20,000Ω potentiometer.
10C/11111	Type 456	1	R_9	50Ω, ⅓ watt.
10C/11087	Type 447	1	R_5	1,000Ω, ⅓ watt.
10C/108B	Type 576	1	R_8	130Ω, ⅓ watt.
10C/11114	Type 459	1	R_6	20,000Ω, ⅓ watt.
	Switches :—			
10F/11115	Bulgin S 80 T	1	S_1	S.P., ON-OFF.
10F/11116	Yaxley RL 7016–15–6	1	S_2, S_3, S_5	Three-bank.
10A/11840	Power unit, Type 5			
	Principal components :—			
	Condensers :—			
10C/10629	Type 440	6	C_2-C_4, C_7-C_9	0·01μF.
10C/10825	Type 484	1	C_6	4 μF.
10C/10911	Type 501	2	C_5, C_1	2 μF.
10H/10916	Fuse, type 1055/150	2	F_1 and spare.	150 mA. Belling Lee.
	Inductances :—			
10C/10805	4062A	1	L_4	A/F choke.
10C/10912	125 LU 8/20	3	L_1, L_5, L_6	
10C/10913	125 LU 8/17	2	L_2, L_3	
10F/10915	Relay, type 4615 AW	1	REL_2	
10C/1617	Resistance	1	R_1	3,000Ω, 5 watt.

* This item required for Wellington only.

† This item necessary only in Blind Approach/T.R.1133 Installations.

APPENDIX—*contd.*

Ref. No.	Nomenclature.	Qty.	Ref. in Fig. 6	Remarks.
	Blind approach receiving equipment :— (*contd.*)			
	Consisting of :—(*contd.*)			
	Receiver R.1124 A :—			
	Principal components :—			
	Condensers :—			
10C/7901	Type 120	1	C_{24}	0·001 μF.
10C/8010	Type 133	11	C_2-C_7, C_{25}-C_{27}, C_{31}, C_{32}	0·002 μF.
10C/10394	Type 404	1	C_8	10 $\mu\mu$F.
10C/11075	Type 502	1	C_{23}	0·01 μF.
10C/11076	Type 503	12	C_9-C_{17}, C_{28}-C_{30}	0·1 μF.
10C/11077	Type 504	24	CT_1-CT_{24}	Trimmers.
10C/11078	Type 505	1	C_{19}-C_{22}	2+2+2+2 μF.
10C/11074	Type 512	1	C_{18}	2 $\mu\mu$F.
	Inductances :—			
10C/11081	20 LU 52 B..	1	L_1	Aerial.
10C/11082	20 LU 52 A..	1	L_2	R/F.
10C/11083	3 LU 24	1	L_3	Oscillator.
10C/11084	20 LU 51 A	3	L_4-L_6	I/F.
10D/22	Rectifier, W X 12, type 15.. ..	1	W_3	Westector.
10D/11080	Rectifier, W X 6	2	W_1,W_2	Westector.
	Resistances :—			
10C/11111	Type 456	1	R_{17}	50Ω, ⅓ watt.
10C/11085	Type 460	1	R_{26}	500Ω, potentiometer.
10C/11086	Type 461	1	R_5	300Ω, ⅓ watt.
10C/11087	Type 447	7	R_3, R_1, R_9, R_{11}, R_{12}, R_{14}, R_{27}	1,000Ω, ⅓ watt.
10C/11088	Type 462	3	R_7, R_{15}, R_{28}	2,000Ω, ⅓ watt.
10C/11089	Type 463	4	R_6, R_{10}, R_{13}, R_{21}	10,000Ω, ⅓ watt.
10C/11090	Type 448	2	R_8,R_{20}	100,000Ω, ⅓ watt.
10C/11091	Type 464	1	R_1	250,000Ω, ⅓ watt.
10C/11092	Type 465	2	R_{22}, R_{24}	500,000Ω, ⅓ watt.
10C/11093	Type 466	1	R_{25}	1 MΩ, ⅓ watt.
10C/11094	Type 467	2	R_{23}, R_{29}	5MΩ, ⅓ watt.
10C/11477	Type 553	1	R_{16}	25,000Ω, ⅓ watt.
10F/11079	Switch, R1.7016-15-5	1	S_1-S_5	Yaxley, five bank.
	Transformers :—			
10A/11099	4300-1	1	T_1	
10A/11100	4300-3	1	T_2	
10D/6	Receiver R. 1125A :—		Ref. in Fig. 7	
	Principal components :—			
	Condensers :—			
10C/7902	Type 121	1	C_2	0·0001 μF.
10C/8009	Type 132	1	C_3	0·0005 μF.
10C/11075	Type 502	3	C_4, C_7, C_9	0·01 μF.
10C/11076	Type 503	1	C_{10}	0·1 μF.
10C/11077	Type 504	1	C_1	Trimmer.
10C/10394	Type CDS 3	1	C_{11}	10 $\mu\mu$F.
10C/11101	Type 506	1	C_6	0·04 μF.
10C/11102	Type 507	1	C_8	0·22 μF.
10C/10651	Type	1	C_5	0·1 μF.

APPENDIX—*contd.*

Ref No.	Nomenclature.	Qty.	Ref. in Fig. 7	Remarks.
	Blind approach receiving equipment:—(*contd.*)			
	Consisting of :—(*contd.*)			
	Receiver R. 1125A :—(*contd.*)			
	Principal components :—(*contd.*)			
	Inductances :—			
10C/10790	3 LU 25 A	1	L_3	Aerial.
10C/11107	20 LU 50 A	1	L_1	2 iron-core. Single case.
	Resistances :—			
10C/11087	Type 447	1	R_7	1,000 μF, $\frac{1}{3}$ watt.
10C/11090	Type 448	3	R_1, R_8, R_9	100,000Ω, $\frac{1}{3}$ watt.
10C 11104	Type 449	3	R_4, R_5, R_6	200,000Ω, potentiometer.
10C/11105	Type 450	1	R_2	100Ω, $\frac{1}{3}$ watt.
10C/11106	Type 451	2	R_3, R_{10}	50,000Ω, $\frac{1}{2}$ watt.
10C/11094	Type 467	1	R_{11}	5MΩ, $\frac{1}{3}$ watt.
	Transformers :—			
10A 11108	6484B	1	T_1	Auto.
10A/11282	CG 4300–4	1	T_2	
	Accessories :—			
	Aerial, aircraft, types 1 and 2 :—			
10A/10866	Impedance, Matching unit, type 8	1		
10B/10869	Insulator, type 40 (for aerial, type 2)	6	—	Tufnol stand-off insulator.
	Aerial, aircraft, type 3 :—			
10A/10858	*Coil, loading	1		
10H/162	Socket, type 87	1	—	Screened.
	Controls, remote :—			
10A/11419	Tool, tensioning	—	—	
	Control unit :—			
10A/10871	Mounting, type 30	1		
10H/7971	Socket, type 29	1	—	Micro-telephone, 4-contact, single pin
	Indicator, visual :—			
	Lamp, filament :—			
5A/2182	12 V., 3 W.	1		
	or			
5A/2183	24 V., 3 W.	1		
10E/6	Lamp, indicating neon No. 3 ..	2		
	Power unit :—			
10A/10917	Brushes, set of	1	—	For rotary transformer
10A/11264	Mounting, type 31	1	—	Comprising base and swing bolts.
10E/10914	Stabilizer, Neon, type V.S 110 ..	1		
	Receiver R.1124A :—			
10A/11421	Tool, tuning	1		
	Valves :—			
10E/11905	Type V.R.106	3	V_1, V_3, V_4	R.F. amplifiers.
10E/11096	Type V.R.108	1	V_5	Second detector.
10E/11097	Type V.R.107	1	V_2	Frequency changer.
10E/11098	Type V.R.109	1	V_6	Output.
	Receiver R.1125A :—			
	Valves :—			
10E/11098	Type V.R. 109	1	V_1	Detector
10E/11096	Type V.R. 108	1	V_2	Output.

* This item required for Wellington, London, Harrow, Hampden and Whitley.

SECTION 3, CHAPTER 8

RECEIVER R.1116

CONTENTS

LIST OF ILLUSTRATIONS

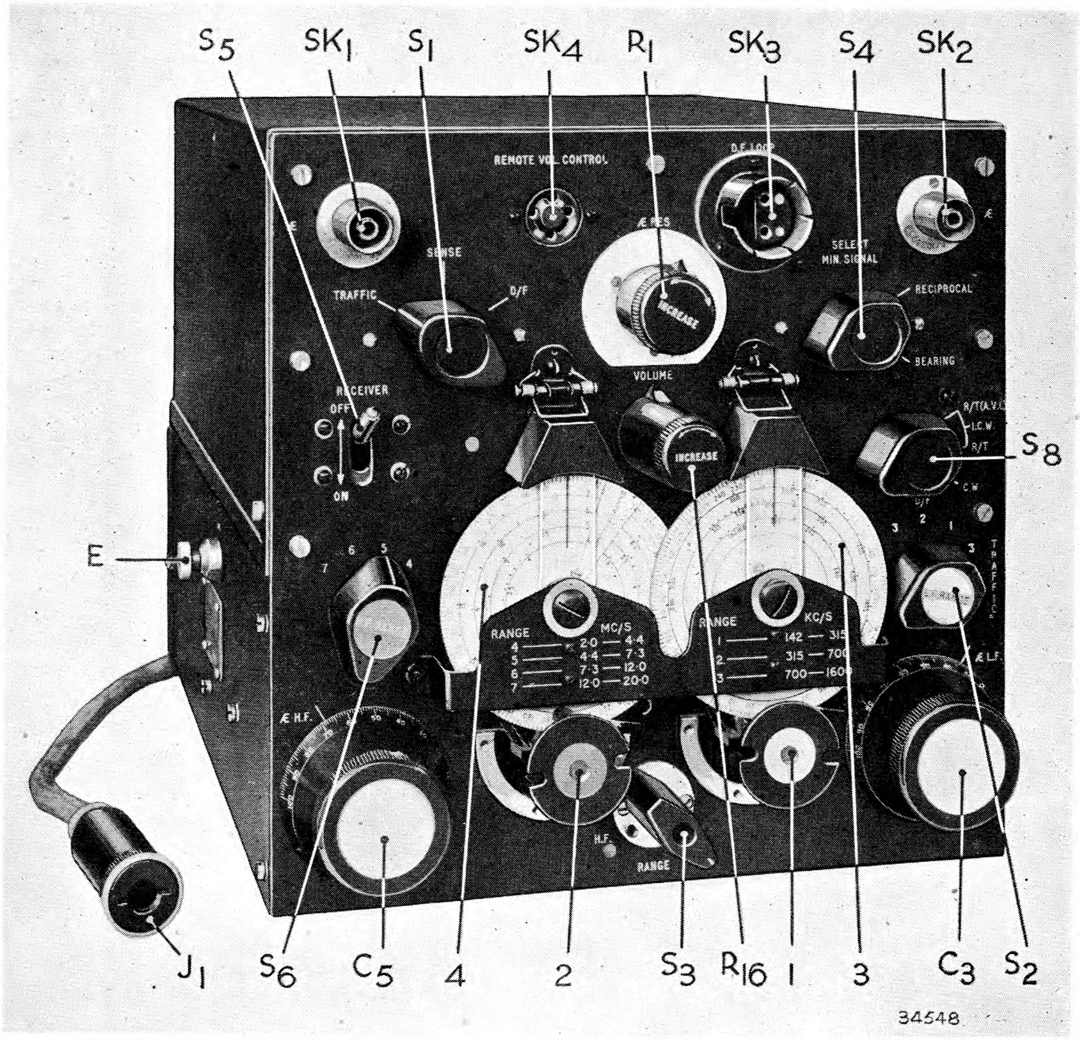


Fig. 1.—R.1116, FRONT PANEL LAYOUT

RECEIVER, TYPE R.1116

(Stores Ref. 10D/10310)

INTRODUCTION

1. The receiver, type R.1116 is a general purpose aeroplane receiver, designed primarily for installation with the transmitter, type T.1115, which is described in Section 1, Chapter 8, of this publication. Provision is made for the reception of C.W., I.C.W. or R/T signals over the frequency bands of approximately 142 kc/s to 1,600 kc/s and 2 Mc/s to 20 Mc/s. Simplified switching permits the instantaneous selection of either of two predetermined frequencies with those bands.

2. In conjunction with the transmitter T.1115 facilities are provided for listening-through, side-tone and intercommunication. Remote control of fine-tuning can be fitted. The receiver is adapted for direction-finding with a D/F loop and sense-finding unit, this application referring only to the 142 kc/s to 1,600 kc/s band.

3. The receiver circuit is a double-frequency change superheterodyne employing seven valves. In addition, a diode valve is connected across the input circuit for listening-through.

4. The L.T. supply is obtained from a 2-volt accumulator, the H.T. supply from a 120-volt battery and the grid bias from a $10\frac{1}{2}$-volt battery. The approximate overall dimensions of the receiver are $10\frac{3}{8}$ in. by $13\frac{1}{4}$ in. by $15\frac{3}{4}$ in. The weight, complete with valves and grid-bias batteries, is $24\frac{1}{2}$ lb. It should be noted that certain earlier models are not suitable for R/T reception, and these are distinguished by bearing the letter 'N' stencilled in white on the side of the case, immediately to the right of the A.M. label.

GENERAL DESCRIPTION

5. A theoretical circuit diagram of the receiver is given in fig. 2. The circuit adopted is the double frequency-change superheterodyne. This choice was dictated by considerations of sensitivity, selectivity, and the switching requirements necessitated by the selection of two predetermined frequencies, one in each range band. A schematic diagram of the circuit of the R.1116 showing the stage by stage arrangement is given in fig. 4, and a simplified circuit diagram in fig. 3.

6. A full discussion of the theoretical aspect of the superheterodyne can be found in Chapter XI ('Amplification') of Air Publication 1093. Each frequency conversation necessitates the provision of a valve-driven R.F. oscillator. During the reception of R/T and I.C.W. the modulation of the incoming signals is transferred to a first intermediate frequency ('first I.F.'), of 1,700 kc/s. The use of this rather high frequency affords a good image ratio even at the highest signal frequency of 20 Mc/s.

7. The modulation is again transferred to a second intermediate frequency ('second I.F.') of 100 kc/s. This second I.F. is low enough to give adequate channel selectivity but, at the same time, provides sufficient band-width for intelligible telephony. The modulated second I.F. signal is then rectified and the A.F. output amplified before reaching the telephone receivers.

8. The action when receiving C.W. is substantially the same as that outlined in the preceding paragraph. Instead, however, of a new modulated carrier frequency being generated by each frequency changer, an unmodulated oscillation is produced. Before rectifying the second I.F., therefore, it is necessary to introduce a heterodyne oscillator operating at a frequency about 1 kc above the second I.F., that is at 101 kc/s. Arrangements are made whereby the output of the R.F. stage is automatically maintained at any desired load, within reasonable limits, when receiving strong signals which would otherwise overload the A.F. stages. This process is commonly referred to as automatic volume control (A.V.C.). If A.V.C. is not required, the R.F. gain may be controlled manually by the operation of a potentiometer, and this operation must be effected during the reception of key-controlled signals.

9. To provide an increased A.F. output for the reception of R/T and for intercommunication, the output stage is arranged in quiescent push-pull (Q.P.P.), a double pentode valve being used. This type of output stage is particularly adapted for use in receivers deriving H.T. supply from a battery source because the mean anode current is considerably less, output for output, than that required by a single power valve operated as a Class A amplifier.

Circuit switching arrangements

10. The aerial is connected *via* the SEND-RECEIVE switch of the transmitter T.1115 to a three-position switch S_1, one section of which has three positions TRAFFIC, SENSE and D/F, whilst

the other section closes at SENSE and opens at TRAFFIC and D/F. The coil switching arrangements are shown diagrammatically in fig. 5.

11. The change from the lower (142 kc/s to 1,600 kc/s) to the upper (2 Mc/s to 20 Mc/s) frequency band is effected by a double-pole double-throw switch S_3. It should be noted that the ranges on this instrument are designated by the same colour code applied to the transmitter T.1115, switch and tuning control positions being coloured YELLOW for the lower and GREEN for the upper band.

12. The switch S_3 is used, as to its sections S_{3a} and S_{3b}, to select either the YELLOW or the GREEN range. With S_{3a} in the YELLOW position the aerial circuit is tuned by one of three inductances, L_1, L_2 or L_3 and a variable condenser C_3. The aerial is then coupled to the tuned circuit by a series condenser C_2. With S_{3a} in the GREEN position one of the inductances L_7, L_8, L_9 or L_{10} is in circuit with an associated tuning condenser C_5 and a series condenser C_4. The section S_{3e} switches on one of the two dial lamps, depending upon the band being used. Sections S_{3d} and S_{3c} switch the grid and anode circuits, respectively, of the first frequency changer. The YELLOW position of S_3 also incorporates the D/F circuit.

13. Section S_{2b} of the switch S_2 selects one of the 'traffic' inductances L_1, L_2 and L_3, or, in conjunction with S_{2a}, one of the three D/F transformers L_4, L_5 and L_6. The section S_{2c} switches in one of the oscillator grid inductances L_{11}, L_{12} or L_{13} together with one of the corresponding anode inductances.

14. The upper frequency, or GREEN range, is switched to one of the four aerial circuit inductances L_4, L_5, L_6 and L_7 by a switch S_6 through its section S_{6c}. The sections S_{6b} and S_{6a} select the appropriate oscillator grid and anode inductances from L_{14}, L_{15}, L_{16} or L_{17}.

15. When the switch S_1 is at TRAFFIC the signal input is capacitance coupled *via* a condenser C_{10} to the signal grid T.C. of a triode-heptode valve V_2. The condenser C_{10} enables the valve to set itself, by grid current, at the correct working condition. A resistance R_5 maintains the grid at a suitable potential.

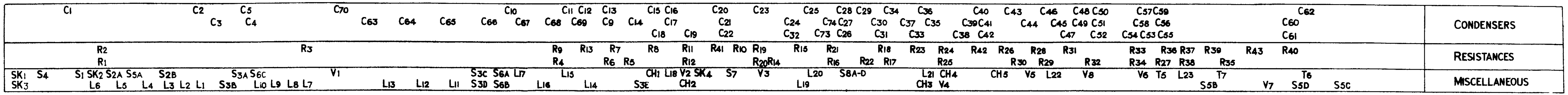
16. The valve V_2 consists of two valves contained within a single metallized glass envelope. The two filaments, connected internally to a single pair of pins, are fed in parallel. The triode-heptode is similar to the triode-hexode, the additional suppressor grid serving to increase the anode resistance and to improve performance at the higher frequencies. A theoretical discussion of the valve action can be found in Chapter XI ('Amplification') of Air Publication 1093, Signal Manual, Part II. A feed resistance R_7 drops the H.T. voltage to a suitable potential at which to maintain the screening electrodes. In the screen circuit a condenser C_{13} acts as a decoupler.

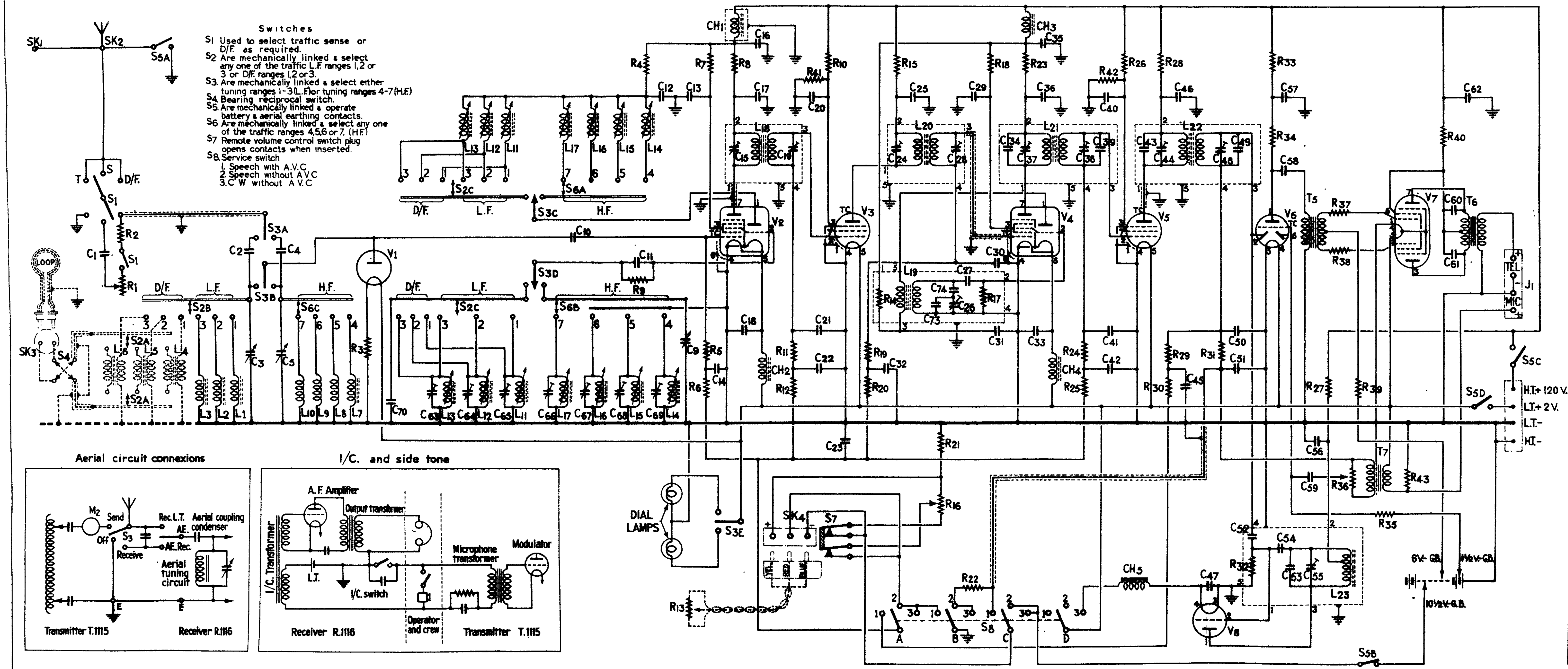
17. In association with the triode portion of V_2 there is a R.F. oscillator of the tuned-grid/tuned-anode type. The oscillator grid and anode coils are all permeability tuned, the grid coils having, in addition, a small capacitance trimmer across each one. The feed-back of energy by the anode to the grid circuit is brought about by the anode-grid capacitance of the valve V_2. The grid of the triode portion of V_2 is maintained at a suitable negative potential by a condenser C_{11} and leak resistance R_9.

18. The first R.F. oscillator is tuned to a frequency 1,700 kc/s above the incoming signal frequency. As the third ('injector') grid of the heptode portion of V_2 is directly connected to the grid of the triode portion, the resultant oscillation is superimposed upon the anode current of the heptode portion which is also oscillating at the signal frequency. In the heptode anode circuit there are, therefore, oscillations both of the sum (signal plug oscillator) and the difference (oscillator minus signal, or 1,700 kc/s) of the two frequencies involved. The circuit comprising C_{15} and the primary winding of an I.F. transformer L_{18}, is tuned to the difference frequency. Only voltages of this frequency are, to any appreciable extent, transferred to the secondary circuit comprising the secondary winding of L_{18} and the capacitance of C_{19}, and these voltages vary in amplitude in accordance with the signal input of the R/T, I.C.W. or C.W. oscillations whichever may apply.

19. The anode circuit of the first R.F. oscillator is fed through the resistance R_4, a decoupling condenser C_{12} being fitted. The heptode portion is fed through resistance R_8, and a high frequency choke Ch_1 and is decoupled by the condenser C_{17}. The choke Ch_1 is of the dust-iron core, screened and earthed variety and in conjunction with the condenser C_{16} decouples the whole feed circuit of the first frequency changer valve from the remainder of the R.F. circuits.

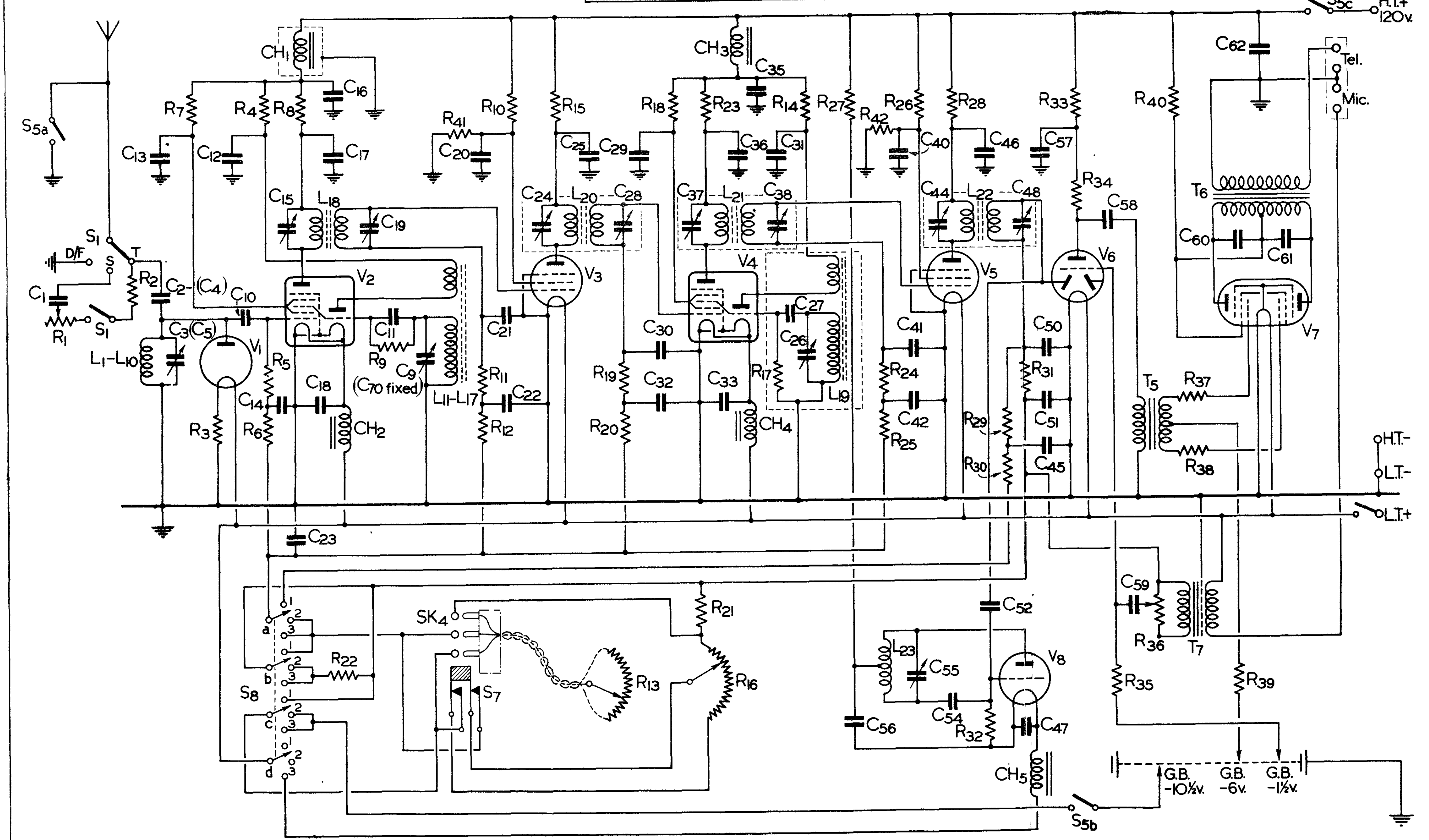
20. The output from the first I.F. transformer L_{18} is applied *via* a condenser C_{21}, to the grid and the filament of a first I.F. amplifier valve V_3 which is a R.F. pentode having variable mu characteristics. A resistance R_{11} determines the grid bias voltage of this valve. A fixed tapping on the potentiometer consisting of R_{10} and R_{41} provides for the mean screen voltage. The capacitance of a condenser C_{20}, between the screen line and earth, practically eliminates the oscillatory component.





CONDENSERS			
C1	25 µµF	C60	0·001 µF
C2	70 µµF	C61	0·001 µF
C3	500 µµF. VAR.	C62	2·0 µF
C4	50 µµF	C63	15-45 µµF
C5	500 µµF. VAR.	C64	15-45 µµF
C9	VAR	C65	
C10	100 µµF	C66	
C11	100 µµF	C67	
C12	0·1 µF	C68	
C13	0·1 µF	C69	
C14	0·01 µF	C70	150 µµF
C15	100 µµF. VAR.	C73	50 µµF
C16	0·1 µF	C74	50 µµF
C17	0·1 µF	RESISTANCES	
C18	0·01 µF	R1	0·25 MΩ
C19	100 µµF. VAR.	R2	30,000 Ω
C20	0·1 µF	R3	0·75 Ω
C21	0·01 µF	R4	30,000 Ω
C22	0·1 µF	R5	1·0 MΩ
C23	0·1 µF	R6	0·1 MΩ
C24	100 µµF. VAR.	R7	60,000 Ω
C25	0·1 µF	R8	1,000 Ω
C26	100 µµF. VAR.	R9	30,000 Ω
C27	100 µµF	R10	0·1 MΩ
C28	100 µµF. VAR.	R11	0·25 MΩ
C29	0·1 µF	R12	0·1 MΩ
C30	0·01 µµF	R13	50,000 Ω
C31	0·1 µF	R14	0·2 MΩ
C32	0·01 µF	R15	1,000 Ω
C33	0·01 µF	R16	50,000 Ω
C34	200 µµF	R17	50,000 Ω
C35	0·1 µF	R18	0·15 MΩ
C36	0·1 µF	R19	0·25 MΩ
C37	100 µµF. VAR.	R20	0·1 MΩ
C38	100 µµF. VAR.	R21	10,000 Ω
C39	200 µµF	R22	50,000 Ω
C40	0·1 µF	R23	1,000 Ω
C41	0·01 µF	R24	0·25 MΩ
C42	0·1 µF	R25	0·1 MΩ
C43	200 µµF	R26	0·1 MΩ
C44	100 µµF. VAR.	R27	50,000 Ω
C45	0·01 µF	R28	1,000 Ω
C46	0·1 µF	R29	1·0 MΩ
C47	0·5 µF	R30	0·1 MΩ
C48	100 µµF. VAR.	R31	0·25 MΩ
C49	200 µµF	R32	0·1 MΩ
C50	300 µµF	R33	1,000 Ω
C51	500 µµF	R34	30,000 Ω
C52	1·5 µµF	R35	1·0 MΩ
C53	100 µµF	R36	0·5 MΩ
C54	100 µµF	R37	5,000 Ω
C55	100 µµF. VAR.	R38	5,000 Ω
C56	0·1 µF	R39	0·15 MΩ
C57	0·5 µF	R40	5,000 Ω
C58	0·1 µF	R41	0·2 MΩ
C59	0·01 µF	R42	0·2 MΩ
		R43	100 Ω

FIG. 2 R.1116. THEORETICAL CIRCUIT DIAGRAM FIG. 2

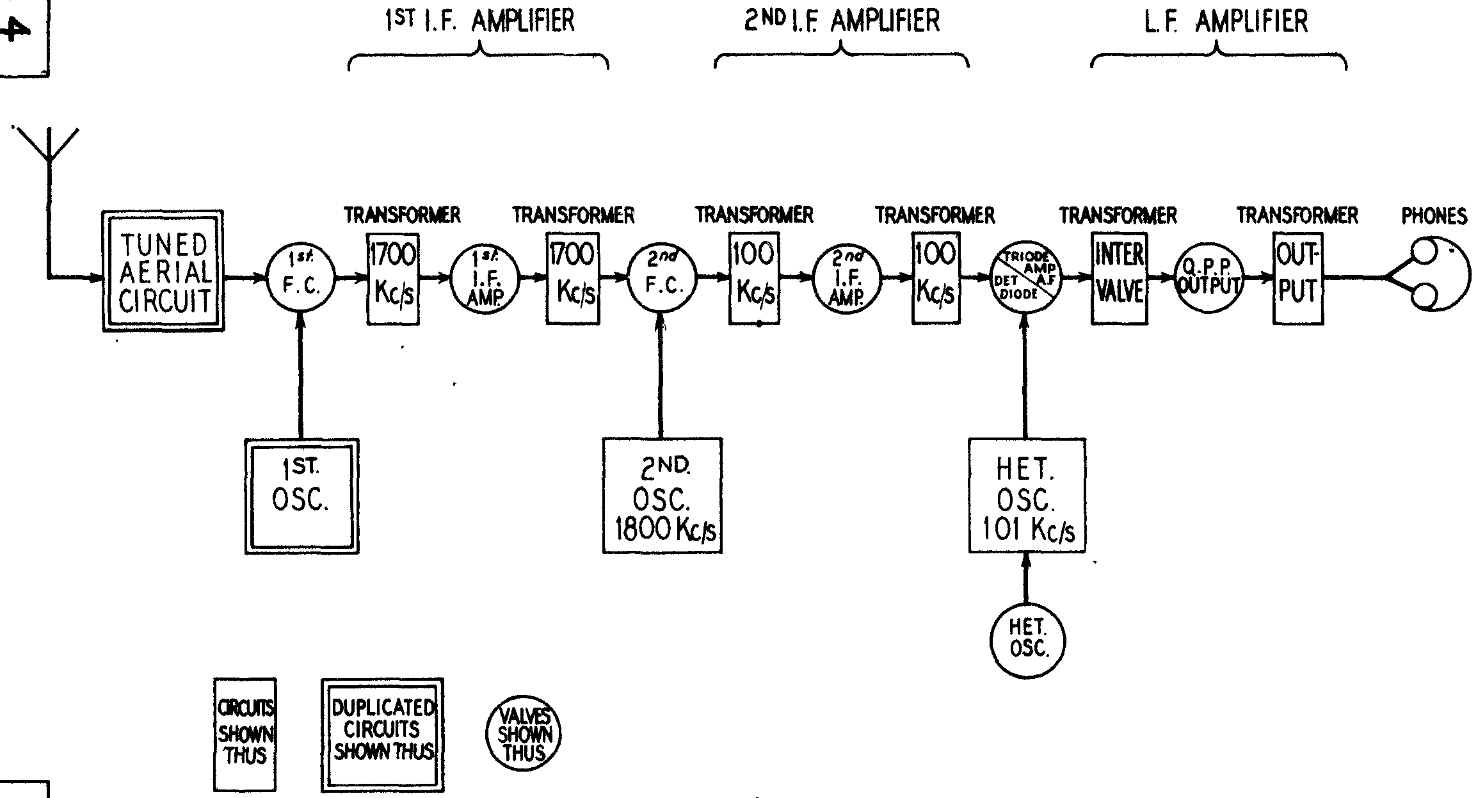


SIMPLIFIED CIRCUIT DIAGRAM

FIG. 3

FIG. 3

FIG 4



SCHEMATIC DIAGRAM

FIG. 4

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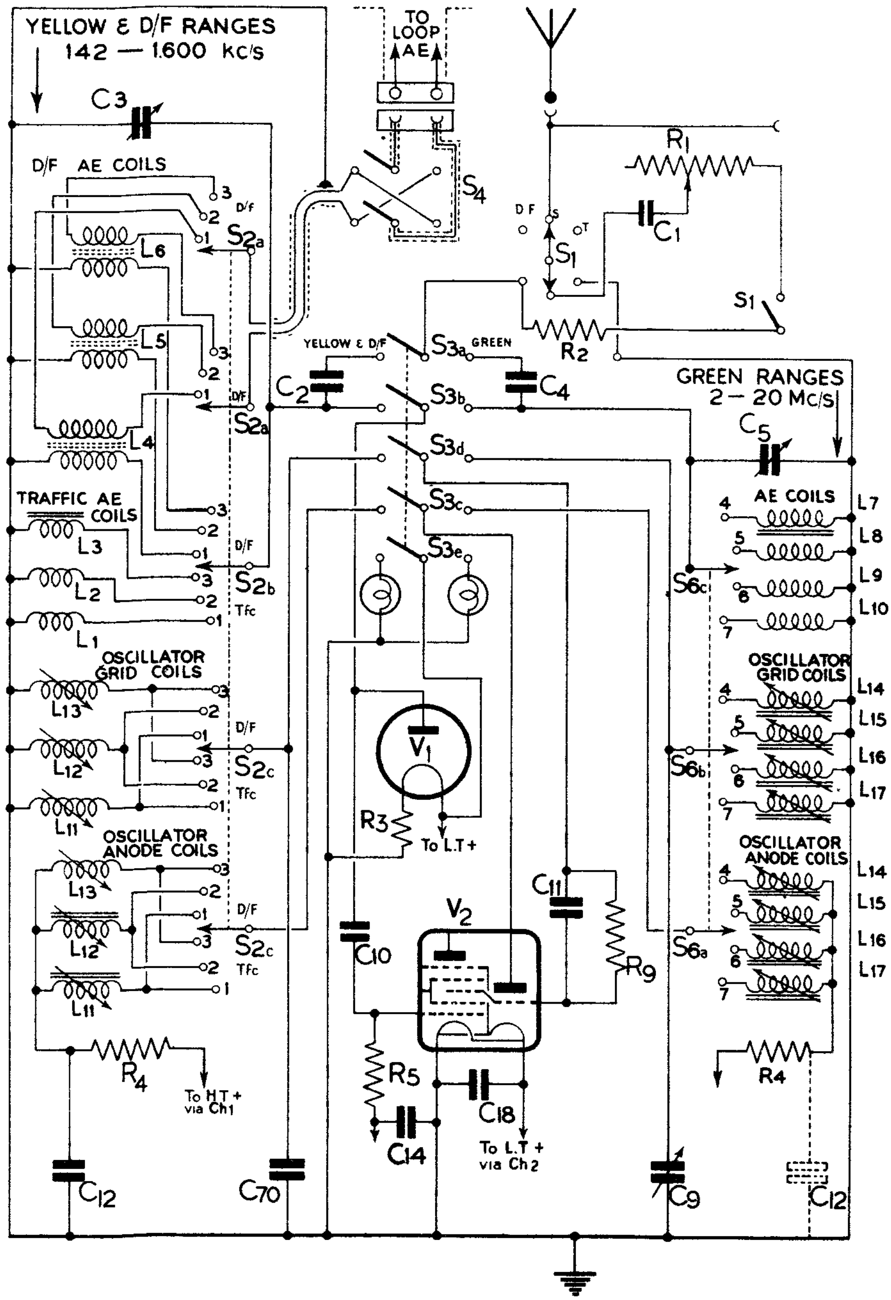

COIL SWITCHING DIAGRAM

FIG. 5

FIG. 5

21. The anode circuit of V_3 comprises the primary winding of an I.F. transformer E_{20}, shunted by a condenser C_{24}, and a dropping resistance R_{15}. A decoupling condenser C_{25} is fitted. Excitation for the second frequency changer valve V_4 is supplied from the secondary winding of L_{20} across which a variable condenser C_{28} is placed. This transformer and the previous one L_{18} have both primary and secondary circuits tuned to the first I.F. Each of the transformers, therefore, acts as a band-pass filter, giving a level response over a frequency band of approximately 5 kc/s centred about the nominal I.F. of 1,700 kc/s.

22. The output voltage of the transformer L_{20} is applied to the signal grid T.C. and filament of the second frequency-changer valve V_4, through a condenser C_{30}, the grid bias being supplied *via* a resistance R_{19}. The arrangement of this valve is similar to that of V_2, the first frequency changer, except that the second R.F. oscillatory circuit is of the tuned grid, mutual inductance type, known as the split-Hartley oscillator, and maintains an oscillation frequency of 1,600 kc/s.

23 The grid circuit of the triode portion is constituted by L_{19} and a trimming condenser C_{26}, grid bias being maintained at a predetermined value by a condenser C_{27} and a leak resistance R_{17}. The anode circuit receives its H.T. supply *via* a fed resistance R_{14} and is decoupled by a condenser C_{31}. The screening electrodes of the heptode portion of V_4 are fed through a resistance R_{18}, a condenser C_{29} maintaining the R.F. potential of the screen at, substantially, zero level.

24. The anode circuit of the valve V_4 contains the primary winding of a transformer L_{21} which is tuned by a fixed condenser C_{34} and a trimmer condenser C_{37} to the difference frequency, namely 100 kc/s, between the 1,700 kc/s of the heptode input and the second R.F. oscillator frequency of 1,600 kc/s. The H.T. is supplied through a resistance R_{23} and the line is decoupled by a condenser C_{36}. The whole H.T. feed arrangement of the valve V_4 is decoupled by an iron-dust cored R.F. choke CH_3 and a condenser C_{35}. The secondary winding of the transformer L_{21} with the condensers C_{38} and C_{39} delivers an output voltage which is of the difference frequency, 100 kc/s and of the same characteristic envelope (R/T, I.C.W. or C.W.) as the incoming signal.

25. The valve V_5 is a pentode of the same type as V_3 and functions as the second I.F. amplifier. The output from the secondary circuit of the transformer L_{21} is applied between the grid and the filament of this valve by a condenser C_{41}. A condenser C_{42} and a resistance R_{25} act as a decoupling arrangement. The bias for V_5 is determined by a resistance R_{24}. The screen mean voltage is set at a suitable potential by the tapping on a potentiometer formed by resistance R_{26} and R_{42}. A condenser C_{40} performs a function similar to that of C_{20} mentioned in para. 20.

26. The anode of V_5 is series-fed *via* a resistance R_{28} and the primary winding of an I.F. transformer L_{22}. This winding has the capacitance of condensers C_{43} and C_{44} in parallel and the line is decoupled by a condenser C_{46}. The transformers L_{21} and L_{22} are electrically similar, being wound on iron-dust cores and having each winding tuned to 100 kc/s by a trimming condenser with a fixed capacitance in parallel. The control grid bias is determined by a volume control potentiometer formed by a variable resistance R_{16} and a fixed resistance R_{21}.

27. A triode valve V_8 is the separate heterodyne oscillator required for C.W. reception, and, with its associated circuit, functions at a frequency of approximately 101 kc/s. The oscillator inductance L_{23} is tuned by a trimmer condenser C_{55} with a fixed capacitance C_{53} in parallel. The anode H.T. is supplied through a resistance R_{27}. The filament positive lead is decoupled by a choke Ch_5 and a condenser C_{47}. The output from this oscillator is capacitance coupled to the secondary winding of the 100 kc/s transformer L_{22} and to a valve V_6 by a condenser C_{52}.

28. The heterodyne oscillator is switched into operation by the four-pole three-way switch S_8 which controls the grid-bias arrangement for the receiver. This switch, when at position 3, completes the filament circuit of V_8. A more complete discussion of S_8 will be found in paras. 35 to 41.

29. The valve V_6 is a double-diode-triode but only one of the two diode anodes is used. The output from the I.F. transformer L_{22}, together with the output from the heterodyne oscillator during C.W. reception, is applied between the detector anode (2) and the filament (3) through the condenser C_{50} which is, in effect, a reservoir condenser. Resistances R_{29} and R_{30} together with the condenser C_{50} and C_{45} are integrally part of the A.V.C. arrangement which are discussed in paras. 35 to 39.

30. As a result of the R.F. excitation between the detector anode and filament, the voltage developed across the condenser C_{50} possesses an A.F. component corresponding to the modulation envelope during the reception of modulated waves and with the beat frequency in the case of heterodyne reception of C.W. This A.F. component is passed by a decoupling network composed of R_{31} and C_{51} and results in the application of A.F. voltages between the grid and filament of the valve V_6. The primary winding of a microphone transformer T_7 and an output level control potentiometer R_{36} are included in this circuit but their presence does not materially affect the receiver action. A condenser C_{59} is included in the grid circuit and a suitable bias voltage is derived from a common grid battery through a resistance R_{35}. The anode load impedance of V_6 consists of the capacitance of a condenser C_{58} and the primary winding of an A.F. transformer T_5.

31. The output stage of this receiver is a Q.P.P. valve V_7. In consequence, the transformer T_5 has a split secondary winding in the two outer leads of which resistances R_{37} and R_{38} are incorporated in order to prevent any tendency to self-oscillation to which the inductive nature both of the input and output circuits renders a circuit of this description particularly prone.

32. The centre-tap of the secondary winding of T_5 is connected to the 6-volt negative tapping on the grid-bias battery through a resistance R_{39}. The auxiliary grid of V_7 is at the same potential as the two anodes. The latter are connected to the outer terminals of the split primary winding of an output transformer T_6 across which two anti-parasitic condensers C_{60} and C_{61} are bridged.

33. The H.T. voltage is fed to the centre-point of the primary winding of T_6 through a resistance R_{40}. A condenser C_{62} by-passes the H.T. supply. The secondary winding of T_6 is connected to the TELEPHONE contacts of a socket J_1 which is of the combined micro-telephone type.

34. A diode valve V_1 which is connected across the input circuit of the receiver acts as a damping resistance to prevent the generation of excessively high currents and voltages in the circuit when the receiver is used for listening through.

Grid bias for R.F. valves

35. The four-pole three-way switch S_8 controls the grid-bias arrangement. The position 1 of the switch is suitable only for R/T reception, the control bias on the valves V_2, V_3, V_4 and V_5 being automatically varied in proportion to the R.F. voltages developed across the secondary winding of the transformer L_{22}. The gain of these stages varies correspondingly so that a weak signal receives greater amplification than a strong signal.

36. The signal intensity is maintained at the desired level by means of the manual volume control which is effected by utilising one of the two variable resistances R_{16}, fitted in the receiver, or R_{13}, fitted in the remote controller. The resistance R_{13} is connected to the receiver by a three-point plug and socket SK_4. The insertion of the plug automatically disconnects the internal volume control. In the theoretical circuit diagrams the plug is shown removed from the socket and for the purpose of the following explanation it will be considered as so removed.

37. Mention was made, in para. 30, of the voltage developed across the condenser C_{50} during the reception of R/T signals. This voltage consists of an A.F. component which it is desired to amplify, superimposed upon a charge which develops a negative polarity upon that side of the condenser which is directly connected to L_{22}. The leakage of this charge, during reception, is effected *via* the resistances R_{31} and R_{16} and unidirectional current flows through them. The resistance of this leakage path may be varied between 250,000 ohms, with R_{16} short-circuited, and 300,000 ohms, with R_{16} fully in

38. A signal of given strength will, depending upon the setting of R_{16}, produce some mean definite potential across C_{50}. The negative side of C_{50} is connected to the grids of the valves V_2, V_3, V_4 and V_5 through a common A.F. filter system comprising resistances R_{29} and R_{30} with condensers C_{45} and C_{23}. Individual decoupling systems are incorporated in the grid circuits of the individual valves; R_6 and C_{14} for V_2; R_{12} and C_{22} for V_3; R_{20} and C_{32} for V_4 and R_{25}; C_{42} for V_5. The respective grids are supplied through R_5, R_{11}, R_{19} and R_{24}.

39. The grid-bias voltages of all the R.F. valves are, therefore, controlled by the mean potential of the reservoir condenser C_{50} of the detector. This, in turn, depends upon the mean amplitude of the R.F. voltage across the output winding of L_{22}, but this amplitude is, in effect, that of the carrier. Thus the grid bias and, consequently, the gain of the R.F. stages is automatically adjusted and is, approximately, inversely proportional to the carrier voltage induced in the aerial by the incoming signal.

40. When the switch S_8 is in position 2, a resistance R_{29} and a condenser C_{45}, in series, are connected in parallel with the detector reservoir condenser C_{50}. The resistances R_{31} and R_{32}, in series, form a leakage path across C_{50} whilst the condenser C_{51} is in parallel with R_{22} and has only a secondary effect. The resistances R_{16} and R_{21}, in series, form an adjustable potentiometer across the grid-bias battery. A fraction of the voltage of this battery is applied, *via* resistances R_6, R_{12}, R_{20} and R_{25}, to the control grids of the R.F. valves. This fraction is adjustable between a lower limit fixed by the resistance R_{22}, and the whole voltage of the battery.

41. When the switch S_8 is in position 3 the bias control is exactly as in position 2 but the filament circuit of the heterodyne oscillator V_8 is completed. Either position 1 or position 2 may be used for R/T reception and position 3 must be used for C.W. reception. For I.C.W. the bias switch should be in position 2.

Intercommunication and side-tone circuit

42. The microphone, which is energized by the L.T. battery, is connected through the socket J_1, in series with the primary winding of the microphone transformer T_7. The secondary winding of T_7 is shunted by the intercommunication volume control R_{36} which is pre-set. The circuit is completed to the grid and filament of the valve V_6 which now functions as a plain triode and amplifies the speech-induced voltages. The amplified voltages are passed through the Q.P.P. output valve V_7 and the output transformer T_6 to the telephone contacts of the socket J_1 for intercommunication.

43. The high impedance primary of the intercommunication transformer has the primary of the transmitter microphone transformer shunted across it. This transformer is of high step-up ratio and the resistance of the primary is in consequence comparatively low. It would seriously load the intercommunication transformer T_7 were it not for a 2 μ F condenser and 1,000-ohm resistance in the O.P. line contained in the transmitter T.1115.

44. This circuit provides not only for intercommunication but also for side-tone on all types of signalling and for R/T. When the T.1115 is arranged for R/T the microphone works into both transmitter and receiver, modulating the former and providing R/T side-tone in the latter. It must be appreciated that such side-tone is no evidence of radiation.

45. A similar circuit is used when the transmitter is arranged for I.C.W. or C.W. The microphone is switched off but the transmitter modulator valve is oscillating and the A.F. frequencies from it are applied *via* the microphone transformer and intercommunication transformer to the receiver A.F. amplifier.

The D/F circuit

46. Provision is made for D/F and sense-finding on the YELLOW or lower frequency range (142 kc/s to 1,600 kc/s) in conjunction with a rotatable screened loop which is part of the aeroplane equipment.

47. When the switch S_1 is in the D/F position the non-directional aerial is earthed. If the rotating loop aerial is fitted it is normally connected by means of a two-point plug and socket Sk_3 to a RECIPROCAL-BEARING switch S_4. When the selector switch S_3 is at the YELLOW (L.F.) and D/F position with the range switch S_2 set to one of the three D/F ranges, the loop aerial is connected to the primary winding of one of the R.F. transformers, L_4, L_5 or L_6.

48. The secondary windings are tuned to the desired frequency by the condenser C_3 and are connected between the grid and the filament of the first frequency changer valve V_2. The same process of amplification, detection and reproduction at the telephones as detailed for the receiver circuit obtains. The direction from which the signals are arriving, relative to the fore-and-aft line of the aeroplane, may be determined, subject to an ambiguity of 180 degrees, by swinging the loop through 360 degrees and noting the minimum signal strength at two readings in accordance with the method described elsewhere in this publication. The position of S_4, either BEARING or RECIPROCAL, is immaterial during this operation.

49. When the switch S_1 is in the SENSE position and the loop aerial is connected to an appropriate range coil, the non-directional aerial is also connected to the secondary winding of the coil through a fixed condenser C_1, variable resistance R_1 and a fixed resistance R_2. At the correct adjustment of R_1 the polar diagram of reception is approximately heart-shaped and the ambiguitv in the bearing of the distant transmitter is resolvable.

50. Of the remaining switching arrangement of this receiver the ON-OFF switch S_5 is a four-pole single throw switch. Three of the poles S_{5b}, S_{5c} and S_{5d} make the grid-bias line, the H.T. positive and L.T. positive respectively. The section S_{5a} short-circuits the aerial tuning coil in the OFF position, and protects the receiver from damage caused by using the T.1115 when the listening-through circuit of the receiver (and the diode valve V_1) is not switched on.

51. The switch S_7 is a break circuit switch mounted as part of the assembly of the socket Sk_4. The insertion of the plug from the remote controller disconnects the internal volume control circuit.

Coil ranges

52. The approximate frequency coverage of the various coils incorporated in the receiver and selected by the switches S_2 and S_6 are as follows:—

TRAFFIC or D/F (YELLOW)

RANGE 1.	142 kc/s	—	315 kc/s
RANGE 2.	315 kc/s	—	700 kc/s
RANGE 3.	700 kc/s	—	1,600 kc/s

UPPER BAND (GREEN)

RANGE 4.	2·0 Mc/s	—	4·4 Mc/s
RANGE 5.	4.4 Mc/s	—	7·3 Mc/s
RANGE 6.	7·3 Mc/s	—	12·0 Mc/s
RANGE 7.	12·0 Mc/s	—	20·0 Mc/s

CONSTRUCTIONAL DETAILS

53. The receiver R.1116 consists of two main portions, namely, a front panel which carries all the controls including the tuning mechanism of the two oscillators and a chassis which carries the amplifier portion. A general view showing the front panel controls is given in fig. 1, a plan view of the chassis in fig. 6 and an underside view in fig. 7. Bench-wiring diagrams of the tuning and amplifier sections are shown in figs. 8 and 9.

54. Referring to fig. 1, the two ranges are coloured YELLOW for the 'L.F.' or lower frequencies, from 142 kc/s to 1,600 kc/s and GREEN for the 'H.F.' or higher frequencies from 2·0 Mc/s to 20 Mc/s, this code being in accordance with that used for the transmitter T.1115. The controls are annotated to correspond with the component actuated by them, as shown in fig. 2.

55. The YELLOW range switch S_2 is driven through gears (1, fig. 6). The switch through its sections S_{2b} and S_{2a} selects one of three TRAFFIC COILS L_1, L_2 and L_3 (Ranges 1, 2 and 3) or one of the three D/F coils L_4, L_5, L_6 which are enclosed in a separate screening compartment (1, fig. 7). The D/F coils have loop windings superimposed upon them. The YELLOW aerial tuning condenser C_3 is driven through a 6:1 reduction gear.

56. The switch S_2 also selects, through its sections S_{2c}, one of the three first oscillator circuits which are simultaneously tuned by a control (1, fig. 1). The control (1) operates the dial (3) through a 21:1 reduction gear, part of the mechanism of which can be seen in fig. 7. The dial is calibrated for each range and has a degree scale on the edge. Readings are taken against a transparent fixed indicator.

57. The control knob (1) is rigidly attached to a flange. A bushed carrier (2, fig. 7) is caused to move along a threaded shaft (3, fig. 7) by rotation. The carrier inserts or withdraws iron dust cores which determine the inductance of the coils. The mechanism for the control of the GREEN range is operated in a similar manner. The switch for this range is S_6 and the tuning control (2) is associated with the dial (4).

58. The aerial is brought to either of two alternative aerial sockets Sk_1 or Sk_2. The internal volume control potentiometer R_{16} is removed from circuit when the external volume control is connected by inserting a plug into the socket Sk_4. The D/F socket Sk_3 is connected, under a screen (2, fig. 6) to the loop reversing switch S_4 engraved RECIPROCAL-BEARING.

59. A plan view of the chassis, with the cover removed, is given in fig. 6. The valves and the screening chambers are identified by the annotations of fig. 2. The grid-bias battery plugs (3) are of the expanding type; before withdrawal the plugs are contracted by turning the top in a counter-clockwise direction.

60. The I.F. transformers and the pre-set tuning arrangements connected with them can be plainly seen. Part of the gearing arrangement (1) in connection with S_2 is visible.

61. The underside view of the chassis in fig. 7 shows the compartment screening which, roughly, corresponds to the various stages of the receiver. The TRAFFIC YELLOW coils are in the compartment (4). The oscillator grid and anode coils are in the compartment (5). The TRAFFIC GREEN tuning arrangements are in the compartment (6).

62. The D/F aerial coils are separately housed in the screening compartment (1) which is itself contained in the compartment (8) associated with the components of the second 100 kc/s I.F. transformer circuit. The components associated with the valve V_5 are in the next compartment (9) which is adjacent to the compartment (10) containing the first 1,700 kc/s I.F. transformer L_{18} circuit components.

63. The first I.F. amplifier (V_3) circuit components with those of the second 1,700 kc/s I.F. transformer L_{20}, the battery supply plug and decoupling components are in the compartment (11) at the bottom left-hand corner. The components associated with the double diode V_6 and the Q.P.P. valve V_7 are in compartment (12). The heterodyne oscillator (13) and its exterior circuit components are mounted directly above the compartment (12). The variable resistance R_{36} is pre-adjusted by a screwdriver through a rubber gommet (14). The oscillator, second frequency changer, and heterodyne oscillator are tuned by a screwdriver through ports, one of which (15) is shown open.

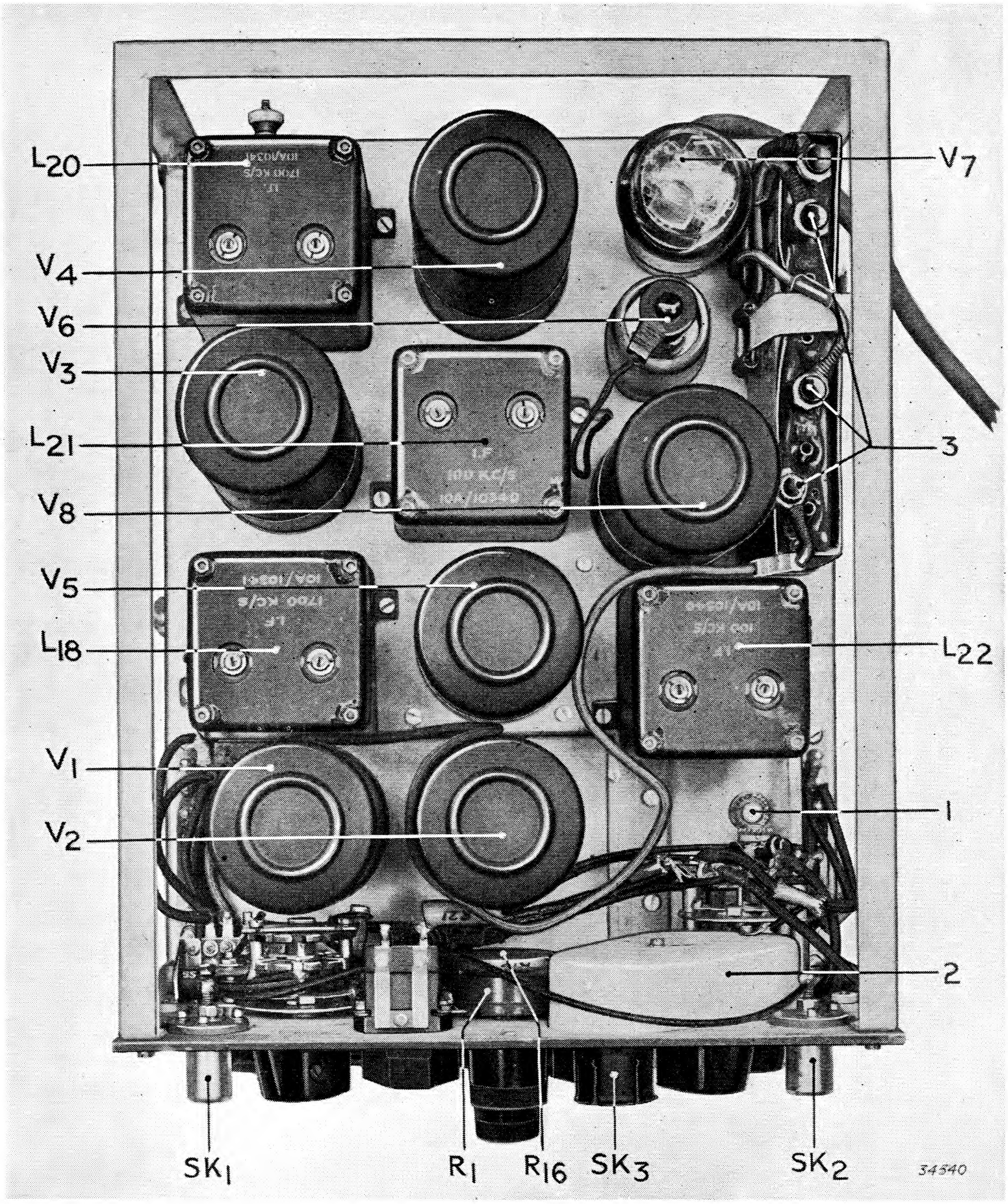

Fig. 6.—PLAN VIEW OF CHASSIS

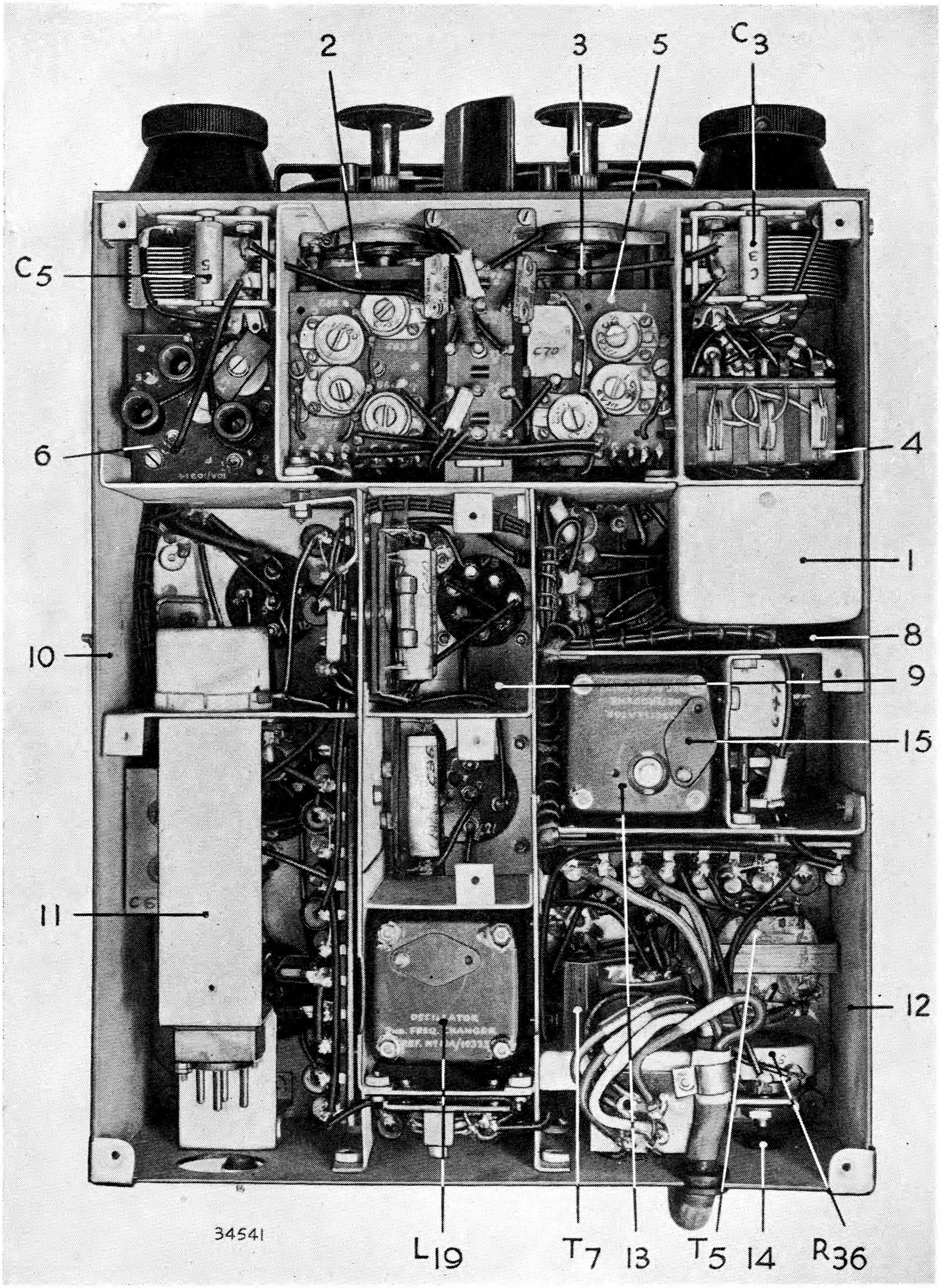

Fig. 7.—UNDERSIDE OF CHASSIS

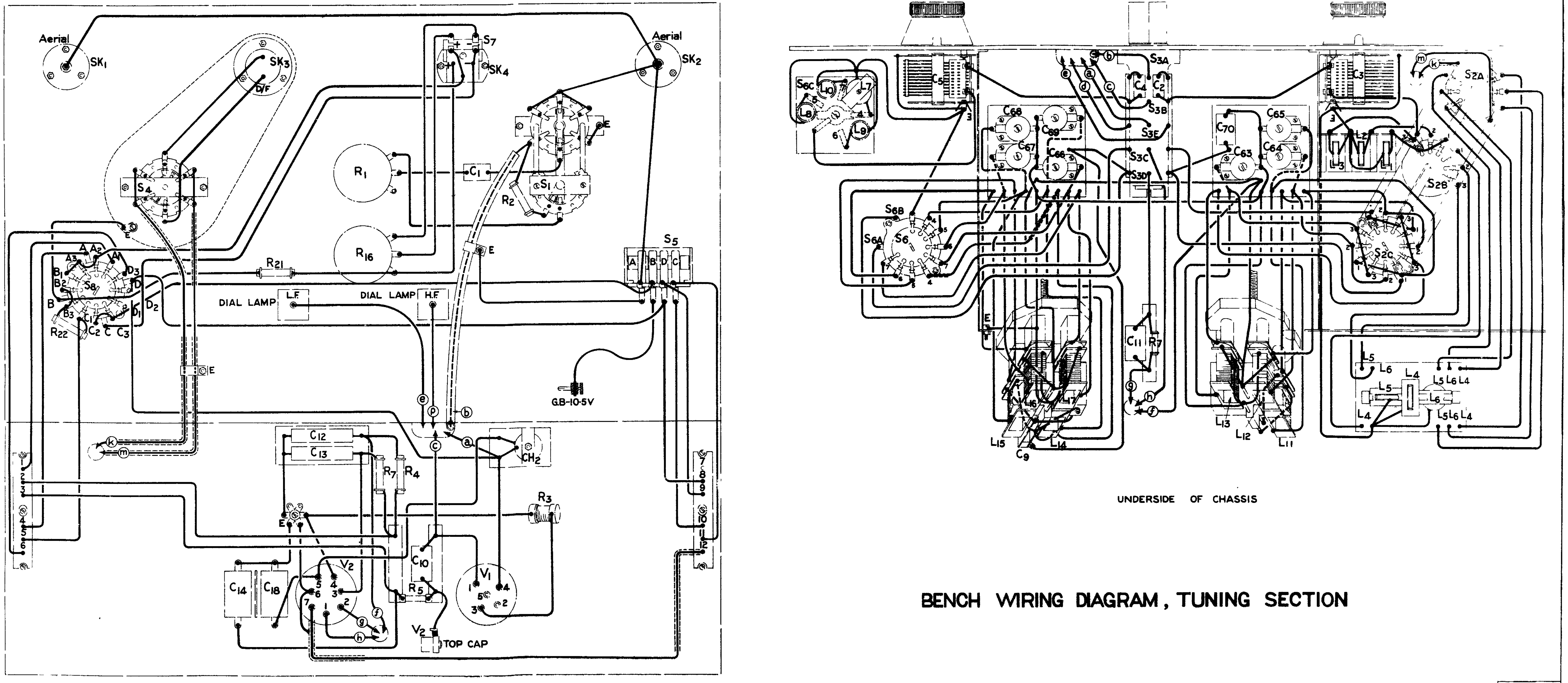

FIG. 8

BENCH WIRING DIAGRAM, TUNING SECTION

FIG. 8

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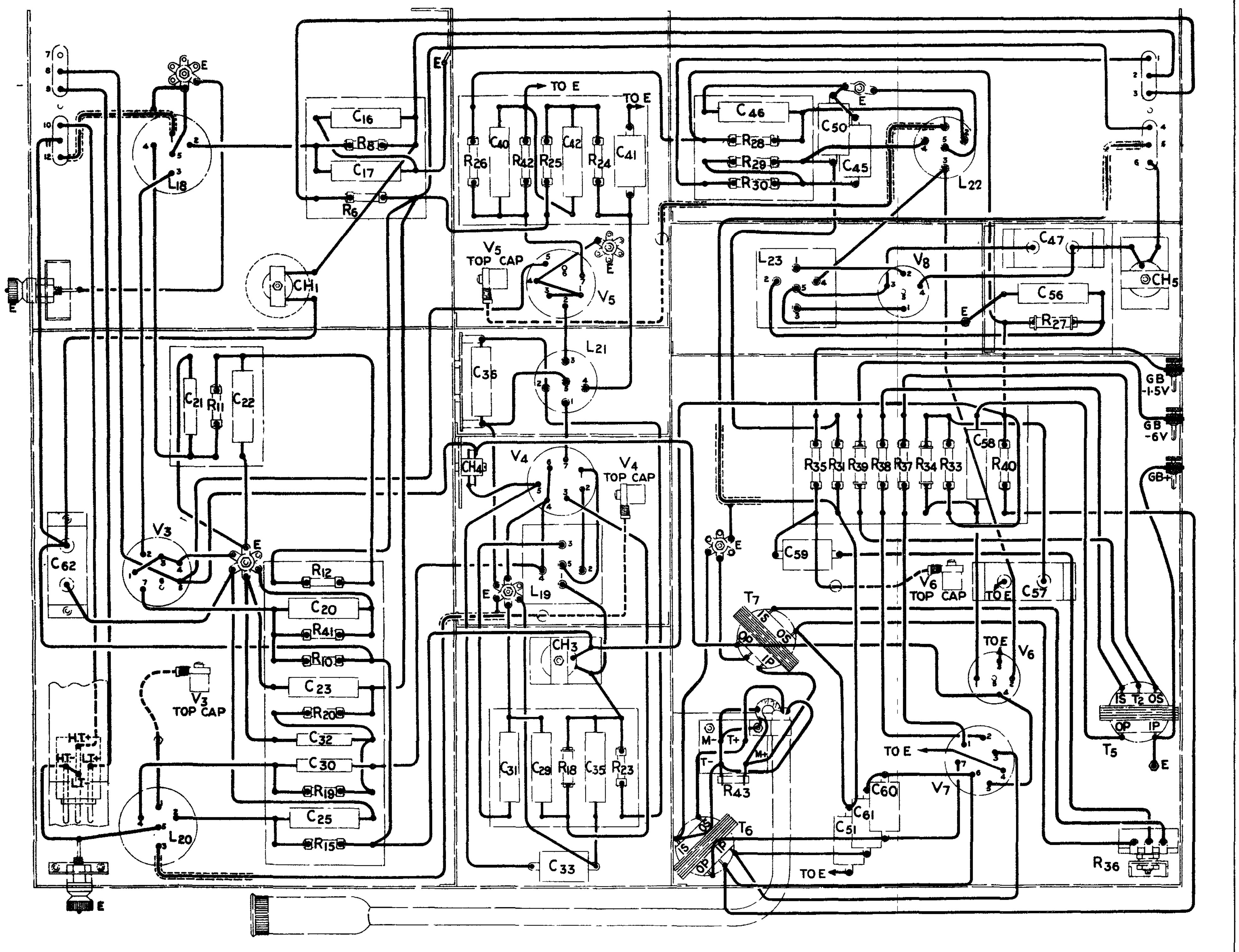


FIG. 9

BENCH WIRING DIAGRAM. AMPLIFIER SECTION

FIG. 9

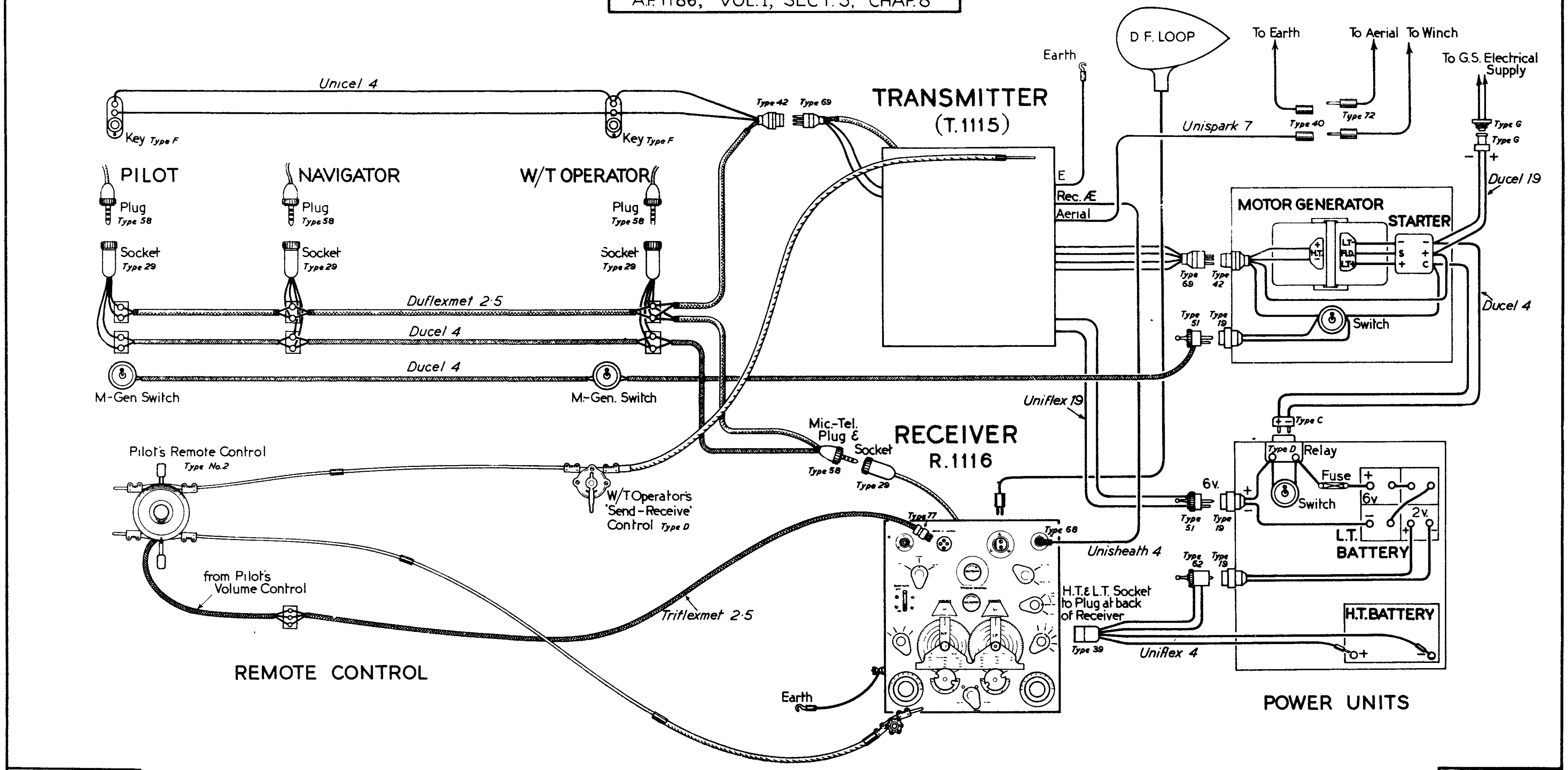


FIG. 10

INSTALLATION DIAGRAM

FIG. 10

REPRINT PP2150 M28881/2459 4/43 4250 C & P Gp. 959(4)

VALVES AND BATTERIES

64. The receiver is battery operated, the H.T. supply being obtained from a 120-volt battery, the L.T. from a 2-volt 20 aH accumulator and the grid-bias from a 10·5-volt battery. The total filament current is approximately 1·6 amperes. The mean H.T. current varies from about 14 mA quiescent to about 25 mA on full load. The full 10·5 volts grid bias is applied to the volume control potentiometer R_{16} and taps are used for the triode portion of the double-diode V_6 (3 volts) and the Q.P.P. output valve V_7 (6 volts).

The valves used in the receiver are as follows:—

- V_1. Protective diode, type V.U.33
- V_2. First frequency changer, type V.R.82
- V_3. First I.F. amplifier, type V.R.83
- V_4. Second frequency changer, type V.R.82
- V_5. Second I.F. amplifier, type V.R.83
- V_6. Double-diode triode, V.R.44
- V_7. Q.P.P., V.R.35
- V_8. Heterodyne oscillator, V.R.21

INSTALLATION AND OPERATION

65. The receiver R.1116 is normally installed in conjunction with the transmitter T.1115, which incorporates a SEND/RECEIVE switch having three positions:—SEND, OFF and RECEIVE. When the switch is put to RECEIVE the aerial is coupled to the receiver through the listening-through condenser and the transmitter tuned circuit is disconnected. This position gives a "free receiver" circuit in which the aerial pick-up is slightly reduced by the listening-through condenser. An installation diagram is given in fig. 10.

To set up the receiver on the ground

66. Reference should be made to the controls mounted on the front panel shown in fig. 1. Before commencing to adjust the receiver to any particular frequency, see that the aerial lead from the transmitter is plugged into one of the two aerial sockets SK_1 or SK_2 and that the headphone and microphone plug is inserted in the jack J_1.

67. Make sure that the battery plug is inserted in the socket at the back of the receiver and that the batteries are connected. The grid-bias plugs must be fitted in the correct sockets on the battery according to the voltages marked on the tags attached to the leads. See that the plugs are locked in position by rotating the top portion and ascertain that all the valves are correctly positioned with their top leads connected.

To set up a frequency in the L.F. band

68. Assuming it is desired to set up the receiver to a frequency of 160 kc/s, switch on by putting the switch S_5 in the ON position. Now set the switch S_1 to TRAFFIC and the switch S_8 to C.W. The volume control R_{16} should be set to a position which gives a comfortable level of background noise in the headphones.

69. The range switch S_3 must now be set to L.F. (YELLOW SPOT), and the band covering the required frequency noted. It will be seen that 160 kc/s is to be found within RANGE 1, so that the L.F. range switch S_2 will have to be set to the position TRAFFIC 1. The oscillator dial (3) and the aerial condenser C_3 must now be tuned to the required frequency, and it should be remembered that the tuning of the oscillator is exceedingly critical whereas that of the aerial is comparatively broad.

70. Set the oscillator dial to the required frequency in accordance with the calibration and adjust the aerial condenser C_3 to a position corresponding approximately to the position of the oscillator dial. Now swing the oscillator tuning by rotating the knob (1) until the required signal (which may be from a distant station, or more usually, a suitable wavemeter or signal generator) is heard. Having tuned the signal on the oscillator dial, readjust the aerial tuning C_3 for maximum volume. The settings of the oscillator and aerial dials should now be recorded in the operator's notebook for future reference. The degree scale round the outer edge of the oscillator tuning dial is provided for this purpose.

71. If R/T or I.C.W. is required, the switch S_8 must be put to the appropriate position. Note that as indicated in the introduction, certain earlier receivers are not suitable for R/T reception due to narrow band width on the second I.F. amplifier. These receivers can be distinguished by the letter N in white on the side of the case to the right of the nameplate.

72. Fine tuning heads (not shown in fig. 1) may be fitted to the knobs (1) and (2) giving an additional reduction of 4:1. These do not change the tuning procedure, but merely require that the control knob of the fine tuning control is rotated rather than the knob (1).

To set up a frequency in the H.F. band

73. Should the required frequency be between 2 Mc/s and 20 Mc/s, the procedure to be followed is exactly the same as already described, except that the range switch S_3 must be set to the H.F. (GREEN SPOT) position and the H.F. range switch S_6 to the position (4, 5, 6 or 7) according to the range within which the required frequency lies. Tuning is then carried out on the H.F. oscillator dial (4), controlled by the knob (2), and the H.F. aerial condenser C_5.

74. It should be noted that when the range switch S_3 is in the H.F. position, tuning the L.F. controls has no effect on the operation of the receiver and *vice versa*. It will be seen, therefore, that the receiver can be set up for two completely independent frequencies, one in the H.F. range and one in the L.F. range, the change-over between them being made simply by the operation of the range switch S_3.

Remote control

75. If remote control is used with any particular installation, it provides fine adjustment of the oscillator tuning, and since it does not give control of the range switch or aerial tuning, it can be used only to tune over a comparatively narrow band. The remote volume control, when plugged into the socket SK_4 renders the internal volume control R_1 inoperative.

Direction finding

76. The actual procedure to be followed for direction finding will depend upon the particular loop employed. In the following description it must be assumed that the receiver is being operated in conjunction with a loop, type 1.

77. Direction finding is possible on the L.F. range only, and when the receiver is used in conjunction with an appropriate D/F loop. It is assumed that the receiver has first been tuned to the required signal, as already described, with the TRAFFIC-SENSE-D/F switch S_1 in the TRAFFIC position.

78. Turn the L.F. range switch S_2 to the position D/F 1, 2 or 3 according to the frequency of the incoming signal, and S_1 to the D/F position. This last operation earths the vertical aerial. At this stage it is advisable to re-adjust the L.F. tuning condenser.

79. Now rotate the loop until the signal is at a minimum and take the reading on the white scale. This gives the bearing of the distant station, but the following procedure is necessary to determine the sense of the bearing.

80. Rotate the loop through 90 deg. until the reading on the red scale corresponds to the bearing previously obtained on the white scale. Now operate the BEARING-RECIPROCAL switch S_4 backwards and forwards until a distinct difference is apparent between the signal strengths at the two settings. Note the setting which gives the weaker signal. If the setting thus obtained indicates BEARING, then the bearing originally obtained on the white scale is correct, but if RECIPROCAL is indicated, then 180 deg. must be added to the bearing originally obtained on the white scale.

PRECAUTIONS AND MAINTENANCE

81. Complete servicing of the receiver requires a comprehensive set of test equipment and will not normally be undertaken by the Service, but certain fairly obvious points should, however, be taken care of by the operator.

82. He should periodically check the H.T. and L.T. battery volts and the condition of the grid bias battery. If the H.T. battery falls below 105 volts on load it should be replaced, and care must also be taken to see that the battery plug is making good contact in its socket. If necessary the split pins can be opened to ensure this.

83. Should all valves in the receiver burn out, remove the top cover and check that there is no short circuit between the adjacent tags on the ON/OFF switch S_5. The tags on the switch may be bent one up and one down in order to give better clearance. Before replacing the valves, check with a voltmeter that the voltage on the filament sockets does not exceed 2 volts with the receiver switched on.

84. A useful check on the condition of the receiver may be made by measuring the resistance between the chassis and pin No. 11 of the connector block on the left-hand side of the receiver. The block is exposed when the top cover is removed and it is located near the front panel. This measurement, taken with the battery plug removed but all valves in position, should give a value of 150,000 ohms if the receiver is in good order. Since this reading is liable to vary with individual receivers, an allowance of $\pm$ 20 per cent. should be made.

APPENDIX

NOMENCLATURE OF PARTS

The following list of parts is issued for information only. When ordering spares for this receiver, the appropriate section of AIR PUBLICATION 1086 must be used.

Ref. No.	Nomenclature	Qty.	Ref. in fig. 2	Remarks
10D/10310	Receiver, type R.1116			
	Principal components.—			
	Choke, H.F.			
10C/10311	Type 38	3	CH_2, CH_4, CH_5	
10C/10312	Type 39	1	CH_1	
10C/10313	Type 40	1	CH_3	
	Coil			
10D/10315	Aerial, type A	1		
10D/10314	Aerial, type B	1		
10D/10324	Oscillator, variable, assembly A	1		
10D/10325	Oscillator, variable, assembly B	1		
10D/10316	Unit, D/F	1		
	Condenser			
10C/9178	Type 279	1	C_{50}	0·0003 μ F.
10C/9179	Type 280	2	C_{60}, C_{61}	0·001 μ F.
10C/9185	Type 286	9	C_{14}, C_{18}, C_{21}, C_{30}, C_{32}, C_{33}, C_{41}, C_{45}, C_{59}	0·01 μ F.
10C/10317	Type 391	2	C_3, C_5	500 μμ F.
10C/10342	Type 392	2	C_{47}, C_{57}	0·5 μ F.
10C/10343	Type 393	1	C_{62}	2·0 μ F.
10C/10165	Type 386	17	C_{12}, C_{13}, C_{16}, C_{17}, C_{20}, C_{22}, C_{23}, C_{25}, C_{29}, C_{31}, C_{35}, C_{36}, C_{40}, C_{42}, C_{46}, C_{56}, C_{58}	0·1 μ F.
10C/11484	Type 535	1	C_2	70 μμ F
10C/11485	Type 536	1	C_4	50 μμ F
10C/11486	Type 537	2	C_{10}, C_{11}	100 μμ F
10C/10570	Type 426	1	C_1	25 μμ F.
10C/3080	Type 1,486	1	C_{70}	150 μμ F.
10C/11490	Type 541	1	C_{51}	0·0005 μ F.
	Connector			
10H/11804	Type 34	4		
10H/11372	Type 40	1		
	Cover			
10D/10318	Bottom	1		
10D/10319	Top	1		
10A/10320	Drive, slow-motion, type 4	2		
	Holder			
10H/9615	Valve, type U	3		
10H/9756	Valve, type S	5		
	Oscillator			
10D/10322	Heterodyne	1		Fitted with:— 1 condenser, type 437 1 condenser, type 529 1 condenser, type 542 1 resistance, type 487
10D/10323	Second frequency changer	1		Fitted with:— 1 condenser, type 394 1 condenser, type 437 1 resistance, type 231 1 resistance, type 145
10D/10560	Pedestal, coupling, tuning	2		
	Plug			
10H/8515	Type 67	1		
10H/9112	Type 82	1		
10H/9113	Type 83	3		
	Resistance			
10C/7954	Type 101	5	R_8, R_{15}, R_{23}, R_{28}, R_{33}	1,000 ohms
10C/7956	Type 103	3	R_{37}, R_{38}, R_{40}	5,000 ohms
10C/8018	Type 110	4	R_{11}, R_{19}, R_{24}, R_{31}	0·25 megohms

Ref. No.	Nomenclature	Qty.	Ref. in fig. 2	Remarks
	Receiver, type R.1116 (contd.)			
	Principal components (contd.)			
	Resistance (contd.)			
10C/8019	Type 111	8	R_6, R_{10}, R_{12}, R_{20}, R_{25}, R_{26}, R_{30}, R_{32}	100,000 ohms
10C/8020	Type 112	4	R_2, R_4, R_9, R_{34}	30,000 ohms
10C/8117	Type 123	3	R_5, R_{29}, R_{35}	1 megohm
10C/8395	Type 144	1	R_7	60,000 ohms
10C/8519	Type 145	3	R_{14}, R_{41}, R_{42}	0·2 megohm
10C/8521	Type 147	1	R_3	0·75 ohm
10C/9134	Type 231	4	R_{13}, R_{17}, R_{22}, R_{27}	50,000 ohms
10C/10326	Type 373	1	R_{16}	50,000 ohms, variable
10C/10327	Type 374	1	R_1	250,000 ohms, variable
10C/10328	Type 375	1	R_{36}	500,000 ohms, variable
10C/10329	Type 376	2	R_{18}, R_{39}	150,000 ohms
	Socket			
10H/9326	Type 46	1	Sk_4	External volume control
10H/10330	Type 56	2	Sk_1, Sk_2	Aerial
10H/10331	Type 57	1	Sk_3	For D/F loop
10H/10379	Type 58	1	J_1	Micro-telephones
	Switch			
10F/10332	Type 146	1	S_1	
10F/10333	Type 147	1	S_4	
10F/10334	Type 148	1	S_3	
10F/426	Type 396	1	S_6	
10F/10336	Type 150	1	S_2	
10F/10337	Type 151	1	S_5	
10F/11713	Type 169	1	S_8	
	Transformer			
10A/10280	Type 16	1	T_5	
10A/10281	Type 17	1	T_6	
10A/11494	Type 25	1	T_7	
10A/10340	Unit, No. 1	2	L_{21}, L_{22}	Fitted with:— 2 condensers, type 394 2 condensers, type 530
10A/10341	Unit, No. 2	2	L_{18}, L_{20}	Fitted with:— 2 condensers, type 394
	Accessories:—			
5A/1387	Accumulator, lead acid, 2 v 20 Ah, type B	1		
	Attachment			
10D/11715	Fine tuning	1		Green handle
10D/11768	Fine tuning	1		Yellow handle
	Battery			
5A/1878	Dry, 10·5 V.	1		
5A/1615	Dry, 120 V.	1		
10D/10567	Case, transit	1		
5A/361	Lamp, filament 3·5 V.	2		
	Plug			
10H/8516	Type 68	1		Aerial
10H/9508	Type 77	1		Volume control
	Rail, guide			
10A/11284	Type 1	1		L.H.
10A/11285	Type 2	1		R.H.
10H/8529	Socket, type 39	1		
10H/8530	Disc, indicating, type S/39/A	1		
	Valve			
10E/7738	V.R 21	1	V_8	Heterodyne oscillator
10E/9829	V.U 33	1	V_1	Listening-through diode
10E/9779	V.R.35	1	V_7	Q.P.P. output
10E/10542	V.R.44	1	V_6	Detector A/F amplifier
10E/4	V.R.82	2	V_2, V_4	Frequency changer
10E/5	V.R.83	2	V_3, V_5	I.F. amplifier

SECTION 4

AMPLIFIERS

SECTION 4

AMPLIFIERS

CONTENTS

SECTION 4, CHAPTER 1

INTER-COMMUNICATION AMPLIFIERS, TYPES B AND C

Contents

List of Illustrations

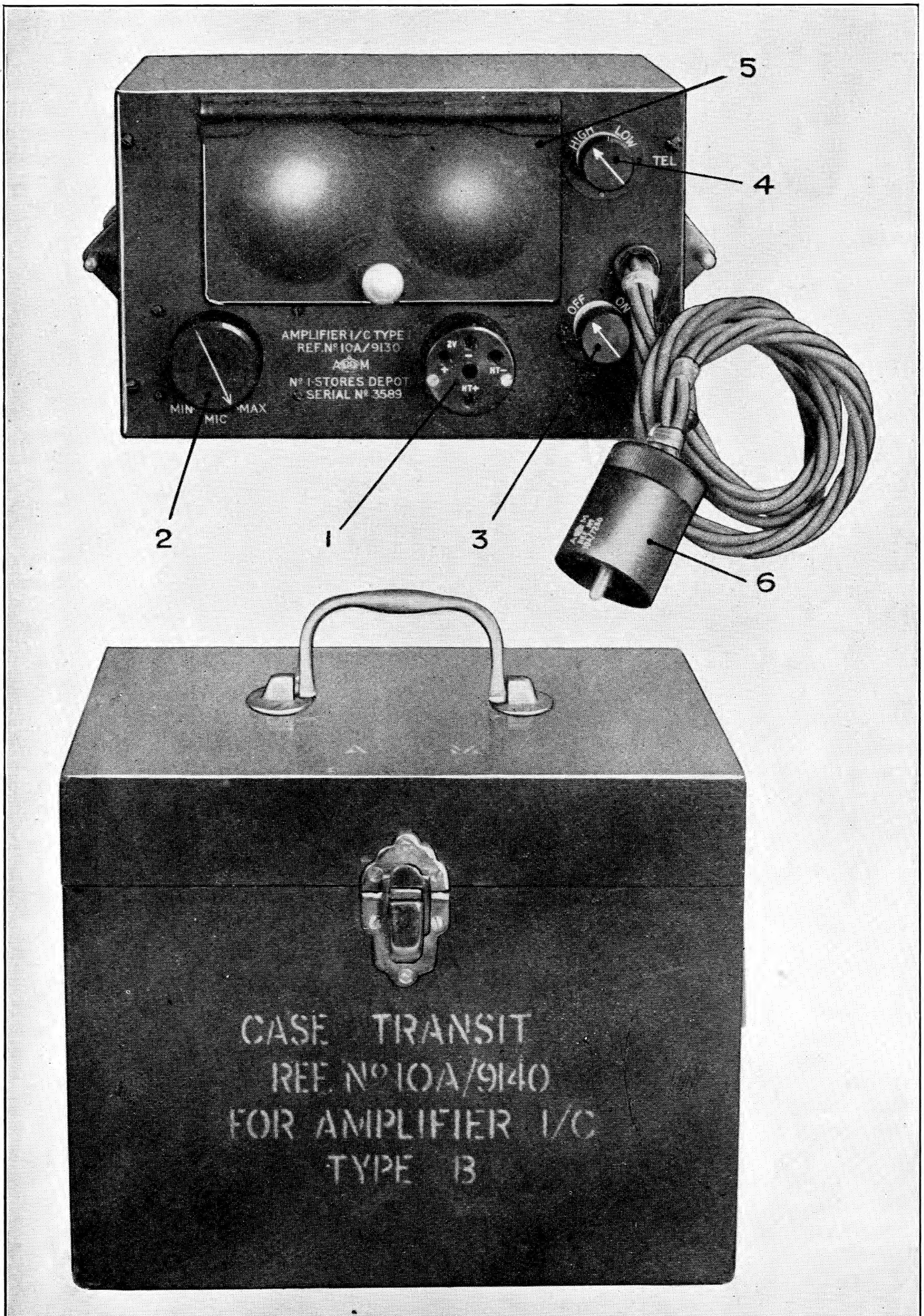
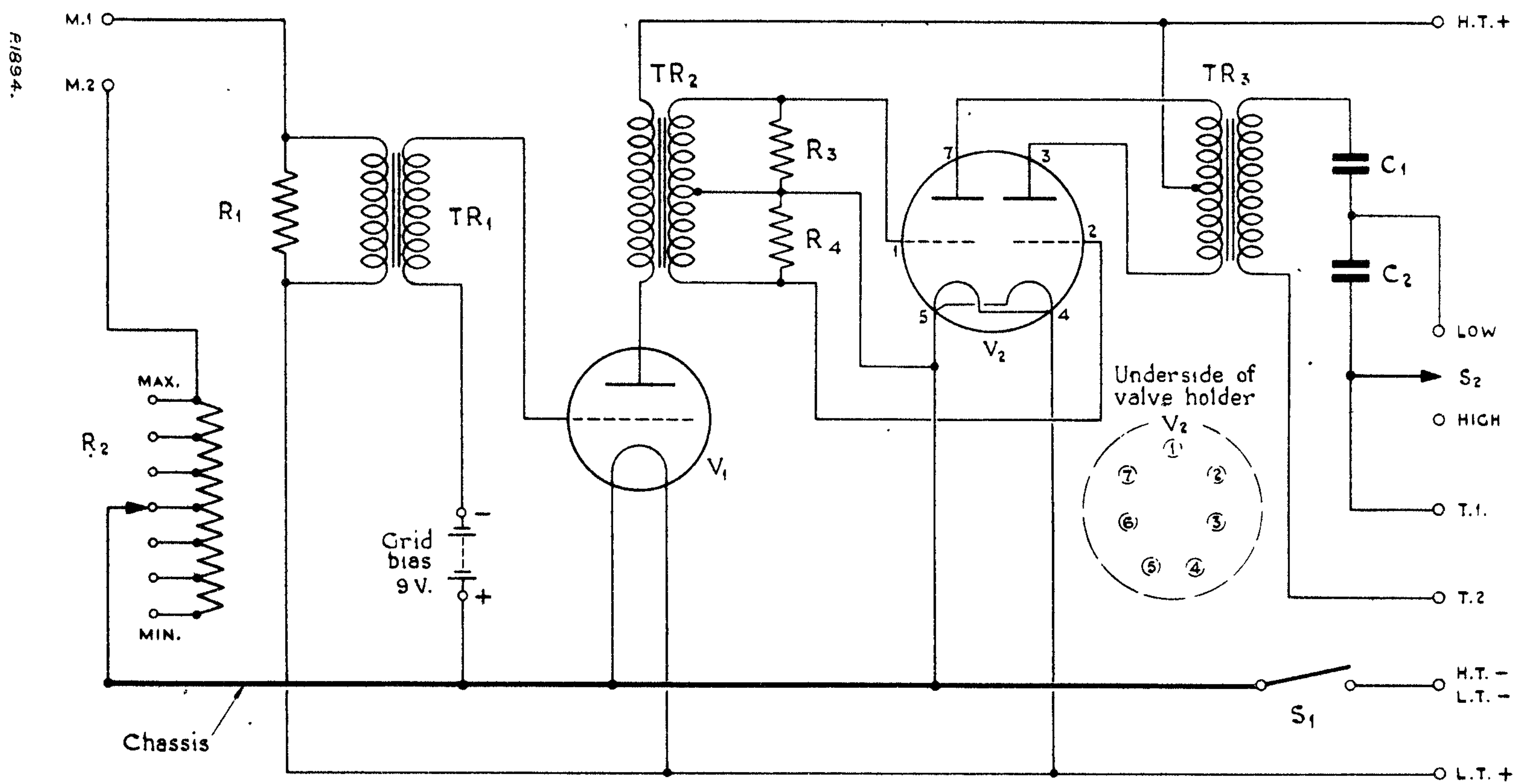


FIG. 1. Amplifier I/C, type B, with transit case.



Resistances (Ω)				Condensers (μF)	
R_1	200	R_3	50,000	C_1	·001
R_2	1,790	R_4	50,000	C_2	·001

FIG. 2. AMPLIFIER I/C TYPE B — THEORETICAL CIRCUIT DIAGRAM.

Facing fig. 1

INTER-COMMUNICATION AMPLIFIERS

TYPE B

(Stores Ref. 10A/9130)

and

TYPE C

(Stores Ref. 10A/11268)

INTRODUCTION

1. The inter-communication amplifiers, types B and C, are employed in order to facilitate telephonic communication between members of the crew of multi-seater aeroplanes. They are suitable for use only with carbon microphones; where electro-magnetic microphones are fitted, a suitable amplifier, e.g. type A1134, must be installed. The two amplifiers are similar in design except for the output transformer. In the type B amplifier, this transformer is designed to match a load consisting of seven pairs of telephones in series, to the impedance of the output valve. The type C instrument is intended to work into a load consisting of from three to seven pairs of telephones in parallel.

2. The dimensions of the amplifier are 7 in. by $4\frac{1}{2}$ in. by 6 in., and its weight, including valves, is approximately $3\frac{1}{2}$ lb. The total weight of the I/C installation, including crates and batteries, is about 28 lb. Fig. 1 shows an amplifier, type B, together with its transit case.

GENERAL DESCRIPTION

3. A theoretical circuit diagram is given in fig. 2. The amplifier is seen to consist of a Class B output stage and a driver stage. The microphones, which are connected in parallel at the input terminals M_1 M_2, are energized from the L.T. supply of the I/C amplifier, a variable resistance R_2 being connected in series to act as a volume control. A 200-ohm resistance R_1 is connected across the primary winding of the input transformer TR_1, in order to suppress any tendency to self-oscillation, and also to reduce distortion due to the frequency-response characteristic of the amplifier. The driver valve V_1 is a triode, and its grid is negatively biased (—9 volts). It operates as a class A power amplifier.

4. The anode load impedance of the driver valve consists of the transformer TR_2. The primary winding is included in the anode circuit while the centre-tapped secondary winding supplies grid excitation to the Class B amplifier valve, V_2, which consists of two complete triode assemblies in a single glass envelope.

5. The centre point of the secondary winding of the transformer TR_2 is connected directly to the negative side of the filament, no grid bias being employed. The resistances R_3, R_4, which are connected across the respective halves of the secondary winding, serve more than one purpose. In the first place, their presence ensures the suppression of parasitic oscillation, to which the circuit would otherwise be subject, owing to the normally inductive nature of the input and output loads. Secondly, they maintain a nearly constant load upon the secondary winding of the transformer TR_2. If these resistances were absent, the load would vary with the amplitude and frequency of the signal to be amplified, giving rise to considerable distortion.

6. The output impedance of the Class B valve consists of the transformer TR_3, the primary winding of which is centre-tapped for anode feed purposes. The secondary winding is connected to the telephone terminals T_1, T_2, through a capacitance consisting either of two condensers C_1, C_2,

in series, or the condenser C_1 alone. The condenser C_2 may be short-circuited at will by means of the switch S_2. This switch is engraved TEL and has two positions HIGH and LOW, with reference to the comparative pitch of voice frequencies. The LOW position may be found to give better quality in the absence of noise, but the HIGH position should give a greater ratio of signal to noise, and the overall intelligibility in this position may be superior.

CONSTRUCTIONAL DETAILS

7. The amplifier is built up on an aluminium chassis consisting of a front panel carrying a U-shaped shelf. It is fitted in a mahogany box which is covered with fabric and painted in standard grey colour. Four suspension spigots are provided for holding it in the amplifier crate. Fig. 1 shows the general appearance, and also the transit case. On the front of the panel are the battery socket (1), the volume control (2), the battery switch (3) and the tone control (4). The valves are inserted in the appropriate sockets through the door (5). When the amplifier is installed in an aeroplane this door should be closed and secured by means of the knurled screw. Connection to the permanent microphone-telephone circuits of the aeroplane is made by means of the four-pin plug (6).

8. Fig. 3 shows the wooden box (1) which houses the grid-bias battery. The cells are maintained in a position by a wooden cover, not shown in the illustration. The battery consists of three dry cells (Stores Ref. 5A/1548) which are connected in series by soldering the terminal lugs. The external leads are also soldered to the end connectors. In renewing this battery it is

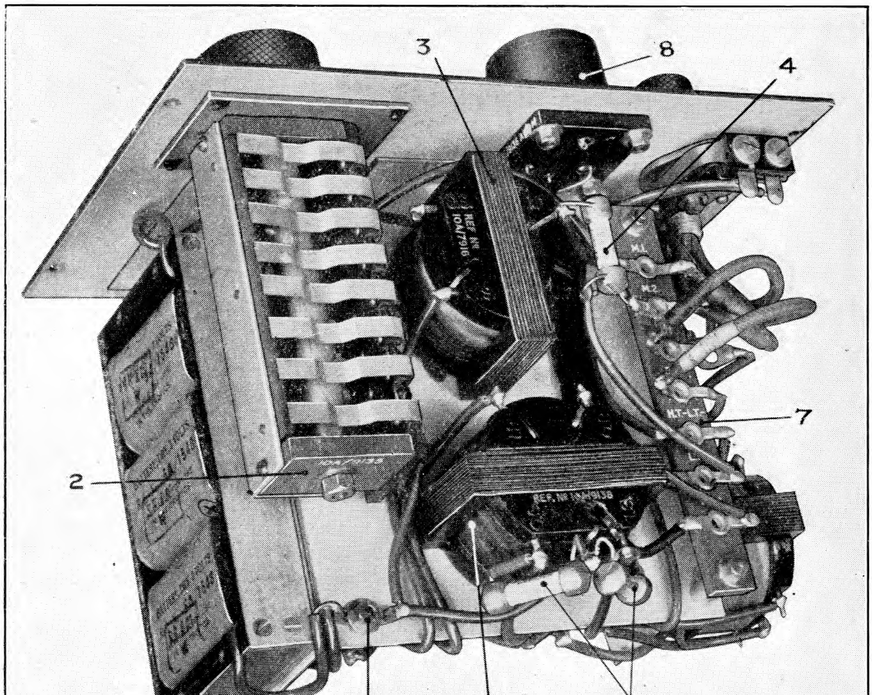


FIG. 3. Chassis, rear view.

most important to perform the requisite soldering operations as rapidly as possible, and with the minimum heat consistent with efficient joints. It is therefore necessary to take particular care in cleaning the connections before soldering.

9. The volume control rheostat (2) consists of a resistance having a maximum value of 1,790 ohms. Eight tappings are provided, the resistance in series with the microphone on the respective tappings being 0, 20, 80, 210, 440, 760, 1,190, 1,790 ohms. The microphone transformer (3) is mounted on the underside of the shelf, a $\frac{1}{2}$-watt rod type resistance (4) of 200 ohms being connected directly across the primary terminals. Below the microphone transformer is the inter-valve or driving transformer (5). Resistances (6) of the $\frac{1}{2}$-watt rod type, 50,000 ohms each, are connected directly across each half of the centre-tapped secondary winding. To the right of the transformers is the terminal strip (7) to which are taken the battery leads from the socket (8) and the microphone-telephone leads from the external circuits. The "filament-negative" line is earthed to the chassis at (9).

10. Fig. 4 shows the 4-pin socket (1) for the driver valve, the 7-pin socket (2) for the output valve, and the output transformer (3). Adjacent to the latter are mounted the two tone control condensers (4). The tone control switch (5) and battery switch (6) are also shown in this illustration.

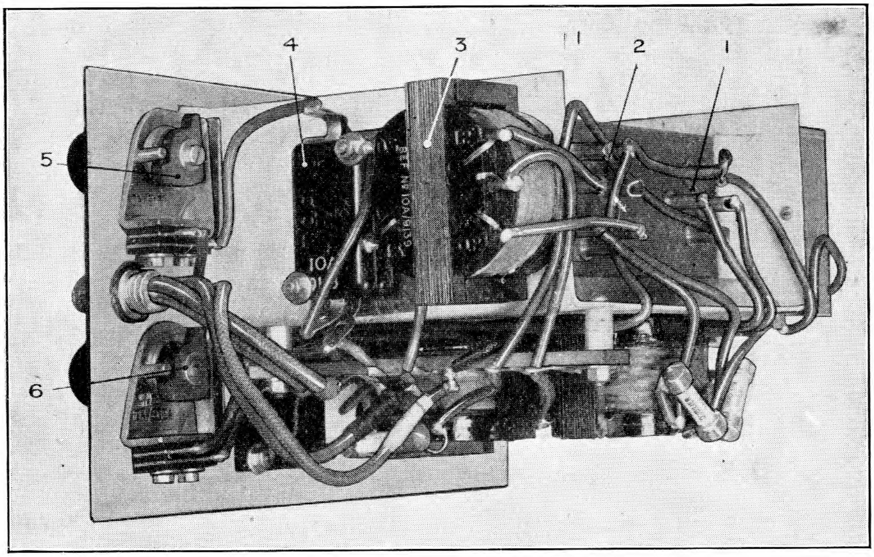


FIG. 4. Chassis, side view.

11. The photographs (figs. 3 and 4) actually show the details of the amplifier, type B. In this instrument, the output transformer is a transformer L/F, type G (Stores Ref. 10A/9139). In the amplifier, type C, the output transformer is a transformer L/F, type F (Stores Ref. 10A/9138) and is identical with the driving transformer. In the amplifier, type B, each tone control condenser has a capacitance of 0·001 uF (condenser type 260, Stores Ref. 10A/9133), while in the amplifier, type C, condensers, type 324, 0·05 uF (Stores Ref. 10A/9629) are fitted. Fig. 5 is a bench wiring diagram of the type B amplifier, and is also applicable to the type C amplifier, subject to the above modifications.

VALVES AND BATTERIES

12. The driver valve is a V.R.19 (Stores Ref. 10A/7846) and the Class B valve a V.R.32 (Stores Ref. 10A/9141). A 2-volt 20 Ah. accumulator (Stores Ref. 5A/1387) is used for L.T.

supply and a 120-volt dry battery (Stores Ref. 5A/1333 or 5A/1615) for H.T. supply. The grid-bias supply consists of three 3-volt dry batteries (Stores Ref. 5A/1548) connected in series, and fitted inside the amplifier. The other supply batteries are fitted in a special crate.

INSTALLATION

Amplifier I/C, type C

13. Certain types of aircraft R/T apparatus, e.g. the T.1083–R.1082 installation, are adapted for inter-communication by employing the microphone circuit of the transmitter and the A/F stages of the receiver as an I/C amplifier. This arrangement is primarily intended for use only in two-seater aeroplanes, but it may also be installed in three-seater aeroplanes, if one of the three positions is rarely manned. When inter-communication is required between all three positions, an I/C amplifier, type C, may be installed. This equipment is particularly adapted for use with the microphone-telephone circuit wiring, as fitted for transmitter-receiver inter-communication in the installation referred to above.

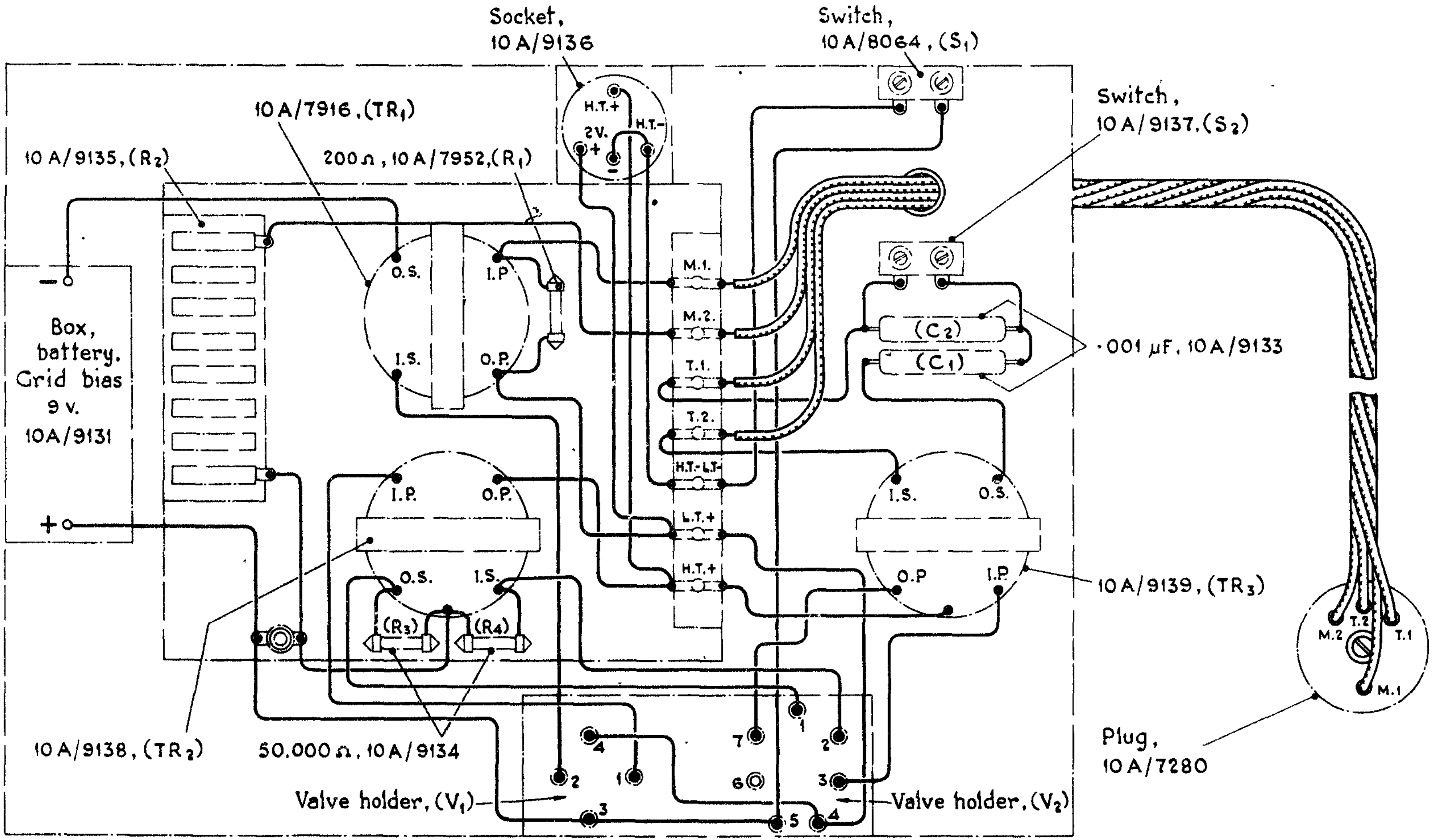
14. A typical installation diagram is given in fig. 6. The I/C amplifier is mounted by means of rubber slings in a special crate, the L.T. and H.T. batteries being fitted in a second crate as close as possible to the amplifier crate. The batteries are connected to the I/C amplifier by suitable plugs and sockets as shown. The requirements of the installation are as follows. The radio operator's microphone and telephones are normally connected to the radio transmitter and receiver respectively, while the microphones and telephones of the other members of the crew are connected to the input and output terminals respectively of the I/C amplifier. Arrangements must be made for the radio operator to transfer his equipment to the I/C circuits as necessary. The other members must therefore be able to inform him that he is required to transfer to this circuit. In addition, provision must be made for other members of the crew to use the R/T installation when necessary.

15. In the installation shown in fig. 6, these requirements are met in the following manner. The " telephone " and " microphone " connections of the I/C amplifier, type C, are brought to a combined micro-telephone socket, type 29, which carries a distinguishing label engraved I/C. Similarly, the input terminals of the transmitter microphone circuit, and the output terminals of the radio receiver, are brought to a similar socket carrying a distinguishing label engraved W/T. These sockets are additional to the three sockets, type 29, appropriate to the three I/C positions, e.g. " pilot ", " bomb aimer ", " radio operator ", which are connected to the microphone and telephone lines by means of terminal blocks, type B.

16. The microphone (+ and —) and telephone (+ and —) lines are connected to a combined micro-telephone plug, type 58, referred to in fig. 6 as the I/C line plug. If this plug is inserted in the " I/C " socket, the I/C lines are connected to the I/C amplifier. If the radio operator inserts his micro-telephone plug, type 58, into the " W/T " socket, he is able to transmit and receive on radio, while the other occupants are connected to the I/C amplifier only. In order to transfer to the I/C system, the radio operator shifts his micro-telephone plug into the " operator's I/C " socket. He is then entirely isolated from the radio installation.

17. Should the pilot or bomb-aimer require to use the R/T installation, the I/C line plug must be transferred to the " W/T " socket, the radio operator's micro-telephone plug being inserted into the " operator's I/C " socket. The R/T installation may then be used by any occupant, the send-receive switch, receiver volume control, etc., being operated by either remote or local control, according to circumstances.

18. The required manipulation of plugs and sockets is performed by the radio operator; the " I/C ", " W/T ", and " Operator's I/C " sockets must be grouped and mounted in a convenient position for this purpose.



Note :- Annotations shown thus (S1) refer to the corresponding annotations in Fig. 2.

FIG. 5. AMPLIFIER I/C TYPE B — BENCH WIRING DIAGRAM.

Facing paras. 13 to 18.

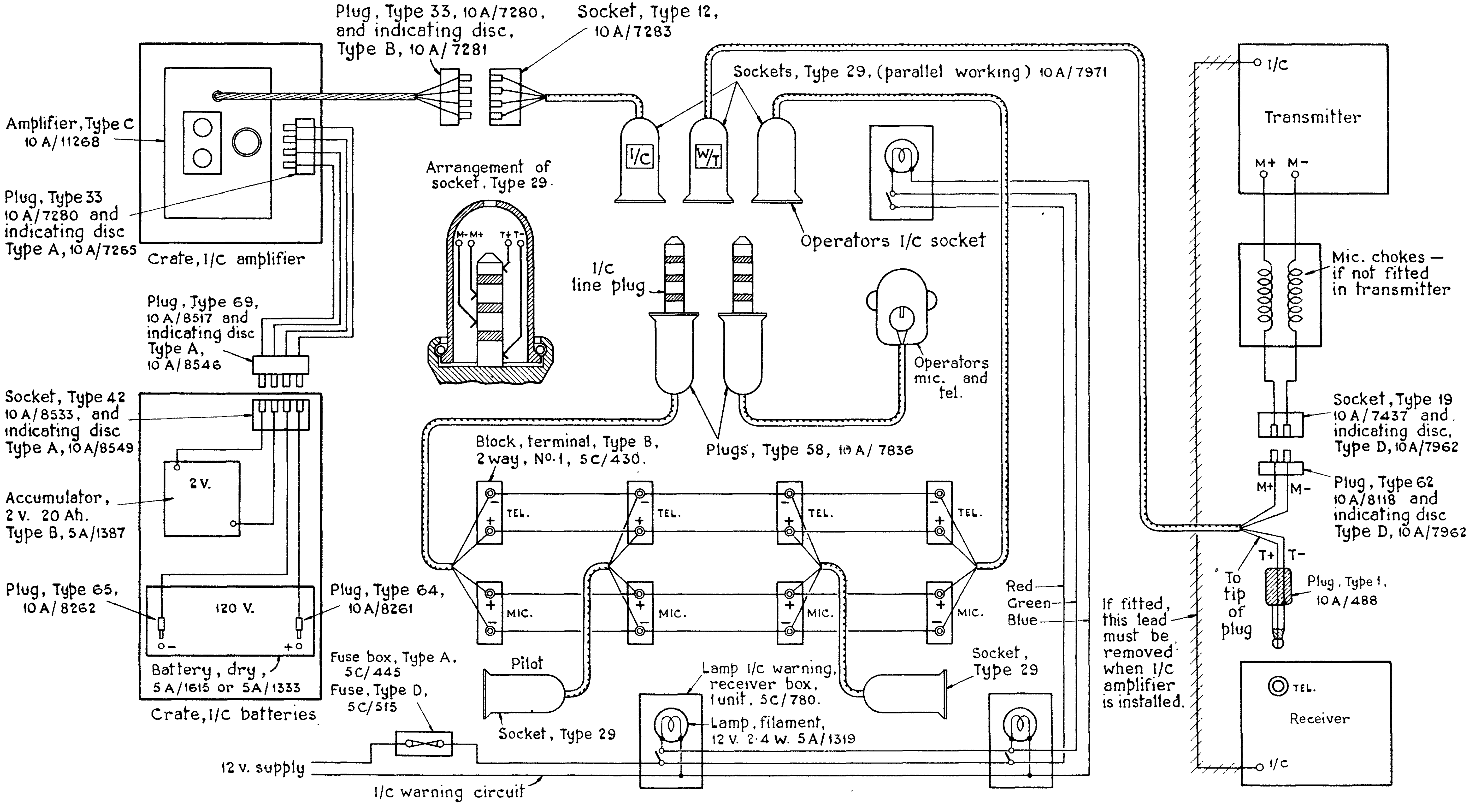


FIG. 6. TYPICAL INSTALLATION DIAGRAM (I/C AMPLIFIER TYPE C)

19. In order to attract the attention of members of the crew before using the I/C system, and in particular that of the radio operator (who may be connected only to " radio ") a system of warning lamps is fitted. This consists of a lamp and push switch at each I/C position. These are fed from the 12-volt general service accumulator through a fuse, type D, mounted in a fuse box, type A. The wiring is so arranged that the operation of any switch causes all three lamps to light.

20. When this system of I/C is installed to replace the transmitter-receiver I/C system, the following points require attention. Unless already mounted in the particular type of transmitter, special microphone chokes will be provided, e.g. in the case of transmitter T.1083, the choke unit, H.T. key and mic (Stores Ref. 10A/8464). Care must be taken that the " Tel + " terminals of all sockets, type 29, are connected to the positive terminals of the telephone terminal stocks, and the latter to the tip of the telephone plug, type 1. The lead connecting the I/C terminals of the transmitter and receiver must be removed before fitting the " operator's I/C " socket.

Amplifier I/C, type B

21. The I/C amplifier, type B, is used to provide inter-communication in multi-seater aircraft. As many as nine I/C points may be wired up, but not more than seven of these, including that of the radio operator, will be in use during any one flight. Each I/C point is fitted with a telephone terminal block, a microphone terminal block, and a combined micro-telephone socket, type 28. This socket is externally similar to the socket, type 29, but the telephone contacts are arranged for connecting telephones in series, i.e., unless a plug, type 58, is actually fitted in the socket, the telephone contacts are short-circuited.

22. In addition to the I/C amplifier, the I/C system incorporates a control switch, by means of which the radio operator exercises a certain degree of control over the microphones and telephone receivers which are connected to the radio installation and the I/C system. The

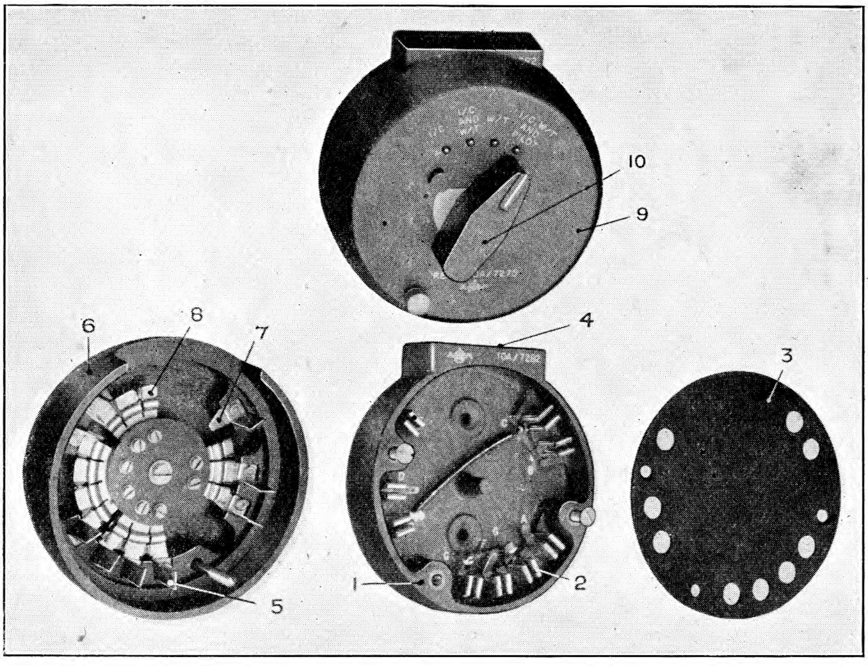


FIG. 7. Switch I/C, type 25.

switch, type 25 (I/C control) is used for this purpose. The general appearance and construction of this switch, and the base upon which it is mounted, is seen in fig. 7. The base is the centre one (1) of the three lower units. It is secured in a position convenient to the radio operator by countersunk screws. The base is fitted with nine female spring contacts (2) carrying soldering tags; these are lettered A to G, C. and G being duplicated. An ebonite cover plate (3) is fitted over the base and secured thereto by countersunk screws shown in the photograph. The wiring is taken through the rectangular duct (4). The cover plate is pierced in order that the male contacts (5) of the switch (6) may engage with the spring contacts in the base.

23. The switch (6), as viewed from the rear, is shown on the left. The nine fixed contacts (only one of which (7) is clearly visible) and thirteen flat spring-jaw contacts (8) form, in effect, four separate four-point switches. A front view of the completely assembled switch (9) is seen above. The switch handle (10) has four positions respectively engraved I/C, I/C and W/T, W/T, I/C, W/T AND PILOT.

24. The four positions function in the following manner :—

I/C.—All telephone receivers are connected in series across the output winding of the I/C amplifier. The radio receiver is isolated from all telephones.

I/C and W/T.—All telephone receivers are connected in series, across the output winding of the I/C amplifier. In addition the radio operator's telephones are connected to the output valve of the radio receiver in the normal manner. Thus the radio operator receives both radio and I/C signals at (practically) full strength. The remainder of the crew obtain full strength I/C, and feeble radio signals which suffice to inform them that the radio operator may be " busy ".

W/T.—In this position, the radio operator's telephones are disconnected from the I/C circuit and connected only to the radio receiver. It will be noted that although he is unable to listen to I/C, he may still speak to any member of the crew.

I/C, W/T and Pilot.—This position is similar to I/C and W/T, except that pilot's and radio operator's telephones are connected to the W/T radio receiver, while all members of the crew are on I/C.

The manner in which these connections are obtained is shown in fig. 8.

25. A typical installation diagram, utilizing what is called the split microphone circuit, is given in fig. 9. The I/C amplifier crates and batteries are omitted as these are exactly the same as in fig. 6. In the split microphone circuit system, there are, in effect, two I/C microphone lines, one for those positions which may require to use the radio installation, and the other for those points which require I/C only. Referring to fig. 9, the input circuit to the transmitter microphone transformer is connected to a plug, type 62, via a pair of microphone chokes. The " I/C only " microphone line is connected to a second plug, type 62. The " R/T and I/C " microphone line is connected to a socket, type 19. By shifting the latter socket from one plug, type 62, to the other, the microphone in positions on the " I/C and R/T " line may be connected either to the position on the " I/C only " line, or to the R/T transmitter. This socket is under the control of the radio operator.

26. The various telephone connections which are obtained by manipulation of the switch, type 25 (I/C control), are easily traced with the aid of fig. 8. It will be observed that although both first and second pilots' positions are wired between points B and E, only one of these will normally be manned. The bomb-aimer's microphone is wired on the " I/C and R/T " line, but his telephones are wired on the " I/C only " line, since he may require to transmit, but not to receive, R/T signals. The navigator's socket may be connected either on the " R/T and I/C " line (in series with those of the pilot) or as shown in the diagram.

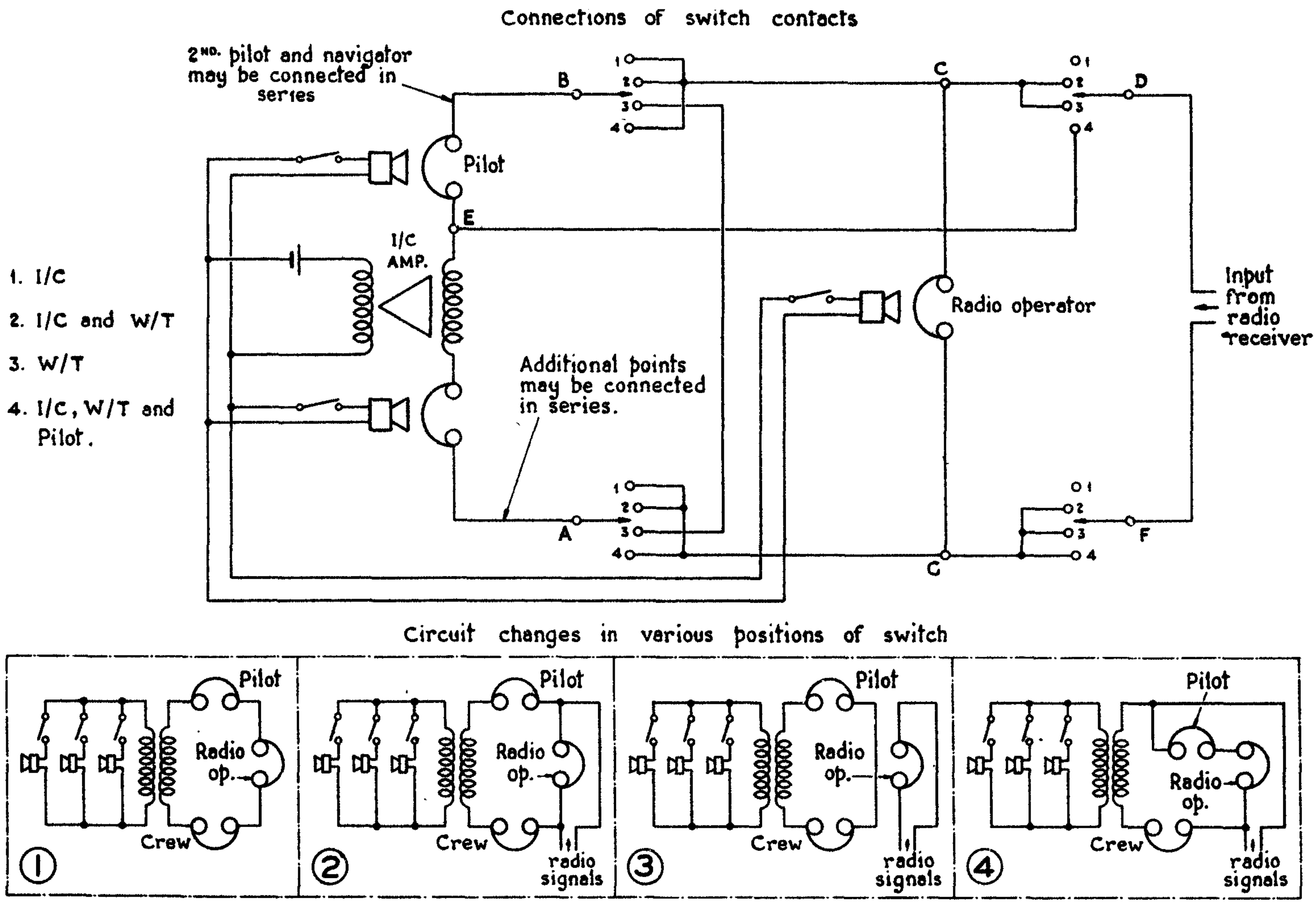


FIG. 8. ACTION OF SWITCH, TYPE 25

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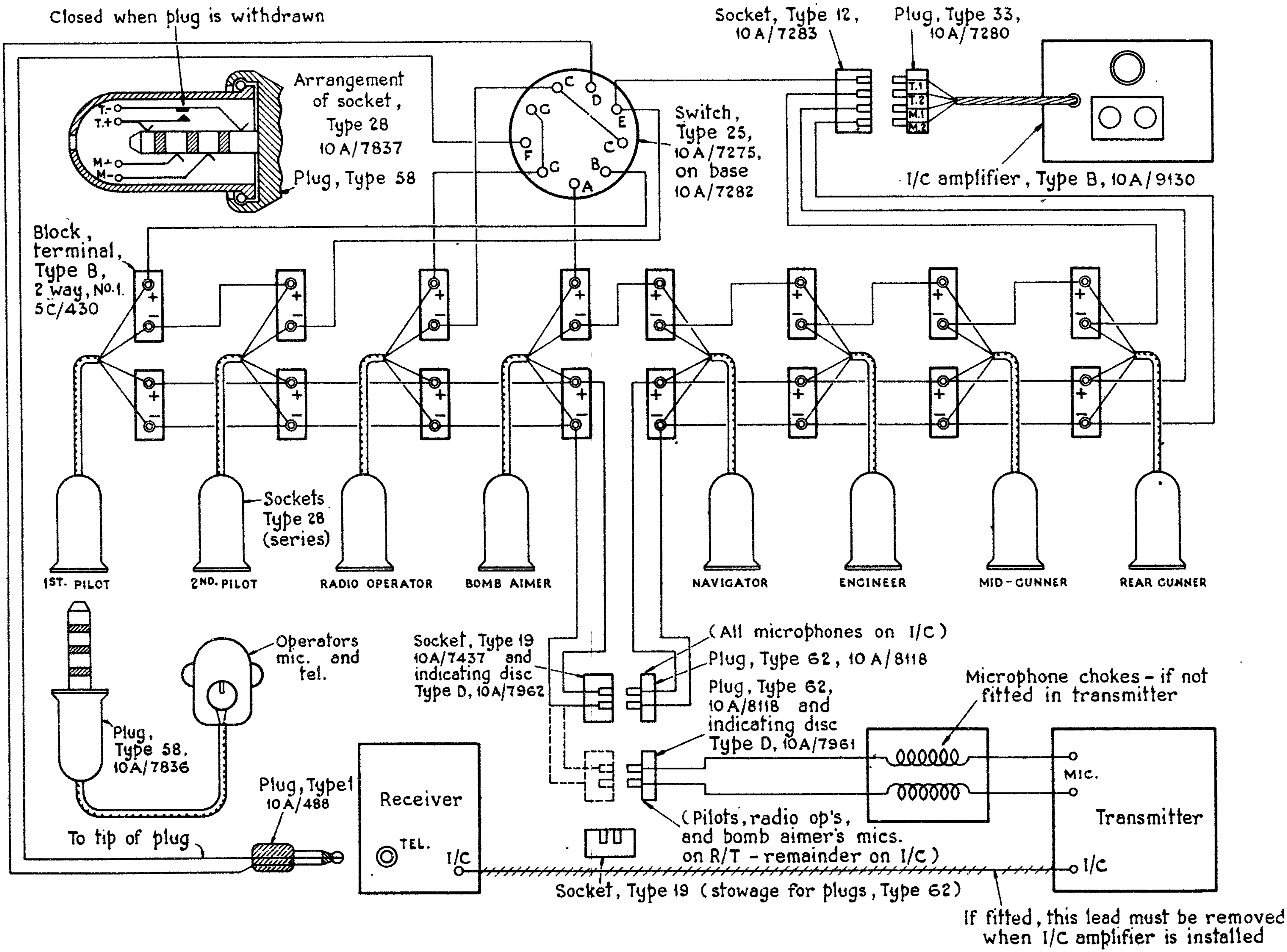

FIG. 9. TYPICAL INSTALLATION DIAGRAM (I/C AMPLIFIER TYPE B, WITH SPLIT MICROPHONE CIRCUIT)

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Following fig. 8

OPERATION

27. In installations incorporating the amplifier, type C, the operator's microphone-telephone plug is normally maintained in the W/T socket and the I/C line plug is fitted in the I/C socket. The W/T operator is therefore isolated from the I/C system, but his attention may be attracted by flashing the warning lamps. A simple pre-arranged code may be arranged, e.g. in order that the W/T operator may indicate that he is handling radio traffic and therefore not able immediately to revert to I/C.

28. In the type B (split microphone circuit) installation, the switch I/C control is used in the following manner. The microphone socket type is normally mated with the " I/C only " plug, type 62, so that all microphones are in parallel. The I/C control switch is maintained in the " I/C and W/T " position, in order that the radio operator may obtain good strength radio signals, while remaining on the I/C circuit. To receive radio signals free from I/C interference he may place the I/C control switch to " W/T ", but must revert to " I/C and W/T " as soon as possible, since no I/C warning circuit is fitted for calling purposes.

29. The position " I/C, W/T and pilot " may be employed while obtaining a D/F bearing. Both operator and pilot receive full strength radio signals and are in intercommunication with each other, but isolated from the I/C circuit. The " I/C " position is rarely required, but allows I/C to be employed in the presence of strong interfering radio signals.

PRECAUTIONS AND MAINTENANCE

30. Since all microphones are connected in parallel, care must be taken that the switch fitted to each is normally maintained in the " off " position, and is switched " on " only when it is necessary to speak. If this is not done, the speech level will be low and the noise level high. Efficient working cannot be expected unless this practice is strictly adhered to.

31. The I/C amplifier must be switched on prior to any flight and continuously maintained in this position. Care must be taken to switch off before leaving the aeroplane. The L.T. battery should be recharged after each flight, and the H.T. battery should be tested at the same time. It should be replaced when the voltage, on discharge, has fallen to 100 volts.

32. The anode current may be checked by removing the plug, type 64 (H.T. +), from the H.T. battery and connecting a suitable milliammeter in series. On switching on the I/C amplifier the no-signal anode current should be of the order of 7 mA. If it differs greatly from this, the valves may be tested separately as follows. Switch off the amplifier and withdraw the triode. The no-signal anode current, i.e. that of the Class B valve alone, should be about 4 mA. A similar test on the triode alone should give a no-signal anode current of about 3 mA. The total anode current during loud speech should be of the order of 12–15 mA.

33. The valves may also be tested by means of a valve tester, type 2, if available. The adjustments of the valve tester, and the meter readings to be expected, are given in the instruction card supplied with the instrument.

34. The grid-bias voltage may be tested *in situ* as follows. Disconnect the amplifier battery plug and withdraw the triode valve. Connect a high resistance voltmeter, reading not less than 0–10 volts, between the L.T.-point on the battery socket and the grid socket of the triode valve-holder, the latter point being connected to the negative terminal of the voltmeter. Switch on the amplifier; the voltmeter should register the voltage of the grid-bias battery. If this is less than 7·5 volts a new grid-bias battery should be fitted.

APPENDIX

NOMENCLATURE OF PARTS

The following list of parts is issued for information only. In ordering spares for I/C purposes, the appropriate sections of AIR PUBLICATION 1086 should be used.

Ref. No.	Nomenclature.	Quantity.		Remarks.
		Type B.	Type C.	
10A/9130 ..	Amplifier, I/C, type B	1	—	
10A/11268 ..	Amplifier, I/C, type C	—	1	
	Principal components :—			
10A/9132 ..	Case	1	1	
10A/9138 ..	Transformer, L.F., type F	1	2	
10A/9139 ..	Transformer, L.F., type G	1	nil	
10A/7916 ..	Transformer, microphone, type G	1	1	
10A/9135 ..	Resistance, type 232	1	1	Variable, 0–1,790 ohms.
10A/9134 ..	Resistance, type 231	1	1	50,000 ohms.
10A/7952 ..	Resistance, type 99	1	1	200 ohms.
10A/9133 ..	Condenser, type 260	2	nil	0·001 μF, tone control.
10A/9629 ..	Condenser, type 234	nil	2	0·05 μF, tone control.
10A/8064 ..	Switch, type 70	1	1	
10A/9137 ..	Switch, type 94	1	1	
10A/9131 ..	Box, battery (grid-bias)	1	nil	
10A/11338 ..	Box, battery (grid-bias)	nil	1	
10A/9136 ..	Socket, type 45	1	1	
10A/7280 ..	Plug, type 33	1	1	
	Fitted with :—			
10A/7281 ..	Disc, indicating, type B	1	1	
10A/7987 ..	Spigot, instrument suspension, type B ..	4	4	
	Accessories :—			
10A/9140 ..	Case, transit, for I/C amplifier	1	1	
5A/1387 ..	Accumulator, 2-V, 20Ah	1	1	
5A/1387 or 5A/1615	Battery, dry, 120-V	1	1	
5A/1548 ..	Cells, dry, 3-V	3	3	
10A/7846 ..	Valve, VR.19	1	1	
10A/9141 ..	Valve, WR.32	1	1	

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SECTION 4, CHAPTER 2

AMPLIFIER, TYPE A.1134

Contents

List of Illustrations

AMPLIFIER TYPE A.1134

(Stores Ref. 10D/11500)

INTRODUCTION

1. The amplifier, type A.1134, has been introduced to facilitate intercommunication between members of the crew of multi-seater aeroplanes. It may also be utilized as a modulation pre-amplifier and receiver output amplifier with the transmitter-receiver T.R.9F and, subject to certain modifications, with the general purpose transmitters such as the T.1083, the T.1154 and the T.1154B. The output from the receivers types R.1082 and R.1155 may be connected to the input circuit of the amplifier. A maximum of seven pairs of telephones can be connected to the output circuit.

2. The A.1134 is suitable for use only with installations incorporating electro-magnetic microphones. The absence of any direct current actuation of the microphone windings and the high gain necessitated in the amplification of the voice-induced currents preclude the substitution of the electro-magnetic microphone by the carbon granule type. The amplifier cannot be used with the modified (" interim ") T.R.9F.

3. Provision is made for certain switching operations by a three-position key, type 145, giving various combinations of communication between the W/T operator and the remainder of the crew of the aeroplane. A link, or locking strip, is provided to lock the switch in the normal, or B position, when necessary.

4. The dimensions of the amplifier are $6\frac{3}{4}$ in. by $4\frac{1}{2}$ in. and its weight, without valves or batteries, is approximately 4 lb. 8 oz. A transit case is provided. The general appearance of the amplifier is shown in Fig. 1.

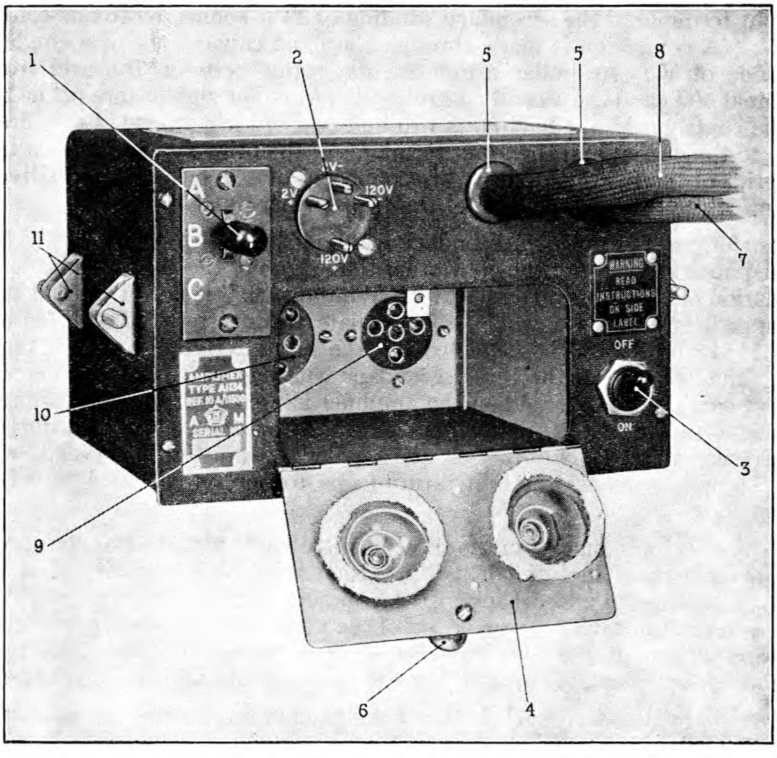

FIG. 1. Amplifier, type A.1134.

GENERAL DESCRIPTION

5. A theoretical circuit diagram of the amplifier A.1134 is given in fig. 2. The instrument incorporates two audio-frequency stages consisting of a Class A voltage amplifier, in which a triode valve V_1 is employed, and a Class B (" quiescent push-pull ") power amplifier with a twin-pentode valve V_2. The electro-magnetic microphones are connected in parallel to the primary winding of a microphone transformer T_1. Two resistances R_1 and R_2 are connected, in series, across the primary winding of T_1, the junction of the resistances being earthed. This arrangement equalizes the potentials of the respective input terminals with respect to earth and thereby assists in the elimination of the undesirable A/F oscillations which would otherwise arise. The output voltage of the microphone transformer T_1 is applied to the grid of the valve V_1 *via* a condenser C_1. The grid of V_1 is biased negatively through a resistance R_3. The values of the condenser C_1 and of the resistance R_3 are so chosen that, together, they constitute a fixed low note attenuation circuit which comes into operation at a frequency of 500 cycles per second and so improves the signal-noise ratio.

6. The anode load impedance of V_1 consists of a transformer T_2 with a split secondary winding. The lead from the anode of V_1 to the output primary of T_2 is screened, the screening being earthed. The centre-tapped secondary of the transformer supplies excitation to the two grids of the twin-pentode V_2 according to the practice known as quiescent push-pull. The value of the grid bias is increased to approximately cut-off point, thus reducing the current drain upon the H.T. battery, the standing anode current remaining at almost zero until the arrival of a signal. Grid bias is applied to the mid-point of the secondary winding of T_2 *via* a resistance R_4 which serves as a decoupling resistance and prevents feed-back to the grid circuit of the triode V_1 by means of the common grid-bias battery.

7. The input terminal of the secondary winding of T_2 is connected to one control grid of the twin-pentode V_2. A connexion is made through the fixed capacitance of a condenser C_2 to the appropriate anode of V_2. A similar arrangement obtains between the lead from the output secondary terminal of T_2 and the second control grid of V_2. The significance of the two condensers C_2 and C_3 in the control grid-anode circuits will be discussed in para. 11. Leads from the anodes of V_2 are taken to the output and the input terminals of the primary winding of a transformer T_3. The auxiliary grids of the twin-pentode V_2 are connected direct to the H.T. positive feed line and to the mid-point of the primary winding of the transformer T_3.

8. The transformer T_3 has three secondary windings " a ", " b ", and " c ". Winding " a " actuates the telephone receivers of the crew other than those of the W/T operators, and is utilized to effect modulation of the transmitter T.R.9F. Winding " b " is not at present used. Winding " c ", being tapped, is used as a whole, to modulate transmitter T.1083. Modulation of the transmitters T.1154 and T.1159B is effected *via* the input terminal and the tapping point of winding " c ". The isolation of the three secondary windings of T_3 enables one side of these to be maintained at earth potential. When the amplifier is used with the general purpose installations certain slight modifications, detailed in para. 29, are necessary to adjust the amplifier output to provide a suitable level of modulation for the transmitters concerned. An additional transformer T_4, having a transformation ratio of one to one, is provided to actuate the W/T operator's telephones.

9. In order to effect a reduction in the three possible kinds of distortion, harmonic, frequency and phase, with consequent loss of fidelity, provision is made in the circuit of the A.1134 to provide inverse or degenerative feed-back. In A/F practice this is often referred to as " negative feed-back ", and consists of taking a proportion of the voltage from the output circuit and feeding it back into the input circuit 180° out of phase. The overall gain of the amplifier, particularly at the higher audio frequencies, is reduced, but the benefits outweigh this loss of amplification.

10. The first channel of feed-back is that from the OS terminal of the winding " a " of the transformer T_3 through a resistance R_{10} to the IS terminal of T_1. The resistance R_{10}, in conjunction with a resistance R_{11}, forms in effect a potentiometer, and the tapping point, or junction,

C1 C4 C5 C2 C3	Condensers
R1 R2 R3 R11 R5 R6 R10 R7 R4 R9 R12 R8 R13 R14	Resistances
S2 T1 V1 T2 V2 S1 T3 T4	Miscellaneous

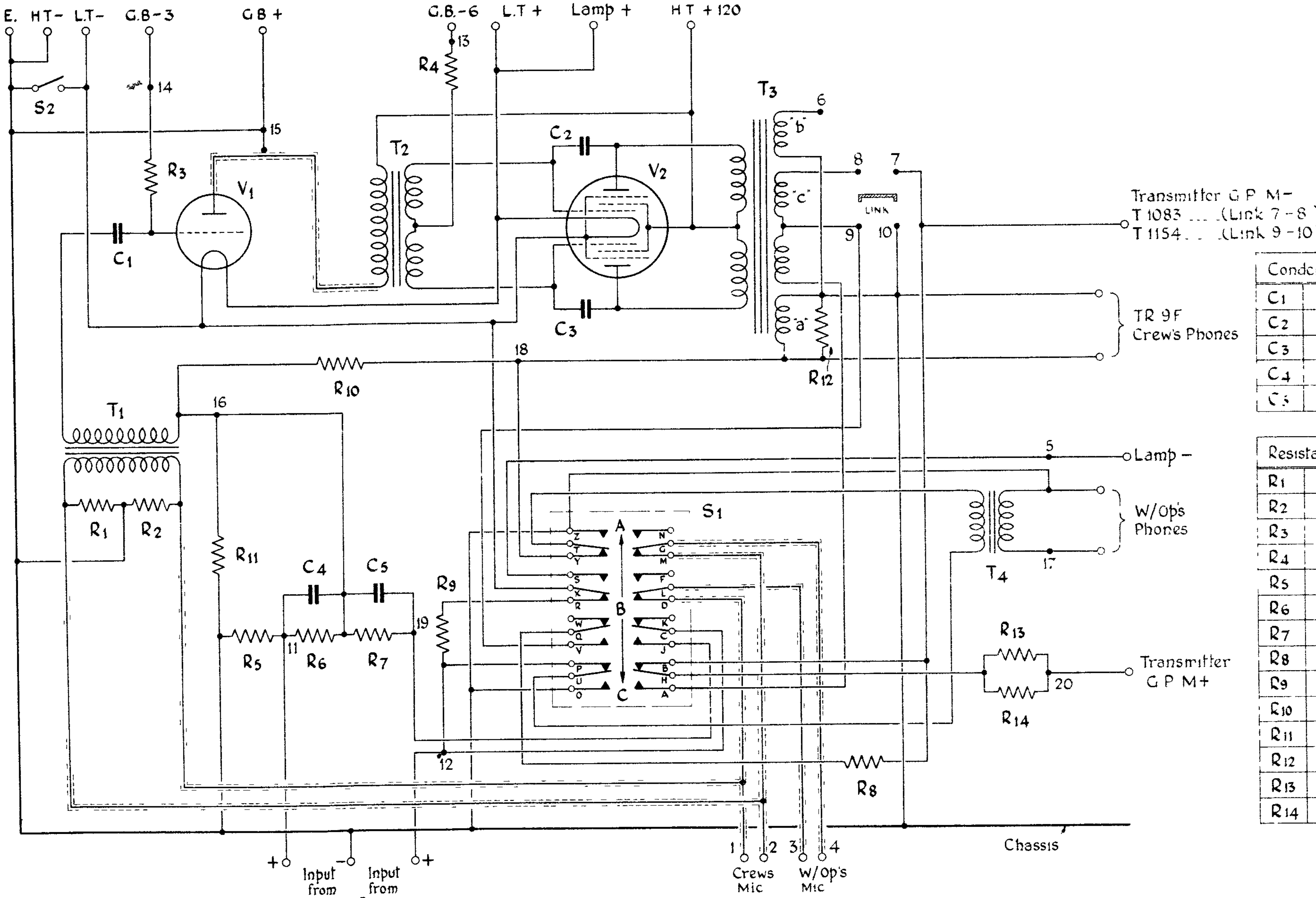

FIG. 2. AMPLIFIER A.1134. THEORETICAL CIRCUIT DIAGRAM

Condensers	
C1	500 μμF
C2	50 μμF
C3	50 μμF
C4	100 μμF
C5	100 μμF

Resistances	
R1	500 Ω
R2	500 Ω
R3	0·5 MΩ
R4	0·15 MΩ
R5	15,000 Ω
R6	1 MΩ
R7	1 MΩ
R8	50 Ω
R9	15,000 Ω
R10	2 MΩ
R11	5,000 Ω
R12	50,000 Ω
R13	75 Ω
R14	75 Ω

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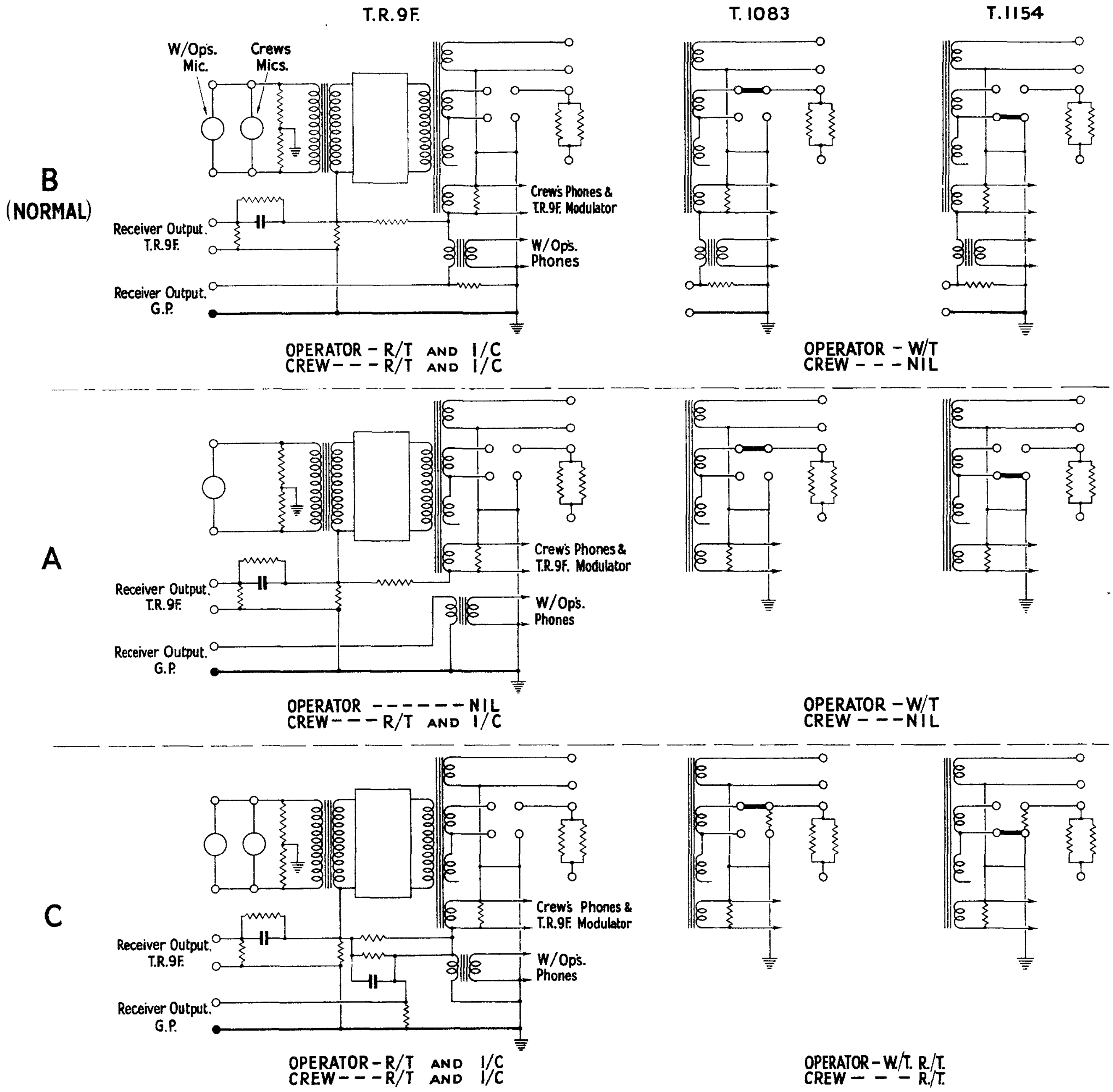


FIG. 3 AMPLIFIER A1134 - CIRCUIT CHANGES WITH SWITCH OPERATION

of R_{10} and R_{11} determines the proportion of the output voltage from winding " a " re-introduced into the grid circuit of V_1. Having regard to the values of R_{10} and R_{11} the proportion of this reverse feed-back is approximately one-quarter per cent.

11. The second method of re-introducing a proportion of the output impulses into the circuit utilizes only the twin-pentode stage of V_2. A fraction of the voltage developed across each half of the primary winding of the transformer T_3 is applied to each of the control grids of the valve V_2 by means of fixed condensers C_2 and C_3. Their capacitance is so chosen that negligible feed-back exists at frequencies below 2,500 cycles per second but above this, the gain of the twin-pentode falls off rapidly. In the absence of the condensers C_2 and C_3 the frequency response of the amplifier would occupy a wider band of the audible spectrum, continuing up to the region of 6,000 cycles per second. The condensers limit the band to approximately that of the electro-magnetic microphones type 19 or type 21. The effect of this cut-off is to render the amplifier more stable and it reduces the tendency to self-oscillation caused by stray capacitance between the output and the input circuits. The use of unscreened plugs and sockets in certain portions of the aeroplane installation precludes the complete elimination of this stray capacitance. As stated in para. 5 the microphone leads are balanced to earth in order to assist in this respect.

12. A resistance R_{12} is connected across the output winding " a " of T_3. Thus, in the absence of telephones this output stage is never entirely unloaded. This resistance also reduces the variation of the load impedance with the frequency of the telephone receivers. It has a negligible effect upon the output when the amplifier is fully loaded. This winding " a " provides for the actuation of six pairs of telephones in parallel.

13. When the amplifier is used as a sub-modulator of the transmitter-receiver T.R.9F, the output from the winding " a " of T_3 is applied *via* a step-down transformer in the T.R.9F to the control grid-filament circuit of the modulator valve. A simplified circuit in fig. 3 illustrates this arrangement. The diagrams in this illustration also incorporate the circuital changes effected by the positioning of the key switch of the A.1134 in the A, B and C positions when used with the T.R.9F or the general purpose installations.

14. When the amplifier is used with the T.R.9F a resistance R_5 is connected direct across the output terminals of the receiver R.1139. The resistance R_5 is in parallel with the series resistances R_6 and R_{11}. A condenser C_4 is in parallel with R_6. The junction of R_6 and R_{11} is joined to the IS terminal of the microphone transformer T_1. Thus, a fraction of the A/F voltage across R_5, as determined by the potentiometer constituted by R_6 and R_{11}, is fed into the grid circuit of the valve V_1. This fraction is so chosen that, after its amplification by V_1 and V_2, the A/F voltage available across the winding " a " of T_3 is approximately equal to the original input A/F voltage across R_5. The signals from the R.1139 are therefore accessible to the crew of the aeroplane at approximately full strength.

15. The condenser C_4 is introduced into the circuit to afford a compensation capacitance. The input capacitance of the valve V_1 and the capacitance-to-earth of the transformer T_1 constitute a high note attenuation circuit which is rendered less serious by the capacitance of C_4.

16. Irrespective of the position of the key switch, when the A.1134 is used with the pilot-operated T.R.9F, intercommunication and R/T are at all times available to members of the aeroplane crew other than the W/T operator.

17. The whole of the tapped secondary winding " c " of the output transformer T_3 is used for the modulation of the transmitter T.1083. Certain modifications as discussed in para. 29 are necessary when the amplifier is used in this connexion. With the three-position key switch in the central B position the primary of the transmitter microphone transformer is short-circuited. The primary winding of the W/T operator's telephone transformer T_4 is now connected between the high potential output terminal of the receiver R.1082 and the high potential end of the amplifier output winding " a " of T_3. The W/T operator therefore receives signals from both the amplifier and the receiver. The impedance of the winding " a " is very low in comparison with that of the primary winding of the transformer T_4 and the voltage developed across the

telephones of the aeroplane crew is negligible. If the receiver is switched OFF the W/T operator still receives I/C signals, since the circuit of T_4 is connected *via* a resistance R_9.

18. When the key switch is in the A position the facilities of the aeroplane crew remain as described in para. 16. The W/T operator's microphone is now disconnected and his telephone transformer is fed from the receiver only. He is accordingly restricted to W/T operation with the transmitter T.1083. He is also isolated from the remainder of the crew and the aeroplane call light system must be used to attract his attention when he is required on the I/C circuit.

19. When the key switch is in the C position the W/T operator's microphone is connected in parallel with the remainder of the I/C line. The primary winding of T_4 is now in parallel with the telephones of the crew. In effect, therefore, all telephones are in parallel across the winding " a " of T_3 and also across the resistance R_9. The modulating winding " c " of T_3 is connected to the microphone transformer of the transmitter, the resistance R_8 being in parallel with a portion of the winding. This resistance is necessitated by the requirements of the transmitters T.1154 and T.1154B, but has a negligible effect upon the input voltages to transmitter T.1083. With the key switch in the C position, the output of the receiver R.1082 is fed into the amplifier as described for the receiver portion of T.R.9F in para. 14. In this instance, however, the resistance R_7 and the capacitance of C_5 replace R_6 and R_4. The resistance R_9 becomes the standard load on the receiver, corresponding in this function to R_5.

20. The modulation of the transmitters T.1154 and T.1154B is effected by a portion of the winding " c " of T_3. With the key switch in the normal, or B position, the modulating connexions are similar to those of the T.1083 installation. Position A of the key switch does not change the modulating connexions but isolates the W/T operator from the I/C line as described in para. 18. In the C position of the key switch the modulating winding " c " of T_3 is connected to the microphone transformer of the transmitter, and the earthing of the I/C line *via* the resistance R_8 preserves the normal loading of the circuit. Facilities are then the same as when the key switch is positioned at B, but R/T is available both to the crew and the W/T operator.

21. Reference is made in para. 18 to the call light system which is a part of the aeroplane installation and is used when the W/T operator is isolated from the rest of the crew. On the ten-point plug of the amplifier provision is also made for a warning lamp circuit operated from the amplifier L.T. battery. Should the necessity for this circuit arise, it consists of a warning lamp and push switches, in series, between the positive and negative terminals of the 2-volt battery. The circuit is broken at the key switch and is only operative when the key is in the A position. Normally the push switches are ON and the warning lamp glows. The occupant of any position on the I/C line may thus attract the attention of the W/T operator by repeatedly pressing the push switch and so flashing the warning lamp.

CONSTRUCTIONAL DETAILS

22. The amplifier is built up on an aluminium chassis consisting of the main panel and a sub-panel joined together by a three-sided box. It is contained in a metal case which is painted black. Four suspension spigots are provided for holding the amplifier in the transit case. The general appearance of the amplifier, with the valves removed and the valve cover opened, is shown in fig. 1. The main panel carries the three-position switch (1), the battery plug (2), battery switch (3), the valve cover (4) and two rubber bushes (5). The valve cover is hinged to permit of the insertion of the valves into their appropriate holders. When in operation in an aeroplane the valve cover should be closed and secured by means of the knurled screw (6). Through the rubber bushes are led, respectively, the tubular braiding covered leads (7) to the four-pole microphone plug, and the leads (8) to the ten-pole I/C modulator and receiver plug. The sub-panel carries the two-valve holders (9) and (10) of the triode V_1 and of the pentode V_2. The three-sided box provides support for the four transformers, a 20-way connexion panel and clips for supporting the grid-bias battery. Two suspension spigots (11) are shown on the left-hand side of the case.

23. An interior view of the chassis is shown in fig. 4. The microphone cable (1) and the I/C modulator and receiver cable (2) are secured to the underside of the main panel by a fixing bracket to which they are whipped with sailmaker's twine. The leads are connected to the appropriately numbered connexion spills on the 20-way panel (3). The grid battery bracket (4) is on the side of the three-sided box. On the top of this box and immediately in front of the connexion panel are secured the transformers T_1 and T_2. A condenser C_1 and a resistance R_3 are connected to the grid pin of the valve-holder (5). Between the appropriate anode and the control grid pins

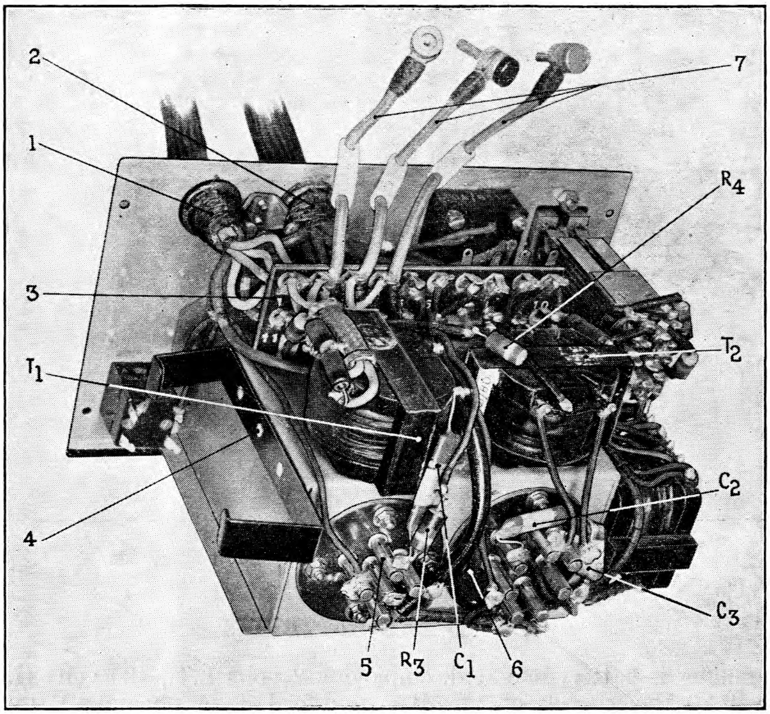


FIG. 4. Interior view of chassis from the right-hand side.

of the pentode holder (6) there are the two condensers C_2 and C_3. The decoupling resistance R_4 is joined to the mid-point of the secondary winding of T_2. Uniflex grid-bias leads (7) are shown, these, reading from the left of the photograph, being the —6, —3 and + leads. These leads are connected respectively, to connexion spills numbered 13, 14 and 15 on the panel.

24. Another interior view of the chassis is shown in fig. 5. On the underside of the main panel can be seen the battery plug casing (1), the key switch (2) and the telephone transformer T_4. Four soldering lugs are visible. The input primary (3) is joined to a six-way connecting lug (not visible in the photograph) which is the common earth terminal. The output primary (4) is connected to spill numbered 17 on the connexion panel. The input secondary (5) and the output secondary (6) both have leads to the key switch. Underneath the telephone transformer T_4 is the output transformer T_3. Five soldering lugs are seen and these are the terminals of the modulator windings " b " and " c ". The output terminal (7) of " c " is joined to the connexion spill (8) numbered 8 on the 20-way panel. The tapping connexion (9) of " c " is connected to a spill (10) on the panel. The input terminal (11) of winding " c " goes direct to the key switch. Of winding " b " the output lug (12) has a lead to the spill (13) numbered 6 on the panel. The input terminal (14) of this winding is earthed. A bench wiring diagram of the amplifier is shown in fig. 6.

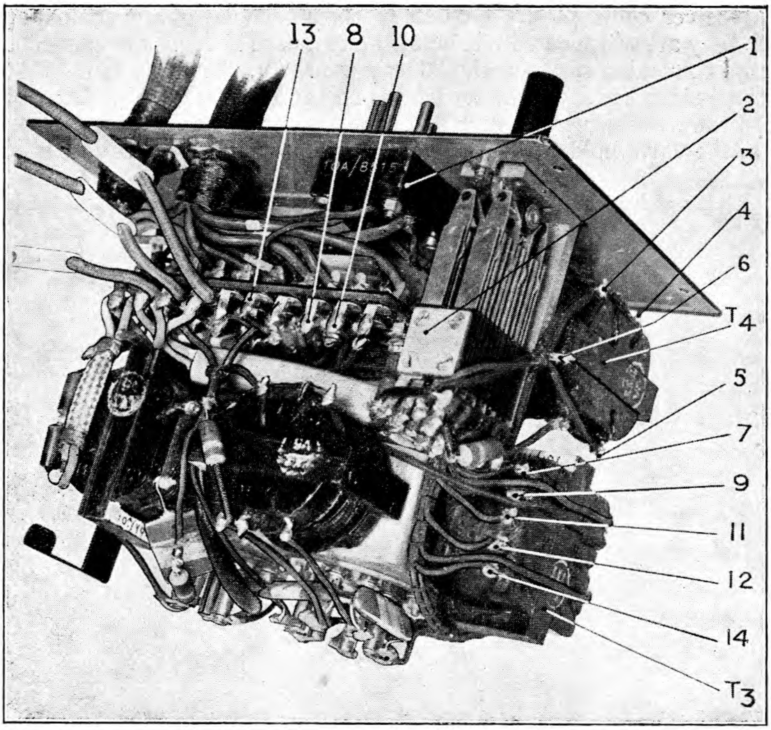


FIG. 5. Interior view of chassis from the left-hand side.

VALVES AND BATTERIES

25. The amplifier is battery-operated, employing 2 volts L.T., 120 volts H.T. and 6 volts grid bias. A 2-volt 20 Ah accumulator, type B, is used for L.T. supply and a 120-volt dry battery or accumulator for H.T. supply. The transmitter batteries must not be used. The grid-bias 6-volt dry battery is fitted inside the amplifier. The valves used are a triode, as first amplifier, V.R.21, and a twin-pentode, V.R.35.

INSTALLATION

26. The necessary manipulation of the plugs and sockets and the operation of the key switch of the amplifier are performed by the W/T operator. The amplifier must be installed in such a position as will ensure convenient access for these operations. The general purpose transmitters and associated receivers are switched to SEND, RECEIVE or OFF by the W/T operator but the corresponding operations for T.R.9F are effected by the pilot.

27. All microphone wiring must be carried out in screened twin-core wire (Dumet 4), the screen being bonded across wherever a break is made at terminal points. The screens must be earthed. All microphone sockets must be wired up in the same electrical direction, that is, all M+ must be joined and all M− joined. The microphone leads must not be earthed at any point. The earth connexion of the amplifier must be joined to the aeroplane earth or at some point connected to it. This connexion may be effected *via* the earth of T.R.9F, R.1082 or R.1154.

28. The amplifier is issued with the key switch handle locked in the B position by means of the locking strip. If necessary the locking strip may be removed when the amplifier is installed in the aeroplane, depending upon the circumstances in which the amplifier is used.

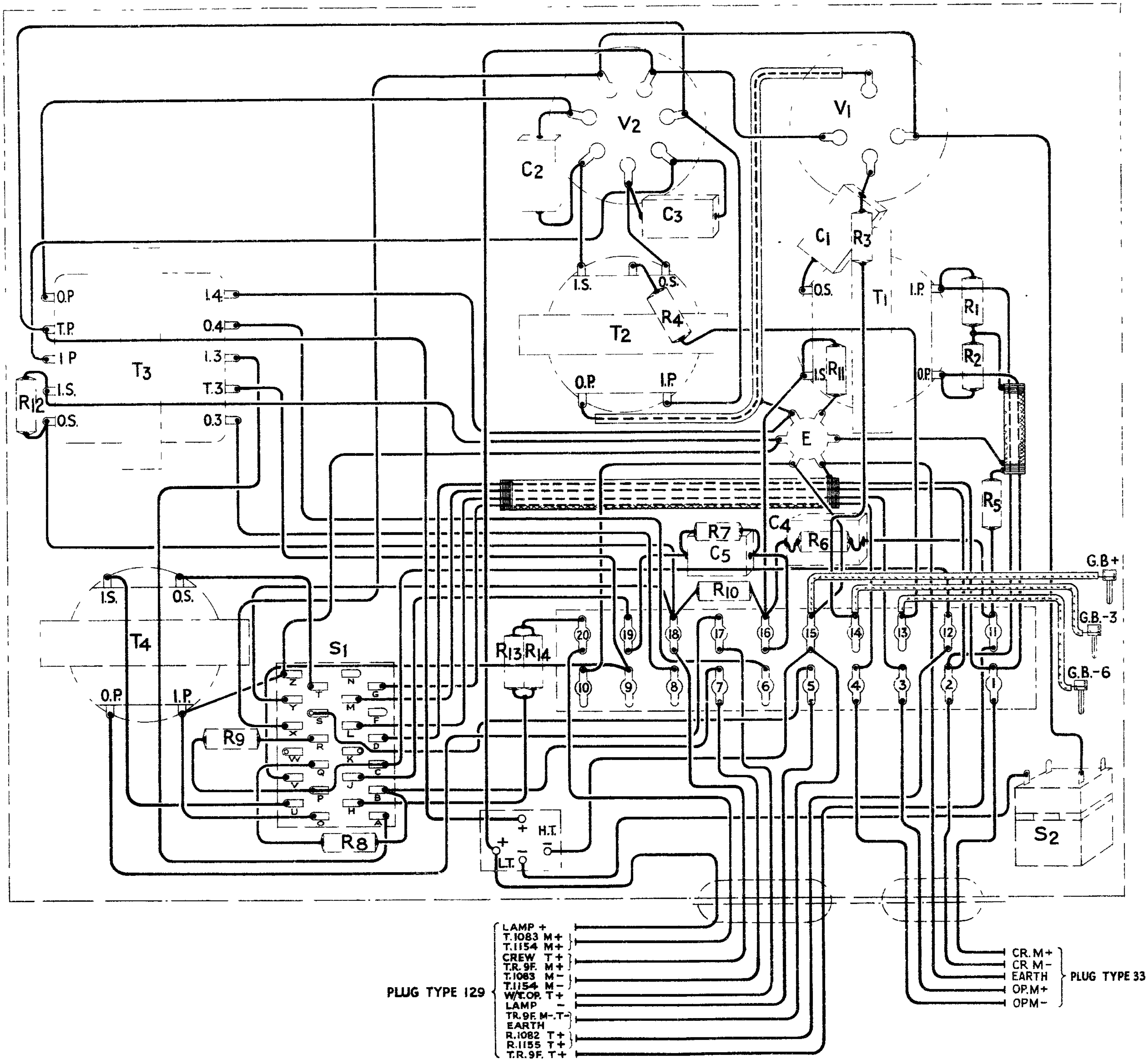


FIG. 6. AMPLIFIER A1134 - BENCH WIRING DIAGRAM

29. The amplifier must not be used with the general purpose installations unless authorization is received. When so utilized, certain modifications must be effected before the amplifier is connected to the installation. On the change-over switch of T.1083 the microphone positive lead (MIC+) must be connected to the L.T.—TRANS. terminal. It should, therefore, be disconnected from the L.T.+ MIC+ terminal. Unless this modification is made the 8-volt supply for the microphone circuit of T.1083 will be short-circuited through the microphone chokes. The I/C lead from the top of the transmitter must be removed. In the amplifier A.1134 the spill connexions numbers 7 and 8, on the 20-way connector panel, must be short-circuited by a link of wire when used with the T.1083. When used with the T.1154—R.1155 installation the spill connexions numbered 9 and 10 on the 20-way panel of A.1134 must be short-circuited by a link of wire.

OPERATION

30. The amplifier, type A.1134 is suitable for use with electro-magnetic microphones only. It is intended, primarily, for use with the T.R.9F but, subject to certain modifications which are detailed on a label affixed to the side of the amplifier case, it may be employed with certain general purpose installations such as the T.1083—R.1082 and T.1154—R.1155. It should be noted that when used with the T.1154—R.1155 installation, a modification to the amplifier as detailed on the label for the T.1115—R.1116 installation (with which it was originally intended to be used) must be effected. The amplifier must not be used with the general purpose installations without authority. The amplifier will not function with the modified (" interim ") type T.R.9F and the wiring of that instrument must be restored to its original condition before any attempt is made to incorporate the A.1134.

31. The various combinations of communication between the W/T operator and the remainder of the aeroplane crew are governed by the three-position key switch (1, fig. 1). The facilities given are detailed in the following table :—

Key-switch Position	Operator			Crew		
	G.P.	T.R.	I/C	G.P.	T.R.	I/C
A	W/T	—	—	—	R/T	I/C
B	W/T	R/T	I/C	—	R/T	I/C
C	W/T R/T	R/T	I/C	R/T	R/T	I/C

When the key-switch is in position A the operator is isolated from the rest of the crew and his attention may be called by the aeroplane call-lamp system. The A.1134 should normally be used with the key-switch in the B position and locked in that position by the locking strip.

32. The A.1134 requires its own battery supplies. It should be switched ON (3, fig. 1) during the entire time the aeroplane is in flight. A slight " chirp " will be heard when the amplifier is switched ON or OFF but this is a transient effect due to the warming up of the valve filaments and is quite normal. Care must be taken to switch OFF before leaving the aeroplane.

33. If instability occurs as shown by a loud howl or abnormal H.T. current and apparent loss of gain (that is, greater than 10 mA with no speech input whilst varying the position of the key-switch) check that the screen of the wiring is bonded throughout. Check that all earth connexions are properly made. Check the batteries, for low voltages may bring about instability.

When the key-switch is in the B position the general purpose transmitters and their associated receivers must never be switched on together or a persistent howl will ensue. The transmitter must be switched off before switching on the receiver or vice-versa.

MAINTENANCE

34. The condition of the L.T., H.T. and grid-bias batteries should be checked regularly. Low battery voltages will encourage instability in the A.1134. The L.T. battery should be recharged after each flight, and the H.T. and grid-bias batteries tested at the same time. The H.T. battery should be replaced when the voltage, on discharge, has fallen to 100 volts. The normal values of the grid bias are —3 volts on V_1 and —6 volts on V_2. Care should be taken to ensure that the battery is correctly connected. To test the grid-bias battery it is necessary to remove the amplifier from its case by taking out the four securing screws at the corners of the main panel.

35. The valves may be tested by using a valve tester, type 2, if available. The adjustments of the valve tester and the meter readings to be expected are given in the instruction card supplied with that instrument. Attention should be paid to the maintenance of the plugs type 58 and the sockets types 28 and 29 and reference should be made to the appropriate section of AIR PUBLICATION 1186, Vol. II, Pt. 1, for details. Occasionally a small drop of transformer or other suitable oil should be injected into the socket type 29 as a precaution against deterioration of the contacts. The electro-magnetic microphones and their cords should be regularly tested in accordance with the practice detailed in AIR PUBLICATION 1186, Vol. II, Pt. 1.

36. It is particularly essential that the screening and insulation resistance of the aeroplane microphone wiring is maintained at a high standard. The insulation resistance should conform to the following minima :—

Mic. positive to Mic. negative	5 megohms
Mic. positive to Tel. positive	5 megohms.
Mic. negative to Tel. positive	5 megohms
Tel. negative to Mic. positive	5 megohms
Tel. negative to Mic. negative	5 megohms
Tel. negative to Tel. positive	5 megohms

APPENDIX

NOMENCLATURE OF PARTS

The following list of parts is issued for information. When ordering spares for this amplifier, the appropriate section of AIR PUBLICATION 1086 must be used.

Reference No.	Nomenclature	Quantity	Reference in fig. 2	Remarks
10D/11500	Amplifier, type A.1134 ..	1	—	Without valves and batteries.
	Principal components :—			
10D/11502	Case	1	—	Fitted with four spigots, type B.
	Condenser :—			
10C/10552	Type 421	2	C_2, C_3	50$\mu\mu$ F.
10C/10553	Type 422	2	C_4, C_5	100$\mu\mu$ F.
10C/10512	Type 543	1	C_1	500$\mu\mu$ F.
	Holder :—			
10H/9615	Valve, type S ..	1	—	
10H/9756	Valve, type U ..	1	—	
10D/11507	Panel, connexion ..	1	—	
	Plug :—			
10H/7280	Type 33	1	—	Microphone plug, fitted with 10H/11510, disc, indicating, type F.
10H/8515	Type 67	1	—	Battery plug mounted on panel.
10H/9112	Type 82	1	—	Grid-bias positive.
10H/9113	Type 83	2	—	Grid-bias negative.
10H/11505	Type 129	1	—	10-pole.
	Resistance :—			
10C/11381	Type 477	1	R_{12}	50,000 ohms.
10C/11382	Type 478	1	R_4	150,000 ohms.
10C/11384	Type 480	2	R_6, R_7	1 megohm.
10C/11385	Type 481	1	R_{10}	2 megohms.
10C/11670	Type 504	1	R_{11}	5,000 ohms.
10C/11674	Type 508	1	R_3	0·5 megohm.
10C/6	Type 540	2	R_1, R_2	500 ohms.
10C/7	Type 541	2	R_5, R_9	15,000 megohms.
10C/8	Type 542	1	R_8	50 ohms.
10C/342	Type 708	2	R_{13}, R_{14}	75 ohms.
	Switch :—			
10A/10255	Type 145	1	S_1	
10A/10338	Type 152	1	S_2	
	Transformer :—			
10A/10280	L/F., type Q	1	T_2	
10A/11503	L/F., type 26 ..	1	T_3	
10A/11504	L/F., type 27 ..	1	T_4	
10A/7915	Microphone, type G ..	1	T_1	
	Accessories :—			
5A/1387	Accumulator, 2 v. 20 Ah, type B.	1	—	
	Battery :—			
5A/1251	Dry, 6 v.	—	—	
5A/1333	Dry, 120 v., type A ..	1	—	Home service.
	or			
5A/1615	Dry, 120 v., type B ..	1	—	Overseas service.
5C/781	Box, receiver	1	—	Circular, to take warning lamp.
10D/11730	Case, transit	1	—	
	Disc, indicating :—			
10H/11511	Type F	1	—	Fitted with 10H/7283.
10H/18	Type P/129/A ..	1	—	Fitted with 10H/11505.
10H/19	Type S/67/A	1	—	Fitted with 10H/8529.
	Plug :—			
10H/8261	Type 64	1	—	
10H/8262	Type 65	1	—	
	Socket :—			
10H/7283	Type 12	1	—	Fitted with 10H/11511.
10H/8529	Type 39	1	—	Fitted with 10H/19.
	Valve :—			
10E/7738	V.R 21	1	V_1	
10E/9779	V.R.35	1	V_2	

(53444) Wt. 30090/1080 4000 12/40 Hw. G.371

(*Issued May, 1941 with A.L. No. 32*)

SECTION 4, CHAPTER 3

AMPLIFIER, TYPE A.1219

Contents

List of Illustrations

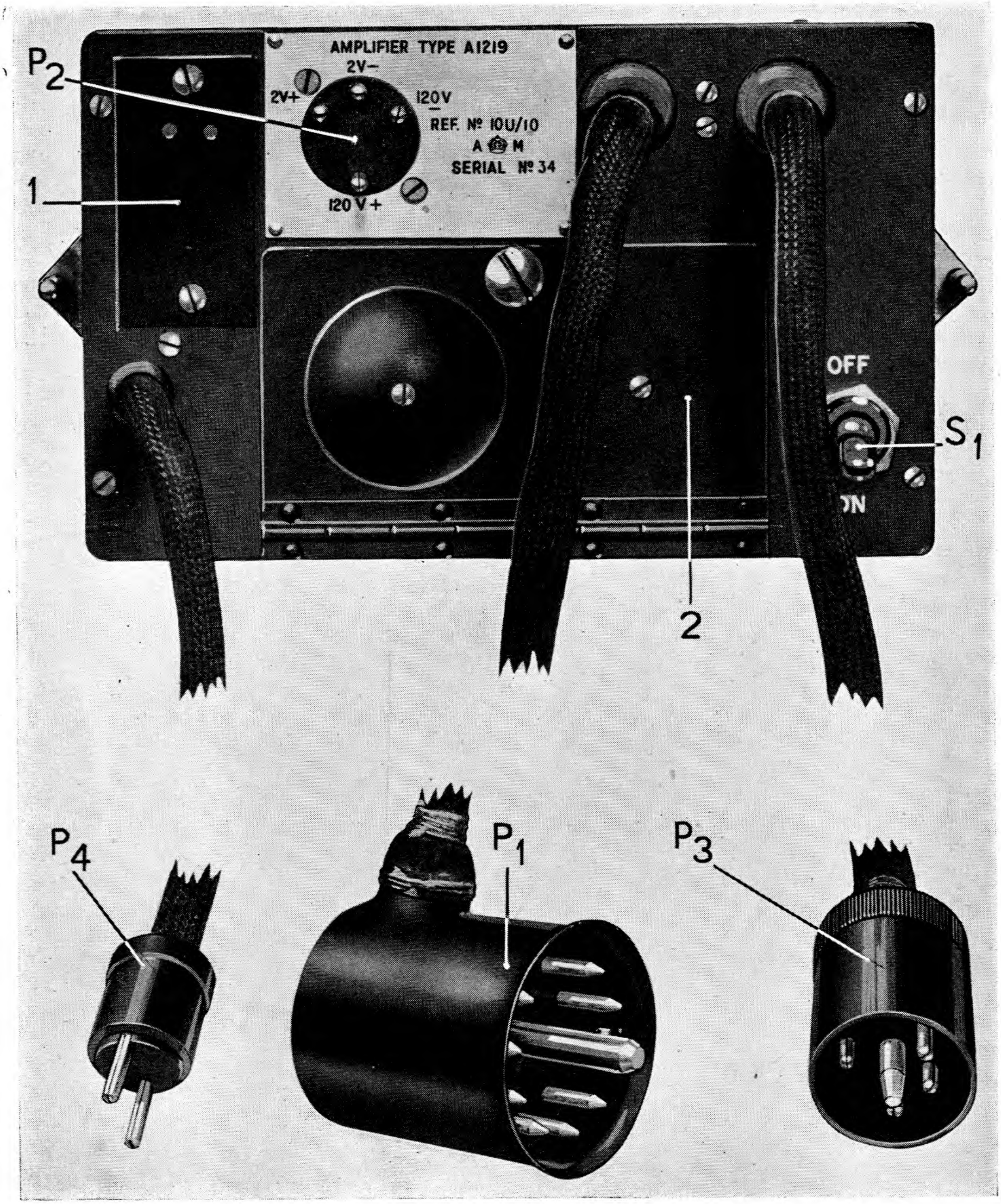


Fig. 1.—Front view

AMPLIFIER, TYPE A.1219

(Stores Ref. 10H/10)

INTRODUCTION

1. The amplifier, type A.1219, has been designed to be used in place of the amplifier, type A.1134, to provide intercommunication between members of the crew of multi-seater aeroplanes, in cases where a transmitter-receiver, type T.R.1133 is installed together with a transmitter, type T.3065 and receivers, types R.3066, R.3080 or R.3085.

2. In addition to acting as an inter-communication amplifier, the A.1219 will act as a speech-input amplifier for transmitter modulation for use with electro-magnetic microphones. Up to seven pairs of phones may be connected to the output circuit.

3. The I/C circuits of the amplifier, A.1219 are adapted for push-button operation by means of a relay, which can be operated automatically, if desired, from the contactor mechanism of the transmitter-receiver T.R.1133, yielding I/C facilities during contactor periods. The push-button controls of the relay disconnect the transmitter-receiver as well as connecting the I/C amplifier in circuit.

4. The amplifier circuits are so designed that though the observer can overhear all incoming and outgoing R/T signals, only the pilot's microphone is capable of being connected to the transmitter, so that communications from the observer to the pilot cannot be radiated.

5. The dimensions of the amplifier, A.1219 are identical with those of the A.1134, namely approximately $7\frac{7}{8}$ in. long by $6\frac{1}{8}$ in. deep by $4\frac{1}{4}$ in. high, and its weight, including valves and grid bias battery, 5 lb. 2 oz. The weight, inclusive of all associated supplies, but exclusive of fixed aircraft wiring, is 19 lb. 6 oz. A general view of the amplifier is given in fig. 1.

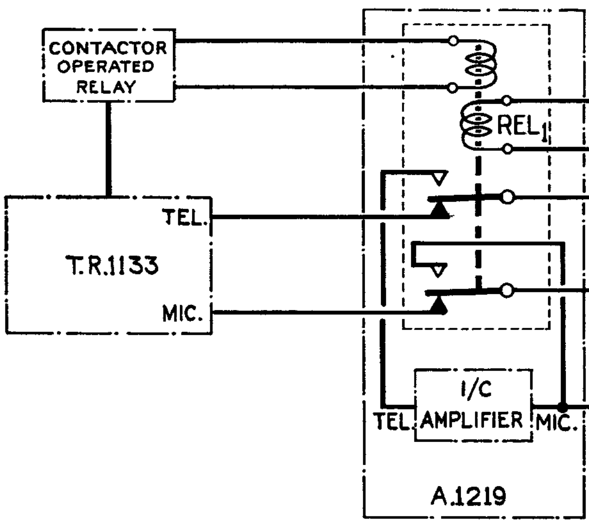


FIG. 2.—FUNCTIONAL DIAGRAM

GENERAL DESCRIPTION

6. From the schematic diagram, fig. 2, showing the interconnection of the amplifier A.1219 with the transmitter-receiver T.R.1133, it will be seen that in the normal position of the relay REL_1, the pilot's microphone is connected to the microphone terminals of the T.R.1133, and the phones of all members of the crew are connected in parallel to the output circuit of the A.F. amplifier of this instrument.

7. When the transmitter of the T.R.1133 is in operation, its amplifier acts as a speech input amplifier, and the outgoing speech is therefore audible in all the phones. Conversely, when the instrument is receiving, the amplifier is connected to the receiver output terminals and therefore the phones will in this case monitor the incoming speech. The observer's microphone, and the amplifier A.1219 are seen to be disconnected.

8. The relay REL_1 may be energised either automatically *via* a contactor-operated relay, actuated by the T.R.1133, or manually by push buttons under the control of members of the crew. When a relay is in the energised condition, the pilot's microphone is connected, in parallel with that of the observer, to the input of the amplifier A.1219, and the phones are all connected across the output of the amplifier, thus providing full I/C facilities. The transmitter/receiver is then disconnected from both the microphone and telephone circuits.

9. Referring to the theoretical circuit diagram, fig. 3, it will be seen that the input circuit to the amplifier is connected *via* a screened twin cable to the primary winding of the transformer T_1, and is balanced with reference to earth by the resistances R_1 and R_2.

10. The secondary winding of the transformer T_1 is connected to the grid-filament circuit of the triode amplifier valve V_1 through the coupling condenser C_1, the grid resistance R_4 being provided to make the necessary connection to the 3-volt tapping of the grid bias battery $BATT_1$ while maintaining the requisite value of grid-filament impedance at the input circuit of the valve. The values of the resistance R_4 and of the condenser C_1 are selected so as to provide attenuation of frequencies below 500 c/s, and thus to reduce noise interference.

11. The low potential terminal of the secondary winding of the transformer T_1 is connected to earth through a resistance R_3 which forms part of a negative feedback circuit designed to stabilise the performance of the amplifier. The operation of this circuit will be fully described in a later paragraph.

12. The anode of the valve V_1 is connected *via* a screened lead to the primary winding of the transformer T_2 and thence to the H.T. supply. The secondary winding of this transformer is centre tapped, and connected to the 6-volt terminals of the grid bias battery $BATT_1$ through the resistance R_5, while the high potential extremities of the winding feed the grid-filament circuits of the quiescent push pull duo-pentode output valve V_2.

13. The two anodes of this valve are connected to the primary winding of the output transformer T_2, and also, through the condensers C_2 and C_3 to the control grids of the two halves of the valve. The condensers C_2 and C_3 produce a restriction of the frequency response band, due to a degenerative action which becomes effective above a frequency of 2,500 c/s.

14. Four secondary windings are provided in the transformer T_3. Two of these are unused, while the third is connected through two resistances R_{10} and R_{11} in parallel, to provide an output similar in characteristic to that obtained from a carbon microphone, which may be used for transmitter modulation, if required.

15. The fourth output winding provides the telephone output, and is loaded by the resistance R_7, whose action is to ensure that the load impedance of the valve does not exceed a predetermined value, even if all the phone circuits are disconnected.

16. One end of this winding is earthed, and the other is connected through the resistance R_6 to the low potential end of the secondary winding of the transformer T_1. The fraction of the output voltage developed across the potentiometer comprising the resistances R_3 and R_6 is thus applied to the grid circuit of the valve V_1, yielding a negative feedback effect which renders the overall gain of the amplifier substantially independent of battery voltage changes and output impedance changes, and also reduces the distortion introduced by the amplifier circuits.

17. The H.T. and L.T. battery connections of the amplifier are connected to the plug P_2, the latter *via* the switch S_1. The remaining external connections of the amplifier are made through a connection panel, to the plugs P_1, P_3 and P_4. The terminals 6 and 18 are intended for use when the aircraft battery has a voltage of 12, while the terminals 20 and 17, which are intended for use with 24-volt aircraft batteries, feed the windings of the relay through the resistances R_9 and R_8 which reduce the operating circuit of the relay to a suitable value when the higher battery voltage is employed.

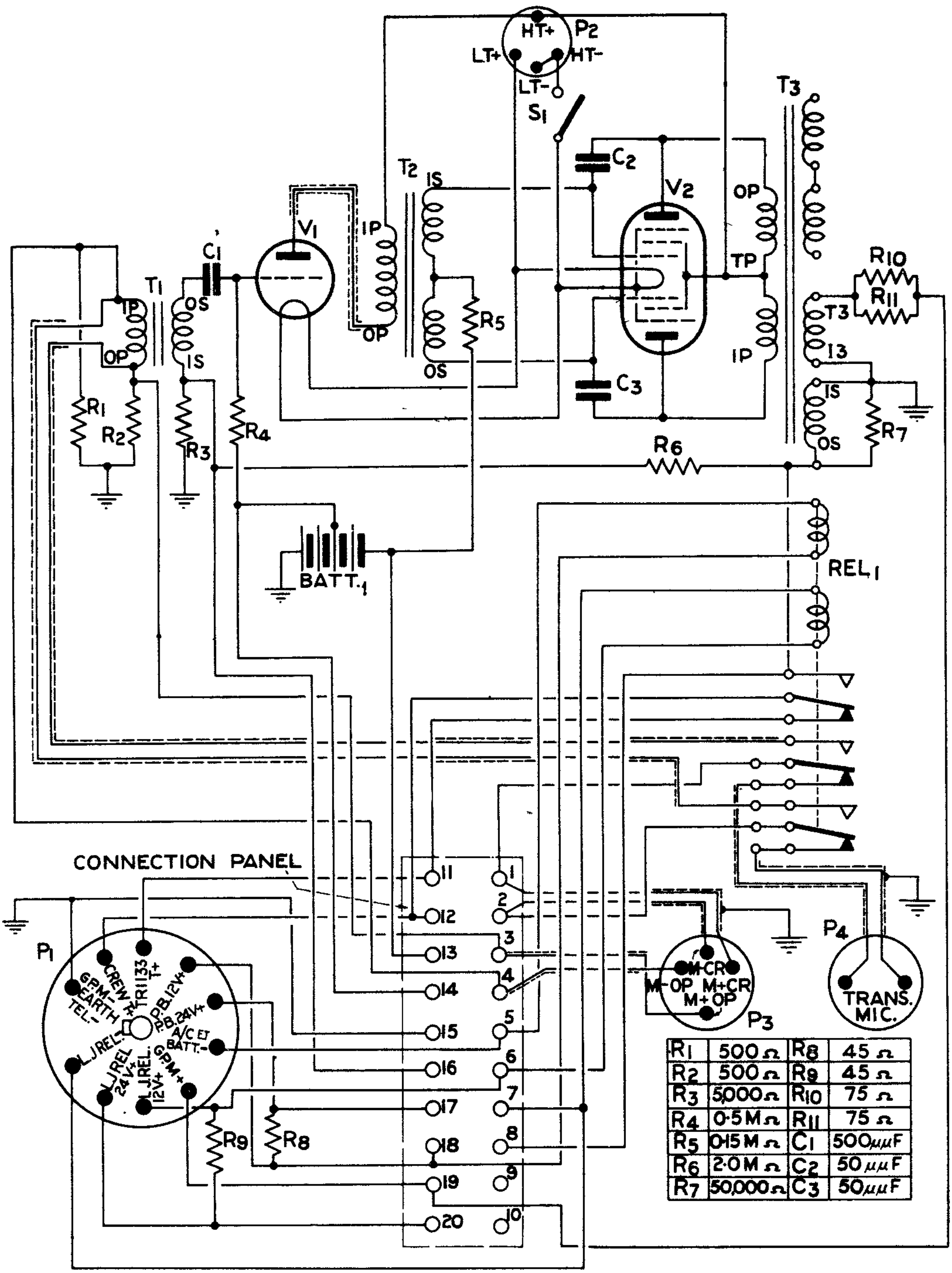
CONSTRUCTIONAL DETAILS

18. Three views of the amplifier, type A.1219, are given in figs. 1, 4 and 5 of which the two latter show the underside and the topside of the chassis respectively, with the cover removed.

19. Referring to fig. 1, it will be seen that all the plugs which provide the external connections of the amplifier, with the exception of the plug P_2, which is mounted on the front panel of the chassis, are connected *via* flexible multi-core cables which are shown broken in the illustration.

20. The screw-on cover (1) gives access to the relay REL_1, while the hinged door (2) which is retained by a coin-headed screw, protects, and gives access to the valves mounted beneath it.

21. From fig. 5, it will be observed that the connections to the grid-bias battery, $BATT_1$, which is mounted within the amplifier chassis, are effected by means of wander plugs.



R1	500 Ω	R8	45 Ω
R2	500 Ω	R9	45 Ω
R3	5,000 Ω	R10	75 Ω
R4	0·5 M Ω	R11	75 Ω
R5	0·15 M Ω	C1	500 μμF
R6	2·0 M Ω	C2	50 μμF
R7	50,000 Ω	C3	50 μμF

THEORETICAL CIRCUIT DIAGRAM

FIG. 3

FIG. 3

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VALVES AND POWER SUPPLY

22. The amplifier, type A.1219, employs one valve, type V.R.21, as voltage amplifier and a valve, type V.R.35 in the output stage. As has previously been explained, a 6-volt grid bias battery is carried within the chassis; the remaining power supplies comprise one 2-volt, 20-amp-hour capacity L.T. battery, and one 120-volt battery, type A.

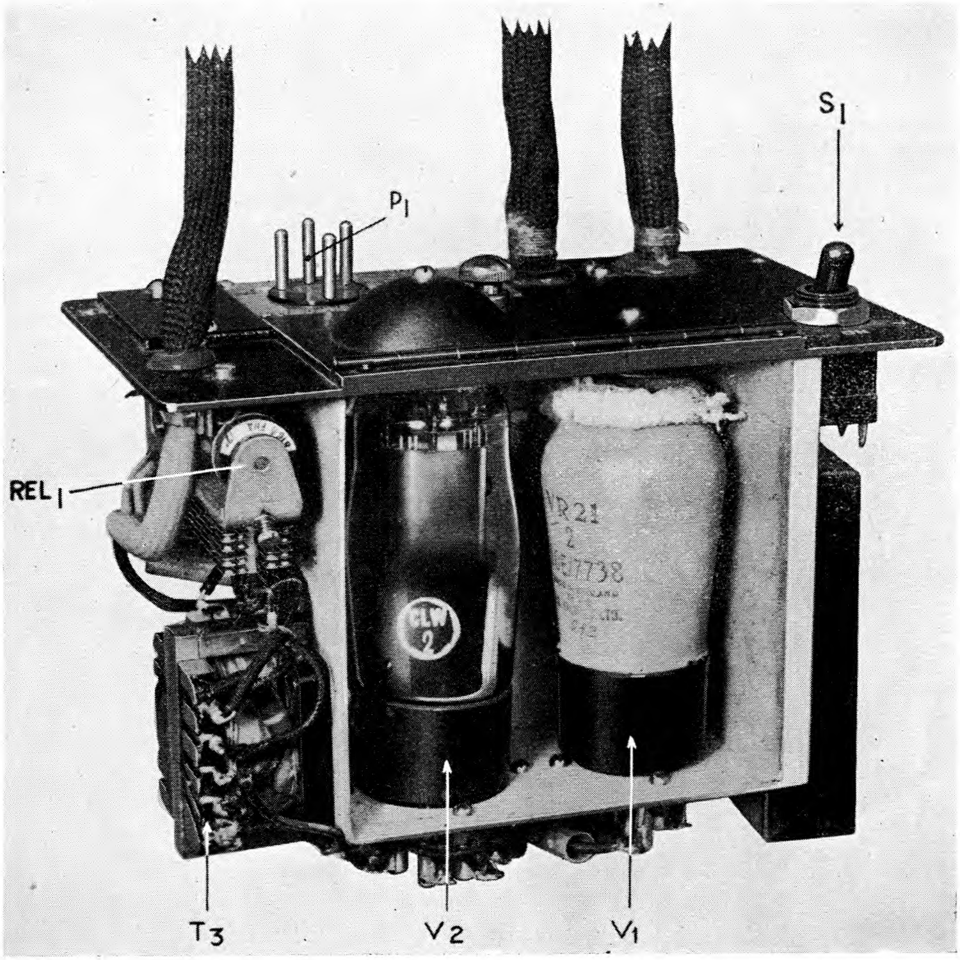

FIG. 4.—UNDERSIDE OF CHASSIS

INSTALLATION AND OPERATION

23. Care should be taken when installing the amplifier, type A.1219, that all the screened leads of the microphone circuits are bonded together, the continuity of the bonding being continued across any necessary junction main earth connexion of the amplifier. The bonding should be joined to the aeroplane earth, or to some point connected to it. It is essential that corresponding leads of all microphones are connected together, namely MIC+ to MIC+, and MIC− to MIC−.

24. The amplifier should be switched on throughout the time that the aircraft is in operation. No further adjustments should be necessary, provided that the necessary battery and other connections have been made, and that the valves and connection plugs are firmly inserted in position.

25. The I/C circuit may be set in operation at any time by depression of one of the push buttons, even should the transmitter/receiver be in operation. The I/C circuit will remain set up only so long as the push button is depressed.

PRECAUTIONS AND MAINTENANCE

26. The voltage of the L.T., H.T., and grid bias battery should be checked at regular intervals. The L.T. battery should be recharged if its voltage, measured under load conditions, is less than 1·8 volts. The H.T. battery should be renewed when the voltage falls below 90, or if the amplifier appears noisy in operation. The grid-bias voltages should not fall below the values 3 and 6 volts, at the points of connection to the circuits of the valves V_1 and V_2 respectively.

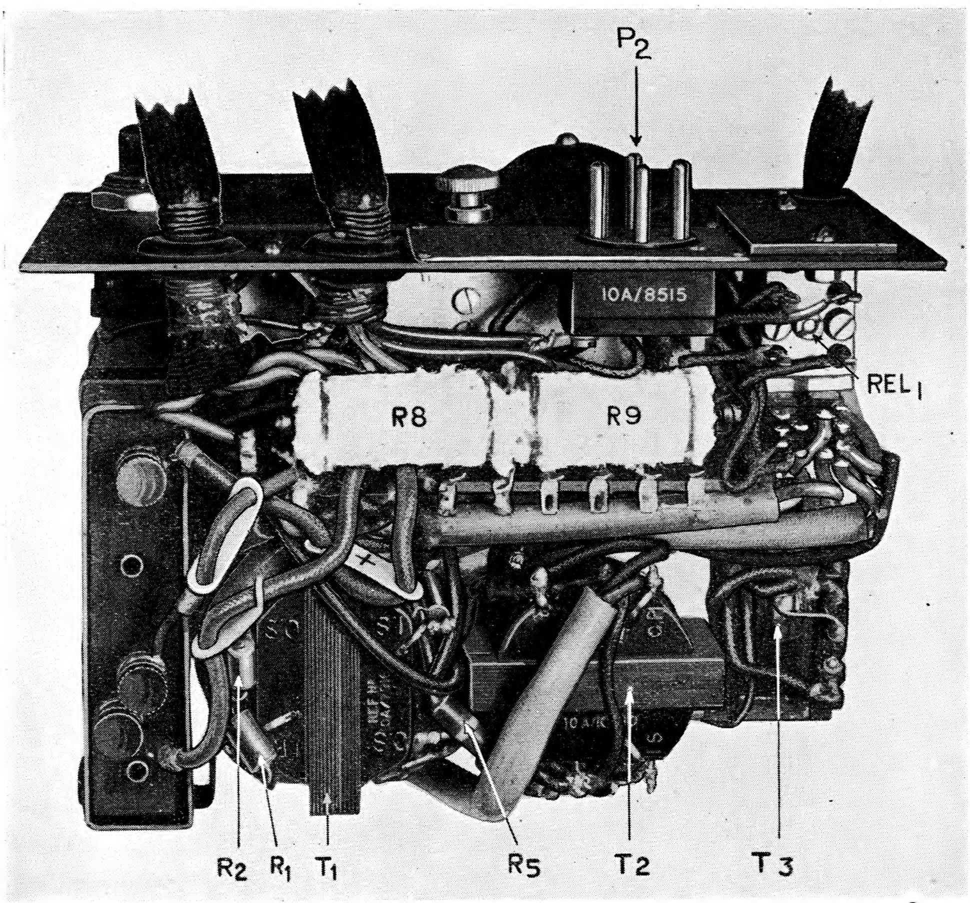

Fig. 5.—Top side of chassis

27. If the amplifier becomes unstable in operation, as demonstrated by "howling" or apparent loss of gain, a thorough check should be made to ensure that the bonding of all screened cable is satisfactory, and that all necessary earth connections have been effected in an efficient manner.

28. Especial care should be taken to ensure that leakage does not take place across the microphone-telephone plugs, as such leakage is a frequent cause of instability. The plugs should periodically be lubricated with a small quantity of vaseline, and a little transformer oil may also be injected into the sockets with advantageous results.

29. If L.T. leakage is suspected, the retaining spring over the valve V, should have 1·5 mm. H.T. insulating tube, grade E, threaded over the three last turns, below the asbestos binding. This eliminates the earthing of the valve metallizing, which short-circuits the L.T. switch S_1.

APPENDIX

NOMENCLATURE OF PARTS

The following list of parts is issued for information only. When ordering spares for this equipment, the appropriate section of AIR PUBLICATION 1086 must be used.

Ref. No.	Nomenclature	Qty.	Ref. in Fig 3	Remarks
10U/10	Amplifier, type A.1219			
	Principal components			
10U/12	Case	1		
	Condenser			
10C/10552	Type 421	2	C_2 C_3	50 $\mu\mu$ F
10C/11511	Type 543	1	C_1	500 $\mu\mu$ F
	Disc, indicating			
10H/11510	Type F	1		
10H/1168	Type P/129/J	1		
	Holder, valve			
10H/9615	Type S	1		7-pin
10H/9756	Type U	1		5-pin
10U/11507	Panel, connection	1		
	Plug			
10H/7280	Type 33	1		4-pole
10H/7274	Type 34	1		2-pin
10H/8515	Type 67	1		4-pole
10H/9112	Type 82	1		Red
10H/9113	Type 83	2		Black
10H/11505	Type 129	1		10-pole
10F/535	Relay, magnetic, type 231	1	REL_1	G.P.O. No. 616
	Resistance			
10C/11381	Type 477	1	R_7	50,000 ohms
10C/11382	Type 478	1	R_5	150,000 ohms
10C/11385	Type 481	1	R_6	2·0 megohms
10C/11670	Type 504	1	R_3	15,000 ohms
10C/11674	Type 508	1	R_4	0·5 megohm
10C/6	Type 540	2	R_1, R_2	500 ohms
10C/1751	Type 1,751	2	R_8, R_9	45 ohms
10C/	Type	2	R_{10} ,R_{11}	75 ohms
10F/10338	Switch, type 152	1		
	Transformer			
10K/10280	Type 16	1	T_1	
10K/11503	Type 100	1	T_3	
10K/7916	Type 51	1	T_2	
	Accessories			
5A/1387	Accumulator, 2V , 20 A.H., Type B	1		L.T.
5A/1251	Battery			
	Dry, 6V	1	$BATT_1$	G.B.
	Dry, 120V			
5A/1333	Type A	1		Home
	or			
5A/1615	Type B	1		Overseas
10U/11730	Case, transit	1		
	Disc, indicating			
10H/11511	Type F	1		
10H/1169	Type S/67/J			
	Plug			
10H/8261	Type 64	1		
10H/8262	Type 65	1		
	Socket			
10H/7283	Type 12	1		
10H/8529	Type 39	1		
10H/11506	Type 67	1		
	Valve			
10E/7739	Type V.R.21	1	V_1	
10E/9779	Type V.R.35	1	V_2	