AIR PUBLICATION 1186
Volume I
December, 1938
Issued February, 1940, *with A.L. No.* 11

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.

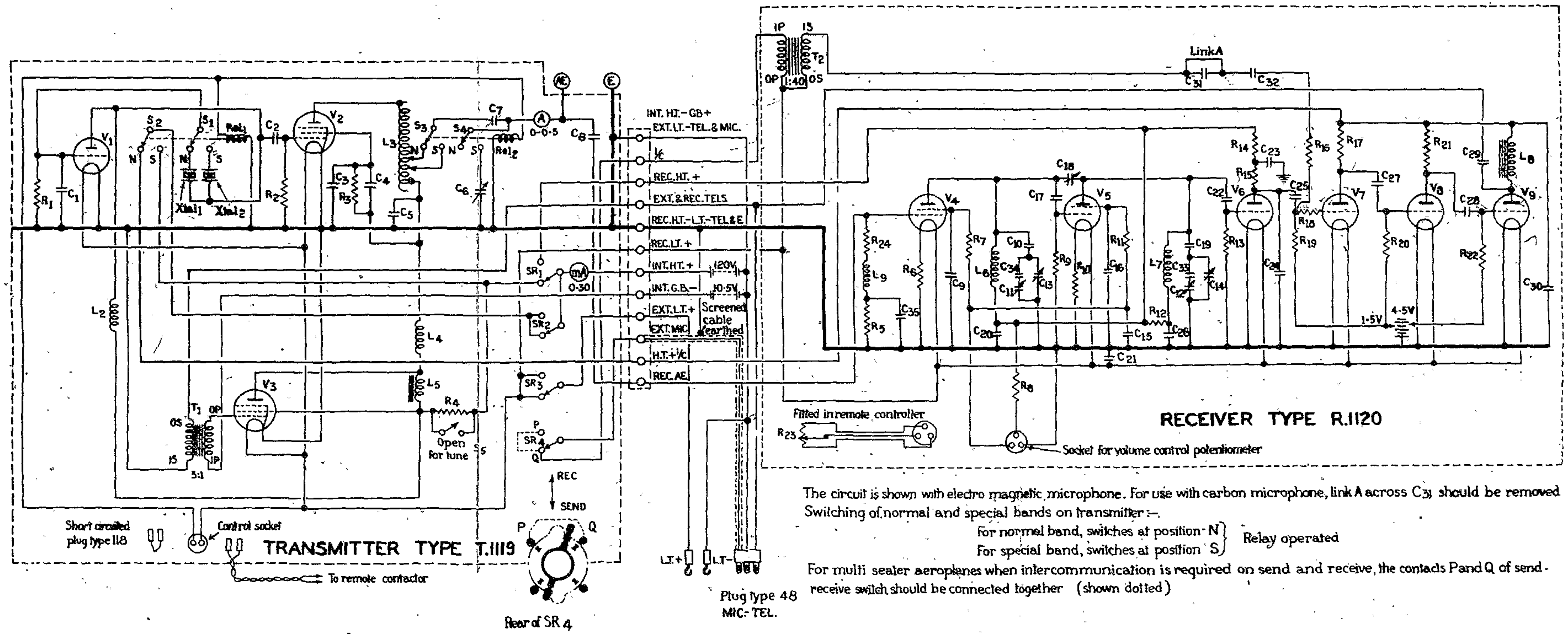
4. The overall dimensions of the transmitter-receiver, in its case, are approximately 19½ in. by 13¼ in. by 9½ in. The weight excluding batteries, is approximately 28 lb. With valves and dry batteries in place, the weight is about 40 lb. The total weight of the complete installation is further increased 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.

CONDENSERS	C_1 C_2 C_3 C_4 C_5 C_6 C_7 C_8 C_{35} C_9 C_{20} C_{11} C_{34} C_{10} C_{13} C_{17} C_{18} C_{16} C_{21} C_{15} C_{26} C_{19} C_{33} C_{12} C_{14} C_{31} C_{22} C_{23} C_{32} C_{25} C_{24} C_{27} C_{28} C_{29} C_{30}
RESISTANCES	R_1 R_2 R_3 R_4 R_{23} R_{24} R_5 R_6 R_7 R_8 R_9 R_{10} R_{11} R_{12} R_{13} R_{14} R_{15} R_{19} R_{16} R_{18} R_{17} R_{20} R_{21} R_{22}
INDUCTANCES	L_2 L_3 L_4 L_5 L_9 L_6 L_7 L_8
MISCELLANEOUS	V_1 S_2 $XTAL_1$ S_1 T_1 REL_1 V_3 $XTAL_2$ V_2 S_3 S_4 S_5 REL_2 SR_1 SR_2 SR_3 SR_4 T_2 V_4 V_5 V_6 V_7 V_8 V_9



The circuit is shown with electro magnetic microphone. For use with carbon microphone, link A across C_{31} 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

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

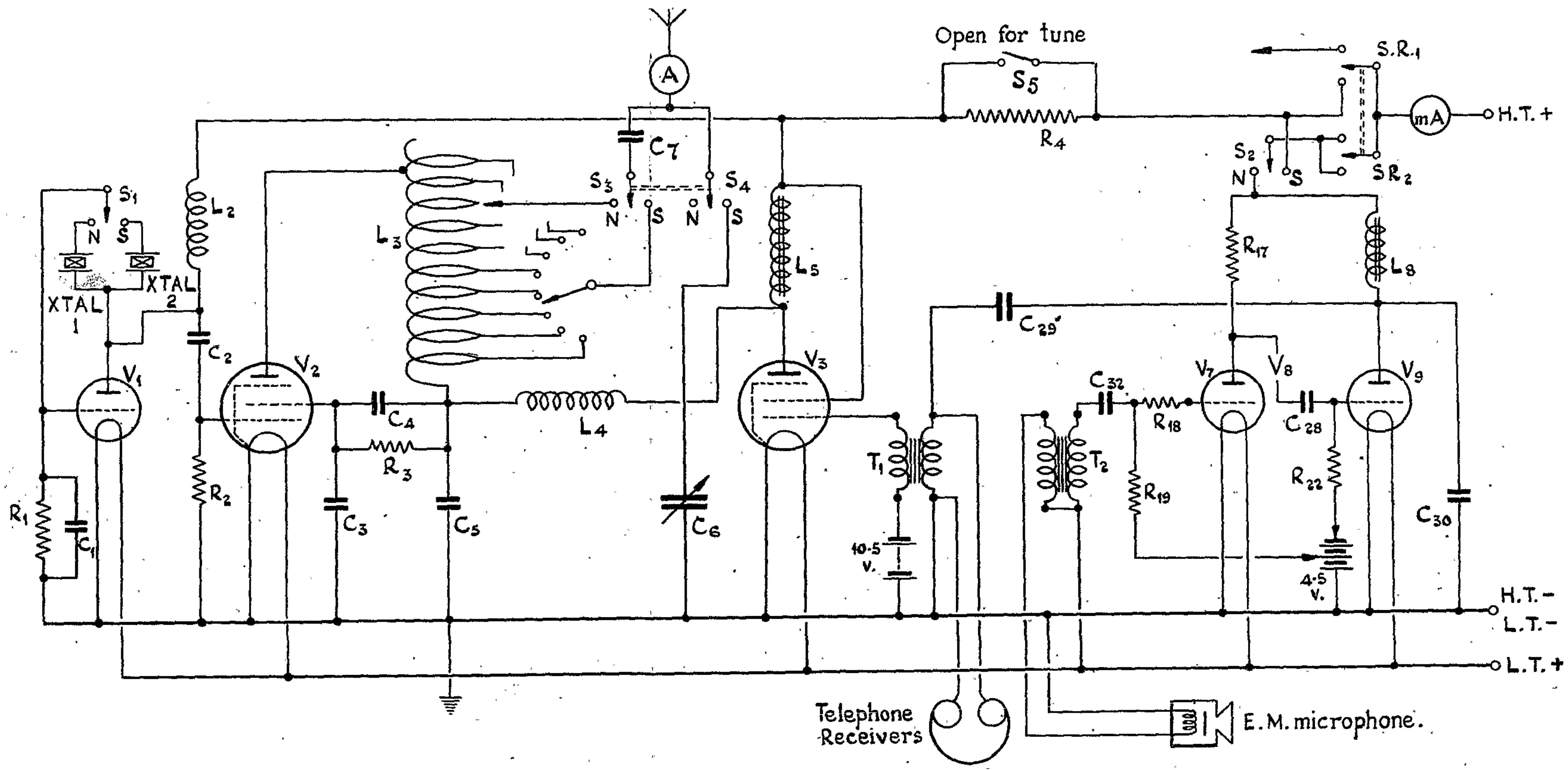


FIG.1. SIMPLIFIED CIRCUIT DIAGRAM (TRANSMITTING)

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_4. 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.

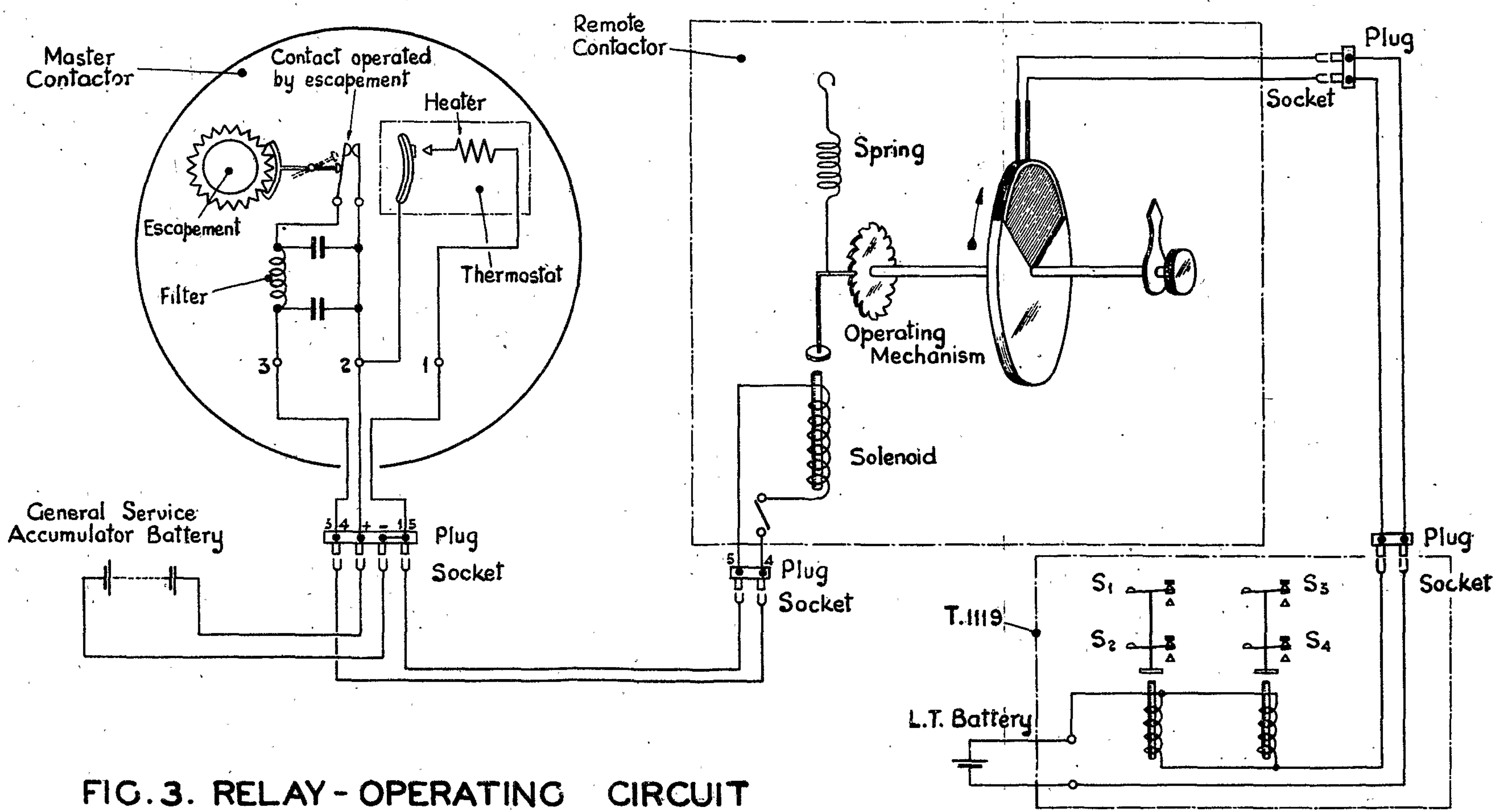


FIG. 3. RELAY - OPERATING CIRCUIT

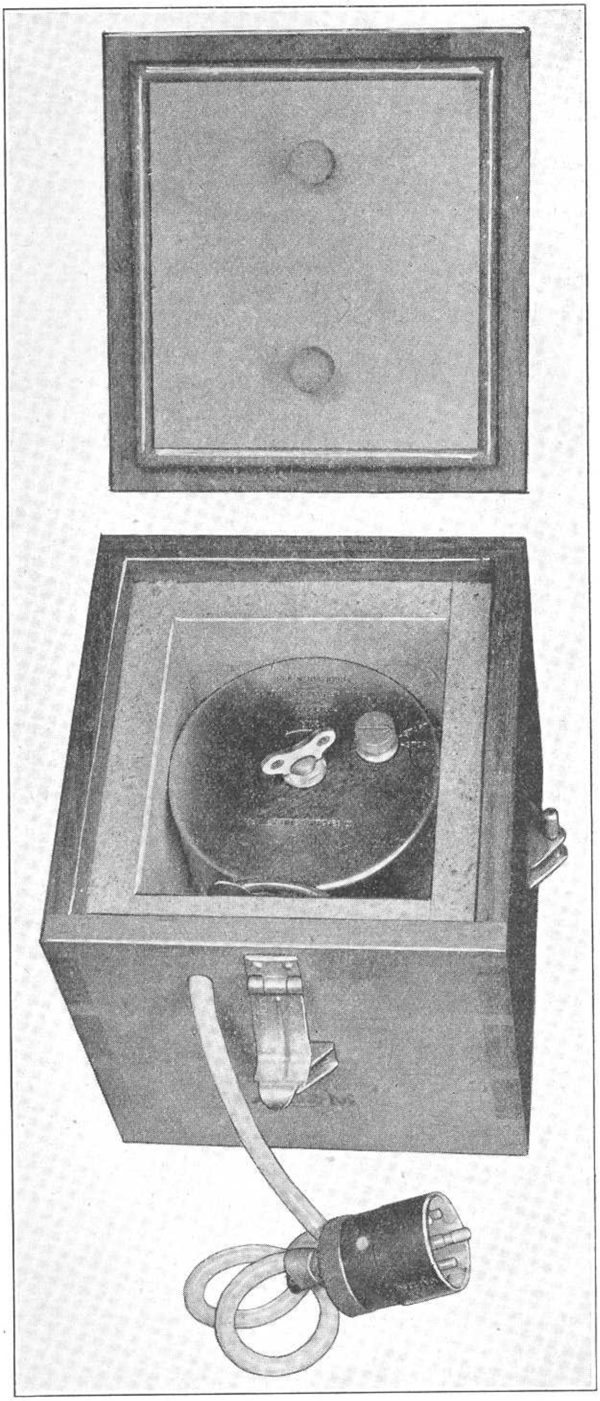


FIG. 4. Master contactor in case.

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.

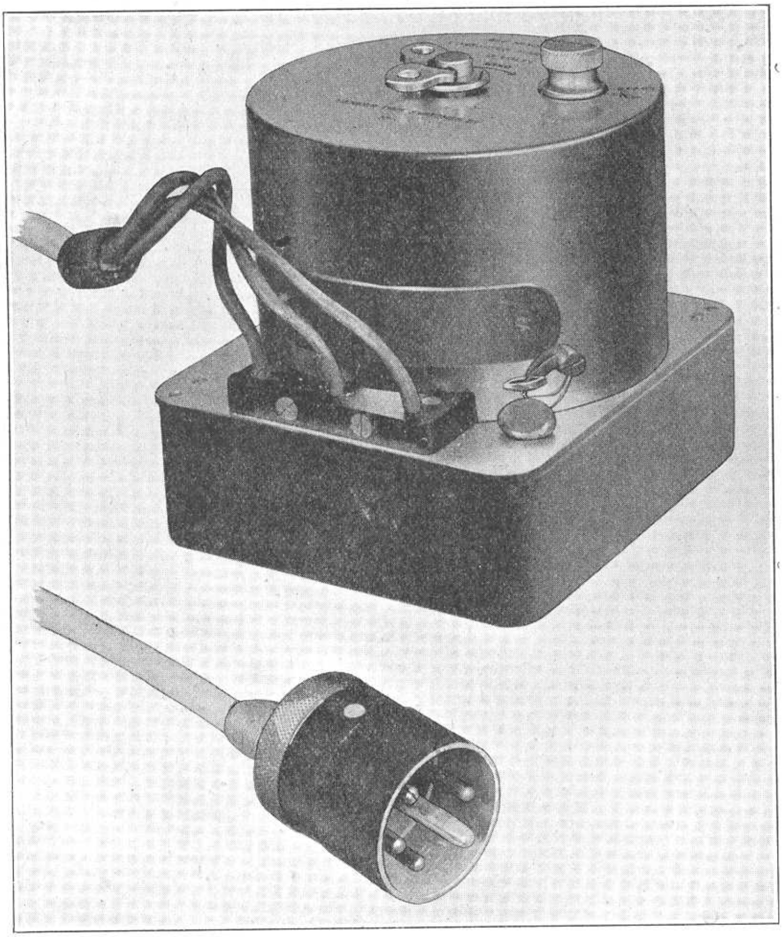


FIG. 5. Master contactor.

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

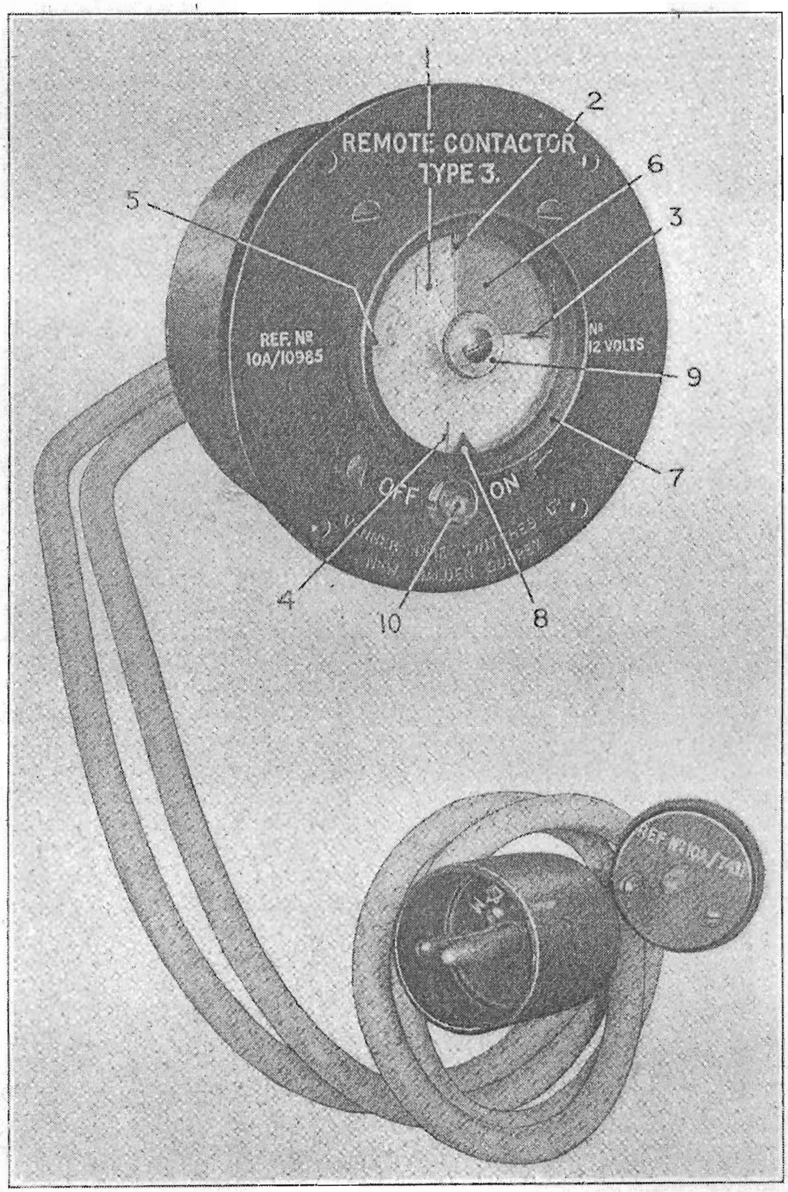


FIG. 6. Remote contactor.

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

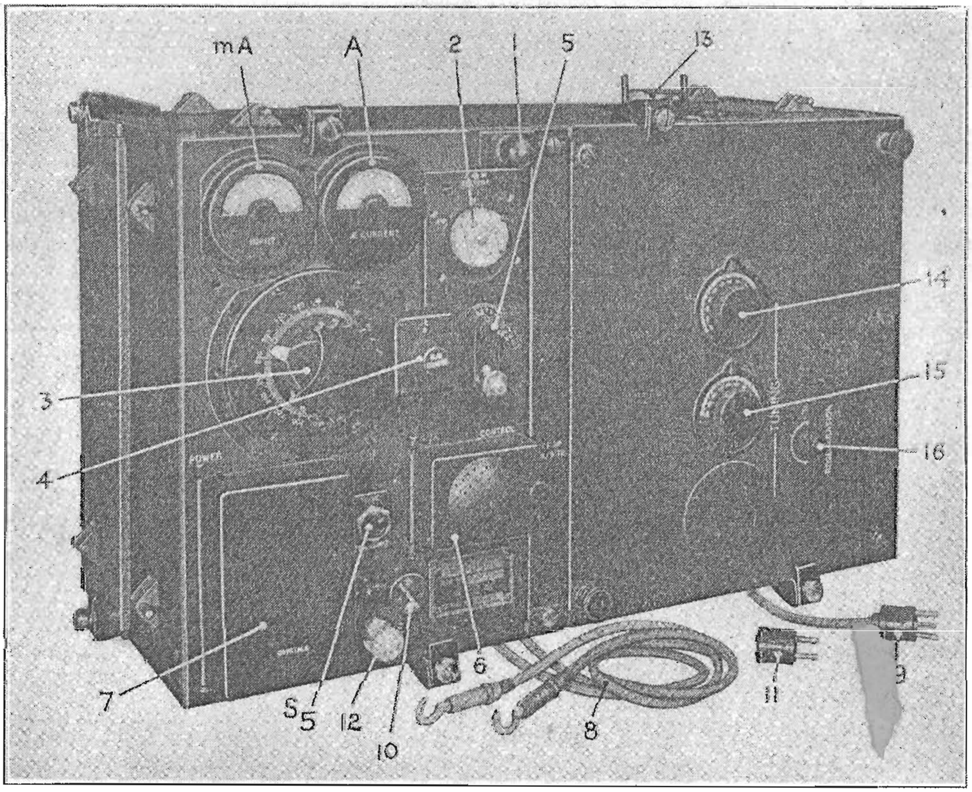


FIG. 7. Transmitter-receiver T.R.9D.

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).

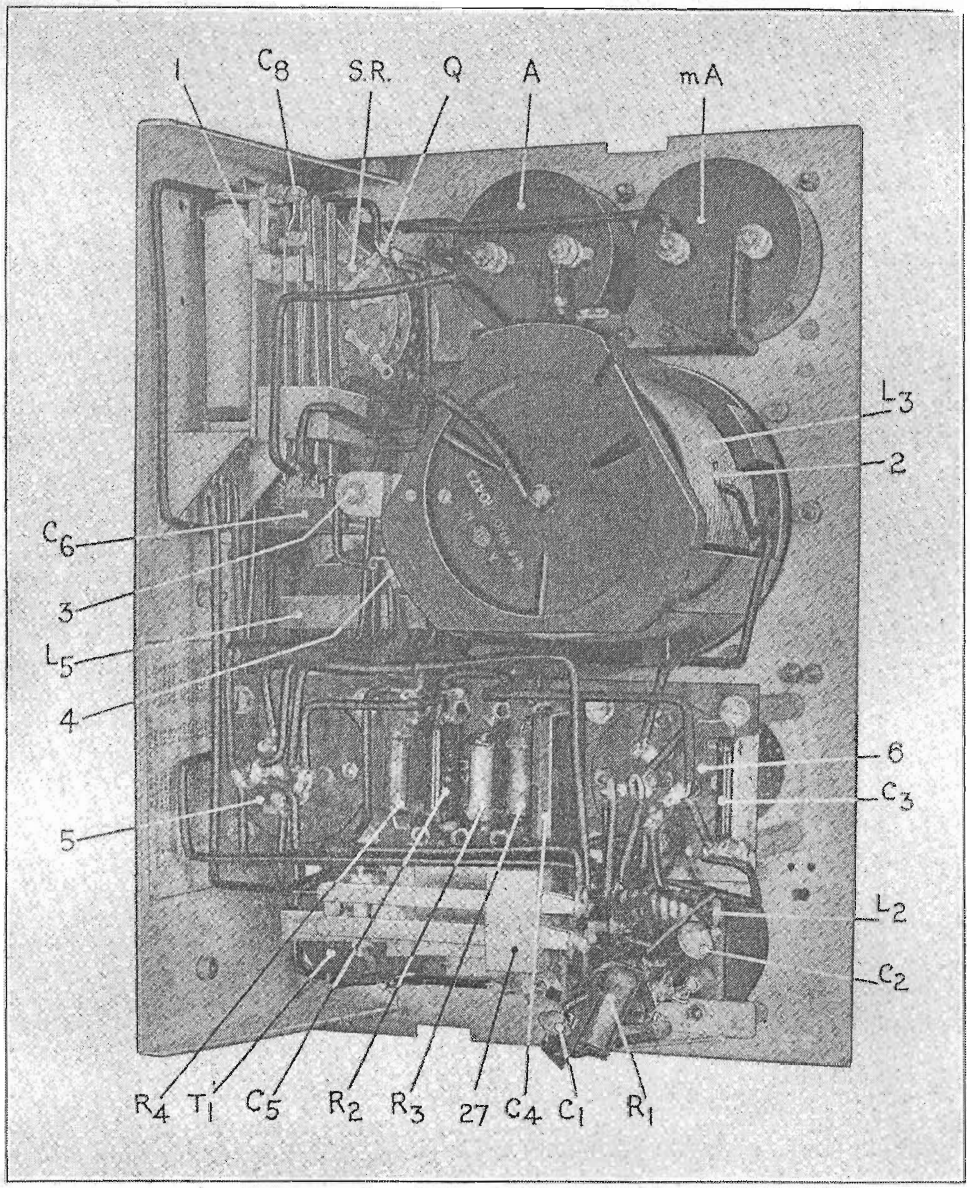


FIG. 8. Transmitter T.1119, rear view.

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, 10½ 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.

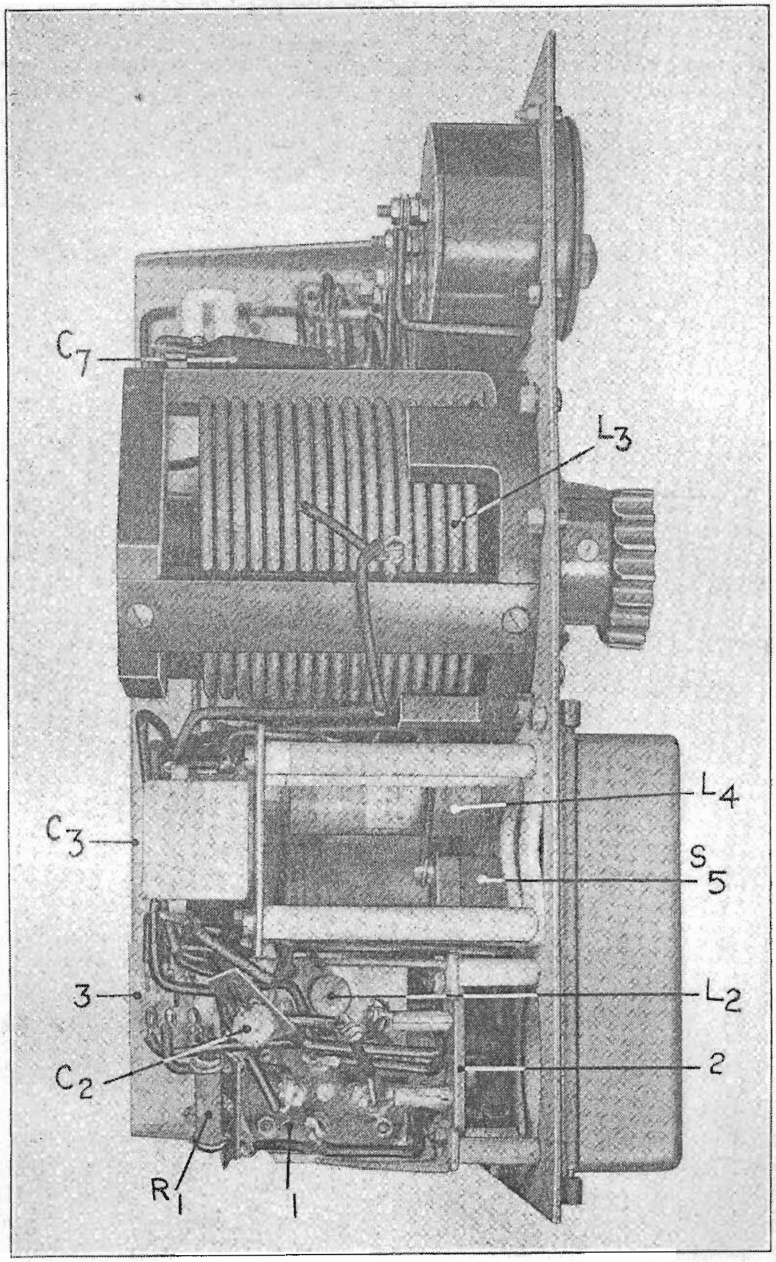


FIG. 9. Transmitter T.1119, side view.

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

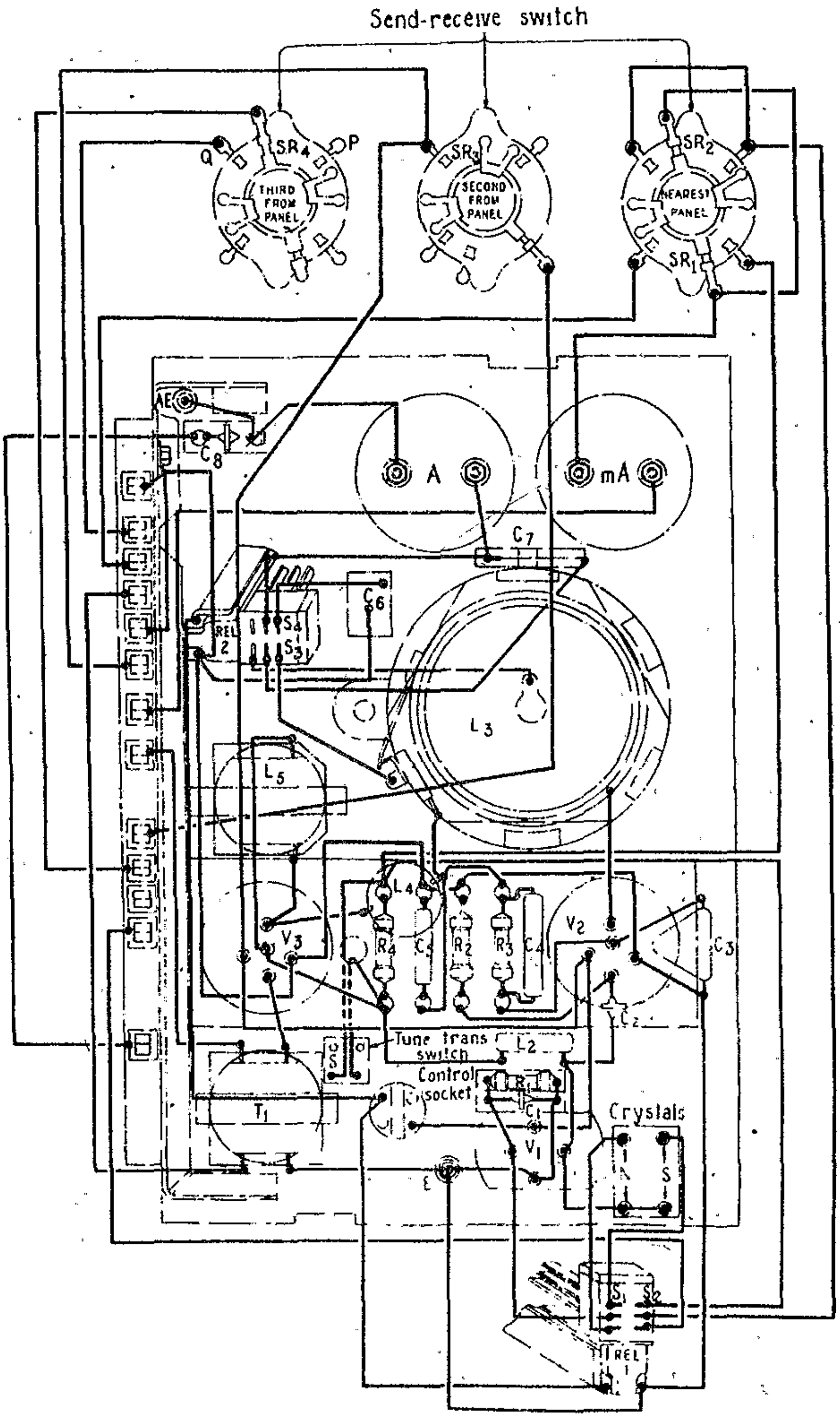


FIG. 10 BENCH WIRING DIAGRAM OF T.1119

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