AP1186 VOLUME ONE

SECTION ONE

CHAPTERS 1 TO 7

Ministry of Defence

FOR USE IN THE
ROYAL AIR FORCE

(Prepared by the Ministry of Technology)

SECTION 1

TRANSMITTERS

LIST OF CHAPTERS

December, 1938

AIR PUBLICATION 1186
Volume I

SECTION 1, CHAPTER 1

TRANSMITTER T.70

Contents

List of Illustrations

TRANSMITTER T.70

(Stores Ref. 10A/7755)

INTRODUCTION

1. Transmitter T.70 is a ground station transmitter, employing a master-oscillator, and is designed for continuous wave, interrupted continuous wave, or radio-telephonic transmission on the frequency bands 6,000 to 2,500 kilocycles.

2. The transmitter incorporates a master-oscillator valve, an amplifying valve, a modulator valve and a sub-modulator (or speech amplifying valve). Temperature control is not fitted, but bv allowing the temperature within the master-oscillator chamber to reach a steady state before making the final tuning adjustments, it is possible to work within very small limits of frequency variations due to this cause.

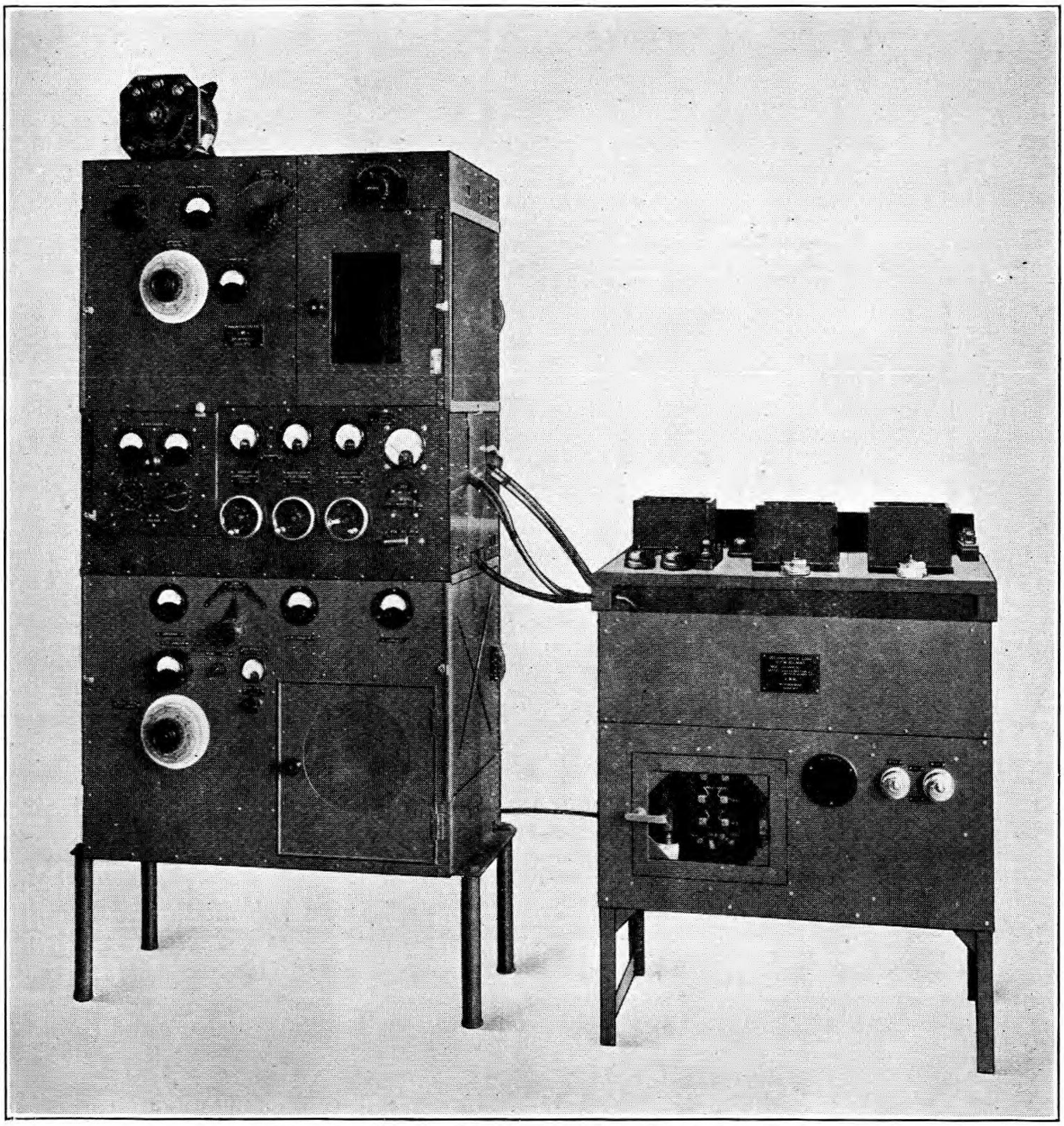


FIG. 1. Transmitter T.70 and rectifier, type B.

3. To minimize frequency variations when C.W. is being radiated, provision is made in the wiring for the use of an entirely separate H.T. supply to the master-oscillator, the latter being constantly energized whilst the amplifier supply is keyed. Where the bulk of the work of the transmitter is R/T, supply is by means of a special self-contained unit known as Rectifier, type B (Stores Ref. 10A/8067) operating from the standard A.C. mains and providing a rectified and smoothed 3,000 volt H.T. anode supply and a 20 volt A.C. filament supply. The transmitter is shown installed with such a unit in fig. 1. Where A.C. is not available the standard 2,000 volt generator is used for H.T. supply.

4. The transmitter is provided with a multiple contact selector switch which makes all the necessary changes when moved into any one of its three positions " R/T ", " C.W." or " I.C.W." It introduces the modulator and sub-modulator valves in the first position, cuts them out and introduces a keying circuit in the second position, and introduces an interrupter in the third position.

5. Radiation of telephony from a remote position over a land line is also provided for, the operation of changing from a local microphone to the line being performed by a conveniently placed switch.

6. The transmitter is built into an upright, three section, duralumin cabinet, approximately 6 ft. high by 2 ft. 8 in. by 1 ft. 8 in., with the controls and indicating instruments mounted on the front. The necessary grid bias arrangements are included in the cabinet and also the rotary interrupter for I.C.W. transmission. The weight of the transmitter alone is approximately $2\frac{3}{4}$ cwt.

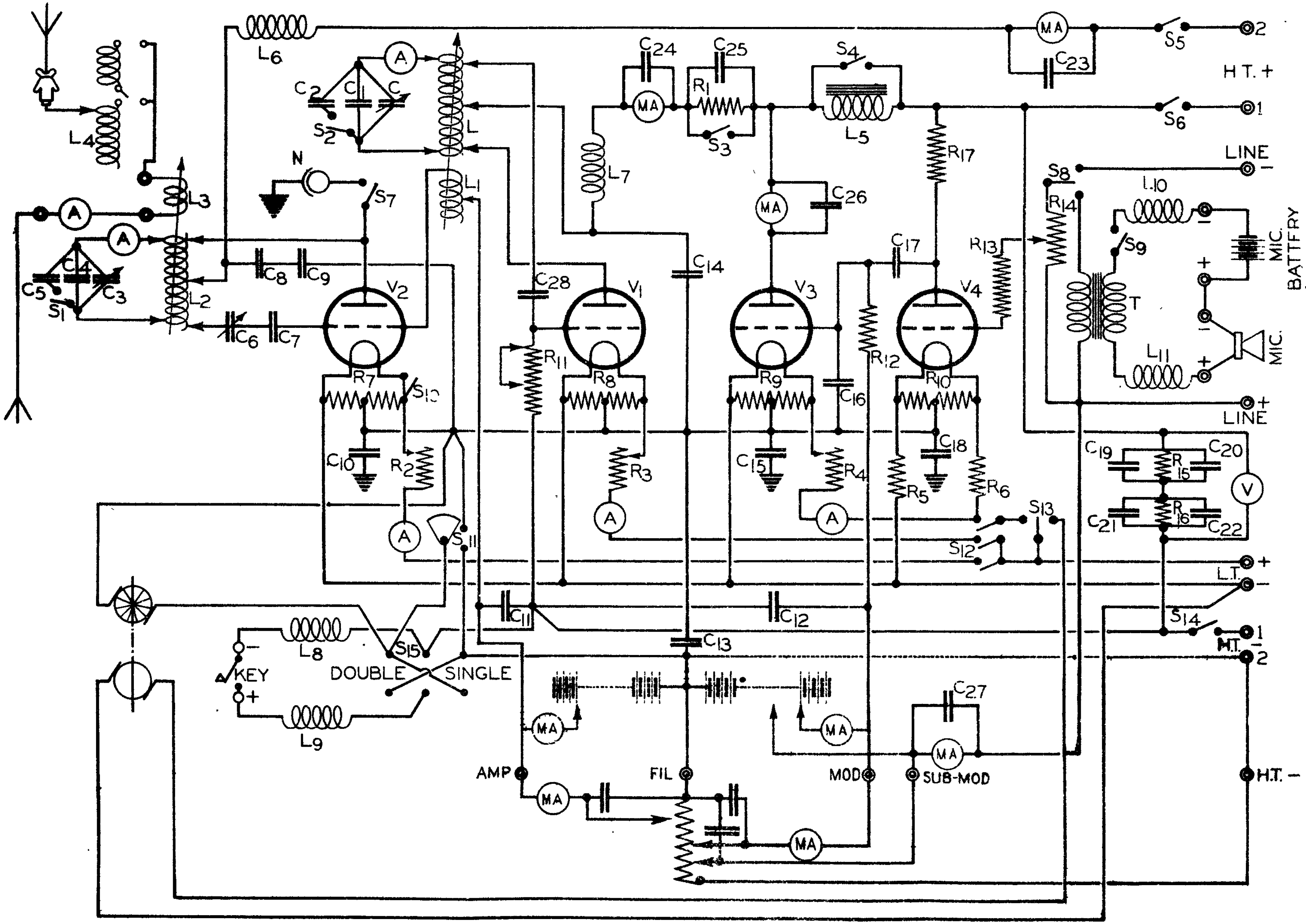
GENERAL DESCRIPTION

7. The master-oscillator circuit oscillates at a frequency determined by the settings of its inductance and capacitance. Coupled to the anode inductance is a coil which is connected in the grid circuit of the amplifier valve. The frequency of the amplifier circuit is therefore governed by that of the master-oscillator circuit. The anode circuit of the amplifier valve is, in turn, coupled to the aerial coil to which the amplified oscillatory currents are transferred, causing radiation at the desired frequency. It is obviously desirable that the amplifier circuit shall have no tendency to self-oscillation but shall function only as an amplifier of the oscillatory current transferred to it from the master-oscillator. Feed-back in the anode-grid circuit of the amplifier valve is therefore guarded against by the provision of an adjustable neutralizing condenser connected between the grid and a tap on the anode inductance. By proper adjustment of this device the R/F voltages occurring as a result of the inter-electrode capacitance of the valve are opposed by equal and opposite voltages *via* the neutralizing condenser.

8. To facilitate setting of the neutralizing device a neon lamp is provided, together with a special switch. The operation of the switch breaks the filament circuit of the amplifier valve and places the neon lamp in the anode circuit. Minimum glow in the lamp indicates correct neutralizer setting.

9. When the selector switch is placed in the C.W. position, the master-oscillator and amplifier valves only are in operation, the filaments of the modulator and sub-modulator being open-circuited. The control choke in the anode circuit of the master-oscillator valve is short-circuited and the key is introduced (H.T. switch in "double" position and separate H.T. supplies connected) between the H.T. negative lead and the cathode of the amplifying valve. The operation of the key does not affect the master-oscillator, the amplifier valve circuit only being made and broken.

10. When the selector switch is placed in the I.C.W. position the modulator and sub-modulator valves are still cut out and the control choke in the anode circuit of the master-oscillator remains short-circuited. A contact is closed which starts up a motor-driven



FIC. 2 THEORETICAL CIRCUIT DIAGRAM

CONDENSERS (μF)	
C	·00036 (max)
C1	
C2	·00023 (max)
C3	·00036
C4	
C5	·00023 (max.)
C6	·00004
C7	·0001
C8	·002
C9	·002
C10	·01
C11	·01
C12	·01
C13	·01
C14	·001
C15	·01
C16	·001
C17	·01
C18	·01
C19	1·0
C20	1·0
C21	1·0
C22	1·0
C23	1·0
C24	1·0
C25	·5
C26	1·0
C27	1·0
C28	·001
RESISTANCES (ohms)	
R1	10,000 or 30,000
R2	4
R3	4
R4	4
R5	7
R6	7
R7	80
R8	80
R9	80
R10	80
R11	60,000 (max.)
R12	50,000
R13	2 MΩ
R14	500,000
R15	5 MΩ
R16	5 MΩ
R17	500,000

(F.1799). F. & C. LTD.

interrupter, and another contact opens and introduces the interrupter disc (which was previously short-circuited) in series with the key. The operation of the key now causes radiation of interrupted continuous waves.

11. When the selector switch is placed in the R/T position the filament circuits of the modulator and sub-modulator valves are closed, bringing these valves into operation. The short-circuit is removed from the control choke, the microphone circuit is completed, the motor interrupter is stopped and the key and interrupter disc short-circuited. The key is now inoperative and all four valves have their H.T. circuits complete. Speaking into the microphone now causes speech currents to be impressed on the sub-modulator valves and these are, in turn, passed on considerably amplified to the modulator valve. Owing to the well known " choke control " action, the anode potential of the oscillator valve is varied (hence the amplitude of the aerial oscillations) in accordance with the original sound vibrations at the microphone, causing radio-telephonic radiation.

12. A theoretical circuit diagram of the complete transmitter is given in fig. 2. V_1 is the master-oscillator valve, V_2 the amplifier valve and V_3 and V_4 the modulator and sub-modulator valves respectively.

13. The oscillatory circuit of the master-oscillator valve comprises an inductance L and condensers C and C_1, the condenser C being variable. A third condenser C_2 of fixed capacitance is provided and is placed in parallel with C and C_1, by means of a link, when working on the lower frequency band. The inductance L has three tappings, one of which is taken directly to the anode of the master-oscillator valve. Another is taken through a fixed condenser C_{28} to the grid of the master-oscillator valve, and the third tapping is the H.T. feed. In this feed is connected a milliammeter, R/F choke L_7, a resistance R_1 shunted by the condenser C_{25} and an iron-cored inductance L_5. Switches S_3 and S_4 are arranged on R_1 and L_5 respectively for the purpose of short-circuiting them for different transmission requirements.

14. The inductance L_1 in the grid circuit of the amplifier valve V_2 is inductively coupled to the inductance L, the coupling being variable. In the anode circuit of the amplifier valve is an inductance L_2 in parallel with which are two condensers C_3 and C_4, C_3 being variable. As in the master-oscillator circuit a third condenser C_5 of fixed capacitance is provided which can be placed in parallel for the lower frequency band by means of a link. Three tapping points are provided on the inductance L_2, the first being directly connected to the anode of the amplifier valve, the second being taken through the R/F choke L_6, and through a milliammeter to H.T. positive. The third lead is taken through the neutralizing condenser C_6 and fixed condenser C_7 to the grid of the valve. From the H.T. feed tapping two condensers C_8 and C_9 are connected in series to the filament line, and a neon lamp N is connected through the switch S_7 to earth for neutralizing purposes.

15. The aerial circuit comprises the inductance L_4 and L_3. The inductance L_4 is in two portions and a connecting link permits one portion or both to be included, depending upon the frequency requirements. The inductance L_3 which is in series with L_4 is inductively coupled to the amplifier inductance L_2, the coupling being variable.

16. Valves V_3 and V_4 are the modulator and the sub-modulator valves for radio-telephony. A microphone circuit including the transformer T, choke coils L_{10} and L_{11}, microphone and battery is connected to the grid circuit of the sub-modulator valve V_4, which is in turn resistance-capacitance coupled to the modulator valve V_3. The anode of the valve V_3 is fed through the iron-cored inductance L_5 from the H.T. line which simultaneously feeds the master-oscillator valve thus effecting modulation by the " choke control " method.

17. The switch S_8 permits either the local microphone circuit or the remote microphone circuit to be connected across the resistance R_{14}. This resistance is provided with a variable contact which is connected through the resistance R_{13} to the grid of the valve V_4, and speech voltage input to the grid-filament circuit of the valve may thus be varied from zero to maximum.

The anode of this valve is fed through a resistance R_{17}, in order to drop the voltage to the correct value and is coupled to the grid of the modulator valve through the condenser C_{17}, the lower end of the associated resistance R_{12} being taken through a milliammeter to a tapping on the grid-bias arrangement. A condenser C_{16} is connected across the grid-filament circuit of the modulator valve and a condenser C_{12} is connected from the tapping to H.T. negative.

18. A second tapping is taken from the grid-bias arrangement through a milliammeter, which is shunted by the condenser C_{27}, to provide the necessary bias for the valve V_4, the circuit being through the resistances R_{14} and R_{13}. The amplifier valve V_2 is biased from the same source, a milliammeter being similarly connected in the circuit. The grid base line of the master-oscillator is fixed by means of the adjustable resistance R_{11}. The value of the resistance included can be varied between zero and 60,000 ohms by means of a short-circuiting link. Condensers C_{11} and C_{13} act as by-pass shunts for the grid-bias circuits. The filaments of the valves are heated normally from a 20 volt A.C. circuit, and the filaments are shunted by the resistance R_7, R_8, R_9 and R_{10} respectively. The centre-points of the resistances are earthed separately through condensers C_{10}, C_{15} and C_{18}, with the exception of that on the oscillator valve.

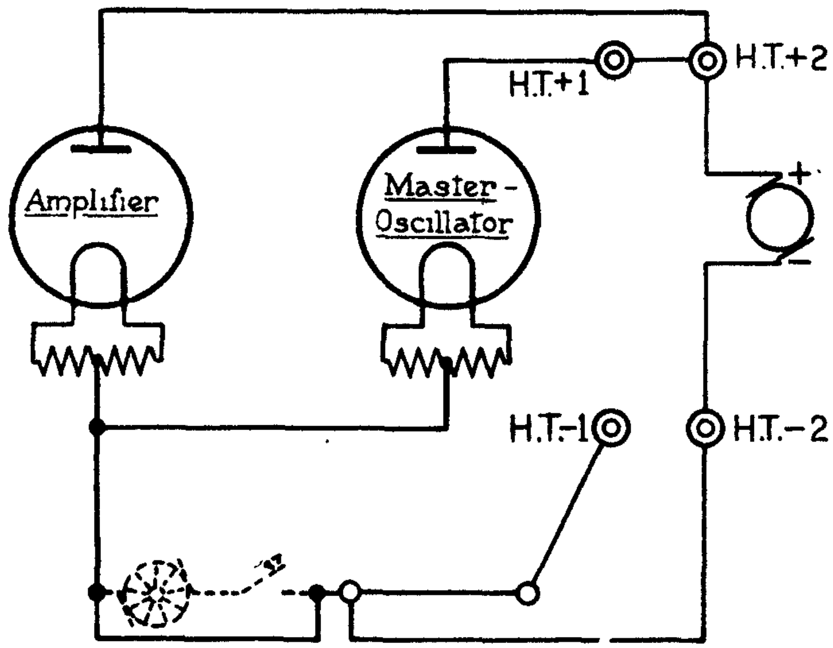
19. The filament circuits of the amplifier, oscillator and modulator valves all include ammeters, and rheostats R_2, R_3 and R_4 are provided for the purpose of setting the filament current. An additional switch is provided in the amplifier circuit to enable the circuit to be broken for neutralizing purposes. The current in the sub-modulator valve filament circuit is not variable, the resistances R_5 and R_6 being included in the circuit to maintain the current at the required value. The switch S_{13} enables the filament circuits of the sub-modulator valves to be broken when R/T is not required.

20. Referring to fig. 3 it will be observed that the H.T. connections are so arranged that the H.T. supply to the amplifier valve and oscillator valve may be entirely independent of one another. Two H.T. positive terminals marked H.T. + 1 and H.T. + 2 and two H.T. negative terminals marked H.T. —1 and H.T. —2 respectively, are provided. The switch S_{15}, located in the amplifier compartment, enables the necessary changes to be made in the connections of the amplifier and master-oscillator valves for common or separate H.T. supply. When R/T is being radiated the switch is placed in the " single " position, and when C.W. or I.C.W. is being radiated the switch is placed in the " double " position. In the " single " position both amplifier and oscillator anode circuits are fed from a common H.T. positive terminal, and the H.T. negative lead is connected to the cathodes of both amplifier and oscillator valves thereby energizing both valves. In the " double " position (when two separate H.T. supplies are connected to the appropriate terminals) the oscillator is continuously energized when the key is open, but the amplifier is energized (from an independent supply) only when the key is closed.

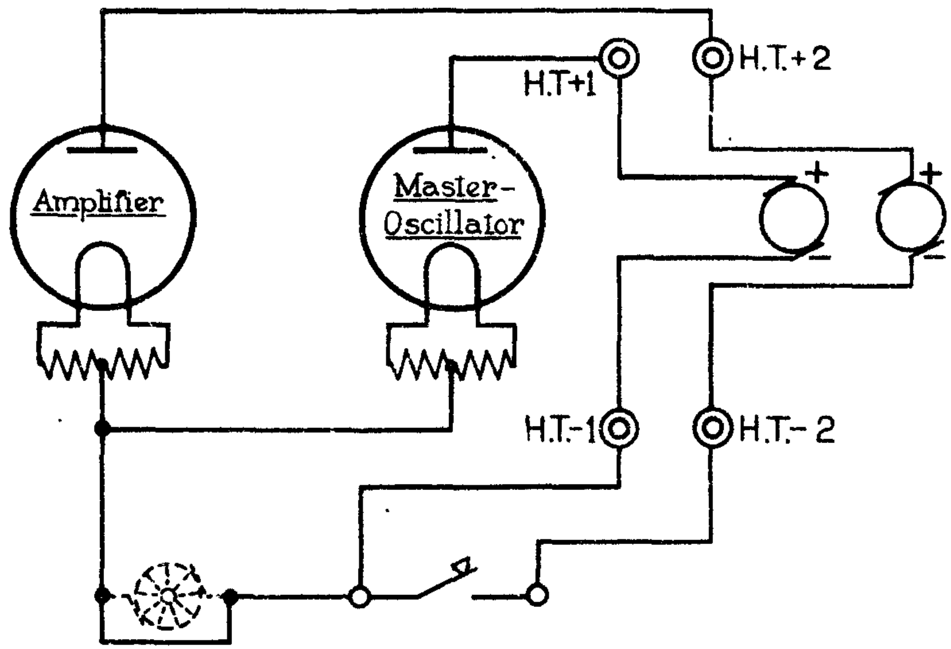
21. In fig. 2 a number of switches are shown separately at various points in the circuit. Actually several of these are arranged for simultaneous operation. For example, the H.T. switches S_{14}, S_5 and S_6 are operated by the movement of a single handle; similarly the switches S_7 and S_{10} are so coupled that when S_{10} is opened the filament circuit of the amplifier is broken, and movement of the switch handle through the remainder of its travel closes S_7, connecting the neon lamp in circuit.

22. The three-position selector switch, when moved into the C.W. position, closes S_4 thereby short-circuiting the control choke, opens the left-hand side of S_{13} thereby breaking the filament circuits of the modulator and sub-modulator valves, closes the first contact of S_{11} which short-circuits the interrupter (leaving the key in circuit), opens the right-hand side of S_{13} which opens the interrupter motor circuit, and opens S_9 which opens the microphone circuit.

23. In the I.C.W. position the switch S_4 is closed and S_{13} (left-hand side) is open as before, but the switch S_{11} is opened thus removing the short-circuit from the interrupter, and S_{13} (right-hand side) is closed thereby starting up the interrupter motor.



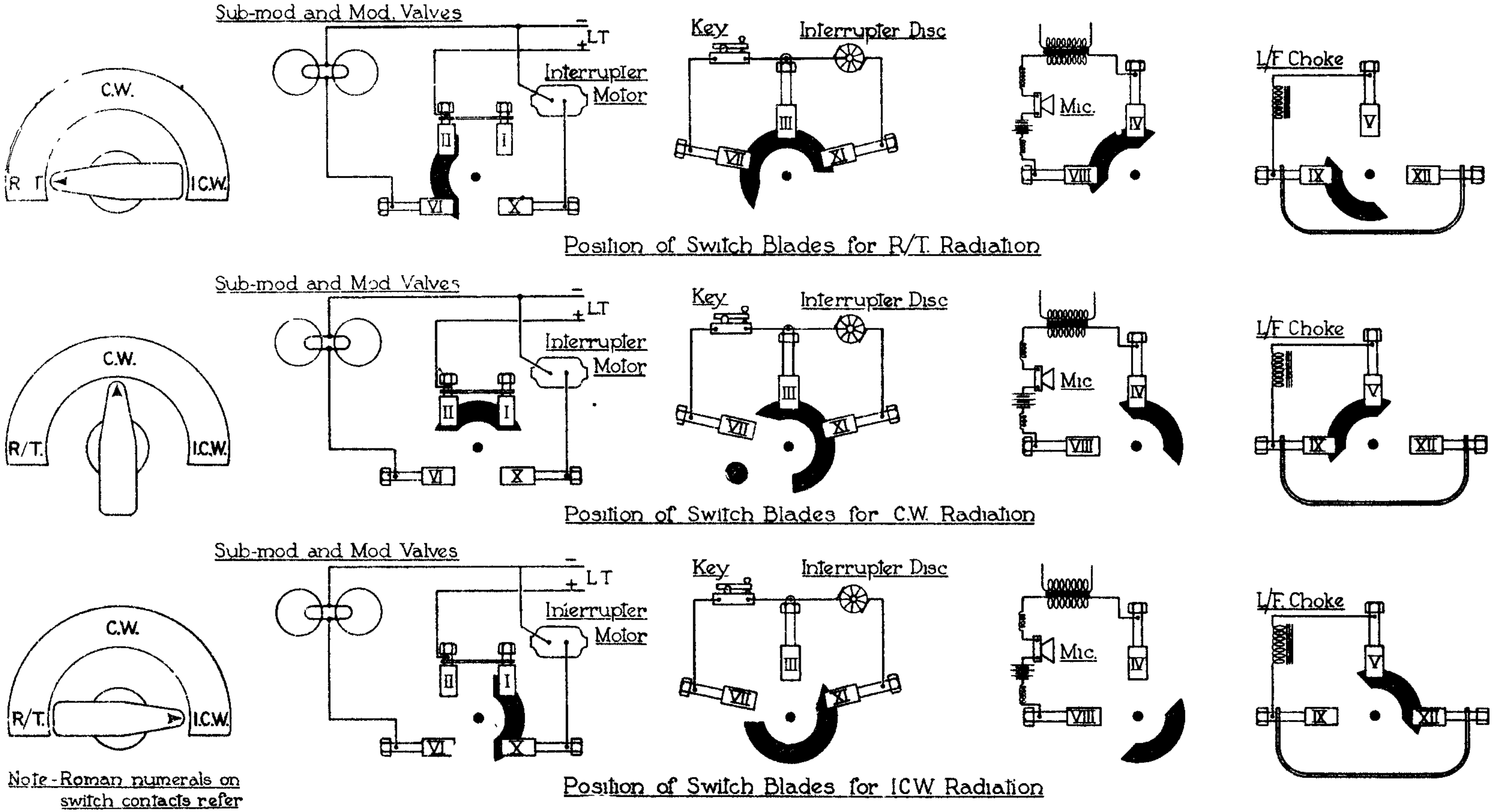
H.T. Switch in "Single" Position for R/T,
Common H.T. Supply



H.T. Switch in "Double" Position for W/T,
Separate H.T. Supply

FIG. 3 ALTERNATIVE H.T. SUPPLY

(F.1799). F. & C. LTD



Note - Roman numerals on switch contacts refer to connections on wiring diagram (fig.9)

FIG. 4. CIRCUIT CHANGES EFFECTED BY SELECTOR SWITCH

24. In the R/T position switches S_{13} (left-hand side), S_{11} (second contact) and S_9 are closed and the following circuit changes are effected. The filament circuits of the modulator and sub-modulator valves are closed, the key and interrupter are short-circuited and the microphone circuit is closed. The switches S_4 and S_{13} (right-hand side) are opened thereby putting into circuit the control choke and opening the circuit of the motor interrupter. The circuit changes effected by the selector switch are clearly shown in the simplified diagram (fig. 4).

25. The resistance R_1 is interchangeable, 30,000 ohms being required for R/T and 10,000 for C.W. and I.C.W. transmission. In the bench wiring diagram (fig. 10) a 10,000 ohm resistance is in place. The resistance unit not in use is housed in a pair of clips fitted in the base of the bottom chamber just inside the door.

26. When the transmitter is required to operate on the higher frequency band with the standard 6-wire " T " type cage aerial, an aerial series condenser is required, and condenser type 7 (Stores Ref. 10A/2951) is suitable for this purpose. It is shown in position on the top of the transmitter in fig. 1. The condenser is of the glass enclosed variable type. It has a maximum capacitance of approximately ·0011 μF. and the scale with which it is equipped is engraved with two sets of graduations, one being in degrees (0–180) and the other in jars of capacitance (·05 to ·95).

CONSTRUCTIONAL DETAILS

27. The transmitter (*see* fig. 1) is built into a rectangular duralumin frame supported on four tabular feet, the overall height of the transmitter being approximately 6 ft. 3 in. It is divided horizontally into three compartments known as top, middle and bottom chambers respectively, the division between the middle and bottom chambers taking the form of a metal screen having terminals carried in insulating bushes.

28. The top and bottom chambers are provided with sliding side panels which can be completely removed, and hinged doors are provided on the front of these two compartments. The front door of the top chamber is provided with a glass window and the front door of the bottom chamber has a circular window fitted with gauze. The main terminal board (*see* fig. 7) is situated under a removable panel on the side of the middle chamber.

29. In the top chamber is housed the amplifier valve complete with its inductances and tuning apparatus. In the middle chamber are situated the switches, grid-bias arrangements, rheostats and a number of indicating instruments. The master-oscillator valve, modulator valve and sub-modulator valve with their associated apparatus are housed in the bottom chamber. Also in this chamber is the motor interrupter for I.C.W. transmission. Bench wiring diagrams of the three chambers are given in figs. 8, 9 and 10.

30. In fig. 5 is given a view of the front of the transmitter. In the top left-hand corner is the aerial tuning control (3). This consists of a moulded dial graduated from 0 to 100, which operates the variable tapping on the aerial inductance. The instrument (14) on the right of the aerial tuning condenser is the aerial ammeter. It is a thermo-ammeter reading 0 to 8 amps. and is connected in the aerial circuit. Next to this is the aerial coupling adjustment (4) which consists of a moulded knob carrying a pointer moving over a scale graduated from 0 to 90. The spindle is extended through the panel and carries the coupling coil (2, fig. 6). On the extreme right of the top of the panel is the neutralizing condenser adjustment (6), the dial of which is graduated from 0 to 120. The closed circuit ammeter (15) is situated near the centre of the upper panel, it is a thermo-ammeter reading 0 to 12 and is connected between the inductance and the condenser in the closed circuit. On the left of this is the amplifier closed circuit tuning adjustment (1), the moulded handle of which carries a transparent scale graduated from 0 to 200. Rotation of this handle operates the variable condenser through a bevel gearing.

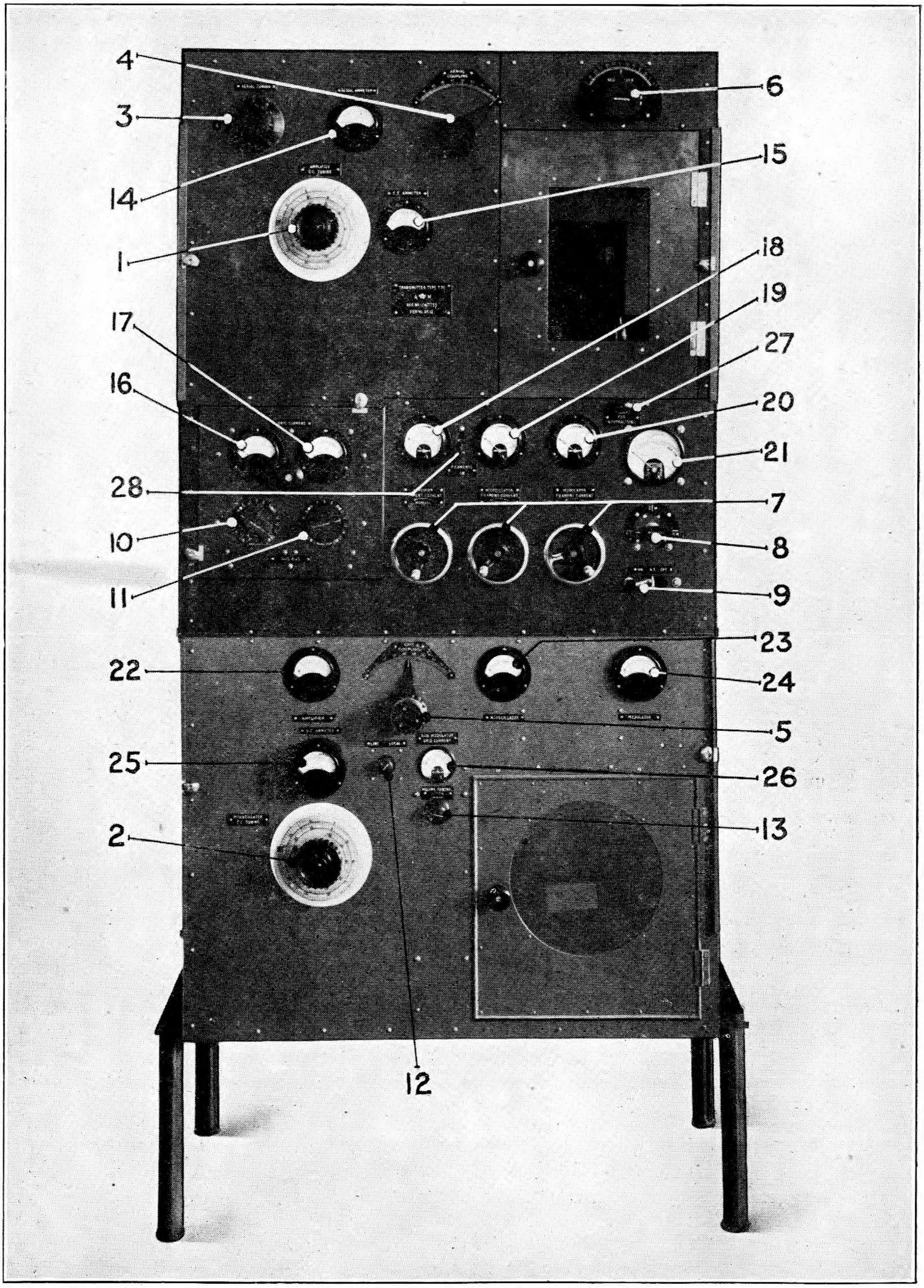


FIG. 5. Transmitter T.70, front of panel.

31. The middle section of the transmitter is provided with a front panel composed of synthetic-resin varnish-paper board on which are grouped six meters, six switches and three rheostat handles. The two meters on the left are milliammeters reading 0–100 and 0–30 respectively. The left-hand meter (16) is connected in the grid circuit of the amplifier valve and the other meter (17) is connected in the grid circuit of the modulator valve for the purpose of indicating when grid current is flowing. These two meters together with the switches seen immediately beneath them are mounted upon a rectangular panel which forms the front of a drawer containing two dry batteries for grid-bias on the amplifier and modulator valves. That for the amplifier is a 300-volt battery, the applied voltage being adjustable by means of a switch (10) in steps of 20 volts from 40 to 300. That for the modulator is a 130-volt battery, the voltage being adjustable by means of the switch (11) in steps of 6 volts, from 60 to 130.

32. A modification has been introduced whereby transmitters working on A.C. supply derive the necessary grid-bias voltages automatically from a tapped resistance connected in the common H.T. negative and grid circuits. The modified wiring is shown in the theoretical circuit diagram fig. 5, whereas the battery bias method is shown dotted. The automatic grid-bias unit improves the performance of the transmitter in that troubles due to gradual deterioration of the batteries are eliminated. Furthermore, battery maintenance and the possibility of failure due to high resistance is removed.

33. The modifications for automatic grid-bias are made in the following manner. After switching off the A.C. supply and withdrawing the existing battery bias draw, the upper rear cover of the transmitter is removed. The four bolts and four connections securing the contact panel are undone and the contact panel with which the draw engaged is removed. A new 5-pole contact panel is secured in place using the same bolts and fixing holes. The terminals marked AMP., MOD. and SUB.-MOD. are connected up as before. A.P. 1186/A.64 gives information on possible modifications to the 5-pole contact panel before fitting.

34. The two leads marked H.T.—2 are removed from the terminal board and connected together and the free end of this lead is connected to FIL. on the new contact panel. The terminal marked H.T.—2 on the terminal board is connected to H.T.—2 on the new contact panel. After the new grid-bias unit is placed in position the rear cover of the transmitter is replaced. The terminals H.T.+1 and H.T.+2 on the terminal panel are connected together externally and joined to H.T. positive of the supply. The terminal H.T.—1 is disconnected and H.T.—2 is connected to H.T. negative of the supply.

35. To the right of this drawer are the three ammeters (18), (19) and (20) in the filament circuit of the amplifier, master-oscillator and modulator valves respectively. Between the first and second filament ammeters is the filament switch (28). Beneath the ammeters are the three filament rheostat handles (7). The larger meter (21) is the H.T. voltmeter reading 0 to 3,500 volts and above this is the neutralizing switch (27) for breaking the filament circuit of the amplifier when carrying out the operation of neutralizing. The selector switch (8) is marked for three positions R/T, C.W. and I.C.W. and effects the necessary circuit changes to enable the three different forms of transmission to be made. The switch beneath this is the main H.T. switch (9) which when placed in the off position breaks both sides of the H.T. supply.

36. The lower section of the transmitter carries, on the front panel, five meters, a switch, a grid-coupling coil control, a master-oscillator tuning control and a volume control. The amplifier milliammeter (22) reads 0–500, the master-oscillator milliammeter (23) reads 0–250 and the modulator milliammeter (24) reads 0–250. These milliammeters are connected in the anode circuits of the respective valves. The remaining two meters on the lower section are the ammeter (25) reading 0–12, connected in the oscillatory circuit, and the milliammeter (26) reading 0–5 connected in the grid circuit of the sub-modulator valve. The grid-coupling control (5) is capable of being turned through 90 degrees and varies the coupling between the amplifier and the master-oscillator. The switch (12) is for the purpose of changing over from local to remote microphone,

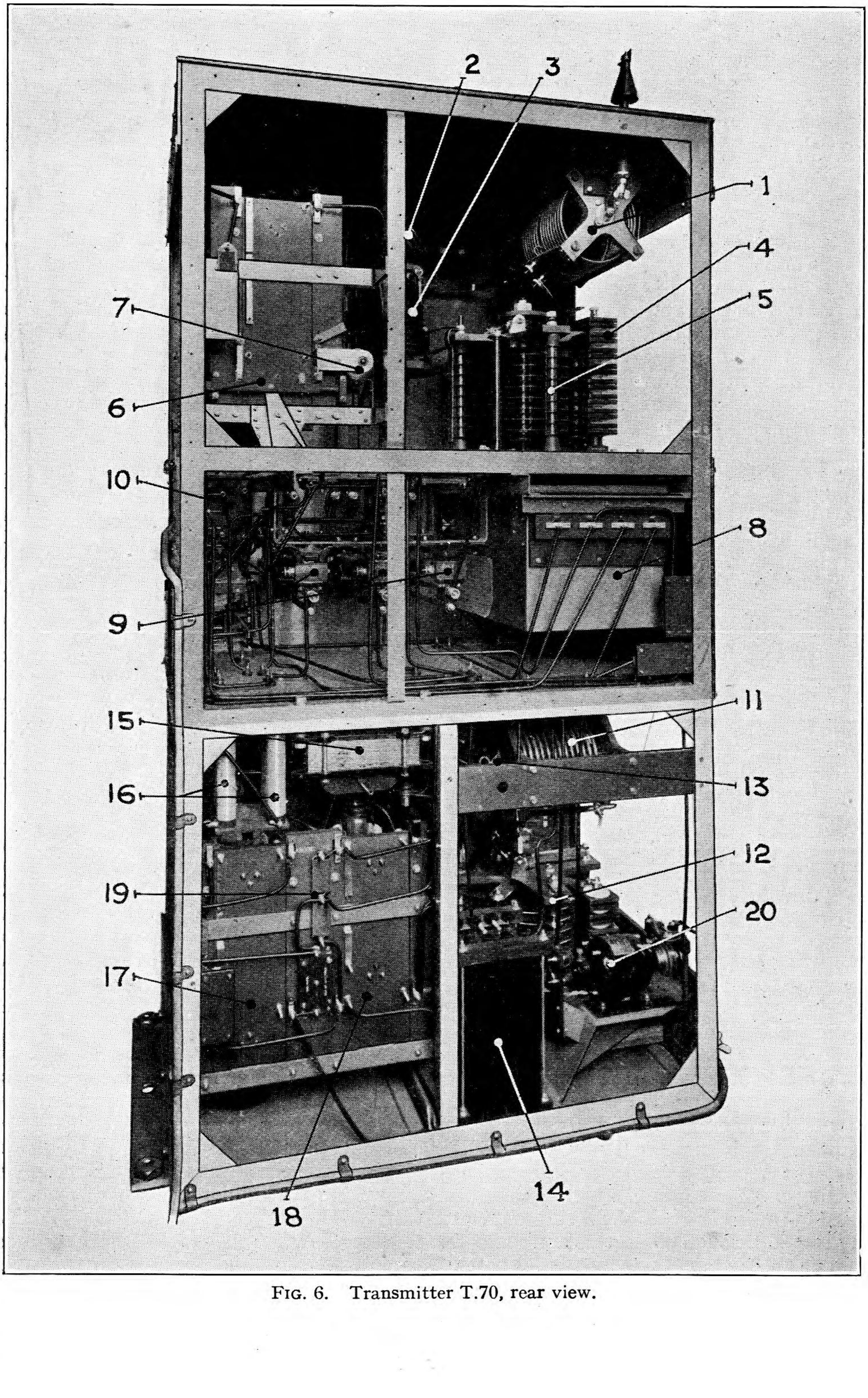


FIG. 6. Transmitter T.70, rear view.

and the volume control (13) is interposed between the microphone circuit and sub-modulator valve. The master-oscillator closed circuit tuning control (2) is similar to that fitted in the top section for the amplifier closed circuit tuning—rotating a condenser through a bevel drive in a similar manner.

37. Referring to fig. 6 the coil (1) is the aerial inductance coil which is constructed of copper tube on an insulating former. This coil has two sections one of which can be isolated by means of a link. In the illustration the link is shown in the open position. In the centre of the coil is a spindle which carries a contact operating around the turns of the coil, the spindle being actuated by the knob (3, fig. 5).

38. From the aerial inductance coil a copper strip is taken to the aerial coupling coil (2) the other end of which is connected through an ammeter (14, fig. 5) to the counterpoise terminal. The coupling coil which is also constructed of copper tube is capable of being rotated through 90 degrees by means of the control (4, fig. 5). Immediately beneath the aerial coupling coil is the amplifier closed circuit inductance coil (3), across which are connected the adjacent condensers, (4 and 5) in series with the closed circuit ammeter (15, fig. 5). The condenser (5) is specially constructed and consists partly of fixed and partly of movable vanes. The minimum capacitance is approximately ·00011 μF. and the maximum approximately ·00036 μF., adjustment being made through a bevel drive operated by the control handle (1, fig. 5) on the front of the panel.

39. The component (4) carried on the side of the adjustable condenser is a packing condenser consisting of 8 sections clamped together giving a total capacitance of approximately ·00023 μF. This is connected in parallel with the adjustable condenser for certain frequencies by means of the link which can be seen at the top of the adjustable condenser.

40. On the left of the top chamber is the amplifier valve panel. The valve itself can be clearly seen in fig. 4. Carried on the rear side of this panel is the switching device (6) which enables the amplifier filament circuit to be opened and a neon lamp (7) to be connected from the anode of the amplifier valve to earth, when carrying out the neutralizing operation.

41. The switch consists of a bar of insulating material on which are carried two contacts spaced approximately 6 in. apart. This bar is mounted in guides and is capable of being moved endways by means of a rack-and-pinion device operated from the front of the panel by the handle (27, fig. 5).

42. It will be observed that when the bar is in the extreme left-hand position, as shown, the left-hand contact closes the filament circuit. When the bar is moved to the right, the left-hand contact is opened. Further movement of the bar causes the right-hand contact to close, thereby connecting the anode of the valve to one side of the neon lamp, the other side of which is permanently connected to earth.

43. In the middle chamber can be seen the drawer (8) which contains the grid-bias batteries, or automatic grid-bias unit. The connections from the grid-bias batteries or from the unit are taken out through spring contacts, the back of the drawer being provided with knife contacts which engage with jaws mounted on an insulating contact bar against which the drawer stops when pushed into place. Terminals are provided on the contact bar to enable the necessary connections to be made to the spring jaws. The front of the drawer can be seen in fig. 5 and a diagram of the internal connections of the grid-bias switches (10 and 11, fig. 5) for both types of grid-bias is given in fig. 11. The three rheostats (9) are in the filament circuits of the amplifier, master-oscillators and modulator valves, and are wound on slate formers with a maximum resistance of 4 ohms. The sliding contacts are operated by handles (7, fig. 5) through worm drives. In the left-hand upper corner of the chamber can be seen the H.T. voltmeter (10). Beneath this is located the " R/T, C.W., I.C.W.", selector switch, and beaneath this is the H.T. on and off switch. A theoretical diagram of the selector switch is given in fig. 4. The H.T. change-over switch for separate or common supply is located on the cross member at the top of the middle chamber but is accessible only through the front door of the top chamber. A theoretical diagram showing the changes effected by this switch is given in fig. 3.

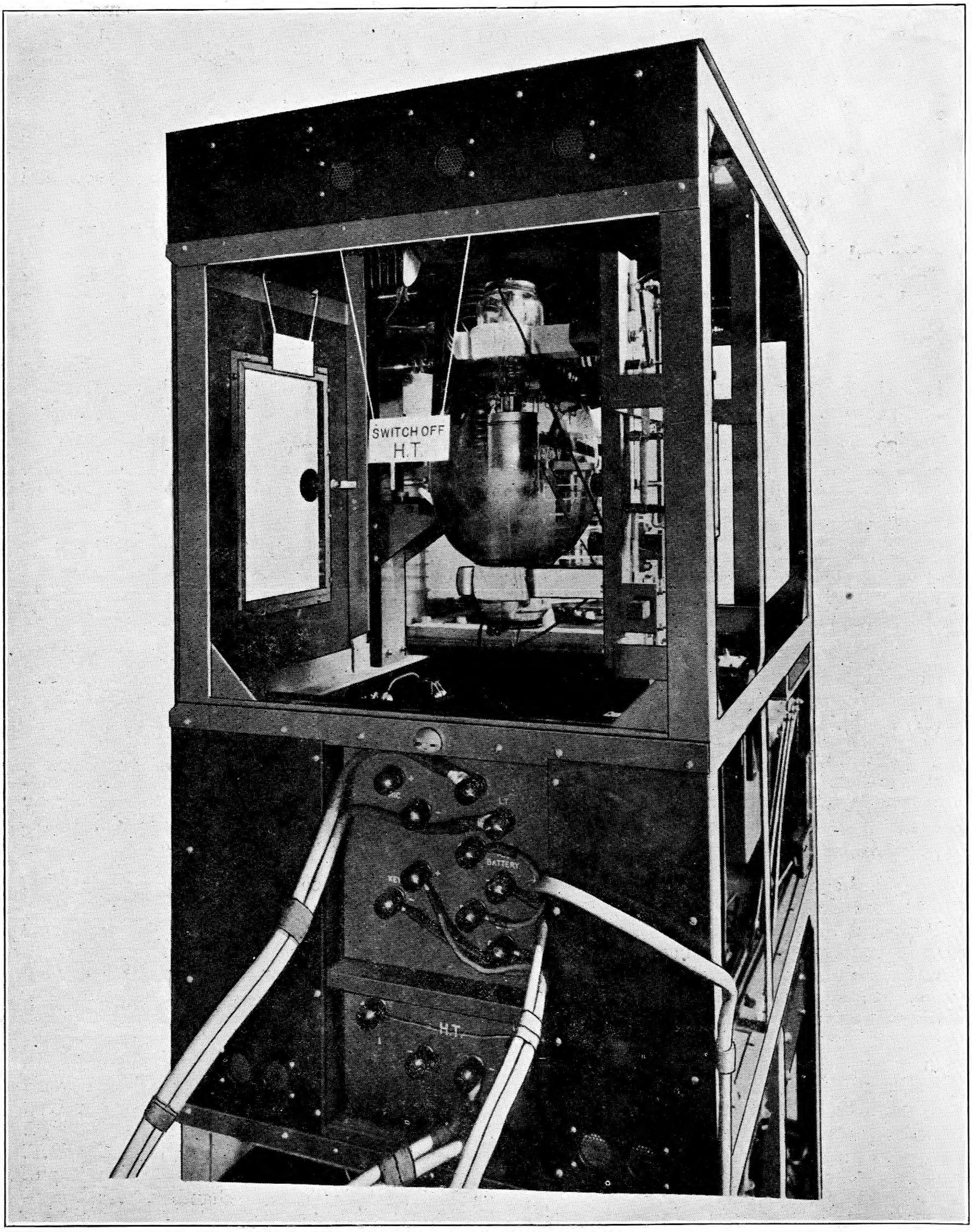
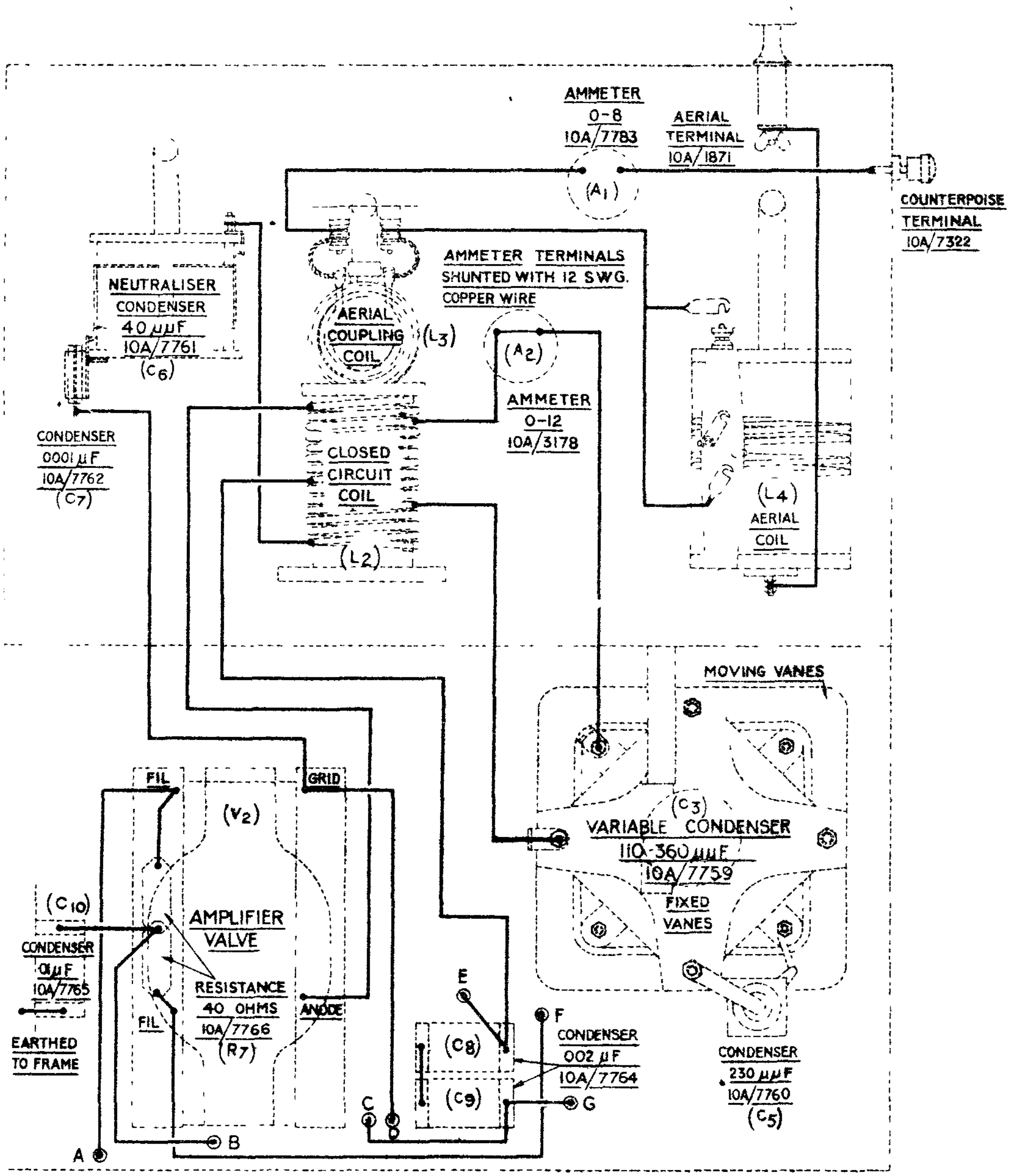


FIG. 7. Transmitter T.70, side view.



LEADS – A,B,C,D,E,F AND G ARE TAKEN INTO MIDDLE CHAMBER (SEE FIG.)

NOTE ANNOTATIONS THUS (L4) REFER TO THE CORRESPONDING ANNOTATIONS IN FIG. 2.

FIG. 8. BENCH WIRING DIAGRAM. TOP CHAMBER

44. In the bottom chamber can be seen the master-oscillator inductance coil (11) with its associated condensers (12). These are of similar construction to those used in the aerial closed circuit and installed in the top chamber. The grid coupling coil (13) is operated by the control handle (5, fig. 5), and an ammeter (25, fig. 5) is connected in the master oscillator closed circuit. The group (14) is a series-parallel group of 4 μF. condensers with two 5-megohm resistances and is connected between H.T. +1 and H.T. −1 on the dead side of the H.T. switch. The group corresponds to C_{19}, C_{20}, C_{21}, C_{22}, and R_{15} and R_{16} in fig. 2. On the left-hand side of the bottom compartment may be seen the L/F choke (15), next to which are the two microphone and two key R/F chokes (16) and the grid-bias by-pass condensers.

45. The master-oscillator, modulator and sub-modulator valves are all housed in the bottom chamber, the master-oscillator and modulator valves being carried on valve bases (17 and 18) which take the form of upright panels held in position by turn-buttons. Each panel is provided with valve clips and terminals for the electrodes, the latter being provided with spring contacts so that the whole panel may be easily plugged into place or withdrawn. The top of the modulator valve can be seen beyond the panel (18). The sub-modulator valve is carried on a separate base near the master-oscillator tuning condenser (12).

46. The resistance (19) is an 80-ohm centre-tapped resistance connected across the filament circuit of the modulator valve. All four valves have similar resistances across their filament circuits. The grid leak for the master-oscillator which consists of 12 sections each having resistances of 5,000 ohms, is installed just inside and above the front door of the bottom chamber. A short-circuiting link is provided on the leak to enable a suitable value of resistance to be obtained for any setting of the transmitter.

47. The interrupter motor (20) is designed to run on either A.C. or D.C. (20 volts). Two pairs of leads are provided, one pair being connected up for D.C. and the other pair for A.C. The shaft of the motor carries a ten-segment interrupter disc.

VALVES AND POWER SUPPLY

48. There are four valves used in the transmitter. A valve, type V.T. 5B is used as a master-oscillator. One V.T. 4B is used as an amplifier. The modulator is a valve, type D.E.T. 3 and the sub-modulator is a V.T. 25. The H.T. and L.T. voltages required for the valves are obtained from the rectifier, type B, (Stores Ref. 10A/8067). A rectifier and smoothing circuit is incorporated in the unit which is described elsewhere in this publication. The rectifier type B is generally placed near the transmitter, connections being made by means of flexible leads.

49. When the T.70 is adapted for operation by remote controls, the remote controls, type 5, are generally used and are mounted on the top of the rectifier unit. A reference to fig. 1 will show the manner in which the various components are usually arranged.

OPERATION

50. In fig. 12 is given a diagram and a table indicating master-oscillator and amplifier inductance settings. The three ranges are numbered 1, 2 and 3 and the sockets are coloured to facilitate rapid changes in the settings. The sockets in use on range 1 are coloured blue, those in use on range 2 are plain and those in use on range 3 are red. Where the same socket is used on two ranges the socket is given two colours, *e.g.*, a condenser connection is made to No. 3 turn for both range 1 and range 3. The socket is therefore coloured blue and red. The inductance coils illustrated in fig. 12 have the connections appropriate to range 1.

51. In Tables 1, 2 and 3 are given typical settings and instrument readings for the 6,000–4,286 kc/s. band (radiating radio telephony), the 4,286–3,000 kc/s. band (radiating C.W.), and

for the 3,000–2,500 kc/s. band (radiating R/T, I.C.W. and C.W.). From these tables can also be ascertained whether or not the packing condensers are required, whether full or half aerial coil is required, and what value of anode feed resistance is to be used for the master-oscillator.

Adjustments for C.W. operation

52. See that the H.T. switch is in the off position. Connect up the two H.T. sources to the appropriately labelled terminals. Place the H.T. supply switch, inside the amplifier compartment, in the " double " position. See that the grid-bias switches are at " 0 ".

53. From the information given in fig. 12 and in the tables, set the master-oscillator tuning condenser, grid coupling, amplifier tuning condenser and neutralizing condenser to the appropriate settings for the desired frequency. Place the packing condenser links in the appropriate positions, and if half aerial coil only is called for, the link should be opened and the strip connection removed from the outer end of the coil and connected at the end of the first half of the coil from which the link has been removed.

54. Set the aerial coupling to zero and the selector switch to the C.W. position. Now turn the filament rheostats as far as they will go in a clockwise direction. Next place the filament switch in the on position and adjust each filament rheostat to give the required current for the particular valve (Amplifier, up to 6 amps. ; oscillator, 5·2 to 5·6 amps. ; each adjusted for maximum aerial current) and set the amplifier grid-bias switch to stud 8. Switch on the H.T supply to the master-oscillator only, and set the transmitter main H.T. switch to on.

55. The main voltmeter, master-oscillator milliammeter, and closed circuit ammeter only should give readings when the correct state of oscillation of the master-oscillator circuit is obtained.

56. Operate the neutralizing switch which opens the amplifier filament circuit and connects the neon lamp to the anode circuit. Turn the neutralizing condenser to " 0 " and tune the amplifier by means of the glow in the lamp. Switch on the H.T. supply to the amplifier. Rotate the neutralizing condenser and note the scale readings at the extreme positions of the condenser for which there is no glow in the lamp. The mean of these values is the correct neutralizing position.

57. Return the neutralizing switch to its original position thereby closing the amplifier valve filament circuit and opening the neon lamp circuit. Depress the key to complete the amplifier circuit and tune the amplifier closed circuit until the current as indicated by the amplifier closed circuit ammeter is a maximum. Set the aerial coupling to, say 45 degrees and tune the aerial circuit. Re-adjust the grid coupling and aerial coupling until the maximum aerial current is obtained. The aerial coupling should be as loose as possible to avoid the " double hump " effect in tuning.

58. With the key closed, check the frequency. It may be found that a slight change of frequency has occurred. If a change has occurred, re-adjust the master-oscillator tuning and repeat the above operations.

59. Re-adjustment of the master-oscillator circuit tuning can be made quite simply in the following way. Suppose that the required frequency is 4,800 kc/s. and that as a result of first adjustment the frequency has changed to 4,762 kc/s. (a difference of 38 kc/s.). By reference to the tables it will be found that in this particular region of frequencies 255 kc/s. is equal to 20 divisions of the master-oscillator condenser scale, so that 38 kc/s. is equal to 3 divisions. It is only necessary therefore to set the master-oscillator tuning condenser back on the scale by this amount and re-tune throughout to reproduce a frequency of 4,800 kc/s. in the aerial circuit.

60. It may sometimes be found that at a certain frequency setting of the master-oscillator a harmonic resonance occurs in the grid coupling coil. This is mainly confined to the higher frequencies of the band covered by the transmitter and is due to the necessity for providing

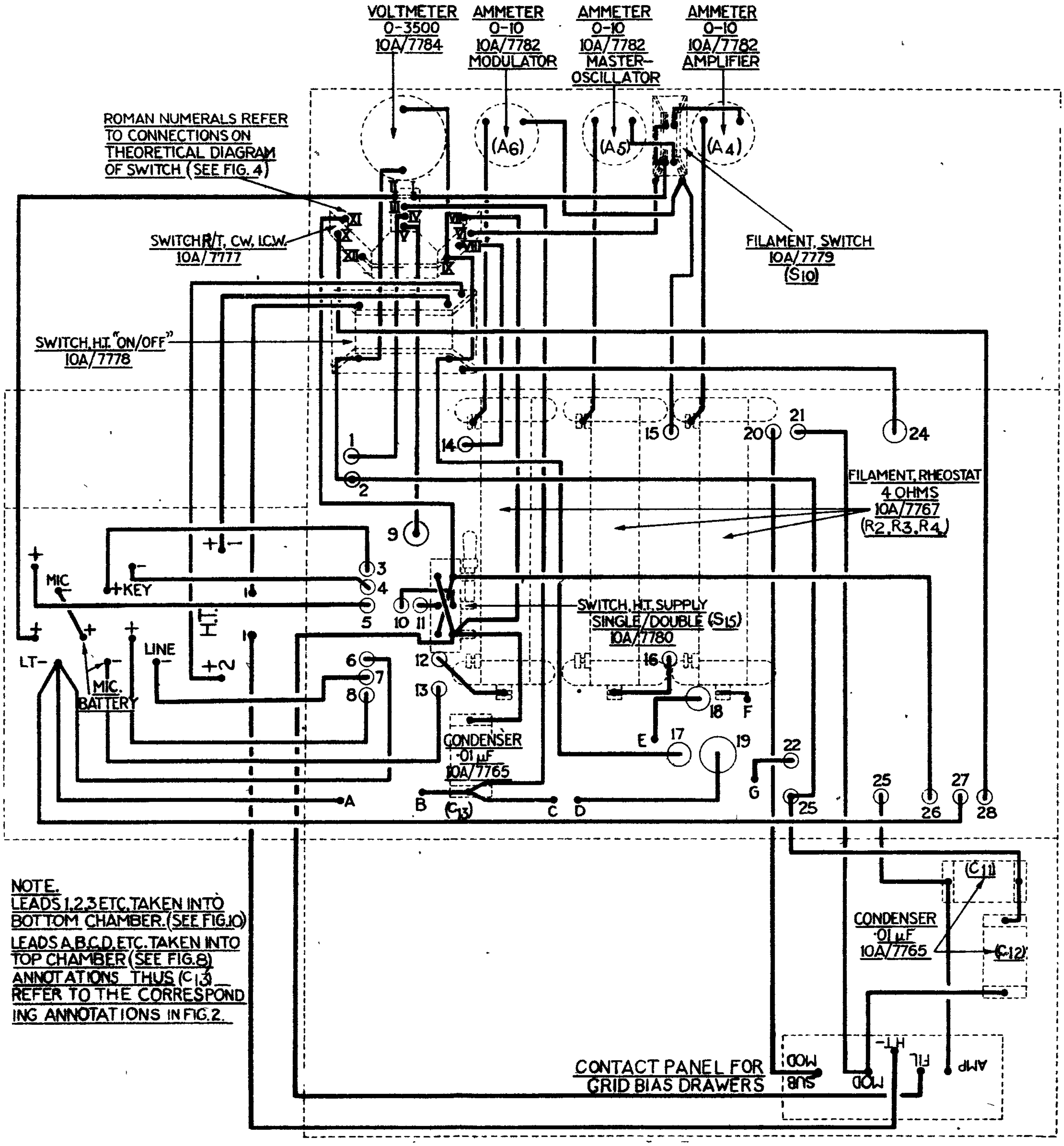
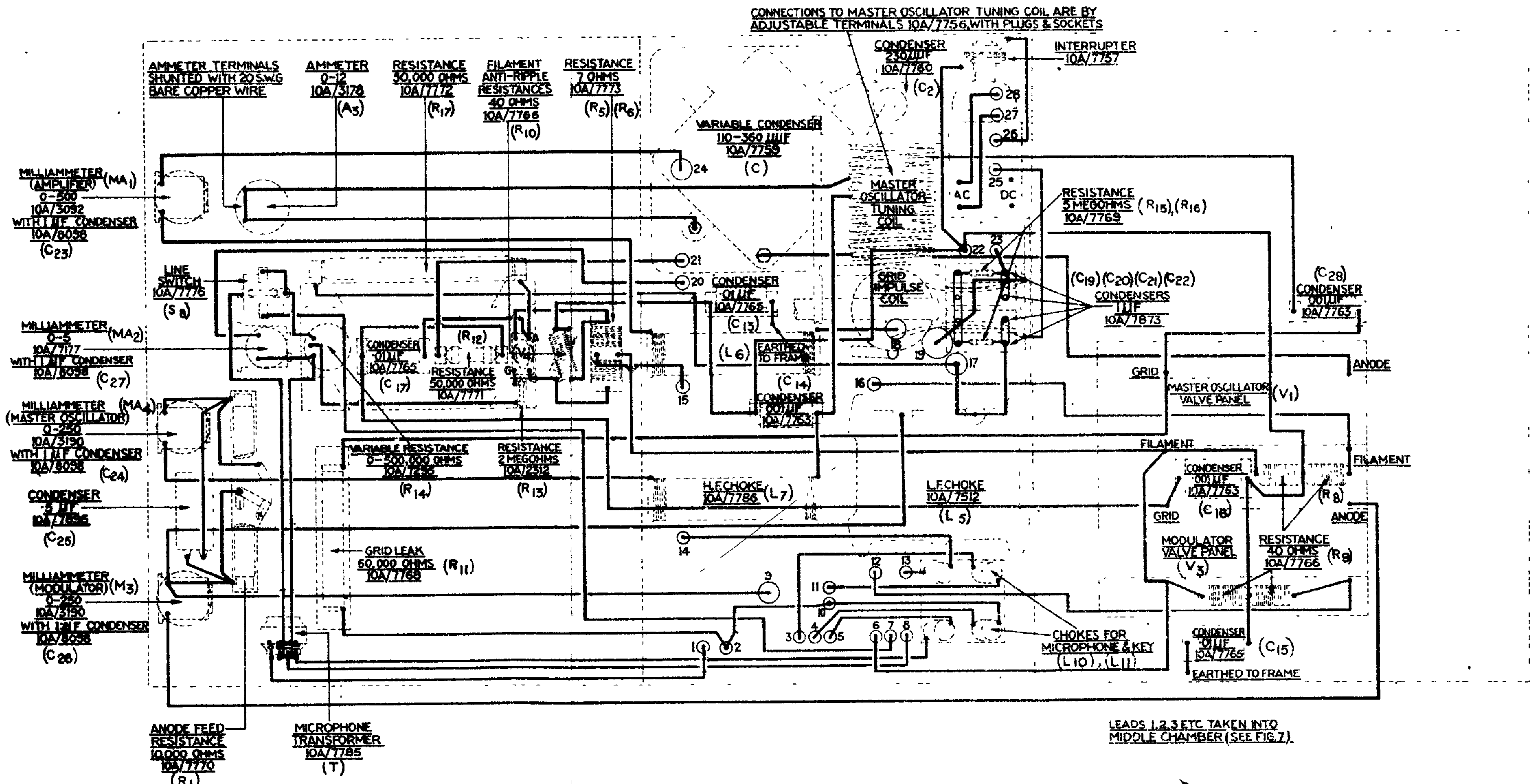


FIG.9. BENCH WIRING DIAGRAM, MIDDLE CHAMBER

(F.1799). F. & C. LTD



NOTE. ANNOTATIONS THUS (R_{17}) REFER TO THE CORRESPONDING ANNOTATIONS IN FIG. 2.

FIG. 10. BENCH WIRING DIAGRAM, BOTTOM CHAMBER

(F.1799). F. & C. LTD.

large inductance in the coupling coil for the lower frequency portion of the band. When, owing to this effect, difficulty is experienced in the process of tuning, or neutralizing, or both, a change of coupling tap will usually effect an improvement.

61. The master-oscillator valve should not take more than 130 milliamps. at 3,000 volts. If the anode current at 3,000 volts is much in excess of this value switch off and increase the resistance of the grid-leak.

62. The amplifier valve is capable of dissipating 450 watts continuously on the anode in which state the anode glows with a bright red colour. This is the normal working state of the valve and is in no way objectionable. In connection with the transmitter T.70 however, this state is sometimes associated with excessive grid current This latter must be avoided by increasing the amplifier bias or decreasing the grid coupling or both. When the grid coupling value is changed the neutralizing condenser may require to be reset.

Adjustments for I.C.W. operation

63. Adjust the transmitter for C.W. working as described above and set the selector switch to the " I.C.W." position. If more power is required than is obtainable with these adjustments, try the effect of increase of coupling (both grid and aerial). If the bulk of the work of the transmitter is to be on I.C.W. it may be advisable to lower the anode tap of the master-oscillator circuit, but this should never be done where there is likelihood of a quick change-over to R/T transmission being required.

Adjustments for R/T operation

64. In order to obtain proper modulating conditions the procedure outlined in the following paragraphs should be observed. Assuming that the transmitter has been properly adjusted for C.W. on the desired frequency, switch off and withdraw the master-oscillator anode feed resistance. Set the selector switch to R/T and the modulator bias switch to stud 16. Now switch on and adjust the amplifier bias until the amplifier anode current milliammeter reads 15–20 mA. with H.T. tap 2, or 30–40 mA. with H.T. tap 3. Switch off and insert the 30,000 ohm anode feed resistance.

65. Switch on and adjust the modulator filament current to 4 amperes (*see* para. 71, modulation of the carrier due to A.C. ripple). Adjust the grid and aerial coupling for maximum aerial current. (Re-tuning of both amplifier and aerial circuits will probably be necessary.)

66. Re-adjust the bias on the modulator valve until this valve is dissipating just less than 250 watts. For an anode voltage of 3,000 volts, for example, the anode current should be slightly less than 83 mA. ; for a voltage of 2,500 volts the anode current should be slightly less than 100 mA. and for a voltage of 2,000 volts the anode current should be slightly less than 125 mA. and so on.

67. The sub-modulator valve should normally require no adjustment. It is advisable, however, to check the sub-modulator bias occasionally with a voltmeter, and it is a good plan to glance at the sub-modulator valve after switching on. Any heating up of its anode is an indication that the bias is insufficient.

68. Read the value of aerial current carefully. Leaving all other adjustments untouched (except the modulator bias which must always be adjusted to limit the anode dissipation to 250 watts) reduce the grid coupling until the aerial current has fallen to half its former value. Proper conditions for modulation should now obtain.

69. When a common H.T. supply is to be used the switch must be put to the " single " position, the H.T. source connected to the H.T. +1 and H.T. —1 terminals, and the two H.T. positive terminals connected together. The terminals H.T. —1 and H.T. —2 must *not* be connected together otherwise arcing may take place when the H.T. switch is required to break a heavy current.

70. When all the adjustments described above have been satisfactorily made, the modulation should be checked by means of a Modulation Indicator. If a Modulation Indicator is not available the following method may be usefully employed. Speak into the microphone and note the readings on the aerial ammeter or on the amplifier closed circuit ammeter. For correct modulation these ammeter readings should rise with modulation (22 per cent. rise for 100 per cent. modulation, 6 per cent. rise for 50 per cent. modulation). At the same time there should be little or no movement of the pointers of the amplifier and the modulator anode current instruments. In the case of the amplifier anode current, an increase indicates that the grid coupling is insufficient or that the bias is too great, or both. Similarly a decrease of anode current indicates the converse. A small amount of movement of the pointer of the anode current instrument may be neglected. When checking the modulator anode current the adjustment to be aimed at is one that gives as little movement of the pointer as possible. A movement of 10 milliamps. should be regarded as the absolute maximum allowable.

71. If it is found, by observation of the Modulation Indicator, that more than 5 per cent. modulation of the carrier, is present owing to A.C. ripple, an increase or decrease of the filament current of the modulator valve may effect a considerable improvement. This is permissible up to a value not more than 20 per cent. or to such a value that the anode current of the modulator valve is not appreciably altered.

72. The amplitude of the speech voltage impressed on the grid of the sub-modulator valve can be controlled by means of the volume control. The volume is increased by rotating the handle of the control in a clockwise direction. The maximum volume allowable is that which produces the 10 milliamps. change mentioned above. Except for extreme ranges a low volume setting should be used.

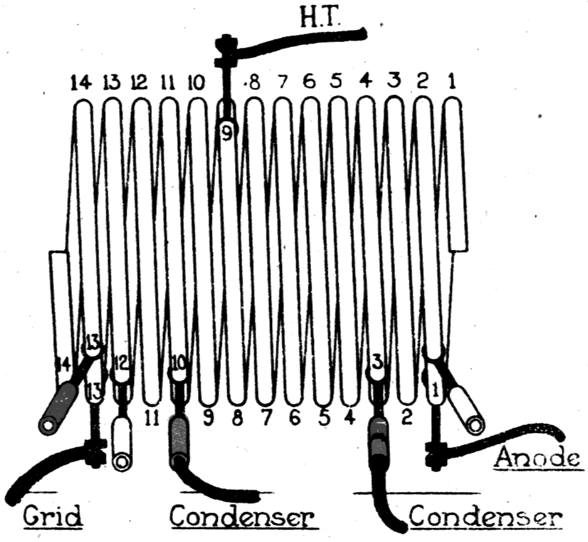
73. The upper limit of frequency of the transmitter is given as 6,000 kc/s. When necessary this upper limit may be raised to 6,666 kc/s. by making the following adjustments.

Master-oscillator coil.

Connection.	Colour.	Turn.
Anode	Black	1
Condenser	Red-black	4
H.T. + ...	Black	9
Condenser	Blue	10
Grid	Black	13

Amplifier coil.

Connection.	Colour.	Turn.
Anode	Blue	3
Condenser	Blue-white	2
H.T. + ...	Black	7
Condenser	Blue	9
Neutrodyne ..	Black	14



Master-Oscillator Coil
(Set up for Range 1)

Range 1 (blue)

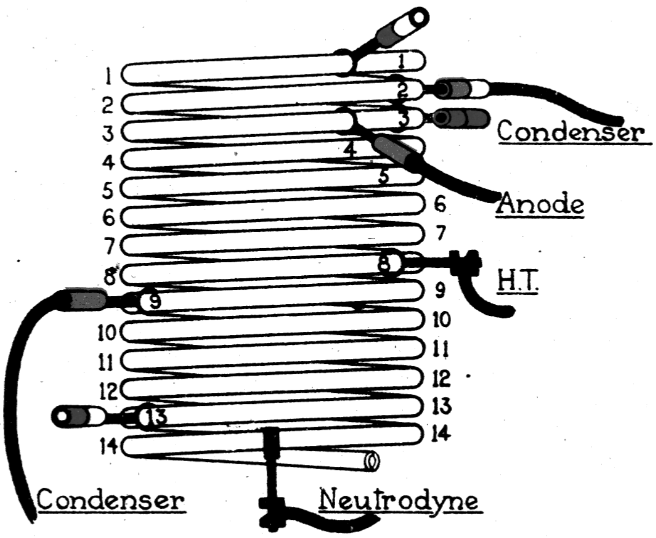
Master-Oscillator		Amplifier	
Anode on turn	1	Anode on turn	3
Condenser on turn	3	Condenser on turn	2
H.T. on turn	9	H.T. on turn	8
Condenser on turn	10	Condenser on turn	9
Grid on turn	13	Neutrodyne on turn	14

Range 2 (plain)

Master-Oscillator		Amplifier	
Anode on turn	1	Anode on turn	1
Condenser on turn	1	Condenser on turn	2
H.T. on turn	9	H.T. on turn	8
Condenser on turn	12	Condenser on turn	13
Grid on turn	13	Neutrodyne on turn	14

Range 3 (red)

Master-Oscillator		Amplifier	
Anode on turn	1	Anode on turn	1
Condenser on turn	3	Condenser on turn	3
H.T. on turn	9	H.T. on turn	8
Condenser on turn	13	Condenser on turn	13
Grid on turn	13	Neutrodyne on turn	14



Amplifier Coil
(Set up for Range 1)

FIG. 12 SETTING OF MASTER-OSCILLATOR AND AMPLIFIER INDUCTANCES

·cing paras 74 82

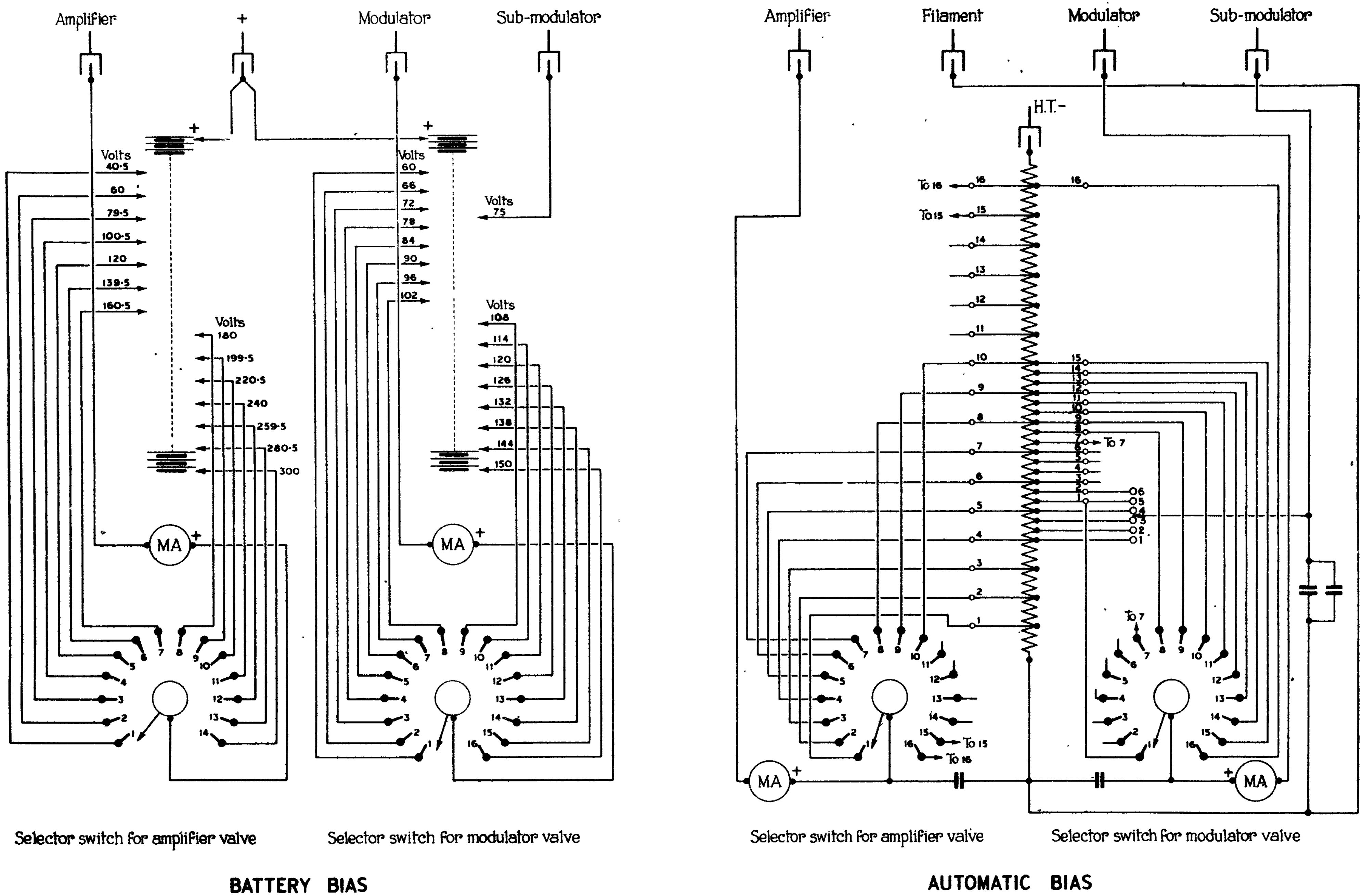


FIG. 11. GRID BIAS SWITCH CONNECTIONS.

74. When rapid changes of frequency are required between 4,300 and 6,000 kc/s. the operation is facilitated by the existence of a table which shows sets of adjustments for the frequencies to be used. Table 4 shows typical sets of adjustments for four frequencies between 4,300 and 6,000 kc/s. A similar table is to be prepared for each transmitter for the particular frequency on which it will be worked and is to be prominently displayed near the transmitter.

75. With practice it is possible to change to any frequency for which the adjustments are known in about 60 seconds. Whilst changing the frequency, the modulator grid-bias control should be set to a maximum. The aerial current, *i.e.*, the unmodulated carrier should not be less than 2 amps. for each frequency adjustment.

With remote control

76. When it is desired to operate the transmitter from some remote position, remote controls, type 5, (Stores Ref. 10A/9523) may be used. Both W/T and R/T remote control are possible with this unit, which is usually mounted on top of the rectifier, type B, near the transmitter.

77. Remote controls, type 5, consist of a board on which are mounted three relays, a repeating coil, a metal rectifier, a transformer, a key, two single tumbler switches and two coupled tumbler switches. The apparatus at the operating end is the same as is usually used for remote control operation and the whole system is described elsewhere in this publication.

78. Two terminal strips are provided on the remote control unit. The terminals on the right-hand strip are connected to the transmitter while the terminals on the left-hand strip are connected to the incoming A and B lines from the operating end and also to the rectifier. The simplified diagram, fig. 14, shows the manner in which the various units are connected up. When it is desired to operate the transmitter remotely, all that is necessary is to ensure that the switch (12, fig. 5) is in the " line " position and that the switch (8, fig. 5) is in the position which gives the type of radiation required, *e.g.*, R/T, C.W. or I.C.W. When R/T is being radiated, the coupled tumbler switches on the remote control unit should be in the R/T position. When C.W. or I.C.W. is being radiated, the coupled tumbler switches should be in the W/T position. The H.T. and L.T. to the transmitter are switched on and off by means of the two relays on the remote control unit, which are in turn controlled from the operating end.

PRECAUTIONS AND MAINTENANCE

79. While carrying out any adjustments to components inside the transmitter, every precaution must be taken to avoid contact with live parts. In no circumstances must a door or panel be opened unless the H.T. switch has first been placed in the off position. Labels bearing the words SWITCH OFF H.T. are hung at various places in the transmitter and these must never be removed.

80. When the transmitter is used for R/T, an anode resistance of 30,000 ohms is included in the H.T. feed to the master-oscillator valve. It has been found that, except when maximum efficiency is required, this value of resistance also suffices for C.W. and I.C.W. transmissions.

81. When the transmitter is in use for R/T, C.W. and I.C.W., this resistance is not to be changed with a change in the type of radiation unless maximum efficiency is required in the transmission of C.W. and I.C.W. Where the transmitter is never used for R/T, the alternative 10,000 ohm anode resistance (Stores Ref. 10A/7770) is to be used permanently for both C.W. and I.C.W.

82. Since the rectifier, type B, is used with this transmitter, the usual precautions peculiar to this unit should be observed. For example, the valves used are of the mercury vapour type and, should any mercury have come in contact with the filaments, the valves will be seriously damaged if the H.T. is switched on before this mercury is removed. To avoid this damage therefore the filaments should be switched on for not less than ten minutes before the H.T.

83. Care should be exercised that the correct fuses are fitted in the rectifier, and also that the relay type K is corectly adjusted. Details of the various precautions necessary for the rectifier unit will be found in the appropriate chapter which appears elsewhere in this publication.

84. If the grid-bias for the transmitter, as explained in para. 30 is obtained from dry batteries housed in a drawer, then in the event of irregularity of behaviour which cannot otherwise be traced, do not omit to check that the batteries are correctly connected and that the connections at the back of the drawer are making good contact.

85. If when adjusting the filament rheostats the correct current cannot be obtained, there is probably a high resistance connection somewhere in the filament circuit. This should be located and cleaned up.

86. It should be borne in mind that it is quite impossible, no matter what depth of modulation is used, to obtain good speech *if the aerial current is too large.* When making the grid coupling adjustments to reduce the maximum aerial current to half value as described in para. 68, it is preferable to *err on the side of small aerial current* rather than large.

87. Even on full power there should be little or no sparking at the key contacts. Excessive grid current will cause sparking and if the required power cannot be obtained without sparking at the key, a 1 μF. condenser in series with a resistance of about 40 ohms should be connected across the key contacts.

88. It is desirable whenever possible to switch on the master-oscillator and to allow the apparatus to attain a steady temperature before commencing to transmit. Generally 10 to 15 minutes will be sufficient and if this procedure is carried out variation of frequency during operation will be almost entirely prevented.

TABLE 1

Range 1. R/T. 6000–4286 kc/s.

Frequency kc/s.	Master-Oscillator. Tuning condenser.	Master-Oscillator. Grid coupling. Tap.	Master-Oscillator. Grid coupling. Degree	Modulator Bias stud.	Modulator Anode current mA.	Amplifier. Tuning condenser.	Amplifier. Bias stud.	Amplifier. Anode current mA.	Neutralizing condenser degrees.	Aerial. Coil setting (half-coil disconnected).	Aerial. Series No. 7 condenser. Jars.	Aerial. Series No. 7 condenser. Deg.	Aerial. Coupling degrees.	Aerial. Current amps.	Volts.
6,100	0	2	40	8	77	23	2	160	57	4·37	0·1	10	90	3·0	2,600
5,970	20	2	13	8	77	39	2	135	61	5·53	0·1	10	90	2·6	2,600
5,572	40	2	0	7	95	62·5	5	135	56	3·98	0·15	20	90	3·0	2,600
5,228	60	3	28	8	75	74·5	1	125	52	3·85	0·2	30	56	2·5	2,600
4,955	80	3	9	7	90	96·5	1	150	52	3·95	0·3	50	40	2·6	2,600
4,700	100	3	10	7	87	121·5	1	150	52	5·36	0·3	50	59	2·5	2,600
4,458	120	3	15	7	87	135	1	155	52	4·27	0·4	70	90	3·0	2,600
4,270	140	3	17	7	90	158	1	145	52	3·92	0·95	180	90	3·0	2,600
4,140	160	4	5	7	95	178	7	150	56	5·0	0·95	180	90	3·0	2,600
4,020	180	5	42	7	95	195	1	155	60	5·52	0·95	180	90	3·2	2,600

The links connecting the fixed " packing " condensers should be disconnected. The plugs on the master-oscillator and amplifier tuning coils should be in the sockets coloured blue. The anode feed resistance of the master-oscillator should be 30,000 ohms

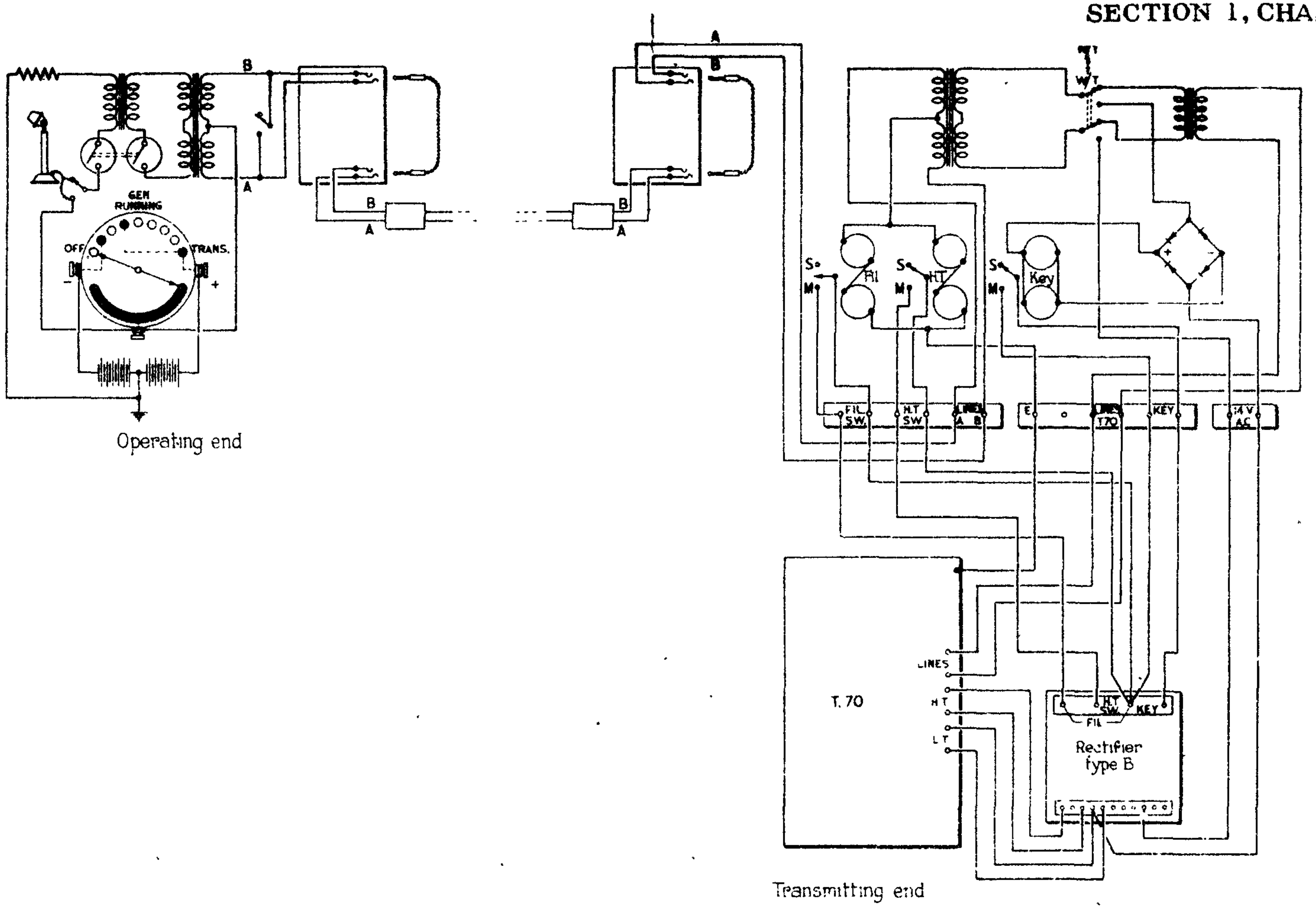


FIG. 13. T 70 AS OPERATED BY REMOTE CONTROLS, TYPE 5

TABLE 2

Range 2. C.W. only. 4286–3000 kc/s.

Frequency kc/s.	Master-Oscillator. Tuning condenser.	Master-Oscillator. Grid coupling. Tap.	Master-Oscillator. Grid coupling. Degrees.	Amplifier. Tuning condenser.	Amplifier. Bias stud.	Amplifier. Anode current mA.	Aerial. Coupling degrees.	Aerial. Tuning coil setting.	Aerial. Current amps.
4,705	20	4	12	9·4	1	230	25	1·66*	5·0
4,355	40	3	15	27·7	1	250	29	3·24*	5·7
4,070	60	3	31	45	1	260	31	5·0*	5·9
3,840	80	4	3	67	1	260	33	6·93*	5·8
3,630	100	4	13	81	1	256	33	7·76*	5·7
3,440	120	4	17	99·6	1	235	33	2·29	5·3
3,300	140	4	26	117	1	240	33	3·62	5·3
3,170	160	5	5	135	1	280	33	4·82	6·0
3,040	180	5	13	152	1	33	33	6·0	6·2
2,940	200	5	18	168	1	300	33	6·97	6·0

Note :—
(1) Use separate H.T. supply to master-oscillator if possible.
(2) Use the least coupling both from master-oscillator to amplifier and amplifier to aerial that will transfer the necessary power to the aerial. For ranges up to 250 miles, 3 amps. in the above aerial system should be ample to work with appropriate service receiver. * Half coil disconnected.

The links connecting the fixed " packing " condensers should be disconnected. The plus on the master-oscillator and amplifier tuning coils should be in the uncoloured sockets. The anode feed resistance to the master-oscillator valve should be 10,000 ohms.

TABLE 3

Range 3. R/T. I.C.W. C.W. 3000–2500 kc/s.

Frequency kc/s.	Master-Oscillator. Tuning condenser	Master-Oscillator. Grid coupling. Tap.	Master-Oscillator. Grid coupling. Degrees.	Modulator. Bias stud.	Modulator. Anode current mA.	Amplifier. Tuning condenser.	Amplifier. Bias stud.	Amplifier. Anode current mA.	Neutralizing condenser degrees.	Aerial. Coupling. degrees.	Aerial. Tuning coil setting (full coil).	Aerial. Current amps.	Volts.
3,000	26	5	15	8	86	35	1	210	66	50	1·98	2·4	2,600
2,851	60	5	47	8	82	67	1	205	66	50	3·28	2·5	2,600
2,725	92	5	90	8	90	95	1	175	66	90	4·0	2·2	2,600
2,604	130	6	4	8	75	140	1	250	66	50	6·38	2·5	2,600
2,500	164	6	12	8	80	167	1	220	66	90	7·31	2·4	2,600

The links connecting the fixed " packing " condensers should be connected to the appropriate terminals. The plugs on the master-oscillator and amplifier tuning coils should be in the sockets coloured red. For R/T the master-oscillator anode feed resistance should be 30,000 ; for C.W. and I.C.W. it should be 10,000 ohms.

For C.W., use separate H.T. supply to the master-oscillator if possible.

TABLE 4

Settings of transmitter T.70 for rapid frequency change between 4,300 and 5,750 kc/s.

Frequency kc/s.	M/O Condenser degrees.	Grid coupling coil		AMP. tuning condenser degrees.	Aerial coupling condenser degrees.	Neutralizing condenser degrees.	Aerial tuning coil		Series aerial condenser degrees.
		Tap.	Degrees.				Turns.	Degrees.	
4,300	180	3	27	163	90	47	8	0	250
5,000	107	3	25	92	90	40	5	0	150
5,550	69	3	37	60	90	44	3	50	150
5,750	53	3	17	46	90	44	1	86	150

APPENDIX

NOMENCLATURE OF PARTS

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

Ref. No.	Nomenclature.	Quantity.	Remarks.
10A/7755	Transmitter T.70 :—		Without valves, neon lamp and batteries.
	Principal components :—		
	Ammeter,		
10A/7782	Moving-iron, 0–10	3	
10A/7783	Thermo, 0–8	1	
10A/3178	Thermo, 0–12	2	
	Choke,		
10A/7786	H/F, type 9	2	
10A/7512	L/F, type C	1	
10A/7756	Clip, tuning coil	10	
	Condenser,		
10A/7759	Type 104	2	110–360$\mu\mu$F (variable).
10A/7760	Type 105	2	·00025μF bank of 8 units.
10A/7761	Type 106	1	40$\mu\mu$F neutralizer.
10A/7762	Type 107	1	·0001μF
10A/7763	Type 108	3	·001μF.
10A/7764	Type 109	2	·002μF.
10A/7765	Type 110	7	·01μF.
10A/7895	Type 118	1	0·5μF.
10A/8098	Type 146	4	1·0μF meter shunts.
10A/10920	Type 428	4	
10A/1871	Insulator, type 5	1	Aerial.
	Milliammeter,		
10A/7177	0–5	1	
10A/7123	0–30, type A	1	
10A/1504	0–100, type A	1	
10A/3190	0–250	2	
10A/3092	0–500, type A	1	
10A/7757	Motor, interrupter, 20-volt	1	
	Resistance,		
10A/2312	Type 26	1	2 MΩ.
10A/7295	Type 40	1	500,000 ohms, variable.
10A/7766	Type 82	8	40 ohms, wire-wound.
10A/7767	Type 83	3	4 ohms, variable.
10A/7768	Type 84	1	60,000 ohms.
10A/7769	Type 95	2	5 MΩ.
10A/7770	Type 86	1	10,000 ohms for C.W. and I.C.W.
10A/7771	Type 87	1	50,000 ohms.
10A/7772	Type 88	1	50,000 ohms.
10A/7773	Type 89	1	7 ohms.
10A/8141	Type 125	1	30,000 ohms for R/T alternative to 10A/7770.
	Switch,		
10A/7774	Type 56	1	14-contact, grid.bias.
10A/7775	Type 57	1	16-contact, grid-bias.
10A/7776	Type 58	1	2-position, line switch.
10A/7777	Type 59	1	R/T., C.W., I.C.W. switch.
10A/7778	Type 60	1	2-position, H.T. switch.
10A/7779	Type 61	1	2-position, L.T. switch.
10A/7780	Type 62	1	H.T. change-over switch.
10A/7781	Type 63	1	Neutralizer.

Ref. No.	Nomenclature.	Quantity.	Remarks.
	Transmitter, T.70—*continued*		
	Principal components—*continued*		
	Transformer, microphone,		
10A/7785	Type E	1	
10A/7322	Terminal	1	Counterpoise.
10A/7784	Voltmeter, moving coil .. .	1	0–3500.
	Accessories,		
5A/1338	Battery, dry, 15-volt	30	For battery grid-bias.
10A/7474	Lamp, indicating, neon, No. 1	1	
	Valves,		
10A/5203	Type V.T.4B.	1	Amplifier.
10A/1651	Type V.T.5B	1	Master-oscillator.
10A/7787	Type D.E.T.3	1	Modulator.
10A/1651	Type V.T.25	1	Sub-modulator.
10A/7104	Interrupter motor, brushes	2	
10A/7758	Interrupter disc, 10-segment	1	
10A/2951	Condenser, type 7 (1 jar)	1	Aerial, series, if required.
10A/9812	Panel contact, grid-bias unit	1	Alternative to battery grid-bias.
10A/9804	Unit, grid-bias	1	Alternative to battery grid-bias.

FOR OFFICIAL USE ONLY

December, 1938

AIR PUBLICATION 1186
Volume I

SECTION 1, CHAPTER 2

TRANSMITTER T.77

Contents

List of Illustrations

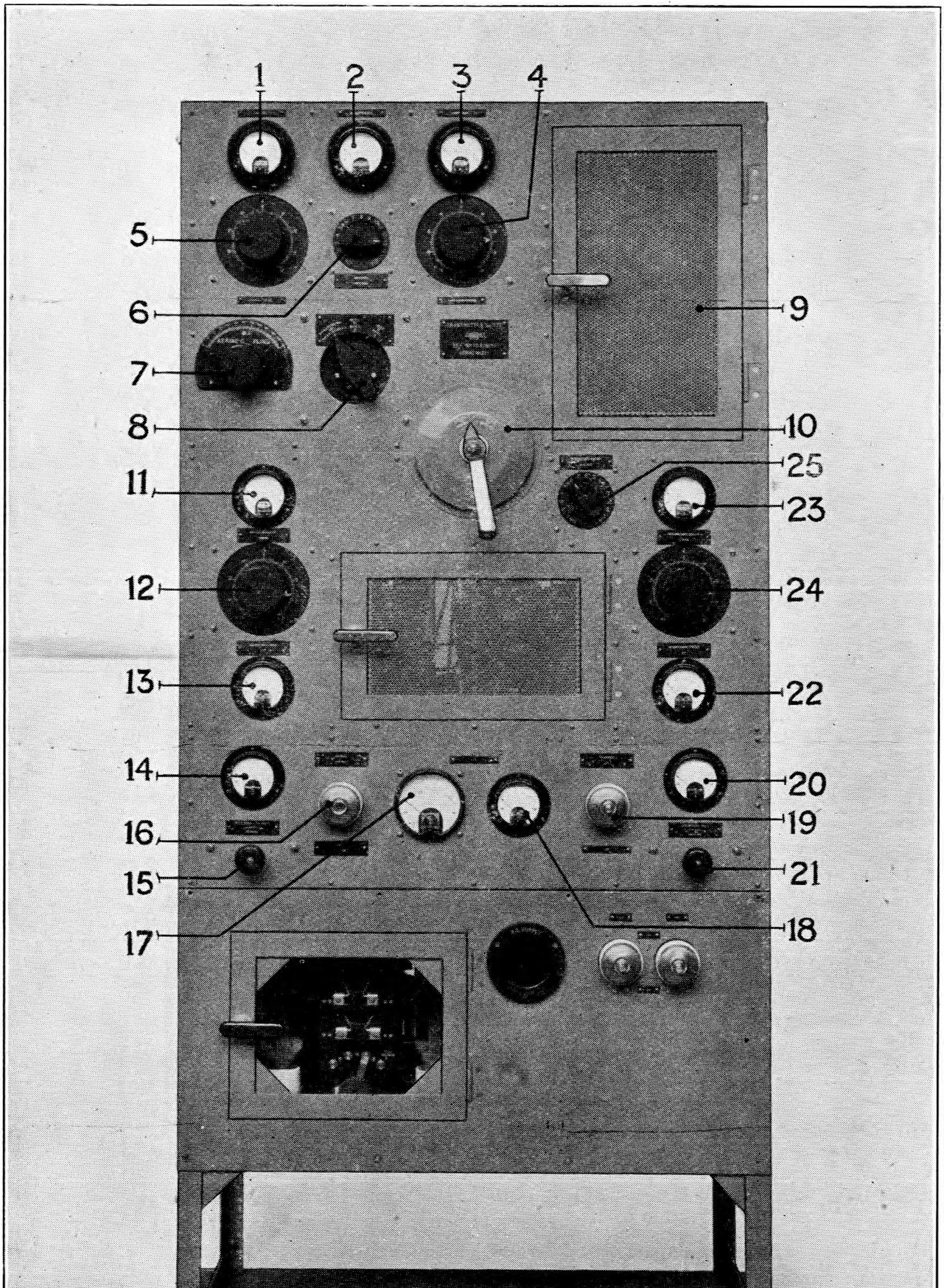


FIG. 1. Transmitter T.77 front view

TRANSMITTER T.77

(Stores Ref. 10A/8151)

INTRODUCTION

1. The transmitter T.77 is a master-oscillator controlled ground station transmitter designed for continuous wave transmission on the frequency bands 143 to 400 kc/s. and 1,500 to 2,256 kc/s. A socket is provided on the transmitter which enables a modulating amplifier to be used when R/T or M.C.W. is required.

2. The transmitter is so designed that it may be conveniently adapted for A.C. or D.C. supply. When used for D.C. the rectifier portion (panel, rectifying, type A, Stores Ref. 10A/8068) is removed and a dummy panel fitted in its place. The smoothing unit which is incorporated in the transmitter is not removed with the rectifier but remains in circuit for D.C. operation. The transmitter is adapted to be operated either directly or by remote control.

3. The transmitter comprises a master-oscillator circuit which controls, through an intermediate amplifier or buffer circuit, a power amplifier or output circuit. The aerial circuit is capacitance-coupled to the amplifier. The buffer circuit serves not only as an amplifying circuit but also as an isolating stage which, by preventing " feedback " between the output circuit and the M/O, serves to stabilize the frequency. This buffer circuit renders neutralization in the output circuit unnecessary.

4. In order to cover the two frequency bands without change of coils, etc., variometer tuning is employed, the windings of the variometers being connected in series for the lower frequencies and in parallel for the higher frequencies. The M/O and intermediate stage variometers are, on the lower frequencies shunted by variable condensers which are mechanically coupled to and simultaneously operated by the variometer spindles. Fixed capacitance coupling is employed between the M/O and the intermediate amplifier stage and between the latter and the output stage. The aerial coupling is effected by a variable condenser. Automatic grid-bias is provided for the valves in the intermediate and power amplifier circuits. Keying is effected by means of an electro-magnetically operated switch which makes and breaks the H.T. negative and grid-filament circuits of all three stages. A combined electro-magnetically operated " Send–Receive " and " H.T. on and off " switch is incorporated in the transmitter. By means of this switch the aerial is disconnected from the transmitter and connected to a receiver, the transmitter H.T. circuit being opened simultaneously.

5. The rectifying portion comprises two gas-filled rectifying valves and the necessary transformers and electro-magnetic switches. The rectifying panel is fully described in another chapter of this publication.

GENERAL DESCRIPTION

Transmitter

6. A theoretical circuit diagram of the transmitter is given in fig. 4. V is the master-oscillator valve, V_1 the intermediate amplifier valve (actually two valves in parallel) and V_2 is the power amplifier or output valve. The oscillatory circuit of the master-oscillator valve V, is of the Hartley type and consists of a variable inductance L across which is connected a variable condenser C. The variable inductance L is a variometer and the two windings are connected in series for the lower frequency band and in parallel for the higher frequency band. A filament centre-connection unit consisting of two condensers C_1 and C_2 and two resistances

R and R_1 is connected across the filament leads of V. The centre-point of the unit is connected to earth *via* the keying relay RL. Two further resistances R_2 and R_3 are included as filament resistances in the M/O filament circuit. R_4 is the grid-leak resistance and C_4 the grid coupling condenser. C_4 is the mains condenser.

7. The H.T. feed to the M/O oscillatory circuit is taken *via* the anode resistance R_5 and R/F choke L_1 through the range change switch to the centre-point of L. A milliammeter M, shunted by the condenser C_5, is in series with the anode resistance and choke. When working on the higher frequency band, instead of the variable condenser C, the inductance L_2 and fixed condenser C_9 are connected in parallel with the inductance L. The H.T. feed is then made to the tapping point of L_2, instead of the centre-point of the variometer. C_6 and C_7 are the coupling condensers between the M/O and the intermediate stage for the lower and higher frequencies respectively.

8. The filaments of the two intermediate amplifier valves V_1 have four resistances R_6, R_7, R_8 and R_9 included in the filament circuits, while the variable resistance R_{10} provides a means of controlling the filament voltage of both the M/O and intermediate stage valves. The variometer L_3, in conjunction with the variable condenser C_{10}, forms the tuned oscillatory circuit for V_1 The windings of L_3 can be connected in series for the lower frequency band and in parallel for the higher frequency band. The H.T. is fed through an anode resistance R_{11} and an R/F choke L_4. A milliammeter M_1 shunted by the condenser C_{11} is also included in the H.T. circuit. Coupling between the intermediate stage and the power output stage is effected by the condenser C_{12} for the higher frequencies, and C_{13} for the lower frequencies. When working on the higher frequency band the inductance L_5 and fixed condenser C_{12} are connected in parallel across the variometer in place of the variable condenser C_{10}.

9. Grid-bias for the valves V_1 is obtained from the resistances R_{12} which are connected between the grid of the valve and H.T.—. A movable arm selects a suitable tapping on the resistance. The R/F choke L_6 is connected in the grid circuit of the valves V_1. For R/T and M.C.W. a modulating amplifier is introduced into the grid circuit by means of the combined socket and switch S.

10. The power amplifying valve V_2 is provided with a filament centre-connection unit consisting of the resistances R_{13} and R_{14} and the condensers C_{15} and C_{16}. The centre-point of this unit is connected to earth *via* the keying relay RL. The filament voltage is controlled by means of the variable resistance R_{15}. Grid bias for the valve V_2 is obtained from the tapped resistance R_{19}, while the choke L_7 is included in the grid circuit of the valve. The R/F choke L_8 and milliammeter M_2, the latter shunted by the condenser C_{18}, are included in the H.T. circuit of V_2.

11. The windings of the variometer L_9 are connected in series for the lower frequencies and in parallel for the higher frequencies. The condenser C_{19} is connected across the variometer for lower frequencies, and the condenser C_{20} and inductance L_{10} in parallel, are connected across the variometer windings for the higher frequencies.

12. The pulse coil L_{11} is provided with several tapping points brought out to a terminal board. A flexible lead from the anode of V_2 terminates in a socket which can be engaged with one of the plugs on the pulse coil. Similarly the two ends of the oscillatory circuit of V_2 can be connected to any tapping point on L_{11}. In the lower frequency position the lower portion of L_{11} is used and in the higher frequency position, the upper portion of L_{11} is brought into circuit.

13. Variable capacitance coupling is employed between the output amplifier and the aerial circuit, C_{21} being used for this purpose. The aerial tuning inductance L_{12} is a variometer, the windings of which are connected in series for the low frequency band and in parallel for the high frequency band. In addition the aerial inductance L_{13} is connected across the variometer windings for the higher frequencies. C_{22} is the mains condenser. The aerial loading coil L_{14} is constructed in two portions and a three position switch S_1, connects the aerial directly to L_{12} in position 1,

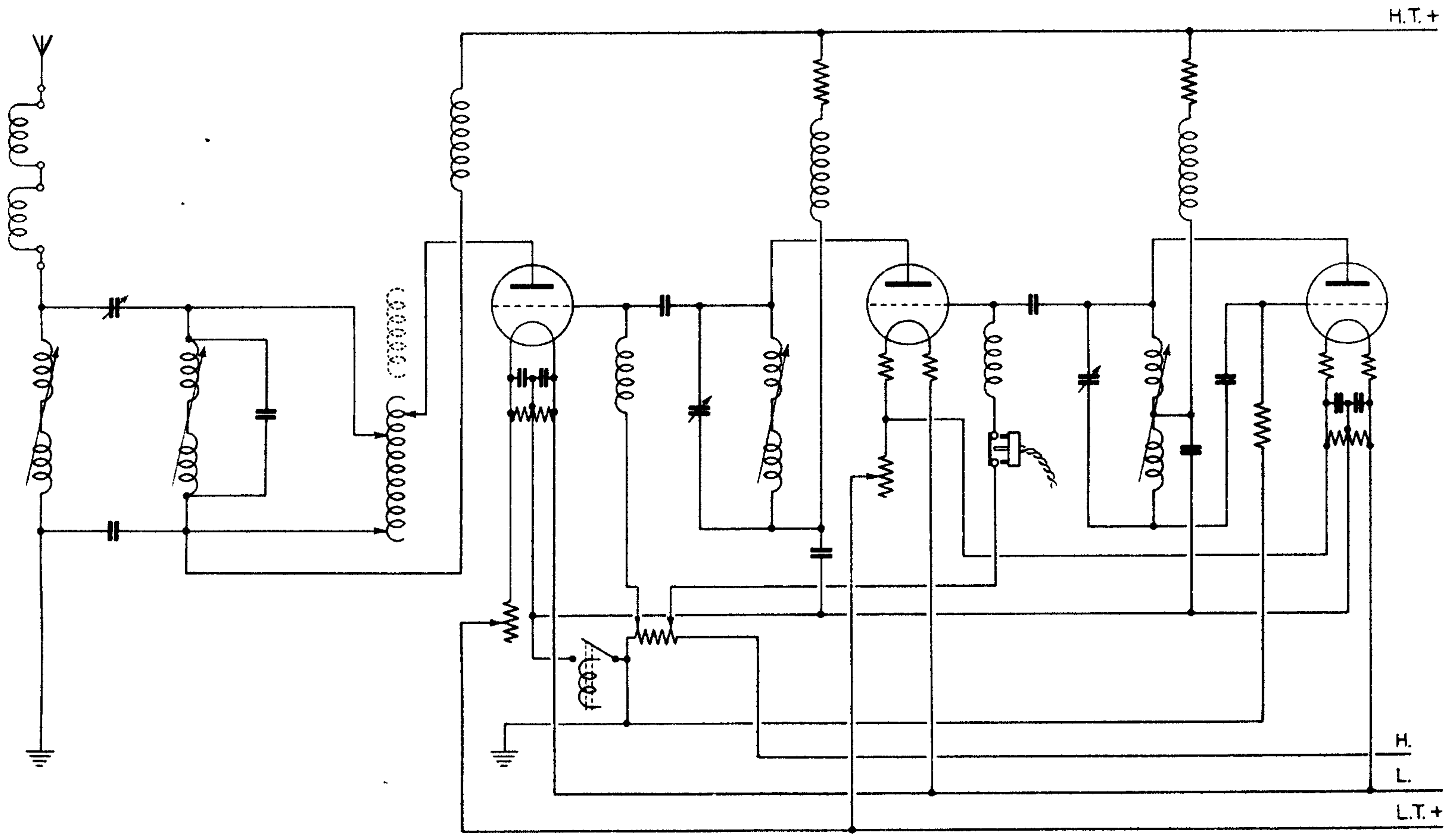


FIG. 2. SIMPLIFIED DIAGRAM (LOWER FREQUENCIES)

(F.1799). F. & C. LTD.

Facing paras. 7-13

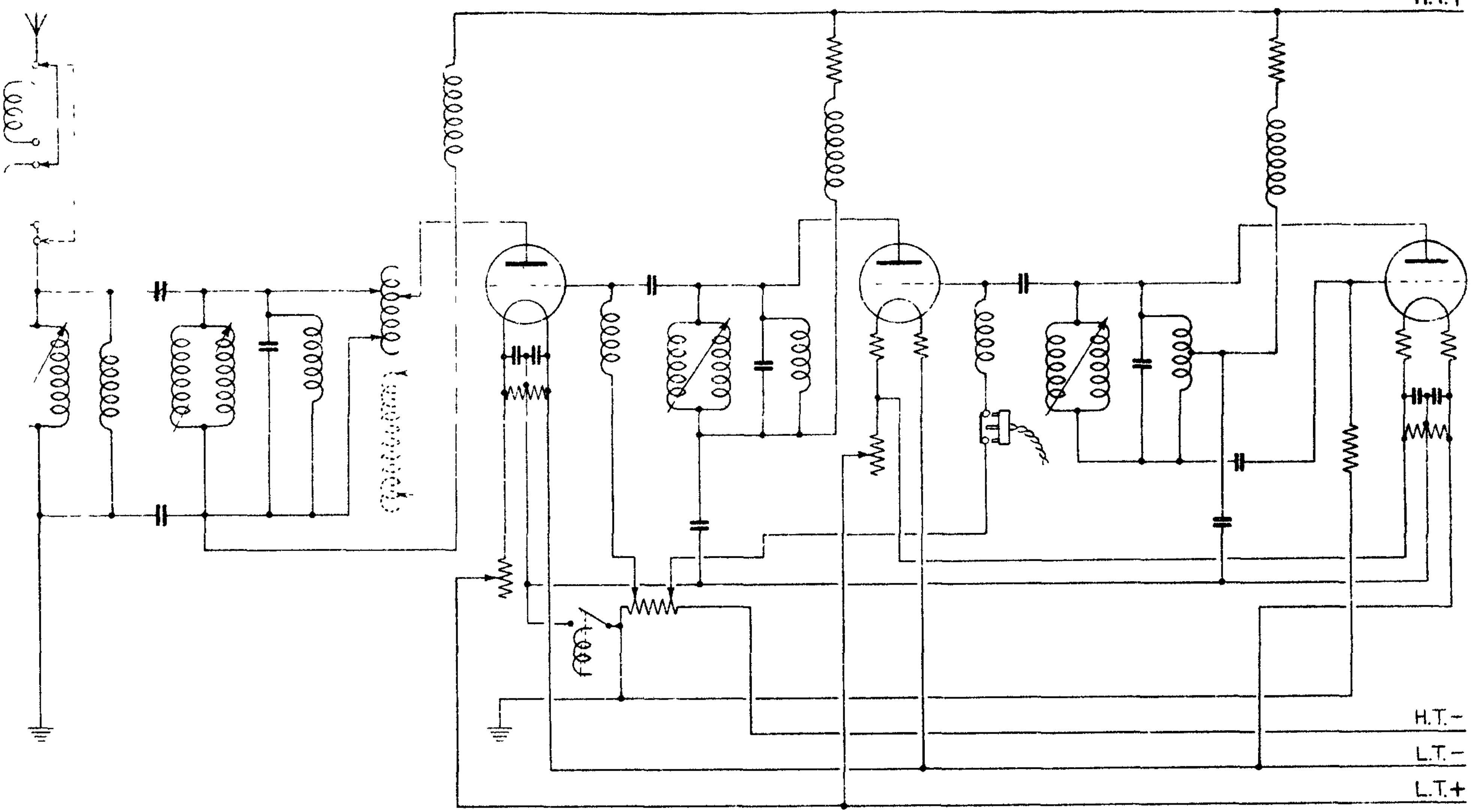
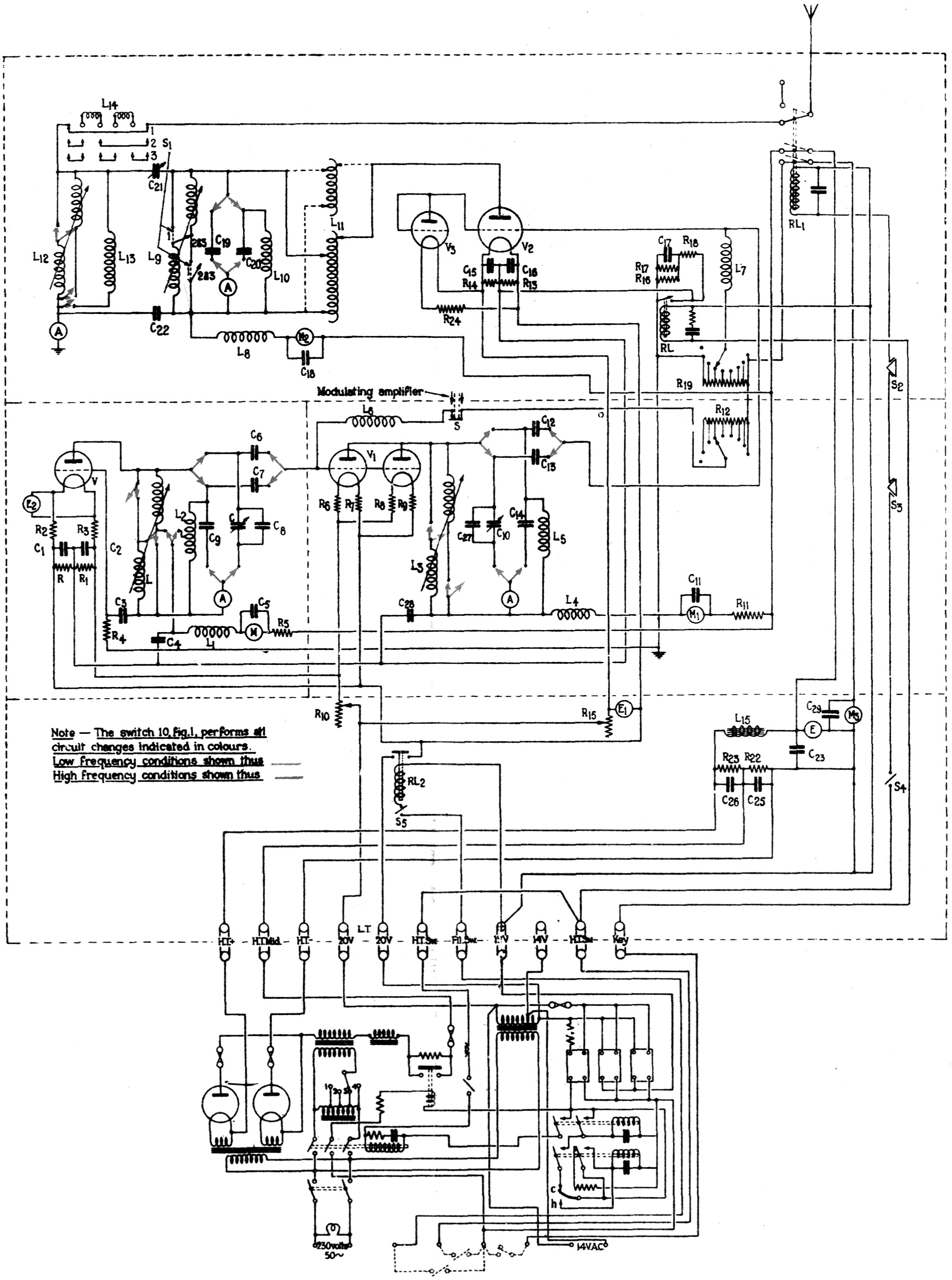


FIG. 3. SIMPLIFIED DIAGRAM (HIGHER FREQUENCIES)



CONDENSERS - µF	
C	·00098 (variable)
C_1	1·0
C_2	1·0
C_3	·01
C_4	·01
C_5	1·0
C_6	·00005
C_7	·00005
C_8	·00103
C_9	·000212
C_{10}	·00098 (variable)
C_{11}	1·0
C_{12}	·00005
C_{13}	·000106
C_{14}	·0002
C_{15}	1·0
C_{16}	1·0
C_{17}	·0003
C_{18}	1·0
C_{19}	·0026
C_{20}	·000192
C_{21}	·00008 (variable)
C_{22}	1·5
C_{23}	1·5 (2 off)
C_{24}	Deleted
C_{25}	1·5 (5 off)
C_{26}	1·5 (5 off)
C_{27}	·00103
C_{28}	·01
C_{29}	1·0
RESISTANCES - (ohms)	
R	40
R_1	40
R_2	1·5
R_3	1·5
R_4	20,000
R_5	15,000
R_6	1·5
R_7	1·5
R_8	1·5
R_9	1·5
R_{10}	0·85 (variable)
R_{11}	10,000
R_{12}	356 (5 off)
R_{13}	40
R_{14}	40
R_{15}	0·85 (variable)
R_{16}	100,000
R_{17}	100,000
R_{18}	500
R_{19}	356 (5 off)
R_{20}	Deleted
R_{21}	Deleted
R_{22}	50,000
R_{23}	50,000
R_{24}	1C

FIG. 4. THEORETICAL CIRCUIT DIAGRAM

connects a portion of the coil in the aerial circuit in position 2, and connects the whole coil in circuit in position 3. The switch S_1 also performs the connections (series and parallel) on the power amplifier variometer L_9. In position 1, the windings are connected in parallel, and in positions 2 and 3 the two windings are connected in series. The relay RL_1 makes and breaks the transmitter H.T. circuit, and also transfers the aerial from the transmit to the receive position.

14. The solenoid for the relay RL_1 and the solenoid for the keying relay RL are both operated from the same source. If A.C. is being used, the solenoids are energized from the rectifiers. If D.C. is used, then a 12-volt battery supplies the power for the solenoids. In circuit with the solenoid for RL_1 are the gate switches S_2 and S_3 and the tumbler switch S_4. This latter switch is represented by (16, fig. 1). The keying relay solenoid is operated by the key. Hence it will be seen that once the switch S_4 is closed, the H.T. is switched on and the aerial is connected in the transmit position. Operation of the key now results in the H.T. negative and filament circuits of the valves in all three stages being interrupted.

15. On closing the tumbler switch S_5, the relay RL_2 is energized and the filament circuits of all three stages are made. The switch (10, fig. 1), which changes the connections of the variometer coils L, L_3, and L_{12}, is represented diagrammatically in this figure by red lines and is shown in the lower frequency position. Movement of the switch handle effects all the changes from red lines to green lines establishing the higher frequency circuits.

16. The input milliammeter M_3 is shunted by the condenser C_{29} and is in the H.T.+ feed. The voltmeter E is across the H.T.+ and H.T.— lines, while the iron-cored choke L_{15} is in the H.T.+ line. The condensers C_{23}, C_{24}, C_{25} and C_{26}, together with the resistances R_{20}, R_{21}, R_{22} and R_{23} form the smoothing unit which is used on either A.C. or D.C. The voltmeter E_1 indicates the filament volts on the power amplifier valve, and E_2 indicates the filament volts for the M/O, and intermediate circuits.

17. Owing to the possibility of secondary grid emission with certain valves used in the power amplifying stage, a three-electrode valve V_3 connected as a diode has been introduced into the grid-filament circuit of the power amplifier to provide a permanent bias on the grid of the valve. To enable this to be fitted, a grid adaptor (Stores Ref. 10A/8297) consisting of a valve-holder and filament resistance is supplied. The adaptor is fitted behind the detachable panel which carries the power amplifying valve V.T.4B. Of the three lugs on the adaptor, the two filament lugs are connected to the filament terminals, and the remaining lug is connected to the grid terminal of the V.T. 4B. valve. The valve used in the adaptor is a V.T. 13C.

Remote controls

18. The transmitter may be used in conjunction with Ground Station Remote Controls type 2 or 4 (for C.W.) or Ground Station Remote Controls, type 3 (for C.W., M.C.W., and R/T). The manner in which the remote controls, type 2, are connected up to the transmitter is illustrated in fig. 5. The apparatus at the operating end comprises a microphone, microphone transformer, switch type 44, repeating coil, key and a 24-volt battery. The apparatus is grouped on a table and wired up as shown on the left of the figure. The ends of the secondary winding of the repeating coil at the operating end are connected through a distribution box, a junction box and through a pair of land lines to similar apparatus at the transmitting end. The pair of land lines carries the operating current for the FIL. and H.T. relays incorporated on the remote controls, type 2, at the transmitting end.

19. The terminal strip on the remote control unit is connected to the terminal strip at the bottom of the transmitter by short leads in the manner illustrated. The 14 volts A.C. required for operating the keying relay is obtained from the rectifier unit incorporated in the transmitter by connecting across the fourth and ninth terminals, reading from the left.

20. The transmitter is capable of being operated from either A.C. or D.C. mains and both methods are shown. The A.C. method is the normal one, but when D.C. mains are used an additional sounder relay is provided on the switch panel. The windings of this relay are connected in parallel with the windings of the filament relay on the remote control unit.

21. When the switch type 44 at the operating end is placed in the " generator running " position, the windings of the FIL. relay on the remote control unit are connected between the positive side of the battery and earth. Since these windings are connected in parallel with the windings of the relay on the switch panel, this relay also becomes energized. The tongue and mark terminals are connected to a relay which closes the D.C. mains circuit, and the motor-alternator may then be started up.

22. The schematic diagram shown in fig. 6 is very similar to fig. 5 except that remote controls, type 3, are used. The lines A and B are connected to the terminal strip at the bottom of the remote control unit. The various connections from FIL.SW., H.T., and KEY are taken to the transmitter as before. The terminals P.O. LINES are for use in connection with remote R/T modulation from a special line. The amplifier A.1104 forms part of remote controls, type 3, and provides the modulating voltage for M.C.W. and R/T transmission. A screened cable terminating at each end in a plug is used for connecting the output of the amplifier to the transmitter. Since 230 volts A.C. is required for A.1104, a pair of leads is taken from the 230 volt terminals on the T.77 to the amplifier. The 14 volts A.C. required for the rectifier in the circuit of the keying relay on remote controls, type 3, is obtained from the rectifier unit incorporated in the transmitter.

23. Provision is again made for operating the transmitter from either A.C. or D.C. mains, the system employed being the same as described previously. The transmitter may be operated or remotely controlled by type 4 remote controls, but as this type is somewhat similar to remote controls, type 2, no mention is made of it here. A full description of remote controls will be found elsewhere in this publication.

CONSTRUCTIONAL DETAILS

Transmitter

24. The transmitter T.77, a front view of which is given in fig. 1, and three bench wiring diagrams in figs. 8, 11 and 12, is built up of aluminium alloy sheets mounted on a duralumin frame work. The overall dimensions are about 5 ft. 6 in. high, by 2 ft. 6 in. wide, by 18 in. deep, and the approximate weight is $4\frac{1}{2}$ cwt. The various components are housed in four compartments or cubicles, and access is given to the various valves by means of three doors. The upper or first cubicle contains the output valve and associated equipment. The second cubicle contains the master-oscillator and the intermediate amplifier components ; the M/O is on the left and suitably screened from the amplifiers which are on the right. The third cubicle houses the smoothing units and the fourth cubicle houses the rectifier unit.

25. The three doors provided on the front of the transmitter are each equipped with a safety switch which operates an electro-magnetic switch to break the power supply circuit. The doors in the first and second cubicles which give access to the power output valve and the M/O valve respectively are provided with perforated panels to allow for ventilation, but the door in the rectifier unit is provided with a glass panel. The rear and side portions of the transmitter are built up of perforated material so that adequate ventilation is available.

26. Referring to fig. 1, it will be seen that a number of instruments and control handles are mounted on the front of the transmitter. The 0 to 6 amp. aerial ammeter (1) can be seen in the top left hand corner and next to it is the power amplifier anode circuit milliammeter (2) reading 0 to 300 mA. The 0 to 12 amp. ammeter (3) is in the closed circuit of the power amplifier,

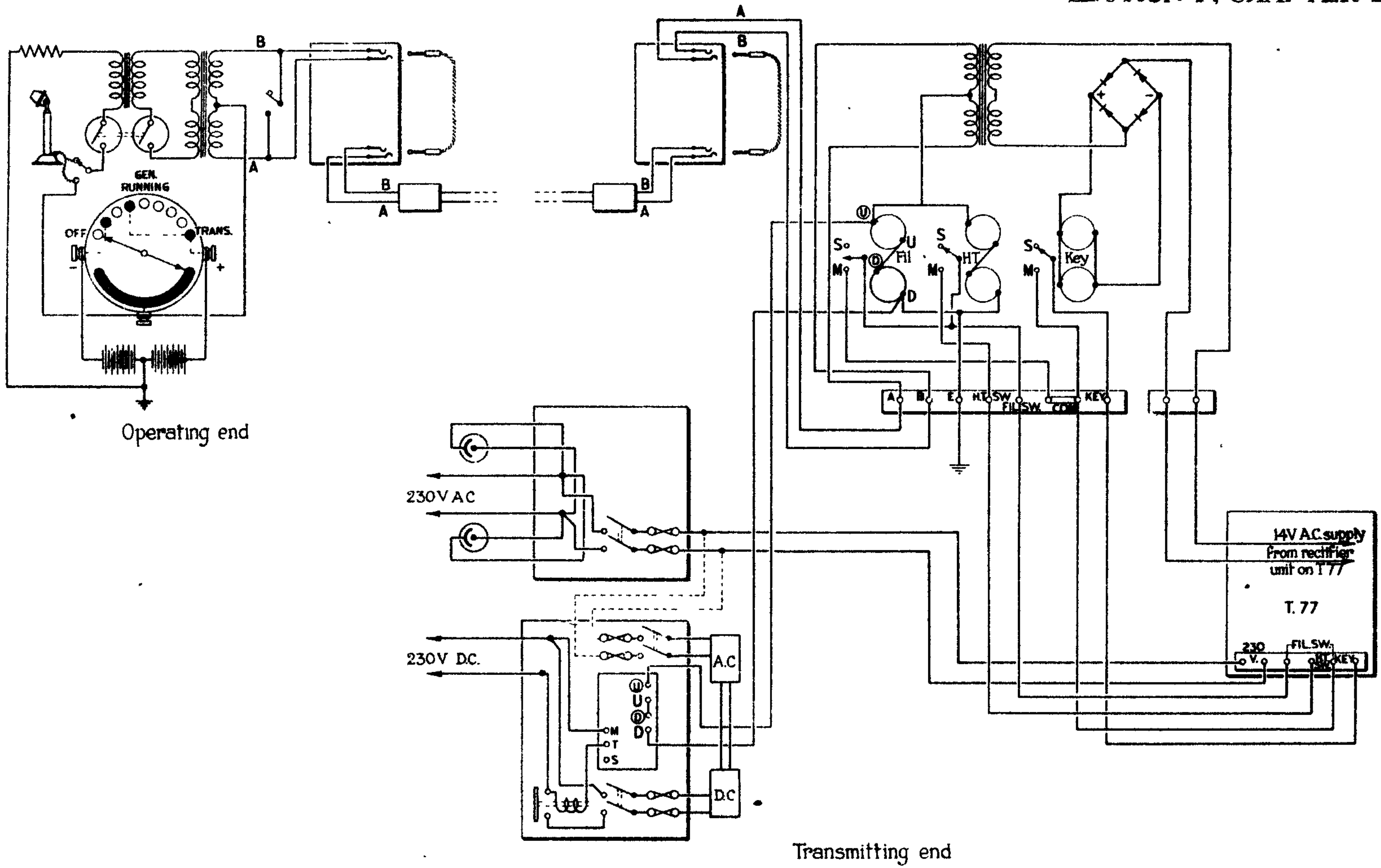


FIG. 5. T. 77 AS OPERATED BY REMOTE CONTROLS, TYPE 2

(F.1799). F. & C. LTD.

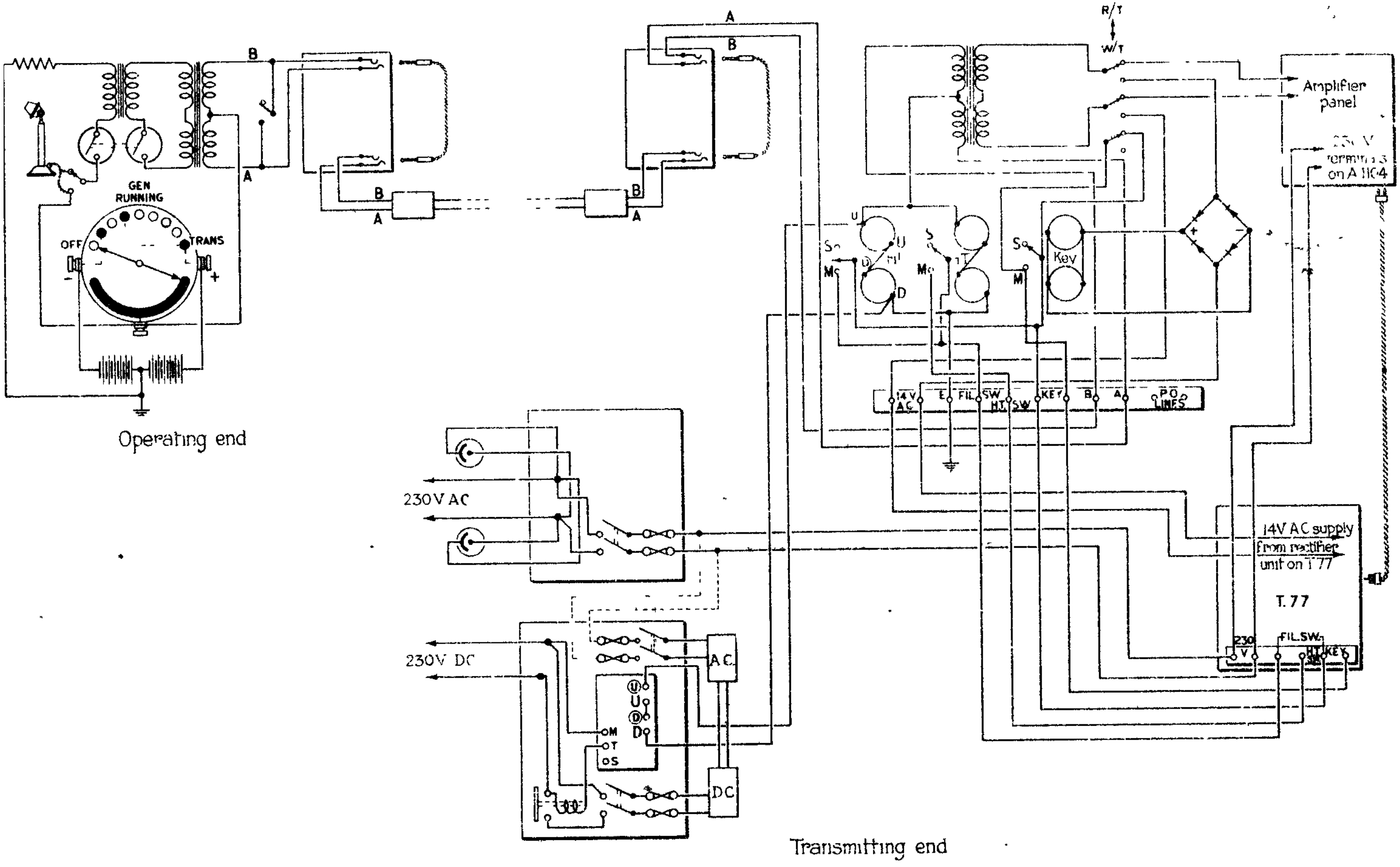


FIG. 6. T.77 AS OPERATED BY REMOTE CONTROLS, TYPE 3

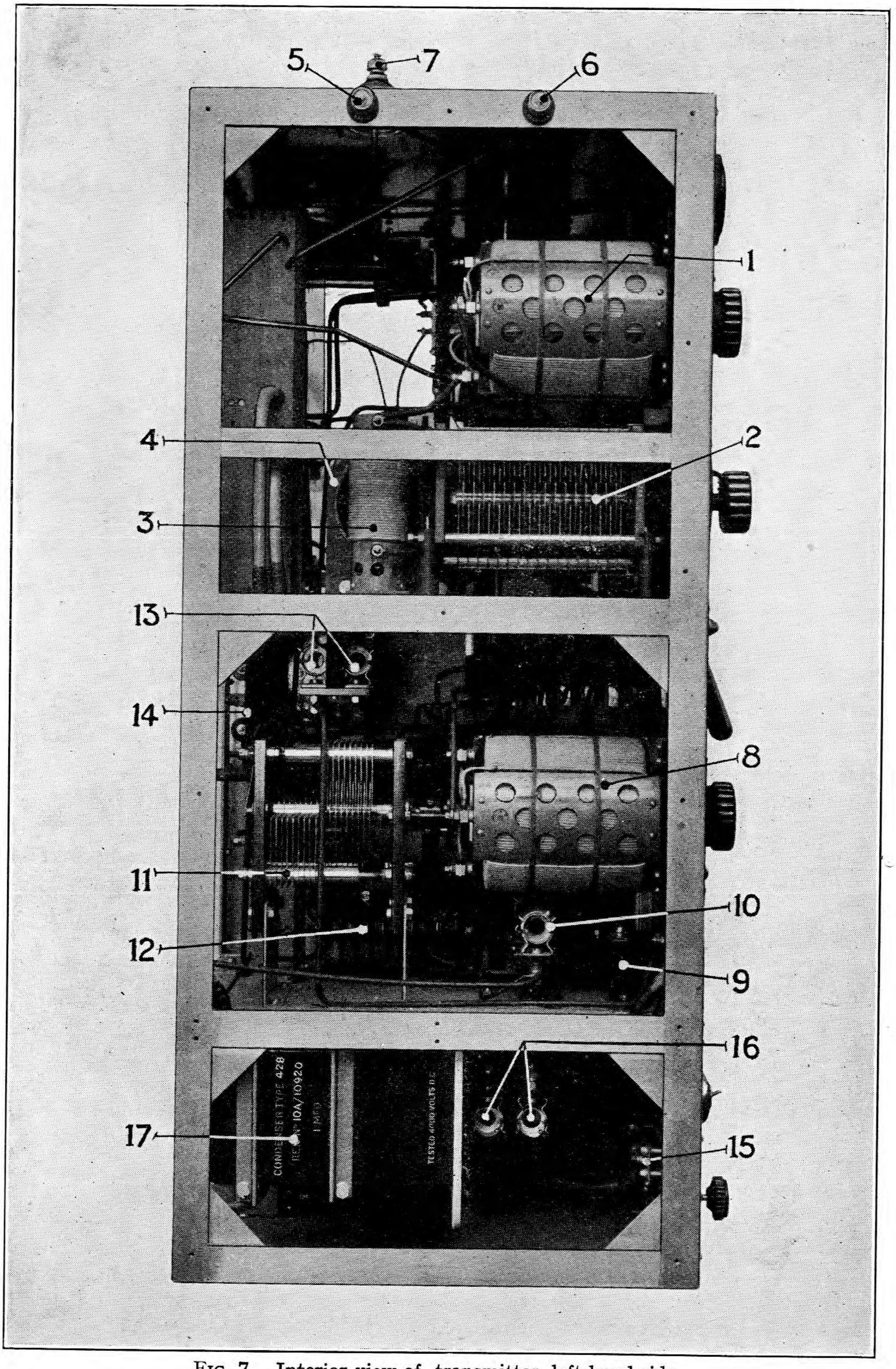


FIG. 7. Interior view of transmitter, left-hand side.

while the control knob (4) underneath it is the power amplifier tuning control. The aerial tuning control (5) is under the aerial ammeter, and to the right of it is the power amplifier grid-bias control knob (6). The aerial tuning knob and the amplifier tuning knob are each provided with an indicator and a scale engraved with one hundred divisions. The number of complete turns made by the knob can be seen through a small window directly above the knob. The amplifier grid-bias has a scale engraved from 0 to 16, and an indicating line on the knob registers with one of these figures.

27. The aerial coupling control (7) is in the bottom left-hand corner of the first cubicle. It has a scale engraved from 0 to 120°. To the right is the aerial loading switch (8). It has three positions, 1, 2 and 3. The first position is engraved 260 to 400 kc/s and 1,500 to 2,256 kc/s, the second position is engraved 160 to 260 kc/s and the third position is engraved 143 to 160 kc/s. The hinged door (9) is provided in order to give access to the amplifier valve. The range change switch (10) in the centre of the transmitter has two positions engraved 143 to 400 kc/s and 1,500 to 2,256 kc/s.

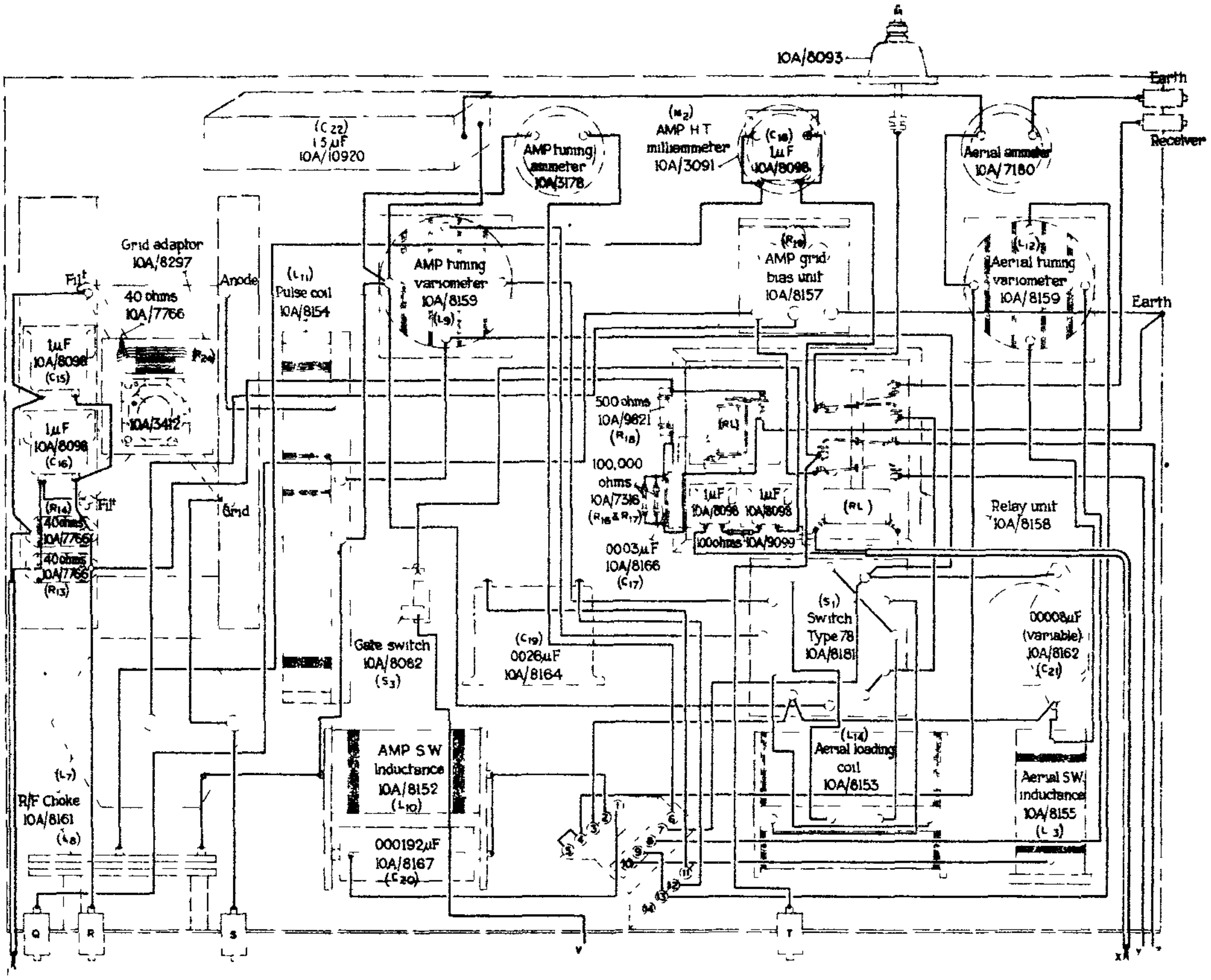
28. The 0 to 4 amps. master-oscillator oscillatory circuit ammeter (11) is in the top left-hand corner of the second cubicle, while just below it is the M/O tuning control (12). It has a scale engraved with one hundred divisions and an indicating window. The master-oscillator H.T. milliammeter (13), reading 0 to 100 mA, is below the tuning control, and below this is the 0 to 15 volts filament voltmeter (14) and control knob (15) for the M/O and intermediate circuit valve filaments. The send-receive switch (16) breaks the H.T. supply in the up or " receive " position and makes the H.T. in the down or " send " position. The 0 to 3,500 volt D.C. voltmeter (17) and the milliammeter (18) reading 0 to 500 mA. register the H.T. volts and the total input respectively. The tumbler switch (19) breaks the L.T. supply to the transmitter valve filaments in the up or off position and makes it in the down or on position.

29. In the right-hand bottom corner can be seen the 0 to 20 volt power amplifier filament voltmeter (20) and rheostat control knob (21). Above the filament voltmeter is the 0 to 200 mA. intermediate amplifier anode circuit milliammeter (22). The 0 to 4 amps. ammeter (23) and control knob (24) are in the tuned circuit of the intermediate amplifier while the grid-bias control (25) is on the left of the ammeter (23). It is engraved from 0 to 16 and a line engraved on the control handle indicates the bias setting. The door in the centre of the cubicle gives access to the M/O and intermediate amplifier valves. When the door is opened a contact switch breaks the H.T. circuit. The bottom cubicle houses all the rectifying equipment and is described elsewhere.

First cubicle

30. Referring to fig. 7 which is a view of the transmitter from the left-hand side, excluding the rectifier unit, some of the aerial and power amplifier components can be seen in the first cubicle. The aerial tuning variometer (1) can be seen on the right and below it the aerial coupling condenser (2) which is represented by C_{21} in the theoretical circuit diagram (fig. 4). The aerial inductance (3) can be seen to the left of the coupling condenser, while the aerial loading coil (4) can just be seen behind the aerial inductance. The wooden container on the left houses the aerial relay and the keying relay. The two terminals (5) and (6) seen at the top of the transmitter are engraved EARTH and RECEIVER respectively, whilst behind them is the aerial lead-in (7). The terminal (5) is connected to a suitable earth and the terminal (6) is provided to allow a receiver to be connected up in certain circumstances.

31. Fig. 9 is a rear view of the transmitter with the panels removed. In the top cubicle can be seen the relay panel. The relay (1) on the right is provided with three sets of contacts. The bottom set opens or closes the H.T.— circuits of the valves, the middle set opens or closes the H.T.+ circuits and the top set changes over the aerial from the " transmit " to the " receive " position and *vice versa*. The relay (2) is in the key circuit and is arranged to " key " the H.T.



NOTE (a) Annotations in parenthesis, for example (C_{19}), refer to the corresponding annotations in Fig 4

(b) Wires U, V X, Y and Z, and terminals Q, R, S and T are also illustrated and similarly annotated in Fig 12

FIG. 8. BENCH WIRING DIAGRAM (FIRST CUBICLE)

negative and filament circuits of all three stages. Future contracts for the T.77 will have the relay type 31 instead of the relay type N as shown in the illustration. The two 1μF condensers (3) and the 100-ohm resistance (4) are part of the relay unit.

32. The 500-ohm resistance (5) and ·0003μF condenser (6) are connected in series across the contacts of the keying relay. The amplifier lower frequency inductance (7) has a bank of six condensers mounted on its frame. Two of these condensers (8) can be seen in the centre foreground. Behind the inductance can be seen the pulse coil (9), which consists of two separate coils wound on the same former. Each coil is provided with several tapping points which are brought out to a numbered terminal board. The coil is connected in circuit by means of flexible leads terminating in sockets. It is represented by L_{11} in the theoretical circuit diagram (fig. 4). The R/F choke (10) on the left of the transmitter is connected in the grid circuit of the power amplifier valve, and the R/F choke (11), which is similar to (10), is connected in the power amplifier H.T. feed. The two resistances (12) seen on the left-hand side have a value of 40 ohms each and are connected in series across the power amplifier filament leads.

33. Referring to fig. 10 which is a view of the transmitter from the right-hand side, the power amplifier valve (1) can be seen on the left. Mounted on the valve-holder support are two condensers (2). They have a value of 1μF each and are connected in series across the valve filament leads. The grid adaptor valve (3) can be seen near the two condensers. The 1·5μF condenser (4) strapped to the top of the cubicle, forms the H.T. blocking condenser represented by C_{22} in the theoretical circuit diagram.

Second cubicle

34. The components associated with the M/O and the intermediate amplifier are housed in the second cubicle the interior of which can be seen in figs. 7, 9, and 10. The M/O components are clearly indicated in fig. 7 which is a view of the left-hand side of the transmitter. On the right is the M/O tuning variometer (8). The two windings of the coil are connected in series for low frequencies and in parallel for high frequencies. The range-change switch (10, fig. 1) effects the change of connections. The 1μF condenser (9) in the bottom right-hand corner is connected across the M/O, H.T. milliammeter. The resistance (10) to the left of the condenser has a value of 20,000 ohms and is the grid-leak resistance for the M/O valve. The variable condenser (11) seen on the left is the tuning condenser, the movable vanes being mechanically coupled to the same spindle by which the variometer (8) is actuated. Behind the condenser may be seen the M/O inductance (L_3, fig. 4). Carried on the frame of this inductance is a bank of ten condensers (12) which are connected across the variable tuning condenser and are represented by C_8 in fig. 4. The two 30,000-ohm resistances (13) connected in parallel form the 15,000-ohm anode resistance for the M/O valve. The R/F choke (14) which can just be seen in the background is represented by L_1 in fig. 4.

35. Both the M/O and the intermediate stage components can be seen in fig. 9. The M/O components are on the right and the intermediate stage components are on the left. The R/F choke (13) has already been referred to in the previous paragraph. To the left of this is the R/F choke (14) in the intermediate amplifier H.T. circuit. The condenser (15) has a value of ·00005μF and is the intermediate amplifier high frequency band coupling condenser, while the condenser (16) below it is the low frequency band coupling condenser and has a value of ·000106μF. The variable condenser (17), of which only the rear can be seen, is the tuning condenser C_{10}, fig. 4.

36. The components seen in the middle cubicle of fig. 10, which is a view of the transmitter from the right-hand side, are associated with the intermediate amplifier stage. The tuning condenser (5) is mechanically coupled to the variometer (6). As in the case of the M/O, this variometer also has its windings connected in series for the low frequency band and in parallel

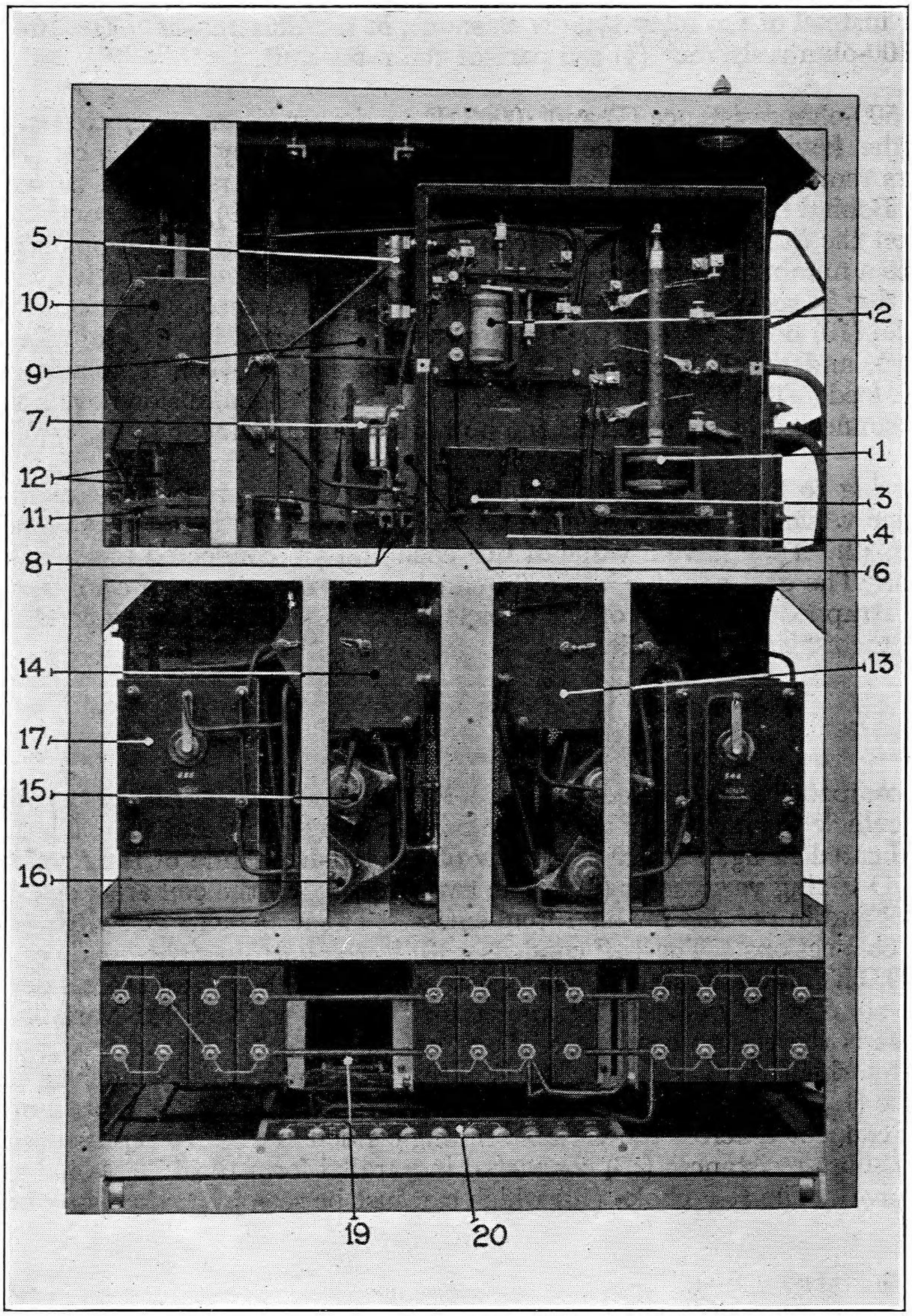


FIG. 9. Rear view of transmitter, without rectifier unit.

for the high frequency band. The modulating amplifier socket (7) is mounted above the variometer. The two 20,000-ohm resistances (8) in the top right-hand corner are connected in parallel to form the 10,000-ohm anode resistance R_{11}, fig. 4. One of the amplifier valve-holders (9) may be seen in the bottom left-hand corner. The 1μF condenser (10) in the left-hand corner is connected across the terminals of the H.T. milliammeter. The bank of ten condensers (11) below the variable condenser (5) are mounted in the frame of the tapped inductance coil (12), just showing behind the variable condenser. The bank of condensers (11) are represented by C_{14} in the theoretical circuit diagram ; they have a total value of ·00103μF and are connected across the variable condenser.

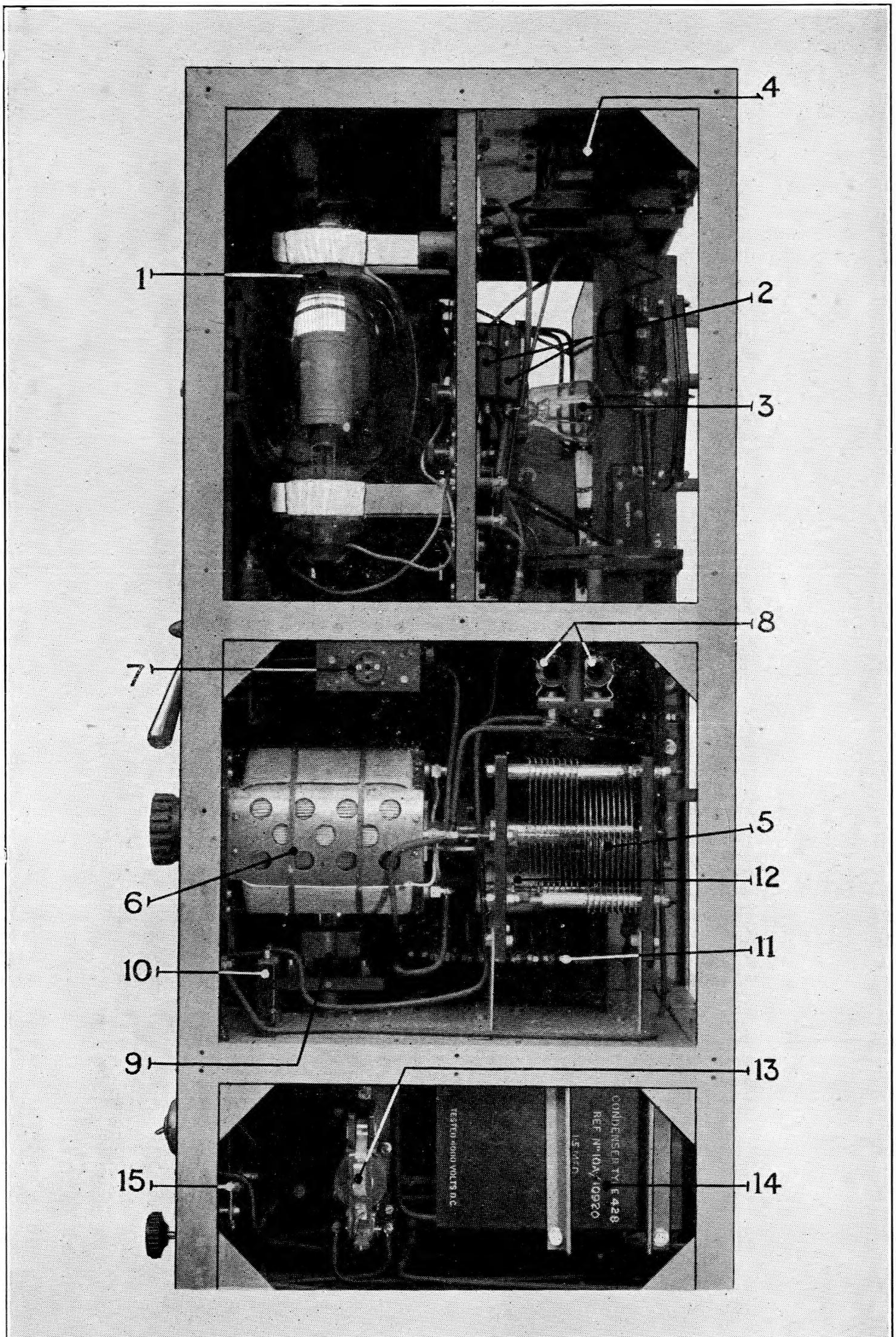
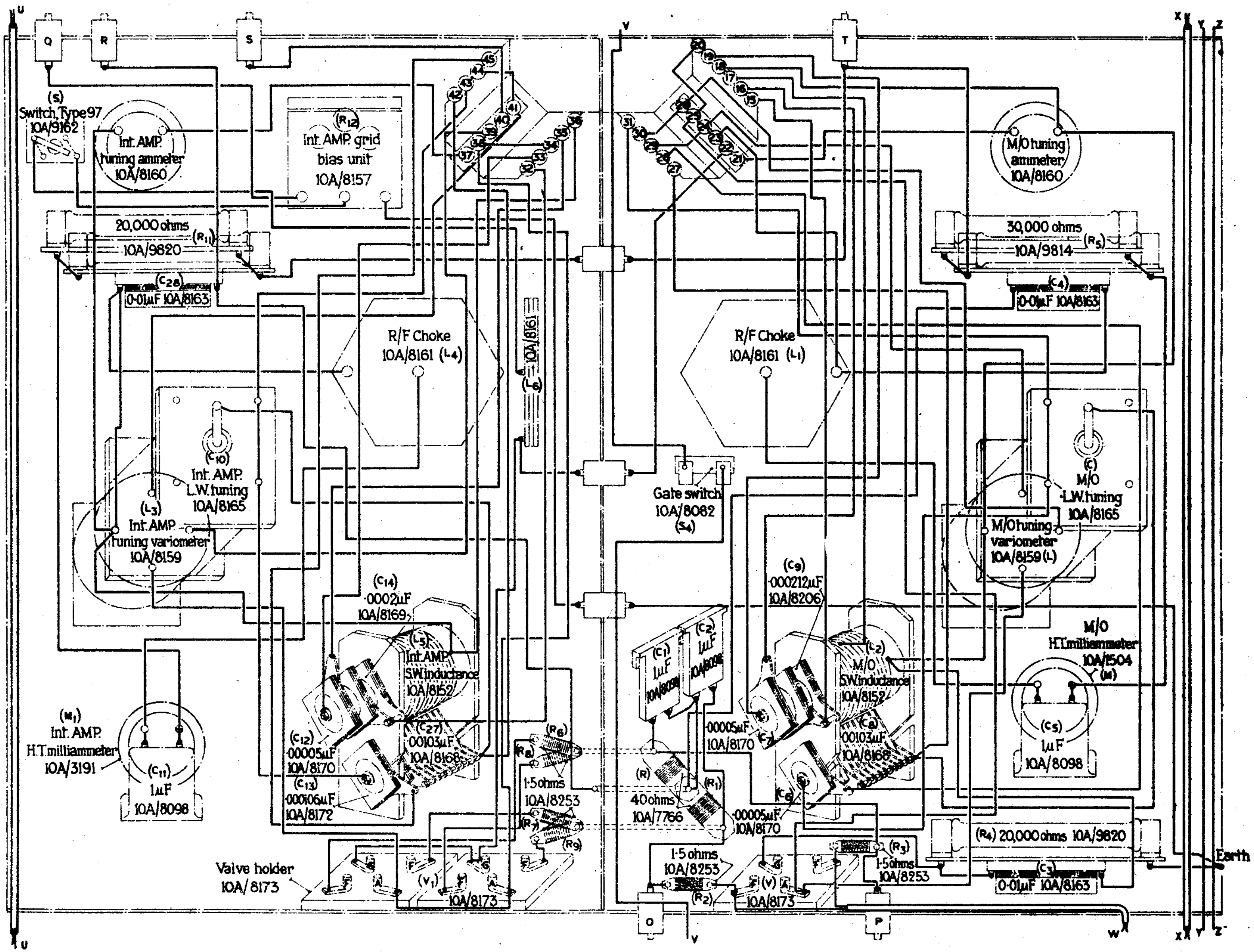


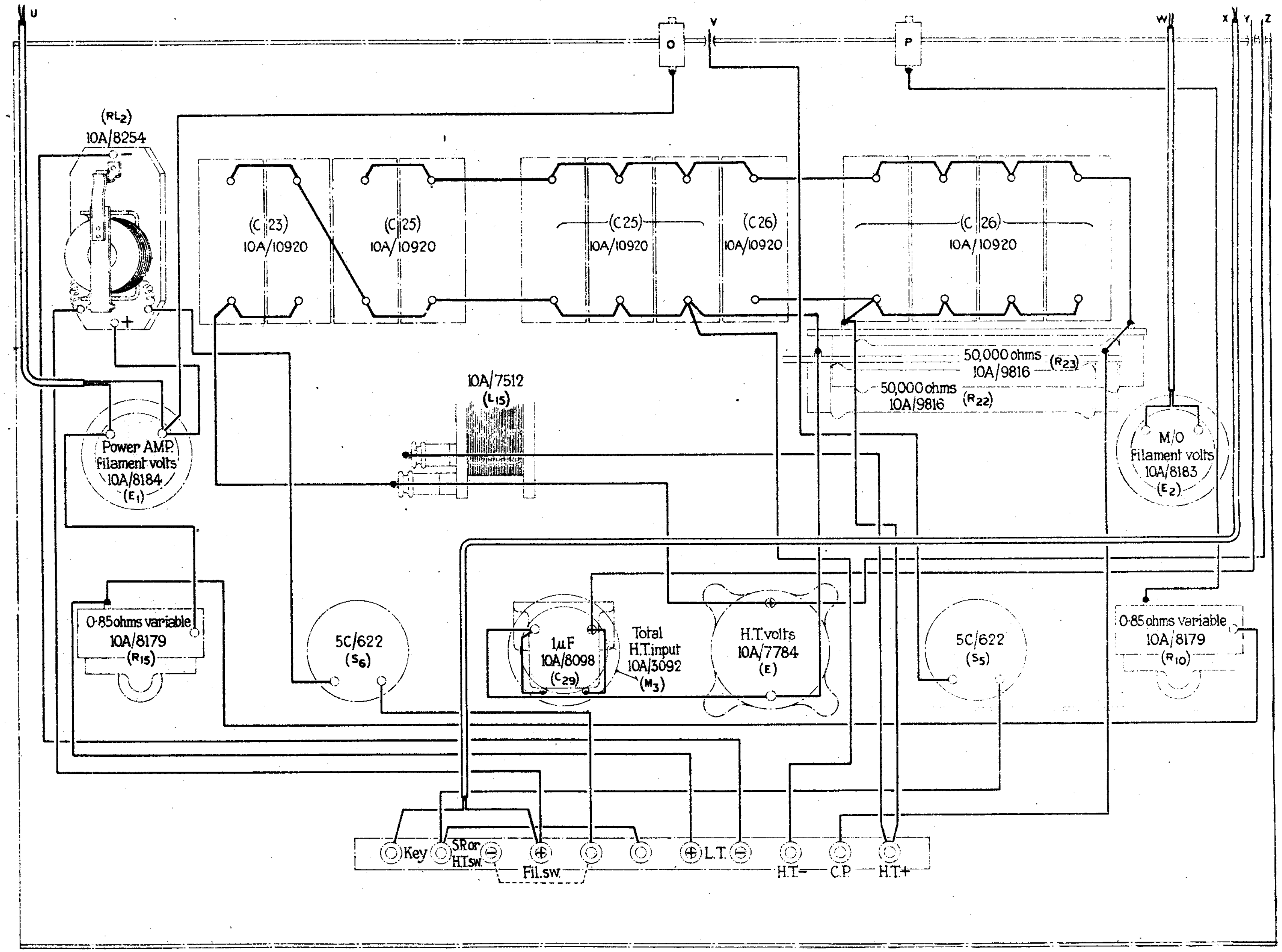
FIG. 10. Interior view of transmitter, right-hand side.



NOTE (a) Annotations in parenthesis, for example (R_9), refer to the corresponding annotations in Fig. 4
(b) Wires U, V, X, Y and Z, and terminals Q, R, S and T (top of Figure) are also illustrated and similarly annotated in Fig. 9
(c) Wires U, V, W, X, Y and Z, and terminals O and P (bottom of Figure) are also illustrated and similarly annotated in Fig. 13

FIG. 11. BENCH WIRING DIAGRAM (SECOND CUBICLE)

(F.1799). F. & C. LTD.



NOTE (a) Annotations in parenthesis, for example (C_{29}), refer to the corresponding annotations in Fig. 4

(b) Wires U, V, W, X, Y and Z, and terminals O and P are also illustrated and similarly annotated in Fig. 12

FIG. 12, BENCH WIRING DIAGRAM (THIRD CUBICLE)

(F.1799). F. & C. LTD.

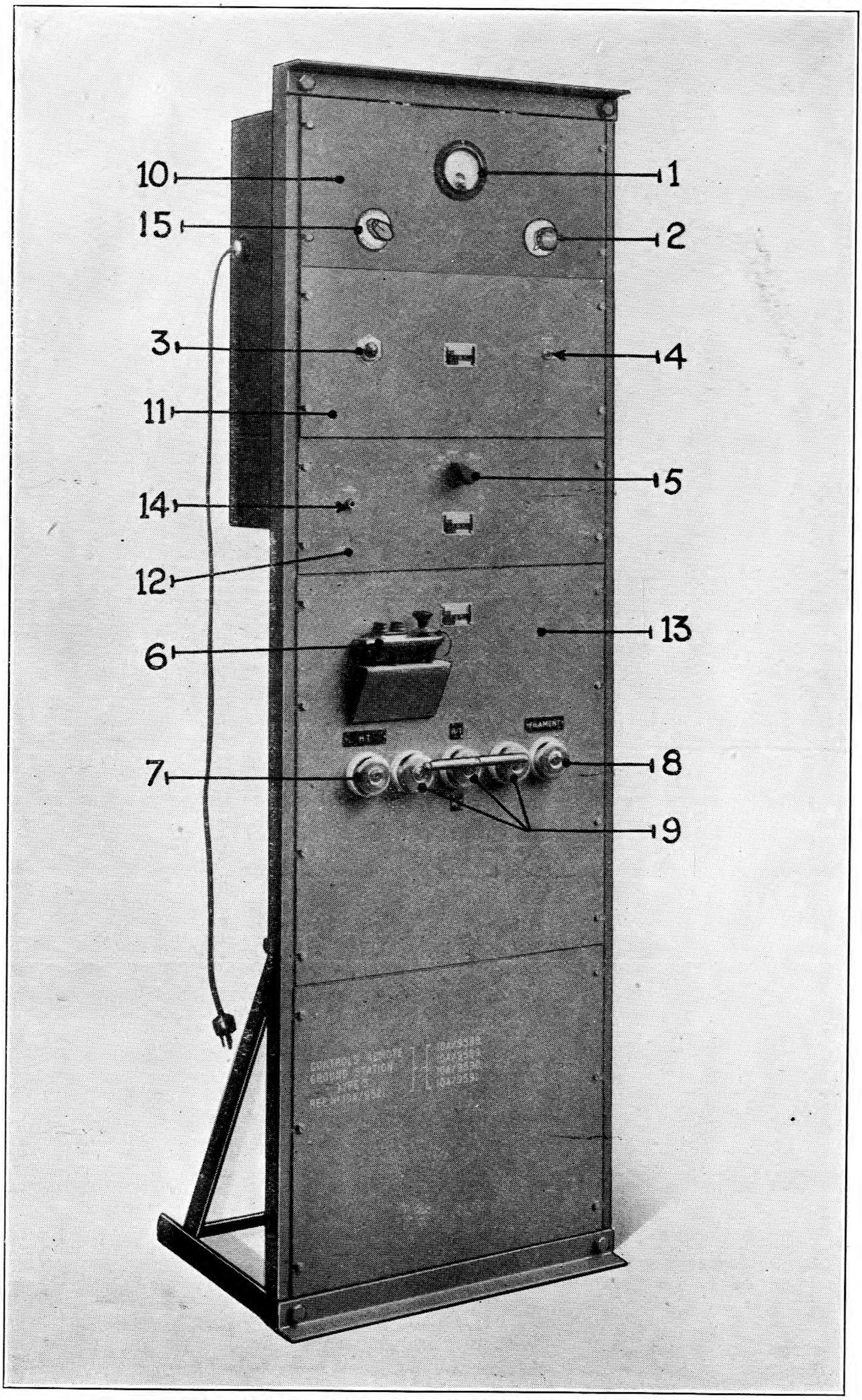


FIG. 13. Ground station remote controls, type 3.

Third cubicle

37. The lowest cubicle (rectifier cubicle not shown) seen in figs. 7, 9, and 10, houses the condensers and resistances forming the smoothing unit. In fig. 7, which shows the components from the left-hand side, the M/O and intermediate amplifier filament rheostat (15) is in the bottom right-hand corner. The two 50,000-ohm resistances (16) form part of the smoothing unit, and are represented by R_{22} and R_{23} in fig. 4. The 1·5μF condenser (17) on the left, is the end one of a bank of 12 such condensers which are strapped to the bottom of the M/O and intermediate amplifier cubicle.

38. In fig. 9 all 12 condensers are clearly indicated. The iron-cored choke (19) in the background, is in the H.T.+ lead and is represented by L_{15} in fig. 4. The terminal strip (20) seen in the bottom foreground is provided with eleven terminals which, if the supply is A.C., are connected by ten links to corresponding terminals on the rectifier unit. When D.C. is being used, apart from the usual H.T. and L.T. supply, a 12-volt battery is connected across the third and fourth terminals from the left and is used to operate the solenoids of the keying relay, the H.T. and aerial switch, and the L.T.— contactor.

39. Referring to fig. 10, a contactor (13) can be seen in the centre of the lowest cubicle. It is connected in the L.T.— line and its solenoid is controlled by the tumbler switch (19, fig. 1). The 1·5μF condenser (14) is the right-hand end condenser of the bank of 13 condensers forming the smoothing unit. The power amplifier filament rheostat (15) is visible in the bottom left-hand corner. It is controlled by the knob (21, fig. 1).

Remote controls.

40. Fig. 13 is a front view of ground station remote controls, type 3, as installed at the transmitter end. The top panel (10) carries the amplifier, which consists of an indirectly-heated triode, transformer-coupled to two triodes in push-pull, the latter forming the output stage. A milliammeter (1) reading 0–150 is connected in the H.T. feed to the output stage, and a potentiometer operated by the handle (2) is connected across the grid-filament of the first valve. A modification subsequently made in the amplifier panel introduced an attenuator. The knob (15) for controlling this may be seen to the left of the potentiometer handle.

41. The second panel (11) is the rectifier unit which incorporates a mains transformer, with five secondary windings, a double wave rectifying valve and a smoothing circuit. Of the five windings on the mains transformer, two 4-volt windings supply the filaments of the first and second stages of the amplifier, and the filament of the oscillator valve on the local control panel. Another winding supplies the anodes of the double wave rectifier (1,000 volts) and another the filament (4 volts) of the rectifier. The remaining winding gives a 10-volt supply to a metal rectifier situated in the local control panel (12). A tumbler switch (4) on the front of the panel switches the primary of the mains transformer across the supply, and a pilot lamp (3) connected across a 2-volt tapping on one of the secondaries gives a visual indication that the transformer is energized. A thermal relay is also incorporated in this panel which delays the connection of the output H.T. until the valve filaments have reached their working temperature.

42. The third panel (12) is the local control panel. This panel carries an indirectly heated triode coupled as a 1,000 c/s oscillator ; this panel also carries two transformers, one for the local microphone and one for use when telephony is being carried out from a remote position on an incoming line. A metal rectifier is provided for the purpose of rectifying the 10-volt A.C. supply obtained from the winding on the mains transformer (previously referred to) and this is smoothed and provides the supply for operating the local microphone. On the front of the panel

is the jack (14) and the 4-position switch (5) ; the former receives the plug from the local microphone. The latter is engraved at its four positions, 600 OHM INPUT, DIRECT GRID, OSCILLATOR, LOCAL MICROPHONE. In the first-mentioned position the secondary of the " line transformer " is connected across the input to the amplifier to produce a suitable matching of the amplifier input to an incoming 600-ohm line. In the second position the transformer is cut out, and the input of the amplifier is connected directly to two terminals marked 50,000 OHMS, DIRECT GRID in order that the input may be matched to any incoming line. In the third position the oscillator is connected to the input of the amplifier. In the fourth position the secondary of the local microphone transformer is connected to the input of the amplifier. In this position, owing to the mechanical coupling of a D.P. switch, the microphone primary circuit is energized from the metal rectifier.

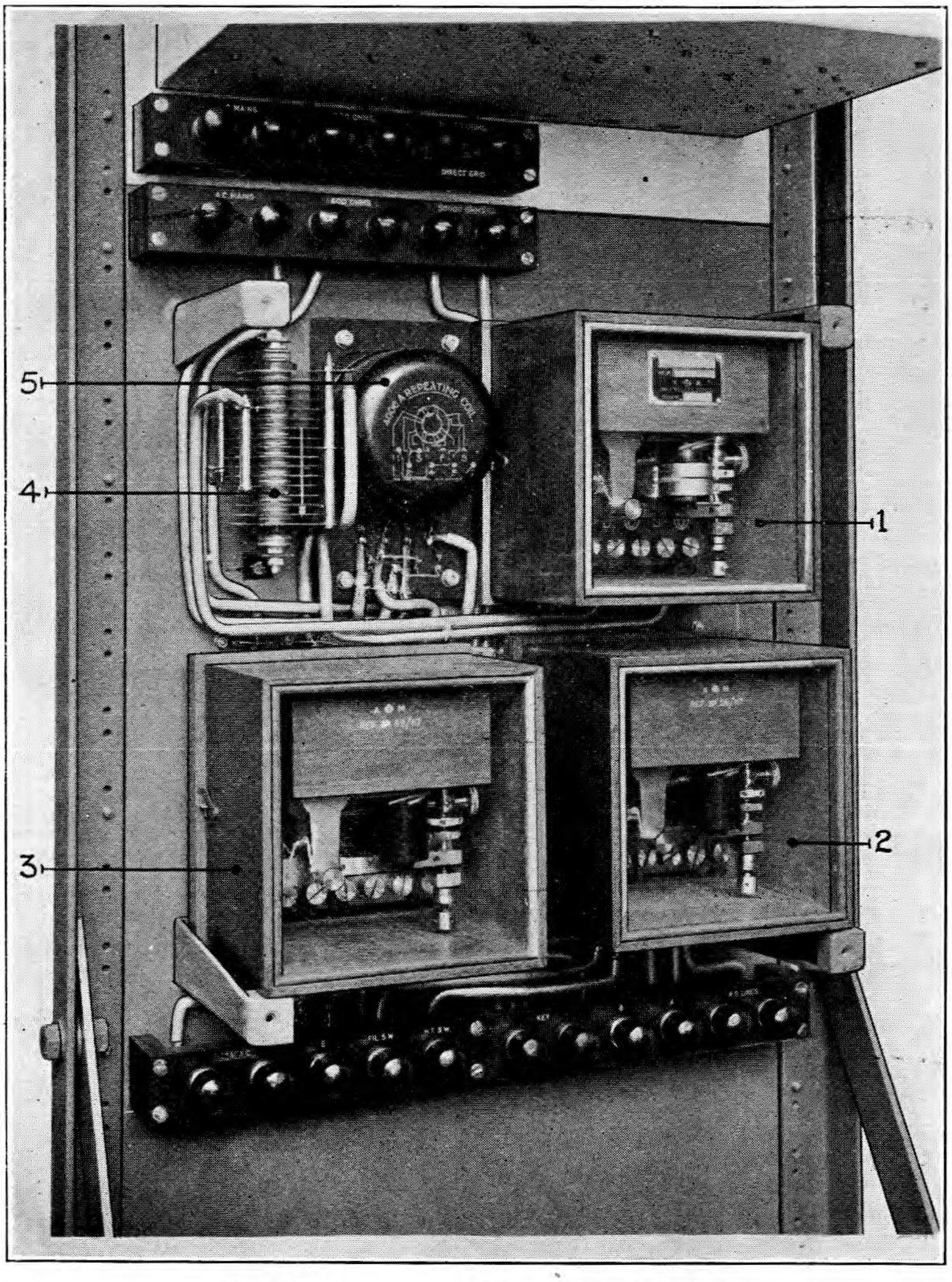


FIG. 14. Rear view of remote control panel.

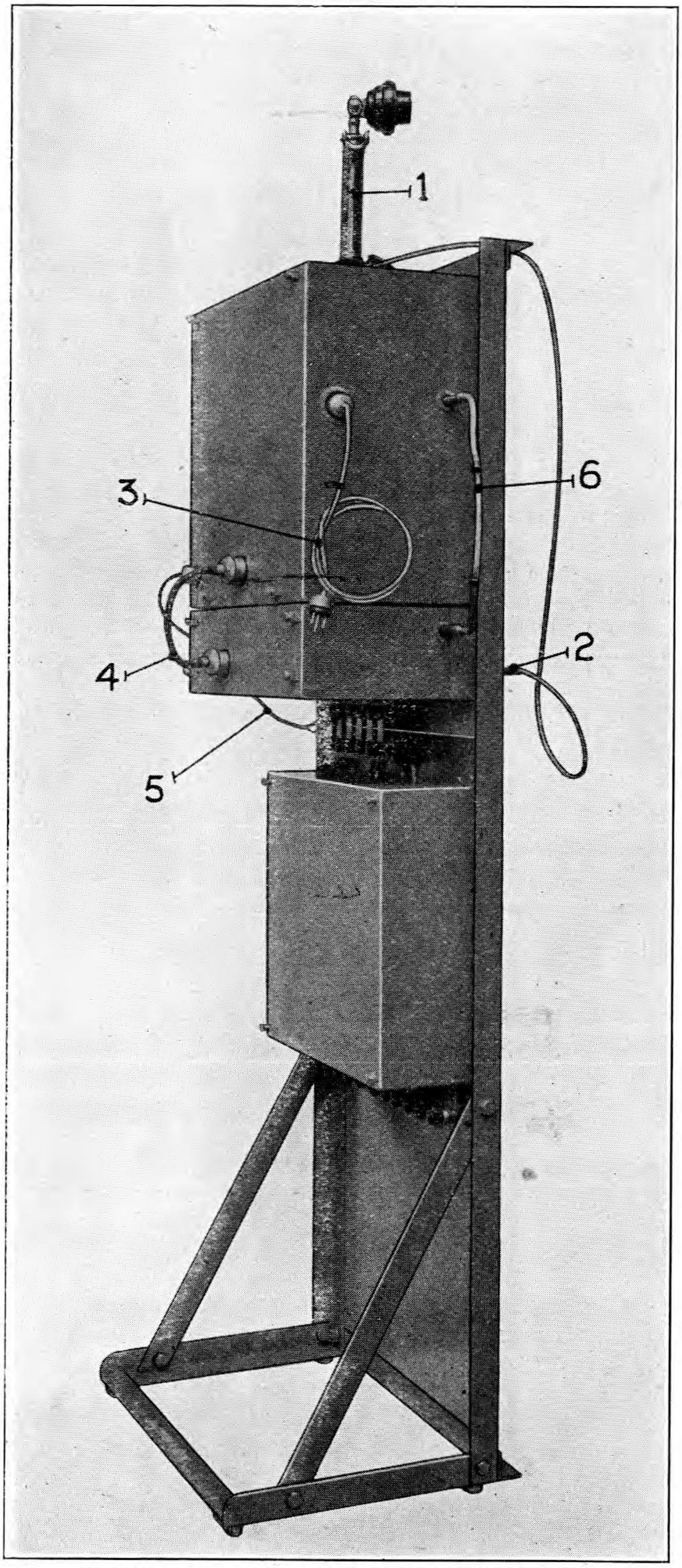


FIG. 15. Rear view of remote controls, type 3.

43. The fourth panel (13) is the remote control panel. On the front of this panel is mounted the morse key (6), the H.T. switch (7), the filament switch (8) and the three coupled switches (9). The rear of this panel can be seen in fig. 15 in which the relay (1) is the keying sounder relay which effects the keying of the transmitter. The relay (2) immediately below this is the H.T. sounder relay which switches the H.T. supply to the transmitter. The relay (3) on the left of this is the filament sounder relay which energizes the filament relay and so switches the filament circuits of the transmitter. To the left of the relay (1) can be seen the metal rectifier (4) and the repeating coil (5).

44. The switch (9, fig. 13) is a three pole two-position switch. Two of the poles change over the connections of the repeating coil secondary from the amplifier input to the 14-volt A.C. supply and rectifier. The former is the R/T position and the latter is the W/T position. The third pole merely short-circuits the tongue and mark terminals of the keying relay in the R/T position.

45. Connections between the various panels are made by means of plugs and sockets and links. Referring to fig. 14, the microphone (1) is connected by a screened lead terminating in a plug (2) which engages with the socket (14, fig. 13). The screened lead (3) effects the connections between the output of the amplifier and the appropriate circuit of the transmitter. The screened cable (4) terminates at each end in a six-point socket. These sockets engage with plugs one of which is situated on the amplifier and the other on the local control panel. This cable carries the filament A.C. supply for the oscillator valve, the A.C. supply to the microphone rectifier, and the smoothed H.T. supply for the oscillator anode supply. The screened cable (5) is connected at one end to the A.C. mains terminals, and terminates at the other end in a two-point socket which engages with a two-point plug connected to the primary winding of the rectifier transformer. The screened cable (6) terminates at each end in a plug. One plug is inserted into a jack on the amplifier and the other is inserted into a jack on the local control panel. This provides the connection between the input of the amplifier and the output of the local control panel. The form of the output may be either speech or a 1,000 c/s audio-modulating frequency for the production of M.C.W.

46. Referring to fig. 15, it will be seen that a row of six terminals is provided at the top of the remote control panel for convenient linking up with a corresponding row at the bottom of the local control panel. The first pair on the left is connected directly to the A.C. supply, and is engraved accordingly. The remaining two pairs are engraved 600 OHMS and 50,000 OHMS respectively.

VALVES AND POWER SUPPLY

47. The valve used in the master-oscillator stage is a valve type V.T.26, and it has a filament voltage of 12 volts. Two V.T.26 valves, connected in parallel, are used in the intermediate amplifier stage. The power amplifier stage uses a V.T.4B valve, the filament voltage of which is 18 volts. One V.T.13C valve, fitted in an adaptor, is connected across the grid-filament circuit of the power amplifier. The valves used in the rectifier are two type V.U.29. These are vapour-filled valves and should be carefully handled in order to avoid any mercury coming in contact with the filaments. The L.T. and H.T. supplies are obtained from any convenient mains power supply.

48. The transmitter may be operated from an A.C. or D.C. supply, the A.C. system being the more usual. A detachable rectifying unit (Panel, Rectifying, Type A, Stores Ref. 10A/8068 or Panel, Rectifying, Type B, Stores Ref. 10A/11156) is provided for this purpose. When operating on D.C. the panel is removed and a dummy panel inserted in its place. The smoothing unit, which is contained in a cubicle above the rectifying unit, remains in circuit for both A.C. and D.C. When working on A.C. the power required for operating the various electro-magnetic switches and relays is obtained from metal rectifiers incorporated in the rectifying unit. When operating on D.C. the power is obtained from a 12-volt battery connected to the appropriate terminals. The transmitter terminals are connected to the rectifier terminals by means of links.

OPERATION

Transmitter tuning

49. The following is a description of the method by which the transmitter may be adjusted and some of the precautions which must be taken. When making the adjustments reference should be made to the tables 1, 2, 3 and 4, and the curves given in figs. 16, 17, 18 and 19.

50. The transmitter filaments should be switched on ten minutes or so before the commencement of routine transmission to allow the master-oscillator to reach a steady temperature and thus obviate frequency creep. The curves in figs. 16, 17, 18, and 19 giving the M/O tunings are not true calibration curves, the frequencies being only approximately correct owing to the slight variations in inductance and capacitance on different models, as well as the effect of different output load conditions. They are given as an easy guide for setting up the transmitter to a given frequency.

51. The tables 1, 2, 3 and 4 give typical settings of the various tunings corresponding approximately to the frequencies quoted, and can be used for the initial setting up to the desired frequency. When the desired frequency is intermediate between two frequencies given in the tables, the curves provide the appropriate interpolation for the M/O setting, and the remaining settings, *i.e.*, grid-bias and aerial coupling, should be interpolated roughly from the tables. The input currents tabulated are quoted for guidance only.

52. When operating on A.C. the adjustments must be carried out in the following order: Switch on the A.C. mains and also the rectifier and transmitter filaments and adjust the filament voltages to 12 volts for the master-oscillator and intermediate amplifier valves and 18 volts for the power amplifier valve, by means of the two controls on the lower part of the panel.

53. Set the master-oscillator tuning to the appropriate setting as indicated on the curve. Set the aerial loading switch and the range change switch to the appropriate positions. Set the pulse coil taps to the positions indicated in the tables and set the aerial coupling to zero. The grid-bias switches should be set to maximum, *i.e.*, stop 16. When working on the 1,500 to 2,256 kc/s band, part of the 143 to 400 kc/s band pulse coil must be short-circuited, and the short-circuiting lead provided should be engaged with plugs 32 and 39. When working on the 143 to 400 kc/s band the short-circuiting lead should be stowed on the dummy plugs provided on the right-hand side.

54. Having set the intermediate amplifier and power amplifier to the approximate settings as shown in the tables, put the voltage switch on the rectifier to the first stud (low volts) and switch on H.T. to the rectifier. The voltage should be approximately 2,000 volts. If necessary, re-adjust the filament voltage of the M/O and intermediate amplifier valves to 12 volts and that of the power amplifier to 18 volts. Switch on H.T. to the transmitter and with the key closed tune the intermediate amplifier by obtaining a maximum ammeter reading. Now set the aerial coupling condenser to its appropriate value. Press the key and tune the aerial circuit by obtaining a maximum reading in the aerial ammeter. Carefully re-tune the power amplifier circuit. This tuning is facilitated by watching for a dip in the reading of the power amplifier input milliammeter. Observing the aerial ammeter carefully, re-tune the intermediate amplifier circuit, and finally re-tune the aerial and power amplifier circuits.

55. It is essential that all setting up should be done in accordance with the figures given in the tables. If any other procedure is adopted, there is a danger that a false tuning will be obtained as a result of harmonics.

56. A final re-adjustment of filament voltages may now be made. Each filament rheostat should be adjusted in turn in order to ascertain whether a small increase or decrease of filament voltage will increase the aerial current reading, and each rheostat should be left at the optimum setting. Check the frequency by means of a suitable wavemeter. Re-tune if necessary by reference to the curves and tables.

57. An increase of power may be obtained by putting up the voltage tap in the rectifier, but operators should find by trial the lowest power necessary for efficient communication and should use this setting for all normal traffic. After any such adjustment the frequency should be re-checked by a wavemeter. The approximate voltages obtainable on load are as follows :—

Tap 1	1,800 volts.
Tap 2	2,500 volts.
Tap 3	3,000 volts.

An additional tap is provided, but when using the rectifier with the transmitter, type T.77, this tap must not be used in any circumstances.

58. The setting up of the transmitter for frequencies between 2,000 kc/s and 2,256 kc/s calls for considerable care if the best output is to be obtained, and a number of adjustments and re-adjustments of tuning between the intermediate amplifier, power amplifier and aerial are necessary. It must be noted that for these frequencies the power amplifier circuit cannot be tuned by the method of observing the dip in anode current unless the aerial coupling is at zero. It is also important to note that the aerial specified requires a series capacitance of 100μμF (a No. 7 condenser set at 0·10 is near enough) to give the best results on these higher frequencies.

Examples showing method of using tables and curves

59. Suppose it is required to set the transmitter to 150 kc/s the dial setting corresponding to this frequency (*see* fig. 18) is 8·81. Set the M/O coil to this reading and tune the transmitter as described above using Table 1. Ascertain the actual frequency radiated by means of a suitable wavemeter or syntonizer. Assume it is found to be 150·8 kc/s, which is 0·8 kc/s high. Now look up this frequency (150·8 kc/s) on the curve (fig. 16) and it will be found to correspond to a dial setting of 8·74. The difference between the first dial setting (8·74) and the setting actually obtained on the transmitter (8·81) is ·07. In this region of the curve, therefore, a difference of ·07 in the setting corresponds to 0·8 kc/s. Since it is required to lower the frequency by 0·8 kc/s the M/O inductance dial setting should be increased by ·07. That is, the transmitter must be set to 8·88 instead of 8·81.

60. In the higher frequency band assume it is required to set the transmitter to 1,800 kc/s. The dial setting corresponding to this frequency (*see* fig. 19) is 3·93. Set the M/O coil to this reading and tune the transmitter as previously described using Table 4. Determine the actual frequency radiated by means of a suitable wavemeter. Suppose the frequency obtained by the wavemeter is 1,790 kc/s, *i.e.*, 10 kc/s too low, on looking up this frequency (1,790 kc/s) on the curve, it will be found to correspond to a setting of 4·00. The difference between the dial setting read off (3·93) and the dial setting actually obtained on the transmitter (4·00) is ·07. In this region of the curve, therefore, 10 kc/s corresponds to a difference in the dial setting of ·07. Since it is desired to raise the frequency by 10 kc/s, the M/O inductance dial setting should be lowered by ·07, *i.e.*, the transmitter must be set to (3·93 — ·07) 3·86. The other curves (figs. 17 and 18) may be used in a similar manner, bearing in mind that the turns are increased to lower the frequency, and reduced to raise the frequency.

Adjustments for R/T and M.C.W.

61. The operations described above for setting up the transmitter for C.W. should first be carried out. The intermediate amplifier bias control should now be set to stud 16 and the bias of the power amplifier adjusted so as to reduce the aerial current by 50 per cent. The connector from the speech amplifier may now be plugged into the socket on the side of the transmitter and modulation checked by means of the Modulation Indicator, type 1. If a modulation indicator

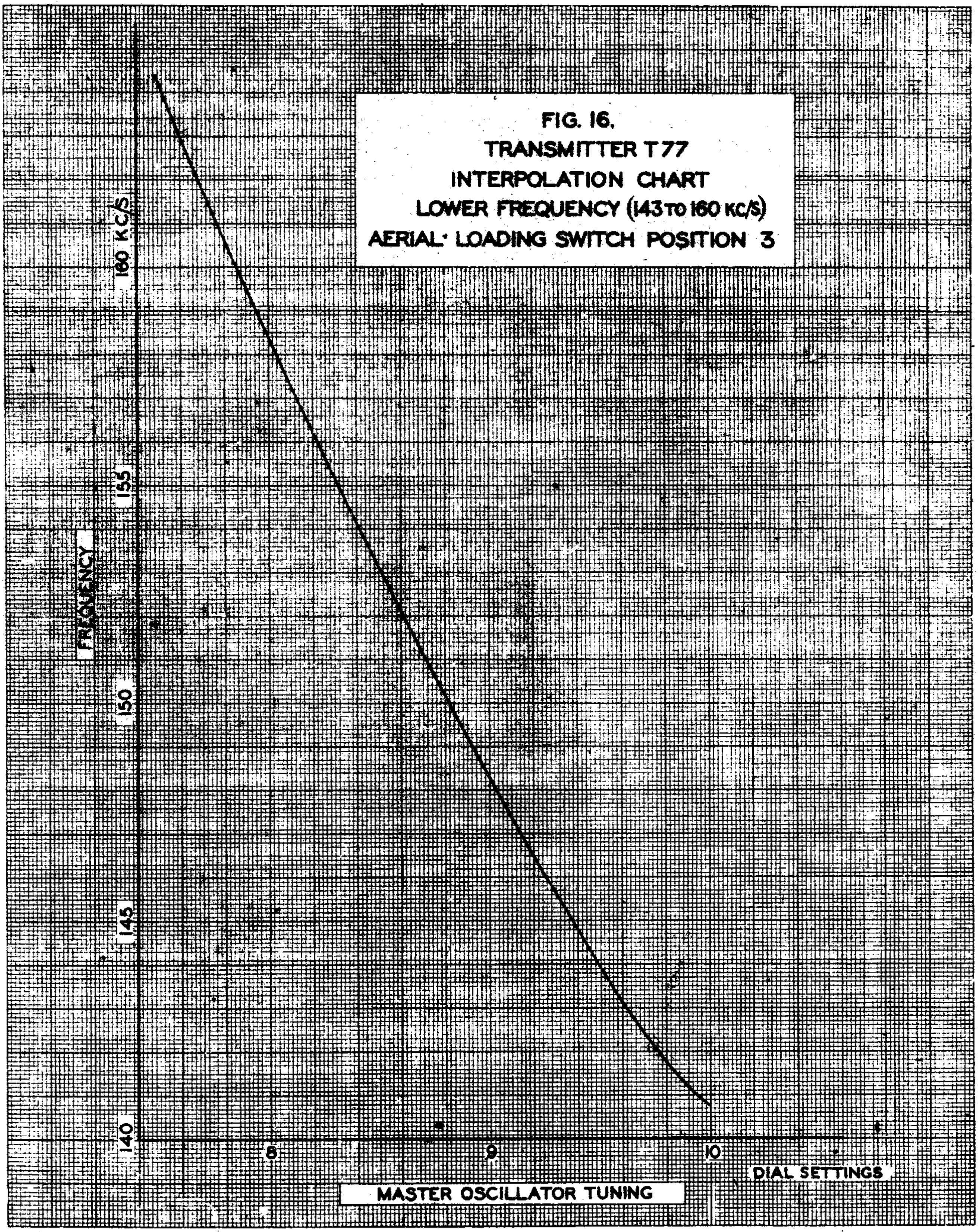


FIG. 16.
TRANSMITTER T77
INTERPOLATION CHART
LOWER FREQUENCY (143 TO 160 KC/S)
AERIAL LOADING SWITCH POSITION 3
FREQUENCY
160 KC/S
155
150
145
140
8
9
10
DIAL SETTINGS
MASTER OSCILLATOR TUNING

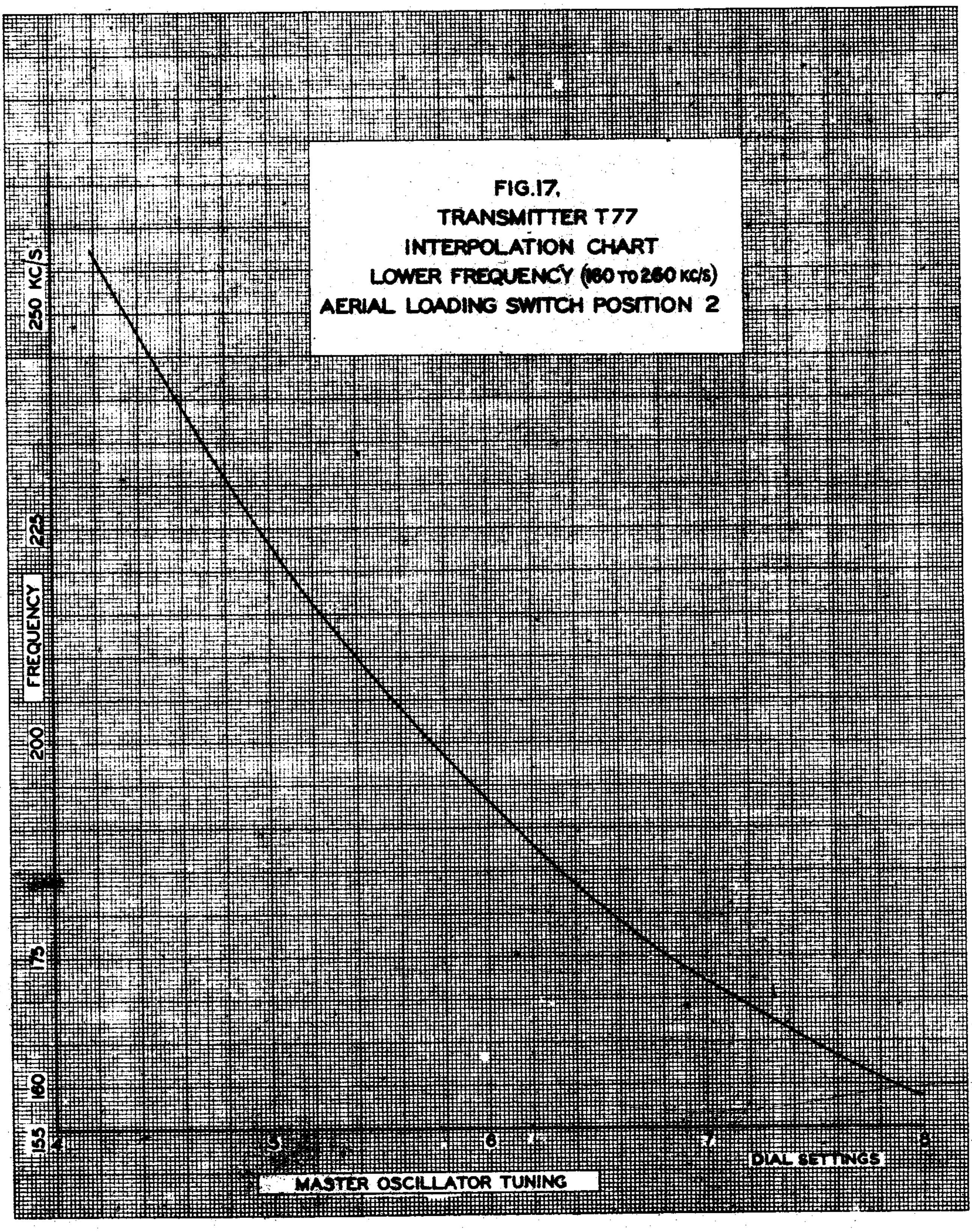


FIG.17.
TRANSMITTER T77
INTERPOLATION CHART
LOWER FREQUENCY (160 TO 260 KC/S)
AERIAL LOADING SWITCH POSITION 2
FREQUENCY
250 KC/S
225
200
175
160
155
4
5
6
7
8
DIAL SETTINGS
MASTER OSCILLATOR TUNING

is not available the aerial ammeter should be watched while speaking into the local microphone. There should be an increase in the reading of aerial current with no appreciable change of input to the amplifier valve. With 100 per cent. modulation the aerial current should rise 22 per cent. It should be borne in mind, however, that for normal speech no such increase will be observed on the aerial ammeter. With normal speech the modulation varies, even falling to zero during pauses. The average variation must therefore be considered and the average increase of the aerial ammeter reading may be no more than about 5 per cent. Since the aerial current for R/T will be of the order of 2·0 amperes this will be equivalent to an increase of 0·1 amperes.

62. If, however, a loud " hello-o-o " is sustained when testing, conditions more nearly approaching 100 per cent. modulation are obtained, and a rise of about 15 per cent. in aerial current may be effected. It should be borne in mind that it is quite impossible, no matter what depth of modulation is used, to obtain good speech if the aerial current is too high.

63. When using remote controls, type 3, the coupled switches on the remote control panel and the 2-way switch at the signals office end must be at R/T. The amplifier output connector must be plugged in and the switch on the local control panel (5, fig. 13) turned to 600 OHM INPUT. The grid-bias must be adjusted as stated in para. 61. If telephony is to be transmitted from an incoming line connected to the 50,000 OHMS terminals, the switch on the local control panel must be turned to the corresponding position. The main supply switch on the speech input amplifier must also be closed. The filament and H.T. supplies to the transmitter must then be switched on by closing the local tumbler switches. The circuit is arranged so that the H.T. cannot be switched on before the filaments.

64. When it is desired to transmit M.C.W. the connector from the remote control amplifier should be plugged into the side of the transmitter and the selector switch on the local control panel set to OSCILLATOR. The tumbler switch on the rectifier panel should be switched on, and the coupled tumbler switches placed in the W/T position. The input potentiometer should be adjusted to give the correct modulation.

PRECAUTIONS AND MAINTENANCE

65. Switch off the H.T. before making any adjustments to the transmitter. Safety switches are provided which cut off the H.T. supply when any of the transmitter doors are opened, but it is advisable not to depend entirely on these. For remote operation of the transmitter, all tumbler switches on the front panel of the transmitter must be in the " on " position, and of course all the doors must be closed.

66. The rectifier is similar to that described in another chapter of this publication, and similar precautions must be observed. The valves used in the rectifier are two type V.U.29 valves. These valves are of the mercury-vapour type and whenever there is any possibility of the mercury having come in contact with the filaments, the filament circuit should be switched on for not less than ten minutes prior to the H.T. being switched on, or the valves may be seriously damaged. This applies in any instance where a valve is shifted, or where the complete panel has been shifted and has been subjected to any inversion or heavy vibration.

67. The output voltage from the rectifier may be varied within limits. Four transformer taps are provided for this purpose as follows :—

Tap 1	1,800 volts.
Tap 2	2,500 volts.
Tap 3	3,000 volts.
Tap 4	3,500 volts.

68. Although four tapping points are provided, the fourth or highest tap must not be used with this transmitter. The R/F voltages generated with this high value of H.T. (3,500) are beyond the safe limit value of the insulation.

69. The valve used in the power amplifier stage is a V.T.4.B. valve. Some of these valves are prone to secondary grid emission. If any valve bearing one of the serial numbers from 2057 to 2684 is fitted, the power amplifier input milliammeter should be carefully watched as the H.T. is switched on. If a surge occurs, switch off immediately and increase the power amplifier filament volts a little. Switch on the H.T. again and watch the milliammeter. Increase the filament volts if necessary until there is no tendency to surge after switching on.

70. Care should be exercised that the correct fuses are fitted in the rectifier. There are four of these fuses each of which should carry two strands of 33 s.w.g. tin wire.

71. The relay, type K, which breaks the H.T. supply from the rectifier is situated in a glass-fronted box on the side of the unit. The contact arms should be adjusted so that when the relay is energized, the lower or L.T. contact arm makes first and the upper or H.T. contact arm makes a fraction of a second later. Each contact arm is provided with a carbon and a metal contact, and it should be adjusted so that the carbon contact makes before the metal contact.

TABLE 1

H.T. Voltage, Tap 2 (2,600 volts on load)

Range change switch position (143 to 400 kc/s)

Aerial loading switch, position 3

Aerial 1,100 $\mu\mu$ F (L-type, 6 wires, 2 ft. spacing, 200 ft. long, on 70-ft. masts)

Radial earth system.

kc/s.	Pulse Coil. Long Wave.			Tuning.				Bias Stud.		Aerial Coupling.	Inputs (mA).			Aerial Current (Amps.).
	Max.	Coupling.	H.T.	M/O.	INT. AMP.	POWER AMP.	AERIAL	INT. AMP.	POWER AMP.		M/O.	INT. AMP. Circuit.	POWER AMP.	
142·9	33	33	42	9·60	9·23	6·74	6·50	4	11	120	69	45	170	4·9
148·4	33	33	42	9·00	8·68	6·22	5·68	4	9	120	66	43	173	4·9
153·1	33	33	42	8·50	8·20	5·94	5·30	3	10	120	72	57	170	4·9
158·3	33	33	42	8·00	7·72	5·62	4·33	4	6	120	68	45	175	5·0
164·4	33	33	42	7·50	7·23	5·25	3·43	3	5	120	72	60	170	4·8

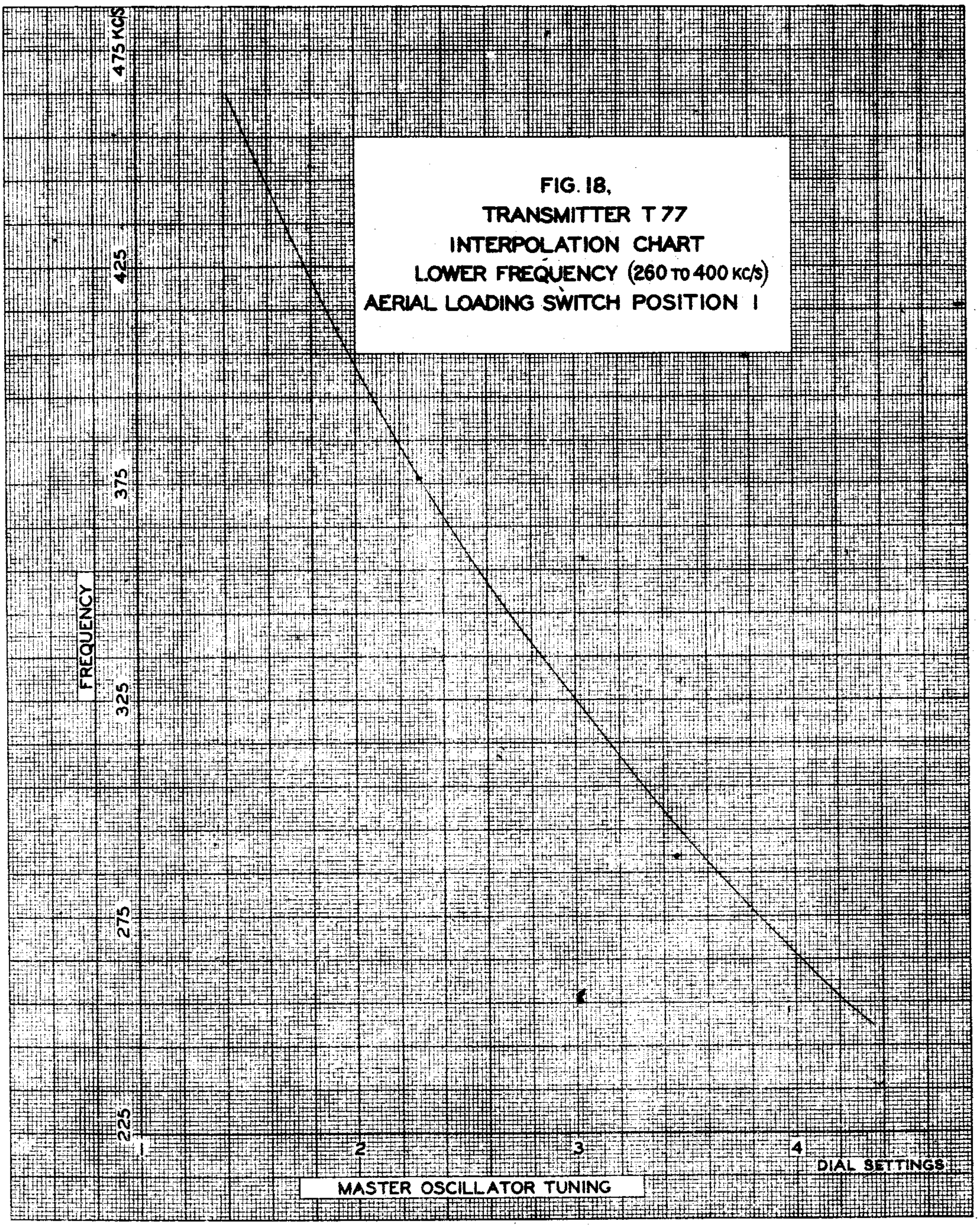


FIG. 18,
TRANSMITTER T 77
INTERPOLATION CHART
LOWER FREQUENCY (260 TO 400 KC/S)
AERIAL LOADING SWITCH POSITION 1
475 KC/S
425
375
325
275
225
FREQUENCY
1
2
3
4
DIAL SETTINGS
MASTER OSCILLATOR TUNING

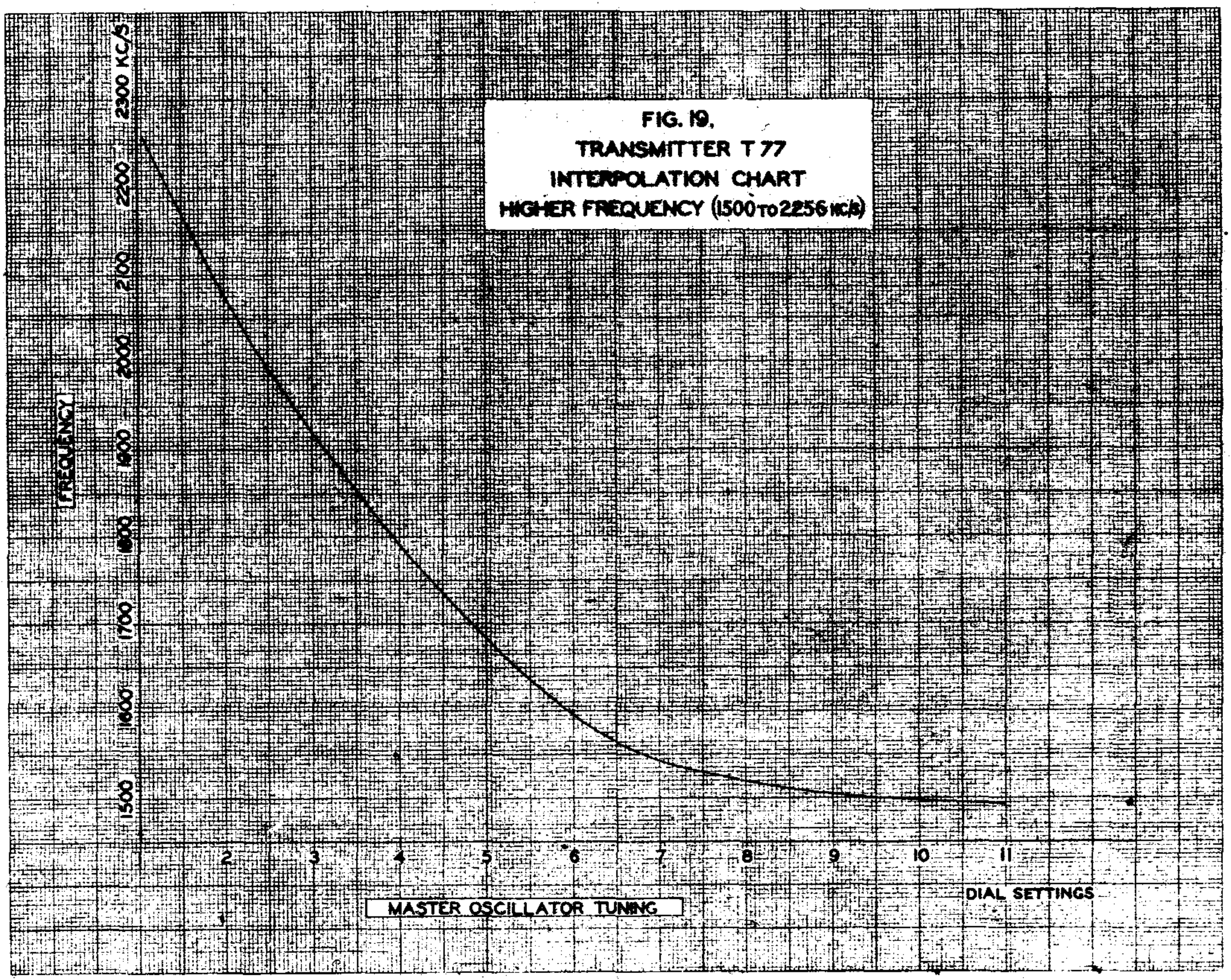


FIG. 19.
TRANSMITTER T 77
INTERPOLATION CHART
HIGHER FREQUENCY (1500 TO 2256 KC/S)
FREQUENCY
2300 KC/S
2200
2100
2000
1900
1800
1700
1600
1500
2
3
4
5
6
7
8
9
10
11
DIAL SETTINGS
MASTER OSCILLATOR TUNING

TABLE 2

H.T. Voltage, Tap 2 (2,600 volts on load)
Range-change switch position—(143 to 400 kc/s)
Aerial loading switch, position 2
Aerial 1,100 μμ F (L-type, 6 wires, 2 ft. spacing, 200 ft. long, on 70-ft. masts) Radial earth system.

kc/s.	Pulse Coil. Long Wave.			Tuning.				Bias Stud.		Aerial Coupling.	Inputs (mA).			Aerial Current (Amps.).
	Max.	Coup-ling.	H.T.	M/O.	INT. AMP.	POWER AMP.	AERIAL	INT. AMP.	POWER AMP.		M/O.	INT. AMP.	POWER AMP.	
158·3	33	33	42	8·00	7·74	5·56	9·43	4	14	120	66	40	175	4·7
168·5	33	33	42	7·20	7·00	5·00	7·52	3	13	85	68	50	170	5·0
176·5	33	33	42	6·77	6·58	4·83	6·73	3	13	90	64	45	170	4·8
185·7	33	33	42	6·20	6·04	4·36	5·73	3	11	57	68	50	170	4·9
199·6	33	33	42	5·74	5·62	4·00	5·03	3	11	63	64	47	170	4·9
215·8	33	33	42	5·20	5·17	3·50	4·10	3	10	57	68	50	170	4·9
230·8	33	33	42	4·78	4·67	3·06	3·18	3	6	60	66	48	170	4·9
256·4	33	33	42	4·20	4·19	2·45	1·62	3	4	120	72	55	170	4·6

TABLE 3

H.T. Voltage, Tap 2 (2,600 volts on load)
Range switch position—(143 to 400 kc/s)
Aerial loading switch, position 1
Aerial 1,100 μμF (L-type, 6 wires, 2 ft. spacing, 200 ft. long, on 70-ft. masts) Radial earth system.

kc/s.	Pulse Coil. Long Wave.			Tuning.				Bias Stud.		Aerial Coupling.	Inputs (mA).			Aerial Current (Amps.).
	Max.	Coup-ling.	H.T.	M/O.	INT. AMP.	POWER AMP.	AERIAL	INT. AMP.	POWER AMP.		M/O.	INT. AMP.	POWER AMP.	
245·9	33	33	42	4·40	4·30	9·97	4·80	3	9	80	70	50	170	4·6
266·2	33	33	42	4·00	3·87	8·01	4·29	2	6	65	74	55	170	4·9
291·8	33	33	42	3·50	3·35	6·28	3·64	2	6	45	74	50	170	4·7
326·8	33	33	42	2·95	2·79	5·32	2·89	2	3	35	74	66	170	4·6
366·0	33	33	42	2·40	2·28	4·46	2·10	1	2	45	74	50	170	4·2
409·8	33	33	42	1·90	1·80	3·78	1·46	1	1	65	80	82	200	4·0

TABLE 4

H.T. Voltage, Tap 2 (2,600 volts on load)

Range switch position—(1,500 to 2,256 kc/s)

Aerial loading switch, position 1

Aerial (vertical cage type, 6 wires spaced 12 in. diameter, top 50 ft.) Radial earth system.

kc/s.	Pulse Coil.			Tuning					Bias.		Aerial Coupling.	Inputs (mA).			Aerial Current (Amps.).
	Anode.	Coupling.	H.T.	M.O.	INT. AMP	POWER AMP.	AERIAL. Variometer.	AERIAL. Series Condenser	INT. AMP.	POWER AMP.		M.O.	INT. AMP.	POWER AMP.	
1,474	1	6	31	10·86	5·32	4·04	3·41	Nil	10	4	63	50	62	170	4·5
1,506	1	6	31	9·00	5·28	3·98	3·37	Nil	10	4	62	54	62	170	4·6
1,526	1	6	31	7·00	5·00	3·72	2·95	Nil	10	4	60	55	62	170	4·3
1,550	1	6	31	6·00	4·09	3·52	2·65	Nil	10	4	60	56	65	170	4·0
1,577	1	6	31	5·50	4·47	3·23	2·35	Nil	10	4	80	54	60	170	3·8
1,605	1	6	31	5·00	4·14	2·85	2·02	Nil	10	1	80	54	57	170	4·0
1,655	1	6	31	4·50	3·74	2·29	1·68	Nil	10	1	80	58	57	150	3·6
1,717	1	6	31	4·00	3·26	2·07	1·03	Nil	8	1	90	57	65	175	3·7
1,717	1	6	31	4·00	3·31	2·17	1·89	980	7	4	80	60	66	165	4·1
1,792	1	6	31	3·50	2·81	1·71	1·65	980	7	5	120	60	67	170	3·7
1,860	1	6	31	3·0	2·32	1·24	0·96	930	5	3	120	62	76	170	3·6
1,947	1	6	31	2·5	1·[illegible]7	0·94	0·56	980	4	1	120	64	84	150	3·2
1,947	1	6	31	2·5	1·93	2·17	7·13	150	4	5	120	65	75	170	3·4
2,040	1	6	31	2·0	1·51	1·05	5·13	150	3	3	80	65	82	175	3·4
2,165	1	6	31	1·5	1·07	0·47	3·[illegible]9	150	2	1	55	64	92	170	3·2
2,199	1	6	31	1·35	0·95	0·20	2·85	150	1	1	60	62	100	160	2·8

APPENDIX

NOMENCLATURE OF PARTS

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

Ref. No.	Nomenclature.	Quantity.	Remarks.
10A/8151	Transmitter T.77		Complete without valves.
	Principal components :—		
10A/8297	Adaptor, grid, amplifier valve	1	Fitted with one valve-holder 10A/3412 and four resistances, type 82.
	Ammeter, thermo :—		
10A/8160	0 to 4 amps.	2	
10A/7180	0 to 6 amps.	1	
10A/3178	0 to 12 amps.	1	
	Choke, R/F. :—		
10A/8161	Type 15	1	
	Choke, A/F. :—		
10A/7512	Type C	1	
	Coil, inductance :—		
10A/8152	No. 1	3	Amplifier, intermediate circuit and M/O inductances with condenser mounting
10A/8153	No. 2	1	Aerial loading, L.W.
10A/8154	No. 3	1	Pulse coil.
10A/8155	No. 4	1	Aerial inductance.
	Condenser :—		
10A/8098	Type 146	8	1·0μF.
10A/8162	Type 150	1	Variable.
10A/8163	Type 151	3	·01μF.
10A/8164	Type 152	1	·0026μF.
10A/8165	Type 153	2	Variable.
10A/8166	Type 154	1	·0003μF.
10A/8167	Type 155	1	·000192μF. Bank of six units mounted on 10A/8152.
10A/8168	Type 156	2	·00103 μF. Bank of ten units each mounted on 10A/8152.
10A/8169	Type 157	1	·0002μF.
10A/8170	Type 158	3	·00005μF.
10A/8172	Type 160	1	·000106μF.
10A/8206	Type 162	1	·000212μF.
10A/9011	Type 256	26	1·0μF.
10A/8157	Grid-bias unit	2	Complete with 5 resistances, type 322.
	Holder, valve :—		
10A/8173	Type G	3	M/O and intermediate amplifiers.
10A/8174	Type H	1	Power amplifier.
	Insulator :—		
10A/8093	Type 16	1	Aerial lead-in.
	Milliammeter :—		
10A/1504	0 to 100 mA	1	M/O. H.T.
10A/3191	0 to 200 mA	1	Intermediate stage H.T.
10A/3091	0 to 300 mA	1	Amplifier H.T.
10A/3092	0 to 500 mA	1	Total input.

APPENDIX—*continued*

Ref. No.	Nomenclature.	Quantity.	Remarks.
	Transmitter T.77—*continued* Principal components—*continued*		
10A/8068	Panel, rectifying, type A	1	For A.C. supply.
	or		
10A/11156	Panel, rectifying, type B	1	
10A/8207	Panel, dummy	1	Alternative to 10A/8068 when supply is D.C.
10A/8254	Relay, magnetic, type M	1	
10A/8158	Relay, unit	1	Complete with magnetic H.T. switch, one relay, magnetic, type N or 31, 2 condensers, type 146, and 1 resistance, type 127.
	Resistance :—		
10A/7316	Type 30	2	100,000 ohms, 1-watt, rod type.
10A/7766	Type 82	4	40 ohms.
10A/8179	Type 130	2	0·85 ohms, variable.
10A/8253	Type 138	6	1·5 ohms.
10A/8607	Type 153	2	5 MΩ 1-watt, rod type.
10A/9814	Type 300	2	30,000 ohms.
10A/9816	Type 302	2	50,000 ohms.
10A/9820	Type 306	3	20,000 ohms.
10A/9821	Type 307	1	500 ohms.
	Switch :—		
10A/8082	Type 75	2	Gate switch.
10A/8181	Type 78	1	Three-position switch.
10A/9162	Type 97	1	Plug operated. Fitted with socket, type 19.
5C/622	Tumbler	2	
10A/8159	Variometer	4	Aerial, power amplifier, intermediate amplifier, and master-oscillator.
	Voltmeter, A.C. :—		
10A/8183	0 to 15	1	M/O and intermediate amplifier filament.
10A/8184	0 to 20	1	Power amplifier filament.
	Voltmeter, moving coil :—		
10A/7784	0 to 3,500	1	D.C. volts.
	Accessories :—		
5A/1219	Lamp, filament, 230 V., 16 c.p... ..	1	Pilot lamp.
10A/7431	Plug, type 51	1	For 10A/9162.
10A/9167	Disc, indicating, type K	1	For 10A/7431
	Valves :—		
10A/5203	Type V.T.4B	1	Power amplifier.
10A/9122	Type V.T.26	3	M/O and two intermediate amplifiers.
10A/8087	Type V.U.29	2	For rectifying panel.
10A/7510	Type V.T.13C	1	For grid adaptor.
	Controls, remote, ground station :—		
10A/9009	Type 2	1	
	or		
10A/9521	Type 3	1	
	or		
10A/9522	Type 4	1	

December, 1938

AIR PUBLICATION 1186
Volume I
Issued July 1939 with A.L. No. 6

SECTION 1, CHAPTER 3

TRANSMITTER T.1087

Contents

List of Illustrations

TRANSMITTER T.1087

(Stores Ref. 10A./8709)

INTRODUCTION

1. The T.1087 is a ground-station transmitter designed for the transmission of C.W., M.C.W., or R/T on the frequency band 1,500 to 20,000 kc/s. Modulation is obtained from a separate amplifier such as the amplifier portion of Remote Controls, type 3 (*see* appropriate Section of this publication). The output from the amplifier is connected to the transmitter by means of a flexible cable and a plug which is inserted in the jack 6 (fig. 8). The transmitter may be operated either direct or by remote control over land lines. The power is normally obtained from a 230-volt 50 cycle A.C. supply, but D.C. may also be used in conjunction with a motor alternator or suitable convertor.

2. The circuit comprises a master-oscillator stage coupled to an amplifier stage comprising two screen-grid valves connected in push-pull. The output circuit consists of an auto-transformer capacitance-coupled to the amplifier circuit. The auto-transformer is provided with several taps whereby various types of aerial systems may be connected to the transmitter and by means of which the transformer ratio may be varied for matching purposes. A separate valve connected up as a rectifier is used to provide the bias for the amplifier valves.

3. A set of three plug-in coils is provided for the master-oscillator tuning inductance. A set of ten sockets is provided on the transmitter, six of which are used at a time, the coils being provided with a suitable number of lugs. The ranges covered are approximately as follows :—

Number 1 Coil	..	16,666 to 20,000 kc/s (18 to 15 metres).
Number 2 Coil	..	3,000 to 18,750 kc/s (100 to 16 metres).
Number 3 Coil	..	1,500 to 3,000 kc/s (200 to 100 metres).

The number 2 coil is adapted to be plugged into any one of four different positions. The plugs are engraved B, C, D and E to correspond to each of the positions and the corresponding ranges covered are :—

Position B	..	15,789 to 18,750 kc/s (19 to 16 metres).
Position C	..	11,110 to 15,789 kc/s (27 to 19 metres).
Position D	..	7,500 to 11,540 kc/s (40 to 26 metres).
Position E	..	3,000 to 7,500 kc/s (100 to 40 metres).

4. Provision is made for alternative values of master-oscillator anode feed resistances. When coil Number 3 is being used, two 20,000-ohm resistances are available. When the other two coils (Numbers 1 and 2) are used, two 10,000-ohm resistances are used. The resistances are of the vitreous embedded type and may be clipped into position as and when desired. When in circuit, the resistances are connected in parallel. The amplifier coil is built in and is tuned by means of taps, the frequency band being covered by various positions of these taps.

5. When transmitting W/T, the key makes and breaks the H.T., thus interrupting oscillations at the space position of the key so as to facilitate listening-through, but during stand-by periods the oscillations are automatically set up again, so as to maintain the temperature of the components of the tuned circuit of the master-oscillator. This stand-by, or space-tuning frequency is adjustable and will not, in general, be the same as the signalling frequency.

6. The change-over to space-tuning frequency occurs automatically if a pause of more than 10 seconds is made in transmission, when a number of relays included in the circuit are energized and perform various switching operations. In addition to switching over the master-oscillator to the space-tuning frequency, the amplifier is rendered inoperative and the aerial and earth are disconnected.

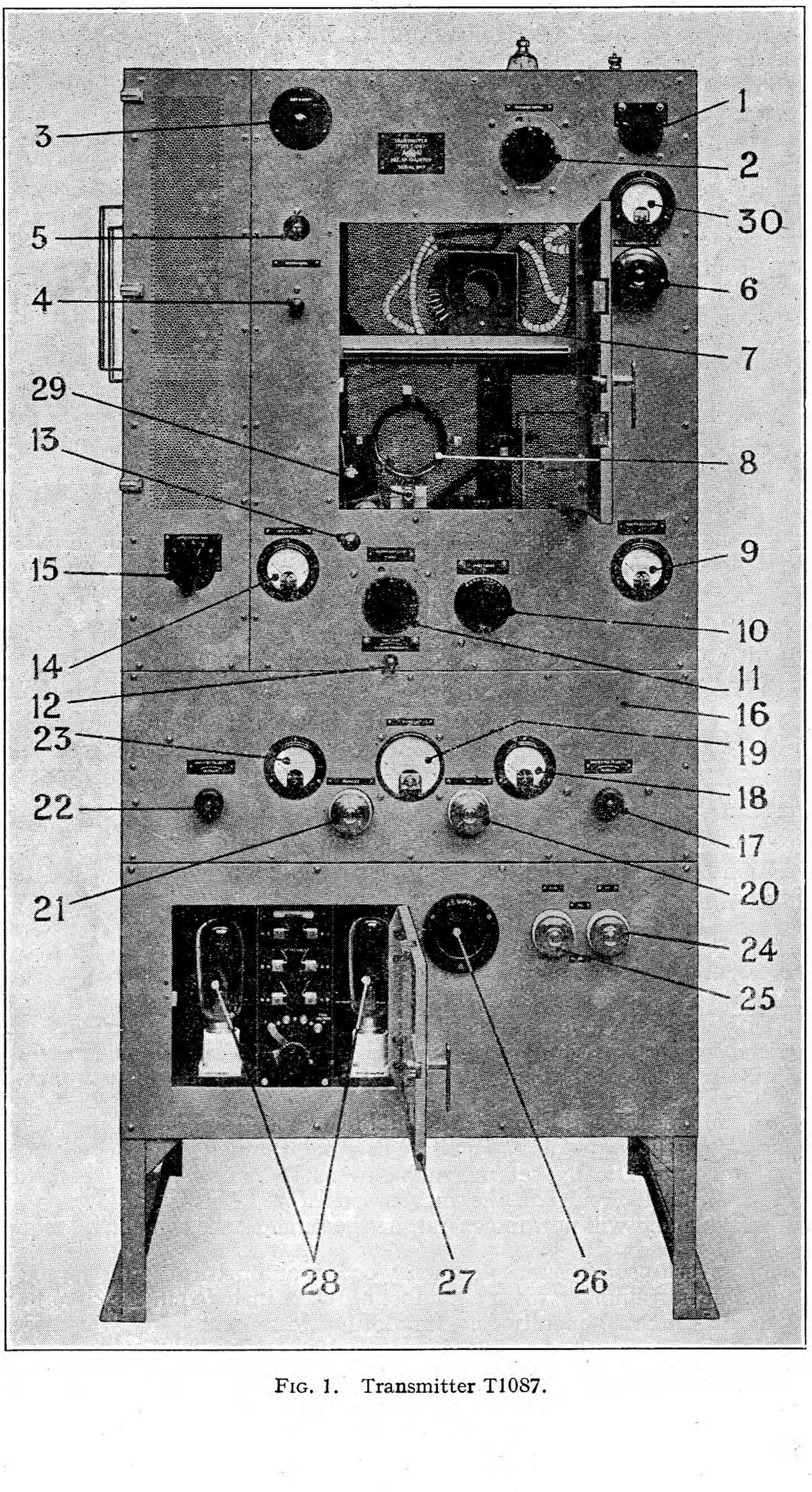
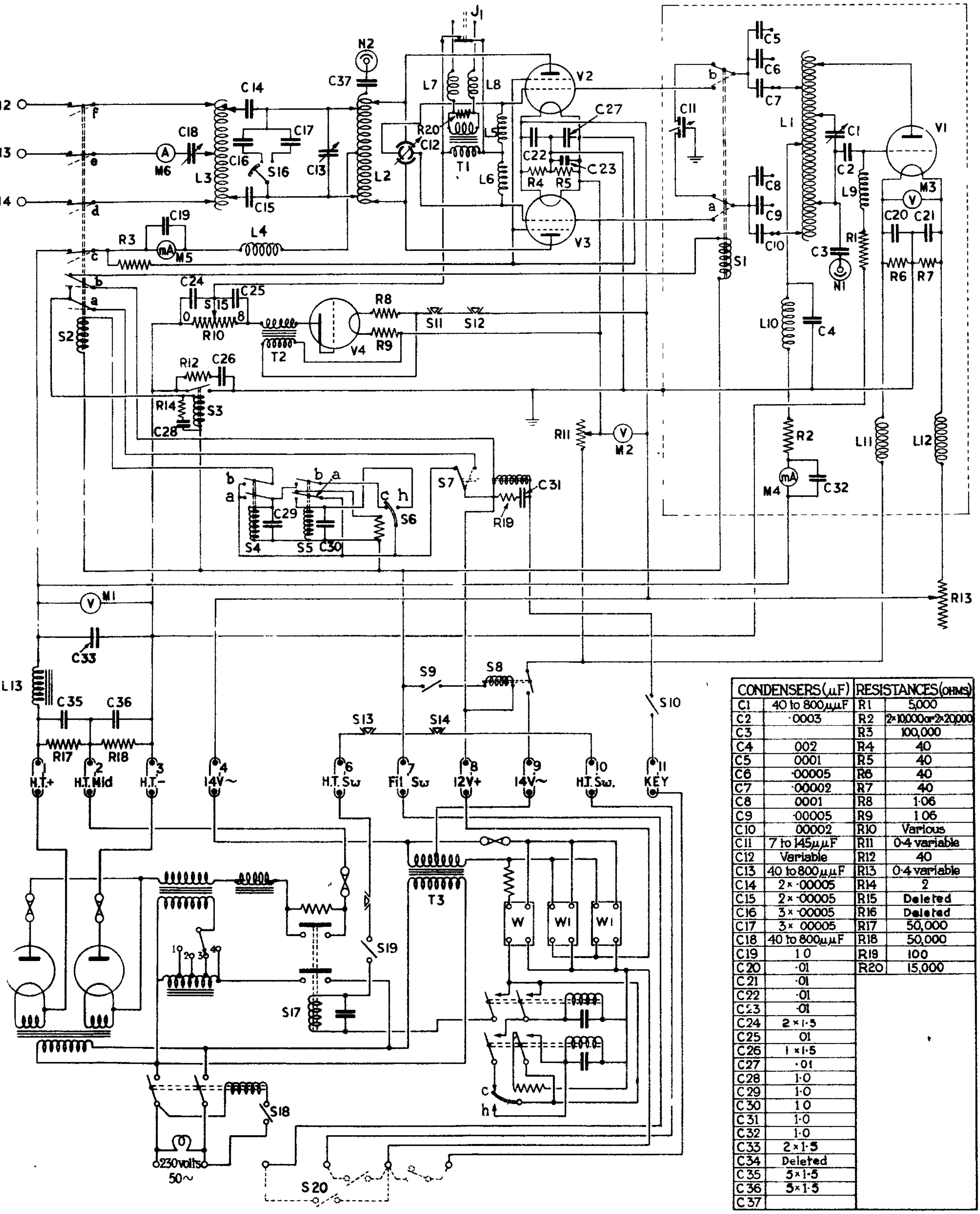


FIG. 1. Transmitter T1087.



CONDENSERS (μF)		RESISTANCES (OHMS)	
C1	40 to 800 μμF	R1	5,000
C2	·0003	R2	2×10,000 or 2×20,000
C3		R3	100,000
C4	002	R4	40
C5	0001	R5	40
C6	·00005	R6	40
C7	·00002	R7	40
C8	0001	R8	1·06
C9	·00005	R9	1 06
C10	00002	R10	Various
C11	7 to 145 μμF	R11	0·4 variable
C12	Variable	R12	40
C13	40 to 800 μμF	R13	0·4 variable
C14	2 × ·00005	R14	2
C15	2 × ·00005	R15	Deleted
C16	3 × ·00005	R16	Deleted
C17	3 × 00005	R17	50,000
C18	40 to 800 μμF	R18	50,000
C19	1 0	R19	100
C20	·01	R20	15,000
C21	·01		
C22	·01		
C23	·01		
C24	2 × 1·5		
C25	01		
C26	1 × 1·5		
C27	·01		
C28	1·0		
C29	1·0		
C30	1 0		
C31	1·0		
C32	1·0		
C33	2 × 1·5		
C34	Deleted		
C35	5 × 1·5		
C36	5 × 1·5		
C37			

FIG. 2. THEORETICAL CIRCUIT DIAGRAM

(F.1799). F. & C. LTD.

GENERAL DESCRIPTION

7. A circuit diagram of the transmitter is given in fig. 2. It consists of a master-oscillator valve V_1 connected up as a Hartley circuit. The tuned inductance L_1 may consist of one of a set of three plug-in coils provided with six tapping points. C_1 is the tuning condenser and C_2 the grid blocking condenser. A neon lamp N_1 is coupled to L_1 by the condenser C_3 and serves to indicate when the master-oscillator is oscillating. The grid leak R_1 and choke L_9 are connected between the grid and H.T.— A connection is made directly from H.T.+ through the anode resistance R_2 and milliammeter M_4, the latter shunted by the condenser C_{32}, to a tap on the inductance L_1, an R/F choke L_{10} and by-pass condenser C_4 being also included in this circuit.

8. Two chokes L_{11} and L_{12} are included in the filament leads of the M/O, while the rheostat R_{13} varies the applied voltage. A filament equalizing unit consisting of the two condensers C_{20} and C_{21} and the resistances R_6 and R_7 is connected across the valve filaments. The voltmeter M_3 indicates the applied filament volts.

9. The M/O and amplifier are capacitance-coupled through the condensers C_5, C_6, C_7, C_8, C_9 and C_{10}, which are so arranged that the appropriate pair is selected by the coil L_1 when it is inserted in position. The relay S_1 has two positions such that when the key is down the relay is energized, and the output from the M/O is connected to the amplifier. If, however, the key is up for more than 10 seconds, S_1 is de-energized and the M/O circuit is connected to the condenser C_{11} and oscillation continues but at some pre-determined space-tuning frequency. Should this cause interference to the reception of weak signals in a near-by receiver, the space-tuning frequency may be adjusted by C_{11} to eliminate such interference.

10. Two screen grid valves V_2 and V_3 are used in the amplifier stage and are connected in push-pull. The filaments are in parallel and are fed from the rectifier unit at the bottom of the transmitter. The unit is Rectifier, type B (Stores Ref. 10A/8067) which is described elsewhere in this publication. A rheostat R_{11} controls the voltage applied to the amplifier valve filaments and also the voltage applied to the filament circuit of the rectifier valve V_4. The volt-meter M_2 measures this voltage. A filament equalizing unit consisting of the condensers C_{22} and C_{23} and the resistances R_4 and R_5 is connected across the filaments of the valves V_2 and V_3. The screen grids of the valves are connected to H.T.+ through the dropping resistance R_3 and are maintained at practically earth potential (R/F) by the condenser C_{27} connected between the screen grids and filament.

11. The socket J_1 provides the means of connecting the output of the external amplifier to the modulating transformer T_1. The two chokes L_7 and L_8 are in series in each side of the primary winding, and a 15,000-ohm. resistance R_{20} is connected across the primary winding to act as a speech improver. When the plug is withdrawn from the jack the secondary winding of the transformer is short-circuited. The amplifier circuit is tuned by means of taps on the coil L_2 and the variable tuning condenser C_{13}. A neon lamp N_2, coupled by the condenser C_{37}, indicates excitation of the tuned anode coil L_2. In addition to the variable condenser C_{13}, two fixed condensers C_{16} and C_{17} are provided. One or both of these may be connected in parallel with C_{13} by means of the switch S_{16}. The various circuit connections to L_2 are made through connecting links. In order to prevent feed-back on the higher frequency settings, a neutralizing arrangement consisting of the differential condenser C_{12} is connected between the anodes and grids of the valves V_2 and V_3.

12. The H.T.+ feed for the amplifier valves is connected to the centre-point of L_2. A milliammeter M_5, shunted by the condenser C_{19}, and a choke L_4 are included in this circuit. Also in this circuit is the contact *c* of the relay S_2. The H.T.— side of the valves V_1, V_2 and V_3 is connected back through the relay S_3, the contacts of which are shunted by the resistance R_{12} and condenser C_{26} in series.

13. Grid-bias for the valves V_2, V_3, is obtained from the rectifier valve V_4. The primary winding of T_2 is connected across the filament supply for V_4 which is obtained from the 50 cycle A.C. mains. The grid and anode of V_4 are strapped together so that the valve functions as a diode. The anode circuit includes the secondary winding of T_2, the grid-bias resistances R_{10} and condensers C_{24} and C_{25}. The end of R_{10} marked 8 is at negative potential with respect to the end marked 0, and the tapping point of R_{10} applies a negative bias to the grids of V_2 and V_3 *via* the chokes L_5 and L_6. When the key is pressed, however, the end of the resistance marked 0 is connected directly to the filament centre-point.

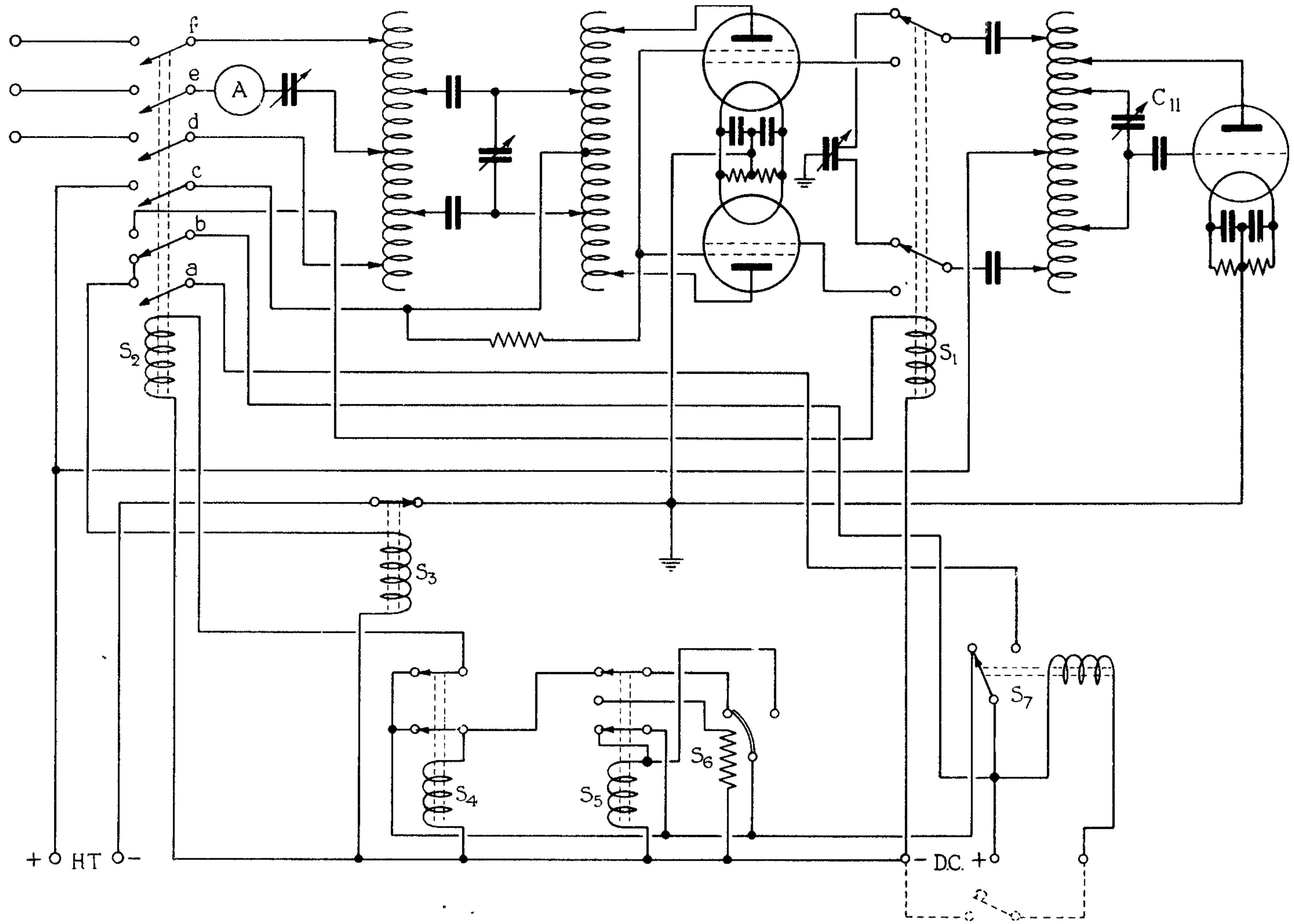
14. The output from the amplifier stage is connected through the blocking condensers C_{14} and C_{15} to the auto-transformer L_3 which consists of a coil, each turn of which is tapped and is provided to enable the transmitter to work into any type of load. The various connections are made by means of sockets, the transformer ratio being varied, for matching purposes, by changing the positions of the sockets on the input side and also those on the output side. Three aerial terminals are provided, two of which are connected by sockets to the output side of L_3 (12 and 14) and the third terminal 13 is connected to L_3 through an ammeter M_6 and variable condenser C_{18}.

15. The terminal 13 is provided to enable an aerial of the $\frac{1}{4}$ wavelength type to be used, for example when working on the higher frequencies. When the aerial is connected to terminal 13, the aerial circuit can be tuned by C_{18}, variation of coupling being effected by adjustment of the taps on the output transformer. If open wire transmission lines are used, they are connected to terminals 12 and 14. When connected thus, it is necessary to use matched ammeters in each of the lines, these being connected externally between the transmission lines and the transmitter.

16. The H.T. smoothing circuit consisting of the choke L_{13}, resistances R_{17}, R_{18} and condensers C_{33}, C_{35} and C_{36} is similar to the corresponding portion of the rectifier, type B. It should be noted that the lower portion of fig. 2 illustrates panel, rectifying, type A (Stores Ref. 10A/8068). Future contracts of the transmitter will have panel, rectifying, type B (Stores Ref. 10A/11156). Both types of panels are dealt with in the chapter on Rectifier, type B contained in this publication. The terminals marked 1 to 11 on the diagram represent the terminals on the transmitter which are connected up by means of links to the corresponding terminals on the rectifier unit. A 14-volt A.C. supply from the transformer T_3 is connected across the terminals 4 and 9. When the gate switches S_{13} and S_{14} are closed across terminals 6 and 10, and the H.T. switches are closed, it is possible for the H.T. relay S_{17} to become energized. A 12-volt rectified D.C. supply is connected across the terminals 7 and 8 in series with the filament switch on the remote control panel. The same 12-volt rectified supply from the metal rectifiers W_1 is connected *via* the terminal 8 through the relay of S_7 and the switch S_{10} to the terminal numbered 11. On closing the key, with S_{10} made, the terminal 11 is connected back to the negative side of the rectifiers W_1 and the relay S_7 operates.

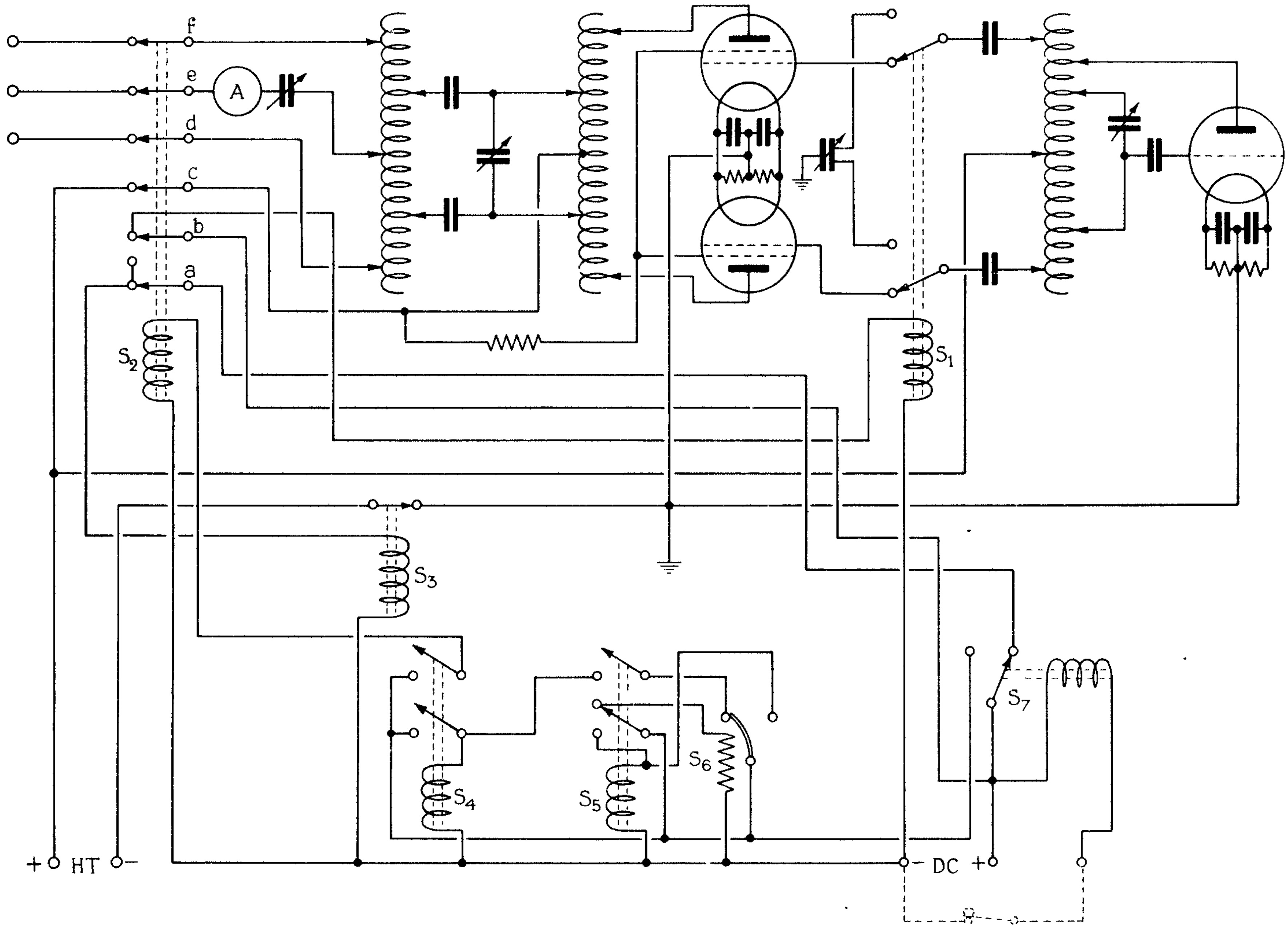
17. When the main A.C. supply is connected to the 230-volt terminals on the rectifier unit, and the switches S_{18} and S_{19} are closed, after a period of about 20 seconds the H.T. supply to the transmitter becomes available. Two simplified circuit diagrams are given in figs. 3 and 4. Fig. 3 shows the condition of the various relays in the transmitter approximately 30 seconds after the switches S_{20} and S_{18} have been closed. The relays S_2, S_3, S_4 and S_5 are energized, the key is up, the M/O valve is oscillating but at some space-tuning frequency determined by C_{11}; the amplifiers are disconnected from the M/O; H.T.+ for the amplifiers is broken at *c* of S_2, and the output circuit is broken at *d*, *e*, and *f* of S_2.

18. A similar circuit is shown in fig. 4 but with the key down. The relays S_1, S_3 and S_7 are energized. The output from the M/O is coupled to the amplifiers, the H.T. circuit of the amplifier valves is made and also the output circuit to the aerial or transmission lines, depending upon what system is being used.



(F.1799). F. & C. LTD.

FIG. 3. SIMPLIFIED CIRCUIT DIAGRAM, TRANSMITTER WARMING UP



(F.1799). F. & C. LTD.

FIG. 4. SIMPLIFIED CIRCUIT DIAGRAM. KEY DOWN

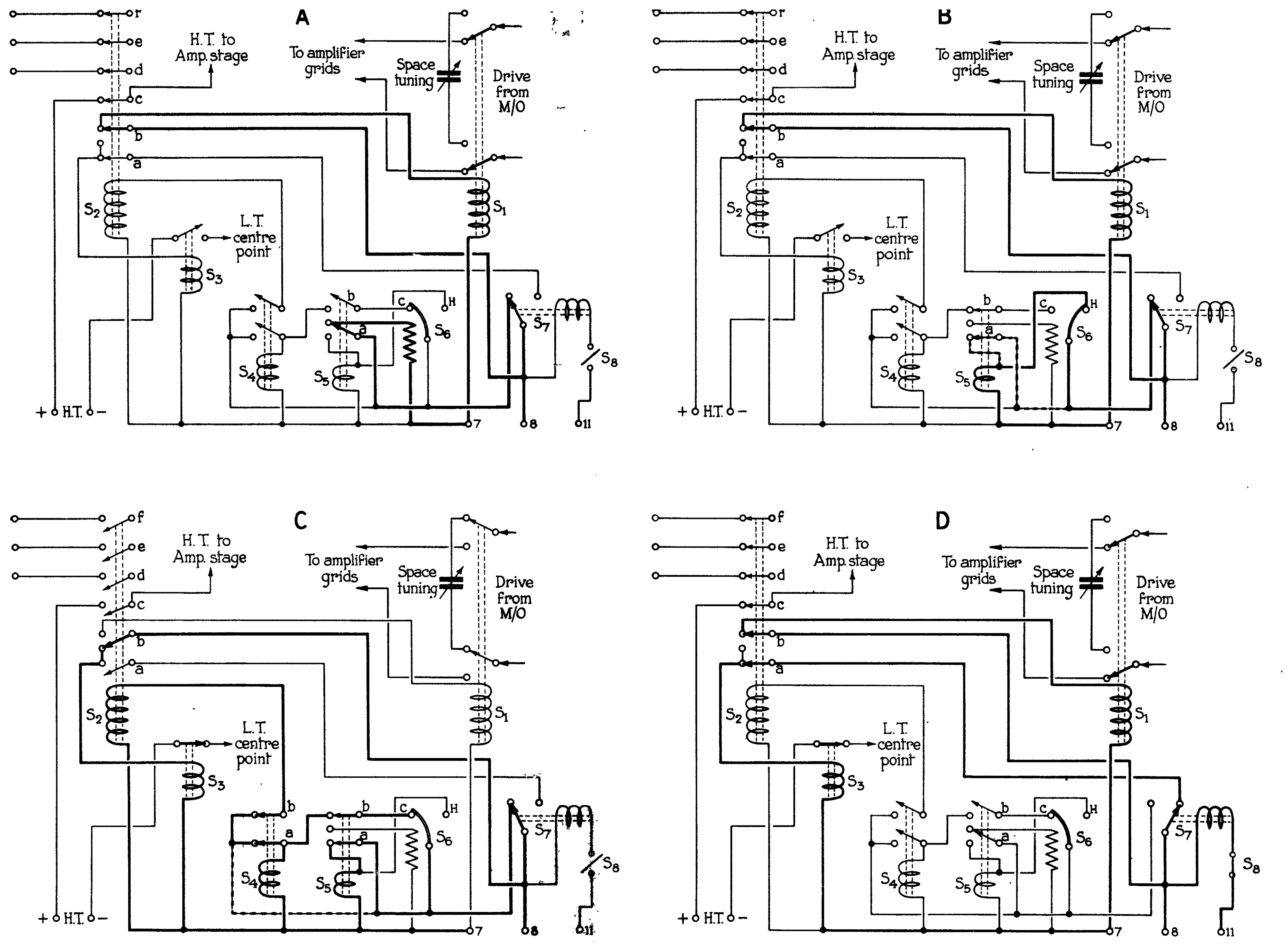


FIG. 5, SEQUENCE OF OPERATIONS DUE TO THERMAL RELAY

(F.1799). F. & C. LTD.

19. Several relays have been introduced into the circuit in order that the M/O circuit components should be maintained at a constant temperature during a pause in transmission. Fig. 5 shows the sequence of operation. As soon as the power supplies are available from the rectifier unit, a 12-volt rectified supply is connected across the terminals (7 and 8, fig. 2), the relay S_1 becomes energized through contact *b* of S_2, the heating element of S_6 becomes energized through contact *a* of S_5 and the open-circuit contact of S_7, and the bi-metal strip starts moving over from the C (cold) to the H (hot) contact of S_6. These conditions are shown at A in fig. 5.

20. When the bi-metal strip reaches the H (hot) contact of S_6, the winding of S_5 becomes energized through this contact and S_7. S_1 remains as before, but the circuit for the heating element of S_6 is broken at *a* of S_5. The relay S_5 is self-locking. As soon as the relay is energized through H of S_6 and S_7, the circuit has two paths, one as shown in heavy lines and the other as shown dotted in B of fig. 5.

21. As soon as S_5 closes, the bi-metal strip starts returning from the H (hot) contact of S_6 to the C (cold) contact. A path is then completed for the winding of S_4 through *b* of S_5, *c* of S_6 and S_7. The relay is self-locking as in the case of S_5, an alternative path being shown dotted (C of fig. 5). When the relay S_4 closes, the winding of S_2 is energized through *b* of S_4 and S_7, the contacts of S_2 move over as shown and relay S_3 becomes energized through *b* of S_2 and the moving contact of S_7. The circuit for S_1 is broken at the same time, at *b* of S_2.

22. This sequence of operations, A, B and C, fig. 5, takes place as soon as the supplies from the rectifier are available and the key is up. When the key is down, however, the conditions will be as shown at D in fig. 5. If S_8 is closed, the 12-volt rectified supply will be connected in series with the key across the winding of S_7 which becomes energized thus breaking the circuits for the relays S_6, S_5, S_4 and S_2. Relay S_3 becomes energized through *a* of S_2 and the closed-circuit contact of S_7, while relay S_1 becomes energized through *b* of S_2 and the moving contact of S_7. The H.T.+ to the amplifiers is made through *c* of S_2 and the aerial system through *d*, *e*, and *f*.

23. The period of delay, that is from the time the supplies are available and the bi-metal strip moves from C to H and back again to C (A, B, C, fig. 5), takes about 10 seconds. It will be seen therefore that if during transmission the key is raised for more than 10 seconds, the M/O circuit will be switched over to the stand-by position (C, fig. 5), and immediately the key is pressed the M/O circuit is switched back to the radiating or transmitting position D, fig. 5. The sequence of operation starts during each space in the signal, but is never completed unless the space period is more than 10 seconds.

CONSTRUCTIONAL DETAILS

Transmitter

24. Several views of the transmitter are given in figs. 1, 6, 8, 9, 11 and 12 and three bench wiring diagrams in figs. 7, 10 and 13. Referring to fig. 1, which is a view of the transmitter from the front, the various controls and instruments may be seen. The transmitter is built up in a duralumin frame-work with perforated metal panels. The overall dimensions are about 5 ft. 10 in. high, 2 ft. 6 in. wide, and 1 ft. 10 in. deep and its approximate weight is $4\frac{1}{2}$ cwt.

25. The switch (1) in the top right-hand corner has three positions engraved A, B and C. Its function is to include one or two condensers as desired in parallel with the amplifier tuning condenser, the control knob of which is at (2). The scale is divided into 100 divisions and a small window indicates the number of complete revolutions made. The neon lamp (3) indicates when the amplifier circuit is tuned. The neutralizing condenser control knob (4) with its scale (5) is mounted on the left.

26. Below the switch (1) is the aerial ammeter (30) reading 0 to 6 amps., and beneath it the aerial condenser tuning control (6). The output auto-transformer (L_3, fig. 2) is seen at (7) and the master-oscillator tuning inductance may be seen at (8). In the bottom right-hand corner of the top section is the master-oscillator H.T. milliammeter (9) reading 0 to 300 mA. To the

left of it is the control (10) for the space-tuning condenser. The master-oscillator tuning control (11) and fine tuning control (12) operate the variable condenser (C_1, fig. 2). The dial is divided into 100 divisions and a window indicates the number of complete revolutions made. The neon lamp (13) indicates when the M/O is oscillating. The amplifier H.T. milliammeter (14) reading 0 to 500 mA is adjacent to the amplifier grid-bias control knob (15). Eight positions are provided on the latter and the dial is engraved accordingly.

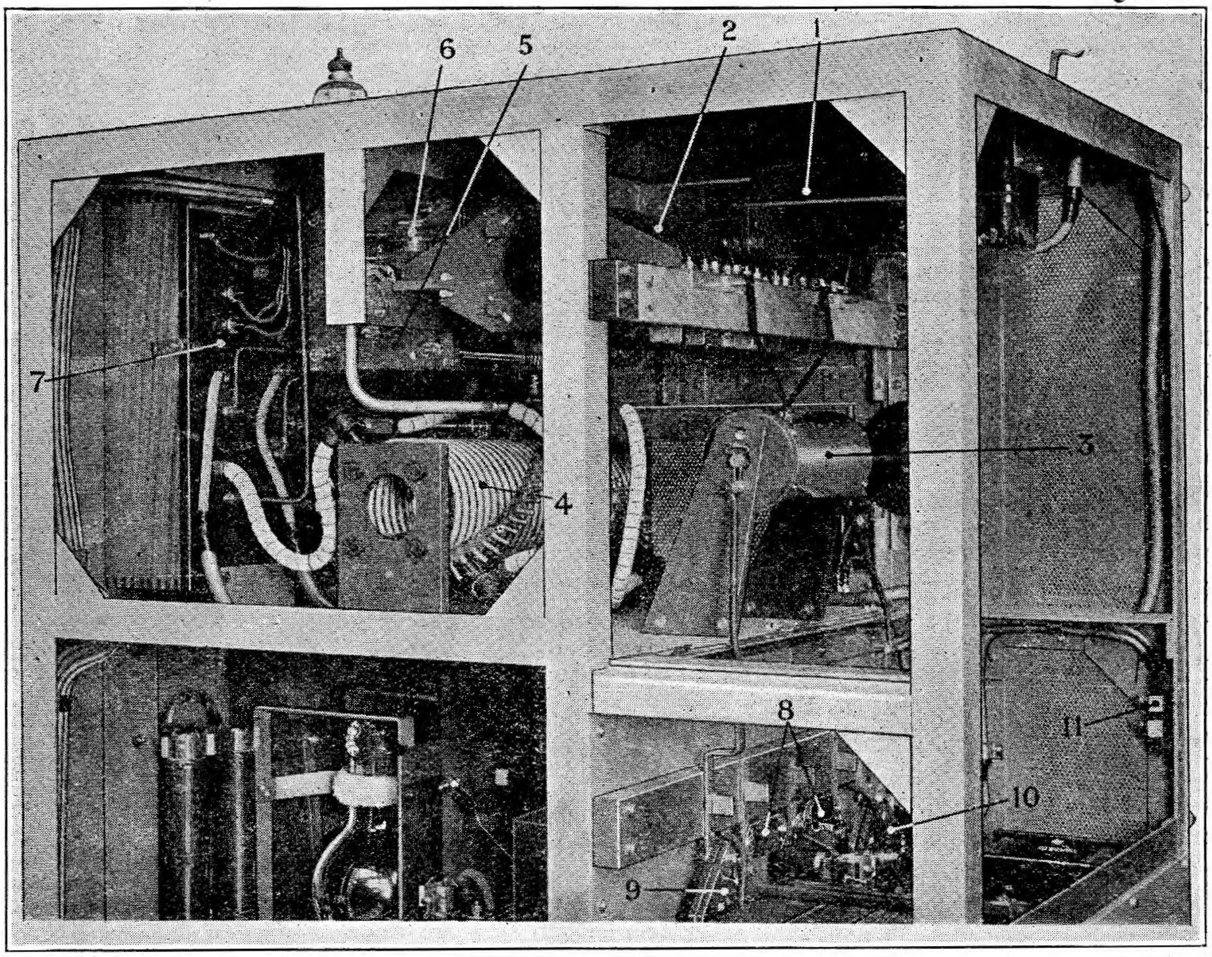
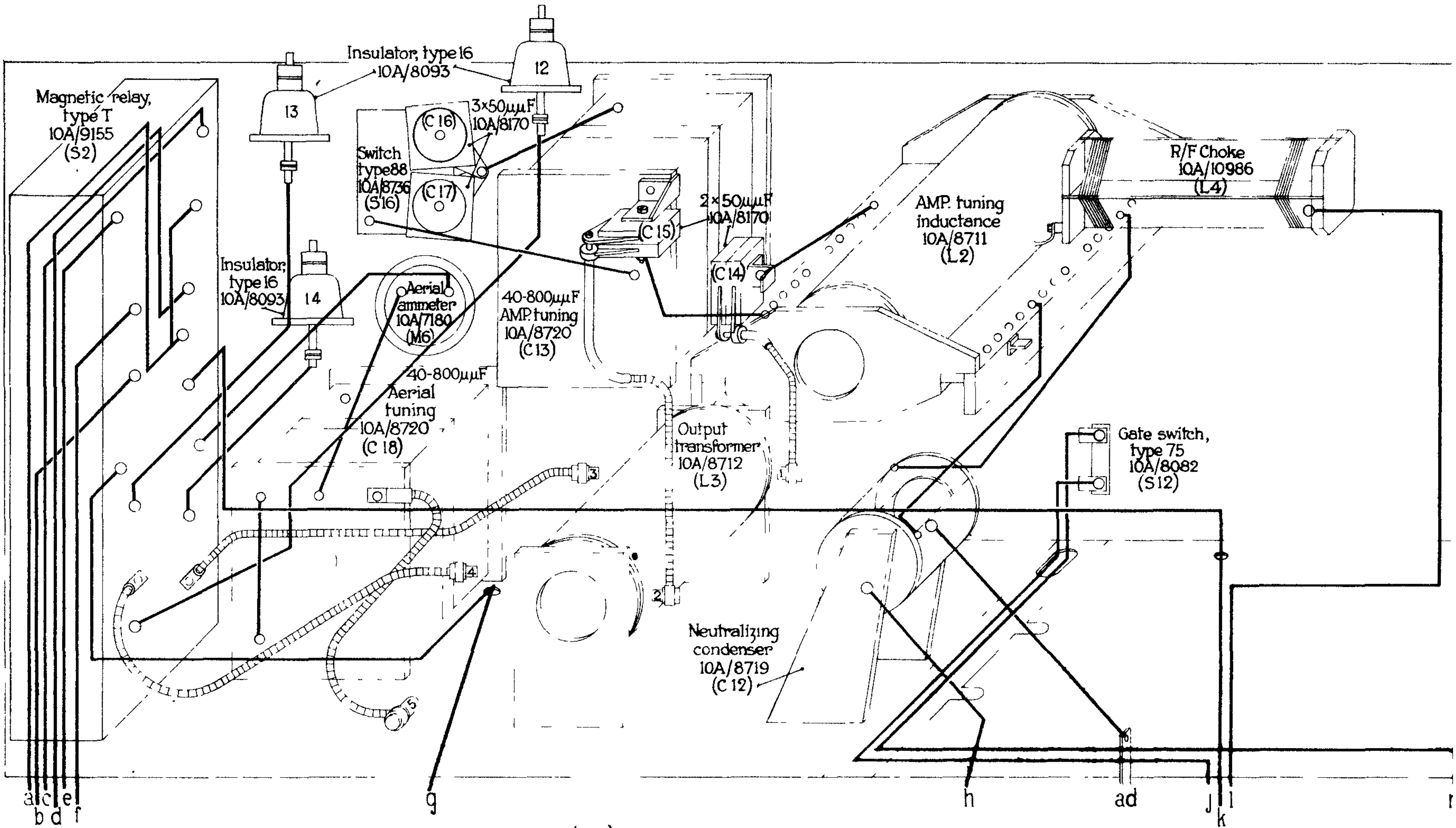


FIG. 6. Interior view of top section.

27. The smoothing unit components are housed behind the panel (16) on the front of which may be seen the M/O filament rheostat (17) and M/O filament voltmeter (18) reading 0 to 15 volts. The H.T. voltmeter (19) is in the centre of the panel and the tumbler switches (20) and (21) on either side of it are engraved KEY and FILAMENT respectively. Mounted on the left of the panel are the amplifier filament rheostat control (22) and the amplifier filament voltmeter (23) reading 0 to 15 volts.

28. The bottom section houses the rectifier components, the two switches (24) and (25) on the right are the H.T. and filament switch respectively. A pilot lamp shows through the window (26) when the main A.C. supply is switched on. Access to the rectifier valves is obtained through the door (27). The two valves (28) may be seen on the left.

29. An interior view of the top section of the transmitter is shown in fig. 6 and a bench wiring diagram of the same section in fig. 7. Referring to fig. 6, (1) is the R/F choke in the amplifier H.T. circuit. The amplifier tuning inductance (2) is on the left of the choke and the neutralizing condenser (3) is below it. The output auto-transformer (4) is mounted below the



NOTE : Annotations in parenthesis, for example (C12), refer to the corresponding annotations in Fig 2

FIG. 7, WIRING DIAGRAM - TOP SECTION

(F.1799). F. & C. LTD.

amplifier tuning condenser (5). The two 50 $\mu\mu F$ condensers (6) are represented by C_{15} in fig. 2. On the left of the illustration is seen the back of the panel (7) on which the relay (S_2, fig. 2) is mounted. In the bottom right-hand corner can be seen the two 40-ohm resistances (8) connected across the amplifier filament circuit, and also the two R/F chokes (9) and (10) connected in the grid circuit of the amplifier valves. The gate switch (11) seen on the right is represented by S_{12} in fig. 2.

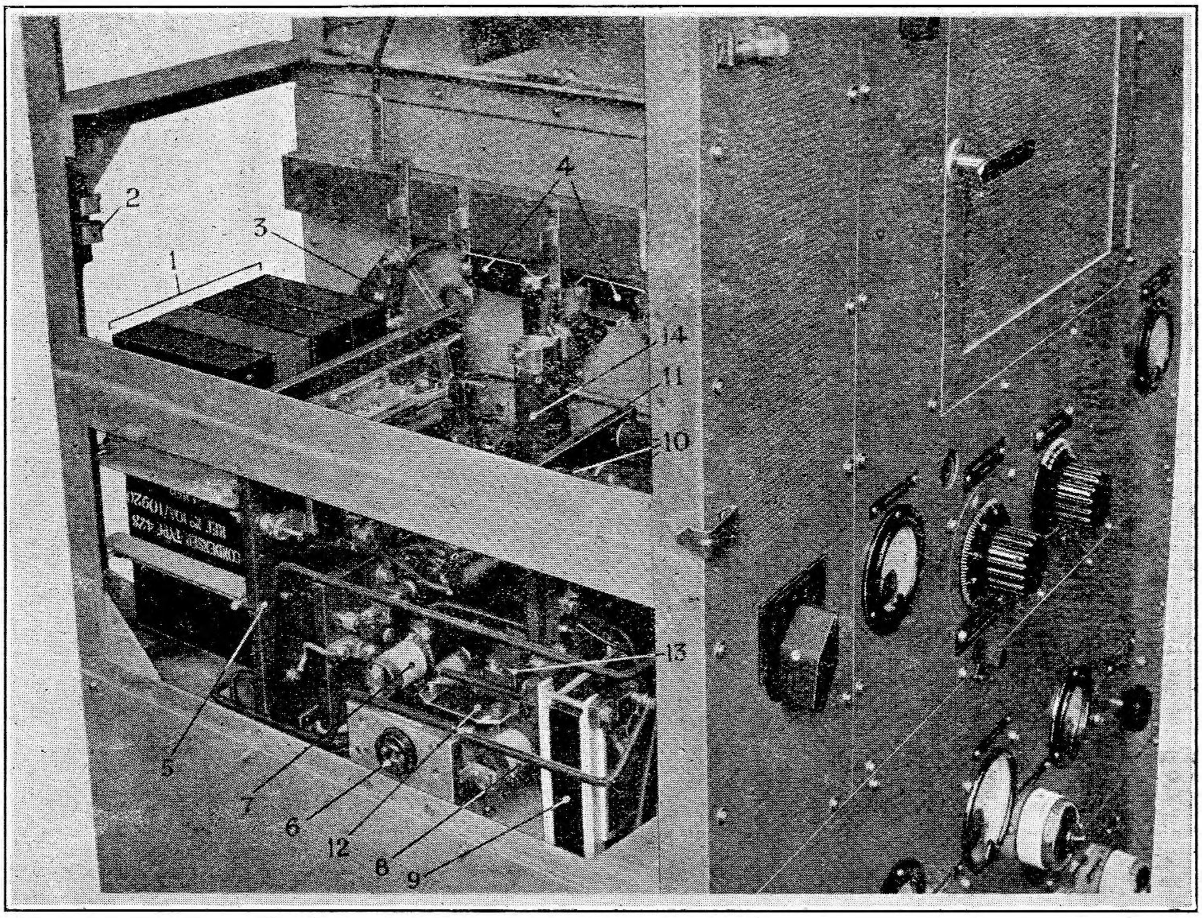


FIG. 8. Interior view of middle section, left-hand side.

30. Three interior views of the transmitter are given in figs. 8, 9 and 11, and a bench wiring diagram of the corresponding section in fig. 10. Referring to fig. 8, the three $1 \cdot 5 \mu F$ condensers (1) are connected up to form the condensers (C_{24} and C_{26}, fig. 2), the condenser nearest the frame being C_{26} and the other two being connected in parallel to form C_{24}. The type 428 condensers illustrated in these figures replace the existing type 256, and form the subject of a future modification. Above the condensers is another gate switch (2). One of the amplifier grid chokes (3) and the filament equalizing resistances (4) may be seen to the right of the condensers.

31. Mounted on the panel (5) are the relays, S_3, S_4, S_5, S_6 and S_7. To the right of the panel may be seen the 2-pole socket (6) into which the external amplifier is plugged. The two chokes (7) and (8) are connected in series with the primary of the input transformer (9). The panel (11) on which the resistances (10) for the amplifier grid-bias unit are mounted, can be seen above the transformer. One of the filament resistances (12) for the rectifier valve (V_4, fig. 2) is mounted on the valve-holder (13). The resistance (14) has a value of 100,000 ohms and is the dropping resistance in series with the H.T. supply to the screen grids of the amplifier valves.

32. In fig. 9, which is a rear view of the middle section, may be seen the two 20,000-ohm resistances (1) which are connected in parallel to form the anode feed resistance for the master-oscillator valve when coil No. 3 is being used. The resistance (2) has a value of 5,000 ohms and is connected with the choke (3) in the grid circuit of the M/O valve. The R/F choke (4) is in the H.T. feed of the M/O and is connected in series with the resistances (1). The M/O tuning inductance (5) is mounted above the M/O tuning condenser (6), and to the right of it is the relay (7) represented by S_1 in fig. 2.

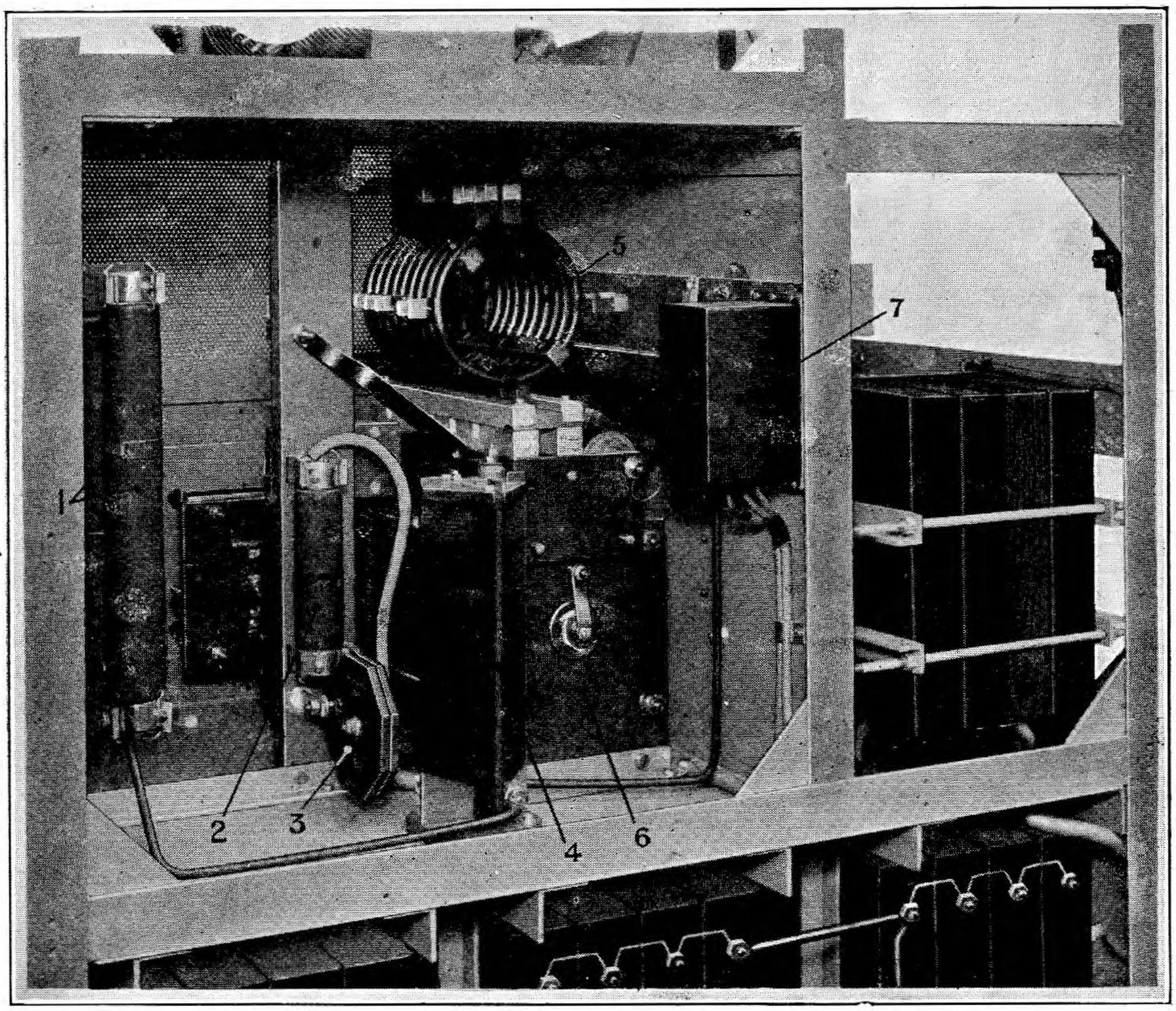
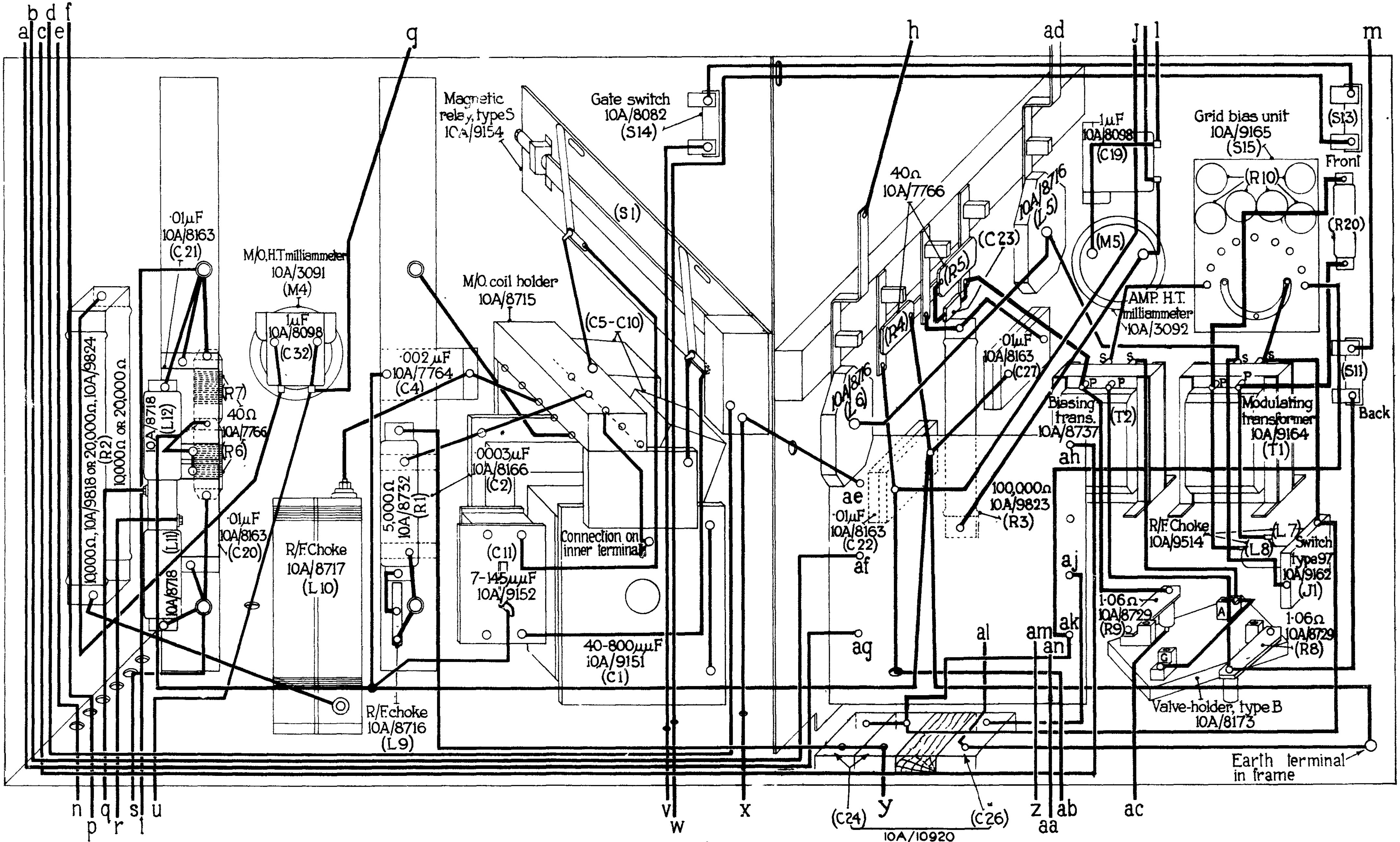


FIG. 9. Interior view of middle section from the rear.

33. Referring to fig. 11, which is an interior view of the transmitter from the right-hand side the filament equalizing unit for the M/O valve can be seen in the foreground. It consists of the two 0·01 μF condensers (1) and the two 40-ohm resistances (2). Mounted near the condensers are two chokes (3) which are connected, one in each leg of the M/O filament circuit. They serve, in conjunction with the by-pass condensers of the filament equalizing unit, to prevent H/F feed-back from the M/O valve. The space-tuning condenser (4) is mounted below the neon lamp (5). The M/O, H.T. milliammeter (6) shunted by the 1 μF condenser (7) may be seen on the left.

34. In the upper portion of the illustration may be seen the aerial tuning condenser (8), aerial ammeter (9) and the relay (10); this relay is represented by S_2 in fig. 2. The three 50 $\mu\mu$F condensers (11) and the three 50 $\mu\mu$F condensers (12) form the condensers C_{16} and C_{17} represented in fig. 2. They are mounted on the switch (13), the blade of which can just be seen. The three aerial terminals (14), (15) and (16) seen above the transmitter correspond to the terminals 12, 13 and 14 respectively in fig. 2.



NOTE : Annotations in parenthesis, for example (C 24), refer to the corresponding annotations in Fig. 2

(F.1799). Wt. 9053. 4,250. 5/43. Gp.959. FOSH & CROSS LTD.

FIG. 10, WIRING DIAGRAM - MIDDLE SECTION

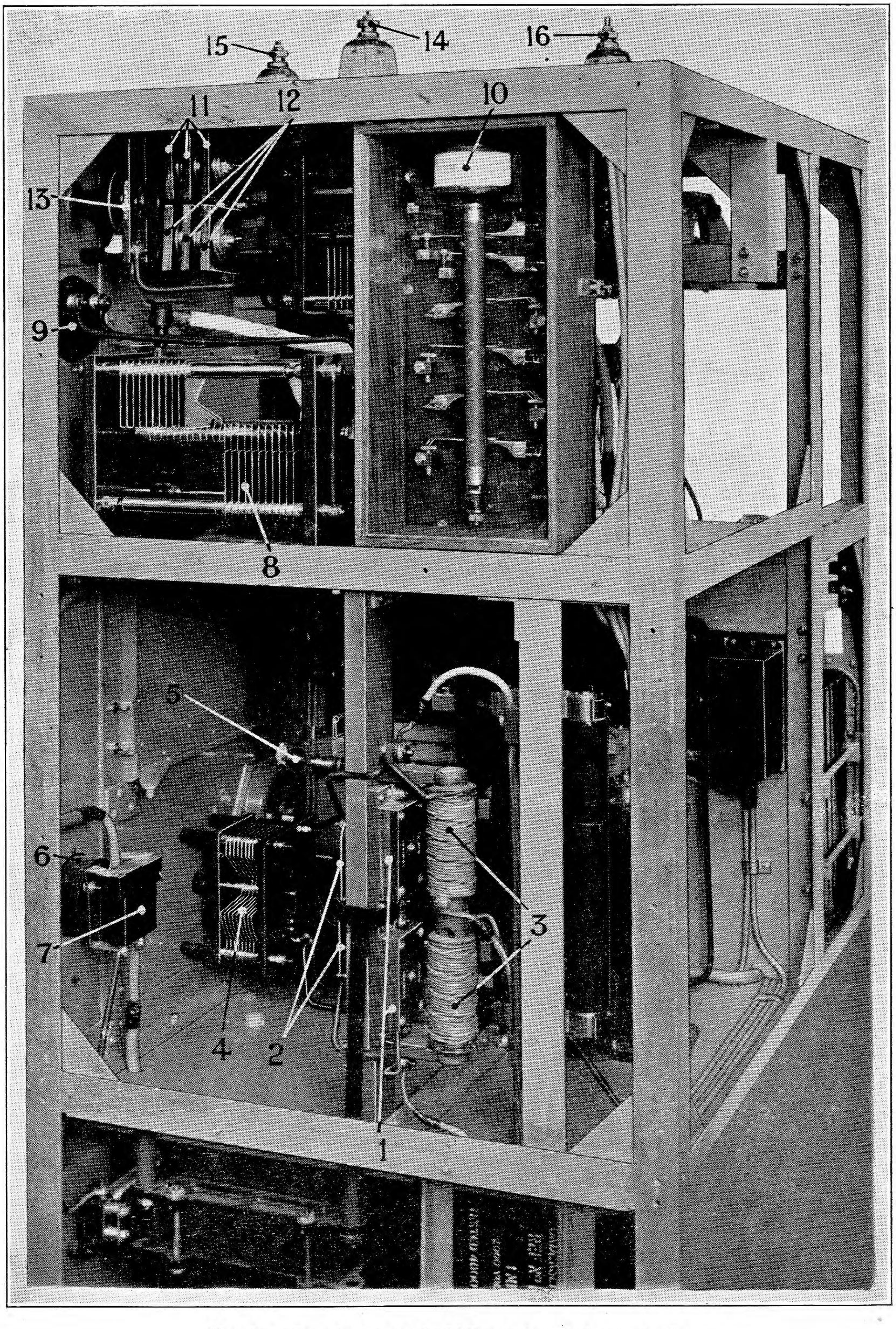


FIG. 11. Interior view of middle section, right-hand side.

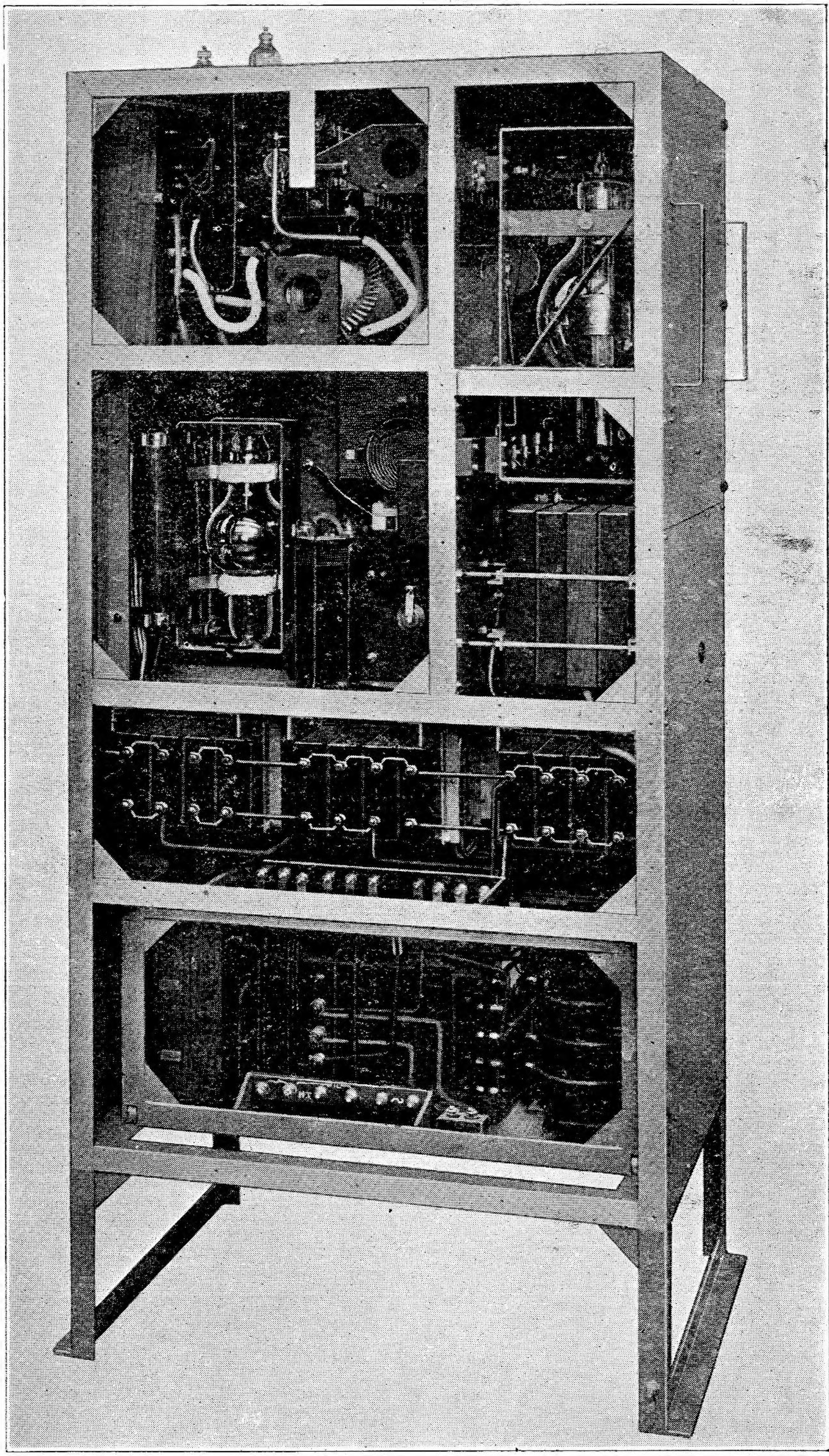
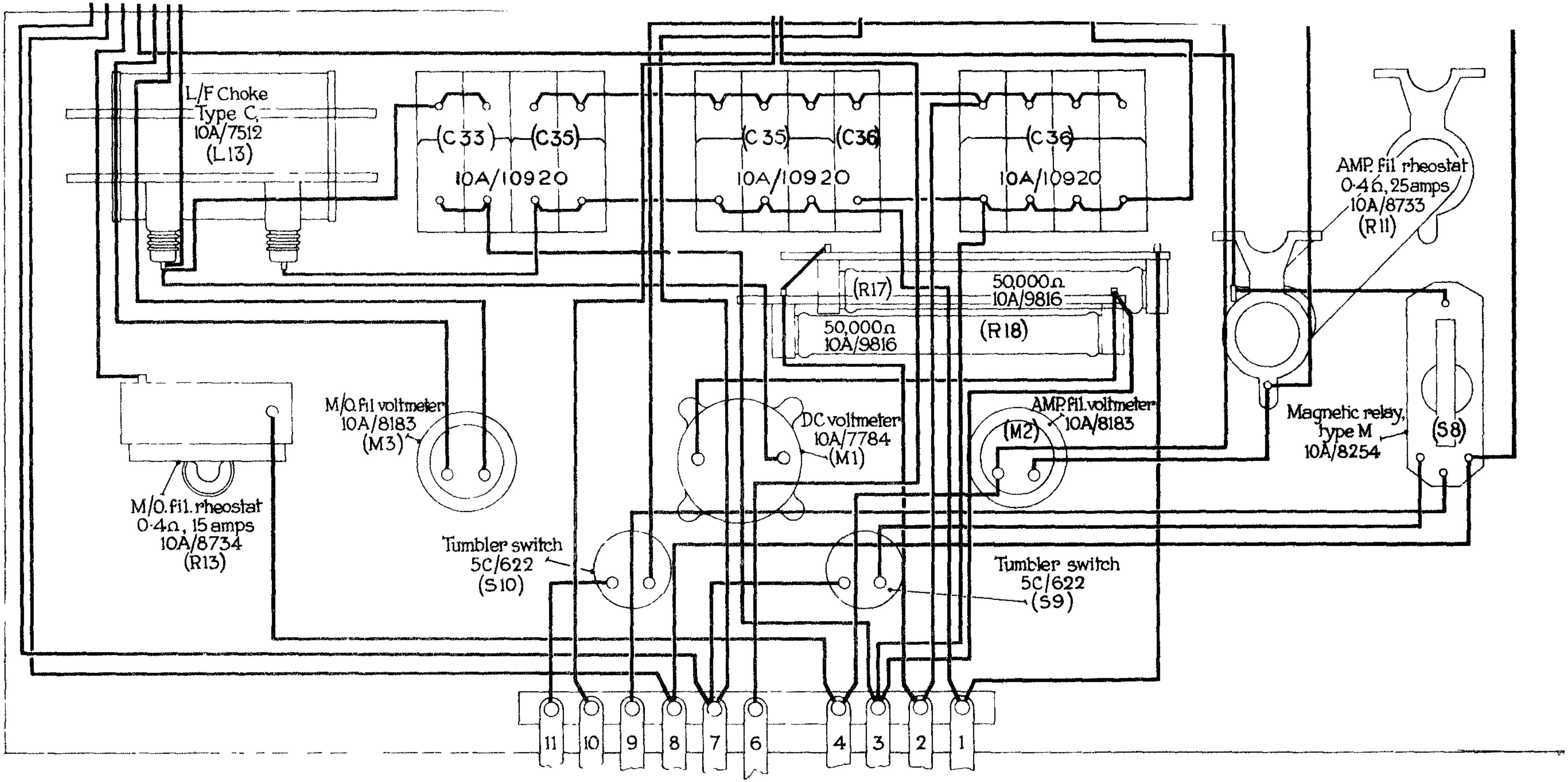


FIG. 12. Rear view of T.1087 with some of the panels removed.



NOTE : Annotations in parenthesis, for example (R13), refer to the corresponding annotations in Fig. 2

FIG. 13, WIRING DIAGRAM - BOTTOM SECTION

(F.1799). F. & C. LTD.

35. A rear view of the transmitter with some of the panels removed is given in fig. 12. The illustration shows the valves in position and also the condensers and resistances which form the smoothing unit. A bench wiring diagram of this unit is given in fig. 13. The rectifier unit is situated below the smoothing unit. It may be withdrawn from the transmitter when desired, the framework being mounted on rollers, two of which may be seen. The rectifier unit and smoothing unit are described elsewhere in this publication.

Coils

36. In order to cover the whole frequency band of the transmitter, the M/O inductance consists of a set of three coils known as No. 1, No. 2 and No. 3. Coils Nos. 1 and 3 are each provided with a set of six contacts, while coil No. 2 is provided with four sets of six contacts, the four sets being engraved B, C, D and E, the lettering corresponding to the various ranges for which the coil may be used.

37. Each coil is a helix, wound on insulating material stiffening pieces. No. 1 coil consists of six turns of 20 s.w.g. copper tube $\frac{3}{8}$ in. dia. and covers the range 16,666 to 20,000 kc/s, the contacts being engraved A. No. 2 coil is wound with nine turns of 20 s.w.g. copper tubing, $\frac{3}{8}$ in. dia., and covers the range 3,000 to 18,750 kc/s, the four sets of contacts being engraved B, C, D and E. No. 3 coil covers the range 1,500 to 3,000 kc/s and is wound with sixteen turns of 20 s.w.g. copper tube, $\frac{1}{4}$ in. dia., the contacts being engraved F.

38. The terminal strip (29, fig. 1) is provided with a set of " C " contacts with which the blade contacts on the M/O coils engage. Access to this terminal strip is obtained through the front door of the transmitter. The right-hand strip is engraved with three lines A–B, C–D and E–F. To insert a coil, first slacken back the thumb-screw, insert the coil in the appropriate set of contacts, i.e. if the No. 2 coil is being used in position D, then the blades engraved D must be inserted in the contacts opposite the line engraved C–D. See that the coil is upright and tighten up the thumb-screw again. When inserting or withdrawing the coil, care should be taken to see that the spacing pieces are not damaged. Always insert or withdraw the coil in a vertical direction and avoid sideways movement.

39. A special stowage case has been provided for the three M/O coils and their associated resistances. The case and coils are illustrated in fig. 14. When the coils are stowed, No. 1 coil is placed over the support (1) so that the stiffening members (2) lie in the grooves of the support. The coil No. 2 goes over the support (3), the same remarks applying to the stiffening members (4). This is arranged so that the blade contacts will not be damaged. Coil No. 3 is inserted in the space (5) with the blade contacts near the panel (6). On the front of the No. 3 coil instructions are engraved stating which resistances should be used. The two resistances (7), when not in use are clipped into the lid of the case.

40. The amplifier inductance, which is a non-interchangeable unit, consists of five separate coils wound with $\frac{1}{4}$ in. dia. 20 s.w.g. copper tube. All five coils are mounted on a suitable support and form one long coil. The arrangement is as follows. A coil of nine turns is followed by one of two turns, then one of eight turns, then one of two turns and lastly one of nine turns giving thirty turns all told.

41. Twenty-six tapping points are brought out to knife contacts which engage with " C " contacts as desired. Looking at the coil from the front of the transmitter there are sixteen knife contacts on the left engraved H, G, F, E, D, C, B, A, A, B, C, D, E, F, G and H. On the right there are ten contacts engraved N, M, L, K, J, J, K, L, M and N. The contacts on the left are the anode taps, and those on the right are the closed circuit taps. H.T.+ is fed to the centre of the eight-turn coil.

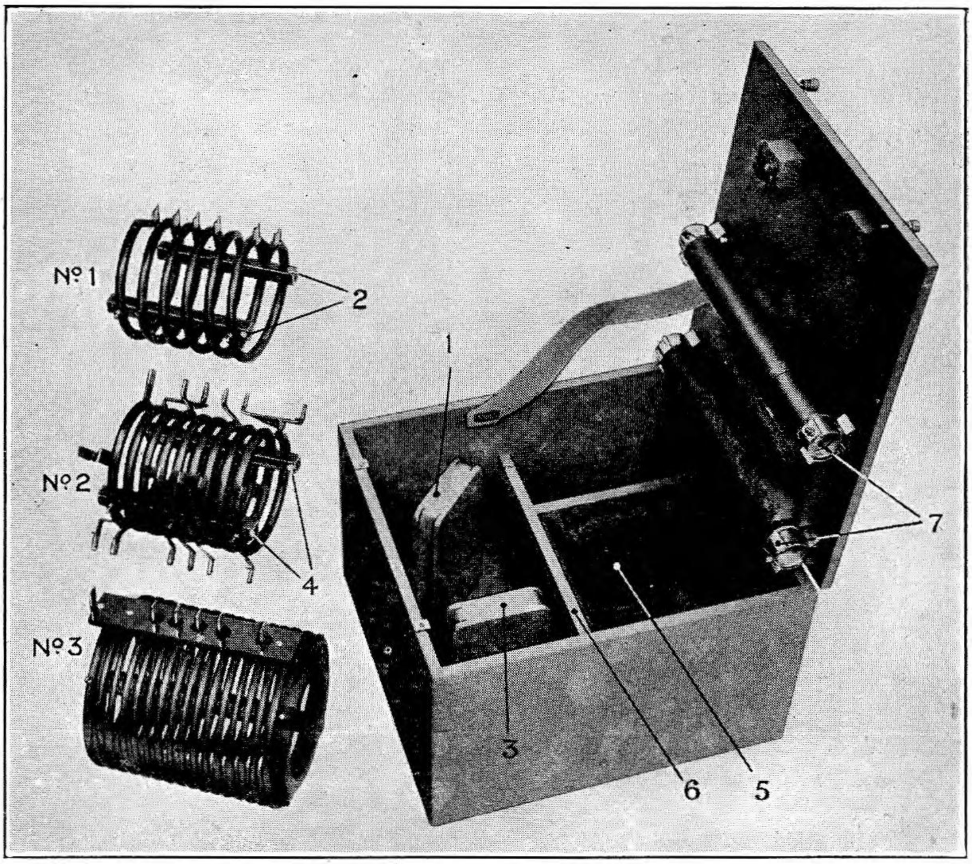


FIG. 14. Master-oscillator coils and case.

42. The auto-transformer output coil is wound with 30 turns of $\frac{3}{16}$ in. dia. 20 s.w.g. copper tube and every turn is tapped. A system of colouring and lettering is employed in order to facilitate connecting up. The taps are brought out to plugs with which sockets may be engaged. Viewing the coil from the front of the transmitter, on the right there are fourteen plugs on white bases, with the letters P to A engraved in black, followed by fourteen plugs on black bases with the letters A to O engraved in white. The sockets (Nos. 3 and 4, fig. 7) can be engaged with any of the white base or black base plugs respectively. On the left-hand side of the coil there are fifteen plugs with red bases engraved with the letters Q to A in white, followed by 15 plugs with yellow bases and the letters A to Q engraved in black. The sockets numbered 1 and 2 (fig. 7) may be engaged with the red and yellow base plugs respectively. One further plug on a green base with the letter X engraved in red is positioned at the centre of the coil.

43. The sockets 1 and 2 are the input sockets and the sockets 3 and 4 the output sockets, when transmission lines are being used. The socket number 5 is used when the usual aerial system is employed. The tables at the end of this chapter show where the various sockets, should be engaged for the various frequencies desired (*see* also para. 77).

VALVES AND POWER SUPPLIES

44. Four valves are used in the T.1087, one as a master-oscillator, two valves in push-pull as the amplifiers and one as a rectifier to supply the grid-bias for the amplifiers. The mercury vapour valves used in the rectifier unit form part of this unit which is described elsewhere. The anode and filament voltages for the four valves in the transmitter are obtained from the rectifier unit.

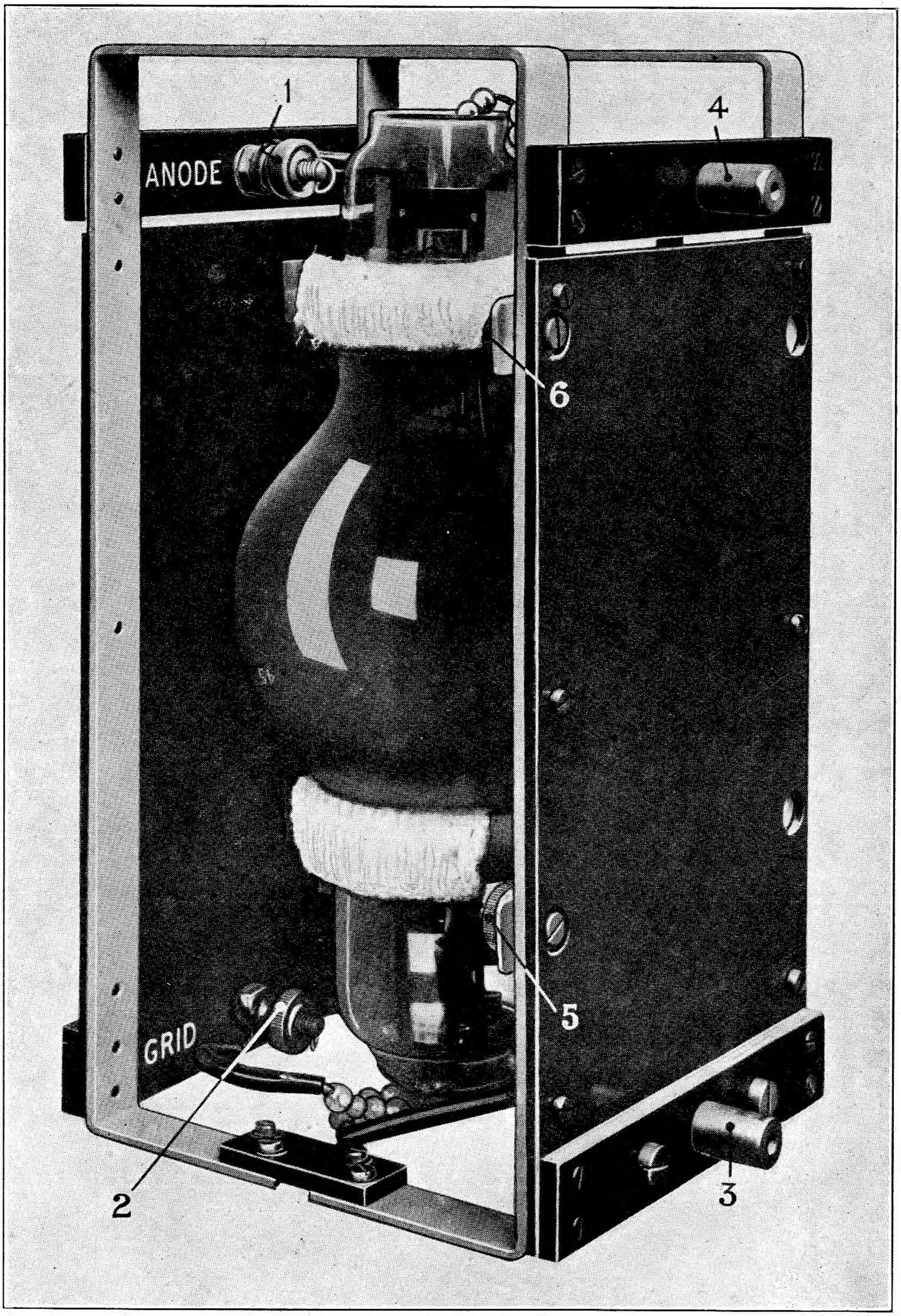


FIG. 15. Master-oscillator valve and valve-holder.

45. The master-oscillator is a valve, type V.T.30, mounted in a special valve-holder. The valve-holder is removable and consists of a box-like structure formed by two strips of metal bent to form a rectangle and provided with two sides. Fig. 15 shows the manner in which the valve is mounted in its holder. Four terminals of the thumb-screw type are provided by means of which the valve is connected in circuit. The anode terminal (1) is on the left, the grid terminal (2) is beneath and the two filament terminals are mounted near each other on the right. The terminals are connected to four cylindrical metal connecting pieces, two of which (3) and (4) may be seen on the right. These two are connected to the valve filament terminals by metal strips. Two similar connectors are provided for the anode and grid.

46. To insert the valve in position, loosen the thumb-screws (5) and (6) on the two movable clips on the frame and displace the clips sufficiently to enable the valve to be inserted. Replace the clips and tighten the screws. Connect the valve leads to the appropriate terminals, keeping the leads as short as possible. To insert the valve-holder in the transmitter rest the top cylindrical contacts of the frame on the top "C" contacts of the supporting pillars inside the transmitter, access being obtained through the door in the top compartment. Push downwards on the frame until these contacts are well home. Rotate the frame about these contacts until the two bottom cylindrical contacts on the valve-holder engage the two bottom "C" contacts on the supporting pillars and push them well home.

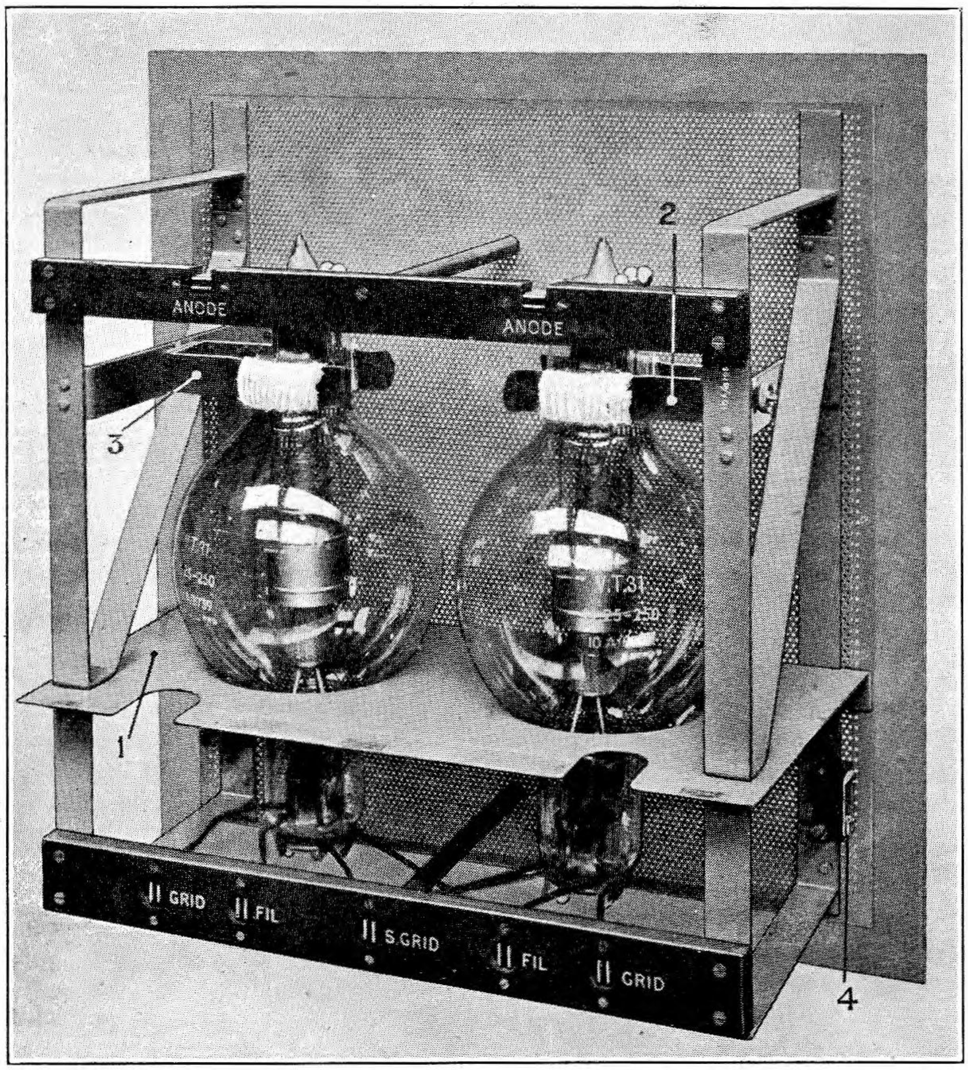
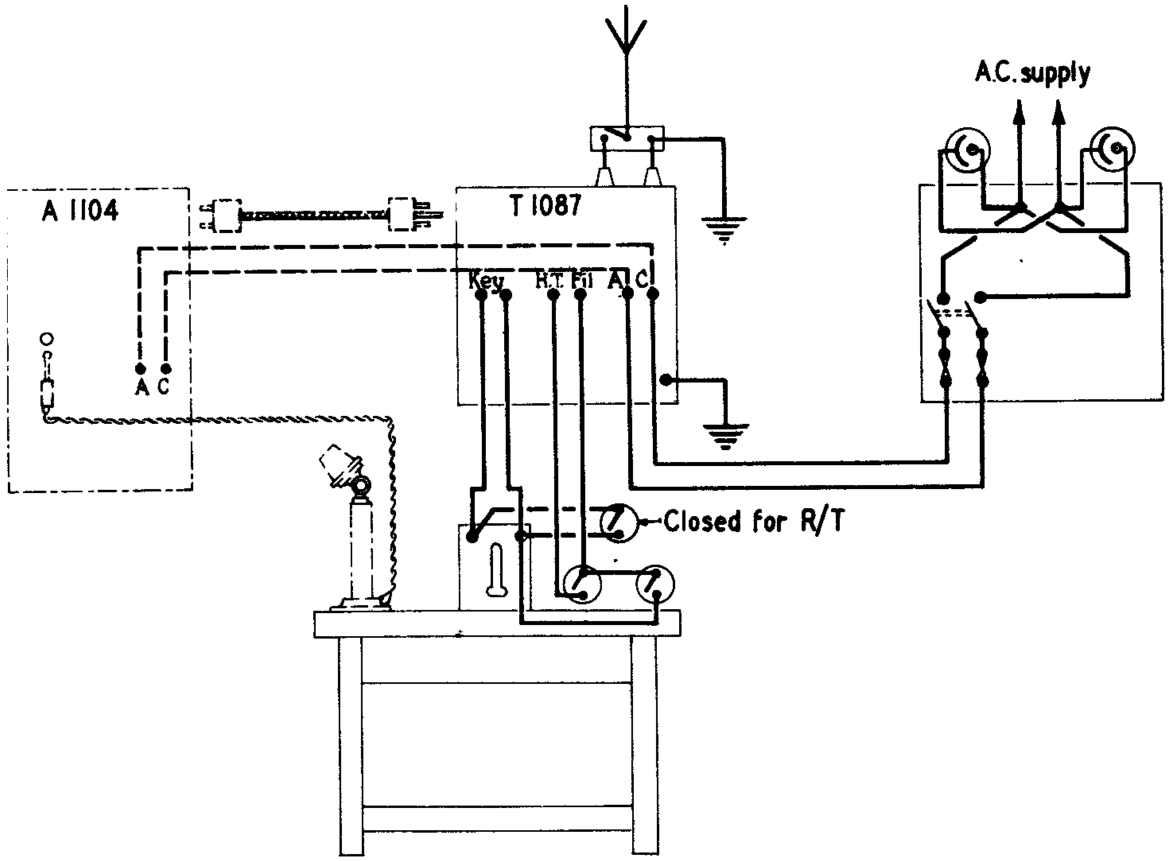
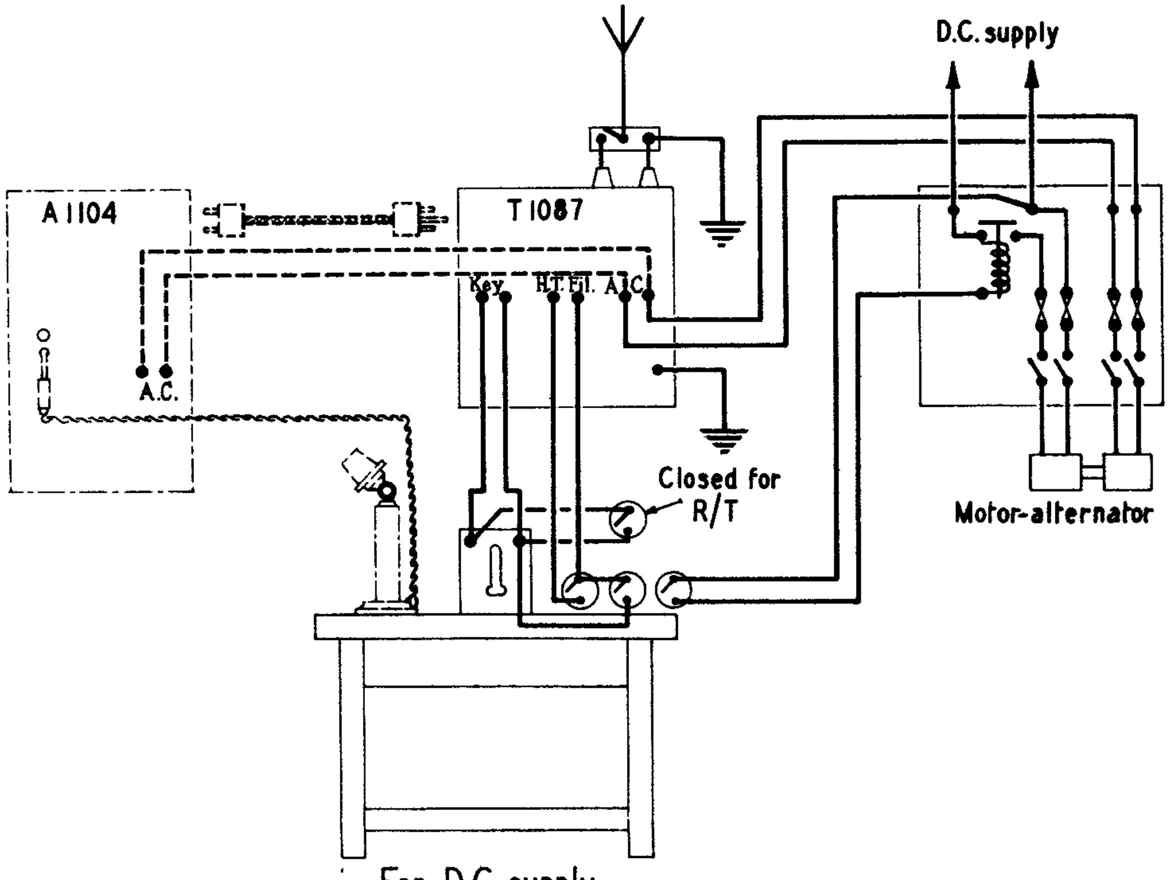


FIG. 16. Amplifier valves mounted on panel.



For A.C. supply 230 V. 50~



For D.C. supply

FIG. 17, TYPICAL INSTALLATION FOR LOCAL CONTROL

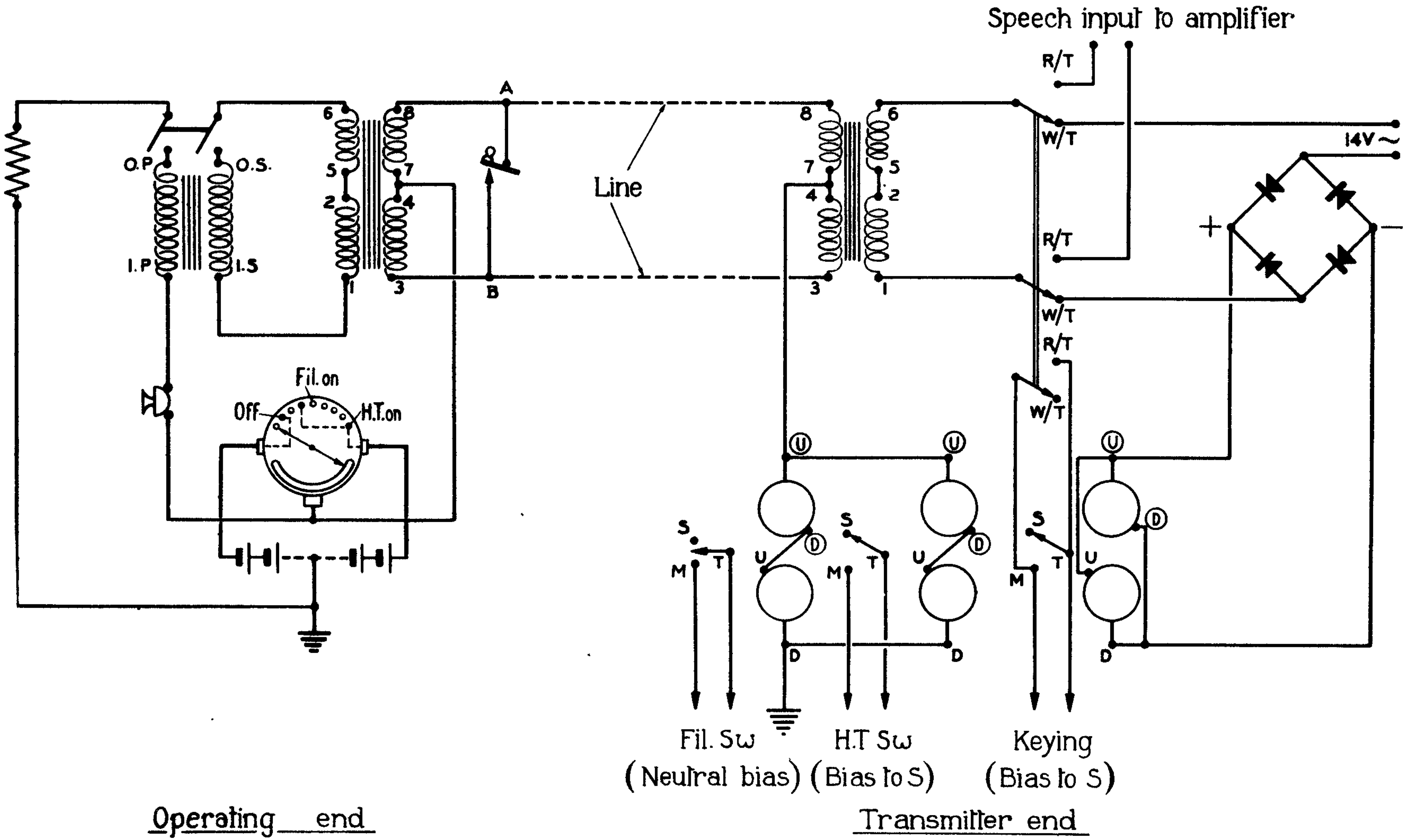
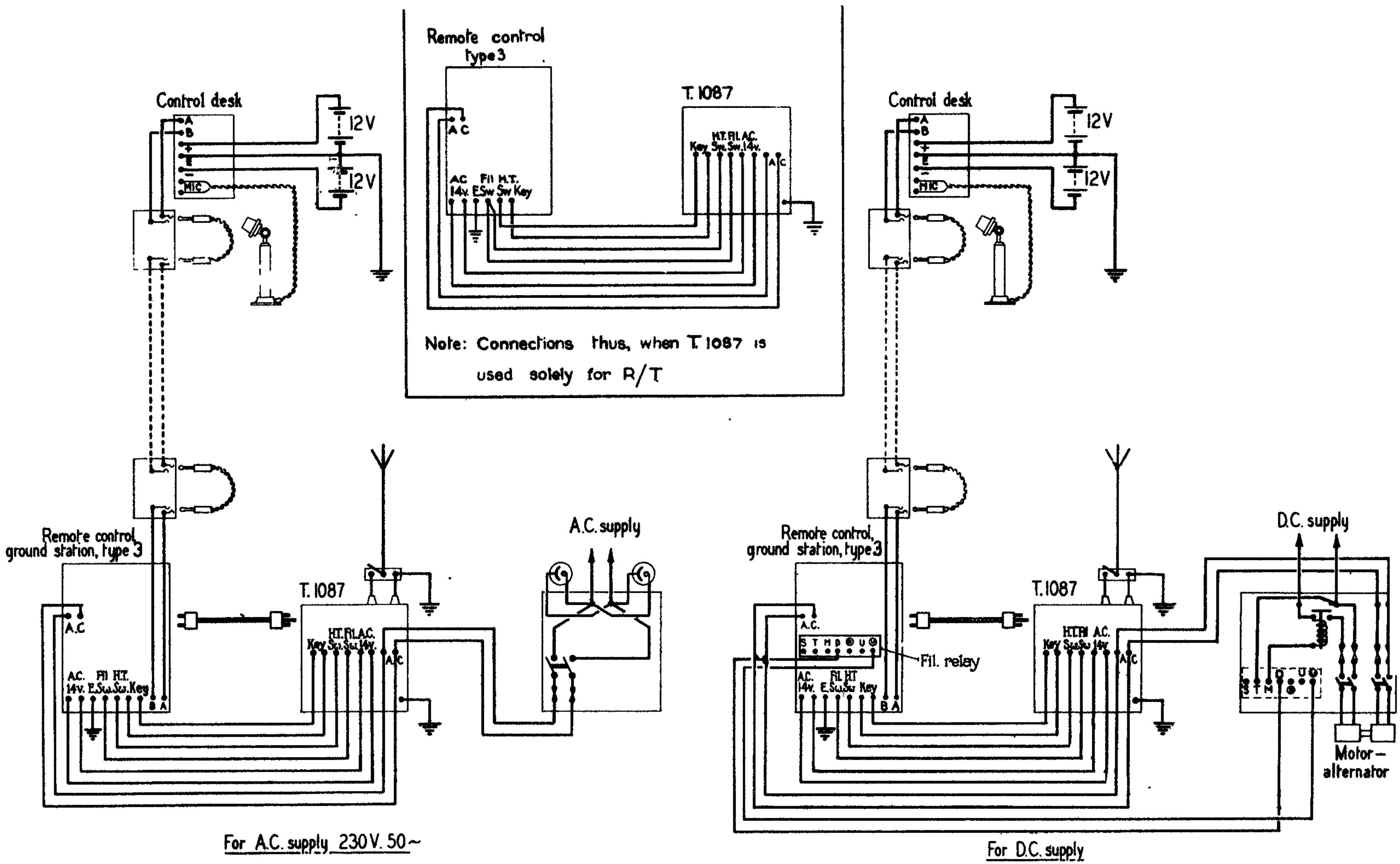


FIG. 18. SCHEMATIC OF REMOTE CONTROL

(F.1799). F. & C. LTD.



(F.1799). F. & C. LTD.

FIG.19. TYPICAL INSTALLATION FOR REMOTE CONTROL

47. Two V.T.31 valves are used for the amplifiers. The valves are mounted in a removable frame, and the various electrodes are connected to " C " contacts which engage blade contacts on the transmitter when the frame is in position. The frame is secured to a perforated metal panel which is held in position on the transmitter by seven spring clips.

48. Referring to fig. 16, it will be seen that the anodes of the valves are brought out to two " C " contacts supported in a strip of insulating material and appropriately engraved. Since the screen-grids of the valves are connected together, one " C " contact is provided. The remaining four " C " contacts on the bottom strip are self-explanatory.

49. To insert the valves in position, slacken the thumb-screws on the valve clips. Insert the filament ends of the valves through the holes provided in the screening panel (1) and rest them on the pads provided. Place the clips (2) and (3) on the tops of the valves and secure them in position by means of the thumb-screws. Connect the valve leads to the appropriate terminals, keeping the leads as short as possible. Hold the frame by means of the two handles provided and push the panel well home so that the " C " contacts engage properly with the blade contacts on the transmitter. Make sure that the blade contact (4) engages with the " C " contacts (2, fig. 8).

50. The rectifier valve which is a type V.T.25 valve is inserted in an ordinary valve-holder type G, wired up in the usual manner. The filament voltage required for the M/O valve is 12·5 volts, the filament voltage for the amplifiers is 11·25 volts, and for the rectifier valve a filament voltage of 8 volts is required.

INSTALLATION

51. The transmitter can be operated locally or by means of remote controls. When remote operation is required, remote controls, types 2 or 3, are employed. The usual procedure is to operate the transmitter remotely, but should the remote cable break down, or for any reason remote operation become impossible, then the transmitter may be operated locally. For R T or M.C.W., the amplifier portion of remote controls, type 3, is essential. As the remote control unit is always installed near the transmitter, both local and/or remote operation is possible.

With local control

52. A typical diagram for local control is given in fig. 17. Both D.C. and A.C. systems are shown but when D.C. is used, the supply is connected to a motor-alternator to produce A.C. which is used to operate the transmitter. The D.C. mains must not be connected directly to the transmitter else the transformer for the biasing valve will be ruined. The portion shown dotted represents the amplifier A.1104 and its connections. The A.1104 is a portion of remote controls, type 3, and it is essential to this transmitter when R/T or M.C.W. is desired.

With remote control

53. When the transmitter is arranged for remote control, the method of wiring shown in the simplified circuit in fig. 18, will normally be used. In this method one pair of leads between the operating station and the transmitting station is used for each transmitter. Through this pair and an earth connection, the filament and H.T. relays are operated, the transmitter is keyed and R/T modulation is performed. For the latter purpose the pair is connected at each end to one winding of a repeating coil.

54. The relays controlling the filament and H.T. supply to the transmitter are operated by direct current derived from a battery at the operations end of the line. The battery is connected between the centre point of the line winding of the repeating coil at the operations end and earth, and the relays are connected in parallel between the centre point of the line winding of the repeating coil at the transmitter end and earth. The direct current to operate the relays thus divides equally in the two lines and there will be equal currents in opposite directions in the half windings of the repeating coil, and the core will not, therefore, be magnetized.

55. A typical installation for remote controls is shown in fig. 19. The circuit, shown in fig. 18 is incorporated in the controlling desk at the operations end, and a circuit diagram of this apparatus is given in fig. 20. A receiver will normally be fitted up on the same desk.

56. In an installation using a D.C. supply, a further relay with neutral bias, is connected in parallel with the filament relay at the transmitter end to operate the starter of the motor-alternator, as shown in fig. 19. Thus when the switch, type 44, at the operations end is placed in the central position (engraved GEN. RUNNING), the motor-alternator is started. When the switch is used in conjunction with A.C. mains, the engraving should be interpreted as " filaments on ". For a description of and the manner in which Remote Controls should be used, reference should be made to the appropriate section of this publication.

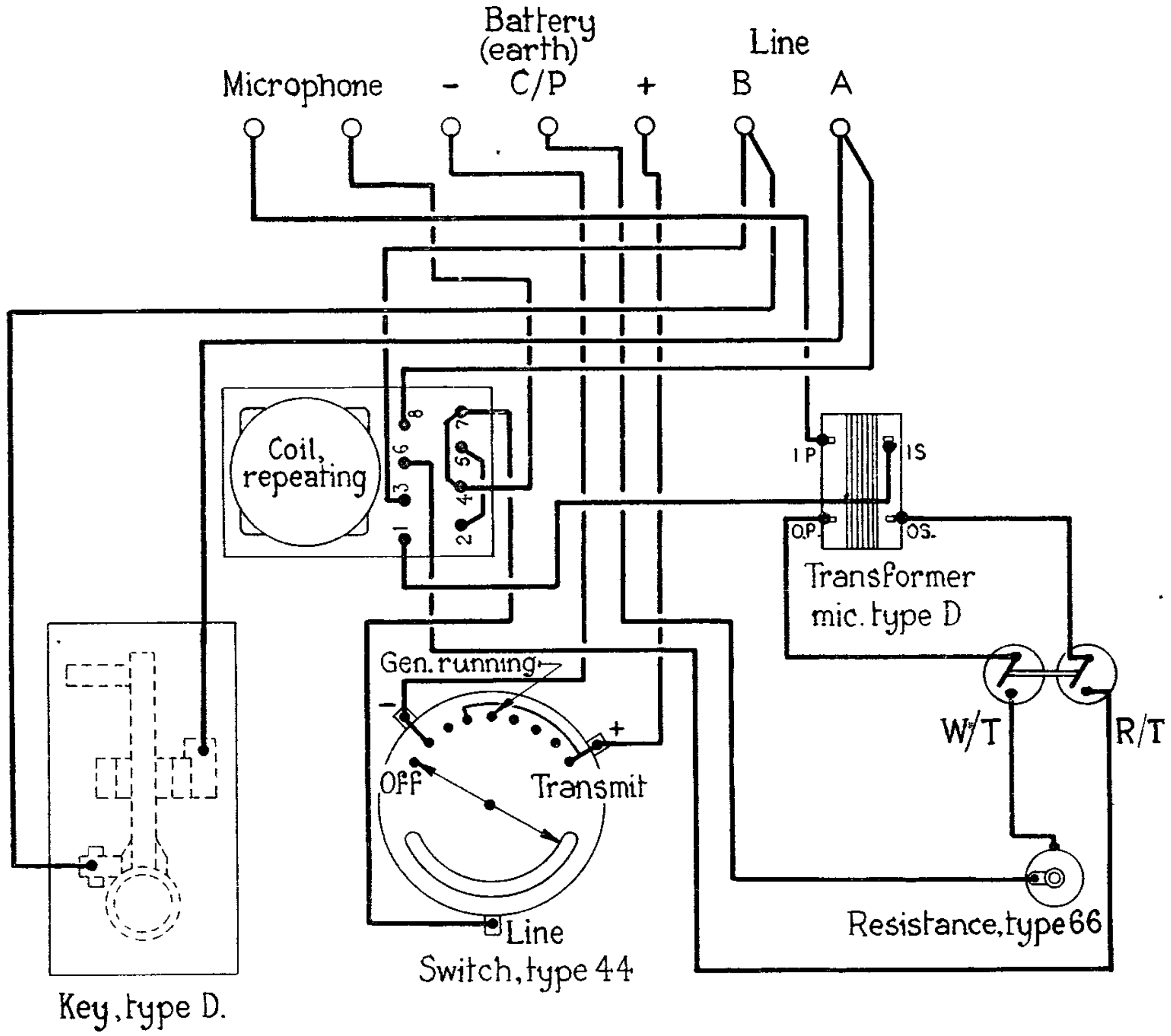


FIG. 20. Circuit diagram of apparatus on Control desk.

OPERATION

Preparation for tuning

57. Before the transmitter is ready for tuning, certain preliminary operations must be performed. Insert the M/O valve as described in para. 46 ; insert the amplifier valves as described in para. 49. Insert the neon lamps—a lamp has to be inserted in each of the positions (3) and (13) (fig. 1). Each lamp screws into a holder incorporating a cylindrical condenser and mounted by its single contact screw. The holder may be removed after loosening the nut on the contact screw, the neon lamp screwed in, and the holder replaced.

58. Insert the biasing rectifier valve in its holder insert the two V.U.29 power rectifying valves in their screwed sockets. Insert the pilot lamp and the fuses in the rectifier panel. There are four of these fuses and each one should carry two strands of 33 s.w.g. tin wire. Make sure that all switches are off, and that bias is on stud 8.

To set up the transmitter for C.W. (Local Control)

59. Connect a 230-V. 50 cycle A.C. supply to the two terminals engraved accordingly at the bottom of the transmitter. Connect the H.T. and filament switch terminals (i.e. the second, third and fourth terminals counting from the left) together by a piece of 16 s.w.g. tinned copper wire. Connect a morse key across the terminals engraved KEY, now close the main A.C. switch, and the pilot lamp in the rectifier should light up.

60. In the following paragraphs all annotational references refer to fig. 1. Close the rectifier filament switch (25) and the delay action referred to in para. 17 starts. Close the transmitter valve filament switch (21), and check the filament voltage on the M/O and Amplifier valves. The M/O filament volts may be read on (18) and should be adjusted by the control (17) to read 12·5 volts. The amplifier filament volts may be read on (23) and should be adjusted by the control (22) to read 11·25 volts.

61. Place the rectifier H.T. switch on stud 1, close the door (27) and switch on the rectifier H.T. by means of the switch (24). The H.T. volts read on (19) should be about 1,900. This is the " no-load " H.T. voltage. When the M/O is switched on to the space-tuning frequency, the voltage will drop to about 1,700 volts.

62. Switch on the key switch (20). This switch is in series with the key which should be up. Switch off H.T. at (24) and tap the key, now insert the appropriate M/O coil, set the various tappings, and adjust the controls by reference to the Tables. Close the rectifier H.T. switch (24) and, after the necessary time delay has occurred, the relays in the transmitter will operate to transfer the M/O circuit to the space-tuning frequency as described in para. 19 *et seq*. The neon lamp (13) should now glow and a reading of approximately 100 mA should be obtained on the M/O H.T. milliammeter (9). The master-oscillator should now be oscillating on the space-tuning frequency, which should be adjusted by the control (10) so as to give a frequency which will not cause local interference.

63. The amplifier stage will now have to be tuned. Off-set the neutralizing condenser to 0° or 180°, set the grid-bias to stud 8. Next the key should be locked in the down position which results in the M/O circuit being transferred immediately to the frequency at which radiation is desired. The neon lamp (3) should glow, due to a transference of R/F volts from the M/O *via* the condensers C_{5-10} (fig. 2), indicating that the amplifier is tuned to the M/O frequency but un-neutralized.

64. It will then be necessary to neutralize the amplifier. The correct neutralizing position may be obtained in the following manner. Assume that (5) is set at 180° as described in the previous paragraph. Rotate the control (4) until the lamp (3) goes out and note the reading on (5), say 110°. Carry on rotating (4) until 0° is reached when (3) will be glowing again. Now rotate (4) in the opposite direction and note the reading of (5) when the lamp (3) goes out again, say 70°. Then the correct neutralizing position is mid-way between 70° and 110°, which is 90°. Set (5) to this figure and the amplifier is now correctly tuned, neutralized and ready for operation.

65. The bias may now be reduced with safety to position O, and the input shown on the milliammeter (14) should be of the order of 170 mA with the H.T. on stud 1. The aerial ammeter should also show some reading. Finally the aerial should be tuned in conjunction with the amplifiers to give maximum output. Although the transmitter will now radiate C.W., it is not necessarily operating at its maximum efficiency. In order to obtain this condition it will be necessary to proceed as set out in paras. 77 *et seq*.

66. The frequency should be checked at this stage and the transmitter adjusted if necessary. The wavemeter W.1081 may be used for any frequency within its range, or wavemeter W.39 or W.39A may be used with harmonics. The frequency of the master-oscillator should be adjusted by means of the fine tuning knob (4), exactly to what is required. One complete turn of this knob corresponds to approximately two divisions of the main condenser. For the use of Crystal Monitor, type 1 (*see* paras. 90 *et seq.*).

To set up the transmitter for R/T or M.C.W. (Local Control)

67. For local R/T or M.C.W. a portion of Remote Controls, type 3, will have to be used. The necessary portions are Panel, Amplifier, (Stores Ref. 10A/9589) and Panel, Local Control, (Stores Ref. 10A/9590). Although Panel, Remote Control, type A (Stores Ref. 10A/9588) is part of Remote Controls, type 3, it is not essential for this purpose. Panel, amplifier is connected to the transmitter by a screened flexible cable terminating at each end in a three-pin plug. One plug is inserted in the output socket of A.1104 and the other plug is inserted in the socket (6, fig. 8) on the side of the transmitter. See that the oscillator panel and amplifier panel are connected together by the double-ended telephone plug lead on the side of the unit, and by means of the double-ended six-pole plug and lead at the back of the unit. The A.C. mains from the transmitter are connected to the terminals engraved A.C. MAINS on the remote control unit. A microphone is plugged into the appropriate socket on the local control panel. The terminals at the back of the transmitter remain connected as for local C.W.

R/T (Local control)

68. The transmitter is set up and tuned in exactly the same manner as for local C.W., except that the bias for the transmitter amplifier valves will require some further adjustment. To do this the reading of the aerial ammeter (30) should be noted and the amplifier bias switch should then be adjusted to the setting which will reduce the aerial current by approximately 50 per cent. This is the best setting for R/T. If the aerial current is too small to allow of accurate tuning, a thermo-ammeter (0 to 2·5 amp.) should be connected in series with the aerial.

69. Now switch on the A.C. switch on the amplifier panel and move the selector switch on the local control panel to the " local microphone " position. Speech may now be radiated, but the volume control on the remote control unit will have to be adjusted to give the necessary " audio volts " in order to modulate the transmitter. The best position for audio volts is a combined setting of the attenuator and volume controls, such that the reading of the milli-ammeter on the amplifier panel remains at about 120 mA without excessive fluctuation when speech is radiated. As an indication of the percentage modulation, an increase of 22½ per cent. in the steady aerial current represents a modulation of 100 per cent.

M.C.W. (Local Control)

70. Set up and tune the transmitter as before, and set the bias as for R/T. Place the selector switch on the local control panel to the " oscillator position ", and connect the oscillator panel to the amplifier panel by means of the screening cable terminating at each end in a telephone plug. Adjust the volume control and attenuator to give the necessary audio volts for correct modulation and then key.

To set up the transmitter for C.W. (Remote Control)

71. For any remote control operation with this transmitter, Remote Controls, type 3 or type 2, may be used. The 230-V. 50 cycle A.C. mains should be connected to the A.C. terminals on the transmitter, and also to the left-hand pair of terminals on the upper terminal strip on the Remote Control unit. Connect the key, filament switch, and H.T. switch terminals on the transmitter to the corresponding terminals on the Remote Controls. Care should be taken to ensure that the correct key terminals are connected up. One key terminal on the transmitter is common to H.T. switch and filament switch and this terminal should be connected to the corresponding one of the Remote Control unit. Connect the 14-V. terminals on the transmitter

to the 14-V. terminals on the R/C unit. Units have been instructed to modify the T.1087 to incorporate these 14-V. terminals which should be connected to the terminals engraved 0 and 14 on the filament transformer in the transmitter rectifier unit (*see* figs. 2 and 12). The incoming lines A and B from the operations block must be connected to the terminals A and B on the R/C unit. The terminal engraved E should be connected to the transmitter earth.

72. It will now be possible to operate the transmitter both locally and remotely. For remote operation, however, it is first necessary to set up and tune the transmitter locally. The two filament, key and H.T. switches on the transmitter are put on. The transmitter may now be set up and tuned, using the switches and key on the R/C unit for the necessary operations, the procedure being exactly the same as for local C.W. When the transmitter has been set up and tuned all the switches, both on the transmitter and on the R/C unit are left on, with the exception of the H.T. switch on the R/C unit, because it is desirable, when using this transmitter, that the filaments should be left on continually. The ganged switches on the R/C unit are put to W/T and the transmitter may then be operated remotely on C.W., all the necessary switching and keying being done at the operations end.

To set up the transmitter for M.C.W. (Remote Control)

73. The transmitter and R/C unit are connected up as before and the transmitter is set up and tuned in the same manner as for remote C.W. Before M.C.W. can be radiated however, the amplifier portion of the R/C unit must be connected to the transmitter. The ganged switches must be in the W/T position, and the selector switch must be set to the " oscillator " position. The volume control must be adjusted as for local M.C.W.

To set up the transmitter for R/T (Remote Control)

74. In this case the connections between the R/C unit and the transmitter are somewhat different. Since the ganged switches on the R/C unit short-circuit the key in the R/T position, the M/O never transfers to the space-tuning frequency, because in effect the key is never up. To overcome this difficulty the transmitter should be connected up in the manner shown in the insert on fig. 19. Close the filament and H.T. switches on the transmitter. Set up and tune the transmitter as for local R/T using the filament and H.T. switches on the R/C unit as desired.

75. When the transmitter is ready, plug in the screened cable, into the socket (6, fig. 8) and also into the R/C unit, switch on the A.C. switch on the amplifier panel, place the ganged switches in the R/T position, and the selector switch in the " Local microphone " position, plug in the local microphone, and adjust the volume control on the amplifier panel for normal speech at the transmitter; bias adjustment will be the same as for local R/T. Leave all switches on except the H.T. switch on the R/C unit. Owing to the resistance of the lines A and B and the consequent loss of speech input to the R/C unit, it may be necessary to make a further adjustment to the volume control when remote R/T is being used.

76. After the transmitter has been set up and adjusted satisfactorily by the local operator (bias adjustment and volume control), the selector switch should be moved to the " 600 ohm input " position. The remote operator should now speak into his microphone while the operator at the transmitter end should watch the milliammeter and adjust the volume control in order to give the necessary audio volts. This further adjustment is not necessary on remote M.C.W., since the oscillations are generated at the transmitter end and are therefore not influenced by the extra resistance of the lines A and B as in the case of remote R/T.

Method of improving transmitter output

77. It should be borne in mind, that if the transmitter has been set up to the Tables, the most favourable operating conditions may not necessarily be obtained. The transmitter will, however, radiate and may be used on these settings. When time permits, units should ascertain for themselves which settings give the best performance and they should make a note of these settings for future reference. The tables are merely given as a guide, and are correct for a particular transmitter, but since transmitters may vary slightly depending upon the source of manufacture and varying impedance of the aerial system, the figures may not apply to every transmitter

for the most efficient operation. In the following paragraphs a method is given of the manner in which a transmitter should be set up, first to the Tables and then adjusted if necessary to improve the output.

78. The reason for the difference between the settings shown in the Tables and those which may be obtained on a T.1087 in Service is due to the following points. The figures and settings shown in the Tables were obtained on a particular transmitter using the correct aerial, namely a 54 ft. 6 in. wire cage outside the building and 5 ft. of lead-in to the aerial terminal. The earth system used was a good radial earth with short connections to the transmitter and there were no other aerial systems in the vicinity.

79. The valve impedance of the two V.T.31 output valves used in the transmitter is of the order of 4,000 ohms and the impedance of a good aerial-earth system as set out in the previous paragraph is approximately 70 ohms. It should be noted here that any alteration in the total length of aerial, or the resistance of the " earth " due to corrosion or dry ground, etc., or the proximity of other aerial systems or power absorbing objects, or the alteration to the height of the aerial will seriously alter the impedance of the aerial circuit. In order to provide for slight variations in these impedances, the output transformer is provided with several tapping points. The combination that should be used will depend on the particular installation. It will be seen therefore, that, unless the conditions are identical with those stated above, the settings, in practice, will differ from those given in the Tables.

80. The following method of improving the transmitter output matching is given as a guide only, and Units should adopt a similar method to obtain the best matching conditions. The result to be aimed at is an increased working efficiency of the transmitter, i.e. the ratio between the output watts and the input watts expressed as a percentage. The output watts are C^2R, where C is the aerial current and R is the resistance of the aerial-earth circuit, the input watts being the product of the amplifier D.C. volts and D.C. milliamps.

81. The output transformer is provided with several tapping points and four plugs are provided to engage these points. When making these adjustments to obtain maximum efficiency, it is desirable to move the plugs one at a time so that any increase or decrease of efficiency may be observed. If two or more plugs are moved at the same time, it will not be clear which one is responsible for the increase or decrease as the case may be.

82. Insert a small 0 to 2·5 amp. thermo-ammeter between the aerial lead-in and the aerial terminal of the transmitter. Before making any alteration inside the transmitter, make a note of the amplifier D.C. volts, D.C. milliamps. and the R/F aerial current. Then, being careful to switch off the H.T. before opening the transmitter, move plug No. 1 one tap either backwards or forwards. It is important to remember in which direction the move has been made. Now switch on the H.T. and re-tune the amplifier for maximum output. The series aerial tuning condenser must be mentioned at this stage as it plays an important part in the tuning of the T.1087. The aerial circuit of this transmitter is fairly tightly coupled to the amplifier circuit, therefore any change of amplifier tuning may affect the aerial tuning. It is therefore desirable that the amplifier tuning condenser and the aerial tuning condenser should be adjusted *together* in order to give maximum aerial output.

83. Having moved plug 1 and re-tuned, it may be noticed that the input milliamps. have decreased while the R/F output has remained the same or even increased. This indicates a definite increase in efficiency and furthermore that the plug has been moved in the right direction. Now move plug No. 2 in a similar manner. The direction in which it should be moved is important. If plug No. 1 has been moved towards the centre of the coil, then plug No. 2 should be moved towards the centre of the coil. Continue moving plugs Nos. 1 and 2 until a position is found where the output efficiency is a maximum. Now leaving plugs 1 and 2 in their new positions, move plugs 3 and 5 separately till the maximum output efficiency is obtained. A further adjustment may be made at this stage. Move plugs 1 and 2 *together* either backwards or forwards, moving each plug the same number of turns and, after finding the best position, move plugs 3 and 5 *together* in a similar manner.

84. The point to bear in mind, while moving these plugs is that a balance is to be aimed at between the two V.T.31 valves. The amplifier stage is a push-pull circuit which has been designed for mechanical and electrical symmetry. Therefore, if an unbalanced aerial circuit is coupled to the amplifier stage, the symmetry is upset and it may be possible for one V.T.31 valve to be overrun. This overrunning may be indicated by the anode of the valve heating up and glowing red. This unbalance can come about as the result of the position of plugs 1, 2, 3 and 5, and it is therefore necessary when making adjustments to these plugs, to observe the effect on the valve anodes and to endeavour to keep them as nearly equal in colour as possible.

85. If the power radiated in these circumstances is adequate, there is no necessity to increase the H.T. tap. Stud 2 or 3 need only be used where greater range is desired, or where the signal to noise ratio may be improved, as for example overcoming local interference. To change the H.T. stud, switch off H.T., set the bias back to 8, move the H.T. switch to stud 2 or 3, switch on H.T. and then reduce bias to 0. It may be necessary to re-tune the amplifier and aerial slightly to give maximum aerial current reading. It may also be necessary to re-adjust the filament volts on the master-oscillator and amplifier: controls (18) and (23) respectively. A check on the frequency is again necessary.

86. Although this tap-changing may appear laborious, it is only necessary to do it once for the frequency or frequencies on which the transmitter is likely to operate. Once the correct settings have been obtained they should be noted, and the transmitter set up when desired to these settings and not to those of the Tables for the same frequency. If it is necessary at any time to set the transmitter to a frequency for which no tap-changing settings have been previously obtained, then the Tables should be followed. When time permits units should endeavour to obtain for themselves the settings which will give the best results for the new frequency.

Rapid tuning between 4·3 and 6·0 Mc/s

87. When rapid changes of frequency are required between 4·3 and 6·0 Mc/s, it will generally be inconvenient to make all the adjustments referred to in the preceding paragraphs. By sacrificing a little output the essential changes may be reduced to a maximum of five. With practice it is possible to change to any frequency, for which the adjustments are known, in about 15 seconds.

88. Table 5 shows typical sets of adjustments for five frequencies between 4·3 and 6·0 Mc/s. A similar table should be prepared for each transmitter for the particular frequencies on which it will be worked, and should be prominently displayed near the transmitter.

89. It will be noticed that the occasions on which it is necessary to switch off the H.T. in order to make adjustments inside the transmitter are limited. The amplifier bias tap, stud 4, is such that the frequency may be safely changed without altering either the bias tap or the H.T. tap which may be left on stud 2 whilst tuning. The aerial current, i.e. the unmodulated carrier, should not be less than 1·9 amp. for each frequency adjustment.

Crystal monitor

90. In order that a rapid and correct check can be made on the frequency radiated by the transmitter, a Crystal Monitor (Stores Ref. 10A/10941) has been developed. The monitor is provided with a set of six crystals which will give six spot frequencies. It will be necessary to calibrate the crystal monitor before making a check on the frequency and the following procedure must be adopted :—

Calibration

91. Place the crystal monitor near the transmitter and ensure that the mains switch on the front panel is off. Remove the perforated back cover and insert crystals corresponding to the frequencies required in the crystal-holder. Ascertain the position of the arrow head on the selector switch corresponding to the selected crystal positions and make a mark to provide a reference to these points. Replace the back cover. Connect the loud speaker to the two-pole socket on the side of the monitor and connect the A.C. mains plug to the two-pole socket on the back of the power source unit.

92. Set the selector switch to the desired frequency, and switch on the mains switch control. Adjust the master-oscillator control of the transmitter until an audible note is produced in the monitor loud-speaker. Adjust the capacitance of the condenser associated with the particular crystal until the note reaches a maximum. A small screwdriver may be used for this purpose, but it should be noted that the potentiometer control should also be adjusted during the operation to suit the relative position of the monitor and transmitter.

93. Adjust the various component controls on the transmitter to arrive at the frequency settings corresponding to the selected crystal in the monitor. The attainment of this frequency will be indicated by the " Dead Space " of the beat note produced in the loud speaker. Make a note of the transmitter settings corresponding to this particular frequency in tabular form. Repeat the transmitter settings for each of the selected crystal positions of the monitor. After the adjustments have been completed, two sets of readings will be available, one for the settings of the transmitter controls, and one for the corresponding positions of the selector switch on the monitor.

Frequency monitoring

94. In order to monitor the frequency radiated by the transmitter, switch on the crystal monitor, set the selector switch on the monitor to the position for the desired frequency and, if necessary, adjust the transmitter controls to the " Dead Space " of the beat note produced in the loud speaker.

Frequency changing

95. In order to effect a rapid change of frequency, switch on the crystal monitor, set the selector switch to the position corresponding to the desired frequency, and set the transmitter controls in accordance with the tables produced in the initial calibration as described in para. 92. Adjust the tuning of the transmitter to the " Dead Space " of the beat note produced in the loud speaker. With practice, a change of frequency can be effected in less than one minute, even in the extreme case where the number of adjustments to be made is a maximum.

96. It should be noted that a seventh or off position is provided on the selector switch. Hence by leaving the mains switch in the on position and placing the selector switch in the off position, the crystal monitor may be left in a virtually inactive state ready for instant use by adjustment of the selector switch. It should also be noted that as no engraving has been provided for the mains switch, the signal lamp should be observed to ensure that the power supply is disconnected when not required. If a crystal monitor is not available, a wavemeter, type W.39A, modified for crystal control may be set up and used as described in the chapter dealing with this wavemeter.

PRECAUTIONS AND MAINTENANCE

97. Before commencing to use the transmitter see that all external leads are correctly connected. Check over the leads (where used) from the valves to the valve-holders. See that the various taps are in the correct position. Check the link connections between the rectifier unit and the transmitter. The link connections should make good contact and the nuts on both inside and outside of the insulating bars should be tightened with a spanner. The conductor connecting the frame of the transmitter to earth should be as short as possible. Finally, check over the connections on the terminals at the base of the rectifier unit and the connections between the transmitter and the remote control unit, depending on which system is being used.

98. Switch off the H.T. before making any changes which necessitate opening the doors of the transmitter. Do not rely wholly on the safety door switches. These switches only isolate the power supply but a number of condensers of large capacitance exist in various circuits and these take a few seconds to discharge. A period of about 15 to 20 seconds should be allowed to elapse before making any adjustments inside the transmitter after opening the doors. On M.C.W. or C.W. the condensers may be discharged by tapping the key. See that the main switch is off before unscrewing any of the side or back panels.

99. See that the adjustment of the contacts of the H.T. switch (S_{17}, fig. 2) is such that the contacts in the primary circuit of the transformer, i.e. the lower contacts, close before the contacts which short-circuit the 1,000-ohm resistance, i.e. the upper contacts. Care must be taken to ensure that the lower contacts are not set so far in advance of the upper contacts that the operating force of the relay is insufficient to close the latter.

100. Always switch on the filament supply first and then the H.T. supply. When shutting down, the procedure should be reversed; H.T. first and then the filaments. The transmitter filament and H.T. supplies should be switched on for ten minutes or so before the commencement of routine transmission. In the case of this transmitter it is advisable to leave the filaments switched on during pauses in transmission in order to minimize the possibility of frequency creep as the master-oscillator warms up. This may be accomplished by leaving the local filament switch on the type 3 remote control unit in the on position.

101. The valves used in the rectifier are two type V.U.29 valves. These valves are of the mercury vapour type, and whenever there is any possibility of the mercury having come in contact with the filaments, the filament circuit should be switched on for at least 10 minutes before the H.T. is switched on, or the valves may be seriously damaged. These remarks apply in any instance where a valve is moved or where the complete rectifier panel has been moved and has been subjected to inversion or heavy vibration.

102. It is very important that the A.C. mains voltage at the transmitter terminals does not drop below 230 volts or several transformers in the transmitter will be affected. The filament supply for the V.U.29 valves in the rectifier should never drop below 4 volts, or the life of the valves will be impaired. The filament transformer in the rectifier has a tapped secondary-winding giving 14 volts and 20 volts A.C. The 14 volt A.C. is reduced to 12·5 volts for the M/O and 11·25 volts for the amplifier valves and the bias rectifying valve, rheostats being employed for this purpose.

103. The 20-volt tapping supplies the three metal rectifiers for operating the relays. One rectifier provides the D.C. voltage for operating the delay relays in the rectifier, the other two are connected in parallel and provide the D.C. voltage for operating the relays in the transmitter. Since the D.C. output from the rectifiers depends on the A.C. input, which in turn depends on the input of the filament transformer, the necessity for keeping the mains at 230 will be appreciated.

104. After the transmitter has been in use some time, the neon lamp (3, fig. 1) may become "hard" owing to ageing, which will be indicated by a blackening of the glass. In these circumstances the lamp may not strike up when the amplifiers are near tune because a greater voltage is required to strike the neon. If, when following the normal tuning procedure the lamp fails to light, reduce the bias until the amplifiers are taking some anode current. This should not exceed 100 mA with the amplifiers off tune. The lamp should strike up, and if the amplifier stage is tuned in the normal manner, the lamp will glow at its brightest at the tune position. Now set the bias back to 8 and the lamp should remain alight. Proceed with neutralizing. If during neutralizing, the lamp fails to strike again when the condenser control is moved in the opposite direction, reduce the bias till the lamp strikes, then move the bias back to 8 and carry on with neutralizing. If however the lamp fails to strike at all in these circumstances it is probably defective and should be replaced. Before finally deciding on the lamp, however, make a careful check on the transmitter and ensure that the coil sittings are correct, and that the relay S_1, fig. 2 has operated to transfer the M/O to the amplifier.

105. Some cases of failure have occurred of the condenser connected across the keying relay (C_{26}, fig. 2). This may be evident both visually and aurally. With the H.T. switched on and the bias at 8, if C_{26} has broken down completely, the transmitter will radiate continually as though the key were down, because in effect the contacts of S_3 are shorted through the resistance R_{12}. If the fault is partial, intermittent transmission will take place, because with the grid-bias at 8, the maximum bias volts from the valve V_4 are virtually across C_{26}. As this voltage may be of the order of 1,000 volts, it may be enough to break down the faulty condenser.

106. A partially defective condenser may be tested in the following manner. Switch off the H.T. and set the bias to 8. The transformer T_2 will still be energized since the primary

is connected across the amplifier filament supply, and the bias volts generated by V_4 are across C_{26}. If the condenser is faulty, it will make a clicking noise every time the condenser flashes over. This flash over may not be apparent in the form of arcing, because it will probably occur inside the condenser, but it will certainly be heard. If when the bias is moved to 0, thus reducing the volts across C_{26}, the noise ceases, the condenser is obviously defective and should be replaced.

107. The condenser (C_{27}, fig. 2) is connected between the screen grids of the amplifier valves and earth. Should it become defective and short-circuit, the fault will be apparent by one or both of the following symptoms. Arcing may occur on the relay type T (S_2, fig. 2), resulting in the burning of the movable copper arm associated with H.T. positive contact, and accompanied in extreme cases by corrosion of the exposed metal parts of the relay. This will be more noticeable when using the higher H.T. studs. With the H.T. switch on Stud 1, the amplifier valves should normally start taking anode current when the bias is moved from stud 8 to stud 7. If C_{27} is short-circuited, then it will be noticed that the anode current does not start until the bias has been reduced to stud 4 or even 3.

108. As soon as either or both the defects are suspected, units are to make an insulation test. Remove the amplifier valve panel and withdraw the 100,000 ohm resistance (14, fig. 8) from its holder. The insulation should then be tested between the top contact of the resistance holder and the frame of the transmitter. A tester bridge megger should be used for this purpose and, if a reading of appreciably less than infinity be obtained, the condenser should be replaced.

109. Some cases of failure have occurred in certain of the resistances incorporated in the transmitter. When any of the following resistances fail they should be replaced by the corresponding tropical grade as follows :—

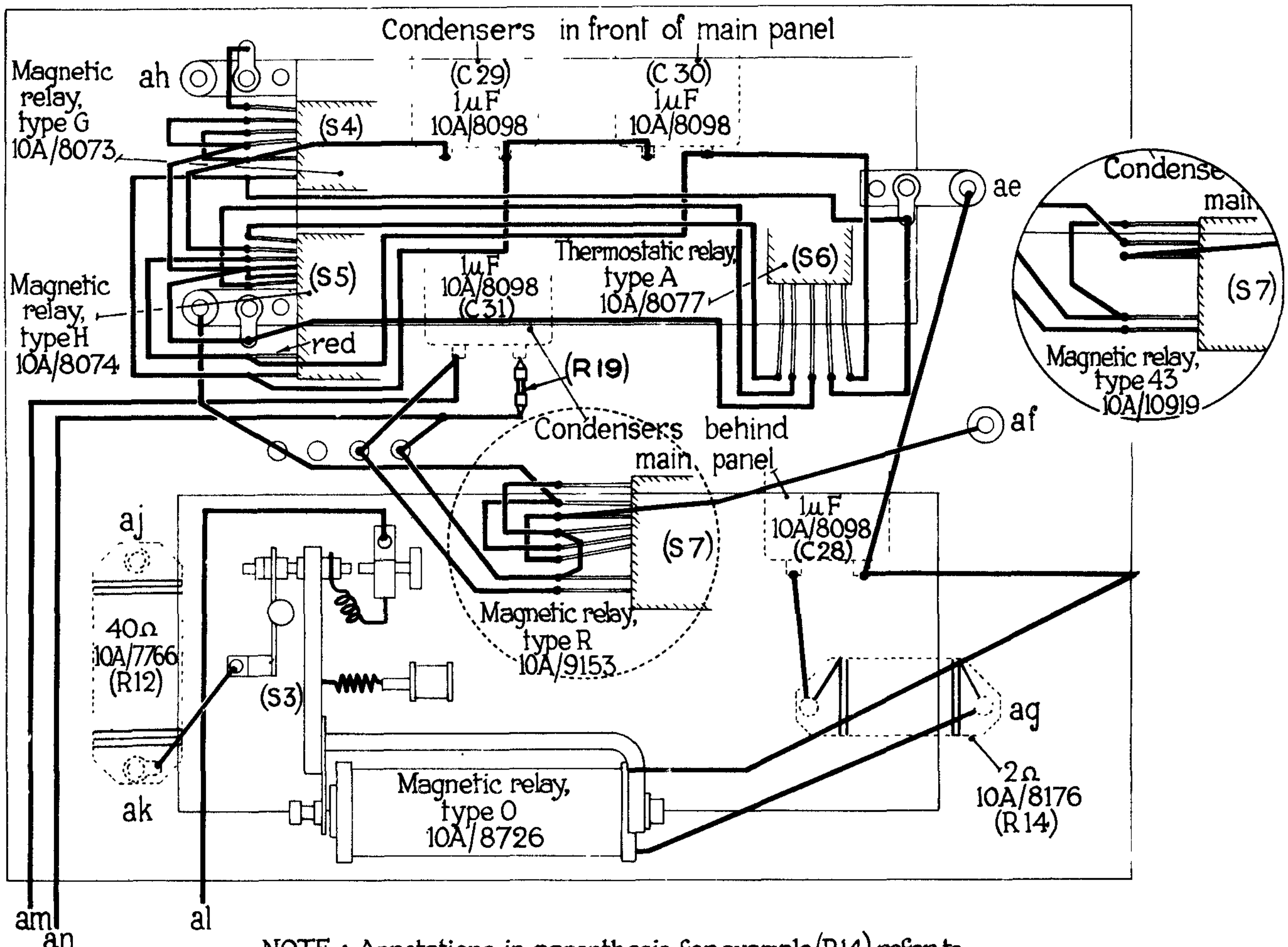
Original				Replacement	
Type 86	10A/7770			Type 304	10A/9818
,, 888	10A/7772			,, 302	10A/9816
,, 187	10A/8730			,, 309	10A/9823
,, 189	10A/8732			,, 308	10A/9822
,, 233	10A/9157			,, 310	10A/9824
,, 235	10A/9159	Part of 10A/9165		,, 323	10A/9862
,, 236	10A/9160			,, 324	10A/9863
,, 237	10A/9161			,, 325	10A/9864

Future contract issues of the transmitter will have these tropical grades incorporated.

110. The magnetic relay, type R is prone to failure, one of the symptoms being an inability to respond to the keying of dots at high speed. When this relay becomes unserviceable it is to be replaced by Relay, Magnetic, type 43 (Stores Ref. 10A/10919). The manner in which the new relay should be connected up is shown in the insert in fig. 21. The component shown in the dotted circle is relay, type R, whilst the component in the full circle is relay, type 43. In addition a 100-ohm resistance type 263 is connected in series with the condenser across the relay, to prevent arcing across the contacts of the sounder relay (Stores Ref. 5C/138) on remote controls types 3 or 4.

111. The transmitter may display instability when used on certain frequencies above 10 Mc/s. This becomes evident in the form of low frequency " motor-boating " and poor R/F efficiency as shown by a definite reduction of aerial current. It is partly due to the R/F choke in the H.T. supply to the amplifier valves being of such electrical dimensions as to cause this instability. A modification to overcome this defect is to reduce the number of turns on the choke to 51. The modified choke will adopt the new nomenclature Choke, H/F, type 43 (Stores Ref. 10A/10986).

112. The modified wiring referred to in para. 74 and shown in fig. 19 must only be applied to transmitters which are used solely for R/T, it must not be applied to transmitters which are required to make a rapid change from R/T to telegraphy. The following table shows how the transmitter is controlled by the switch, type 44, at the operations end. It should be noted that, during the intervals between R/T transmission, the switch, type 44, must be placed in the " Generator running " position ; furthermore, telegraphy cannot be transmitted with the modified connections.



NOTE : Annotations in parenthesis, for example (R14), refer to the corresponding annotations in Fig. 2

(F.1799). F. & C. LTD.

FIG. 21, WIRING DIAGRAM - RELAY PANEL

Position of Switch, type 44.	Condition of Transmitter.
Off	Off
Generator running	H.T. and filaments on, after 10 seconds M/O is on (stand-by frequency) but amplifier is off.
Transmit	H.T. filaments and key are on. M/O and amplifiers are on desired frequency. Carrier wave is radiated ; ready to speak.
Generator running	H.T. and filaments on, key up. After 10 seconds M/O is on (stand-by frequency), but amplifier is off.
Off.	All off.

113. It is difficult to see the V.T.25 bias valve from the front of the transmitter and occasions have arisen where the filament of the valve had burnt out and, owing to its position, the defect was not apparent. On C.W. the bias switch should be set at stud 0 for maximum output. At this position of the switch the bias is zero, and the transmitter will operate normally even though the bias valve is defective. In these circumstances, the resistance connected across the valve becomes a grid leak and, as the grid current through it is small, insufficient volts are dropped to provide enough bias voltage to shut down the amplifier valves. The indication of a burnt out filament on the bias valve is that, with the bias switch on stud 8, the amplifier valves will be taking some anode current instead of nothing.

114. Some cases have occurred where the filament of the bias valve has sagged, when hot, and makes contact with the grid. This fault will be indicated by a normal anode current reading when the bias switch is on stud 8 and the transmitter will radiate at the normal output. As the bias switch is reduced progressively from 8 to 0, the anode milliammeter will show a minimum reading at about stud 4 or 5. This dip in anode current is due to the charging and discharging of the condenser connected across the bias resistance.

TABLE 1

Settings of T.1087 for C/W signalling, with balanced load of 600 ohms, using terminals 12 and 14.

Freq. kc/s.	Master Oscillator.		Amplifier Anode Coil and Tuning.				Output Transformer.				Ampl. Grid-Bias Stud.	Ampl. Anode Curr. mA.	Aerial Tuning Cond.	Load Curr. Amps.
	Coil.	Condenser.	Anode Taps.	Tuned Taps.	Condensers.		Input Sockets.		Output Sockets.					
					Fixed.	Variable.	1	2	3	4				
	(L1)	(C1)	(L2)	(L2)	(S16)	(C13)	(L3)	(L3)	(L3)	(L3)	(S15)	(M5)	(C18)	
3,800	E	5–50	CEH	M	B	1–41	E yel.	E red	G wh.	G Blk.	1	245	—	0·66
4,286	E	3–96	CEH	M	A	4–00	D ,,	D ,,	F ,,	F ,,	1	240	—	0·68
5,550	E	2–50	CEH	L	B	6–00	Q ,,	Q ,,	B ,,	B ,,	1	220	—	0·62
6,680	E	2–00	CEH	M	A	1–18	D ,,	D ,,	D ,,	D ,,	1	255	—	0·69
6,820	E	1–83	CEH	L	A	2–23	M ,,	M ,,	D ,,	D ,,	1	240	—	0·66
6,500	D	5–72	CEH	L	A	4–68	Q ,,	Q ,,	D ,,	D ,,	1	200	—	0·6
6,820	D	5–07	CEH	L	A	1–90	M ,,	M ,,	D ,,	D ,,	1	235	—	0·6
6,500	C	8–97	CEH	L	A	4–68	Q ,,	Q ,,	D ,,	D ,,	1	200	—	0·49
8,400	C	5–00	CEG	K	A	3–47	P ,,	P ,,	G ,,	G ,,	1	255	—	0·5
8,400	C	5–00	CF	K	A	8–68	Q ,,	Q ,,	D ,,	D ,,	2	230	—	0·48
10,700	C	3–00	CF	K	A	3–00	Q ,,	Q ,,	F ,,	F ,,	1	240	—	0·55
10,700	C	3–00	CF	J	B	4–29	H ,,	H ,,	E ,,	E ,,	2	230	—	0·52
11,400	C	2–60	CF	J	A	3–05	E ,,	E ,,	D ,,	D ,,	3	230	—	0·52
13,350	C	1–80	D	J	A	8–15	G ,,	G ,,	D ,,	D ,,	3	190	—	0·38
14,620	C	1–34	D	J	A	3–70	M ,,	L ,,	D ,,	D ,,	2	220	—	0·39
13,350	B	2–20	D	J	A	8–15	G ,,	G ,,	D ,,	D ,,	2	200	—	0·35
14,620	B	1–90	D	J	A	3–75	E ,,	E ,,	D ,,	D ,,	1	250	—	0·34
14,620	A	2–00	B	J	A	8–50	D ,,	D ,,	B ,,	B ,,	2	200	—	0·29
17,500	A	1–50	B	J	A	1–61	D ,,	D ,,	B ,,	B ,,	1	228	—	0·35
17,500	A	1–50	A	J	A	5–83	E ,,	K ,,	K ,,	H ,,	2	215	—	0·24
20,000	A	1–10	A	J	A	1–22	E ,,	K ,,	K ,,	H ,,	2	230	—	0·29

TABLE 2

Settings of T.1087 for R/T signalling with 4-wire cage aerial 7 ft. 6 in. top and counterpoise using terminal 12 for earth and 13 for aerial.

Frequency kc/s.	Master-Oscillator. Coil.	Master-Oscillator. Tuning.	Amplifier. Anode Tap. Back.	Amplifier. Anode Tap. Front.	Amplifier. Closed Circuit Tuning. Coil Taps. Back.	Amplifier. Closed Circuit Tuning. Coil Taps. Front.	Amplifier. Closed Circuit Tuning. Condenser. Fixed.	Amplifier. Closed Circuit Tuning. Condenser. Variable.	Output Transformer. Input Sockets. 1 Red.	Output Transformer. Input Sockets. 2 Yellow.	Output Transformer. Output Sockets. 3 White.	Output Transformer. Output Sockets. 5 Black.	Neutralizing.	Bias Stud.	Amplifier mA Output.	Aerial Tuning Condenser (Degrees)	Aerial Current.
	(L1)	(C1)	(L2)	(L2)	(L2)	(L2)	(S16)	(C13)	(L3)	(L3)	(L3)	(L3)	(C12)	(S15)	(M5)	(C18)	(M6)
8,400	E	1–45	CF	CF	K	K	A	5–10	D	D	D	D	87°	4	115	0°	0·85
8,000	E	1–58	CF	CF	K	K	A	6–73	D	D	D	D	87°	4	105	20°	1·0
7,500	E	1–78	CF	CF	L	L	A	2–90	D	D	D	D	87°	3	135	25°	1·15
7,000	E	2–0	CEG	CEG	L	L	A	2–43	G	G	D	D	87°	3	125	27°	1·25
6,700	E	2–15	CEG	CEG	L	L	A	3–52	G	G	D	D	87°	4	110	35°	1·15
6,000	E	2–62	CEG	CEG	L	L	A	6–40	J	J	D	D	87°	4	110	55°	1·4
5,400	E	3–14	CEG	CEG	L	L	B	2–12	L	L	D	D	87°	4	110	160°	1·5
5,000	E	3–58	CEG	CEG	M	M	A	2–87	K	K	D	D	87°	3	145	170°	2·0
4,600	E	3–79	CEG	CEG	M	M	A	3–74	K	K	D	D	87°	3	150	170°	2·0
4,250	E	4–73	CEG	CEG	M	M	A	5–92	K	K	F	F	87°	3	115	170°	2·0

H.T. Stud 2. Volts on load, 2,100.

TABLE 3

Settings of T.1087 for C.W. signalling with 54-ft. cage aerial and radial earth using terminal 12 for earth and 13 for aerial.

									Red.	Yellow.	White.	Black.					
5,100	E	3–60	CEG	CEG	L	L	B	3–10	G	G	A	A	87°	0	300	16°	1·3
4,800	E	3–38	CEG	CEG	L	L	B	4–90	G	G	A	A	87°	0	290	26°	1·3
4,635	E	4–08	CEG	CEG	L	L	B	7–38	G	G	A	A	87°	0	330	20°	1·62
4,482	E	4–33	CEH	CEH	M	M	A	3–24	D	D	B	B	87°	0	300	20°	1·95
4,368	E	4–54	CEH	CEH	M	M	A	3–70	D	D	B	B	87°	0	320	23°	2·05
4,195	E	4–90	CEH	CEH	M	M	A	4–59	D	D	B	B	87°	0	280	26°	2·25
3,900	E	5–55	CEH	CEH	M	M	A	5–87	E	E	B	B	87°	0	370	35°	2·75
3,700	E	6–08	CEH	CEH	M	M	A	7–00	E	E	B	B	87°	0	320	40°	2·3
3,500	E	6–73	CEH	CEH	M	M	A	8–45	E	E	B	B	87°	0	290	45°	2·3
3,300	E	7–50	CEH	CEH	M	M	B	3–45	E	E	B	B	87°	0	280	63°	2·6
3,150	E	8–15	CEH	CEH	M	M	B	4–72	F	F	B	B	87°	0	300	82°	2·7
2,900	E	9–53	CEH	CEH	M	M	B	7–70	G	G	B	B	87°	0	300	136°	3·0

H.T. Stud 2. Volts on load, 2,000.

TABLE 4

Settings of T.1087 for R/T, C.W. or M.C.W. signalling, with aerial 54 ft., 6-wire cage to 70 ft. mast and radial earth, using terminals 12 and 14.

Freq. kc/s.	Master Oscillator.		Amplifier Anode Coil and Tuning.				Output Transformer.				Ampl. Grid-Bias Stud.	Ampl. Anode Curr. mA.	Aerial Tuning Cond.	Load Curr. Amps.
	Coil.	Con-denser.	Anode Taps.	Tuned Taps.	Condensers.		Input Sockets.		Output Sockets.					
					Fixed.	Vari-able.	1	2	3	4				
	(L1)	(C1)	(L2)	(L2)	(S16)	(C13)	(L3)	(L3)	(L3)	(L3)	(S15)	(M5)	(C18)	
1,500	F	6–50	CEH	N	C	7–07	Q red	A yel.	P wh.	P blk.	1*	255	—	3·6
1,605	F	5–75	CEH	N	C	4–72	L ,,	A ,,	P ,,	L ,,	1*	240	—	3·6
1,720	F	5–00	CEH	N	B	8–00	L ,,	C red	L ,,	J ,,	1*	215	—	3·4
1,920	F	4–10	CEH	N	B	4–90	L ,,	C ,,	L ,,	L ,,	1*	200	—	3·1
2,130	F	3–35	CEH	N	A	8–00	L ,,	C ,,	H ,,	H ,,	1*	200	—	3·1
2,375	F	2–75	CEH	N	A	5–83	L ,,	B ,,	F ,,	F ,,	1*	240	—	3·3
2,630	F	2–30	CEH	N	A	4–20	L ,,	C ,,	F ,,	A ,,	1*	220	—	2·82
3,050	F	1–83	CEH	N	A	2–32	L ,,	C ,,	F ,,	A ,,	1*	225	—	2·15

*For R/T and M.C.W. use bias stud 3.

TABLE 5

Settings of T.1087 for rapid frequency change made with a standard T type aerial, with 7 ft. 6 in. roof and counterpoise.

Frequency kc/s.	Master-Oscillator Condenser.		Amplifier Anode Coil and Tuning.				Bias Stud.	Output Transformer.		Aerial Tuning Condenser.
	Turns.	Degree.	Anode Taps.	Tuned Taps.	Condensers.			Input Sockets.	Output Sockets.	
					Fixed.	Variable.				
4,338	4	65	C.F.	L	C	5–46	4	D.D.	E.E.	180
4,500	4	33	C.F.	L	C	6–75	4	G.G.	E.E.	180
5,000	3	61	C.F.	L	B	7–62	4	G.G.	E.E.	180
5,500	3	05	C.F.	L	B	3–90	4	G.G.	E.E.	180
6,000	2	63	C.F.	L	A	8–05	4	G.G.	E.E.	180
								Switch off H.T. before adjusting.		

APPENDIX 1

NOMENCLATURE OF PARTS

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

Ref. No.	Nomenclature.	Qty.	Remarks.
10A/8709	Transmitter, type T.1087		Without valves or indicating lamps.
	Principal components :—		
10A/7180	Ammeter, thermo 0–6 amps	1	
10A/9166	Case, stowage	1	For M O coils and resistances.
	Choke, H/F		
10A/8716	Type 22	3	
10A/8717	Type 23	1	
10A/8718	Type 24	1	
10A/9514	Type 35	2	
10A/10986	Type 43	1	
10A/7512	Choke, L/F, type C	1	
	Coil, inductance ..		
10A/8713	No. 1	1	M/O range A, 20,000 to 17,000 kc/s.
10A/8710	No. 2	1	M/O ranges B, C, D and E, 18,750 to 3,000 kc/s.
10A/8728	No. 3	1	M/O range F, 3,000 to 1,500 kc/s.
10A/8711	No. 4	1	Amplifier, 20,000 to 1,500 kc/s.
10A/8712	No. 5	1	Output transformer 20,000 to 1,500 kc/s.
	Condenser		
10A/7764	Type 109	1	0·002 μF.
10A/8098	Type 146	6	1·0 μF.
10A/8163	Type 151	5	0·01 μF.
10A/8166	Type 154	1	300 $\mu\mu$F.
10A/8170	Type 158	12	50 $\mu\mu$F.
10A/8496	Type 188	1	0·01 μF.
10A/8719	Type 217	1	Variable, neutralizing.
10A/8720	Type 218	2	40 to 800 $\mu\mu$F. variable
10A/8721	Type 219	2	100 $\mu\mu$F. matched pair.
10A/8722	Type 220	2	20 $\mu\mu$F. matched pair.
10A/10920	Type 428	15	1·5 μF.
10A/9151	Type 263	1	40 to 800 $\mu\mu$F. variable.
10A/9152	Type 264	1	7 to 145 $\mu\mu$F. variable.
	Connector		
10A/8731	Type A	2	Fitted with sockets and lug ends.
10A/8735	Type B	2	Fitted with sockets and lug ends.
10A/8740	Type C	1	Fitted with sockets and lug ends.
10A/9163	Type D	1	Fitted with sockets and lug ends.
10A/9165	Grid-bias unit	1	Fitted with :— 1 condenser type 151, 4 resistances type 235*, 1 resistance type 236*, 1 resistance type 237*.
	Handle, condenser, vernier drive		
10A/7719	Type B	1	
10A/8723	Type E	2	
10A/8714	Holder, neon lamp	2	
	Holder, valve		
10A/8173	Type G	1	Rectifier (grid-bias).
10A/8724	Type N	1	Master-oscillator.
10A/8725	Type O	1	Amplifier.
10A/8093	Insulator, type 16	3	
	Milliammeter		
10A/3091	0 to 300, type A	1	Master-oscillator, H.T.
10A/3092	0 to 500, type A	1	Amplifier, H.T.

In the event of failure of items marked thus*, *see* para. 109.

APPENDIX—*contd.*

Ref. No.	Nomenclature.	Qty.	Remarks.
	Transmitter T.1087—(*contd.*)		
	Principal components—(*contd.*)		
	Mounting, anti-vibration		
10A/8803	Type 1	3	
10A/8715	Mounting, M/O coils	1	
10A/8068	Panel, rectifying, type A or ..	1	
10A/11156	Panel, rectifying, type B	1	
	Relay, magnetic		
10A/8073	Type G	1	
10A/8074	Type H	1	
10A/8254	Type M	1	
10A/8726	Type O	1	
10A/9153	Type R	1	In the event of failure, *see* para. 110.
10A/9154	Type S	1	
10A/9155	Type T	1	
10A/8077	Relay, thermostatic, type A	1	
	Resistance		
10A/7766	Type 82	7	40 Ω
10A/7770	Type 86*	2	10,000 Ω, when 10A/9157 is not in use.
10A/7772	Type 88*	2	50,000 Ω
10A/8176	Type 127	1	2·0 Ω
10A/8729	Type 186	1	1·06 Ω
10A/8730	Type 187*	1	100,000 Ω
10A/8732	Type 189*	1	5,000 Ω
10A/8733	Type 190	1	0·4 Ω, 25 amps. variable.
10A/8734	Type 191	1	0·4 Ω, 15 amps. variable.
10A/9157	Type 233*	2	20,000 Ω, when 10A/7770 is not in use.
10A/9099	Type 263	1	100 Ω.
10A/9863	Type 324	1	15,000 Ω, vitreous rod.
10A/7437	Socket, type 19	1	
5C/622	Switch, tumbler, 5 amp. S.P. ..	2	
10A/8082	Type 75	4	Gate switches.
10A/8736	Type 88	1	Three-position, radial contacts, fitted with 6 condensers, type 158.
10A/9162	Type 97	1	Fitted with socket, type 19, plug operated.
10A/8737	Transformer, biasing	1	
10A/9164	Transformer, modulating	1	
	Voltmeter		
10A/8183	0 to 15 volts	2	M/O and amplifier filaments.
10A/7784	0 to 3,500 volts	1	D.C. voltage.
	Accessories :—		
10A/7474	Lamp, indicating, neon, No. 1. ..	2	
	Valve		
10A/8738	Type V.T.30	1	Master-oscillator.
10A/8739	Type V.T.31	2	Amplifiers.
10A/7312	Type V.T.25	1	Biasing.

In the event of failure of items marked thus*, *see* para. 109.

APPENDIX 2

TRANSMITTER T.1087 WITH THE ADAPTOR, TYPE 9
(Stores Ref. 10D/1)

INTRODUCTION

1. The transmitter T.1087 with the Adaptor, type 9, is a modified form of the transmitter T.1087, described n this chapter. It has been introduced to provide a high degree of frequency stability with the elimination of frequency modulation and the initial warming-up period which was essential with the T.1087. The circuit comprises a crystal-controlled oscillator stage coupled to an amplifier stage, consisting of two valves in parallel, the output from which is capacitance-coupled to the aerial. The frequency range covered is from 6·6 Mc/s to 3·0 Mc/s.

2. The stabilization of frequency in the transmitter is effected by the use of a quartz crystal and to incorporate this element in the circuit of the transmitter T.1087 with the minimum of reconstruction, an adaptor has been designed. This apparatus is known as Adaptor, type 9, and its general appearance is shown in fig. 1 of this Appendix. It consists of a single valve unit mounted in the original master-oscillator valve

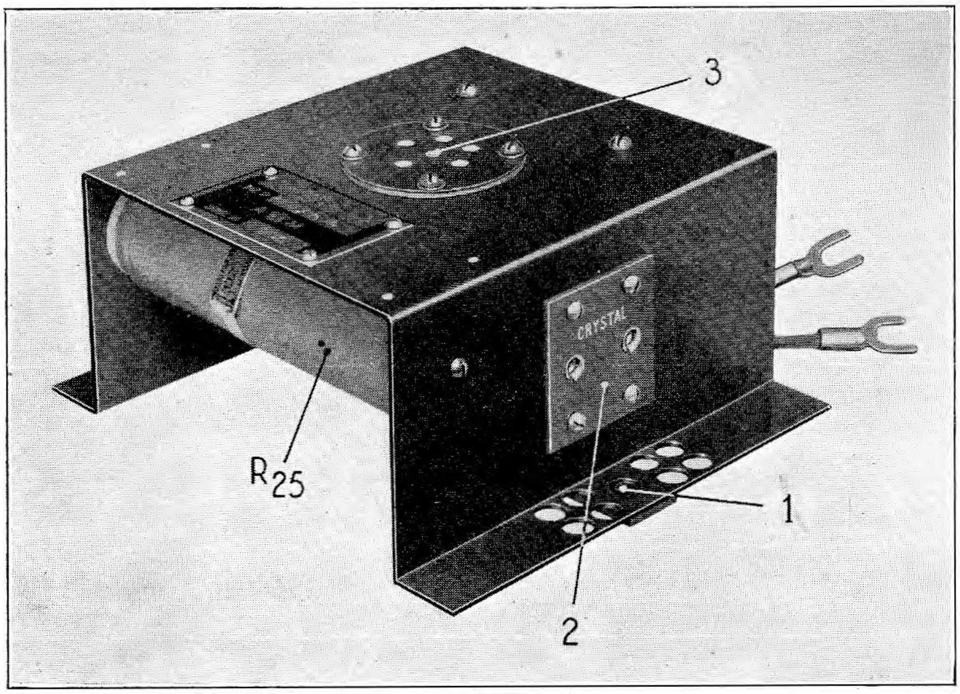


FIG 1.—App. 2. The Adaptor, type 9.

holder; when this is done only two connexions from the adaptor, other than those made by the normal contacts of the valve-holder, are necessary. The whole assembly is, therefore, self-contained; the overall dimensions being $5\frac{3}{4}$ in. by 5 in. by $2\frac{1}{2}$ in. The general appearance of the transmitter is shown in fig. 2. It should be noted that all references to illustrations or tables herein are to those included in this Appendix.

3. Whilst the adaptor is self-contained the existing tuning circuits of the master-oscillator of the T.1087 are retained and provide the tuned anode circuit of the crystal-controlled valve. This valve is of the type V.T.81, a pentode requiring 7·5 volts on the filament. The filament supply utilized for this transmitter is substantially that of the T.1087, dropping resistances being incorporated in this modified stage.

4. The introduction of the Adaptor, type 9, renders necessary certain modifications in the original circuit of the T.1087. As apart from the adaptor circuit these changes involve the master-oscillator tuning coil with its associated condenser, the amplifier valves, which are now used in parallel and not, as formerly, in push-pull, the neutralizing arrangement, which is now rendered unnecessary, and the output circuit. The inclusion of a frequency-controlling element renders the space-tuning arrangements of the T.1087 unnecessary. In order to avoid useless repetition only such aspects of the transmitter wherein it differs materially from the T.1087 are dealt with in this Appendix.

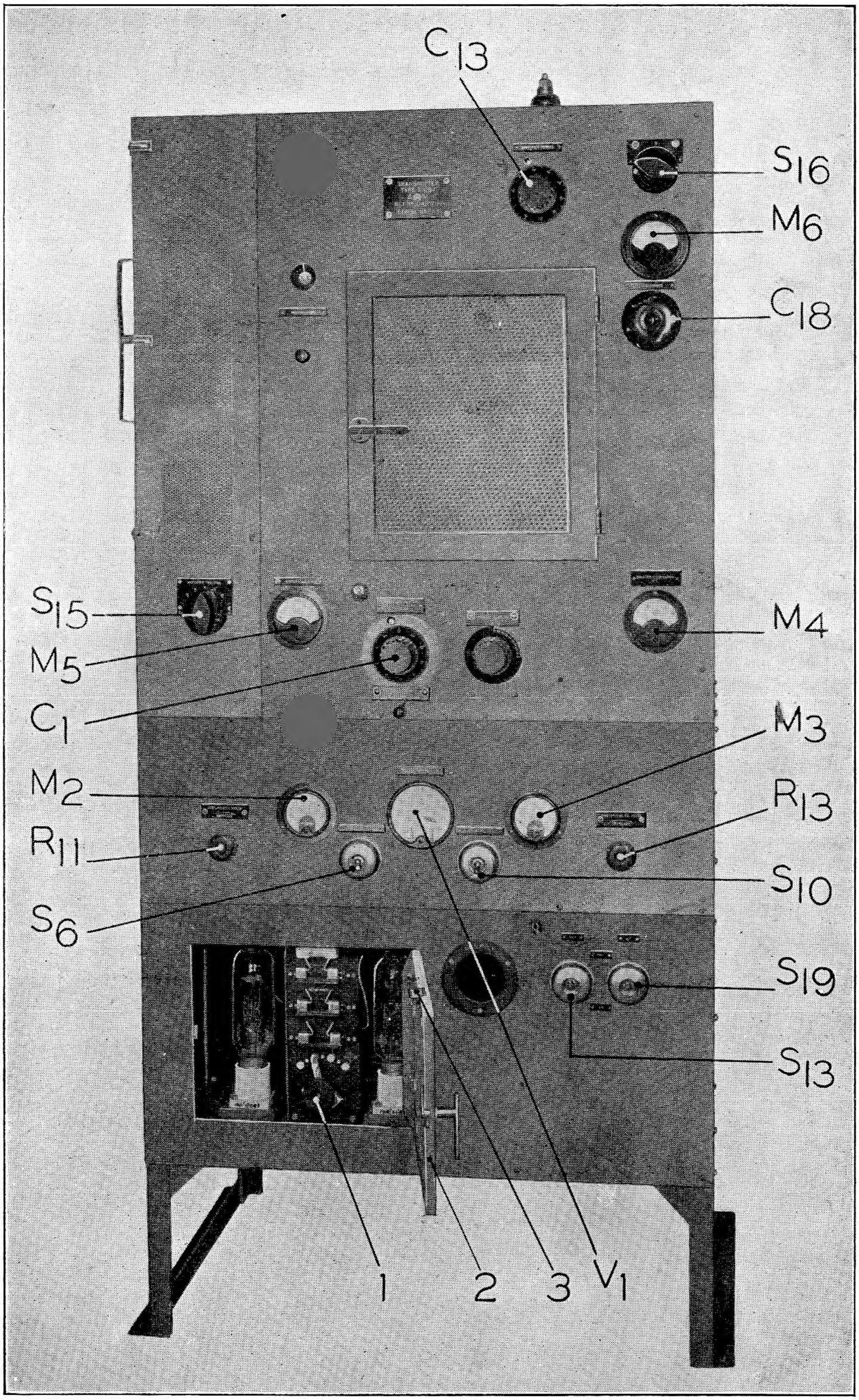


FIG. 2.—App. 2. The Transmitter.

CONDENSERS	C_{35} C_{33} C_{36} C_{19} C_{18} C_{28} C_{26} C_{15} C_{43} C_{14} C_{16} C_{24} C_{17} C_{25} C_{13} C_{42} C_{37} C_{12} C_{31} C_{22} C_{27} C_{23} C_{11} C_5 C_8 C_6 C_9 C_7 C_{10} C_4 C_1 C_3 C_{32} C_{38} C_{41} C_{20} C_{21} C_{39} C_{40}
RESISTANCES	R_{17} R_{18} R_{14} R_{12} R_3 R_{10} R_8 R_9 R_{19} R_{20} R_4 R_5 R_{11} R_2 R_{25} R_{27} R_{21} R_6 R_{22} R_7 R_{13} R_{23} R_{24} R_{26}
INDUCTANCES	L_{13} L_3 L_4 L_2 L_7 L_8 L_5 L_6 L_{10} L_1 L_{11} L_{12} L_9
MISCELLANEOUS	S_2 M_1 M_6 M_5 S_3 S_{15} S_{16} S_{13} T_2 S_9 S_{14} V_4 N_2 S_7 S_8 J_1 T_1 S_{11} S_{12} V_2 V_3 S_{10} M_2 S_1 M_4 N_1 V_X M_3 X

Condensers and Resistances Additional to, or replacing, those of T.1087	
In the Adaptor, Type 9.	
C38	0·01 μF
C39	0·01 μF
C40	0·01 μF
C41	0·0025 μF
R21	40 ohms
R22	40 ohms
R23	50,000 ohms
R24	50 ohms
R25	50,000 ohms
R26	0·93 ohms
R27	0·93 ohms
In the Transmitter	
C1	Half section only used
C18	" " " "
C42	0·01 μF
C43	0·01 μF
R2	1 of 10,000 ohms
	or 1 of 20,000 ohms

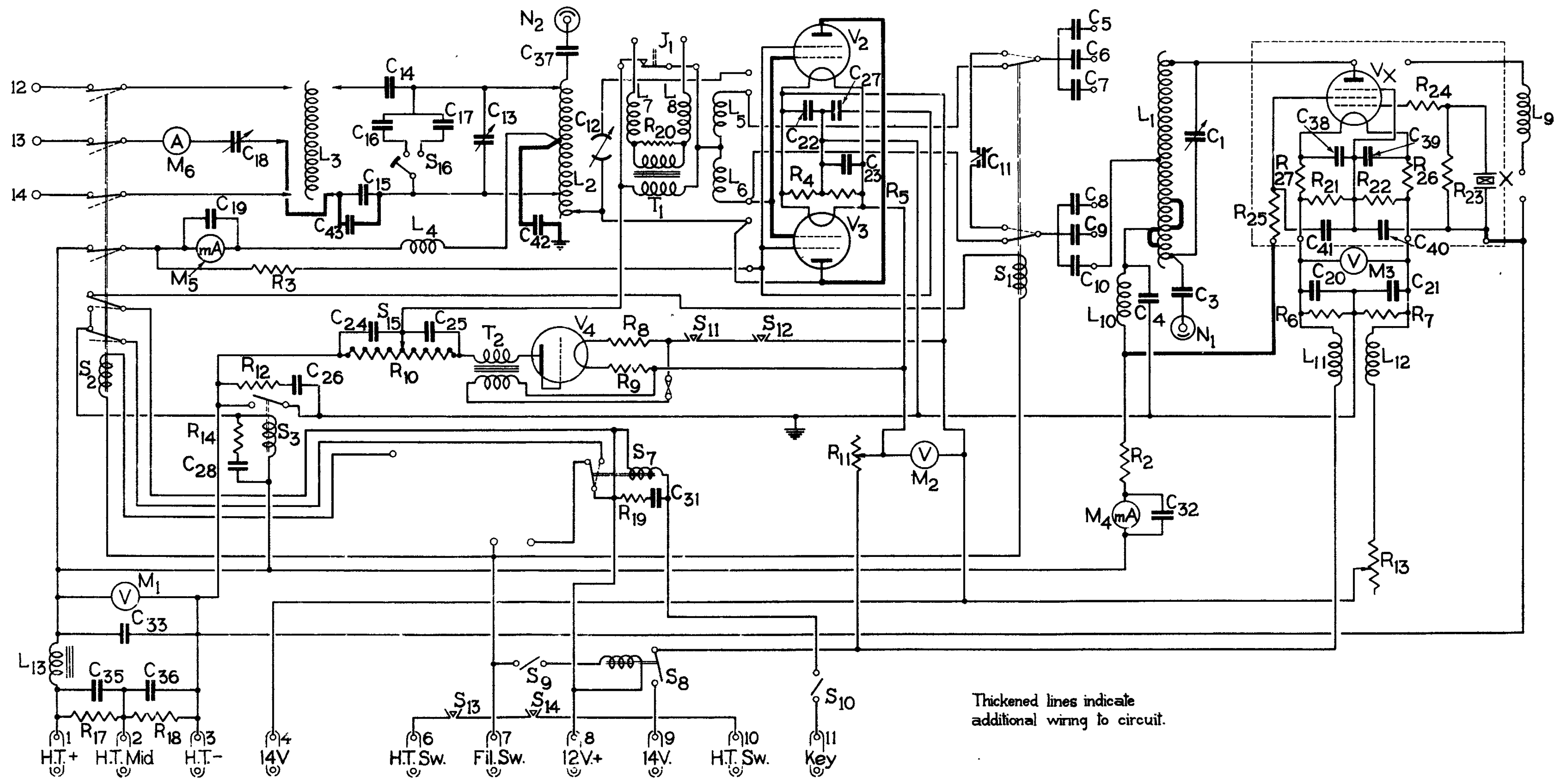


FIG. 3, APP. 2, THEORETICAL CIRCUIT DIAGRAM

GENERAL DESCRIPTION

5. A circuit diagram of the transmitter, omitting the power source, is given in fig. 3. The essential differences between this circuit and that of the T.1087 are emphasized by the thickened lines, specifying additions, and by the omission of certain components which featured in the T.1087. Wherever a component has been omitted from this circuit the omission is signified by a break in the sequence of annotational reference. To facilitate comparison, components additional to those of the parent transmitter have been allocated index numbers beyond any used in the original diagrams. A table of the constants of the new, or altered components is included in fig. 3. The components included in the Adaptor, type 9, are indicated within the dotted lines on fig. 3.

Circuit of the adaptor, type 9

6. The adaptor circuit consists of a crystal-controlled oscillator wherein the frequency-determining element is inserted in the grid circuit of a pentode valve. The crystal-oscillator valve V_x, together with its associated filament and grid circuits, is mounted on the adaptor together with a filament centre-pointing arrangement comprising two resistances R_{21} and R_{22} and the two condensers C_{38} and C_{39}. The suppressor grid of V_x is connected directly to the centre point of the filament circuit. To the grid of V_x a resistance R_{24} is joined. The resistance R_{24} prevents the development of parasitic oscillations and serves to limit the excitation of a fundamentally-operated quartz crystal X to a safe working condition. The crystal X, with which a grid-leak resistance R_{23} is in parallel, is joined between the resistance R_{24} and the GRID LEAK terminal of the adaptor. To this low-potential junction a connexion is made with the resistance R_{23} and a R/F by-pass (crystal current to filament) condenser C_{40}, the opposite side of which leads to the filament centre point. The connexion of the resistance R_{23}, at its low-potential end, to the H.T. negative side of the transmitter keying relay, assists in the prevention of sparking at the key contacts when operating on C.W. A condenser C_{41} is the screen-to-filament R/F by-pass condenser.

7. The screen voltage of the valve V_x is derived from the power supply source through a limiting resistance R_{25}. The anode of V_x is series fed from the supply line which includes a milliameter M_4, an interchangeable resistance R_2, a choke L_{10} and the anode tuning inductance L_1. To provide for the correct filament voltage to the valve V_x, dropping resistances R_{26} and R_{27} are incorporated in the leads from the 14-volt supply.

8. The anode tuning inductance L_1 is actually the coil F with its inductance reduced to cater for the range of frequency coverage desired. It provides for the transfer of an unbalanced input to the amplifier stage. Tuning of L_1 is effected by a condenser C_1 but the maximum capacitance of C_1 is not required and only one half of it is used.

Circuit of the amplifier

9. The unbalanced output from the crystal-oscillator stage is capacitance-coupled to the grid of a screened-grid tetrode valve V_3 through a condenser C_{10}. In order to give this R/F excitation the necessary amplification, the valve V_3 is connected in parallel with another tetrode V_2. This combination of a stable drive frequency with the use of tetrode output valves renders unnecessary any neutralizing device.

10. To effect a maximum transfer of power from the anodes of the valves V_2 and V_3 to the output circuit, an amplifier anode inductance L_2 is tuned by a condenser C_{13} in parallel with it. The H.T. positive voltage for the amplifier valves is derived from the supply source through a choke coil L_{13}, a milliameter M_5 shunted by a condenser C_{19}, a choke coil L_4 and the centre-point of the inductance L_2. An anode R/F by-pass condenser C_{42} is inserted between the anode end of the choke L_4 and earth and provides for the effective by-passing to earth of the centre point of L_2.

Circuit of the aerial system

11. The output from the amplifier is coupled to the aerial in accordance with the type of diffusion system to be employed. The normal output circuit consists of an auto-transformer L_3 having its input side capacitance-coupled by the condensers C_{14} and C_{15}. The circuit is available for working into a 600-ohm open line system.

12. When working into either a direct aerial system or concentric feeders the unbalanced output load is capacitance-coupled to the amplifier closed circuit through the condenser C_{15} and a variable condenser C_{18}, L_3 not being in circuit. The condenser C_{18} is in two sections but only one half of its maximum capacitance is used. At certain settings the condenser C_{15} is of too low a capacitance to enable optimum coupling to be attained and the additional capacitance of a condenser C_{43} is connected in parallel with it. When working into a 600-ohm open line system the condenser C_{43} is not required and must be disconnected from the circuit.

CONSTRUCTIONAL DETAILS

The Adaptor, type 9

13. The illustrations, figs. 1, 5 and 6 show the construction of the Adaptor, type 9, the arrangement of its components and its application to the valve holder, or crate, with the valve type V.T.81 in position. A bench wiring diagram of the adaptor is given in fig. 4. An interior view of the transmitter showing the valve-holder in position, is shown in fig. 7. Wherever applicable the annotational references of fig. 3 have been used in these illustrations.

14. The adaptor consists of an aluminium flanged channel section. The channel sides are 2½ in. deep and have right-angled flanges of ¾ in. The section is black-enamelled with a semi-gloss finish. Referring to fig. 1, the flanges are drilled (1) for mounting in the valve-holder. On one side of the channel a paxolin panel of 3½ in. by 1½ in. carries two terminals marked GRID LEAK and H.T. + SCREEN GRID respectively. On the opposite side the two crystal sockets (2) are mounted in paxolin. The valve-holder (3) is centred on the top panel.

15. Referring to fig. 5, it will be seen that the components are, for the most part, suspended between the sockets of the valve-holder (1) and a strip of paxolin (2) spacing the flanges. The 50,000-ohm screen resistance R_{25} also bridges the sides of the section and has both ends secured by screws and spaced by washers (3). The filament resistances R_{26} and R_{27} each of 0·93 ohms, are suspended from the top panel. The two 40-ohm resistances R_{22} and R_{21} are wired to R_{26} and R_{27}, two flexible leads terminating in spade terminals (4) and (5) being wired to the junction points.

16. The manner in which the adaptor is secured in the valve-holder is shown in fig. 6, the 4 B.A. screw (1) and the paxolin distance piece (2) being visible below the crystal holder. In this illustration the valve V_x is in

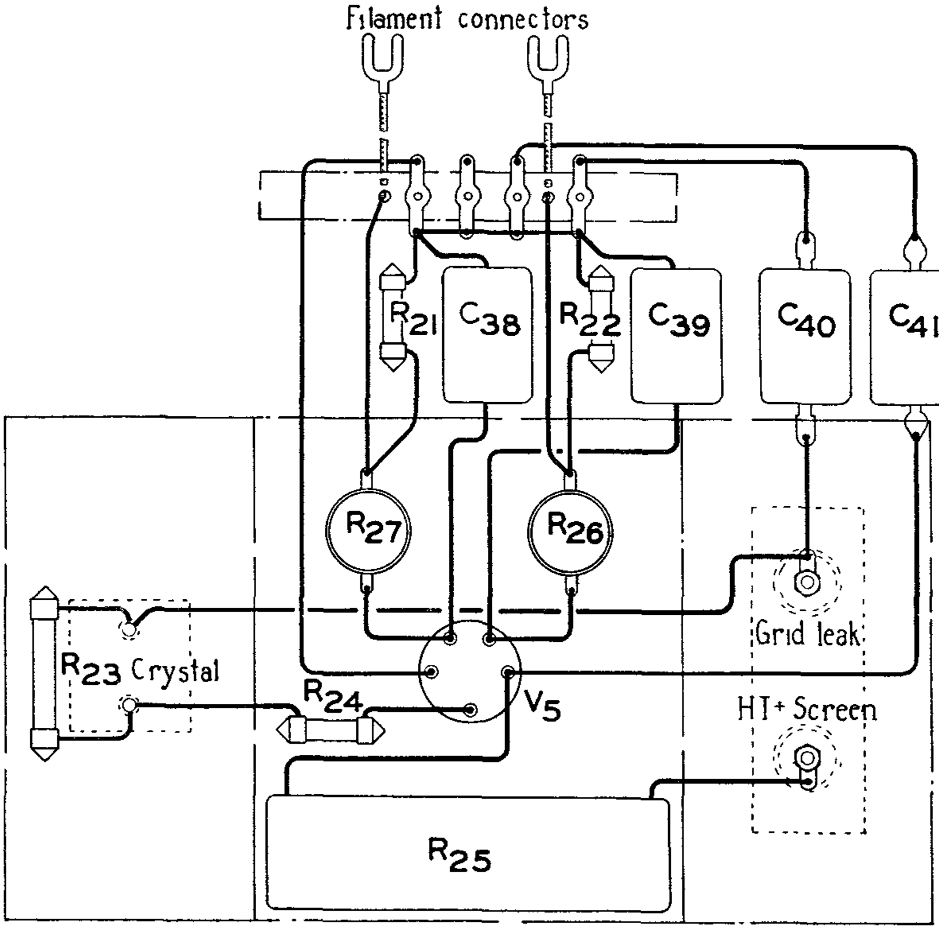


FIG. 4.—App. 2. The Adaptor, type 9—bench wiring diagram.

position and is secured by two clips (4) which are held in position by thumb-screws (5). The valve-holder, or crate, is composed of two strips of metal (6) bent to form a rectangle. Spacer pieces (7) carry the terminals for the anode (8) and the filament connectors (9) and (10). The fourth terminal (11) is not used in this instance.

VALVES AND POWER SUPPLY

17. The crystal-oscillator valve V_x is of the type V.T.81, a pentode with a high ratio of anode to input power and it requires 7·5 volts on the filament, this being indicated by 13·5 volts on the voltmeter M_3. The screen current of V_x is approximately 20 mA and the screen voltage approximately 300 volts. The anode feed resistance R_2 should be one of 20,000 ohms for H.T. voltages of 2,000 and above, and should be changed for one of 10,000 ohms when the H.T. supply is lowered to 1,500 volts. The remaining valves of the transmitter and the associated power supply are the same as those of the T.1087 and are described elsewhere in this publication. A rear view of the instrument with panels removed is given in fig. 7 which shows the V.T.81 valve V_x and the crystal adaptor (1) in position.

INSTALLATION

18. The transmitter can be operated locally or by means of remote controls. The method of installation has been detailed in connexion with the transmitter T.1087 and need not be recapitulated.

19. The installation of the crystal adaptor in the transmitter T.1087 and the modification necessary to effect the change of that instrument to the present transmitter are detailed in this and subsequent paragraphs. The master-oscillator valve-holder must be removed from the transmitter T.1087 and the valve V.T.30 taken out and stored. The adaptor is mounted on the valve-holder by drilling two 4 B.A. clearance holes in the paxolin distance pieces (2, fig. 6) to suit the holes, one of which is annotated on fig. 1. The adaptor is secured to the valve-holder by means of $\frac{1}{2}$ in. 4 B.A. screws and nuts, but care must be taken to ensure that clearance is maintained between the screws fixing the paxolin distance pieces and the metal chassis of the adaptor. The correct position of the adaptor in the holder is shown in fig. 6, that is, with the crystal sockets to the front and with the anode and grid terminals of the valve-holder to the left.

20. Referring to fig. 5, the two flexible leads (4) and (5) attached to the resistances R_{26} and R_{27} are connected to the adjacent filament terminals of the valve-holder. A valve, type V.T.81, is inserted in the five-pin socket and the anode of this valve is joined to the anode terminal of the valve-holder by means of the cap connector

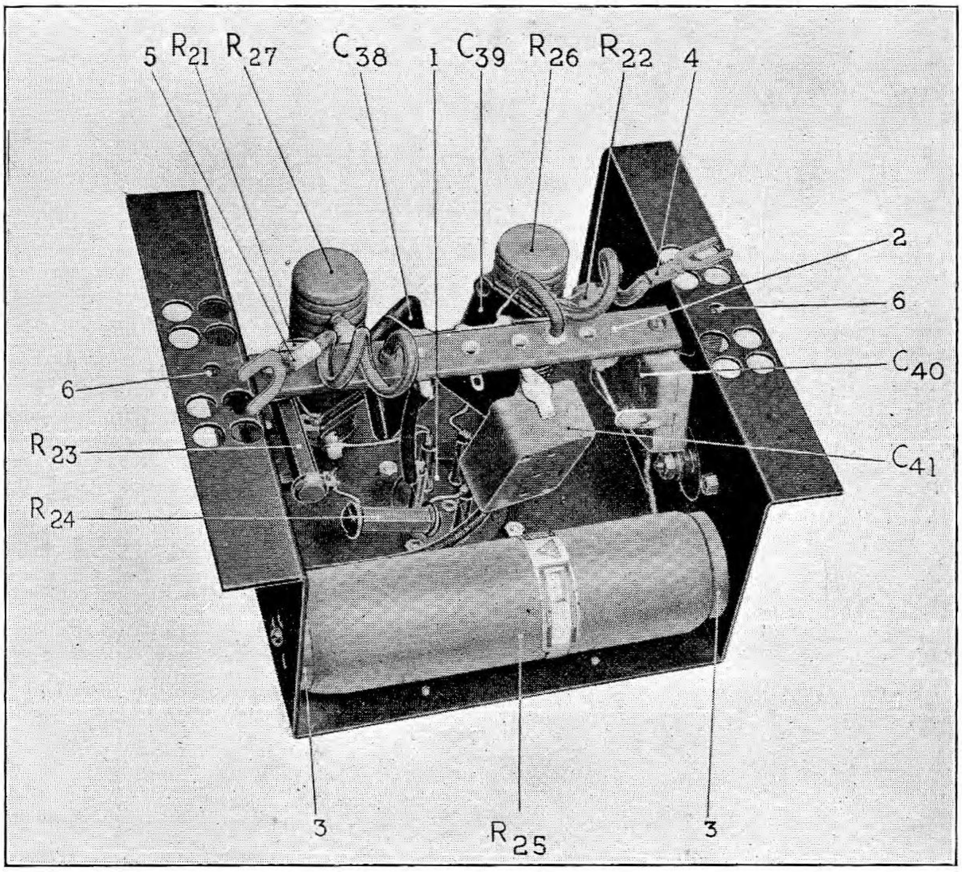


FIG. 5.—App. 2. The Adaptor, type 9—underside view.

and lead (12, fig. 6). The valve-holder is then replaced in the transmitter. Access to the interior of the transmitter is obtained through the door in the top compartment. To insert the holder, rest the top cylindrical contacts of the frame on the top " C " contacts of the supporting pillars. Push downwards on the frame until these contacts are properly engaged and rotate the frame about the contacts until the bottom two cylindrical contacts of the holder engage the bottom " C " contacts, pushing them into complete engagement. The adaptor terminal engraved H.T. + SCREEN is connected to the lower clip (2, fig. 7) of the master-oscillator grid leak of T.1087. It will be necessary to treat with Dope Solvent any screws or nuts which are locked due to the bakelite varnish fixer.

21. Having installed the adaptor it is necessary to effect certain internal modifications of the transmitter T.1087. The master-oscillator grid leak must be removed and retained in store. The two leads connecting the neutralizing condenser C_{12} to the amplifier grid contacts should be disconnected and stored. The space-tuning arrangements of the transmitter T.1087 not being necessary, the top portion of the relay panel is detached from the main panel and retained in store.

22. The parallel connector situated at the rear of the anode tuning condenser C_1 must be removed and the adjustment of C_1 checked. When the dial is set to read 0·00 the moving plates of C_1 should be out of mesh and set parallel to the fixed plates. If not in this position, the condenser drive should be slackened off and the rotor moved to the correct position.

23. Two additional 0·01 μF condensers, type 151, are mounted on the underside of the top panel and spaced from it by 6 B.A. nuts. The position of the condenser C_{42} (fig. 7) should be mid-way between the choke L_4 and the back of the transmitter. To fix C_{42}; take out the second screw securing the top panel to the back of the frame, remove the paint and clean around the screw hole on both sides, then screw a 4 B.A. terminal into position. The external portion of the terminal may be used as an additional earthing point for the transmitter.

24. The other condenser, type 151, is C_{43}, and it is mounted in parallel with C_{15}. It is fixed in a manner similar to that mentioned in para. 23, but is positioned above L_2 and as near to C_{15} as is convenient to facilitate wiring.

25. The direct aerial and the co-axial lines are terminated in a junction box, type 4. To mount this box on the top panel of the T.1087 remove the base plate and mark off and drill a $\frac{5}{16}$ in. fixing hole positioned 6 in.

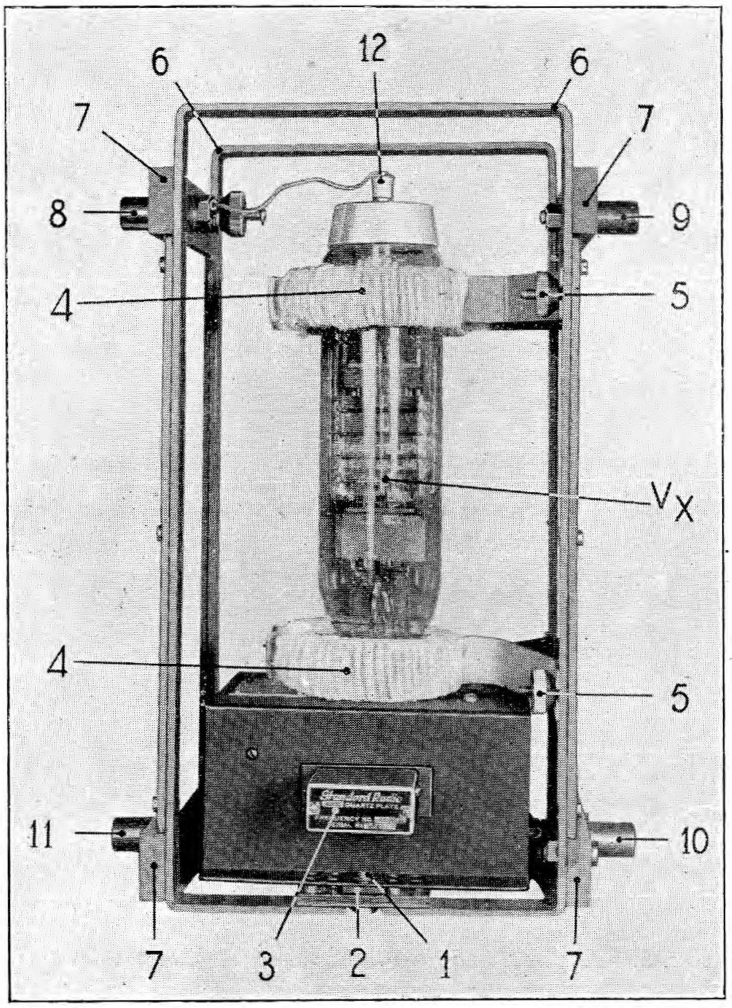


FIG. 6.—App. 2. Valve holder with crystal adaptor in position.

from the front and $\frac{3}{8}$ in. from the right-hand top edge of the T.1087. Using the junction box base plate as a template, mark off and drill a second fixing hole so that the box when mounted is parallel to the front edge of the T.1087. Ensure good electrical connexion between the box and the transmitter frame by removing the paint and then cleaning round the fixing holes. The junction box should be secured to the top panel by $\frac{3}{8}$ in. × $\frac{5}{16}$ in. Whitworth screws and washers. The method of internal wiring of the junction box is outlined on the box itself and reference should be made to this when connecting either coaxial cable or direct aerial.

26. The oscillator inductance coil F needs modification to provide for the two frequency bands. For frequencies between 5·5 Mc/s and 3·0 Mc/s, the prongs 2 and 3 (counting from the engraved end of the coil) are short-circuited. For frequencies between 6·6 Mc/s and 5·5 Mc/s, two turns, counting from prong 3 (fifth

to seventh turn from the engraved end) must be short-circuited in addition to those mentioned above. The figure 5·5 Mc/s is approximate and the tuning on the first-named band should be maintained to its highest limit frequency.

27. The output valve crate (4, fig. 7) should be removed and the anode lead disconnected from the front valve V_2 (nearer the panel) and joined to the anode terminal of the rear valve V_3. The grid lead of V_2 should be disconnected and joined to the grid terminal of V_3. If any extension of these leads is necessary, a length of R 4 wire enclosed in insulating tubing H.T. grade D 2·5 mm. should be used.

28. When working into a direct aerial system or concentric feeders the connexions to the output coil L_3 should be changed in order to omit the auto-transformer from the circuit. Remove socket No. 1 from the output coil and plug it into stowage for socket No. 5. Plug sockets Nos. 3 and 4 into the back plugs on the output coil. Join the sockets Nos. 2 and 5 together by means of a $1\frac{1}{2}$ in. length of $\frac{3}{16}$ in. copper or brass rod. Both sections of the aerial series condenser C_{18} are not required and the parallel connector must be removed.

29. When working into a balanced open wire feeder system the condenser C_{43} referred to in para 24 should be disconnected from the circuit. In other respects the normal output circuit is maintained.

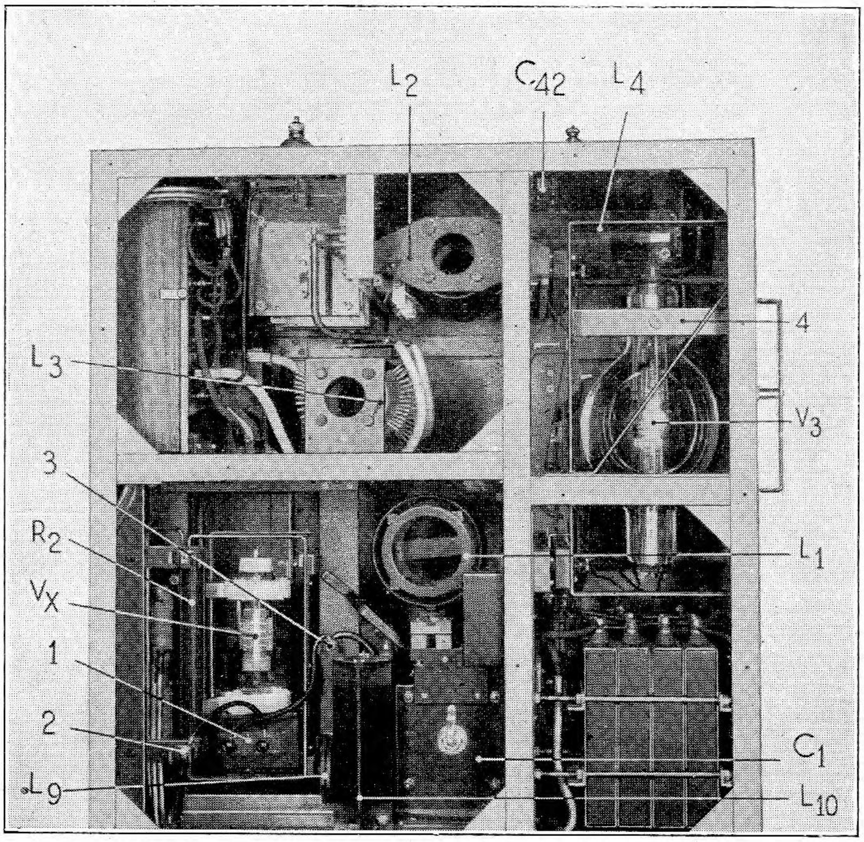


FIG. 7.—App. 2. Interior view of the transmitter.

OPERATION

30. The incorporation of the frequency-controlling element in this transmitter obviates the necessity for any stabilization of frequency by an initial "warming up" period. As apart from this, however, and the absence of any visual indication of oscillation in the oscillator stage, the operational notes applicable to the T.1087 apply equally to this transmitter. Reference to the appropriate section of the chapter upon the T.1087 should be made for the preliminary operations involved, in so far as they refer to the insertion of the amplifier valves, the rectifying valves, H.T. pilot lamp and fuses. The method of setting up the transmitter for C.W., and the incorporation of the appropriate modulator when used for M.C.W. or R/T can also be found in that chapter. The notes herein are additional to or in variation of the steps set out under T.1087. A general view of the transmitter showing the front panel controls is given in fig. 2.

Direct aerial or concentric feeder system

31. Before the transmitter is ready for operation into a direct aerial or concentric feeder system the modification detailed in paras. 21 to 29 must have been effected and the adaptor, carrying a crystal of the desired frequency, inserted in position. A final check should be carried out to ensure that these preliminary steps have been taken. The resistance R_2 (either 20,000 ohms or 10,000 ohms, whichever may apply) is placed in its clips and the modified coil F (para. 26) plugged into the oscillator coil sockets and locked into position.

32. The amplifier output circuit having been modified in accordance with the instructions contained in para. 27 the amplifier anode coil switches, the variable condenser C_{13} and the switch S_{16} should be adjusted as specified in the operational Tables 1, 2, 4 or 5. Set the condenser C_{18} to zero and adjust the oscillator condenser C_1 to a reading of say, 50 degrees less than that indicated in Table 1. The panel controls and instruments are annotated in fig. 2 and the references of fig. 3 are maintained in this diagram. The rectifier is switched on at S_{13}.

33. Switch ON the filament supply at S_6, adjusting the oscillator filament resistance R_{13} so that the filament voltmeter M_3 reads 13·5 volts. The amplifier filament voltmeter M_2 is adjusted by means of R_{11} to read 11·25 volts. Set the rectifier H.T. switch (1) which can be seen inside the door (2) at the bottom left-hand corner of fig. 1 to Stud 1 and the bias switch S_{15} to 8. On the top edge of this door can be seen a safety gate switch contact (3). Close the keying circuit switch S_{10} and put the H.T. switch, which is annotated S_{19} on fig. 2, but does not appear on fig. 3, to the ON position.

34. Increase the oscillator tuning condenser C_1 slowly until the milliameter M_4 shows a sudden dip. Adjust the tuning to the point of lowest input. Then set the H.T. switch to Stud 2, adjusting S_{15} to a position at which the amplifier is drawing 100 mA, as indicated by the milliameter M_5. The condenser C_{13} is then adjusted for resonance as indicated by a minimum reading on M_5.

35. Increase the aerial series condenser C_{17} slowly, at the same time keeping C_{13} in step to preserve resonance, until there is optimum coupling between the amplifier anode circuit and the output load. This condition is obtained when the output current, as indicated by the ammeter M_6, remains stationary or begins to fall while the input to the amplifier, as indicated by M_5, rises.

C.W. operation (local control)

36. For C.W. operation reduce the amplifier grid bias by means of S_{15} to give full output and adjust the oscillator tuning condenser C_1 very slowly and carefully to give minimum input as read on the milliameter M_4. Finally, carefully reduce the oscillator tuning condenser to a point at which M_4 reads approximately 5 mA in excess of the previously obtained minimum. This ensures that the crystal commences to oscillate readily and that, when working on C.W., the transmitted morse will not be clipped.

R/T operation (local control)

37. The transmitter is set up and tuned in exactly the same manner as for local C.W., but when the maximum C.W. output has been attained, the amplifier bias must be adjusted in order to reduce the aerial current by approximately 50 per cent. of that maximum. In most cases this adjustment can be done by moving the bias switch to tap 3. Then carefully adjust the oscillator tuning to minimum input as indicated on M_4, finally reducing the condenser until the input reads approximately 5 mA in excess of the minimum previously obtained as outlined in the preceding paragraphs. This adjustment may slightly reduce the output, as it may also do on C.W., but it is preferable to have certainty of switching and keying rather than a slightly increased output.

R/T operation (remote control)

38. Having set up and tuned the transmitter as for local R/T the selector switch of the remote controls, type 3, should be moved to LOCAL MICROPHONE and the volume control adjusted so that with normal speech output the current from the transmitter will rise 20 per cent. (equivalent to 100 per cent. modulation). Whilst deep modulation is essential for R/T, over-modulation should be avoided, as distorted speech will not only impair communication but will reduce the effective operating range. Mark the position of the volume control. Check the modulation with aeroplanes at effective range.

Balanced output, open-wire feeder system

39. The previous paragraphs relating to the setting up of the crystal-oscillator apply equally when working into a balanced output load. The amplifier anode circuit and the output coil taps should be adjusted in accordance with Table 3. The output load is, in this instance, connected across the terminals 12 and 14 (fig. 3).

PRECAUTIONS AND MAINTENANCE

40. The normal precautions associated with the transmitter T.1087 apply to this modification of it. The adaptor requires little or no maintenance and there are no special precautionary measures to be taken beyond the usual care to be exercised in the handling of apparatus. The crystal contained in the holder, by virtue of its physical dimensions, and the frail nature of its metallic "splutter" demands careful handling and, because of this fact, stations are not permitted to take down or to repair the holder. The percentage of failures in this element are, however, remarkably low and, provided no unauthorized attempt has been made to dismantle the apparatus, operators may have every confidence in it both for ease of starting and in its maintenance of oscillation at the specified frequency.

41. The valve V.T.81 should remain effective for a period much longer than that normally associated with transmitting valves. Low input to the crystal-oscillator valve V_x, coupled with the absence of tuning, will indicate that either the screen condenser C_{41} has broken down, thus earthing the screen-grid, or that there is no anode connexion.

MODIFICATION TO PERMIT USE OF CRYSTAL OSCILLATOR VALVE AS A MASTER-OSCILLATOR

42. To convert the transmitter to master-oscillator control, using the crystal-oscillator valve V_x as the M/O, reference should be made to Leaflet A.113 of A.P. 1186, Vol. II. The crystal-holder is removed and a specially constructed condenser is inserted between the left-hand (viewed from the front of the transmitter) crystal socket of the adaptor and the condenser C_1. On frequencies above 4 Mc/s the coil E replaces the modified coil F (para. 26) and on frequencies below 4 Mc/s an unmodified coil F is used or, alternatively, the parallel connector of C_1 is replaced and a coil E used. The following table shows typical settings of the transmitter so modified :—

Frequency Mc/s	Condenser C_1 Dial Readings		
	C_1 modified as in para. 22		*Alternative* C_1 Connector replaced
	E Coil	F Coil (unmodified)	E Coil
3·00	—	3–16	8–81
3·25	—	2–67	7–56
3·50	—	2–26	6–57
3·75	—	1–96	5–79
4·00	9–50	1–69	5–14
4·25	8–35	1–44	4–61
4·50	7–44	1–23	4–15
4·75	6–70	0–98	3–78
5·00	6–00	—	3–44
5·25	5–45	—	3–12
5·50	4–96	—	2–90
5·75	4–55	—	2–70
6·00	4–16	—	2–51
6·25	3–66	—	2–33
6·50	3–53	—	2–18
6·75	3–27	—	2–05
7·00	3–02	—	1–93

TABLE 1 (APPENDIX 2)

Typical settings of T.1087 with the adaptor, type 9, working into coaxial cable.

Coaxial cable connected to terminal 13 *via* junction box and earth.

Frequency Mc/s	Oscillator		Input mA (M_4)	Amplifier Anode Coil and Tuning				Series Aerial Condenser (C_{18})	Amplifier Grid Bias Stud (S_{15})	Amplifier Input (M_5)	Output Amps. to Line (M_6)	H T Volts Stud 2
	Coil F	Condenser (C_1)		Anode Taps	Tuned Taps	Condensers						
						Variable (C_{13})	Fixed (S_{16})					
6·66	See para. 27	1/10	60	C.E.G.	L	5/73	A	38	0	230	1·65	2,050
6·00	See para. 27	1/65	59	C.E.G.	L	9/50	A	38	0	235	1·65	2,040
5·30	See para. 27	1/10	58	C.E.G.	M	3/16	A	32	0	235	1·70	2,020
4·75	See para. 27	1/63	58	C.E.G.	M	4/92	A	36	0	250	1·70	2,030
4·25	See para. 27	2/22	56	C.E.G.	M	6/74	A	38	0	245	1·70	2,030
4·00	See para. 27	2/61	54	C.E.G.	M	7/90	A	40	0	260	1·70	2,030
3·50	See para. 27	3/63	54	C.E.G.	M	2/80	B	44	0	250	1·65	2,020
3·25	See para. 27	4/30	54	C.E.G.	M	4/97	B	46	0	250	1·65	2,020
3·00	See para. 27	5/18	53	C.E.G.	M	7/95	B	48	0	250	1·65	2,000

Note.—The annotational references are to fig. 2.

TABLE 2 (APPENDIX 2)

Typical settings of T.1087 with the adaptor, type 9, working into 54-ft. wire cage aerial and earth. Aerial to be connected to terminal 13 *via* junction box.

Frequency Mc/s	Oscillator		Input mA (M_4)	Amplifier Anode Coil and Tuning				Series Aerial Condenser (C_{18})	Amplifier Grid Bias Stud (S_{15})	Amplifier Input mA (M_5)	Load Current in Amps. (M_6)	H.T. Volts Stud 2
	Coil F	Condenser (C_1)		Anode Taps	Tuned Taps	Condensers: Variable (C_{13})	Condensers: Fixed (S_{16})					
4·25	See para. 27	2/46	60	C.E.G.	M	6/17	A	27	0	250	1·48	2,100
4·00	See para. 27	2/88	60	C.E.G.	M	7/18	A	31	0	255	1·54	2,100
3·50	See para. 27	3/92	58	C.E.G.	M	3/09	B	47	0	290	1·87	2,100
3·25	See para. 27	4/62	58	C.E.G.	M	5/00	B	46	0	278	2·00	2,100

Note.—The annotational references are to fig. 2.

TABLE 3 (APPENDIX 2)

Typical settings of T.1087 with the adaptor, type 9, working into 600-ohm open wire feeders. Lines connected to terminals 12 and 14.

Frequency Mc/s	Oscillator		Input mA (M_4)	Amplifier Anode Coil and Tuning				Output Transformer				Amplifier Grid Bias Stud (S_{15})	Amplifier Input mA (M_5)	Load Current Amps. (M_6)	H.T. Volts Stud 2
	Coil F	Condenser (C_1)		Anode Tap	Tuned Taps	Condenser: Variable (C_{13})	Condenser: Fixed (S_{16})	Input Sockets 1	Input Sockets 2	Output Sockets 3	Output Sockets 4				
6·50	See para. 27	1/15	68	C.E.G.	L	4/63	A	C	C	E	E	0	258	0·64	2,000
5·30	See para. 27	1/11	62	C.E.G.	L	9/03	A	E	E	C	C	0	280	0·66	2,000
4·75	See para. 27	1/65	60	C.E.G.	M	3/05	A	D	D	F	F	0	305	0·70	2,000
4·25	See para. 27	2/24	60	C.E.G.	M	5/19	A	D	D	F	F	0	290	0·67	2,000
4·00	See para. 27	2/62	60	C.E.G.	M	6/46	A	D	D	F	F	0	270	0·66	2,010
3·25	See para. 27	4/33	56	C.E.H.	M	4/50	B	F	F	G	G	0	238	0·64	2,030

Note.—The condenser C_{43} must be removed from circuit.
The annotational references are to fig. 2.

TABLE 4 (APPENDIX 2)

Typical settings of T.1087 with the adaptor, type 9, working into 40-ft. vertical wire aerial and earth. Aerial to be connected to terminal 13 *via* junction box.

Aerial length measured from transmitter.

Frequency Mc/s	Oscillator		Input mA (M_4)	Amplifier Anode Coil and Tuning				Series Aerial Condenser (C_{18})	Amplifier Grid Bias Stud (S_{15})	Amplifier Input mA (M_5)	Load Current in Amps. (M_6)	H.T. Volts Stud 2
	Coil F	Condenser (C_1)		Anode Taps	Tuned Taps	Condensers						
						Variable (C_{13})	Fixed (S_{16})					
6·60	See para. 27	1/00	60	C.E.G.	M	5/20	A	33	0	225	1·16	2,120
6·00	See para. 27	1/60	58	C.E.G.	M	7/64	A	39	0	245	1·40	2,120
5·50	See para. 27	2/04	58	C.E.G.	M	2/08	A	37	0	240	1·60	2,100
5·50	See para. 27	1/02	61	C.E G.	M	2/08	A	38	0	255	1·85	2,100
4·75	See para. 27	1/85	61	C.E.G.	M	3/56	A	64	0	250	2·25	2,120
4·25	See para. 27	2/46	60	C.E.G.	M	5/16	A	95	0	245	2·30	2,130

Note.—The annotational references are to fig. 2.

TABLE 5 (APPENDIX 2)

Typical settings of T.1087 with the adaptor, type 9, working into 70-ft. vertical single wire aerial and earth. Aerial to be connected to terminal 13 *via* junction box. Aerial length measured from transmitter.

Frequency Mc/s	Oscillator		Input mA (M_4)	Amplifier Anode Coil and Tuning				Series Aerial Condenser (C_{18})	Amplifier Grid Bias Stud (S_{15})	Amplifier Input mA (M_5)	Load Current in Amps. (M_6)	H.T. Volts Stud 2
	Coil F	Condenser (C_1)		Anode Taps	Tuned Taps	Condensers						
						Variable (C_{13})	Fixed (S_{16})					
4·25	See para. 27	2/46	50	C.E.G.	M	6/15	A	26	0	280	1·57	2,120
4·00	See para. 27	2/84	58	C.E.G.	M	7/00	A	35	0	282	1·85	2,100
3·50	See para. 27	3/90	56	C.E.G.	M	3/40	B	42	0	265	1·66	2,120
3·25	See para. 27	4/61	55	C.E.G.	M	5/05	B	60	0	290	1·85	2,100
3·25	See para. 27	4/61	58	C.E.H.	M	4/51	B	68	0	255	1·90	2,100
3·00	See para. 27	5/47	58	C.E.G.	M	7/37	B	80	0	275	2·10	2,120
3·00	See para. 27	5/47	58	C.E.H.	M	6/55	B	104	0	270	2·20	2,220

Note.—The annotational references are to fig. 2.

NOMENCLATURE OF PARTS

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

Ref. No.	Nomenclature.	Qty.	Ref. in Fig. 3.	Remarks.
10D/1	Transmitter, type T.1087, with the adaptor, type 9.	—	—	Without valves or lamps.
	Comprising :—			
10D/8709	Transmitter, type T.1087	1	—	Modified.
10A/11890	Adaptor, type 9	1	—	For details, see below.
10A/11819	Box, junction, type 4	1	—	—
10C/8163	Condenser, type 151	2	C_{42}, C_{43}	0·01 μF.
10E/3	Valve, type 81	1	V_x	Oscillator.
	Adaptor, type 9 :—			
	Principal components :—			
	Condenser,			
10C/7906	Type 125	2	C_{38}, C_{39}	0·01 μF.
10C/10511	Type 378	1	C_{41}	0·01 μF.
10C/336	Type 663	1	C_{40}	0·0025 μF.
	Holder,			
10H/203	Crystal, type 3	1	—	—
10H/202	Valve, type 45	1	—	—
	Resistance,			
10C/9634	Type 272	1	R_{24}	50,000 ohms.
10C/11685	Type 519	1	R_{23}	50 ohms.
10C/66	Type 566	2	R_{21}, R_{22}	40 ohms.
10C/336	Type 752	1	R_{25}	50,000 ohms.
10C/338	Type 766	2	R_{26}, R_{27}	0·93 ohm.
10H/7227	Terminal	2	—	—
	Accessories :—			
	Connector,			
10H/204	Type 167	1	—	—
10H/205	Type 168	1	—	—
10H/206	Type 169	1	—	—
10X/ as required.	Crystal unit, type A	—	X	With plug-in holder.