AIR PUBLICATION
2550B
VOLUME 1
THIRD EDITION
1951

TRANSMITTER T.1509

Prepared by direction of
the Minister of Supply

A. C. Powlett.

Promulgated by Order
of the Air Council

J. H. Barnes.

1. Considerable difficulty is being experienced when the transmitter Type T.1509 is prepared for use owing to the complexity of packing and lack of instructions regarding unpacking and installation.

2. The equipment weighs about 8 cwt. and is provided with lifting eyebolts for screwing into the top of the unit. Unfortunately the sockets for these eyebolts have been stowed in their stowage position inside the transmitter cabinet and are not easily observed.

3. To prevent serious damage that may arise if the transmitter is moved by means other than the eyebolts provided, it is to be ensured that *an instruction label (specimen below) is prepared and fitted to the transmitter in a prominent position.*

IMPORTANT

INSTRUCTION TO UNPACKING CREW

POSITION OF LIFTING EYES

Remove two red transit bolts located beneath screw cover plates at top rear sides of instrument, unscrew six large bolts securing front panel of top unit and pull forward.

LIFTING EYES will be found on top left-hand side, inside cabinet.

IMPORTANT. Top unit must be replaced, six panel bolts secured and red transit bolts re-inserted BEFORE LIFTING TRANSMITTER.

In those instances where the transmitters are still in their packing, *the label is to be fixed to the packing* until such time as it is removed prior to installation. A fresh label should then be fixed to the transmitter as previously stated.

CONCISE DETAILS OF TRANSMITTER T.1509

Purpose of equipment	*General-purpose HF communications transmitter for use in fixed or mobile ground stations. Hand or high-speed keying. Crystal or MO control, with temperature compensated MO circuit.*
Type of wave	*CW, MCW, and R/T.*
Frequency range	*1.5 to 20 Mc/s.*
Modulation	*100 per cent.*
Output impedance	*50 ohms co-axial feeder.*
Audio input impedance	*600 ohms.*
Valves	*Oscillator, Type CV 124 (Barretter Type CV 2734)* *Multiplier, Type CV 124* *Power Amplifier (2), Type CV 26* *Modulator (2), Type CV 26*

AMPLIFIER

Compression amplifier, Type CV 1932
Bias and muting, two valves, Type CV 1054
First AF, Type CV 1941
Second AF, Type CV 1932
Push-pull output (2), Type CV 124

POWER UNIT

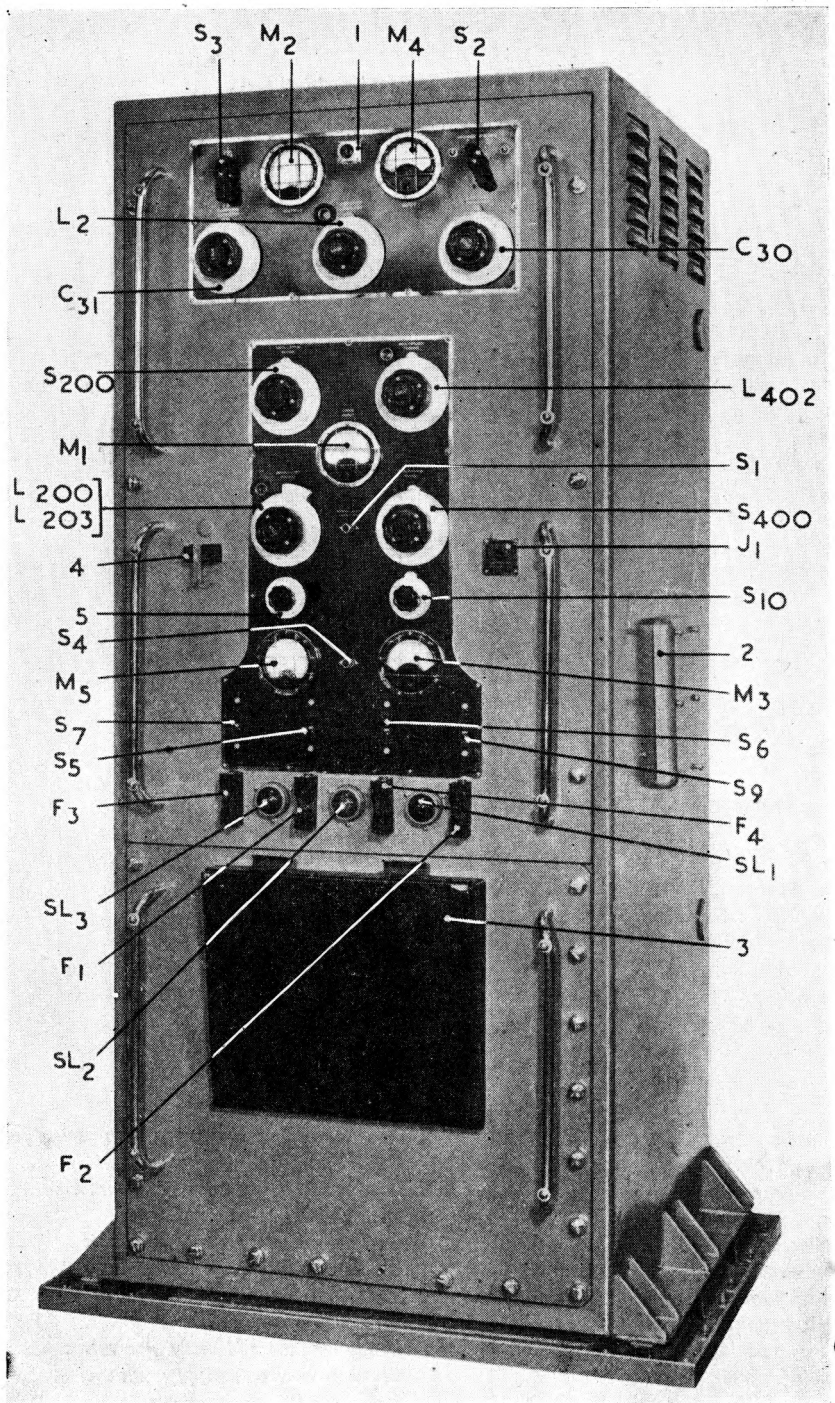
Four valves, Type CV 187
Two valves, Type CV 235
Four valves, Type CV 45 (voltage stabilizers)

Power input	*From 180/250-volt, 50-cycle AC mains*
Power output	*300-watt carrier on all services*
Approximate overall dimensions	*Width* 2 ft. 5 in. *Depth* 1 ft. 10½ in. *Height* 4 ft. 11 in. (Excluding shock-absorbing base)
Weight	*800 lb.*
Associated equipment	*Control unit, Type 310 (Stores Ref. 10L/171) or Control unit, Type 88 (Stores Ref. 10L/37)*

TRANSMITTER TYPE T.1509

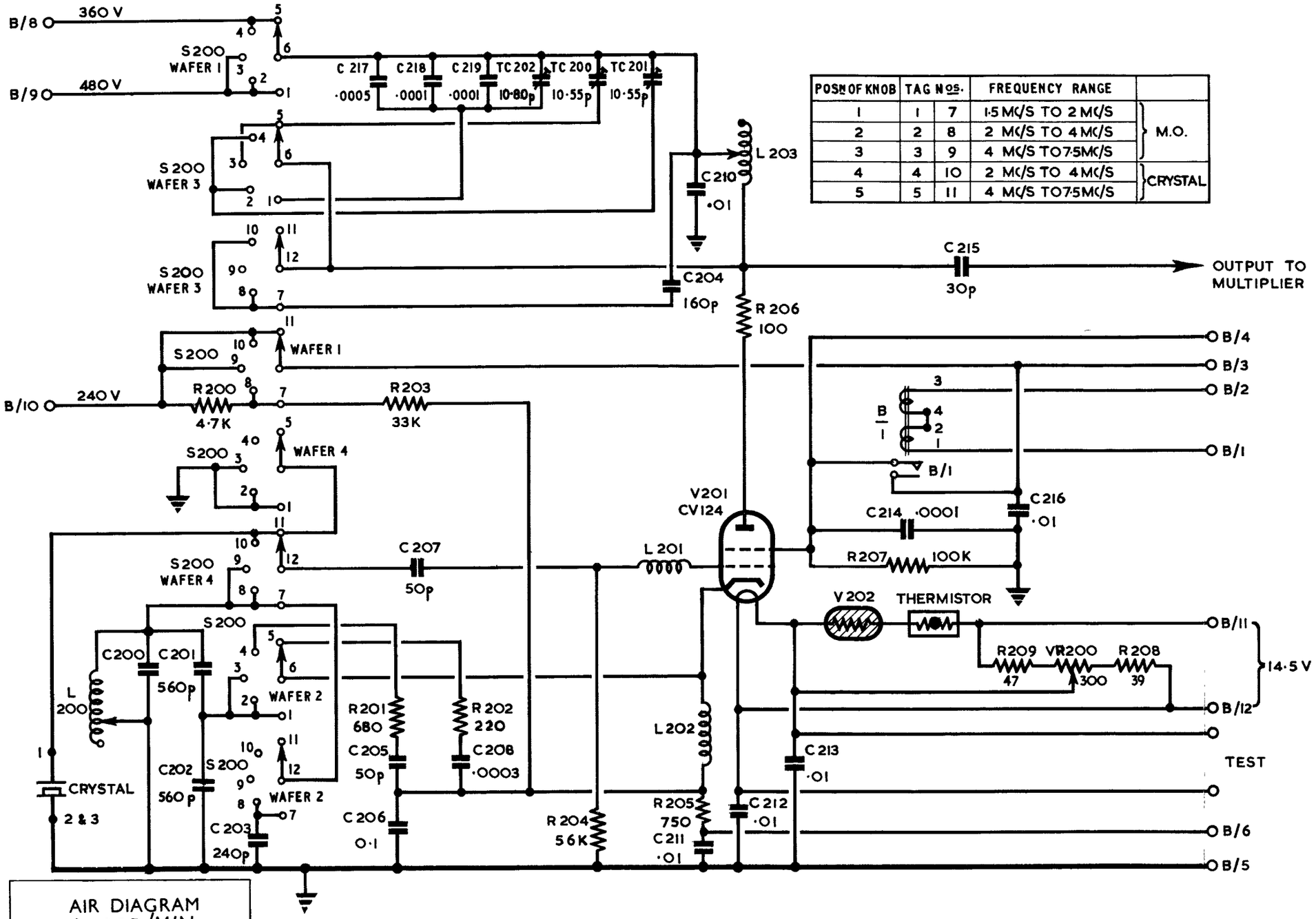
LIST OF CONTENTS

LIST OF ILLUSTRATIONS

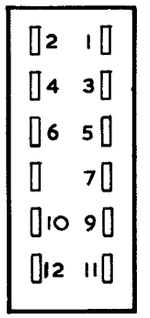


1 OUTPUT SOCKET
2 MAIN TERMINAL BLOCK
3 TRAY FOR CALIBRATION CHARTS
4 CRYSTAL
5 OSCILLATOR FINE TUNING CONTROL

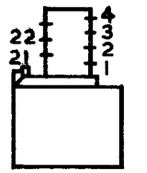
FIG. 1. GENERAL VIEW OF TRANSMITTER, T.1509



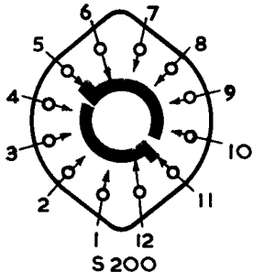
POSN OF KNOB	TAG NOS.		FREQUENCY RANGE	
1	1	7	1·5 MC/S TO 2 MC/S	M.O.
2	2	8	2 MC/S TO 4 MC/S	M.O.
3	3	9	4 MC/S TO 7·5 MC/S	M.O.
4	4	10	2 MC/S TO 4 MC/S	CRYSTAL
5	5	11	4 MC/S TO 7·5 MC/S	CRYSTAL



PLUG B
VIEW LOOKING AT BLADE CONTACTS



INDEX TO CONTACT NUMBERING RELAY B/1



S200

FOUR WAFERS IDENTICAL SWITCH WAFERS VIEWED FROM REAR IN MAX. ANTI-CLOCKWISE POSITION OF KNOB. (THAT IS, POSITION 5)

AIR DIAGRAM 6298D/MIN

ISSUE. 1 | PREPARED BY MINISTRY OF SUPPLY FOR PROMULGATION BY AIR MINISTRY

FIG. 2 — T 1509, OSCILLATOR UNIT, CIRCUIT

TRANSMITTER T.1509
(Stores Ref. 10D/1721)

Introduction

1. The transmitter T.1509 is a ground station transmitter for CW, MCW, or R/T operation in the frequency range from 1·5 to 20 Mc/s. Between 2 and 20 Mc/s, either crystal or master oscillator control, may be used. The range from 1·5 to 2 Mc/s is covered by MO working. A multiplier stage enables crystals from 2 to 7·5 Mc/s to cover the range of output frequencies from 2 to 20 Mc/s. Either crystal or master oscillator operation can be selected by means of a switch, no internal adjustments being required. A compensating condenser is incorporated in the MO circuit the spacing of whose plates varies with temperature in order to provide frequency compensation.

2. All the necessary circuits for remote control from a control unit, Type 310 or Type 88, are incorporated in the transmitter. Both units provide remote HT switching, tone-to-line keying, and facilities for modulation from a carbon microphone. The control unit, Type 310, also permits remote selection of CW, MCW, or R/T working, and intercommunication between the control point and the transmitter using a normal two-line circuit between the remote control point and the transmitting station.

3. The transmitter circuit comprises an oscillator unit, a multiplier unit (acting as a buffer stage between 1·5 and 7·5 Mc/s) and a PA and modulator stage. The oscillator and multiplier units are sub-assemblies of the transmitter unit, which in addition to the PA and modulator stages contains the control circuits referred to in *para.* 2. An amplifier unit, Type 367, for sub-modulation or amplification of keying tone, is also mounted on the transmitter unit. A power unit, Type 381, occupies the lower portion of the transmitter cabinet. The transmitter and power units can be pulled forward out of the cabinet on runners for inspection, as well as being completely removable when required. The cabinet measures 4 ft. 11 in. high by 2 ft. 5 in. wide by 1 ft. 10½ in. deep, and stands on a shock-absorbing base.

4. The transmitter is designed for operation on 180-250 volts, 50 cycle single phase AC mains and provides a 300-W carrier on CW, MCW, or R/T. High speed keying may be employed, terminals being provided for connection of an external relay. In these circumstances the multiplier stage is keyed. For hand operation keying takes place in the oscillator stage. When MCW is required the transmitter is set up as for R/T. The carrier is then radiated continuously, the oscillator keying contacts being short-circuited and the tone from the control unit, Type 310 or Type 88, modulates the carrier when the key is pressed.

GENERAL DESCRIPTION

Transmitter unit

5. The transmitter unit includes PA and modulator stages, the principal control circuits, the LT transformers, and the keying tone and modulator bias rectifiers. The oscillator, multiplier, and amplifier units are sub-assemblies of the transmitter unit.

Oscillator unit

6. The circuit of the oscillator unit is shown in *fig.* 2. Switch S200 selects the frequency range and the method of frequency control. On positions 1, 2 and 3 the valve V201 acts as a master oscillator, and on positions 4 and 5 the circuit is arranged for crystal control. A description of the circuit changes involved is given in *para.* 15 to 21.

7. Wafer 1 of S200 selects the appropriate anode and screen-grid supplies for the various conditions of working. In the three MO positions of the switch, the anode of V201 is connected to the 480-volt input from the power unit. The voltage is applied through the tapping of the variable inductance L203, the tapping point being at earth potential to RF by reason of the bypass condenser C210. In both crystal control positions of S200 the anode of V201 is connected to the 360-volt input. Resistor R206 in the anode circuit is a parasitic suppressor.

8. A potentiometer consisting of resistors R200, R203, and R205 is connected across the 240V input from the power unit, the return to earth from contact 6 of the oscillator plug B being completed in the transmitter unit (*para.* 35). For MO working on the two lower frequency ranges the screen-grid of V201 is connected to the junction of resistors R200 and R203 in this potentiometer. On the third MO range and on both crystal ranges the screen-grid is connected direct to the 240-volt input.

9. The cathode of V201 is connected via L202 to the junction of resistors R203 and R205 in the potentiometer referred to above

and is thus given a positive bias. Automatic bias for the valve is developed by the grid leak and condenser combination R204, C207. The DC cathode current returns to earth through switch S1 in the transmitter unit, which permits a milliammeter to be brought into circuit when required (*para.* 35).

10. The LT input to the unit is 14·5 volts and is dropped to 6·3 volts for the heater of V201 by means of a thermistor and the barretter V202. The thermistor is a surge limiting device to prevent damage to the barretter when the L.T. is switched on. This damage may occur due to the low resistance of the barretter and of the heater of V201 when cold. A shunt consisting of resistors R208, R209 and potentiometer VR200 is connected across the heater and is adjusted by means of VR200 so that a voltage of 6·3 is read on a meter placed across the points marked TEST. When this adjustment has been made, the barretter will stabilize the heater current against variations in the supply voltage.

11. In both MO and crystal conditions of working the valve V201 is keyed in the screen-grid circuit by the contacts of relay B/1. The relay is energized by the rectified keying tone from a control unit, Type 310 or Type 88, which is supplied to contacts 1 and 2 of plug B on the oscillator unit. The tone is first amplified in the amplifier, Type 367 and then rectified by the metal rectifier W1 in the transmitter unit (*fig.* 8).

12. When the transmitter is used for R/T, relay contacts B1 are short-circuited through contacts 3 and 4 of plug B, contacts A4 of the R/T relay A/4 in the transmitter unit (*fig.* 8), and HT is thus permanently on the screen of V201.

13. Condenser C216 is the main screen decoupling condenser; the screen is returned to earth *via* R207, which is by-passed by C214 alone in the stand-by condition.

14. The RF output from the oscillator unit is coupled to the grid of the valve in the multiplier unit through condenser C215. Other connections to the oscillator unit are made through the plug B.

Master oscillator operation

15. The circuit arrangements for master oscillator operation are shown in simplified form in *fig.* 3. An electron-coupled oscillator circuit is employed, the electron stream reaching the anode of V201 being modulated at a frequency dependent upon the adjustment of the oscillatory circuit L200, C201, C202 between grid and screen of the valve.

16. The screen-grid, control-grid and cathode of V201 form an inverted triode oscillator, the screen-grid serving as the oscillator anode and being held at earth potential to RF by the condenser C214 between it and the earth line. In this type of oscillator the RF potential of the cathode varies (while that of the anode is fixed), the RF choke L202, being connected between cathode and earth.

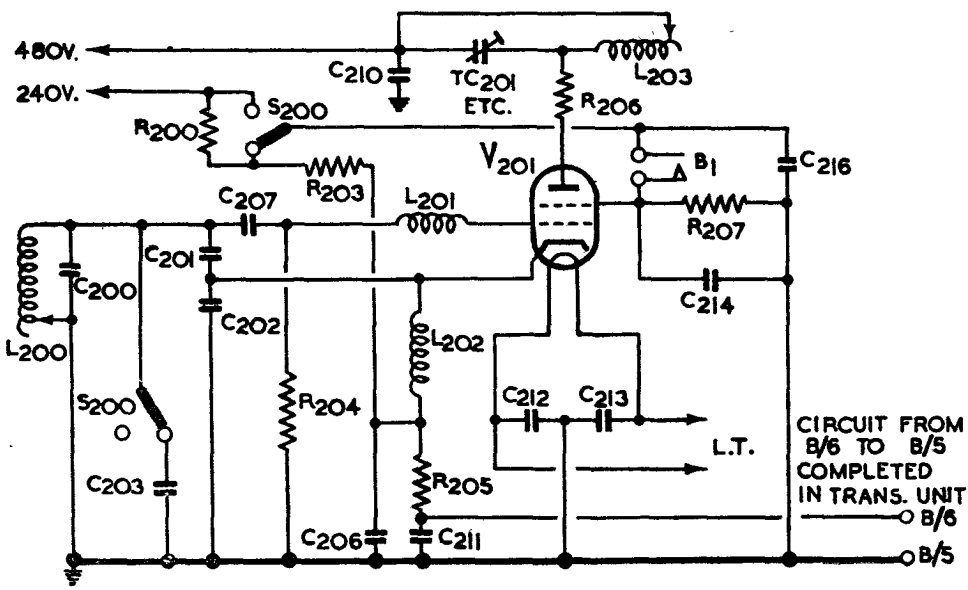


Fig. 3. Simplified circuit, master oscillator control

17. Feedback for the oscillator is obtained by the Colpitts method, the centre point of condensers C201 and C202 across the oscillator coil L200 being connected to cathode. An additional condenser C203, is placed in parallel with the coil on the two lower frequency ranges. Condenser C200 is the compensating condenser referred to in *para.* 1.

18. The anode circuit of V201 is tuned to fundamental frequency of the oscillatory circuit L200, C201, C202 to give output frequencies between 1·5 and 2 Mc/s, to twice that frequency for output frequencies between 2 and 4 Mc/s and to three times that frequency for frequencies 4 to 7·5 Mc/s. The circuit consists of the variable inductance L203 with a trimming condenser and, on position 1 of S200, an additional fixed capacity in parallel. Referring back to *fig.* 2, it will be seen that on switch position 1 the parallel capacity consists of TC202, C217 to C219 and C204 in parallel; on position 2, TC201 and C204 and on position 3, TC200.

19. In all the MO positions of S200, both crystal sockets are earthed by wafer 4.

Crystal control

20. Positions 4 and 5 of S200 arrange the circuit for crystal control as shown in *fig.* 4 and provide for output frequencies between 2 and 7·5 Mc/s. The crystal is connected between grid and screen of V201 and the valve functions as an electron-coupled crystal oscillator as in the case of MO operation, the anode being tuned to the crystal frequency. A tuned circuit is included in the cathode, to provide the necessary feedback for satisfactory keying with crystal operation, consisting of choke L202 with condenser C205 or C208 in parallel. Resistors R201 and R202 reduce the Q of the circuit and oppose any tendency to the continuance of oscillations when the key is up.

21. It will be seen from the circuit diagram, *fig.* 2, that for the 2-4 Mc/s range the anode circuit tuning capacity consists of TC201 and C204, and from 4 to 7·5 Mc/s by TC200 alone. Reference should be made to *para.* 19 for MO operation on these ranges.

Multiplier unit

22. The output from the oscillator unit is applied to the grid of the valve V400 in the multiplier unit (*fig.* 5). For final radiated frequencies between 1·5 and 7·5 Mc/s the valve acts as a buffer, this condition obtaining in positions 1 to 3 of the switch S400 on the unit. In position 4 the anode circuit is tuned to twice, and in position 5 to three times the input frequency.

23. In order to obtain satisfactory harmonic generation, this valve is operated with a high value of negative grid bias, part

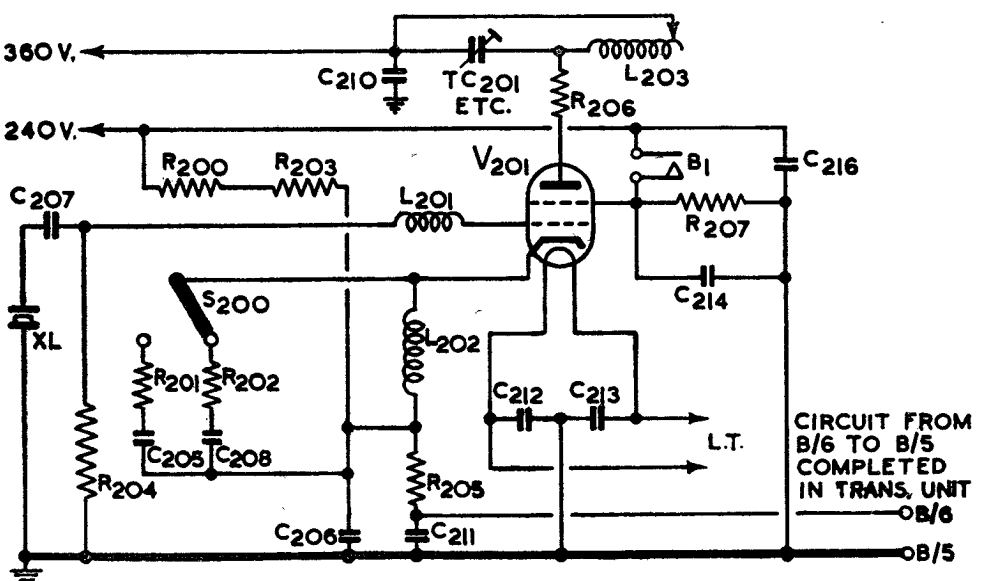
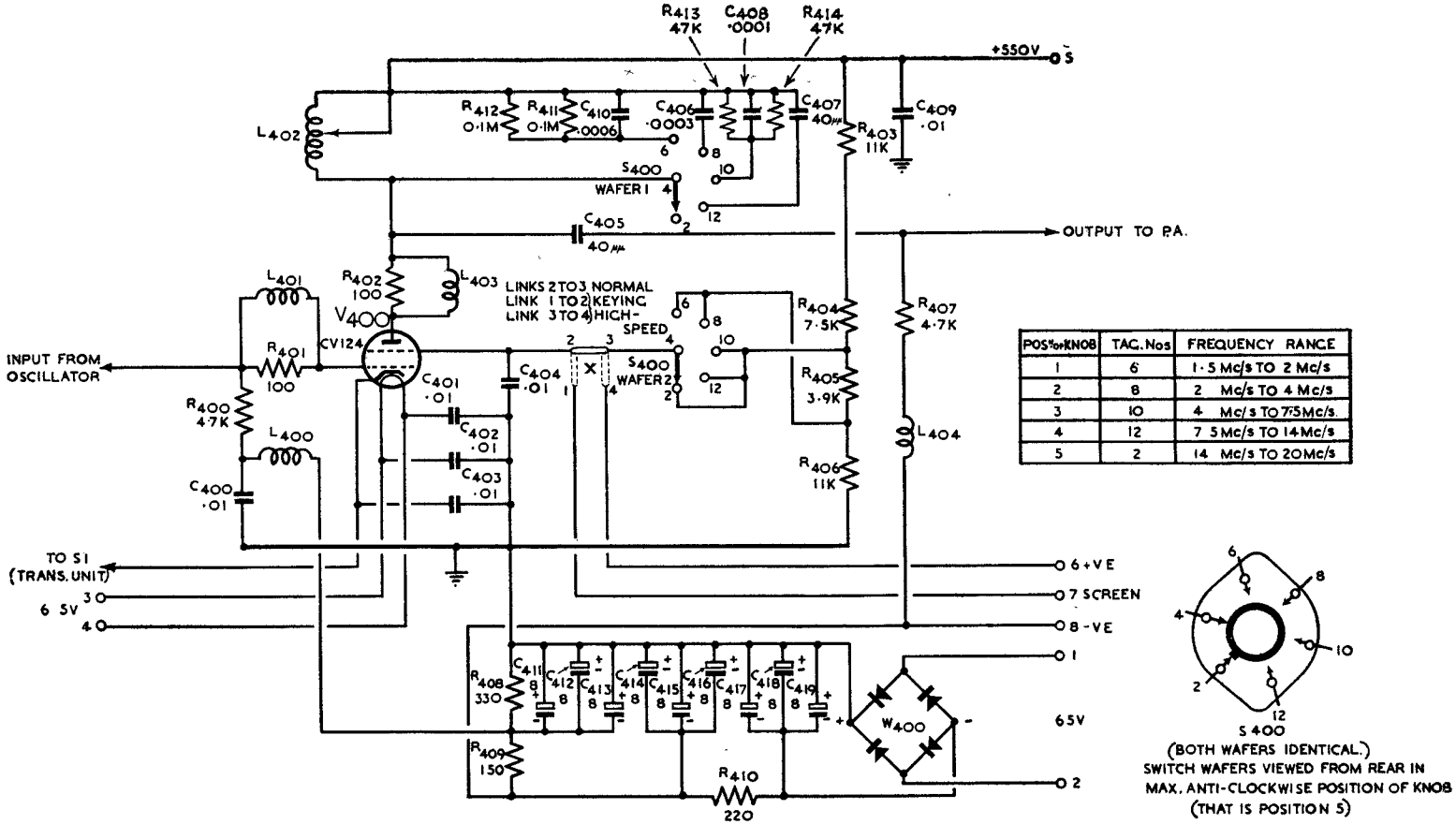


Fig. 4. Simplified circuit, crystal control



POS'n of KNOB	TAG. Nos	FREQUENCY RANGE
1	6	1·5 Mc/s TO 2 Mc/s
2	8	2 Mc/s TO 4 Mc/s
3	10	4 Mc/s TO 7·5 Mc/s.
4	12	7 5 Mc/s TO 14 Mc/s
5	2	14 Mc/s TO 20 Mc/s

(BOTH WAFERS IDENTICAL.)
SWITCH WAFERS VIEWED FROM REAR IN MAX. ANTI-CLOCKWISE POSITION OF KNOB (THAT IS POSITION 5)

FIG. 5. CIRCUIT OF MULTIPLIER UNIT

of which is obtained by grid current flowing in R400, the remainder being a fixed supply at 32 volts approx. A negative bias of 45 volts is required for the power amplifier, and both these potentials are provided in the multiplier unit and are obtained from a metal rectifier, W.400, which is connected across a 65-volt winding on the LT transformer T2 in the transmitter unit (*fig.* 8).

24. The screen-grid voltage for V400 is taken from alternative tappings on the potentiometer R403 to R406 across the 550-volt HT input, the tapping being selected by wafer 2 of S400. Wafer 1 of the switch selects the parallel tuning capacity for the variable anode inductance L402. On the 1·5-2Mc/s range, resistors R411 and R412 are connected across the coil to limit the power developed when the stage is working as a buffer on the lowest frequencies. Resistors R413 and R414 perform a similar function on range 3.

25. Chokes L401 and L403, shunted by resistors R401 and R402, are parasitic suppressors.

High-speed keying

26. When high-speed keying is used with the transmitter it takes place in the multiplier stage. Links X are altered to the positions shown dotted on *fig.* 5 and as shown in full on the simplified high-speed keying circuit diagram *fig.* 6. When the tongue (T) of the high-speed keying relay is at " mark " (M) the supply circuit to the screen grid of V400 is completed.

27. When the tongue is at " space " (S) this circuit is broken, and the screen grid is connected to the negative end of resistors R408, R409 across the rectifier W.400 in the multiplier. A negative bias of approximately 45 volts is thus applied to the screen-grid and the valve is biased beyond cut-off.

28. The high-speed relay which is external to the transmitter, is connected to three terminals marked HIGH-SPEED KEY on the main terminal block, which corresponds to terminals 6, 7 and 8 on the multiplier unit, terminal 6 being ultimately connected to the relay " mark " contact ; terminal 7 to the tongue " contact " ; and terminal 8 to the " space " contact.

29. For a description of a high-speed signalling system, reference should be made to A.P.2980A, Vol. I.

30. The cathode of V400 in the multiplier unit is connected to switch S1 in the main unit (*fig.* 8) where it is returned to earth either direct or through a milliammeter (M1 of *fig.* 1) to read the cathode current of the valve.

Power amplifier stage

31. The power amplifier stage is shown in simplified form in *fig.* 7. Valves V1 and V2 are beam tetrodes, connected in parallel.

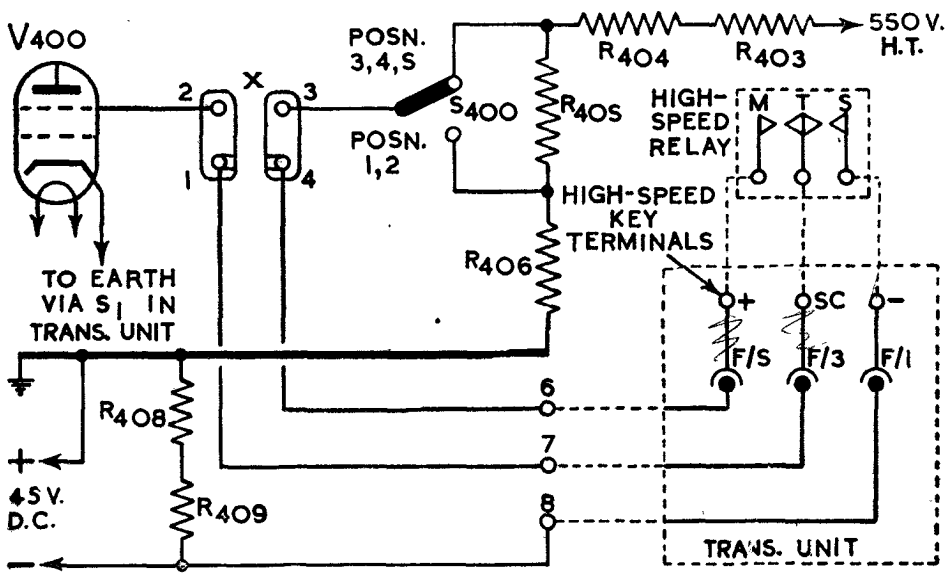


Fig. 6. High-speed keying circuit

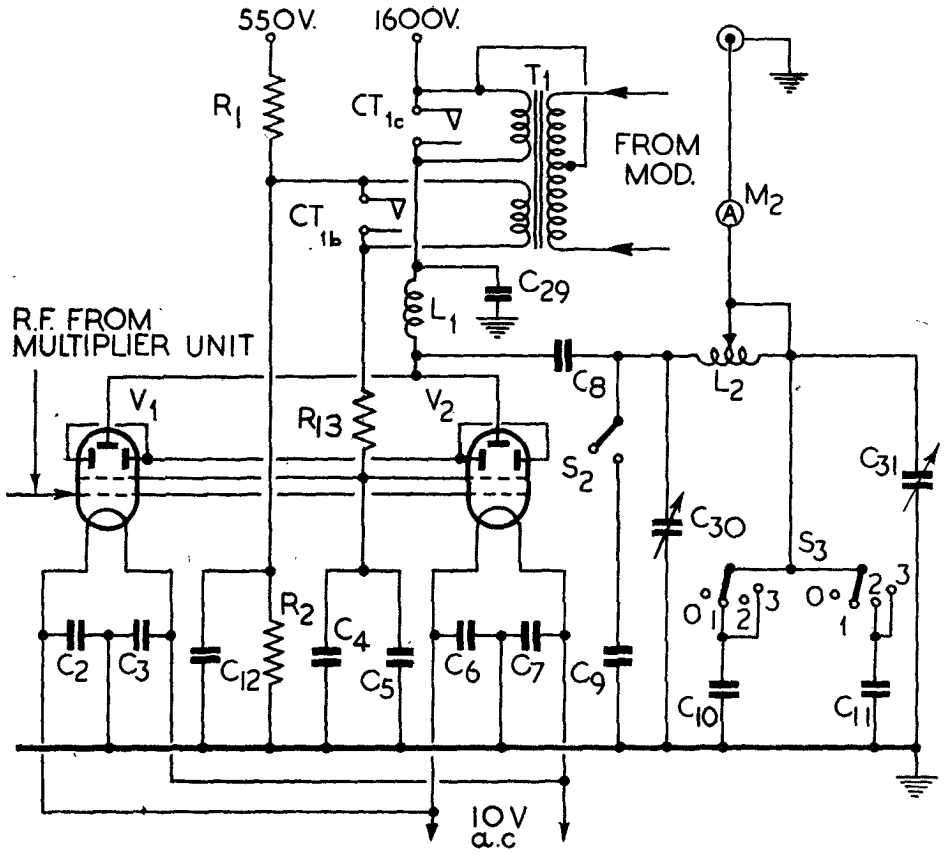


Fig. 7. Simplified circuit of power amplifier

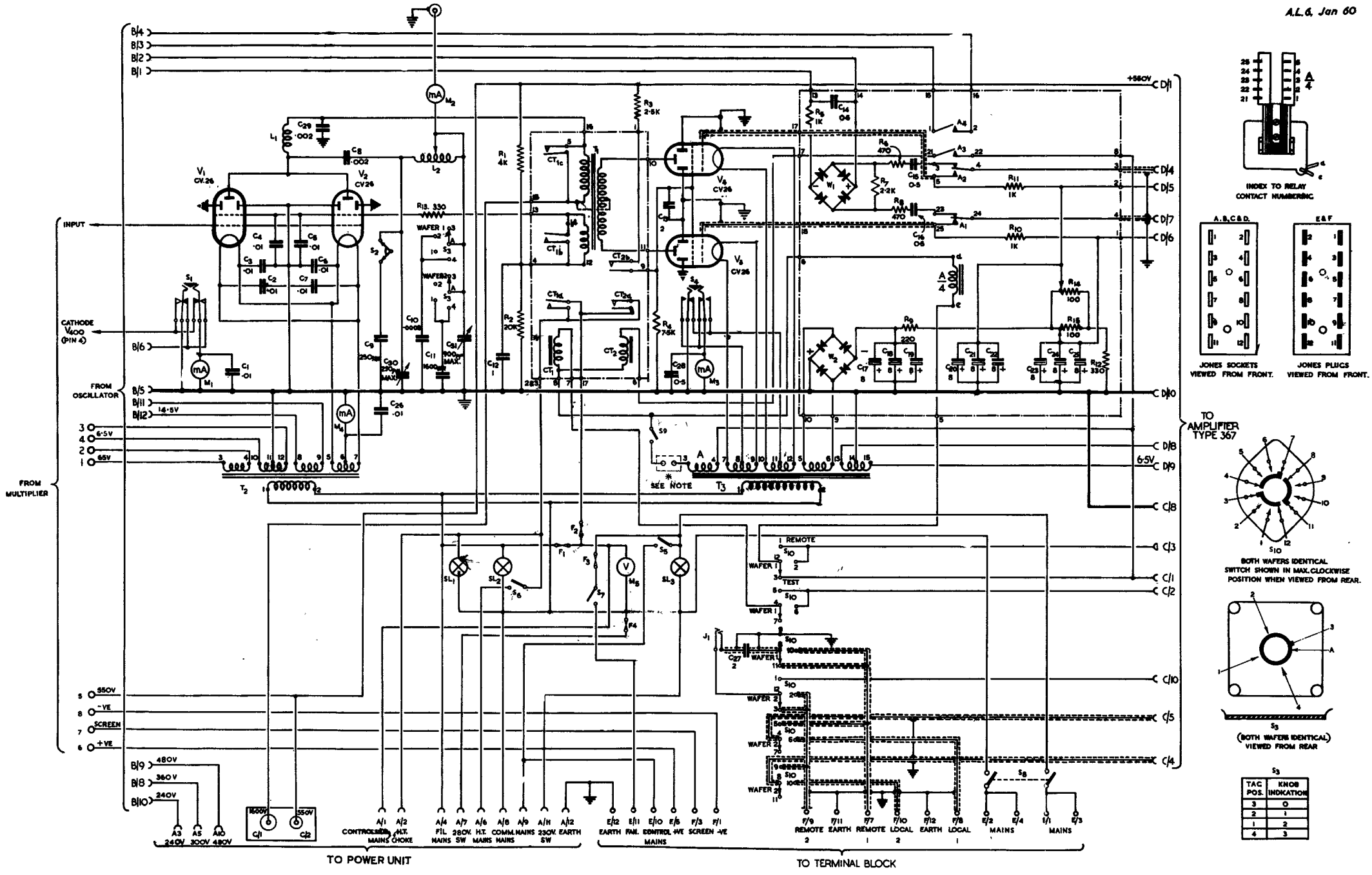
Their tuned anode circuit consists of the variable inductance L2 and the variable condensers C30 and C31. The fixed condenser C9 is connected in parallel with C30 by the RANGE switch S2, on the 1·5—2Mc/s range. Adjustment of aerial coupling is provided by the variable condenser C31, and the fixed condensers C10, C11 (selected by the COUPLING switch S3). The switch has four positions, labelled 0 to 3 as shown in *fig.* 7. Aerial coupling is reduced as the capacity from the aerial end of L2 to earth is increased, the couplings being minimum on switch position 3 when C10, C11 and C31 are all in parallel. Meter M2 reads the RF output current.

32. The stage is parallel-fed through the HF choke L1. For R/T transmission, anode and screen modulation is obtained by feeding the HT supply to these electrodes through the secondary windings of the modulation transformer T1. These secondaries are short-circuited by the contacts CT1b, and CT1c of the CW contactor, CT1, during CW transmission. The DC screen-grid voltage is tapped off from the junction of resistors R1, R2 across the 550-volt input to the unit. The resistor R13 is a parasite stopper.

33. Class C operation is employed both on CW and R/T, the grid of V1 and V2 being connected to the negative end of resistors R408, R409 across the metal rectifier W.400 in the multiplier unit (*fig.* 5 and *para.* 23). A negative bias of approximately 48 volts is applied to the grids, via resistor R407 and choke L404 (*fig.* 5).

34. Both PA valves are directly heated, and the filaments are by-passed to earth through condensers C2, C3 and C6, C7. The screen grids are maintained at earth potential to RF by condensers C4, C5.

35. Referring to the full circuit diagram of the transmitter unit (*fig.* 8) the switch S1 is the meter switch referred to in *para.* 9



TAC POS.	KNOB INDICATION
3	0
2	1
1	2
4	3

AIR DIAGRAM 6298A/MIN.	
ISSUE 3	PREPARED BY MINISTRY OF AVIATION FOR PROMULGATION BY AIR MINISTRY

(MOD 4666 INCORPORATED) * NOTE:- Terminal block introduced by MOD 5550. These terminals must be linked if unit is disconnected from aerial exchange

FIG. 8. CIRCUIT OF TRANSMITTER UNIT, 59 (T1509)

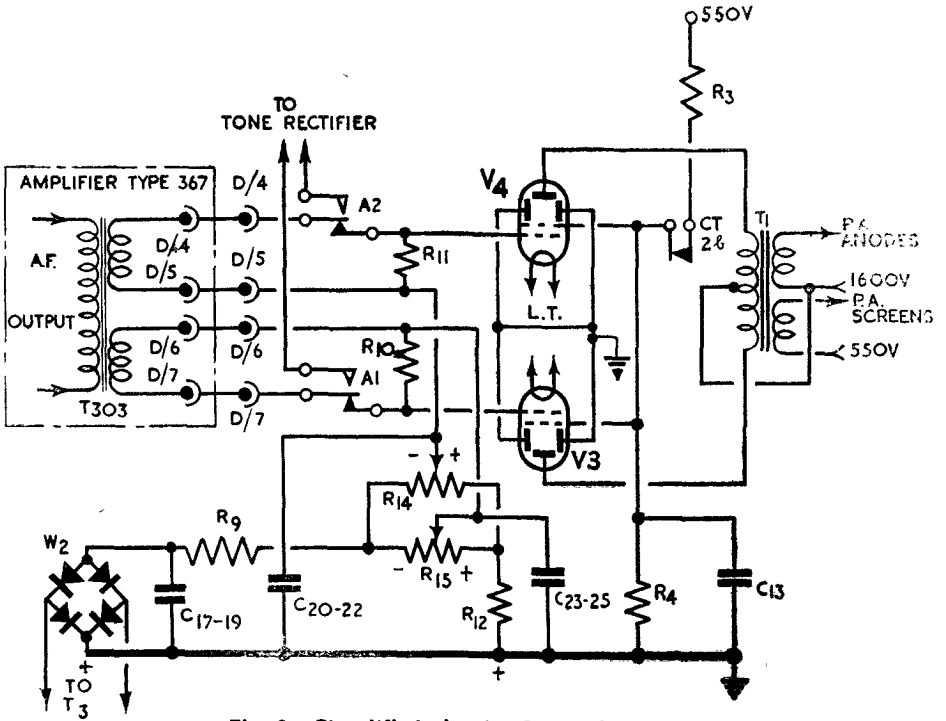


Fig. 9. Simplified circuit of modulator stage

and 30. When the contacts are in the position shown, the cathode of the oscillator valve V201 (*fig.* 2) is returned direct to earth through contact 6 of the Jones socket B and the left-hand set of switch contacts. At the same time the cathode of the multiplier valve, V400 (*fig.* 5) is earthed through the right-hand set of switch contacts and the milliammeter M1, enabling its cathode current to be read. When the switch button is pressed, the milliammeter is tranferred to the cathode of V201 and the cathode of V400 is earthed direct.

36. The meter M4 reads the combined cathode current of the PA valves, V1, V2.

Modulator stage

37. The circuit of the modulator stage is shown in simplified form in *fig.* 9 with the various relay and contactor contacts in the positions for R/T operation. The secondaries of the output transformer T303 in the speech amplifier are connected by relay contacts A1, A2, to feed the grids of the modulator valves V3, V4 in push-pull. When these contacts are reversed, as for CW working, the amplifier output is switched to the tone rectifier, W1 (*fig.* 8).

38. The stage operates under Class AB2 conditions, bias being obtained from the rectifier W2, (*fig.* 8) the input to which is taken from a secondary winding on the transformer T3 (*fig.* 8). Resistance-capacity smoothing is employed, and potentiometers R14, R15 (*fig.* 9) permit individual adjustment of the bias to each valve grid. When the potentiometers are in the minimum bias position, the grids are still negative to earth by the PD across R12.

39. Contacts CT2b of the R/T contactor, CT2, connect the screen-grids of the modulator valves to the junction of resistors R3, R4 across the 550-volt input to the transmitter unit. The HT to the anodes of V3 and V4 is taken from the 1,600-volt line and applied to the centre tap on the primary of T1.

40. Referring to the circuit diagram, *fig.* 8, it will be seen that the cathode current of either modulator valve can be read on the milliammeter M3, the push-button switch S4 enabling the meter to be switched into either cathode circuit. Normally the meter is in the cathode circuit of V3. Pressing the switch button transfers the meter to the cathode circuit of V4.

41. Also in *fig.* 8 can be seen the resistance-capacity filter R9 and C17 to C25, which smoothes the DC output from the bias rectifier W2.

Amplifier, Type 367

42. A circuit diagram of the amplifier, Type 367 is given in *fig.* 13. The switch S300 must be set according to the type of control unit in use. In position 1, as shown in the diagram, the circuit is arranged for the use of a control unit, Type 310. The SERVICE switch on this unit enables a 24-volt supply to be connected with either polarity across lines 1 and 2 (terminating at contacts 4 and 5 of plug C). When the switch is at R/T, the positive side of the supply is connected to line 2 and current passes through rectifier MR300 and the operating coil of the R/T relay D/1 to line 1. In this condition the passage of current through the winding of the CW relay, E/1 is opposed by rectifier MR301.

43. When the R/T (D/1) relay operates, a circuit is made between contacts 1 and 3 of plug C, causing first the transmitter R/T relay, A/4, to be energized and then the transmitter R/T contactor, CT2 (*para.* 73).

44. Operation of the SERVICE switch on the control unit, Type 310 to the CW position connects the positive side of the 24-volt supply to line 1 and current now passes through the operating coil of the CW relay E/1 and rectifier MR301 (being opposed by MR300) to line 2.

45. When the CW (E/1) relay operates, a circuit is made from pin 1 to pin 2 of plug C, thereby completing the energizing circuit for the CW contactor CT1 in the transmitter (*para.* 70).

46. The AF input voltages (speech or keying tone) to the amplifier are applied *via* pins 4 and 5 of plug C across the primary of the transformer T300. It will be seen that although the primary is split from the DC point of view, the two halves of the winding are in series to AF through condenser C300.

47. When a control unit, Type 88 is used with the transmitter, the amplifier relays D/1 and E/1 are operated by 24 volts DC over a line and earth circuit, the relay for the service required being selected by the amplifier switch S300. To operate the transmitter, the HT switch on the control unit, Type 88, is placed ON; this connects the positive terminal of a 24-volt battery to a centre tap in the output winding of the line transformer in the unit. With switch S300 in the amplifier unit in positions RT or CW, the two halves of the primary of T300 are connected in series through the right-hand pole of the switch, and their junction is returned to earth through the operating coil of relay D/1 or E/1 by one of the other two poles. The line to earth circuit for operation of the relay required is thus completed. The incoming AF voltages appear across the primary of T300 as before.

Intercom. relay

48. Relay F/2 enables the lines from the remote control point to be used for intercommunication with the transmitter attendant, and provides for breaking the I/C circuit when the transmitter HT is switched on.

49. Until the transmitter and amplifier HT circuits are made, the relay is de-energized and contacts F2 are closed. The mic-tel jack on the transmitter (J1, *fig.* 8) is connected through contact 10 of the amplifier plug C across part of the secondary winding of T300 (*fig.* 13) so that communication can be carried on over lines 1 and 2 (*fig.* 13) with the remote control point. Contacts F1 are open and there is therefore no input to the grid of V300 or V303. Telephone sets F Mk. 1 (Stores Ref. 10G/137) should be employed for this I/C circuit, as these employ a buzzer calling device which does not affect the line relays. Telephone sets F Mk. 2 may also be used if available.

50. When HT is switched on to the transmitter and amplifier, the relay is energized from the 550-volt input through resistors R317 and R318. Contacts F2 then open to break the I/C circuit, and contacts F1 close, connecting the amplifier input potentiometer, VR305, across the secondary of T300. Simultaneously the telephone set at the control unit, Type 310 is disconnected from the lines, this operation being performed automatically when the transmitter HT switch on the unit is placed ON.

Automatic gain control

51. The first amplifying valve is V303, the modulating voltages from the lines being applied to the grid through the moving

contact of the pre-set volume control VR300, condenser C303 and resistor R302. This valve is a variable-mu RF pentode, and its grid receives a negative bias dependent upon the average level of the input signal. The bias is developed by the triode amplifier V300, and the full-wave rectifier V301. Condenser C305 and resistor R305 provide a time constant to delay the decay of the bias on the grid of V303 during momentary pauses in the incoming signal. It is, however, necessary for the bias to be applied instantaneously on receipt of a signal, and this is achieved by the first diode of V302, which is connected across R305. The diode conducts to allow C305 to charge rapidly, but opposes current in the reverse direction and in consequence C305 discharges slowly through R305.

Muting

52. A simplified diagram of the amplifier muting system and of the biasing arrangements described in *para.* 51 is given in *fig.* 14. With zero or small inputs to the grid of V303, the second diode of V302 is conducting, since the anode of V302 is returned through the grid resistor of V303 (R306) resistors R305 and R303 to the top of R308. Under this condition a small positive bias is developed by the anode current of V303 at this point, so that V302 anode is positive in respect to its cathode.

Due to the presence of R302 in series with the input to the grid of V303, the amplifier is then muted by the presence of a low-resistance path to earth provided by the conducting diode (diode 2 of V302, *fig.* 14).

53. When a signal is received, the grid of V303 goes negative bias being supplied by the AGC amplifier valve V300 and the diode rectifier V301 as already described. Since the second diode anode of V302 is connected to the grid of V303, this anode goes negative as well, and at the same time the anode current of V303 falls, reducing the positive bias developed across R308; consequently, the second diode of V302 rapidly becomes non-conducting and does not affect the performance of the AF amplifier at normal input levels.

54. Initial grid bias for V303 is obtained across the unshunted cathode resistor R307.

55. By means of VR300 the input level can be adjusted.

Amplifying stages

56. The first amplifying valve V303 is resistance-capacity coupled to the triode amplifier, V304, the pre-set gain control

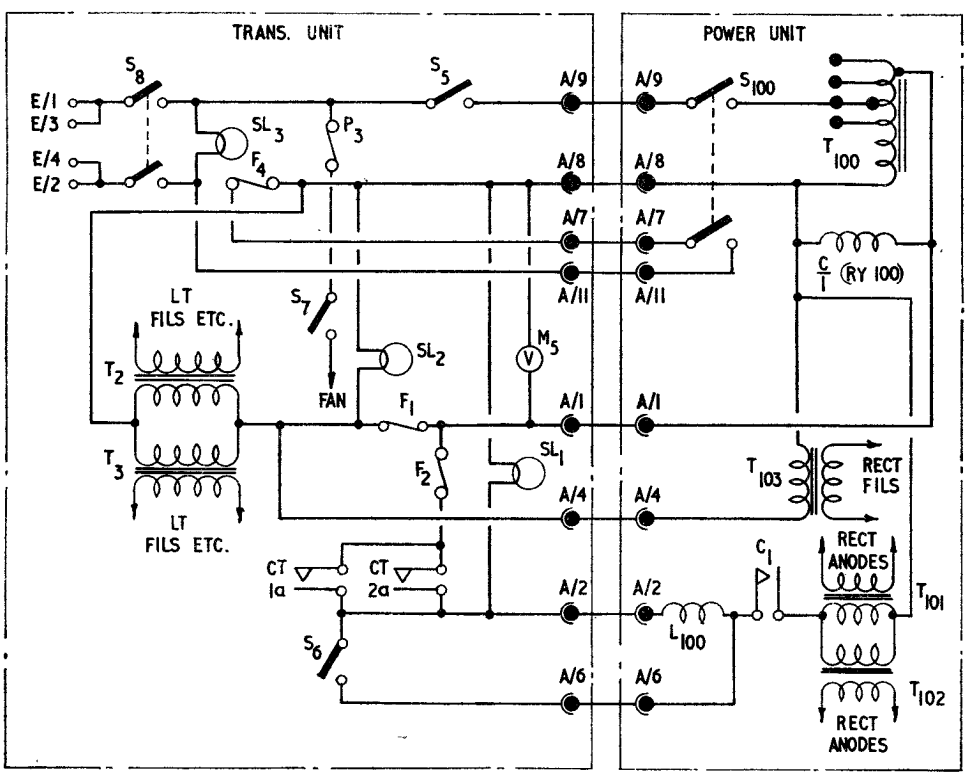


Fig. 10. LT and HT switching circuit ◀Mod. 4666 incorporated▶

VR301 being provided so that the output level of the amplifier can be adjusted to the correct level for 100 per cent. modulation after its input level has been controlled by the AGC circuit. Condensers C307, C311 and C313 are included to attenuate the output at frequencies above those required for speech transmission. This stage is transformer-coupled by T302 to two tetrode valves V305, V306 in push-pull. The unshunted cathode resistors R322, R323 are included to provide bias and negative feedback, further bias being developed across the common cathode resistor R319, shunted by C315. The output transformer T303 is provided with two secondary windings to allow the individual adjustment of the bias on the grids of the modulator valves in the transmitter.

Control circuits

57. The principal control circuits are incorporated in the transmitter unit, and are shown in full in *fig.* 8. The mains input to the transmitter, speech amplifier and power unit is connected across contacts 1 to 4 of plug E on the transmitter unit; E/2, E/4 and E/1, E/3 are paralleled for convenience when wiring up.

LT and HT switching

58. A simplified diagram of the LT and HT switching circuits is given in *fig.* 10. Provided the transmitter safety switch S8 is closed, the MAINS lamp SL3 is alight all the time the mains are connected. The circuit to the fan motor can then be completed by closing the FAN switch S7.

59. On closing the LT switch S5 the mains are applied *via* the safety switch S100 to the auto-transformer, T100, in the power unit, the input tapping on which is adjusted according to the supply voltage. The mechanical delay relay C/1 is also energized from the output of T100, its contacts C1 closing after an interval of 25 to 35 sec. to enable the HT voltage to be applied to the anodes of the power unit rectifiers *via* the HT transformer T101 when the HT switch is closed. This switch (S9 of *fig.* 8) applies the 50-volt winding of T3 (*fig.* 8) to the coil of HT contactors CT1 or CT2 according to the type of service in use, and their contacts, CT1a and CT2a feed the mains to the HT transformers (T101, T102 of *fig.* 10) *para.* (63).

60. The 230-volt controlled output from T100 returns to the transmitter and reaches the common mains line through the primaries of transformers T2, T3 in the main unit. The secondaries of T2 supply the filaments of the oscillator, multiplier, and PA valves and the bias rectifier for the multiplier and PA valves (W.400 *fig.* 5). The secondaries of T3 supply the filaments of the modulator valves, the heaters of the valves in the amplifier, Type 367, the modulator bias rectifier W2 (*fig.* 8), the CW and R/T contactors CT1, CT2 and relay A/4. Current also passes to the primary of T103 in the power unit, the secondaries of which supply the rectifier filaments.

61. The LT lamp SL2 lights up and the voltmeter M5 shows the controlled voltage.

62. To complete the circuit from the controlled voltage line to the primary of transformers T101, T102 in the power unit, which supply the anodes of the rectifier valves, contacts CT1a or CT2a must be closed. These belong respectively to the CW and R/T contactors (CT1, CT2 *fig.* 8). Either contactor may be energized when the HT switch S9 (*fig.* 8) is closed, the one which operates being determined by the position of the SERVICE switch on the control unit, Type 310, or, if a control unit, Type 88 is used, by the position of the switch S300 in the amplifier, Type 367 (*fig.* 13).

63. If the TUNE-TRANSMIT switch S6 is open (TUNE position), the input to the primaries of H.T. transformers T101, T102 is reduced by the LF choke L100. This is done to protect the transmitter valves during tuning. Closing the switch (TRANSMIT position) short-circuits the choke and applies the full voltage to the transformers.

Note . . .

Under no circumstances must the transmitter be operated in the TUNE *position.*

64. The HT lamp SL1 lights up when either the CW or the R/T contactor closes, indicating that the HT voltage is on the rectifier anodes, provided that the delay contactor C1 has closed.

65. ◀Prior to Mod. 4666, S100 broke the lead from A/8 to T.100, A/7 and A/11 were not used and F4 (left) was connected direct to SL3-S8 junction.▶

Selection of service

66. The transmitter is operated from a control unit, Type 310, or alternatively Type 88, and provision is made for the connection of two units of either type, one in the transmitting station and the other at a suitable remote control point.

67. The units are connected to a terminal block on the transmitter and thence to the contacts of plug F marked LOCAL and REMOTE (*fig.* 8). Switch S10 has three positions, labelled REMOTE, LOCAL and TEST.

On the first two positions, the remote or local control unit is connected to the transmitter, and on the TEST position both are out of circuit but the transmitter HT supply is completed and the contactors are operated in the R/T-MCW position, so that the oscillator keying contacts are short-circuited by the A4 contact of relay A4 (*para.* 74) and adjustment can be carried out.

68. A description of the control unit, Type 310 is given in *para.* 95 to 112 of this publication and of the control unit, Type 88 in A.P.2529A, Vol. I., Chap. 2.

69. Switch S300 in the amplifier, Type 367 (*fig.* 13) is set to the appropriate position for the type of control unit in use. When using a Type 310 unit, selection of CW or R/T and MCW operation is carried out by the SERVICE switch on the unit and may therefore be done remotely. With a control unit, Type 88, the service is selected by switch S300 in the amplifier. The amplifier switching and relay operation is described in *para.* 42 to 45.

CW operation

70. When the CW relay E/1 in the speech amplifier (*fig.* 13) is operated from the local or remote control unit, a circuit is completed between contacts 2 and 1 of socket C in the transmitter unit (*fig.* 8). Provided that the transmitter HT switch S9 is closed, there is now a circuit from secondary A of T3, through S9, the operating coil of CT1 and wafer 1 of S10 (provided that the switch is at LOCAL or REMOTE) to contact 2 of socket C. As has been mentioned, contacts 1 and 2 of the socket are connected through the amplifier and it will be seen that this completes a return path to the other end of secondary A of T3. The controlled mains voltage has already been applied to the primary of T3 by closing the LT switch S5 (*para.* 59).

71. The R/T relay, A/4, is not energized in this condition and the circuit to the R/T contactor CT2 is broken at relay contacts A3. Contacts A1 and A2 of the relay apply the output from the amplifier, Type 367, which in this case consists of amplified keying tone, to the rectifier W1. The output of the rectifier, smoothed by R5 and C14 is supplied to the operating coil of the keying relay B/1 in the oscillator unit (*fig.* 2), thus applying *via* its contacts, HT to the oscillator screen grid when the telegraph key is down.

72. When the CW contactor CT1 operates, its contacts CT1a complete the mains input to the HT transformers T101, T102 in the power unit. Contacts CT1b and CT1c short-circuit the two secondaries of the modulation transformer T1, so that the HT supply to the anodes and screens of the PA valves does not pass through those windings.

R/T operation

73. When the R/T relay D/1 in the amplifier (*fig.* 13) is operated from the control unit, contacts 3 and 1 of socket C in the transmitter unit (*fig.* 8) are connected through the amplifier. Thus the operating circuit of the CW contactor is broken between contacts 1 and 2. A circuit is made, however, from secondary A of T3, through S9, the operating coil of the R/T relay A/4, and wafer 1 of S10 (provided that switch is at LOCAL or REMOTE) to contact 3 of socket C. As previously mentioned, contact 3 is connected to contact 1 through the speech amplifier, and this again completes the return circuit to the other end of secondary A of T3. The R/T relay, A/4, is therefore energized. The first effect to observe is the closing of relay contacts A3, which complete a second circuit from secondary A of T3, through S9, the R/T contactor CT2, and relay contacts A3, back again to the secondary, thereby energizing the R/T contactor CT2. Contacts CT2a are in parallel with contacts CT1a of CT1 (*para.* 72) and therefore complete the primary circuits of the HT transformers, T101, T102 in the power unit. Contacts CT2b apply HT to the screen grids of the modulator valves V3, V4. Since contacts CT1b and CT1c of the CW contactor CT1 are now open, the HT to the anodes and screens of the PA valves is applied through the secondaries of T1 and is modulated at audio-frequency from the microphone in the control unit.

74. Referring again to the R/T relay, A/4, when this is energized as described, contacts A4 close to short-circuit the keying contacts of relay B/1 in the oscillator unit (*fig.* 2). Contacts A1 and A2 change over and switch the output from the amplifier, Type 367 to the grids of the modulator valves.

75. In reading the foregoing paragraphs on CW and R/T operation, reference should be made primarily to the complete circuit diagrams quoted in brackets. The contac-

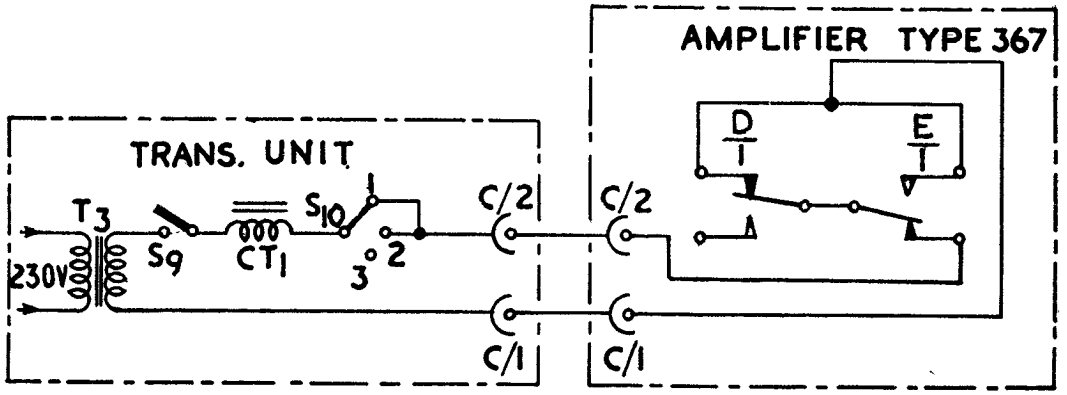


Fig. 11. Operating circuit for CW contactor

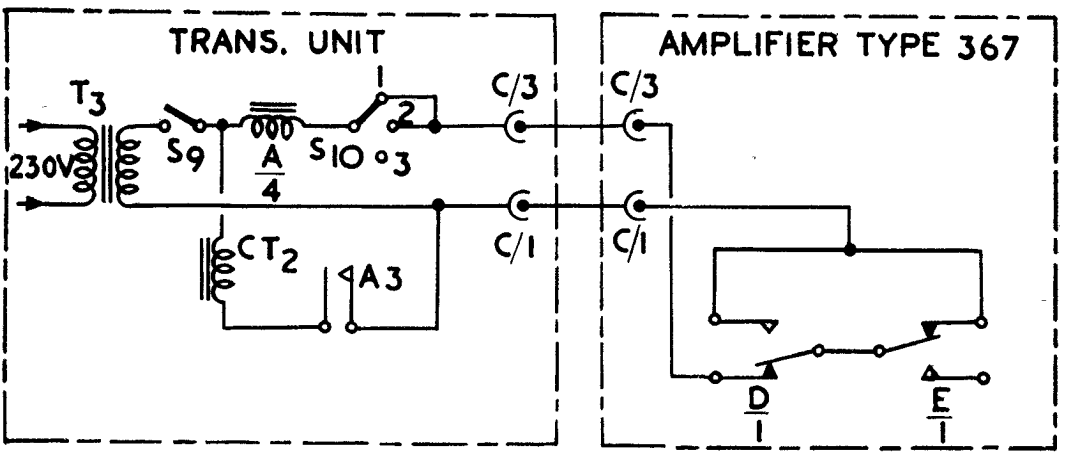


Fig. 12. Operating circuit for R/T relay and contactor

tor operating circuits are also shown schematically in *fig.* 11 and 12, which will assist in tracing the path of the current and the sequence of the components involved.

MCW operation

76. For MCW operation the transmitter is set up as for R/T. The HF oscillator stage is therefore permanently keyed as described in *para.* 74, and the tone from the control unit, Type 310 or Type 88 is applied by contacts A1 and A2 of the R/T relay A/4 to the grids of the modulator valves V3 and V4. The carrier is thus radiated continuously but is modulated by the tone only when the key is pressed.

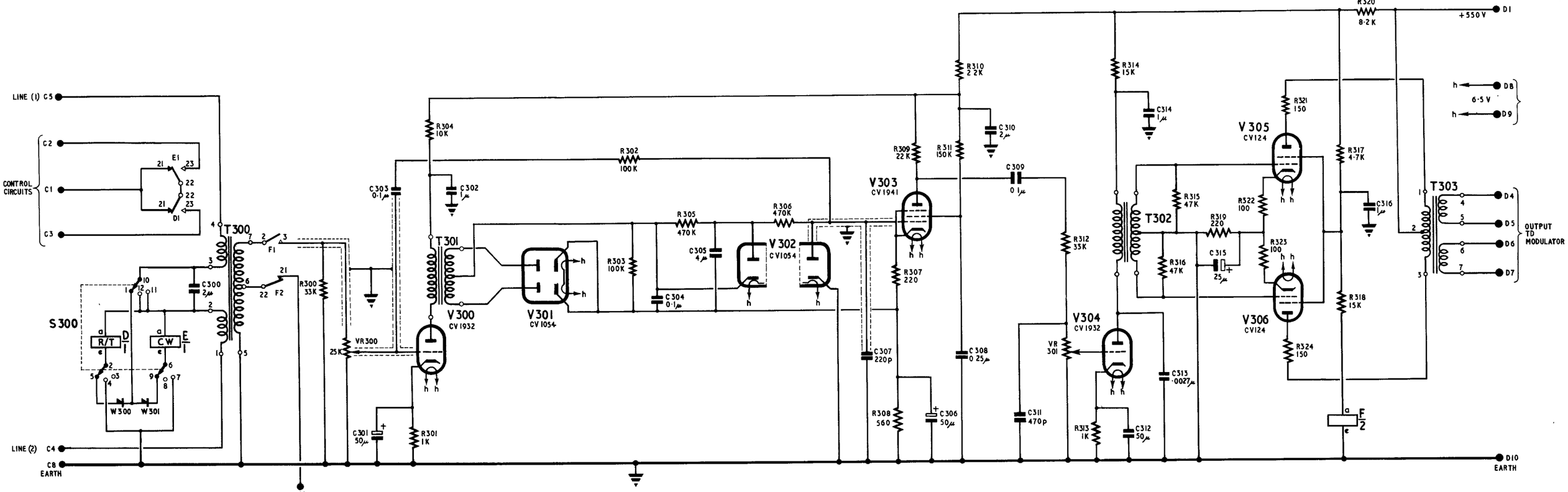
" Test " position of S10

77. In *fig.* 8 the switch S10 is shown in the TEST position. The local and remote control units are then disconnected. The R/T relay A/4 is energized from secondary A of T3 *via* S9 and wafer 1 of the switch. This again has the effect of energizing the R/T contactor CT2, the circuit being completed by the closing of contacts A3 of relay A/4, and the HF oscillator made operative by the contact A4.

78. In this position of the switch, also, the telephone jack J1 is connected directly across the lines to the distant control unit, and not *via* the intercom. relay in the amplifier as for normal working (*para.* 48).

High-speed keying

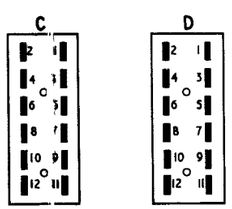
79. For high-speed keying service the link adjustment described in *para.* 26 is made, enabling the screen of the multiplier valve to be keyed from an external relay. The transmitter HT may be switched locally or remotely by means of a control unit, the latter being set for CW service and the normal telegraph circuit closed to keep the transmitter oscillator stage continuously keyed. Under emergency conditions the



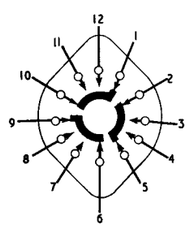
ALL POTS SHOWN IN MAX ANTI-CLOCK POSITION

S 300 SHOWN IN POSITION FOR OPERATION FROM CONTROL UNIT TYPE 310

CENTRE POSITION = RT
RIGHT HAND SIDE = CW
} FOR CONTROL UNIT TYPE 88



JONES PLUGS
(VIEW LOOKING ON TAGS)



POS. OF KNOB	TAG NOS.			LABEL
1	5	9	1	CONTROL UNIT 310
2	4	8	12	CONTROL UNIT 88 RT
3	3	7	11	CONTROL UNIT 88 CW

SWITCH SHOWN IN MAX CLOCKWISE POSITION WHEN VIEWED FROM REAR

RELAY CONTACT NUMBERING

Amplifier Type 367

Fig. 13

(A.L.3, May 58)

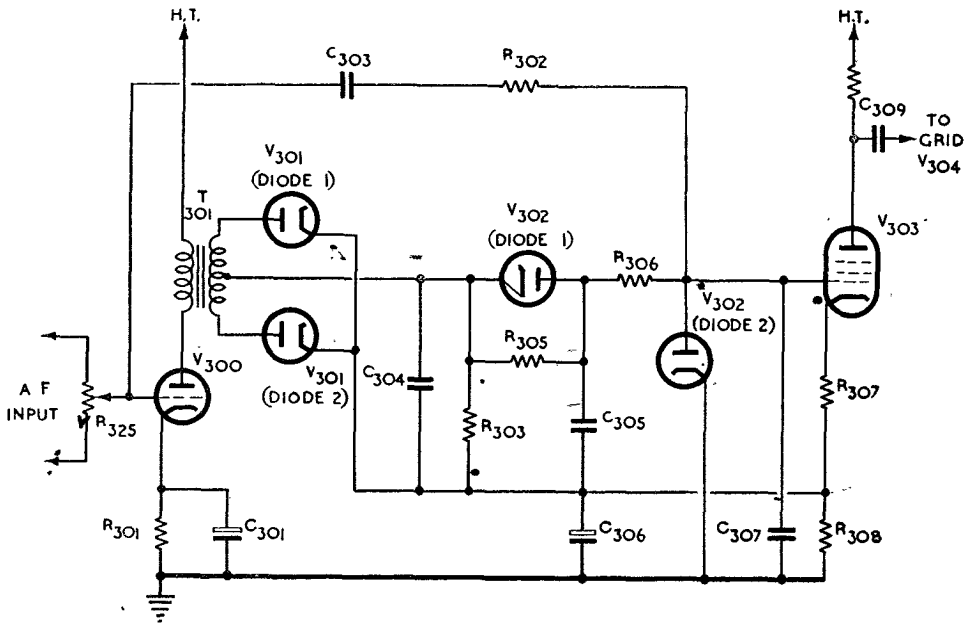


Fig. 14. Amplifier gain control and muting circuits

control unit need not be used, and in these circumstances it is necessary to short-circuit the contacts of the CW relay E/1 in the amplifier Type 367 (*fig.* 13), and also to short-circuit the contacts of the oscillator keying relay B/1 in the oscillator unit (*fig.* 2). It should be understood that these contacts must not be short-circuited when a control unit is being used, or damage in the modulator unit will result.

Note . . .

HT should always be switched to OFF *at the control unit during stand-by periods of more than a few minutes.*

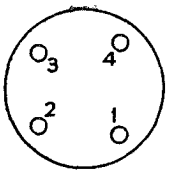
Power unit, Type 381

80. The circuit of the power unit, Type 381 is shown in *fig.* 15. Switch S100 is a gate switch operated by a plunger at the rear of the unit, and is closed by the plunger bearing against the rear of the cabinet when the unit is in position. The mains input is applied to the tapped auto-transformer T100. As has been described in *para.* 61, the controlled output voltage from T100 is applied to the primary of the filament transformer T103 when the LT switch (S5 of *fig.* 2) in the transmitter is closed. At the same time the coil of the mechanical delay relay C/1 is energized. Contacts C1 close after an interval of 25 to 35 sec. (pre-set by the manufacturer) in preparation for the switching on of HT. Should the transmitter HT switch be already closed when the LT is switched on, the relay ensures that the HT circuit is not completed until the LT supply has been established for a pre-determined valve heater warming period.

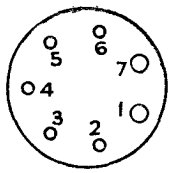
81. When the TUNE-TRANSMIT switch in the transmitter unit is at TUNE the input to the HT transformers T101, T102, arrives at contact 2 of plug A and the voltage on the primaries is reduced by L100. When the switch is at TRANSMIT, the input is applied to contact 6 and L100 is out of circuit so that the full 230 volts appears across the primaries of T101 and T102.

82. Valves V101, V102 and V104, V105, form a full-wave rectifier consisting of two pairs of parallel diodes. The 1,600 volts DC output from these valves is smoothed by a two-stage choke input filter comprising L101, L103 and condensers C107, C100, C101 and C102.

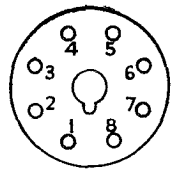
83. A stabilizing system consisting of the gas-filled voltage stabilizers V106 to V109 is connected in series with R102 across the 1,600-volt output and the HT supplies to the oscillator unit are tapped off from suitable points. Resistors R103 to R106 provide the necessary potential across the



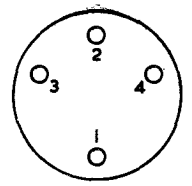
U.S. MEDIUM 4-PIN (U.S.M.4)



U.S. GIANT 7-PIN (U.S.G.7)



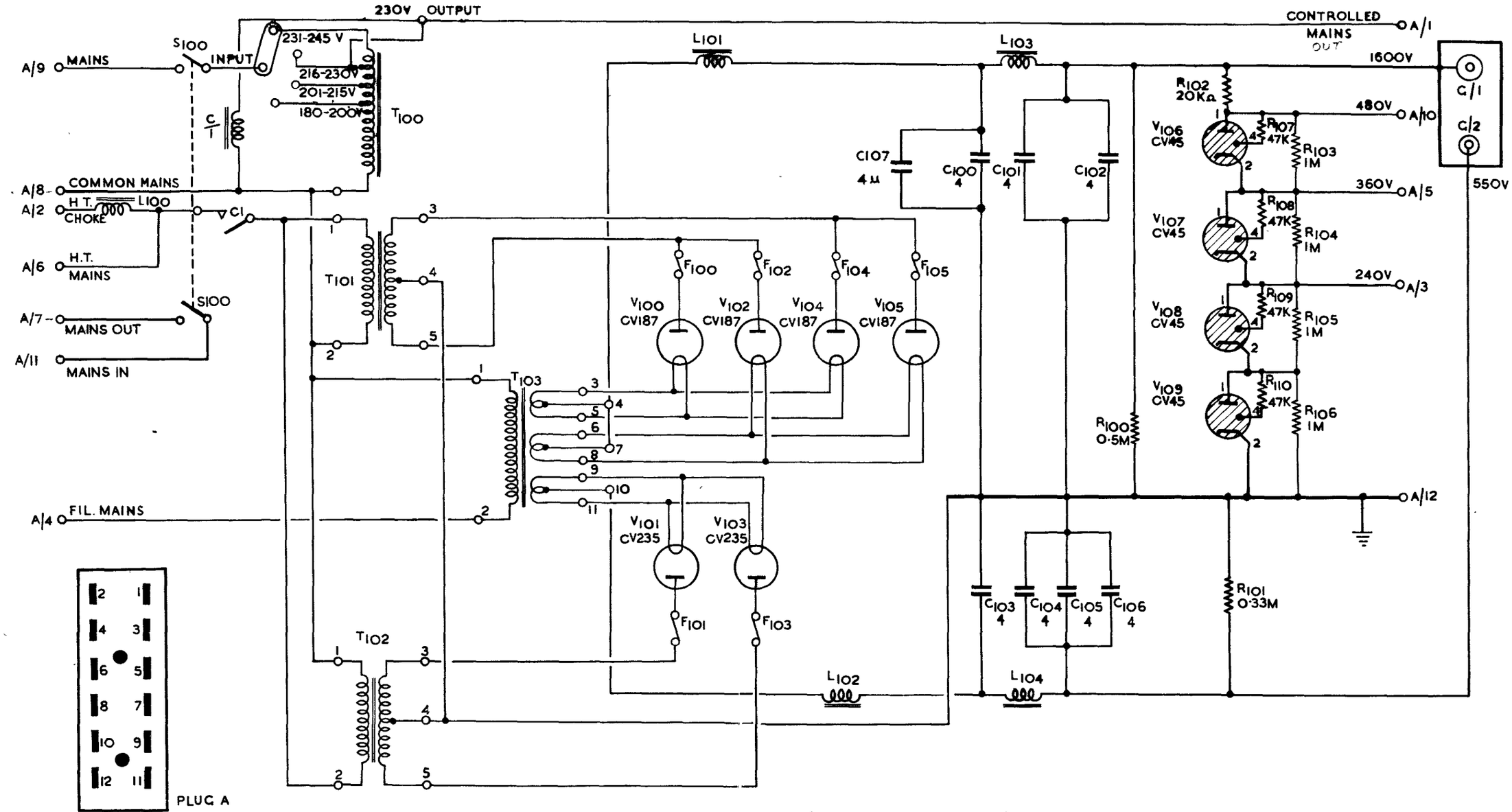
INTERNATIONAL OCTAL (I.O.)



BRITISH 4-PIN (B4)

Valve Type	Type of base	Connections to pins
CV.124 (Stores Ref. 10CV/124)	USM5	1. H 2. G2 3. G1 4. C 5. H Top Cap. A
CV.26 (Stores Ref. 10CV/26)	Giant 7-pin bayonet	1. F 2. – 3. Screen grid 4. Control grid 5. Beam forming plates 6. – 7. F.
CV.1054 (Stores Ref. 10CV/1054)	I.O.	1. Metallising, internal shield 2. H 6. – 3. A2 7. H 4. C2 8. C1 5. AI
CV.1932 (Stores Ref. 10CV/1932)	I.O.	1. – 5. G 2. H 6. – 3. A 7. H 4. – 8. C
CV.1941 (Stores Ref. 10CV/1941)	I.O.	1. Metallising 2. H 3. A 4. G2 5. G3 6. – 7. H 8. C Top Cap. G1
CV.187 (Stores Ref. 10CV/187)	B4	1. – 2. – 3. F 4. F Top Cap. A
CV.235 (Stores Ref. 10CV/235)	B4	1. – 2. – 3. F 4. F Top Cap. A
CV.45 (Stores Ref. 10CV/45)	B4	1. A 2. C 3. – 4. Priming anode

FIG. 16. VALVE BASES AND CONNECTIONS TO PINS



AIR DIAGRAM
6298F/MIN.

ISSUE. 2 | PREPARED BY MINISTRY OF SUPPLY FOR PROMULGATION BY AIR MINISTRY

FIG.15 – POWER UNIT, TYPE 381

(A.L.4, Aug. 58)

7938 338629 9/58 1,650 + 2,250 C.B. & S. LTD GP924

stabilizers for them to strike. The resistor R102 drops the HT to 480 volts to give the stabilizers their correct voltage. The resistors R107 to R110 are connected between the trigger and anode electrodes of each of the four CV45 valves to improve stabilization.

84. Valves V101 and V103 form a full-wave rectifier from which a DC ouput of 550 volts is taken for the HT supplies to the multiplier unit, amplifier, Type 367, and modulator and PA screens. Chokes L102, L104 and condensers C103 to C106 comprise a two-stage choke input filter.

Valves and power supplies

85. The valves in the oscillator and multiplier units are indirectly-heated tetrodes, Type CV124 (Stores Ref. 10CV/124) with 6·3-volt heaters taking a current of 0·9A, the anode dissipation being 25W.

86. Four directly-heated beam tetrodes, Type CV26 (Stores Ref. 10CV/26) are used in the PA and modulator stages with 10-volt filaments taking 5A. The anode dissipation is 100W.

87. Valves V300 and V304 in the amplifier, Type 367 are indirectly-heated triodes, Type CV1932 (Stores Ref. 10CV/1932), with 6·3-volt heaters taking 0·3A. The rated anode voltage is 250, and the anode dissipation 2·5W. The two double-diodes, V301 and V302, are valves Type CV1054 (Stores Ref. 10CV/1054) with 6·3-volt heaters taking 0·2A.

88. Valve V303 in the amplifier is an indirectly-heated variable-mu HF pentode, Type CV1941 (Stores Ref. 10CV/1941). The heater voltage is 6·3 and heater current 0·3A. The rated anode voltage is 250.

89. The amplifier push-pull output valves are Type CV124 (Stores Ref. 10CV/124) and are similar to those used in the oscillator and multiplier units.

90. All the power unit valves have 4-volt filaments taking 3·3A. The two pairs of parallel diodes for the 1,600-volt output are valves Type CV187 (Stores Ref. 10CV/187). The maximum peak anode voltage is 2,000 and the maximum DC output current 250 mA.

91. The two diodes which form the full-wave rectifier for the 550-volt output are valves Type CV235 (Stores Ref. 10CV/235). This type is similar to the CV187. (The CV187 can be used in the 550-volt unit in emergency, but CV235 should not be used in the 1,600-volt supply).

92. Valves V106 to V109 in the power unit are gas-filled voltage stabilizers, Type CV45 (Stores Ref. 10CV/45). The maximum voltage is 135, and the normal stabilized voltage 120. The maximum space current is 75 mA.

93. Diagrams of the bases of all valves in the transmitter amplifier power unit, and control unit, Type 310 (*para.* 111) are given in *fig.* 16.

94. The applications of the various outputs from the power unit are tabulated below:—

1,600V.	....PA and modulator anodes.
550V.	....PA and modulator screens; multiplier anode and screen, and amplifier, Type 367.
480V. (stabilized)	....Oscillator anode (M.O. control).
360V. (stabilized)	....Oscillator anode (crystal control).
240V. (stabilized)	....Oscillator screen.

Control unit, Type 310

95. By means of a control unit, Type 310 the transmitter can be operated at considerable distances (the maximum line resistance permissible being 1,000 ohms), the HT to the transmitter switched, and CW, tone modulation or R/T operation selected from a remote control point. The transmitter can be keyed or modulated for R/T. Intercommunication with the transmitter is also provided. The circuit of the unit is shown in *fig.* 17. Valve V1 is an AF oscillator for generation of the keying tone which (when the unit is set for CW operation) after rectification in the transmitter, operates the keying relay or provides the tone for MCW keying in the R/T condition. Valves V2, V3 and V4 form a two-stage amplifier for amplification of the keying tone or the input from a microphone before application to the line.

96. Provision is made for muting a receiver while the transmitter is working. For this

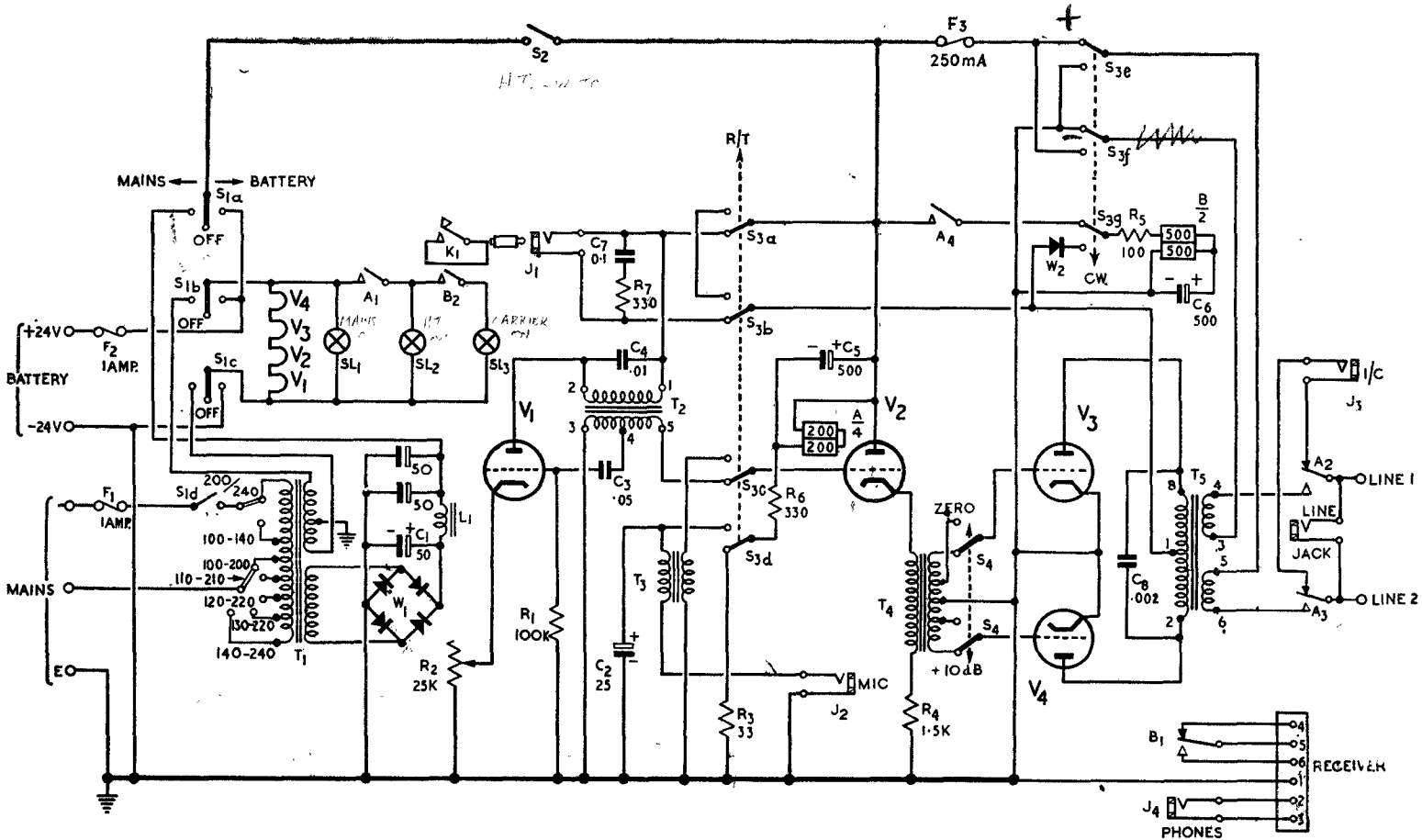


FIG. 17. CIRCUIT OF CONTROL UNIT, TYPE 310

purpose a single-pole changeover contact is added to relay B/2 and brought out on terminals 4, 5 and 6 (*para.* 104). The receiver output can be supplied to a telephone jack on the control unit for operating or monitoring when required.

97. A power unit for operation from 100-140 and 200-240 volts AC mains is included in the instrument and provides an output of approximately 24 volts DC for the HT supply to the valves, relay operation in the unit and at the transmitter, and energization of a microphone: together with 24 volts AC for valve heaters and signal lamps. Alternatively, a 24-volt battery may be used, and terminals are provided so that it can be permanently connected to the unit, instantly replacing the power unit by means of a switch (S1), if necessary, in circumstances such as a failure of the mains supply.

Selection of service

98. Switch S2 in fig. 17 is the transmitter HT control switch which when closed applies 24 volts DC to the lines to the transmitter. The positive side of the supply is connected either to line 1 or line 2 according to the position of the SERVICE switch S3. This is a three-position key switch, labelled R/T, TONE MODULATION and CW. When moved to R/T, sections *a* to *d* are operated to their upper contacts; sections *e* to *g* remain as shown. In the CW position, section *a* to *d* remain as shown in the diagram and sections *e* and *g* change over to the lower contacts. In *fig.* 17, the switch is shown in the TONE MODULATION position, and it will be seen that a circuit is made from the positive side of the power unit or the battery (according to the position of S1), through S2 and section *e* of S3 to line 2 *via* the secondary of T5, contact A3 being made to the line when the control unit is switched on (i.e., relay A/4 is energized *via* S2, R6, S3*d* and R3 (*para.* 101), thus moving contacts A2/A3 to the lower position). Line 1 is earthed *via* A2, T5 and S3*f*. In *fig.* 18 the arrangements inside the amplifier, Type 367 in the transmitter are shown, and the circuit can be traced through the R/T relay and the rectifier W300 back to line **1**.

99. Referring again to *fig.* 17, when S3 is at R/T, sections *e* to *g* of S3 remain in the positions shown and the R/T relay is energized as before. In the CW position, sections *e* to *g* of S3 move to the lower contacts and the positive side of the supply is connected by section *f* to line 1. The circuit in the amplifier is then made through the rectifier W301 and the CW relay to line 2. Line 2 is then earthed in the control unit to complete the circuit.

100. The circuit changes in the transmitter made by the CW and R/T relays are described in *para.* 70 to 75.

101. When transmitter HT switch S2 is closed, irrespective of the position of S3, the relay A/4 is energized from the 24-volt supply. The transmitter HT ON lamp SL2 lights up, being connected across the 24-volt supply to the unit by contacts A1. The changeover contacts A2 and A3 disconnect

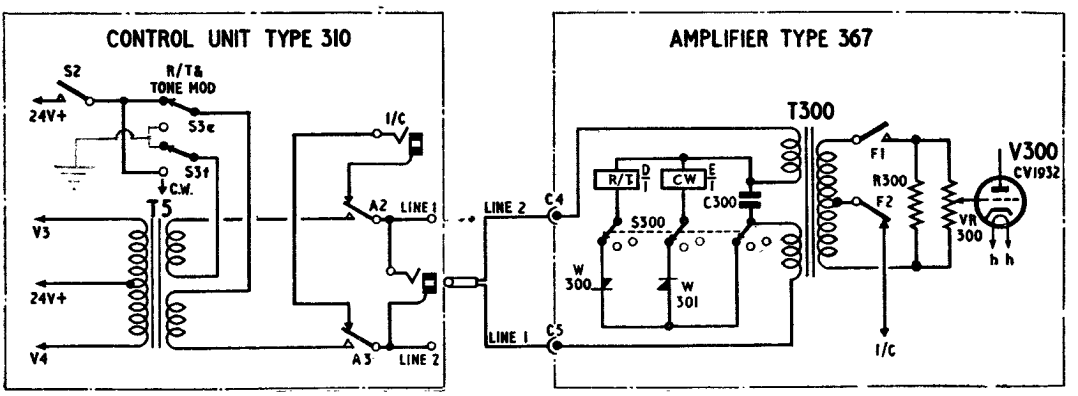


Fig. 18. Interconnections of control unit and amplifier

the lines to the transmitter from the I/C jack, J3 and switch them across the secondaries of the amplifier output transformer T5. Simultaneously, relay F/2 in the amplifier, Type 367 at the transmitter operates (*para.* 48 to 50) so that the I/C jack on the transmitter is disconnected from the amplifier.

CW working

102. It has already been mentioned (*para.* 95) that V1 is an AF oscillator for production of keying tone, feedback being obtained by anode-to-grid coupling through a portion of the secondary of T2. The frequency is approximately 1,000 cycles/sec. Automatic bias is developed across the grid leak R1. The cathode bias resistor R2 has a screwdriver adjustment and is pre-set to a position in which a sinusoidal AF output is obtained from the unit. The secondary of T2, in which the AF oscillations appear, is connected between the grid of the first stage amplifier valve V2 and earth. This valve is arranged as a cathode-follower in order to present a small load to the oscillator and also to provide a low output impedance so that valves V3 and V4 can be driven into grid current without distortion of the output waveform. The ratio of T4 can be varied by means of S4 so as to give an output of either 1 mW or 10 mW.

103. Valves V3 and V4 form a push-pull output stage and are coupled to the lines through the transformer T5. Keying takes place in this stage, the HT to V3 and V4 when S3 is at CW or TONE-MODULATION being supplied through section *a* of S3 the key jack J1, and key K1 section *b* of S3, and the centre tap in the primary of T5. Condenser C7 and resistor R7 form a key-click filter.

104. When the key is pressed, relay B/2 is energized and its changeover contacts B1 are available to reduce the gain of the associated receiver so that transmitter sidetone is heard at a comfortable level. The charge on the condenser C6 holds the relay during momentary release of the key, the rectifier W2 preventing the condenser from discharging through circuits other than the relay coils. When the key is up for longer intervals, however, the condenser has time to discharge through the relay winding, releasing contacts B1 and restoring the receiver gain to normal after about 1/4 second.

105. Relay contacts B2 close when the key is down, and connect the CARRIER ON lamp SL3, across the 24-volt AC supply. By reason of the delayed release of the relay described above, this lamp does not follow the keying, but remains alight until the key is left up for the delay period.

R/T working

106. When S3 is at R/T, sections *a* and *b* of the switch short-circuit the key, so that HT is continuously on the anodes of V3, V4. Since relay contacts A4 close when the transmitter HT is switched on by means of S2, relay B/2 is continuously energized through section *g* of S3, so that the receiver is muted, and SL3 is alight all the time the transmitter is radiating a carrier. S3*d* is now in the upper position and relay A/4 is energized *via* J2 and the microphone. A standard carbon insert-type microphone is employed; it obtains its energizing voltage *via* A/4 and R6.

107. Section *c* of S3 connects the secondary of the microphone transformer, T3, between grid and earth of V2, at the same time disconnecting the oscillator output from the amplifier stages; section *d* connects the microphone in series with the windings of relay A4 so that it is energized when S2 is closed. If a microphone with a pressel switch is employed, S2 may be permanently closed and the pressel used for send/receive switching.

Note . . .

The TRANSMITTER HT switch must be thrown to OFF during stand-by periods.

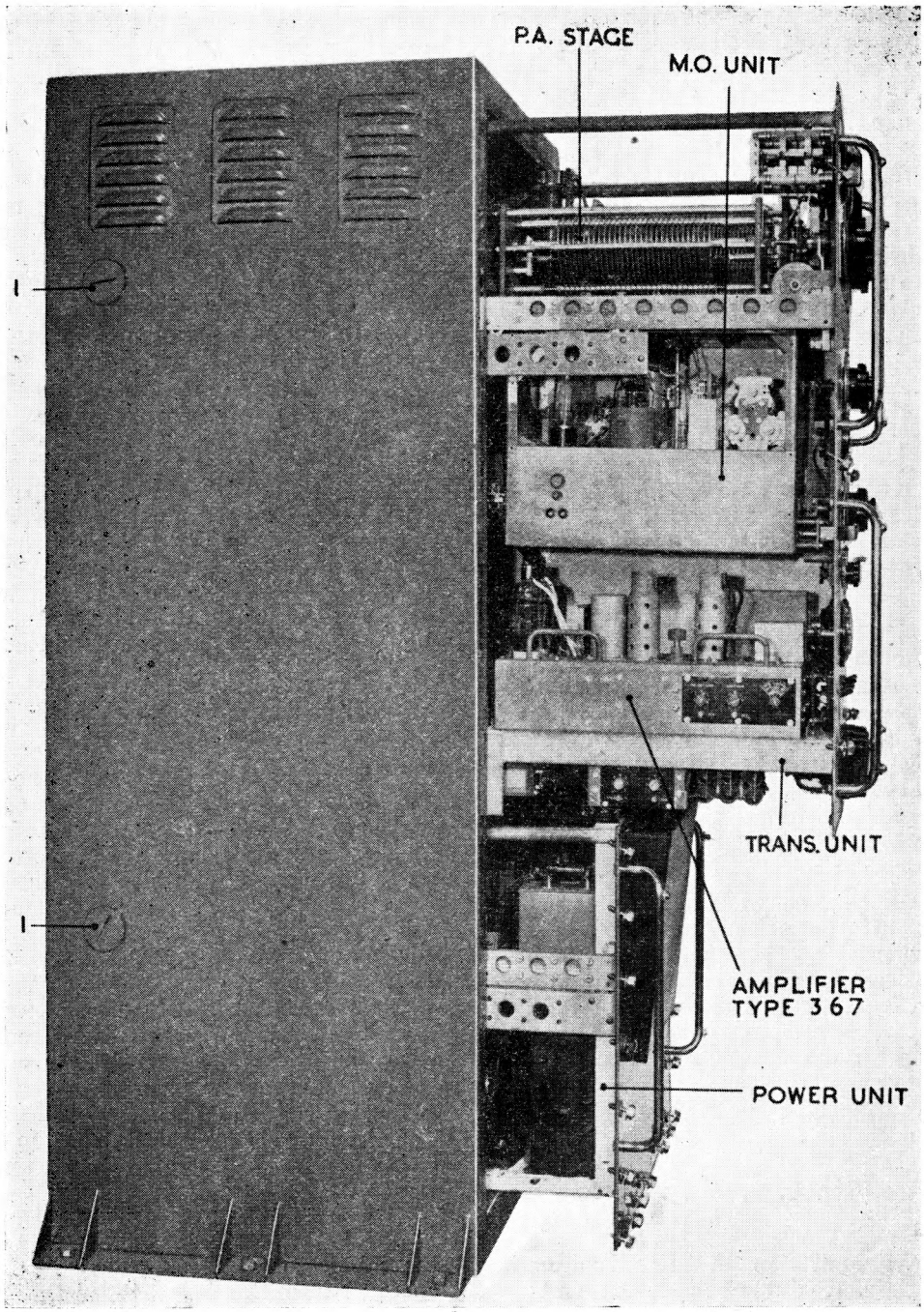
MCW working

108. For MCW the transmitter must be set up as for R/T, and the supply is therefore passed to line 2 as already described. It is, however, necessary for the output from the control unit to be keyed; it will be seen from *fig.* 17 in which S3 is shown in the TONE-MODULATION (MCW) position, that this is done in the same manner as on CW.

Power supplies

109. The primary of the mains transformer T1, is tapped for inputs between 100/140 and 200/240 volts. One secondary supplies the full-wave metal rectifier W1, which gives an output of approximately 24 volts DC smoothed by L1 and the three conednsers C1. The other secondary gives 24 volts AC for the

2507 79976 4/53 1,650 C.B.&S.LTD. GP.30



REMOVABLE COVERS, FOR INSERTION OF SECURING BOLTS

FIG. 19. SIDE VIEW OF TRANSMITTER, WITH UNITS PULLED FORWARD FOR INSPECTION

valve heaters, which are connected in series, and for the signal lamps SL1 to SL3. The lamp SL1 lights up when the switch S1 is turned to MAINS or BATTERY. Lamps SL2 and SL3 do not light until relays A/4 or B/2 have operated as already described.

Note . . .

If the lamps SL1, SL2 and SL3 are operating this does not necessarily indicate that the unit is working normally : e.g. the fuse F3 could be open circuited.

110. Switch S1 selects mains or battery input to the control unit. When at MAINS, section *a* of the switch connects the main 24-volt line to the rectifier output or the battery, and sections *b* and *c* connect the signal lamps and heaters across the 24-volt AC winding of T1. Section *d* is closed to complete the mains input to T1, *via* a 1-amp. fuse F1. When S1 is at BATTERY the DC is applied through a 1-amp. fuse F2 to one side of S2 and the SL1 (also to SL2 and SL3 when the appropriate relays close). Spare fuses are housed inside the cabinet.

Valves

111. All valves in the unit are Type 6J5G (Stores Ref. 10E/348), VR67 (Stores Ref. 10E/11448) or CV1932 (Stores Ref. 10CV/1932). These are indirectly-heated triodes with 6·3-volt heaters and have the international octal type of base. The connections to the pins are shown in *fig.* 16.

Connections to lines

112. The remote control lines are normally connected to the unit by means of the line jack, which takes the usual type of double-ended connector from the distribution box. Terminals are provided as an alternative method of connection so that lines of steel wire which will not go into the normal plug, can conveniently be used. Such lines are employed in mobile or temporary installations in the field.

CONSTRUCTIONAL DETAILS

General

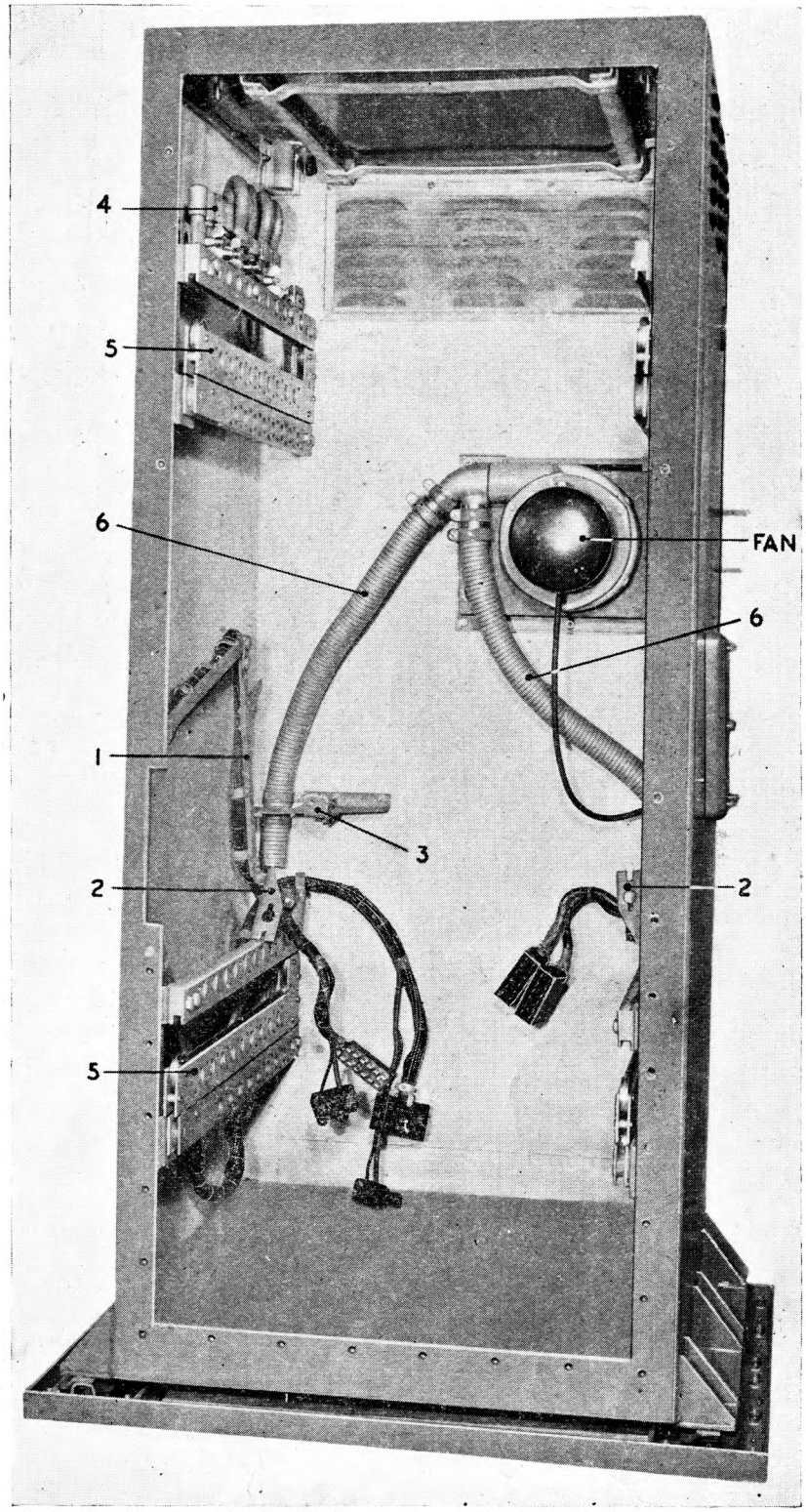
113. A general view of the transmitter is given in *fig.* 1. In this figure the controls are labelled with their circuit references and it should therefore be consulted when reading the section on operation. For transit purposes, the controls are covered by three rectangular metal plates, which are attached to the withdrawal handles by means of the screws and washers which can be seen in the illustration. When the transmitter is in use the cover plates are stowed inside the top of the cabinet. The transmitter cabinet stands on a shock-absorbing base. The tray assembly (3) contains two pull-up drawers with calibration charts and data sheets.

114. In *fig.* 19 the main and power units of the transmitter are shown pulled forward out of the cabinet on their runners. To remove a unit completely it must be pulled out until arrested by a stop. The connectors may then be removed (*para.* 116). The stop is cleared by raising the front of the unit, after which the unit can be lifted bodily out of the cabinet.

115. The covers (1) in *fig.* 19 give access to two apertures through which bolts are inserted to hold the internal units firmly when the equipment is being transported. There are two similar apertures in the other side of the case. This view shows the location in the main unit of the MO and amplifier sub-assemblies. The multiplier unit is not visible in this illustration, being on the other side of the main unit behind the oscillator unit. The modulator stage is part of the main unit and is not seen in *fig.* 19 as it is on the far side of the amplifier unit.

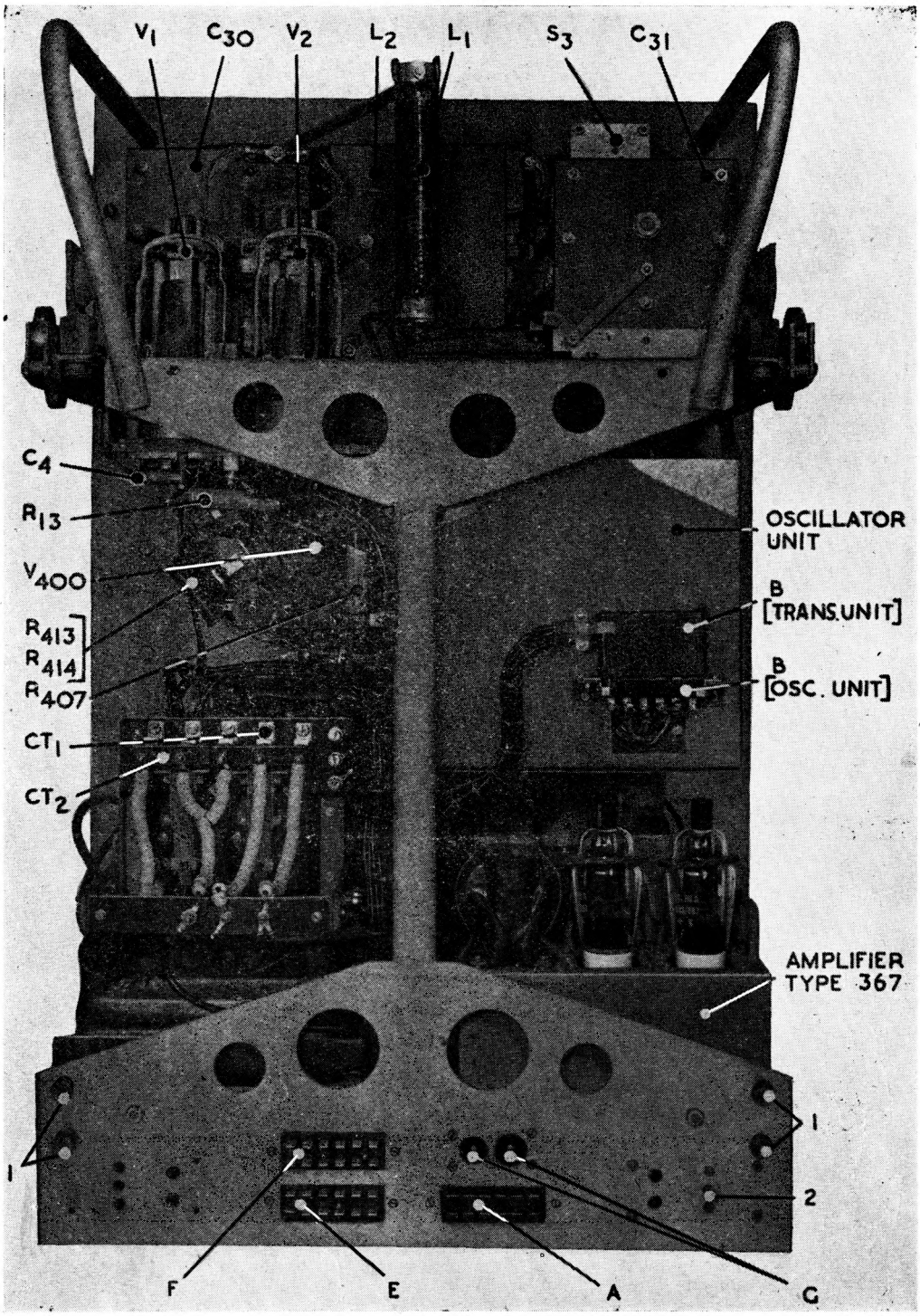
116. A view of the case with the units withdrawn is given in *fig.* 20. The connectors from the power unit and terminal block to the transmitter unit are supported by pivoted arms, one of which is seen at (1). Each arm has at its free end a flange (2) which is attached to the rear of the transmitter unit. The large holes in the flanges are of sufficient diameter to clear the heads of the fixing screws on the transmitter unit, so that the screws need not be removed when the unit is lifted out of the cabinet, it being sufficient merely to slacken them enough for the flange to be moved slightly until the hole coincides with the top screw head after which it can be withdrawn over the screw head.

117. The bracket (3) fixed to the rear of the cabinet operates the safety switch S8, on the transmitter unit. When the unit is inside the cabinet, a plunger bears against the bracket and closes the switch contacts. As soon as the unit is pulled forward, the plunger is released and the switch contacts break, cutting off the mains input to the transmitter. A similar plunger-operated



1 HINGED ARM, CARRYING CONNECTOR CABLE
2 FLANGE FOR ATTACHMENT OF CABLE ARMS TO UNITS
3 STOP FOR ACTUATING PLUNGER-TYPE SAFETY SWITCH ON TRANSMITTER UNIT
4 BOLTS FOR SECURING UNITS DURING TRANSIT
5 SLIDING RUNNERS (SUPPORTING UNITS WHEN IN CABINET)
6 AIR DUCTS FROM BLOWER

FIG. 20. INTERIOR OF CABINET WITH UNITS REMOVED



1 SCREWS FOR ATTACHMENT OF CABLE ARMS

FIG. 21. REAR VIEW OF TRANSMITTER UNIT

switch is provided on the power unit and is operated by the plunger bearing against the back of the cabinet.

118. In *fig.* 20 the stowage for the bolts mentioned in *para.* 115 can be seen at (4) and also one set of the runners (5) for the transmitter and power units. Behind the bolts is a set of four ringbolts which screw into the top of the cabinet for hoisting purposes. At the back of the cabinet are the ducts (6) for delivering air from the blower.

119. A rear view of the transmitter unit is given in *fig.* 21 showing at (1) the screws which hold the cable-carrying arms (*para.* 116) and at (2) the plunger of the safety switch S8 (*para.* 117). Plug G and socket A at the bottom of the unit receive the two cables from the power unit (seen at the left of the cabinet in *fig.* 20) and plugs E and F the two cables from the terminal block (on the right of the cabinet in *fig.* 20). The plug and socket B on the right of *fig.* 21 are for the oscillator supplies and the connections from the oscillator unit to the transmitter unit except for the RF output lead from the coupling condenser C215 in the oscillator unit which is taken direct to the choke and condenser assembly, L401, R401, at the rear of the multiplier unit (shown in *fig.* 23).

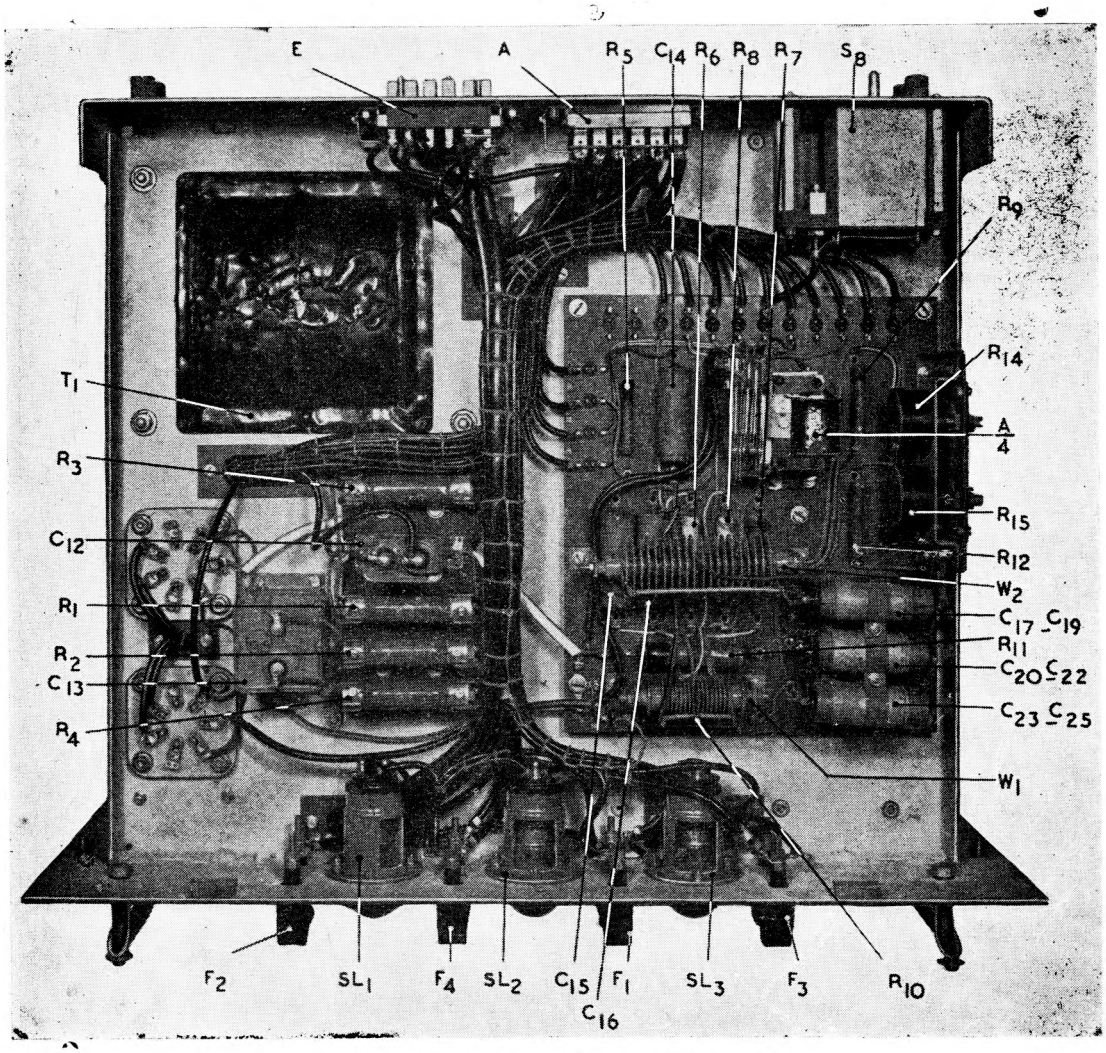
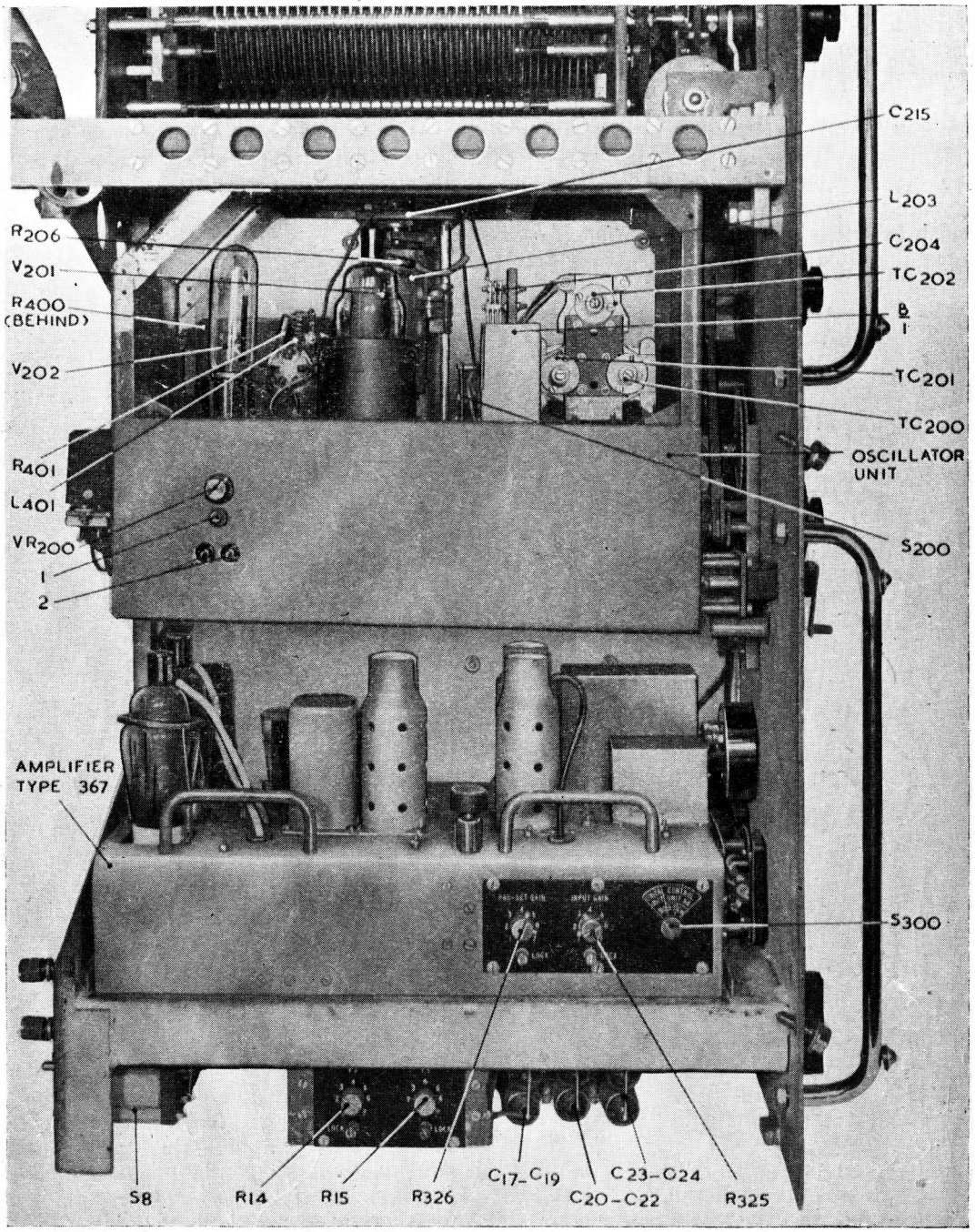


Fig. 22. Underside view of transmitter unit

120. The components on the underside of the transmitter unit are shown in *fig.* 22. On the right of the illustration can be seen the assembly mounting the R/T relay, A/4 the tone and modulator bias rectifiers (W1, W2), the modulator bias controls (R14, R15) and associated components. The transmitter unit safety switch S8, is in the top right-hand corner of the illustration.

Oscillator unit

121. The oscillator unit is shown in position in the transmitter unit in *fig.* 23 with the amplifier, Type 367 below it. Coil L203



1 LOCKING SCREW FOR LT POTENTIOMETER 2 TEST POINTS FOR LT VOLTAGE MEASUREMENT

Fig. 23. Oscillator and amplifier units located in transmitter unit

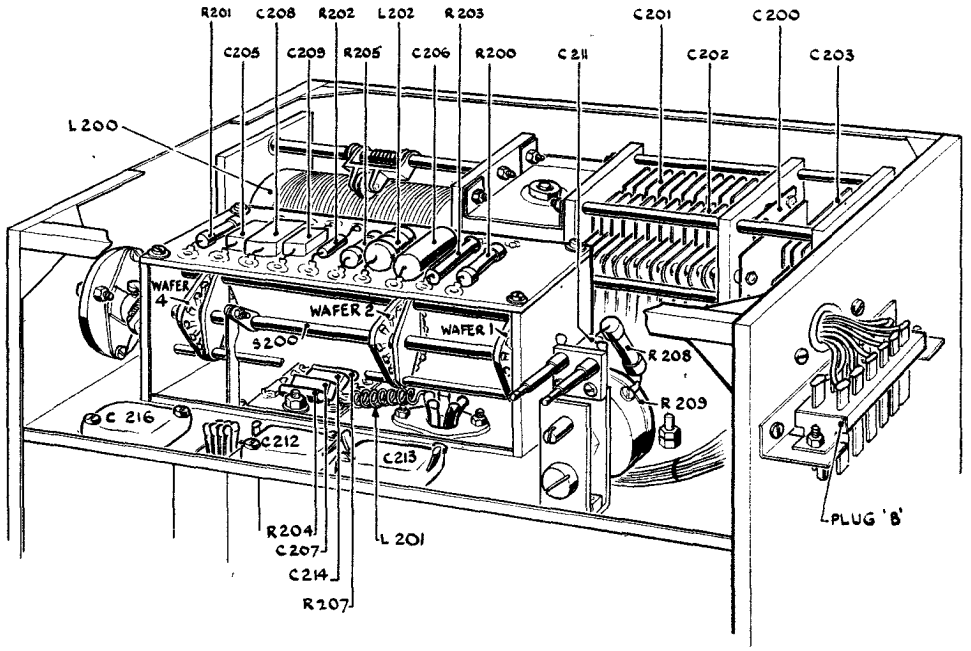


Fig. 24. Underside of oscillator unit

is the anode tuning inductance, and is adjusted simultaneously with the oscillator coil L200, by means of the OSCILLATOR TUNING control on the front panel. The oscillator coil can be seen in the underside view of the unit, *fig.* 24. Both coils are rotatable (L203 being driven through bevel gearing) and have pulley-wheel wipers which travel up and down the windings as the coils are turned.

122. A vernier adjustment is provided for the coil setting, consisting of a cam, actuated by the INCREASE-DECREASE knob on the front panel, which bears against a rocking bar. The bar is coupled to the coil driving shaft when the LOCK knob on the tuning control is screwed in and consequently causes the coils to shift through one dial division.

123. Wafers 1, 2 and 4 of S200 are below the chassis (*fig.* 24) and wafer 3, which can just be seen in *fig.* 23, is on the top deck.

124. The screw adjustment VR200 in fig. 23 enables the voltage across the heater of V201 to be adjusted to 6·3 volts, at which it is kept constant by the barretter V202. When adjusting VR200 the voltage is read by connecting a voltmeter to the plug (2). The screw (1) enables VR200 to be locked when the correct setting is found.

125. Part of the multiplier unit can be seen between V201 and V202 in *fig.* 23, the components R401 and L401 being adjacent to the base of the multiplier valve V400 which is mounted horizontally.

126. Both the amplifier gain controls R325 and R326 and the modulator bias adjustments, R14 and R15, are visible in the illustration.

127. Referring to the underside view of the oscillator unit, *fig.* 24, condenser C200 is the compensating condenser, the spacing of its two plates varying with temperature changes and so counteracting the effects of expansion and contraction of the oscillator coil L200. One plate is mounted on zero temperature coefficient metal and the other mounted on brass rods. Both are fixed to the main assembly of C201, C202. Expansion or contraction of the brass rods varies the spacing of the plates.

Multiplier unit and modulator

128. The view of the transmitter unit *fig.* 25 shows the components of the multiplier unit at the top and the modulator unit at the bottom. The multiplier output coupling condenser C405 is connected directly to the grid pin of the holder of the PA valves V1 and V2, and the multiplier valve cathode to switch S1 in the transmitter unit. Apart

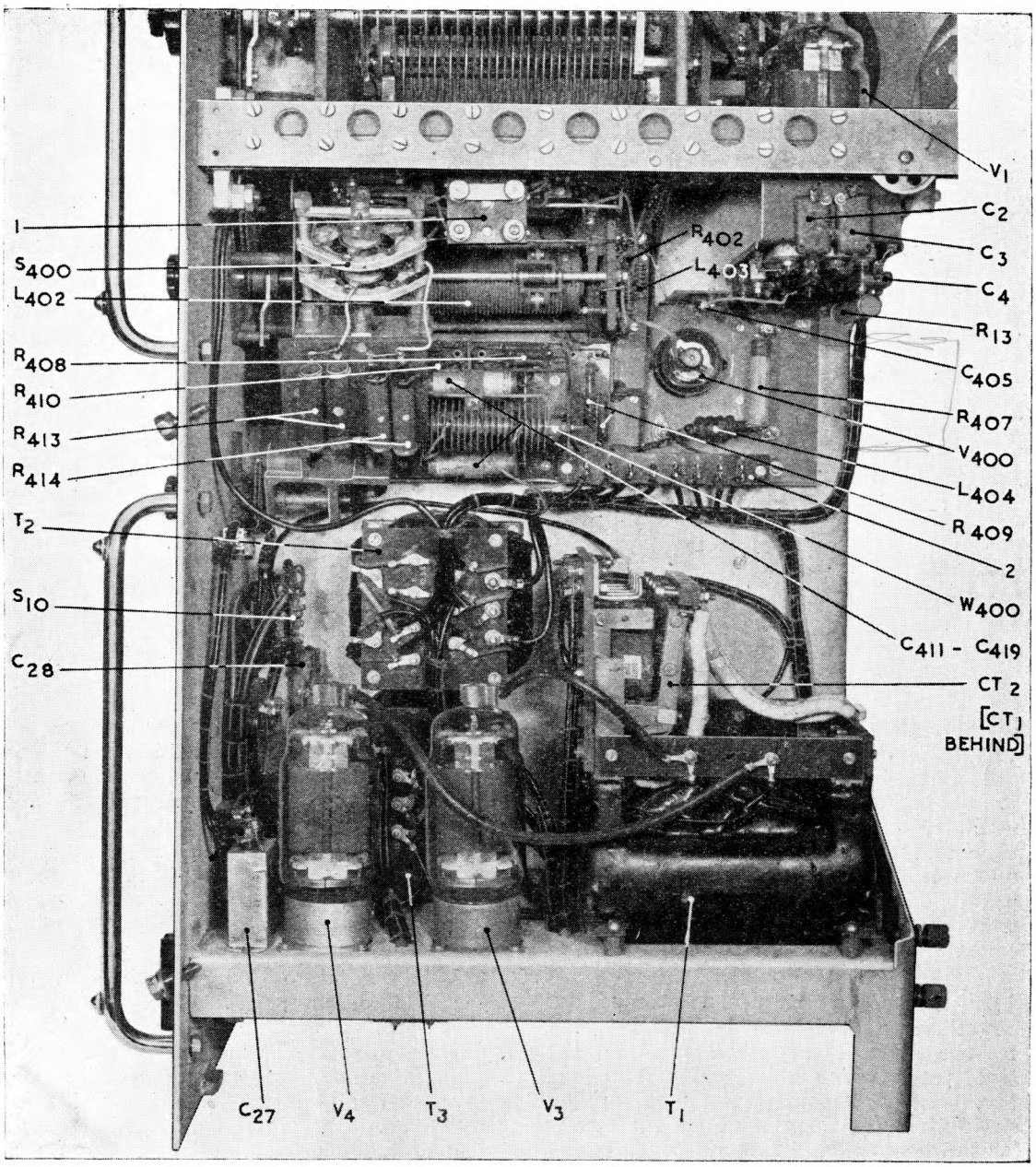


Fig. 25. Multiplier unit and modulator valves

from this and the multiplier input connection, described in *para* 119, all other connections are made to the tagboard (2). The links (1) are shown in the position for hand keying of the transmitter. When high-speed keying is required they must be reconnected as shown in *fig.* 5 and 6 (*para.* 26).

129. The multiplier tuning coil L402 is rotatable similarly to the oscillator tuning coils, but is not provided with a vernier adjustment.

130. Both the multiplier and oscillator units can be removed as complete assemblies from the main unit. The layout of the multiplier components which cannot be seen in *fig.* 25 is shown in *fig.* 26.

131. The CW and R/T contactors CT1 and CT2, form one assembly with the modulation transformer T1.

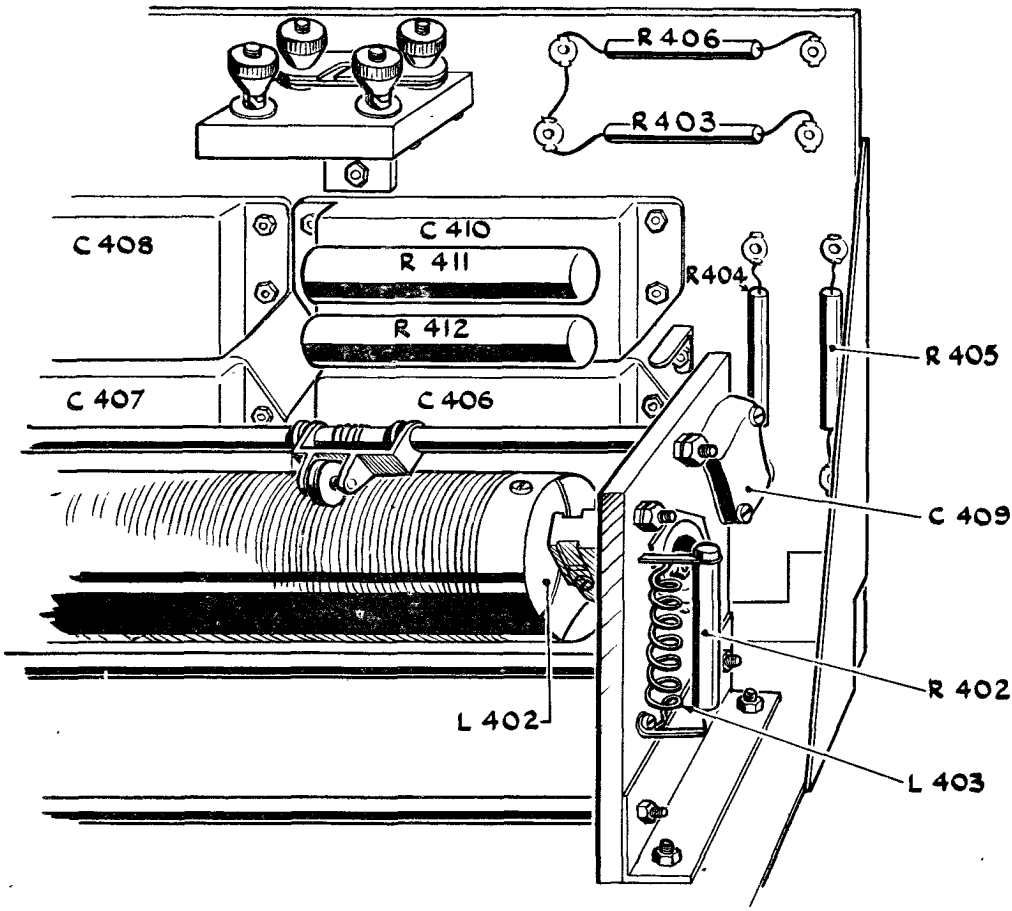


Fig. 26. Close-up view of multiplier unit

Power amplifier

132. A view of the PA components is given in *fig.* 27. One of the fixed output coupling condensers, C10, is visible and C11 is behind the variable coupling condenser C31. Condenser C9 is connected in parallel with the anode tuning condenser C30 by means of the RANGE switch S2 on the 1·5-2Mc/s band only. A special wire-wound vitreous resistor is used to form the anode choke L1.

Amplifier and power units

133. Two views of the amplifier, Type 367 are given in *fig.* 28 and 29. The amplifier can be removed from the main unit by undoing the thumbscrew seen in *fig.* 28 and pulling the unit forward ; all connections to the amplifier are made through the plugs C and D, which engage directly with two sockets in the transmitter unit.

134. The power unit is shown in *fig.* 30 and 31. Plugs A and G for the connectors to the main unit can be seen in *fig.* 20. The two drawers containing calibration charts of data sheets are fitted on the front of the power unit.

135. Both views of the power unit show the mechanical time-delay relay C/1. This can be adjusted by means of a small calibrated scale, and is set by the manufacturer to give a time delay of 35 to 45 sec.

136. The resistors R103 to R106 are not visible in the illustrations of the power unit, being mounted underneath the holders of the stabilizer valves, V106 to V109. The voltage-dropping choke L100 is on the base of the unit, between chokes L101 and L102.

INSTALLATION

Unpacking

137. Before attempting to unpack the transmitter, Type T.509, the following instructions should be carefully read. All concerned are warned that the packing

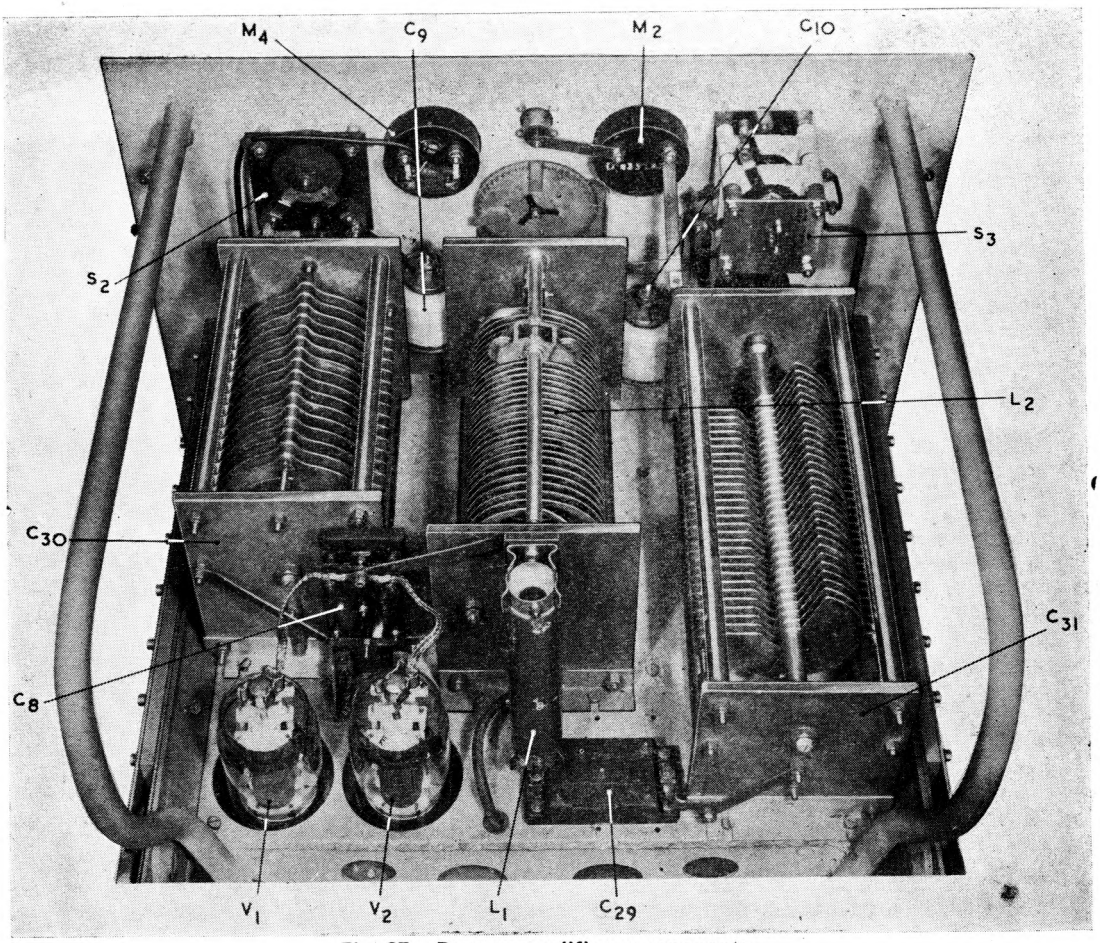


Fig. 27. Power amplifier components

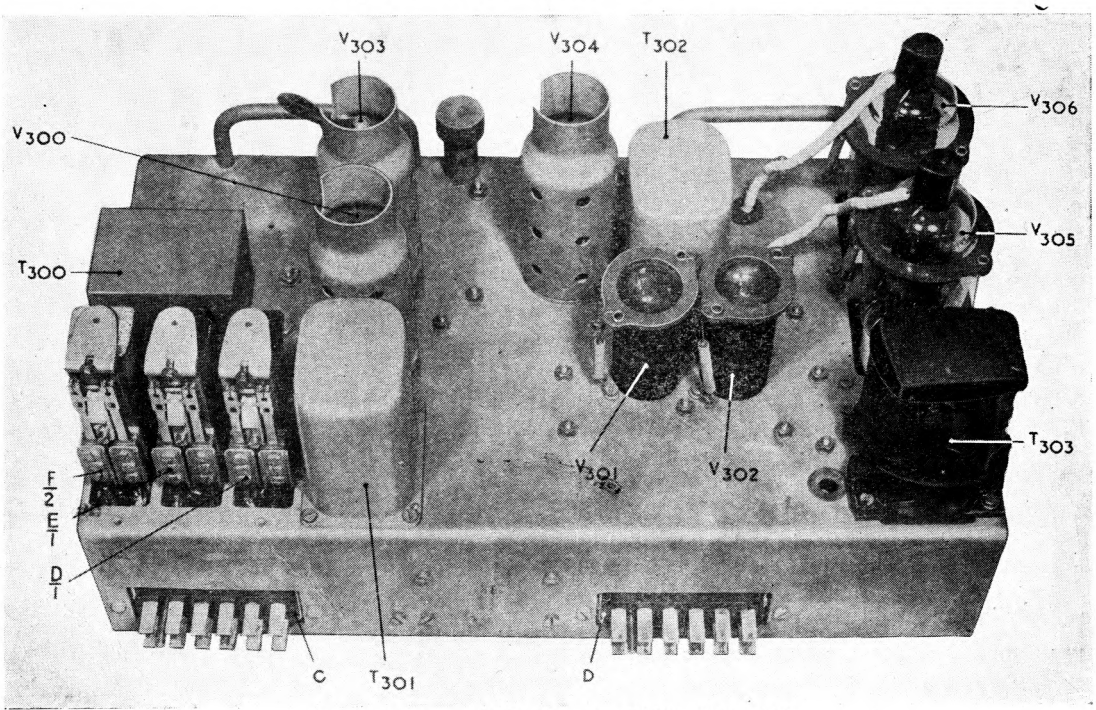


Fig. 28. Top of chassis, amplifier, Type 367

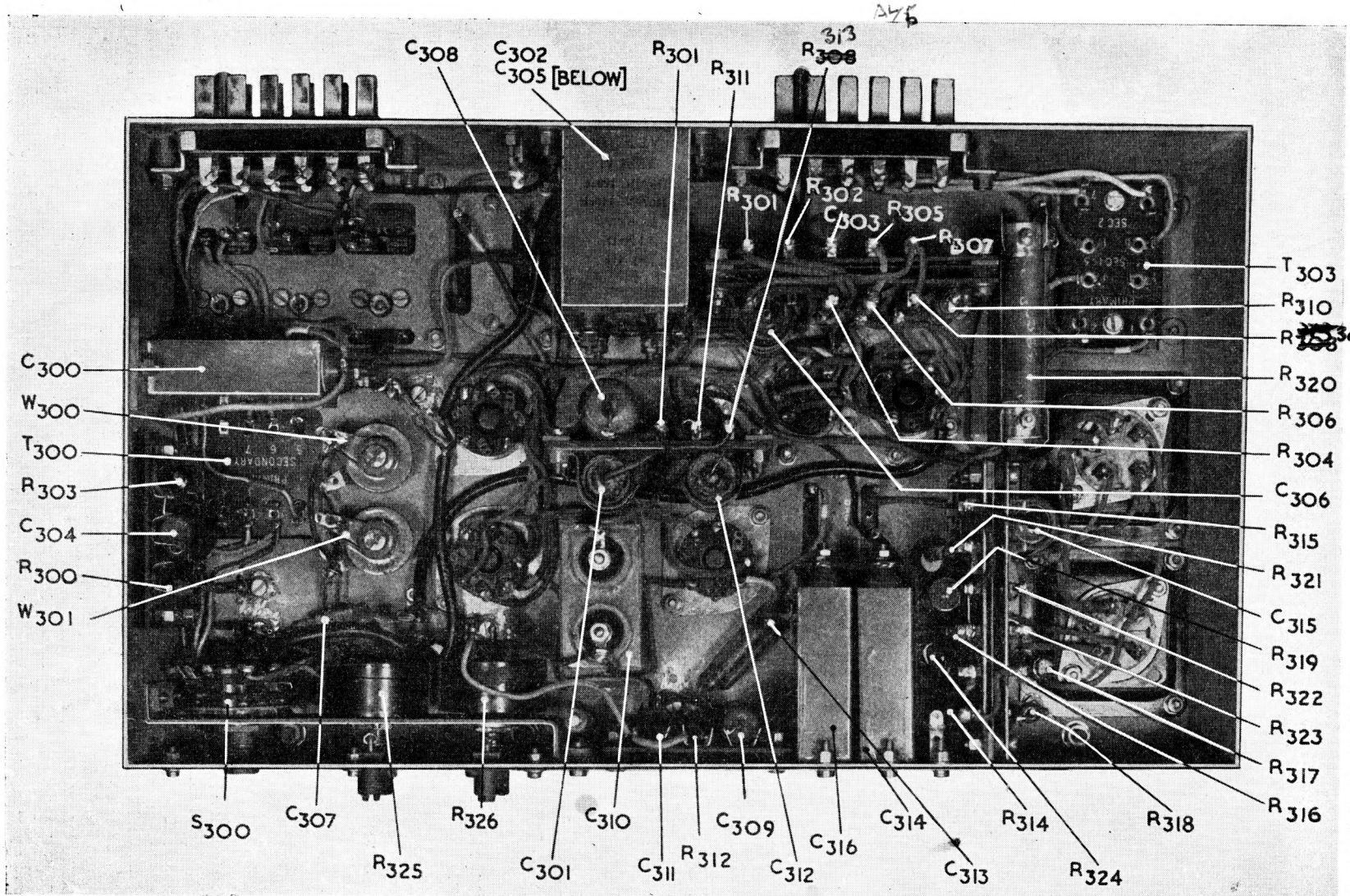


FIG. 29. UNDERSIDE OF AMPLIFIER CHASSIS

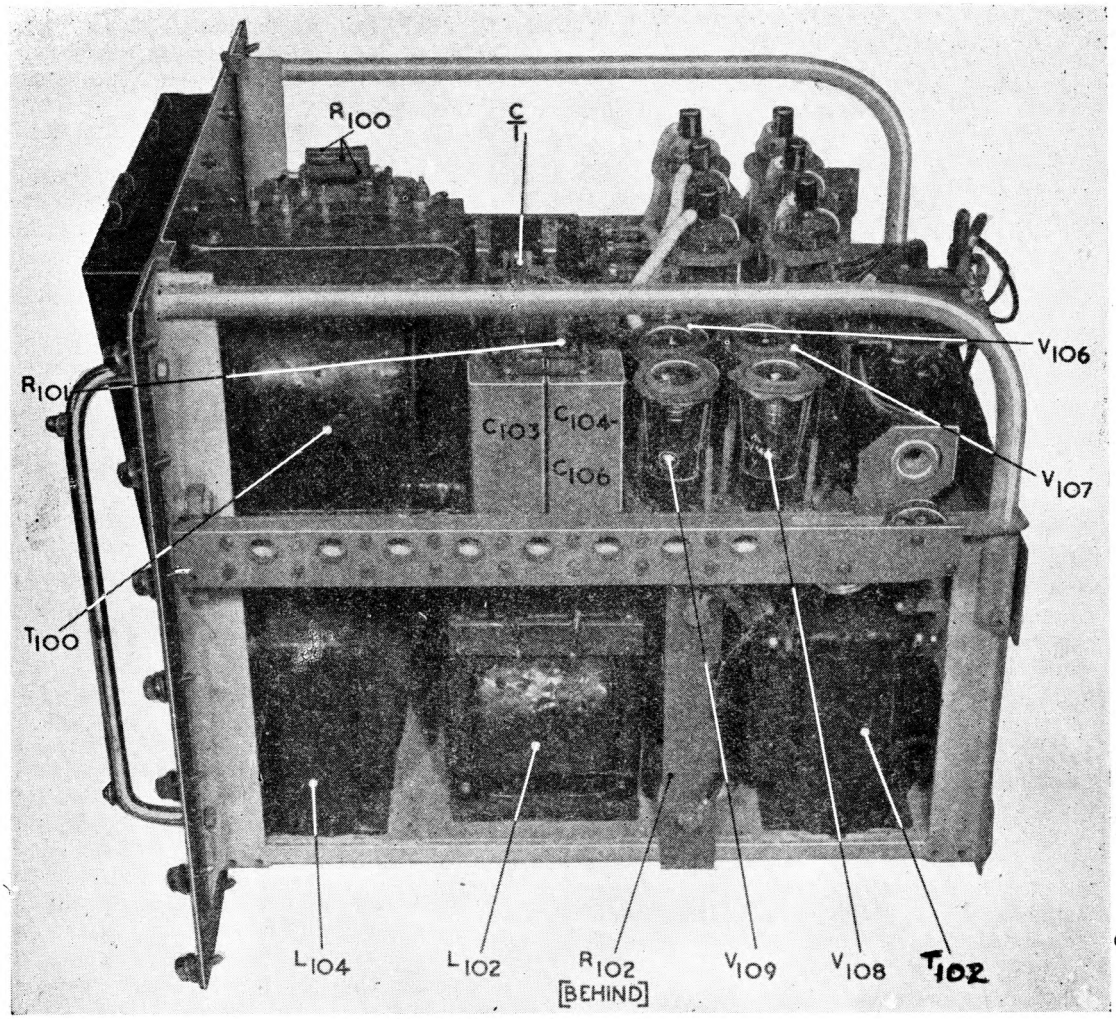


Fig. 31. Right-hand view of power unit

two red transit bolts must be reinserted and screwed up tight. To do this the top unit should be pushed back into the transmitter case and the six panel bolts secured. The shock-absorbing base frame should be bolted to the transmitter with the larger shock-absorbers toward the rear of the transmitter.

Note . . .

On no account must both withdrawable units be withdrawn at the same time unless the transmitter is secured to the floor.

145. Having positioned the transmitter, remove the four disc covers which enclose the four securing bolts. The four red securing bolts must again be removed and stowed, together with the lifting eyes, in the clips provided in the transmitter case (*fig.* 20).

146. After unscrewing the protective covers from the front of the transmitter, these may be stowed inside and at the top of the transmitter case. To position these covers the transmitter unit must be completely removed as described in *para.* 114. The covers are secured by means of the bolts and butterfly nuts provided. Before replacing the transmitter unit, the fan transit bolts must be loosened as described in *para.* 147.

147. When installing the transmitter and before operating it, two transit bolts must be loosened from the fan housing to bring the shock absorber mountings into operation.

Before these bolts are loosened, the top unit of the transmitter must be removed as described in *para.* 114. Reference should be made to *fig.* 34.

(1) Unscrew the butterfly nut (B) until it is tight against the head of bolt (C), then unscrew the nut (A) until it firmly Locks (B) into the position where it has just been placed.

(2) Using a large screwdriver screw up bolt (C) in a clockwise direction to the full extent of its travel. This operation carries the collar (D) away from the fan mounting plate which was previously held between it and locknut (A).

Note . . .

Considerable force should be used to ensure that (A) (B) and (C) remain in this position during operation.

148. The transmitter is designed for operation with an aerial system fed by a 50-ohm coaxial cable. The cable is connected to the transmitter at the coaxial socket (1) shown in the general view of the transmitter *fig.* 1.

149. All other connections are made to the terminal block on the right-hand side of the cabinet, shown at (2) in *fig.* 1. The block is provided with a removable cover, which must be replaced after the connections are made. A rear view of the block, looking inside the cabinet, is given in the installation diagram *fig.* 32.

150. The remote control lines are connected to the REMOTE terminals on the block, and the control unit in the transmitting station to the terminal marked LOCAL. No connection is made in the present installation to the terminals marked CONTROL MAINS.

Note . . .

The lines must be connected to their corresponding numbers.

151. When a high-speed keying relay is used, it is connected to the three HIGH SPEED KEY terminals in the transmitter. The relay terminals are marked M, T and S, and are connected respectively to the POSITIVE SCREEN, and NEGATIVE terminals at the transmitter. The relay will normally be a relay, magnetic, Type P (Stores Ref. 10F/8783) a description of which is given in A.P.2980A, Vol. I, Sect. 4, Chap. 1.

OPERATION

Preliminary adjustments

152. The transmitter output should be connected to a 50-ohm 450-watt artificial aerial load and the following procedure followed, referring to *fig.* 1 for locations of controls except where otherwise stated :—

(1) Place the LOCAL-REMOTE-TEST switch (S10) at TEST. In this condition the transmitter circuits are arranged as for R/T or MCW.

(2) Place the TUNE-TRANSMIT switch S6 at TUNE.

(3) Close the LT switch (S5).

(4) Find the required frequency on the calibration charts (A and B of *fig.* 33). Note that if this is above 7·5 Mc/s it will be necessary to divide by 2 or by 3 to arrive at the correct oscillator frequency.

(5) Set the oscillator range switch (S200) to the appropriate position. Set the oscillator tuning dial (L200, L203, *fig.* 1) to the figures shown on the chart provided with the transmitter. The dial can be "read off" to great precision. The numbers shown in the window indicate the number of coil turns in use, the number on the dial sub-divides each coil turn by 100, and the vernier divides the dial division by 10. Each transmitter is individually calibrated, and the re-setting accuracy of the oscillator is such that the transmitter output can be re-set to better than 50 c/s in one megacycle in any part of the range. The master oscillator is calibrated every 100 Kc/s, up to 5 Mc/s, and every 50 Kc/s over the remainder of the frequency range. Frequencies not directly related to the calibration points can be set up by interpolation, or alternatively, by using a sub-standard frequency meter.

(6) Set the MULIPLIER RANGE switch (S400) in the appropriate position for the output frequency. The dial of this switch is marked with the multiplication factors for the various ranges of output frequency and consequently enables the correct master oscillator frequency to be arrived at.

(7) Place the MULTIPLIER RANGE control (L402), the AMPLIFIER INDUCTOR (L2) and the AMPLIFIER CAPACITOR (C30) at the readings indicated on the charts.

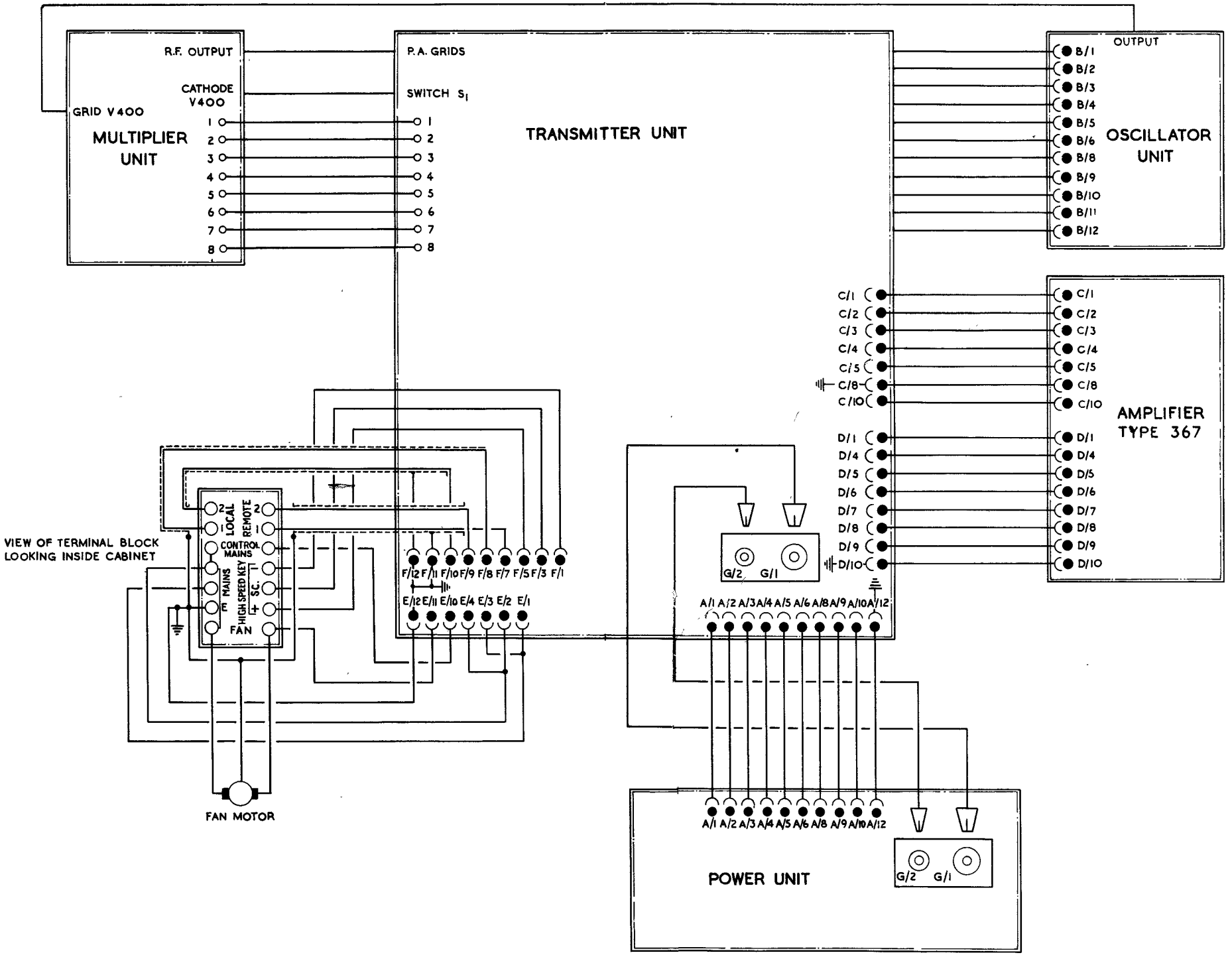


FIG. 32 — INTERCONNECTION OF UNITS, T.1509

A

TRANSMITTER TYPE 1509
OSCILLATOR TYPE 180 SERIAL Nº
CALIBRATION SHEET 2 OF

Frequency Mc/s	Range	Oscillator Tune	Multiplier Tune	Power Amplifier Capacitor	Inductor	Coupling
4·3	4·0-7·5	22-04·3				
4·4	"	20-81·3	18·33	15	15·18	0/46
4·5	"	19-66·8				
4·6	"	18-60·2	17·12	14	14·57	0/43
4·7	"	17-58·6				
4·8	"	16-63·0	16·04	13	14·07	0/41
4·9	"	15-72·1				
5·0	"	14-87·4	15·1	12·5	13·58	0/41
5·05	"	14-45·3				
5·1	"	14-05·8				
5·15	"	13-67·7				
5·2	"	13-31·0	14·27	12·0	12·9	0/39

FREQUENCY 4·3 MC/S TO 5·2 MC/S CALIBRATED_____
OVERLEAF 5·25 MC/S TO 6·1 MC/S DATE _____
NOTE:-MULTIPLIER AND POWER AMPLIFIER TUNINGS ARE APPROXIMATE ONLY

B

TRANSMITTER TYPE 1509
OSCILLATOR TYPE 180
CALIBRATION SHEET 4 OF

Frequency Mc/s	Oscillator	Multiplier Range	Multiplier Tune	Power Amplifier Capacitor	Inductor	Coupling
7·5	SET M.O. TO ½ REQUIRED FREQUENCY.	7·5-14	12·23	10	8·45	0/28
8·0		"	11·39	10	7·86	0/28
9·0		"	10·49	7	7·48	0/23
10·0		"	8·33	7	5·98	0/21
11·0		"	7·62	8	5·39	0/19
12·0		"	6·65	8	4·82	0/16·5
14·0		"	5·39	7	3·98	0/13
14·0	SET M.O. TO ⅓ REQUIRED FREQUENCY.	14-20	7·85	7	3·8	0/12·5
15·0		"	7·41	6	3·5	0/12
16·0		"	6·92	35	3·74	0/10
18·0		"	5·89	2·0	3·34	0/7·5
20·0		"	5·14	0	2·88	0/6·0

FREQUENCY 7·5 MC/S. TO 20·0 MC/S. CALIBRATED_____
DATE _____
NOTE:-MULTIPLIER AND POWER AMPLIFIER TUNINGS ARE APPROXIMATE ONLY.

Fig. 33. Specimen calibration charts

The range switch, S2, should be set to the required frequency range.

(8) Place the coupling switch S3, in position 3 (minimum coupling) and the COUPLING CAPACITOR (C31) at maximum capacity (minimum coupling) (highest dial reading).

153. The HT switch S9, can now be closed, and a reading will be observed on the DRIVE INPUT meter M1. This indicates the multiplier cathode current. As the multiplier and amplifier stage calibration is only approximate, these stages should now be trimmed, the multiplier being adjusted for minimum current on M1, and the amplifier, by means of the AMPLIFIER INDUCTOR, for minimum current on the INPUT meter (M4).

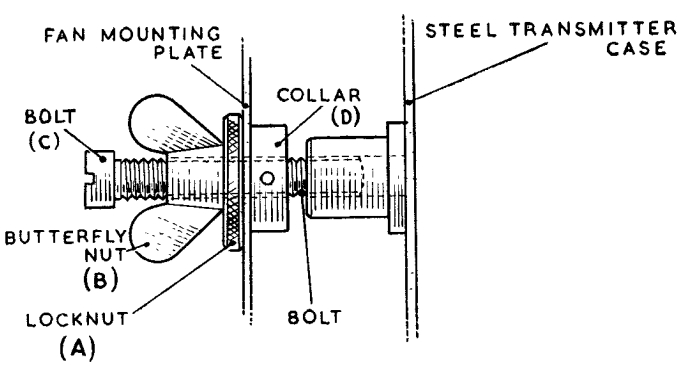


Fig. 34. Fan transit bolts

154. The power amplifier can now be loaded. Loading is controlled by the COUPLING CAPACITOR (C31) in conjunction with the fixed condensers C10 and C11 (*fig.* 8) the latter being put in parallel with C31 *via* S3 ; the setting will vary according

to the frequency and type of load. Adjustment must therefore be made as follows to suit the prevailing conditions.

155. Leave S3 on position 3, and rotate C31 towards minimum capacity, observing the cathode current of the amplifier stage on M4. Should no increase of current be shown by the time minimum capacity is reached, S3 should be turned to position 2, C31 replaced at maximum and the process repeated.

156. If a similar result is obtained reduce S3 to position 1 and again to 0 if required. It will usually be found that the 0 position of S3 is the correct setting for frequencies above 7 Mc/s.

157. When the correct setting of S3 is found, C31 should be returned to maximum, and then slowly reduced in capacity until the current shown by M4 is about 190 mA. The AMPLIFIER INDUCTOR control (L2) is then rotated slowly to obtain a minimum reading of M4. Further reduction in the capacity of C31 will bring the reading of M4 up to 190 mA again. Adjustment of L2 and C31 in this manner should be continued until the reading of M4 can no longer be reduced by trimming L2. Should it be found that it is impossible to dip the reading of M4 below 190 mA (with the switch S3 on position 3 and the condenser C31 at maximum capacity) due to the transmitter load being reactive, L2 should be readjusted a turn or so in one direction and C31 retrimmed for minimum reading on M4. If this is not effective, rotate L2 a similar amount in the opposite direction at the point where adjustment was originally started and again retrim C31 for minimum reading on M4. In the event of it being found impossible to obtain the above conditions, a highly reactive load is indicated and correct functioning of the transmitter will be unobtainable.

158. Now place the TUNE-TRANSMIT switch (S6) at TRANSMIT, and again observe the reading of M4. This should be 350 mA ; if this is not so, slight readjustment of C31 and L2 should be made, ensuring that L2 is tuned to the centre of the " dip " when a reading of 350 mA on M4 is obtained.

159. The transmitter is now correctly tuned for maximum output and the audio-frequency stages can be adjusted for correct operation.

Balancing of modulator valves

160. Leaving the transmitter adjusted as described in the preceding paragraphs, read the current shown on the MODULATOR meter M3. This will be the cathode current of V3. To read the current of V4, press the switch-button S4. Both readings should be the same, and approximately 50 mA with no signal applied to the modulator. If this is not so, the pre-set bias controls, R14 and R15 (*fig.* 23) must be adjusted. These controls are inside the transmitter unit, which must be pulled forward from the cabinet for the adjustment to be made.

161. The bias to V3 is adjusted by R14, and that to V4 by R15. As the mains input to the transmitter unit is automatically broken by the plunger-operated gate switch, S8 (*fig.* 8 and 22) when the unit is withdrawn, it will be necessary to replace the unit between each adjustment. Note that after the unit is replaced no current will be shown on the meters until the delay contactor has closed (i.e. for about 30 sec.).

Adjustment of amplifier bias controls

162. When the modulator grid bias has been adjusted as described, the two gain controls in the amplifier, Type 367, must be set so that the drive to the modulator will provide 100 per cent. modulation. For this purpose the control unit, Type 310 is required ; the two LINE terminals on the unit must be connected to the appropriate LOCAL terminals on the transmitter terminal block. The transmitter switch S10, must be turned to LOCAL. Set the switch S300 on the amplifier (shown in *fig.* 23) to the CONTROL UNIT 310 position. Carry out the following adjustments :—

(1) Connect a telegraph key to the KEY jack on the control unit, Type 310.

(2) Set the SERVICE switch on the control unit at TONE MODULATION.

(3) Set switch S4 on the control unit at 1 mW.

(4) Turn the INPUT GAIN control R325 in the amplifier to its mid-position. This control and the PRE-SET GAIN control, R326, are fitted on the side of the amplifier chassis (*fig.* 23).

(5) Replace the transmitter in the cabinet ; place the TUNE-TRANSMIT switch at TRANSMIT.

(6) Close the transmitter LT switch S5 and the HT switch S9.

(7) Switch on the transmitter by closing the switch S2 (marked HT ON) on the control unit, Type 310.

(8) Press the telegraph key and observe the current shown on the transmitter MODULATOR meter M3.

(9) The INPUT GAIN and PRE-SET GAIN controls can now be adjusted to provide the correct drive to the modulator valves for 100 per cent. modulation. Adjust the PRE-SET GAIN control so that the current shown on M3 is 150 mA. If this figure is not reached by the time the control is fully clockwise, the control should be reduced to about ¾ of maximum clockwise rotation, and the INPUT GAIN control should be advanced (clockwise) until the required reading of 150 mA is obtained. Lock both controls.

163. The speech amplifier and modulator are now correctly adjusted. Periodic checking of the modulator current balance should be made, and re-balancing adjustments carried out when necessary.

Transmitter tuning (crystal control)

164. The transmitter crystal sockets are shown at (4) in *fig.* 1. For output frequencies between 2 Mc/s and 7·5 Mc/s, crystals of the output frequency are used. From 7·5 Mc/s to 14 Mc/s the crystals must be half the output frequency, and from 14 Mc/s to 20 Mc/s one-third the output frequency.

165. Tuning is by initially setting all controls from the tuning charts (para. 152). The multiplier tuning should then be offset by rotating L402 about one full turn. HT switch S9, should now be closed. The oscillator tuning control should be rotated until a reading in the drive input meter (M1) is obtained. A sharp rise will occur from zero to approx. 35 to 45 mA. (the limit of oscillation of the crystal). The oscillator tuning dial should be set to the centre of that part of its travel over which a reading is seen in M1. This is to minimize slight variation in the operating conditions throwing the crystal off oscillation.

166. The multiplier and output stages are then tuned as already described.

167. Now, with the TUNE-TRANSMIT switch on TRANSMIT, check the keying with the local receiver. Slight re-adjustment of the oscillator tuning control may be needed to obtain satisfactory keying characteristics.

PRECAUTIONS AND SERVICING

General

168. The oscillator coils and contact wheels should be cleaned at regular intervals to ensure smooth frequency control. This can be done with the unit in position. Remove the cover from the lower half of the unit. Use a small clean brush, some clean lint-free rag, and some carbon tetrachloride. The coils can be rotated whilst the cleaning material is held against them. The wheels and the rod on which they run should be given careful attention ; the wheel can be lifted free of the coil, and the rod rubbed clean. The wheels must be replaced as described in *para.* 176.

Removal of oscillator unit

169. This should only be done when absolutely essential, since the frequency calibration may be impaired as a result. Remove the transmitter unit Type 59 from the cabinet (*as in para.* 114) and lay the unit on its side with the oscillator upwards. To remove the oscillator unit the dials OSCILLATOR TUNING INCREASE/DECREASE and OSCILLATOR RANGE must be removed. The rotary coil knobs are fitted with a safety release clutch and if the grubscrews are not visible through the holes in the knob, the dial should be held whilst the knob is rotated until the grubscrews appear opposite these holes. Before withdrawing the OSCILLATOR TUNE knob, the LOCK knob must be fully unscrewed (counter-clockwise) and withdrawn from the shaft. Next remove the screws and washers holding the spindle lock plates, together with the indicating cursors. These screws are located underneath the dials and can be seen when the dials are withdrawn from their shafts. Remove the bezel through which the oscillator tuning counter is viewed, (that adjacent to the OSCILLATOR TUNING control) and also the crystal retaining clip assembly.

170. Disconnect socket B on the cable form from the main unit from the oscillator plug B (*fig.* 21). Disconnect the lead from the condenser C215 in the oscillator unit to the mounting of R401 and L401 at the rear of the multiplier unit. This lead should be detached at the multiplier end.

171. The unit may now be removed by unbolting it from the two mounting brackets beneath it and removing the two bolts

which secure it to the deck of the power amplifier stage in the main unit.

Replacing the oscillator unit

172. Frequency instability may be encountered unless :—

(1) The oscillator sub-chassis must lie snugly in the main chassis and must not be under strain at any point.

(2) The sub-chassis sides must not contact the panel Parker Kalon screws.

173. The bolt holes in the range switch spindle bearing plate must lie in line with their respective bolt holes in the main panel after the sub-chassis is fixed in position, so that the bearing plate may be bolted to the main panel after the sub-chassis is fixed in position and so that the bearing plate may be bolted to the main panel without putting any strain on the spindle. Forcing the bearing plate into position will throw the ceramic switch contacts out of position and the range switch will then prove ineffective.

Method of fitting master oscillator dial

174. The dial actuating the variable inductance in the anode and grid of the master oscillator carries two grub screws. One grub screw has a pointed end and the other is flat. The pointed screw fits into a hole in the driving shaft. When fitting the dial, the pointed grub screw should be at 3 o'clock, when the flat one is at 12 o'clock.

175. The pointed grub screw should be screwed home in its locating hole in the shaft before tightening the flat grub screw. If this procedure is adopted the original calibration will be maintained.

176. The correct position of the contact rollers on the coil is as follows :—

(1) With the window dial against the 30 division (end of travel) stop, and reading 30·70, the grid (lower) coil roller should be at $2\frac{1}{4}$ turns from the forward end.

(2) The anode (upper) roller should then be $3\frac{1}{4}$ turns from the bottom.

Method of fitting oscillator unit

177. Place the bezel and all the fixing screws in their respective holes and screw them into the main panel so that they are no more than finger tight, check the operation of the controls for excessive stiffness.

178. If all is well, screw home the top fixing screws on the amplifier deck. After this is done, screw home the bottom screws above the speech amplifier housing. Check operation, and check the frequency against a sub-standard to ensure that the calibration is correct.

Removal of the multiplier unit

179. Before removing the multiplier unit, detach the knobs and back plates of the MULTIPLIER RANGE and MULTIPLIER TUNING controls and the bezel adjacent to the multiplier tuning dial.

180. Disconnect the leads to the tagboard (2) (*fig.* 25) and the grey lead from C405 in the multiplier unit to the grid pin of valve V1 in the power amplifier.

181. Disconnect the lead from the cathode of V400 to the switch S1 (on the oscillator side of the main unit) and also the flying input lead from the oscillator.

182. In order to remove the multiplier unit, the transformer T3 (*fig.* 25) must be unscrewed from the vertical chassis and pulled slightly forward so that the unit can be pulled back far enough for the control spindles to clear the hole in the front panel.

Replacing the multiplier unit

183. When the unit is replaced, the dial setting must be aligned with the settings of the contact rollers on the variable inductances. The dial is replaced by a procedure which is similar to that on the oscillator unit described in *para.* 174 to 176. The roller in this case is set on the front end of the coil when the dial is reading 35/50.

Main unit

184. Facilities which are provided in the cabinet for raising or lowering the main unit and power unit also permit correction of horizontal misalignment.

185. The corrections are carried out by varying the position of the runner channels, which are operated by two vertically mounted bolts working in brackets attached to the cabinet sides. Locking bolts are also provided to lock the final adjustment.

186. The channels can be moved through a distance of approximately $\pm\frac{1}{4}$ in., but adjustment is actually limited to one-tenth of an inch, which represents the clearance

between the panel bolts and their clearance holes.

187. Lateral movement, by which the units may be moved to one side or the other, is effected by the addition or subtraction of shims placed behind the channels. It should be noted, however, that to correct excessive lateral movement, shims should be added to the left-hand side of the cabinet only to prevent the transmitter chassis moving too far to the left. Excessive movement in this direction would endanger the speech amplifier potentiometer spindles and locking devices through contact with the cabinet side when withdrawing the unit from, or returning it to, the cabinet.

188. Stops in the form of pins are provided in the cabinet channels, to prevent the channels falling out when the unit is placed on them. The pins come up against the rear edge of the rollers when the channels are pulled forward and care should be taken to ascertain that the stops are correctly positioned before placing the unit on the channels. If this is not done, there is nothing to prevent the unit rolling off the channels and falling to the ground. For the same reason, if it is found that the unit will not go properly home, it can be assumed that the channels stops are on the wrong side of the rollers. If for any reason it is thought that the unit is incorrectly mounted, it is strongly urged that the block and tackle is affixed before any attempt is made to withdraw the unit. This precaution is necessary to prevent accidents to personnel.

Power unit

189. Adjustment of the power pack in the cabinet is undertaken in a similar manner to that of the transmitter unit, and the precautions mentioned in the case of the main unit also apply to this unit.