Chapter 4

STATION CONTROL 312B-4

and MICROPHONE SM-2

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INTRODUCTION

1. The station control 312B-4 (fig. 1 and 2) has two principal functions. First, it controls by means of two switches the operation of the transceiver KWM-2A and provides microphone and loudspeaker facilities or, if required, enables the KWM-2A a.f. input and output to be connected to a 600-ohm telephone line by means of a phone patch circuit. Secondly, it incorporates an r.f. directional coupler and wattmeter by means of which the forward and reflected power in the transceiver KWM-2A or r.f. linear amplifier 30L-1 output lines can be measured and, hence, v.s.w.r. calculated.

2. An under-chassis view of the 312B-4 showing the phone patch circuit components is provided in fig. 3. The directional coupler sub-assembly unit, with covers removed, is illustrated in fig. 4.

3. Details of the operating controls on the 312B-4 are listed in Table 1. Three of these controls are located on the front panel (fig. 1), but the fourth (VOX BAL) will be found at the rear of the unit (fig. 2).

TABLE 1

Operating controls

Control	Reference	Function
WATTMETER	S3	Selects meter range for measuring forward or reflected r.f. power.
FUNCTION	S1	Enables the KWM-2A to be held in the receive only or transmit only functions if desired.
PHONE PATCH	S2	Enables the KWM-2A to be connected to a 600-ohm telephone line if desired, and can also, if necessary, maintain the equipment in a mute condition.
VOX BAL	R10	Balances the phone patch impedances so that the KWM-2A receiver output is not fed back to actuate the VOX circuit.

Microphone SM-2

4. The microphone SM-2 (fig. 1) is a high impedance, dynamic microphone with a frequency response of 250 to 3500 c/s at -3dB. It is an omni-directional, desk-mounting instrument and is supplied with a 5-foot length of cord and a plug for connecting into the MIC socket on the station control 312B-4 (normal operation) or transceiver KWM-2A front panels. It is not fitted with a 'press-to-transmit' (p.t.t.) switch. If it is required to make use of the KWM-2A p.t.t. facility, any similar high impedance dynamic microphone with the p.t.t. switch can be used provided that the switch is connected to the tip of the microphone jack plug.

CIRCUIT DESCRIPTION

5. A complete circuit diagram of the 312B-4 is shown in fig. 5 and the following circuit description is divided into three parts dealing with the phone patch circuit, the control switches and the directional coupler.

Phone patch

6. The 600-ohm balanced telephone line connected to the PHONE LINE terminals is fed via a low pass filter network, L1, L2, C2-C5, and the switch S2 in the ON position to the phone patch impedance matching circuit. Capacitor C1 and resistors R2 and R5 in series with R3 and the complex resistor network in parallel with R3, present an impedance of 600 ohms to the telephone line.

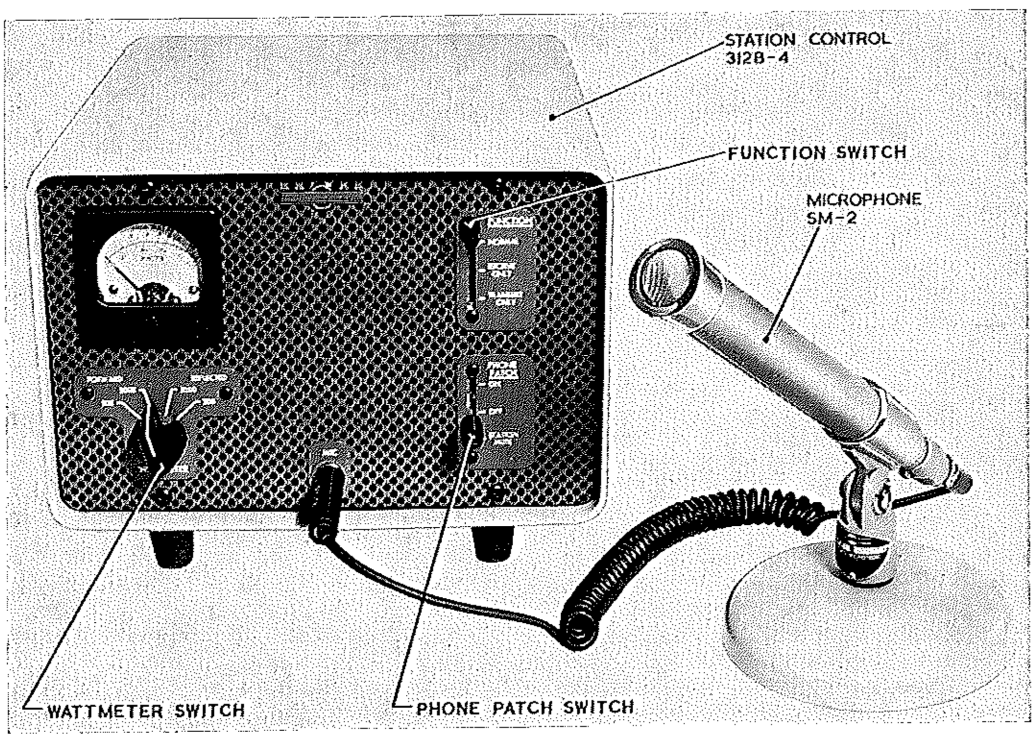

Fig. 1. Station control 312B-4 and microphone SM-2

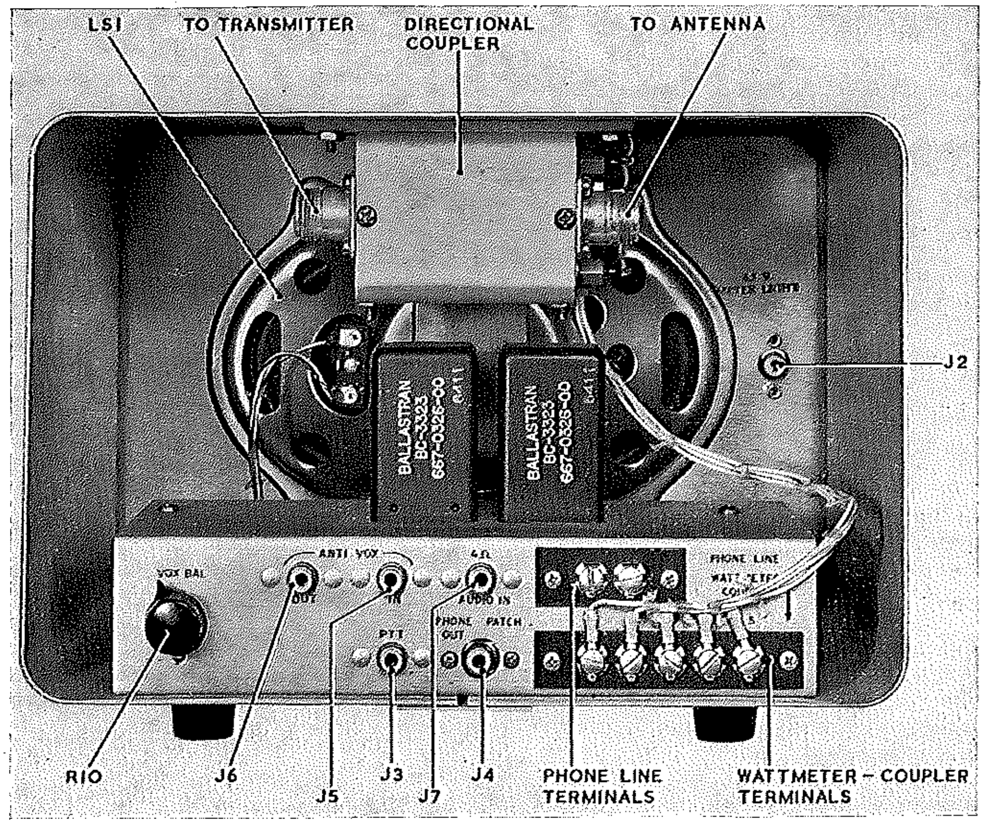

Fig. 2. Station control 312B–4: rear view

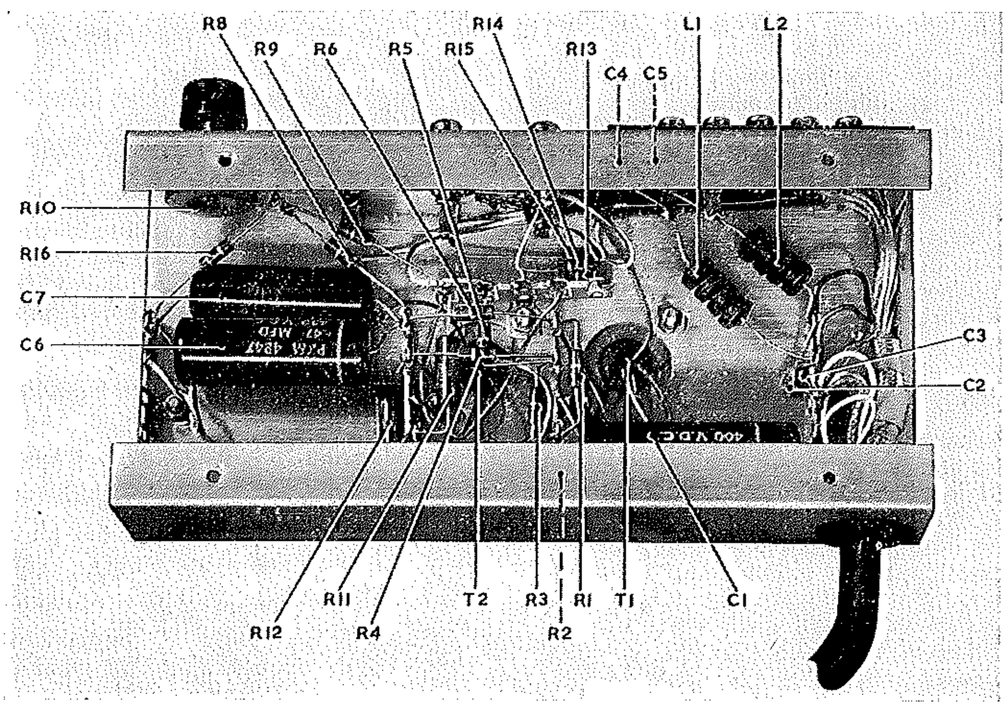

Fig. 3. Station control 312B–4: under chassis view

7. When audio information to be transmitted is being received over the telephone line, the signal is connected to T1 primary via R4 and R12 in series and R1. One side of T1 secondary is grounded and the unbalanced output is connected via S2 in the ON position to the PHONE PATCH OUT connector J4. From J4 the a.f. signal is routed to the a.f. input stage of the transceiver KWM-2A thereby actuating the VOX circuit and switching the KWM-2A to the transmit function. The phone patch impedance transformed by T1 appears as a high impedance at the input to the KWM-2A.

8. When the transceiver KWM-2A is in the receive function, the a.f. signal to be transmitted over the telephone line is taken from the 500-ohm output socket on the KWM-2A to J5 on the 312B-4. From J5 it is connected via an impedance matching circuit formed by R13-R15 to one end of T2 primary. The opposite end of T2 primary is grounded through S2 in the ON position and S1 in the NORMAL or RECEIVE ONLY positions, and the balanced a.f. signal induced in T2 secondary is connected to the telephone lines via R9, R8, R6 and R1 in series and R4.

9. It is important to ensure that the received signal appearing across T2 secondary is not coupled through T1 back to the transmitter circuit, and this is achieved in the following manner. The two equal value resistors R11 and R12 connected across T2 secondary produce a null point at their junction, and one end of T1, primary is connected to this point. Therefore, to ensure that no signal is fed back through T1 the opposite end of T1 primary must also be at a null point and this is arranged by providing equal impedance paths from opposite ends of T2 secondary to the other end of T1 primary. It will be seen from fig. 5 that the two paths each consist of two 100-ohm and one 820-ohm resistors—R6, R8, R9 and R1, R3, R4. The balancing of the circuit is completed by the addition across R8 of a resistor-capacitor network equivalent to the telephone line network across R3. This is formed by C6, C7, R16 and R10 (VOX BAL). With the average telephone line the circuit should balance within the range of adjustment of R10. In the event of it not being possible to balance the circuit, a spare 0·5 mfd. capacitor is supplied with the unit for connecting either in place of C7, or in parallel with C6 and C7.

Control switches

10. The 4-ohm audio output from the transceiver KWM-2A is connected to one side of the loudspeaker LS1 in the 312B-4 via J7 (4Ω AUDIO IN) on this unit. The other side of LS1, however, is connected to ground to complete the circuit only in certain positions of the control switches S1 and S2. Similarly, the microphone plugged into J1 is connected to the KWM-2A audio input only in certain positions of S1 and S2, and the function and operation of each of these switches are discussed in the following paragraphs. Each of the nine possible combinations of the two 3-position switches will be discussed in turn.

11. Switch S1 in NORMAL position and S2 in ON position:

(1) The tip contact of the microphone plug is connected to J3 (PTT) so that the transceiver KWM-2A can be held in the transmit function by the operation of the press-to-transmit switch on the microphone (para. 4).

(2) The microphone output is open-circuit.

(3) The phone patch output from T1 is connected to J4 (PHONE PATCH OUT).

(4) Loudspeaker LS1 is open-circuit.

(5) Transformer T2 primary is grounded thereby connecting the 500-ohm audio output from the KWM-2A into the phone patch.

(6) The telephone line is connected to the phone patch.

12. Switch S1 in NORMAL position and S2 in OFF position:

(1) The tip contact of the microphone plug is connected to J3 (PTT).

(2) The microphone output is connected to J4 (PHONE PATCH OUT).

(3) Transformer T1 secondary is open-circuit.

(4) Loudspeaker LS1 is connected to ground and this loudspeaker is now operational.

(5) Transformer T2 primary is open-circuit.

(6) The telephone line is disconnected from the phone patch.

13. Switch S1 in NORMAL position and S2 in STATION MUTE position:

(1) The p.t.t. line at J3 is open-circuit.

(2) The microphone output is open-circuit.

(3) The audio output line at J4 is open-circuit.

(4) Loudpseaker LS1 is open-circuit.

(5) The telephone line is disconnected from the phone patch.

(6) Transformer T2 primary is grounded. This is necessary in order to present the correct load impedance to the a.f. amplifier output stage in the transceiver KWM-2A which, in the STATION MUTE position of S2, is always in the receive function.

14. Switch S1 in RECEIVE ONLY position and S2 in ON position:

(1) The p.t.t. line at J3 is open-circuit.

(2) The microphone output is open-circuit.

(3) The audio output line at J4 and T1 secondary are short-circuited to ground.

(4) Loudspeaker LS1 is open-circuit.

(5) Transformer T2 primary is grounded thereby connecting the 500-ohm audio output at J5 into the phone patch.

(6) The telephone line is connected to the phone patch.

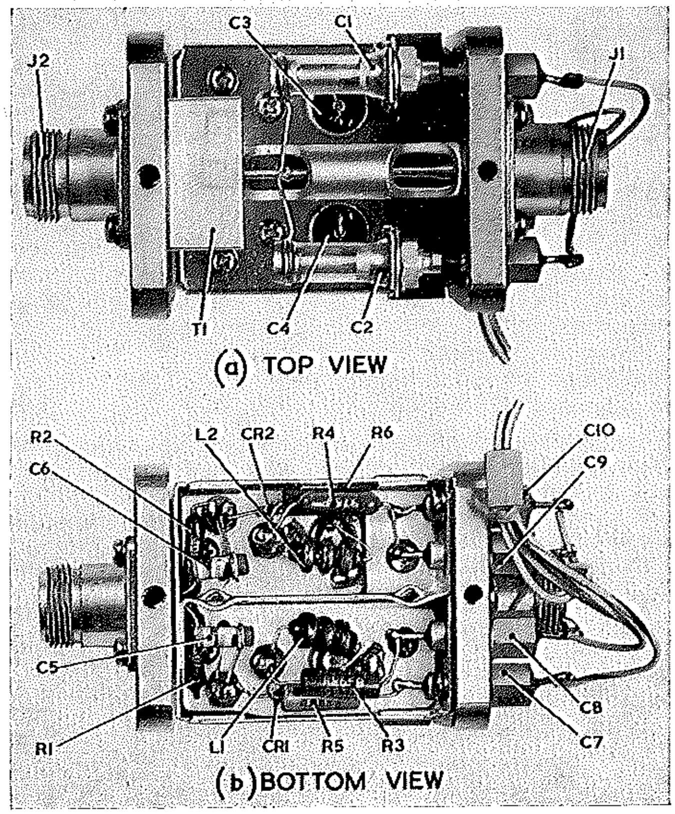

Fig. 4. Directional coupler with covers removed

15. Switch S1 in RECEIVE ONLY position and S2 in OFF position:

(1) The p.t.t. line at J3 is open-circuit.

(2) Transformer T1 secondary is open-circuit.

(3) The audio output line at J4 and the microphone output are short-circuited to ground.

(4) Loudspeaker LS1 is connected to ground and this loudspeaker is now operational.

(5) Transformer T2 primary is open-circuit.

(6) The telephone line is disconnected from the phone patch.

16. Switch S1 in RECEIVE ONLY position and S2 in STATION MUTE position:

(1) As para. 13 except that the audio output line at J4 is short-circuited to ground.

17. Switch S1 in TRANSMIT ONLY position and S2 in ON position:

(1) The p.t.t. line at J3 is connected to ground thereby maintaining the transceiver KWM-2A in the transmit function.

(2) The microphone output is open-circuit.

(3) The phone patch output from T1 is connected to J4.

(4) The 4-ohm audio input at J7 is short-circuited to ground.

(5) Transformer T2 primary is grounded. This is necessary in order to present the correct impedance to the phone patch.

(6) The telephone line is connected to the phone patch.

18. Switch S1 in TRANSMIT ONLY position and S2 in OFF position:

(1) The p.t.t. line at J3 is connected to ground.

(2) Transformer T1 secondary is open-circuit.

(3) The microphone output is connected to J4.

(4) The 4-ohm audio intput at J7 is short-circuited to ground.

(5) Transformer T2 primary is grounded, although the phone patch circuit is not connected in this particular configuration.

(6) The telephone line is disconnected from the phone patch.

19. Switch S1 in TRANSMIT ONLY position and S2 in STATION MUTE position:

(1) As para. 13 except that the 4-ohm audio input at J7 is short-circuited to ground.

Directional coupler and wattmeter

20. The purpose of the directional coupler (fig. 4) is to provide a means of measuring the forward and reflected powers existing in a coaxial r.f. feeder connecting either the transceiver KWM-2A or the r.f. linear amplifier 30L-1 to the antenna. The reason for the presence of reflected power in the r.f. feeder is as follows. When the load impedance presented by the antenna is of a different value to the impedance of the power amplifier, the potential developed across the antenna load impedance by the current flowing in the feeder will be greater or less than that developed by the same current in the power amplifier impedance. The antenna load will now appear as a voltage source generating a current in the feeder independent of the current due to the power amplifier voltage source. This constitutes the reflected current in the feeder. The phase of the two currents will be such as to cause standing waves to exist in the feeder resulting in a reduction of radiated power. The standing waves can be expressed in terms of the current, or voltage, standing wave ratio between forward and reflected currents (para. 33). In practice, therefore, it is important that the best possible match between source and load impedances be achieved.

21. If desired, the directional coupler can be removed from the 312B-4 and installed elsewhere. If this is done, however, extension leads must be provided between the five terminals on the directional coupler and the corresponding WATTMETER COUPLER terminals at the back of the 312B-4 (fig. 2).

Transformer T1

22. The r.f. input to the unit is fed directly from connector J2 to connector J1 via an unscreened cable. This part of the transmission line forms the primary of T1. The secondary is in the form of a toroidal coil and this is fitted in the directional coupler so that the primary passes through the middle of the secondary to form a loose coupling.

23. With both ends of the secondary winding connected to ground through resistors R1 and R2, any current induced in the secondary will flow equally through the resistors and develop voltages across these that will be of equal potential, opposite phase and proportional to the primary current.

24. The variable capacitors C1 and C2 together with C3 and C4 form two capacitive voltage dividing networks and the voltages developed at the two capacitor junctions are equal in potential and are in phase. It should be noted that the development of these voltages and those developed across R1 and R2 make an important contribution towards the measuring of r.f. power.

Measurement of r.f. power

25. The operation of the directional coupler is best described by considering the two possible conditions of operation: mismatched, when reflected power is present in the feeder, and matched, when no reflected power is present.

26. In the mismatched condition, the voltages developed across R1 and R2 are each the vector sum of two components of voltage, (a) the voltage proportional to the current in the forward direction, and (b) the voltage proportional to the current in the reflected direction. Similarly, the voltage developed at the junction of each capacitive voltage divider is also the vector sum of two components of voltage representing forward and reflected current respectively.

27. There are now two vector derived voltages across each rectifier CR1 and CR2, but the phase relationship between the component voltages is such that the r.f. voltage across CR1 is the arithmetical sum of the two forward components, and the r.f. voltage appearing across CR2 is the arithmetical sum of the two reflected components.

28. In the matched condition there is no reflected wave to be measured. In the forward direction the voltage developed across R1 is equal to, but of opposite phase to, the voltage developed at the junction of C1 and C3. The r.f. voltage across CR1 is therefore the sum of the two voltages, or twice the value of either. The voltages developed across R2 and at the junction of C2 and C4 are also equal but are in phase, so that the voltage across CR2 is zero.

29. The r.f. voltages developed across CR1 and CR2 are proportional to the forward and reflected power respectively and require to be rectified for application to the meter M1. The rectifying circuits are formed by CR1, C3 and L1 for the forward direction, and by CR2, C4 and L2 for the reflected direction. After rectification the d.c. voltage is divided by resistor networks R5 or R3 in the forward direction and by R6 or R4 in the reflected direction in order to give the meter a range of 0-200 watts and 0-2000 watts for each direction. R.F. decoupling of the four output lines is provided by C7-C10.

Calibration accuracy

30. Calibration accuracy is maintained over the frequency range 3·4 to 30 Mc/s in both the inductive and capacitive coupling elements. Any increase of voltage introduced in the inductive coupling by increasing frequency is nullified by the voltage drop in T1 secondary due to the increase in reactance with frequency. Capacitors C5 and C6 are included to compensate for any stray series inductance in R1 and R2 that would otherwise cause an increase in the impedance of these resistors with increase in frequency. In the case of the capacitive dividers, the reactance ratio of the two capacitors remains constant and is unaffected by frequency changes. It should be noted, however, that the settings of C1 and C3 are correct for a 50-ohm feeder line only.

Wattmeter

31. The directional coupler output applied to M1 is selected by the 4-position WATTMETER switch, S3, on the 312B-4 front panel. The calibration of the four ranges of M1 is controlled by the four series resistors, R3-R6, in the directional coupler (para. 29). The values of these resistors are selected during the production test of the unit.

32. An internal lamp for dial illumination is incorporated in M1, and, as the 312B-4 has no power supply, a 6·3V a.c. supply is connected to J2 (6·3V METER LIGHT) from a special outlet on the transceiver KWM-2A provided for this purpose.

V.S.W.R. calculation

33. The voltage, or current, standing wave ratio (v.s.w.r.) in the r.f. feeder is calculated from the following equation:

$$\text{v.s.w.r.} = \frac{1+\sqrt{\dfrac{\text{reflected power}}{\text{forward power}}}}{1-\sqrt{\dfrac{\text{reflected power}}{\text{forward power}}}}$$

Chapter 5

A.C. POWER SUPPLY PM-2

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INTRODUCTION

1. The a.c. power supply PM-2 (fig. 1 and 2) fits onto the rear of the transceiver KWM-2A and provides that unit with the required positive h.t. and negative bias supplies and an a.c. valve heater supply. Extension bars at the front of the chassis (fig. 2) locate in slots on either side of the rear of the transceiver KWM-2A and are secured to the KWM-2A chassis sidewalls by thumb screws. The output socket P2 on the PM-2 mates with the plug J13 on the KWM-2A when the two units are pushed firmly together.

2. The PM-2 basically consists of a transformer with four secondary windings, bridge rectifier, voltage-doubler and half-wave rectifier circuits with the associated filter networks, and a low impedance loudspeaker. Semiconductor rectifiers are used throughout to reduce heat generation to a minimum and to ensure that on switching on the unit the output supplies are available instantaneously with no warm-up period. A list of the output voltages is given in Table 1.

TABLE 1

Output voltages

Voltage	Maximum load	Function
+800V	230 mA	power amplifier h.t. supply.
+275V	210 mA	general purpose h.t. supply.
—50 to—90V	—	adjustable bias supply.
6·3V a.c.	11A	valve heater supply.

3. The unit operates from a 115 or 230V, 50 to 60 c/s, single-phase mains supply. The switching of this supply is controlled externally by the function switch OFF-ON-NB-CAL on the transceiver KWM-2A front panel.

CIRCUIT DESCRIPTION

Input voltage

4. A circuit diagram of the PM-2 is shown in fig. 3. The live line of the incoming a.c. supply is routed out again via pin 7 of P2 to an external on-off switch on the transceiver KWM-2A and thence back again via pin 5. The a.c. mains operating voltage for the unit is determined by the setting of the LINE VOLT SELECTOR switch, S1, located inside the unit on the chassis (fig. 1). In the 115V position, S1 connects the two primary windings of T1 in parallel across the a.c. mains via the 4-amp fuse F1. In the 230V position, S1 connects the primary windings in series via a 2-amp fuse, F2, across the a.c. mains. It will be seen, therefore, that when switching the unit from one input voltage condition to the other there is no need to change the input fuse as this is taken care of automatically.

5. Grounding of this unit and the associated transceiver KWM-2A is usually achieved by the use of a 3-wire mains supply. In the absence of a 3-wire supply, the GND terminal at the rear of the unit (fig. 1) should be connected to a good ground line.

Output voltages

+800V d.c.

6. This voltage is obtained from a conventional voltage-doubler circuit consisting of the four diodes CR1-CR4 and the associated capacitors C1-C4 connected to the first of the four secondary windings of T1. The rectifier diodes are series connected in pairs because of the reverse voltage limits on these components. Similarly, the reservoir capacitors are also connected in pairs because of the d.c. working voltage limits. Resistors R3-R6 provide a discharge path for the capacitors when the unit is switched off. The transformer winding is of sufficiently high resistance for it to be unnecessary to use a surge-suppression resistor, as fitted in the other two d.c. circuits on this unit.

+275V d.c.

7. This voltage is obtained from a full-wave bridge rectifier, CR5-CR8, connected to the second of the four T1 secondary windings. The rectified output is smoothed by a Y-section filter, L1 and C7A-B. Resistor R1 provides a discharge path for C7 when the unit is switched off. The surge-suppression resistor R5 limits the peak current through the rectifier diodes.

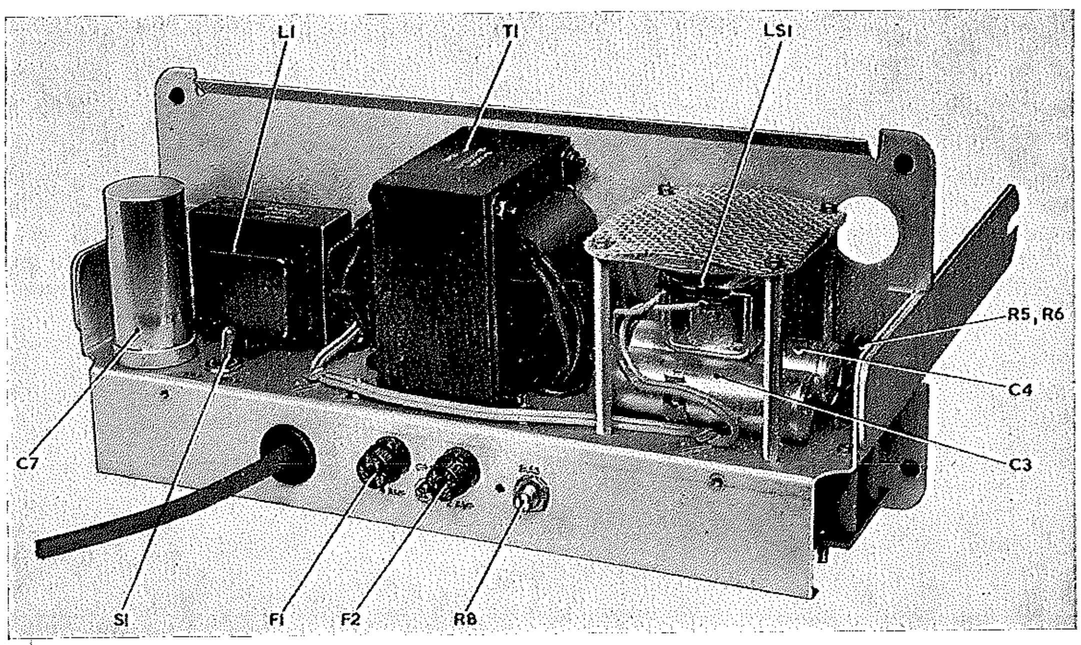

Fig. 1. A.C. power supply PM-2: rear view, removed from case

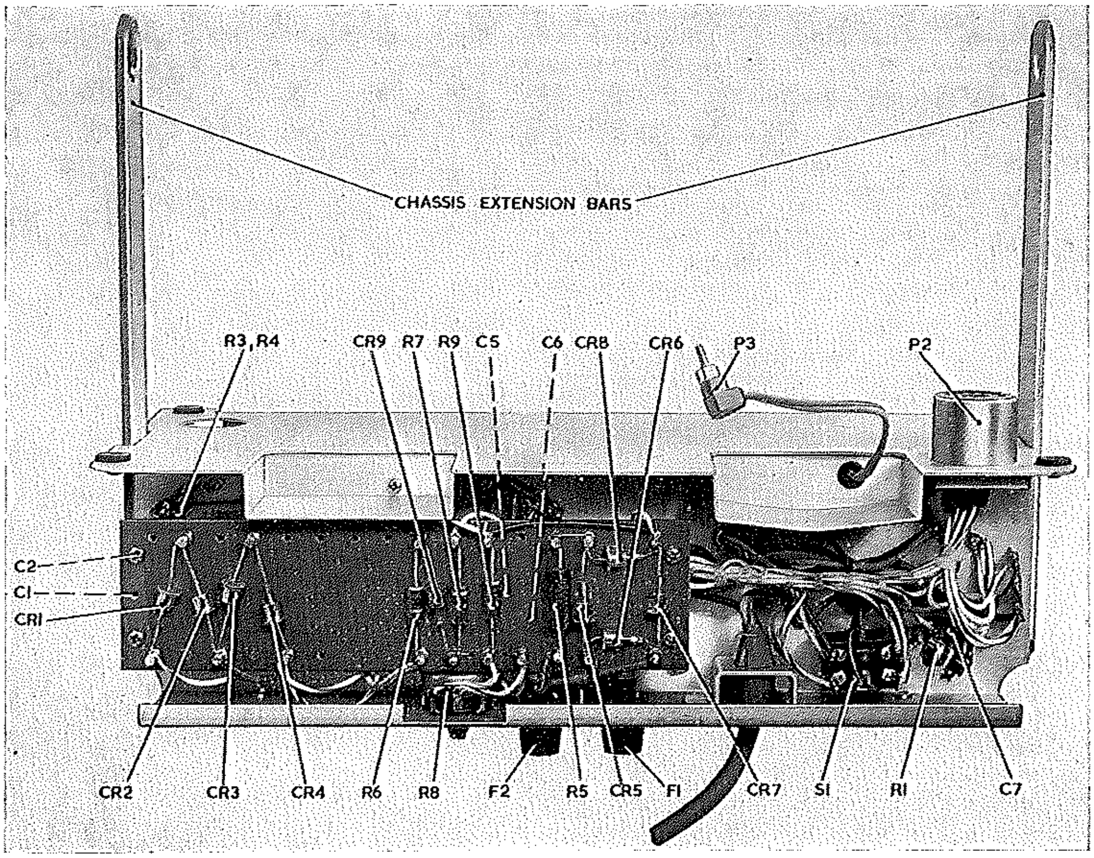

Fig. 2. A.C. power supply PM-2: under chassis view

—50 to —90V d.c.

8. The output from the third secondary winding is applied via a surge-suppression resistor, R6, to a half-wave rectifier, CR9. The negative d.c. output smoothed by C5, is applied to a voltage-divider network R7-R9 and the final output, adjustable over the range —50 to —90V, is taken from the slider of the BIAS control, R8. Additional smoothing is provided by C6. This d.c. supply has a relatively high source impedance and, therefore, can provide only a negligible current output. It is intended for use only as a bias or reference supply.

Valve heater supply

9. The fourth secondary winding provides a 6·3V a.c. output, one side grounded, used as a valve heater supply in the transceiver KWM-2A. Owing to the method of connecting the valve heaters on the KWM-2A, this output is routed via two pins on P2.

Loudspeaker

10. Incorporated in the PM-2 is a small 4-ohm loudspeaker connected to the plug P3 via an extension lead (fig. 2). If it is required to use the loudspeaker, P3 is inserted in the 4-ohm audio output socket at the rear of the transceiver KWM-2A.

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