VIKING
ACCESSORIES
MANUAL
PART G
ITEM 7

TRANSMITTER-RECEIVER
TYPE T.R.1464

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AMENDMENT RECORD SHEET

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TRANSMITTER-RECEIVER
TYPE T.R.1464

CONTENTS

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CONCISE DETAILS

Purpose of Equipment ..	For airborne communication.
Special Features	(i) 4 pre-set automatically tuned channels, remotely controlled. (ii) Weight of equipment has been kept to a minimum.
Type of Wave	RT and MCW.
Frequency Range	100-124 Mc/s.
Frequency Stability	Crystal controlled ; separate crystals for transmitter and receiver.
Crystal Multiplication Factor	18.
Intermediate Frequency ..	9.72 Mc/s.
Percentage Modulation ..	Minimum 83%, normal — 90% (with maximum AF output).
Minimum Sensitivity	100 microvolt input gives an audio output not more than 6 dBs. below that obtained with an input of 50 millivolts.
Minimum Signal to Noise Ratio	20 dBs. at 100 microvolts.
Selectivity	At $\pm$ 140 kc/s., the attenuation must be greater than 40 dBs., and at 4$\pm$0 kc/s. the attenuation must be less than 6 dBs. The set is designed to work with 180 kc/s. channel spacing.
Second Channel Attenuation ..	At 112 Mc/s. it is greater than 55 dBs.
Output Impedance	Transmitter—to match 50 ohm coaxial feeder. Audio— to match :— (i) 3 pairs of high impedance telephones, type 16 or (ii) 3 pairs low impedance telephones, type 32.
Microphone	Electromagnetic, type 26.
Amplifier Class	Amplifier—Class A. Modulator—Class AB1. Transmitter output—Class C.
Supply Voltage	22 to 29 volts. Nominal voltage : 24. Average working and testing voltage : 26.
Current Consumption at 26 Volts	6 amps. on Receive, plus 2 amps. surge for motor when changing channels ; 8½ amps. when Transmitting.
Power Output of Transmitter	Minimum 4½ watts. Normal 6 to 7 watts.
Stores Reference	10D/1379.
Overall Dimensions	13 inches × 17 inches × 8 inches.
Weight	36 lb.
Associated Equipment ..	Electric Controller, type 12. Antivibration Mounting for set—type 636/1.

TABLE A

List of valves

Circuit Reference	*AM type number*	*Equivalent valves*	*Type of valve*	*Function*	*Location*
V101	VR91	EF50 Z92	R/F pentode	Crystal oscillator and trebler	On Transmitter Deck
V102	VT501	TT11	R/F beam tetrode	Frequency doubler	On Transmitter Deck
V103	VT501	TT11	R/F beam tetrode	Push-pull trebler	On Transmitter Deck
V104	VT501	TT11	R/F beam tetrode	Push-pull trebler	On Transmitter Deck
V105	VT501	—	R/F beam tetrode	Push-pull PA output	On Transmitter Deck
V106	VT501	—	R/F beam tetrode	Push-pull PA output	On Transmitter Deck
V107	VR67	6J5, 6J5GT/G, L63, or American VT94	Triode	Second A/F	On Transmitter Deck
V108	VT52	EL32	Pentode	Modulator	On Transmitter Deck
V109	VT52	EL32	Pentode	Modulator	On Transmitter Deck
V201	VR91	EF50 Z92	R/F pentode	Receiver R/F	On Receiver Deck.
V202	VR91	EF50 Z92	R/F pentode	Mixer	On Receiver Deck.
V203	VR91	EF50 Z92	R/F pentode	Crystal osc. & trebler	On Receiver Deck.
V204	VR91	EF50 Z92	R/F pentode	Sextupler	On Receiver Deck.
V205	VR53	EF39	variable-mu pentode	Controlled I/F stages	On Receiver Deck.
V206	VR53	EF39	variable-mu pentode	Controlled I/F stages	On Receiver Deck.
V207	VR91	EF50 Z92	R/F pentode	3rd I/F	On Receiver Deck.
V208	VR54 –CV1054	EB34	Double diode	Detector and AVC	On Receiver Deck.
V209	VR56 –CV1056	EF36	Pentode	1st A/F	On Receiver Deck.
V301	VR53	EF39	variable-mu pentode	BA marker amplifier *	On Power Unit.

* Where the BA facilities of the TR.1464 are not used this valve need not be fitted.

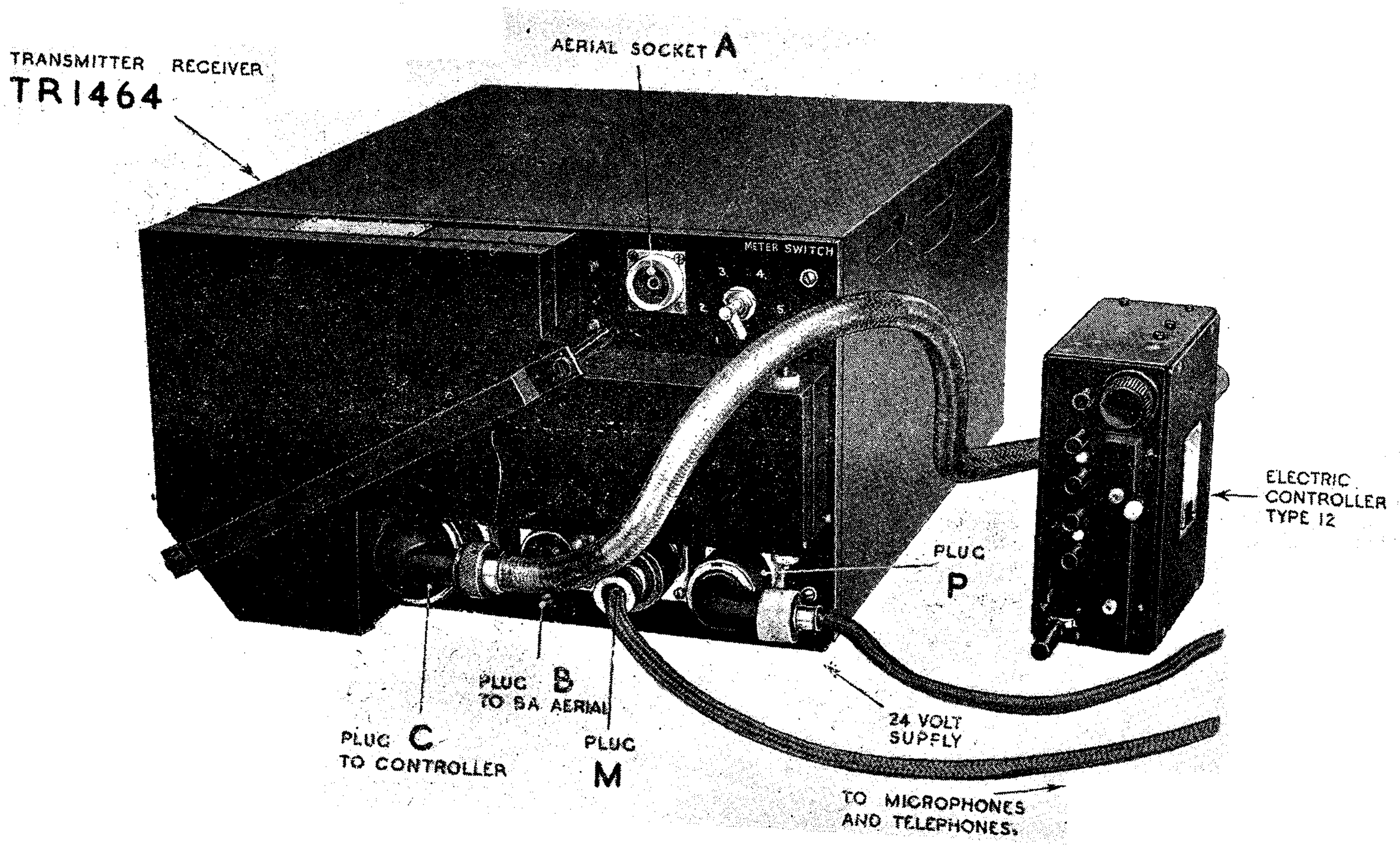


Fig. 1—TR.1464 with controller.

TRANSMITTER-RECEIVER TYPE T.R.1464

1. The transmitter-receiver T.R.1464 is a VHF transmitter-receiver for airborne use. Communication is normally by RT, but MCW is provided as an alternative. Four pre-set channels, each crystal controlled for receiving and for transmitting, are provided. These channels are within the 100 to 124 Mc/s. band and are selected by the depression of buttons of an electric controller. The range of the equipment is confined approximately to the visual horizon.

2. The dimensions and weight of the T.R.1464 are :—

Dimensions (overall) ... 13in. × 17in. × 8in.
Weight ... ... 36 lbs.

Figure 1 shows a general view of the set with its controller. The audio frequency circuits can be used as an intercomm. amplifier which can serve up to three positions in the aircraft. Press-to-Transmit facilities are available. A Beam Approach marker signal amplifier is included in the set.

3. No junction box is necessary as the power unit is incorporated in the transmitter-receiver itself. Five straight connections are sufficient for a complete installation. In order to employ the minimum practicable channel spacing, and thus the greatest possible number of channels crystal oscillators are used in both transmitter and receiver. Crystals of a frequency higher than about 8 Mc/s are difficult to manufacture, and so crystals in the 5-7 Mc/s band are used, and their frequency multiplied by 18. This multiplication factor suits the channel spacing of 180 kc/s. Such close spacing would not be possible without crystal control because of frequency drift on temperature variation. This channel spacing and the multiplication factor of 18, means that the crystals for adjacent channels are 10 kc/s apart.

OPERATION IN THE AIR

4. Switching on and selection of the required channel are effected by depressing the corresponding channel button on the electric controller. As soon as the channel is selected by the frequency selecting mechanism the depressed channel button is illuminated. The switch of the electric controller is normally in the RECEIVE position. To transmit, the T.R switch is held over in the transmit position against spring pressure while speaking. Alternatively, the press-to-transmit button, is depressed whilst speaking. To switch off the set, depress the OFF button on the controller.

5. For Beam Approach reception, the T.R switch on the controller is moved to the BA position, and the red warning light becomes illuminated. The switch is self-locking in this position. The appropriate channel button must be depressed for reception of the main beacon signals, the signal strength of which in the telephones may be adjusted by means of the volume

WARNING

I The T.R.1464 is a LIGHTWEIGHT SET.

The strength of the covers and framework has been sacrificed for lightness. Do NOT use the light withdrawal handle at the front as a carrying handle. Keep the set in the mounting tray as far as possible.

II ALL VALVES MUST BE PLUGGED-IN before switching on. When testing, switch off before removing any valve, and replace it before switching on. Damage to valve heaters will result if the set is operated with any valve absent.

III THE METER SWITCH MUST BE LEFT IN POSITION 6, or transmission may be impossible.

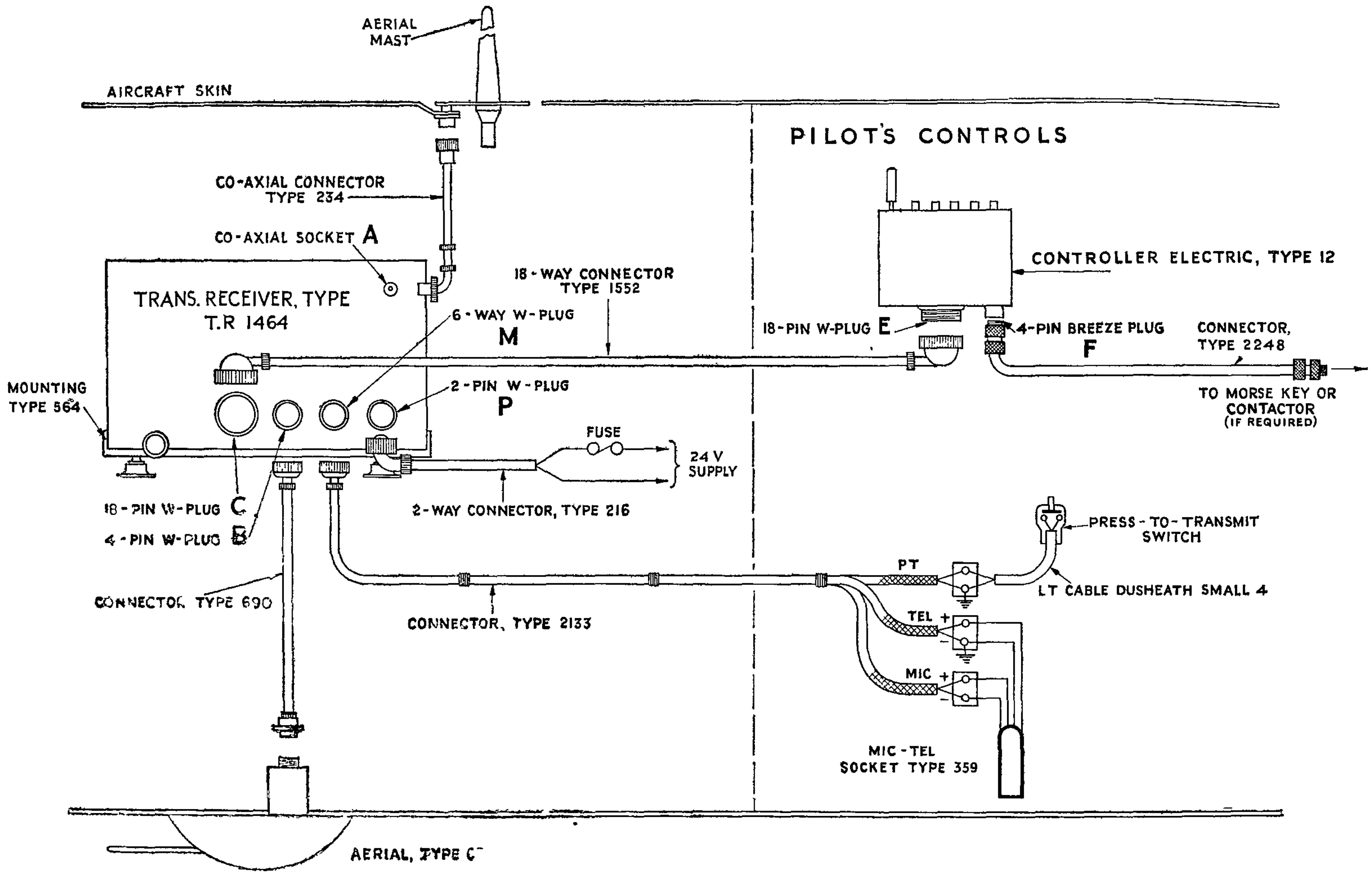


Fig. 2—TR.1464—connection diagram.

A diagram of the Viking installation is given in the Maintenance Manual.

control on the controller. While the switch is in the BA position the press-to-transmit button is ineffective.

6. Intercomm. is available at any time while the equipment is switched on. Speech into any of the microphones when the equipment is in the transmit condition will be radiated. Any member of the crew can modulate the transmitter by depressing his press-to-transmit button and speaking, provided the pilot has not put the T.R switch into the BA position.

NOMENCLATURE

7. The components of the T.R.1464 are designated by three suffixes, for example, C501, R123. The "hundreds" figure indicates the particular unit which contains the component. Table B shows units with their associated component designations.

TABLE B — COMPONENT REFERENCE SYSTEM

Unit	*Component Reference*
Transmitter, Modulator and 2nd A/F Amplifier	100—199
Receiver and 1st A/F Amplifier	200—299
Power Unit and B/A Amplifier	300—399
Drive Motor	400—499
Controller	500—599

8. Standard detached contact relay notation is used. Relay coils are represented by a small rectangle containing figures showing the resistance of the coils in ohms. Near the rectangle representing the relay coil is a reference, for example, BA/4. The relay is known by the letters, and the number below gives the total of contacts operated by the relay armature. In the text a relay is usually mentioned by these letters only. The actual contacts, numbered in this case BA1, BA2, BA3 and BA4, appear wherever it is convenient to show them in a circuit, and not necessarily near the rectangle used to indicate the coil. The relay letters followed by a number in the text, represent a relay contact.

9. Each plug in the installation has been given an identification letter. Figures 1, 2 and 3 show the letters associated with the outgoing plugs of the T.R.1464. In the circuit diagrams the connections of the plug pins are referred to by the plug letter followed by the number of the pin, e.g., E15 for pin 15 on the plug E of the controller. The symbol is a clear circle in the wire-line.

10. The connections between the three decks, and the front panel of the T.R.1464 are effected by soldering the wires from the cable forms to mounted tag strips. These tags are convenient test points, and are shown in the circuit diagrams as a solid circle. The hundreds numbers associated with the tags follow the designations given in Table B. Figure 6 gives the tag location key.

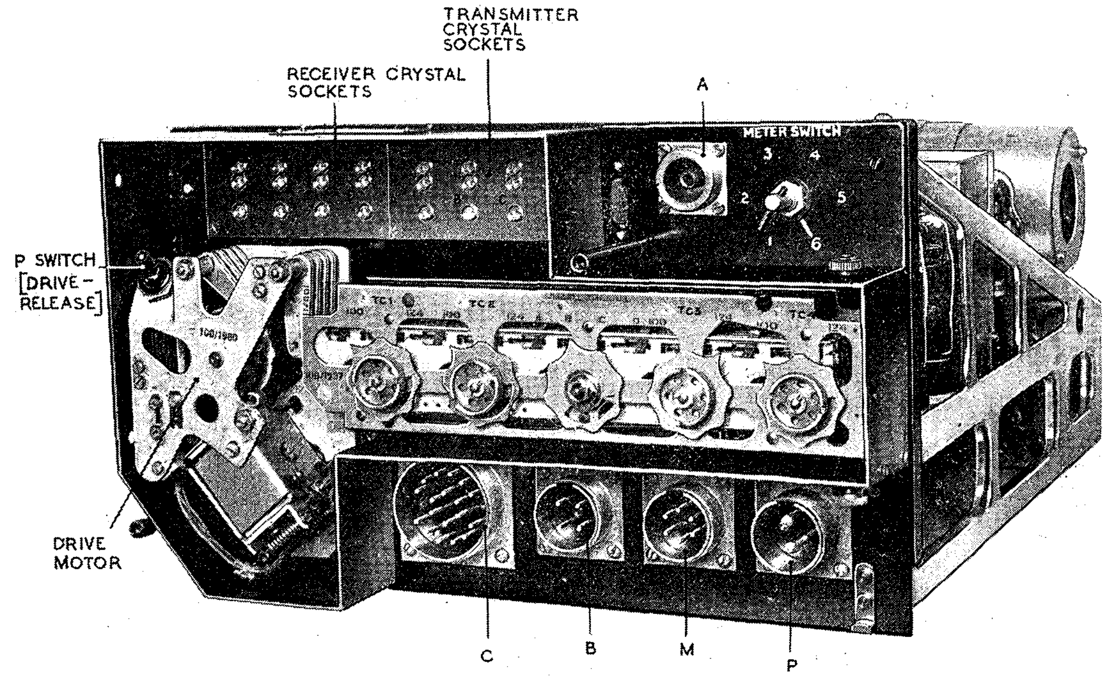


Fig. 3—TR.1464—front view (front cover and case removed).

CONSTRUCTION

11. Two views of the transmitter-receiver are given in figs. 3 and 5 which show the major items :—

1. The Front Panel.
2. The Transmitter deck.
3. The Receiver deck.
4. The Power Unit and BA marker amplifier chassis.

12. The three chassis and the front panel are constructed of mild steel dipped in tin for preservation. The covers are of similar material, and their strength has been sacrificed for lightness. Care should be used when handling them as they are easily dented.

13. The metal surround to which the front dust cover is attached, may be removed in two sections by withdrawing the fixing screws. In this way access is obtained to the drive motor, and to the slide bar mechanism of the condenser drive unit, as shown in fig. 3.

14. The three trays upon which are mounted the transmitter, the receiver and the power unit components, are not normally removable. If it is essential to separate them, it will be necessary to unsolder all the tap strips from the main cable forms, as well as to remove the fixing screws.

15. The rotary transformer is mounted on a sprung table on the rear power unit chassis. It may be removed as a unit by unfastening the retaining clip around the rotary transformer itself, and by disconnecting the input and output connections. The commutator and the rotary cooling fan (the latter is painted red ; figure 5) are enclosed by a cylindrical dust cover, which

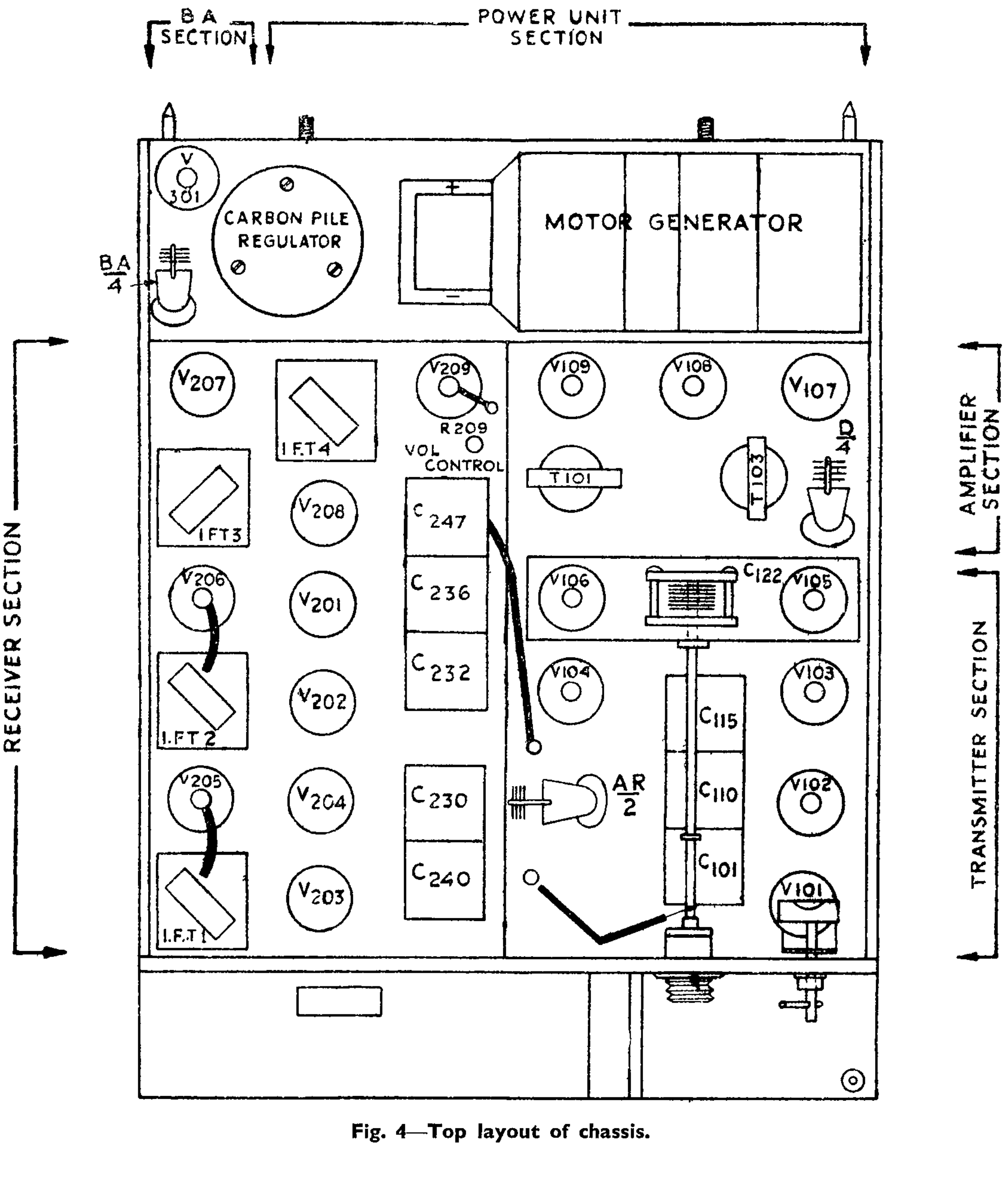


Fig. 4—Top layout of chassis.

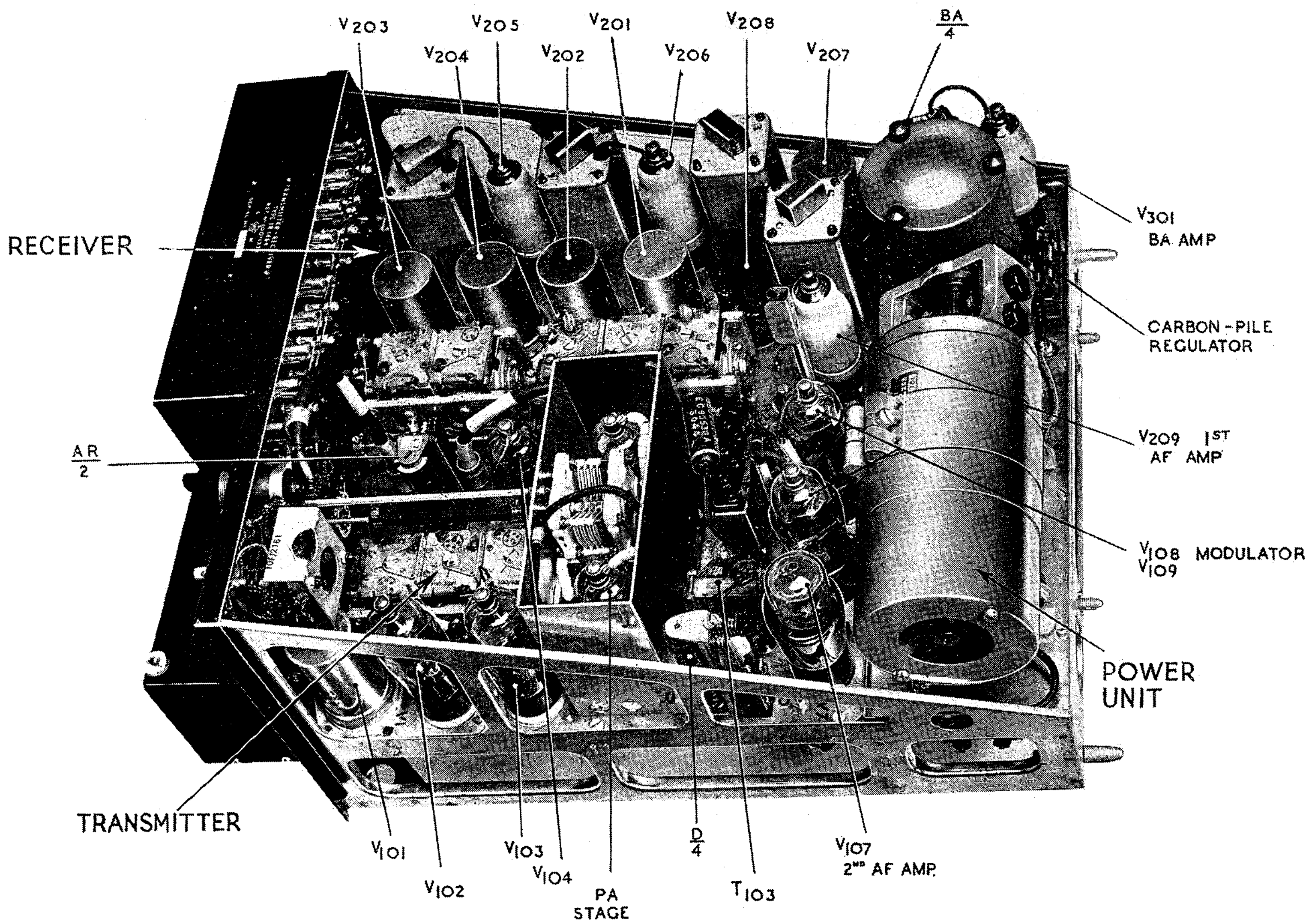


Fig. 5—TR.1464—top view (case removed).

can be removed by the withdrawal of the two retaining screws. The carbon-pile regulator unit is mounted on the same chassis and its cover may be removed by withdrawing the three fixing screws on the top of the regulator and removing the moisture-proof adhesive tape at the base of the cover. It is recommended that the carbon-pile regulator be touched as little as possible.

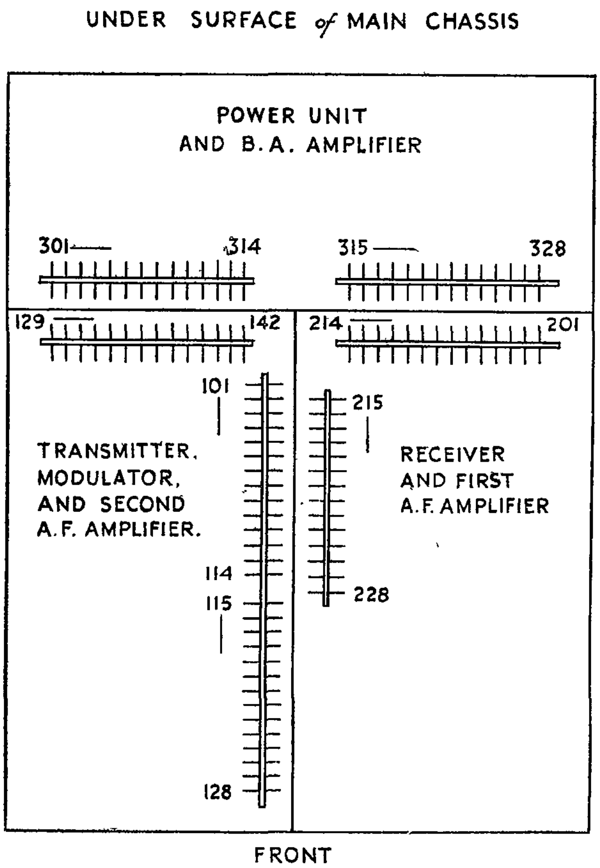


Fig. 6—Tag numbering.

ASSOCIATED EQUIPMENT

Electric controller, type 12

16. The T.R.1464 requires the connection of an electric controller, type 12 (as shown in fig. 1) for its operation. The push buttons, which are made of translucent plastic so that the depressed button may be illuminated, each operate a single contact. The controller incorporates a red BA warning light, and also a volume control for the receiver output which is effective *only* when using the beam approach system. Figures 19, 20 and 21 give views of this controller.

Aerial, type 62

17. The aerial, type 62 is installed in the aircraft and connected to the T.R.1464 for the reception of the Beam Approach marker beacon signals. The aerial, type 62 is really a complete receiver in itself, and its signals only require A F amplification. The amplification is provided by V301 and the normal intercomm. amplifier valves.

Morse key

18. M.C.W. transmission may be radiated from the T.R.1464 by the connection and operation of a morse key. Figure 2 shows the 4-pin breeze plug F on the back of the controller, to which the morse key must be connected. It is preferable to strap tags 117 and 118, if they have not already been connected.

TABLE C — CONNECTORS

Items and Plugs Connected	*Connector*	*Description*
Aerial, to Plug A of TR.1464	Assembly type 5229VB	Uniradio 4 or 5.
Plug E of Controller type 12, to Plug C of TR.1464	Assembly type 5229VA	Cable form No. 6, 18-way.
24 volt supply, to Plug P of TR.1464	49853-SH117	Dumet 19 (24 volt) blue, negative, to pin No. 1 and red, positive, to pin No. 2.
Microphones, telephones and press-to-transmit switch, to Plug M of TR.1464	49853-199	3 sets of Dumet 4: first pair—to microphones. 2nd pair—red to telephone +, blue to telephone — and aerial relay. 3rd pair—to P/T switch. Blue earthed.
Plug F (Breeze plug) of Controller, to Morse Key.		Quadramet 4.

THE RECEIVER

19. The T.R.1464 receiver is a superheterodyne with an intermediate frequency of 9.72 Mc/s. It possesses selectivity suitable for the employed channel separation of 180 kc!s. Figure 8 shows the I F selectivity limit specifications.

20. One R F stage is used, an additive first-detector or mixer valve following. The local oscillator voltage is derived from a two-stage crystal oscillator. Three stages of intermediate frequency amplification are used, and a diode acts as the second detector. A second diode (in the same valve-envelope) is arranged to provide delayed automatic volume control.

21. A plan diagram of the receiver shewing the positioning of the valves, the tuning condensers, and the I F transformers is given in fig. 7. This should be viewed in conjunction with fig. 5. Figure 26 gives the circuit diagram. Figure 27 shews the detailed wiring on the underside of the chassis.

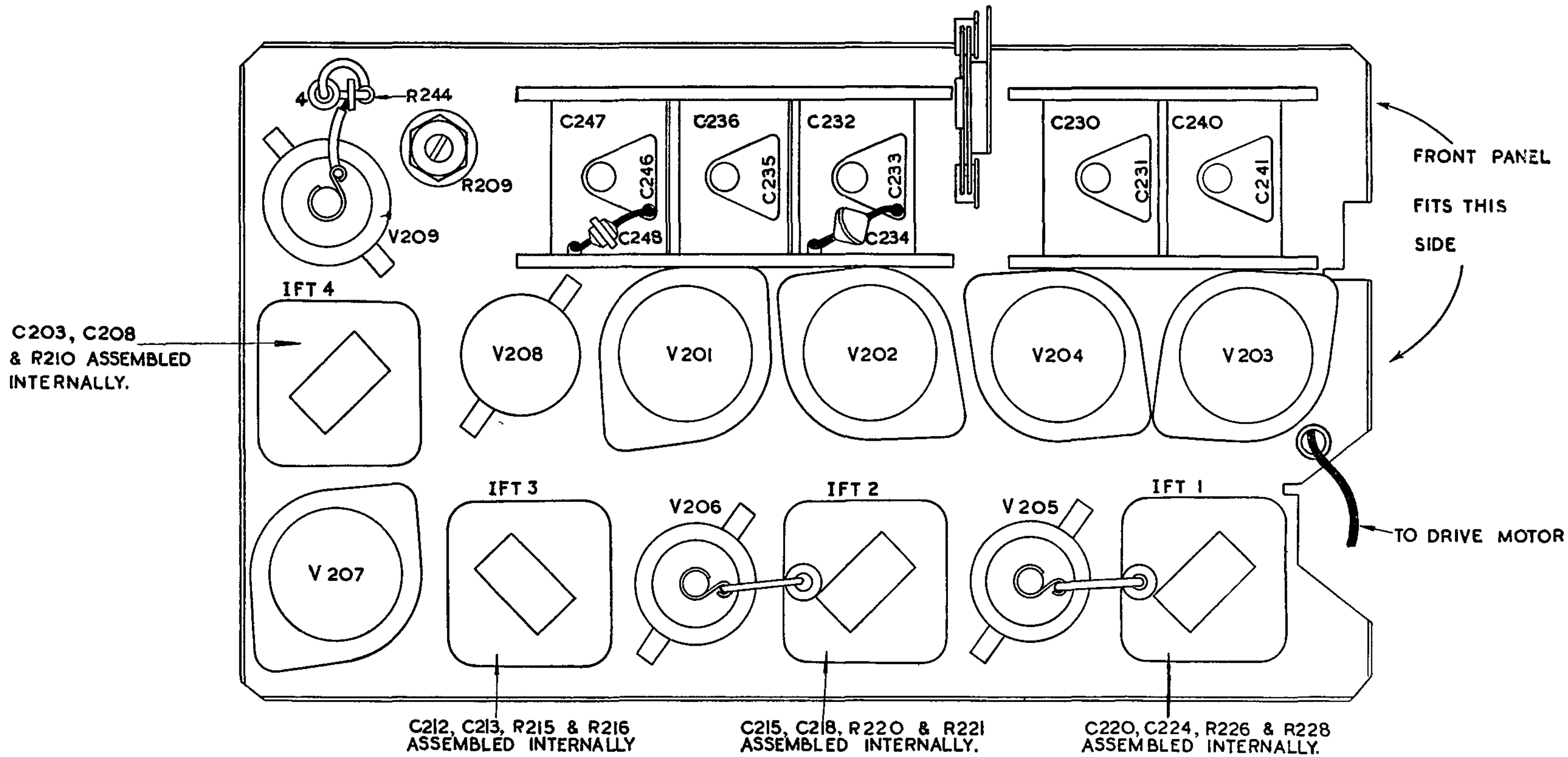


Fig. 7—Receiver, plan view.

CIRCUIT DESCRIPTION

The R F stage

22. The signal from the aerial is fed from the socket A (figure 3) to 'the A.R. relay on the transmitter chassis. A second co-axial socket on this chassis feeds the signal through another section of 50 ohm co-axial cable (see fig. 5) to the receiver chassis. This cable is terminated by a tapping point on the coil L.205 which feeds the valve V.201, a V.R.91, the R F. stage. This has a single input tuned circuit, isolated from the D.C. biasing voltages applied from the A.V.C. line by the 8$\mu\mu$F. condenser C.249. C.249 has this low value because the input impedance of a V.R.91 in the 100-124 Mc/s. band is of the order of one thousand ohms, which would damp the circuit L.205—C.247, as that has an impedance of the order of five thousand ohms.

23. It will be noted that the screen of V.201 is fed through a high resistance (R.243, 100K.) and not from the usual potentiometer (e.g. V.205). This is to give the V.R.91 a variable-mu characteristic (not normally associated with this type of valve) since it has to be controlled by the A.V.C. voltages. The variable-mu characteristic also ameliorates the possibilities of cross-modulation from adjacent channels. The anode current of V.201 may be assessed by turning the meter switch to position 3. If the meter is the standard 75 ohms 1 mA type, full scale deflection is equivalent to an anode current of 10 milliamps.

24. V.201 is resistance-capacity coupled to the band-pass tuning circuit comprising L.206, C.236 and L.207, C.232, plus the trimming condensers C.235, C.233 and C.234. C.247, C.236 and C.232 are all ganged together, and brought out to tuning control T.C.2 (fig. 3) C.248 and C.234 (each 6$\mu\mu$f) are "fixed" trimmers, inserted across L.207 and L.205, to simulate the capacity which the anode of valve V.201 throws across L.206, and so make possible accurate ganging over the entire band.

The local oscillator

25. If the signal frequency (which is, of course, the same as the transmitter frequency) is S Mc/s., the receiver crystal frequency is :—

$$\frac{S-9.72}{18}\ \text{Mc/s.}$$

$$= \frac{S}{18} - 540\ \text{kc/s.}$$

= Transmitter crystal frequency — 540 kc/s.

V.203 fulfils two functions: that of crystal oscillator and of frequency trebler.

The crystal oscillator

26. In considering the crystal oscillator the screening grid (g2) of V.203 should be regarded as an "anode," earthed from the R F. point of view by C.244 (.01 μf). The control grid is connected to one side of the crystal plates, and the "anode" (g2) is effectively connected to the earthed side of the crystal plates, via C.244. The cathode of V.203 is capacitatively tapped by the condensers C.242 and C.243 across the crystal. This is an orthodox Colpitts arrangements. L.202 is a small inductance (approximately 600 μH) and provides a D.C. path to earth for the cathode of V.203. L.201, a similar inductance, performs the same function for the control grid of the valve. From the point of view of R F. currents these inductances are by-passed by the large capacitors C.242 and C.243.

The frequency-trebler

27. The same valve V.203 acts as a frequency-trebler. The electron stream passing through g2 (the effective "anode" of the oscillator) is fluctuating at the crystal frequency. This passes through the suppressor to the true anode. The anode circuit consists of L.203 tuned by C.240 to three times the crystal frequency, with C.241 as a trimmer. V.203 gives about 100 volts swing of this 3rd harmonic output. This voltage is transferred through the 20 $\mu\mu$f condenser C.239 to the resistance R.235 (100K.). A portion of this voltage appears across the meter shunt R.236. The meter is connected across R.236 when the meter switch is in position 1. The output of the crystal trebler can thus be assessed. 100 volts output gives a deflection of about 50 divisions on the meter. If the reader prefers to think of terms of "grid current," 50 meter divisions correspond to 1 mA of grid current.

The sextupler

28. The second valve of the receiver oscillator section is another V.R.91, V.204. This acts as a frequency-sextupler. Its cathode is connected direct to earth. It works under class C conditions, the standing voltage produced across C.239 by the grid current representing the bias. The anode circuit of V.204 is tuned to eighteen times the crystal frequency—which is six times the frequency of the voltage applied to its grid.

29. The anode circuit is tuned by C.230 which is ganged by C.240 in the anode circuit of V.203. This double-gang arrangement is brought out to tuning control T.C.1. (Extreme left, front panel, as seen from front). The output of this eighteenth harmonic is naturally small and is of the order of 1 volt. It is fed through the small condenser C.229 (3$\mu\mu$f) and so appears across R.232 (100K.), the grid resistor of the first detector valve V.202.

30. The anode circuit of V.204 is thoroughly decoupled by R.234 (10K.) and by C.227 (.01 μf) and C.228 (300 $\mu\mu$f). C.227 decouples for the I F. voltages, and C.228 for the oscillator voltages, as it is important that no stray currents from the oscillator section appear in other parts of the receiver, or distracting whistles result.

The mixer or first detector stage

31. The signal output of the first A F stage is fed to R.232 through the 53 $\mu\mu$f capacitor, C.226. Thus across R.232 there are two sets of voltages : (i) the signal voltage, and (ii) the oscillator

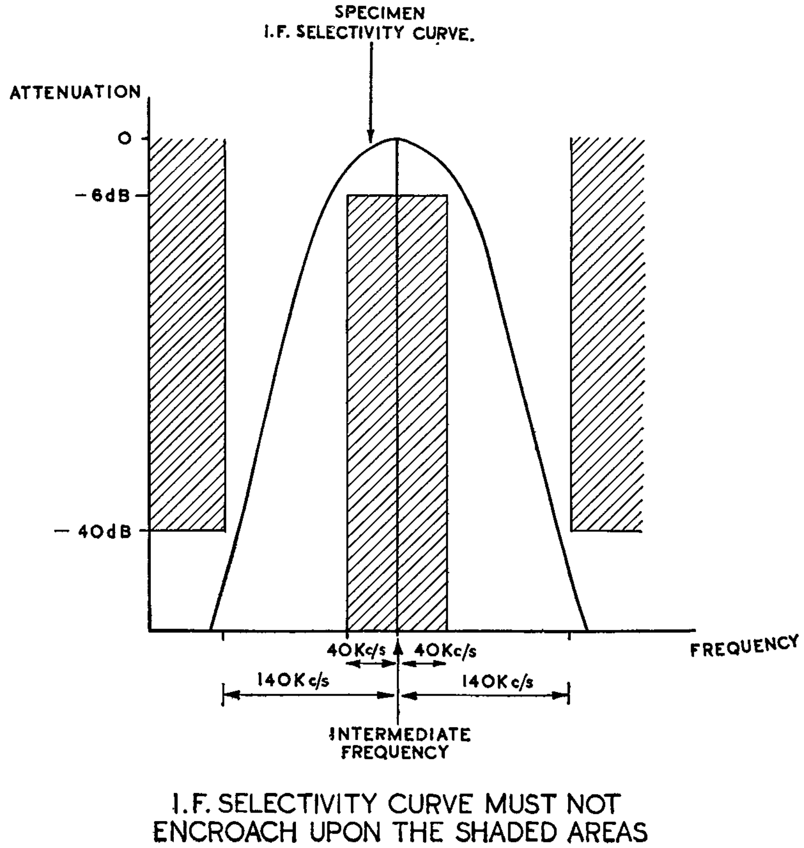


Fig. 8—I/F selectivity curve.

voltage. The mixing is thus accomplished here, but before the resultant (i.e. the intermediate frequency; can appear, rectification is necessary.

32. V.202 is another V.R.91. It is biased by the large resistor (for this type of valve) R.230 (1K.) so that the input voltages appear on the "bottom bend" of the characteristic curve. The screen of the valve is connected in the "floating" fashion, as for V.201, to lengthen the tail of the characteristic. The valve thus functions as a square-law detector, producing sum and difference frequencies from the two voltages on its grid.

33. The anode circuit is tuned by the I F transformer IFT.1 to the intermediate frequency of 9.72Mc/s., and so extracts the first difference frequency, which is passed to the I F. amplifying valves.

The I F. amplifier

34. Three stages of I F. amplification are provided. The intercoupling between the valves is provided by the screened I F. transformers. The cores of these transformers are of dust-iron and are tunable. Each winding is paralleled by a 75 $\mu\mu$f fixed condenser and is trimmed by adjustment of the variable iron cores. The temperature coefficients of the core of the condensers happen to be opposite in sign, so good stability is afforded to the I F. stages. To give the requisite band width of 40 kc/s. at 6dB down (see fig. 8) a 100K. damping resistor is connected across each transformer winding. This resistor is omitted in the case of the output winding of IFT.4, as this feeds a diode valve, which provides more than the necessary damping.

35. The first and second I F. amplifying valves are V.205 and V.206. Both of these valves are V.R.53's which have a variable-mu characteristic, and so no floating screen arrangement is necessary here. Both valves derive their bias from the A.V.C. line and play the major part in the automatic volume control of the set. (The other valve so controlled is V.201).

36. The third and last I F. valve is a V.R.91 (V.207). This has a "floating" screen voltage so that it can handle the large voltages applied from the previous stage. All the I F. stages are thoroughly decoupled.

The detector

37. IFT.4 feeds a conventional diode detector of the series type. R.209 is the load resistance of the detector and is a potentiometer so that the audio output level may be adjusted if need be. R.208, C.204 and C.205 form a π section filter for the removal of the intermediate frequencies as well, of course, providing the necessary capacity across R.209 so that the load time-constant is long for the modulation voltages, but short for the I F.

38. V.208 is a V.R.54, a valve containing two entirely separate diode elements. The second diode is connected to provide delayed A.V.C.

A.V.C. system

39. I F. output is applied to the A.V.C. diode through the high resistance R.205 (470K.), which "decouples" the A.V.C. diode from the detector. The A.V.C. rectifier is of the parallel type, the load resistance being the grid circuits of the controlled valves. C.202 (.1 μf) arranges that the time-constant of the system is considerably greater than the time of the cycle of the lowest audio frequency. However, when the set is being used to receive the morse signals of the Beam Approach director beacon, clipping of the long dashes by the A.V.C. system can occur, and make it difficult for the pilot to distinguish between dashes and dots. When the controller switch is thrown to B.A. and the B.A. relay operated, contact B.A.2 connects C.312 (on the Power Unit chassis) across the A.V.C. line. This condenser is 2 μf so that the time constant is lengthened considerably.

The delay system

40. Delayed A.V.C. is provided by the potentiometer R.202 and R.206. The voltage from here is of the order of 80 volts, and is applied to the A.V.C. potential network—R.203, R.204, R.205, R.208, R.209 to earth (R.208 and R.209 are partially shorted by IFT.4 and the detector diode).

41. The anode of the A.V.C. diode is connected to the junction of R.204 and R.205, which would be maintained at a constant positive potential (about 10 volts) with respect to earth, if the A.V.C. diode were not there. The cathode of the diode is maintained always at a small fixed negative voltage (about 2 volts) by the grid-biasing voltage GB-1 (C.206 ties down the cathode to earth with respect to I F. voltage). Thus the A.V.C. diode is normally conducting under no-signal conditions, and the A.V.C. voltage is equal to GB-1, since the diode has a very low impedance in the conducting condition.

42. When a carrier appears, the A.V.C. diode does not rectify it until it reaches approximately 15 volts peak. The diode then produces a negative D.C. rectified voltage equal to approximately 60 per cent. of the peak carrier voltage (i.e. about 10 volts). This rectified voltage now counterbalances the nominal 10 volts delay, and the diode ceases to conduct. The difference between carrier and delay voltage is fed to the A.V.C. line. When the rectified voltage is below the 10 volts delay voltage, the diode remains conductive and no A.V.C. voltage (beyond the standing bias GB-1) is applied.

Receiver adjustments

43. There are three receiver controls: T.C.1, T.C.2, and R.209. There is also the crystal switch, operated by the spindle of the drive motor.

44. T.C.1 and T.C.2 are the only tuning controls and should be adjusted according to the instructions in the section on tuning the transmitter-receiver—see paragraphs 113-122. R.209, the output volume control, is set up by the manufacturers to give a standard level of audio signal and should need no adjustment. However, should a small reduction or increase in receiver level be desired, as might be occasioned if it were found that the intercomm. level was very different from that of the receiver, R.209 could be adjusted. Fig. 7 shows the location on the chassis of R.209. The transmitter-receiver should be tuned to a strong signal (such as that from a local ground station using R/T). The microphone must be switched off whilst adjusting R.209. The final setting of R.209 must be below the point at which distortion commences.

45. The crystal switch for the receiver is the oak-type wafer D.M.4, mounted (as the lettering indicates) on the spindle of the drive motor, immediately behind D.M.3 (which is the channel-selector wafer. Fig. 35 shows the location and wiring of this switch.

Current consumption

46. The H.T. consumption of the receiver is normally about 70 milliamps. Fig. 16 shows the heater circuits. Decoupling condensers and one choke have been included where it has been discovered that there is feedback through the valve heaters to the cathodes. It should be noted that the 3 banks of parallel heaters of the receiver section are not in themselves correctly balanced. *The receiver valve-heaters must therefore not be worked separately. The heaters of all the valves of the entire set must be functioning even though only one section is being tested.* The only exception is V.301, the B.A. amplifier valve which is not used for communication and need not be fitted.

THE AUDIO-FREQUENCY AMPLIFIERS

47. The audio-frequency section of the T.R.1464 consists of a 1st A F. amplifier, a 2nd A F. amplifier, which is the output stage to the telephones, and a push-pull modulator stage. V.209, the 1st A F. amplifier is the centre of the audio-frequency system. It supplies speech voltages to the 2nd A F. amplifier and to the modulator. It amplifies the receiver signals and the microphone signals.

The 1st A F. amplifier

48. V.209 is located on the receiver chassis——see fig. 7. Its output includes the transformer T.201 (see fig. 10) with R.244 (33K.) as a grid stopper. This and the condenser C.255, prevent any tendency to self-oscillation. Grid bias is applied via the high impedance winding of T.201. The input winding of T.201 is balanced with respect to earth and is damped by the resistors R.245 and 246, to avoid any possibility of oscillation should all the microphone plugs be removed. The microphones are connected to pins 2 and 6 of plug M.

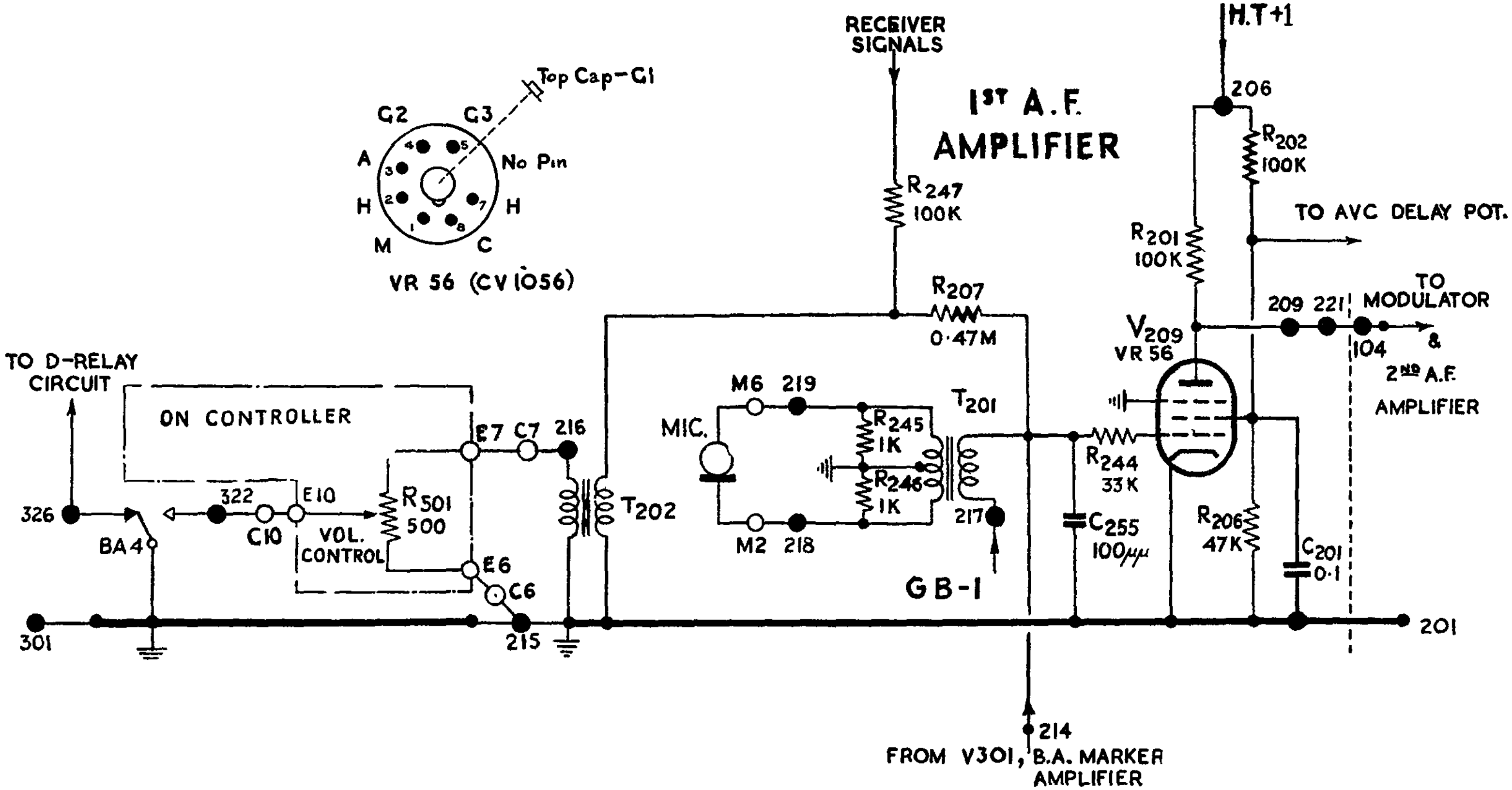


Fig. 10—First A/F amplifier circuit.

49. The output of the B.A. marker amplifier V.301 is fed via its decoupling resistance R.309 to the same point as the output of the microphone transformer. The receiver signals to V.209 are fed via the decoupling resistors R.247 and R.207 to the same input point. The receiver output is damped by the high impedance secondary of the transformer T.202. The low impedance primary of this transformer is connected by way of plugs C and E, to the 500-ohm B.A. volume control R.501 on the controller. This normally imposes a constant damping on the receiver output only (R.247 and R207 decouple its effect). However, when the B.A. relay is energised, contact B.A.4 earths the slider (and also renders inoperative the D relay or M.C.W. circuit), of the B.A. volume control and so a variable damping may be imposed on the receiver output, this providing an effective control of the volume of the main beam approach signals. The reason for including the transformer T.202 in the circuit is so that a low impedance volume control and line can be used to damp a high impedance input circuit (as is the grid circuit of V.209).

50. The output of V.209 if fed to the second A F. amplifier and to the modulator.

watts output. T.103 is connected as a 2.5 : 1 step-down output transformer. A tap is provided near the earthy end of the secondary (the ratio is 1 : 11.7) to which the cathode is connected. The voltage here is in phase with the input voltage (i.e. as the grid goes positive, so does the cathode), which results in negative feed-back. This has the effect of making the output impedance of the amplifier considerably lower than the matching impedance. It also improves the quality and tends to correct the mechanical deficiencies of the telephones. It also makes the system much less dependent upon the load, i.e., the volume is very much the same whether one pair of phones is connected or whether three pairs of phones are used.

52. It will be seen that the combination of V.209 and V.107 forms the intercomm. amplifier. When low impedance phones are in use, the wire from tag 111 is connected to the cathode tap (see fig. 13). The valve then behaves as a cathode follower giving no voltage gain, but providing the necessary current amplification required for low impedance telephones. Side-tone from the modulator is applied to this stage via R.142 and C.134 to the high impedance winding of the transformer.

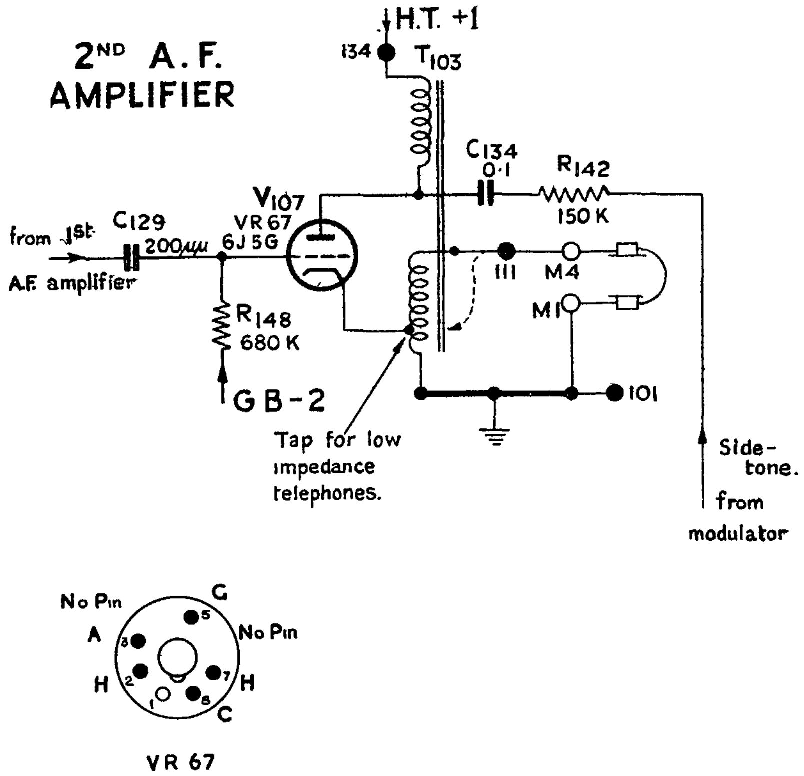


Fig. 11—Second A/F amplifier circuit.

The second A F. amplifier

51. Figure 11 shows the theoretical circuit of the 2nd A F. amplifier (V. 107) which is mounted on the transmitter chassis. It has a conventional input circuit, the bias being provided from the G.B. network. It is capable of giving 350 milli-

The Modulator

53. This is located on the transmitter chassis. Figure 12 gives the theoretical circuit. The modulator stage has two functions: (1) the amplitude modulation of the transmitter by microphone output from the 1st A F. amplifier,

and (2) the generation of an M.C.W. tone for modulation of the transmitter.

54. The first use is the normal one. The output from the 1st A F. stage is fed via the network C.133, R.147 and R.146, which gives a slight emphasis to the higher frequencies. The speech currents go via D.1, to the grid of V.108. This has the transformer T.102 connected in its input circuit as an auto-transformer so that an equal, but inverted, voltage is fed to the grid of V.109, to give push-pull working. These valves are both V.T.52 pentodes and are biased (G.B.-4) from the G.B. network to work in class A.B.1. The anode circuit of these valves is a push-pull transformer T.101. Only one side (V.108) of this transformer is loaded by the transmitter, but the auto-transformer effect distributes the load evenly between the valves. The H.T. to the transmitter P.A. stage flows through only one winding of T.101. When the M.C.W.-tone relay D is operated, contact D.1 disconnects the modulator input from V.209, and connects a network C.124, R.140, C.126, R.143 and R.144, from the anode of V.109 to the grid of V.108. The modulator then becomes an audio-oscillator. The frequency of oscillation is that frequency at which the phase-change over the network is zero and this is of the order of 1,000 cycles per second.

55. This oscillation is liable to become large in amplitude, and this means that for a considerable portion of the cycle, the anodes of the V.T.52's are cut off and the screens are taking most of the current. This tends to make the screens red hot with consequent emission of occluded gases and softening of the valves. To avoid this possibility, contact D.3 opens on M.C.W. tone-generation, and inserts the 10K. resistor R.141 in the screen connections.

56. Under normal circumstances—i.e. speech modulation with relay D released—the screens of V.108 and V.109 glow a dull red, but this is not serious. Side-tone of the modulator output (whether speech or M.C.W. tone) is fed from a small winding (which is really a continuation of the main winding through which the H.T. flows) to the 2nd A F. amplifier via R.142 and C.134. The modulator output is normally between 120 and 212 volts. Its distortion at 165 volts output is 9 per cent. total harmonic.

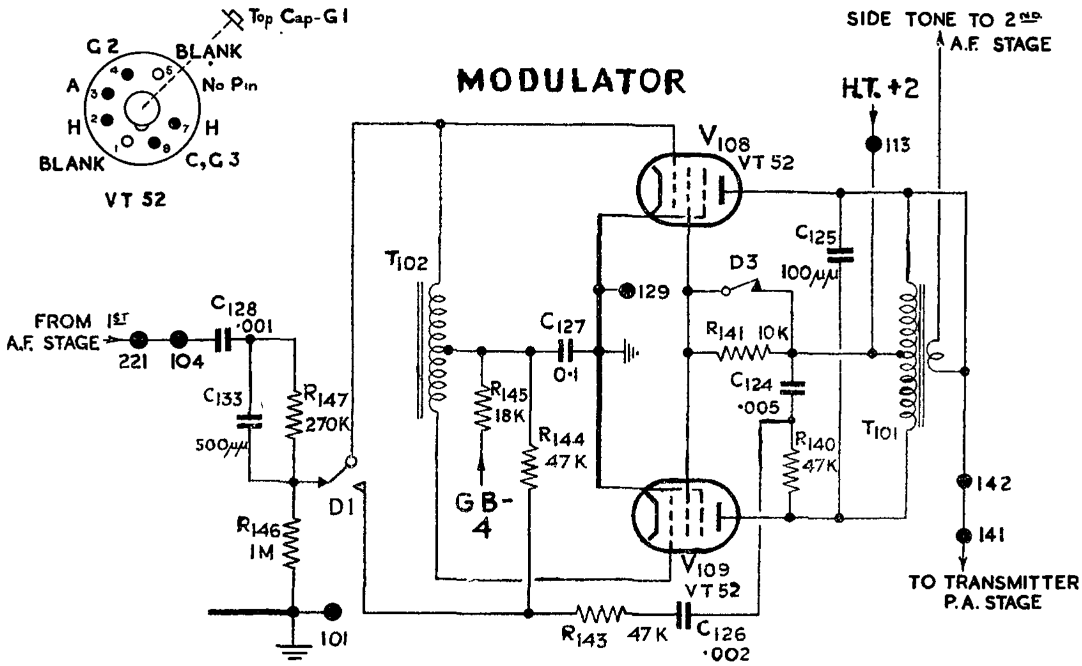


Fig. 12—Modulator circuit.

THE TRANSMITTER

57. The transmitter chassis is in the foreground in fig. 5. A diagram of the layout of this chassis is given in fig. 13. This chassis includes the modulator (V.8 and V.9), the second A F. amplifier (V.107), the M.C.W. relay D, and the transmit-receive relay A.R. Fig. 28 gives the theoretical circuit.

58. The transmitter uses six valves, V. 101 (a V.R.91) is a crystal oscillator and trebler, V.102 is a doubler, V.103 and V.104 make a push-pull trebler stage, and V.105, V.106 form the push-pull P.A. output stage (inside screening can). These last five valves are V.T.501s. The transmitter is amplitude modulated by deriving the H.T. supply for the P.A. anodes and screens, from the output transformer of the modulator.

The crystal oscillator and trebler

59. This section is similar in principle to the crystal oscillator and trebler in the receiver

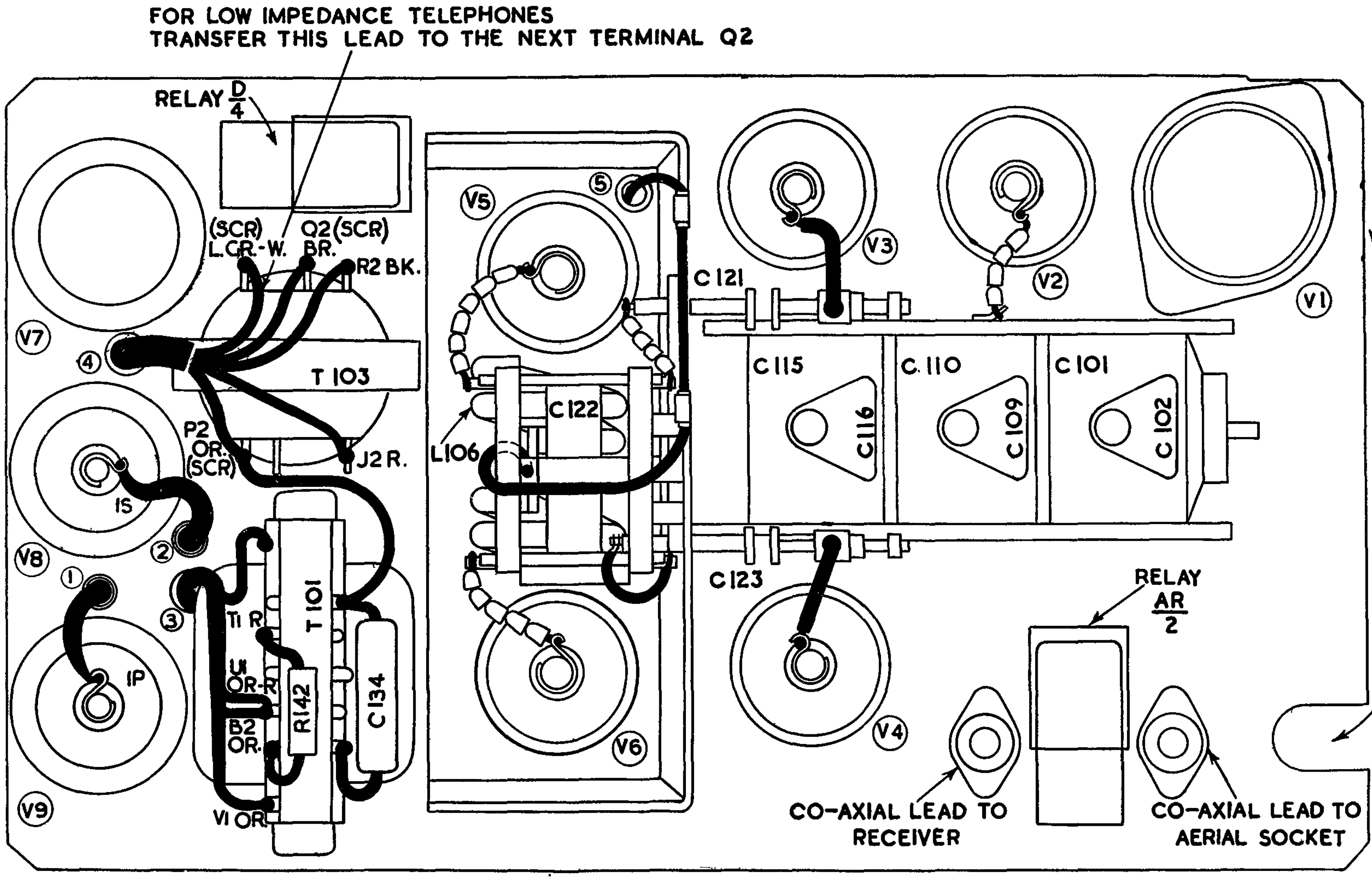


Fig. 13—Transmitter, plan view.

section. The screening grid, control grid and cathode of the V.R.91 (V.101) are connected to the crystal in the manner of a Colpitt's oscillator. The anode circuit is tuned to three times the crystal frequency, thus extracting the third harmonic. This voltage is fed by a resistance-capacity coupling (C.106, R.106) to the grid of the second stage V.102.

The frequency-doubler stage

60. The frequency-doubler valve is a V.T.501 (or V.T.501A) like the subsequent valves in the transmitter. Its screen is fed via a normal potentiometer network. The anode circuit is arranged so that balanced push-pull output voltages can be obtained for the ensuing push-pull trebler stage. The anode circuit consists of the coil L.104, tuned by the split-stator variable condenser C.110 (trimmed by C.109)—see fig. 13. The centre point of this circuit is made "earthy" by connecting here the H.T. supply, instead of at the end of the coil. The coil then acts as an auto-transformer and induces equal and opposite voltages at the ends. A condenser C.108 (6 $\mu\mu$f) is connected at the "free" end to simulate the capacity with which the valve loads the other end. It is possible that the stray capacities of the fixed stators of C.110 form a different "centre-tap" to earth from that provided by the H.T. lead. This could damp a portion of the coil excessively, and to reduce this possibility R.120 is included in the H.T. lead. The valve is biased for Class C working to produce the maximum second harmonic output.

The push-pull trebler stage

61. The trebler stage converts the drive from the doubler (which is six times the crystal frequency) into a push-pull drive for the P.A. stage at eighteen times the crystal frequency. It is a push-pull class C. amplifier, using V.103 and V.104, both V.T.501 or V.T.501A. valves.

62. The drive for V.103 and V.104 is taken from either end of the coil L.104 through the 100 $\mu\mu$f condensers C.111 and C.112, and appears across the resistors R.121 and R.122. Bias is applied through the meter shunt R.123 (position 2 of the meter switch connects the meter) so that the voltage drive for the doubler stage may be measured. Full scale deflection of the meter corresponds to 170 volts peak swing of each grid of the trebler stage, or 340 volts total. This represents a total grid current of 5 mA.

63. The anode circuit of the trebler stage is a conventional push-pull tuned circuit. The variable condenser C.115 is ganged to the tuning condensers of the doubler and the crystal oscillator-trebler stages, and is brought out to tuning control T.C.3. Meter switch position 4 measures the anode and screen currents of the trebler stage.

The P.A. stage

64. This is a conventional power amplifier employing two push-pull valves (V.105, V.106). Its grid circuit is similar to that of the previous trebler stage, although the coupling condensers are of a lower value to secure the maximum of drive with the minimum of damping. Meter position 6 measures the total effective peak drive (full scale deflection equals 216 volts drive or 3.5 mA of grid current).

65. The anode circuit is a coil L.106 tuned by the variable condenser C.122. No trimmer is necessary as C.122 is not ganged with any other stages, and is the sole condenser operated by tuning control T.C.4. Neutralization is provided by the condensers C.121 and C.123 (see fig. 13). These should normally need no adjustment at all, the manufacturer having done all the setting needed for most of the V.T.501 or V.T.501A valves likely to be encountered. Neutralizing instructions are, however, given in paragraphs 177 and 178 in the section on Maintenance.

66. The modulated H.T. is fed to the P.A. anodes via the centre tap of the coil, and also to the screen potential dividers. Meter position 5 measures the P.A. H.T. consumption, full scale deflection corresponding to 100 milliamps. The P.A. stage is biased to work in almost class C conditions. The actual condition is somewhere between class A.B.2 and class C.

67. The output from the transmitter, is stepped down by the coupling of the coil L.107, coupled to L.106, the P.A. anode circuit coil to match a 50 ohm load. A 50 ohm coaxial feeder takes the power to the blades of contact A.R.1. This spring set connects either the receiver or the transmitter to the aerial (the receiver in the un-energised condition). This relay incorporates earthed balancing blades designed to simulate the 50 ohms resistive impedance of a correctly terminated line, and so introduce no discontinuity in the transmission line characteristic over the relay contacts.

Transmitter adjustments

68. There are two tuning controls for the transmitter: T.C.3 for the C.O. and multiplier stages, and T.C.4 for the P.A. stage.

69. When any of the first four valves are changed it is recommended that the associated trimming condenser be adjusted for maximum drive—meter position 6.

70. Crystal changing for the transmitter is effected by the central cam assembly on the condenser drive unit. This is set up by the manufacturer and needs no adjustment. Fig. 35 shews the switch attached to the cam assembly. The front pointer acts as an indicator for designating the channel in use. Instructions on tuning the transmitter are given in paragraphs 111 to 126.

THE POWER SUPPLY

71. The power supply for the T.R.1464 is derived from the 24 volt D.C. aircraft system. The heater circuits are fed via a voltage regulator Type 6 (see fig. 16) and the high tension and grid bias voltages are provided by a rotary transformer

Type 79 (see fig. 14). These items with associated filters are mounted with the B.A. marker amplifier section on the rear chassis of the T.R.1464.

The Rotary Transformer Type 79 for H.T. and G.B. supply

72. The rotary transformer type 79 is a three commutator shunt wound machine, cradle mounted on the power unit chassis. It operates from a nominal 24 volt supply and provides H.T. at 300 volts and G.B. (sometimes known as M.T.) at 150 volts. A view of the rotary transformer is given in fig. 5, and figs. 30 and 31 show wiring and assembly details. Figure 14 shows the electrical circuit details of the associated filters.

73. A yoke of soft iron houses the two pole pieces which are held in position by countersunk screws. The field coils are former wound and fitted around the pole shoes. The end frames are made of light alloy and are secured to the yoke by two through bolts. The input end frame is slotted to allow adjustment of the brush position. The armature is of conventional construction and the input and output windings are carried in the armature slots which are skewed to reduce ripple.

through an opening in this cover for connection to the 24 volt supply which is made via the contacts of relay B.

75. The rotary transformer type 79 is designed to give not less than 50 per cent. efficiency. It is rated to give continuously 300 volts H.T. at 50 mA. with an intermittent rating of 220mA. for 50 per cent. of the running time. The T.R.1464 may take up to 275 mA. when in the transmit condition, so it is unwise to transmit for excessively long periods, or overheating of the rotary transformer will result.

76. The regulation is such that the rise in the H.T. voltage does not normally exceed 45 volts when the H.T. current is reduced from 220 mA. to 50 mA., with the G.B. load maintained at 6 mA. The unfiltered ripple voltage does not normally exceed one per cent.

77. The 24-volt input to the motor of the rotary transformer is fed *via* the double contact on-off relay B. (Londex type) and the filter unit type 144 mounted in a cubical metal box on the underside of the chassis (see fig. 30) immediately below the rotary transformer. It is a two stage filter and comprises four 0.1 microfarad condensers, and two H F. chokes type 711, which are wound

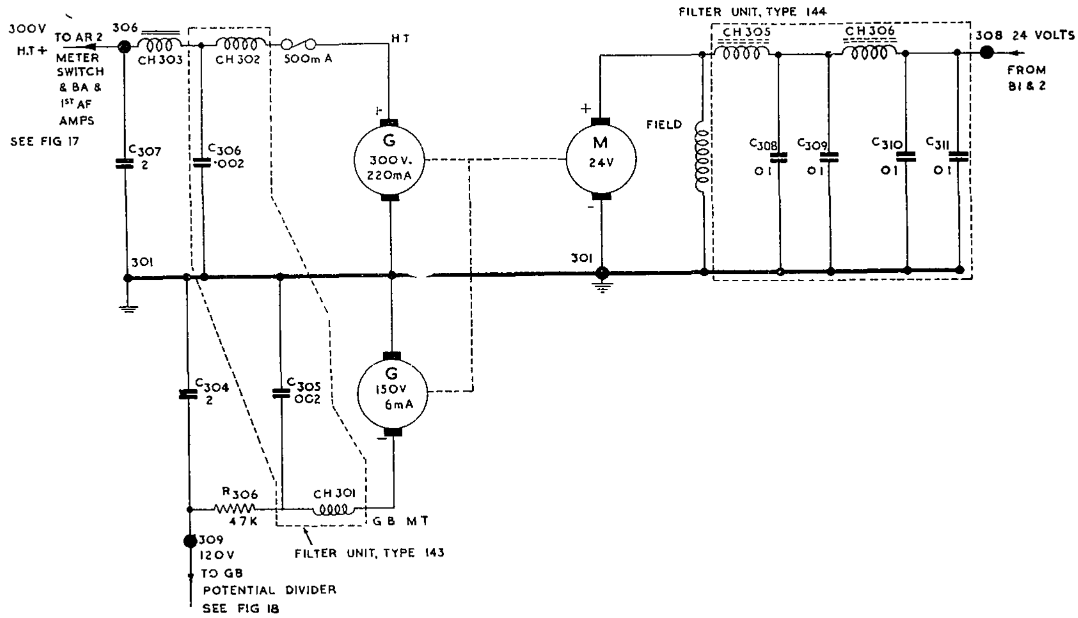


Fig. 14—Circuit of rotary transformer type 79, and filters.

74. The shaft rotates in oil-lubricated ball bearings. A drilled lubrication port is situated in each end frame just above the bearing housing and an oil thrower is fitted on to the inner side of the output end bearing. At the input end the shaft is extended to carry a seven-bladed fan for cooling. It should be noted that the H.T. brushes are chamfered to facilitate correct assembly. The output end of the rotary transformer (i.e. the end adjacent to the carbon-pile regulator) is open, but the input end is protected by a cover. The leads from the brush boxes are brought out

on dust-iron cores. Filter unit type 143 is mounted in another screened box underneath the chassis at the carbon-pile regulator end. It has two sections: C.H.302 with C.306, and C.H.301 with C.305 the former for the removal of the high frequency elements of the tooth and commutator ripple in the H.T. supply, and the latter section for a similar function in the G.B. supply.

78. A 500 mA. fuse (Bulgin, type T.) is inserted in the lead between the H.T. generator and the choke C.H.302. Another filter consisting of the

components C.H.303 (L.F. choke, type 514) and a two microfarad condenser C.307, removes most of the low frequency tooth and commutator ripple from the H.T. supply to the set. Both of these items are mounted underneath the chassis on either side of the filter unit, type 144.

79. The low frequency ripple is removed from the G.B. supply by a resistance-capacity filter R.306 and C.304. R.306 is 4.7K, so the G.B. voltage is dropped from the nominal 150 volts from the generator, to about 120 volts output from the terminal 309 to the various potential dividing networks, with normal load of about 6 mA.

80. The H.T. supply is fed constantly (see fig. 17) to the 1st, 2nd and B.A. amplifiers. When relay A.R. is non-energized, contact A.R.2 provides the receiver with H.T. voltage, and when operated, the transmitter and modulator, *providing the meter switch is correctly disposed in position* 6. The grid bias supplies are constantly applied, and are taken from the potentiometer network shewn in fig. 18.

The Voltage regulator type 6, for heater supply

81. The heater supply of the T.R.1464 is derived from the 24-volt input through a carbon-pile voltage regulator. Fig. 16 shows the circuit of the heaters and this regulator. The valve heaters are wired in three parallel banks, the banks being in series with each other. The rating of the valves is 6.3 volts each so the total

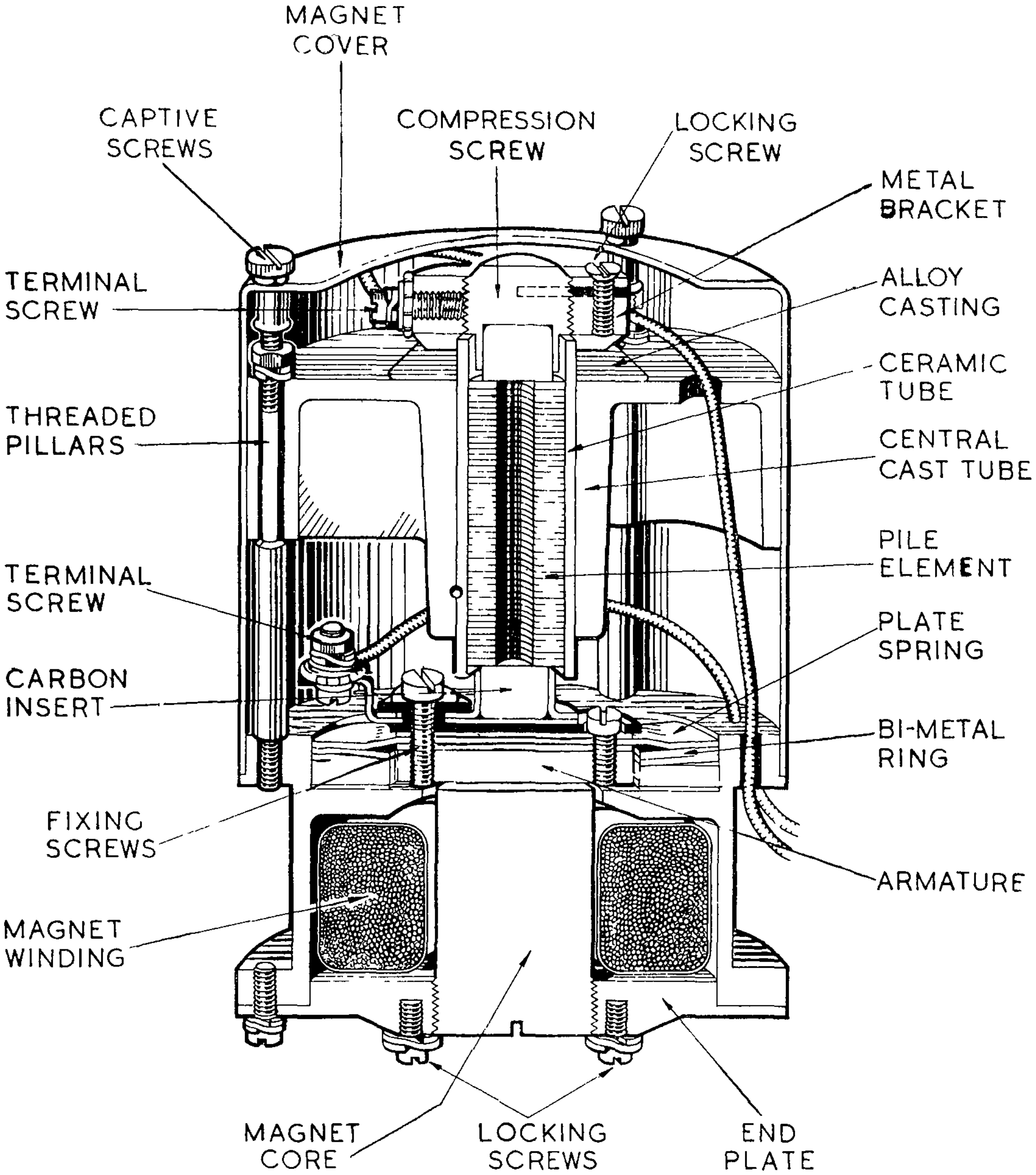


Fig. 15—Voltage regulator, type 6

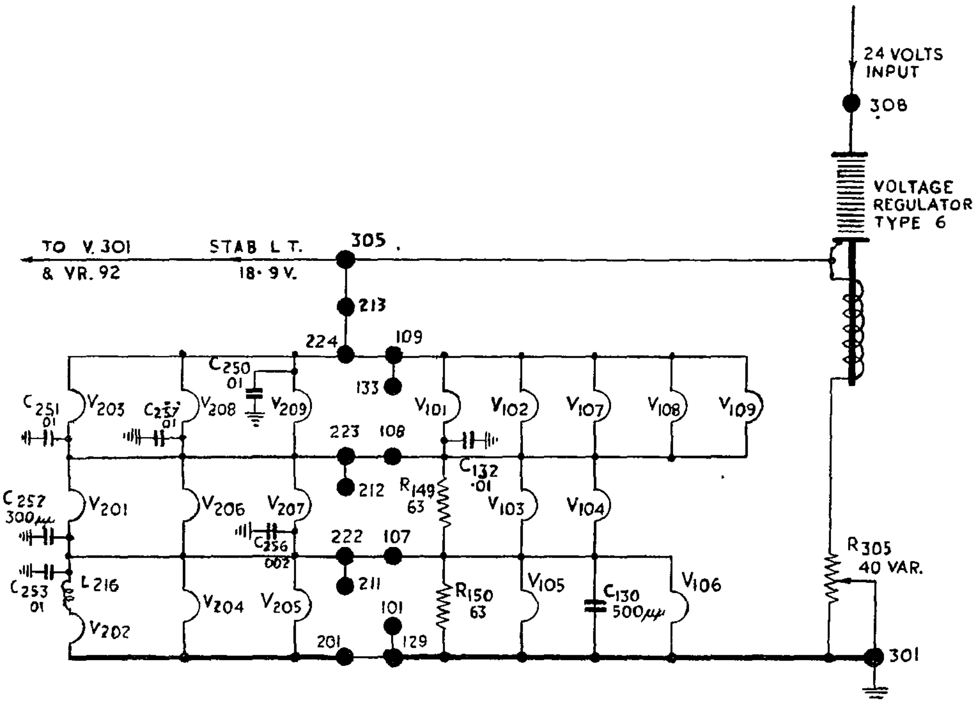


Fig. 16—Heater and regulator circuit.

supply across the network has to be maintained at 18.9 volts. The 24-volt supply is fed to the top of the heater network through the carbon resistance. In parallel with the heater network is the carbon-pile operating solenoid and R.305, a 40-ohm variable resistance. Fig. 31 shows the positioning of R.305. An indication is also given in fig. 30.

82. The action is as follows : when an excessive input voltage is applied, the increased current in the energising solenoid causes the pressure of the spring on the carbon-pile to be reduced, which in turn increases the resistance of the carbon-pile, thus reducing the output voltage to the fixed value of 18.9 volts.

83. Conversely, if the input voltage falls, the spring is allowed to exert an increased pressure on the carbon-pile and the carbon discs are compressed, their resistance reduced and the output voltage increased. It can be seen from this network that it is most essential that the entire set be switched off when any valve is removed. If this is not done, the associated valves at the same level will be fed with an increased heater current which will reduce their lives.

84. Fig. 15 shows the regulator unit in section with the major components annotated. The pre-set ballast resistor R.305 is not shown here. This resistor completes the volt-coil circuit and regulates the current in it. Brief constructional notes are given below :

85. The magnet coil is wound round a core screwed into an end plate which is fastened to a yoke. A slot in the end of the core enables its position to be adjusted. The core when energised, exerts a pull on the armature, which is attached to a 3-leaf spring, compensation for temperature being effected automatically by the pre-set ballast resistor R.305 in conjunction with a dished bi-metal ring, upon which the spring arms rest. A carbon-capped plunger, in contact with the carbon pile is rigidly fixed to, but insulated from the armature. The carbon pile is housed within a ceramic tube, secured in position by a split pin. A bracket is fitted at the end of the casting into which is screwed the pile compression screw. The latter is locked in position by a locking screw, and must not be interfered with except as specified in the servicing instructions.

THE CONTROL SYSTEM

86. Fig. 32 gives the electrical connections of the control circuits. These circuits are located in the electric controller, the drive motor, and in the various relays. They have the following functions :

(i) ON-OFF switching.
(ii) Channel selection and changing, A, B, C, or D.
(iii) TRANSMIT-RECEIVE control.
(iv) B.A. control.
(v) M.C.W. transmission.

ON-OFF switching

87. This is controlled by the Londex Type Relay B. Switching on and off involves heavy currents of the order of 8-10 amps., and so this relay uses two contacts in parallel. Fig. 31 shows the location of this relay.

88. Fig. 32 shows the equipment switched off. Contacts B.1 and B.2 isolate the 24 volt input.

The OFF button has been depressed. To switch on, push any of the channel buttons. Suppose it is button A which is depressed—this is the channel on which the equipment was last used. As button A goes in, the OFF button is mechanically released and it pops out, making its associated contact. There is now a circuit for relay B as follows :—

P.2 — 313 — Relay B. — 312 — C.16 — E.16 — OFF contacts — El — C.1 — Earth. Contacts B.1

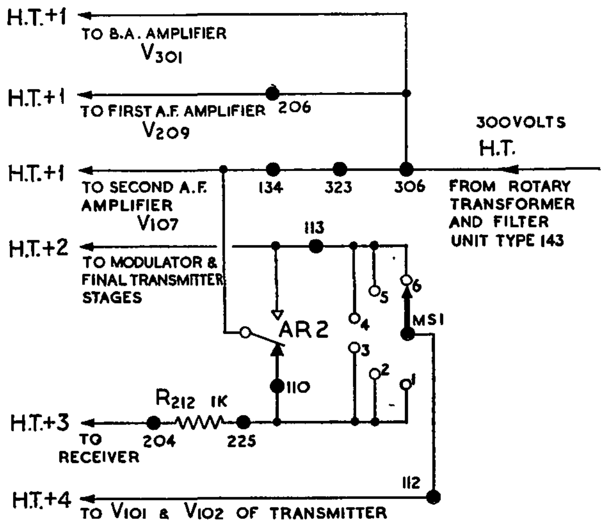


Fig. 17—H.T. supply system

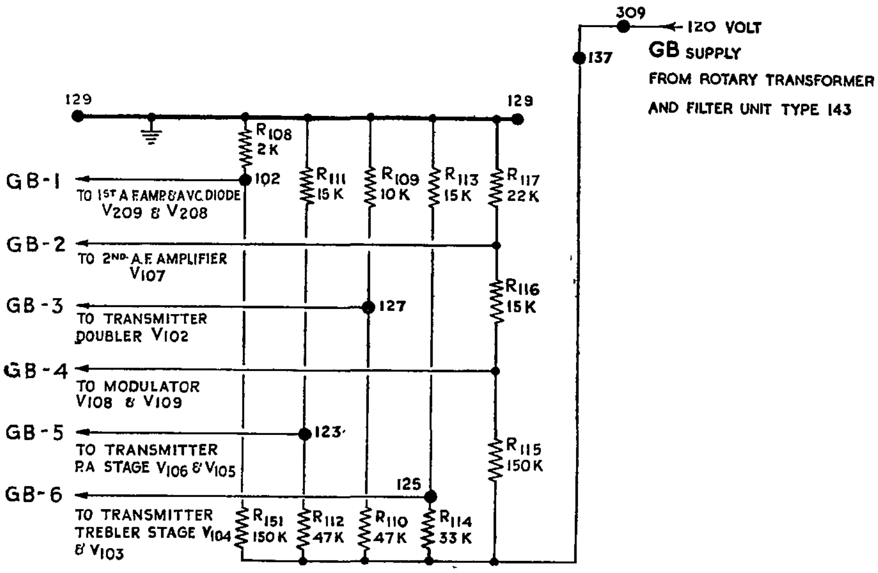


Fig. 18—G.B. supply system

and B.2 operate. Power is applied to the rotary transformer and to the carbon-pile regulator. The set warms up. There is a circuit for the pilot lights P.L.2 and P.L.3 through the coil of the drive motor. The depressed button A. glows from the reflected light of P.L.2, P.L.3. As it is shorted by the B.A. switch on the controller, P.L.1, the red B.A. warning lamp, does not light. The set is now fully operational in the Receive condition on channel A.

Channel changing

89. Channel changing is effected by controlling the drive motor through its associated cams D.M.2 and D.M.3. Fig. 23 shews an outline of the cam D.M.2 and fig. 33 the driving sequence over one quarter of a revolution. D.M.2 operates the motor to drive home successively the slide-bars B, C, D and A. The notch determines the point at which the contact D.M.2a opens, and this is arranged to coincide with the driven-home position of the slide bar. D.M.3 is the channel selection switch, and maintains the motion of the drive motor until it finds the earthed contact A, B, C or D. It does not locate the drive motor accurately, but determines for D.M.2 which of the four bars shall be driven home, by allowing each to be driven in turn, and then vesting the "stopping power" in D.M.2 at the approach of the selected slide bar.

90. Consider the detailed action ensuing on the pressing of button C. Button A pops out and C locks itself in (becoming illuminated). A circuit is completed for the drive motor as follows:

+24 volts — D.M.1 — D.M/4 — D.M.3 (contact C.) — C.5 — E.5 — Button C. — E.15 — C.15 — 118 — D.2 — Earth.

The drive motor starts, and "pecks" a ratchet tooth each time the self-interrupting contact D.M.1 breaks. The motor does this at the approximate speed of 42 teeth per second.

91. After two teeth have been "pecked," slide-bar A releases and D.M.2a closes, affording a second circuit for D.M.4 through the releasing switch P. This circuit is in parallel with the circuit via D.M.3, and gives a fine control for the stopping of the drive motor. It ensures that the system will only stop when a slide bar has been pushed home, and D.M.2 has fallen into a notch. The "pecking" of the next nineteen teeth drives home slide-bar B. After two more teeth, D.M.2a opens and interrogates the selector switch D.M.3. The gap in the contact of this switch is opposite the B contact and the circuit through the C button is still maintained. The motor therefore continues running.

driven fully home; and after two more, D.M.2a opens and the drive motor stops.

93. It will be noted that during the action of channel changing, the controller lamps and the A.R. relay are shorted out. This precludes the possibility of transmission on any intermediate channel.

94. Operation of the drive-release switch P transfers the control to D.M.2b, and the motor then locates itself with the contact D.M.2 on the rise of the cam. In this position, the slide which was last pushed home is released, and the motor is stopped before the next one is driven home.

Transmit-receive control

95. The transmit-receive control is governed by relay A.R. The coil of this relay is shown on fig. 32: when it operates, A.R.1 changes over the aerial lead from the receiver to the transmitter. Contact A.R.2 (fig. 17) changes the H.T. supply from the receiver to the transmitter. (There is a third contact on the assembly but this is not used).

96. The A.R. relay may be operated for the purposes of transmission by one of three methods.

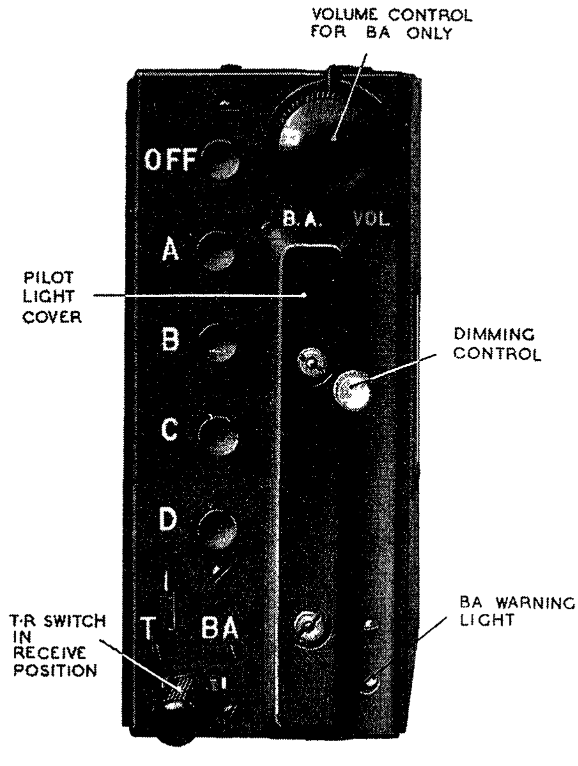


Fig. 19—Electric controller, type 12—front view.

92. After the first fifteen teeth of this second quarter revolution, the gap in the switch ring of D.M.3 comes opposite the earthed contact C. Neither A, B or D are earthed, so the drive motor is relying entirely on the circuit via D.M.2a. After four more teeth, the selected slide-bar C is

1. Putting the T R switch on Controller to T.

The circuit is :—

+24 volts — D.M./4 — 114 — A.R./2 — 135 — C.13 — E.13 — T R. switch — E.1 — C.1 — Earth.

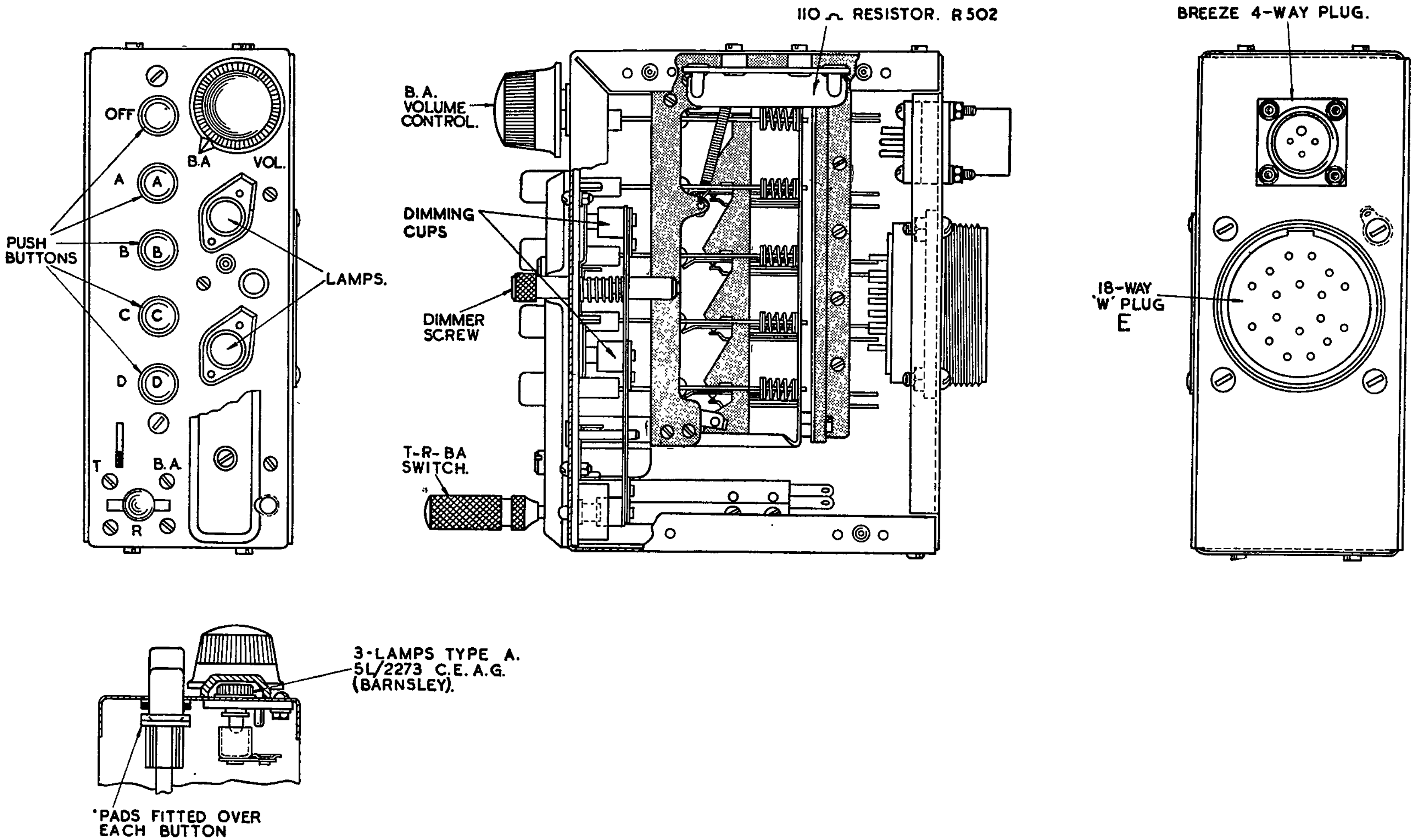


Fig. 20—Electric controller, type 12.

2. Pressing the press-to-transmit button. The circuit is :—

+24 volts — D.M./4 — 114 — A.R./2 — 135 — 307 — B.A.3 — 321 — M.5 — P.T. button — M.1 — Earth.

3. Operating relay D. The circuit is over contact D.4. For this use see section on M.C.W. operation. (paragraph 98).

B.A. control

97. To use the set for V.H.F. beam approach, the controller T-R switch is placed over to the right at B.A. (see fig. 19). The switch locks in this position. The B.A. relay coil is operated over the following circuit

+24 volts — B.A./4 — 319 — C.14 — E.14 — Controller switch — E.1 — C.1 — Earth.

The relay operates. *Contact B.A.1* (fig. 12) removes the short on the output of the B.A. marker amplifier and connects this signal to the 1st A F. valve V.209.

Contact B.A.2 connects the condenser C.312 to the A.V.C. line of the receiver (fig. 26) to lengthen the A.V.C. time constant.

Contact B.A.3 opens and prevents any crew member from operating the transmitter by pressing the P/T. button (fig. 32).

Contact B.A.4 (fig. 32) prevents the operation of the M.C.W. relay D, and connects the B.A. volume control (on the controller) across the 1st A.F. amplifier. The set is now operational on the V.H.F. beam approach system.

M.C.W. transmission

98. It may be necessary on occasions to send modulated C.W. signals. A morse key for this purpose is connected to the Breeze plug at the back of the controller—to pins B. and C. It is recommended that tags 117 and 118 are strapped, if the manufacturer has not already done so. Depression of the key completes a circuit for relay D :—

+24 volts — D./4 — 115 — C.17 — E.17 — C. — Key — B. — E.18 — C.18 — 326 — B.A.4 — 301 — Earth.

Contact D.1 (fig. 11) disconnects the modulator from the 1st A F. amplifier, and causes the modulator to generate the M.C.W. tone. *Contact D.3* protects the modulator valve screens—see paragraph 55.

Contact D.2 effects no change.

Contact D.4 operates the A.R. relay, so that the set transmits the M.C.W. tone generated by the modulator.

ELECTRIC CONTROLLER, TYPE 12

99. Complete control of the T.R.1464, once it has been set up for its four predetermined channels, is obtained by the use of the electric controller type 12. This control system is used so that the set itself may be stowed in any desired place in the aircraft, while the smaller control unit can be installed wherever it is most convenient for operation. Fig. 19 shows a photograph of the controller type 12, fig. 20 the mechanism and the switch contacts, and fig. 21 is a photograph of

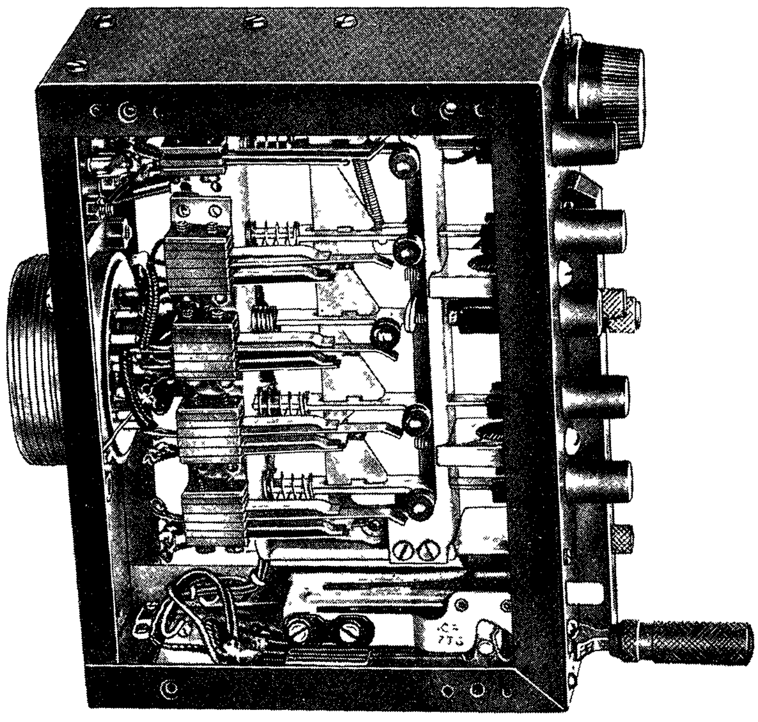


Fig. 21—Electric controller—side plates removed.

the controller with the side plates removed. The relations of the controller items to other parts of the circuit are shown in fig. 32. On Viking aircraft also fitted with the T.R.1196 the controller is mounted on the radio crate panel, but where the Murphy equipment is fitted in place of the T.R. 1196, the controller has been fitted in the back of the throttle box.

100. The controller carries five translucent press-button ,switches, marked A, B, C, D and

first button is only light, it will spring back again, but with normal pressure will engage with the slide-bar and lock home.

103. A special inter-locking arrangement is included so that two buttons cannot be depressed together. This is necessary to prevent the drive motor from revolving continuously and possibly burning out its contacts, which would occur if two of the button switches were shorted at the same time.

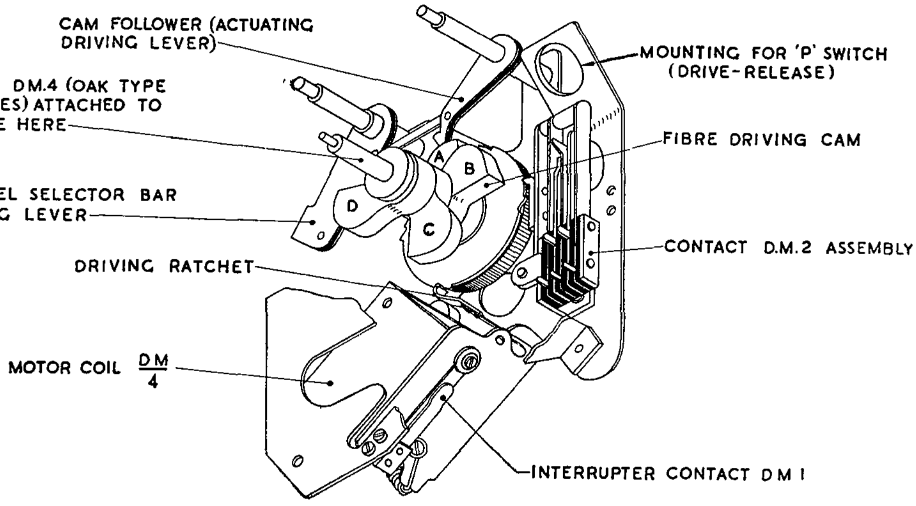


Fig. 22—Drive motor—perspective.

OFF. When depressed, buttons A, B, C or D glow. The illuminating pilot lamps, P.L.2 and P.L.3, can be dimmed by a small metal knurled knob on the right of the push-buttons. This actuates a mechanical dimming device consisting of two cups which may be screwed down over the pilot lamps themselves. The illumination of a depressed button is received indirectly from these pilot lamps, shields being arranged to prevent illumination of the buttons not depressed.

101. At the bottom right-hand corner of the controller is a small red lamp for B.A. warning. It is illuminated only when the T R switch is pushed to the extreme right—the B.A. position. In the central position of the T R switch the equipment is at Receive, and movement of this switch to the left changes over the set to Transmission. Normally the switch has to be held in the T-position and will spring back immediately it is released. However, by pushing up the small detent lever immediately above it, the T-position can be made locking. This detent lever should be left normally down. The B.A. position of the T R switch is self-locking.

102. Referring to figs. 20 and 21, it can be seen that when a button is depressed a slot in the bar attached to the button presses against the chamfered face of the principal detent lever and forces it upwards against the tension of the spring. The first result is to release the button previously depressed. If the pressure on the

THE DRIVE MOTOR

104. This is a single-unit which drives the slide-bars of the condenser drive unit. Motive power is provided by springs driving a ratchet. The springs are extended by the solenoid D.M./4 which is then released by the associated contact D.M.1, which breaks the circuit when the solenoid has pulled the armature so that the pawl is nearly over the next tooth. The springs release the armature and the pawl pulls the ratchet round one tooth. Fig. 22 shews the salient points of the motor. Its principle is similar to that of a uniselector, and it is sometimes known as a "pecking" motor.

105. The driving of the slide-bars is done by the bakelized fabric driving cams. The shape of these is more clearly shewn in fig. 33, which

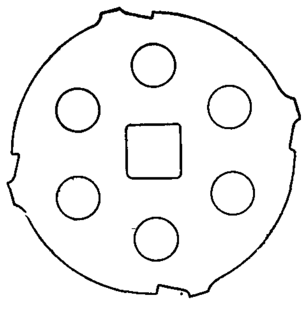
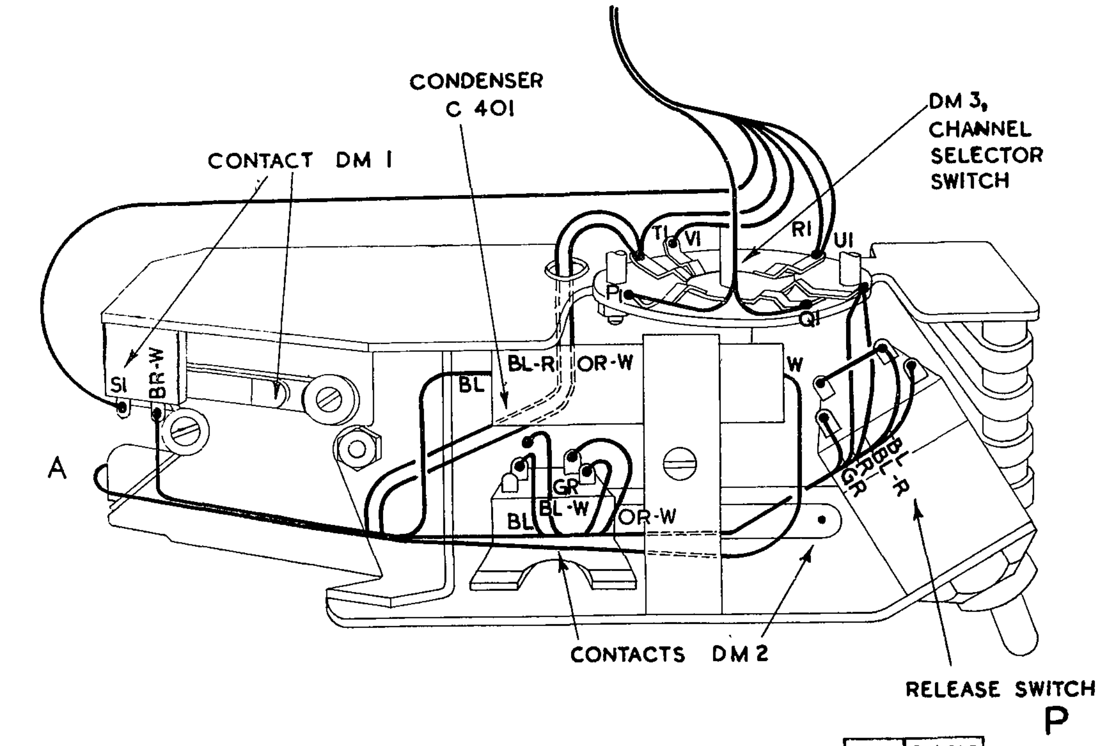
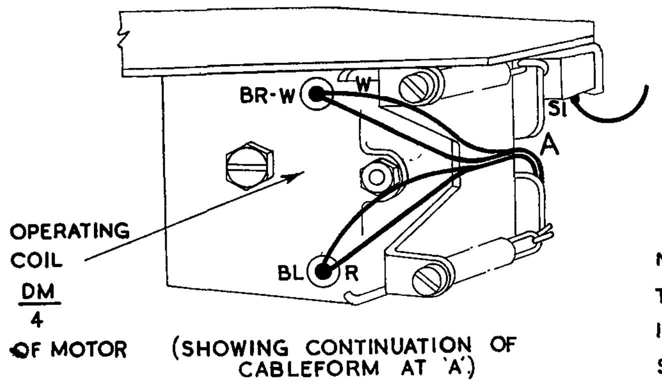


Fig. 23—Outline of cam DM2



LEAD	COLOUR
PI	BL - OR
QI	BL - W
RI	BL - BR
SI	SL - W
TI	OR - GR
UI	BK
VI	BL - R



NOTE :— SWITCH WAFER DM 4, THE RECEIVER CRYSTAL SWITCH, IS MOUNTED DIRECTLY ABOVE DM 3; SEE FIG. 35 FOR WIRING.

Fig. 24—Drive motor—wiring diagram.

illustrates the action involved in the driving process and how the links communicate the motion to the slide-bar. The motor action is controlled by cam D.M.2 (fig. 23), the movement of which in conjunction with the driving cams, is shewn in fig. 33.

106. Ganged on to the same shaft, are two oak type switches D.M.3 and D.M.4. D.M.3 provides an approximate channel selection according to the Electric Controller, although D.M.2 completes the location process to the exact tooth. D.M.4 is the receiver crystal switch. Fig. 24 illustrates the wiring system and the electrical operation is described in paras. 89 to 94.

THE CONDENSER DRIVE UNIT

107. Fig. 34 shows the condenser drive unit. The arms operated by the bakelized fabric cams of the driving motor of fig. 33, engage with the associated slide-bar. As the slide bar is pushed home, it locks the five associated cams to their pre-determined positions, rotating the spindles to which they are attached. The first, second, fourth and fifth spindles are associated with the receiver and the transmitter tuning condensers, but the centre cam operates the transmitter crystal switch. This cam is permanently set up by the manufacturers and needs no adjustment during the tuning process.

The cam assembly

108. Fig. 25 shows the cam assembly. Each cam (made of yellow metal), has a pair of cups, one on either side associated with it. These cups are separated from the cups of adjacent cams by special spring friction washers. The friction washers are shaped so as to grip tightly the splines on the main spindle.

109. During the tuning process when the cam positions are being adjusted, the knurled locking

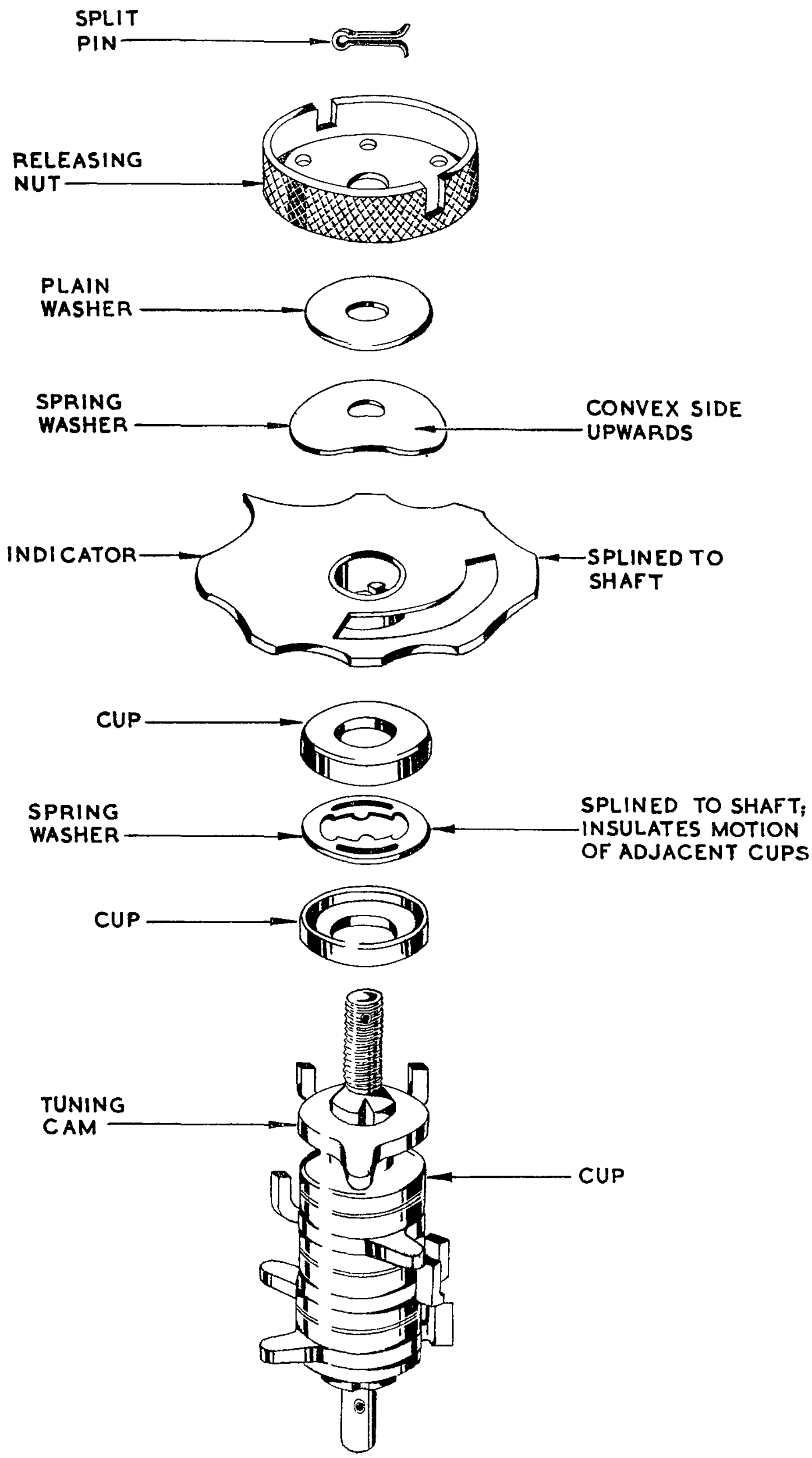


Fig. 25—Tuning cam assembly.

nuts are loosened to free the cams. They may then be positioned on the spindles and subsequently locked. The friction washers prevent the communication of motion from one cam to any of the other three, each cam with its two adjacent cups being motionally isolated from the other three. When all four cams have been set up to the tuning position on each spindle, each locking nut is turned tightly to lock up the assembly.

110. The driving home of any one of the four slide bars results in its guide faces engaging with the cam projections, and pushing these so that they are all in line. The final location of the cams is effected by means of spring-controlled detent levers which engage at one end with the cam noses and at the other end with the fixed pillars which support the slide bar assembly.

TUNING INSTRUCTIONS

111. The test equipment required for tuning and setting-up T.R.1464 on the bench, comprises a test set, type 98, and a 50-ohm artificial aerial. The preliminary setting up is carried out with the transmitter-receiver on the test bench, the front dust covers being removed. A battery supply is required which is capable of carrying a load of 10 amps. at 26 volts without voltage drop. Connect the electric controller, type 12, the mictels., and the battery supply to the appropriate W-plugs on the front panel. Connect the polarized socket of the test set, type 98, to the front panel meter plug (see fig. 3), and connect the artificial aerial type 14, to the aerial socket.

112. Insert the correct crystals in the appropriate crystal sockets on the front panel. The frequency of the transmitter oscillator crystal is obtained by dividing signal frequency by 18. The corresponding receiver crystal frequency is then 540 kc/s. less than the transmitter crystal frequency.

113. Depress any channel obtained on the controller. This will start the motor generator and supply current to the heaters, relays, and selector motor. Move the drive-release switch P. (see fig. 3) to the RELEASE position, that is downwards. Loosen the locking nuts on the spindles of T.C.1, T.C.2, T.C.3 and T.C.4, about one and a quarter turns anti-clockwise from the fully locked position.

Note:—The central channel indicator must not be loosened on any account.

114. Move the T R switch on the controller to the RECEIVE position. Partially depress any other channel button on the controller until the depressed button rises so that all buttons on the controller are then up.

115. To set up channel A, drive the selector motor to channel A position, by moving the P switch up and down until it is in the drive position and the channel indicator is in position A. The movement of the switch upwards sends the motor into the next drive position and the movement downwards to the following release position.

116. Put the meter switch into position 1. Tune T.C.1 (the receiver oscillator) for maximum reading on the test set meter, and then set T.C.2 (the receiver R.F. stage) to approximately the same position. Move the meter switch to position 2, and tune T.C.3 for maximum meter reading. Move the meter switch to position 3, remove the transmitter crystal from the channel in question (in this case channel A) and then *note the meter reading*. Replace this transmitter crystal. With the meter switch still in position 3 and the crystal in circuit, the transmitter oscillator, trebler and doubler valves are functioning and the meter will indicate the anode current of the receiver R.F. valve. This current will vary with the setting of T.C.2, which should now be tuned to obtain the *minimum* meter reading. T.C.3 should now be detuned in either direction until the meter reads 2 or 3 scale divisions less than the reading previously noted. The tuning of T.C.2 and of T.C.1 should then be checked to ensure that they are finally set to positions giving the minimum meter readings and at the same time T.C.2 should be adjusted to ensure that the final reading is not more than two or three divisions less than the reading noted above. Set the meter switch to position 6 and move the T.R. switch to the transmit position. Tune T.C.3 for maximum meter reading.

117. Move the meter switch to position 5 and tune T.C.4 until a dip is obtained. Return the T R. switch to receive. This completes the setting up of channel A, and it should now be checked that all four pointers T.C.1, T.C.2, T.C.3 and T.C.4 are in approximately similar positions —any wide variation in positions indicates the need for retuning. It should be noted that only the extremes of the frequency range are indicated above the tuning controls—100 to 124 Mc/s.

118. To select channel B, move the drive-release switch P to RELEASE, and then return it to the DRIVE position. Repeat the tuning procedure for channel B. Do the same for channels C. and D., selecting these channels by operating the P. switch and not by depressing the channel buttons on the controller.

119. After setting up channel D, move the drive release switch to the RELEASE position, and carefully turn each of the tuning controls fully clockwise by means of the knurled locking nuts. Tighten the locking nuts to lock the cam assemblies.

120. Finally return the drive-release switch to the DRIVE position. Change the channels several times by means of the controller. Read the test set meter at each of the positions 1 to 6 of the meter switch for all four channels, selecting the channels by means of the controller buttons. A large difference in reading on different channels in any position of the meter switch indicates mistuning and the complete channel should then be retuned. If no retuning is necessary, *ensure that after all readings have been taken, the meter switch is left in position* 6 (*normal position*).

Tuning a single channel

121. In order to set up a single channel without disturbing the cams controlling the remaining channels, the following instructions should be observed:

With the set at RECEIVE, release all the channel buttons as described above. Select the channel previous to the one it is desired to set up (i.e. A. for B, B for C, C for D, or D for A), by operating the P switch as explained in paragraphs 114, 115. Move the P switch to the RELEASE position, and loosen the locking nuts on T.C.1, T.C.2, T.C.3 and T.C.4. Move the P switch to the drive position and then set up the channel in the usual manner. Lock the tuning controls (having first set the P switch to the RELEASE position), return the switch to the drive position and check all four channels as described in paragraph 120. Lastly, ensure that the meter is in position 6 after all the readings have been taken.

Re-installation in aircraft

122. The transmitter-receiver should now be returned to the aircraft and all connectors fitted, after which it is necessary to re-adjust the output citcuit of the transmitter to match into the particular aircraft aerial and also to check the modulation. An inter-connection diagram is given in the Maintenance Manual. Place the test set adjacent to the aircraft aerial and in such a position that it is possible to read the meter when at the transmitter-receiver. From the pilot's position, switch on the set by depressing channel button D on the controller, and move the T R switch to TRANSMIT. Partially depress any other channel button in order to release all four channel buttons.

123. Remove the front dust cover from the transmitter-receiver, move the P switch to the RELEASE position, and loosen the locking nut on T.C.4. Return the drive release switch to the DRIVE position, thus selecting channel A. Switch on the test set and tune it until the meter dips. Tune T.C.4 for *minimum* meter reading.

124. Repeat the above procedure for channels B, C and D, selecting these channels by means of the drive release switch. Finally, move the drive release switch to RELEASE and lock T.C.4.

125. Return the drive release switch to the DRIVE position and depress each channel button on the controller in turn; the test set meter should give substantially the same reading for each channel. Any wide diversity of readings indicates mistuning of the channel in question.

126. Having completed these tests, modulate the transmitter and note that the meter reading decreases during modulation periods. If a test set type 98, is employed, an audio test of modulation can be carried out by plugging the telephones into the phone jack on the test set, one operator modulating the transmitter and the second operator listening out.

SERVICING

127. The equipment should be maintained in a clean condition, any dust being removed by blowing out with clean dry air. At intervals, all key, relay, and switch contacts should be cleaned with carbon tetrachloride, care being taken not to cause deformation in the process of cleaning.

Note:—When removing V.R.91 valves, use Extractor V.R.91.

128. Table F gives a list of major faults which may be encountered on T.R.1464, and means of identifying them. For the receiver oscillator and R/F. stages, and the transmitter stages, faults can normally be localized to a particular stage, by taking anode and grid current readings of each stage and comparing them with figures given in table D.

129. To measure grid current in the transmitter stages, the test set meter should be connected as under:—

(1) Crystal oscillator—across tags 128, 129.
(2) Doubler stage—across tags 126, 127.
(3) Push-pull trebler stage—meter connected to meter plug and meter switch in position 2, T R switch at RECEIVE.
(4) P.A. stage—meter connected to meter plug and meter switch in position 6.

Typical grid current values are given in table D, but some variations may be encountered in different sets. Further analysis of any faults should be conducted with the aid of the theoretical and lay-out diagrams, by testing the anode and screen voltages of the valves. A careful examination of the physical states of the components in an affected stage (e.g. test if the valves are warm) is not to be despised.

130. The reader is warned against attempting any adjustments to receiver trimmers, unless equipped with the proper test gear and information. When the transmitter valves are changed it is advisable to make *small* readjustments to the trimmers of the associated circuits. It is not normally necessary to re-neutralize the P.A. stage on changing the valves, but should this be desirable, the following method should be used.

Receiver I F. alignment

131. The signal generator should have stability equal to that given by crystal control and be capable of being adjusted with accuracy to the required frequency. The peak I/F. frequency is 9.72 Mc/s. and the trimmers must be adjusted to reproduce the curve shown in fig. 8. At ± 40 Kc/s. the reading on the output meter must fall to -6db ($\frac{1}{2}$) and at ± 140 Kc/s. the reading must fall to -40db ($\frac{1}{100}$ of the reading at 9.72 Mc/s). Connect a suitable a.c. voltmeter across the telephone circuit, adjust R.209 to its maximum value and adjust the input from the signal generator to a low value to avoid the generation of an A.V.C. voltage. Place a temporary short-circuit across the grid of valve V.204 and earth and

adjust the trimmers to obtain the maximum reading on the output meter, starting with the trimmer nearest to the diode detector and continuing backwards to the anode circuit of the valve V.202. Make a final check to confirm that the response curve complies with fig. 8 and finally remove the temporary short-circuit across the grid of V.204.

Transmitter neutralization

132. If the P.A. valves are changed, it *may* be necessary to adjust the neutralization of the output stage. Remove the link across tags 141 and 142 to cut out the output stage H.T. voltage, and insert a crystal of frequency 6.225 Mc/s. (or nearest value). Connect a 50 ohm artificial aerial, type 14, to the aerial socket. Place the meter switch in position 6 and the T R switch on the controller to Transmit. Tune T.C.3 for maximum reading on the test set meter connected via the meter plug. This will give a reading of the P.A. grid current.

133. Rotate T.C.4 slowly over its whole travel and check that the total change in the grid current meter reading is not greater than *one scale division.* A change of reading greater than one scale division may occasionally be encountered; in such an instance, adjust the two neutralizing condensers situated near the top of C.115 (see fig. 13), until it is found that T.C.4 can be rotated over its full travel without the meter reading changing by more than one scale division. As the adjustable plate of each neutralizing condenser is connected to the push-pull trebler valve anode, the T R switch must be thrown to the RECEIVE position whenever a neutralizing condenser is adjusted in order to avoid a shock from the H.T. supply. After neutralizing, reconnect the link between tags 141 and 142.

Drive motor and channel selector mechanism

134. Moving parts of the drive motor and the link mechanism should be lubricated periodically by applying a trace of anti-freezing oil to the bearings, using the end of a piece of wire for this purpose. *No oil should be applied to the slide-bar mechanism or to any switch contacts.*

135. The normal speed of the motor is 42 teeth per second, or one revolution in 2 seconds. Therefore, changing from A to D (or B to A, etc.) should not take longer than 1½ seconds. If it does, the self-interrupting contact D.M.1 (see figs. 22 and 24) should be adjusted so that its gap is 12 thousandths of an inch. The armature restoring springs should be tight enough to drive home completely the slide bars.

The Rotary Transformer

136. The rotary transformer should be periodically blown out and particular attention should be given to the brushes. Brushes should slide freely in their boxes and bed down evenly over their whole thickness and 80 per cent. of their contact area. Bad bedding will result in sparking. If the brushes are removed for inspection, it is advisable to mark them so that they may be returned the correct way round to the same boxes. The H.T. brushes are chamfered and can only be inserted one way round.

137. The following sizes and grades of brushes are used on the rotary transformer, type 79 :—

L.T. Input brushes	0.5 × 0.25 inches, grade C.M.3H.
M.T. (G.B.) output brushes	0.218 × 0.093 inches, grade Morgan 7308.
H.T. output brushes	0.187 × 0.187 inches, grade I.M.7.

Renewal of the brushes depends upon the following factors :—

(1) The minimum permissible brush pressure,
(2) The effective length of the brush in its box.

The brushes should be renewed when the minimum pressure and/or effective length is considered to have been reached, i.e. when the brush no longer fits smoothly in its box and there is a tendency to chatter.

138. If the end frames are removed, care should be taken when reassembling, to see that the marks punched on the yoke and the end frames are in line so that the correct brush position is attained. It should be noted that on this type of rotary transformer, the tags sweated to the ends of the field connections have to be unsoldered before the input end frame can be removed.

139. Cleanliness and adequate lubrication are important. The commutator should be kept clean and free from carbon dust. 5 drops of oil (D.E.D.2472A/O) should be inserted in the oil ways on installation, and afterwards, 2 drops at the appropriate inspection period. The insulation resistance between all live parts together in the frame should not be less than 20 megohms when tested at a potential of 500 volts d.c.

The Carbon-pile voltage regulator

140. The following tests must be made by authorized personnel only, testing instruments of known accuracy being used and not the aircraft voltmeter. It must be remembered that any adjustment of the pile compression screw alters the voltage level and tests must be made and the unit adjusted as necessary. The locking screws must also be firmly tightened after test and a final test made to ensure that the pile setting remains unaltered.

141. *Test prior to installation.*—Due to the presence of moisture in the carbon pile, the voltage setting of the regulator may vary from the value set at the manufacturers' works. Before the units are checked for voltage level, they should be dried out by running on a load of 5 amps, for approximately 20 minutes. If regulators are set while moisture remains in the pile, the voltage level will tend to drift. **This precaution is vital.** Other than the above, little or no adjust-

ment should be required prior to installation but it must be remembered that the regulator is tested at the manufacturers' works on a resistance loading and some small alteration may possibly be needed before putting into service.

142. *The standard tests.*—The standard tests which should be made periodically to the carbon-pile regulator are as follows :—

(1) Correct heater voltage with nominal supply voltage ... Test no. 1
(2) Satisfactory heater voltage regulation ... ... Test no. 2
(3) Absence of mechanical oscillation in the carbon-pile regulator Test no. 3

143. *Test number* 1—Adjust the supply voltage to obtain an input of 26 at Plug P with the heater circuit load normal. The heater voltage (measured with an 0-50 voltmeter connected across terminal 109 or terminal 224, and earth) should be 18.9.

144. *Test number* 2—Adjust the voltage input to Plug P to 21.6 volts and then slowly increase to 29 volts, watching the 0-50 voltmeter across the controlled heater supply. Then slowly decrease the input voltage to 21.6, still watching the meter. The difference between the highest and lowest controlled heater voltages encountered throughout this operation, must not exceed 1 volt.

145. *Test number* 3.—Connect in series a head-phone set and a large condenser (say 1 or 2 micro-farads) and apply these across the controlled heater supply. Adjust the input voltage to Plug P to 29 volts and then switch the equipment on and off several times. No note should be heard in the telephones at any time during this switching operation. If an oscilloscope is available, this can be used in place of the head-phones, oscillation being revealed by deflection of the trace.

146. *Setting up of regulators which are out of adjustment.*—Should the above tests give an incorrect result, then the following adjustment procedure must be adopted. Care must be taken to ascertain that the regulator is in a dry condition before the adjustments are made, and the setting up must be done by skilled personnel.

147. It is first necessary to determine the carbon-pile coil current of the regulator under test. Disconnect the earth lead from the ballast resistor R.305, and insert an 0-1 ammeter between the earth side of the resistance and earth. Regulate the input voltage to 26 with the heater load normal (i.e. all valves in position), and adjust the slider of R.305 until the 0-50 voltmeter, which must remain connected across tag 109 or 224, and earth reads exactly 18.0 volts, and then record the current as indicated on the ammeter. (The reason for a heater voltage of 18.0 is that the carbon-pile regulator was originally adjusted by the manufacturers to provide a control voltage of 18 and, therefore this voltage must be employed in determining the correct coil current). The coil current as now read should be between 0.25 and 0.275 amperes, and latter value being the maximum permissible.

148. Having established the coil current, disconnect the supply from plug P, and remove the end dust cover from the motor generator. Disconnect the positive input lead. Apply exactly 18.9 volts from an external supply across the heater supply terminals 109 or 224 and earth (ensuring that the *negative* battery terminal is connected to earth) and adjust R.305 to obtain the same coil current as was recorded in the 18.0 volt test in the previous paragraph. Lock the slider of R.305, remove the ammeter, reconnect the earth lead to R.305 and disconnect the external 18.9 volt supply.

149. Tests 1, 2 and 3 should be repeated. If test number 1 does not give the correct result, then the above procedure must be repeated.

150. If either test number 2 or 3 gives incorrect results on rechecking, a slight adjustment of the core screw (at the base of the regulator ; the two locking screws will have to be slackened first), should give the correct result, but *the readjustment of this screw must not exceed* 1/16*th of a turn clockwise or* 1/8*th of a turn anti-clockwise.*

TABLE D — METER READINGS

Typical meter readings as given by (0-1 mA) 75 ohms meter scale marked 0-100. These readings serve as a guide only. *Input battery voltage* 26.

Valve	*Meter Switch Position*	*Meter Reading*		*Remarks*
		Minimum	*Maximum*	*T-R Switch at*
V.204 Grid current	1	50	70	R
V.103 } Grid V.104 } current	2	50	100	R
V.201 Anode current	3	25		R (Trans. crystal removed).
V.103 } Anode V.104 } current	4	50	65	T
V.105 } Anode V.106 } current	5	50	60	T
V.105 } Grid V.106 } current	6	20	45	T
V.101 Grid current	6 (Meter connected between terminals 128 and 129)	20	50	T
V.102 Grid current	6 (Meter connected between terminals 126 and 127)	30	70	T

TABLE E — TYPICAL SUPPLY READINGS

(Note: These readings are typical; some variation may be expected.)

	Terminals	*T-R Key at Transmit*	*T-R Key at Receive*
HT voltage	113 to E	290 volts	—
HT voltage	225 to E	—	340 volts
HT voltage	204 to E	—	300 volts
GB voltage	137 to E	– 120 volts	– 120 volts
Input current	—	7.5 amps.	5.1 amps.
HT current	—	220 mA Unmodulated	—
HT current	—	—	55mA
GB current	—	7.0 mA	8.0 mA

Heater voltage, terminal 109 to E .. .. .. 18.9 volts
,, ,, ,, 108 to E .. .. .. 12.6 volts
,, ,, ,, 107 to E .. .. .. 6.3 volts

TABLE F — FAULT-FINDING CHART

FAULT	*INDICATION*	*CHECK*	*Type of Meter*	*MEASURE* *From*	*To*	*CORRECT READING* *Greater Than*	*Less Than*
O/C Heaters	Valve heaters fail to light	Input Heater Supply 18.9 volts	20 volt DC, or greater	133 or 109	Chassis	16.5	21.5
		12.6 volt level	20 volt DC	108	Chassis	11.0	14.5
		6.3 volt level	20 volt DC	107	Chassis	5.5	7.2
Disconnected Heaters	Valve heaters light to unequal brilliance	One or more valves disconnected from supply or O/C heater in brightest level					
HT supply failure	No readings of any kind Heaters alight	HT supply volts	350 volts DC	134	Chassis	260	340
		Tx. supply volts	350 volts DC	113	Chassis	260	340
HT short cct.	Generator runs slow, low volts	Isolate each HT circuit and test for short circuit to chassis					
No output	No output indication on test set or dummy load	Tune TC4 for maximum output					
No Drive	No reading on meter switch position 6	Tune TC3 for maximum output	0 to 1mA 75 ohms.	meter switch position 6	—	2	5
		Tune TC3 for maximum current	0 to 1mA 75 ohms.	meter switch position 4	—	50	65
Bias supply failure to Output stage	Reading greater than 65 on meter switch position 5	Check incoming bias supply	150 volt DC	137	Chassis	110	130
Bias supply failure Transmitter Trebler stage	Reading greater than 70 on meter switch position 4	Check incoming bias supply	150 volt DC	1	37	110	130
HT failure to transmitter, Oscillator—Trebler stage	No reading on meter switch position 5	Check HT line	350 volt DC	V105/V107 Top Caps	Chassis	250	320
HT failure to Transmitter Trebler stage	No reading on switch meter position 4	Check HT line	350 volt DC	V103/V104 Top Caps	Chassis	270	340

TRANSMITTER-RECEIVER T.R.1464

LIST OF PARTS

This list of parts is issued for information only. When ordering spares for this equipment, reference should be made to the provisioning register, part III.

CAPACITORS

Transmitter deck

Circuit Reference	*Value*	*Tolerance per cent. or in μμF*	*Working Voltage*	*Details*
C 101	3.5–22.3μμF			1st section of ganged unit TC3.
C 102	2–6μμF			ceramic based air trimmer to C 101.
C 103	25μμF	5	500	ceramic disc
C 104	100μμF	15	500	ceramic tubular
C 105	500μμF	15	350	moulded mica-wire ends.
C 106	25μμF	5	500	ceramic disc.
C 107	500μμF	15	350	moulded mica-wire ends.
C 108	6μμF	0·5μμF	500	ceramic disc.
C 109	2–6μμF			ceramic based air trimmer to C 110.
C 110	3·3–16·1μμF			2nd section of ganged unit TC3.
C 111	100μμF	15	500	ceramic tubular.
C 112	100μμF	15	500	ceramic tubular.
C 113	500μμF	15	350	moulded mica-wire ends.
C 114	500μμF	15	350	moulded mica-wire ends.
C 115	3·3–16·1μμF			3rd section of ganged unit TC3.
C 116	2–6μμF			ceramic based air trimmer to C 115.
C 117	15μμF	5	500	ceramic disc.
C 118	15μμF	5	500	ceramic disc.
C 119	100μμF	15	500	ceramic tubular.
C 120	100μμF	15	500	ceramic tubular.
C 121	0·2–1·5μμF			
C 122	2·8–8·2μμF			Includes L106, L107—TC4.
C 123	0·2–1·5μμF			
C 124	·005μF	25	1,000	paper tubular.
C 125	100μμF	15	500	ceramic tubular.
C 126	·002μF	10	1,000	paper tubular.
C 127	0·1μF	20	350	paper tubular.
C 128	·001μF	25	1,000	paper tubular.
C 129	200μμF	15	375	moulded mica-wire ends.
C 130	500μμF	15	350	moulded mica-wire ends.
C 131	100μμF	15	500	ceramic tubular.
C 132	·01μF	20	375	paper tubular.
C 133	500μμF	15	350	moulded mica-wire ends
C 134	0·1μF	20	350	paper tubular.

Receiver deck

C 201	0·1μF	20	350	paper tubular.
C 202	0·1μF	20	350	paper tubular.
C 203	75μμF	2	350	protected silvered mica.
C 204	300μμF	15	350	moulded mica-wire ends.
C 205	100μμF	15	350	moulded mica-wire ends.
C 206	0·1μF	20	350	paper tubular.
C 207	·01μF	20	375	paper tubular.
C 208	75μμF	2	350	protected silvered mica.
C 209	·01μF	20	375	paper tubular.
C 210	·01μF	20	375	paper tubular.
C 211	·01μF	20	375	paper tubular.
C 212	75μμF	2	350	protected silvered mica.
C 213	75μμF	2	350	protected silvered mica.
C 214	·01μF	20	375	paper tubular.
C 215	75μμF	2	350	protected silvered mica.
C 216	·01μF	20	375	paper tubular.
C 217	·01μF	20	375	paper tubular.
C 218	75μμF	2	350	protected silvered mica.
C 219	·01μF	20	375	paper tubular.
C 220	75μμF	2	350	protected silvered mica.

Receiver deck—contd.

Circuit Reference	*Value*	*Tolerance per cent. or in* $\mu\mu$F	*Working Voltage*	*Details*
C 221	·01μF	20	375	paper tubular.
C 222	·01μF	20	375	paper tubular.
C 223	·01μF	20	375	paper tubular.
C 224	75$\mu\mu$F	2	350	protected silvered mica.
C 225	·01μF	20	375	paper tubular.
C 226	5$\mu\mu$F	0·5$\mu\mu$F	500	ceramic disc.
C 227	·01μF	20	375	paper tubular.
C 228	300$\mu\mu$F	15	350	moulded mica-wire ends.
C 229	3$\mu\mu$F	0·5$\mu\mu$F	500	ceramic disc.
C 230	4–19$\mu\mu$F			1st section of ganged unit TC1.
C 231	2–6$\mu\mu$F			ceramic-based air trimmer to C 230.
C 232	4–18$\mu\mu$F			3rd section of ganged unit TC2.
C 233	2–6$\mu\mu$F			ceramic-based air trimmer to C 232.
C 234	6$\mu\mu$F	0·5$\mu\mu$F	500	ceramic disc.
C 235	2–6$\mu\mu$F			ceramic-based air trimmer to C 236.
C 236	4–18$\mu\mu$F			2nd section of ganged unit TC2.
C 237	500$\mu\mu$F	15	350	moulded mica-wire ends.
C 238	·01μF	20	375	paper tubular.
C 239	20$\mu\mu$F	10	500	ceramic disc.
C 240	4–19$\mu\mu$F			2nd section of ganged unit TC1.
C 241	2–6$\mu\mu$F			ceramic-based air trimmer to C 240.
C 242	25$\mu\mu$F	5	500	ceramic disc.
C 243	100$\mu\mu$F	5	500	ceramic cup.
C 244	·01μF	20	375	paper tubular.
C 245	300$\mu\mu$F	15	350	moulded mica-wire ends.
C 246	2–6$\mu\mu$F			ceramic-based air trimmer to C 247.
C 247	4–18$\mu\mu$F			3rd section of ganged unit TC2.
C 248	6$\mu\mu$F	0·5$\mu\mu$F	500	ceramic disc.
C 249	8$\mu\mu$F	5	500	ceramic cup.
C 250	·01μF	20	375	paper tubular.
C 251	·01μF		375	paper tubular.
C 252	300$\mu\mu$F	15	350	moulded mica-wire ends.
C 253	·01μF	20	375	paper tubular.
C 254	·01μF	20	375	paper tubular.
C 255	100$\mu\mu$F	15	500	ceramic tubular.
C 256	·002μF	10	1,000	paper tubular.
C 257	·01μF	20	375	paper tubular.

Power unit and B.A. amplifier deck

C 301	·02μF	20	750	paper tubular.
C 302	·01μF	20	375	paper tubular.
C 303	·01μF	20	375	paper tubular.
C 304	2μF	20	250	paper, metal case, terminals.
C 305	·002μF	15	350	moulded mica, wire ended.
C 306	·002μF	15	350	moulded mica, wire ended.
C 307	2μF	20	400	paper, metal case, terminals.
C 308	0·1μF	20	350	paper tubular.
C 309	0·1μF	20	350	paper tubular.
C 310	0·1μF	20	350	paper tubular.
C 311	0·1μF	20	350	paper tubular.
C 312	2μF	20	250	paper, metal case, terminals.
C 313	0·1μF	20	350	paper tubular.
C 314	0·1μF	20	350	paper tubular.
C 315	300$\mu\mu$F	15	350	moulded mica-wire ends.

Drive unit

C 401	1μF	—	250	paper tubular, metal case.
	or	20	400	paper, in rectangular case, tropical.

RESISTORS

Transmitter deck

Circuit Reference	*Value in ohms*	*Tolerance per cent.*	*Rating in Watts*	*Details*
R 101	47	10	½	
R 102	15,000	,,	,,	
R 103	1,000	,,	,,	
R 104	1,000	,,	,,	
R 105	220	,,	,,	
R 106	33,000	,,	,,	
R 107	1,000	,,	,,	
R 108	2,000	5	,,	
R 109	10,000	10	,,	
R 110	47,000	,,	,,	
R 111	15,000	,,	,,	
R 112	47,000	,,	,,	
R 113	15,000	,,	,,	
R 114	33,000	,,	,,	
R 115	150,000	,,	,,	
R 116	15,000	,,	,,	
R 117	22,000	,,	,,	
R 118	47,000	,,	,,	
R 119	100,000	,,	,,	
R 120	220	,,	,,	
R 121	33,000	,,	,,	
R 122	33,000	,,	,,	
R 123	18	,,	,,	
R 124	100,000	,,	,,	
R 126	15,000	,,	,,	
R 127	15,000	,,	,,	
R 128	0·75	2	1	wire-wound woolcard type.
R 129	100	10	½	
R 130	33,000	,,	,,	
R 131	33,000	,,	,,	
R 132	33	,,	,,	
R 133	100,000	,,	,,	
R 134	100,000	,,	,,	
R 135	15,000	,,	,,	
R 136	15,000	,,	,,	
R 137	33,000	,,	,,	
R 138	33,000	,,	,,	
R 139	0·75	2	1	wire-wound woolcard type.
R 140	47,000	10	½	
R 141	10,000	,,	1	
R 142	150,000	,,	½	
R 143	47,000	,,	,,	
R 144	47,000	,,	,,	
R 145	18,000	,,	,,	
R 146	1M	,,	,,	
R 147	270,000	,,	,,	
R 148	680,000	20	,,	
R 149	63	5	1	wire-wound woolcard type.
R 150	63	5	1	wire-wound woolcard type.
R 151	150,000	10	½	

Receiver deck

R 201	100,000	20	½	
R 202	100,000	,,	,,	
R 203	2·2 M		,,	
R 204	2·2 M		,,	
R 205	0·47 M	20	,,	
R 206	47,000	,,	,,	
R 207	0·47 M	,,	,,	
R 208	47,000	,,	,,	

Receiver deck—contd.

Circuit Reference	*Value in ohms*	*Tolerance per cent.*	*Rating in Watts*	*Details*
R 209	100,000	20	½	Potentiometer, linear, carbon, moulded, small.
R 210	100,000	10	,,	
R 211	10,000	20	,,	
R 212	1,000	10	12	Vitreous wire-wound.
R 213	47,000	20	½	
R 214	330	,,	,,	
R 215	100,000	10	,,	
R 216	100,000	,,	,,	
R 217	100,000	20	,,	
R 218	68,000	,,	,,	
R 219	100,000	,,	,,	
R 220	100,000	10	,,	
R 221	100,000	,,	,,	
R 222	4,700	20	,,	
R 223	100,000	,,	,,	
R 224	68,000	,,	,,	
R 225	100,000	,,	,,	
R 226	100,000	10	,,	
R 227	1,000	20	,,	
R 228	100,000	10	,,	
R 229	10,000	20	,,	
R 230	1,000	,,	,,	
R 231	47,000	,,	,,	
R 232	100,000	,,	,,	
R 233	100,000	,,	,,	
R 234	10,000	,,	,,	
R 235	100,000	,,	,,	
R 236	75	±5Ω		
R 237	8·3	±0·3Ω		
R 238	47,000	20	½	
R 239	220	,,	,,	
R 240	15,000	,,	,,	
R 241	100,000	,,	,,	
R 242	2,200	,,	,,	
R 243	100,000	,,	,,	
R 244	33,000	,,	¼	
R 245	1,000	,,	½	
R 246	1,000	,,	,,	
R 247	100,000	,,	,,	
R 248	47,000	,,	,,	

Power unit and BA marker amplifier deck

R 301	1 M	20	¼	
R 302	330,000	20	½	
R 303	68,000	20	½	
R 304	1·5 M	20	½	
R 305	40 VAR.	10		adjustable wire-bound.
R 306	4,700	10	½	
R 307	126	10	1·5	wire-wound vitreous.
R 308	31·5	10	1·5	wire-wound vitreous.
R 309	100,000	20	½	
R 310	330	,,	,,	

Electric Controller type 12

R 501	500 VC	20	1	linear-wire-wound potentiometer (Colvern 21C/4).
R 502	110	5	6	wire-wound ceramic.

VALVES, LAMPS AND FUSES

	Circuit Reference	Type	Civil Type
Transmitter deck	V101	VR91	EF50 or Z92
	V102, V103, V104, V105, V106	VT501	TT11
	V107	VR67	L63 or 6J5G
	V108, V109	VT52	EL32
Receiver deck	V201, V202, V203, V204, V207	VR91	EF50
	V205, V206	VR53	EF39
	V208	VR54 (CV1054)	EB34
	V209	VR56 (CV1056)	EF36
Power unit deck	V301	VR53	EF39
	H.T. Fuse	500ma.	
Electric controller	Lamps, PL501, PL502, PL503	3 volt, 0·6 watts, Special C.E.A.G.	

VALVE-HOLDERS

9-pin octal base for VR91 valves

Holders, valve, type 238 .. .. 9-pin, ceramic, earth clip, metal flange, 1·812 inch fixing centres. Belling Lee L500C.

with Retainers, valve, type 19 .. Spring steel, Carr fastener S75/536, for VR91.

International octal base.

Holders, valve, type 35 .. .. International octal, ceramic, metal flange, Celestion RFS/US (as on transmitter deck).

Holders, valve, type 73 .. .. International octal, ceramic, moulded with metal plate insert. Amphenol SP8/US (as on receiver deck).

Caps, valve, type 13 .. .. Unscreened, reinforced, for valves with 0·25 inch dia. top. Benjamin 75/548.

CHASSIS AND MECHANICAL ITEMS

Condenser-drive unit .. .. .. Cam mechanism for driving 4 variable condensers and 4-position switch, selecting 4 positions.

It includes :—

4 Knobs, type 293	MS. Nic. Pl. 0·87 in. d. × 0·16 in., knurled, tapped for 4 B.A. shaft.
5 Pointers, type 37	As type 21 but with plain bearing.
4 Springs, tension	Helical, 0·12 in. d. × 1·16 in., ring ends.
20 Springs, tension	Helical, 0·11 in. d. × 0·4 in. close winding, hook ends.
1 Wafer, Switch	Rotary, SP. 4-position, selector, 4 contacts evenly spaced at 30 deg., 1 rotor contact. Oak type for switching Transmitter crystals.

Drive-unit, type 37 .. .. .. Electromagnetic ratchet drive, 4-cam, condenser tuning.

It includes :—

Armature and pawl assembly.	
Coil.	
Condenser, type 4027	1μF, 250V. DC. wkg. paper, tubular, metal case, 0·62 in. d. × 1·5 in. long, wire ends, tropical. Hunt W.4991/1.
or type 4607	1μF ±20%, 400/V. DC. test, paper rectangular case, upright mounting, 1·187 in. × 2·5 in. high over terminals, × 0·56 in. thick, 2 fixing holes at 1·59 in. crs., terminals, tropical. G.E.C. type D.
Levers, toggle (4).	
Plate, switch mounting	MS. 16 s.w.g. 0·609 in. × 2·437 in. for P switch (drive-release).
Screws, retractor spring (2)	MS. 16TPI Whit. × 0·406 in. Std. 3 B.A. Ch. Hd.
Shafts, cam	Assembly of shaft, main cam, ratchet wheel and 4 cams.
Spindles, main bearing	Stainless steel, 0·125 in. d. × 2·562 in.
Springs, leaf type 10	Flat, with lip. For restraining driving ratchet wheel. 22 s.w.g. Staybright steel, 1·47 in. × 0·23 in.

Spring-sets type 34	1 make and 1 break. Complete with mounting bracket.
Spring-sets type 35	1 break. Complete with mounting bracket. Interrupter.
Springs, tension, type 67	Nickel music wire 0·056 in. d., 10 convolutions, 0·28 in. d. × 0·81 in. Hook one end. 18–24 lb. pull, 0·12 in. extension max. Retractor.
Switches, type 152	S.P. on/off moulded.
Wafers, switch	Rotary, 4-position, 4 contacts spaced at 90 deg., shorting 3 progressively, 2 rotor contacts. Oak type.
Wafers, switch	Rotary, 4-position selector, 4 contacts spaced at 90 deg., 1 rotor contact. Oak type.

Covers

Cover, type 447	Main dust cover. Aluminium, 13 in. × 15 in. × 7·5 in. high, louvres at back and sides, perforated bottom, two 0B.A. captive nuts at front.
Cover, type 448	Front. Marked TRANS-REC. TR 1464.
Cover, type 449	Bottom, front surround.
Cover, type 450	Top, front surround.

Co-axial connexions

Connector, type 1405/2	Cable, electric, H.F. Uniradio No. 32, length 6 in., complete with moulded polystyrene SP coaxial socket. Connects socket A on front panel to AR relay.
Cable, electric, Uniradio No. 32, 12in.	Connects AR relay to transmitter.
Connector, type 1405/3	Cable, electric, H.F. Uniradio No. 32, length 9 in., complete with moulded polystyrene SP. coaxial socket. Connects AR relay to receiver.
Cable, electric, Uniradio No. 32, 6 in.	Connects mixer stage to 1st I.F.

Condenser couplers

Coupling, type 121	S.R.B.F. link 0·218 in. × 0.59 in. × 0·046 in. spring loaded, coupling link each end with bushes to fit condenser shaft and drive shaft. Drives TC1.
Coupling, type 122	S.R.B.F. link 0·218 in. × 1·59 in. × 0·046 in. spring loaded, coupling link each end with bushes to fit condenser shaft and drive shaft. Drives TC2.
Coupling, type 123	S.R.B.F. link, spring loaded coupling link each end with bushes to fit condenser shaft and drive shaft. Drives TC5.
Coupling, type 124	Flexible spring couplings with bush each end for coupling condenser drive unit (TC2) to condenser coupling shaft. Length o/all 0·75 in.
Coupling, type 125	S.R.B.P. tube 0·18 in. d. with spring coupling each end, length o/all 1·5 in. approx. Drives TC4.
Coupling, type 126	MS rod end S.R.B.P. tube with spring coupling one end only. Length o/all 5·62 in. For TC5.
Shafts, condenser drive	MS. 0·123 in. d. × 3·75 in. with groove 0·093 in. d. × 0·06 in. wide, 0·625 in. from one end. For TC2.

Plugs

Plug, W.198	4-pole, panel mtg. sq. flange. Plug B on front panel (connects to BA system).
Plug, W.199	6-pole, panel mtg. sq. flange. Plug M on front panel (connects mic.-tels. and P/T button).
Plug W.203	18-pole, panel mtg. sq. flange. Plug C on front panel (connects to controller).
Plug, W.204	2-pole, 20 amp. panel mtg. sq. flange. Plug P on front panel (connects to 24v. supply).
Plug, type 582	SP. coaxial, matched impedance. Used in conjunction with Connectors 1405/2-3. Fixed adjacent to AR relay.

Tagboards

Tagboards, type 74 (2)	S.R.B.P. 2·25 in. × 0·43 in. × 0·06 in. fitted with 4 tags.
Tagboard, type 75	S.R.B.P. 1·87 in. × 0·43 in. × 0·06 in. fitted with 3 tags.
Tagboards, type 375 (2)	S.R.B.P. 3·84 in. × 0·37 in. × 0·093 in. fitted with 14 pin type tags, double ended. Two fixing holes 0·120 in. d. at 3·468 in. crs.
Tagboard, type 493	S.R.B.P. 2·25 in. × 0·43 in. × 0·06 in. fitted with 3 tags. Two fixing holes 0·128 in. d. at 1·87 in. crs.
Tagboard, type 494	As type 493 but fitted with 2 tags.
Tagboard, type 376	S.R.B.P. 0·75 in. × 0·468 in. × 0·06 in. fitted with one brass tag. Two fixing holes 0·096 in. d. at 0·468 in. crs.
Tags, earthing (14)	Brass, hard, sil. pl. 38 s.w.g. angular, 0·390 in. × 0·281 in., clip each end.
Tagboard, type 305	S.R.B.P. 5·16 in. × 2·87 in. × 0·062 in., fitted with 19 tags and 14 wire tags.
Tagboards, type 377	S.R.B.P. 7·37 in. × 0·437 in. × 0·06 in. fitted with 17 tags.
Tagboards, type 378	S.R.B.P. 4·75 in. × 0·437 in. × 0·06 in. fitted with 11 tags.
Tagboards, type 379	S.R.B.P. 2·218 in. × 0·437 in. × 0·06 in. with right angle bracket each end. Fitted with 4 tags.
Tagboards, type 380	S.R.B.P. 5·75 in. × 0·437 in. × 0·06 in. Two fixing holes 0·12 in. d. at 3·468 in. centres. Fitted with 11 tags.

Miscellaneous

Bracket, type 368	MS. 20 s.w.g. Triangular, 1 ·37 in. × 1 ·218 in., fixing lug 0 ·87 in. × 0 ·25 in. with 2 holes 0 ·116 in. d. at 0 ·62 in. crs. Complete with spring. For Condenser drive shaft 10D/1989 to TC2, on receiver deck.
Bush (crystal switch)	MS. 0 ·25 in. o/d × 0 ·125 in. i/d × 0 ·437 in., with flat each side and two 8 B.A. fixing holes.
Handle, type 34 (withdrawing) ..	MS. 14 s.w.g. × 0 ·62 in. wide, × 9 ·98 in., 0 ·5in. high.
Holder, crystal, type 45	S.R.B.F. 3 ·56 in. × 1 ·56 in. × 0 ·046 in., to mount 4 crystal units type A or U.S. pattern. Engraved : REC. A, B, C, D. Used for receiver crystals.
Holder, crystal, type 46	As type 45 but engraved : TRANS. A, B, C, D. Used for transmitter crystals.
Nuts, cover fixing (2)	0 B.A. brass circular, 0 ·59 in. long, head 0 ·5 in. d. × 0 ·17 in., screwdriver slot 0 ·078 in. × 0 ·1 in. deep. Shank 0 ·358 in. d. C'bored 0 ·31 in. d. c 0 ·093 in. At rear of chassis.
Pillars, handle, withdrawing (2) ..	MS. tube 0 ·31 in. o/d × 0 ·125 in. i/d × 2 in. Tapped 2 B.A. × 0 ·375 in. and c'bored 0 ·218 in. d. × 0 ·093 in. each end. On front panel.
Pins, locating, type 10 (2)	MS. 0 ·31 in. d. × 1 ·718 in. tapered end. Reduced 0 ·216 in. d. × 0 ·89 in., cross-drilled 0 ·067 in. d. At rear of chassis.
Springs, compression, type 85 ..	16 s.w.g. nickel piano wire, 5 turns 0 ·25 in. i/d × 0 ·594 in. free length. Ends ground flat. Load to compress solid 35 lb. Used with locating pins 10A/17451 at rear of chassis.
Screws, 8 B.A. × 0 ·156 in., MS. Ch. hd., pointed ends	Case hardened. For couplings.
Screws, 4 B.A. special	MS. 0 ·4 in. o/all length. Head 0 ·28 in. d. × 0 ·17 in., shoulder 0 ·187 in. d. Used to fix Drive Unit.
Screws, captive, 2 B.A.	MS. 0 ·687 in. o/all length. Head 0 ·31 in .d. × 0 ·28 in., knurled, screw-driver slot 0 ·078 in. wide × 0 ·093 in. deep. Shank reduced 0 ·14 in. d. × 0 ·125 in. Used to fix withdrawing handle.
Straps, Condenser fixing for C 304 and C 307 (2)	MS. 20 s.w.g. × 0 ·25 in. 2 ·015 in. × 2 ·06 in. high, with feet. Two fixing holes 0 ·125 in. d. at 2 ·37 in. crs.
Strap, Condenser fixing for C 312 ..	MS. 20 s.w.g. × 0 ·25 in. 2 ·39 in. × 0 ·968 in. high, with feet. Two fixing holes 0 ·125 in. d. at 2 ·687 in. crs.
Switch, type 1361 (Meter switch) ..	Rotary, 2 wafers, each SP. 6-position, complete with handle, and protector plate.

CHOKES AND INDUCTANCES

L101, L102	Chokes, HF type 607 ..	2 section, wave wound single. 175 turns each section, continuous between windings and 1 section 350 turns wave wound single 0 ·006 in. cu. wire. On S.R.B.P. former 0 ·25 in. d. × 2 in.
L103	Inductance, type 1029 ..	11 turns, 18 s.w.g. tinned cu. wire, wound on grooved vulcanite former 0 ·95 in. o/d × 0 ·75 in. i/d.
L104	Inductance, type 1028 ..	7 turns, 16 s.w.g. tinned cu. wire, wound on grooved vulcanite former 0 ·953 in. o/d × 0 ·75 in. i/d × 1 ·281 in.
L105	Inductance, type 1030 ..	3 turns, 16 s.w.g. 0 ·462 in. i/d at 0 ·25 in. pitch, extended ends.
L106	See C122 — transmitter output circuit is in one unit.	
L107	Inductance, type 1031 ..	16 s.w.g. H.C. cu. wire, 2 turns 0 ·75 in. i/d, fitted to S.R.B.P. mtg. board 2 in. × 0 ·75 in. × 0 ·06 in.
L201, L202	Chokes, HF, type 607 ..	For description see L101, L102.
L203	Inductance, type 1027 ..	15½ turns, 0 ·0124 in. d., en. cu. wire on vulcanite former 0 ·5 in. d. × 1 ·343 in.
L204	Inductance, type 1026 ..	16 s.w.g. cu. wire, 3 turns 0 ·270 in. i/d at 0 ·109 in. pitch, extended ends.
L205	Inductance, type 1025 ..	As type 1026 but with additional connecting strip.
L206, L207	Inductance, type 1024 ..	16 s.w.g. cu. wire, 3 turns 0 ·325 in. i/d at 0 ·109 in. pitch, extended ends.
CH301, CH302	Chokes, HF, type 709 ..	25 turns, 22 s.w.g., en. cu. wire on S.R.B.P. former 0 ·187 in. d. × 2 ·12 in.
CH303	Choke, L.F., type 514 ..	1,300 turns 0 ·0148 in. (28 s.w.g.), en. cu. wire. Open type 2 ·5 in. × 1 ·75 in. high, with feet and tagboard at top.
CH305	1 Choke, HF, type 711 ..	Complete assembly on moulded base, inductance 21μH at 1000 cps.
CH306	1 Choke, HF, type 712 ..	As type 711 above, but opposite hand.

TRANSFORMERS

AF type:		
T101	Transformer, type 1604 ..	Modulation.
T102	Transformer, type 1606 ..	Phase-splitting, auto.
T103	Transformer, type 1605 ..	AF output.
T201	Transformer, type 1603 ..	Microphone input. Microphone, Primary, 108 turns 0·006 (38 s.w.g.) en. S.S. cu. wire. Tapped at 54 turns. Sec. 4300 turns 0·0024 (46 s.w.g.) en. SC. cu. wire.
T202	Transformer, type 1856 ..	BA volume control, AF miniature complete with clamp.
IF type:		
IFT1 } IFT2 }	Transformers, type 1169 ..	1st and 2nd IF with top cap connexion to valve cap.
IFT3	Transformer, type 1170 ..	3rd IF.
IFT4	Transformer, type 1171 ..	4th IF.

RELAYS

AR/2	Relay, Magnetic, type 841	Aerial change-over relay. P.O. 600 type, 24V, 500 ohm. 2 c/o (1 pair of c/o contacts consists of 50 ohm matched line). Tropical.
B/2	Relay, magnetic, type 609	Londex type ML modified. ON-OFF relay. 24 volt, 500 ohm, 2m. in series.
BA/4 & D/4	Relays, magnetic, type 842	Beam-approach and MCW relays. P.O. 600 type, 24V, 500 ohm. 2 c/o, 1 break and 1 make. Tropical.

POWER UNIT ITEMS

Rotary Transformer, type 79	Input: 26 volts, D.C. Output: 300 volts, 220 milliamps, D.C. 150 volts, 6 milliamps, D.C.
Power Regulators, type 6	Magnet pot assembly.
Cradle for Rotary Transformer	Complete with strap and rubber mounting bushes.
It includes :—	
1 Screw captive, 2 B.A.	Ch. Hd. Length o/all 1·5 in. Threaded 0·56 in. Shank reduced 0·14 in. d. × 0·937 in.
Filter unit, type 143	2 leg, 1 stage, HT and GB filter.
It includes :—	
2 Chokes, HF, type 709	CH301, CH302, 25 turns, 22 s.w.g. en. cu. wire on S.R.B.P. former 0.187 in. d. × 2.12 in.
2 Condensers, type 580	C305, C306, 0·002μF ± 15%, 350V, DC. wkg., mica, moulded, wires.
Filter unit, type 144	1 leg, 2 stage, input filter.
It includes :—	
1 Bracket, type 369	MS., 16 s.w.g. × 0·312 in., 2·312 in. high, with base 1·032 in. Two 6 B.A. studs in upright member. Outer stud near base.
1 Bracket, type 370	As type 369, but with studs reversed.
4 Condensers, type 3362	C308, C309, C310, C311 each. 0·1μF. ± 20%, 350V. DC. wkg. paper, tubular.
1 Cover, type 451	Tinplate, 26 s.w.g., 1·87 in. × 2·25 in. × 2·31 in. high.
2 Tagboards, type 381	S.R.B.P. 1·25 in. × 0·312 in. × 0·046 in., 2 fixing holes 0·125 in. d. at 1 in. ctrs. Fitted with 1 tag.

ANCILLARY EQUIPMENT

Case, Transit, TR.1464	Includes anti-vibration mountings.
Controller, Electric, type 12	See next section for details.
Adjusters, type 24	Screwdriver, insulated, for trimming condensers.
Extractor VR91	For removing VR91 valves.

CONTROLLER

Controller, Electric, type 12	Remote, 5 push-button operation, complete with lamps and dimming devices.
Items of controller :—	
Cover, type 444	Base. Aluminium, 22 s.w.g. with holes for fitting Breeze and W plugs.
Cover, type 445	Left-hand side. Aluminium 16 s.w.g., 5·437 in. × 4 in.
Cover, type 446	Right-hand side. Aluminium 16 s.w.g., 5·437 in. × 4 in.
Cover, Lamp, Top	Moulded, 4·812 in. × 0·781 in. × 0·25 in., complete with non-loose nuts
Cover, Lamp, Inner	Moulded, 0·906 in. × 0·64 in. × 0·343 in.
Clips, Dimmer Screw	2 off brass, 0·020 in. thick, 'U' shaped.
Dimmer-plates	M.S. plate 27 s.w.g., with 3 cups which cover filament lamps when operated.
Frame	Aluminium. Comprising sides and top, and engraved.
Knobs, type 402	Moulded, 1·12 in. dia. skirt with pointer, × 0·12 in. at top × 0·125 in. high. To fit 0·25 in. dia. spindle.
Lamp Holder, type 143	S.R.B.P. sheet fitted with 3 lamp holders to take lamps 5L/2273.
Lamp, Filament	3 volt, 0·6 watt, C.E.A.G. Barnsley.
Plug, W203	Plug E—18 pole, panel mounting with square flange.
Plug, single, type AC.1	Special 4-pin Breeze plug F.
Resistance, type 4650	R501, 500 ohm ± 20%, 1 watt. Potentiometer, linear, wire-wound, moulded body with cover. Spindle 0·25 in. dia. × 0·5 in. Colvern 21C/4.
Resistance, type 4651	R502, 110 ohm ± 5%, 6 watt, wire wound, ceramic Dubilier AB.
Spring, Compression, type 84	23 s.w.g., nickel piano wire, 12 turns, 0·265 in. internal dia. × 0·75 in.
Switch, type 1359	T-R-BA switch. P.O. type, lever key, with special cam.
Switch, type 1360	5 digit push button assembly. Interlocking, 4 make and 1 break.
Tagboard, type 495	S.R.B.P. 1·87 in. × 0·87 in. × 0·06 in. with two 6 B.A. tapped bushes at 0·75 in. centres. Fitted with two tags.

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RECEIVER

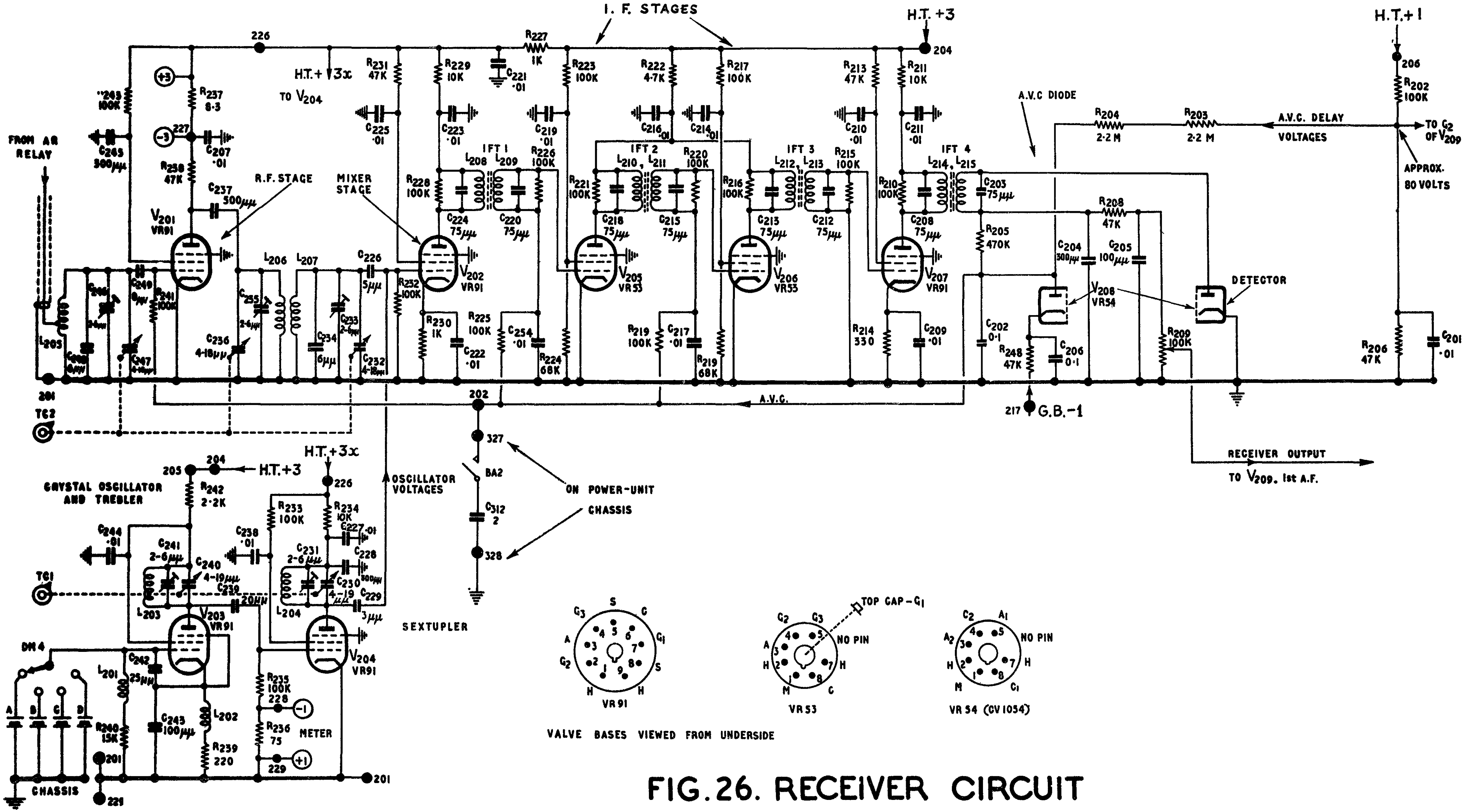


FIG. 26. RECEIVER CIRCUIT

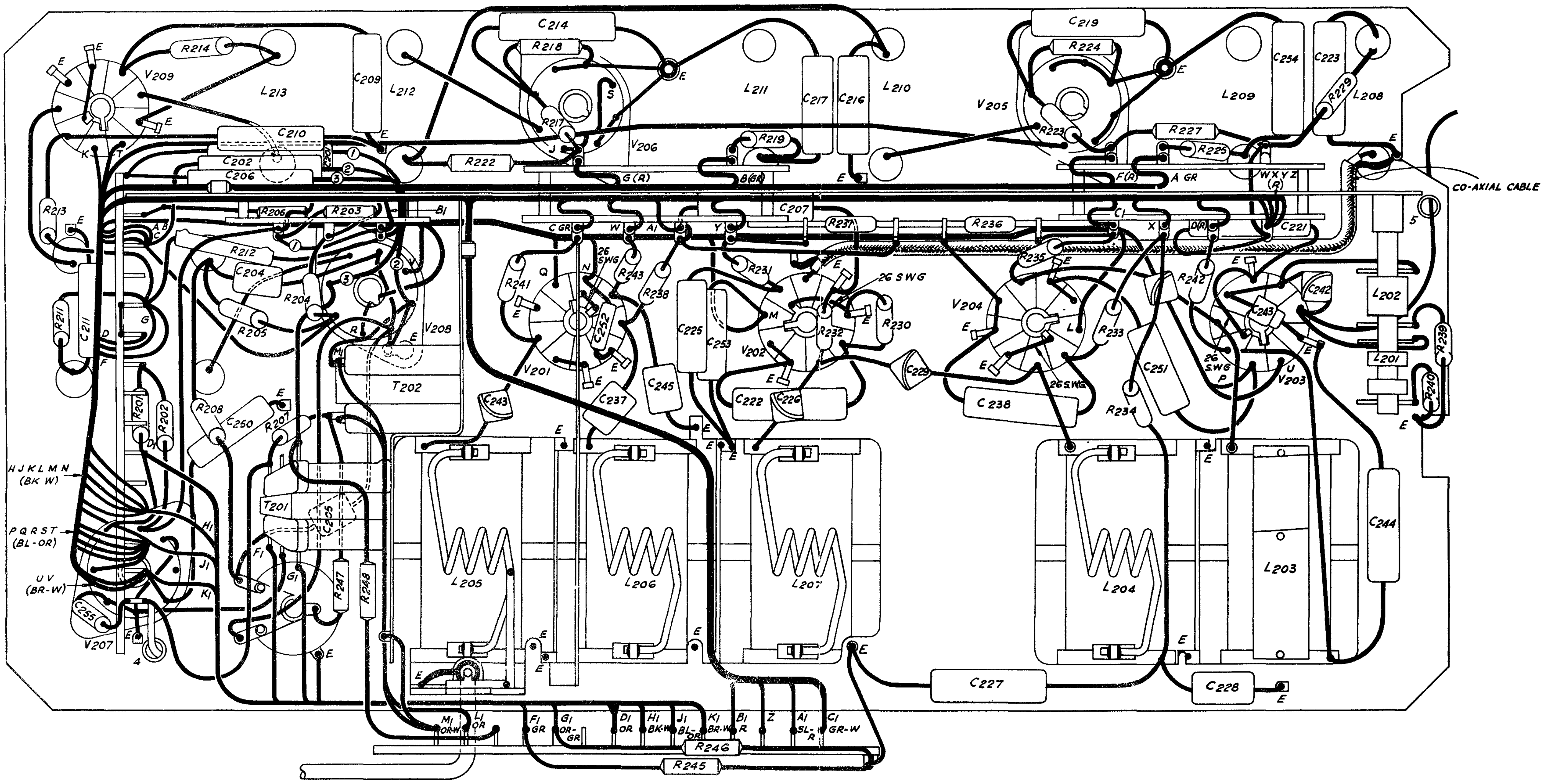


FIG. 27. RECEIVER LAYOUT, UNDERSIDE VIEW

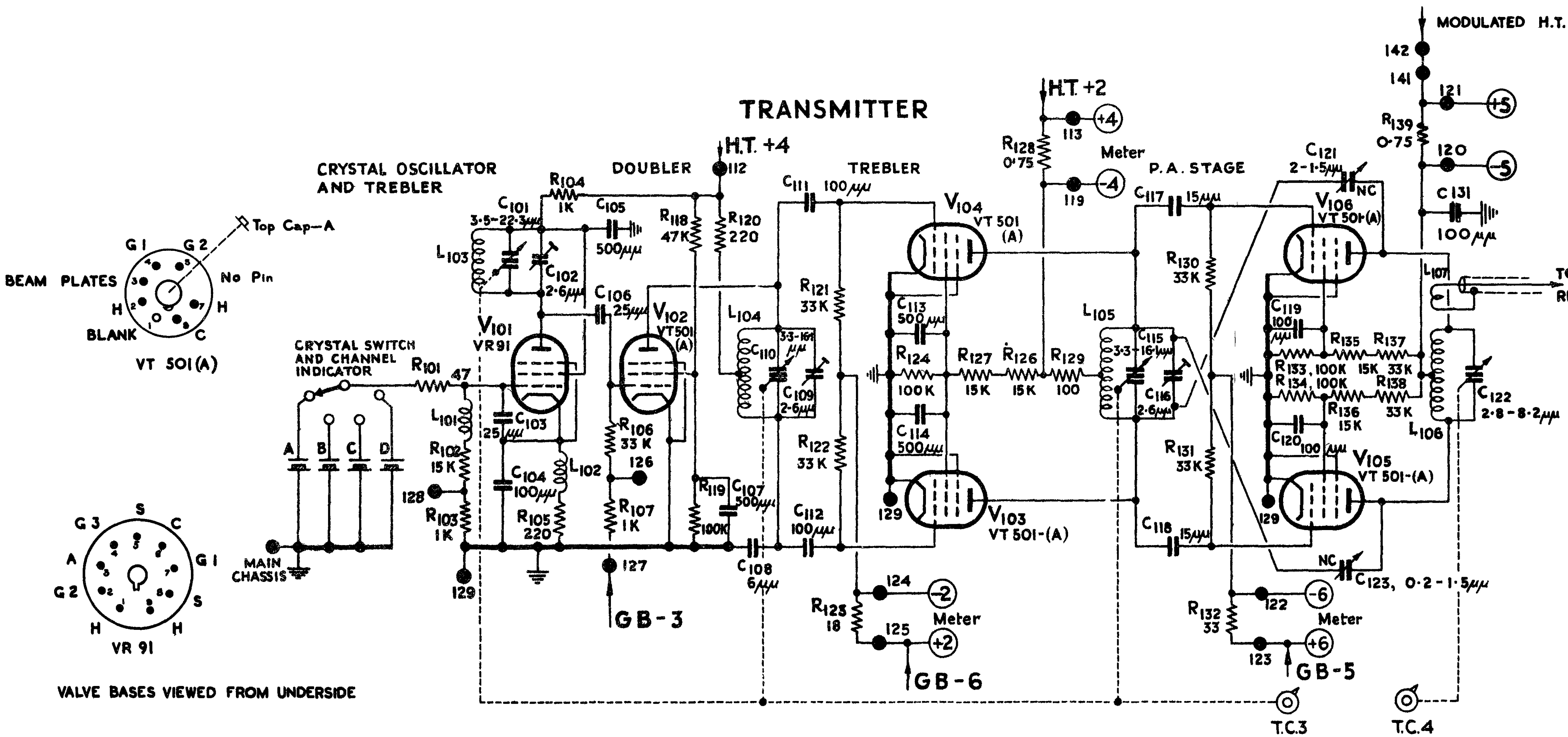


FIG. 28. TRANSMITTER CIRCUIT

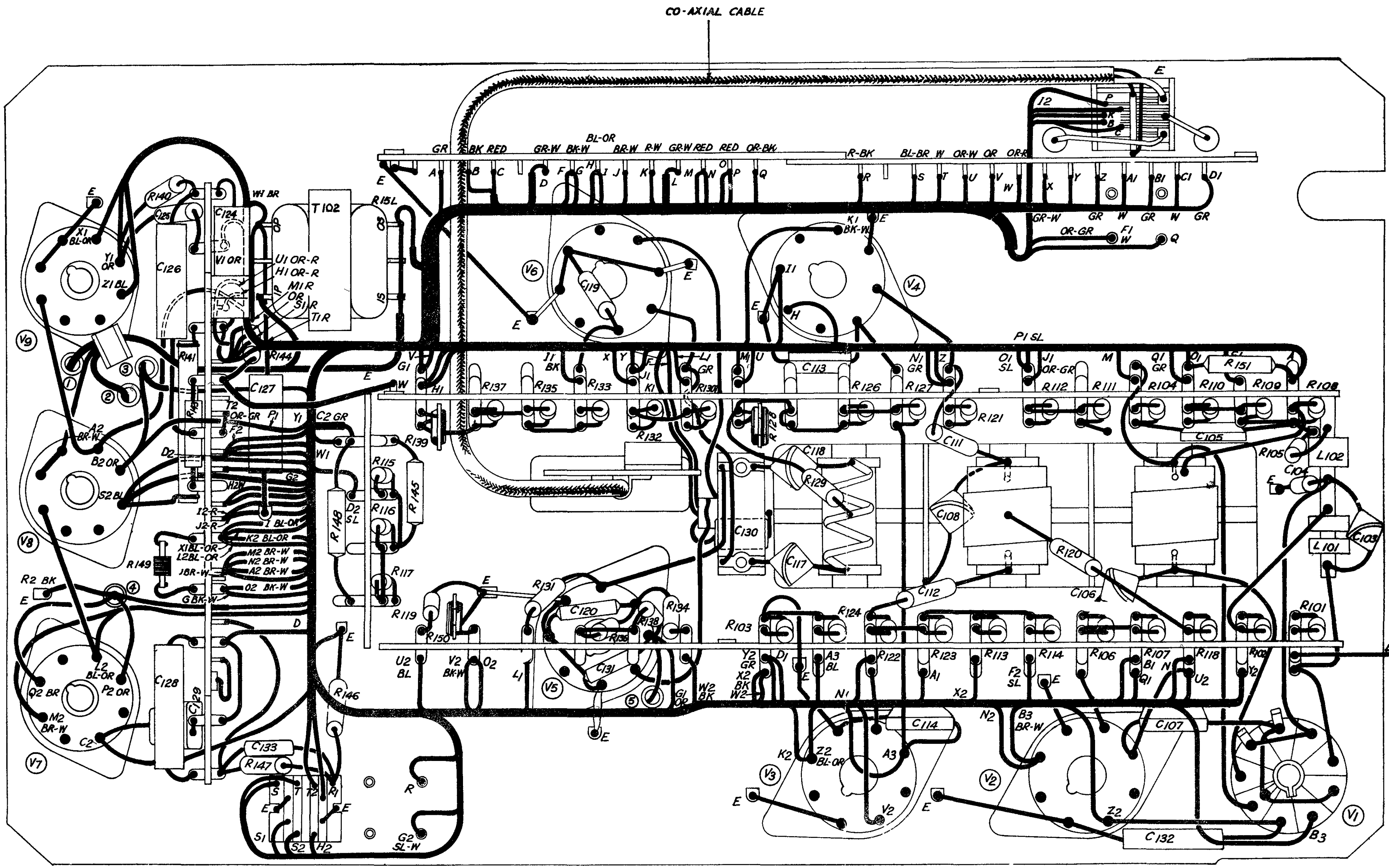


FIG. 29. TRANSMITTER LAYOUT, UNDERSIDE VIEW

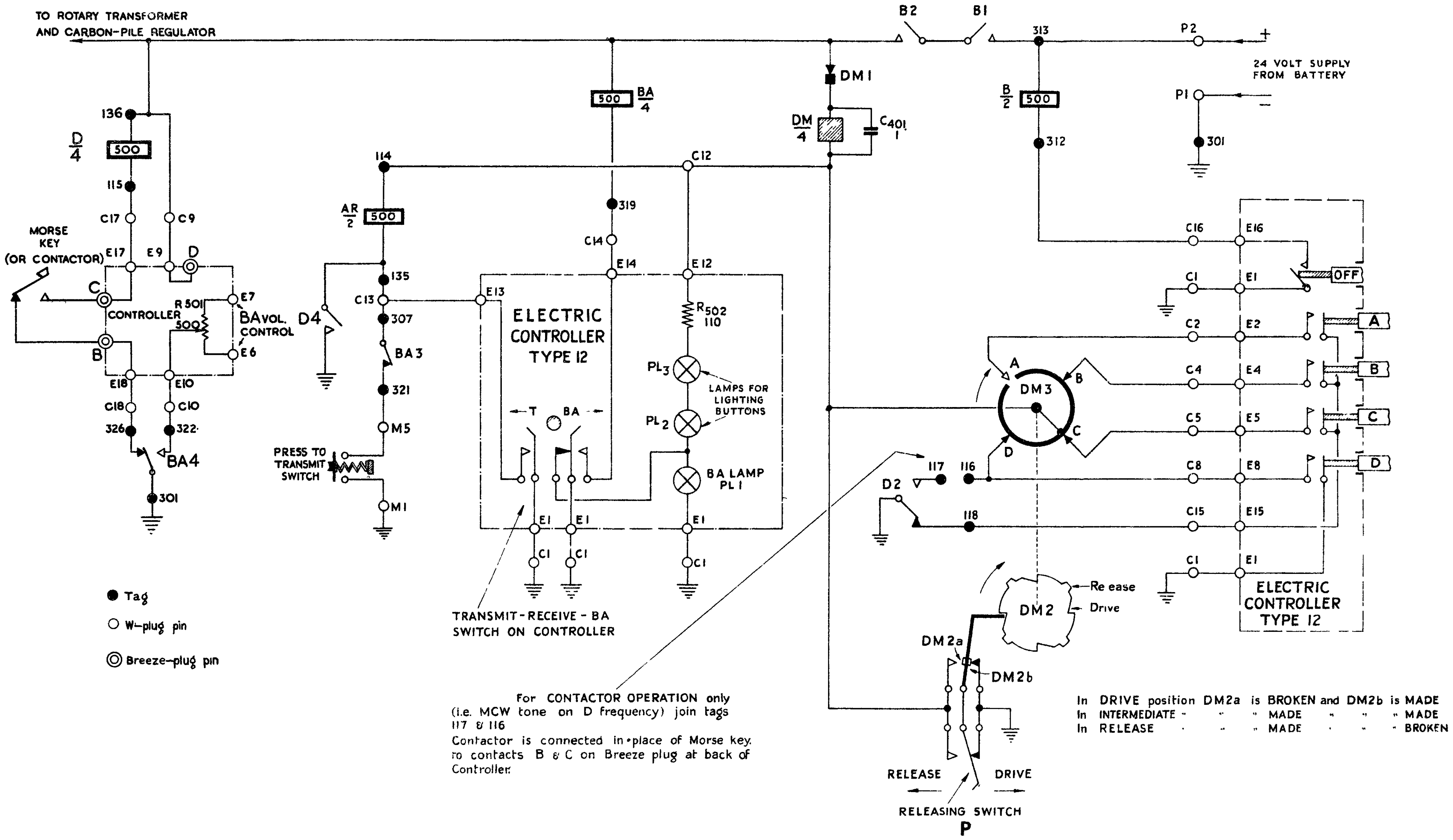


FIG.32. THE CONTROL CIRCUITS

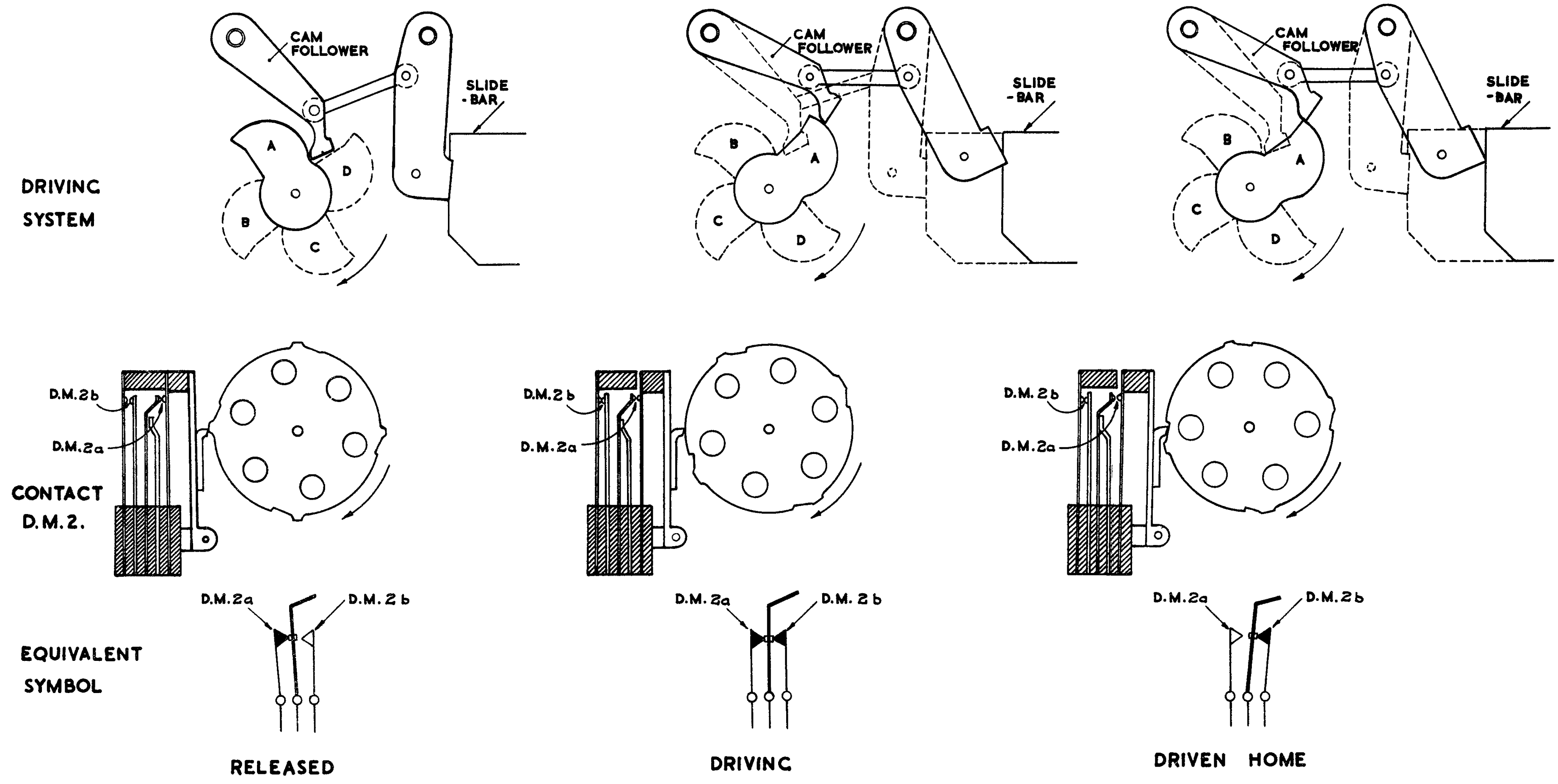


FIG.33. DRIVE - MOTOR OPERATION

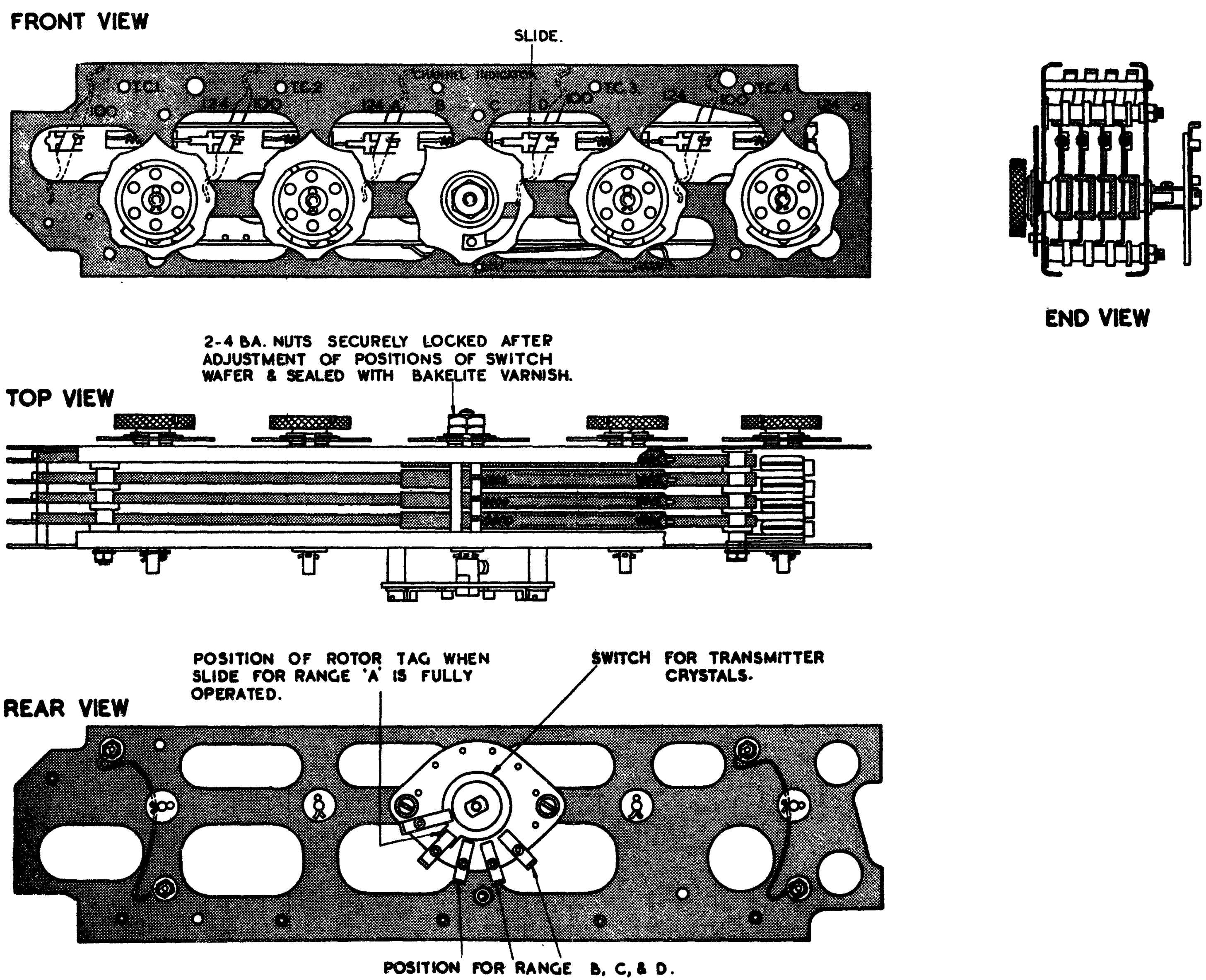
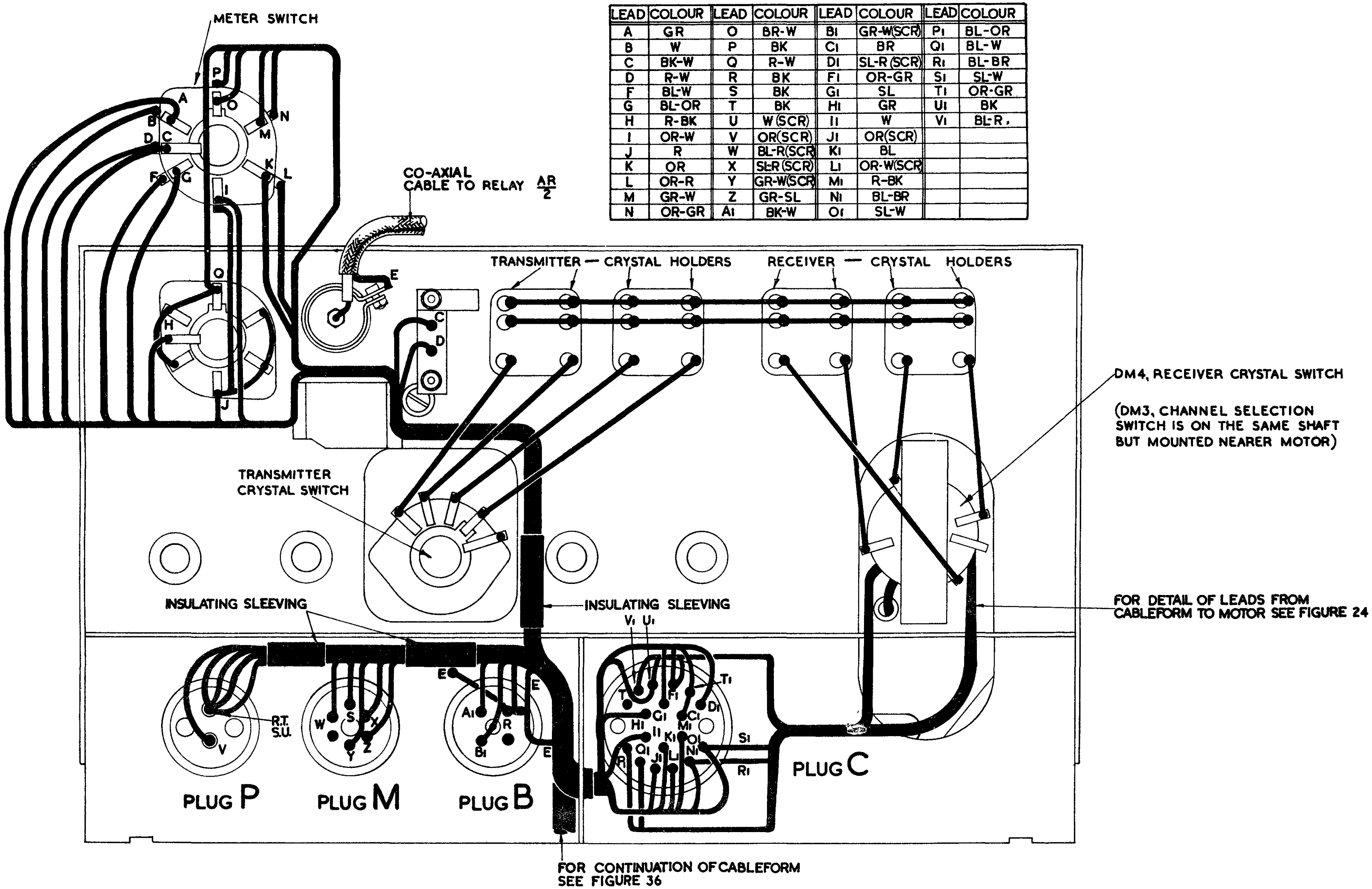


FIG.34, CONDENSER DRIVE UNIT.



LEAD	COLOUR	LEAD	COLOUR	LEAD	COLOUR	LEAD	COLOUR
A	GR	O	BR-W	B_1	GR-W(SCR)	P_1	BL-OR
B	W	P	BK	C_1	BR	Q_1	BL-W
C	BK-W	Q	R-W	D_1	SL-R(SCR)	R_1	BL-BR
D	R-W	R	BK	F_1	OR-GR	S_1	SL-W
F	BL-W	S	BK	G_1	SL	T_1	OR-GR
G	BL-OR	T	BK	H_1	GR	U_1	BK
H	R-BK	U	W(SCR)	I_1	W	V_1	BL-R,
I	OR-W	V	OR(SCR)	J_1	OR(SCR)		
J	R	W	BL-R(SCR)	K_1	BL		
K	OR	X	SL-R(SCR)	L_1	OR-W(SCR)		
L	OR-R	Y	GR-W(SCR)	M_1	R-BK		
M	GR-W	Z	GR-SL	N_1	BL-BR		
N	OR-GR	A_1	BK-W	O_1	SL-W		

FIG. 35. FRONT PANEL & MAIN FRAME, BENCH WIRING DIAGRAM

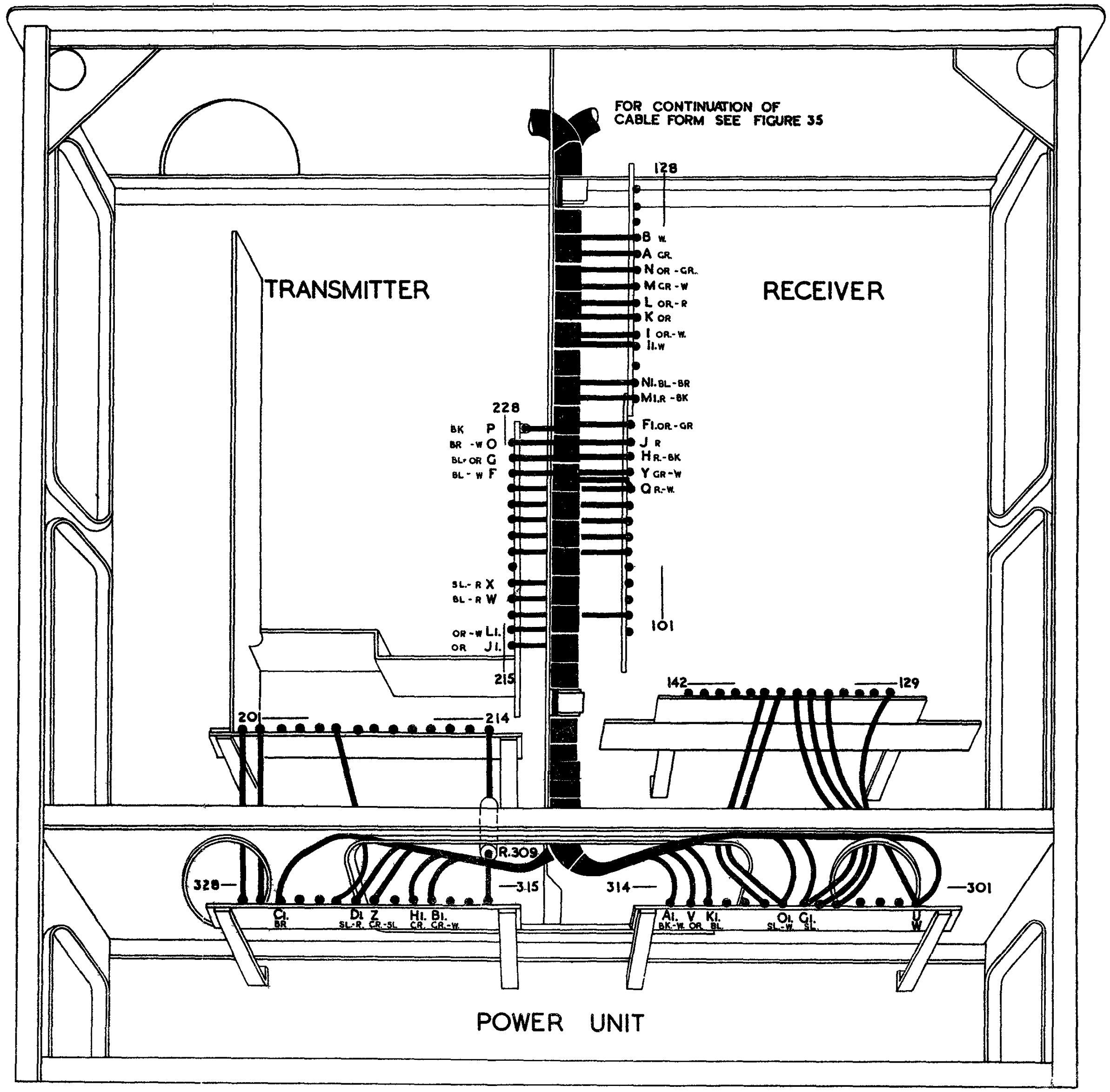


FIG. 36. CHASSIS BENCH WIRING DIAGRAM.