

CHAPTER 4

TRANSMITTER-RECEIVER T.R.1143

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Introduction

1. The transmitter-receiver T.R.1143, hereafter referred to as the T.R.1143, is an airborne communication equipment which may be operated on any one of four pre-determined frequencies within the 100 to 124 Mc/s band.

2. Communication is entirely by R/T and, under normal conditions, the range of the equipment is 125 miles air-to-air or air-to-ground, when the aircraft is at an altitude of 10,000 ft.

3. The T.R.1143 comprises a transmitter and receiver, both of which are crystal-controlled, and an A/F amplifier unit used in conjunction with the transmitter and receiver. The A/F amplifier unit also functions as an I/C amplifier in multi-seater aircraft. The transmitter is available for modulation by the pilot alone but other members of a crew can monitor incoming and outgoing speech.

4. The dimensions and weight of the T.R.1143 equipment (less power unit) are as follows:—

Length ...	16 inches
Breadth ...	13 inches
Depth ...	10½ inches (including W-plugs)
Weight ...	46 lbs.

The complete installation with B.A. equipment, interconnecting harness and junction boxes, etc., weighs approximately 104 lbs.

5. A press-button controller, accessible to the pilot alone, permits selection of the particular operating frequency and embodies a 3-position key switch performing the following functions:—

Switch Position	Function
1	Transmit
2	Receive
3	Voice-operated transmit and receive switching

A detent on the key switch is provided which withdraws the V/O facility and switches the equipment to receive except when the switch is manually retained in the transmit position.

6. The operation of the press-button controller may be overridden by an external contactor, the operation of which causes the transmitter to radiate tone modulated C.W. periodically at intervals determined by the contactor. The frequency of the tone modulation is 1,000 c.p.s.

GENERAL DESCRIPTION

7. Associated with the transmitter, receiver and amplifier is a power unit and the press-button controller which operates through control circuits embodied in the transmitter-receiver. The whole equipment is interconnected by a junction box through screened cables terminating in multi-way screened W-type sockets.

8. In some versions of T.R.1143, the components and terminals themselves are sign-written with three-figure numbers, of which the prefix, or hundreds digit, indicates the unit of which the component or terminal forms a part. In the case of terminals, the numbers form a guide to the interconnections, as terminals whose numbers are similar except as regards the hundreds digits, are interconnected. These prefixes are as follows:—

Number	Unit
100	Chassis
200	Transmitter
300	Receiver
400	A/F Amplifier
500	Selector motor drive mechanism
600	Relay unit
700	Controller—electric
800	Mic-Tel set—Pilot
900	Mic-Tel set—Crew

9. These three-figure numbers have been used in the following text. In the theoretical circuit diagram, fig. 3 the prefix figures are omitted owing to considerations of space.

Transmitter unit type 17

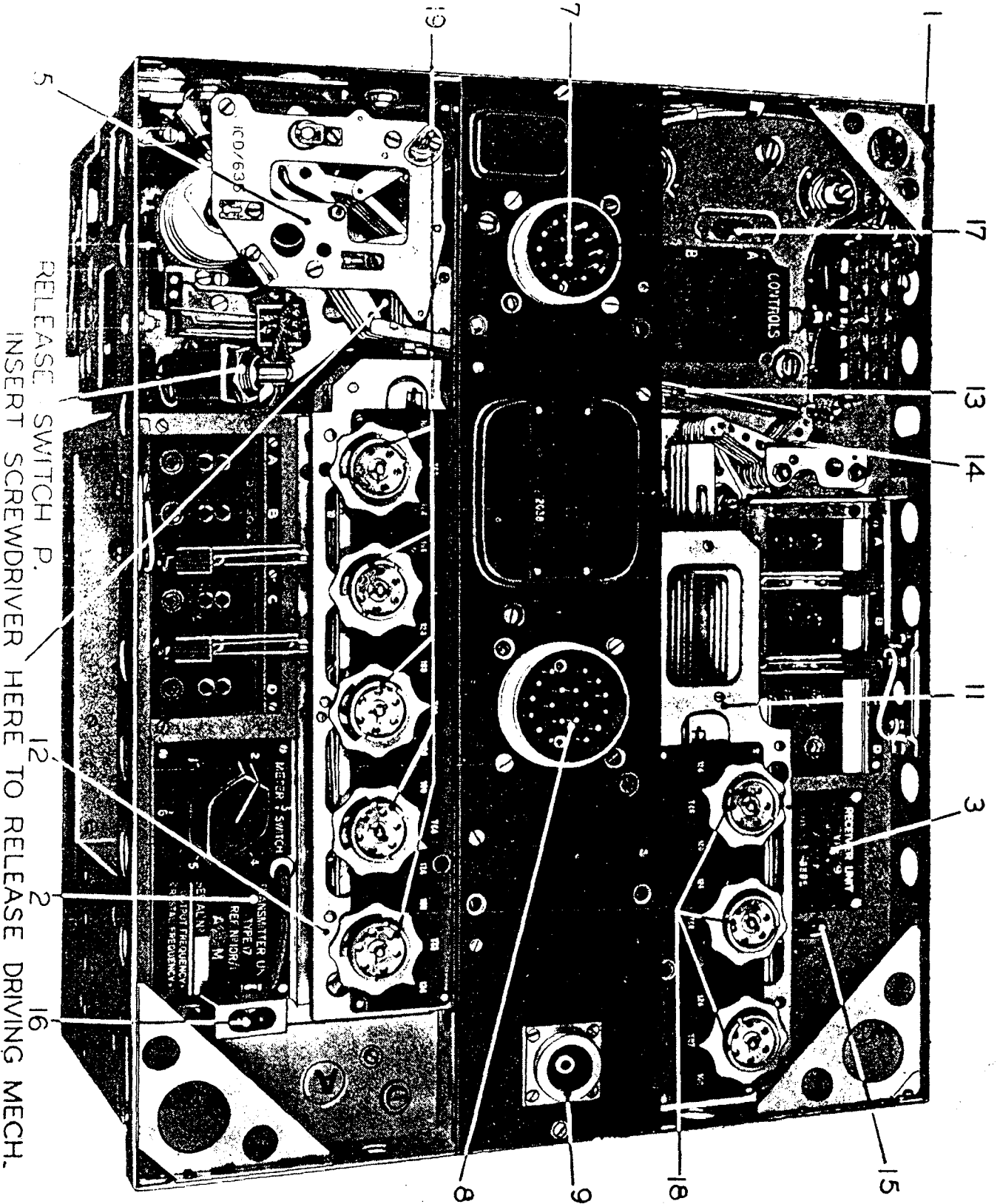
10. The transmitter unit, a circuit diagram of which is included in fig. 3 employs seven valves which perform the following functions:—

Valve	Type	Function
V-201	V.R.53	Crystal-oscillator
V-202	V.R.53	1st frequency trebler stage
V-203	V.T.501	2nd frequency trebler stage
V-204	V.T.501	Frequency doubler stage
V-205	V.T.501	Push-pull output
	or V.T.501A	
V-206	V.T.501	Push-pull output
	or V.T.501A	
V-207	V.R.92	Diode for output measurement

Alternatively, two valves, type V.T.501-A, may be used to replace the output stage V₂₀₅, V₂₀₆, but this type must not be employed elsewhere (*see* para. 20). It will be seen from the above table that the operating frequency is 18 times the crystal frequency and it should be noted by reference to fig. 3 that this output stage is anode modulated.

1. Top tray
2. Transmitter unit
3. Receiver unit
5. Tuning motor unit
7. Power plug
8. Control plug
9. Aerial plug
11. Receiver tuning slide
12. Transmitter tuning slide
13. Pull rods
14. Bell-cranks
15. Receiver meter plug
16. Transmitter meter plug
18. Receiver tuning condensers
19. Transmitter tuning condensers

FIG. 1. T.R. 1143
Front view, covers removed



RELEASE SWITCH P. 12 2 16
INSERT SCREWDRIVER HERE TO RELEASE DRIVING MECH.

11. The heaters of all valves are connected in series parallel with the exception of V_{207} which has the 42-ohms resistor R_{235} included in its heater circuit.

12. Fixed grid bias is applied to each of the valves, with the exception of V_{201} , from the grid bias potentiometer comprising the resistors R_{226} , R_{227} , R_{228} , R_{229} and R_{230} . This potentiometer is fed from a 150 volt commutator in the power unit via the resistor R_{101} which drops the voltage to 125 volts, with respect to earth, at terminal 201. In addition, a certain amount of bias is also obtained by all the valves from their individual grid resistors.

13. H.T. is supplied from the 300-volt source directly to V_{202} , V_{203} and V_{204} . The H.T. supply to V_{201} is supplied via the aerial changeover relay R_2 . The valves V_{205} and V_{206} obtain their H.T. supply via the modulator transformer T_{405} which is embodied in the A/F amplifier unit.

14. The various feeds to the valves V_{202} to V_{207} may be measured on an external meter in conjunction with the switch S_{205} and the resistors R_{222} to R_{225} connected in series with the H.T. supply to valves V_{202} , V_{203} , V_{204} and the output stage (V_{205} and V_{206}) respectively, provide suitable shunts for the meter. The resistor R_{234} connected between the chassis and the junction of C_{232} and R_{233} provides a suitable shunt for measurement of the current through the diode V_{207} . The resistor R_{217} is connected in the output stage grid circuit as a shunt for measurement of the grid current of the output stage V_{205} , V_{206} .

15. The following table shows the switch positions of S_{205} for the measurement of the various feeds referred to in para. 14, these switch positions correspond to those marked on the switch panel.

Switch Position	1	2	3	4	5	6
Value No. ...	V_{202}	V_{203}	V_{204}	V_{205} , V_{206}	V_{207}	Grid Current V_{205} and V_{206}
Measurement ...	Anode current	Anode current	Anode current	Anode, screen and potentiometer current	Diode current	Grid current

Circuit description

16. The crystal oscillator consists of a conventional pentode circuit employing a crystal as a tuned circuit connected to the grid of V_{201} via the selector switch S_1 to S_4 , and capacitance feed-back is provided by the condenser C_{201} . Any one of the four crystals may be switched into circuit by the operation of the selector mechanism, the remaining three being connected to earth. In fig. 3, S_1 is shown in the operated condition and this condition will be assumed to exist throughout the circuit descriptions of other associated units in order to clarify the tracing out of switching sequences.

17. The coupling from V_{201} to V_{202} is made via the condenser C_{205} connected directly between the anode and grid of these two valves.

18. The first trebler valve V_{202} is a pentode, operating as a tetrode and is biased below anode current cut-off point. When the anode circuit of the crystal oscillator valve V_{201} is tuned by the condenser T.C.₁ to crystal resonance, R.F. voltage is applied via the condenser C_{205} to the grid of V_{202} and this cancels some of the fixed bias already applied with the result that anode current commences to flow. The screen of V_{202} is series fed via R_{207} , and R_{208} is simply an anode circuit decoupling resistor. The circuit L_{202} T.C.₂₀₂ is tuned to three times the crystal frequency and this R.F. voltage is applied to the second trebler valve V_{203} via the coupling condenser C_{210} .

19. The second trebler valve V_{203} is an aligned-grid tetrode and operates in a similar manner to V_{202} . The anode circuit of V_{203} includes the inductance L_{203} tuned by the condenser T.C.₂₀₃ to a frequency nine times that of the crystal frequency.

20. It should be noted here that in earlier models the screen of V_{203} is fed via the relatively high resistance R_{209} and hence if this valve has a high screen current, then the screen voltage will be low and the performance of this stage will be inferior. High screen current valves are designated V.T.501A and whilst these valves may be used in the output stage (V_{205} , V_{206}) which is less critical, they should not be used in place of V_{201} .

21. The R.F. output voltage from V_{203} is fed via the condenser C_{214} to the grid of the doubler valve V_{204} . The doubler valve V_{204} operates in much the same way as V_{202} and V_{203} . The anode inductance L_{204} is tuned by the condenser T.C.₂₀₄ to eighteen times the crystal frequency.

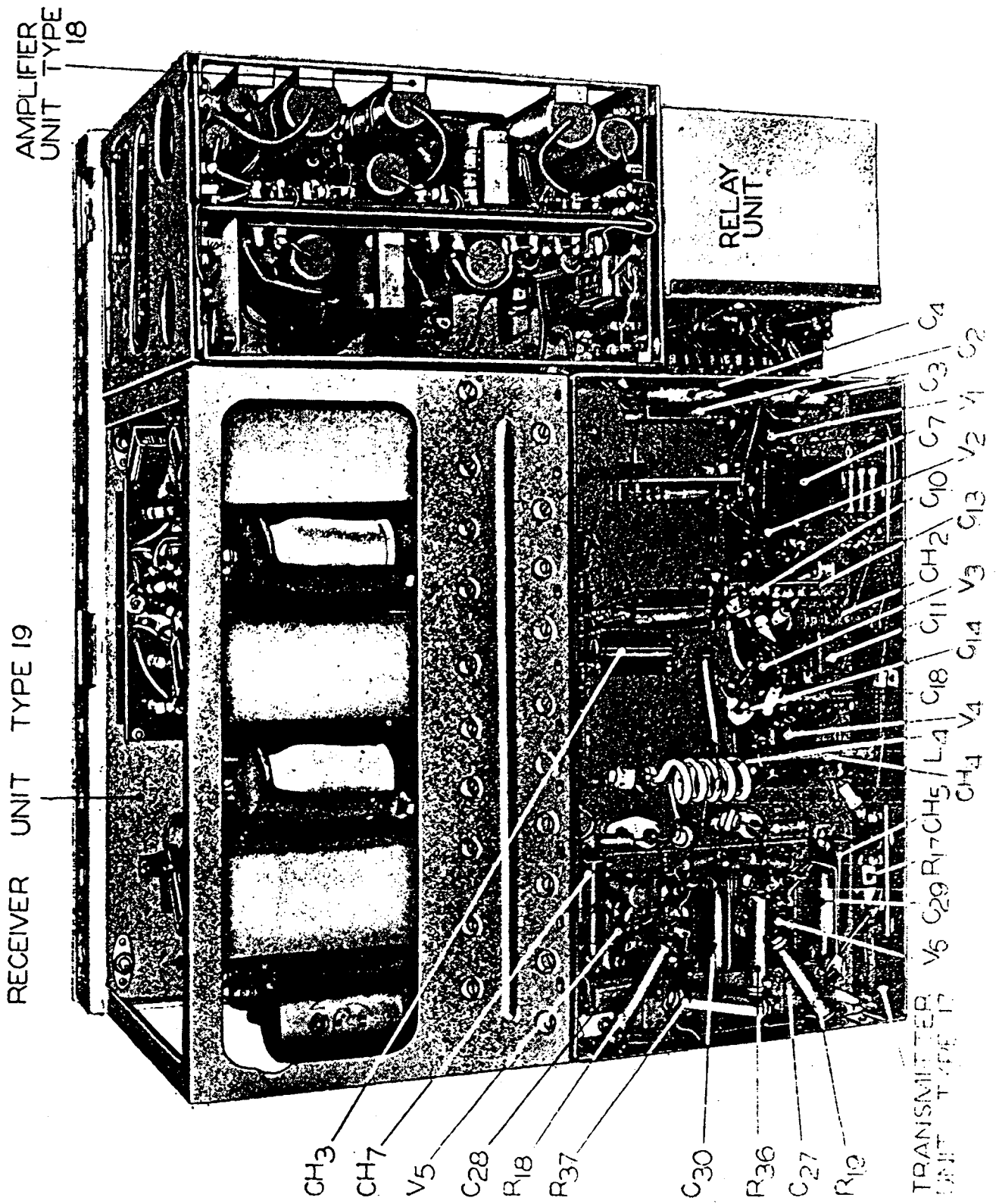
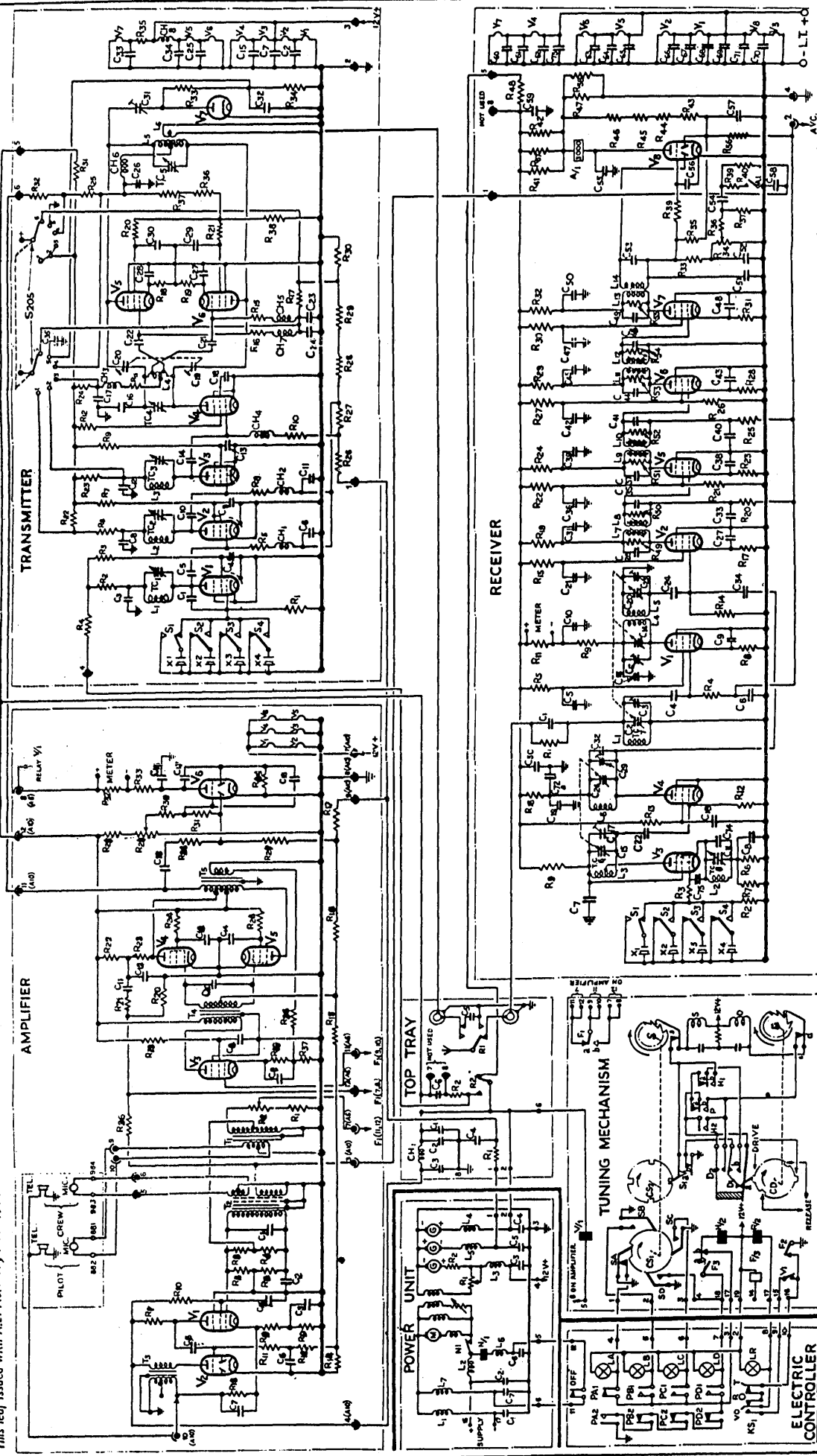


Fig. 2.—T.R.1143 rear view, case removed

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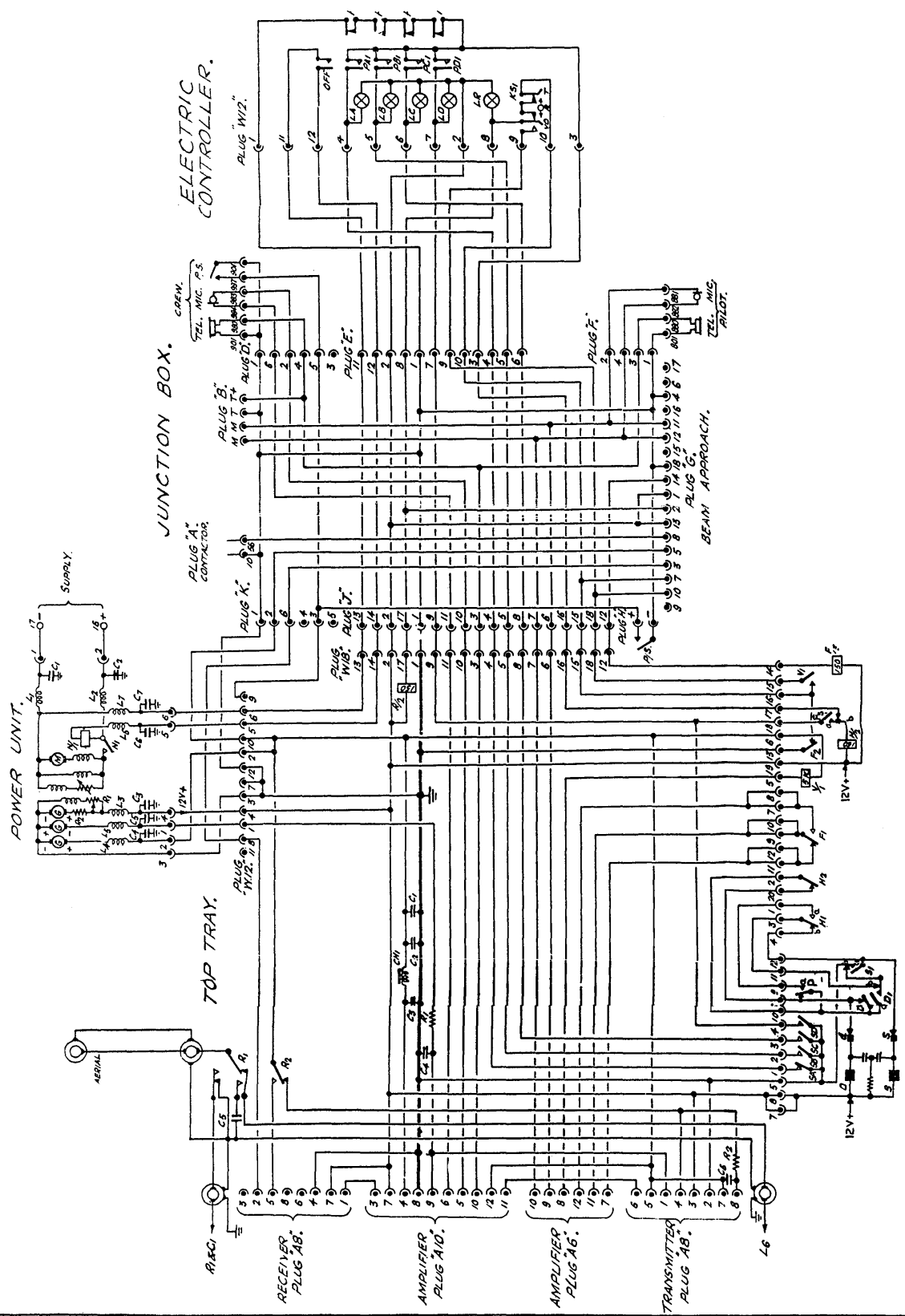


T.R. 1143 CIRCUIT DIAGRAM

FIG. 3

FORM 11230G(10) 12-28-35 0-11-41

NOTE: I RELAYS IN TUNING MECHANISM AND POWER UNIT SHOWN BLOCKED-IN ARE ENERGISED BY ACTION OF PA1 AND "OFF" CONTACTS.
NOTE II EQUIPMENT IS SHOWN SWITCHED TO "RECEIVE" POSITION.



INTERCONNECTION DIAGRAM.

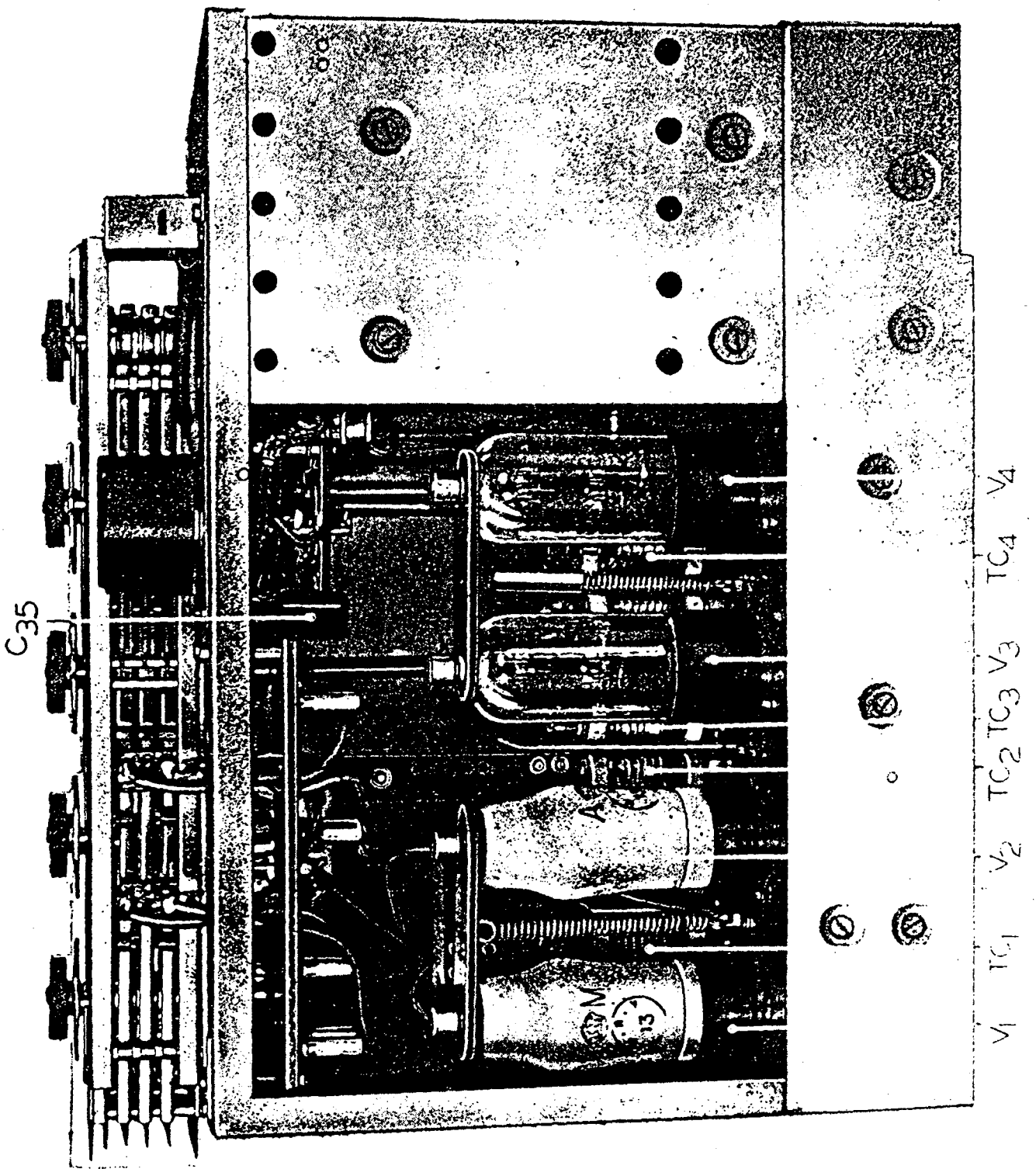


Fig. 4. Transmitter unit, type 17—side view

22. It will be noted by referring to fig. 3 that the inductance L_{204} is centre-tapped and the balancing condenser C_{216} connected between the junction with T.C.₂₀₄ and earth. This circuit causes the phase reversal necessary to feed the two output valves. The coupling to V_{205} and V_{206} is obtained via the condensers C_{221} and C_{222} which are tapped down the inductance L_{204} to decrease the loading on V_{204} . The condensers C_{221} and C_{222} are cross-connected in order to provide the correct phase relationship. Neutralization of the output stage is carried out by means of the built-in neutralizing condensers C_{219} and C_{220} . (See tuning instructions).

23. The output valves V_{205} , V_{206} are power amplifiers operating in push-pull and their fixed grid bias is less than that of the frequency multiplier valves. Both the anode and screen grid of each output valve are supplied with H.T. via the modulation transformer. The screen grids of V_{205} and V_{206} are fed by the potentiometer R_{236} , R_{237} and R_{238} to ensure a correct depth of modulation reasonably free from distortion. In contrast to the multiplier stages, V_{205} and V_{206} have some anode current flowing even when the crystal oscillator is not oscillating or when the T.R.1143 is switched to "Receive".

24. Coupling to the aerial relay socket is obtained via the link inductance L_{206} . A small amount of R/F output is also fed to the diode rectifier valve V_{207} via the disc which forms C_{231} . R_{233} is the rectifier load resistor.

Receiver unit, type 19

25. This receiver, a circuit diagram of which is included in fig. 3 is a crystal-controlled super-heterodyne and employs eight valves which perform the following functions:—

Valve	Type	Function	Remarks
V_{301}	V.R.91	Signal frequency amplifier	---
V_{302}	V.R.91	Mixer valve	---
V_{303}	V.T.52	{ Crystal oscillator Frequency multiplier	Crystal freq. $\times 3$
V_{304}	V.R.91	Frequency multiplier	$3 \times$ Crystal freq. $\times 6$
V_{305}	V.R.53	1st I.F. amplifier	I.F. = 9.72 mc/s.
V_{306}	V.R.53	2nd I.F. amplifier	---
V_{307}	V.R.91	3rd I.F. amplifier	---
V_{308}	V.R.55	{ 2nd detector A.V.C. control Muting control	---

26. The signal frequency is applied to the control grid of V_{301} via the condensers C_{301} , C_{304} . The grid circuit is tuned to the signal frequency by the condensers C_{302} and trimmer C_{303} connected across the inductance L_{301} .

27. The output of V_{301} is applied to the control grid of the mixer valve V_{302} via the band-pass circuit consisting of L_{304} , L_{305} tuned by C_{314} and C_{320} respectively. To facilitate tuning the condensers C_{302} , C_{314} and C_{320} are gang-controlled and provision is made for a tuning meter to be connected in the anode circuit of V_{301} across the shunt resistor R_{311} .

28. The valve V_{303} is a pentode and combines the following functions:—

- (i) Crystal controlled oscillator.
- (ii) Frequency multiplier.

The oscillation frequency of V_{303} is determined by one of the four crystals X_1 , X_2 , X_3 or X_4 selected by the same switch mechanism as in the case of the transmitter unit. In fig. 1 "A" channel is shown in the operated position.

29. The anode circuit of V_{303} includes the inductance L_{303} which is tuned by the condenser C_{315} (T.C.8) and the trimmer C_{317} to a frequency three times that of the selected crystal. The output of V_{303} supplies the requisite drive via the condenser C_{322} to the control grid of the frequency multiplier valve V_{304} . The magnitude of this drive is determined by the tuning of the anode circuit inductance L_{303} by the condenser C_{315} (T.C.8) and also by the tuning of the cathode circuit inductance L_{302} by the condenser C_{311} (T.C.8).

30. It should be noted that the circuit L_{302} , C_{311} operates as a feed-back circuit to the crystal but this circuit is *not* tuned to the crystal frequency and its inclusion is intended only to assist the drive obtained from the anode circuit of V_{303} in cases where the particular crystal has a low degree of activity. In such cases the normally flat characteristic of this circuit becomes sharp, and a marked effect results from accurate tuning. Further detailed information regarding the tuning of this circuit will be found under "Tuning Instructions".

31. The valve V_{304} is a pentode operating under class "C" conditions and functions as a harmonic generator. The anode inductance L_{306} is tuned by the condenser C_{326} to a frequency eighteen times that of the crystal frequency.

32. The eighteenth harmonic output of V_{304} is applied via the condenser C_{334} to the control grid of the valve V_{302} , thus at this point both the signal frequency and the eighteenth harmonic of the crystal frequency are together applied to the control grid of V_{302} which functions as a mixer valve.

33. The valve V_{302} is also a pentode and the primary winding of the first I.F. transformer L_{307} is included in its anode circuit with the condenser C_{328} and damping resistance R_{349} connected in parallel with it. The intermediate frequency to which this and the subsequent I.F. transformers are tuned is 9.72 Mc/s. The secondary winding L_{308} with its associated condenser C_{335} and damping resistor R_{350} is connected to the control grid circuit of the first I.F. amplifier valve V_{305} .

34. The anode circuit of V_{305} is similar to that of V_{302} and the I.F. signal is successively amplified by the valves V_{306} and V_{307} coupled together by I.F. transformers similar to that employed between V_{302} and V_{305} .

35. The output of the valve V_{307} is fed via the transformer windings L_{313} , L_{314} , to one of the diode circuits of the double diode-triode valve V_{308} . This valve combines the functions:

- (i) Second detector.
- (ii) A.V.C. control valve.
- (iii) Muting valve.

36. The diode portion of the valve V_{308} referred to in para. 35 de-modulates the I.F. signal, the audio frequency component of which appears across the potentiometer R_{334} . The combination R_{333} , C_{351} and C_{352} are included to filter out the remaining R/F component of the signal and the A/F signal is now fed via the attenuating network R_{336} , R_{337} and R_{340} , coupled by the condenser C_{354} to the output terminal. The condenser C_{358} is included in order to attenuate the higher audio frequencies and thus improve the signal/noise ratio of the receiver unit.

A.V.C.

37. The A.V.C. voltage required for the controlled valves V_{301} , V_{305} and V_{306} is obtained from the D.C. potential developed across the resistances R_{333} and R_{334} during the process of de-modulation of the I.F. signal referred to in para. 36 and this voltage is applied via the resistor R_{350} to the A.V.C. line. Suitable delay action is obtained by the combination of the potentiometer network R_{343} to R_{346} and the resistor R_{335} in conjunction with the remaining diode portion of V_{308} . Under "no signal" conditions, a current of approximately 20 micro-amperes flows through the potentiometer formed by the resistors R_{343} to R_{346} and the second diode portion of the valve V_{308} to earth. The anode of this diode portion to which the A.G.C. line is connected is at approximately zero potential. When the voltage developed across the signal diode load circuit comprising C_{351} , R_{333} and R_{334} approaches 10 volts negative with respect to earth potential, the current through the resistor R_{335} approaches 20 micro-amperes. The diode current therefore approaches zero, and any further increase of the voltage across the diode load circuit will then be applied to the A.G.C. line.

Muting

38. The same D.C. potential developed across the resistors R_{333} and R_{334} is also applied to the control grid of the triode portion of V_{308} via the resistor R_{338} . The time constant of the combination R_{338} and C_{356} is such that the muting action of the triode portion of V_{308} does not follow modulation variations but adheres to the mean carrier level and prevents the muting relay A/I from operating on modulation peaks. Thus an increase of negative grid potential on the grid of V_{308} will cause a reduction in the anode current of this valve, and as this current flows through the winding of the A/I relay which is normally retained in the operated position, such a reduction will cause the relay to release. The release of the A/I relay disconnects the resistor R_{339} which is connected across the output terminals and is of such a value that, in the absence of signal input the receiver noise level is greatly reduced.

39. The resistance network R_{341} , R_{342} , R_{347} , R_{357} and R_{358} is included as a potentiometer to provide the correct operating voltage for V_{308} and to maintain this voltage at a sensibly constant value.

40. It should be noted that, as in the case of the transmitter unit the valve heaters in the receiver unit are connected in series-parallel and fed from the Power Unit, type 15 or 16.

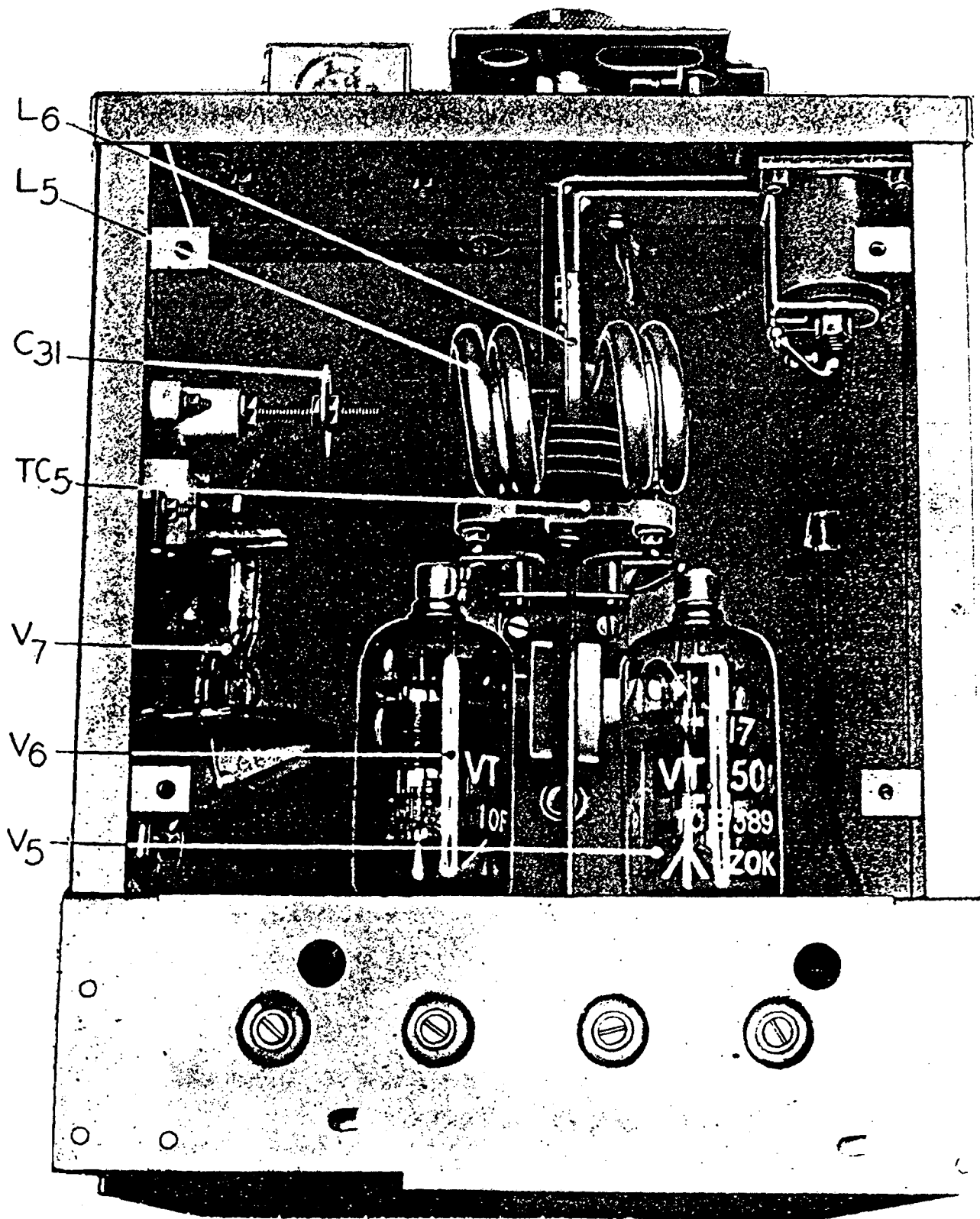


Fig. 5.—Transmitter unit, type 17- end view

Amplifier unit, type 18

41. The A/F amplifier unit employs six valves as shown in the table and performs the following functions:—

- (i) Amplifies the receiver unit output.
- (ii) Amplifies speech on I/C circuits.
- (iii) Modulates the transmitter.
- (iv) Generates 1,000 c/s oscillations during periods of contactor operation.
- (v) Operates the V/O send-receive switching.

Valve	Type	Function	Remarks
V ₄₀₁	V.R.56	Receiver and I/C amplifier	Output to V ₄₀₂
V ₄₀₂	V.R.55	Receiver and I/C amplifier	Output to pilot, and crew's phones
V ₄₀₃	V.R.56	1st Stage Transmitter Mod.	—
V ₄₀₄	V.T.52	2nd Stage Transmitter Mod.	Push-pull amplifiers
V ₄₀₅	V.T.52	2nd Stage Transmitter Mod.	
V ₄₀₆	V.R.55	Voice-operated Send-Receive switching	

42. Referring to the circuit diagram given in fig. 3 it will be seen that the transformer T₄₀₂ has two primary windings one of which is connected to the crew's microphone circuit, and the other winding to the receiver unit output.

43. The condenser C₄₀₁ is connected across the secondary winding of T₄₀₂ in order to correct the transformer frequency characteristic and this condenser also serves to by-pass any R/F component.

44. The secondary winding of T₄₀₂ which is approximately balanced to earth is connected to a bridge consisting of the four resistors R₄₀₃ to R₄₀₆.

45. One of the centre points of the bridge is earthed at the junction of R₄₀₅ and R₄₀₆, and one half of the output voltage of T₄₀₂ is thus applied by one arm of the bridge to the control grid of V₄₀₁.

46. The condenser C₄₀₂ is connected in parallel with the other arm of the bridge to counteract any unbalance of the transformer T₄₀₂ to earth including the effect of the grid-cathode capacitance of V₄₀₁.

47. The other centre point of the resistance bridge i.e. the junction of R₄₀₃ and R₄₀₄, is connected to the tapping on the secondary winding of T₄₀₁. Since the resistance bridge R₄₀₃ to R₄₀₆ is balanced, no voltage will be fed from the secondary winding of T₄₀₂ to the tapping on the secondary winding of T₄₀₁ or to the control grid of V₄₀₃. Thus the output from the crew's microphones and also the receiver unit output will only be passed to the I/C amplifier valve V₄₀₁ and will not affect the transmitter modulation.

48. It will also be appreciated that as the pilot's microphone circuit is connected to the primary winding of T₄₀₁ and the tapping on the secondary winding of T₄₀₁ is connected to the junction of R₄₀₃ and R₄₀₄, the output from the pilot's microphone is applied to both the control grid of the modulator valve V₄₀₃ and the I/C amplifier valve V₄₀₁, thus the pilot's microphone output modulates the transmitter and also the I/C system.

49. The valve V₄₀₂ functions as the output stage of the receiver unit and I/C amplifier. The control grid bias is obtained via the resistors R₄₁₁ and R₄₁₂ which are connected in series to the bias supply line. The condenser C₄₀₆ by-passes any A/F or R/F components developed in these resistors.

50. The output from the total secondary winding of the transformer T₄₀₃ is applied across three resistors in series, R₄₁₃, R₄₀₈ and R₄₀₉. The resistors R₄₀₈ and R₄₀₉ are connected in the cathode circuit of V₄₀₁, and in consequence a small fraction of the output voltage of the I/C amplifier is fed to the grid-earth circuit of V₄₀₁ in opposite phase to the original input voltage. This results in an improvement in the linearity of the I/C amplifier characteristic, rendering it substantially independent of alterations in output load impedance. The negative feed-back applied is increased at low frequencies by the condenser C₄₀₃ connected across R₄₀₉, and at high frequencies by the condenser C₄₀₇ connected across R₄₁₃.

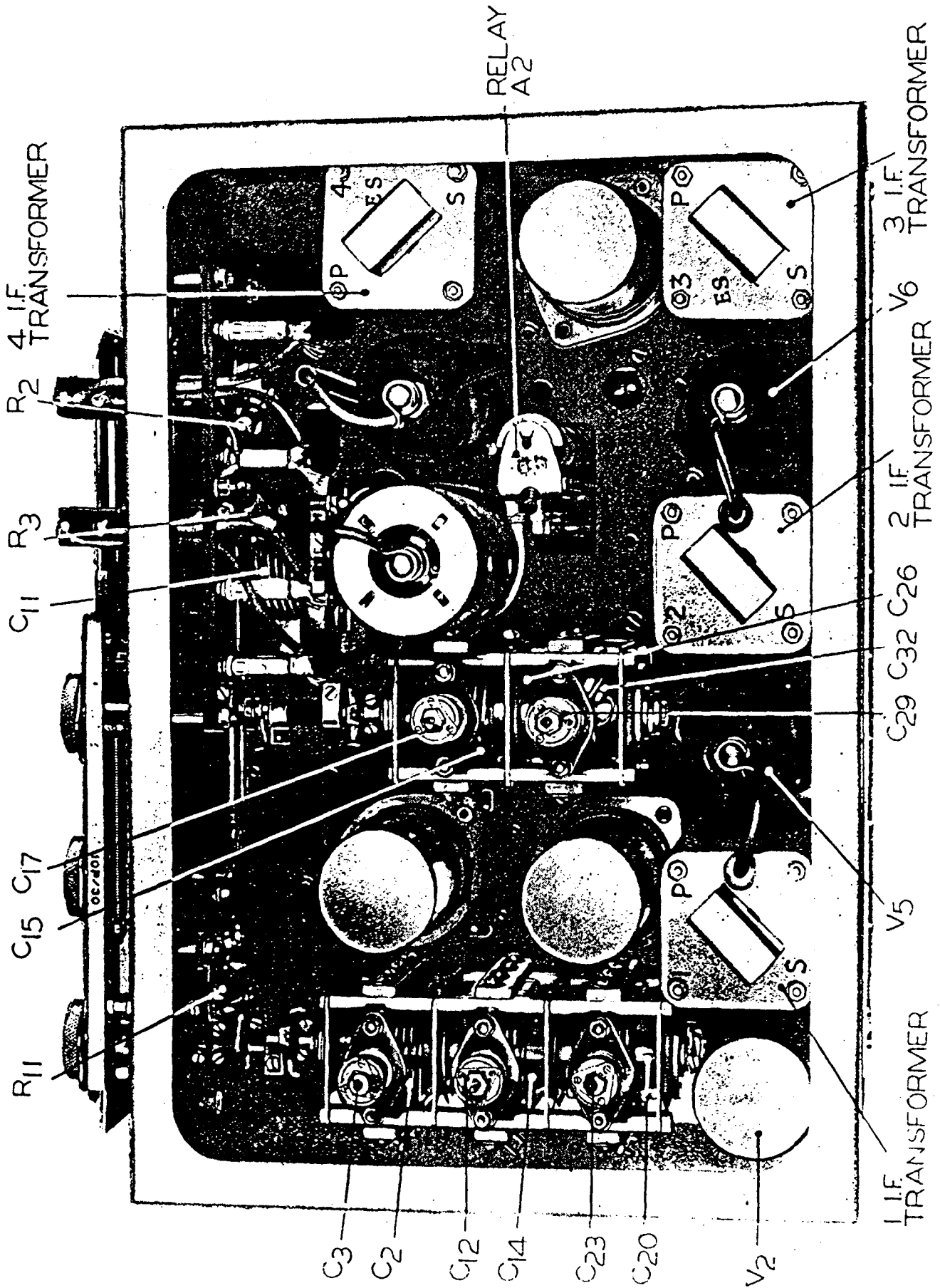


Fig. 6. Receiver unit, type 19 top view

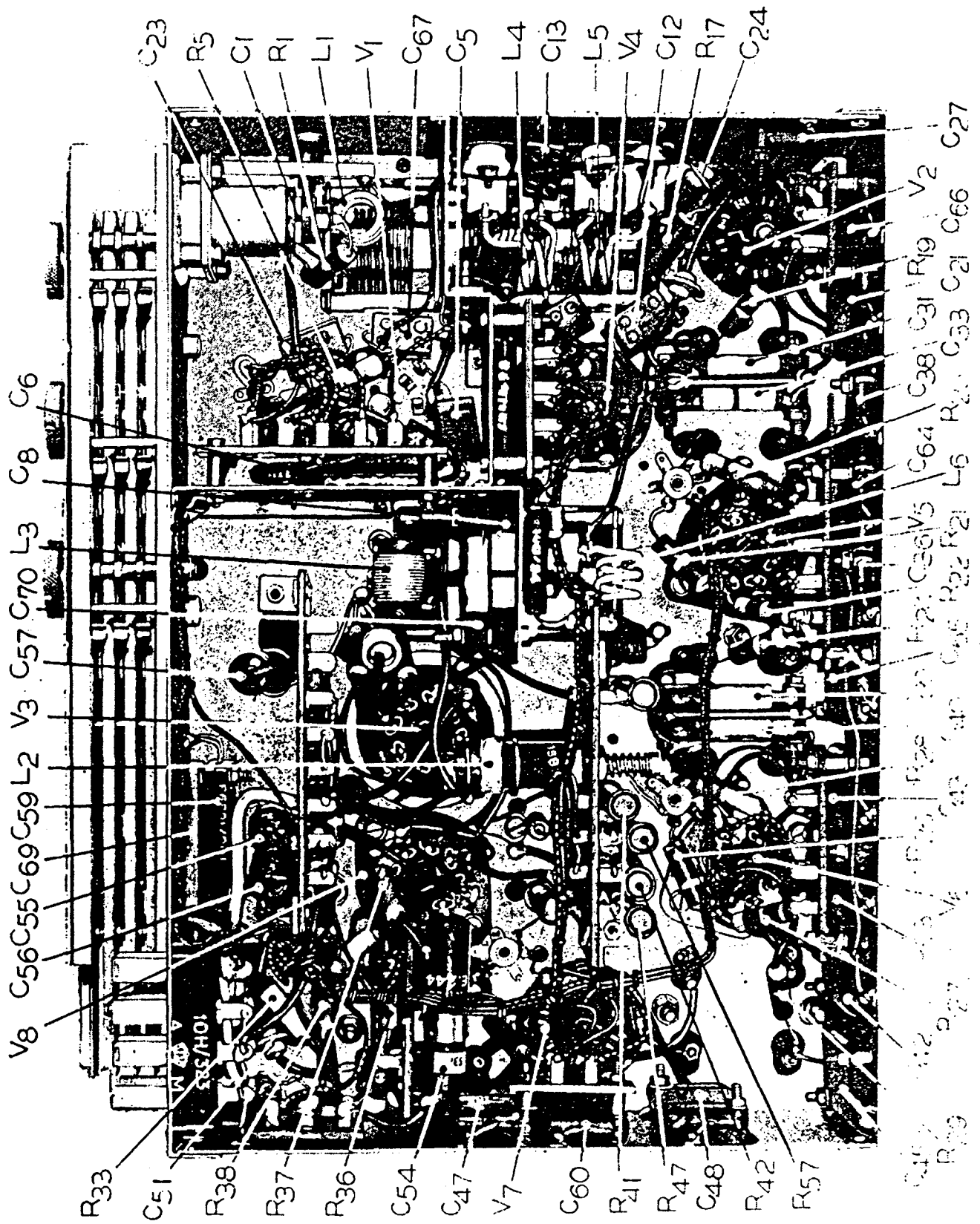


Fig. 7.- Receiver unit, type 19 base view

51. As stated in para. 48 the output from the pilot's microphone is applied via the transformer T_{401} , to the control grid of the modulator valve V_{403} . Connection to the control grid of V_{403} is normally made via the tapping on the potentiometer R_{402} and the contacts F_1 (9.10) and F_1 (11.12) (R_{401} is included to restrict the variation obtainable by the potentiometer R_{402}).

52. The anode of the valve V_{403} is coupled via the transformer T_{404} , to the push-pull valves V_{404} and V_{405} . The primary winding of the output transformer T_{405} is connected to the anodes of V_{404} and V_{405} at two points symmetrically placed about the H.T. feed tapping. The terminal which provides modulation to the transmitter is connected at a point on this winding which gives a suitable step-up voltage ratio.

53. The secondary winding of T_{405} provides negative feed-back to V_{403} via the potentiometers R_{435} , R_{437} . The resistor R_{418} provides cathode bias for the valve V_{403} . In some cases R_{437} is replaced by a metal filament lamp PL_{401} the resistance of which increases with the current flowing through it, and in this manner the negative feed-back voltage increases with the output, resulting in volume compression.

Voice operation valve

54. The valve V_{406} is included to provide the facility of voice-operated changeover from *receive* to *send* by means of a relay V/1 and this facility is intended for use by the pilot only.

55. This relay is connected to the H.T. supply and via the meter shunt R_{432} the load resistor R_{433} to the triode anode of V_{406} . The control grid of this valve is normally so biased as to permit an anode current sufficient to maintain the relay in the *operated* condition which leaves the equipment in the *receive* condition.

56. The bias circuit may be traced from a tapping on the potentiometer R_{429} via the resistors R_{430} , R_{431} and R_{427} to the junction of R_{416} and R_{417} on the main grid bias potentiometer.

57. One of the diode portions of the valve is connected via R_{426} and C_{415} to the transmitter modulator terminal II (A_{10}). The capacitance of C_{415} is made small to avoid the possibility of operation of the V/O system by the low frequency components of engine noise, and, for the same reason the delay bias provided by R_{437} is made fairly large.

58. When the A/F voltage developed in the modulation circuit by speech frequencies is sufficient to overcome the delay voltage, the diode immediately starts to function as a rectifier, and its anode assumes a negative D.C. potential with reference to the earthed cathode. The effect of this is to alter the voltage gradient along the bias potentiometer, thus reducing the current of the triode section of the valve below that required to maintain the relay in the *operated* condition. The relay releases and the equipment is changed over to *send* condition.

59. The decrease in the anode current decreases the voltage drop across the load resistance R_{433} with the result that the anode voltage rises and increases the charge in the condenser C_{417} the charging current being supplied by the diode. The condenser C_{418} is also charged slightly in the opposite polarity.

60. When modulation ceases, the charges in the condensers C_{417} , C_{418} maintain the operating voltages at their existing values for a short period until these charges leak away and the triode once more reassumes its previous state, i.e. prior to the commencement of the modulation. The discharge is slow, for when the diode is inoperative, the only leakage path is through the resistance R_{434} the value of which has been selected, in conjunction with that of the condensers C_{417} and C_{418} to ensure suitable delay.

61. This delay is approximately two seconds between the cessation of modulation and the reversion of the equipment into the *receive* condition.

62. The rapid changeover from *receive* to *send* and the relatively slow change over from *send* to *receive* is designed to prevent as far as possible clipping of the preliminary syllables of a transmission, and also to prevent the equipment from reverting to the *receive* condition during the short pauses which are common in speech.

Contact operation

63. During periods of contactor operation, the normal connection between the pilot's microphone transformer T_{401} and the control grid of valve V_{403} is broken by the relay contacts F_1 (9.10) and F_1 (11.12). The control grid is, instead, connected to the junction of R_{420} and R_{421} via the relay contacts F_1 (7.8) and F_1 (9.10) which are then operated.

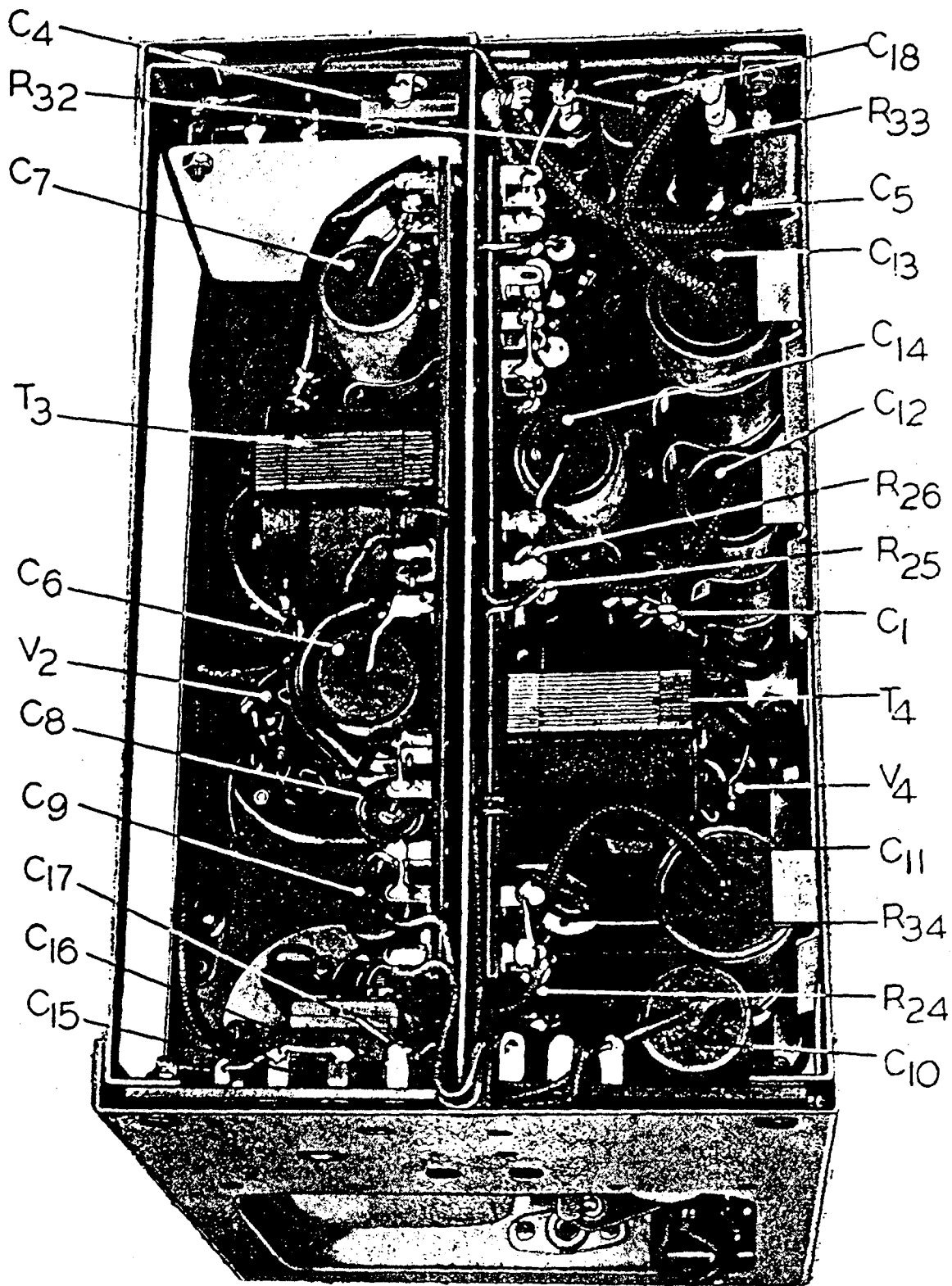


Fig. 8.—Amplifier unit, type 18 top view

64. This interconnection between the control grid of V_{403} and the anode of V_{404} causes self-oscillation to commence due to the phase-change introduced by the network R_{420} , R_{421} , C_{411} and C_{412} . The frequency of this oscillation (approximately 1,000 c/s) is that at which the phase shift through the feed back network, from the anode of V_{404} to the grid of V_{403} becomes zero.

Control circuits

65. As has previously been stated, full control of the T.R.1143 is obtained by the use of an electric controller, Type 3. This controller comprises five press button switches, the operation of any one of which causes the following sequences to occur:—

- (i) Switch on H.T. and L.T. supplies.
- (ii) Select the operational frequency from one of four pre-determined crystal frequencies.

66. A separate button switch is provided for switching off, and in this case it should be noted that the contacts of the ON-OFF button switch are *operated* when the button is raised and *broken* when the button is depressed, thus permitting the frequency selection action of the other four button switches to be carried out without switching off the supplies.

67. A three position key switch permits the selection of any one of the three conditions.

- (i) Transmit.
- (ii) Receive.
- (iii) V/O transmit and receive operation.

The V/O facility automatically switches the equipment from Receive to Transmit when modulation is applied as described in para. 55.

68. For descriptive purposes the main contacts of the frequency selection press button switches are designated PA_1 , PB_1 , PC_1 and PD_1 corresponding to the four pre-selected frequency channels A, B, C and D, and the subsidiary contacts are designated PA_2 , PB_2 , PC_2 and PD_2 . These contacts PA_2 to PD_2 are provided in order to prevent the continuous rotation of the selector motor and to retain the selected channel in the event of any one of the selector button-switches becoming released accidentally after operation, and it should be noted, the contacts PA_2 to PD_2 operate in the reverse direction to the contacts PA_1 to PD_1 .

Send-Receive circuits

69. Referring to fig. 3 and 3A, the designation of the switch contacts are as described and the equipment is shown in the condition where "A" channel has been selected and the equipment is in the "receive" condition. The relay contacts are *not* shown in close proximity to their respective relay windings and the relay windings are represented by rectangles bearing an index letter and a figure indicating the number of contacts operated by each particular relay. In certain cases where several contacts are operated by one relay the individual contacts are distinguished by the use of a small index letter in addition to the figure and number, for example H_1b indicates the lower contact (b) of the H_1 contacts of the relay H/2, and H_1a indicates the upper contact of this assembly.

70. Some contacts such as D_1 and S_1 are mechanically operated by the Drive and Selector motor cams.

71. In fig. 3 these relays which are in the energised condition due to the action of the frequency selector button-switch contacts PA_1 are shown blocked in, and it should be borne in mind that in the subsequent description of the action of these relays and switching mechanisms it will become necessary to assume later that certain of these relays are de-energised and the contacts corresponding to this condition are actuated, in order to trace the various circuits.

72. In fig. 3 the contacts R_1 and R_2 of the relay R/2 are operated. A circuit may be traced from 12V + through the winding of the relay R_2 and V/O contacts and T contacts of KS_1 and the contacts F_2 to earth. The lamp LR which is connected in parallel with the winding of the relay R/2 lights up, indicating to the pilot that the equipment is switched to RECEIVE.

73. The operation of the relay R/2 switches the H.T. supply from the anode circuit of the transmitter oscillator valve to the receiver via the contacts R_2 (shown in top tray). The contacts R_1 perform the requisite aerial changeover.

74. When the key switch KS_1 in the controller electric is set to "TRANSMIT" the energising circuit of the relay R is broken, thus reversing the operation described in the preceding paragraphs.

75. When the switch KS_1 is set in the V/O position, the energising circuit of the relay R is made once more and may be traced via the circuit:

$$12V + \rightarrow V_1 \rightarrow F_2 \rightarrow \text{earth}$$

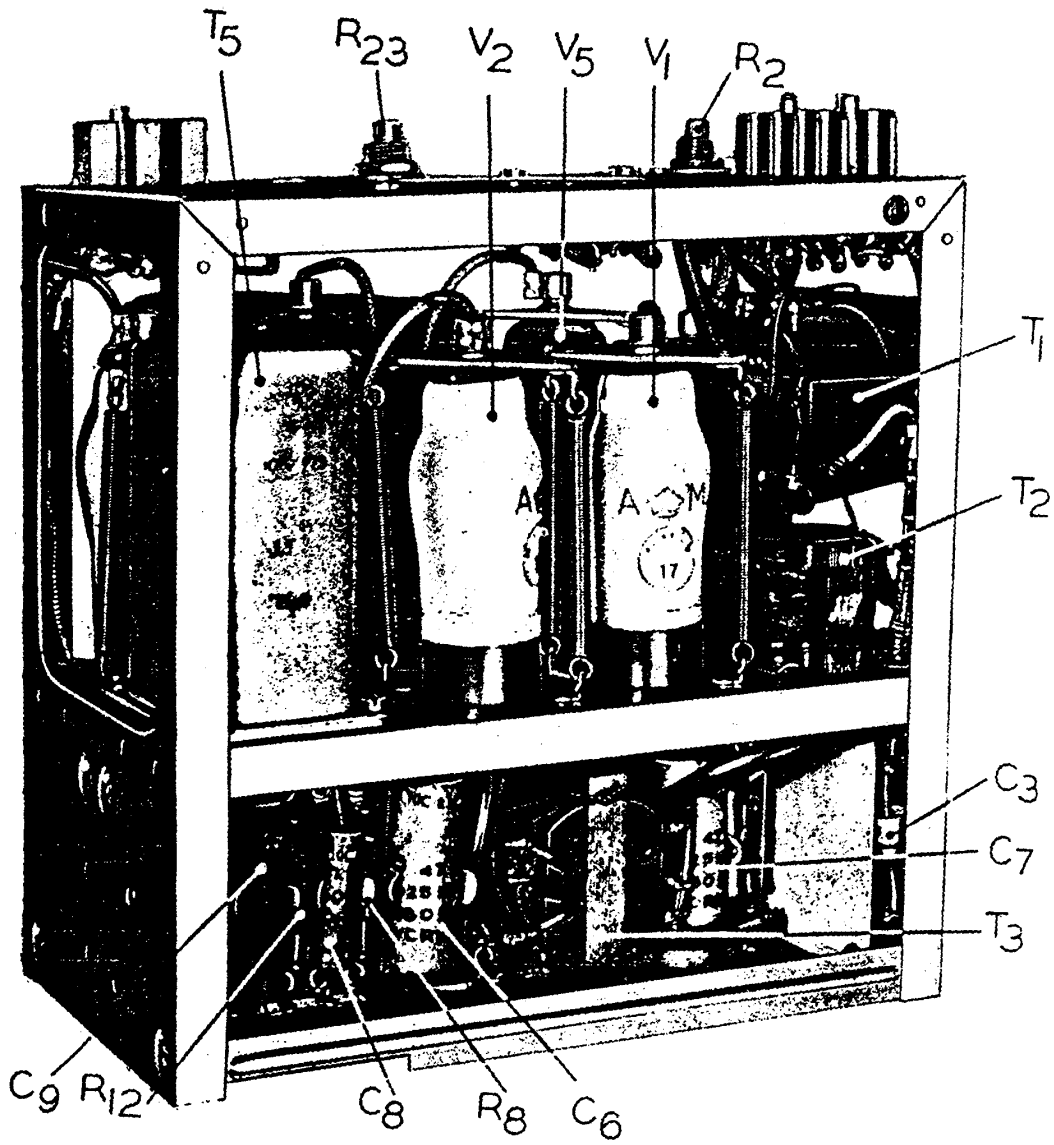


Fig. 9.—Amplifier unit, type 18—side view

1. Transmitter slide operated position
2. Receiver slide operated position
3. Transmitter slide unoperated position
4. Receiver slide unoperated position
5. Spacing washers
6. Guide pins
7. Guide washers
8. Locking balls
9. Locking grooves
10. Tuning cams
11. Cam projections
12. Cam guides
13. Detents
14. Cam noses
15. Detent pillars
16. Detent springs
17. Crystal switches
18. Bell-crank levers
19. Bell-crank pivots
20. Bell-crank strings
21. Bell-crank strings
22. Pull rod
23. Pull rod adjusters
24. Pull rod pivots
25. Pull rod springs
26. Pull rod pins
27. Motor hook
28. Pull rod lock
29. Pull rod slot
30. Driving motor shaft
31. Driving motor operating pin
32. Driving lever (driven home)
33. Driving lever guide face
34. Driving-lever guide pin
35. Toggle lever
36. Crank
37. Toggle lever selector face
38. Toggle lever pivot
39. Toggle crank pivot
40. Toggle link
41. Transmitter drive lever
42. Guide face for 41
43. Guide face for 41
44. Guide for 42
45. Guide for 43
46. Drive surface of 41
47. Driving lever (selected position)
48. Selector pin
49. Driving lever (normal position)
50. Selector cam
51. Toggle lever retaining spring
52. Toggle lever (selected position)
53. Toggle lever (normal position)

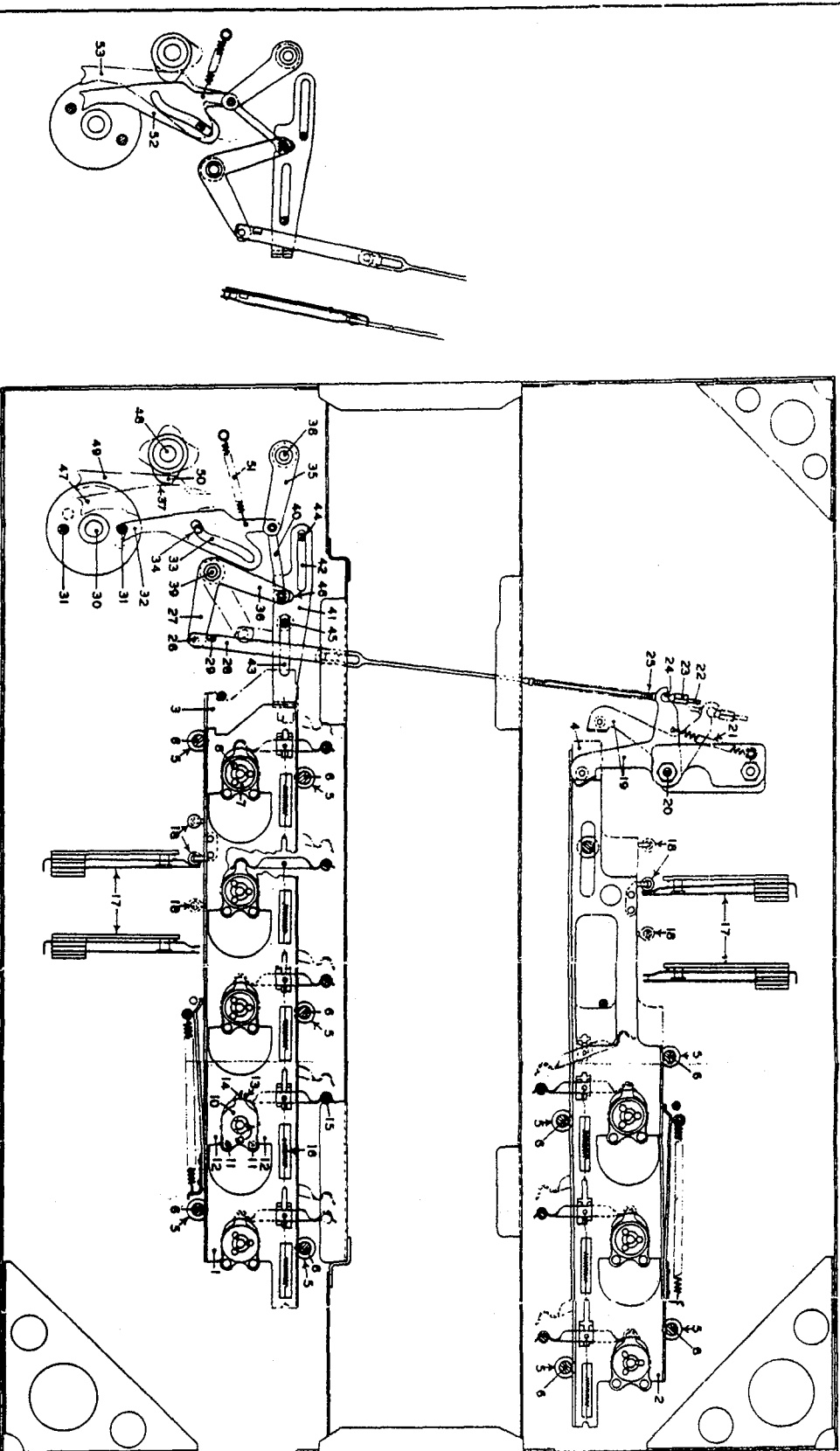


FIG.10

TR.1143, TUNING MECHANISM.

FIG.10

1. Transmitter slide operated position
2. Receiver slide operated position
3. Transmitter slide unoperated position
4. Receiver slide unoperated position
5. Spacing washers
6. Guide pins
7. Guide washers
8. Locking balls
9. Locking grooves
10. Tuning cams
11. Cam projections
12. Cam guides
13. Detents
14. Cam noses
15. Detent pillars
16. Decent springs
17. Crystal switches
18. Crystal switch operators
19. Bell-crank levers
20. Bell-crank pivots
21. Bell-crank strings
22. Pull rod
23. Pull rod adjusters
24. Pull rod pivots
25. Pull rod springs
26. Pull rod pins
27. Motor hook
28. Pull rod lock
29. Pull rod slot
30. Driving motor shaft
31. Driving lever (driven home)
32. Driving lever guide face
33. Driving-lever guide pin
34. Toggle lever
35. Crank
36. Toggle lever selector face
37. Toggle lever pivot
38. Toggle crank pivot
39. Toggle link
40. Transmitter drive lever
41. Guide face for 41
42. Guide face for 41
43. Guide for 42
44. Guide for 42
45. Drive surface of 41
46. Driving lever (selected position)
47. Selector pin
48. Driving lever (normal position)
49. Selector cam
50. Toggle lever retaining spring
51. Toggle lever (selected position)
52. Toggle lever (normal position)
- 53.

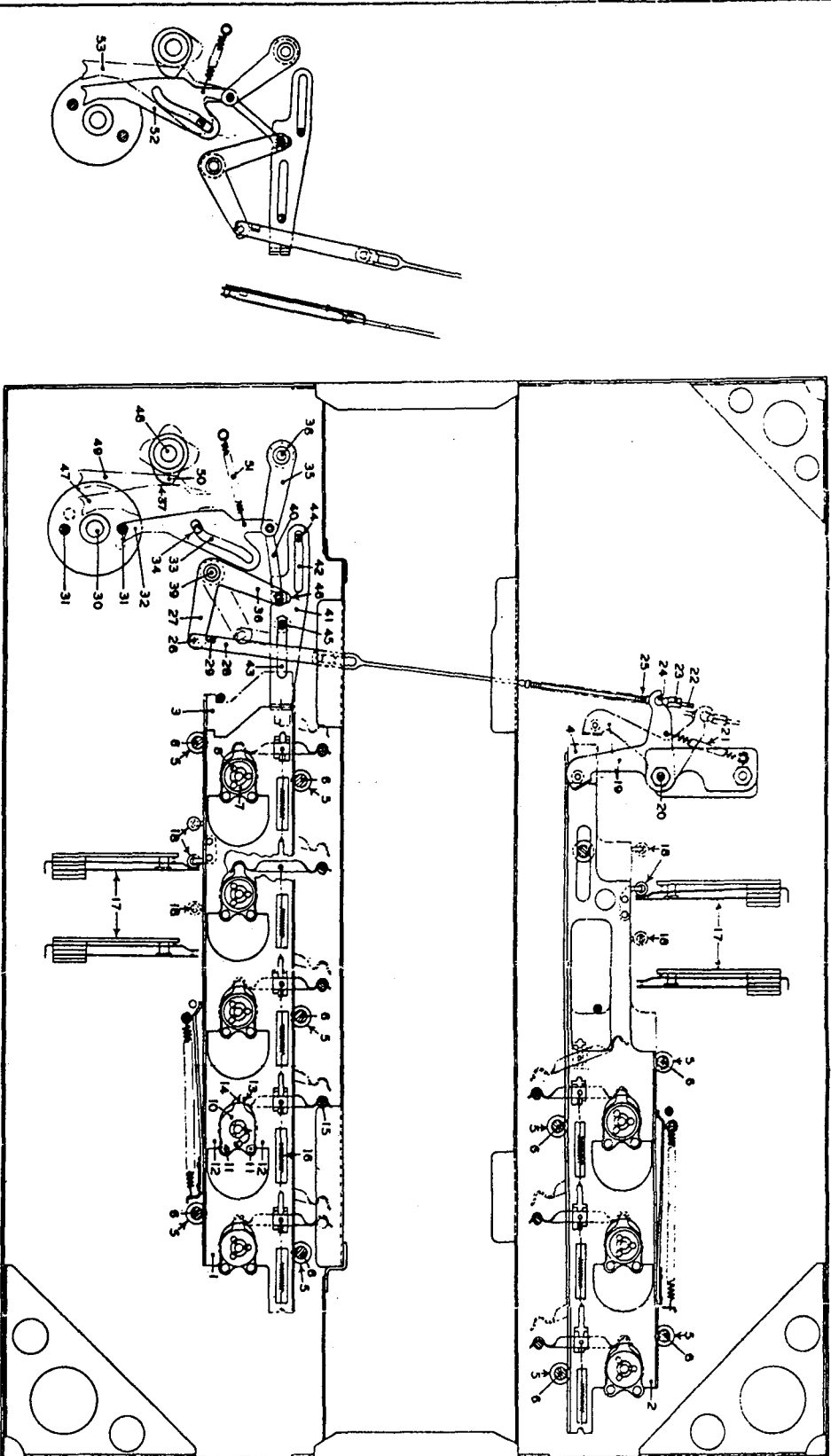


FIG. 10

T.R.1143, TUNING MECHANISM.

FIG. 10

The relay R_1 is therefore energised only so long as the contacts V_1 and F_3 are closed, that is, so long as the relay V/1 is operated. As described in para. 55 the energising winding of the relay V/1 is connected in the anode circuit of the V/O valve, hence the switching required for RECEIVE-TRANSMIT operates in accordance with the presence of or absence of modulation from the pilot's microphone.

Tuning circuits

76. The remaining components shown in fig. 3 comprise the tuning control circuits, which are also operated by any one of the four push-buttons on the controller via their respective contacts PA_1 to PD_1 .

77. In fig. 3 the contacts PA_1 (corresponding to "A" channel) are shown operated, and consequently the OFF button is released and the contacts of this switch are operated (*see* para. 66), thus completing the circuit of the starter relay N/1 of the lower unit operating from the aircraft electrical supply. The contacts N_1 are operated, completing the motor circuit of the rotary transformer which supplies power to the equipment.

78. The tuning motor system employs two motors, one of which (S in fig. 1) selects the operating frequency and the other (D in fig. 1) drives or releases the slide mechanism which actuates the tuning condensers and crystal switches of the transmitter and receiver. The rotors of the selector and driving motors are ratchet-operated by the impulsing magnets S and D respectively actuated by the make-and-break contacts s and d.

79. As stated, the circuits shown in fig. 1 are switched for operation on "A" channel. Apart from the mechanical position of the cams CS_1 and CS_2 operated by the selector motor S, the *electrical* conditions are identical with those existing in the final tuning position at any other of the four channels, except that the contacts PA_1 and the selector motor contacts SA corresponding to "A" channel, will be unoperated, and one of the contacts PB_1 to PD_1 together with its associated selector contact SB, SC, or SD *will* be operated, this depending on which channel is in use.

80. Considering a change from "A" channel to "B" channel the following sequence of operation will occur.

81. On depressing the control button PB, the mechanical interlock in the electric controller releases the button PA, thus the contacts PB_1 are made and PA_1 are open.

82. In these circumstances, the circuit of the relay H/2 which was
 $12V + \rightarrow \text{Relay H} \rightarrow \text{Contacts } F_3b \rightarrow \text{contact } PA_1 \rightarrow \text{contact SA} \rightarrow \text{earth}$
 will be *broken* at the points PA_1 and SA.

83. In consequence the relay H/2 releases, thus reversing the position of the contacts H_1 , H_1b and H_2 .

84. The circuit will then become:

$12V + \rightarrow D \rightarrow d \rightarrow H_2 \rightarrow D1_a \rightarrow S1_b \rightarrow \text{earth}$
 and in consequence the motor D will commence to rotate. The first effect of this rotation is that the contacts D_2 close; the rotation continues until the cam CD reaches the RELEASE position when the contacts $D1_a$ and $D1_b$ are changed over, $D1$ making contact with $D1_b$. The impulsing circuit of the motor D is broken and rotation ceases. During this process the tuning slides previously driven home are released.

85. The changeover of the contacts $D1_a$ and $D1_b$ completes the impulsing circuit of the selector motor S as follows:

$12V + \rightarrow S \rightarrow s \rightarrow H1_b \rightarrow D1_b \rightarrow S1_b \rightarrow \text{earth}$

The motor S then commences to rotate, and immediately changes over the contacts $S1_b$ and $S1_a$, the motion continuing through the new circuit established directly to earth via the contacts $S1_a$.

86. The next result of this motion is that a separate cam CS_1 attached to the spindle of the motor S closes the next of the series of contacts SA to SD, in this case SB is closed. When this occurs, since the contacts PB_1 are made, the energising circuit of the relay H/2 becomes:

$12V + \rightarrow H/2 \rightarrow F3b \rightarrow PB_1 \rightarrow SB \rightarrow \text{earth}$

87. When the cam reaches the position SB, the relay H/2 therefore operates once more and in consequence the contact $H1_a$ is made and H_2 is broken. When the motor S has rotated through

90 degrees the contacts S_{1a} and S_{1b} revert to their original position, so that both the energising circuits of the motor S are broken and motion will cease. The precise stopping position of the motor S is determined by S_{1a} when the preliminary condition is satisfied by the switch contact SB in conjunction with the associated press-button contact PB_1 .

88. *The action described in the preceding paragraphs completes that necessary for the selection of channel B.*

89. On completion of the channel *selection* operations the driving motor D again commences to operate through the energising circuit

$$12V + \rightarrow D \rightarrow d \rightarrow D_2 \rightarrow P_a \rightarrow H_{1a} \rightarrow D_{1b} \rightarrow S_{1b} \rightarrow \text{earth}$$

90. The operation of driving the selector *tuning* mechanism is then performed, motion continuing after the cam CD has passed over the release position and D_1 has changed D_{1a} and D_{1b} over again, when the energising circuit becomes:—

$$12V + \rightarrow D \rightarrow d \rightarrow D_2 \rightarrow D_{1a} \rightarrow S_{1b} \rightarrow \text{earth}$$

Motion ceases at the instant when D_2 breaks this energising circuit, i.e. when the cam CD reaches the DRIVE position and the contact D_2 breaks. *This completes the sequence of changeover from "A" channel to "B" channel.*

91. The RELEASE switch P provides a means of releasing the tuning slides when required and facilitates dismantling the transmitter-receiver assembly. When operated, the contacts P_a and P_b are changed over, P_b becoming operated and the impulsing circuit of the driving motor becomes

$$12V + \rightarrow D \rightarrow d \rightarrow P_b \rightarrow D_{1a} \rightarrow S_{1b} \rightarrow \text{earth}$$

92. Rotation of the driving motor will continue until the cam CD reaches the release position and D_{1a} changes over to D_{1b} . The reverse process occurs when the release switch P is in the driven position as shown by the circuit D (motor) starts via $12V + \rightarrow D \rightarrow d \rightarrow D_2 \rightarrow P_a \rightarrow H_{1a} \rightarrow D_{1b} \rightarrow S_{1b} \rightarrow \text{earth}$ and motion continues until CD passes over the RELEASE position when D_{1b} makes contact and the energising circuit becomes

$$12V + \rightarrow D \rightarrow d \rightarrow D_2 \rightarrow D_{1a} \rightarrow S_{1b} \rightarrow \text{earth}$$

Motion ceases when D_2 breaks contact, i.e. when the cam CD again reaches the DRIVE position.

93. The relay F/3 is energised by the operation of the external contactor and when this occurs the energising circuit of the relay H/2 is interrupted by the breaking of the contacts F_3b . The operation of retuning to the D (special frequency) channel normally reserved for contactor operation, proceed in the manner already described as the relay H/2 is released until the contact SD operates. When the contactor circuit is broken, the relay H/2 is again released, and the sequence of operations for retuning to the channel pre-selected by the press-button circuits begins again.

94. In fig. 1, the profiles of the motor-driven cams which actuate the tuning motor circuits are shown. It will be observed that the selector motor travels through 90, 180 or 270 degrees according to the spatial relationship of the selected channel with that of the channel previously in use. The driving motor turns through 40 degrees to release, and a further 140 degrees to drive, totalling 180 degrees per operation.

Supply circuits

95. The supplies in the T.R.1143 equipment are obtained from a power unit which incorporates a rotary transformer operated from the aircraft electrical supply. A power unit, type 15, is used with 12-volt aircraft electrical supply, and type 16 for 24-volt supplies. Particulars of these units will be found in A.P.1186D, Vol. I, Sect. 8, Chap. 3. The circuits of these units are identical, with the exception of the value of the resistance R_1 (see fig. 17). Details of the rotary transformers types U and V, used in the power units types 15 and 16 respectively, are given in A.P.1095, Vol. I, Sect. XIV, Chap. 3 or in A.P.1186D, Sect. 3, Chap. 3.

96. The approximate input required for the power unit, type 15 or 16 is 295 watts. During transmission the current load is approximately 23 amps. or 11.5 amps., depending on whether the aircraft supply voltage is 12 volts or 24 volts. These power units are designed to provide power for the low-voltage, the grid bias, and the high voltage supplies of the transmitter, receiver and control circuits of the T.R.1143 transmitter-receiver. They include a carbon-pile voltage regulator type "G" (5U/1577) which maintains the output voltages within close limits at any battery input voltage over the ranges 21.6 to 29 volts in the 24 V. unit (type 16) and 10.8 to 14 volts in the 12 V. unit (type 15). The voltage regulator is described in A.P.1186D, Sect. 2, Chap. 3, or A.P.1095, Sect. 5, Chap. 3.

97. Referring to figures 16 and 17, the rotary transformer has three generator commutators supplying 300 volts at 0.26A (H.T.), 150 V. at 0.01 amps. (G.B.) and 14.5 V. at 4.9 amps. (L.T.) also one motor commutator (input). There are three fields operating from the battery voltage. A long shunt field, and a series field which ensures sufficient starting torque at low temperatures, are both assembled on the same pair of poles and act on all four armature windings. A second pair of poles is provided on which are wound the regulator field coils. This regulator field acts only on the motor armature winding and is so connected that its flux induces a voltage in the motor armature winding, in a direction which reduces its normal counter E.M.F., and so increases its speed and the output voltages.

CONSTRUCTIONAL DETAILS

98. The transmitter-receiver T.R.1143 is fixed in a metal case by four Dzus fasteners. Two sliding covers, which are shown removed, give access to the interior, as shown in fig. 2.

99. A front view of the transmitter-receiver, with the covers removed, is given in fig. 1. The top tray (1) accommodates the transmitter unit (2), the receiver unit (3), the amplifier unit and the tuning motor unit (5). A centre compartment contains the inter-unit wiring, the plugs (7) and (8) which provide connections to the ancillary equipment, the aerial plug (9) and the aerial relay (not shown in photo). The meter plugs of the receiver, transmitter and amplifier are seen at (15), (16) and (17) respectively.

100. Referring to fig. 1, the spindles (18) of the tuning condensers of the receiver are each provided with four cams operating the four pre-selected tuning frequencies. These are located by four slide members in the tuning mechanism (11). The five tuning condenser spindles (19) of the transmitter are similarly located by the mechanism (12). The slide members of the transmitter are directly driven by the motor (5), while those of the receiver are driven via pull rods (13) and bell crank levers (14). Both mechanisms are provided with tuning scales, those on the receiver being shown removed to display the interior of the mechanism.

101. A diagrammatic view of the tuning mechanism is given in fig. 10, which shows the top slide members (1) and (2) of the transmitter and receiver respectively, in the operated position, and the remaining sliders (3) and (4) unoperated. These are shown chain-dotted, to avoid confusion. Spacing between the sliders is obtained by means of the washers (5).

102. The slide movement is guided by the pins (6) and partly by the washers (7) which serve to separate the condenser cams and which may be locked in position by balls (8) engaging with slots in the washers and in grooves (9) in the condenser cam spindles.

103. The cams (10) which serve to rotate the tuning condensers are roughly located by the slides and possess projections (11) which normally clear the sides (12) of the slots in the slider, and which are moved by the leading edges of these slots during the initial motion of the slider until they do so.

104. The cams are finally positioned, when the slides are fully driven home, by means of the detents (13) which engage with the noses (14) of the cams and with fixed pillars (15). These detents are retained in the slides by a helical spring (16).

105. The four crystal switches (17) on the transmitter and receiver, take the form of relay springs, and are mounted in pairs one above the other. They are operated by suitably positioned projections (18) on the slides.

106. The bell crank levers (19) which operate the receiver slides, are pivoted at (20) and retained in their rest position by springs (21). The pull rods (22) are screwed for adjustment purposes, the knife-edged nut (23) engaging with the pivot (24) and retained in contact with it by the pressure of a spring (25). The other ends of the push rods are bifurcated and provided with a pin (26) engaging with hooks (27) on the motor. The pins are retained in contact with the hooks by projections on the swivelling locking pieces (28), these projections engaging with slots (29) in the bifurcated ends of the rods.

107. The perspective view of the receiver slide mechanism given in fig. 11 showing the upper slides removed indicates the general arrangement of the slide (1) in the spacers (2) and shows the method of attachment of the detents (3) to the spring (4). The four cams (5) on each condenser cam spindle are separated by the cups (6) and the slotted washers (7) which are prevented from rotation by the balls (8) of which there are 12 in all (per cam spindle), 3 being of a larger diameter than the

rest and fitting in the top cup (6) nearest the indicator (9). The cam assemblies together with the indicators (9) are clamped together by the knurled knob (10), washer (17) and spring washer (11) when the positions of the cams relative to the condenser cam spindles have been adjusted. The 4 crystal switches and one of the slide projections operating them are seen at (12) and (13) respectively. The slides are normally retained in position by the springs (14) which assist their return when the motor releases. Bouncing on return is prevented by the braking action of leaf spring (15).

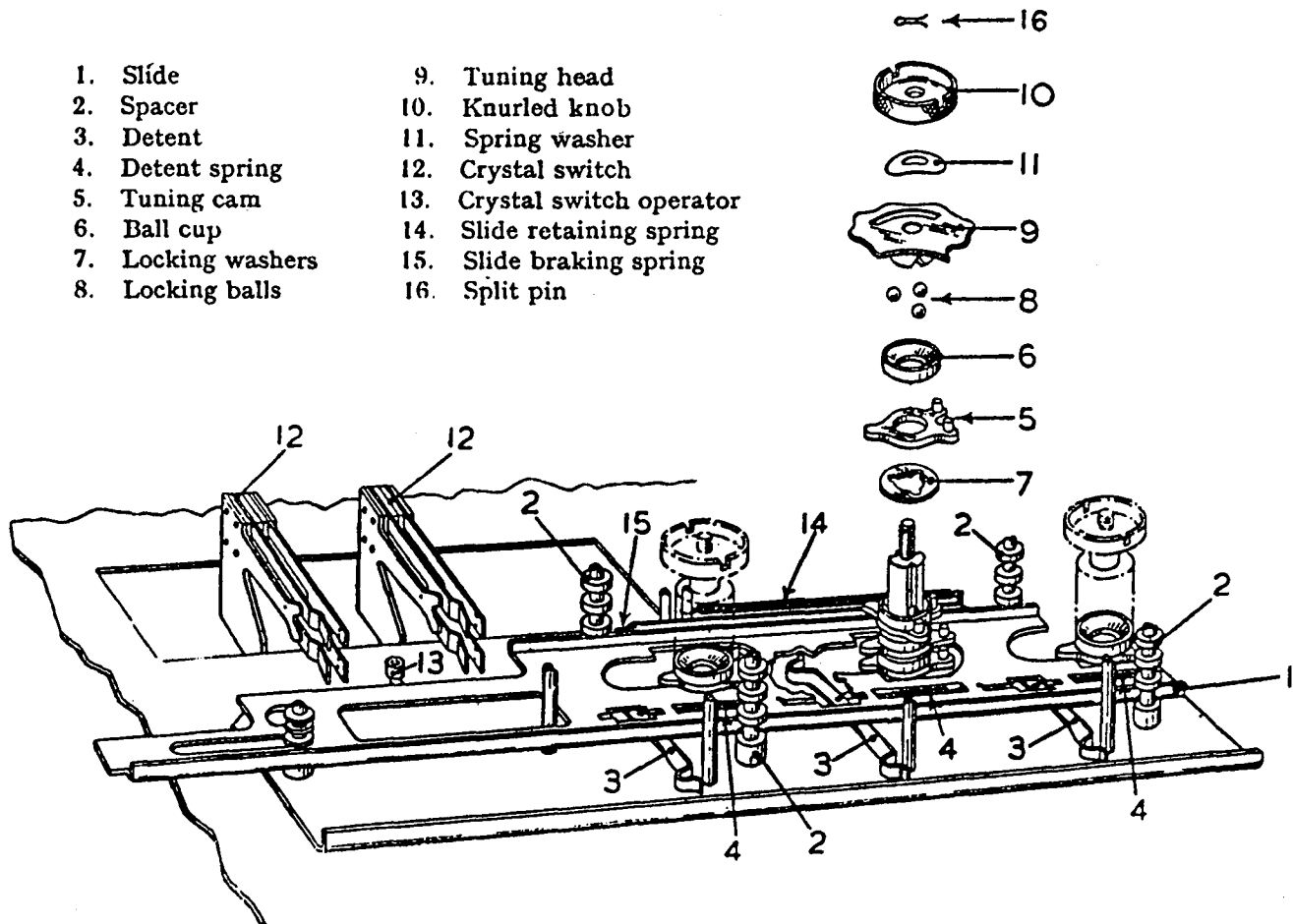


Fig. 11.—Tuning cams (perspective)

Driving motor

108. Referring again to fig. 10, the shaft (30) of the driving motor carries two diametrically spaced pins (31) engaging with the end of the lever (32) whose motion is determined by the slot (33) engaging with a fixed guide pin (34) and by a toggle mechanism consisting of the lever (35) and bell crank (36) whose pivots (38) and (39) are fixed, and of the link (40).

109. The lever (41) which operates the transmitter slide mechanism is provided with two slots (42) and (43) which, in conjunction with the fixed pins (44) and (45) act as guides. The lever is moved by the toggle mechanism described in the preceding paragraph, simultaneously with the bell crank, the cut-out (46) engaging with a pivot.

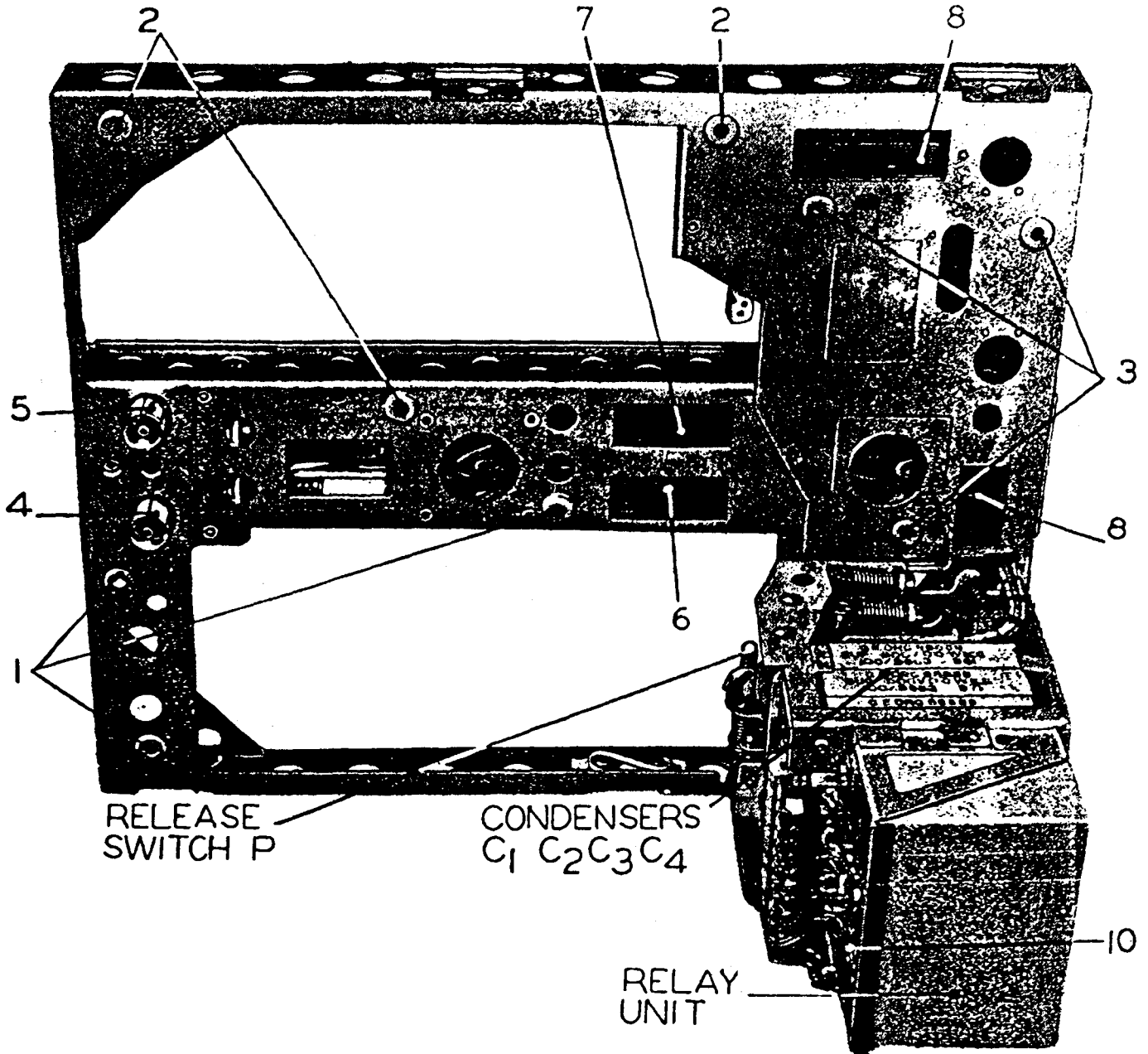
110. Four sets of toggles and levers corresponding to the four sets of tuning slides are provided in the driving motor. One set as shown by the full line is in a finally operated position. The chain-dotted line (49) shows the mechanism unoperated but prepared for operation by the selector motor.

Selector motor

111. Referring to fig. 10, the selector shaft (48) bears 4 cams at right angles at levels corresponding to the driving motor toggles and to the slide mechanism. These press against the suitably profiled sides (37) of the levers and bring them when required into line with the pins (31) of the driving motor. As shown by the chain-dotted line (49), the position of the toggle levers, when not prepared for operation, leaves them unaffected by rotation of the driving motor. In the case of the selector cam (50) it will be seen that the corresponding toggle lever has been pressed forward against the tension of the spring (51). At (52) and (53) are shown additional sketches of the motor mechanism unoperated in the selected and unselected positions.

Tray

112. A rear view of the transmitter-receiver T.R.1143 is given in fig. 2, showing the main tray and the relative positions of the transmitter, the receiver and the amplifier. The motor unit and the relay unit are separately attached to the main tray which mounts the condensers and other components of the supply system.



- | | | |
|-----------------------------|------------------------------|----------------------------|
| 1. Transmitter fixing holes | 4. Transmitter aerial plug | 7. Receiver supply socket |
| 2. Receiver fixing holes | 5. Receiver aerial plug | 8. Amplifier supply socket |
| 3. Amplifier fixing holes | 6. Transmitter supply socket | 10. Relay unit connections |

Fig. 12. Main tray

113. A rear view of the main tray, with the transmitter, receiver and amplifier units removed, is given in fig. 12, at (1), (2) and (3) are seen holes for the fixing screws of the transmitter, receiver and amplifier, respectively. These screws are all accessible from the front when the two sliding covers are removed. At (4) and (5) are seen the receiver and transmitter aerial plugs, and at (6) and (7), the supply sockets. The amplifier supply sockets are shown at (8). The dust cover (9) of the relay unit (10) is shown removed.

114. A rear view of the relay unit, showing its connections, is given in fig. 19.

Controller

115. Referring to fig. 13, the controller, shown in the illustration, is seen to be fitted with a key switch, five press-buttons and five jack-mounted pilot lamps, which are annotated in accordance with fig. 1. The lamp caps are covered by a shield incorporating a dark slide for night flying; this is operated by the control (1), and is secured by the screws (2).

116. In the sectional view, the plungers (3) of the press-buttons are seen each fitted with springs (4) which normally maintain them in the outward position, and with buffers (5) which operate the switch mechanism (6). The plungers are also fitted with slots (7) and (8), which engage with the detent lever (9).

117. When any button is depressed, the leading face of the slot (7), presses against the chamfered face (10) of the detent lever, and forces it upwards against the tension of the spring (11), motion being permitted by the links (12).

118. When the plunger has completed a full stroke, the detent enters the slot (8) and resumes its normal position owing to the spring (11). The preliminary upward movement of the detent when any plunger is depressed releases any buttons previously depressed, which will return to the outward position under the influence of the springs (4).

119. If two or more buttons are depressed simultaneously, only one of them can engage with the detent, as the other will be prevented from completing its travel by a drift block interlock consisting of the cam plates (13) which are designed always, to cover all but one of the exit slots (14) for the plungers, and are moved by the end of the plungers due to their bevelled faces. If the buttons simultaneously depressed are exactly in step with each other, none of them will be able to advance to the locking position.

120. The key switch also shown in plan below, is seen to be of normal design, except that the toggle (15) is cut away. A pin (16) on the hinged slide (17), which may be moved by the projection (18) which extends through the face of the controller, engages with the cut on (15) and prevents the key switch, from being set in the V/O position. At the same time the spring (19) engages with the other side of the toggle, and prevents "locking" of the key switch in the "send" position.

INSTALLATION AND OPERATION

121. A diagram showing the layout of a typical installation for single-seater or multi-seater aircraft, is given in fig. 14. It should be noted that the transmitter-receiver and power unit may be mounted either separately or together, as shown, and that, where desirable, right-angle entry plugs may be used to replace straight-entry, or vice versa. In all cases where the aircraft electrical supply is 12-volts the link on the regulator controlling the main aircraft electrical supply should be set in the *parallel* position. This will ensure that the supply voltage to the power unit does not exceed 14.0 volts. This condition does *not* apply to aircraft with 24-volt electrical systems.

122. The disposition of the sockets in the junction boxes, one of which is illustrated in fig. 14, may vary according to the installation by the reversal of lid and base. In all types the lid and base are retained by captive nuts, and the sides may be slid off after loosening the sockets.

123. Before installation of the instrument, a check should be made to ensure that all the valves are in position. This may necessitate partial dismantling, as described in the ensuing paragraphs.

124. The complete T.R.1143 unit is secured to the aircraft mounting tray by means of four screws engaging with fixed Simmonds nuts, riveted inside the unit casing. After removal of these screws the complete unit may be withdrawn.

125. Access to the tuning controls and crystal compartments may then be obtained by turning the four small Dzus fasteners on the front panel 90 deg. counter-clockwise, raising the two covers slightly, and sliding them backwards when they pull back against the sides of the casing.

126. To obtain access to the interior, it is also necessary to unscrew the four large Dzus fasteners at the sides of the outer case, adjacent to the front panel. These, when loosened, are withdrawn by their spring mountings, allowing the whole chassis to be lifted out from its casing by means of the finger holds.

127. The cover strip over the control portion of the main deck may be removed after unscrewing the eight plated screws, of which four are located round the edges, and four around the supply plugs. Three red-capped screws retain the amplifier, and receiver units in position on the top tray, and four similar screws retain the transmitters. On removing these screws, the units may be withdrawn by pulling them backwards from the main deck to free them from the plug and socket connections.

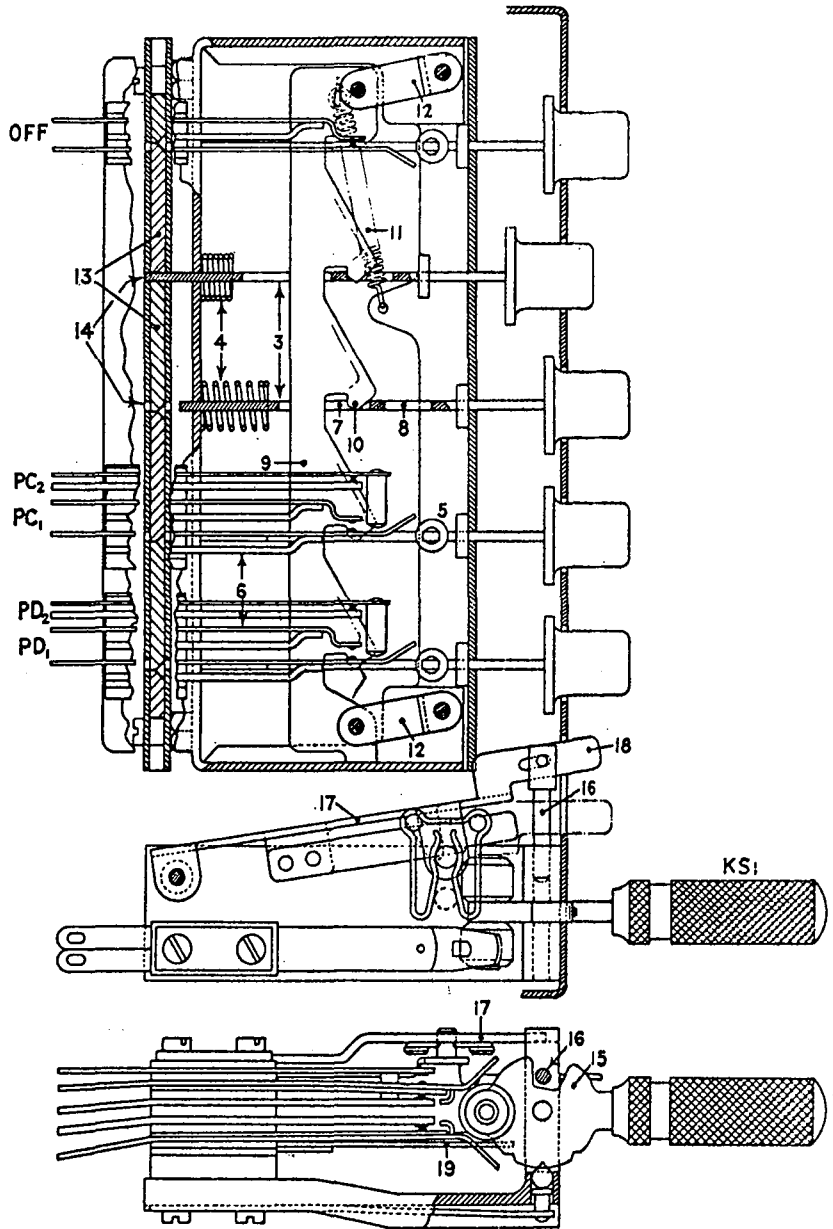
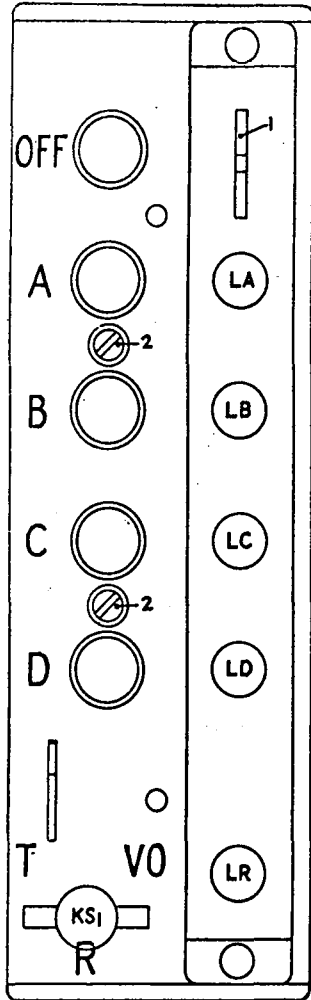
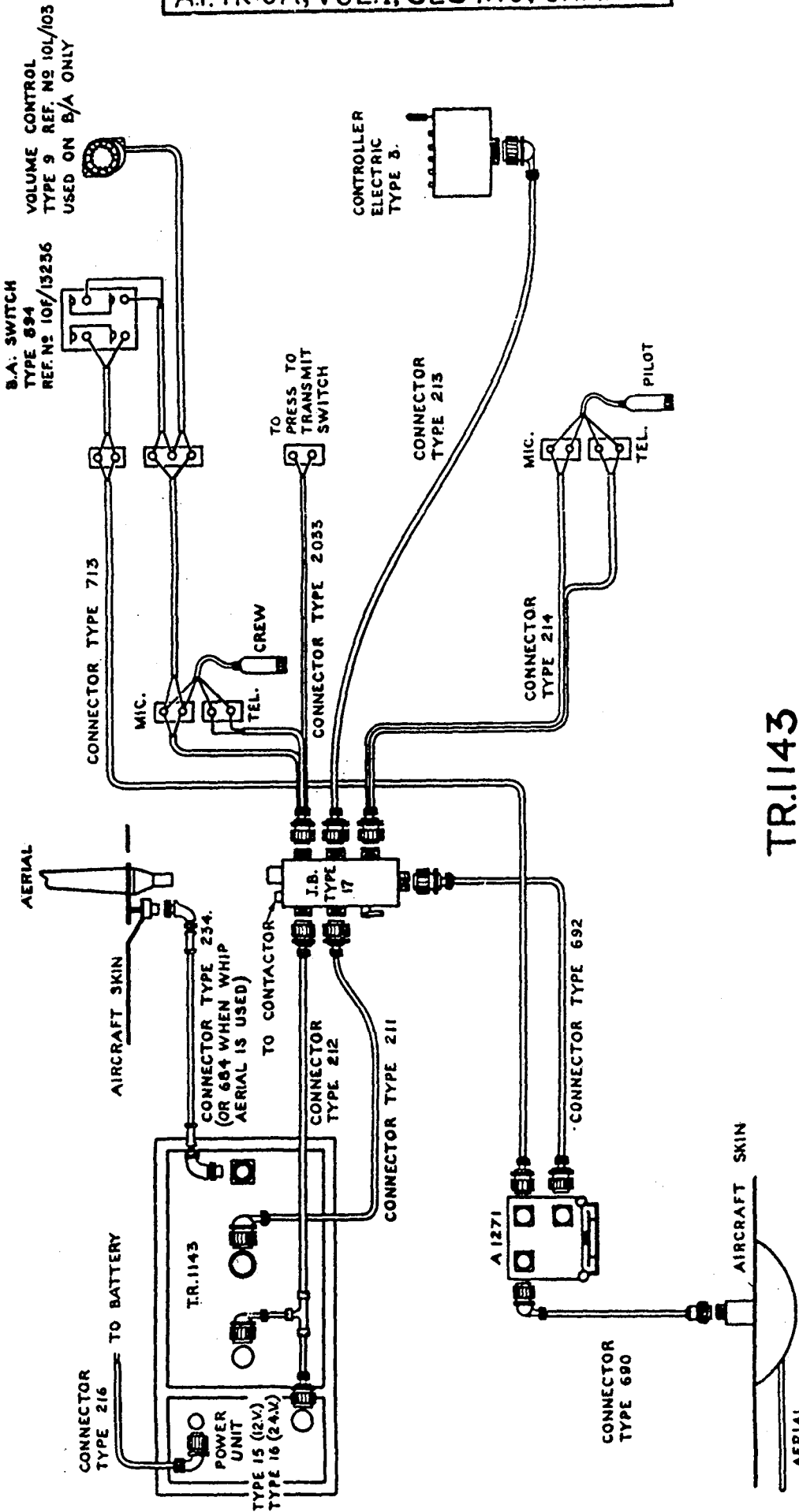


FIG. 13

ELECTRIC CONTROLLER TYPE 3.

FIG. 13.



TR.1143
TYPICAL INSTALLATION DIAGRAM.

128. BEFORE REMOVING THE TRANSMITTER OR RECEIVER, IT IS ESSENTIAL THAT THE TUNING MECHANISM SHOULD BE SET IN THE RELEASE POSITION, WITH ALL THE OPERATING SLIDES RETRACTED. This is effected by setting the release switch P, which is normally retained in the OPERATE position by the cover, to the RELEASE position, in which the toggle is pointing upwards through the plane of the cover. This measure is only effective when battery supply is available.

129. In other circumstances, as an emergency measure only, the amplifier unit should first be removed, and the driving motor mechanism operated manually, by inserting the fingers between the motor and the transmitter unit, or a screwdriver between TX and TM (*see fig. 1 note*). The motor mechanism should be moved until the release position is attained. Firm rapid pressure and release is necessary to operate the motor successfully as there is danger of the ratchet becoming jammed, in which case it may be freed if the movement of the motor cam assembly is assisted manually. THE SELECTOR MECHANISM, ON THE EXTERNAL SIDE OF THE MOTOR UNIT SHOULD ON NO ACCOUNT BE MOVED.

130. The motor unit may similarly be removed, after detaching the four pull-rods actuating the receiver tuning mechanism. These pull-rods are freed by using tweezers to lift the upper member from the yoke, to remove the detent, and moving it laterally so that the detent does not re-enter its slot. The remainder of the yoke may then be freed from the hooked end of the motor lever. This process should be repeated in sequence for each of the lower push rods. When all are free, the three screws retaining the motor, which pass through the side of the main frame may be removed, and the motor unit withdrawn forwards.

131. The relay unit at the rear of the main deck may be removed by sliding it back laterally, after loosening two small Dzus fasteners and lifting out. It is positioned by screw heads resting in an L groove.

132. Assembly may be carried out by reversal of the procedure described in the foregoing paragraphs, care being taken that all fixing screws are tight, and taking care to line up motor slides with transmitter slides. Partly tighten screws before finally adjusting, then tighten so that top motor lever engages with slide. When fixing the Dzus fasteners, they should be turned while exerting gentle pressure until the slot on the fastener engages with the wire spring, which is indicated by a sudden movement inwards. The screw heads should then be rotated, exerting considerable pressure, through about 90 degrees, when a click is heard, indicating that the fastener is fully home. Before replacing the slide covers on the front of the instrument, a check should be made to ensure that the release switch P is depressed.

Tuning

133. The layout used for tuning (*see fig. 15*) is identical with that given in *fig. 14*, except that the contactor and aerial are not fitted, and a test set, type 5A is connected to the transmitter-receiver as shown. A 12 or 24-volt battery of capacity 250 or 125 ampere hours, should be used according to whether a power unit, type 15 or type 16, is employed. With the test set, type 5A, it is essential that an artificial aerial, type 14, should be used.

134. Having completed the connection of the test circuit, the necessary crystals and valves should be fitted in position in the transmitter, receiver and amplifier. It should be noted that the operational frequency of the transmitter is 18 times the resonant frequency of the crystals, while the frequency f_r the receiver crystals in kc/s may be determined by the formula:—

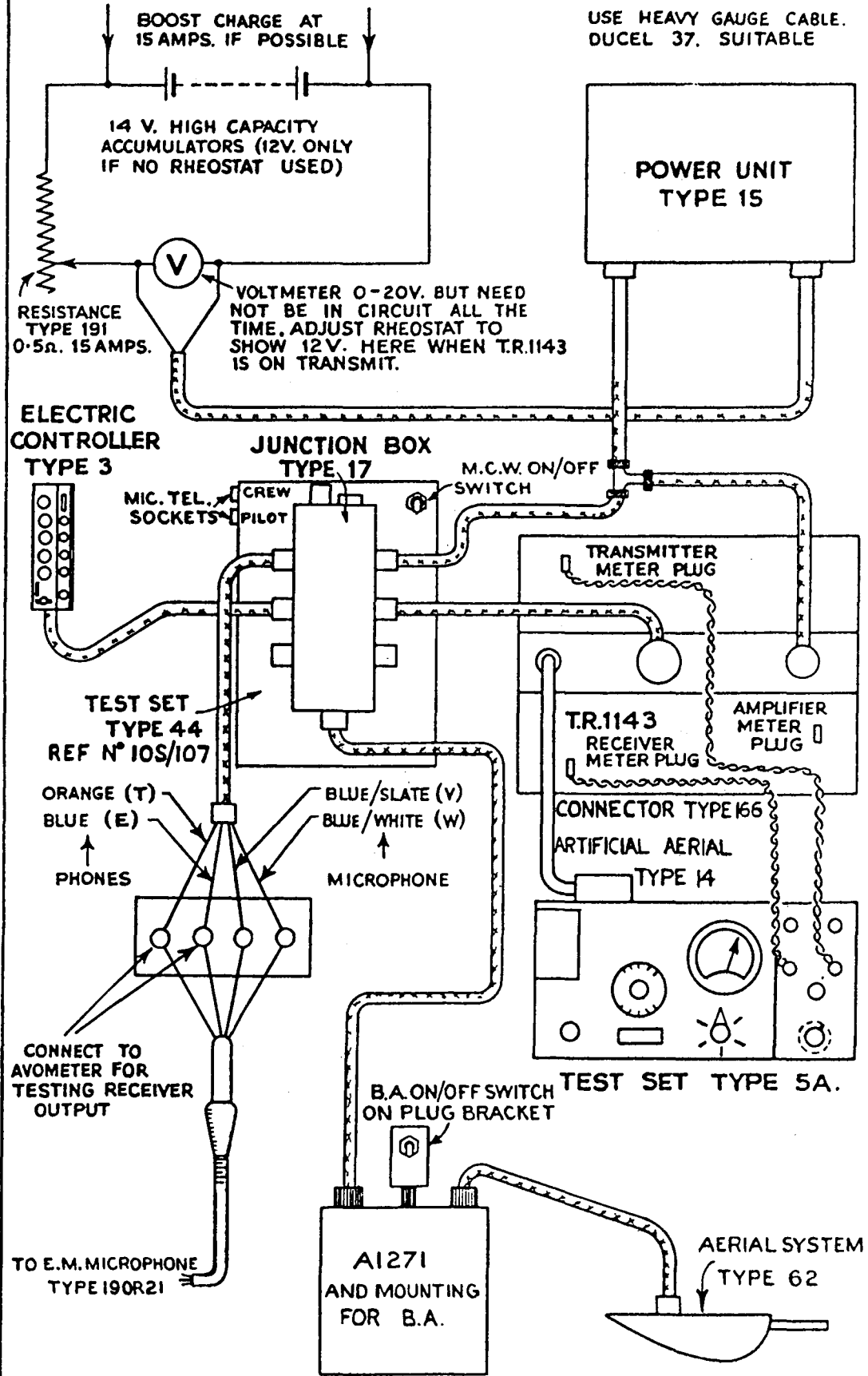
$$f_r = f_t - 540 \text{ kc/s}$$

where f_t = transmitter crystal frequency in kc/s.

Transmitter tuning

135. The meter sockets of the test set, type 5A, should be connected to the transmitter and receiver metering plugs, and the aerial, type 14, connected to the aerial socket. The transmitter-receiver should then be switched on using the button on the controller corresponding to the lowest frequency, and also setting the key switch to TRANSMIT. After allowing approximately two minutes for the equipment to warm up, tuning may be started as follows.

136. Set the switch P in the RELEASE position (pointing outwards from the cover) and loosen the locking nuts on the condenser spindles about $1\frac{1}{2}$ turns from fully locked position counter-clockwise, set the meter switch on the transmitter to position 1 and that on the test set to the TRANS, ANODE position. The switch P should be reset in the operate position (lying flat) and the appropriate tuning condensers TC₁, TC₂, TC₃, TC₄ and TC₅ should be set by movement of the pointer, to the approximate frequency, TC₁ should be adjusted until the current indicated on the meter is a maximum.



BENCH LAYOUT FOR TUNING & ADJUSTING T.R.1143

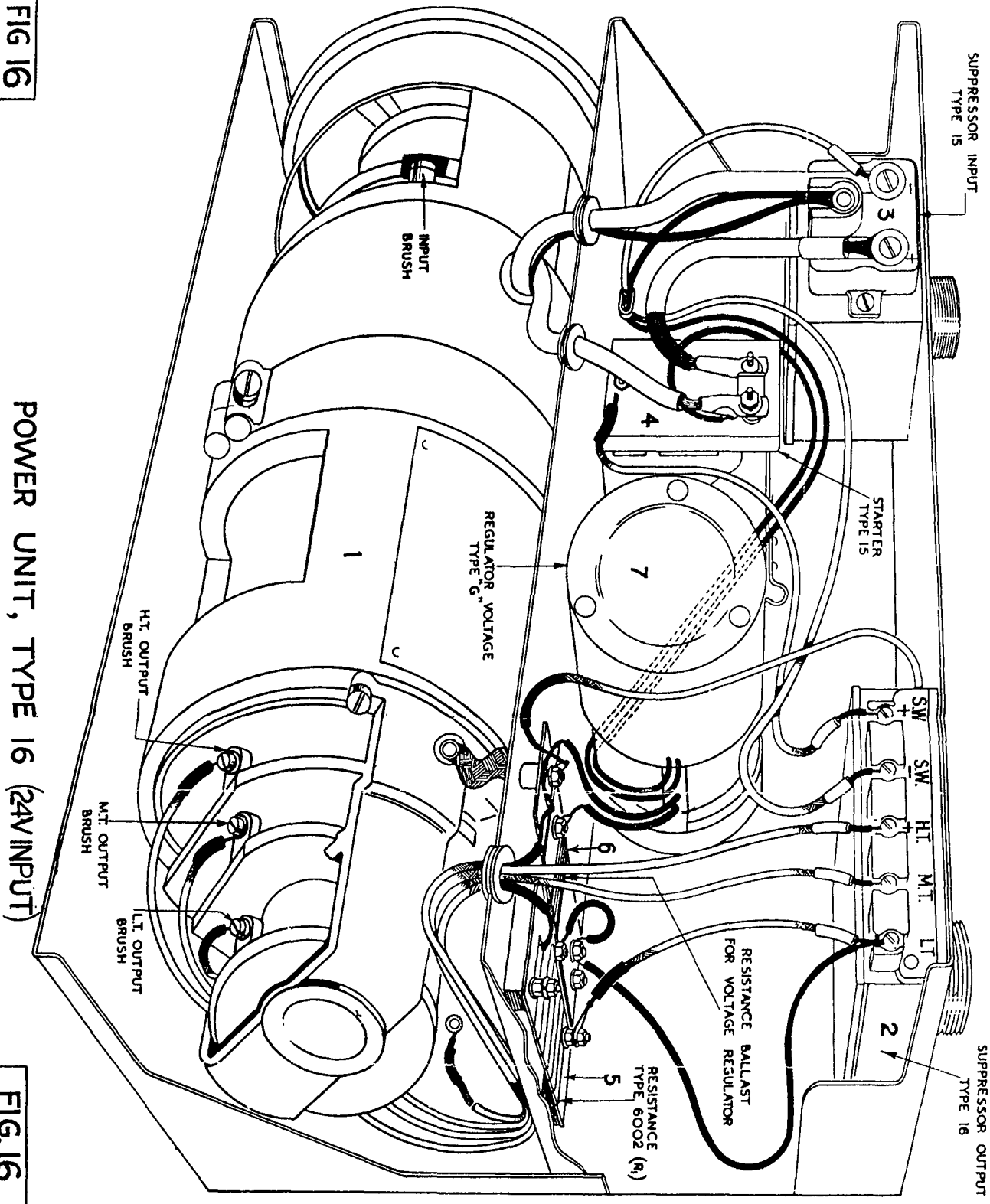


FIG 16

POWER UNIT, TYPE 16 (24V INPUT)

FIG. 16

137. The condenser TC₂ should next be adjusted until the current indicated with the meter switch in position 2, is a maximum, and the condenser TC₃ and TC₄ should be similarly adjusted with the meter switch in positions 3 and 4 respectively.

138. The meter switch should then be set in position 5, and the condenser TC₅ carefully tuned to the maximum meter reading. This completes the preliminary tuning operation, which should be performed as rapidly as possible to avoid overheating the valves.

139. The meter switch should now be turned to position 6 in order to measure the total grid current of V₂₀₅ and V₂₀₆. Condensers TC₄, TC₃ and TC₂ should be carefully readjusted *in that order* to obtain a maximum reading in position 6. If this reading exceeds 50, the condenser TC₁ should be de-tuned towards the *high* frequency end of the scale until a reading of 50 is obtained. This may again necessitate a slight readjustment of TC₄, TC₃ and TC₂. If a reading of 50 cannot be obtained, then TC₁ should be adjusted for maximum obtainable reading, provided that such adjustment renders the *final* position of TC₁ on the high frequency side of resonance.

140. The high frequency end of the scale may be identified by noting that the anode current of V₂₀₂, when the meter switch is at position 1, decreases more gradually than when TC₁ is moved in the lower frequency direction. If no grid current reading can be obtained the preliminary tuning operations should be repeated with greater care.

141. The tuning process should then be carried out on the other channels in order of increasing frequency, the procedure being the same as before. After tuning all four channels, the switch P should be set in the RELEASE position and the tuning condensers locking nuts gently turned clockwise using the knurled clamp nuts. Continue movement until nut is tight. This locks the cam assemblies. Finally reset the switch P in the OPERATING position and read meter current in all six positions at all four frequencies. A large change of current in any position at the different frequencies will indicate mistuning, which should be corrected by repeating the tuning procedure of the stage affected.

142. When the transmitter is finally tuned, the meter readings should lie within the limits given in the following table. These values are to some extent dependent on the frequency and tend to increase as the frequency increases. If the readings fall very far outside the specified limits even after thoroughly rechecking all tuning adjustments, reference should be made to the instructions given in Precautions and Care.

Switch position	1	2	3	4	5	6
Not greater than	62	70	82	65	50	50
Not less than	42	40	60	55	40	35

These figures assume that the power unit supplies the following voltages on load:—

H.T.	—	300 volts
Bias	—	150 volts at generator or 120 volts at transmitter
L.T.	—	12.6 volts at transmitter or 13.1 volts at generator

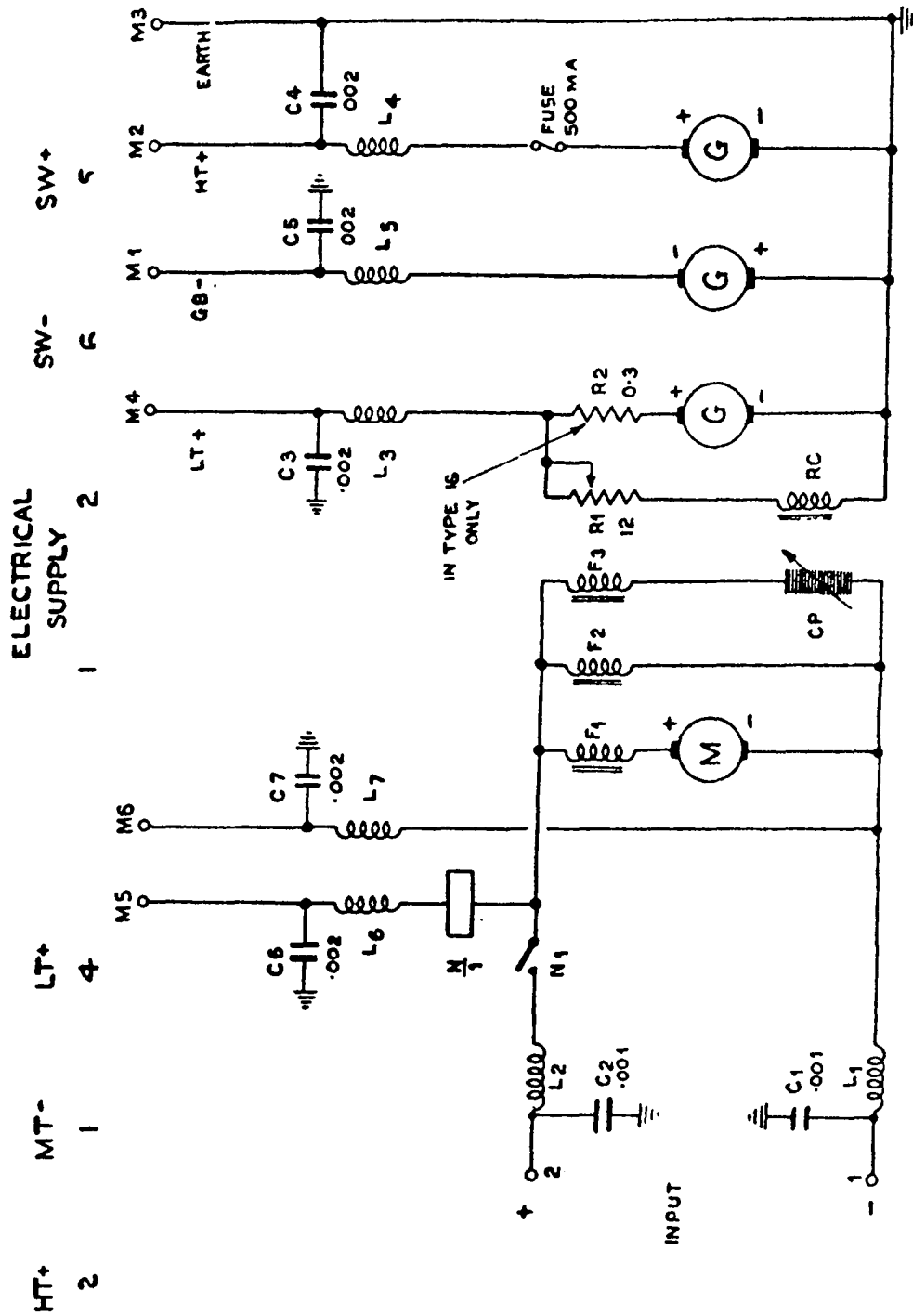
Receiver tuning

143. The receiver is similarly tuned, after inserting the crystals and loosening the tuning cam locking nuts by about one turn as before. The test set control switch should be moved to the position REC. A.G.C. and the key switch on the controller set to RECEIVE. The press button corresponding to the lowest operating frequency should then be depressed after resetting the switch P to the operate position.

144. The test set should then be set in operation at the required frequency, using the appropriate crystal. The output should be set at the maximum. The frequency of the crystal (f_x) is given by the expression:—

$$f_x = \frac{f_s - \text{I.F.}}{18}$$

Where f_s = Signal frequency in Mc/s
and I.F. = Intermediate frequency = 9.72 Mc/s.



SIGNALS

Fig. 17.—Circuit diagram for power unit, type 16 (24 volt)
(Issued with A.L.41)

P13806 M12529/G.1938 1/49 3500 C & P Cp. 1

137. The condenser TC₂ should next be adjusted until the current indicated with the meter switch in position 2, is a maximum, and the condenser TC₃ and TC₄ should be similarly adjusted with the meter switch in positions 3 and 4 respectively.

138. The meter switch should then be set in position 5, and the condenser TC₅ carefully tuned to the maximum meter reading. This completes the preliminary tuning operation, which should be performed as rapidly as possible to avoid overheating the valves.

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140. The high frequency end of the scale may be identified by noting that the anode current of V₂₀₂, when the meter switch is at position 1, decreases more gradually than when TC₁ is moved in the lower frequency direction. If no grid current reading can be obtained the preliminary tuning operations should be repeated with greater care.

141. The tuning process should then be carried out on the other channels in order of increasing frequency, the procedure being the same as before. After tuning all four channels, the switch P should be set in the RELEASE position and the tuning condensers locking nuts gently turned clockwise using the knurled clamp nuts. Continue movement until nut is tight. This locks the cam assemblies. Finally reset the switch P in the OPERATING position and read meter current in all six positions at all four frequencies. A large change of current in any position at the different frequencies will indicate mistuning, which should be corrected by repeating the tuning procedure of the stage affected.

142. When the transmitter is finally tuned, the meter readings should lie within the limits given in the following table. These values are to some extent dependent on the frequency and tend to increase as the frequency increases. If the readings fall very far outside the specified limits even after thoroughly rechecking all tuning adjustments, reference should be made to the instructions given in Precautions and Care.

Switch position	1	2	3	4	5	6
Not greater than	62	70	82	65	50	50
Not less than	42	40	60	55	40	35

These figures assume that the power unit supplies the following voltages on load:—

H.T.	—	300 volts
Bias	—	150 volts at generator or 120 volts at transmitter
L.T.	—	12.6 volts at transmitter or 13.1 volts at generator

Receiver tuning

143. The receiver is similarly tuned, after inserting the crystals and loosening the tuning cam locking nuts by about one turn as before. The test set control switch should be moved to the position REC. A.G.C. and the key switch on the controller set to RECEIVE. The press button corresponding to the lowest operating frequency should then be depressed after resetting the switch P to the operate position.

144. The test set should then be set in operation at the required frequency, using the appropriate crystal. The output should be set at the maximum. The frequency of the crystal (f_x) is given by the expression:—

$$f_x = \frac{f_s - \text{I.F.}}{18}$$

Where f_s = Signal frequency in Mc/s

and I.F. = Intermediate frequency = 9.72 Mc/s.

ELECTRICAL
SUPPLY

HT+ 2

MT- 1

LT+ 4

M6

1

2

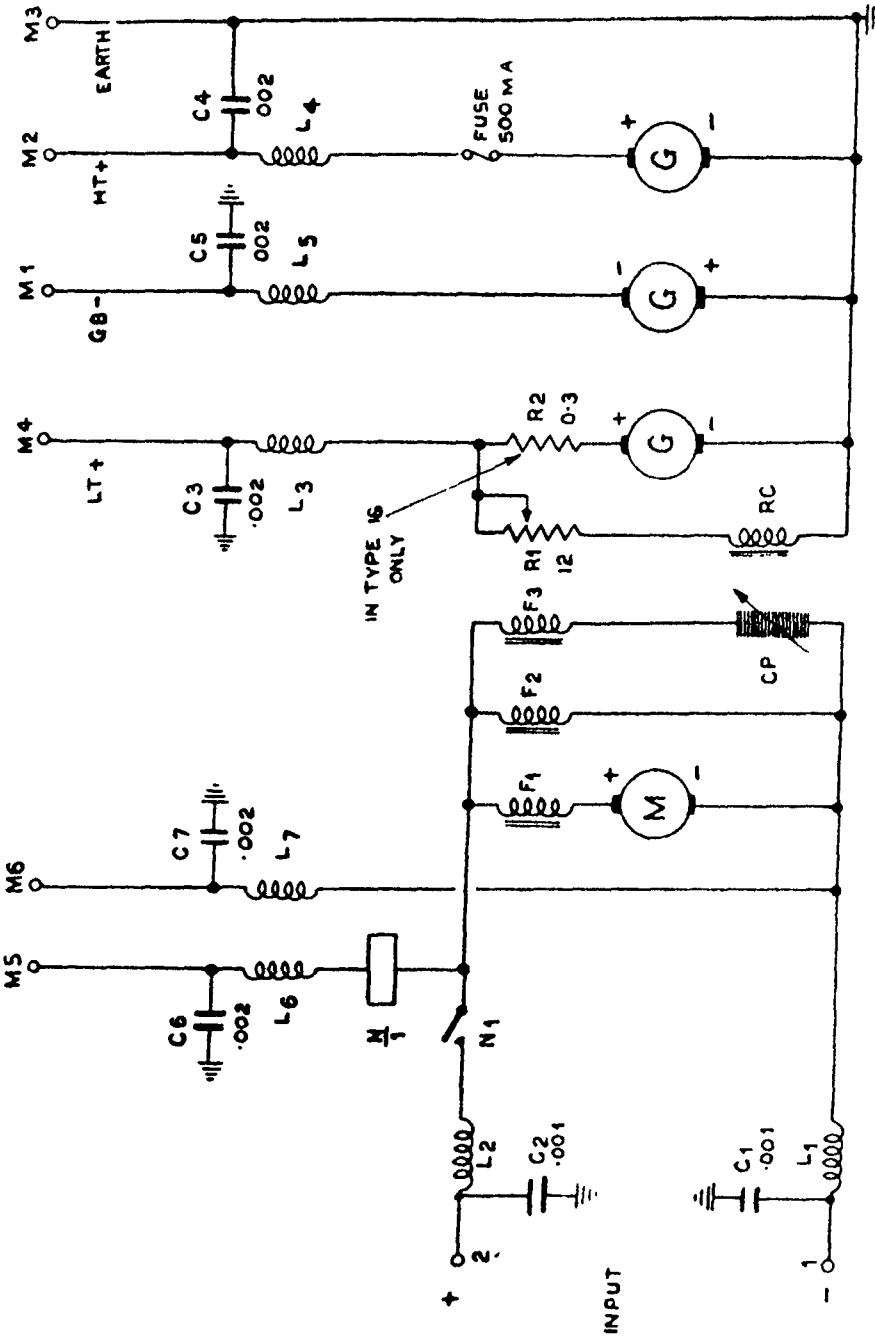
SW-

SW+

M3

M2

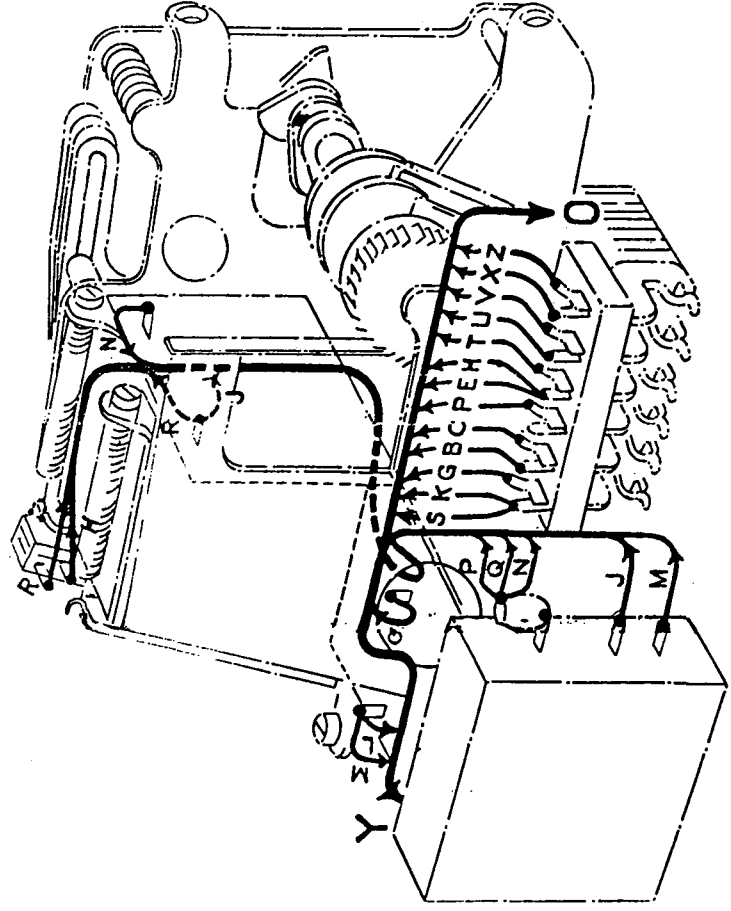
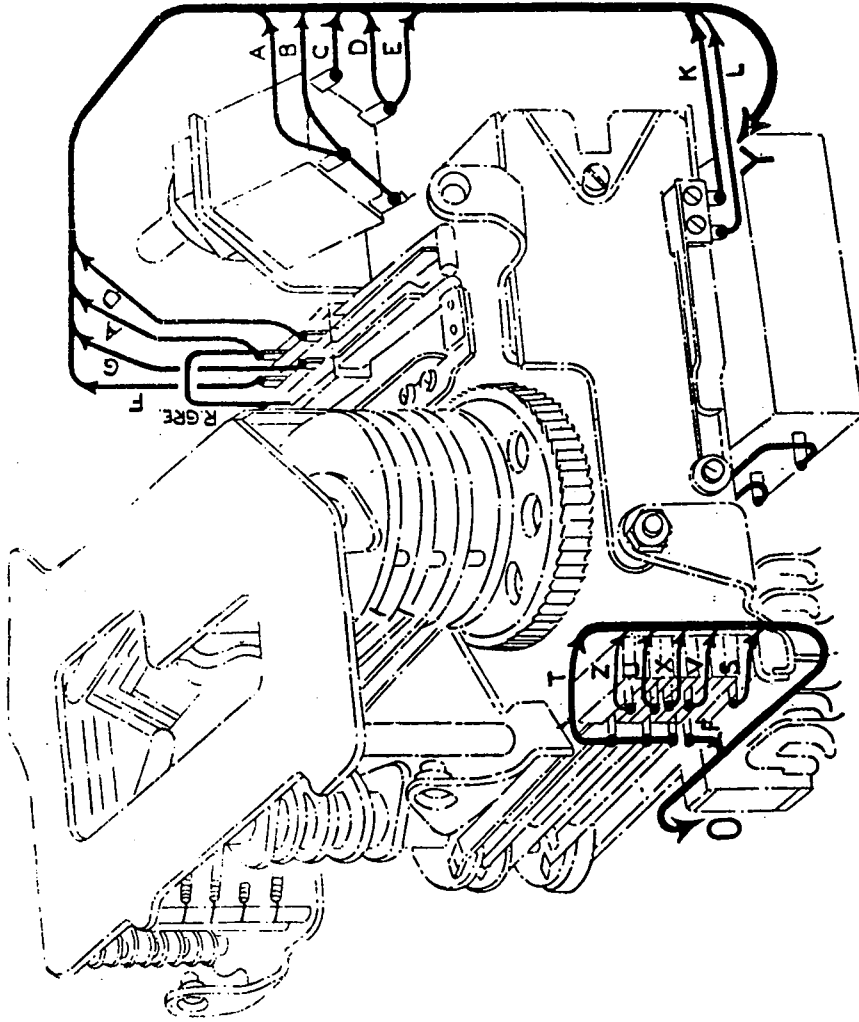
M1



SIGNALS

Fig. 17.—Circuit diagram for power unit, type 16 (24 volt)
(Issued with A L.41)

P13806 M12529/G1938 1/49 3500 C.A.P. Gp. 1



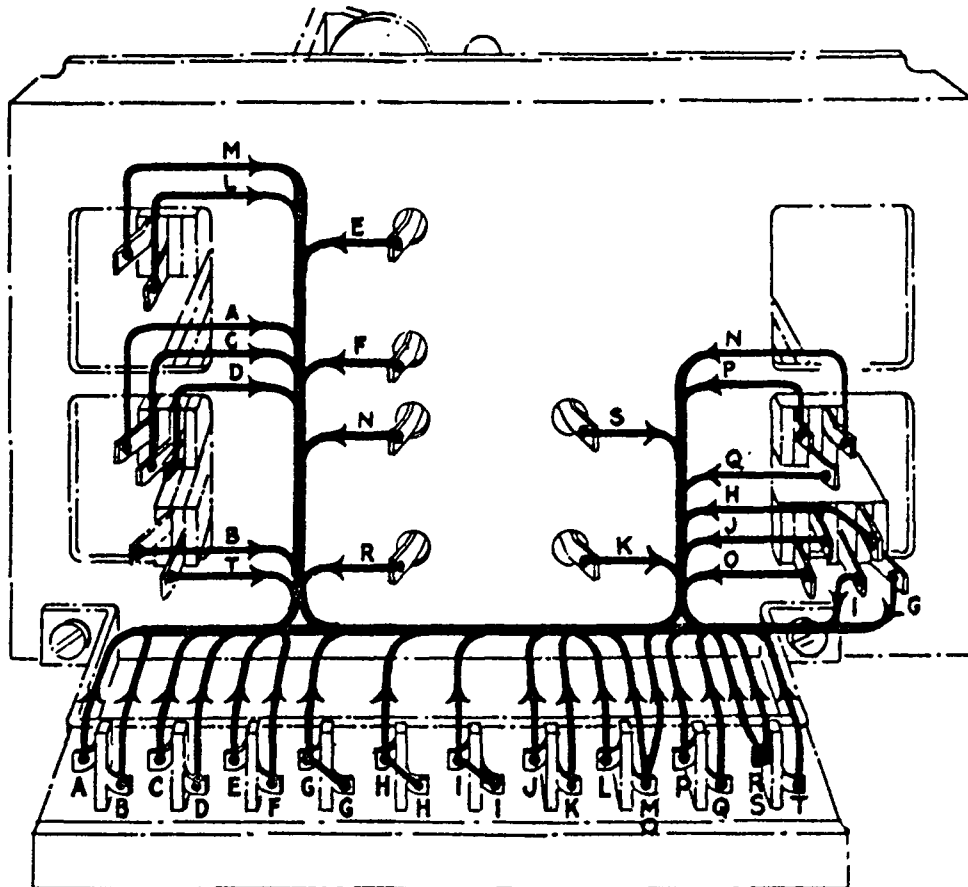
COLOUR INDEX TO LEADS

LEAD	A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q	R	S	T	U	V	X	Z
COLOUR	R-	R-	O-	O-	BLU-	R-	O-	R-	R-	R-	W.	W.	W.	W.	O.	R-	BLK.	SL.	R-	BR.	BLU	
OR																						
LEAD	GRE.	GRE	BLU.	W.	W.	SL.	W	BR.	BR.	BR.	BR.	BR.	BR.	BR.	BR.	BR.	BR.	BR.	BR.	BR.	BR.	BR.

T.R.1143 TUNING MOTOR, BENCH WIRING DIAGRAM.

COLOUR INDEX TO LEADS

LEAD	COLOUR OF LEAD	LEAD	COLOUR OF LEAD
A	R. Blu.	K	R.O.
B	R. Gr.	L	Blu. W.
C	R. SL.	M	Blu.
D	R. Br.	O	Blu.
E	O.	P	Sl. W.
F	R.	Q	Sl.
G	Gr. O.	R	W.
H	Gr.	S	W.
I	Gr. W.	T	O. W.
J	Blk.	N	Br. W.



T.R. 1143 RELAY UNIT
WIRING DIAGRAM

145. The receiver unit tuning condensers should then be set manually to the approximate operating frequency selected and adjusted in the following manner.

146. Swing TC_6 , TC_7 and TC_8 until an audio output is heard. With large output from the test set, type 5A, many responses may be obtained whilst swinging TC_6 , hence it is important to reduce this output until the response corresponding to the smallest input is obtained. Having identified the correct response in this manner, TC_6 , TC_7 and TC_8 should be adjusted in that order until the maximum sensitivity is obtained.

Particular attention should be given to the adjustment of TC_8 . As stated in para. 29 this controls the tuning of the cathode feed-back circuit to the crystal and provided that the crystal in use is of normal activity, the characteristic of this circuit will be flat and no definite tuning point may be obtainable. In all cases it is important that TC_8 should be set to the same approximate scale setting as TC_6 so that if, for any reason the activity of the crystal in use should decrease, the cathode feed-back circuit will be correctly tuned to assist the requisite drive from the anode circuit of V_{303} .

147. The tuning operations described may first be carried out aurally as stated but the final tuning should be carried out using the A.G.C. meter in the test set, and adjusting until the maximum "backing-off" is observed. The test set output must be reduced during the final tuning until a "backing-off" of approximately ten scale divisions is obtained. Under these conditions, more accurate settings of TC_6 and TC_7 will be obtainable.

148. The tuning operations should be performed for the three higher frequencies, in ascending order, switch P released, and the mechanisms finally locked as described for adjustment of the transmitter. The switch P should then be reset in the operate position, and the tuning checked by reading the current at each frequency in turn using the same output setting for the test set, but resetting the test frequency each time. The current readings at each frequency should be approximately equal.

149. On completion of the tuning, the instrument should be installed in the aircraft and connected up. A test set, type 11, should be used to check the radiation of the transmitter on all frequencies and the output tuning condensers readjusted, if necessary, to obtain maximum output. Instructions for the setting of the lock of the S/R switch of the electric controller are to be obtained from the Signals Officer. The setting of the contactor is dealt with in Section 2, Chapter 4 of A.P.1186.

Setting up of amplifier

150. Referring to fig. 3 Control A (R_{429} in fig. 3) on the top panel should be adjusted with the microphone switch until the standing current is 50mA. The gain control B (R_{402} in fig. 3) should then be adjusted to reduce anode current to 45mA with the engine running and the pilot's microphone switch ON.

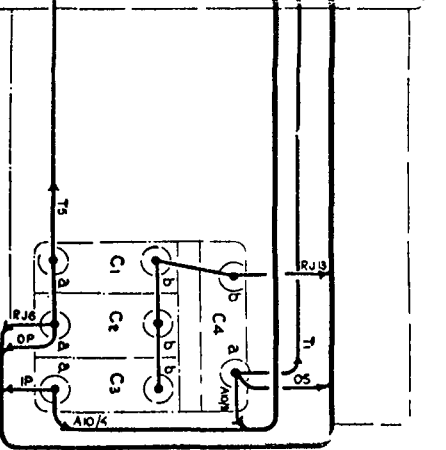
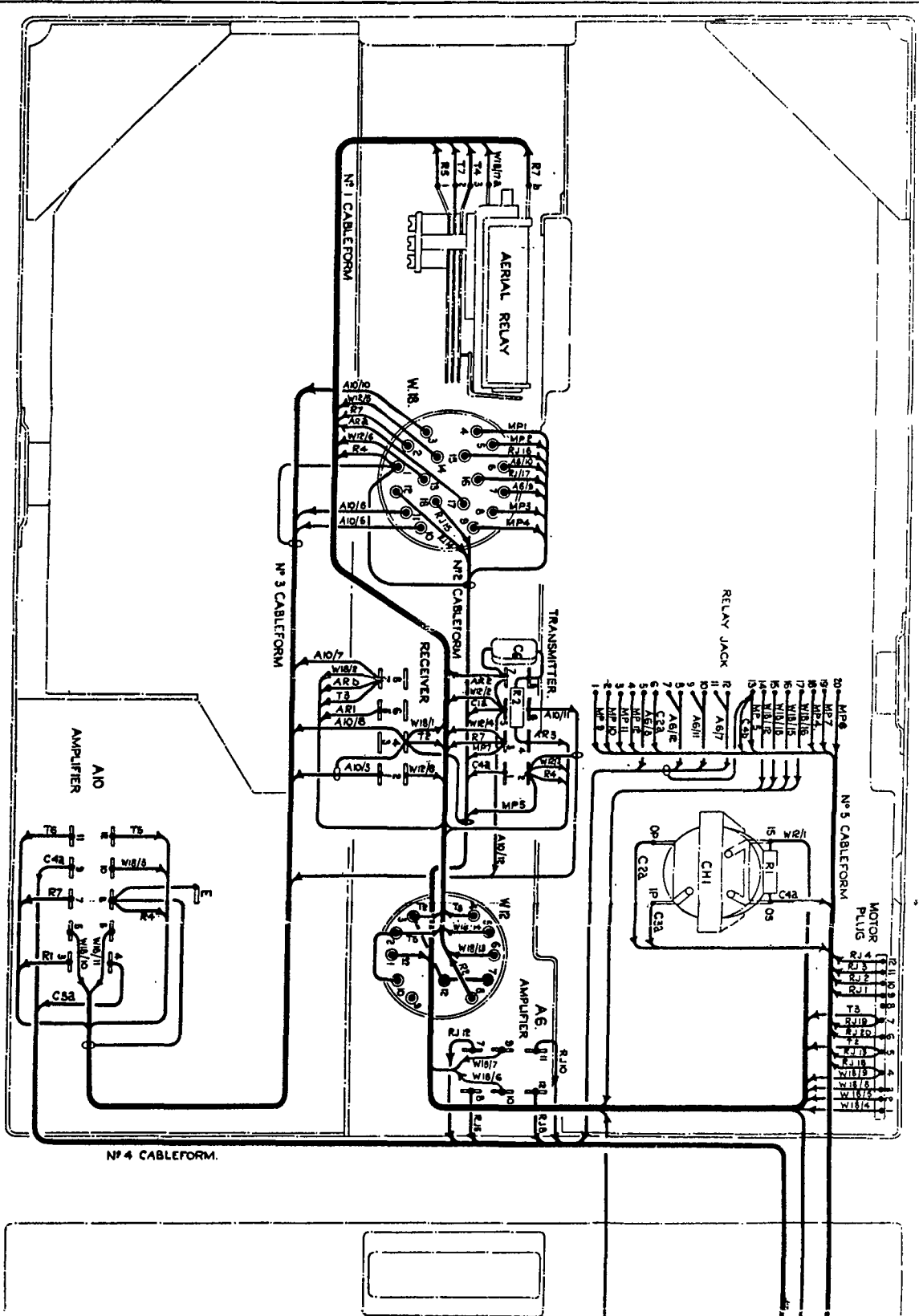
Operation in the air

151. Switching on and selection of the required frequency is effected by depressing the appropriate button on the electric controller, and switching off is similarly effected by means of the OFF button. Where full facilities, namely, send, receive and V/O are required, it will be necessary to set the key switch lock in the *release* position, otherwise it will be necessary to hold the key switch over in the T position for transmission, or it will revert to the receive position.

PRECAUTIONS AND CARE

152. The equipment should be kept in good, clean condition throughout, any dust being removed by blowing out with clean, dry air wherever necessary. All key, relay and plug contacts should be cleaned at intervals with carbon tetrachloride, care being taken not to deform them in the process. Suitable procedure is to pour a few drops of the liquid over the contacts, then operate the contacts manually several times. Moving parts of the tuning mechanism and tuning motor, etc., should periodically be lubricated with a trace of anti-freezing oil, applied to the bearings with the end of a piece of wire dipped in the oil. *No oil should be applied to the variable condenser cam assemblies, nor to switch contacts nor insulators.*

153. *On no account should any of the trimming condensers on the receiver ganged condensers, nor the I/F tuning adjustments be interfered with except by authorised personnel provided with the appropriate testing equipment. The same applies to the preset variable resistance controls on the receiver and amplifier.*



COLOUR INDEX TO LEADS				
LEAD	COLOUR	LEAD	LEAD	LEAD
ARI	R. GRE.	R5	W10/3	0
ARI	FORM 1	R5	W10/3	FORM 3
AR2	R.	T7	W10/10	GRE O
AR2	R.	T7	W10/10	GRE O
AR3	R. O.	T4	W10/11	GRE S1
AR3	R. O.	T4	W10/11	GRE S1
AR4	BR. W.	W10/17	R7	W
AR4	BR. W.	W10/17	R7	W
AR5	W.	R7	R1	BLU
AR5	W.	R7	R1	BLU
AR6	BLK	R4	R4	BLK
AR6	BLK	R4	R4	BLK
AR7	W.	R7	T8	R.
AR7	W.	R7	T8	R.
AR8	BLK	R4	R4	BLK
AR8	BLK	R4	R4	BLK
AR9	R. GRE	W10/15	T6	S1
AR9	R. GRE	W10/15	T6	S1
AR10	BLK	R4	AD/4	R. BR.
AR10	BLK	R4	AD/4	R. BR.
AR11	BLK	W10/15	AD/9	GRE W
AR11	BLK	W10/15	AD/9	GRE W
AR12	W.	R7	AS/7	GRE W
AR12	W.	R7	AS/7	GRE W
AR13	W.	W10/4	AS/8	O
AR13	W.	W10/4	AS/8	O
AR14	R.	W10/2	AS/11	GRE
AR14	R.	W10/2	AS/11	GRE
AR15	R.	W10/2	AS/12	GRE O
AR15	R.	W10/2	AS/12	GRE O
AR16	Y.	W10/8	AS/12	R18
AR16	Y.	W10/8	AS/12	R18
AR17	BLU	BR	MP1	R. BLU
AR17	BLU	BR	MP1	R. BLU
AR18	BR	MP2	R12	R. GRE
AR18	BR	MP2	R12	R. GRE
AR19	R. BLU	AS/10	R13	R. S1
AR19	R. BLU	AS/10	R13	R. S1
AR20	R. S1	AS/9	R14	R. BR
AR20	R. S1	AS/9	R14	R. BR
AR21	R. BLK	MP3	R15	R.
AR21	R. BLK	MP3	R15	R.
AR22	S1	MP4	R16	BLK
AR22	S1	MP4	R16	BLK
AR23	RO.	A14	R18	BLK
AR23	RO.	A14	R18	BLK
AR24	BLU	R16	R19	S1.
AR24	BLU	R16	R19	S1.
AR25	BLU	R17	R19	W.
AR25	BLU	R17	R19	W.
AR26	BLU	R15	R20	O.W.
AR26	BLU	R15	R20	O.W.
AR27	R.	C1A	OS	MP6
AR27	R.	C1A	OS	MP6
AR28	GRE W	C4A	LP	R.
AR28	GRE W	C4A	LP	R.
AR29	BLK	MP5	IS	R. BR.
AR29	BLK	MP5	IS	R. BR.
AR30	GR.	MP5	IS	C3A
AR30	GR.	MP5	IS	C3A

FIG. 20

T.R. 1143, TOP TRAY, BENCH WIRING DIAGRAM.

FIG. 20

Controller

154. Apart from contact cleaning and lubrication of the press-button mechanism and key switch detent, the controller should need no maintenance. Renewal of the pilot lamps, when necessary, may be effected by removing the front plate assembly, held by two screws, extracting the lamp cap with pliers, and withdrawing the affected lamp by means of an ordinary penholder. The renewal may be pushed home with the finger tip, followed by a pencil.

Transmitter

155. If any difficulty is experienced in tuning the transmitter to obtain the required output or grid current, one or more of the valves may need renewal. A faulty valve is usually indicated by the fact that when the set is tuned, the anode current of the earlier valves will be high while those of the subsequent valves will be low. When changing the valves, it is convenient to remove the top cap connection by leverage, using the end of a screwdriver. When two valves have a common retainer, both caps and retainer should be removed before changing the valve. In the case of the valves V_{205} and V_{206} , the locking clamp at the base of the valve should be loosened by unscrewing the clamping screw.

156. A check of the efficiency of the valves may be made by checking the anode current of each valve when its anode circuit is tuned. This entails tuning $T.C._2$ with the meter switch in position 1, $T.C._3$ in position 2, $T.C._4$ in position 3, $T.C._5$ in position 4. A pronounced dip should be observed at resonance in each case.

Neutralization

157. Neutralization of the output stage may be necessitated after changing the output valves or for other reasons. Faulty neutralization is indicated by instability when the equipment is set to RECEIVE and high input is applied to the pilot's microphone, in which case a howl may be heard in the receiver, or the receiver may be blocked. Alternatively, the transmission may be extremely distorted. A check of the neutralization may be made after releasing the switch P, switching the equipment to RECEIVE and short-circuiting the contactor contacts of the junction box so as to set the amplifier oscillating and applying high modulation voltage to V_{205} , V_{206} in the transmitter. With the meter switch in position 5, verify that whatever the relative position of $T.C._4$ and $T.C._5$ within the complete frequency range, no meter reading is observed in these conditions. If *no* meter reading is observed the transmitter is correctly neutralized.

158. If as a result of the test described in the preceding paragraph, output current is found in the meter, position 5, it will be necessary to re-neutralize the transmitter by proceeding as follows. Remove the amplifier unit, set the equipment at TRANSMIT and after inserting a 6,225 kc/s crystal, or a crystal of the nearest frequency to this available, tune the set as described in paras. 139 to 144, then set the switch to position 6 and adjust $T.C._4$ to maximum. Then switch to position 5 and adjust $T.C._5$ to maximum. If the reading exceeds *one* division, full scale corresponding to 100, readjust neutralization condensers C_{219} and C_{220} , until the meter reading becomes *less* than one division, and repeat the test procedure described in para. 157.

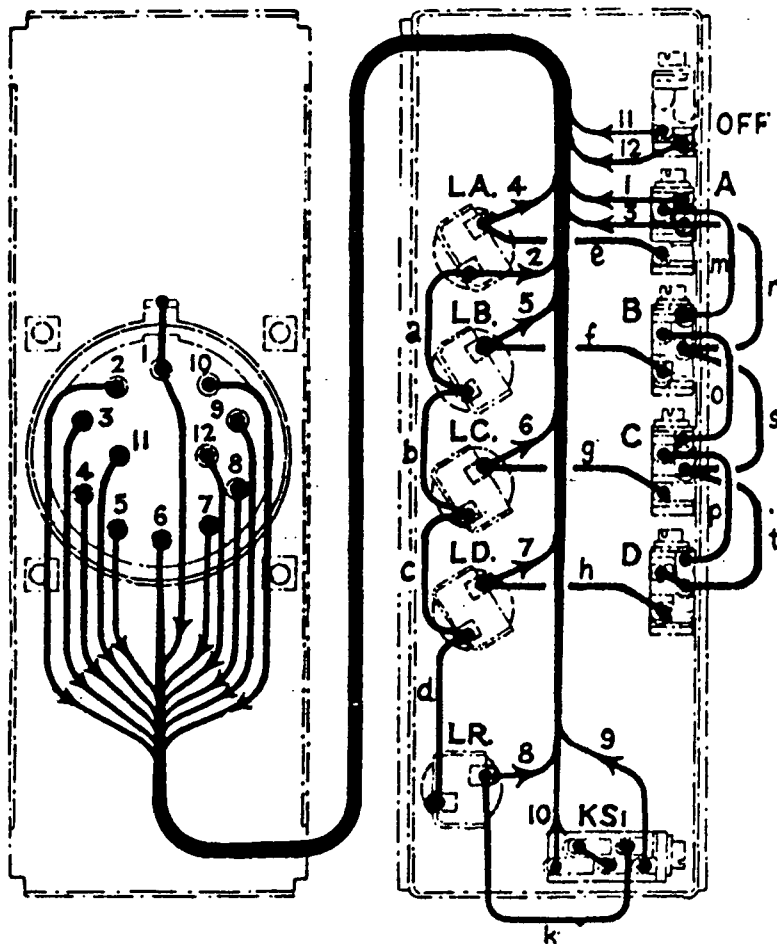
159. The neutralizing condensers are adjusted by moving the shutter upwards or downwards after loosening the clamping screws. These should only be loose enough to permit easy movement of the shutter when pushed down by a screwdriver applied as a lever between the tabs on the shutter and the chassis. When making final adjustments, it is advisable to tighten one of the clamping screws and pivot the opposite side of the shutter down as necessary.

160. As a guide to the directions of movement necessary, if the frequency at which a reading was obtained under the conditions described in para. 157 lies at the low frequency end of the frequency range, move the shutter upwards, and if at the high frequency end, move the shutter downwards. Adjustment should be continued until conditions given in para. 158 are satisfied and operation should again be checked in accordance with the tests given in para. 157.

161. Note, as regards changing valves, that the valve even if unsuitable in one position may frequently be useful in another position, that is, a valve which will not perform in a proper manner as a frequency trebler V_3 or doubler V_4 may be suitable for use as an output valve in position V_5 or V_6 .

162. Apart from poor neutralization, apparent trouble in tuning the output stage involving low output reading in position 5 with normal performance of the valves V_5 and V_6 , may be caused by failure of the monitor valve V_7 , or by the wrong setting of the monitor coupling condenser C_{310} .

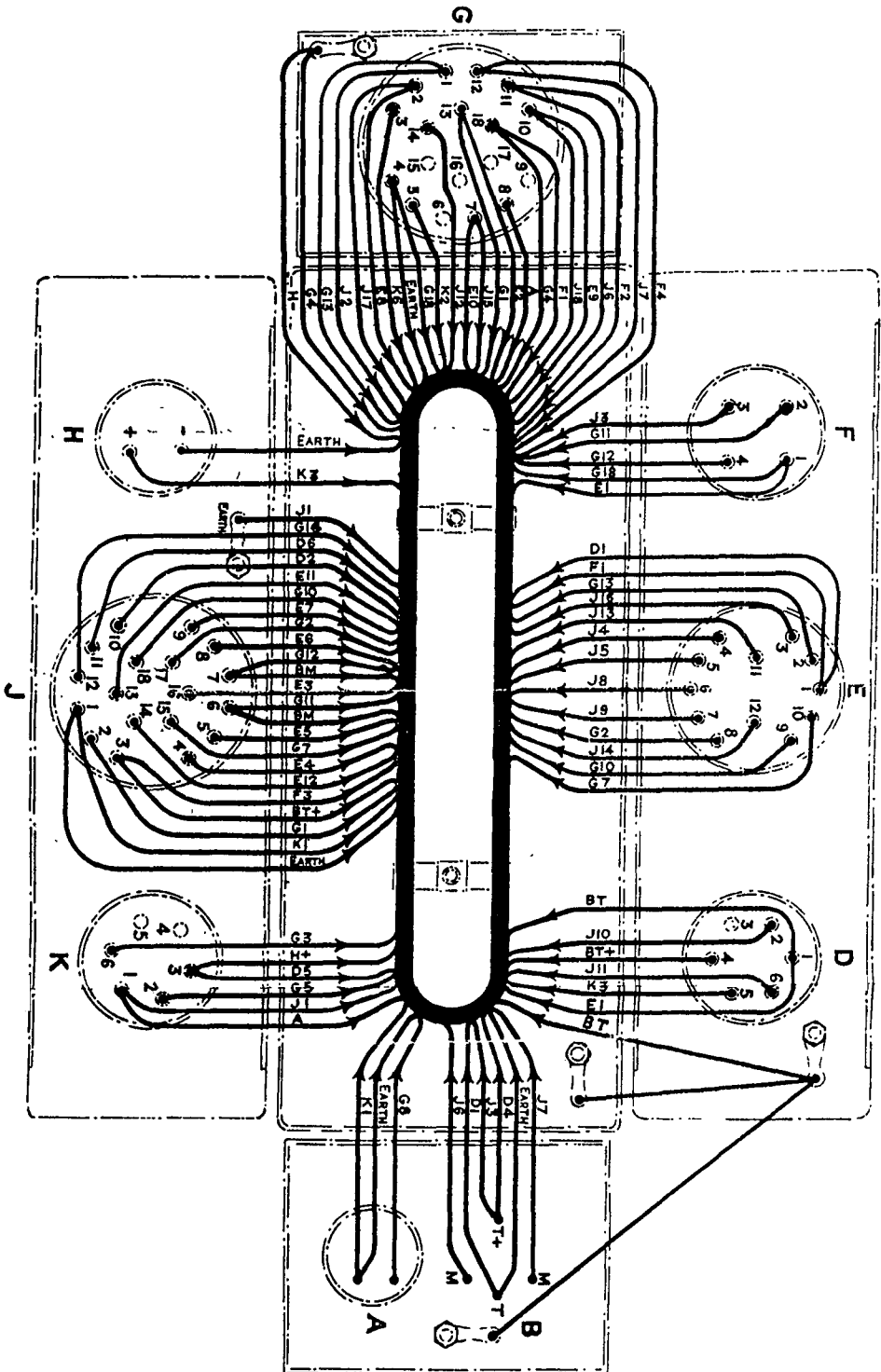
COLOUR INDEX TO LEADS		
LEAD		COLOUR OF LEAD
1	m, o, p,	BLK.
2	a, b, c, d,	R.
3	r, s, t.	BR.O.
4	e.	O.
5	f.	SL.
6	g.	W.R.
7	h.	W.BLU.
8	k.	BR.SL.
9		BR.GRE.
10		BR.BLU.
11		BR.BLK.
12		BR.R.



ELECTRIC CONTROLLER TYPE 3,
WIRING DIAGRAM.

FIG.21

FIG.21.



PLUG	LEAD	CLOUR INDEX TO LEADS	PLUG	LEAD
A	8	BLK	G	Earth Tag
B	1	BR	K	1
A	2	BLK	D	2
B	3	BLK	D	3
"	4	BLK	D	4
"	5	BLK	D	5
"	6	BLU	D	6
"	7	BLU	D	7
"	8	BLU	D	8
"	9	BLU	D	9
"	10	BLU	D	10
"	11	BLU	D	11
"	12	BLU	D	12
"	13	BLU	D	13
"	14	BLU	D	14
"	15	BLU	D	15
"	16	BLU	D	16
"	17	BLU	D	17
"	18	BLU	D	18
"	19	BLU	D	19
"	20	BLU	D	20
"	21	BLU	D	21
"	22	BLU	D	22
"	23	BLU	D	23
"	24	BLU	D	24
"	25	BLU	D	25
"	26	BLU	D	26
"	27	BLU	D	27
"	28	BLU	D	28
"	29	BLU	D	29
"	30	BLU	D	30
"	31	BLU	D	31
"	32	BLU	D	32
"	33	BLU	D	33
"	34	BLU	D	34
"	35	BLU	D	35
"	36	BLU	D	36
"	37	BLU	D	37
"	38	BLU	D	38
"	39	BLU	D	39
"	40	BLU	D	40
"	41	BLU	D	41
"	42	BLU	D	42
"	43	BLU	D	43
"	44	BLU	D	44
"	45	BLU	D	45
"	46	BLU	D	46
"	47	BLU	D	47
"	48	BLU	D	48
"	49	BLU	D	49
"	50	BLU	D	50
"	51	BLU	D	51
"	52	BLU	D	52
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"	64	BLU	D	64
"	65	BLU	D	65
"	66	BLU	D	66
"	67	BLU	D	67
"	68	BLU	D	68
"	69	BLU	D	69
"	70	BLU	D	70
"	71	BLU	D	71
"	72	BLU	D	72
"	73	BLU	D	73
"	74	BLU	D	74
"	75	BLU	D	75
"	76	BLU	D	76
"	77	BLU	D	77
"	78	BLU	D	78
"	79	BLU	D	79
"	80	BLU	D	80
"	81	BLU	D	81
"	82	BLU	D	82
"	83	BLU	D	83
"	84	BLU	D	84
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"	87	BLU	D	87
"	88	BLU	D	88
"	89	BLU	D	89
"	90	BLU	D	90
"	91	BLU	D	91
"	92	BLU	D	92
"	93	BLU	D	93
"	94	BLU	D	94
"	95	BLU	D	95
"	96	BLU	D	96
"	97	BLU	D	97
"	98	BLU	D	98
"	99	BLU	D	99
"	100	BLU	D	100

JUNCTION BOX TYPE 17B WIRING DIAGRAM.

FIG. 22

FIG. 22

If the lock nuts of the movable disc of this component have become loose, C_{310} may possibly have been set too far away from TC_5 . The normal position of the disc is approximately $2/3$ in. from the nearest point of the stand-off insulator.

163. If difficulty is experienced in tuning TC_2 , TC_3 or TC_4 at the extreme ends of the frequency scale, this may be due to either C_{210} or C_{214} having become displaced from their correct positions so that they are in close proximity to the chassis or other earthed component. Alternatively, a faulty valve may cause this trouble.

APPENDIX I

Voltage and Current Values Analyses for Valves in T.R.1143

1. All measurements are made with avometer, type F (Stores Ref. 10S/1).

Transmitter unit, type 17

Static condition

Test	Freq. in Mc/s.	V-1	V-2	V-3	V-4	V5-6	V-7
Anode—Earth	—	165 v.	280 v.	300 v.	298 v.	295 v.	—
Screen—Earth	—	72 v.	170 v.	236 v.	242 v.	190 v.	—
Bias—Earth	—	—	58 v.	73 v.	100 v.	26 v.	—
Anode Current	—	*0.9 mA	—	—	—	0.13 mA	—

Dynamic condition

Test	Freq. in Mc/s	V-1	V-2	V-3	V-4	V5-6	V-7
Anode—Earth	108	217 v.	225 v.	300 v.	270 v.	280 v.	—
Screen—Earth	108	115 v.	120 v.	193 v.	180 v.	150 v.	—
Bias—Earth	108	—	58 v.	75 v.	102 v.	27 v.	—
Anode Current	108	*5 mA	0.43 mA	0.47 mA	0.59 mA	0.56 mA	0.44 mA
Anode Current	124	*5 mA	0.49 mA	0.55 mA	0.68 mA	0.51 mA	0.47 mA
Grid Current	108	—	—	—	—	0.50 mA	—
Grid Current	124	—	—	—	—	0.36 mA	—

Note.—

- (i) All voltage readings taken on 0–400 v., D.C. range.
(ii) Current readings taken on 0–1 mA 75 ohms meter range except for currents marked * where 0.01 amp. range is used

Receiver unit, type 19

Static condition

Test	V1	V2	V3	V4	V5	V6	V7	V8	Total Current
Anode—Earth	240 v.	270 v.	250 v.	240 v.	240 v.	240 v.	240 v.	150 v.	= 79 mA
Screen—Earth	200 v.	240 v.	250 v.	100 v.	100 v.	100 v.	200 v.	—	
Cathode—Earth	1.6 v.	3.4 v.	20 v.	—	2.3 v.	2.3 v.	1.6 v.	—	

Dynamic condition

Test	V1	V2	V3	V4	V5	V6	V7	V8	Total Current
Anode—Earth	240 v.	270 v.	240 v.	260 v.	240 v.	240 v.	240 v.	200 v.	= 74 mA
Screen—Earth	200 v.	240 v.	240 v.	150 v.	100 v.	100 v.	200 v.	—	
Cathode—Earth	1.6 v.	3.4 v.	25 v.	—	2.3 v.	2.3 v.	1.6 v.	—	

Note.—

- (i) All dynamic readings obtained at point of Relay Release at frequency = 110 Mc/s.
(ii) All readings taken on 0–400 v., D.C. range except V₃ cathode on 100 v., D.C. range and all other cathodes on 10 v., D.C. range.

Amplifier unit, type 18

Voltage readings

Test	V ₁	V ₂	V ₃	V ₄ /V ₅ No input	V ₄ /V ₅ 30 mV input	V ₈ No input	V ₈ 30 mV input
Anode—Earth	130 v.	290 v.	297 v.	297 v.	297 v.	230 v.	290 v.
Screen—Earth	60 v.	—	40 v.	265 v.	230 v.	—	—
Cathode—Earth	3.0 v.	—	0.9 v.	—	—	—	—

Current readings

<i>Test</i>	V_1	V_2	V_3	V_4/V_6 <i>No</i> <i>input</i>	V_4/V_5 <i>30 mV</i> <i>input</i>	V_6 <i>No</i> <i>input</i>	V_6 <i>30 mV</i> <i>input</i>
Anode Current	0.6 mA	5.5 mA	1.2 mA	33 mA	60 mA	5 mA	—
Screen Current	0.2 mA	—	0.35 mA	5.8 mA	14 mA	—	—

Note,—

- (i) Total bias current (i.e. through R_{19}) = 1.2 mA.
- (ii) Voltage to earth at junction of R_{18} and R_{19} = 35 v.
Voltage to earth at junction of R_{17} and R_{18} = 26 v.
Voltage to earth at junction of R_{15} and R_{17} = 6.0 v.
- (iii) All voltage measurements made on 0-1000 v. range, except cathode voltages taken on 100 v. and 10 v. ranges.

APPENDIX II

Values of Components

	Resistances (ohms)				Condensers			
	Ref.	Value	Ref.	Value	Ref.	Value	Ref.	Value
Power unit	R1	12			C1	0.001 μ F	C7	0.002 μ F
	R2	0 or 0.3			C2	0.001 μ F		
	R3				C3	0.002 μ F		
					C4	0.002 μ F		
Chassis					C5	0.002 μ F		
					C6	0.002 μ F		
	R101	3900			C101	2 μ F		
	R102	47			C102	2 μ F		
	R103	33			C103	2 μ F		
					C104	2 μ F		
Transmitter					C105	20 μ F		
					C106	0.0003 μ F		
	R201	100000	R226	47	C201	1.6 μ F	C226	0.001 μ F
	R202	15000	R227	6200	C202	0.005 μ F	C227	0.001 μ F
	R203	100000	R228	6200	C203	0.005 μ F	C228	0.001 μ F
	R204	47	R229	6200	C204	0.001 μ F	C229	0.0005 μ F
	R205	100000	R230	6200	C205	200 μ F	C230	0.0005 μ F
	R206	15000	R231	47	C206	0.005 μ F	C231	1 μ F
	R207	150000	R232	47	C207	0.005 μ F	C232	0.001 μ F
	R208	39000	R233	6800	C208	0.005 μ F	C233	0.001 μ F
	R209	47000	R234	27	C209	0.001 μ F	C234	0.0005 μ F
	R210	39000	R235	42	C210	100 μ F	C235	0.0002 μ F
	R211	1000	R236	9100	C211	0.001 μ F		
	R212	47000	R237	9100	C212	0.0005 μ F		
	R213		R238	47000	C213	0.0005 μ F		
	R214				C214	100 μ F		
	R215	15000			C215	0.001 μ F		
	R216	15000			C216	8 μ F		
	R217	33			C217	0.0005 μ F	TC1	3.2/20 μ F
	R218	620			C218	0.0005 μ F	TC2	3.2/20 μ F
	R219	620			C219		TC3	3.2/20 μ F
	R220	1000			C220		TC4	3.2/9.1 μ F
	R221	1000			C221	20 μ F	TC5	2.8/6.1 μ F
	R222	10.72			C222	20 μ F		
	R223	1.92			C223	0.0003 μ F		
R224	1.92			C224	0.0003 μ F			
R225	0.76			C225	0.001 μ F			
Receiver	R301	10000	R340	68000	C301	3 μ F	C340	0.01 μ F
	R302	47000	R341	22000	C302	4/16 μ F	C341	75 μ F
	R303	47	R342	22000	C303	2/6 μ F	C342	0.01 μ F
	R304	100000	R343	2.2 M	C304	8 μ F	C343	0.01 μ F
	R305	47000	R344	2.2 M	C305	0.0003 μ F	C344	75 μ F
	R306	1800	R345	2.2 M	C306	0.0003 μ F	C345	0.01 μ F
	R307	1800	R346	2.2 M	C307	0.01 μ F	C346	75 μ F
	R308	220	R347	47000	C308	0.01 μ F	C347	0.01 μ F
	R309	2200	R348	47	C309	40 μ F	C348	0.01 μ F
	R310	10000	R349	100000	C310	0.01 μ F	C349	75 μ F
	R311	8.3	R350	100000	C311	3.2/20 μ F	C350	0.01 μ F
	R312	100000	R351	100000	C312	2/6 μ F	C351	50 μ F
	R313	100000	R352	100000	C313	0.0003 μ F	C352	50 μ F
	R314	100000	R353	100000	C314	4/16 μ F	C353	75 μ F
	R315	47000	R354	100000	C315	4/16 μ F	C354	0.1 μ F
	R316		R355	100000	C316		C355	0.05 μ F
	R317	1000	R356	100000	C317	2/6 μ F	C356	0.02 μ F
	R318	10000	R357	22000	C318	300 μ F	C357	0.1 μ F
	R319	10000	R358	47000	C319	300 μ F	C358	0.002 μ F
	R320	100000			C320	4/16 μ F	C359	0.01 μ F
	R321	100000			C321	0.01 μ F	C360	0.01 μ F

	Resistances (ohms)				Condensers			
	Ref.	Value	Ref.	Value	Ref.	Value	Ref.	Value
Receiver (Cont.)	R322	68000			C322	20 $\mu\mu\text{F}$	C361	0.0003 μF
	R323	330			C323	2/6 $\mu\mu\text{F}$	C362	0.0003 μF
	R324	10000			C324	5 $\mu\mu\text{F}$	C363	0.01 μF
	R325	100000			C325		C364	0.01 μF
	R326	100000			C326	4/16 $\mu\mu\text{F}$	C365	0.01 μF
	R327	68000			C327	0.01 μF	C366	0.01 μF
	R328	330			C328	75 $\mu\mu\text{F}$	C367	0.0003 μF
	R329	10000			C329	2/6 $\mu\mu\text{F}$	C368	0.0003 μF
	R330	47000			C330	0.01 μF	C369	0.01 μF
	R331	220			C331	0.01 μF	C370	0.01 μF
	R332	10000			C332	6 $\mu\mu\text{F}$	C371	0.01 μF
	R333	47000			C333	0.01 μF	C372	0.002 μF
	R334	200000			C334	3 $\mu\mu\text{F}$	C373	0.01 μF
	R335	470000			C335	75 $\mu\mu\text{F}$	C374	75 $\mu\mu\text{F}$
	R336	82000			C336	0.01 μF	C375	20 $\mu\mu\text{F}$
	R337	33000			C337	75 $\mu\mu\text{F}$		
	R338	2.2 M			C338	0.01 μF		
	R339	4700			C339	0.01 μF		
	Amplifier	R401	47000	R428	470000	C410	0.0003 μF	
R402		1 M	R429	470000	C407	8 $\mu\mu\text{F}$		
R406		1 M	R418	10000	C402	0.25 μF		
R405		1 M	R424	10000	C401	0.25 μF		
R403		1 M	R425	470000	C416	0.01 μF		
R404		1 M	R423	1 M	C404	0.01 μF		
R436		200000	R422	470000	C403	100 $\mu\mu\text{F}$		
R407		600	R427	100000	C405	0.5 μF		
R410		3300	R426	2.2 M	C406	0.25 μF		
R413		1 M	R431	1 M	C409	100 $\mu\mu\text{F}$		
R411		2.2 M	R430	8.33	C408	0.001 μF		
R408		100000	R433	10000	C413	0.0003 μF		
R409		1 M	R435	2.2 M	C417	0.25 μF		
R412		4700	R421	125	C414	0.25 μF		
R414		15000	R420	2.2 M	C411	0.002 μF		
R432		7500	R437	1.5	C412	0.01 μF		
R415		68000			C415	0.5 μF		
R416		600			C418	0.1 μF		
R417		680000						
R419		6800						
R434	1 M							
Condenser Motor	R501	10			C501	1 μF		
					C502	1 μF		

APPENDIX III

SERVICING

General

1. The TR.1143, power unit, type 16, electric controller, type 3, junction box assembly, type 17B and connectors should be removed from the aircraft to the Signals Workshop. All necessary batteries and testing apparatus should be readily available there.

2. All numbered references to figures and diagrams refer to those used in A.P.1186A, Vol. I, Sect. 10, Chap. 4 (Provisional) or A.P.2528, Vol. I, Sect. 1.

3. Where relay contacts have to be cleaned, the best method to adopt is to cut from thin stiff clean card several narrow strips approximately 4 in. \times $\frac{1}{2}$ in. If one of these, with a moistening of carbon tetrachloride (Ref. 33C/620), is placed between the actual relay contacts and given several forward and backward movements while manually operating the relay armature, cleaning of the actual bearing surface of the contacts will be accomplished without distortion of the leaf springs.

4. Where oil has to be applied to moving parts, use anti-freeze oil very sparingly, ensuring that it does not penetrate to other parts on the chassis.

Dismantling

5. Remove outer casing by releasing four large Dzus fasteners and lift set out. Clean outer case.

6. Remove two slide-back metal covers, 10A/13014 and 10A/13015, by unscrewing retaining screws at each end.

7. *Ensure that all selector mechanism is at neutral*, i.e., that all selector fingers are disengaged from slide bars controlling rotation of transmitter and receiver tuning condensers. If this is not already so, connect set to a supply and operate release switch (10F/10338) on top of motor unit.

8. Remove centre metal cover, 10A/13013, bearing TR.1143 serial and reference numbers, by unscrewing four nickel-plated round head screws and four nickel-plated cheese head screws. No black enamelled screws need be removed. Removal of this cover exposes the aerial change-over relay and all connections of the Jones sockets into which the transmitter, receiver and amplifier chassis plug.

9. Remove transmitter, receiver and amplifier chassis by removing red painted screws (four for transmitter, three for receiver, three for amplifier). If the whole chassis is stood on the end nearest the selector mechanism, the transmitter, receiver and amplifier will ease out gradually without distortion of the chassis.

Transmitter unit, type 17 (Stores Ref, 10R/1)

10. Remove crystals. Check for wear on small insulating cylindrical washers which operate the crystal switch contacts. Clean crystal switch contacts.

11. Remove end and side panels to expose valves.

12. Remove valves and examine valve pins and caps for security and cleanliness. Examine the valve holders and retaining clips and springs. Clean valve pins with carbon tetrachloride. Examine braided flexible lead to valve top cap clips for evidence of fraying and renew if necessary.

13. Ensure that the braided leads to the valve caps of the VT.501 valves in the second trebler and doubler stages (V.203 and V.204) are not long enough to permit them to earth against the chassis under vibration.

14. Inspect coils for security and check for foreign matter or dust between tuning condenser vanes. Clean out with stiff card if necessary.

15. Screens exist between the variable condensers TC.201-TC.202-TC.203-TC.204. In some cases, the washers on the condenser assembly pillars project to a degree where they touch these screens. In such cases the side of the washer nearest the screen is to be filed flat, using a small flat file. Care must be taken to remove the filings after this operation.

16. Check that condenser spindle extensions are not loose.

17. Check all four selector slides for cleanliness, freedom of movement and their prompt return to neutral position when free. Oil may be used sparingly on the slides, care being taken to ensure that it is not allowed to reach the condenser assemblies which are not intended to be oiled.

18. If meter switch contacts are dirty, clean with small camel-hair brush moistened with carbon tetrachloride

19. Inspect wiring for dry joints and security.

20. Clean out the under chassis, particularly near the R.F. sections of the circuit, using a small soft brush and/or a blower. *Do not distort the R.F. wiring or coils in any way and do not twist either condensers or resistors on their end wires.*

21. Inspect all screw connections and component supports and tighten where necessary.

22. Clean or blow out dust that may be lodged between the two flat metal plates mounted together and running from the aerial coupling coil (L.206) to the aerial socket.

23. Replace valves, retaining clips, etc., and metal panels.

Receiver unit, type 19 (Stores Ref. 10P/2)

24. Remove crystals. Check for wear on small insulating cylindrical washers which operate crystal switch contacts. Clean crystal switch contacts.

25. Remove valves and check as in para. 12 above (care must be used in the extraction of the VR.91's).

26. Inspect components above and below chassis for security and cleanliness. Use blower to remove dust. *Do not distort R.F. coils or wiring.*

27. Inspect tuning condenser vanes for freedom of movement and cleanliness. See para. 14 above *re* cleaning. Pay particular attention to oscillator tuning condenser TC.8 which, because of its position, is liable to be overlooked.

28. Check condenser tuning spindle extensions for looseness.

29. Do *NOT* move settings of any of the small trimming condensers nor the I.F. transformer adjustments.

30. Check muting relay adjustment and clean contacts.

31. Check selector slides as in para 17 above.

32. Clean out the aerial coaxial socket and check wiring.

33. Replace valves, retaining clips and bends. Ensure that the top cap connections are secure when fitted and that their flexible leads are not frayed. In the case of the oscillator valve, VT.52 (V.303, fig. 14), ensure that the top cap connection does not make contact with the earthed screening can.

Amplifier unit, type 18 (Stores Ref. 10U/2)

34. Remove valves and deal with them and their holders as in para. 12 above.

35. Examine components and wiring for security and cleanliness. Clean with blower.

Relay unit (Stores Ref. 10A/13027)

36. Turn the main chassis over carefully with the "W" sockets undermost and with the selector motor nearest the front of the bench. The relay unit is now uppermost and may be removed by releasing two Dzus fasteners which are on a cross member between the relay unit and the selector motor assembly. Remove unit by sliding and lifting, and remove the dust cover which is retained by one screw.

37. Inspect row of knife connections arranged in ten pairs. Clean carefully without distorting or shorting any connections.

38. Clean relay contacts carefully. Depress each relay armature manually and see that it opens and closes contacts and has not become dislodged from its normal pivoting position.

39. Examine wiring and connections and check security of relays.

40. Replace dust cover carefully.

Selector motor unit (Stores Ref. 10D/635)

41. Place main chassis in normal position, i.e., aerial relay uppermost.

42. Lift off each of the four extension rod yokes going to receiver selector fingers across the top of the chassis (see fig. 10). These rod yokes are each held in position on the selector motor bell cranks (point 26) by a thin leaf spring which normally prevents them slipping off. Gently lift each spring and ease the rod yoke free, starting with the topmost. When all four are free and clear of the selector motor mechanism, and *not before*, the three screws holding the selector motor unit to the main chassis may be unscrewed and the unit withdrawn upwards.

43. By depressing and releasing manually the selector motor and driving motor armatures, the normal movement of the mechanism may be observed in slow motion. Check that each ratchet movement is working correctly.

44. The longer armature found underneath the release switch operates the cams and insulating discs associated with the leaf spring contacts. These should be inspected and the relative movement of the contacts checked. Clean carefully.

45. The other motor armature should be operated manually through a whole cycle and the movement and return of the selector fingers checked.

46. Other contacts on the leaf spring should be cleaned carefully, care being taken not to distort them.

47. Oil must be used sparingly, and then only on the working bearings, cog teeth and sliding parts.

48. Check wiring (see fig. 19).

49. Leave all selector fingers and bell crank levers in neutral position.

Main chassis (top tray)

50. Clean all dust from chassis with small soft brush and/or blower.

51. Check return springs on receiver selector fingers.

52. Inspect all wiring and connections for security (see fig. 21).

Inspect all knife connections into which slide the appropriate connections of the motor relay unit, and, where these show signs of being opened unduly, careful repositioning should

Aerial change-over assembly (Stores Ref. 10F/774)

54. This unit is attached to the main chassis by three screws which are accessible from the top of the chassis. They can be readily identified by observing the underside of the main chassis near the two aerial sockets into which the transmitter and receiver plug.

55. Clean relay contacts.

56. Clean between strips connecting aerial sockets and relay leaf springs. *Do not distort them in any way.*

57. Clean dust from insulating material inside and outside of the three aerial sockets.

58. Check wiring and connections for security (see fig. 21).

Re-assembling

59. Replace aerial change-over assembly.

60. Replace relay unit, carefully engaging knife contacts.
61. Replace selector motor unit. Do not screw down tightly at this stage. Connect up extension rod yokes to bell crank levers in original position.
62. Replace amplifier and screw to chassis firmly.
63. Replace receiver. Screw up to chassis firmly, ensuring that the selector fingers on the main chassis register with the appropriate channel slides on the receiver.
64. Replace transmitter and screw up to chassis firmly.
65. Now loosen and line up selector motor mechanism so that the selector fingers on the motor unit engage correctly with the slide bars on the transmitter chassis and screw up tightly when positioned.
66. The whole unit may now be tested for correct operation, using a known serviceable junction box assembly. If satisfactory, covers may be replaced.

Controller, electric, type 3 (Stores Ref. 10J/26)

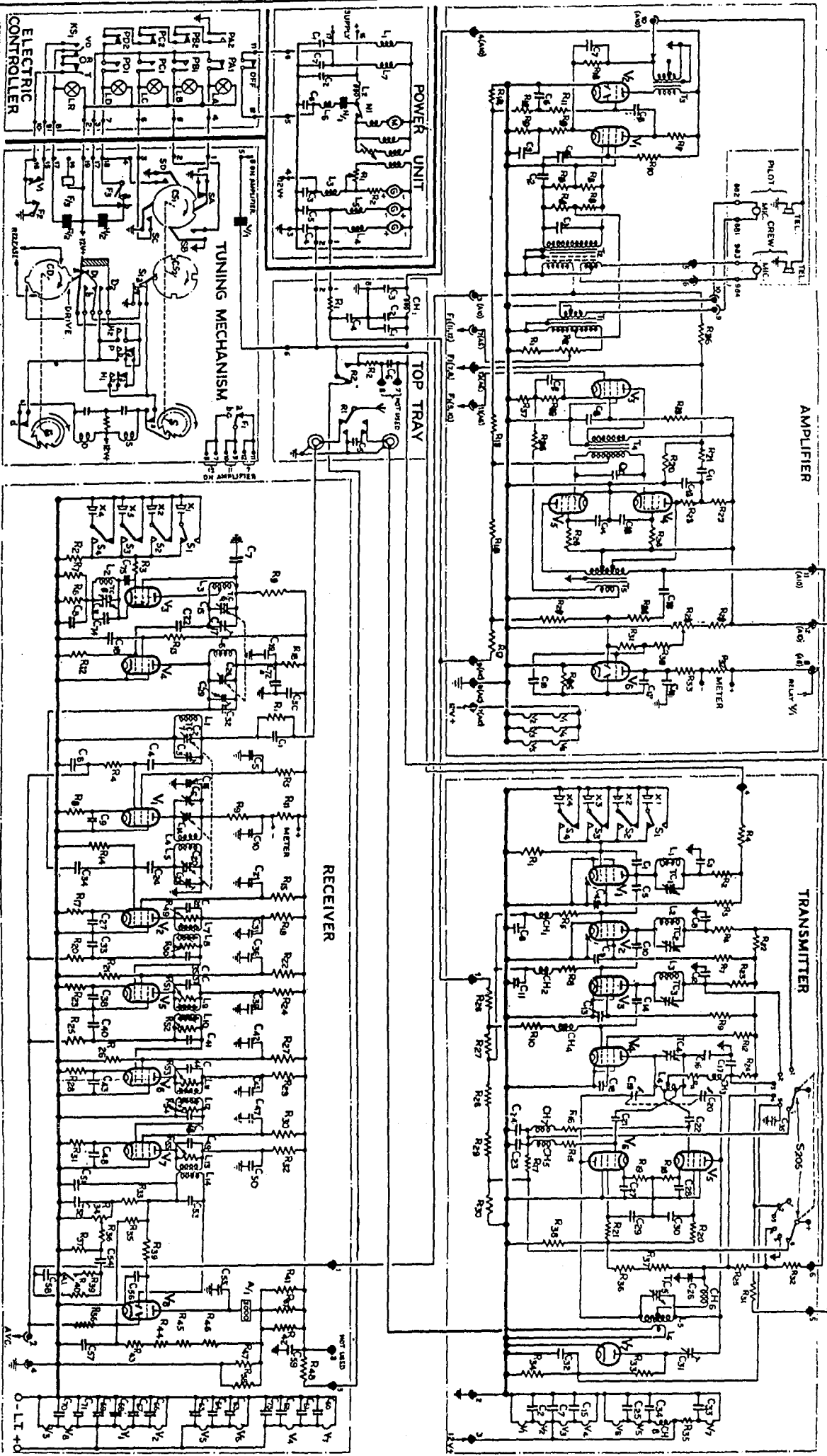
67. Apart from contact cleaning and lubrication of the pressbutton mechanism and key switch detent, the controller should need no maintenance. Renewal of the pilot lamps, when necessary, may be effected by removing the front plate assembly, held by two screws, extracting the lamp caps with pliers, and withdrawing the unserviceable lamp by means of an ordinary penholder. The renewal lamp may be pushed home with a pencil.

Junction box assembly, type 17B (Stores Ref. 10A/12650)

68. All connectors are easily detachable from the junction box and should be completely removed for testing.
69. Ensure that all connectors are firmly attached to the Breeze metallic sleeving and that the knurled locking nuts are undamaged.
70. Check continuity of wiring in junction box and connectors (see figs. 3 and 23).
71. Re-assemble and connect up to associated TR.143, controller electric, type 3, and power unit, type 16. Check and tune for correct channel selector and operation before replacing in aircraft.

Power units, types 15 and 16

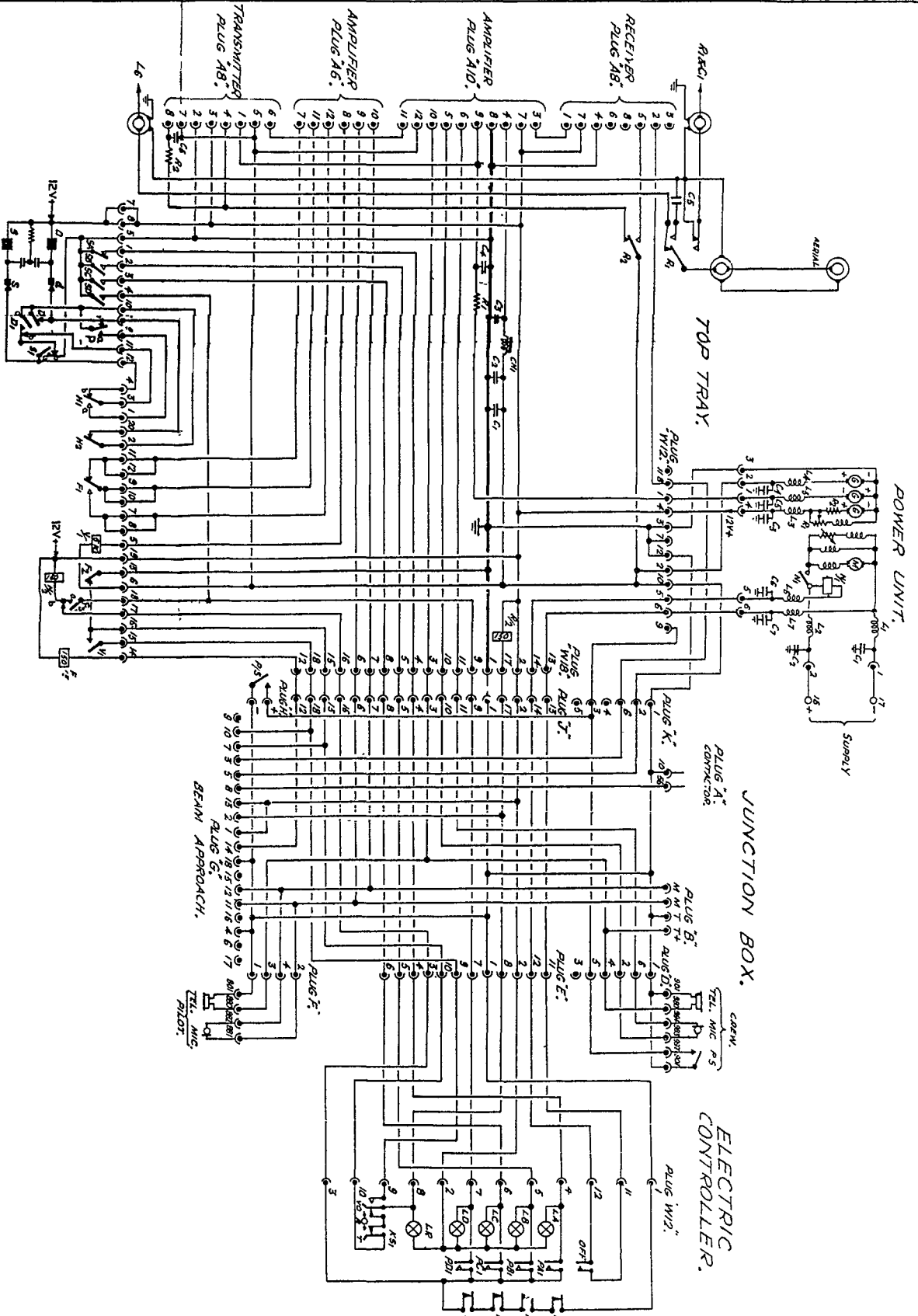
72. Instructions for the servicing of the Rotary Transformers will be found in A.P.1186D, Vol. I, Sect. 3, Chap. 1. The servicing and adjusting of the Voltage Regulator are described fully in A.P.1186D, Vol. I, Sect. 2, Chap. 3.



TR.1143 CIRCUIT DIAGRAM

FIG. 3

7720A MISSISSAUGA 1248 3300 CAF (4-50-41)



INTERCONNECTION DIAGRAM.

