Chapter 1

TUNING UNIT (AERIAL) TYPE 7180

LIST OF CONTENTS

LIST OF TABLES

LIST OF ILLUSTRATIONS

INTRODUCTION

1. The aerial tuning unit Type 7180 provides an impedance matching π-network between the transmitter and the complex impedance presented by a fixed wire aerial. The unit contains two variable inductors and a selection of fixed capacitors operated by three remote control elements.

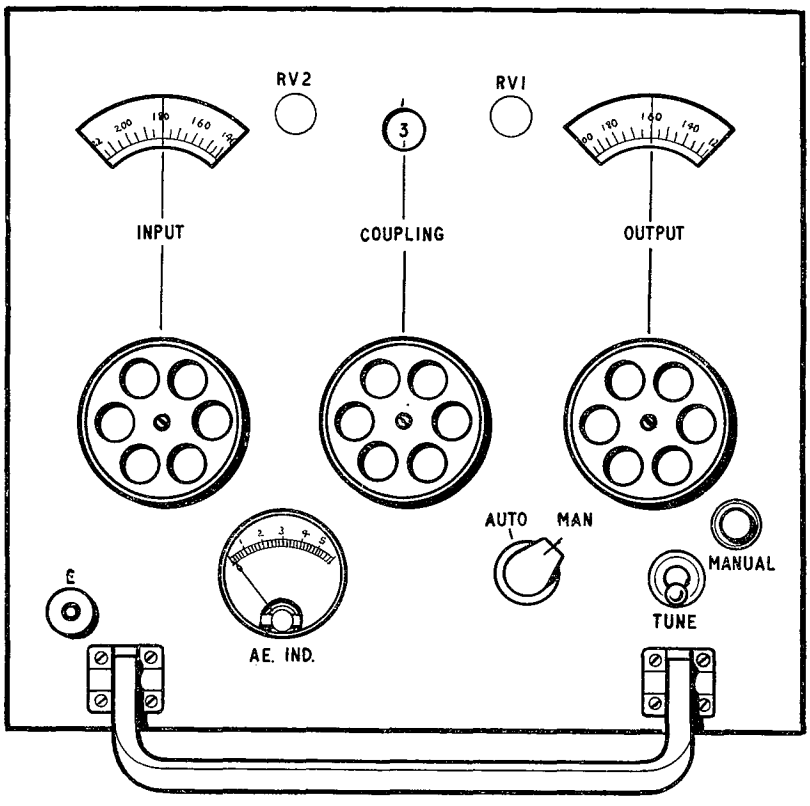


Fig. 1. Tuning unit (aerial) Type 7180—front panel

CONSTRUCTION

2. The components are mounted on a rectangular angle-framework with a shallow chassis base. All the manual controls are mounted on the front panel (*fig.* 1) and connections to the other units of the equipment are made via one multi-pin and one coaxial plug on the rear panel, the connection to the aerial is made via a polythene plug on the rear panel.

3. A removable dust cover (cover Type 1028—10AP/257) is fitted over the complete chassis and is fixed by an Oddie fastener at the rear. The front panel measures 8 in. by 8 in. and the length of the chassis is 12·5 in.

4. On the left and right hand sides of the rear of the base chassis are mounted the input and output variable inductors L1 and L2 (*fig.* 2 and 3). These coils are connected through the "anti-inertia" couplings to the front panel controls and to the driving motors. Above these coils, on the centre line, are mounted the fixed capacitors C1 to C6 and the associated switch S3.

5. The space between the coils is occupied by the relays of the bridge circuits operating the motors.

Front panel

6. A sub-panel on which the front panel is mounted, bears the three balancing potentiometers of the remote control circuits with the gearing between these and their respective manual control knobs and motors. The motors are mounted at the bottom of the unit below the gearing and are jointly disengaged from the gear trains when the AUTO-MAN switch is at the MAN position. The motors are held in pivoted cylindrical housings and can be removed from these by withdrawal from the underside.

7. The three motors MG1, MG2 and MG3 and the associated components are part of drive unit mechanical Type 7510 (*fig.* 2).

8. The front panel has the following controls, all for use on manual operation.

(1) Three tuning knobs and the associated dials —INPUT, COUPLING and OUTPUT.

(2) Two switches—AUTO-MAN and TUNE.

(3) A meter M1 giving indication of aerial excitation. (AE. IND.)

(4) Two variable resistors RV1 and RV2 for preset adjustment of the aerial monitor circuit.

(5) A red lamp which is illuminated when the AUTO-MAN switch is at MAN.

Rear panel

9. At the rear of the unit, close to the high potential output plug PL3, is mounted the aerial excitation monitor circuit, which includes the components associated with M1. The rear panel is fitted with the following plugs (*fig.* 5):—

(1) PL1—coaxial plug—Transmitted RF input.

(2) PL2—28-way plug—Control circuits.

(3) PL3—High voltage plug—Output to wire aerial.

Note . . .

The component group associated with the aerial excitation monitor circuit is accessible after the removal of the screws securing the rear panel. On no account must the screws securing the 28-way plug PL2 be removed since this will disturb the alignment of the plug with the associated socket in the back-plate. For further information see Chap. 3.

10. The underside of the base chassis displays the control relay connections and mounts the associated components (*fig.* 4).

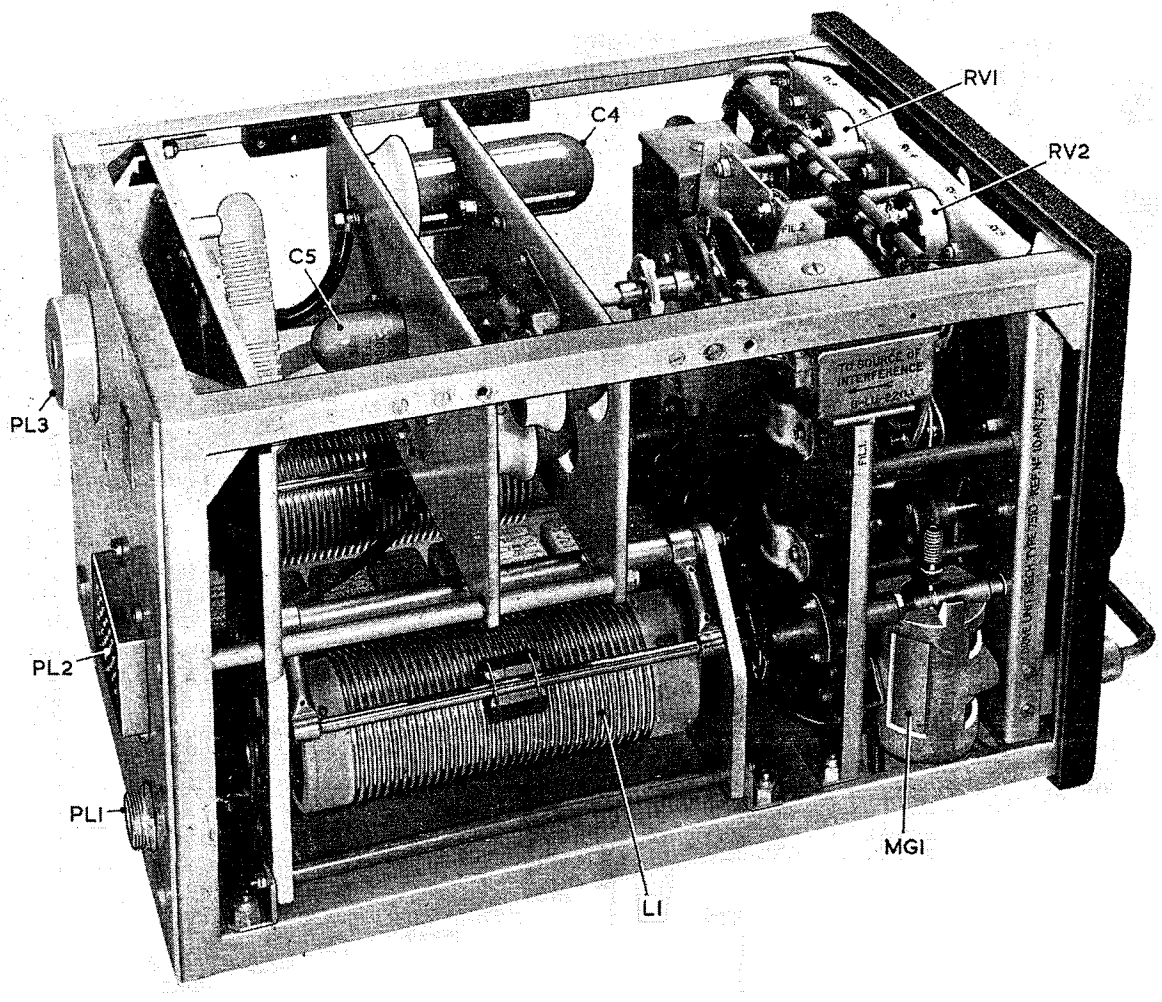


Fig. 2. Tuning unit—left side of chassis

CIRCUIT DESCRIPTION

RF circuit

11. The unit employs a π-network to match the 70-ohm resistance output from the transmitter to the complex impedance of a wire aerial. L1 is the input shunt element, one of the capacitors C1 to C6 the series element, and L2 the output shunt element (*fig.* 6). The transmitter output is connected to PL1 and the aerial to PL3.

Monitoring of aerial excitation

12. A toroidal coil, wound on an iron dust core and mounted in a "gapped" screen insulated from chassis forms an aerial current transformer T1; the aerial lead which passes through the centre being in effect a "single turn" primary. The secondary output shunted by R1, is rectified by the germanium rectifier W2 and the current in the load consisting of RV3, RV1 in series is measured with the meter M1.

13. A capacitance potential-divider formed by the insulated coil screen and C7 connects a fraction of the aerial potential to a second germanium rectifier W1, the rectified current then being measured again by M1 in series with R2 and RV2. The meter M1 will therefore read an indication of aerial current plus aerial potential.

14. Thus on a low impedance aerial the meter will give an indication mainly of aerial current, while on a high impedance aerial an indication mainly of aerial voltage is obtained. This ensures that a good indication of aerial excitation is given no matter what the aerial impedance.

15. Potentiometers RV1 and RV2 facilitate the adjustment of the circuit for a particular aerial. Generally these will be set so that the meter scale represents amps and kilovolts. The indication is given either on M1 on the aerial tuning unit or remotely, dependent upon the position of the AUTO-MAN switch; in the second event a separate earth wire is used via pin 26 of PL2 to avoid interference with the indication from earth currents

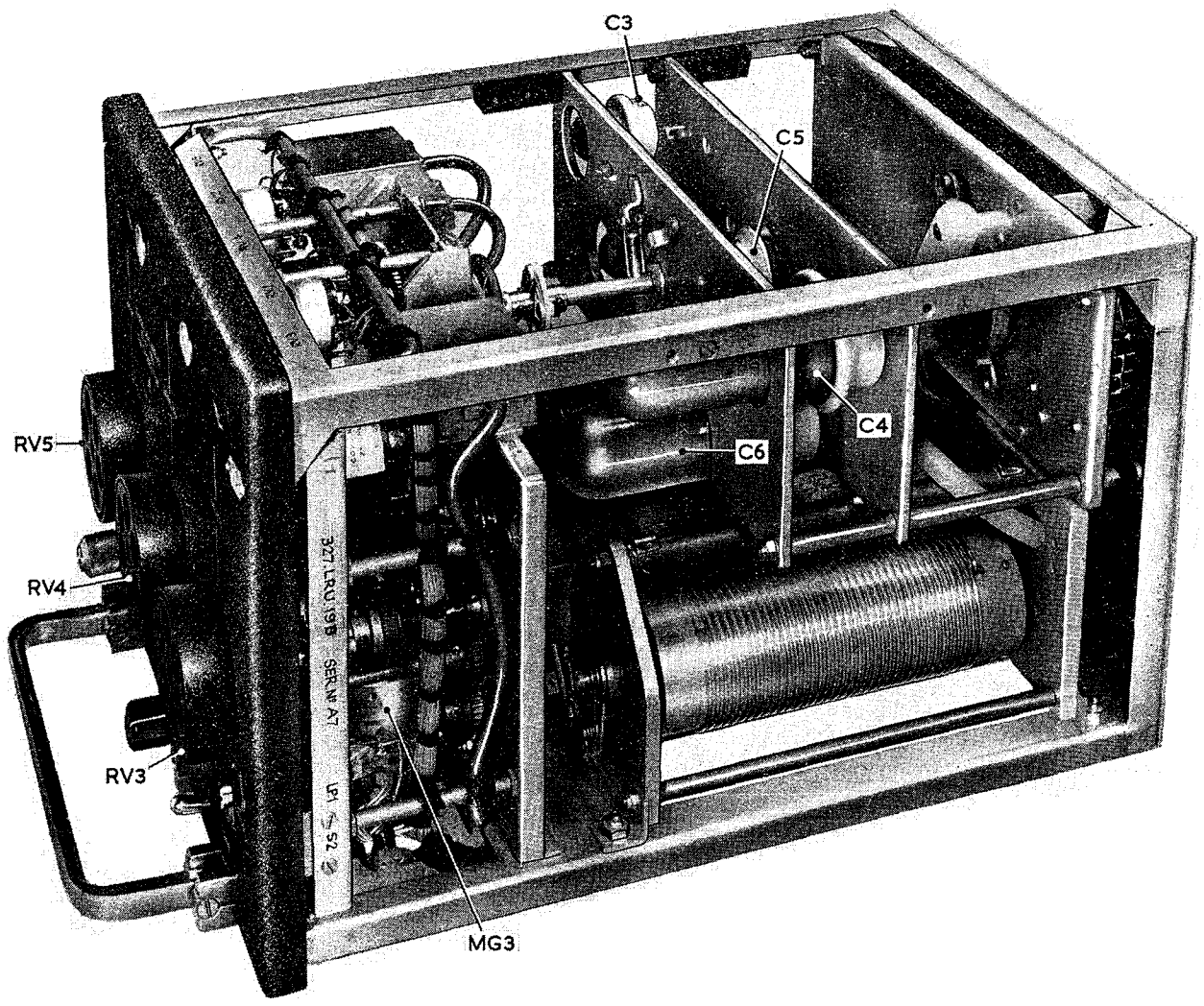


Fig. 3. Tuning unit—right side of chassis

due to the control circuits flowing in a common earth line.

Control circuits

16. The three motors MG1, MG2 and MG3 are remotely tuned by the settings of the associated potential dividers in the control unit Type 4243 (*Chap.* 2). The relay circuits of these motors are described in para. 22 to 43. The 28-volt supply for the motor relays is obtained from PL2/5. Motor MG2 operates three ganged switches S3A, S3B, S3C.

17. Switch S3B selects the series capacitor, S3A indicates to the control and drive unit which capacitor is selected by earthing one of the six signal wires of pins 20-25 on PL2, and S3C renders the TUNE switch S2A inoperative except when the contact of S3B is on a capacitor position. This avoids S3B making or breaking RF potentials.

18. Switch S1A-B has two positions. In the AUTO position the tuning unit is controlled remotely; S1A connects the output of the aerial monitor circuit to the remote meters via pin 6 on PL2 (AE IND); S1B connects the 19-volt supply to the remote bridge circuits of this unit from the drive unit.

19. In the MANUAL position, the meter M1 is connected to the monitoring circuit by S1A; switch S1B removes the bridge circuit supply to the drive unit at SK2/7 and a cam coupled to S1 disengages the mechanical drives from the tuning motors to the tuning elements (L1, C1 to C6, L2).

20. This arrangement allows manual tuning for initial setting up with a fixed aerial. The MANUAL condition is also marked by the switch S1B switching on MANUAL lamp LP1, indicating that remote control has been removed. The manual adjustments are made by use of the three front panel dials INPUT, COUPLING and OUTPUT, and the TUNE switch S2 (*fig.* 1).

21. The "rest" position of the spring-loaded TUNE switch S2 is the normal operating position (unmarked). In the spring-loaded position TUNE the key circuit is made by earthing pin 11 of PL2 via S2A and S3C. At the same time the "safe" condition is introduced by earthing the SAFE line at pin 17 of PL2. The TUNE switch thus allows a check to be made of the tuning unit in either positions of the AUTO-MAN switch S1.

Tuning motors and "Wheatstone Servo" circuits

22. The three servo systems used to drive the tuning motors MG1, MG2 and MG3 are identical with the exception of the component circuit reference numbers (*fig.* 6). All three circuits are similar to those used for the receiver and transmitter tuning.

23. Each servo system has two functions. The first is to turn the motors by remote control to tune up the aerial tuning unit from the control and drive unit (control unit Type 4243). The second is to provide a means of returning to these chosen tuning conditions when selection of a frequency channel is made.

24. The tuning circuit is described as a "Wheatstone Servo" and is fundamentally a self-balancing bridge. The circuit for all three tuning motors is described in the following paragraphs by reference

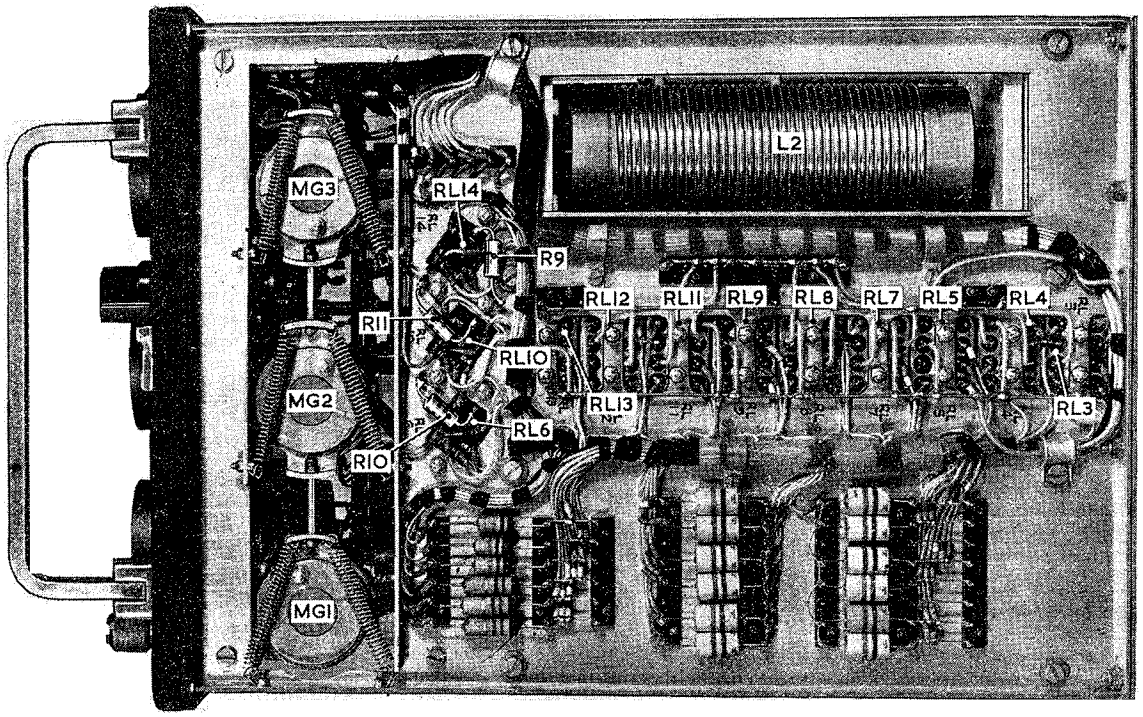


Fig. 4. Tuning unit—underside

to the circuit consisting of tuning motor MG1 and the motor-balancing potentiometer RV5 (etc.).

25. The setting potentiometer POT.3 (or POT.4) in the control unit Type 4243 (*Chap.* 2) is coupled by connectors to the motor-balancing potentiometer RV5. The bridge is supplied with 19V except when the equipment is in the MANUAL condition and when the selector motor in the control and drive unit is running.

26. A separate earth wire on the bridge, earthed at one end only (control earth) is used to avoid other DC earth currents affecting the centre-stable relay RL6/1.

27. The wiper of POT.3 is taken via pin 8 (control det.) of PL2 through the relay contact RL5A to the 110-ohm winding of the sensitive relay RL6/1, and thence to the wiper of RV5 driven by gearing from the tuning motor MG1.

28. When the bridge is unbalanced, relay RL6/1 operates and closes contacts 6A. Since the contacts of this relay cannot handle the motor current, contact 6A is arranged to energize the slave relays RL3/2 and RL4/2 from the 28V supply.

29. If the unbalance of the bridge is such that the direction of movement of contact 6A causes the relay RL3/2 to be energized, contacts 3A and 3B close. The 28V supply is then taken via contacts 4A and 3B to one side of the motor M, which being earthed on its other pole via contacts 4B and 3A starts to rotate (the motor has a permanent-magnet field).

30. When the bridge is restored to its balanced condition, contact 6A returns to the centre position and relay RL3/2 is released. Contact 3B then short-circuits the motor armature, thus providing a braking action to prevent over-run of the motor.

31. If relay RL4/2 is energized by reason of the position of the relay contact 6A, the contacts 3B and 4A will apply the battery supply to the motor in the reverse direction to that described in para. 26. The direction of the rotation of the motor will then of course, be reversed.

32. Since the sensitive centre-stable relay RL6/1 operates with an energizing current of approximately 200 microamperes, the 110-ohm winding must be protected from overload when the bridge is well out of balance. A Thermistor or non-linear resistance, W3 is connected in series with the safety relay RL5/2 and both are connected across the 110-ohm winding of RL6/1.

33. In conditions of overload the non-linear resistance falls to a low value and sufficient current passes to energize the safety relay, thus opening contact 5A and placing the resistor R4 in series with the sensitive winding to protect it.

34. At near balance conditions the contact 5A closes and thus restores the centre-stable relay to its full sensitivity.

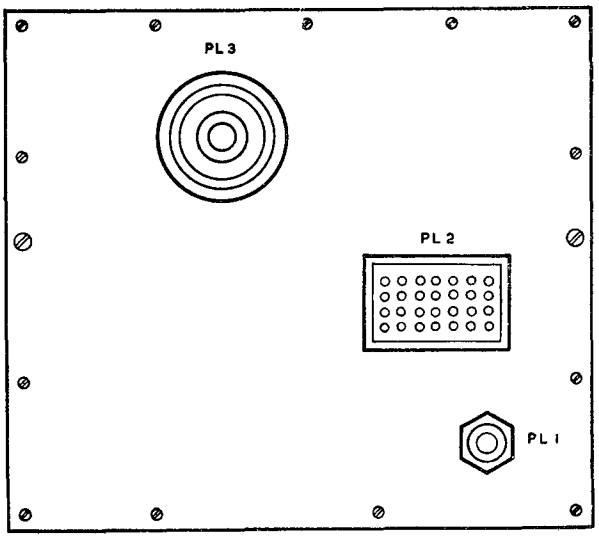


Fig. 5. Tuning unit—rear panel

35. The relay contact 6A is protected by the spark quench rectifiers W6 and W7, which also slow the release of the slave relays RL3/2 and RL4/2. The spark quench rectifiers W4 and W5 are connected across the motor to protect the contacts 3A, 3B, 4A and 4B.

36. Unless certain precautions are taken the system as described in the foregoing paragraphs will tend to "over-shoot" the balance point and then hunt before coming to rest. "Over-shoot" and the consequent hunting is prevented by the inclusion of an "anti-hunt" circuit using a 45-ohm second winding on the centre-stable relay RL6/1. This will be described as a "feed-back" circuit, although the action is not as is generally understood by this term.

37. Assume that the motor is moving towards the balance point with relay RL3/2 energized; contact 3B closed (22-23); the positive potential at the motor pole (relay contact 3B) is applied through the second winding of 45-ohms on relay RL6/1 through the feedback resistance R5 to earth at 3A. The mode of action of the 45-ohm winding is in opposition to that of the detector winding so that relay RL6/1 will reach its neutral position to stop the motor before the actual balance point is obtained.

38. In this condition, the feedback winding no longer has any effect since the positive supply is removed by the movement of relay contact 3B, however, the out-of-balance current still flows through the 110-ohm winding because the true balance point is not yet reached.

39. The sensitive relay RL6/1 thus closes once again to indirectly operate relay RL3/2 but as the effect of the 45-ohm winding is now greater the contacts 3A and 3B are immediately thrown off.

These conditions are repeated until the unbalance current falls below the operating value of the 110-ohm winding of RL6/1 and thus equilibrium is reached.

40. If the motor had been energized through the closed relay contact 4B, the feedback direction would then have been from 4A to 4B, thus still in opposition to the action of the 110-ohm winding. In practice, this causes the slave relays to run the motor to a point just before balance and then "tick" into the rest position. If overshoot occurs owing to varying loads on the motor, the feedback circuit greatly reduces the duration of hunting.

Note . . .

Relay contacts RL5B, RL9B and RL13B are not in use, but may be used in servicing to check the operation of these relays.

41. "Hash" filters are fitted to each pole of the tuning motor and are enclosed in a screened box FIL. 1. When the motor is running one of the contacts 4B or 3A of the slave relays will be operated and will earth the TUNE line. This indicates on a TUNE lamp on the control unit Type 4243 and the remote control unit, that a tuning motor is operating and normally prevents the key placing the transmitter on "mark". The latter function is more fully described in Section 1.

42. To prevent the control system driving the motors until the mechanical rotation limit-stops on the associated driven components are reached, it is necessary to arrange electrical stops inside the rotation limits. This is achieved by limiting the wiping length of the 12-way setting potentiometers in such a way that a small portion of the resistance is always left in circuit. The limitation ensures that the balancing potentiometer RV5 will always reach balance before the end of its travel.

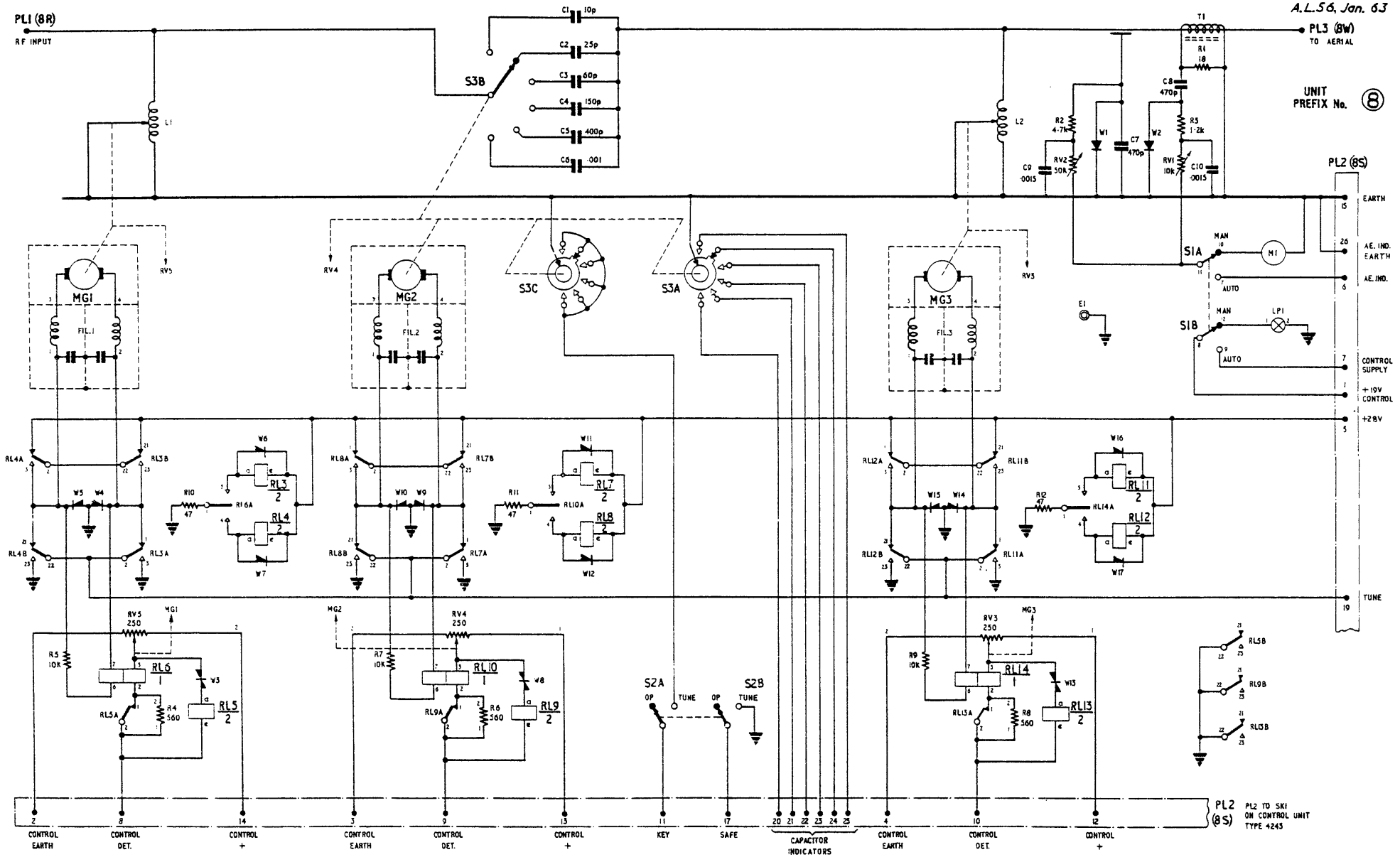
43. The components used in the bridge circuits are tabulated against the function of the tuning motors in Table 1.

TABLE 1

Major operating components of tuning circuits

Function of tuning motor		Component reference					
		12-Way pot	Motor	Balancing pot	Slave relays	Detector relay	Safety relay
Transmitter (Sect. 1)	RF stages	POT. 1 (1A-1M) POT. 2 (2A-2M) Control unit Type 4243	2MG1	2RV1	2RL8 2RL9	2RL6	2RL7
Aerial tuning unit	Input	POT. 3 (1A-1M) POT. 4 (2A-2M)	8MG1	8RV5	8RL3 8RL4	8RL6	8RL5
	Coupling	POT. 5 (1A-1M) POT. 6 (2A-2M)	8MG2	8RV4	8RL7 8RL8	8PL10	8RL9
	Output	POT. 7 (1A-1M) POT. 8 (2A-2M)	8MG3	8RV3	8RL11 8RL12	8RL14	8RL13

H726 544940/3262 8/55 625 B. & S. Ltd. Gp.539/4



AIR DIAGRAM
6103K/MIN.
ISSUE 2
PREPARED BY MINISTRY OF AVIATION FOR PUBLICATION BY AIR MINISTRY

PP9319 2006/470926 2,65 C.& P

AR1.5874 - Tuning unit (aerial) Type 7180 - circuit

Fig 6

RESTRICTED