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VOLUME I

SINGLE SIDEBAND RADIO RECEIVING EQUIPMENT R.1923

RACK ASSEMBLIES TYPE 238 and 239
(Marconi CRD 150/20A with SSR2)

GENERAL AND TECHNICAL INFORMATION

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LAYOUT OF

2980S — SINGLE SIDEBAND RADIO RECEIVING EQUIPMENT

VOL. 1	General and technical information
VOL. 2	General orders and modifications *(To be issued later)*
VOL. 3	Schedule of spare parts *(Applicability to be determined later)*
VOL. 4	Planned servicing schedules *(Applicability to be determined later)*
VOL. 5	Basic servicing schedules
VOL. 6	Repair and reconditioning instructions *(Applicability to be determined later)*

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P19208 M34601/G1355 9/51 500 C & P **Gp. 1**

PART I

GENERAL INFORMATION

P19210 M34601/G1355 9/51 500 C & P Gp. 1

PART 1

GENERAL INFORMATION

LIST OF CHAPTERS

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Chapter 1. — GENERAL DESCRIPTION AND OPERATION

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INTRODUCTION

Purpose and facilities

1. The receiving equipment R.1923 comprising rack assemblies Type 238 and 239 is a high-grade triple diversity equipment which may be used for the reception of single sideband, twin channel single sideband or double sideband (i.e., ordinary A.M.) signals in the frequency spectrum of 1·5-30 Mc/s.

2. The output fed to line is at audio frequencies, the frequency range of the sidebands being 200 c/s—5800 c/s. VF telegraph signals of the two-tone type may be received but as no facilities are provided for DC outputs, the conversion of VF to DC is accomplished at the terminal equipment.

3. Double sideband signals may be combined in the equipment or fed out separately to the terminal equipment. In the case of single sideband signals a path selector may be used to select the best signal automatically, or the six outputs may be fed directly to line.

Brief electrical description (*fig. 1 and 2*)

4. The equipment is contained in two rack assemblies known as the Type 238 (CRD 150/20A) and Type 239 (SSR2). The first mentioned contains all the units necessary for the reception of double sideband signals using the triple-diversity system, namely:—

(1) Three receivers.
(2) Common oscillator.
(3) Two power supply panels.
(4) Distributing panel.
(5) Combining panel.
(6) Illuminating panel.

The SSR2 rack houses the additional equipment required to receive signals of the single sideband type, namely:—

(7) Three IF panels.
(8) Frequency changer panel.
(9) Two filter panels.
(10) Two power supply panels.
(11) Distributing panel.
(12) Monitoring panel.
(13) Path selector panel.
(14) Illuminating panel.

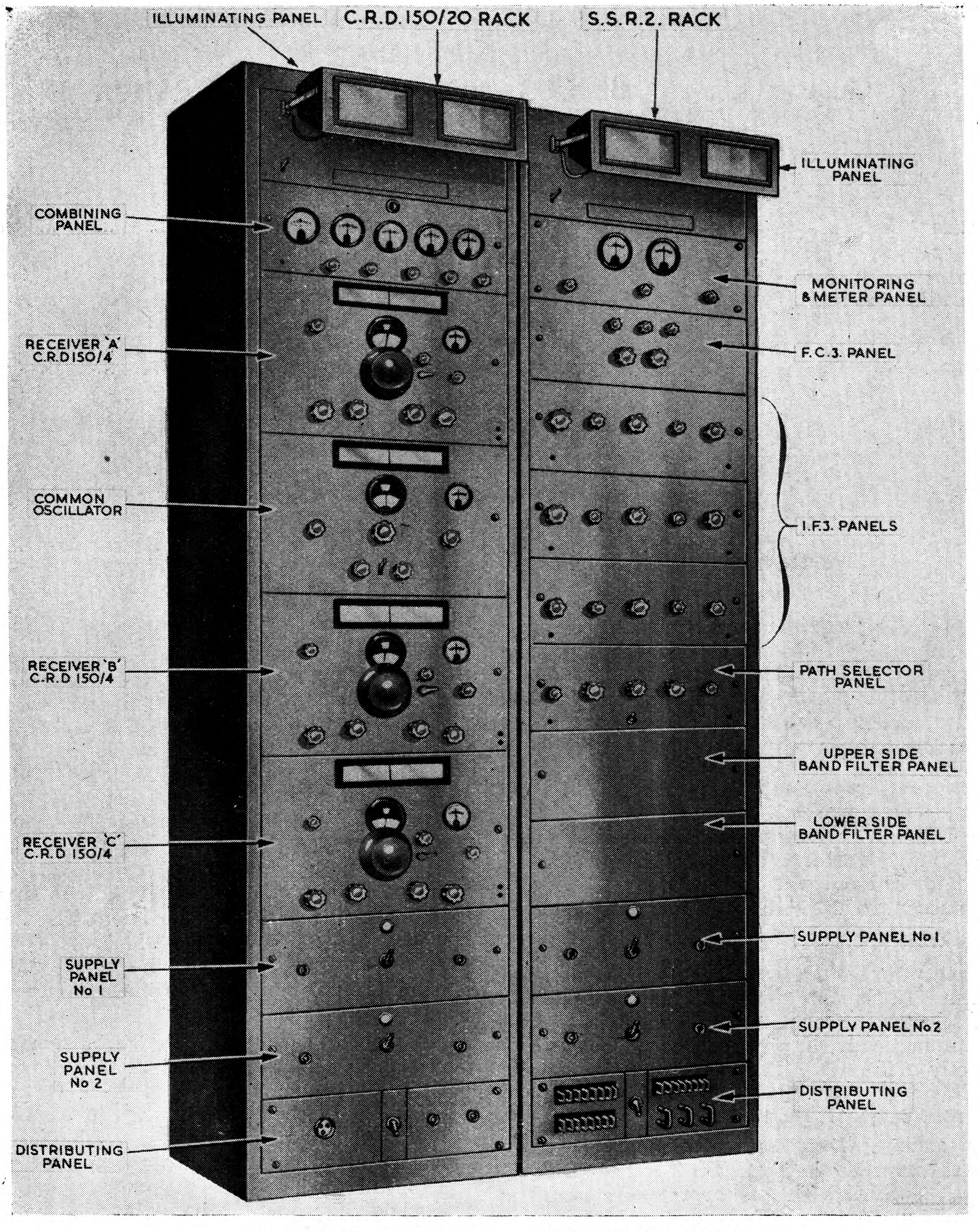
5. Signals from the three aerial systems are taken to the three double superheterodyne receivers which have common local oscillators. The first oscillator is variable, giving a first IF of 1·2 Mc/s and the crystal-controlled second oscillator provides a second IF of 465 kc/s. For double sideband reception the signals are demodulated at this stage and the three paths may either be fed to separate lines or combined in the combining unit and taken out to a single line. The maximum output is 100 mW into 600 ohms. AGC and AFC voltages are provided in each receiver and may be commoned or individually connected to each unit.

6. For the reception of the single sideband type of signals the three 465 kc/s outputs from the CRD.150/20A rack are fed to the FC3 unit (SSR2 rack) where they are changed to an IF of 100 kc/s. The upper and lower sidebands and the carrier are separated by filters and taken to the IF3 units where the sideband signals are demodulated and fed to the path selector unit. This unit selects the strongest signal in each sideband and passes it to line with a maximum output of 100 mW in 600 ohms. The carrier voltage provides "reconditioned carrier" for demodulation and also AFC and AGC voltages for application to the receivers.

Mechanical description

7. The equipment consists of two racks, each 7 ft. 3 in. high and 1 ft. 10½ in. wide, bolted together and interconnected by cable forms. The panels are arranged as in fig. 1.

8. Movable front panels and hinged doors in the rear are provided to give access to all valves and components for servicing and they may be withdrawn or opened whilst the set is in operation.



RACK ASSEMBLY TYPE 238 RACK ASSEMBLY TYPE 239

Fig. 1. Front view

9. The following units pull forward on runners and may then be turned on trunnions from a horizontal to a vertical position.

(1) The three receivers.
(2) Common oscillator.
(3) Combining unit.
(4) FC3 unit.
(5) Three IF3 units.
(6) Path selector unit.

The remainder of the units with the exception of the two illuminating, distributing and monitoring units can be pulled forward and do not tip. The non-sliding units can be quite easily removed from the rack by removing the four screws and carefully lifting out.

Inter-unit wiring

10. Colour coding is employed for all inter-unit wiring on each rack. Coloured PVC wire is used and the code is employed by using the colour of the wire as the base colour and adding a second colour by means of a coloured sleeve. Thus, a red wire with a white sleeve would give the colour code "Red-White". On a fixed reference strip on the chassis this would appear as Red-White-Red, which will indicate a colour code of "Red-White".

11. Co-axial cables employ two sleeves, one long and one short, the base colour being indicated by the long sleeve and the secondary colour by the short sleeve.

12. All inter-unit wiring is arranged to allow for permanent connections during the withdrawal and tipping of units. Connections to a unit are made at the rear of the chassis. The leads for each unit are fed from the main rack cable form through a flexible PVC tube, which is anchored to the chassis. Details of the wiring are given in Chap. 7.

Inter-rack wiring

13. An inter-rack cable form enters each rack through a 4-in. hole in the base of each cabinet through a foundation duct. Wiring diagrams are given in Chap. 7.

TUNING AND OPERATION

DSB reception

14. Switch the power on at the distribution panel and power supply units and allow the equipment to warm up for about 20 minutes.

15. Turn the HF and LF GAIN controls of receivers "B" and "C" fully counter-clockwise. On the combining unit set the DSB-SSB switch to DSB, AGC switch to OFF, and the AFC switch to OFF.

16. Adjust the HF GAIN control on receiver "A" fully clockwise, set the band-change switch to the appropriate frequency band and the main tuning dial to approximately the required frequency. Set the pass-band switch to 8,000 c/s, the LF GAIN control at about the half-way position, the operational switch to AGC OFF and the INPUT ATTENUATOR to zero. Plug the telephones into jack JK1.

17. Set the common oscillator band-change switch to the frequency band required and the tuning dial to the required frequency. Switch the AFC motor OFF and put the 2nd oscillator tuning control to zero. Search on the 1st oscillator tuning control for the signal as for normal tuning, bearing in mind that the selection is obtained by the oscillator tuning and not by receiver tuning. Having located the signal, turn the BFO switch to position 2 and accurately tune to zero beat. If necessary, reduce the HF GAIN control to avoid overloading on a strong signal. Switch BFO OFF and adjust the receiver tuning and aerial trimmer for maximum indication on the combining unit receiver "A" meter M2.

18. Tune in receivers "B" and "C" leaving the common oscillator set up as above, bring AFC into action by operating the AFC motor switch on the common oscillator and the AFC switch (to LOCAL) on the combining unit.

19. The AGC system may now be brought into use by turning the AGC switch on the combining unit to LOCAL COMB AGC and the operational switches on the receivers to the required AGC position. Suitable positions for telephony are AGC LOCAL positions 3 or 4.

20. The pass-band switch should be set to 13,000 or 8,000 c/s for telephony or 2,500, 1,000 or 100 c/s for telegraphy.

21. After tuning, the equipment should operate with no further attention other than retuning should the lamp PL1, on the common oscillator unit, light up, indicating that a frequency drift of 3 kc/s has occurred.

SSB reception

22. Proceed as in para. 14 above.

23. Turn the DSB-SSB switch on the combining unit (receiver rack) to SSB. Set the operational switches on the three receivers to AGC, SSB and the AGC switch on the combining unit to OFF. All distribution unit links should be in position.

24. Set the pass-band switch on each receiver to 8,000 c/s for single channel or 13,000 c/s for double channel working. Turn the third oscillator switch on the FC3 unit to SINGLE CHANNEL or DOUBLE CHANNEL above or below 10 Mc/s as required and set the CHANNEL (PATH) GAIN controls fully clockwise. Set the switch on each IF3 unit chassis to SINGLE or DOUBLE channel as required.

Note . . .

On some models the CHANNEL GAIN *controls on the FC3 unit are called* PATH GAIN *controls.*

25. Put the AFC switch on the combining unit and the AFC motor switch on the common oscillator unit to the OFF position.

26. Select the appropriate frequency band on the receivers and the common oscillator and set the tuning dials to the required frequency. Set the BFO switch to position 2.

27. Set receivers HF GAIN controls fully clockwise; the LF GAIN controls should be adjusted to give a suitable level in the telephones.

28. Ensure that the second oscillator control on the common oscillator unit is at the zero position.

29. Plug the telephones into jack JK1 of receiver "A" and tune the signal for zero beat by means of the 1st oscillator tuning control. Switch the BFO to OFF and tune the receiver and aerial trimmer for maximum signal strength.

30. Set the IF3 input attenuators to + 12 dB; the AF GAIN controls should be at their normal working points. Transfer the telephones to the IF3 unit "A"; a signal should now be heard in the telephones. If there is no signal, the tuning procedure in para. 29 has not been carried out accurately and it should be repeated. Adjust the second oscillator tuning control so that the beat note effect between the received signal and the receiver noise in the carrier channel is reduced to zero, when the signal should become intelligible. The alignment of the pilot carrier within the carrier filter can be checked by observing the anode currents of V6 and V7 in the common oscillator unit. When the carrier is exactly 100 kc/s the currents will be equal; an off-tune condition will cause one current to increase and the other to decrease.

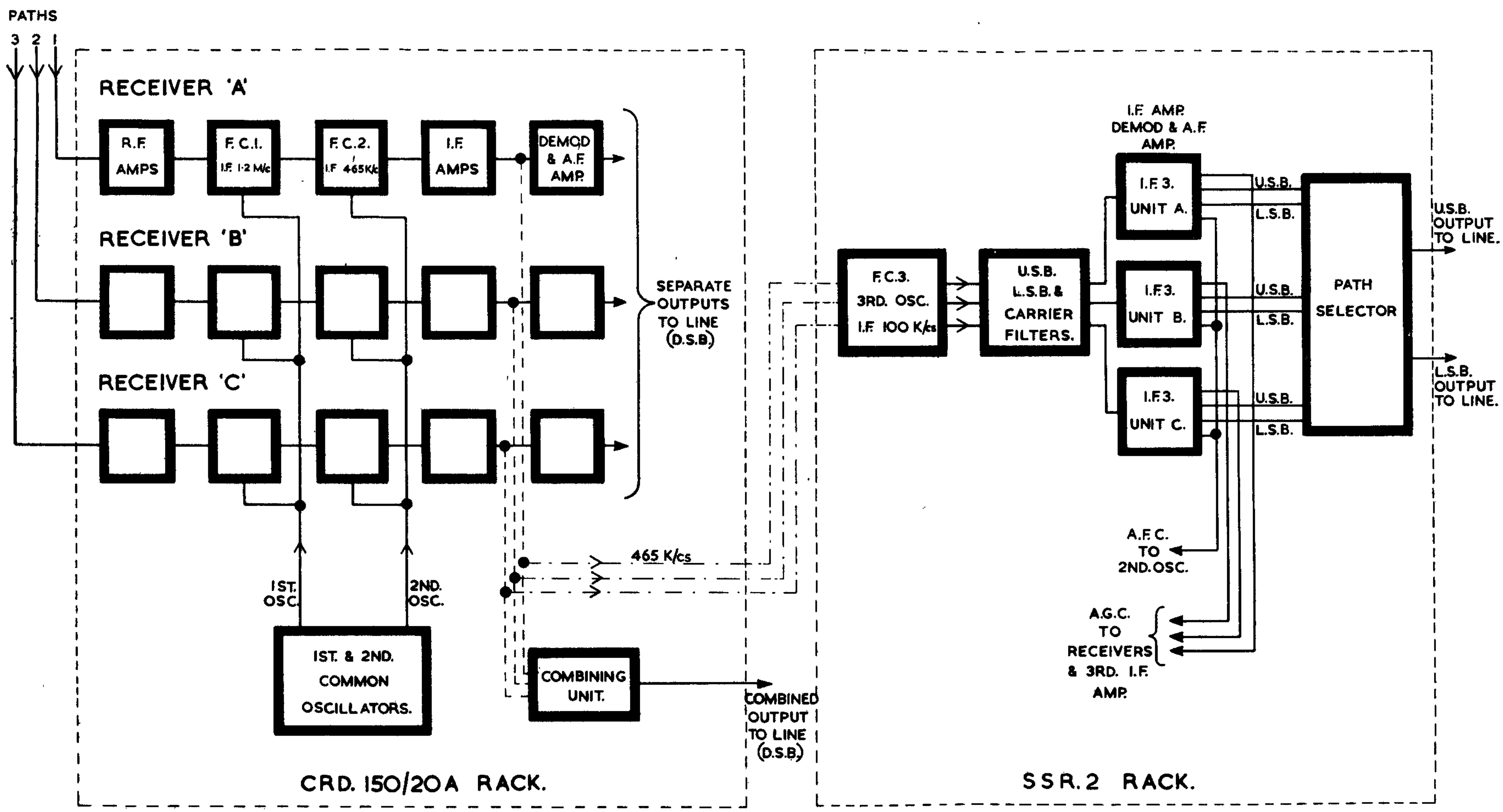


Fig. 2. Schematic

31. Turn the AFC switch to EXT on the combining unit, switch the AFC motor to ON on the common oscillator unit and note that the signal remains in tune. If it does not, repeat the tuning procedure in para. 29-30 above. Check the channel output at the respective jack on the IF3 unit.

32. Tune in receivers "B" and "C", ensuring that the common oscillator remains set up as above.

33. When the three receivers have been tuned the audio levels of each path at the IF3 unit output should be checked. Turn the OUTPUT LEVEL switch on the monitoring and meter unit to the appropriate range and the LF OUTPUT switch to the respective paths in turn. The levels registered on the meter should be the same; if they are not, adjust the CHANNEL (PATH) GAIN controls on the FC3 unit accordingly.

34. The telephones should now be transferred to the appropriate jack on the path selector unit and the output checked by means of the monitoring unit with the selector switch at positions "A", "B" and "C" in turn. The selector switch should now be turned to AUTO and the required output to line obtained by adjustment of the COMBINED OUTPUT control.

35. For normal operation with AGC derived from the carrier, turn the AGC switch in the combining unit to EXT COMB and remove links 17, 18 and 19. If AGC is required to operate on both the side bands and the carrier, e.g., on single channel telegraphy systems, the controls and U-links should be set up as follows:—

(1) Remove links 22, 23 and 24 on the distribution panel (SSB rack) and insert links in positions 17, 18 and 19.

(2) Put the AGC switch on the combining unit to LOCAL COMB.

(3) Turn the operational switches on the receivers to AGC LOCAL 2.

(4) Adjust the CHANNEL (PATH) GAIN controls on the FC3 unit so that the mean output level from each IF3 unit is about 10mW.

GENERAL DESCRIPTION

Receivers

36. The three aerials, which are located several wavelengths apart to give "triple (spaced) diversity reception" are connected through 75-ohm co-axial feeders to Pye plugs on the receiving rack, and thence to the three receivers A, B and C.

37. In each receiver the signal, whose frequency lies between 1·5 and 30 Mc/s passes through an attenuator (used if there are strong interfering signals) to two stages of RF amplification, and thence to the first frequency changer, which reduces the effective carrier frequency to 1·2 Mc/s. The "first oscillator" is common to all three receivers and forms a part of the local oscillator panel (*para.* 46); a buffer valve in each receiver couples the oscillator line to the frequency changer.

38. The RF amplifier stages are tuned by ganged condensers, manually adjusted, as is the first oscillator in the local oscillator panel.

39. The 1·2 Mc/s signal passes to a second frequency changer which reduces the effective carrier frequency to 465 kc/s. The oscillator is again common to all three receivers and is mounted in the local oscillator panel (*para.* 46). It is tuned to 735 kc/s, but has provision for a variation in frequency over plus or minus 4 kc/s, the tuning being effected manually or automatically by an AFC motor (*para.* 47).

40. Two stages of IF amplification are provided in each receiver, and four alternative bandwidths are provided, namely, 1, 2·5, 8 and 13 kc/s wide, 6dB down.

41. The route taken by the signals after the second stage of IF amplification depends on the required working condition. There are three choices:—

(1) DSB single path.

(2) DSB combined path (*para.* 47).

(3) SSB path (*para.* 49).

DSB single-path

42. In DSB single-path working the signals remain in the receivers and pass on to double-diode triode valves providing detection, AGC and AF amplification, and thence pass through an optional 950—1,050 c/s filter to the output amplifier and the line.

43. The AGC voltage goes to the AGC selector in the combining unit (*para.* 48); the incoming AGC voltage is applied to the two RF and first of the second IF amplifiers and to the second frequency changer.

44. The output of a beat frequency oscillator in the common oscillator unit (*para.* 46) can be applied through a buffer valve to the output of the last IF amplifier for CW reception or for tuning.

45. Each receiver contains a noise limiter valve, and a calibrator valve generating harmonics of a 500 kc/s crystal for checking the tuning dial of the receiver.

Common oscillator

46. The common oscillator unit enables all the receivers to be tuned to the same frequency. It contains:—

(1) The "first oscillator" (*para.* 37) with buffer and power amplifier which is manually tuned and compensated against drift due to temperature change.

(2) The "second oscillator" (*para.* 39) tuned to 735 kc/s (1,200 kc/s minus 465 kc/s), but adjustable through ± 4 kc/s to compensate for frequency drift (*para.* 47).

(3) The beat frequency oscillator (*para.* 44) tuned to 465 kc/s for zero-beat tuning or 464 kc/s for CW reception (giving a 1,000 c/s beat note).

DSB combined-path

Combining unit

47. This unit contains three diodes with a common load resistor. These, when the equipment is used for DSB combined-path working (*para.* 41 (2)), each accept the IF output from one of the receivers. The common load acts as an automatic selector and biases back the weaker IF outputs, giving preference to the stronger which contributes most to the output and is fed by a two-stage amplifier to the line. Audio and visual monitoring facilities for the output of the panel are also provided, and discriminator circuits for operating the AFC tuning motors of the receivers.

48. The following controls are also located on the panel.

(1) AGC selection (*para.* 43 *and* 53 (1)).

(2) AFC selection and alarm (*para.* 53 (2)).

(3) DSB/SSB selector.

The functions of the panel are more fully described in Chap. 4.

SSB operation

Third frequency changers (FC3)

49. For single sideband operation, the 465 kc/s IF output of the receivers (*para.* 41) pass on individually to the third frequency changer panel which is located on the SSB rack. This panel comprises three frequency changers and a common oscillator. The third intermediate frequency is 100 kc/s.

50. The third oscillator is crystal controlled, but has four optional frequencies. Two of these are required for single-channel SSB and two for double-channel SSB. In each case one or the other of the two appropriate crystals is used according to whether sideband inversion is required or not.

(1) For double-channel use the crystal frequencies are 365 or 565 kc/s each beating with 465 kc/s to produce 100 kc/s. To simplify transmitter design by reducing the frequency coverage of the oscillator for carrier frequencies of 10 Mc/s and above, the upper sideband channel is transmitted on the high-frequency side of the carrier; and for carriers below 10 Mc/s, the upper sideband is transmitted on the low-frequency side. The frequency of the third oscillator is selected to correct the inversion; 565 kc/s for carriers of 10 Mc/s and above, 365 kc/s for carriers below 10 Mc/s.

(2) In single-channel use, a 568 kc/s crystal is used for carriers of 10 Mc/s and above, and a 362 kc/s crystal for carriers below 10 Mc/s. This makes the carrier frequency "sit" to one side of the receiver pass-band instead of in the centre, and allows the 8 kc/s bandwidth to be used instead of the 13 kc/s bandwidth necessary for two channels, thus reducing noise.

51. In the FC 3 panel from the frequency changer stages the signals pass to sets of three filters which in each case separate:—

(1) The upper sideband 100-106 kc/s.

(2) The lower sideband 94-100 kc/s.

(3) The carrier itself 100 kc/s.

The actual pass-band of the carrier filter is 2 kc/s, 10dB down and 4 kc/s, 50dB down.

Third IF amplifier units (IF3)

52. Three IF amplifier units are provided, one per receiver; each one performs three main functions:—

(1) Amplifies and demodulates the upper sideband.

(2) Amplifies and demodulates the lower sideband.

(3) Amplifies and limits the carrier and provides AGC and AFC voltages.

53. In each panel the carrier undergoes two stages of amplification and then splits:—

(1) One branch is rectified and used as AGC voltage (*para.* 43).

(2) The second branch is applied to a limiter, and the output after limiting is used to demodulate the sidebands and applied to a discriminator valve which produces the AFC voltage.

The carrier amplification can be reduced by 10dB to compensate (as regards AVC voltage) for the increase in carrier level at the transmitter when working single-channel.

54. The sideband outputs are applied (through variable attenuators) together with the reconditioned carrier (output from the limiter, *para.* 53) to balanced demodulators. The AF outputs are amplified and passed to the path selector units (*para.* 55).

Path selector unit

55. This panel has controls for manually selecting one or more paths from the upper sideband and lower sideband outputs, or allowing automatic selection. The working of the automatic selection circuit, which allows only the strongest signal of the three to go to the line, is described in Chap. 4.

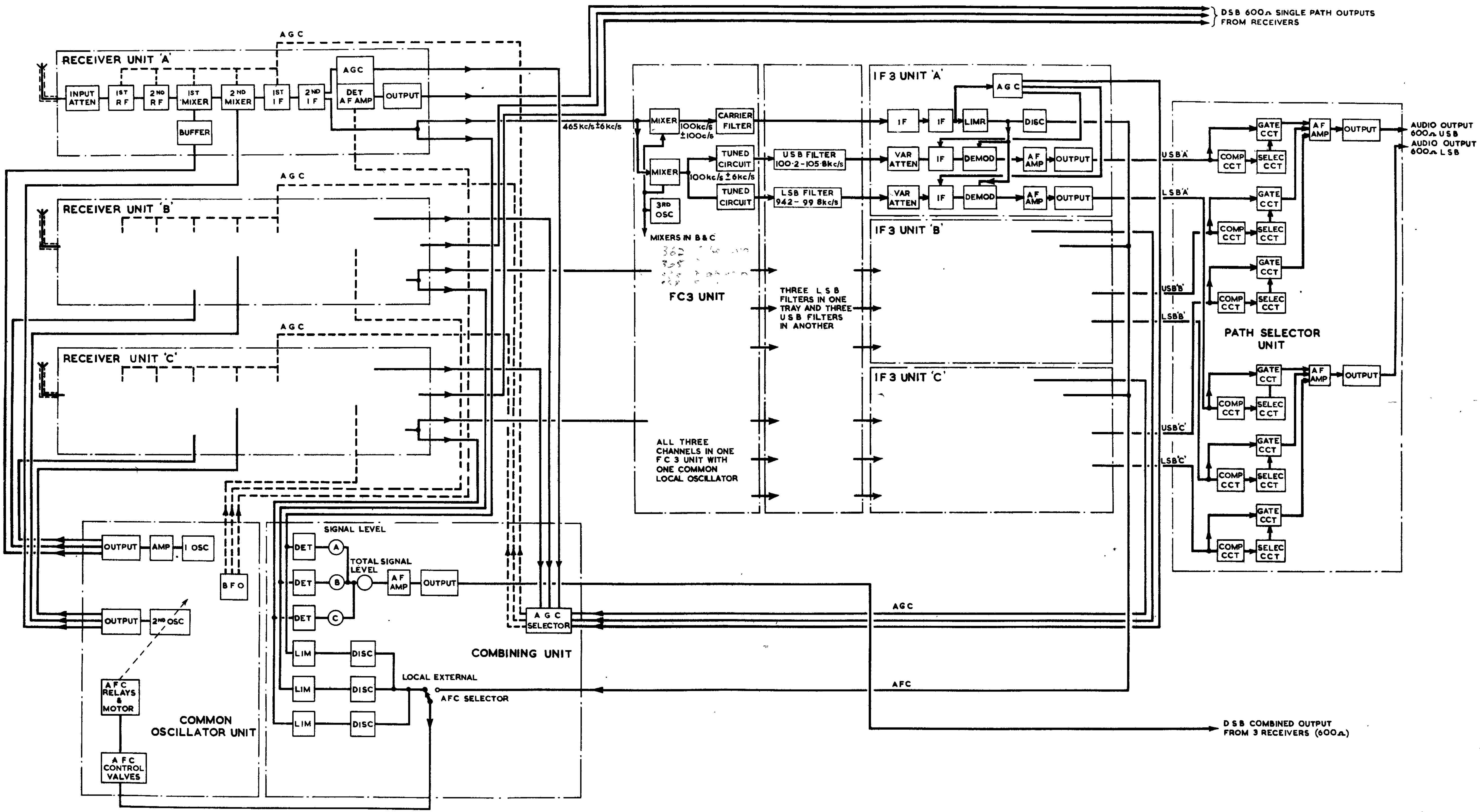


Fig. 3 Block diagram Fig. 3

Chapter 2. — RECEIVERS

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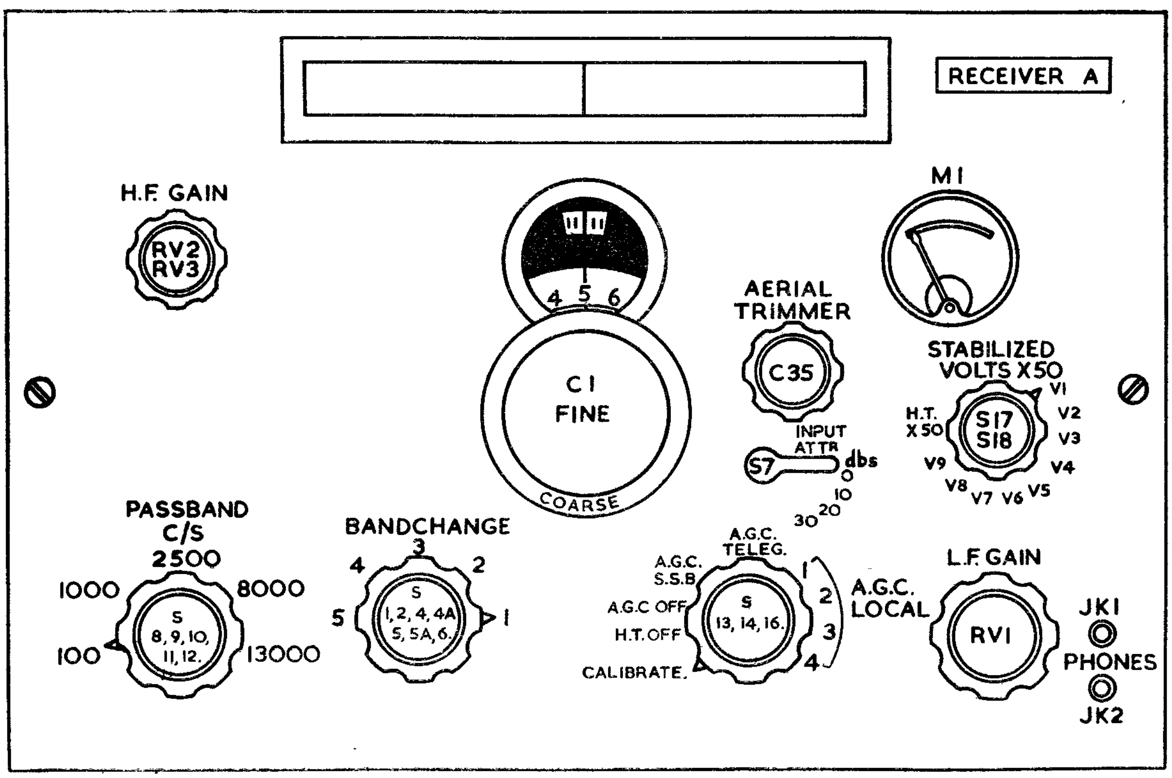

Fig. 1. Front panel

SUMMARY

1. There are three receivers (receiving units Type 115, 10P/16133) in the rack assembly Type 238 and each has its own 75-ohm aerial input. Each receiver consists of an input control attenuator, two RF amplifiers, the first frequency changer, (1·2 Mc/s), the second frequency changer, (465 kc/s), two IF amplifiers, a detector stage, an AGC rectifier and a line amplifier. The oscillator voltages for the two frequency-changing stages are fed in from the common oscillator unit.

2. The three outputs from the line amplifiers may either be fed to lines, or to the combining unit from which they emerge to line as one output.

3. The three AGC outputs are fed to the combining unit and from there to the RF amplifiers, the second frequency changer and the first 465 kc/s IF amplifier.

4. In each receiver a meter is provided for checking valve currents and HT voltages, and a crystal calibrator for checking the calibration of the tuning control.

CONTROLS (*fig. 1*)

5.

Name	*Function*	*Circ. Ref.*
HF GAIN	Controls RF amplifier gain	RV2, 3
Main tuning	For flat tuning of RF stages	C1
AERIAL TRIMMER	Controls impedance matching of aerial/input circuit	C35
INPUT ATTENUATOR	Switches in resistors to reduce input to receiver on very strong signals	S7
Meter switch	Connects valves and HT supplies in turn to M1 for measuring	S17, 18
PASS BAND c/s (5 positions)	Gives varying degrees of selectivity from 100 c/s–13 kc/s	S8, 9, 10, 11, 12
BAND CHANGE (5 *positions*)	Selects frequency band required	S1, 2, 4, 4A, 5, 5A, 6
Operation switch (9 *positions*)		S13, 14, 16
Calibrate	Switches on 500 kc/s crystal oscillator for checking receiver dial calibration	
HT off	Switches off HT from all valves except the output valve	
AGC off	Disconnects AGC	
AGC SSB	Enables the AGC to be fed from the SSR2 rack (Type 239)	
AGC teleg.	Enables the AGC to be fed from a telegraph equipment	
AGC local (4 positions)	Switches AGC line to diode providing different time constants	
LF GAIN	Controls output to line and phones on DSB signals	RV1
PHONES	Phones check on output	JK1, 2

CIRCUIT DESCRIPTION

Aerial circuit (*fig. 2 — at end of Chapter*)

6. The aerial input is fed via a 75-ohm co-axial plug and socket to the input attenuator. The attenuator has a front panel control with four positions:—

(1) 0 dB
(2) 10 dB
(3) 20 dB
(4) 30 dB

The attenuator is made up of fixed resistors R24, R24A, R24C, R24D and R24E. The required section of the attenuator is selected by S7.

Frequency bands

7. The receiver covers a band of frequencies from 1·5 Mc/s to 30 Mc/s in five bands. The band change switch has five positions and is made up of S1F, S1R, S2, S5F, S5R, S4, S5AF, S5AR, S4A and S6. The positions of the switch, which come out to a front panel control, are:—

(1) 1·5–2·8 Mc/s
(2) 2·8–5·0 Mc/s
(3) 5·0–9·0 Mc/s
(4) 9·0–17·0 Mc/s
(5) 17·0–30·0 Mc/s

Aerial unit

8. There are five coils L1–L5 in the aerial unit, one to each waveband. Wafer S1F selects the appropriate coupling coil and connects it to the aerial input attenuator. This switch also short circuits to earth the primaries of other coils of a lower frequency than that selected. The lower ends of the primaries are earthed via S1R.

9. S2 selects the required secondary and applies it to the grid of V1 and the tuning capacitor C1A. It also connects the secondaries of all coils of a lower frequency to earth via C28. C9–C13 are trimming capacitors for L1–L5. C35, across the ganged tuning capacitor C1A, is the aerial trimmer.

RF amplifiers

First RF amplifier, V1

10. The first RF amplifier V1 is a CV1091 arranged in a circuit of conventional design. Reduced AGC of approximately one-third of normal value is applied via R1 and the inductors to the grid. C28 decouples the AGC line. Cathode bias is developed across R4 and RV2, the RF gain control; C30 is the cathode by-pass capacitor and R5 provides voltage for the screen grid which is decoupled by C29. The anode load is the selected primary of L11–L15. R62 is the anode current test resistor for V1.

HF unit

11. This contains the inductors L11–L15 which couple V1 to V2 and cover the same wavebands as L1–L5. The appropriate primary winding is selected by S5F. R7 is the anode decoupling resistor for V1 and C36 is the decoupling capacitor.

12. The appropriate secondary winding for the band required is selected by S4 and connected to the grid of V2 and to C1B, the tuning capacitor. C19–C23 are the trimmers for the five bands. S4 also connects the secondaries of inductors of a lower frequency than that selected to earth. C31 is a fixed trimmer across the ganged tuning capacitor C1B.

Second RF amplifier, V2

13. This stage is a conventional RF amplifier using a CV1091 valve. Reduced AGC of one-third normal value is applied to the grid via R8 and the inductor. Reduced AGC is employed on the two RF stages because the valves used have a short grid base. C41 decouples the AGC line. Cathode bias is developed across R11 and the RF gain control RV2, and decoupling is by C34. R12 supplies the screen grid which is decoupled by C33. R6 is a grid stopper.

1·2 Mc/s stages

Mixer unit, V3

14. The mixer unit contains the inductors L6 to L10. The required primary winding is selected by S5AF. R14 and C32 provide decoupling for the anode circuit of V2 and R63 is the test resistor across which the anode current of V2 is measured. C2 to C5 are connected across the primaries of L6–L9 in order to correct for variations of gain over the frequency bands.

15. The switch S4A selects the appropriate secondary and applies it to the grid of the first frequency changer, V3, and to the ganged tuning capacitor C1C. S4A also connects together and earths all secondaries of coils of a lower frequency than the one selected.

CV1091. A 75-ohm grid resistor is provided to give the correct termination for the 75-ohm co-axial feeder. Cathode bias is developed across R2 and by-passed by C39. R13 and C38 are screen dropper and decoupler respectively. R21 is the anode load and R22 and C46 the anode decouplers· R65 is the anode test resistor.

19. The output from V4 is fed via R19 and C54 to the switch S6 which applies it to the appropriate coil L16–L20. All coils of lower frequency than that selected are connected together and earthed. C24 to C27, C37 and C58 are trimmers and C48, C49, C49A, C50, C50A, C51, C52 and C52A are padding capacitors. C1D is the ganged tuning capacitor and C8 is its trimmer. C44 couples the oscillator voltage to the suppressor grid of V3.

465 kc/s stages

Second frequency changer, V5

20. The second frequency changer is a triode-

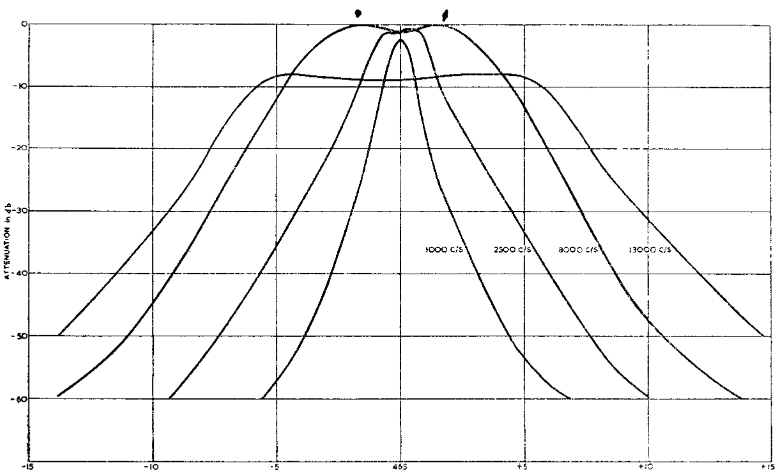

Fig. 3. Selectivity curves

hexode, Type CV1347. The 1·2 Mc/s output from IF1 is fed from the potentiometer R25 and R26 to the signal grid of V5. R25 and R26 also provide damping to the secondary of IF1 and widen its response curve. R27 and C85 are screen dropper and decoupler respectively. Cathode bias is developed across R28 and RV3, which is ganged to RV2 the RF gain control. C86 is the cathode by-pass capacitor. The anode of the triode section of the valve is strapped to earth since the oscillator voltage is applied from an external oscillator. R30 and C87 are the anode decoupling resistor and capacitor respectively, while R66 is the anode test resistor. Full AGC is fed to V5 via R36, and C84 decouples V5 from the AGC line.

21. The output of the second oscillator in the common oscillator unit is fed to the primary of L23. Across the secondary winding is R67 to present the correct input impedance to the primary. The secondary is connected between oscillator grid and cathode of V5; and C61 with R75 provides automatic bias for the oscillator grid. Electronic mixing occurs in the hexode section of the valve and the desired 465 kc/s IF is developed across the tuned primary of IF2.

16. The signal is fed to the grid of V3 (Type CV1091) via a blocking capacitor, C47, to prevent the grid being returned to earth through inductors, as only the voltage developed across cathode resistor R15 is required as grid bias. R10 is a grid stopper. Cathode bias is developed across R15 and R16 and by-passed by C42. The grid is returned via R9 to the junction of these two resistors, applying a small bias to the grid, but a larger bias to the suppressor grid which is returned to earth via R23.

17. V3 is an RF pentode and suppressor mixing is employed, the first oscillator voltage being injected at the suppressor grid from V4 which is a buffer amplifier for the first oscillator (*para.* 18). The anode load is the transformer IF1 tuned to 1·2 Mc/s, the first intermediate frequency. R18 and C45 provide anode decoupling. R64 is the anode test resistor. R17 and C43 are screen dropper and decoupler respectively.

First oscillator buffer amplifier, V4

18. The output of the first oscillator in the common oscillator unit is fed in via a 75-ohm co-axial feeder and plug to the grid of V4, Type

Selectivity control (fig. 3)

22. The IF pass-band from V5 onwards can be varied in five steps by the ganged switches S8–S12. These come out to a front panel control which has five positions corresponding to the following pass-bands measured 6 dB below the peak.

(1) 100 c/s
(2) 1,000 c/s
(3) 2,500 c/s
(4) 8,000 c/s
(5) 13,000 c/s

23. *Position* 1: (Control fully counter-clockwise). S8 disconnects the over-coupling coil in IF2 and connects the lower end to the crystal filter. S9 connects the secondary of IF2 to IF3 (a double crystal filter which reduces the pass band to 2,500 c/s) and connects the output of IF3 to the grid of V6, the first IF amplifier. S11 disconnects the over-coupling coil of IF4. S12 connects the output of the secondary of IF4 to IF5, a double crystal filter, and also connects the output of IF5 to the grid of V7, the second 465 kc/s IF amplifier. IF5 reduces the bandwidth to 1,000 c/s. S10 connects the output from V8, the first AF amplifier, through an LF filter (C80, C81, L35, L36, C82 and C83) which reduces the pass band to 100 c/s. S10 also connects the output of the LF filter to the grid of V11, the output amplifier.

24. *Position* 2 is the same as position 1, but the LF filter is taken out of circuit. Bandwidth 1,000 c/s.

25. *Position* 3—as for position 2, but the crystal filter IF5 is taken out of circuit. Bandwidth 2,500 c/s.

26. *Position* 4—as for position 3, but the crystal filter IF3 is taken out of circuit. Bandwidth 8,000 c/s.

27. *Position* 5—as for position 4, but the over-coupling coils are put into circuit. Bandwidth 13,000 c/s.

28. Taking the 13 kc/s bandwidth case, the output of the secondary of IF2 is fed via S9 to the grid of V6, the first IF amplifier.

First IF amplifier, V6

29. The first IF amplifier, V6, is a CV1053 and has full AGC applied to its grid via R31, and C88 decouples the stage from the AGC line. R32 and C91 are the screen dropper and decoupler respectively. The anode load is the tuned primary of IF4, and anode decoupling is provided by R35 and C92. R68 is the anode current test resistor. Cathode bias is provided by R34 and C93. The output from the secondary of IF4 is applied to the grid of V7 via S12.

Second IF amplifier, V7

30. The second IF amplifier, V7, is a CV1053 arranged in a circuit of conventional design. Cathode bias is developed across R40, C104 being the by-pass capacitor. R39 is the screen dropper and C102 the decoupling capacitor. The screen is decoupled to cathode and not to earth as previously. R41 is the anode decoupling resistor with C103 the decoupling capacitor. R69 is the anode current test resistor. The anode load is the tuned primary of IF6 which is damped by R52 to flatten the response curve. An output to the AGC diode in V8 is taken from the anode end of the primary of IF6. A coupling coil in IF6 feeds out 465 kc/s either to the combining unit or to the SSR2 rack (Type 239).

AF stages

Detector, AGC diode and AF amplifier, V8

31. V8, a double diode triode Type CV587, is the detector, AGC and AF amplifier stage. The output from the secondary of IF6 is applied between the cathode and the detector diode of V8. The detector load is made up of R42 and R43. C108 and C128 filter the IF from the output which is applied to RV1, the AF gain control, via C107. Cathode bias for V8 is provided by the voltage drop across R45 and is by-passed by C111.

32. The AGC diode is fed from the primary of transformer IF6 through C105. The diode load consists of R46 and R47 with R72, C117 and C109 and choke CH1 to filter out the IF. The diode load is split in order to provide reduced AGC voltage to the RF stages. Connections are brought out from the diode and its load in order that AGC voltages may be fed in from the SSR2 rack on SSB working. Various time constants may be introduced by the switch S14F as stated below.

33. S13R, S14R, S14F and S16 make up the AGC/CALIBRATE control which is led out to a front panel control and has nine positions:—

(1)	CALIBRATE	HT is applied to the calibrator valve V10, causing it to oscillate
(2)	HT OFF	The HT supply to all units is broken by S16
(3)	AGC OFF	The receiver AGC is connected to earth by S13R
(4)	AGC SSB.	The AGC from the SSR2 rack is used to operate the controlled stages. The receiver AGC is disconnected
(5)	AGC TELEG.	External AGC from a telegraph equipment rack is used to control the receiver circuits
(6)	AGC LOCAL 1 (0·1 sec.)	Different time constants for the AGC (given in brackets) are selected by S14F. Used with local AGC from the receiver
(7)	AGC LOCAL 2 (0·3 sec.)	
(8)	AGC LOCAL 3 (0·7 sec.)	
(9)	AGC LOCAL 4 (1·3 sec.)	

34. The grid of V8 is supplied from the slider of the AF gain control RV1. R48 is the anode load and C120 by-passes any IF that may be present in the output. Anode decoupling is accomplished by R49 and C113. R70 is the anode current test resistor. The output is fed through C114 and S10 to the grid of the output stage V11.

Output stage, V11

35. This is a conventional triode output amplifier valve Type CV1067 with transformer T1 as its anode load. The stage is matched to a 600-ohm line by the 5:1 step-down secondary; the 70:1 secondary winding is not used. The maximum output is 100 mW into 600 ohms. R53 provides cathode bias and as it is not by-passed it also introduces negative (current) feedback into the stage. Two monitoring jacks JK1 and JK2 are fed from the primary side of T1 through R58 and C118.

Miscellaneous facilities

BFO amplifier, V9

36. The output from the BFO on the common oscillator unit is fed in via a co-axial plug and cable to the grid of V9, CV1053; R38 provides the screen grid voltage and it is decoupled by C99. R74 is the cathode bias resistor and C127 is the cathode by-pass capacitor; R37 and C100 provide anode de-coupling. R61 is the anode test resistor. The anode load is the tuned circuit L33, C97 which resonates between 464 and 465 kc/s.

37. The output from the anode of V9 is coupled to the detector diode of V8 by a very small capacitor C101; here it produces either a 1000 c/s note for ON/OFF CW reception or a zero beat for tuning purposes.

Voltage stabilizer, V12

38. V12 is the voltage stabilizing valve type CV1068. The valve is made up of five separate anodes, and when the valve strikes there is a potential of 70 volts between each anode. The maximum regulated voltage across all anodes is 280 volts. Three of the anodes of V12 are strapped together, and a steady potential of 140 volts is maintained across it. R57 is used to assist the valve to strike when the power is switched on.

39. The stabilized 140 volts HT is applied to the anodes of V3 and V4 and to the screen grids of V1, V2, V3, V4, V5, V7 and V9. All other HT supplies are at 240 volts unstabilized.

Noise limiter and calibrator, V10

40. V10, a double diode triode Type CV587 is the calibrator and noise limiter stage.

Calibrator

41. In position 1 of the AGC switch, the HT supply is applied to V10 via S16. S14R in the cathode circuit connects the cathode of V10 to earth.

42. The triode section is a crystal-controlled Colpitts oscillator. Bias is developed across R80 and C126. The RF voltage developed across CH3 is fed via C55 to the grid of V1. The oscillator operates at a frequency of 500 kc/s and the output is rich in harmonics. This output is used to check the calibration of the receiver and provides a check point every 500 kc/s on the dial by virtue of the harmonic output. At all other settings of the AGC switch no HT is applied to V10 anode circuit and the cathode is returned to the mid-point of R42, R43 via S14R.

Noise limiter

43. The diode section of V10 is used as a noise limiter. Both diode anodes are strapped together and connected via R50 to one side of R42, part of the detector diode load. The cathode of V10 is connected to the other side of R42 via S14R, hence the DC voltage developed across R42, due to rectification of the audio signal, is applied to the diodes. Normally, therefore, the diode anodes will be negative with respect to the cathode and the valve will not conduct. If a positive noise peak occurs, however, it will be fed directly on to the diode anodes and the valve will temporarily conduct, thus effectively short circuiting the audio output during the noise impulse. Note that only noise impulses which are above the average audio level will operate the limiter circuit and also that it only operates on the positive noise peaks.

Metering

44. A 0–10 mA meter M1 is mounted on the front panel for checking the anode currents of the valves and for checking the stabilized and unstabilized HT supplies. A small resistor is incorporated in the anode circuit of each stage and this is used as a shunt for the meter.

45. The meter switch is made up of S17 and S18. The switch has eleven positions. The switch connects the meter across the shunt resistor of the stage to be tested or in series with the multipliers R33 and R73.

The switch positions are:—

(1) Stabilized volts × 50–meter reading is multiplied by 50
(2) V1 anode current
(3) V2 anode current
(4) V3 anode current
(5) V4 anode current
(6) V5 anode current
(7) V6 anode current
(8) V7 anode current
(9) V8 anode current
(10) V9 anode current
(11) HT volts × 50– meter reading is multiplied by 50

CONSTRUCTION

Chassis (fig. 4 and 5)

46. The receivers are of normal chassis construction with a front panel suitable for rack mounting, and arranged to slide on the bearers described in Chap. 1.

Tuning system

47. The receiver band switch, besides selecting the required set of coils, rotates a drum which indicates the frequency band in use through the glass window of the tuning scale. The main tuning control has coarse and fine movement knobs and operates a pointer that moves across the frequency scale. It also rotates the logging scales which are visible through a circular window just below the main tuning scale. Two scales are visible in the window; main divisions are read on the upper scale and sub-divisions on the lower scale. The divisions on this scale decrease with increasing frequency.

48. The logging scale has an equivalent length of 18 ft. It has 1,250 divisions which can be read to one quarter of a division. At 20 Mc/s one scale division is approximately equal to a 12 kc/s change of frequency.

49. The use of the logging scales enables the receiver to be re-set accurately to the frequency of any desired signal. Two dial lamps LP1 illuminate the scales.

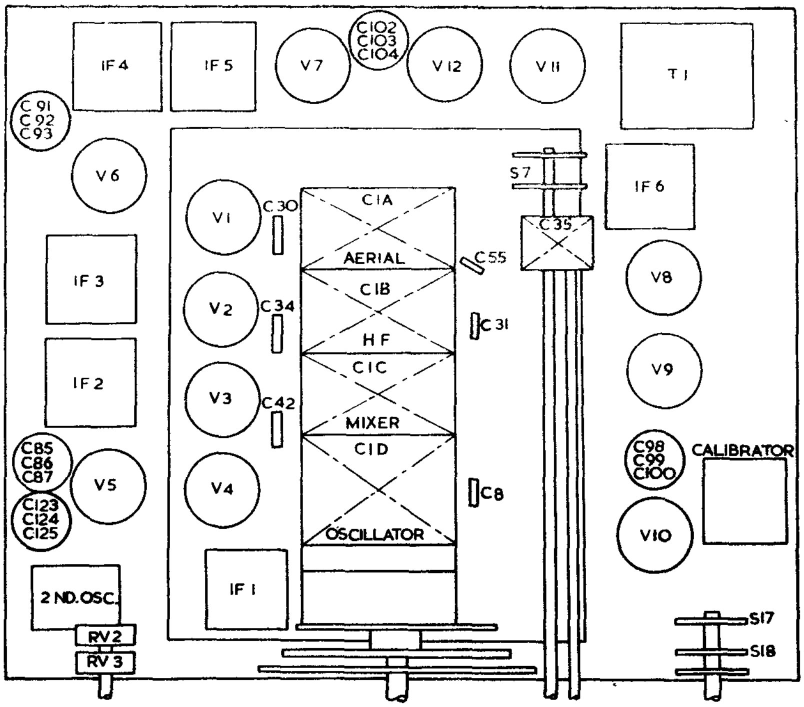

Fig. 4. Top of chassis

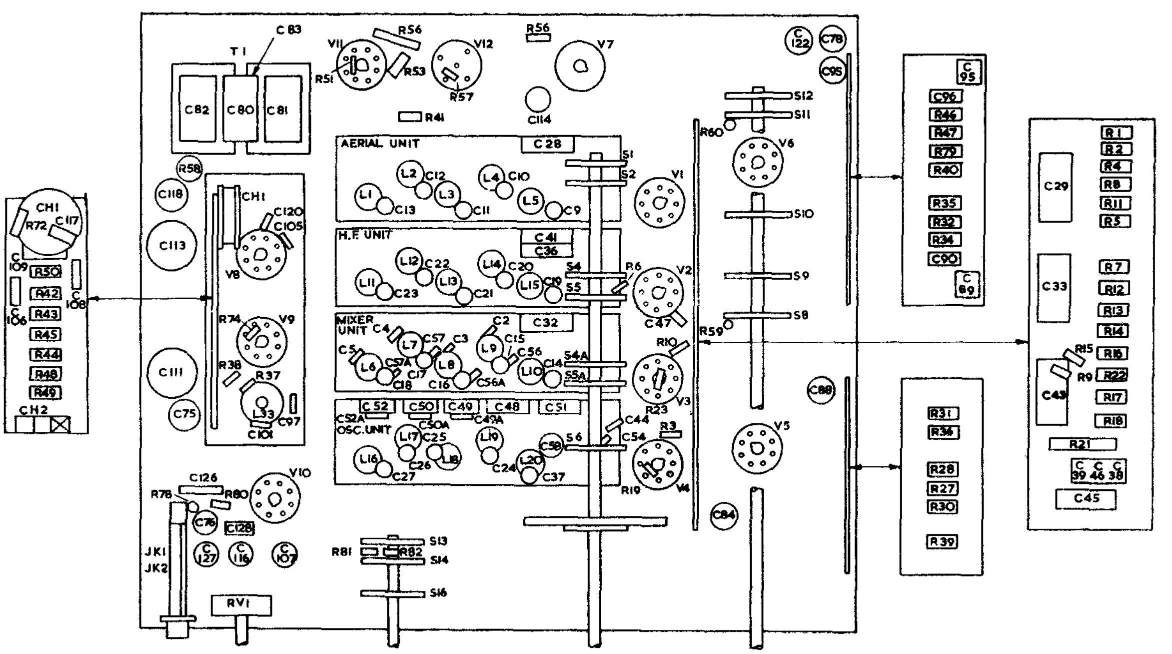

Fig. 5. Underside of chassis

COMPONENT VALUES

50. *Condensers.* Unless otherwise stated, working voltages are 350 and components are of silvered-mica construction. Values are given in micro-microfarads.

Circuit Ref.	*Value*	*Tolerance ± per cent*	*Voltage (working)*	*Type*
C1A,B,C	174·8 max.	—	—	Var.
C1D	179·3 max.	—	—	Var.
C2	10	10		—
C3	100	10		—
C4	220	10		—
C5	1 000	10		—
C8	15	20	500	Tubular
C9–27	3–30	—	—	Var.
C28–30	10 000	20		Moul. mica
C31	10	20	500	Tubular
C32–34	10 000	20		Moul. mica
C35	5–25	—	—	Var.
C36	10 000	20		Moul. mica
C37	3–30	—	—	Var.
C38–39	2 000	20		Moul. mica
C41–43	10 000	20		,, ,,
C44	10	10	500	Tubular
C45	100 000	15		Paper
C46	500	20		Moul. mica
C47	100	20		,, ,,
C48	1 500	5		
C49	820	5		
C49A	27	5		
C50	470	5		
C50A	47	5		
C51	2 700	5		
C52	270	5		
C52A	10	5		
C54	100	10	500	Tubular
C55	1	5	500	Tubular
C56–57A	10	10		
C58	10	10	500	Tubular
C59, 60	100	5		
C61	1 000	5		
C64, 65	220	5		
C66	180	5		
C67	47	5		
C68	220	5		
C69	180	5		
C70	47	5		
C71	180	5		
C72	220	5		
C75	100 000	20		Paper
C76	500 000	20		,,
C77	220	5		
C78	20 000	20		Paper tub.
C79	1 000	5		
C80	3 100	2		
C81–82	1 450–2 000	—	—	Var. mica trimmers
C83	3 100	2		
C84	20 000	20		Paper tub.
C85–87	100 000			Note 1
C88	20 000	20		Paper tub.
C89	3–30	—	—	Var.
C90	20	5		
C91–93	100 000			Note 1
C95	3–30	—	—	Var.
C96	20	5		
C97	470	5		
C98–100	100 000		—	Note 1
C101	0·5	20	500	Cup

Circuit Ref.	Value	Tolerance ± per cent	Voltage (working)	Type
C102–104	100 000			Note 1
C105–106	100	20		Moul. mica
C107	10 000	20		Paper tub.
C108–109	100	20		Moul. mica
C111–113	1 000 000	20		Paper tub.
C114	10 000	20		,, ,,
C116	50 000	20		,, ,,
C117	100	20		Moul. mica
C118	100 000	20		Paper tub.
C120	500	20		Moul. mica
C122	20 000	20		Paper tub.
C123–125	100 000			Note 1
C126	1 000	20		Moul. mica
C127	100 000	20		Paper
C128	100	20		Moul. mica

Note 1 . . .

Three paper capacitors each of 0·1 *mfd. tolerance* 20 *per cent,* 350 *volts working are contained in one metal case having a common earthing point which is not connected to the case.*

51. *Resistors.* Unless otherwise stated, the following resistors are of half-watt rating, carbon type, and of 20 per cent tolerance. Values are given in ohms unless K (thousands) follows the figure in the value column.

Circuit Ref.	Value	Remarks	Circuit Ref.	Value	Remarks
R1	47K		R37	2 200	
R2	220		R38	33K	
R3	75		R39	22K	
R4	220		R40	330	
R5	47K		R41	2 200	
R6	22		R42–3	150K	
R7	10K		R44	10K	
R8	47K		R45	1 000	
R9	100K		R46	2 200K	
R10	10		R47	4 700K	
R11	220		R48	47K	
R12	47K		R49	22K	
R13–14	10K		R50–51	2 200K	
R15	100		R52	220K	
R16	3 300		R53	1 000	
R17–18	10K		R54	330K	
R19	22		R55	150K	
R20	—		R56	3 300	5 per cent 6W wire
R21	10K	1W	R57	470K	
R22	1 000		R58	47K	
R23	100K		R59, 60	10	
R24	56		R61–66	56	5 per cent
R24A, B	39	10 per cent	R67	68K	10 per cent
R24C	68	10 per cent	R68–70	56	5 per cent
R24D	15	10 per cent	R71	470	5 per cent
R24E	68	10 per cent	R72	150K	
R25–26	33K		R73	500K	5 per cent
R27	15K		R74	330	5 per cent
R28	330		R75	470K	
R30	10K		R76	22K	
R31	47K		R77	100K	
R32	100K		R78	4 700	
R33	500K	5 per cent	R79	470K	
R34	330		R80	1 000K	
R35	10K		R81–82	2 200K	
R36	47K		RV1	500K	¼W log law pot.
			RV2	2 500	¼W linear pot.
			RV3	5 000	¼W linear pot.

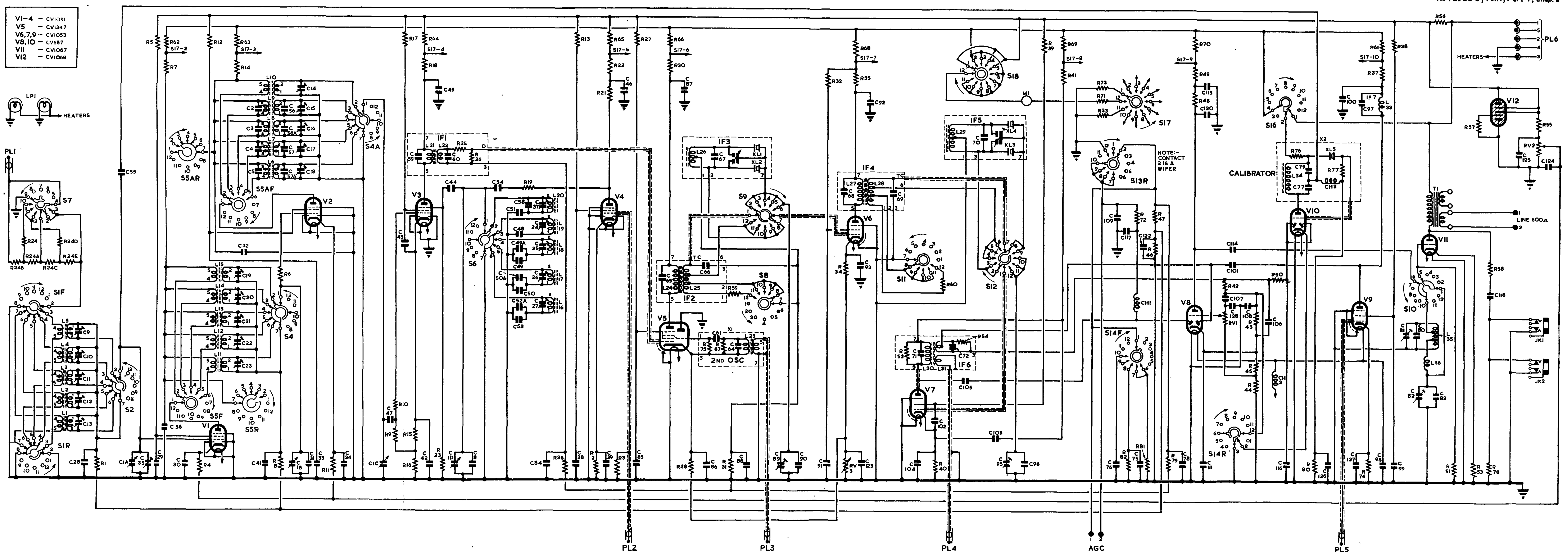

Fig. 2

Receiver circuit diagram

Fig. 2

PP6632 M34670 G1524 7 51 C&P Gp. 959 (4)

Chapter 3

COMMON OSCILLATOR UNIT

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LIST OF ILLUSTRATIONS

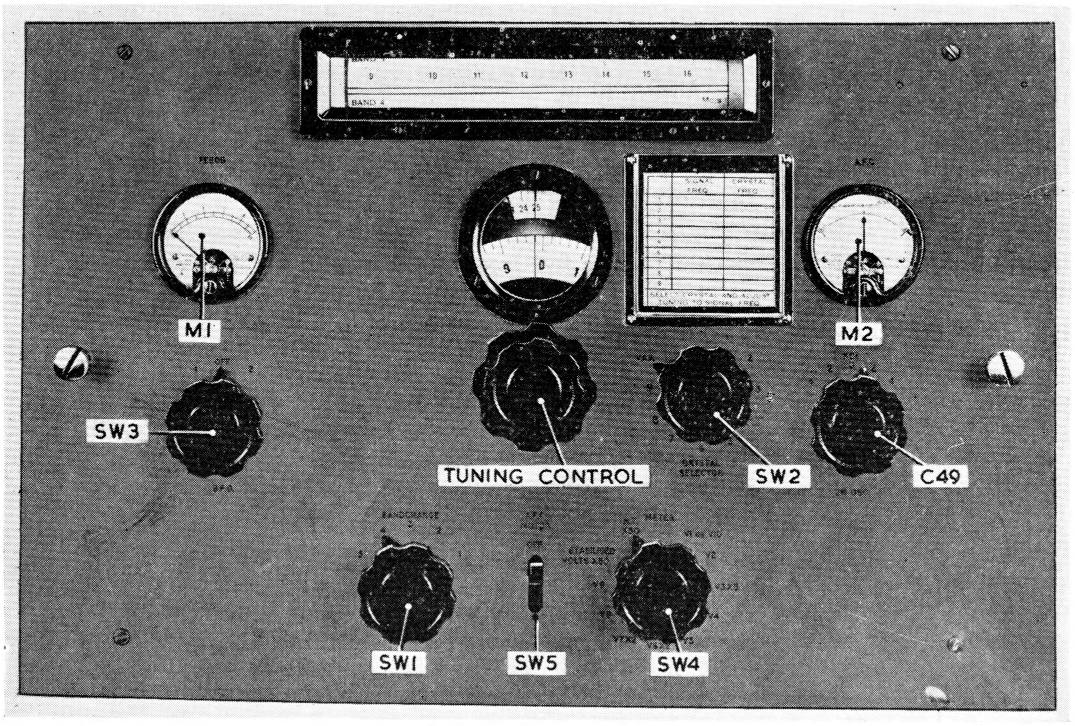

Fig. 1. Common oscillator unit

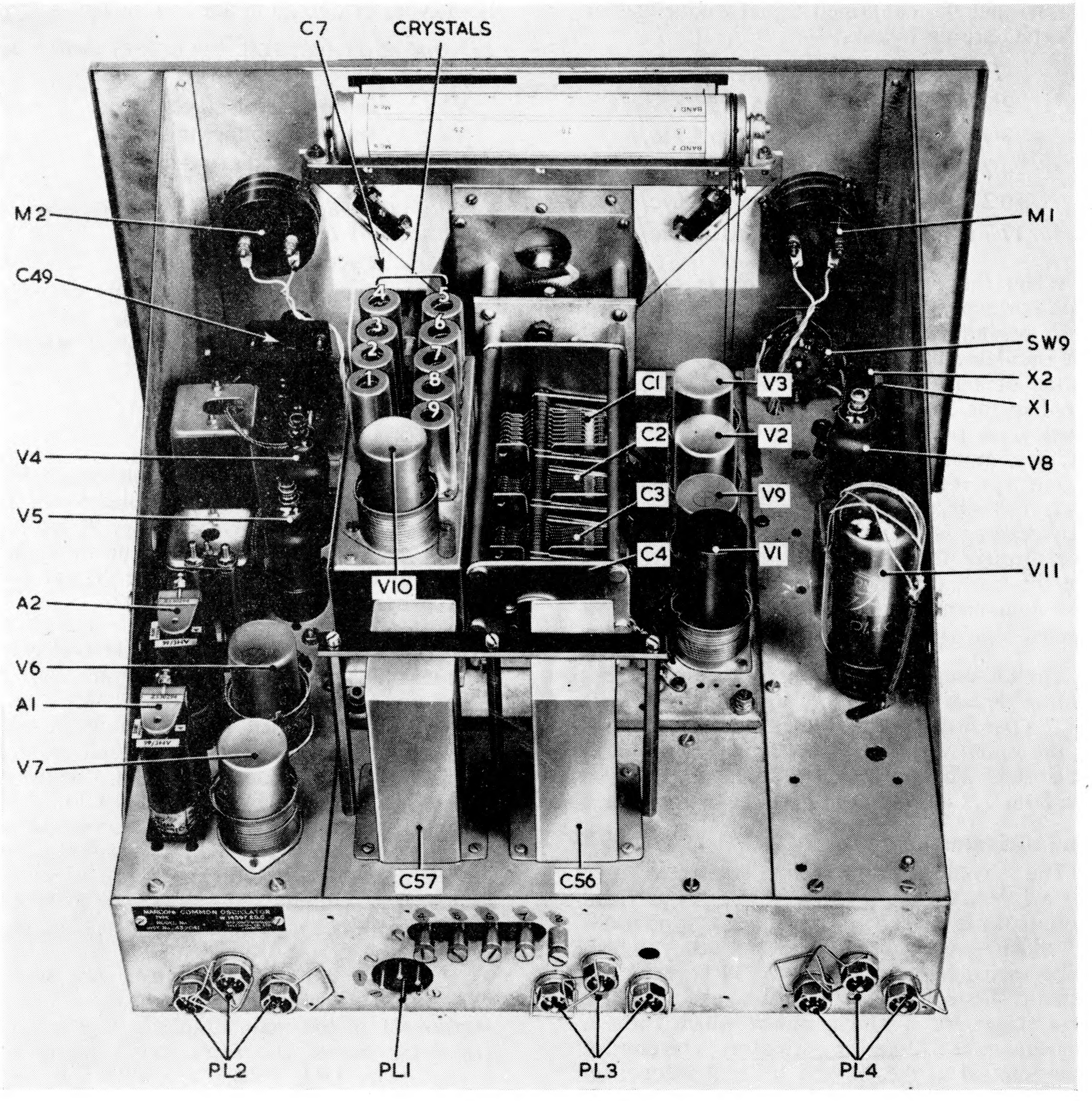

Fig. 2. Rear view of oscillator unit

BRIEF DESCRIPTION

9. Fig. 3 is a block diagram showing the valve stages used in first, second and third oscillators.

First oscillator

10. The first oscillator may be operated either as a crystal-controlled circuit giving nine spot frequencies within the band 2·7 to 31·2 Mc/s, or as a LC type oscillator giving any frequency within the band 2·7 to 31·2 Mc/s.

11. The stages used when first oscillator is crystal-controlled are shown at the top of fig. 3; the CRYSTAL SELECTOR switch is set to positions 1 to 9. The frequency is selected by the CRYSTAL SELECTOR switch; under these conditions V10 (the crystal oscillator) is used. The output from the oscillator V10 is fed through the buffer and output stages V2 and V3, when bands 1, 2 or 3 are being ▶◀ used. When bands 4 or 5 are used an additional stage V9 is employed; on band 5 V9 operates as a doubler stage and selects the second harmonic of the crystal frequency, which is then fed to V2, the buffer amplifier stage.

12. When the first oscillator is LC controlled the CRYSTAL SELECTOR switch is set to VAR (*fig.* 3) and V1 is used instead of V10; the output from V1 is fed to V2 and then to V3, the output stage. Tuning is carried out by sections C1, C3 and C4 of the main tuning capacitor. The outputs from the 1st oscillator are fed to the three receivers via the Pye plugs PL3 (A, B and C).

13. The BANDCHANGE switch S1 selects the required frequency band; five frequency bands are used to cover the full range of the first oscillator,

INTRODUCTION

1. The common oscillator unit (Type 327, 10V/16214) consists of three separate oscillators which are common to all three receivers. The oscillator unit (*fig.* 1) is mounted on the standard rack and forms part of the rack assembly Type 238.

2. Three separate oscillators are contained in this unit, and are as follows:—

(1) First oscillator, which has a frequency range ◀of 2·7 to 31·2 Mc/s, generated either in an▶ LC circuit (continuously variable), or from a crystal controlled circuit (giving nine spot frequencies within the range 1·5 to 30 Mc/s). Five frequency bands are used to cover this range.

(2) Second oscillator generating a frequency of 735 kc/s in an LC circuit—automatic frequency control is applied to this oscillator.

(3) Third oscillator (beat frequency oscillator) generating two spot frequencies of 464 and 465 kc/s in crystal controlled circuits.

3. Using oscillators common to receivers in a diversity system ensures that the intermediate frequencies of the receivers are the same, and simplifies the application of automatic frequency control.

4. The functions of the oscillator Type 327 when used in the receiving equipment R.1923 are as follows:—

(1) To provide the local oscillator frequency to the first frequency changers in the three receivers; the first oscillator frequency is combined with the signal to produce the first intermediate frequency of 1·2 Mc/s.

(2) To provide the second local oscillator frequency of 735 kc/s, which is combined with the 1st IF of 1·2 Mc/s, in the second frequency changers in the three receivers, to produce the second IF of 465 kc/s. The automatic frequency control is applied to this oscillator.

(3) To provide two spot frequencies of 464 and 465 kc/s.

5. The power supplies to the oscillator unit are provided by supply unit No. 2, which is also part of Rack assembly Type 238, and are fed into the unit via a 5-pin plug PL1 (*fig.* 2). The power supplies are as follows:—

Pin 1—110mA at 250 volts positive
◀Pin 2—Earth▶
Pin 3—4·4 amps at 6·8 volts, 50 c/s.
Pin 4—Earth
◀Pin 5—2 amps at 15 volts, 50 c/s.▶

6. The outputs from the oscillator unit Type 327 are as follows:—

◀(1) 2·7 to 31·2 Mc/s via Pye sockets PL3A, B and▶ C (three sockets connected in parallel) (*fig.* 2).

(2) 735 kc/s via Pye sockets PL2A, B and C (three sockets connected in parallel) (*fig.* 2).

(3) 464 or 465 kc/s at Pye sockets PL4A, B and C (three sockets connected in parallel) (*fig.* 2).

7. The five screw-terminals mounted at the rear of the oscillator unit (*fig.* 2) provide a means of terminating the AFC control circuits and are as follows:—

Terminal 4—AFC alarm lamp in the combining unit.
Terminal 5—*This terminal is not used.*
Terminal 6—AFC voltage from the combining unit.
Terminal 7—AFC voltage from the combining unit.
Terminal 8—Earth.

CONTROLS

8. The controls mounted on the front panel of the oscillator unit Type 327 and their functions in the unit are as follows:—

Control	*Function*	*Circuit Ref.*
CRYSTAL SELECTOR	Selects any one of the nine crystal frequencies and switches over to the continuously variable LC oscillator	SW2
BANDCHANGE	Selects any one of the five frequency bands of the first oscillator	SW1
TUNING CONTROL	Tuning capacitor for the five frequency bands of the first oscillator	C1–3
2ND OSC.	Tuning control for the second oscillator; range ± 4 kc/s	C49
AFC MOTOR	Switches the AC supply to the AFC motor	SW5
BFO	Selects either the 464 or 465 kc/s in the third oscillator	SW3
MONITORING SWITCH	Connects the FEEDS meter across the HT supply, and also connects the meter across each of the monitoring resistors in each of the valve circuits	SW4
FEEDS METER	Indicates voltages and currents of the HT supply and the valves in the unit	M1
AFC METER	Indicates the condition of the AFC circuit when the circuit is in balance, or whether the frequency correction applied is high or low	M2
TOP SCALE	The scale appearing behind the top window which is changed for each of the five frequency bands by operation of the BANDCHANGE switch; the pointer in front of the scale indicates the frequency to which the oscillator is tuned	
LOWER SCALE	Magnified scale which is coupled to the tuning control and permits a more accurate frequency reading	

the tuning scale is calibrated in terms of signal frequency. The frequency coverage of the first oscillator, and the calibrated signal frequency for each band, are as follows: —

Band	*First osc. freq.*	*Calibrated freq.*
1	2·7 to 3·95 Mc/s	1·5 to 2·75 Mc/s
2	3·95 to 6·2 Mc/s	2·75 to 5 Mc/s
3	6·2 to 10·2 Mc/s	5 to 9 Mc/s
4	10·2 to 17·7 Mc/s	9 to 16·5 Mc/s
5	17·7 to 31·2 Mc/s	16·5 to 30 Mc/s

14. When the BANDCHANGE switch is operated, a scale corresponding to the setting of the switch appears behind the rectangular window at the top of the oscillator unit panel; this scale is calibrated in terms of signal frequency which is 1·2 Mc/s lower than the actual tuning of the first oscillator frequency. A pointer coupled to the main tuning capacitor is moved across the scale as the main tuning control is rotated, indicating the frequency of the received signals. A more accurate signal frequency reading is obtained from the logging discs visible through the circular window situated just above the main tuning control. The logging scale has an equivalent length of 18 feet and has 1,250 divisions.

15. The LC oscillator V1 has a temperature compensating device which limits the frequency drift to 2 kc/s per hour for frequencies below 20 Mc/s, after the initial warming up period of 30 minutes has elapsed. The frequency drift for frequencies above 20 Mc/s does not exceed 5 kc/s per hour.

Second oscillator

16. The second oscillator section comprises valve stages V4, V5, V6 and V7 (*fig.* 3); the output from this oscillator is 735 kc/s. V4 is an LC type oscillator which generates a single frequency which may be varied between 731 and 739 kc/s by the automatic frequency control. V6 and V7 are control stages for a tuning motor which turns a tuning capacitor C49 in the oscillator. The control voltage applied to the V6 and V7 is developed in the discriminator circuit of the combining unit. The output from V4 is fed into a buffer stage V5 before being fed to the receivers via Pye plugs PL2A and B.

Third oscillator (BFO)

17. The third oscillator V8 (*fig.* 3) generates two fixed frequencies of 464 and 465 kc/s, both of which are crystal controlled. The crystals are switched in the oscillator circuit by means of the BFO control in the front panel.

Stabilizer

18. The neon stabilizer valve V11 is connected across the 250 volt positive supply in the oscillator unit and provides stabilized supplies of 70 and 140 volts positive.

CIRCUIT OPERATION

First oscillator

19. The first oscillator section functions either as an LC controlled oscillator generating a continuous frequency range of 2·7 to 31·2 Mc/s or as a crystal-controlled oscillator generating 9 spot frequencies within the same range. The valve stages used for both types of operation are as follows: —

LC operation (CRYSTAL SELECTOR) *switch set to VAR*

V1	LC oscillator stage
V2	Buffer/amplifier stage
V3	Output stage

Crystal controlled (CRYSTAL SELECTOR) *switch set to positions* 1 *to* 9

V10	Crystal oscillator stage
V9	Buffer/doubler stage (this stage is only operative when the BANDCHANGE switch is set to positions ◀4 or 5▶)
V2	Buffer/amplifier stage
V3	Output stage

LC operation

20. When the CRYSTAL SELECTOR switch SW2 is set to VAR, the HT voltage is applied to the anode of the LC oscillator valve V1 (*fig.* 5) via section SW2/E of the switch; at the same time the HT supply to the anode of V10 (the crystal osc.) is broken by section C of switch SW2.

21. Valve V1 is a pentode, triode connected in a shunt-fed Meissner oscillator circuit capable of generating frequencies of 2·7 to 31·2 Mc/s; this frequency range is divided into five bands. A separate transformer is used to cover each band, the primary of which is connected (via C5) between the grid of V1 and earth by means of section A of the BANDCHANGE switch SW1; this section of the switch also short-circuits the primaries of the transformers not in use. Section SW1/B of the BANDCHANGE switch short-circuits the secondaries of the four transformers not in use, and connects the secondary winding of the transformer in use, via capacitor C29, to the grid of the following stage V2. The oscillator is manually tuned by means of section C1 of the main tuning capacitor which is connected across the secondary winding of the transformers TR1, TR2, TR3, TR4 and TR5.

22. The grid bias on V1 is provided by the action of grid capacitor C5 and leak resistor R4; the grid current charges C5 negatively, tending to bias back the valve. Resistor R4 allows the charge on C5 to leak away.

23. Resistor R1 forms the anode load; the oscillatory voltage developed across R1 is applied to the grid of V2, the buffer-amplifier stage. The anode circuit of V1 is decoupled by means of resistor R26 and capacitor C37.

24. A temperature compensating capacitor C7 is connected in parallel with the tuning capacitor C1 to compensate for the drift in oscillator frequency caused by temperature changes. C7 consists of two metal plates mounted parallel to each other; one of the plates is supported by means of a bimetal strip which bends slightly when the temperature rises. Changes in temperature cause a variation in the distance between the plates forming the capacitor, thereby altering the capacitance. Whilst a valve is warming-up the inter-electrode capacitances increase with the rise in temperature and as the inter-electrode capacitances are effectively in parallel with the tuned circuit, the oscillator frequency is reduced. The temperature compensating capacitor C7 is designed so that its capacitance is reduced with an increase in temperature, tending to compensate for the drift in the oscillator frequency during the warming-up period.

25. The HT applied across the oscillator valve V1 is fed from a 140-volt positive stabilized supply.

26. The buffer amplifier V2 is a pentode valve operating in a tuned amplifier stage; five separate coils (L1 to L5) are provided to cover the five frequency bands, and are switched individually into the anode circuit of V2 by means of the BANDCHANGE switch (SW1/1). The circuits are tuned by the variable capacitor C3. The five coils (L1 to L5) are pre-tuned by means of their trimmer capacitors. Resistor R3 is connected in series with the anode and its function is to prevent parasitic oscillations in the amplifier circuit. The grid bias for V2 is developed across the cathode bias resistor R6, which is decoupled by capacitor C9. The amplified RF voltage developed across the coil in circuit is fed via a tapping on the coil, through section K of the BANDCHANGE switch SW1 to the grid of V3, the output stage.

27. The HT voltage applied to V2 is provided by the 250V positive unstabilized supply.

28. The output stage consists of a pentode valve V3, which is used in a tuned amplifier circuit. Five separate tuned transformers (TR6 to TR10 inclusive) are switched individually into the anode circuit by means of the BANDCHANGE switch (SW1/K and SW1/M). The variable tuning capacitor C4 (part of the main tuning capacitor) is used to tune the primary circuits of the five transformers.

29. The oscillations fed into the grid of V3 are amplified in the tuned anode circuits; the amplified output voltage developed across the secondary is matched to the low impedance output by the secondary winding, and is fed to three Pye plugs PL4A, B and C (which are connected in parallel). The bias applied to V3 is developed across the cathode bias resistor R14; the cathode is decoupled by capacitor C20. R21 has a low resistance and is connected in series with the anode to prevent parasitic oscillations from occurring in the output stage.

30. The HT voltage applied to V3 is provided by the 250V positive unstabilized supply.

Crystal controlled

31. When the CRYSTAL SELECTOR switch SW2 is set to positions 1 to 9 the HT voltage is applied to the anode of V10 (the crystal oscillator) via section B of switch SW2; at the same time section A of SW2 removes the HT voltage from the anode of V1 (the LC oscillator).

32. Valve V10 is a pentode valve driving a crystal oscillator circuit. The circuit is known as a Pierce oscillator; the crystal is connected between anode and grid, and operates as a tank circuit providing the coupling between the anode and grid. Nine separate crystals are available and are connected individually in the circuit by means of the CRYSTAL SELECTOR switch SW2 (sections F and H). The circuit oscillates at the fundamental frequency of each crystal. Self-bias is provided by the charging network, resistor R51 and capacitor C33, connected between grid and cathode of V10. Resistor R57 forms the anode load, the oscillator voltage developed across R57 is fed to the following stage via section F of the BANDCHANGE switch SW1.

33. When the BANDCHANGE switch is set to BAND 1, 2 or 3 the output from the crystal oscillator V10 is fed via SW2F and capacitor C70 to the grid of V2 the buffer-amplifier valve.

34. When the BANDCHANGE switch is set to positions 4 or 5 the output from the crystal oscillator V10 is fed into the grid of V9, the buffer doubler stage.

35. V9 is a pentode valve operating in a tuned amplifier stage, two tuned coils L6 and L7 are used, and are switched in the anode circuit individually to cover BAND 4 and BAND 5 by means of SW1/H. The coils are tuned to any frequency within their band coverage by means of section C2 of the main tuning capacitor. The amplified RF voltage developed across the coil in the anode circuit is fed via capacitor C72 to the grid of V2, the buffer-amplifier stage. V9 is biased by the voltage developed across the cathode bias resistor R59, the cathode is decoupled by capacitor C59. On BAND 5, V10 operates at half the required oscillator output frequency and V9 operates as a doubler.

36. The HT supply to V9 is provided by the 250V positive unstabilized supply.

Second oscillator

37. The pentode valve V4 is connected as a triode and operates in a Colpitts oscillator circuit. Resistor R45 is the anode load. Capacitor C46 is connected between the anode and grid, and provides the positive feedback necessary to sustain oscillations. The automatic frequency control is effected by means of the variable capacitor C49 which is connected across the tank coil L8; C49 is mechanically coupled to the AFC motor which is controlled by the AFC voltage developed in the combining unit Type 6. Bias applied to V4 is developed across grid resistor R46. The oscillations developed in the tank circuit are fed via C51 to the grid of the buffer-output stage V5.

38. The HT supply to V4 is provided by the 140V positive stabilized voltage.

39. The second oscillator V4 generates a nominal frequency of 735 kc/s which may be varied between the limits of ± 4 kc/s by the AFC motor.

40. The buffer-output stage consists of a pentode valve V5 operating in a tuned amplifier stage. The oscillations generated in the second oscillator stage V4 are fed into the grid of V5, and are amplified in the tuned transformer TR11 and fed to the Pye plugs PLA, B and C by the secondary of TR11 which also provides the high to low impedance match. The bias on V5 is provided by the cathode bias resistor R49, which is decoupled by capacitor C50.

41. The HT supply to V5 is provided by the 140V positive stabilized voltage.

Control circuit

42. The AFC motor is controlled by valves V6 and V7 and relays RL2/2 and RL1/2. The control voltage, developed in discriminator circuit in the combining unit, is fed via terminals AFC1 and AFC2 to the grid of V7 and the junction of resistors R39 and R40 (in the cathode circuit of V6).

43. V6 and V7 form the control stage and are pentode valves connected as triodes; the two valves share the common cathode resistors R39 and R40 (*fig.* 5). The grid of V7 is returned to earth via the discriminator circuit in the combining unit. The grid of V6 is connected to a potential divider consisting of resistors R41, VR1 and R43 connected in series between the positive 250V HT line and earth. VR1 is used to balance the circuit when the second oscillator is on tune (735 kc/s).

44. When terminal AFC1 is positive with respect to terminal AFC2, V7 anode current will increase so that V7 anode voltage will drop. The increase in V7 anode current will cause the potential at the cathodes of V6 and V7 to rise, and as the grid of V6 is held at a steady potential the anode current of V6 will decrease and cause the anode to go more positive. As the anode of V6 is positive with respect to the anode of V7, a current will flow through rectifier W1 and the winding of relay RL1 through the meter M2 to the anode of V7. Thus relay RL1 is energized, which causes rotation of the motor armature in one direction.

45. When AFC1 is negative with respect to AFC2, the anode current of V7 decreases, which makes the anode more positive. Less current will flow through cathode resistors R39 and R40, so that the cathode potential will drop, this will cause an increase in V6 anode current, with the result that V7 anode will be positive with respect to V6 anode. A current will flow from the anode of V7 through meter M2, relay RL2 and rectifier W2 to the anode of V6. Relay RL2 will be energized and cause the motor armature to rotate in the opposite direction.

46. The control circuit is adjusted by means of VR1 so that when terminals AFC1 and AFC2 are at the same potential the voltages at the anode of V6 and V7 are equal and both relays remain unoperated.

AFC motor

47. The AFC motor is a series type having two windings, which are wound in opposition to each other (*fig.* 4)*. One end of each winding is connected to the armature via one of the brushes; the other two ends of the windings marked B and C are connected via two pairs of relay contacts RL1 and RL2 to earth. The motor operates from an 18V alternating supply; the auto transformer TR1 steps up the 12V input from the supply unit No. 2 to 18V. The motor shaft is coupled to the variable capacitor C49 via a reduction gear. A cam on the capacitor shaft closes a pair of contacts when rotation of C49 has caused a frequency deviation in the second oscillator of 3 kc/s, above or below 735 kc/s. The contacts, when closed, operate an alarm circuit which lights a lamp in the combining unit.

48. ◀When the relay RL1 is energized, contacts RL1/1 and RL1/2▶ will close and the supply current to the motor flows through the field winding (B) and the motor armature; a smaller current will flow through the field winding (C) as resistor R62 is connected in series with it. The magnetic field produced by winding C will oppose that field produced by winding B, but as the current through the latter is the greater, it will predominate and thus determine the direction of rotation of the armature and shaft.

49. When relay RL2 is energized, contacts RL2/1 and RL2/2 will close and allow a current to flow through field winding (C) and the motor armature; resistor R62 will be in series with winding (B) so that a smaller current will flow through this winding. The field produced by winding C will predominate and will determine the direction of rotation of the motor armature, which will be in the opposite direction to the rotation when relay RL1 is energized. ◀A thermal switch is built into the end housing of the AFC motor.

Sequence of AFC operations

50. The three conditions of the AFC circuit are as follows:—

(1) When the second IF is on tune—control voltage from the discriminator circuit is zero—both relays unoperated—no current flowing in either winding of the motor—motor armature stationary—SECOND OSC control set to 0 kc/s.

(2) When the second IF is high—terminal AFC1 positive with respect to terminal AFC2—V6 anode positive with respect to V7 anode—relay RL1/2 energized—motor armature rotates in such a direction as to reduce the capacity of C49—frequency of the second oscillator is increased, which reduces the second IF until it is on tune, when the AFC circuit is returned to its balanced condition as in (1).

(3) When the second IF is low—terminal AFC2 is negative with respect to terminal AFC2—V7 anode positive with respect to V6 anode—relay RL2/2 energized—motor armature rotates in such a direction as to increase the capacity of C49—frequency of the second oscillator is reduced, which increases the second IF until it is on tune, when the AFC circuit is returned to its balanced condition as in (1).

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*In fig. 4, $\frac{RL1}{1}$ between V7 and V6 should read $\frac{RL1}{2}$

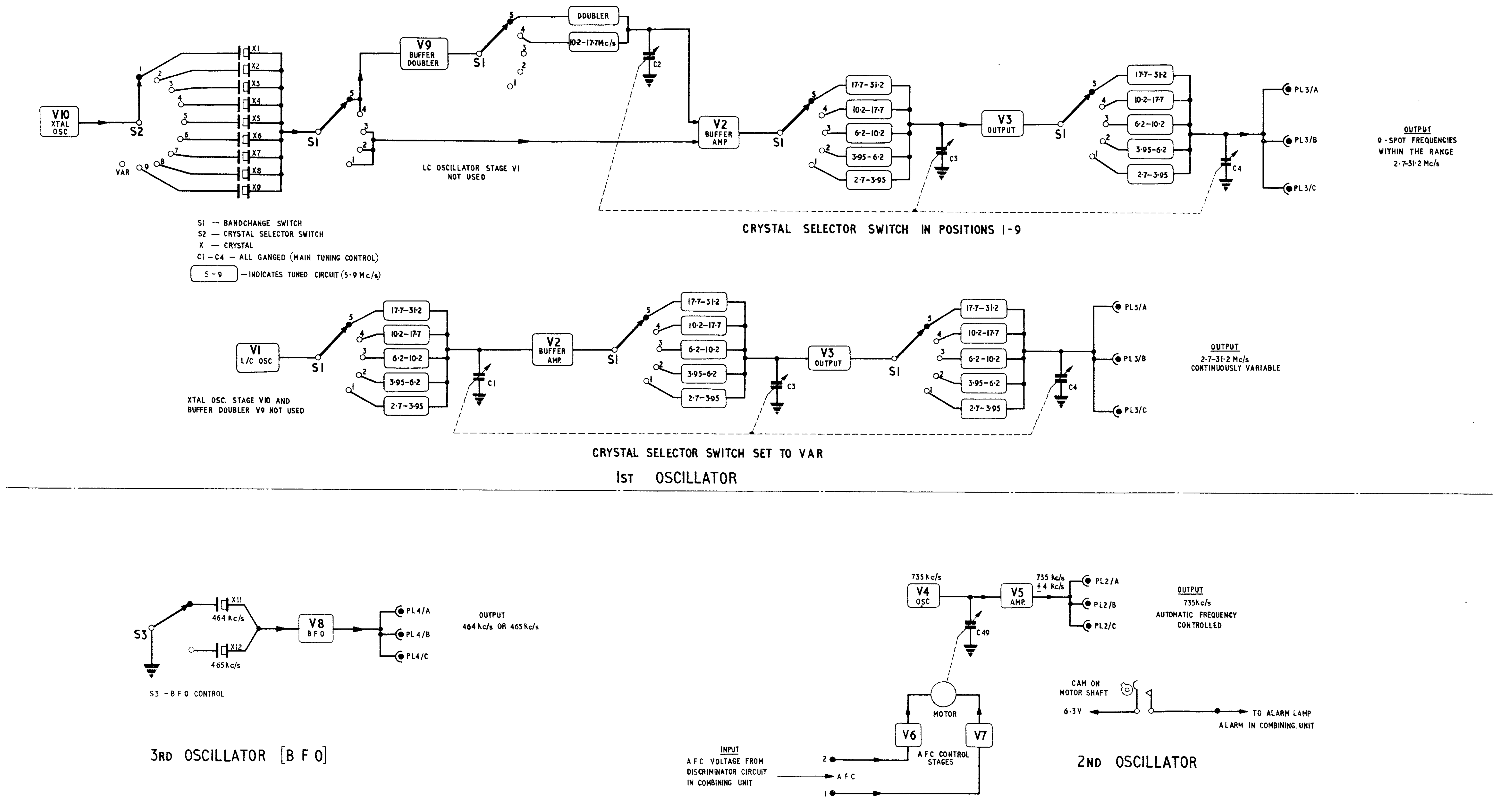

Fig. 3 Common Oscillator unit (Type 327)– block diagram Fig. 3

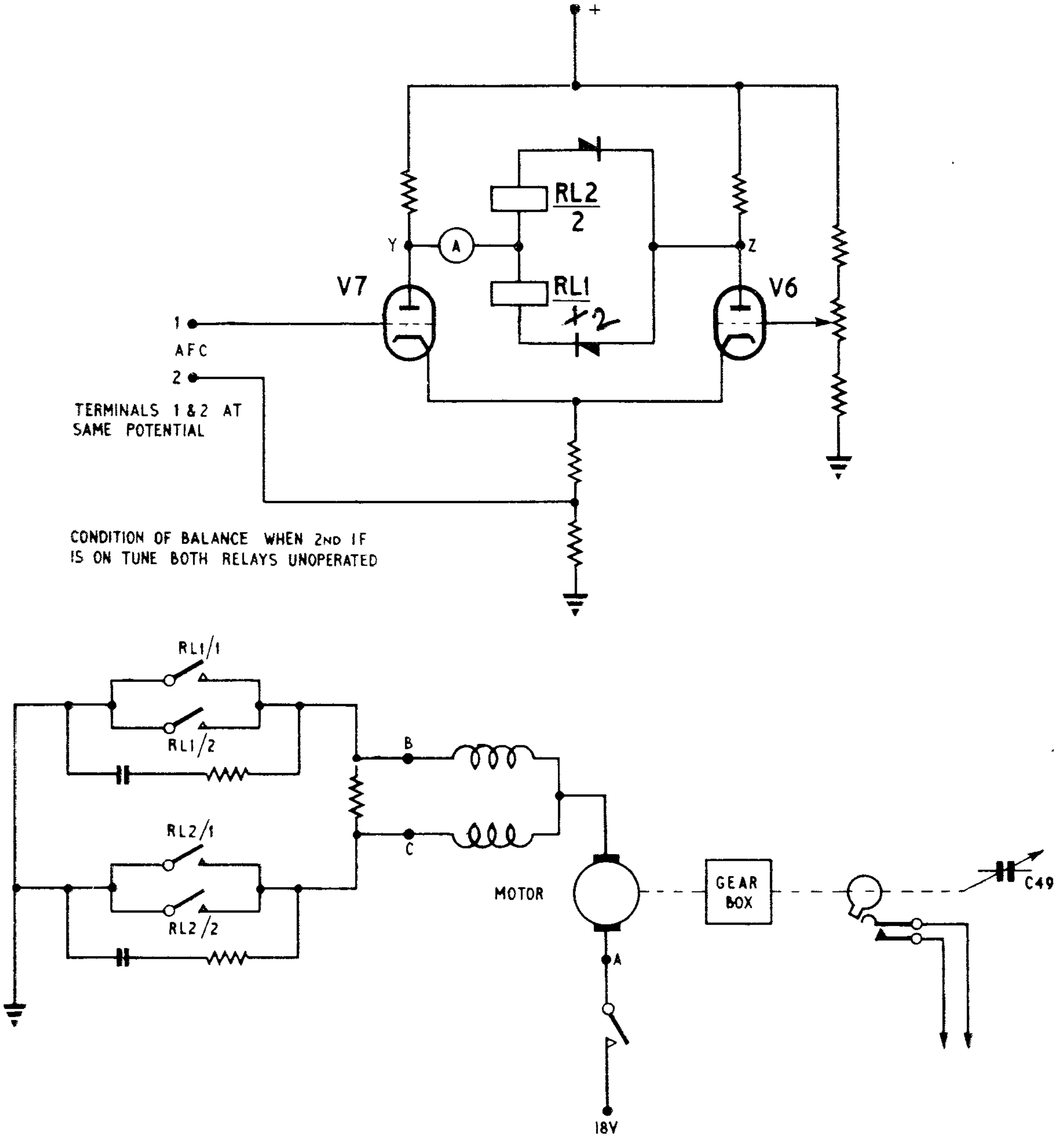

Fig. 4. AFC circuit

Third oscillator

51. The third oscillator consists of a pentode valve V8 operating in a crystal-controlled circuit. Two crystals are employed and are switched individually into the circuit, giving two spot frequencies of 464 and 465 kc/s by means of the BFO switch SW3. The feedback necessary to maintain oscillations is provided by the crystals which are connected between the anode and grid of V8. The bias on V8 is provided by capacitor C66 and resistor R52; when the grid goes positive it draws grid current which charges C66 negatively, applying negative bias to the grid. Resistor R52 allows the charge on C66 to leak away.

52. The BFO switch SW3 has three positions; in the centre (OFF) position the HT supply to the anode of V8 is disconnected by section B of the switch. When the switch is set to position 1 the HT is applied to the anode, and the 464 kc/s crystal X1 is connected between anode and grid of V8. When the switch is set to position 2, the 465 kc/s crystal X2 is connected between anode and grid. The oscillatory voltage generated by V8 is developed across the primary of TR13, and is coupled to the three Pye sockets PL4A, B and C by the secondary winding.

MONITORING

53. The monitoring circuit consists of the 11-position METER switch SW4 and an 0–1 m/a moving coil meter M1. Operation of the METER switch enables the supply voltages, and the anode currents of each valve to be checked. The meter is used as a voltmeter, and is connected across metering resistors which are connected in series with the anode of each valve; the value of the metering resistor is known and the volt-drop measured by the meter is interpreted as anode current on the meter scale.

54. The positions of the METER switch, and the meter connections for each position of the switch are as follows:—

(1) V1 or V10
The meter M1 is connected across metering resistor R28. When the CRYSTAL SELECTOR switch is set to VAR, R28 is in series with V1 which has HT applied to it.
When the CRYSTAL SELECTOR switch is set to positions 1–9, resistor R28 will be connected in series with the anode of V10 which has HT applied to it.

(2) V2
The meter M1 is connected across metering resistor R29 which is connected in series with the anode of V2.

(3) V3
The meter M1 is connected across metering resistor R30 which is connected in series with the anode of V3.

(4) V4
M1 is connected across metering resistor R31 which is connected in series with the anode of V4.

(5) V5
M1 is connected across metering resistor R32 which is connected in series with the anode of V5.

(6) V6
M1 is connected across metering resistor R33 which is connected in series with the anode of V6.

(7) V7
M1 is connected across metering resistor R34 which is connected in series with the anode of V7.

(8) V8
M1 is connected across metering resistor R35 which is connected in series with the anode of V8.

(9) V9
M1 is connected across metering resistor R42 which is connected in series with the anode of V9.

(10) STABILIZED VOLTS × 50
The meter M1 is connected in series with resistor R36 between the positive 140-volt stabilized line and earth.

(11) HT × 50
The meter M1 is connected in series with resistor R36 between the positive 250-volt line and earth.

CONSTRUCTIONAL DETAILS

55. The oscillator unit consists of a front panel bearing meters and controls and a box-type base bolted to the panel at right-angles. The unit slides into the rack on runners, which allows the unit to be fully withdrawn from the rack and raised at an angle to permit access to the components mounted underneath the base, whilst still being supported by the runners.

56. The base is divided into three sections. The components of the first oscillator are mounted on the centre section; the main tuning capacitor is mounted in the centre of this section with the crystal-controlled section on the left-hand side (*fig.* 2), and the LC section on the right-hand side.

57. The left-hand base section (*fig.* 2) carries the second oscillator components and the AFC motor, with control valves and associated relays.

58. The right-hand base section carries the third oscillator (BFO) and the stabilizer valve V11.

59. The five frequency band scales are fitted to a drum which is turned by operation of the BAND-CHANGE switch, bringing the appropriate scale into view behind the horizontal window at the top of the front panel. The drum is coupled to the switch by means of a cord drive. A pointer is moved across the frequency scale in view (from the front of the panel) by means of another cord drive attached to the main tuning control.

60. The logging scales mounted below the horizontal scale are driven from the main tuning control by means of a reduction gear train mounted between the inside of the front panel and the main tuning capacitor.

61. Two lamps mounted on the inner side of the front panel illuminate both horizontal and circular (logging scales).

62. The oscillator unit is locked in the normal (flush) position by means of the two captive screws, situated one on each side of the front panel.

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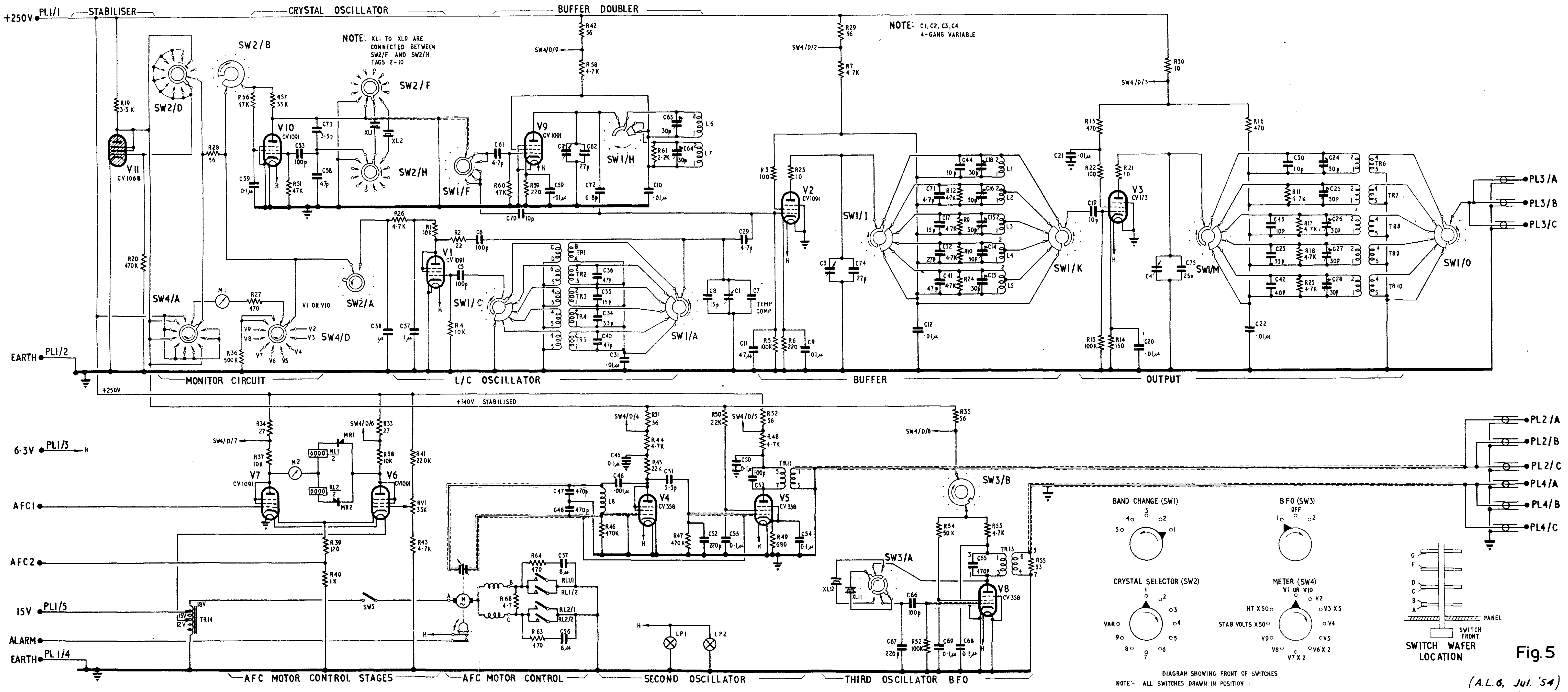

Fig.5

(A.L.6, Jul. '54)

Fig.5

Common Oscillator unit (Type 327)— circuit

CHAPTER 4.—COMBINING UNIT

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INTRODUCTION

1. The combining unit acts as the combined output panel when the equipment is used for double sideband (DSB) reception (i.e., normal amplitude-modulation use) when it is necessary to send to line only the best of the signals obtained by diversity reception. For this purpose it accepts the second IF output from the three receivers and demodulates them separately, combines them, and amplifies the combined output.

2. The unit similarly provides the AFC voltage applied to the common oscillator (*Chap.* 3) when the equipment is used for SB reception. This voltage is also obtained from the second IF outputs by the use of frequency-discriminating circuits followed by a combining stage.

3. The third main function of the unit is to route the AGC voltages available from the receivers or the SSR2 rack back to the receiver AGC lines, with or without previous combination.

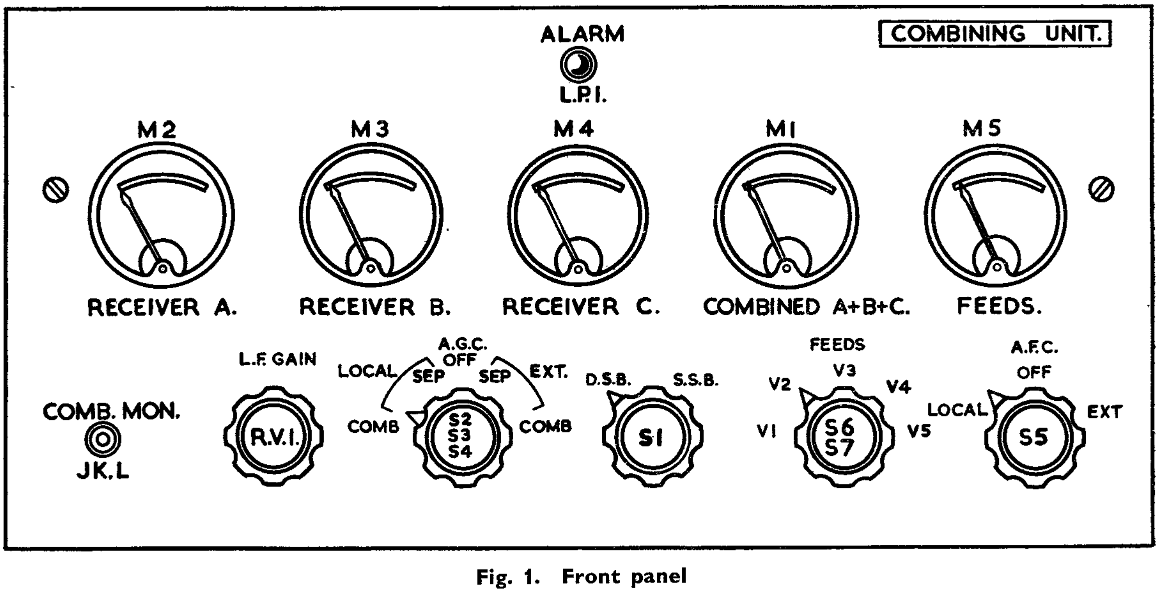

Fig. 1. Front panel

4. The unit (panel Type 771, 10D/16133) is mounted on the rack assembly Type 238, as described in Chap. 1.

Controls

5. The following controls are fitted on the front panel of the unit:—

Panel engraving	*Function*	*Circuit Ref.*
ALARM (*Lamp*)	Indicates ± 3 kc/s drift of 2nd oscillator	LP1
Meters:		
RECEIVER 'A' RECEIVER 'B' RECEIVER 'C'	Indicates the diode current in the demodulation valve of receiver units when on DSB signals	M2 M3 M4
COMBINED 'A', 'B' and 'C'	Indicates the three path combined outputs and the level to the line amplifier	M1
FEEDS	Indicates valve feed currents	M5
COMB. MON.	Phones check on output	JK1
LF GAIN	Controls output to line when on DSB signals	RV1
AGC (*switch*)	(*para.* 6)	S2, 3, 4
DSB/SSB (*switch*)	Controls valve heater supply	S1
FEEDS (*switch*)	Connects each valve in turn to M5 to measure feed currents	S6, S7
AFC (*switch*)	(*para.* 7)	S5

6. The AGC switch has five positions as follows:—

Panel engraving	*Function*
(1) LOCAL COMBINED	Connects together the AGC outputs of all three receiver units and applies them to the receiver AGC lines
(2) LOCAL SEPARATE	Connects each receiver unit AGC line to its own AGC output
(3) OFF	Connects the AGC line of each receiver unit to earth
(4) EXTERNAL SEPARATE	Connects AGC line in each receiver unit to SSR2 rack
(5) EXTERNAL COMBINED	Connects the combined AGC of all three receiver units to SSR2 rack

7. The AFC switch has three positions, namely:—

Panel engraving	*Function*
(1) LOCAL	Connects AFC voltage from discriminator in combining unit to receivers—for use on D.S.B. reception
(2) OFF	Disconnects AFC circuit
(3) EXTERNAL	Controls AFC from SSR2 rack Connects AFC voltage from SSR2 rack to receivers for use on SSB reception

CIRCUIT DESCRIPTION

General

8. The unit consists of three detector valves, V6, V7 and V8, which are diodes Type CV1054, a two-stage AF amplifier consisting of the valves V1 (CV1073) and V2 (CV1932), three limiters V3, V4 and V5 Type CV1056, and three AFC discriminators V9, V10 and V11 Type CV1054. Also contained in the unit are the AGC switches S2, S3 and S4, the AFC switch S5, the DSB/SSB switch S1, the motor switches S6 and S7, and the associated meter M5. Meters M1–M4 are permanently wired into circuit to measure the diode currents of the three signal paths.

AF stages

9. The three 465 kc/s outputs from the final IF amplifiers in the three receivers are fed into the unit via co-axial plugs and thence to the three input transformers L1, L2 and L3. The outputs from the secondaries of these transformers are applied to the three detectors V6, V7 and V8. These three valves share a common load R2. In series with each lead from the detectors is a choke, L4, L5 and L6, to filter out the 465 kc/s RF, and meters M2, M3 and M4 to measure the diode current in each path. A meter M1 is included to measure the combined audio current, and its reading should be equal to the highest of the currents in the three individual paths.

10. The voltage developed across R2 by the strongest signal automatically biases the other two diodes so that they do not conduct, thus providing a form of selective switching. Therefore the strongest signal only is applied to the AF amplifier.

11. The AF voltage developed across R2 is applied to the grid of V1 via a blocking capacitor C9 and the gain control RV1. R5 is a grid stopper. Cathode bias is developed across R9, and C15 is the cathode by-pass capacitor. R7 and C12 are the anode decouplers. The voltage developed across R8, the anode load, is applied via C14 to the grid of the ouput valve V2. Cathode bias for this stage is developed across R21 and C36. Voltage negative feedback is applied to the grid of V2, via R19 and C13. The anode load of V2 is transformer T4, which has two secondaries of ratios 70 : 1 and 5 : 1. The 5 : 1 ratio feeds out to a 600-ohm line a maximum of 100 milliwatts. The 70 : 1 secondary supplies a telephone jack JK1, which may be used for monitoring purposes.

AFC system

12. The three outputs from the secondaries of L1, L2 and L3 are also fed to the three limiters and discriminators V5, V9; V4, V10 and V3, VII. As all three circuits are identical, only one will be described.

13. The output from L1 is applied via C17 to the grid of V5. No standing bias is applied to the grid of this valve, therefore the signal causes grid current to flow. This charges up C17 negatively and so biases back the grid in proportion to the amplitude of the input signal. The HT supply for anode and screen is supplied via the potentiometer network R10 and R11. R22 is the screen

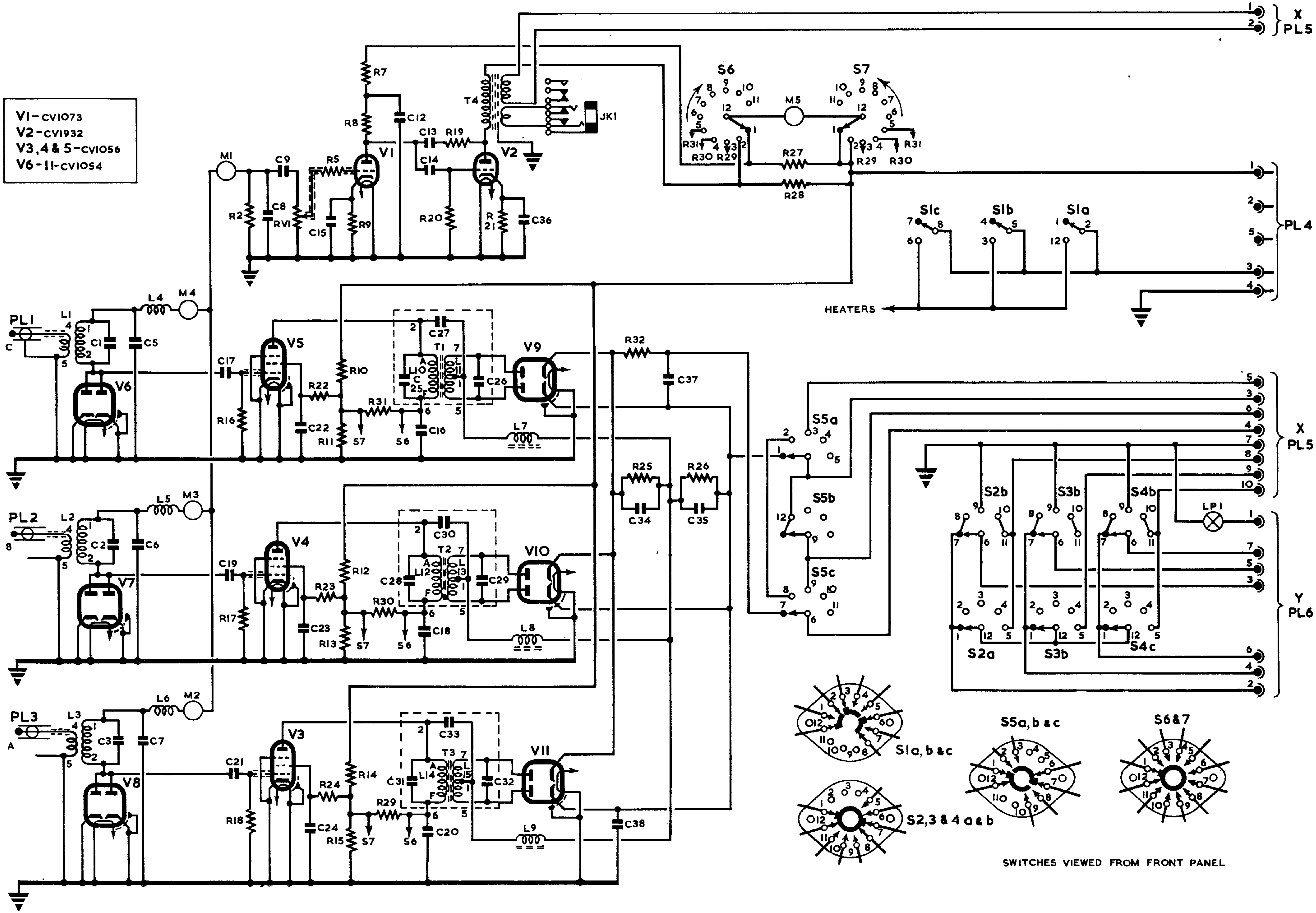

Fig. 2 Combining unit circuit Fig. 2

dropper, with C22 the screen decoupling capacitor. C16 is the anode decoupling capacitor. The anode voltage to V5 is very small and the valve is limited both by the small HT supply and by the bias which increases with increasing input. Hence the output from V5 is appreciably constant for wide variations in input voltage. The output is restored to a sinusoidal waveform by the tuned circuit L10 and C25.

14. The secondary of T1 feeds the anodes of V9, which is connected as a Foster-Seeley discriminator. When the IF is exactly 465 kc/s the voltage applied to the anodes of V9 are equal. This results in equal voltages at the cathodes and across R25 and R26, and the potential difference between the two cathodes is zero. When the frequency becomes higher than 465 kc/s the positive potential across R25 is less than that across R26. This results in the voltage at terminal 3 on terminal strip X being greater than that on terminal 4, and will make the AFC motor turn so as to increase the capacitance of the AFC capacitor, and so lower the frequency of the second oscillator. When the incoming frequency is less than 465 kc/s the positive potential across R25 is greater than that across R26. Terminal 4 becomes positive with respect to 3 and the AFC motor turns the AFC capacitor to decrease its capacitance, so increasing the frequency of the second oscillator.

15. All three discriminators share common loads R25 and R26, and thus the strongest signal voltage appears across these resistors.

16. LP1 is an alarm lamp which lights when the AFC has corrected for a frequency drift of ± 3 kc/s. When this occurs, the equipment should be retuned manually. When the AFC capacitor on the common oscillator has turned to correct for an error of ± 3 kc/s, a cam on the motor shaft operates a pair of contacts which completes the alarm circuit, causing it to operate the lamp on the combining unit.

17. The output from the discriminators is fed to the AFC switch S5a, b, c. This has three positions:—

(1) LOCAL *(used only for double side-band reception)* — The AFC from the combining unit is used to correct the frequency of the second oscillator.

(2) OFF — The AFC voltages are disconnected from the AFC output terminals 3 and 4, and these terminals are connected together.

(3) EXTERNAL *(used only for single side-band reception)* — The external AFC terminals 5 and 6 are connected to terminals 3 and 4 respectively. In this position the AFC voltage from the SSR2 rack controls the second oscillator (*Chap.* 5). Better control is obtained in this position.

18. S1a, b, c is the system switch, and has two positions:—

(1) DSB.

(2) SSB.

In the SSB position the heater supply to all valves in the combining unit is disconnected, as the combining unit is used only for the reception of normal double side-band signals.

19. S6 and S7 are the meter switches which connect the meter M5 across test resistors in the anode circuits of V1, V2, V3, V4 and V5 to check their anode currents.

20. The three ganged switches S2, S3 and S4 together form the AGC switch which has five positions providing the following facilities:—

(1) LOCAL COMBINED — Combines the AGC of all three receivers.

(2) LOCAL SEPARATE — Allows for separate AGC in each receiver.

(3) OFF — Connects the controlled AGC line for each receiver to earth.

(4) EXTERNAL SEPARATE — Allows the AGC line in each receiver to be fed from the appropriate AGC line in the SSR2 rack.

(5) EXTERNAL COMBINED — Combines the controlled AGC lines in the three receivers and allows for these to be fed from the SSR2 rack.

COMPONENT VALUES

Capacitors

21. Unless otherwise stated, the tolerance in value in the components listed here is plus or minus 10 per cent. The following abbreviations are used in the Remarks column—V means volts and follows the figure for the rated working voltage. If no voltage is stated, 350 must be assumed. E, MM, SM, T or P describe the construction (electrolytic, moulded mica, silvered mica, tubular, or paper respectively). All values are given in micro-microfarads.

Ref.	*Value*	*Remarks*
C1–C3	220	5 per cent SM
C5–C7	200	MM
C8	500	MM
C9	10 000	1 000V 25 per cent TP
C12	1 000 000	400V 20 per cent P
C13	100 000	20 per cent TP
C14	20 000	20 per cent 750V TP
C15	25 000 000	—20+50 per cent 25V TE
C16	100 000	20 per cent TP
C17	1 000	20 per cent MM
C18	100 000	20 per cent TP
C19	1 000	20 per cent MM
C20	100 000	20 per cent TP
C21	1 000	20 per cent MM
C22–24	100 000	20 per cent TP
C25	330	TP

Ref.	Value	Remarks
C26	150	MM
C27	470	20 per cent MM
C28	330	MM
C29	150	MM
C30	470	20 per cent MM
C31	330	MM
C32	150	MM
C33	470	20 per cent MM
C34–35	500	MM
C36	25 000 000	—20+50 per cent 25V TE
C37–C38	100 000	20 per cent TP

Resistors

22. The following values are given in ohms except where K, meaning thousands of ohms, or kilohms, follows the number given for the value. Unless otherwise stated in the Remarks column, the tolerance in each case is 20 per cent, the wattage rating is $\frac{1}{4}$ (0·25). The component is of carbon construction unless WW (wire-wound) appears under Remarks. W (alone) stands for watts after a number giving the rating.

Ref.	Value	Remarks
R2	100K	—
R5	100K	—
R7	22K	—
R8	100K	—
R9	1 000	—
R10	47K	2W 5 per cent WW
R11	10K	1W
R12	47K	2W 5 per cent WW
R15	10K	1W
R16–R19	220K	—
R20	470K	—
R21	1 000	—
R22–R24	4·7K	—
R25–R26	1 000K	—
R27–R31	1 000	—
R32	500K	—
RV1	500K	Variable

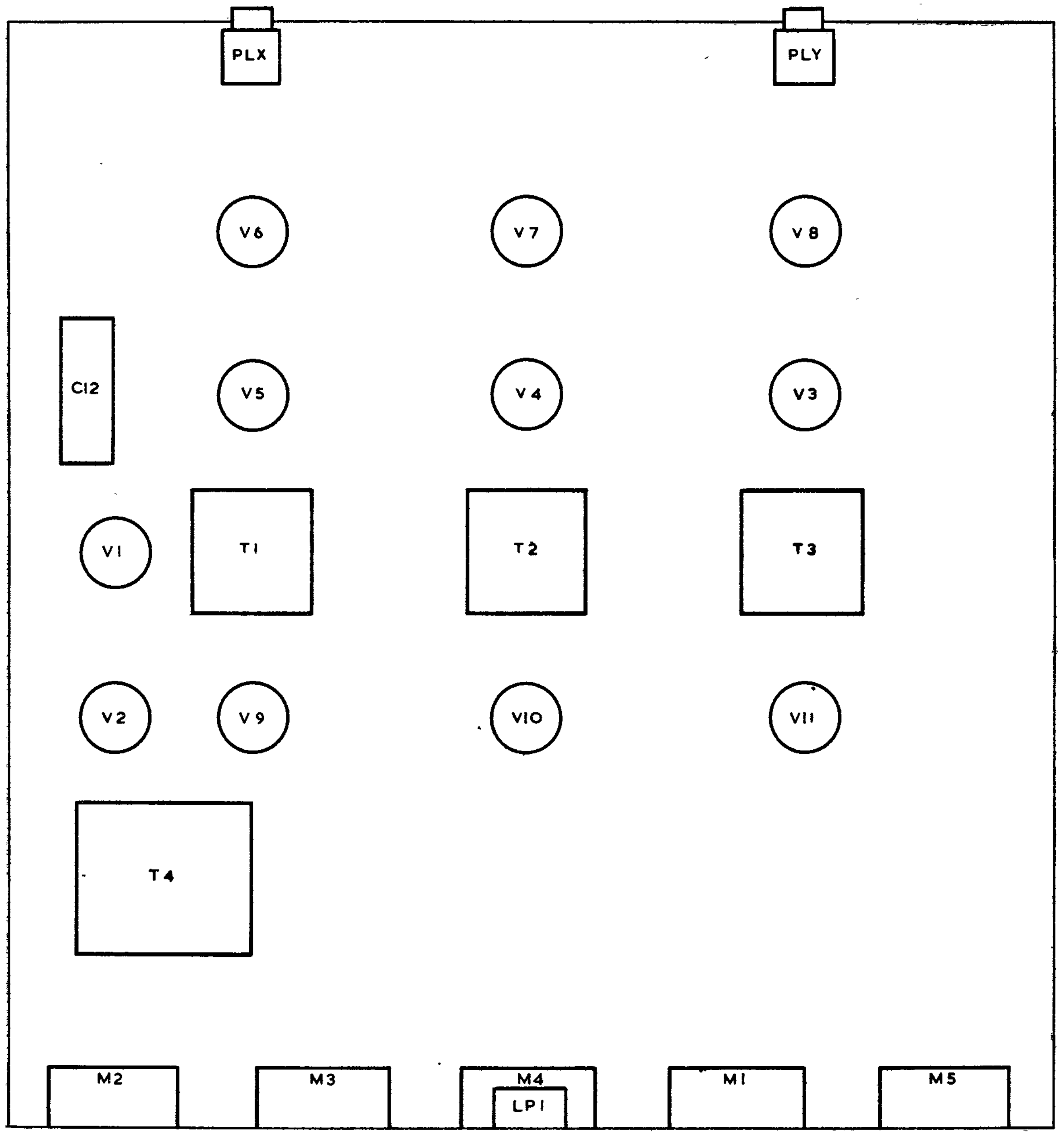

Fig. 3. Topside of Chassis

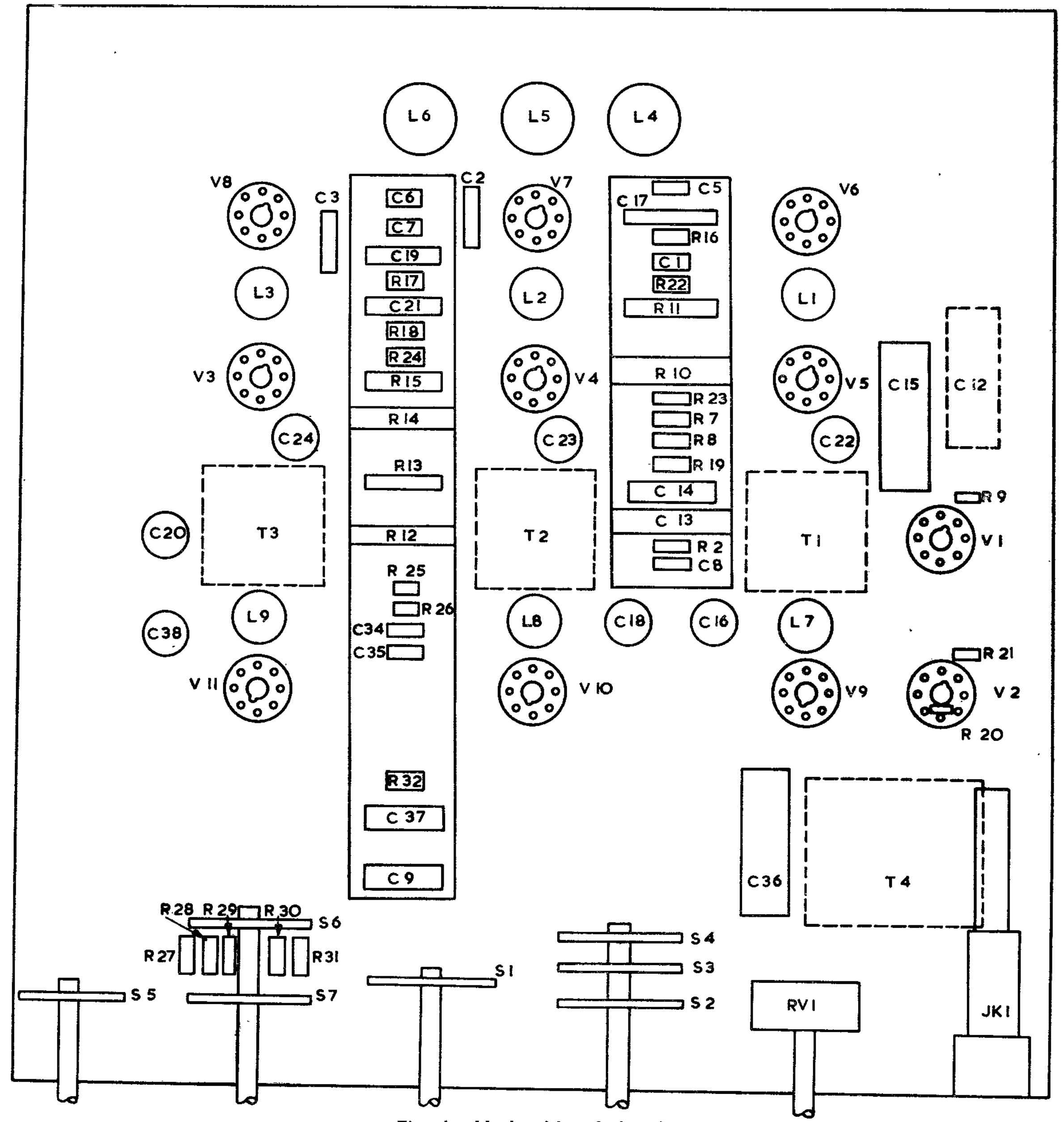

Fig. 4. Underside of chassis

Chapter 5

IF3 UNITS

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INTRODUCTION

1. The IF3A unit (*fig.* 1) forms part of the SSR2 rack. Three of these units are mounted one above the other on the rack, and are identical in construction and operation. One IF3 unit is used in each of the three paths. Only the IF3A unit will be described in this chapter, as the operation of the IF3B and C units is similar.

2. This unit amplifies the carrier, the upper and lower sidebands and demodulates the upper and lower sideband channels. The demodulated U.SB and L.SB channels are amplified and fed out to the path selector unit. AFC voltage is produced from the carrier and is fed out to the common oscillator unit on the CR150/20A rack. Automatic gain control is derived from the carrier channel and applied to the U.SB and L.SB channel amplifiers in the unit, and externally to the three receivers on the CR150/20A rack.

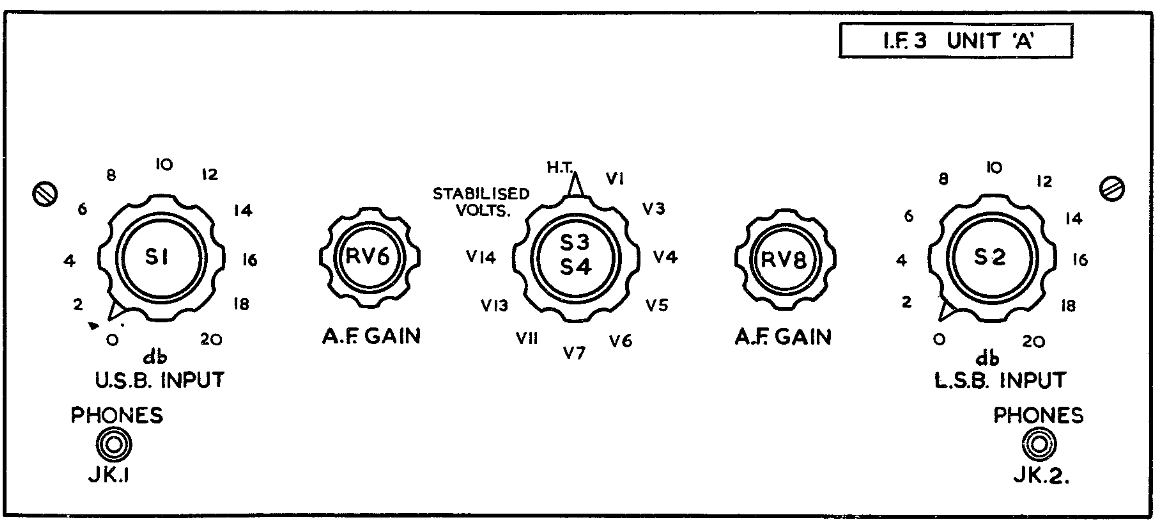

Fig. 1. IF3 unit A

3. The input signals and voltage fed to this unit are as follows:—

(1) Carrier frequency at 100 kc/s from the FC3 unit.

(2) Upper sideband frequency (103 kc/s) from the U.SB filter unit.

(3) Lower sideband frequency (97 kc/s) from the L.SB filter unit.

(4) Positive 240 volts from supply unit No. 2.

(5) 6·3V heater supply voltage from the supply unit No. 2.

4. The output signals and voltages fed out from the IF3 unit are as follows:—

(1) Upper sideband audio output fed to the path selector unit.

(2) Lower sideband audio output fed to the path selector unit.

(3) Automatic gain control voltage fed to the receivers on the CRD/150/20 rack.

(4) Automatic frequency control voltage fed to the common oscillator unit (CRD150/20 rack).

(5) Monitoring voltage fed to the Monitoring and Meter unit.

CONTROLS

5. The controls and their functions in this unit are as follows:—

Control	*Function*	*Circ. Ref.*
U.SB INPUT	A variable attenuator range 0–20 dB in 2 dB steps, connected between the U.SB input plug and the grid circuit of V1.	SW1
L.SB INPUT	A variable attenuator range 0–20 dB in 2 dB steps, connected between the input plug and the grid circuit of V11.	SW2
AF GAIN (LH side of the front panel)	A 100K variable potentiometer connected between the output from the demodulator valve V2 and the first AF amplifier valve V3 in the U.SB channel. This is a preset control mounted on the front panel.	RV6
AF GAIN (RH side of the front panel)	A 100K variable potentiometer connected between the output from the demodulator valve V12 and the first AF amplifier valve V3 in the L.SB channel. This is a preset control mounted on the front panel.	RV8
Monitoring switch	11-position switch mounted at the centre of the front panel. This switch selects the appropriate resistor in the feeds to the valve and connects the meter in monitor panel, so that the valve currents and HT voltage may be checked.	S3–54
PHONES (LH side of the front panel)	A jack-type socket connected in the output circuit of the AF output valve V4. Headphones connected to this socket will enable the U.SB channel audio output to be monitored.	JK1
PHONES (RH side of the front panel)	A jack-type socket connected in the output circuit of the AF output valve V14. This enables the L.SB channel audio output to be monitored.	JK2
CARRIER GAIN	A 10K preset potentiometer in the cathode circuit of the first carrier amplifier V5. This control enables adjustment of the carrier level. This preset control is mounted at the rear of the unit chassis.	RV1
U.SB GAIN	A 5K preset potentiometer in the cathode circuit of the U.SB amplifier valve V1. This enables the U.SB channel level to be adjusted. This preset control is mounted at the rear of the chassis.	RV3
L.SB GAIN	A 5K preset potentiometer in the cathode circuit of V11. This control provides for adjustment of the L.SB channel level and is mounted at the rear of the unit.	RV4
R57	A 5K preset potentiometer in the cathode return of V6, the second carrier amplifier. This control enables adjustment of the carrier level when the equipment is working on single channel. It is mounted on top of the chassis and is not accessible without withdrawing the IF3 unit from the rack.	RV2
SCH/DCH switch	A single-pole ON/OFF switch which when closed (set to DCH) short-circuits RV2 in the cathode circuit of V6 for double channel working. The switch is left open (SCH) for single channel working.	S5
U.SB DEMODULATOR BALANCE	A 50K preset potentiometer in the balanced demodulator circuit and is used to balance the demodulator V2 in the upper sideband channel. This control is mounted on the chassis and is not accessible without withdrawing this unit from the rack.	RV5
L.SB DEMODULATOR BALANCE	A 50K preset potentiometer in the balanced demodulator circuit. This control is used to balance the demodulator V12 in the lower sideband channel, and is mounted on top of the chassis.	RV7

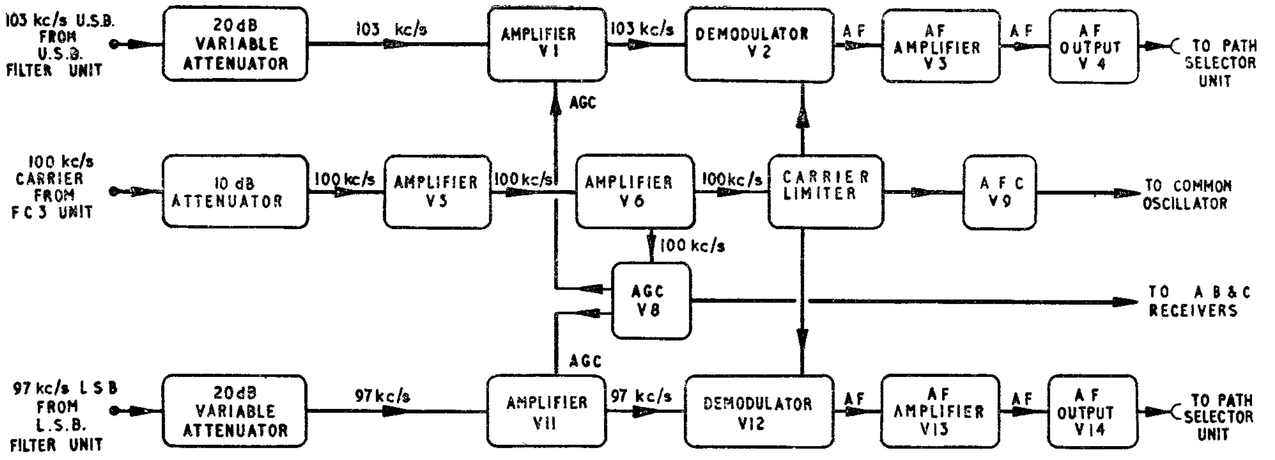

Fig. 2. Block diagram—IF3 unit

CIRCUIT OPERATION

6. A block diagram of this unit is given in fig. 2. The upper sideband signal is fed via a variable attenuator to the U.SB amplifier V1 and then to the U.SB demodulator V2. The lower sideband signal is fed via a variable attenuator to the L.SB amplifier V11 and then to the L.SB demodulator V12. The carrier signal is fed via a fixed attenuator to the first carrier amplifier V5 and then to the second carrier amplifier V6. The carrier output from V6 is passed through the carrier limiter V7 and then to both the upper and lower sideband demodulators V2 and V4.

7. The demodulated U.SB signal from the demodulator V2 is amplified by the AF amplifier V3 and is then fed via the output valve V4 to the output terminals 3 and 4.

8. The demodulated L.SB signal from the demodulator V2 is amplified by the AF amplifier V13. The audio signal is fed via the output stage V14 to the output terminals 9 and 10.

9. The output from the carrier limiter stage V7 is fed into a discriminator stage, which produces a control voltage proportional to the carrier frequency deviation. This control voltage is fed to the common oscillator unit via terminals 6, 7 and 8.

10. An output from the second carrier amplifier stage V6 is fed to a double-diode AGC circuit which produces a negative AGC voltage. This AGC is applied to both the U.SB and L.SB amplifiers in this unit, and externally, via terminal 5, to the three receivers on the CRD150/20A rack.

Upper sideband channel

Input attenuator

11. The upper sideband signal is fed into a 20 dB variable unbalanced attenuator. This attenuator consists of resistors R1 to R22 and 11-position switch SW1 (U.SB INPUT). The resistors are arranged as a ladder-type attenuator, each section attenuating the input by 2 dB.

U.SB amplifier V1

12. The attenuated U.SB signal is fed into an IF transformer IFT1. The secondary winding of IFT1 is tuned by capacitor C2. The signal appearing at the secondary of IFT1 is applied to the grid of V1, the U.SB amplifier stage. V1 is a pentode valve with IF transformer IFT3 connected in its anode circuit. The amplified signal developed in the anode circuit is applied, via the secondary winding of IFT3, to the balanced demodulator V2. The primary of IFT1 is overcoupled to its secondary winding to give a wider frequency response. Resistor R23 provides correct loading to match the input to the impedance of the attenuator.

13. Automatic gain control is applied via the secondary winding of IFT1 to the grid of V1; the AGC is developed by V8. Cathode bias is provided by resistor R27 and potentiometer RV3 (U.SB GAIN). The gain of this stage is controlled by RV3, which is a preset control mounted at the rear of the chassis.

14. The primary of IFT3 forms the anode load for V1 and is shunted by R26 to flatten the response curve.

Balanced demodulator

15. The demodulator circuit consists of the secondary winding of IFT3, diode sections A and B of the double-diode valve V2 and the network consisting of capacitors C10, C11, C12 and resistors R30, R31 and RV5 (U.SB DEMOD. BALANCE). The carrier signal is fed from V7 via inductor L1 to the centre-tap on the secondary winding of IFT3.

16. The carrier voltage from V7 is approximately ten times greater in amplitude than the U.SB signal developed in the secondary winding. In the absence of a U.SB signal the carrier voltage is applied to the anode of V2a (*fig.* 9) and the cathode of V26. When the carrier goes positive, V2a will conduct and cause C11 to charge and develop a positive voltage at point A (*fig.* 9). The negative half-cycles of the carrier signal will cause V2b to conduct and C12 will charge and cause point B (*fig.* 9) to be at a negative potential which is numerically equal to that at point A. The potential between A and B will thus be twice the potential across C11, and will be earthed at its centre-point. Resistors R30, R31 and RV5 (U.SB DEMOD. BALANCE) form a centre-pointing network and RV5 is adjusted to give a zero voltage, so that this point is virtually at earth potential. When this circuit is balanced there will be no voltage across RV6.

17. When the U.SB signal is applied via V1 it will appear in the secondary winding of IFT3. The U.SB signal will be applied to diodes V2b and V2a, but there will be 180 degrees phase difference. If the voltage applied to the anode of V2a is in phase with the carrier, they will add, and the voltage applied to the cathode of diode V2b will be the difference of the carrier and sideband voltages.

18. As the combined carrier and sideband signals are applied to the anode of V2a the diode will conduct on the positive half-cycles and the positive envelope (modulation) will appear in the resistor network (R30, R31 and RV3). V2b will only conduct on the negative half-cycles so that V2b will pass the negative envelope of the combined carrier and sideband signals into the network. The voltage difference between the positive modulation envelope and the negative modulation envelope passed by diodes V2a and V2b respectively will cause a current flow around the network and a voltage corresponding to the modulation will appear at the centre-point of RV5; the amplitude of this voltage is dependent on the peak value of the sideband voltage. The voltages appearing at the centre-point of RV5 will be:—

(a) A band of frequencies from 0–6 kc/s.

(b) A band of frequencies from 200–206 kc/s.

19. The desired modulation (audio) frequency appears across RV7. The rejector circuit (C13 and L3) is tuned to 100 kc/s and prevents any of the carrier frequency from appearing across RV7. C59 bypasses the 200 kc/s to earth.

20. Provision is made for monitoring the demodulated current by means of a switch-socket SK1 mounted at the rear of the IF3 unit. This switch is connected via screened leads to the resistor network in the demodulator circuit. Capacitor C10 bypasses any RF from the meter, which is connected via the SK1 socket. Plugging a meter into SK1 breaks the circuit and inserts the meter in series with the resistor network (R30, R31 and RV5). When the meter is removed, the terminals are short-circuited to complete the circuit.

AF amplifier

21. The demodulated signal appearing across RV6 (AF GAIN) is applied to the grid of V3, the AF amplifier. The amplified signal appears across the anode load R35. Negative feedback is applied to this stage by omitting the cathode bypass capacitor, thus applying current feedback; voltage feedback is applied from the anode of the following stage via R110 to the cathode of V3. The amplified signal developed at V3 anode is fed via C15 to the grid of V4.

Output stage

22. The triode valve V4 forms the output stage; the anode load is the primary winding of T5, the output transformer. The secondary is formed by two separate windings. The first winding has a turns ratio of 5:1 and applies the output signal via terminals 3 and 4 into the 600-ohm input impedance of the path selector unit. The second winding has a turns ratio of 70:1; the signal is applied via this winding to the jack socket JK1 (PHONES). Headphones may be connected via JK1 when monitoring the signal.

Lower sideband channel

23. The lower sideband signal is treated in a similar manner to the upper sideband signal. The L.SB signal is fed via an attenuator (identical to the U.SB attenuator) and then to valve stages V11, the U.SB demodulator V12, the AF stage V13 and the output stage V14.

Carrier channel

1st carrier amplifier V5

24. The 100 kc/s carrier signal is fed in this unit via the Pye plug to the grid of V5 (the first carrier amplifier). Resistor R107 is used to terminate the coaxial cable. V5 is a pentode valve operating in a tuned RF amplifying circuit. A tuned circuit consisting of L10 and C21 forms the anode load of V5, and is tuned to 100 kc/s. Cathode bias is provided by resistors R53 and RV1 (CARRIER GAIN). The cathode is bypassed by C23.

2nd carrier amplifier V6

25. V6 is a pentode valve operating in a tuned RF amplifying circuit. The voltage developed at the anode of V5 is applied via C22 to the grid of V6. The anode load of V6 is the tuned circuit consisting of L11 and C2, which is tuned to 100 kc/s. Bias on V6 is provided by resistors R56 and RV2 in the cathode circuit. A single-pole switch S5 (SCH/DCH) is connected across RV2. RV2 is used to adjust the gain of V6 when single channel (SCH) working is used. The switch S5 short-circuits RV2 in the DCH position to increase the gain of the stage when double channel working is used. This is necessary because the carrier level is 26 dB down relative to the sidebands when double channel working is used as compared to a carrier level of only 16 dB down (on the sidebands) when single channel (SCH) is used. Hence this stage is required to operate at a higher gain on double channel working. The amplified signal developed at the anode of V6 is applied via C27 to the grid of V7, the limiter valve, and also via C31 to the anodes of the AGC valve V8.

Carrier limiter V7

26. V7 is a pentode valve operating as a limiter stage. The signal applied to the grid is approximately halved by the capacitors C27 and C28 (47pF). The limiting action of this valve is provided by grid current, as the cathode is connected directly to earth, thus providing no cathode bias. When the signal is applied to the grid it will cause grid current to flow. This charges C28 which then applies a negative bias to the grid proportional to the amplitude of the applied signal. The anode load is formed by the tuned primary circuit of IFT7 (C35 and L12). Distortion of the

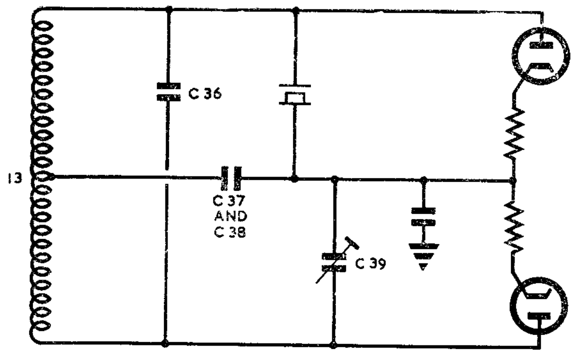

Fig. 3. Simplified discriminator circuit

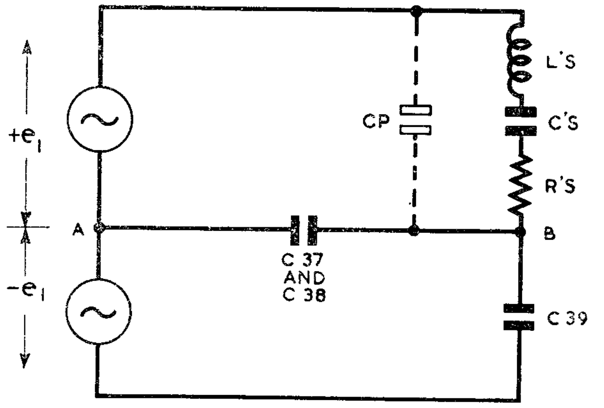

Fig. 4. Equivalent input circuit (discriminator)

signal by the limiting action of V7 is corrected by the action of the tuned anode load. The limited carrier signal at the anode is applied via C9 to the U.SB demodulator stage V2, and via C49 to the L.SB demodulator stage V12. The output from V7 is also applied to the AFC discriminator stage V9 via transformer coupling in IFT7.

Automatic gain control V8

27. V8 is a double-diode valve used to develop a negative voltage for controlling the gain of the U.SB and L.SB amplifier stages, V1 and V11. The diodes comprising V8 are connected in parallel (anodes and cathodes strapped). The 100 kc/s carrier signal developed at the anode of V6 (the second carrier amplifier) is applied to the anodes of V8 via a potential dividing network consisting of capacitors C31 and C32 (22pF). Only half the amplitude of signal developed at V6 anode is applied to V8. The cathodes of the AGC diode are connected to a potential divider network R61 and R62, connected between HT+ and earth; the positive voltage on the cathodes provides a delay of approximately 10V in the AGC system. When the carrier signal on the diode anodes exceeds 10 volts the diodes will conduct on the positive half-cycles and a negative voltage is developed across R64, R65 and C33. The full AGC voltage developed across R64 and R65 is fed externally via terminal 5 to the receivers. One-third of the full AGC voltage (that developed across R65) is fed internally to V1 and V11.

AFC discriminator V9

28. A double-diode valve V9 is arranged in a balanced circuit with a crystal to form a phase discriminator to convert any frequency drift of the carrier frequency into a positive/negative DC control voltage. This control voltage is applied via terminals 5, 6 and 7 externally to the common oscillator unit, where it is applied to a motor-driven capacitor which automatically corrects the local oscillator frequency.

29. The discriminator circuit employs the relative phase change of the current/voltage necessary to give the out of balance conditions off resonance. The discriminator circuit (*fig.* 9) may be simplified into the form shown in fig. 3; the secondary winding L13 of IFT7 is tuned to 100 kc/s, L5 is omitted, and C37 and C38 are combined to form the series element common to each half of the circuit.

30. The equivalent input circuit is shown in fig. 4, where the voltages induced in L13 are represented by two generators giving voltages of of e_1 and $-e_1$. The crystal is represented by its equivalent circuit consisting of L's, C's and R's with Cp as the equivalent parallel capacitance. The parallel *i* capacitance Cp is balanced out by C39, which is variable. The crystal resonates at 99·925 kc/s, but as it is effectively in series with C37 and C38 the capacitance is sufficient to increase its series resonant frequency to 100 kc/s. The crystal frequency is compared with the incoming frequency to give the out-of-balance control voltages.

31. Fig. 5 shows the equivalent circuit of the discriminator. The voltage developed across C37 and C38 depends on the current *i* flowing through it and equivalent crystal circuit (L's, C's and R's). When the applied voltages (e_1 and $-e_1$) are at 100 kc/s the circuit will be at its resonant frequency and the current *i* will be at its maximum; the voltage e_2 will be greater than e_1. When the applied voltage e_1 is at frequencies above or below that of the crystal (100 kc/s) the current *i* will be less in amplitude than it was in the resonant condition, and will have a phase lag or lead on e_1. These conditions are represented by the current vectors shown in fig. 6.

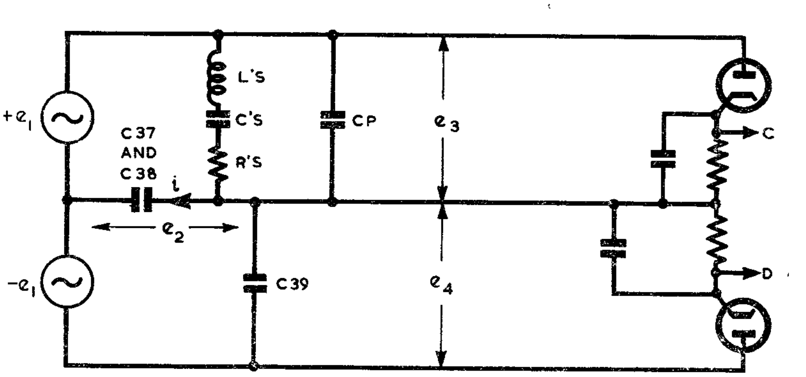

Fig. 5. Explanatory diagram of discriminator

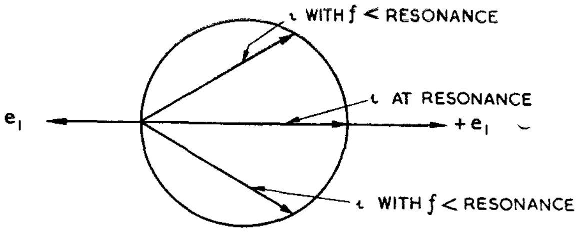

Fig. 6. Discriminator current vectors

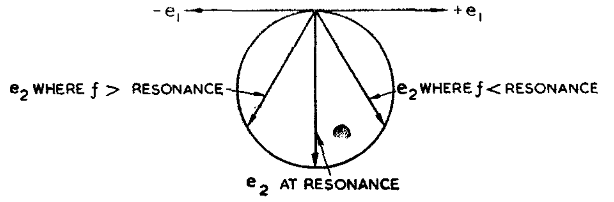

Fig. 7. Discriminator voltage vectors

32. The voltage vectors for resonance, above resonance, and below resonance are shown in fig. 7.

33. The voltages appearing across the diodes are represented by e_3 and e_4 in fig. 8. e_3 will be the vector sum of the input voltage e_1 and the voltage across C37 and $C38_1$ (e_2). e_4 will be the vector sum of the input voltage $-e_1$ and e_2. Referring to fig. 8A it will be seen that at resonance the amplitude of e_3 is equal to that of e_4, and as these voltages are applied to the diodes in opposition the resultant control voltage between points C and D (*fig.* 5) is zero. Hence when the carrier frequency is the same as the crystal frequency (100 kc/s) there will be no control voltage applied via terminals 6 and 8 to the AFC circuit in the common oscillator unit.

34. Fig 8B shows the relative amplitudes and phase of e_3 and e_4 when the carrier frequency is below 100 kc/s. The vector summation of e_1 and e_2 is shown on the left-hand side of fig. 8B, and is e_3. The addition of voltages $-e_1$ and e_2, shown on the right-hand side of fig. 8B, is equal to e_4. The amplitude of e_4 is greater than e_3, and when applied to the diodes will cause point D to become positive to point C.

35. When the carrier frequency is above 100 kc/s the voltage vectors corresponding to e_3 and e_4 are shown in fig. 8C. The amplitude of e_3 is greater than that of e_4, this will cause point C (*fig.* 5) to become positive with respect to point D.

36. These out-of-balance voltages are fed via terminals 6, 7 and 8 to the common oscillator unit, which will cause the AFC motor to correct the local oscillator frequency and cause points C and D in the discriminator circuit to be at the same potential.

Stabilizer and supply voltages

37. A stabilized voltage regulator V10 has the 240-volt DC applied via R67 to one of its anodes, the other anode is connected to earth. The 140-volt stabilized supply is taken from the anode of V10 and supplies the screened grids of valves V1, V5, V6 and V11. The 70-volt stabilizer is taken from the electrode of V10 (pin 5) and fed to the screened grid of V7 and also the potential divider consisting of R61 and R62, which supplies the delay voltage to the AGC circuit.

38. The anode supply voltages are provided by the 240-volt DC unstabilized supply from the supply unit which is fed in via pin 1. The 6·3-volt alternating heater supply voltage to all valves is provided by the supply unit, and is fed into this unit via pin 3. The heater circuit is completed by an earth return (one heater pin on each valve is earthed).

Monitoring

39. A metering resistor (of low value) is connected in series with the supply to the anode

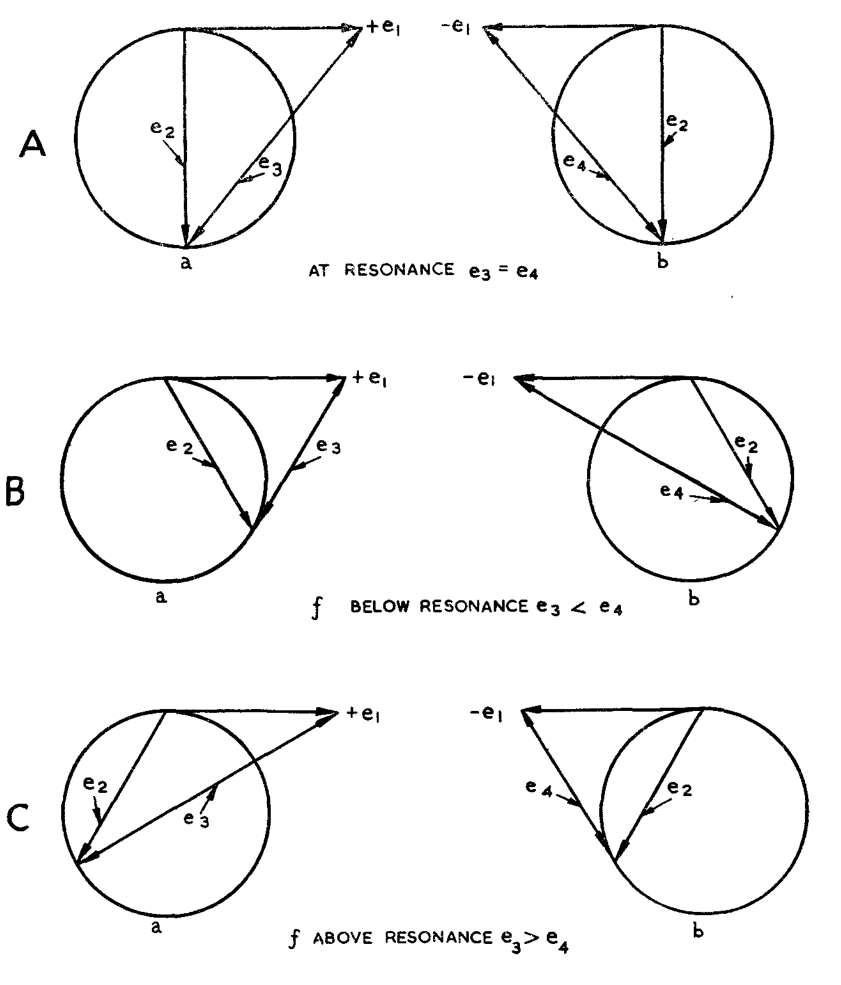

Fig. 8. Discriminator vectors for balanced and unbalanced conditions

(*fig.* 9) of each valve in this unit (with the exception of the diodes). The metering resistors form shunts, which are connected individually across the meter in the monitor and metering unit by means of the monitoring switch (S3 and S4). The positions of the monitoring switch and its function are as follows:—

Switch position	*Switch marking*	*Action*
1	v1 (fully counter-clockwise)	V1 valve current
2	v3	V3 valve current
3	v4	V4 valve current
4	v5	V5 valve current
5	v6	V6 valve current
6	v7	V7 valve current
7	v11	V11 valve current
8	v13	V13 valve current
9	v14	V14 valve current
10	STABILIZED VOLTS	140V positive stabilized voltage,
11	HT	240V positive supply voltage

40. When the monitoring switch is in positions 10 and 11 the meter (monitor and metering unit) operates as a voltmeter and is connected in series with a multiplier resistor R40 (position 10), and resistor R39 (position 11) for measuring the 140 volt stabilized and the 240 volt unstabilized DC supplies respectively.

41. Two test points (switch sockets SK1 and SK2) are provided so that the demodulator currents in the upper and lower sideband amplifiers respectively may be measured. These sockets are mounted at the rear of the unit.

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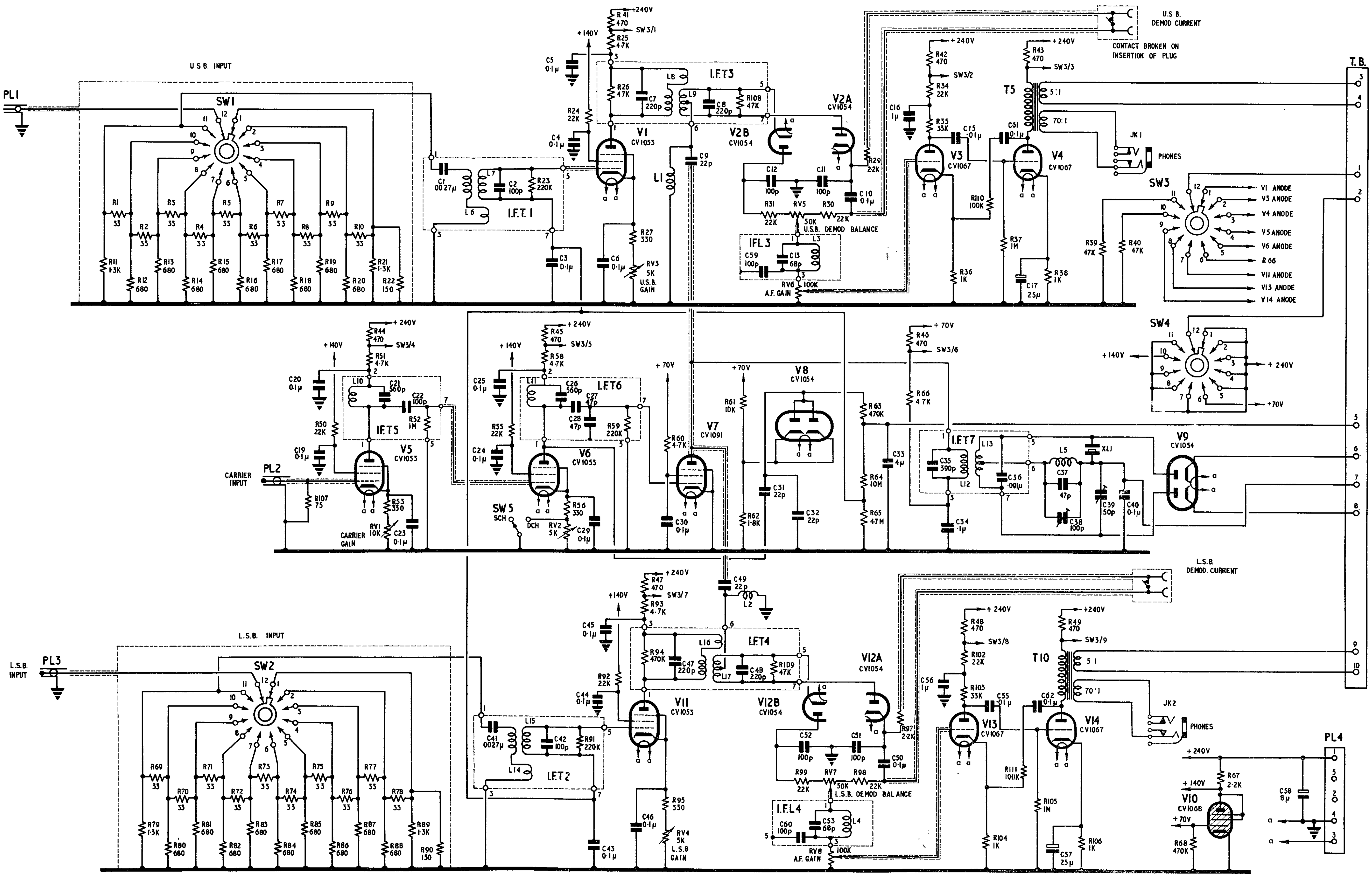

Fig. 9 I.F.3 unit - circuit (A.L.10.Nov.54) Fig. 9

Chapter 6

FC3 PANEL AND FILTER UNITS

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LIST OF ILLUSTRATIONS

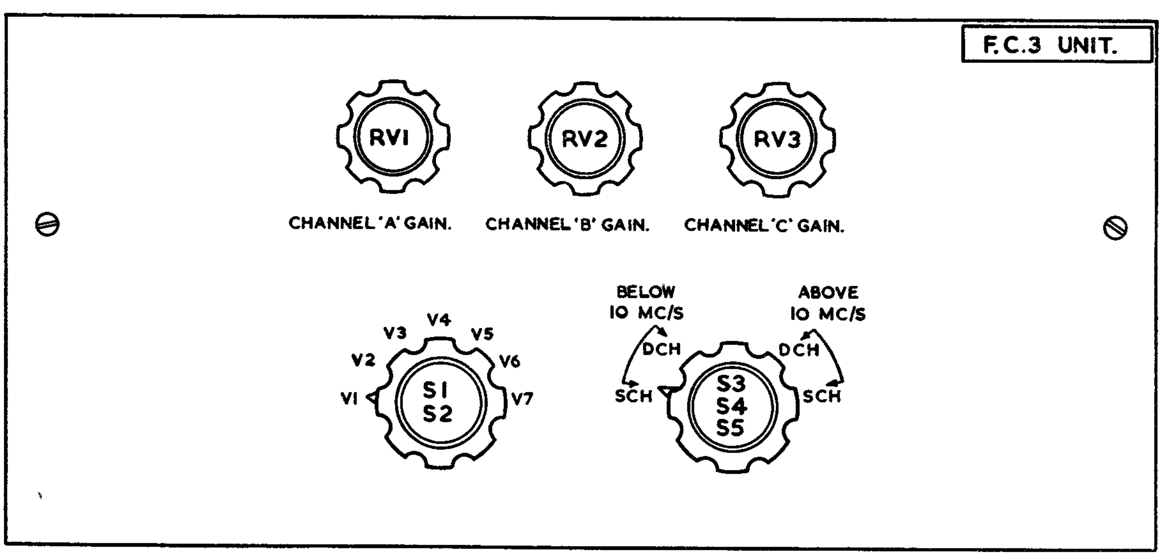

Fig. 1. FC3 panel

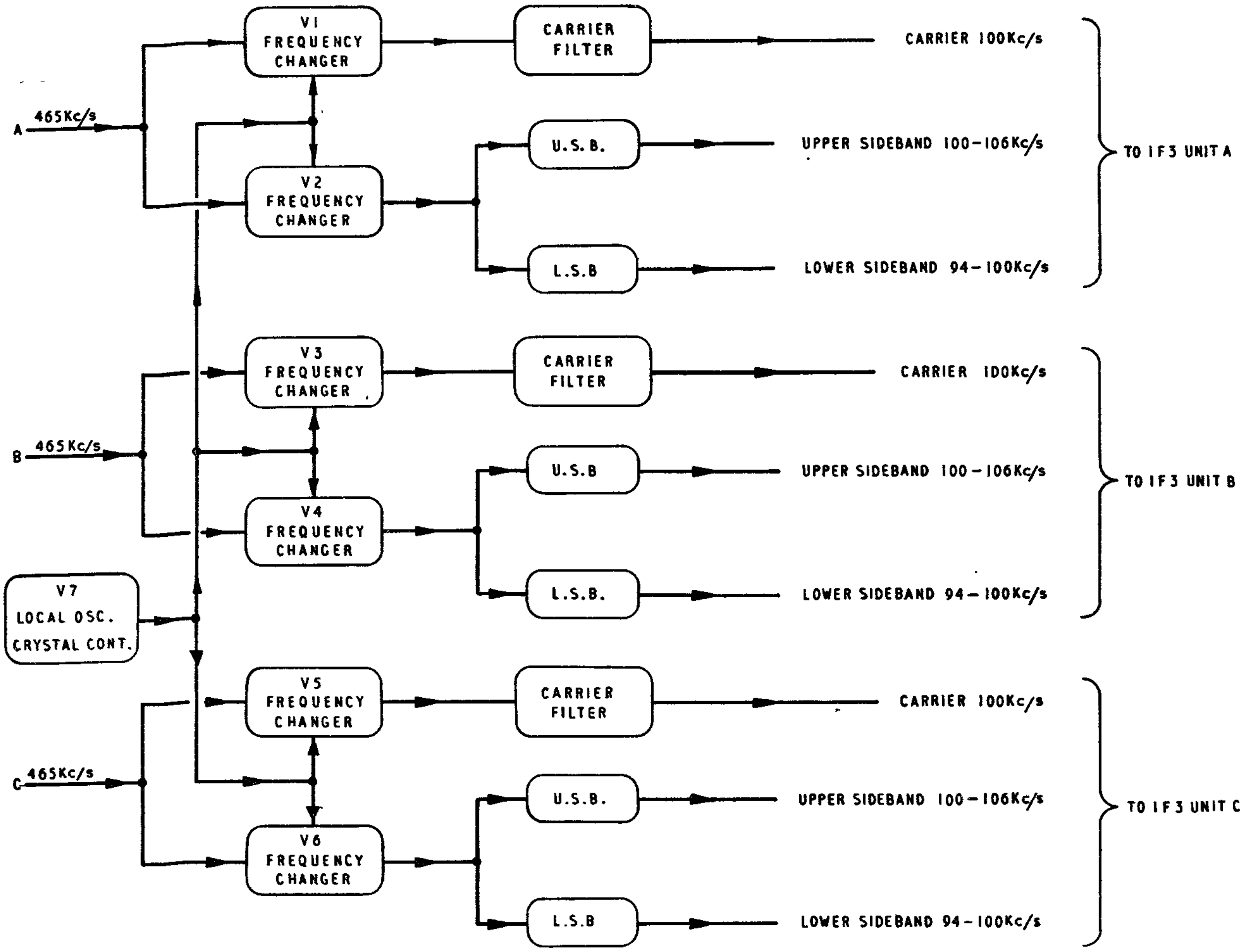

Fig. 2. FC3 unit-block diagram

FC3 PANEL

INTRODUCTION

1. The FC3 panel unit (*fig.* 1) changes the 465kc/s outputs (paths A, B and C) from the A, B and C receivers to 100kc/s and provides a carrier and upper and lower sideband outputs for each of the three paths.

2. Six separate frequency changer valve stages are employed and one local oscillator stage which is crystal-controlled and is common to the six frequency changers.

3. The input signals and supply voltages fed into this unit are as follows:—

(1) 465kc/s signal from Receiver A in the CRD 150/20A rack fed in via Pye plug PL1.

(2) 465kc/s signal from Receiver B (CRD150/20A rack) fed in via Pye plug PL2.

(3) 465kc/s signal from Receiver C (CRD150/20A rack) fed in via Pye plug PL3.

(4) 250-volt positive supply from Supply unit No. 1 on the SSR2 rack, fed in via pin 1 of plug PL13.

(5) 6·3-volt alternating supply from Supply unit No. 1 (SSR2 rack), fed in via pin 3 of PL13.

(6) Earth connection to Supply unit No. 1 via pin 4 of plug PL13.

(7) AFC voltage from the 3 IF 3 units fed in via terminals 3, 4 and 5 on tagboard X.

(8) Earth connection from distribution unit fed in via terminal 10 on tagboard X.

4. The output signals and voltages from this unit are as follows:—

(1) The 100kc/s A path carrier frequency fed out to the IF3 unit A, via Pye plug PL4.

(2) The 100kc/s B path carrier frequency fed out to the IF3 unit B, via Pye plug PL5.

(3) The 100kc/s C path carrier frequency fed out to the IF3 unit C, via Pye plug PL6.

(4) The 100–106kc/s A path upper sideband frequency fed out to the U.S.B. filter panel via Pye plug PL7.

(5) The 100–106kc/s B path upper sideband frequency fed out to the U.S.B. filter panel via Pye plug PL9.

(6) The 100–106kc/s C path upper sideband frequency fed out to the U.S.B. filter panel via Pye plug PL11.

(7) The 94–100kc/s A path lower sideband frequency fed out to the L.S.B. filter unit via Pye plug PL8.

(8) The 94–100 kc/s B path lower sideband frequency fed out to the L.S.B. filter unit via Pye plug PL10.

(9) The 94–100 kc/s C path lower sideband frequency fed out to the L.S.B. filter unit via Pye plug PL12.

(10) The monitoring voltages fed out to the Monitor and Metering unit via terminals 1 and 2 on tagboard X.

(11) The AFC voltage fed out to the distribution unit (at the base of the SSR2 rack) via terminals 6 and 7 on tagboard X.

CONTROLS

5. The controls on this unit and their function and circuit reference are as follows:—

Control	*Function*	*Circuit Ref.*
PATH A GAIN	Controls the gain of frequency changers V1 and V2	RV1
PATH B GAIN	Controls the gain of frequency changers V3 and V4	RV2
PATH C GAIN	Controls the gain of frequency changers V5 and V6	RV3
Monitoring switch	Selects the anode currents of valves in this unit to be checked	S1, S2
3rd oscillator control	Selects any one of the four crystal-controlled frequencies. Also reverses the polarity of the AFC voltage which is fed into this unit from the 3 IF3 units and then fed out to the distribution unit	S3, S4 and S5

CIRCUIT OPERATION

Brief description

6. A block diagram of the FC3 unit is given in fig. 2. The circuit is divided into three separate channels, the carrier, the upper sideband, and the lower sideband. Each path consists of two frequency changer stages, one for converting the carrier from 465 kc/s to 100 kc/s, and one for changing the 465 kc/s input into upper and lower sideband frequencies of 100–106 kc/s and 94–100 kc/s. A common local oscillator is used for both frequency changers in all three paths. This oscillator is crystal-controlled and has four spot frequencies, selected by the third oscillator switch on the front panel.

Detailed description

Path A

7. The 465 kc/s input from receiver A on the CRD 150/20A rack is fed in via Pye plug PL4 to the primary winding of transformer T1 (*fig.* 8). The signal developed across the tuned secondary is fed to the grids of V1 (the carrier frequency changer) and V2 (the sidebands frequency changer). The tuned secondary winding is damped by the action of R1.

8. V1 is a triode-hexode valve operating as a frequency changer. The triode-section is not used as an oscillator and the triode-anode is strapped to cathode. The local oscillator frequency, applied to the triode-section grid, is provided by V7, the crystal-controlled oscillator valve. Cathode-bias for V1 is developed across resistors R4 and RV1 (CHANNEL A GAIN). RV1 is a potentiometer which is in the cathode return path of both V1 and V2 and is used to control the gain of V1 (carrier frequency changer) and V2 (the sidebands frequency changer). The cathode of V1 is decoupled by C4. Self-bias on the triode-section is provided by the action of R12 and C11.

9. A carrier filter is the anode load of V1 which is tuned to 100 kc/s and has a bandwidth indicated by the carrier filter response characteristic given in fig. 3. The difference frequency appearing at the output of the carrier filter will be 100 kc/s ± 100 c/s which is fed via Pye plug PL4 to the carrier amplifier in the IF3 "A" unit.

10. V2 is a triode-hexode valve operating in the sidebands (U.S.B. and L.S.B.) frequency changer stage. The triode-section is not used and the triode

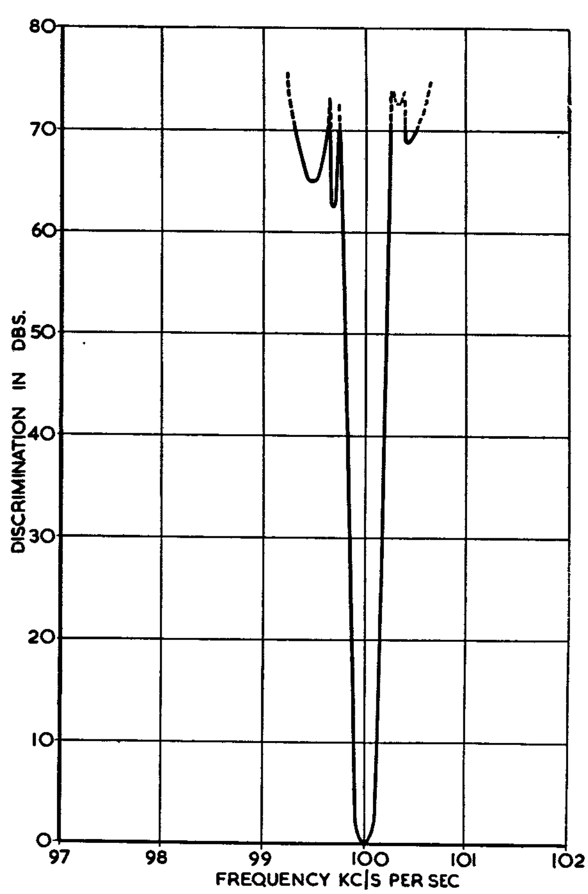

Fig. 3. Carrier filter response

anode is connected to cathode. The oscillator voltage generated by V7 is fed into the triode-section grid. Self-bias on the triode-section is provided by the action of R12 and C11. Bias for the hexode-section is provided by R10 and RV1 (CHANNEL A GAIN); the cathode is decoupled by C10.

11. The 465kc/s input signal applied to the hexode grid is taken from the secondary winding of transformer T1. The anode load is formed by two tuned circuits consisting of the primary winding of transformer T2 tuned by C6, connected in series with the primary winding of T3 tuned by C7. Transformer T2 is tuned to 103kc/s (the upper sideband) so that the upper sideband signal of 103kc/s is induced in the secondary winding of T2 and is fed via Pye plug PL7 to the upper sideband filter panel. Transformer T3 is tuned to 97kc/s (the lower sideband) so that the lower sideband signal is induced in the secondary winding of T3, and is fed via PL8 to the lower sideband filter panel.

Path B

12. The B path carrier frequency changer is V3, and the sidebands frequency changed is V4. The operation of these stages is identical with that of V1 and V2 described in the preceding paragraphs. RV2 is in the cathode return of both valves V3 and V4, and is the CHANNEL B GAIN control.

Path C

13. V5 and V6 are the carrier and sidebands frequency changers respectively for path C. The operation of these stages is identical to that of V1 and V2 in path A. CHANNEL C GAIN control is RV3 and is common to the cathodes of V5 and V6.

Carrier filters

14. The three carrier filters in the anode circuits of V1, V3 and V5 are identical in construction and operation. Each filter consists of three sections connected in tandem; each section contains two quartz crystals. The input transformer is built into the filter unit. The filter output impedance is 75 ohms and is unbalanced. The transformer and all components of the filter are contained in a hermetically sealed case. The response characteristic of the filters is given in fig. 3.

Local (third) oscillator V7

15. V7 is a pentode valve operating as a crystal-controlled oscillator. The anode to grid coupling is provided by one of the four crystals XL1, XL2, XL3 and XL4. Any one of the four crystals may be selected by the third oscillator switch section S3. Cathode bias is provided by resistor R50 which is decoupled by C53. The voltage on the grid is limited on the positive half-cycles by the flow of grid current, and by the crystal rectifier MR1 on the negative half-cycles. This limiting action of the grid circuit tends to give a constant amplitude output signal which is fed to the six frequency changer valves in this unit.

16. The four fundamental frequencies at which V7 operates, and the corresponding switch (third oscillator) settings are:—

Frequency	*Switch setting*
362kc/s	S.CH BELOW 10Mc/s
365kc/s	D.CH BELOW 10Mc/s
565kc/s	D.CH ABOVE 10Mc/s
568kc/s	S.CH ABOVE 10Mc/s

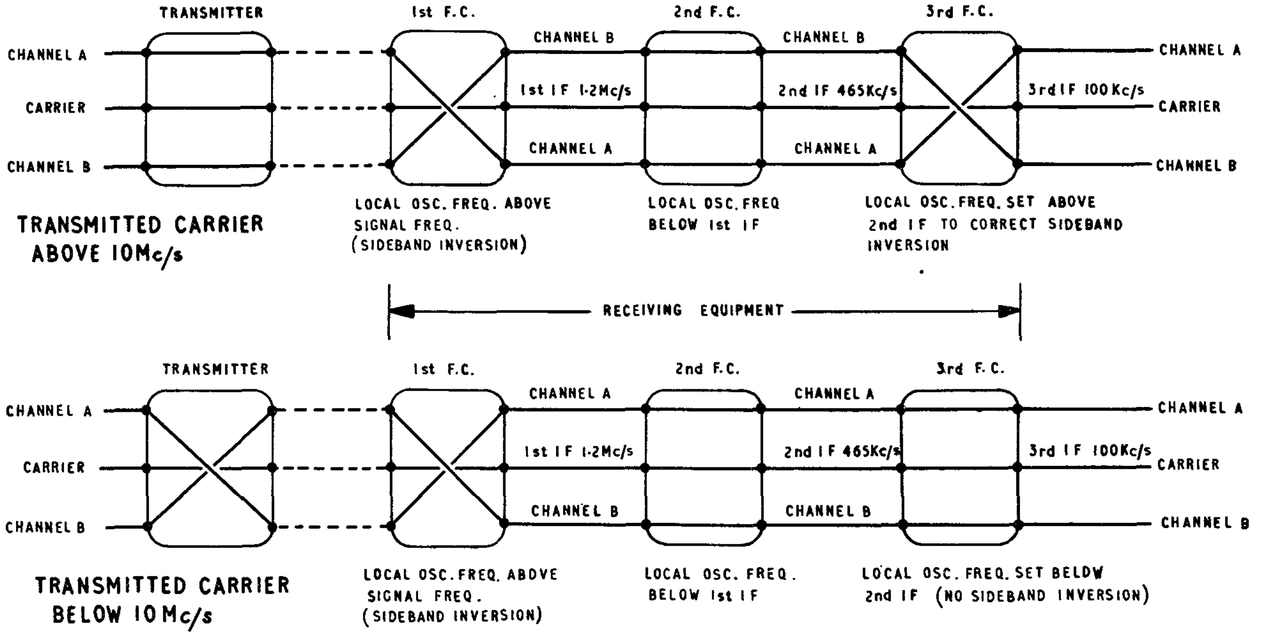

Fig. 4. Sideband Inversion

17. By convention, in single sideband systems, Channel A is transmitted as the upper sideband when the carrier frequency is above 10 Mc/s; when the carrier frequency is below 10 Mc/s Channel A is transmitted in the lower sideband. Some arrangement is necessary in the S.S.B. receiving equipment to invert the sidebands when the carrier frequency received is below 10 Mc/s.

18. In this equipment sideband inversion takes place in the first frequency changer because its local oscillator frequency is above that of the received signal (*fig.* 4). No inversion takes place at the second oscillator, as its local oscillator frequency is below that of the 1st IF. It will be necessary to cause sideband inversion (*fig.* 4) in the third frequency changer; this is achieved by making the local oscillator frequency above the 2nd IF of 465. In this condition (when a carrier frequency of over 10 Mc/s is being received) the 3RD OSC switch is set to either of the S.CH. or D.CH. ABOVE 10 Mc/s positions. This connects either the 568 kc/s or the 565 kc/s between the anode and grid of V7.

19. When the carrier frequency of the received signal is below 10 Mc/s, by convention Channel A will be transmitted in the lower sideband (*fig.* 4). Sideband inversion takes place at the 1st frequency changer; no further inversion is necessary as it has now been restored to its condition prior to being transmitted. In this condition the local oscillator frequency at the 3RD frequency changer is arranged so that it is below 465 kc/s (2nd IF). The 3RD OSC switch is set to either the S.CH or D.CH BELOW 10 Mc/s positions when either the 362 kc/s or the 365 kc/s crystal will be connected between anode and grid of V7.

AFC

20. The automatic frequency control voltage is produced in the IF3 units from the carrier channel at the 3rd intermediate frequency of 100 kc/s. This control voltage is applied to the local oscillator of the 2nd frequency changer to slightly change the frequency in order to keep the receiver on tune. When sideband inversion is used in the 3rd frequency changer (the local oscillator frequency above the 2nd IF) it will be necessary to invert the AFC voltage.

21. The AFC voltage from the IF3 units is fed into this unit via terminals 3, 4 and 5 through the 3RD OSC (S5a) switch contacts and then out to the Common oscillator unit (CRD150/20A rack) via terminals 6 and 7. When the 3RD OSC switch is changed from BELOW 10 Mc/s to ABOVE 10 Mc/s the polarity of the AFC voltage is changed.

Double channel (D.CH.)

22. Positions D.CH. ABOVE 10 Mc/s and D.CH. BELOW 10 Mc/s are used for double channel working and set the 3RD local oscillator frequency to 365 and 565 kc/s respectively. When the equipment is operating on double channel the 1st and 2nd local oscillators are adjusted (Common oscillator unit CRD150/20A rack) so that the 2nd IF is 465 kc/s (*fig.* 5). The receiver bandwidths are set to 13 kc/s so that both sidebands are received. The 3RD local oscillator is tuned to either 565 kc/s (ABOVE 10 Mc/s) or 465 kc/s (BELOW 10 Mc/s). The output of the 3RD frequency changer is 100 kc/s (*fig.* 5a).

Single channel (S.CH.)

23. When the receiver is adjusted for single channel working and the frequency of the received

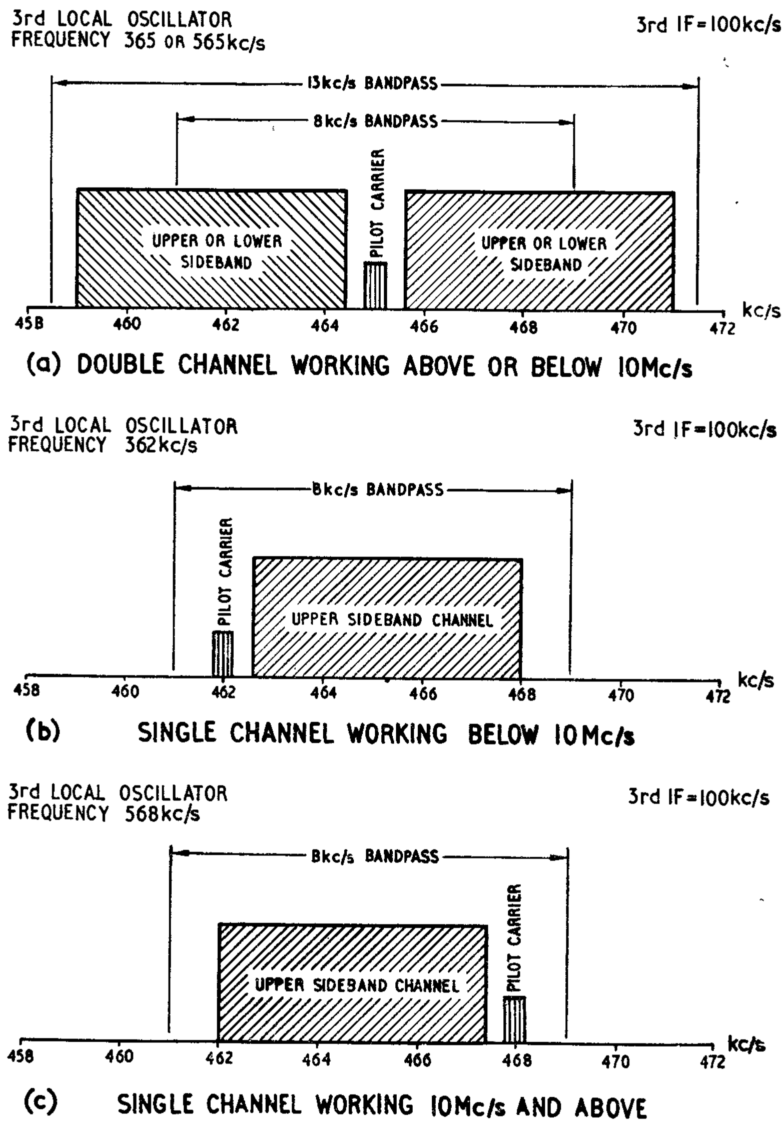

Fig. 5. Bandwidth—D.CH/S.CH working

carrier is below 10 Mc/s the first and second local oscillators are tuned so that the pilot carrier appears at 462 kc/s in the second IF band (*fig.* 5b). This arrangement permits the receiver pass-band to be reduced to 8 kc/s and still pass the single channel. Reducing the bandwidth from 13 kc/s used in the double-channel working to 8 kc/s for the single-channel system considerably reduces noise. If the receiver was set up as in fig. 5a for the reception of a single channel, the effect of the unoccupied channel would be to contribute only noise. By displacing the pilot carrier in the 2nd IF by 3 kc/s to 462, the single channel and pilot carrier may be received on the 8 kc/s receiver passband. As the pilot carrier is now at 462 kc/s the 3RD local oscillator is adjusted to 362 kc/s so that the 3rd IF will be 100 kc/s. This is achieved by setting the 3RD OSC switch to S.CH. BELOW 10 Mc/s.

24. Single-channel working on a carrier frequency of 10 Mc/s or above is achieved by adjusting the 2nd local oscillator so that the pilot carrier is displaced above 465 kc/s by 3 kc/s to 468 kc/s (*fig.* 5c) and setting the receiver passband to 8 kc/s. The third local oscillator frequency is set to 568 kc/s (S.CH. ABOVE 10 Mc/s), this when combined in the third frequency-changer with the 468 kc/s (2nd IF) gives the 3rd IF of 100 kc/s.

Stabilizer and supply voltages

25. A gas-filled stabilizer valve V8 has one of its anodes connected to earth, the other is connected to the 250-volt DC supply (pin 1, plug PL4). The 140-volt DC stabilized voltage is taken from the anode of V8 and fed to the screened grids of V1, V2, V3, V4, V5 and V6, and the anode of V7. The screen grid of the oscillator valve V7 is fed from the 250-volt unstabilized voltage. The anode supplies for all valves other than V7 are taken from the 250-volt unstabilized supply. The heater supply for all valves is the 6·3-volt alternating supply from Supply unit No. 1 and is fed in via pin 3 on plug PL4.

Monitoring

26. Low value resistors R13 to R19 (*fig.* 8) are connected individually in the anode supply circuits of valves V1 to V7 inclusive. The meter switch SW1 and SW2 selects any one of the seven metering resistors and connects one of the meters in the monitoring unit across the selected resistor. The meter interprets the voltage drop across the metering resistor in the selected anode circuit in terms of anode supply current.

FILTER UNITS

27. Two separate filter units are used, the U.S.B. filter unit and the L.S.B. filter unit, which are mounted one above the other in SSR2 rack. Each filter unit contains three separate filter circuits, one for each of the three (A, B and C) paths.

U.S.B. filter unit

28. The upper sideband unit consists of an A-path filter, a B-path filter and a C-path filter; all of these filters are identical in construction and performance. Each path filter unit is contained in a hermetically sealed case.

29. Each path filter consists of three lattice sections connected in series. The sections consist of one single and one double quartz crystal resonators arranged in lattice form. The upper-sideband filter response is shown in fig. 6. The input and output impedances of the filter are 75 ohms. The passband is 100 to 106·5 kc/s.

L.S.B. filter unit

30. The lower sideband unit consists of an A-path filter, a B-path filter and C-path filter; these filters are identical in construction and performance. Each

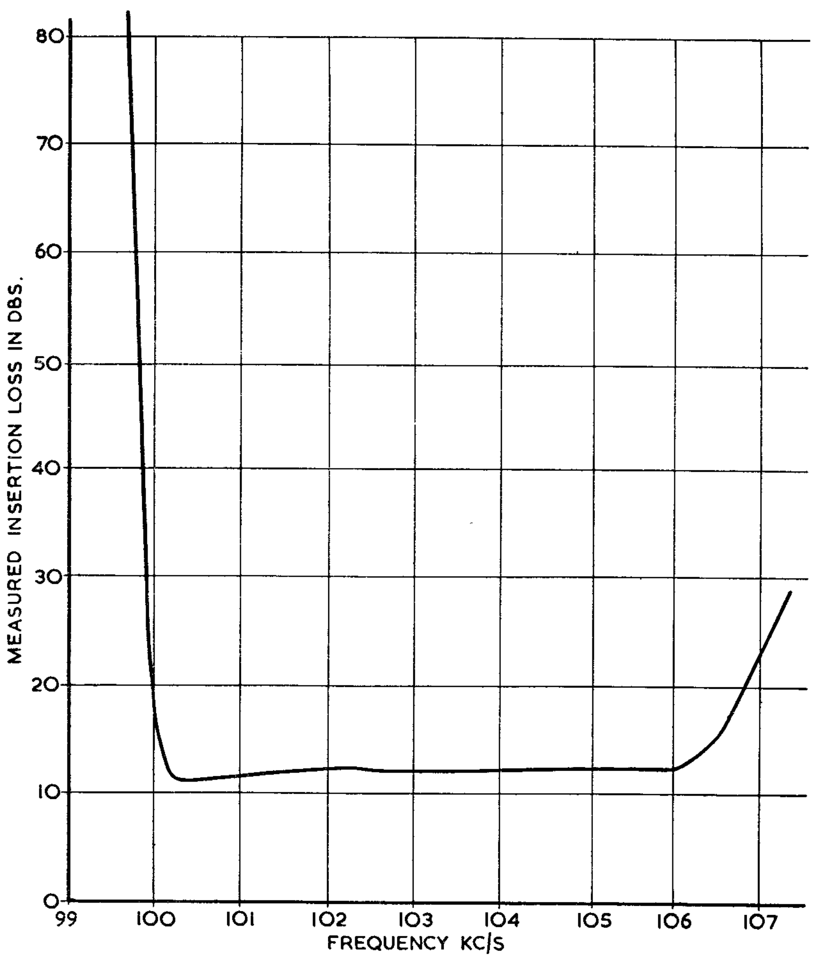

Fig. 6. Upper sideband filter response

path filter unit is contained in a hermetically sealed case. The path filters each contain three lattice sections, connected in series. The sections consist of one single and one double quartz crystal resonator arranged in lattice form. The lower sideband filter response is shown in fig. 7. The input and output impedances of the filter are 75 ohms. The passband is 94 to 99·5 kc/s.

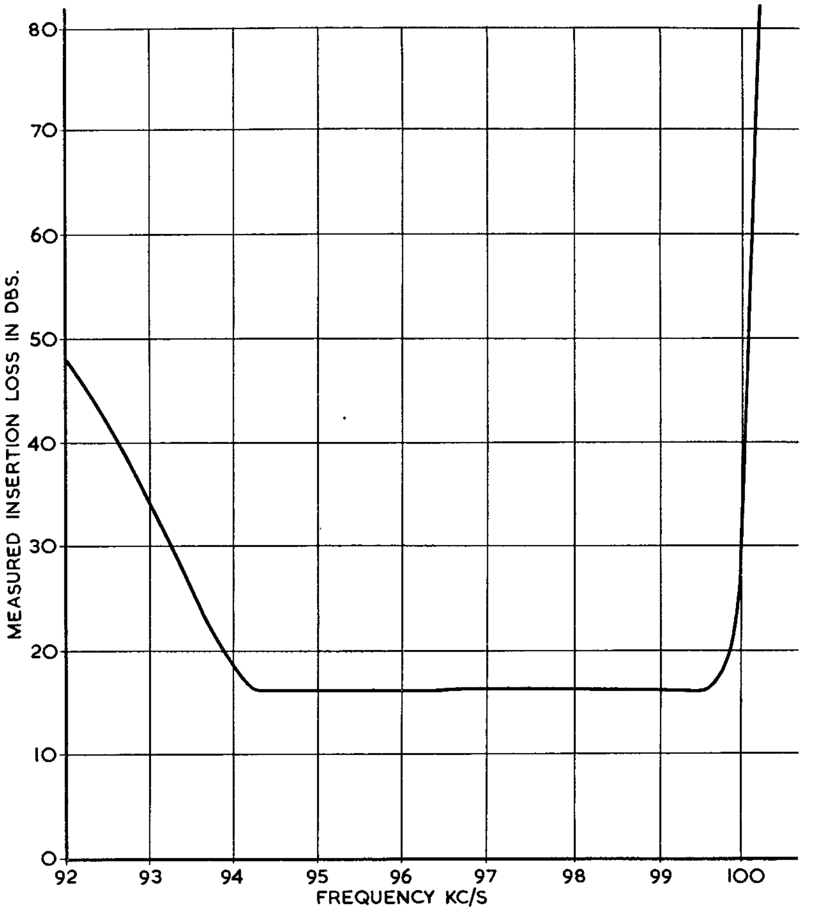

Fig. 7. Lower sideband filter response

47480 460432 7124 10/54 625 CWSLtd1013 Gp539-2

SWITCH	POSN. 1.	POSN. 2.	POSN. 3.	POSN. 4.	POSN. 5.	POSN. 6.	POSN. 7.
SW1-SW2 (METER)	V1	V2	V3	V4	V5	V6	V7
SW3-SW5 (CRYSTAL)	BELOW	10 Mc/s	ABOVE	10 Mc/s			
	SINGLE CHANNEL	DOUBLE CHANNEL	DOUBLE CHANNEL	SINGLE CHANNEL			

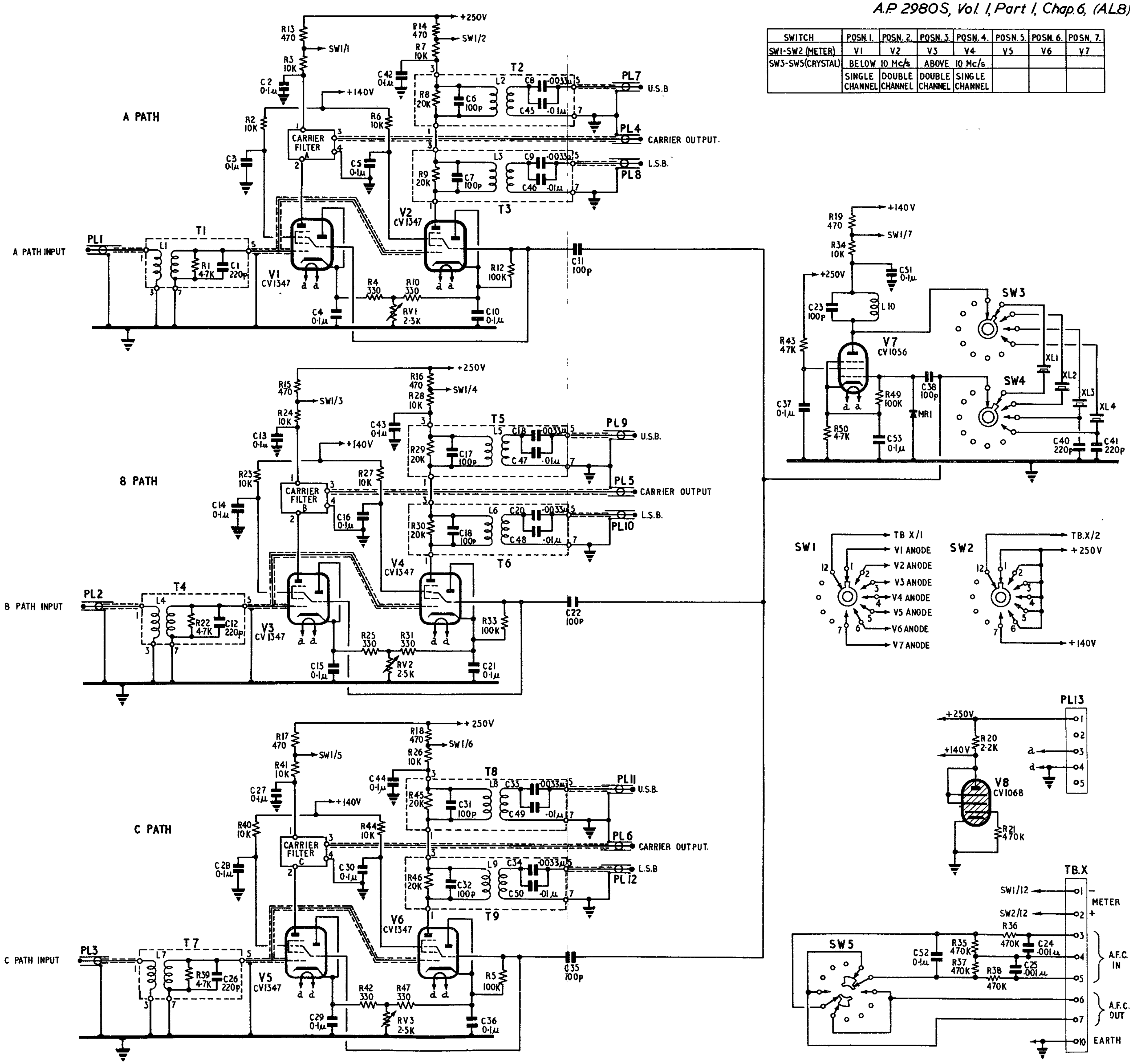

Fig.8 FC 3 unit : circuit Fig. 8

Chapter 7

PATH SELECTOR UNIT

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LIST OF ILLUSTRATIONS

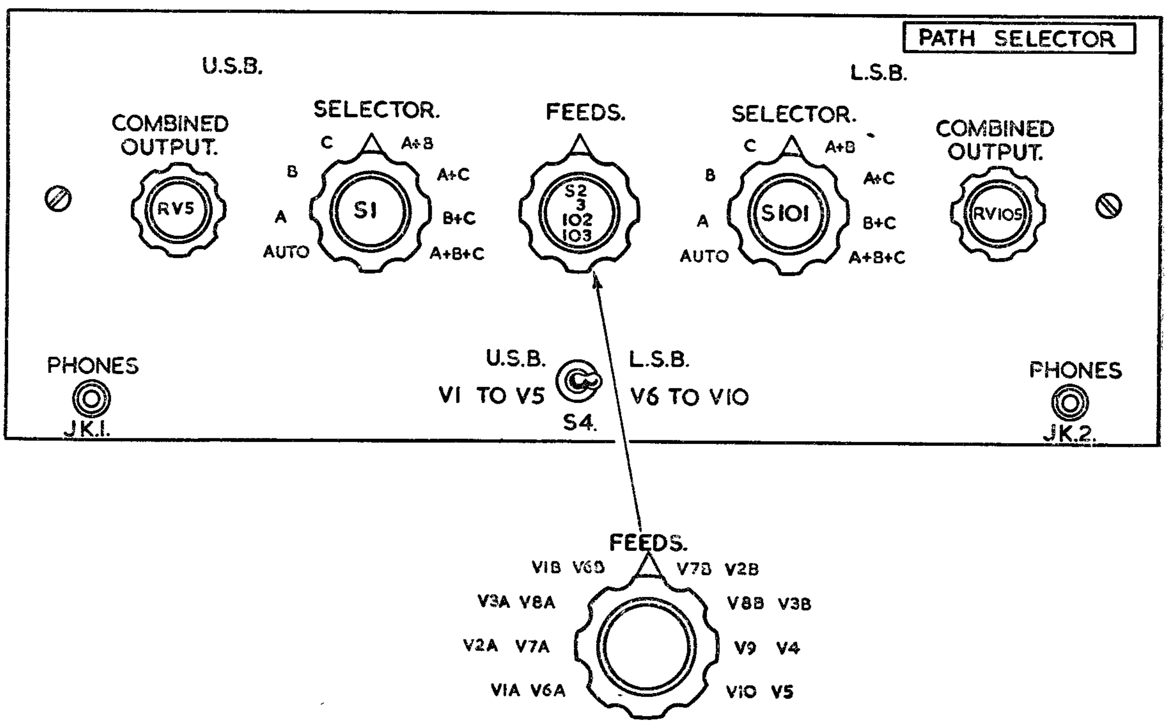


Fig. 1. Path selector unit

INTRODUCTION

1. The path selector unit (*fig.* 1) is used in the single sideband receiving equipment R.1923 and forms part of rack assembly Type 239 (SSR2).

2. This unit automatically selects the path (A, B or C) having the strongest signal. The unit consists of two similar sections, one used to select the upper sideband channel of the path having the strongest signal and the other selects the lower sideband channel of the path having the strongest signal. Each section consists of a comparison, a selector gate, and output circuits.

3. The input signals and control voltages fed into this unit are as follows:—

(1) The A-path upper sideband AF signal from IF3 A unit fed in via terminals 1 and 2 on tagboard X.

(2) The B-path upper sideband AF signal from IF3 A unit fed in via terminals 3 and 4 on tagboard X.

(3) The C-path upper sideband AF signal from IF3 C unit fed in via terminals 5 and 6 on tagboard X.

(4) The A-path lower sideband AF signal from IF3 unit fed in via terminals 1 and 2 on tagboard Y.

(5) The B-path lower sideband AF signal from IF3 B unit fed in via terminals 3 and 4 on tagboard Y.

(6) The C-path lower sideband AF signal from IF3 C unit fed in via terminals 5 and 6 on tagboard Y.

(7) The 240-volt positive HT voltage fed in via pin 1 of plug PL2 from supply unit No. 1.

(8) 6·3-volt alternating heater supply from supply unit No. 1 fed in via pin 3 of plug PL2.

(9) Earth connection (pin 4 of plug PL2) from supply unit No. 1.

4. The output signals and voltages fed out from this unit are as follows:—

(1) The upper sideband combined AF output fed out to the distribution unit via terminals 7 and 8 on tagboard X.

(2) The lower sideband combined AF output fed out to the distribution unit via terminals 7 and 8 on tagboard Y.

(3) Monitoring voltage fed out via terminals 9 and 10 on tagboard X to the monitoring and meter unit.

CONTROLS

5. The controls and their functions in this unit are as follows:—

Control	*Function*	*Circ. Ref.*
U.S.B. COMBINED OUTPUT	A 100K potentiometer which controls the gain of the AF combined paths of the upper sideband signal.	RV5
L.S.B. COMBINED OUTPUT	A 100K potentiometer which controls the gain of the AF combined path of the lower sideband signal.	RV105
U.S.B. SELECTOR	An 8-position rotary switch which is used to switch the upper sideband signal to line. Various combinations of paths are selected by the switch positions.	SW1
L.S.B. SELECTOR	An 8-position rotary switch used to switch the lower sideband signal to line. Various combinations of paths are selected by the switch positions.	SW101
FEEDS	An 11-position rotary switch which connects the monitoring voltages developed across the metering resistors in the various valve feeds to the monitoring and meter unit.	SW2, 3, 102 and 103
U.S.B./L.S.B.	A single-throw toggle switch which operates in conjunction with the FEEDS control and switches the monitoring circuit to either the upper sideband circuit V1 to V5, or the lower sideband circuit V6 to V10.	SW4
U.S.B. PHONES	A Post-office type jack socket connected in the combined upper sideband AF output circuit to enable the output to be monitored by phones.	JK1
L.S.B. PHONES	A Post-office type jack socket connected in the combined lower sideband AF output circuit to enable the output to be monitored by phones.	JK101
RV1	A 50K preset potentiometer used to adjust the A-path U.S.B. selector valves V1A and V1B.	RV1
RV2	A 50K preset potentiometer used to adjust the B-path U.S.B. selector valves V2B and V2A.	RV2
RV3	A 50K preset potentiometer used to adjust the C-path U.S.B. selector valves V3B and V3A.	RV3
RV101	A 50K preset potentiometer used to adjust the A-path L.S.B. selector valves V6A and V6B.	RV101
RV102	A 50K preset potentiometer used to adjust the B-path L.S.B. selector valves V7A and V7B.	RV102
RV103	A 50K preset potentiometer used to adjust the C-path L.S.B. selector valves V8A and V8B.	RV103

Control	*Function*	*Circ. Ref.*
RV4	A 1K preset potentiometer used to adjust the bias on the U.S.B. selector valves.	RV4
RV104	A 1K preset potentiometer used to adjust the bias on the L.S.B. selector valves.	RV104

OPERATION

6. This unit can be divided into an upper sideband section and a lower sideband section (*fig.* 2), and as both sections are identical in construction and operation, only the upper sideband section will be described.

UPPER SIDEBAND SECTION

7. The upper sideband section (*top of fig.* 2) comprises the three (A, B and C) paths which are fed from the three IF units. Part of the signal applied to each path is fed to a comparison circuit. There are three comparison circuits, one for each path; these circuits have a common resistor and are so arranged that they control the valves in the selector circuits. The selector circuits "gate" the three paths between the IF units and the AF amplifier and output stages. The whole circuit operates in such a manner as to "gate", or suppress, the two weaker signals and leave the path passing the strongest signal "open".

8. The circuit may be divided into four parts:—

Comparison circuit
Selector circuit
Gating circuit
AF and output circuit.

Comparison circuits

9. The three comparison circuits (for the A, B and C paths) consist of potential dividers. Considering the A path only, it consists of resistors R1 and R2, a transformer TR1, signal rectifiers MR3 and MR4, load resistor R7 and capacitor C1; R6 and C2 form a smoothing circuit. The B and C path circuits have components of the same value and are arranged in a similar manner to those comprising the A path comparison circuit.

10. The rectified and smoothed signal voltages from each comparison circuit path are fed directly to the grids of the respective valves V1B, V2B and V3B, in the selector circuit. The rectified signal currents from rectifiers MR3, MR7 and MR11 are fed through a common resistor R25; C7 maintains a peak potential across R25, whilst smoothing is provided by R26 and C8.

11. When the AF signals from the A, B and C paths are fed from the IF units to the path selector a portion of the signal is applied to each of the three comparison circuits. The signal will be rectified by rectifiers MR4, MR8 and MR12; capacitors C1, C3 and C5 will charge to the peak valves of their respective signals. The voltages appearing across capacitors C2, C4 and C6 (smoothing capacitors in the A, B and C path comparison circuits respectively) will be proportional to the signal strengths in the main signal paths. These voltages are applied to the grids of V1B, V2B and V3B.

12. The rectifiers MR3, MR7 and MR11 will cause a voltage to be developed across R25 and C7. The voltage across C7 will be equal to whichever of the three potential differences corresponds to the strongest signal.

13. The potential difference between the grid of V1B and earth will be the voltage across C2, plus the voltage across C8 (which is the voltage across C7 after smoothing). Assuming that path A has the strongest signal, then the voltage across C2 will be equal to the voltage across C7. The algebraic sum of these voltages will be zero as they are in opposition. Hence the voltage at the grid of V1B is zero, whilst the resultant voltages appearing between the grids of V2B and V3B and earth will be positive.

14. The comparison circuit receiving the strongest signal will cause the potential at the grid of the valve it controls to be zero. The two comparison circuits receiving the weaker signals will apply positive potentials at the grids of the valves they control.

Selector circuit

15. The selector circuit consists of the three triode valves V1A, V2A and V3A whose grid potentials are controlled by the valves V1B, V2B and V3B respectively. The valves V1A, V2A and V3A are so arranged so that the anode of V1A is directly coupled to the grids of V2A and V3A. The anode of V2A is connected to the grids of V1A and V3A and the anode of V3A is coupled to the grids of V1A and V2A. The anodes of the three valves are directly connected with each other via the resistor network consisting of R45, R46, R47, R48, R49 and R50. The cathodes of these three valves are connected via a common resistor R51 and preset potentiometer RV4 to earth.

16. This selector circuit may be regarded as an extension of the Eccles-Jordan circuit. In the stable condition any two of the three valves will be conducting with the third valve cut-off. The resistors R33 and R5 connected between the HT line and the anode of V1A form part of the gating circuit in the A-path signal line between the IF3 A-unit and the path selector AF and output stages. Similarly, resistors R34 and R12, and R35 and R14 in the anode circuits of V2A and V3A form part of the gating circuits in the B and C-path signal lines.

17. When the selector valve associated with the gating circuit is conducting the "gate" is closed so that no signal will be passed by this line. Only the gating circuit associated with the non-conducting selector valve will be "open" and pass the signal.

18. If the B-path signal is the strongest, the potential at the grid of V2B will be zero and the potential at the cathode of V2B will be at its minimum (less positive). This decrease in V2B cathode potential will cause a reduction in the grid potential of V2A and cause this valve to cut-off, so that the voltage at the junction of R34 and R12 will be equal to the HT voltage. As V2B anode is positive, it will cause the grids of V1A and V3A to go positive, causing these valves to conduct more heavily. The anode currents of V1A, V2A and V3A flow through a common cathode resistor R51 and cause an increase in the positive potential at the three cathodes. This will increase the negative grid/cathode potential of V2A and take the grid beyond cut-off. Valves V1A and V3A conduct heavily and the potentials at their anodes fall, closing the "gates" in the A and C signal paths.

Gating circuits

19. The gating circuits in each of the three signal paths are identical. The A-path gating circuit consists of the secondary winding of transformer TR2 and the primary of TR3 in the AF signal path between the IF3 A-unit and the AF output stages in the path selector circuit. TR2 winding is centre-tapped and signal rectifiers MR1 and MR2 are connected back-to-back between the outer ends of the windings and the centre tap of TR2. Resistors R27 and R28, connected between the HT line and earth, form a potential divider which applies a bias on rectifiers MR1 and MR2. The centre-point on the secondary winding of TR2 is connected to the junction of resistors R33 and R36, which are connected between the HT line and the anode of V1A.

20. Assume that the path selector circuit is stable in the condition described in para. 17 and 18 (B-path signal is the strongest). The valve V2A will be cut off so that the potential at the junction of resistors R34 and R12 (centre-tap of TR5 secondary winding) will be at HT potential. The potential at the junction of resistors R29 and R30 is slightly below HT potential. In this condition a negative bias is applied to both rectifiers MR5 and MR6. Hence these rectifiers will appear as a high impedance connected across the windings TR5 and TR6, which will have no appreciable shunting effect on the B-path signal, and it will be passed on to the secondary winding of TR6 and thence to the AF and output amplifiers.

21. Whilst valve V2A is cut off, both V1A and V3A will be conducting. The potentials at the centre-points of transformers TR2 and TR8, in the A and C signal paths respectively, will be below that of the HT positive line. This will cause the centre-points of TR2 and TR8 to be more negative relative to the biasing points of rectifiers MR1 and MR2, MR9 and MR10. A positive bias will, in effect, be applied to rectifiers MR1 and MR2, MR9 and MR10. These rectifiers will conduct and provide a low-resistance shunt path across the A and C-path signal lines, thereby suppressing the A and C-path signals.

22. To summarize the circuit action of the path selector unit for the three stable conditions, the state of each stage is listed below:—

Strongest Signal	*V1A*	*V2A*	*V3A*	*V1B*	*V2B*	*V3B*	*A-path gate*	*B-path gate*	*C-path gate*
A-path	Near Cut-off	Conducting	Conducting	Cut-off	Conducting	Conducting	Open	Closed	Closed
B-path	Conducting	Near Cut-off	Conducting	Conducting	Cut-off	Conducting	Closed	Open	Closed
C-path	Conducting	Conducting	Near Cut-off	Conducting	Conducting	Cut-off	Closed	Closed	Open

AF and output stages

23. The AF output signal appearing at any one of the three secondary windings of TR3, TR6 or TR9 is applied to the grid of V4 (the AF amplifier stage) via a potentiometer RV5 (the COMBINED OUTPUT control). V4 is a pentode valve operating as a Class A amplifier. The amplified voltage appearing across R55, the anode load, is applied via C10 to the grid of the output valve V5.

24. The output valve V5 is a triode operating as a Class A amplifier having transformer TR10 as its anode load. Cathode bias is provided by resistor R58 and which is bypassed by C12. Negative feedback is applied over these two stages by coupling the anode of V5 back via C11 and R59 to the cathode of V4. The signal developed in the output transformer TR10 is coupled to the 600-ohm output via the 5:1 ratio secondary winding. The output power is 100mW.

25. The other secondary winding on TR10 has a turns ratio of 70:1 and is connected to a telephone type jack-socket (U.S.B. PHONES) JK1 for aural monitoring the U.S.B. output signal.

Selector switch

26. The selector switch SW1 and its associated circuit permit any one of the three signal paths to be selected manually, or any combination of the three signals. The switch has eight positions; the circuit operation for any one of these positions is described in the following paragraphs, the headings of which correspond to the switch settings.

AUTO

27. In this position the path selection is automatic, as described in para. 18 to 21.

A

28. The grid of V1A is connected via SW1 to earth; this causes a large negative bias to be applied to V1A, cutting it off. V1B is cut off and path A gate is opened, allowing the A-path signal to appear in the output. The gate circuits in the B and C paths are closed.

B

29. The grid of V2A is earthed via SW1. V2A and V2B are cut off, thus " opening " the B signal path " gate " and allowing the B-path signal to appear at the output. The A and C-path gate circuits are closed.

C

30. The grid of V3A is earthed via SW1. V3A and V3B are cut off, thus " opening " the C signal path " gate ". Only the C-path signal appears at the output stage.

A+B

31. In this position of the selector switch both the V1A and V2A valve grids are connected to earth. V1A, V2A, V1B and V2B are all cut off, so that both the A and B signal path gate circuits are " open ", allowing both the A and B-path signals to appear at the output stage.

A+C

32. V1A and V3A valve grids are connected to earth. V1A, V3A, V1B and V3B are all cut off, thus permitting the A and C-path signals to appear at the output stage. The B-path valves V2B and V2A are conducting, which closes the B signal path.

B+C

33. The grids of V2A and V3A are earthed via SW1. V2A, V2B, V3A and V3B are all cut off, thus opening the B and C signal path gate circuits. Only the B and C signals appear at the output stage.

A+B+C

34. The grids of V1A, V2A and V3A are all earthed via SW1. All six selector valves are cut off, opening the gate circuits of all three signal paths. The A, B and C signals all appear at the output stage.

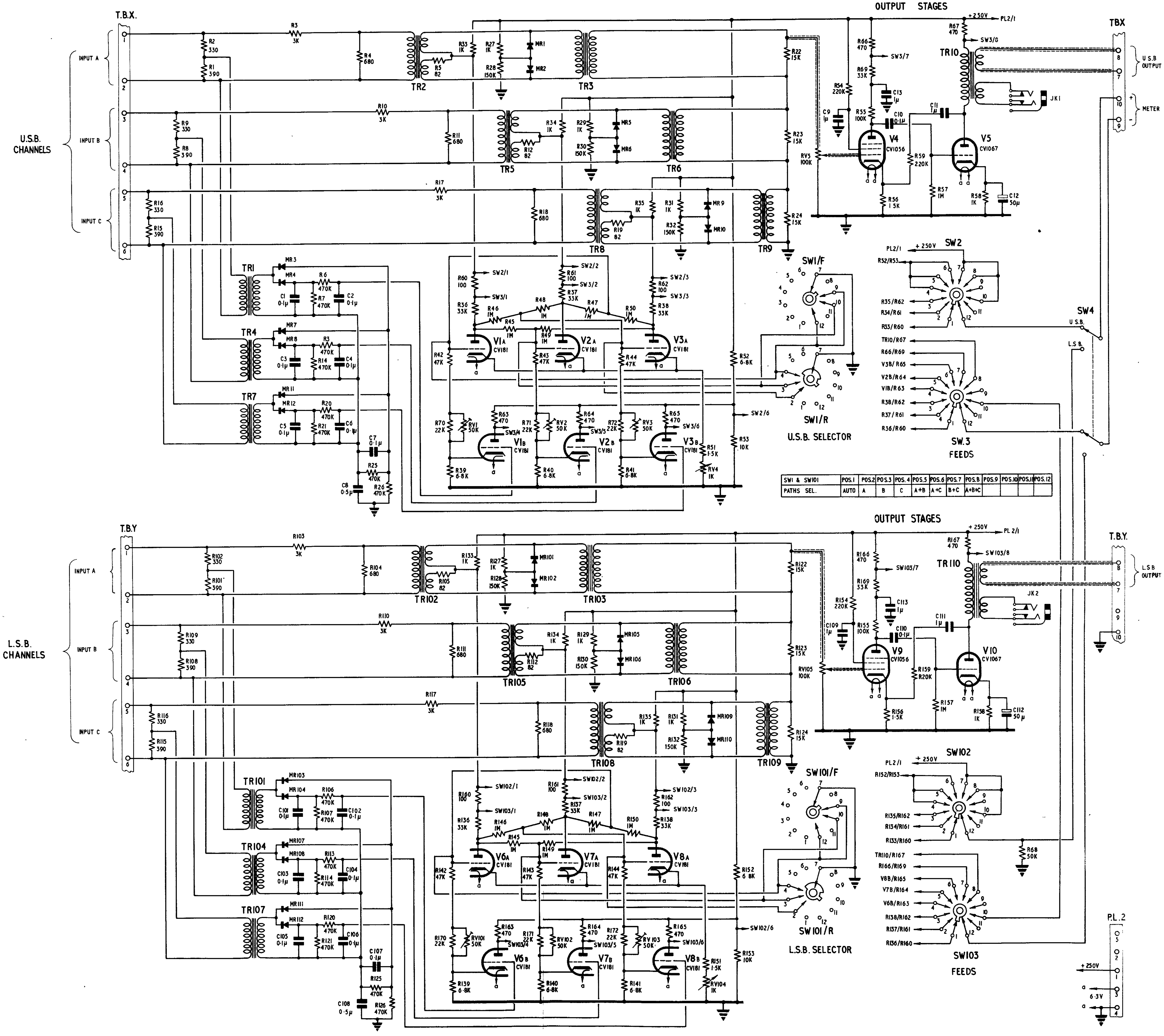
LOWER SIDEBAND SECTION

35. The lower sideband section (see lower half of *fig.* 2) is identical in operation to that of the upper sideband section, previously described. The strongest A, B or C-path lower sideband signal is automatically selected in a manner similar to that used in the U.S.B. section. Valves V6A, V7A, V8A, V6B, V7B and V8B form the selector circuit. Valves V9 and V10 form the AF and output stages. The L.S.B. selector switch SW101 performs a similar function to that of SW1.

MONITORING

36. A low-value metering resistor is connected in the anode circuit of each valve to enable the valve current of each valve to be checked. An 11-position FEEDS switch (SW2, SW3, SW102 and SW103) connects the meter in the monitoring and meter unit across the metering resistors in each valve circuit. The meter in the monitoring and meter unit measures the volt-drop across the selected metering resistor and gives an indication in terms of anode current. A single-throw toggle switch (SW4) U.S.B. V1 to V5 *and* L.S.B. V6 to V10 is used in conjunction with the FEEDS switch, enabling the valves V1 to V5, when SW4 is in the U.S.B. position, to be monitored. When SW4 is in the L.S.B. position, valves V6 to V10 may be monitored.

54608 471345 2493 12/54 625 CWSLtd1127 Gp539-2



SW1 & SW101	POS.1	POS.2	POS.3	POS.4	POS.5	POS.6	POS.7	POS.8	POS.9	POS.10	POS.11	POS.12
PATHS SEL.	AUTO	A	B	C	A+B	A+C	B+C	A+B+C				

Chapter 8

SUPPLY UNITS, MONITORING AND ILLUMINATING PANELS

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LIST OF ILLUSTRATIONS

SUPPLY UNITS

Introduction

1. Four identical power supply units (*fig.* 1) are used in this equipment (R.1923). Two supply units (No. 1 and 2) are mounted on the rack assembly Type 238 and provide the various supply voltages for the other units on this rack. The other two supply units (No. 1 and 2) are mounted on rack assembly Type 239 (SSR.2) and provide the various supply voltages for the other units in this rack.

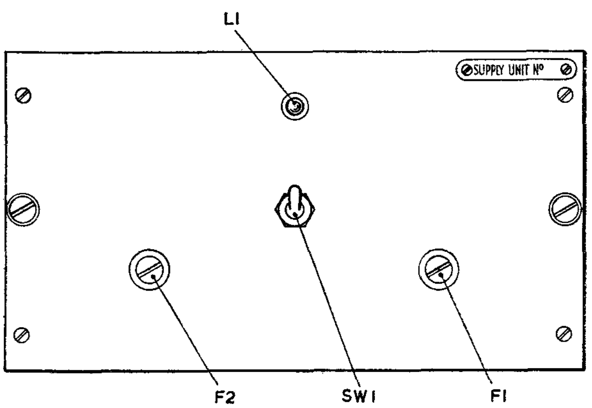


Fig. 1. Supply unit

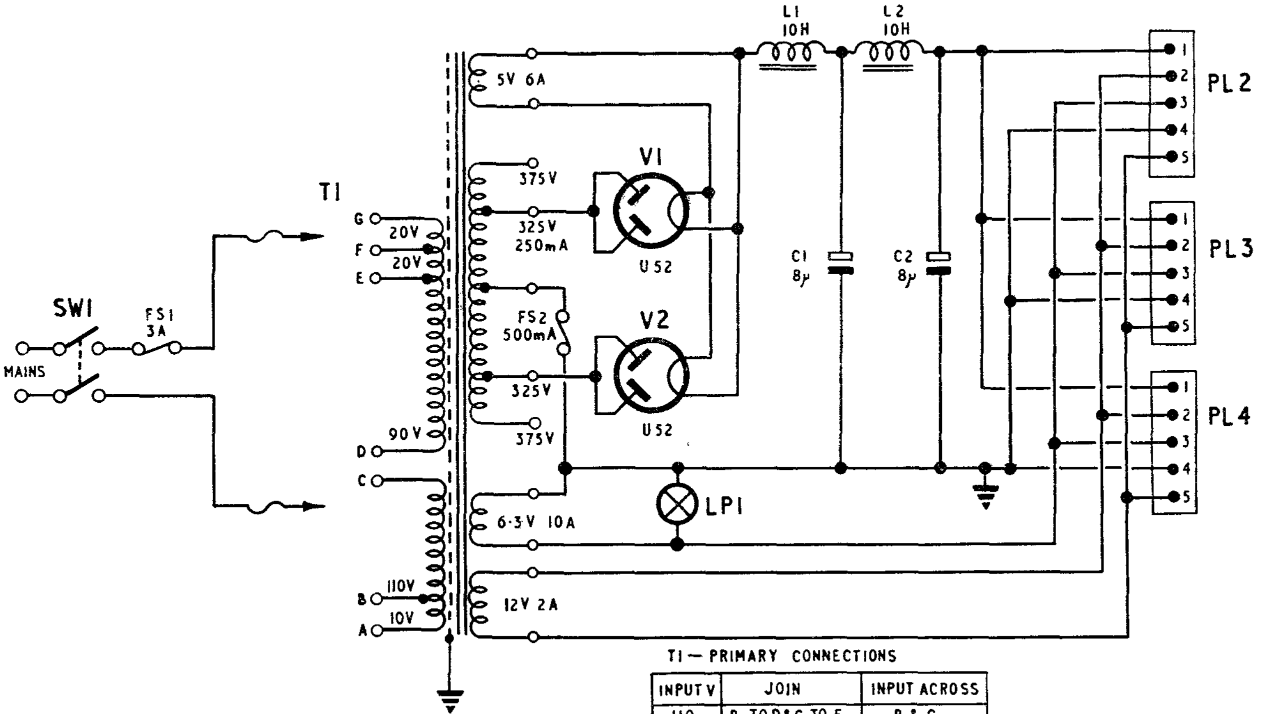
Description

2. The supply units are as shown in fig. 1. Mounted on the front panel are a pilot lamp LP1, two fuses FS1 and FS2, and a double-pole mains ON/OFF switch SW1.

Operation

3. The supply unit circuit is given in fig. 2. A power transformer T1 provides the various voltages in the supply unit. The primary is in two sections each having a number of tappings; by suitably connecting these windings an input supply voltage ranging from 110 to 250 volts may be used. The specific connections for the varying input voltages are given by the table in fig. 2. When the supply unit is operated from 110-volt supply the two primary windings are connected in parallel; this arrangement allows for the higher primary current when the 110-volt input voltage is used. The windings are connected in series when a 200V, or above, input is used.

4. The mains voltage is applied to the primary of T1 via a double-pole switch SW1 which is mounted centrally on the front panel of the unit. A 3-amp. cartridge type fuse FS1 is connected between one pole of the switch and the primary winding. Access to this fuse is from the front panel and it is mounted to the right of the switch (*fig.* 1).



T1 — PRIMARY CONNECTIONS

INPUT V	JOIN	INPUT ACROSS
110	B TO D & C TO F	B & C
200	C TO D	B & E
210	C TO D	A & E
220	C TO D	B & F
230	C TO D	A & F
240	C TO D	B & G
250	C TO D	A & G

Fig. 2. Supply unit—circuit

5. The 240-volt DC output from this unit is provided by a full-wave rectifier circuit. A 325–0–325-volt centre-tapped secondary winding on T1 provides the HT voltages to the two rectifier valves V1 and V2. These valves are normally full-wave rectifiers, but in this instance the two anodes of each valve are strapped and each valve used as a half-wave rectifier. The heater supply for V1 and V2 is provided by the 5V winding on the secondary of T1. The valves are of the directly heated type; the rectified positive HT voltage is taken from one side of the heater. The centre-tap on the 325–0–325 winding is connected via a 500 mA cartridge type fuse FS2 to earth. The HT fuse FS2 is accessible from the front panel of the unit and is mounted to the left of the switch SW1 (*fig.* 1). Additional tappings at 375 volts are provided at each end of the secondary HT winding on T1 to provide for an increase of HT voltage.

6. A choke-input smoothing circuit consists of iron-cored inductor L1 and electrolytic capacitor C1. Additional smoothing is provided by inductor L2 and capacitor C2. The smoothed positive output taken from the junction of L2 and C2 is 240V positive relative to earth, and is connected to pins 1 on plugs PL1, PL2 and PL3. The earth connection is taken to pins 4 on plugs PL1, PL2 and PL3.

7. A pilot lamp LP1 mounted on the front panel of the unit is connected across the 6·3-volt winding and indicates when the supply unit is switched ON.

8. A separate 12-volt secondary winding is provided and is connected directly to pins 2 and 5 on plugs PL1, PL2 and PL3.

9. The output voltages from this unit are fed out via three 5-pole plugs PL1, PL2 and PL3. The voltages appearing at the various pins on the three plugs are as follows:—

Pin No.	*Plug*	*Voltage*
1	PL1, PL2, PL3	240V positive HT
2	PL1, PL2, PL3	12V AC
3	PL1, PL2, PL3	6·3V AC
4	PL1, PL2, PL3	Earth
5	PL1, PL2, PL3	12V AC

Rack assembly Type 238 (CRD/150/20)

10. Supply unit No. 1 is mounted above supply unit No. 2 on rack assembly Type 238.

Supply unit No. 1

11. Supply unit No. 1 provides HT and heater voltages to the following units on rack assembly Type 238:—

240V positive HT (pin 1)	PL1 to receiver C PL2 to receiver B
6·3V AC heater (pin 3)	PL1 to receiver C PL2 to receiver B
Earth (pin 4)	PL1 to receiver C PL2 to receiver B

Note . . .

Plug PL3 is not used on this unit.

Supply unit No. 2

12. Supply unit No. 2 supplies HT and heater voltages to the following units on rack Type 238:—

240V positive HT (pin 1)	PL1 to common oscillator PL2 to receiver A PL3 to combining unit
12V AC (pin 2)	PL1 to common oscillator
6·3V AC (pin 3)	PL1 to common oscillator PL2 to receiver A PL3 to combining unit
Earth (pin 4)	PL1 to common oscillator PL2 to receiver A PL3 to combining unit
12V AC (pin 5)	PL1 to common oscillator

Rack assembly Type 239 (SSR2)

13. Supply unit No. 1 is mounted above supply unit No. 2 in rack assembly Type 239.

Supply unit No. 1

14. Supply unit No. 1 provides HT and heater voltages to the following units on rack Type 239:—

240V positive HT (pin 1)	PL1 to F.C.3 unit PL2 to path selector unit
6·3V AC heater (pin 3)	PL1 to F.C.3 unit PL2 to path selector unit
Earth (pin 4)	PL1 to F.C.3 unit PL2 to path selector unit

Note . . .

Plug PL3 is not used on this unit.

Supply unit No. 2

15. Supply unit No. 2 provides HT and heater voltages to the following units on rack assembly Type 239:—

240V positive HT (pin 1)	PL1 to I.F.3 unit B PL2 to I.F.3 unit C PL3 to I.F.3 unit A
6·3V AC heater (pin 3)	PL1 to I.F.3 unit B PL2 to I.F.3 unit C PL3 to I.F.3 unit A
Earth (pin 4)	PL1 to I.F.3 unit B PL2 to I.F.3 unit C PL3 to I.F.3 unit A

MONITORING AND METER UNIT

Introduction

16. The monitoring and meter unit (*fig.* 3) is mounted on rack assembly Type 239 and enables various circuit potentials and currents to be checked on five units in the SSR.2 rack (rack Type 239). Provision is also made to measure the audio output levels for the three paths (A, B and C) and the U.S.B. and L.S.B. channels in each path, and the combined output level. The five units monitored by the monitoring and metering units are as follows:—

F.C.3 unit
I.F.3 A unit
I.F.3 B unit
I.F.3 C unit
Path selector unit

Controls

17. The controls and their functions on this unit are as follows:—

Control	*Function*	*Circuit Ref.*
VALVE FEEDS	A 0–10mA instrument which indicates valve currents and HT voltages in the F.C.3, I.F.3 A, I.F.3 B, I.F.3 C, and path selector units. The particular unit is selected by the FEEDS switch.	M1

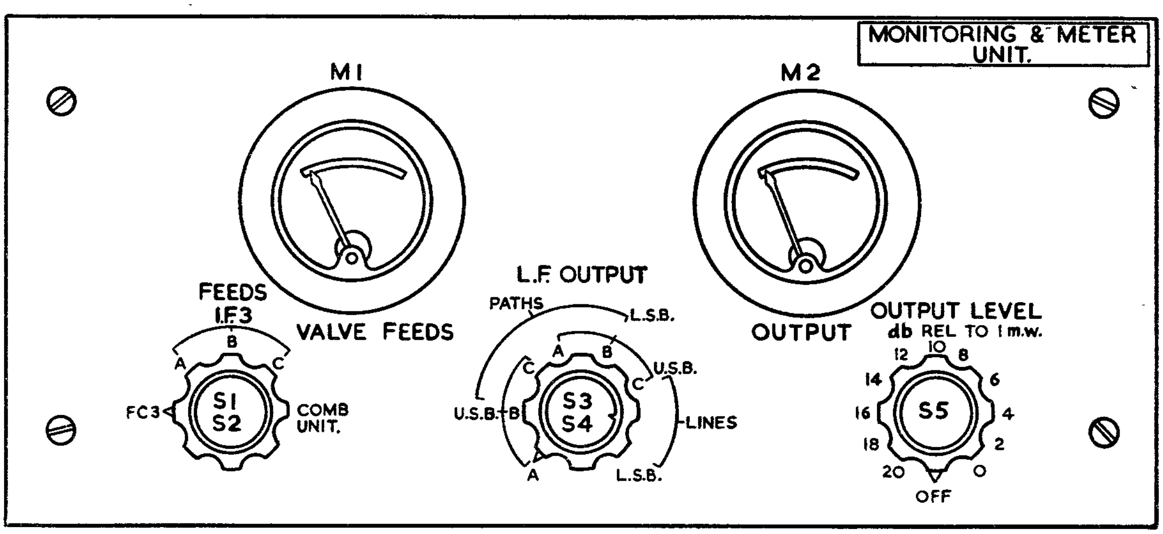


Fig. 3. Monitoring and meter unit

Control	*Function*	*Circuit Ref.*
OUTPUT	A 0–250μA DC instrument used to indicate the A.F. output levels in the A, B and C paths for the upper and lower sidebands, and the combined outputs.	M2
FEEDS	A 5-position rotary switch used to connect the VALVE FEEDS meter M1 to the I.F.3, A, B, C, F.C.3 or path selector units and enables the various circuit potentials (selected by the monitoring switch on the selected unit) to be measured. **Note . . .** COMB UNIT *refers to path selector unit.*	S1, S2
LF OUTPUT	An 8-position rotary switch which connects either the upper or lower sideband AF outputs in the A, B or C paths or the combined level to the output monitoring circuit.	S3, S4
OUTPUT LEVEL dB REL TO 1 M.W.	An 11-position rotary switch connected in 20dB attenuator circuit, arranged in 2dB steps. Used in conjunction with the OUTPUT meter M2. This switch enables the output level to be measured in dB relative to 1mW.	S5

Operation

Circuit monitoring

18. The 0–10mA meter M1 is connected via sections S1 and S2 of the FEEDS switch to terminals on the terminal board TB1 (*fig.* 4). The VALVE FEEDS meter M1 may be connected to the monitoring circuits of any of the following units:—

Switch position	*Unit*	*Meter M1 connected:—*
1	F.C.3	between terminals 9 and 10
2	I.F.3 A	„ „ 7 „ 8
3	I.F.3 B	„ „ 5 „ 6
4	I.F.3 C	„ „ 3 „ 4
5	COMB UNIT (path selector)	„ „ 1 „ 2

19. When the FEEDS switch is set to any one of the five units, the meter M1 is connected via terminal board 1 and the inter-unit cabling to the monitoring circuit of the selected unit. The meter is then switched across valve metering resistors and HT lines in the unit by means of the monitoring switch on the unit under test.

AF output monitoring

20. The output AF signal levels for the A, B and C paths and the combined path are measured on this unit. The PATHS switch selects the path to be measured and the upper or lower sideband channel. The switch position and the corresponding path, unit and channel under test are as follows:—

Switch position	*Path*	*Unit*	*Channel*
PATHS U.S.B. A	A	I.F.3 A	Upper sideband
PATHS U.S.B. B	B	I.F.3 B	Upper sideband
PATHS U.S.B. C	C	I.F.3 C	Upper sideband
PATHS L.S.B. A	A	I.F.3 A	Lower sideband
PATHS L.S.B. B	B	I.F.3 B	Lower sideband
PATHS L.S.B. C	C	I.F.3 C	Lower sideband
LINES U.S.B.	Combined	Path selector	Upper sideband
LINES L.S.B.	Combined	Path selector	Lower sideband

The connections to the various units are made via terminal boards 1 and 2 (*fig.* 4) and the distribution unit (SSR.2 rack) by means of the inter-unit cabling.

21. The PATHS switch S3 and S4 connects the measuring circuit, consisting of a 20dB variable attenuator (OUTPUT LEVEL) and OUTPUT meter M2 with its rectifier MR1, across the output selected by the switch. The output is measured in dB relative to 1mW by means of the 20dB variable attenuator and the 0–250μA instrument; the output is rectified by the full-wave bridge rectifier MR1 before being applied to the meter M2. The attenuator (resistors R1 to R12) is adjusted by means of the OUTPUT LEVEL switch S5 in 2dB steps.

ILLUMINATING PANELS

Introduction

22. Two identical illuminating panels are used on this equipment and are mounted, one at the top of the rack assembly Type 238 and one at the top of rack assembly Type 239. These units illuminate the front of both of the racks in the equipment.

Description

23. Each panel consists of a projecting lamp shade with the lamp mounted on the inside of shade and arranged so that the lamp illuminates the front of its respective rack.

24. The lamp supply is fed via a 3-pole plug mated with a socket mounted on the front panel of the unit. A switch mounted on the front panel controls the supply to the socket. This socket (240V at 5 amp.) may be used to supply a soldering iron or inspection lamp.

25. Two display panels are provided on the outer-side of the lamp shade which may be used to hold information useful in the operation of the equipment.

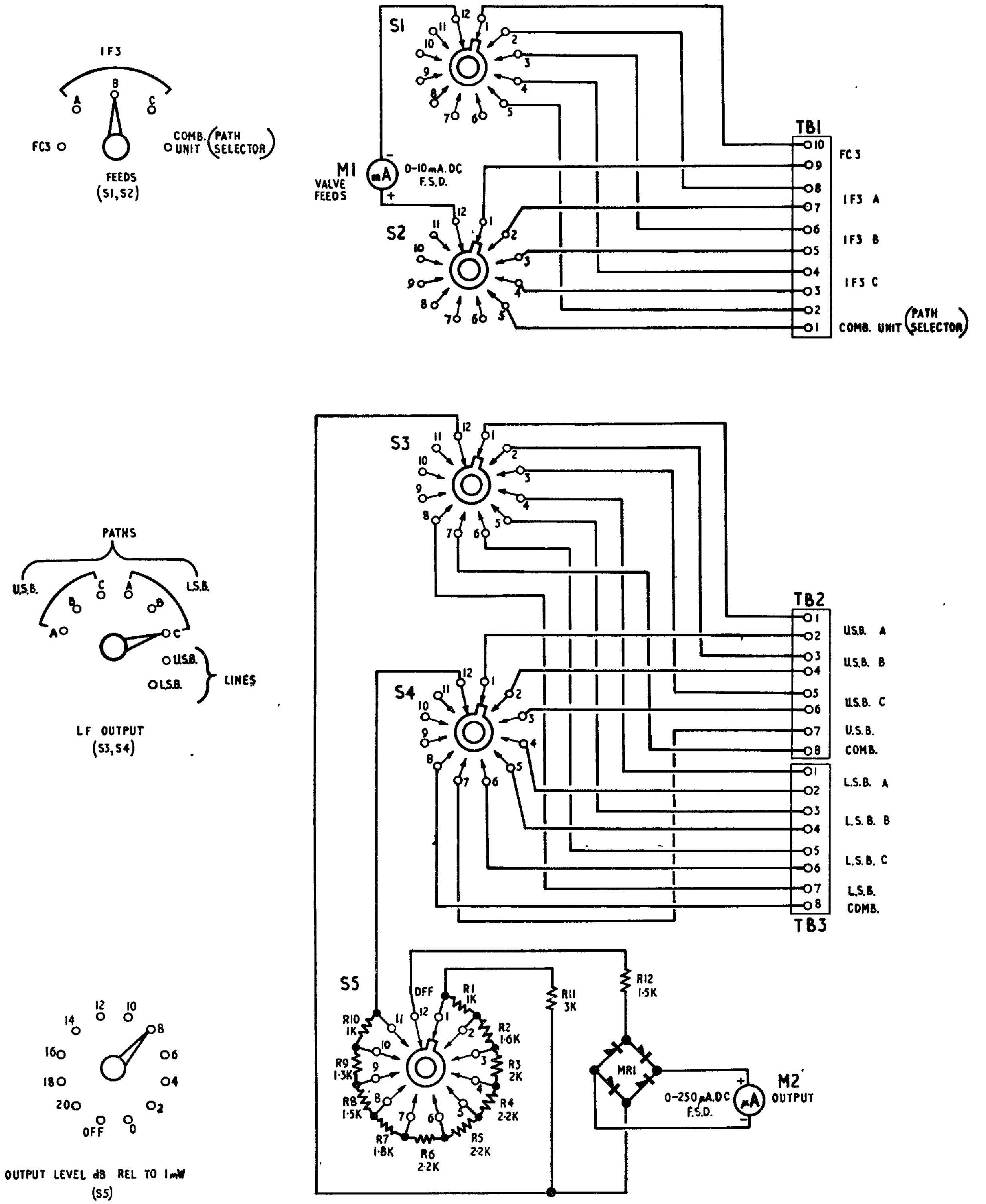


Fig. 4. Monitoring and meter unit—circuit

50722 464439 7607 11/54 625 CWSLtd1061 Gp539-2

Chapter 9

DISTRIBUTION UNITS AND EQUIPMENT INTERCONNECTIONS

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LIST OF ILLUSTRATIONS

DISTRIBUTION UNITS

Introduction

1. Two separate distribution units used are on this equipment:—

CRD150/20A distribution unit (*fig.* 1)

SSR2 distribution unit (*fig.* 2).

2. The distribution unit CRD150/20A is mounted at the base of rack assembly Type 238; distribution unit SSR2 is mounted at the base of rack assembly Type 239.

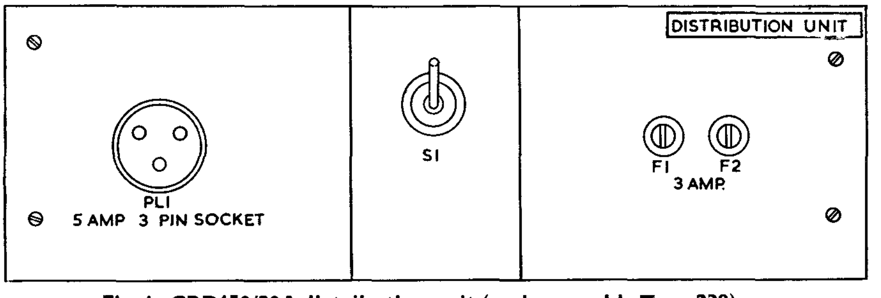


Fig. 1. CRD150/20A distribution unit (rack assembly Type 238)

CRD150/20A—Distribution unit (rack assembly Type 238)

3. This unit consists of a panel bearing a 3-pole mains outlet socket PL1, a double pole mains ON/OFF switch SW1 and two cartridge type fuses F1 and F2. The single-phase 240V mains supply is fed from the termination at the base of rack assembly Type 238 through fuses F1 and F2 and ON/OFF switch SW1 to the 3-pole outlet socket PL1. The mains output voltage is applied to various units on this rack via PL1.

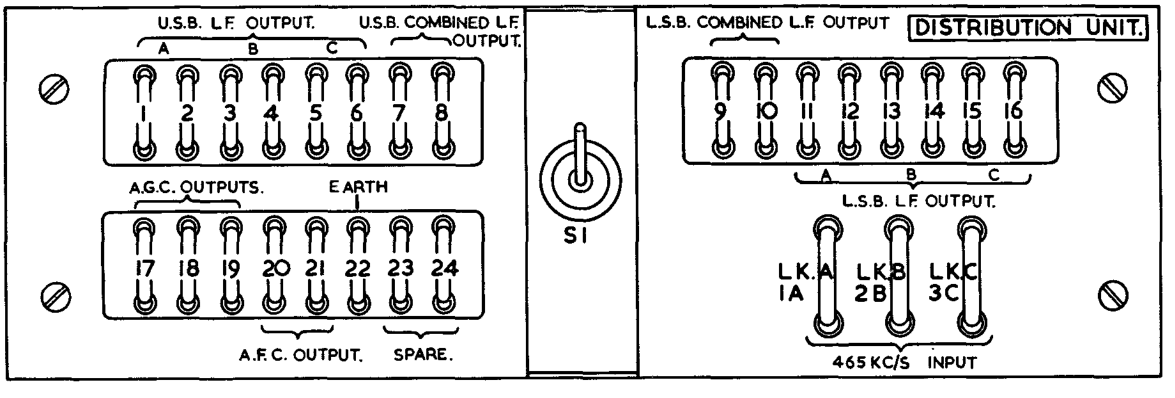


Fig. 2. SSR2 distribution unit (rack assembly Type 239)

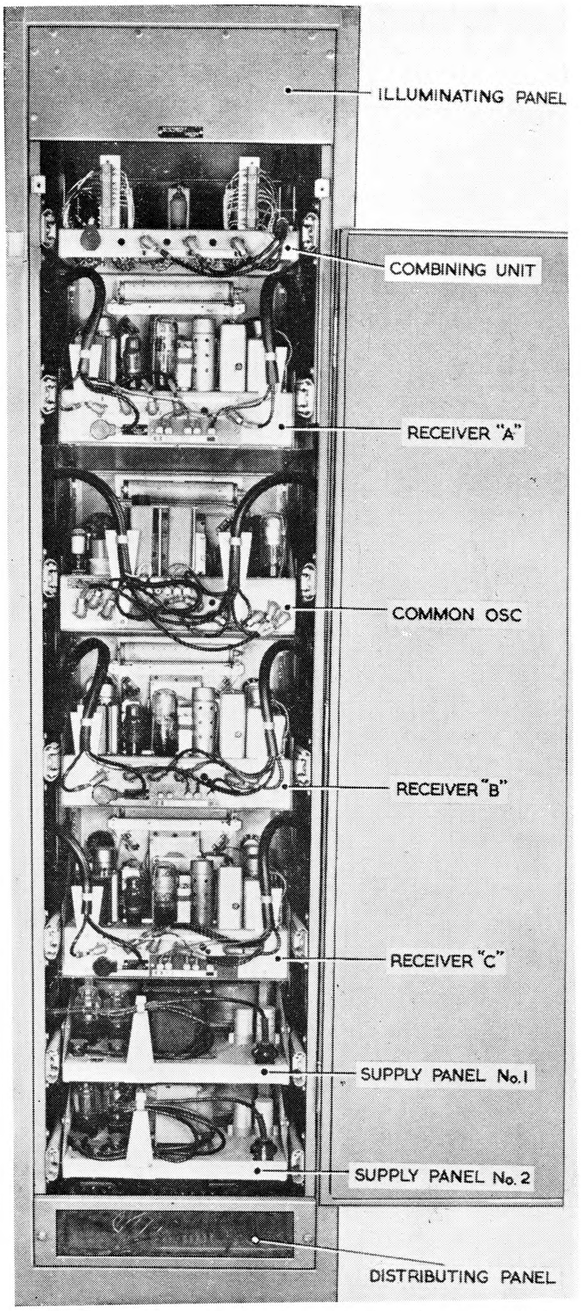


Fig. 3. Rear view of rack assembly Type 238

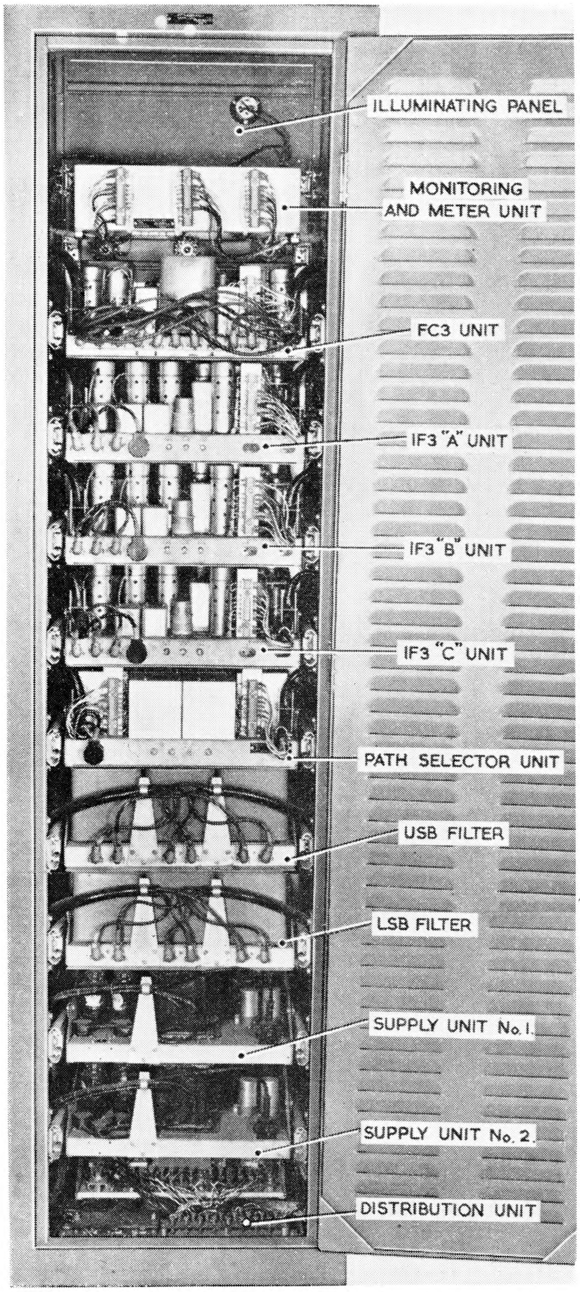


Fig. 4. Rear view of rack assembly Type 239

4. The three 465 kc/s outputs from the receivers on rack assembly Type 238 are fed to plugs A, B and C. For telephony working the three connectors to the combining unit are plugged in at A, B and C. For single-sideband working the three combining unit plugs are inserted into the three dummy plugs M on the bottom of the rack, and the three SSR2 connectors are inserted into plugs A, B and C.

5. The connections to the terminal board in this unit are as follows:—

Terminal No.	*Connected to—on Rack assembly Type 238*	*External connection*
1	Combining unit	Combined DSB output
2	Combining unit	LF output
3	Combining unit	AFC from SSR2 rack
4	Combining unit	AFC from SSR2 rack
5	Earth connection to all chassis and cabinet earth	Earth
6	Combining unit	AGC voltages from the SSR2 rack
7	Combining unit	AGC voltages from the SSR2 rack
8	Combining unit	AGC voltages from the SSR2 rack
9	Receiver A	AF output (Double sideband) from rereceiver A
10	Receiver A	AF output (Double sideband) from rereceiver A

Terminal No.	*Connected to—on CRD150/20A rack*	*External connection*
11	Receiver B	Double sideband AF output from receiver B
12	Receiver B	
13	Receiver C	Double sideband AF output from receiver C
14	Receiver C	Double sideband AF output from rereceiver C
15	Not used	
16	Not used	

SSR2—Distribution unit (rack assembly Type 239)

6. This unit consists of a double-pole mains ON/OFF switch SW1, two cartridge-type fuses F1 and F2, line output terminals and three 465 kc/s IF inputs from the receivers. U-links are provided so that the IF inputs and AF outputs can be broken for test purposes.

7. The three 465 kc/s IF inputs are fed through coaxial U-links A, B and C from the three receivers, and are then fed to the F.C.3 unit.

8. The mains input is fed from the three terminals at the bottom of the cabinet via the inter-unit cabling to the three terminals in the distribution unit. The mains supply then passes through the double-pole mains ON/OFF switch SW1 and the two fuses F1 and F2. The supply is fed via F1 and F2 out to the supply units No. 1 and 2 and the illuminating unit on the rack assembly Type 239.

9. The 24 Post Office Type U-links mounted on the front panel are connected in the following outputs:—

Link No.	
1 and 2	Path A
3 and 4	Path B
5 and 6	Path C
7 and 8	Upper sideband combined AF output
9 and 10	Lower sideband combined AF output
11 and 12	Path A Lower sideband AF output
13 and 14	Path B Lower sideband AF output
15 and 16	Path C lower sideband audio frequency output
17	Path C automatic gain control from IF3 unit A
18	Path B automatic gain control from IF3 unit B
19	Path A automatic gain control from IF3 unit C
20 and 21	Automatic frequency control output
22	Path C automatic gain control output to CRD150/20A. (rack assembly Type 239)

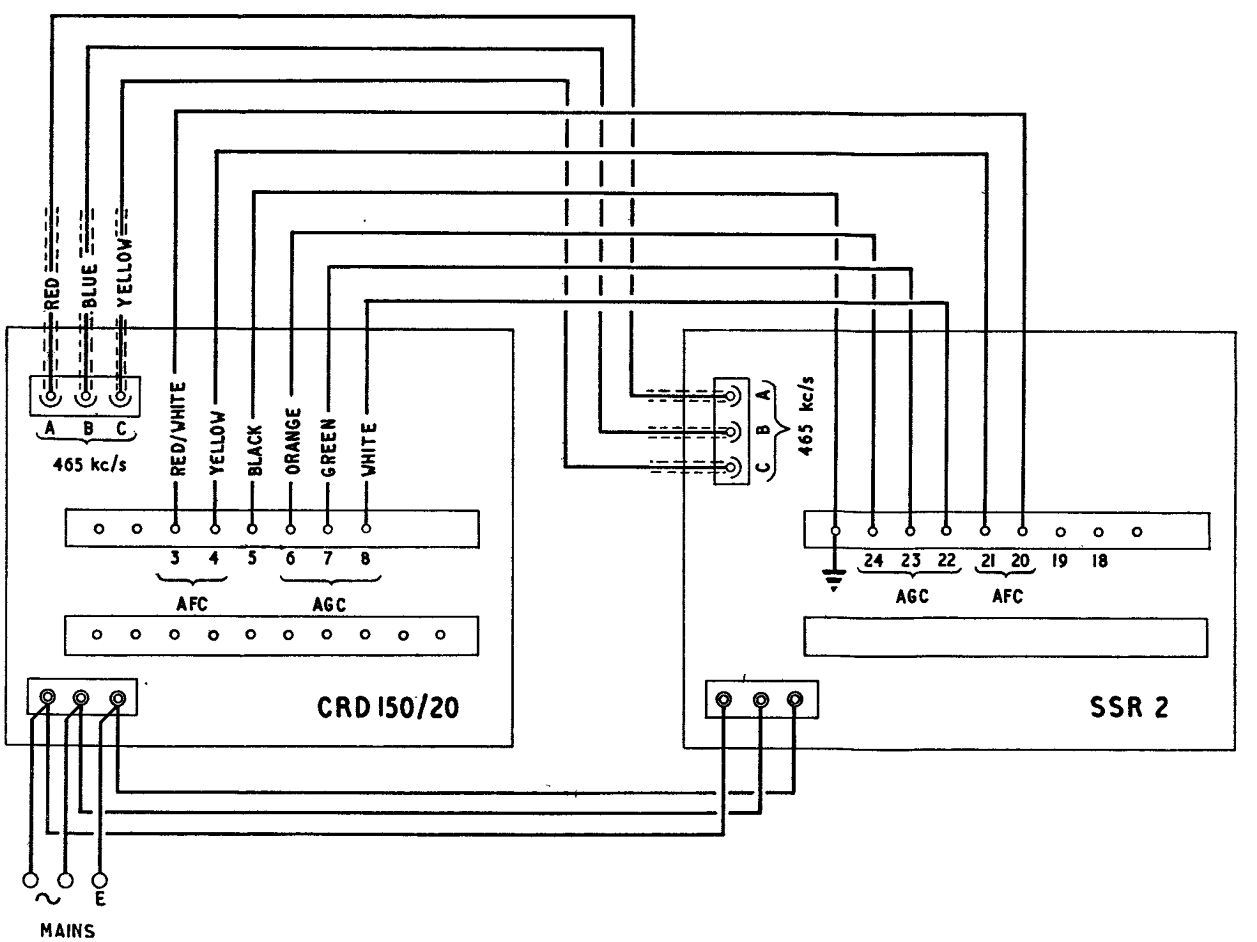
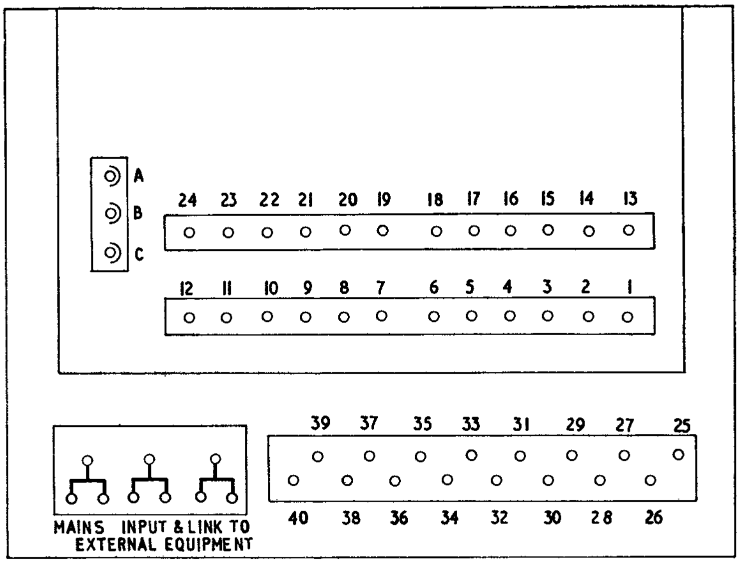


Fig. 5. Diagram showing connections between rack assemblies Type 238 and Type 239



TAG No	DESIGNATION
1, 2	USB AF OUTPUT 'A'
3, 4	USB AF OUTPUT 'B'
5, 6	USB AF OUTPUT 'C'
7, 8	USB COMBINED OUTPUT
9, 10	LSB COMBINED OUTPUT
11, 12	LSB AF OUTPUT 'A'
13, 14	LSB AF OUTPUT 'B'
15, 16	LSB AF OUTPUT 'C'
17	AGC OUTPUT 'C'
18	AGC OUTPUT 'B'
19	AGC OUTPUT 'A'
20, 21	AFC OUTPUT
22	AGC INPUT TO CRD 150/20 'C'
23	AGC INPUT TO CRD 150/20 'B'
24	AGC INPUT TO CRD 150/20 'A'

1 AF OUTPUTS
FOR TELEGRAPHY WORKING, V.F. OUTPUTS TO BE TAKEN FROM TERMINALS 1-6 & 11-16
FOR TELEPHONE WORKING TERMINALS 1-6 ARE CONNECTED TO TERMINALS 25-30 BY A CABLEFORM AND TERMINALS 11-16 ARE CONNECTED TO TERMINALS 31-36 BY A CABLEFORM THE SELECTED OUTPUTS ARE TAKEN FROM TERMINALS 7-10

2 AGC
(1) FROM CARRIER ONLY LINKS 17, 18 & 19 ARE REMOVED LINKS 22, 23 & 24 ARE IN PLACE
(2) FROM CARRIER & SIDEBAND LINKS 22, 23, & 24 ARE REMOVED LINKS 17, 18, & 19 ARE IN PLACE

Fig. 6. Output terminal layout (SSR2)

Link No.	
23	Path B automatic gain control output to CRD150/20A (rack assembly Type 239)
24	Path C automatic gain control output to CRD150/20A (rack assembly Type 239)

EQUIPMENT INTERCONNECTIONS

Introduction

10. The two racks CRD150/20A and the SSR2 each contain a number of separate units which are connected together by means of cable-forms at the rear of the racks (*fig.* 3 *and* 4). The units are arranged to slide in and out of the racks; provision is made for looping the cables to the rear of the units and so enable the units to be partially withdrawn from the rack for ease of servicing. Access to the rear of the units, and the cabling, is by the hinged doors at the rear of the two racks.

11. A separate cabling system is used in each rack. The connections between the CRD150/20A and the SSR2 rack are made between the terminals at the base of each unit and are shown in fig. 5.

12. The terminals used for external connections to other equipment are shown in fig. 6 and are situated at the base of the SSR2 rack and its distribution unit.

CRD150/20A—Rack assembly Type 238

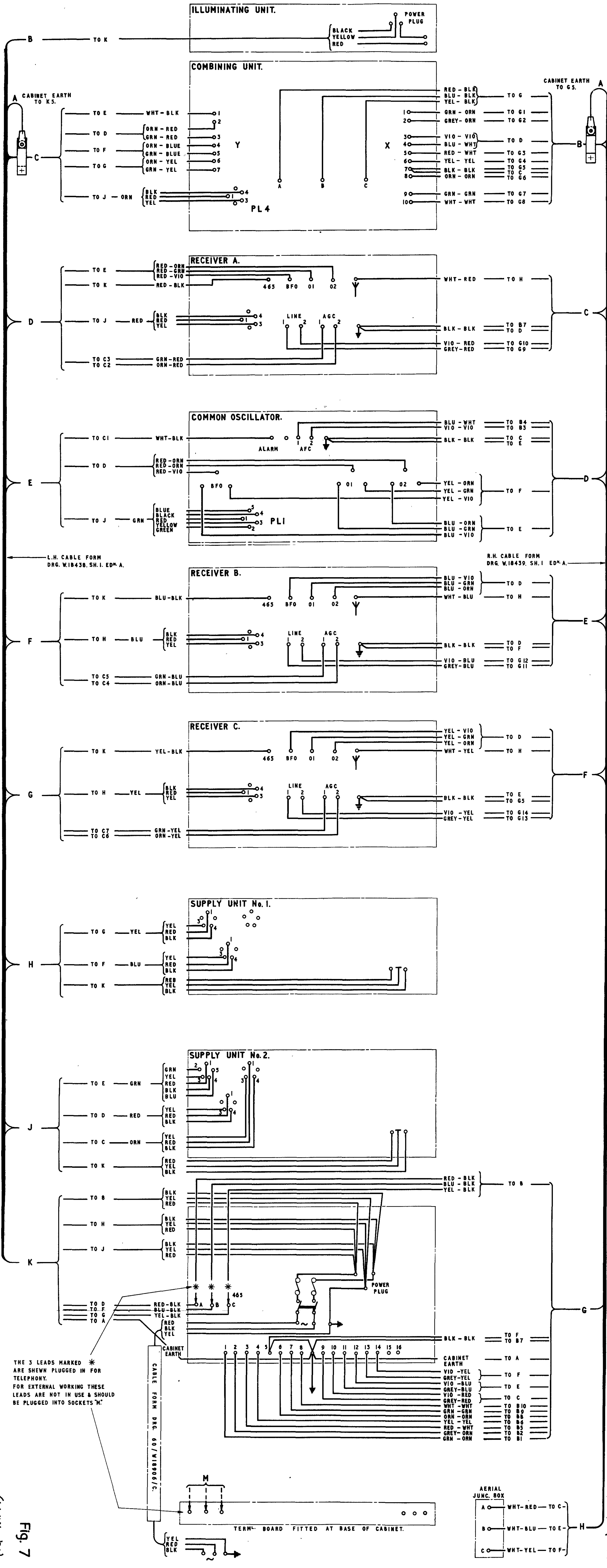
13. The unit interconnections and cabling on this rack is shown in fig. 7. Tracing wires between units is facilitated in fig. 7 by the letters indicating the branches of the cabling serving particular units. The individual wires are indicated by their colour.

SSR2—Rack assembly Type 239

14. The unit interconnections and cabling on this rack are shown in fig. 8. The letters indicate the branch of the cabling serving a particular unit. Individual wires are traced by the colour coding indicated in fig. 8.

53454 469234 8037 12/54 625 CWSLtd1110 Gp539-2

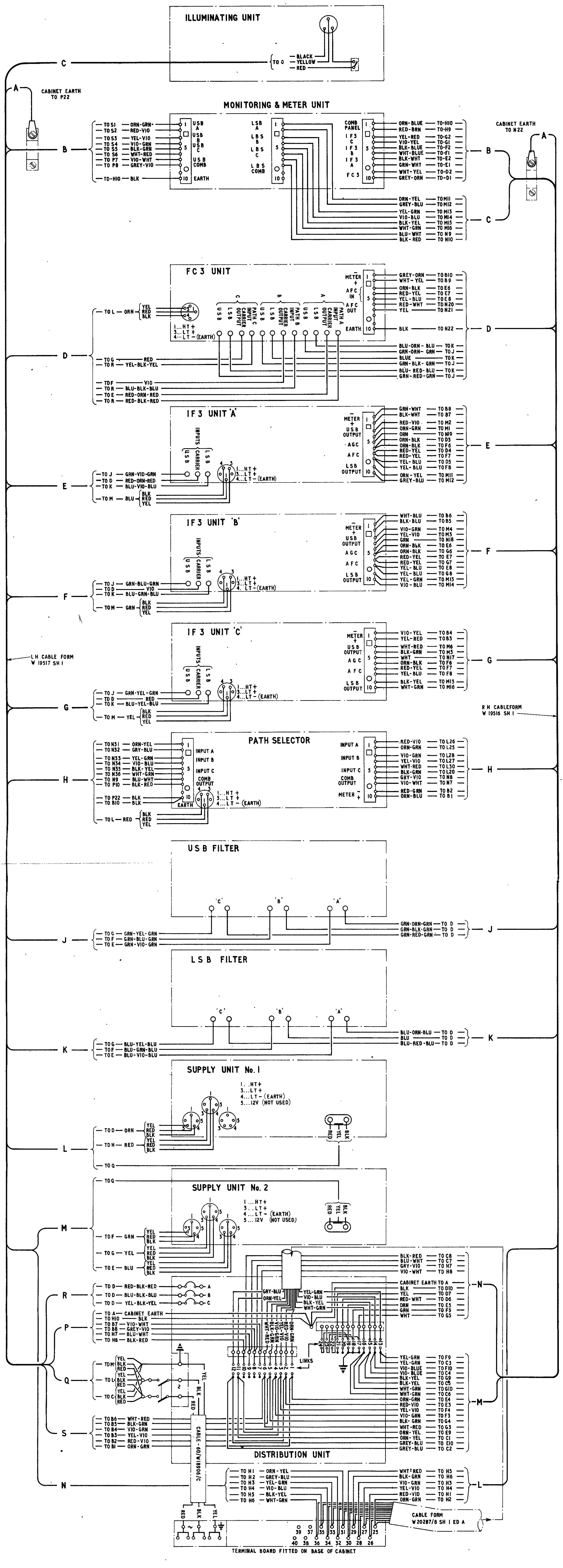
Fig.7



Rack assembly Type 238—unit interconnections

Fig. 7

(A.L.11/Nov. 54)



Rack assembly Type 239–unit interconnections

A.P 2980S, Vol.1, Part 1, Chap. 9 (A.L. 11)

(A.L.11/Nov.54)

PART 2

TECHNICAL INFORMATION

(SERVICING)

P19210 M34601/G1355 9/51 500 C & P Gp. 1

Chapter I.—OVERALL PERFORMANCE TESTS

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LIST OF ILLUSTRATIONS

Introduction

1. This chapter contains the recommended method of carrying out overall performance tests on the triple diversity receiving equipment R.1923, comprising rack assemblies Type 238 and Type 239.

Test equipment

2. The following test equipment will be required to carry out the overall performance tests:—

Item	*Qty.*	*Stores Ref.*
Signal generator Type 56	2	10S/647
Output units (signal generator)	2	10S/16209
Output dividing units	1	10S/16519
Combining units (signal generator)	1	10S/16205
Output power meter Type 2	1	10S/11934
Headphones	1 Pr.	

3. To carry out many of the tests in this chapter a single-sideband signal is simulated by means of two signal generators Type 56 and a signal generator combining unit arranged as shown in fig. 1. One of the signal generators is tuned to the carrier frequency whilst the other is tuned to the upper or lower sideband frequency. The output level of the carrier signal generator is reduced to 26 dB below the output level of the sideband signal generator by means of the signal generator output unit. The outputs from both signal generators are combined in the signal generator combining unit and then fed into the aerial input socket of the receiver under test.

Signal generator output unit (fig. 1)

4. This unit has one input and two output co-axial sockets and a switch. The input socket is connected directly to the signal generator output socket. One of the output sockets is labelled DIRECT and feeds the signal generator output via a 0·1-microfarad capacitor and a 68-ohm resistor. The socket labelled –26 dB is connected to the signal generator output via an attenuator pad, introducing a loss of 26 dB.

Note . . .

The double-pole switch on the combining unit should be normally **open**; *it is only to be closed when outputs exceeding 100 mV (plus 100 dB) are taken from the signal generators, as in these conditions the output impedance of the generators increase from 10 ohms to about 50 ohms.*

Signal generator combining unit (fig. 1)

5. The combining unit has two input and one output co-axial sockets, and combines the outputs from the two signal generators before feeding them into the receiver under test; at the same time it effects an impedance match between the output of the signal generators and the input of the receiver under test. The unit introduces loss of 6 dB in the combined output from the signal generators.

Output dividing unit (fig. 2)

6. This unit combines the outputs from two signal generators and simultaneously applies the combined output to the aerial input sockets of the three receivers under test. The unit also provides an impedance match between the signal generator output unit and the aerial input circuits of the receivers, and introduces a loss of 26 dB in the combined output level. The dividing unit has three output and two input co-axial sockets.

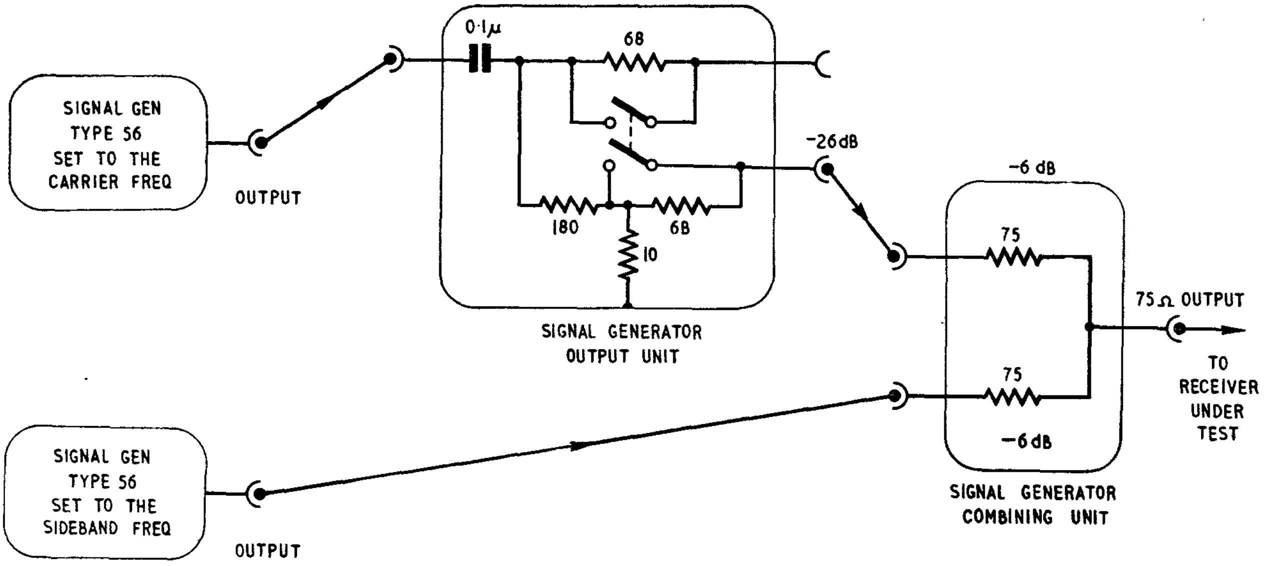

Fig. 1. Block diagram–single sideband test signal

Overall sensitivity test

7. Before carrying out this test ensure that the controls on the rack assemblies Type 238 and 239 are set up as follows: —

Receivers

(Receiver under test) HF GAIN control to maximum (fully clockwise)

(Other two receivers) HD GAIN control to minimum (fully counter-clockwise)

(All three receivers) PASS BAND switches to 13,000 c/s.

(All three receivers) Operational switches to AGC–SSB

(All three receivers) INPUT ATTENUATORS to 0 dB

Common oscillator

2ND oscillator tuning to zero

BFO switch to OFF

AFC MOTOR switch to EXT.

FC 3 unit

Third oscillator switch to BELOW 10 Mc/s—DCH PATH GAIN controls to maximum (fully clockwise)

IF 3 units

(All three units) USB INPUT attenuators to 12 dB

(All three units) LSB INPUT attenuators to 12 dB

Distribution unit

Remove links 17, 18 and 19 and connect 0·5 megohm resistors across the sockets (to reduce the AGC time constant)

Ensure that links 22, 23 and 24 are in position.

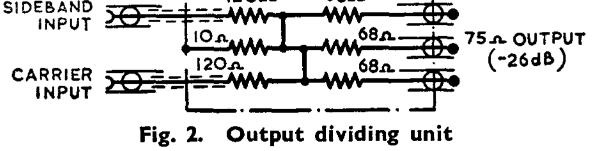

Fig. 2. Output dividing unit

Path A

8. Set the BANDCHANGE switch on receiver A to position 1. Set the BANDCHANGE switch on the common oscillator to position 1. Set the USB SELECTOR switch to PATH A on the path selector unit.

9. With the set-up described in para. 3 for simulating a single sideband signal, connect the output lead from the signal generator combining unit to the aerial socket of receiver unit A (at the rear of the unit).

10. Tune the carrier signal generator to 2 Mc/s and set the output voltage to *plus* 18 dB relative to 1 microvolt.

Note . . .

All further references to signal generator levels are relative to 1 microvolt.

11. Tune the 'sideband' signal generator to 2 Mc/s and set the output voltage to plus 18 dB.

12. Plug in headphones to the PHONES jack on the left-hand side of the IF3 A unit. Rotate the INCREMENTAL TUNING dial on the 'sideband' signal generator until a 1000 c/s tone is heard in the headphones. The signal level will be indicated by a reading on the OUTPUT meter on the monitoring and meter unit.

13. Adjust the attenuator control (under the output meter) until the output meter indicates 0 dB (centre scale).

14. Switch ON the AFC MOTOR (on the common oscillator unit) and ensure that the signal remains in the IF pass band (observe the output meter and ensure that a signal level is indicated).

15. Note the output signal level by reading the setting of the attenuator control and the output meter reading (on the monitoring and meter unit).

16. Disconnect the output lead from the 'sideband generator' at the signal generator output unit socket, and measure the output level by means of the attenuator and output meter on the monitoring and meter unit.

17. Compare the level measured in para. 15 with that measured in para. 16 and note the difference. *The level measured in para. 15 must be at least 20 dB above that measured in para. 16.* This ensures that the ratio (signal + noise)/noise is at least 20 dB. The 'noise' is represented by the 'carrier' generator.

18. Repeat the tests outlined in para. 9 to 17 for each of the following carrier frequencies:—

4 Mc/s
7 Mc/s
13 Mc/s
24 Mc/s

The (signal + noise)/noise ratio must be at least 20 dB for each of these frequencies applied to path A.

Path B

19. Connect the combined output from the 'carrier' and 'sideband' signal generators to the aerial socket of receiver B (at the rear of the unit).

20. Set the USB SELECTOR switch on the path selector unit to **B**, and plug in the headphones to the PHONES jack on the left-hand side of the IF3 B unit.

21. Repeat the tests outlined in para. 14, 15, 16 and 17.

Path C

22. Connect the combined output from the 'carrier' and 'sideband' generators to the aerial socket at the rear of receiver C.

23. Set the USB SELECTOR switch on the path selector unit to **C**, and plug in the headphones to the PHONES jack on the left-hand side of the IF C unit.

24. Repeat the tests outlined in para. 14, 15, 16 and 17.

Test of AF level

25. Set the AFC motor switch to ON, and ensure that all other controls on the equipment are set to the positions given in para. 7.

26. Set the BANDCHANGE switches on the three receivers and the common oscillator to BAND 2.

27. Simulate an upper sideband signal with the two signal generators as described in para. 3. Connect the output from the signal generator combining unit to the aerial socket of Receiver A. Adjust the INCREMENTAL TUNING dial on the 'sideband' signal generator until a 1000 c/s tone is heard in the headphones plugged into the PHONES jack on the left-hand side of the IF3 A unit.

28. Set both the output levels of the 'carrier' and 'sideband' signal generators to plus 66 dB.

Upper sideband

29. Measure the output level from the IF3 A unit by setting the PATHS switch on the monitoring and meter unit to USB A and noting the setting of the attenuator switch and the reading of the output meter.

30. The AF output level under these conditions must be at least 10 dB above 1 mW.

Lower sideband

31. Set the PATHS switch on the monitoring and meter unit to LSB A, and plug the headphones into the PHONES jack on the right-hand side of the IF3 A unit.

32. Adjust the INCREMENTAL TUNING dial on the 'sideband' signal generator until a 1000 c/s tone is heard in the headphones. (Ensure that the output level on both the 'carrier' and 'sideband' signal generators is 66 dB.)

33. Measure the AF output level by means of the attenuator and output meter on the monitoring and meter unit.

34. The AF output level must be at least 10 dB above 1 mW. *Failure to meet these levels for the upper and lower sidebands will necessitate the re-adjustment of levels.*

AF response and sideband filter check

35. It is important to ensure that the sideband filters are covering the required audio frequency range; otherwise, when working with multi-channel systems, some channels may be lost. This may be ascertained by means of an overall AF response check carried out in the following manner:—

Path A–upper sideband

36. With the receiving equipment controls set as for the previous tests and using the same test equipment, set the PATHS switch on the monitoring and meter unit to USB A and plug the headphones in the PHONES jack on the left-hand side of the IF3 A unit.

37. Rotate the INCREMENTAL TUNING dial on the 'carrier' signal generator until a 200 c/s tone is heard in the headphones.

38. Measure the output level by means of the attenuator and output meter on the monitoring and meter unit.

39. Rotate the INCREMENTAL TUNING dial on the 'carrier' signal generator in such a direction as to cause an increase in frequency of the tone heard in the headphones, and at the same time ensure that the variation of level indicated on the monitoring and meter unit does not exceed 6 dB.

40. Increase the upper sideband frequency to 5800 c/s by means of the INCREMENTAL TUNING dial on the 'carrier' signal generator and note the output level variation, which must not vary from the level measured at 200 c/s by more than 6 dB.

Path A–lower sideband

41. Set the PATHS switch on the monitoring and meter unit to LSB A and plug the headphones into the PHONES jack on the right-hand side of the IF3 A unit.

42. Repeat the tests in para. 36 to 40 inclusive.

Paths B and C (upper and lower sidebands)

43. Repeat the AF response tests for the upper and lower sidebands for paths B and C.

Path selector tests

44. Set the path selector switch to AUTO (path selector unit) and ensure that all other controls on the receiving equipment are set as listed in para. 7.

45. Set the COMBINED OUTPUT control on the path selector unit to maximum (fully clockwise position).

46. Connect the output leads from the 'carrier' and 'sideband' signal generator output units to the input sockets of the output dividing unit; connect the three output leads to the three aerial input sockets of the receivers.

47. Set the 'carrier' signal generator to 2 Mc/s and the output level to plus 60 dB.

48. Set the PATHS switch to USB A on the monitoring and meter unit and plug the headphones into the PHONES jack on the left-hand side of the IF3 A unit.

49. Rotate the INCREMENTAL TUNING dial on the 'sideband' signal generator until a 1000 c/s tone is heard in the headphones; adjust the signal generator output level control until the output level indicated by the output meter and attenuator control is 1 mW (a reading of 0 dB) on the monitoring and meter unit.

50. Ensure that this output level is obtained when the PATHS switch is set to positions B and C.

Upper sideband

51. Set the FEEDS switch to COMB, and the PATHS switch to USB A, on the monitoring and meter unit. Set the FEEDS switch on the path selector unit to V1A.

52. Set the USB INPUT control on the IF3 A unit to 14 dB.

53. If the switching action of the path selector is functioning correctly a reading of approximately 0·6 mA should be indicated by the VALVE FEEDS meter on the monitoring and meter unit; turn the FEEDS switch on the path selector unit first to V3A and then to V2A, the VALVE FEEDS meter should read approximately 4·4 mA in both instances. Reduce the output of the IF3 A unit by means of the USB attenuator to 10 dB, when V1A should conduct more heavily and either V2A or V3A should show a reduced feed current.

Lower sideband

54. Set PATHS switch to LSB A; plug the headphones into the PHONES socket on the right-hand side of the IF3 A unit and readjust the INCREMENTAL TUNING control on the sideband signal generator until a 1000 c/s note is heard in the phones. Ensure that the 'carrier' output level is set to 60 dB, and adjust the output level of the 'sideband' generator until the level measured on the output meter (monitoring and meter unit) is 0 dB.

55. Ensure that this output level is obtained when the PATHS switch is set to LSB, positions B and C.

56. Set the LSB INPUT control to 14 dB on IF3 A unit.

57. Repeat the tests detailed in para. 53, reducing the output by means of LSB attenuator to 10 dB.

AFC check (local)

58. This test is to ensure that the AFC discriminators in the combining unit are correctly balanced and that the AFC motor and relay valves are functioning correctly.

Note . . .

The combining unit must be switched on by operation of the DSB/SSB switch to DSB for at least 20 minutes before carrying out these tests.

59. The controls should be set as follows:—

Receivers

HF GAIN controls to maximum (fully clockwise)
PASS BAND switches to 13000 c/s.
Operational switches to AGC LOCAL I.
INPUT ATTENUATOR to 0 dB.

Common oscillator

2ND Oscillator tuning control to 0
BFO switch to OFF
AFC MOTOR switch to OFF

Combining unit

DSB/SSB switch to DSB
AGC switch to LOCAL SEP
AFC switch to LOCAL

Relay valves

60. To check that the relay valves in the common oscillator are correctly adjusted, turn the AFC switch on the combining unit to OFF. Turn the GAIN controls on the receiver to minimum (counter-clockwise) and switch ON the AFC MOTOR (common oscillator). The 2ND OSC. control on the common oscillator unit should remain stationary; if there is any movement of this control it will be necessary to carry out adjustment of the relay valves.

61. Turn the receiver GAIN controls to maximum (fully clockwise), and set the AFC MOTOR control to OFF.

Path A

62. Connect one of the signal generators to the aerial socket of receiver A (at the rear of the unit) via the signal generator output unit. Set the switch on the output unit to 75 (the output to the receiver is taken via the 0 dB socket). Tune the signal generator to 3 Mc/s and set the output level to 20 dB.

63. Set the BANDCHANGE switches on the receiver A and the common oscillator unit to BAND 2, and plug in the headphones to the PHONES socket on the receiver A unit. Tune the common oscillator and receiver A units to the unmodulated signal fed in by the signal generator.

64. Turn the BFO control on the common oscillator unit to position 2 and retune until a zero beat note is heard in the headphones. Turn the BFO control to the OFF position.

65. Set the AFC MOTOR switch on the common oscillator unit to ON and check that there is no movement of the 2ND OSC control from its zero position.

66. Swing the INCREMENTAL TUNING control on the signal generator slowly on either side of the zero position between the limits of +1 Kc/s and −1 Kc/s. Check that the AFC system operates in the right sense to bring the signal back into the IF pass band, and that the 2ND OSC control returns to zero when the INCREMENTAL TUNING control on the signal generator is returned to zero. This may be checked by setting the feeds switch on receiver A to V6 and observing the meter on the receiver unit for minimum feed current.

67. Swing the INCREMENTAL TUNING control on the signal generator to + and −3 Kc/s and check that the alarm lamp on the combining unit lights when the 2ND OSC control reaches the + and −3 Kc/s marks.

Path B

68. Connect the output from the signal generator to the aerial socket of receiver B via the signal generator output unit; set up the frequency and output level as in para. 60.

69. Repeat the tests given in para. 61 to 65 on receiver B.

Path C

70. Connect the output from the signal generator to the aerial socket of receiver C, and set the frequency and output level as in para. 60.

71. Repeat the tests given in para. 61 to 65 on receiver C.

AFC check (external)

72. This test is to ascertain that the discriminators in the IF3 units are operating correctly.

73. Set the receiving equipment controls to the positions given in para. 7.

Path A

74. Connect the output from a signal generator through the output unit to the aerial socket of receiver A (at the rear of the unit); tune the signal generator to 2 Mc/s and set the output level to 20 dB.

75. By means of the TUNING CONTROL on the common oscillator unit, the tuning control on the receiver unit A and the 2ND OSC control of the common oscillator unit, tune to the unmodulated 2 Mc/s signal.

76. Set the AFC MOTOR control (common oscillator unit) to ON; set the monitoring switch on the IF3 unit to V1. Set the FEEDS switch (monitoring and meter unit) to IF3 A. Check that the AFC system maintains the signal within the pass band of the carrier filters by observing that the feed to V1, indicated on the VALVE FEEDS meter on the monitoring and meter unit, remains at a minimum value.

77. Swing the 2ND OSC control a very small amount on either side of the zero and check that the AFC system brings the equipment back on tune.

Path B

78. Connect the signal generator to the aerial socket of receiver B (at the rear of the unit). Set the frequency and output level of the signal generator as given in para. 74.

79. Repeat the tests in para. 75 to 77, for path B.

Path C

80. Connect the signal generator to the aerial socket of receiver C (at the rear of the unit). Set the frequency and output level of the signal generator as given in para. 74.

81. Repeat the tests in para. 75 to 77, for path C.

AGC check (local)

82. Set the operational switch on receiver A to AGC LOCAL I; set the AGC switch on the combining unit to LOCAL SEP. Set the DSB/SSB on the combining unit to DSB. Set the other controls on the receiver and SSB racks to the positions given in para. 7.

Path A

83. Connect the output from one of the signal generators via the signal generator output unit to the aerial socket of receiver A. Set the frequency of the signal generator to 2 Mc/s and apply a 1000 c/s modulation at a depth of 40 per cent. Set the output level to 0 dB.

84. Connect the output power meter Type 2 across tags 1 and 2 of terminal strip X at the rear of the combining unit; set the output meter to 600-ohm input.

85. Adjust the IF GAIN control on receiver A until the output power meter indicates an output of 100 mW (with an input to the receiver of 1 microvolt).

86. Vary the input to the receiver A by means of the output control on the signal generator from 0 to 60 dB, and check that the level on the output power meter is constant to within 9 dB.

Path B

87. Connect the output from the signal generator via the signal generator output unit to the aerial socket of receiver B. Set up the signal generator as in para. 83.

88. Repeat the tests given in para. 85 to 87 for receiver B.

Path C

89. Connect the output of the signal generator via the signal generator output unit to the aerial input socket of receiver C. Set up the signal generator as in para. 83.

90. Repeat the tests given in para. 85 to 87 for receiver C.

91. Turn the AGC switch on the combining unit to LOCAL COMB, and set the GAIN controls of the three receivers to maximum (fully clockwise).

92. Connect the signal generator output to the aerial input socket of receiver A.

93. Increase the output of the signal generator from 0 to 60 dB, and check that the AGC voltage is effective on all three receivers by observing that the current indicated by the RECEIVER B and RECEIVER C meters on the combining unit decreases as the current indicated by RECEIVER A meter increases.

AGC check (external)

Path A

94. Simulate a single sideband signal by the method described in para. 3 and feed the combined output into the aerial socket of receiver A, so that a 1000 c/s tone is heard in the headphones plugged into the PHONES socket on the left-hand side of the IF3 A unit, with the PATHS switch set to LSB A.

95. Set the rest of the controls on the equipment to the positions given in para. 7.

96. Set the output attenuators on the carrier and sideband signal generators to 6 dB and note the output signal level by means of the output meter and attenuator on the monitoring and meter unit.

97. Increase the output level of the carrier and sideband generators simultaneously up to 86 dB and check that output level measured on the monitoring and meter unit does not vary more than 5 dB from the level noted in para. 96.

98. Set the AGC switch on the combining unit to EXT COMB, and the HF GAIN controls of all the three receivers to maximum (fully clockwise).

99. Vary the output of the two signal generators in a manner described in para. 96 and 97, and with the feeds switch on each of the three receivers set to V6, observe that the indications on the meters on the three receivers decrease progressively.

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