AIR PUBLICATION

2980R

VOLUME I

# DUAL-DIVERSITY RECEIVING EQUIPMENT FGRI. 18014

*(Rack assembly Type 272)*

## GENERAL AND TECHNICAL INFORMATION

Prepared by direction of
the Minister of Supply

Promulgated by Command
of the Air Council

AIR MINISTRY
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# LAYOUT OF A.P.2980R

## DUAL-DIVERSITY RECEIVING EQUIPMENT

**Vol. 1 General and technical information**

**Vol. 2 General orders and modifications**

**Vol. 3 Schedule of spare parts**

**Vol. 4 Planned servicing schedules**

**Vol. 5 Basic servicing schedules**

**Vol. 6 Repair and reconditioning instructions**

# LIST OF PARTS

**Note.**—*A list of Chapters appears at the beginning of each Part.*

# INTRODUCTION

**1.** The dual diversity receiving equipment FGRI.18014 includes a number of panels mounted on a rack assembly. The general arrangement of the rack assemblies—of which there exist four variants—is described in Chapter 1, and the individual panels in Chapters 2 to 9.

**2.** It should be noted, in connection with Chapter 1, that only the first version of the rack assembly, namely Type 272, Stores Ref. 10D/18707, is described. Later variants are as follows :—

| *Type* | *Stores Ref.* |
|---|---|
| 272A | 10D/19931 |
| 9352 | 10D/19932 |
| 9352A | 10D/19933 |

**3.** Types 9352 and 9352A are not fitted with the tone sender unit (Chapter 6).

**4.** Type 272A and Type 9352A are fitted with a switch panel different from that described in Chapter 9. The differences are very minor ones, and are shown on Marconi drawing W.26936, Sheet 2, Edition D—the earlier version is covered in Edition B of the same drawing.



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## PART I

# GENERAL INFORMATION

AIR MINISTRY

DUAL-DIVERSITY RECEIVING EQUIPMENT FGR1.18014

**This is A.L. No. 1 to A.P.2980R, Volume 1**

**Part 1.** *Insert* the attached List of Chapters and Chapter 7 to follow Part 1 Marker Card. *Record* the incorporation of this A.L. in the Amendment Record Sheet.

SIGNALS

**PART 1**

# GENERAL INFORMATION

## LIST OF CHAPTERS

**Note.**—*A list of contents appears at the beginning of each chapter.*

# Chapter 1

# GENERAL DESCRIPTION AND PRINCIPLE OF OPERATION

## LIST OF CONTENTS



## LIST OF ILLUSTRATIONS



## INTRODUCTION

**1.** The dual diversity receiving equipment FGRI.18014 is designed to receive spaced diversity telephone and telegraph signals.

**2.** The equipment consists of nine separate units mounted one above the other in rack assembly Type 272 (*fig.* 1) the physical dimensions of which are as follows :—

Height — 7 ft. 0¼ in.

Width — 1 ft. 11½ in.

Depth — 1 ft. 8½ in.

The overall weight is approximately 5 cwt.

**3.** The power supply required to operate this equipment is 200-250V (50-60 c/s), or 110V at 50-60 c/s ; the power consumption is 600 watts.

## TECHNICAL FEATURES

### Types of service

**4.** The services provided are as follows :—

(1) Reception of a continuous wave (CW/ON/OFF) telegraphy signal.

(2) Reception of a modulated continuous wave (M.C.W.) telegraphy signal.

(3) Reception of a frequency shift keyed (F.S.K.) telegraphy signal.

(4) Reception of an amplitude modulated telephony signal.

### General

**5.** Two separate receivers are used to receive and amplify the two spaced diversity signals. Three frequency changers are used ; the local oscillators for the frequency changers of both receivers are common and are all contained in the oscillator unit Type 327.

**6.** Three intermediate frequencies are used, viz.:—

(1) 1·2 Mc/s

(2) 465 kc/s.

(3) 50 kc/s.

**7.** Selection of the stronger signal is automatic and automatic frequency control applied to the second frequency changer ensures that the residual mistune does not exceed plus or minus 20 c/s. The output is capable of operating any DC telegraphy equipment.

**8.** A tone-sender unit is included and enables a tone output to be fed to the line.

**9.** The frequency coverage is 1·5 to 30 Mc/s, arranged in five bands.

### Monitoring

**10.** Visual indication (by meters) of both of the signal path levels and the combined level is provided. Audio monitoring using the beat-frequency oscillator for both signal paths is provided. Provision is made for checking all valve currents and HT voltages.

### Sensitivity

**11.** The sensitivity of the receivers (CW reception) at a bandwidth of 1·8 kc/s at any carrier frequency is as follows :—

0·3 to 0·6$\mu$V for a 10dB signal/noise ratio.

### Selectivity

*Second channel*

**12.** The ability of the receivers to reject the second channel signal is indicated by the following figures :—

At 1·5-9·0 Mc/s signal to be at least 70dB above second channel level.

At 9·0-16 Mc/s signal to be at least 50dB above second channel level.

At 16·5-30 Mc/s signal to be at least 25dB above second channel level.

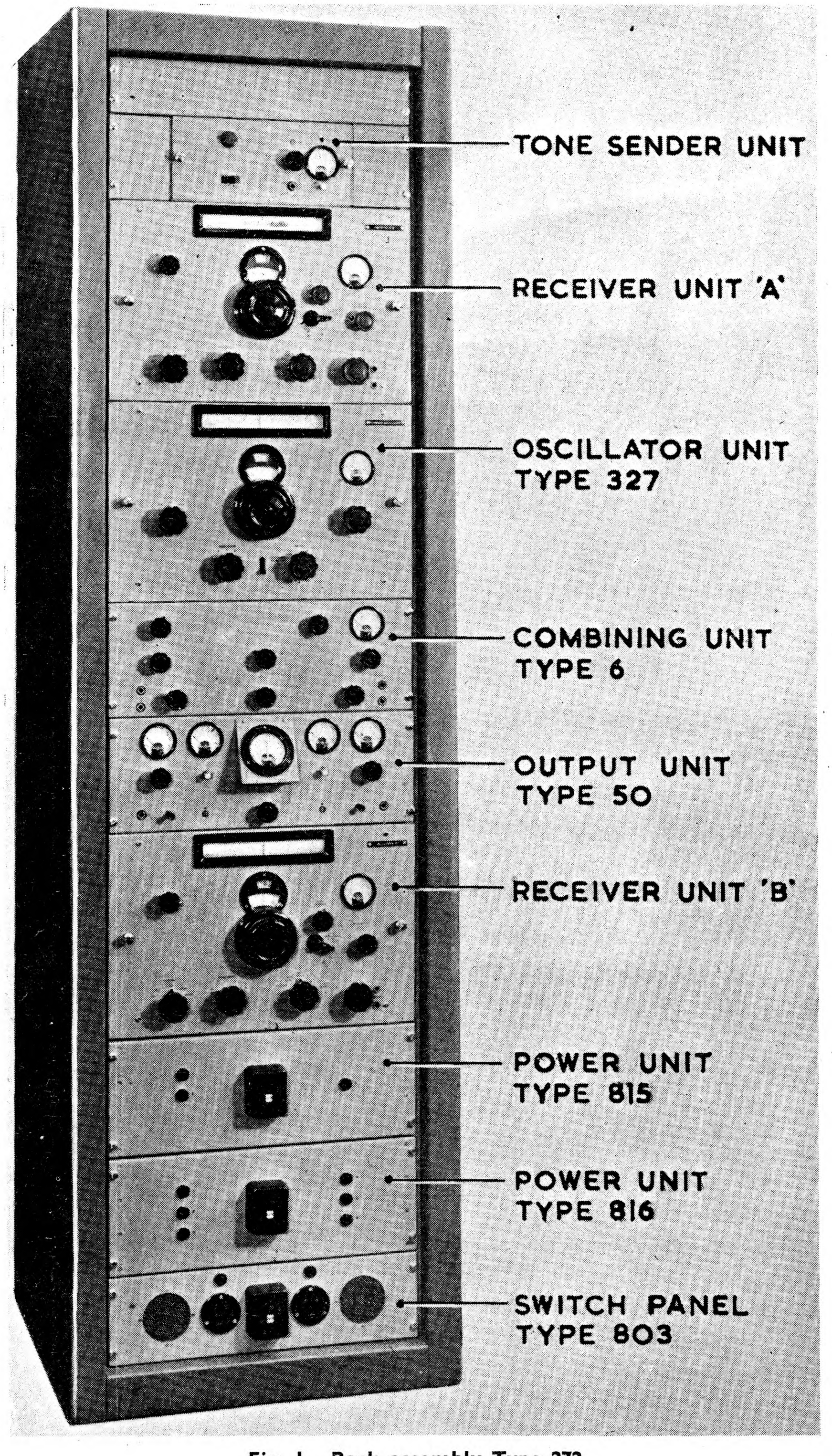


**Fig. 1. Rack assembly Type 272**

*Adjacent channel*

**13.** The ability of the receivers to reject the adjacent channel signal is indicated by the following figures :—

| Nominal bandwidth | | |
|---|---|---|
| *Telephony* | *Telegraphy* | *Adjacent channel* |
| 6·6 kc/s | 1·3 kc/s | 3dB below signal level |
| 17·5 kc/s | 4·4 kc/s | 40dB ,, ,, ,, |
| 28 kc/s | 6·2 kc/s | 60dB ,, ,, ,, |

**Keying speed**

**14.** This equipment will handle a telegraphy signal having a keying speed of up to 200 bauds (250 words per minute).

**Outputs**

**15.** The output impedance, when the tone sender is used, is 600 ohms.

**16.** The DC signal output is a maximum of 30-0-30mA delivered into a 1000-ohm earthed load.

## GENERAL DESCRIPTION

**Layout**

**17.** The location of the units comprising the complete equipment is given in fig. 1. The two receiver units, the oscillator unit, the combining unit and the output unit are made accessible for maintenance by mounting them on runners attached to the rack. These units may be fully withdrawn from the rack whilst being supported by runners, and tilted to permit easy access to the undersides of the chassis. The two power supply units are arranged so that they may be pulled out of the rack and are supported by brackets. The tone sender unit may be pulled forward, clear of its case. A hinged door is provided at the rear of the rack to give access to the rear of the units and the interconnections between them. Louvres in the door provide ventilation.

**Operation**

**18.** A brief general description of the operation of the complete equipment is given in the following paragraphs. A more detailed circuit description of each unit will be given in the appropriate chapter (see List of Chapters.)

**19.** The block diagram (*fig.* 2) indicates the signal paths through the various stages and units of the equipment.

**20.** The two signals received by the two spaced aerials referred to in the text as the A and B path signals, are fed into the input circuits (RF amp) of the A and B receivers. The signals are amplified and passed to the 1st frequency changers in the receivers.

**21.** A common oscillator (oscillator unit Type

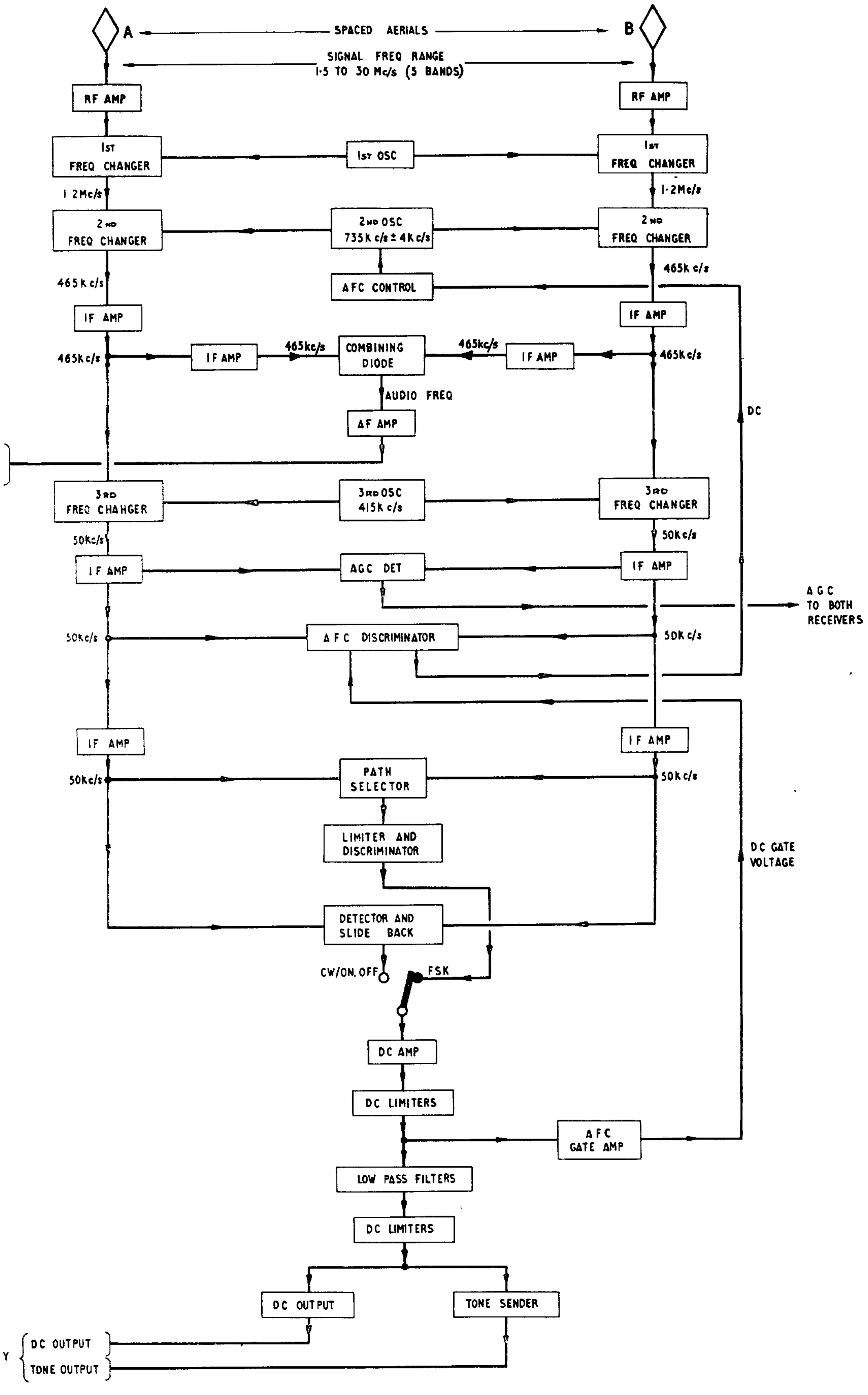


**Fig. 2. Dual diversity receiving equipment—block diagram**

327) provides the local oscillator frequency for both of the receivers. The practice of using one common oscillator in diversity systems simplifies the problem of frequency drift and automatic frequency control.

**22.** The A and B path signal frequencies are converted to 1·2 Mc/s by the 1st frequency changers in both receivers. The 1st I.F. is fed to the second frequency changers in both receivers. The 2nd local oscillator is also common to both receivers and is contained in the oscillator unit Type 327. Automatic frequency control is applied to this oscillator. The frequency control is effected by a motor-driven capacitor in the oscillator circuit. The voltage controlling this motor is developed by the AFC discriminator in the combining unit Type 6.

**23.** The outputs from the 2nd frequency changers are 465 kc/s and are fed to their respective 2nd IF amplifier stages in the A. and B receivers. The outputs from the 2nd IF amplifiers (in the receiver) are fed to 465 kc/s amplifiers in the combining unit Type 6.

**24.** The A and B (path) signal outputs from the 2nd IF amplifiers in the combining unit are combined in the combining stage and demodulated. The audio signal is amplified by the AF amplifier stage and is fed to the AF (telephony) output terminals.

**25.** The A and B path outputs from the 2nd IF stages in the receivers are fed into the two 3rd frequency changers in the combining unit. The local oscillator for the 3rd frequency changer is crystal-controlled at a frequency of 415 kc/s. The outputs from the two frequency changers are the 3rd IF's of 50 kc/s and are fed into the 3rd IF stages (combining unit).

**26.** The outputs from the two 3rd IF stages are combined in an AGC detector stage. The output from this stage is the AGC voltage which is fed back to the RF stages in the A and B path receivers to control the gain.

**27.** The outputs from the 3rd IF stages are fed to a discriminator stage which converts any frequency deviation of the IF into a control voltage which is fed back to frequency-control the circuit of the 2nd frequency changer stage in the common oscillator unit.

**28.** The outputs from the 3rd IF stages in the combining unit are fed to the 50 kc/s IF stages in the output unit Type 50. The two outputs from these IF stages are fed into a path selector stage which suppresses the weaker path signal and passes the stronger signal to the limiter and discriminator stage. The discriminator stage converts the frequency-shift signal into a DC positive/negative-going signal, which is fed to the FSK/CW switch.

**29.** The outputs from the 3rd IF stages in the output unit are fed into the detector and slide-back stage which combines and demodulates the A and B path CW/ON/OFF signals, so providing a DC positive/negative-going signal. This demodulated signal is fed to the FSK/CW switch.

**30.** The FSK/CW switch selects either the demodulated FSK or the demodulated CW/ON/OFF reception. The demodulated signal is limited and shaped by the DC amplifier and the limiter stages. A low-pass filter between the DC limiter stages reduces the noise. Provision is made for raising the cut-off frequency to permit the reception of the high-speed keying. This facility is available by means of the FSK/CW switch.

**31.** The shaped signal is passed through a final limiter stage and then to the DC output stages. The output stages provide a positive/negative-going DC signal of up to 30mA into a 1000-ohm load. Provision is made at the final limiter stage to enable the keying convention to be reversed by means of the DC REVERSING switch (i.e. a mark to be represented by a negative instead of a positive signal).

**32.** The signal voltage at the final limiter stage is taken to the tone sender unit. The tone sender unit converts the square-wave signal from the output unit Type 50 into a 1000 c/s tone at a constant output level. Provision is made on the tone sender unit to measure and control the level of the keyed tone output.

**33.** A gating voltage taken from the DC limiter stages in the output unit is fed to the AFC discriminator stage in the combining unit. This voltage controls the AFC circuit when the transmission is in either the MARK or SPACE condition.

#### Power supplies

**34.** The power supplies for the receiver units, the common oscillator, the combining unit and the output unit are provided by the power units Type 815 and Type 816. The alternating mains supply for the power units is fed via the switch panel Type 803. The mains input circuit is protected from overload by the circuit-breaker mounted on the switch panel at the base of the rack.

**35.** The power unit Type 815 provides HT and heater supplies to the following units in the rack assembly Type 272 :—

(1) Receiver ‘ A ’
(2) Oscillator unit Type 327
(3) Combining unit Type 6
(4) Receiver ‘ B ’.

**36.** The power unit Type 816 provides the positive and negative HT voltages and the heater voltages for the output unit Type 50.

**37.** The tone-sender has its own built-in power unit.

### OPERATING INSTRUCTIONS

#### CW, MCW and ON/OFF reception

**38.** Switch on all power supplies and allow at least five minutes for the equipment to warm up.

**39.** Set the AFC MOTOR switch (Oscillator unit Type 327) to the OFF position. Set the 2ND OSC control to 0 kc/s. Set the first oscillator to the required frequency by means of the main tuning control. Turn the BFO control to the OFF position.

**40.** Set the PASSBAND switches on the two receivers to 2,500 c/s. Turn the HF GAIN controls on both receivers to approximately ¾ of the fully-clockwise position. Set the INPUT ATTENUATORS to 0dB. Set both of the operational switches to AGC TELEG. Set the BANDCHANGE switches on both receivers to the required frequency range and adjust the main tuning controls to the frequency to be received.

**41.** Set the AGC TIME CONSTANT switch (combining unit Type 6) to either of the FAST, MED. or SLOW positions, according to the rapidity of fading. Set the AFC SELECTOR switch to ON/OFF. Set the TELEGRAPHY MON switch to A., when listening to path A (or to B when listening to path B). Set the MON OSC switch to ZERO BEAT.

**Note . . .**
*Whilst tuning in a signal, set the* AGC INTENSITY *control to* 0.

**42.** Set the traffic speed switch on the output unit Type 50 to ON/OFF LS (for the reception of signals having a keying speed of from 0 to 100 bauds (125 WPM morse), or to ON/OFF HS for speeds from 100 to 200 bauds.

**43.** Operate both the PUSH TO BREAK A and the PUSH TO BREAK B push-button switches and adjust the SPACE control (output unit Type 50) until the DC OUTPUT meter indicates a current of 30mA. With the TEST switch operated, adjust the MARK control until the DC OUTPUT meter indicates a current of 30mA in the opposite direction. Pull out both of the PUSH TO BREAK A and B switches. Pull out the REVERSE DC KEYING switch, if a negative current is to be sent to line in the idle (no signal) condition. This is the normal morse convention.

**Note . . .**
*For reversed ON/OFF keying, this switch should be pushed in. Set the* SIGNAL BIAS *control (output unit Type 50) to 5.*

**44.** If the tone sender is required, turn the monitor switch (tone sender unit) to the LEVEL position, and with the line connected, push the TEST switch and adjust the LEVEL control with a screwdriver until the meter on the tone sender unit indicates the desired level.

**45.** The normal keying convention (REVERSE DC KEYING switch on the output unit pulled out) is such that no tone is sent to line for Space (no signal). Pushing in the switch will reverse this condition and also will reverse the undulator tape.

**46.** Plug a pair of headphones into one of the TELEGRAPHY MON jacks on the combining unit, and search for the required signal by adjusting the main tuning control of the common oscillator. unit. When the signal has been found, tune it carefully to give a zero beat by means of the 2ND OSC control. Switch on the AFC MOTOR and adjust the main tuning controls on receivers A and B to give the maximum reading on their respective level indicators (LEVEL A and B) on the output unit. Adjust the HF GAIN controls of the two receivers until the level indicators read approximately half-scale.

**Note . . .**
*If the received signal is weak, the* HF GAIN *controls must be adjusted until ' noise ' just fails to mark the tape when there is a long pause in transmission. The* AGC INTENSITY *control can now be increased to between 3 and 6 (with a fast time-constant, an intensity of 3 should be used to avoid ' dot-splitting').*

**47.** Finally, adjust the SIGNAL BIAS control on the output unit for ' neutral ' tape. The waveform of the DC output can be inspected by connecting an oscilloscope via the MON DC OUTPUT jack.

**FSK reception**

**48.** Switch off the AFC MOTOR (oscillator unit Type 327).

**49.** Repeat the instructions in para. 38 to 40.

**50.** Set the AGC TIME CONSTANT switch (combining unit) to either of the FAST, MED. or SLOW positions, according to the rapidity of fading. Set the TELEGRAPHY MON switch to A, when listening to path A (or to B when listening to path B). Set the MON OSC switch to ZERO BEAT.

**51.** Set the traffic speed switch on the output unit Type 50 to FSK LS (for the reception of signals having a keying speed of from 0 to 100 bauds), or to FSK HS for speeds of 100 to 200 bauds.

**52.** Operate both the PUSH TO BREAK A and the PUSH TO BREAK B push-button switches and adjust the SPACE control (output unit) until the DC OUTPUT meter indicates a current of 30mA. With the TEST switch operated, adjust the MARK control until the DC OUTPUT meter indicates a current of 30mA in the opposite direction. Pull out both of the PUSH TO BREAK A and B switches. Pull out the REVERSE DC KEYING switch if a negative current is to be sent to line in the idle (no signal) condition.

**53.** Repeat the instructions in para. 44 and 45.

**54.** Plug in a pair of headphones to one of the TELEGRAPHY MON jacks on the combining unit and search for the required signal by adjusting the main tuning control of the common oscillator unit. When the signal has been found, tune it by means of the 2ND OSC control so that the note heard in the headphones is the same for both Mark and Space (i.e. for a 500 c/s shift the note will be 250 c/s).

**Note . . .**
*It will be found helpful to check the accuracy of the tuning by monitoring the audio output on an oscilloscope.*

**55.** Set the AFC SELECTOR switch on the combining unit to FSK, HIGH or LOW depending on which radio frequency the transmitting station uses in the 'rest' (no signal) condition. Set the AFC DEVIATION control (combining unit) to half the shift of the received signal (i.e. for a 500 c/s shift, set the control to 250 c/s).

**56.** Set the traffic speed control on the output unit to FSK LS (HS for speeds greater than 100 bauds). Switch on the AFC MOTOR (common oscillator unit) and slightly readjust the AFC DEVIATION control (combining unit) until the notes heard in the headphones are again equal.

**Note . . .**
*To check whether the transmitter 'rests' on the higher or lower frequency, observe the feed to the valve in the combining unit; if this valve conducts in the 'rest' condition the* AFC *controls have been set up correctly.*

**57.** Adjust the HF GAIN controls (receivers A and B) until the level indicators read between half and full scale. The AGC INTENSITY control on the combining unit should be set between 4 and 10.

# Chapter 2

# RECEIVER UNITS "A" AND "B"

## LIST OF CONTENTS



## LIST OF ILLUSTRATIONS



### INTRODUCTION

**1.** Two identical receivers (A and B) are used in the dual-diversity receiving equipment FGRI. 18014 (receiving units Type 115) and are mounted on the rack assembly Type 272. The information given in this chapter will apply equally to both receivers.

**2.** The receiving unit Type 115 (*fig.* 1 *and* 2) is of the double superhetrodyne type capable of receiving signals within the range 1·5 to 30 Mc/s. This range is covered by five separate frequency bands which are as follows :—

BAND 1 1·5 to 2·75 Mc/s
BAND 2 2·75 to 5·0 Mc/s
BAND 3 5·0 to 9·0 Mc/s
BAND 4 9·0 to 16·5 Mc/s
BAND 5 16·5 to 30·0 Mc/s.

**3.** The local oscillator frequencies for the first and second mixers are provided by the oscillator unit Type 327 which is common to both receivers and is mounted between the receivers on the rack assembly Type 272.

### BRIEF DESCRIPTION

**4.** Figure 3 is a block diagram showing the stages used in the receiver. The receiver consists of an input control attenuator, two RF amplifying stages, a buffer amplifying stage for the first oscillator frequency, the first mixer stage, the second mixer stage, a bandpass filter, first and second IF stages, a B.F.O. amplifying stage, a detector-amplifier-AGC stage, a calibrator and noise limiter stage, and an AF amplifying stage.

**5.** The input signals and voltages to this unit are as follows :—

(1) Signal voltages induced in the aerial and fed via plug PL1 to the input attenuator.

(2) Oscillatory voltage from the first oscillator in the oscillator unit Type 327 fed via plug PL2 to the first oscillator buffer amplifier.

(3) Oscillatory voltage from the second oscillator in the oscillator unit Type 327 which is fed via plug PL3 to the second mixer stage.

(4) Automatic gain control voltages fed from the combining unit Type 6 via terminals AGC 1 and 2 at the rear of the unit.

**6.** The output signals and voltages fed from this unit are as follows :—

(1) 465 kc/s output from the second IF stage via plug PL4 to the combining unit Type 6.

(2) Audio signal frequency fed via terminals 1 and 2 to the 600-ohm line.

**7.** The power supplies to this unit are as follows :—

(1) 250 volts positive, fed from supply unit Type 815 via pin 1 of plug PL6.

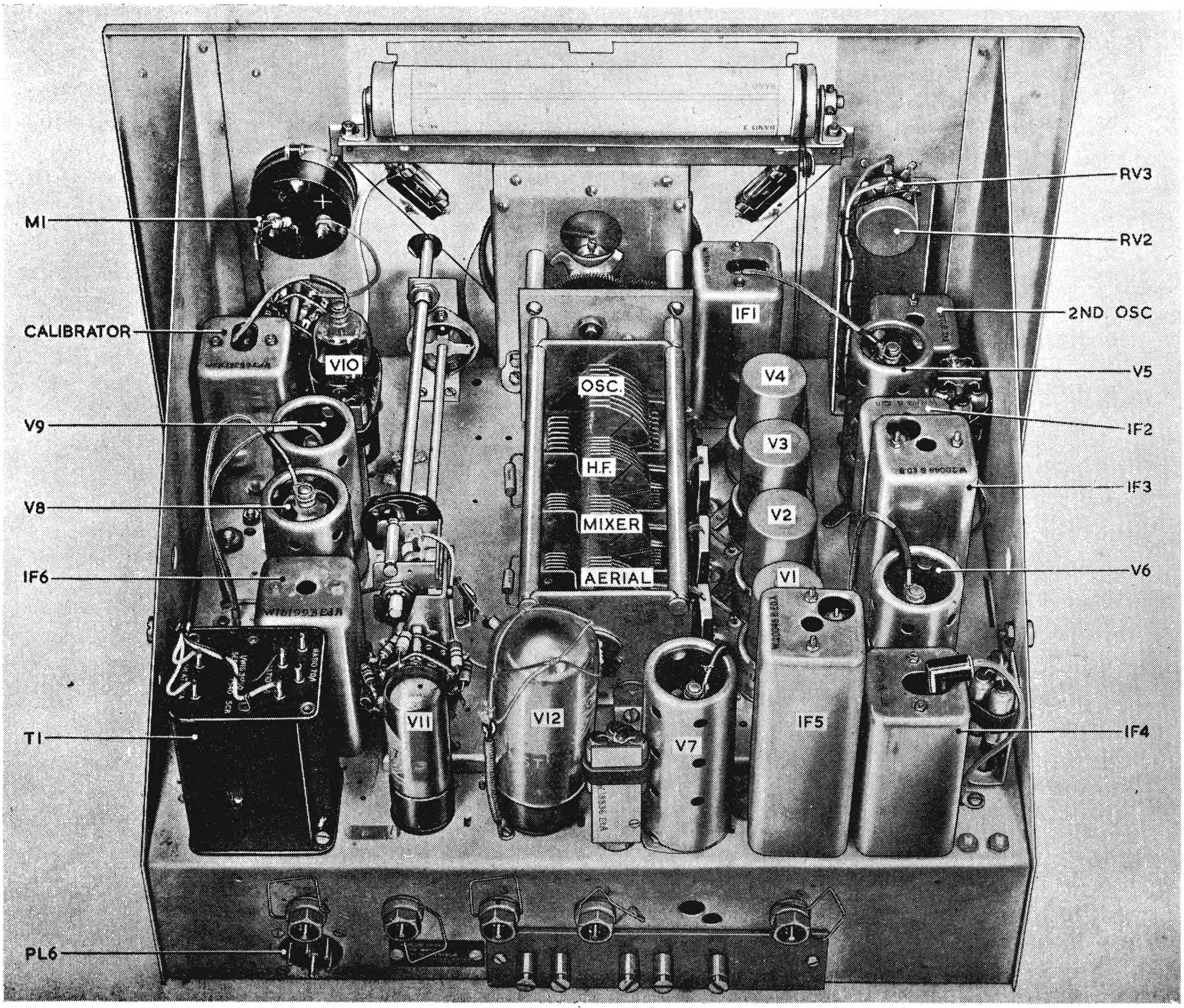


**Fig. 2. Rear view of receiving unit**

R24A, R24C, R24D and R24E. The required section of the attenuator is selected by means of the INPUT ATTENUATOR switch SW4.

#### Aerial unit

**11.** There are five tuned RF transformers L1 to L5 in the aerial unit, one for each of the five wavebands. Section M of the BANDCHANGE switch SW1 selects the appropriate primary winding and connects one end to the input attenuator. This section of the switch, by means of the bridging wiper, short-circuits to earth the primaries of the other transformers for the lower frequency bands than the one selected. The lower ends of the primary windings are earthed via SW1/N. The five RF transformers are dust-iron cored and each one is pre-tuned by means of the trimmer capacitors connected across its secondary winding.

**12.** Section K of the BANDCHANGE switch selects the required secondary winding and applies the signal developed across it to the grid of V1. The signal is tuned by means of section A of the main tuning capacitor C1 which is connected across the selected secondary winding by means of the switch. The secondary windings of the transformers used for the frequency bands lower than the one selected are short-circuited to earth by the bridging wiper on SW1/K.

**13.** A preset trimmer capacitor C35 is connected across the tuning capacitor C1A, and is used to tune grid circuit of V11 to the aerial circuit.

#### First RF amplifier V1

**14.** The first RF amplifier V1 is a pentode valve operating in a conventional circuit. Bias on this valve is provided by the voltage developed across the cathode bias resistor R4, and the variable potential (provided VR1 the HF GAIN control) to which the other end of R4 is returned. The cathode is decoupled by capacitor C30. R5 is the screen resistor which is decoupled by capacitor C29. The anode load of V1 is the selected transformer primary winding.

**15.** Reduced AGC of approximately one third of the normal value is applied to the grid of V1 via resistor R1 and the secondary winding of the selected transformer. R1 is decoupled by capacitor C28.

**HF unit**

**16.** This unit contains five RF transformers which feed the RF signal from the anode of V1 to the grid of V2. The appropriate primary winding is selected by section G of the BANDCHANGE switch SW1.

**17.** The appropriate secondary winding for the band required is selected by section I of the switch SW1, and connected to the grid of V2. Section B of the main tuning capacitor C1 tunes the selected secondary winding. The primary and secondary windings of each transformer are pre-tuned by trimmer capacitors.

**Second RF amplifier V2**

**18.** V2 is a pentode valve operating in a conventional RF amplifier circuit. Bias is provided by the voltage drop across the cathode resistor R11, and the potential across the HF GAIN control VR1 ; the cathode is decoupled by capacitor C34. The anode load of this valve is formed by the primary of the selected transformer in the mixer unit.

**19.** Reduced AGC is applied to V2 grid via resistor R8 and the secondary winding of the selected transformer in the HF unit ; R8 is decoupled by capacitor C41. Reduced AGC is applied to valves V1 and V2 because they have short grid bases.

**Mixer unit**

**20.** The mixer unit contains five RF transformers L11 to L15 which couple the signal developed at the anode of V2 to the grid of V3. The primary winding of the selected transformer is connected in series with the anode of V2 by section C of the BANDCHANGE switch SW1. Section E of this switch connects one end of the selected secondary winding to the grid of valve V3, whilst short-circuiting the secondary windings of the transformers used for the lower frequency ranges, to earth. The secondary windings are pre-tuned by means of trimmer capacitors connected across each winding. Section C of the main tuning capacitor C1 is connected across the secondary winding of the selected transformer and tunes the grid circuit of V3 to the incoming signal frequency.

***First mixer valve V3***

**21.** V3 is a pentode valve used in a mixer circuit ; the signal is fed in on the grid, whilst the local oscillator frequency is applied to the suppressor grid. The difference frequency (1st IF) appears across the transformer IF1 the primary of which is connected in the anode circuit of V3. The cathode is returned to earth via resistors R15 and R16 ; the grid is returned to the junction of R15 and R16 via a grid stopper R10 and grid leak R9. The bias applied to the grid is that voltage developed across the cathode bias resistor R15. The bias applied to the suppressor grid is that voltage developed across resistor R15 and R16, as the suppressor is returned to earth via R23. The cathode is decoupled by capacitor C42. The primary winding of IF1 forms the anode load of V3 ; IF1 is tuned to 1·2 Mc/s.

**Oscillator unit**

**22.** This unit contains five tuned inductors L16 to L20 which are connected individually across the suppressor grid of V3 by means of section A of the BANDCHANGE switch SW1. The switch also short-circuits to earth the inductors which operate on a lower frequency than the one selected. The inductors L16 to L20 are used to cover the five frequency bands, but these coils are tuned to 1·2 Mc/s above the signal frequency ; this is the frequency, of the first oscillator in the oscillator unit Type 327, which is fed into the suppressor grid of V3. Tuning of the suppressor grid circuit is effected by section D of the main tuning capacitor C1 which is connected across the selected coil by means of SW1/A.

***First oscillator buffer amplifier V4***

**23.** The output of the first oscillator in the oscillator unit Type 327 is fed into the receiver unit via a 75-ohm coaxial feeder and plug PL2 to the grid of V4 the buffer amplifier. The output of V4, developed across the anode load R21, is fed via R19, C54, and C44 to the suppressor grid of V3, the first mixer.

**24.** V4 is a pentode valve operating in an untuned RF buffer amplifier circuit. Cathode bias is provided by resistor R2, which is decoupled by capacitor C39.

***Second mixer stage V5***

**25.** The 1·2 Mc/s output from the secondary of IF1 is fed into the signal grid of V5, the second mixer stage. The second mixer valve V5 is a triode-hexode valve. The 1·2 Mc/s output from the secondary of IF1 is fed from across R26 ; R25 and R26 form a potential divider to reduce the IF signal output, and provide damping in the secondary of IF1, to widen the response curve. Cathode bias on V5 is provided by cathode resistor R28 and VR2 the HF GAIN control which are in series with the cathode return to earth. Capacitors C86 and C123 provide the decoupling for R28 and VR2. The triode anode of V5 is connected to earth, as the second oscillator frequency (735 kc/s) is generated in oscillator unit Type 327 and fed into the receiver unit via plug PL3 and transformer L23 to the grid of the triode section.

**26.** AGC is applied to V5 via R36 and the secondary of IF1 to the hexode-section grid ; R36 is decoupled by capacitor C84.

**27.** Transformer L23 is used to couple output from the second oscillator in the oscillator unit Type 327 ; R67 is connected across the secondary winding to provide an impedance match in the primary. The secondary is connected between the triode section grid of V5 and the cathode. Bias on the triode section grid is provided by the self-biasing action of C61 and R75.

**28.** The 1·2 Mc/s fed into the signal grid, and the 735 kc/s fed to the triode-section grid are

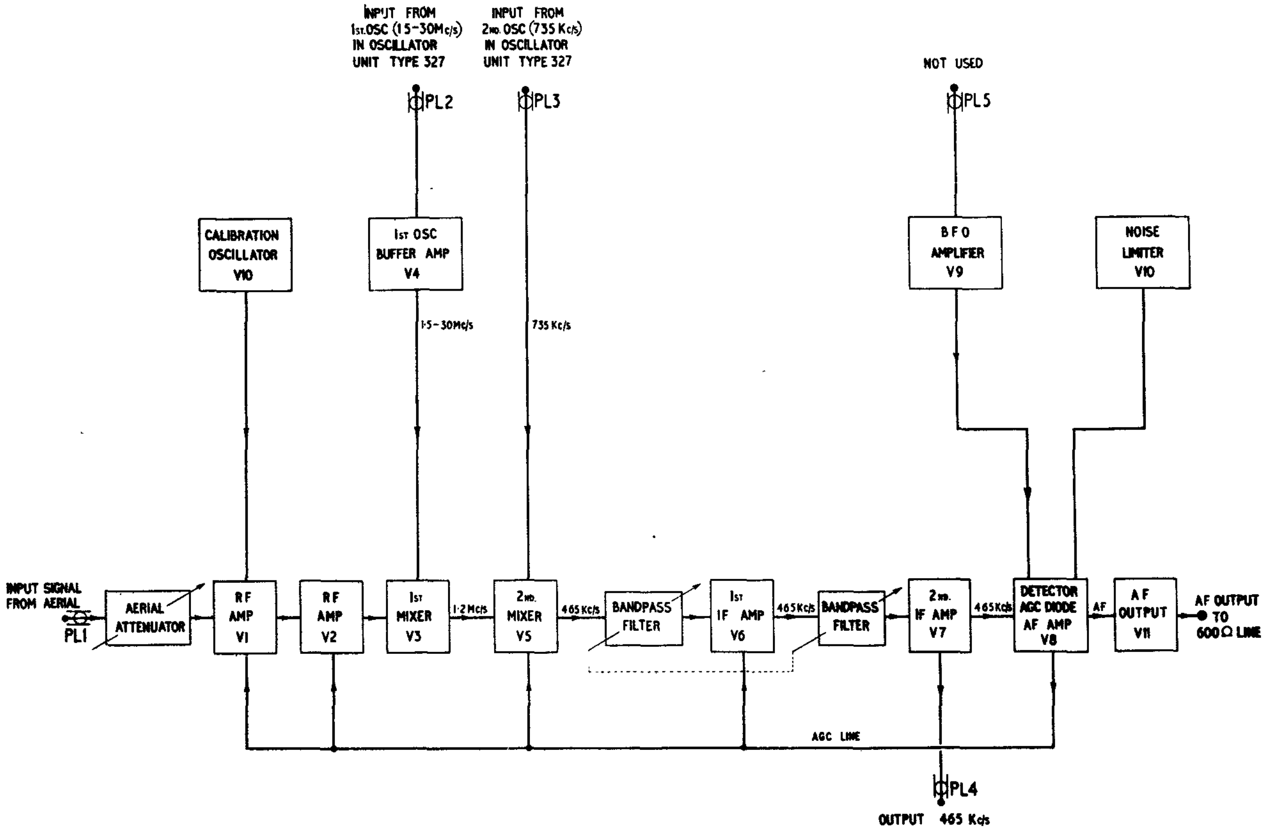


Fig. 3. Block diagram

electronically mixed in the hexode section of the valve and the second IF of 465 kc/s is developed across the tuned primary of IF2 which is connected in series with the anode of V5.

**29.** Two IF amplifying stages V6 and V7 amplify the second IF of 465 kc/s and provide a variable bandwidth, controlled by means of the PASSBAND switch SW2.

**PASSBAND switch**

**30.** The IF passband can be varied in five steps by means of the PASSBAND switch SW2. The five positions of the switch correspond to the following passbands which are measured at 6dB below the peak :—

(1) 100 c/s (*this position is not used in this equipment*)
(2) 1,000 c/s
(3) 2,500 c/s
(4) 8,000 c/s
(5) 13,000 c/s

The circuit arrangement for each position of the switch is given in fig. 5.

*100 c/s (position 1)*

**31.** The second IF of 465 kc/s is developed across the secondary winding of IF2 and is fed via section SW2/C of the PASSBAND switch to the double crystal filter IF3 which limits the bandwidth to 2,500 c/s. The output from the crystal filter is fed via section SW2/C to the grid of V6. The amplified 465 kc/s signal appearing at the anode of V6 is applied to the second double crystal filter IF5 via the secondary winding IF3 and section SW2/J of the PASSBAND switch. The crystal filter IF5 limits the bandwidth to 1,000 c/s ; the output from this filter is fed via SW2/J to the grid of V7. The amplified IF voltage appearing at the anode of V7 is applied to the grid of V8 via IF transformer IF6. V8 is the detector stage and the audio signal appearing at the anode is fed via capacitor C114 and SW2/F to the low pass filter which only passes frequencies up to 100 c/s. The output from the low pass filter is fed via section F of the switch SW2 to the grid of the output valve V11.

*1,000 c/s (position 2)*

**32.** The circuit operation is the same as for position 1 of the PASSBAND switch with the exception that the low pass filter in the audio stage is switched out by means of SW2/F ; the audio signal developed at the anode of V8 is fed via capacitor C114 to the grid of the output valve V11.

*2,500 c/s (position 3)*

**33.** The bandpass filter IF3 is connected between valve stages V5 and V6 for positions 1 and 2 of the PASSBAND switch. The second bandpass filter IF5 is disconnected and to maintain similar circuit conditions to that which existed when the filter IF5 was connected, capacitors C95 and C96 are connected across the secondary of IF4 by means of SW2/J, and a tapping on this winding is connected via SW2/J to the grid of V7.

*8,000 c/s (position 4)*

**34.** The bandpass filter IF3 is disconnected; capacitors C89 and C90 are connected across the secondary winding of IF2, and the output from this winding is taken via a tapping to the grid of V6 through SW2/C to keep the circuit impedance conditions the same as when the bandpass filter IF is in circuit. The passband is determined by the transformers IF2 and IF4 which is 8,000 c/s.

*13,000 c/s (position 5)*

**35.** The circuit connections are the same as in position 4 of the PASSBAND switch with the exception that the overcoupling coils are connected in series with the secondary windings of IF2 and IF4 by means of SW2/A and SW2/G. The overcoupling coils increase the bandwidth of the two IF transformers to 13,000 c/s.

**First IF amplifier**

**36.** The first amplifier stage V6 amplifies the 465 kc/s signal fed to its grid; the amplified output appears across the secondary winding of IF4 the transformer whose primary is connected in series with V6 anode. The signal applied to V6 grid is either fed direct from secondary winding of IF2, or from the bandpass filter IF3 depending on the position of the PASSBAND switch. The full AGC voltage is applied to the grid of V6 via resistor R31, sections A and C of the PASSBAND switch, the secondary winding of IF4, and inductor L29 of the bandpass filter IF3. The bias applied to this valve is a combination of cathode bias developed across cathode resistor R34 and that voltage developed across the variable resistor (HF GAIN) VR3, which is the common cathode resistor for V5 and V6. The tuned primary of IF4 forms the anode load; the anode is decoupled by resistor R35 and capacitor C92. The amplified output voltage appearing across the secondary of IF2 is fed either directly to the grid of V7, or via the bandpass filter IF5 depending on the position of the PASSBAND switch.

**Second IF amplifier**

**37.** The second amplifier stage V7 amplifies the 465 kc/s signal applied to its grid. Cathode bias is developed across resistor R40; the cathode is decoupled by capacitor C104. The screen grid is decoupled to cathode instead of to earth. The anode load is formed by the primary winding of IF6; the amplified output voltage appears across the secondary and is applied to the diode section of V8. Resistors R53 and R54 are connected across the primary and secondary windings of IF6 to damp the tuned circuits, and so increase the bandwidth.

**Signal detection and noise limiting**

**38.** A separate diagram of the signal detector and noise limiter circuit is shown in fig. 4. Section A of the double-diode valve V8 is connected in series with the IF output and earth; the detector load is provided by resistors R42 and R43, connected in series. The noise limiting is provided

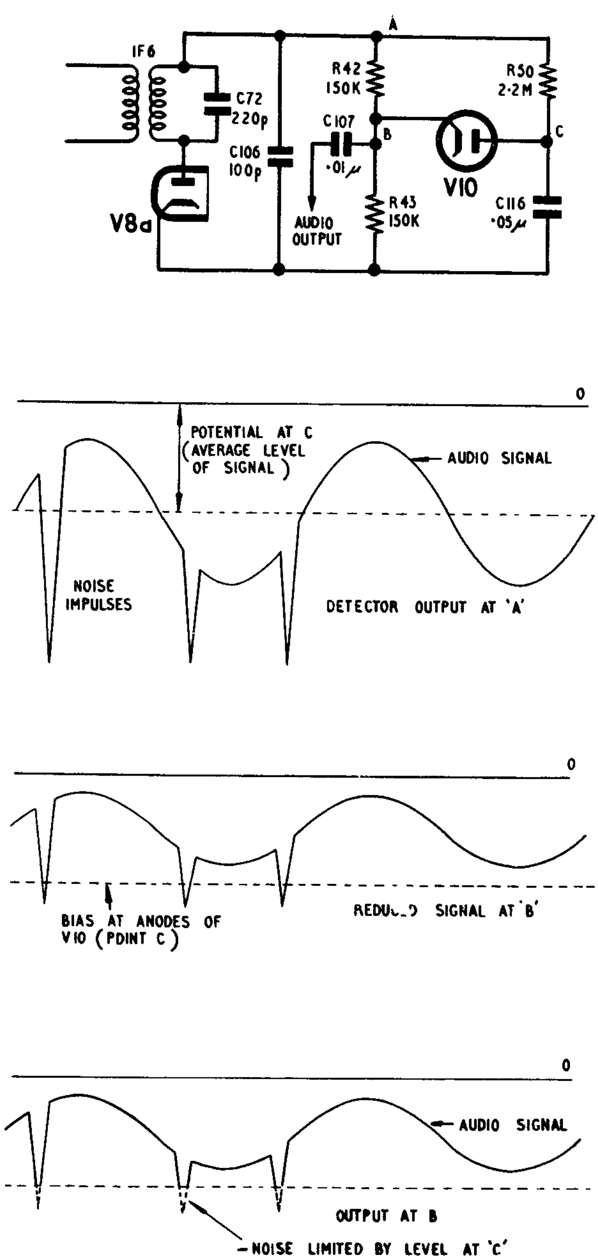


**Fig. 4. Signal detection and noise limiting circuit**

by the double-diode section of V10, in the audio signal circuit from the junction of R42 and R43.

**39.** From the first waveform shown in fig. 4 it will be seen that a typical noisy signal at the output of the detector (point A) consists of a negative-going sine wave with the noise represented by the negative-going spikes. The average level of signal, representing the carrier level of an unmodulated input, is shown as a dotted line through the waveform. A series circuit (R50 and C116) connected across the detector load (R42 and R43) provides a very long time constant so that the varying components of the signal are smoothed out and C116 charges up to the average level.

**40.** The potential at the cathode of V10 the noise limiting diode (point B) is identical in form to that at point A, but because of the potential divider

(R42 and R43) the amplitude is just half that at point A. As the diode anodes of V10 are connected to the junction of R50 and C116 (point C) the mean potential of the audio signal appears as a bias potential which is always more negative than the required part of the waveform at point B.

**41.** With reference to the second waveform drawn in fig. 4, it will be seen that noise pulses of small amplitude and the required audio signal at the anodes of the limiter diodes (point C) will be more negative than the cathode and therefore the diode will not conduct so that the audio signal and small noise pulses will appear at the output (point B).

**42.** In the presence of large amplitude noise pulses the cathode of V10 will be carried below the potential of the anode, making the anode positive and causing the diodes to conduct thus holding point B at the potential of point C. The waveform appearing at point B (output) will consist of the audio signal with the noise amplitude considerably reduced.

**Automatic gain control**

**43.** The diode (section B of V8) is used to demodulate the signal and provide automatic gain control on the first and second RF amplifiers (V1 and V2), the second mixer stage (V5) and the first IF amplifier V6. The diode load consists of resistors R46 and R47 connected in series. The signal voltage taken from the primary of IF6 is fed to diode anode via C105. The RF choke CH1, resistor R72, and capacitors C117 and C109, filter out the RF component of the rectified signal. The full AGC voltage developed across R47 and R46 is applied via R79 to the second IF amplifier stage V6 and the second mixer stage V5. A reduced AGC voltage developed across R46 is applied to the first two RF stages V1 and V2. External AGC may be applied via the terminals AGC1 and 2 with the operation switch set to AGC SSB or AGC TELEG.

**44.** The conditions of AGC existing for each setting of the operational switch are as follows :—

| *Switch position* | *AGC condition* |
|---|---|
| CALIBRATE | Internal AGC applied to V1, V2 V5 and V6. |
| HT OFF | AGC to all valves disconnected. |
| AGC OFF | AGC inoperative, cathodes of V1, V2, V5 and V6 returned to earth. |
| AGC SSB | This service is not used. |
| AGC TELEG | External AGC applied from the combining unit Type 6. |
| AGC LOCAL 1 | Internal AGC applied to V1, V2, V5 and V3. A delay network switched in the AGC line gives a time-constant of approximately 0·1 sec. |
| AGC LOCAL 2 | As for AGC LOCAL 1, with a time-constant of approximately 0·3 sec. |
| AGC LOCAL 3 | As for AGC LOCAL 1, with a time-constant of approximately 0·7 sec. |
| AGC LOCAL 4 | As for AGC LOCAL 1, with a time-constant of approximately 1·3 sec. |

**B.F.O. amplifier V9**

**45.** This stage is not used in the receiver when it forms part of this equipment.

**Output stage V11**

**46.** This is a conventional triode output stage. The audio signal developed across the anode load R48 of V8 is applied via C114 to the grid of the output valve V11.

**47.** When the PASSBAND switch is set to 100 c/s the audio signal developed across R48 is not fed directly to the grid of V11 but is first passed through a low frequency filter, which only passes frequencies up to 100 c/s, to the grid of V11. For all other positions of the PASSBAND switch the audio signal developed at the anode of V8 is fed via C114 to the grid of V11. The amplified output signal developed in the primary of transformer T1 is matched to a 600 ohm output by the secondary winding. A potential divider consisting of R58 and R76 reduces the audio signal output applied to the phone jacks J1 and J2. The output is 100 mW into 600 ohms. The cathode resistor R53 provides bias on the output stage ; negative feedback is applied to this stage by the omission of the cathode decoupling capacitor.

**Calibrator V10**

**48.** When the operational switch is set to CALIBRATE the HT voltage is applied to the anode of the triode section of V10, and the cathode is connected to earth.

**49.** The triode section of V10 is connected as a crystal-controlled Colpitts oscillator. The oscillator, operates at a fundamental frequency of 500 kc/s, which has a high harmonic content. The RF voltage developed across CH3 is fed via C55 to the grid of V1. This service is used to check the calibration of the receiver and provides check points against the dial markings at every 500 kc/s.

**50.** At all positions, other than the CALIBRATE, the HT is removed from the anode of V10 and the cathode is returned to the junction of R42 and R43.

**Voltage stabilizer V12**

**51.** V12 is a gas-filled stabilizer valve. This valve has five separate anodes. When the valve strikes, a potential of 70 volts exists between each anode. Three anodes are connected together ; a steady potential of 140 volts is maintained at these anodes. This voltage is applied via a potential divider (R53 and VR1) and is the bias voltage, controlled by HF GAIN (VR1) to valves V1 and V2 ; it is also 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 240 volts unstabilized.

**Monitoring**

**52.** The 0-10 mA meter M1 is mounted on the front panel (*fig.* 1) and is used for checking the anode currents of the valves, and for checking the stabilized and unstabilized supplies. A metering resistor of low value is connected in series with anode of each valve. The voltage drop across these resistors is interpreted in terms of anode current by the meter M1.

**53.** The STABILIZED VOLTS x 50 switch SW5 connects the meter across the metering resistor, appropriate to the setting of the switch.

**54.** The switch positions are :—

(1) STABILIZED VOLTS x 50 (the 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 x 50 (the meter reading is multiplied by 50).

## CONSTRUCTIONAL DETAILS

**55.** The receiver unit is of the normal construction with a front panel suitable for rack mounting and is arranged to slide on bearers.

**Tuning system**

**56.** The BANDCHANGE switch SW1 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 which control 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 the sub-division on the lower scale.

**57.** 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.

**58.** The use of the logging scales enables the receiver to be re-set accurately to the frequency of any desired signal. Two dial lamps are used to illuminate the scales.

## COMPONENT VALUES

**59.** The values and tolerances of the components on the circuit diagram (*fig.* 6) are listed in the following paragraphs.

**Capacitors**

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

| *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 | | |

| *Circuit Ref.* | *Value* | *Tolerance ± per cent.* | *Voltage (working)* | *Type* |
|---|---|---|---|---|
| C52 | 270 | 5 | | |
| C52A | 10 | 5 | | |
| C54 | 100 | 10 | 500 | Tubular |
| C55 | 1 | 5 | 500 | ,, |
| 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 | 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 |
| 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 . . .**

*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.*

**Resistors**

**61.** 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* |
|---|---|---|
| R1 | 47K | |
| R2 | 220 | |
| R3 | 75 | |
| R4 | 220 | |
| R5 | 47K | |
| R6 | 22 | |
| R7 | 10K | |
| R8 | 47K | |
| R9 | 100K | |
| R10 | 10 | |
| R11 | 220 | |
| R12 | 47K | |
| R13-14 | 10K | |
| R15 | 100 | |
| R16 | 3,300 | |
| R17-18 | 10K | |
| R19 | 22 | |
| R20 | — | |
| R21 | 10K | 1W |
| R22 | 1,000 | |
| R23 | 100K | |
| R24 | 56 | |
| R24A, B | 39 | 10 per cent. |
| R24C | 68 | 10 per cent. |
| R24D | 15 | 10 per cent. |
| R24E | 68 | 10 per cent. |
| R25-26 | 33K | |
| R27 | 15K | |
| R28 | 330 | |
| R30 | 10K | |
| R31 | 47K | |
| R32 | 100K | |
| R33 | 500K | 5 per cent. |
| R34 | 330 | |
| R35 | 10K | |
| R36 | 47K | |
| R37 | 2,200 | |
| R38 | 33K | |
| R39 | 22K | |
| R40 | 330 | |
| R41 | 2,200 | |
| R42-3 | 150K | |
| R44 | 10K | |
| R45 | 1,000 | |
| R46 | 2,200K | |
| R47 | 4,700K | |
| R48 | 47K | |
| R49 | 22K | |
| R50-51 | 2,200K | |
| R52 | 220K | |
| R53 | 1,000 | |
| R54 | 330K | |
| R55 | 150K | |
| R56 | 3,300 | 5 per cent. 6W wire |
| R57 | 470K | |
| R58 | 47K | |
| R59, 60 | 10 | |
| R61-66 | 56 | 5 per cent. |
| R67 | 68K | 10 per cent. |
| R68-70 | 56 | 5 per cent. |
| R71 | 470 | 5 per cent. |
| R72 | 150K | |
| R73 | 500K | 5 per cent. |
| R74 | 330 | 5 per cent. |
| R75 | 470K | |
| R76 | 22K | |
| R77 | 100K | |
| R78 | 4,700 | |
| R79 | 470K | |
| R80 | 1,000K | |
| R81-82 | 2,200K | |
| RV1 | 500K | $\frac{1}{4}$W log law pot. |
| RV2 | 2,500 | $\frac{1}{4}$W linear pot. |
| RV3 | 5,000 | $\frac{1}{4}$W linear pot. |

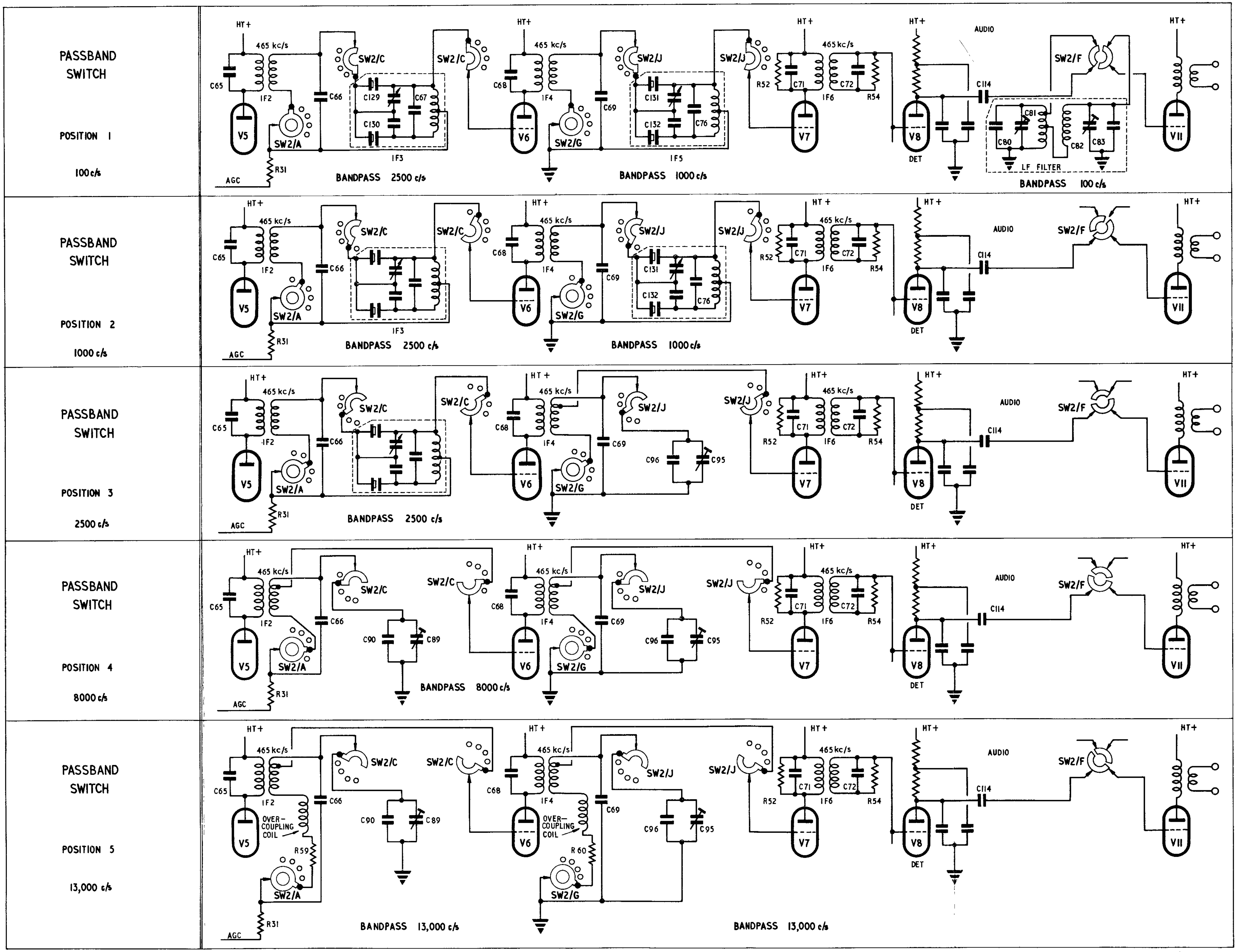


Fig.5 Passband circuits— receiving unit Type 115 Fig.5

(3) Third oscillator (beat frequency oscillator) generating two spot frequencies of 464 and 465 kc/s in crystal controlled circuits. (This oscillator is not used when this unit forms part of FGRI.18014).

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

**4.** The functions of the oscillator Type 327 when used in the dual diversity receiving equipment FGRI.18014 are as follows :—

(1) To provide the local oscillator frequency to the first frequency changers in both 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 both 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. This service is not used on the rack assembly Type 272.

**5.** The power supplies to the oscillator unit are provided by the power unit Type 815 which is also part of rack assembly Type 272, and are fed into the unit via a 5-pole plug PL1 (*fig.* 2). The power supplies are as follows :—

Pin 1—250 volts positive at 110 mA

Pin 2—Earth

Pin 3—6·8 volts at 50 c/s at 4·4A

Pin 4—Earth

Pin 5—15 volts at 50 c/s at 2A.

**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)) ; these outputs are not used when the oscillator unit is used in the dual diversity receiving equipment.

**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 Type 6

Terminal 5—This terminal is not used

Terminal 6—AFC voltage from the combining unit Type 6

Terminal 7—AFC voltage from the combining unit Type 6

Terminal 8—Earth.

## CONTROLS

**8.** The controls mounted on the front panel of the oscillator unit Type 327 (*fig.* 1) 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 |
| Main tuning control | Tuning control for the five frequency bands of the first oscillator. | C1-3 |
| 2ND OSC. | Tuning control for the second oscillator ; range ± 4 kc/s. | C49 |
| A.F.C. MOTOR | Switches the AC supply to the A.F.C. motor. | SW5 |
| B.F.O. | Selects either the 464 or 465 kc/s in the third oscillator (*this control is not used when the oscillator unit forms part of the dual diversity receiving equipment*). | 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 |

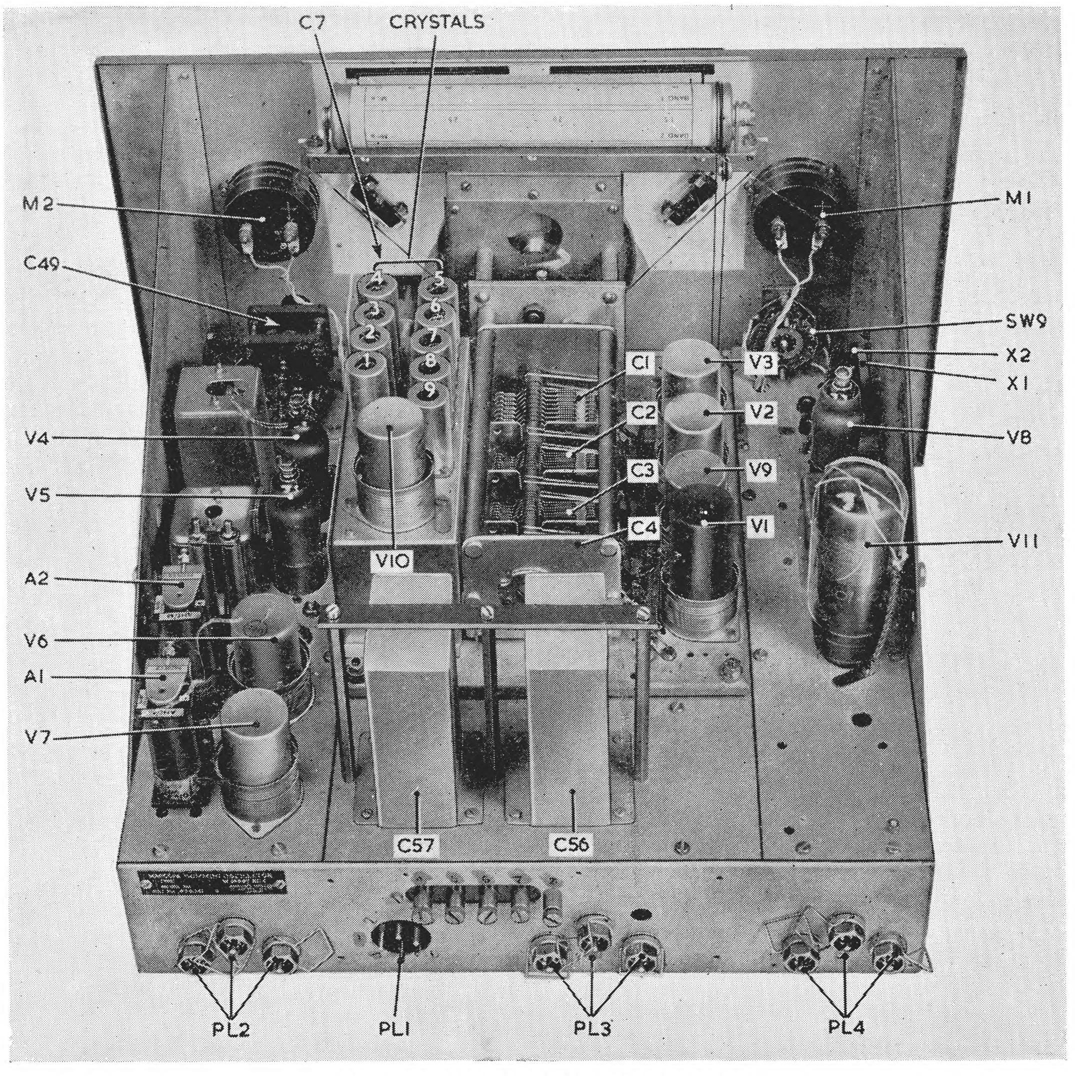


**Fig. 2. Rear view of oscillator unit**

| *Control* | *Function* | *Circuit Ref.* |
|---|---|---|
| Top scale | The scale appearing behind the top window is changed for each of the five frequency bands by operation of the BAND-CHANGE 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. | |

## BRIEF DESCRIPTION

**9.** Figure 3 is a block diagram showing the valve stages used in first, second and third oscillators. Only the first and second oscillators are used in the dual diversity receiving equipment.

### 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 an 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 two receivers via the Pye plugs PL3 (A and B).

**13.** The BANDCHANGE switch S1 selects the required frequency band ; five frequency bands are used to cover the full range of the first oscillator, 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 ,, | 2·75 to 5 ,, |
| 3 | 6·2 to 10·2 ,, | 5 to 9 ,, |
| 4 | 10·2 to 17·7 ,, | 9 to 16·5 ,, |
| 5 | 17·7 to 31·2 ,, | 16·5 to 30 ,, |

**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 in the combining unit Type 6. 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 (B.F.O.)

**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 B.F.O. control in the front panel. This oscillator is not used in the dual diversity receiving equipment FGRI.18014.

### 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 Meisner 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 tranformers 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 bi-metal 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 capacities 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 frequency, 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 of 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 731 kc/s and 739 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 PL, A, 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 Type 6 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 Type 6. 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 will go negative. The increase in V7 anode current will cause the cathodes of V6 and V7 to go positive 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 positive. Less current will flow through cathode resistors R39 and R40 so that the cathode will go negative, 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 anodes 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 15V input from the power unit Type 815 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 Type 6.

**48.** When 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 arma-

* In fig. 4 the relay $\frac{RLI}{1}$ should read $\frac{RLI.}{2}$

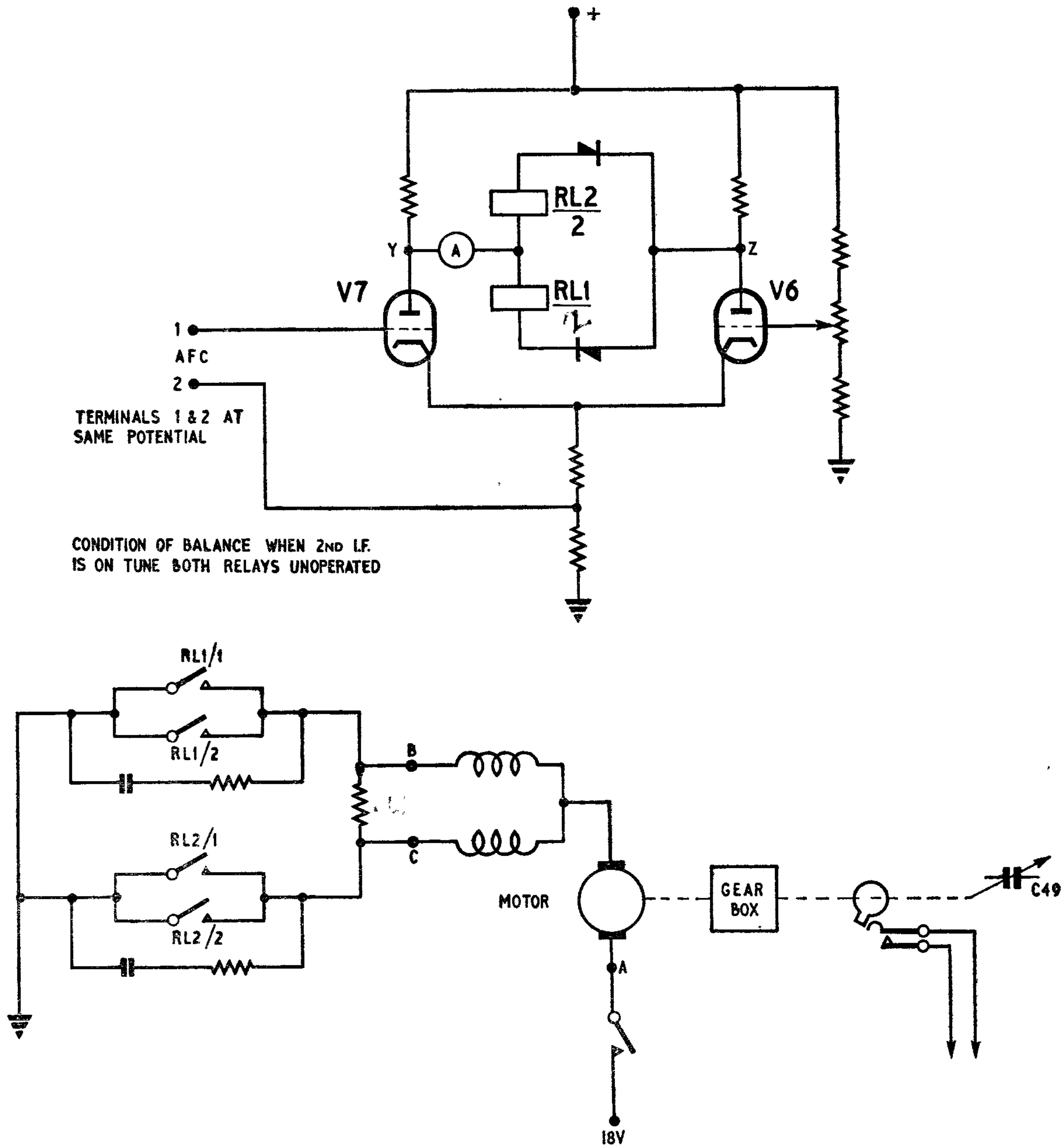


**Fig. 4. AFC circuit**

ture; 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 capacitance 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 AFC1 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 capacitance 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).

**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 PL4, A, B and C by the secondary winding.

## MONITORING

**53.** The monitoring circuit consists of the 11-position METER switch SW4 and an 0-1 mA 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 the 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 X 50
The meter M1 is connected in series with resistor R36 between the positive 140-volt stabilized line and earth.

(11) HT X 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 withdrawn fully 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, control valves and associated relays.

**58.** The right-hand base section carries the third oscillator (B.F.O.) 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

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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 the horizontal and circular (logging scales).

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

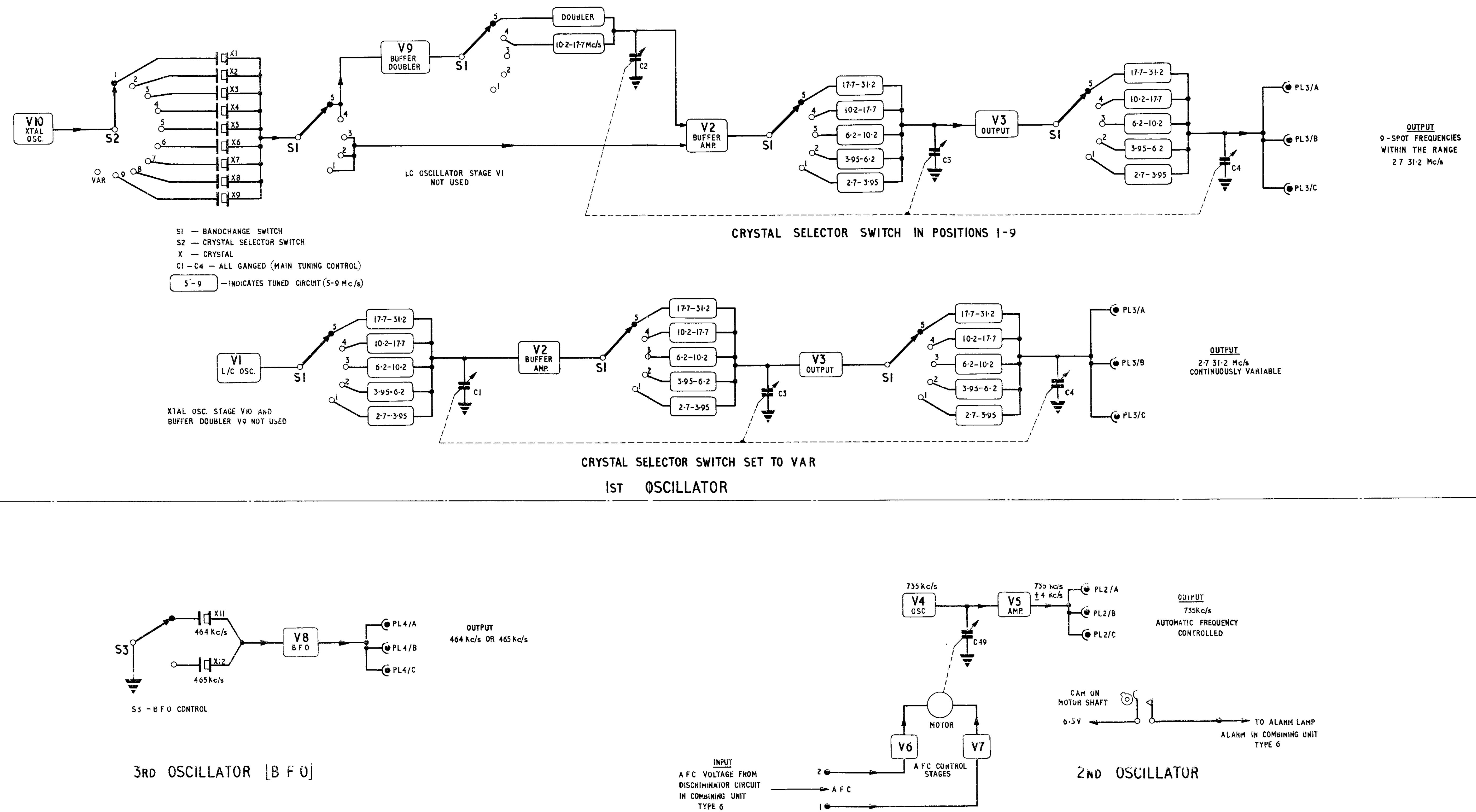


Fig. 3 Oscillator unit Type 327 – block diagram Fig. 3

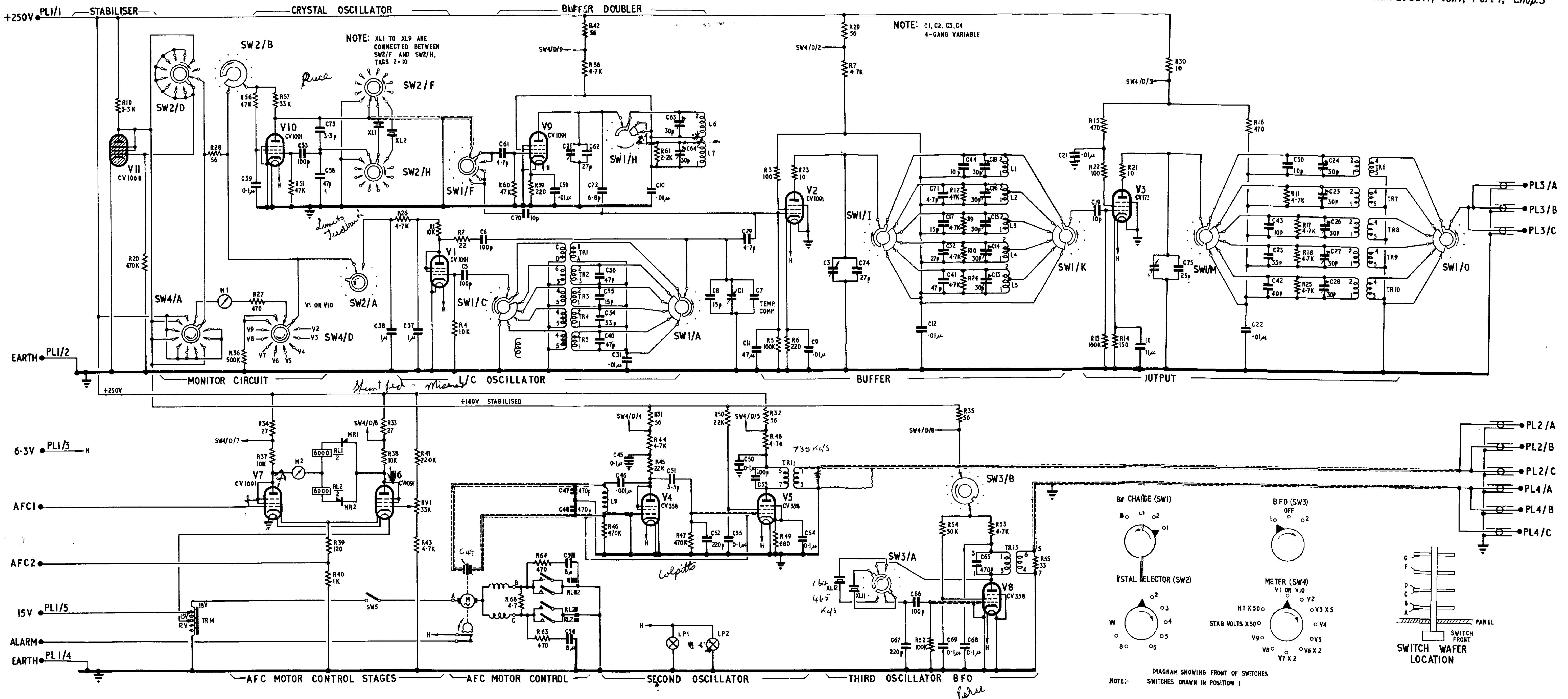


Fig.5 Oscillator unit Type 327 — circuit (A.L.S. May '54) Fig.5

AIR MINISTRY

DUAL-DIVERSITY RECEIVING EQUIPMENT FGRI. 18014
This is A.L. No. 4 to A.P.2980R, Volume I
Part I. List of Chapters: *delete "(to be issued later)"* after the title of Chapter 4 and *write "(A.L.4)"* in the outer margin against the deletion.
*Insert this Chapter 4 to follow the LIST OF CHAPTERS.*
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SIGNALS

# Chapter 4

# COMBINING UNIT TYPE 6

## LIST OF CONTENTS



## LIST OF ILLUSTRATIONS



## INTRODUCTION

**1.** The combining unit Type 6 (10D/18709) (*fig.* 1) forms part of the dual diversity receiving equipment, and is mounted on the rack assembly Type 272. This unit combines the signals from the A and B receivers.

**2.** The functions of this unit in the dual diversity receiving equipment are as follows :—

(1) Demodulate and combine the 465 kc/s A and B signals, producing the andio frequency (telephony) output.

(2) Convert the two 465kc/s signals (A and B) to 50 kc/s, by means of a common 3rd mixer stage, and feed the 50 kc/s to the output unit Type 50.

(3 Demodulate and combine the two 50 kc/s (A and B) signals to produce the automatic gain control voltage which is fed to the receivers A and B on the rack assembly.

(4) Demodulate and combine the 50 kc/s A and B signals to produce the automatic frequency control voltage which is fed to the oscillator unit Type 327 to control the frequency of the 2nd oscillator.

**3.** The signals fed into the combining unit are as follows :—

(1) 465 kc/s modulated signal from the 2nd IF stage in receiver A, fed in via Pye plug PL5 (*fig.* 4).

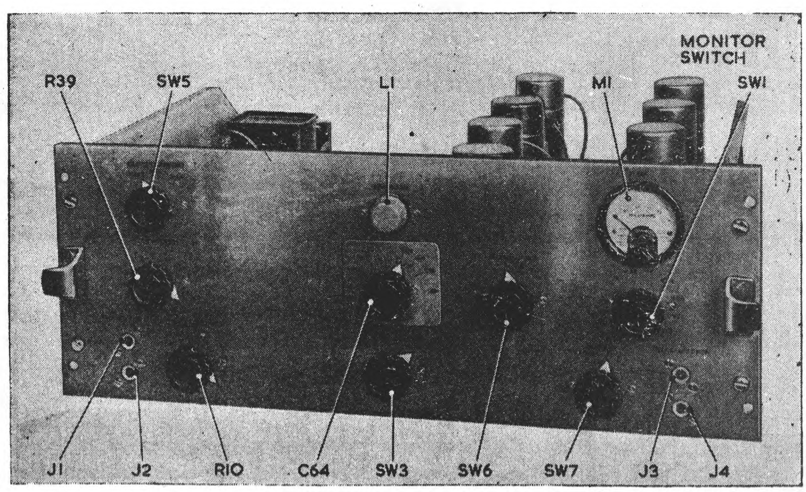



**Fig. 1. Combining unit Type 6**

(2) 465 kc/s modulated signal from the 2nd IF stage in receiver B, fed in via Pye plug PL4 (*fig.* 4).

(3) Bias voltage from the output unit Type 50 to the suppressor grid of the limiter and gate valve V12, via pins 4 and 5 plug PL3 (*fig.* 4).

**4.** The supply voltages fed into the combining unit are as follows :—

(1) 6·8-volt heater supply from the power unit Type 815, via pins 3 and 4 on plug PL1.

(2) 250-volt positive HT supply from the power unit Type 815, via pin 1 on plug PL1.

(3) 250-volt negative supply from power unit Type 815, via pin 7 on plug PL1.

5. The output signals and control voltages from the combining unit are as follows :—

(1) The audio frequency (telephony) output via pins 4 and 5 on socket SK2.

(2) 50 kc/s modulated signal (path A) to the IF amplifier in the output unit Type 50, via Pye plug PL7 (*fig*. 4).

(3) 50 kc/s modulated signal (path B) to the IF amplifier in the output unit Type 50, via Pye plug PL6 (*fig*. 4).

(4) Automatic gain control voltage to the receivers A and B, via pins 6 and 7 on plug PL3 (*fig*. 4).

(5) Automatic frequency control voltage to the AFC motor in the oscillator unit Type 327, via pins 1 and 2 on plug PL3.

6. A monitoring circuit is incorporated in this unit enabling the frequency of the two signals (A and B) to be compared against the output from either a 50 kc/s crystal oscillator, giving a zero beat note, or against the output from a 51 kc/s crystal oscillator giving a 1 kc/s tone.

7. Provision is made for checking the positive HT voltage, and the anode currents of the valves in this unit.

## CONTROLS

| 8. *Control* | *Function* | *Circ. Ref.* |
|---|---|---|
| A.G.C. TIME CONSTANT (*3-position*) | Varies the time constant between the AGC detector diodes and the AGC amplifier V11. Compensates for a FAST, MEDIUM or SLOW fade in the signals. | SW5 |
| A.G.C. INTENSITY | Variable potentiometer connected between V10 diode anodes and earth. Controls the amplitude of AGC voltage fed to receivers A and B | R39 |
| TELEPHONY GAIN | Variable potentiometer in the grid circuit of the telephony amplifier V4. Controls the amplitude of the audio output. | R10 |
| A.F.C. DEVIATION | A variable capacitor which controls the deviation of the automatic frequency control by varying the tuning of the input circuit to the discriminator valve V13. | C64 |
| A.F.C. SELECTOR (*4-position*) | Controls the operation of the automatic frequency control circuit to suit the four following types of reception :—<br>FSK HIGH — Frequency shift keying—AFC only operating on the high frequency deviation.<br>FSK LOW — Frequency shift keying—AFC only operating on the low frequency deviation.<br>ON/OFF (*CW and MCW*) — AFC only operating whilst a signal is being received; this prevents noise from operating the AFC in the absence of a signal.<br>PHONE — AFC is not switched off at all and operates throughout reception. | SW3 |
| TELEGRAPH MON (*2-position*) | Switches either A or B signals to the monitor mixer valve V5. | SW6 |
| MON. OSC. (*2-position*) | Switches either the 51 kc/s or 50 kc/s crystals in the local oscillator circuit of the monitor mixer valve V5. | SW7 |
| Monitor switch (*10-position*) | Switches the meter M1 between the positive HT supply and earth, and across the metering resistors connected in each valve circuit. | SW1 |
| TELEPHONY MON. | 2 jack-sockets enabling headphones to be connected in the output circuit of V4. | JK1 and JK2 |
| TELEGRAPHY MON. | 2 jack-sockets enabling headphones to be connected in the output circuit of the monitor mixer to aurally monitor the 1 kc/s tone, or zero beat note. | JK3 and JK4 |
| A.F.C. ALARM | A lamp which lights when the AFC circuit has operated. | L1 |
| FEEDS | A moving coil meter which indicates the HT voltage, and the anode current of the valves in the unit. | M1 |

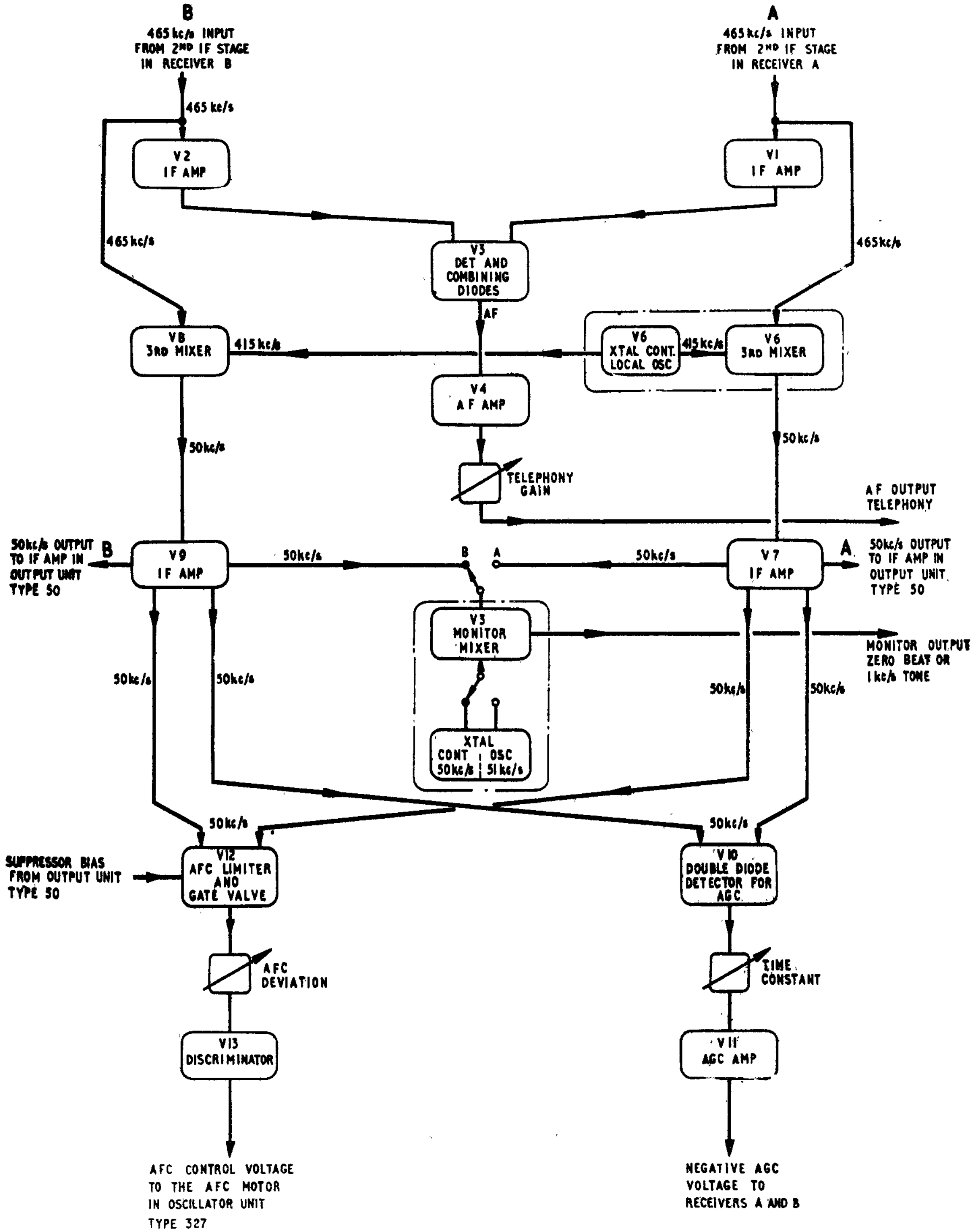



**Fig. 2. Block diagram**

## CIRCUIT OPERATION

### General

**9.** Fig. 2 is a block diagram showing the A and B signal paths in the combining unit. The two 465 kc/s input signals are amplified by V1 and V2, combined and demodulated in V3, amplified by V4 and fed out as telephony output. The 465 kc/s input signals are also fed to 3rd mixers, which have a common local oscillator V6 (crystal controlled) operating at 415 kc/s, so that the 3rd intermediate frequencies are 50 kc/s. The two 50 kc/s signals are fed, each into its own 50 kc/s IF amplifier, before being fed out to the output unit Type 50. The two 50 kc/s signals are combined and demodulated in V10; the DC component of the modulation is fed to the AGC amplifier V11 and finally fed to receivers A and B to control the gain of the receivers. The 50 kc/s A and B signals are also fed to a limiter valve V12, before being applied to the discriminator valve V13 which produces a voltage proportional to amount of frequency deviation from 50 kc/s. The AFC voltage is fed to the AFC motor in the combining unit, which in turn corrects the frequency drift of the 2nd mixer oscillator. The A.F.C. ALARM lamp is illuminated when the AFC system has operated.

#### Telephony

**10.** The two 465 kc/s signals (paths A and B) are applied via Pye plugs PL5 and PL4 to the grids of valves V1 and V2 respectively (*fig.* 5). V1 and V2 operate as 465 kc/s amplifiers using tuned transformers IFT1 and IFT2 in their anode circuits. The outputs from these transformers are applied, each to a separate cathode of the double-diode detector valve V3. A two-stage RF filter composed of resistors R7, R8, and capacitors C6 and C74, by-passes the RF to earth, and the audio (telephony) signal is fed via capacitor C7 to potentiometer R10 (TELEPHONY GAIN). The amplitude of the audio signal applied to the grid of V4A is controlled by the setting of R10. V4A is a triode valve operating as a Class A amplifier; the amplified audio signal at the anode of V4A is fed to the grid of V4B which also operates as a Class A triode amplifier. The output is taken from the secondary winding of transformer TR1, the primary winding of which is in series with the anode of V4B. Resistor R15 and capacitor C11 are connected between the anodes of V4A and V4B, forming a negative feedback path for the higher frequencies; thus the amplification of the circuit will be reduced, tending to cut-off the high audio frequencies.

**11.** The audio (telephony) output is fed from the secondary winding on transformer TR1 to pins 4 and 5 on the socket SK2 mounted at the rear of the unit. The two jack-sockets labelled TELEPHONY MON are connected in parallel across another winding on the output transformer TR1.

#### 3rd mixer stages (telegraphy)

**12.** Potential dividers consisting of resistors R2 and R3 (in path A), and resistors R46 and R47 (in path B) are connected between each of the 465 kc/s input plugs PL5 and PL4, and earth. The signal voltage developed across R3 is fed to the third mixer (in path A) V6. The signal voltage developed across R47 is applied to the third mixer (in path B) V8.

**13.** The mixer V6 (in path A) is a triode-hexode valve; the triode section operates as a crystal controlled oscillator generating a frequency of 415 kc/s. The 465 kc/s signal developed across R3 is applied to the grid of the hexode section of V6 and is mixed with the 415 kc/s oscillator frequency; the difference frequency of 50 kc/s (3rd IF) is selected by the tuned transformer IFT3 in the anode circuit of the hexode section.

**14.** The 3rd mixer V8 (in path B) is a triode-hexode valve; the 415 kc/s generated by the triode-section of V6 is fed into the triode-section grid of V8 via capacitor C50. The 465 kc/s signal (B) developed across R47 is applied to the grid of the hexode-section of V8; the difference frequency of 50 kc/s is selected by the tuned transformer IFT4 in the anode circuit of the hexode-section.

**15.** The 50 kc/s signal (A) in transformer IFT3 is applied to the grid of the 3rd IF amplifier V7. The amplified signal is selected by the transformer IFT5; the output winding on the transformer feeds the signal into a 75-ohm line via Pye plug PL7.

**16.** The 50 kc/s signal (B) developed in IFT4 is applied to the grid of V9, which is a pentode valve operating as an IF amplifier; the output signal developed in IFT6 is fed into a 75-ohm line via Pye plug PL6.

**17.** The 50 kc/s A and B signals are fed via coaxial cables to the output unit Type 50.

#### Automatic gain control

**18.** The AGC circuit comprises a double-diode valve V10 and a double-diode-triode valve V11. The 50 kc/s A and B signals are applied, one to each anode of V10; the cathodes of this valve are connected together to the junction of resistors R32 and R33 which are connected in series between the HT positive line and earth. The cathodes of V10A and B are thus held at a steady positive potential; for the diodes to conduct, the signal voltages applied to the anodes will have to rise above the cathode potential, so that the signal amplitude will have to rise above this potential before AGC is applied.

**19.** The anode loads R34 and R35 of V10A and V10B are connected together so that the negative rectified voltage resulting from the combination of the A and B signals will appear across resistor R36.

##### *AGC time constant*

**20.** Provision is made to apply the AGC voltage to the receivers via a time-delay circuit, which may be manually set to any of three positions, namely, FAST, MEDIUM or SLOW. This facility is provided to compensate for different signal fading periods experienced when operating the dual-diversity receiving equipment.

**21.** When a rapidly fading signal is being received the switch is set to FAST; this connects capacitor C33 in the grid circuit of V11 presenting the longest time constant to the negative going signal applied to the grid. The signal voltage at the grid will not be applied sufficiently long to enable the grid capacitor to charge-up negatively and reduce the anode current of V11; under these conditions no AGC voltage is applied to the receivers.

**22.** When the switch is set to MEDIUM capacitor C32 is connected in the grid circuit; the time constant is reduced to one fifth of that in the previous condition. A slower fading signal will cause the grid capacitor to charge negatively to a potential which will cause some reduction in the anode current of V11, and hence provide some measure of AGC.

**23.** When a slowly fading signal is being received it is desirable that the full AGC voltage be applied to the receivers to reduce the effects of fading. Under these conditions the switch is set to SLOW; this connects capacitor C31 in the grid circuit which reduces the time constant to a fifth of that in the previous condition (*para.* 22). The time constant is sufficiently short compared with the fading time of the signal to allow the grid to reach the full negative potential, and so cause a greater reduction of anode current. This allows the full AGC to be applied.

**24.** Valve V11 is a double-diode-triode; its anode is connected directly to the 250-volt positive line, whilst the cathode is returned via resistors R38 and R40 to the 250-volt negative line. The diode anodes are connected together and returned to earth via R39. The negative signal is applied to the grid.

**25.** In the absence of a signal at the grid of V11, the triode section of the valve will conduct; the anode current flowing through the cathode resistors R38 and R40 will raise the cathode to just about earth potential. The diode anodes are at earth potential so that the diodes will not conduct; there will be no current flowing through R39 and no AGC voltage developed across it.

**26.** When the negative signal is applied to the grid of the triode section of V11 it will cause a reduction in anode current. The reduction in anode current will allow the cathode to move towards the negative potential to which it is returned. The cathode will be negative with respect to earth, while the diode anodes are at earth potential. The diodes will conduct and the resulting current flow in R39 will cause the diode-end of the resistor to go negative. A portion of the negative voltage is fed via the slider of R39, the A.G.C. INTENSITY control, to receivers A and B via pins 6 and 7 on plug PL3.

**27.** A gas-filled stabilizer valve V14 is included in the cathode circuit of V11 to stabilize the bias line.

#### Automatic frequency control

**28.** The automatic frequency control voltage is developed by valves V12 and V13. The A and B signals (50 kc/s) are fed to the grid of V12 via capacitors C58 and C59. Valve V12 operates as a limiter stage limiting the signal amplitude applied to the discriminator V13. The DC output from the discriminator is fed to the AFC motor control circuit via pins 1 and 2 on plug PL3.

**29.** The 50 kc/s A and B signals are combined at the grid of the limiter valve V12. The limiting action of this valve takes place when the combined signal applied to the grid causes the grid to go positive with respect to the cathode; grid current flows back building up a negative charge across capacitor C60 which biases the valve. The signal is then limited by grid current on the positive peaks and by cut-off of the valve on the negative peaks. Resistor R71 allows the charge on C60 to leak away. Tuned transformer IFT7 in series with the anode of V12 applies the signal to the anodes of V13 (discriminator). The AFC system is switched off and on by bias voltages applied to the suppressor grid of V12 for the different types of reception. The AFC SELECTOR switch SW3 applies the bias voltages to V12 suppressor grid.

**30.** The double-diode valve V13 operates in a Foster-Seeley discriminator circuit (*fig.* 3) which converts the frequency deviation of the signal from the carrier frequency into a DC control voltage; this voltage, when applied to the AFC motor, retunes the 2nd oscillator in the oscillator unit Type 37.

**31.** The voltage applied to each diode is the vector sum of the primary voltage Vp and the voltage induced in one half of the secondary winding (½ Vs). When the diodes A and B conduct, the diode currents IA and IB flow through resistors R73 and R74 respectively to the common centre-point. The potential difference between points *a* and *b* (*fig. 3A*) is used to control the AFC motor in the oscillator unit.

**32.** When the signal voltage Vp, developed in the primary, is on tune (50 kc/s) the vector additions of the primary voltage Vp and ½ Vs (*fig. 3a*) result in the two voltages VA and VB being applied across diodes A and B. These voltages are equal in amplitude so that the resulting diode currents IA and IB are equal but are flowing in opposite directions; the potentials across resistors R73 and R74 are equal. When the signal is on tune therefore, the potential difference between points *a* and *b* is zero.

**33.** When the signal frequency drifts below 50 kc/s the phase relations of the voltages in the discriminator circuit are as shown in fig. 3b; hence the voltage VA across diode A is less in amplitude than VB, which appears across diode B. The resulting diode current IB is greater than IA, hence the voltage developed across R74 is greater than that across R73 so that point *b* is made positive with respect to point *a*. The potential difference between points *a* and *b* is applied via pins 1 and 2 on plug PL3 to the AFC circuit in the oscillator unit Type 327, and the motor turns the tuning capacitor in the 2nd oscillator circuit to compensate for the frequency drift.

**34.** When the signal frequency is above 50 kc/s the phase relations of the voltages in the discriminator circuit are shown in fig. 3c; the voltage VA across diode A is greater in amplitude than VB which appears across diode B.

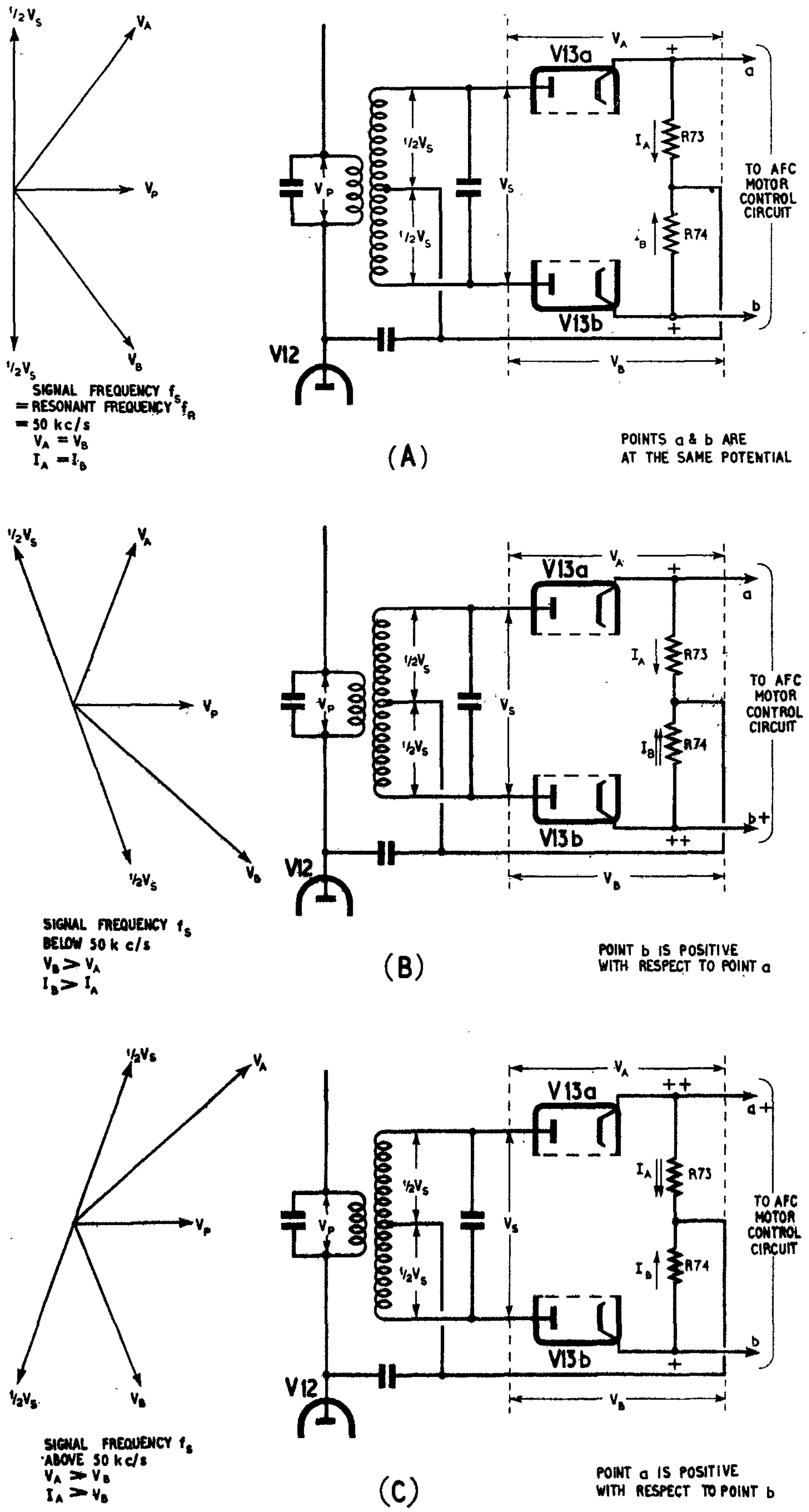



**Fig. 3. Discriminator circuits (AFC)**

The diode current $I_A$ is greater than $I_B$ so that point *a* is positive with respect to point *b* ; this potential controls the AFC motor in the oscillator unit to correct the drift in signal frequency.

**35.** The control voltage output from the discriminator circuit, appearing across pins 1 and 2 on plug PL3, is limited to approximately 2V by the four rectifier units MR1, MR2, MR3 and MR4.

**36.** A potential of approximately 1V applied in the forward direction across a single rectifier is required before it will pass any appreciable current.

**37.** Two rectifier units MR1 and MR2 are connected in series between pins 1 and 2 ; pin 2 is thus prevented from becoming more than 2V positive with respect to pin 1. The other two rectifier units MR3 and MR4 are also connected in series between pins 1 and 2, but in the reverse direction. Thus the potential at pin 1 is limited to 2V positive with respect to pin 2.

**AFC selector**

**38.** The A.F.C. SELECTOR switch SW3 controls the operation of the AFC circuit for all types of reception ; the switch has four positions which are listed in the following paragraphs together with the circuit changes effected with each position of the switch.

*FSK high*

**39.** The variable capacitor C64 (A.F.C. DEVIATION) control is connected across C68, which is connected across the secondary circuit of IFT7, the winding feeding the discriminator valve V13 A and B. The resonant frequency of the circuit may be tuned to the higher radio frequency by means of the A.F.C. DEVIATION control. The suppressor grid of V12 is connected to V17B anode in the output unit Type 50, and lifts the bias on the higher radio frequency deviation allowing the AFC system to operate.

*FSK low*

**40.** Capacitor C64 is connected across the secondary winding of IFT7 feeding the discriminator, and the circuit is tuned to the lower radio frequency by the A.F.C. DEVIATION control. The suppressor grid of V12 is connected to the anode of valve V17A, the AFC gate limiter, in the output unit Type 50. When the lower radio frequency is being received the potential at the anode of V17A lifts the suppressor bias on V12 which allows the AFC system to operate.

*On/off*

**41.** Capacitor C62 and C63 are connected in parallel across the secondary winding of IFT7, tuning the discriminator circuit to 50 kc/s. The suppressor grid of V12 is connected to the anode of V17A (*output unit Type* 50). In the absence of a signal valve V17A applies a negative

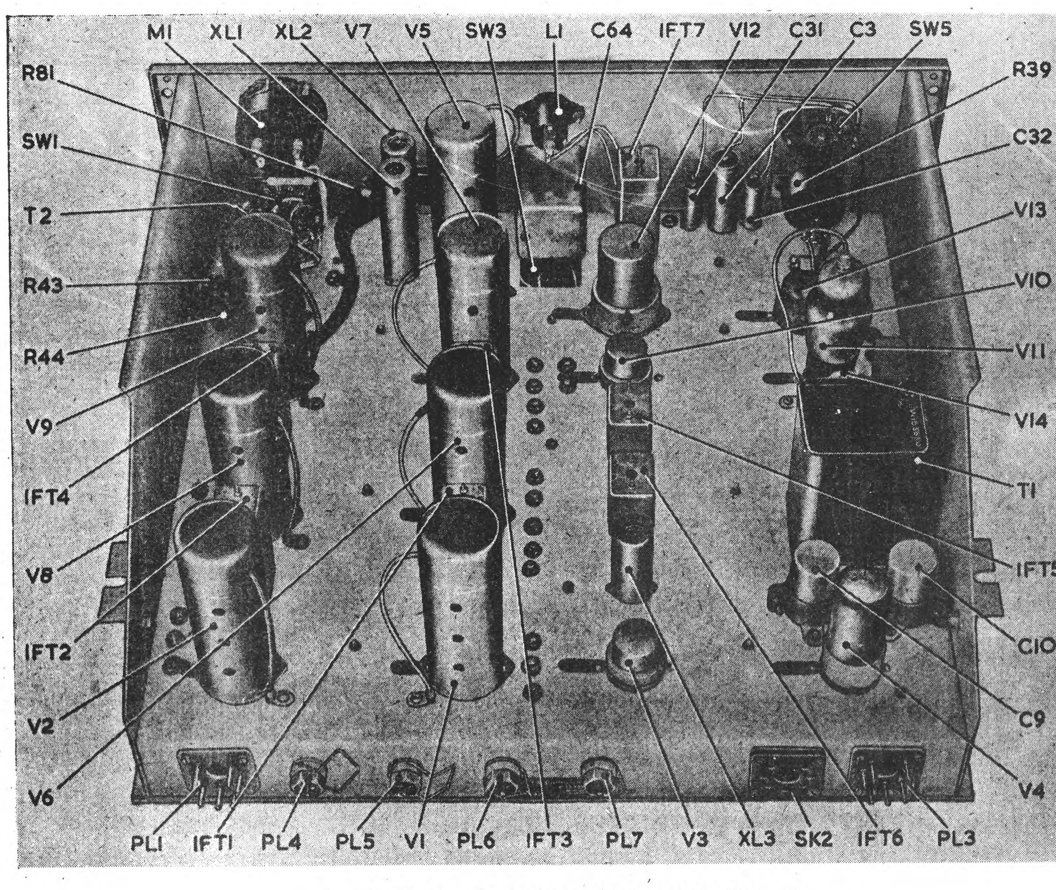
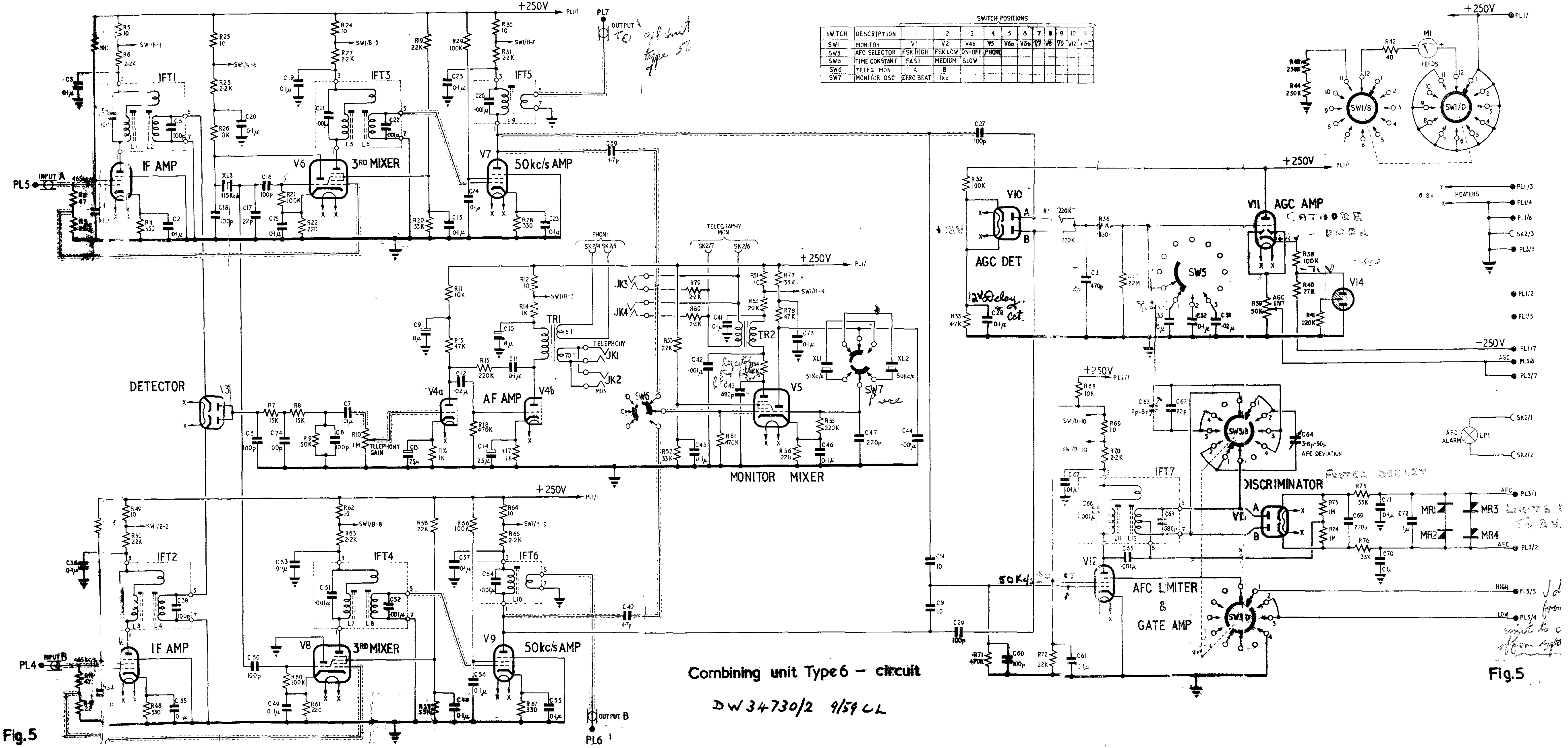



**Fig. 4. Rear view of combining unit Type 6**




| SWITCH | DESCRIPTION | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SW1 | MONITOR | V1 | V2 | V4b | V5 | V6a | V6b | V7 | V8 | V9 | V12 | +HT |
| SW3 | AFC SELECTOR | FSK HIGH | FSK LOW | ON-OFF | PHONE | | | | | | | |
| SW5 | TIME CONSTANT | FAST | MEDIUM | SLOW | | | | | | | | |
| SW6 | TELEG MON | A | B | | | | | | | | | |
| SW7 | MONITOR OSC | ZERO BEAT | 1kc | | | | | | | | | |

**Combining unit Type 6 – circuit**

DW 34730/2 9/59 CL

Fig. 5

potential to V12 suppressor grid, cutting-off the valve; this prevents noise from operating the AFC system.

*Phone*

**42.** Capacitors C62 and C63 are connected in parallel across the secondary winding of IFT7 tuning the discriminator circuit to 50 kc/s. The suppressor grid of V12 is connected to earth so that the AFC system operates throughout reception.

**Monitoring**

**43.** Two monitoring circuits are provided, one to check the signal frequency against a crystal controlled oscillator, the other to check the HT voltage and valve currents in the unit.

*Frequency*

**44.** The triode-hexode valve V5 is used as a frequency monitor stage to check the 3rd intermediate frequencies (50 kc/s) for paths A and B. The triode-section operates as a crystal controlled oscillator generating either a 50 kc/s output or a 51 kc/s output; two crystals are used and are selected by the MON OSC switch SW7.

**45.** The TELEGRAPHY MON switch SW6 feeds either the A path (50 kc/s) from the anode of V7, or the B path (50 kc/s) from the anode of V9, to the grid of the hexode-section of V5 (the frequency monitor valve).

**46.** When the MON OSC switch is set to ZERO BEAT the 50 kc/s crystal is switched in the triode-oscillator section of V5 and when mixed with either the (50 kc/s) A or B signals, will produce a frequency of 100 kc/s, and a zero beat note. A filter, consisting of resistor R54 in series with the anode of V5, and capacitors C42 and C43, by-passes the 100 kc/s to earth. Transformer TR2 couples the anode of V5 to the MON jack-sockets JK3 and JK4. When the signal is on tune, a zero beat note will be detected in the phones which may be connected to either of the MON jack-sockets.

**47.** When the MON OSC switch is set to 1 kc/s the 51 kc/s crystal is switched in the triode-oscillator section of V5; when mixed with either the A or B signal applied to the grid of the hexode section the 1 kc/s difference frequency will be fed to the MON jack-sockets. The 101 kc/s frequency in the anode of V5 will be by-passed to earth by the filter consisting of R54, C42 and C43.

*HT and valve currents*

**48.** The monitor switch SW1 connects the meter M1 between the HT positive line and earth, in position 11 (engraved HT+ on the front panel). The switch, when set to any of the positions, connects the meter M1 across the appropriate metering resistor in series with the valve; the voltage-drop across the metering resistor is interpreted in terms of anode current by the meter M1.

# Chapter 5

# OUTPUT UNIT TYPE 50

## LIST OF CONTENTS



## LIST OF ILLUSTRATIONS



## INTRODUCTION

**1.** The output unit Type 50 (*fig.* 1) forms part of the dual diversity receiving equipment and is mounted in the rack assembly Type 272.

**2.** The functions of this unit are as follows :—

(1) Combines the A and B path signals when CW. ON/OFF reception is being used, to overcome fading.

(2) Demodulation of the CW. ON/OFF signals; limits and 'clean's-up' the demodulated signals to reduce noise.

(3) Provides a MARK/SPACE D.C. output varying between fixed limits for the operation of teleprinter units etc. (for both CW. ON/OFF and F.S.K. operation).

(4) Comparison of the A and B path signals when F.S.K. reception is being used and selects the stronger path signal, and suppresses the weaker signal.

(5) Demodulation of the F.S.K. signal; limits and 'clean's-up' the demodulated signal.

(6) Provides AFC in either the MARK or SPACE condition so that the AFC is operative in the

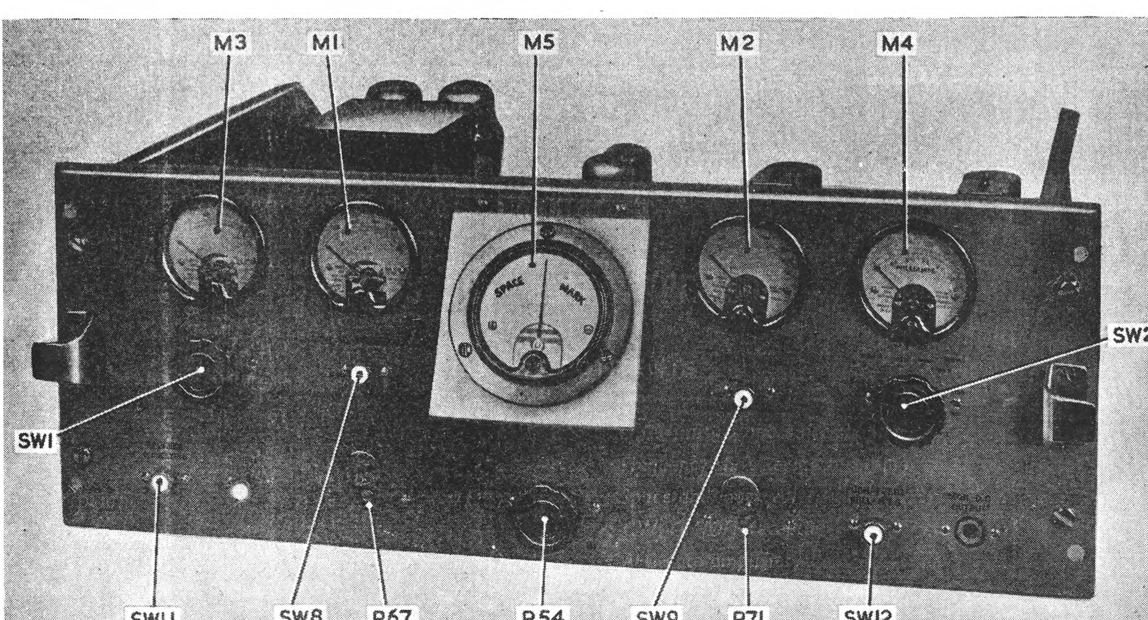



Fig. 1. Output unit Type 50

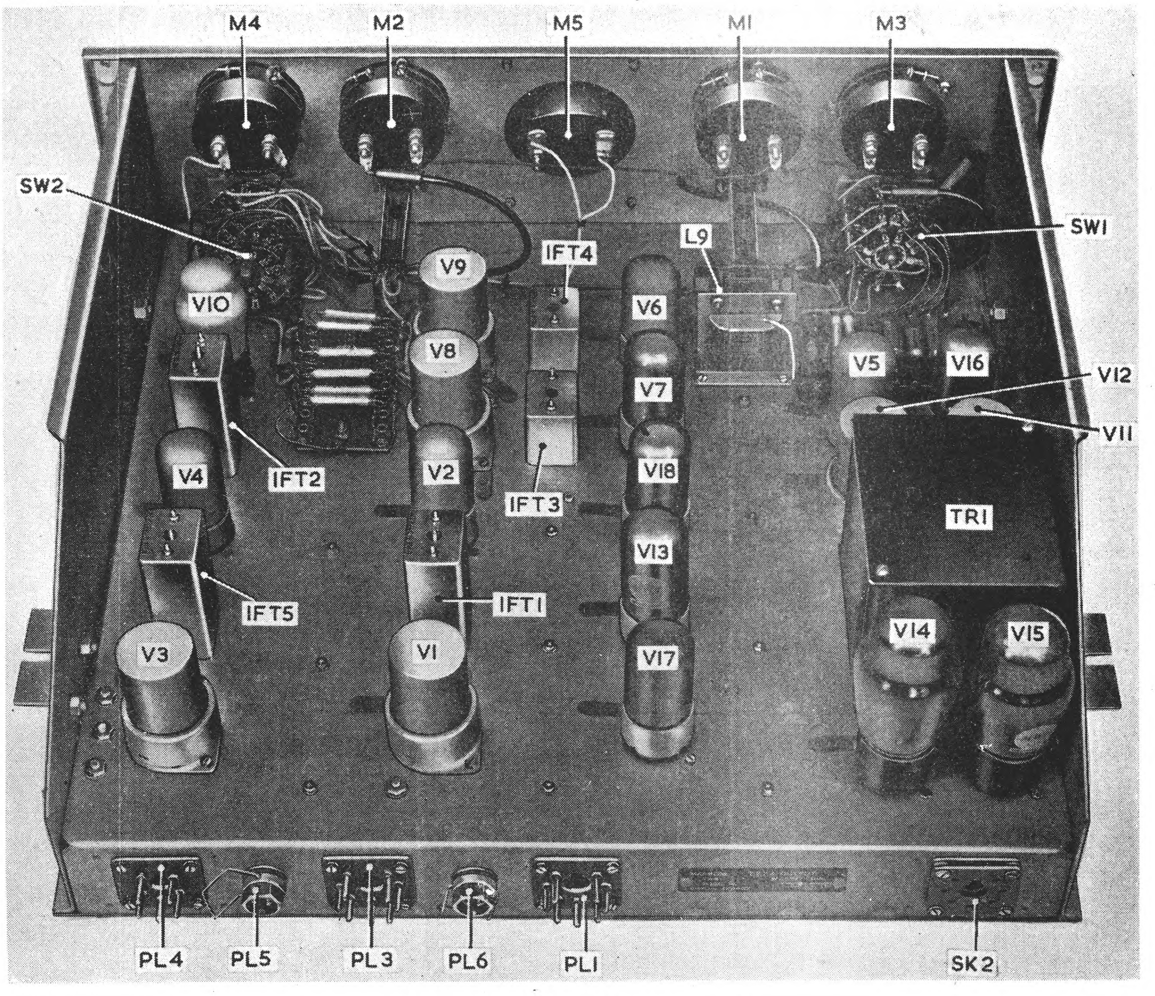



**Fig. 2. Rear view of output unit**

rest condition whatever keying convention is used.

**3.** The signals fed into the output unit are as follows :—

(1) 50 kc/s modulated A path signal fed from the IF amplifier V7 in the combining unit Type 6, fed in via Pye plug PL6 at the rear of the unit (*fig*. 2).

(2) 50 kc/s modulated B path signal fed from the IF amplifier V9 in the combining unit Type 6, fed in via Pye plug PL5 at the rear of the unit.

**4.** The supply voltages fed into this unit are as follows :—

(1) 230 volt alternating supply (50 c/s), from the mains-input termination at the base of the rack, via pins 1 and 2 on plug PL4 (pin 4 earth).

(2) 70-volt negative stabilized voltage, from power unit Type 816, via pin 1 on plug PL1.

(3) 140-volt positive stabilized (A), from power unit Type 816, via pin 1 on plug PL1.

(4) 140-volt positive stabilized (B), from the power unit Type 816, via pin 3 on plug PL1.

(5) 140-volt negative stabilized supply, from the power unit Type 816, via pin 6 on plug PL1.

(6) 280-volt negative stabilized supply, from the power unit Type 816, via pin 7 on plug PL1.

(7) 250-volt positive supply (unstabilized) supply from the power unit Type 816, via pin 4 on plug PL3.

(8) 6·8-volt alternating supply, from the power unit Type 816, via pins 1 and 7 and pins 2 and 8 (earthed in this unit) on plug PL3.

**5.** The output signals and control voltages from this unit are as follows :—

(1) The 30-0-30 mA max signal fed to the undulator or teleprinter via pin 1 on socket SK2.

(2) AFC voltage to the suppressor grid of V12 in the combining unit Type 6 via pins 4 and 5 on socket SK2.

(3) DC signal output to the tone sender unit via pin 2 on socket SK2.

(4) Pins 3 and 7 on socket SK2 are connected to earth (chassis).

## CONTROLS

**6.**

| *Control* | *Function* | *Circ. Ref.* |
|---|---|---|
| F.S.K.—ON/OFF | In the FSK positions this switch applies the demodulated F.S.K. signal from the AFC discriminator to the DC limiting and output stages. When the switch is in the FSK. H.S. position the components of the low-pass filter between the limiter stages V16, V11 and V12, are changed so as to raise the cut-off frequency to allow reception of a higher keying speed.<br>When the switch is in the FSK. L.S. position the low-pass filter cut-off frequency is lowered to reduce noise, when a lower keying speed of signal is being received.<br>In the ON/OFF positions the output from the ON/OFF demodulator valve V5, is applied to the DC limiter and output stages.<br>When the switch is in the ON/OFF L.S. position cut-off frequency of the low-pass filter between valve stages V16, V11 and V12 is lowered.<br>When the switch is in the ON/OFF H.S. position, the cut-off frequency of the low-pass filter is raised to permit reception of a higher keying speed. | SW1 |
| SIGNAL BIAS | A calibrated potentiometer in the grid circuit of V12 (DC limiter). It selects a portion of the signal to be amplified and may be adjusted to prevent noise from operating the telegraph equipment. | R54 |
| PUSH TO BREAK A | A push-button switch which when operated removes the HT from the screen of V1 and connects it to earth—this suppresses the A-path signal. | SW8 |
| PUSH TO BREAK B | A push-button switch which when operated removes the HT from the screen of valve V3 and connects the screen to earth, suppressing the B-path signal. | SW9 |
| REVERSE D.C. KEYING | A push-button type switch which when 'pressed' changes the keying convention. | SW11 |
| TEST | A push-button type switch which when 'pressed' applies a negative potential to the grid of V16, holding the circuit in one of the keying conventions, for test purposes. | SW10 |
| PUSH-FEEDS PULL-H.T.S. | A push-button type switch which when pushed-in enables the feed currents on the FEEDS meter for the valve stages in the circuit to be checked, the particular stages to be checked are selected by the meter switch SW2. When this switch is pulled-out the FEEDS meter indicates the HT potentials in the unit, the particular voltage being selected by the meter switch SW2. | SW12 |
| Meter switch | 11-position rotary-type switch enabling the valve feed currents to the various stages to be monitored when the PUSH-FEEDS switch is pushed in. The feed currents are indicated on the FEEDS meter. This switch also facilitates the checking of the six HT potentials used in the circuit (when the PUSH-FEEDS switch is pulled-out.) | SW2 |
| MARK | A preset potentiometer connected in the screen circuit of the MARK valve V15. This control adjusts the current delivered to the load under MARK signal conditions. | R71 |
| SPACE | A preset potentiometer connected in the screen circuit of the SPACE valve V14. This control adjusts the current delivered to the load under SPACE signal conditions. | R67 |
| COMBINED meter | An 0-500 microamp. instrument which indicates the combined levels of the A and B-path signals for ON/OFF reception. | M3 |
| LEVEL A meter | An 0-500 microamp. instrument which indicates the level of the A path signal for ON/OFF reception. | M1 |
| LEVEL B meter | An 0-500 microamp. instrument which indicates the level of the B-path signal (ON/OFF reception). | M2 |
| FEEDS meter | An 0-1 milliamp. instrument which is scaled 0-2 mA, and 0-500 volts ; and is used to check valve feed currents and HT voltages. | M4 |
| D.C. output | A centre-zero instrument which indicates the MARK/SPACE current delivered into the output. | M5 |

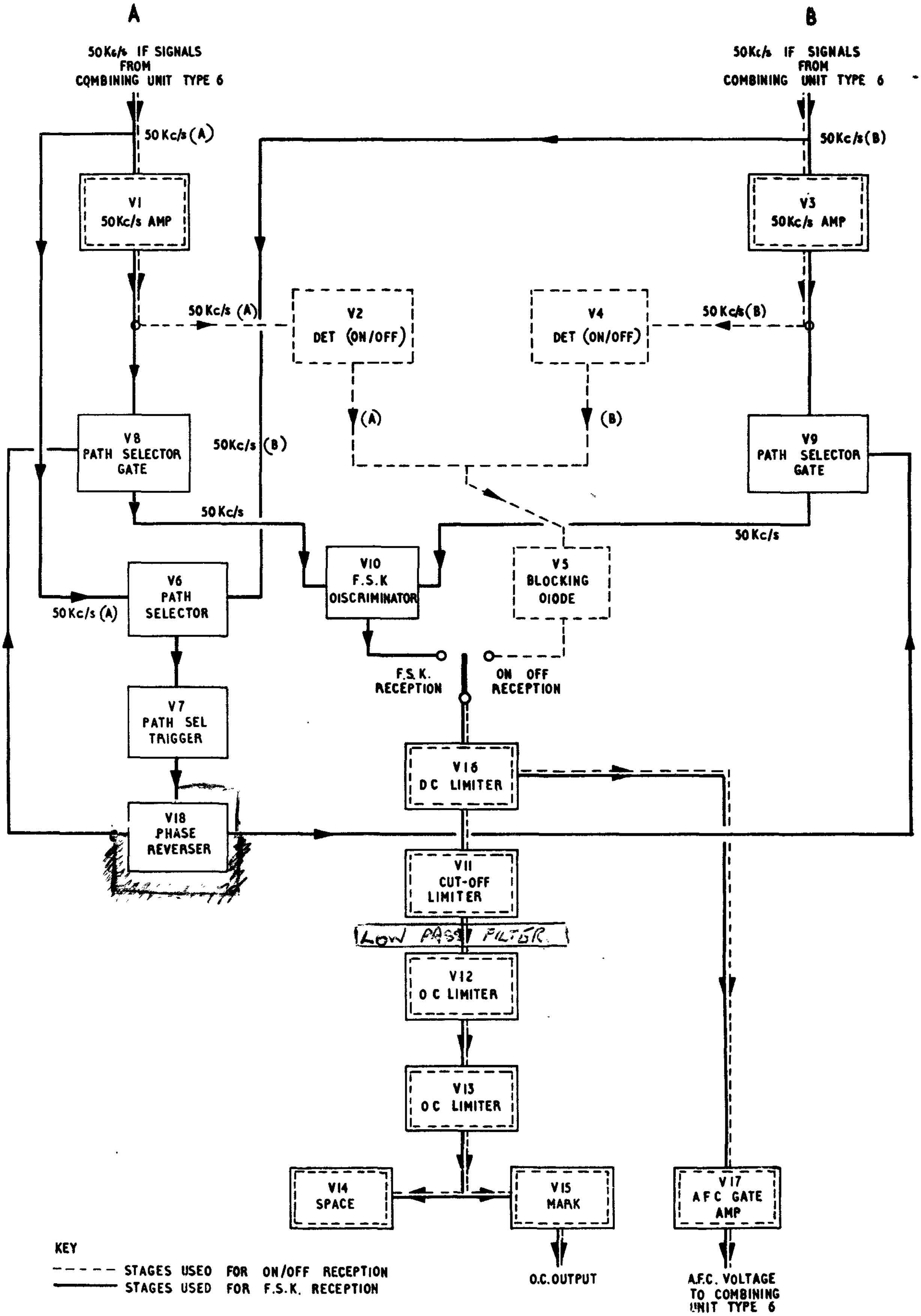



**Fig. 3. Block diagram**

## BRIEF DESCRIPTION

**7.** Fig. 3 is a block diagram showing the stages in this unit. The 50 c/s IF amplifier stages V1 and V3 are used to amplify the A and B path signals respectively, for both ON/OFF and F.S.K. reception. The amplified IF signals (ON/OFF reception) for the A-path are fed into diode V2. The B-path IF signals (ON/OFF reception) are fed into diode V4.

**8.** The diode loads of V2 and V4 are arranged so that the A and B path signals are combined and fed to the blocking diode V5 which demodulates the combined signal and feeds it via switch SW1 to the limiter stage V16. The A and B path signals, for F.S.K. reception are fed to V6 the double-diode path selector. The diode loads are arranged so that polarity of the voltage developed across them will change when one of the signals is stronger than the other. This voltage is passed through a sensitive DC amplifier V7 and then through triode V18 to obtain the 180 deg. phase shift. The two signals (in antiphase) are fed to two gate valves V8 and V9 in the A and B path chains respectively. The gate valve in the chain of the weaker path is switched-off by suppressor bias so that only the stronger signal arrives at the discriminator stage V10 where it is converted into a positive/negative-going DC signal. This demodulated F.S.K. signal is fed to the switch SW1.

**9.** By means of the FSK/ON/OFF switch SW2 either the demodulated FSK signals, or the demodulated ON/OFF signal is fed to the limiter and shaping circuits, V16, V11, V12, V13. These stages are used to limit and shape the signals for both the ON/OFF and FSK receptions.

**10.** The output from V13 is fed to V14 and V15 the space and mark valves which deliver a 30-0-30 m/A DC output into the load.

**11.** A signal is taken from V16, the first DC limiter, and fed to V17 the AFC gate amplifier. V17 provides control voltages to the combining unit Type 6, to ensure that the AFC is operative in the rest condition (no signal) whatever keying convention is used.

## CIRCUIT DESCRIPTION

### IF stages V1 and V3

**12.** Two identical 50 kc/s IF amplifier stages V1 and V3 (*fig.* 4) amplify the 50 kc/s A and B path input signals from the combining unit Type 6.

**13.** The IF stages consist of pentode valves operating in a conventional IF circuit. Push-button type switches SW8 and SW9 are connected in the HT feed to the screened-grids of both valves. Operating the switch removes the HT from the screen of the respective valve and connects the screen to earth; thus rendering the stage inoperative, for test and setting-up procedure.

**14.** The A and B-path signals are fed to the grids of V1 and V3 by means of Pye plugs PL6 and PL5 respectively. The amplified signals appear across the primary windings of the IF transformers IFT1 and IFT2.

**15.** These stages amplify the signals used in CW. ON/OFF reception and the signals used in F.S.K. reception. When CW. ON/OFF reception is used, the amplified signals appear across the secondary windings of IFT1 and IFT2. When F.S.K. reception is used the primary windings of IFT1 and IFT2 are used as the anode loads of V1 and V3 respectively, the amplified signal appearing at the anodes of V1 and V3 are fed via coupling capacitors C18 and C20 to the grids of V8 and V9.

### Combining and detection (CW. ON/OFF)

**16.** The combining of the A and B-path signals and the detection is performed by the double-diode valves V2, V4 and V5 and their associated circuits.

**17.** The amplified 50 kc/s A path signal appears across the secondary winding of IFT1; the amplified B-path signal apears at the secondary winding of IFT2. The anodes of V2a and V4a are connected in parallel to a common load R9. The A-path signal at the secondary of IFT1 is applied to the cathode of V2a; the B-path signal being applied to the cathode of V4a. When the cathodes of V2a and V4a are carried negative by the A and B-path signals, the signal current flowing through the common load R9 will be the combination of the demodulated signal currents for the A and B-paths. The signal voltage appearing across R9 will represent the combined signal (A and B-path).

**18.** Diode-sections V2b and V4b are used as limiter diodes in the A and B-path signals respectively. The cathodes of V2b and V4b are connected to the other ends of IFT1 and IFT2 secondary windings.

**19.** A bias is applied to the anodes of V2b and V4b (connected in parallel) by a bleeder network consisting of R11 and R12 between the 70-volt negative supply and earth; the negative bias of approximately 5 volts is applied to the anodes of V2b and V4b. Resistor R10 forms the common load for the limiter diodes.

**20.** The A and B-path limiter-diodes will only conduct when the signal at the cathodes exceeds 5 volts. The limiter diode load R10 is connected in series with the detector-diode load R9, so that the voltage developed across R9 is opposed to the voltage developed across R10.

**21.** The voltage applied to the cathode of the blocking diode V5 will be the difference of the voltages developed across R9 and R10; this limits the signal applied to the blocking diode. The resultant voltage applied to the cathode of V5 will be negative, and cause V5 to conduct. Resistor R13 forms the load for diode V5. The negative-going signal will appear across R13.

**22.** Two 500 microamp. instruments M1 and M2 are connected in the anode circuits of V2a and V4a to indicate the signal levels of the A and B-paths. Another 500 microamp. instrument M3 is connected at the junction of the V2a and V4a anodes to indicate the combined level of the two signals.

**Path selector (F.S.K.)**

**23.** The A and B-path 50 kc/s signals are taken from the Pye plugs PL5 and PL6 and fed into the primary windings of IF transformers IFT3 and IFT4 respectively. The secondary windings are connected to the path-selector diode circuit.

**24.** The path selector diode circuit consists of a double-diode valve V6; the 50 kc/s A path signal is fed to one diode, whilst the 50 kc/s B-path signal is fed to the other diode. The diodes are connected in opposition, their diode loads R15 and R14 are connected in series, so that the demodulated voltages developed across them are in opposition.

**25.** The voltage applied to the grid of V7 will be the difference of the demodulated signal voltages across R15 and R14. If the A-path signal is the greater in amplitude the voltage across R15 will be greater than that developed across R14, so that the resultant voltage (that applied to the grid of V7) will be negative. If the B-path signal is of larger amplitude, the signal voltage across R14 will be the greater, hence the voltage at the grid of V7 will be positive.

**26.** The path-selector trigger valve V7 is a double-triode arranged as a sensitive DC amplifier. The triode sections share a common cathode resistor R24 and are DC coupled.

**27.** A further stage V18 is used to invert the phase of the control voltage taken from the second anode of V7. This stage is a double-triode the second stage is not used (its three electrodes are connected together).

**28.** When the A-path signal is the larger, the control voltage at the grid of V7 is negative; this will reduce the anode current of V7a and allow the grid of V7b to rise. V7b will conduct more heavily, and the potential at its anode will fall and cause the grid of V18a to move into the negative region. As the grid of V18a is connected to the suppressor grid of V9; this negative voltage will cut-off V9 (the B-path gate valve) suppressing the B-path signal.

**29.** The negative control voltage at the grid of V18a will reduce its anode current causing the anode voltage to rise and lift the bias on the suppressor grid of V8 (the A-path gate valve) allowing V8 to conduct and pass the A-path signal to the discriminator.

**30.** When the B-path signal is greater than the A path signal the control voltage at the grid of V7a will be positive, causing its anode current to increase and the anode voltage to fall. The grid of V7b will be carried negative and cause a reduction in its anode current; the anode potential will rise and lift the suppressor bias of V9 (the B-path gate valve) allowing V9 to conduct and pass the B-path signal to the discriminator.

**31.** The potential rise at the anode V7b will raise the grid potential of V18a causing its anode voltage to fall, which results in a negative potential being applied to the suppressor grid of V8, cutting it off and suppressing the A-path signal.

**Path selector gate valves V8 and V9**

**32.** Two pentode valves V8 and V9 operate as RF amplifiers for the A and B-path signals respectively. V8 and V9 share a common anode load consisting of the primary winding of a 50 kc/s IF transformer IFT5. These valves are switched off and on by means of the control voltage, from the path selector circuit (described in previous paragraphs) applied to their suppressor grids. The A and B-path signal voltages fed to the grids of V8 and V9 are developed at the anodes of V1 and V3 (the primary windings of IFT1 and IFT2 forming the anode loads).

**F.S.K. discriminator**

**33.** A double-diode valve V10 is arranged in circuit with the secondary winding of IFT5 as a Foster-Seeley discriminator. The purpose of this circuit is to convert the frequency deviation, representing either a mark or a space character, into positive and negative DC potential.

**34.** A detailed circuit description of a Foster-Seeley discriminator will be found in Chapter 4 of this volume.

**D.C. limiting and pulse shaping**

**35.** Valve stages V16, V11 and V12 are designed to amplify, limit and re-shape the demodulated signal, for both the CW. ON/OFF and the F.S.K. types of reception. Circuit changes are made by the operation of the ON/OFF F.S.K. switch to accommodate F.S.K. or ON/OFF reception for either a high or low speed of keying. When the switch is set to F.S.K. the demodulated F.S.K. signal at the discriminator output is fed via the switch contacts the grid of V16a. When the switch is set to ON/OFF the demodulated ON/OFF signal developed across R13 is fed via the switch contacts to the grid of V16a.

**Frequency shift keying reception**

**36.** The demodulated F.S.K. signal developed across R37 and R38 will be positive and negative-going with respect to earth. This signal is DC restored about earth by the capacitor C28 and resistor R38 so that the signal appears negative with respect to earth at the grid of V16a.

**37.** The double-triode valve V16 is used as two separate triodes V16a and V16b. V16a operates as a triode-amplifier which is D.C. coupled to the following stage V16b, bias is provided on V16b by returning its grid to the 70 volt negative line, through resistor R47.

**38.** The large negative-going signal at the grid of V16a will carry the grid well beyond cut-off, so that a large portion of the SPACE, or negative signal, is removed; thus removing a large proportion of the noise imposed on this part of the signal. The ' space ' portion of the signal appearing at the anode of V16a will be limited and the noise reduced. The ' mark ' portion of the signal at V16a anode will carry the grid of V16b well beyond cut-off thus limiting this portion of the signal and removing the noise imposed on it. The signal at the anode of V16b is applied to the grid of V11 via the D.C. coupling.

**39.** Valve V11 is a pentode operating as a D.C. limiter stage. The action of this valve is to limit the amplitude of the signal.

**40.** The limited signal developed at the anode of V11 will be applied to the grid of V12 via the inductor L9 (D.C. coupling). L9 forms part of a low-pass filter between V11 and V12; the elements of the filter are R49 and R50, and capacitors C30, C31, C32 and C33. When the switch SW/1 is set to F.S.K. H.S. C31 is connected across R49, and C33 across R50; the inductor L9 is reduced by means of the tapping, which is selected by the switch.

**41.** The action of this low-pass filter is to remove the higher frequency noise components of the signal. The cut-off frequency of the filter is raised when the switch SW1 is set to F.S.K. HIGH to enable the higher speed keying signal to be passed by the filter.

**42.** V12 is a pentode valve connected as a triode. The bias applied to the grid of this valve may be varied by means of the potentiometer R54 (SIGNAL BIAS) which forms part of a bleeder network of resistors R50, R53 and R56, connected between the 140-volt positive supply and the 70-volt negative line. The signal developed at the anode of V11 is passed through the filter via L9 to the grid of V12.

**43.** By means of the SIGNAL BIAS control a section of the signal may be ' sliced out ', the level of the section is varied by the control. This enables a section of the signal to be selected where the noise interference is at a minimum. This valve (V12) operates as a limiter so that only a signal of small amplitude is actually applied to the grid.

**44.** The amplified signal developed across the anode load of V12 (R52) is D.C. coupled to the grid of V13a. V13 is a double-triode having a common cathode resistor R86 which is returned to the 70-volt negative line.

**45.** The signal applied to the grid of V13A is squared and applied to V13B by means of the common cathode coupling. The signal developed across R64 (V13B anode load) is in antiphase the signal developed across the anode load of V13A (R62).

**46.** The REVERSE DC KEYING switch SW11 feeds either of these voltages to the grid of V14 depending on the setting of the switch so that a space or mark may be converted into a positive or negative-going signal.

**Space and mark valves**

**47.** Two tetrode valves V14 (space) and V15 (mark) are connected in series between the 140-volt positive supply and the 140-volt negative supply. The output is taken from the cathode of V15 and fed to the telegraph equipment via pin 1 on socket SK2. The signal developed at either the anode of V13A or the anode of V13B (depending on the setting of the REVERSE KEYING switch) is applied to the grid of V14. The anodes of V13 are D.C. coupled to the grid of V14.

**48.** When the signal applied to the grid of V14 goes positive, V14 conducts and the potential at its anode falls causing the grid of V15 to go negative, cutting-off V15. The cathode is maintained a positive potential, relative to the grid, by the current drain through R71 and R72 and V14. The voltage fall at the anode of V14 will cause both the grid and cathode potentials of V15 to fall so that a negative voltage appears at the output.

**49.** When the signal applied to the grid of V14 causes it to go negative (with respect to its cathode) the valve cuts-off and the potential at its anode rises. The anode of V14 goes positive and raises the potential at the grid and cathode of V15 causing this valve to conduct; the potential at the cathode of V15 is raised. A positive voltage appears at the output.

**50.** A 50K potentiometer (SPACE) R67 is connected in the screen circuit of V14. This SPACE control enables adjustment of the anode current of V14 (when it is conducting). This control is used to adjust the current through the load under space signal conditions.

**51.** The MARK control consists of a potentiometer R71 in the screen circuit of V15; this control is used to adjust the current delivered to the load under mark signal conditions. This control enables adjustments of V15 anode current (when it is conducting).

**52.** A centre-zero milliammeter is connected between the cathode of V15 and the load resistance (1000Ω), which is external to this unit. This instrument indicates the direction and flow of the current through the load for both the mark and space-signal conditions.

**53.** The MARK and SPACE controls are adjusted so that a current of 30-0-30 mA is delivered to the telegraph equipment when a signal is being received.

**CW. ON/OFF reception**

**54.** When the F.S.K./ON/OFF switch is set to either of the ON/OFF positions the demodulated, combined, signal voltage, developed across R13 is applied via the switch contacts to the grid of V16a.

**55.** The large negative signal applied to the grid of V16a will be limited in a manner described in para. 38 ; the limited signal developed at V16a anode is DC coupled to the grid of V16b. The action of V16b is to limit the signal (*para.* 38) ; the limited signal at the anode of V16b is DC coupled to the grid of V11.

**56.** A capacitor C29 is connected between the grid of V11 and earth in both of the ON/OFF positions of the switch. The action of this capacitor is to partially shape the signal. The signal is limited and further shaped in the anode circuit of V11:

**57.** The signal at the anode of V11 is applied via a filter (to reduce noise) to the grid of V12. When the F.S.K./ON/OFF switch is in either of the two ON/OFF positions the filter is made-up of resistors and capacitors (the inductor L9 is shorted-out). The cut-off frequency is raised when the switch is set to the ON/OFF H.S. to permit reception of a higher-speed of keying of the signal.

**58.** The action of the subsequent stages V12, V13, V14 and V15 on a CW. /ON/OFF signal is similar to that for an F.S.K. signal (described in para. 42 to 54).

**AFC gate amplifier**

**59.** V17 is a double-triode valve having a common cathode load R76. This valve is used to produce a control voltage for the A.F.C. circuit in the combining unit Type 6.

**60.** The signal voltage developed across the anode load (R41) of V16b is fed to the grid of V17a. A positive signal at V17a grid will cause the valve to conduct and a negative-going signal is developed across R77 the anode load. The increase in V17a anode current causes the cathode to go positive and as the grid of V17b is connected to the 140-volt negative line the valve will cut-off and a positive going voltage is developed across the anode load, R79. The control voltages developed across R77 and R79 are in antiphase.

**61.** The voltage developed across R77 is used to control the AFC in the combining unit Type 6 when the CW. ON/OFF reception is being used. This voltage is fed out via pin 4 of socket SK2.

**62.** When F.S.K. reception is used, control voltages are taken from both anodes and fed to the combining unit Type 6. This ensures automatic frequency control of the equipment whether the transmission rests in either the high or low condition. The control voltage (high) is taken from V17b anode to pin 5 of socket SK2. The other control voltage (low) is taken from V17a anode to pin 4 of socket SK2.

**Heater supplies**

**63.** The heater supplies to some of the valves in this unit are provided by the transformer T1. The primary winding is fed with the 230 volt alternating supply fed in via pins 1 and 2 of plug PL4 (Pin 4 is earthed). Three separate 6·3v secondary windings (*fig.* 4) are provided on the transformer. The heater supplies to valves V14 and V17 are provided from one winding on T1 which is isolated because of the negative cathode potentials at which these valves operate. The heater supply to V15 is provided by another winding on T1. The third winding provides the heater voltages for valves V7, V18, V16, V11, V12, and V13 ; one end of this winding is earthed. The heater supply to the remaining valves in this unit is at 6·3V and is fed from the power unit Type 816 via pins 1 and 7 (in parallel) and pins 2 and 3 (in parallel); pins 2 and 3 are earthed in this unit.

## MONITORING

**64.** A monitoring circuit is provided to enable the various HT positive and negative voltages to be checked ; and also the anode currents of certain valves in this unit to be measured.

**65.** The monitoring circuit is made-up of a milliammeter M4 (FEEDS), mounted on the front panel, an 11-position rotary type switch (METER SWITCH) and a push-button type switch (PUSH FEEDS PULL-HT'S) SW12.

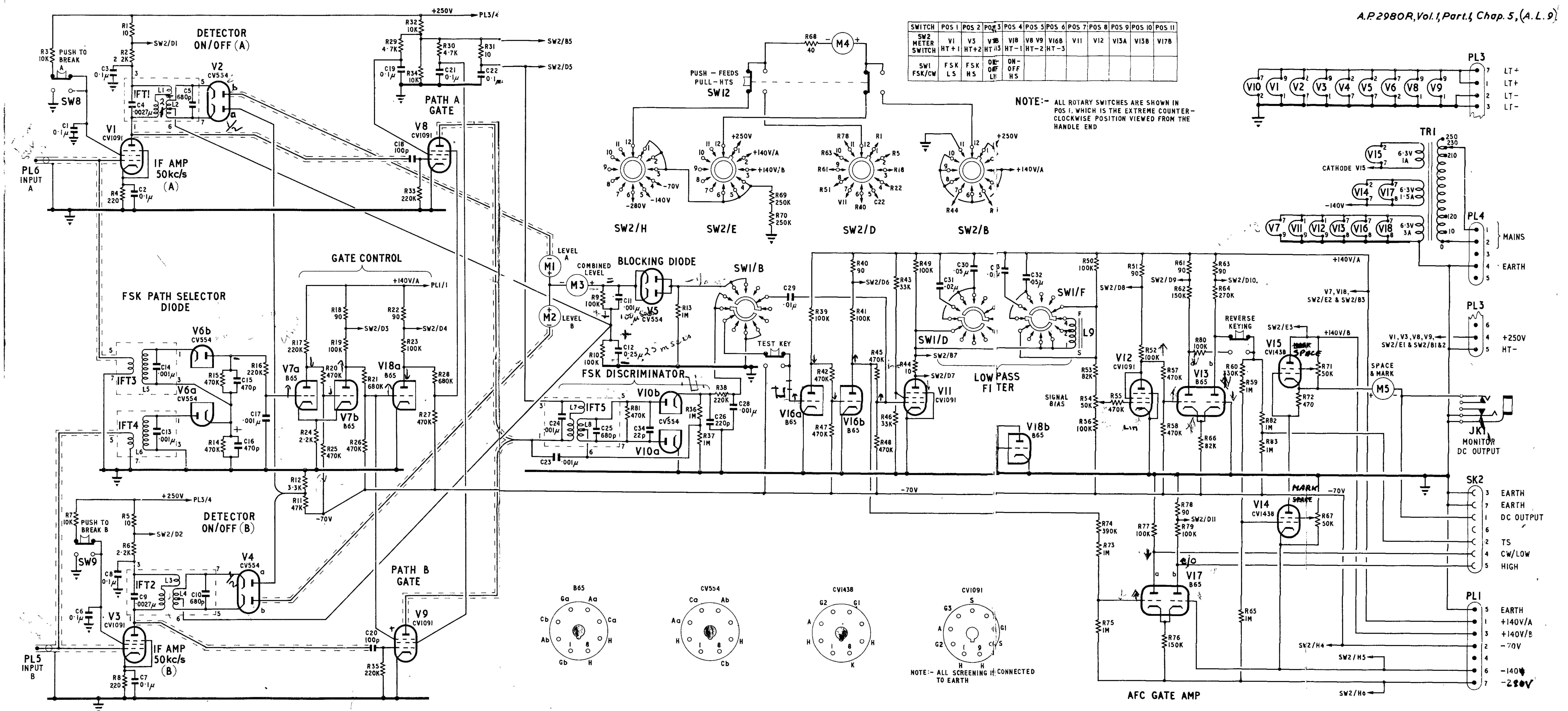
**66.** When the switch SW12 is pulled-out the meter M4 indicates HT voltages. The switch settings and the HT voltages measured are as follows :—

| *Switch position* | | *Voltage measured* |
|---|---|---|
| HT+1 | | 250-volt positive supply |
| HT+2 | (A) | 140-volt positive supply |
| HT+3 | (B) | 140-volt positive supply |
| HT−1 | | 70-volt negative supply |
| HT−2 | | 140-volt negative supply |
| HT−3 | | 280-volt negative supply |

**67.** When the push-button switch SW12 is pushed in, the meter M4 is connected across the metering resistor (appropriate to the setting of the METER SWITCH) in series with the anode of the valve concerned. The voltage drop across the metering resistor is interpreted on the meter scale as anode current. The engravings on the front panel, around the METER SWITCH indicate the particular valve stage being monitored when the switch is in this position.

## CONSTRUCTIONAL DETAILS

**68.** The output unit consists of a front panel bearing the meters and controls and a box-type base bolted to the panel. The whole unit slides into the rack on runners ; this arrangement permits the unit to be fully withdrawn from the rack and raised at an angle to permit access to the components mounted under the base whilst the unit is still supported by the runners attached to the rack.




| SWITCH | POS 1 | POS 2 | POS 3 | POS 4 | POS 5 | POS 6 | POS 7 | POS 8 | POS 9 | POS 10 | POS 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| SW2 METER SWITCH | V1 HT+1 | V3 HT+2 | V1[illegible] HT[illegible]3 | V18 HT-1 | V8 V9 HT-2 | V16B HT-3 | V11 | V12 | V13A | V13B | V17B |
| SW1 FSK/CW | FSK LS | FSK HS | ON-OFF LS | ON-OFF HS | | | | | | | |

NOTE:- ALL ROTARY SWITCHES ARE SHOWN IN POS 1, WHICH IS THE EXTREME COUNTER-CLOCKWISE POSITION VIEWED FROM THE HANDLE END

Fig. 4

Output unit Type 50 — circuit

AIR MINISTRY

DUAL DIVERSITY RECEIVING EQUIPMENT FGRI 18014

**This is A.L. No. 3 to A.P.2980R, Vol. 1**

**Part 1.** List of Chapters: *delete* "(*To be issued later*)" after the title of Chapter 6 and *write* "(A.L. 3)" in the outer margin against the deletion. *Insert* this Chapter 6 to follow List of Chapters. *Record* the incorporation of this A.L. in the Amendment Record Sheet.

**SIGNALS**

# Chapter 6—TONE SENDER UNIT

## LIST OF CONTENTS



## LIST OF ILLUSTRATIONS



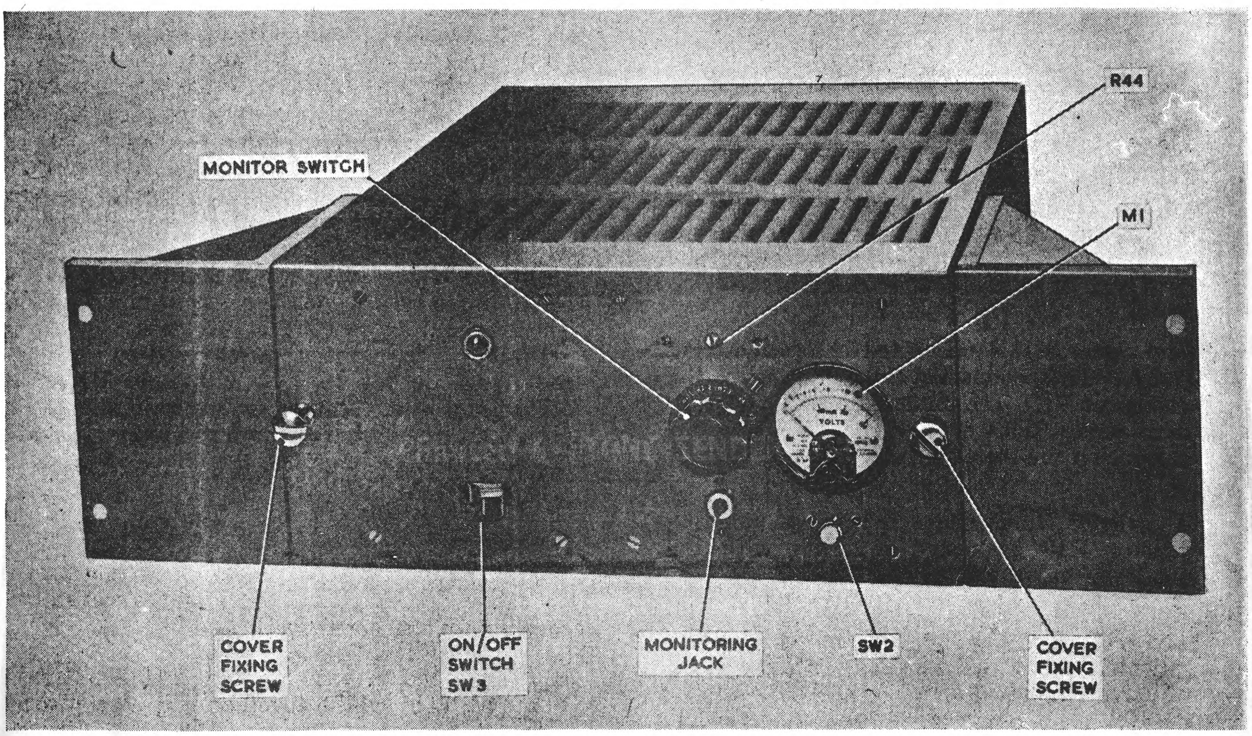



**Fig. 1. Tone sender unit**

**Introduction**

**1.** The tone sender unit 10D/18708 (*fig.* 1) consists of a 1,000 c/s tone generator which may be keyed either from the output unit Type 50, or manually. Provision is made to control and measure the tone output.

**2.** This unit forms part of the dual diversity receiving equipment and is mounted on a metal panel which fits into the standard rack. (Rack assembly Type 272.)

**3.** The functions of the unit are as follows :—

(1) To provide a 1,000 c/s tone at a constant output level and fixed frequency.

(2) To provide means of keying the tone by the square-wave output from the output unit Type 50.

(3) To measure and control the level of the keyed tone output.

**4.** The tone sender unit has its own internal power unit which may be operated from mains voltages of between 110 and 250.

**5.** Monitoring facilities are provided by which the operator may check voltages on the valves used in the unit. This is performed by operating the rotary switch on the front panel and observing the meter M1.

**6.** The tone sender unit is fully tropicalised and will maintain a constant frequency and output voltage over appreciable changes in the ambient temperature.

**Controls**

*ON/OFF switch*

**7.** A double-pole single-throw switch SW3 mounted on the lower left-hand side of the front panel, which when set to ON, completes the primary circuit of the power unit transformer to the mains supply.

*Monitor switch*

**8.** This is an 8-position rotary switch mounted on the left-hand side of the front panel. The switch is actually an 11-way but modified mechanically to operate only on the first eight positions. The function of the circuit with the switch in each of its positions is as follows :—

(1) V1
The meter M1 is connected across metering resistor R29 connected in series with the anodes of V1. The meter measures the volt-drop across R29 which is read as total anode current on the meter scale.

(2) V2
The meter M1 is connected across metering resistor R18 connected in series with the anodes of valve V2.

(3) V3a
The meter M1 is connected across metering resistor R25 connected in series with the anode of valve V3a.

(4) V3b
The meter M1 is connected across the metering resistor R26 connected in series with the anode of valve V3b.

(5) V4
The meter M1 is connected across the resistor R10 in series with the anode of valve V4.

(6) HT1
The meter M1 is connected in series with the resistor R30 across the 150-volt supply to V1.

(7) HT2
The meter M1 is connected in series with the resistor R31 across the 250-volt supply to V2 and V3.

(8) LEVEL
The switch in this position connects the meter M1 across the output attenuator ; the signal voltage is rectified by the rectifier unit MR4 before being applied to the meter M1.

*Attenuator control*

**9.** This control is mounted on the front panel and is a preset variable potentiometer R44 which controls the amplitude of the signal at the output terminals.

*Monitoring jack*

**10.** This jack-socket is mounted below the monitor switch on the front panel and is provided so that headphones may be connected in the output circuit.

*Push-button switch (SW2)*

**11.** This switch is mounted below the meter M1 on the front panel, and when pressed, causes valve V4 to cut-off. This provides a continuous tone output so that the level of the output may be measured and adjusted.

*Oscillator control*

**12.** This control is mounted inside the unit R42 (*fig.* 3) and is preset. It forms the cathode coupling resistor between valves V3A and V3B and controls the amplitude of the tone generated by these two valves.

**Operation**

**13.** Fig. 2 is a block diagram of the tone sender unit. A 1,000 c/s tone generator feeds into an output stage ; the output stage is switched on and off by the keying stage which is controlled by the square wave output from the output unit Type 50. The keyed tone output is fed into a variable attenuator whose output is matched to the line ; the signal output level is monitored by meter M1 when the monitoring switch is in the LEVEL position. The internal power supply provides DC and heater voltages for the unit.

**Circuit description** (*fig. 4*)

*Tone generator*

**14.** The 1,000 c/s tone generator circuit consists of valves V2, V3a and V3b and a resistance-capacitance phasing network.

**15.** The tone is generated by the two triodes V3a and V3b, which together with the phasing network consisting of capacitors C3, C4 and resistors R23 and R24 form a Wien bridge

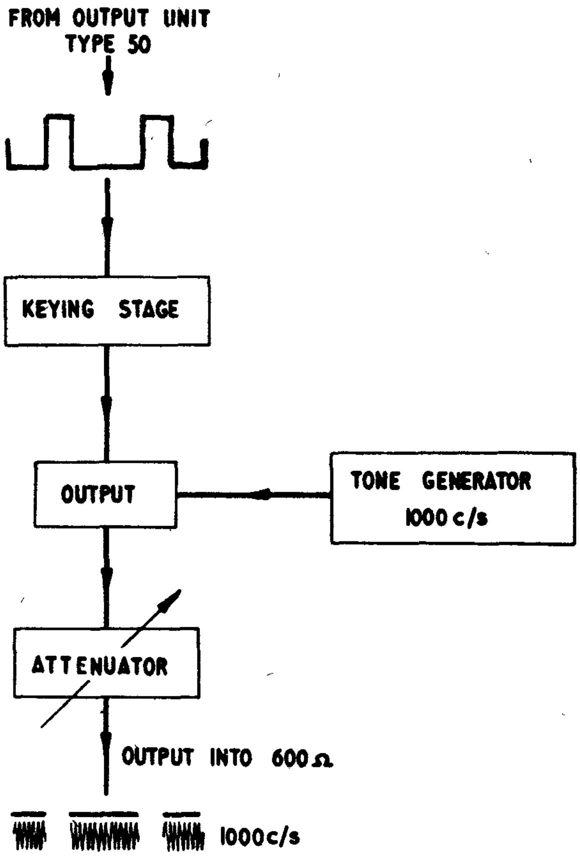



**Fig. 2. Block diagram**

oscillatory circuit. Regeneration between V3a and V3b is controlled by the variable cathode coupling resistor R42. V2 is included as a cathode-follower and effects a high-to-low impedance match in the feedback path from the anode of V3b to the input of the phasing network at the junction of C3 and R22.

**16.** The feedback path between the anode of V3b and the grid of V3a is thus via the cathode-follower V2 and the phasing network. This phasing network will give minimum attenuation and zero phase-shift at the grid of V3a at one frequency only ; by arranging the values of capacitors C3 and C4 and resistors R23 and R24, this frequency is set at 1,000 c/s. Thus the circuit will oscillate at 1,000 c/s only and, owing to the high phase sensitivity of the feedback circuit, will have a high degree of frequency stability.

**17.** The lamp L2 is connected in series with the input of the feedback network to keep the input voltage constant ; as the current through the lamp increases so the filament resistance increases tending to reduce the current. Capacitor C1 blocks the DC to the feedback network and is of necessity of very large capacitance so that it introduces negligible phase shift and attenuation in the feedback circuit.

**18.** The loop gain of the circuit and hence the amplitude of oscillations is controlled by the variable resistor R42 included in the cathode coupling between V3a and V3b.

*Output stage*

**19.** The output amplifying stage is provided by the double-triode valve V1, the two triodes being operated as a push-pull amplifier. The grids of the triodes are fed in antiphase from the ends of the secondary winding on transformer TR2 ; the 1,000 c/s tone is fed from the feedback network between valves V3a and V3b to one end of the primary winding of transormer TR2, the other end of which is earthed. The anodes of the triodes are connected to the push-pull output transformer TR1, the HT voltage being fed to the centre point of the primary winding. The tone output is fed into the attenuator via the secondary winding on transformer TR1.

**20.** The anode load of valve V4 is in the grid to cathode return path for valve V1 ; when V4 is conducting V1 is biased to cut off and vice versa. The tone output to the attenuator can thus be switched off and on by the action of the keying valve V4.

*Keying valve*

**21.** The anode of the keying valve V4 is connected to the strapped cathodes of V1 via the load and metering resistors R11 and R10 and the normal bias resistor R9 of V1 ; the anode of V4 is also connected directly to the centre-point of the grid transformer TR2. The voltage drop developed across the anode load of V4 when conducting is thus applied between cathode and grid of V1, so that when V4 is conducting, V1 is cut off. When V4 is not conducting, V1 conducts normally. Valve V4 is a double-diode triode which is controlled by the square wave output from the output unit Type 50. The square wave is applied between grid and cathode of V4 via pins 1 and 2 on plug PL1 ; the grid is earthed externally via pin 1, while pin 2 is connected to the cathode. V4 is normally conducting and is cathode biased by R15. V1 is then cut off and the tone output is suppressed.

**22.** With the application of the square wave output from the output unit Type 50, the positive-going half-cycle raises the cathode of V4, so increasing the bias sufficient to cut the valve off. V1 then conducts and the tone output is fed to pins 6 and 7 of plug PL1. The negative half-cycles of the input waveform are limited by the action of the strapped diodes in V4.

**23.** The tone may be manually keyed across pins 1 and 4.

**24.** Valve V4 may be biased to cut-off by operating the push-switch SW2 ; this connects the grid to the HT negative line. The cathode is connected to the positive end of resistor R33, so that on depressing SW2 the grid is made negative with respect to the cathode. This cuts off the keying valve, which in turn allows V1 to conduct and feed continuous tone to the output terminals.

*Output attenuator*

**25.** The output attenuator is connected between

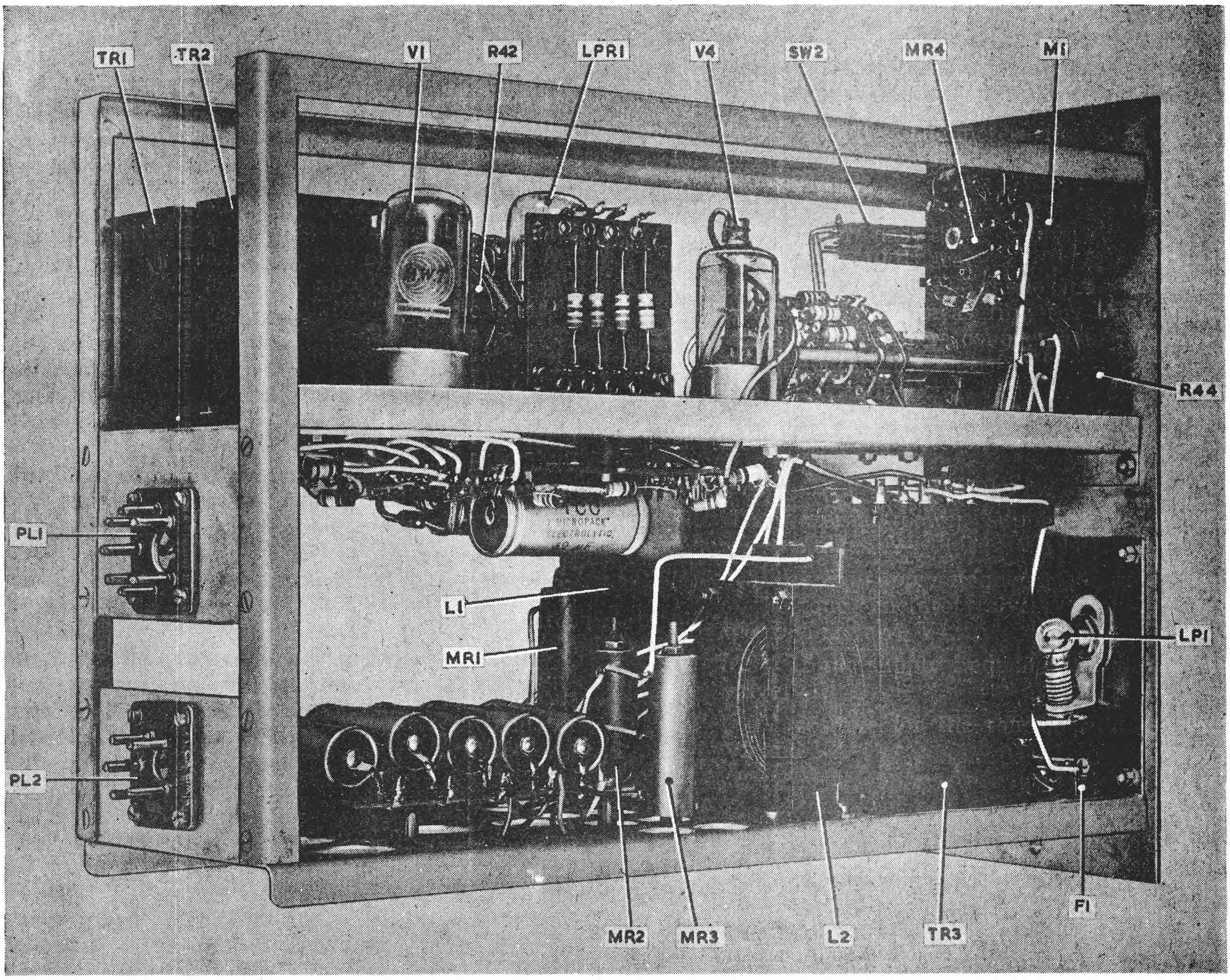



**Fig. 3. View showing component layout**

the output from TR1 and pins 6 and 7 on plug PL1.

**26.** The attenuator matches the output from the tone sender unit to a 600-ohm line and also provides a means of controlling the output signal level ; the attenuator control R44 is a preset potentiometer mounted on the front panel. The fixed attenuator pad consists of resistors R1, R2 and R3 and introduces a loss of 10dB. The full output from V1 delivered into the 600-ohm input impedance of the attenuator is approximately 100 mW.

**27.** When the monitor switch is in the LEVEL position the meter M1, together with its bridge rectifier MR4, is connected across the output from the attenuator so that the tone output level may be measured. The meter is calibrated from minus 4 to plus 10dB (relative to 1mW).

**28.** Jack socket JK1 is provided so that headphones may be connected across the output from the push-pull amplifier V1 to enable the operator to aurally check the tone output. The socket is connected across the output winding of the transformer TR1 ; the level of tone heard in the headphones will be unchanged when the attenuator control R44 is adjusted.

*Monitoring*

**29.** A multi-position switch (monitoring switch) SW1 and a 1mA f.s.d. moving coil meter (M1) with a full-wave bridge rectifier MR4 form the monitoring circuit. The metering circuits selected for each position of the monitor switch are outlined in para. 8.

**30.** The meter has three calibrated scales, a minus 4 to plus 10dB scale, a 0 to 300-volt scale and a 0 to 5mA scale. The anode current measurements are made by measuring the voltage-drop across metering resistors connected in series with the valve anodes ; the meter scale is calibrated to indicate the equivalent current values. This metering practice obviates disconnecting valve circuits to insert the meter in series with the valves.

*Power supply*

**31.** The internal power supply provides the following voltages :—

(1) 6·3V at the supply frequency for the heaters of the tone generator valves V2 and V3, and the keying valve V4.

(2) 6·3V at the supply frequency for the output valve V1.

(3) 250V positive for the tone generator valves V2 and V3.

(4) 200V positive for the keying valve V4.

(5) 150V positive for the output valve V1.

**32.** The two 6·3-volt heater supplies are provided by two separate windings on the power transformer TR3. A pilot lamp LP1, mounted on the front panel, is connected across the 6·3-volt heater winding supply valves V2, V3 and V4 and indicates when the mains supply to the tone sender unit is switched ON.

**33.** The 250-volt positive supply is developed across a bridge rectifier composed of units MR2 and MR3 fed from the 210-volt winding on transformer TR3. The positive DC output is smoothed by the capacitance-input filter consisting of capacitors C8 and C7 and inductor L2.

**34.** The 200-volt positive supply for the keying valve V4 is taken from the positive terminal of the bridge rectifier in the 250-volt supply circuit and fed to the anode of V4 via the dropping resistor R43. Capacitor C8 is used to decouple resistor R43 ; the 250-volt positive output from the rectifier is reduced to approximately 200V by the voltage dropped across resistor R43. The 200-volt positive line is connected to the negative of the 150-volt positive supply for the output valve V1.

**35.** The positive HT voltage of 150 for the output valve V1, is provided by the bridge rectifier MR1 supplied from the 135-volt winding on transformer TR3. The DC output is smoothed by the capacitance-input filter consisting of capacitors C5 and C6 and inductor L1. As the negative of this supply is connected to the positive of the 200-volt supply feeding valve V4, the voltage between positive of the supply feeding V1 and the negative of the 250-volt supply will be approximately 350V.

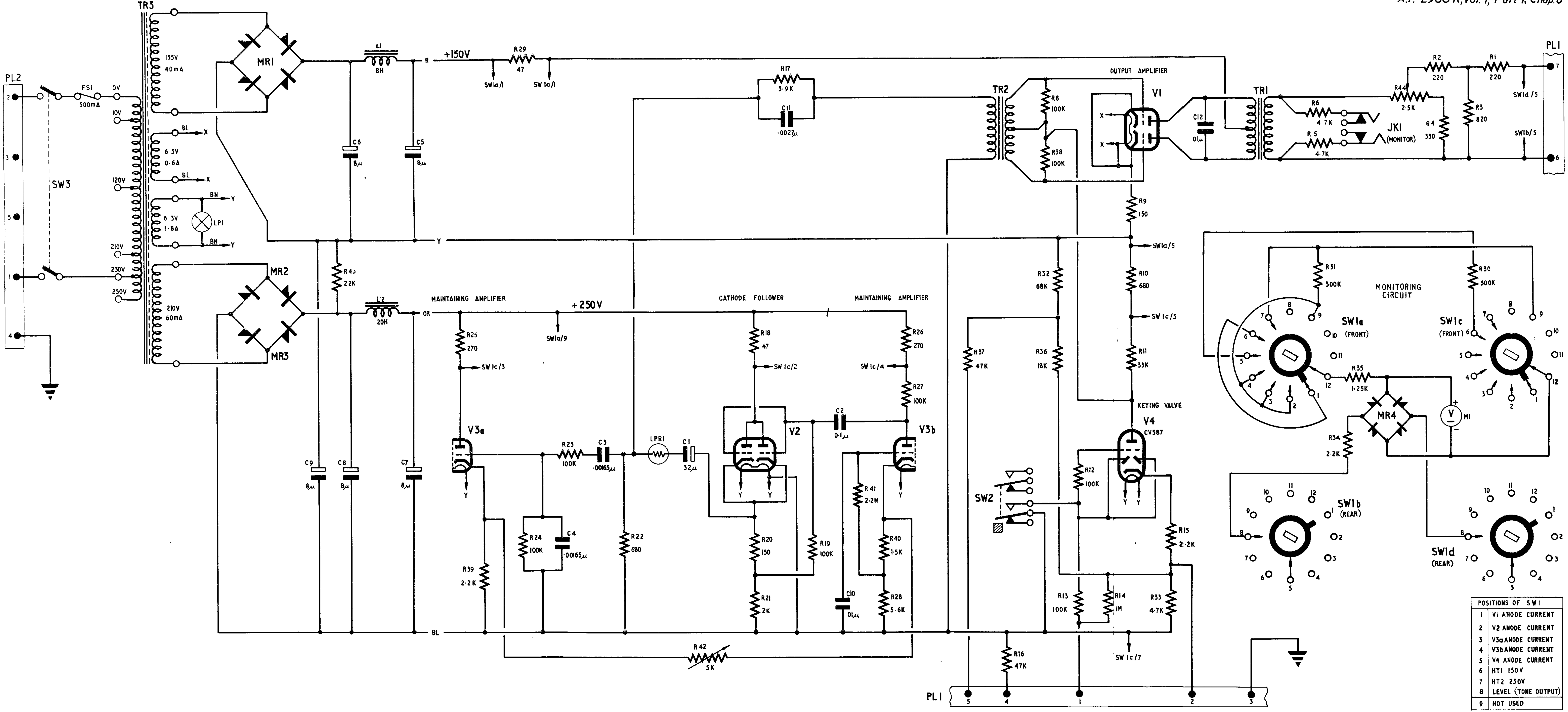
**36.** The mains input to the primary winding of transformer T3 is made via pins 1 and 2 on plug PL2, the contacts of the double-pole mains ON/OFF switch SW3 and the fuse FS1.

#### Constructional details

**37.** The tone sender unit consists of metal front panel with a rectangular framework bolted to the panel from the rear. The framework contains two metal trays arranged vertically to the front panel. The left-hand tray looking from the front of the panel carries all the components of the power unit, whilst the tone sender, output stage, keying valve and monitoring components are mounted on the right-hand tray. The two plugs PL1 and PL2 are mounted on plates at the rear of the framework.

**38.** A metal cover slides over the framework from the rear end and is secured behind the front panel by the two cover fixing screws through the panel.

**39.** Two brackets are mounted one at each end of the front panel to enable the unit to be mounted in the standard receiver rack.




| POSITIONS OF SW1 | |
|---|---|
| 1 | V1 ANODE CURRENT |
| 2 | V2 ANODE CURRENT |
| 3 | V3a ANODE CURRENT |
| 4 | V3b ANODE CURRENT |
| 5 | V4 ANODE CURRENT |
| 6 | HT1 150V |
| 7 | HT2 250V |
| 8 | LEVEL (TONE OUTPUT) |
| 9 | NOT USED |

Fig. 4 Tone sender unit - circuit

Fig. 4

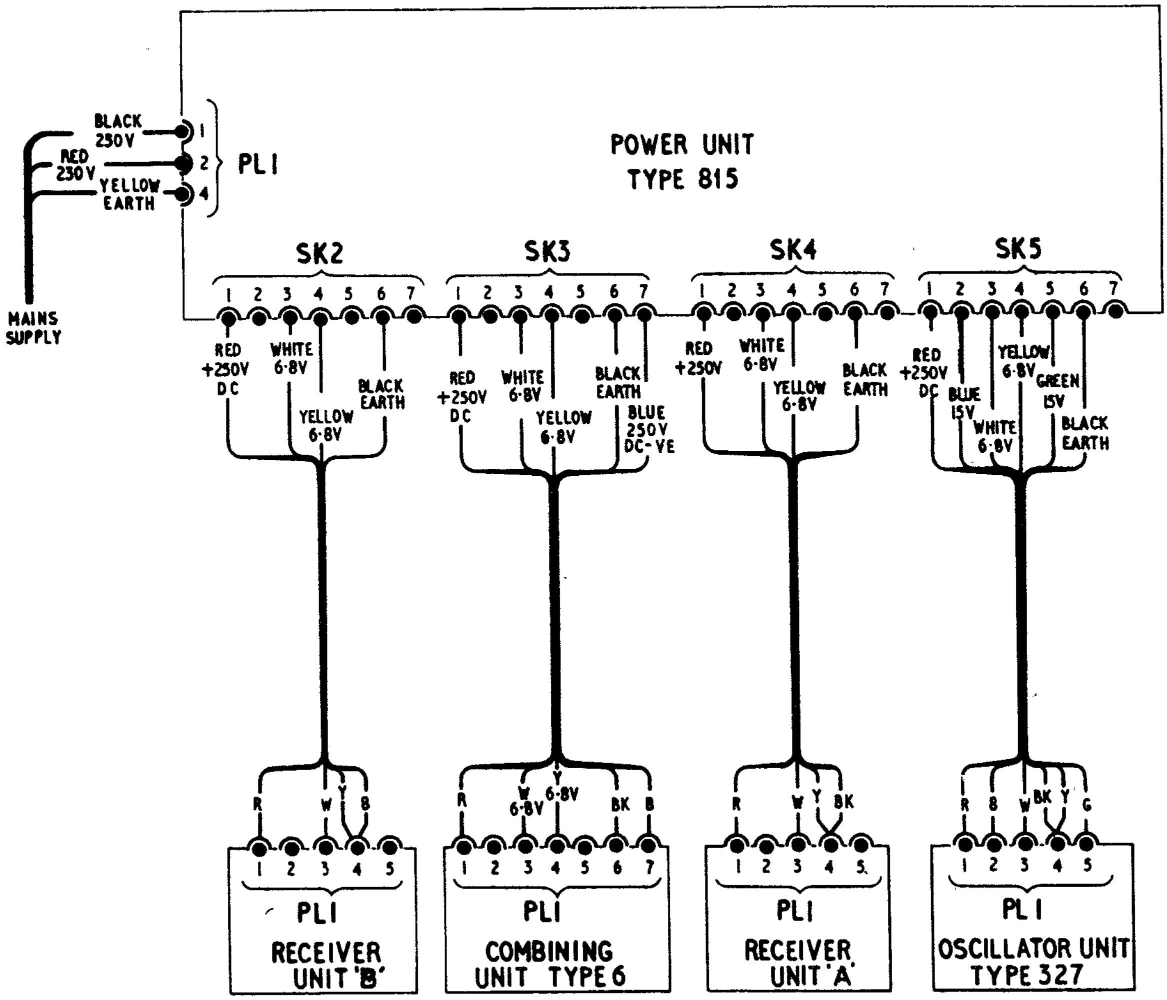



**Fig. 2. Diagram showing outputs to external units**

**Circuit description** (*fig. 3*)

**6.** The primaries of the transformers TR1 and TR2 are connected in parallel to the mains input terminals. Tappings on the primaries of TR1 and TR2 are provided so that the unit may be operated from mains supplies varying from 110 to 250 volts; the connections for various mains voltages are given in the table at the bottom of fig. 3.

*Heater supplies*

**7.** The 6·8-volt alternating supply voltage for the valve heaters is provided by a secondary winding on transformer TR2; the maximum output current from this winding is 20 amperes. The 6·8-volt heater supply is fed to the external units via pins 3 and 4 on the output sockets SK2, SK3, SK4, and SK5.

**8.** The 15-volt alternating supply for the valve heaters is provided by a secondary winding on transformer TR1; this winding has a current rating of 2 amperes. The ends of the winding are connected to the external units via pins 2 and 5 on each of the output sockets.

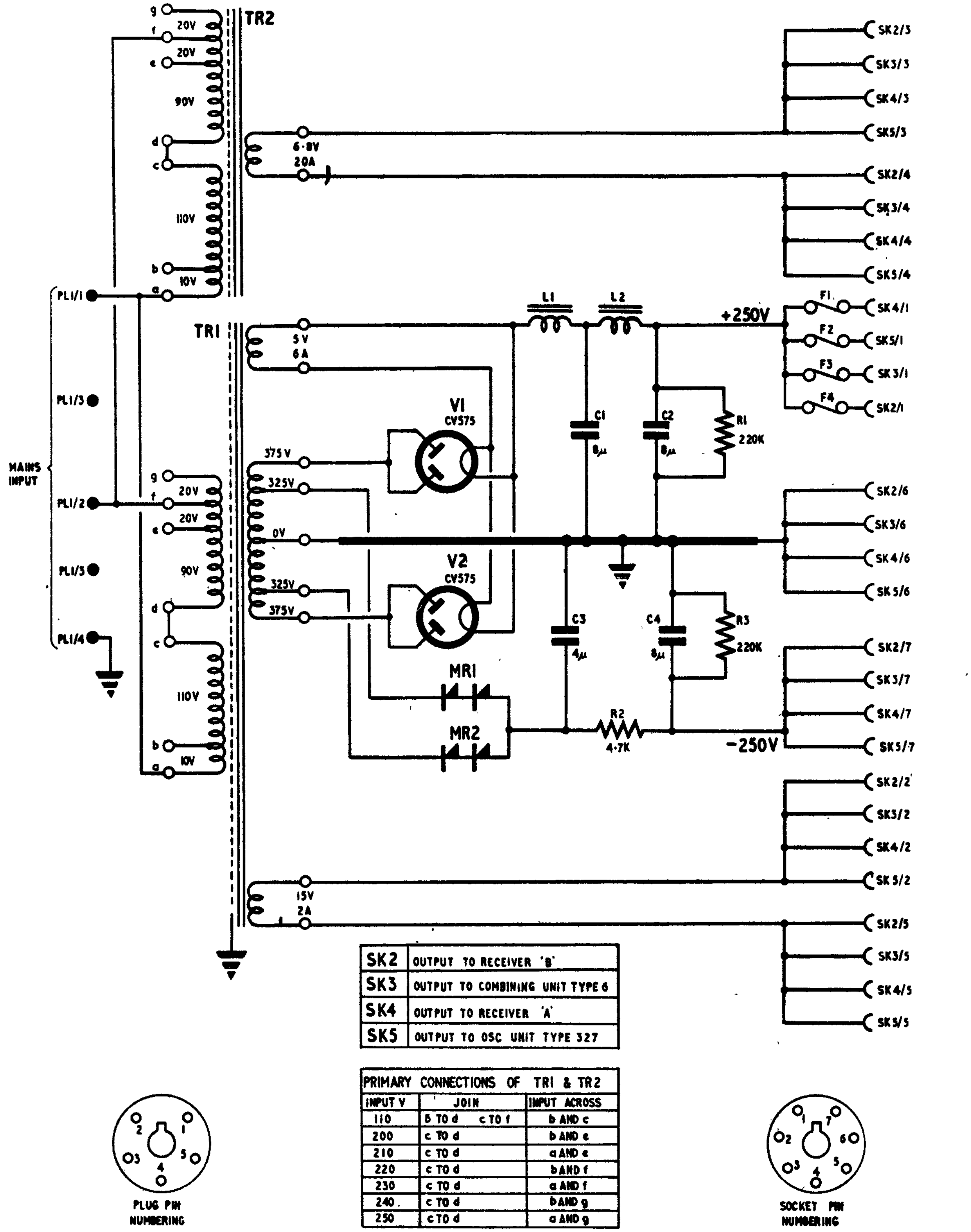
*250-volt positive supply*

**9.** The 375-0-375-volt winding on transformer TR1 provides the anode voltages for the two full-wave rectifiers V1 and V2; the anodes of each of the rectifier valves are connected in parallel, and each valve is operated as a half-wave rectifier. The HT winding has its centre tap connected directly to chassis (earth). The 5-volt winding on transformer TR2 provides the filament voltage for the rectifier valves V1 and V2. The rectified output is taken from one of the filament connections common to valves V1 and V2.

**10.** The rectified output is fed into the choke-input filter consisting of two inductors L1 and L2 and capacitors C1 and C2. Resistor R1 is connected across C2 to allow the charge on the capacitor to leak away after the power unit is switched off. The smoothed positive output of 250V is fed via four fuses, F1 to F4, to pin 1 on each of the four output sockets.

*250-volt negative supply*

**11.** The 250-volt negative supply is provided by the rectifying circuit using the two metal rectifier units MR1 and MR2; the rectifiers are fed from




| | |
|---|---|
| SK2 | OUTPUT TO RECEIVER 'B' |
| SK3 | OUTPUT TO COMBINING UNIT TYPE 6 |
| SK4 | OUTPUT TO RECEIVER 'A' |
| SK5 | OUTPUT TO OSC UNIT TYPE 327 |

| PRIMARY CONNECTIONS OF TR1 & TR2 | | |
|---|---|---|
| INPUT V | JOIN | INPUT ACROSS |
| 110 | b TO d c TO f | b AND c |
| 200 | c TO d | b AND e |
| 210 | c TO d | a AND e |
| 220 | c TO d | b AND f |
| 230 | c TO d | a AND f |
| 240 | c TO d | b AND g |
| 250 | c TO d | a AND g |

**Fig. 3. Power unit Type 815—circuit**

the 325-0-325-volt winding on transformer TR1. The smoothing circuit consists of capacitors C3 and C4, and resistor R2; resistor R3 is provided to allow the charge on C4 to leak away when the unit is switched off. The smoothed output is approximately 250V negative with respect to earth (chassis), and is connected to pin 7 on each of the four output sockets.

*Earthing*

**12.** Pin 6 on each of the four output sockets, and pin 4 on the input plug are connected to chassis.

**Introduction** (*fig. 1*)

**1.** Power unit Type 816 (10K/17206) provides HT and heater voltages to the output unit Type 50 in the dual-diversity receiver. The unit is rack mounted and requires a mains supply of between 110 to 250 V.

**General description**

**2.** The supply voltages provided by this unit are as follows :—

(1) 230V positive, unstabilized (60mA output)
(2) 140V positive, stabilized (10mA output)
(3) 70V negative, stabilized (5mA output)
(4) 140V positive, stabilized (35mA output)
(5) 140V negative, stabilized (35mA output)
(6) 280V negative, stabilized (2mA output)
(7) 6·8V alternating (4A output)

**3.** The mains input supply is connected via the 5-pin plug PL1 mounted at the rear of the unit, as are the two 7-pin output sockets SK2 and SK3.

**4.** With the exception of the 70-volt negative supply, all outputs from the unit are fused. Five of the fuses are mounted on the front panel, whilst the sixth, the heater supply fuse, is mounted at the rear of the unit. The five fuses F1 to F5 on the front-panel are numbered from left to right when viewed from the front of the unit.

**Circuit description** (*fig. 2*)

**5.** Transformer T1 transforms the mains voltage to the required output supply voltages; the primary winding is tapped to allow the unit to be operated from mains supplies of either 110/120 or 200 to 250V. The mains input is applied to the primary winding via pins 1 and 2 on plug PL1.

*230-volt positive supply*

**6.** The 280-volt secondary winding of transformer T1 is connected to a full-wave bridge rectifier MR1 ; the rectifier is of the selenium type.

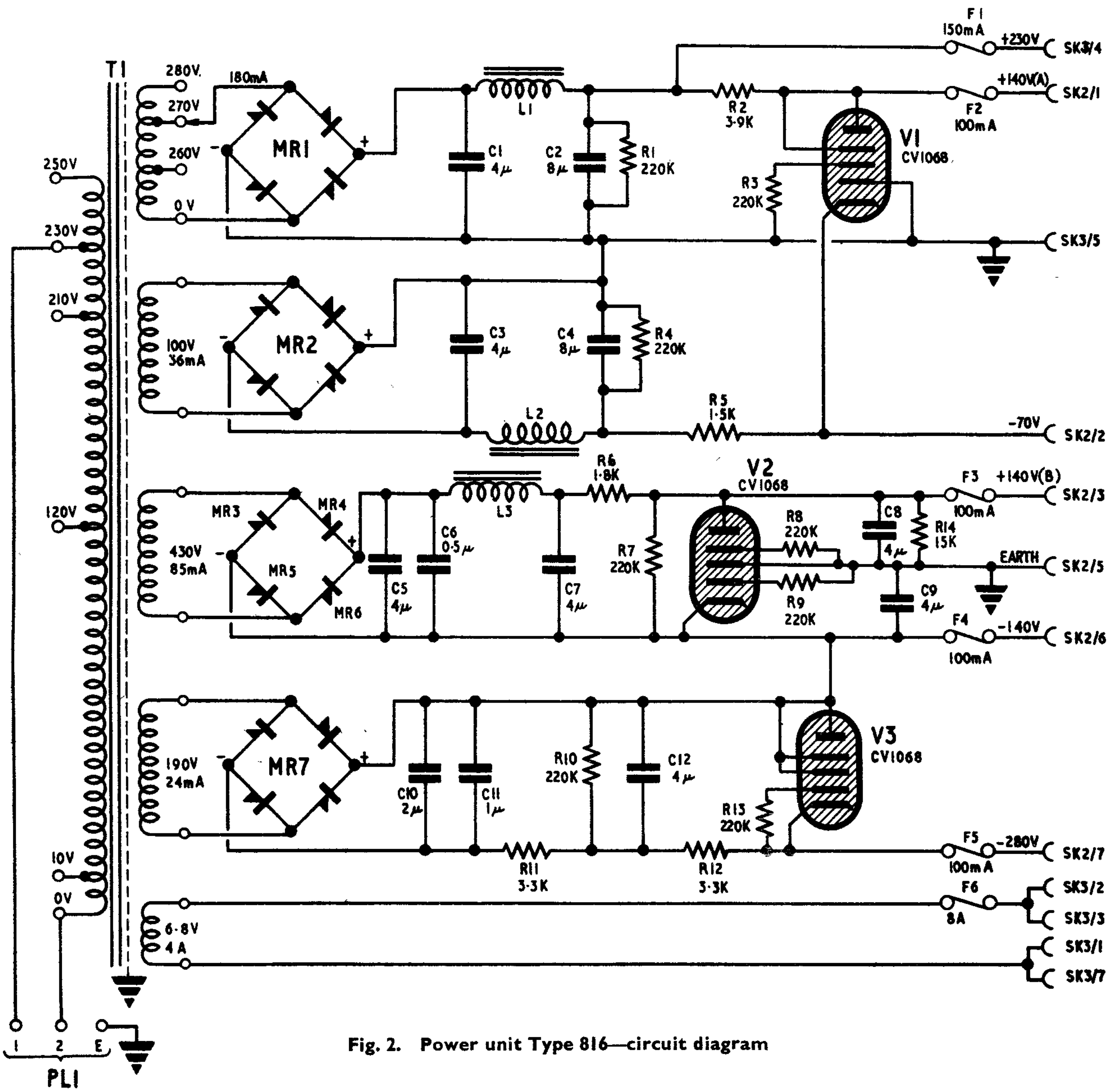



**Fig. 2. Power unit Type 816—circuit diagram**

The positive output is taken from the bridge rectifier and fed to a capacitance-input smoothing circuit consisting of capacitors C1 and C2 and inductor L1. Resistor R1 is connected across C2 to allow the charge on this capacitor to leak away when the main supply to the unit is switched-off. The 230-volt positive supply is taken from the positive side of C2 through fuse F1 to pin 4 of socket SK3. The negative terminal of the bridge rectifier unit is connected to earth and pin 5 of socket SK3.

*140-volt positive stabilized supply*

**7.** The 140-volt supply is taken from the 230-volt positive supply and is stabilized at 140V by the gas-filled stabilizer valve V1. The final anode of V1 is connected via a load resistor R2 to the 230-volt positive output. The centre anode of this valve is connected via resistor R3 to earth. The 140-volt positive stabilized supply is taken from the final anode of V1 via fuse F2 to pin 1 on socket SK2. When the voltage applied to the final anode of V1 increases, due to a reduction in load, the current drawn by the valve increases ; this increases the volt-drop across R2 and tends to lower the output voltage. The reverse conditions apply when an increase in load tends to lower the anode voltage of V1. The output voltage is thus stabilized at 140V.

*70-volt negative stabilized supply*

**8.** The 100-volt secondary winding on T1 is connected to a full-wave bridge rectifier unit MR2. The positive terminal of the rectifier unit is connected to earth, whilst the negative terminal is connected to a capacitance-input smoothing circuit consisting of capacitors C3 and C4 and inductor L2. Resistor R4 is connected across capacitor C4 to allow the charge to leak away when the mains supply is removed. This voltage is stabilized by using the lower half of valve V1 ; the cathode of V1 is connected via the load resistor R5 to the negative end of capacitor C4, while the first anode of V1 is connected to earth. The negative stabilized voltage is taken from the junction of R5 and the cathode of V1 and is fed direct to pin 2 of socket SK2. The stabilization of the 70-volt negative supply by the lower portion of V1 is effected in a similar manner to that of the 140-volt positive supply by the upper portion.

*140-volt positive and negative stabilized supplies*

**9.** The 140-volt positive and the 140-volt negative supplies are provided by the 430-volt secondary winding on transformer T1 and the full-wave bridge rectifier made up of the rectifier units MR3, MR4, MR5 and MR6. The positive terminal of the bridge rectifier is connected to a capacitance-input smoothing circuit consisting of capacitors C5, C6 and C7 and inductor L3. The negative terminal of the rectifier unit is connected via fuse F4 to pin 6 on socket SK2. Valve V2 is a gas-filled stabilizer connected across the output from the smoothing circuit via a load resistor R6. The centre anode of V1 is connected to earth and also to pin 5 on socket SK2 ; thus the DC supply is centre-tapped to earth, so that the outputs taken from anode and cathode respectively of V2 with respect to earth, are 140-volts positive (anode) and 140-volts negative (cathode). The 140-volt positive supply is connected via fuse F3 to pin 3 on socket SK2. C8 and C9 connected across the positive and negative outputs are decoupling capacitors. The 140-volt negative output is taken from the cathode of V2 via the fuse F4 to pin 6 on socket SK2.

*280-volt negative stabilized supply*

**10.** The 190-volt secondary winding on transformer T1 is connected across the full-wave bridge rectifier unit MR7. The positive terminal of the unit is connected direct to the 140-volt negative output at the cathode of V2. The negative terminal on the bridge rectifier is connected to a smoothing circuit consisting of capacitors C10, C11 and C12, and resistor R11. R10 is a leak-resistor for C12. The negative output is stabilized by the gas-filled stabilizer valve V3 which is connected across the DC output from the rectifier unit.

**11.** The DC output from the rectifier unit MR7 is connected in series with the 140-volt negative supply, so that the negative output taken from the cathode of V3 is 280V ; this output is fed to pin 7 on socket SK2 via fuse F5.

*6·8-volt heater supply*

**12.** One end of the 6·8-volt secondary winding on T1 is connected direct to pins 1 and 7 on socket SK3 whilst the other end of the winding is connected via fuse F6 to pins 2 and 3 on the same socket.

# Chapter 9

## SWITCH PANEL TYPE 803

LIST OF CONTENTS



LIST OF ILLUSTRATIONS



**Introduction**

1. The switch panel Type 803 (10D/18728) (*fig.* 1) is used in the dual diversity receiving equipment and forms part of the rack assembly Type 272.

2. The switch panel consists of a metal panel bearing a circuit-breaker type switch (double-pole) an ON/OFF double-pole switch and two mains type 3-pole outlet sockets.

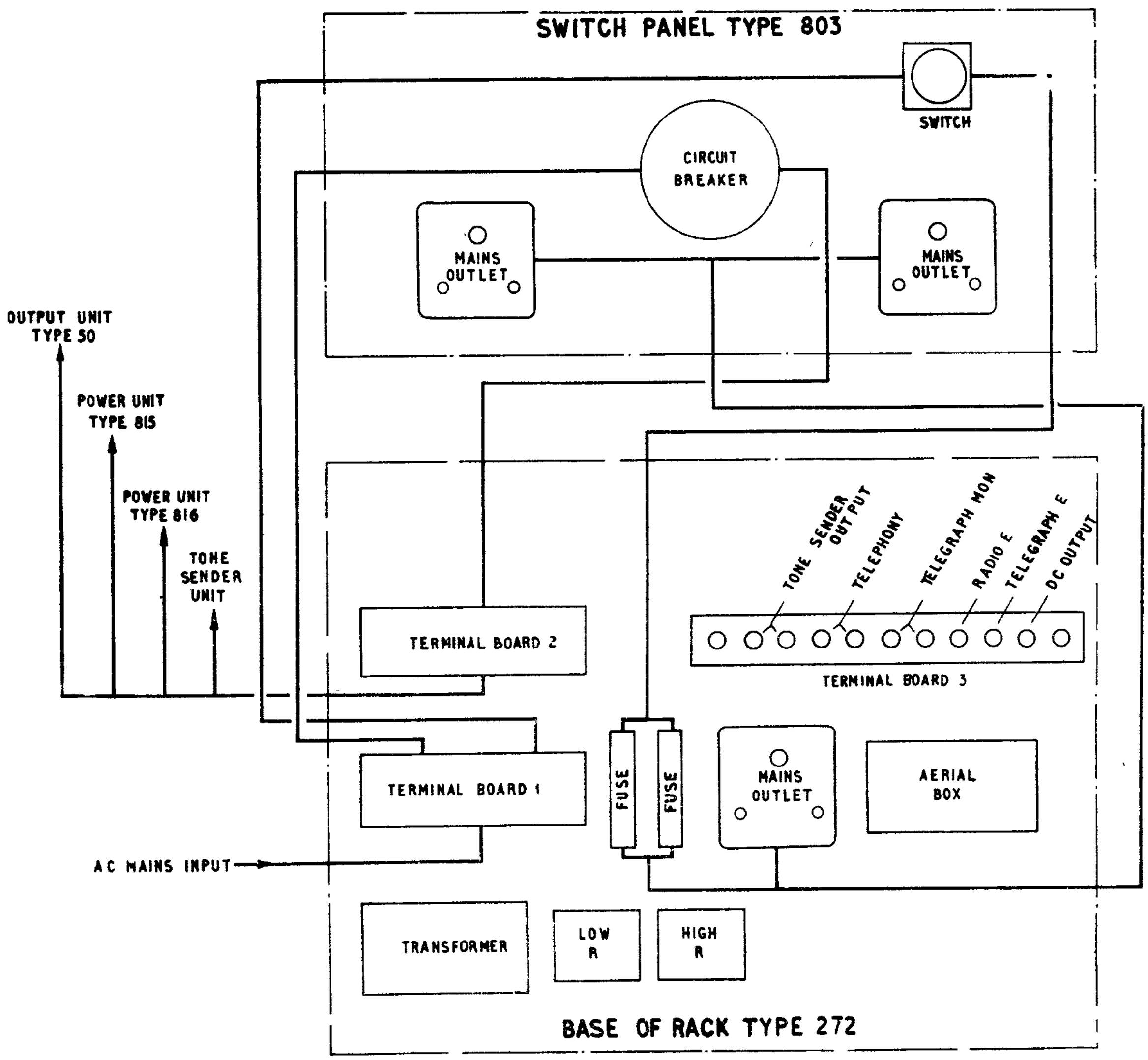



**Fig. 1. Switch panel Type 803 and base layout**

### Base (rack assembly Type 272)

**3.** The termination of the mains input supplies, and the output signals is carried out at the base of the rack assembly Type 272.

**4.** Terminal board No. 1 is used to terminate the mains input. The mains supply through the circuit breaker is connected to terminal board No. 2 and from there is fed to the units on the rack. Terminal board No. 3 is used to terminate the output signals. A transformer is used to match the output from the output unit Type 50 to the telegraph equipment. Two 5-pole sockets mounted to the rear of the base are used, with a shorting plug, to provide a high or low resistance output match. When the shorting plug is mated with the socket (HIGH RESIS) the high resistance DC OUTPUT (terminal board 3) is connected directly to the output of the output unit Type 50.

**5.** When the shorting plug is mated with the LOW RESIS socket the output from the output unit Type 50 is fed from a tapping on the transformer in order to match the low impedance of the telegraph equipment to the output unit Type 50.

**6.** The two aerials (A and B path) are connected to the aerial box, terminals 7 and 8, and from there to the aerial input terminals of the A and B path receivers.

### Mains supplies

**7.** The incoming AC mains supply is connected to terminal board 1 (base) and from there is connected to the circuit breaker, and the ON/OFF switch (switch panel). From the circuit breaker, the supply is returned to terminal board 2 (base) and from here to the following units :—

Output unit Type 50
Power unit Type 815
Power unit Type 816
Tone sender unit

The mains supply from the other side of the ON/OFF switch is fed via two fuses, on the base, to three 3-pole mains outlet sockets, one situated in the base and the other two on the switch panel.