

DUAL DIVERSITY SWITCHING UNIT TYPE MA. 168B
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SECTION 1
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OPERATING AND DESCRIPTION
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TECHNICAL SPECIFICATION

Overall gain:	With b.f.o. on and an unmodulated i.f. input signal of 50 mV, a 1 kc/s audio output of 0 dBm ± 1 dB into a 600-ohms load is obtainable. With b.f.o. off, the same input signal modulated to 30% by 1 kc/s produces a similar a.f. output.
Path selection switch operation:	With a nominal i.f. input signal of 10 mV to each path, the switch operates to select the greater signal when either input is varied by 6 dB. With a nominal i.f. input signal of 30 mV to each path, the switch operates to select the greater signal when either input is varied by 3 dB.
Diversity i.f. output:	The output level measured across a 75-ohms load is within ± 3 dB of the input level for either path. The difference in output level of the two paths is less than 0.25 dB.
Attenuation of path not in use:	Greater than 40 dB relative to path in use.
Path switching transient:	Does not exceed 10 mV measured across output of unit.
Switching time:	Less than 10 μ s for the i.f. switch control stage to change state.
B.F.O. break-through:	The break-through, measured across a 75-ohms load at the i.f. output, is less than 300 μ V.
Intermodulation products:	Within the C.C.I.R. requirements for i.s.b. transmission 3rd order products better than -36 dB.
Bandwidth of i.f. paths:	Not less than ± 10 kc/s to the 3 dB points.
B.F.O. frequency variation:	Capable of ± 8.5 kc/s minimum deviation from 100 kc/s. Dial calibration in 500 c/s intervals from 0 to 8 kc/s. Dial accuracy ± 100 c/s.

B.F.O. frequency stability: Less than 50 c/s in first hour. Less than 10 c/s per hour at constant ambient temperature after initial 1-hour warm-up period. Drift less than 600 c/s over a period of one hour during temperature rise from 0°C to 70°C. Maximum pulling occurring between no input signal and 200 mV signal input to mixer is 5 c/s.

C. W. distortion: Less than 7% total harmonic distortion of 1 kc/s audio product with 200 mV actual i.f. signal; audio output level for this requirement is +2.5 dBm.

C. W. response: Within 4 dB over the range of 500 c/s to 8.5 c/s.

Amplitude modulation detector: Range of handling of i.f. signals, 10 mV to 150 mV with 30% modulation at 1 kc/s. Distortion of a.f. output less than 5%. Response within 4 dB in the range of 500 c/s to 8 kc/s, when either the Audio Gain or Line Level control has been adjusted to give an output level of +2 dBm with 150 mV input.

Input signals: Two 100 kc/s inputs one from each receiver. Connections are made by BNC coaxial connectors.

Output signals: One diversity i.f. output 100 kc/s within ±3 dB of the input. Connections made by BNC coaxial connector. Impedance 75 ohms. 600 ohms audio output to line by rear mounted terminal strip; maximum output level of 2.5 dBm, balanced or unbalanced (c.w. or m.c.w.) input.

Phone (monitor) output: Phone jack socket providing +2.5 dBm audio output at 600 ohms (c.w. or m.c.w. input).

Receiver phase locking connections: RA.17A Mk.2 and RA.17L:-
From each receiver, a second v.f.o. signal in the range 2.1 to 3.1 Mc/s at a level between 180 and 300 mV; these two signals are phase locked by a switch in the Diversity Unit. A special loaded cable for interconnecting the 1 Mc/s oscillators in each receiver; the oscillator in one of the receivers is rendered inoperative.

RA. 117:-

The 1 Mc/s, 1.7 Mc/s and 3.6 to 4.6 Mc/s oscillators in one of the receivers are rendered inoperative; three 75-ohm cables are used to connect the two receivers such that the above oscillators are common to both.

Power requirements
and consumption:

100 to 120V or 200 to 250V in 10V steps, 45 to 65 c/s a. c. Consumption 4.5 watts.

CHAPTER 1

GENERAL DESCRIPTION

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CHAPTER 1

GENERAL DESCRIPTION

Introduction

1. The Dual Diversity Switching Unit Type MA. 168B is a transistorised unit designed to reduce the effect of fading resulting from adverse propagational conditions. The unit is essentially an electronic switching device which automatically selects the greater i. f. output of two receivers. The receivers must be fed by two diversity-spaced aerials of equal, or nearly equal, noise characteristics.
2. The unit has a built-in power supply and will accept m. c. w. or c. w. signals of telegraph speeds up to 1000 bauds; r. t. or single sideband working is selected by a switch
3. The unit is designed for use in conjunction with any two of the Racal Communications Receivers in the RA. 17 or RA. 117 range. If the RA. 17A receiver is used, a minor modification, as described later, is required.

Brief Technical Description

4. Figure 2 shows the block diagram and interconnections of the equipment to which this brief description refers. The 100 kc/s i. f. outputs from each receiver (A and B) are applied to the two inputs of the Diversity Unit. Each signal has two paths within the unit, a transmission path and a monitor path. The monitor path contains an amplifier and detector circuit, the output of both detectors being fed to a d. c. adder and monitor circuit. The polarity of the output from the circuit is a function of the relative amplitudes of the i. f. signals A and B, and is used to operate two on/off gates (A and B) in the i. f. transmission paths. One polarity causes gate A to open; the other causes gate B to open. At all times the gate in the path of the stronger signal is held open thus giving an unattenuated output derived from the stronger i. f. signal.
5. The output from the two i. f. gates is taken to a common point from which it is distributed on three lines; firstly, to an i. f. amplifier, the output of which is taken to a diversity i. f. output socket; secondly, to an a. m. amplifier/detector circuit, and thirdly, to a mixer circuit. A switch is provided by

which the output of either detector or mixer may be selected to feed a line and a phone amplifier whose outputs are terminated at suitably marked sockets. A b.f.o. feeds the mixer circuit when the latter is selected (i.e. on c.w. signals).

6. The i.f. input signals to each path are continuously monitored by two meters. One of these meters can also be used to monitor the line output level.
7. Indication of which path is in use is provided by two miniature cathode-ray indicators.
8. Power for all circuits is derived from a stabilised power supply contained within the unit.

CHAPTER 2

OPERATING PROCEDURE

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CHAPTER 2

OPERATING PROCEDURE

Use with RA. 17A Receiver

- 1. If the RA. 17A Mk.2 Receiver is being used, the following modification must be made; remove capacitor C143A (2.2 pF) which is directly connected between the base of PL11 and pin 5 of V12 on the underside of the 2nd v.f.o. chassis. Connect the base of PL11 to pin 2 of V12.

Preliminary Setting-Up of Receivers (RA. 17A Mk.2 or RA. 17L)

- 2. The functioning of the dual diversity switching unit is affected by the reception of the 100 kc/s i.f. signals from a diversity pair aerial receiver system. In operation therefore, it is necessary to ensure that the two receivers are correctly set up and modified, before any attempt is made to use the switching unit. After allowing one hour for warm-up, the following procedure should be carried out on the receivers.
 - (1) Remove V1 in B receiver; this operation is permanent as long as the receivers are used in a diversity system employing the MA.168 Diversity Unit.
 - (2) Connect the 1 Mc/s loaded coaxial lead between the 1 Mc/s output sockets of the diversity pair receivers (fig. 2 (a)).
 - (3) Ensure that each receiver will function correctly on the type of signal required. Test the receivers individually using the built-in monitor speakers. When checking on c.w. stations, the individual b.f.o.'s must be used for testing but these MUST be switched off before the switching unit, which has its own b.f.o., is brought into operation.
 - (4) Check the relative noise levels of the two receivers. These should be equal for the correct operation of the unit, and will generally be quite close if identical aerial systems are used. If there is a severe discrepancy, the i.f. gain of one or other receiver may be adjusted to compensate.

- (5) Tune each receiver approximately to the frequency of the transmission to be received and set the System switch on each to A.V.C. Set the BANDWIDTH switches for the desired bandwidth, ensuring that both receivers use the same position.

Preliminary Setting-Up of Receivers (RA.117)

3. The setting-up procedure when using the RA.117 receivers is similar to that described in para.2 except for the interconnections which are shown in figure 2 (b). The following changes to interconnections within receiver B must be made and retained as long as the receiver is employed for the purpose.

- (1) Remove the dust cover on the B receiver.
- (2) Referring to figure 8 in the RA.117 manual, disconnect PL12 and PL2 from the T connector TA1; remove the T connector from SKT2 and fix it to the clip provided on the right gusset plate; connect PL12 to SKT3 and PL2 to SKT2.
- (3) Remove crystal XL1 and fit to clip on right gusset plate.
- (4) Using a plain coaxial link, interconnect the 1 Mc/s sockets on the rear of each receiver.

NOTE 1: Receiver A leaves the factory already connected to provide a 1 Mc/s output at the 1 MC/S socket (SKT4) on the rear; the above instructions convert the function of the 1 Mc/s oscillator in receiver B to that of an amplifier which is fed from the 1 Mc/s output of receiver A.

- (5) Remove PL303A from SKT306 and fit it to SKT303.
- (6) Remove crystal unit XL300 and fit to clip on right gusset plate.
- (7) Using a plain coaxial link, interconnect the 1.7 Mc/s sockets on the rear of each receiver.

NOTE 2: Receiver A leaves the factory already connected to provide a 1.7 Mc/s output at the 1.7 MC/S socket (SKT5) on the rear; operations (5) and (6) convert the function of the 1.7 Mc/s oscillator in receiver B to that of an amplifier which is fed from the 1.7 Mc/s output of receiver A.

- (8) Set the V.F.O. preset switch on the front panel of receiver B to EXT.
- (9) Remove PL302 from SKT304 and fit it to SKT302.
- (10) Using a plain coaxial link, interconnect the 2nd V.F.O. sockets on the rear of each receiver.

NOTE 3: Receiver A leaves the factory already set up and connected to provide a 3.6 to 4.6 Mc/s output at the 2nd V.F.O. socket SKT10 on the rear; operations (8) and (9) immobilise the 2nd v.f.o. in receiver B and render it as suitable for taking a 2nd v.f.o. input from receiver A. Hence, the 'kilocycles' part of an aerial signal to both receivers is tuned in by the KILOCYCLES control on receiver A only.

- (11) Proceed as for operations (3), (4) and (5) of para. 2.

NOTE 4: The use of RA. 117 receivers no longer entails the connections from each 2nd v.f.o. to the two sockets on the rear of the Diversity Unit (para. 4).

Preliminary Setting-Up of Switching Unit

4. Before operating the system, make the following checks on the Diversity Unit.
 - (1) Ascertain that the primary tap on the mains transformer is set to agree with the supply voltage in use.
 - (2) Ensure that all input and output cables are correctly connected to their respective points (refer to fig. 2).
 - (3) Connect the 2nd v.f.o. linking leads between the receivers and the 2nd v.f.o. socket on the Diversity Unit. This is not necessary when using RA. 117 receivers (refer to para. 3).
 - (4) Check that the three fuses are intact and of the correct electrical rating: i.e. 1 amp, $\frac{1}{2}$ amp and $\frac{1}{2}$ amp.
 - (5) Check mains supply to unit.

Operating Procedure (RA. 17A Mk. 2 or RA. 17L)

5. Before the unit may be used functionally, the following adjustments must be carried out.
- (1) Set the function switch (located in the centre of the front panel) to REC. A position. Plug a pair of 600-ohm phones into the phone jack on the front panel and tune Receiver A to the required signal.
 - (2) Adjust the I.F. GAIN control of receiver A until a reading of approximately $50 \mu\text{A}$ is obtained on M2, the left-hand meter. Note that the meter movements have a full-scale deflection of $200 \mu\text{A}$; the presence of the overload diode in each meter circuit (see main circuit diagram) results in a scale which is linear to the approximate $100 \mu\text{A}$ position and beyond this becomes non-linear. The meter scales are calibrated in terms of micro-amps.
 - (3) Set the function switch to REC. B and tune receiver B to the same signal as receiver A.
 - (4) Adjust the I.F. GAIN control of receiver B until a reading of approximately $50 \mu\text{A}$ is obtained on M1, the right-hand meter.

Operating Procedure (RA. 117)

6. Here, it is only necessary to tune both receivers to the same signal and equalise the receiver gains as described in operations (2), (3) and (4) of para. 5. Note that when tuning both receivers, the MEGACYCLES controls are set to the same required position but the KILOCYCLES control of receiver A only is set to its required position.

Noise Similarity Balance

7. For c.w. or frequency shift operation, the following balancing procedure should be adopted.
- (1) Set the SIGNAL SELECTOR switch (SC) to select the speed of signal to be received (C, W. range of positions).

- (2) If the subsequent terminal equipment used with the unit employs a filter, set the B.F.O. dial on the switching unit to the centre frequency of this filter. If no filter is employed, set the dial to 2 kc/s.
 - (3) Operate the spring loaded SET LEVEL switch on the unit and adjust the LINE LEVEL control until the right-hand meter M1 reads on the red line. This indicates a line output level of 0 dBm.
 - (4) Release the SET LEVEL switch.
 - (5) Adjust the input gain control of the terminal equipment to give optimum working conditions.
 - (6) Set the function switch of the unit to REC. B position.
 - (7) Accurately tune receiver B, ensuring that the bandwidth switches of both receivers are set to the same desired position.
 - (8) Adjust I.F. GAIN control of receiver B for optimum working of the terminal equipment.
8. The noise levels of the two signals fed to the terminal equipment should be very similar if the above procedure is followed.

Balancing for R. T. and S. S. B. Working

9. The noise balancing procedure for r.t. or single sideband operation must be carried out by ear, using phones plugged into the phone jack of the switching unit and setting SC to select the desired signal. This procedure, whilst not being so accurate, is best performed with the a. v. c. switched OFF at both receivers (i.e. System switches set to MAN). Restore switches to A. V. C. after balancing.

OPERATION

10. After the procedures detailed above have been carried out the switching unit should operate satisfactorily when switched to the diversity position (DIV); the switching action of the unit may be checked by observing the two indicators on the front panel. The receiver in use is shown by illumination of one or other of these indicators.

NOTE: The terminal equipment can use the 100 kc/s i. f. output from the switching unit (connected by means of a BNC coaxial connector) or the audio line output made at the terminal board provided at the rear of the switching unit. The line output can be balanced or unbalanced with a 600-ohms output impedance; a gain control (LINE LEVEL) is provided. Line output can be monitored from a jack socket on the front panel; the monitor amplifier also has a gain control (AUDIO GAIN).

M. C. W. Operation

11. Set the SIGNAL SELECTOR switch to the required position on the M. C. W. side.

CHAPTER 3

CIRCUIT DESCRIPTION

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CHAPTER 3
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CIRCUIT DESCRIPTION
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Introduction

1. The Dual Diversity Switching Unit is a transistorised equipment designed to reduce the effect of fading resulting from adverse propagation conditions. The unit, intended for use with a diversity aerial receiver system, essentially performs an electronic switching function by automatically selecting the greater of the two receiver outputs for subsequent phone or telegraphic use.

Mechanical

2. The equipment uses the front panel mounting technique and will fit standard 19 in. racking. It is retained in position by four bolts passing through holes at the end of the front panel.

Electrical

3. Most operational controls are mounted on the front panel of the unit, together with two meters, a phone jack and two channel indicators. Electrical connections to the unit are made by means of connectors on the rear panel. Audio output line connections are made by a rear terminal block, adjacent to which is a toggle switch used to select balanced or unbalanced line conditions.

Power Supply

4. The power supply forms an integral part of the unit and provides supply outputs of +14 volts and -8 volts. Each supply is derived from a separate Zener referenced transistor stabilising circuit, fed from a full-wave rectified output from the mains transformer T14. Both secondary winding circuits are separately fused at 1/2-amp and the primary winding at 1-amp. Fine adjustment of the two power supply output voltages is accomplished by means of preset potentiometers. In addition, two further windings on T14 provides l.t. (1V, 60 mA) and h.t. (60V, 2 mA r.m.s.) supplies for the two indicators. The diode D31 is used to provide half-wave rectification which produces a 50-volt d.c. supply.

1 Mc/s Locking Lead and V. F. O. Locking

5. A special loaded coaxial lead is supplied with the switching unit, and is used to connect the 1 Mc/s oscillators of the two diversity receivers, ensuring that they remain locked in phase. The second v. f. o. receiver outputs are each taken to the switching unit where they are connected together by switch contacts when diversity operation is selected. The purpose of locking these oscillators is to ensure that the ultimate i. f. receiver outputs are at all times in phase; this is essential to the proper functioning of the unit.

I. F. Inputs (Fig. 3)

6. The 100 kc/s outputs from the two diversity receivers are fed into the switching unit by two BNC coaxial connectors mounted on the rear panel of the unit. The signals are then passed along two distinct paths within the unit. For the purpose of this description these paths shall be named A and B as shall the respective receivers which feed them.

7. Each path is sub-divided into two signal paths, a transmission path and a monitor path. The transmission paths each contain an on/off gate, the output of which is taken to a common diversity i. f. output point. The operation of the two gates is described later in this chapter.

8. On the monitor paths, the i. f. signals A and B are individually amplified and detected, and the detected signals are fed to an adding circuit where they are combined to produce a varying mean d. c. potential. The two detector circuits are arranged to produce opposite polarity outputs; thus, if the two outputs are equal in amplitude, they will cancel to produce zero volts at the adding circuit output.

I. F. Path Selection Amplifier and Detector Circuit (Fig. 10)

9. One single-stage amplifier circuit is provided in each path; the two are identical. Each i. f. input is fed to the base of an earthed emitter transistor (VT10 and VT11) and the output developed in a transformer (T6 and T7) in the collector circuit.

10. The detector circuits are both of the full-wave type and are identical in all respects excepting in the polarity of their diodes and resulting outputs; all the diodes in these two bridge circuits must be accurately matched (refer to para. 25 of Sect. 2, Chap. 1). The secondary windings of the i. f. transformers are centre-tapped and connected to a common point. This is the d. c. reference point of the detector circuit output, and is heavily decoupled to earth by capacitor C7.

11. Path A detector produces a negative d. c. output proportional in amplitude to the i. f. signal developed in the secondary of T6. The output is the result of conduction of diodes D9 and D10 during the negative half-cycle excursions of their respective halves of T6 secondary, and is negative in respect to the centre-tap of T6. R41, R124 and R42 form the detector load.
12. Detector B functions in a similar way to detector A except that its diodes are reversed, giving a positive d. c. output, in respect to the common centre-tap point, across the diode load R46, R125 and R47.
13. A fraction of each detector load (R42 for path A and R46 for path B) is used as a meter shunt during the measurement of relative signal levels of the two paths. This is accomplished by meters M1 and M2. M1 is also used to monitor the a. f. line output level when the biased switch SE (SET LEVEL) is operated.

Meter Overload Circuits

1S115 = 3A152...159, BY 204/8, 1N4005...07

14. The purpose of the diodes D32 (path A) and D33 (path B) is to provide (a) meter protection and (b) a scale calibration law which is linear to approximately half-scale and beyond this becomes non-linear to provide a compressed scale. This enables accurate matching for small signal input levels and prevents meter overloading on large inputs. The level at which non-linearity commences corresponds to approximately 0.4 volt across the diode. When meter M1 is switched to measure line level, the scale calibration is linear throughout; at the scale division of 60, a red line indicates 0 dBm. The meter circuit for this condition consists of bridge rectifier D15 to D18, R105 and R106 which prevent shunting of the line by the bridge.

Adding Circuit

15. The outputs from detector A and detector B are taken to a common point, via resistors R40 and R45 respectively. The two resistors are of equal value; hence, the potential appearing at the junction of these two resistors, with reference to the common centre-tap of the i. f. transformers, defines which of the paths is passing the greater signal and by how much this signal exceeds the smaller signal. The greater signal is defined by the polarity of the voltage; i. e. if it is positive, then path B is the greater; if negative, path A. The magnitude of this voltage is roughly proportional to the difference in signal levels.

D.C. Amplifier and Detector Time Constant

16. Transistors VT8 and VT9 form a common-emitter amplifier, based functionally on the principle of the conventional long-tailed pair circuit employed in valve techniques. The bi-polar output from the adding circuit is applied across the two base connections of VT8 and VT9. The base of VT8 is heavily damped against responding to sudden changes in potential, and remains substantially steady. The base of VT9, however, has only a relatively short time-constant damping; the actual value of this being determined by the capacitive value of the detector time-constant capacitor selected by wafer 4 of the SIGNAL SELECTOR switch, SC.

17. The purpose of the detector time-constant capacitors C8, C9, C10, C11 and C12 is to reduce the susceptability of the circuit as a whole to switching over (from path A to B say) as a result of spurious transients; e.g. radio interference. The value of these components is chosen to eliminate the effect without interfering with the normal functioning of the unit on the type of signal selected by SC. RV5 is a sensitivity control which serves to govern the amplitude of the detector outputs; the control provides a means of setting the threshold point at which gate-changeover occurs.

Operation of First Stages

18. The stages so far described function in the following manner. The two i.f. signals from the diversity pair receiver system are individually amplified by amplifier stages VT10 and VT11. The signals are rectified to produce two opposite polarity d.c. voltages which are added in the adding circuit. The resulting voltage is then amplified by transistors VT8 and VT9, and is subsequently taken from the collector of VT8 to trigger a toggle circuit.

Toggle Circuits

19. Transistors VT6 and VT7 form a bi-stable toggle circuit. This has two operational states; either VT6 may be conducting and VT7 held cut-off, or VT7 may be conducting and VT6 held cut-off. No other state is possible. The circuit is triggered at the base of VT7 by the output of the VT8/VT9 amplifier, and the operating state of the toggle is dependent on the base-to-emitter potential of VT7.

20. If the base of VT7 is made negative with respect to the emitter, VT7 conducts and starts a cumulative action due to the presence of the common-emitter resistor R33 and feedback resistors R32 and R35. The toggle

circuit finally becomes stable with VT7 conducting heavily and VT6 cut-off. It remains in this state until the input at the base of VT7 changes sufficiently to cause a reduction in conduction of VT7, when cumulative action again takes place, this time resulting in the full conduction of VT6 and the cutting-off of VT7.

21. The output from the toggle circuit is taken from a single point; i.e. the collector of VT6. This point is positive when VT6 is conducting and negative when VT6 is cut-off, and is connected to a stationary contact on wafer 1 of switch SA. When this switch is in position 3, i.e. DIV., the output from the collector of VT6 is fed via R28 to the base of VT5. VT5 and VT4 form a second toggle circuit which is similar in operation to the first, except that it has two outputs. The circuit, which is bi-stable, assumes an operating state governed by the potential appearing between the base and emitter of VT5. This, in turn, is dependent on the position of SA. When the switch is in its DIV position, the second toggle assumes a state dependent on the state of the first toggle; i.e. when VT6 is conducting its collector potential is such that it cuts VT5 off at its base, via the coupling through R28. The state of the second toggle circuit is thus governed by which path has the stronger signal.

22. The switch SA provides a means of overriding the automatic switching function of the unit. In position 1 the base of VT5 is connected via R28 to the -8 volt line, causing VT5 to conduct and VT4 to be cut-off. This ultimately selects the output of path A to be passed out at the diversity output connector. When SA is set to position 2 the base of VT5 is raised to the approximate potential of VT5 emitter, causing VT5 to be cut-off and VT4 to conduct heavily. In this way, the output of path B is selected at the diversity output connector. The action of the gates which select the appropriate output is described in subsequent paragraphs.

Gate Drive Circuits

23. The transistors VT3 and VT2 are used in emitter-follower circuits to drive the transmission path on/off gates. The base leads of VT3 and VT2 are directly coupled to the collectors of VT4 and VT5 respectively. Hence, VT3 conducts when VT4 is cut-off, and VT2 conducts when VT5 is cut-off. The bi-stable characteristic of the second toggle circuit ensures that one or other of VT2 and VT3 is conducting at any one time. The emitter-follower outputs of these two transistors are taken to the operating points of the two transmission path on/off gates and connected such that conduction of VT3 operates A to 'on' state, and conduction of VT2 operates gate B to 'on' state.

On/Off Gates (Fig. 4)

24. The two on/off gates in the transmission paths are identical. The accompanying diagram shows a simplified circuit of path A gate.
25. A gate circuit essentially comprises an input transformer and an output transformer (T4 and T2 respectively) connected back-to-back via two series diodes (D1 and D4). The diodes are arranged one in each connecting lead with the cathodes facing the output transformer (T2). The i.f. signal from the receiver is applied to the primary of the input transformer, one end of which, together with the centre-tap of the secondary winding, is earthed. The centre-tap of the output transformer is taken via a resistor (R8) to the emitter-follower gate driver transistor (VT3).
26. The operation of the series diodes is as follows. When VT3 is not conducting, the potential on its emitter is positive with respect to earth. This is applied via T2 secondary to the cathodes of D1 and D4 and results in reverse biasing of both diodes, holding them in a cut-off condition. The i.f. signal from T4 is therefore prevented from passing to T2, and the gate is 'off'. When, however, VT3 conducts, its emitter becomes negative with respect to earth and the diodes D1 and D4 conduct, allowing the i.f. signal to feed into T2; the gate is then 'on'.
27. In addition to the two series diodes described above, each gate has two shunt diodes. These come into operation when the gate is in its 'off' condition, and their purpose is to connect a dummy load across the secondary winding of the input transformer; this ensures that the impedance reflected back to the receiver i.f. output remains essentially constant whether the gate be 'on' or 'off'. The operation of the gate would otherwise affect, to some degree, the input signal level to the monitor circuit.
28. The operating point of the shunt diodes D2 and D3 is taken from the junction of load resistors R13 and R14, via R12 to the emitter of gate B drive transistor VT2. The diodes are therefore made to conduct when VT2 conducts; i.e. when gate B is 'on' and gate A is 'off'. The operation of gate B is similar to that of gate A above.

Diversity I.F. Output Amplifier

29. The secondary windings of the two gate output transformers T2 and T3 are both connected across the primary winding of T15, which is shunted by resistor R9. The secondary of T15 feeds the base circuit of VT1, which is basically an earthed-emitter amplifier stage operating above earth potential;

i. e. the emitter is taken to a positive d. c. supply feed, but is essentially at earth potential so far as a. c. is concerned. The amplified i. f. output is taken from the secondary of T1, the primary of which is in the collector circuit of VT1.

30. From the secondary winding of T1 the output of the diversity i. f. amplifier is fed along three routes:

- (1) To the diversity i. f. output connector, via R2.
- (2) To an a. m. amplifier/detector circuit, via R109, C19.
- (3) To a mixer circuit, via R109, C37.

The operation of the circuits (2) and (3) is described below.

A. M. Amplifier/Detector (Fig. 5)

31. The diversity i. f. output is fed to the base of VT12, an earthed-emitter amplifier. The amplified output from the collector circuit of this transistor is detected by diodes D13 and D14 in the secondary circuit of T11. The audio output of the detector circuit is taken to contacts 6, 7, 8, 9 and 10 of switch SC, wafer 3, whence it is fed to the base of VT13 when SC is set to select m. c. w. working.

Mixer Circuit

32. The mixer circuit is used to produce an audio output from the unmodulated i. f. signal obtained by c. w. working. The resulting signal may be two-tone (i. e. frequency-shift keying) for telegraph use, or voice frequency for phone application.

33. Transistor VT13 is an audio amplifier feeding an emitter-follower stage VT25. This feeds two potentiometers RV1 and RV2. RV1 serves as a gain control by controlling the audio signal fed to the phone amplifier stage VT18. RV2 sets the line output level by controlling the audio signal applied to the base of the line amplifier VT17. The power supply to the a. m. amplifier circuit is removed by SC, wafer 1, when SC is set to select c. w. working.

34. The diversity i. f. output signal is applied to the base of mixer transistor VT16. A b. f. o. comprising VT14 and VT15 and associated components, injects a signal into the emitter circuit of VT16 via transformer T9. Both of the high-frequency mixing components are removed in the collector circuit of VT16 by the combined action of C38, T10 and C39. The remaining a. f. signal is then taken to contacts 1, 2, 3, 4, and 5 of SC, wafer 3, where it is switched for phone and line applications when c. w. working is selected. Wafer 2 of this switch applies power to mixer and b. f. o. circuits only when c. w. working selection is made.

Line Amplifier

35. The line amplifier, VT17, is a conventional earthed-emitter stage using an output transformer T12 with a centre-tapped secondary winding. This may be connected to, or isolated from, earth by means of SB, a switch selecting balanced or unbalanced line outputs. The line audio level may be adjusted by means of RV2. Line output connections are taken to terminals at the rear of the unit via a 6 dB balanced 'T' pad providing an output impedance of 600 ohms.

Phone Amplifier

36. This amplifier is of similar design to the line amplifier but its output is unbalanced. Output connection is made by means of a phone jack mounted on the front panel of the unit. A resistive load, R85, is automatically connected across the output transformer when the jack socket is not in use. Output impedance is 600 ohms.

Indicator Stage

37. The outputs from the switch control stage (+8V and -6V or -8V and +6V) are taken to the grids of the two indicators N1 and N2. When the emitter of transistor VT2 is at +8 volts, channel A is in use and indicator N1 glows; when the emitter of VT3 is at +8 volts, channel B is in use and indicator N2 glows.

Power Supplies

38. Two d. c. power lines provide the +14 volts and -8 volts supplies for the unit. A common mains transformer, T14, provides output voltages of 20 volts and 15 volts which are individually rectified and fed to their respective stabilising circuits. Each circuit has a voltage regulating adjuster RV4 for the +14 volt and RV3 for the -8 volt supply. The return lead of each supply is commoned to earth.

SECTION 2
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MAINTENANCE
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CHAPTER 1

SETTING-UP AND TESTING

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CHAPTER 1

SETTING-UP AND TESTING

Test Equipment

1. (1) Two signal Generators to provide 100 kc/s from 75 ohms output impedance; Airmec Type 201.
- (2) Audio Signal Generator: Advance J2.
- (3) Multi-range meter with 20 000 ohms/volt on the d. c. ranges: AVO Model 8.
- (4) Valve millivolt meter: Advance 'Advac'.
- (5) Power Output meter: Marconi TF. 340.
- (6) Oscilloscope having a frequency response of 2 Mc/s on the 10 millivolt range: Solartron 523S.
- (7) Frequency Meter: Racal SA.21B, SA.501, SA.505 or SA.520.
- (8) Variable Transformer: Variac Type 200.
- (9) Audio Waveform Analyser: Wayne Kerr A321.
- (10) Two Racal Receivers Type RA.17A Mk.2, RA.17L or RA.117.

Initial Procedure

2. The following preliminary procedure must be carried out before the dual diversity switching unit is bench-tested for compliance to specifications.
 - (1) Ensure that the tapping of the mains transformer is set to agree with the main supply voltage.

- (2) Check the three cartridge fuses in the holders on the unit rear panel for correct electrical rating, and test them for continuity. Replace fuses in their correct holders.
- (3) Remove top and bottom cover plates from unit and place the unit on a suitable test bench.
- (4) Connect the unit to mains supply using extension lead if necessary.
- (5) Switch unit ON and allow approximately five minutes for warm-up.

The following tests may now be performed on the unit.

TEST PROCEDURES

Power Supply Tests

3. -8 volt line: Measure the potential of the -8 volt line to earth using the AVO test meter. Adjust RV3 to obtain a reading as close as possible to nominal value.
4. +14 volt line: Measure the potential of the +14 volt line as above, and adjust RV4 to obtain nominal value.

Regulation

5. Connect the Variac transformer between the unit supply plug and the power feed line, first ensuring that the Variac output is correct for the setting of the mains transformer tapping. Measure each of the power supply output lines whilst varying the input voltage to the unit by $\pm 10\%$ of the nominal value. The regulation in each instance should permit less than 2% variation.

Ripple

6. The 100 c/s ripple, measured on each power supply output line, should be less than 50 mV r.m.s. as measured with the oscilloscope.

Overall Gain and Performance Tests

7. Test the overall gain of the unit in the following manner.
 - (1) Using one of the R.F. Signal Generators, apply 50 mV actual signal at 100 kc/s (unmodulated) to the i.f. input connector of path A of the switching unit.
 - (2) Set SIGNAL SELECTOR switch to any C. W. position and B.F.O. tuning to 1 kc/s.
 - (3) Measure the audio output (using the Marconi output meter) into 600 ohms at both the phone jack and the line terminals. Adjust the AUDIO GAIN and LINE LEVEL controls to give an output level of 0 dBm \pm 1 dB.
 - (4) Apply the same signal, 30% modulated at 1 kc/s.
 - (5) Set the SIGNAL SELECTOR switch to any M. C. W. position and measure the audio output. Adjust the AUDIO GAIN and LINE LEVEL controls to give an output level of 0 dBm \pm 1 dB.
 - (6) Terminate the DIV OUTPUT socket with a 75-ohm resistive load and measure the output. This should be within \pm 3 dB of the i.f. input. The SIGNAL SELECTOR switch can be set to any position.
 - (7) Repeat the procedures detailed in (1) to (6) above, but applying the signal to path B.

Switch Sensitivity

8. Test the functioning of the unit, as a switch, at two levels of signal as follows:-
 - (1) Apply 10 mV at 100 kc/s to each input socket (A and B on rear).
 - (2) Vary one input level up and down and observe the two path indicators on the front panel, noting the level at which the unit switches to the other path. This should occur within \pm 6 dB change.

- (3) Repeat the operation, varying the other path input. The same requirement exists.
- (4) Apply equal signals of 30 mV or more to both i. f. inputs.
- (5) Vary each signal and note the points at which the switching action occurs. This should be within ± 3 dB of the nominal input value.

NOTE: If the above specifications are not met the switching action threshold must be adjusted by means of RV5, a slotted spindle potentiometer accessible through a cut-out in the left-hand side of the unit's framework. Should the range of RV5 be insufficient, the value of R39 should be adjusted approximately; see note on circuit diagram (fig. 10).

Path Selection Amplifier

9. Repeat the operations in para. 8 (Switch Sensitivity) at 90 kc/s and 110 kc/s.

Speed of Operation

10. Check the speed of switch operation as follows:-
 - (1) Set the SIGNAL SELECTOR switch to select either of the 1000 baud speed positions. This produces a minimum time-constant damping effect on the detected signals.
 - (2) Feed in equal i. f. input signals to the two paths, each input of approximately 30 mV.
 - (3) Modulate one input at 30% modulation, 1000 c/s.
 - (4) The unit should now switch continuously at 1000 c/s; this may be checked by using the oscilloscope connected across the DIV output. Waveform shown in figure 6.

Gate Control Voltage

11. Using the AVO test meter, measure the voltages to earth at the emitters of VT2 and VT3, the gate drive transistors. Depending on which switch

is operated at the time of measurement, these readings should be +8 volts and -6 volts, or -8 volts and +6 volts, ± 1 volt. The choice of switch condition may be manually set for these measurements by positioning SA to the REC. A and REC. B positions.

Gate Efficiency

12. The losses of the two gates in 'off' and 'on' conditions are measured in the following manner.

13. ON condition

- (1) Apply a 30 mV signal to the i. f. input of path A.
- (2) Set SA to the REC. A position.
- (3) Terminate the DIV OUTPUT socket with a 75-ohm resistive load and measure the output. This should be within ± 3 dB relative to input.
- (4) Repeat the sequence (1) to (3) above, feeding the signal into path B, setting SA to the REC. B position. The total loss should be within 0.25 dB of the value in (3) above.

14. OFF condition

- (1) Apply a signal of 30 mV to the input of path A.
- (2) Manually select path B by setting SA to REC. B; gate A will now be in the OFF condition.
- (3) Measure the diversity output; the attenuation should be greater than 40 dB relative to input.
- (4) Repeat the operations detailed in (1) to (3) above, feeding the signal to path B and setting SA to the REC. A position.

NOTE: The loss through the gate circuit above (across R9) in the 'on' condition should be less than 2 dB relative to input.

Switching Transient

15. This test is carried out with no 100 kc/s input to either path in order that the transient effect can be observed on an oscilloscope. Continuous switching is simulated by using a 400 c/s sinewave signal applied as indicated below.

- (1) Set the OUTPUT control on the audio signal generator to OFF.
- (2) Connect the output of the generator through a 0.1 μ F capacitor to the junction of R40, R45 and the base of VT9.
- (3) Connect the oscilloscope to the DIV OUTPUT socket on the rear of the MA.168, and set the oscilloscope to the 10 mV (2 Mc/s) range.
- (4) Set the SIGNAL SELECTOR switch on the MA.168 to M. C. W. 1000 BAUD.
- (5) Slowly increase the output from the generator until the two neon indicators appear to glow simultaneously at a brilliance which is slightly below normal.
- (6) The oscilloscope will display a series of 'spikes', in a positive and negative direction, on a horizontal trace. The peak value of any one of these 'spikes' should not exceed 10 mV above the horizontal trace; if a peak value of greater than 10 mV is obtained, the diodes D1 to D8 should be rematched in accordance with para. 25.

I. F. Bandwidth

16. With a 30 mV input signal to each path, the bandwidth should be in excess of ± 10 kc/s to the 3 dB points. This may be conveniently measured by selecting each path in turn by switch SA and measuring the output at the DIV OUTPUT socket whilst rocking the tuning control of the signal generator.

B. F. O. AND MIXER

B. F. O. Range

17. The b. f. o. deviation range must not be less than ± 8.5 kc/s deviation with a 100 kc/s signal. The exact maximum figure may vary according to tracking requirements of individual units.

Calibration

18. The dial of the b.f.o. control is calibrated from 0 to ± 8.5 kc/s in 500 c/s markings, and must track (in both directions) to an accuracy of ± 100 c/s. Two-point tracking facilities are provided by the adjustable core of L1 (accessible through the printed circuit board from the underside) and the concentric-cup trimmer capacitor C33. The capacitor affects the upper range of adjustment (i.e. when the tuning capacitor C32 is near its minimum value position) whilst the core provides adjustment at the lower frequencies. Tracking procedures are similar to those adopted in the tracking of local oscillators of radio receivers.

NOTE: Re-tracking of the b.f.o. should only be attempted where movement of the dial in relation to the capacitor will not correct tracking errors, i.e. when the error is of a serious non-linear nature.

Frequency Pulling

19. The b.f.o. and mixer circuits are closely allied in function resulting in slight inter-dependence between the two. Therefore, the application of a signal to the mixer input affects, to some degree, the frequency of the b.f.o. The maximum permitted frequency pulling is 5 c/s with the application of an input signal of 200 mV to the mixer stage. The test requires the use of a digital frequency meter or 'event-per-unit-time' meter, direct coupled to the junction of R73 and the primary of T9. Such an arrangement provides an output with a minimum of damping to the circuit.

B.F.O. Break-through

20. The break-through of the b.f.o. into the diversity i.f. output circuit must be less than $300 \mu\text{V}$. The measurement is made with the DIV OUTPUT socket terminated with a 75-ohm load.

NOTE: The b.f.o. circuit is automatically switched off when the SIGNAL SELECTOR switch is set to M.C.W. The circuit is brought into operation only when this switch is positioned to C.W.

C.W. Response and Distortion

21. In the C.W. condition, the equipment should be capable of handling a 200 mV input signal with not more than 7% harmonic distortion of the audio output at 2.5 dBm. The audio response should be within 4 dB from 500 c/s to 8 kc/s.

A.M. Detector

22. This circuit should be capable of handling i.f. signals ranging from 10 to 150 mV (actual value) with 30% modulation, to give less than 5% harmonic distortion of audio product. The audio response should be better than 4 dB variation over the range of 500 c/s to 8 kc/s.

Audio Outputs

- 23. Each amplifier should be capable of delivering an output of 2.5 dBm with less than 5% total harmonic distortion.
- 24. The interaction between phone and line amplifiers should be such that the output level of the line amplifiers varies by less than 0.5 dB when the phone output gain control is turned from minimum to maximum limits.

Replacement of Diodes

25. The following instructions, for matching purposes, are to be carried out when one or more diodes fails in either of the bridge systems D1 to D4 or D5 to D8. (Refer to para. 15.)

NOTE: No matching is required for fitting any diodes Type CV7127 in any other circuit position.

These diodes must be matched in groups of 8 for assembly in positions D1 to D8 according to the instructions below.

26. Using the test circuit shown in figure 7, the eight diodes are matched to within 0.05 mA. The meter reading obtained should be within the range of 7 to 10 mA, and this is achieved by the suitable choice of battery voltage (not to exceed 1.5 volts) and series resistor; the value of resistor depends on the state of the battery, and is chosen to give a meter deflection in the range 7 to 10 mA.

1 Mc/s Connecting Cable (RA.17A Mk.2 or RA.17L)

27. The 1 Mc/s loaded coaxial cable, when connected between the 1 Mc/s output sockets of each receiver (one oscillator having been disabled by removal of V1), shall not introduce an attenuation of more than 1 dB.

CHAPTER 2

PREVENTIVE MAINTENANCE

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Performance Check	4
Dismantling	5
Replacing Components	6 - 7
Repairs to Printed Circuit	8
Meters	9

CHAPTER 2

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PREVENTIVE MAINTENANCEMechanical

1. Daily: Wipe over all exterior surfaces of the cabinet and panels with a dry duster. Carry out visual check on all exterior items, i.e. controls, sockets, indicator lamp meters etc. Check control knobs for security on shafts and rotary and toggle switches for positive sharp operation. Check meters for signs of stiction and off-centre zero return (see also para.2). The zero adjusting screw for each meter is located on the meter case and access to this is obtained by removing the unit from its rack and removing the top cover plate.
2. Six-monthly: Check security of all retaining screws on the unit, and of all removable components.

NOTE: Over tightening of the screws securing the meters to their fixing brackets is to be avoided. They should be secure, and are fitted with spring washers; over tightening may cause distortion of the meter housing and result in stiction in the movement.

Electrical Checks

3. Three-monthly: Carry out a visual check on all components and examine particularly for signs of cracking, corrosion, seepage, soakage and deterioration. Parts showing such signs must be tested at the earliest convenient time. Check the two power supply voltages, i.e. +14 volts and -8 volts, adjusting RV4 and RV3 as necessary. Do not attempt to remove any items (see para.7).

Performance Check

4. Perform the operations described under 'Noise Similarity Balance' in Section 1, Chapter 2 of this handbook, weekly or as may be found necessary. Proceed to test the functioning of the unit in the following manner.

- (1) Insert an r.f. attenuator in each of the receiver i.f. leads to the switching unit. Set both attenuators to give 0 dB attenuation.
- (2) Set up the switching unit and receivers as described in Section 1, Chapter 2.
- (3) Note which receiver is switched into use by the unit, and add attenuation in the lead connecting this receiver to the switching unit. Attenuate in steps of 1 dB, noting at which step the changeover to the other receiver takes place. Changeover should occur when 3 dB or less has been introduced provided the input to the MA. 168 exceeds 30 mV.
- (4) Repeat operation, attenuating the other receiver signal.

NOTE: The above test may only be performed under ideal conditions; i.e. during periods of negligible fading. A similar test may be made when fading is evident by substituting the receiver inputs to the unit by the outputs from two similar signal generators, tuned to 100 kc/s. Additional attenuators may then be dispensed with, the signals being reduced at the signal generators as required.

Dismantling

5. The switching unit may be removed from its rack by first removing the various connections to the unit and the four securing screws on the front panel, and then withdrawing the unit. The unit has two cover plates, top and bottom, secured by screws passing into tapped bushes in the outer framework.

Replacing Components

6. Printed circuit technique is employed in the switching unit, and extreme care must be exercised in the replacement of faulty components on a printed board. Resistors, Capacitors, Diodes and Transistors should never be soldered or unsoldered without the application of an effective heat sink to the wire ends of ALL components likely to be heated by the action. Soldering must be limited to short applications of the soldering bit to avoid blistering or damage to the printed circuit board. If a good joint is not achieved after five seconds application, the soldering bit must be removed and the entire joint allowed to cool off before another attempt is made.

7. When removing suspect components, the same care outlined above must be exercised; it may afterwards be found that a component suspected of being faulty is proven to be good, and if reasonable care is taken over its removal, it may later be used as a serviceable spare. All component changing must be performed as far as is practicable without removing the printed circuit board from its framework. Unnecessary removal of the board could result in stresses causing mechanical failure of the metallic circuit coating strips, a fault which may not be detected visually without the aid of a microscope.

Repairs to Printed Circuit

8. In cases of slight damage to the circuit coating strips fractures may be bridged by soldering short lengths of fine wire across the gap. If this is done, several individual strands must be used and soldered as close to the fracture as possible. The fracture must be cut back to avoid intermittent bridging contact of its ends.

Meters

9. Stiction in a meter may result if the meter case is subjected to stresses by over tightening of its fixing screws. The screws should first be slackened and the meter tested for stiction. If the trouble disappears, the screws must be tightened alternately by degrees until the spring washers are slightly compressed. Test again for stiction. If the fault is persistent the meter must be replaced and the troublesome unit sent for repair.

CHAPTER 3

COMPONENTS LIST

Cct. Ref.	Value	Description	Rat.	Tol. %	N. A. T. O. No.	Manufacturer
<u>Resistors</u>					5905-99-	
R1	82Ω	High stability	$\frac{1}{4}$ W	1	021-9402	Erie 108
R2	470Ω	High stability	$\frac{1}{2}$ W	1	021-5556	Painton 73
R3	150Ω	carbon	$\frac{1}{2}$ W	10	022-1132	Erie 8
R4	390Ω	carbon	$\frac{1}{2}$ W	10	022-1186	Erie 8
R5	180Ω	carbon	$\frac{1}{4}$ W	10	022-1142	Erie 16
R6	1.2kΩ	carbon	$\frac{1}{2}$ W	10	022-2018	Erie 8
R7	3.9kΩ	carbon	$\frac{1}{2}$ W	10	022-2081	Erie 8
R8	1.2kΩ	carbon	$\frac{1}{2}$ W	10	022-2018	Erie 8
R9	100Ω	High stability		1	021-5396	Painton 73
R10	1.2kΩ	carbon	$\frac{1}{2}$ W	10	022-2018	Erie 8
R11	1.2kΩ	carbon	$\frac{1}{2}$ W	10	022-2018	Erie 8
R12	1.2kΩ	carbon	$\frac{1}{2}$ W	10	022-2018	Erie 8
R13	100Ω	High stability		1	021-5396	Painton 73
R14	100Ω	High stability		1	021-5396	Painton 73
R15	100Ω	High stability		1	021-5396	Painton 73
R16	100Ω	High stability		1	021-5396	Painton 73
R17	68kΩ	carbon	$\frac{1}{2}$ W	10	022-3018	Erie 8
R18	68kΩ	carbon	$\frac{1}{2}$ W	10	022-3018	Erie 8
R19	6.8kΩ	carbon	$\frac{1}{2}$ W	10	022-2111	Erie 8
R20	6.8kΩ	carbon	$\frac{1}{2}$ W	10	022-2111	Erie 8
R21	68kΩ	carbon	$\frac{1}{2}$ W	10	022-3018	Erie 8
R22	33kΩ	carbon	$\frac{1}{2}$ W	10	022-2195	Erie 8
R23	3.3kΩ	carbon	$\frac{1}{2}$ W	10	022-2069	Erie 8
R24	33kΩ	carbon	$\frac{1}{2}$ W	10	022-2195	Erie 8
R25	1.2kΩ	carbon	$\frac{1}{2}$ W	10	022-2018	Erie 8
R26	3.3kΩ	carbon	$\frac{1}{2}$ W	10	022-2069	Erie 8
R27	22kΩ	carbon	$\frac{1}{2}$ W	10	022-2174	Erie 8
R28	27kΩ	carbon	$\frac{1}{2}$ W	10	022-2186	Erie 8
R29	22kΩ	carbon	$\frac{1}{2}$ W	10	022-2174	Erie 8
R30	1.8kΩ	carbon	$\frac{1}{2}$ W	10	022-2039	Erie 8
R31	1.5kΩ	carbon	$\frac{1}{2}$ W	10	022-2027	Erie 8
R32	22kΩ	carbon	$\frac{1}{2}$ W	10	022-2174	Erie 8
R33	1.2kΩ	carbon	$\frac{1}{2}$ W	10	022-2018	Erie 8
R34	3.3kΩ	carbon	$\frac{1}{2}$ W	10	022-2069	Erie 8
R35	68kΩ	carbon	$\frac{1}{2}$ W	10	022-3018	Erie 8
R36	1.8kΩ	carbon	$\frac{1}{2}$ W	10	022-2039	Erie 8
R37	330Ω	carbon	$\frac{1}{2}$ W	10	022-1174	Erie 8

Cct. Ref.	Value	Description	Rat.	Tol. %	N. A. T. O. No.	Manufacturer
Resistors - continued					5905-99-	
R38	2.7kΩ	carbon	$\frac{1}{2}$ W	10	022-2060	Erie 8
R39	470kΩ	carbon	$\frac{1}{2}$ W	10	022-3123	Erie 8
R40	47kΩ	carbon	$\frac{1}{2}$ W	10	022-2216	Erie 8
R41	22kΩ	carbon	$\frac{1}{2}$ W	10	022-2174	Erie 8
R42	1kΩ	carbon	$\frac{1}{4}$ W	10	022-2004	Erie 16
R43	470Ω	carbon	$\frac{1}{2}$ W	10	022-1195	Erie 8
R44	470Ω	carbon	$\frac{1}{2}$ W	10	022-1195	Erie 8
R45	47kΩ	carbon	$\frac{1}{2}$ W	10	022-2216	Erie 8
R46	1kΩ	carbon	$\frac{1}{4}$ W	10	022-2004	Erie 16
R47	22kΩ	carbon	$\frac{1}{2}$ W	10	022-2174	Erie 8
R48	47Ω	carbon	$\frac{1}{4}$ W	10	022-1069	Erie 16
R49	680Ω	carbon	$\frac{1}{2}$ W	10	022-1216	Erie 8
R50	680Ω	carbon	$\frac{1}{2}$ W	10	022-1216	Erie 8
R51	47Ω	carbon	$\frac{1}{4}$ W	10	022-1069	Erie 16
R52	8.2kΩ	carbon	$\frac{1}{2}$ W	10	022-2123	Erie 8
R53	2.7kΩ	carbon	$\frac{1}{2}$ W	10	022-2060	Erie 8
R54	2.7kΩ	carbon	$\frac{1}{2}$ W	10	022-2060	Erie 8
R55	8.2kΩ	carbon	$\frac{1}{2}$ W	10	022-2123	Erie 8
R56	47Ω	carbon	$\frac{1}{4}$ W	10	022-1069	Erie 16
R57	680Ω	carbon	$\frac{1}{2}$ W	10	022-1216	Erie 8
R58	470Ω	carbon	$\frac{1}{2}$ W	10	022-1195	Erie 8
R59	4.7kΩ	carbon	$\frac{1}{2}$ W	10	022-2090	Erie 8
R60	4.7kΩ	carbon	$\frac{1}{2}$ W	10	022-2090	Erie 8
R61	DELETED					
R62	4.7kΩ	carbon	$\frac{1}{2}$ W	10	022-2090	Erie 8
R63	10kΩ	carbon	$\frac{1}{2}$ W	10	022-2132	Erie 8
R64	1kΩ	carbon	$\frac{1}{2}$ W	10	022-2006	Erie 8
R65	5.6kΩ	carbon	$\frac{1}{2}$ W	10	022-2101	Erie 8
R66	270Ω	carbon	$\frac{1}{2}$ W	10	022-1165	Erie 8
R67	4.7kΩ	carbon	$\frac{1}{2}$ W	10	022-2090	Erie 8
R68	5.6kΩ	carbon	$\frac{1}{2}$ W	10	022-2102	Erie 8
R69	4.7kΩ	carbon	$\frac{1}{2}$ W	10	022-2090	Erie 8
R70	1kΩ	carbon	$\frac{1}{2}$ W	10	022-2006	Erie 8
R71	47Ω	carbon	$\frac{1}{4}$ W	10	022-1069	Erie 16
R72	1kΩ	carbon	$\frac{1}{2}$ W	10	022-2006	Erie 8
R73	1kΩ	carbon	$\frac{1}{2}$ W	10	022-2006	Erie 8

Cct. Ref.	Value	Description	Rat.	Tol. %	N. A. T. O. No.	Manufacturer
Resistors - continued					5905-99-	
R74	18k Ω	carbon	$\frac{1}{2}$ W	10	022-2165	Erie 8
R75	47 Ω	carbon	$\frac{1}{4}$ W	10	022-1069	Erie 16
R76	4.7k Ω	carbon	$\frac{1}{2}$ W	10	022-2090	Erie 8
R77	15k Ω	carbon	$\frac{1}{2}$ W	10	022-2153	Erie 8
R78	1k Ω	carbon	$\frac{1}{2}$ W	10	022-2006	Erie 8
R79	330 Ω	carbon	$\frac{1}{2}$ W	10	022-1174	Erie 8
R80	2.2k Ω	carbon	$\frac{1}{2}$ W	10	022-2048	Erie 8
R81	1.8k Ω	carbon	$\frac{1}{2}$ W	10	022-2039	Erie 8
R82	10 Ω	carbon	$\frac{1}{4}$ W	10	022-1003	Erie 16
R83	220 Ω	carbon	$\frac{1}{2}$ W	10	022-1153	Erie 8
R84	180 Ω	carbon	$\frac{1}{2}$ W	10	022-1144	Erie 8
R85	680 Ω	carbon	$\frac{1}{2}$ W	10	022-1216	Erie 8
R86	270 Ω	carbon	$\frac{1}{2}$ W	10	022-1165	Erie 8
R87	2.2k Ω	metal oxide	$\frac{1}{2}$ W	5		Welwyn F20 'Metox'
R88	10 Ω	carbon	$\frac{1}{4}$ W	10	022-1003	Erie 16
R89	330 Ω	carbon	$\frac{1}{2}$ W	10	022-1174	Erie 8
R90	1.8k Ω	carbon	$\frac{1}{2}$ W	10	022-2039	Erie 8
R91	270 Ω	carbon	$\frac{1}{2}$ W	10	022-1165	Erie 8
R92	270 Ω	carbon	$\frac{1}{2}$ W	10	022-1165	Erie 8
R93	150 Ω	carbon	$\frac{1}{2}$ W	10	022-1132	Erie 8
R94	8.2k Ω	carbon	$\frac{1}{2}$ W	10	022-2123	Erie 8
R95	1.8k Ω	carbon	$\frac{1}{2}$ W	10	022-2039	Erie 8
R96	470 Ω	carbon	$\frac{1}{2}$ W	10	022-1195	Erie 8
R97	470 Ω	carbon	$\frac{1}{2}$ W	10	022-1195	Erie 8
R98	330 Ω	carbon	$\frac{1}{2}$ W	10	022-1174	Erie 8
R99	8.2k Ω	carbon	$\frac{1}{2}$ W	10	022-2123	Erie 8
R100	2.2k Ω	carbon	$\frac{1}{2}$ W	10	022-2048	Erie 8
R101	22 Ω	wirewound	3W	5	011-3280	Painton 306A
R102	15 Ω	wirewound	3W	5	011-3276	Painton 306A
R103	DELETED					
R104	3.3k Ω	carbon	$\frac{1}{2}$ W	10	022-2069	Erie 8
R105	2.2k Ω	metal oxide	$\frac{1}{2}$ W	5		Welwyn F20 'Metox'
R106	2.2k Ω	metal oxide	$\frac{1}{2}$ W	5		Welwyn F20 'Metox'
R107	8.2k Ω	carbon	$\frac{1}{2}$ W	10	022-2123	Erie 8
R108	2.7k Ω	carbon	$\frac{1}{2}$ W	10	022-2060	Erie 8
R109	100k Ω	High stability	$\frac{1}{4}$ W	5	021-9257	Erie 109
R110	470 Ω	carbon	$\frac{1}{4}$ W	10	022-1193	Erie 16

Cct. Ref.	Value	Description	Rat.	Tol. %	N. A. T. O. No.	Manufacturer
Resistors - continued					5905-99-	
R111	DELETED					
R112	47Ω	carbon	$\frac{1}{2}$ W	10	022-1069	Erie 8
R113	51Ω	metal oxide	$\frac{1}{2}$ W	5		Welwyn F20 'Metox'
R114	120Ω	metal oxide	$\frac{1}{2}$ W	5		Welwyn F20 'Metox'
R115	120Ω	metal oxide	$\frac{1}{2}$ W	5		Welwyn F20 'Metox'
R116	51Ω	metal oxide	$\frac{1}{2}$ W	5		Welwyn F20 'Metox'
R117	750Ω	metal oxide	$\frac{1}{2}$ W	5		Welwyn F20 'Metox'
R118	4.7kΩ	carbon	$\frac{1}{2}$ W	10	022-2090	Erie 8
R119	56kΩ	carbon	$\frac{1}{2}$ W	10	022-3009	Erie 8
R120	100kΩ	carbon	$\frac{1}{4}$ W	10	022-3037	Erie 16
R121	100kΩ	carbon	$\frac{1}{4}$ W	10	022-3037	Erie 16
R122	3.9kΩ	carbon	$\frac{1}{2}$ W	10	022-2081	Erie 8
R123	2.2kΩ	carbon	$\frac{1}{2}$ W	10	022-2048	Erie 8
R124	680Ω	carbon	$\frac{1}{4}$ W	10	022-1214	Erie 16
R125	680Ω	carbon	$\frac{1}{4}$ W	10	022-1214	Erie 16
R126	4.7kΩ	carbon	$\frac{1}{4}$ W	10	022-2088	Erie 16
R127	3.3kΩ	carbon	$\frac{1}{4}$ W	10	022-2067	Erie 16
<u>Potentiometers</u>						
RV1	1kΩ	carbon, linear				Morganite BJNAR
RV2	1kΩ	carbon, linear				Morganite BJNAR
RV3	250Ω	wirewound				Colvern CLR1501/95
RV4	500Ω	wirewound				Colvern CLR1501/95
RV5	250kΩ	carbon, linear				Morganite BJ
<u>Capacitors</u>					5910-99-	
C1	0.04μF	paper	250V	20	012-0116	Hunt W97/BM16K
C2	DELETED					
C3	12μF	electrolytic	25V		972-6314	T. C. C. CE67C
C4	0.04μF	paper	250V	20	012-0116	Hunt W97/BM16K
C5	0.003μF	paper	500V	20	012-0121	Hunt W97/BM19K
C6	0.04μF	paper	250V	20	012-0116	Hunt W97/BM16K
C7	12μF	electrolytic	25V		972-6314	T. C. C. CE67C
C8	1μF	paper	200V		011-9836	Hunt W197/B5030KZ

Cct. Ref.	Value	Description	Rat.	Tol. %	N. A. T. O. No.	Manufacturer
Capacitors - continued					5910-99-	
C9	0.1 μ F	paper	200V		011-9827	
C10	0.05 μ F	paper	250V		011-9825	
C11	0.01 μ F	paper	250V	20	012-0113	Hunt W97/BM13K
C12	0.005 μ F	paper	500V	20	012-0122	Hunt W97/BM20K
C13	12 μ F	electrolytic	25V		972-6314	T. C. C. CE67C
C14	0.04 μ F	paper	250V	20	012-0116	Hunt W97/BM16K
C15	0.02 μ F	paper	250V	20	012-0114	Hunt W97/BM14K
C16	12 μ F	electrolytic	25V		972-6314	T. C. C. CE67C
C17	0.04 μ F	paper	250V	20	012-0116	Hunt W97/BM16K
C18	0.02 μ F	paper	250V	20	012-0114	Hunt W97/BM14K
C19	0.02 μ F	paper	250V	20	012-0114	Hunt W97/BM14K
C20	12 μ F	electrolytic	25V		972-6314	T. C. C. CE67C
C21	0.04 μ F	paper	250V	20	012-0116	Hunt W97/BM16K
C22	0.002 μ F	paper	250V	20	012-0108	Hunt W97/BM7K
C23	0.002 μ F	paper	250V	20	012-0108	Hunt W97/BM7K
C24	2 μ F	electrolytic	50V			T. C. C. CE268D
C25	2 μ F	electrolytic	50V			T. C. C. CE268D
C26	400 μ F	electrolytic	15V			Wima Printilyt
C27	12 μ F	electrolytic	25V		972-6314	T. C. C. CE67C
C28	2 μ F	electrolytic	50V			T. C. C. CE268D
C29	0.04 μ F	paper	250V	20	012-0116	Hunt W97/BM16K
C30	0.01 μ F	paper	500V		Z119218	Suflex
C31	255pF		350V	1		Suflex HS10/K
C32	7-149.5pF	variable				Hackson
C33	3-30pF	variable			016-7006	Mullard E7876
C34	4700pF		500V		Z119216	Suflex
C35	0.04 μ F	paper	250V	20	012-0116	Hunt W97/BM16K
C36	2 μ F	electrolytic	50V			T. C. C. CE268D
C37	0.02 μ F	paper	250V	20	012-0114	Hunt W97/BM14K
C38	680pF		500V		Z119211	Suflex
C39	0.01 μ F	paper	250V	20	012-0113	Hunt W97/BM13K
C40	0.02 μ F	paper	250V	20	012-0114	Hunt W97/BM14K
C41	0.02 μ F	paper	250V	20	012-0114	Hunt W97/BM14K
C42	12 μ F	electrolytic	25V		972-6314	T. C. C. CE67C
C43	12 μ F	electrolytic	25V		972-6314	T. C. C. CE67C
C44	50 μ F	electrolytic	12V		580-1472	T. C. C. CE131BD
C45	12 μ F	electrolytic	25V		972-6314	T. C. C. CE67C

Cct. Ref.	Value	Description	Rat.	Tol. %	N. A. T. O. No.	Manufacturer
Capacitors - continued					5910-99-	
C46	50 μ F	electrolytic	12V		580-1472	T. C. C. CE131BD
C47	12 μ F	electrolytic	25V		972-6314	T. C. C. CE67C
C48	50 μ F	electrolytic	50V		014-5513	Hunt L38/1 JE103KZ
C49	50 μ F	electrolytic	50V		014-5513	Hunt L38/1 JE103KZ
C50	500 μ F	electrolytic	50V	-20 +100	014-5519	Hunt L38/1 JE106AKZ
C51	1000 μ F	electrolytic	25V	-20 +100	014-5520	Hunt L38/1 JE57KZ
C52	0.005 μ F	paper	250V	20	012-0111	Hunt W97/BM9K
C53	0.005 μ F	paper	250V	20	012-0111	Hunt W97/BM9K
C54	64 μ F	electrolytic	25V			Mullard C426AE/F64
C55	4 μ F	electrolytic	200V			T. C. C. CE32G
C56	64 μ F	electrolytic	25V			Mullard C426AE/F64
<u>Transformers</u>						
T1		100 kc/s output				Racal CA16955/C
T2		Modulator				Racal CA16955/A
T3		Modulator				Racal CA16955/A
T4		Modulator				Racal CA16955/A
T5		Modulator				Racal CA16955/A
T6		100 kc/s amplifier				Racal CA16955/B
T7		100 kc/s amplifier				Racal CA16955/B
T8		DELETED				
T9		b. f. o. output				Racal CA16955/D
T10		Mixer				Racal BA16974
T11		100 kc/s amplifier				Racal CA16955/B
T12						Racal AT21417
T13						Racal AT21417
T14		Mains				Racal BT21083
T15		I. F. Output				Racal CA16955/E
<u>Switches</u>					5930-99-	
SA		Function - front wafer rear wafer				Racal BSW17050 Racal BSW16922

Cct. Ref.	Value	Description	Rat.	Tol. %	N. A. T. O. No.	Manufacturer
Switches - continued					5930-99-	
SB		BALANCED/UNBALANCED OUTPUT			051-0504	N.S.F. QM
SC		SIGNAL SELECTOR				Racal BSW16914
SE		MAINS			051-0504	N.S.F. QM
SF		SET LEVEL				Racal ASW16900
<u>Transistors</u>						
VT1					CV7044	Mullard OC201
VT2					CV7044	Mullard OC201
VT3					CV7044	Mullard OC201
VT4					CV7044	Mullard OC201
VT5					CV7044	Mullard OC201
VT6					CV7044	Mullard OC201
VT7					CV7044	Mullard OC201
VT8					CV7044	Mullard OC201
VT9						Mullard OC202
VT10					CV7044	Mullard OC201
VT11					CV7044	Mullard OC201
VT12					CV7044	Mullard OC201
VT13					CV7044	Mullard OC201
VT14					CV7044	Mullard OC201
VT15					CV7044	Mullard OC201
VT16					CV7044	Mullard OC201
VT17					CV7044	Mullard OC201
VT18					CV7044	Mullard OC201
VT19					CV7044	Mullard OC201
VT20					CV7044	Mullard OC201
VT21					CV7084	Mullard OC35
VT22					CV7044	Mullard OC201
VT23					CV7044	Mullard OC201
VT24					CV7084	Mullard OC35
VT25					CV7044	Mullard OC201
<u>Diodes</u>						
D1					CV7127	Hughes Int. HG5004

Cct. Ref.	Value	Description	Rat. Tol. %	N. A. T. O. No.	Manufacturer
Diodes - continued					
D2				CV7127	Hughes Int. HG5004
D3				CV7127	Hughes Int. HG5004
D4				CV7127	Hughes Int. HG5004
D5				CV7127	Hughes Int. HG5004
D6				CV7127	Hughes Int. HG5004
D7				CV7127	Hughes Int. HG5004
D8				CV7127	Hughes Int. HG5004
D9				CV7041	Mullard OA95
D10				CV7041	Mullard OA95
D11				CV7041	Mullard OA95
D12				CV7041	Mullard OA95
D13				CV7041	Mullard OA95
D14				CV7041	Mullard OA95
D15				CV7127	Hughes Int. HG5004
D16				CV7127	Hughes Int. HG5004
D17				CV7127	Hughes Int. HG5004
D18				CV7127	Hughes Int. HG5004
D19				CV7045	Texas 1S111
D20				CV7045	Texas 1S111
D21				CV7045	Texas 1S111
D22				CV7045	Texas 1S111
D23				CV7045	Texas 1S111
D24				CV7045	Texas 1S111
D25		DELETED			
D26				CV7045	Texas 1S111
D27				CV7138	Texas Instruments 1S7033A
D28				CV7013	Texas 1S7000A
D29				CV7127	Hughes Int. HG5004
D30				CV7127	Hughes Int. HG5004
D31				CV7046	Texas 1S115
D32				CV7046	Texas 1S115
D33				CV7046	Texas 1S115
<u>Plugs and Sockets</u>				5935-99-	
PL1		Mains		056-0565	Plessey Mk. IV

Cct. Ref.	Value	Description	Rat. %	Tol.	N. A. T. O. No.	Manufacturer
Plugs and Sockets - continued					5935-99-	
SKT1		'A' I.F. INPUT				F. & E. UG1094/U
SKT2		'B' I.F. INPUT				F. & E. UG1094/U
SKT3		DIV. OUTPUT				F. & E. UG1094/U
SKT4		REC. 'A' SECOND V.F.O.				F. & E. UG1094/U
SKT5		REC. 'B' SECOND V.F.O.				F. & E. UG1094/U
JK1		PHONES jack socket				Igranic P72
<u>Miscellaneous</u>					5920-99-	
L1		b.f.o. coil assembly				Racal AA16881
F1	500mA	fuse			059-0108	Belling Lee L562
F2	500mA	fuse			059-0108	Belling Lee L562
F3	1 amp	fuse			059-0109	Belling Lee L562
M1		Meter				Racal BSW22110/B
M2		Meter				Racal BSW22110/A
N1		Indicator lamp				Mullard DM160
N2		Indicator lamp				Mullard DM160
		Terminal strip two-way (line Output)				Cinch 79/593
		Free plug (coaxial)				F. & E. UG206B/U
		Transistor mounts				Hellerman HV4518
		Bellows coupling				Racal AD14364/1
		Fuseholder				Belling Lee L575

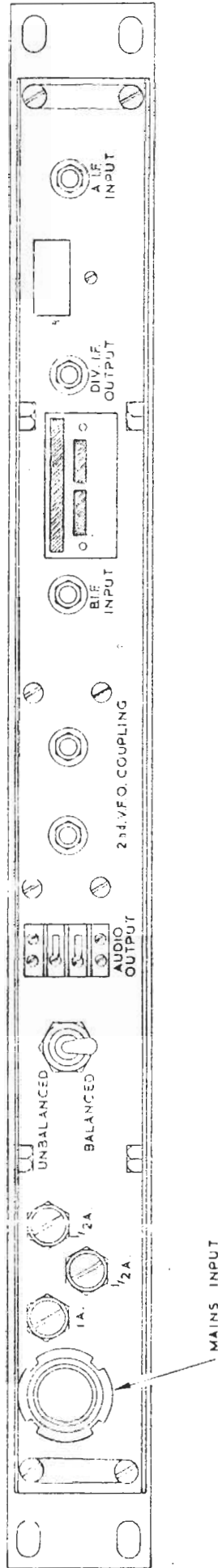
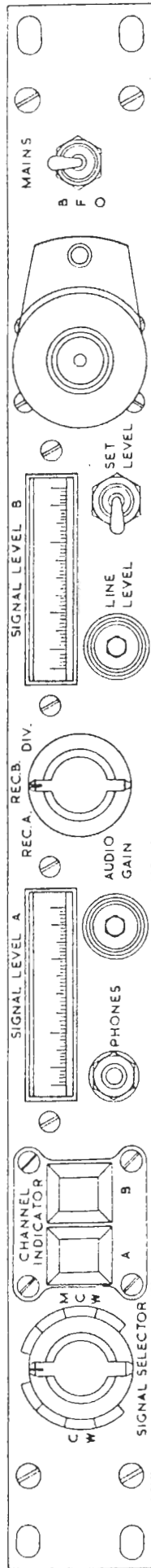
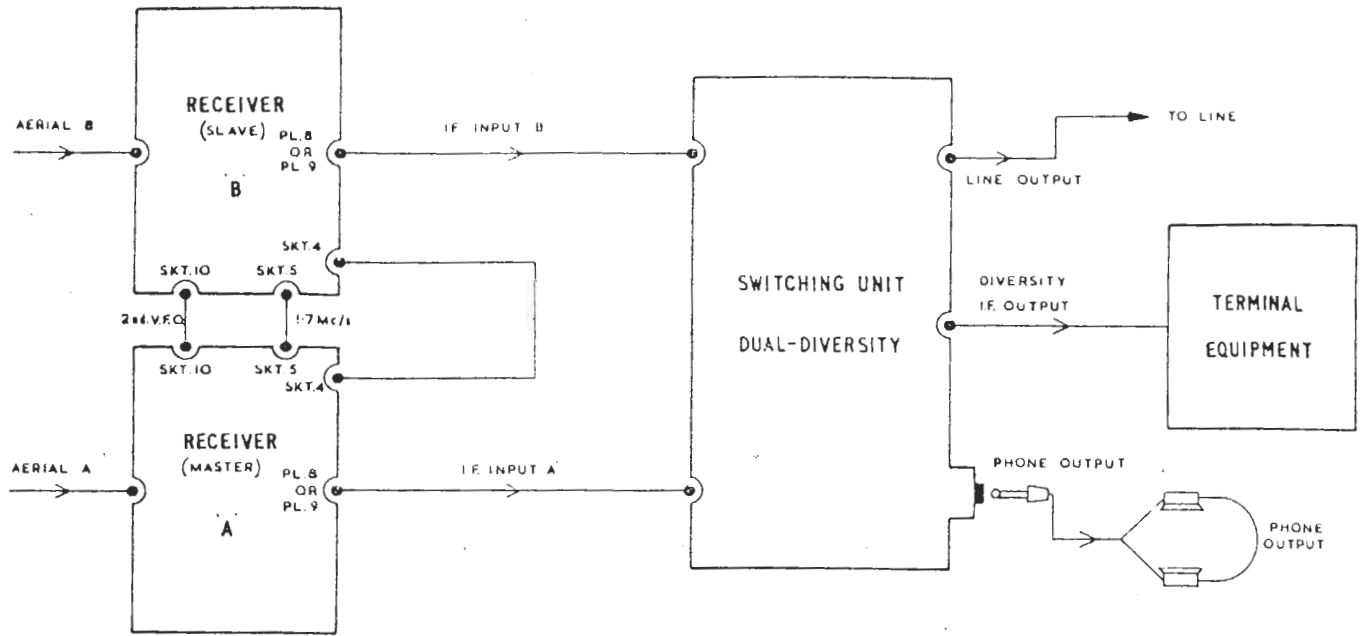


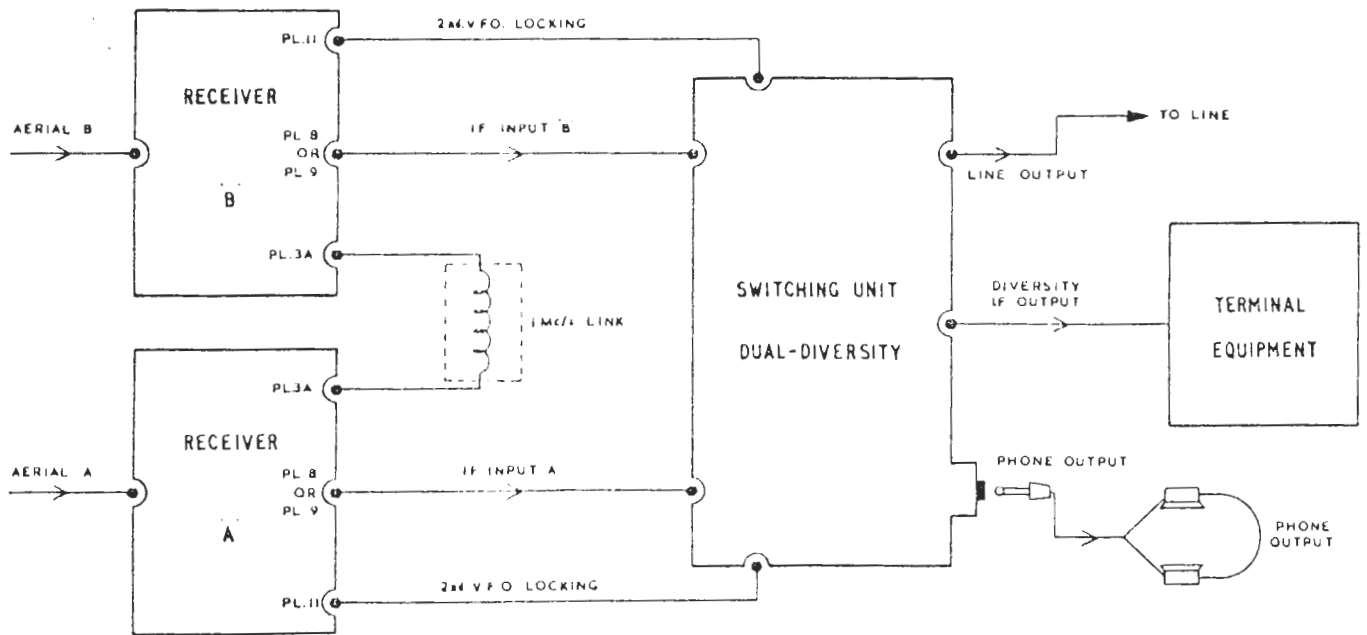
Fig. 1

126212

FRONT & REAR PANELS: DIVERSITY SWITCHING UNIT TYPE MAJ68B



USE WITH RA.117 RECEIVER (b)

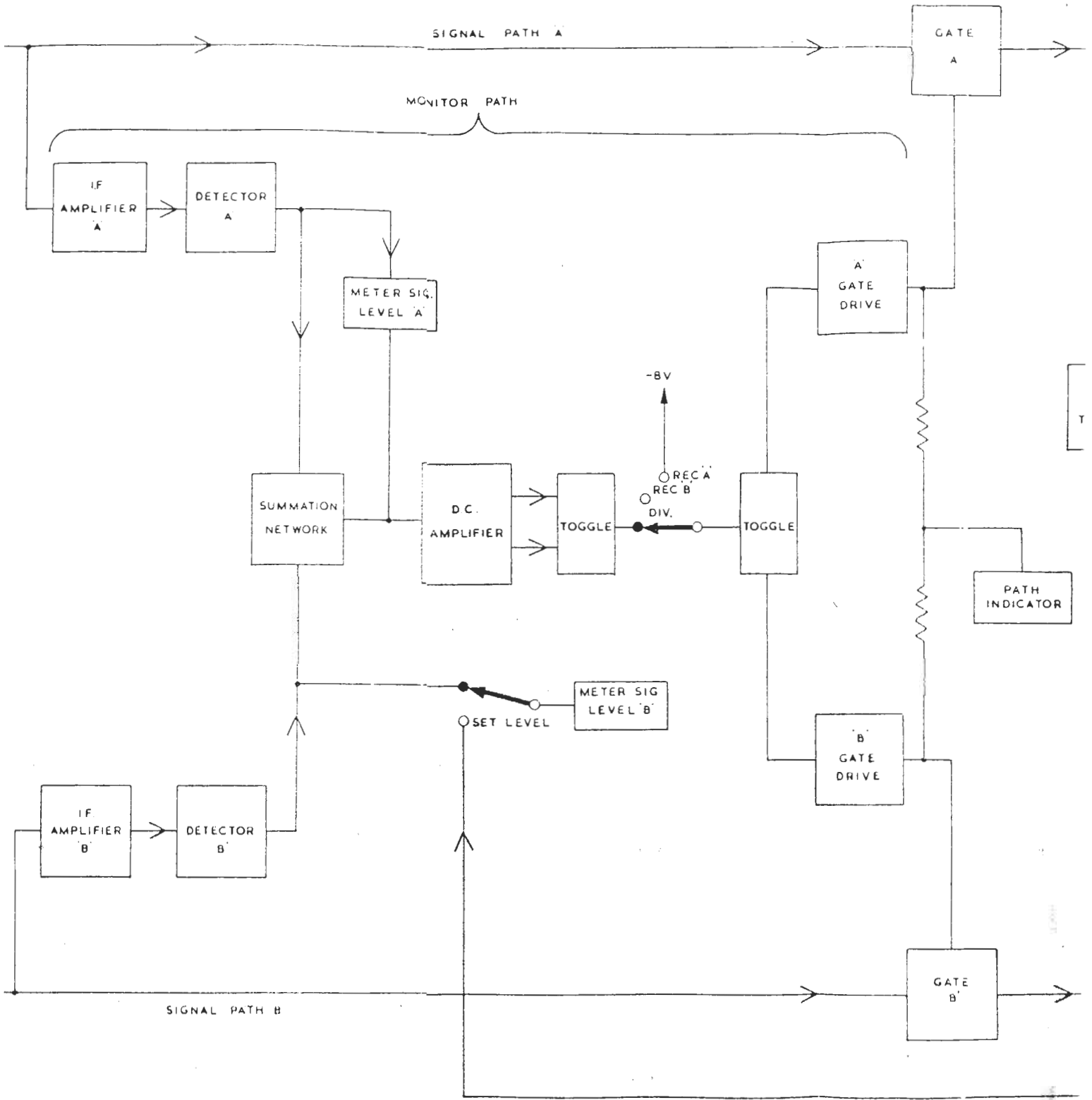


USE WITH RA.17 MK.2 OR RA.17L RECEIVER (a)

126213

INTERCONNECTIONS : DUAL-DIVERSITY RECEIVING SYSTEM

Fig.2



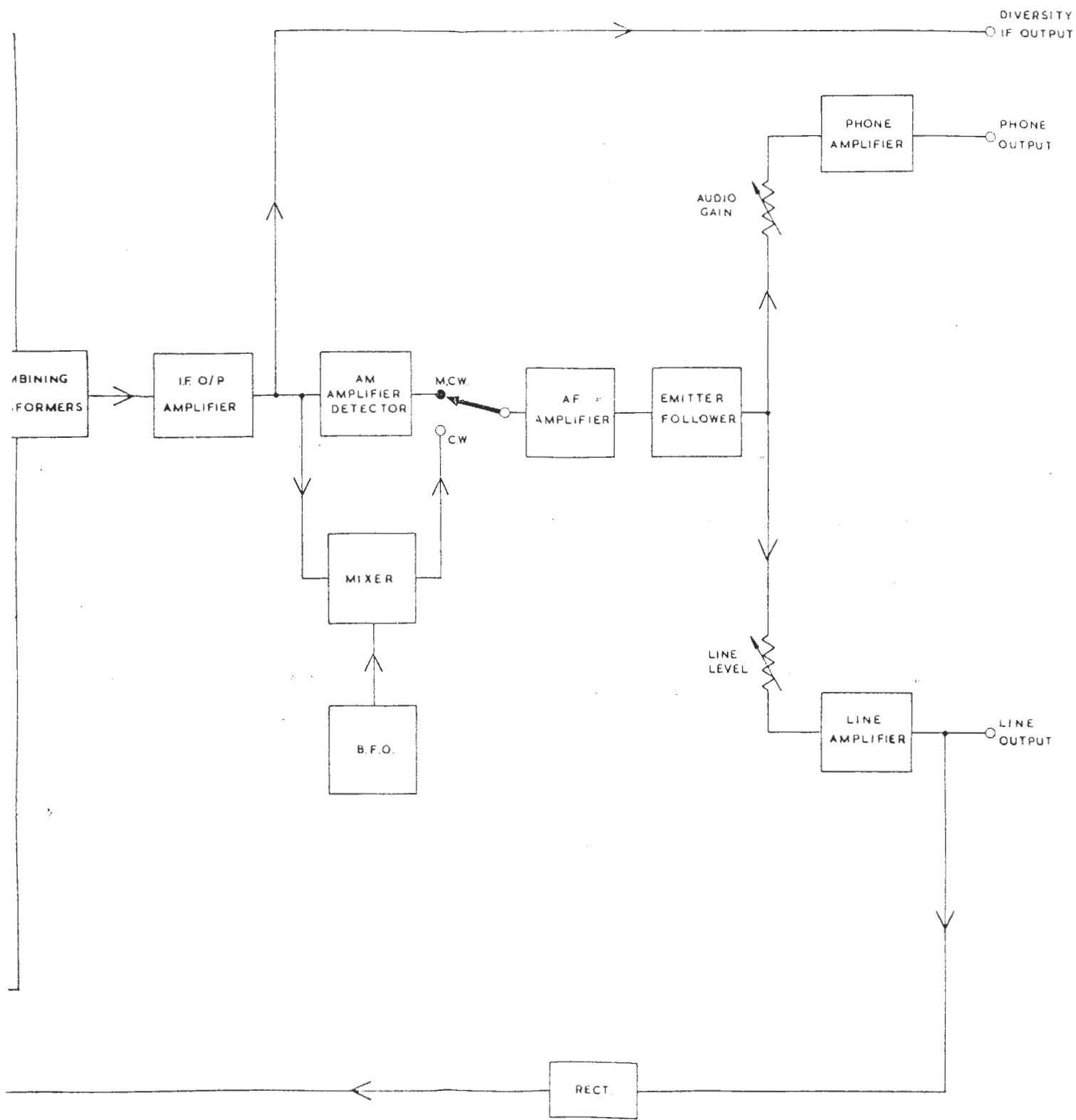
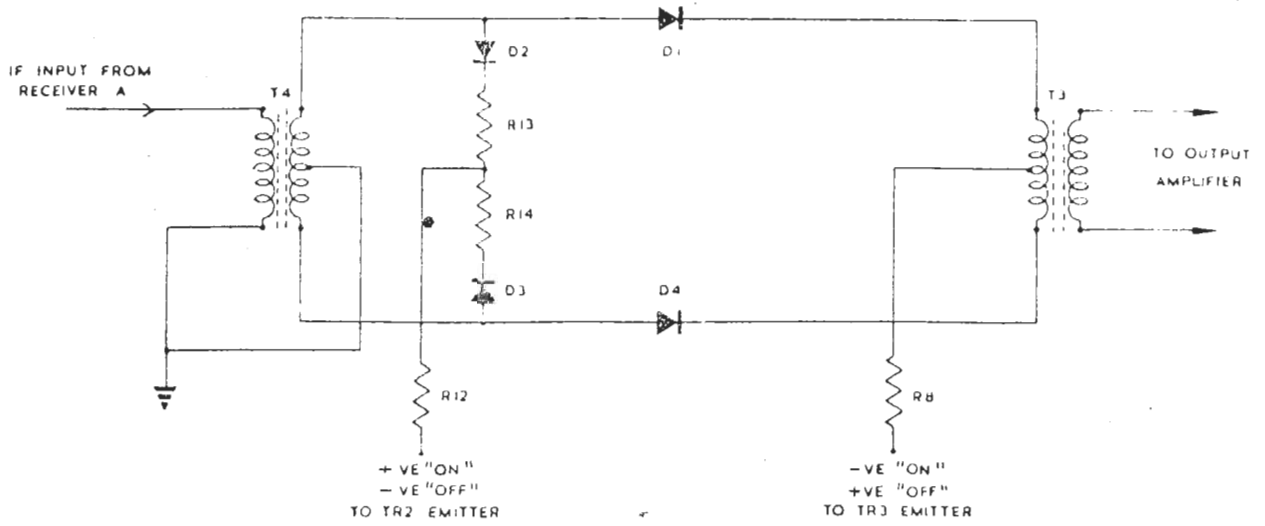


DIAGRAM : DIVERSITY SWITCHING UNIT TYPE MA.168B

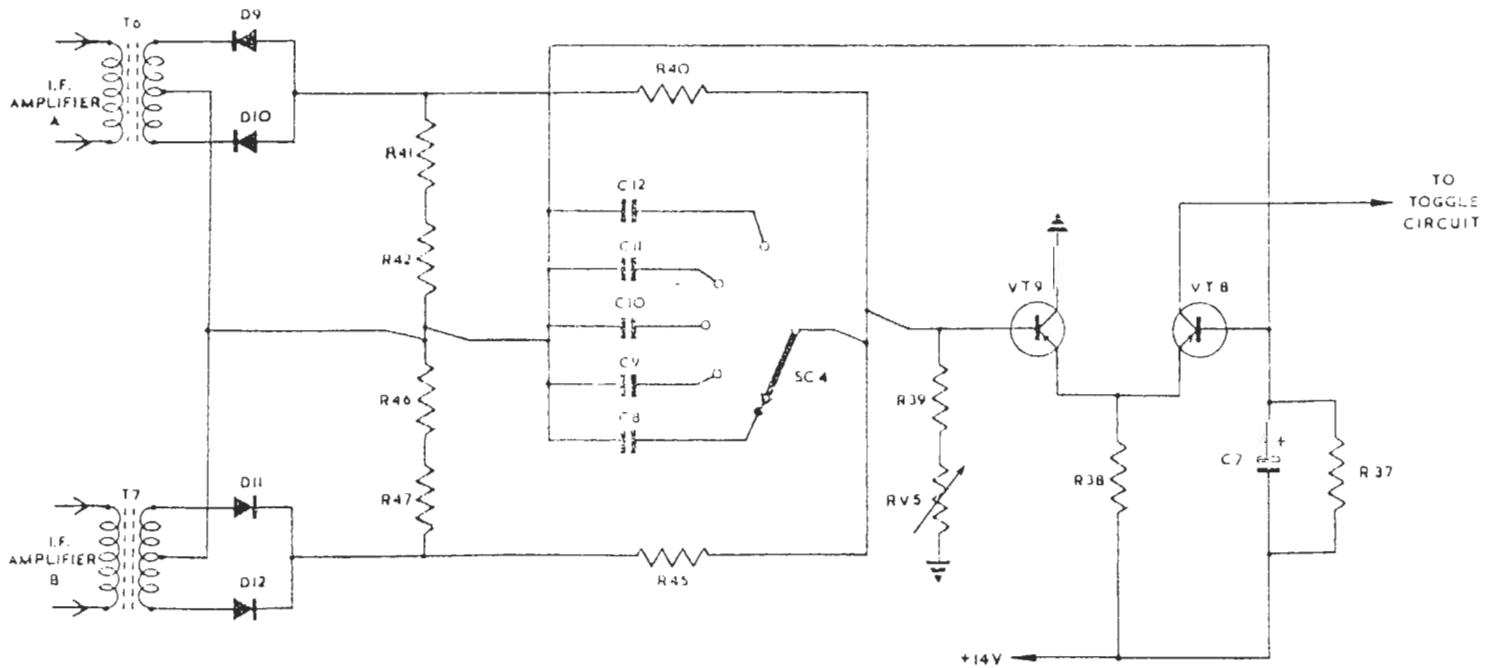
Fig.3



126215

SIMPLIFIED CIRCUIT : PATH 'A' GATE STAGE

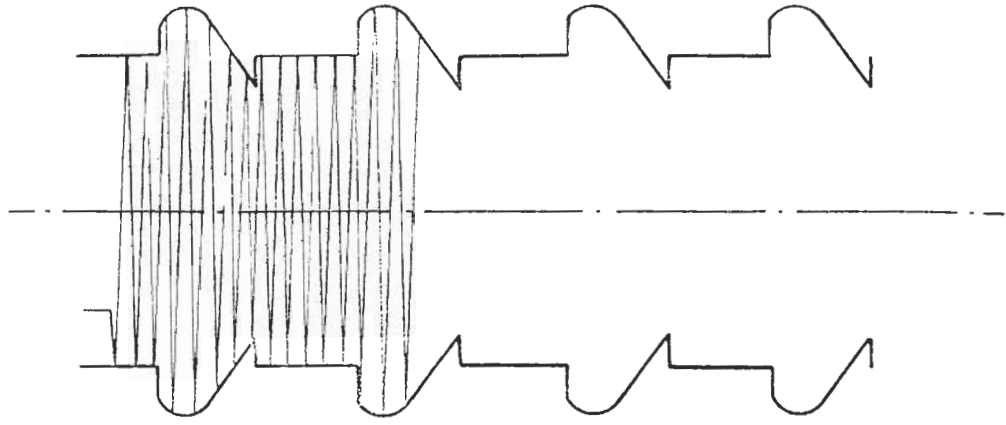
Fig.4



126216

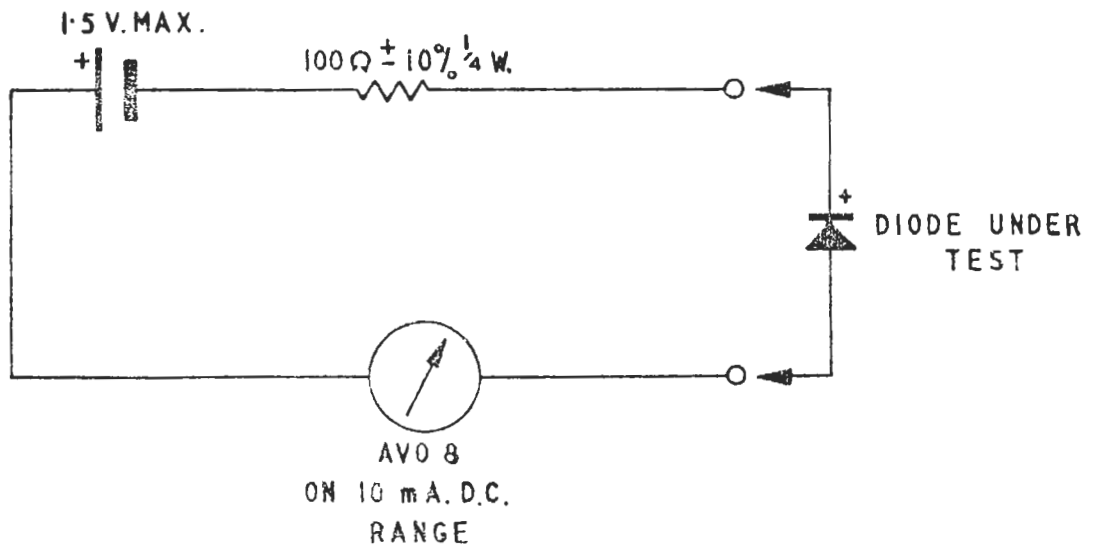
SIMPLIFIED CIRCUIT : DETECTOR SUMMATION & D.C. AMPLIFIER STAGES

Fig.5



126217

WAVEFORM : SPEED OF OPERATION TEST Fig.6

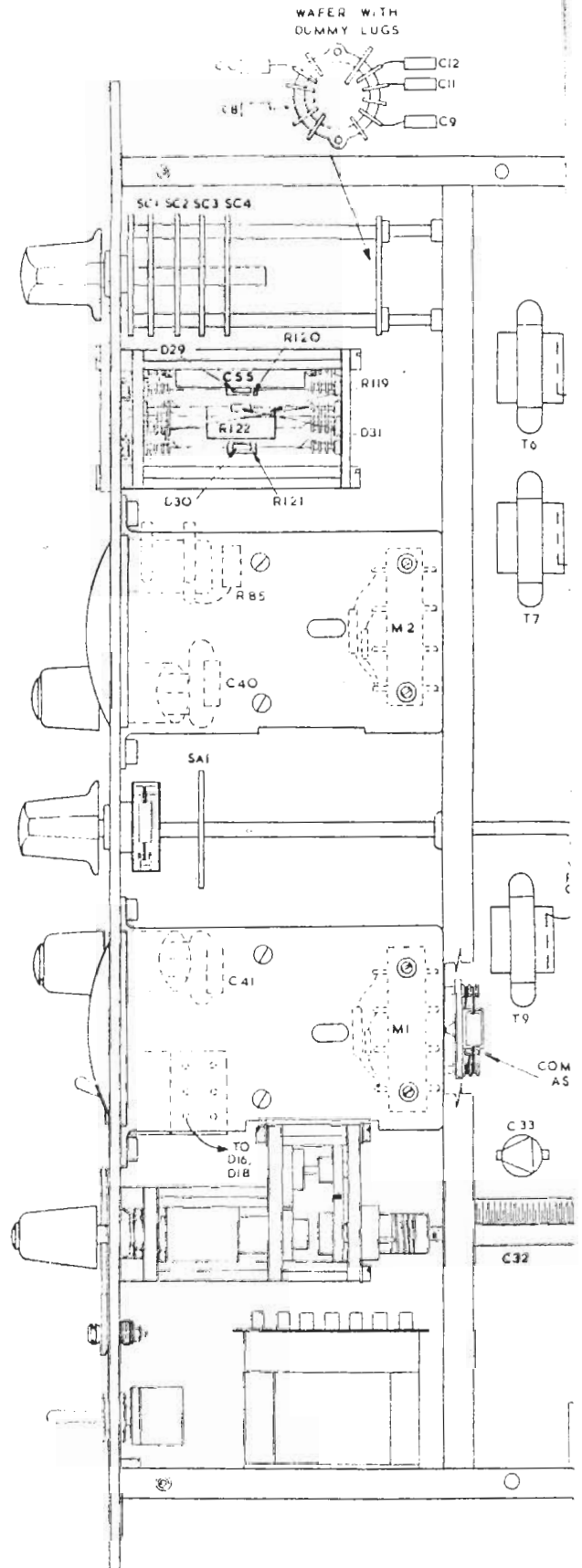
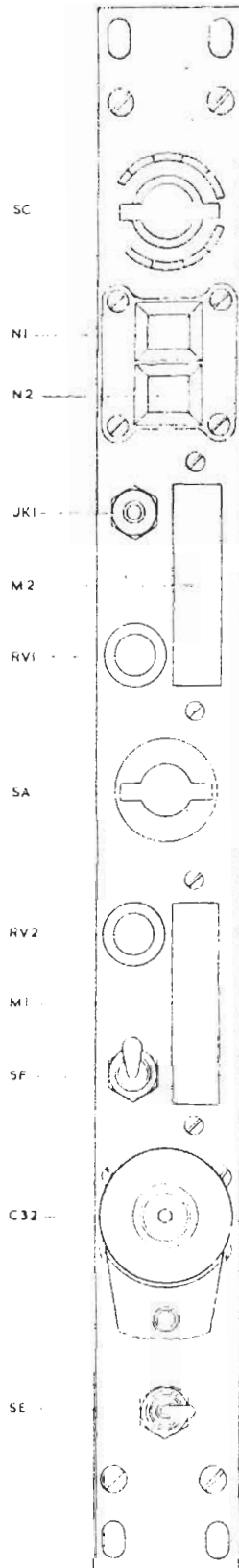


126218

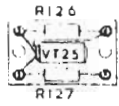
TEST CIRCUIT FOR MATCHING DIODES

Fig.7

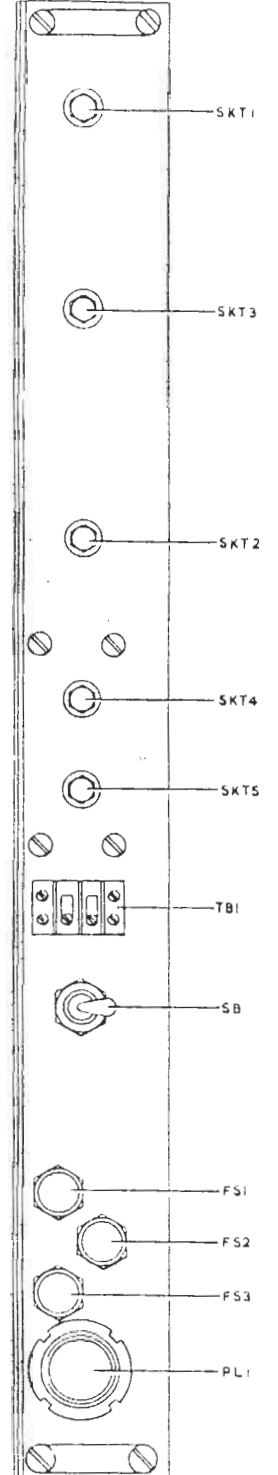
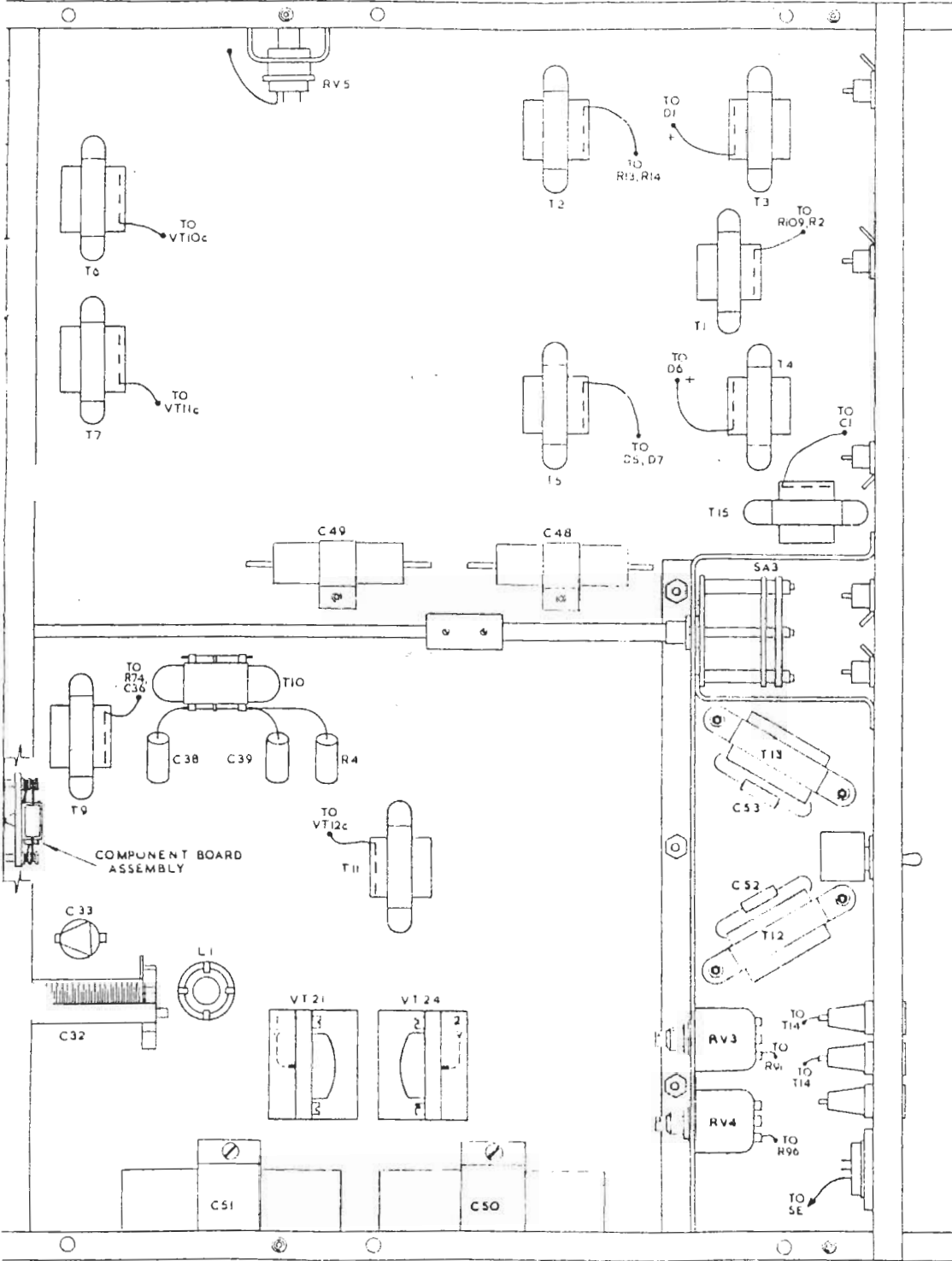
MISC	C	R
R/S SKT. SC T2,3		
T6 N1 D29 D31 T1 SKT 3 N2 D30	55	120 119 122 121
T7 JK1 T5,4		85
M2 SKT 2 T15 RVI	40	
SKT 4	49,48	
SA		
SKT 5 T10		
T9 RV2 T13	38, 39 41	4
M1	53	
T11, SB		
SF	52	
T12	33	
L1		
FS1 RV3 VT21, 24 FS2	32	
FS3 RV4 T14		
SE PL1	51,50	



C12
C11
C5

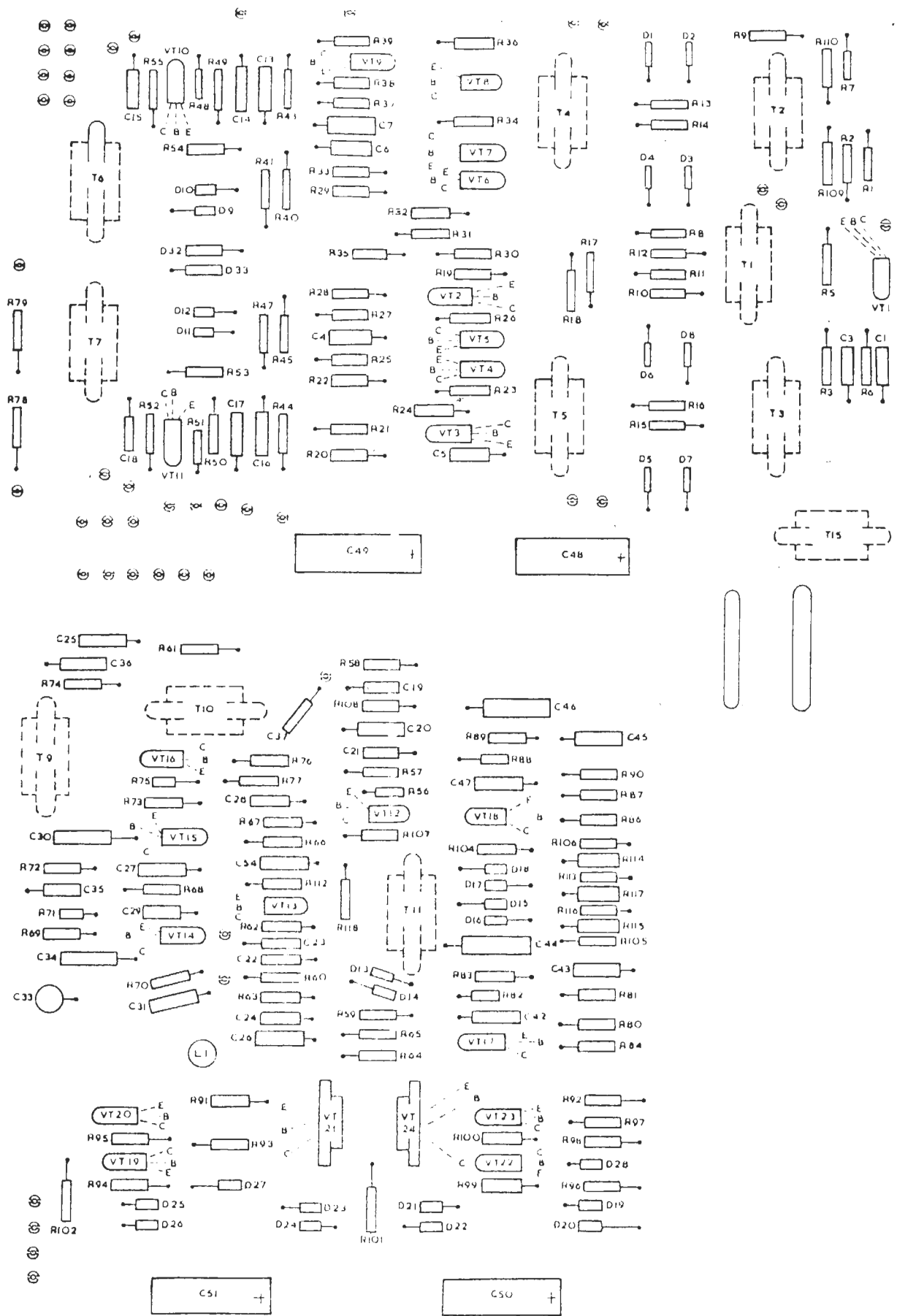


COMPONENT BOARD ASSEMBLY



6^aB MAIN CHASSIS - TOP

Fig.8

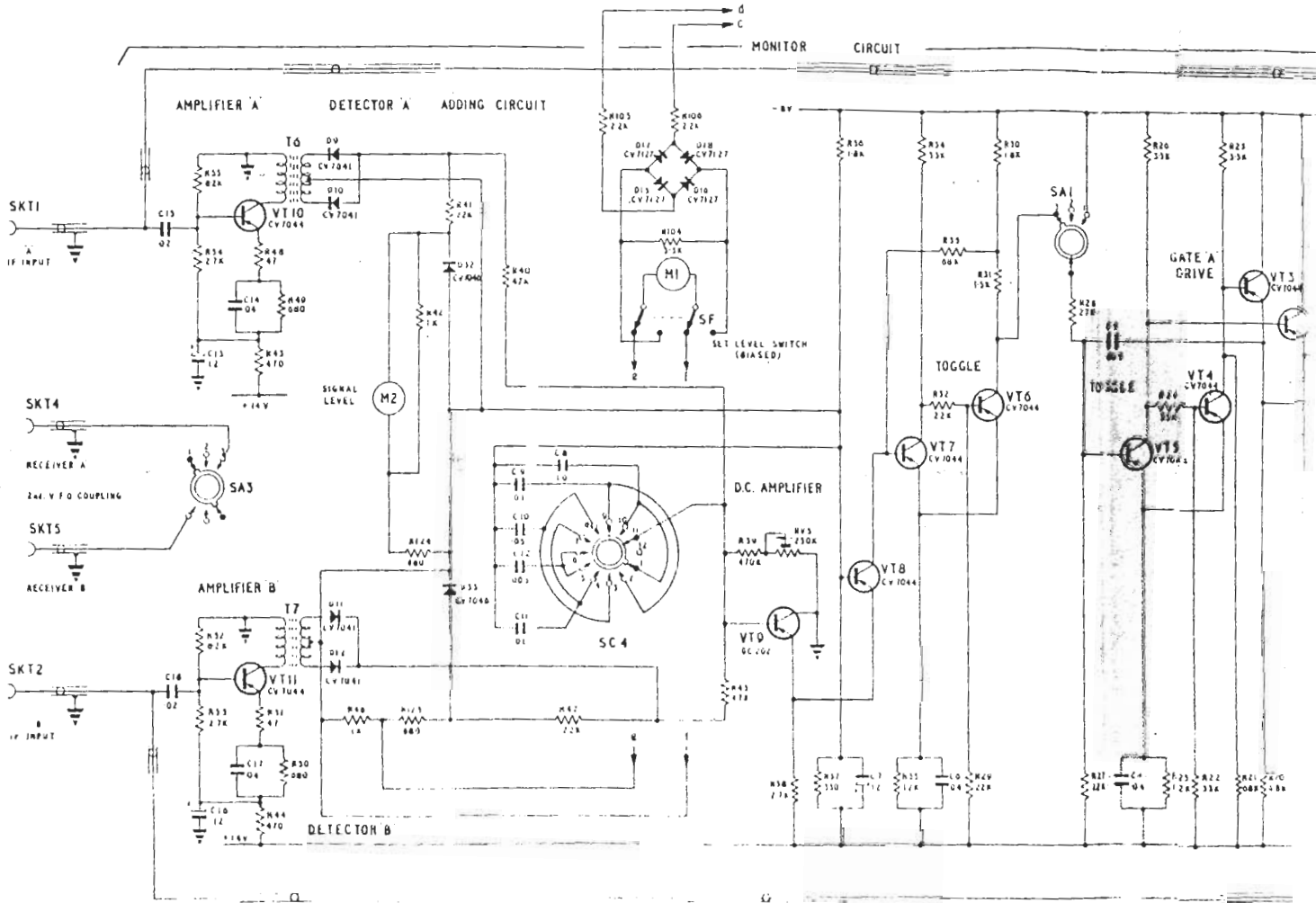


126220

COMPONENT LAYOUT : MA.168 B
 PRINTED WIRING BOARD 1

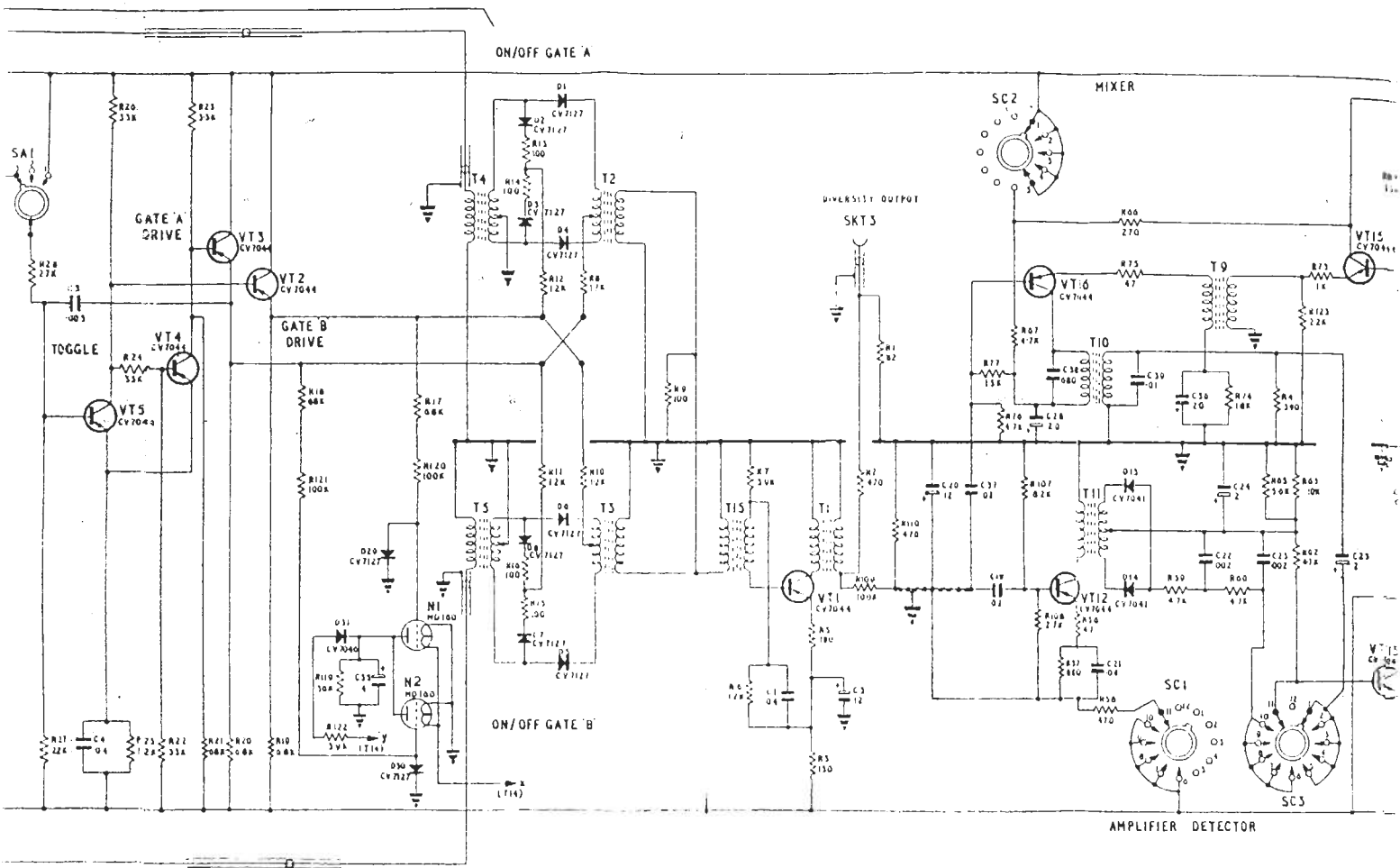
Fig.9

R		13	13	14		40	42	42	41	40	47	105	106	45	30	17	10	33	34	35	30	28	27	20	24	23	20	19	
C		13	13	14														7	8	9	11	14							
VT																													
MISC	SA1 SKT4 SA12 SKT5	SA3	T4 T7	D9, D10 D11, D12	M2	D12 D33					SC4	D15, D16 D17, D18	AV5									SA1							



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28	27	69	25	22	25	21	20	19	18	122	11	120	12	11	8	10	9	7	3	2	1	77	67	107	57	53	58	50	59	74	40	55	4	123	75			
5	4										33											1	3		20	17	10	28	18	21	19	30	22	24	23	25		
SA1											D31	D29	D30	H1	T4	D2D3	D1,D4	T2								SC2		T10	D13		SC1	T9			SC3			



CIRCUIT DIVERSITY SWITCHING UNIT TYPE MA.168B

71	72	80	81	82	83	84	85	114	117	118	119	120	102	R			
78	79	80	81	82	83	84	85	114	117	118	119	120	102	C			
35	36	37	38	39	40	41	42	43	44	45	46	47	48	VT			
4	5	6	7	8	9	10	11	12	13	14	15	16	17	MISC.			
RV1	LI	RV2	T12	T18	SB	JK1	RV3	RV4	D27	D28	D29	D30	F52	F53	SE	PL1	MISC.

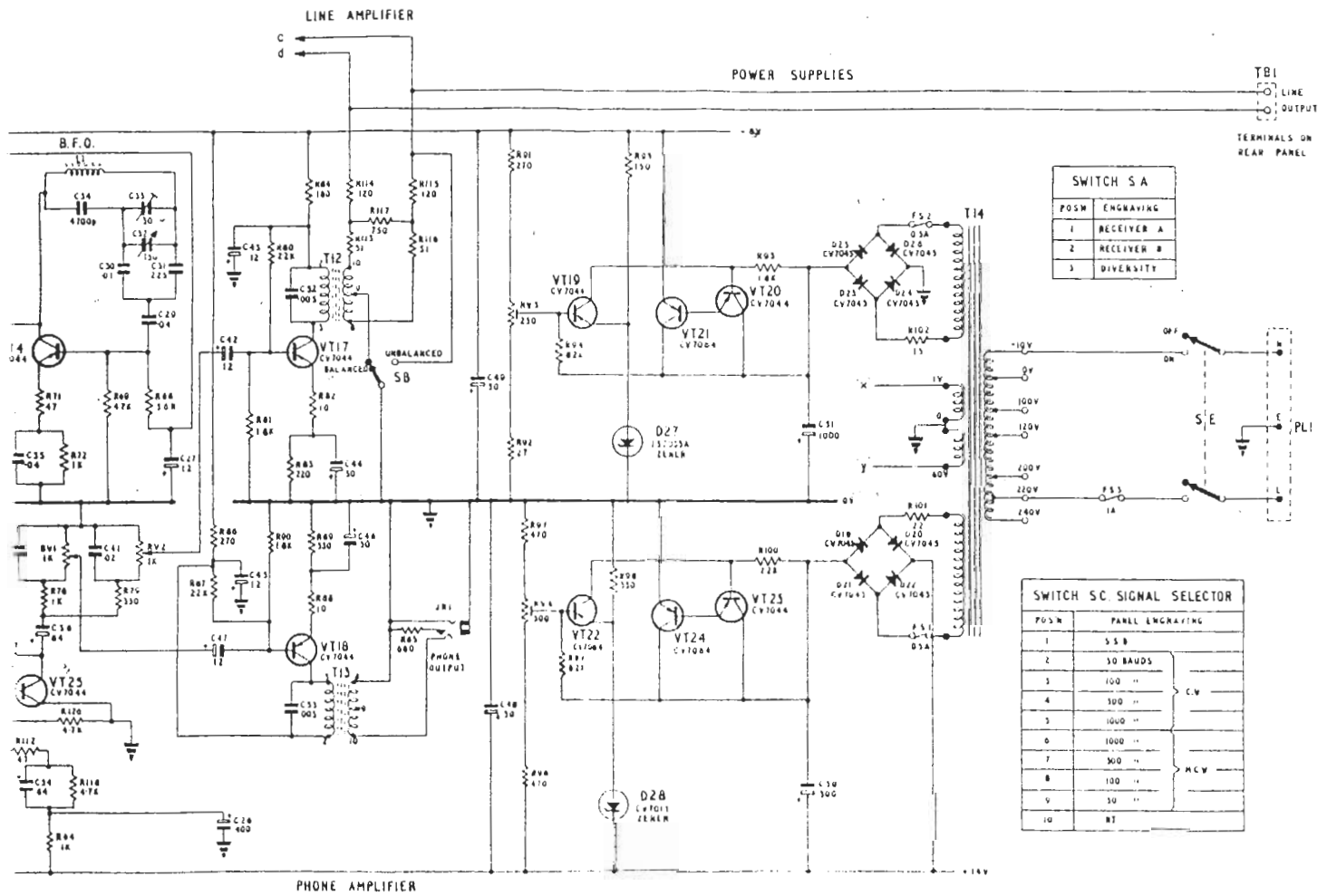


Fig.10