G.E.C. Radio Communication Equipment

G.E.C.

COMMUNICATIONS RECEIVER

BRT.400 and BRT.402

Operating Handbook

Manufacturers, Wholesale Only.

THE GENERAL ELECTRIC CO., LTD.

Head Office : Magnet House, Kingsway, LONDON, W.C.2

Telephone: TEMple Bar 8000 (90 lines). Telegrams: "Electricity, Westcent, London"
Cablegrams: "Polyphase, London."

Branches throughout Great Britain and in all the principal markets of the world

MADE IN ENGLAND BY THE GENERAL ELECTRIC CO. LTD., RADIO AND TELEVISION WORKS, COVENTRY.

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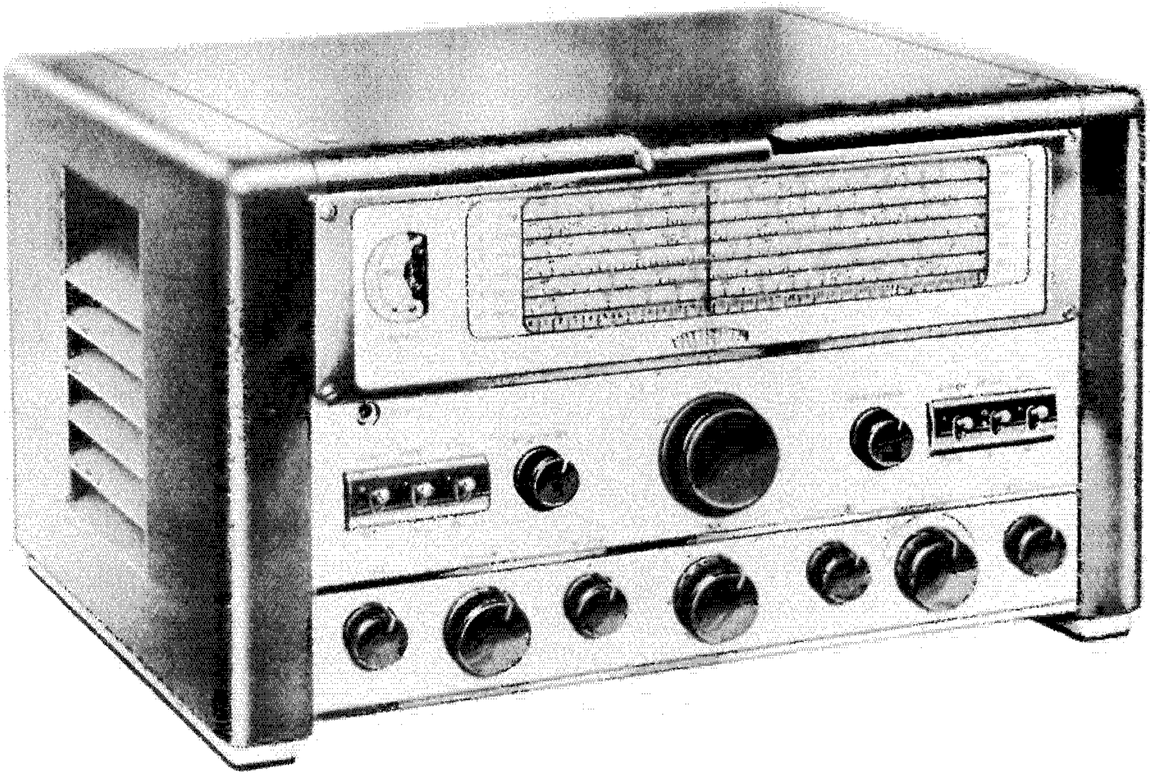

Communications Receiver BRT.400, Table Model

Communications Receiver BRT.402, *for Rack Mounting*

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1. SPECIFICATION

1.1 General

The receiver is an 11 valve superheterodyne with an integral mains-operated power supply unit using 3 valves, making a total of 14 valves in all. The normal mains supply required to operate the receiver is 40–80 c.p.s. A.C. between 95–130 V. or 195–250 V., but in the absence of A.C. mains, or for emergency purposes, the receiver may be operated by a 12-volt battery-operated power supply unit Type BRT.401. It is intended as a general-purpose Communications Receiver, which will give excellent results over a wide band of frequencies for the reception of C.W., speech and high-quality broadcast transmissions. The components, materials and finishes used in its construction have been individually selected and tested for tropical use; they conform to British Services Specifications or have been subjected to the Standard K.110 Tropical Test, so that the receiver is suitable for use in any country, and under climatic conditions which would usually be considered very severe.

The receiver is supplied either as a Table Model (BRT.400) or for mounting in a standard 19-inch rack (BRT.402).

Provision has been made so that a number of the receivers may be worked in a simple form of diversity.

1.2 Frequency Range

Total six Ranges 150–350 Kc/s., 0.55–33 Mc/s.

Range 6	..	150– 350 Kc/s.
,, 5	..	550– 1,400 ,,
,, 4	..	1,400– 3,500 ,,
,, 3	..	3,500– 9,500 ,,
,, 2	..	9,500–21,000 ,,
,, 1	..	21,000–33,000 ,,

1.3 Bandspread

Bandspread is obtained by means of a 64:1 slow-motion drive fitted with a flywheel. A logging scale and dial divided into 3,200 divisions are provided; these give an effective scale length of 41½ feet per range. On the three high frequency ranges one division of the logging dial covers an average of 3.3 Kc/s.

1.4 Calibration

The scales are printed on six edge-lit perspex strips, the range in use being illuminated. The length of each strip is approximately 10 inches.

1.5 Sensitivity

Input is less than 1mV. modulated 30% to give 1.5 watts output at all frequencies.

1.6 Signal to Noise Ratio

Input modulated 30% for 20 db signal/noise output ratio.

Ranges 1–4	..	Less than 7.0 μV.
Ranges 5 and 6	..	Less than 15.0 μV.

1.7 Image Attenuation

Greater than 30 db at 30 Mc/s. increasing to greater than 100 db below 1,400 Kc/s.

1.8 Intermediate Frequency

455 Kc/s.

1.9 Selectivity

Telephony:	Three switched bandwidths without crystal filter. Overall bandwidths for 6 db, attenuation 5.5, 7.0, 9.0 Kc/s.
Telegraphy:	Three switched bandwidths with crystal filter. Overall bandwidths for 6 db, attenuation 0.5, 1.0, 2.0 Kc/s.

1.10 **A.V.C.**

3 db change in output for a 90 db change in input. Zero level 5 μV.

1.11 **Input Impedances**

Ranges 1–4 ..	75 ohms.	Balanced or unbalanced.
Ranges 5 and 6 ..	400 ohms.	Unbalanced only.

1.12 **Output Impedances and Levels**

To line at 600 ohms ..	0.01 Watts
120-ohm Headphones ..	0.05 ,,
2.5-ohm Speaker	3.0 ,,
15-ohm Speaker	3.0 ,,

1.13 **Controls**

Main Tuning Control.
Range Change Switch.
Aerial Trimmer.
A.F. Gain.
I.F. Gain.
R.F. Gain.
Selectivity Switch.
Crystal Phasing.
B.F.O. Pitch Control.
Noise Limiter Control.
Send/Receive Switch.
Mains On/Off Switch.
A.V.C. On/Off Switch.
1,000 c.p.s. Audio Filter In/Out Switch.
Speech/Music Switch.
B.F.O. On/Off Switch.

1.14 **Valve Sequence**

V1	1st R.F. Amplifier	W.81
V2	2nd R.F. Amplifier	W.81
V3	1st Detector	X.81
V4	Local Oscillator	N.77
V5	1st I.F. Amplifier	W.81
V6	2nd I.F. Amplifier	W.81
V7	2nd Detector, I.F. A.V.C. Delay, 1st Audio Amplifier ..	DH.81
V8	Noise Limiter, R.F. A.V.C. Delay	D.63
V9	Output	KT.81
V10	A.V.C. Amplifier	Z.77
V11	Beat Frequency Oscillator	Z.77
V12	Voltage Regulator	S.130
V13	Smoothing Valve	KT.81
V14	Rectifier	U.52

Ten Lamps 6.5 V. 0.3 A.

Osram Valves are employed in British Empire Territories and Geco Valves elsewhere.

1.15 **Consumption**

135 Watts.

1.16 **Weight**

BRT.400 : 75 lbs. BRT.402 : 72 lbs.

1.17 **Dimensions**

BRT.400 : Height 10½ inches, Width 21 inches, Depth 14½ inches.
BRT.402 : Height 10½ inches, Width 21 inches, Depth 14½ inches.

2. TECHNICAL DESCRIPTION

2.1 General

The complete receiver uses 14 valves, three of which are in the power supply unit.

The amplifying chain is as follows :—

1. Two R.F. Amplifiers, V1, V2.
2. First Detector, V3, Local Oscillator V4.
3. Crystal Filter, Two 455 Kc/s. Intermediate Frequency Amplifiers, V5, V6, Second Detector, V7.
4. First Audio Amplifier, V7, Output Valve V9.

The accessory valves are :—

1. Noise Limiter, V8.
2. A.V.C. Amplifier, V10.
3. Beat Frequency Oscillator, V11.

The second diodes of V7 (Second Detector) and V8 (Noise Limiter) are for A.V.C. Delay.

The three valves in the power supply are Voltage Regulator, V12, Smoothing, V13, and Rectifier, V14.

2.2 R.F. Amplifier, First Detector, Local Oscillator

The R.F. Amplifier consists of two stages of amplification, followed by the First Detector using a separate Local Oscillator.

To keep the overall gain of the R.F. Amplifier level, mixed couplings have been used between the R.F. stages. Range 1 uses high frequency resonant primaries ; Ranges 2, 3 and 4 low frequency resonant primaries and top capacity coupling ; Ranges 5 and 6 high frequency resonant primaries and bottom capacity coupling, parallel feed also being used on these two ranges.

The purpose of the aerial trimmer TC5 is to ensure that good ganging of the first tuned circuit is obtained, with different aerial loads.

The gain of the two stages is made adjustable by the manually operated gain control R14 in the cathodes of both valves.

The 1st Detector Stage consists of a triode hexode valve with a separate Local Oscillator. A separate oscillator is used because of the better all-round performance which can be obtained, especially better stability and less pulling at higher frequencies.

The Mixer portion of this circuit is quite conventional. The Local Oscillator voltage is taken to the grid of the triode portion of the triode hexode, its anode being earthed. To improve stability and conversion gain at higher frequencies no A.V.C. or manual gain control is applied to this stage.

The Local Oscillator has a parallel fed tuned anode circuit, for stability its anode and screen voltages are derived from the S.130 Voltage Stabiliser. Both inductance and capacity temperature compensation are used to counteract thermal drift. The inductance compensation is obtained from the difference in expansion between the brass rod on which the iron cores for inductance trimming are mounted, and the material of which the former is made. The capacity compensation is by negative temperature coefficient capacitors.

2.3 I.F. Rejector

An intermediate frequency filter is incorporated in the cathode of the first R.F. Amplifier. Its purpose is to prevent a signal which might be on or near the Intermediate Frequency of the receiver breaking through the R.F. Amplifier into the I.F. Amplifier. This is only likely if the interfering signal is very strong and the receiver is tuned to the low frequency end of Range 5, or the high frequency end of Range 6.

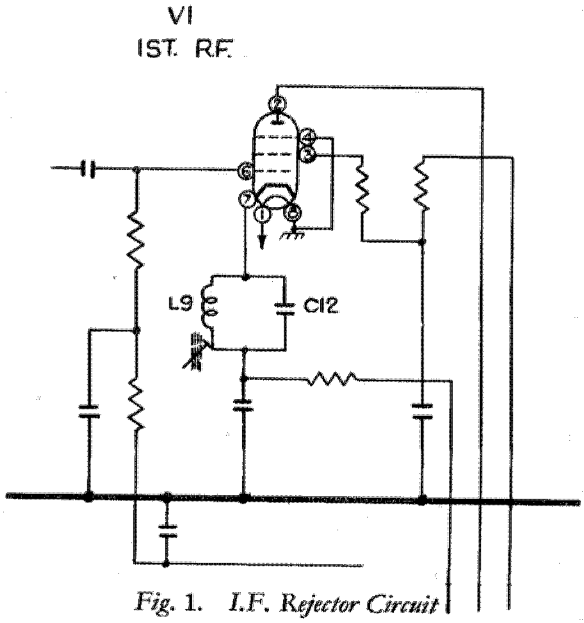


Fig. 1. I.F. Rejector Circuit

The operation of the filter is as follows : in the cathode circuit of the first R.F. Amplifier (see Fig. 1) there is an unbypassed tuned circuit consisting of L9 and C12 to the intermediate frequency. At resonance the impedance of the tuned circuit is high, thus producing a large amount of negative feedback and thereby reducing the stage gain. At frequencies removed from resonance the impedance is small, hence the negative feedback is small and the gain of the valve is normal.

2.4 Crystal Filter

By means of the crystal filter three narrow bandwidths can be selected (see Fig. 2)

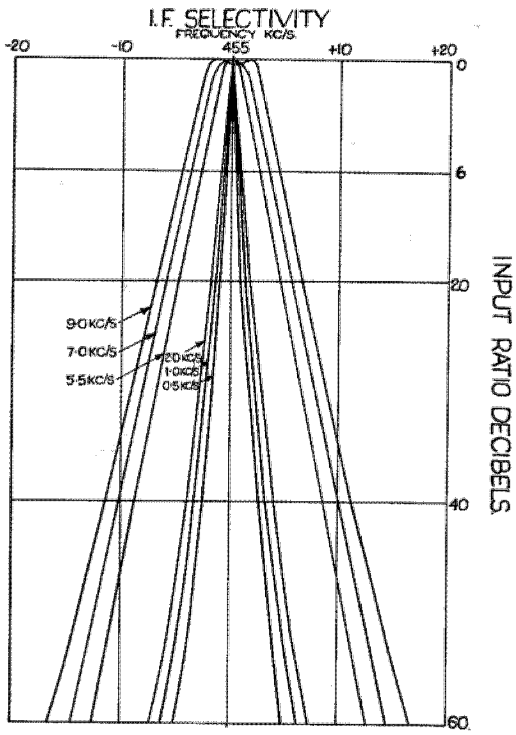


Fig. 2. Crystal Filter and I.F. Response Curves

The circuit is shown in Fig. 3. The crystal phasing condenser TC8 (a split stator balancing condenser) neutralises the electrostatic capacity of the crystal; with perfect neutralisation the crystal becomes equivalent to a series resonant circuit and the response curve is symmetrical (Fig. 4b). By varying the phasing condenser the crystal will go into parallel resonance at either a higher or lower frequency than the series resonant frequency, giving a frequency of very high attenuation (Fig. 4b and 4c). This frequency of high attenuation can be moved away from or be brought close to the frequency of maximum response, thus producing the "single signal" effect (see Figs. 4a and 4c).

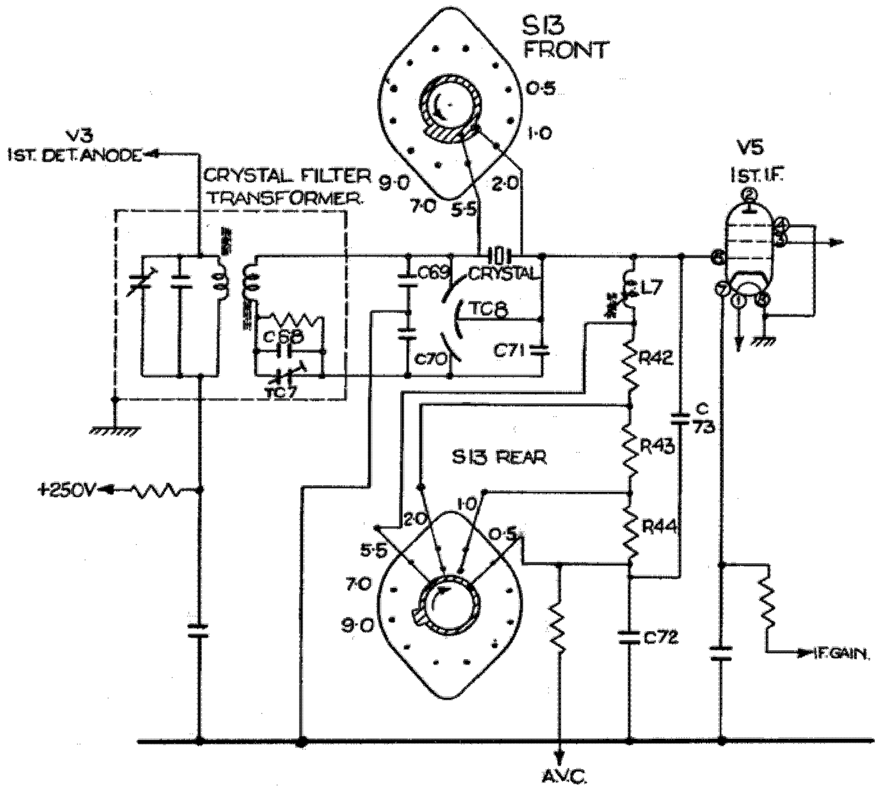


Fig. 3. Crystal Filter Circuit

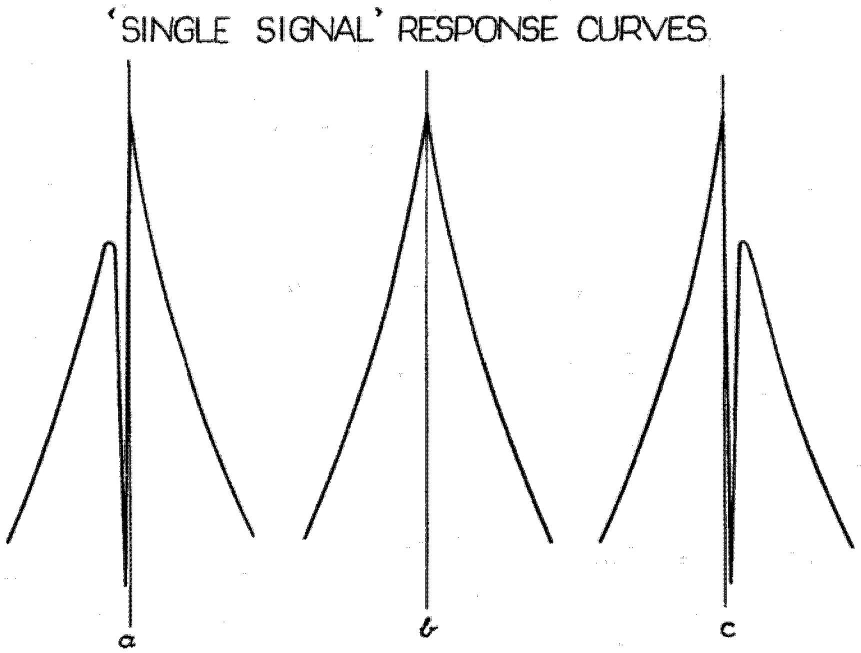


Fig. 4. "Single Signal" Response Curves

When receiving a C.W. station with an interfering signal close to its frequency the interference may be eliminated or greatly reduced by adjusting the phasing condenser so that the frequency of high attenuation coincides with the interference.

The changes in bandwidth are obtained by mismatching the terminating load into which the filter works. To obtain narrow bandwidths the filter must be supplied from a source of low impedance and this is achieved by tapping down the secondary tuned circuit of the crystal filter input transformer by means of the capacity potentiometer C68 and TC7, C70, C69. The output circuit must also be low impedance. The various bandwidths are obtained by varying the impedance of this circuit, the method chosen being to insert resistors R42, R43, R44 in series with the tuned circuit L7, C73. This method gives fairly equal gain for the various bandwidths.

The tuned circuit is returned to earth for intermediate frequency by C72. A.V.C. is applied in series with it from R41.

Capacitor C71 is used to balance the stray capacitance across the crystal due to the connections to the shorting switch.

A symmetrical response is obtained with the phasing condenser at half capacity. When the condenser vanes are in this position the pointer of the knob is vertical; rotating the knob clockwise a frequency of high attenuation is obtained at a higher frequency than the resonant frequency, and rotating it anti-clockwise the frequency of high attenuation is at a lower frequency. It must be made clear that the "single signal" effect can be produced only when the crystal filter is in circuit, that is when the selectivity switch is in any of the three narrow bandwidth positions. The crystal itself is mounted in a B7G based valve envelope and is therefore unaffected by climatic conditions.

2.5 Intermediate Frequency Amplifier

The amplifier consists of two stages of 455 Kc/s. amplification coupled by two circuit intermediate frequency transformers.

The bandwidth (see Fig. 2) of the amplifier may be changed in three steps by varying the coupling of both transformers. This is achieved by means of a small tapped tertiary winding which is part of the primary tuned circuit but is closely coupled to the secondary. The coupling is normally less than "critical" and gives the 5.5 Kc/s. bandwidth, but for the 7.0 and 9.0 Kc/s. bandwidths either a portion or the whole of the tertiary winding is switched into circuit.

In the three broader bandwidth positions the crystal and phasing condenser are switched out, and when the crystal filter is in use the intermediate frequency amplifier is automatically switched into its narrowest position.

Full A.V.C. is applied to the first amplifier, this A.V.C. having its own delay. The second amplifier receives a portion of the A.V.C. but it is undelayed and is applied to the valve even when the A.V.C. to the rest of the receiver is switched off. This is necessary for the correct operation of the signal strength meter (see 2.6).

A portion of the cathode resistor of the second amplifier is unbypassed, this applies negative feedback, reducing the detuning which might occur when a strong signal is being received. The cathode potential of the first amplifier may be varied by the manually operated potentiometer R46 to provide the I.F. Gain Control.

2.6 Signal Strength Meter

The Signal Strength Meter is controlled indirectly by the A.V.C. applied to the second intermediate amplifier. The variation of the A.V.C. voltage on the grid of this valve will cause the cathode current to change. This change in current actuates the meter.

The meter is in a bridge circuit (Fig. 5) formed by R55, R54, R53, and the valve to H.T.+ and R84, R83, R82. With no signal input to V6, no A.V.C. voltage is developed, the cathode current is maximum and the meter is adjusted to zero by R84 (*i.e.*, the bridge is balanced); any change in current through the cathode resistors will unbalance the bridge and cause a current to flow through the meter. R74 is across the meter to provide a full scale adjustment which is independent of the set zero control R84.

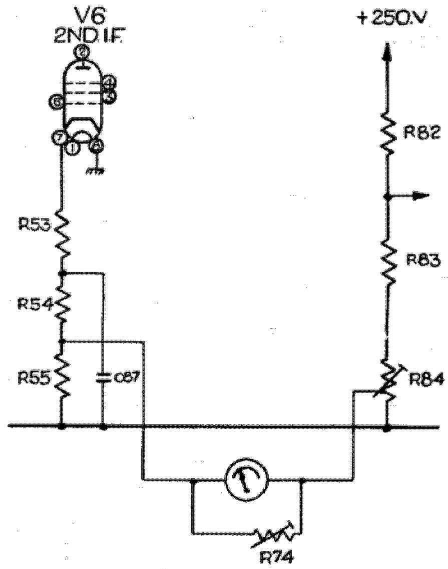


Fig. 5. Signal Strength Meter Circuit

The purpose of applying undelayed A.V.C. which is also independent of the A.V.C. On/Off Switch (see 2.5) is to operate the signal strength meter satisfactorily at low inputs and with A.V.C. off.

2.7 Second Detector

This consists of one diode of the double diode triode valve, the common cathode being earthed.

It differs from the more usual diode detector in one respect, a small positive voltage is applied to the anode of the diode from R73, its purpose being to move the operating point of the diode anode volts/anode current curve to a more favourable point, enabling signals with a higher percentage modulation to be handled with less distortion.

2.8 A.V.C.

The A.V.C. (Fig. 6) is amplified with two levels of delay. Detection and amplification are obtained by means of an anode bend detector V10 (see Fig. 7).

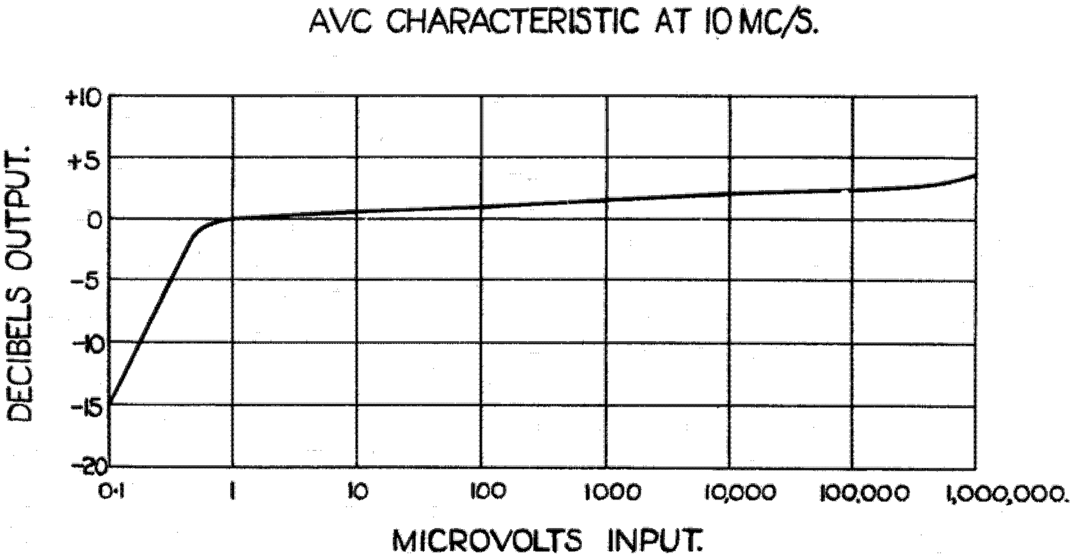


Fig. 6. A.V.C. Characteristic Curve

Its anode load R56, R57, is connected to ground and its cathode is at a potential which is negative with respect to ground; hence a voltage of suitable polarity for A.V.C. is developed across its anode load. The grid of the valve is supplied from the anode of the second I.F. Amplifier through C83. The valve is biassed to cut off by means of the potentiometer R62, R63, R65 and the cathode resistor R64. R58 and C86 are decoupling components.

Two levels of delay are provided, one for the I.F. and one for the R.F. Amplifiers. The R.F. delay must be greater than the I.F. to ensure that the full gain of the R.F. valves is obtained on weak signals.

The principle of operation of the delaying diodes is as follows: If a positive potential is applied to the anode of a diode, the cathode being at ground potential, the diode will conduct and provide a low resistance path from the anode to ground, hence, if a diode with a fixed positive potential on its anode is connected across the A.V.C. line, the A.V.C. voltage will be shorted until the negative A.V.C. potential exceeds the fixed positive potential and the anode of the diode becomes negative, ceases to conduct, and the valve then presents a high impedance path.

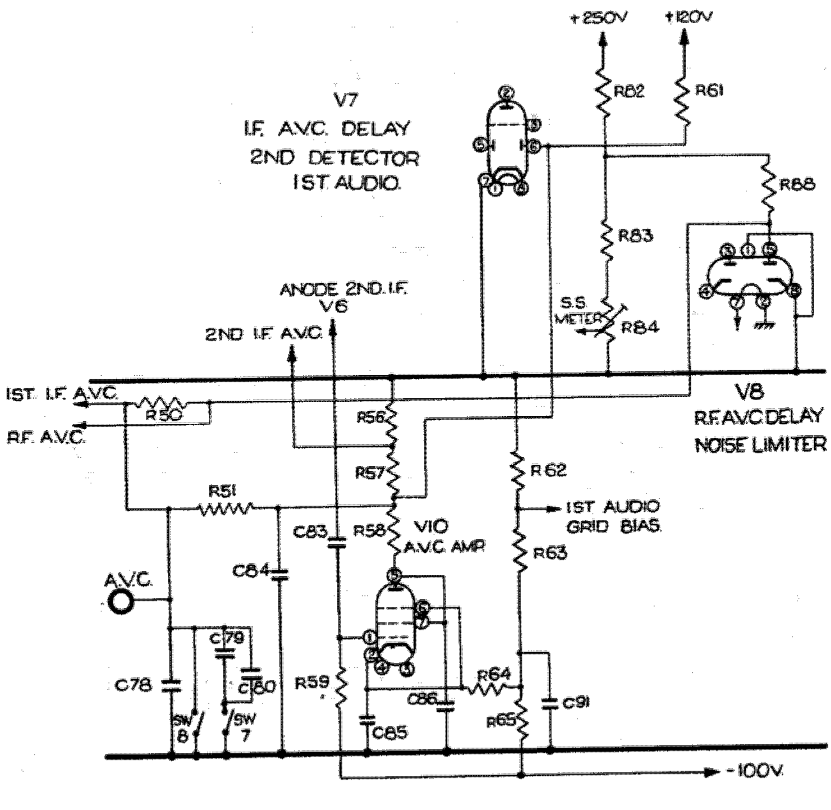


Fig. 7. A.V.C. Circuit

The A.V.C. is taken from the junction of R57, R58. The I.F. delay diode V7 has its anode connected to this point; its cathode being at ground potential, the delaying positive voltage is derived from R61. The A.V.C. is first applied to V5 the first I.F. Amplifier. R50 separates the I.F. and R.F. delays, the R.F. A.V.C. is taken from the opposite end of this resistor, the R.F. delay diode V8 is also across this point, the delaying voltage being applied to its anode through R88.

The system will operate as follows: If a gradually increasing signal is applied to the grid of V10 through C83 the voltage at the junction of R57, R58 will tend to increase but owing to the delay, diode V7 will be shorted and no A.V.C. will be applied to the receiver. As the signal is further increased the delay voltage will be overcome and A.V.C. will be applied to the I.F. Amplifier. The R.F. delay is greater than the I.F. delay, so, as yet, no A.V.C. is applied to the R.F. Amplifiers. A further increase in input will be required before this delay is overcome. The A.V.C. to all controlled stages except the 2nd I.F. Amplifier may be removed by the A.V.C. On/Off Switch (SW.8) which short circuits the A.V.C. to ground.

A.V.C. may be used with the B.F.O. on since the B.F.O. On/Off Switch (SW.6, SW.7) does not remove the A.V.C. The use of A.V.C. with the B.F.O. being left to the discretion of the user, but this switch does automatically lengthen the time constant of the A.V.C. by putting C79 and C80 between the main A.V.C. line and ground; this is done to prevent excessive rise in background noise between the characters of a C.W. transmission. A.V.C. for diversity operation is obtained from the main A.V.C. line.

2.9 B.F.O.

This is a standard cathode tapped Hartley oscillator. For stability its anode and screen are supplied from the stabilised supply and the tuned circuit has a fairly low L/C ratio.

The B.F.O. voltage is taken from the anode of the valve, and is injected directly on the anode of the signal diode.

Very careful screening of the B.F.O. circuit has been provided so that the spurious responses when it is in use are negligible.

2.10 Noise Limiter

This is a device for reducing the effects of external interference of the ignition type.

The audio voltage developed across the diode load (Fig. 8) is passed through a diode. If a positive potential is applied to the anode of this diode of such a value that the diode will just pass the peak audio voltage applied, any noise impulse superimposed on the waveform will be clipped. This controlling voltage is obtained from the slider of R70, a point less negative than the junction of R68 and R69, the source of the audio voltage.

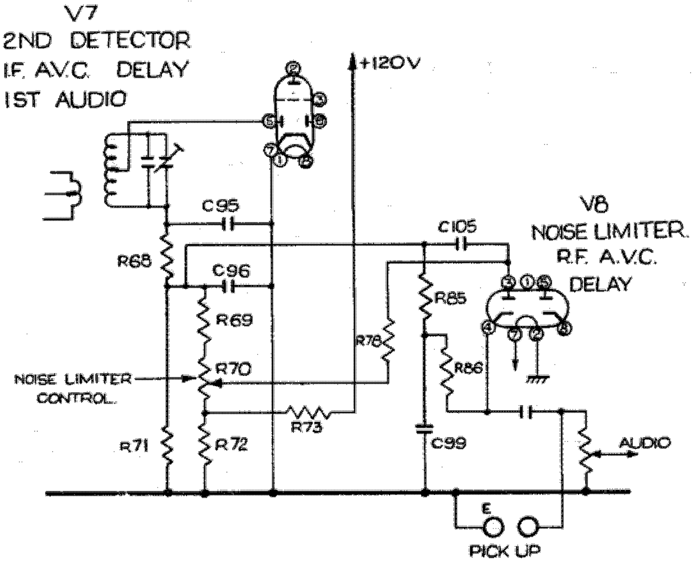


Fig. 8. Noise Limiter Circuit

The audio voltage is applied to the anode of the diode, through C105; from the same point a potential is applied to the cathode through the delay network R85, C99 (modulation frequencies will not affect this potential, but the delay is not sufficiently long to affect the slower changes due to fading). Due to the voltage from R70 the anode is always positive in relation to the cathode and the diode will always conduct. With the slider at the R69 end the noise limiter will accept a signal modulated about 25%, when it is at the R72 end it will easily accept a signal modulated 100%. The delay network holds the cathode at a fixed potential during the time interval of the noise pulse, but the anode becomes more negative and clipping occurs.

It may be found in practice that the limiter control does not appear to reduce the noise as much as might be expected. There is no Limiter On/Off switch to remove the limiter completely but provided the limiter control is turned to minimum a signal modulated 100% may be handled without distortion, but noise peaks are still being greatly reduced; it was felt that to have a degree of limiting in circuit continually was advantageous. The amount of limitation which is being obtained can be checked by short circuiting the limiter anode and cathode.

2.11 Audio Amplifier

The amplifier is in two stages. The voltage amplifier is the triode portion of the double diode triode, and the power output stage is a tetrode. To simplify the detector and I.F. delay circuits, the cathode of the double diode triode is earthed and negative bias for the triode grid is obtained from the potentiometer R62, R63 and R65 across the negative supply line.

The triode is resistance capacity coupled to the tetrode. The capacity coupling can be reduced by the Speech/Music Switch (SW.5). In the Speech position SW.5 is open, putting C104, .005 μF, in series with C103 the normal coupling capacitor and gives a cut in bass response of about 6 db at 300 c.p.s. (see Figs. 9 and 10).

The output valve is conventional except for the negative feedback circuits. When receiving speech or music R95 and C110 are in circuit providing negative voltage feedback.

The 1,000 c.p.s. filter circuit is also a negative voltage feedback circuit. When the 1,000 c.p.s. filter coil and C109 are in resonance the impedance will be high, the feedback small and the gain of the valve normal. Off resonance the impedance falls, the feedback increases and the gain of the valve falls, hence a very sharply tuned response can be obtained (Fig. 11).

The output transformer caters for 2.5 ohms and 15 ohms speakers, 600 ohms line for connection to telephone lines and 120 ohms phones.

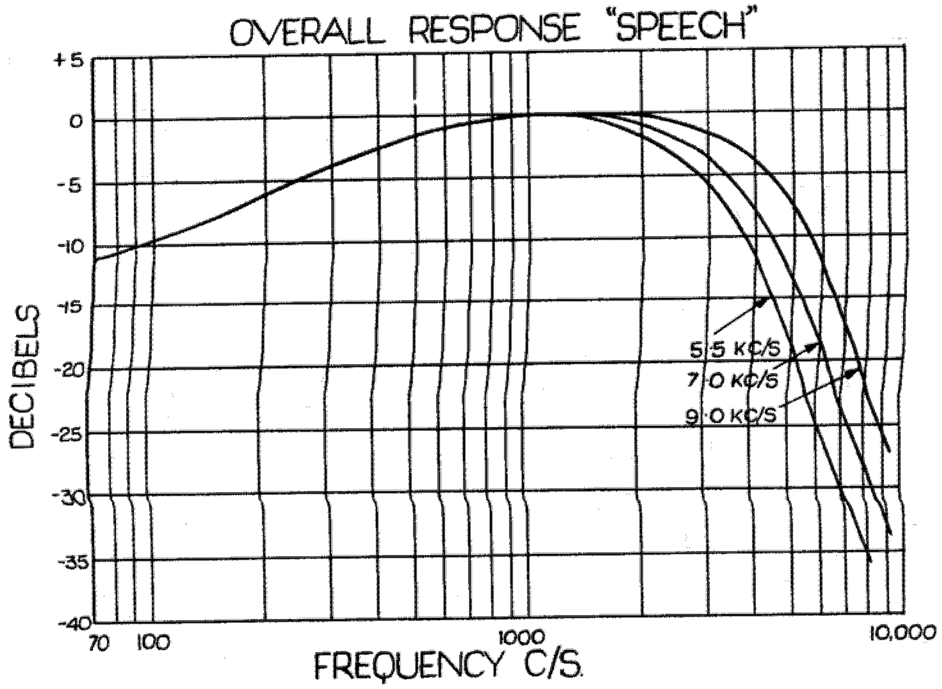


Fig. 9. Overall Response "Speech"

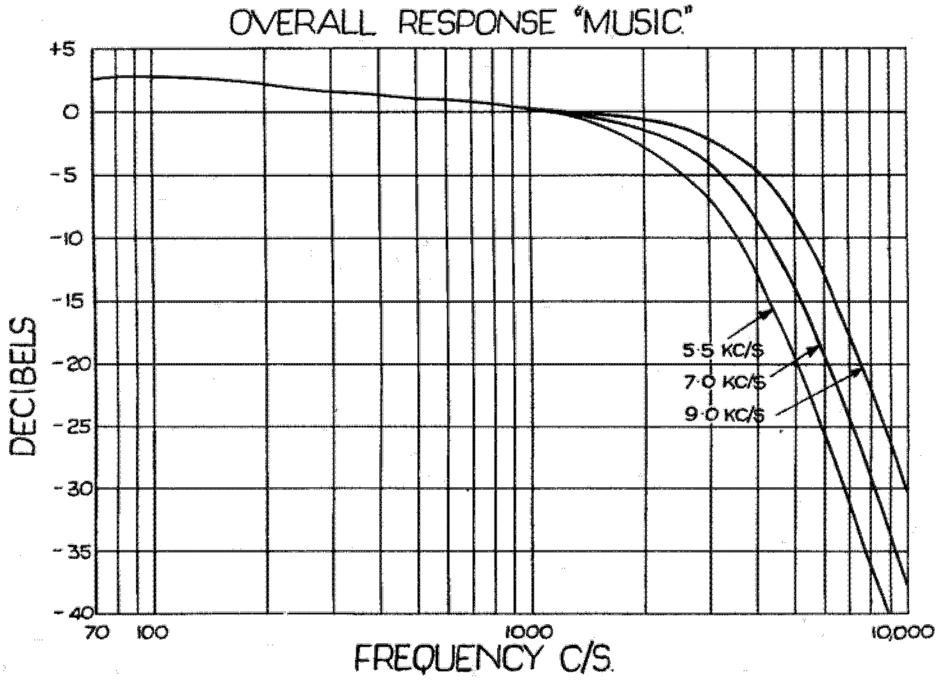


Fig. 10. Overall Response " Music "

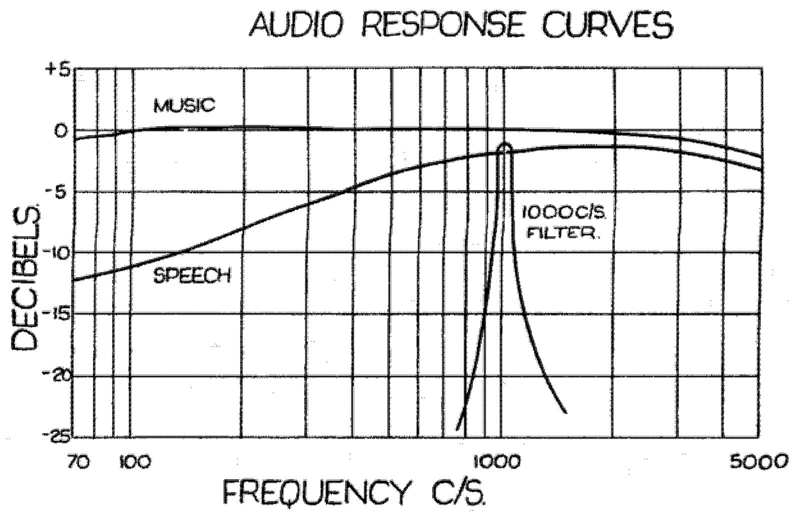


Fig. 11. Audio Response Curves

When using a 2.5 or 15 ohms speaker the load is correctly matched to the valve; when the phones are plugged in the speaker is disconnected and replaced by a resistor R97 to maintain correct matching. The 600 ohms output is provided for re-broadcast over telephone lines. The output transformer and associated wiring have been designed to conform to Standard British Post Office Specifications. As the input to a telephone line is limited by regulations, the output must be limited, this is achieved by putting resistors R95, R96 in series with a low impedance secondary winding. This in itself is insufficient to load the valve, but when a receiver is used for this service it is invariably continuously monitored, therefore either a speaker or phones should always be in circuit.

2.12 Power Supply

To avoid the use of electrolytic condensers and yet obtain very low hum values in a reasonable space, valve smoothing is used.

The smoothing valve, V13, is effectively a phase changing device. A portion of the ripple voltage is applied to the grid of the valve through C112, its phase is changed by 180° and it is fed back into the main H.T. line, the amount fed back being controlled by varying the gain of the valve by the variable cathode resistor R104. A neon voltage regulator V12 is used for stabilising the oscillator H.T. voltage, and a selenium rectifier and resistance capacity filter network for providing the negative voltage for the A.V.C. Amplifier and the first audio amplifier grid bias.

Arrangements have been made for the receiver to be supplied from an alternative power supply unit. This alternative power supply unit Type BRT.401 is operated from a 12 V. accumulator. This accumulator also provides the heater supply for the valves.

When the socket at the rear of the receiver marked " Alternative Supply " is removed, the A.C. heater, —100 V. and +250 V. supplies are disconnected. The smoothing valve V13 is not required with the alternative supply so it is automatically removed from circuit, its heater is disconnected when the socket is removed, and its anode load R100 is short circuited by the alternative power supply socket.

2.13 Diversity

The principle of diversity operation is that if two or more aerials are spaced a distance of several wave-lengths apart, during fading the possibility of a signal being at a minimum on all aerials at the same time is remote. If the A.V.C. lines and outputs of the receivers connected to these aerials are commoned, the receiver which is receiving the largest signal develops the greater A.V.C. voltage and automatically reduces the gain of the others ; thus a good signal is always available from at least one receiver and the others are unable to contribute noise during troughs of fading since their gain is reduced by the A.V.C. action of the receiver receiving the strong signal.

3. INSTALLATION

3.1 Valves and Crystal

The receiver is despatched with valves and 455 Kc/s. crystal in position and held by cardboard valve retainers. When the receiver has been taken from its crate and all packing removed, it should be ascertained that each valve is in the correct holder and care should be taken to ensure that the valves are pushed fully home in their sockets and that the earthing clips on the R.F. and I.F. valves (V1, V2, V3, V5 and V6) are making good contact with the valve containers. The three B7G valves (V4, V10, V11) and the crystal have spring can retainers and these should be removed, the valves and crystal pushed fully home, and the retainers replaced.

3.2 Mains Supply

The receiver is suitable for operation on 40–80 c.p.s. A.C. Mains between 95–130 V. or 195–250 V., or from the 12 V. Battery Power Supply Unit Type BRT.401. It is despatched with the mains voltage tap adjusted for 250 V.

If the receiver is to be mains operated, check the voltage of the mains and, if necessary, adjust the mains taps on top of the mains transformer (see Fig. 12).

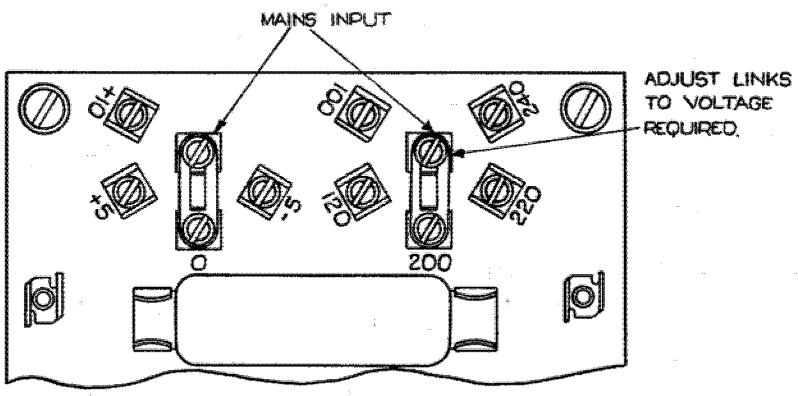


Fig. 12. Mains Transformer Taps

It will be noted that the taps are brought out for two stages of adjustment, one a coarse adjustment and the other in steps of five volts. The adjustment is carried out by loosening the screws at either end of the links, setting them to the correct combination and tightening the screws.

A two-pin socket and a mains cord is provided with the receiver for connecting to the mains supply (see Fig. 22).

It is recommended that the receiver is not switched on until Chapter 4 of this Handbook, explaining the function of the various controls, has been read.

3.3 Battery-operated Power Supply

Where the receiver is to be operated from the 12-volt battery supply, remove the 12-way socket marked " Auxiliary Power Supply " from the rear of the receiver and replace it by the socket attached to the cable from the battery power supply (see Fig. 22).

Connect the battery power supply to a suitable battery and charging unit.

3.4 Aerial

Although good results will be obtained with aerials of the simplest types, the input circuits have been specifically designed for a long wire aerial on the two low frequency ranges and a horizontal half-wave dipole on the four high frequency ranges.

When using an inverted " L " or any single-ended type of aerial, it should be connected to terminal A1 at the rear of the set (see Fig. 22) and the earth link provided connected between A2 and E.

If a balanced aerial such as a dipole is used, the two downleads should be connected to A1 and A2, leaving the earth link off. Where the downleads are screened the screen should be connected to the terminal marked " E."

For those who wish to make up their own dipole aerial, a graph showing the length of each half of the aerial against optimum frequency is given in Fig. 13.

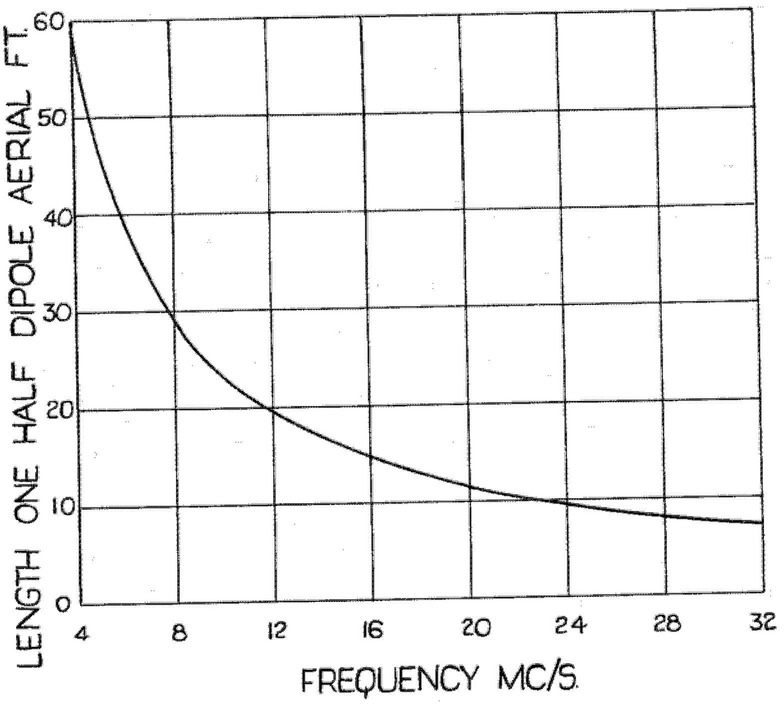


Fig. 13. Length Dipole/Frequency

This type of aerial is directional and will give best results when the aerial is at right-angles to the direction of the required station. The down lead is important in that it should match the aerial and should have low losses at radio frequency in all weather conditions. Suitable twin and single screened cables are Pirelli-General Types PG228 and PG232.

3.5 Earth

The earth terminal of the receiver (see Fig. 22) should be connected to ground by a low resistance path. Satisfactory earths are a water pipe or a sheet of copper buried at least 3 feet in the ground and kept damp.

3.6 Loudspeaker, Headphones and 600 ohms Line

So that full advantage may be taken of the balanced fidelity given in the 9 Kc/s. bandwidth position, a high-quality large diameter speaker is recommended. When the receiver is to be used for the reception of speech or C.W. only, a 6-inch or 8-inch speaker is adequate. Connections for the loudspeaker are shown in Fig. 22. There are only two terminals at the rear of the receiver but two output impedances are available on the output transformer.

When despatched from the factory, the receiver has the output transformer tap on 2.5 ohms and to change this to 15 ohms the brown screened lead from the second terminal from the left-hand side of the front terminal strip on the output transformer should be removed and connected to the vacant terminal which is the fourth from the left-hand side (see Fig. 20).

The connection for headphones is by means of a plug which is supplied with the receiver ; this is plugged into the phone jack on the front panel (see Fig. 18).

The phones should have an impedance of approximately 120 ohms.

A 600 ohms output is also provided for connection to land lines, the terminals giving this output being shown in Fig. 22.

3.7 Transmitter Remote Control

When a transmitter is to be operated in conjunction with the receiver, arrangements may be made to operate the transmitter remotely by means of the receiver Send/Receive Switch. When this switch is in the " Send " position the two terminals at the rear of the receiver marked " Relay " (see Fig. 22) are closed while, in the " Receive " position, they are open, thus, if they are connected to a suitable relay system, remote control may be obtained.

It must be made clear that the receiver switching will handle only low current and voltage and no attempt should be made to break the H.T. supply to a transmitter by this switch ; the maximum current and voltage should not exceed 1 amp. and 250 volts.

3.8 Gramophone Pick-up

The input to the Pick-up Terminals (see Fig. 22) required to give full output is approximately 300 mV. and any type of pick-up capable of giving this output may be used. Where it is desired to use a pick-up giving considerably less than this output a pre-amplifier will be required and care must be taken when connecting any apparatus to the Pick-up Terminals to ensure adequate screening of the connecting leads.

3.9 Diversity Operation

It is presumed that if the receivers are to be used in diversity, a batch of receivers will be supplied for that specific purpose. When installed, the A.V.C. Earth and Output connections of each receiver must be connected to the identical terminals on the other receivers (Fig. 22).

3.10 Fuses

There are three fuses. The cartridge type 500 mA. fuse is found on top of the mains transformer [there is a spare on top of the gang condenser cover (Fig. 20)], and two mains fuses are at the rear of the receiver below the mains input plug (Fig. 22). The latter are 2 A. and may be repaired with 2 A. fuse wire or 42 s.w.g. copper wire.

4. OPERATION

4.1 Frequency Calibration, Logging Scales

The calibration of the ranges is printed on the edge-illuminated perspex strips (Fig. 18). It is intended that the calibration be only an indication of frequency, although the accuracy is within 1.0% ; but owing to the short length of the scale no claim is made that a particular frequency could be selected by the use of the calibrated scales alone, except perhaps at the lowest frequencies. Their purpose is to enable the user to find the approximate frequency to which the receiver is tuned without reference to graphs. For accurate logging of a particular frequency, the rotating logging dial (Fig. 18) should be used in conjunction with the logging scale. This scale is the lowest of the seven scales and is permanently edge-lit.

4.2 Tuning Control

This rotates the main tuning condenser via the reduction gearbox. Owing to the high sensitivity of the receiver it is possible, on Range 1, to receive a station on the image frequency if the signal is sufficiently strong. This can be avoided by tuning from the high frequency end, as the correct setting is always the higher of the two possible tuning points.

4.3 Aerial Trimmer

To obtain good ganging of the radio frequency stages, the capacitance trimming of the aerial coils is brought out to a variable control on the front panel. This control allows the difference in loading on the first tuned circuit of different aerials to be accurately compensated. The trimmer is designed to be at half capacitance (*i.e.*, with the pointer of the knob in a vertical position) for normal aerial load.

The adjustment of this trimmer may be carried out in two ways. If a steady signal is being received, adjust for maximum deflection of the signal strength meter ; if the signal is weak and fluctuating, detune from the station and adjust for maximum background noise. Once this adjustment has been made on one range it will not vary greatly on the other ranges provided the aerial is not changed, but its accurate adjustment is important, especially when receiving weak signals on the higher frequency ranges, and its setting should always be checked.

4.4 Range Switch

This switch selects the various ranges and also switches the edge illumination of the calibrated scales.

4.5 B.F.O. On/Off Switch

The B.F.O. is used to produce an audible note in the speaker or phones when receiving C.W. It is usual for this switch to switch off the A.V.C. also, but as A.V.C. may be used when receiving C.W. with the B.F.O. on, this has not been done. If A.V.C. is used there is a tendency with normal A.V.C. time constants for the noise level to rise between characters ; it has therefore been arranged that when the B.F.O. is switched on the A.V.C. time constant is increased.

4.6 B.F.O. Pitch

This control varies the pitch of the audible note heard when receiving C.W. with the B.F.O. on. It should be set to that side of zero beat which gives the most suitable heterodyne (see al o 4.8).

4.7 A.V.C. On/Off Switch

When receiving speech or music, A.V.C. should always be " On." In certain cases when receiving C.W. better results may be obtained with A.V.C. off, but as stated in 4.5 the B.F.O. On/Off Switch does not automatically switch off the A.V.C. and the use of A.V.C. is left to the choice of the operator.

4.8 Audio Filter In/Out Switch

To reduce noise when receiving C.W. a sharply tuned 1,000 c.p.s. audio filter may be switched into circuit. With the filter in circuit and the B.F.O. tuned to 1,000 c.p.s. a great reduction in background noise is obtained. Use may also be made of this to reduce the effects of unwanted signals and if two heterodynes are obtained it is usually possible to adjust the B.F.O. Pitch Control so that the frequency of the wanted signal is 1,000 c.p.s. and the frequency of the unwanted signal is considerably different, and by switching in the Audio Filter the unwanted signal will either be eliminated or greatly reduced

4.9 Selectivity Switch

This switch controls the bandwidth of the crystal filter and the I.F. Amplifier which varies the selectivity of the receiver and, with narrow bandwidths, reduces the higher audio frequency response.

The three narrow bandwidths are obtained by means of a crystal filter and the three broader bandwidths by varying the coupling of the Intermediate Frequency Transformers. In general, the three narrow bandwidths are used for C.W. and the three broader bandwidths for speech and music, although when receiving speech under adverse conditions the 2 Kc/s. bandwidth position may be used advantageously in conjunction with the Speech/Music Switch (see 4.11).

For speech it is advisable to have the selectivity switch in the 5.5 Kc/s. position. If the quality of the transmission is good and conditions favourable to wider bandwidths they can be used with advantage. When receiving music the 9.0 Kc/s. bandwidth should be used wherever possible.

4.10 Crystal Phasing Condenser

The Crystal Phasing Condenser is effective only when the selectivity switch is in any of the three crystal filter positions. Its purpose is to alter the shape of the selectivity curve in such a way that a frequency of very high attenuation may be obtained and brought close to the resonant frequency.

When the pointer of the control is in a vertical position a symmetrical response is obtained, but by turning the control to the right or left, signals of a higher or lower frequncy than that of the wanted signal may be rejected (see also 2.4).

4.11 Speech/Music Switch

When receiving speech in adverse conditions, using the narrower bandwidths, a better intelligibility may often be obtained by having this switch in the " Speech " position, which attenuates the bass. This is particularly advantageous if the crystal filter is being used for the reception of speech (see 4.7). For the reception of music it should generally be in the " Music " position.

4.12 Noise Limiter

Under certain receiving conditions a " peaky " type of interference may be encountered, either climatic or caused by other electrical apparatus in the neighbourhood. The judicious use of the Noise Limiter will assist in making weaker signals more intelligible when these conditions are present; it will not remove the interference entirely but will materially reduce it.

The Noise Limiter is to a certain extent automatic in operation, in that once it has been set to limit at a given modulation depth, it will follow fluctuations in signal strength. Maximum limiting is obtained with the control fully clockwise and care must be used in its operation, in that a very steep rise in audio distortion occurs as limitating is increased.

In general, the control should be set fully anti-clockwise and used sparingly when absolutely essential. No switch is provided to switch the Noise Limiter out of circuit, it having been found that the suppression of noise peaks exceeding 100% modulation is always advantageous.

4.13 R.F., I.F. and A.F. Gain Controls

These carry out their stated functions. Generally, the R.F. and I.F. Controls should be turned to maximum (*i.e.*, fully clockwise) except when receiving a very strong signal (greater than 100 db on the signal strength meter), or a weak signal adjacent to a strong signal, when the R.F. Gain should be reduced.

Under certain conditions when receiving C.W. it is considered by some to be advantageous to be able to reduce the I.F. Gain.

4.14 Speaker, Phones, 600 ohms Line

There is a choice of output between speaker and phones. It has been assumed that it will never be required to use both the speaker and phones at the same time and arrangements have been made to switch the speaker out of circuit automatically by the action of plugging in the phones.

The 600 ohms line has the specialised application of connecting the output of the receiver directly to telephone land lines. For this purpose it has been assumed that the output will be continuously monitored and when using the 600 ohms output either phones or a speaker must be permanently in circuit to load the output valve correctly.

4.15 Mains On/Off and Send/Receive Switches

The Mains On/Off Switch applies the A.C. Mains Supply to the receiver; it will be inoperative if the battery-operated alternative supply is being used.

The Send/Receive Switch mutes the receiver but leaves the heater supply on. If it is desired to switch the receiver off for a period but to have it ready for instantaneous use when required, the Send/Receive Switch should be set to " Send " leaving the Mains On/Off Switch in the " On " position.

The Send/Receive Switch also makes a circuit between the two terminals marked " Relay " at the rear of the receiver in the " Send " position, breaking the circuit in the " Receive " position, so that a transmitter may be switched on and off automatically by the receiver (see 3.6).

4.16 Signal Strength Meter

This meter gives an indication of the strength of the signal at the aerial terminals. It is calibrated roughly in db above 1 μV. input with both R.F. and I.F. Gain Controls at maximum.

It may also be used as a tuning indicator, in that when the signal is accurately tuned in, the meter will register maximum deflection. The meter will operate with A.V.C. either on or off but the calibration will not hold with the A.V.C. off.

No claim is made for the accuracy of this meter as it will vary with different aerials and on different bands due to variations of the R.F. stage gains.

5. PERFORMANCE

To enable the user to check from time to time that the receiver is performing satisfactorily, extracts from the specification to which all receivers are tested at the factory are given in this chapter.

5.1 Audio Amplifier

5.1.1 *Conditions of Test*

Input is from an Audio Beat Frequency Oscillator at 1,000 c.p.s., unless otherwise stated, via a Microvolter (output impedance 400 ohms) to the pick-up terminals. The output is measured across resistive loads from the following :—

(*a*) 2.5 ohms tap on the output transformer from the speaker terminals.
(*b*) 600 ohms line across 600 ohms.
(*c*) Phone jack across 120 ohms.

The first I.F. valve to be removed from the receiver. Volume control to be at maximum, output level 50 mW. across 2.5 ohms speaker terminals unless otherwise specified.

5.1.2 *Sensitivity*

(*a*) Speech/Music Switch in Music Position 32–52 mV.
(*b*) Speech/Music Switch in Speech Position, output to be not more than 2 db less than (*a*).
(*c*) Speech/Music Switch in Music Position, Audio Filter in. Output should not be more than 3 db less than (*a*). Note that the Audio B.F.O. should be tuned to the resonant frequency of the filter which should be 1,000 c.p.s. ± 100 c.p.s.
(*d*) Speech/Music Switch in Music Position, output from phone jack. Output level 5 mW. 75–110 mV. input.
(*e*) Speech/Music Switch in Music Position. Phone jack plugged in. Output from 600 ohms line, output level 5 mW., input 160–220 mV.

5.1.3 *Hum Level*

The output with any setting of the audio volume control, no input, should not exceed .002 V.

5.1.4 *Response*

The output at 70 c.p.s. and 5,000 c.p.s. reference level 1,000 c.p.s. to be within the following limits (Constant Input Method) :—

(*a*) Speech/Music Switch in Music Position 70 c.p.s. —2 db ±2 db. 5,000 c.p.s. —2 db ±1 db.
(*b*) Speech/Music Switch in Speech Position 70 c.p.s. —11.5 db ±2 db. 5,000 c.p.s. —1 db ±1 db.
(*c*) Speech/Music Switch in Speech Position, Filter in. At both resonant frequency +100 c.p.s. and resonant frequency —100 c.p.s. the output should be between —10 db and —15 db with reference to the output at the resonant frequency.

5.1.5 *Distortion*

With an output level of 2 W. the distortion to be less than 5%.

5.2 I.F. Amplifier

5.2.1

C47 to be disconnected from the Range Switch. For alignment, bandwidth and symmetry tests the low impedance terminals of the signal generator to be connected to this capacitor through a small capacitance less than 0.5 pF. For sensitivity measurements the signal generator to be connected directly to this capacitor, the A.V.C. being switched off and the Local Oscillator valve removed from the receiver.

5.2.2 *Bandwidths, Assymmetry (I.F. Amplifier)*

Measure the 5.5 Kc/s. bandwidth, re-check that the signal generator is at resonance, switch to 7.0 Kc/s. bandwidth, measure the bandwidth without readjustment of the signal generator. Switch to 5.5 Kc/s. bandwidth, re-check the signal generator setting, measure the 9.0 Kc/s. bandwidth.

The widths of the response curves should not differ by more than 10% from those shown in the table below. The assymmetry should not exceed 10%.

Overall bandwidth	5.5 Kc/s.	7.0 Kc/s.	9.0 Kc/s.
Input Ratio 6 db	5.5	7.0	9.0
Input Ratio 40 db	18.0	21.0	23.5

5.2.3 *Bandwidth (Crystal Filter)*

Feed in the signal generator directly to C47, switch off the modulation, switch the selectivity switch to 2.0 Kc/s. bandwidth, feed in sufficient signal to give an indication on the signal strength meter (500 μV. approximately), measure the bandwidth using this meter as an indicator, repeat for 1.0 Kc/s. and 0.5 Kc/s. bandwidths. Bandwidths should not differ by more than 20% from those shown in the table below.

Overall bandwidth	0.5 Kc/s.	1.0 Kc/s.	2.0 Kc/s.
Input Ratio 6 db	0.5	1.0	2.0
Input Ratio 40 db	5.5	6.5	8.0

5.2.4 *Sensitivity*

Connect the signal generator directly to C47, feed in a signal sufficient to give 50 mW. output, reduce the output by 20 db by means of the A.F. Gain Control, increase the input to give 50 mW.; this input should be less than 70 μV.

5.3 **R.F. Amplifier**

5.3.1 *Conditions of Test*

The tests should be carried out in a screened room, if this is impossible allowance to be made for interference. The dummy aerial to be 75 ohms resistive on Ranges 1–4 and 400 ohms resistive on Ranges 5 and 6. Modulation depth 30%, frequency 400 c.p.s.

5.3.2 *Signal/Noise Ratio*

The ratio of output for a modulated carrier to the output with an unmodulated carrier for an input of 7 μV. on Ranges 1–4 to be greater than 20 db. On Ranges 5 and 6 the ratio to be greater than 20 db for an input of 15 μV.

5.3.3 *Sensitivity*

With an input of 1 μV. the output to be greater than 1.5 watts.

5.3.4 *A.V.C.*

When the input is increased 90 db relative to 5 μV., the audio output should not increase by more than 3 db.

5.3.5 *Image Attenuation*

This should be greater than the figures given in the table below.

Range	Frequency	Attenuation db
1	21 Mc/s.	40
2	9.6 Mc/s.	60
3	4.7 Mc/s.	100
4	1.46 Mc/s.	100
5	590 Kc/s.	100
6	160 Kc/s.	100

5.3.6 *I.F. Ratio*

This ratio to be greater than 70 db at 590 Kc/s. and greater than 90 db at 340 Kc/s. These measurements should be made with an unmodulated carrier using the signal strength meter as an indicator.

5.4 General Performance

5.4.1 *Noise Limiter Control*

With an input of 100 μV., modulation depth 70%, Noise Limiter Control at minimum, the overall distortion should not exceed 5% for an audio output of 2 W. Reduce the modulation depth to 30%, set the Noise Limiter to maximum, the overall distortion should not exceed 25% or be less than 15%.

5.4.2 *Diversity*

This test is only practicable if more than one receiver is available.

Connect the A.V.C. and Earth terminals of the receiver under test to the standard receiver. Tune both receivers to 4.0 Mc/s., adjust the Noise output of the standard receiver to be 50 mW. The input required to the receiver under test to reduce the noise output by 20 db from the standard receiver to be less than 5 μV.

6. FAULT TRACING, PERIODIC CHECKS

No attempt can be made to give a list of specific faults and their cure but a broad outline of fault tracing which has been found effective is given.

6.1 Loss of Performance

This may usually be traced to partial valve failure. First check the voltages on the Distribution Panel (see Fig. 23 and 7.1), then check each portion of the receiver commencing with the Audio Amplifier (5.1), I.F. Amplifier (5.2), R.F. Amplifier (5.4) and the Local Oscillator voltages (7.4). By this means the loss in gain may be traced to a section of the receiver. To determine the faulty stage check the stage gains (7.3) and, when the loss in gain has been corrected, check the A.V.C. (5.3.4.).

6.2 Absolute Failure

In the case of absolute failure the fault may often be found by inspection. If there is no obvious sign of a burnt-out resistor or fuse failure, check through the set with an ohmmeter commencing at the mains input (the mains should not be applied until it is quite certain that there is no short circuit across the H.T. supplies). If this gives no result proceed as 6.1 above and determine the faulty stage, when this has been located the actual fault may usually be easily found.

6.3 Periodic Checks

If the receiver is used frequently by one operator, changes in performance will usually be quickly noticed, but it is advisable that it should be checked from time to time to ensure that its original performance is being maintained.

A good simple test is to check the A.V.C. Knee (5.3.4.) on each range, if this is satisfactory the performance generally will not have deteriorated.

6.4 Component Layout

To assist in finding the position of a component Figs. 21 and 24 show the position of each component with its circuit reference and it is suggested that these be used in conjunction with the photographs shown in Figs. 19, 20 and 23.

6.5 Spares

The components supplied if a spares kit is ordered are given in Section 11. Two spare lamps, a spare H.T. fuse and a trimming tool are attached to the gang condenser cover (see Fig. 22).

If it is necessary to order a component, details should be taken from the lists shown in Section 10.

7. OTHER ELECTRICAL CHARACTERISTICS

To assist in fault finding, tables of voltages and current measurements, stage gains and local oscillator voltages are given in the following Section.

It must be emphasised that the figures quoted are average and will vary in practice due to valve and resistor tolerances.

7.1 Table of Voltage Measurements

Valve	Anode Volts	Screen Volts	Cathode Volts
V1	245 (239)^1	82 (79)^1	(2.4)^3
V2	245 (239)^1	82 (79)^1	(2.4)^3
V3	248 (245)^1	95 (92)^1	(1.9)^3
V4	36 (32)^1	111 (108)^1	(0.85)^3
V5	246 (240)^1	97 (90)^1	(2.6)^3
V6	246 (240)^1	66 (64)^1	(2.0)^3
V7	99 (92)^1	— —	—
V9	245 (243)^1	248 (246)^1	(4.0)^3
V10	— (16)^2	— (16)^2	104 (96)^1
V11	— (26)^2	95 (86)^1	—
V12	115 (114)^1	— —	—
V13	250 (250)^1	249 (248)^1	(4.5)^3

Measurements made on the Distribution Panel (see Fig. 23).

1. (250)^1 250 Red
2. (115)^1 114 Yellow
3. (12.6)^5 A.C. Grey
4. (6.3)^4 A.C. Beige
5. (—113)^1 Blue

Voltage at the Junction R62, R63 (see Fig. 23).
—(1.0)^3

Rectifier Heater Voltage, V14.
(5.3)^4 A.C.

The voltages have been measured wherever possible with both an electrostatic meter and a 500 ohms/volt meter. The figures in brackets refer to the latter meter and the suffix denotes the range.

( )^1 1,000 V. D.C.
( )^2 400 V. D.C.
( )^3 10 V. D.C.
( )^4 10 V. A.C.
( )^5 100 V. A.C.

7.2 Table of Current Measurements

Valve	Anode mA.	Screen mA.	Cathode mA.
V1	8.2	2.9	11.1
V2	8.2	2.9	11.1
V3	1.0	1.8	2.8
V4	7.0	1.5	8.5
V5	6.1	1.7	7.8
V6	6.5	2.3	8.8
V7	0.7	—	—
V9	34.1	6.8	40.9
V10	0	0	0
V11	0.75	1.1	—
V12	31	—	—
V13	31.2	5.0	36.2

Current through R100 (see Fig. 19).
167 mA.

Primary current of mains transformer 230 V. tap.
0.59 A.

7.3 Stage Gains

Measured at 1 Mc/s.

Aerial Terminals	— 1st R.F. Grid	5
1st R.F. Grid	— 2nd R.F. Grid	7
2nd R.F. Grid	— 1st Det. Grid	7
1st Det. Grid	— 1st I.F. Grid	3
1st I.F. Grid	— 2nd I.F. Grid	166
2nd I.F. Grid	— P.U. Terminals	9
P.U. Terminals	— Output Grid	16
Output Grid	— Output Anode	34

7.4 Local Oscillator Grid Volts, Peak

Range	1	2	3	4	5	6
L.F. Tracking Frequency	8.5	10.8	14.4	15.8	12.2	4.9
H.F. Tracking Frequency	9.6	15.1	18.1	19.2	25.2	31.0

Peak Volts = Grid Current (R24) × Grid Leak Resistor × 1.2

8. ELECTRICAL ALIGNMENT

It should be stressed that adjustments should be carried out only by suitably qualified personnel equipped with adequate test instruments.

8.1 Intermediate Frequency Amplifier

The apparatus required to align the intermediate frequency amplifier is a 455 Kc/s. Signal Generator modulated with an audio frequency of approximately 400 c.p.s., with incremental tuning calibrated in Kc/s. up to ± 5 Kc/s., and an output meter.

Place the receiver on its side on a table or bench with the top facing to the right. Place the signal generator on the left-hand side and the output meter on the right.

Connect the output meter to the speaker terminals at the rear of the receiver; if the meter is high resistance, either the speaker or a resistive load must be in circuit so that the output valve is correctly loaded.

Remove the Local Oscillator valve V4 (Fig. 20) from its socket, disconnect C47 from the switch S6 (Fig. 23) and connect the signal generator to it through a small capacitance of the order of 0.5 pF. (in practice clip the lead from the signal generator on to the insulated sleeving on the capacitor lead). Earth the signal generator to the screen just below the smoothing choke, switch the A.V.C. off, and set the selectivity switch to 5.5 Kc/s.

The alignment may now be carried out.

First align roughly to 455 Kc/s. by adjusting trimmers TC18, TC17, TC10, TC9, TC7, TC6 (Fig. 19), found on the top of the intermediate frequency transformers and the crystal filter input transformer, for maximum output.

To align accurately, switch the selectivity switch to 0.5 Kc/s., set the crystal phasing condenser so that the pointer is vertical, adjust the signal generator to the crystal frequency by tuning it so that maximum output is obtained on the output meter, switch back to 5.5 Kc/s. selectivity, and re-trim.

8.2 Crystal Filter

As explained in 2.4, the crystal filter is normally a broad bandwidth device, the narrow bandwidths being obtained by mis-matching the load into which the filter works. This load is the tuned circuit L7, C72 (Fig. 3) and the mis-matching is obtained by reducing the dynamic resistance of the tuned circuit by switching resistors in series with the coil. When the selectivity switch is in the 5.5 Kc/s. bandwidth position, no resistance will be in series with the coil, and if the connection from the crystal shorting switch to the phasing condenser is removed (*i.e.*, remove the short circuit across the crystal and make it work into a high resistance load), L7 will be correctly adjusted when the bandwidth is the widest.

The only satisfactory method of aligning this coil is with a wobbulator and an oscilloscope.

Remove the oscillator valve V4, disconnect the lead (Fig. 23) from the phasing condenser to the crystal shorting switch, disconnect C47 from the range switch (S.6), disconnect the orange lead from the junction R68, R71. Connect the wobbulator to C47 and take the output to the oscilloscope from across R71. Turn the selectivity switch to 5.5 Kc/s. bandwidth and set the phasing condenser so that the response is symmetrical (*i.e.*, the pointer of the controlling knob vertical). Adjust L7 (Fig. 19) to obtain the broadest and most symmetrical response possible (it may be necessary to re-adjust the phasing condenser while carrying out this alignment). The response curve obtained should be similar to that shown in Fig. 14 (b); (a) and (c) of Fig. 14 show the response curve obtained when the inductance is too low, and too high respectively.

8.3 B.F.O.

Turn the selectivity switch to 0.5 Kc/s. bandwidth position, set the phasing condenser so that the pointer is vertical, feed in an unmodulated signal tuned to the maximum response of the crystal. Set the pointer of the B.F.O. Pitch Control so that the pointer is vertical, switch the B.F.O. on and adjust L8 for zero beat (see Fig. 19).

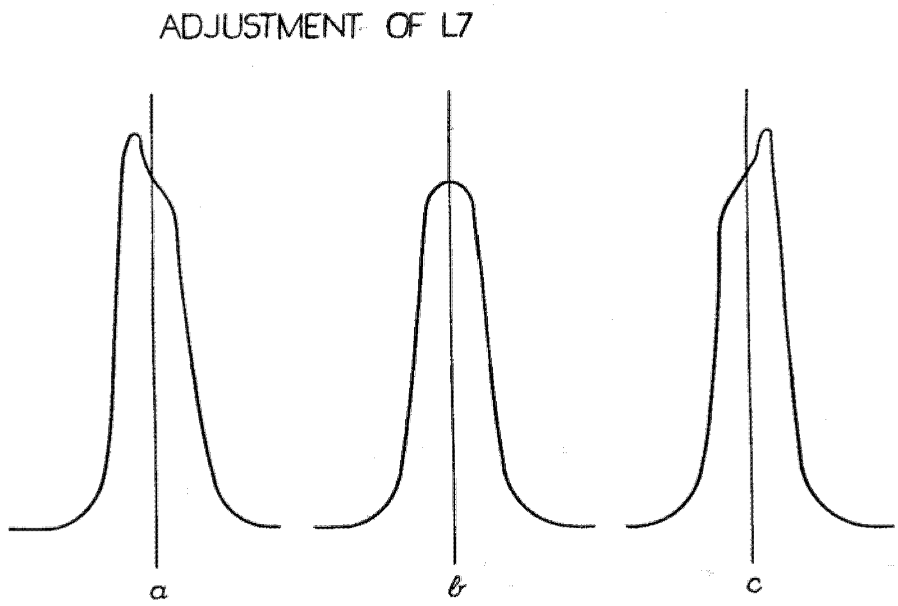


Fig. 14. L7 *Adjustment Curves*

8.4 R.F. Amplifier

The apparatus required to align the R.F. Amplifier is a Signal Generator covering the range 150 Kc/s.—34 Mc/s. and, for greater accuracy, a harmonic crystal oscillator giving harmonic outputs of 10 Kc/s., 100 Kc/s. and 1 Mc/s. The method of alignment of each range is similar and the ranges may be aligned in any order except that Range 5 should be aligned before Range 6 (see 8.5).

The method of alignment is as follows :—

Feed the signal generator into the aerial terminals and adjust it to the frequency of the low frequency tracking point. Set the gang condenser to this frequency by setting the logging scale to the reading given in the table below. Adjust the inductance trimming (see Fig. 19) of the local oscillator for response as shown on the signal strength meter. Adjust the R.F. circuits for maximum response, set the aerial trimmer to half capacity, adjust the aerial coil inductance and set the signal generator to the high frequency tracking frequency. Adjust the gang condenser to this frequency by setting the logging scale to the figure given in the table, adjust the oscillator trimmer condenser for response and adjust the R.F. and aerial trimmers (see Fig. 23) for maximum response.

These processes should be repeated, except that the aerial trimmer should not be touched at the low frequency adjustment, until the logging scale reading is within 10 divisions of that given in the table, when the gang condenser is set to the opposite end of the range to that being adjusted.

To align accurately, the signal generator should be replaced by the harmonic crystal oscillator, and the above adjustments repeated until the logging scale readings agree with those in the table $\pm$ one division. Check frequencies are given which, where possible, are the next greater harmonic frequency of the crystal oscillator and, providing the rough alignment has been carried out, it should be easily possible to identify the check frequency. Thus, when aligning Range 2 at 20.5 Mc/s. there might be uncertainty whether the receiver is being aligned to 20.4 or 20.6 Mc/s. but, by counting the responses between the alignment frequency and the check frequency of 20 Mc/s., for which the calibration is given, the frequency to which the receiver is being aligned may be established beyond doubt.

8.5 I.F. Rejector

Complete the approximate alignment of Range 5, tune the receiver to 550 Kc/s., change the frequency of the Signal Generator to the I.F. frequency, tune the generator for maximum response as shown on the signal strength meter, adjust L9 for minimum response (see Fig. 23). The exact alignment of Range 5 may now be completed.

8.6 **Signal Strength Meter**

Set the receiver to 9.6 Mc/s. (Range 2 Low Frequency Tracking Frequency), turn the I.F. and R.F. Gain Controls to minimum and adjust the meter to zero by the set zero potentiometer (this potentiometer is the higher of the two on the panel fixed to the meter terminals, see Fig. 19). Turn the gain controls to maximum and feed into the aerial terminals 0.1 volt from the signal generator and, by means of the set maximum potentiometer, adjust the meter to read 100 db.

8.7 **Hum Level**

Turn the audio gain control to minimum, and use a low range valve voltmeter (0.5 volt full scale), an oscilloscope or, in the absence of these, a speaker, as an indicator across the speaker terminals. Adjust the hum control R104 (Fig. 19) for minimum hum output.

8.8 **Range Coil Alignment Data**

Range	Tracking Frequency	Logging Dial Reading	Check Frequency	Logging Dial Reading	Instructions	Adjust
1	21 Mc/s.	4.54			Adjust for Response	L31
					Adjust for Max. Response	L21, L11, L1
	33 ,,	29.17			Adjust for Response	TC31,
					Adjust for Max. Response	TC21, TC11 TC5
2	9.5 Mc/s.	3.08	10 Mc/s.	5.38	Adjust for Response	L32
					Adjust for Max. Response	L22, L12, L2
	20.5 ,,	28.79	20 ,,	27.93	Adjust for Response	TC32
					Adjust for Max. Response	TC22, TC12, TC5
3	3.7 Mc/s.	4.26	4 Mc/s.	7.30	Adjust for Response	L33
					Adjust for Max. Response	L23, L13, L3
	9.2 ,,	28.75	9 ,,	28.15	Adjust for Response	TC33
					Adjust for Max. Response	TC23, TC13, TC5
4	1.46 Mc/s.	3.80	1.5 Mc/s.	4.98	Adjust for Response	L34
					Adjust for Max. Response	L24, L14, L4
	3.45 ,,	29.08	3.4 ,,	28.58	Adjust for Response	TC34
					Adjust for Max. Response	TC24, TC14, TC5
5	590 Kc/s.	5.16	600 Kc/s.	5.94	Adjust for Response	L35
					Adjust for Max. Response	L25, L15, L5
	1,360 ,,	28.76	1,300 ,,	27.45	Adjust for Response	TC35
					Adjust for Max. Response	TC25, TC15, TC5
6	160 Kc/s.	5.60	200 Kc/s.	13.64	Adjust for Response	L36
					Adjust for Max. Response	L26, L16, L6
	340 ,,	28.41	300 ,,	24.46	Adjust for Response	TC36
					Adjust for Max. Response	TC26, TC16, TC5

9. MECHANICAL DETAILS

9.1 Gearbox

9.1.1 *General Description*

The unit (Fig. 20) has an overall ratio of 64:1 and 32 full turns of the tuning knob are required to cover a range, the full ratio being obtained by the sequence 1:1:4:4:4.

Each spindle is ball-race mounted and adjustable (see Figs. 15 and 16) and in order to prevent backlash in the drive, each of the large gears is spring-loaded against the pinions. The latter is achieved by the large gears being made up of two thin plates held together by the central bush and loaded by means of three equally spaced springs.

A positive stop comes into operation after 32 revolutions of the tuning knob spindle in either direction. This is possible by a stop lug being placed on the first gear which engages against a left-hand or a right-hand arm (depending upon the direction of rotation), the arm being moved into the path of the stop lug by a stud riveted to the final gear. Thus, if the tuning knob is spun toward the end of its travel the blow is taken by the tuning knob spindle and no load is taken either by the gearbox or the gang condensers.

9.1.2 *Flywheel and Clutch*

To facilitate rapid change and ease of tuning, a flywheel has been fitted to the tuning knob spindle. This is located directly behind the logging dial and is mounted to the same bush as the logging dial. In order to relieve the impact on the stop, the flywheel is fitted with a slipping clutch, achieved by a heavy spring holding the flywheel against the bush by friction. On hitting the stop, the momentum of the flywheel causes the clutch to slip, thus relieving the pressure on the stop.

9.1.3 *Adjustments and Maintenance*

The bearings and spindles of the gearbox are case hardened and the amount of maintenance should be negligible. If, however, the front bearing [*i.e.*, the bearing of the tuning knob spindle (see Fig. 15)] needs attention, remove the flywheel assembly, slacken the large hexagon nut locking the tuning knob spindle to the plate, screw in the sleeve until the spindle is free from shake and retighten the hexagon nut.

Should other bearings require adjustment they may be treated in a similar manner after removing the gearbox from the gang condenser framework.

Note: Care must be taken when refitting the gearbox to the gang condenser framework that, before tightening the spindle coupling screws, the tuning knob spindle is held hard against the stop in its anti-clockwise position with the gang condensers closed.

Should the top cover of the gearbox (Fig. 20) be removed during any adjustment, care must be taken when it is replaced that it is fitted hard against the front plate to prevent light spread from the logging dial lamps.

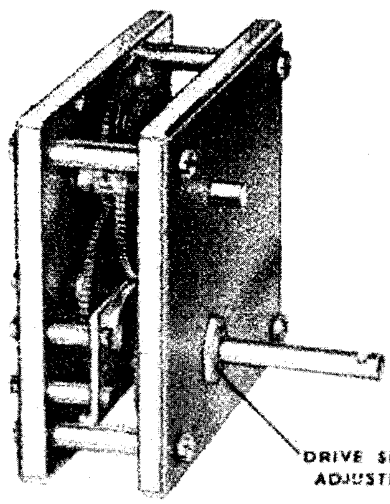


Fig. 15. Front View of Gearbox

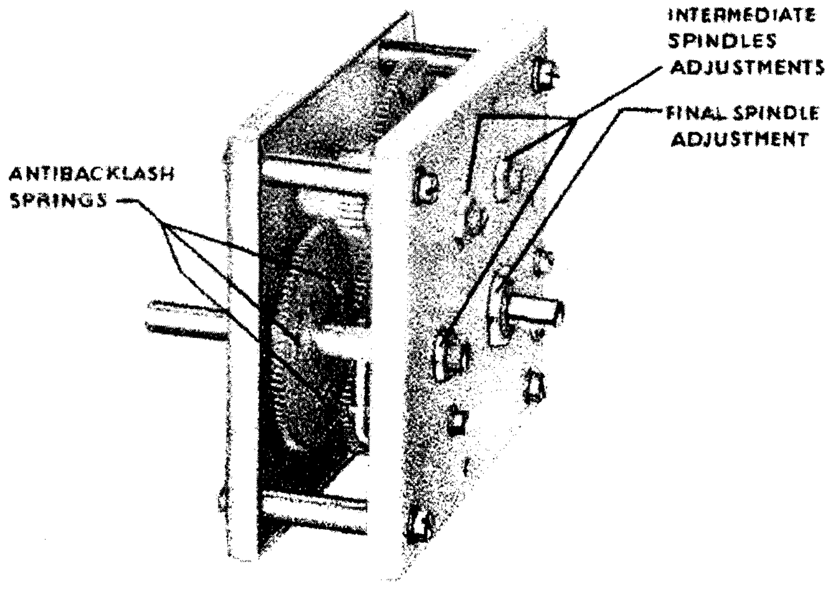


Fig. 16. Rear View of Gearbox

9.2 Pointer Mechanism

This consists of a length of stranded steel wire screwed at both ends to a drum fitted to one of the intermediate spindles of the gearbox. On one end of the wire is a screwed stem adjustable in relation to the drum and allowing some tension to be placed on the wire. The wire is connected to the pointer carriage by a soldered joint.

Fig. 17 shows the mechanism with the pointer positioned at the low frequency end of the register. Care must be taken when refitting a drive wire to avoid any kinks or twists in the wire and, after fitting, the wire should be smeared with grease over the whole of its length.

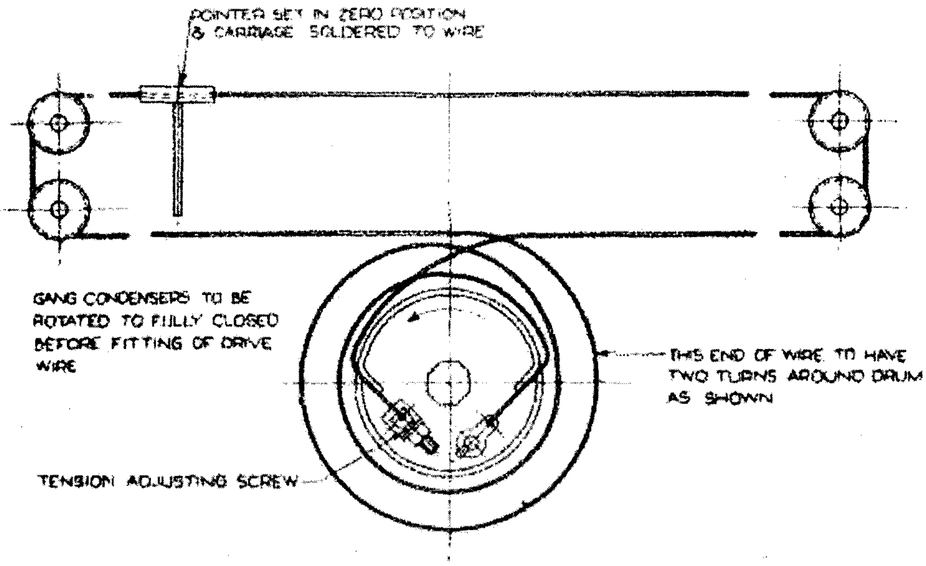


Fig. 17. Pointer Mechanism

9.3 Logging Dial

This is a translucent disc marked 0–100 and riveted to a central disc secured by three screws to the bush carrying the flywheel. It is adjustable as follows :—

First rotate the tuning knob in an anti-clockwise direction until it engages against the stop ; set the logging dial approximately to zero and lock the central bush to the spindle with the three set screws. By slightly slackening the screws securing the dial to the bush it will be found that the dial has a limited amount of rotary motion in relation to the bush. The tuning knob should be held against the stop the dial set accurately to zero and the fixing screws tightened.

Care must be taken when locking the bush to the spindle that the dial is not too far forward, thus fouling the rear face of the front panel.

Should the four small pulleys require lubrication, a little good quality oil will be adequate.

9.4 Lamps

A total of 10 lamps (Fig. 20) are used for illumination, six for the edge lighting of the calibrated range scales and the others for the illumination of the register, the logging dial and the signal strength meter. Only one of the six lamps for edge lighting is used at a time and is selected by S.10 on the range switch.

The lamps for edge lighting are mounted on two strips, one on the left-hand side of the register carrying the three lamps for Ranges 2, 4 and 6 and the other on the right-hand side of the register the three lamps for Ranges 1, 3 and 5 and a fourth lamp for the Logging Scale, the latter being always on. The lamp for general illumination of the register is mounted on the gang condenser cover.

All lamps may be removed for servicing by undoing the knurled nuts and lifting off the mounting strips.

9.5 Switches

Two each of three types of toggle switch (Fig. 20) and two rotary-type switches (Fig. 23) are used and comprise :—

Mains On/Off (SW.1, SW.2)	—	2-pole On/Off
B.F.O. On/Off (SW.6, SW.7)	—	2-pole On/Off
Send/Receive (SW.9, SW.10)	—	2-circuit
Filter In/Out (SW.3, SW.4)	—	2-circuit
A.V.C. On/Off (SW.8)	—	Single-pole On/Off
Speech/Music (SW.5)	—	Single-pole On/Off
Range and Lamp (S.1 to S.10)	—	Rotary
Selectivity (S.11 to S.13)	—	Rotary

Any of the toggle switches may be changed by removing the switch escutcheon on the front panel, undoing the nut holding the switch in place and taking the switch through the back of the front panel. The range switch may be removed by unsoldering the connecting leads to it, removing the switch earthing springs, screen tiepieces and knob, undoing the nuts holding the switch to the rear flange of the chassis, removing the bolts securing the switch mounting plate and lifting out the switch.

The selectivity switch may be removed by taking the screws from the mounting bracket and knob, undoing the nut holding the switch to the front flange of the chassis and lifting it out.

10. COMPONENTS LISTS

10.1 Capacitors

Circuit Ref.	Value	Tolerance	Working Voltage	G.E.C. Part Number
C1	3,000 pF	± 2%	350	RK.202345
C2	15 pF	± 10%	350	RK.201597
C3	3,000 pF	± 2%	350	RK.292345
C4	15 pF	± 10%	350	RK.201597
C5	15 pF	± 10%	350	RK.201597
C6	183 pF	± 1%	350	RK.202587
C7	1,400 pF	± 2%	350	RK.202582
C8	0.01 µF	± 20%	350	RK.202446
C9	100 pF	± 5%	500	RK.202321
C10	0.1 µF	± 25%	250	RK.202188
C11	0.05 µF	± 25%	250	RK.202187
C12	5,000 pF	± 2%	350	RK.202346
C13	0.05 µF	± 25%	250	RK.202187
C14	68 pF	± 10%	500	RK.202580
C15	3,000 pF	± 2%	350	RK.202345
C16	15 pF	± 10%	350	RK.201597
C17	82 pF	± 10%	500	RK.202202
C18	3,000 pF	± 2%	350	RK.202345
C19	82 pF	± 10%	500	RK.202202
C20	10 pF	± 10%	500	RK.202309
C21	2.2 pF	+ 0.5 pF	500	RK.202340
C22	6.8 pF	± 5%	500	RK.202280
C23	0.05 µF	± 25%	350	RK.202186
C24	15 pF	± 10%	350	RK.201597
C25	15 pF	± 10%	350	RK.201597
C26	183 pF	± 1%	350	RK.202589
C27	1,400 pF	± 2%	350	RK.202582
C28	100 pF	± 5%	500	RK.202321
C29	0.01 µF	± 20%	350	RK.202446
C30	0.1 µF	± 25%	250	RK.202188
C31	0.05 µF	± 25%	250	RK.202187
C32	0.05 µF	± 25%	250	RK.202187
C33	68 pF	± 10%	500	RK.202580
C34	3,000 pF	± 2%	350	RK.202345
C35	15 pF	± 10%	350	RK.201597
C36	82 pF	± 10%	500	RK.202202
C37	3,000 pF	± 2%	350	RK.202345
C38	82 pF	± 10%	500	RK.202202
C39	10 pF	± 10%	500	RK.202309
C40	2.2 pF	+ 0.5 pF	500	RK.202340
C41	6.8 pF	± 5%	500	RK.202280
C42	0.05 µF	± 25%	350	RK.202186
C43	15 pF	± 10%	350	RK.201597
C44	15 pF	± 10%	350	RK.201597
C45	183 pF	± 1%	350	RK.202589
C46	1,400 pF	± 2%	350	RK.202582
C47	100 pF	± 5%	500	RK.202321
C48	0.05 µF	± 25%	250	RK.202187
C49	0.05 µF	± 25%	250	RK.202187
C50	137 pF	± 1%	350	RK.202583
C51	15 pF	± 10%	350	RK.201597
C52	400 pF	± 1%	350	RK.202584
C53	1,415 pF	± 1%	350	RK.202585
C54	3,250 pF	± 2%	350	RK.202586
C55	5.6 pF	± 10%	500	RK.201872
C56	8.2 pF	± 0.5 pF	500	RK.202344
C57	3.3 pF	± 0.5 pF	500	RK.202279
C58	178 pF	± 1%	350	RK.202588

10.1 Capacitors

Circuit Ref.	Value	Tolerance	Working Voltage	G.E.C. Part Number
C59	1,200 pF	± 1%	350	RK.202587
C60	22 pF	± 10%	500	RK.201865
C61	39 pF	± 10%	500	RK.201875
C62	100 pF	± 5%	500	RK.202321
C63	0.01 μF	± 20%	350	RK.202446
C64	0.05 μF	± 25%	250	RK.202187
C65	0.05 μF	± 25%	250	RK.202187
C66	82 pF	± 5%	350	RK.202703
C67	0.1 μF	± 20%	350	RK.202446
C68	130 pF	± 2%	350	RK.202702
C69	0.001 μF	± 10%	350	RP.101971
C70	0.001 μF	± 10%	350	RP.101971
C71	3.3 pF	± 0.5 pF	500	RK.202279
C72	0.1 μF	± 25%	250	RK.202188
C73	39 pF	± 10%	500	RK.201875
C74	0.1 μF	± 25%	250	RK.202188
C75	0.1 μF	± 25%	250	RK.202188
C76	0.1 μF	± 20%	350	RK.202093
C77	100 pF	± 5%	500	RK.202321
C78	0.25 μF	± 25%	350	RK.202185
C79	2.0 μF	± 25%	150	RK.202184
C80	2.0 μF	± 25%	150	RK.202184
C81	100 pF	± 5%	500	RK.202321
C82	0.1 μF	± 25%	350	RK.202093
C83	47 pF	± 10%	500	RK.202341
C84	0.25 μF	± 25%	350	RK.202185
C85	0.1 μF	± 20%	350	RK.202093
C86	0.1 μF	± 20%	350	RK.202093
C87	0.1 μF	± 25%	250	RK.202188
C88	0.1 μF	± 25%	250	RK.202188
C89	0.1 μF	± 20%	350	RK.202093
C90	100 pF	± 5%	500	RK.202321
C91	0.1 μF	± 20%	350	RK.202093
C92	470 pF	± 2%	350	RK.201999
C93	100 pF	± 5%	500	RK.202321
C94	100 pF	± 5%	500	RK.202321
C95	100 pF	± 5%	500	RK.202321
C96	100 pF	± 5%	500	RK.202321
C97	10 pF	± 10%	500	RK.202309
C98	0.25 μF	± 25%	350	RK.202185
C99	0.05 μF	± 20%	500	RK.202204
C100	0.1 μF	± 25%	250	RK.202188
C101	0.1 μF	± 25%	250	RK.202188
C102	47 pF	± 10%	500	RK.202341
C103	0.1 μF	± 20%	350	RK.202093
C104	0.005 μF	± 20%	1,000	RK.202203
C105	0.1 μF	± 20%	350	RK.202093
C106	0.1 μF	± 20%	350	RK.202093
C107	0.03 μF	± 25%	350	RK.202201
C108	0.05 μF	± 25%	350	RK.202186
C109	5,000 pF	± 2%	350	RK.202346
C110	0.001 μF	± 25%	500	RK.202196
C111	2 μF	± 20%	400	RK.201994
C112	0.1 μF	± 20%	350	RK.202093
C113	0.1 μF	± 20%	350	RK.202093
C114	4 μF	± 20%	400	RK.202017
C115	2 μF	± 20%	250	RK.202195
C116	2 μF	± 20%	250	RK.202195
C117	2 μF	± 20%	250	RK.202195
C118	0.1 μF	±25%	250	RK.202188

10.2 **Resistors**

Circuit Ref.	Value (ohms)	Tolerance	Wattage	G.E.C. Part Number
R1	10,000	± 20%	½	RP.191138
R2	1 Megohm	± 20%	½	RP.191150
R3	100,000	± 20%	½	RP.191144
R4	220	± 20%	½	RP.191128
R5	47	± 20%	½	RP.191124
R6	10,000	± 20%	½	RP.191138
R7	4,700	± 20%	½	RP.191136
R8	10,000	± 20%	½	RP.191138
R9	2,200	± 20%	½	RP.191134
R10	1,000	± 20%	½	RP.191132
R11	1 Megohm	± 20%	½	RP.191150
R12	100,000	± 20%	½	RP.191144
R13	220	± 20%	½	RP.191134
R14	2,200	± 20%	3	RK.202244
R15	47	± 20%	½	RP.191124
R16	10,000	± 20%	½	RP.191138
R17	4,700	± 20%	½	RP.191136
R18	10,000	± 20%	½	RP.191138
R19	2,200	± 20%	½	RP.191134
R20	1,000	± 20%	½	RP.191132
R21	1 Megohm	± 20%	½	RP.191150
R22	10,000	± 20%	½	RP.191138
R23	1,000	± 20%	½	RP.191132
R24	100,000	± 20%	½	RP.191144
R25	15,000	± 20%	½	RP.191139
R26	3,300	± 20%	½	RP.191135
R27	680	± 20%	½	RP.191131
R28	330	± 20%	½	RP.191129
R29	47	± 20%	½	RP.191124
R30	22	± 20%	½	RP.191122
R31	47,000	± 20%	½	RP.191142
R32	1,000	± 20%	½	RP.191132
R33	10,000	± 20%	½	RP.191138
R34	10,000	± 20%	½	RP.191138
R35	100,000	± 20%	½	RP.191144
R36	100	± 20%	½	RP.191126
R37	47	± 20%	½	RP.191124
R38	1,000	± 20%	½	RP.191132
R39	2,200	± 20%	½	RP.191134
R40	680,000	± 20%	½	RP.191149
R41	100,000	± 20%	½	RP.191144
R42	150	± 5%	½	RP.190918
R43	220	± 10%	½	RP.191056
R44	470	± 20%	½	RP.191130
R45	330	± 20%	½	RP.191129
R46	2,200	± 20%	3	RK.202244
R47	100,000	± 20%	½	RP.191144
R48	22,000	± 20%	½	RP.191140
R49	2,200	± 20%	½	RP.191134
R50	1 Megohm	± 20%	½	RP.191150
R51	47,000	± 20%	½	RP.191142
R52	1 Megohm	± 20%	½	RP.191150
R53	100	± 20%	½	RP.191126
R54	100	± 20%	½	RP.191126
R55	22	± 20%	½	RP.191122
R56	220,000	± 20%	½	RP.191146
R57	220,000	± 20%	½	RP.191146
R58	10,000	± 20%	½	RP.191138
R59	1 Megohm	± 20%	½	RP.191150

10.2 **Resistors**

Circuit Ref.	Value (ohms)	Tolerance	Wattage	G.E.C. Part Number
R60				
R61	2.2 Megohm	± 20%	½	RP.191152
R62	470	± 20%	½	RP.191130
R63	47,000	± 20%	½	RP.191142
R64	4,700	± 20%	½	RP.191136
R65	4,700	± 20%	½	RP.191136
R66	22,000	± 20%	½	RP.191140
R67	2,200	± 20%	½	RP.191134
R68	47,000	± 20%	½	RP.191142
R69	220,000	± 20%	½	RP.191146
R70	1 Megohm	± 15%	0.1	RK.202165
R71	100,000	± 20%	½	RP.191144
R72	470,000	± 20%	½	RP.191148
R73	680,000	± 20%	½	RP.191149
R74	100	± 20%	1	RK.202082
R75	100,000	± 20%	½	RP.191144
R76	150,000	± 20%	½	RP.191145
R77	100,000	± 20%	½	RP.191144
R78	680,000	± 20%	½	RP.191149
R79	1,000	± 20%	½	RP.191132
R80	100,000	± 20%	½	RP.191144
R81	22,000	± 20%	½	RP.191140
R82	22,000	± 5%	12	RK.202326
R83	2,200	± 20%	½	RP.191134
R84	47	± 20%	1	RK.202174
R85	680,000	± 20%	½	RP.191149
R86	470,000	± 20%	½	RP.191148
R87	100,000	± 20%	½	RP.191144
R88	2.2 Megohm	± 20%	½	RP.191152
R89	500,000	± 15%	0.15	RK.202164
R90	470,000	± 20%	½	RP.191148
R91	470,000	± 20%	½	RP.191148
R92	100	± 20%	½	RP.191126
R93	100,000	± 20%	½	RP.191144
R94	150	± 10%	½	RP.191054
R95	330	± 20%	½	RP.191129
R96	330	± 20%	½	RP.191129
R97	2.5	± 5%	4	RK.202436
R98	1.5 Megohm	± 20%	½	RP.191151
R99	3,000	± 5%	10	RK.202193
R100	220	± 5%	25	RK.202192
R101	100	± 20%	½	RP.191126
R102	100,000	± 20%	½	RP.191144
R103	100	± 20%	½	RP.191126
R104	100	± 20%	1	RK.202082
R105	22,000	± 20%	½	RP.191140
R106	22,000	± 20%	½	RP.191140
R107	1 Megohm	± 20%	½	RP.191150
R108	1 Megohm	± 20%	½	RP.191150

10.3 R.F. Coils

Circuit Ref.	G.E.C. Part Number
L1	RP.111000
L2	RP.111001
L3	RP.111002
L4	RP.111003
L5	RP.111004
L6	RP.111005
L11	RP.113965
L12	RP.111007
L13	RP.111008
L14	RP.111009
L15	RP.111010
L16	RP.111011
L21	RP.113965
L22	RP.111007
L23	RP.111008
L24	RP.111009
L25	RP.111010
L26	RP.111011
L31	RP.111018
L32	RP.111019
L33	RP.111020
L34	RP.111021
L35	RP.111022
L36	RP.111023

10.4 Sundry Adjustable Coils

Circuit Ref.	G.E.C. Part Number
L7	RP.111082
L8	RP.111084
L9	RP.111083

10.5 I.F. Transformers

Crystal Filter Input R.802814
I.F.1 .. .. R.802870
I.F.2 .. .. R.802871

10.6 Transformers and Chokes

Mains Transformer R.802866
Smoothing Choke R.802726
1,000 c.p.s. Filter Coil R.803038
Output Transformer R.802867

10.7 Preset Trimmers

TC.11	TC.21	TC.31	TC.6	
TC.12	TC.22	TC.32	TC.7	
TC.13	TC.23	TC.33	TC.9	RK.202218
TC.14	TC.24	TC.34	TC.10	
TC.15	TC.25	TC.35	TC.17	
TC.16	TC.26	TC.36	TC.18	

10.8 Variable Trimmers

TC.5 .. .. RK.202463
TC.8 .. .. R.802875
TC.19 .. .. RK.202463

10.9 Gang Condenser

TC.1 and TC.2 TC.3 and TC.4	RK.292173

10.10 Rotary Switches

S.1 –S.10	RK.202061
S.11–S.13	RK.202062

10.11 Toggle Switches

SW.1, SW.2	RK.202178
SW.3, SW.4	RK.202176
SW.5	RK.202177
SW.6, SW.7	RK.202178
SW.8	RK.202177
SW.9, SW.10	RK.202176

10.12 Valves

V1	1st R.F. Amplifier	W.81
V2	2nd R.F. Amplifier	W.81
V3	1st Detector	X.81
V4	Local Oscillator	N.77
V5	1st I.F. Amplifier.	W.81
V6	2nd I.F. Amplifier	W.81
V7	2nd Detector, I.F. A.V.C. Delay, 1st Audio ..	DH.81
V8	Noise Limiter, R.F. Delay	D.63
V9	Output	KT.81
V10	A.V.C. Rectifier	Z.77
V11	Beat Frequency Oscillator	Z.77
V12	Voltage Stabiliser	S.130
V13	Smoothing Valve	KT.81
V14	Rectifier	U.52

Osram Valves are employed in British Empire Territories and Geco-Valves elsewhere.

10.13 Sundry Items

Drive Wire	RP.111657
S.S. Meter	RK.202179
6.5 V. Lamps	RK.200630
500 mA. Fuse	RK.202181
Phones Jack	RK.202191
Phones Plug	RK.201628
Auxiliary Power Supply Inter-connecting Socket ..	R.803216
Trimming Tool	RP.111932
Gearbox	R.803126
Mains Cord	R.803259
Mains Socket	RK.202091
455 Kc/s. Filter Crystal	RK.202189
Selenium Rectifier	RK.201947

11. SPARES REPLACEMENT LIST

The Spares listed hereunder, based on two years' servicing of the receiver under tropical conditions, are supplied when requested. The quantities quoted are for an installation comprising one receiver; when a greater number of receivers are to be serviced the quantities are modified to suit probable requirements.

Description	G.E.C. Part Number	Quantity
Socket	RK.202091	1
Transformer (Mains)	R.802866	1
Transformer (Output)	R.802867	1
Choke (H.T. Smoothing)	R.802726	1
I.F. Transformer No. 1	R.802870	1
I.F. Transformer No. 2	R.802871	1
Potentiometer 100 ohms	RK.202082	1
Potentiometer 47 ohms	RK.202174	1
Potentiometer 2,000 ohms	RK.202244	1
Potentiometer 500,000 ohms	RK.202164	1
Potentiometer 1 Megohm	RK.202165	1
Fuse 500 mA.	RK.202181	4
Condenser 4 μF. 400 V.	RK. 202017	1
Condenser 2 μF. 400 V.	RK.201994	1
Condenser 2 μF. 250 V.	RK.202195	1
Lamp (6.5 V.)	RK.200630	24
Valveholder B7G	RK.202027	1
Valveholder B8G	RK.202194	1
Valveholder Octal	RK.200731	1
Valveholder 4 pin	RK.200740	1
Core for $\frac{3}{8}$" dia. coil.	RK.202199	2
Core for $\frac{1}{2}$" dia. coil	RK.202198	2
Resistor 22 ohms ± 20% $\frac{1}{2}$ W.	RP.191122	1
Resistor 47 ohms ± 20% $\frac{1}{2}$ W.	RP.191124	1
Resistor 100 ohms ± 20% $\frac{1}{2}$ W.	RP.191126	1
Resistor 68 ohms ± 20% $\frac{1}{2}$ W.	RP.191125	1
Resistor 220 ohms ± 20% $\frac{1}{2}$ W.	RP.191128	1
Resistor 330 ohms ± 20% $\frac{1}{2}$ W.	RP.191129	1
Resistor 1,000 ohms ± 20% $\frac{1}{2}$ W.	RP.191132	1
Resistor 2,200 ohms ± 20% $\frac{1}{2}$ W.	RP.191134	1
Resistor 10,000 ohms ± 20% $\frac{1}{2}$ W.	RP.191138	1
Resistor 4,700 ohms ± 20% $\frac{1}{2}$ W.	RP.191136	1
Resistor 47,000 ohms ± 20% $\frac{1}{2}$ W.	RP.191142	1
Resistor 100,000 ohms ± 20% $\frac{1}{2}$ W.	RP.191144	1
Resistor 15,000 ohms ± 20% $\frac{1}{2}$ W.	RP.191139	1
Resistor 1 Megohm ± 20% $\frac{1}{2}$ W.	RP.191150	1
Resistor 3,300 ohms ± 20% $\frac{1}{2}$ W.	RP.191135	1
Resistor 22,000 ohms ± 20% $\frac{1}{2}$ W.	RP.191140	1
Resistor 68,000 ohms ± 20% $\frac{1}{2}$ W.	RP.191143	1
Resistor 470,000 ohms ± 20% $\frac{1}{2}$ W.	RP.191148	1
Resistor 680 ohms ± 20% $\frac{1}{2}$ W.	RP.191131	1
Resistor 220 ohms ± 5% 25 W.	RK.202192	1
Resistor 3,000 ohms ± 5% 10 W.	RK.202193	1
Resistor 2.5 ohms ± 5% 4 W.	RK.202436	1
Resistor 470 ohms ± 20% $\frac{1}{2}$ W.	RP.191130	1
Resistor 10 ohms ± 10% $\frac{1}{2}$ W.	RP.191040	1
Resistor 220 ohms ± 10% $\frac{1}{2}$ W.	RP.191056	1
Resistor 150 ohms ± 5% $\frac{1}{2}$ W.	RP.190918	1
Resistor 150,000 ohms ± 20% $\frac{1}{2}$ W.	RP.191145	1
Resistor 220,000 ohms ± 20% $\frac{1}{2}$ W.	RP.191146	1
Resistor 680,000 ohms ± 20% $\frac{1}{2}$ W.	RP.191149	1
Resistor 2.2 Megohms ± 20% $\frac{1}{2}$ W.	RP.191152	1
Resistor 22,000 ohms ± 5% 5 W.	RK.202326	1
Resistor 1.5 Megohms ± 20% $\frac{1}{2}$ W.	RP.191151	1

11. Spares Replacement List

Description	G.E.C. Part Number	Quantity
Capacitor 0.01 μF. 350 V.	RK.202446	1
Capacitor 0.05 μF. 250 V.	RK.202187	1
Capacitor 0.05 μF. 350 V.	RK.202186	1
Capacitor 0.1 μF. 250 V.	RK.202188	1
Capacitor 2 μF. 150 V.	RK.202184	1
Capacitor 0.1 μF. 350 V.	RK.202093	1
Capacitor 68 pF. 500 V.	RK.292580	1
Capacitor 82 pF. 500 V.	RK.202202	1
Capacitor 10 pF. 500 V.	RK.202309	1
Capacitor 100 pF. 500 V.	RK.202321	1
Capacitor 47 pF. 500 V.	RK.202341	1
Capacitor 22 pF. 500 V.	RK.291865	1
Capacitor 39 pF. 500 V.	RK.201875	1
Capacitor 2.2 pF. 500 V.	RK.202340	1
Capacitor 6.8 pF. 500 V.	RK.202280	1
Capacitor .003 μF. 350 V.	RK.202345	1
Capacitor .005 μF. 350 V.	RK.202346	1
Capacitor 470 pF. 350 V.	RK.201999	1
Capacitor 15 pF. 350 V.	RK.201597	1
Capacitor .001 μF. 350 V.	RP.101971	1
Capacitor 1,400 pF. 350 V.	RK.202582	1
Capacitor 137 pF. 350 V.	RK.202583	1
Capacitor 400 pF. 350 V.	RK.202584	1
Capacitor 1,415 pF. 350 V.	RK.292585	1
Capacitor 3,250 pF. 350 V.	RK.202586	1
Capacitor 1,200 pF. 350 V.	RK.202587	1
Capacitor 178 pF. 350 V.	RK.202588	1
Capacitor 183 pF. 350 V.	RK.202589	1
Capacitor 0.25 μF. 350 V.	RK.202185	1
Capacitor 0.1 μF. 350 V.	RK.202093	1
Capacitor 0.005 μF. 1,000 V.	RK.202203	1
Capacitor 0.03 μF. 350 V.	RK.202201	1
Capacitor 0.05 μF. 500 V.	RK.202204	1
Capacitor 0.001 μF. 500 V.	RK.202196	1
Valve Type W.81		4
Valve Type X.81		1
Valve Type N.77		1
Valve Type DH.81		1
Valve Type D.63		1
Valve Type KT.81		2
Valve Type Z.77		2
Valve Type U.52		1
Stabiliser Type S.130		1
Crystal Unit (455 Kc/s.)	RK.202189	1

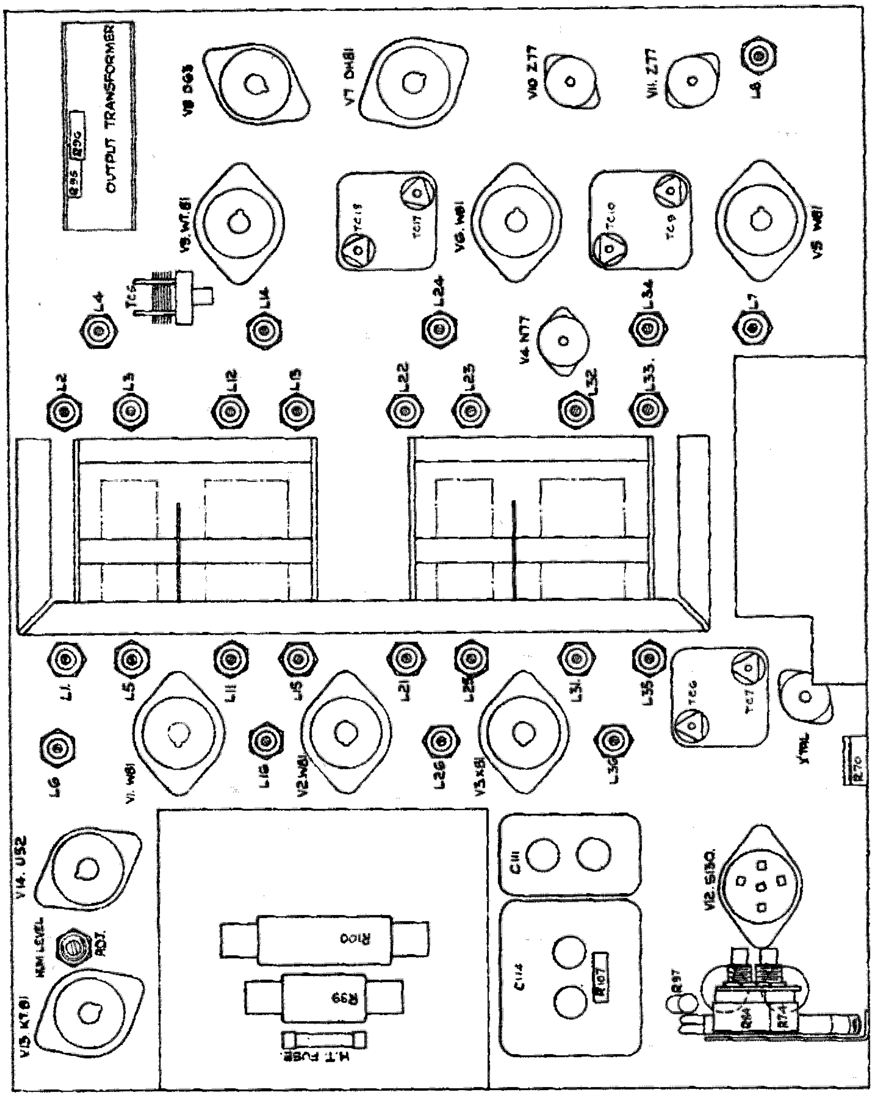


Fig. 21. Component Layout, Top View

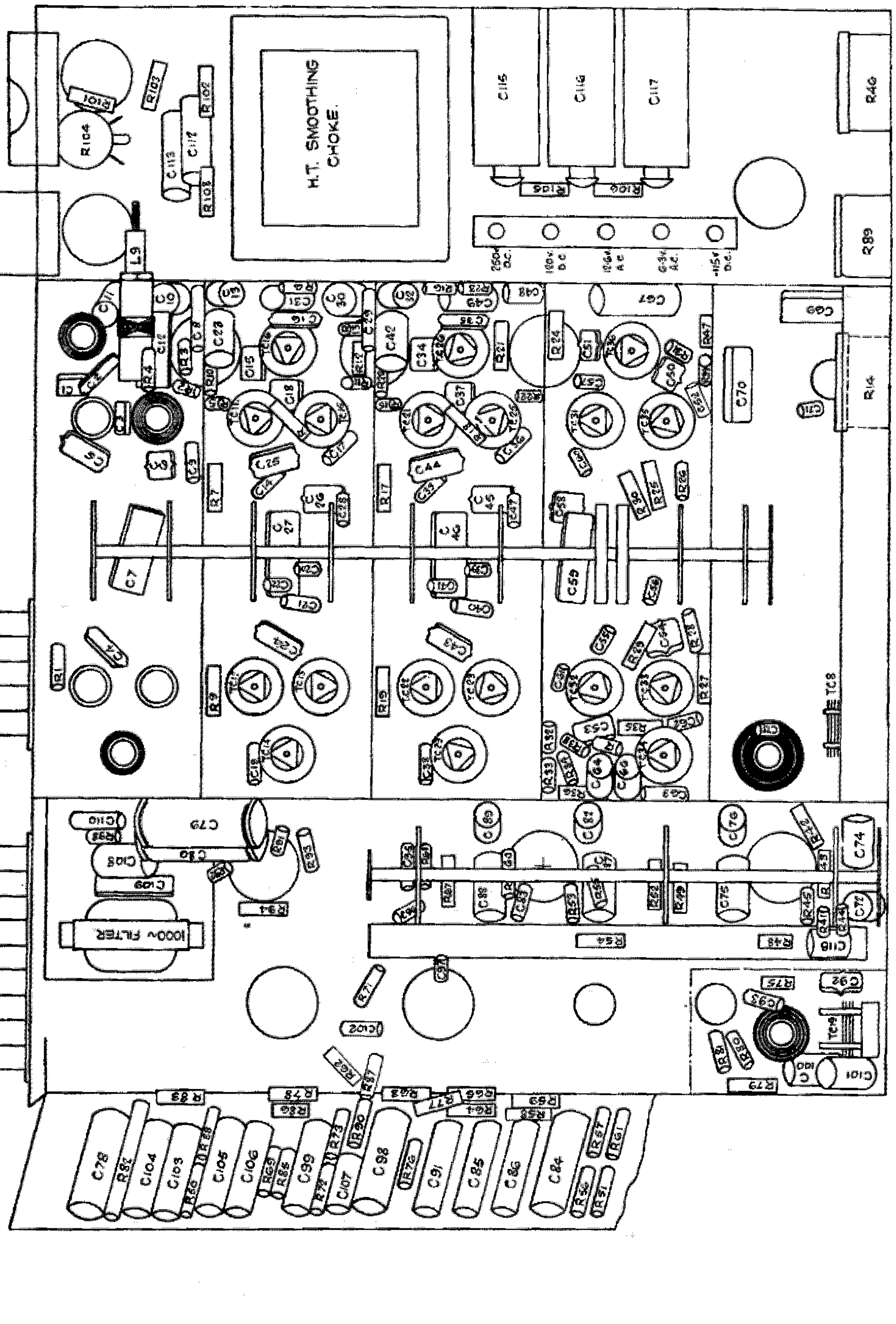
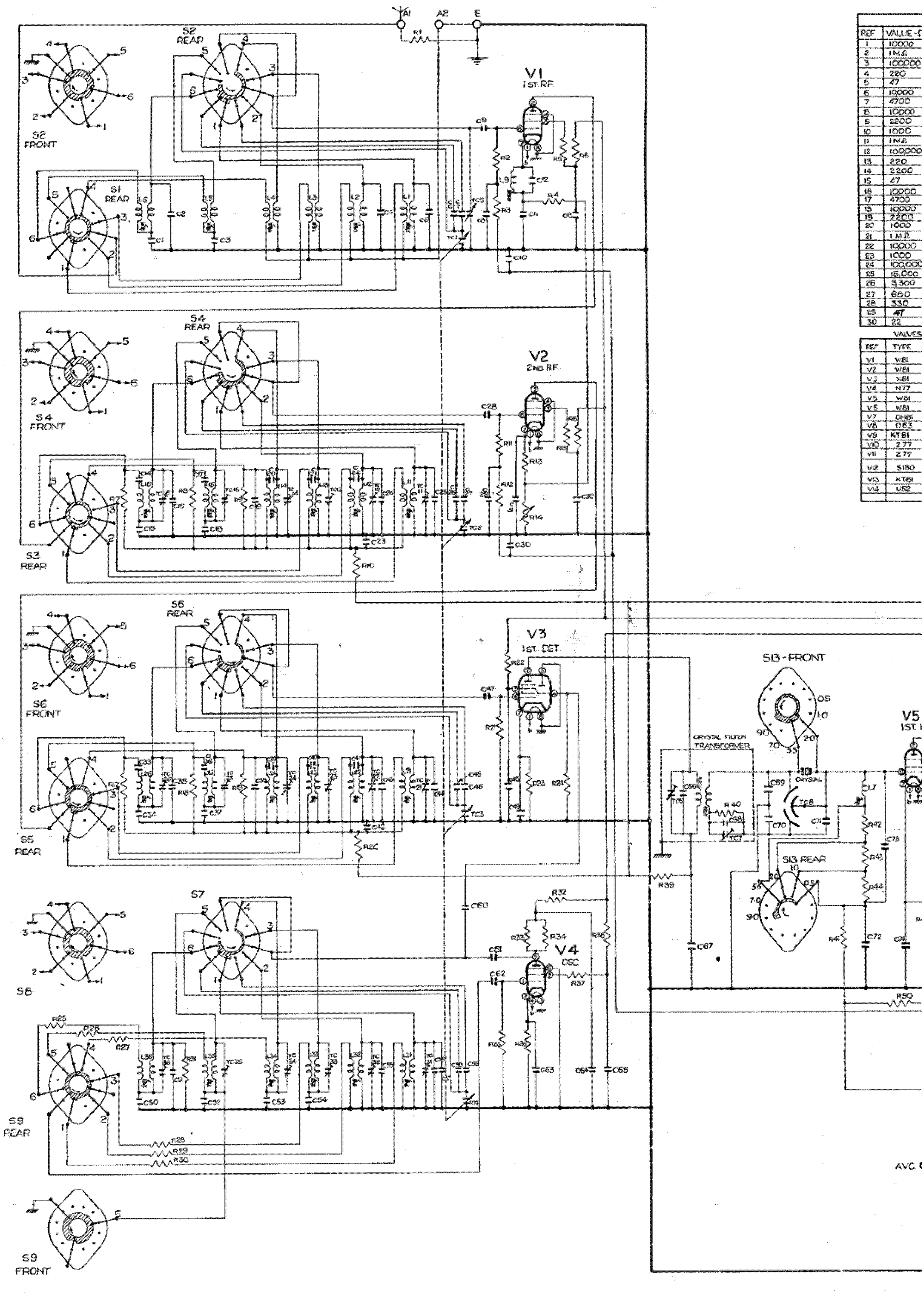


Fig. 24. Component Layout, Underneath View

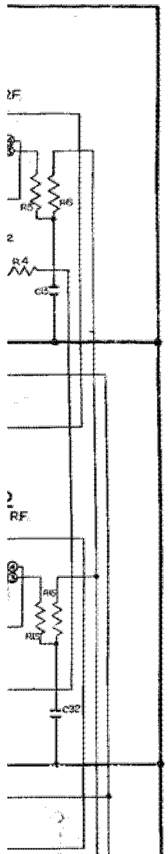


REF	VALUE - Ω
1	10000
2	1 MΩ
3	100,000
4	220
5	47
6	10,000
7	4700
8	10000
9	2200
10	1000
11	1 MΩ
12	100,000
13	220
14	2200
15	47
16	10000
17	4700
18	10,000
19	2200
20	1000
21	1 MΩ
22	10,000
23	1000
24	100,000
25	15,000
26	3,300
27	680
28	330
29	47
30	22

VALVES

REF.	TYPE
V1	W81
V2	W81
V3	X81
V4	N77
V5	W81
V6	W81
V7	DH81
V8	D63
V9	KT81
V10	Z77
V11	Z77
V12	5130
V13	KT81
V14	U52

CIRCUIT FOR CC



RESISTORS

REF	VALUE-Ω	TOL %	W	TYPE	REF	VALUE-Ω	TOL %	W	TYPE	REF	VALUE-Ω	TOL %	W	TYPE	REF	VALUE-Ω	TOL %	W	TYPE
1	10000	20	½		31	47000	20	½		61	2.2MΩ	20	½		91	470000	20	½	
2	1MΩ	20	½		32	1000	20	½		62	470	20	½		92	100	20	½	
3	100000	20	½		33	10,000	20	½		63	47000	20	½		93	100000	20	½	ERIE 8
4	220	20	½		34	10,000	20	½		64	4700	20	½		94	160	10	½	
5	47	20	½		35	100,000	20	½		65	4700	20	½	ERIE 8	95	330	20	½	
6	10000	20	½		36	100	20	½		66	22000	20	½		96	330	20	½	
7	4700	20	½	ERIE 8	37	47	20	½		67	2200	20	½		97	2.5	5	4	WELWYN AW 3116
8	10000	20	½		38	1000	20	½	ERIE 8	68	4700	20	½		98	1.5MΩ	20	½	ERIE 8
9	2200	20	½		39	2200	20	½		69	220000	20	½		99	3000	5	10	PAINTON [illegible]
10	1000	20	½		40	680000	20	½		70	1MΩ	15	01	DUBILIER TYPE Y	100	220	5	25	PAINTON [illegible]
11	1MΩ	20	½		41	100,000	20	½		71	100000	20	½		101	100	20	½	
12	100,000	20	½		42	150	5	½		72	470000	20	½	ERIE 8	102	100000	20	½	ERIE 8
13	220	20	½		43	220	10	½		73	680000	20	½		103	100	20	½	
14	2200	20	3	COLVERN CLR 4201	44	470	20	½		74	100	20	1	COLVERN CLR 1256	104	100	20	1	COLVERN CLR 1256
15	47	20	½		45	330	20	½		75	100,000	20	½		105	22000	20	½	ERIE 8
16	10000	20	½		46	2200	20	3	COLVERN CLR 4201	76	150,000	20	½		106	1MΩ	20	½	ERIE 8
17	4700	20	½		47	100,000	20	½		77	100,000	20	½		107	22000	20	½	ERIE 8
18	10000	20	½		48	22000	20	½		78	680,000	20	½	ERIE 8	108	1MΩ	20	½	ERIE 8
19	2200	20	½		49	2200	20	½		79	1,000	20	½						
20	1000	20	½		50	1MΩ	20	½		80	100,000	20	½						
21	1MΩ	20	½		51	47000	20	½		81	22,000	20	½						
22	10000	20	½		52	1MΩ	20	½		82	22,000	5	12	WELWYN AW 3112					
23	1000	20	½	ERIE 8	53	100	20	½	ERIE 8	83	2,200	20	½	ERIE 8					
24	100,000	20	½		54	100	20	½		84	47	20	1	COLVERN CLR 1256					
25	15,000	20	½		55	22	20	½		85	680,000	20	½						
26	3,300	20	½		56	22,0000	20	½		86	470,000	20	½	ERIE 8					
27	680	20	½		57	220000	20	½		87	100,000	20	½						
28	330	20	½		58	10000	20	½		88	2.2MΩ	20	½						
29	47	10	½		59	1MΩ	20	½		89	500,000	15	05	DUBILIER TYPE Y					
30	22	20	½		60					90	470,000	20	½	ERIE 8					

REF	VALUE	TOL %	WKG V
1	3000PF	2	35
2	15PF	10	35
3	3000PF	2	35
4	15PF	10	35
5	15PF	10	35
6	183PF	1	35
7	1400PF	2	35
8	0.01uF	20	35
9	100PF	5	50
10	0.1uF	25	25
11	0.05uF	25	25
12	5000PF	2	35
13	0.05uF	25	25
14	68PF	10	50
15	3000PF	2	35
16	15PF	10	35
17	82PF	10	50
18	3000PF	2	35
19	82PF	10	50
20	10PF	10	50
21	2.2PF	0.5PF	50
22	6.8PF	5	50
23	0.05uF	25	35
24	15PF	10	35
25	15PF	10	35
26	183PF	1	35
27	1400PF	2	35
28	100PF	5	50
29	0.01uF	20	35
30	0.1uF	25	25

VALVES

REF	TYPE	BASE
V1	W81	B8B
V2	W81	B8B
V3	X81	B8B
V4	N77	B7G
V5	W81	B8B
V6	W81	B8B
V7	DH81	B8B
V8	D63	OCTAL
V9	KT81	B8B
V10	Z77	B7G
V11	Z77	B7G
V12	S130	BRITISH 4 PIN
V13	KT81	B8B
V14	U52	OCTAL

TOGGLE SWITCHES

C=CLOSED O=OPEN

	SW 1	SW 2	SW 3	SW 4	SW 5	SW 6	SW 7	SW 8	SW 9	SW 10
MAINS-ON	C	C								
MAINS-OFF	O	O								
SEND									O	C
RECEIVE									C	O
AVC-ON								O		
AVC-OFF								C		
SPEECH					C					
MUSIC					O					
BFO-ON						C	C			
BFO-OFF						O	O			
FILTER-IN			O	C						
FILTER-OUT			C	O						

ROTARY SWITCHES

S1 TO S10	RANGES
S11 TO S13	SELECTIVITY

PRESET ADJUSTABLE INDUCTANCES

RANGE	AERIAL	1ST RF	2ND RF	OSC
1	L1	L11	L21	L31
2	L2	L12	L22	L32
3	L3	L13	L23	L33
4	L4	L14	L24	L34
5	L5	L15	L25	L35
6	L6	L16	L26	L36
CRYSTAL FILTER	L7			
BFO	L8			
I.F. REJECTOR	L9			

PRESET CONCENTRIC TRIMMERS 3-30PF

RANGE	1ST RF	2ND RF	OSC
1	TC11	TC21	TC31
2	TC12	TC22	TC32
3	TC13	TC23	TC33
4	TC14	TC24	TC34
5	TC15	TC25	TC35
6	TC16	TC26	TC36
CRYSTAL FILTER INPUT TRANSFORMER		TC6	TC7
1ST I.F.T.		TC9	TC10
2ND I.F.T.		TC17	TC18

VARIABLE TRIMMERS

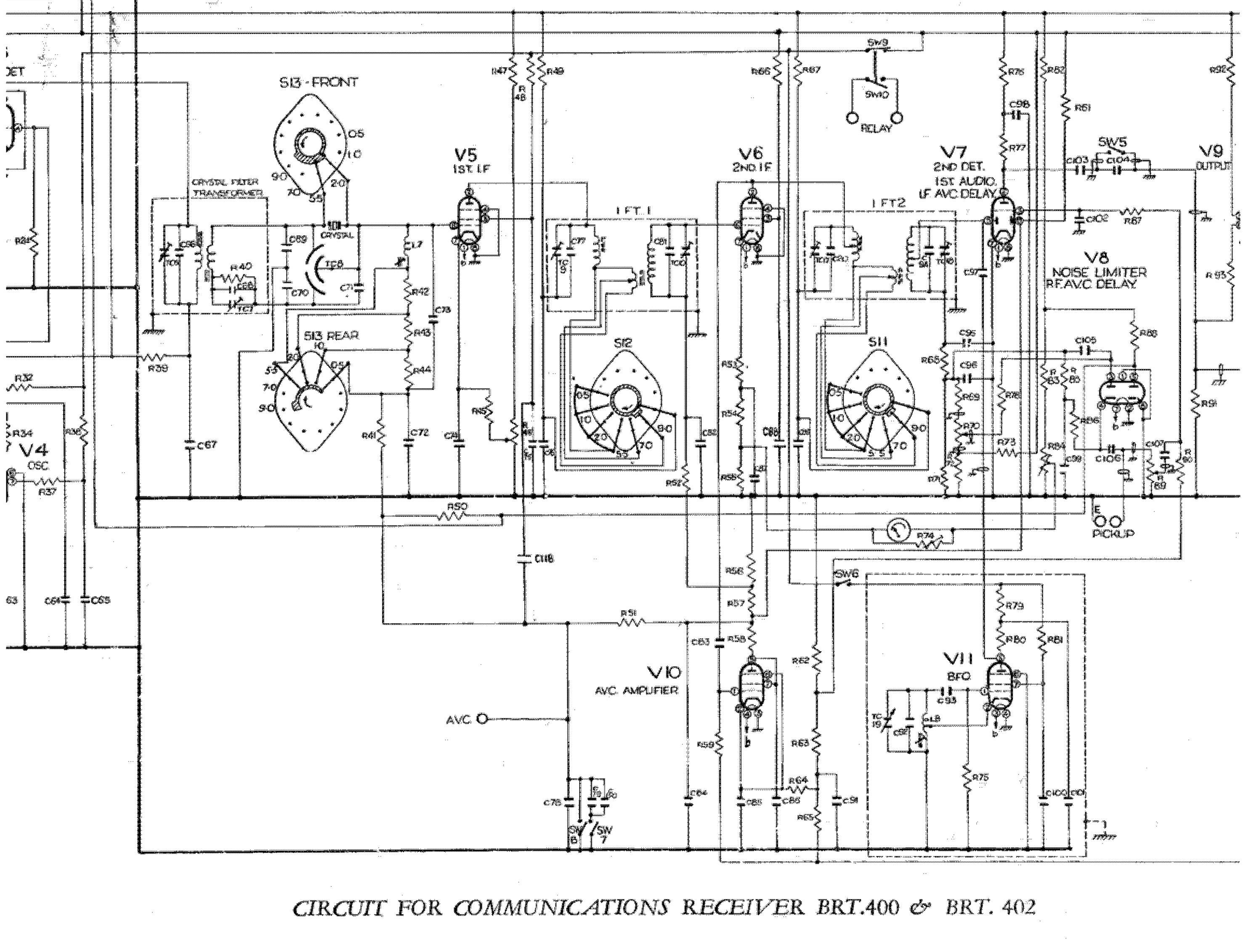
AERIAL TRIMMER	3-25PF	TC5
CRYSTAL PHASING	[illegible]	TC8
BFO PITCH	3-25PF	TC19

GANG CONDENSER 431.5PF SWING

AERIAL	TC1
1ST RF	TC2
2ND RF	TC3
OSC	TC4

B8

OCTAL



CIRCUIT FOR COMMUNICATIONS RECEIVER BRT.400 & BRT. 402

RESISTORS									
REF	VALUE -Ω	TOL ±%	W	TYPE	REF	VALUE -Ω	TOL ±%	W	TYPE
61	2·2MΩ	20	½		91	470000	20	½	
62	470	20	½		92	100	20	½	
63	47000	20	½		93	100000	20	½	ERIE 8
64	4700	20	½		94	150	10	½	
65	4700	20	½	ERIE 8	95	330	20	½	
66	22000	20	½		96	330	20	½	
67	2200	20	½		97	2·5	5	4	WELWYN AW 3115
68	4700	20	½		98	1·5MΩ	20	½	ERIE 8
69	220000	20	½		99	3000	5	10	PAINTON P7000
70	1 MΩ	15	0·1	DUBILIER TYPE Y	100	220	5	25	PAINTON P2001
71	100000	20	½		101	100	20	½	
72	470000	20	½	ERIE 8	102	100000	20	½	ERIE 8
73	680000	20	½		103	100	20	½	
74	100	20	1	COLVERN CLR 1206	104	100	20	1	COLVERN CLR 1206
75	100,000	20	½		105	22000	20	½	ERIE 8
76	150,000	20	½		106	1MΩ	20	½	ERIE 8
77	100,000	20	½		107	22000	20	½	ERIE 8
78	680,000	20	½	ERIE 8	108	1MΩ	20	½	ERIE 8
79	1,000	20	½						
80	100,000	20	½						
81	22,000	20	½						
82	22,000	5	12	WELWYN AW 3112					
83	2,200	20	½	ERIE 8					
84	47	20	1	COLVERN CLR 1206					
85	680,000	20	½						
86	470,000	20	½	ERIE 8					
87	100,000	20	½						
88	2·2MΩ	20	½						
89	500,000	15	0·15	DUBILIER TYPE Z					
90	470,000	20	½	ERIE 8					

CAPACITORS											
REF	VALUE	TOL ±%	WKG VOLTS	TYPE	REF	VALUE	TOL ±%	WKG VOLTS	TYPE		
1	3000PF	2	350	HUNTS L4/1	31	0·05uF	25	250	DUBILIER 418		
2	15 PF	10	350	HUNTS L4/3	32	0·05uF	25	250	DUBILIER 418		
3	3000PF	2	350	HUNTS L4/1	33	68PF	10	500	CERAMICON N750		
4	15PF	10	350	HUNTS L4/3	34	3000PF	2	350	HUNTS L4/1		
5	15PF	10	350	HUNTS L4/3	35	15 PF	10	350	HUNTS L4/3		
6	183 PF	1	350	HUNTS L4/4	36	82PF	10	500	CERAMICON N750		
7	1400PF	2	350	HUNTS L4/1	37	3000PF	2	350	HUNTS L4/1		
8	0·01uF	20	350	DUBILIER MINICAP	38	82PF	10	500	CERAMICON N750		
9	100 PF	5	500	CERAMICON N750	39	10PF	10	500	CERAMICON N750		
10	0·1uF	25	250	DUBILIER 418	40	2·2PF	0.5pF	500	DUBILIER CP/SCXI		
11	0·05uF	25	250	DUBILIER 418	41	6·8PF	5%	500	DUBILIER CP/SCX2		
12	5000PF	2	350	HUNTS L4/1	42	0·05uF	25	350	DUBILIER 418		
13	0·05uF	25	250	DUBILIER 418	43	15 PF	10	350	HUNTS L4/3		
14	68PF	10	500	CERAMICON N750	44	15 PF	10	350	HUNTS L4/3		
15	3000PF	2	350	HUNTS L4/1	45	183PF	1	350	HUNTS L4/4		
16	15 PF	10	350	HUNTS L4/3	46	1400PF	2	350	HUNTS L4/1		
17	82 PF	10	500	CERAMICON N750	47	100PF	5	500	CERAMICON N750		
18	3000PF	2	350	HUNTS L4/1	48	0·05uF	25	250	DUBILIER 418		
19	82 PF	10	500	CERAMICON N750	49	0·05uF	25	250	DUBILIER 418		
20	10 PF	10	500	CERAMICON N750	50	137 PF	1	350	HUNTS L4/4		
21	2·2PF	0.5pF	500	DUBILIER CP/SCXI	51	15 PF	10	350	HUNTS L4/3		
22	6·8PF	5	500	DUBILIER CP/SCX2	52	400PF	1	350	HUNTS L4/2		
23	0·05uF	25	350	DUBILIER 418	53	1415 PF	1	350	HUNTS L4/1		
24	15 PF	10	350	HUNTS L4/2	54	3250PF	2	350	HUNTS L4/1		
25	15 PF	10	350	HUNTS L4/2	55	*5·6 PF	10	500	DUBILIER CP/SCX2		
26	183PF	1	350	HUNTS L4/4	56	*8·2PF	0.5pF	500	DUBILIER CP/SCX2		
27	1400 PF	2	350	HUNTS L4/1	57	*3·3PF	0.5pF	500	DUBILIER CP/SCXI		
28	100PF	5	500	CERAMICON N750	58	178 PF	1	350	HUNTS L4/4		
29	0·01uF	20	350	DUBILIER MINICAP	59	1200PF	1	350	HUNTS L4/1		
30	0·1uF	25	250	DUBILIER 418	60	22 PF	10	500	CERAMICON N750		

REF	VALUE	TOL ±%	WKG VOLTS	TYPE	REF	VALUE	TOL ±%	WKG VOLTS	TYPE
61	39 PF	10	500	CERAMICON N750	91	0·1uF	20	350	METAL CASED TUB
62	100PF	5	500	CERAMICON N750	92	470 PF	2	350	HUNTS L4/2
63	0·01uF	20	350	DUBILIER MINICAP	93	100PF	5	500	CERAMICON N750
64	0·05uF	25	250	DUBILIER 418	94	100PF	5	500	CERAMICON N750
65	0·05uF	25	350	DUBILIER 418	95	100PF	5	500	CERAMICON N750
66	82PF	5	350	HUNTS L4/4	96	100PF	5	500	CERAMICON N750
67	0·10uF	20	350	METAL CASED TUB	97	10 PF	10	500	CERAMICON N750
68	130PF	2	350	HUNTS L4/4	98	0·25uF	25	250	DUBILIER 418
69	0·001uF	10	350	MOULDED MICA	99	0·05uF	20	500	METAL CASED TUB
70	0·001uF	10	350	MOULDED MICA	100	0·1uF	25	250	DUBILIER 418
71	3·3PF	0.5pF	500	DUBILIER CP/SCXI	101	0·1uF	25	250	DUBILIER 418
72	0·1uF	25	250	DUBILIER 418	102	47PF	10	500	CERAMICON N750
73	39PF	10	500	CERAMICON N750	103	0·1uF	20	350	METAL CASED TUB
74	0·1uF	25	250	DUBILIER 418	104	0·005uF	20	1000	METAL CASED TUB
75	0·1uF	25	250	DUBILIER 418	105	0·1uF	20	350	METAL CASED TUB
76	0·1uF	20	350	METAL CASED TUB	106	0·1uF	20	350	METAL CASED TUB
77	100PF	5	500	CERAMICON N750	107	0·03uF	25	350	DUBILIER 418
78	0·25uF	25	250	DUBILIER 418	108	0·05uF	25	350	DUBILIER 418
79	2·0uF	25	150	DUBILIER 418	109	5000PF	2	350	HUNTS L4/1
80	2·0uF	25	150	DUBILIER 418	110	0·001uF	25	500	DUBILIER MINICAP
81	100PF	5	500	CERAMICON N750	111	2uF	20	400	PAPER BLOCK
82	0·1uF	25	250	METAL CASED TUB	112	0·1uF	20	350	METAL CASED TUB
83	47PF	10	500	CERAMICON N750	113	0·1uF	20	350	METAL CASED TUB
84	0·25uF	25	350	DUBILIER 418	114	4uF	20	400	PAPER BLOCK
85	0·1uF	20	350	METAL CASED TUB	115	2uF	20	250	PAPER BLOCK
86	0·1uF	20	350	METAL CASED TUB	116	2uF	20	250	PAPER BLOCK
87	0·1uF	25	250	DUBILIER 418	117	2uF	20	250	PAPER BLOCK
88	0·1uF	25	250	DUBILIER 418	118	0·1uF	25	250	DUBILIER 418
89	0·1uF	20	350	METAL CASED TUB					
90	100PF	5	500	CERAMICON N750					

OPEN

ROTARY SWITCHES

S1 TO S10	RANGES
S11 TO S13	SELECTIVITY

PRESET ADJUSTABLE INDUCTANCES

RANGE	AERIAL	1ST RF	2ND RF	OSC.
1	L1	L11	L21	L31
2	L2	L12	L22	L32
3	L3	L13	L23	L33
4	L4	L14	L24	L34
5	L5	L15	L25	L35
6	L6	L16	L26	L36
CRYSTAL FILTER	L7			
B.F.O.	L8			
I.F. REJECTOR	L9			

PRESET CONCENTRIC TRIMMERS 3-30PF

RANGE	1ST RF	2ND RF	OSC.
1	TC 11	TC 21	TC 31
2	TC 12	TC 22	TC 32
3	TC 13	TC 23	TC 33
4	TC 14	TC 24	TC 34
5	TC 15	TC 25	TC 35
6	TC 16	TC 26	TC 36
CRYSTAL FILTER INPUT TRANSFORMER	TC6	TC7	
1ST. I.F.T.	TC9	TC10	
2ND I.F.T.	TC17	TC18	

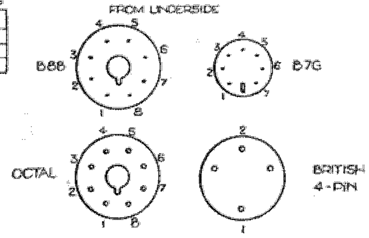
VARIABLE TRIMMERS

AERIAL TRIMMER	3-25PF	TC5
CRYSTAL PHASING	5PF DIFFERENTIAL	TC8
B.F.O. PITCH	3-25PF	TC19

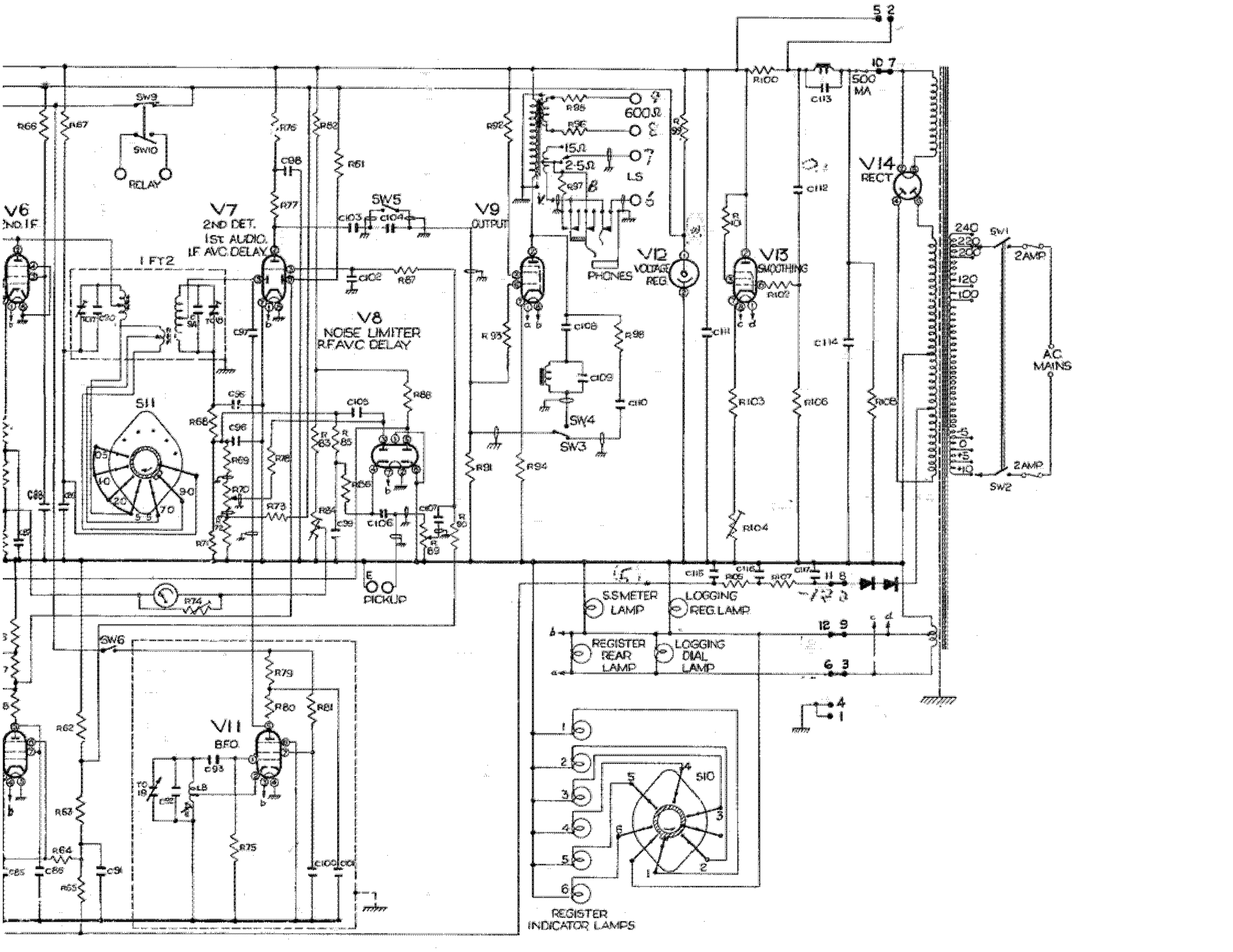
GANG CONDENSER 431.5PF SWING

AERIAL	TC1
1ST RF	TC2
2ND RF	TC3
OSC	TC4

VALVEHOLDERS VIEWED FROM UNDERSIDE



NOTES : 1. CAPACITORS MARKED * ARE TEMPERATURE CORRECTION CAPACITORS.



…IVER BRT.400 & BRT. 402