G.E.C. **Radio Communication Equipment**

G.E.C.

COMMUNICATIONS RECEIVER

BRT.400D, BRT.402D, BRT.400E, BRT.402E,
BRT.400DN, BRT.402DN, BRT.400EN & BRT.402EN

Operating Handbook

The G.E.C. Reserve the right to alter technical details

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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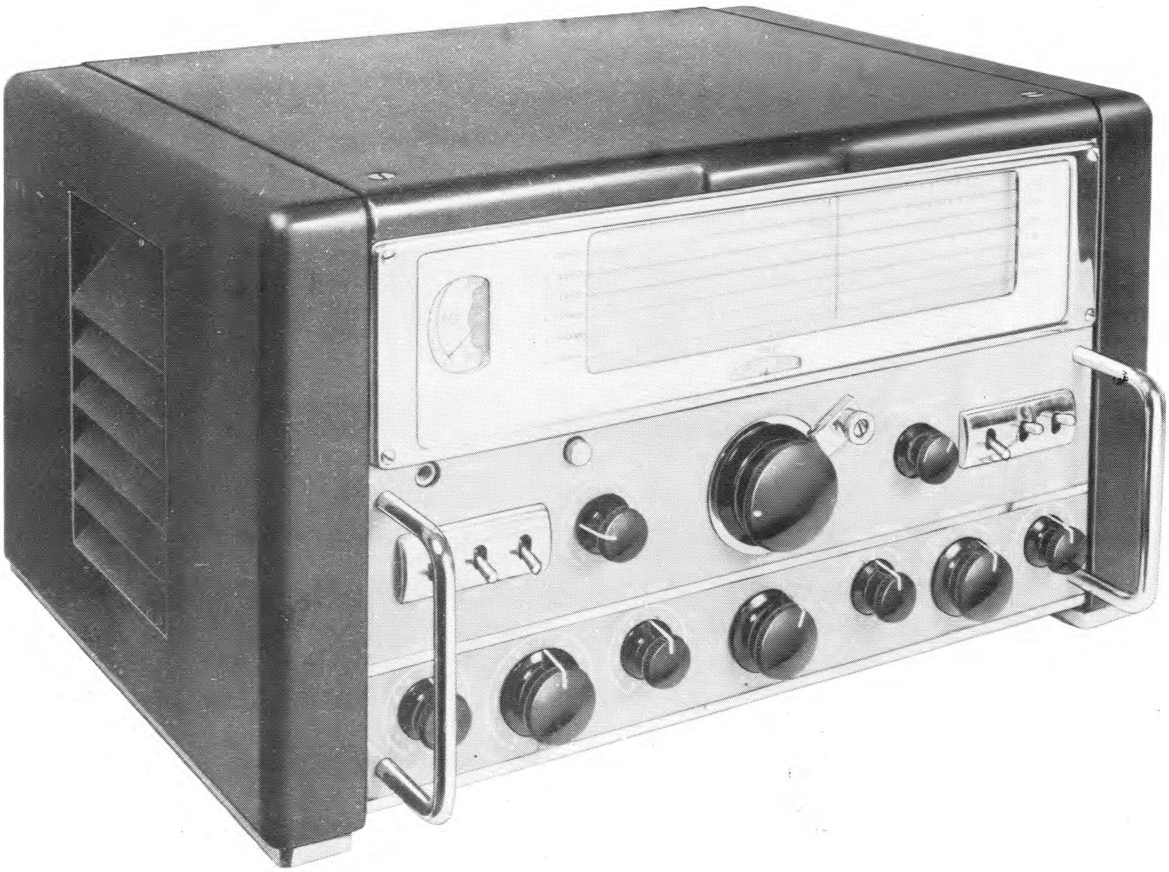
ILLUSTRATIONS



Communications Receiver BRT.400E, Table Model

Communications Receiver BRT.402E, for Rack Mounting

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, or for mounting in a Standard 19-inch rack.

Provision has been made so that a number of the receivers may be worked in a simple form of diversity, and an output has been provided from the I.F. amplifier so that they may be used for F.S.K. reception.

1.2 Types

The chassis and circuitry (except for small modifications) is identical in all types. The BRT.400D and BRT.402D are the basic receivers, the former being a Table Model, the latter for mounting in a 19-inch rack.

The BRT.400E and BRT.402E are similar to the BRT.400D and BRT.402D, but are fitted with a crystal calibrator Type BRT.403. The addition of the suffix N, BRT.400DN, BRT.402DN, BRT.400EN, BRT.402EN indicates that they are similar to the BRT.400D, BRT.402D, BRT.400E and BRT.402E except that in place of the 1 Kc. Audio Acceptor Filter they have a 9 Kc/s. Audio Rejector Filter.

1.3 Frequency Range

Total six Ranges 150-385 Kc/s., 0.51-30 Mc/s.

Range	6		150- 385	Kc/s.
"	5		510- 1,300	"
"	4	..	1,300- 3,200	"
"	3	..	3,200- 8,500	"
"	2	..	8,500-20,000	"
"	1	..	20,000-30,000	"

1.4 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 3.4 Kc/s.

1.5 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 calibrated in frequency, the accuracy of calibration being ± ½%.

1.6 Sensitivity

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

1.7 Signal to Noise Ratio

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

Ranges 1-4	..	Less than 7.0 μ V.
Ranges 5 and 6	..	Less than 10.0 μ V.

1.8 Image Attenuation

Greater than 30 db at 30 Mc/s. increasing to greater than 100 db below 3,400 Kc/s.

1.9 Intermediate Frequency

455 Kc/s.

1.10 Selectivity

Telephone:	Three switched bandwidths without crystal filter. Overall bandwidths for 6 db attenuation 5.5, 9.0, 13.0 Kc/s.
Telegraphy:	Three switched bandwidths with crystal filter. Overall bandwidths for 6 db attenuation 0.5, 1.0, 2.0 Kc/s.

1.11 Overall Fidelity

Less than - 2 db at 50 c.p.s., less than - 6 db at 5,500 c.p.s., measured in broadest selectivity position, 600 ohms output.

1.12 A.V.C.

3 db change in output for a 100 db change in input. Zero level 3 μ V.

1.13 Input Impedances

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

1.14 Output Impedances and Levels

To Line at 600 ohms	0.2	Watts
120-ohm Headphones	0.05	"
15-ohm Speaker	2.5	"
2.5-ohm Speaker	2.5	"

1.15 F.S.K. Output

5 mV across 100 ohms.

1.16 Crystal Calibrator

Frequency 500 Kc/s ± 0.01%.

1.17 1000 c.p.s. Audio Acceptor Filter

200 c.p.s. bandwidth at 6 db Attenuation.

1.18 9 Kc/s Audio Rejector Filter

Attenuation : Greater than 30 db

1.19 Speech/Music Switch

Bass Cut 7.5 db at 400 c.p.s.

1.20 Local Oscillator Frequency Drift

Less than 5 Kc/s at 29 Mc/s, 3 Kc/s at 19 Mc/s, and 2 Kc/s at 8 Mc/s and 3 Mc/s.

1.21 Local Oscillator Radiation

Less than 250 μ V.

1.22 Controls

Main Tuning Control.
Dial Lock.
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.
Calibrator On/Off.
Audio Filter In/Out Switch.
Speech/Music Switch.
B.F.O. On/Off Switch.

1.23 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 P.
V13	Smoothing Valve	KT.81
V14	Rectifier	U.52
V15	Calibrating Oscillator	Z.77

Ten Lamps 6.5 V. 0.3 A.

The equipment is designed to use valves and dial lamps supplied by The General Electric Co., Ltd., of England. In British Commonwealth countries The General Electric Co. Ltd., are the proprietors of the Trade Mark OSRAM and in these territories valves and dial lamps are branded with their Trade Mark OSRAM. In other territories valves and dial lamps supplied by The General Electric Co. Ltd. are branded with their Trade Mark G.E.C. The alternative branding is in no way associated with any difference in quality or manufacture. Replacements should always be made with the appropriate type, other types should not be substituted.

1.24 Consumption

135 Watts.

1.25 Weight

BRT.400D: 81 lbs.	BRT.402D: 78 lbs.
BRT.400E: 82 lbs.	BRT.402E: 79 lbs.

1.26 Dimensions

BRT.400D: Height 11 11/16 inches, Width 20 1/8 inches, Depth 17¼ inches.
BRT.402D: Height 10½ inches, Width 19 inches, Depth 17¼ 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. Ranges 5 and 6 are stagger-tuned to prevent sideband cutting; Ranges 1, 2, 3 and 4 have low frequency resonant primaries and top capacity coupling; Ranges 5 and 6 have 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 R 16 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.130P 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.

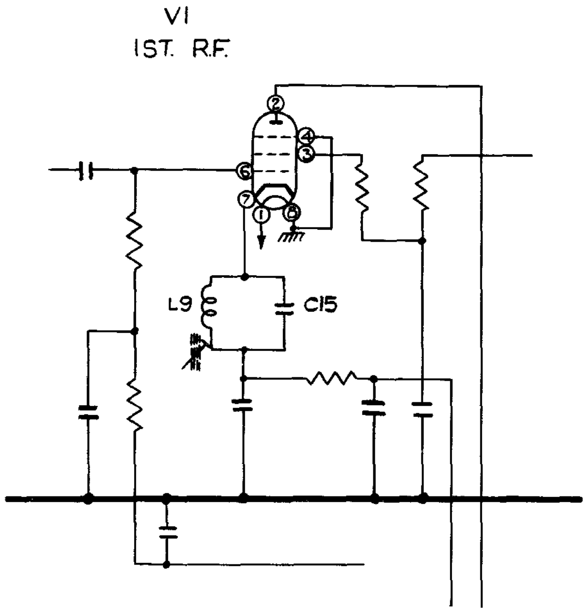


Fig. 1 I.F. Rejector Circuit

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 circuit consisting of L9 and C15 tuned 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 low, 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).

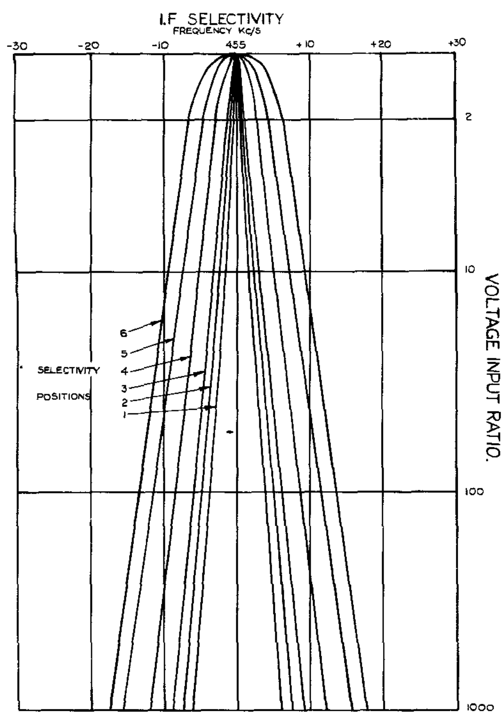


Fig. 2. Crystal Filter and I.F. Response Curves

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).

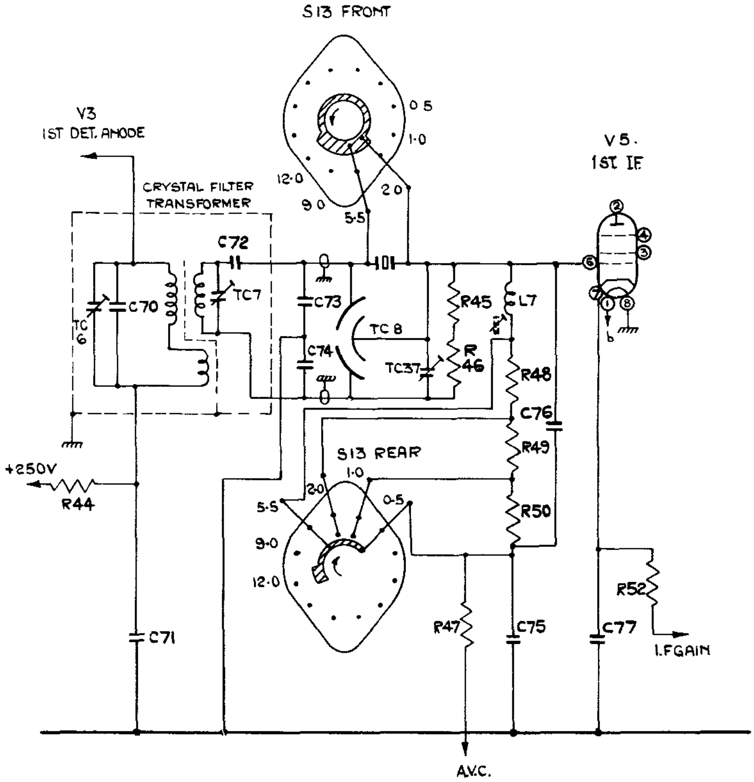


Fig. 3. Crystal Filter Circuit

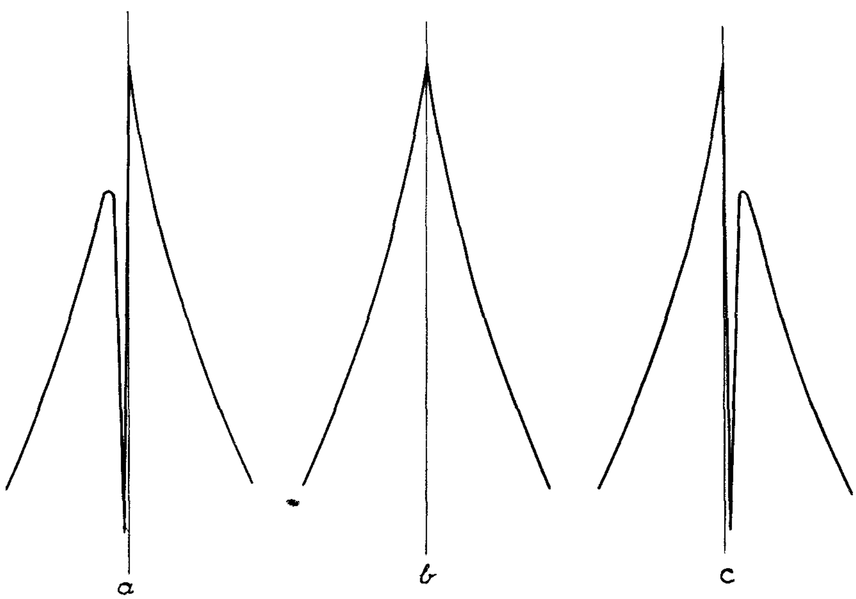


Fig. 4. "Single Signal" Response Curves

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 attenuation of the interfering signal exceeds 45 db when the frequency difference between the wanted and unwanted signals is 1 Kc/s.

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 C72 and C73, C74. 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 R48, R49, R50 in series with the tuned circuit L7, C76. This method gives fairly equal gain for the various bandwidths.

The tuned circuit is returned to earth for intermediate frequency by C75. A.V.C. is applied in series with it from R47.

Capacitor TC37 is used to balance the stray capacitance across the crystal due to the connections to the shorting switch. It is set so that a symmetrical response is obtained when the pointer of the phasing control knob is set vertically.

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 position 1, 2 or 3. 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 9.0 and 13.0 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 R53 to provide the I.F. Gain Control.

The F.S.K. output is taken from the cathode of the 2nd I.F. amplifier; this resistor which is partly unbypassed provides a convenient low impedance source.

Switch S.10 is to equalise the Audio output for the three I.F. selectivities; this is necessary because the coupling of the 2nd I.F.T. is changed to obtain the various bandwidths. A change in gain of the receiver is therefore made at a later stage than the source of the A.V.C. voltage (which would normally tend to keep the output constant; thus some other means of achieving this must be provided.

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 R62, R61, R60, the valve to H.T. + and R91, R90, R89 with R88 and R92 in parallel. 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 R90 (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. R87 is across the meter to provide a full scale adjustment which is independent of the set zero control R90.

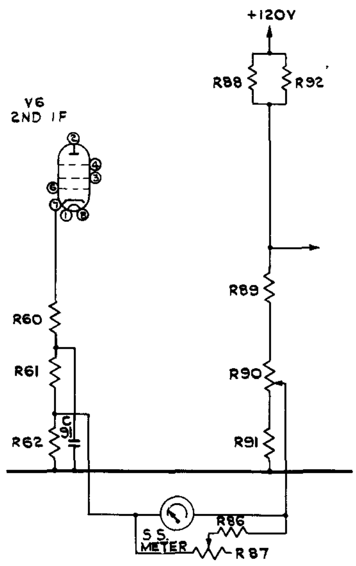


Fig. 5. Signal Strength Meter Circuit

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.

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).

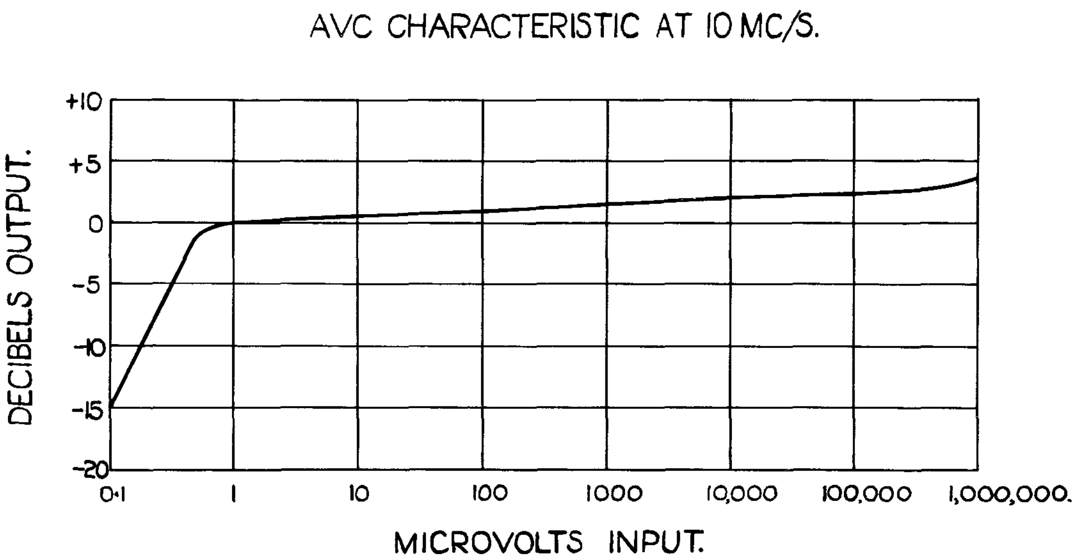


Fig. 6. A.V.C. Characteristic Curve

Its anode load R63, R64, 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 C89. The valve is biassed to cut off by means of the potentiometer R69, R70, R71 and the cathode resistor R66. R65 and C93 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.

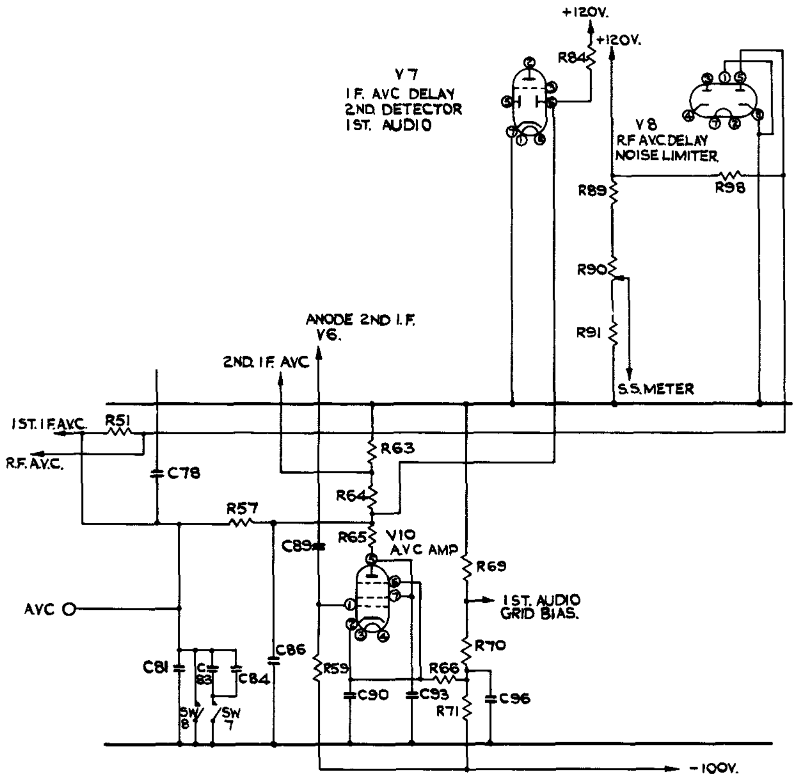


Fig. 7. A.V.C. Circuit

The A.V.C. is taken from the junction of R64, R65. 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 R84. The A.V.C. is first applied to V5, the first I.F. Amplifier. R51 separates the I.F. and R.F. delays, the R.F. A.V.C. being 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 R98.

The system will operate as follows: If a gradually increasing signal is applied to the grid of V10 through C89 the voltage at the junction of R64, R65 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. is left to the discretion of the user, but this switch does automatically lengthen the time constant of the A.V.C. by putting C83 and C84 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. The positive controlling voltage is obtained from the potentiometer R94. Due to the network R93, R94, R95, whatever the setting of R94 some positive voltage is always applied to the diode; with the slider of R94 at the R95 end the noise limiter will accept a signal modulated about 25%; when it is at the R93 end it will easily accept a signal modulated 100%.

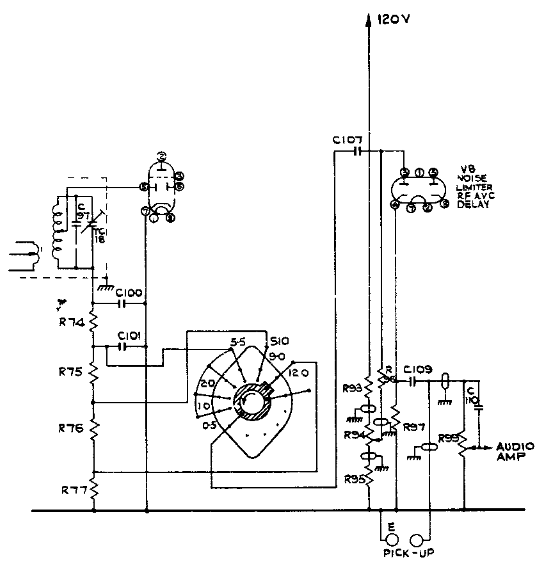


Fig. 8. Noise Limiter Circuit

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 greatly reduced; it was felt that to have a degree of limiting in circuit continually was advantageous. The amount of limiting 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 R69, R70 and R71 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 C112, .005 μF, in series with C108 the normal coupling capacitor, giving a cut in bass response of about 7 db at 400 c.p.s. (see Figs. 9 and 10).

The output valve is conventional except for the negative feedback circuits. When receiving speech or music R108 and C115 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 C114 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.

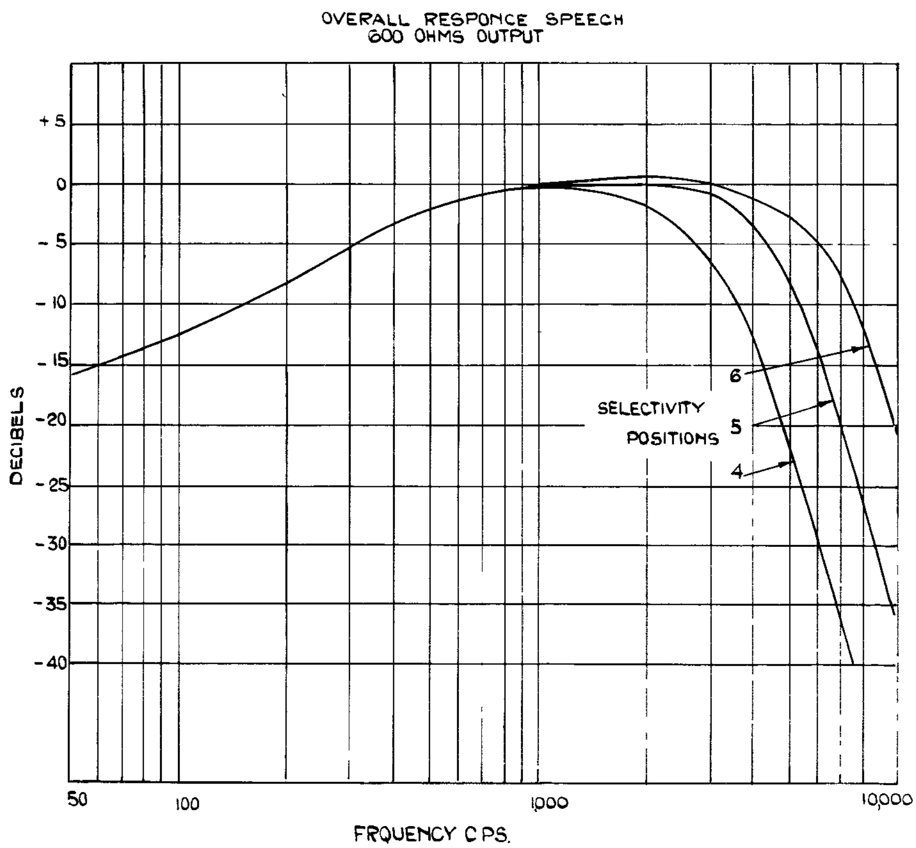


Fig. 9. Overall Response "Speech"

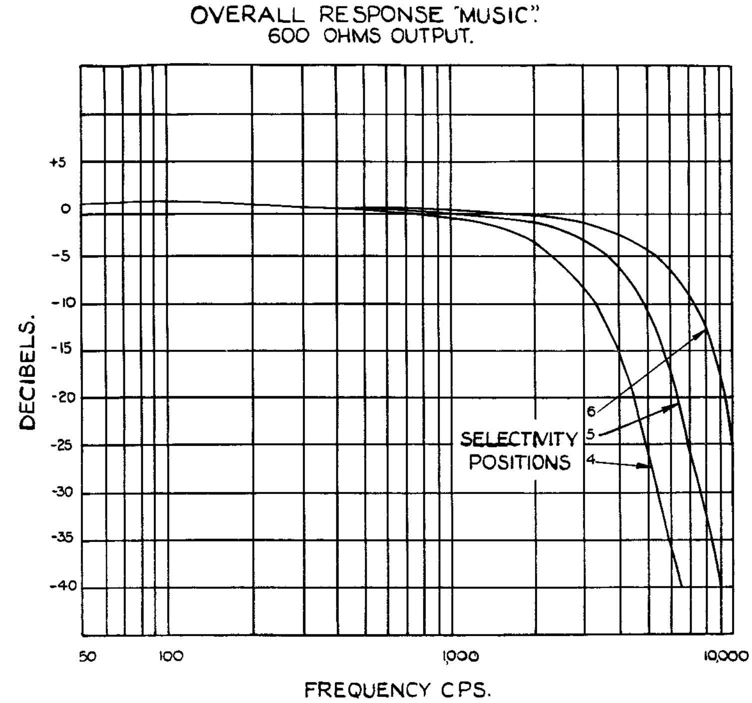


Fig. 10. *Overall Response "Music"*

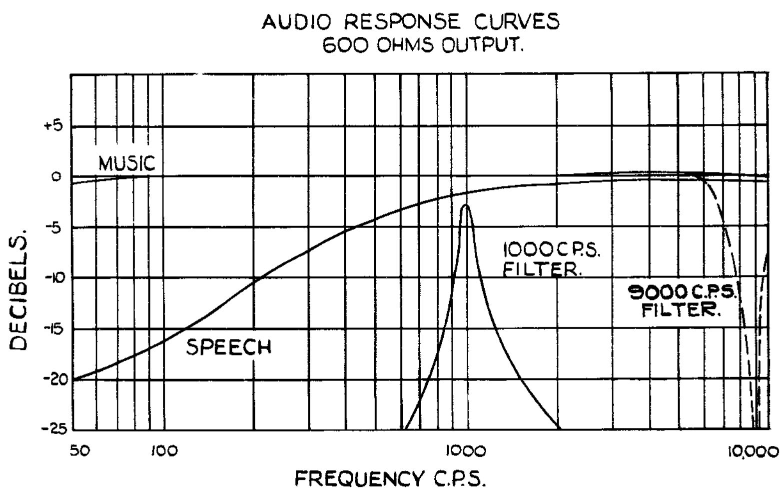


Fig. 11. *Audio Response Curves*

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 R107 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. The output is limited by putting resistors R105, R106 in series with a low impedance secondary winding.

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 C119, 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 R113. 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 R116 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 wavelengths 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.

2.14 Crystal Calibrator

The oscillator is a cathode tapped Hartley. The crystal controlling its frequency is in series with the tuned circuit.

To increase the amplitude of the higher harmonics the anode load is a parallel tuned circuit resonant at a frequency higher than the highest frequency covered by the receiver. The output of the generator is fed into the grid of the 2nd R.F. Amplifier in the receiver. The 2nd R.F. Amplifier was chosen, firstly to prevent radiation from the aerial, which would be objectionable if more than one receiver is to be operated on the same aerial system, and secondly to reduce the 90 Kc/s. higher harmonic.

The 90 Kc/s. spurious is caused by the beat between (Signal Frequency + 1,000 Kc/s.) - (Local Oscillator + 1F) or 1,000 Kc/s. - 2 1F = 90 Kc/s.

This spurious occurs at a higher frequency than the desired beat and can generally be heard only on the highest frequency range.

To reduce interference when the calibrator is used with the aerial connected to the receiver, the Crystal Calibrator ON/OFF Switch disconnects the screen of the 1st R.F. Valve from the 120-volt supply and also switches the BFO on.

2.15 9 Kc/s Audio Rejector Filter

The Filter is a π network adjusted to give maximum attenuation at 9 Kc/s. The attenuation at 6 Kc/s is negligible, (Fig. 11) and so does not impair the fidelity when the widest bandwidth position is used, while at 9 Kc/ the overall attenuation exceeds 45 db.

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; 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). Access is obtained by removing the protection cover.

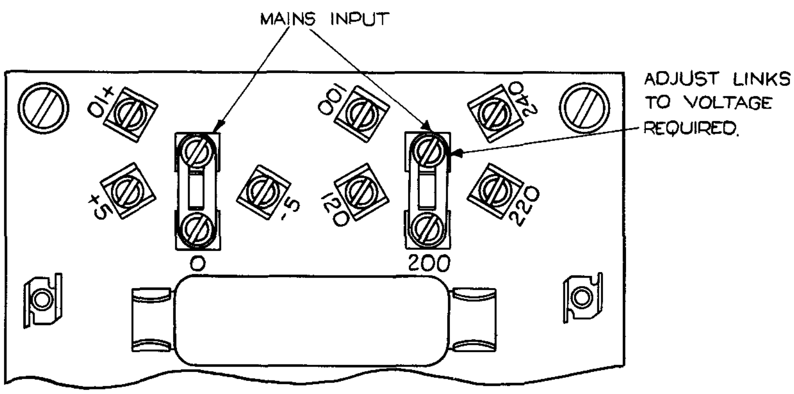


Fig. 12. Mains Transformer Taps

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

The aerial system is a very important factor in obtaining good results from receiving equipment; it should be chosen and designed with considerable care according to the use to which the receiver is to be put.

For general purpose use the G.E.C. All-Wave Aerial Type BC.636 or an inverted L will give good results.

When the receiver is used for listening over a narrow band of frequencies, half-wave dipoles are recommended. The receiver has an input impedance of 75 ohms; a horizontal dipole is of this impedance and may be connected directly to the aerial terminals (a graph showing the dimensions of a dipole against frequency is given in Fig. 13).

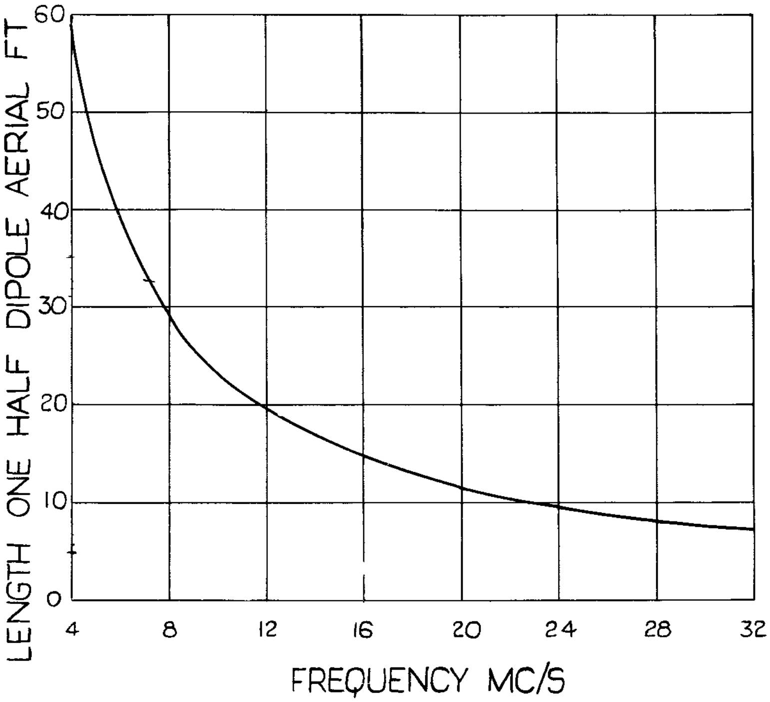


Fig. 13. Length Dipole/Frequency

Where the service is to cover a limited number of frequencies, and in particular directions over long distances, a more directional and high gain aerial such as a rhombic should be used, this will require a matching device to transform the impedance of the aerial down to 75 ohms.

In all cases the Company will advise, and if required supply a suitable aerial system.

The connections to the receiver are as follows. Single-ended aerials are connected to terminal A.1 at the rear of the set (see Fig. 22) and the earth link provided connected between A.2 and E. Balanced aerials are connected to A.1 and A.2; the earth link is omitted.

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 6 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 wide 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 connected to the 15 ohms winding; to change this to 2.5 ohms the brown lead from the fourth terminal from the left-hand side of the front terminal strip on the output transformer should be removed and connected to the ~~second~~ third terminal from the left-hand side.

STET

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.

The 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 underneath the protection cover [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 Scale

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 ½%; 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. A tuning control lock is provided.

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. Its setting is also of great importance on the two low frequency stagger tuned ranges in that misalignment of this circuit will upset the overall response, more especially with the selectivity switch in position 6.

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 also 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.

With those receivers that are fitted with a 9 Kc/s Rejector Filter, a great improvement in adjacent channel whistle will be found by the use of the filter; this should allow the use of a wider I.F. selectivity position than would normally be used with a consequent improvement in quality of reception. The effect of the filter on the overall audio response is negligible.

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 13 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 frequency 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.

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 limiting 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 μ V. 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.

4.17 Crystal Calibrator

When the Crystal Calibrator On/Off Switch is depressed, and the tuning knob rotated a series of beats will be heard every 500 Kc/s. Thus by plotting the logging dial reading against frequency, an accurate calibration of the receiver may be obtained. It must be remembered that the frequency law of the gang condenser is not linear, and at least one point on either side of the required frequency range must be plotted, and a smooth curve drawn through all the points.

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 400 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) 15 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 15 ohms speaker terminals unless otherwise specified.

5.1.2 *Sensitivity*

(a) Speech/Music Switch in Music Position 40-65 mV.
(b) Speech/Music Switch in Speech Position, output to be 7.5 ± 2 db less than *(a)*.
(c) Speech/Music Switch in Music Position, Audio Filter in. Output should be the same as *(a)* ± 1 db. 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. 105-155 mV. input.
(e) Speech/Music Switch in Music Position. Phone jack plugged in. Output from 600 ohms line, output level 100 mW., input 270-350 mV.

5.1.3 *Hum Level*

The output with any setting of the audio volume control, no input, should not exceed .002V. measured across 15 ohms.

5.1.4 *Response*

The output at 70 c.p.s. and 5,000 c.p.s. reference level 400 c.p.s. to be within the following limits (Constant Input Method):-

(a) Speech/Music Switch in Music Position 70 c.p.s. -0.5 db ± 1 db. 5,000 c.p.s. -2 db ± 1 db.
(b) Speech/Music Switch in Speech Position 400 c.p.s. -7.5 db ± 2 db. 5,000 c.p.s. -3 db ± 2 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 -5.5 db ± 1.5 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 *Conditions of Test*

C49 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 9.0 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 13 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%.

Switch Position	4	5	6
Input Ratio 6 db	5.5	9.0	13.0
Input Ratio 40 db	18.0	23.5	28.0

5.2.3 *Bandwidth (Crystal Filter)*

Feed in the signal generator directly to C49, 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 μ V. 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.

Switch Position	1	2	3
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 C49. An output of 50 mW. should be obtained with an input of less than 10 μ V.

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 all Ranges. 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 μ V. 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 10 μ V.

5.3.3 *Sensitivity*

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

5.3.4 *A.V.C.*

When the input is increased 100 db relative to 3 μ V., 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	20 Mc/s.	50
2	8.8 Mc/s.	80
3	3.4 Mc/s.	100
4	1.4 Mc/s.	100
5	550 Kc/s.	100
6	160 Kc/s.	100

5.3.6 *I.F. Ratio*

This ratio to be greater than 65 db at 550 and 370 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 μ V., 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 μ V.

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

Two spare lamps, a spare H.T. fuse and a trimming tool are attached to the gang condenser cover (see Fig. 22). The components supplied, if a spares kit is ordered, are given in Section 12.

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}	(2.6)^{3}
V4	36 (32)^{1}	111 (108)^{1}	(0.85)^{3}
V5	246 (240)^{1}	72 (65)^{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

R116

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	12
1st I.F. Grid	-	2nd I.F. Grid	170
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 (R28) x Grid Leak Resistor x 1.2

7.5 Crystal Calibrator

Supply Voltage H.T.	117 V
Anode Voltage	79 V
Screen Voltage	90 V
Anode Current	2.1 mA
Screen Current	0.8 mA

The voltage measurements were made with a 500 ohms/voltmeter using the 1,000 V. Range.

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 $\pm$ 20 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 C49 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 position 4.

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 position 1, 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 position 4 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, C76 (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 No. 3 bandwidth position the filter will be terminated by a high impedance load if R48 is short circuited, and 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, short circuit R48, disconnect C49 from the range switch (S.6). Connect the wobbulator to C49 and take the output to the oscilloscope from across R75, R76, R77. Turn the selectivity switch to position 3 and set the phasing condenser so that the response is symmetrical (*i.e.*, the pointer of the controlling knob approximately 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. Then set the pointer of the phasing control knob exactly to the mark on the panel, and adjust TC37 so that the response is symmetrical.

8.3 B.F.O.

Turn the selectivity switch to No. 1 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).

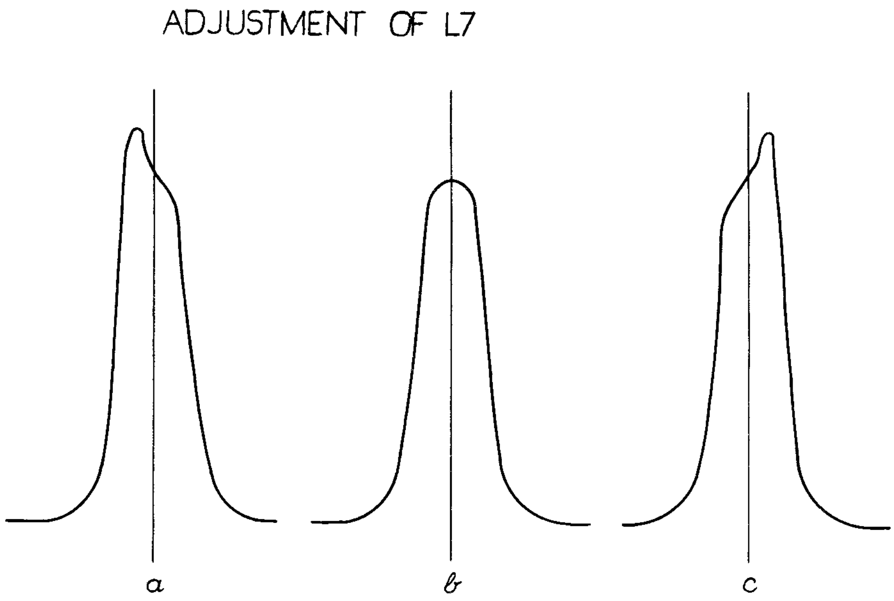


Fig. 14. L7 *Adjustment Curves*

8.4 **R.F. Amplifier**

The apparatus required to align the R.F. Amplifier is a Signal Generator covering the range 150 Kc/s. - 30 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 principle 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).

8.4.1. *Alignment of Ranges* 1, 2, 3 *and* 4

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 ± one division. Check frequencies are given which, where possible, are the nearest 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 19.5 Mc/s. there might be uncertainty whether the receiver is being aligned to 19.4 or 19.6 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 we established beyond doubt.

8.4.2 *Alignment of Ranges* 5 *and* 6

The alignment procedure is similar to that for Ranges 1, 2, 3 and 4 except that the two R.F. stages are aligned 10 Kc/s. on either side of the aerial circuit. To accomplish this, complete the accurate alignment of the oscillator, replace the crystal oscillator by a signal generator, tune the signal generator to the receiver at the tracking points, and align the aerial circuit. Then reduce the frequency by 10 Kc/s. by means of the incremental tuning of the signal generator and align the first R.F. circuit. Then increase the frequency by 10 Kc/s. and align the second R.F. circuit. Proceed until no increase in output can be obtained.

8.4.3 *Adjustment of Calibrated Scales*

After accurate alignment, remove the escutcheon surrounding the calibrated scales, the glass and the mask. At the end of each calibrated scale there is a screw holding it in place, the fixing holes in the scale being slotted. Loosen the fixing screws and adjust the position of the scale for minimum calibration error over each range.

8.5 I.F. Rejector

Complete the approximate alignment of Range 5, tune the receiver to 510 Kc/s., change the frequency of the Signal Generator to the I.F., 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 8.8 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 (0.05 volt full scale), an oscilloscope or, in the absence of these, a speaker, as an indicator across the speaker terminals. Adjust the hum control R113 (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	20.0 Mc/s	5.10			Adjust for Response	L31
					Adjust for Maximum	L21, L11, L1
	30.0 Mc/s	29.20			Adjust for Response	TC31
					Adjust for Maximum	TC21, TC11, TC5
2	8.8 Mc/s	4.12	9.0 Mc/s	5.15	Adjust for Response	L32
					Adjust for Maximum	L22, L12, L2
	19.5 Mc/s	28.87	19.0 Mc/s	27.99	Adjust for Response	TC32
					Adjust for Maximum	TC22, TC12, TC5
3	3.4 Mc/s	4.51	4.0 Mc/s	10.24	Adjust for Response	L33
					Adjust for Maximum	L23, L13, L3
	8.3 Mc/s	28.91	8.0 Mc/s	27.86	Adjust for Response	TC33
					Adjust for Maximum	TC23, TC13, TC5
4	1.4 Mc/s	5.19			Adjust for Response	L34
					Adjust for Maximum	L24, L14, L4
	3.1 Mc/s	28.42			Adjust for Response	TC34
					Adjust for Maximum	TC24, TC14, TC5
5	550 Kc/s	5.24	600 Kc/s	8.75	Adjust for Response, Max.	L35, L5
	540 Kc/s				Adjust for Maximum	L15
	560 Kc/s				Adjust for Maximum	L25
	1290 Kc/s	29.46	1,300 Kc/s	29.74	Adjust for Response, Max.	TC35, TC5
	1280 Kc/s				Adjust for Maximum	TC15
	1300 Kc/s				Adjust for Maximum	TC25
6	160 Kc/s	5.19			Adjust for Response, Max.	L36, L6
	150 Kc/s				Adjust for Maximum	L16
	170 Kc/s				Adjust for Maximum	L26
	370 Kc/s	28.43			Adjust for Response, Max.	TC36, TC5
	360 Kc/s				Adjust for Maximum	TC16
	380 Kc/s				Adjust for Maximum	TC26

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 back-lash 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.

Apositive stop comes into operation after32revolutions 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 momentumof 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 lamp.

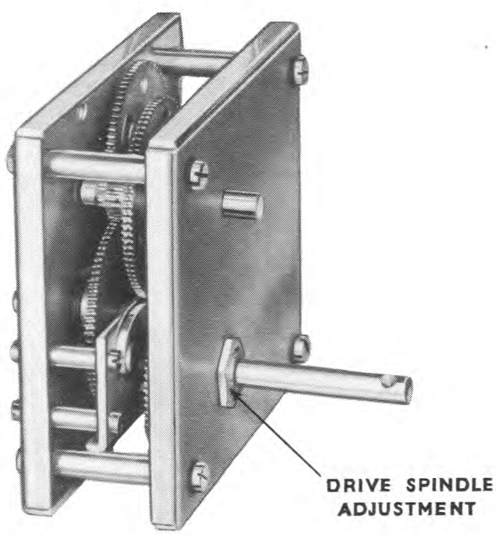


Fig. 15. Front View of Gearbox

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 wire guides require lubrication, a little good quality grease 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 levering off the switch escutcheon on the front panel with a screwdriver, 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. CRYSTAL CALIBRATOR

10.1 Fitting to Existing Receiver

The crystal calibrator type BRT.403 is fitted in the factory to receivers types BRT.400E and BRT.402E only, but it can be very easily fitted to an existing receiver of the following types BRT.400B, BRT.402B, BRT.400D and BRT.402D; it is a matter of greater difficulty to fit it to receiver types BRT.400 and BRT.402 as the front panels of these receivers were not drilled to take the push switch.

If a crystal calibrator is ordered for fitting to an existing receiver, it will be supplied with a gang condenser cover on which it is mounted, a switch and mounting bracket, cable form, condenser and sundry screws.

To fit to the receiver, remove the gang condenser cover and the two leads to the lamp mounted on the cover from the receiver. Fit the new cover with the calibrator and wire up the cable form (see Figs. 19 and 20). Mount the crystal calibrator ON/OFF Switch on the front panel, connect the cable form to the switch and logging dial lamp, wire up the switch according to the circuit; the necessary leads will be found loosely tied in the cable form, the lead from R.8 to the distribution panel of the receiver being deleted.

Then connect the 1.5 pf capacitor from the tag strip in the 1st R.F. valve coil compartment to the fourth tag down on the switch (see Fig. 23); connect the screened lead from the crystal calibrator to the single way tag strip.

11. COMPONENTS LISTS

11.1 Capacitors (Receiver)

Circuit Ref.	Value	Tolerance ± %	Working Voltage	G.E.C. Part Number
C1	3000 pF	2	350	RK.202345
C2	10 pF	10	500	RK.202309
C3	1400 pF	10	350	RK.204022
C4	3000 pF	2	350	RK.202345
C5	6.8 pF	0.5 pF	500	RK.202280
C6	10 pF	10	500	RK.202309
C7	22 pF	10	350	RK.203747
C8	22 pF	10	350	RK.203747
C9	178 pF	1	350	RK.202588
C10	4000 pF	2	350	RK203746
C11	100 pF	5	500	RK.202321
C12	0.01 μF	20	350	RK.202446
C13	0.1 μF	25	250	RK.202188
C14	0.05 μF	25	250	RK.202187
C15	5000 pF	2	350	RK.202346
C16	0.01 μF	20	350	RK.202446
C17	0.05 μF	20	500	RK.203152
C18	250 pF	5	350	RK.203741
C19	3000 pF	2	350	RK.202345
C20	82 pF	10	500	RK.202202
C21	3000 pF	2	350	RK.202345
C22	82 pF	10	500	RK.202202
C23	10 pF	10	500	RK.202309
C24	2.2 pF	0.5 pF	500	RK.202340
C25	6.8 pF	0.5 pF	500	RK.202280
C26	0.05 μF	20	500	RK.203152
C27	15 pF	10	350	RK.201597
C28	22 pF	10	350	RK.203747
C29	178 pF	1	350	RK.202588
C30	4000 pF	2	350	RK.203746
C31	100 pF	5	500	RK.202321
C32	0.01 μF	20	350	RK.202446
C33	0.1 uF	25	250	RK.202188
C34	0.05 μF	25	250	RK.202187
C35	0.05 μF	20	500	RK.203152
C36	250 pF	5	350	RK.203741
C37	3000 pF	2	350	RK.202345
C38	82 pF	10	500	RK.202202
C39	3000 pF	2	350	RK.202345
C40	82 pF	10	500	RK.202202
C41	10 pF	10	500	RK.202309
C42	2.2 pF	0.5 pF	500	RK.202340
C43	6.8 pF	0.5 pF	500	RK.202280
C44	0.05 μF	20	500	RK.203151
C45	15 pF	10	350	RK.201597
C46	22 pF	10	350	RK.203747
C47	178 pF	1	350	RK.202588
C48	4000 pF	2	350	RK.203746
C49	100 pF	5	500	RK.202321
C50	0.05 μF	20	500	RK.203152
C51	0.05 μF	25	250	RK.202187
C52	0.05 μF	20	500	RK.203152
C53	137 pF	1	350	RK.202583
C54	400 pF	1	350	RK.202584
C55	1330 pF	1	350	RK.203743
C56	10 pF	5	500	RP.194042
C57	2800 pF	2	350	RK.203744
C58	8.2 pF	0.5 pF	500	RP.194041
C59	12 pF	5	500	RP.194043
C60	12 pF	5	500	RP.194043

11.1 **Capacitors (Receiver)** *(contd.)*

Circuit Ref.	Value	Tolerance ± %	Working Voltage	G.E.C. Part Number
C61	165 pF	1	350	RK.203742
C62	2000 pF	1	350	RK.203745
C63	22 pF	5	350	RP.194045
C64	22 pF	5	500	RP.194044
C65	100 pF	5	500	RK.202321
C66	0.01 μF	20	500	RP.194014
C67	0.01 μF	20	500	RP.194014
C68	0.01 μF	20	500	RP.194014
C69	0.01 μF	20	500	RP.194014
C70	82 pF	5	350	RK.203756
C71	0.1 μF	20	350	RK.202093
C72	220 pF	2	350	RK.203757
C73	400 pF	1	350	RK.202584
C74	400 pF	1	350	RK.202584
C75	0.05 μF	25	250	RK.202187
C76	47 pF	5	350	RK.203748
C77	0.1 μF	25	250	RK.202188
C78	0.1 μF	25	250	RK.202188
C79	0.1 μF	20	350	RK.202093
C80	0.1 μF	20	350	RK.202093
C81	0.25 μF	25	350	RK.202185
C82	100 pF	5	350	RK.203759
C83	2 μF	25	150	RK.202184
C84	2 μF	25	150	RK.202184
C85	100 pF	5	350	RK.203759
C86	0.25 μF	25	350	RK.202185
C87	0.1 μF	20	350	RK.202093
C88	470 pF	2	350	RP.194010
C89	22 pF	10	500	RK.203747
C90	0.1 μF	20	350	RK.202093
C91	0.1 μF	25	250	RK.202188
C92	0.1 μF	20	350	RK.202093
C93	0.1 μF	20	350	RK.202093
C94	0.1 μF	20	350	RK.202093
C95	100 pF	5	350	RK.203759
C96	0.1 μF	20	350	RK.202093
C97	100 pF	5	350	RK.203759
C98	470 pF	2	350	RP.194010
C99	100 pF	5	500	RP.202321
C100	100 pF	5	500	RP.202321
C101	100 pF	5	500	RP.202321
C102	10 pF	10	500	RK.202309
C103	0.25 μF	25	350	RK.202185
C104	0.1 μF	20	350	RK.202093
C105	0.1 μF	20	350	RK.202093
C106	47 pF	10	500	RK.202341
C107	0.1 μF	20	350	RK.202093
C108	0.1 μF	20	350	RK.202093
C109	0.1 μF	20	350	RK.202093
C110	22 pF	10	500	RK.201865
C111	0.03 μF	25	350	RK.202201
C112	0.005 μF	20	1000	RK.202203
C113	0.05 μF	25	350	RK.202186
C114	4400 pF	2	350	RK.203758
C115	0.005 μF	20	500	RK.202095
C116	2 μF	20	400	RK.201994
C117	2 μF	20	250	RK.202195
C118	2 μF	20	250	RK.202195
C119	0.1 μF	20	350	RK.202093
C120	0.1 μF	20	350	RK.202093
C121	4 μF	20	400	RK.202017
C122	2 μF	20	250	RK.202195

11.2 Resistors (Receiver)

Circuit Ref.	Value (ohms)	Tolerance ± %	Wattage	G.E.C. Part Number
R1	220	20	½	RP.191128
R2	15	10	½	RP.191042
R3	10.000	20	½	RP.191138
R4	1MΛ	20	½	RP.191150
R5	100.000	20	½	RP.191144
R6	220	20	½	RP.191128
R7	47	20	½	RP.191124
R8	10.000	20	½	RP.191138
R9	10.000	20	½	RP.191138
R10	150	10	½	RP.191054
R11	10.000	20	½	RP.191138
R12	2.200	20	½	RP.191134
R13	1.000	20	½	RP.191132
R14	1MΛ	20	½	RP.191150
R15	100.000	20	½	RP.191144
R16	2.500	10	5	RK.204405
R17	220	20	½	RP.191128
R18	47	20	½	RP.191124
R19	10.000	20	½	RP.191138
R20	10.000	20	½	RP.191138
R21	100	20	½	RP.191126
R22	10.000	20	½	RP.191138
R23	2.200	20	½	RP.191134
R24	1.000	20	½	RP.191132
R25	1MΛ	20	½	RP.191150
R26	10.000	20	½	RP.191138
R27	1.000	20	½	RP.191132
R28	100.000	20	½	RP.191144
R29	15.000	20	½	RP.191139
R30	1.000	20	½	RP.191132
R31	680	20	½	RP.191131
R32	22	10	½	RP.191044
R33	47	20	½	RP.191124
R34	330	20	½	RP.191129
R35	15.000	20	½	RP.191139
R36	47	20	½	RP.191124
R37	100.000	20	½	RP.191144
R38	100	20	½	RP.191126
R39	10.000	20	½	RP.191138
R40	10.000	20	½	RP.191138
R41	1.000	20	½	RP.191132
R42	47	20	½	RP.191124
R43	1.000	20	½	RP.191132
R44	2.200	20	½	RP.191134
R45	4.7MΛ	10	½	RP.191108
R46	6.8MΛ	10	½	RP.191110
R47	100.000	20	½	RP.191144
R48	100	20	½	RP.191126
R49	330	5	½	RP.190926
R50	680	5	½	RP.190934
R51	1MΛ	20	½	RP.191150
R52	330	20	½	RP.191129
R53	10.000	10	5	RK.204421
R54	120.000	10	½	RP.191089
R55	22.000	20	½	RP.191140
R56	2.200	20	½	RP.191134
R57	47.000	20	½	RP.191142
R58	1MΛ	20	½	RP.191150
R59	1MΛ	20	½	RP.191150
R60	100	20	½	RP.191126
R61	100	20	½	RP.191126
R62	22	10	½	RP.191044
R63	220,000	10	½	RP.191092

11.2 **Resistors (Receiver)** ***(contd.)***

Circuit Ref.	Value (ohms)	Tolerance ± %	Wattage	G.E.C. Part Number
R64	220,000	10	½	RP.191092
R65	10.000	20	½	RP.191138
R66	4.700	20	½	RP.191136
R67	22.000	20	½	RP.191140
R68	2.200	20	½	RP.191134
R69	470	20	½	RP.191130
R70	47.000	20	½	RP.191142
R71	4.700	20	½	RP.191136
R72	22.000	5	½	RP.190970
R73	22.000	5	½	RP.190970
R74	47.000	20	½	RP.191142
R75	22.000	5	½	RP.190970
R76	39.000	5	½	RP.190976
R77	47.000	5	½	RP.190978
R78	100.000	20	½	RP.191144
R79	68.000	20	½	RP.191143
R80	100.000	20	½	RP.191144
R81	1.000	20	½	RP.191132
R82	100.000	20	½	RP.191144
R83	22.000	20	½	RP.191140
R84	2.2MΛ	20	½	RP.191152
R85	100.000	20	½	RP.191144
R86	15	10	½	RP.191042
R87	100	10	1	RK.202082
R88	33.000	10	½	RP.191082
R89	3.300	10	½	RP.191070
R90	22	10	1	RK.204424
R91	22	10	½	RP.191044
R92	33.000	10	½	RP.191082
R93	680.000	20	½	RP. 191149
R94	1MΛ	15	0.15	RK. 204419
R95	47.000	20	½	RP.191142
R96	680.000	20	½	RP.191149
R97	470.000	20	½	RP.191148
R98	2.2MΛ	20	½	RP.191152
R99	500.000	15	0.15	RK.202164
R100	470.000	20	½	RP.191148
R101	470.000	5	½	RP.191002
R102	47.000	20	½	RP.191142
R103	100	20	½	RP.191126
R104	120	10	½	RP.191053
R105	220	5	½	RP.190922
R106	220	5	½	RP.190922
R107	18	5	4	RP. 195000
R108	560.000	5	½	RP.191004
R109	2.000	5	10	RP.195003
R110	100.000	10	½	RP.191088
R111	100	20	½	RP.191126
R112	100	5	½	RP. 190914
R113	100	10	1	RK.202082
R114	22.000	20	½	RP.191140
R115	22.000	20	½	RP.191140
R116	220	5	25	RK.202192
R117	100.000	20	½	RP.191144
R118	1MΛ	20	½	RP.191150

11.3 **Capacitors (9 Kc/s Rejector Filter)**

Circuit Ref.	Value	Tolerance ± %	Working Voltage	G.E.C. Part Number
C1b	2000 pf	1	350	RK.203745
C2b	2000 pf	1	350	RK.203745

11.4 **Resistors (9 Kc/s Rejector Filter)**

Circuit Ref.	Value (ohms)	Tolerance ± %	Wattage	G.E.C. Part Number
R1b	220.000	10	½	RP.191092

11.5 **Capacitors (Crystal Calibrator)**

Circuit Ref.	Value	Tolerance ± %	Working Voltage	G.E.C. Part Number
C1a	1.5 pF	0.5 pF	500	RK.203371
C2a	470 pF	2	350	RK.201999
C3a	10 pF	10	500	RK.202309
C4a	0.1 μF	25	250	RK.202188
C5a	0.1 μF	25	250	RK.202188

11.6 **Resistors (Crystal Calibrator)**

Circuit Ref.	Value (ohms)	Tolerance ± %	Wattage	G.E.C. Part Number
R1a	68.000	20	½	RP.191143
R2a	22.000	20	½	RP.191140
R3a	33.000	20	½	RP.191141

11.7 R.F. Coils

Circuit Ref.	G.E.C. Part Number
L1	RP.117927
L2	RP.118255
L3	RP.117928
L4	RP.117929
L5	RP.117930
L6	RP.117931
L11	RP.117932
L12	RP.117971
L13	RP.117933
L14	RP.117934
L15	RP.118256
L16	RP.117935
L21	RP.117932
L22	RP.117971
L23	RP.117933
L24	RP.117934
L25	RP.118256
L26	RP.117936
L31	RP.117937
L32	RP.120356
L33	RP.120357
L34	RP.120028
L35	RP.120358
L36	RP.117942

11.8 **Sundry Adjustable Coils**

Circuit Ref.	G.E.C. Part Number
L7	RP.111082
L8	RP.111084
L9	RP.111083
L37	RP.118417

11.9 **Fixed Inductance** L10 RP.118418

11.10 **I.F. Transformers**

Crystal Filter Input R.805962
I.F.1 .. .. R.805959
I.F.2 .. .. R.805960

11.11 **Transformers and Chokes**

Mains Transformer R.802866
Smoothing Choke R.802726
1,000 c.p.s. Filter Coil R.803038
Output Transformer R.805974

11.12 **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	
TC.37				RK.204400

11.13 **Variable Trimmers**

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

11.14 Gang Condenser

TC.1 and TC.2 TC.3 and TC.4	RK.202173

11.15 Rotary Switches

S.1 - S.9	RK.204409
S.10-S.13	RK.204411

11.16 Toggle Switches

SW.1, SW.2	RK.204407
SW.3, SW.4	RK.204408
SW.5	RK.204406
SW.6, SW.7	RK.204407
SW.8	RK.204406
SW.9, SW.10, SW.11	RK.204408

11.17 Push Switch

SW.12, 13 and 14	RK.201066

11.18 Valve Holders

B.8.B	RK.202194
B.7.G	RK.202027
Octal	RK.200731
4 Pin	RK.200740

11.19 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 Stabilizer	S.130P
V13	Smoothing Valve	KT.81
V14	Rectifier	U.52
V15	Calibrating Oscillator	Z.77

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

11.20 Sundry Items

Drive Wire	RP.118777
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.204410
500 Kc/s. Calibrating Oscillator Crystal	RK.203643
Aerial Plug	RK.204402
Aerial Socket	RK.204403
F.S.K. Plug	RK.204417
F.S.K. Socket	RK.204418

12. SPARES REPLACEMENT LIST

The spares listed hereunder, based on two years servicing of the equipment under tropical conditions, can be 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. It should be pointed out that if it is found necessary to change any component shown in the list, the new component will be automatically supplied against an order for spares.

If any component not included in the following list should require to be replaced, full information should be given, i.e.

(i) Circuit Reference

(ii) Description as shown in Components Lists

(iii) Equipment the part is to be used with

(iv) Quantity required

G.E.C. Part No.	Description	Quantity
QP.301368	Tag Strip (2 way)	1
QP.301351	Tag Strip (3 way)	1
QP.301370	Tag Strip (4 way)	1
QP.301366	Tag Strip (5 way)	1
QP.303180	Tag Strip (Single Way)	1
RK.202027	Valveholder B7G.	1
RK.202194	Valveholder B9G.	1
RK.200731	Valveholder (Octal)	1
RK.200740	Valveholder (4 pin)	1
QP.308433	Tag Strip (Two Way Osc. Comp.)	1
RP.116300	Springs (Valve retainer)	2
RK.203995	Valve Retainer (SP.52)	1
RK.203996	Valve Retainer (SP.126)	1
RP.103275	Terminal Plate Single Way	1
RP.118777	Link (Drive Wire)	2
RP.119475	Screw 6BA Special 7/32" long Left Hand Thread (Dial Lock)	1
RP.119472	Disc (Dial Lock)	1
RP.119285	Strip (Dial Lock)	1
RS.12205	Screw 4BA MSC. $\frac{5}{8}$" (Knob)	1
RS.13241	Screw 6BA MSC. 7/16" (Knob)	1
RP.104141	Plug (Mains)	1
RK.200630	Lamps (6.5v)	36
RK.204410	Rectifiers Selenium	1
RP.110964	Supply Tag Strip 5 way	1
RP.110961	Tag Strip (16 way)	1
RP.119832	Screws (Escutcheon Window)	2
RP.110980	Screws (Escutcheon Window)	2
RP.110935	Window	1
RK.204421	Potentiometer 10,000 ohm ± 10%	1
RK.202181	Fuses (500 m/a)	6
RK.202017	Condenser (4uF) 400v	1
RK.201994	Condenser (2uF) 400v	1
RK.202195	Condensers (2uF) 250V	1
RK.202446	Capacitor 0.01uF ± 20% 350V	1
RK.202187	Capacitor 0.05uF ± 25% 250V	1
RP.194045	Capacitor 22 pF ± 5% 350V	1
RK.202188	Capacitor 0.1uF ± 25% 250V	1
RK.202184	Capacitor 2uF ± 25% 150V	1
RK.202093	Capacitor 0.1uF ± 20% 350V	2
RK.202202	Capacitor 82 pF ± 10% 500V	1
RK.202309	Capacitor 10 pF ± 10% 500V	1
RK.202321	Capacitor 100 pF ± 5% 500V	1
RK.202341	Capacitor 47 pF ± 10% 500V	1

12. Spares replacement list *(contd.)*

G.E.C. Part No.	Description	Quantity
RK.203747	Capacitor 22 pF ± 10% 350V	1
RK.201865	Capacitor 22 pF ± 10% 500V	1
RK.203188	Capacitor 2.2 pF ± 0.5 pF 500V	1
RK.202280	Capacitor 6.8 pF ± 0.5 pF 500V	1
RK.203741	Capacitor 250 pF ± 5% 350V	1
RK.202345	Capacitor .003 uF ± 2% 350V	1
RK.202346	Capacitor .005 uF ± 2% 350V	1
RP.194010	Capacitor 470 pF ± 2% 350V	1
RK.201597	Capacitor 15 pF ± 10% 350V	1
RP.194041	Capacitor 8.2 pF ± 0.5 pF 500V	1
RK.203746	Capacitor 4,000 pF ± 2% 350V	1
RK.204022	Capacitor 1,400 pF ± 10% 350V	1
RK.202583	Capacitor 137 pF ± 1% 350V	1
RK.202584	Capacitor 400 pF ± 1% 350V	1
RK.203743	Capacitor 1,330 pF ± 1% 350V	1
RK.203744	Capacitor 2,800 pF ± 2% 350V	1
RK.203745	Capacitor 2,000 pF ± 1% 350V	1
RK.202588	Capacitor 178 pF ± 1% 350V	1
RK.203742	Capacitor 165 pF ± 1% 350V	1
RK.203748	Capacitor 47 pF ± 5% 350V	1
RP.194014	Capacitor 0.01 uF ± 20% 500V	1
RP.194121	Capacitor 0.05 pF ± 20% 500V	1
RP.194042	Capacitor 10 pF ± 5% 500V	1
RP.194043	Capacitor 12 pF ± 5% 500V	1
RP.194044	Capacitor 22 pF ± 5% 500V	1
RP.191108	Resistors 4.7 Mohm ± 10% ½W	1
RP.191110	Resistors 6.8 Mohm ± 10% ½W	1
RP.191044	Resistors 22 ohm ± 10% ½W	1
RP.191124	Resistors 47 ohm ± 20% ½W	1
RP.191126	Resistors 100 ohm ± 20% ½W	1
RP.190922	Resistors 220 ohm ± 5% ½W	1
RP.191128	Resistors 220 ohm ± 20% ½W	1
RP.191129	Resistors 330 ohm ± 20% ½W	1
RP.191132	Resistors 1,000 ohm ± 20% ½W	1
RP.191134	Resistors 2,200 ohm ± 20% ½W	1
RP.191138	Resistors 10,000 ohm ± 20% ½W	1
RP.191142	Resistors 47,000 ohm ± 20% ½W	1
RP.191144	Resistors 100,000 ohm ± 20% ½W	2
RP.191139	Resistor 15,000 ohm ± 20% ½W	1
RP.191150	Resistor 1 Mohm ± 20% ½W	1
RP.191054	Resistor 150 ohm ± 10% ½W	1
RP.191140	Resistor 22,000 ohm ± 20% ½W	1
RP.190970	Resistor 22,000 ohm ± 5% ½W	1
RP.191002	Resistor 470,000 ohm ± 5% ½W	1
RP.191131	Resistor 680 ohm ± 20% ½W	1
RK.202192	Resistor 220 ohm ± 5% 25W	1
RP.195003	Resistor 2,000 ohm ± 5% 10W	1
RP.195000	Resistor 18 ohm ± 5% 4W	1
RP.190976	Resistor 39,000 ohm ± 5% ½W	1
RP.190914	Resistor 100 ohm ± 5% ½W	1
RP.190926	Resistor 330 ohm ± 5% ½W	1
RP.190934	Resistor 680 ohm ± 5% ½W	1
RP.190978	Resistor 47,000 ohm ± 5% ½W	1
RP.191042	Resistor 15 ohm ± 10% ½W	1
RP.191053	Resistor 120 ohm ± 10% ½W	1
RP.191089	Resistor 120,000 ohm ± 10% ½W	1
RP.191088	Resistor 100,000 ohm ± 10% ½W	1
RK.202082	Potentiometer 100 ohm ± 10%	1
RK.204424	Potentiometer 22 ohm ± 10%	1
RK.204405	Potentiometer 2,500 ohm ± 10%	1
RK.202164	Potentiometer 500,000 ohm ± 15%	1
RK.204419	Potentiometer 1 Mohm ± 15%	1

12. Spares replacement list *(contd.)*

G.E.C. Part No.	Description	Quantity
RK.204406	Switches S.P. ST.	1
RK.204407	Switches D.P. ST.	1
RK.204408	Switches D.P. DT.	1
R.805962	Crystal Filter Transformer (IF)	1
R.802875	Condenser (Crystal Phasing)	1
R.808705	Condensers (25 pF Variable Aerial & B.F.O.)	2
R.805959	I.F. Transformer No.1	1
R.805960	I.F. Transformer No.2	1
RK.202091	Socket (Mains)	1
RK.204412	Plug Button	1
RK.203371	Capacitor 1.5 pF Ceramicon	1
RK.202185	Capacitor 0.25 uF ± 25%	1
RK.202203	Capacitor 0.005 ± 20% 1000V DC.	1
RK.202201	Capacitor 0.03 ± 25%	1
RP.191136	Resistor 4,700 ohm ± 20% ½W	1
RP.191070	Resistor 3,300 ohm ± 10% ½W	1
RP.191082	Resistor 33,000 ohm ± 10% ½W	1
RP.191148	Resistor 470,000 ohm ± 20% ½W	1
RP.191149	Resistor 680,000 ohm ± 20% ½W	1
RP.191152	Resistor 2.2 Mohm ± 20% ½W	1
RP.191130	Resistor 470 ohm ± 20% ½W	1
RP.191143	Resistor 68,000 ohm ± 20% ½W	1
RP.191092	Resistor 220,000 ohm ± 10% ½W	1
RK.202186	Capacitor .05 uF	1
RK.202095	Capacitor .005 uF	1
RK.203758	Capacitor 4,400 pF ± 2%	1
RP.191004	Resistor 560,000 ohm 5% ½W	1
RP.191141	Resistor 33,000 ohm ± 20% ½W	1
RK.201999	Capacitor 470 pF ± 2%	1
RP.117929	Aerial Coil (R4)	1
RP.117930	Aerial Coil (R5)	1
RP.117971	R.F. Coil & Condenser (R2)	1
RP.117933	R.F. Coil & Condenser (R3)	1
RP.117934	R.F. Coil & Condenser (R4)	1
RP.118256	R.F. Coil & Condenser (R5)	1

RCH.1067/51

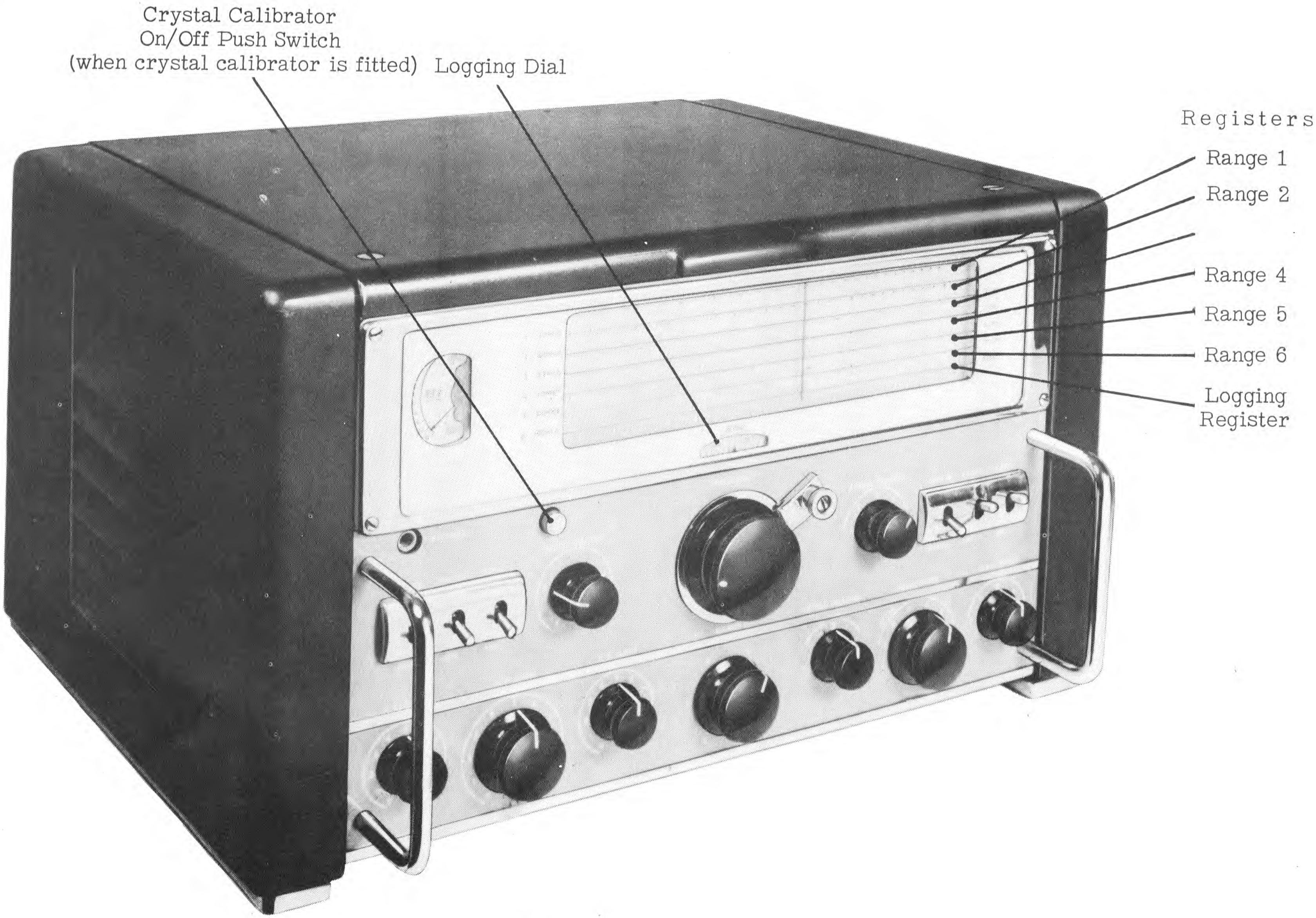


Fig. 18. Front View of Receiver

RCH.1067/53

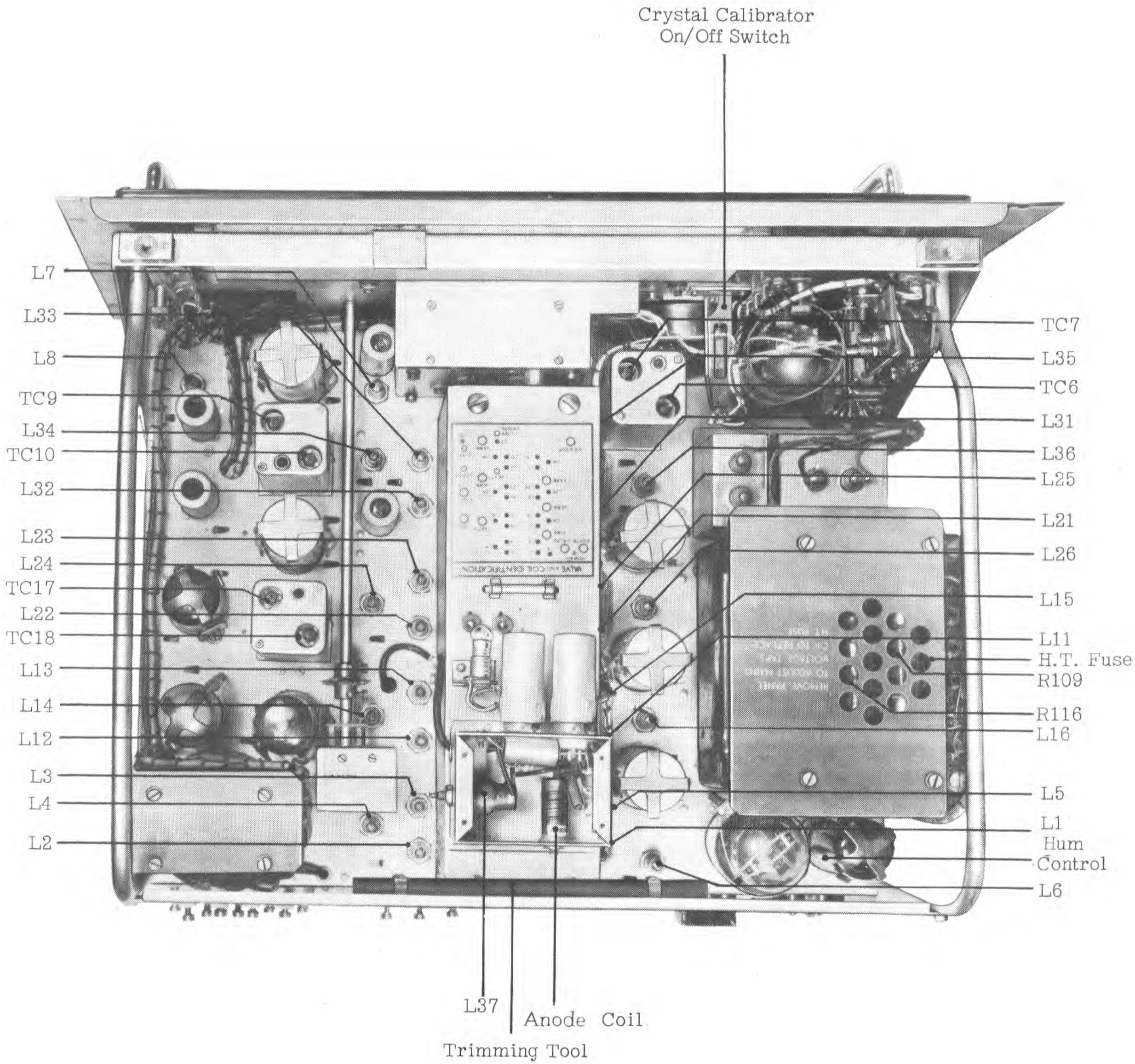
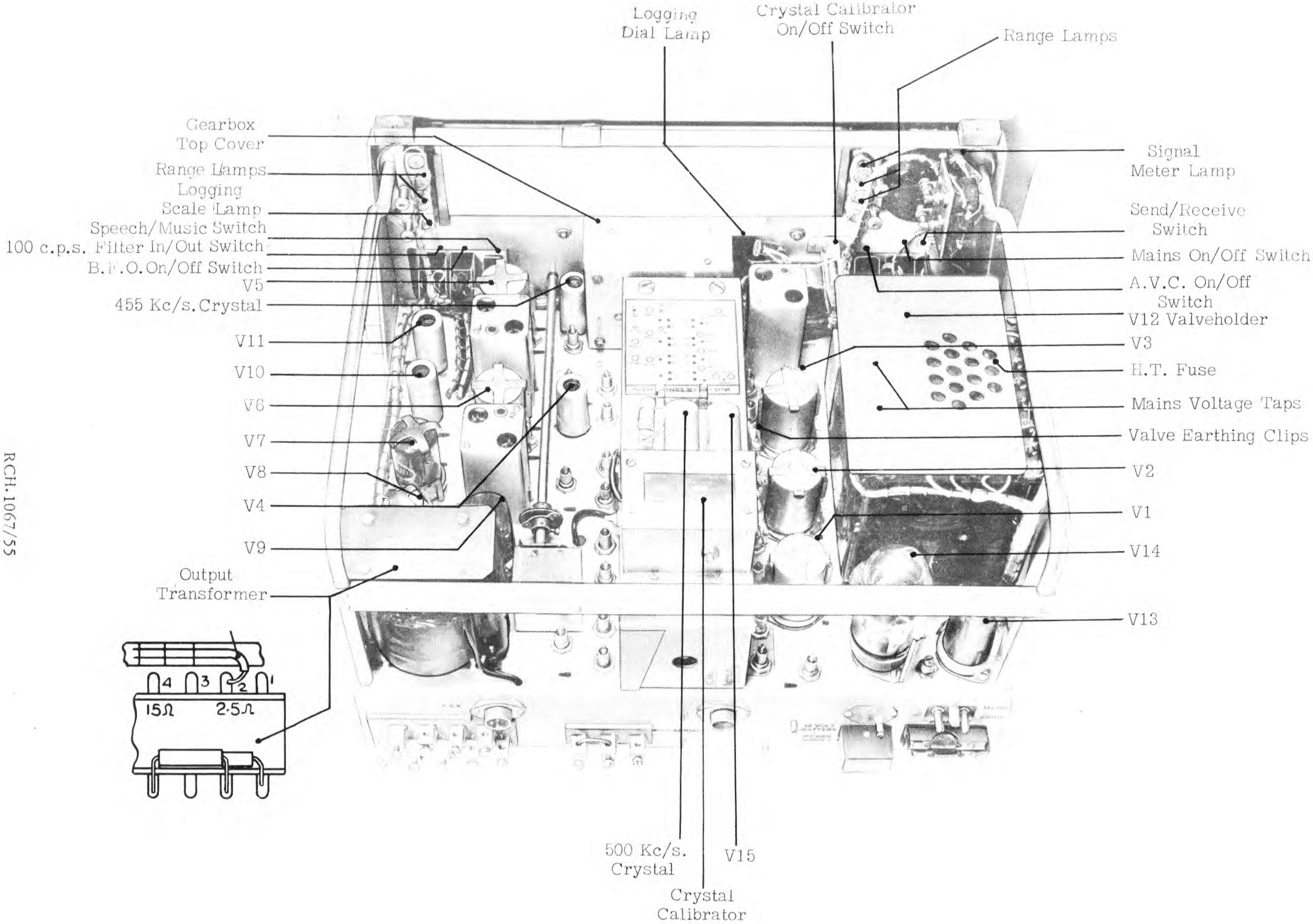


Fig. 19. Top View of Receiver



RCH.1067/55

Fig. 20. Top View of Receiver with Voltage Regulator removed

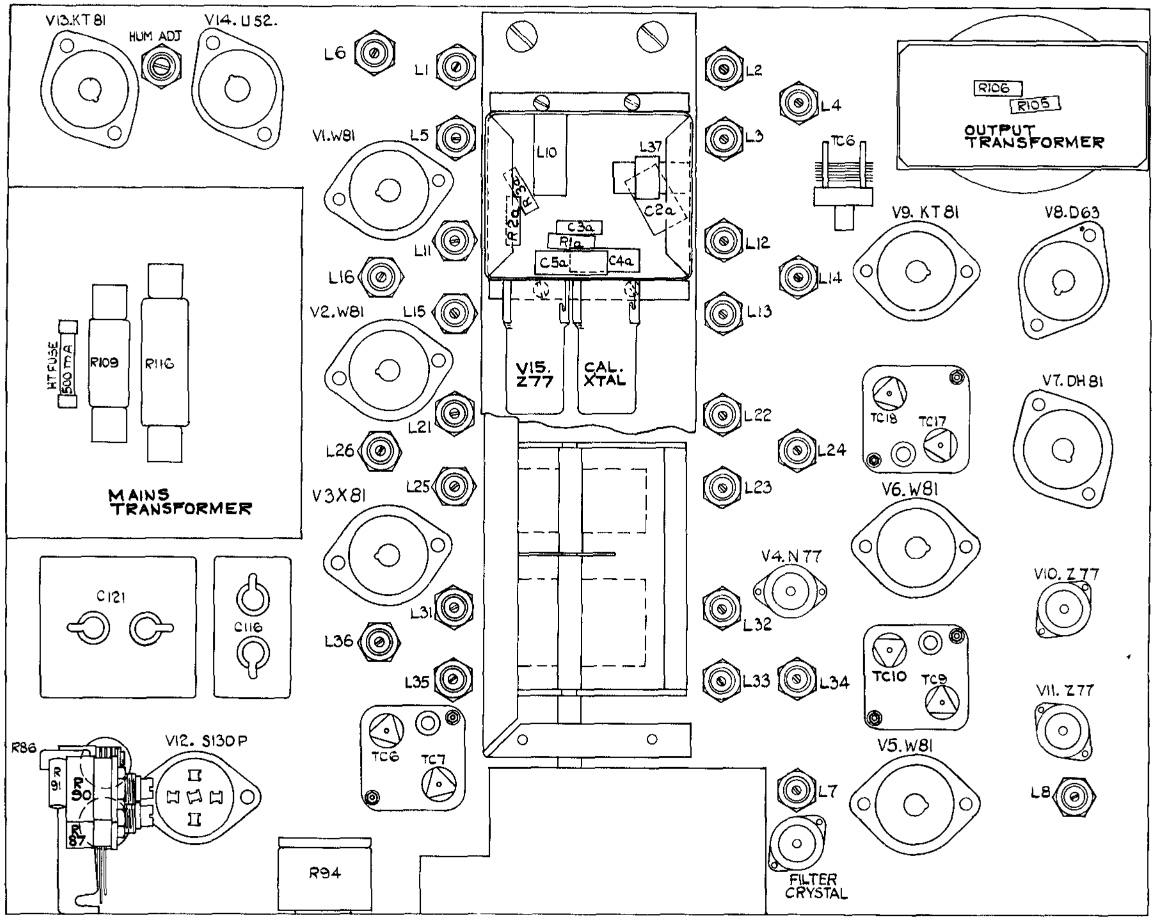


Fig. 21. Component Layout, Top View

RCH.1067/59

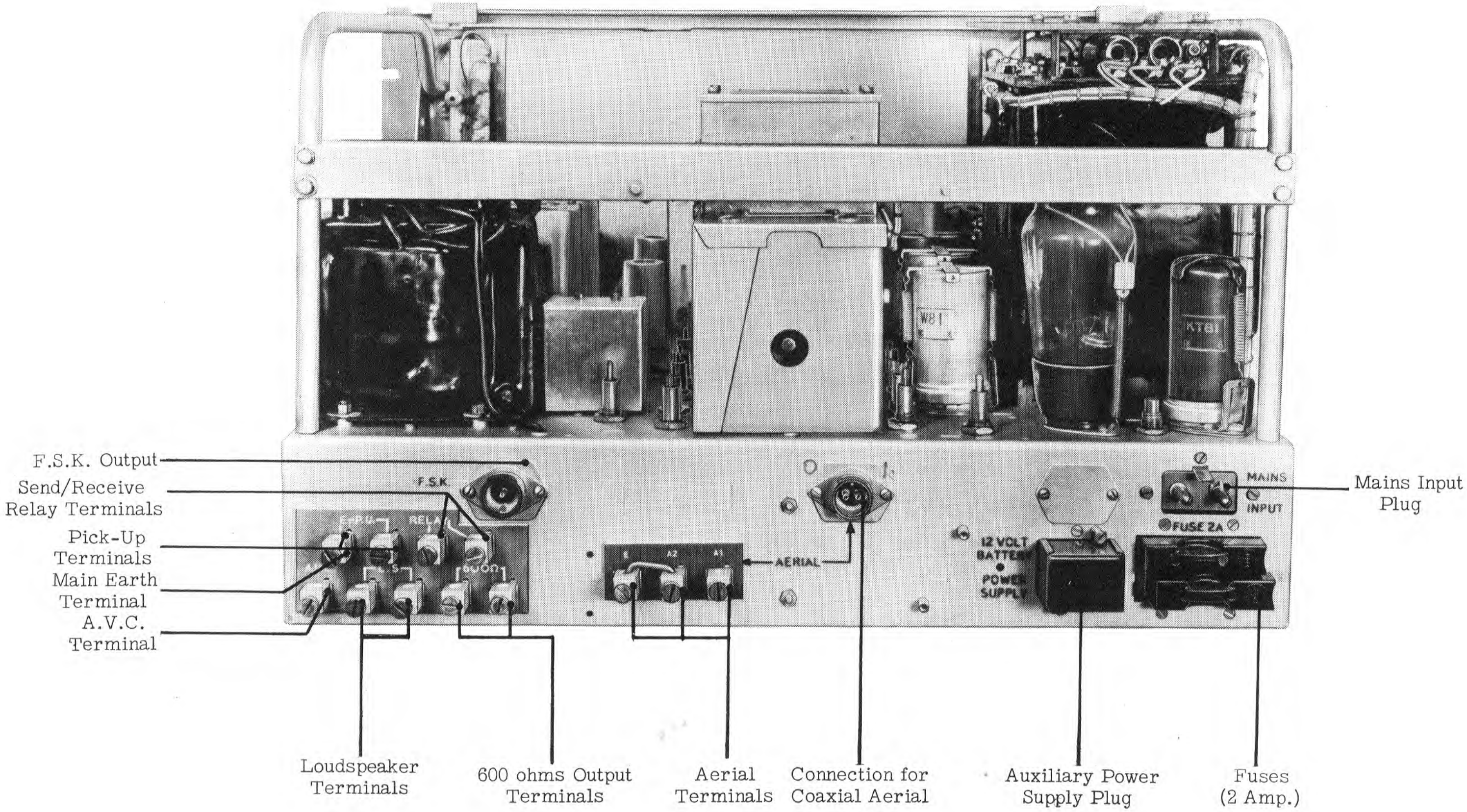


Fig. 22. Rear View of Receiver

RCH.1067/61

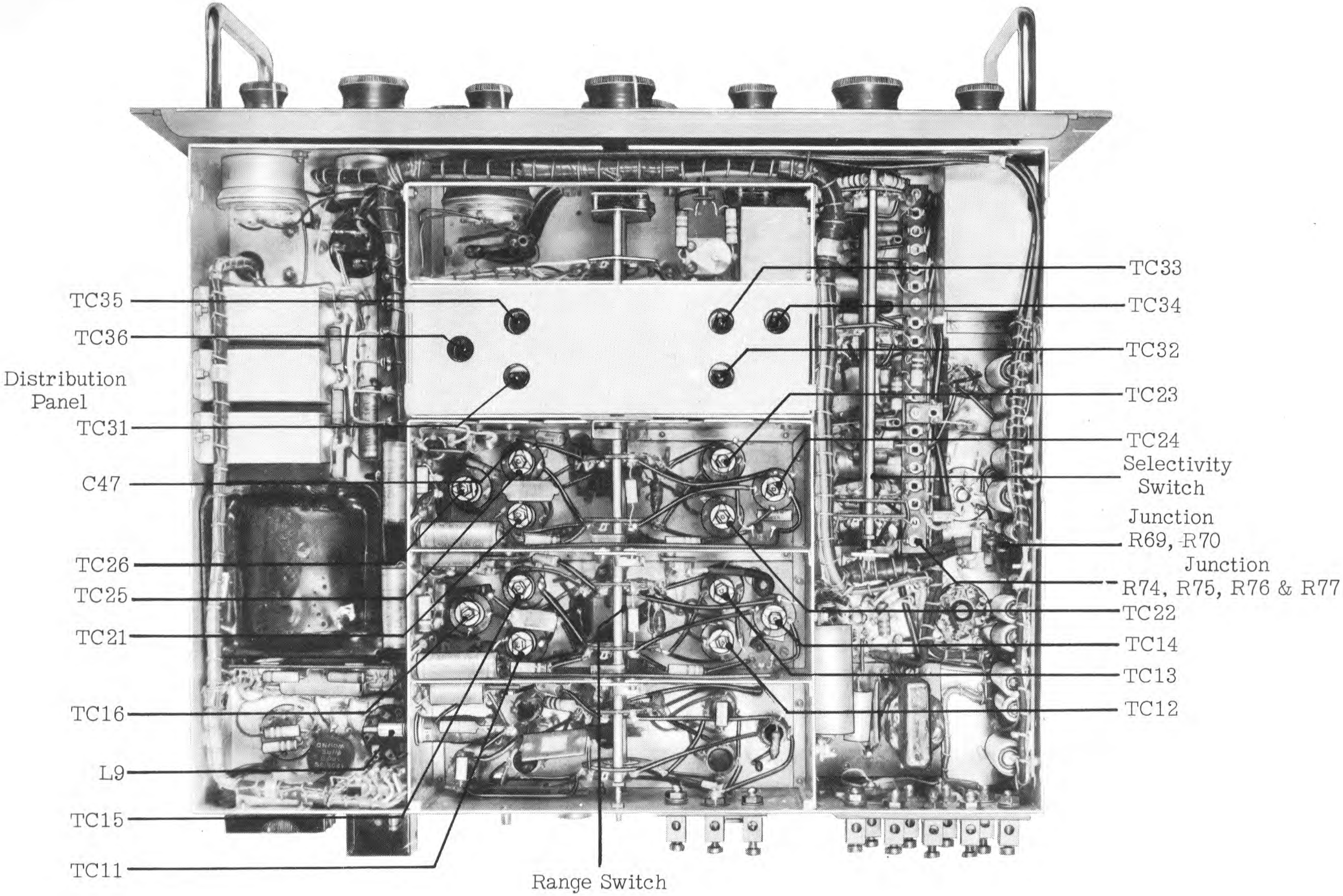


Fig. 23. Underneath View of Receiver

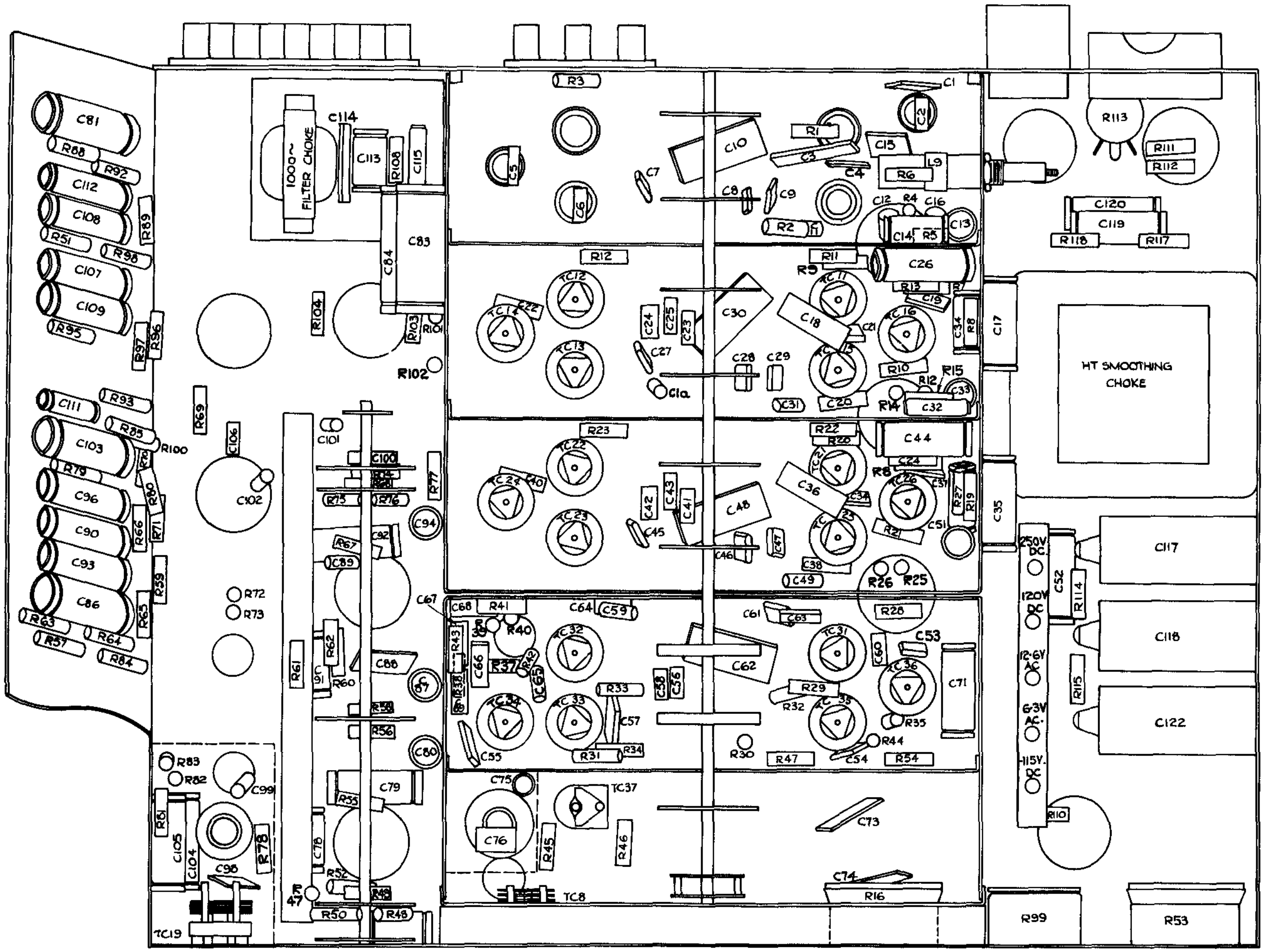


Fig. 24. Component Layout, Underneath View

Fig. 25. CIRCUIT OF COMMUNICATIONS RECEIVERS BRT.400D, BRT.402D, BRT.400E, BRT.402E, BRT.400DN, BRT.402DN, BRT.400EN and BRT.402EN.

RCH. 1067/65

RESISTORS

R No	VALUE Ω	TOL ±%	W	TYPE	R No	VALUE Ω	TOL ±%	W	TYPE	R No	VALUE Ω	TOL ±%	W	TYPE	R No	VALUE Ω	TOL ±%	W	TYPE
1	220	20	½		32	22	10	½		63	220000	10	½		94	1 MΩ	15	0.5	DUB Z
2	15	10	½		33	47	20	½		64	220,000	10	½		95	47000	20	½	
3	10000	20	½		34	330	20	½		65	10,000	20	½		96	680000	20	½	ERIE 8
4	1MΩ	20	½		35	15000	20	½		66	4700	20	½		97	470000	20	½	
5	100000	20	½		36	47	20	½		67	22000	20	½		98	2·2 MΩ	20	½	
6	220	20	½		37	100000	20	½		68	2200	20	½		99	500000	15	0.5	DUB Z
7	47	20	½		38	100	20	½		69	470	20	½		100	470000	20	½	
8	10000	20	½	ERIE 8	39	10000	20	½		70	47000	20	½		101	470000	5	½	
9	10000	20	½		40	10000	20	½		71	4700	20	½		102	47000	20	½	
10	150	10	½		41	1000	20	½		72	22000	5	½		103	100	20	½	ERIE 8
11	10000	20	½		42	47	20	½	ERIE 8	73	22000	5	½		104	120	10	½	
12	2200	20	½		43	1000	20	½		74	47000	20	½	ERIE 8	105	220	5	½	
13	1000	20	½		44	2200	20	½		75	22000	5	½		106	220	5	½	
14	1MΩ	20	½		45	4·7 MΩ	10	½		76	39000	5	½		107	18	5	4	AW3115
15	100,000	20	½		46	6·8 MΩ	10	½		77	47000	5	½		108	560000	5	½	ERIE 8
16	2500	10	5	BERCO R5	47	100000	20	½		78	100000	20	½		109	2000	5	10	P2000
17	220	20	½		48	100	5	½		79	68000	20	½		110	100000	10	½	
18	47	20	½		49	330	5	½		80	100 000	20	½		111	100	20	½	ERIE 8
19	10000	20	½		50	680	5	½		81	1000	20	½		112	100	5	½	
20	10000	20	½		51	1MΩ	20	½		82	100000	20	½		113	100	10	1	CLR1206
21	100	20	½		52	330	20	½		83	22000	20	½		114	22000	20	½	ERIE 8
22	10000	20	½		53	10000	10	5	BERCO R5	84	2·2 MΩ	20	½		115	22000	20	½	ERIE 8
23	2200	20	½		54	120000	10	½		85	100000	20	½		116	220	5	25	P2001
24	1000	20	½	ERIE 8	55	22000	20	½		86	15	10	½		117	100 000	20	½	ERIE 8
25	1MΩ	20	½		56	2200	20	½		87	100	10	1	CLR1206	118	1 MΩ	20	½	ERIE 8
26	10000	20	½		57	47000	20	½		88	33000	10	½	ERIE 8	119				
27	1000	20	½		58	1MΩ	20	½		89	3300	10	½	ERIE 8	120				
28	100,000	20	½		59	1MΩ	20	½	ERIE 8	90	22	10	1	CLR1206	121				
29	15000	20	½		60	100	20	½		91	22	10	½		122				
30	1000	20	½		61	100	20	½		92	33000	10	½	ERIE 8	123				
31	680	20	½		62	22	10	½		93	680000	20	½		124				

CAPACITORS

C No	VALUE	TOL ±%	WKG VOLTS	TYPE	C No	VALUE	TOL ±%	WKG VOLTS	TYPE	C No	VALUE	TOL ±%	WKG VOLTS	TYPE	C No	VALUE	TOL ±%	WKG VOLTS	TYPE
1	3000pF	2	350	P.S.M	32	0·01 µF	20	350	MINICAP	63	22 pF	5	350	P.S.M	94	0·1 µF	20	350	M.C.T.
2	10pF	10	500	CERAMICON N750	33	0·1 µF	25	250	DUB418	64	22 pF	5	500	N750	95	100 pF	5	350	P.S.M
3	1400pF	10	350	P.S.M	34	0·05 µF	25	250	DUB418	65	100 pF	5	500	N750	96	0·1 µF	20	350	M.C.T
4	3000pF	2	350	P.S.M.	35	0·05 µF	20	500	M.C.T	66	0·01 µF	20	500	M.S.M	97	100pF	5	350	P.S.M
5	6·8pF	0.5pF	500	CTS310W	36	250 pF	5	350	P.S.M	67	0·01 µF	20	500	M.S.M	98	470 pF	2	350	P.S.M
6	10 pF	10	500	CERAMICON N750	37	3000pF	2	350	P.S.M	68	0·01 µF	20	500	M.S.M	99	100 pF	5	500	N750
7	22pF	10	350	P.S.M.	38	82 pF	10	500	CERAMICON N750	69	0·01 µF	20	500	M.S.M	100	100 pF	5	500	N750
8	22pF	10	350	P.S.M	39	3000 pF	2	350	P.S.M	70	82pF	5	350	P.S.M	101	100 pF	5	500	N750
9	178 pF	1	350	P.S.M.	40	82 pF	10	500	CERAMICON N750	71	0·1 µF	20	350	M.C.T	102	10pF	10	500	N750
10	4000pF	2	350	P.S.M	41	10pF	10	500	CERAMICON N750	72	220pF	2	350	P.S.M.	103	0·25 µF	25	350	DUB418
11	100pF	5	500	CERAMICON N750	42	2·2pF	0.5pF	500	CTS310W	73	400pF	1	350	P.S.M	104	0·1 µF	20	350	M.C.T
12	0·01 µF	20	350	MINICAP	43	6·8 pF	0.5pF	500	CTS310W	74	400 pF	1	350	P.S.M.	105	0·1 µF	20	350	M.C.T.
13	0·1 µF	25	250	DUB 418	44	0·05 µF	20	500	M.C.T.	75	0·05 µF	25	250	DUB418	106	47 pF	10	500	N750
14	0·05 µF	25	250	DUB 418	45	15 pF	10	350	P.S.M	76	47 pF	5	350	P.S.M	107	0·1 µF	20	350	M.C.T
15	5000pF	2	350	P.S.M	46	22 pF	10	350	P.S.M	77	0·1 µF	25	250	DUB418	108	0·1 µF	20	350	M.C.T
16	0·01 µF	20	350	MINICAP	47	178 pF	1	350	P.S.M	78	0·1 µF	25	250	DUB418	109	0·1 µF	20	350	M.C.T.
17	0·05 µF	20	500	M.C.T	48	4000 pF	2	350	P.S.M	79	0·1 µF	20	350	M.C.T	110	22 pF	10	500	N750
18	250 pF	5	350	P.S.M	49	100 pF	5	500	CERAMICON N750	80	0·1 µF	20	350	M.C.T	111	0·03 µF	25	350	DUB418
19	3000 pF	2	350	P.S.M.	50	0·05 µF	20	500	M.C.T	81	0·25 µF	25	350	DUB418	112	0·005 µF	20	1000	M.C.T.
20	82 pF	10	500	CERAMICON N750	51	0·05 µF	25	250	DUB	82	100 pF	5	350	P.S.M	113	0·05 µF	25	350	DUB418
21	3000pF	2	350	P.S.M.	52	0·05 µF	20	500	M.C.T	83	2 µF	25	150	DUB418	114	4400pF	2	350	P.S.M
22	82pF	10	500	CERAMICON N750	53	131 pF	1	350	P.S.M	84	2 µF	25	150	DUB 418	115	0·005 µF	20	500	MINICAP
23	10pF	10	500	CERAMICON N750	54	400pF	1	350	P.S.M.	85	100pF	5	350	P.S.M.	116	2 µF	20	400	PAPER BLOCK
24	2·2pF	0.5pF	500	CTS310W	55	1330 pF	1	350	P.S.M.	86	0·25 µF	25	350	DUB418	117	2 µF	20	250	PAPER BLOCK
25	6·8pF	0.5pF	500	CTS310W	56	10pF *	5	500	N750	87	0·1 µF	20	350	M.C.T	118	2 µF	20	250	PAPER BLOCK
26	0·05 µF	20	500	M.C.T	57	2800pF	2	350	P.S.M	88	470 pF	2	350	P.S.M	119	0·1 µF	20	350	M.C.T
27	15 pF	10	350	P.S.M	58	82pF *	0.5pF	500	N750	89	22 pF	10	500	N750	120	0·1 µF	20	350	M.C.T
28	22pF	10	350	P.S.M	59	12pF *	5	500	N750	90	0·1 µF	20	350	M.C.T	121	4 µF	20	400	PAPER BLOCK
29	178pF	1	350	P.S.M	60	12 pF *	5	500	N750	91	0·1 µF	25	250	DUB418	122	2 µF	20	250	PAPER BLOCK
30	4000pF	2	350	P.S.M	61	135 pF	1	350	P.S.M.	92	0·1 µF	20	350	M.C.T.					
31	100 pF	5	500	CERAMICON N750	62	2000 pF	1	350	P.S.M	93	0·1 µF	20	350	M.C.T					

* TEMPERATURE COMPENSATING CAPACITORS

9 KC/S REJECTOR FILTER

RESISTORS					CAPACITORS				
R. No	VALUE Ω	TOL ±%	W	TYPE	C. No	VALUE	TOL ±%	WKG VOLTS	TYPE
1b	220000	10	½	ERIE 8	1b	2000 pF	1	350	P.S.M
					2b	2000 pF	1	350	P.S.M

CRYSTAL CALIBRATOR

RESISTORS					CAPACITORS				
R No	VALUE	TOL ±%	W	TYPE	C No	VALUE	TOL ±%	WKG VOLTS	TYPE
1a	68000 Ω	20	½	ERIE 8	1a	1·5 pF	0.5pF	500	P100
2a	22000 Ω	20	½	ERIE 8	2a	470pF	20	350	P.S.M
3a	33000 Ω	20	½	ERIE 8	3a	10 pF	10	500	N750
					4a	0·1 µF	25	250	DUB418
					5a	0·1 µF	25	250	DUB418

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	S130P	4 PIN
V13	KT81	B8B
V14	U83	OCTAL
V15	Z77	B7G

TOGGLE SWITCHES

	SW1	SW2	SW3	SW4	SW5	SW6	SW7	SW8	SW9	SW10	SW11	SW12	SW13	SW14
MAINS-ON	C	C												
MAINS-OFF	O	O												
SEND	[illegible]													
RECEIVE	[illegible]													
A.V.C.-ON	[illegible]													
A.V.C.-OFF	[illegible]													
SPEECH	[illegible]													
MUSIC	[illegible]													
B.F.O.-ON	[illegible]													
B.F.O.-OFF	[illegible]													
FILTER-IN	[illegible]													
FILTER-OUT	[illegible]													
XTAL CAL ON	[illegible]													
XTAL CAL OFF	[illegible]													

C = CLOSED O = OPEN

CRYSTALS

FILTER XTAL	455 KC/S
CAL. XTAL	500 KC/S

ROTARY SWITCHES

S1 TO S9	RANGE
S10 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		
CAL. OSC. UNIT		L37		

PRESET CONCENTRIC TRIMMERS 3-30 pF

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	

GANG CONDENSER 431·5 pF SWING

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

VARIABLE TRIMMERS

VARIABLE TRIMMER 3-25 pF	TC5
CRYSTAL FILTER OUTPUT TRANS.	TC8
B.F.O. PITCH	TC19

FIXED INDUCTANCES

CAL. OSC. ANODE	L10
9 KC/S REJECTOR	L11
1 KC ACCEPTOR	L12

PRESET TRIMMER

CRYSTAL FILTER 2-8 pF	TC37

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