Racal RA-117

Radio Receiver

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3. Technical Specification

Frequency range:	1 – 30 Mc/s
Stability:	Afterwarm-up, overall drift is less than 50 c/s per hour under conditions of constant supply voltage and ambient temperature.
Input impedance:	(1) Wideband 2000-ohms approx. (2) Wideband 75 ohms. (3) 5 double-tuned circuits, 75 ohms. (a) 1 – 2 Mc/s (b) 2 – 4 Mc/s (c) 4 – 8 Mc/s (d) 8 – 16 Mc/s (e) 16 – 30 Mc/s
Tuning:	Effective scale lenght of approximately 145 feet, i.e. 6 inches of scale lenght corresponds to 100 kc/s Frequency increments remain constant over the entire range.
Calibration:	A 100 kc/s signal derived from a 1 Mc/s crystal oscillator having an accuracy of 5 parts in 10^6 provides check points at 100 kc/s intervals.
Sensitivity:	A1 reception, bandwidth 3 Kc/s; 1μV for 18dB signal-to-noise ratio. A2 reception, 30% modulated, bandwidth 3 Kc/s; 3μV for 18dB signal-to-noise ratio.
Intermodulation:	More than 100dB down for interfering signals at least 10% removed from the wanted signal.
Cross modulation:	For wanted signal levels between 3μV and 1mV, an interfering signal 10 Kc/s removed and modulated 30% must have a level greater than 50dB above that of the wanted signal to produce a cross modulation of 3%. The ratio of wanted to unwanted signal is improved up to 10% off tune, at the rate of 3dB per cent.
Blocking:	With similar conditions to those for cross modulation an unwanted signal f_2 must be 60dB greater before the audio output of the wanted signal f_1 is reduced by 3dB due to blocking.
Selectivity:	Six alternative I.F. bandwitchs are obtained by means of a selector switch. Filter details are:

	-6dB	-66dB
(1)	13 kc/s	35 kc/s
(2)	6.5 kc/s	22 kc/s
(3)	3.0 kc/s	15 kc/s
(4)	1.2 kc/s	8 kc/s
(5)	0.3 kc/s	Less than 2 kc/s
(6)	0.1 kc/s	Less than 1.5 kc/s

	Bandwidths 5 and 6 are obtained with crystal-lattice filters; differences in centre frequencies of these bandwitdth settings do not exceed 50c/s.
I.F. Output:	100 kc/s at 75-ohms impedance. Level 0.2 V approx, with A.V.C. in operation. Two outlets in parallel are provided.
Image and Spurious Responses:	With wideband or tuned input, external image signals are at least 60dB down. Internally generated spurious responses are less than 2dB above noise level in all cases.
Noise Factor:	Better than 7dB throughout entire range.
B.F.O. Range:	±8 kc/s
B.F.O. Stability:	With constant ambient temperature and supply voltage, drift after warm-up does not exceed 50 c/s. For input level variations from 10μV to 1mV, B.F.O. drift is negligible.
Automatic Volume Control:	An increase in signal level of 20dB above 1μV improves the signal-to-noise ratio by 18dB. An increase in signal level of 100dB above 1μV increases the A.F. output by less than 7dB.
A.V.C. Time Constants:	**Short:** Charge 25 milliseconds Discharge 200 milliseconds **Long:** Charge 200 milliseconds Discharge 1 second
A.F. Response:	With 13 kc/s bandwidth, response remains within ±4dB from 250 c/s to 600 c/s.
A.F. Output:	1. 2.5-in. loudspeaker on front panel (switched). 2. Two headphone sockets in parallel on front panel. (see Note) 3. Three independent outputs of 3mW at 600-ohms at rear of chassis. 4. One output of 10mW at 600-ohms. Preset level is independent of A.F.GAIN control setting. 5. One output of 1W at 3-ohms. Note: The two headphone sockets are connected across one of the 600-ohms, 3mW outlets.
Distortion:	Not greater than 5% at 1W output.
Hum Level:	With A.F.GAIN control at maximum, the hum level is never worse than 40dB below rated output (1W)
Noise Limiter:	A series noise limiter circuit van be switched into operation to provide limiting at modulation levels exceeding 30%.
Meter Indication:	Alternative switching for indication of signal carrier level, A.F. output level or "S" meter indication.
Power Supply:	100-125V and 200-250V, 45-65 c/s. Power consumption 100W approx.

Dimensions:

	Height	Width	Depth
For rack mounting (fitted dust cover)	10.5in 26.7cm	19in 48.25cm	20.125in 51cm.
Fitted cabinet	12in 30.5 cm	20.5in 52cm	21.875in 55.6cm

Weight:

Rack mounted	62 lb (28 kg)
In cabinet	92 lb (42 kg)

4. Introduction

General Description

1. The Communications Receiver Type RA.117 has been designed for use as a general purpose receiver which will provide a high order of selectivity and stability. The receiver covers a frequency range from 1.0 to 30.0 Mc/s.
2. A built-in crystal-controlled calibrator provides reference signals at each 100 kc/s division to permit exact alignment of the scale pointer. Two independent I.F. outputs, in parallel, at 100 kc/s are provided for external use if required. A number of audio outputs are available providing flexibility during operation; a small loudspeaker is fitted for monitoring purposes.
3. The receiver is designed to operate from 100-125 volts and 200-250 volts, 45-65 c/s main supply. The power consumtion is approximately 100 watts.

Constructional Details

4. The receiver is designed for both bench (table) and rack mounting. The front panel is painted Light Battleship Grey (British Standard Specification 381C, colour 697) and has been carefully designed to minimize operator fatigue.
5. The dimensions of the 1/8 in. thick front panel conform with the requirements for mounting in a standard 19 in. rack.
6. For bench mounting, the receiver is fitted in a robust steel cabinet which has a rear opening to enable the operator to gain easy access to the fuses and the termination strips.
7. A dust cover is provided with both models. This may be removed from cabinet-mounted receivers in conditions of high ambient temperature.
8. The chassis and major modules are of cast construction thus ensuring maximum rigidity and effective electrical screening. Each receiver is supplied with three keys to facilitate removal of the control knobs, insulated trimming tool and coaxial terminations for aerial and I.F. connections. Extra sleeves can be provided with the terminations for alternative coaxial cable sizes.

5. Installation

1. After carefully unpacking the receiver, remove the dust cover and make sure that all valves and screening cans are firmly in place and that no packing material remains within the tuning mechanism.

POWER SUPPLY.

2. Ascertain that the mains transformator is set to the appropriate voltage tapping. This is carried out by means of soldered connections to the transformer. A power lead is permanently fitted to the receiver which can be connected directly to the power supply. Check that the terminals HT1 and HT2 situated on the main chassis are linked (unless the L.F. Converter is in use).

FUSES.

3. Ensure that the rating of the supply fuse and the H.T. fuse correct wiz:

Supply fuse	2A
H.T. fuse	350mA, anti surge.

AERIAL.

4. The impedance at the aerial (antenna) input plug is designed to match into a 75-ohms unbalanced transmission line. The cable termination supplied with the receiver can bee provided with alternative sleeves to enable it to be used with a type UR.18 or UR.70 cable or similar cables of nominal diameter 1/2-in or 1/4-in. respectively.

AUDIO OUTPUTS.

5. A number of audio outputs are available to give the following facilities.
   (1) The two telephone jack sockets situated on the front panel are connected across one of the 600 Ohms, 3mW outlets.
   (2) The following outputs are connected to the terminal strip at the rear of the receiver:-
      (a) Three 600-ohms outlets at 3mW.
      (b) One 3-ohm outlet at 1W.
      (c) One 600-ohms outlet at 10mW. This output is controlled by a preset A.F. LEVEL control on the front panel and is independent of the outputs previously described.

100 kc/s I.F. OUTPUT.

6. The connection consists of two coaxial plugs connected in parallel to the 100 kc/s output. The total load should not be less than 75-ohms (e.g. with outlet loaded by 75-ohms, the other can be can used as a high impedance source).

EXTERNAL INPUT/OUTPUT CONNECTIONS.

7. The following input and output connections are available on a panel at the rear of the receiver (fig.1):-

1 Mc/s input/output:	May be used diversity operation.
2nd V. F. O. output/input(3.6 – 4.6 Mc/s)	For diversity operation and external channelizer crystal oscillator output.
1.7 Mc/s input/output	For diversity operation and fine tuning unit input.
R.F. (2 – 3 Mc/s) input:	Input from an L.F. converter.

The above input/output connections are selected by internal linkage, the connections should be made as follows:-

1 Mc/s input	Remove “T” adaptor and place in clip provided on side of gusset plate. Connect the free plugs PL12 to SKT3 and connect the free plug PL2 to SKT2.
1 Mc/s output	Disconnect plugs PL12 and PL2 and connect “T” adaptor to socket SKT2. Connect plugs PL12 and PL2 to the “T” adaptor.
2nd V.F.O. input	Connect the free plug PL302 to SKT302.
2nd V.F.O. output	Connect the free plug PL303A to SKT304.
1.7 Mc/s input	Connect the free plug PL303A to SKT303.
1.7 Mc/s output	Connect the free plug PL303A to SKT306. (blue)

Note 1 When using the internal oscillators with crystals, the connections should be made for outputs since the cable capacity will pull the internal crystal off frequency.

Note 2 The 1 Mc/s and 1.7 Mc/s crystal must be removed if an external source is applied to the input socket. Stowage space is provided on the chassis for the crystals when they are not in use.

AUTOMATIC VOLUME CONTROL.

8. The A.V.C. line is brought out to the terminal strip at the rear of the chassis for such applications as diversity reception.

6. Operation

1. References to the controls are in capitals and are in accordance with the panel titles adjacent to them (fig.2).
2. It should be noted that the method of operation of the receiver extremely simple, depens largerly upon the purpose for which the receiver is being embloyed.

FUNCTION OF CONTROLS.

3. The front panel controls are described in the order in which they could be used for setting-up prior to use.

POWER	Makes and breaks the power supply to the mains transformer.
R.F. RANGE MC/S	This control enables the selection of one any of five antenna ranges plus two WIDEBAND positions, one of 75-ohms input impedance and other a high impedance input of 2000-ohms.
R.F. ATTENUATOR	This control enables the operator to reduce the level of all incoming signals when strong unwanted signals are present which cannot be rejected sufficiently by tuning the antenna.
MEGACYCLES	This control selects the desired Mc/s frequency. The dial should be checked periodically to ensure that its setting is reasonably central with respect to the band in use. This is indicated by a reduction of signal or noise on either side of the correct setting.
SYSTEM	This switch provides facilities for STANDBY, MANUAL, A.V.C., CALIBRATION and CHECK B.F.O.
BANDWIDTH	The two crystal filters determining the band- width are adjusted to ensure that their centre frequencies are all within 50 c/s, thus any bandwidth can be selected without retuning the receiver. Six bandwidths are provided as follows:- 13 kc/s, 6.5 kc/s, 3 kc/s and 1.2 kc/s (L-C) 300 c/s and 100 c/s (crystal)
A.F. GAIN	The A.F. GAIN control adjusts the audio output.
KILOCYCLES	This control selects the desired kc/s frequency. The calibration of this scale may be checked at 100 kc/s intervals by setting the system switch to the CAL. position and V.F.O. switch set to INT.
B.F.O.	The B.F.O. ON/OFF switch makes or breaks H.T. to the beat frequency oscillator.
B.F.O. NOTE KC/S	The B.F.O. is exatly tuned to a central point on the I.F. amplifier response when B.F.O. NOTE KC/S control is st to zero-beat with the calibrator. Having standardized the B.F.O. frequency, the frequency of an incoming signal may be accurately measured by setting the KILOCYCLES control to a zero-beat position; the B.F.O. should de detuned in order to produce an acceptaple note for c.w. reception.

R.F. TUNE	If maximum sensitivity is not required, the antenna need not be tuned unless strong unwanted signals are present. It should be noted that the presence of very strong singnals anywhere within the spectrum may cause crossmodulation unless the aerial is tuned. Under these conditions, CARE MUST BE TAKEN TO AVOID TUNING THE INPUT TO THE INTERFERING SIGNALS instead of the signal required. Familiarity with the tuning controls will facilitate this.
R.F./I.F. GAIN	The R.F./I.F. GAIN control is operative both in the MAN. and the A.V.C. position of the SYSTEM switch. In the MAN.position of the SYSTEM switch the setting of the control should be always at a minimum consistent with satisfactory A.F. level. The following should be noted when the SYSTEM switch is in the A.V.C. position. Reducing the I.F. gain results in a reduction of a A.V.C. loop gain together with the a degraded A.V.C. characteristic. Therefore when in the A.V.C. position, it is desirable that the R.F./I.F. GAIN control be set to maximum. A possible execption of this occurs when receiving interrupted signals in which the carrier is periodically switched off; in this case , receiver noise could be troublesome during the quiet intervals.
A.V.C.	The choice of time-constant depends upon conditions. The LONG time-constant (1 second) should be employed with the choice signals, the SHORT time-constant may be used with high speed telegraphy or voice. For hand (low) speed telegraphy, the MAN. position of the SYSTEM switch should be used (refer to R.F./I.F. GAIN)
A.F. LEVEL	The preset control sets the A.F. level in a separate A.F. stage for feeding a 600-ohms, 10mW line. It is unaffected by the position of the main A.F. GAIN control. IT IS MOST IMPORTANT that the A.F. LEVEL is not turned towards its maximum position unless the 10mW 600-ohms winding is suitable terminated.
LIMITER	When swithced into use, the LIMITER reduces the effects of noise peaks exceeding the level of a 30% modulated signal. It does not introduce noticeable distortion below a 30% modulation level.
"S" METER	With the METER switch in the R.F. LEVEL position the meter indicates the signal diode current. In the A.F. LEVEL position, the 10mW, 600-ohms output only is monitored. A calibration mark is provided at 10mW.
SPEAKER	The loudspeaker may be switched ON or OFF as required. The two telephone jack sockets remain in circuit in either position of the SPEAKER switch. The insertion of a telephone jack disconnects the loudspeaker.
V.F.O.	This switch should be set to the EXT. position when a external 3.6 – 4.6 Mc/s source is applied.

PRELIMINARY SETTING-UP.

4. The instructions given below are concerned with tuning the receiver to a signal of known frequency. These instructions (1) to (8) apply with the V.F.O. switch in either position.
   (1) Set the power switch to ON. Allow a few minutes for the receiver to warm-up.
   (2) Set the R.F. RANGE MC/S switch to WIDEBAND.
   (3) Set R.F. ATTENUATOR to MIN.
   (4) Set A.F. GAIN control to its mid-position.
   (5) Set SYSTEM switch to MAN.
   (6) Set LIMITER and B.F.O. switch to OFF.
   (7) Select bandwidth of 3 or 6.5 kc/s.
   (8) Rotate the R.F./I.F. GAIN control to three-quarters of fully clockwise.

FILM SCALE CALIBRATION

5.
   (1) Set the SYSTEM switch to CAL.
   (2) Select BANDWIDTH of 3 kc/s.
   (3) Set the KILOCYCLES scale to that of the 100 kc/s point which is nearest to the frequency required and adjust the control accurately until a zero-beat note is obtained. Move the milled cursor slide on the dial escutheon so that the pointer coincides exactly with the selected 100 kc/s division.
   (4) Restore all other controls to the preliminary setting shown in para.4. above.

B.F.O. CALIBRATION

6.
   (1) Set the B.F.O. to on.
   (2) Set the SYSTEM switch to CHECK B.F.O.
   (3) Adjust the B.F.O. NOTE KC/S control to zero-beat.
   (4) Restore all other controls to the preliminary setting shown in para.4. above.

TUNING

7.
   (1) Set R.F. RANGE MC/S to the desired frequency band.
   (2) Set R.F. ATTENUATOR to MIN.
   (3) Set MEGACYCLES dial to the required integer (1 to 29). The position of maximum receiver noise will indicate the correct setting.
   (4) Set SYSTEM switch to CAL.
   (5) Set Bandwidth to 3 kc/s.
   (6) Set A.F. GAIN to mid-position.
   (7) Adjust KILOCYCLES scale to zero beat at the 100 kc/s point nearest to the desired frequency.
   (8) Adjust the milled cursor slide to coincide with this point.
   (9) Switch B.F.O. on.
   (10) Set SYSTEM switch to CHECK B.F.O.
   (11) Adjust B.F.O. NOTE KC/S control to zero beat.

(13) Set KILOCYCLES scale to the required frequency and critically tune for zero beat in order to centralize the signal within the I.F. pass-band.
(14) Adjust R.F. TUNE for maximum signal (or noise). For optimum c.w. reception, "off-tune" the B.F.O. to produce an acceptaple beat note.
(15) Set the A.F. GAIN to its maximum clockwise position and adjust the output level with the R.F./I.F. GAIN control.
(16) For m.c.w. or voice reception, switch B.F.O. off.
(17) Set the SYSTEM switch to A.V.C. if required.
(18) Set BANDWIDTH for optimum reception.

"S" METER

8. The "S" meter should be correctly set to zero.
9. With no antenna connected, set the R.F. ATTENUATOR to MAX. Set the SYSTEM switch to A.V.C. Turn the R.F./I.F. GAIN control to the maximum clockwise position.

NOTE: Unless the R.F./I.F. GAIN control is in the maximum position, the "S" meter calibration is upset.

10. Remove the plated cap below the meter. Adjust the setting of the balance control (accessible through the hole in the panel) by means of a screwdriwer until the meter reads zero.

7. Brief Technical Description

1. This section describes briefly, with the aid of the block diagram fig. 3, the basic theory of operation. For a more detailed explanation of the receiver, DETAILED CIRCUIT DESCRIPTION, should be consulted.

SIGNAL INPUT

2. The receiver is designed for an input impedance of 75-ohms for all positions of the R.F. RANGE switch except WIDEBAND; in the WIDEBAND position the input impedance is 2000-ohms.

FIRST MIXER

3. Input signals between 0.98 and 30 Mc/s are via an R.F. amplifier and a 30 Mc/s low-pass filter to the first mixer (M1) where they are mixed with the output from a variable frequency oscillator VFO-1 (MEGACYCLES tuning). This oscillator has a frequency range of 41.5 to 69.5 Mc/s. The first I.F. stage is in effect a band-pass filter tuned to 40 Mc/s ±650 kc/s. Thus, according to the setting of VFO-1, any spectrum of signals 1 Mc/s wide and existing in the range 0.98 to 30 Mc/s can be mixed in M1 to produce an output acceptable to the first I.F. band-pass filter.
4. It should be noted at this stage that the exact setting of VFO-1 is determined by conditions in the second mixer and harmonic mixer circuit ; These restrict the possible settings to position 1 Mc/s apart (e.g. 41.5, 42.5, 43.5 Mc/s, etc.).

HARMONIC GENERATOR AND MIXER

5. The output from a 1 Mc/s crystal oscillator is connected to a harmonic generator. The harmonics derived from this stage are passed through a 32 Mc/s low-pass filter and mixed with the output from VFO-1 in the harmonic mixer. This mixer provides an output at 37.5 Mc/s which is amplified before passing through a band-pass filter tuned to 37.5 Mc/s with a bandwidth of ±150 kc/s.
6. The presence of this filter restricts the setting of VFO-1 to an exact number of Mc/s plus 37.5 Mc/s in order to give an output acceptaple to the filter and amplifier. As a result, the first V.F.O. must be tuned in 1 Mc/s steps.

SECOND MIXER

7. The 40 Mc/s first I.F. signal is mixed in the second mixer (M2) with the 37.5 Mc/s output from the harmonic mixer in order to produce an output consisting of a 1 Mc/s spectrum in the frequency range 2 – 3 Mc/s (second I.F.).
8. To clarity this method of operation, some examples of dial settings and intermediate frequencies corresponding to various incoming signals are tabulated below:

Dial Mc/s	Settings kc/s	Signal Freq. (f_s) Mc/s	VFO-1 (f_o)Mc/s	Xtal harmonic (nf_c)Mc/s	1st I.F. Mc/s	2nd I.F. Mc/s
4	1.000	5.0	44.5	7th	39.5	2.0
5	0	5.0	45.5	8th	40.5	3.0
18	600	18.6	58.5	21st	39.9	2.4

9. Frequency drift of VFO-1 within the limits of the 37.5 Mc/s filter bandwidth, does not affect the frequency stability of the receiver. A change in this oscillator frequency will alter the first I.F. to the same extent and in the same sense as the nominal 37.5 Mc/s signal from the harmonic mixer. Therefore the difference frequency from M2 will remain constant.

THIRD MIXER

10. The 2 – 3 Mc/s receiver, which follows M2, is preceded by a pre-tuned bandpass filter. The 2 – 3 Mc/s output from the filter is mixed in the third mixer with either the output from the second variable frequency oscillator VFO-2 or an external signal within the frequency range of 3.6 to 4.6 Mc/s to provide the third intermediate frequency of 1.6 Mc/s.

FOURTH MIXER

11. The 1.6 Mc/s intermediate frequency is mixed in the fourth mixer (M4) with the 1.7 Mc/s output from the 1.7 Mc/s oscillator/amplifier to provide the fourth and final intermediate frequency of 100 kc/s.

FOURTH I.F. STAGE

12. The final I.F. stages are preceded by crystal lattice and L-C filters which provide six alternative bandwidths. Separate signal and A.V.C. diodes are employed and alternative switched time-constants give the optimum conditions for telegraphy and telephony reception. An additional I.F. amplifier is incorporated to give an independent output at 100 kc/s.

A.F. STAGES

13. Two independent audio frequency stages are incorporated for either line output or headphone sockets and internal loudspeaker; each stage is provided with a level control (see TECHNICAL SPECIFICATION).

CRYSTAL CALIBRATOR

14. A crystal calibrator unit is incorporated to enable the scale of VFO-2 to be checked at 100 kc/s intervals when the V.F.O. switch is set to INT. position. These check points are obtained from a regenerative divider controlled by the 1 Mc/s crystal oscillator.

8. Detailed Circuit Description

1. Reference should be made to the circuit diagram at the end of this handbook.

AERIAL CIRCUIT

2. A 75-ohms unbalanced aerial source is connected to the tuned R.F. amplifier through a three-section 30 Mc/s low-pass filter and a five- position attenuator covering a range of 0 to 40 dB. Switch S2 selects wide- band 75-ohms or wideband (high impedance) or any one the five double-tuned aerial coils L4-L8 for tuned operation. These aerial coils are aligned by means of dust iron cores. The aerial is tuned by a capacitor C18A/B which is switched out of circuit in both wideband positions.

R.F. AMPLIFIER

3. The incoming signal is fed via C28 and grid stopper R25 to the grid of V3B; the R.F. stage (V3) employs a variable-mu, low-noise double- triode; the two halves of the valve are connected in cascode so as to utilize the low-noise high-gain properties of the valve. A delayed A.V.C. voltage, derived from a shunt diode network, is applied to the grid of V3B when the signal level is approximately 10μV. The capacitors C40 and C41 ensure that the cathode is adequately decoupled over the wide frequency range. Ferrite beads have been fitted to the heater lead, connected to pin 4, the anode of V3A and the cathode of V3B adjacent to C41, to prevent parasitic oscillations occurring.

30 MC/S LOW-PASS FILTER

4. The amplified signal is passed to a 30 Mc/s low-pass filter which has a substantially flat responseover the frequency range. L27, C47 and R28 constitute the first 'L half Section' of the filter. The signal is then fed at low impedance (680-ohms) through the coupling capacitor C74 and the grid stopper R45 to the control grid of V7, the first mixer stage. The input capacitance of V7 forms the capacitance to chassis betweeenL15 and L17 required to the filter network.

NOTE: This capacitance is not critical, therefore no adjustment will be necessary should V7 be changed.

FIRST VARIABLE FREQUENCY OSCILLATOR (VFO-1)

5. This circuit comprises a cathode-coupled Hartley oscillator stage (V5) which may be continously tuned over the frequency range of 40.5 to 69.5 Mc/s. The frequency determining components are an inductance L36 and a variable capacitance C76. Alignment is accomplished by adjusting aluminium core of L36 and the trimming capacitor C77. The variable capacitor C76 is coupled to the Mc/s dial which is calibrated from 0 to 29 Mc/s. The anode load consists of L20, a compensating inductance which is wound on a 470-ohm resistor R18. The oscillator is coupled via C85 to the signal grid of the first mixer stage V7 and also via C42 to the control grid of the harmonic mixer V4.

NOTE: The Mc/s dial calibration may be affected if V5 if changed. The necessary correction may be made by adjusting C77 with the Mc/s dial set to 29 Mc/s.

FIRST MIXER (M1)

6. The outputs from the 30 Mc/s low-pass filter and the variable frequency oscillator VFO-1 are fed to the signal grid of the mixer stage (V7) which produces a signal at 40 Mc/s. The signal is then passed to a 40 Mc/s band-pass filter which forms the anode load of this stage.

40 MC/S BAND-PASS FILTER

7. The 40 Mc/s band-pass filter consists of eight over-coupled tuned circuits connected in cascade and is tuned by the trimming capacitors C21, C33, C43, C53, C61, C70, C79 and C88. This filter, which has a passband of 40 Mc/s ±650 kc/s, ensures that only the required 1 Mc/s spectrum of signals is passed to the second stage. This filter is deliberately set to a slightly wider passband than is theoretically required, to allow for possible drift in VFO-1.

1 MC/S CRYSTAL OSCILLATOR/AMPLIFIER

8. The frequency of the crystal oscillator V1 may be set precisely to 1 Mc/s by adjusting the trimming capacitor C2A. The crystal XL1 which is connected between the control grid and the screen grid is electron coupled to the anode. The anode coil L2 is adjusted to resonate at 1 Mc/s by means of a dust iron core. The fixed capacitors C9, C10 and C11 complete the tuned circuit. When an external signal is applied to socket SK3, the valve operates as an amplifier.
9. The output from V1 is capacitance-coupled to the harmonic generator V2 and via SK2 to a "T" adptor for feeding a 1 Mc/s input into the L.F. converter and also the control grid of the mixer valve V13.

HARMONIC GENERATOR

10. The 1 Mc/s signal is fed via coupling capacitor C8 to the control grid of the harmonic generator V2. The H.T. is fed to the screen grid via R12 and is decoupled by C8A. Harmonics produced at this stage are passed to a 32 Mc/s low-pass filter.

32 MC/S LOW-PASS FILTER

11. The megacycle harmonics are fed through a 32 Mc/s low-pass filter circuit to prevent harmonics other than those required from passing to the harmonic mixer (V4). Limited control over the cut-off frequency is provided by C7 which is adjusted to equalize the output from yhe filter at the frequencies corresponding to 28 and 29 Mc/s on the MEGACYCLE dial.

HARMONIC MIXER

12. The outputs from the 32 Mc/s low-pass filter and VFO-1 are mixed in the harmonic mixer by applying the filtered megacycle harmonics to the suppressor grid and the output from the VFO-1 to the control grid. The 37.5 Mc/s output is selected by the tuned anode load, consisting of a fixed capacitor C50 and an inductance L28 which may be adjusted by means of a dust iron core, and coupled by C51 to V6. R36 is grid stopper.

2-STAGE 37.5 MC/S AMPLIFIER (1)

13. The anode load of V6 is a tuned circuit consisting of a fixed capacitor C67 and an inductor L33 Which is tuned to 37.5 Mc/s. Frequency adjustment is by the dust iron

core L33. This stage feeds the amplified signal via C68 to the following stage V8. The 37.5 Mc/s signal is then passed to the 37.5 Mc/s band-pass filter. The anode load of this stage is provided by this filter.

37.5 MC/S BAND-PASS FILTER

14. The 37.5 Mc/s band-pass filter consists of eight under-coupled tuned circuits arranged in cascade. These filter sections may be tuned by C24, C35, C45, C55, C63, C72, C81 and C91 respectively. This filter, which has a passband of 300 kc/s, allows for possible drift in VFO-1. The narrow passband and high rejection to frequencies outside the passband prevent spurious signals from reaching the second mixer stage (V9).

37.5 MC/S AMPLIFIER (2)

15. The filtered 37.5 Mc/s signal is further amplified by V10 before being passed to the second mixer stage (V9). To prevent interaction between the 40 Mc/s band-pass filter and the 37.5 Mc/s tuned circuit (L50 and C113) and to enable either circuit to be adjusted without affecting the other, a balancing circuit is included which is shown in simplified form in fig. 4. The 40 Mc/s signal is introduced into the 37.5 Mc/s tuned circuit at a point of zero R.F. potential since L50 is centre tapped and C108 is adjusted to be equal to the total of the capacitance of V10 anode to chassis. C107 and the input capacitor of V9.

NOTE: The anode load of V10 is adjusted to 37.5 Mc/s by adjusting the dust iron core in L50. The balancing circuit will be affected if V9 or V10 is changed.

SECOND MIXER (M2)

16. This mixer (V9) produces the second intermediate frequency of 2 – 3 Mc/s by mixing the 40 Mc/s I.F. and the 37.5 Mc/s signal. The tuned circuit formed by L300, C300 remove the 37.5 Mc/s frequency whilst the other tuned circuit formed by L301, C301 remove the 6 Mc/s frequency so that only the second I.F. is passed to the 2 – 3 Mc/s band-pass filter preceding the third mixer.

2 – 3 MC/S PRE-TUNED BAND-PASS FILTER

17. This filter consists of two pre-tuned band pass filter sections. The characteristic impedance of the filter is 1000 ohms.

THIRD MIXER

18. The output from the 2 – 3 Mc/s band-pass filter is resistance-capacitance coupled to the signal grid of V25 together with the output (3.6 – 4.6 Mc/s) from the second V.F.O. amplifier V11 when the V.F.O. switch (S300) is set to the INT. position. With the V.F.O. switch set to the EXT. position, V11 operates as a buffer amplifier. This mixer (V25) produces the third intermediate frequency of 1.6 Mc/s. The signal is then fed to a 1.6 Mc/s band-pass filter which forms the anode load of this stage.
19. The 1.6 Mc/s band-pass filter consists of two double-tuned I.F. trans- formers, the first section of the filter is formed by C320, L306, L309 and C325 and the second section by C332, L313, L314, C334. This filter has a bandwidth of 13 kc/s.

SECOND VARIABLE FREQUENCY OSCILLATOR (VFO-2)

20. The second variable frequency oscillator, covering a frequency range 3.6 to 4.6 Mc/s, is an electron coupled Hartley circuit embloying one half of double-triode V12. The oscillator frequency is determined by an inductance L55, two fixed capacitors C303, C305, a trimming capacitor C306 and a variable capcitor C301. The KILOCYCLES scale which is calibrated between 0 and 1000 kc/s is coupled to this variable capacitor.
21. The output from VFO-2 is resistance-capacitance coupled to the grid of V12A, a cathode-follower stage. With the V.F.O. switch set to the INT. position the output from V12A is fed via PL305 and PL300A to the control grid of the second v.f.o. amplifier V11. In the EXT. position the external 3.6 to 4.6 Mc/s signal is fed to V11.

FOURTH MIXER

22. The output from the 1.6 Mc/s band-pass filter is directly coupled to the signal grid of a pentagrid valve V26; it is mixed with a 1.7 Mc/s signal from V27 fed via the coupling capacitor C339 to the oscillator grid of V26. The resistor R68 completes the d.c. path from this grid to earth. The 100 kc/s output from this mixer stage is then fed via SK6, PL6 to the crystal filter unit.

1.7 MC/S CRYSTAL OSCILLATOR/AMPLIFIER

23. The frequency from the crystal oscillator C27 may be set precisely to 1.7 Mc/s by adjusting the trimming capacitor C337. The crystal XL300 which is connected between the control grid and the screen grid is electron coupled to the anode. When an external signal is applied to socket SK303A the valve operates as an amplifier. The output from this circuit is fed via C339 to the oscillator grid of the fourth mixer V26.

CRYSTAL FILTER

24. Six alternative switched I.F. bandwidths are available as follows:-

$$\left.\begin{array}{c}100\ \text{c/s}\\300\ \text{c/s}\end{array}\right\}\ \text{Crystal}$$

$$\left.\begin{array}{c}1.2\ \text{kc/s}\\3.0\ \text{kc/s}\\6.5\ \text{kc/s}\\13.0\ \text{kc/s}\end{array}\right\}\ \text{L} - \text{C}$$

25. In the crystal positions the fourth mixer anode is connected to L48 in the crystal filter. L47 and L49 provide a balanced output which is tuned by capacitors C109 and C110. In the 100 c/s position, the balanced output is connected via crystals XL2 and XL5 to the first tuned section of the 100 c/s L-C filter. The differential trimmer C118 is the phasing control for this bandwidth. XL3, XL6 the capacitor C119 form a similar circuit for the 300 c/s position. Damping resistors R64 and R65 are connected across the tuned circuits to obtain the required bandwidth.

100 KC/S L-C FILTER

26. This filter consists of four tuned circuits arranged in cascade. In the L-C bandwidth positions, the signal is fed to the tuned circuit formed by L61 and the combination of the capacitors C145, C146, C146A and C147. The second section consists of L62

and L63 in series with C152, C152A and C153. The final section consisting of L68 and L71 in series with C161 and C162, is damped by the series resistors R86, R87A and R88 according to the bandwidth. In the L-C positions the output is taken from a capacitive divider formed by C161 and C161A with C170, to equalize the gains in the L-C and crystal bandwidth positions.

27. The L-C banwidths are obtained by varying the degree of coupling between each section of the filter in addition to the damping resistors in the final stage. The capacitor C175 is included to compensate for the effective reduction of the input capacitance of V14, appearing across the tuned circuit, when switching from crystal to L-C positions.
28. To maintain the input capacitance of the L-C filter, in the crystal positions, a trimming capacitor C148 is switched into circuits. This trimmer is adjusted to be equal to the output capacitance of V26 and the screened cable. In the crystal bandwidth positions, the L-C filter is operating in its narrow bandwidth positions, i.e. 1.2 kc/s.

NOTE: The 470-kilohm damping resistors R77 and R80 are disconnected except during filter alignment.

FIRST 100 KC/S I.F. AMPLIFIER

29. The output from the L-C filter is passed through a coupling capacitor C164 to the control grid of the pentode amplifier valve V14. This grid is returned via R96 to the A.V.C. line which is filtered at this point by R102 and C173. The screen potential is derived from a potential divider formed by R93, R97 and RV4. This stage is coupled to the second I.F. amplifier and the I.F. output stage by a double tuned transformer having an over-coupled characteristic.

SECOND 100 KC/S I.F. AMPLIFIER

30. The signal from the first I.F. tranformer is fed through the grid stopper R114 to the control grid of the second I.F. amplifier. H.T. is supplied to the screen via the dropping resistor R113 and is decoupled by C181. The anode load is tuned circuit consisting of L77, C192 and C191. This circuit is heavily damped by R112. The secondary winding L78 and L79 is tuned by C195 and C195B with R120A as a damping resistor. The output is fed to the diode detector anode.

DIODE DETECTOR

31. The low potential end of L79 is connected through the R.F. filter (C209, R128, C210, C219 and C211) to the diode load R130. With the meter switched to R.F. LEVEL, the meter indicates the detector diode current. The resistor R131 is incluced to complete the diode detector circuit when the meter is switched out of circuit.

NOISE LIMITER

32. The noise limiter diode (pins 2 and 5 of V21) is connected in a series circuit to operate at approximately 30% modulation. its operation is explained with reference to fig.5.

33. The d.c. path from point A is through R134, R135, the diode and R137. The A.F. signal path from detector diode load is through C216, the diode and C218 when S8 is open. In the presence of a signal, a negative potential varying with the depth of modulation, will be developed at point A thus causing the diode to conduct. The negative potential

at B, will be lower than at A and will be maintained at a constant level due to the long time constant of R134 and C217. R135 allows the cathode potential to vary in sympathy with the modulation provided the modulation depth does not exceed 30%. The potential appearing at the cathode of the noise limiter diode therefore consists of a steady negative potential with the modulation superimposed. When noise impulses corresponding to high modulation peaks appear at point A and via C216 at point C, the voltage across the diode changes sign thereby causing the diode to stop conducting and open-circuit the A.F. signal path. With S8 in the OFF position the limiter is inoperative.

A.V.C. AND T.C. DIODE

34. The signal appearing at the anode of V16 is passed through the capacitor C139 to the anode of the A.V.C. diode. The diode load is formed by R116. A positive potential derived from R120, R121 and R122, supplies the required A.V.C. delay voltage to the cathode of this diode.When A.V.C. switch is in the SHORT position and the SYSTEM switch set to a position in which the A.V.C. is operative, i.e. A.V.C., CAL. or CHECK B.F.O., the anode of the A.V.C. diode is connected to the A.V.C. line via L81 and R127. The choke L81 is tuned by C203 to a frequency slightly below 100 kc/s so that is presents a small capacitance at 100 kc/s, thus R127 is prevented from shunting the diode load. When the signal level falls, the capacitors C182 and C173 discharge through R118, R127 and L81 into the diode load resistor R116. The A.V.C. potential is brought out via R123 to the tag strip at the rear of the receiver for external use if required. With the SYSTEM switch set to the MANUAL position, the A.V.C. line is connected to the R.F./I.F. GAIN control RV1, thus the gain of the 100 kc/s amplifiers may be varied by adjusting the negative potential applied to the A.V.C. line.

AUDIO OUTPUT

35. Audio frequencies are applied to the control grid of V23B via RV2 the A.F. GAIN control. The output transformer (T2) provides four separate outputs as follows: 1W into 3-ohms, and three windings supplying 3mW into 600- ohms.
36. The internal loudspeaker (which may be switched out of circuit by operating S11) is connected across the 3-ohm winding. The headphone jacks JK1 and JK2 are connected across one of the 600-ohms windings.

A.F. LINE OUTPUT

37. The audio frequencies are also applied to the grid of V23A via RV3, the A.F. GAIN LEVEL control; this control presets the level from output transformer T3. The transformer provides a 10mW output at 600-ohms which is suitable for direct connection to landlines. A bridge rectifier MR1 is connected across the output via R142 and R143. Th meter may be switched across the rectifier circuit so that the operator can monitor the A.F. output.

BEAT FREQUENCY OSCILLATOR

38. The beat frequency oscillator (V19) employs an electron-coupled Harley circuit. The oscillation frequency is determined by a fixed inductor L82 and a variable capacitor C200 in parallel with C202 and C201. the trimming capacitor C201 is adjusted to

produce an output frequency of preisely 100 kc/s when the beat frequency oscillator frequency control is set to zero. Bias is applied to this valve by C199 and R125.

39. The B.F.O. output is coupled to the diode detector anode via C215. The B.F.O. is supplied with H.T. via S7 except when SYSTEM switch is in the CAL. or STANDBY positions.

100 KC/S I.F. OUTPUT

40. The control grid of V17 is connected to the secondary of the first 100 kc/s I.F. transformer which feeds the stage with the 100 kc/s signal. The screen resistor R108 and the cathode bias resistor R115 are of the same values as used in the scond 100 kc/s I.F. amplifier, hence the A.V.C. characteristic of this stage is identical to that of the main receiver. The anode load resistor R109 feeds the auto transformer L76 via blocking capacitor C189. This transformer provides a 70-ohms output at PL8 and PL9 for external applications.

NOTE: PL8 and PL9 are connected in parallel, therefore only one 100 kc/s output is available at 75-ohms, and to avoid a mismatch the other connection should be made at high impedance.

CRYSTAL CALIBRATION

41. The crystal calibrator, controlled by the 1 Mc/s crystal or by the 1 Mc/s standard input to V1, feeds signals at 100 kc/s intervals to the signal grid of the third mixer stage to provide calibration check points. The calibration can only be carried out when the V.F.O. switch S300 is set to the INT. position.

42. The 1 Mc/s signal, fed through SK2, is connected through PL2 and the grid stopper R83 to the first grid of the mixer valve V13. The anode load consists of a 100 kc/s tuned circuit (L70, C167) and is coupled to the control grid of V15 through the capacitor C168. The anode load of V15 (L75, C117) is tuned to 900 kc/s and is coupledvia C178 to the third grid of V13. V15 is heavily biased so that it functions as a frequency multiplier.

43. An output of 900 kc/s, appearing across the tuned circuit (L75, C177) is coupled to grid 3 of V13 thereby producing a difference frequency of 100 kc/s relative to the 1 Mc/s input. The 100 kc/s output appears across the anode tuned circuit (L70, C167) and is fed to the control grid of V15. The ninth harmonic is selected in turn by the anode tuned circuit (L75, C177) of V15 and fed back to the third grid of V13 to provide the beat frequency of 100 kc/s with the 1 Mc/s input. This crystal controlled regenerative circuit is thus self-maintaining. The 100 kc/s output is obtained from the coil L69 which is mutually coupled to L70 and fed via the octal plug (PL7) to the cathode-follower V12A.

POWER SUPPLIES

44. The primary of the mains transformer is tapped to provide for inputs of 100 – 125 and 200 – 250V. To remove mains-borne interference the capacitors C224 and C225 are incluced. The secondary winding of T1 feeds a bridge-connected full-wave rectifier MR4, MR5, MR6 and MR7 whose output is filtered by C206, L80 and C198 and fed via the receiver muting relay RL1/1 to the SYSTEM switch S5. A 120-ohm resistor

R124 is connected between the negative line and earths thus providing a negative 25V d.c. supply for gain control purposes.

SYSTEM SWITCH

45. The following conditions exist for each setting of the SYSTEM switch. The link on H.T. adaptor terminal is assumed to be in position.

(1) STANDBY — S5A disconnects the H.T. from all stages and connects R119A across the H.T. as a compensating load.

(2) MANUAL
- (a) The H.T. passes through S5A, S5B and S5C to all stages except the calibration unit.
- (b) S5F connects H.T. to the B.F.O. when S7 is switched on.
- (c) The A.V.C. line is disconnected from the A.V.C. diode by S5D and connected to the R.F./I.F. GAIN control (RV1) by S5E.

(3)
- (a) (2)(a) and (2)(b) are applicable.
- (b) S5D connects the A.V.C. line to the A.V.C. diode.

(4)
- (a) H.T. is applied via S5A, S5B and S5F to all stages except:-
  The R.F. amplifier (V3)
  The first V.F.O. (V5)
  The first mixer (V7)
  The second mixer (V9)
  The final 37.5 Mc/s amplifier (V10)
  The B.F.O.

(5) CHECK B.F.O.
- (a) (4)(a) applicable except that H.T. is also applied to the B.F.O. via S7.
- (b) (3)(b) applicable.

"S" METER

46. The "S" meter is connected between the cathode of V14 and a point of preset (RV4) positive potential. It is calibrated to provide an indication of signal strengh; a 1μV signal provides a typical reading of between "S1" and "S3" and ascending "S" points in approximately 4 dB steps. The variation in treshold is dependentupon the gain of the R.F. stages. It should be remembered that only with the R.F./I.F. GAIN control

at maximum is the correct calibration maintained.

9. Maintenance

WARNING! The receiver will, under normal conditions, remain in alignment over an extremely long period time, consequently ALL POSSIBILITY OF OTHER CAUSES OF LOW SENSITIVITY SHOULD BE ELIMINATED BEFORE RE-ALIGNMENT IS CONSIRED, and should then only be undertaken by order of the Engineer responsible for the maintenance of the equipment.

Should it become necessary to re-align any part of the receiver only a very small angular adjustment of the trimmers should be necessary unless units have been changed.

TEST EQUIPMENT REQUIRED FOR MAINTENANCE

1. The following items of test gear are required to carry out the maintenance described in this section of the manual:-
   (1) Valve voltmeter reading up to 10V at frequecies up to 70 Mc/s.
   (2) Signal generator capable of operating on fundamental frequencies up to 40 Mc/s.
   (3) Digital frequency meter measuring frequencies at least up to 2 Mc/s.
   (4) Multimeter measuring A.C. and D.C. quantities uo to 500V with recistance of 20,000 ohms per volt.
   (5) Heterodyne wavemeter measuring 40 – 70 Mc/s.
   (6) Telephone headset (low impedance).
   (7) Output power meter.
   (8) Noise generator TF1106 Marconi. (or similar)
   (9) Miscellaneous: viz. 0.1μF capacitor, 4.7 kilohms resistor and 12pF trimmer capacitor.

NOTE: Major uses of the RA.117 receiver are advised to obtain factory type test jigs for alignment of the various units. details of these jigs and specially designed test gear will be supplied on request. A supplement to “ALIGNMENT PROCEDURES” describing the employment of this gear can be made available to such users./par

10. Spurious Responses

ORIGINS OF SPURIOUS RESPONSES

1. In a high sensitive receiver, precautions against internally generated spurious responses are essential. To this end, various sections of the receiver have been carefully screened and the power supplies filtered.
2. Any reduction in the screening efficiency or the failure of any filtering component may results in spurious signals being generated. It is therefore essential to ensure that the bonding surfaces are clean and that all securing screws are tight. Spurious responses in the receiver may occur from the following main causes:-
   (1) 37.5 Mc/s break-through from the second mixer V9 to the third mixer V25.
   (2) Break-through of 1 Mc/s harmonics.
   (3) Break-through of B.F.O. harmonics.
   (4) Responses at 3.800 and 4.000 Mc/s due to second v.f.o. break- through.
   (5) Responses of 1.7 and 3.4 Mc/s due to 1.7 crystal oscillator break-through.
   (6) Response of 3.2 Mc/s due to 6 Mc/s break-through.

CHECKS FOR SPURIOUS RESPONSES

3. Spurious responses are measured relative to receiver noise in the following manner:-

   When response is located, the receiver is de-tuned from it just sufficiently to render the beat inaudible. The A.F. gain is then adjusted to provide a convenient noise reference output (1mW) and the receiver retuned to the spurious signal for maximum output. The dB rise in audio output is a measure of the spurious signal level relative to receiver noise.

   Standard conditions of test:

   No connection to aerial socket
   System switch to MAN.
   R.F./I.F. Gain at MAX.
   B.F.O. on
   3 kc/s bandwidth
   R.F. ATTENUATOR at MIN.
   Set V.F.O. switch to INT.

37.5 MC/S BREAK-THROUGH TO THIRD MIXER

4. Switch R.F. RANGE Mc/s to WIDEBAND 75-ohms. This response will be indicated as a beat note which varies rapidly in frequency with respect to the KILOCYCLES scale, i.e. a change of 1 kc/s on the scale results in a much larger change in the note. It will also move along the KILOCYCLES scale if the MEGACYCLES dial is adjusted slightly. This response may be eliminated by adjusting the 37.5 Mc/s strap (L300 at second mixer anode).

6 MC/S BREAK-THROUGH

5. When the receiver is tuned to 3.2 Mc/s the first v.f.o. frequency is 43.5 Mc/s. This reaches the second mixer and combines with 37.5 Mc/s giving a stable 6 Mc/s which may pass through the 2.3 Mc/s BPF where it combines with the second v.f.o. running at 4.4 Mc/s giving 1.6 Mc/s which then follows normal paths. This can be tuned out by L301.

1 MC/S HARMONIC BREAK-THROUGH

6. Switch R.F.RANGE Mc/s to WWIDEBAND 75-ohms. 1 Mc/s break-through responses appear at 0 and 1,000 on the KILOCYCLES scale at each setting of the MEGACYCLES dial and are generally more prominent with wideband input. If the response is dependent upon the setting of the MEGACYCLES dial, the 1 Mc/s spectrum is probably breaking through to the first mixer stage. If the response is independent of the MEGACYCLES dial setting, it is due either to break-through of the second and/or third harmonic to the second or third mixer stage. Remove second mixer valve to eliminate this stage and so determine in which stage the break-through occurs.

FIRST V.F.O. HARMONICS

7. Spurious responses may occur at 4.5, 5.5 and/or 17.5 Mc/s, if C42A and/or C194A are open circuit. These responses are caused by the harmonics of the first v.f.o. breaking through to the second mixer stage and beating with the harmonics of the 37.5 Mc/s heterodyne voltage.

B.F.O. HARMONICS

8. These responses may be detected at 100 kc/s intervals between 1 and 1.5 Mc/s when the B.F.O. frequency is 100 kc/s and the receiver aerial input is tuned.

SECOND V.F.O. BREAK-THROUGH

9. Responses may occur at 3.8 and 4.3 Mc/s with tuned aerial input. Ascertain that the first and second v.f.o. are not in contact, that the v.f.o. chassis is well bonded to the main chassis and the fixing screw are tight.

NOTES: A failure in any one of the following capacitors C66, C92, C96, C97, C98, C103 or C104 may result in increased 'end of band' responses. These responses will disappear when the MEGACYCLE dial is detuned. The failure of C117, C327, C207, C208 or C214 can result in 'end of band' responses, or B.F.O. harmonic break-through. Detuning the MEGA- CYCLES dial will have no effect.

1.7 MC/S BREAK-THROUGH

10. Responses may occur at 1.7 and 3.4 Mc/s with tuned aerial input due to radiation from the 1.7 Mc/s crystal oscillator. Ascertain that bonding is effective between the 1.7 Mc/s oscillator/mixer chassis and the first V.F.O. chassis.

11. Fault Diagnosis

INTRODUCTION

1. The following notes and test procedures enable the faulty section of the receiver to be determined with the minimum of delay. Unless other- wise stated the meter on the front panel is used for measuring purposes. This is set to R.F. LEVEL and the reference figure is 100μA for all sensitivity tests.
2. Since the audio stages of the receiver are conventional and accessible, normal practice will serve to trace any fault which may occur in this section.

TEST EQUIPMENT REQUIREMENTS

3. The following test equipment will be required:
   (1) Valve Voltmeter.
   (2) 12pF trimmer capacitor.
   (3) Signal generator.

NOTE: The input capacitance of the valve voltmeter must be padded to 12pF by the trimmer or alternatively by a fixed capacitor. Before the value or the trimmer or the fixed capacitor can be selected, the input capacitance of the valve voltmeter must be know. If the trimmer is used this should be connected across a capacitance bridge and set to the required value.

FAULT DIAGNOSIS

4. Set the controls on the front panel as follows:-

   A.F. GAIN set to max.
   R.F./I.F. GAIN set to max.
   B.F.O. switch to off.
   LIMITER switch to OFF.
   SYSTEM switch to MAN.

5. Remove the valve V12 and crystals XL1 and XL300, and connect the output of the signal generator to socket SKT303.
6. Set the BANDWIDTH control to 100 c/s and tune the signal generator for maximum indication on the meter at 100 kc/s. Switch through the bandwidth positions. The sensitivity should be approximately as follows:-

3 kc/s	less than 800μV for a deflection of 100μA
100 c/s 300 c/s 1.2 kc/s 6.5 kc/s 13.0 kc/s	To be within 10dB of sensitivity measured on 3kc/s position

7. In the event of the figure above not being realized, the renewal of one or more of the following valves will probably effect an improvement.

V26	Fourth mixer
V14	First I.F. amplifier
V16	Second I.F. amplifier
V27	1.7 Mc/s oscillator/amplifier

8. Set BANDWIDTH control to 3 kc/s. Refit the 1.7 Mc/s crystal XL300. Connect the output of the signal generator to socket SKT301 (pink) and tune the generator to a frequency of 1.6 Mc/s. The sensitivity should be better than 75μV for 100μA.
9. In the event of the figure above not being realized the renewal of V25 will probably effect on improvement.
10. Refit the valve V12 and set the KC/S scale to 500. Connect the output of the generatorto socket SKT11 and set generator to a frequency of 2.5 Mc/s approximately and tune for maximum deflection on the meter. The sensitivity should be better than 250μV for 100μA.
11. Set the kc/s scale to 0 kc/s and 1000 kc/s and the signal generator to 3 and 2 Mc/s respectively. The sensitivity should not vary from 250μV by more than 3dB.
12. The maximum difference between check point should not exceed 3dB. The renewal of V11, or V9 will probably effect an improvement if this figure is not met, providing that the conditions outlined in previous paragraphs have been achieved.
13. Refit the crystal XL1 and check the 1 Mc/s output (SKT2 on top of the main chassis) with the valve voltmeter to ensure that there is at least 2V output.

12. Representative Test Data

	Signal Input to:	Frequency	Input	Output	Remarks
(a)	Junction of	1,000 c/s	0.8V	50mW in 3 ohms	AUDIO GAIN MAX. A.F. LEVEL MAX.
	C218 and C221B	1,000 c/s	1.0V	10mW in 600 ohms (output to line)	R.F. & I.F. GAIN MIN. B.F.O. off. LIMITER off.
(b)	Grid V16	100 kc/s c.w	360mV level	100μA R.F.	B.F.O. off
	Grid V14	100 kc/s c.w	850μV level	100μA R.F. GAIN MAX.	SYSTEM switch MAN. R.F./I.F.
	Socket SKT303	100 kc/s c.w	800μV level	100μA R.F.	1Mc/s and 1.7Mc/s crystals removed. V.F.O. switch set to EXT. Mc/s scale set to 20. BANDWIDTH 3kc/s.
(c)	Grid of second mixer (TP3)	2.2 Mc/s c.w	25μV level	100μA R.F.	1 Mc/s and 1.7Mc/s crystals
		2.5 Mc/s c.w	25μV level	100μA R.F.	re-inserted. V.F.O. switch set
		2.9 Mc/s c.w	25μV level	100μA R.F.	to INT. Image response (i.e. receiver frequency plus 200 kc/s) should be at least 60db down.
(d)	Aerial input (WIDEBAND 75-ohms)	3.5 Mc/s c.w	250mV	0.5 at TP2	WIDEBAND 75-ohms INPUT R.F. ATTENUATOR MIN. V5 and V7 removed. Valve voltmeter input shunted to 12pF.
(e)	Aerial input (WIDEBAND 75-ohms)	3.5 Mc/s c.w	250mV	0.5 at TP3	WIDEBAND INPUT R.F. ATTENUATOR MIN. V5 and V7 refitted. V9 and 1 Mc/s crystal removed. Valve voltmeter input shunted to 12pF. MEGACYCLES scale 3.
(f)	Grid V10 Grid V8 TP1	37.5 Mc/s c.w	100μV	1V at TP3 70μV 8mV	V9 and V5 and 1Mc/s crystal removed Valve volt- meter input shunted to 12pF.

(g) With the 1 Mc/s crystal in place, the output at socket SKT2 should be approximately

2 volts.

(h) The level of the 37.5 Mc/s drive at TP3 should be between 2 and 10 volts at any MEGACYCLES setting.

13. General Servicing and Aligment Procedures

13.1. General Servicing

INTRODUCTION

1. The following tests will assist in checking the performance of the receiver.
2. Component layout illustrations, fig.8 to fig.23 inclusive, give an overall picture of the receiver sub-assemblies and chassis underside.
3. Removal of the main base cover will, without removal of further covers, reveal the power and audio stages, and the 100 kc/s I.F. amplifier chassis.
4. To gain acces to other stages, furher covers must be removed, they are the second mixer (compartment 7) and the crystal oscillator/amplifier and harmonic generator stages (compartments 4, 5 and 6) fig. 15.

TEST EQUIPMENT REQUIREMENTS

5. The following test equipment will be required to carry out tests on the receiver:-
   (1) Telephone headset
   (2) Output power meter
   (3) Signal generator
   (4) Multimeter

13.2. Receiver Tests

RECEIVER OVERALL GAIN TESTS (C.W.)

6. Perform a sensitivity test as follows:-
   (1) Set the controls on the receiver as follows:-

R.F.RANGE	2 – 4 Mc/s
MEGACYCLES	3
KILOCYCLES	500
R.F ATTENUATOR	MIN.
SYSTEM switch	MAN.
BANDWIDTH	3 kc/s
B.F.O. switch	ON
B.F.O. NOTE	1 kc/s
R.F./I.F. GAIN	fully-clockwise

   (2) Set the controls of the output meter for 600 ohms impedance and a range of 6mW. Connect the output meter across one of the 600 ohm 3mW windings and terminate the other windings with resistor to match their marked impedance.
   (3) Set the controls of the signal generators for a c.w output of 1μV at 3.5 Mc/s and an impedance of 75 ohms. Connect the output of the signal generator to the antenna input of the receiver.
   (4) Tune the receiver to the output frequency of the signal generator and check that a reading of 3mW can be obtained within the range of the A.F. GAIN control.
   (5) Repeat the test with the B.F.O. switched off and a 30% modulated signal at level of 3.5μV from the signal generator.

SIGNAL-TO-NOISE TEST

7. Perform a signal-to-noise test as follows:-
   (1) Set the receiver controls as follows:-

R.F. RANGE	1 – 2 Mc/s
MEGACYCLES	1
KILOCYCLES	500
R.F. ATTENUATOR	MIN.
SYSTEM switch	MAN.
BANDWIDTH	3 kc/s
B.F.O. switch	ON
B.F.O. NOTE	1 kc/s
A.F. GAIN	fully-clockwise
SPEAKER	OFF

   (2) Set the controls of the output meter for an impedance oa 3 ohms and a power range of 60mW and connection it to the 1W 3 ohm output terminals of the receiver.
   (3) Set the controls of the signal generator for a c.w output of 1μV at 1.5 Mc/s and an impedance of 75 ohms. Connect the output of the signal generator to the receiver antenna input socket.
   (4) Tune the receiver to the output frequency of the signal generator and adjust the R.F./I.F. GAIN control a reading of 50mW on the output meter.
   (5) Switch off the input signal and check that the output meter does not reade more than 0.82mW.
   (6) Repeat the test with a 30% modulated signal at a level of 3.5μV and the receiver B.F.O. switched off.
   (7) Perform signal-to-noise ratio tests at 3.5, 6.5, 12.5 and 24.5 Mc/s.

A.V.C. TEST

8. Perform a test of the A.V.C. circuits as follows:-
   (1) Set the controls of the receiver as follows:-

R.F. RANGE	2-4 Mc/s
MEGACYCLES	3
KILOCYCLES	500
R.F./I.F. GAIN	fully-clockwise
R.F. ATTENUATOR	MIN.
SYSTEM switch	A.V.C.
A.V.C. switch	SHORT
BANDWIDTH	3 kc/s
B.F.O. switch	OFF

   (2) Set the controls of the output meter for an impedance of 3 ohms and power range of 200mW. Connect the meter to the 1W 3-ohm terminals of the receiver.

(3) Set the controls of the signal generator for a 30% modulated signal of 1μV at 3.5 Mc/s and an impedance of 75 ohms. Connect the signal generator output to the receiver antenna input socket.
(4) Tune the receiver to the output frequency of the signal generator and adjust A.F. GAIN control until the output indicates 10mW.
(5) Increase the output of the signal generator to 100mV (+100dB) and check that the reading on the output meter does not exceed 50mW (+7dB on 10mW).

A.F. LEVEL METER TEST

9. Perform a test of the A.F. LEVEL meter calibration as follows:-
(1) Set the controls of the output meter for an impedance of 600 ohms and a power range of 120mW. Connect the meter across the 600-ohm 10mW output terminals.
(2) Set the controls of the signal generator for a 30% modulated output of 3.5 Mc/s at an impedance of 75 ohms and a level of 5μV. Connect the signal generator to the antenna input socket of the receiver.
(3) Tune the receiver to the output frequency of the signal generator and adjust the A.F. LEVEL control until the meter reads exactly 10mW. Check that the external output meter reads within 1dB of 10mW.

NOTE: It is important that the A.F. LEVEL control is not turned towards its maximum position unless the 10mW 600-ohm winding is suitably terminated with a load.

NOISE FACTOR TEST

10. Perform a noise factor tests as follows:-
(1) Set the receiver controls as detailed below:-

R.F. RANGE	16 – 30 Mc/s
MEGACYCLES	29
KILOCYCLES	0
SYSTEM switch	MAN.
R.F. ATTENUATOR	MIN.
BANDWIDTH	3 kc/s
B.F.O. switch	ON
LIMITER	OFF
R.F./I.F. GAIN	maximum gain position
B.F.O. NOTE	±1 kc/s
SPEAKER	ON

(2) Set the noise generator RANGE switch to OFF.
(3) Connect the noise generator output to the receiver antenna input socket.
(4) Set the controls of the output meter for an impedance of 3 ohms and a power range of 60mW and connect it to the 1W 3-ohm output terminals of the receiver.
(5) Set the A.F. GAIN control for a convenient level and adjust the MEGACYCLES tuning and R.F. TUNE controls for maximum noise in the loudspeaker.
(6) Adjust the A.F. GAIN control to obtain a reading of approximately 10mW on the output meter. Check that the MEGACYCLES and R.F. TUNE controls are set for maximum output and then reset the A.F. GAIN control for exactly 10mW.

(7) Set the noise generator RANGE switch to 0 – 10.

(8) Adjust the noise generator output level control until a reading of 20mW is obtained on the output meter.

(9) The noise factor of the receiver is given by the noise generator meter reading for the range in use.

(10) Perform noise factor tests at 1.5, 3, 6, 12 and 24 Mc/s, the noise level should not exceed 7dB throughout the entire frequency range.

14. Alignment Procedures

14.1. Introduction

11. The receiver will, under normal conditions, maintain the factory alignment over an extremely long period of time. Consequently ALL POSSIBILITY OF OTHER CAUSES OF TROUBLE SHOULD BE ELIMINATED BEFORE RE-ALIGNMENT IS CONSIDERED.
12. If it becomes necessary to re-align any part of the receiver, only a very small angular adjustment of any trimmer should be necessary. The signal generator must have a high degree of frequency resetting accuracy and be very stable.
13. Unless otherwise stated, the front panel mounted meter is used as the output indicator.

14.2. 100 kc/s I.F. Amplifier

FIRST AND SECOND I.F. AMPLIFIER

14. Remove the second v.f.o. valve V12. Set the SYSTEM switch to MAN, the R.F./I.F. GAIN to MAX and the meter switch to R.F. LEVEL. Connect the signal generator (100 kc/s c.w) via a 0.1μF capacitor to the grid of V16 (pin 1) Adjust C191 to obtain maximum indication on the meter. The output from the generator required to produce 100μA deflection on the meter should be approximately 320mV. Connect the signal generator via a 0.1μF capacitor to the grid of V14 (pin 1) and connect a 4.7-kilohms damping resistor across L72. Adjust C179 and C195B to give maximum indication.
15. Remove the 4.7-kilohms resistor from L72 and connect it across L73. Adjust C171 for maximum indication. Remove the 4.7 kilohms resistor. The signal generator output required to produce a 100μA deflection should be approximately 800μV. Tune the signal generator through the passband and note the 'double peak' response. The peak separation should be approximately 9 kc/s and be symmetrical about 100 kc/s. If the peak amplitudes differ, slight re-adjustment of C195B will compensate for this. The 6dB bandwidth should be approximately 14 kc/s.

14.3. 100 kc/s (L-C) Filter

16. Remove the left hand gusset plate. Remove the 1.7 Mc/s crystal XL300 and set the controls as in 14 above. Connect the output signal generator (100 kc/s) to socket SKT303. Remove the L-C filter can. Locatethe two red free-ended leads connected at one end of the trimming capacitors C153 and C158 in the second and third sections of the filter and connect the free ends to their respective 470k damping resistor R77 and R80 at the terminal post ends. Replace the filter can. Set the bandwidth to 100 kc/s. Tune the signal generator to give maximum indication on the front panel meter then switch to 1.2 kc/s. The frequency of this setting should be within ± 100 c/s of 100 kc/s. Adjust the trimming capacitors C162, C158, C153 and C147 in this order several times until maximum output is obtained.
17. Remove the L-C filter can and disconnect the red leads from the terminal post ends of the 470-kilohms resistors. Replace the filter can. Set the controls of the signal generator

for an output of 200μV approximately for 100μA on front panel meter. Check that the bandwidths agree (approximately) with the folowing figures:-

-6dB	-66dB	Sensitivity for 100μA
3.0 kc/s	15 kc/s	Less than 200μV (Measured input becomes reference level)
100 c/s	Less than 1.5 kc/s	)
300 c/s	Less than 2.0 kc/s	) To be within 10dB of
1.0 kc/s	8 kc/s	) reference level
7.0 kc/s	22 kc/s	) measured on 3
13.0 kc/s	35 kc/s	) position

Crystal Filter

18. Remove the 1.7 Mc/s crystal XL300 and set the controls as in 14. above. Set the BANDWIDTH switch to 300 c/s. Connect the signal generator to socket SKT303. Tune the signal generator slowly through the passband and observe the crystal responses (f_1 and f_2). Care must be taken as the tuning of these is very sharp. Retune the signal generator to the mean of f_1 and f_2 and adjust C110 and C148 for maximum output. Reset the signal generator frequency to 100 kc/s and adjust the output to produce a reading of 100μA. Set the generator frequency to 101,025 c/s, increase the output by 66dB and adjust the phasing control C199 to obtain minimum output (i.e. the point of recection occurs). Increase the generator frequency slowly and ascertain that the meter reading does not exceed 100μA. Slowly decrease the signal frequency until 100μA reading is obtained and check that the frequency is not greater than 100,900 c/s. Tune through the passband, adjusting the signal generator output as necessary to avoid meter damage. Note the highest frequency at which a signal generator output equal to that used at 101,025 c/s gives an output an output of a 100μA. This frequency should not be less than 99,100 c/s.
19. Slowly decrease the signal frequency and ensure that the output does not rise above 100μA. Decrease the generator output by 66dB and re- check the frequency response within the passband, re-adjusting C110 and C148 if necessary. Set the signal generator frequency to 100 kc/s and adjust the output for 100μA level. Increase the signal generator output by 6dB and check the bandwidth for 100μA output. The bandwidth should be between 270 and 330 c/s and the mid-position should not deviate from 100 kc/s by more than 25 c/s. The sensitivity should be approximately 200μV for 100μA deflection.
20. Switch the BANDWIDTH control to 100 c/s. Repeat the procedure with signal generator frequency settings of 100,925 c/s, 100,800 c/s and 99,200 c/s. Adjust the phasing capacitor C118 only. The 6dB bandwidth should be between 80 and 120 c/s and the deviation from the mean less than 25 c/s. For 100μA output, the input should be approximately 150μA.
21. Disconnect the signal generator and refit the 1.7 Mc/s crystal.

Use of Digital Frequency Meter

22. The alignment of the I.F. amplifier and in particular the crystal filter involves the measurement of frequencies to far greater accuracies than those normally obtainable

from signal generators. A digital frequency meter should therefore be employed. The equipment should be connected to SK8 or SK9. The exact frequency passing through the circuit will be displayed on the indicator panel. Should the level of output at any time during the alignment procedure be insufficient to drive the frequency meter, the signal generator output can be increased to obtain the frequency check but must be restored to the lower value for level measurements. When such increases are made, the meter on the receiver panel should be switched to A.F. LEVEL to avoid damage.

14.4. Second V.F.O.

Minor Corrections

23. The variable capacitor has been carefully adjusted and should not be re-adjusted unless absolutely necessary. Minor corrections can be made as follows:-
    (1) Set the SYSTEM switch to CAL.
    (2) Set the KILOCYCLES cursor in line with the MEGACYCLES cursor (i.e. central)
    (3) Ensure that the B.F.O. switch is OFF.
    (4) Rotate the R.F./I.F. GAIN to MAX.
    (5) Set the BANDWIDTH switch to 3 kc/s.
    (6) Set the KILOCYCLES scale to zero (0 kc/s) and adjust the capacitor C306 to give zero beat note in the loudspeaker.
    (7) Set the KILOCYCLES scale tothat zero beat point which is nearest to the 1000 kc/s position.
    (8) Lock the drive sprocket.
    (9) Adjust the position of the film scale to produce a correct calibration.

NOTE: When moving film scale relative to the sprockets, grip both sides of the film scale in order to create a loop which will allow the film to slide round the drive sprocket; the drive sprocket is on the left when facing the receiver and hence movement of the film scale will have to be to the left.

    (10) Repeat (6) to (9) until an adequate degree of accuracy is obtained.

IMPORTANT NOTE: The tuning slug of L55 has been sealed by the manufacturer and must not be touched under any circumstances.

Replacement of Variable Capacitor

24. The procedure described below should not normally be carried out unless the variable capacitor C310 is being replaced. Before electrical adjustment, the following mechanical points should be verified:-
    (1) Check that the fixed and movable vanes of C310 are fully meshed.
    (2) Check that the distance from the cursor to the extreme end of the scale adjacent to the 1000 kc/s point, is approximately 71/2-in. Should this distance vary appreciably from 71/2-in. Carefully lift the scale from the drive and move the scale round the required position.
    (3) Whenever the scale is replaced, endeavour to re-align by adjusting the film to the correct position before trimming.
25. The procedure for electrical adjustment is carried out as follows:-
    (1) Proceed as in 24. (1) above.

(2) Check the calibration of the v.f.o. at 100 kc/s intervals; if the error exceeds 1 kc/s, adjust carefully the plates of the rotor of the variable capacitor in order to correct the calibration.

1.6 **Mc/s Rejection Filter**

26. Disconnect lead to SK300A and apply 1.6 Mc/s signal generator output to SKT300A. Set METER switch to S-METER and adjust core of L302 for minimum meter deflection.

B.F.O.

27. Set the SYSTEM switch to the CHECK B.F.O. position. Switch the meter switch to R.F. LEVEL. Switch the B.F.O. on and set the B.F.O. frequency control knib to zero. Adjust C199 as necessary to obtain zero-beat. Observe that the meter reads at least 100μA.
28. If the B.F.O. frequency control knob has been removed, adjust the frequency capacitor for zero-beat with the identification mark on the shaft uppermost. Replace the knob so that the pointer indicates zero.

37.5 **Mc/s Filter and Amplifier**

29. Remove the 1 Mc/s crystal, second mixer valve V9 and first v.f.o. valve V5. Check that all the screening covers are in place. Connect a suitable valve voltmeter, shunted 12pF, to TP3. Inject an accurate 37.5 Mc/s signal at TP1. Ensure that the valve voltmeter and signal generator leads are short to avoid regeneration. Adjust L50, C90, C81, C72, C63, C55, C45, C35, C24, L28 and L33 in that order, several times, to obtain maximum output. The input required to produce 1V should be approximately 2.5mV. The 6dB bandwidth of the 37.5 Mc/s chain should lie between 229-300 kc/s. The bandwidth at 40dB should not exceed 750 kc/s. The mean of the frequencies corresponding to the 6dB points should not deviate from 37.5 Mc/s by more than 20 kc/s and more than 25 kc/s at 40dB banwidth.
30. C108 is adjusted to avoid interaction between the 37.5 and 40 Mc/s filters and should not normally require further adjustment. Fit the 1 Mc/s crystal, the second mixer and the the first v.f.o. valve.

1 Mc/s Oscillator

31. Connect the valve voltmeter to the 1 Mc/s output plug PL2 and adjust L2 for maximum output (2 – 3 volts). C2A may be adjusted to "pull" the crystal to the correct frequency; however, adjustment of crystal frequency should not be attempted unless a standard is available having an accuracy of better than one part in 10^7.

Second Mixer Drive Level

32. Remove the second mixer valve V9. Connect the valve voltmeter, shunted to 12pF, to TP3. Tune through each megacycle calibration point and check that the level output lies between 2 and 10V. To equalize the drive at 28 and 29 Mc/s carefully adjust C7.

First V.F.O. Calibration

33. Slacken off the mechanical end-stop until it is inoperative. Set C76 to maximum capacity and ensure that the calibration mark at the zero end of the MEGACYCLES dial coincides with the cursor. Tighten end-stop after moving the scaale free from the

stop. Check that the mechanical stops operate before the capacitor end-stops become effective at both ends of the band.

34. To re-adjust the first v.f.o. calibration, a heterodyne wavemeter should be employed. This is Coupled very loosely to V7 by placing its input lead in the vicinity of the valve base. The 1 Mc/s crystal, V12 and V27 should be removed.
35. Set the wavemeter to 40.5 Mc/s and the MEGACYCLES dial to zero. Adjust L36 for zero-beat. Change the wavemeter setting to 69.5 Mc/s and the MEGACYCLES dial to 29. Adjust C77 for zero-beat. Repeat adjustment as necessary. Check the frequency calibration at 1 Mc/s intervals and ensure that the megacycle positions are reasonably central on the scale markings. Remove the first mixer valve V7 and connect the valve voltmeter, shunted 12pF, between TP2 and the chassis. Check that the valve voltmeter indicates at least 1.5V over the range. Refit the 1 Mc/s crystal, V12 and V27.

Antenna Circuit

36. Remove the first V.F.O. valve V5 and the first mixer valve V7 and set the receiver controls as follows:-

R.F. ATTENUATOR	MIN.
R.F. RANGE MC/S	1 – 2 Mc/s
SYSTEM switch	MAN.
R.F./I.F. GAIN	MAX.

37. Remove the screening cover from around C18A/B and connect a 1 kilohm resistor across the secondary section (C18B rear section). Set the R.F. TUNE control approximately 7/8ths of its travel in a clockwise direction.
38. Connect the valve voltmeter, shunted to 12pF, between TP2 and chassis. Connect the output of the signal generator to the aerial input socket. Set the generator for a frequency of 1 Mc/s.
39. Remove the top core From the transformer L8 and adjust the primary core for a maximum deflection on the valve voltmeter. (The position of this core should be such that it tunes at a point nearest the bottom of the transformer).
40. Remove the 1 kilohm resistor from the secondary section and connect it across the primary section of C18.
41. Refit top core (secondary) and adjust it for a maximum deflection on the valve voltmeter.
42. Remove the 1 kilohm resistor from the primary of C18.
43. Reset the signal generator frequency to 2 Mc/s and adjust the R.F. TUNE control (C18) for maximum output on the valve voltmeter then adjust the trimmer capacitor C233 for a maximum deflection on the valve voltmeter also check for symmetrical response.
44. Repeat the above procedure for the R.F. RANGE switch settings and frequencies listed in Table 1 below. Check that the maximum voltage input to give 0.5 volts output is as shown in Table 2 below.

Table 1

R.F. RANGE	INDUCTOR	ALIGNMENT FREQUENCY	TRIMMER	ALIGNMENT FREQUENCY
2 - 4	L7	2 Mc/s	C234	4 Mc/s
4 - 8	L6	4 Mc/s	C235	8 Mc/s
8 - 16	L5	8 Mc/s	C236	16 Mc/s
16 - 30	L4	13 Mc/s	(C18 at C237 max.)	30 Mc/s

Table 2

R.F RANGE	L.F.	H.F.
1 - 2 Mc/s	7mV	7mV
2 - 4 Mc/s	10mV	10mV
4 - 8 Mc/s	12mV	16mV
8 - 16 Mc/s	22mV	26mV
16 - 30 Mc/s	22mV	30mV

Crystal Calibrator

46. Should no output be obtained from this unit when the SYSTEM switch is in the CAL position and the KILOCYCLES scale set at a 100 kc/s check point, or if spurious responses are obtained over the kilocycles range, proceed as follows:-

    Set the KILOCYCLES scale to a 100 kc/s point and check the tuning of L70 by carefully rotating the core a half-turn either side of the setting. If the signal does not appear, restore the core to its original setting and repeat the check with L75. If the signal is heard, the cores of L70 and L75 should be set to centre of the range of adjustment over which a clean signal is produced.

47. Should a major fault be suspected, or if L70 or L75 have been inad- vertently misaligned, it will be necessary to remove the unit and make up an extension cable so that the unit may be operated outside the receiver. The crystal calibrator may be aligned as follows:-

    Remove V13 and connect the valve voltmeter probe to grid 3 (pin 7). Inject a 900 kc/s c.w. signal, from the signal generator, at the grid of V15 (pin 1) and adjust L75 for maximum output. Disconnect the valve voltmeter and the signal generator, replace V13 and remove V15. Connect the signal generator to grid 1 (pin 1) of V13 and the valve voltmeter to the grid 1 connection (pin 1) of V15. Set the signal generator to 100 kc/s c.w. and adjust L70 for maximum indication on the valve voltmeter. Disconnect the valve voltmeter and the generator. Fit V15. Connect the coaxial connector to PL2 on the receiver.

48. The output should be approximately 0.2V measured between pin 6 of the octal plug and earth.

40 **Mc/s Filter**

49. This filter is over-coupled and cannot be readily aligned without a 40 Mc/s sweep oscillator. Re-adjustment therefore should not be attempted unless the specially designed test equipment and factory-type alignment jigs are available.

1.6 **Mc/s Band-pass Filter**

50. To carry out alignment of this filter, the mixer chassis must first be removed. After the removal of the chassis, turn the receiver on to its side and reconnect, from the underside, the two leads (6.3V and 200V H.T.) to their respective pins.
51. Remove all the valves on the chassis except the third mixer V25. Connect a suitable valve voltmeter, shunted to 7pF, to pin 7 of V26. Inject an accurate 1.6 Mc/s signal at socket SKT301 (pink). A large input from the generator should be used initially and reduced as necessary throughout the alignment. Adjust cores L306 and L309 in the first I.F. transformer and cores L313, L314 in the second I.F. transformer for a maximum reading on the valve voltmeter.
52. Check the gain of the I.F. amplifier as follows:-
    (1) Connect the signal generator to SKT301 of V25. For an input of 125mV, an output of not less than 500mV should appear at pin 7 of V26.
    (2) Check that the 13 kc/s bandwidth is obtained with not more than 2dB fall in output and that the response curve is reasonably symmetrical.
    (3) Refit valves and mixer chassis.

2 – 3 Mc/s Band-pass Filter

53. This filter is pre-aligned and should not require further adjustment. If the performance of the receiver has deteriorated and the filter is suspected, it should be returned to the factory to re-adjustment.

1.7 MC/S OSCILLATOR/AMPLIFIER

54. With a valve voltmeter connected to SKT306, adjust the core of L330 for maximum meter indication.

15. Dismantling

Unit Breakdown

1. The receiver may be rapidly dismantled to eight sub-units as follows:-
   (1) Front Panel
      (a) Tuning escutcheon.
      (b) Loudspeaker and escutcheon.
      (c) Output level meter.
   (2) Second Variable Frequency Oscillator
      (a) Second v.f.o. (V12).
   (3) First Variable Frequency Oscillator
      (a) R.F. Amplifier (V3).
      (b) First v.f.o. (V5).
      (c) First Mixer (V7).
   (4) 100 kc/s I.F. Amplifier
      (a) Beat frequency oscillator (V19).
      (b) Crystal Filter.
      (c) L-C filter.
      (d) First and second I.F. amplifiers (V14 and V16)
      (e) A.V.C. and T.C. stages (V18)
      (f) Detector and noise limiter (V21)
      (g) 100 kc/s output (V17)
   (5) Crystal Calibrator (V13 and V15)
   (6) Main Chassis
      (a) Aerial (antenna) attenuator.
      (b) Crystal oscillator amplifier (V1).
      (c) Harmonic generator (V2).
      (d) 30 and 32 Mc/s low-pass filters.
      (e) 37.5 and 40 Mc/s band-pass filters.
      (f) Harmonic mixer (V4).
      (g) The 37.5 Mc/s amplifiers (V6), (V8) and (V10).
      (h) Second mixer (V9).
      (i) A.F. output stages (V22) and (V23).
   (7) 1.7 Mc/s oscillator/amplifier and mixer unit
      (a) Second v.f.o. amplifier (V11).
      (b) Third mixer (V25).
      (c) Fourth mixer (V26).
      (d) 1.7 Mc/s oscillator/amplifier (V27)
   (8) 2 – 3 Mc/s Band-pass Filter

Dismantling and Re-Assembly Instructions

2. Front Panel
   (1) Remove all control knobs.
   (2) Unscrew the eight instrument head panel fixing screws.

NOTE: The two screws at the bottom of the front panel, adjacent to the jack sockets, are secured to the main chassis with nuts.

(3) Carefully withdraw the front panel and unsolder the connections to the meter and speaker switches; alternatively, the number of wires to be unsoldered can be minimized (loudspeaker only) by removing the seciring nuts on the SPEAKER and METER switches. The panel may now be completely removed.

NOTE: When replacing the B.F.O. NOTE control knob, ensure that the identification mark on the saft is uppermost and that the pointer indicates zero when zero-beat is obtained.

(4) Re-assemble in the reverse order.

NOTE: When removing the control knobs secured by a hexagon collet insert the collet must be shot loose from the spindle by a slight knock on the chromed centre of the control knob.

Second Variable Frequency Oscillator

3.

(1) Remove the bottom cover.
(2) Unsolder the three connections on the 4-way tag strip, adjacent to the terminal strip, situated in compartment 11 (see fig. 15: Key to Under-chassis Layout).
(3) Remove the front panel: see para.2. above.
(4) Withdraw the Crystal Calibrator Unit by slackening the two knurled nuts, disconnecting the coaxial cable and unplugging the unit.
(5) Unbolt the cable cleat securing the dial light cable.
(6) Unclip the lampholder.
(7) Disconnect the coaxial cables.
(8) Remove the screws securing the Megacycles dial to the boss and withdraw the dial.

NOTE: Do not unscrew the boss from the shaft. Unscrew the two unit retaining screws on the top of the chassis and one retaining screw from the underside of the main chassis in compartment 11.

(9) The v.f.o. may now be withdraw vertically. When servicing this assembly, clean the wormwheel and the split gear on the ganged capacitor shaft with carbon-tetrachloride, then apply with a brush, to the wormwheel only (Fig.11), a thin coating of Molybdenum Disulphine grease (Rocol "Molypad").
(10) Re-assemble in the reverse order.

Renewal of Film Tuning Scale

NOTE: Great care must be taken when feeding a new film into position to avoid twisting or buckling.

Removal

4.

(1) Rotate the KILOCYCLES scale to the limit of its travel at the 1000 kc/s end of the scale. Apply the scale lock.
(2) Remove the dial illuminating lamp and its holder.

(3) Hold the two gear wheels at the top of the right-hand film bobbin against the spring tension and remove the two screws securing the idler gear mounting assembly.
(4) Ease the idler gear clear of the film bobbin gear wheels and carefully ease the spring tension from them. The film bobbins are then free to revolve independently.
(5) Carefully lift the film clear of the tuning drive sprocket and withdraw the film via the back of the loudspeaker.

Fitting a New Film Scale

5.

(1) Carefully feed the low frequency end of the film scale via the rear of the loudspeaker, the front of the tuning drive sprocket and the front of the guide roller mounted between the two right-hand film bobbins. Engage the prepared end of the film in the right-hand bobbin. Slowly wind the film, under very light tension, onto the bobbin until the STOP marking is approximately in the centre of the escutcheon window.
(2) Carefully feed the free end of the film via the rear of the loudspeaker and the rear of the tuning drive sprocket. Engage the prepared ond of the film in the left-hand film bobbin. Slowly wind the film, under very light tension, onto the bobbin until the sprocket holders in the film engage with the tuning drive sprocket.
(3) Maintain the STOP marking approximately in the centre of the escutcheon window and take up any slack in the film by rotating the bobbins in opposite directions. When all the slack has been taken up, rotate the gear wheels on top of the bobbins a further 1/2 to 3/4 turn against the spring tension and hold them in position. Refit the idler gear wheel and mounting plate. Secure the mounting plate screws and release the gear wheels.
(4) Check that the STOP marking is still approximately in the centre of the escutcheon window.

Second V.F.O. Variable Capacitor

NOTE: Refer to the v.f.o. alignment procedure in para. 24. before attempting to refit the variable capacitor.

6.

(1) Remove the second v.f.o. from the receiver in accordance with the instructions in para.3. above.
(2) Unscrew the remaining cover plate.
(3) Unsolder the capacitor connections.
(4) Remove the drive gear and collet.
(5) Unscrew the four fixing screws holding the capacitor to the bracket.
(6) Re-assemble in the receiver order, ensuring that the anti- backlash gears are loaded.

First Variable Frequency Oscillator

7.

(1) Remove the front panel, the bottom cover and the screens from compartments 1, 6 and 8. (See Fig.15: Key to Under- chassis Layout).

(2) Unsolder the connecting wires from the two turret lugs situated in compartment 8, the leads to the turret lug in compartement 6, the pin connections compartment 2 and the screened cable compartment 1.
(3) Unscrew the three fixing screws on the top of the unit.

8.
(1) Fitting a new chain:-
 (a) Take a 63-link lenght of chain.
 (b) Hold chain tension sprocket down towards the chassis, and fit new chain round the two chain wheels.
 (c) Release the tension sprocket that ensuring that it holds the chain under tension. See Front Panel instructions refitting of B.F.O. control knob; para.2. above.

100 kc/s I.F. Amplifier

9.
(1) Remove the left-hand gusset plate adjacent to the unit.
(2) Unsolder the leads to the 4 and 12-way tag strips (fig.7) and the 100 KC/S OUTPUT plugs.

(3) Disconnect the coaxial lead to the 1.7 Mc/s oscillator/ amplifier and mixer unit.
(4) Remove the six screws securing this unit to the main chassis.

NOTE: Removal of the R.F./I.F. GAIN control on the B.F.O. assembly is necessary in order to obtain acces to one of the six securing screws.

(5) Re-assemble in the reverse order.

Beat Frequency Oscillator

10.
(1) Remove Front Panel.
(2) Remove bottom cover.
(3) Disconnect leads from R.F./I.F. GAIN potentiometer.
(4) Remove side plates adjacent to I.F. amplifier.
(5) Remove screw securing cable cleat situated adjacent to 150mH choke assembly on underside of I.F. amplifier.
(6) Disconnect red-white lead of B.F.O. cableform from terminal on adjacent 12-way tag strip.
(7) Withdraw red-white lead from cableform.
(8) Disconnect brown leads from pin 4 of V18 socket.
(9) Disconnect blue leads from pin 7 of V21 socket.
(10) Remove remaining three screws and crinckle washers to release B.F.O. assembly from I.F. amplifier chassis.
(11) Re-assemble in the reverse order.

1.7 Mc/s Oscillator/Amplifier and Mixer Unit

11.
(1) Remove the bottom cover and the screen from compartment 7.
(2) Unsolder the two pin connections.

(3) Disconnect the coaxial cables.
(4) Remove the three screws securing this unit to the main chassis.
(5) Re-assemble in the reverse order.

Valve Replacement

12. With the exception of V5, replacement of valves will not affect receiver alignment. When V5 is replaced refer to GENERAL SERVICING AND ALIGNMENT PROCEDURES.

16. Component List 1.

Resistors

Cct. Ref.	Value	Description	Rat.	Tol. %
R1	10k	carbon	1/4W	10
R2	100ohm	carbon	1/4W	10
R3	150ohm	carbon	1/4W	10
R4	100ohm	carbon	1/4W	10
R5	150ohm	carbon	1/4W	10
R6	4.7Kohm	carbon	1/2W	10
R7	150ohm	carbon	1/4W	10
R8	150ohm	carbon	1/4W	10
R8A	47Kohm	carbon	1/4W	10
R8B	680ohm	carbon	1/4W	10
R9	220ohm	carbon	1/2W	10
R10	150ohm	carbon	1/4W	10
R11	150ohm	carbon	1/4W	10
R12	33Kohm	carbon	1/2W	10
R13	33Kohm	carbon	1/4W	10
R14	150ohm	carbon	1/4W	10
R15	100ohm	carbon	1/4W	10
R15A	75ohm	carbon	1/4W	10
R15B	2.2Kohm	carbon	1/4W	10
R16	680ohm	carbon	1/4W	10
R17	1Kohm	carbon	1/2W	10
R18	470ohm (Assy. with L20)	carbon	1/2W	10
R19	270Kohm	carbon	1/4W	10
R19A	100Kohm	carbon	1/4W	10
R20	1Kohm	carbon	1/4W	10
R21	330ohm	carbon	1/4w	10
R22	470ohm	carbon	1/4W	10
R23	82ohm	carbon	1/4W	10
R24	10Kohm	carbon	1/4W	10
R25	10ohm	carbon	1/4W	10
R26	10ohm	carbon	1/4W	10
R27	10ohm	carbon	1/4W	10
R28	680ohm	carbon	1/4W	10
R29	1Kohm	carbon	1/4W	10
R30	220ohm	carbon	1/4W	10
R31	470ohm	carbon	1/4W	10
R32	100Kohm	carbon	1/4W	10

R32A	100Kohm	carbon	1/4W	10
R32B	10Kohm	carbon	1/4W	10
R33	10Kohm	carbon	1/4W	10
R34	470Kohm	carbon	1/4W	10
R35	DELETED			
R36	10ohm	carbon	1/4W	10
R37	1Kohm	carbon	1/4W	10
R38	68ohm	carbon	1/4W	10
R39	22Kohm	carbon	1/4W	10
R40	10ohm	carbon	1/4W	10
R41	10Kohm	carbon	1/4W	10
R42	27Kohm	carbon	1/2W	10
R43	6.8Kohm	carbon	1/4W	10
R44	27Kohm	carbon	1/4W	10
R45	10ohm	carbon	1/4W	10
R46	100Kohm	carbon	1/4W	10
R47	56ohm	carbon	1/4W	10
R48	10ohm	carbon	1/4W	10
R49	68ohm	carbon	1/4W	10
R50	2.2Kohm	carbon	1/4W	10
R51	1Kohm	carbon	1/4W	10
R52	15Kohm	carbon	1/4W	10
R53	470ohm	carbon	1/4W	10
R54	100ohm	carbon	1/2W	10
R55	1Kohm	carbon	1/2W	10
R55A	1Kohm	carbon	1/2W	10
R56	15Kohm	carbon	1/4W	10
R57	10ohm	carbon	1/4W	10
R58	470Kohm	carbon	1/4W	10
R59	56ohm	carbon	1/4W	10
R60	150ohm	carbon	1/4W	10
R61	DELETED			
R62	27Kohm	carbon	1/2W	10
R63	DELETED			
R64	330Kohm	carbon	1/4W	10
R65	100Kohm	carbon	1/4W	10
R66	1Kohm	carbon	1/2W	10
R67	DELETED			
R68	22Kohm	carbon	1/4W	10
R68A	470ohm	carbon	1/4W	10
R69	27Kohm	carbon	1/2W	10
R70	DELETED			
R71	10Kohm	wirewound	3W	5
R71A	470ohm	carbon	1/4W	10

R72	DELETED			
R73	DELETED			
R74	150ohm	carbon	1/4W	10
R75	DELETED			
R76	DELETED			
R77	470Kohm	carbon	1/4W	10
R78	DELETED			
R79	2.2Kohm	carbon	1/4W	10
R80	470Kohm	carbon	1/4W	10
R81	2.2Kohm	carbon	1/2W	10
R81A	1.5Kohm	carbon	1/4W	10
R81B	10Mohm	carbon	1/4W	10
R81C	10Mohm	carbon	1/4W	10
R82	DELETED			
R83	4.7Kohm	carbon	1/4W	10
R84	1Mohm	carbon	1/4W	10
R85	220ohm	carbon	1/4W	10
R86	22ohm	carbon	1/4W	10
R87	120ohm	carbon	1/4W	10
R87A	68ohm	carbon	1/4W	10
R88	330ohm	carbon	1/4W	10
R89	2.2Kohm	carbon	1/2W	10
R90	4.7Kohm	carbon	1/2W	10
R91	4.7Kohm	carbon	1/2W	10
R91A	470Kohm	carbon	1/4W	10
R92	270Kohm	carbon	1/4W	10
R93	33Kohm	carbon	1/2W	10
R94	27Kohm	carbon	1/2W	10
R95	100ohm	carbon	1/4W	10
R96	470Kohm	carbon	1/4W	10
R97	15Kohm	carbon	1/2W	10
R97A	39Kohm	carbon	1/4W	10
R98	2.2Kohm	carbon	1/4W	10
R99	22Kohm	carbon	1/4W	10
R100	22Kohm	carbon	1/4W	10
R101	120ohm	carbon	1/4W	10
R102	82Kohm	carbon	1/4W	10
R103	2.2Kohm	carbon	1/4W	10
R104	1Mohm	carbon	1/4W	10
R105	1Kohm	carbon	1/4W	10
R106	68Kohm	carbon	1/2W	10
R107	2.2Kohm	carbon	1/2W	10
R108	33Kohm	carbon	1/2W	10
R109	4.7Kohm	carbon	1/2W	10

R110	100ohm	carbon	1/4W	10
R111	2.2Kohm	carbon	1/2W	10
R112	47Kohm	carbon	1/4W	10
R113	33Kohm	carbon	1/2W	10
R114	100ohm	carbon	1/4W	10
R115	150ohm	carbon	1/4W	10
R116	470Kohm	carbon	1/4W	10
R116A	6.8Kohm	carbon	1/4W	10
R117	150ohm	carbon	1/4W	10
R118	2.2Mohm	carbon	1/4W	10
R119	DELETED			
R119A	10Kohm	wirewound	10W	5
R120	100Kohm	carbon	1/2W	10
R120A	27Kohm	carbon	1/4W	10
R121	100Kohm	carbon	1/2W	10
R122	6.8Kohm	carbon	1/4W	10
R123	82Kohm	carbon	1/2W	10
R124	120ohm	wirewound	6W	5
R125	47Kohm	carbon	1/4W	10
R126	100ohm	carbon	1/4W	10
R127	82Kohm	carbon	1/4W	10
R128	18Kohm	carbon	1/4W	10
R129	18Kohm	carbon	1/4W	10
R130	82Kohm	carbon	1/4W	10
R131	4.7Kohm	carbon	1/4W	10
R132	1Kohm	carbon	1/4W	10
R133	4.7Kohm	carbon	1/4W	10
R133A	27Kohm	carbon	1/4W	10
R134	1Mohm	carbon	1/4W	10
R135	1.2Mohm	carbon	1/4W	10
R135A	100Kohm	carbon	1/4W	10
R136	47ohm	wirewound	3W	5
R137	1.5Mohm	carbon	1/4W	10
R138	120ohm	carbon	1/4W	10
R138A	100Kohm	carbon	1/2W	10
R139	120ohm	carbon	1/4W	10
R139A	470Kohm	carbon	1/4W	10
R140	270ohm	carbon	1/2W	10
R140A	4.7Kohm	carbon	1/4W	10
R140B	2.2Kohm	carbon	1/4W	10
R141	680ohm	carbon	1/4W	10
R142	1.2Kohm	carbon	1/4W	10
R143	1.2Kohm	carbon	1/4W	10
R144	DELETED			

R144A	10ohm	carbon	1/4W	10
R300	820ohm	carbon	1/2W	10
R300A	220ohm	carbon	1/4W	10
R301	100Kohm	carbon	1/4W	10
R302	47ohm	carbon	1/4W	10
R303	33Kohm	carbon	1/4W	10
R304	220ohm	carbon	1/4W	10
R305	1.5Kohm	carbon	1/4W	10
R306	4.7Kohm	carbon	1/4W	10
R307	470Kohm	carbon	1/4W	10
R308	100ohm	carbon	1/4W	10
R309	100Kohm	carbon	1/4W	10
R310	47Kohm	carbon	1/4W	10
R311	1Kohm	carbon	1/4W	10
R312	15Kohm	carbon	1/4W	10
R313	100ohm	carbon	1/4W	10
R314	56ohm	carbon	1/4W	10
R315	470Kohm	carbon	1/4W	10
R316	100ohm	carbon	1/4W	10
R317	2.2Kohm	carbon	1/4W	10
R318	220ohm	carbon	1/4W	10
R319	10Kohm	carbon	1/4W	10
R320	470ohm	carbon	1/4W	10
R320A	1Kohm	carbon	1/4W	10
R321	DELETED			
R322	1.5Kohm	carbon	1/4W	10
R323	100Kohm	carbon	1/4W	10
R324	47Kohm	carbon	1/4W	10
R325	100ohm	carbon	1/4W	10
R326	220ohm	carbon	1/4W	10
R327	8.2Kohm	carbon	1/4W	10
R328	470ohm	carbon	1/4W	10

POTENTIOMETERS

Cct. Ref,	Value	Type
RV1	1Kohm	Wirewound
RV2	2Mohm	Composition log/law 1” spindle
RV3	2Mohm	Composition log/law 5/8” spindle
RV4	1Kohm	Wirewound

Capacitors

Cct. Ref.	Value	Description	Rat.	Tol. %
C1	2.7pF	Ceramic	750V	10
C2	DELETED			
C2A	33pF	Trimmer		
C2B	10pF	Silver/Mica	350V	1pF
C2C	0.01μF	Paper	500V	20
C3A	0.01μF	Paper	400V	20
C4	14.7pF	Ceramic	750V	10
C5	14.7pF	Ceramic	750V	10
C6	14.7pF	Ceramic	750V	10
C7	10pF	Trimmer		
C8	10pF	Ceramic	750V	5
C8A	0.001μF	Ceramic	350V	20
C9	100pF	Silver/Mica	350V	10
C10	0.01μF	Paper	500V	20
C10A	100pF	Silver/Mica	350V	10
C11	0.005μF	Paper	400V	20
C11A	47pF	Silver/Mica	350V	5
C12	14.7pF	Ceramic	750V	10
C13	14.7pF	Ceramic	750V	10
C14	0.01μF	Paper	500V	20
C15	10pF	Ceramic	750V	5
C16	0.01μF	Paper	500V	20
C17	0.001μF	Ceramic	350V	20
C18	DELETED			
C18A	212pF	Variable (2 gang)		
C18B	212pF	Variable (2 gang)		
C18C	6.8pF	Ceramic	750V	5
C19	10pF	Ceramic	750V	5
C20	10pF	Ceramic	750V	5
C21	16pF	Trimmer, with acetate case	1000V	
C22	33pF	Silver/Mica	350V	5
C23	0.001μF	Ceramic	350V	
C24	16pF	Trimmer, with acetate case	1000V	
C25	15pF	Silver/Mica	350V	5
C26	0.05μF	Paper	350V	25
C27	0.001μF	Ceramic	350V	20
C28	220pF	Silver/Mica	350V	5

C29	0.001μF	Ceramic	350V	
C30	0.001μF	Ceramic	350V	
C31	10pF	Ceramic	750V	5
C32	10pF	Ceramic	750V	5
C33	16pF	Trimmer, with acetate case	1000V	
C34	39pF	Silver/Mica	350V	5
C35	16pF	Trimmer, with acetate case	1000V	
C36	33pF	Silver/Mica	350V	5
C37	0.001μF	Ceramic	350V	20
C38	0.001μF	Ceramic	350V	20
C39	0.1μF	Paper	150V	25
C40	0.001μF	Ceramic	350V	
C41	0.1μF	Paper	150V	25
C42	220pF	Silver/Mica	350V	5
C42A	0.001μF	Ceramic	350V	
C43	16pF	Trimmer, with acetate case	1000V	
C44	39pF	Silver/Mica	350V	5
C45	16pF	Trimmer, with acetate case	1000V	
C46	33pF	Silver/Mica	350V	5
C47	8.2pF	Ceramic	750V	10
C48	0.001μF	Ceramic	350V	
C49	0.01μF	Paper	500V	20
C49A	0.05μF	Paper	350V	25
C50	100pF	Silver/Mica	350V	5
C51	220pF	Silver/Mica	350V	2
C52	0.001μF	Ceramic	350V	
C53	16pF	Trimmer, with acetate case	1000V	
C54	39pF	Silver/Mica	350V	5
C55	16pF	Trimmer, with acetate case	1000V	
C56	33pF	Silver/Mica	350V	5
C57	0.001μF	Ceramic	350V	
C58	0.001μF	Ceramic	350V	

C59	0.001μF	Ceramic	350V	
C60	0.001μF	Ceramic	350V	
C61	16pF	Trimmer, with acetate case	1000V	
C62	39pF	Silver/Mica	350V	5
C63	16pF	Trimmer, with acetate case	1000V	
C64	33pF	Silver/Mica	350V	5
C65	0.001μF	Ceramic	350V	
C66	0.001μF	Ceramic	350V	
C67	100pF	Silver/Mica	350V	5
C68	220pF	Silver/Mica	350V	2
C69	0.001μF	Ceramic	350V	
C70	26pF	Trimmer, with acetate case	1000V	
C71	39pF	Silver/Mica	350V	5
C72	16pF	Trimmer, with acetate case		
C73	33pF	Silver/Mica	350V	5
C74	220pF	Silver/Mica	350V	5
C75	220pF	Silver/Mica	350V	10
C76	100pF	Variable		
C77	33pF	Trimmer		
C78	0.001μF	Ceramic	350V	
C79	16pF	Trimmer, with acetate case	1000V	
C80	39pF	Silver/Mica	350V	5
C81	16pF	Trimmer, with acetate case	1000V	
C82	33pF	Silver/Mica	350V	5
C83	0.001μF	Ceramic	350V	
C84	0.001μF	Ceramic	350V	
C85	3.3pF	Ceramic	750V	10
C86	0.001μF	Ceramic	350V	
C87	0.001μF	Ceramic	350V	
C88	16pF	Trimmer, with acetate case	1000V	

C89	33pF	Silver/Mica	350V	5
C90	16pF	Trimmer, acetate case	1000V	
C91	15pF	Silver/Mica	350V	1pF
C92	0.001μF	Ceramic	350V	
C93	0.001μF	Ceramic	350V	
C94	0.001μF	Ceramic	350V	
C95	0.01μF	Paper	500V	20
C95A	0.001μF	Ceramic	350V	
C96	0.001μF	Ceramic	350V	
C97	0.25μF	Paper	150V	25
C98	0.01μF	Paper	500V	20
C98A	0.001μF	Ceramic	350V	
C99	0.001μF	Ceramic	350V	
C100	0.001μF	Ceramic	350V	
C101	0.05μF	Paper	350V	25
C102	0.001μF	Ceramic	350V	
C103	0.1μF	Paper	150V	25
C104	0.001μF	Ceramic	350V	
C104A	0.25μF	Paper	150V	25
C105	0.01μF	Paper	500V	20
C106	0.001μF	Ceramic	350V	
C107	220pF	Silver/Mica	350V	10
C108	33pF	Trimmer		
C109	220pF	Silver/Mica	350V	2
C110	33pF	Trimmer		
C111	0.001μF	Ceramic	350V	
C112	0.01μF	Paper	500V	20
C113	27pF	Ceramic	350V	5
C114	0.001μF	Ceramic	350V	
C115	0.001μF	Ceramic	350V	
C116	DELETED			
C117	0.01μF	Paper	500V	20
C118	9.3pF	Diff.trimmer		
C119	9.3pF	Diff.trimmer		
C120	DELETED			
C121	DELETED			
C122	DELETED			
C123	DELETED			
C124	DELETED			
C125	DELETED			
C126	DELETED			
C127	DELETED			

C128	DELETED			
C129	DELETED			
C130	0.001μF	Ceramic	350V	
C130A	0.01μF	Paper	500V	20
C131	0.001μF	Ceramic	350V	
C132	0.001μF	Ceramic	350V	
C133	0.001μF	Ceramic	350V	
C134	DELETED			
C135	DELETED			
C136	DELETED			
C137	DELETED			
C138	DELETED			
C139	DELETED			
C140	0.001μF	Ceramic	350V	20
C140A	0.001μF	Ceramic	350V	20
C141	0.05μF	Paper	350V	25
C142	DELETED			
C143	DELETED			
C144	DELETED			
C145	6800pF	Silver/Mica	350V	5
C146	270pF	Silver/Mica	350V	2
C146A	100pF	Ceramic	350V	2
C147	70pF	Trimmer, 12 vane with acetate case		
C148	70pF	Trimmer, 12 vane with acetate case		
C149	DELETED			
C150	0.1μF	Paper	150V	20
C151	DELETED			
C152	290pF	Silver/Mica	350V	2
C152A	100pF	Ceramic	750V	2
C153	70pF	Trimmer, 12 vane with acetate case		
C154	DELETED			
C155	DELETED			
C156	0.01μF	Paper	500V	20
C157	290pF	Silver/Mica	350V	2
C157A	100pF	Ceramic	750V	5
C158	70pF	Trimmer, 12 vane with acetate case		

C159	0.05μF	Paper	350V	20
C159A	0.1μF	Paper	150V	20
C159B	0.001μF	Ceramic	350V	
C160	0.05μF	Paper	350V	20
C161	290pF	Silver/Mica	350V	2
C161A	100pF	Ceramic	750V	5
C162	70pF	Trimmer, 12 vane with acetate case		
C163	0.05μF	Paper	350V	25
C164	330pF	Silver/Mica	350V	10
C165	0.05μF	Paper	350V	25
C166	0.05μF	Paper	350V	25
C167	470pF	Silver/Mica	350V	5
C168	10pF	Ceramic	750V	5
C169	0.1μF	Paper	150V	20
C170	2700pF	Silver/Mica	350V	5
C170A	33pF	Silver/Mica	350V	5
C171	70pF	Trimmer, 12 vane with acetate case		
C172	120pF	Silver/Mica	350V	5
C173	0.1μF	Paper	150V	25
C174	0.05μF	Paper	350V	20
C175	33pF	Ceramic	750V	5
C176	0.1μF	Paper	150V	20
C177	100pF	Silver/Mica	350V	10
C178	10pF	Ceramic	350V	5
C179	70pF	Trimmer, 12 vane with acetate case		
C180	100pF	Silver/Mica	350V	5
C181	0.05μF	Paper	350V	25
C182	0.1μF	Paper	150V	25
C183	0.05μF	Paper	350V	20
C184	0.05μF	Paper	350V	20
C185	0.1μF	Paper	150V	20
C186	0.05μF	Paper	350V	25
C187	0.05μF	Paper	350V	25
C188	0.05μF	Paper	350V	25
C188A	1μF	150V	20	
C189	0.01μF	Paper	500V	20
C190	0.1μF	Paper	150V	25
C191	70pF	Trimmer, 12 vane		

		with acetate case		
C192	390pF	Silver/Mica	350V	5
C193	100pF	Ceramic	750V	10
C193A	0.001μF	Ceramic	350V	
C194	0.1μF	Paper	150V	20
C194A	0.001μF	Ceramic	350V	
C195	0.1μF	Paper	350V	20
C195A	390pF	Silver/Mica	350V	5
C195B	70pF	Trimmer, 12 vane with acetate case		
C196	0.5μF	Paper	150V	20
C197	100μF	Electrolytic	50V	
C198	32+32μF	Electrolytic	350V	
C199	70pF	Trimmer, 12 vane with acetate case		
C200	50pF	Variable		
C201	220pF	Silver/Mica	350V	5
C202	39pF	Silver/Mica	350V	2pF
C203	22pF	Ceramic	750V	5
C204	0.1μF	Paper	150V	20
C205	0.001μF	Ceramic	350V	
C206	32+32μF	Electrolytic	350V	
C207	0.05μF	Paper	350V	20
C208	0.05μF	Paper	350V	20
C208A	0.01μF	Paper	500V	20
C209	330pF	Silver/Mica	350V	10
C210	330pF	Silver/Mica	350V	10
C211	330pF	Silver/Mica	350V	10
C212	0.1μF	Paper	150V	20
C213	0.1μF	Paper	150V	20
C214	0.1μF	Paper	150V	20
C215	47pF	Ceramic	750V	5
C216	0.01μF	Paper	500V	20
C217	0.1μF	Paper	150V	20
C217A	0.01μF	Silver/Ceramic	750V	20
C218	0,01μF	Paper	500V	20
C218A	33pF	Silver/Mica	350V	10
C219	0.001μF	Ceramic	350V	
C220	560pF	Ceramic	500V	20
C220A	0.1μF	Paper	150V	20
C221	0.01μF	Paper	500V	20

C221A	8μF	Electrolytic	350V	85C
C221B	68pF	Silver/Mica	350V	10
C222	50μF	Electrolytic	12V	
C222A	0.001μF	Ceramic	350V	
C222B	0.05μF	Paper	350V	20
C223	DELETED			
C224	0.01μF	Silver/Ceramic	750V	20
C225	0.01μF	Silver/Ceramic	750V	20
C226	82pF	Silver/Ceramic	750V	5
C227	82pF	Silver/Ceramic	750V	5
C228	82pF	Silver/Ceramic	750V	5
C229	82pF	Silver/Ceramic	750V	5
C230	82pF	Silver/Ceramic	750V	5
C231	82pF	Silver/Ceramic	750V	5
C232	DELETED			
C233	22pF	Trimmer		
C234	22pF	Trimmer		
C235	22pF	Trimmer		
C236	22pF	Trimmer		
C237	22pF	Trimmer		
C300	4.7pF	Ceramic	750V	1/2
C301	220pF	Silver/Mica	350V	5
C302	0.01μF	Paper	500V	20
C302A	0.01μF	Paper	500V	20
C303	15pF	Ceramic	750V	5
C304	0.01μF	Paper	500V	20
C305	33pF	Ceramic	750V	2
C306	16pF	Trimmer	1000V	
C307	0.01μF	Paper	250V	20
C308	47pF	Silver/Mica	350V	5
C308A	120pF	Silver/Mica	350V	5
C309	0.01μF	Paper	500V	20
C310	100pF	Variable		
C311	100pF	Silver/Mica	350V	5
C312	10pF	Silver/Mica	350V	5
C313	0.01μF	Paper	500V	20
C314	150pF	Silver/Mica	350V	2
C315	0.01μF	Paper	500V	20
C315A	0.01μF	Paper	500V	20
C316	47pF	Silver/Mica	350V	2
C317	220pF	Silver/Mica	350V	5
C318	12pF	Silver/Mica	350V	5
C319	100pF	Silver/Mica	350V	2
C320	100pF	Silver/Mica	350V	5

C321	0.01μF	Paper	500V	20
C321A	0.001μF	Silver/Mica	350V	5
C322	300pF	Silver/Mica	350V	2
C323	0.01μF	Paper	250V	20
C234	15pF	Silver/Mica	350V	2
C235	100pF	Silver/Mica	350V	5
C326	0.001μF	Silver/Mica	350V	5
C327	0.001μF	Silver/Mica	350V	5
C328	53pF	Silver/Mica	350V	2
C329	0.005μF	Paper	250V	20
C330	0.001μF	Silver/Mica	350V	5
C331	155pF	Silver/Mica	350V	2
C332	100pF	Silver/Mica	350V	5
C333	DELETED			
C334	100pF	Silver/Mica	350V	5
C335	DELETED			
C336	0.01μF	Paper	500V	20
C337	33pF	Trimmer		
C338	470pF	Silver/Mica	350V	5
C339	220pF	Silver/Mica	350V	5
C340	0.01μF	Paper	500V	20
C341	0.01μF	Paper	250V	20
C342	0.02μF	Paper	250V	20
C343	820pF	Silver/Mica	350V	5
C344	6800pF	Silver/Mica	350V	20

17. Component List 2

Valves

V1	Pentode	CV4010	6AK5W
V2	Pentode	CV4010	6AK5W
V3	Double-Triode	CV5331	6ES8/ECC189
V4	Pentode	CV4011	6AS6
V5	Pentode	CV4009	6BA6
V6	Pentode	CV4009	6BA6
V7	Pentode	CV3998	6688/E180F
V8	Pentode	CV4009	6BA6
V9	Pentode	CV3998	6688/E180F
V10	Pentode	CV4009	6BA6
V11	Pentode	CV4010	6AK5W
V12	Double-Triode	CV4024	12AT7
V13	Heptode	CV4012	6BE6W
V14	Pentode	CV4009	6BA6
V15	Pentode	CV4009	6BA6
V16	Pentode	CV4009	6BA6
V17	Pentode	CV4009	6BA6
V18	Double-Diode	CV4007	6AL5
V19	Pentode	CV4010	6AK5W
V20	DELETED		
V21	Double-Diode	CV4007	6AL5
V22	Output-Tetrode	CV4019	6AQ5
V23	Double-Triode	CV4024	12AT7
V24	Diode	CV469	5704/EA76
V25	Pentode	CV3998	6688/E180F
V26	Heptode	CV4012	6BE6W
V27	Pentode	CV4010	6AK5W

Inductances

L1	0-30 Mc/s filter
L2	Crystal anode coil
L3	Common assembly with L1
L4	Coil Assembly 16-30 Mc/s
L5	Coil Assembly 8-16 Mc/s
L6	Coil Assembly 4-8 Mc/s
L7	Coil Assembly 2-4 Mc/s
L8	Coil Assembly 1-2 Mc/s
L9	DELETED
L10	Common assembly with L1
L11	Common assembly with L1
L12	Common assembly with L1

L13	Filter detail assembly
L14	Common assembly wth L13
L15	Common assembly with L1
L16	Common assembly with L13
L17	Common assembly with L1
L18	Common assembly with L13
L19	Common assembly with L13
L20	First V.F.O. anode coil (assy with R18)
L21	Common assembly with L13
L22	Common assembly with L13
L23	40 Mc/s filter
L24	37.5 Mc/s filter
L25	40 Mc/s filter
L26	37.5 Mc/s filter
L27	Coil assembly R.F. Amp. anode
L28	Coil assembly 37 Mc/s mixer anode
L29	40 Mc/s filter
L30	37.5 Mc/s filter
L31	40 Mc/s filter
L32	37.5 Mc/s filter
L33	Coil Assy. 37 Mc/s Amp. Anode
L34	40 Mc/s filter
L35	37.5 Mc/s filter
L36	Coil Assy. First V.F.O.
L37	40 Mc/s filter
L38	37.5 Mc/s filter
L39	40 Mc/s filter
L40	37.5 Mc/s filter
L41	40 Mc/s filter
L42	37.5 Mc/s filter
L43	Choke
L44	Filter coil
L45	Choke
L46	Filter coil
L47	Crystal input transformer
L48	Crystal input transformer
L49	Crystal input transformer
L50	37.5 Mc/s tapped anode coil
L51	DELETED
L52	DELETED
L53	Filter coil assembly
L54	Filter coil assembly
L55	Coil assembly
L56	DELETED

L57	DELETED
L58	DELETED
L59	DELETED
L60	DELETED
L61	First L-C filter stage
L62	Common assembly with L61
L63	Second L-C filter stage
L64	Common assembly with L63
L65	Choke
L66	DELETED
L67	Third L-C filter stage
L68	Common assembly with L67
L69	0.1 Mc/s coupling coil
L70	Common assembly with L69
L71	Final L-C filter stage
L72	)
L73	) 100 kc/s I.F. first stage
L74	)
L75	0.9 Mc/s anode coil
L76	I.F. output Transformer assy.
L77	)
L78	) 100 kc/s final stage
L79	)
L80	Smoothing choke
L81	150mH choke
L82	B.F.O. coil
L83	Filter coil (Antenna)
L84	Filter coil (Antenna)
L85	Filter coil (Antenna)
L300	Coil Assembly
L301	Coil Assembly
L302	Coil Assembly
L303	Coil Assembly
L304	Coil Assembly
L305	Coil Assembly
L306	Coil Assembly
L307	Coil Assembly
L308	Coil Assembly
L309	Coil Assembly
L310	Coil Assembly
L311	Coil Assembly
L312	Coil Assembly
L313	Coil Assembly
L314	Coil Assembly

L330 Coil Assembly

Transformers
T1 Mains
T2 Audio Output
T3 A.F. Line Output

Rectifiers
MR1 Meter Rectifier, 1mA
MR4 Rectifier
MR5 Rectifier
MR6 Rectifier
MR7 Rectifier

Loudspeakers
LS 2 1/4 inch square 3 ohm

Meter
M1 200 micro-amp.

Crystals
XL1 1 Mc/s ±0.005%
XL2 99,964 c/s ±0.005%
XL3 99,890 c/s ±0.005%
XL4 DELETED
XL5 100,036 c/s ±0.005%
XL6 100,110 c/s ±0.005%
XL300 1.7 Mc/s

Fuses
F1 Mains Fuse, 2A
F2 Fuse anti-surge, 350mA

Lamp
ILP1 Mains indicating, 8V, 1.6 W

18. Valve Data

INTRODUCTION

1. Details of valves used in the receiver are given in Tables 1 and 2 overleaf. The location of valves is shown in fig. 8 and valve base connections are given in the circuit diagram. Voltages were obtained from a B9A or B7G stand-off valve base using a 20,000 ohms/volt meter on the optimum range in each case. Valve pin numbers are indicated in brackets in Table 2.
2. The receiver was set as follows:-
   (1) SYSTEM switch to MAN.
   (2) R.F./I.F. GAIN to MAX.
   (3) No signal i.e. first and second v.f.o. off tune.
   (4) B.F.O. off except for checking V19.
   (5) SYSTEM switch to CAL in order to check V13 and V15 only.

TABLE 1.

Pin No.	6AK5W M8100	6ES8 ECC189	6AS6	6BA6 EF93	6688 E180F	12AT7 ECC81	6BE6W	6AL5 EB91	6AQ5
1	Grid1	Anode2	Grid1	Grid1	Cathode	Anode2	Grid1	Cathode1	Grid1
2	Cathode & Grid3	Grid2	Cathode	Grid3	Grid1	Grid2 & Grid5	Cathode	Anode2 & Grid3	Cathode
3	Heater	Cathode2	Heater	Heater	Cathode	Cathode2	Heater	Heater	Heater
4	Heater	Heater	Heater	Heater	Heater	Heater	Heater	Heater	Heater
5	Anode	Heater	Anode	Anode	Heater	Heater	Anode	Cathode2	Anode
6	Grid2	Anode1	Grid2	Grid2	I.C.	Anode1	Grid2 & Grid 4	Screen	Grid2
7	Cathode	Grid1	Grid3	Cathode	Anode	Grid1	Grid3	Anode1	Grid1
8		Cathode1			Grid 3 & Screen	Cathode1			
9		Screen			Grid2	Heater C.T.			
Base	B7G	B9A	B7G	B7G	B9A	B9A	B7G	B7G	B7G

TABLE 2

Cct. Ref.	Type Anode	Screen	Cathode	American	Equivalent	Function
V1	140(5)	75(6)	1.16(2)	6AK5W	M8100	Crystal osc./ amplifier
V2	165(5)	120(6)	3.0(2)	6AK5W	M8100	Harmonic generator
V3	172(1) 90(6)	-	1.1(8)	6ES8	ECC189	R.F.amplifier
V4	175(5)	120(6)	2.0(2)	6AS6		Harmonic mixer
V5	175(5)	95(6)	-	6BA6	EF93	First v.f.o.
V6	196(5)	85(6)	0.95(2)	6BA6	EF93	37.5 Mc/s amplifier
V7	173(7)	120(9)	0.85(1)	6688	E180F	First mixer

V8	195(5)	85(6)	0.95(2)	6BA6	EF93	37.5 Mc/s amplifier
V9	168(7)	135(9)	0.86(1)	6688	E180F	Second mixer
V10	205(5)	108(6)	2.06(2)	6BA6	EF93	37.5 Mc/s amplifier
V11	155(5)	110(6)	1.95(2)	6AK5W	M8100	Second v.f.o. amplifier
V12	100(6)	-	-	12AT7	ECC81	Second v.f.o.
	195(1)	-	44(3)			
V13	225(5)	90(6)	2.0(2)	6BE6W		Calibrator
V14	175(5)	70(6)	0.92(7)	6BA6	EF93	First I.F. amplifier
V15	220(5)	110(6)	6.5(7)	6BA6	EF93	Calibrator
V16	180(5)	88(6)	1.46(7)	6BA6	EF93	Second I.F. amplifier
V17	150(5)	92(6)	1.36(7)	6BA6	EF93	I.F. output
V18	-	-	27.0(1)	6AL5	EB91	A.V.C. and T.C.
V19	155(5)	110(6)	-	6AK5W	M8100	B.F.O.
V20						
V21	-	-	-	6AL5	EB91	Detector and noise limiter
V22	200(5)	198(6)	8.5(2)	6AQ5		Audio output
V23	205(1)	-	2.2(3)	12AT7	ECC81	Audio amplifier
	104(6)	-	1.5(8)			and A.F. output
V24	-	-	-		EA76	
V25	165(7)	135(9)	0.72(1)	6688	E180F	Third mixer
V26	185(5)	135(6)	0.72(2)	6BE6W		Fourth mixer
V27	140(5)	80(6)	1.45(2)	6AK5W	M8100	1.7 Mc/s crystal oscillator/ amplifier

19. Illustrations