SECTION 6

GENERAL PURPOSE RECEIVER RC1/1

Introduction

The RC1/1 is a general-purpose receiver intended for use at studio centres and transmitters as a replacement for the G.E.C. Overseas 10. The complete equipment comprises a Chapman Type-S6 receiver mounted on a 19-inch panel and fitted with carrier-failure alarm and audio output circuits. The general appearance of the RC1/1 is illustrated in Fig. 6.1 (front view) and Fig. 6.2 (rear view). The rear view shows the carrier-alarm relay and associated d.c. amplifying valve accommodated on a subchassis mounted on the main receiver chassis near its centre. It also shows the output transformer mounted at the back of the receiver.

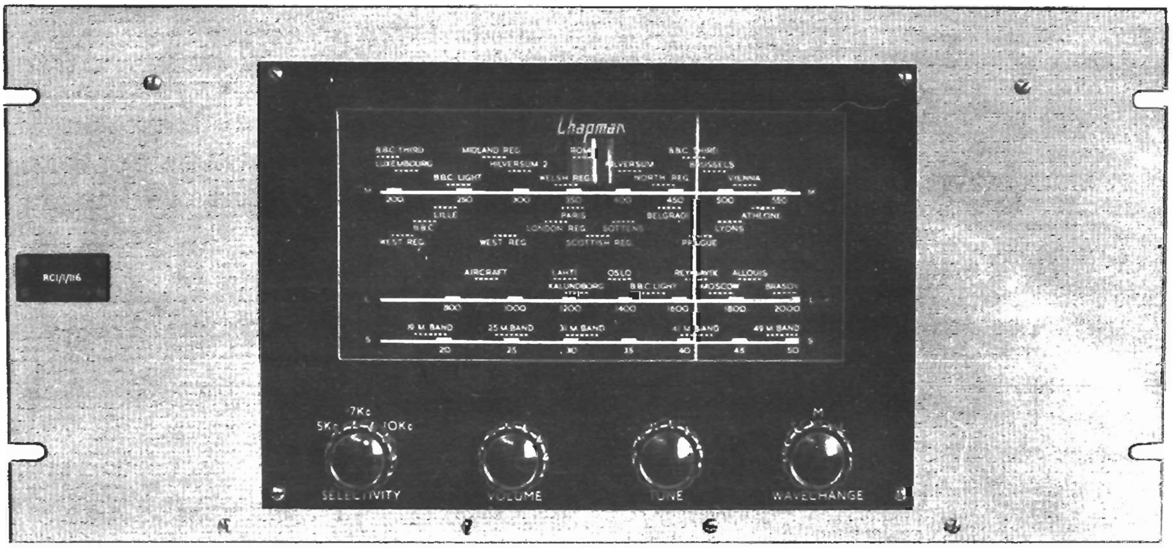

Fig. 6.1. RC1/1 Receiver: Front View

General Description

A simplified block diagram of the RC1/1 is given in Fig. 6.3. The receiver is an a.m. superheterodyne type covering the following three wavebands:

long waves:	150 kc/s to 375 kc/s,
medium waves:	550 kc/s to 1·5 Mc/s,
short waves:	6 Mc/s to 15 Mc/s.

The receiver has an r.f. stage preceding the frequency changer and two i.f. stages preceding the diode detector. The second and third i.f. transformers include facilities for varying the bandwith. The output of the detector is amplified by a two-stage a.f. amplifier with negative feedback.

An unusual feature of the receiver is the provision of a third i.f. stage which feeds the a.g.c. diode and the magic-eye tuning indicator. This is a system of amplified a.g.c., in which the amplification occurs at intermediate frequency instead of at zero frequency as in the more usual amplified a.g.c. systems. This third i.f. stage also feeds the d.c. amplifier which operates the carrier-failure alarm relay.

Circuit Description (Fig. 9)

General

A complete circuit diagram of the receiver is given in Fig. 9. The signal input is applied to an r.f. transformer which is shown as a block: this block represents the primary windings, the secondary (tuned) windings for all three wavebands, and a section of the waveband switch. Circuit details are shown in Fig. 6.4. The earthy end of the secondary windings is returned to the a.g.c. line via the decoupling components R3 C20; this arrangement is the only source of grid bias for V1 since the cathode is returned directly to the earth line. The screen-grid of V1 is fed from the potential divider R1 R2 and is decoupled by C1.

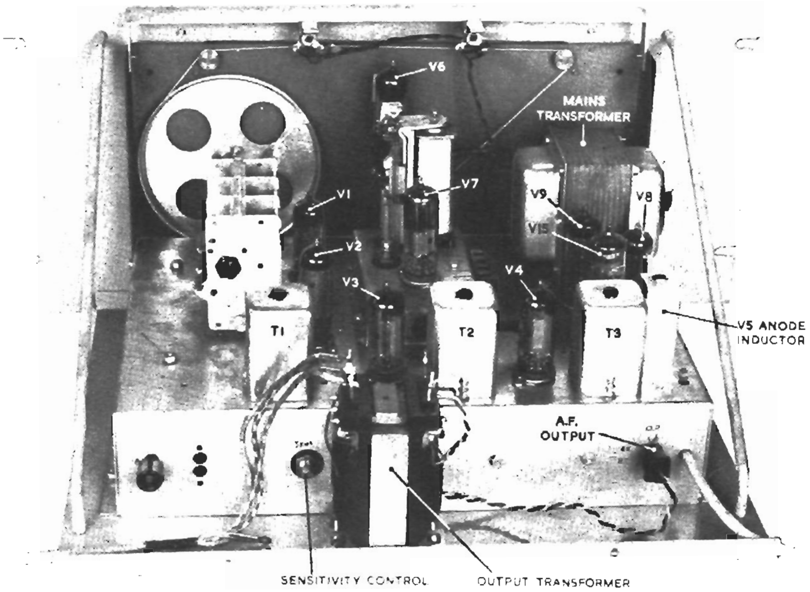

Fig. 6.2. RC1/1 Receiver: Rear View

Frequency Changer

The r.f. transformer coupling V1 to the frequency changer V2 is also shown as a block which represents inductors for all bands and a second section of the waveband switch. Circuit details are given in Fig. 6.4. The h.t. supply for V1 is fed to the transformer via R4, which is decoupled by C3. The grid circuit of V2 is returned to the a.g.c. line via R5 and is decoupled by C4. The screen grid of V2 is fed from the potential divider R6 R7 and is decoupled by C5. Standing bias for V2 is provided by R8 C6 in the cathode circuit. The triode section of V2 is the oscillator and the inductors are again shown as a block which represents inductors for three bands and a third section of the waveband switch. Circuit details are shown in Fig. 6.4. R9 and C10 are the automatic-bias components for the oscillator.

First I.F. Stage

The first i.f. transformer which couples V2 anode to V3 grid is damped by R42 in parallel with R43 on the secondary side. This gives this transformer a wide bandwidth. R43 is a 250-kilohm gain control which adjusts the magnitude of the i.f. signal fed to V3 grid. The secondary winding is returned to the a.g.c. line by R11 and is decoupled by C12. The h.t. supply for V3 is taken via R13 and is decoupled by C9, V3 screen-grid being supplied via the series resistor R44 and decoupled by C16. V3 has no standing bias, the cathode being directly earthed.

Second I.F. Stage

The second i.f. transformer, which couples V3 to V4, has no damping resistors but includes an adjustable bandwidth facility provided by altering the degree of coupling between the windings of the transformer. A small inductor, closely coupled to the primary winding of the transformer, can be connected in series with the secondary winding by means of the selectivity switch when increased

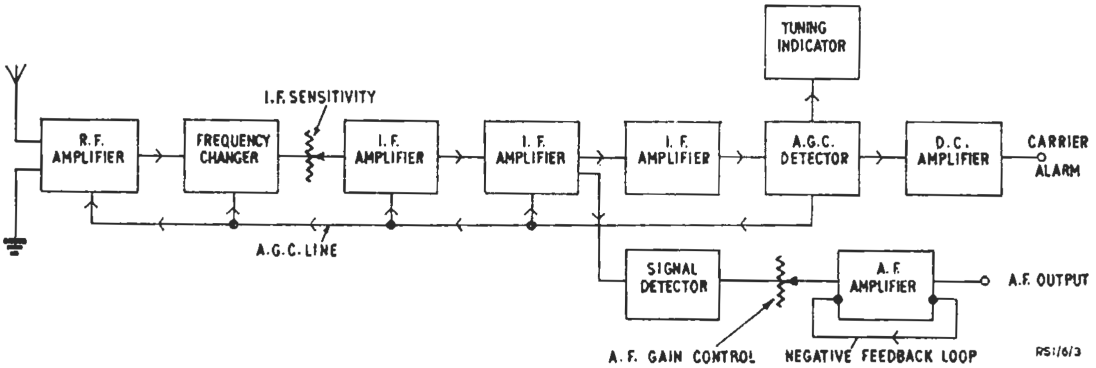

Fig. 6.3. RC1/1 Receiver: Block Schematic

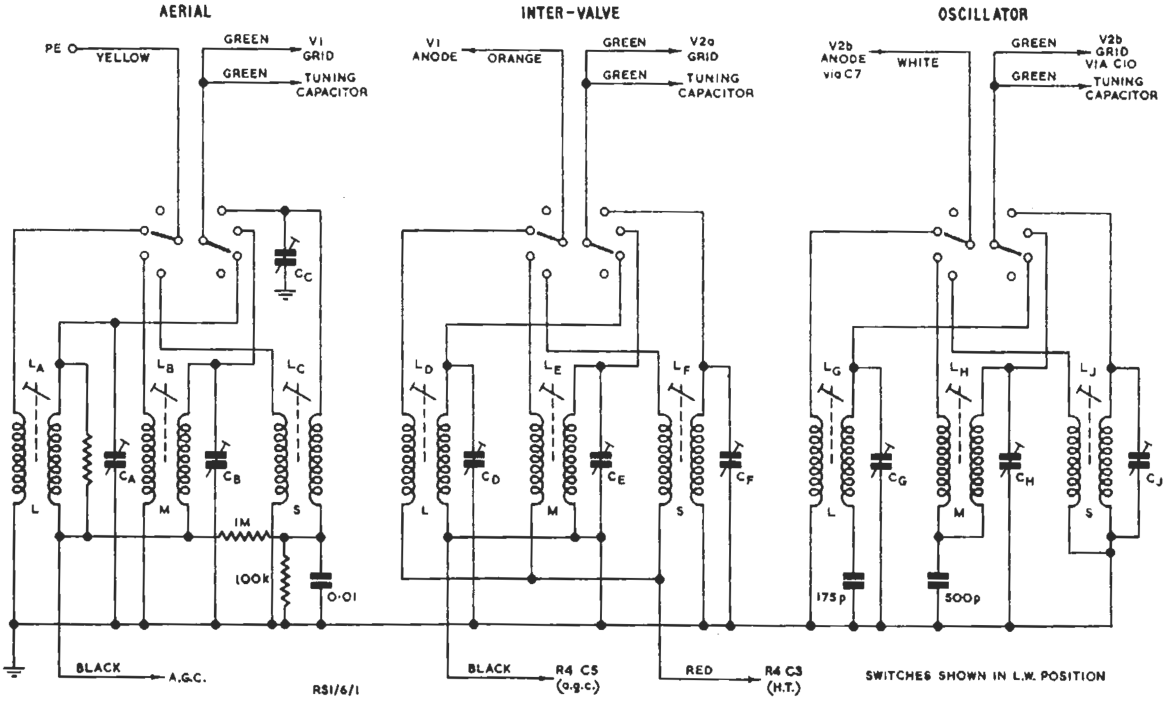

Fig. 6.4. RC1/1 Receiver: Circuit Details of Coil Assembly

coupling and increased bandwidth are required. The selectivity switch has three positions, and the coupling coil is in circuit giving increased bandwidth in positions 1 and 2. The inclusion of the coupling coil in series with the secondary winding lowers the resonance frequency of the secondary circuit, but the coil is small enough for this effect to be negligible. The earthy end of the secondary winding is returned to the a.g.c. line via R12 and is decoupled by C15. A second section of the selectivity switch puts the resistor R14 in circuit for positions 2 and 3; this resistor reduces the a.g.c. voltage applied to V4 grid, and makes the gain of the receiver independent of the switch setting. The h.t. supply circuits for V4 anode and screen-grid are similar to those for V3.

Detector

The third i.f. ransformer couples V4 to V5 and is of similar construction to the second. The coupling winding is, however, in circuit (giving wide bandwidth) only for position 1 of the selectivity switch; this is necessary to achieve three values of bandwidth in the i.f. amplifier as a whole. The secondary winding feeds the signal diode incorporated in the double-diode-pentode V5, audio-frequency signals being developed across R17 and R18. The a.f. voltage developed across R18 is fed via C14 and the gain control R22 to the a.f. amplifier V8. Nearly 12 dB of a.f. gain is lost in this detector output circuit. This gain is sacrificed to minimise the peak clipping which would occur at high modulation percentages if the gain control were connected across R17 as well; moreover, the attenuation also ensures that V8 is not overloaded at high settings of the gain control.

A.G.C. Amplifier

The a.g.c. amplifier V5 is fed from V4 anode via a small capacitance formed by wrapping the insulated grid lead to V5 around the anode lead of V4. The h.t. feed to V5 is decoupled by R21 and C17; the screen-grid feed is decoupled by R24 and C22. Automatic cathode bias is obtained from the 330-ohm cathode resistor R20, which is not decoupled. An *LC* circuit resonant at the intermediate frequency is included in V5 anode circuit; the i.f. voltage developed across this is fed via the capacitor C21 to the second diode of V5 to provide the a.g.c. voltage. The diode load R25 is returned to the h.t. negative line, thus biasing the diode anode negative with respect to the cathode. This gives an effective delay to the a.g.c., because the diode cannot conduct until the peak r.f. signal applied to its anode exceeds the voltage across R20. The a.g.c. voltage developed across R25 is smoothed by R23 and C19 to eliminate any a.f. signals, and is then fed to the grids of V1, V2, V3 and V4 and also to the grid of the magic-eye tuning indicator V6.

Carrier Alarm

The i.f. signal at V5 anode is also fed via C23 to a point-contact diode, the output being developed across the diode load R27. This signal is applied to the grid of V7, the carrier-alarm amplifier, via the components R28 and C24 which greatly attenuate a.f. signals. V7 is a pentode, but the anode is connected to the screen-grid (via a 100-kilohm resistor) and the valve thus functions as a triode. In the absence of an input from the diode, the cathode potential of V7 is adjusted by the resistor R34 to give a value of anode plus screen-grid current which is too low to energise the alarm relay RLA in the anode circuit. When, however, a positive voltage of sufficient magnitude is received at V7 grid from the point-contact, this relay is energised and closes contacts RLA-1 and RLA-2, which can be used to operate lamps or buzzers or any other form of alarm. The alarm can be set to operate on any strength of received signal within certain limits by adjustment of R34.

A.F. Amplifier

The a.f. signal from the gain control R22 is applied to the grid of the triode V8a and the amplified signal at its anode is fed to the grid of a second triode V8b via C26 and R38. The anode circuit of V8b includes an output transformer, from the secondary winding of which the a.f. output of the receiver is taken. Negative feedback is applied from the anode of V8b to the cathode of V8a by the components C30, R45 and R36. The cathode circuit of V8b includes an automatic-bias resistor R37 which is not by-passed.

Power Supply

The mains rectifying and smoothing equipment is conventional. V9 is a full-wave rectifier, the heater of which is fed from the l.t. winding which supplies the heaters for the other valves in the receiver. C28 is the reservoir capacitor and the supply to all valves is smoothed by the single section R40 C27. A further smoothing stage R39 C25 is included in the supply to V8.

Test Data

Electrical Data

The following are the voltages at various points in the receiver. These apply with the receiver controls set as indicated below:

Wavechange switch set to medium waves
Selectivity switch set to 5 kc/s
Sensitivity control at maximum
Tuning capacitor at maximum
R34 at maximum resistance
Mains tapping agreeing with mains voltage
No aerial connected

Point of Measurement	*Voltage*
Across C27	180 ±18
V1 screen	57 ±14
Junction R4, C3	150 ±30
V2 screen	55 ±14
V2 cathode	1·2 ±0·3
Junction R13, C9	155 ±30
V3 screen	43 ±10
Junction R16, C11	155 ±30
V4 screen	40 ±10
V5 screen	36 ±9
V5 cathode	0·8 ±0·2
Junction R21, C17	160 ±35
Anode V8(a)	54 ±14
Anode V8(b)	155 ±30
Cathode V8(a)	1·9 ±0·5
Cathode V8(b)	4·3 ±1·0
Heater supply (r.m.s.)	6·3 ±0·3

A.F. Amplifier

Remove valve V5 and short-circuit capacitor C13. Terminate a tone-source with 600 ohms and inject −15 dB at 1 kc/s across R22. Measure the output level on a high-impedance amplifier detector. With R22 set for maximum gain, the output level should be +6 dB ±2 dB. Terminate the amplifier output with 600 ohms when the output level should drop by 6 dB ±1 dB. Adjust the tone-source to give zero level output from the amplifier into 600 ohms. Measure the frequency response of the a.f. amplifier.

The output level from the amplifier should not vary by more than ±1·0 dB from 40 c/s to 15 kc/s relative to the output at 1 kc/s.

With the amplifier correctly terminated measure the harmonic distortion at the frequencies and levels given below. The distortion should be better than the figures shown.

Frequency	*Output Level* (dB)	*Harmonic Distortion Separation* (dB)	
		2nd	*3rd*
1 kc/s	0	—44	—55
	+8	—37	—55
	+12	—33	—50
60 c/s	0	—42	—50
	+8	—35	—50
	+12	—32	—50

Reset the tone source to 1 kc/s and adjust its level to give zero level into 600 ohms at the amplifier output. Measure the output level on a high-impedance test programme meter with the amplifier output terminated by 600 ohms. Adjust the controls so that the meter peaks to '4'. Disconnect the tone source from the amplifier and adjust the level controls of the T.P.M. so that the meter peaks to '6'. The difference between the two readings then represents the signal-to-noise ratio of the amplifier. This should be better than 55 dB.

Remove the short-circuit from across C13 and replace valve V5.

R.F. Sensitivity

Connect an Avometer Model 8 set to its 25-volt d.c. range across capacitor C13. Leave the controls at the settings given under *Electrical Data*. Where r.f. voltages are quoted, these may be taken as source voltages if the output impedance of the signal generator is less than 100 ohms.

Inject r.f. signals at the following frequencies and levels into the receiver aerial and earth sockets.

Wave-band	*Frequency*	*R.F. Signal Input* (μV)	*Meter Reading (Volts D.C.)*
Long	160 kc/s	6	2·7
	300 kc/s	6	3
Medium	600 kc/s	6	1·7
	1·5 Mc/s	6	2·9
Short	6·7 Mc/s	3	1·8
	15 Mc/s	3	1·8

In each instance the signal should be injected and the receiver tuned to the signal to give a maximum voltage across C13. Check at the same time that the dial calibration of the receiver agrees with reasonable accuracy with the injected frequency. The voltage across C13 should in each instance be greater than that shown.

Finally, disconnect the Avometer from across C13.

A.G.C. and Noise Level

Set the signal generator to 1 Mc/s and modulate it with 1 kc/s tone to give 40 per cent amplitude modulation. Set the signal generator to give 1 mV into the receiver and tune in the signal. Adjust the receiver a.f. gain control to give zero level output into 600 ohms with the selectivity switch in the 5-kc/s position. Vary the r.f. input signal between 100 μV and 10 mV. The a.f. output should not vary by more than +4 dB or —2 dB.

Leave the signal generator set to 1 Mc/s and at 1 mV output. Modulate the signal generator with 1 kc/s to give 40 per cent amplitude modulation. Set the selectivity control to the 5-kc/s position. Measure the output level across 600 ohms on a test programme meter. With the level control of the T.P.M. adjusted to '0' the meter should read '4'. Remove the modulation from the signal generator and adjust the level controls of the T.P.M. so that the meter peaks to '6'. The reading of the T.P.M. then represents the signal-to-noise ratio, which should be better than 40 dB. At the same r.f. input level, measure the weighed noise using an ASN/4. The weighted signal-to-noise ratio should be better than 55 dB. Reduce the input level to 100 μV and repeat the measurement of *unweighted* noise. The signal to noise ratio should then be better than 35 dB.

Carrier Failure Alarm Circuit

Disconnect the signal generator from the receiver and connect an Avometer in series with the h.t. lead to the carrier failure alarm subchassis. Set R34 so that RLA *just* deoperates. The Avometer should read about 4 mA. Set the signal generator to give 25 μV into the receiver and remove the modulation. Check that at the following frequencies the carrier failure alarm relay operates with an input of 25 μV and that the relay releases when the signal is removed.

Waveband	*Frequency*
Long	200 kc/s
Medium	600 kc/s
Medium	1 Mc/s
Medium	1·5 Mc/s
Short	6·5 Mc/s
Short	12 Mc/s
Short	18 Mc/s

Reset the signal generator to 1 Mc/s and tune the receiver to the signal. Set R34 for maximum resistance. Increase the signal level to 1 mV and check that RLA is not operated. Reduce the valve of R34 until RLA *just* operates. Gradually reduce the r.f. input level until RLA releases. This should occur at between 70 and 150 μV. Disconnect the Avometer and restore the h.t. to the carrier-failure alarm subchassis.

Alignment Procedure

Intermediate Frequency

The alignment procedure should be carried out with the receiver controls set as indicated previously under *Electrical Data.*

Connect an Avometer Model 8 set to its 25-volt d.c. range across capacitor C13. Inject an unmodulated signal at 470 kc/s into the grid (pin 2) of valve V2. Adjust the cores of the three i.f. transformers for maximum Avometer reading. Progressively reduce the signal-generator output as alignment proceeds to that the Avometer reading is always small (say less than 1 volt). When alignment is complete an input of 10 μV at V2 grid should give an Avometer reading exceeding 1 volt.

Swing the signal generator frequency about 470 kc/s and check that maximum indication on the magic eye tuning indicator coincides with maximum Avometer reading. If it does not, adjust inductor L1 as follows:

If a valve-voltmeter is available, connect it between the grid (pin 1) of V6 and chassis. Adjust input frequency for maximum valve-voltmeter reading. With the core of L1 initially well away from the centre of the coil, advance the core slowly. The valve-voltmeter reading rises to a maximum and then falls to a mimimum. Seal the core at the position giving minimum reading.

If a valve-voltmeter is not available, set the signal generator to give a modulated output at 470 kc/s and adjust L1 so as to obtain the best possible agreement between maximum indication from the tuning indicator and maximum a.f. output from the receiver.

Radio Frequency

When the i.f. alignment has been completed, align the r.f. circuits as described below.

Short Waveband. Connect an Avometer Model 8 across C13 and apply modulated r.f. input to the aerial and earth terminals from a signal generator via a dummy aerial. Switch the receiver to short waves, set the pointer to 50 metres and adjust the signal generator to 6 Mc/s. Tune in the generator signal by adjustment of oscillator inductor L_J. (See Fig. 6.5). Now retune the receiver to 20 metres and the signal generator to 15 Mc/s, and tune in the generator signal by adjustment of oscillator trimmer C_J. Restore the receiver tuning to 50 metres and the signal generator to 6 Mc/s, and if necessary adjust L_J to tune in the signal. Reduce the signal generator output to a low value and adjust inductors L_F and L_C for maximum a.f. output. Again set the receiver to 15 metres and the signal generator to 20 Mc/s, and if necessary adjust C_J to tune in the signal. With a small signal input to the receiver, adjust trimmers C_F and C_C for maximum audio output. The short waveband is now aligned.

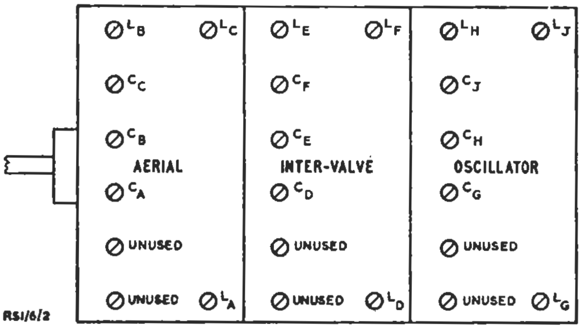

Fig. 6.5. RC1/1 Receiver: Details of Inductors and Trimmers

Medium Waveband. Set the waveband switch to medium waves and the receiver tuning to 500 metres. Adjust the signal generator to 600 kc/s and tune in the signal by adjustment of oscillator inductor L_H. Retune the receiver to 200 metres and the signal generator to 1·5 Mc/s, and tune in the signal by adjustment of the oscillator trimmer C_H. Restore the receiver tuning to 500 metres and the signal generator to 600 kc/s, and if necessary adjust L_H to tune in the signal. With a weak signal input, adjust the inductors L_E and L_B for maximum audio output. Again set the receiver to 200 metres and the signal generator to 1·5 Mc/s, and if necessary adjust C_H to tune in the signal. With a small signal input to the receiver, adjust trimmers C_E and C_B for maximum a.f. output. The medium waveband is now aligned.

Long Waveband. Set the waveband switch to long waves and the receiver tuning to 1,820 metres. Adjust the signal generator to 165 kc/s and tune in the signal by adjustment of oscillator inductor L_G. Retune the receiver to 1000 metres and the signal generator to 300 kc/s, and tune in the signal by adjustment of the oscillator trimmer C_G. Restore the receiver tuning to 1,820 metres, and if necessary adjust L_G to tune in the signal. With a weak signal input adjust the inductors L_D and L_A for maximum a.f. output. Again set the receiver to 1,000 metres and signal generator to 300 kc/s, and if necessary adjust C_G to tune in the signal. With a small signal input to the receiver, adjust trimmers C_D and C_A for maximum a.f. output. The long waveband is now aligned.

R.F. Sensitivity

After alignment, the voltage obtained across C13 should be greater than the value quoted in the table of r.f. sensitivities given under *Test Data.*

Adjustment of Carrier-failure Alarm

When the carrier-failure alarm facility is required the following procedure should be adopted.

Connect an Avometer in series with the h.t. positive lead to the carrier-failure alarm sub-chassis. Set R34 for maximum resistance. Tune the receiver to the required carrier and then adjust R34 until RLA just operates. Note the Avometer current, which should be about 6 mA. Disconnect the aerial from the set and connect an unmodulated signal generator in its place. Tune the signal generator to the receiver frequency and set its amplitude so that the Avometer reads the same current as before. Reduce the signal-generator voltage by 6 dB and adjust R34 until the Avometer again reads the same current as before. Disconnect the Avometer and the signal generator and re-connect the aerial. The carrier-failure alarm circuit is now aligned.

If it is found in the first instance that with R34 set to maximum resistance relay RLA is already operated, then the incoming r.f. signal must be attenuated by the use of a suitable external pad. In any event when the carrier-failure alarm facility is required the incoming r.f. signal should not exceed 10 mV. The receiver sensitivity control should always be set for maximum sensitivity and should not be used to reduce the signal, as this would alter other parameters of the receiver.