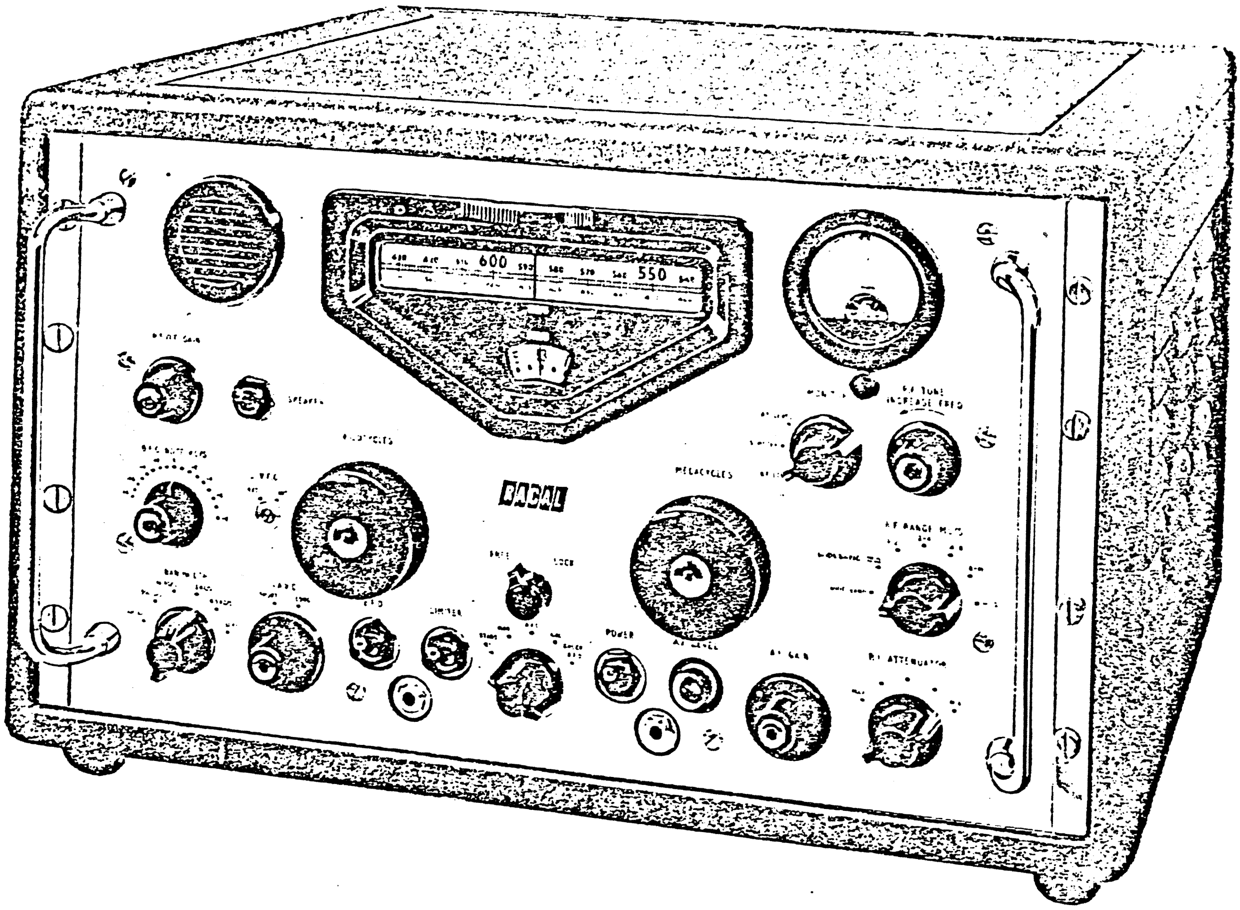

THE RACAL COMMUNICATIONS RECEIVER
TYPE RA. 117

BRIEF TECHNICAL DESCRIPTION

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HANDBOOK CHANGE INFORMATION

At RACAL, we continually strive to keep up with the latest electronic developments by adding circuit and component improvements to our equipments.

Sometimes, due to printing and despatch requirements, we are unable to incorporate these changes immediately into printed handbooks. Hence, your handbook may contain new change information on following pages.

The user is recommended to hand-amend this handbook, as soon as possible, in accordance with the corrections, if any, which follow this sheet.

CONTENTS

SECTION 1

TECHNICAL DETAILS AND OPERATION

Frequency range:	1-30 Mc/s
Stability:	After warm-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 length of approximately 145 feet, i.e. 6 inches of scale length 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.

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 6000 c/s.

A.F. output:

1. $2\frac{1}{2}$-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 can 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	$10\frac{1}{2}$	19	20.1/8	in.
(fitted dust cover)	26.7	48.25	51	cm.
Fitted cabinet	12	$20\frac{1}{2}$	21.7/8	in.
	30.5	52	55.6	cm

Weight:

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

an unwanted signal f2 must be 60dB greater before the audio output of the wanted signal f1 is reduced by 3dB due to blocking.

Selectivity:

Six alternative i.f. bandwidths 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)	0.10 kc/s	Less than 1.5 kc/s

Bandwidths 5 and 6 are obtained with crystal-lattice filters; differences in centre frequencies of these bandwidth settings do not exceed 50 c/s.

I.F. output:

100 kc/s at 75-ohms impedance. Level 0.2V 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.

Chapter 1

INTRODUCTION

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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 mains supply. The power consumption 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.

INSTALLATION

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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.

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 transformer 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 is correct viz:

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 be provided with alternative sleeves to enable it to be used with a type UR. 18 or UR. 70 cable or similar cables of nominal $\frac{1}{2}$-in or $\frac{1}{4}$-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-ohm 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 one outlet loaded by 75-ohms, the other can be used as a high impedance source).

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 for 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 connection should be made as follows:-

1 Mc/s Input	Remove the "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.
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.
Output	Connect the free plug PL302 to SKT304.
1.7 Mc/s input	Connect the free plug PL303A to SKT303.
Output	Connect the free plug PL303A to SKT306 (blue).

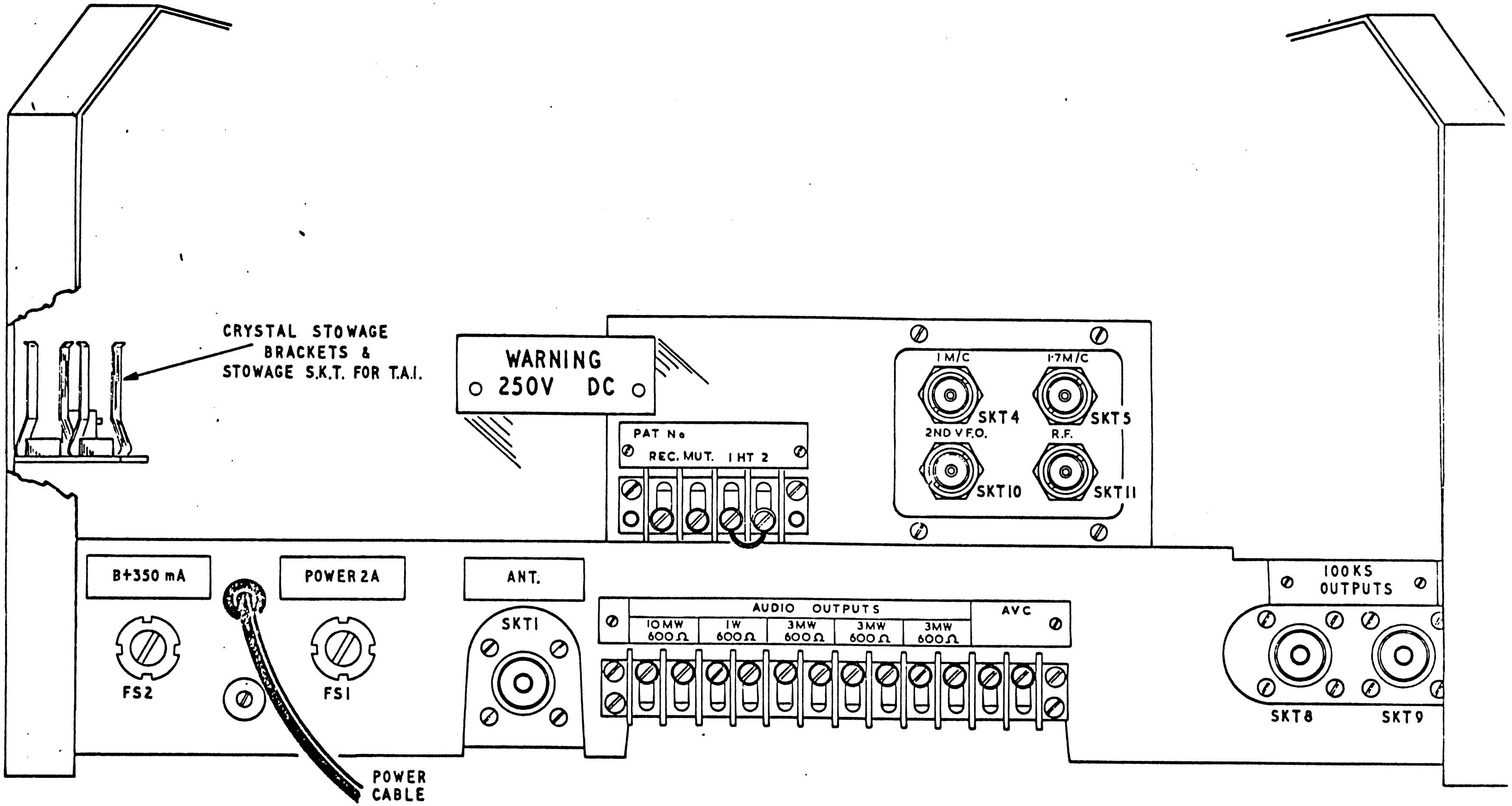
Note 1.......

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 crystals 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.

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.



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REAR VIEW OF RECEIVER CHASSIS

Fig. 1

OPERATION

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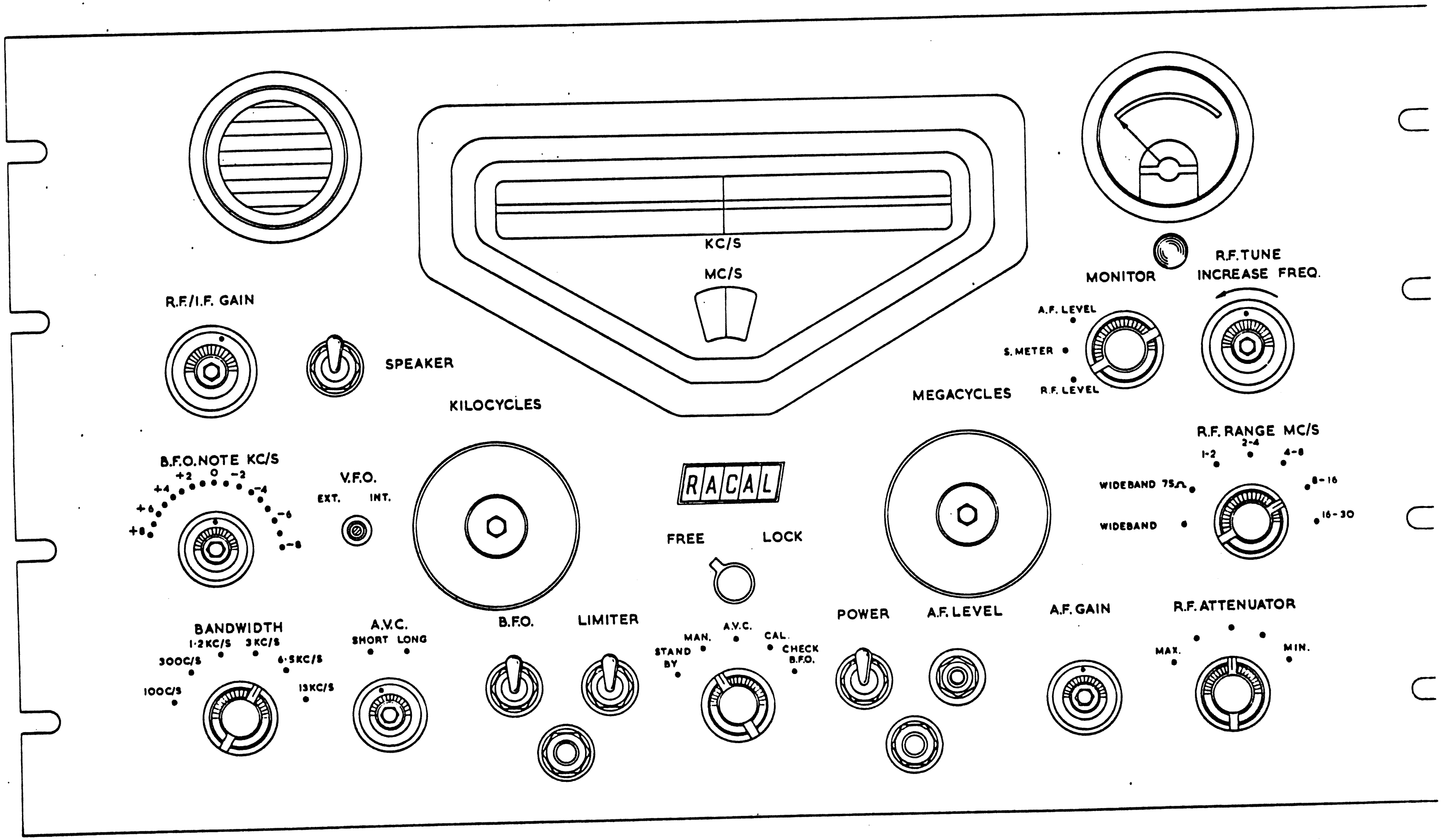

Fig. 2

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FRONT PANEL, RA. 117

500 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 exactly tuned to a central point on the i.f. amplifier response when the B.F.O. NOTE KC/S control is set 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 be detuned in order to produce an acceptable 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 signals anywhere within the spectrum may cause cross-modulation 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. positions 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.v.c. loop gain together with 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 exception 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.

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, which is extremely simple, depends largely upon the purpose for which the receiver is being employed.

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 any one of five antenna ranges plus two WIDEBAND positions, one of 75-ohms input impedance and the other a high impedance input of 2000-ohms.
verzwakker 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 bandwidth 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:

should be employed with the noise 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 suitably terminated.
LIMITER	When switched 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 plug disconnects the loudspeaker.
V.F.O.	This switch should be set to the EXT. position when an 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.

(6) Set LIMITER and B.F.O. switches to OFF.

(7) Select a 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 a BANDWIDTH of 3 KC/S.

(3) Set the KILOCYCLES scale to that 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 escutcheon 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

(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.

(12) Rotate the system switch to MAN.

(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 acceptable 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 screwdriver until the meter reads zero.

AMENDMENT

CIRCUIT DIAGRAM

Trimmer capacitors C233 to C237 inclusive changed from 22 pF to 18 pF.
Capacitor C195A changed from 390 pF to 330 pF.
Capacitor C195C 33 pF added; connected in parallel with C195A and C195B.

COMPONENTS LIST

C233 to C237	18 pF	Trimmer	Mullard C004EA/18E
C195A	330 pF	Silv'd mica	J & M CX-22S
C195C	33 pF	Silv'd mica	J & M CX-22S

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<u>CORRIGENDA</u>

<u>Main Circuit</u>

Capacitor C329, value changed from .01 μF to .005 μF. Resistor R124, value and rating changed from 165Ω 10W to 120Ω 6W.

Chapter 4

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, Chapter 5 (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 fed 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 circuits; these restrict the possible settings to position 1 Mc/s apart (e.g. 41.5, 42.5 and 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 acceptable 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 clarify 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_sMc/s	VFO-1 f_oMc/s	Xtal Harmonic nf_cMc/s	1st I.F. f_o-f_s	Het Freq. f_o-nf_c	2nd I.F. nf_c-f_s
4	1,000	5.0	44.5	7th	39.5	37.5	2.0
5	0	5.0	45.5	8th	40.5	37.5	3.0
18	600	18.6	58.5	21st	39.9	37.5	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 band-pass 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 the INT. position. These check points are obtained from a regenerative divider controlled by the 1 Mc/s crystal oscillator.

Chapter 5

DETAILED CIRCUIT DESCRIPTION

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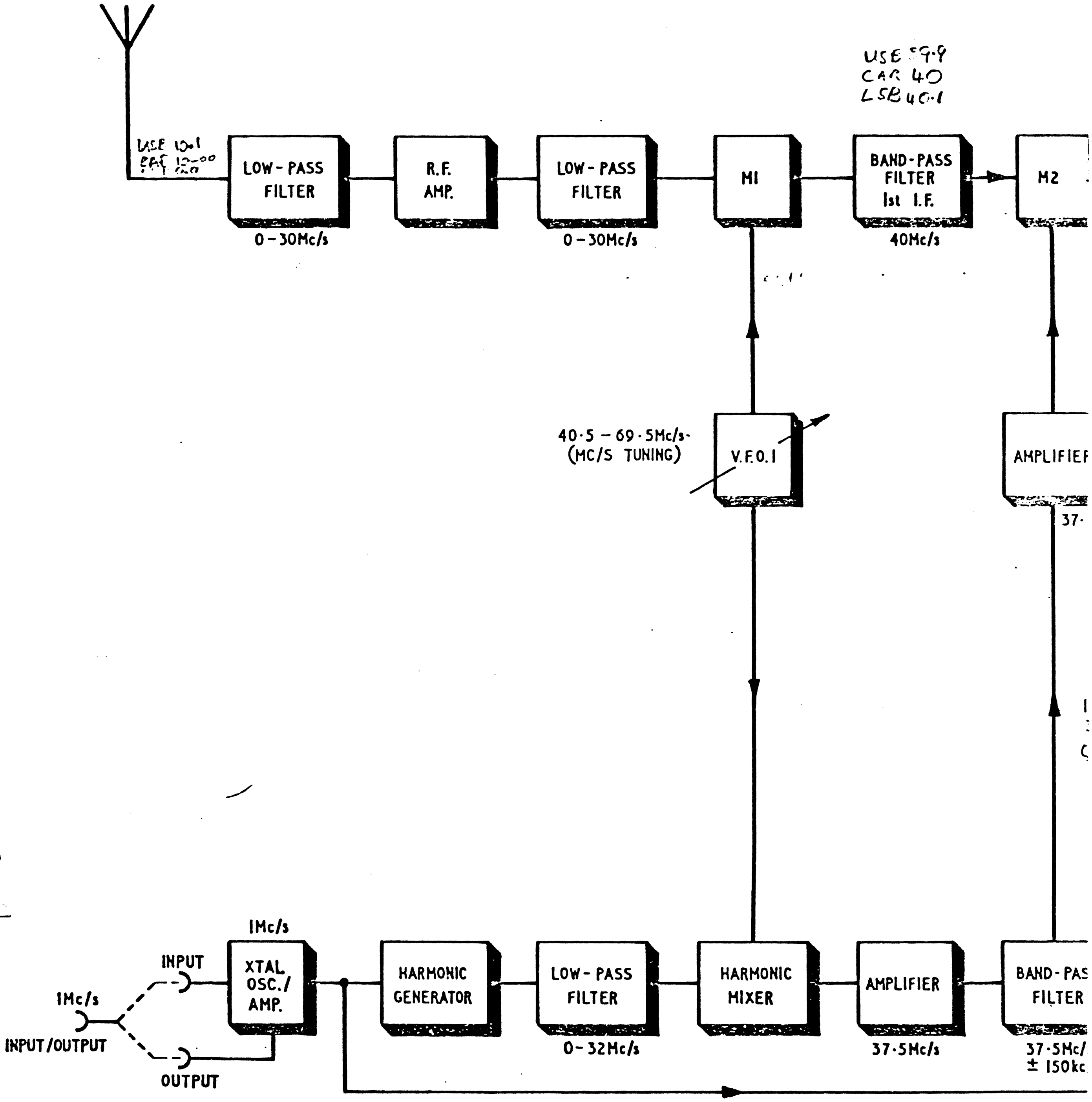

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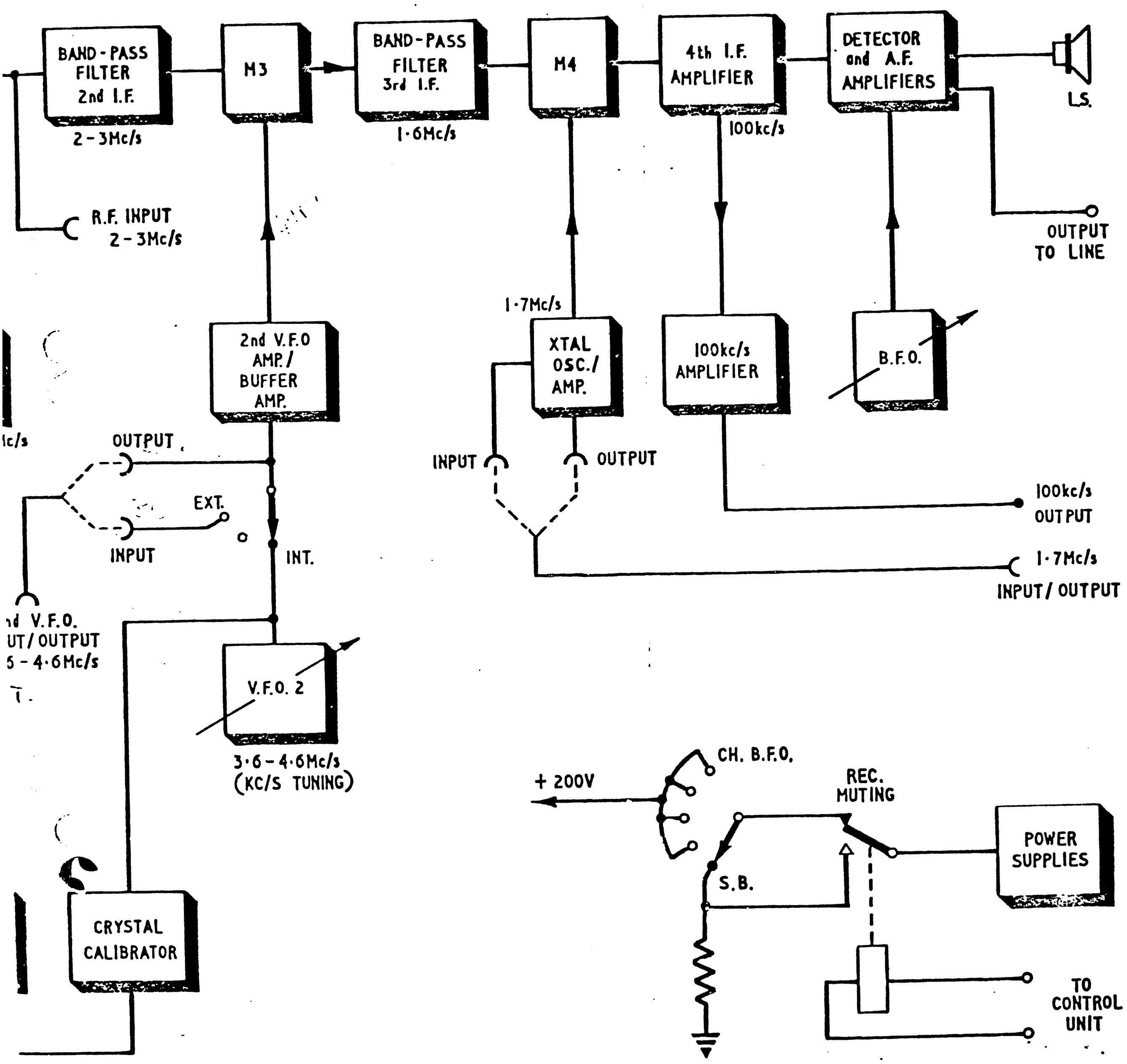

BAND-PASS FILTER 2nd I.F.
2-3Mc/s
M3
BAND-PASS FILTER 3rd I.F.
1·6Mc/s
M4
4th I.F. AMPLIFIER
100kc/s
DETECTOR and A.F. AMPLIFIERS
L.S.
OUTPUT TO LINE
R.F. INPUT 2-3Mc/s
1·7Mc/s
2nd V.F.O AMP./ BUFFER AMP.
XTAL OSC./ AMP.
100kc/s AMPLIFIER
B.F.O.
OUTPUT
INPUT
EXT.
INT.
INPUT
OUTPUT
100kc/s OUTPUT
1·7Mc/s INPUT/OUTPUT
V.F.O.
UT/OUTPUT
5-4·6Mc/s
V.F.O. 2
3·6-4·6Mc/s (KC/S TUNING)
CH. B.F.O.
+ 200V
REC. MUTING
S.B.
POWER SUPPLIES
CRYSTAL CALIBRATOR
TO CONTROL UNIT

IAGRAM

Fig. 3

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 40dB. Switch S2 selects wideband 75-ohms or wideband (high impedance) or any one of 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 response over 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 between L15 and L17 required to complete 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 continuously 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 the 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-ohms 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 is changed. The necessary correction may be made by adjusting C77 with the Mc/s dial set to 29 Mc/s. (See Section 2, Chapter 5, para. 33.).

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

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 ±6[illegible] kc/s, ensures that only the required 1 Mc/s spectrum of signals is passed to the second mixer 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" adaptor 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 the filter at the harmonic 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 a grid stopper.

2-stage 37.5 Mc/s amplifier (1)

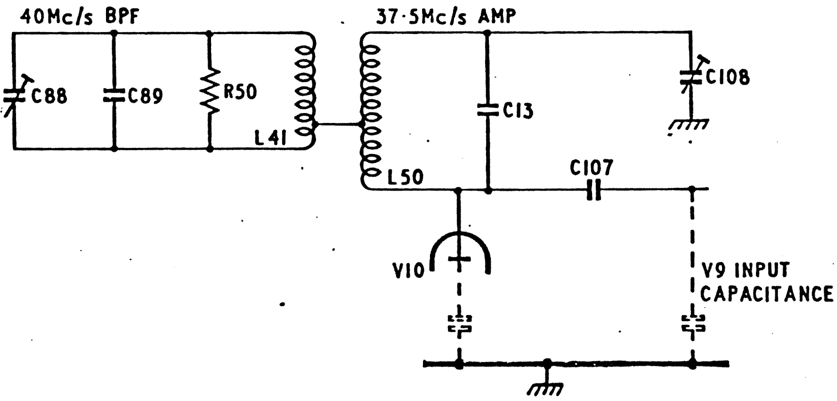
13. The anode load of V6 is a tuned circuit consisting of a fixed capacitor C67 and an inductor L33 which is tuned to 37.5 Mc/s. Frequency adjustment is by the dust iron core in L33. This stage feeds the amplified signal via C68 to the following stage V8. The 37.5 Mc/s signal is then passed to the 37.5 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 C90 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 a simplified form in figure 4.



SIMPLIFIED BALANCING CIRCUIT 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 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. transformers, the first section of the filter is formed by C320, L306, L309 and C[illegible] 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 employing one half of a double-triode V12. The oscillator frequency is determined by an inductance L55, two fixed capacitors C303, C305, a trimming capacitor C306 and a variable capacitor 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 of 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:-

100 c/s)	Crystal	1.2 kc/s)	
300 c/s)		3.0 kc/s)	
		6.5 kc/s)	L-C
		13.0 kc/s)	

25. In the crystal positions the fourth mixer anode is connected to L48 in the crysta 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 kc/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, R87, 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 bandwidths 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.

To maintain the input capacitance of the L-C filter, in the crystal positions, a trimming capacitor C148 is switched into circuit. 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. transformer 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 a tuned circuit consisting of L77, C192 and C191. This circuit is heavily damped by R112. The secondary winding L78 and L79 is tuned by C195A and C195B with R120A as a damping resistor. The output is fed to the diode detector anode.

Diode detector

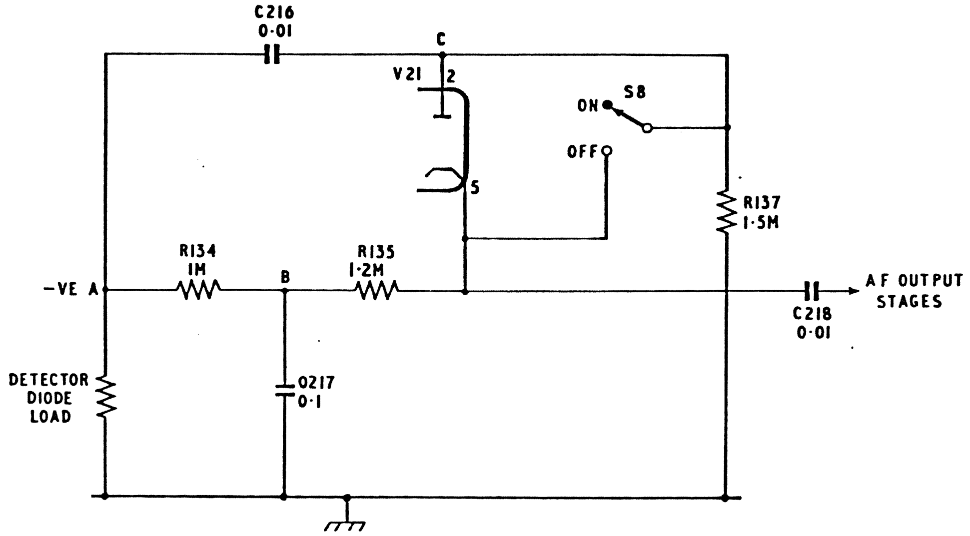
31. The low potential end of L79 is connected through the r.f. filter (C209, R128, C210, R129 and C211) to the diode load R130. With the meter switched to R.F. LEVEL, the meter indicates the detector diode current. The resistor R131 is included to complete the diode detector circuit when the meter is 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 Figure 5.

33. The d.c. path from point A is through R134, R135, the diode and R137. The a.f. signal path from the 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 that 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.



NOISE LIMITER CIRCUIT Fig. 5

A.V.C. and T.C. diode

34. The signal appearing at the anode of V16 is passed through the capacitor C193 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 the 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 A.V.C. switch is in the LONG position the a.v.c. decoupling capacitors C182 and C173 are charged through R127 and the Time Constant diode. 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 the 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. The 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 precisely 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 the 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 second 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 the 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 coupled via 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/ 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 100-125V and 200-250V. To remove mains-borne interference the capacitors C224 and C225 are included. 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 earth 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 the 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. is passed through S5A, S5B and S5C to all stages except the calibrator 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.V.C.

(a) (2) (a) and (2) (b) are applicable.

(b) S5D connects the a.v.c. line to the a.v.c. diode.

(4) CAL

(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 strength; a 1 µV signal provides a typical reading of between "S1" and "S3" and ascending "S" points in approximately 4 dB steps. The variation in threshold is dependent upon 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.

SECTION 1

Technical details and Operation

SECTION 2

Maintenance