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The RADIO Constructor

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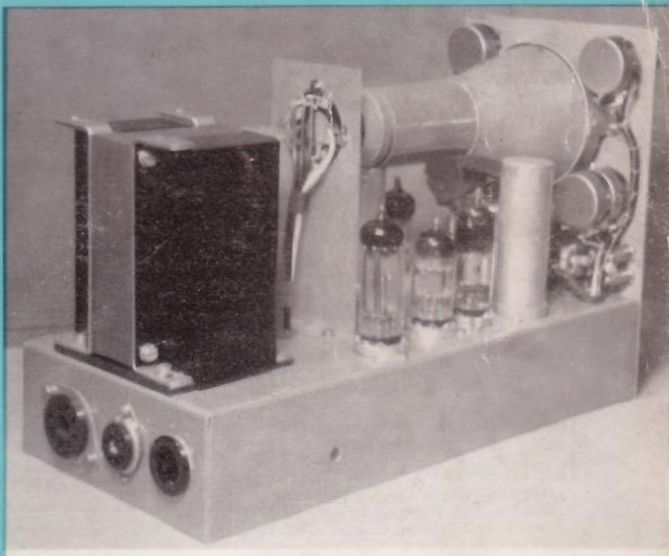

A Constructor's Oscilloscope

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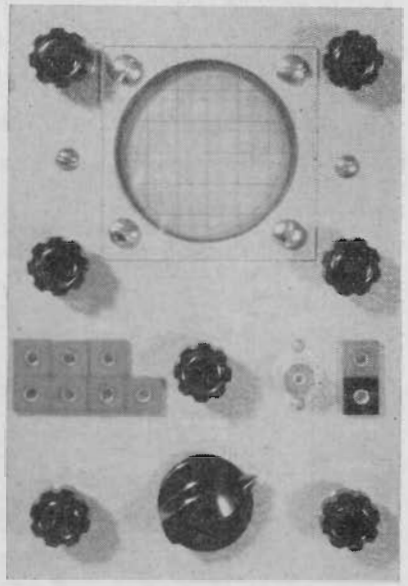
A CONSTRUCTOR'S OSCILLOSCOPE

by **D. NOBLE, G3MAW**
and **D. M. PRATT, G3KEP**



PART 1—*A Construction of the Mullard Design*

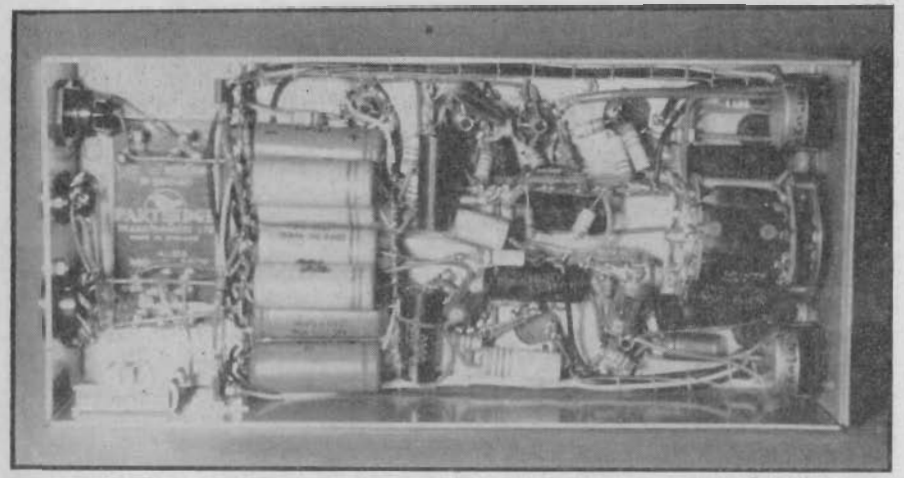
Design Considerations

The oscilloscope to be described in this series of articles* was designed to meet the need for an adequate but not over-elaborate instrument suitable for most radio and television applications. It uses standard components, most of which may be obtained through normal channels. No special e.h.t. transformer is required, as the Mullard DG7-32 cathode ray tube used will operate on a final anode voltage as low as 400 volts.

Details of an attenuator probe and high-gain probe of limited bandwidth for use with the instrument will be given later.

Conventional chassis and wiring methods are used and despite its small size, the oscilloscope is designed to be easily assembled.

* The circuit of the oscilloscope was published in "Circuit for a Simple Oscilloscope", *Mullard Technical Communications*, Volume 4, No. 32, this being based on a report prepared by L. S. Brown of the Mullard Applications Research Laboratory. Further information was given in *Scope for Service*, Mullard Publication No. TP374.



Under-chassis view of the oscilloscope. Note that the mains transformer is fitted with tags and not flying leads

Specification

	Direct Input	Probe x 10	Pre-amplifier
Input resistance	1MΩ	10MΩ	0.5MΩ
Input capacitance	20pF	10pF	10pF
Maximum sensitivity	100mV/cm	1,000mV/cm	1mV/cm
Maximum signal input	30V	300V	3V
Frequency response (to 3dB)	2 c/s to 2.5 Mc/s		5 c/s to 20 kc/s

Circuit Description

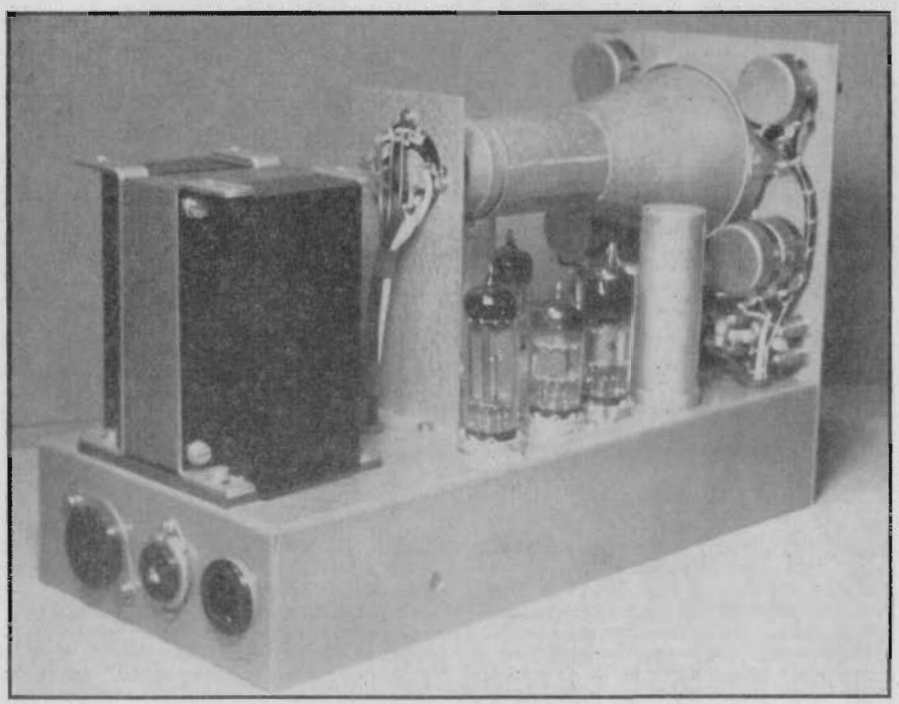
The main circuit diagram for the oscilloscope is given in Fig. 1.

Y Amplifier

A simple high gain circuit is used incorporating two triode-pentodes, V_2, V_3. The circuit comprises a cathode follower, two pentode amplifiers and a phase-splitter giving push-pull output to the tube deflector plates. The gain control (RV_{21}) is provided after the cathode follower, from which point is taken the connection to the internal sync socket also. The two pentode sections provide a gain of about 60 times, some frequency correction being given by the cathode decoupling condensers, C_8, C_{10}, which are effective only at high frequencies. The frequency response of the amplifier to 3dB is 2 c/s to 2.5 Mc/s.

Timebase

The timebase oscillator consists of the EF80, V_5, in a Miller-transitron circuit. The associated double-triode, V_4, is used as a sync amplifier and as a phase-inverter. The timebase frequency is dependent upon the time constant of RV_{44}, the fine frequency



Above-chassis view of the completed oscilloscope

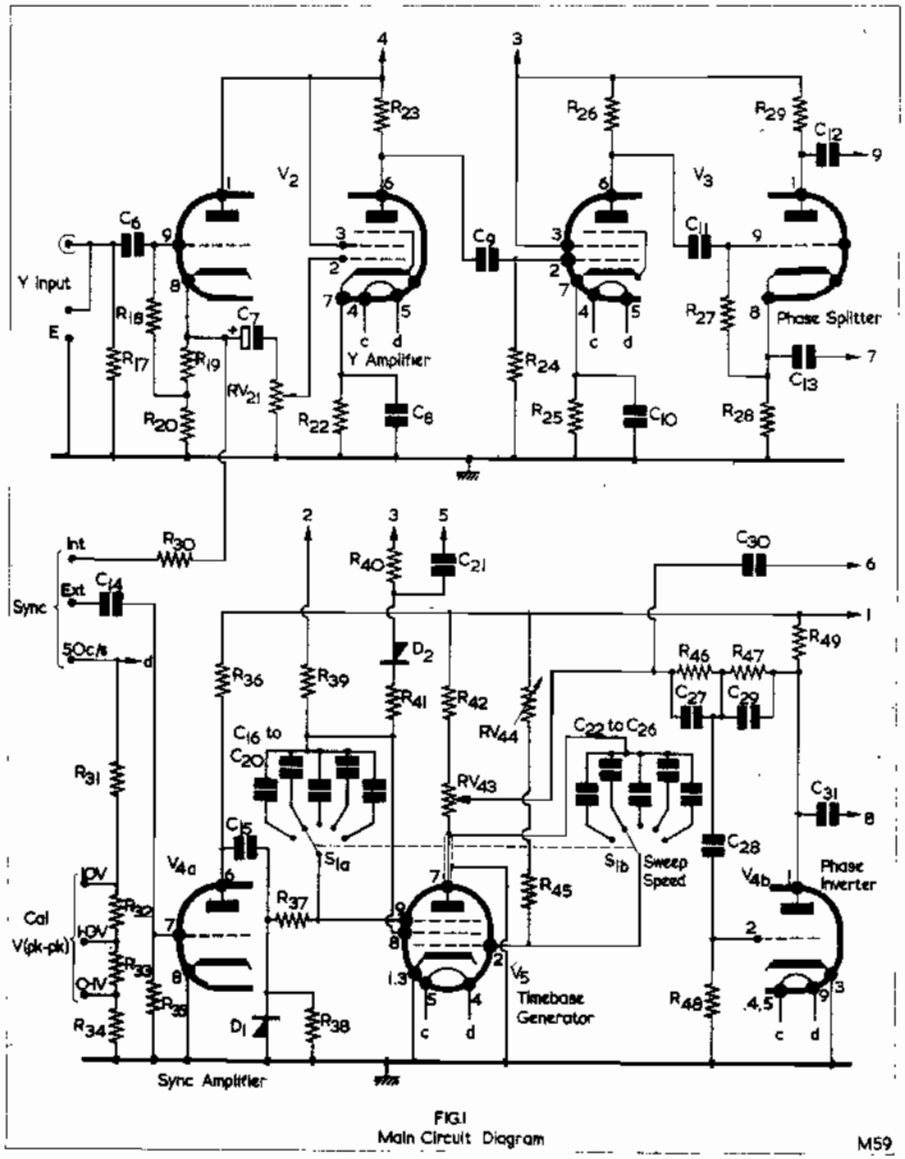


FIG.1
Main Circuit Diagram

control, R_{45}, and a condenser selected by $S_{1(b)}$, the coarse frequency control. The frequency coverage is from 20 c/s to 20 kc/s in five ranges with overlap between ranges.

$S_{1(a)}$ selects a G_2–G_3 coupling condenser of the correct value to give constant drive on each range. The slider of the X-gain control RV_{43} feeds one X deflector plate via C_{30}, while other plate is fed via C_{31} from the anode of the phase-inverter, $V_{4(b)}$, the amplitudes being kept equal by feeding the grid of the phase-inverter from the balancing network comprising R_{46}, R_{47}, C_{27} and C_{29}.

The sweep width is variable from 2cm to 8cm, and blanking of the flyback lines is provided by the flat-topped waveform developed across R_{40} and fed to the c.r.t. grid via C_{21}.

Shift Controls

In the original circuit no shift controls were provided, but they were considered desirable and are shown in Fig. 1. The two potentiometers, RV_{15}, RV_{16}, are double 2MΩ linear components with common spindles, and can be obtained from A.B. Metals Ltd.

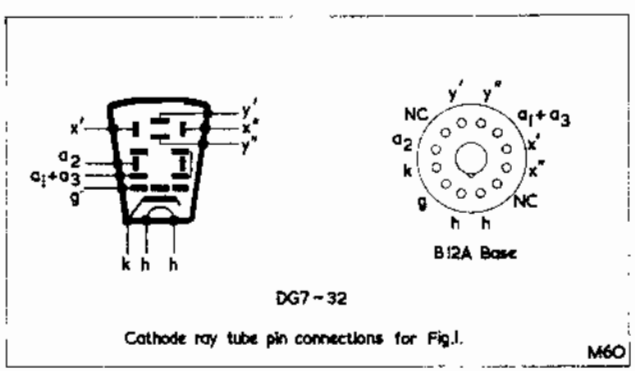
Sync Amplifier

Provision is made for synchronising signals to be fed from an external source via the "Sync Ext." socket on the front panel, or from the input signal, or from 50 c/s by using a shorting link between the appropriate sync sockets.

The diode D_1 provides d.c. restoration of the amplified synchronising signal at the anode of $V_{4(a)}$, which is then fed as a positive-going signal to the suppressor grid of the oscillator valve (V_5).

Calibration

Calibration reference voltages of 0.1, 1 and 10 volts (peak to peak) are obtained from a potential divider network (R_{31}–R_{34}) in the heater supply. A 50 volt reference voltage is also provided from one half of the h.t. secondary winding of the mains transformer T_1 via R_1 and R_2. The waveform of the 50 volts calibration supply tends, however, to be distorted, since the positive peaks are cut off due to the effect of the resistance of the transformer winding and the heavy current drawn by the rectifier at the instant of conduction.



Cathode ray tube pin connections for Fig.1.

Components List

Resistors

R_1 150kΩ 1W
R_2 22kΩ ½W
RV_3 50 kΩ Linear A.B. Metals Type 37
RV_4 100kΩ Linear A.B. Metals Type 37
R_5 270kΩ ½W
R_6 2.2kΩ ½W
R_7 2.2kΩ ½W
R_8 2 x 8.2kΩ 2 x 2W in parallel
R_9 8.2kΩ 2W
R_{10} 100kΩ ½W
R_{11} 3.9MΩ ½W
R_{12} 3.9MΩ ½W
R_{13} 3.9MΩ ½W
R_{14} 3.9MΩ ½W
RV_{15} 2 x 2MΩ 2-gang Linear A.B. Metals Type D37
RV_{16} 2 x 2MΩ 2-gang Linear A.B. Metals Type D37
R_{17} 1.2MΩ ½W
R_{18} 1MΩ ½W
R_{19} 330Ω ½W
R_{20} 10kΩ ½W
RV_{21} 10kΩ Linear A.B. Metals Type 37
R_{22} 220Ω ½W
R_{23} 5.6kΩ ½W
R_{24} 1MΩ ½W
R_{25} 270Ω ½W
R_{26} 5.6kΩ ½W
R_{27} 10MΩ ½W
R_{28} 10kΩ ½W
R_{29} 10kΩ ½W
R_{30} 10kΩ ½W
R_{31} 390Ω ½W
R_{32} 470Ω ½W
R_{33} 47Ω ½W
R_{34} 2 x 10Ω ½W in parallel
R_{35} 1MΩ ½W
R_{36} 82kΩ ½W
R_{37} 100kΩ ½W
R_{38} 10kΩ ½W
R_{39} 27kΩ ½W
R_{40} 10kΩ ½W
R_{41} 10kΩ ½W
R_{42} 4.7kΩ ½W
RV_{43} 25kΩ Linear A.B. Metals Type 37
RV_{44} 2MΩ Linear A.B. Metals Type 37
R_{45} 390kΩ ½W
R_{46} 1MΩ ½W
R_{47} 1.2MΩ ½W
R_{48} 10MΩ ½W
R_{49} 100kΩ ½W

Potentiometers are ±20% tolerance, all other resistors are ±10%.

Condensers

C_1 32μF 350V electrolytic
C_2 16μF 350V electrolytic
C_3 25+25μF 300V electrolytic
C_4 25+25μF 300V electrolytic
C_5 16μF 350V electrolytic
C_6 0.1μF 500V paper
C_7 25μF 50V electrolytic
C_8 220pF 350V ceramic
C_9 0.1μF 500V paper
C_{10} 220pF 350V ceramic
C_{11} 0.05μF 350V paper
C_{12} 0.25μF 350V paper
C_{13} 0.25μF 350V paper
C_{14} 1,800pF 350V silver-mica
C_{15} 0.01μF 350V paper
C_{16} 0.05μF 350V paper
C_{17} 0.01μF 350V paper
C_{18} 2,200pF 350V silver-mica
C_{19} 560pF 350V silver-mica
C_{20} 150pF 350V silver-mica
C_{21} 0.1μF 350V paper
C_{22} 0.1μF 350V paper
C_{23} 0.02μF 350V paper
C_{24} 0.005μF 350V paper
C_{25} 1,200pF 350V silver-mica
C_{26} 300pF 350V silver-mica
C_{27} 33pF 350V ceramic
C_{28} 0.05μF 350V paper
C_{29} 33pF 350V ceramic
C_{30} 0.25μF 350V paper
C_{31} 0.25μF 350V paper

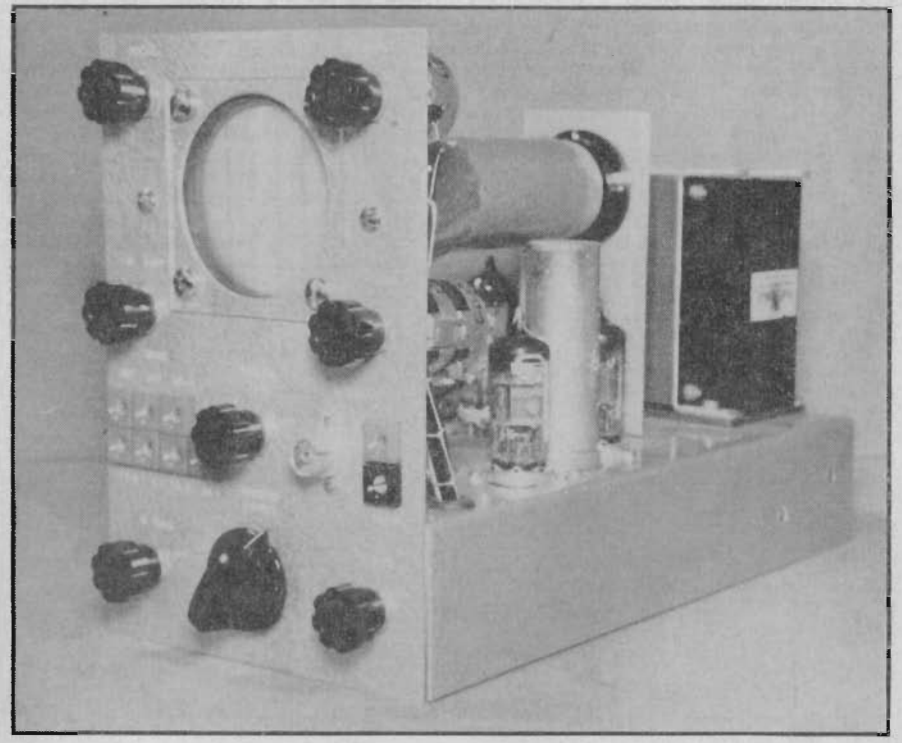
Miscellaneous

CRT Mullard DG7-32 with M.E.A. Mumetal Shield Type ST9B
V_1 EZ80
V_2, V_3 ECF80
V_4 ECC81
V_5 EF80
D_1, D_2 OA81
MR_1 Westalite Contact Cooled Rectifier Type 18RA1-1-16-1
T_1 Partridge Mains Transformer Type H250/40
FS_1 Belling-Lee Fuse Holder Type L575 with 1 amp fuse
$S1_{(a),(b)}$ 2 pole, 5 position rotary switch (see note below)
6 B9A valve bases (McMurdo Type BM9/U)
1 B12A tube base (McMurdo Type X12/E)
1 Mains input plug and socket assembly (Bulgin Type P360)
2 3-way tagstrips (Bulgin Type T19)
2 5-way tagstrips (Bulgin Type T20)
1 7-way tagstrip (Bulgin Type T23)
2 7-way tagstrips (Bulgin Type T24)
8 4mm sockets (red) (Belling-Lee Type L1318/Red)
1 4mm socket (black) (Belling-Lee Type L1318/Black)
Plugs to fit (Belling-Lee Type L378/4)
1 Coaxial input socket (Belling-Lee Type L604/S/Cd)
7 Bulgin midget fluted Instrument knobs Type K111
1 Pointer knob (Bulgin Type K370)
C.R.T. mask (Standard Insulator Co. Ltd. Type S.I.C.5882
Panel Signs Set No. 3 (Data Publications Ltd.)
4 2BA hank bushes
4 2BA chrome screws
2 4BA chrome screws
Chassis, front panel and tube mounting brackets (see note below)
Graticule and filter (see note below)
Grommets, nuts bolts, etc.

Note: Details of $S1_{(a),(b)}$, the chassis metalwork and brackets, and the graticule and filter are given in Part 2 of this series. The filter, which is optional, employs 0.01 in green gelatine manufactured by Strand Electric Co. Ltd.

Names and Addresses of Suppliers

Mullard Ltd., Mullard House, Torrington Place, London, W.C.1.
Magnetic and Electrical Alloys Ltd., Mercury House, Theobald's Road, London, W.C.1.
The Standard Insulator Co. Ltd., Standard Works, Bridge Road, Camberley, Surrey.
Partridge Transformers Ltd., Roebuck Road, Chessington, Surrey.
A.B. Metal Products Ltd., Walkden House, Melton Street, Euston Square, London, N.W.1.
Strand Electric and Engineering Co. Ltd., 29 King Street, London, W.C.2.
A. F. Bulgin and Co. Ltd., Bye Pass Road, Barking, Essex.
The McMurdo Instrument Co. Ltd., Victoria Works, Ashtead, Surrey.
National Switch Factory Ltd., Keighley, Yorkshire.
Data Publications Ltd., 57 Maida Vale, London, W.9.



Three-quarter view of the chassis and front panel

Power Supply

A single Partridge type H250/40 mains transformer (T_1) is used. It supplies 250–0–250 volts at 40mA for h.t., 6.3 volts at 2A for all the valves, and a separate winding for 6.3 volts at 1A for the tube heater. In the Mullard publication, *Scope for Service*, a transformer with flying leads is specified; but as this is only available to special order, provision has been made on the chassis for fitting the equivalent type with tagboard connections, as can be seen in the accompanying photographs.

The EZ80 full-wave rectifier V_1 supplies an h.t. voltage of just over 300 which feeds the final anode of the c.r.t. and the valves. A negative voltage of approximately the same value is provided by the metal rectifier MR_1, and this is supplied to the tube cathode, giving a total available tube voltage of about 600 volts. The rectifier used is of the contact cooled variety, but any alternative type capable of carrying a few milliamperes at the required voltage may be used providing the appropriate alterations are made to the chassis construction.

It should be mentioned that in place of the octal socket which can be seen at the rear of the instrument (see illustrations) the chassis drawing provides for the fitting of a Belling & Lee miniature fuse holder. The chassis is also designed for the electrolytic condensers, C_3 and C_4, to be of the prong fixing types with associated mounting plates, because of their smaller diameter.

(To be continued)

A SIMPLE TRANSISTOR SET WITH REACTION

By S. SMITH

THE FOLLOWING DESIGN REQUIRES, AS THE bulky items, a ferrite slab aerial, a variable condenser, and a potentiometer. Two transistors, four resistors and five condensers then complete the receiver. Of the latter, two condensers are not really vital in all cases: it is difficult to imagine a two-transistor set with fewer components.

A ferrite slab aerial (see the accompanying circuit diagram) provides an r.f. signal, which is coupled from the low impedance tap on L_1 via C_3 to the r.f. transistor (OC45) TR_1. The reaction coil, L_2, in the collector circuit of TR_1 provides positive feedback, the amount of which is controlled by R_3 acting as a short-circuit. Any ferrite aerial with a reaction coil is suitable but, as a rule-of-thumb, the greater the volume of ferrite enclosed by the windings the stronger the induced r.f. signal. Therefore, in the prototype, a rather bulky slab aerial was used. The positive feedback causes detection with reaction, and gives high selectivity together with the maximum amplification of the resultant audio signal of which TR_1 is capable.

TR_1 is biased, via R_1, with the potential built up across R_5 by the emitter current of TR_2. If TR_1 happens to pass extra current there is an extra potential drop across R_2,