# TRANSMITTER —

# For 160 Metres

by F. G. Rayer

**This article describes the circuit of a 160-metre transmitter-receiver and commences to give details of construction. These will be completed in the concluding article, to be published next month, which will also deal with the processes of setting up and operation.**

ALTHOUGH THIS EQUIPMENT WAS BUILT TO GIVE A compact mobile station, it has proved highly satisfactory also at the author's permanent location. It covers 1.8 to 2.0MHz, with 10 watts input, adequately modulated, when transmitting. On reception the receiver section, which has a tuned r.f. stage, gives good sensitivity and freedom from second channel interference. An internal speaker is fitted. It is thus only necessary to provide a power supply, aerial and microphone to obtain a complete Top Band station.

## SWITCHING

In equipment of this nature it is possible to have one or more circuits common to both receiving and transmitting sections. After experiments, however, common stages were not incorporated in the present design, the benefit being that each stage could then be designed for its own particular purpose only, whereupon there is a considerable simplification in switching. Other transceiver techniques, such as using the transmitter p.a. coil for aerial tuning on reception, were also tried but discarded. In this particular case, a separate aerial coil for reception gives a worth-while improvement in rejecting second channel signals.

Instead of switching a single meter to indicate p.a. input when transmitting and signal strength when receiving, a permanently connected meter is used in the transmitting circuits and an EM84 tuning indicator in the receiver section. A result of this circuitry is that the transmitter and receiver sections are virtually separate. This simplifies testing or possible modification later, and means that either the receiver or transmitter could in fact be built alone.

## RECEIVER

The circuit of the receiver section is shown in Fig. 1. S1(a)(b) is a 2-pole 2-way Transmit-Receive switch. S1(a) couples the aerial to C1 on 'Receive', whilst S1(b), applies h.t. via R15. The full h.t. voltage of around 300 volts which is available is not required for the receiver, and it is reduced to about 220 volts by means of R15, R16 and the current drawn by the receiver valves.

L1 and L2 are the aerial and mixer signal frequency coils respectively, and L3 is the oscillator coil. Details of these, and the other coils in the equipment, are given in a Table which will appear in Part 2. Coverage is 1.8 to 2.0MHz with a little to spare, and this allows for easy tuning. VC2–VC3 is a 2-gang capacitor with ball tuning drive. VC1 is a panel aerial trimmer and is peaked for best reception to ensure that changes to the aerial do not cause loss of efficiency. VR1 is the r.f. gain control.

Diode D1 provides detection and a.g.c. bias, the latter being applied to V3 and the tuning indicator, V5. VR2 is the audio gain control, being followed by the double triode, V4, which functions as a 2-stage a.f. amplifier. The circuit has some simplifications, but it easily gives adequate speaker volume. H.T. drain is about 35mA.

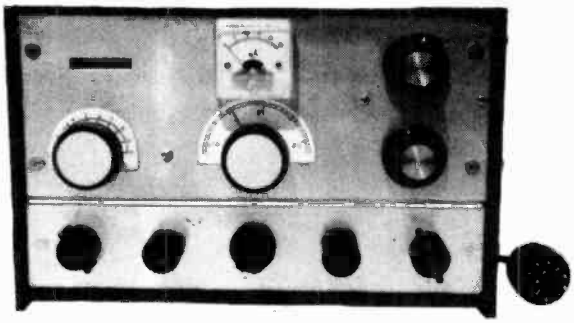
S2(a) is part of a 2-pole 2-way switch. Its other section (shown in Fig. 2) applies h.t. to the transmitter v.f.o. and buffer amplifier when 'Net' is selected. When S2(a) is at 'Net' it inserts R7 in the cathode circuit of V3, thereby reducing the gain of this valve and ensuring that the output of the v.f.o. does not swamp the a.g.c. circuit. As a result, the tuning indicator, V5, may be used as an aid to tuning the receiver and transmitter to the same frequency, either to commence calling on a chosen frequency or to reply to a transmission whose frequency has been located by the receiver.

# RECEIVER

Cover Feature - 2

Part 1

Assoc.I.E.R.E., G30GR



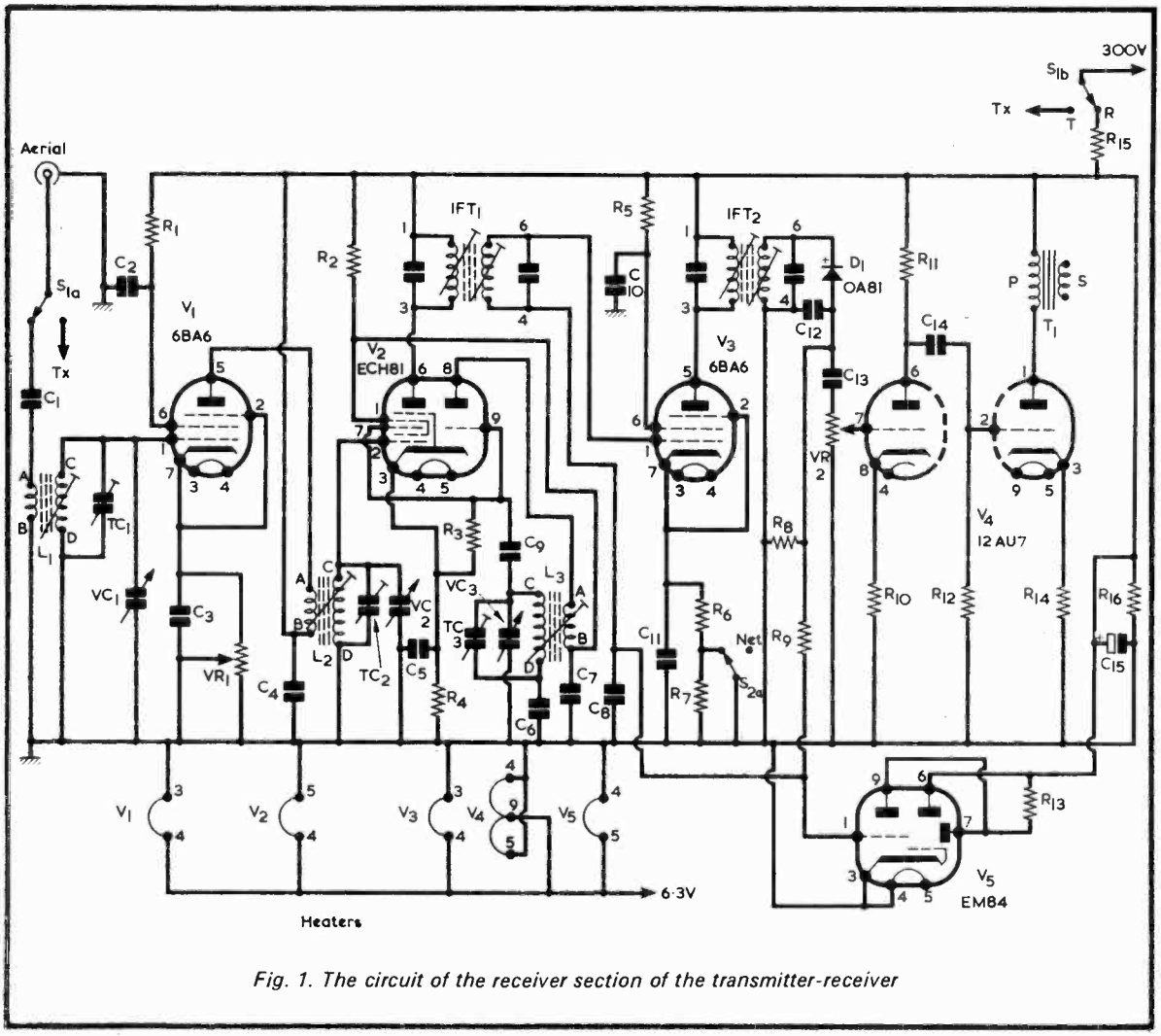



*Fig. 1. The circuit of the receiver section of the transmitter-receiver*

## COMPONENTS — *Receiver Section*

*Resistors*
(All fixed values 10%)

| | |
|---|---|
| R1 | 47kΩ 1 watt |
| R2 | 22kΩ 1 watt |
| R3 | 47kΩ ½ watt |
| R4 | 220Ω ½ watt |
| R5 | 47kΩ 1 watt |
| R6 | 82Ω ½ watt |
| R7 | 220kΩ ½ watt |
| R8 | 270kΩ ½ watt |
| R9 | 2.2MΩ ½ watt |
| R10 | 2.2kΩ ½ watt |
| R11 | 220kΩ ½ watt |
| R12 | 470kΩ ½ watt |
| R13 | 470kΩ ½ watt |
| R14 | 1kΩ ½ watt |
| R15 | 5.6kΩ 5 watt |
| R16 | 22kΩ 3 watt |
| VR1 | 25kΩ 1 watt potentiometer, linear |
| VR2 | 500kΩ potentiometer, log. |

*Capacitors*
(All fixed values 350 V.Wkg.)

| | |
|---|---|
| C1 | 300pF silvered mica |
| C2 | 0.01μF plastic foil or ceramic |
| C3 | 0.01μF plastic foil or ceramic |
| C4 | 0.25μF plastic foil |
| C5 | 0.01μF plastic foil or ceramic |
| C6 | 400pF silvered mica |
| C7 | 0.02μF plastic foil |
| C8 | 0.02μF plastic foil |
| C9 | 45pF silvered mica |
| C10 | 0.01μF plastic foil or ceramic |
| C11 | 0.1μF plastic foil |
| C12 | 300pF silvered mica or ceramic |
| C13 | 0.01μF plastic foil |
| C14 | 0.01μF plastic foil |
| C15 | 8μF electrolytic |
| VC1 | 50pF variable, type C804 (Jackson Bros.) |
| VC2-VC3 | 25+25pF, 2-gang type U101 (Jackson Bros.) |
| TC1 | 30pF or 60pF trimmer |
| TC2 | 30pF or 60pF trimmer |
| TC3 | 30pF or 60pF trimmer |

*Inductors*

| | |
|---|---|
| L1–L3 | See Table (to appear in Part 2) |
| IFT1 | i.f. transformer type IFT11/465 (Denco) |
| IFT2 | i.f. transformer type IFT11/465 (Denco) |
| T1 | Small valve output transformer, ratio around 40:1, Home Radio Cat. No. TO43 or similar |

*Valves*

| | | | |
|---|---|---|---|
| V1 | 6BA6 | V4 | 12AU7 |
| V2 | ECH81 | V5 | EM84 |
| V3 | 6BA6 | | |

*Diode*

| | |
|---|---|
| D1 | OA81 |

*Speaker* 3Ω speaker, 3 or 3½ in.

*Miscellaneous*
2 epicyclic ball drives type 4511/F (Jackson Bros.)
2 B7G valveholders with skirts
3 B9A valveholders with skirts
1 spindle coupler
Speaker fabric

## COMPONENTS — *Transmitter Section*

*Resistors*
(All 10%)

| | |
|---|---|
| R17 | 68kΩ ½ watt |
| R18 | 4.7kΩ 1 watt |
| R19 | 15kΩ 3 watt |
| R20 | 10kΩ 1 watt |
| R21 | 33kΩ 1 watt |
| R22 | 100kΩ ½ watt |
| R23 | 22kΩ 1 watt |
| R24 | 1kΩ ½ watt |
| R25 | 6.8kΩ 1 watt |
| R26 | 1MΩ ½ watt |
| R27 | 220kΩ ½ watt |
| R28 | 470kΩ ½ watt |
| R29 | 100kΩ 1 watt |
| R30 | 3.3kΩ ½ watt |
| R31 | 470kΩ ½ watt |
| R32 | 150Ω 1 watt |

*Capacitors*
(All fixed values 350 V.Wkg unless otherwise stated)

| | |
|---|---|
| C16 | 150pF silvered mica 1% |
| C17 | 680pF silvered mica 1% |
| C18 | 680pF silvered mica 1% |
| C19 | 2,000pF silvered mica |
| C20 | 100pF silvered mica |
| C21 | 0.01μF plastic foil or ceramic |
| C22 | 0.01μF plastic foil or ceramic |
| C23 | 100pF silvered mica |
| C24 | 2,000pF plastic foil 500 V.Wkg |
| C25 | 2,000pF plastic foil 600 V.Wkg |
| C26 | 2,000pF plastic foil 600 V.Wkg |
| C27 | 22pF silvered mica or ceramic |
| C28 | 2,000pF silvered mica or plastic foil |
| C29 | 0.01μF plastic foil |
| C30 | 25μF electrolytic, 25 V.Wkg |
| C31 | 0.01μF plastic foil, 600 V.Wkg |
| VC4 | 100pF variable, type U101 (Jackson Bros.) |
| VC5 | 500pF variable, type E1 (Jackson Bros.) or similar |
| VC6-VC7 | 500+500pF, 2-gang, type L2 (Jackson Bros.) or similar |
| TC4 | 30 or 60pF variable, ceramic or air-spaced |

*Inductors*

| | |
|---|---|
| L4-L7 | See Table (to appear in Part 2) |
| RFC1 | 2.5mH r.f. choke, type CH1 (Repanco) |
| RFC2 | 2.6mH r.f. choke, type RFC5 (Denco) |

*Valves*

| | |
|---|---|
| V6 | 6C4 |
| V7 | 6AM6 |
| V8 | 5763 |
| V9 | 12AX7 |
| V10 | EL84 |
| V11 | OB2 |

*Meter*

| | |
|---|---|
| M1 | 0–100mA moving-coil meter. Henelec 38 series, or similar. (See text) |

*Miscellaneous*
2 B7G valveholders with skirts and cans (for V6, V7)
1 B9A valveholder with skirt and can (for V9)
2 B9A valveholders
1 B7G valveholder

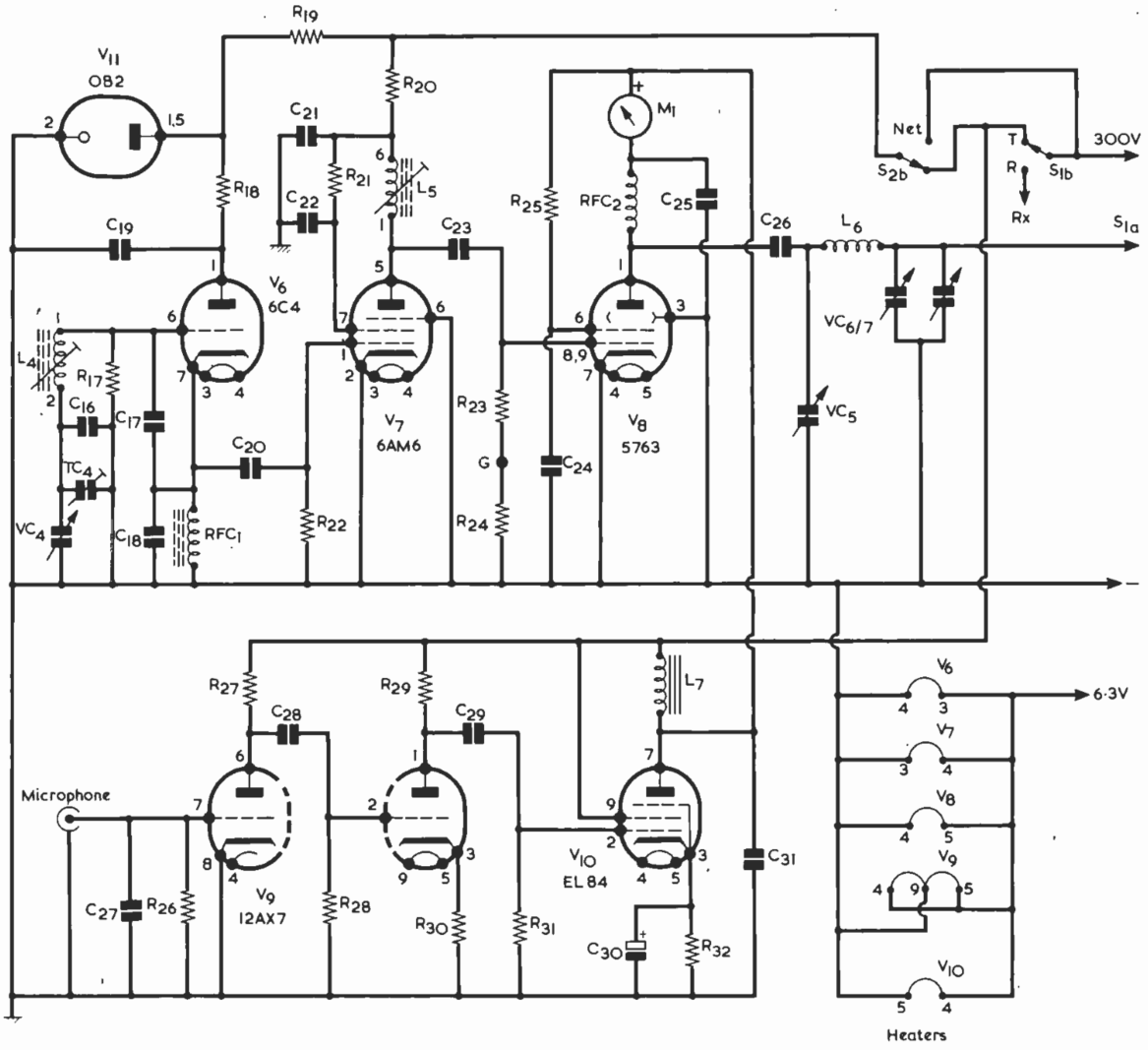



*Fig. 2. The transmitter and modulator section*

## COMPONENTS

*Common Items*

*Switches*

S1(a)(b) 2-pole 2-way rotary
S2(a)(b) 2-pole 2-way rotary

*Miscellaneous*

2-off coaxial sockets
7-off ¾ to 1 in. knobs
2-off 1½ in. knobs
2-off 'Universal Chassis' flanged members 10 by 4 in. Cat. No. CU58A (Home Radio)
2-off flanged members, 10 × 2in., Cat. No. CU139 (Home Radio)
1-off flanged member, 9 × 2 in., Cat. No. CU138 (Home Radio)
1-off flat plate, 10 × 8 in., Cat. No. CU195 (Home Radio)
1-off flat plate, 2½ × 3½ in.
Case sides, top and bottom (see text)
Tagstrips, solder tags, etc.

## TRANSMITTER

The transmitter circuit is shown in Fig. 2. Here, V6 is the v.f.o., and is tuned by VC4. Its h.t. supply is stabilised by V11. The band coverage is adjusted for 1.8 to 2.0MHz, with a little extra at the extreme positions of VC4, by adjusting TC4 and the core of L4.

The particular capacitor specified for VC4 may be difficult to obtain from retail sources. It can, if necessary be purchased direct from its manufacturers, Jackson Brothers (London) Limited, Kingsway, Waddon, Croydon, CR9 4DG.

V7 is a buffer amplifier, L5 being broadly resonant at about 1.9MHz. S2(b) allows h.t. to be applied to V6 and V7 alone when 'Net' is selected. When S1(b) is set to 'Transmit', h.t. is applied to all the transmitter stages.

The power amplifier, V8, is easily capable of offering the full 10 watts allowed on the band. A meter clipped between point 'G' and chassis allows V8 grid current to be checked when initially setting up the circuit. The pi tank network given by VC5, L6 and VC6–7 allows loading of the p.a. stage by the usual aerials, and meter

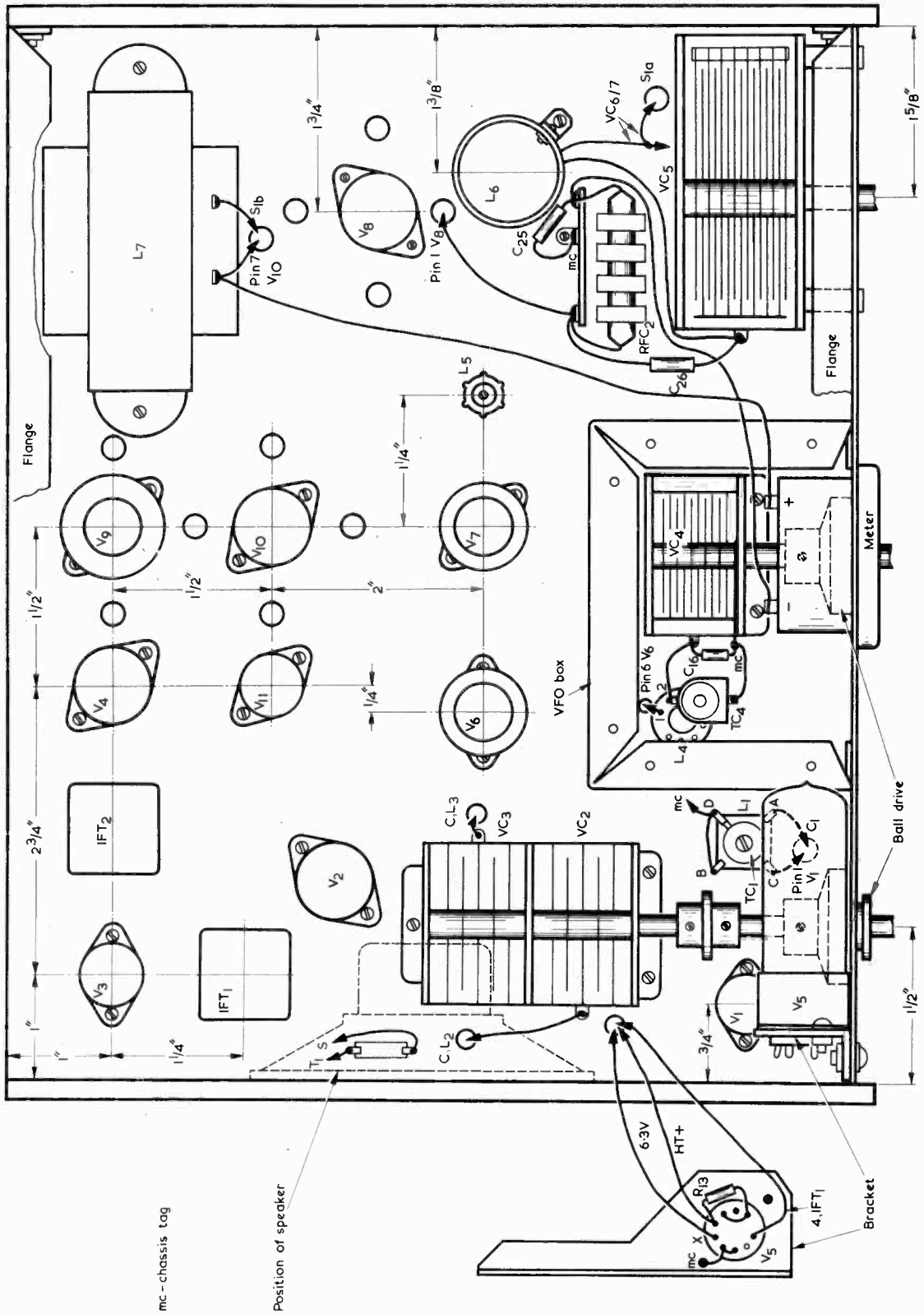



*Fig. 3. Components and wiring above the chassis*

M1 indicates the p.a. anode current.

V9 is a double-triode which provides two stages of a.f. amplification, and is followed by the choke modulator stage incorporating V10. The modulation amplifier given by V9 and V10 is intended for operation with a general purpose crystal microphone, with which it provides adequate gain. The gain can be increased a little by connecting a capacitor of around 50μF at 6 V.Wkg across R30, but this was not found necessary with the prototype.

No general h.t. bypass capacitor is included in the modulation amplifier circuit. This was found to work quite satisfactorily with leads to the power supply about 4 ft. long. If any trouble does arise due to the lack of a bypass capacitor (caused perhaps by a high output impedance in the supply) a 32μF 450 V.Wkg capacitor could be added between the amplifier h.t. positive line and chassis.

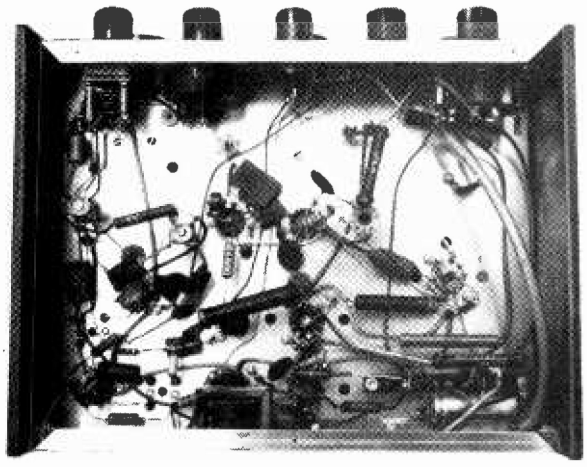
The power output of V10 is about 6 watts and, bearing in mind inevitable circuit losses and the fact that the screen-grid of V8 is modulated in addition to the anode, this output is quite adequate.

The meter employed in the prototype had an f.s.d. of 50mA and proved satisfactory in practice. However, it may be found a little more convenient to use a 0–100mA meter instead, and such a meter is specified in the Components List.

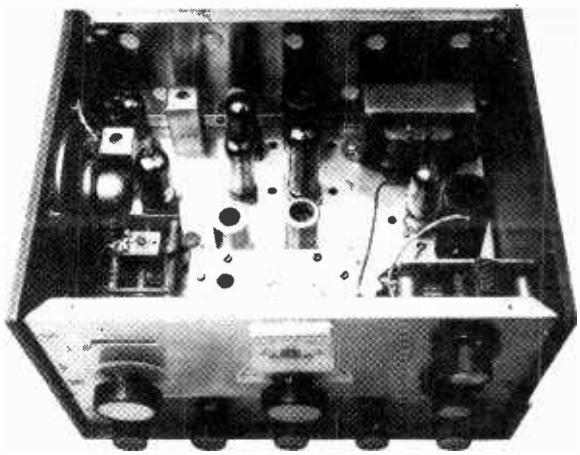
## CASE

An inexpensive, strong and satisfactory case for the transmitter-receiver is made up largely from Home Radio 'Universal Chassis' parts. The front panel consists of a 10 by 4 in. flanged member with a 10 by 2 in. flanged member below it. Similar parts are employed for the rear of the case. The valveholders and other chassis components are mounted on a 10 by 8 in. flat plate. This is sandwiched between the adjacent flanges of the flanged members which make up the front panel and the case rear.

The sides of the case are 3-plywood, varnished in advance, and they measure 8¼ by 6¾ ins. These dimensions allow a projection of about ¼ in. at the front and top, and a projection of about ½ in. at the bottom which assists in providing ventilation. The front and rear panels are secured by bolts passing through the plywood



*Wiring and components below the chassis*



*The components above the chassis.*

and the end flanges of the flanged members. The flanged members are supplied with holes pierced for assembly, and those which appear at the front are filled with 6BA chrome bolts and washers. It should be remembered that a 3 in. diameter cut-out for the speaker is required in the left-hand plywood panel. Its position is best adjudged with the aid of the speaker itself, and it should enable the speaker to be clear of VC2–VC3 when this is mounted.

The two sides could alternatively be made of metal, if desired. The top of the author's transmitter-receiver is plywood to match the sides but, here again, metal could also be employed. The bottom is perforated metal measuring 10 by 8 in., and is fitted to the bottom flanges of the front panel and case rear. Alternatively, a 10 by 8 in. flat plate with ventilation holes could be used. Both the top and the bottom should be mounted so that they can be easily removed for checks and adjustments.

Five holes for controls are required along the centre of the lower flanged member of the front panel. Spacing is as shown in Fig. 4. Holes are required in the lower flanged member of the case rear for the coaxial aerial socket, the microphone input socket and the power lead. The microphone socket is a little to the left of the V9 valveholder, as shown in Fig. 4, and the aerial socket and power lead hole (not shown in the diagram) are to the left of the microphone socket.

The upper flanged member of the front panel requires holes for VC2–VC3, VC4, VC6–VC7 and VC5. Those for VC2–VC3 and VC4 should be 1 in. diameter to take the ball drives and their height is marked out from the capacitors themselves. The remaining two holes for the capacitors are ½ in. diameter. The hole for VC6–VC7 (mounted below VC5) may be marked out with the aid of the capacitor, and that for VC5 is directly above it. These last two capacitors, are mounted by bolts which pass through the front panel, and further details concerning their mounting are given later, when the top of the chassis assembly is discussed.

If it is desired to have the front panel holes for VC2–VC3, VC4 and VC6–VC7 on a horizontal line it may be necessary for the first two capacitors to be mounted on spacing pillars. This should not be done if it results in VC4 fouling the top of the v.f.o box, which is 2 ins. deep. Next to be cut out in the upper flanged member of the front panel are holes for the meter and a rectangular opening, 1⅜ by ¼ in., for the tuning indicator. These may be centred on a horizontal line with the spindle of VC5. Finally, two rows, each of five ½ in. diameter holes, are cut in the upper flanged member of the case

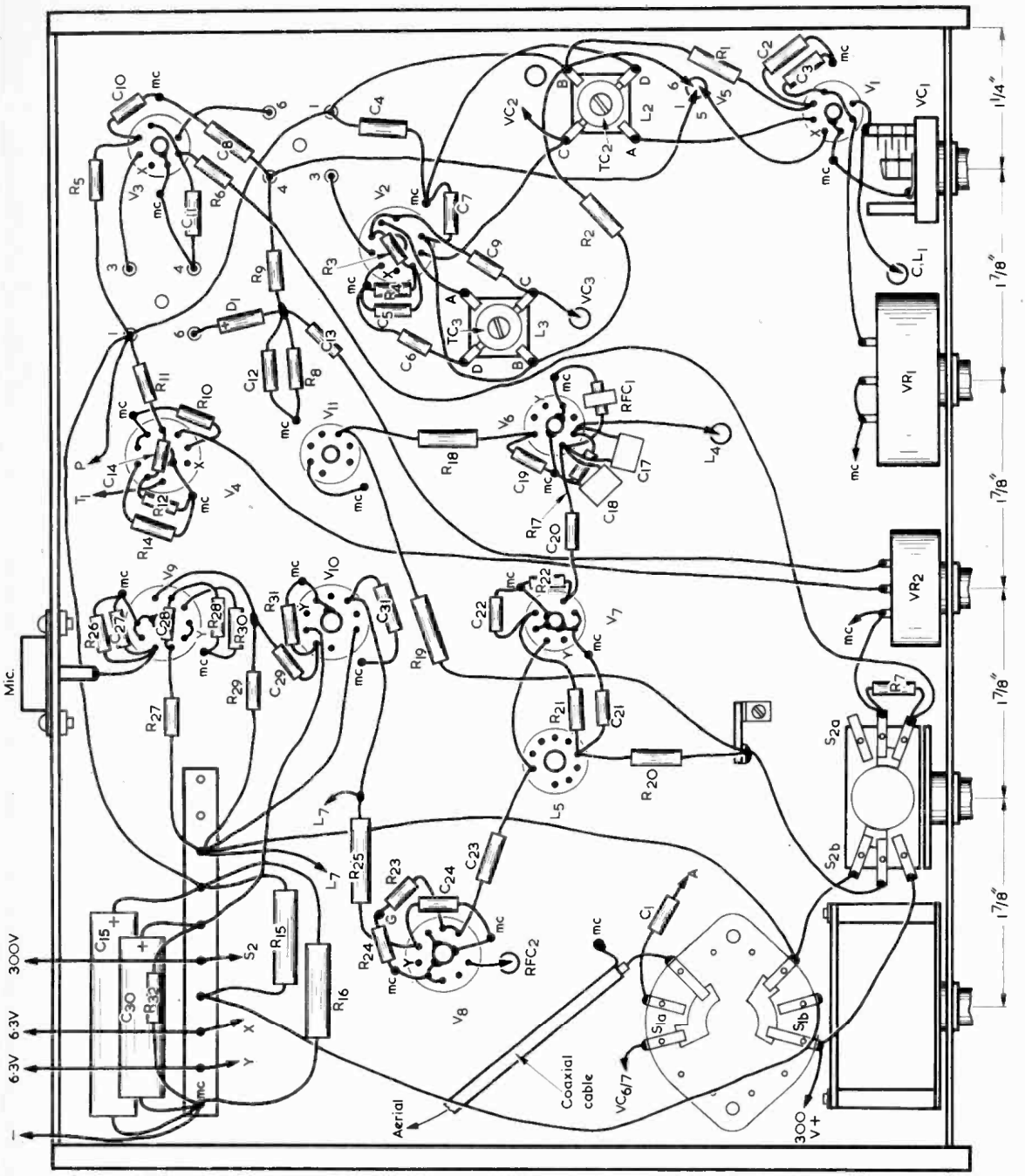



*Fig. 4. Wiring and layout underneath the chassis*

rear for ventilation.

Valveholder holes are next cut in the 10 by 8 in. flat plate. Orient the valveholders to the positions shown in Fig. 4 and use them to mark out their mounting holes. Drill these for 6BA bolts. A few ¼ in. holes are drilled around the holders for V8 and V10 to provide ventilation. Note that some of the valves require skirted valveholders, these being noted in the Components List. V6, V7 and V9 are fitted, also, with screening cans. Drilling should, at this stage, be carried out for the i.f. transformers and other items, as indicated in Figs. 3 and 4. The holes for the i.f. transformer pins should be large enough to ensure adequate clearance. Insulated sleeving may be passed over these pins when the transformers are mounted, to ensure full insulation.

## NEXT MONTH

Details of construction will be continued in the concluding article, which will appear in next month's issue. Some of the parts specified in the Components List will also be discussed further next month, these including, in particular, the coils.

*(To be concluded)*