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KEY BOOKS

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MORE SIMPLE RADIO CIRCUITS

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MORE SIMPLE RADIO CIRCUITS

Edited by

A. T. COLLINS

A NEWNES KEY BOOK

MORE SIMPLE RADIO CIRCUITS

The success of the first book in this series on radio circuits has encouraged me to produce a further selection of circuits for the radio enthusiast covering such interesting apparatus such as amplifiers, power units, transistor receivers, superhets etc.

I am sure the constructor will enjoy building this apparatus as much as he did with the previous book.

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MORE SIMPLE RADIO CIRCUITS

Edited by

A. T. COLLINS

(Managing Editor, Practical Wireless Magazine)

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Two-station Radio and Amplifier

ALTHOUGH using only three valves, one of which is the rectifier, this unit embodies the functions not only of a switch-tuned local-station radio receiver but also of an audio amplifier capable of producing over three watts of power at quite reasonable quality.

At first glance, the circuit may appear to be a little complicated, though it is in fact quite straightforward. Provision is made for the reception of two programmes; in the case of the prototype, these were the Home Service on the medium-wave band, and the Light Programme on the long-wave band. In theory, any two selected stations could be received but it should be pointed out that the selectivity and sensitivity of the circuit is necessarily limited to a certain extent—it is essentially for local stations. Programmes are selected by means of a three-position switch; the third position converts the unit into a two-stage amplifier.

The Radio Circuit

Only one tuned circuit is employed in this design for each channel; therefore the initial alignment of the equipment is greatly simplified. Leaky-grid detection together with a measure of positive feedback ensures a reasonable level of sensitivity. The positive feedback is regulated by adjusting the voltage on the screen-grid of V₁, the cathode of this valve being connected to a tapping on the tuning coil—in this way, a very stable adjustment can be achieved.

The value of the grid-leak resistor R₃ calls for some

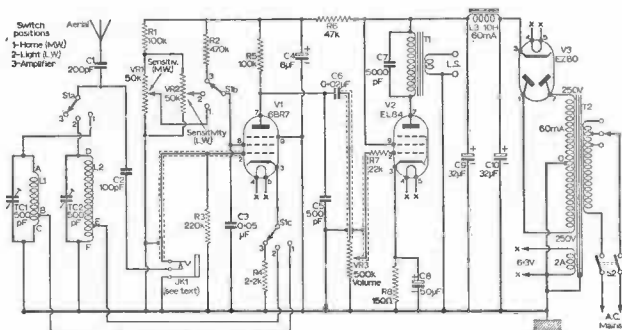


Fig. 1. The circuit of the receiver.

comment. It is usual to find a resistor of several megohms in this position, but, in this design, the component doubles as the grid-leak resistor for the first stage of the audio amplifier, and thus a smaller value of resistance has to be used. It is found that in practice the specified value of 220k Ω is quite suitable.

The operation of the output stage, V₂, is the same on both radio and amplifier functions. The volume control VR₃ is included in its grid circuit. A measure of tone-correction is introduced by the capacitor C₇; this together

COMPONENTS LIST

Resistors:

R1 100k Ω R3 220k Ω R5 100k Ω R7 22k Ω
 R2 470k Ω R4 2.2k Ω R6 47k Ω 1W R8 150 Ω 5W
 A11 10%, ½W unless otherwise stated.
 VR1 50k Ω potentiometer, pre-set, log
 VR2 50k Ω potentiometer, pre-set, log
 VR3 500k Ω potentiometer, mid-gate type with d.p. switch (S2)

Capacitors:

C1 200pF mica C8 50 μ F electrolytic 50V
 C2 100pF mica or ceramic C9 32 μ F electrolytic 350V
 C3 0.05 μ F paper 350V C10 32 μ F electrolytic 350V
 C4 8 μ F electrolytic 350V TC1 500pF compression type trimmer
 C5 500pF ceramic TC2 500pF compression type trimmer
 C6 0.02 μ F paper 1000V
 C7 5000pF paper 350V

Inductors:

L1, L2 (see text and Fig. 5)
 L3 Smoothing choke 10H 60mA

Transformers:

T1 Output transformer 3.5W (see text)
 T2 Mains transformer tapped primary
 Secondaries: 250-0-250V 60mA; 6.3V 2A
 S1 Rotary switch 3-pole, 3-way
 S2 Toggle switch s.p.s.t. (see VR3)
 JK1 Jack-socket, closed-circuit type (Bulgin J12)

Valves:

V1 6BR7 V2 EL84 V3 EZ80

Miscellaneous:

Coaxial socket; three B9A valveholders; screened lead; wire for coils (see text); connecting wire and sleeving.

with the slight degree of negative feedback produced over the first stage (in the "amplifier" position) by the elimination of the usual by-pass capacitor for R₄, leads to a very satisfactory performance.

The Amplifier Circuit

The input to the amplifier is made via a jack-plug and socket. This socket has integral switching contacts whose function can be clearly seen from the circuit diagram (Fig. 1). It should be noticed that in order to convert the unit from a radio receiver to an amplifier, it is necessary to switch the selector-switch S1 to position three, and then to plug in the jack-plug.

The plug must be removed before the unit can again be used as a radio receiver. This slight inconvenience was thought to be justifiable since it avoids complicating further the selector-switch connections.

Power Supplies

The power-pack is quite conventional. The rectifier valve used is an EZ80 having a 6.3V heater. An EZ81 is equally suitable, though if other valves are used, then C10 should be reduced to 16 μ F. The chassis should be earthed.

Construction

The unit is constructed on an aluminium chassis size 7in \times 5in \times 2in deep. The drilling details for this chassis are given in Fig. 2. It would not be practicable to use a chassis of smaller dimensions than the one specified.

The valveholders, transformers and smoothing choke are mounted first together with the three variable resistors, group-board, and the reservoir and smoothing capacitors (C9 and C10). Earth connections are made to an earth busbar which is connected to the chassis at one point only. This busbar is conveniently made of a length of 16 s.w.g. or 18 s.w.g. tinned copper wire, and it is mounted as shown in the wiring diagram (Fig. 3).

Fig. 2. The dimensions and drilling details of the chassis.

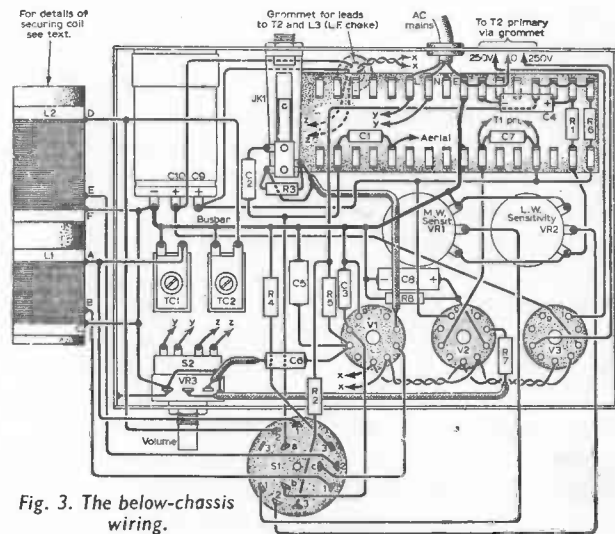
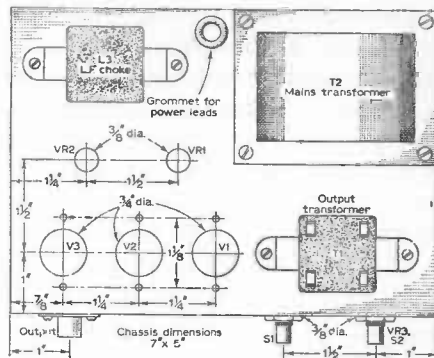


Fig. 3. The below-chassis wiring.

The heater wiring and the wiring to the mains switch S2 should be completed next. This wiring which carries alternating current should be twisted together tightly as shown and pressed hard against the chassis. The power

supply should now be wired, followed by the output stage and last of all the first stage.

Screened lead should be used where it is shown on the circuit diagram and a determined effort should be made to keep all the wiring as short as is practicably possible. This applies particularly to the first stage. This method of construction leads to a less tidy arrangement than might otherwise be possible, but it pays dividends in that less trouble is experienced from instability.

The grid-stopper resistor R7 should be connected as close to its appropriate valve-pin as possible.

Wiring

A suggested wiring plan is given in Fig. 3, and the connections to the jack-sockets are shown in Fig. 4. The metal ferrule on the socket must make good contact with the chassis. The trimmers TC1 and TC2 each have one of their tags soldered to the earth busbar which then serves as a mechanical support for these components.

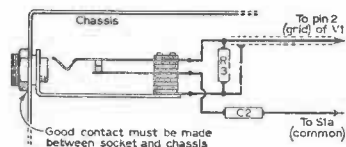


Fig. 4. The connections to the jack-socket, JK1.

Construction of the Tuning Coil

The coils used in the prototype receiver were home-made. Details of their construction are given in Fig. 5. The former used was a length of 1 in outside-diameter paxolin tubing—cardboard tubing or even a tube made from gummed paper would serve equally well. The gauge of the wire is not particularly critical, 34 s.w.g. enamelled copper being

suitable. On completion, the coils should be varnished or waxed.

The coils were fixed to the chassis in the prototype using a clip made from cardboard reinforced with plastic tape. A metal clip is not suitable. Care should be taken to see

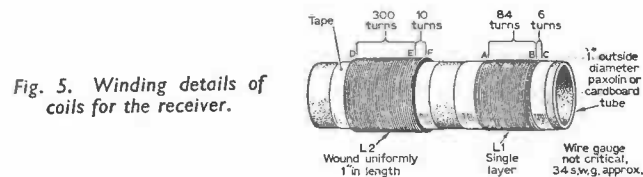


Fig. 5. Winding details of coils for the receiver.

that the coil is not placed hard up against the chassis or other metal components.

Commercially made coils could certainly be used in this circuit, but they would have to be modified in order to incorporate the cathode tapping. This is most easily done by winding a few more turns on to the coil in the same direction as the original winding. The end of the original winding then becomes the cathode tapping. About four to six turns would be required in the case of a medium-wave coil and eight to ten turns for a long-wave coil.

Components

The valves specified are all miniature B9A-based components. Older international-octal types could be used, however. In this case, a 6J7G should be substituted for V1 (the 6J7 and 6BR7 are electrically almost identical), and a 6V6 for the EL84. The output obtainable from the unit would be reduced, however, since the 6V6 has a lower slope than the EL84. If a 6V6 is used, the value of R8 should be increased to 270Ω. A larger chassis will probably be required if octal valves are employed.

Using the EL84 output valve, the output transformer should have a ratio of 40:1 for a 3Ω loudspeaker, or 16:1 for a 15Ω loudspeaker (for a 6V6, the ratios are 50:1 and 23:1 respectively). The transformer should have a power rating of 3.5W and the primary should be rated for at least 40mA d.c.

Alignment and Testing

On completion, the wiring should be carefully checked and an aerial connected to the receiver. An indoor aerial will suffice in areas of good signal strength, though an outdoor arrangement is of course to be preferred.

The selector-switch is then turned to the medium wave-band position and the unit switched on. On rotation of the appropriate feedback control (VR1 in this case) a point should be reached where the set starts to oscillate. The control is turned back until the oscillation just ceases and the trimmer capacitor TC1 is adjusted to tune in the local Home Service broadcasts. VR1 is then re-adjusted for best reception.

The same procedure is repeated for the Light Programme; in this instance, VR2 and TC2 are adjusted. The amplifier circuit requires no initial adjustment.

Transistorised Converter for Short Waves

THIS small transistorised converter can be connected "in front" of any medium-wave superhet to provide coverage of the short-wave bands. The coils used are for an intermediate frequency of 1.6Mc/s and when the main receiver is tuned to that frequency (at the h.f.-end of the m.w. band), the combination forms a "double superhet". In other words, the mixer of the superhet receives the output from the converter and heterodynes it to the normal i.f. of 465kc/s, or whatever it happens to be. It will be seen that due to the double conversion, selectivity is greatly improved.

Although the Denco coils specified are designed for a valve mixer circuit, slight modification in the form of an extra winding on each coil will permit these to be used in this transistor circuit. With care in adjusting, coverage can be obtained from 19m to 50m. The 16m band can also be received, but possibly with some sacrifice of strength on the 20m amateur band.

The coils are designed to plug into B9A valveholders, and other ranges may be tried if desired.

Padders

If other ranges are used, the pins for padders on the mixer coils fit into different numbers. This is because each range has a different value of padder, so by this means the

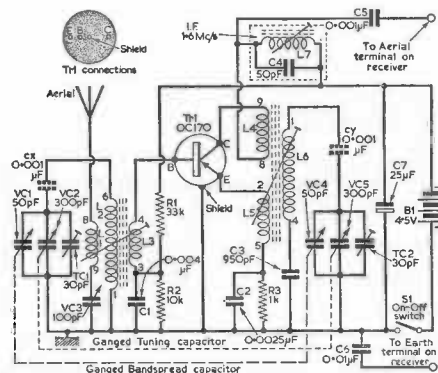


Fig. 1. The circuit of the converter.

correct padder will always be in circuit. In the circuit described here, however, only pin 4 is used.

The circuit (Fig. 1) is a normal transistor mixer TR1 with the output from the collector fed into the secondary winding of an ordinary medium-wave aerial coil acting here as an i.f. coil. This coil is inserted in an empty i.f. can for screening. The output of the converter is taken to the main receiver through a small capacitor C11 and the chassis is connected through C13 to the main chassis, effectively preventing pick-up of medium-wave stations.

Should a powerful m.w. station break through, or make a "carrier-squeak", the main tuning-dial can be moved

slightly to a quiet position. Little difference is caused by this tuning and, in fact, the main tuning-dial can be used as a vernier control for more accurate tuning.

The converter works satisfactorily with a supply of 4.5V and there is no point in using a higher voltage, as this will only increase background noise and transistor hiss.

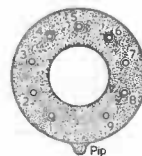
Aerial Coil

A Denco Range 4 (Blue) coil is used here. The existing connections are: primary winding—(8) aerial, (9) earth; secondary winding—(1) earth, (6) grid.

An extra winding is added for the base circuit of TR1, in the following manner. As two additional pins are required in the positions of 3 and 4, straighten out a wire paper-clip, hold it with a pair of pliers in a gas flame, and when the end is just red-hot, push it carefully into the pin-end of the plastic coil-former, having first marked the position.

Do this with the coil-former pin-side up on a piece of metal, so that when the hot wire goes through, it does not

Fig. 2. The arrangement of the pin numbers on the coils.



Looking at open end of coil former
The numbers refer to the novel base numbering of pins
The pip simulates the valve base locating spigot

penetrate too far and damage the existing coil. When the plastic cools, it will contract and grip the wire firmly in position. See that the length of wire protruding on the upper side is just sufficient for the new coil to be soldered to it.

Cut the new pin to the same length as the existing ones. Then wind on one turn of 34 s.w.g. cotton-covered or

enamelled copper wire over the main coil, near the bottom, and in a clockwise direction from pin 4 to pin 3 (looking at the pin-end of the coil). Solder the ends of the new coil to the new pins 3 and 4.

Mixer Coil

The Denco Range 4 (White) is a superhet oscillator coil and the existing connections are: oscillator grid winding, pins 1 and 4; coupling coil, pins 8 and 9.

As with the aerial coil, two extra pins are added to this coil-former, one as pin 2 and the other as pin 5. Then, wind on $2\frac{1}{2}$ turns of 34 s.w.g. wire tightly on the outside (top) of the uppermost (anode) coil, clockwise from pin 5 to pin 2 (looking at the pin-end of the coil). Note that the half-turn corresponds to the distance between the two pins. Pin 2 is the emitter connection, and pin 5 that of the emitter resistor and capacitor.

The layout and wiring of the converter is simple and

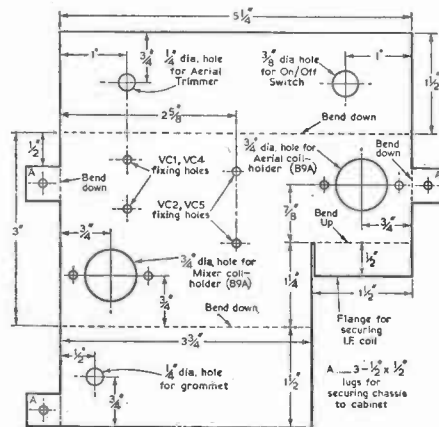


Fig. 3. Dimensions and drilling-details of the chassis.

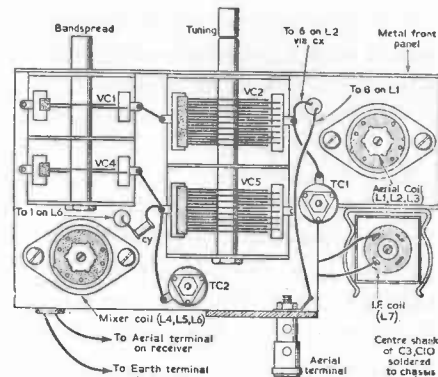


Fig. 4. The layout of the major components.

straightforward, though the usual care in soldering-in the transistor is needed, using long-nosed pliers as a heat-sink (with an elastic band over the handles to close the pliers and leave the hands free). The transistor should be mounted last.

The variable capacitor VC3 is not absolutely essential, but it helps to separate stations on the highest frequencies, and to reduce the volume of powerful signals.

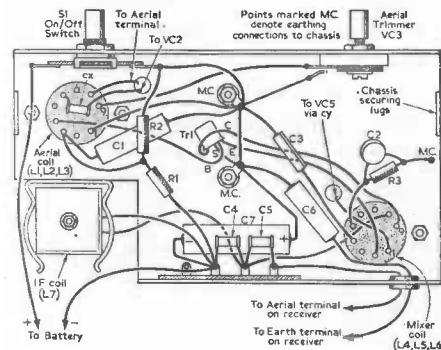


Fig. 5. The below-chassis wiring.

The prototype converter was made on an old chassis from a valved receiver; some constructors may prefer to mount the components on paxolin, but a metal front-panel is essential to avoid hand-capacity effects.

Battery Sets

When used with a battery set, an earth connection to the converter is an advantage, but this connection should be avoided with a mains set as there is a strong risk of damaging the transistor by a.c. flowing from the mains receiver, despite the series-capacitors.

The battery-holder is a piece of paxolin with two small angle-brackets screwed on as contacts. When the battery is inserted, it is kept in place with an elastic band. The negative (long brass contact) is bent right over against the side to avoid incorrect connection. The battery consumption is under 2mA, so the life of the battery is long.

Bandspread

A bandspread, two-gang capacitor is essential. Even with a slow-motion spindle or an epicyclic drive on the main capacitor, tuning is too sharp to do without a bandspread control. If a 300pF twin-gang tuning capacitor is not to hand, a 500pF type may be used provided that a 1000pF

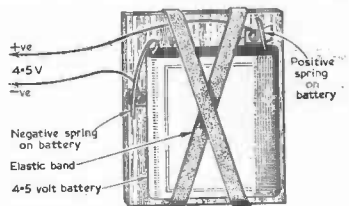
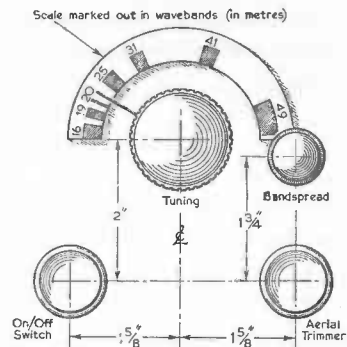


Fig. 6. Mounting the battery.

Fig. 7. The layout of the front panel.



COMPONENTS LIST

Resistors:

R1 33k Ω R2 10k Ω R3 1k Ω
All 20%, $\frac{1}{4}$ W carbon.

Capacitors:

C1 4000pF ceramic or mica VC1, VC4 50pF + 50pF two-gang tuning capacitor
C2 2500pF ceramic or mica VC2, VC5 300pF + 300pF two-gang tuning capacitor
C3 950pF ceramic or mica (750pF + 200pF)
C4 50pF ceramic or mica TC1 30pF concentric trimmer
C5 1000pF ceramic or mica TC2 30pF concentric trimmer
C6 0.01 μ F paper or plastic-foil
C7 25 μ F electrolytic 12V VC3 100pF concentric trimmer

Coils:

L1-3 Aerial coil. Denco range 4 Blue (see text)
L4-6 Mixer coil. Denco range 4 White (see text)
L7 I.F. coil. Weymouth or similar m.w. coil with screening can

Miscellaneous:

Tr1 OC170 B1 4.5V dry battery
S1 Single-pole on/off switch
Two B9A valveholders (non-skirted); aerial terminals; slow-motion drive for VC2, VC5; knobs; tag strips, etc.

fixed capacitor is inserted in series with each section of the gang, as indicated with dotted lines on the circuit diagram, Fig. 1.

Operation

Set the tuning-dial of the main receiver to its lowest wavelength (about 188m). Connect an aerial to the converter, and the output from the converter to the aerial socket of the receiver. Tune in Radio Paris on the 49m band, or some other strong station. Adjust L7 for maximum output—the setting is not critical. The setting of the core of the aerial coil will be found to be correct when it is almost all the way out, while that of the core of the mixer coil is correct when the core is some 7 turns into the coil. The mixer trimmer (TC2) should be set about half-way, and the aerial trimmer (TC1) rather further out. Careful turn-by-turn adjustment of these is needed to keep the transistor oscillating at the h.f. end.

If the emitter coil L5 has been wound correctly, there should be oscillation and therefore stations heard on most of the range of the dial. With patient trimming, the range of the converter can be arranged to extend from the 49m (maximum capacity of the tuning capacitor) to 16m (minimum capacity).

If there should be any tendency to overload the input of the main receiver, the value of C5 should be reduced to about 50pF.

Double-triode Receiver with Power Unit

DESPITE the simple circuitry employed, this pair of matching units can, when used together, provide a remarkably wide range of listening enjoyment. The units are small physically and both are easy to construct. Either unit may be built independently of the other, for some constructors might find Unit "I" of interest, while others might not, and vice versa.

Unit "I" is a simple two-stage receiver constructed originally to provide headphone reception of signals transmitted in the bands from 0.5Mc/s to 15Mc/s (20-560m approximately). Tuning is continuous, due to the use of ready-made plug-in coils.

Unit "II" is a simple power unit and although it is intended primarily for use with Unit "I" it can also be used for other purposes if this does not involve heavy current demands.

The Receiver

Circuit details are given in Fig. 1; V1A operates as a grid-leak detector-cum-audio amplifier, with V1B providing increased a.f. amplification. Signals are conveyed to the tuned circuit inductively from the aerial, a variable trimmer, TC1, being fitted so that best results can be obtained. Band-changing is, as was mentioned earlier, by the "plug-in" method, and coils from the well-known Denco range have been chosen since these conveniently fit a standard Noval valve-holder. The coils are designed to operate in conjunction with a tuning capacitor of 300pF (nominal) value and this fits in with the arrangements used, as will be seen later.

The circled figures associated with L1 in Fig. 1 refer to the coil spills and also coincide with the appropriate pins on the B9A valve-holder into which they are inserted as required.

Considering the circuitry associated with V1A it will be noted that the cathode of this section is connected to a capacitive potentiometer connected across the coil, the "outers" of which are taken to the grid and anode of the valve. Due to C5, the anode is "earthy" and when operating conditions are suitably adjusted, positive feedback results, the r.f. choke L2 assisting the function. Control may be effected by varying the applied potentials and this is done by the potentiometer VR1, which is inserted on the "hot" side of the anode feed-resistor R3. By using VR1 judiciously, V1A may be pushed smoothly to its most sensitive operating point, to the edge of oscillation.

Tuning Capacitance

The effect of capacitively tapping the coil causes its tuning range to be restricted since the maximum external capaci-

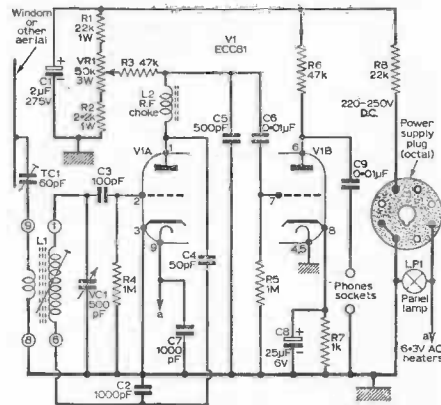


Fig. 1. The circuit of the receiver unit.

tance across it must always be less than the smallest value used, due to the series connection. The problem is resolved here, however, by choosing values of 500pF and 1000pF for VC1 and C2 respectively, thus reducing the overall maximum tuning capacitance to that recommended by the coil maker. Other types of regeneration circuit are possible, of course, but here the primary winding of the coil is left free for aerial-connection purposes.

The operation of V1B is simple enough to warrant no explanation but it will be noted that the parallel-fed headphone outlet provides safety to the user, since d.c. is blocked off. The receiver is not fitted with an on/off switch since this is contained in Unit "11".

Mechanical and Constructional Notes

The smallness of the unit makes it possible to use a simple aluminium "tray" chassis which is secured to a hardboard panel that carries the controls together with a coloured warning lens, reduction-drive mechanism and

COMPONENTS LIST

Receiver

Resistors:

R1 22k Ω 1W	R5 1M Ω
R2 2.2k Ω 1W	R6 47k Ω
R3 47k Ω	R7 1k Ω
R4 1M Ω	R8 22k Ω

(All $\frac{1}{2}$ W, except where otherwise indicated)
 VR1 50k Ω potentiometer, wire-wound 3W

Capacitors:

C1 2 μ F 300V electrolytic	C7 1000pF ceramic or mica
C2 1000pF ceramic or mica	C8 25 μ F 6V electrolytic
C3 100pF ceramic or mica	C9 0.01 μ F ceramic or paper
C4 50pF ceramic or mica	VCI 500pF variable
C5 500pF ceramic or mica	TC1 60pF trimmer
C6 0.01 μ F ceramic or paper	

Miscellaneous:

- L1 Miniature coils (Denco, yellow)
 Range 2: 0.5–1.5Mc/s (580–194 metres)
 3: 1.6–5.3Mc/s (180–57 metres)
 4: 5.0–15Mc/s (60–20 metres)
- L2 R.F. choke (see text) VI ECC81
 PL1 Octal plug (see text) PLI Lamp 6–8V 0.04A
 Headphone sockets (Radiospares); two noval (B9A) valve-holders; tag strip; two spire clips; lamp holder and lens.
 Chassis 5in \times 2in \times $\frac{1}{2}$ in.

headphone sockets. Details of the chassis and the panel are given in Figs. 2 and 3 respectively and are self-explanatory, although the actual panel should be cut $\frac{1}{4}$ in. smaller than the horizontal dimension given and $\frac{1}{8}$ in. shorter than the vertical dimension because the $\frac{3}{8}$ in. quadrant which is glued as a frame to the panel edges is allowed to overlap to form a rabbet for the side and top members of the cabinet; the quadrant should be mitred at the corners, of course, and the bottom section routed out to receive the headphone sockets. Metal cooking-foil glued to the inside of the panel

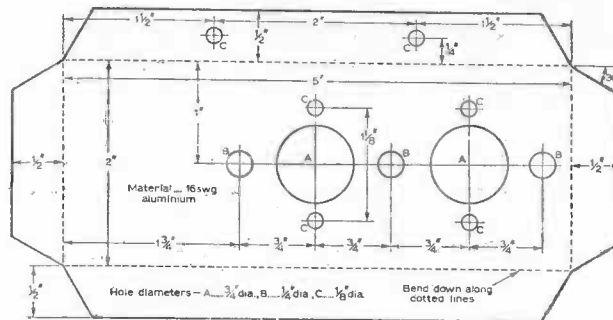
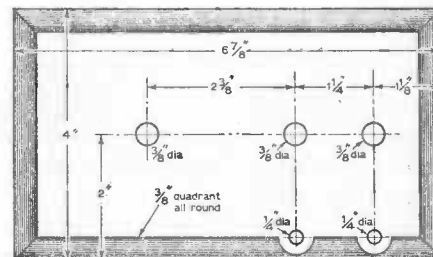


Fig. 2. Drilling details of the chassis for the receiver unit.

and in contact with the chassis prevents unwanted hand-capacity effects from interfering with operation. Although the trimmer TC1 and the aerial socket may be mounted on rear flange of the chassis, these are fixed to the back of the cabinet and fitted with flexible leads.

Diagrams showing the above-chassis and below-chassis layouts and wiring are given in Figs. 4 and 5 and show that modern miniature components are fitted to prevent congestion. L2 is also small and mounted with the connections close to the chassis.

Fig. 3. The front panel of the receiver unit.



Power Cable

It is convenient to obtain the power supplies via a three-core cable terminated with a standard octal plug to fit a socket provided for it on Unit "II" (to be described later) and the idea is shown in Fig. 4, where it can be seen that the receiver-end of the cable is connected to a tag-strip to which the various feeds are connected. A suitable plug can

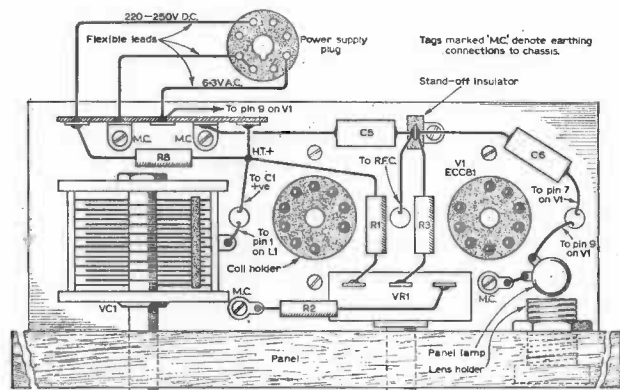
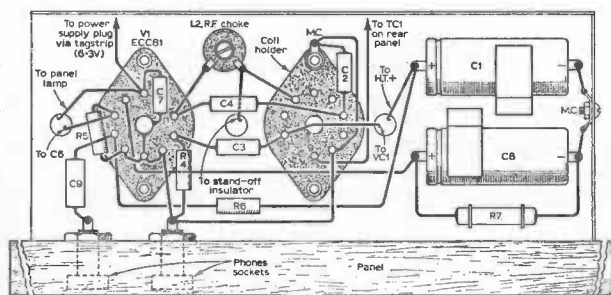


Fig. 4. The above-chassis layout and wiring of the receiver unit.

Fig. 5. The below-chassis layout and wiring of the receiver unit.



be obtained by placing an unwanted octal-based valve in a strong paper bag and tapping it smartly with a hammer to break the glass.

The orientation of the valveholders permits short wiring and a spare tag on the coil-holder is utilised as an anchor for the choke L2, this item consisting—since it needs to be physically small—of a miniature dust-cored long waveband coil sawn off to the length of the core and the primary winding removed.

The power unit (Unit "II") is very simple—see Fig. 6—

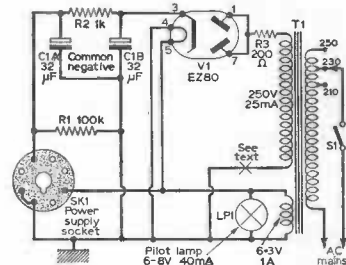


Fig. 6. The circuit of the power unit.

a small mains isolating-transformer of the type used for pre-amplifiers and the like providing the necessary safety and supplying 6.3V for the valve heaters and panel lamps in addition to a higher voltage which is rectified by V1.

Safety Measures

A warning lens is fitted to the front panel together with the on/off switch, while a fixed resistor, R1, provides a discharge path for C1A and C1B should the external apparatus be removed too soon at any time. If a more rugged unit is desired, V1 may be replaced by a miniature contact-cooled rectifier unit. Also as a safety measure, a

COMPONENTS LIST Power Unit

Resistors:

R1 100Ω ½W R2 1kΩ 1W R3 200Ω ½W

Capacitors:

C1A 32μF electrolytic 350V C1B 32μF electrolytic 350V

Miscellaneous:

T1 Mains transformer, tapped primary, secondaries: 0-250V 25mA; 6.3V 1A; V1 EZ80; S1 toggle on/off switch; LPI lamp 6-8V, 0.04A; tag strip, 3-way; stand-off insulator; lamp holder and lens. One noval (B9A) and one I.O. valveholder (SK1). Chassis 6in × 3in × ½in; spire clip.

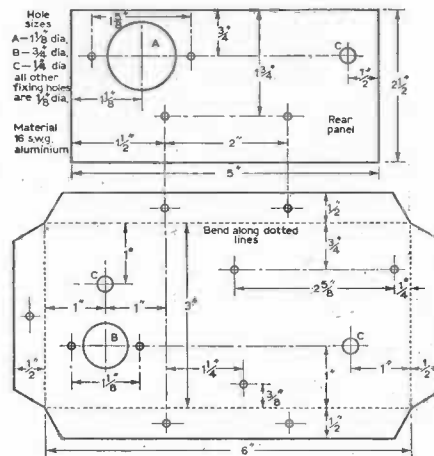
torch bulb may be wired in at point "X" (Fig. 6) to protect the h.t. winding against overload.

The Panel and Chassis

The overall dimensions of the panel are identical with those used for the receiver unit (see Fig. 3) except that the drilling is different, only two holes being needed—for the lens and the switch. The chassis is slightly larger, however (see Fig. 7), and the outlet socket SK1, which is a standard international-octal valveholder, is located on a small sub-panel fixed to the rear flange. The above-chassis and below-chassis plans are shown in Figs. 8 and 9 and it will be noted that leads are anchored to a tag-strip, since spare tags on the valveholder must not be used for this purpose.

Various types of mains transformer exist which are suitable for use here and therefore some slight wiring variations are likely with respect to this item. Rigid wiring is essential and the whole must be thoroughly tested for faults prior to bringing it into use.

Fig. 7. The drilling-details and dimensions of the power-pack chassis and the rear-panel.



Testing

Provided no wiring or other faults exist the two units may be interconnected, headphones plugged in, and an aerial connected (a "Windom" type being suitable). A coil from the range shown in the Components List of the receiver unit is then inserted in the socket provided.

Care should be taken to ensure that the locating lug on the coil-base coincides with the spare or blank pin position on the valveholder (see Fig. 1). The mains plug may then be inserted in its socket, VCI rotated to minimum and S1 closed, when the two warning lenses should become illuminated.

It is then a relatively simple matter to tune in various transmissions by carefully manipulating the two controls, taking care not to advance VCI too far accidentally and so cause oscillation. If transmissions tend to "spread", TCI should be unscrewed to reduce the aerial coupling. It will also be found that coverage can be varied slightly by adjust-

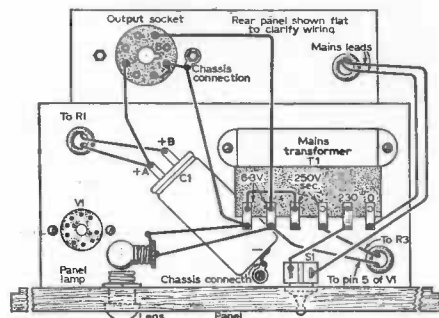


Fig. 8. The above-chassis layout of the power unit.

ing the coil-core, which should be locked by means of a 6B.A. nut when the optimum setting has been found.

If loudspeaker results are required, it is a simple matter to feed the output into a small audio amplifier.

Simple Cabinets for the Units

Suitable cabinets may be constructed from plywood or even hardboard and the external dimensions are shown in Fig. 10. Both cabinets are identical in size but a hinged lid is fitted to Unit "I" to permit coil-changing, thus ensuring safety. It might be found more convenient to use a larger aperture here or even to arrange for the whole top to lift

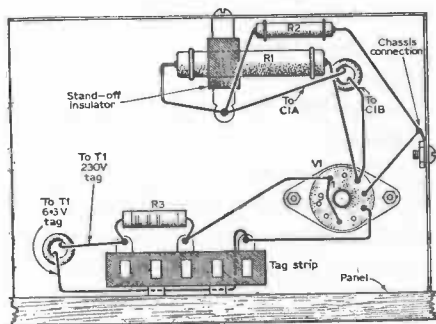


Fig. 9. The below-chassis wiring of the power unit.

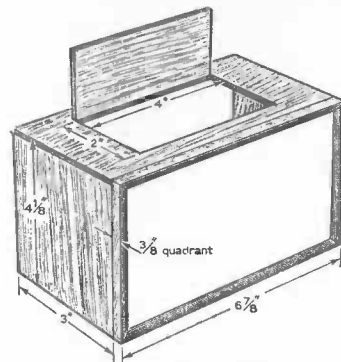


Fig. 10. Details of a cabinet suitable for both the power unit and the receiver unit. The hinged lid is needed only for the receiver unit (to facilitate coil-changing).

up; furthermore, if difficulty is experienced in exchanging coils, it is possible to extend either the brass stem of each coil or fit an extension to the coil-former via the polystyrene locking nut.

The cabinets are easily held together with panel-pins and glue and may be finished to suit individual taste.

Beginner's Three-transistor Reflex

THIS is a pocket-size, three-transistor, reflexed m.w. receiver whose sensitivity should be good enough for local-station reception in most areas. A long wave-band may be added later. A simplified version is also possible, if the third stage is omitted.

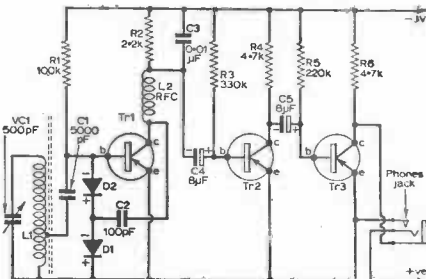
There is nothing particularly novel about the circuit, which is shown in Fig. 1, but the practical methods used in construction may be of interest and offer some new ideas to constructors.

The unit is laid out on a wooden baseboard and pressure-contacts may be used for all but about five of the twenty or so junction-points. Alternatively, solder-tags may be used instead of brass washers for the various points on the board and all components soldered into position to make a more permanent job of the receiver.

Those readers who are still not too sure of their skill with a soldering iron may care to make the receiver in the

first way to gain confidence, and then substitute soldered joints at a later stage.

Fig. 1. The complete circuit of the receiver.



Chassis

The chassis consists of a piece of good quality soft-wood such as deal, and the dimensions are such that it fits into a small plastic box. Naturally, if the constructor has a plastic box different in size from the one used in the prototype, the size of the chassis may need altering.

First, the main shape, $4\text{in} \times 2\frac{3}{4}\text{in} \times \frac{1}{2}\text{in}$ (planed) is cut out as shown in Fig. 2. Then, three pieces are removed—at X, Y, and Z. The chassis may then be smoothed where necessary with fine-grade sandpaper and tried out for a neat fit in the bottom of the plastic case. The small box used for the case is of coloured opaque polystyrene and is available from many of the well known retailers of radio components for the home constructor. Its size is about $4\frac{1}{2}\text{in} \times 3\text{in} \times 1\frac{1}{4}\text{in}$ and the manufacturer is the Plastic Box Company, Market Rasen, Lincolnshire.

The fifteen small brass washers (or solder-tags), if needed may now be fitted on to the board with small round-headed brass wood-screws. A suitable size will probably be $\frac{3}{16}\text{in}$. No. 2 gauge (a thicker screw might introduce the risk of

splitting the wood at the edges). If solder-tags are to be fitted, $\frac{1}{4}$ in screws of the same gauge will be quite adequate for the purpose.

The layout of the contact-points is important, as might be guessed, when using so small a baseboard. For this reason, Fig. 2 should be followed carefully.

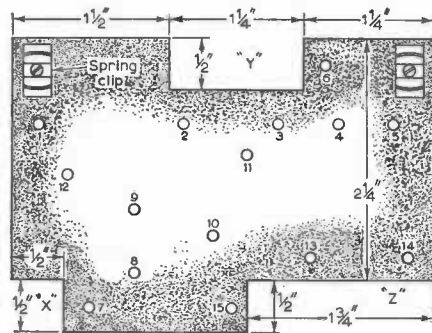


Fig. 2. Details of the wooden "chassis" of the receiver.

The two Terry clips are of the smallest size (gauge 000) and are supplied with their own wood-screws. The clips may be rather a tight fit on some of the thicker types of ferrite rod, but this seems to have no harmful effects.

Fitting the Main Components

All of the components used should be the smallest obtainable as this makes for easy construction. There are a few points which are perhaps not immediately apparent from Fig. 3 (which should be used as the main guide for mounting the smaller components). Firstly, all resistors and capacitors should be mounted flat on the board, the wires being shortened only as much as is necessary to give

a firm but neat-looking contact. Secondly, the wires of the small r.f. choke (L2) should not be shortened but bent to form a double crank so that the choke stands clear of the board, roughly level with the ferrite rod. Thirdly, the electrolytic capacitors and the diodes must be connected the correct way round, the polarity (+ or -) being shown in Fig. 3.

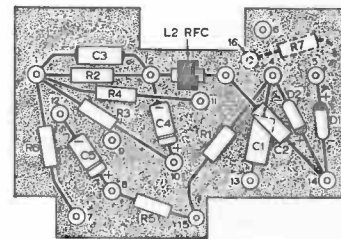


Fig. 3. The layout of the main components.

For guidance, the can of an electrolytic capacitor is always the negative (-) connection, and the wire emerging through an insulating bush is always the positive (+). The red end of the diode indicates the positive connection, and the black, or colourless, end denotes the negative connection.

A short length of p.v.c. sleeving (this may be stripped from a piece of standard connecting wire) should be slipped over the left-hand wire lead of the 100pF capacitor C2 where it passes over the 0.005μF capacitor C1 and the 100kΩ resistor R1, or their leads.

A similar piece of sleeving should be slipped over the right-hand wire lead connecting the 4.7kΩ resistor R4 to the point where it passes over the 8μF electrolytic capacitor C4 (or its lead).

COMPONENTS LIST

Resistors:

R1 100k Ω	R3 330k Ω	R5 220k Ω
R2 2.2k Ω	R4 4.7k Ω	R6 4.7k Ω

Sub-miniature, low wattage ($\frac{1}{10}$ or $\frac{1}{4}$ W),
10% tolerance.

Capacitors:

C1 0.005 μ F	} Any type as small as possible	C4 8 μ F	} Electrolytic, at least 3V working; sub-miniature
C2 100pF		C5 8 μ F	
C3 0.01 μ F			

Semiconductors:

D1, D2	Crystal diodes (OA81)
Tr1	R.F. transistor (SB078; SB305; OC170; OC171; etc.—see text)
Tr2, 3	Audio transistors (OC71)

Miscellaneous:

Crystal earpiece with plug and socket. L2 Miniature r.f. choke, wire-ended. 1mH to 2mH (2mH to 3mH if both wave bands required). VCI 500pF compression-type trimmer (Radiospares). Plastic case (see text). Softwood board 4in \times 2 $\frac{3}{4}$ in \times $\frac{1}{2}$ in. Two U16 cells. Screws, washers, miniature crocodile-clip, wire, etc.

The Three Connecting Wires

There are only three connecting wires on the board itself. These should be of p.v.c.-insulated wire (preferably a small gauge, since this will be more flexible and less bulky). The three wires are connected as follows, passing in as short a path as possible under the components or their leads, directly from:

- Point 1 to Point 15;
- Point 5 to Point 9;
- Point 11 to Point 12.

It is important that these connecting wires should be in close contact with the board and be passed under the components since, in this position, accidental breakage during handling is much less likely to occur. Fig. 4 shows the three connecting wires in position.

Transistors

The preferred transistor for Tr1 is an SB078, or failing that, an SB305. If an OC170 or OC171 is used, it may be necessary to include a resistor (R7) in the emitter lead of Tr1 (the optimum value for this resistor can soon be de-

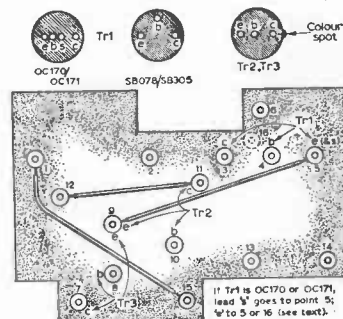


Fig. 4. The positions of the connecting wires, and details of the bases of the transistors.

termined by experiment). The "s" lead of the OC170 or OC171 type of transistor must be connected to point 5. If a resistor is needed in the emitter circuit, the emitter can be wired to a point 16 (near points 3 and 4) and the resistor wired between point 16 and point 5.

The three transistors are connected as shown in Fig. 4. Note that the emitters of both the a.f. transistors share a common junction-point (9). The leads of the transistors should not be shortened, but all of the wires curved gently

over so that the body of each transistor rests against the lid of the case when it is closed.

If at any time the transistor leads are soldered into position, a "heat-shunt" should be used and the connections made as quickly as possible. A pair of long-nosed pliers used to grip the lead being soldered between the body of the transistor and the point of soldering forms an effective heat-shunt. The soldering iron should be earthed.

Earpiece Socket

The crystal earpiece recommended for this receiver is an inexpensive one generally available from stockists of radio components for the amateur constructor. It is normally supplied complete with a miniature jack-plug and socket. If not, the dealer from whom it is bought should be able to supply a suitable plug and socket. However, the socket has to be modified slightly before use.

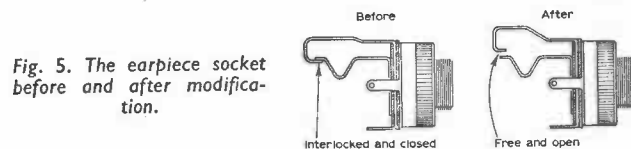
When it is inserted into the socket, the plug makes contact with the tube part of it and with a small springy arm which clicks into a groove towards the end of the stem of the jack-plug. Besides these two essential parts, there is an extra arm which extends rigidly outside and beyond, and finally hooks round the end of the springy arm. When the plug is inserted into the socket, the springy arm moves slightly away from the larger, fixed one, the resulting gap breaking the electrical contact between the two arms.

The crystal earpiece is intended for use with a small loudspeaker radio, and the extra contact on the socket is provided so that the loudspeaker may be automatically switched off when the earpiece is being used for personal listening.

The modification required for this receiver is quite simply performed. The "hook" part of the outer fixed arm

is slightly straightened so it no longer embraces the end of the smaller springy arm. It is then strained upwards away from the springy arm and the hook part then re-bent to its former shape. Fig. 5 should make the whole operation clear.

The outer arm is the only part of the socket which needs to be moved and when correctly adjusted should just fail to touch the springy arm when the jack-plug is absent, but make a good contact when the plug is inserted. The action of the switch in the socket has, in short, been reversed. Although the procedure may sound complicated, it is in



fact a matter of a minute's work with tweezers or sharp-nosed pliers.

The socket is provided with three perforated tags and a 4in length of insulated connecting wire (flexible) should be soldered to each, using the minimum of solder (see Fig. 6c).

Tuning Capacitor

The tuning capacitor is a small, compression-type, solid-dielectric trimmer of about 500pF capacity. The screw of the trimmer must first be removed together with its two washers, one brass, one mica or transparent plastic. The screw and the mica washer are discarded and a longer screw of the same gauge (6 B.A.) substituted, the original brass washer being replaced. The new screw should be about 1in

long. It is important that the transparent washer should not be replaced.

Notice that the capacitor is not symmetrical. One of the brass strips is flat whilst the other has a small "hump" to provide a point of flexion (see Fig. 6b). It is important to distinguish between the two terminals when the capacitor is connected up and the term "humped" will be used to make the difference quite clear.

The two brass connecting tags should be bent double to touch the porcelain base (to save space) and a 4in length of insulated wire soldered to each of them.

This completes the main soldered joints of the receiver.

Aerial Coil

The signal pick-up device is a 4in length of ferrite rod wound with a suitable coil. If the ferrite rod needs to be

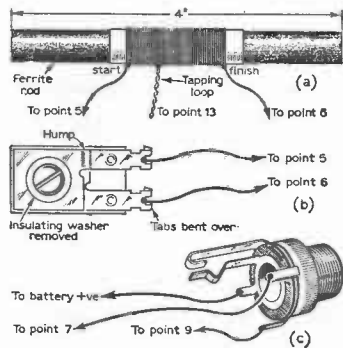


Fig. 6. The connections from (a) the aerial coil; (b) the tuning capacitor; and (c) the earpiece socket.

shortened to give exactly 4in, it is best carried out by filing a fairly deep groove all the way round to form a ring. The rod can then be clamped in a vice between two pieces of

softwood to act as jaws, and, providing that the groove lies exactly at the edge of the wood, a steady pressure on the protruding end will snap it off precisely where desired without risk of failure.

To wind the coil (medium waveband) make a small paper sleeve on the middle of the rod and leaving 6in of wire to form a connecting lead, wind on ten turns of 30 s.w.g. (approximately) enamelled copper wire. Form a loop about 4in long and twist it to make it secure. Carry on winding a further 35 turns in the same direction, leaving a final 6in free at the end (see Fig. 6a).

The first and last turns will have to be anchored in some way, with Durofix, balsa cement, or Sellotape. Note that the winding should form a single layer with each turn touching its neighbour—"pile-winding" is not suitable.

Final Steps

Two holes are required in the plastic case and these may now be drilled. By placing the tuning capacitor on its side and sliding it along the bottom of the case so that the screw touches the rear wall of the case, the correct level for drilling can be found. It will be roughly $\frac{3}{8}$ in from the bottom and midway along the back. A $\frac{3}{16}$ in drill will be required.

The other hole (for the earpiece socket) is in the left wall of the case, towards the front, so that the "works" of the socket occupy a position just above the $\frac{1}{2}$ in \times $\frac{1}{2}$ in missing corner of the base-board. (This piece of wood was cut out, of course, to enable the base-board to be removed from the case without having to take out the socket.) A $\frac{1}{4}$ in hole is needed to accommodate the fixing-bush of the socket.

The chassis can now be lowered into the case and the flying-leads from the socket and tuning capacitor connected to the correct points (see Fig. 6). Note that the "humped"

terminal of the tuning capacitor must be connected to point 5 on the board. The socket and tuning capacitor must be tightly fixed to the plastic case, using the nuts and washers provided.

All that remains to be connected are the three coil-terminations, which may now be fixed. These wires may be shortened a little where necessary and beginners should remember that the ends of enamelled wire need to be scraped or burnished clean before connection can be made.

The ferrite rod assembly may now be fitted into its two clips.

The Tuning Capacitor Knob

A knob of some sort will be needed for the tuning capacitor, of course, and although these can be bought, it is more interesting to seek out an attractively coloured plastic button, bottle cap, or toothpaste-tube cap, which can be drilled with a suitably sized drill to enable it to be fitted to the screw of the capacitor. The knob can be retained in position by clamping it tightly between two 6 B.A. nuts towards the end of the screw.

Note that the tags of the tuning capacitor point away from the earpiece socket—i.e., to the right.

Battery

The receiver uses two 1.5V cells for power, and these are the Ever Ready UI6 type, or the equivalent in another maker's range. They have to be wired in series to give the required 3V. The best plan is to tape the two cells together with Sellotape in such a way that the brass pip on one cell is near the bottom of the zinc case of the other (see Fig. 8). One of the brass pips should then be connected to the zinc

case of the other cell using a short piece of insulated wire. The connections will have to be soldered using a hot iron and cored solder, after having first cleaned the surfaces where the joints are to be made. Thus, a 3V battery will have been formed and the positive terminal of this is the brass pip (the one which so far has no connecting wire) and the zinc case of the other cell.

The wire from the earpiece (marked "to battery +ve")

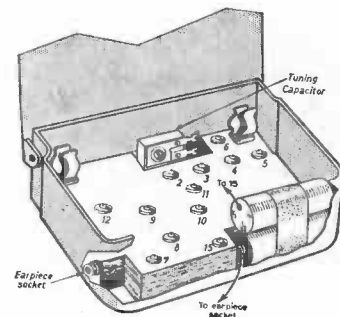


Fig. 7. A view of the chassis mounted in its case, showing the positions of the battery, tuning capacitor and earpiece socket.

in Fig. 6c, must be connected to the brass pip, and the wire from tag 15 to the negative of the battery—the zinc case. Again, these joints need to be soldered, and it is very important to get the battery connections the correct way round. The wiring of the battery should be carried out as shown in detail in Figs. 7 and 8.

Testing the Receiver

Only when the jack-plug of the earpiece has been pushed fully home will any sound be heard in the earpiece because of the battery-switching device which has been constructed from it by the modification described earlier.

A slight hiss in the earpiece indicates that current is flowing through the transistors. The r.f. choke must now be pushed as close as possible to the aerial coil wound on the ferrite rod. When the tuning knob is turned through its full range of movement, a number of heterodyne squeals should be heard as various stations are tuned through.

If no such sounds are heard, there is no need to worry. The ferrite rod should be eased from its clips, turned end-for-end, then clipped back into position facing the opposite way.

If all components and contacts are correct, the heterodyne notes will be heard on turning the tuning knob.

The only thing which remains to be done is to move the r.f. choke further away from the tuning coil, little by little, until the local stations are heard clearly and without distortion. The pocket receiver is now complete. To switch off, simply remove the earpiece plug from the socket.

Long Wave Coverage

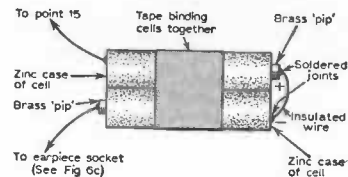
Many constructors will be interested in adding l.w. coverage to this receiver, principally to receive the Light Programme on 1500m. For this, all that is required is a small on/off switch of some sort and some extra coil wire.

The existing coil should be unwound and a new one made according to the following instructions.

(1) Proceed exactly as before, but when the 45th turn is reached, do not cut the wire, but instead form a second loop, 4in long, and twisted as before.

(2) Place a second paper sleeve on the rod as close to one of the clips as possible. Lead the wire to this sleeve and wind on it 100 turns in a deep bundle or pile, leaving 6in free at the end and anchoring the last turn firmly. Both coils should be wound in the same direction.

Fig. 8. The wiring-up of the two cells to form the 3V battery.



The first loop (the tap at the 10th turn) goes to point 13 as before. The second tapping (45th turn) goes to one terminal of the on/off switch and the end of the coil (145th turn) goes to point 6. A piece of connecting wire must now be fixed between point 6 and the other terminal of the on/off switch which has been added (there is plenty of room for fitting a small switch of this type somewhere in the case).

The position of the r.f. choke may have to be adjusted slightly now that l.w. coverage has been added, but apart from this, the set should function immediately as a two-waveband receiver.

Modern Three-valve T.R.F.

IN this t.r.f. receiver, a regenerative circuit is used to increase sensitivity and sharpen tuning so that the detector valve can be brought to its most sensitive operating point (the edge of oscillation) if required.

Considerable thought has been given to beginners' requirements and they will find this set an easy and inexpensive way of tackling mains equipment—perhaps for the first time. Chassis work has been kept small deliberately and a “baffle-mounting” plan adopted to simplify construction.

The Circuit

Referring to Fig. 1, it will be seen that a simple grid-leak detector is used, signals being conveyed from the aerial to L1 via TC1 and selected as required by VC1.

Provision for tuning over the medium waveband only is given in the original but other ranges can be covered by

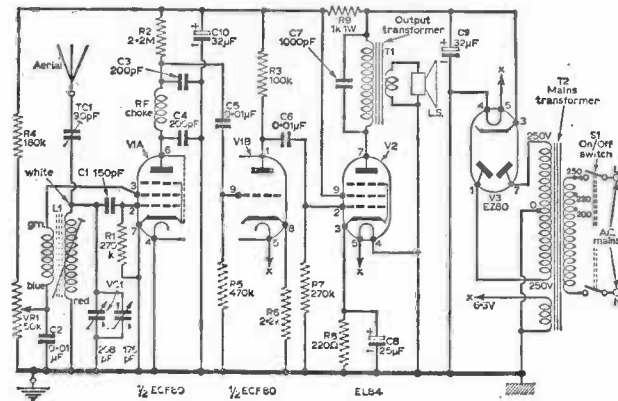


Fig. 1. The circuit of the receiver.

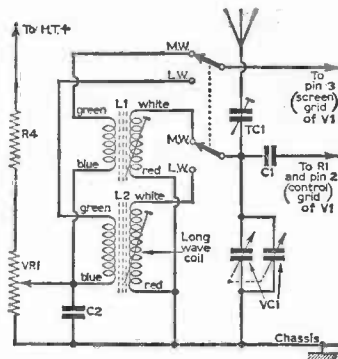
fitting extra coils and a miniature rotary wave-change switch. The extra circuitry required for incorporating a long wave-band range, for example, is given in Fig. 2. Space can be obtained by repositioning, or fitting a miniature type of output transformer, etc.

Detection

The cathode and grid of V1A perform the demodulating process, R1 acting as the diode load—the two electrodes perform effectively as a diode valve. The resultant audio signal, together with unfiltered r.f. passes to the anode.

The positive potential required for the screen grid is obtained from a potential divider connected across the power supply and reaches the grid via a winding on L1. The r.f. accompanying the audio signal thereby circulates in this winding which if correctly phased can cause positive feedback and oscillation. By making the screen voltage

Fig. 2. A modification to the circuit in Fig. 1 to include long waves.



variable, the feedback can be controlled and made to increase sensitivity. Potentiometer VR1 performs this function and allows the detector to be brought to the threshold of oscillation without seriously affecting the setting of VCI.

The r.f. signal also appears at the anode of V1A where it is not wanted, but a filter comprising capacitors C3 and C4 in association with an r.f. choke prevents it from reaching the grid of V1B where only audio signals are required. Omission of this choke would seriously affect operation.

The pentode section of V1 also amplifies the audio signals and thus performs two operations simultaneously. The triode section of V1 operates as a conventional a.f. voltage amplifier before presenting the signals to the output valve, V2.

The anode of V2 is fed with relatively unsmoothed h.t. and this permits use of a low wattage resistor for R9. The reservoir capacitor, C9 is large enough (32 μ F) to ensure that hum from the mains is removed. The value of C10 can actually be increased to 50 μ F with the particular type of rectifier valve specified.

COMPONENTS LIST

Resistors:

R1 270k Ω	R7 270k Ω
R2 2.2M Ω	R8 220 Ω
R3 100k Ω	R9 1k Ω 1W
R4 180k Ω	VR1 50k Ω pot., preferably wire-wound with double-pole mains switch
R5 470k Ω	
R6 2.2k Ω	

(All $\frac{1}{2}$ W except R9 and all 10%)

Capacitors:

C1 150pF mica	C8 25 μ F 25V electrolytic
C2 0.01 μ F ceramic or paper	C9 32 μ F electrolytic 350V
C3 200pF ceramic or mica	C10 32 μ F electrolytic 350V
C4 200pF ceramic or mica	VCI miniature tuning capacitor (see text)
C5 0.01 μ F mica or paper 250V	TC1 60-100pF trimmer
C6 0.01 μ F mica or paper 250V	
C7 1000pF ceramic	

Tuning Coils:

Weymouth HA3 (see text)

Transformers:

T1 tapped mains primary; secondaries 250V-0-250V 60mA, 6.3V 2A
T2 40:1 ratio for 3 Ω speech coil

Loudspeaker:

7in \times 4in elliptical

Valves:

V1 ECF80 V2 EL84 V3 EZ80

Miscellaneous:

R.F. choke (Osmar QCI); aluminium sheet for chassis (5in \times 4in and 6in \times 3in); three B9A valveholders; two control knobs; loudspeaker fabric; metal foil; plywood, etc.

The Power Supply

The full-wave rectification adopted is considerably more efficient than the half-wave type usually fitted to simple receivers. The cost is approximately equal for both types and space differences are negligible. Half-wave rectification is not recommended for use here.

A fuse may be fitted if desired by connecting the secondary centre-tap of T2 to chassis via a 0.15A torch bulb instead of directly as shown in the diagram. This will provide safety should a fault such as a heater-to-cathode short circuit develop in V3 which would cause a heavy flow of current.

Mechanical Details

As may be seen from Fig. 3, the "chassis" consists of a simple rectangle of aluminium (5in × 4in) and this carries the tuning capacitor, the potentiometer VR1, with integral on/off switch, the r.f. choke and the tuning coil together with a narrow aluminium shelf (top surface 5in × 2in) which carries the three valves. This valve-shelf is bolted to the rectangle where shown by means of 6 B.A. nuts and

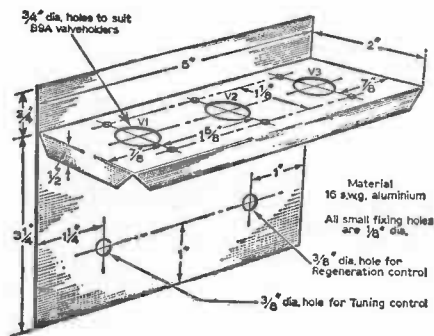


Fig. 3. The main drilling-details of the chassis.

bolts. The weight is negligible and supporting stays are not required.

The tuning capacitor is air-spaced being a miniature type intended primarily for transistor applications (Jackson "00" type—208pF + 176pF). It has lower maximum capacitance values than are usually required for valve receiver tuning circuits. Here, the two sections are connected together (in parallel) to provide sufficient capacitance to cover most of the medium waveband. There is some restriction at the low-frequency end of the band but this is not important. A conventional air-dielectric single-gang capacitor (nominal value 500pF) or even a solid-dielectric type could be used instead, provided it is not too large physically.

An iron dust-cored type of tuning coil is desirable due to the reduced value of tuning capacitance used. The specified coils are remarkably simple to fit, only a single 6 B.A. bolt being required. Also the core-extension is brought out on a threaded brass rod which fractures less easily than in the type where the adjusting slot is integral with the core material.

Location of Parts

The miniature mains transformer is mounted directly on the inside of the front panel as are the output transformer, reservoir and smoothing capacitors and elliptical loud-speaker. Prior to fixing these items, a sheet of metal foil is glued to the inside of the panel, and if this is omitted care should be taken to ensure that the casings of all metal components are connected to the chassis.

The location of the larger components provides balance of weight (the heaviest items are mounted centrally) so that the receiver is made stable. The balance will be lost if the loudspeaker and transformers are transposed;

longer inter-connecting leads will also become necessary.

Use of $\frac{3}{8}$ in plywood permits these components, and also the chassis, to be screwed to the panel without the front being defaced. If desired, or where space is needed, a 3in-square loudspeaker may be used in place of the elliptical model shown. A volume control can be fitted by replacing R5 by a 500k Ω potentiometer and feeding the grid of the triode from its slider. In the prototype, VR1 was found to perform this function adequately however.

Wiring

The chassis of the receiver can be wired up independently of the remainder of the circuit. Wiring is simple but the valveholders are best attended to first. In the layout and wiring diagram (Fig. 4), the valve platform is shown pressed out flat so that the connections on the underside may be

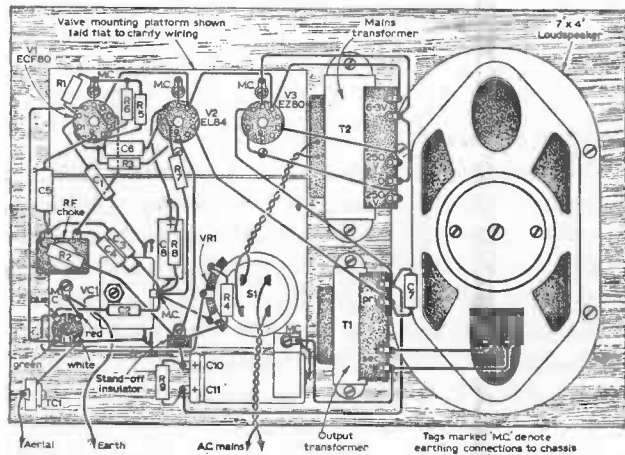
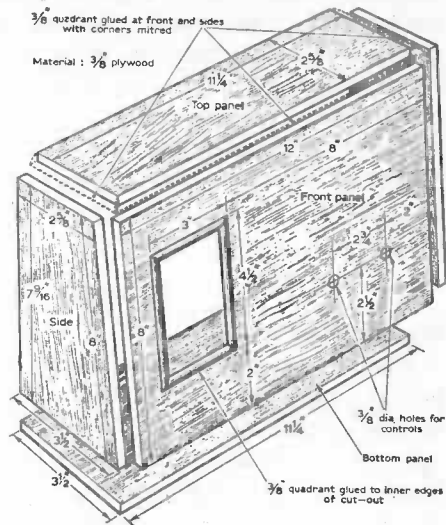


Fig. 4. The complete wiring of the receiver.

Fig. 5. Complete details, including dimensions, of a suitable cabinet for the receiver.



seen clearly. Use of modern miniature capacitors and resistors is desirable in order to prevent undue congestion, and the electrolytic decoupling capacitor, C8, should be a miniature type.

Testing

The usual tests and checks for faults in the wiring are made with a test-meter prior to switching on, particular care being taken to ensure that the mains wiring is correct. A three-pin plug should be fitted to the end of the mains lead in the correct sense and a pair of attractive control knobs fitted on the receiver. If all is in order, it may be switched on and an aerial connected (a few feet of wire will do). It should then be possible to tune in various trans-

missions by operating VCI and VRI judiciously, care being taken not to let the receiver oscillate. The precise setting of TCI will depend upon the aerial in use, location, etc., but the best position can soon be found by experimenting, the smallest capacitance possible probably giving the most satisfactory result over the band. The value of C7 can also be altered experimentally; for example; if reproduction tends to be shrill, the value may be increased to 5000pF or more as required.

Housing the Receiver

All the dimensions of the woodwork required are shown in Fig. 5. The sides are glued to the inside of the panel and are held securely by metal "L" brackets; wooden reinforcement blocks will also serve just as well. Quadrant ($\frac{3}{8}$ in) is glued to the top of the panel and sides to form a frame mitred at the front corners. Similarly, quadrant is fitted to the inside edges of the loudspeaker aperture.

F.M. Tuner with A.F. Amplifier

THIS receiver was designed with three objects in mind, namely that it should be easy to construct, produce reasonable quality sound and be cheap to build. It is felt that this design has satisfied these requirements. Originally the set was designed for the reception of the London transmissions at a range of about ten miles, but later the receiver was modified to receive these transmissions at about 30 miles from the transmitter.

Three Stages

The prototype was constructed in three stages—each complete in itself. Initially only that section shown in Fig. 1 was constructed, and it was used to feed a high quality a.f. amplifier. Later an extra i.f. stage was added to increase the sensitivity of the set for use at the increased range, and finally the a.f. amplifier was constructed to make the complete receiver.

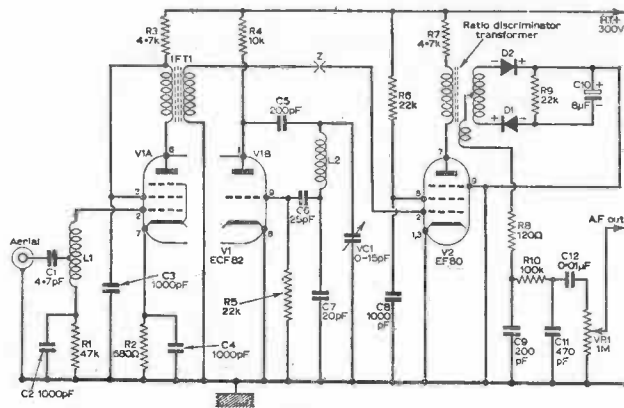


Fig. 1. The main circuit.

The F.M. Tuner—R.F. Section

The aerial is coupled to the centre of L_1 by C_1 , this capacitor helping to prevent break-through at the intermediate frequency (10.7Mc/s). L_1 in turn takes the signal to the grid of V_{1a} which is the pentode section of the ECF82. As L_1 is heavily damped by the valve, the tuning of the coil will be extremely broad and there will be very little advantage in trying to tune the coil manually, so the core of L_1 is adjusted for the best results for the centre-frequency of the three stations to be received, and sealed in this position. V_{1a} acts as an r.f. amplifier and mixer, the resultant signal at 10.7Mc/s being coupled via i.f.t.1 to the grid of V_2 .

The Oscillator

The oscillator is constructed around the triode section of the ECF82 (V_{1b}). A very reliable circuit form has been

adopted and, in an attempt to overcome frequency drift, so common in receivers of this type, C_7 is specified as a negative temperature co-efficient component.

The oscillator contains the only continuously variable tuned circuit in the whole receiver. The oscillator runs at 10.7Mc/s below the frequency of the signal. There is no direct coupling between V_{1a} and V_{1b} as it was found that stray capacitance coupling was more than enough for satisfactory operation. However, should this not prove to be the case (and this is very unlikely) the anode of V_{1b} should be coupled to the grid of V_{1a} by a capacitor having a value of $1-2\text{pF}$; alternatively a short piece of 20 s.w.g. wire (about 1in long) should be soldered to pin 1 of V_1 and a similar piece of wire soldered to pin 2 of V_1 . These wires should be sleeved completely and twisted together ensuring that they do not make electrical contact. This will provide adequate coupling between the two stages.

I.F. and Demodulation

V_2 has two functions as it acts as an i.f. amplifier and partial limiter for the ratio detector stage. The ratio detector is a little unusual since it is of the unbalanced type rather than the more familiar balanced type.

The a.f. signal is taken from the junction of R_{10} and C_{12} via VR_1 and thence to the a.f. amplifier.

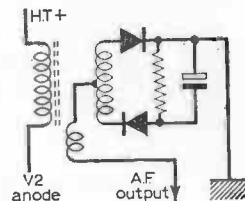


Fig. 2. The basic circuit of the detector.

Construction

The only critical sections of the receiver are the r.f. and oscillator sections where the wiring should be short and point-to-point. No attempt should be made to make the wiring "look pretty". A wiring diagram for these two stages is shown in Fig. 3. Coil L1 is wound on a $\frac{5}{16}$ in diameter dust-cored former and consists of $5\frac{1}{4}$ turns of 20 s.w.g. wire, each turn being spaced from the next by a distance equal to the diameter of the wire. The coil is tapped at exactly its mid-point. The coil is mounted beneath the chassis and may be left un-screened.

Coil L2 consists of 6 turns of 20 s.w.g. wire on a $\frac{5}{16}$ in diameter dust-cored former being wound, like L1, with each turn separated from the next by the diameter of the wire. This coil should be fitted with a screening can.

The wiring may now be undertaken as shown. It is recommended that in these two stages, only components of the type specified should be used, as the use of inferior components, especially in the by-pass and decoupling circuits, can result in instability or alterations to the response characteristic of the receiver, causing asymmetrical operation of the detector stage and thus a distorted audio output. To avoid unfortunate capacitance effects, VC1 should be mounted as close as possible to L2.

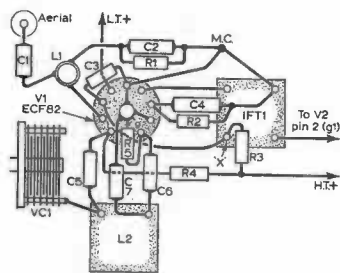


Fig. 3. The wiring of the r.f. and oscillator stages.

I.F. and Detector

This is a very straightforward piece of construction. It is recommended that the i.f. by-pass and de-emphasis circuits be mounted on a tag strip as shown in Fig. 4 as this makes for a reasonably neat layout and helps to avoid hum pick-up. Screened wire should be used to take the output from the detector stage to the volume control to eliminate 50c/s hum.

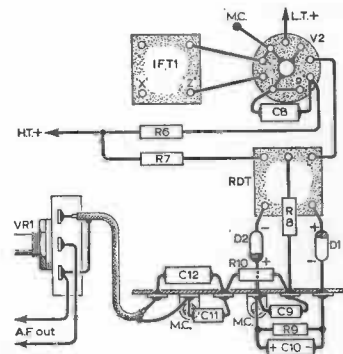


Fig. 4. The wiring of the i.f. and detector stages.

Another useful precaution in this respect would be to keep the leads carrying the heater current well away from all a.f. points.

The unit, as it stands, may be used as a local-station tuner by connecting it up to a suitable power unit (250-300V d.c. at 25mA and 6.3V at 0.6A). The setting-up and test procedure is exactly the same as for the more sensitive receiver (except, of course, that there is one less i.f. coil to align).

However, it will be found that the set is too insensitive for satisfactory results at a range above that of ten miles from the transmitter and so for areas of weaker signal strength, another i.f. stage will have to be added. Also, since the signal strength will be less at this greater range

the effect of interference will be greater, and so the limiting action of the circuit will have to be increased to overcome this difficulty. The improved circuit for increased sensitivity is shown in Fig. 5 where the r.f. and oscillator sections remain intact, the new circuit continuing from point Z in Fig. 1.

The Improved Circuit

The extra i.f. gain is obtained from V3 and its associated network. The only circuitry of interest here is the combina-

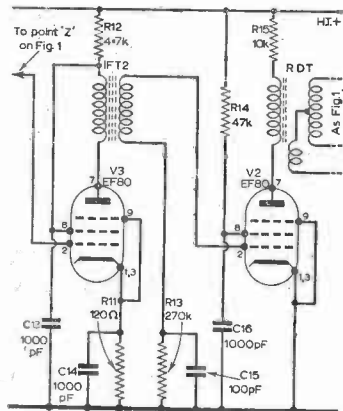


Fig. 5. The circuit of an additional i.f. stage which may be interposed between V1 and V2 in Fig. 1 to increase the sensitivity of the receiver.

tion of C15 and R13 which gives a time constant of $27\mu\text{s}$ and provides a certain amount of standing bias on the grid of V2. This circuit has a limiting action and thus aids V2 in a.m.-interference suppression.

The wiring diagram for the additional i.f. stage is shown in Fig. 6 and indicates only the wiring for V3 (the wiring for V2 is exactly the same as in Fig. 4 except for the change

COMPONENTS LIST

Resistors:

R1 47k Ω	R6 22k Ω	R11 120 Ω	R16 2.2k Ω
R2 680 Ω	R7 4.7k Ω	R12 4.7k Ω	R17 150k Ω
R3 4.7k Ω	R8 120 Ω	R13 270k Ω	R18 47k Ω
R4 10k Ω 1W	R9 22k Ω	R14 47k Ω	R19 1M Ω
R5 22k Ω	R10 100k Ω	R15 10k Ω 1W	R20 120 Ω

(All $\frac{1}{4}$ or $\frac{1}{2}$ W unless otherwise stated)
 VRI 1M Ω carbon potentiometer

Capacitors:

C1 4.7pF mica or ceramic	C12 0.01 μF paper
C2 4000pF ceramic	C13 1000pF ceramic
C3 1000pF ceramic	C14 1000pF ceramic
C4 1000pF ceramic	C15 100pF ceramic
C5 200pF ceramic	C16 1000pF ceramic
C6 25pF mica or ceramic	C17 25 μF electrolytic 12V
C7 20pF ceramic (neg. temp. co-efficient)	C18 8 μF electrolytic 450V
C8 1000pF ceramic	C19 0.01 μF paper
C9 200pF ceramic	C20 16 μF electrolytic 450V
C10 8 μF electrolytic 150V	C21 16 μF electrolytic 450V
C11 470pF ceramic	VCI 0-15pF air variable

Inductors:

L1 Aerial coil (see text)	IFT1, 2 10.7Mc/s i.f. transformer (Denco)
L2 Oscillator coil (see text)	
L3 L.F. choke 10H, 100mA	IFT11/10.7
RDT Discriminator transformer (Denco RDT1/10.7)	
T1 Output transformer 40: 1 (for 3 Ω loudspeaker)	
T2 Mains transformer with tapped primary, Secondaries: 300V 100mA. (h.w.); 6.3V 2A	

Valves:

V1 ECF82	V4 EF86
V2 EF80	V5 EL84
V3 EF80	

Diodes:

D1, D2 OA81 germanium diode (or similar)
D3 3 \times RM2 selenium power rectifier (or similar)

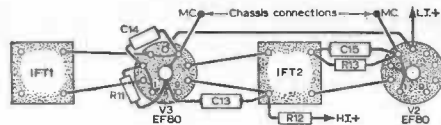


Fig. 6. The wiring of the additional i.f. stage.

in values of R6 and R7, making them R14 and R15 respectively). The alignment and testing of the tuner is described under the heading of "Testing and Tuning".

The A.F. Amplifier

The a.f. amplifier may take several forms. A simple circuit built around a single ECL82 would be quite satisfactory for ordinary domestic use if a little can be sacrificed in the way of quality. The circuit of the a.f. stage used in the prototype is shown in Fig. 7. It will be seen that this is quite an ordinary circuit form—pre-amplification being given by a triode-connected EF86 feeding a single-ended output pentode (EL84).

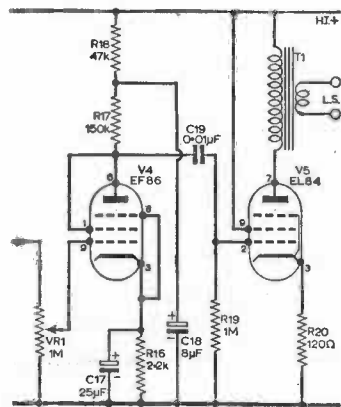


Fig. 7. The circuit of the a.f. amplifier.

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Construction of this stage should follow normal high gain a.f. practice—especially in that heater leads should be kept well away from control-grid leads and associated components—otherwise the layout is not critical. A wiring diagram for the a.f. stage is given in Fig. 8.

A suitable power pack for use with the completed receiver is shown in Fig. 9. Any power unit capable of giving 250–300V at 80–90mA and 6.3V at 1.5A will, however, be suitable.

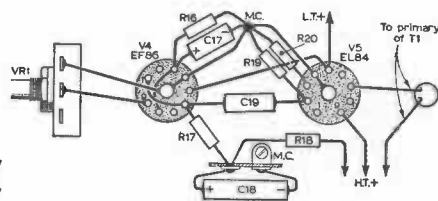


Fig. 8. The wiring of the a.f. amplifier.

Testing and Tuning

Initially the whole of the wiring should be checked for wrong connections against the diagrams, and the h.t. and l.t. leads examined for shorts to the chassis.

If the tuner section only has been constructed it should first be connected to an a.f. amplifier and a suitable power supply.

A "rushing" sound should be heard from the loudspeaker indicating that the oscillator is functioning. Connect a piece of wire (2ft to 3ft long) to pin 1 of V1, when morse signals, whistles, etc., will probably be heard if the i.f. amplifiers are working properly. Remove the wire from pin 2 and connect an f.m. aerial to the aerial socket, and rotate C7 when the local f.m. broadcasts should be heard. Decrease VR1 until the station can only just be heard and adjust the i.f. coils for maximum performance, reducing VR1 as

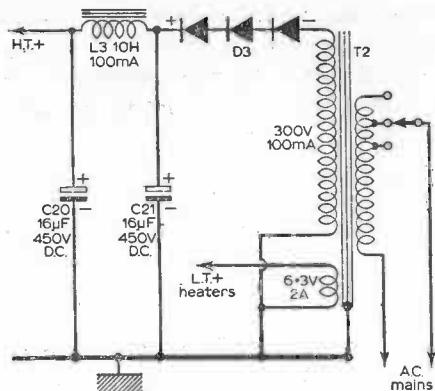


Fig. 9. The circuit of the power supply.

necessary (very little adjustment will be required as the i.f. transformers are pre-aligned by the manufacturer).

Adjust L4 for maximum signal finally trimming the discriminator transformer for maximum output. L2 should now be set so that the centre-frequency station (normally, the Third Programme) is received with C7 half-closed. Seal the core in place with adhesive.

Two-transistor Portable

A COMPARATIVELY small cash outlay is involved in the construction of this receiver and little or no test equipment is required to bring it into use.

It is powered by a single 4.5V dry battery and the current consumption is low (less than 1mA).

The frequency coverage is 600-1460kc/s (500-205m), thus covering practically the whole of the medium wave-band. If long-wave reception is required this can be incorporated but has not been attempted in the prototype.

The Circuit

In Fig. 1 it can be seen that the first transistor Tr1 is operated as a regenerative demodulator feeding a stage of audio amplification built around Tr2, high impedance headphones being inserted in the collector circuit of this transistor.

By controlling the emitter current of Tr1 by means of a variable resistor by-passed by a capacitor, detection can

occur if the transistor is not allowed to oscillate but instead is brought close to the point of oscillation.

A suitable impedance-match into the base of Tr1 can be effected by employing a capacitive potentiometer across the coil and using one section of it for tuning. Capacitors VC1 and C3 perform this function.

Since these capacitors are connected across the coil in series the total value of capacitance available will always be less than that of the smaller of the two. This reduced

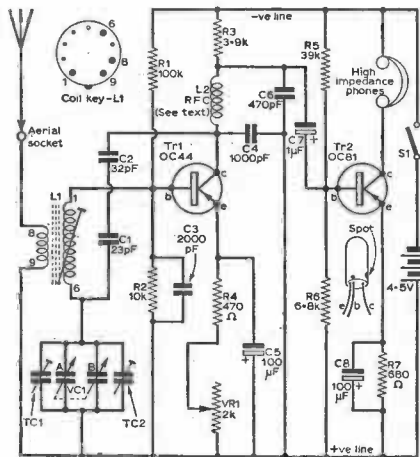


Fig. 1. The circuit of the receiver.

capacitance effect will make itself most apparent at the low-frequency end of the band, i.e. where the vanes of VC1 are most fully engaged, and if a suitable coil is not used for L1, only a section of the band will be receivable. Fortunately, suitable coils are available from the Denco miniature range.

A miniature Jackson "00" twin-gang tuning capacitor with sections paralleled (208pF + 176pF) form a total value of 384pF, ignoring the trimmers, but this is reduced to

COMPONENTS LIST

Resistors:

R1 100k Ω	R5 39k Ω
R2 10k Ω	R6 6.8k Ω
R3 3.9k Ω	R7 680 Ω
R4 470 Ω	
VR1 2k Ω wire-wound potentiometer	

Capacitors:

C1 23pF mica	VC1 { 208pF } twin-gang variable { 176pF } (Jackson "00")
C2 32pF mica	
C3 2000pF ceramic	TC1 } trimmers—with VC1 TC2 }
C4 1000pF mica	
C5 100 μ F electrolytic 6V	
C6 470pF mica	
C7 1 μ F electrolytic 6V	

Switches:

S1 Toggle switch on/off

Inductors:

L1 M.W. coil (Denco Yellow dual-purpose range 2)
L2 R.F. choke (see text)

Transistors:

Tr1 OC44 Tr2 OC81

Miscellaneous:

Miniature 18-way tag board 4½in × 1½in (Radiospares).
Battery: 4.5V (Ever-Ready 1289); high impedance headphones; panel material; hardboard; aerial and head-phone sockets; control knobs.

about 330pF by C3 and is then suitable for use with the coil specified.

Note that two capacitors—C1 and C2—are fitted between the collector of Tr1 and L1; this is not a safety measure but an aid to obtaining good results on completion, since these

items control to a great extent the amount of positive feedback.

The efficiency of the receiver largely depends upon the characteristics of Tr1 and this should be a good specimen; the use of a surplus type is not recommended.

The small r.f. choke of 3mH inductance (L2) fitted in

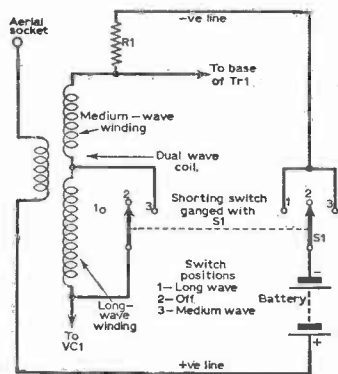


Fig. 2. The modified circuitry necessary to provide coverage of long waves.

the collector circuit of Tr1, consists of the main winding of a dust-cored long-wave coil, the primary winding being removed and the coil-former sawn off to the length of the core.

As mentioned earlier, inclusion of long wave-band facilities can be provided either by fitting a separate coil from the Denco range (Range No. 1) or by using a miniature dual-waveband coil as shown in Fig. 2. The additional switching required can be incorporated with S1 by using a rotary switch. A two-pole, three-way switch used as shown will allow the central position to be "off", with "medium" and "long" situated on either side. This makes it less likely that the receiver will be left switched on than with other

arrangements. No extra panel-control will be needed if this idea is followed.

Constructional Notes

The receiver is built around a miniature 18-way tag-board to which is affixed a simple metal panel that carries the three controls. This assembly is located on a main hard-board panel to which simple sections are finally fitted to form a cabinet. A short throw-out type of aerial is required and this, together with the headphones, is plugged into sockets provided on one side.

Preliminary work consists of constructing the metal panel for the controls from tin-plate or 16 s.w.g. aluminium and details of this are given in Fig. 3. Prior to bolting this panel to the tag-board, one of the small holes running down the

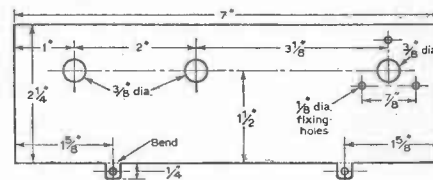


Fig. 3. Dimensions and drilling-details of the control-panel.

centre of the board must be enlarged with a circular file to $\frac{1}{4}$ in diameter—as indicated in Fig. 5—to accept the coil-mounting stem. The coil is locked in position by means of the polystyrene nut provided and this should only be twisted "finger-tight"; if pliers are used, the stem will fracture.

Wiring Up

The remaining construction consists of mounting and

wiring the various components to agree with the above-chassis and below-chassis plans shown in Figs. 4 and 5 respectively, leaving the transistors on one side until a good check has been made.

Testing

High impedance headphones should be connected before switching on and these should not be removed while the set is working or the collector circuit of Tr2 will be broken. With VR1 set to approximately half-travel, and a short aerial connected, the set may be switched on and VC1 swung through its full range of rotation. If oscillations are heard, all is well, but VR1 should be adjusted very quickly to remove them, when little difficulty should be experienced in receiving transmissions. The quality should be crisp and will be surprisingly clear and alive. It will now be discovered that VR1 can be used as a volume control; it should normally operate very smoothly indeed. Smoothness of operation will best be obtained from use of a wire-wound component in the VR1 position, but care should be taken not to advance the control excessively or the programme material will be supplanted by undesirable oscillation.

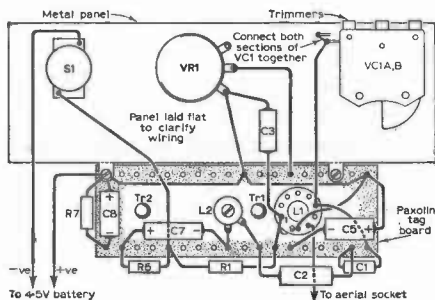
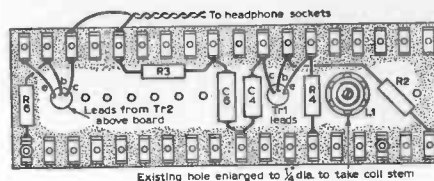


Fig. 4. The connections between the tag-board and the control-panel. The tag-board has been drawn in the same plane as the control-panel for clarity.

Fig. 5. The reverse side of the tag-board.



Faults

If the receiver fails to oscillate at any setting of VR1 or VC1, either C1 or C2—but not both together—may be temporarily short-circuited to increase feedback. Resistor R1 might need changing also if an indifferent transistor is in use and the value may be reduced to about $56k\Omega$. Noise may result in the form of a rushing sound if R1 is excessively reduced in value ($39k\Omega$ is about the limit).

If, on the other hand, it is not possible to eliminate oscillations at any setting of VC1 or VR1, remove C2 and replace it with one of smaller value—say $10pF$ —and try again. The emitter resistor R4 can also be increased to, say, 680Ω or even 820Ω , this further limiting the current in Tr1. The receiver should, of course, be switched off before making alterations.

Four-valve Superhet

THIS handy little receiver will give a good account of itself in the less favourable reception areas where simpler sets are inadequate; a directional aerial enhances the selectivity of the superhet circuit.

Mixer and I.F. Stages

Referring to Fig. 1, it will be seen that the signal from the ferrite-rod aerial is applied via the switch S_1 , to the grid of a frequency-changer valve, 12AH8, the capacitor C_1 being included so that the lower ends of the aerial windings can be returned to earth, and a.g.c. applied in the parallel mode to the grid.

Switches S_2 and S_3 select the oscillator coil appropriate to each waveband, and signal and oscillator frequencies are combined in the valve to produce in the anode circuit the difference frequency of 465kc/s.

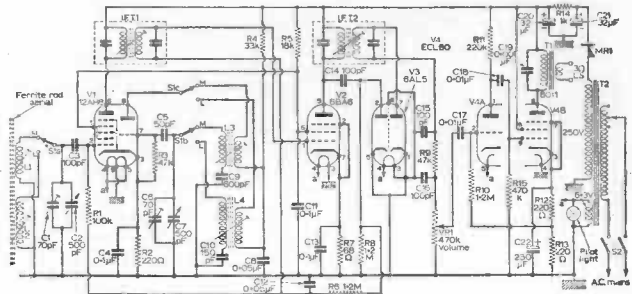


Fig. 1. The circuit of the receiver.

Detection and A.G.C.

The a.g.c. voltage is derived from the primary of the second i.f. transformer. The voltage available at this point is considerably greater than that of the secondary, making the gain control that much more effective. The insulation of the capacitor C_{14} is important and a good quality mica component should be used.

Resistor R_8 is the a.g.c.-diode load and the filter R_6/C_{12} , removes the i.f. and audio components before the voltage is applied to the grids of the controlled valves. It will be noticed that the sensitivity to weak signals is limited by the absence of a delay voltage in the a.g.c. system, but a receiver of this sort would not normally be used for reception of weak and distant transmissions.

The second diode in V_3 demodulates the signal for a.f. amplification, the filter network C_{15}/R_9 , removing the now unwanted intermediate frequency before the signal is passed via the volume control, VR_1 , to the a.f. and output stages.

A.F. Stages

Portability imposes its limitations, and in order to keep

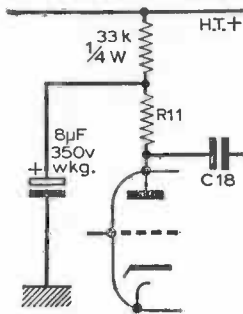


Fig. 2. The hum level of the receiver can be reduced by additional smoothing between R11 and the h.t. line (see text).

the power-pack down to a reasonable size and weight, a.f. amplification and power output are obtained from a triode-pentode valve type ECL80, which has only a modest current requirement.

The triode section is employed as a resistance-coupled amplifier with an anode load of 220kΩ, while to provide the optimum bias, the grid resistor of 1.2MΩ is returned to a tapping on the cathode resistor instead of to earth as would be done if there were a separate triode cathode.

The pentode section provides a power output of about 1½W. The optimum load is 11000Ω and for a 3Ω loud-speaker; the output transformer ratio should therefore be about 60:1. Connected across the primary is a capacitor, C19, which corrects the response at the higher audio frequencies. The cathode network which is common to both sections of the valve, must be by-passed by a large capacitance and C22 should not be less than 250μF.

The overall gain of the two stages, though adequate, is not high and no trouble is likely to be experienced with hum. The residual hum level of the receiver is very low and can be reduced to inaudibility if desired by some additional smoothing in the anode circuit of V4A, as shown in Fig. 2.

COMPONENTS LIST

Resistors:

R1 100kΩ	R5 18kΩ 1W	R9 47kΩ	R13 220Ω
R2 220Ω	R6 1.2MΩ	R10 1.2MΩ	R14 1kΩ 5W
R3 47kΩ	R7 68Ω	R11 220kΩ	R15 470kΩ
R4 33kΩ ½W	R8 1.2MΩ	R12 220Ω	VRI 470kΩ log.

(All ½W except where otherwise specified)

Capacitors:

C1 70pF trimmer	C13 0.1μF
C2 500pF gang	C14 100pF (mica)
C3 100pF	C15 100pF
C4 0.1μF	C16 100pF
C5 50pF	C17 0.01μF
C6 70pF trimmer	C18 0.01μF
C7 500pF gang	C19 0.001μF
C8 0.05μF	C20 32μF electrolytic
C9 600pF	C21 32μF electrolytic
C10 150pF	C22 250μF electrolytic 15V
C11 0.1μF	(350V working unless otherwise stated)
C12 0.05μF	

Valves:

- V1 12AH8, B9A base
- V2 6BA6, B8G base
- V3 6AL5, B7G base or two diodes GEX34 or similar
- V4 ECL80, B9A base

Dial Light:

6.3V 0.3A

Rectifier:

250V, 50mA contact-cooled

Transformers:

Mains: 250V, ½-wave, 45mA; 6.3V, 1.5A
 Output: Ratio 60: 1 for 3Ω loudspeaker
 I.F.: 465kc/s miniature (2 required)

Coils:

Ferrite rod aerial for long and medium wavebands with oscillator coils to suit.

Power Supply

An h.t. supply of about 45mA at 200V is required and the valve heaters and dial-light need 1.5A at 6.3V. A double-wound miniature mains transformer reduces mains borne interference to a minimum and makes the chassis safe to handle at all times.

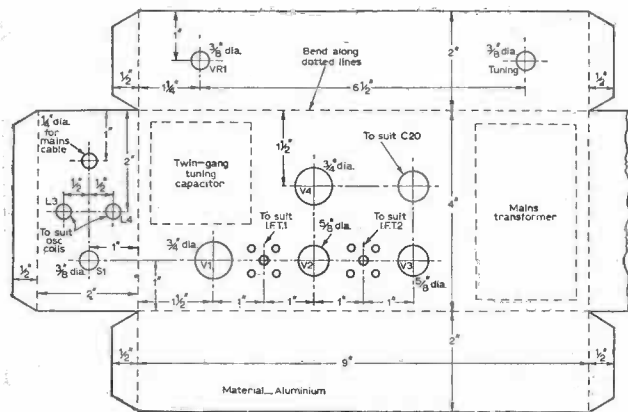


Fig. 3. Drilling details of the chassis.

It has a 250V half-wave secondary which feeds a contact-cooled metal rectifier, MR1. Smoothing is provided by the resistor R14 and the two electrolytic capacitors, C20 and C21, which may of course, be one double component if desired.

Many miniature transformers do not have tapped primaries, so that the h.t. secondary voltage may vary somewhat with the mains voltage. The value of R14 may therefore need to be adjusted to produce the correct h.t.-line voltage of 200. Mains-switching is incorporated with VR1.

Components

To simplify alignment, fixed padding capacitances are used in the oscillator circuit, but this will be satisfactory only if the oscillator coils are designed for use with the particular ferrite-rod aerial employed and the capacitances are those recommended by the manufacturer.

The values shown in Fig. 1 for C9 and C10 are typical but not universal. The mains transformer must be a miniature type and the i.f. transformers should not be larger than 1in square. All the other components can be standard and, as there is nothing critical about them, the constructor can use anything he has to hand which is electronically suitable and can be fitted in.

Construction

The receiver is constructed on a chassis of 18 s.w.g. sheet aluminium, 9in \times 4in \times 2in, the details of which are given in Fig. 3.

A rough wooden box should then be made in which the chassis can be suspended upside-down by its end-flanges while the wiring is carried out. Tinned copper wire of 22 s.w.g. is suitable for this, covered with sleeving in the case of connections more than 1 in. or so in length.

Fig. 4 shows all the under-chassis wiring with the connections opened out for clarity. The only really critical point is the lead to the grid of V2; if instability is experienced, it will almost certainly be due to pick-up here, and screening may be required even though the lead is short.

Aerial

The method of securing the aerial will vary somewhat according to the fittings, if any, supplied with it. If there

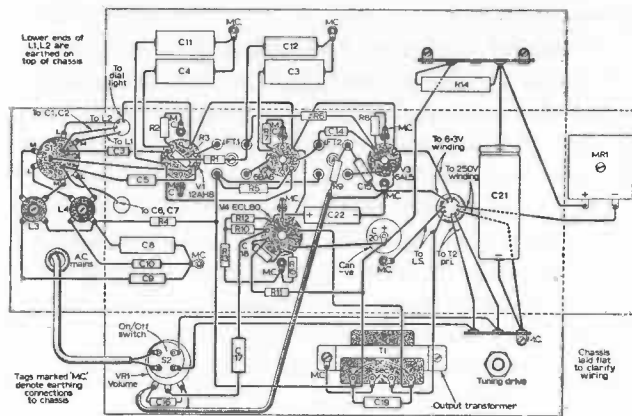


Fig. 4. The complete wiring of the receiver.

are none, a satisfactory arrangement is a bracket of 18 s.w.g. aluminium to the measurements given in Fig. 5. Fit rubber grommets in the two $\frac{3}{8}$ in holes and pass the aerial rod through them. This assembly can conveniently be supported at a height of about $4\frac{1}{2}$ in above the chassis on a strip of 16 s.w.g. aluminium, $5\text{in} \times 1\text{in}$, having $\frac{1}{2}$ in turned at right angles at the bottom for bolting to the deck of the chassis.

Tuning Drive

The not inconsiderable expense of a tuning drive and scale is avoided by the arrangement shown in Fig. 6. The

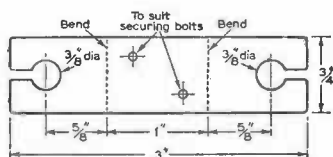


Fig. 5. Details of the mounting-bracket for the aerial.

drive-spindle is a discarded volume control with the body removed and carries a brass pulley (from a well-known constructional toy), drilled out and soldered to it.

The drive cord is taken via two more pulleys (a) and (b) fitted to the chassis, to a $2\frac{1}{2}$ in drive-drum on the tuning capacitor, engaging on the way with a cursor which is free to move along the length of an aluminium plate, $5\text{in} \times 1\frac{1}{4}\text{in}$, secured to the front chassis-runner. The plate should be mounted on two 1in long bolts and positioned by distance-pieces or nuts far enough from the chassis-runner to permit the drive-cord to pass freely behind it. The exact position of pulley (b) in Fig. 6 is unimportant, but (a) should be positioned so that the upper drive-cord which engages the cursor is horizontal. The cursor is of 24 s.w.g. tin-plate.

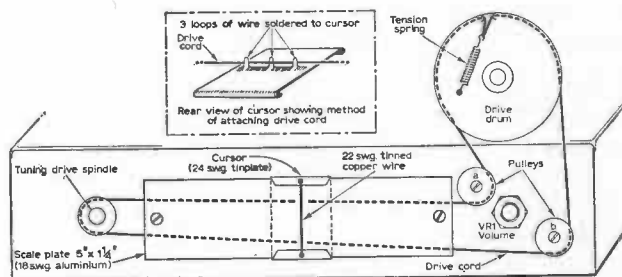


Fig. 6. The tuning-drive assembly.

An arbitrary horizontal scale can be affixed to the aluminium plate or, alternatively, the plate can be painted matt black and the scale can be engraved on the Perspex window in the front of the cabinet. This was done in the prototype by using a section of a scale on Perspex found in a piece of ex-Government equipment.

Testing

Before switching on, apply a meter on a high "ohms" range between C21 and chassis to see that there are no shorts in the h.t. wiring. Power can then be applied and the presence of voltages at the valve electrodes verified with the meter. Measure the h.t.-line voltage. It should be between 200 and 210V and if it is not, the value of R14 should be altered to bring it within this range.

I.F. Alignment

If pre-tuned transformers have not been used, it will be necessary first to align the i.f. amplifier with the aid of a signal generator. Inject a signal of 465kc/s at the grid of V1 and adjust the transformer cores for maximum response; the best indicator of resonance is a high resistance d.c. voltmeter connected across VR1, positive to chassis, but if this is not available, a modulated signal can be used and the result observed with an output meter or judged by the sound output from the speaker. Keep the generator signal to the minimum necessary for adequate response.

R.F. Alignment

Start with the medium waveband. Normal coverage for a circuit of this sort with a 500pF tuning capacitor, is from 1550kc/s to 515kc/s, and the first step is to obtain this. Set the medium wave aerial coil about $\frac{1}{2}$ in from the end of the rod, open the tuning capacitor fully and inject a 1550kc/s signal by bringing the generator output lead into the vicinity of the aerial. Tune for maximum response with the trimmers C1 and C6.

Next, close the capacitor fully, inject 515kc/s and adjust the core of L3 and the position of the aerial coil upon the

rod for optimum response; secure the coil in position with a little beeswax. It now remains to track the oscillator. Using a signal of 1450kc/s, manipulate the tuning capacitor and the trimmer C6 to find the combination of settings for maximum response; note the scale position carefully (point A). (If the scale is not fitted, mark the position of the cursor on the scale plate.)

Inject now 600kc/s and by manipulation of the tuning capacitor and the core of L3, again find the optimum combination and note the scale reading (point B). Repeat the adjustments at both points till no further improvement can be obtained, finishing off at point A.

Turn now to the long waveband. Close the tuning capacitor fully, inject a signal of 175kc/s and adjust the core of L4 and the position of the aerial coil for maximum response. Tune in the Light Programme on 200kc/s and check that the capacitor and the core of L4 are in optimum combination. Seal L2 in position with wax. Do not alter the settings of the trimmers C1 and C6.

Alignment Without A Generator

This can be accomplished satisfactorily provided the i.f. transformers are pre-tuned. Commence with the medium wave signal and oscillator circuits as already described, using identifiable broadcast transmissions in place of the generator signals.

It will not be possible, of course, to check the coverage exactly but it is usually possible to find transmissions at or near the ends of the band from which a close approximation can be made. The frequencies of the transmissions selected for alignment points A and B are not unduly critical or difficult to find; Radio Luxembourg (1439kc/s) and the BBC Third Programme (647kc/s) will be suitable in many areas.

On the long waveband, set L2 about $\frac{1}{2}$ in from the end of the rod and manipulate the tuning capacitor and the core of L4 for optimum reception of the Light Programme on 200kc/s. Adjust L2 for maximum and repeat once; fix L2 in position.

Cabinet

The cabinet for the receiver was made very simply from four pieces of $\frac{3}{8}$ in plywood, plus a piece of $\frac{1}{8}$ in hardboard for the front. No skilled joinery is needed, nor is there any painting, staining or french polishing to be done. Fig. 7 shows how the four pieces of ply are assembled.

Remember to cut a $\frac{3}{8}$ in hole in the right-hand side for the wave-change switch and a few holes in the bottom for ventilation.

The assembly should be given a rough sanding off, sufficient to remove any splinters, projections at the corners, etc. Nothing more than this is needed because the professional external appearance is achieved by covering the top and sides of the cabinet with laminated plastic as used on kitchen working surfaces, etc.

The top should be cut first, very slightly longer than the cabinet and $\frac{1}{8}$ in wider than the depth, so that when fixed,

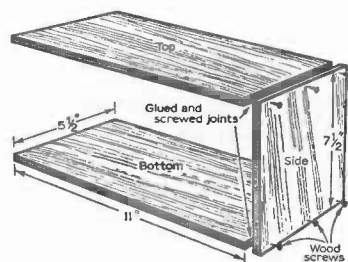


Fig. 7. The construction of the cabinet.

there will be an overhang of $\frac{1}{8}$ in at the rear, into which the back of the cabinet can be fitted. Fix it with the special impact adhesive sold for the purpose, taking care that the two surfaces come together in exactly the right position at the first attempt—they are extremely difficult to separate once contact is made.

Allow an hour or so for the adhesive to harden and then trim the ends of the laminate accurately with a file. The sides can then be cut, fixed and trimmed in similar fashion, again cutting very slightly longer than the height and $\frac{1}{8}$ in wider than the depth.

Finishing

The next operation is to fit the loudspeaker, and cover the whole of the cabinet front with loudspeaker fabric secured with adhesive; make sure that good positive attachment is obtained round the edges of the aperture. When the adhesive is dry, holes should be made for the control spindles and the fabric over the tuning scale aperture should be cut diagonally, folded back through the aperture and stuck to the rear of the hardboard.

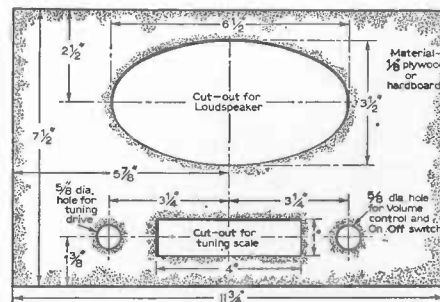


Fig. 8. Details of the front of the cabinet.

If the Perspex window is now cut accurately to size, it will be a tight push-fit into the aperture. The front must now be treated with some kind of trim to hide the edges of the loudspeaker fabric and hardboard.

Fitting the Receiver

Reduce the length of the wave-change spindle to $\frac{1}{2}$ in and cut the other controls to the required length. Place the receiver in position and drill upwards through the bottom of the cabinet and through the chassis end-flanges, two holes about $\frac{1}{8}$ in diameter at the mains-transformer end and one at the other.

The chassis can then be secured by bolts or, if the holes in the wood are enlarged, by wood-screws inserted from below, of such diameter that they will have a self-tapping action as they enter the aluminium.

Mains Power-supply for Transistor Sets

THIS eliminator allows mains operation of any small transistor receiver or amplifier which is designed to run from a 9V or similar battery. Working costs are negligible, and the unit is, of course, very useful indeed when testing receivers or experimenting with them. It can be disconnected in a few moments, so that the battery can be replaced when the receiver is to be taken elsewhere. No circuit changes whatever are needed in the receiver.

The circuit is shown in Fig. 1. The transformer isolates the secondary circuit and receiver from the mains. Two rectifiers are used in a full-wave circuit, with a centre-tapped secondary winding. The 220Ω resistor draws a current of about 45mA, and as a result the output voltage is largely stabilised against fluctuations which would otherwise arise with changes in current drawn by the receiver. The $100\mu\text{F}$ condenser is for smoothing.

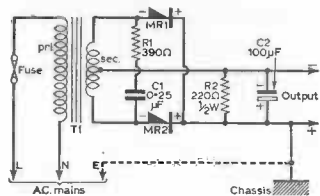


Fig. 1. The circuit of the power-supply unit.

Constructional Details

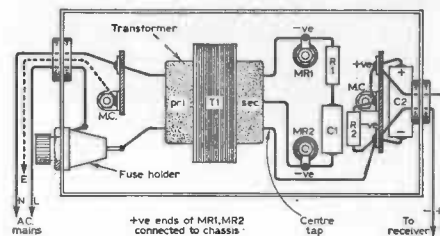
Fig. 2 shows the layout of parts, and all wiring. A box approximately 4in × 2in × 1½in deep will easily hold the components. An aluminium plate is cut to fit in the box, with a little clearance, and the parts are assembled on this.

Both rectifiers are bolted to the chassis-plate by their positive terminals, and the plate is also common to the mounting tag of the 3-tag strip, and the positive lead of the output circuit. It is essential that the centre-tap of the secondary goes to the negative side of the circuit, as shown. The 100μF condenser should have an insulated sleeve, or should be covered with some type of insulation, to avoid contact between the can (negative) and chassis.

Twin flexible leads of convenient length pass through a grommet, to supply the receiver. If the receiver uses any of the popular kinds of 9V battery, a pair of battery clips can be soldered to these leads. The battery leads of the receiver may then be clipped to the output leads of the eliminator with a minimum of trouble. If the receiver uses a battery with sockets, a suitable socket strip can be purchased, or obtained from an old battery.

For the mains circuit, use good quality flex. A 100mA fuse is inserted in the fuse-holder, and it is preferable that this fuse be wired in the "live" mains lead, as in Fig. 1, so if a non-reversible (3-pin) plug is used, employ red for this lead, and take it to the "L" pin of the plug. Black is then

Fig. 2. The wiring of the unit.



used for "N" (neutral). When a 3-pin plug is available, the chassis and secondary circuit can be earthed at the earth-pin, as shown by the dotted line in Fig. 1.

Testing

If a meter is available, connect it to the output leads, and insert the mains plug. The meter should show about 9V, the exact figure depending on the mains voltage, etc. The voltage on the prototype was found to read just over 9, with no load, and slightly under 9 with a receiver drawing 16mA. This compares favourably with a battery, and is suitable for any set of the usual type.

COMPONENTS LIST

Resistors:

- R1 390Ω ½W
- R2 220kΩ ½W

Capacitors:

- C1 0.25μF 150V working
- C2 100μF 12V working electrolytic
- MR1, MR2 GJ7-M rectifiers
- T1 9V-0-9V transformer (Osmor)
- Two tag-strips, 100mA fuse, fuseholder, etc.

Polarity

The meter will confirm that polarity is correct—it is essential that this is so. If the clips or sockets have been soldered to the correct leads, it will be impossible to connect the receiver incorrectly.

4.5V Output

Some transistorised receivers work from 4.5V batteries and a 4.5V output can be obtained from this unit by dividing R2 into two resistors in series, each of 100Ω , and taking the negative output from their junction. This output will be about 4.5V, the actual value depending upon the mains voltage and the current taken by the receiver being fed. A capacitor of $100\mu\text{F}$, 6V working, should be connected between the junction of the two 100Ω resistors and the positive line for additional smoothing.

The 4.5V output should be used only for feeding small receivers which require little current—such as those described in Chapters 2 and 7.

Mains Portable with Two R.F. Stages

THIS handy little receiver was first built with one r.f. stage followed by a diode detector and in this form it gave good service. When later it was required for use in a less favourable location, a second r.f. stage was added to increase the sensitivity.

The signal is supplied by a ferrite-rod aerial (L1, L2 in Fig. 1) and two r.f. pentodes, EF91, are used to amplify it to a suitable detection level.

The full gain of the two stages is not required and indeed could not be used with stability, so the gain is reduced by resistance loading in both anode circuits and by omitting by-pass capacitors from the cathodes. If greater gain is required, one or both of these capacitors may be inserted in the manner of C4, which is shown dotted in Fig. 1. Decoupling is provided in both anode circuits.

The inductance of the rod aerial is adjustable within fairly wide limits and the second tuned circuit, which is

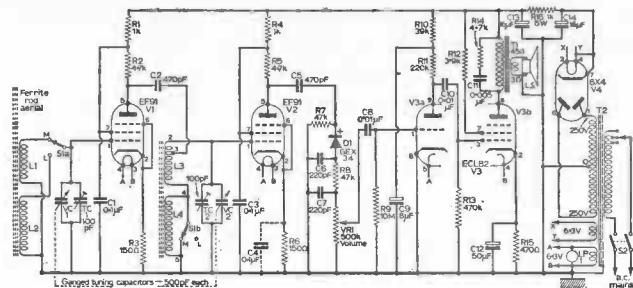


Fig. 1. The complete circuit of the receiver.

ganged to it, may therefore incorporate any dual range dust-cored coil designed to cover the long and medium-wave bands with a 500pF tuning capacitor.

Demodulation

The signal at the anode of V2 is rectified by a germanium diode D1 (GEX34). After passing through the r.f. filter C6, R8, C7, audio frequencies appear across the volume control, VR1 together with a d.c. voltage, negative with respect to chassis, which is used for alignment purposes, as will be described.

A.F. and Output Stages

A triode-pentode valve, ECL82, is used here in a conventional arrangement. Grid-leak bias for the triode section avoids the need for a bias resistor and capacitor, but the pentode bias resistor must be by-passed in the normal manner in order to avoid negative current-feedback which is, of course, undesirable in an output stage. The optimum load of the valve is 5600Ω and to match this to a 3Ω loud-

speaker, the output transformer must have a ratio of about 45:1.

If the d.c. resistance of the primary is more than about 200Ω, it is advisable to insert a resistor (R12) in the screen supply so that the voltage at the screen will not exceed that at the anode. The network R14, C11 serves to correct the response at the higher audio frequencies where valve and loudspeaker impedance rise considerably.

Power Supply

The receiver requires an h.t. supply of about 60mA at 210V and a heater supply of rather less than 2A at 6.3V. The use of a double-wound mains transformer to supply this makes the chassis safe to handle at all times and considerably reduced mains-borne interference.

It is convenient to have a separate 6.3V winding to supply the heater of V4 so that there is not a large potential difference between its heater and cathode, but if only one winding is available, it is quite in order to include the heater of V4 with the others. If this is done, the winding should be rated at not less than 2.5A and it is most important to omit the connections between pins 4 and 7 to the rectifier (see Fig. 1).

Smoothing is provided by R16 in conjunction with the electrolytic capacitors C13 and C14, while R10 and C9 provide a little extra for the anode of V3a. The value of R16 may need adjustment in some cases to produce the correct h.t. line voltage. The mains switch is incorporated with VR1.

Construction

The receiver is constructed on a chassis of 18 s.w.g.

aluminium sheet, 9in × 2in, details of which are given in Fig. 2. The layout is not critical. The grid circuit of V1 which includes the aerial, is the point where instability is most easily introduced and care must be taken that it is not capacitively coupled to any of the later wiring. V1 and V2 must be screened.

The trimmers TC1 and TC2 are mounted on top of the tuning capacitor, and a small screen should be erected between them. The pilot-light is also mounted on top of

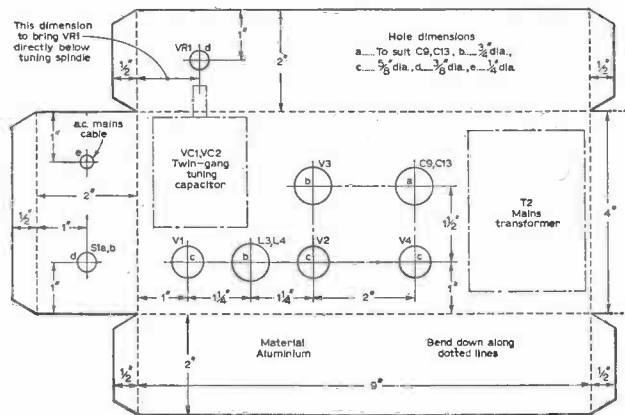


Fig. 2. The drilling details of the chassis.

the tuning gang and to achieve a symmetrical appearance in the finished receiver, should be positioned so that its height above the tuning-spindle is equal to the distance between the tuning-spindle and the spindle of VR1 below.

The aerial is mounted in an aluminium bracket, details of which are given in Fig. 3. Rubber grommets should be inserted in the two 3/8in holes and the ferrite rod passed through them. The metal can then be closed up to obtain

COMPONENTS LIST

Resistors:

(20% $\frac{1}{2}$ W carbon unless otherwise stated)

R1 1k Ω	R5 4.7k Ω	R9 10M Ω	R13 470k Ω
R2 4.7k Ω	R6 150 Ω	R10 39k Ω	R14 4.7k Ω
R3 150 Ω	R7 47k Ω	R11 220k Ω	R15 470 Ω 1W
R4 1k Ω	R8 47k Ω	R12 3.9k Ω	R16 1k Ω 1W

VR1 500k Ω carbon pot. with switch (S2)

Capacitors:

C1 0.1 μ F paper 350V	C8 0.01 μ F paper 350V
C2 470pF ceramic or mica	C9 8 μ F electrolytic 350V
C3 0.1 μ F ceramic or mica	C10 0.01 μ F paper 350V
C4 0.1 μ F ceramic or mica	C11 5000pF paper 350V
C5 470pF ceramic or mica	C12 50 μ F electrolytic 25V
C6 220pF ceramic or mica	C13 16 μ F electrolytic 350V
C7 220pF ceramic or mica	C14 16 μ F electrolytic 350V
VC1 500pF twin-gang	TC1 100pF trimmer
VC2 500pF twin-gang	TC2 100pF trimmer

Valves:

V1 EF91	V2 EF91	V3 ECL82	V4 6X4
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Diodes:

GEX34 or similar

Miscellaneous:

LPI 6.3V 0.3A; T1: Output, 45: 1; T2: Tapped primary—secondaries: 250V-0-250V 60-70mA, 6.3V 2A, 6.3V 1A; LS 3 Ω ; 7in × 4in elliptical; S1 2-pole, 3-way; S2 d.p.s.t. (see VR1); L1, L2 Ferrite-rod aerial, type FRA. 2; L3, L4 Miniature, dual-range, dust-cored. Three B7G valveholders: one B9A valveholder; screening cans for V1 and V2; material for chassis.

a good tight grip. Take care in closing up the edges of the metal that they do not meet, or the equivalent of a shorted turn will be formed around the rod and its inductance will be reduced.

The second tuned circuit, L3, L4, is mounted above

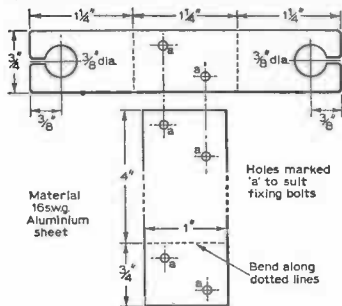


Fig. 3. The mounting-bracket for the ferrite-rod aerial.

chassis in a screening can. Some manufacturers supply coils in aluminium containers which can be used for this purpose but any seamless container of suitable shape and size will do. Do not forget to remove any paint, paper labels, etc., from the lid before bolting it to the chassis.

The coil used in the prototype was designed to plug into a B9A valveholder which was fitted below the chassis on the 6 B.A. bolts used to secure the lid of the can.

Components and Wiring

No special components are needed but it is advisable to use good quality mica capacitors for C2 and C5 because their insulation is important. Resistors can be mostly $\frac{1}{2}W$ or $\frac{1}{4}W$; where higher ratings are required they are specified in the list of components. Capacitors should be 350V working except for C12 for which 25V will suffice.

A complete wiring diagram for the two-stage receiver is given in Fig. 4. In order to make the connections clear, the positions of the components are only approximate and the wiring has been opened out. In construction, components should be fitted in the most convenient positions and wiring should be no longer than necessary.

Tinned copper wire of 22 s.w.g., covered with sleeving is suitable for all the wiring. The "earthy" end of L2 is taken to chassis on the aerial supporting bracket and is consequently not shown in Fig. 2.

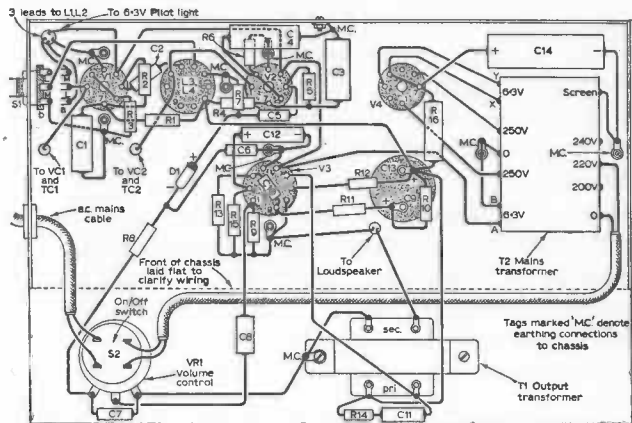


Fig. 4. The below-chassis wiring of the receiver.

Testing

When construction is complete, test with a meter between C14 and chassis to see that there are no shorts in the h.t. wiring. If all is well, switch on and check that voltage is present at the anodes and screens of the valves. Measure the voltage of the h.t.-line; it should be between 200 and 220 and if it is not, it must be brought within this range by altering the value of R16.

Alignment

Set the tuning capacitor near the fully open position,

switch to m.w. and fix the aerial coil L₁ temporarily in position about $\frac{1}{4}$ in from the end of the ferrite rod. Tune in a station at the high frequency end of the band and peak it with the trimmers TC₁ and TC₂.

If a high resistance voltmeter or a "magic-eye" tuning indicator is available, connect it across VR₁, positive to chassis; it will give a more accurate indication of optimum response that can be obtained by ear.

The next operation is to match the inductances of the two circuits. Tune in a station at the low frequency end of the band and adjust the position of L₁, at the same time moving the tuning capacitor back and forth a little till the optimum combination of settings is found. Adjust the core of L₃ for maximum signal. Repeat the adjustments at each end of the band after which L₁ can be fixed in position with a little wax. The final adjustment should be to the trimmers at the high frequency end of the band.

Now turn the switch to the long-wave position and adjust the position of L₂ and the setting of the tuning capacitor for optimum reception of the Light Programme on 200kc/s. Fix L₂ in position. Do not make any alteration to the trimmers.