SIMPLE RADIO CIRCUITS...

a complete 'build your own radio' guide. Every page is packed with expert practical advice and, for those who have recently joined the ranks of the wireless enthusiast, valuable and instructive experience will be gained by building this up-to-date selection of receivers.

SIMPLE RADIO CIRCUITS

A COMPLETE 'BUILD YOUR OWN RADIO' GUIDE

A.T.COLLINS

NEW

SIMPLE RADIO CIRCUITS

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Simple Mains Short Wave Receiver

THIS simple receiver is very suitable for all beginners. If used as a single-range receiver, it will cover approximately 15m to 40m, and this includes those bands most generally used for long distance reception. The set also works well on other wavebands, over the range 9m to 200m, and can easily be wired to take plug-in coils.

Circuit

The circuit is shown in Fig. 1, and none of the component values are critical. The tuning capacitor, VC1, is shown as 160pF, but 100pF to 200pF may be fitted, with some change in band coverage. Current is obtained from a mains power pack, and the phones are isolated from h.t. and main voltages. The receiver will be safe, if the power pack is arranged as described. Consumption is quite low, and it may be possible to take supplies from an existing amplifier or receiver. If so, the safety precautions mentioned for the power pack should be observed.

Regeneration in the detector is controlled by VR1 and this gives high sensitivity. Reaction is obtained by a cathode tap on the coil L1, and this is an effective and very satisfactory

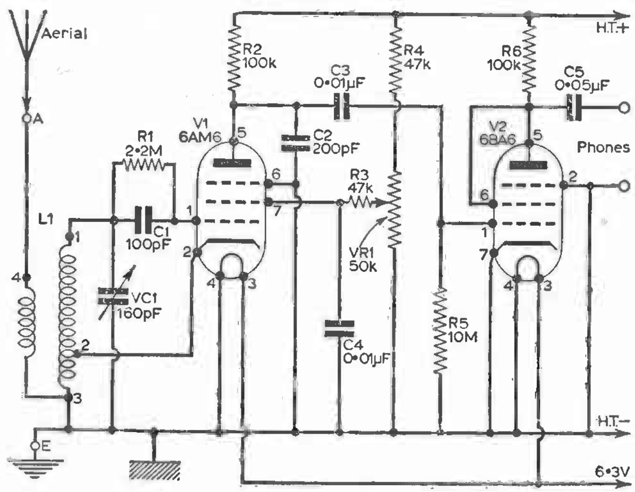


Fig. 1. The receiver circuit less power supplies.

method. The second valve (V2) acts as an audio amplifier, with bias developed across R5, which is 10MΩ. C3 should be a mica capacitor to avoid upsetting working conditions.

Coil Windings

For a single, fixed coil, a waveband of about 15-40m is most generally satisfactory, as mentioned. This coil is thus recommended. But if it is wished to tune other wavebands, it is quite easy to wind further coils for these. Ribbed,

COMPONENTS LIST

Resistors:

R1 2·2MΩ	R3 47kΩ	R5 10MΩ
R2 100kΩ 1W	R4 47kΩ 1W	R6 100kΩ 1W

All ±10%, $\frac{1}{2}$W carbon unless otherwise stated
VR1 50kΩ potentiometer

Capacitors:

C1 100pF mica
C2 200pF mica
C3 0·01µF mica
VC1 160pF air-spaced variable
C4 0·01µF paper 250V
C5 0·05µF paper 500V

Valves:

V1 6AM6 V2 6BA6

Miscellaneous:

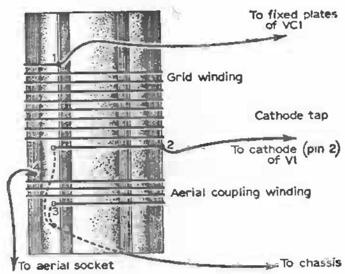
Aluminium chassis 7 in. × 4 in. × 2$\frac{1}{2}$ in. Aluminium panel 7 in. × 4 in. Two B7G valveholders. Slow-motion tuning drive and dial. Two twin-sockets for aerial, earth and 'phones. 1$\frac{1}{2}$ in. dia. ribbed coil former, 2$\frac{1}{2}$ in. long, with chassis socket if plug-in type (Eddystone). Small, insulated tag strip. Bracket for VC1. Two knobs. Tinned copper wire for coils. Connecting wire, nuts, bolts, etc.

plug-in coil formers, with a chassis mounting holder to suit, may be easily obtained and as many coils as wanted can then be wound.

For the 15-40m coil, a ribbed former about 1$\frac{1}{4}$ in. to 1$\frac{1}{2}$ in. in diameter, and at least 2 in. long, will be required. The windings are shown in Fig. 2. There is no need to adhere to the exact wire gauges, turns spacing, or other details. Changes in these, or in the coil diameter, will modify the band coverage, but results should be just as good.

The "grid winding" of the 15-40m coil consists of 9 turns of 22 s.w.g. tinned copper wire, turns being spaced to occupy about 1 in. The "cathode tap" is soldered on one-half turn from the earthed end of the winding. For "aerial coupling",

Fig. 2. Details of the aerial coil, L1.



4 turns of 26 s.w.g. wire are used, this winding being about $\frac{1}{8}$ in. from the grid winding, as in Fig. 2. The ends of both windings are joined, as indicated, this lead going to the receiver chassis.

Other Ranges

If required, other coils can be wound to give approximate bands as follows:

9-15m 4 turns 20 s.w.g. occupying 1 in. space; tap at $\frac{1}{2}$ turn; aerial coupling, 2 turns.

30-60m 16 turns 24 s.w.g. occupying $1\frac{1}{2}$ in.; tap at $\frac{3}{4}$ turn; aerial coupling, 6 turns.

60-110m 32 turns 24 s.w.g. occupying $1\frac{1}{2}$ in.; tap at 1 turn; aerial coupling, 8 turns.

100-200m 55 turns 24 s.w.g. occupying $1\frac{1}{2}$ in.; tap at $1\frac{1}{4}$ turns; aerial coupling, 12 turns.

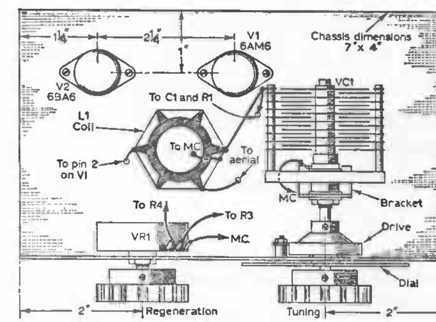
Aerial coupling windings of coils covering 30 to 200m can

be of 28 s.w.g. or similar enamelled wire, with turns side by side, to save space.

Chassis and Panel

Fig. 3 shows the layout, the chassis being 7 in. × 4 in. and 2 in. or $2\frac{1}{2}$ in. deep. The panel is 7 in. × 6 in. and is secured to the front runner of the chassis by means of two 6 B.A. bolts. This layout allows the valveholder holes to be suitably placed, and indicates the positions for valves.

Fig. 3. Components and connections above chassis.



Further details of the tuning drive will be seen in Fig. 5. The dial is just clear of the panel. Some form of reduction drive is essential and a small ball-drive of this kind is easy to fit. The projecting lug on the drive must be prevented from rotating, and this is arranged by passing a bolt through the panel, as in Figs. 3 and 5. A slotted bracket will allow the tuning capacitor to be mounted at the correct height, so that the whole turns smoothly.

Wiring

The moving plates tag of the tuning capacitor is connected to a tag bolted to the chassis. Lead 1 from L1 is left long enough to reach the fixed plates (Fig. 3). An insulated lead also passes from this point, through the chassis, to R1 and C1.

Lead 4 of the coil is long enough to reach the aerial socket, and is covered with sleeving. The cathode tap goes to pin 2 of V1. The remaining coil lead passes directly through the chassis to a tag.

Three leads are taken from the 50kΩ potentiometer; all these may be passed through a single hole, provided they are correctly identified, or the lead marked "M.C." may be earthed to the panel at the potentiometer bush.

Wiring and components under chassis will be seen from Fig. 4. A tag is placed on each bolt holding the valve-holders, and also on the bolt near the earth socket. These points, marked M.C., must make good contact with the chassis. If the valveholders are the type with a centre metal spigot, this is joined to the nearest M.C. tag.

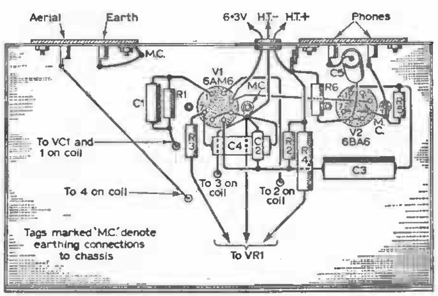


Fig. 4. The main wiring underchassis.

A single tag, on a small tag strip, and insulated from the chassis, forms the h.t. positive junction point, for R2, R4 and R6. The three power supply leads emerge through a grommet in the rear runner, and should be identified to make sure there is no error in connecting the receiver to its power pack. A lead from the chassis forms the h.t. negative

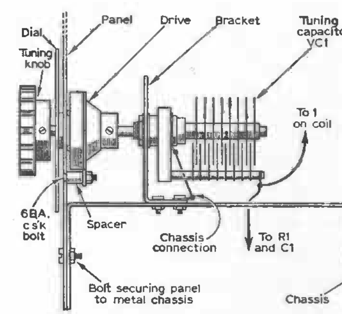
connection, and is also the return to the heater circuit. Pins 3 on both holders are joined, and the lead from this point is for the 6·3V supply. The remaining lead is for h.t. positive, as described.

The wires from R1 and C1 to pin 1 should be short, to avoid hum. For the same reason, the wires from C3 to R5, to pin 1 of the second holder, should be short, direct, and clear of the heater lead.

Power Supply

If a mains unit is to be constructed for the receiver, the circuit in Fig. 6 will be satisfactory, and can provide current for larger equipment than this receiver. The 6X5 requires 0·6A for its heater. Added to the 0·6A of the V1 and V2 heaters, the total consumption is 1·2A, so a 1·5A winding will easily provide this current, and also current for

Fig. 5. Details of the tuning drive mechanism.



a 6·3V, 0·3A indicator lamp, if wanted. A 6·3V heater winding with a higher current rating is also suitable.

The receiver requires a very small h.t. current, at 150V to 250V or so. For the receiver only, the smoothing choke may be replaced by a 5kΩ resistor. However, the power pack is more useful for other purposes when a choke is used. The h.t. voltage will rise somewhat, with little or no current drawn, so a 47kΩ bleeder resistor is fitted. The h.t. voltage can be reduced, if wished, by wiring a resistor between the 60mA fuse and the choke. This fuse is merely to protect the rectifier and transformer, in the event of an h.t. short.

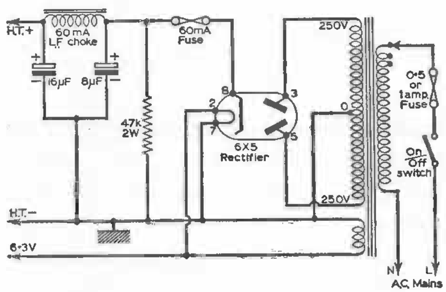


Fig. 6. Circuit of the power pack.

Current is drawn from a 3-pin plug, and the chassis of the receiver is earthed. If this earthing is effective, and a 500mA or other low-rating fuse is included in the mains circuit as in Fig. 5, mains voltages cannot be present at the receiver, even if the mains transformer were faulty.

If preferred, the power pack can be scaled down, to provide a supply of up to 10mA or so, at 150V to 200V. This can be arranged by using a small metal rectifier, and "feeder" type mains transformer. The earthing, and mains fuse should not be omitted, however.

The receiver must *not* be worked from an a.c./d.c. power circuit, in which the h.t. negative line is connected to one mains lead.

Operating Notes

Any kind of aerial can be used, including short indoor

wires. Naturally a fairly efficient aerial will give best results with the weaker, more distant stations. If the aerial is at all long, a small capacitor should be added in series with it, at the receiver. A 25pF pre-set trimmer is suitable, or the lead-in can be twisted for a few inches round another insulator wire, to form a small capacity.

Tuning will be very sharp and critical, especially with weak stations, and with loose aerial coupling. Reaction is also very critical, with weak distant stations. Powerful stations will be heard easily, and the exact setting of the reaction control will not then be very important, but, for weak stations, this control must be operated very carefully. It is slowly turned clockwise, from zero, until the set is just on the point of oscillation. Sensitivity is then extremely high, and very long distance reception is possible. The reaction control should be carefully adjusted, as necessary, while tuning. It must not be rotated too far, or the receiver will oscillate and sensitivity will be reduced.

2

Medium Wave Transistor Receiver

THIS set is of extremely simple construction, and is thus ideal for beginners looking for an easy, straightforward circuit. There are three stages—a crystal diode detector, followed by an audio amplifier, and a Class A output stage. The set is intended to run from a L5048 or similar $7\frac{1}{2}$V battery, though a 9V battery may be used.

The circuit is shown in Fig. 7. A receiver of this kind is not intended for reception of distant or overseas stations, and it requires some kind of aerial and earth. For local station reception, for which it is intended, an indoor aerial should usually be sufficient. The aerial may be taken to tappings B and D, or to the beginning of the coil L1 (A) according to conditions.

There is no reason of course, why a ready-made coil should not be used for L1, but then it must be wired to agree with the maker's data. As the receiver will also be

found to work well on long waves in those areas where the Light Programme on 1500m is available, a small three-way rotary switch can replace the on/off switch, to facilitate dual-wave tuning. In this case, a suitable coil should be wired up according to the coil maker's instructions leaflet.

Components

Holders are used for the transistors. This avoids possible damage due to overheating when soldering, and allows any

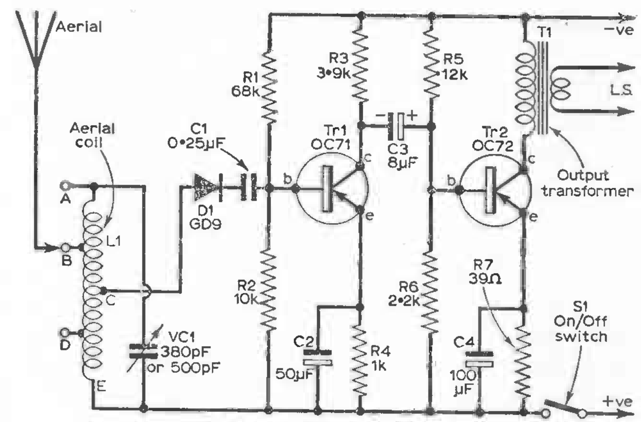


Fig. 7. The two-transistor circuit.

audio frequency transistors which are to hand to be tried. The transistor in the Tr1 position can best be an OC71 or similar type, while the Tr2 transistor is an OC72 or similar output type. Results obtained with spare transistors can easily be compared by inserting them in the holders.

For optimum amplification, resistor values are quite important. It is easy to check the working of each stage, with 'phones and a meter, as described later.

Capacitor values are not particularly critical. VC1 is a midget air-spaced capacitor of about 380pF, but the value is not important, and a 500pF solid-dielectric tuning capacitor could be used instead. Alternatively, a 500pF air-spaced capacitor, or similar component would be suitable. C1 may be 0·1μF to 0·5μF, C2 may be 32-100μF, while C3 may be 4-8μF.

The output transformer T1 is a non-miniature transistor-type component. The loudspeaker specified is a highly sensitive one, but there is no actual need to use this particular size. Many speakers have a 2 to 3Ω speech coil, and these require a 2 to 3Ω secondary on the transformer T1.

COMPONENTS LIST

Resistors:

R1 68kΩ	R3 3·9kΩ	R5 12kΩ	R7 39Ω
R2 10kΩ	R4 1kΩ	R6 2·2kΩ	

All $\pm$10%, ½W carbon

Capacitors:

C1 0·25μF paper
C2 50μF electrolytic 3–6V
C3 8μF electrolytic 6–9V
C4 100μF electrolytic 3–6V
VC1 380pF or 500pF variable

Semiconductors:

Tr1 OC71 Tr2 OC72 D1 GD9 crystal diode

Miscellaneous:

S1 S.P.S.T. toggle switch
T1 Output transformer, ratio 8:1
Ferrite slab. Transistor holders. Piece of Paxolin, 8 in. × 4 in. 3½ in 3Ω loudspeaker (W/B HF.3·57 or similar). Control knob. 28 s.w.g. d.c.c. wire for coil. L5048 battery or equivalent. Connecting wire, etc.

Speakers of other impedance may be used, with suitable matching transformers. A 75Ω loudspeaker, however, may be connected directly, with no transformer.

Preparing the Paxolin Panel

The receiver is built and wired on a Paxolin panel 4 in. × 8 in. Material $\frac{1}{16}$ in. thick is sufficiently strong, though $\frac{3}{32}$ or $\frac{1}{8}$ in. Paxolin could be used. All the holes are drilled as indicated in Fig. 8. Holes for leads can be made with a

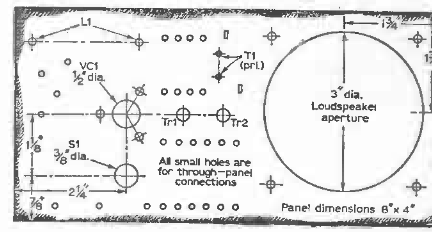


Fig. 8. Drilling details of the Paxolin panel.

$\frac{1}{16}$ in. or similar small drill. Holes for the speaker and L1 mounting bolts should be about $\frac{1}{8}$ in. diameter, while VC1 is secured with three short 4B.A. bolts.

If any alternatives are made use of, such as to the speaker or VC1, these holes should be modified to suit. T1 has two lugs, which are passed through slots and twisted. These slots can be made by drilling two or three small holes close together.

All holes are drilled before mounting any parts. The transistor holders are made a tight push fit in their holes, and are held with a touch of cement. The speaker can be left off until wiring is otherwise finished.

All the components are fitted to the panel, on the back, as in Fig. 9. C2, C3 and C4 have positive and negative ends, so their leads must be inserted through the holes as indicated. There should be no possibility of wiring or component value errors, if care is taken to insert the resistors and capacitors as shown.

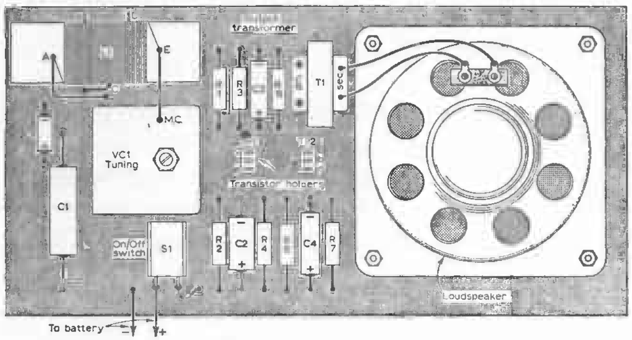


Fig. 9. Layout of components on the rear of the panel.

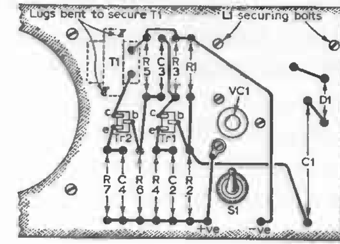
Winding the Tuning Coil

The tuning coil is wound with 28 s.w.g. double cotton covered wire, on a ferrite slab about $\frac{1}{8}$ in. × $\frac{5}{8}$ in. × 3 in. Referring to Figs. 7 and 9, there are 20 turns from A to B, six turns from B to C, six turns from C to D, and 20 turns from D to E, making a total of 52 turns. All turns are wound in the same direction, closely side by side, and some modification to the number of turns, or gauge of wire, or the size of the slab, will not be very important.

The tapping points B, C and D can be made by twisting small loops, during winding, and a dab of cement will hold the ends A and E, which are left long enough to reach VC1. A is taken to the fixed plates tag, and E goes to the frame, which is also connected to the battery positive line, on the other side of the panel.

Two small blocks of hardwood or other insulating material are secured to the Paxolin by means of small screws. The

Fig. 10. Front-of-panel wiring details.



ferrite slab rests on top of these blocks, and is held with elastic bands passed through holes, and tied.

Wiring

All wiring is on the front of the panel, and is very simple. Leads can be of any thin, insulated wire, and all connections are kept flat against the Paxolin. Wiring is shown in Fig. 10. Point +ve joins a tag held by one of the bolts securing the variable capacitor. These bolts must be short, or have washers, so that they do not touch the fixed plates of the capacitor. With the solid dielectric type of capacitor, take the lead through to the moving plates tag.

Clips, or a non-reversible 2-pin plug, may be obtained for the battery, and are convenient, while assuring the battery is not wrongly connected. If a meter is to hand, this may be connected in series with one battery lead, when first testing the receiver. More than 9V should not be used, and the battery must never be connected the wrong way round.

Testing

An earth was not found to be essential in some cases, but is preferable, as much better volume is then obtained. A simple indoor aerial can be arranged by having a few yards of thin, insulated wire round the room, near the ceiling. An outdoor aerial will usually give better volume, but is not essential.

The aerial lead is taken to the tapping which gives best results. Point A gives best volume, especially with a poor aerial. Points B and D allow rather more selective tuning, especially with a fairly long aerial.

With no transistors or battery, headphones may be wired across R2. Reasonable headphone volume should then be obtained. If not, the diode (D1) may be suspected, or wiring, etc., in this stage, or the aerial and earth system may be too inefficient. With any reasonably effective aerial, and an average earth, quite good 'phone volume should be obtained from local stations.

The 'phones may then be wired in parallel with R6, and Tr1 inserted. (There is no need to cut the transitor leads, but thin sleeving should be placed over them, to avoid shorts. It is essential that the collector, base and emitter leads are inserted in the correct sockets, as in Figs. 9 and 10.)

Volume should now be very much increased. Current consumption of Tr1 will depend on the transistor, but can be expected to be around 1mA. If the stage does not amplify, or if results are distorted, suspect the transistor, or wiring, etc. If Tr1 is of a type much different from that mentioned, the values of R1 and R4 may need changing.

The 'phones can then be removed, and Tr2 inserted. Consumption should be around 18mA to 25mA, with average loudspeaker volume. If current is over about 25mA, with the values shown and a particular transistor of different type, R5 may be increased in value, until the set draws about 20mA or so. If current is low, with lack of volume, R5 may be reduced in value, until the set draws about 20mA. An L5048 or similar battery will have a long life, with this current drain.

Cabinet

The receiver is not intended for portable use, so the

smallest possible cabinet is not required. If no cabinet is to hand, one can be constructed from thin wood.

The receiver front consists of a piece of Paxolin or any other thin material, with holes to agree with VC1, on/off switch (S1), and the speaker aperture. Silk or other fabric is stretched over the front, and cemented round the edges. Holes are cut in the fabric to clear the switch, and the spindle of VC1.

The securing nut of the switch is removed, and washers are placed on the spindle, so that the front panel will just clear the receiver wiring. The two panels are then locked together with the switch nut, and a control knob is placed on the tuning capacitor spindle.

3

Dual Wave One-valver

THIS receiver is of small size, but neither miniature components nor a very compact layout have been adopted. Construction is thus very easy indeed, and the completed receiver is inserted as a single unit into its cabinet. The circuit is shown in Fig. 11, and uses an ECC83 or 12AX7 double-triode. This valve has a heater which may be operated from a 6·3V or 12·6V transformer. In the wiring diagram (Fig. 13) the heater is wired for 6·3V operation. If a 12·6V transformer is to hand, heater circuit connections are made to pins 4 and 5 on the holder, and pin 9 is not used.

The Function of the Components

The set covers long and medium waves. C1 is an isolating capacitor, and is fixed on the inside of the cabinet, so that a length of thin flex may be attached to it, to use as a "throw

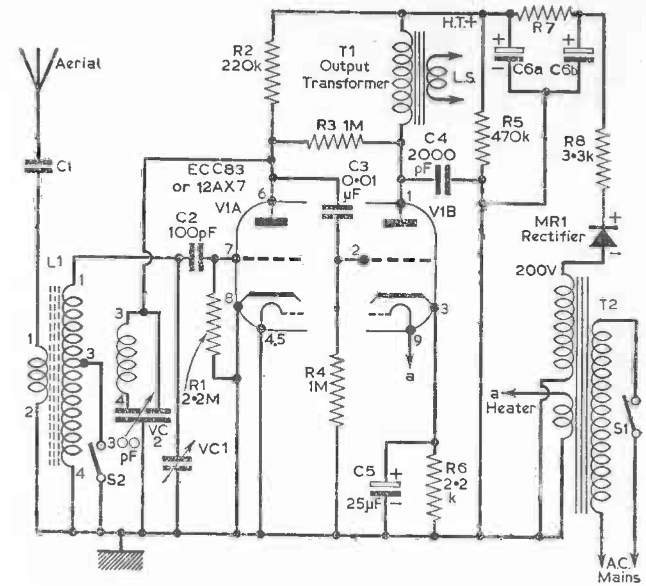


Fig. 11. The complete circuit.

out" aerial. If a short aerial will always be used, a 500pF mica capacitor will be satisfactory here. If a longer or better aerial can be provided, results can be improved by using a much smaller value such as 50pF. Alternatively, a small pre-set capacitor may be joined in series with C1, and adjusted for best results. The value is in no way critical, but selectivity is improved if C1 (or the pre-set) is of fairly low capacity.

VC1 is for tuning, and in the interests of small size a 384pF air-spaced capacitor was fitted. The usual 500pF air-spaced capacitor is too large to be accommodated, unless panel and chassis dimensions are slightly increased. A 500pF solid-dielectric capacitor may be used, but is less efficient.

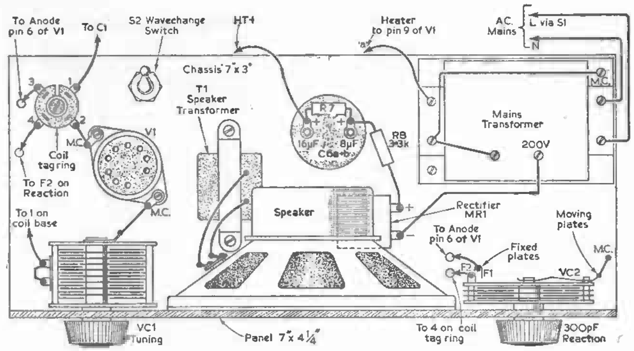


Fig. 12. Chassis and panel dimensions, layout and wiring above chassis.

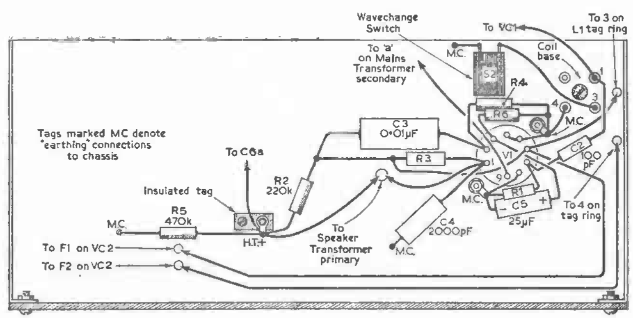


Fig. 13. Underchassis wiring. As an alternative arrangement, S1 and S2 could be mounted on the side of the cabinet.

As the valve has a high gain, some negative feedback is introduced by the 1MΩ resistor (R3) between anodes. The anode current is small, and permits a personal portable type of output transformer to be used. (These are intended for 3S4 and similar all-dry output valves.)

H.T. is obtained from a small contact-cooled rectifier (MR1) with series resistors for smoothing, and to keep the voltage down to a suitable figure. The mains switch is a lead-through type, as used for lamps, etc., and included in the flex to the receiver.

Chassis Details

The chassis is 7 in. × 3 in., with ½ in. runners at either end and can be made from a piece of aluminium 8 in. × 3½ in. The front ends of the side runners are bent over, forming brackets to which the panel is bolted (Fig. 13). The panel is of 3-ply, and is 7 in. × 4¼ in. with holes for variable

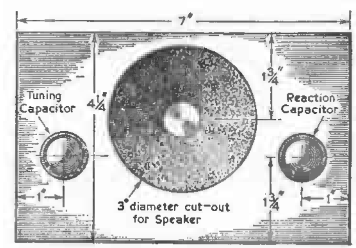


Fig. 14. Details of the front panel.

capacitors and the loudspeaker, as shown in Fig. 14. It is covered with silk or similar material after construction is finished.

Construction

Fig. 12 shows components and wiring above the chassis. The heater consumption is only 0·3A at 6·3V so the smallest type of mains transformer will suffice. That fitted to the prototype was a "converter" transformer. The h.t. winding should give about 200V at 20mA but transformers giving 150–180V will be suitable also.

COMPONENTS LIST

Resistors:

R1 2·2MΩ	R3 1MΩ	R5 470kΩ	R7 3·3kΩ
R2 220kΩ	R4 1MΩ	R6 2·2kΩ	R8 3·3kΩ

All ±10%, ½W carbon

Capacitors:

C1 500pF mica see text	C4 2,000pF
C2 100pF	C5 25μF electrolytic
C3 0·01μF mica	C6a, b 16+8μF elec. 350V

VC1 208+176pF air-spaced variable (Jackson)
VC2 300pF differential reaction

Transformers:

T1 Small output transformer to suit loudspeaker
T2 Mains transformer. Primary to suit mains. Secondaries 180–200V 20mA; 6·3V 0·6–2A

Miscellaneous:

V1 ECC83 or 12AX7
MR1 250V contact-cooled rectifier
S1 Lead-through S.P.S.T. mains switch
S2 Insulated S.P.S.T. toggle switch
L1 QR11D coil (Osmor)
B9A valveholder. Aluminium chassis 7 in. × 3 in. 3½ in. dia. permanent magnet loudspeaker. Wood for panel and cabinet. Two knobs. Insulated tag, nuts, bolts, wire, etc.

The double smoothing capacitor has a tag soldered to its common negative lug so that it can be bolted to the chassis. The frame of the tuning capacitor VC1 is also connected to the chassis. To obtain the 384pF capacity with the small capacitor listed, both sets of fixed plates are wired in parallel, as in Fig. 12.

The reaction capacitor (VC2) is a differential type, and thus has two sets of fixed plates. These are marked F1 and

F2 in Fig. 12. The moving plates tag is joined to the chassis.

Transformer Wiring

Leads from the speaker transformer (T1) secondary pass to the speaker unit speech coil tags, as in Fig. 12. Primary leads from the transformer pass through the chassis, to the h.t. positive line and pin 1 on the valveholder. The rectifier is bolted to the chassis, under the speaker. The total h.t. consumption is only a few milliamps, so a very small rectifier is satisfactory. It must, however, be intended for a 250V a.c. input.

Connect a length of twin flex to the mains transformer (T2) primary. Take one side of the circuit to the neutral pin of the mains plug—this is marked "N" in Fig. 12. Wire the on/off switch (S1) in the "L" conductor of the flex, at a convenient distance from the receiver. Take this lead to the "L" pin, or internal fuse, on the mains plug.

Components and wiring under the chassis are shown in Fig. 13. The insulated tag forms a connecting point for h.t. positive. The 470kΩ resistor (R5) from here to the chassis serves to discharge the large capacitor.

Anode and grid leads should be kept short and direct, and run near to the chassis. A 0·01μF mica capacitor (C3) is recommended for coupling between stages, as any leakage will upset working.

Coil Connections

The coil specified has a square base with numbered tags, and a circular tag ring, with slot. Connections to the square end of the coil are shown in Fig. 13. The coil is supported by a very short, stout lead from tag 4 to a soldering tag, which is bolted to the chassis. Tag 1 goes to C2 and the fixed plates of VC1. A short length of thin flex is taken from tag 3 to the wavechange switch, S2. This switch may be mounted in any convenient position.

The tag ring end of the coil is shown in Fig. 12. Tag 1 goes to C1, for the aerial connection. Tag 2 is connected to the chassis. Tag 3 goes to anode (pin 6 of V1) while tag 4 is connected to F2 on VC2. If it should be found that reaction is unsatisfactory, reverse the leads going to tags 3 and 4.

The actual frequencies tuned will depend somewhat on the position of the coil core, so this should be altered, if necessary, to obtain the required coverage. Reaction should be carefully adjusted to build up the volume of weak stations. This control should not, however, be turned fully clockwise, as this will only cause oscillation and poor reception.

Preparing the Front Panel

The loudspeaker is attached to the front panel by means of wood screws, taking care these are not long enough to penetrate. A quick-drying adhesive is then applied round the perimeter of the panel, and a piece of silk or similar material is prepared by cutting clearance holes for the variable capacitors. The material is then placed on the panel, and kept taut with a few drawing pins at the edges, until the

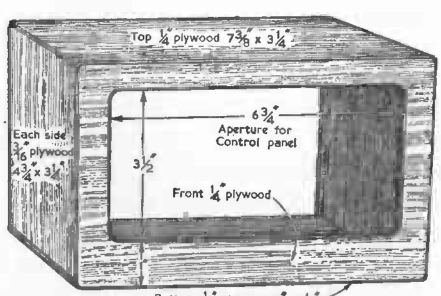


Fig. 15. Construction of a suitable cabinet for the receiver.

adhesive has dried. Any surplus material can then be cut away.

Making the Cabinet

Constructional details of the cabinet are shown in Fig. 15. Care must be taken to leave a little clearance so that the receiver can be inserted from behind. The parts are held together with glue and panel pins. When the glue has hardened, all edges and corners can be smoothed with a glasspaper block.

The finish given to the cabinet is a matter of choice. The original receiver was given a coat of quick-drying cream enamel. If there are defects in the joints or the wood has an open grain, fill with one of the packet fillers sold for such purposes, allow to dry and smooth off with glasspaper. If varnishing is preferred, two coats are best. The first should be allowed to dry, and should then be lightly sanded before applying the second coat.

4

Broadcast Bands Receiver

THIS unpretentious little receiver can be built very cheaply. Considering the extreme simplicity of the circuit, it has a very good performance and with careful manipulation of the controls, the single tuned circuit will enable all the more powerful transmissions to be received clear of interference.

Circuit

The EF91 is a high slope miniature valve which is available very cheaply indeed. Three of them are used in this receiver. The first is arranged as a pentode r.f. amplifier but it will be noticed from Fig. 16 that there is no tuned circuit associated with it. The high slope of the valve, however, goes a long way towards repairing this omission and quite a worthwhile gain is achieved. Because the EF91 does not have variable-mu characteristics it was necessary to achieve some method

of gain control other than by variation of bias, and the problem was solved very satisfactorily and simply by feeding the signal from the aerial to the slider of a 1MΩ potentiometer (VR1) in the grid circuit.

The second valve, connected as a triode, is used as a conventional leaky grid detector, regeneration being applied through the variable capacitor VC1 to sharpen the tuning and increase the sensitivity. Because the r.f. stage isolates

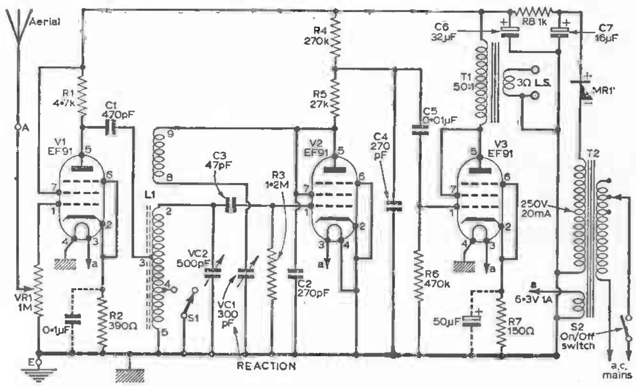


Fig. 16. The receiver circuit.

the aerial from the tuned circuit, the tuning is not affected by aerial loading and if by chance, as will sometimes happen, too much reaction is applied, the resultant oscillations will not be radiated to the annoyance of the neighbours. Resistor R5 and capacitors C2 and C3 remove the r.f. component from the output and the audio signal is passed via the capacitor C5 to V3, the output valve. This is another EF91, again triode connected. The optimum load could not be discovered but this is not of much importance with the triode connection and an output transformer having a ratio of 50:1 was found very satisfactory for a 3Ω loudspeaker.

Power Supply

A miniature double-wound mains transformer of the instrument type, having an output of 20mA at 250V and 1A at 6·3V, supplies the power in conjunction with a contact-cooled metal rectifier. Smoothing is provided by the resistor R8, and the associated electrolytic capacitors C6 and C7. A pilot or dial light, if fitted, should be 6·3V 0·04A, so as not to exceed the rating of the transformer winding. A separate on/off switch was fitted in the prototype but there is no reason why mains switching should not be incorporated with VR1. The power consumption from 240V a.c. mains is less than 20W.

Modifications

It will be noticed that the bias resistors of V1 and V3 are not bypassed. Consequently, if greater gain is required, capacitors may be fitted across them as shown in dotted outline in Fig. 16. A further increase in gain can be obtained by

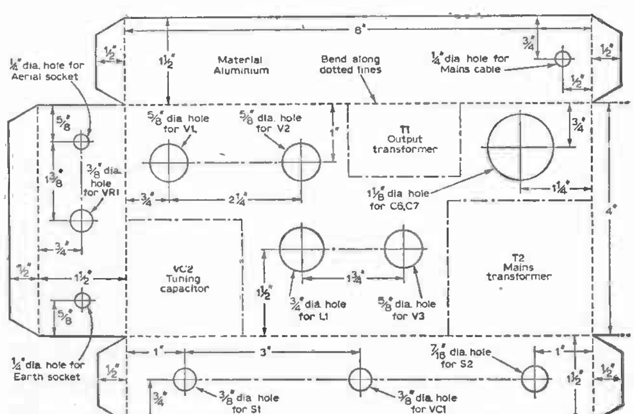


Fig. 17. Dimensions of the chassis.

reducing the value of R2 to 150Ω but this will increase the current through the valve and is permissible only if the mains transformer can accept the extra load. The total h.t. current in the prototype was exactly 20mA.

Construction

The prototype was constructed on a chassis of 18 s.w.g. aluminium sheet measuring 8 in. × 4 in. × 1½ in., details of which are given in Fig. 17. This gives plenty of room for standard size components with the exception of the reaction capacitor, VC1, where a miniature one must be used in order that it may be accommodated within the depth of 1½ in.; alternatively, the chassis could be made deeper. Construction may proceed in any convenient order. The layout and the arrangement of the wiring and components is not at all critical so long as the connections around V2 and

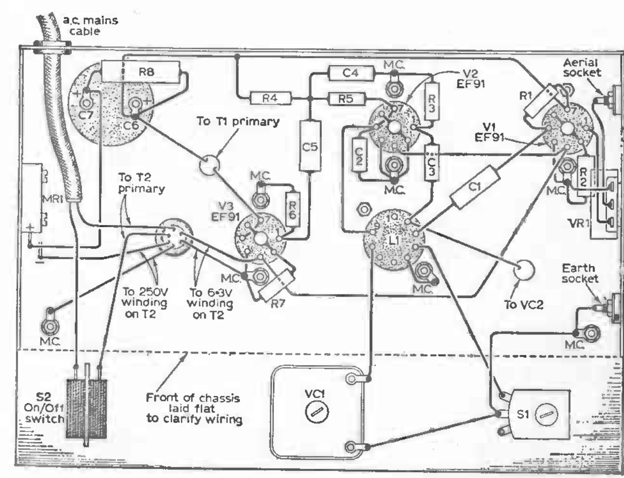


Fig. 18. The complete underchassis wiring diagram.

the coil (L1) are kept to a reasonable length. Tinned copper wire of 22 s.w.g. covered with sleeving is recommended for all the wiring, details of which are given in Fig. 18. The loudspeaker is connected direct to the secondary terminals of the output transformer on top of the chassis. It is good

COMPONENTS LIST

Resistors:

R1 4·7kΩ	R3 1·2MΩ	R5 27kΩ	R7 150Ω
R2 390Ω	R4 270kΩ	R6 470kΩ	R8 1kΩ 1W

All ±10%, ½W carbon unless otherwise stated
VR1 1MΩ carbon potentiometer

Capacitors:

C1 470pF ceramic or mica
C2 270pF ceramic or mica
C3 47pF ceramic or mica
C4 270pF ceramic or mica
C5 0·01μF paper 350V
C6 32μF electrolytic 350V
C7 16μF electrolytic 350V
VC1 300pF solid dielectric variable
VC2 500pF air dielectric variable

Valves:

V1 EF91 V2 EF91 V3 EF91

Inductor:

L1 Dual range, medium and long waves with reaction winding. Iron dust core. (Repanco DRR2)

Transformers:

T1 Output transformer; 50:1 ratio (approx.)
T2 Mains transformer. Tapped primary. Secondaries 250V 20mA; 6·3V 1A

Miscellaneous:

S1 S.P.D.T. rotary switch
S2 S.P.S.T. toggle switch
MR1 250V 20mA contact-cooled rectifier
Aerial and earth sockets. Two B7G valveholders. Aluminium for chassis. Coil socket (if required). Wire, solder tags, etc.

practice to connect one of these terminals to chassis and a solder tag should be fitted for the purpose on one of the transformer holding-down bolts.

Components

Resistors may be ½W or ¼W, except R8 which should be 1W. The smoothing capacitors have to withstand the full h.t. voltage from the rectifier when first switching on and must therefore be 350V working. Any kind of tuning capacitor, air-spaced or otherwise can be used for VC2 or one-half of a two-gang component can be used as in the prototype. The coil L1, may be any iron-dust-cored dual-wave type with a reaction winding, but it is convenient if it is designed to plug into a B9A or B7G valve base. For tuning, a 3 in. diameter engraved knob is fitted direct to the tuning capacitor but there is no reason why a slow motion drive should not be fitted if desired.

Testing and Operation

When the wiring has been completed, a test should be made with a meter between C6 and chassis to see that there are no short-circuits in the h.t. wiring. If all is well, power can be applied and transmissions should then be received. Two or three feet of wire as a throw-out aerial will usually be enough, though in poor reception conditions, some more efficient arrangement may be necessary. An earth is not essential, but will reduce mains-borne interference.

It will probably be found that with VR1 at maximum, some programmes will be receivable at adequate volume with VC1 set at minimum, but will suffer from interference from adjacent stations. In this case, the procedure is to reduce the volume by means of VR1 and bring it back to the desired level by the application of reaction, at the same time adjusting VC2 for the best results.

5

Two-valve Short Waver

VERY long range reception is always an exciting prospect for the beginner and is possible even with a short wave one-valver, and the addition of an amplifying stage provides a useful increase in volume. The circuit described here uses two 1T4 valves, but any equivalents, such as the CV785, W17, or DF91 are equally suitable. The two wavebands permit tuning from approximately 10m to 60m, and thus cover the most popular s.w. bands.

Bandspread Tuning

"Bandspread tuning" is incorporated, and this allows accurate logging of transmissions. This method of tuning does not make construction difficult, as no reduction drives are needed. The circuit is shown in Fig. 19, and in use, the 150pF capacitor VC2 is adjusted to the required band, which

is then covered by means of the 15pF capacitor VC3. The small capacity of the latter makes tuning easy, and dial readings can be noted down so that they can be returned to when necessary. But more about this later.

Two coils are fitted, the required coil being selected by means of the 2-way switch, S2.

For high tension, 45V or more will be needed. A 45V supply can, if necessary, be obtained by wiring two $22\frac{1}{2}$V batteries in series. Less than 45V is not recommended, as insufficient reaction is available. A standard $67\frac{1}{2}$V battery may also be used, and would do very well.

The valve filaments require 1·4V and this can be obtained from a $1\frac{1}{2}$V battery, as used in portables. Alternatively, dry cells such as found in torch and lamp batteries may be used, provided they are wired in parallel. With such

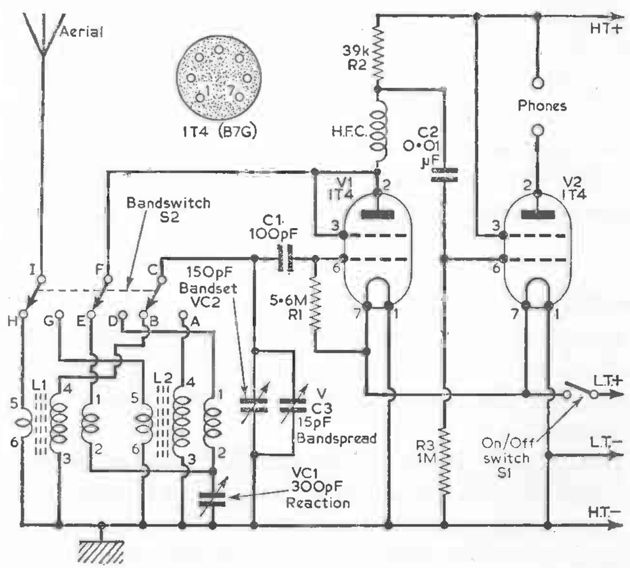


Fig. 19. The circuit.

batteries, the zinc case is negative. Cells must not be wired in series, nor must more than 1½V be used. The filament consumption is only 0·1A.

Components

There is reasonable latitude in the selection of components, so items to hand may possibly be used. For bandspreading, a capacitor of about 10pF to 20pF is satisfactory. Some s.w. capacitors can easily have plates removed, to reduce the capacity. For bandsetting, 100pF or 200pF could be fitted, if to hand, with some modification in the band coverage.

The h.f. choke must be capable of working over the frequencies tuned, so a reliable s.w. or all-wave component is needed. As the insulation of the 0·01μF coupling capacitor, C2 must be very good, a mica component, preferably new, is best used here. Leakage would cause a positive voltage to reach the amplifier valve grid.

It is worth noting that the receiver can be constructed as a one-valver, merely by omitting V2, R2, R3 and C2. 'Phones are then connected from the h.f. choke to h.t. positive. Quite good results may be obtained with the single valve.

Chassis Preparation

Chassis and panel should be drilled before mounting any parts. A chassis about 7 in. × 4 in. × 2½ in. deep will be convenient, but some change in size will not affect performance.

Fig. 20 shows the top of the chassis. Holes for the B7G valveholders can most readily be made with a chassis cutter or valveholder punch. If these are not available, a ring of small holes may be drilled, the piece broken away, and the hole smoothed with a round or half round file.

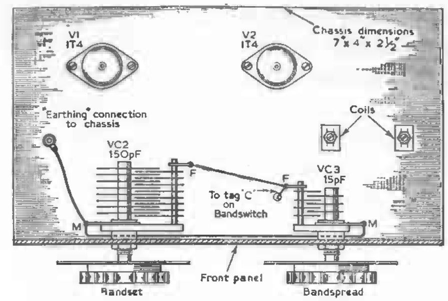


Fig. 20. The simple layout of components.

The front panel can be about 7 in. × 6 in. On this panel are the five controls. VC1, S1 and S2 are mounted through holes along the front runner of the chassis and then through three matching holes in the bottom half of the panel, so that when their respective nuts are screwed on, the controls, chassis and panel are held firmly together (Fig. 21). The bandset and bandspread capacitors, VC2 and VC3 are

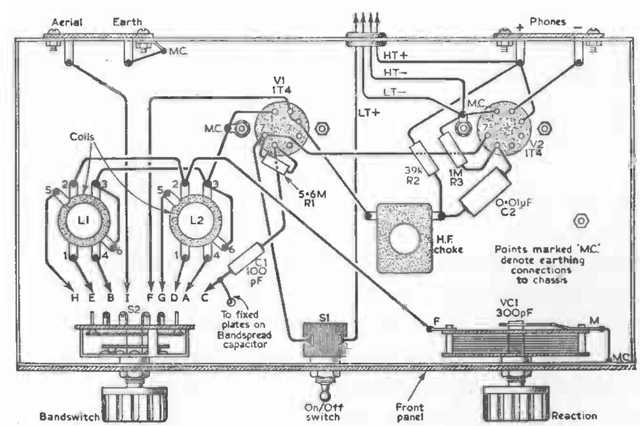


Fig. 21. Underchassis connections.

mounted through holes made in the top half of the panel which extends above the top of the chassis (Fig. 20).

At the rear of the chassis, drill or punch clearance holes for the two socket strips. Ensure that aerial and 'phone sockets will be well clear of the metal. Holes are also made to take the coils, but these are best left off until later.

Wiring

Fig. 21 shows the wiring and component layout under the chassis. The three points marked "M.C." consist of tags bolted to the chassis, so that leads may be soldered to

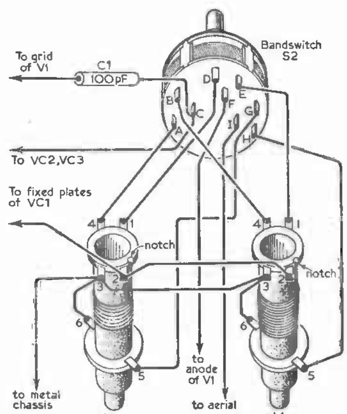


Fig. 22. Details of the switch and coil interconnections.

them. Place the valveholders so that the sockets come approximately as in Fig. 21.

Soldering will cause no difficulty if the iron is really hot, and tags and leads are perfectly clean. Use a cored solder, as sold for radio work. Do not carry solder to the joint on the iron. Instead, apply iron and solder to the joint, so that the flux can take effect where required.

The moving plates tags of both VC2 and VC3 are wired together, as in Fig. 20, and the lead soldered to a soldering tag which is bolted to the top of the chassis. The fixed plates of these variable capacitors are similarly joined, and a lead goes through the chassis to the 100pF fixed capacitor (C1), and switch (tag C in Fig. 22).

Use flex for battery connections, and fit suitable plugs, or identify the leads so that the filament circuit will not be taken to the h.t. battery in error.

Most of the wiring in Fig. 21 can be done first, the coils being left until last. All leads in the coil, switch, and tuned circuit section should be reasonably short and direct. With VC1, the moving plates tag goes to chassis, and the fixed plates tag to tags 2 of the coils.

Coil Connections

When the receiver is viewed from underneath and behind, the coil and switch connections will appear as in Fig. 22. Note that each coil has a notch, for tag identification.

Wire tags 6 to tags 3 before mounting the coils, and also solder leads a few inches long to tags 5. The higher wavelength coil (which has most turns) is placed at the right in Fig. 22. The coils can then be inserted, and secured with their clips. Ensure that tags 5 and 6 cannot touch the chassis.

The remainder of the wiring, as shown in Fig. 22, can then be completed. Connections should be short and direct, but clear of each other. The same identification letters are used in Figs. 19, 21 and 22, and no difficulty is likely to arise in wiring up the switch correctly.

Dials and Knobs

Fairly large knobs are best for VC2 and VC3. Scales

(0-100 or 0-180) should be fitted to the knobs or panel, so that readings can be noted.

For reaction, a very small knob makes operation a little difficult, as the reaction setting is critical, with weak signals. The band selection switch can be of the same type, to match.

'Phones, Aerial and Earth

'Phones should be of the usual medium or high impedance type, and low impedance surplus 'phones are likely to be unsatisfactory.

If an earth is available, it is taken to a plug which is inserted in the socket marked in Fig. 21. An earth lead may be connected to an earth spike, or water pipe, or any similar

COMPONENTS LIST

Resistors:
R1 5·6MΩ R2 39kΩ R3 1MΩ
All ±10%, ½W carbon

Capacitors:
C1 100pF mica C2 0·01μF mica
VC1 300pF solid dielectric reaction variable
VC2 150pF air dielectric variable
VC3 15pF air dielectric variable

Valves:
V1 1T4 V2 1T4

Miscellaneous:
S1 S.P.S.T. toggle switch
S2 3-pole, 2-way rotary switch
L1, 2 SWQ1 and SWQ2 Osmor coils
H.F.C. H.F. choke (Osmor)
Two B7G valveholders. Battery plug. Chassis and panel material. Earth, aerial and 'phones sockets. Control knobs, dials, battery, nuts, bolts, etc.

metal object in contact with the ground. The lead should not be connected to gas pipes, hot water pipes, or mains earth circuits.

For general purposes the aerial can be a single uncut length of insulated wire, forming both aerial and "lead-in". The actual length which can be erected will depend on circumstances, and may be anything from about 20 ft to 45 ft or so. The wire and downlead should be as far from walls and other earthed objects as possible. One or two aerial insulators are used at each suspension point. Reception of distant stations is, of course, possible with an indoor aerial, but volume will be reduced. It is thus worthwhile trying to fit up a reasonably effective aerial.

If a really long aerial is available, it can be used. If it is found that reaction is difficult to obtain on some frequencies, a small fixed or pre-set capacitor should be included in series with the lead-in, at the aerial socket. A capacity of about 50pF is generally satisfactory. If a pre-set is used, adjust it for best results.

Using the Receiver

If the constructor is not familiar with s.w. reception, it should be remembered that the results obtained on the various bands depend on the time of day, and other conditions. Most broadcast stations use wavelengths near each other, and are thus found congregated into bands, such as the 49, 41, 31, 25 and 19m bands. Morse and various other transmissions will be heard between these bands.

The actual tuning range of each coil, and also reaction, will be modified to some extent by the core position. The cores should be adjusted until reaction is easily obtained. If necessary, some modification of this position is possible, to change band coverage. The cores should then be locked with nuts, as moving them will change dial readings.

The reaction capacitor (VC1) should be closed slowly until a sudden increase in sensitivity, and oscillation on tuning through a station, shows that the optimum position has been passed. While tuning, the reaction control is adjusted to keep the receiver just below the oscillation point. In this condition it is extremely sensitive. If the reaction control is insufficiently advanced, only powerful stations will be heard. On the other hand, if the control is turned too far, results will be very poor. However, the way in which the reaction control operates will soon become apparent.

For reception of ordinary stations, or telephony (voice and music) the receiver is kept just below the oscillating point, as described. The setting is not critical with powerful stations, but is quite exact with weak stations. To receive c.w. morse (unmodulated carrier) the reaction control has to be advanced to the oscillation point.

VC2 is only used to locate the various bands. The dial reading of this capacitor should then be noted down as accurately as possible. Tuning is then carried out on VC3, in conjunction with reaction, as described.

If there is any variation in the efficiency of the 1T4 valves, the best valve should be placed in the detector (V1) position.

It is not very likely that any fault should arise in the receiver, but if no results are obtained, a few simple tests should localise the trouble. First, the 'phones may be connected across R2. If normal one-valve reception is then obtained, the amplifier stage is faulty. The valve can be tested by placing it in the detector position.

If results are absent with the one-valve circuit, check the detector stage wiring. If reception is obtained with one coil, but not the other, suspect the switch connections, or the wiring to the inoperative coil.

6

Amateur Bands Hybrid

THIS receiver is highly sensitive and selective, and, although it cannot equal the performance of the more expensive commercial sets, it will provide a useful introduction for the beginner to the short-wave, amateur, and broadcast bands.

It is built as two separate sections; the detector section and the output section.

Specifications

The coverage is from about 18m (16·66Mc/s) to 60m (5Mc/s), and from 150m (2Mc/s) to 300m (1Mc/s) in another band. This covers the 20, 40, and 160m amateur bands and the 19, 25, 31, 41, and 49m broadcast bands.

Sensitivity and Output

The output from the receiver will be from 250mW to

600mW according to the transistors used. As might be expected, selectivity is excellent owing to the well-designed coils, and no difficulty will be experienced in separating stations, even on the crowded amateur bands. Sensitivity is sufficient to allow long distance reception on 'phones, and loudspeaker reception of the stronger broadcast stations.

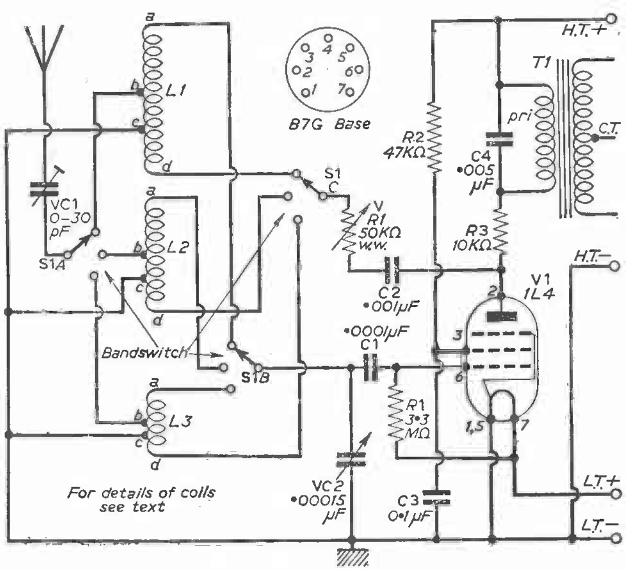


Fig. 23. The circuit of the detector stage.

Circuit Details

The detector circuit (Fig. 23) is unusual as only a single tapped coil is used (for each band) with anode reaction. The detector is of the leaky grid type, chosen for its high sensitivity and simplicity. However, if carelessly constructed,

COMPONENTS LIST

Resistors:

R1 3·3MΩ R3 10kΩ R5 220Ω R6 33Ω
R2 47kΩ R4 2·2kΩ All $\frac{1}{4}$W carbon
VR1 50kΩ w.w. potentiometer

Capacitors:

C1 100pF silver mica
C2 0·001μF silver mica
C3 0·1μF paper 150V
VC1 0–30pF trimmer
C4 0·005μF paper 150V
C5 200μF elec. 3V
C6 0·05μF
VC2 150pF air-spaced variable

Transformers:

T1 Input transistor transformer, with secondary centre tap
T2 Output transistor transformer, with primary centre-tap
T3 Pentode output transformer

Miscellaneous:

V1 1L4 or equivalent (see Table 1)
Tr1, 2 OC71 or any small power output transistors not requiring heat sink
S1 A, B, C, 3-pole, 3-way rotary switch
L1, L2, L3 see Table 2
Slow-motion tuning drive. B7G valveholder. Aerial and earth socket. Two $1\frac{1}{4}$ in. dia. and one 2 in. dia. coil formers. 90-120V; $1\frac{1}{2}$V battery. 9V battery. Chassis material. 3Ω loudspeaker. Headphones, wire, etc.

with poor quality components, it will prove very unstable with the type of reaction used. Transistors have been used in the output stage owing to their low current requirements and high efficiency. These components have a reputation of an extremely high noise level, and, although this is true in some circuits using cheap transistors, the noise in this circuit is very low and will not prove troublesome even where faint signals are concerned.

Alternative Valve Types

The valve for the detector stage, V1, is the 1L4. Its current requirements are 0·1A at 1·4V, and 2mA at 90V. Other types which may be used are the 1AE4, 1AF4, 1AJ4, 1F2, 1F3, 1AF5*, 1AH5*, 1FD9*, 1S5*, 1T4, 1U4, DAF91*, DF91, DF92, DF95 and DF904. The base connections of all these valves are the same as those for the

TABLE 1

Valve Type	Filament Current	Valve Type	Filament Current	Valve Type	Filament Current
1L4	0·1	1T4	0·05	DAF91†	0·05
1AE4	0·1	1U4	0·05	1AF5†	0·025
1AF4	0·025	DF91	0·05	1AH5†	0·025
1AJ4	0·025	DF92	0·05	1FD9†	0·1
1F2	0·05	DF96	0·025	1S5†	0·05
1F3	0·05	DF904	0·05	(Current in Amps)	

†The pin 1, 6 and 7 connections for these valves are the same as the 1L4 connections; however, pin 2 is no connection, pin 3 is diode anode (wire to earth), pin 4 is screen grid, and pin 5 is anode.

1L4, except those marked thus*. The approximate filament current requirements are given in Table 1. All the valves have an approximate filament voltage of 1·4V except the 1AE4 which requires 1·25V.

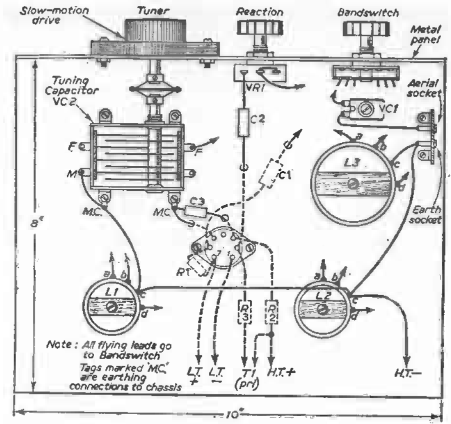


Fig. 24. Component-layout and wiring of the detector.

Constructional Details of Detector

The wiring diagram of this first stage is given in Fig. 24. It may be constructed on a metal or wooden chassis, metal being better than wood on account of its superior screening properties. In either case a metal front panel is essential to screen the controls from the operator to prevent hand-

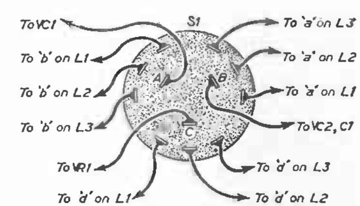


Fig. 25. S1 bandswitch connections.

capacity effects. At all times, short, direct wiring is extremely important. The layout diagram is given for guidance, but it should not be adhered to rigidly; i.e., if it is possible to make a wire shorter than is shown, this should be done. Any long leads should be of coaxial or screened cable.

The Coils

These coils are home-made, winding details are given in Table 2. For L1 and L2, the turns should be of enamelled copper wire of the gauge recommended. The turns should

TABLE 2

Coil	Number of turns	Wire Gauge	Tappings b	Tappings c	Diameter of former
L1	100	28 s.w.g.	50	75	$1\frac{1}{4}$ in.
L2	30	22 s.w.g.	15	20	$1\frac{1}{4}$ in.
L3	10 over 2 in.	18 s.w.g.	5	$7\frac{1}{2}$	2 in.

start and finish securely, and the taps can be made by twisting the wire and scraping the enamel insulation at the positions given. The ten turns of 18 s.w.g. wire which comprise L3, should be spaced over a 2 in. length of the former to achieve the correct spacing between each turn.

Any slow-motion tuning drive will serve and one of Admiralty pattern should be easily obtainable fairly cheaply from surplus equipment stores. The prototype used one of 200:1 ratio of this type, which is excellent.

Calibration

A dial marked in frequencies would not be particularly suitable however, in view of the home-wound coils used. A

1-100 scale will allow stations to be logged with reasonable accuracy, and once the receiver has been completed and tested, a graph may be drawn up for a more accurate determination of frequency. The procedure is as follows.

First, a station is accurately tuned in and its frequency noted. The dial reading is also taken and the procedure repeated until a number of stations at different frequencies are logged. Then a graph is drawn up of dial reading against frequency. This is shown in Fig. 26. The curve obtained

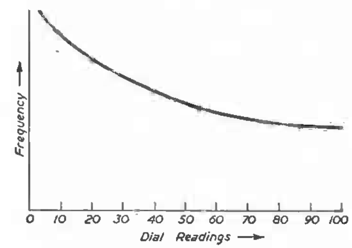


Fig. 26. A calibration graph for this receiver will look something like this.

may or may not be a straight line according to the type of tuning capacitor used, but it should be regular. Any points well away from the main curve should be disregarded —they are either from faults in reading the tuning dial, or harmonics of a strong station.

Operation of the Detector

If desired, 4000 Ω headphones may be connected to the output, instead of the primary of T1, to test the detector. First, check the wiring to ensure that the h.t. voltage cannot reach the filament of the valve, and then connect the batteries: 90-120V h.t. and $1\frac{1}{2}$V l.t. Without an aerial, advance VR1. There should be no crackling or other noises. Somewhere between the middle and end of the travel of this control, there should be a faint "plop" and the set will break into an oscillation howl.

Testing

Now that it is proved that reaction is functioning satisfactorily, an aerial may be plugged in and the set tested on all bands. The reaction control should be adjusted to be just below the point of oscillation.

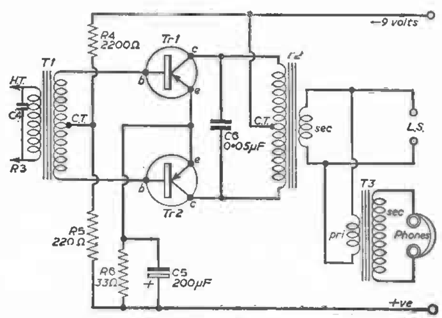


Fig. 27. The transistorised output stage.

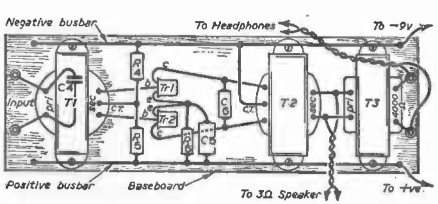


Fig. 28. Wiring of the output stage.

The Output Stage

The circuit of this is shown in Fig. 27. It is constructed on a wooden baseboard which can conveniently be mounted in the loudspeaker cabinet. The loudspeaker is best a 5 in.

or larger unit, although smaller types can be used, but they will not give such a good tone.

"Busbars"

The "busbars" (see Fig. 28) can be of 18 s.w.g. bare copper wire attached to the baseboard with insulated staples. The current for this unit is supplied by a PP9 battery, which will have a useful life of a year or even more. A switch for this part of the set can be accommodated in the loudspeaker cabinet. If a switch is desired for the detector stage, it may be wired in the positive l.t. lead and mounted on a suitable place on the front panel.

7

Transistor Superhet Tuner

THE "superheterodyne" receiver, as opposed to the simple t.r.f. receiver employing regeneration, which might perform well enough in a high signal strength area but under less favourable conditions cause disappointment due to the low reserve of gain and limited tuned circuits, must hold pride of place for reliability, stability, sensitivity and general performance, and beginners in particular are well advised to realise this for it is easy to become misled.

Details of a transistor superhet tuner are given here which, when fed into the input sockets of, say, a 10W mains-powered audio amplifier will give excellent performance.

The unit can also be connected to the "Gram" sockets of a standard broadcast receiver, or alternatively, it can be used as a complete headphone, or personal receiver.

The Circuit

This was designed on conventional lines with special consideration given to reliability—see Fig. 29.

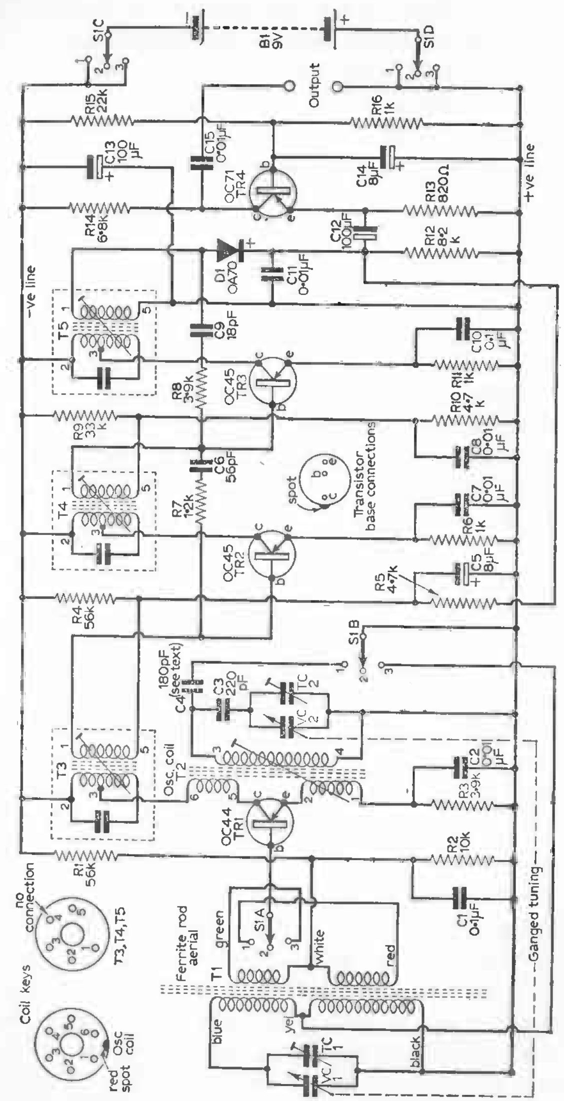


Fig. 29. The four-transistor circuit of the tuner.

Both the medium and long wavebands are covered, the switching being arranged so as to minimise the chance of the unit being left switched on accidentally. A standard 4-pole, 3-way rotary switch is employed: S1A and S1B selecting the waveband coverage, and the other two sections performing on/off duties and ensuring that the battery is completely disconnected at position "2". The central switch position is "off"; it is thus impossible to change from one band to the other without going through the "off" position.

Tr1 (OC44) functions as the frequency changer with Tr2 and Tr3 (OC45) as intermediate frequency amplifiers. Following the demodulator diode, D1, is an additional transistor, Tr4 (OC71) which is used to drive the subsequent amplifier. The average emitter current of Tr4 is 400μA and the whole tuner consumes less than 4mA, thus making battery replacement a rare occurrence.

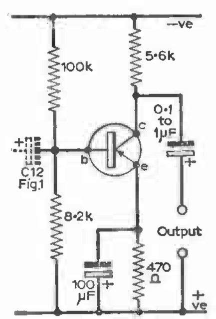


Fig. 30. An alternative circuit arrangement, operating Tr4 in the common-emitter mode.

If higher gain is required Tr4 may be operated under "common emitter" conditions but the output impedance will be lowered to approximately 5kΩ. The necessary rearrangement of the stage is shown in Fig. 30 and if the unit is to be used as a headphone receiver this is the best method to adopt.

A minor economy can then also be effected by omitting the 5·6kΩ collector resistor together with the output capacitor connecting instead high impedance 'phones between the negative rail and Tr4 collector. It might also become necessary to experiment slightly with the 100kΩ base feed resistor to obtain optimum results.

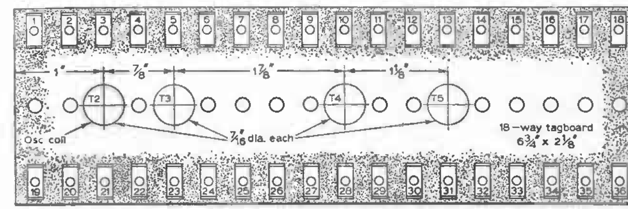


Fig. 31. An 18-way tag board is modified as shown to accommodate the oscillator and i.f. coils, as well as the majority of the smaller components.

If the circuit of Fig. 30 is used to feed a valve amplifier it might also become necessary to vary the value of the upper base feed resistor, 100kΩ, since the collector resistor is, as specified, a little on the high side. Only a small emitter current is required—about 0·5mA.

Referring again to Fig. 29 it will be noted that all transistors are stabilised by the familiar potentiometer, emitter resistor form, and this together with the neutralising circuitry makes the unit completely stable.

Mechanical Details

The whole tuner is constructed on a standard 18-way tagboard, the tags having been given reference numbers to assist correct identification.

The oscillator coil and the three i.f. transformers are mounted so that their pins project through the tag side of the board and although a separate hole may be drilled for each pin it is simpler to use a single hole—just large enough for all the pins to pass through together—for each component. This also makes the cores available from either end of the can. An array of small holes lies along the centre of the tagboard when it is purchased and it is only necessary to enlarge these as required.

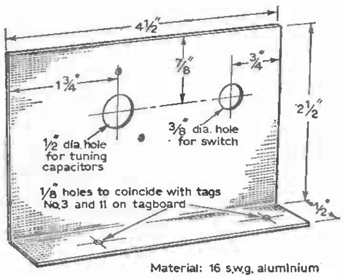


Fig. 32. Details of the panel which carries the tuning capacitor and wave-change switch, and which is bolted to the component tag board.

Panel

The wavechange switch, twin gang tuning capacitor and outlet insulator are mounted on a metal panel fixed on top of the tagboard in such a way that the tag side of the board points down, away from the panel (see Fig. 34). For dimensions of this panel see Fig. 32. Because it is made of metal the $\frac{1}{8}$ in. fixing holes must be arranged to coincide with tags 3 and 11 on the board as shown and prior to bolting it in position $\frac{1}{16}$ in. thick Paxolin washers must be placed over the bolts before they are passed through the board to prevent the underside of the flange of the panel from short circuiting all the tag eyelets it covers.

A very simple bracket will also be needed to hold the ferrite aerial (which should be left to one side at this stage) and this will be bolted to an unused tag (28) on the same side as the panel.

Constructional Notes

Actual wiring construction should commence by fixing the canned transformers by letting their fixing lugs pass through small holes drilled for them. Care should be taken to check that the orientation agrees with that shown. These lugs are then pressed out flat and soldered as shown in Fig. 33.

Before proceeding further it is advisable to plug each core

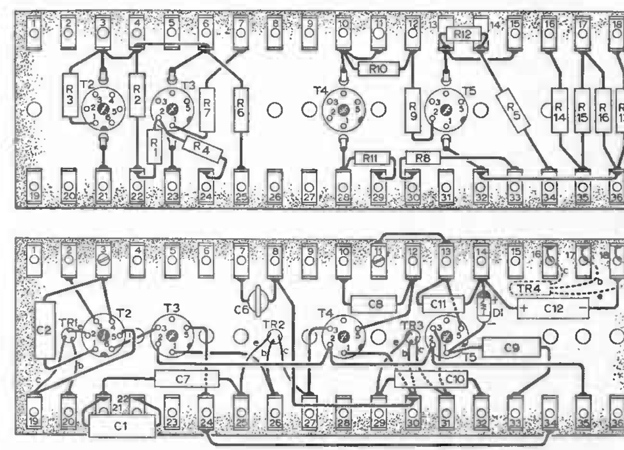


Fig. 33. Top—main positive- and negative-line wiring. Note connections of transformer cans to the positive-line. Bottom—remainder of tag board wiring.

hole on the transformers with sleeving or something similar to prevent any blobs of solder accidentally spilling in and locking the cores which are rather fragile.

The remainder of the tag side of the board can then be wired as indicated in Fig. 33. The transistors should be left until last. Check that electrolytic capacitor C12 and diode D1 are connected in the correct sense as shown. The taut layout allows for all component lead-out wires to be snipped off short.

When wiring of the tag side of the board is complete (except for the transistors) the other side can be tackled and all wiring is illustrated in Fig. 34 where the panel is shown folded out flat for clarity. C13 actually lies flush with the top of the board and must be slender enough not to foul the aerial.

When the capacitors are in position—observe polarities—the transistor wires may be sleeved and passed through existing small holes on the board. Provided thin sleeving has been used, the set of leads on each transistor will fit firmly yet not overtightly. The transistor shells thus remain on the top side of the board whilst their wires pass below and are soldered using the normal techniques. This means gripping each transistor lead with a pair of long-nosed pliers between the body of the transistor and the end being soldered. This helps to conduct heat away from the transistor lead before it can reach the body of the component and cause serious damage. The soldering operation must be executed speedily and the iron left on the lead and tag to be joined, just long enough for the solder to melt and flow evenly over the joint.

The aerial may now be fixed in position as shown and wired allowing the connecting leads (which should be of stranded conductor) just loose enough to permit free movement of the two coils along the ferrite rod.

The Switch

Each of the four central "pole" tags of S1 control three of the "way" tags disposed around the rim of the switch and a visual check is initially required to identify them correctly. It is then advisable to press flat alternate "way" sections as shown in Fig. 34 to obviate incorrect connections being

made. If the battery flex leads are left until all the wiring has been checked over, chances of damaging the transistors will be minimised.

When satisfied that all is well a black flexible lead approximately 6 in. long is soldered to S1C rotor and a similar, but red, lead connected to S1D rotor. The switch should then be set to position "2", the central position, and the appropriate stud battery connectors affixed to the free ends of the flexible leads which may then be twisted together neatly.

Setting Up

The following alignment procedure requires the use of a signal generator which needs a certain amount of skill to operate. The absolute beginner, therefore who does not possess such an instrument nor the experience to use one, is advised to approach a knowledgeable friend or colleague with regard to obtaining assistance in this stage of the construction.

A length of suitable cable (coaxial will do it not very long) should be connected to the stand-off insulator (Fig. 34) the far ends being equipped suitably and connected to an amplifier or to the "Gram" sockets of a suitable broadcast receiver which may then be switched on and adjusted to normal three-quarter volume level setting. Alternatively high impedance 'phones may be used.

Control knobs are then fitted to the tuner and switch spindles and a battery connected. The rotary switch should then be turned to position "3" (m.w.) and the vanes of the ganged tuning capacitor fully enmeshed.

The modulated output from a signal generator tuned to 470kc/s is now applied to the fixed vanes connection of VC1. The cores of T5, T4 and T3 should be adjusted for maximum output in that order, the generator output being kept at a low level.

Next the generator is set to 600kc/s and the oscillator coil core adjusted to receive the signal which is then further strengthened by sliding the medium-wave coil along the ferrite rod until best results are obtained.

If the ganged capacitor is now rotated towards the other end of its travel the note should reappear again at 1,200kc/s,

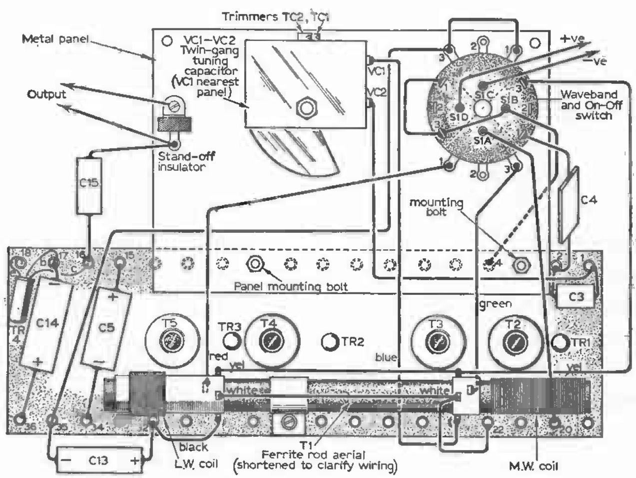


Fig. 34. Wiring on top of tag board and connections to aerial and front panel.

before the vanes are fully disengaged, to which frequency the generator may now be set before the aerial and oscillator trimmers TC1 and TC2 respectively, are carefully adjusted for best results.

Should the aerial trimmer need to be set fully home and the signal is still not considered correctly peaked, then unscrew the oscillator trimmer slightly until the signal disappears. Now adjust VC1 to slightly fuller capacity when

the signal will reappear; it should now be necessary to unscrew the aerial trimmer TC1 slightly to obtain a peaking point. The adjustments should then be made over again, viz at 600kc/s and 1,200kc/s, until no improvement is possible.

The Long Wave Band

The rotary switch is next turned to position "1" and an attempt made at receiving the Light Programme on 200kc/s with the vanes of VC1 approximately one-half enmeshed. It is quite possible that C4 will need padding a little and is located in such a way as to be easily accessible for this purpose. Values as small as 30pF connected in parallel make a good deal of difference. Experiment by temporarily connecting various small value capacitors (50-150pF) across VC2 in turn at the same time swinging the vanes over full travel.

Another quick method is to connect a 90pF trimmer across VC2 temporarily. Immediately the signal is received the long wave coil should be slid gently along the ferrite rod to obtain best results in association with VC1, and an assessment made of the precise value of capacitance needed for C4.

Warning

The unit must not be used under any circumstances in connection with a receiver or amplifier of the a.c./d.c. class nor with a so-called a.c. receiver that derives its h.t. from the mains direct. It may be used with a transistorised amplifier, however, if required.

Comparable results are not likely to be obtained if alternative components, or transistors of another make, are utilised; the use of any sub-standard items is almost certain to ensure disappointment.

COMPONENTS LIST

Resistors:

R1 56kΩ	R5 4·7kΩ	R9 33kΩ	R13 820Ω
R2 10kΩ	R6 1kΩ	R10 4·7kΩ	R14 6·8kΩ
R3 3·9kΩ	R7 1·2kΩ 5%	R11 1kΩ	R15 22kΩ
R4 56kΩ	R8 3·9kΩ 5%	R12 8·2kΩ	R16 1kΩ

All ±10%, $\frac{1}{4}$W carbon unless otherwise stated

Capacitors:

C1 0·1μF paper	C9 18pF mica ±1%
C2 0·01μF ceramic or paper	C10 0·1μF paper
C3 220pF mica	C11 0·01μF ceramic or paper
C4 180pF mica (see text)	C12 100μF elec. 12V
C5 8μF elec. 6V	C13 100μF elec. 12V
C6 56pF mica ±1%	C14 8μF electrolytic 6V
C7 0·01μF ceramic or paper	C15 0·01μF ceramic or paper
C8 0·01μF ceramic or paper	

VC1, 2 208+176pF twin gang variable, with trimmers (TC1, 2) Jackson "00"

Inductors:

T1 Medium and long wave ferrite aerial (RA2W)
T2 Oscillator coil (P50/1) T3 470kc/s i.f. coil (P50/2)
T4 470kc/s i.f. coil (P50/2) T5 470kc/s i.f. coil (P50/3)
All these coil types are from the Weymouth range

Semiconductors:

Tr1 OC44 (White), Tr2 OC45 (Orange), Tr3 OC45 (Blue) } RFG3 Pack or Set
Tr4 OC71 D1 OA70

Miscellaneous:

S1 Miniature, single wafer, 4-pole, 3-way rotary switch
B1 PP4 or other 9V battery
18-way tagboard. Aluminium for panel. Stand-off insulator. Two knobs. Hardboard, wire, etc.

Cabinet

Dimensions of a suitable easily made cabinet are shown in Fig. 35. It is made from hardboard held together with internally glued reinforcement strips, little weight being involved.

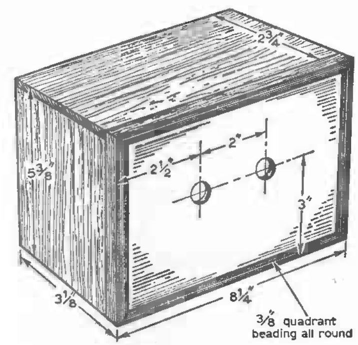


Fig. 35. A suggested design for a cabinet.

To avoid defacing the cabinet front the tuner can be locked by creating a sub-panel of hardboard through which four 4B.A. bolts may be passed and countersunk to coincide with holes in the metal tuner panel. This sub-panel can then be glued—with the bolts projecting—to the inside of the cabinet. When dry the tuner is placed in position and the four 4B.A. nuts applied and screwed home.

The actual cabinet front is cut $\frac{1}{4}$ in. smaller than the dimensions given in Fig. 35, a frame of $\frac{3}{8}$ in. quadrant beading being allowed to overlap by $\frac{1}{8}$ in. all round to form a rebate for the sides, top, etc.

As mentioned earlier the unit can be used as a completely self-contained headphone receiver if required and in this case a 'phone outlet can be provided on the panel.

8

Battery-operated Short Wave Converter

SOONER or later newcomers to the radio hobby experiment with the short wavebands and this may be done either by (a) constructing a separate short wave receiver such as have already been described in this book, or (b) building a converter that will change the signals and make them suitable for feeding into an existing receiver via the aerial socket. The unit described here falls into the latter category.

Operation

A popular short waveband is that covering 5-15Mc/s (20m-60m). By converting the signal frequencies to say 1·5Mc/s (200m) and feeding them to a standard broadcast receiver not equipped for short wave reception, it is possible to increase one's listening horizon as the short wave

transmissions will be heard via the receiver's loudspeaker. If the broadcast receiver used is a superhet, two changes of frequency occur and the "double superhet" principle is in use.

Not all enthusiasts have access to the main power supply however, but fortunately, this useful converter can be constructed and operated successfully from dry batteries.

Aerial Connection

Switching is incorporated to make the aerial bypass the unit immediately it is switched off; it is reconnected when the unit is switched on the next time. This means that the converter and receiver may be left permanently connected once set up, the latter performing normally when the former is not in use.

The converter may be used to feed a mains receiver provided it is fitted with aerial and earth sockets and is not of the a.c./d.c. variety. Transistorised and t.r.f. receivers, being less sensitive, are not particularly suited to use with this unit, however, suggested modifications to help improve sensitivity are given later.

The Circuit

This is illustrated in Fig. 36, When S1A, B, C is set to position "1", the aerial is connected to V1 via L1 which is tuned by one section of a twin gang capacitor, VC1. The selected signal appears again at pin 2 of V1 and is fed to the frequency changer, V2. The signal grid circuit of V2 is untuned in the interests of simplicity and to permit the use of a twin gang capacitor. Nevertheless sufficient signal is developed across R2.

Valve V2 is the oscillator and mixer and 1·5Mc/s signals appear at the anode of the valve where they are developed

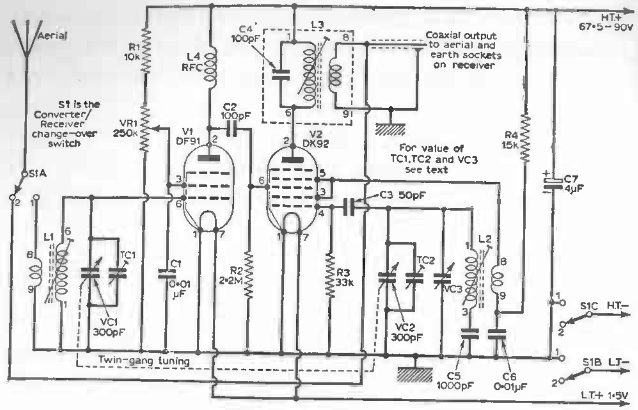


Fig. 36. The converter circuit.

across L3 which is tuned precisely to this frequency. To enable a suitable match to be made to the aerial coil of the subsequent receiver with which the converter is used, the low impedance winding associated with L3 is employed and the coil is in fact a standard medium wave coil used in reverse.

R.F. Amplifier

Although the above represents the working of the basic circuit, several finer points of interest exist. It might be argued that V1 could be omitted and the aerial coil connected direct to the signal grid of V2, and although this is true, benefits of slight extra gain would be lost and, furthermore, a sensitivity adjustment would scarcely be practicable. Here, the r.f. amplifier can be used beneficially as a variable gain device by feeding its screen grid from a potentiometer connected across the h.t. supply.

The oscillator circuit is of interest, too, since variable trimming is provided and consists of VC3 arranged as a

panel control. This permits manual control of oscillator frequency within limits and also acts as a fine tuner giving a bandspread effect. Any small air-spaced type of variable trimmer may be used, and a plentiful supply is often present

COMPONENTS LIST

Resistors:
R1 10kΩ   R2 2·2MΩ   R3 33kΩ   R4 15kΩ
All ±10%, ½W carbon
VR1 250kΩ potentiometer

Capacitors:
C1 0·01μF ceramic or paper
C2 100pF silver mica
C3 50pF silver mica
C4 100pF silver mica
C5 1000pF silver mica
C6 0·01μF ceramic or paper
C7 4μF elec. 200V
VC1, 2 300pF twin-gang variable VC3 see text
TC1, 2 30 or 50pF trimmers (may be fitted to VC1, 2)

Valves:
V1 DF91   V2 DK92

Inductors:
L1 see text (Denco Blue)
L2 see text (Denco White)
L3 Denco Yellow, range 2
L4 R.F. choke (Denco RFC5)

Miscellaneous:
S1A, B, C 4-pole, 3-way rotary switch
Two B7G ceramic valveholders. Stand-off insulator. 5-way tag-strip. Aerial socket. Aluminium for chassis. 67·5–90V, 1·5V battery. Tuning drive and dial (Eddystone 843). Knobs, wood, wire, etc.

in surplus apparatus. The total number of vanes should not exceed four, unwanted ones being removed, since a large capacitance value is undesirable. The control spindle should be fitted with a small scale calibrated 0-10. The general bandspreading is mechanical and consists of an RF27 Muirhead drive, but other suitable types such as the Eddystone 843 may also be used.

Grid Wiring

Connecting pins 3 and 5 of V2 together was found to be the most reliable method of operation.

The signal and oscillator coils are not screened but it is desirable that L3 should be screened to prevent unwanted self pick-up at 1·5 Mc/s. Note that a fixed capacitor (C4) is connected across the main winding of L3 instead of a trimmer, this being quite satisfactory since the coil can be brought to resonance by means of its core, and the capacitor may thus be contained within the coil can. The coils are supplied individually packed in round aluminium screw lid containers which may be used for screening.

The inclusion of C7 is particularly beneficial when the h.t. battery exhibits considerable inherent resistance such as occurs towards the end of its life; it is important that it should be connected as shown in the diagram on the converter side of S1C, otherwise the h.t. battery will discharge even when the unit is not in use.

Rotating S1 to position "2" switches off the converter and breaks both h.t. and l.t. feeds, and allows C7 to discharge via R1 and VR1. Simultaneously, the aerial is disconnected from L1 and reconnected to tag 8 on L3 so that the broadcast receiver can function normally. The switch shown in Fig. 40 as S1 is a 4-pole, 2-way miniature rotary type, the spare tags being ignored.

Switching of the earth lead is unnecessary when coaxial cable is used between the converter and receiver, the two chassis being automatically inter-connected via the outer braiding. For this reason *a.c./d.c. apparatus must not be used with the converter.*

Coverage

The prototype covers the 5-15Mc/s band, but alternatives are possible by changing L1 and L2 for coils from another range. The value of padder capacitor will then also require alteration. Suitable coils can be chosen from the Denco range as shown in Table 3.

The coils are wound on colour-coded formers, and for L1, Blue is required, with White for L2.

Waveband switching could be fitted but would necessitate a large chassis with consequently lengthened leads. Separate trimmers, TC1 and TC2, are specified, but these can well be an integral part of an existing twin gang capacitor. Use of a 500pF (nominal) type is possible for tuning, but high grade mica 1000pF fixed capacitors must be connected in series with each section to reduce the maximum capacitance value.

TABLE 3

Metres	Mc/s	Padder (C5)	Denco Range No.
57–180	1·67–5·3	340pF	3
20–60	5·00–15·00	1000pF	4
9·5–28	10·50–31·50	2000pF	5

Constructional Notes

The dimensions of the small chassis with all necessary cutting and drilling details are shown in Fig. 37. The front panel carries all the variable controls, and the dimensions of this are shown in Fig. 38. Hardboard or plywood may be used provided aluminium foil is glued firmly to the back to eliminate "hand capacity" effects when operating. Quadrant—$\frac{3}{8}$ in. or $\frac{1}{2}$ in.—should be cut and mitred to provide rigidity and also improve the appearance. The chassis and front panel may be fixed together by whatever is considered the simplest method. Coils L1 and L2 should be mounted direct and locked thumb tight only by means of

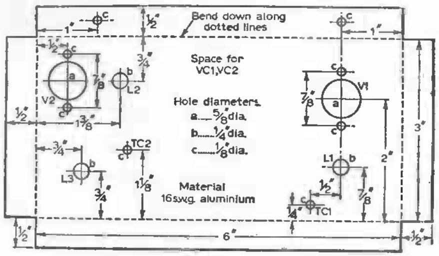


Fig. 37. Drilling dimensions of the aluminium chassis.

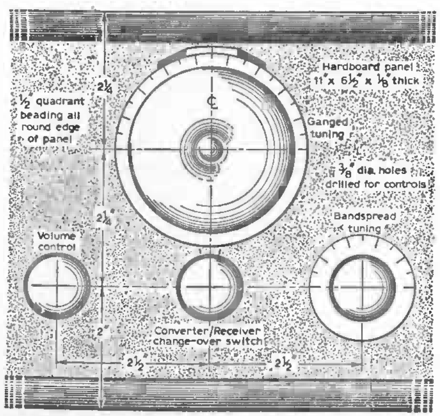


Fig. 38. Front panel layout of controls.

the polystrene locking nuts provided, but, for L3, the lid of the metal container supplied should be drilled and the coil mounted through it. The body of the tin can be screwed into position later.

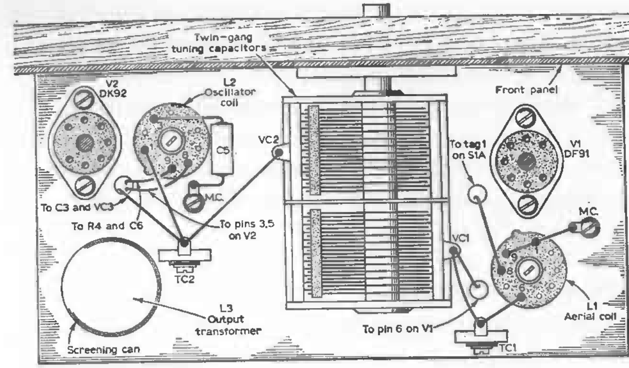


Fig. 39. Chassis component layout.

At this stage wiring can start using Figs. 39 and 40 for reference. (Avoid overheating the coil spills when soldering.) The small dimensions of the chassis permit short and mostly self-supporting wiring, which is a desirable feature in short-

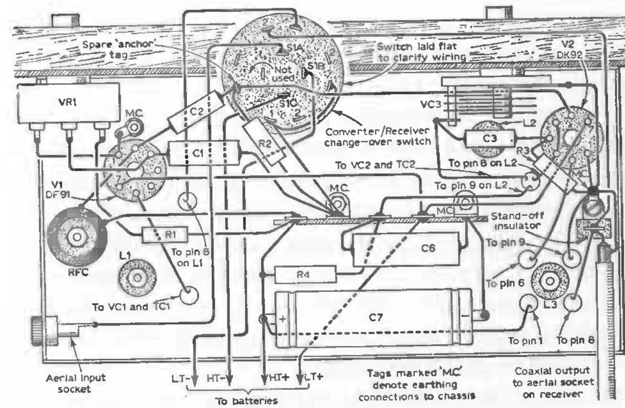


Fig. 40. Complete underchassis wiring digram.

wave equipment. Note carefully the location of the stand-off insulator used as an anchoring and take-off point for the coaxial outlet lead (Fig. 40).

All fixed capacitors should be of very high quality and of modern miniature design, since "leaky" specimens are likely to cause poor operation. Ceramic valvebases were used in the prototype, but are perhaps not entirely essential.

Testing and Alignment

Once all the wiring has been completed and checked S1 may be switched to position "2", valves inserted and batteries connected at the appropriate points, polarity being carefully observed. Coaxial cable should then be connected to the aerial and earth sockets of the receiver with which the unit is to be used, after first transferring the aerial lead to the converter.

The receiver should then be switched on and tuned to a silent point on its dial around 1·5M/s (200m), the volume control being turned well up. The converter sensitivity control, VR1, should next be set to the h.t. end of its travel and VC3 set at approximately half capacity—with its moving vanes half enmeshed in the stationary ones. The converter can now be switched on and aligned.

The dial of the converter is first rotated until some hiss or a signal is heard, when the core of L3 should be manipulated in an attempt to strengthen the signal. The next step lies in trimming and padding the signal and oscillator circuits at the high and low frequency ends of the scale, taking care to allow only the minimum of capacity to be introduced via the trimmers. The oscillator should operate on the high side of the signal frequency, and normally the coil cores will be screwed in reasonably well.

No adjustments should be made to VC3 until alignment is complete, which may take a little time. The sensitivity

control might need to be turned down as certain transmissions are received.

Faults

The above supposes "first time working", which in practice might not result. When the converter is first switched on, there might well be silence, and if this occurs, and voltage supplies, etc. are in order, as indicated by a suitable testmeter, the oscillator section of V2 should come under suspicion. All-dry frequency changers quite often are more temperamental than their mains-powered counterparts, but oscillator functioning can be checked by disconnecting R4 from the h.t. line and inserting at this point a meter switched to read 0-10mA. The current flow should then be noted, and the value should alter when spills 8 and 9 of L2 are momentarily short circuited. Should no change be detected the oscillator is not operating and no frequency changing can occur. The remedy lies in checking that part of the circuit very carefully and reducing R4 to 10kΩ or increasing the value of C3 to, say, 100pF.

When the oscillator is working, the above test should be made at several points on the tuning scale, for it is quite possible for it to cease functioning at a particular frequency. Should no signals be heard when oscillator operation is satisfactory, try removing V1 and temporarily connecting a lead from pin 6 on its base to pin 6 on V2 base. If signals now result, V1 or the associated circuitry is at fault and should be investigated.

Modifications

Where the output is considered insufficient, or where the broadcast receiver used with it is of low sensitivity, improved converter efficiency would result from fitting a further valve

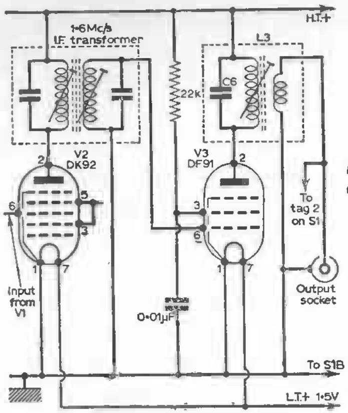


Fig. 41. Increased output may be obtained with this circuit modification.

of the type specified for V1 and using it as an intermediate amplifier. The principle is shown in Fig. 41 where the V3 is the added valve. Coil L3 is removed from the frequency changer anode and a miniature 1·6Mc/s i.f. transformer fitted instead. The amplified output is taken from L3, which is transferred to V3 anode. Extra care must be taken in a circuit of this kind to ensure adequate rejection of signals in the 1·5Mc/s band and a wavetrap tuned to the frequency might become necessary at the aerial input.

9

Five-transistor T.R.F. Receiver

THE unit to be described is a five transistor portable radio receiver of high sensitivity which, compared with some other types of t.r.f. transistor portable, gives above-average quality of reproduction. Reaction is not employed, and two or three stations are pre-tuned and selected by means of a switch. Selectivity is good and there is a marked absence of background noise and interference.

The aerial coil is externally tuned and one section of the station selector switch merely shunts extra capacity across it, bringing it approximately to the frequency of the station selected. The external tuner is then used for final trimming, and is extremely useful for making adjustments under conditions of poor signal reception or when surrounding objects have a damping effect upon the aerial.

A 7 in. by $4\frac{1}{2}$ in. elliptical speaker is used in order to take full advantage of the reproduction available. H.T. is derived from 9V battery and total current consumption of the unit from 5 to 6mA under "no signal" conditions.

The R.F. Amplifier and Detector

The r.f. section comprises two r.f. amplifiers and a diode detector. The diode selected was an OA81 but other types such as the OA71 are suitable. The transistors are both OC44s but here again equivalents are suitable.

In order to provide tuning of the entire medium wave band, the value of the variable capacitor or trimmer VC1 must be 500pF and is adjusted externally. The values of the fixed capacitors C4 and C7 are 100pF and with S1 in position "1" make it possible to tune the r.f. transformers, by adjusting their dust-cores, to the frequency of any station between 200 and 270m. With S1 in position "2" the trimmers TC1 and TC2 will extend the range to about 350m. The switch in this position also shunts the aerial coil with a fixed capacitor C1. The value of each of these capacitors is 200pF.

With S1 in position "3" a further trimmer (not shown in Fig. 42) may be switched across each r.f. transformer primary and a fixed capacitor across the aerial coil in order to select a third station.

The A.F. Amplifier

The a.f. amplifier is a standard 200mW type using an OC71 as driver and a matched pair of OC72's in push-pull for output.

There are several sets of matched driver and output transformers on the market, and supplied with some of these sets is a suggested circuit for their use. It is well to point out here that not all of the output transformers in these sets are suitable for matching to a standard 3Ω loudspeaker and the constructor is advised to enquire on this matter when making any purchase.

If headphones or an earpiece is used, the output stage may be omitted entirely, the three remaining transistors will

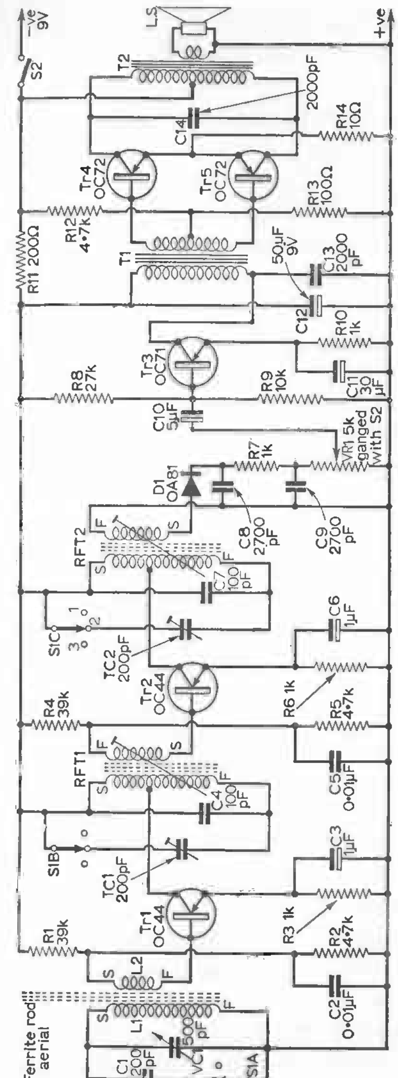


Fig. 42. The transistor circuit.

provide more than adequate power. The r.f. stages alone make an admirable tuner unit for feeding into a high quality amplifier.

The values of coupling and decoupling capacitors in this section are not critical. The decoupling capacitor across the h.t., that is from the primary of the driver transformer to earth, must be at least 50μF. In general it is best to keep the value of all these capacitors as high as possible.

R.F. Transformers

The r.f. transformer coils (RFT1 and RFT2) are home-wound on $\frac{13}{32}$ in. dia. formers using 7/45 Litz wire (see Fig. 43). They must be fitted with variable dust-cores and screening cans. Standard i.f. formers and cans are ideal.

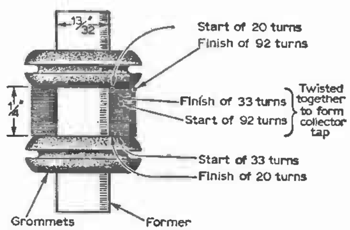


Fig. 43. Construction details of one of the r.f. transformers.

First a single layer of 20 turns is wound on to the former. This should be about $\frac{1}{4}$ in. in length and spaced by grommets or other suitable spacers. Leave a sufficient length of wire free at the beginning and end of each winding and identify these with "S" and "F" tags, indicating the "start" and "finish" respectively of the windings. Now wind on top of this first layer a further 33 turns forming another layer and the commencement of a third. Finally 92 turns are added in single layers remembering to wind all coils in the same

COMPONENTS LIST

Resistors:

R1 39kΩ	R5 4·7kΩ	R9 10kΩ	R12 4·7kΩ
R2 4·7kΩ	R6 1kΩ	R10 1kΩ	R13 100Ω
R3 1kΩ	R7 1kΩ	R11 200Ω	R14 10Ω
R4 39kΩ	R8 27kΩ	All ±10%, $\frac{1}{8}$W	

VR1 5kΩ potentiometer, plus S2

Capacitors:

C1 200pF	C8 2,700pF
C2 0·01μF	C9 2,700pF
C3 1μF electrolytic	C10 5μF electrolytic
C4 100pF	C11 30μF electrolytic
C5 0·01μF	C12 50μF electrolytic 9V
C6 1μF electrolytic	C13 2,000pF
C7 100pF	C14 2,000pF

VC1 500pF solid dielectric variable
TC1 200pF trimmer TC2 200pF trimmer

Semiconductors:

Tr1 OC44	Tr4 OC72 } Matched Pair
Tr2 OC44	Tr5 OC72 }
Tr3 OC71	D1 OA81

Miscellaneous:

T1, 2 Matched pair of driver and output transformers. See text
S1A, B, C 3-pole, 3-way rotary switch
S2 On/off switch on VR1
Length of $\frac{3}{8}$ in. dia. ferrite rod. Two $\frac{13}{32}$ in. dia. formers for RFT1, 2. 3Ω loudspeaker. 9V battery. Paxolin. Pair of battery connectors. Three knobs. Litz wire, enamelled copper wire, grommets, etc.

direction. The "finish" of the second coil of 33 turns and the "start" of the third coil of 92 turns must be twisted together to form the collector tap.

The entire operation requires less time than one may imagine and is quite simple to carry out, the only difficulty being the removal of the enamel insulation from the Litz wire. The following method, although not the speediest, is certain to ensure that all the strands are clean and undamaged.

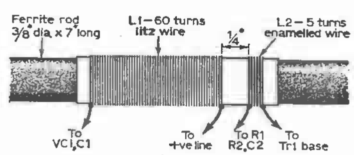
The cotton or silk is removed from the wire and the strands played out fan shape. They are then drawn along fine flour paper until the copper appears through the enamel. The wire is then turned over and the treatment repeated until all the strands are clean. Finally the strands are counted to ensure all seven are intact, twisted together and tinned.

All the coil ends are then soldered to the wire pillars fitted in the transformers, remembering to note pin connections before finally closing the screening can. The coils may be waxed or doped on completion to prevent damp entering.

Coils on Ferrite Rod

The aerial and coupling coils L1 and L2 are wound on to a $\frac{3}{8}$ in. by 7 in. ferrite rod using 7/45 Litz wire for L1 and 40 s.w.g. enamel covered wire for L2 (Fig. 44).

Fig. 44. Winding details of the aerial.



A paper tube is made to fit freely over the rod and on to this is wound 60 turns of Litz wire to form L1. The coupling coil L2 is five turns of 40 s.w.g. spaced $\frac{1}{4}$ in. from the aerial coil. Both windings are close-wound, and must slide easily on the paper tube along the ferrite rod in order to allow adjustment during alignment.

Before winding the coils it is advisable to insert two straight lengths of wire between the paper tube and the rod

opposite each other. On completion of the coil these are removed and the coil will slide freely. For the wiring details of L1 and L2 see Fig. 44.

Construction Suggestions

The chassis used in the prototype consisted of a Paxolin base with an upright panel at one side for the mounting of controls. Holes are drilled where connecting pins are required and small lengths of 16 s.w.g. tinned copper wire are pushed through. Owing to the close proximity of the ferrite rod aerial to the upright panel, the material used for its construction must not be metal.

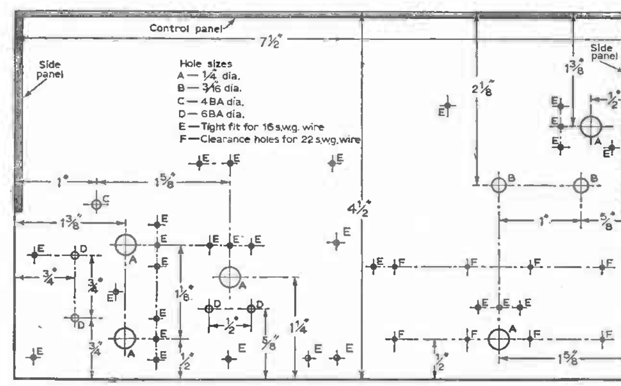
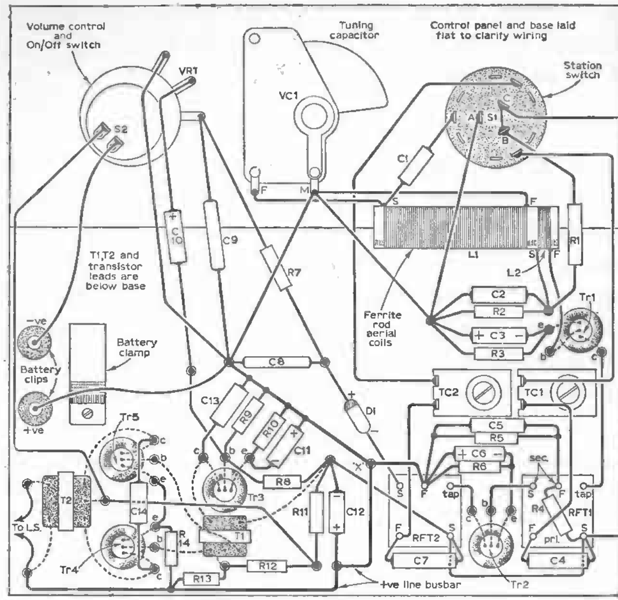


Fig. 45. Dimensions of the chassis.

In order to reduce the overall thickness of the receiver case, the r.f.t. cans are laid on their sides and held secure to the chassis by lengths of 22 s.w.g. wire which is passed through holes in the Paxolin base and soldered. The thickness of the finished case is finally decided upon by the depth of the loudspeaker magnet and the size of battery used.



Transistors are secured through grommets mounted on base

Fig. 46. Complete wiring diagram and connections between control panel and chassis.

C4 and C7 are mounted directly on to the pins of the r.f. transformers and S1 is located at the r.f. end of the chassis in order to prevent instability due to r.f. leads being too long.

With the receiver standing on its base the controls appear at the top panel of the case.

Alignment

Firstly the constructor must decide on the stations required. Of the stations required, the one situated at the lowest end of the medium-wave band should be aligned first.

In the case of the prototype receiver this station was the BBC Light Programme.

A length of wire to form a temporary aerial is connected via a capacitor to the top end of the aerial coil L1 and VC1 is set to near its minimum capacitance, or to approximately 100pF. With S1 switched to position "1" and the r.f.t. dust-core at mid-position, it may be possible to receive the Light Programme.

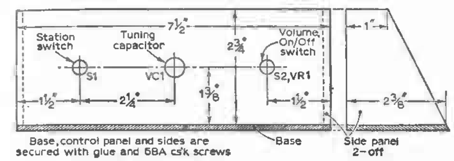


Fig. 47. Front and side views of the receiver case.

The coils L1 and L2 must be situated near one end of the ferrite rod with the base coupling coil L2 on the inside. They may now require some adjustment by sliding them along the ferrite rod. If the station is not yet audible or the gain is low, slowly turn the core of RFT2 until results are achieved. RFT1 is then adjusted and VC1 turned for maximum gain.

The whole process is repeated with the temporary aerial removed, until further improvement is not possible. Owing to the directional quality of ferrite rod aerials the receiver must be rotated for best results, on each station tuned.

S1 is then switched to position "2" and the trimmers TC1 and TC2 treated in a similar manner to that of the r.f.t. cores in order to select the second station required. VC1 is permanently variable and may need some adjustment but the cores of the r.f. transformers must not be moved after selection of the first station. Coils L1 and L2 are finally adjusted for best results on both stations and then permanently fixed.

10

Four-valve Superhet Portable

WHILE transistors have unquestionable advantages for portable equipment, as illustrated in the preceding chapter, there are many constructors who still prefer the positive and assured results that are obtained with a well-tried and conventional valve circuit. By taking advantage of the miniature components that are now available a very compact valve set may be constructed with the sure knowledge that it will work first time and give good performance.

Modern low consumption valves are used in this circuit and these, in conjunction with an inexpensive combined h.t. and l.t. battery, provide quite an economical receiver.

All the parts are standard proprietary lines and therefore easily obtainable.

The Circuit

The circuit (Fig. 48) is a completely conventional 4-valve superhet covering full medium wave and sufficient of

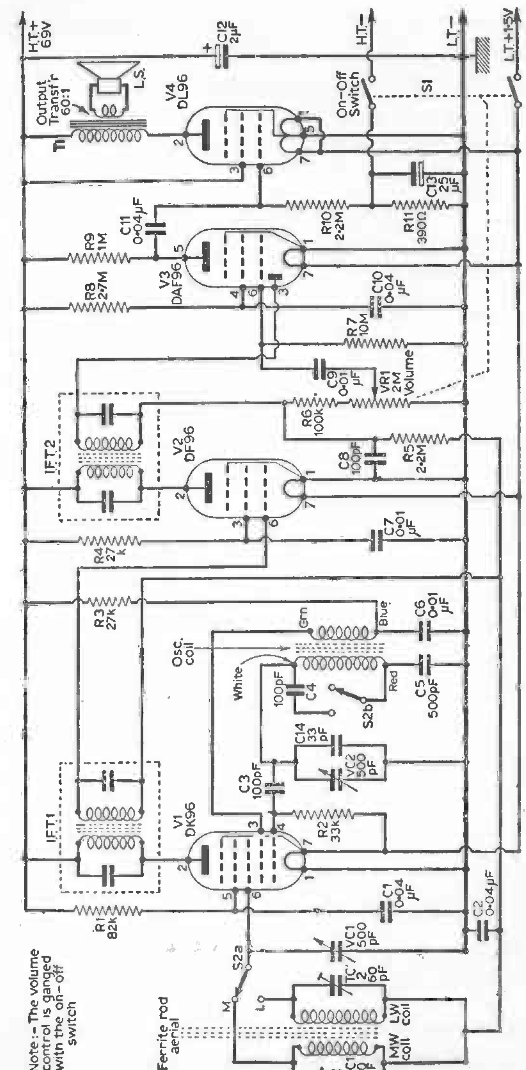


Fig. 48. The battery-operated circuit.

the long wave to tune the Light Programme, at good strength, anywhere in the country.

The actual lay-out has been very carefully arranged to achieve a neat and compact design and from the group-board wiring diagrams (Figs. 49 and 50) it will be seen

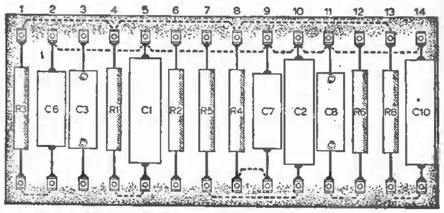


Fig. 49. Most of the smaller components mounted on a main group board.

that practically all the small components can be mounted on to two groupboards which can be completely assembled and wired up before fitting to the chassis.

Aluminium Chassis

The chassis is constructed from a piece of 18 s.w.g. aluminium, $5\frac{1}{2}$ in. $\times$ $4\frac{1}{2}$ in., and drilling details are given in Fig. 51. Strips along two edges of the aluminium are

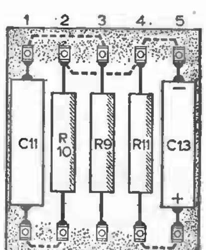


Fig. 50. Wiring of an auxiliary group board.

folded down—as shown in the diagram—so that the finished chassis measures $5\frac{1}{2}$ in. $\times$ 3 in. with $\frac{3}{4}$ in. runners, front and back. The front runner is drilled with four 6B.A. bolt holes

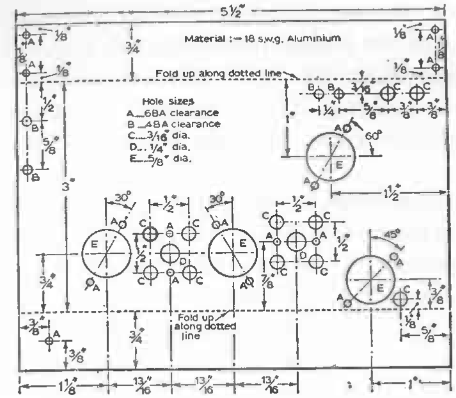


Fig. 51. Dimensions and drilling details of the chassis.

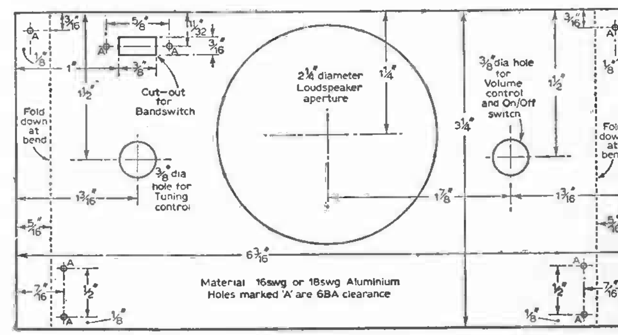


Fig. 52. Dimensions of the front panel.

to match four holes at the bottom of the front panel—Fig. 52. By this means the chassis will be joined to the front panel.

Wiring the Groupboards

Before assembling any components on to the chassis, it will be best to wire and mount the smaller components on the two groupboards; the exact position of these and the method of wiring up at the back of the boards will be seen quite clearly in Figs. 49 and 50. It is recommended that one end of the board is marked in some way, as it is quite easy to be confused when constantly turning it round for wiring up.

As these groupboards have to be bolted to the main chassis, remember to leave the two relevant components off until the boards have been mounted, to enable the screws to pass through the holes. It is also important to note that an insulated back-plate must be placed between the back of the board and the chassis, to prevent the tag eyelets being shorted by the aluminium.

Mounting the Major Components

Having completed and fitted the groupboards, the next step is the mounting of all the main components to the chassis taking particular note of the orientation of the valve-holders (Fig. 51). The i.f. transformers have similar windings for primary and secondary and it is not important which way round they are fitted. If preferred the front panel with its associated controls and parts may remain separate from the main chassis until later in the assembly. It is suggested that a strip of insulation tape along the inside of the front chassis runner is a useful precaution as the clearance between it and the group-board tags is rather small.

It is advisable to leave the ferrite rod aerial to last as some alterations to it are necessary before fitting, and also it will eliminate the risk of breaking or damaging it during construction.

The two-gang tuning capacitor is mounted from the front of the panel using three countersunk 4B.A. screws, see Fig. 53. (Ensure that these are cut down short enough to prevent them from projecting through and interfering with

the movement of the vanes of this capacitor.) The loudspeaker can also be mounted in a similar manner, using 4B.A. countersunk screws with nuts on the inside to make it secure. When all the parts have been fitted to the front panel it can be completed by covering with fine mesh expanded metal, or loudspeaker covering material, leaving a small aperture for the miniature wave-change switch. If it is intended to fit dials one can be mounted under the fixing nut for the volume control and the other one for the tuning indicator is best secured by using contact adhesive.

Wiring

Most of the wiring is quite straightforward and obvious from a study of Figs. 53 and 54.

In order to simplify the wiring some slight alterations will need to be carried out to the Repanco ferrite rod aerial before fitting. In the first place it will be found that there are low impedance coupling windings over the top of each of the

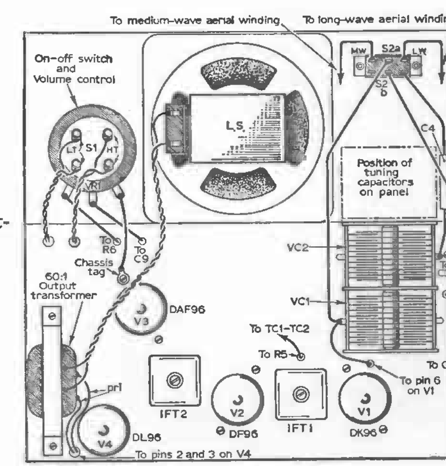


Fig. 53. Interconnections above chassis.

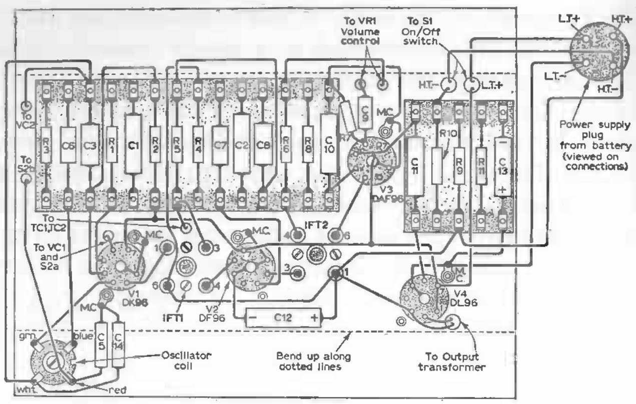


Fig. 54. Underchassis wiring extra to the group board wiring.

two coils and these are removed completely. If it is desired to use this set with a car radio aerial in a car these windings may be left on and taken in parallel to a suitable socket for the car aerial. It will be seen from Fig. 55 that the medium wave winding is connected to two tags on the right-hand aerial bracket, with a miniature 60pF trimmer soldered into position across it, and that the long wave winding is connected to another pair of tags also with a 60pF trimmer positioned in parallel. Sufficient length of lead should be left to allow both these coils to be moved along the ferrite rod

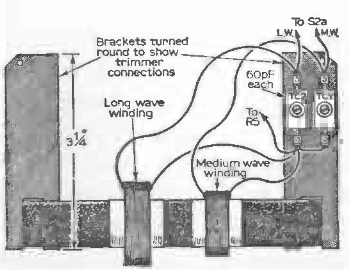


Fig. 55. Mounting and wiring details of ferrite rod aerial and trimmers.

for tuning to the best position. It should be noted that this aerial coil wire is Litz and it is essential when making soldered joints that every single strand is carefully cleaned and tinned otherwise performance may be affected. The ends can conveniently be cleaned by placing on a firm surface and scraping gently with fine emery cloth, or another method is to heat the wire ends in a small flame and while still hot, plunge them into methylated spirit after which the ends can be wiped clean and then soldered.

Battery Polarity

Great care should be taken in wiring the special battery plug as a careless mistake can prove an expensive one since all the valves could be destroyed in a moment if incorrect voltages were applied to them. To be absolutely safe it is a good idea not to insert the valves at first but to test the filament wiring by plugging in the battery and checking between pins 1 and 7 on the valveholders of V1, V2, and V3, and between pins 1 and chassis on the valveholder of V4 using a voltmeter or a 2·5V bulb. The reading should be 1·5V in each case or if using a bulb it should just light up dully. If the bulb flashes and blows then there is a mistake in the l.t. wiring which must be located and put right before the valves go in.

Alignment

Having carried out this test satisfactorily the valves can be inserted into their correct positions and the set switched on. With the volume control turned full on, a quick test of the l.f. portion of the set can be made by lightly touching pin 6 of V3 when distinct clicks and possibly a faint hum will be heard. Now turn the tuning control slowly until some signal is heard however faint and then the upper and lower tuning cores in the two i.f. transformers should be carefully adjusted in turn to bring the signal to its loudest, if necessary reducing the setting of the volume control progressively, as it is easier to detect the peak of adjustment at lower volume levels. It is worth while to go over these adjustments several times to ensure that the best setting has been obtained. This alignment is more easily carried out if access to a signal generator is possible but in any case it is not difficult using the normal broadcast stations.

Oscillator Adjustment

In view of the fact that the tuning dial will probably only be marked from 0 to 10 it was considered that exact calibration was not very important and therefore no oscillator trimmers were provided, the only oscillator adjustment is the core of the coil and this was set to give the medium wave Light Programme on 2·5 on the dial. The Home Service then came in at 4 and Luxembourg was received at excellent strength on 1.

Having completed the i.f. and oscillator adjustments, the aerial circuits should be trimmed for optimum performance, and it should be noted that for all the alignment adjustments it is preferable to use a non-metallic trimming tool. Switch to long wave and tune in the Light Programme which should be about 6 on the dial and then adjust for the maximum result by sliding the long wave aerial coil each way along the ferrite rod aerial and at the same time adjusting the long wave aerial trimmer.

Now switch to medium wave and select a station round about 6 (probably Hilversum) and adjust the medium wave aerial coil by sliding each way on the ferrite rod aerial for optimum signals. Next tune to Luxembourg or another station at about 1 on the dial and adjust the medium wave trimmer for maximum volume. As it will be found that all

COMPONENTS LIST

Resistors:

R1 82kΩ	R4 27kΩ	R7 10MΩ	R10 2·2MΩ
R2 33kΩ	R5 2·2MΩ	R8 2·7MΩ	R11 390Ω
R3 27kΩ	R6 100kΩ	R9 1MΩ	

All ±10%, $\frac{1}{2}$W carbon
VR1 2MΩ log. potentiometer, plus D.P.S.T. switch S1

Capacitors:

C1 0·04μF 150V	C8 100pF mica
C2 0·04μF 150V	C9 0·01μF 150V
C3 100pF mica	C10 0·04μF 150V
C4 100pF mica	C11 0·04μF 150V
C5 500pF mica	C12 2μF electrolytic 150V
C6 0·01μF 150V	C13 25μF electrolytic 150V
C7 0·01μF 150V	C14 33pF mica

VC1, 2 500+500pF twin gang tuning (Jackson "02")
TC1 60pF miniature compression trimmer
TC2 60pF miniature compression trimmer

Valves:

V1 DK96 V2 DF96 V3 DAF96 V4 DL96

Transformers:

I.F.T.1 465kc/s i.f. transformer (Denco IFT.11)
I.F.T.2 465kc/s i.f. transformer (Denco IFT.11)
T1 Miniature output transformer, ratio 60:1

Switches:

S1 D.P.S.T. switch on VR1
S2A, B D.P.D.T. slider switch

Miscellaneous:

Oscillator coil (Weymouth radio type HO3). Medium and long wave aerial (Repanco FS2). 14-way miniature groupboard. 5-way miniature groupboard. 69V, 1·5V battery. $2\frac{1}{2}$ in. 3Ω loudspeaker. 4 B7G valveholders. Suitable battery plug. Aluminium, wire, nuts, bolts, knobs, etc.

these adjustments are slightly inter-dependent and altering one will affect the others, it is worth while going over them all two or three times until satisfied that the best results are being obtained.

The Cabinet

Owing to this set's neat and compact shape the cabinet is quite simply constructed from $\frac{3}{8}$ in. plywood with a suitable cut-out in the front for the controls and loudspeaker. Two runners, also of $\frac{3}{8}$ in. plywood, are fitted to the inside of the cabinet to support the set which is then held firmly in position by a small block glued inside the back. The battery can then be accommodated in an accessible position beneath the chassis.