9 BAND SHORT WAVE RADIO

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ANY means of spreading the great number of short wave transmissions which can he heard over an increased tuning range is helpful, simplifying and easing tuning. When several ranges are needed it becomes difficult to use separate inductors for each range, involving a large number of coils, with all the associated switching.

In the receiver described here, only two coils are required band-changiog being achieved by hringiog in pairs of fixed capacitors. This breaks up the full tuning range into a numher of smaller divisions.

CIRCUIT

Fig. 1 is the mixer stage circuit tbe wiring being very much simplified by using this switching arrangement. L1 is the aerial coil, tuned by VC1, and L2 tbe oscillator coil, tuned by VC2. VC1 and VC2 are sections of a small ganged capacitor, operated through a cord drive.

The 2-pole 9-way rotary switch S2/S3 selects the required band. With the switcb in position 1, VC1/2 alone are in use, for the highest frequency band. When the switch is in position 2, C2 and C10 are in circuit. Each of these capacitors is 50pF, so the next range runs on from the frequency reached wben S2/3 was in position 1, and VC1/2 fully closed. In a similar manner, positioo 3 of tbe switch brings in C3 and C11, each of 100pF. The next lower frequency band employs C4 aod C12, eacb of 150pF, with the switcb in position 4. This continues for the nine ranges, each pair of capacitors heing 50pF larger in value than the previous pair.

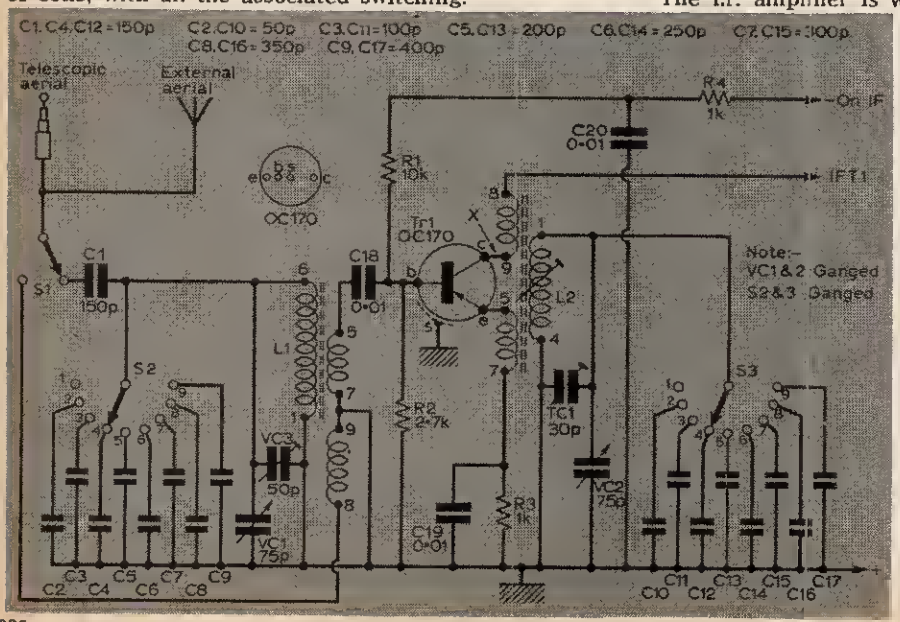
VC1/2 has a swing of a little over 50pF, so that ranges overlap. VC3 is a panel trimmer, whicb can he set for hest volume on any band, or wheo altering the aerial. S1 is ao aerial switcb, used for the attacbed telescopic aerial or an external aerial.

The capacitors C2 to C9 for the aerial circuit, and C10 to C17 for the oscillator, are 1% or 2% silvermica, and any variation in the exact capacitances of the components used is easily cancelled out by VC3.

IF AMPLIFIER

A conventional high gain intermediate frequency amplifier is used, Fig. 2. This has two double-tuned i.f.t.'s, aod one single tuned i.f.t. resulting in good selectivity.

The i.f. amplifier is wired as a separate unit, on



The complete circuit of the 9 Band Receiver is made up of Fig. 1, (left) mixer stage; Fig. 2, I.f. stages and Fig. 3 the audio output stage. The constructor only need assemble the mixer and i.f. stages since the audio stage is a packaged module.

a small insulated hoard. Input from the mixer stage is to pin 2 of i.f.t.1 and audio output is from D1 aod C26. VR1 is the usual audio volume control.

AUDIO AMPLIFIER

This provides high gain aod 330mW output into a 15 ohm speaker. Fig. 3 is the circuit and Tr4 is the first a.f. amplifier stage, stahilised by R14. Output from Tr4 collector is via C30 to the hase of Tr5, which witb Tr6 forms a Darlington pair driver for the output transistors. Tr7 and Tr8. These form a push-pull complementary-symmetry stage, working in Class B, with diode D2 for thermal stabilisation. Feedback througb R17 maintains operating conditions for the four directly-coupled transistors Tr5 to Tr8.

This circuit has plenty of amplification and volume. In order to simplify construction of the whole receiver, the audio amplifier is obtained as a printed circuit package, ready for use, and incorporating matched transistors.

A is the common positive line, and D the negative line. Point C is for audio input. The resistor R13 is iocluded in the amplifier. R12, which is in series with R13, was found to be necessary for stable working in this particular receiver.

Leads from D (battery negative line) and E run to the 15 ohm speaker. The circuit is of the transformerless type and a speaker of other than 15 obm impedance should not he used.

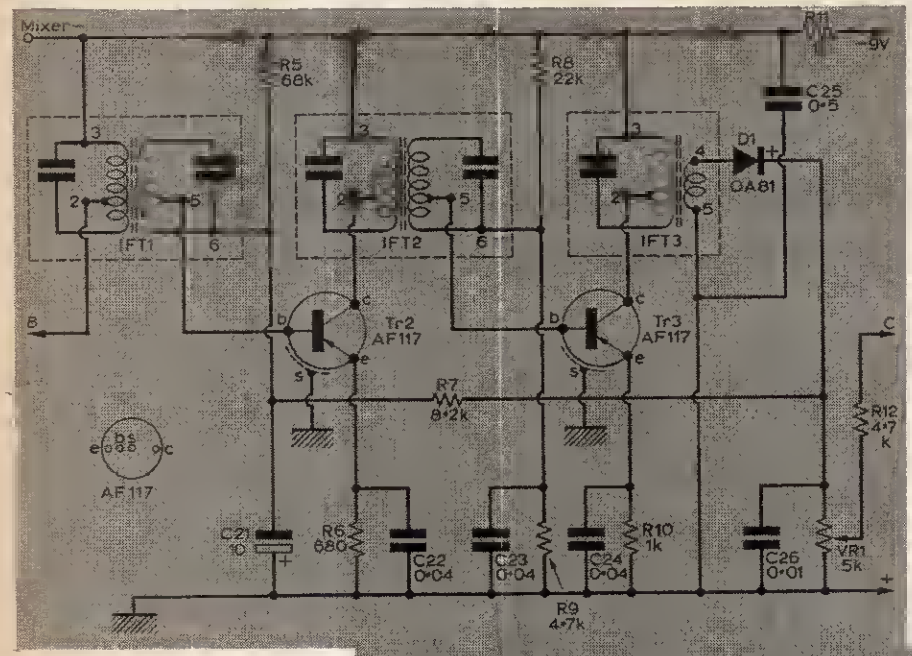


Fig. 2. The circuit of the i.f. stages, constructed as a separate unit on a paxolin panel (See Fig. 6). The input comes from pin 8 on L2 in the mixer stage.

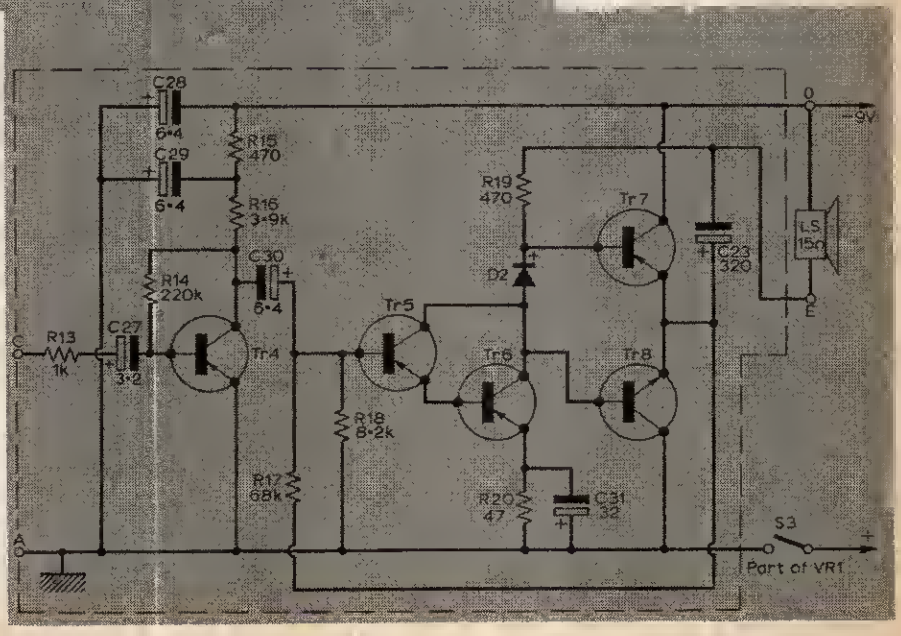


Fig. 3. Since the audio stages are contained within a packaged module this circuit of the 5 transistor unit is given for interest only. Input from the i.f. assembly goes to pin C, the loudspeaker to pins D and E and the earth line to the on/off switch S3. (Note: C23 should read C32.)

MIXER STAGE ASSEMBLY

A 10in. x 4in. flanged plate (universal chassis member) serves as panel for the controls and the top of the case. The controls are placed 1in. from the bottom of this plate, VC3 and the cord drive spindle being $1\frac{3}{4}$in. from the plate ends and S2/3 and VR1 equally spaced between these.

VC1/2 is fixed as in Fig. 4 so that the top of the drum is about $\frac{1}{8}$in. below the top of the plate. One pulley is above the cord drive spindle, to keep the cord parallel with the plate. The second pulley guides the cord clear of the bushes of S2/3 and VR1. The pulleys are on bolts fixed with lock nuts to the plate. The cord is given one complete turn round the drive spindle, then passes round the wheels and

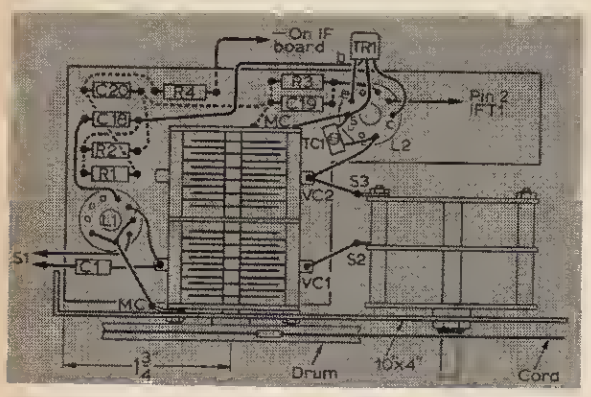


Fig. 4. Layout of the mixer assembly built on an aluminium plate.

drum. It is taken through the drum slot, and tied so that it is under tension from the spring.

Fig. 4 shows wiring, etc., for this stage. L1, L2 and the other items are mounted on a piece of paxolin 5in. x $2\frac{1}{2}$in., which has a cut-out section to clear S2/3. VC1/2 is bolted to the 10in. x 4in. plate, and the paxolin is in turn bolted to the underside of the ganged capacitor. Additional support is given by a bracket attached to the paxolin and rear of the 9-way switch.

Transistor Tr1 has three leads soldered directly

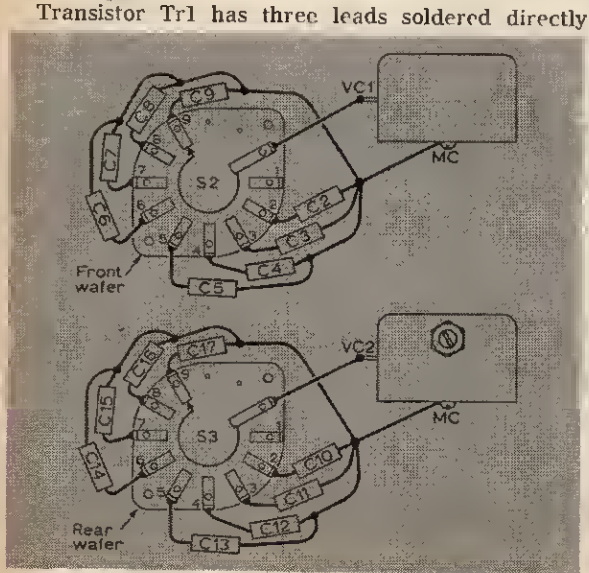


Fig. 5. Details of the wiring of the bandswitch S2/S3.

★ components list

Resistors:

R1	10kΩ	R5	68kΩ	R9	4·7kΩ
R2	2·7kΩ	R6	680Ω	R10	1kΩ
R3	1kΩ	R7	8·2kΩ	R11	1kΩ
R4	1kΩ	R8	22kΩ	R12	4·7kΩ

All ¼W 10%.

VR1 5kΩ potentiometer, log, with switch (S3).

Capacitors:

C1	150pF	C10	50pF	C19	0·01μF
C2	50pF	C11	100pF	C20	0·01μF
C3	100pF	C12	150pF	C21	10μF 6V
C4	150pF	C13	200pF	C22	0·04μF
C5	200pF	C14	250pF	C23	0·04μF
C6	250pF	C15	300pF	C24	0·04μF
C7	300pF	C16	350pF	C25	0·5μF
C8	350pF	C17	400pF	C26	0·01μF
C9	400pF	C18	0·01μF		

Capacitors C1 to C17 inc. are 1% or 2% silver mica.

VC1/2 2 gang, 75 – 75 pF approx. See text.
VC3 50pF air-spaced variable.
TC1 30pF pre-set.

Semiconductors:

Tr1 OC170 Tr3 AF117
Tr2 AF117 D1 OA81

Inductors:

IFT1 IFT18/465 (Oenco) L1 Range 4 Blue (Transistor)
IFT2 IFT18/465 (Denco)
IFT3 IFT14/465 (Denco) L2 Range 4 Red (Transistor)

Audio Amplifier:

PC3 Packaged circuit (Newmarket).

Miscellaneous:

Cabinet: 2 off, 10in. x 4in. Universal chassis flanged member (Home Radio). 2 off, $7\frac{1}{2}$in x $4\frac{1}{2}$in. plywood. 2 off, 10in x 7in. hardboard. Tuning drive: Drum, $2\frac{1}{2}$in. dia., DL34 drive spindle, spring, cord, pulleys (Home Radio). Speaker, 7in. x $3\frac{1}{2}$in., 15Ω. Telescopic aerial. Aerial socket, knobs, rubber feet.

to the pins of L2. The base lead B is extended by soldering on connecting wire, to run to C18. Connections in this stage should be reasonably short and direct. R3, C19 and C20 are wired to a tag under the paxolin, in contact with the metal frame of VC1/2.

VC3 is mounted directly under VC1/2 and is connected in parallel with it by short leads.

The bandswitch occupies the position shown in Fig. 4, and is wired as in Fig. 5. The switch has separate single-pole 9-way wafers connected directly to VC1 and VC2 by short leads. No extra connection is made to position 1. Position 2 has the pair of capacitors C2 and C10 (50pF each). Position 3 has equal capacitors C3 and C11 (100pF each), and so on.

The capacitors are best arranged to lie partly over the wafers, in the manner giving shortest leads to a stout wire which returns to the frame tag of the ganged capacitor.

GANGED CAPACITOR BAND SWITCH

S2/3 introduces fixed capacitor increments of 50pF at each position. There is a certain amount of stray circuit capacitance, to which is added the

minimum capacitance of VC1/2. This means that a ganged capacitor having a maximum capacitance of 50pF each section is not quite sufficient and results in small gaps in the tuning range.

A ganged capacitor with a capacitance swing of just over 50pF (say from 10pF to 70pF) would be ideal. To obtain a little overlap, and allow for variations of C2 to C17, the nearest standard value is 75pF, which is satisfactory.

When this tuning arrangement was first used, a 2 x 100pF capacitor was fitted and some plates pulled off, but this resulted in too many being removed. A new capacitor thus had to be fitted. Caution is therefore required, if a capacitor is modified in this way. With a 2-gang 100pF capacitor, the effective value can be reduced to about 75pF by placing a 300pF fixed capacitor (silver mica) in series with each section. The lead from L1 to VC1 must then run over VC1 so that it can join the lead from S2.

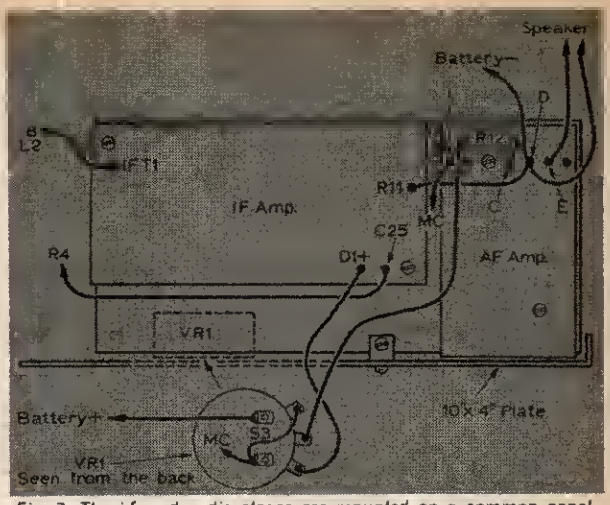


Fig. 7. The i.f. and audio stages are mounted on a common panel.

IF AMPLIFIER ASSEMBLY

This is assembled and wired on a paxolin panel $3\frac{3}{4}$in. x $1\frac{3}{4}$in. All components are mounted on one side and wiring is on the reverse, as in Fig. 6. Note that the different spacing of the pins of the i.f.t.'s enable these to be identified. Remember to drill holes for adjustment of the cores.

Small holes are drilled for the leads of the other components. Note the polarity of C21 and diode D1. Connections underneath are made by bending over the wires and snipping off the ends and by using thin connecting wire where required. Insulated sleeving is put on all leads where necessary. Two bolts holding the tags MC, locked on, will mount the finished amplifier and provide a positive return circuit.

Solder a lead to pin 2 of i.f.t.1. This is later soldered to pin 8 of the oscillator coil L2.

Take a black lead from R11, to use as negative. Solder a wire to the junction of R11 and C25, as shown, which will later run to R4. The remaining external connection is from R7, C26 and D1, and goes to the volume control VR1.

Both i.f. and a.f. amplifiers are mounted on a piece of paxolin $5\frac{1}{2}$in. x $2\frac{1}{2}$in. which is supported by the bracket mentioned earlier, and by a further bracket bolted to the 10in. x 4in. aluminium plate. Extra nuts are put on the bolts holding the tags MC, Fig. 6. The bolts pass through the $5\frac{1}{2}$in. x $2\frac{1}{2}$in. paxolin. Further tags are then put on fixed with nuts. The tags are wired to the volume control and metal plate (positive line).

The audio amplifier package is mounted in a similar way, Fig. 7. R12 is soldered to point C. A black lead for battery negative is taken to point D, and white leads for speaker connections to points D and E. A red lead from point A runs to the positive line at VR1 and the on-off switch.

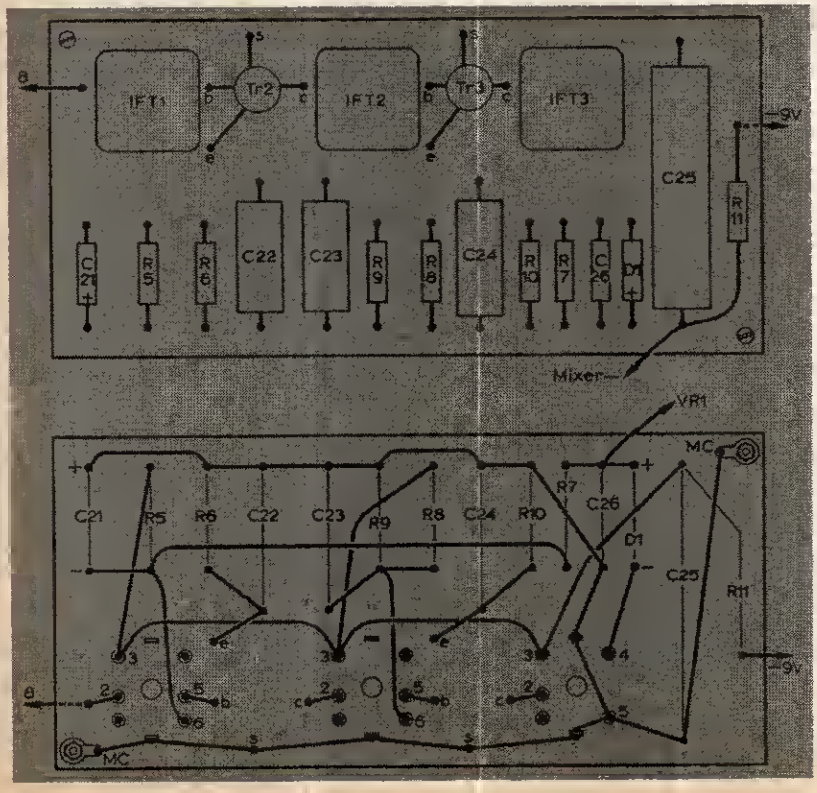


Fig. 6. Layout and wiring diagram of the i.f. assembly built on a paxolin panel, $3\frac{3}{4}$in x $1\frac{3}{4}$in.

ALIGNMENT

The complete assembly on the 10in. x 4in. flanged plate is aligned and tested before fitting it in the cabinet. A speaker of the correct type (15 ohms) must be connected.

The five cores of the i.f.t.'s are rotated with a suitable tool, such as the Denco TT5, for best results. A weak signal is most suitable from a signal generator, or from a transmission, a short wire aerial being temporarily

connected to tag 8 of L1. VR1 should be near maximum volume, hut a strong signal should he avoided hecause the automatic gain control circuit will then make critical adjustment of the cores difficult.

Once the i.f.t. cores have been correctly peaked for best sensitivity, they should he left alone. A meter placed in one battery lead should show a current of under 15mA with weak signals, rising to peaks of 50mA or more with signals giving good volume.

The cores of L1 and L2 are then rotated until about $^{3}/_{8}$in. of threaded hrass projects. Set VC3 and TC1 at ahout half capacitance. Open VC1/2, set the bandswitch at Position 1, and rotate TC1 as necessary to tune to about 15MHz.

Leave VC3 and TC1, switch to Position 9, and close VC1/2. Rotate the core of L2 as necessary to tune to approximately 3·6MHz. Switch to Position 8, tune in a transmission, and rotate the core of L1 for best results.

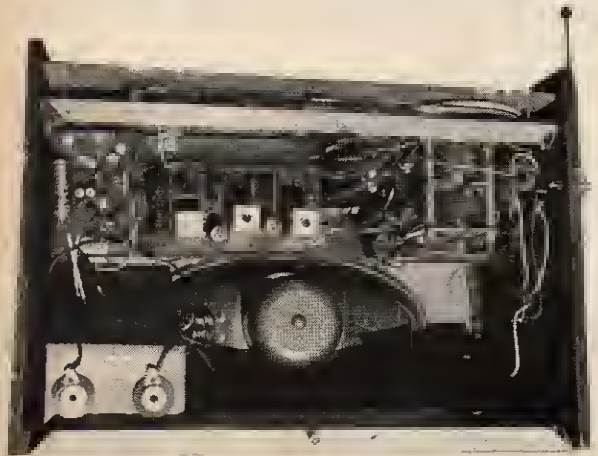
It should then he found that with the bandswitch in any position, and a transmission tuned in, VC3 can be peaked for hest reception. Should VC3 need to be either fully open or fully closed with tbe switch in Positions 1 or 2, re-adjust TC1 as required. If VC3 is either fully open or fully closed to give hest results with the switch in positions near the low frequency end of the coverage provided (especially Position 8 or 9) then the core of L1 needs slight re-adjustment to avoid this.

It sbould be found that VC3 generally only needs one adjustment for each band and that often even this will not be necessary. VC3 can he peaked up for hest reception of weak signals at any time, when changing the aerial, or switching S1.

1f it is found that almost uninterrupted whistles arise at the extreme h.f. end of the coverage provided, include a resistor at X in Fig. 1, hetween collector and pin 9 of L2. Its value should be the lowest which prevents oscillation and will generally be around 47 ohms to 470 ohms or so. This depends on the individual transistor and other factors.

CABINET ASSEMBLY

Fig. 8 will help to clarify assemhly of the case. Cut two pieces of hardhoard 10in. x 7in. and with a pad saw or keyhole saw cut a hole to match the speaker cone. Clean up all edges with glasspaper and wipe off any dust. Fahric is then stretched over the hardhoard, brought round tbe edges, and glued on the inside.



A view inside the 'works' shows the three units forming the complete receiver.

The sides are 3-ply, each $7^{1}/_{2}$in x $4^{1}/_{2}$in., sanded and varnished. The 10in x 4 in. flanged plate forming the case hottom is placed on a flat surface, and the sides are positioned as in Fig. 8. Mark through the flange holes, drill the sides to match, and fix them with holts.

Drill tbe hardboard front for speaker and front flange, and holt this as in Fig. 8, with the speaker in position.

The receiver panel should then be finished. Cut a piece of plywood or other thin wood about 5in. x 2in. and fix this with small screws through the 10in x 4in. plate, to hring the tuning scale about level with tbe drive cord. Clip a small piece of tinplate on the cord, and solder a straight wire pointer on this, so that it moves along the scale.

A piece of perspex is cut 10in. x 4in., and drilled to match the four control spindles and for 6BA bolts in line with the four boles which are in the universal chassis flanged plate. A piece of coloured card is also cut this size, and a window about $5^{1}/_{4}$in. x $1^{1}/_{4}$in. is cut in it with a sharp hlade, to lie over the tuning scale.

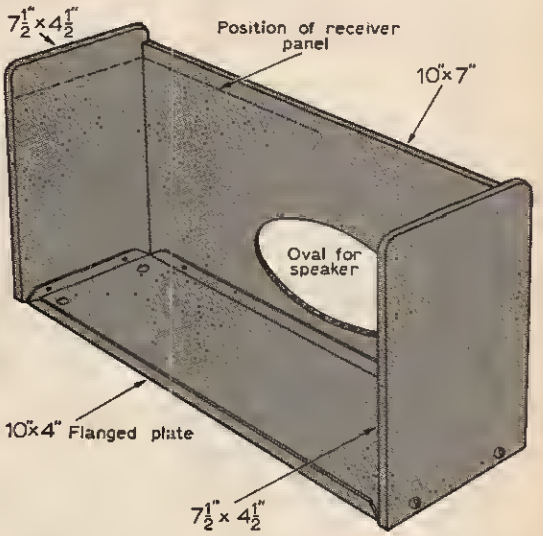


Fig. 8. Details of the construction of the receiver cabinet.

Four 1in. long 6BA bolts are put through tbe holes in the perspex and card. A washer and nut is put on each holt, and the nuts are tightened. An extra nut is then put on each holt, and the whole is fixed in place with further nuts behind the flanged plate. The nuts are adjusted to give ahout $^{1}/_{2}$in. clearance, to take tbe drum, cord and pointer.

The assembly is then put in the top of the case, so that tlie flanged plate is about $^{1}/_{2}$in. down, as in Fig. 8, and the perspex is flush with the case front. Drilling positions are then marked through the holes punched in the flanges. The sides are drilled, and the receiver bolted in place. The receiver case front is also bolted to the front flange of tbe 10in. x 4in. plate.

—continued on page 738

AERIALS

The telescopic type aerial has a bracket, so that it can be bolted directly on the left hand side of the case, about 1in. from the back. An insulated socket is fitted on the side of the case for an external aerial. Many transmissions can be received at ample volume with the telescopic aerial alone but an external aerial will greatly improve the reception of weak signals.

DIAL SCALE

Because each of the nine bands covers a relatively small frequency range, the main tuning scale is fitted with a card marked 0 to 50.

The bandswitch has nine positions, and the card scale under it has ten frequency markings. The bandswitch pointer comes to rest between these markings, which thus show the approximate frequency coverage of that particular range. For example, if the pointer rests between 4·6 and 5·0, the range is 4·6-5·0MHz, while if it is between 5·0 and 5·6 the range is 5·0-5·6MHz, covered with the normal tuning control.

The full markings are as follows: 3·6—3·8—4·3—4·6—5·0—5·6—6·3—7·4—10—15. This scale is best put under the perspex. ■