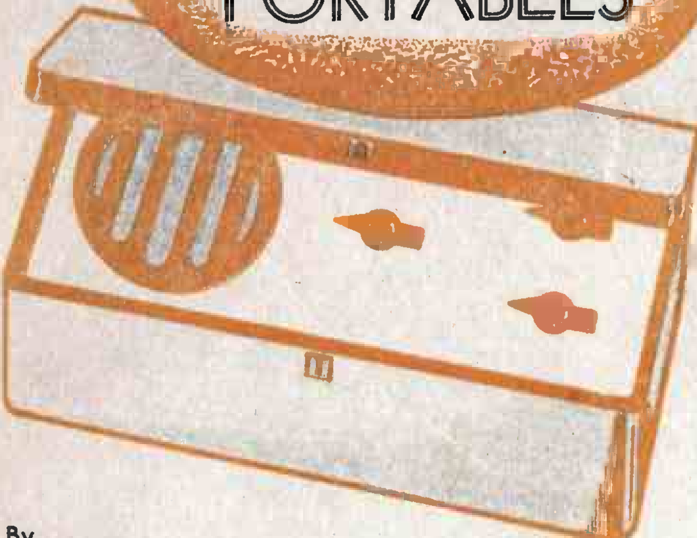
THE PRACTICAL CONSTRUCTOR'S BOOK OF

PERSONAL PORTABLES



By
EDWIN N. BRADLEY

BRADBOOKS,
SENNEN,
CORNWALL.

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PREFACE

The Personal Portable, the most modern development in broadcast receivers, has much to commend it to the constructor who builds such a set. Light to carry and easily packed, the personal portable can provide radio entertainment anywhere, and is ideal for the cyclist and hiker as well as for the motorist, yachtsman and camper, whilst such a receiver also serves as a valuable standby set in the home. Despite these facts the personal portable has, until the time of writing, received but scant attention in the technical press, and it is in the belief that it will fill a definite requirement of radio constructors that this book is written.

The circuits described and illustrated include receivers both of the T.R.F. and superhet type, and the range will therefore suit all constructors from the novice to the expert, as well as all pockets. Each receiver is the result of a considerable amount of experiment, and each has been tested in a remote and very poor reception area, a mile from Land's End, with very satisfactory results.

The efficiency of the receivers has further been increased by the inclusion of an unusual output stage arrangement, which gives excellent volume and tone for a considerably smaller battery consumption than is usually the case :—L.T. consumption in this stage is halved and H.T. consumption reduced by about 30% compared with normal figures.

Whilst one circuit, that of a simple superhet, gives medium wave coverage only, like the majority of commercial personal portables, the rest of the receivers give both medium and long wave coverage whilst one circuit covers short waves as well ; the first published personal portable circuit, it is believed, to give all wave tuning.

All the components employed are standard and readily obtainable at the time of writing, whilst the mechanical and cabinet work, the least interesting to most constructors, is considerably less troublesome than in the case of normal sized receivers.

Each circuit is illustrated with all the necessary diagrams including panel layout and drilling dimensions, valve sub-chassis and component support dimensions, and a point-to-point wiring diagram for the benefit of the constructor who likes to make a check of wiring against such an illustration. The receivers are therefore suitable for constructors of all ages and degrees of experience, and no trouble should be encountered in obtaining the same pleasing results given by the prototypes.

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PREFACE TO THE SECOND EDITION

Since the original publication of *Personal Portables* reports from many areas have proved the circuits capable of excellent reception under widely varying conditions, and an unusually large number of congratulatory letters have been received. It has therefore been thought unnecessary to alter any of the circuits described in these pages, and variations have accordingly been limited to a modernisation of component specifications in the few instances where manufacturers have withdrawn or replaced their products.

The major variation is in the I.F. transformers. The Weymouth IFM2 types originally specified have been replaced by P4 transformers; in a few cases it may still be possible to obtain IFM2 transformers from stocks and the drawings have therefore been left unchanged. When P.4 transformers are employed attention should be given to the note at the end of Chapter 6.

The 1S4 (British, DL91) type of output valve has also become increasingly popular and more readily obtainable since the first edition of this book was published, and this valve type may conveniently be substituted for the output valves shown, if desired. The circuit changes are as noted in Chapter 6 for the 3S4/DL92 valve type, except for the filament connections which, on the 1S4, correspond to those already shown in the diagrams for the 1T4, i.e. tag 1, negative, tag 7 positive, 1.5v.

Small loudspeakers and output transformers can now so readily be obtained, and in such variety, that named specifications are no longer made. Care must of course be taken to employ the smallest type possible in order that the stated case dimensions may hold good ; the drilling dimensions given suit the majority of components but should be checked against the speaker fixing holes before the actual drilling is commenced. If a number of output transformers are available a choice should be made by trial so that the best matching is obtained, especially when a 1T4 output valve is used.

A note concerning the frame aerial windings is, perhaps, necessary. Slight discrepancies can easily enter into a winding duplicated from instructions, and if in the superhet circuits reception falls off at the low frequency end of the medium wave tuning range, this can probably be corrected by an experimental variation of the winding—generally an increase in the number of turns is required, of the order of 2 or 3 turns extra.

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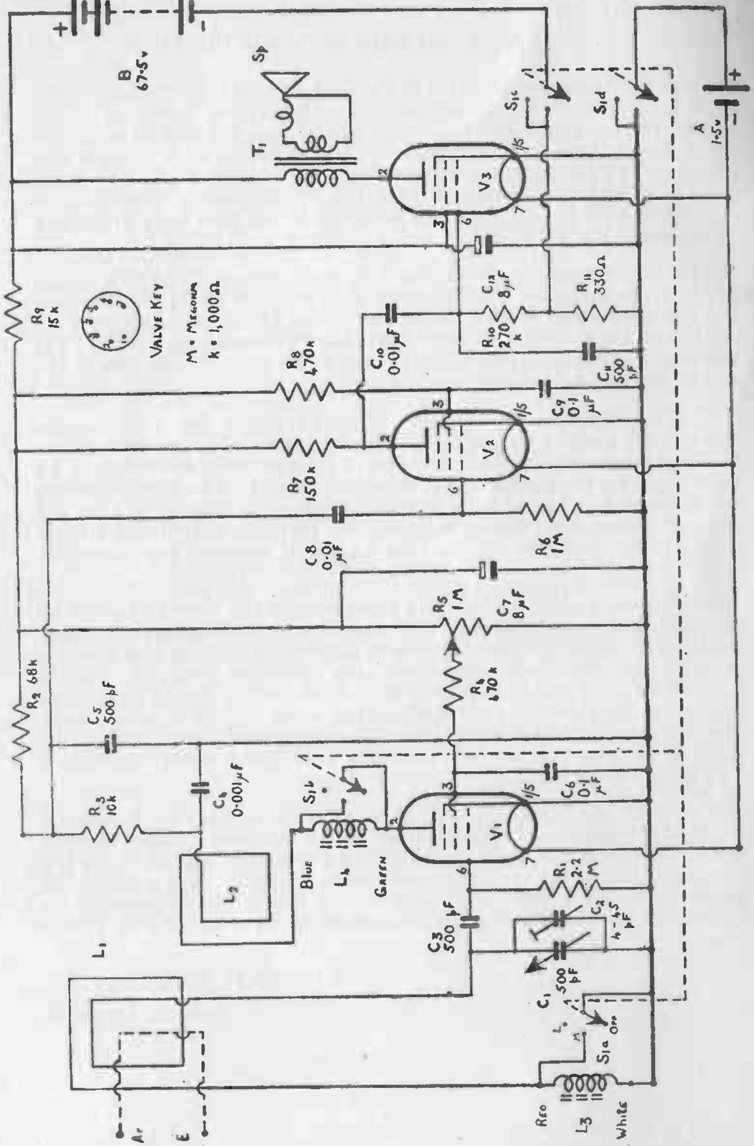

Fig. 1. The "Minor"

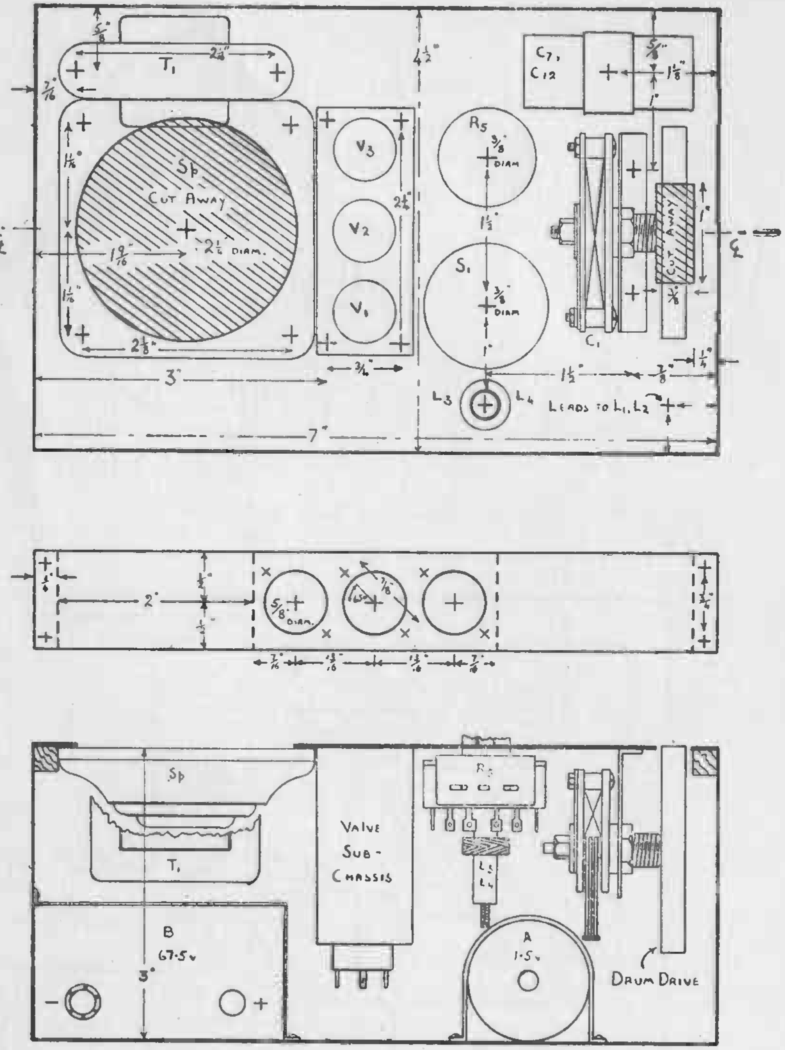

Fig. 2. Panel Dimensions, Sub-chassis and Side Constructional View of the "Minor"

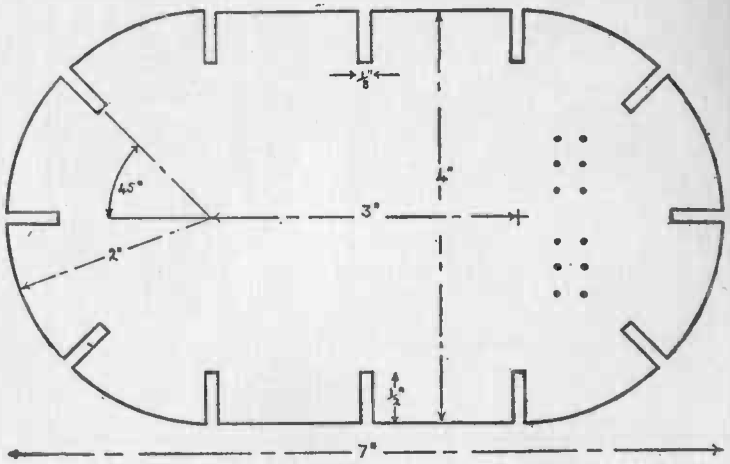

Fig. 3. The Frame Aerial Former

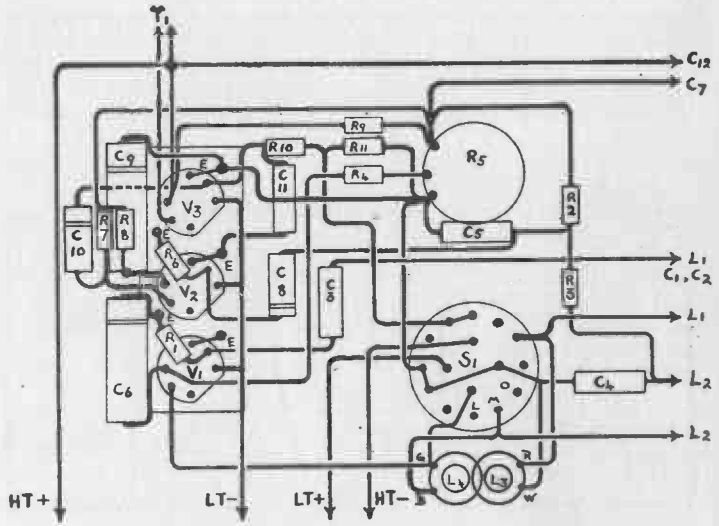

Fig. 4. Point-to-point Wiring Plan of the " Minor "

CHAPTER I

THE " MINOR "

The simplest circuit which can be employed for a radio receiver (apart from crystal receivers) consists of a reacting detector followed by an audio amplifier and output stages, and the " Minor " personal portable shown in Fig. 1 employs this arrangement. Although such a circuit is often considered out of date it is still capable of good results if care is taken in the design work to ensure the maximum selectivity possible, coupled with maximum gain in the detector before the critical reaction point is reached, and in the design of the " Minor " these requirements received much attention.

The use of a frame aerial as the tuned circuit ensures selectivity on the medium wave band, whilst reaction is controlled by variable screen feed to a pentode detector. The reaction coil, L2, is kept small so that practically full voltage must be applied to the pentode screen grid before the critical reaction point is reached, the valve thus giving good audio amplification, whilst an unusually high value for C4, the reaction capacitor, ensures stability.

The receiver operates over both the medium and long wave bands, L3 and L4 being switched into circuit for long wave tuning when L4 provides the extra feedback coupling required for this wave band. On long waves the critical reaction point is just reached with the screen feed potentiometer, R5, advanced to its fullest setting with the result that the receiver can be tuned over the main long wave stations—the Light Programme and other stations—like a superhet.

As may be expected from such a simple and cheaply constructed set the " Minor " is not really suitable for medium wave reception in distant and poor reception locations. In the test area, where medium wave results are notoriously poor, the Light and Home programmes were received only weakly until an auxiliary aerial was connected in; long wave results were remarkably good, however, and no auxiliary aerial was required.

A third winding on the frame aerial former permits the coupling in of an auxiliary aerial, only a short length of wire being required.

The " Minor " is therefore suitable for daily travelling in a fair or good reception area, for walkers, campers and picnic parties not too far afield, and for cyclists who can use their machines as the auxiliary aerial in poor reception areas. Although the " Minor " has its limitations these are by no means serious, and the constructor who does not wish to build a superhet, on the score of either expense or lack of experience, will almost certainly find this receiver adequate for his purpose.

The " Minor " is also of especial interest to the beginner since it demonstrates simply the method of construction employed for all the circuits to be described. The whole receiver is mounted onto a metal panel and thus suspended inside the carrying case, the batteries alone being clamped to the receiver cabinet, whilst the frame aerial, wound to occupy the minimum of space, is fitted into a shallow lid which can be closed to protect the whole receiver. This type of construction permits the whole receiver, with batteries, to be enclosed in a 7in. x 4½in. x 3in. case, the extra depth of the lid being determined by the size of control knobs employed.

COMPONENTS LIST FOR THE "MINOR"

Fig. 1.

L1, L2—Frame Aerial (See text below).
L3, L4—Weymouth HH1 coil.
C1—500 pF. variable tuner, solid dielectric. Jackson Bros. "Dilecon."
C2—50pF. trimmer. Walter Insts. M.S.50.
C3, C5, C11—500 pF. 350 v.w. Mica. T.C.C. CM20N.
C4—0.001 mF. 350 v.w. Mica. T.C.C. CM20N.
C6, C9—0.1 mF. 200 v.w. Tubular. T.C.C. 246.
C7, C12—8 mF. 150 v.w. Electrolytic. T.C. CE18F.
C8, C10—0.01 mF. 200 v.w. Tubular. T.C.C. CP112H.
R1—2.2 megohms, ¼ watt.
R2—68,000 ohms, ¼ watt.
R3—10,000 ohms, ¼ watt.
R4, R8—470,000 ohms, ¼ watt.
R5—1 megohm variable, midget volume control. Centralab.
R6—1 megohm, ¼ watt.
R7—150,000 ohms, ¼ watt
R9—15,000 ohms, ¼ watt.
R10—270,000 ohms, ¼ watt.
R11—330 ohms, ¼ watt.
T1—Midget output transformer.
Sp—2½in. midget speaker.
V1, V2, V3—1T4 or Mullard DF91.
3 B7G valveholders.
S1a, b, c, d—4 pole 3 way rotary switch. Walter Insts. B.T.
A—1.5 volt cell, U2.
B—67.5 volts battery. EverReady "Minimax."
Panel, 7in. x 4½in. Valve sub-chassis, 2in. x 2½in. x 1in.
Tuner mounting bracket, 2in. x 1½in. Clamp for C7, C12.
Case, internal dimensions 7in. x 4½in. x 3in. with shallow lid.
3 small control knobs. Nuts bolts, wire, sleeving, etc.
1 Jackson Bros. 2⅛in. driving drum.

CONSTRUCTION

The metal parts, panel, valve sub-chassis and tuner bracket, should be cut from fairly stout aluminium sheet. Brass should be avoided for the

panel, and a thick grade of metal employed to prevent boominess and resonance from the speaker, since the panel acts as the speaker baffle.

The valve sub-chassis is formed to "cradle" the valves between itself and the chassis, and it is most convenient to drill the mounting holes and stamp out the valveholder holes before the 1in. wide strip of metal is finally cut from the main sheet ; if the holes are drilled and stamped last there is some chance of the strip's buckling or wrinkling.

The ⅝in. diameter holes should be cut with a chassis punch to suit this standard B7G diameter.

The panel drilling dimensions are shown in the rear panel view of Fig. 2, the large hole for the speaker aperture being cut away either with a tank cutter or a fretsaw with a metal cutting blade (although ordinary wood cutting blades will serve if worked at a slow speed and not forced). The main components may then be mounted on the panel and a fretsaw may also be used to cut away the spare length of the volume control spindle, so that the knob is close to the panel.

Note that the spindle of the tuning capacitor does not protrude through the panel ; the component is instead mounted on a bracket and rotated by pressing the finger on a standard drum drive through a hole in the panel. The tuner is mounted on a bracket 2in. wide by 1½in high, with a ½in. fixing flange bent up at its foot for bolting to the panel. The mounting hole for the tuner is drilled so that the hole centre is spaced 1in. below the panel.

The driving drum should have its hollow edge or rim filled with a neat binding of thread, a strip of thin white card then being stuck down on the rim over the whole circumference. On this card can be calibrated station names or wavelengths, or, more simply, the tuning points of the main stations can be denoted by a spot of coloured ink or paint, using say blue for medium waves and red for long waves. If the card is carefully calibrated it adds to the appearance of the receiver, however, and the white surface can be protected against the rubbing of the finger by a coat or two of clear lacquer.

The majority of small components are assembled and mounted in the wiring of the valve sub-chassis, and this unit should be assembled as a whole before being bolted to the panel. The point-to-point wiring plan shown in Fig. 4 is expanded to permit of clarity ; in the actual construction it will be found possible to group all the capacitors and resistors shown quite closely around the bases of the valveholders.

Leads to components mounted on the panel should be wired to the sub-chassis and left about 6in. long, so that they can be measured, trimmed and finally connected in when the sub-chassis is in place.

Before the valve sub-chassis is bolted into place the valves should be plugged into their holders. The clearance between the valves and panel is not great, in order that the valves, if loosened, cannot fall from their sockets. A suitable rubber grommet placed over the pip of each valve is a useful addition, since the valves are then cushioned against the panel and gripped gently but firmly and held in place.

The two small electrolytic capacitors are mounted one above the other in the position shown in Fig. 2. Remember that their negative tags must be connected directly to the panel which acts as the main negative busbar. The clamp holding these two capacitors can be cut from a strip of scrap aluminium and the whole assembly fixed by a single bolt and not to the panel.

On the point-to-point wiring plan the letters E on the sub-chassis denote direct earthed connections to the metal. These connections are provided by bolting a soldering tag under one fixing bolt of each valveholder.

The frame aerial is wound on a former cut from good white cardboard about 1/16in. thick, the pattern being drawn onto the card by reference to Fig. 3. In the positions marked twelve small holes are punched in which the wire can be anchored at the start and finish of the windings, and the main winding is then put on the former. This consists of 18 turns of 34 S.W.G. enamelled wire wound in and out of the slots, the turns not being bunched but lying neatly side by side. Turns do not cross at the slots, since there are an even number of slots, but always fall together.

Mark the start and finish of the winding with the letters S and F, and leave an ample length of wire for connecting into the receiver.

The coupling or reaction winding is then put on, consisting of a further 5 turns of similar wire, insulated from the main winding by ⅛in. spacing. This secondary winding should be wound in the same manner and in the same direction as the main winding, and its start and finish should be marked Sr. and Fr.

If the start of the main winding is connected to the grid of V1, and the start of the reaction winding to the anode of V1 (via L4, of course) the coils will be correctly connected for reaction.

If the " Minor " is to be used in a poor reception area a third winding, to permit the coupling in of an auxiliary aerial, is desirable. This third winding may consist of another 3 or 4 turns of 34 S.W.G. enamelled wire in the slots of the former, one end of this winding being connected to the auxiliary aerial and the other to an actual, physical earth. Note that the receiver chassis is not earthed in this instance ; it is generally found best to leave the receiver " floating " with only the coupling winding earthed.

The frame aerial is fitted into the shallow lid of the case and covered

with a layer of card or leatherette to hide and protect the windings. If the coupling winding is used this should be brought out to two small sockets or clips within the lid to which the aerial and earth can be connected ; small clips can be obtained from old diode holders or sockets from an octal valveholder could be used, a pair of old valve pins then being used as miniature plugs.

The leads from the frame aerial are taken through the hole in the corner of the receiver panel to the main circuits, or, better, short lengths of thin rubber covered flex could be used as aerial leads between the frame and receiver, such material withstanding the bending imposed by the opening and closing of the lid better than the copper wire.

Care must be taken when the long wave padding coils L3 and L4 are wired up, since these coils have very thin leads identified by coloured beads. A cotton and enamel coating must be removed from each lead, and this is best done by passing the end of the lead very quickly through a match flame, then cleaning off the char with the finest emery paper.

One component, C2, is omitted from both constructional views. This trimmer is actually mounted between the terminals of the main tuner, and serves to set the minimum wavelength tuned by the receiver to any required figure round the 200 metre mark. If desired C2 can be omitted from the circuit, and in coastal locations this is sometimes preferable, since then it is often possible to tune in lighthouse and lifeboat signals on the 1.5—1.7 Mcs. band.

Testing

With the receiver completed, check the wiring very carefully before connecting up the batteries. These are clamped in the bottom of the case in the positions shown, and the writer prefers to make a positive contact between the battery terminals and battery leads by soldering the leads to the battery lugs, rather than by employing sprung contacts. This admittedly makes battery changing a slightly longer operation, but certainty of good contact more than repays the extra work. The battery leads should be of sufficient length to allow the panel to be removed from the case, the leads coiling up with the panel in place. When soldering leads to batteries use a hot iron and deft touches, to avoid heating up the active cell elements.

With the wiring checked and in order rotate the switch to the central or mediun wave position and rotate R5 almost to the full volume position, when the set should slide quietly into oscillation. Turn the volume control back to the critical and most sensitive point and rotate the main tuner ; the local Home station at least should be found without difficulty and probably other stations beside. If nothing can be heard try coupling in a small auxiliary aerial and use an earth.

Then test the receiver over the long waves with R5 fully advanced. The Light programme should be received at good strength without an auxiliary aerial, and can be brought to a convenient point on the dial by adjusting the core of the padding coils L3 and L4. This core should be almost fully withdrawn from the coil former.

The total L.T. consumption of the receiver is 150 mAs. and the H.T. consumption only about 6 or 7 mAs.

Note that the L.T. cell is connected in what would normally be the reverse manner, with its positive side to the H.T. negative and the main negative busbar. This method of connection was found in the original model to give smoothest reaction and best results, but the normal method of connection may also be tested out by the constructor.

It is also wise to experiment with the connections of the output transformer. Using the Radiospares midget 30 mAs. type of transformer best results were obtained in the prototype when the blue and green leads (Battery Triode) were connected in, but if for any reason a different speaker or transformer is employed the output ratio should be checked for best results.

Panel Finishing

With the receiver finally adjusted and in working order, it remains to finish the panel and to give the set a pleasing appearance. The panel will have boltheads protruding through it and these must be hidden; the simplest method of achieving this is to cover the panel with card, the card being punched or cut away at each bolthead position and of a thickness such that when the card is stuck down to the panel the boltheads are level with, or below, the surface of the card. The card must also be cut away over the speaker aperture, of course. On this foundation the final finishing layer may be placed; a fabric finish is excellent especially as this may be laid directly over the speaker to hide the cone and protect it from knocks without the trouble of cutting a grille, but many other materials may be used, including ivorine or a further thin layer of card coloured with a brilliant enamel.

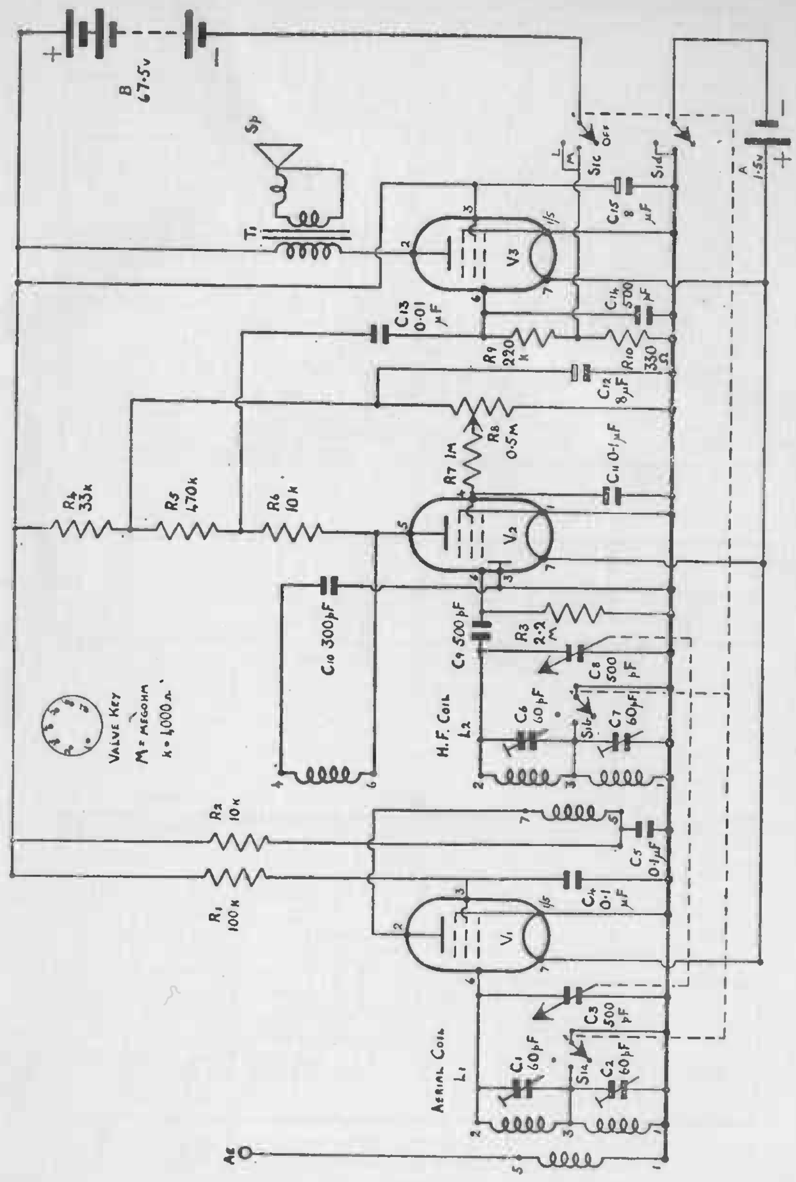

Fig. 5. The "Carri-Minor"

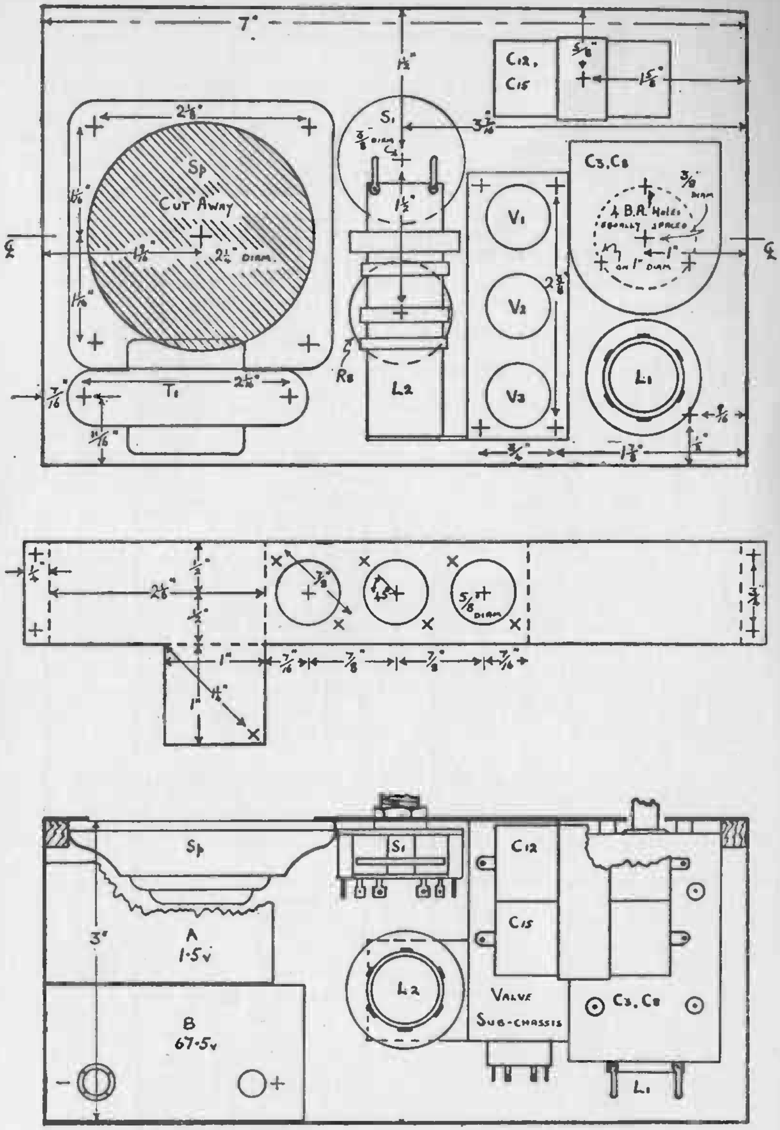

Fig. 6. Panel Dimensions, Sub-chassis and Side Constructional View of the " Carri-Minor "

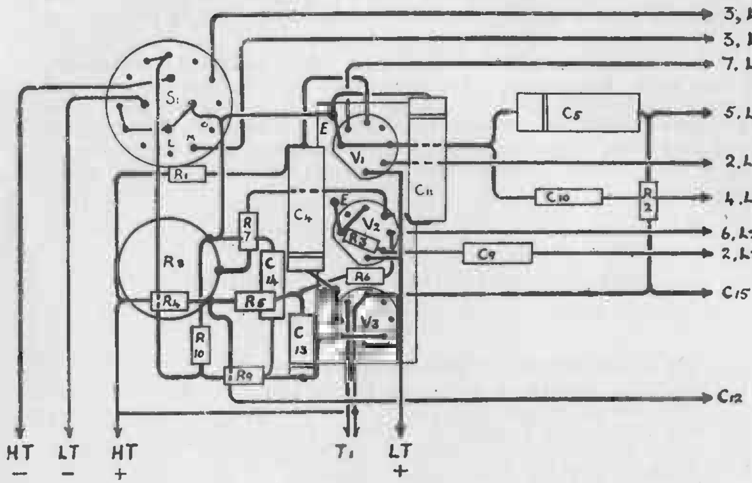

Fig. 7. Point-to-Point Wiring Plan of the " Carri-Minor "

CHAPTER 2

THE " CARRI-MINOR "

Two of the receivers to be described, the present " Carri-Minor " and the " Carri-Major " of a later chapter, may be described as double purpose sets, suitable either for true personal portable operation as a receiver to be carried, or for semi-permanent locations such as camps, caravans and trailers, and yachts, where an aerial can be erected without trouble. In the case of the " Carri-Major " a frame aerial is impracticable whilst in the present circuit, shown in Fig. 5, it was decided to obtain the maximum gain from an R.F. and detector combination using matched coils, a small external aerial being used for personal portable operation and as large an aerial as desired being employed when the receiver is used in a fixed location.

For portable operation the aerial is most easily made up by incorporating it in a carrying strap, although it is also possible to run a fine wire beneath the lining of a coat or jacket. The aperiodic coupling between the aerial and first tuned circuit nullifies the effect of varying body capacities when such an aerial is used, and no variation in tuning is observed when different aerials are connected in up to quite wide limits. When a very large aerial is used it is in any case most desirable to couple it through a small capacitor in order that selectivity may be retained.

The circuit is again of the T.R.F. type, the second stage, the detector, being made regenerative. Inductive coupling between the first and second stages, with good decoupling against unwanted feedback, gives excellent sensitivity and selectivity with complete stability. The medium and long wave bands are covered and commercial coils are employed. As in the "Minor" a single switch provides wave changing and on-off positions.

Components List for the "Carri-Minor"

Fig. 5.

L1, L2—1 pair Weymouth coils, Type CT2W2.
C1, C2, C6, C7—60 pF. trimmers. Walter Insts. M.S.70.
C3, C8—500 pF. two gang midget tuner. (See text.)
C4, C5, C11—0.1 mF. 200 v.w. Tubular. T.C.C. 246.
C9, C14—500 pF. 350 v.w. Mica. T.C.C. CM20N.
C10—300 pF. 350 v.w. Mica. T.C.C. CM20N.
C12, C15—8 mF. 150 v.w. Electrolytic T.C.C. CE18F.
C13—0.01 mF. 200 v.w. Tubular. T.C.C. CP112H.
R1—100,000 ohms, ¼ watt.
R2, R6—10,000 ohms, ¼ watt.
R3—2.2 megohms, ¼ watt.
R4—33,000 ohms, ¼ watt.
R5—470,000 ohms, ¼ watt.
R7—1 megohm, ¼ watt.
R8—0.5 megohms, variable, midget volume control. Centralab.
R9—220,000 ohms, ¼ watt.
R10—330 ohms, ¼ watt.
T1—Midget output transformer.
Sp—2½in. midget speaker.
V1, V3—1T4 or Mullard DF91.
V2—1S5 or Mullard DAF91.
3 B7G valveholders.
S1a, b, c, d—4 pole 3 way rotary switch. Walter Insts. B.T.
A—1.5 volt cell, U2.
B—67.5 volts battery. EverReady "Minimax."
Panel, 7in. x 4½in. Valve sub-chassis, 2⅛in. x 2⅝in. x 1in.
Case, internal dimensions 7in. x 4½in. x 3in. with shallow lid.
3 small control knobs. Nuts, bolts, wire, sleeving, etc.

Construction

The panel and valve sub-chassis should be cut from fairly thick aluminium, the valve cradle being punched and drilled before separation from the main sheet of metal, and it must be noted that in this receiver the sub-chassis has a wing or lug 1in. square on one endpiece to act as a mounting bracket for the H.F. coil. The coil is thus held parallel with the main bar of the sub-chassis, and perpendicular to the aerial coil, the coils then being shielded one from the other and at an angle to minimise stray coupling.

The main tuning capacitor must be of the midget variety and the layout and drilling diagrams of Fig. 6 are shown to suit the Plessey type of two gang 500 pF. tuner, which can be widely obtained as surplus gear. This type of tuner is mounted by means of three 4 B.A. holes equally spaced on a 1in. diameter at the control spindle end of the capacitor, and the tuner must be spaced from the rear of the panel by a ⅛in. spacing washer over each bolt. The bolts may require trimming to length to ensure that they do not protrude sufficiently far into the body of the tuner to foul the moving or fixed vanes.

If this type of tuner cannot be obtained the constructor should consult Chapter 6, "Notes on Components."

It will be necessary to trim off the spare lengths of the tuner, volume control and switch spindles to bring the control knobs close to the panel.

The main components are mounted directly on the panel and the valve sub-chassis is assembled as a complete unit, with the valves inserted, before being bolted down to the panel. The valves may have rubber grommets slipped over their top pips to serve as buffers and retainers. The letters "E" on the wiring plan denote direct contacts to the chassis via soldering tags secured under valveholder bolts.

The trimmers are not shown in the constructional diagrams since these are soldered directly across the appropriate lugs on the two coils, space thus being saved and a firm anchorage being provided.

The Aerial

The aerial socket on the receiver is also not shown, since this will depend to some extent on the type of aerial finally decided upon. If a carrying strap aerial is employed, (suitable for all but very poor reception locations), the aerial terminal on the receiver might well be a small eye on the side of the case, a second eye on the other side of the case providing the second point of attachment for the strap or sling.

The aerial is made by sewing a strip of thin leather or leatherette into a tube, the dimensions of the flat strip being about 1¼in. or 1½in. broad by 3 to 4 feet long, depending on the height of the constructor. Into the tube, as it is formed, are sewn three or four pieces of rubber covered flex, each piece being as long as the tube. These lengths are sweated together at the connecting end, and left isolated at the far end.

Each end of the sling so formed must be fitted with a sprung clip, similar to " dog-lead " clips. At one end of the strap or sling the junction of the aerial wires must be sweated to this clip which then connects with the eye acting as the aerial terminal; at the other end of the sling the clip is of course insulated from the aerial. The strap is then clipped into place and the set suspended from the shoulder, the input circuit being supplied from the aerial within the strap.

If a larger aerial is needed this can be formed of thin enamelled wire worked between the material and lining of a coat or jacket, the wire running back and forth or up and down to allow a good length to be used. The end of the aerial can then emerge from a pocket and be clipped or plugged into a socket on the receiver side or panel.

For permanent locations a long outside aerial can be employed, a 100 pF. mica capacitor being connected in series between the aerial and aerial socket or terminal on the receiver.

Testing

With the receiver completed, check the wiring very carefully before connecting up the batteries. These are clamped to the bottom of the case, the L.T. battery being above the H.T. battery and positioned so that it falls into the space to one side of the loudspeaker. The leads are soldered to the batteries, for preference, as described in Chapter 1.

The set is easily aligned on signals, but the work is simplified if a signal generator is available. Switch to the medium waves and inject a weak signal at 1.5 Mcs. into the aerial terminal, setting the main tuner to minimum capacitance and trimming first C6, then C1 for maximum volume. Then switch to the long wave band and inject a 300 kcs. signal to the input circuit, setting the main tuner about one third in. Trim C7, then C2, for maximum volume.

For these adjustments the reaction-volume control, R8, should be set to slightly below the critical reaction point.

When the receiver is to be used in permanent or semi-permanent locations the use of a direct earth connection may be helpful. An earth terminal can be provided by the unconnected eye for the carrying sling, or by a small socket or clip on the panel. The earth terminal in this receiver should be connected directly to the main negative busbar, that is to the panel.

H.T. consumption is of the order of 7mAs, the L.T. current being 150 mAs.

Panel Finishing

With the receiver correctly trimmed and checked, the panel should be finished as already described in Chapter 1. It then remains to fit a small tuning scale onto the panel, below the tuning knob which should preferably be of the pointer type. Here again a fully calibrated scale may be employed; this can be drawn onto an ivorine panel finish with good effect: on the other hand the main stations can be indicated merely by coloured dots, the full tuning scale being omitted and this method is preferable when a fabric finish is used.

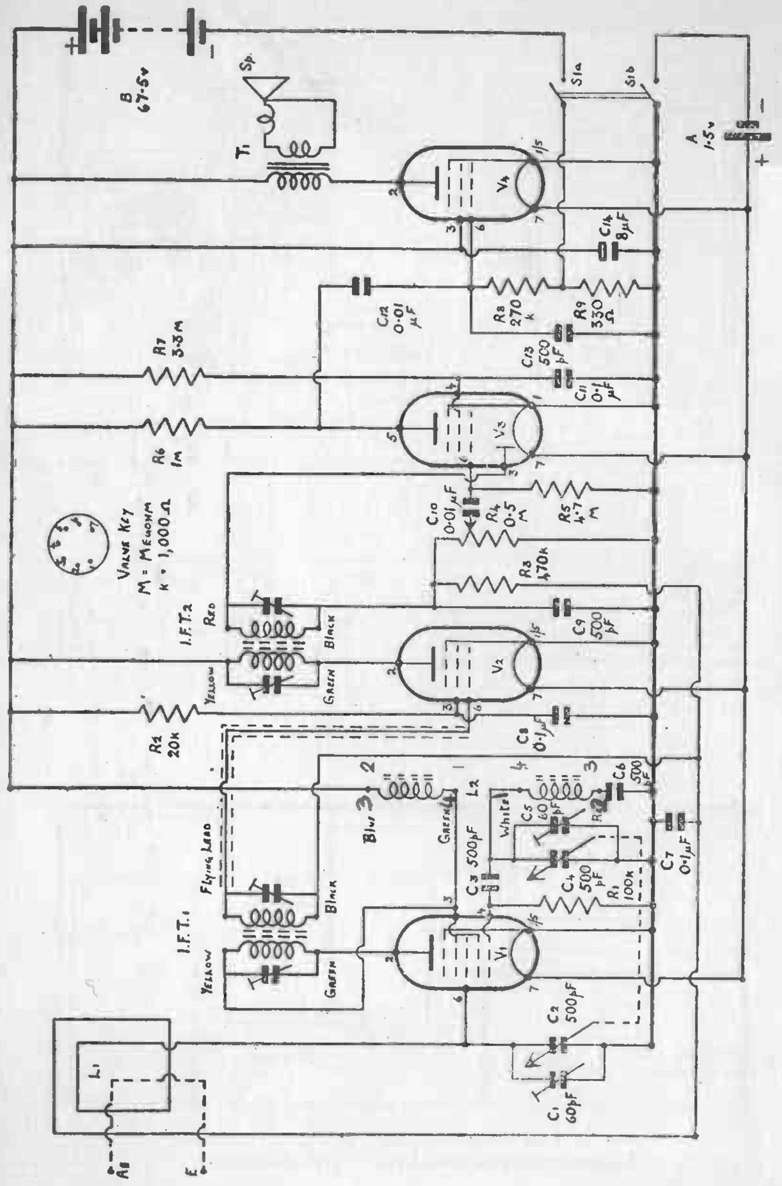

Fig. 8. The " Simplest Super "

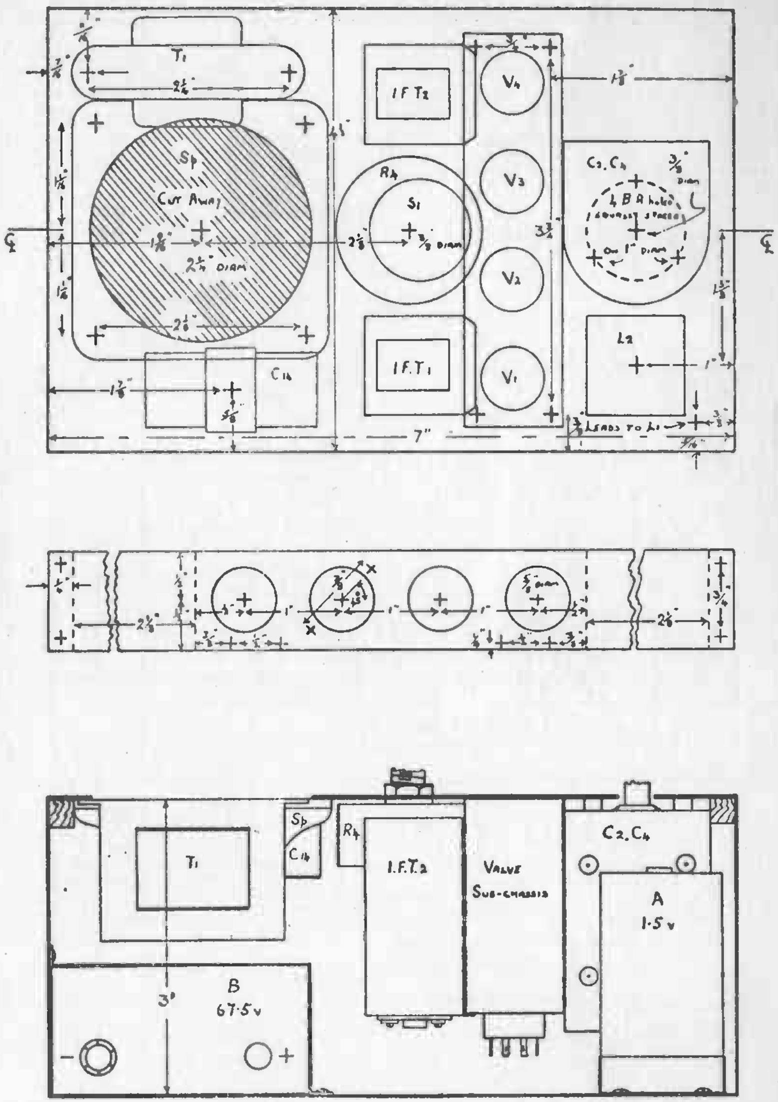

Fig. 9. Panel Dimensions, Sub-chassis and side Constructional View of the " Simplest Super "

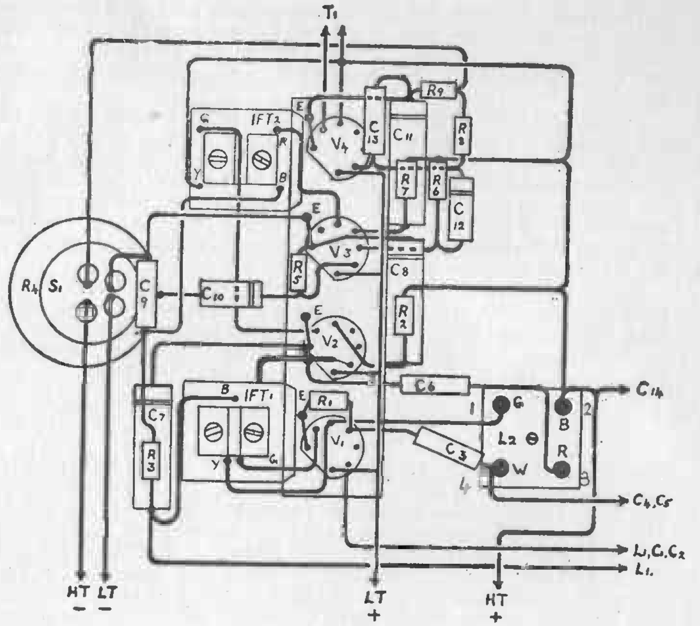

Fig. 10. Point-to-Point Wiring Plan of the " Simplest Super "

CHAPTER 3

THE " SIMPLEST SUPER "

Many newcomers to radio construction require a good personal portable receiver and, at the same time, would like to build a simple superhet circuit with no complicated features and which can easily be lined up. The " Simplest Super " of Fig. 8 satisfies both demands yet although it is of straightforward design its performance should also please the most experienced constructor.

The receiver covers the medium waveband only over the range of 200 to 550 metres, thus obviating switching and permitting a very simple oscillator circuit. The input is from a frame aerial which also acts as the first tuned stage and a commercial coil is employed for the oscillator stage.

A marked feature of the superhet circuits to be described is the excellent stability obtained over the I.F. stages. Although there are no "trick" circuits, damping resistors or decoupling filters it has been found impossible to put the I.F. circuits into a state of regeneration in the prototypes, a performance due to lengthy and careful tests of all available I.F. transformers. The components finally chosen, Weymouth IFM2, or P4 transformers, must be employed in the present and following circuits if this degree of stability is to be retained.

The circuit of Fig. 8 has only one unusual feature ; the H.T. supply to the anode of V1 is drawn through the oscillator secondary together with the oscillator H.T. supply. The extra current flow ensures good oscillation over the whole band as the voltage of the H.T. battery drops with age and this method of connection causes no ill effects.

Components List for the "Simplest Super"
Fig. 8.

L1—Frame Aerial (See text).
L2—Weymouth KO3 coil.
C1, C5—60 pF. trimmers. Walter Insts. M.S. 70.
C2, C4—500 pF. two gang midget tuner (See text).
C3, C6, C9, C13—500 pF. 350 v.w. Mica T.C.C. CM20N.
C7, C8, C11—0.1 mF. 200 v.w. Tubular. T.C.C. 246.
C10, C12—0.01 mF. 200 v.w. Tubular. T.C.C. CP112H.
C14—8 mF. 150 v.w. Electrolytic. T.C.C. CE18F.
R1—100,000 ohms, ¼ watt.
R2—20,000 ohms, ¼ watt.
R3—470,000 ohms, ¼ watt.
R4—0.5. megohms, variable, with 2 pole switch.
R5—4.7 megohms ¼ watt.
R6—1 megohm, ¼ watt.
R7—3.3 megohms, ¼ watt.
R8—270,000 ohms, ¼ watt.
R9—330 ohms, ¼ watt.
T1—Midget output transformer.
Sp—2½in. midget speaker.
V1—1R5 or Mullard DK91.
V2, V4—1T4 or Mullard DF91.
V3—1S5 or Mullard DAF91.
4 B7G valveholders.
S1a, b—2 pole on-off switch ganged with R4.
A—1.5 volt cell, U2.
B—67.5 volts battery. EverReady "Minimax."
I.F.T. 1, 2—Weymouth I.F. transformers, 1 pair IFM2. or P4J.
Panel, 7 x 4½in. Valve sub-chassis, 2½in. x 4in. x 1in.
Case, internal dimensions 7in. x 4½in. x 3in. with shallow lid.
2 small control knobs. Nuts, bolts, wire, sleeving, etc.

Construction

The panel and valve sub-chassis should be cut from fairly thick sheet aluminium, the sub-chassis, as before, being drilled and punched before separation from the main sheet of metal. It will be seen from Fig. 9, the layout and constructional view diagrams, that the I.F. transformers are mounted on the sub-chassis as well as the valves, being bolted to one edge of the cradle top. The transformers have fixing lugs on either side ; one of these lugs should be cut right off and the other trimmed down to a width of ⅛in., care being taken to choose the correct lug for this to bring the connecting wiring into the positions shown in Fig, 10, the point-to-point wiring view in which the letters "E" denote direct connections to the metal via soldering tags.

The small lug left is drilled with holes to correspond with those drilled in the side of the sub-chassis main member ; although the fixing strip is narrow there is room for small fixing bolts, 8 B.A. being a preferred size. Note that for clarity the fixing holes for only one valveholder are shown in the sub-chassis plan of Fig. 9 ; these holes are duplicated at the other valve positions.

The IFM2 transformers cannot be obtained without a flying lead on I.F.T.1 for single ended valves, but this is no disadvantage. The screened flying lead is amply long to be brought up to pin 6 on V2, and the screen can be earthed at pin 1 of this valveholder. This earthed contact also serves to anchor the screened lead so that it cannot wander or vibrate as the set is carried and so short circuit out to any pin on the valveholder. A small piece of wide diameter sleeving also helps to safeguard against shorts, and may be slipped over the flying lead as an extra precaution.

Since the I.F. transformers are mounted beside the valves a considerable part of the wiring can be completed before the sub-chassis, complete with valves, is bolted onto the main panel ; the other components are mounted directly on the panel ; the KO3 coil has a screw at the top of its can which should be removed and passed through the fixing hole in the panel and retightened as the mounting for this coil. The can lugs at the foot of the coil can may be bent down or cut away since they play no part in securing the coil.

A full-sized volume control/on-off switch is used since although midget volume controls with switches can be obtained the switches on such components are only of the single pole type. For safe and satisfactory on-off switching a double pole switch is essential in order that both the L.T. and H.T. supply lines may be broken. The switch is placed between the I.F. cans and is in a convenient position both for panel symmetry and wiring up.

The single electrolytic capacitor is again clamped to the panel by a strip of scrap metal, but in this design it is placed beside the loudspeaker to leave the space beside the tuner capacitor unoccupied. This space is taken up by the L.T. cell which can be seen in the side constructional view standing upright, clamped by a circular grip to the base of the carrying case. A suitable clamp can be obtained ready made in the shape of a capacitor can clamp.

The trimmer capacitors are not shown in the constructional drawings since these are mounted directly across the main tuning capacitor.

As in the previous design the main tuner is bolted to the panel and spaced by $\frac{1}{8}$in. spacing washers. The spindles of both this component and the volume control must be cut down to protrude only sufficiently to give a seating for the control knobs.

The Frame Aerial

The frame aerial for this receiver is wound on a former cut from thin card to the size and shape shown in Fig. 3. The main winding consists of 18 turns of 24 S.W.G. enamelled wire wound in and out of the slots, the turns lying neatly side by side. It is wise to wind on a further small aerial coupling coil for use in the poorest reception areas so that a small auxiliary aerial and an earth connection can be connected in when available ; this secondary coil may consist of a winding of 4 turns of 24 S.W.G. enamelled wire, brought out to small sockets or clips in the lid of the carrying case as described in Chapter 1.

The frame aerial is placed in the shallow lid of the case and camouflaged by further card, leatherette or any other suitable non-metallic covering. The winding ends may be left long enough to carry through the hole in the panel to the receiver circuits, or thin rubber covered flex leads may be soldered on to the ends of the winding to act as connecting wires.

Testing and Aligning

With the receiver assembled and the wiring carefully checked the batteries may be connected up and the receiver switched on. Turn the volume control to the full position and lightly tap pins 6 and 4 of the V1 valveholder with a screwdriver blade held in the hand, being careful to short out no other valve pins as this is done. When either pin is touched—do not short out the pins, but gently tap them separately—there should be a distinct click in the speaker to indicate that the oscillator is working correctly. If no click can be obtained the wiring and components of the oscillator section should be checked ; trouble here, is of course, unlikely.

If a signal generator is available connect its output terminals across the auxiliary aerial coupling winding of the frame aerial or, if this has been omitted, wind a few turns of wire round the lid of the case to serve as a signal generator coupling. Rotate the main tuner of the set till the vanes are fully meshed, and inject a 465 kcs. signal from the generator. Tune up the I.F. transformers, commencing with the secondary of I.F.T.2 and working back to the frequency changer, trimming for maximum volume and reducing the signal generator output as much as possible after a rough trim is obtained, to avoid operating the A.V.C. line.

Open the tuner capacitor to minimum mesh and set the generator to 200 metres, 1.5 Mcs., trimming C5 till the signal is heard, then adjust C1 for maximum volume. Set the tuner to about four-fifths of full mesh, marking the setting so that it can be repeated, and tune the signal generator to 500 metres, 600kcs. Adjust the core of the KO3 coil till the signal can be heard, rocking the tuner from side to side about the marked position as the coil core comes into alignment to give maximum volume.

Retune both the set and the generator to the 200 metres point and retrim C5, then retune to the 500 metres point and make a further core adjustment on the KO3 coil. Repeat these two adjustments of trimming and padding till one fails to have effect on the other; the receiver is then aligned and requires only a last readjustment to C1 for maximum volume. This final setting of C1 should be carried out on a weak broadcast signal.

If no signal generator is available the set must be aligned on signals. Leave the I.F. transformers as obtained from the manufacturers and tune the receiver till a station (probably the local Home programme) is received. Remember that any portable with a frame aerial is directional, and the tuning must be made with the set in various positions till a signal is heard. If no station can be heard set the I.F. trimmers to their midway positions and try again.

When a signal is received adjust the I.F. transformer trimmers for maximum volume, then endeavour to tune in a station at the low wavelength end of the band. Ascertain the wavelength and by adjusting C5 bring in this station at a suitable point on the dial. Then tune to the high wavelength end of the scale and find another station, preferably around the 500 metres point, setting this station on a suitable tuning point, and bringing up its volume, by adjusting the core of the KO3 coil.

Retune to the first station on about 200 or 250 metres and retrim C5 for best results, together with an adjustment of C1, then readjust the coil core on the 500 metre station, and continue trimming and padding in this way for good results all over the tuning range of the receiver.

This method of alignment calls for considerable patience since until the circuits are brought into rough trim very little can be expected in the way of signals. In the event of real difficulty it is helpful to couple in an outside aerial and a physical earth connection for the first trials to give as high a signal strength as possible until the receiver is approaching alignment.

With the receiver working correctly the H.T. consumption is of the order of 8mAs. and the L.T. consumption is 200 mAs. This L.T. drain on a U2 cell is perhaps a little heavy although the cell life is of good duration, but it was thought preferable to design the receiver to fit into a small case than to use a long life L.T. cell which would require a considerably larger case size with corresponding waste space.

When all the receiver adjustments are made and the circuit is working correctly the panel should be finished in the manner described in Chapters 1 and 2.

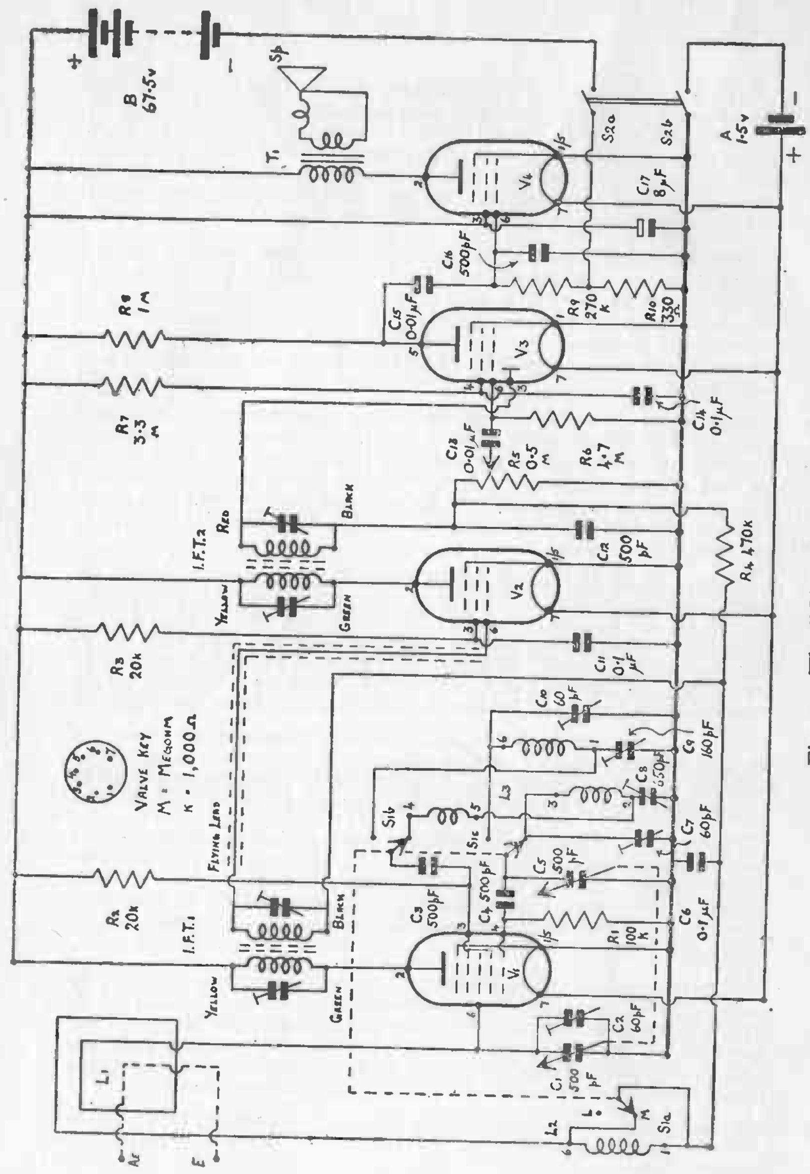

Fig. 11. The "Two-Band Super"

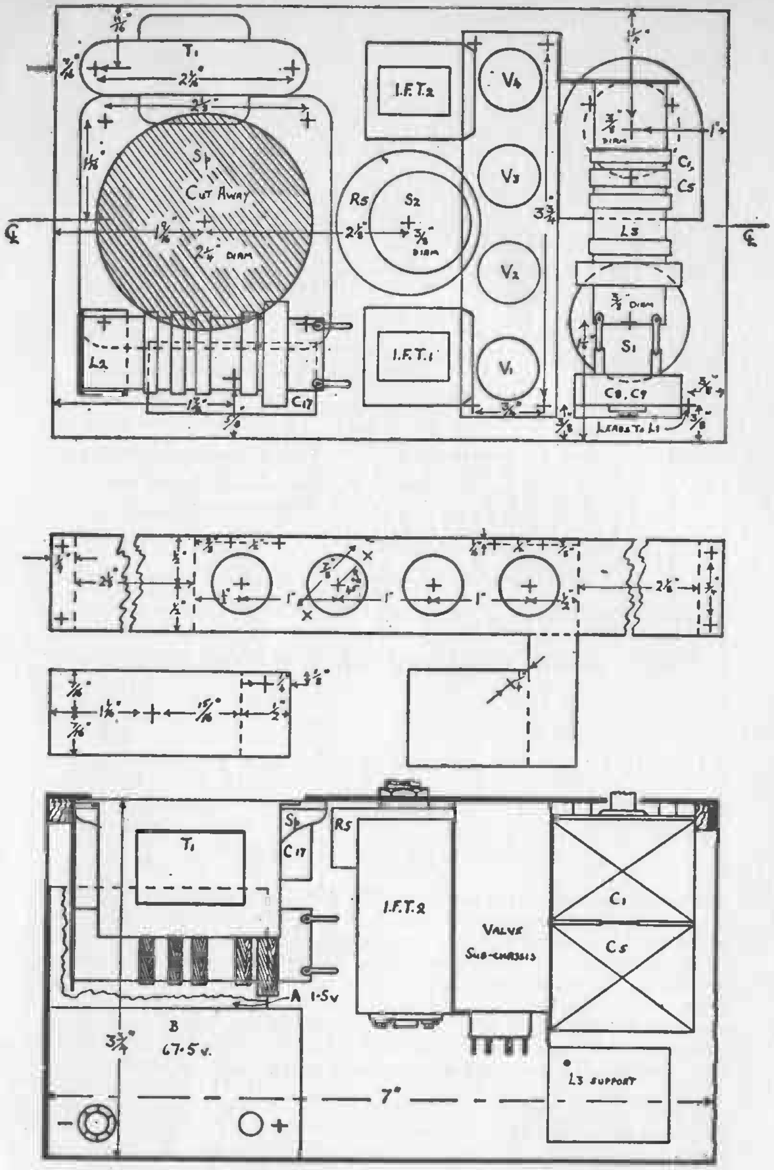

Fig. 12. Panel Dimensions, Bracket, Sub-Chassis and Side Constructional View of the "Two-Band Super"

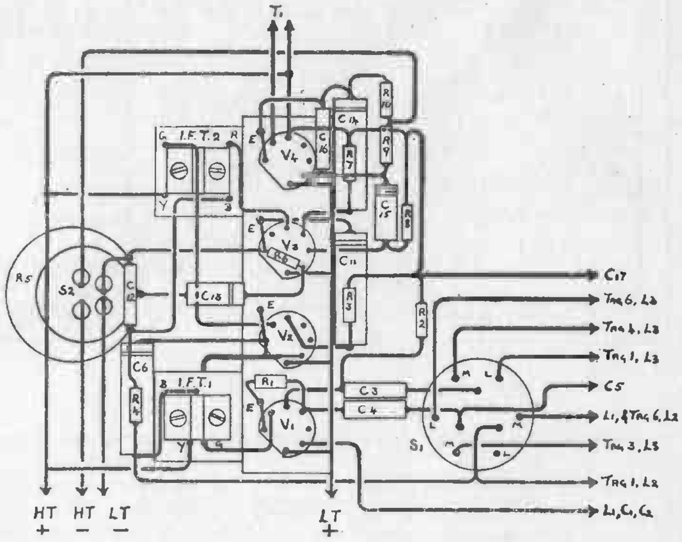

Fig. 13. Point-to-Point Wiring Plan of the " Two-Band Super "

CHAPTER 4

THE " TWO-BAND SUPER "

The simple superhet described in the preceding chapter will be found ideal for the majority of reception locations, but there are situations in which the medium wave Light programme signal is very poorly received —one correspondent has informed the writer that in Ireland a receiver must cover the long wave band to be of any use, and the same is true of other areas closer to B.B.C. transmitters. At the same time many constructors like to receive other long wave stations, and for general purpose operation over both the medium and long wave bands in all reception areas the circuit shown in Fig. 11 should prove highly satisfactory.

It will be seen that the I.F. detector/A.V.C. and output circuits are similar to those of the " Simplest Super," the frequency changer stage being adapted for the more comprehensive coverage. In multi-band portable receivers every effort must be made, during the design work, to make the signal frequency and oscillator circuits match in, or track,

as efficiently as possible, and in this receiver good tracking is obtained over both wave bands by matching the frame aerial to the medium wave section of a Weymouth CS3W3 oscillator coil, employing the aerial coil of the pair as a padder for long wave reception. The CS3W3 coils also give short wave coverage, when used in a more conventional circuit, but in the present receiver the short wave windings are ignored.

As the coils are air cored variable padding capacitors must be included in the oscillator circuits, but the receiver is quite simple to align, especially if a signal generator is available.

The size of the coils chosen for the circuit make it necessary to provide a little more space in the carrying case ; nevertheless the case depth is still only 3¾in. so that the receiver is no less portable than those already described.

Components List for the " Two-Band Super "

Fig. 11.

L1—Frame Aerial (See Text).
L2, L3—1 pair Weymouth coils, Type CS3W3.
C1, C5—500 pF. two gang midget tuner. (See Text.)
C2, C7, C10—60 pF. trimmers. Walter Insts. M.S. 70.
C3, C4, C12, C16—500 pF. 350 v.w. Mica. T.C.C. CM20N.
C6, C11, C14—0.1 mF. 200 v.w. Tubular. T.C.C. 246.
C8—650 pF. padder. (Orange Spot.)
C9—160 pF. padder. (Yellow Spot.) Use Walter Insts. Double Padder, Type 356, as per text.
C13, C15—0.01 mF. 200 v.w. Tubular. T.C.C. CP112H.
C17—8 mF. 150 v.w. Electrolytic T.C.C. CE18F.
R1—100,000 ohms, ¼ watt.
R2, R3—20,000 ohms, ¼ watt.
R4—470,000 ohms, ¼ watt.
R5—0.5 megohm variable, with 2 pole switch.
R6—4.7 megohms, ¼ watt.
R7—3.3 megohms, ¼ watt.
R8—1 megohm, ¼ watt.
R9—270,000 ohms, ¼ watt.
R10—330 ohms, ¼ watt.
T1—Midget output transformer.
Sp—2½in. midget speaker.
V1—1R5 or Mullard DK91.
V2, V4—1T4 or Mullard DF91.
V3—1S5 or Mullard DAF91.
4 B7G valveholders.
S1a, b, c—3 pole 2 way rotary switch. Walter Insts. B.T.
S2a, b—2 pole on-off switch, ganged with R5.
A—1.5 volt cell, U2.
B—67.5 volts battery. EverReady " Minimax."
I.F.T.1, 2—Weymouth I.F. transformers, 1 pair IFM2, or P4J.
Panel, 7in. x 4½in. Valve sub-chassis, 2⅝in. x 4in. x 1in. with coil lug. (Fig. 12). Coil bracket, 2in. x ⅞in. with ½in. foot.
Case, internal dimensions 7in. x 4½in. x 3¾in. with shallow lid.
3 small control knobs. Nuts, bolts, wire, sleeving, etc.

The panel, sub-chassis and coil bracket should be cut from stout aluminium, and drilled as shown in Fig. 12, the sub-chassis being drilled and punched before being separated from the main sheet of metal. It will be seen that there are some changes in the panel arrangement for this receiver in order to incorporate all the components as neatly as possible ; the main tuner and the wavechange switch are in line at one end of the panel with the oscillator coil supported below the main tuner. This coil is mounted on an extension of the valve sub-chassis, this extension being bent down and round to make a firm bracket. Note that for clarity the fixing holes for only one valve position are shown, these holes being duplicated at the other valve positions.

The long wave coil in the signal frequency circuit, L2, is also bracket mounted on a simple bent bracket which is bolted down under one of the loudspeaker retaining nuts. L2 falls below the electrolytic capacitor C17 which is clamped to the panel, as before, by a scrap of sheet metal bent round and secured by a bolt.

The trimmers are not shown in the constructional views since these are mounted directly between the coil contacts, in the case of the oscillator coil trimmers, C7 and C10, and across the C1 section of the main tuner in the case of C2. Note that the long wave coil L2 does not require trimming separately.

Some care must be taken in arranging the oscillator trimmers to lie against the body or former of L3, for the double padder is also supported by the contact lugs of this coil as shown in the panel view of Fig. 12. The lugs of the double padder, identified by coloured spots as in the components list, when a Messrs. Walter Instruments component is employed, are slightly bent and sweated to tags Nos. 1 and 2 of L3, the other two lugs of the padder being directly earthed to the nearest earthed soldering tag on the valve sub-chassis by a length of stout wire, e.g. S.W.G. 18 tinned copper wire. This earthing lead assists in keeping the whole oscillator coil assembly firm and rigid.

In this circuit again a full sized volume control on-off switch is employed in order that the advantage of two pole switching may be retained.

The main tuner should be of the surplus type as made by Plesseys, and as in the other circuits described it is bolted to the panel by three 4 B.A. bolts equally spaced on a 1in. diameter, the tuner being mounted ⅛in. off the panel by using spacing washers. The spindle of the tuning capacitor, together with the spindles of the wave-change switch S1 and the volume control will require cutting down to length by means of a hacksaw or fretsaw so that the control knobs are close down on the face of the panel.

The valve sub-chassis is completely assembled and wired with the valves inserted before it is bolted down to the panel. The valves may have rubber grommets slipped over their top pips to serve as grips and buffers.

The arrangement of the I.F. transformers is similar to that already described in the previous chapter, which may be consulted for the notes given there on wiring up the screened lead from I.F.T. 1, etc.

The leads from L2 to the wavechange switch may be of thin rubber flex twisted into a pair. They should be carried round I.F.T.1 and the end of the valve sub-chassis.

THE FRAME AERIAL

As before, the frame aerial is wound on a former made to the shape and size shown in Fig 3 and cut from thin card. The main winding consists of 18 turns of 24 S.W.G. enamelled copper wire anchored in small holes punched in the former, the leads being left sufficiently long to carry to S1, or alternatively and preferably, thin flex leads being employed. If the receiver is to be used in poor reception areas a small auxiliary aerial coupling coil should also be wound onto the frame former, this coil consisting of 3 or 4 turns of 24 S.W.G. enamelled wire. This coil is taken out to small sockets or clips mounted in the lid of the receiver, as described in Chapter 1.

The frame aerial is fitted into the lid of the case and covered with a sheet of thin card or leatherette or other non-metallic decoration.

THE OUTPUT CIRCUIT

The note in Chapter 1 with reference to the output transformer should perhaps, be repeated. When the Radiospares midget 30 mAs. type output transformer is employed the blue and green leads should generally be connected into V4 for best results. If some other type of transformer is employed it is wise to experiment with all the ratios available in order that the best results may be obtained.

TESTING AND ALIGNING

With the wiring carefully checked the receiver can have the batteries connected in—these are clamped to the bottom of the case with the L.T. cell above the H.T. battery as shown in Fig. 12. The cell is positioned to fit between the curve of the loudspeaker and the output transformer, and the leads to the batteries are lightly soldered to the contacts. Switch on the receiver, turning R5 to the position giving maximum volume, then lightly tap pin 4, followed by pin 6, on the V1 valveholder, using a screwdriver blade held in the hand. When these pins are touched, with the set switched to either wave band, there should be a distinct click in the loudspeaker, indicating that the oscillator is functioning correctly. If no clicks can be heard switch off the set and check the wiring and components.

To align the receiver when a signal generator is available, connect the generator output sockets to the auxiliary aerial winding on the frame, or if this has been omitted, to 3 or 4 turns of wire round the lid of the receiver case. Switch on the set and the signal generator, turning R5 to full volume and setting the wave band switch to the long wave position. Tune the signal generator to 465 kcs. and adjust the I.F. transformers for maximum volume working from the secondary of I.F.T.2 back to the primary of I.F.T.1. Keep the signal generator output low to avoid operating the receiver A.V.C. line.

When the I.F. transformers are trimmed to frequency tune the signal generator to 1,000 metres, 300 kcs., and set the receiver main tuning capacitor to about one-third of full mesh. Tune C10 from its minimum capacitance (fully unscrewed) towards maximum until the signal is heard, then retune both set and generator to 1,500 metres, 200 kcs., the main tuner then being about two-thirds fully meshed. The two tuning positions of C1, C5 should be marked on the receiver panel so that the tuner can be returned to these settings. Adjust C9 from its minimum capacitance towards maximum until the signal is heard, rocking the main tuner as the adjustments are made—as the adjustment proceeds the Light programme may be heard beating with the generator note.

Retune set and generator to the 300 kcs. position and correct the setting of C10, then retune to the 1,500 metres point and correct the padder, C9, continuing these adjustments until variation of one setting has no effect on the other. The long wave band is then aligned, and although C2 has yet to be adjusted on the medium wave band it should be possible to tune in the Light programme and, probably, Continental stations.

Switch the receiver to the medium wave band and set the main tuner to minimum position, i.e. fully unmeshed. Tune the generator to 200 metres, 1.5 Mcs. and trim C7 from its minimum position towards maximum until the signal is heard. Trim C2 for maximum volume.

Set the receiver main tuner to four-fifths of full mesh, and mark the setting, then tune the signal generator to 500 metres, 600 kcs. Adjust the padding capacitor C8 from the minimum position as the main tuner is rocked about the marked setting until the signal is tuned for best volume, then return to the original 1.5 Mcs. point and correct C7. Retune to the 600 kcs. point and correct the padder, and continue to make these two adjustments until one has no further effect on the other. Finally correct C2 for maximum volume on the 247 metres Light programme with the generator coupling removed from the frame aerial.

The receiver is now correctly aligned.

If no signal generator is available the set must be aligned on signals. Leave the I.F. transformers as set by the manufacturer, switch to the long wave band and with C10 set at about half maximum capacitance,

endeavour to tune in the Light programme on 1,500 metres. Remember that the set is directional and may require rotating to bring in the signal at best strength. Unless the I.F. transformers are seriously out of alignment it should be possible to pick up the Light programme signal, and when this tuned in, adjust the I.F. transformers for maximum volume.

Now endeavour to tune in Kalundborg on 1,224 metres, 245 kcs., using an auxiliary aerial if necessary, and trim the oscillator, C10, to position this signal correctly on the tuning range and give good volume. Now tune to the French service on 1,829 metres, 164 kcs., and pad C9 to give good volume and correct positioning on the tuning range. Mark both these tuning points in pencil on the panel, and retune from one to the other, trimming and padding on the signals till one adjustment has no effect on the other. Approximately correct tuning points on the tuning range of the set can be chosen by reference to the tuning scale of the domestic receiver.

Now switch to the medium wave band and endeavour to tune in the Light programme on 247 metres, 1,214 kcs. When the signal is received adjust the oscillator trimmer C7 to bring the signal to the correct point on the tuning range (again by reference to the scale of the domestic receiver), trimming C2 to maintain maximum volume as the oscillator trimmer is varied. With the Light programme signal set, mark its tuning point on the panel, and then endeavour to tune in the Moorside Edge transmitter on 434 metres, 692 kcs., or some other indentifiable station at the high wavelength end of the medium band. Adjust the padder, C8, to position the signal correctly on the tuning range and to give good results, marking the tuning point on the panel. Now retune to the Light programme and correct the oscillator trimmer, afterwards retuning to the high wavelength station chosen for padder correction. Repeat the adjustments till one no longer affects the other, and make a final correction on C2 for maximum volume on the Light programme. The receiver is then aligned on both wave bands.

Some patience is required to align the receiver on signals in this way, and if the I.F. transformers are far off frequency it may take some experimenting with their settings to receive any signal at all, but this method can be used in all but the poorest reception locations. Naturally the signal generator alignment is to be preferred since it is then possible to trim every circuit for maximum efficiency. The finished receiver should draw about 8 mAs. H.T. current and requires 200 mAs. of L.T. current. This means that the L.T. cell life is not so long as the H.T. battery life, but cell replacement is neither expensive nor difficult.

The receiver panel should be finished in the manner described in Chapters 1 and 2.

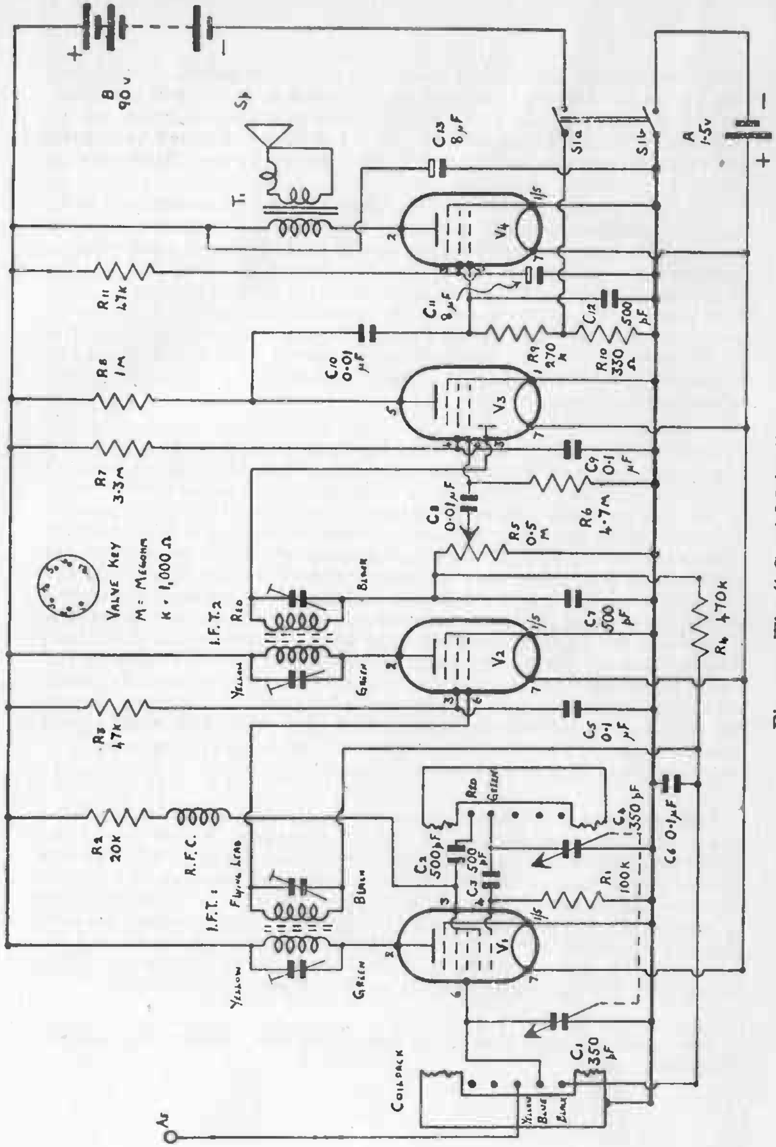

Fig. 14. The "Carri-Major"

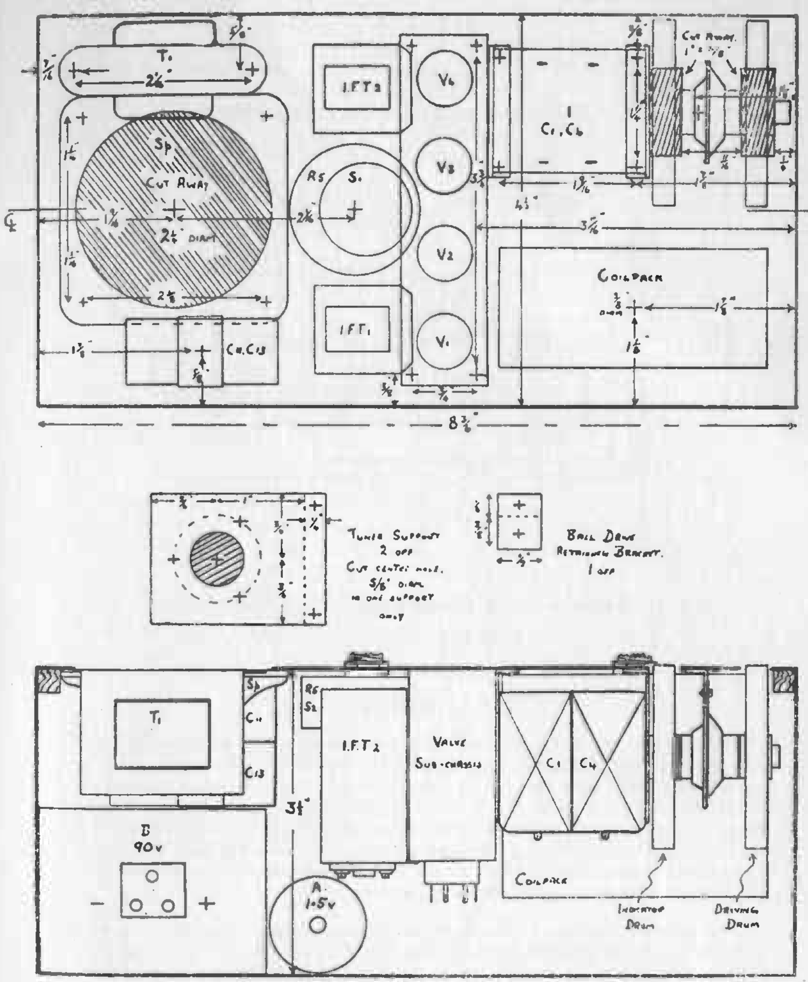

Fig. 15. Panel Dimensions, Brackets and Side Constructional View of the "Carri-Major"

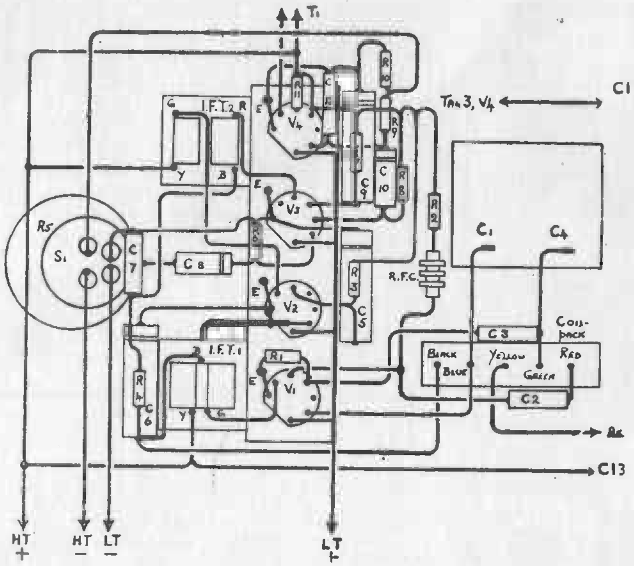

Fig. 16. Point-to-Point Wiring Plan of the "Carri-Major"

CHAPTER 5

THE "CARRI-MAJOR"

During the design work on the previously described superhets it was found that the gain and selectivity obtained were of a standard sufficiently high to warrant the development of an all-wave model employing a coilpack, and the "Carr-Major," shown in Fig. 14, was the result. One modern coilpack, the Weymouth B5, is sufficiently small to be fitted into a portable set without causing the panel and case dimensions to become inconveniently large, and the receiver is still small enough to be termed a personal portable.

For general operation the receiver input is supplied from a strap or sling aerial as described for use with the "Carri-Minor" in Chapter 2, whilst when employed in a semi-permanent location such as a camp, caravan, beach hut, yacht, etc., a larger aerial and a direct earth connection can be used. At the same time the gain of the receiver is such that in good reception areas a loop aerial in the receiver lid gives sufficient pickup ; this loop is wound in the same manner as a frame aerial but only one end of the winding is connected into the circuit, the other end of the winding being left free or "floating."

For short wave reception it is necessary to use as good an aerial as possible, and loud speaker reception cannot be expected, except in the case of one or two stations, from the loop or sling types of aerial. Nevertheless it would be a simple matter to fit a headphone jack socket into the panel beside the loud speaker for short wave reception under poor or limited conditions, the 'phones being connected via a 0.1 mF. capacitor between pin 2 of V4 and the negative line.

Direct tuning drive is perfectly satisfactory for the medium and medium-long wave receivers described, but for short wave reception slow motion tuning is essential. This is provided in the "Carri-Major" by employing an epicyclic gear and a double drum drive, one drum acting as an indicator or tuning scale (and also as a direct drive drum, if desired, for the medium and long wave ranges), and the second drum as a slow motion drive.

Components List for the "Carri-Major"

Fig. 14.

Coilpack—Weymouth type B5.
C1, C4—350 pF. midget two gang tuner. Messrs. Jackson Bros. Type M.M.
C2, C3, C7, C12—500 pF. 350 v.w. Mica. T.C.C. CM20N.
C5, C6, C9—0.1 mF. 200 v.w. Tubular. T.C.C. 246.
C8, C10—0.01 mF. 200 v.w. Tubular. T.C.C. CP112H.
C11, C13—8 mF. 150 v.w. Electrolytic. T.C.C. CE18F.
R1—100,000 ohms, ¼ watt.
R2—20,000 ohms, ¼ watt.
R3, R11—47,000 ohms, ¼ watt.
R4—470,000 ohms, ¼ watt.
R5—0.5 megohms, variable, with 2 pole switch.
R6—4.7 megohms, ¼ watt.
R7—3.3 megohms, ¼ watt.
R8—1 megohm, ¼ watt.
R9—270,000 ohms, ¼ watt.
R10—330 ohms, ¼ watt.
T1—Midget output transformer.
Sp—2½in. midget speaker.
V1—1R5 or Mullard DK91.
V2, V4—1T4 or Mullard DF91.
V3—1S5 or Mullard DAF91.
4 B7G valveholders.
S1a, b—2 pole on-off switch, ganged with R5.
A—1.5 volt cell, U2.
B—90 volts battery, EverReady Type B.126.
I.F.T.1,2—Weymouth I.F. Transformers, 1 pair IFM2, or P4J.
R.F.C.—3 mH. R.F. Choke. See Chapter 6.
Panel, 8¾in. x 4½in. Valve sub-chassis, 2⅛in. x 4in. x 1in. (as in Fig. 9). Tuner and ball drive brackets as shown.
Case, internal dimensions 8¾in. x 4½in. x 3½in. with shallow lid.
2 small control knobs. Nuts, bolts, wire, sleeving, etc.
2 Jackson Bros. 2⅛in. driving drums.
1 Jackson Bros. Ball Drive Unit.

The panel, sub-chassis and tuner supports, with the small ball drive retaining bracket are all cut from sheet aluminium of good thickness, the sub-chassis being drilled and punched before separation from the main sheet of metal to prevent wrinkling or bending. Note that the sub-chassis is not shown in Fig. 15, the sub-chassis plan of Fig. 9 being employed. Whilst the electrical work on this receiver is simple, as may be seen from the circuit and point-to-point wiring diagrams, the mechanical work is a little more involved than in the previous receivers, and the panel dimensions and arrangement must be carefully noted.

For the indicator and driving drums two rectangular holes are cut in the panel, sized 1in. x ⅜in., the ball drive retaining bracket being mounted between these holes. This bracket holds the lug on the outer rim of the drive, so that the ball drive body is kept stationary as both spindles revolve. The indicating drum has its recessed rim wound full of thread, a paper band being stuck down on this surface for the calibration as already described in Chapter 1. It is suggested that the main calibration should be for the short waves, the medium and long wave stations being marked on this scale by dots of coloured ink or paint.

The coilpack is mounted by a single hole fixing, the bearing and nut of the pack providing the earth connection between the coil assembly and the main negative busbar. All coilpack adjustments are on one side of the shielding case, which should therefore be towards the outside of the receiver. The connections to the 5 lugs of the pack are clearly colour coded and shown in Fig. 14.

As before the valve sub-chassis should be completely assembled and wired before it is bolted down to the panel. The points marked " E " on the point-to-point wiring plan denote connections direct to the metal via soldering tags fixed under valveholder bolts. Note that in the diagram of the sub-chassis in Fig. 9 the fixing holes for only one valveholder are shown for the sake of clarity ; these holes are duplicated at each valveholder position. Tag 4, V4 is used as an H.T. tie or anchoring point.

The main tuning capacitor is mounted between brackets with its domed top towards the panel. The Jackson Bros. Type M.M. tuner must be used if the panel dimensions are to be accurate, and it will be seen that a 350 pF. tuner is employed instead of the more usual value 500 pF. There are surplus capacitors of 300 pF. value on the market and these may be used, though then the tuning range will be slightly compressed ; a capacitor value of more than 370 pF. maximum may not be used. If for any reason it is possible only to obtain a 500 pF. tuner, each section should have a 0.001 mF. capacitor connected in series between it and the coil pack connections to reduce the maximum capacitance.

Note that one tuner bracket must have a centre hole of ⅜in. diameter to clear the raised spindle bearing on the front end of the tuner. The tuner spindle must be cut down to a length of ½in. or very slightly more, the indicator drum being fitted on the tuner spindle which is then run into the slow motion side of the ball drive. The ball drive spindle should also be reduced in length to fit into the case ; the driving drum is fitted over this spindle.

The spindle of the volume control/on-off switch must also be cut down to allow the control knob to fall close to the chassis, and the same is true of the coilpack spindle. Take care that no metal dust enters the coilpack when trimming this spindle.

The electrolytic capacitors are clamped, as before, by a strip of scrap metal to a bolt beside the loudspeaker.

It will be seen from Fig. 14 that the oscillator screen feed to pin 3 of V1 is taken through an R.F. choke. It is possible to omit the choke, and its value is not critical, but it does assist in maintaining oscillator performance as the battery voltage falls.

AERIALS

When a strap or sling aerial is to be employed with this receiver the aerial should be made up as already described in Chapter 2 and connected to the receiver by " doglead " clips or in some similar manner. A longer aerial can then also be clipped onto the aerial connector, a series capacitor of 100 or 200 pF. being inserted in series with the lead-in for large aerials. A direct earth connection may also be tried, connected straight to the receiver panel.

In good reception areas a loop aerial may be tried in the receiver lid. This should be wound on a former similar to the design of Fig. 3 although the former length can be increased to 8½in. or so, and the slots may be cut deeper into the former body. The former is then wound with a number of turns of wire, the turns being slightly separated ; old enamelled wire of practically any gauge may be employed, and the wire can be taken from an old coil, choke or similar component. The number of turns is not critical and the former can be wound full if the wire is to hand. One end of the winding is then taken to the aerial connector of the receiver.

Instead of the wound aerial, a plate aerial may also be tried. This consists of a metal plate fitted into the receiver lid and insulated from the rest of the receiver,(i.e. a metal case could not be used since then the case and lid would be earthed down to the panel) this plate being connected to the aerial terminal.

Either of these small aerials should give good reception on the local transmitters in reasonable reception areas, but results cannot be guaranteed.

TESTING AND ALIGNING

With the receiver completed and every connection carefully checked the batteries may be wired up. Note that in this set a 90 volts battery is employed for H.T., so that the H.T. consumption is up to about 10 mAs. or so with a new battery. If desired, a 67.5 volts battery may be used, but the extra voltage assists the short wave operation of the set and gives remarkable volume on broadcast stations. The B126 battery specified has a 3 socket connecting plate and a suitable plug should be obtained when the battery is bought. The L.T. cell should have the filament leads sweated on.

For the alignment of the receiver a signal generator is essential; the coilpack efficiency makes exact alignment a necessity and especial care must be taken on the short wave band.

With the coilpack is supplied a chart showing the position of the trimmer and core adjusters on the rear of the coilpack. The codings given in this chart are used in the following description of the alignment.

Viewing the receiver from the panel, the wavechange switch is turned to the left for the short waves, centrally for medium waves and to the right for long waves.

Switch on the receiver, turning the volume control fully up, and check for oscillation on the medium and long wave ranges by tapping first pin 4, then pin 6 of the V1 holder with a metal screwdriver held in the hand, taking care to short out no connections. At each position there should be a distinct click from the speaker.

Switch to the long wave band, set the tuner centrally, and feed into the aerial connector and the panel a 465 kcs. signal from the generator. (The panel is used as the earth connection to the generator.) Trim up the I.F. transformers from the secondary of I.F.T. 2 to the primary of I.F.T. 1, reducing the generator output as soon as possible to the lowest amplitude for audibility. The generator output must be kept well down throughout the whole trimming process to avoid operating the A.V.C. line.

When the I.F. trimmers are correctly aligned set the main tuner to one-third of full mesh, the wave change switch still being in the long wave position, and feed in a 900 metres, 333 kcs. signal. Mark the tuning point on the indicator drum and adjust the 30 trimmer till the signal is heard, bringing up volume by the 3a trimmer. Then set the main tuner to about four-fifths of full mesh, marking the point, and feed in a 1,740 metres, 172 kcs. signal. Adjust the 30 core whilst rocking the main tuner about the marked point until the signal is heard. The coil cores must always be adjusted gently as it is possible to damage the core slot, especially if a metal screwdriver is used; a proper trimming tool should be employed whenever available.

Retune both set and generator to the 900 metres point and correct the setting of the 30 trimmer till the signal is again heard. Retune to the 1,740 metres point and correct the 30 core setting, repeating these two adjustments till one has no effect on the other.

Switch to the medium wave range and set the main tuner to about one-quarter of full mesh, marking the tuning point. Feed in a 230 metres, 1,305 Kcs. signal, and adjust the 20 trimmer till the signal is heard, bringing up volume by the 2a trimmer. Set the main tuner to four-fifths

of full mesh, marking the indicator drum, and feed in a 500 metres, 600 kcs. signal, adjusting the 20 core whilst rocking the main tuner slightly till the signal is heard at best volume. Retune to the 230 metres point and correct the 20 trimmer, then return to the 500 metres point and correct the 20 core, continuing these two adjustments till one has no effect on the other.

Switch to the short wave range and set the main tuner to one-fifth of full mesh, feeding in a 17 metres, 17.7 Mcs. signal. Mark the tuning point on the scale, aad adjust the 10 trimmer to bring in the signal obtaining full volume by adjusting the 1a trimmer. Set the main tuner to four-fifths of full mesh and feed in a 45 metres, 6.66 Mcs. signal, and, after marking the tuning point, adjust the 10 core for best reception of the signal whilst slightly rocking the main tuner. The short wave adjustments are delicate and signals are tuned very sharply.

Retune the set and generator to the 17 metres point and correct the 10 trimmer, then retune to the 45 metres point and correct the 10 core, repeating these adjustments until one has no effect on the other.

It now remains to adjust the aerial coil cores and trimmers with the receivers applied from the normal aerial. Connect in the aerial which will be used most frequently—the strap or sling aerial in most cases—and very loosely couple this to the signal generator by running the aerial by the output socket of the generator, or beside a length of wire connected to the generator output socket. On each wave range of the receiver set the aerial trimmers at the trimming wavelength already used and the aerial cores at the padding wavelength already used—i.e., on the long waves the 3a trimmer is adjusted at 900 metres and the core at 1,740 metres, on the medium waves the 2a trimmer is adjusted at 230 metres and the 2a core at 500 metres, and on the short waves the 1a trimmer is adjusted at 17 metres and the 1a core at 45 metres. In each case the trimmer and core are set to give best results, the adjustments being repeated one after the other till one has no effect on the other.

The receiver is then correctly aligned, and the tuning scale on the indicator drum can be calibrated in any way desired. If the suggested short-wave calibration is to be drawn on, the receiver should be kept loosely coupled to the signal generator and the generator tuned over the wave range in steps. Either wavelength or frequency calibrations can be used, the latter being preferable. The generator should be tuned in steps of 1 or 0.5 Mc. and at each setting the receiver is then tuned in to the generator and the indicator drum marked. A line on the panel can act as the pointer, the drum being marked against this line at each setting, and the frequency noted and drawn on.

The medium and long wave stations are best calibrated against the station signal itself, one colour being used for the medium and another colour for the long, wave bands.

Finally the receiver panel should be finished as described in Chapters 1 and 2.

CHAPTER 6

NOTES ON ASSEMBLY AND COMPONENTS

Cases and Assembly

Each receiver, when electrically complete, is assembled in a carrying-case and the following notes on case construction cover the requirements of each personal portable.

The carrying case should be made of wood; metal may not be employed since this would exert too great a screening effect on the frame aerial, where this is used, and on internal coils. The effect of the metal panel on the operation of the frame aerial appears to be negligible, but a metal case does affect results adversely.

A good grade of plywood is quite suitable for the construction of carrying cases, and this material may be finished in one of several ways. If the wood is rubbed down with fine sandpaper a bright enamel finish is very effective, or a black finish with high gloss can give the effect of a plastic case. The appearance of the receiver is improved remarkably by building a case with rounded corners, and whilst this takes rather more time and trouble, the work is assisted by quarter round mouldings which can be obtained from a good wood-dealer.

An alternative finish is to cover the case with leatherette or a similar grained tough paper, small sides and ends being covered first with the overlaps hidden by the main panel coverings, and it is also worthwhile to experiment with fabric coverings which can be very pleasing. Tweed-like material gives the best result; this can be applied to the woodwork after the case has been rubbed down and given a very thin coating of good glue.

In each receiver the panel is supported in the same manner, on $\frac{1}{4}''$ square battens tacked and glued round the inside of the case. For this purpose a $\frac{1}{4}''$ edge has been left clear of components around each panel, except where it has been necessary to allow parts to overlap this clearance area; in all cases the output transformer takes up a little of the space, as do the driving and indicating drums of the "Carri-Major" receiver.

The battening should be cut away or chamfered down in these spots to permit the receiver readily to be inserted in its case.

The depth of the lid fitted to the set must depend finally on the size of the control knobs obtainable. The writer favours the instrument or pointer type of knob, especially the Eddystone type 1044, but builders may prefer small round knobs; the chief point to observe in choosing knobs for these sets is to ascertain that the knob has a base recess which covers the component fixing bolts, so bringing the knob close to the panel.

Components

The component specifications are not too rigid, but the types and names quoted in the parts lists are preferred and should be employed whenever possible. As has already been mentioned, the coil and I.F. transformer specifications must be regarded as fixed; other types may give quite satisfactory operation, but this cannot be guaranteed, and a change of I.F. transformers will very probably lead to instability in the I.F. stages. Should instability arise for any reason it can be damped out by connecting a fixed resistance of about 47,000 ohms in value across the secondary of the first I.F. transformer, but this should yb no means be necessary if the receivers are built as described.

The EverReady " Minimax " H.T. batteries used with the prototype receivers were of a surplus type and can still be obtained, on occasion, at about 5s. each from advertisers in the periodical radio press. A new EverReady battery type, the B.126, is employed with the " Carri-Major " receiver and a 90 volt battery of this type can be used with each receiver if so desired. In most cases it will be necessary to increase the case depth slightly to allow for the extra battery size. The Vidor 67.5 volts layer type H.T. battery is also suitable for the receviers (Vidor L5500).

Combined H.T. and L.T. batteries are not recommended for these or any portable receivers. One unit invariably runs out before the second, resulting in battery wastage. A U2 cell is found quite satisfactory for normal running; a cell of the " Alldry " 35 type, made by EverReady, gives long life at low cost but requires too much case room to be practicable in a personal portable.

The running of two U2 cells in a parallel to give a greater current capacity is not really satisfactory for one cell soon has an internal resistance different from that of the other with resulting heavy currents between the cells.

Series heater operation has been tried with these receivers and the results obtained were definitely less pleasing than those given by parallel operation. Experimenters who desire to test series heater feed must remember that it is essential to equalise the voltage drops across the heaters by the use of shunt resistors, the potential across each heater being measured by a high resistance voltmeter. The filament shunts necessary average out between 200 and 300 ohms.

The only component supply difficulty which may be experienced concerns the midget two gang 500 pF. tuners. The bulk of those produced goes to receiver manufacturers and so the constructor is, at least for the moment chiefly dependent on the surplus market. The tuners used in the prototypes and the R.F. choke used in the "Carri-Major," were obtained from Messrs. M. Watts and Co., of 8, Baker Street, Weybridge, Surrey, who can also supply most components needed, whilst other advertisers in the technical press regularly announce stocks of midget tuners. In the event of real difficulty a standard Jackson Bros. M.M. type of tuner with a maximum capacitance of 300 or 350 pF. can be employed with a corresponding reduction of the tuning range ; the main British stations can be tuned in with this capacitance however. The M.M. type of tuner can be ordered from retailers.

A feature of the receivers described is the use of the IT4 or Mullard DF91 as an output valve, giving a saving of 50 mAs. L.T. and a worth-while reduction of H.T. for output and tone not apparently inferior to those of a more usual 3S4 or Mullard DL92. A requirement of the DF91 is that the total cathode current shall not exceed 5.5 mAs. ; for 67.5 volts operation as an output valve this limit is not approached and it is barely touched when the valve is supplied from a 90 volts H.T. battery. It must be noted, however, that under these latter conditions the screen must be supplied through a dropping resister which brings the screen voltage down to 67.5 volts and the screen must be decoupled through an 8 mF. capacitor, as in Fig. 14. The value of 470,000 ohms shown is satisfactory and give excellent and safe operation.

Should it be desired to use a DL92 type output valve in place of the DF91 in any circuit the following connection and component alterations are required. The bias resistor should be changed from the present value of 330 ohms to 680 ohms, and the grid leak from the present 270,000 ohms to 2.2 megohms. The valve connections are as follows: join tag 1 to tag 7 and treat the common junction as the filament positive point. Use tag 5 as the filament negative point. Take the grid feed to tag 3, take the screen feed to tag 4 and the anode line to the output transformer from either tag 2 or tag 6. The DL92 must be operated with the screen at a potential of no more than 67.5 volts ; if a 90 volts battery is employed as in Fig. 14 the screen must be supplied through a 16,000 ohms resistor and decoupled with 8 mF.

The constructor is again reminded that in the point-to-point wiring diagrams the components are shown as " expanded " for clarity and can actually be closely grouped. The points marked " E " on these diagrams show connections direct to the sub-chassis via soldering tags.

Wiring and Soldering.

Provided that brand-new components are used the receivers, once build up, should give excellent results indefinitely without any need for servicing, but if such performance is to be assured the wiring and soldering must receive care and attention. A portable set is subject to a considerable amount of strain and vibration, and weak joints or poor wiring may break loose, possibly with short-circuiting damage to the valve as a consequence.

Almost all the wires in the receivers, whether plain leads or the wire ends of components, are carried between the tags of valveholders, coils, switches and capacitors. At each junction the wire should be hooked through the tag aperture and finally clamped down to make a firm mechanical joint before the solder is applied. Where several leads or wires are taken to the same tag they should all be passed through the tag aperture, and all clamped firmly, before the soldering operation.

The most suitable type of soldering iron to employ in the construction of midget circuits is a "gun" with a wire bit. A broad bit iron cannot be applied neatly to the small tags of a B7G valveholder, and when such an iron is used in a confined space there is a considerable likelihood of charring the insulating sleeving slipped over the leads.

All soldered joints should be made using a resin cored solder, Ersin " Multicore " being preferred and highly recommended. Solder gauges of 16 or 18 S.W.G. are best for the joint types and sizes found in the Personal Portables.

Each lead and wire must be completely and thoroughly insulated so that if a jar or vibration brings leads into contact there is no possibility of a short circuit. The metal cased capacitors specified for some positions (for example the 0.01 mF. " Metalmites ") should be spaced away from other components so that circuits cannot be made accidentally through the capacitor can.

It must be remembered that the metal cans of the 8 mF. electrolytic capacitors used for smoothing and decoupling are not a satisfactory negative connection, and that the negative tags of these capacitors must be earthed directly to the valve sub-chassis or the panel.

In each receiver the bulk of the wiring is on the valve sub-chassis and it is advisable to wire up the stages sequentially so that no lead is inadvertently omitted. As in larger receivers it is a good plan to connect up the filament circuits first, keeping the main lead between tags 7 on the valveholders pressed down close to the chassis surface, out of the way, but with this wire in place each stage should then be wired as a unit, so far as is possible.

Leads which are left protruding from the valve sub-chassis for later connection to components on the main panel are generally identifiable without trouble, but the inexperienced constructor may find it advisable to code these wires in some way. A convenient method of coding is to use a few lengths of various coloured sleeving, slipping a green sleeve on a wire to a coil, for example, and a red sleeve on a wire to a switch, and so on. When the sub-chassis is finally bolted into place on the main panel these leads can be taken one by one, the temporary coding sleeve removed for future use, and a piece of sleeving of the type used in the rest of the wiring slipped on in its place before the lead is finally connected up.

Before such coding sleeves are employed a chart should be drawn up and each colour assigned to a particular connection.

Using P4 I.F. Transformers.

Where Weymouth P4 I.F. transformers are employed, these may be mounted in the manner shown in the diagrams, the colour coding of the leads remaining identically similar. P4J types should be used in both stages as these have all connections brought out to the base ; the Red pin in I.F.T.1. corresponds to a pigtail or flying lead and is taken to the grid of V2.

The only precaution necessary is to use a length of screened insulating sleeving on this grid lead ; this screening must be carried over the I.F. transformer base pin and right to the grid pin and earthed, care being taken, of course, to insulate the screening from the I.F.T. pin and valve-holder pin. When the grid lead is thus totally screened there should be no trouble from instability.

I.F. instability or feedback is shown by stations being tuned as heterodyne whistles which are unresolvable ; if this effect is noted the screening on the V2 grid circuit must be checked and improved. The shortest possible lead should be employed.

P4 transformers have their adjusting screws at the top and bottom of the can and therefore the panel may be drilled with a hole over each I.F. transformer position to permit simple adjustment of the upper screws. The screws should be sealed with wax or cement when the transformers are correctly aligned, and the panel holes will be hidden by the panel covering when this is applied.
