THE LISTENER IN

HANDBOOK No. 6

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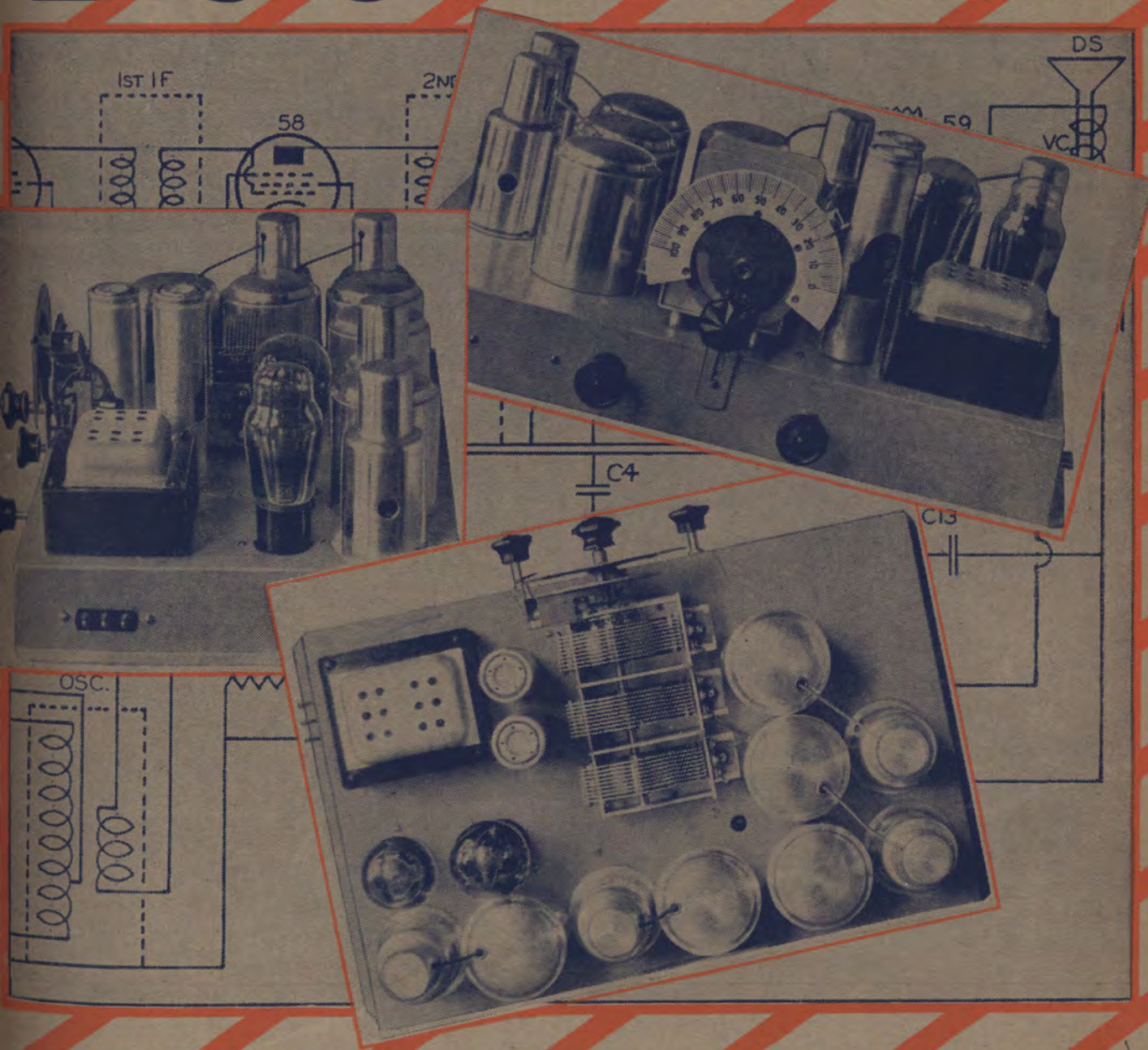
SUPER-HET BOOK AND A.C. CIRCUITS



Over Thirty-five Modern Circuits Included

HANDBOOK No. 6

Contents

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Foreword

In presenting this Handbook, No. 6 of The Listener In Series, to the ever-growing body of Australian Broadcast Listeners our objects are two-fold. Firstly, it is designed to be a concrete answer to the constant query "What shall I build?" Secondly, it is hoped that it will reply definitely to the equally important question, "But can I build it regardless of previous experience?"

Between the covers of The Super-Het and A.C. Circuits Book are contained upwards of forty different circuits ranging from the simplest forms of all-electric, or battery, two-valvers to the most modern types of multi-tube super-heterodyne models. Each has been chosen as an able representative of its class. All are practical materialisations that have been worked out to the ultimate detail. None of the originals has presented difficulties that have not been either squashed in construction or eliminated by explanation. Amongst this widely differentiated collection there must be at least one receiver that will meet your individual requirements exactly.

We are convinced that every set described can be reproduced efficiently by anyone capable of using a soldering-iron, possessing ordinary commonsense, and implicitly following directions. The absence of our omnipotence makes it possible, however, that points here and there may be unclear to certain readers even though such difficulties may not be apparent to the several authors. In such instances the remedy is very obvious. Submit the trouble to The Listener In and, through one or other of the usual channels, every effort will be made to eradicate it.

In this relation a general word of warning can be issued here to the average constructor. Each design is accompanied by a very detailed list of the components employed in its assembly. This list should be adhered to very strictly and especially does this recommendation apply to receivers of the super-heterodyne class. Alterations or modifications that may seem of little importance to the layman, often function so adversely that the resultant model is a hopeless failure.

Coupled with this obvious warning, we offer a three-word text that may inspire you in case of the temporary absence of results:— "The original worked."

In conclusion, we desire to offer our sincere thanks to the Postmaster General's Department for assisting us in the compilation of the lists of Australian and Foreign Broadcasting Stations, and also to the various valve-makers for the exhaustive Data Sheets covering the characteristics of their products.

"RADEX."

THE SUPER-HETERODYNE

By H. K. LOVE

The super-heterodyne circuit is the most selective and (when properly built) the most sensitive of all radio receivers. Unfortunately it is not simple, and its intricacies must be understood if you propose to handle it efficiently. In non-technical language this article describes how and why the super-het. "supers."

EVER since its discovery the Super-heterodyne system of reception has been considered the Rolls Royce of radio receivers. It has many advantages over the T.R.F. system when reception is to take place on a crowded broadcast band. The chief among these is the selectivity which is readily obtained with a small number of valves.

We have become accustomed to regard a Superheterodyne receiver as one employing a number of valves and a whole string of complicated controls—this is a relic of the older types which frequently measured about 36 inches of panel with countless controls and gadgets. These old receivers brought home the stations, but they were anything but pleasant to work.

It will be interesting therefore, to trace briefly the changes which have taken place and to indicate the reasons for their adoption.

Modernised Tuning

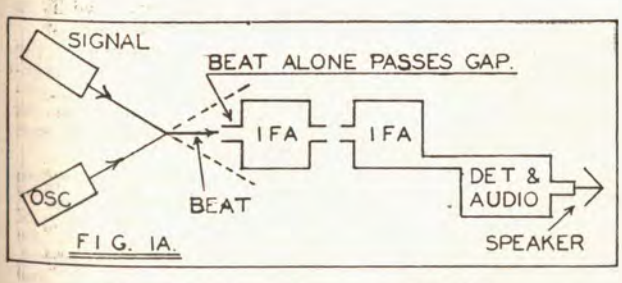
The modern Super has one tuning control only—this has been brought about by two features: (A) The ganging of tuning condensers, and (B) the method of ganging the oscillator condenser to the tuning condensers. This latter has been accomplished by two systems. One using one section of a 3 or 4 gang condenser with a special pad condenser to off track the oscillator tuning system by the frequency to which the intermediate amplifier is tuned, and a special plate on the oscillator section of the gang. By these means the oscillator tuning follows the T.R.F. tuning at a higher frequency and keeps in track over the whole tuning band.

In the older supers a separate control was provided for the oscillator and the main tuning had to be followed by the second dial; this entailed two-handed tuning. When this system was used it was possible to obtain a beat of the difference frequency either above or below the incoming signal frequency; at the best then it was only possible to reduce each station to two distinct readings about five to 10 degrees apart on the dial. Such a system was very inconvenient, and with a crowded broadcast band it would be very confusing indeed. One of the big advantages of the modern super is the one spot tuning.

Notwithstanding this advance, it is still possible to get an image or second spot 30 or 40 degrees away from the true reading—this is caused chiefly by a combination of circumstances, but in most cases by the generation of a harmonic of the true wave plus the frequency of the intermediate amplifiers. This disadvantage, although not a very serious one, can be overcome by the use of an intermediate frequency which when added to the harmonic produces a frequency which falls outside the broadcast band of frequencies, or, in other words, off the tuning dial.

With some frequencies used for the I.F. amplifier, repeats would be very numerous, but with the American standard of 175 kilocycles they are reduced to a minimum. To eliminate them altogether other means can be adopted in the circuit itself.

The sure cure for this disadvantage lies in the selection of a frequency of approximately 465 kilocycles. As, however, the repeats on 175 kilocycles are not at all serious, except when the receiver is very close to a powerful station, we consider we can neglect it in the description of the circuits which follow.



Theoretical stages of every superhet. design.

The Number of Valves

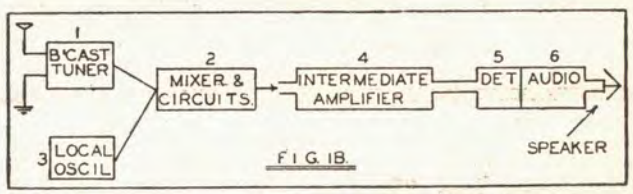
Modern circuit design has not disregarded the needs of the man who cannot afford a receiver with a big number of tubes; it is possible to build a very small super-heterodyne today, and it is our intention to describe the circuits of—

1. A 3-valve superheterodyne.
2. A 4-valve superheterodyne.
3. A 6-valve superheterodyne.

The two former circuits use autodyne oscillators, i.e., a combined detector and oscillator valve.

There are two ways of building a 3-valve super. It becomes obvious that one valve must be cut out, and a 3 valve super can be made by cutting out either (a) audio valve, i.e., the second detector; or (b) a radio valve, which must be the I.F. amplifying valve. If built under heading (a) the receiver will be a good distance getter, but the audio output will be strictly limited, as the output valve must be used as a combined audio system and second detector—direct into a special speaker.

While both circuits will be described, the intending builder is advised that if it is to be used for local reception it should be built to the circuit under the heading (b). If distance is desired, it will be far better to make a good job of it and construct the 4-valve circuit.



How the functions of theory are allocated in a practical design.

Preliminary Explanation

Before going into the constructional details of any of the circuits it will make the whole matter much simpler if a description of the general working of any super is made clear. In order to get down to the working of the circuit, we will side-step the strictly technical and accurate function, and we will supply a simplified analogy which will convey the various functions of a super circuit better.

The most important principle involved in a super circuit is the change of frequency. In any ordinary T.R.F. circuit the incoming frequency is amplified in turn by each stage rectified, and then amplified at audio frequencies.

In the super the incoming signal is tuned in on one or more circuits and is heterodyned by another signal, generated by the oscillator in the receiver. The combination of these two frequencies produce a difference or beat frequency. It is this frequency which the intermediate amplifier is arranged to select and amplify.

If the reader will for a moment turn

(Continued on page 13)

THE ULTRA SUPER-HET.

By RADEX

The six-pin valve removes noise level. A modern receiver in minute detail. Operating on an intermediate frequency of 465 kilocycles this "kit" super-heterodyne is one of the latest on the market.

THE average set constructor is more concerned with results than with the theory of production. Where sundry coils have to be wound, some knowledge of their function is desirable, but in the instance of this Ultra Super-Het model we are going to work around a manufactured kit, and, therefore, construction details are worthy of the maximum space available.

Suffice it to say, therefore, that this design claims your attention on two counts. Firstly, its employment of pentode-type valves in all positions except those of oscillator and rectifier, affords a surprising degree of sensitivity, coupled with relative freedom from parasitic noises, usually grouped under the general term of "noise level." Secondly, operation at the intermediate frequency of 465 k.c. (645 metres approximately) obviates "double-spot" tuning and allows couplings to be so arranged that a large signal voltage can be impressed respectively on both the r.f. tube and the first detector (or mixer).

The Circuit

Running through the scheme of the circuit's design, the whole will be much simpler if you mentally remove those components enclosed in dotted rectangles which come to you as the Radiokes Ultra Kit. There are six items in all, viz., aerial coupler AE.C., radio frequency coupler RF.C., oscillator coupler OC., two intermediate frequency coupler 1.IF. and 2.IF., and adjustable padder condenser PD. Of these AE.C., RF.C. and OC. are already mounted together in an integral assembly, so that they may be fitted under the chassis.

Attention is directed to the condensers shown wired in parallel with the coils of both intermediate frequency transformers. These are already enclosed in those particular cans. They are adjusted and sealed accordingly. These seals should on no account be broken.

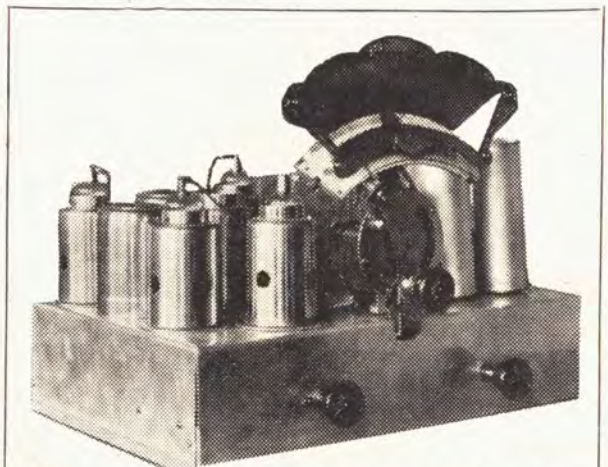
Of the valves, functions are distributed as follows:—V1 r.f. amplifier, VT mixer or first detector, V3 intermediate amplifier, V4 second detector, V5 pentode audio and V6 oscillator. With the exception of V5, all these are heated from secondary A of power transformer PT while secondary B supplies V5 only.

Volume is controlled by high resistance potentiometer VR in conjunction with limiting resistance R1. For local reception, "local-distance" switch S is opened, thereby placing resistance R2 of 1500 ohms in series with VR and so permitting of the output being reduced to a whisper.

Attention is drawn to the method employed of supplying voltage to the second detector's screening grid through R7, which is tapped off that valve's plate system after the important r.f. choke CH. The audio system is perfectly conventional, bias being furnished through the agency of resistor R11, while R10 and C7 serve as de-couplers.

It is highly desirable that a full 250 volts be delivered to the plates of all valves except V6 and, in consequence, special values must be applied to the power-pack system. Transformer PT must deliver at least 350 volts each side of its centre tap; in the original a Radiokes type 1-12 was used which makes available 375 volts. The field FC of the dynamic speaker DS is used also a the power choke, but this must not be large if economy of voltage is to be achieved. To this end it is assigned a maximum value of 1300 ohms with 1200 ohms for preference. Commercial speakers with fields of such values are easily obtainable. However, if trouble is experienced in this direction, an ordinary 30 Henry choke may be substituted for the position of FC and then the speaker's field coil will have a minimum value of 8000 ohms and be shunted across from the centre-tap of the 5V winding and earth.

All components listed and illustrated are essential to the set's satisfactory operation. When completed, certain listeners may desire to lower the tone of its output. In such instances the objective can be reached most easily by shunting a fixed condenser across the plate and screen of valve V5 or, what is the same thing but perhaps easier to get at, across the input terminals of the transformer built into the speaker. Such condenser might have a value of 0.006 mfd at least. The greater the value of this unit (within reasonable limits) the deeper will be the tone.



Front view of the completed Ultra Super-Het. Of the two knobs protruding from the chassis, that on the left is the volume control, while the other is the L/D switch.

Review of the Parts

A Voltage Plug makes a safe input for the power mains and also permits of the set being adapted easily to either 200 or 240 volt mains.

Three Section Blocks are recommended for the combinations of 0.5 mfd fixed condensers C1A-B-C and C2A-B-C, because they occupy a minimum of space in an area that is already very restricted. However, that is not to say that six separate 0.5 mfd. units could not be placed if necessary.

Fixed Condensers of small values should be of the manufacturers' type. All components are so packed together that it will be found generally that these can be wired in with their own tags alone

R.F. Choke should be of a stout and rigid type, as almost all the parts comprising the audio system are actually hung from it.

Dynamic Speaker must have the constants allotted to it in the list of parts for reasons already given in the text.

A Triple-gang Condenser is not supplied with the ultra kit, and so has to be bought separately. See that it is capable of being fitted in the manner shown in the photos, and that its vernier dial's scale reads in accordance with its direction of motion.

A Power Transformer of the type specified is highly desirable both because it is physically small and because its constants are designed to suit the circuit.

Resistors, with the exception of those specifically marked "carborundum," are all of Radiokes series and can be ordered on their numbering. Some of them could be replaced with other makes, but the originals (like the fixed condensers) fit from point to point in their own lengths, and are therefore to be recommended for ease in making connections.

Sundries. — In buying the special shields for the Type 58-series valves, care should be taken to see that they fit the Marquis valve-sockets, thus allowing the same set of screws

to secure both in position. The chassis dimensions are just right with nothing to spare. It carries seven 1½-inch diameter holes for the valves, another similar one in the rear hang-over for the socket into which the speaker is plugged, a square one for the fitment of the power transformer, and several smaller circular ones for the mounting of the electrolytic condensers, the passage of wires from below the intermediate transformers, and the inset of the vernier dial's support.

General Assembly

While an inspection of the photos. will show that but few of the parts can be fitted before the commencement of the wiring, it is advisable to see that everything will fit in comfortably, as, and when, required. Nothing is more annoying than to be forced to remove several difficultly placed leads in order to drill a forgotten hole.

Unless you are looking for work, it is advisable to have the larger holes cut in the chassis by your metal merchant. Make sure these are properly located by supplying him with a paper template upon which all top components have been laid out first in test.

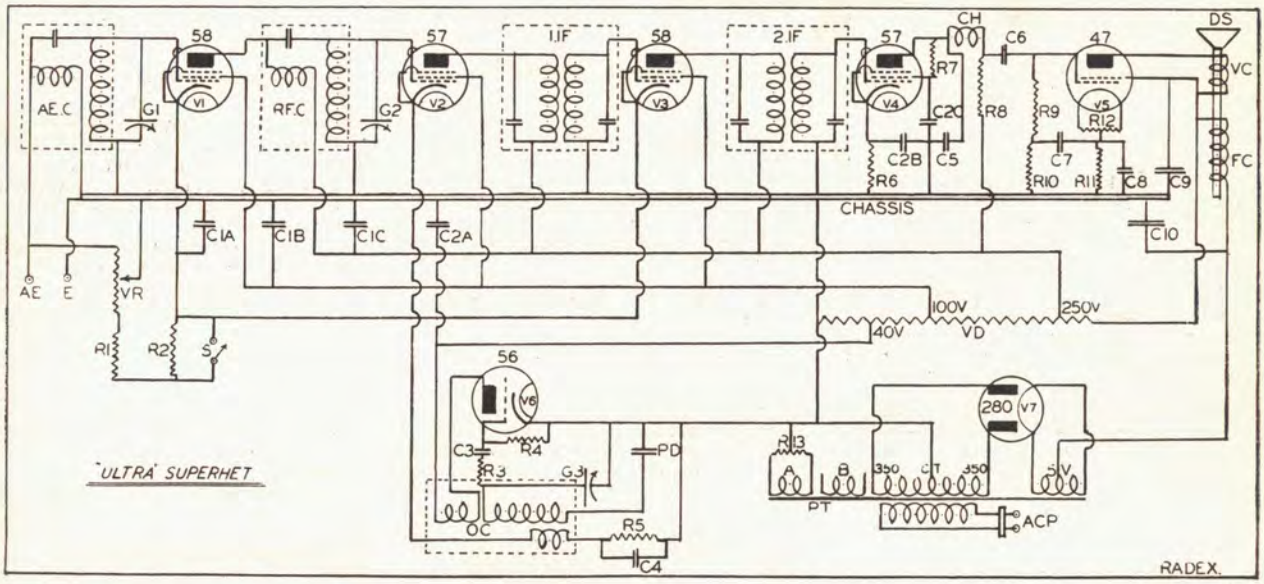
The 3-gang tuning condenser assembly occupies the centre of the chassis, in the edge of which provision is made to take the support of the vernier dial. Working from the centre outwards, discover the positions of the sockets, allowing room for the cans of the two I.F. transformer-couplers. On the power (right hand) side of the chassis there is plenty of room, but remember the socket for the speaker's plug is in the rear hang-over immediately behind that of the pentode V5.

The front hang-over carries the volume control VR and L/D switch S respectively left and right of the main dial. If it is desired to fit a variable tone control it should occupy the position assigned to S, while the latter will take up a place just below the dial.

Beneath the chassis the three-unit coil assemble fits immediately under the ganged condenser, while the padder condenser is located between socket V1 and that of the oscillator V6. As a start, about the only things that you will be safe in fitting will be the seven valve-sockets and the power transformer. Practically the last item to go in is the voltage-divider. One 3 by 0.5 condenser unit fits into the corner near volume control VR, the other is at the oscillator end of the three-unit coil. In view of the fact that the oscillator unit (OC) of this latter is that furthest to the rear, the section of the ganged condenser nearest the dial will be G1, G2 is in the centre, and G3 at the rear over OC.

Combined Assembly and Wiring

Using heavy twisted flex (electric light variety) successively join up the filament terminals on sockets V1, V2, V6, V3 and V4, and continue to the "A" pair on PT (marked 2.5 V 10 A). Across the latter wire resistor R13 and earth its centre. Take the "B" pair of PT (2.5 V 3 A) to the F terminals of the pentode's socket



Complete scheme of the Ultra Receiver and its built-in power pack. Units inclosed in dotted rectangles constitute the Radiokes Kit. Note that the speaker's field (FC) is also the smoothing system's choke. Its resistance must be low or the voltage drop becomes too great.

KEY TO CIRCUIT

KIT—By Radiokes, comprises aerial coupler (AER), radio coupler (RFC), oscillator coupler (OC), two intermediate frequency transformers (1.IF and 2.IF), and adjustable padder condenser (PD).

ACP—3-Pin voltage plug.

C1 and C2—Chanex fixed condenser of three sections (A, B and C), each section being of 0.5 mfd.

C3—T.C.C. condenser of 0.001 mfd.

C4 and 6 — T.C.C. condensers of 0.01 mfd.

C5 — T.C.C. condenser of 0.00025 mfd.

C7—Chanex condenser of 2 mfd.

C8—Chanex tail-type condenser of 0.1 mfd.

C9 and 10 — Dulytic electrolytic condensers of 8 mfd.

CH—r.f. choke (Velco, M-M).

DS—Jubilee dynamic speaker having input transformer (VC) to suit type 247 pentode and a field (FC) of thirteen hundred ohms.

G1-2-3—Triple gang Stromberg-Carlson or Raycophone variable condenser.

PT—Power transformer (Radiokes Hilco Aegis)

R1—Wire-wound 150 ohms.

R2—Ditto 1500 ohms Type 4-11.15.

R3—Ditto 2000 ohms Type 4-11.20.

R4—Ditto 20,000 ohms.

R5—Ditto 10,000 ohms.

R6—Ditto 50,000 ohms.

R7—Carborundum 1 watt 0.5 meg.

R8—Carborundum 1 watt 0.25 meg. (W.W Radiokes or Aegis resistors.)

R9—Carborundum 1 watt 2 meg.

R10—Wire-bound 100,000 ohms.

R11—Ditto 4000 ohms Type 4-12.4.

R12 and 13—Centre-tapped filament resistors.

S—L/D switch.

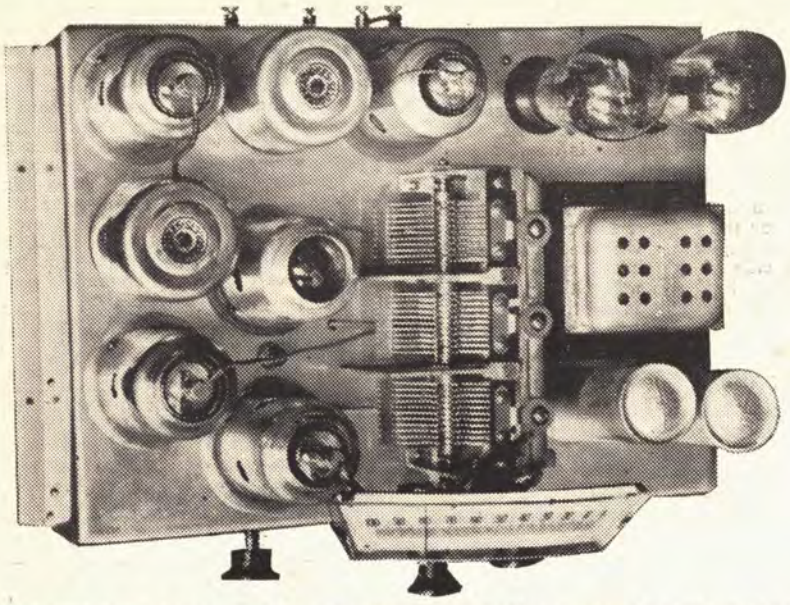
VD—Adjustable voltage divider of 15,000 ohms. Type 4.24.

VR—Marquis 10,000-ohm potentiometer (volume control).

Valves—Two Type 58, two 57, one 56, one 247 and one 280 (Ken-Rad).

Chassis.—Of No. 16 gauge Aluminium, measuring 14 by 10 by 3in.

Sundries—Valve-sockets, Marquis, four 6-pin, 2 UY and 2 UX. F've Type 58 valve-cans, sundry machine screws, nuts and washers, rubber-covered flex. 4 main terminals.



Looking down on the Ultra and showing how the valves and the two intermediate frequency transformers are arranged.

V5, and connect resistor R12 across them at the socket.

By a twisted pair connect the 5V winding of PT to the F's of the rectifier's socket V7. Take the two "375" tags to P and G of V7 and earth "CT" of that winding. On the power in-put section of PT wire "O" to the centre plug of the in-put socket (ACP) and "200" and "240" to the other plugs.

From the nut of electrolytic condenser C10 go to the centre-tap of the 5 volt winding and thence to an F of the eighth (speaker) socket DS. Connect together the remaining F and the socket's P terminal, go to the normal cathode on socket V5 and finish at the nut of electrolytic C9.

Join P of V5 to G of DS. Mount choke CH on one of the bolts holding V5. To one side of CH attach resistor R8 and C6. Take the other side of C6 and a tail of R9 to G of V5. Connect the other tail of R9 and one of R10 to C7. Earth the other tail of R10. From the centre-tap of R12 go to the free side of C7 and ends of both R11 and C8. Earth the opposite ends of R11 and C8.

Attach a tail of R7 and a lead from P of V4 to the free side of CH. The other tail of R7 goes to G2 of socket V4 and C2C. Connect C5 across plate of V4 and earth. Connect G3 and K of V4 to R6 and C2B and earth R6. Earth the remaining sides of C2B and C2C and one side of C2A.

Looking well ahead attach tails to all vacant points on sockets V1, V2, V3, and V6, roughly gauging their lengths. From now on we will describe the wiring as though all parts were mounted, but it will be obvious that many of these tails will remain free at one of their ends until such time as it becomes possible to fit their associated parts later.

The R.F. Section

Before mounting the two IF transformers solder differently colored leads to their underneath P. B and C tags, but leave G vacant. On 1.IF take P to P of V2, B to C1C and C to earth. On 2.IF take P to P of V3, B again to the same side of C1C, and earth C.

Mount the 3-gang condenser and then the three-unit coil assembly, but, before doing so, carefully note down the numbers stamped against the tags protruding from the latter.

Earth 2 and 5 of A.E.C., 2 of R.F.C., and one side of padder PD. Take 1 of A.E.C. to fixed vanes of G1, and leave a tail to reach to the pip on valve V1. Join 1 of R.F.C. to fixed vanes of G2 and have a tail to reach to the pip of V2. Attach on tail of R3 to 1 of OC and continue thence to fixed vanes of G3.

Take 4 of R.F.C. to P on socket V1. On the same coil 5 goes to that side of C1C, which already carries two other leads. Earth the other side of C1C, and also sides of C1A and C1B. Attach ends of C3 and R4 to G of V6. Earth R4's other side. Join together the vacant ends of C3 and R3.

Connect 2 of OC to the free side of padder PD. Take 3 of that coil to K and G3 of socket V2. Join 4 to P on socket V6. From C2A go to 5 of OC and thence to tap 40 of VD. Connect ends of R5 and C4 to 6 of OC and earth their other ends.

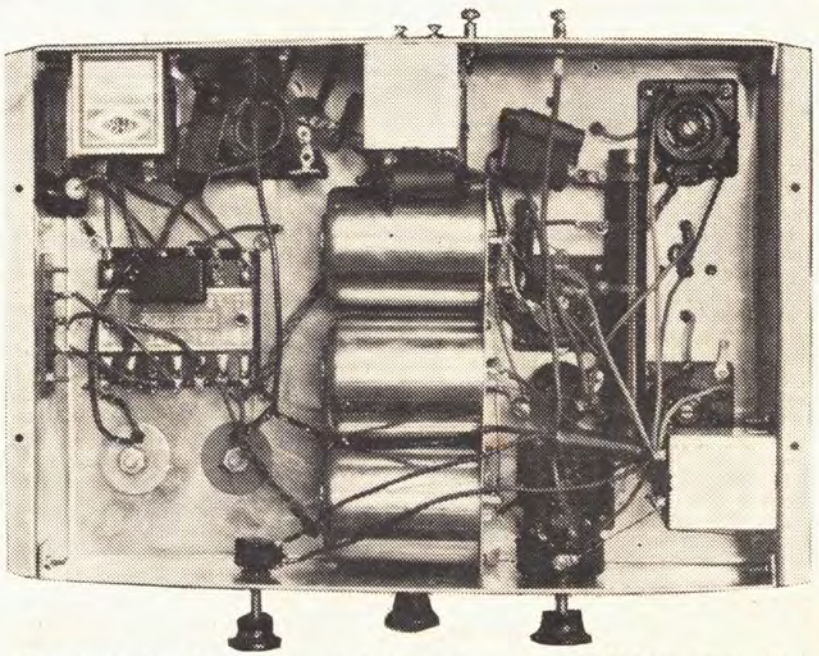
Wire together K and G3 of V3 and K and G3 of V1, continue to C1A an end of R2 and one side of S. From the other side of S go to the other side of R2, and a tail of R1. Attach R1's other tail to an outer of VR. Earth VR's arm.

Connect together terminals G2 of sockets V3, V2 and V1, go to the free side of C1B and thence to clip 100 on the voltage divider. From the side of C1C to which three wires have already been taken, run a fourth to clip 250 of VD and continue to the vacant tail of detector coupling resistor R8. Connect the aerial terminal to the remaining outer of volume control VR and continue to tag 4 on aerial coil AE.C. Run a second lead from the nut on electrolytic C9 to the end of VD nearer socket V1. Earth VD's other end.

Adjustments

On the top side of the chassis fit grid-clips on the wires protruding from 1.IF and 2.IF to go to valves V3 and V4 respectively. For the grids of valves V1 and V2 attach clips to the tails waiting them from sections G1 and G2 of the ganged condenser.

It is a pity that good voltmeters are not more common, as the use of one here is extremely illuminating. However, all being well with the power pack, the maximum end of the voltage divider should show between 265 and 280 volts. The clip marked "250" can be spaced about a quarter of an inch from that end. Clip "40" should be about 1¼ inch from VD's earthed end, while "100" is slightly over half an inch from "40." Before attempting to switch on the power



The chassis from below. There is just enough space in which to place the components, but they must be carefully packed.

see that the speaker's 4-pin plug is fitted into socket DS., and also that the speaker's field winding is wired to the thick "F" pins of that plug.

Screw the padder about three or four turns upwards from full in. Set the arm of VR nearly hard over in the direction of its outer that is wired to R1. CLOSE switch S. Fit all the valves, the five valve-cans, and the four grid-clips.

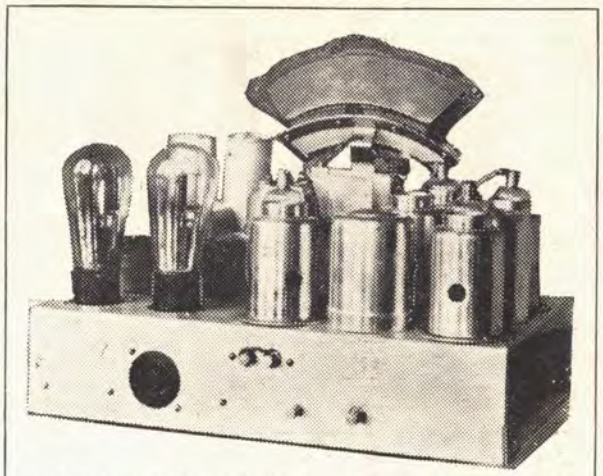
Lining Up

Owing to the proximity of its intermediate frequency to that of the upper end of the broadcast band, the lining up of this type of super-heterodyne receiver is carried out in an entirely different manner to the usual. Unless this modified system is followed, your task will seem hopeless, so please be careful to follow these details.

Remove the clips from valves V3 and V4 and also from V2. Fit the latter (coming from G2) to V4. This will give you a three-valve set in which V1 is the radio stage, V4 the detector and V5 the audio. With the exception of the rectifier, all other tubes will now be dead and both section G3 and the padder PD are temporarily inoperative.

Using a moderate aerial (say, 20 feet or so of wire round a picture rail) tune to a local fairly low on the dial—3DB or 3KZ. Adjust the trimmers of G1 and G2 for best volume, and if the set shows a tendency to burst into oscillation (evidenced by howls) slightly turn back VR. Carefully note the dial setting and then tune in as many other locals as possible. Note the dial settings of each, but refrain from re-adjusting the trimmers except on stations below 3UZ.

Return the grid-pip clips to their proper valves, turn VR pretty well full on again, and exactly set the dial to some station coming in below 20 degrees. Quite possibly you will hear nothing. Now very carefully adjust the trimmer of G3 until the station fixed on the main dial comes in again. You may find two settings of this trimmer; if you do, the one to use is that when the screw is not quite hard down.



At the rear of the chassis, from right to left, are the aerial and earth terminals, the pair of terminals for the gramo pick-up, and the UY socket into which the speaker is plugged.

Now, turn to the predetermined setting of some comparatively long waved station, such as 3AR. Again little may be heard until (this time) the padder is adjusted and here confine your operations solely to PD. Reasonable clarity having been achieved, revert to the short-waved test transmission and, in all probability, some further adjustment of G3's trimmer will be necessary.

This operation is likely to take rather longer than its description. On earlier superhets the setting of the padder had little effect on results low down in the band; here its effect is something more than appreciable. In consequence it will be obvious that if it is not somewhere in the vicinity of being correct initially, the achievement of a short-wave balance with the trimmer of G3 alone is a partial impossibility. Some fiddling at both ends of the band is necessary, therefore, before either end comes into line easily.

Once you feel yourself "hitting the spot" (and we are deliberately making this slightly more difficult than it really is), as the volume rises from any given station, cut it back on VR. If that control is insufficient itself, open the switch and so bring the limiting powers of R2 into force.

Final adjustments must be made on a couple of distant stations, one at about 80 and the other at about 10 degrees on the dial. Of course, when searching initially for interstate reception in the future, switch S must be CLOSED, thus short-circuiting resistance R2.

For those who have not a voltmeter a final aural test of the voltages from the divider may be helpful in producing the last ounce. For this purpose get someone to hold the chassis on its right-hand end. Set the dial to a reasonably steady distant station, loosen the screws of clips 40 and 100 on the divider and switch on the power.

Using your fingers gently, but refraining from touching the chassis, try various settings of both clips; check results by listening carefully to the speaker's quality of reproduction. Neither is very critical, and you will easily find the best positions for both. There is no danger about this operation: even if you do touch the chassis, you will only notice a slight tingling in the finger tips.

Finally, if, after a good average night, you are satisfied that you have got all three trimmers and the padder just right, leave them severely alone in future. Poor nights will come, of course, and there is always the temptation, when signals appear below par, to play around with those critical adjustments. Do not do so. Leave things alone and the next good evening will prove your sense.

THE SUPER-HETERODYNE—(Continued from page 9).

his attention to the sketch in Fig. 1, A.—the system can perhaps be better understood.

We have shown here a line representing an incoming signal, another line meeting it, representing the signal produced by the local oscillator, and a third for the selectivity of a super circuit, the collision of the incoming and the local.

It will be understood that if the intermediate amplifier is sharply tuned to receive and amplify the beat frequency only, the adjustment between the incoming and the oscillator signals must be such that the correct frequency is the result of the collision between the two. The I.F.A.—it is this that accounts for the selectivity of a super circuit. The I.F.A., in the sketch of Fig. 1, is represented by a container with a small gap; this gap represents the tuning width of the frequency which the I.F.A. is tuned to accept and amplify. If the beat frequency wanders towards the position indicated by the dotted lines, it will miss the I.F.A. In practice, of course, there is no actual gap, but a tuned circuit or circuits peaked on one frequency only.

The conclusions to be reached from the foregoing illustration are as follows:

1. A tuning circuit must be provided for reception of signals over the full broadcast band.
2. Another circuit must be provided arranged to beat the incoming signal at a predetermined frequency in order to provide a difference or beat frequency.
3. An intermediate frequency amplifier must be provided with its circuits tuned to accept the difference frequency.
4. The amplified signal from the intermediate amplifier must be rectified and amplified at audio frequencies and so passed on to the reproducer.

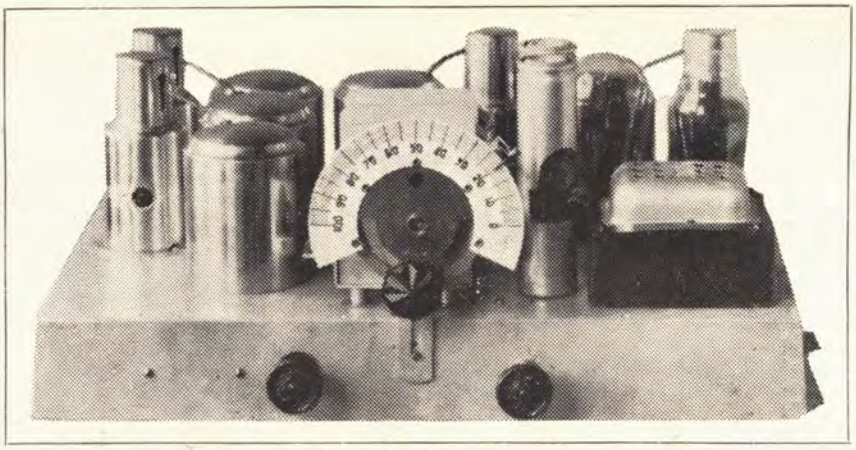
If the reader has got a grip of what we must set out to do, it should be easy to follow the building up of the electrical circuit in any type of superheterodyne.

Circuits

Before constructional details are described, we had better run over a simple circuit, as this uses a separate oscillator, identifiable with the illustrative sketch of Fig. 1A.

It is common practice to call one valve in any super system a first detector—this description is a little confusing, and we will not use the term in this series of articles—we will call it the mixing valve, as this is its actual function.

In the case of 3-valve and 4-valve circuits the section of Fig. 1B shown as broadcast tuner, local oscillator and mixing valve and circuits are all fulfilled by one valve—with a number of associated circuits. These are simple enough when they are understood.



Front view of the "Melbourne" super-het.'s completed chassis. The subsidiary controls are volume on the left and local-distance on the right.

All valves and coils must be completely shielded, and particular attention is directed to the super-caps fitted to the normal valve shields.

THE "MELBOURNE" SUPER-HET.

By RADEX

An Autodyne Super-Heterodyne Receiver in Five Valves and a Rectifier, with all modern improvements, including types 57, 58 and 59 valves.

WRITING this description in March, 1933, I can say with the greatest confidence that this is at once the easiest, the purest and most sensitive super-heterodyne radio receiver it has yet been my good fortune to build. The original, situate in what is admitted to be a poor receiving area, has produced 49 stations to date, and that during a fortnight that has been marked by severe static almost nightly. Even with so drastic a handicap, signals came in so strongly that the number stated formed a positively identified list. In addition, at least a dozen other transmissions have been located on the dial most of them probably outside Australia) but, by reason of poor autumnal conditions, their calls were indecipherable.

It affords pleasure to be able to state that the kit employed is the product of a Melbourne factory. It is of robust manufacture and lends itself to very easy assembly. Accuracy of its construction is proved by the simplicity with which the condensers were lined up, the subsequent clear-cut signals from stations on closely allied wave lengths, and freedom from double spotting. The results, as out-lined above, were obtained with Radiotron valves.

The Circuit

Of the five valves employed in the receiver circuit proper, we start with a 58 functioning as an initial radio frequency amplifier, and this is followed by a 57 which combines the office of a first detector and oscillator ("mixer"). Next comes another 58 as the intermediate frequency amplifier, and then a second 57 for the second detector. Finally there is a 59 (the latest indirectly-heated power pentode) that gives tremendous volume (when such is desired) but is, owing to the nature of its construction, entirely free from signs of hum.

All these tubes being indirectly heated, all can be fed from the one centre-tapped 2½-volt filament secondary, thereby considerably simplifying wiring and so further reducing chances for the intrusion of hum or other parasite noises. The two 58's, being variable-Mu valves, include variable resistor (potentiometer) VR in their common cathode circuits, and the set's volume ("degree of sensitivity" would be a better term) is perfectly controlled through its agency.

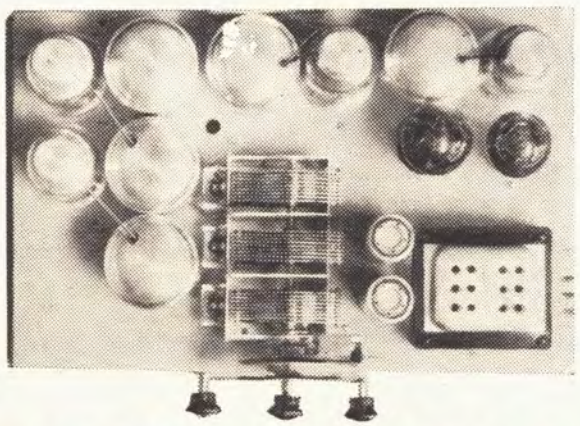
Two means are taken to obviate any signs of "blasting" on locals; from a tap (40) on the voltage divider VD a small positive voltage is impressed on the positive end of VR, and this permits of even the strongest signals being reduced to something less than a whisper. Secondly, a "local-distance" switch LDS is provided, across which is wired fixed resistor R1; when LDS is opened R1 is placed in series with VR, thus allowing of a sudden volume-drop on moderately strong signals without any alteration to VR whatsoever.

The autodyne system, as applied to super-het circuits, has already been described exhaustively in articles by H. K. Love and others. Investigations of its theoretical side would therefore be out of place in a practical constructional article, such as this. Suffice it to say that through the agency of the oscillator coil unit (OSC) the mixer's plate circuit energy is in part fed back to its grid circuit by means of a tuned pick-up in the cathode return of that tube.

In the particular kit employed the resultant beat produces an intermediate frequency of 180 k.c. (1666 metres). The presence of series padder PD and the formula of the tuned winding in the oscillator ensures the production of beat frequencies ranging between 1725 and 720 k.c. This means that the sweep of the tuning dial easily takes in up to 2CO and down to 3AK with some five or six degrees to spare at both ends of the scale.

The apparently complicated series of resistors and fixed condensers in the second detector's grid and cathode returns are, in actuality, wired up very simply. Their objective is the suppression of heavy stray r.f. currents and the ensurance that the tube will pass nothing but pure audio frequencies to the audio amplification system. They also have the advantage of eliminating need for de-coupling systems in the purely audio circuit. High resistor R8 steadies the feed to the pentode's control grid and automatically monitors its subsequent output.

The power and smoothing system is perfectly conventional so long as it is remembered that only one 2.5-volt secondary of the transformer PT is used to heat the filaments of the re-



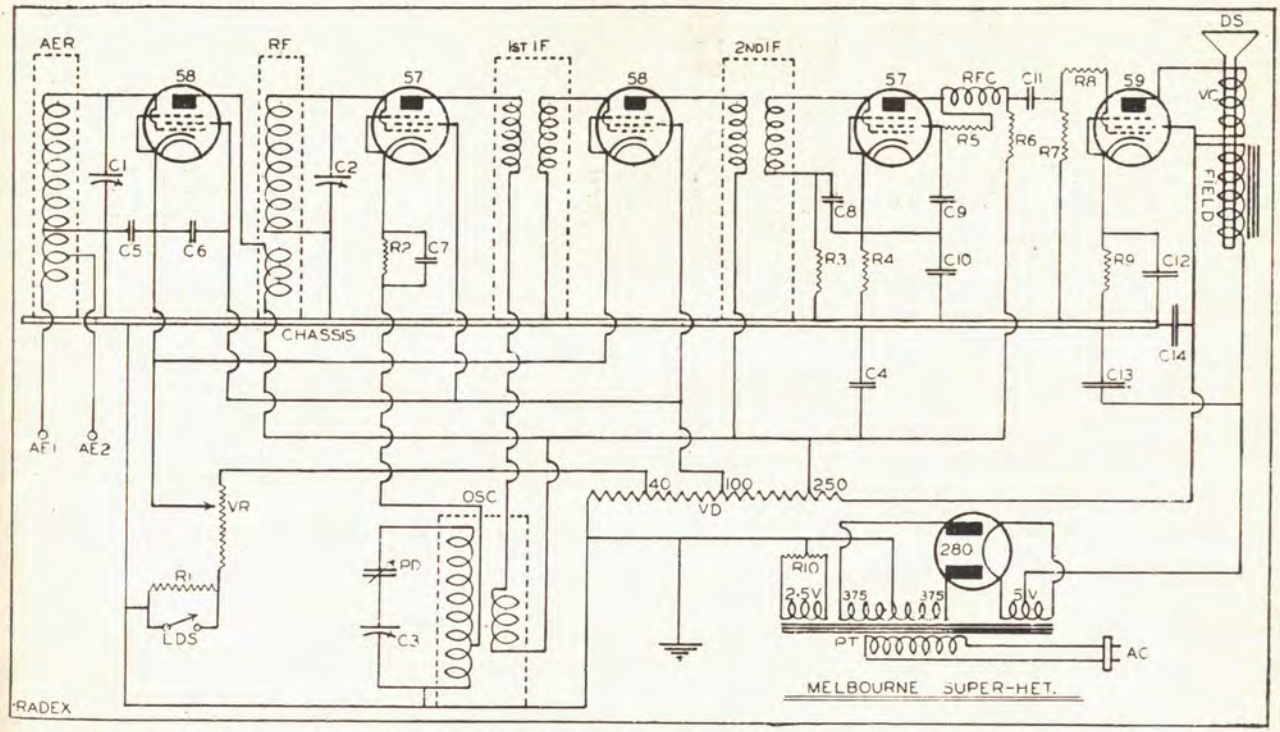
Looking down on the chassis. In order from the left the valves are:—RF 58, mixer 57, IF 58 and 2nd detector 57. The 280 and 59 are unshielded, the latter being on the right. The coil-cans follow the same order, that for the oscillator being on the left of the back row.

ceiver's tubes (omitting the rectifier). If a second such winding is included in PT. as is usual, one of its ends must be earthed. The speaker's field takes the place of a choke in the smoothing system while VD provides the required variations in voltage.

Notes on the Parts

The "59" Pentode is a 7-pin tube with an indirectly heated cathode, the lead from the latter to earth including a suitable fixed resistor that provides the necessary free bias. The 59 can be used as a Class A triode, a Class B triode or a Class A pentode, and hence its variety of pins which can be variously linked to provide this range of functions. Here its pentode application is utilised and, in consequence, its cathode and third grid (or suppressor) are permanently linked in the wiring. Viewed from below the base, and running in clockwise order, its pins are:—Two thick pins, heaters; plate; second grid taking maximum voltage from the smoothed B supply; control or in-put grid; third or suppressor grid; and cathode.

The Dynamic Speaker's specifications are given in the List of Parts, and the field winding's resistance should not exceed the value there given; however, it can be less if provision is made therefor. For example, if you have a pentode speaker with a lower field value a resistor equal to the difference should be inserted before the B input to that field and after the tap off to C13 (vide diagram). The original was a case in point: the available speaker's field was of only 1750 ohms, consequently a 750-ohm resistor (capable of carrying 100 M.a.) was inserted as already indicated. Again, provided the centre-tap and one outer only is employed, a built-in in-put voice-coil transformer of the push-pull type may be used with the single pentode.



Complete circuit diagram of the "Melbourne" Super-Het. Compare the lettering of its components with the list below.

Melbourne super-het kit, comprising: Aerial coupler (A.E.R), Radio coupler (RF), Oscillator unit (OSC), two intermediate frequency tuned transformers (1st and 2nd IF's), and adjustable padder condenser (PD).

COMPONENT PARTS

AC.—Three-pin voltage socket and plug.

AE 1 and 2.—Alternative aerial plug connections.

C 1, 2, 3.—Triple gang variable condenser of 0.00043 mfd per section with trimmers (Stom.-Carl, Raycophone, Essanay) and vernier dial (Radiokes, Ship, Darelle).

C4.—Condenser of 0.5 mfd 1000-volt test (Chanex).

C 5 and 9.—Condenser of 0.5 mfd low test (Chanex).

C6.—Condenser of 0.1 mfd tail type (Chanex).

C7.—Mica condenser of 0.01 mfd. (TCC).

C8.—Condenser of 0.5 mfd tail type (Chanex).

C10.—Mica condenser of 0.00025 mfd (TCC).

C11.—Mica condenser of 0.02 or 0.03 mfd (TCC).

C12.—Electrolytic condenser of 10 mfd tested to 40 volts. (Dulytic, Concourse).

C13 and 14.—Electrolytic condenser of 8 mfd tested to 500 volts. (Dulytic, Polymet, Dubilier).

DS.—Dynamic speaker with input transformer matching pentode (VC) and field of between 2000 and 2500 ohms. (See text). (Jensen Jubilee).

LDS. — Shafted "Local-Distance" snap switch.

PT.—Power transformer; power secondary 375-0-375 volts 100 M.a., rectifier secondary 2A at 5V; heater secondary 10A at 2.5V; second heater secondary, optional but unused. (Hilco heavy duty or Radiokes 1-12).

R1.—Wire-wound resistor of 1500 ohms (Radiokes, M-M, Velco).

R2.—Ditto 3000 ohms carrying 25 M.a. (Ditto, ditto).

R3.—Carborundum 50,000 ohms.

R4.—Wire-wound 6000 ohms (Radiokes, M-M, Velco).

R5 and 7.—Carborundums 500,000 ohms.

R6 and 8.—Carborundums 250,000 ohms.

R9.—Wire-wound 400 ohms to carry 75 M.a. (Radiokes).

R10.—Centre-tapped filament resistor (optional).

RFC.—Radio frequency choke. (Master-made).

VD.—Voltage divider of 25,000 ohms adjustable (Radiokes, Master-Made).

VR.—Potentiometer of 10,000 ohms. (Marquis, Radiokes).

Valves.—Two 57's, two 58's, one 59, and one 280; four 6-pin, one 7-pin and two UX sockets; four valve-cans and tops; four grid-clips. (Radiotron, Ken-Rad, National; Marquis or A.W.A. sockets).

Chassis. — Aluminium measuring 17½ by 11 by 2 inches, drilled and cut to requirements; casting preferred, but can be of No. 16 gauge sheet.

Sundries. — Single and twin flex; ½ by ⅛ inch machine screws and nuts, bushings of scrap ebonite or bakelite, aerial and earth plugs.

Carborundum resistors, if the genuine product, are all of the one watt type. Care should be taken to see that the **wire-bound resistors** are capable of carrying the currents assigned to them.

Full screening is an essential of the 57 and 58 valves; this means that, in addition to the ordinary cans, they must be capped as well in aluminium. These latter accessories are now generally obtainable.

Fixed condensers are fully evaluated as regard test voltages in the list. Two only (apart from the high voltage electrolytics) have to withstand heavy strains; they are C4 and C6. At the same time it is essential that C11 (audio coupler) be of the highest quality; the slightest sign of leakage in it will ruin reproduction.

The Power Transformer should be capable of furnishing at least 100 m.a. from its 375-volt secondary, and, if possible, its 5 and 2.5-volt windings should be centre-tapped. In such a case R10 is not needed. If "5V" is not so wound then the lead (CT) off to C13 and "Field" is taken from a filament terminal on the rectifier's socket.

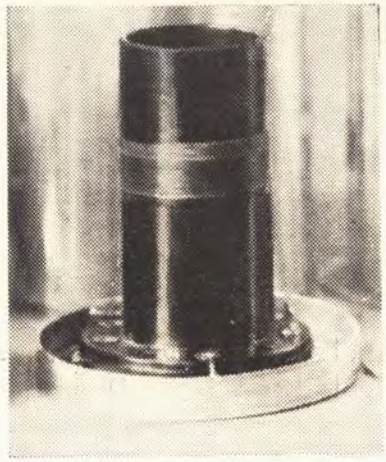
The Triple-Gang Condenser should be carefully inspected for the even allignment of its moving sections and its trimmers must be easily accessible. The vernier dial MUST be free from backlash.

The Chassis' solidity is of great importance. At the dial's lower end many stations come in with less than half a degree's separation from their next-door neighbors, therefore a flimsy chassis is liable to defeat such delicate tuning. The original employed a ready-cut caste aluminium chassis of marked rigidity, and it is beleived that the makers of the kit can supply copies on demand.

The Coil Kit

For purposes of future wiring all open coils should be carefully inspected before they are mounted, but the two intermediates must NOT be taken to pieces nor may the locked adjusting screws in their bases be touched. To these latter three connections only are made to the lugs protruding from the bases, that unmarked "G." being left blank; the grid-leads to the following valves protruding from their sides.

The aerial coil has five connections as follows:—Top enamel to grid and fixed vanes (FV) C1, bottom earth; top green earth, centre AE2 and bottom AE1. R.F. coil has four connections: Top large coil to grid and FV C2, bottom earth; top small coil B+, bottom to preceding plate. Five leads go to the oscillator unit: Top enamel to padder; tap to bias resistor R2 and C7, bottom to earth; top of over-wound coil to "B" on 1st I.F., bottom to B+250.



Appearance of the oscillator coil upon which the order of connections is most important.

Assembly

Before attempting assembly, the accompanying photos should be thoroughly inspected. In the downward view, and starting from the left of the 3-gang condenser, the order of the valves is:—RF 58, Mixer 57, IF 58, and 2nd detector 57. The distinctive shape of the 59 easily identifies it. Similarly the coil-cans run:—AER, RF, OSC, and 1st and 2nd IF's. The padder is made fast below the chassis, and is adjustable through a hole placed to the left rear of C3 and in the angle formed by RF, OSC and 1st IF.

Below the chassis it will be seen that there are a minimum of fixtures. The exceptions are three fixed condensers and the voltage divider. Other condensers and all the resistors are suspended in the wiring by means of their own tags or tails. However, in order to achieve a reasonable degree of rigidity, it is desirable that one end of each such component should be firmly anchored to some definite fixture, such as a socket connection, etc. In addition the R.F. choke, RFC, is bolted to one of the screws holding the second detector's socket, and from it many of the audio components are suspended.

Chassis is also earth, and all returns are taken thereto. In order to simplify such connections it is desirable to scatter around solder lugs fairly freely. They are quite inexpensive; they serve also as washers, and one under at least one or the bolts of each part will be of great assistance in getting short paths to earth.

Detailed Wiring

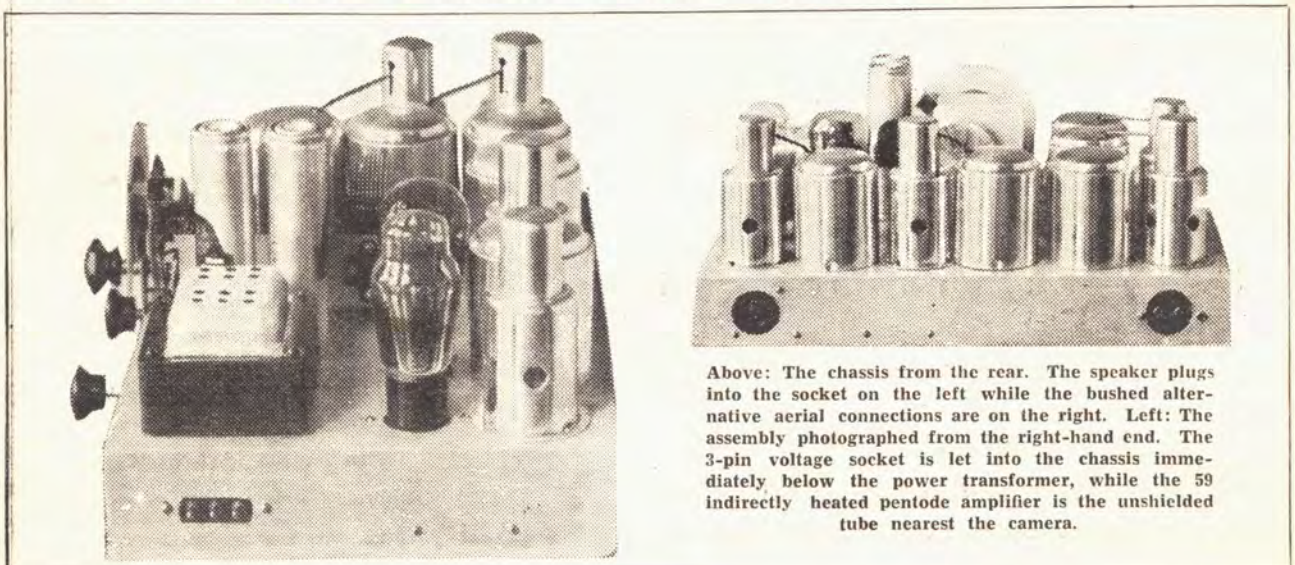
Mount the parts only as the wiring calls for them. Start by fitting all six valve sockets, the power transformer and the 3-pin voltage plug. On the in-put side of PT wire zero to the centre of the 3-pin plug and the latter's outers to "200" and "230" respectively. If the transformer carries a "250" connection it can be left blank.

Successively, using tightly twisted heavy twin flex wire, join together the heater terminals on all 57, 58 and 59 sockets. From the centre socket (IF 58) take a similar pair to the 10A 2.5v. contacts on PT. If this winding is centre-taped, earth that tap; if it is not, connect R10 across it, and then earth that resistor's centre.

Take two leads from the outers of the 2A 5V winding to the F connections of socket 280. Connect the latter's P and G contacts to the outers of the 375-volt secondary and earth its centre tap.

Wire the centre-tap of the 2A 5V semondary to C13 and thence to one F of the DS socket. Connect the sockets other F to G, and continue to second grid of 59, an end of VD and the centre terminal of C12. Earth VD's other end. Attach P of 59 to P of socket DS, this latter being, of course, the UX socket into which the dynamic speaker's plug fits. This completes the power-pack proper.

Connect together cathode and 3rd grid of 59 and attach ends of R9 and C12 thereto (using the tail from the latter's red end)). Earth the other tails of R9 and C12. Solder R8 to G (control grid) of 59. Wire together R8's other



Above: The chassis from the rear. The speaker plugs into the socket on the left while the bushed alternative aerial connections are on the right. Left: The assembly photographed from the right-hand end. The 3-pin voltage socket is let into the chassis immediately below the power transformer, while the 59 indirectly heated pentode amplifier is the unshielded tube nearest the camera.

GUARANTEE

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tail and those of C11 and R7. Earth R7's other end. Connect the other tail of C11 and that of R6 to one side of RFC.

From the other contact of RFC take a lead to P of 2nd det. 57 and a tail of R5. R5's other tail and one side of C9 goes to the S/G of the same socket.

Wire together the suppressor grid and cathode of that same socket, and to these points connect C9's other side and tails of C8, R4 and C10. Earth the opposite ends of R4 and C10. Mount the second IF trannie and solder the free eid of C8 and a til of R3 to its F. Earth R3's remaining tail.

On the same trannie connect P to P of the second 58. From its B go to one side of C4, a clip on VD and the remaining tail of R6. Earth the other side of C4. From the second clip on VD go to the S/G contacts on the same 58, the mixer 57 and the RF58. Connect C6 to the latter point.

Connect together the suppressor grids and cathodes of both 58's, join them to each other, connect to them the free side of C6 and tone tag of C5, and terminate at the arm terminal of VR.

Under the 1st IF take F to earth, P to P on mixed socket 57, and B to the top of the over-wound coil of OSC. From the top of RF's small coil go to the bottom of OSC's over-wound coil and continue to the unearthed side of C4.

Connect together cathode and suppressor grid of mixer 57 and go on to the tails of R2 and C7. Take the other ends of these latter to the tap on OSC's larger coil. The top of the latter goes to PD, while its bottom is earthed. Wire PD's other terminal to the fixed vanes of C3.

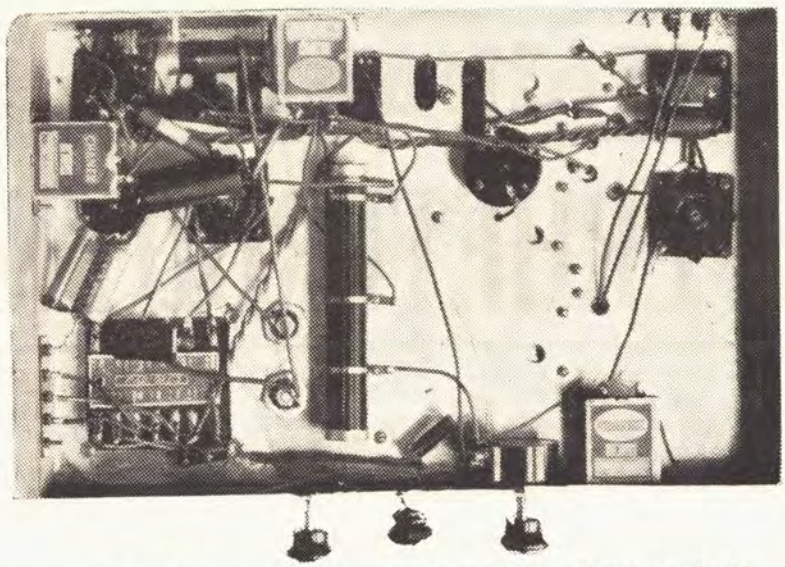
Earth the bottom of RF's larger coil. Take the bottom of its smaller one to P of RF valve 58. Earth the bottom of AER's larger coil and the top of its smaller one. On the latter take the tap to AE2, and the bottom of AE1. Connect the third clip of VD to one outer of VR. To the latter's other outer attach one side of R1 and LDS. Earth the clips on VD to the approximate positions in which they are shwn in the chassis' under photo, its earthed end being that nearer to the rear of LDS.

Coming on top of the chassis, cut small slots in the bottoms of cans covering AER and RF coil units. Through these take leads from the tops of the larger windings to the fixed vanes of condensers C1 and C2 respectively. From the tops of the same coils, going through holes provided in the sides of the cans, make connections to the grid-pips of the first 58 and 57. Similarly, connect the protruding grid-leads of cans 1st and 2nd IF to the following 58 and 57. All these grid leads should be just as short as possible. Cover the 57's and 58's with their cans, and add their can-caps.

Fit the vernier dial, being careful to see that its scale reads "zero" when the triple-gang condensers' moving vanes are ALL OUT. Close LDS thereby shorting out R1, and so providing for the maximum degree of sensitivity. Turn the arm of VR until it is within a quarter of an inch of the outer end already wired to C5, etc. Plug in the the speaker, being watchful that its field leads go to the plug's thick pins. Attach a moderate aerial to AE1, and earth the chassis. That is all.

Operating Adjustments

Completely screw down the padder's adjustment, and then loosen it by one complete turn or just a fraction over. Set the ganged condenser's trimmers about half way in, but have that of C1 a shade further down than that of C2. Plug in the mains, and give the set half a minute to warm up. Do not be alarmed if condenser C13 frys a little; owing to the 59 being indirectly heated (and therefore slow in coming into operation and absorbing current) for a few seconds there is a very high potential on C13, but, as it is self sealing, no harm will be done.



Looking into the under-chassis lay-out and its wiring. This photo. should be followed carefully while the wiring in words is being followed.

Swing the dial to some station low on its scale—say 3AW, and adjust C3's trimmer very carefully so soon as signals come in. As the volume comes up, systematically reduce it first with VR and then by opening LDS if you are in the suburbs. In general the gang will tune itself basically to the setting of C2 so when you are satisfied with C3, C1 must be trimmed a little. Now go over all three trimmers in turn until you have the last ounce from them on a low wave length

Advert now to a long waved station—say 3AR. Leaving the trimmers severely alone, adjust the padder PD for maximum volume, again reducing it, as required, with VR. With 3AR at full strength go up higher to 2CO and see if PD needs further attention. Revert to 3AW and try if C3's trimmer wants just a tiny touch. This completes the lining-up adjustments but they should be re-checked on a weak distant station at both ends of the scale, 3GL and 2CO for example. As a rough guide it may be mentioned that on the original 3AW read 19¼, 3GL 20, 3AR 82 and 2CO 92.

It only remains, if possible, to see that you have applied the correct voltages from the voltage divider as specified on the schematic diagram. These can be found only by the employment of a genuine "1000-ohm per volt of scale" voltmeter and the centre clip ("100") can only be read correctly when VR's arm is given its most sensitive setting; i.e., when the set is almost going into oscillation.

Aerial Alternatives

Used conventionally, the set's chassis is earthed while the aerial plug is either in sockets AE1 or AE2, according to such considerations as required volume, condition of the atmosphere, etc. Strange though it may seem, when static is bad, its presence is less marked when the above arrangement is used than in the case of that to follow.

From a view point of sentitivity, far better signals were obtained when the aerial was discarded altogether and the earth lead only connected to AE1—and this notwithstanding the fact that the lead to earth was not more than nine feet in length. With this hook-up Western Australian stations were approximately 50% stronger than with the aerial and earth attached normally. It is regrettable that the same improvement was accorded to the static's volume too! Nevertheless this alternative should be kept in mind against the arrival of a really clear night, such as can be expected in the winter.

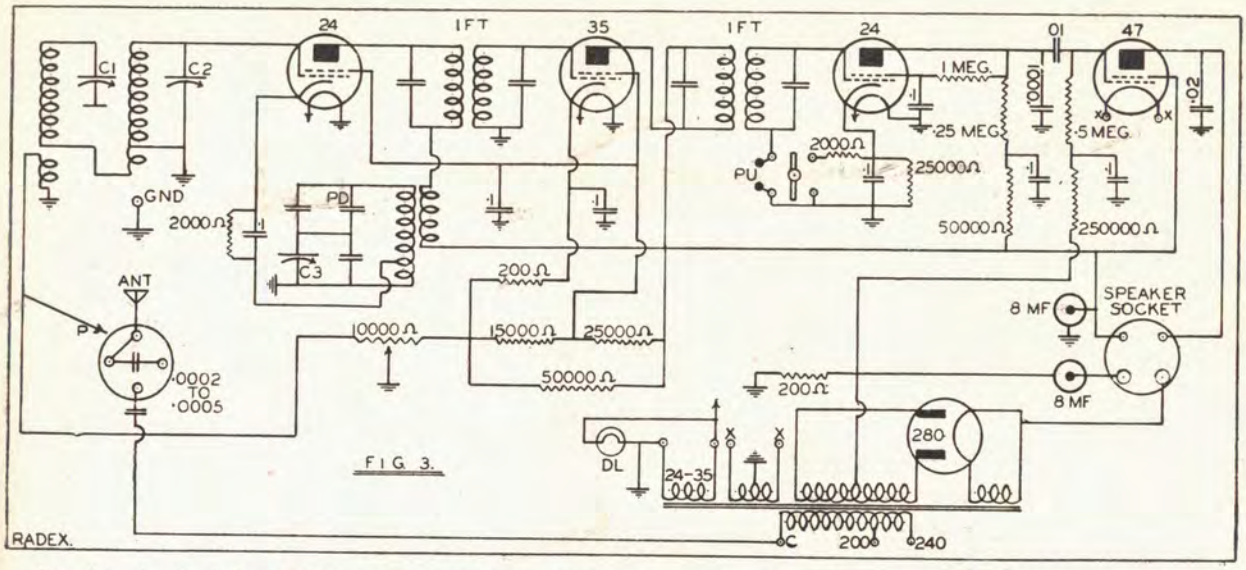
A main's aerial may also be used with perfect assurance of satisfactory results, but with it an earth (to its normal point of connection) must be employed, otherwise a hum will arise. A main's aerial is made by connecting one side of a genuine mica fixed condenser of 0.0001 mfd. to one side of the A.C. mains where the latter come into the set, and then wiring the condenser's other side to aerial terminals either AE1 or AE2.

It is of the highest importance that the 0.0001 mfd condenser be of the best quality. A cheap and nasty specimen would result in a short of the house lighting system to earth and a consequent rapid demise of the majority of the fuses.

Tonal Variations

The general system of de-coupling and the employment of a high value shunt C12 across the pentode's bias resistor R9, results in a good average tone in which there is very little excess of bass as compared with the treble. Certain listeners may think that an even deep tone would be better. This can be attained by shunting a mica fixed condenser of from 0.01 to 0.05 across plate and screen of the 59, the larger the condenser, the deeper the tone.

Adjustable tone can be made available by the employment of a fixed condenser of 0.1 mfd. and a variable resistance (potentiometer type) of 10,000 ohms. One side of the condenser is wired to the 59's plate and its other side taken to the resistor. The latter's arm is earthed in its own mounting. In this case cutting out resistance lowers the tone.



F I G. 3.

Complete circuit of the standard 4-valve super-heterodyne, plus rectifier. The scheme allows of energisation either from an aerial or the A.C. mains.

The Four-Valve Super-Heterodyne

Modern commercial design reduced to its lowest common denominator. The article contains a full explanation of the circuit and details of the coil-winding data.

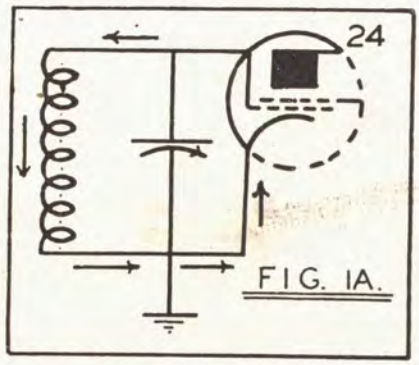
THIS circuit differs from the standard arrangement as described in other articles in that it employs the Autodyne system, i.e., the mixing valve and oscillator are one.

Full superhets, use a separate oscillator, the output of which is fed into the grid circuit of the mixing valve through the agency of its cathode. Most readers will appreciate that by feeding back some of the plate energy of any valve to its grid circuit, the valve begins to oscillate. This is demonstrated in the simple reactive two valve circuit where the detector can be brought to a state of oscillation at will by the reaction control.

In order to use the first or mixing valve as both oscillator and mixer it must, of course, be kept in an oscillating condition. If the sketch of Fig I A is examined it will be seen that the grid circuit of a valve is completed by return to the cathode in the case of an A.C. valve. The three functions to be performed by the mixing valve in a 4-valve super are as follow:—(1) It must tune in the incoming signal in its grid circuit. (2) It must oscillate at a frequency higher than the incoming signal. (3) It must mix these two frequencies and sort out the difference in its plate circuit.

The method of fulfilling the first function of this valve is standard practice—the grid is tuned to the incoming signal by the circuit marked "A-C1" in Fig. 1 B. The grid circuit is split into two sections—the return for the grid is not completed to the cathode until it has passed through portion of the combination coil and condenser B and C 2. The coil B is excited by the feed back coil from the plate coil C. The oscillating circuit formed by "B-C2" and C is tuned through the rotation of the condensers C1 and C2 to a frequency 175 kilocycles in advance of the grid circuit. By this means the oscillation created in the circuit combination "B-C2" and C beat the signal to which A and C1 are tuned—as the difference is set to be 175 kilocycles over the whole tuning range of the condensers—a difference frequency of 175 will appear in the plate circuit of the mixing valve.

It is this difference frequency we use as the intermediate. It remains therefore to filter or tune the result of the mix by means of a tuned circuit also included in the plate circuit. As the circuit is tuned to one frequency only it will select and amplify only when this frequency is present in the plate circuit of the valve.



F I G. IA.

The Grid-Cathode Path.

The arrangement of this device is shown in Fig. 2 at D and D1. It will be noted that D is in series with the plate circuit and D1 is coupled to the grid of the intermediate frequency amplifying valve. D and D1 are the primary and secondary of the first radio frequency transformer respectively. Fig. 2 shows the complete arrangement of the circuit A, B, C and D. All components go to make the Autodyne detector or mixer.

It will be appreciated that the energy flowing in both A and B must mix, as that from A can only return to the cathode through a section of coil B. The beat therefore appears in the plate circuit and is passed through the tuned circuit D, arranged to accept it, and so it goes on through the system in the normal manner. The usual series padding system is used in the oscillator section B.

If the reader will now turn his attention to the circuit of Fig. 3 it will be seen how the scheme of Fig. 2 fits in. A pre-selector has been added to the tuning system; otherwise the increasing signals would be too broad and would be likely to cause overload or cross modulation and indifferent selectivity. By pre-tuning, a fairly sharp signal arrives on the grid of the first or mixer valve.

Circuit Description

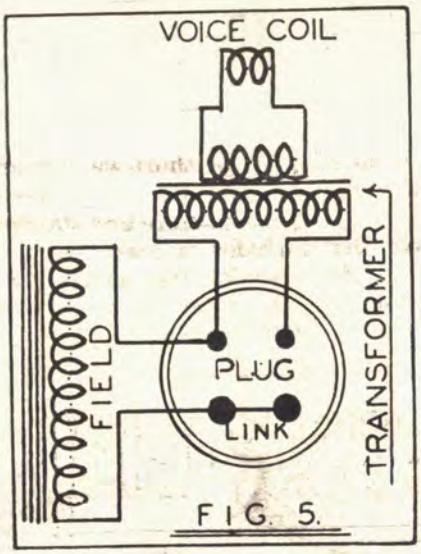
In order to follow the functions of this circuit we will again trace the path of the signal through the system from the aerial to the loudspeaker. It will be noticed that the aerial plug marked P in the drawing is arranged on a line with one end attached to the top end of the aerial coil and its other end to one side of the 10,000 potentiometer. When the moving arm of the potentiometer is moved back to lower the volume, the aerial is gradually shorted out direct to ground. The plug can be put into socket 1 to use the mains as an aerial, into 2

to use the aerial through a condenser; when the plug is in 3 the aerial is direct to the coil. The signal will be transferred from the aerial through the coupling coil to the tuned pre-selector coil and by a 3-turn coupling arrangement it is fed on to the filter coil, which is attached to the grid of the 224.

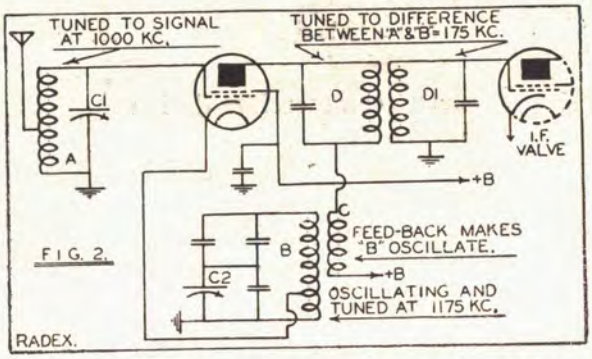
It will be noticed that the cathode of the first 224 or mixer valve completes its circuit to ground through a section of the oscillator coil, which is tuned to a different frequency to that of the grid coil. Therefore the signal arriving on the grid of the mixer valve is mixed with the oscillation which is generated in the oscillator section by the introduction of the feed back coil from the plate circuit. The difference in frequency will be found in the plate circuit and is accepted by the tuned primary winding of the first intermediate frequency transformer. The secondary of this transformer passes a resultant beat on to the grid of the 35 tube and so on through the system to the second detector and the audio tube, the 247.

In this circuit the speaker field coil is used as a choke, and for convenience the speaker is plugged into a 4 pin valve holder which is marked "Speaker Socket" in the drawing. The wiring for this socket is perhaps a little peculiar, and at first sight it may appear that there is something wrong with the arrangement. Actually the socket is wired in such a way that when the speaker plug is removed from the socket the high tension is cut off the electrolytic condensers. A back view of the wiring of the plug is shown in the sketch of Fig. 5.

From the plate of the penthode tube a condenser is taken to ground. It can be either .01 or .02, depending on the amount of high notes it is desired to cut off. Without some condenser in this position the highs are too predominant. This arrangement may be varied by the use of a .1 condenser in series with the 10,000 ohm resistor to ground. This is shown in Fig. 4. This arrangement permits the variation of the tone to suit the individual.



Read in conjunction with both Parts 1 and 2 of this modern article, the sketch shows how a dynamic speaker's plug can be so safely wired that chance of strain on the electrolytic condensers is eliminated.



Circuit illustrating the functions of a "mixer" and its associated filter circuits.

Coil Details

The coils for this receiver are divided into three groups, as will be seen by the drawing. The first is the aerial coupling coil and the tuned coil of the pre-selector. This section is wound on a 1¼in. former and consists of 87 turns of No. 34 enamel wire. Over the lower end of this coil is wound the primary or aerial coil. and it should be arranged on a piece of empire cloth to insulate it from the previous windings. It should then be wound on and in the same direction as the secondary and consist of 15 turns of No. 40 S.W.G. double silk.

These two coils are mounted in their own can, which should be standard in diameter. The next coil is the filter coil and this consists of a secondary on a 1¼in. diameter former wound with 87 turns of 34 enamel covered wire. After the 87th turn from the grid end of this coil, three turns should be added for coupling back to the preselector. This coil should also be mounted in its own standard can.

The third set of coils are those employed as the oscillator section. They consist of one inductance wound on a 1¼in. diameter former, consisting of 65 turns of 34 S.W.G. enamelled wire. A tap should be taken at the 10th turn from the grounded end for the feed-back for the cathode of the mixing tube. The feed-back, or plate coil, should be wound on the grounded end of the secondary over a strip of empire cloth, which will act as insulation. This coil consists of 40 turns of No. 40 D.S.C. covered wire, close wound, and in the same direction as the secondary. These coils should be mounted also in their own can.

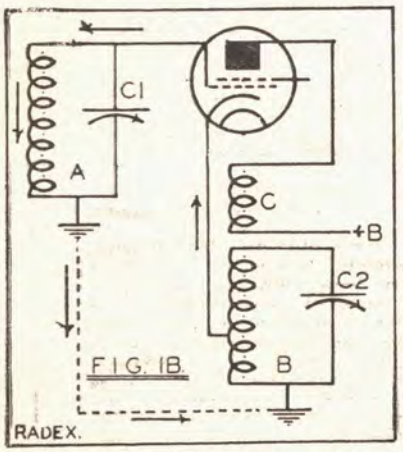
The other coils are the intermediate frequency transformers, and unless the builder has the equipment to match these, it would be preferable to purchase them ready made. A set of ill-matched intermediate transformers is likely to give a lot of trouble, or even worse may give no results at all.

The third section of the three gang condenser used for the tuning of this circuit tunes the 65 turn oscillator coil but it has in series with it a fixed condenser of approximately .0013 mfd., and a variable padding condenser which should have a value of approximately .001 mfd. The other variable condenser shown across the third gang in the drawing, is merely the trimmer, which is normally provided with any three gang condenser.

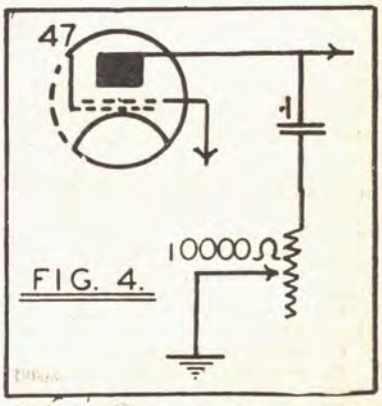
The Resistance Network

None of the resistances shown in this circuit are particularly critical. The 2000 ohm resistor across the .01 condenser in the cathode lead of the first 224 is probably the most critical resistor in the circuit. In order to play safe it may be as well to use a 1500 ohm resistor here, as the value of this resistor has a marked effect on the ability of the 224 to oscillate. The lower its value the easier will be the oscillation, particularly at the top end of the band.

The network of resistances in the bleeder may be described as follows: The 10,000 ohm potentiometer should be wire-wound. The 200 ohm minimum bias resistor in the cathode lead of the 35 tube should be wire wound. The 15,000, the 25,000 and the 50,000 ohm should all be one watt carborundum resistors. All other resistances in the circuit are carborundum one watts with the exception of the 200 ohm main bias resistor from the transformer centre tap to ground. This should be a 100 mill. wire wound type.



Oscillatory circuit of an indirectly heated tube.



Method of fitting an easily controlled tone control to any final pentode power valve.

(Continued on page 34)

A SUPER-HET IN TWO VALVES

Here is an adaptor for short-wave reception that functions on the super-heterodyne system. Placed before any standard receiver that includes at least one radio stage in its cascade, the adaptor will give you simple access to world-wide programmes.

By "RADEX"

ARE short - waves worth while?"

Hundreds of ordinary broadcast listeners, imbued with a liking for the creation of their own receivers, have asked themselves this question. In many instances the answer is a very definite negative.

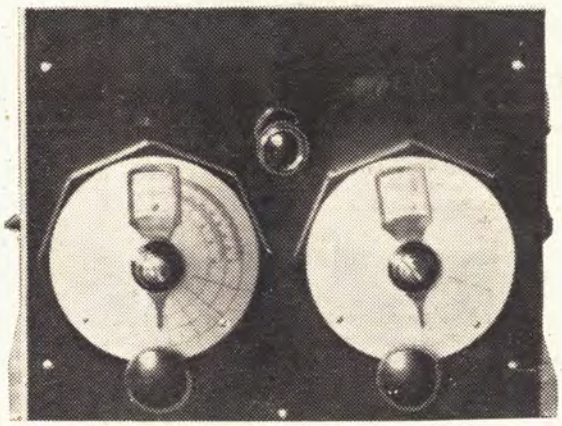
Against this the recognised short-wave amateur operators of Australia number well over 1000, and one cannot imagine that they collectively would spend huge sums of hard-earned cash on a myth. Admittedly they use more Morse than speech, but through that channel they certainly accomplish wonders.

Lastly, returning again to the B/C listener type, many are convinced that short-wave sets are simply waste of money. They have built corresponding receivers, got absolutely nothing out of them, and are satisfied that there was never anything in them.

The whole fact of the matter is that the average short-wave receiver depends upon the personal factor to too great an extent. To the enthusiastic amateur with a knowledge of Morse, this is no detraction; on the contrary it is an asset because it opens up new fields for him to conquer. On the other hand, it leaves the ordinary listener in the dark, and from the maze he rarely stumbles to anything even approaching clarity.

This new model removes the personal factor and therein lies its secret.

Certainly it is not a self-contained receiver; all it does is to take in signals conveyed on higher frequencies and transmute them into impulses of similar form on a lower frequency. It is equally certain that it is not an adaptor; such an instrument is so arranged that it can be made to understudy a standard set's radio and detector stages while utilising its audio section and power supplies. Actually it is a converter in the truest sense of the term, and yet "converter" is synonymous with "super-heterodyne" in terms of radio frequency.



Front panel of the Super-het. Short-wave Two. The right-hand dial's setting is the only critical adjustment.

Confirming this, we find that our combined receiving unit for the short-wave band can be sectionalised as follows:—The unit itself contains two tubes. The first is tuned to high frequencies (short waves), while the second is made to interpolate an ever different frequency upon the first. The result is a beat frequency which (plus or minus as the case may be) has a predetermined value of approximately 545 k.c. (otherwise 550 metres) and this is just about the limit to which the average receiver will tune.

From this it will be obvious that the two stages, each employing a valve, of our unit imitate the mixer and oscillator sections of any common (or garden) broadcast super-heterodyne receiver.

But the output of any super-het.'s mixer (or first detector) is one of a radio frequency variety and is therefore useless for recording or reproduction purposes without the employment of a second detector. Just at this point your standard receiver (no matter what its type so long as it includes at least one stage of tuned r.f. amplification) comes into the picture. That is to say, our unit manufactures an intermediate frequency (resultant from the mixture of in-coming signal and oscillator's output), and we use the main set to resolve that I.F. into an audible reproduction.

The main set's radio stages become a superhet.'s intermediate frequency amplification, its detector becomes the second detector, and its audio section fulfills its usual function as an amplifier of volume. Confusing though it may seem (and here I am not going to cloud the issue by enlarging upon details), I have got the best results from the unit by putting its output through a full-sized super-heterodyne set, thereby completing the cycle of frequency changing operations twice over.

On these premises it would seem that we are justified in naming our high frequency receiving device a "Short-Wave Super-heterodyne Two-Valver.

Valve Notes

Adverting to the theoretical diagram of the circuit as shown in Fig. 1, it is necessary to begin with a consideration of the valves. Of these M is the "mixer"

LIST OF PARTS

AE.—Aerial connection.

A1 and A2, B1 and B2, C1 and C2.—Pairs of coils covering.—A 14 to 32 metres, B 25 to 50 metres, and C 40 to 80 metres. Material.—Two 2½-inch diameter tubes, each 3½ inches long; two pieces ebonite, each 3 inches square; two ditto, each 4 inches square; 1 doz. each English valve legs, and plug sockets, reel No. 22 d.c.c. and reel No. 32 d.s.c.

B200.—Plate input from main set; can vary between 175 and 225 volts.

C1.—Fixed mica condenser of 0.01 mfd.

C2.—Ditto of 0.00025 mfd.

C3 and C4.—Ditto (2) of 0.0001 mfd.

C5 and C6.—Ditto (2) of 0.006 mfd. (All condensers at T.C.C. manufacturer's type).

CH1.—Manufacturer's type radio frequency choke.

CH2 and 3.—Special short-wave r.f. chokes. Material two 1-inch diameter tubes, each 2¼ inches long, and a reel of No. 36 d.s.c. wire.

E.—Connection to earth and also to earth on main set.

F.R.—Centre-tapped 30 or 50-ohm filament resistor.

M.—Philips valve E452T and UY socket.

O.—Philips valve E438M and UY socket.

Pot.—Potentiometer of 50,000 ohms, wire wound. (Master made.)

R1.—1-watt Carborundum resistor of 250,000 ohms.

R2.—2-watt Carborundum resistor 50,000 ohms.

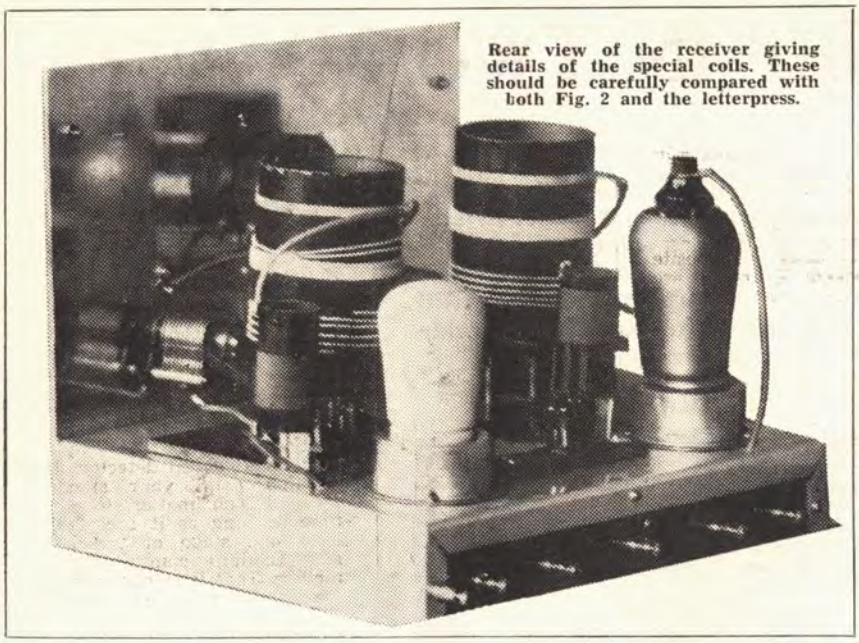
R3.—Ditto of 25,000 o..

Sec.—4-Volt filament secondary.—See special note in text.

VC1 and 2.—Radiokes midget 23-plate variable condensers with Ormond vernier dials.

VR.—Potentiometer of 5000 ohms used as variable resistor. (Master made.)

Assembly Material.—No. 16 gauge aluminium chassis 10 x 9 by 1½ inches deep, with one long hang-over removed, and replaced by an ebonite strip measuring 1¼ by 9⅞ inches; one ebonite panel 10 inches by 8, sheet No. 20 gauge aluminium, same size as panel, to act as its back shield; 6 terminals, some rubber covered flex, and sundry machine screws and small angle-brackets.



Rear view of the receiver giving details of the special coils. These should be carefully compared with both Fig. 2 and the letterpress.

or first detector, and O is the oscillator. It is highly desirable that M should be a screen-grid valve having a steep slope and for this it was found that the E452T was admirable. This is not to say that every make of tube was tried, and that this was the only one fitted to the job. On the contrary, it is quite possible that some other type may be better still, but, as far as time permitted, that indicated proved the best to date. The oscillator O is a triode, and it is only important that it should be a valve having a naturally high factor of amplification. Complications are avoided if both are of the metallised variety.

In order to anticipate queries it may be as well here to explain why tubes of the 4-volt series were used in preference to the common American type calling for a 2½-volt filament supply.

Quite apart from the characteristics of the valves selected, the main reason for this choice turned on the important question: "From where can a filament supply be drawn?" In this respect broadcast receivers must be divided into two classes, the manufactured and the home-made.

In the former case the average power transformer used is probably loaded up to capacity and is certainly inaccessibly placed so far as the amateur listener is concerned. Without a very definite assurance from the makers there are few (so called) experts who would be prepared to feed two more filaments (consuming 3½ amperes) from such a source of power. In such an instance it becomes necessary to heat these added valves' filaments (M and O) from some separate source, and therefore it is just as easy to employ a transformer giving 4 volts as it is to get one supplying 2½ volts.

In the instance of the set-builder there is a degree of pre-knowledge regarding any given power transformer included in the main set. Today it might be said that most transformers installed include a 4-volt filament winding, and this is left idle; indeed, in order to allow for future possibilities, we have often recommended the employment of such instruments (the Standard power pack is a case in point), and here a use for that winding presents itself. Without this supply the home builder is in the same position as the owner of a manufactured receiver. He simply procures an independent 4-volt suppy and goes on his way rejoicing.

This supply of energy, whether it be an independent unit or part and parcel of the main transformer, is indicated by "Sec" in the drawing. It is shunted by centre-tapped filament resistor FR and, toward the further elimination of hum, each half of this divider is shunted to earth by means of small fixed condensers C5 and C6. Looking at the top view of the unit, the two terminals bringing in this supply are the second and third from the left, immediately behind the metallised (but pin-less) oscillator.

Circuit Details

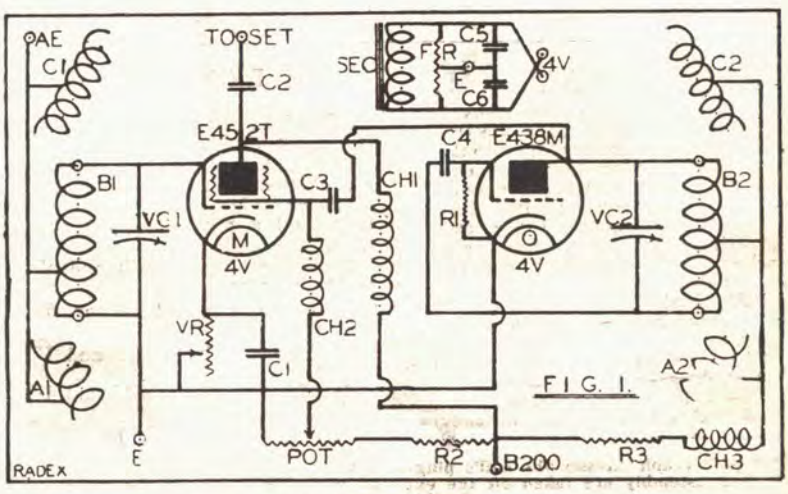
Although, as indicated in the list of parts, one of three coils only is associated with tuning condenser VC1 and the grid of M at a time, three are offered in order to cover the range of from 14 to 80 metres in three bands. These are A1, B1 and C1, and matters are so arranged that the two not in use are short-circuited upon themselves, although, at predetermined points, the aerial AE is wired to all three simultaneously.

The bias of this valve is important; therefore it is made adjustable by virtue of the presence of VR, which is shunted by moderately large capacity C1. M's plate is fed from a 200-volt input (B200) through an ordinary r.f. choke CH1, and radio frequency output is permitted through small coupling condenser C2. This output is fed to the main set through the agency of the latter's usual aerial terminal.

The analytical reader will see that, so far, we have made a common independent r.f. stage which, however, rectifies by virtue of the special over-bias applied through the offices of VR—i.e., anode bend rectification. The only difference is that while such a stage would normally cover a band of from 200 to 535 metres, here, by making VC1 relatively small, and having grid coils of corresponding inductive indices, we have limited the activities of the stage between 14 and 80 metres. There is nothing in consequence at all complex in this.

The circuit centring round valve O is a simple Hartley oscillator. Again, we have three interchangeable coils, the idle two being automatically closed on themselves, while that in use is tuned by small variable condenser VC2. This oscillatory combination is connected across the grid and plate of the tube—the former being made through condenser C4, and the necessary leakage supplied by resistor R1. Plate voltage is fed at the mid-point of the coil in action, but it should be noted that this centre-feed remains a fixture to the idle coils also. In this instance, however, we do not make the full 200 volts available. Instead, we break it down through the agency of resistor R3, and localise oscillatory activities with special high frequency choke CH3.

And now comes the linkage between oscillator and mixer. Naturally the plate is O's output, the point being assured by the presence of CH3. This energy is fed to the screening-grid of M through coupling condenser C3, and its path to that grid is safeguarded by special high



Schematic diagram of the Short-wave 2 Valve Super-heterodyne.

frequency choke CH2. Thus the "mix" is effected.

The voltage applied to the screen is naturally critical and has to be found by mild experiment. To this end the main B200 is earthed through resistor R2 (50,000 ohms) and a fifty-thousand-ohm potentiometer in series. The potentiometer's arm selects the best value and feeds it to the screen through CH2. Usually this arm is one-quarter of its total travel from the end wired to R2. It is necessary to note that M's screen is not, as usual, shunted to earth, though a fixed capacity; such action would be fatal to the conveyance of energy to that valve from O. C3 is the only condenser to be associated with this important screening-grid.

Winding the Coils

Each former carries three windings and each individual coil is the counterpart of its relative on the other former except as regards the tapping points. How these are arranged is fully illustrated in the accompanying photographs, while the method of making their internal and external connections is shown in Fig. 2.

From the latter, note first that the two ends of any one coil come out to connections diametrically opposite each other on the "base." These six connections are arranged equidistantly around a circle, that is to say, they form the points of a perfect hexagon. Such connections are the valve-legs which are made fast in one of the smaller (3-inch) ebonite squares. The stand is one of the 4-inch squares, and on it are arranged six English plug-sockets. It is obvious that they are arranged in a similar manner to the legs, and a moment's thought will show the importance of their exactly equal spacing. Suppose one pair (say C and C) were slightly out; no matter how the coils were rotated that pair would always stop all the others from making the essential easy, but perfect, fit.

The squares (2) carrying the sockets are bolted to the chassis, from which a 3-inch square should be cut to ensure freedom from shorts. The smaller ebonite squares carrying the legs (2) are fastened to ends of the 2½-inch diameter formers by means of small angle-brackets. Possibly the painstaking reader may have the energy to convert these latter squares into discs and fasten them inside the ends of their respective formers. Certainly this would be a neater job, but neatness will not augment results in this case.

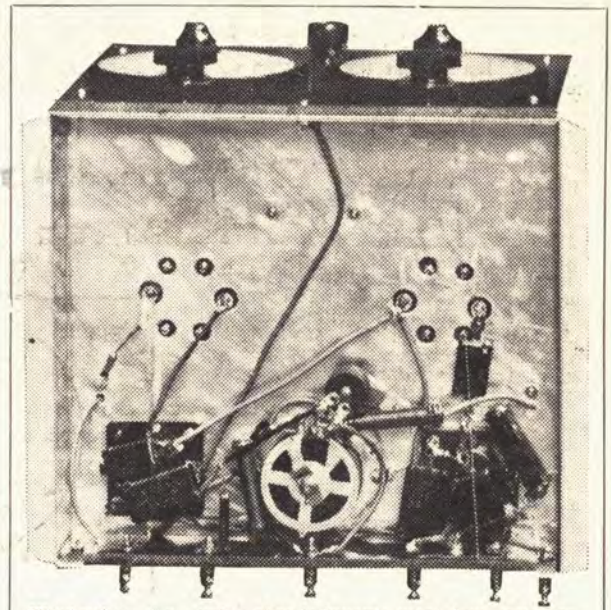
Adverting to the stands; note that diametrically opposite sockets X and Y are those that convey contact to the associated circuit. The two remaining opposite pairs are connected to each other, thus providing the previously mentioned automatic short-circuits. Nevertheless under no circumstances must these "shorts" be considered as "earths"; an earth here, in the case of the oscillator coils, would be disastrous.

Coil Ratios

As pointed out before, each pair of coils (say A1 and A2, or B1 and B2) contains the same number of turns; they differ only in their tapping points, for the constant aerial connection and constant "B" voltage input respectively. The following table shows the ratios and taps:—

Coils	Turns	Wire	Tap A1	Centre-tap A2
A1 & A2	5	22 d.c.c.	1 turn	2½ turns
B1 & B2	13	22 d.c.c.	2 turns	6½ turns
C1 & C2	13	32 d.s.c.	3 turns	6½ turns

The turns of coils A1 and A2 are spaced one-eighth inch apart. All complete coils are spaced five-eighths inch apart on the former, measured from the last turn of the finished coil to the beginning of the first turn of the next coil. In order to keep them in position the turns of A1 and A2 may be lightly fixed in position with thin shellac or celluloid varnish.



Illustrating the under-chassis layout; what few parts are used are well packed.

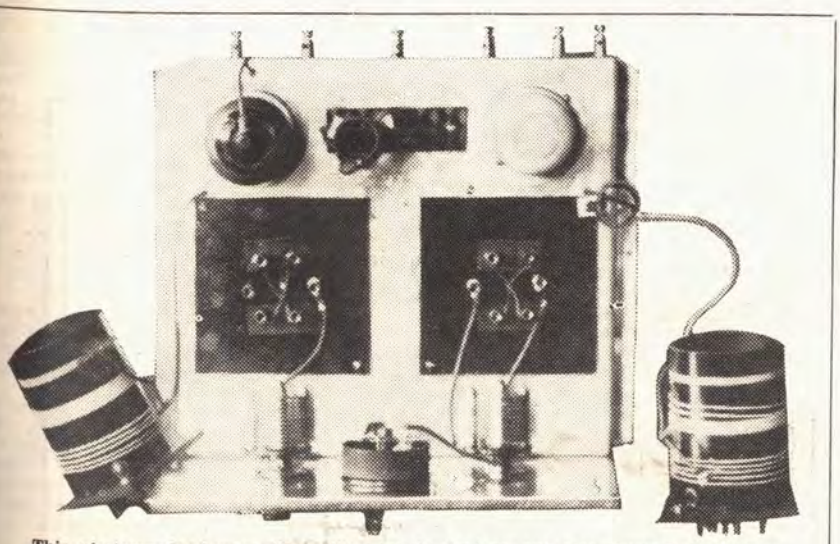
The taps on A1, B1 and C1 are counted from those coils' earthed ends. All taps consist of tightly twisted loops in the wire made at the appointed places during winding. When the coils are completed one heavy wire joins the loops of A1, B1 and C1 (another performs a similar service for the oscillator's coils), and this is left for future permanent connection into the external circuit.

Take care over this coil-winding. If your dial-readings are to be near ours (which will be useful for your guidance in the first attempt at tuning), exactitude will repay you. Unlike the usual varieties of short-wave receivers, these extremely simple coils (together with the total absence of reaction) allow careful copies to register very similarly to the original. This does not mean that our registration of — say, RV59 (Moscow T.U.) at 80 on the B coils will correspond on your reaction, but it does ensure reproduction of the same transmission within 10 or 15 degrees (plus or minus) of that reading. This is a marked improvement on the older short-wave receivers, wherewith the novice is lucky if he gets a given station on the specified coil—let alone on degrees of the condenser's dial.

Chassis Assembly

The specifications in the list of parts and the photos reproduced on these pages will have given you a general idea of the assembly. There are certain points, however, that require special mention and attention.

It has been stated already that the chassis is to be cut where the ebonite coil-stands are fitted. The under view will show that this was not done in the case of the original. Instead, the points of protrusion of the sockets were marked and these were drilled and rhimered out to a diameter of half an inch. You may take whichever course seems the easier, although the former is probably the more certain preventive of accidental short circuits.



This photograph stresses the coil's plug-in devices, and also shows how the taps on each assembly are taken off the external circuit by means of a common flexible lead.

The rear hang-over of the chassis is filled in with the ebonite strip provided. This carries five of the main terminals. Looking at the set's top view (the one with the coils removed) from left to right, these are—Main aerial input, output to aerial terminal on main set, "B" battery input of approximately 200 volts, and (2) input from 4-volt source of filament supply. The sixth is the earth terminal, which is used also as a bolt to fasten the ebonite to the chassis and so makes essential and automatic contact with the latter.

The locations of the two UY valve-sockets are obvious. Between them is placed the 500 ohm potentiometer "POT," which must be entirely and surely insulated from the chassis. In the original this was done by drilling an over-sized hole for its shaft in the latter and actually mounting it on a narrow strip of ebonite.

The ebonite panel, for purposes of hand-capacity elimination, is backed by a thin sheet of aluminium. This naturally makes metallic contact with the chassis which is "earth." Inspection of the Fig. 1 will show that both the moving plates of variable condenser VC1 and the arm of VR (5000-ohm variable bias resistor) are earthed, therefore they should make absolute contact with the back plate. In the case of VC2 the conditions are reversed. Both its fixed and moving plates are subjected to a 200-volt potential, therefore any earth contact would be fatal. To avoid such an accident the ebonite panel is first drilled to exactly accommodate its shaft; at the corresponding point on the back-plate is cut a hole having a diameter at least 1 inch greater.

The Special Chokes

The two short-wave chokes CH2 and CH3 are wound both in exactly the same manner.

Upon one of the 1-inch diameter tubes closely wind 80 turns of the No. 36 d.s.c. wire and then for another twenty turns wind each turn about its own width from its neighbor. When completed lightly paint over the spaced turns with thin shellac or celluloid varnish.

Notes on Wiring

Manufacturers' type-fixed condensers are used throughout, and at least one of the lugs of each should be made fast to some definite fixed point without any intermediate wire. The same direction applies to pig-tailed resistors. All connections must be soldered, and lugs should be freely used in conjunction with the stranded rubber-covered flex.

The socket of the E438M (O) is common UY; its connections therefore are: —Clockwise from the lonely grid, plate, two filaments, cathode, and so back to grid. The E452T (M) is a Continental type screen-grid tube. The screen takes its input from the normal plate point, while the plate itself is operated from the terminal on top of the bulb. In mounting these sockets, see that their filament connections are those nearer the ebonite terminal strip.

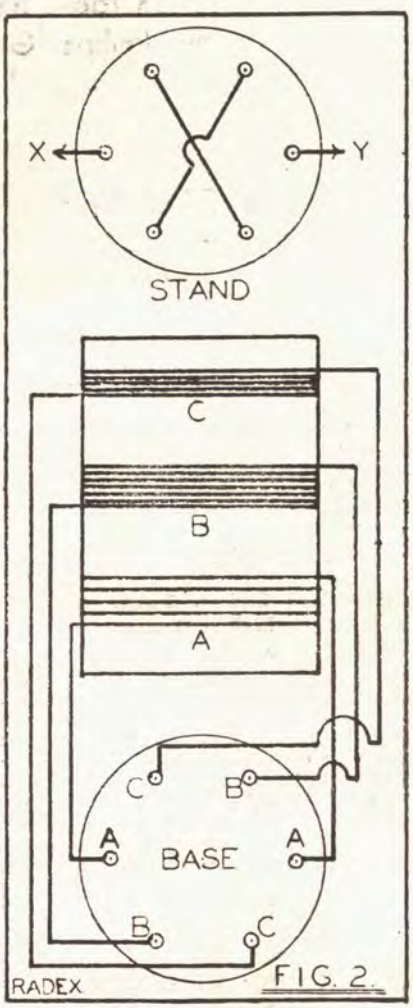
Point to Point Wiring

Connect fixed condenser C4 across between Y of the oscillator coil-stand and G of socket O. Wire resistor R1 from the same G to K of O, and then earth. From P of that socket go to X of the same stand.

Take the grid of M to Y of the mixer coil-stand; earth X of the same. Earth the arm of VR. Take one of its outers to K of socket M, and between the latter point and earth connect fixed condenser C1. Cross wire diametrically opposite pair of sockets on both coil-stands—vide Fig. 2.

Three leads go from main P200, one to an end of R2, of which the other end goes to an outer of POT, another to a lug on choke CH1, and the third to resistor R3. Earth the outer of POT and take its arm to the close wound end of CH2. Connect the free end of R3 to the close wound end of CH3.

Attach the space wound end of CH2 and a tag of C to P of M. Wire the other end of C3 to socket X of the



In winding the coil-units follow this diagram carefully, but compare it also with the various photos. of the set and its descriptive letterpress.

oscillator coil-stand (second lead to this point). Fasten a tag of condenser C2 under the output terminal ("to set"). Connect the free side of CH1 to its other end, and from there run a lead up through the chassis to reach the plate terminal on top of valve M.

Put tags of C5 and C6 (one each) under the 4-volt input main terminals and connect FR across them. Earth the other ends of C5 and C6, and also the centre-tap of FR. With a twisted pair of leads connect up this same pair of main terminals with the filaments of both valve-sockets.

coils. Both these last leads must be flex-vanes of VC1 to Y of the mixer's coil-stand.. The fixed and moving plates of VC2 go similarly and respectively to the Y and X of the oscillator's coil-stand.

Fit the coils into their stands. Take a lead from the common joining the taps of the mixer's coils down through the chassis to main AE terminal. The spaced end of CH3 is connected to the common joining centre-taps of oscillator's coils.

Operation

Connect up the 4 and 200 volt sources of power. Attach your ordinary aerial to AE of the unit, and connect its output terminal to the aerial terminal of the main set, the dial of which has been turned to just below its maximum reading—say, 98 degrees. If possible, for the initial trial at least, connect a pair of phones in the main set's audio system

Set the formers so that A1 and A2 coils are in contact with the respective pairs of X and Y sockets. Turn the arm of VR rather less than one-third of its travel from the outer connected to K of M. Have almost the whole of P O T in circuit—i.e., its arm should be nearly over to the end wired to R2. The potential on M's screen should now be in the region of between 60 and 75 volts.

It only remains for you to discover one or two land-marks on the dials (that turning VC2 being the much more important and critical), in order that you will not fish in the dark. For this purpose the local beam stations are very useful, as one operates just below 25 metres and the other just above. They will be found on the "A" coils, and their dial settings on VC2 were 71 and 98 degrees—these readings being from the Ormond dial's outer scale, which runs from zero to 180 degrees.

Having located one of these, you will notice that, while VC1 is broad, the removal of your hand from VC2 eliminates signals. This is due to hand-capacity, as neither the fixed nor the moving plates of VC2 are at earth potential, and this constitutes the unit's most serious detraction. Fortunately, it is easily countered. Say you get a signal at 71. Turn VC2 a mere fraction above that value, and remove your hand. You may or may not continue to hear faint Morse at a very fast speed (the ability to read it is immaterial). Now delicately turn back the dial of the main receiving set, and the signals will come again at full strength.

A Few Hints

The uncertain will find VK3ME's transmissions on 31.55 metres on Wednesday and Saturday evenings, and VK2ME's on 31.28 metres during Sunday afternoons, very useful as markers of good and constant strength. They can be given reliance, and, in short-wave work, let me tell you that faith is half the battle.

Using coils "A," these will come in around 170, while they approximate 12 degrees on coils "B"—thus indicating a comfortable overlap.

Adverting to our "bracket" obtained from the two beams, 25-metre stations will be found between them on coils "A." Thus Paris and "Empire" can be expected about 83 degrees.

Finally, suggestions for substitutions in this design cannot be entertained. As it is, it works well; prophecy having no contact with radio, I cannot foretell what may happen under varying but unexplored conditions. Without doubt this circuit, like all others, can be improved or modified. If you wish to test the truth of this axiom, by all means do so. But do it yourself, and please do not ask me to do it for you.

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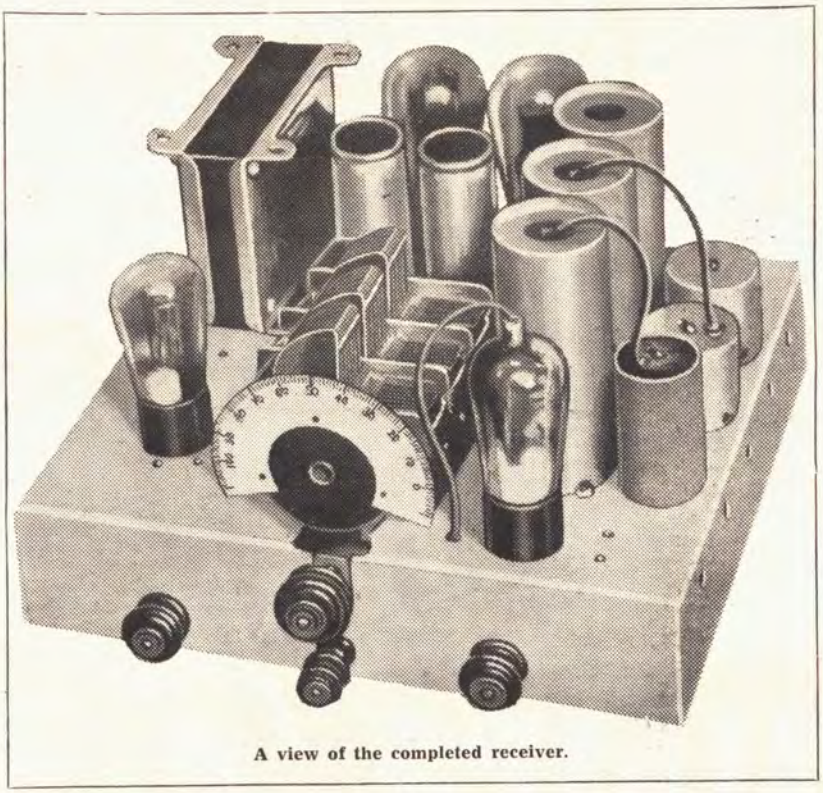
AN EXPERIMENTAL SUPER-HET.

The professional evolution of a big design with some notes on its mathematics.

By RADEX

SUPER-HETERODYNE circuits are nearly as old as regeneration. Logically treated, in conjunction with an accurate kit of coils, their home assembly presents no serious snag. Actually if you can build a 3-valve A.C. set then you should have the ability to put together a 6 or 7-valve super. Why is it, then, that some listeners make a success of the design while others fail to obtain results commensurate with the monetary outlay?

The plain fact of the matter is that we take this, the world's most selective receiving device, and expect each and every one of its variably tuned circuits to remain in complete sympathy with each other throughout the entire limit of the broadcast band (ranging from 550 to 1500 kc.). But we forget that while, with the aid of delicate and costly apparatus, a manufacturer can make this happen, we are unlikely to have access of such resources. And this difficulty arises from our demand that a set must restrict itself to one tuning control and one only. If, on the other hand, we would be prepared to use one major and one minor adjustment, troubles would automatically fade out. Our easily built "super" would maintain its unexcelled qualities throughout the entire wave-band.



A view of the completed receiver.

A Word of Theory

Any valve receiver beats a crystal set, because while the latter is actuated solely by the minute power intercepted by its aerial, in the former the speaker is operated by the power stored in the pack or batteries, which is merely released by the tiny incoming signal. The super-het. goes further still. In itself it is a complete rebroadcasting station—operating on one predetermined wavelength—and by virtue of that entity it relays the selected programme. In consequence it is influenced by signals that are far too attenuated to make the slightest recorded impression on straight sets.

This quality by itself would not militate against complete gang-tuning. Fortunately — or the reverse, as the case may be — in reducing all signals to a common denominator the design becomes ultra selective, and this, of necessity, means that its adjustments must be extremely precise. If but one of its variables gets out of step with the others, the results obtainable compare unfavorably with a badly built three-valver.

We have said that a super-het includes its own transmitter, and the phrase is factual. The heart of the design is the oscillator valve, which is placed in its own little circuit (including a variable condenser), and is so enabled to "send" over a certain band of wave-lengths. This band is so arranged that it will always (or ought always to) have a definite fixed difference from any in-coming wave in the outside broadcast band. The difference—or, in some cases, summation — produces the set's common denominator, i.e., its own constant wave, to which all its intermediate R.F. stages are attuned.

It is obvious, therefore, that the accurate adjustment of this oscillator condenser, in relation to the other variables of the complete cascade, is of paramount importance. How this can be simply done, without loss of either selectivity or sensitivity, is this article's objective.

The Receiver In Outline

We have recently been afforded an early view of a super-heterodyne 6-valve set (7 valves including the rectifier), which tunes acutely and yet does not demand any laborious lining-up of the variable condensers. It is expected that the coil-kit for this design will be available shortly, but, in the meantime, and illustrative of the point at issue, a photo of the experimental model is reproduced on these pages. The circuit diagram will, however, be probably more illuminative.

For all practical purposes we can dismiss the rectifier valve RT, power-pack (including transformer, PT and smoothing system PCH, C10, C11 and C12), and the resistance-capacity coupled audio stage centreing round pentode A. These form something of a standard and, to be quite frank, if their constants are beyond you, then you will be unwise to embark on super-het. construction.

Of the remaining five tubes D1 is the first detector, but it would be more correctly described as a "mixer" in that through its agency incoming signals are so mingled with the output of the local oscillator O as to produce a constant called the "intermediate frequency." The value of this frequency is fixed at 175 k.c., which is approximately 1715 metres, and the grid circuits of R.F. valves R1 and R2 and second detector D2 are solely attuned thereto. Indeed, to make doubly sure of this D1's plate circuit it is similarly regulated so that coupling unit TF — together with its built-in condensers CS and CP—forms a "band-pass" device.

Working backwards again in order to give the design a fair chance of fulfilling itself, it is necessary to interpolate some kind of weeding-out agent between the aerial and D1. This takes the form of an independent tuning circuit comprising coupler TA and variable condenser VC1. A signal, having been accepted by this combination, is fed to D1 through the path made by TG and VC2. Owing to the winding ratios employed in TA and TG, variables VC1 and VC2 line up quite easily, and therefore here no difficulty is present.

A few figures—but, be it understood, very approximate ones—will explain

what happens. Imagine that VC1 and VC2 are set to receive on 400 metres (750 k.c.). As our private system (R1, R2 and D2) will only respond to a frequency of 175 k.c., we must beat up this input with a wave of 521 metres (575 k.c.), which is produced by valve 0 when suitably adjusted by VC3. The resultant carrier being 175 k.c. (subtract 575 from 750), it passes TF, T1 and T2, and eventually records itself at the speaker. Now suppose that VC3 were slightly out of step with VC1 and VC2, making the oscillator create a local wave of 520 metres—i.e., only one metre out. The frequency difference would now become 173 k.c., corresponding to 1730 metres. Thus an error of only one in 400 has grown to 15 in 1715, and this the sharply tuned intermediate stages would refuse to tolerate. The speaker would be silent because the 400-metre signal would not affect R1, etc.

From this the importance of the setting of VC3 will be appreciated. The example given is not overdrawn, and it will therefore be obvious that unless that condenser lines up with the others all the time, results cannot come up to either theory or expectation.

The solution of the trouble is extremely simple. It merely consists of the addition of small trimmer condenser TC across VC3. It is true that this at once forms a minor control of more than usual importance, but—granted that the six-coil units are accurate in the first place—the little extra manipulation involved will insure even reception through the broadcast band.

Assembly

The chassis pictured measures 12 inches square by 3 inches deep, and for obvious reasons it is desirable that the components should be so grouped as to keep all R.F. leads as short as possible.

Of the four knobs shown, that operating TC is in the lower centre, with that of the 3-gang condenser above it. Two subsidiary controls are offered, and although, through the diagram, they would both appear to govern volume, actually their functions differ.

LIST OF PARTS

C1, C4 and C8 — Fixed condensers of 0.1 mfd.
C2, C5, C6 and C13 — Fixed condensers of 1 mfd.
C3 and C7 — Mica condensers of 0.0005 mfd.
C9—Mica condenser of 001 mfd.
C10—Fixed condenser of 4 mfd., tested to 1000 volts.
C11 and C12—Electrolytic condensers of 8 mfd. working voltage 450.
C14—Mica condenser of 0.001 mfd.
CS and CP—Fixed condensers built into coil-kit.
CH1 and 2—R.F. choke coils.
Dynamic—D.C. type, with 2000 ohm field and pentode input.
FR1 and 2—Centre-tapped filament resistors.
PCH—Smoothing choke, 30 Henries to carry 100 ma (C30-H).
PT — Power transformer; secondaries:—350-0-350 at 100 ma, 2.5 volts at 3 amps, 2.5 volts at 10 amps, and 5 volts at 2 amps.
PU—Terminals for pick-up attachment.
R1, R4, R5, R6, R7—Carborundum resistors of 50,000 ohms.
R2—Ditto of 25,000 ohms.
R3 and R8—Ditto of 250,000 ohms.
R9 — Wire-wound resistor of 500 ohms to pass 50 ma.
TA to T2—Super-het kit of six coil-units.
TC—Trimmer condenser of 5 plates.
VC1, 2 and 3—Three-gang variable condenser of 0.00043 mf with vernier dial.
VR1—Variable wire-wound resistor of 10,000 ohms.
VR2. — Potentiometer of 500,000 ohms.

VALVES

D1 and D2—Type UY224 valves and cans.
R1 and R2.—Type UY235 valves and cans.
A—Pentode UY247.
Oscillator type UY227.
R.T.—Rectifier type UX280.
6—UY valve-sockets and one UX.
Aluminium chassis and sundries.

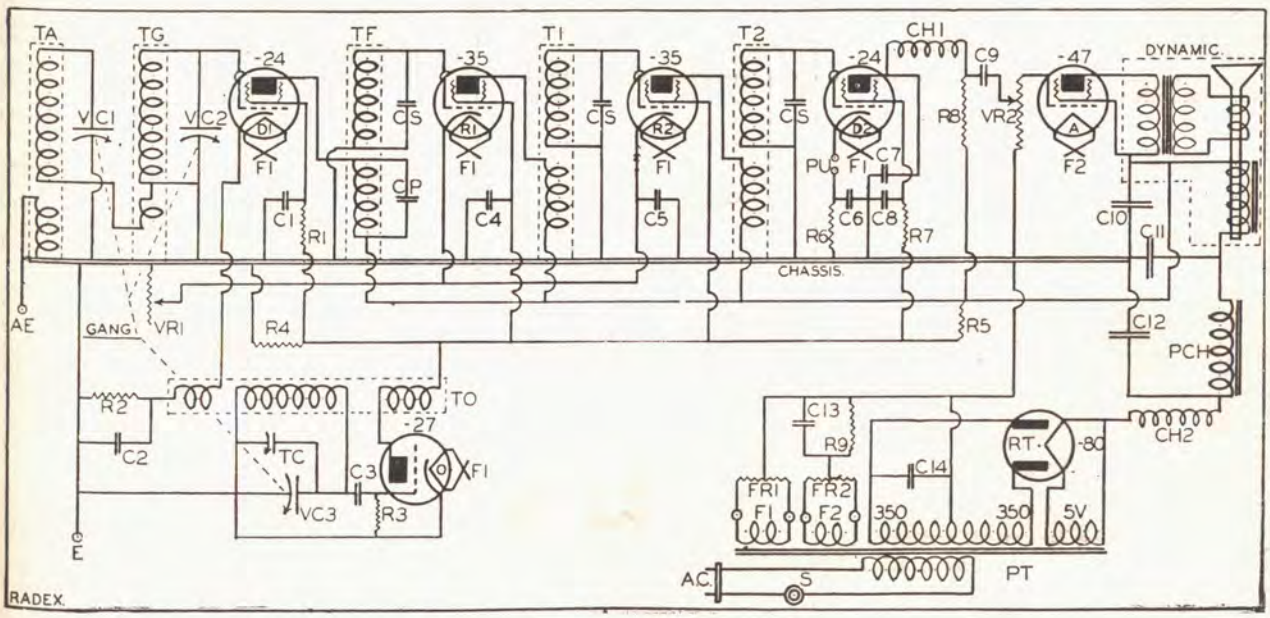
VR1 is the bias resistor for variable-MU valves, R1 and R2, and therefore, if the noise-level happens to be inordinately high, their sensitivity can be lowered accordingly. On the other hand, VR2 is a genuine volume regulator applicable either to the entire set or to the last two valves (D2 and A) only when the pick-up (PU) is in use.

What actually happens is that when VR1 is so set as to give maximum sensitivity it is necessary to cut back VR2, otherwise the volume is intolerable in any ordinary house. In consequence, as a general rule, one or other of these resistors is always slightly retarded.

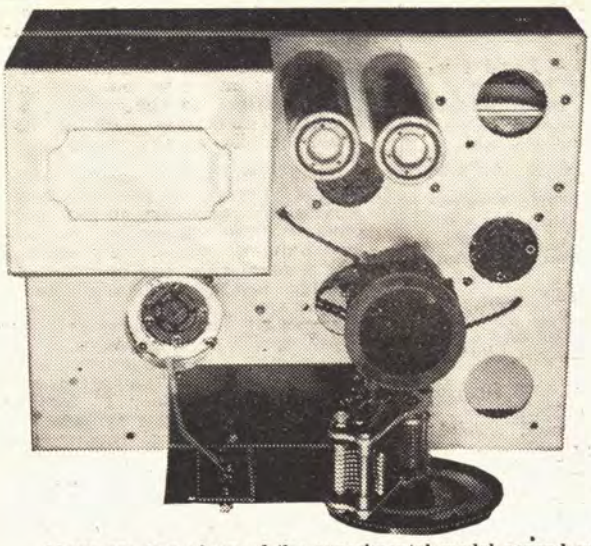
While all the usual rules of wiring apply equally to this design, it must be remembered that filament current to the extent of nearly 9 amperes is being drawn from secondary F1 for the five indirectly heated valves. This flow insists upon the employment of heavy flex being used in wiring these filaments —otherwise there will be a detractive voltage drop.

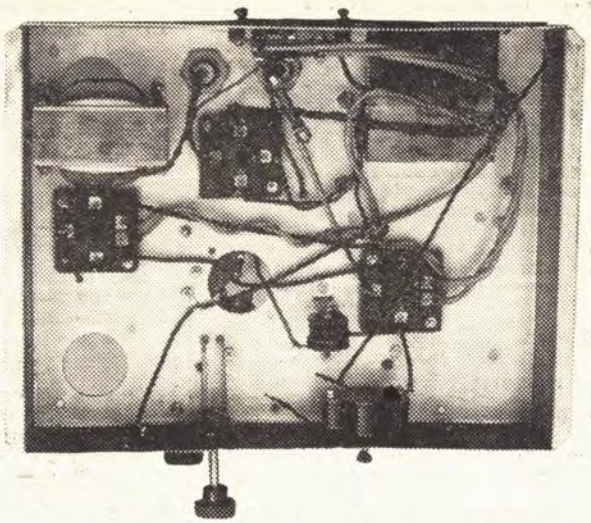
The inclusion of both choke (PCH) and the field of the dynamic speaker in the smoothing system ensures practically humless operation, provided the power transformer is of the specification given in the list of parts. With these safeguards, modulation hum (rather than the normal variety) will be the fault most to be avoided. Towards this end, RF choke CH2 is included in the supply system in addition to modulation condenser C14. Switch (S) does not appear on the chassis; usually it is more convenient to operate through that at the house power-point.

The employment of Pentode UY247 as the final amplifier allows of variation of the speaker's tone to suit your own ear. Changes in depth can be obtained by shunting a fixed mica-condenser across the plate and auxiliary grid of that tube, although this adjunct is not shown in the diagram. As it stands, the tone will be a little high for the average listener. Shunt values of 0.01, 0.02 and 0.04 mfd. will lower it more and more in that order.



Circuit of the Experimental Super-heterodyne.





Above are two views of the experimental model around which Mr Love's article on a Short-wave Super-heterodyne is written. In this particular arrangement only three valves are used, namely, the mixer, the oscillator and the power-pack rectifier. This cascade was then hooked to an ordinary broadcast receiver (either another super-het. or a T.R.F.) and this latter supplied the intermediate frequency stages, the second detector and such audio amplification as was necessary. We propose, in the near future, describing another variation of the design, which will be complete in itself; nevertheless the accompanying theoretical description in the main will hold good for both.

A Short-Wave Super-Heterodyne

A single control design with world range and fool-proof simplicity. The circuit may be assembled as a complete independent receiver or it can take the form of a super-het. adaptor to precede any standard set—either another super-het or a T.R.F. model.

By H. K. LOVE

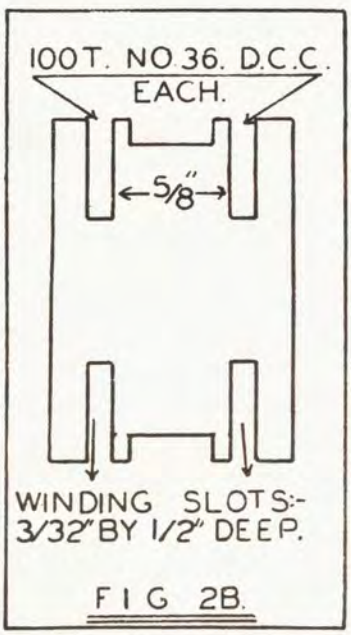
THIS design requires very little skill to get into operation; the only circuits which need matching are the intermediate frequency transformers. A quick and easy method of doing this by the use of a signal will be described.

In order to achieve absolute single control of a short-wave super-heterodyne the circuit reproduced at Fig. 1 has been designed. This circuit consists of a short-wave super-heterodyne arranged with five valves and a rectifier, with one tuning control only on the oscillator circuit. The input circuit is untuned except for a small peaking condenser which may be varied at different wave bands — it is not actually part of the tuning system.

The principle underlying the operation of this receiver is that any signal caught on the aerial will be heterodyned by the signal from the local oscillator and will cause a beat, or difference, which will be extracted from the plate circuit of the mixing tube, amplified by the intermediate frequency amplifier, and detected by the second 224, then amplified at audio frequencies by the 247.

Winding the Coils

Apart from the intermediate frequency amplifier the only tuning coil which needs construction is L. L2, the plate feed-back coil, is wound on the same former. L. consists of a 1¼in. former (preferably ribbed) on to which are wound 15 turns of No. 20 gauge double silk covered wire spaced half a diameter of the wire apart. A tap is taken out for the ground and 3 turns are then added for connection to the cathode of the mixing tube.



Two of these formers are to be turned up in wood, and upon them are wound the simple intermediate frequency transformers.

Taps are taken out of the main section of the tuning coil L. in 3 places — (1) the full number 16 turns, (2) at 8 turns, and (3) at 4 turns. A switch is arranged so that the variable condenser can be switched to any of these taps, thus enabling a variation of the wave length band to be quickly effected without the actual use of plug in coils. The coil L2 is wound ⅛in. away from L. and consists of 8 turns of No. 28 gauge double silk covered wire close wound.

The next coils which call for description are those which go to make up the two intermediate transformers. There are two coils in each transformer, a primary and a secondary. They are both exactly alike.

A very satisfactory intermediate frequency transformer can be made by using a wooden former 1¼in. diameter turned out in the manner shown at Fig. 2 B. Into the slots provided in this former somewhat between 90 and 100 turns No. 36 or 38 gauge double cotton-covered wire should be wound Each of these coils should then be tuned with a small compression type condenser, and connected up as shown in the main circuit. Once the correct tuning has been found, the condensers can remain untouched.

The reader will have to look round for the most satisfactory type of compression condenser or midget (maximum capacity about 0.0001 mfd.), whichever is available to tune these circuits. Each

intermediate frequency transformer should be enclosed completely in a metal can, and provision made for the variation of the tuning condensers by allowing small holes so that they may be adjusted with a screwdriver or a small knob provided for the purpose.

Values

The values of the resistances are shown in some cases on the circuit. The value of the resistor, R, is 30 ohms, R 1, 25,000 ohms; R 2 is a half megohm variable potentiometer, R 3, 25,000 ohm carborundum; R 4, is a 400 ohm wire wound 50 mill. resistor; R 5 is a 250,000 ohms carborundum resistor.

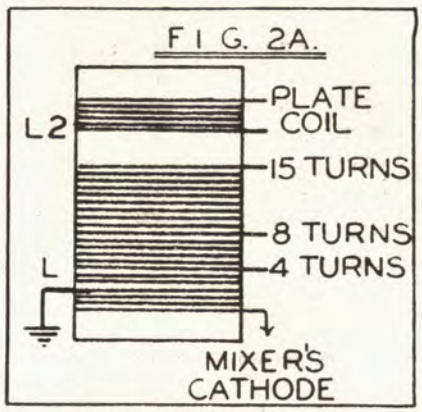
The condensers marked C in the drawing all have a value of .1 mfd., but .5's could be used if these were not available. Condenser, C1, is an 8 mfd. dry electrolytic penthode by-pass condenser. C2 is a .006 mfd. mica coupling condenser. All other values are shown in the circuit.

Setting Up the Receiver

After the circuit has been laid out and built the method of lining up should be followed very carefully.

Having made sure that all valves light and that all pressures are correct, the first thing to do is to remove the aerial from the terminal A and place it at the point marked X in the diagram. It is anticipated that the intermediate frequency transformers will be lined up at somewhat about 550 kilocycles. This frequency, however, is not at all critical. Any frequency within the broadcast band will be satisfactory, but it is desirable to pick one which is off that of any broadcasting station, particularly local.

In order to get a start, however, with the aerial attached to the point X and the power on, the trimming across the primaries and secondaries of the intermediate frequency transformers should be adjusted until station 3AR goes through the system at maximum. In short, the receiver is working as an ordinary broadcast receiver at this point. As the frequency of 3AR is approx. 610



Coil data of the oscillator's circuit.

kilocycles, the reader will know that all four tuned circuits in the intermediate frequency amplifier are in line at this frequency. It may be necessary to run over the trimmers very carefully several times to make certain that all these 4 circuits are definitely in line.

In order to achieve a frequency of 550 kilocycles the condensers across the primaries and secondaries of the intermediate frequency transformers will need advancing in capacity just a little. The difficulty about this operation will be in advancing them all the same amount and keeping them in line. This can be checked, however, by putting the aerial back on to A and tuning in any station at all, and then adjusting the intermediate frequency trimming condensers once more until a maximum signal is heard.

It should be clearly understood that the frequency to which the amplifier is tuned is not the least bit critical. It can be at the bottom of the band or at the top, or in the middle. The main point is to get all four circuits accurately lined up.

Operation

Having fixed the intermediate frequency circuits in line, all tuning is carried out by the condenser TC. This condenser should be controlled by the best possible vernier dial available.

In normal circumstances Morse stations will not come in unless they are of the modulated variety. Pure C.W. stations will not be found unless provision is made for their reception by the introduction of a reaction system as indicated by coil T and midget control condenser M the second detector circuit. This added coil can take the form of from 25 to 40 turns of No. 40 gauge wire wound on top of the secondary of the second intermediate frequency transformer. Control of reaction may be effected by the use of a reaction condenser, which should be a midget of from 13 to 15 plates.

By starting and stopping the system oscillating, the operator has command of the reception of both code stations and telephone stations. Reaction will have to be practically stopped in order to secure satisfactory and clear reception from the latter. Control volume is effected by potentiometer R.2.

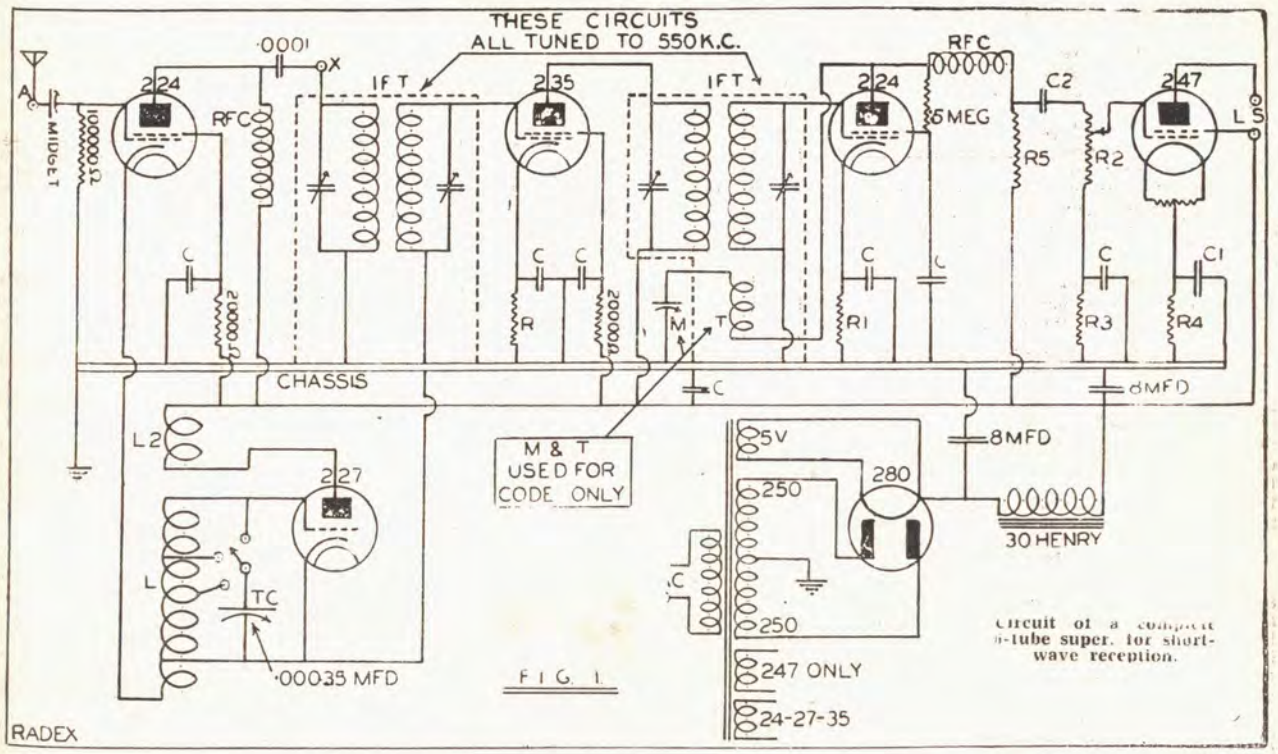


FIG. 1.

Circuit of a compact 6-tube super, for short-wave reception.

A Battery Super-Het. in Four Valves

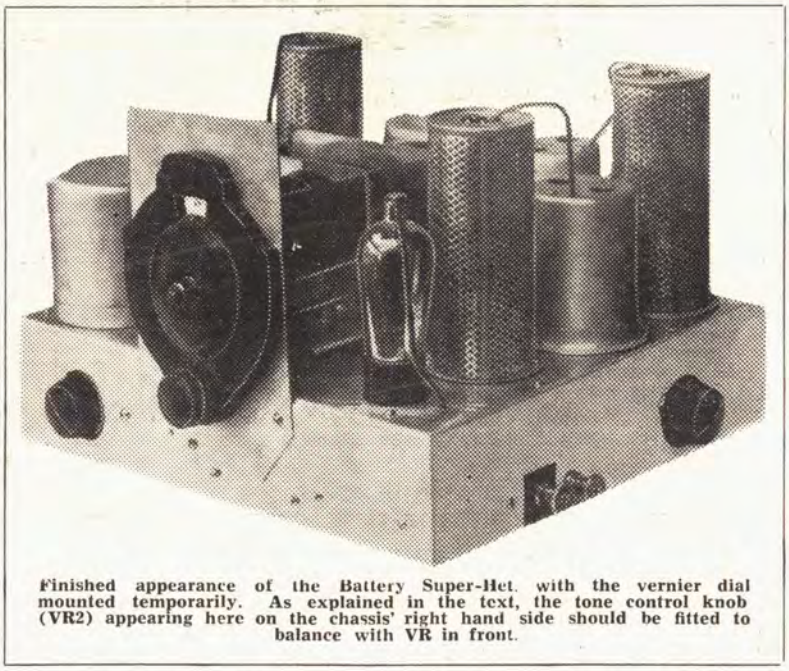
By E. M. WEBB

An effective and completely battery operated super-heterodyne for the country listener. Built on the autodyne system, the employment of 6-volt indirectly heated tubes (Series 36-38-39) simplifies both design and wiring.

THE chief excuse for this experimental construction is a brother in Central Australia far from sources of A.C., and in need of a distance getter of the battery type which will be selective.

Our air is fairly crowded these days, and even in the heart of the continent the overlap of strong stations is becoming a problem. One of his complaints to me was that some Japanese station was interfering with 3LO. When I told him that I would have a go at something selective for him I did not promise to cure that trouble.

However, apart from all that, there is a genuine demand for a battery super-heterodyne which is low in B battery consumption. But there was a greater appeal in the job than that. B batteries are another problem of Central Australia, and the idea at the beginning of this set was to do without them. It sounds ridiculous, but it can be done, provided the A supply is easily obtained. The brother aforesaid takes his A supply from two 6-volt car accumulators used alternatively. An old car generator and the station engine keep them charged, so low tension electricity is easily obtained.



Finished appearance of the Battery Super-Het. with the vernier dial mounted temporarily. As explained in the text, the tone control knob (VR2) appearing here on the chassis' right hand side should be fitted to balance with VR in front.

The Problem of "B" Supply

The original idea was to find an electrician who would built up a small motor generator capable of stepping up the 6-volt supply to something like 150 volts with sufficient mils to give a reasonable B supply. I never found the electrician, because one day while peering into a radio shop I discovered the very thing. A motor car set was on display, and with it was a little generator to work off the car battery and deliver 180 volts and 40 mils Eureka!

Suitable Valves

Very early in the piece it became imperative that the valves should be of the 6-volt variety, and that the high amplification and selectivity of the super-het were also necessary. On the question of valves I went to that excellent authority, "Radex." He immediately produced data concerning the new indirectly heated battery valves for motor car sets. They are a little heavy on A current, but in this instance A current was not a problem. For various reasons these were chosen, one being their ability to give free bias, thus doing away with C batteries altogether.

I might state here that if you have any difficulty in charging batteries; if you have no charger on the place, and have to take the accumulator away for attention, this circuit is not suitable for you. These valves consume 0.3 ampere each, whereas the ordinary directly-heated battery tubes need only .06. If on top of this you use the motor generator for your B supply, the A drain will be heavy. However, few people in the country are without motor cars in these days, and the car battery could be brought into requisition.

These motor car valves are light on B current, so that B batteries can be used in this circuit, and they work very well. The valves themselves are splendid little tubes. Of the four used, two are 236's, equivalent to the A.C. 224. One is a variable mu—the 239—and you can control volume on its cathode just the same as with a 235. The fourth is an output pentode—a 238. For ordinary reception I prefer triodes direct-coupled, but this pentode is a good valve, and if you use a tone control to deal with the exaggerated high-audio frequencies you will get excellent reception.

Gleaning Information

For super-het. advice I went to Mr H. K. Love. The kit used is his design, and is manufactured by Radiovision Ltd., of whose set-making activities Mr Love is in charge. It is a neat job and a good one, and when fitted to the chassis gave reception straight away.

The circuit is the same as that described by Mr Love in The Listener In of January 7, with some slight modification. There is a first detector-mixer followed by an intermediate stage, an anode bend detector, and an output pentode.

Before the first detector a pre-selector is used. This gives high initial selectivity and assists the intermediate frequency transformers to pass on a signal devoid of background and interference. The pre-selector used is condenser-coupled. With the two following inductance couplings in the intermediate stages, a perfectly flat-topped signal is ensured throughout the tuning band. I have never handled a more selective set than this one.

The Autodyne System

No oscillator valve is used. The oscillator frequency is generated in the feed-back device from the plate of the first detector-mixer. It is fed into the valve through the cathode, which is biased by a 1500 ohm resistor (R2). In the original set this value was firstly 2000, which was too high and prevented oscillation over a part of the band. The resistor used was a 2000-ohm with a movable tap. This is handy because the constructor can vary the resistance by means of the tap and find the best operating spot. It will be noticed that there is no direct current in the oscillator tuning coil, the feed-back being induced by the coupling coil, L5.

Another feature of construction is the reversal of the leads on the first coil and the second intermediate frequency band pass. This is done to prevent feed-back.

Reproductive Stage

The audio circuit is the conventional resistance capacity coupling with 100,000 ohms in the detector plate feed. The grid leak R7 can be anything from ½ a meg to two megs. Grid leaks are such pernickety things that one hesitates to lay down the law as to values. The one that gives the best reception is the best.

A choke condenser outfit is included. The plate of the pentode draws only eight

mils, and the screen 2.5, so that a magnetic speaker can be used directly coupled to the plate of the valve, but the indirect attachment is preferable.

Detection is by anode-bend, and the bias resistor is 25,000 ohms. It seems a high value, but it works well. The detector plate, using 135 volts of B battery receives about 60 volts, which is enough.

Simple Power Feeds

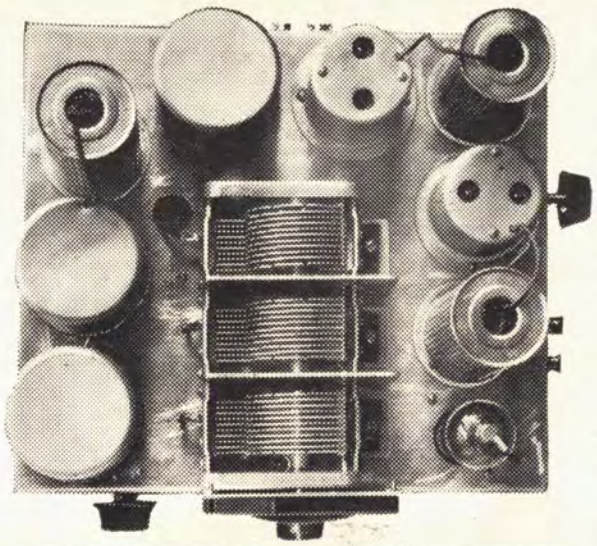
Another feature of the set is its single high tension feed. One lead only from the B supply is necessary. The current is broken down inside the set. To give the necessary voltage on the screens of the first detector and intermediate valves, 50,000 ohms (R3) is used. A 250,000 ohms resistor (R5) taken from the plate side of the detector plate feed delivers the required voltage to the detector screen.

The oscillator circuit shows four condensers in the tuning circuit. G3 is the third unit of the three-gang tuning condenser. The condenser T is parallel with it and is its trimmer. P.D. is the padding condenser, of about .001 mfd. capacity, and the other in parallel with it (about .0013), and in series with the tuning condenser enables the oscillator tuner to keep track over the band with the two R.F. tuners. It will be noticed that the oscillator frequency feed to the cathode of the first detector is from a tap in the tuning coil, and not from a separate winding.

Governing the Output

The volume control in the original set is a 200,000 ohm. potentiometer of the carbon strip type, which gives fine graduations.

Lower values were tried, but were not satisfactory. One terminal is connected to the aerial, and the other to the cathode of the 239. The tap is to earth, through the arm's one-hole mounting.



Looking down on the set the order of the valves from the left is 36, 39, 36 and 38.

Construction Notes

The super-het. needs very careful hooking up. The values of coils and condensers in all stages are highly critical. They are oscillator matched at the factory, and the slightest clumsiness in construction will throw one part out and upset the general balance.

Make sure particularly that there are no long plate leads or long wires from coils to tuning condensers. Long leads introduce extra capacity into the circuit, and should be avoided. Particularly is this so with the lead from the oscillator coil to its condenser. The neat job is always the best job.

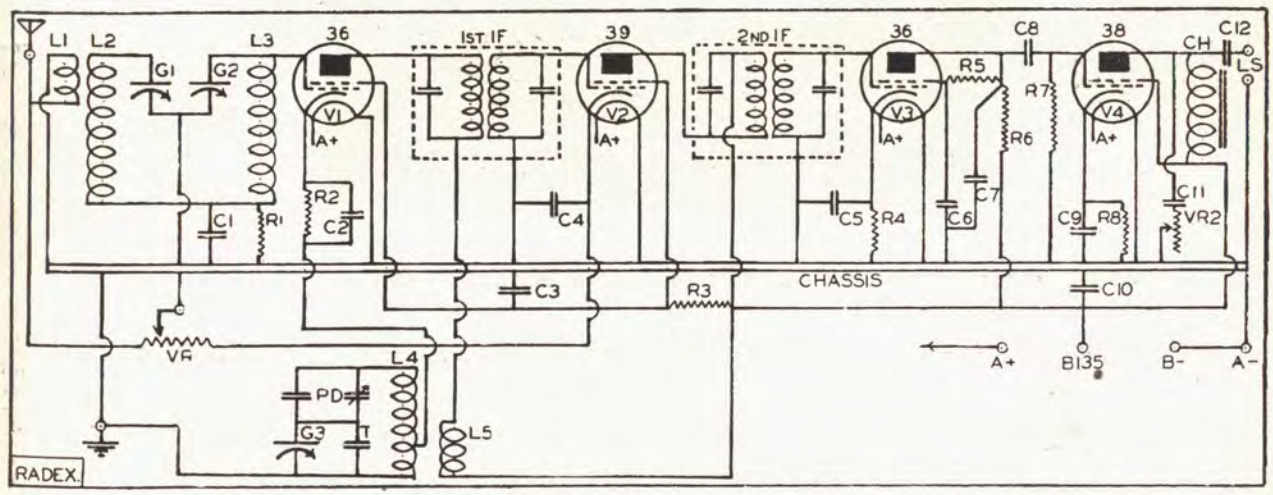
All the by-pass condensers dealing with R.F. current are of the .1 mfd. pigtail type. They are easy to mount. Do not forget C10, which provides a by-pass for the high-tension supply. It is 1 mfd. and most necessary.

The Matter of Tone

The 238 pentode needs a tone control. This consists of a .1 condenser C11 and a 10,000 ohm. variable resistance (V.R.2) in series between the plate of the pentode and earth. The best tone can be secured by experiment. The tone control can also be used to cut out static on distant stations. Static is high frequency noise and lowering the resistance of V.R. will by-pass some of it to earth.

The resistance R1 is 10,000 ohms. carborundum. It brings the grid of the first detector to earth and is technically necessary, although I have always found that it makes little or no difference unless the voltage on the plate of the following valve is unusually high. However, it is better to be on the safe side.

A and B minus are to the chassis. A switch in the A plus feed to switch current on and off is necessary. It is not shown in the diagram.



Complete circuit diagram of the Battery Super-Het. VR controls volume while VR2 controls the depth of tone. 1st and 2nd IF's should be manufactured products.

LIST OF PARTS

One R.V.A. Super-het. kit.

Valves: Two 236; one 239; one 238 (Philips or Ken-Rad).

Four U.Y. valvet sockets (Marquis).

Condensers: Five .1 pigtail (C2, C3, C4, C5, C6); one .04 (C1); one .0001 (C7); one .01 (C8); two 2 mfd. (C9, C12); one 1 mfd. (C10); one .1 (C11) (Chanex, TCC.).

Resistances: One 10,000 ohm carborundum (R1); one 2000 with movable tap, wire wound (R2); one 50,000 ohm carborundum (R3); one 25,000 carborundum (R4); one 250,000 carborundum (R5); one 100,000 carborundum (R6); one grid leak ½ to 2 meg. (R7); one 1250, wire wound (R8) (wire wound by Radiokes, M.M. or Aegis).

One 20 Henry output choke (CH).

One potentiometer 20,000 ohms (V.R.).

One 10,000 ohm variable resistance (VR2).

One six volt accumulator.

"B" batteries, 135 volt, or special "B" eliminator, as specified.

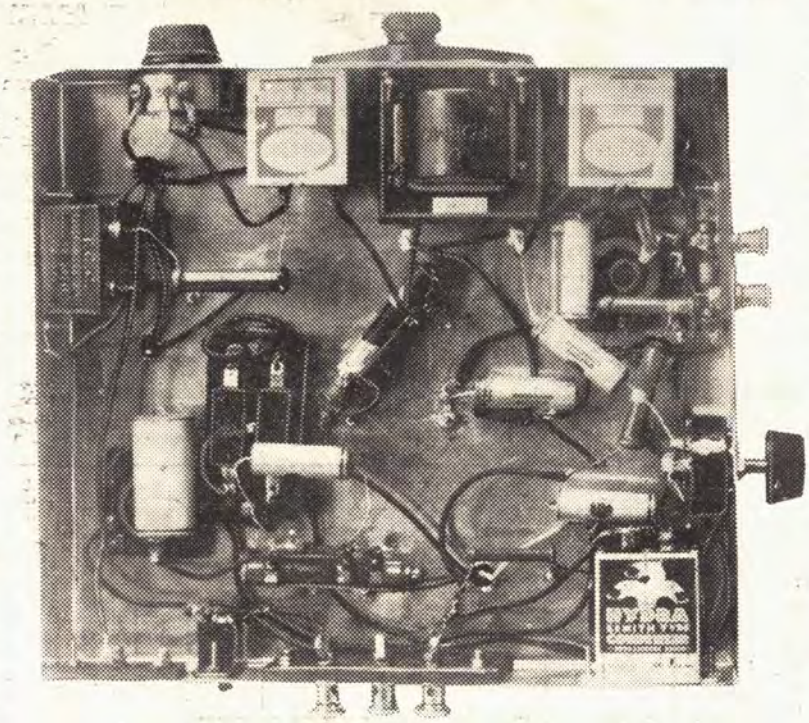
Chassis dimensions are 18-gauge aluminium, 12 x 10½ inches by 2½ inches deep.

The General Sub-Assembly

The photograph of the underneath part of the chassis shows how the parts are laid out. Prominent under the tuning condenser are the two 2 mfd. condensers, in the cathode of the pentode, and in the output stage respectively. Between them is the 30-henry output choke. The large condenser on the opposite side is the 1 mfd. to by-pass the high tension supply. On the left-hand side of the platform is the .04 condenser, which couples the two pre-selector coils. The pigtails condensers are the .1 R.F. by-passes, with the exception of the one set diagonally on the right-hand side. This is the tone control condenser leading from the plate side of the output choke to the variable resistor.

The tone control was an afterthought, and it is not in the best position. Its proper place should be where the output condenser is on the right of the tuning knob. The speaker terminals are seen outside the platform on the right. Of the three plugs at the back of the chassis, the middle one is superflous. The left one is the A plus lead, and is connected to the switch at its left. The right one is the B plus terminal. The aerial connection is a banana socket on the extreme left. Ground and A and B minus connections are banana sockets bolted to the chassis.

The dark object in the middle left is the under-side of the padding condenser, which is bolted to the chassis through two blocks of wood or bakelite, to give the padder, which is on the other side, a good clearance from the chassis. The adjusting screw of the padder is available through a large hole in the top of the platform.



The view beneath the chassis. The almost exclusive use of pig-tail types of fixed condensers and resistors greatly simplifies wiring.

Initial Settings

When the set is completed and being given its try-out, have the oscillator trimmer nearly out and the other trimmers nearly in. The padding condenser should be right in.

The best station to trim on is a distant one low on the dial, either 3GL or one adjacent. When the signal comes in, work on No. 1 trimmer until maximum volume is achieved. Then treat No. 2 similarly, and follow with No. 3. Do this carefully until best results are obtained. Then switch over to 2CO in daylight and work on the padder, at the same time rocking the tuning control a little. The loudest adjustment will be found, and the padder should be left there. Go over the business again, and trimming and ganging should be complete.

If set does not oscillate on the high wave-lengths, lessen the resistance R2 in the cathode of the first detector. Should that not have any results, re-set R2 at 1500 ohms and try altering slightly the plate feed padding condenser on the first intermediate transformer, at the same time seeking 2CO or 3AR. Oscillation can be detected by the rushing, crackling sound in the speaker. The adjusting screws of the intermediate transformer condensers can be plainly seen on the top of the can.

Do not use a screwdriver if these have to be turned. Give a piece of wood a flat sharpened end like a screwdriver and use that. The metal screwdriver makes capacity with the condenser and will not give the right adjustment.

Handle Intermediates Reluctantly

Try everything else before touching the intermediate padders. If the set is constructed properly and has no long plate or tuning condenser leads, the intermediates should not need touching. If, however, selectivity is not what it should be, the matching of the intermediates has been thrown out by stray capacities, and they will have to be adjusted on the set.

The performance of this hook-up exceeded expectations. It brings in all Australian stations of any reasonable power. Sydney, Brisbane and Adelaide romp in. Time has not permitted a logging, but a quick run down the dial brought in station after station.

While writing this article, I had the set switched on to what I thought was 3AR. It proved to be 5CK.

A Valuable Hint

There is one suggestion I would like to make to constructors. This is an experimental set and no first lay-out is entirely perfect. Were I building it again I would reverse the positions of the oscillator coil and the first detector valve.

Looking down on the photograph of the top of the set, the valve will be seen between two cans on the left of the tuning condenser. The can furthest from the condenser and at the back of the chassis contains the oscillator coil. Place this alongside the other can, which contains the second pre-selector coil. Then bring the valve as close to the tuning condenser and the oscillator coil as possible to give the shortest lead from the second can to the top of the valve. The first intermediate then comes close to the valve and the plate lead from it will be shorter and more satisfactory than in the present lay-out. I strongly advise this alteration.

The valves used were Philips or Ken-Rad. Both gave equally good results.

Kit Notes

In the R.V.A. Superhet. Kit the second pre-selector coil contains two taps. One of these is midway and can be ignored to start with. The other is at the bottom, and is followed by three turns, which are used in R.V.A. sets as a coupling inductance instead of the .04 coupling condenser (C1).

When using the coupling condenser ignore the last three turns and make the connection to the first coil and the .04 condenser from the lower tap. If there are interference, harmonics or heterodyne whistles on 3LO, take the grid lead to the top of the first detector from the rst tap on the coil and the trouble should end.

Coil Details

For those who wish to wind thei r own coils, Mr Love supplies the following details. The first pre-selector coil requires 87 turns of 34 enamel wire on a 1¼ inch former. Place insulating material round the base of the winding, and then put on 15 turns of DSC at the bottom end for the aerial coupling.

The second pre-selector coil needs 87 turns on the same size former of the same wire.

The oscillator coil has 65 turns with a tap taken at 10 turns above the base where the coupling is made to the cathode of the mixer-first detector. The plate coupling coil in the oscillator is 40 turns of the same wire wound over the base of the 65 winding with insulating material in between. All these details were given in Mr Love's superhet. four article in The Listener In of January 7.

The intermediates are better purchased. In fact, purchase of the whole kit is recommended, but if you are going to wind your own pre-selector and oscillator coils, remember that you will need intermediate frequency transformers of 240 k.c. and not of the standard 175. The ordinary kind sold are almost invariably 175 and rarely, if ever, 240.

The B Supply

While the set works well off 135 volts of B battery, it also put up an excellent

THE UNIVERSAL TIME CHART

Operating Instructions

THE number of ways of setting out an international universal time chart is legion, but the one shown here is considered as good as is compatible with easy operation.

Its use is simplicity itself. Melbourne, Sydney and Brisbane common standard time is indicated over the heavy horizontal line. To discover the time in any other part of the world corresponding with Standard Time in Eastern Australia, read **down** except for New Zealand or the Fiji Islands, which are still ahead of our standard time. If the deduced time falls below the diagonal midnight line (O), the date will be **yesterday.**

Conversely, to ascertain standard time in Eastern Australia, which corresponds with some known time in a foreign country, read **up,** excepting again New Zealand and Fiji Islands. If the foreign time begins below the midnight line the date in Eastern Australia will, of course, be tomorrow.

A 24 hour "clock" has been used to obviate the difficulty of deciding whether it is to be a.m. or p.m. International time is always expressed as four figures, in which the first figures indicate the hour and the **last two** the minutes past the hour. From midnight to midday the hours are numbered from 0 to 12, and the afternoon hours from midday to midnight are numbered from 13 to 23 — 1.30 (or 01.30) is "half-past one" in the early morning; 12.30 is "thirty minutes after **midday**"; 13.30 is "half-past one" in the afternoon, and "six thirty p.m." becomes 18.30 in international time.

THE SUPER-HETERODYNE —(Continued from page 20)

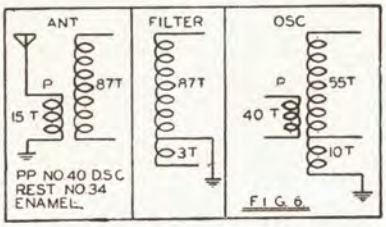
Lining Up

Having wired the circuit, measured all pressures, and made sure that there are no mis-connections, the process of lining up can be attempted.

The three-gang variable condenser, which is represented by C1—C2—C3, should be adjusted with its trimmers in the following positions:—The trimmer of the oscillator section C3 should be three-quarters of the way out. The trimmers of C1 and C2 should be screwed down about three-quarters of the way in. The gang should then be turned by the dial to a position representing 1400 kilocycles, that is the wave-length of 3GL, Geelong. In this position the final lining of the trimmers of C1 and C2 should be made.

Should 1400 kilocycles come in too high or too low on the dial, its position on the dial may be shifted by the adjustment of the oscillator trimmer of C3. C1 and C2 will need to be again brought into line with the oscillator if its condenser is shifted.

The checking at 1400 kilocycles should be done very carefully and quite often to make sure that all circuits are perfectly in line. When the operator is satisfied on this point the 3 gang condenser should be moved round to a point where 3AR would be expected to come in. The adjustable padding condenser should then be screwed in until maximum signals are received from this station. Each time the padding condenser is adjusted the position at which 3AR will be received will shift a degree or so. The condenser should be rocked back to maximum each time an adjustment is made to the padding condenser, until maximum signals are assured.



System of coil winding used in the aerial, filter and oscillator circuits of the average 4-valve super-heterodyne.

If the set refuses to oscillate as the condenser is tuned up towards the top of the band, and the changing of the 2000 ohm bias resistor to 1500 ohms does not effect the cure, a slight adjustment to the primary tuning condenser of the first intermediate frequency transformer may stabilise the receiver. If it does so it will probably be necessary to re-adjust all the trimmers on both I.F.T.'s in order to bring them in line with the new setting of the primary winding. This adjustment should be made when receiving a weak signal at somewhere between 1400 and 1100 kilocycles.

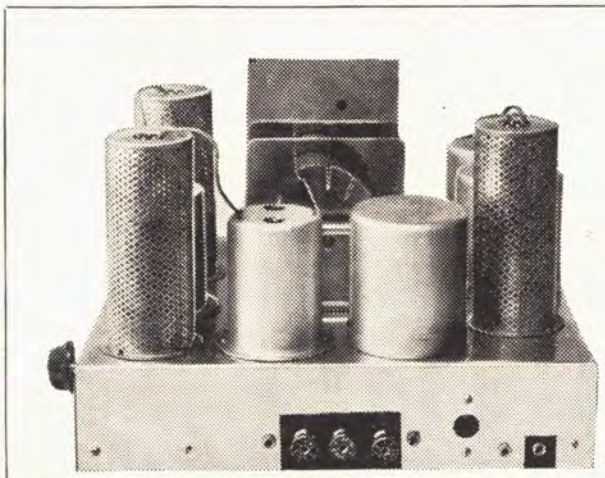
To summarise the lining up. 1. Line all circuits controlled by C1—C2—C3 at 1400 K.C. 2. Line the padding condenser P.D. at 610 K.C. 3. If adjustment is necessary to the intermediate frequency transformers do it with the three gang condenser set at 1400 K.C. or not higher on the tuning scale than 1100 K.C.

A BATTERY SUPER-HET, IN FOUR VALVES —(Continued from page 32)

performance when using a Bosh Magmotor eliminator. This device, which was specially designed for use with motor car sets, will be a godsend to country people who have plenty of A current and means of charging the A battery on the spot. The Magmotor in principle is a motor generator which works off the 6-volt battery and delivers 160 volts and 40 milliamps for the B supply.

Used in this set it effectively took the place of the B batteries. The high tension supply is well filtered and the speaker is silent. Naturally, the further the Magmotor is placed from the set the better. The manufacturers advise three feet at least, and this distance should be observed.

Theoretically the Magmotor will deliver slightly over six watts, but the input must be more because there are losses in transforming. The device, however, is extraordinarily efficient. When using it the whole drain from the A battery is about three amps at six volts. The heaters of the valves take altogether 1.2 amps, and the theoretical demand of the Magmotor is 6.4 watts, or 1.4 amps at six volts. That makes 2.6 amps consumed by the set in any case. The fact that the losses in transforming current for the B supply amount only to .4 amp speaks well for the efficiency of the eliminator. The makers claim that it will run for at least two years without requiring attention. After that the brushes may need looking to. No oiling is necessary.



At the rear of the chassis are the battery, aerial and earth connections. To the right of the three large terminals is the "A" battery switch followed by the aerial and earth plugs.

I would again reiterate that B batteries must be used where accumulators have to be sent away for charging, or dry cells are used. The drain of three amps is heavy, and will soon run the battery down. But if I were in the country with easily secured A supply, I would not worry about B batteries any more.

THE UNIVERSAL TIME CHART

(See opposite page for instructions)

LONGITUDE.		STANDARD TIME FOR:-	HOURS.																							
East	180	Fiji Islands.....	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1
	165	New Zealand..(=).....	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0
	150	Vic., N.S.W., Q'land..... (==)	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
	135	Japan, Far Eastern ..... Siberia	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
	120	Western Australia and..... Philippine Islands	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
	105	Java, Siam, French Indo- China	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	90	Calcutta..(+).....	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
	75	Russia (East of Urals)....	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
	60	Mauritius, Seychelles.....	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	45	Madegascar, Aden, Moscow,. East Africa..(++).	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
	30	South Africa, Egypt.....	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
East	15	Italy, Germany, Austria... Scandanavia	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
G.M.T.	0	Britain, France, Holland.. (Empire Stations).	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13
West	15	Western Sudan.....	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12
	30	Mid Atlantic.....	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11
	45	Rio de Janeiro.....	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9	10
	60	Buenos Aires, Newf'dland..	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8	9
	75	New York, Montreal, (East- Standard Time).	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7	8
	90	Chicago, Manitoba, (Cent- Standard Time).	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6	7
	105	Mexico.(Mountain Standard Time).	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5	6
	120	Los Angeles, Vancouver.... (Pacific Standard Time)	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5
	135	North West Canada.....	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4
	150	Alaska.....	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3
	165	Samoa, Hawaii..(=+).....	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2
West	180	Suva.....	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1

NOTES: (=) Add ½ hour for N.Z. Standard Time.
(==) Subtract ½ hour for Adelaide Time.
(+) Local time, subtract ½ hour for India Standard Time.
(++) Subtract ½ hour for Kenya Colony, Nairobi.
(=+) Subtract ½ hour for Hawaiian Standard Time.

A STANDARD POWER PACK

By RADEX

This unit forms the "ne plus ultra" of audio amplification. It combines two '45's in push-pull empowered from a Ferranti transformer and driving a suitable dynamic speaker. In addition the chassis carries a full power pack capable of delivering up to 300 volts and of heating valves to the extent of 10 amperes at 2.5 volts. Special provisions are made to permit of the unit being applicable to any A.C. receiver assembly.

THE design of this unit turns on the fact that the major portion of any pack's power is consumed in the final stage of the conjunctive radio set's circuit. The radio and detector stages of even a very large receiver (such as, say, a super-het.) impose a total power-drain which is invariably less than is that of its audio end. Consequently, if we design a pack to supply two UX245's in push-pull and then allow a 50 per cent. over-plus thereon we shall be assured of a sufficiency of current at the maximum plate-voltage demanded—250 volts being a good working maximum.

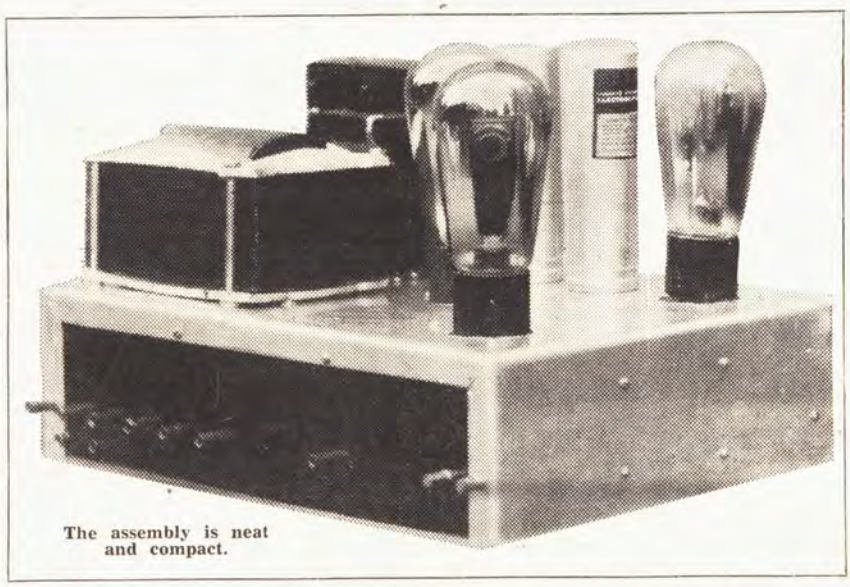
It will be obvious, from the above, that owing to the final amplifier's big draw it really becomes the most important matter for consideration, and that, in fact, will save in all directions if that amplifier be permanently combined with the power-pack as an integral unit.

The Circuit

Having decided on our plate voltage and current requirements (up to 100 ma at 250 volts), the combined power transformer PT and full wave rectifier RT (vide Fig. 1) become the heart of the system. Radiotron UX280 will amply carry out the labor assigned to RT, as its maximum load is 125 ma at 350 volts. Naturally, the transformer should furnish the same voltage at just a slightly lower amperage (say 110 ma), but to allow for possibilities it must also have two 2.5-volt secondaries and an extra one giving 4 volts is a valuable asset.

The important smoothing system consists of two 8-MFD electrolytic condensers C1 and C2 (tested to work at 450 volts if necessary) and choke PCH of 30-Henries and designed to pass 100 ma. RFC is an ordinary slot-wound manufacturer's type radio frequency choke which, together with small mica condenser C4, is inserted in the circuit to suppress modulation hum. In the reception of normal broadcasting the beneficial effect of choke RFC is not very noticeable, but its presence in short-wave work is important. In any case its inclusion in the circuit is strongly recommended.

Having now reached the point lettered as "250V," we actually come to the end of the pack's circuit as a furnisher of power—although means have still to be taken in order that that maximum voltage may be suitably broken down as requiured. However, as it is a permanency, we can consider combination resistor R3 and shunt condenser C5, being the means whereby free bias is provided for audio valves VP1 and VP2—as part of this section. "JHV" indicates the 2.5-volt filament output for indirectly heated valves in the preceding receiver.



The assembly is neat and compact.

The Amplifier

In view of the fact that dynamic speakers are designed to work in conjunction with specific types of valves and that they are offered with a variety of field resistances, no proposals for an amplifier circuit can be complete without simultaneously allowing for the dynamic's characteristics. Further, a little thought will show that its field can be usefully employed as a partial means of breaking down the initial maximum plate voltage—thereby saving the cost of portion of a resistance system needed for that purpose.

Operating the amplifier's two valves in push-pull naturally means that the speaker's built-in in-put transformer must be of a corresponding type As a general average valves others than those in the last stage do not demand a plate voltage of more than 200, consequently by offering our initial 250 volts two paths we not only feed the '45's, and energise the dynamic field, but, in addition, utilise its 2500-ohm field resistance to give us the required value.

Coming now to the output plate voltages available, we have one BH giving approximately 200 volts and another BL delivering around 80. These are obtained by placing the dynamic's field resistance in series with fixed resistors R4 of 5000 ohms and R5 of 2500 ohms. In effect these three resistances together form a rough voltage divider, but the real office of R5 and R4 is to ensure a steady current through the speaker's field, irrespective of any other draw in associated circuits.

It might be suggested that this parallel system of voltage-feed will later create trouble when radio stages precede the amplifier and pack. Such does not arise, however, because points BH and BL are merely rough points of output. In between them and the ultimate valves they are to operate will come resistors (properly shunted to earth where necessary), but because of the initial heavy work done by R4 and R5, the individual items need only be of the inexpensive power grid-leak types.

The 5000-ohm resistor between BH and BL is lettered "R4 A & B" for a definite reason. It was found cheaper to purchase two 2500-ohm resistors than to get one of 5000 ohms of corresponding current carrying capacity. As indicated in Fig 2, this split value was then utilised to provide an intermediate voltage tap B1, which offers around 150 volts. This tap has no immediate use, but the future may provide one.

Refinements

It is often very desirable to listen to your set's performance with a pair of headphones (HP); unfortunately a receiver in which all joints are permanently soldered rarely offers an easy point at

which a suitable phone connection can be made. Against this it must be remembered that phones are invaluable when ganged condensers are being linked or when a short-wave set is hooked up.

Such a means of connection is offered here, HP is a pair of phone terminals (one of which is earthed) or an open-circuit jack. A fixed condenser, C6, is connected between the amplifier's main input terminal, IP, and the other HP. If C6 is given a value between .002 and .006 mf quite good signals will be produced in the phones without appreciably decreasing the main output volume from push-pull transformer AFT. Further, no matter what voltage is fed out from IP, the presence of C6 will guard the phones against undue strain.

It frequently happens that a push-pull amplifier fails somewhat because its valves do not match. This possibility can be removed by the insertion of fixed resistors, R6 and R7, and shunt condenser, C7. Naturally the inclusion of these parts, and also C6 and HP, is optional.

Chassis Assembly

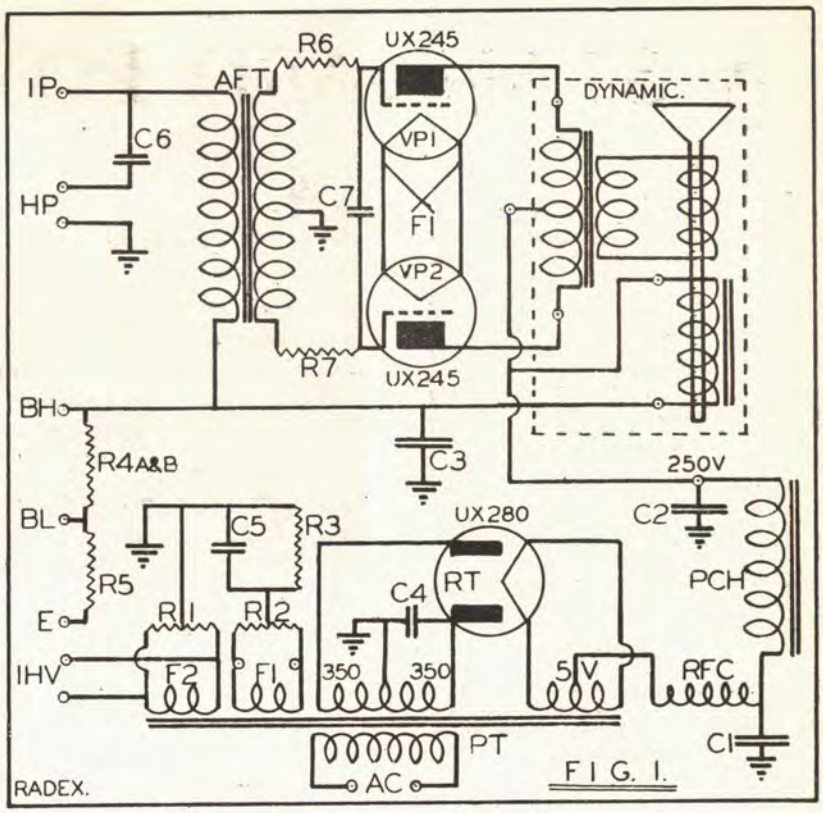
The accompanying photographs will give you a good idea of the manner in which the various components are laid out on and under the chassis, but, from a viewpoint of utility, the most important item to note is that one of its long sides is composed of a strip of ebonite measuring 11⅞ by 2⅞ inches. This strip carries a regularly spaced series of single English-type valve-plugs to which the various main connections (IP, F2, etc.) are made internally. When we come to build a receiver to work with this pack its chassis will have a corresponding side with valve-legs similarly spaced, and so, to connect up, it will merely be necessary to push one series into the other.

The dimensions given for this chassis were those suited to the set of components used of which transformer PT and choke PCH naturally occupy the most space. Should your parts be larger it will be advisable to increase the length beyond 12 inches rather than to widen it over nine inches.

In order to allow for varying local voltages, the A.C. connection takes the form of a 3-pin voltage socket with reversible plug. Care must be taken that these pins cannot make accidental contact with the aluminium.

Fig. 2 gives a plan impression of the lay-out and wiring with the sides spread flat while the metal is presumed to be transparent. The general arrangement should be followed if possible, but some latitude is permissible with regard to the placement of socket DS into which the connections of the speaker and its field are plugged by means of an old valve base. In my case it is most convenient where it is, but the employment of a cabinet of limited dimensions might insist upon it being located at the back —alongside of A.C.

"RX," which is not shown in Fig. 1, is a variable resistor capable of carrying 100ma. It is not included in the circuit, and is, at present, unnecessary. It would, however, have to be employed were it ever desirable to reduce the maximum output voltage, and so the point of its wiring is merely sketched in here for future reference. Centre-tapped filament resistor R1 is omitted from this drawing; it is wired across filament secondary F2 which feeds the indirectly heated valves, and it was found better to locate it in the coming chassis carrying the set proper.



Both pack and amplifier in theory.

Wiring Details

As this pack is going to be a complete unit that will last for years and will not be subjected to frequent alterations, take time about the wiring and do it properly. Avoid straggling leads, remember that air is the best insulator and carefully make every joint with resin-core solder. Frayed strands of flex are always a danger; to avoid this twist up every cut end and tin it before re-soldering it to its proper point.

Starting with transformer PT, first be sure that you have clearly differentiated between its twelve or fourteen lug-connections and then take the 5-volt pair to the F terminals of socket RT—continuing from one such F to a side of choke RFC. Join one "350" to G of that socket. Take a lead from an end of

ORIGINAL PARTS USED

AC — Three-pin voltage socket and plug.
AFT. — Quality push-pull audio transformer (Ferranti or A.W.A.).
C1 & C2—Electrolytic condensers of 8 m.f. to work up to 450 volts.
C3—Fixed condenser of 4 m.f. tested to 1000 volts.
C4 and C7—Mica condensers of 0.001 m.f. (T.C.C.).
C5. — Fixed condenser of 1 m.f. tested to 500 volts.
C6.—Mica condenser of 0.004 m.f. (T.C.C.).
DS.—Dynamic speaker, with push-pull input transformer and field of either 2000 or 2500 ohms (A.W.A., Amplion, Jensen, Jubilee).
E—Earth connections.
F1 and F2—See PT.
PCH—Power smoothing choke of 30 henries to carry 100 ma. (C30H).
PT—Power transformer, having following secondaries: — Main 350-0-350 to 100 ma, 5v. at 2a. for RT, 2.5v. at 3a. for F1, 2.5v. at 10a for F2, and (optional) 4v. at 2a. (Radiokes H4554 or Hilco, Aegis.)
R1 and R2.—Centre-tapped filament resistors.
R3—Wire-wound resistor of 750 ohms, rated for 10 watts.
R4a, R4b, and R5—Wire-wound resistors of 2500 ohms each, to carry 25 ma. (Aegis, M-M.)
R6 and R7—Carborundum resistors of 25,000 ohms each.
RFC—Manufacturer's type R.F. choke coil. (Velco.)
RT—Rectifier; Radiotron UX280.
VP1 and VP2.—Push-pull power amplifiers; Radiotrons UX245.
4 type UX sub-panel valve sockets (Marquis).
7 English type single valve plugs.
3 small terminals.
Chassis of No. 16 gauge aluminium, measuring 9 x 12 x 3 inches deep, but with one side omitted (see text).
Piece of ebonite 11⅞ x 2⅞ inches, some heavy rubber-covered flex, and sundry machine screws and nuts.

condenser C4 to the other "350," and thence to P of RT. Earth the free end of C4 and also the centre tap ("O") of the 350-volt secondary.

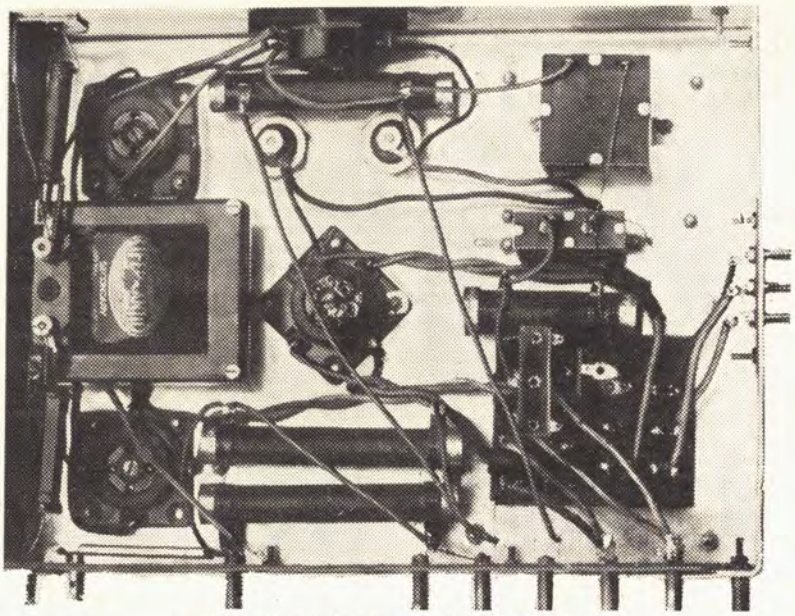
Run a twisted pair from F2 (2.5 volts at 10 amps) to legs F2 on the ebonite side. Run another pair from F1 (2.5 volts at 3 amps) successively to the F terminals of VP1 and VP2; also connect resistor R2 across F1. Wire the centre of R2 to ends of R3 and C5. Earth the other ends of R3 and C5. Connect the three pins of AC to the correspondingly marked lugs of PT in the order shown.

Join the vacant side of RFC to the nut of C1 and continue to PCH. From the other lug of PCH go to the nut of C2 and the P clip of socket DS. From one side of C3 go successively to an end of R4a, G on socket DS, terminal B on audio transformer AFT, and finish at leg BH. Independently wire the F terminals of DS to the P terminals of sockets VP2 and VP1. Earth the remaining side of C3.

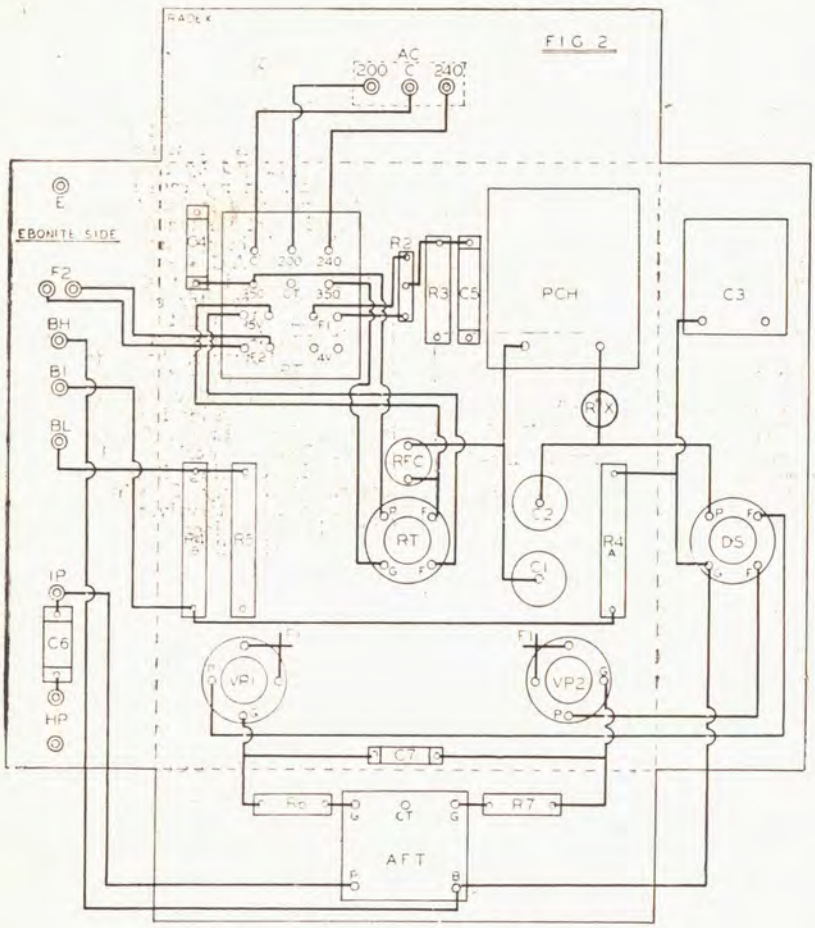
Wire the free ends of R4a to R4b and continue to leg BI. Connect one side of R5 to the vacant end of R4b and terminate at leg BL. Earth the free end of R5.

Join P of AFT to leg IP and an end of condenser C6. Connect the other side of C6 to one HP terminal. The other HP is earthed to chassis as also is leg E.

Connect resistor R6 between a G terminal of AFT and G of socket VP1. Similarly connect R7 from the other G of AFT to G of socket VP2. Wire condenser C7 across the G's of both these sockets. Earth the audio transformer's CT terminal.



There is ample space under the chassis.



Compare this wiring diagram with the wiring details.

In Conclusion

Without going to a lot of unnecessary trouble, you will not be immediately able to test out this unit—having, as yet, nothing to put in front of it. In the meantime you can, of course, turn on the power from the mains and see that the three valves show their usual dull red glow.

Be very careful with the order of the speaker's connections, which, as previously mentioned, are made through the agency of an old UX valve base. Having cleared out the old solder from that base's legs, first solder both the lead from the speaker's in-put transformer's centre-tap and a lead from one end of its field to the P leg. After that take the field's other end to leg G. The job is completed by wiring the outers of the in-put transformer to the F legs.

If you have a good voltmeter—one of the 1000-ohm per volt of scale type—you should (with the speaker plugged in) obtain a reading of around 225 volts between BH and earth. Again, between P. of either sockets VP1 or VP2, and earth, you should obtain around 300 volts. These readings are, of course, slightly higher than they will be normally as the total load lacks the drain to be imposed later by the receiver proper. For the moment, however, they serve as proofs of continuity of your wiring and the faultlessness of the parts employed.

Conversely, failure to obtain these voltages would indicate a fault and you would then progressively test backwards until the trouble shows itself. Thus a low reading would indicate either a partial short to earth or a leaking condenser, while lack of any reading at all would mean either an open circuit or a dead short to earth. In the latter case the Radiotron UX280 would assume a bluish tinge and power should be shut off at once.

However, these are only unlikely happenings. If you purchase good parts, lay them out carefully, and connect them up firmly and cleanly, you should experience no more trouble than I did—and that was "Nil."

The "47-80" Power Amplifier Pack

By RADEX

A compact combined power supply and pentode audio amplifier unit. It provides the maximum of service in a minimum of space, and is easily applicable to any receiver assembly. Elasticly designed, the "47-80" will empower any assembly of from one to eight modern valves.

BEFORE going into the construction of this two-valve combined power-pack and pentode amplifier unit, it may be as well to clear up the always uncertain matter of the associated dynamic speaker.

Upon this question the writer's personal experience has shown that many home set-constructors evidence deplorable ignorance. They persistently confuse the functions of the instrument's field and voice coils. The latter in modern speakers is fed invariably from some form of transformer.

Functions of a Dynamic

In order to make the matter quite clear a dynamic speaker should be regarded as two distinct entities: (a) its associated voice-coil and transformer, and (b) its field resistance. There is no practical connection between the two, although their association is productive of sound.

The actual resistance of the voice-coil is relatively low—far too low, in fact, for direct connection to any modern type of power valve. To obviate this disability dynamics incorporate a built-in step-down transformer that varies in winding ratio according to the type of tube with which its association is proposed. Thus, without making any alteration to the voice-coil, a particular ...e of transformer will adapt the unit to operation in conjunction with a single 245, two 245's in push-pull, a single 247, two 247's in push-pull or to the characteristics of any other power tube that may be specified. Again, where the input transformer is wound for push-pull its speaker may be operated by a single tube of the type when connection is made to one outer and the centre-tap of the particular transformer. In all of these variations the field winding has neither part nor lot; it has an entirely different function, and in the matter of "matching" it has no standing whatsoever.

Briefly a dynamic speaker is a dually energised reproducer. Firstly with the object of overcoming inertia, it is owner of a directly and continuously magnetised field, secondly impulses released by the power valve modify that continuity in a partially counter direction and so produce sounds. The resistance of the winding which produces the continuous magnetism (the "field") is of no theoretical importance at all; modern practice, however, finds other ...uses for this winding besides the original, and so variations of its resistance value can be made in order to adapt it economically to predetermined circuits.

This means that, apart from the type of valve in the circuit, the value of the dynamic speaker's field resistance should be selected solely with a viewpoint to utility in as much as it can be employed as a smoothing choke, a means of reducing voltage, or a mere passenger.

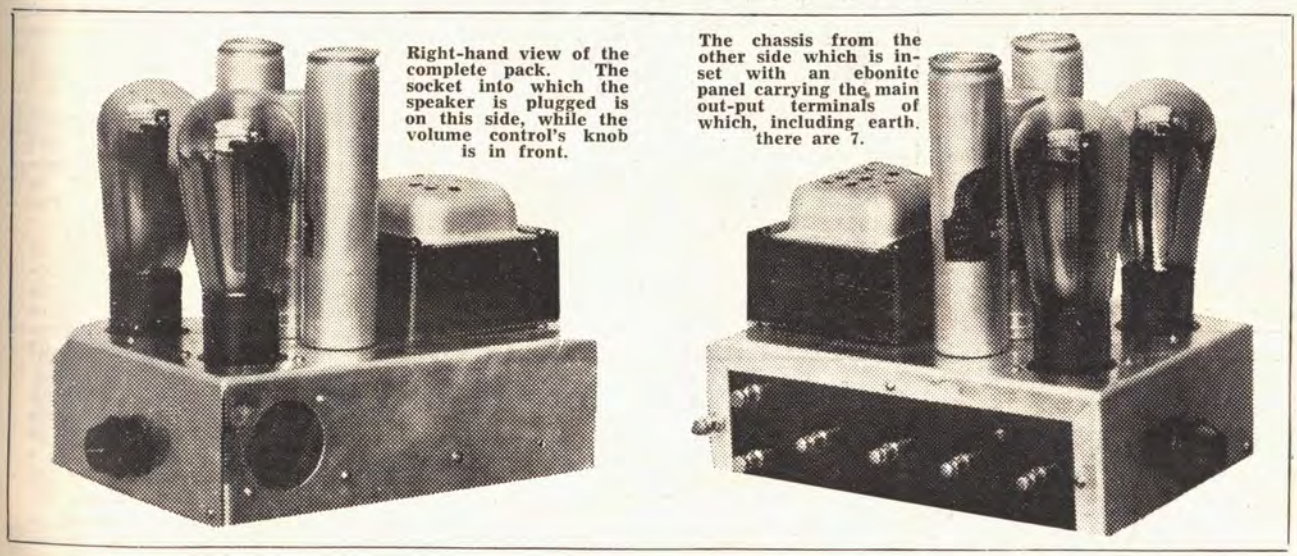
If the field is to be employed as a smoothing choke its resistance should be lower than 2000 ohms; as an additional voltage dropping device or adjunct it is justified in being between 2000 and 2500 ohms; as a passenger (or connection across the main output of the rectifier valve) it should be at least 7500 ohms. In this particular instance the field is going to be employed as a substitute for a regular smoothing choke, and its value is to average around 1500 ohms.

Crystallising these remarks the intending purchaser must remember to ask for a dynamic in two dimensions. First he must specify the type of input; secondly, he must give the field's resistance that is required. Furthermore, do not be discouraged if your particular radio trader says that such a field value is not in stock. Dynamic speakers are made in Australia, and fields can be wound to any value on request. Their material value is merely a matter of your insistence.

The Circuit

Commencing with ordinary multi-secondary power transformer PT, rectification is afforded, through the agency of the 280-type full-wave tube and the full direct, but unsmoothed, out-put is made available from the centre-tap of the rectifier's 5-volt filament secondary. When the transformer used does not furnish such a centre-tapped secondary, corresponding delivery is made from either of the rectifier socket's filament terminals.

The smoothing system consists of the dynamic's field coil FC, which carries earthed electrolytic condensers C5 and C4. The power-pack is completed by adjustable voltage divider VD. From it and from the second 2.5-volt secondary of PT leads are taken to points B1, B2, B3 and pair F for filament supply, of these B1 being the maximum "B" voltage. These form the links that energise the foregoing receiver. CX is an optional condenser, only inserted if the speaker



Right-hand view of the complete pack. The socket into which the speaker is plugged is on this side, while the volume control's knob is in front.

The chassis from the other side which is inset with an ebonite panel carrying the main out-put terminals of which, including earth, there are 7.

KEY TO PARTS

AC. Three-pin voltage plug and socket.

B1, B2 and B3. Out-put points of "B+" voltages.

C1. Fixed mica condenser of 0.01 mfd. (T.C.C.).

C2. Fixed condenser of 1 or 2 mfd. (T.C.C.).

C3. Dry electrolytic condenser of 8 mfd. (T.C.C.).

C4 and C5. Electrolytic 8 mfd. condensers, 450 volts test. (Polymet).

CX. Fixed mica condenser of 0.006 mfd. (T.C.C.).

CH. Radio frequency choke (Velco).

DS. Dynamic speaker with in-put transformer (VT) matched to type 247 and a field (FC) resistance of between 1250 and 1500 ohms. (Jensen, Amplion, Jubilee.)

E. Connection to earth and to earth on associated main set.

Filament leads (2.5 volts) from PT to main set.

"IN." Audio input from associated receiver.

PT. Power-transformer with either 400-0-400 or 350-0-350 main secondary one 5 volts 2 amps, one 2.5 volts and 3 amps (A) and one 2.5 volts and 10 amps (F.). (Radiokes, Hilco Aegis.)

R1. Centre-tapped filament resistor of 20 or 30 ohms.

R2. Carborundum resistor of 100,000 ohms, 1 or 2 watts.

R3. Wire-wound 400-ohm resistor to pass 50 Ma. (Radiokes, Aegis.)

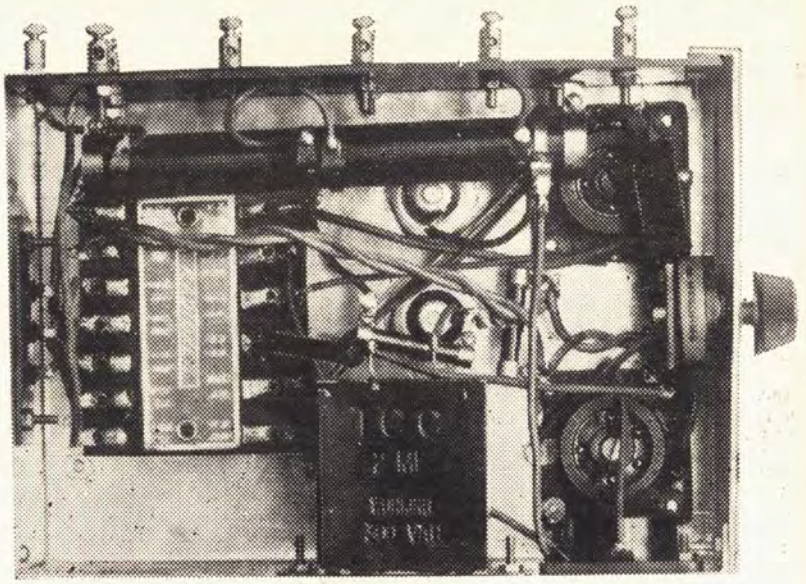
VC. Potentiometer of 500,000 ohms used as a volume control.

VD. Adjustable voltage divider of 15,000 ohms.

Valves—One type UY247 and one type UY280. (Ken-Rad).

Chassis:—No. 16 gauge aluminium, measuring 8½ x 6 x 2¾ inches deep, with one long side left blank and filled in with an ebonite inset measuring 8¾ x 2½ inches.

Sundries: 3 Marquis valve sockets (1 UY and 2 UX). Rubber covered flex, 7 main terminals and sundry machine screws and nuts.



Looking beneath the chassis that measures only 6 by 8½ inches. There is, however, ample room providing the wiring is executed according to the accompanying directions.

reproduces modulation hum. Using the power transformer and smoothing system specified, need for it has not been found yet.

The audio stage is self-contained. It consists primarily of coupling condenser C1 (preceded by r.f. choke CH) and high resistance potentiometer VC that functions simultaneously as a grid-leak and volume control, while resistor R2 and condenser C2 serve as de-couplers. Free bias is afforded through the agency of R3, but, in order to give depth of tone to the reproduction, shunt condenser C3 in an 8 mfd. dry electrolytic.

Assembly

VOLUME CONTROL VC MUST BE INSULATED FROM THE ALUMINIUM CHASSIS. THIS IS OF PARAMOUNT IMPORTANCE. Resistors R1, R2 and R3, are supported by their own wiring. One end of R2 is soldered to point "CT" on the power-transformer PT and the latter point is earthed.

The chassis requires a number of large holes. There are three about 1 5-8in. in diameter for the valve-sockets, three ¾ in. in diameter for the electrolytics, and one around 4in. square in which to inset the transformer. In addition, the cutting out of one side and the provision of the small flaps requires care. So that you may have a neat job it is advisable that your metal merchant should make the bends and incisions.

Wiring

Commence by mounting the power transformer, the voltage plug AC, and the three valve sockets. On PT connect the taps "Pri 210 and Prl 240" to the outers of the voltage plug. The centre pin of the plug goes to "Pri—+."

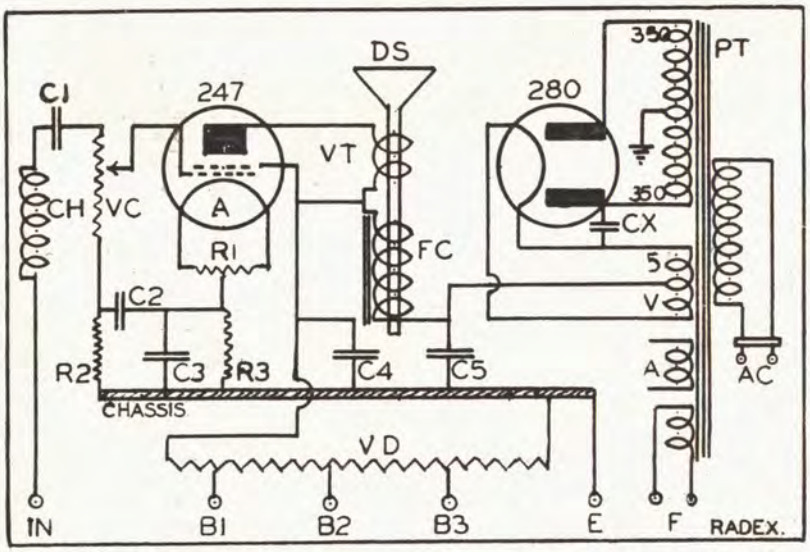
Take the pair of "350's" (or "375's" as the case may be) to G and P of the rectifier socket. Connect the F pair of the same socket to the pair "Rect 5V." Wire the PT pair "2.5V 3A" to the F terminals of the UY socket, and shunt R1 across that pair.

Wire P of 47 to P of DS socket. Mount electrolytics C4 and C5. From the centre of the 5-volt secondary ("Rect CT") go to C5 and thence to an F on DS. Join together G and the remaining F on DS and go to the cathode of the 47 and C4.

Inset the ebonite side and mount its terminals and the voltage divider thereon. Connect pair "2.5V 10A" of PT to the F pair of terminals on the panel. Continuing from the already wired end of C4, go on to one end of VD; connect the latter's other end to earth (chassis). Wire VD's three adjustable clips to the three main terminals provided therefor.

Mount the volume control. Connect condenser C1 between one of its outers and main terminal "IN." Take its arm to G of the 47 socket. From its other outer go to one side of C2 and a tail of R2. The remaining tail of R2 is taken to "HT CT" of PT and then earthed.

From the vacant side of C2 go to the centre of C3, an end of R3 and the centre tap of R1. Earth R3's other end. The casings of condensers C3, C4, and C5 are already earthed in their mountings



Complete circuit of the "47-80" power unit. Note that the two sections (power and audio) are indissolubly linked in association.

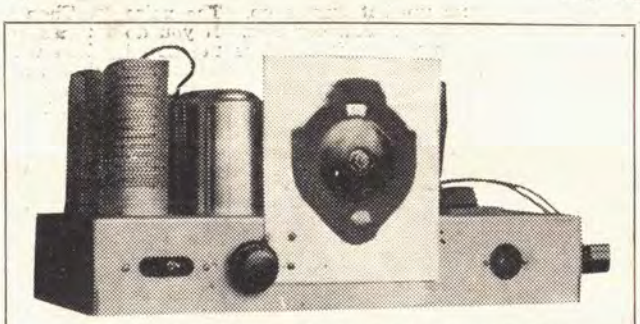
The Perfect Four-Valve Receiver

By E. M. WEBB

A Definitely selective interstate circuit using a new and very simple form of Loftin-White Direct Coupled Audio Amplifier.

THIS set was designed partly to discover an answer to the superhet., and partly to test the value of the pre-selector in a four-valve circuit. The results exceeded expectations.

While this four does not possess the intense selectivity and distance-getting ability of the superhet., it is almost as good in both respects. Nevertheless, it is selective and good on distance. Its chief virtues are that it is extremely quiet in operation, develops no background noises or popping, and its tone is perfect. As a receiver of local broadcasts it is without peer. As a distance-getter, it is good. Manila and a couple of Japanese stations have been logged on it in favorable conditions

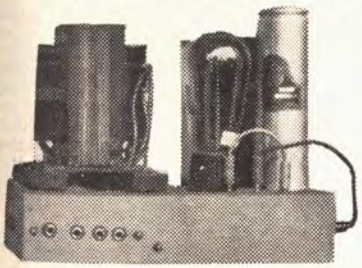


The Perfect Four is controlled by a single dial.

The Circuit

The set employs two stages of radio, furnished by two 235 valves, a 224 detector and a 245 output valves, Loftin-White coupled. Let me adjure readers not to hesitate here. The Loftin-White is the simplest circuit in the world. It looks formidable in the diagram, but it is not at all complicated. If you want perfect reception, nothing else will give it to you; but if you merely want noise any sort of audio circuit will do.

The pre-selector is the most interesting part of the set. It is an arrangement which has become standard in Britain, where selectivity is of paramount importance. The two tuned circuits are coupled by a .04 mica condenser (C2). In this design increasing the value of the connecting condenser produces finer tuning. Reducing it makes the set broader. This type of pre-selector was chosen because under test it gave the best results.



The power pack is a separate unit.

The second R.F. stage and the detector are coupled by two radio-frequency transformers, L4-L5 and L6-L7. The volume control is a 25,000-ohm potentiometer, one end of which is attached to the cathodes of the two 235 valves. The other end goes to the aerial post, and the moving arm to earth. This method does not always give good results in receivers containing more than four valves, but in this set it is satisfactory.

The Coils

The coil formers used were of the Marquis 1 inch variety. The two pre-selector coils consist of 135 turns of No. 30 D.S.C. The aerial coupling is six turns of the same wire wound over the base of the first pre-selector coil.

The R.F transformers contain 135 turns of the same wire for the secondaries and 50 turns wound over the bases of the secondaries for the primaries.

The Condensers

A four gang condenser is necessary for tuning purposes.

The by-pass condensers used were mostly all of the one micro-farad capacity but .5 would probably do just as well. R.F. current is by-passed from the plate of the detector by a .00025 mfd (C7) mica condenser. This value is not critical. I have used .0001 with equally good results, but larger sizes are apt to carry over high audio frequencies as well.

The screens of the two R.F. valves are connected to a point on R2 which will give them between 75 and 90 volts.

PARTS NEEDED

4 Marquis coil formers.
4oz. reel of 30 D.S.C. wire.
4-gang condenser (C1).
1 Condenser, .04 (C2).
4 Condensers, 1 mfd. (C3, C4, C5, C6).
1 Condenser, .00025 (C7).
1 Condenser, 2mfd. (C8).
Variable resistance, 25,000 ohms. (V.R.).
Resistance. 5000 ohms (R1).
1 Resistance, 6700 ohms. (wire-wound) (R2).
1 Resistance. Carborundum, 500,000 ohms (R3).
1 Resistance, Carborundum, 500,000 ohms; 1 Resistance, 250,000 ohms (R4).
4 Centre taps, 20 ohm, for filaments.
1 Radio frequency choke.

The Audio Circuit

The audio circuit is a simplified Loftin-White which gives excellent results. The detector is biased by R1, having a value of 5000 ohms.

R2 is a wire-wound tapped resistor of 6700 ohms value. This resistance is fairly critical, and the figure should be observed carefully. The tap for the screens of the 235's can be found with a voltmeter, preferably one of the A.C. variety unless the D.C. one you possess has a very high resistance.

The 6700-ohm resistance is divided into sections of 2400 ohms and 4300 ohms. To the middle (or junction) tap is attached the 500,000-ohm resistor for the screen of the detector. This division is not very critical and a good guess should suffice. The diagram shows approximately where the tap is made and also the other point (higher up) for the screens' voltage supply. The tapping point for the R.F. valves' plate voltage is also clearly indicated.

R3 has a value of 500,000 ohms. The best kind to use is the carborundum pigtail variety colored green with a yellow spot in the centre. Instead of this resistance a tap low down on R2 can be taken to the detector screen. It can be found by a little experimenting.

The tap has the advantage of eliminating the cost of one resistor. If it is taken off an ordinary voltage divider the 2400-ohm and 4300-ohm divisions will not be necessary.

R4 is 750,000 ohms. The best resistor here is the carborundum pigtail. You will need two in series—the 500,000 green with yellow spot, and the 250,000 red with yellow spot.

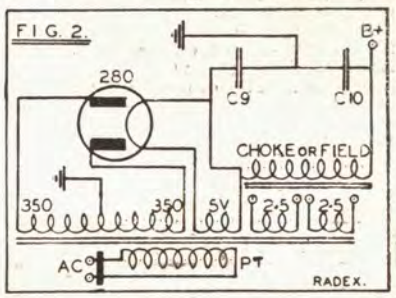


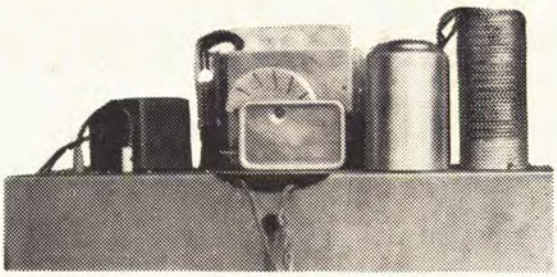
Diagram showing the pack's connections.

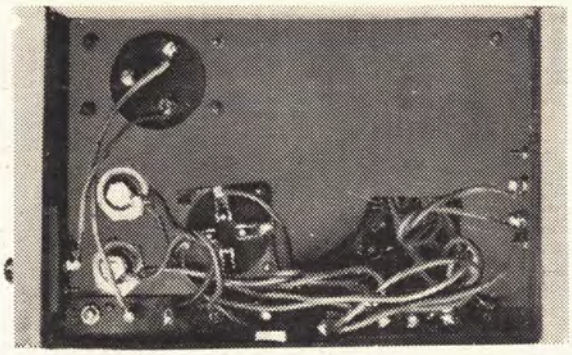
R5 is a 20 or 30 ohm centre-tap across the filament of the 245 power valve. To ensure entire freedom from A.C. hum it is necessary to centre-tap all filaments. A 20 ohm does for each of these, the centre being earthed and the ends soldered to the filament points of the valve socket.

A good radio frequency choke is necessary, between the plate of the 224 and the grid of the 245.

The Assembly

The chassis is of steel, and was bought already boxed. Its dimensions are 16½ x 10½, with a 3-inch platform. It is the





Above: Rear view of the receiver's chassis. Right: There is little wiring under the pack's assembly.

right size if it is to include the power components, but could be several inches shorter if a separate pack is used.

It may be noticed from the photograph that the hook-up is the conventional Loftin-White audio circuit, without many resistances and hum-tricker. This was first installed, but was subsequently eliminated in favor of the simplified form, which gave far better results.

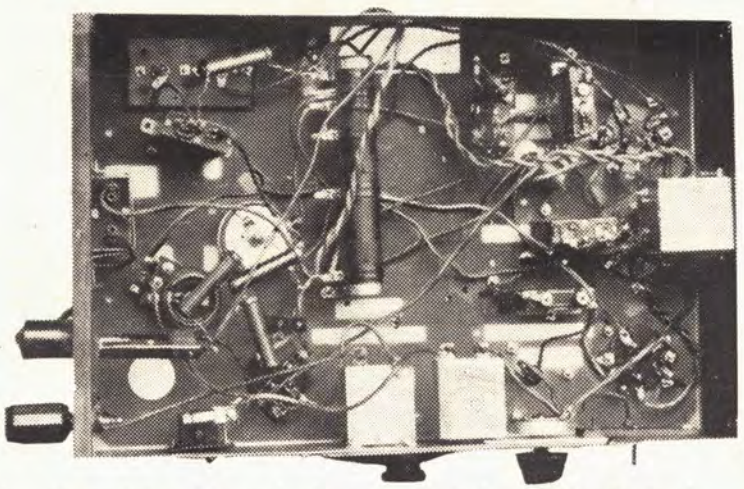
Wiring and Power Notes

Be very careful how you hook up the pre-selector. There is only one way, and that is set out in the diagram. Any variation will probably cut the signal right out.

The original set was worked from a standard power-pack, giving 350 volts each side of the centre-tap. Loftin-White circuits have always been associated with extremely high voltages, but the set works well on 350.

A cone speaker will need a choke-condenser output following the power valve. The original set worked a dynamic, with the field coils as the power pack choke. With a couple of electrolytic condensers there was no hum.

When the set is first switched on it will hum until it warms up. The noise surges up and suddenly dies. If you do not get this surge just before the signal comes in, the set is not in its most sensitive condition, and volume is being lost somewhere.



View of the wiring and minor components beneath the chassis of the receiver proper.

Ganging the Condensers

Begin the lining-up of the condensers with the trimmers half way in. Tune in on the lowest wave-length you can receive with fair volume.

Then operate on trimmer No. 1, which tunes the first coil of the pre-selector. You will almost certainly have to screw it down. If you find that you have to go down to the limit of the trimmer, let out No. 2 trimmer a trifle and try again.

When the best point is reached on No. 1, go to No. 2. Here you will only have to make the slightest adjustment, and probably none at all if No. 1 has been properly trimmed.

Continue on to No. 3 until the most sensitive point is reached, and then do the same to No. 4. Once the condensers are trimmed on a low wave-length station, they need not be touched again. They should operate as efficiently then on 2CO as on 3AW.

A condenser-coupled pre-selector tunes sharply on the low wave-lengths, and tends to produce two peaks on the high wave-lengths. The correction for this disability is to introduce a compensating amount of inductive coupling, which has the opposite effect. Since there are two stages of inductive coupling in the R.F. and detector coils, the effect is sharp peak tuning all over the dial.

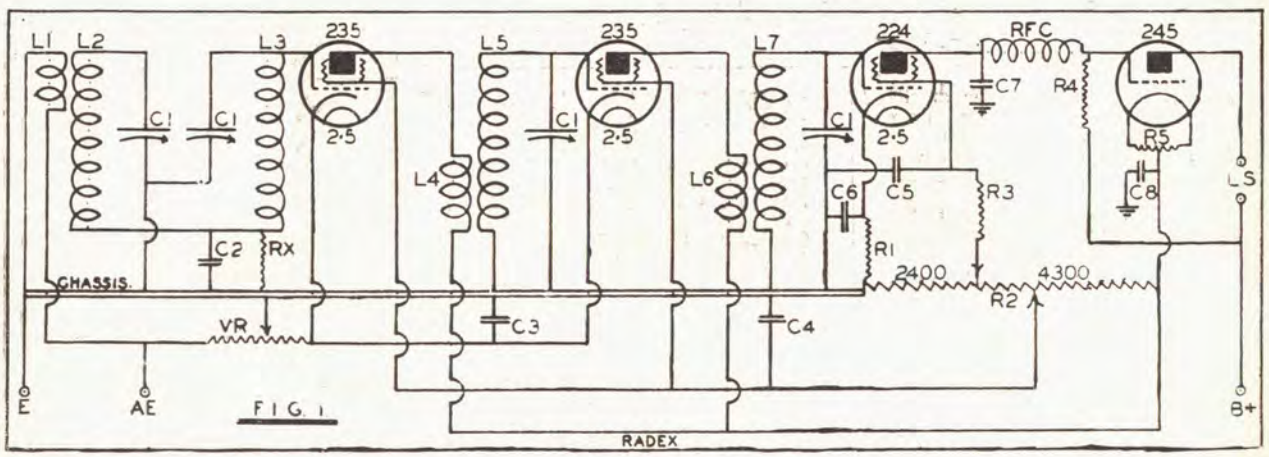
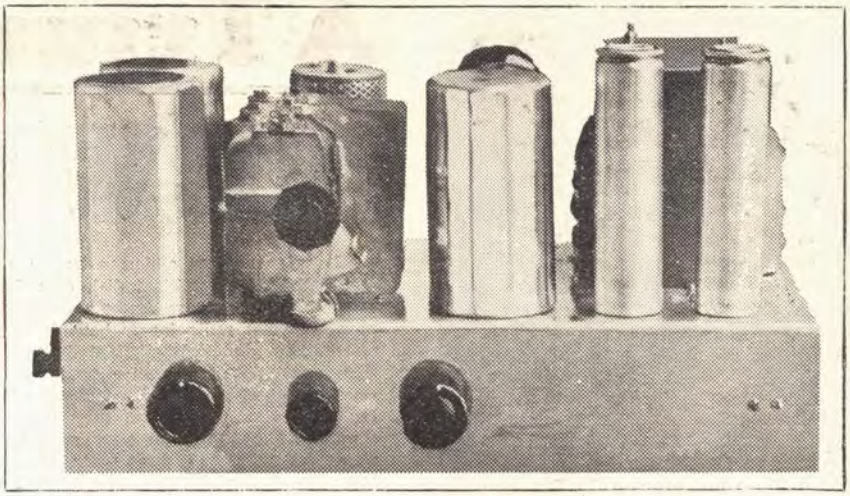


Diagram showing the connections of The Perfect Four. Attention is directed to the important values assigned to resistor R2—this forming the only critical point of the circuit.



The front view of the finished chassis will show the constructor how the coils are mounted in line on either side of the three ganged tuning condensers, while the electrolytic filtering condensers are mounted to the fore of the power transformer. The three lower knobs are the volume, balancing and reaction controls respectively.

It will be noticed that the main tuning dial has been replaced with a knob, this was only to permit the reader to obtain a more unobstructed view of the front of the chassis. When placing the outfit into a cabinet we would suggest that a full-vision type of dial should be employed.

A Complete Radio-Gramo Three

By P. R. DUNSTONE.

With this compact receiver radio and records are reproduced readily. Its construction is extremely simple, the set is empowered by its own built-in power-pack and the results are most gratifying when the following directions are adhered to strictly.

SINCE commercially made receivers are being turned out so rapidly and cheaply these days the average person is tempted to purchase his receiver ready made.

However, for the enthusiast who is still desirous of constructing his own receiver, the design herewith described will be found to suit his requirements. In addition to being excellent for reception of broadcast programmes, this ensemble can also be used in conjunction with a radio gramophone record to be reproduced in a manner far superior to that of the average sound box.

On glancing at the schematical diagram accompanying this article the reader will see that a screen grid variable Mu type of valve has been used for the radio frequency stage which is fed into a 224 type screen grid as a detector. It will be seen that anode bend detection has been used in preference to grid leak, eliminating any tendency for distortion which may be experienced with the grid leak detector.

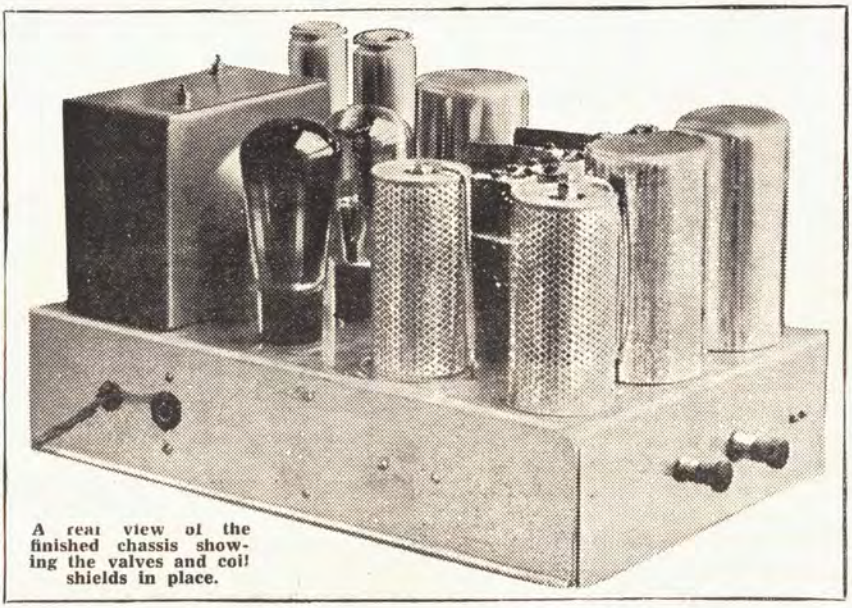
From the detector stage it is passed through a Philips resistance coupler and applied to the grid of a 45 type power valve, which handled the volumes satisfactorily.

The power side of this receiver uses the standard 280 type rectifier which is quite suitable for the job.

Selectivity has become a big consideration in the modern broadcast receiver, and it will be noticed that a pre-selector has been included in the circuit.

This pre-selector circuit is rapidly becoming popular with most of the home set builders, and, properly constructed, it will give a high degree of selectivity without the loss of volume which is usually experienced in most types of selective devices.

Regarding the speaker to be used with this set, it will be seen that the original employed a dynamic; this is not essential, as a cone type may be utilised, provided the volume is cut back to such an extent that the speaker will not be overloaded.



A rear view of the finished chassis showing the valves and coil shields in place.

Reviewing the Components

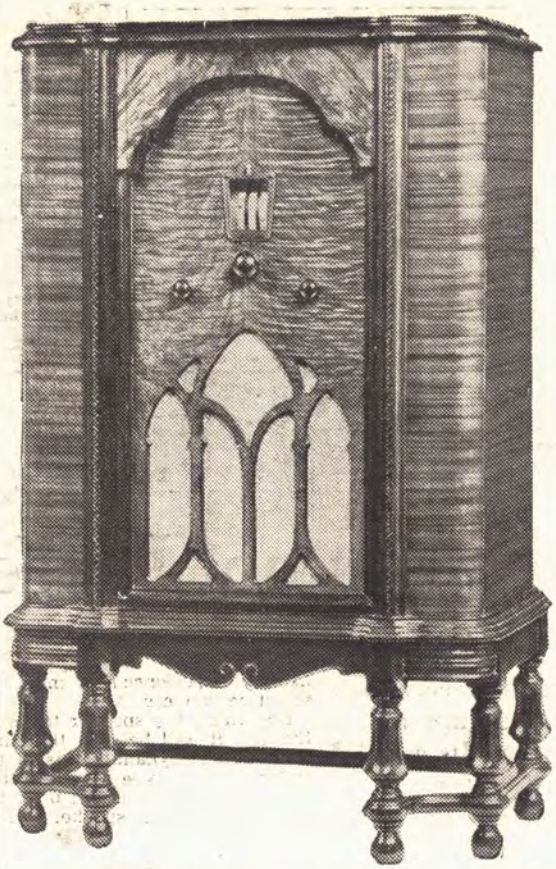
For the benefit of those who are thinking of constructing this receiver, a quick run through the components will be given to simplify matters when purchasing the goods.

Tuning Condenser. — This consists of a three-ganged Racophone condenser having a capacity of .00043 mfd. The condenser is used to tune the three coils—L2, L3 and L4.

Valve Sockets are of the sub-panel mount type, the number required being 2 UY and 2 UX.

Resistance Coupler.—In the original receiver a Philips resistance coupler was employed, and was found to work satisfactorily, but it is not essential that this particular make of coupler be used. The builder can construct his own unit, provided the following values are used. For the plate resistance a value of 200,000 ohms should be employed. For the coupling condenser, .006 mfd will be found to be high enough. The grid resistor should be a .5 megohm.

Regarding the plate resistor, it would be advisable for the resistance to be of the wire-wound type, while the grid resistor



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NEW and . . . Exclusive Features

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STROMBERG-CARLSON 633

The illustration at left shows the beautiful six-legged console in Queensland walnut which houses the super powerful Stromberg-Carlson 633 Super-Heterodyne with its **dual Dynamic Speakers.** Uses latest types of 6 and 7 pin valves Every Set (valves excepted) guaranteed 12 months by makers' warranty. Write or call for Free Art Literature.

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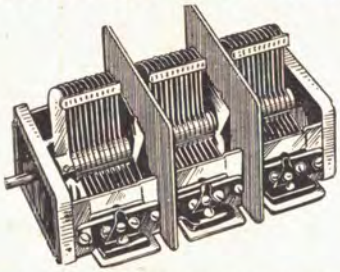
Stromberg-Carlson Condensers

For successful reception with modern circuits, the ganged condensers play an essential part. Sturdiness of construction, reliability and accuracy are features of the Stromberg-Carlson range—that is why they are standard equipment with many commercial receivers, and almost universally recommended by writers of radio, technical, and constructional articles.

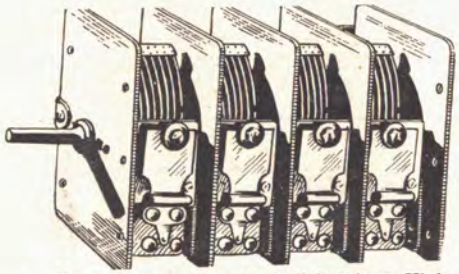
For the Home Set Builder



Designed especially for the Home Set Builder.

1 Gang .00043, less cover	8/-
2 Gang .00043, less cover	14/6
3 Gang .00043, less cover	20/6
4 Gang, .00043, less cover	26/9

For the Manufacturer



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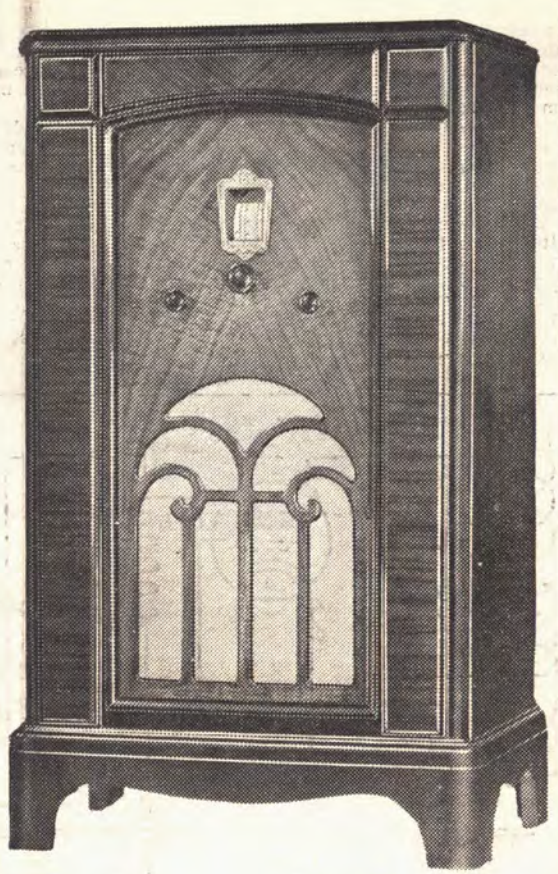

33 and Audiola 693
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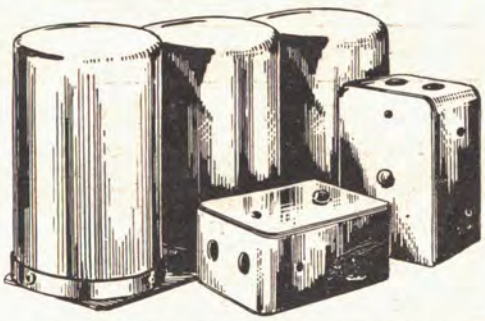
For the Critical Buyer—and Listener
The Stromberg - Carlson
SUPER-HETERODYNE KIT



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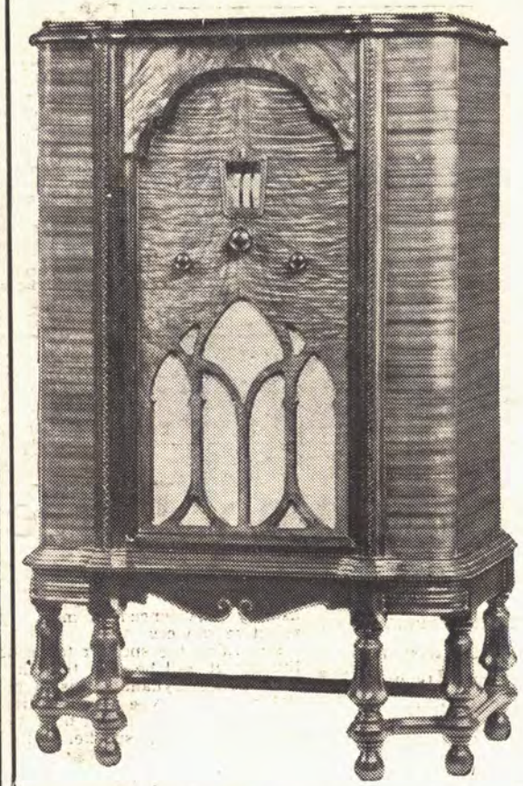

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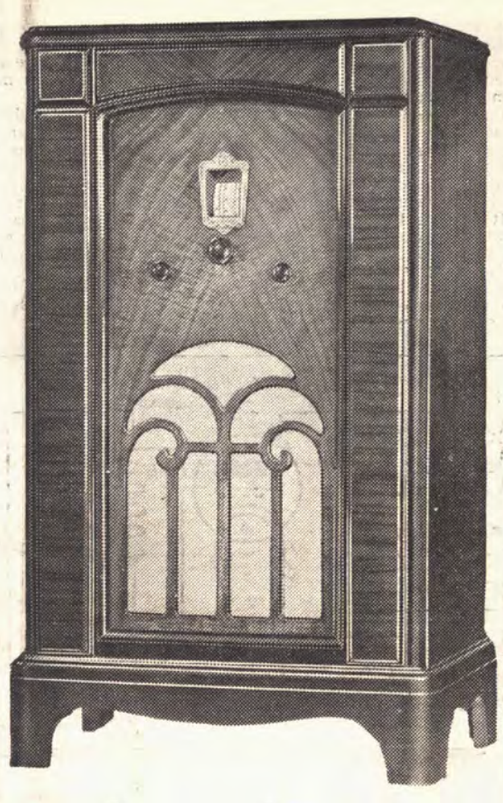

Stromberg-Carlson 633 and Audiola 693

All Electric Super-Heterodynes

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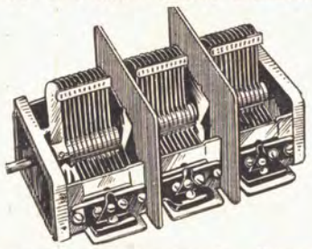

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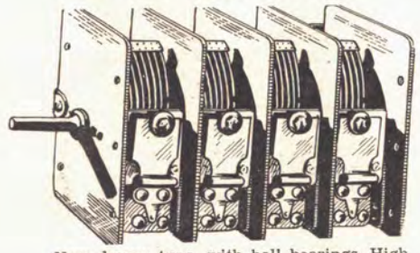

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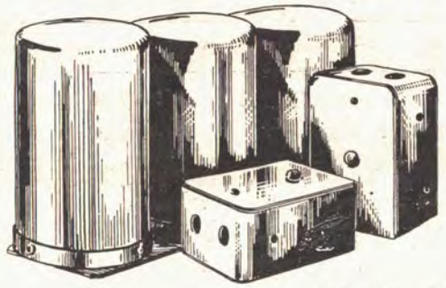

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may be of the usual grid leak type.

Variable Resistance.—VC is a variable resistance, having a value of 10,000 ohms. It is used to bias the 35 as well as being a volume control.

Coupling Condenser. C4.—This condenser will have a tendency to control the selectivity and volume of the receiver. If you are situated near a powerful broadcasting station, the value should be between .0001 mfd. and .0005 mfd. It will be found that if a higher capacity up to about .006 mfd. is used, greater gain will be obtained from the radio frequency stage. The higher the capacity is, the less selective becomes the set.

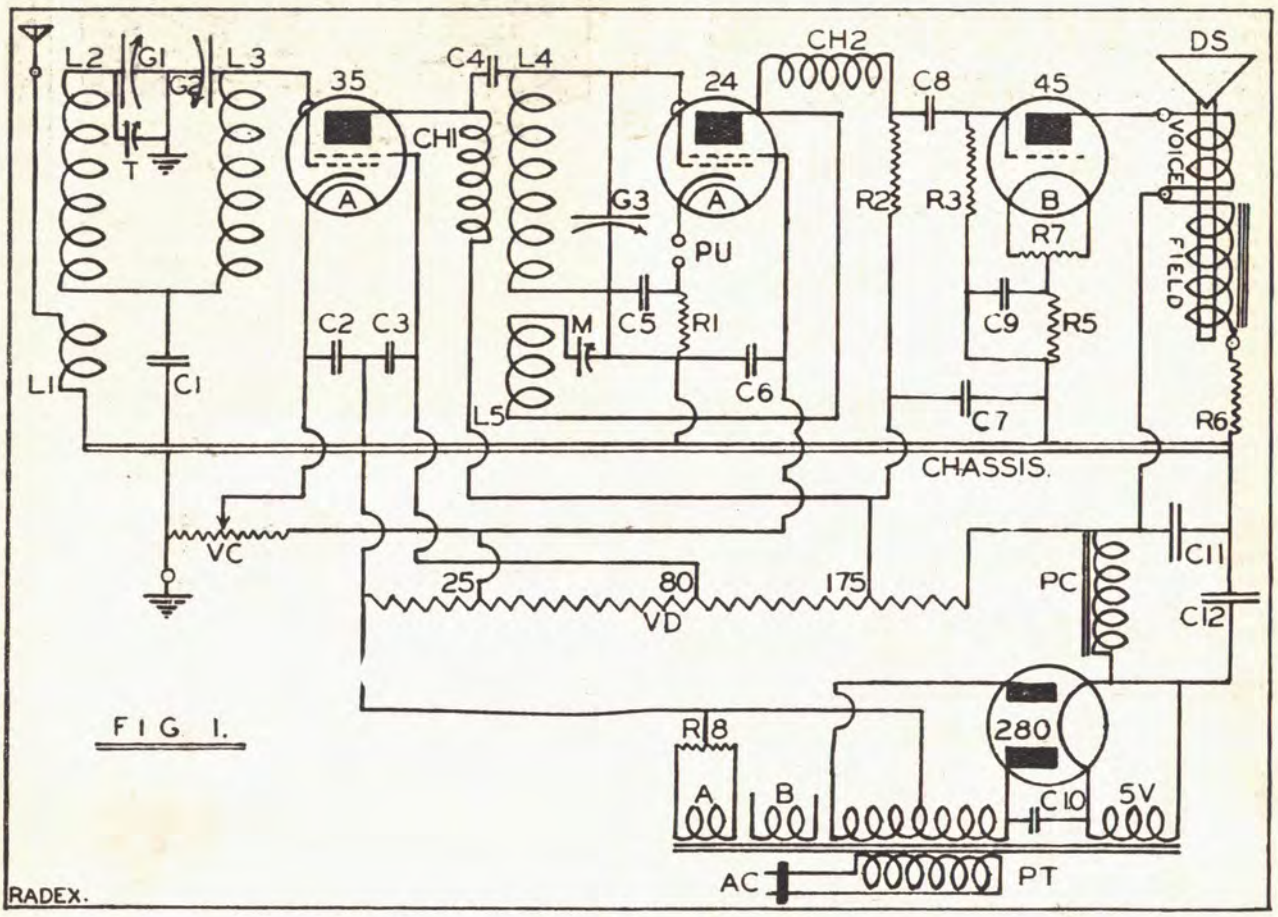
By-Pass Condenser. — C2 C3 and C7 should have a capacity of .01 mfd. But it is not essential for these values to be used, and a capacity ranging between .001 mfd. and .1 mfd. will be quite suitable.

Reaction Condenser.—This is 11-plate midget condenser. Provided the correct number of turns is applied to the coil this size midget condenser will be found to give smooth oscillation.

The Radio Frequency Chokes. — It would be advisable for the builder to construct his own radio frequency chokes, for it is difficult to purchase a type which is satisfactory in the plate lead of the radio frequency stage.

If two pieces of fibre are used approximately the size of a penny in diameter and bolted together with a quarter inch washer between them, and wire having a gauge of approximately 35 to 40 is wound on until the reel is filled, the result will be found to be far more suitable for the job than most of the chokes on the market. Bias resistor, R5, should have a value of 1500 ohms, provided the valve used in the last stage is a 45 type. Whether this valve of any other type is employed it is essential that it can pass the plate current drawn by the valve.

Voltage dividing resistance should be of a reputable make, and should have a value of 25,000 ohms, otherwise it will be found to draw too much "bleeder" current from the power pack.



Schematical diagram of the Radio-Gramo Three Valver.

LIST OF PARTS REQUIRED

4 .01 mfd. fixed condensers, C1, C2, C3 and C6—Alpha.

1 Racophone three-ganged variable condenser .00043 mfd., G1, G2 and G3.

3 1¼ inch Marquis formers with coil shields, L1, L2, L3, L4 and L5.

1 piece of former 1½in. in diameter, 2in. long.

1 Radiokes 13-plate midget condenser, M.

1 30 henry Choke, PC. (Aegis.)

1 resistance, 10,000 ohms, R1.

1 resistance, 1500 ohms, R5—Radiokes.

1 resistance coupler (see text—R2, R3 and C8).

1 variable resistance, 10,000 ohms. VC. (Chanex Marquis.)

1 voltage divider, 2500 ohms, VD (Radiokes Aegis.)

3 fixed condensers, 1mfd., 1500 volts test, C5, C7, C9—Hydra.

2 centre-tapped filament resistances—R7 and R8.

1 Radiokes 5-plate midget condenser, T.

1 condenser, .0001 mfd., C4.

1 power transformer having 350 volts each side of the centre tap, one filament winding for the rectifier and two 2.5 volt windings for the three valves, PT. (Hilco.)

2 UY sub-panel 1 valve sockets and shields.

2 UX sub-panel valve sockets.

2 Radio frequency chokes CH1 and CH2.

4 terminals.

One A.C. plug.

Some flex.

1 dynamic speaker with field of 750 ohms.

1 resistance, 2000 ohms, R6.

One sheet of aluminium, gauge 16, measuring 21 by 16 inches — Geo White and Co.

2 electrolytic 8 mfd. condensers C11, C12. (Polymet.)

1 condenser, .006 mfd., C10—Sangamo.

Machine screws.

1 reel of wire guage 30 D.S.C.—Henley.

Valves—235, 224, 245, 280.

If a smaller power transformer is used, this resistance may be reduced in accordance with the voltage delivered.

Constructing the Chassis

A piece of aluminium measuring 21 by 16 inches and having a gauge of about 16 may be used for the chassis. Cut a 3-inch square from each of the corners. Having done this, place the aluminium in a right angular metal edge and bend the sides over. Fasten the corners of the chassis with the pieces of aluminium cut from them by simply putting them in a vice and bending them at right angles.

Winding the Coils

The winding of the coils should offer little difficulty provided the details given are followed closely. We will begin by winding the coils L1 and L2 on one of the 1¼ inch Marquis formers, which is included in the list of components required.

It will be necessary to drill four holes at the bottom of the former to permit small soldering lugs to be fastened on.

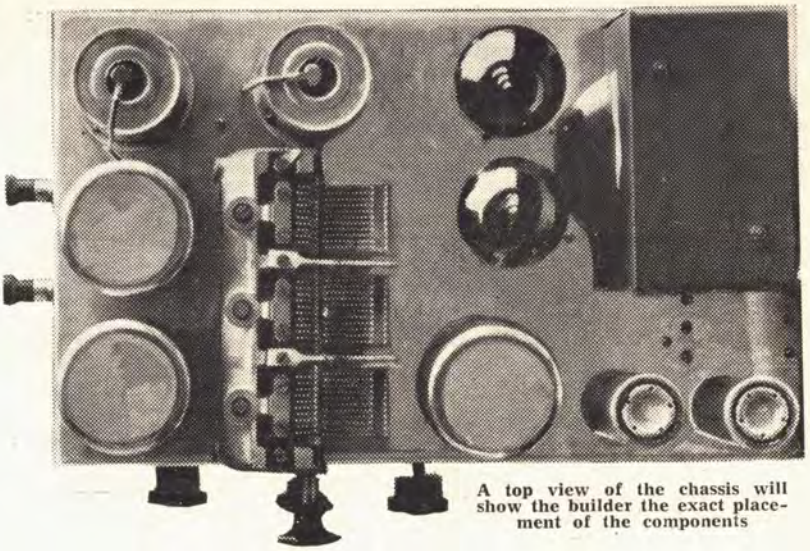
Having mounted the four small soldering lugs on the bottom of the former and soldered the end of the wire to one of the lugs, commence by winding on about 30 turns. This coil is known as the aerial coil, and, since the selectivity in the receiver is of a high degree, it will be found that with this number of turns on the former a length of aerial up to 100 feet may be used without receiving interference. If the builder is desirous of using the receiver on a small aerial it will be necessary for him to increase the number of turns on this coil.

However, when finished, take the other end of the wire to another lug at the bottom of the former.

In L2 coil the same procedure is followed, but this coil will require 104 turns wound on it.

The next coil, L3, will only require two soldering lugs fastened to it, as this former has only one coil wound on it. The number of turns that should be placed on this coil is 106.

Having wound all the coils on the other two formers, we come to coils L4 and L5. Here we have a slight variation to the others. On glancing at Fig. 2 it will be seen that L5 has been drawn above L4. Actually, L5 is a separate piece of former, having a diameter of 1½ inches, and when finished is slipped over the top of L4.



A top view of the chassis will show the builder the exact placement of the components

Coil L4 will require 104 turns wound on it, while coil L5 should be of approximately 35 turns. It would be advisable for the builder to experiment with L5 until he finds that he can make the receiver go in and out of oscillation smoothly.

In mounting the three-ganged condenser it will be seen that the one used in the original receiver was mounted on its side, the reason being to simplify matters when ganging up the three condensers, as the trimmers are mounted on the side of the condensers. When fitting this condenser, three small rubber washers should be placed underneath before it is bolted to the chassis, these giving it a little flexibility.

Wiring in Words

We will commence the wiring by taking a lead from the beginning of the L1 to the terminal mounted on the side of the chassis, namely, the aerial, which is bushed from the chassis by means of a piece of fibre.

The other end of this coil E is connected direct with the chassis.

G1 end of coil L2 will be taken to the fixed plates of the front condenser of the three-ganged, namely, G1.

A lead is also taken from the fixed plates of this condenser G1 to the fixed plates of the five plate trimmer, T.

The movable plates of these condensers are automatically connected to earth through the medium of the chassis.

The other end of coil L2 is joined to one side of the condenser C1.

In wiring L3 into circuit, you will connect G2 to the fixed plates of condenser G2, and a lead from the fixed plates of the same condenser to valve pip on top of the 35, this being the grid terminal of the valve.

The other end of L3—X1—is also connected to the same side of the condenser, C1, as that of the previous coil, while the other side of this C1 is taken direct to the chassis.

The P terminal of the 35-valve socket is joined to one side of the radio frequency choke, CH1, and to one side of C4.

The remaining end of this choke, CH1, is taken to a tapping on the voltage divider which will deliver approximately 175 volts.

The other side of condenser C4 is connected to G3 end of coil L4, and from there to the fixed plates of the condenser G3, and from here it is carried to the pip on top of the valve socket namely, the grid connection of the 24.

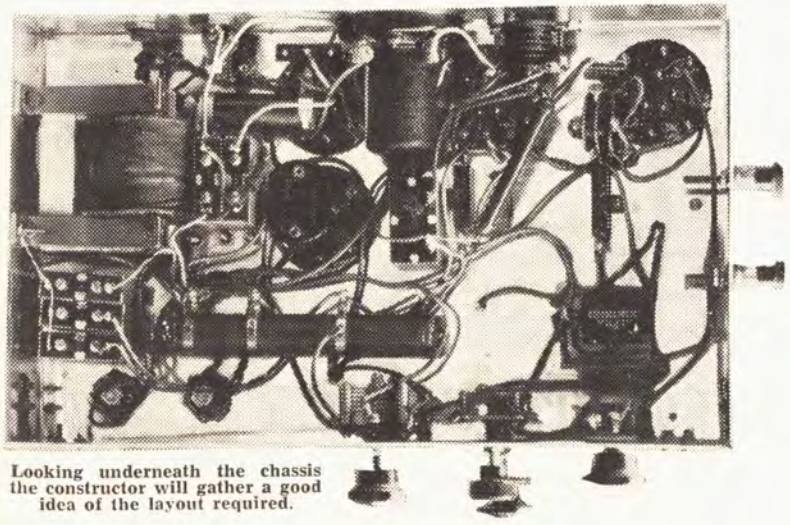
The E end of the coil L4 is taken to chassis.

The M connection of coil L5 should be joined to the fixed plates of the midget condenser M, while the other end of the coil L5 is connected to the plate terminal on the 24-valve socket. The movable plates of the midget condenser are connected through the medium of the chassis.

The cathode terminal of the valve socket 24 is connected to one of the pick-up terminals while the remaining pick-up terminal is joined to one side of the 10,000 ohms resistor R1 on one side of the condenser C5. The other end of this resistor R1 going to chassis.

The screen terminal of the valve socket 24, which is the normal grid connecting on other valves, is connected to a tapping on the voltage divider, having about 25 volts. This lead is bypassed with C6 to earth. We will now finish off the wiring in the r.f. stage.

The cathode terminal on the valve



Looking underneath the chassis the constructor will gather a good idea of the layout required.

socket 35 is taken to the movable arm of the resistance VC while one of the outer terminals on VC is connected to earth. The other side of the resistance VC is also connected with the 25 volt tapping on the voltage divider VD.

The cathode terminal is by-passed with condenser C2.

The screen grid terminal of the radio frequency valve socket is connected to a tapping on the voltage divider VD, having a voltage around about 80 volts. The lead is also by-passed to earth by condenser C3.

One side of CH2 is connected to the P terminal on the detector valve socket 24.

The other side of this choke CH2 is joined to the P terminal on the resistance coupler R2. While the other end of this resistance R2 is connected to the same tapping on the voltage divider VD and that of the P terminal tapping in the radio frequency stage.

One side of condenser C8 is joined to the end of resistance R2 that the CH2 is connected to. The other side of this condenser is connected to the resistance R3 and to the grid terminal on the 45 valve socket.

The other end of resistor R3 is connected to chassis.

We will assume that a dynamic speaker is to be used with this receiver.

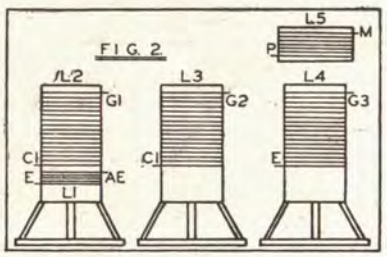
The P terminal on the valve socket 45 will be connected to one of the terminals on the voice coil of the speaker DS, while the remaining terminal on the voice coil and one side of the field coil will be connected together and taken down to the choke PC.

The other end of the field coil will be connected through the medium of resistance R6 to earth.

In wiring the filaments of the first two valves, namely 35 and 24, the lead will have to be tightly twisted and kept as short as possible, otherwise hum will be introduced into the circuit. Connect the two filament terminals on each of the valve sockets together and take them down to the filament winding A on the power transformer.

The resistance R8 is connected across the terminals of the filament winding A and the centre tap is taken direct to chassis.

This leaves the filament of the 45 valve to be wired into circuit. Having



Coil details.

connected the resistance R7 across the filament terminals, take two tightly-twisted leads to the filament winding B on the power transformer. The centre-tap of resistance R7 is connected to one side of resistance R5 and to one side of condenser C9. The other side of resistance R5 and condenser C9 are connected to chassis.

A condenser C7 is wired from the end of the resistance R2, which is connected to the voltage divider VD, the other end going to chassis.

Leads from the two outer terminals on the power-pack are connected to the two plate terminals of the 280 valve socket, while the centre-tap of this winding is taken to chassis. The two leads from the five-volt filament winding are connected to the two filament terminals on the rectifier valve socket.

On one side of the choke, PC, is connected to one of the filament terminals on the rectifier valve socket and to one side of C12.

The other side of the choke PC is joined to one side of the condenser C11 VD, and to one side of the voltage divider.

The other end of the voltage divider VD is connected direct to the chassis. In most cases the condensers C11 and C12 are automatically connected to earth through the medium of the casing.

A condenser will probably have to be inserted across one of the plate and filament terminals of the rectifier to prevent modulation hum. This can only be found by experimenting. It will be found that C10 will stop any tendency to modulation hum due to the construction of the transformer.

The remaining two terminals on the power transformer are connected to the A.C. mains.

Operation

Connect the aerial and earth to their respective terminals on the side of the chassis and bridge the two pick-up terminals. The loud speaker being already wired into the circuit, connect the power plug into the electric light and allow the valves to warm up; then rotate dial of the three ganged condenser until a station is audible; adjust reaction until it is brought in at max. volume. Make certain that the variable resistance on the 35 is not cut back, otherwise no signals will be heard.

In ganging the condensers the volume should be cut back, and the trimmers adjusted on the side until the station tuned to is received at best signal strength.

ALL STATIONS *on the* AIR

Below, arranged in descending order of their wave lengths, appears a list of Australian National, Relay and Class B stations. While every effort has been made to give the full hours of working, it should be noted that Class B transmitters are liable to vary their hours without notice. All times quoted are those current in the Zone of the particular station. Thus, when Perth—6WF—is quoted as closing at 11 p.m., that hour corresponds to 1 a.m. of the following day in Victoria.

Call	Wave	PLACE	HOURS—MONDAY TO FRIDAY	HOURS—SATURDAY	HOURS—SUNDAY	Dial
2CO	536	Corowa	See 3LO and 3AR	See 3LO and 3AR	See 3LO and 3AR.	
7ZL	517	Hobart	7.30 to 8.30, 11.30 to 5.15, 6 to 11.30	7.30 to 8.30, 11.30 to 5.15, 6 to 11.	10.30 to 12.15, 3 to 4.30, 6 to 10.	
3AR	492	Melbne	8.15 to 11, noon to 5.45, 6.15 to 10.30	8.15 to 11, noon to 5.45, 6.15 to midnight.	11 to 3, 4.30 to 10.	
5CK	472	C'sti Bk	See 5CL.	See 5CL.	See 5CL.	
2FC	451	Sydney	7 to 8.15, 10.30 to 4.45, 5.45 to 11.30	7 to 8.15, 10.30 to 4.45, 5.45 to 11.30.	10 to 12.30, 3 to 4.30, 6 to 10.30	
6WF	435	Perth	See 7ZL.	See 7ZL.	See 7ZL.	
5CL	411	Adelaide	7.30 to 8.30, 11 to 2, 3 to 4.30, 5.50 to 11.	7.30 to 8.30, 11.30 to 5.15, 5.50 to 10.30.	10.30 to 12.30, 3 to 4.30, 5.50 to 10.	
4QG	395	Brisbane	7.30 to 8.30, 11 to 2, 3 to 4.30, 6 to 11	7.30 to 8.30, 11.30 to 5, 6 to 11.30.	10.30 to 12.15, 3 to 4.30, 6 to 10.	
3LO	375	Melbne.	7 to 8.15, 10.30 to 12.30, 1 to 4.30, 5.45 to 11.30.	7 to 8.15, 10.30 to 12.30, 1 to 5, 5.45 to 11.30.	10 to 12.30, 3 to 4.30, 6 to 10.30.	
2BL	351	Sydney	8.15 to 11, noon to 5.45, 6.15 to 10.30.	8.15 to 11, noon to 5.45, 6.15 to midnight	10.55 to 3, 4.30 to 10.	
6PR	341	Perth	10.30 to 11.30, 4.30 to 10.30.	See Monday.	11 to 1, 6.30 to 10	
7HO	337	Hobart	8 to 9, noon to 2, 6 to 10.30.	See Monday.	8 to 9.30.	
4RK	330	Rock'ton	See 4QG.	See 4QG	See 4QG	
3UZ	326	Melbne	7 to 8.30, 9 to 2, 3.30 to 11.30.	7 to 8.30, 9 to noon, 6 to midnight.	10.30 to 12.30, 5.45 to 10.	
2GB	316	Sydney	7 to 11.30, 12.15 to 11.30.	See Monday.	5 to noon 1.30 to 10.30.	
5DN	313	Adelaide	7.15 to 10, 11 to 11.15.	7.15 to 1, 5.30 to 11.15.	6.45 to 10.20	
3BO	309	Bendigo	7.30 to 10.0.	7.30 to 10.30	7.0 to 9.0	
4GR	300	Toowoomba	9 to 10.0, 12.0 to 2.0, 6.0 to 10.0.	9.0 to 10.0, 12.0 to 12.30, 1.15 to 5.0, 7.0 to 10.0.	10.0 to 1.0, 7.0 to 10.0.	
3HA	297	Hamilton	12.0 to 2.0, 6.30 to 10.30.	12.0 to 1.15, 6.30 to 10.30.	7.0 to 10.30.	
2UE	293	Sydney	7 to 8.15, 8.15 to 10.0, 10.0 to 12.30, 2.0 to 4.0, 5.0 to 11.30.	Noon to 5.0	9.0 to noon 6.0 to 11.0.	
5PI	288	Pt Pirie	5.30 to 10.	5.30 to 11.0.	No service.	
2CA	285.7	Canberra	7.30 to 10.	7.0 to 10.0.	8.0 to 10.0.	
3YB	283	Mobile	6.30 to 10.30.	6.30 to 10.30	6.30 to 10.30.	
4MB	283	Maryboro.	6.30 to 10.0.	Silent	Silent.	
2KY	280	Sydney	7.0 to noon, 6.0 to 10.30.	Noon to 4.30, 6.0 to 10.0.	7.30 to 10.30, 6.0 to 10.30.	
3SH	278.9	Swan Hill	7.30 to 10.0.	Same as Mon.	12.15 to 2.15, 4.15 to 6.0, 7.15 to 10.0	
7LA	273	Launceston	3.0 to 4.30, 6.0 to 10.30.	1.30 to 10.30.	6.0 to 10.0.	
2HD	270	N'castle				
2UW	267	Sydney	7.30 to 9.. 10.30 to 2, 3 to 5, 5.15 to 10.30.	7.30 to 12.30, 5.15 to 10.30.	10.30 to 1.0, 3.0 to 5.0, 5.15 to 10.30	
6ML	264	Perth	11.0 to 3, 5.45 to 10.30.	3.0 to 4.0, 6.0 to 10.30.	7.0 to 10.0.	
4BC	262	Brisbane	7.0 to 9.0, 10.0 to 3.30, 5.30 to 11.0	7.0 to 9.0, 7.30 to 11.0.	10.0 to 11.0.	
2WG	260	Wagga	7.45 to 8.30, 7 to 10.	Same as Mon.	No service.	
4TO	258.1	T'sville	6.30 to 10.15.	Same as Mon.	8.0 to 10.15.	
3DB	255	Melbourne	7 to 8.30 10.45 to 1.45, 2 to 11.	7.0 to 8.30, 2.0 to 11.0.	2.30 to 4.30, 6.0 to 10.0.	
4MK	252	Mackay	7.0 to 10.15.	7.0 to 11.0.	10.0 to 11.20, 2.0 to 5.30, 6.0 to 9.30.	
5KA	250	Adelaide	7.0 to 8.0, 10.0 to 12.0.	Same as Mon.	10.0 to 11.0, 3.0 to 4.0, 4.45 to 5.30 7.0 to 10.0.	
2CH	248	Sydney	7.0 to 8.30, 10.0 to 12.30, 2.0 to 4.30, 5.10 to 10.30.	7.0 to 8.30, 10.0 to 12.30, 2.0 to 5.0, 5.15 to 10.30.	10.30 to 12.30, 2.30 to 4.45, 5.15 to 10.0	
6KG	246	K'goorlie	11.0 to 1.0, 6.30 to 10.30.	2.0 to 5.0, 7.0 to 10.30.	7.45 to 10.30.	
2NC	241	N'castle	See 2FC.	See 2FC.	See 2FC.	
3WR	238	Wang'ta	12.30 to 1.30, 6.30 to 10.0.	Same as Mon.	8.0 to 10.0.	
2SM	236	Sydney	7.0 to 8.30, 1.0 to 2.0, 5.30 to 10.30.	7.0 to 8.30, 5.30 to 11.30.	11.0 to 1.30 6.0 to 10.30.	
3TR	234.2	Sale	10.30 to 2.0, 6.0 to 10.15	10.30 to 1.0, 6.0 to 10.15.	7.0 to 10.0.	
4BK	233	Brisbane	8.30 to 1.0 4.30 to 11.0.	8.30 to 12.0, 5.45 to 11.0.	7.0 to 10.0.	
3BA	230.1	Ballarat	1.0 to 2.0 7.0 to 10.30.	7.0 to 11.0.	1.0 to 3.0 6.30 to 10.0.	
5AD	229	Adelaide	7.0 to 8.30, 10.0 to 2.0, 3.0 to 5.0, 5.30 to 11.0.	7.0 to 12.30, 2.0 to 5.30, 6.0 to 7.50, 8.0 to 11.0.	5.50 to 9.50	
2MO	227	Gunnedah	7.45 to 8.45, 7.0 to 9.0.	Same as Mon.	7.0 to 9.0.	
4RO	225.5	R'hampton	6.0 to 10.0.	1.30 to 5.0, 6.0 to 10.0.	No service.	
2XN	224	Lismore	6.30 to 11.0.	Same as Mon.		
3KZ	222	Melbourne	7.0 to 1.30 2.30 to 4.30, 5.15 to 11.30	7 to 10.45 a.m., 12.15 p.m. to 1 a.m.	Mdt. to 1.0, 2.30 to 4.30, 6.0 to 10.0.	
4BH	217	Brisbane	7.0 to 8.30, 11.0 to 12.30, 12.30 to 1.15, 1.15 to 2.0, 6.0 to 10.30.	7.0 to 8.30, 5.45 to 11.0.	Nn. to 2.0, 7.0 to 10.0.	
2GN	216	Goulburn	Hours irregular.	6.30 to 10.30.	7.30 to 9.30.	
3GL	214.2	Geelong	7.45 to 9.15 1.0 to 2.0, 5.30 to 10.30.	7.45 to 9.15, 10.30 to 11.45, 6.0 to 10.30.	7.0 to 10.0.	
2KO	212	Sandgate	10.15 to 11.30 5.15 to 10.30.	9.0 to 11.0, 5.15 to 11.0.	7.0 to 9.0.	
3AW	210	Melbourne	7.0 to 8.30, 2.0 to 11.0.	7.0 to 8.30, 2.0 to 11.0.	10.30 to 12.30, 4.30 to 10.30.	
2WL	209.06	Wol'gong	6.30 to 10.0.	Same as Mon	7.0 to 9.0	
7UV	204.5	U'verstone	12.0 to 2.0, 5.30 to 10.30.	12.0 to 2.0, 5.30 to 11.0.	7.0 to 10.0.	
2AY	203	Albury	6.30 to 10.30.	7.0 to 10.30.	7.30 to 10.30.	
3AK	200	Melbourne	Mdt. to 2.0 5.0 to 7.0, 11.30 to Mdt	Mdt. to 2.0, 5.0 to 7.0, 1 p.m. to 2.0, 11.30 to Mdt.	Mdt. to 3.0, 12.30 to 2.30, 10.0 to Mdt.	

SOME FOREIGN BROADCASTERS

Below is a list of some of the more powerful stations transmitting broadcast programmes located in countries comparatively adjacent to Australia. It is not suggested that even 5 per cent. of these programmes are audible regularly here; however a combination of good receiver, fine conditions and a favored site sometimes works wonders.

Should you hear what appear to be foreign signals, carefully note your dial setting. Get a bracket on this reading by finding a station above and below it on page 49, and then approximate the strange wave length in column three of this page. Time is also an illuminating factor; foreigners using approximately our time (vide page 35) come in during the late evening, while those to the west and east are best during the early morning and late afternoon respectively.

Dial Says	Call-sign	Wave Length	Name of Station	Country	Owner's Postal Title
	KOAC	545	Corvallis	Oregon, U.S.A.	Oregon State Agricultural College.
	KTAB	536	Oakland	Cal., U.S.A.	Associated Broadcasters (Inc.)
	KMTR	526	Los Angeles	Cal., U.S.A.	The KMTR Radio Corporation.
	KXA	523	Seattle	Wash., U.S.A.	American Radio Telephone Co.
	XFI	507	Federal Dist.	Mexico	Secretaria de Industria, Comercio y Trabajo,
	XFA	500	Tacubaya del Distrito Fed.	Mexico	Dereccion de Estudios Geograficos y Climatologicos.
	KZRM	485	Manila	Philippines	Radio Corp. of the Philippines.
	COTN	480	Tientsin	China	The Government of Tientsin City.
	JONK	472	Nagano	Japan	Nippon Hoso Kyokai.
	KF	468	Buena Park	Cal., U.S.A.	Earle C. Anthony (Inc.).
	4YA	461	Dunedin	N.Z.	Radio Broadcasting Co. of N.Z.
	ZTJ	450	Johannesburg	South Africa	Broadcasting Co. Ltd., Box 4559, Johannesburg
	JFAK	448	Taihoku	Japan	Nippon Hoso Kyokai.
	COHB	445	Harbin	China	N.E. Telephone, Telegraph and Radio Administration.
	KPO	441	S. Francisco	Cal., U.S.A.	Hale Bros.' Stores (Inc.).
	JOLK	441	Fukuoka	Japan	Nippon Hoso Kyokai.
	JOKK	429	Okayama	Japan	Nippon Hoso Kyokai.
	VPB	429	Colombo	Ceylon	Government of Ceylon.
	KMPC	423	Beverly Hills	Cal., U.S.A.	R. S. MacMillan
	JOJK	423	Kanazawa	Japan	Nippon Hoso Kyokai
	2YA	417	Wellington	N.Z.	Radio Broadcasting Co. of N.Z.
	ZTD	410	Durban	South Africa	Broadcasting Co. Ltd., Box 4559, Johannesburg
	XEN	410	Federal Dist.	Mexico	General Electric, S.A.
	JOBK	400	Osaka	Japan	Nippon Hoso Kyokai
	KVI	395	Des Moines	Wash., U.S.A.	Puget Sound Broadcasting Co.
	JQAK	395	Dairen	Kwantung	Kantoshu Teishinkyoku.
	JOHK	390	Sendai	Japan	Nippon Hoso Kyokai
	VUM	390	Madras	India	Corporation of Madras
	KELW	385	Burbank	Cal., U.S.A.	Magnolia Park Ltd.
	KTM	385	St. Monica	Cal., U.S.A.	Pickwick Broadcasting Corp.
	JOPK	385	Shizuoka	Japan	Nippon Hoso Kyokai.
	KGO	380	Oakland	Cal., U.S.A.	National Broadcasting Co.
	JOGK	380	Kumamoto	Japan	Nippon Hoso Kyokai
	ZTC	375	Capetown	South Africa	Broadcasting Co. Ltd., Box 4559, Johannesburg
	VUC	370	Calcutta	India	State Broadcasting Service.
	JOCK	370	Nagoya	Japan	Nippon Hoso Kyokai
	JODK	366	Keijo	Japan	Keijo Hoso Kyoku
	KOA	361	Denver	Colorado, U.S.A.	National Broadcasting Co.
	JOIK	361	Sapporo	Japan	Nippon Hoso Kyokai.
	XFX	357	Federal Dist.	Mexico	Secretaria de Educacion Publica
	VUB	357	Bombay	India	State Broadcasting Service.
	ZBW	355	Victoria Pk.	China	Colonial Government, Hong Kong.
	JOFK	353	Hiroshima	Japan	Nippon Hoso Kyokai

Dial Says	Call-sign	Wave Length	Name of Station	Country	Owner's Postal Title
	HSP—1	350	Bangkok	Siam	Administration des Postes et des Telegraphes
	JOAK	345	Tokai	Japan	Nippon Hoso Kyokai.
	KLX	341	Oakland	Cal., U.S.A.	Tribune Publishing Co.
	VUL	340	Lahore	India	Y.M.C.A. Radio Co.
	KHJ	333	Los Angeles	Cal., U.S.A.	Don Lee (Inc.) .
	1YA	333	Auckland	N.Z.	Radio Broadcasting Co. of N.Z.
	KROW	323	Richmond	Cal., U.S.A.	Educational Broadcasting Corp.
	KFWI	323	S. Francisco	Cal., U.S.A.	Radio Entertainments Ltd.
	KZRC	320	Cebu	Philippines	Radio Corp. of Philippines
	HSP—3	320	Saladeng	Siam	Administration des Postes et des Telegraphes
	KGU	319	Honolulu	Hawaii	Advertiser Publishing Co.
	KFWB	316	Hollywood	Cal., U.S.A.	Warner Bros.' Broadcasting Co.
	XOPP	315	Peiping	China	Peiping Radio Station.
	3YA	306	Christchurch	N.Z.	Radio Broadcasting Co. of N..Z
	KFVD	300	Culver City	Cal., U.S.A.	Los Angeles Broadcasting Co.
	XEI	300	Morelia	Mexico	Carlos Gutierrez, Morelia.
	KQW	297	St. Jose	Cal., U.S.A.	Pacific Agricultural Foundation.
	KNX	286	Los Angeles	Cal., U.S.A.	Western Broadcast Co.
	XGZ	280	Central	China	Kaomintung Headquarters.
	KSMS	277	Shanghai	China	Shanghai Daily News
	KGDM	273	Stockton	Cal., U.S.A.	E. F. Peffer
	KFSG	270	Los Angeles	Cal., U.S.A.	Echo Park Evangelistic Association.
	KMCS	268	Inglewood	Cal., U.S.A.	Daltons (Inc.).
	2ZW	267	Wellington	N.Z.	L. E. Strachan
	2ZJ	260	Gisborne	N.Z.	C. T. C. Hands
	4ZP	258	Invercargill	N.Z.	Parson's Radio Supplies
	KEX	254	Portland	Oregon, U.S.A.	Western Broadcasting Co.
	KOB	254	College	N. Mex., U.S.A.	College of Agriculture.
	KGFJ	250	Los Angeles	Cal., U.S.A.	Ben S. McGlashan.
	KVOS	250	Bellingham	Wash, U.S.A.	Station KVOS (Inc.).
	KPPC	250	Pasadena	Cal., U.S.A.	Pasadena Presbyterian Ch.
	KWG	250	Stockton	Cal., U.S.A.	Portable Wireless Tel. Co.
	KSMR	250	St. Maria	Cal., U.S.A.	Santa Maria Radio
	KMJ	248	Fresno	Cal., U.S.A.	James McClatchy Co.
	2ZL	245	Dunedin	N.Z.	Radio Service Ltd.
	KGGM	244	Albuquerque	N. Mex., U.S.A.	New Mexico Broadcasting Co.
	KYA	244	S. Francisco	Cal., U.S.A.	Pacific Broadcasting Corp.
	2YB	243	New Plymouth	N.Z.	Radio Broadcasting Co. N.Z.
	KFAC	231	Los Angeles	Cal., U.S.A.	Los. Angeles Broadcasting Co.
	KGEF	231	Los Angeles	Cal., U.S.A.	Trinity Methodist Church.
	KFBK	229	Sacramento	Cal., U.S.A.	James McClatchy Co.
	KGMB	227	Honolulu	Hawaii	Honolulu Broadcasting Co.
	KGB	225	Spokane	Wash., U.S.A.	N.W. Broadcasting System.
	KGER	221	Long Beach	Cal., U.S.A.	Consolidated Broadcasting Corp.
	KFJI	219	Astoria	Oregon, U.S.A.	KFJI Broadcasters (Inc.).
	KOOS	219	Marshfield	Oregon, U.S.A.	H. H. Hanseth (Inc.)
	KGFL	219	Raton	N. Mex., U.S.A.	Station KGFL (Inc.)
	KRE	219	Berkeley	Cal., U.S.A.	First Congregational Ch.
	KFQU	211	Alma	Cal., U.S.A.	W. E. Riker and Co.
	KGGC	211	S. Francisco	Cal., U.S.A.	Golden Gate Broadcasting Co.
	KECA	210	Los Angeles	Cal., U.S.A.	Earle C. Anthony (Inc.)
	KLS	208	Oakland	Cal., U.S.A.	Warner Bros.
	KGA	204	Spokane	Wash., U.S.A.	N.W. Broadcasting System
	KXO	200	Centro	Cal., U.S.A.	E. R. Irey and F. M. Bowles.

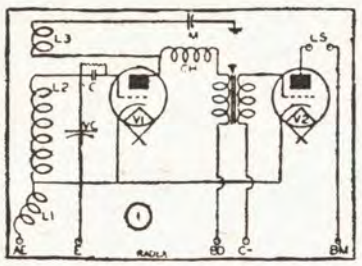
EASY ELECTRIC RECEIVERS

A comparison of some simple A.C. sets for the beginner.

By RADEX

THE new-comer to home-made all electric radio, irrespective of whether he has previously made battery-operated models or is an absolute novice, is often bewildered at the number of strangely named adjunctive parts with which he is faced. Frequently their objectives, or even their strict necessity, are obscure, while the situation is further complicated by the vast variety of valves (each having widely ranged characteristics) which are offered.

If, however, a few salient points are rigorously observed, there is no serious reason for bewilderment, and the construction of an all-electric receiver presents no more difficulty than did its parent—the battery model. A.C. valves, while individually capable of handling more input energy and of collectively delivering greater power, are fundamentally similar to their D.C. cousins; each has a filament (called in this instance, a "cathode") which has to be



The simplest of all Two's.

brought to a condition of radiant heat by raw alternating current supplied by a low voltage source—such as a transformer; the plate (or "anode") of each must be positively polarised from a source of high voltage commonly called the "B" supply; and, in any cascade of such valves, certain individuals—as required by the entire circuit design — must have their grids negatively biased, which corresponds to the function of the "C" battery in old-fashioned sets.

Were it not that the high current-drain would make the scheme unwarrantedly expensive, the filaments of A.C. valves could be heated by an accumulator, while their B and C battery requirements could be supplied by the old blocks of dry cells.

Power Supply

Bearing the foregoing remarks in mind, the major problem of the All-Electric Receiver lies in its power-supply (called a "power-pack" when it is an integral portion of the set) and this can be viewed from two diametrically-opposite aspects. If a designer sets out to achieve a definite object with his finished receiver (whether it be range, or exceptional purity of out-put, or the two combined), he assembles a cascade of valves capable of fulfilling the specification, and then, knowing the various current drains and voltage supplies entailed, builds a commensurate power-

Series I:
ELIMINATOR OPERATED TWO-VALVERS

pack, with, say, a 25 per cent. margin of safely for overload. This, of course, is the technically correct method, but, under certain circumstances, it can be the more expensive one. The alternative, the opposite view-point, is to start with the makings of a power supply (such as a "B" or "B" and "C" eliminator) and, around that, so to speak, build a receiver of which the valves (either through their numbers or the excessive current consumption of one of them) will not over-load the available supplies.

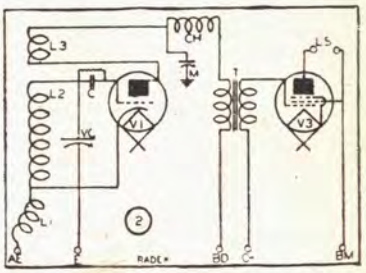
Given an eliminator, or even at the price of purchasing one, the latter is by

KEY TO 2-VALVE SETS

AE.—Aerial connection.
BD.—Positive voltage from eliminator to detector; best value about 30 volts, but higher and lower values to be tried.
BM.—Maximum voltage from eliminator — say, 200 volts.
C—.—Negative grid bias to suit type of power valve used, vide valve-maker's directions.
C.—Fixed mica condenser of 0.00025, with clip and shunted gridleak of 2 megohms. (T.C.C.)
C2.—Fixed paper condenser of 0.1 mf.
C3.—Fixed condenser of .001 mf. tested to 500 volts.
C4.—Mica fixed condenser of 0.01 mf. (T.C.C.)
CH.—Radio frequency choke coil.
E.—Earth connection; also carries leads from eliminator earth centre tap and casing of 4009 filament transformer, and (if used) positive end of independent C battery.
L1.—Adjustable aerial coil.
L2.—Grid tuning coil.
L3.—Fixed tickler coil. (For coil detail—see text.)
LS.—Terminals to take loud-speaker leads.
M.—Midget reaction condenser of 23 plates (Radiokes).
R.—Fixed carborundum 2-watt resistor of 50,000 ohms.
R2.—Ditto, of 100,000 ohms.
R3.—Gridleak of ½ megohm, with mounting clips.
T.—Audio transformer—any ratio between 3/1 and 5/1.
VC.—Variable tuning condenser of 0.0005 mf., with vernier dial.
VR.—Potentiometer of 500,000 ohms.
Valves, All of 4 Volt Series.
V1.—Indirectly heated detector UY.
V2.—Indirectly heated power amplifier UY.
V3.—Directly heated pentode UX.
V4.—Screen-grid tube used as detector UY.

far the simpler and safer scheme, and it is therefore the one that is recommended to the new-comer in A.C. operated reception. In this, and in the next two articles in this series, it will be the system employed.

Crystallising the above, in the four two-valve A.C. sets treated herein, our power-supply will consist of three distinct sections. Firstly, we will have an independent centre-tapped transformer (such as a Philips 4009), which is fed with A.C. from the house mains and delivers raw A.C. current at four volts; secondly, our eliminator will give us up to a maximum voltage of 200, but will carry tappings allowing lower values to be used at will; and thirdly, we will provide grid bias either from the eliminator itself (if it is one of the "B & C" type) or from a tapped light duty 30-volt B battery. Incidentally, and because the 4009 delivers four volts, we will confine ourselves to the use of A.C.



A Pentode provides plenty of volume.

valves of the four-volt series (such as Osrams, Philips, Cossors, Mullards, and the like).

A.C. Valves

Valves operated by alternating current are divided into two distinct classes, viz., directly heated and indirectly heated. In the former case the current passes through a filament, heats it, and so forces it to function as a cathode—"cathode" meaning a pole emitting electrons which, in turn, bombard the plate or "anode." Such a valve is obviously of the same form of construction as a D.C. Valve, and, in fact, any D.C. power-valve or pentode audio amplifier is an A.C. directly heated tube; on the other hand, such a valve should only be used in a receiver's last, or output, stage as, employed elsewhere in the set, it will cause an ineradicable hum. However, some manufacturers turn out medium power valves that are indirectly heated and, under certain circumstances, they are very useful. Indirectly heated valves are true to their name, inasmuch as the raw A.C. heating current is not allowed to make direct contact with the cathode and, in consequence, we have what is practically tantamount to the introduction of a fourth element. Accordingly, while a directly heated tube fits a UX socket, the indirectly heated type has five pins in its base and so fits only into a socket called a "UY." In actual internal construction, while the indirectly heated valve has (in the triode variety) an or-

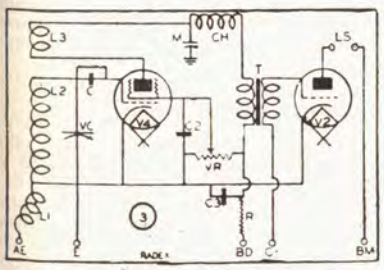
dinary plate and grid, its radio-active cathode is partially wrapped in mica (or some other insulating material) and over this is wound the heater element and the action is similar to that illustrated by a soldering-iron or other electrically operated device.

The Universal Coil

For the sake of simplicity, and more especially because it is of well proved efficiency, the same inductance unit (combined L1-L2-L3) is used in all four sets and, as will be shown, it can be used with either the Reinartz or the Schnell systems of reaction—although it is personally believed that the latter is preferable. To make it are required:—One treated tube 3 inches long and 2 in diameter, another 1 inch in diameter and half an inch long, a reel of No. 30 d.s.c. wire, and an inch by eighth machine screw with nut and a couple of washers.

Punch a small hole (eighth diameter) about quarter of an inch from one end of the long tube and punch another in the centre of the length of the small tube. On the latter wind eight turns of wire, laying four on each side of the hole, and bind them in position at three points with silk thread. This makes coil L1—vide the accompanying drawing entitled "Coil Detail."

On the long tube, and starting half an inch from the already punched end, put on fifty-four turns to make L2. Leave a gap of three-eighths inch, and then wind twenty turns to form fixed tickler coil L3. The lettering against the ends of coils L2 and L3 indicates the correct order of the connections to the rest of the circuit, and will be explained later. It might be mentioned that L3 has been made a little larger than necessary in order to allow for characteristic differ-



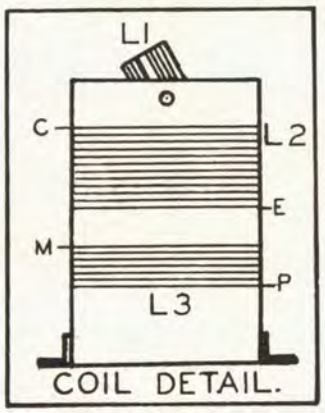
The Screen-grid detector sharpens the tuning of this circuit.

ence in the various makes of valves used as detectors. If, in your particular case, reaction is too fierce, the trouble can be removed by decreasing the size of the coil, a turn or two at a time, from the end marked "P." As sketched, L1 is suspended inside the top of L2 and held tightly in position by means of the screw.

Set No. 1

This is the very simplest form of electric 2-valver. Purely for illustrative purposes, Reinartz reaction is shown, but the Schnell system, as drawn into No. 2, can be employed, and it may be as well to compare the two. Both use exactly the same parts, the only difference being in the manner in which they are connected up.

With the Reinartz two connections are made to the plate terminal of the detector Valve V1—one to the coil L3 and the other to choke CH, while the other end of L3 is earthed through midget reaction-control condenser M. With the Schnell lay-out (No. 2), the detector's plate goes only to an end of tickler L3, while the other end of L3 goes both to CH and M. Thus, to change the Reinartz into Schnell it is merely necessary to disconnect the choke from the plate of V1 and reconnect the same end of CH to L3 side of the midget.



The output valve can be either one of the indirectly heated power tubes (such as Osram ML4 or a Cossor 41-MXP) or any directly heated power valve such as you are now using in the last stage of a battery operated set. Owing to its singular freedom from hum the former type is the better. For the same reason, while fully capable of operating a small speaker, this set is particularly useful for deaf persons who desire to listen-in with head-phones.

Set No. 2

This is the next simplest 2-valver, but by virtue of the fact that it uses a pentode in the audio stage, it is capable of delivering much more volume than is No. 1. The Schnell reaction is particularly smooth.

In using pentode valves, great care should be taken to see that their grids are furnished with an ample bias, and, in this respect, the directions on the folder accompanying the valve should be carefully followed. The average objection to pentodes is that they accentuate the high notes at the expense of those in the lower register. That trouble, should it annoy any particular listener, can easily be removed if a fixed condenser of 0.03 mf. is wired directly across the LS speaker terminals.

Set No. 3

Here a screen-grid valve is employed as a detector at V4, thereby both sharpening the tuning and increasing the sensitivity.

The voltage fed to the screening-grid of V4 is extremely critical. While it can be said to vary somewhere between 15 and 35 volts—according to the make of tube—there is a very definite point at which the output will be most efficient, and at which the reaction will work most smoothly. In order that this point may be exact for any given valve this critical voltage is obtained through the use of a high resistance potentiometer VR, which is initially set to give the best results, and then needs no further attention; accordingly VR need not be on the panel, and is better located somewhere in the vicinity of socket V4.

Owing to their naturally high impedance and the desirability of the external circuit being an approximate match, a screen-grid detector is not desirably followed by an ordinary audio transformer T. However, as you may have such a transformer on hand, here the circuit is faked by adding impedance in the form of resistor R, but shunt condenser C3 is optional. The audio amplifier is similar to that employed in No. 1, and the same remarks apply to it.

Set No. 4

This is the technically ideal screen-grid 2-valver. The detector circuit is the same as in No. 3, but approximately correct external impedance is obtained by employing resistance-capacity coupling between detector and audio stages. With such a coupling, in order to compensate for lack of step-up of the voltage, it is essential that the audio valve V3 should be of the pentode type.

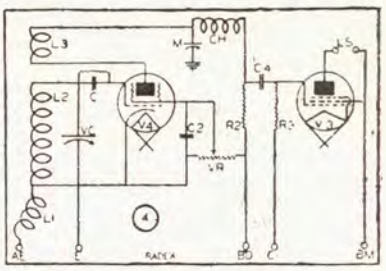
It should be noted that while between 30 and 45 volts are ample at BD for the first two sets, this voltage should be between 100 and 135 in the cases of the sets using an S-G detector. This increase is necessitated by the natural voltage drop which occurs across either R or R2.

General

In order to obviate hum, it is essential that all filament leads be tightly twisted together, and that they be kept as far as possible from either grid or plate leads. For the beginner it is a sound idea to use a metal base-plate, and to run the filament leads under this plate —all other leads being kept above it. Such a plate is also made "earth," and terminal E is screwed directly to it.

On the initial test the moving vanes of midget M should be almost wholly unmeshed and coil 1 should be turned nearly parallel to the turns of L2. After a station has been brought in by VC, M is turned in until maximum volume is obtained.

Should you suffer from interference at this stage—and very probably you will



Maximum results are the product of an S-G detector and Pentode output.

do so—L1 is gradually pushed out of parallel with L2 until the annoyance is either removed or made negligible. While this is being done it will be necessary to make small adjustments to VC to maintain the volume.

In the cases of sets Nos. 3 and 4 it will be necessary to properly adjust VR before any attempts are made to bring the reaction into operation or to sharpen tuning by the setting of coil L1.

The order of the coil connections (vide sketch) is as follows:—C to condenser and grid-leak C and also fixed vanes of VC; E to earth; P to plate of the detector valve; and M to the fixed vanes of the midget condenser. Of the two ends of L1, one goes to the aerial terminal and the other to earth, but the order is immaterial.

These sets will operate either an ordinary magnetic cone speaker or a small A.C. operated dynamic. Owing to the strain they would impose on the limited eliminator supply, D.C. dynamics are not always suitable unless that eliminator be of a heavy duty type.

Easy Electric Receivers

Series II.—ELIMINATOR OPERATED LOCAL THREE-VALVERS

CONDENSING the introduction to Series One, it was there shown that the main difficulty in the home-manufacture of simple All-Electric Receivers lies in and around the power-pack. It was decided logically to treat A.C. valves just as though they were of the D.C. variety—which, in fact, they are, although normally fed differently.

In consequence, we evolved an easy power supply consisting of three distinct units, viz.: a filament transformer (such as a Philips 4009) fed from the house current and delivering raw A.C. at 4 volts; an eliminator as a source of B voltages, and a grid-bias system fed either from the "C" side of the eliminator, if such is included therein, or, failing that, a tapped light-duty 30-volts "B" battery to serve as a "C" battery.

Given these, we can build a variety of A.C. sets with no more chances of trouble arising than would be the case with the battery-operated types — or perhaps, "prototypes" would be more accurate.

The four 3-valvers detailed in this article are, in the main, simply the extension of the previous set of 2-valvers into receivers capable of delivering more power to the loud-speaker. Operated at full power, they will tend to over-load all but the best types of magnetic cone speakers, and therefore the A.C. type of dynamic is recommended as a reproducer.

Augmented output means that some form of volume control is essential, and such a device is included in each design — although its position varies in accordance with the exigency of a particular circuit It is, of course, understood that volume can be reduced by so adjusting the variable tuning condenser (VC) that the incoming signals will be detuned, but this is not a good method, because it frequently results in a background of interference.

Again, single-circuit sets, such as these, tune most sharply (i.e., are least subjected to interference) when reaction, as controlled by midget M, is at its maximum in conjunction with the exact adjustments of VC. Under those conditions distorted signals might result, but the employment of the volume control obviates such an effect.

The Coils

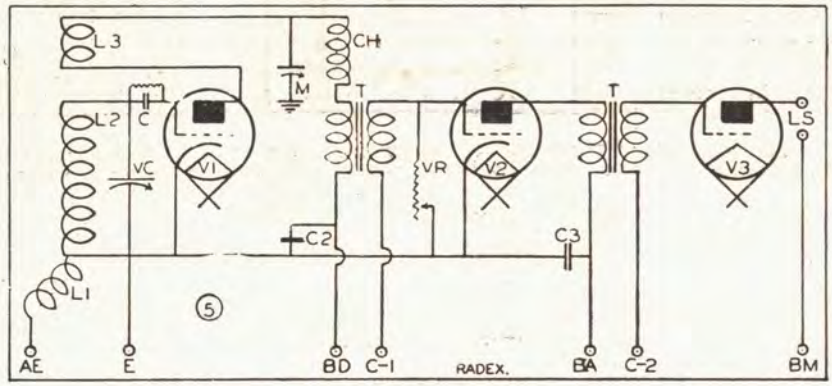
As in the previous series a standard assembly of three coils (often called a "tuner") suits all four three-valvers and a sketch of the finished unit is reproduced herewith. To make it up you will require: One treated tube, 2 inches in diameter and 3 inches long; another tube 1 inch in diameter and half an inch long; a reel of No. 30 d.s.c. wire; an inch by an eighth machine screw with a nut and two washers, and a couple of small angle brackets.

Punch a small hole (eighth diameter) about a quarter of an inch from one end of the long tube and another in the centre of the length of the small tube. On the latter wind eight turns of wire, laying four on each side of the hole, and bind them in position at three points, with fine silk thread, thus forming coil L1. (Vide pages 52 and 53).

On the long tube, starting half an inch from the end already punched, put on 54 turns to make L2. Leave a gap of three-eighths inch and then wind on 20 turns to form fixed tickler coil L3.

The small letters against the ends of coils L2 and L3 (which must both be wound in the same direction) indicate the following external connections: C to the grid condenser C and the fixed vanes of VC; E to earth; M to the fixed vanes of the midget condenser M; and P to the plate terminal of the detector valve. One end of L1 goes to the aerial terminal and the other is taken to earth, but the order is immaterial.

In the initial tuning L1 is rotated from the position pictured, until its turns are parallel to those of L2. Later, should interference be experienced, L1 is gradually pushed out of this parallel position, the movement being continued until the annoyance is reduced to a minimum. In this operation be ready to slightly readjust VC — otherwise signal volume will be lost. Should reaction be too fierce the trouble can be removed by reducing the number of turns in coil L3; turns should be taken off one or two at a time from the end marked "P."



Here is the simplest of 3-valve receivers.

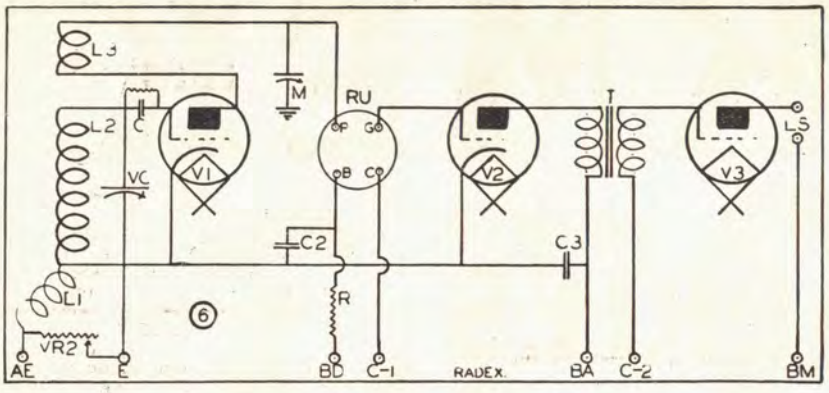
Set No. 5

This is the most straightforward type of three-valver. It consists, like the three others, in a regenerative detector (V1) and two audio tubes (V2 and V3), but the inter-stage transformer coupling (T and T) make its assembly very obvious. It is, however, of very great importance that these audio transformers be of really good quality —otherwise the reproduction will be of a poor quality.

Fixed condensers, C2 and C3, both here and in the other designs, serve as shunts to earth, and augment the sometimes questionable smoothing power of the eliminator. Their inclusion is optional, and to some extent they might be considered as luxuries — nevertheless their use is recommended.

KEY TO LOCAL 3-VALVE SETS

AE.—Aerial terminal.
BA. — Intermediate plate voltage from eliminator for first audio stage.
BD. — Detector plate voltage from eliminator—vide text.
BM.—Maximum output of eliminator.
C—1.—Bias on first audio valve.
C—2.—Bias on out-put power valve.
C.—Fixed mica condenser of 0.00025 mf., with clips and shunted grid-leak of 2 megohms.
C2 and C3.—Fixed condensers of 1 mf. each—500 volt test.
C4.—Paper condenser of 0.1 mf.—500 volt test.
C5.—Mica condenser of 0.0006mf.
C6.—Mica condenser of 0.01 mf.
CH.—Radio frequency choke coil.
E. — Earth terminal; also carries earth lead from eliminator and its B—terminal, and the frame and centre tap of 4009 filament transformer.
L1.—Adjustable aerial coil.
L2.—Grid tuning coil.
L3.—Fixed tickler coil. (For coil data see text).
LS.—Loud-speaker terminals.
M.—Midget reaction condenser of 22 plates.
P.—Potentiometer of 500,000 ohms.
R.—Wire-wound resistor of 10,000 ohms to carry 5 ma.
R2.—Carborundum resistor of 250,000 ohms to carry 5 ma.
R3.—Wire-wound resistor of 100,000 ohms to carry 5 ma.
R4.—Grid leak of 0.5 megohm.
RU.—Resistance - capacity coupling unit. (Philips 4001 or the like).
T.—Audio frequency transformers.
VC.—Variable condenser of 0.0005 mf., with vernier dial.
VL.—Potentiometer of 500,000 ohms.
VR.—Ditto, used as variable resistor.
VR2.—Potentiometer of 10,000 ohms, used as a resistor.
V1.—Detector valve and UY socket. (See text re Set No. 6).
V2.—First stage audio valve, and UY socket.
V3.—Power amplifier valve to operate at 200 volts and UX socket.
V4.—Screen-grid valve used as detector, and UY socket.
V5.—Valve suitable for resistance-capacity coupling in first audio stage, and UY socket.
All valves should be of the A.C. 4-volt series.



Technically this design should be pure by virtue of its resistance coupling.

Here the volume control VR is placed across the secondary of the first audio transformer T. VR is really a high resistance potentiometer, but only two of its terminals are used, i.e., an outer goes to the G terminal on T, while the arm is earth and, of course, adjustable.

Set No. 6

The particular purity of output of this design is its claim for attention, and this is achieved through a combination of audio couplings. In this the detector stage V1 is coupled to the first audio V2 by means of a manufactured resistance-capacity unit RU (Philips 4001). This part contains a built-in R.F. choke, so an external one is unnecessary. In order to prevent chances of "motor-boating" it is desirable to insert fixed resistor R in series with the B supply to RU, and, owing to the over-all high resistance in the plate circuit of V1, it is desirable that the B voltage applied to BD should be in the region of 100 volts.

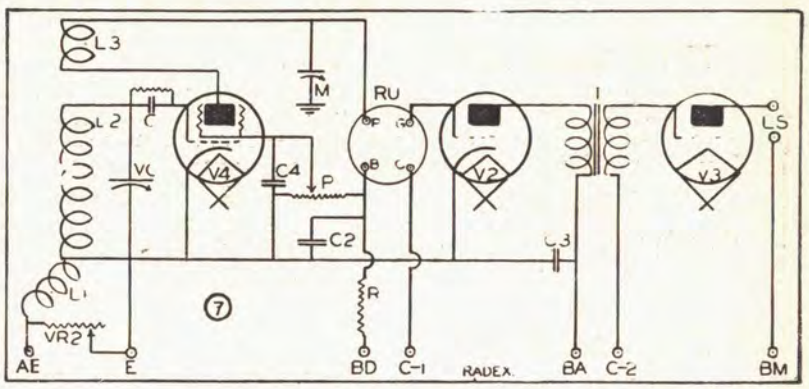
As regards volume control; we could place a variable resistor VR across the secondary of the transformer between valves V2 and V3, but this would not be very good for a number of reasons. A better scheme is to employ a resistor VR2 of lower maximum value than VR, across primary coil L1. Naturally, the strongest signals are obtained when the arm is so turned that all the resistance is in circuit.

While practically any indirectly heated tube will function as the detector V1 in Set 5, here it is desirable to use a tube at V1 which is specially designed for resistance coupling.

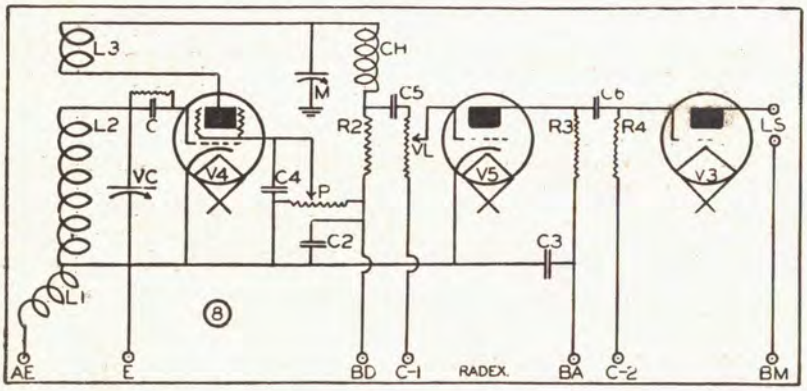
Set No. 7

The employment of a screen grid valve (V4) as a detector in this design means that it is much more sensitive than the foregoing two, and its powers of selectivity are higher. Its use, however, entails the inclusion of a few extra parts.

The voltage on the screening grid of V4 is critical and must be found by experiment, although it will vary between about 18 and 35 volts, according to the make of valve. To this end high resistance potentiometer is included and mounted close to the V4 socket. It is set initially to give the best volume together with the smoothest control of reaction and, thereafter, requires no further attention.



The introduction of an s-g detector augments both volume and selectivity.



The Ultimate Three achieved with an S-G detector and full resistance coupling.

The volume control is arranged on the same system as in Set 6, and again a fairly high voltage, say, between 100 and 135, must be applied to BD. The combined high resistance across P and B of unit RU and that of R suit the naturally high impedance of theS-G detector and give excellent results. Given a good quality transformer at T and the careful initial adjustment of P (which is a simple matter), this design is easily the best of the four on the counts of selectivity, sensitivity, purity and volume.

Set No. 8

Inter-valve resistance-capacity coupling is the feature of this design. Provided the various resistors are of good quality its purity of reproduction is assured, but it will lack the volume obtainable from No. 7.

The S-G system of detection is the same as that used in the previous set, and again the adjustment of high resistance potentiometer P is critical. Variation in design permits us to utilise a different method of controlling volume. Here another high resistance potentiometer VL functions as a grid-leak to valve V5 and its adjustable arm gives any variation in volume between silence and full blast. Like V1 in Set No 6, valve V5 should be of the type specially designed for resistance coupling.

General

A rough estimate of the voltages applicable to BD has already been given. In all except No. 8 about 150 volts should be fed to BA, but in the exceptional case of No. 8 this can be increased up to 200. BM invariably indicates the maximum voltage obtainable from the eliminator as it is not anticipated that this will ever be greater than 200.

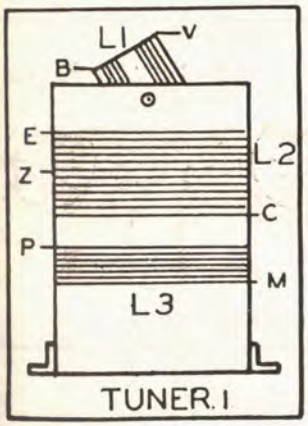
It is impossible to give even the roughest idea of the negative bias voltages to be applied to C-1 and C-2. The valve-makers' instructions should be carefully noted in this respect, but it must be remembered that, in general, the ear is the best test If reproduction sounds "tight"—as though it were only struggling through with a strenuous effort—it is always a clear indication that the bias voltages are too low, and this holds good even though there may be plenty of volume. On the other hand, it is safe to say that an over-application of bias will never do any harm either to eliminator or valves, although it may, under some circumstances, moderate the volume.

Easy Electric Receivers

Series III.—ELIMINATOR THREE-VALVERS WITH SELECTIVITY

IN the two previous articles in this series it has been shown that, given three common essentials, a beginner can easily make up two or three-valve all-electric receivers for local reception. For the sake of uniformity it was suggested that the 4-volt types of A.C. valves be solely dealt with (such as the British series). Given this proviso our power supply consists of the following three items:—A 4-volt filament transformer (such as a Philips 4009 or the like), to furnish the "A" supply; an eliminator to supply the various B voltages required; and either the C side of the eliminator (if such exists), or a tapped 30-volt light-duty B battery to give grid-bias where required.

With these essentials at hand you have no worries regarding critical resistor values, nor do you have to indulge in calculations involving Ohm's Law. Their presence makes the construction of an electrically operated set as simple as that of the old battery models.



Coil used in Set No. 9.

Selective 3-Valvers

With seven official broadcasting stations on the air, Melbourne is beginning to discover what Sydney (with its eight stations) has already realised; and that is that singly tuned receivers (such as those described in Series 1 and 2), must almost invariably suffer from marked backgrounds of interference when tuned to particular transmissions. To overcome that trouble the only solution is to increase the number of tuned circuits in the design, which means that to avoid losses the instrument must include a stage of radio frequency amplification.

With the exception of No. 9—which is a kind of hybrid and requires a special description—the sets in this design have their valves allocated as follows: — The first V3 is a screen-grid working as an R.F. amplifier. The second is the regenerative detector; an ordinary indirectly heated triode is employed in Nos. 10 and 11, but another screen-grid is used in No. 12 where it is the second V3. In all four the output valve V2 is a pentode.

Again ignoring No. 9, it will be seen that each of the others includes two tuned circuits, one controlled by variable condenser VC and the other by VC2. In consequence the chances of interference are something more than quartered as compared with single-circuit receivers.

In the case of battery-operated valves in a receiver's radio frequency stages, the use of bias is generally optional, and, in fact, quite rarely of much good in simple circuits. With A.C. valves, functioning as R.F. amplifiers, some sort of bias is absolutely essential, and this bias when obtained from some independent source (such as a suitable C battery), is both cumbersome and, in the main, unsatisfactory. R.F. bias is one of the instances where the "voltage dropping" method is in all respects the more useful. In the next article of this series, "free bias," or bias obtained from differentiated voltages, will be described in detail; here we will merely use it and let the explanation go.

In all these circuits the R.F. valve obtains a bias by virtue of the presence of variable resistor R2, which is necessarily shunted to earth through the agency of fixed condenser C2. Were the R.F. valve of some specified make, R2 could be a fixed resistor of predetermined value, but, unfortunately, this value differs with every make of tube. The better course, therefore, is to have R2 variable, and so it can be made to suit any valve, while, when turned away from the critical setting, it will simultaneously act as an efficient volume control.

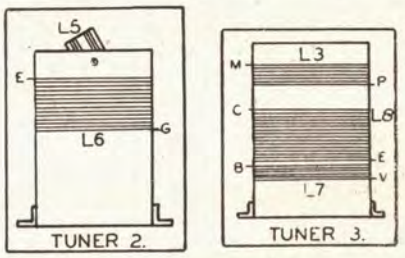
KEYS TO PARTS USED

A.E.—Aerial terminal.
AC.—Centre-tapped audio frequency choke—not to be confused with a power smoothing choke.
B.D.—Positive detector voltage — about 45 except in case of No. 12.
BM.—Maximum voltage from eliminator.
BS.—Screening grid voltage—about 75.
C.—Negative bias voltage — between 15 and 30, according to make of pentode at V2.
C.—Mica grid condenser of 0.00025 mf.
C2, C3 and C4.—Fixed condensers of 1 M.F.D.—to stand 500 volts.
C5 and C8.—Fixed condensers of 0.1 mf each—to stand 500 volts.
C6.—Mica condenser of 0.006 mfd.
C7.—Mica condenser of 0.01 mfd.
CH (2).—Radio frequency choke coils.
E.—Earth terminal; also carries leads from earth and B negative of eliminator and centre-tap and casing of 4009 filament transformer.
GL.—Grid-leak of 2 megohms with mounting clips. Note shunt wiring of GL in No. 10.
L1 and L7.—Plate circuit primary coils.
L5.—Adjustable aerial coil.
L4 and L6.— R.F. grid coils.
L3.—Fixed tickler coils.
L2 and L8.—Detector grid coils. (For coil data see text.)
LS.—Loud-speaker connections.
M.—Midget condenser of 22 plates.
P.—Potentiometer of 500,000 ohms resistance.
R.—Fixed resistor (either carborundum or wire-bound types) of 100,000 ohms.
R2.—Potentiometer of 2000 ohms (A.G.N. or the like) used as a variable resistor.
SH.—Shielding plate; piece of sheet aluminium measuring 6½ by 9 inches.
T.—Audio frequency transformer of ratio between 3/1 and 6/1.
VC1 and VC2.—Variable condensers of 0.0005 mf with vernier dials.
VR. — Potentiometer of 500,000 ohms.
V.—Any indirectly heated triode valve and UY socket.
V1.—Indirectly heated detector valve and UY socket.
V2.—Directly heated pentode and UX socket.
V3.—Indirectly heated screen-grid valve with UY socket and suitable valve can.

Set No. 9

Strictly speaking, this design hardly comes in the "selective" class, although it falls under the general heading of "R.F., Detector and Pentode Audio." Its objective will be clear from its story.

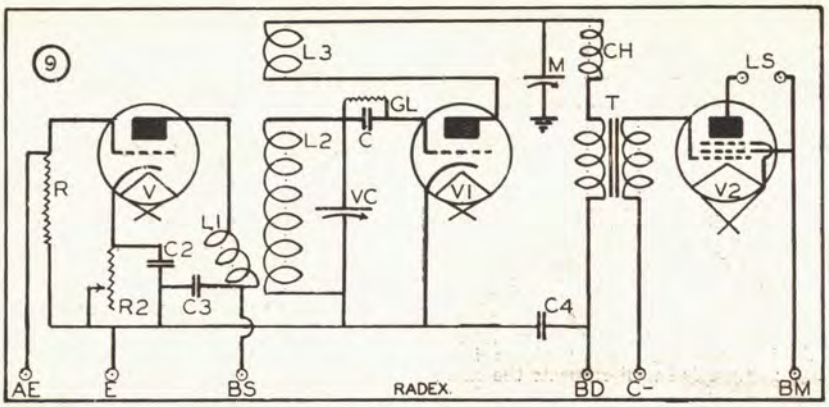
A friend had an early model manufactured 3-valver which, like all of these, was operated from a filament transformer and eliminator. The set was in a metal box, and there was no room for another variable condenser or an extra valve, but, owing to its location at some distance from town, it failed to bring in B Class stations at reasonable strength. Obviously some sort of a radio frequency boost was required; the problem was how to get it in? As others may be in the same predicament, here is one simple solution.



Types of coils used in Sets Nos. 10, 11 and 12.

Visualise three valve-sockets in a row, of which the first to the left is the detector and the other two are transformer-coupled audio stages. Remove the first audio transformer, and now consider the second socket as carrying the detector — naturally condenser-leak combination C-GL will be connected to this socket, and with it will be associated the coils and variable condenser V.C.

The first socket to the the left now becomes the centre of an untuned stage of R.F. amplification, to which the aerial is coupled through the agency of high resistor R and L1 (which was originally the aerial coupling coil as in No. 5 of Series 2) is converted into a primary by means of which the plate out-put of V is transferred to the grid circuit of V1. Finally, to compensate for the loss of the first audio stage, a pentode is employed at V2.



Circuit of a straight three valver converted for an increased range.

The scheme of the coils employed is sketched as "Tuner 1," and is made up from the following material:—2-inch diameter tube 3 inches long, 1-in. diameter tube half an inch long, and some No. 30 d.s.c. wire. As shown L1 is wound on the small tube and is suspended inside the top end of the larger tube; it carries 12 turns of wire and is so suspended that it can be turned at will. On the larger tube L2 contains 54 turns, then there is a gap of half an inch and L3 follows with 20 turns. All three coils must be wound in the same direction.

The wiring of Tuner 1 is as follows:—B to main BS, V to plate terminal of valve V; to earth, C to C and the fixed vanes of VC; P to plate of valve V1 and M to fixed vanes of M. The strongest signals will be obtained when L1 is parallel to L2 and pushed in an anti-clockwise direction—vide sketch. When pushed out of the parallel the tuning sharpens, but signals tend to weaken disproportionately; the set would, therefore, not be very useful in congested areas, but under the circumstances outlined it is quite effective.

Set 10

Here is a design capable of giving tremendous punch, but its degree of selectivity is not very high — although far superior to that of No. 9. Out of the "shock area" — say at such places as Werribee, Dandenong, etc.—it will easily separate all the locals and even on an indoor aerial will give reasonable signals therefrom. Associated with an average outdoor pick-up at such points, fair conditions will permit of it bringing in Sydney. Its D.C. counterpart was published in the Listener In as "The Simplest Three," and I know of several cases where that set is being used in North Queensland to bring in 3LO nightly.

Inside the shock area a 10ft. picture-rail aerial is ample. More than that will risk serious interference.

Coil L4 is so simple that a drawing of it is unnecessary. It consist of 50 turns of No. 30 d.s.c. on a 2-inch diameter tube 2 inches in length and is tapped (X) at the third, sixth, ninth and fifteenth turns. Zero end goes to earth and the other to the grid of V3 and the fixed vanes of VC. The aerial is connected to whichever of the X taps suits local conditions; naturally connecting to the third turn gives greater selectivity than to the sixth and so on. If conditions allow of the use of the fifteenth tap it may be necessary to remove three or four turns from the other end of the coil in order to get down to 3AW.

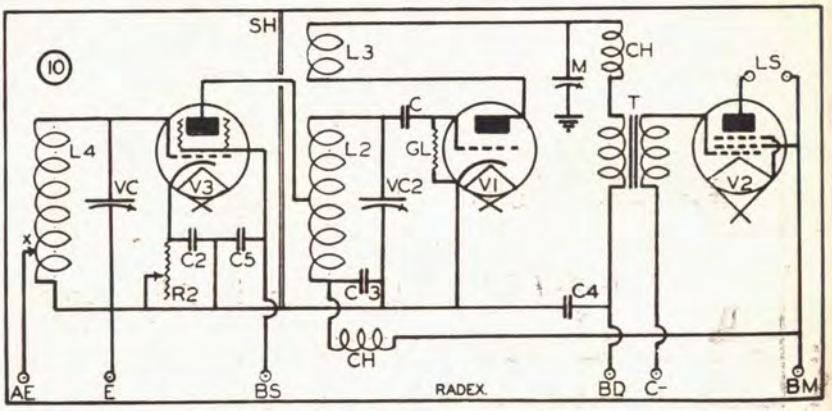
Coils L2 and L3 are those pictured as Tuner 1, but L1 is omitted and there is a tap Z at the end of the 27th turn of L2. The wiring is also the same with these two exceptions—Z goes to the plate of V3, and end E, instead of running to earth, goes to both an end of first choke CH and one side of fixed condenser C3—the other end of the latter being earthed.

The set functions easily and without any critical adjustments at all. You have merely to recollect what was said above about aerials and locations and select the best point for the X aerial tap by experiment.

Set No. 11.

Here is a selective and reasonably sensitive design which may be used in almost any area with the assurance of good results. If desired, it will give excellent volume on a ten or fifteen-feet aerial and in congested spots, its selectivity is improved if coil combination L5-L6 (Tuner 2) is totally enclosed in a can.

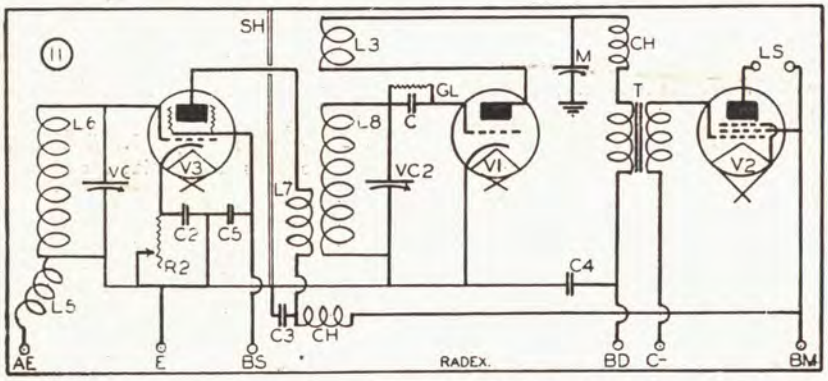
Tuner 2 employs a 2-inch diameter tube 3 inches long, another 1 inch in diameter and half an inch long and some No. 30 d.s.c. wire. L5 is formed by putting eight turns of wire on the smaller tube. L6 consists of 54 turns on the larger one, started about half an inch from one of its ends. As pictured, L5 is suspended inside the end of L6 by a single machine screw and nut and can be roughly rotated thereon. The ends of L5 go to aerial and earth respectively; G of L6 goes to the fixed vanes of VC and the G terminal of valve-socket V3, while its E end runs to earth.



A good design for country areas where interference is not likely to be encountered.

The R.F. valve V3 is coupled to the detector V1 by a home-made R.F. transformer which is pictured as Tuner 3. This is wound on a 2-inch diameter tube 3 inches long and again No. 30 d.s.c. wire is used. Starting about a quarter of an inch from one end of the tube, put on 20 turns to make fixed tickler coil L3. Leave a space of half an inch and then lay on 52 turns to form grid coil L8. Continuing without any gap at all, wind 30 turns for plate coil L7. It is important that all coils be wound in the same direction. If such is available, better results will be obtained if L7 is wound with wire of finer gauge, and anything down to No. 40 enamel-covered may be used therefor.

The wiring of Tuner 3 is as follows:—L3, M to fixed vanes of midget M and P to plate terminal of detector V1; L8, C



An all-round reliable circuit for general use which includes nothing particularly critical.

to grid-condenser C and fixed vanes of VC2, and E to earth; L7, B to end of first choke CH and one side of condenser C3, and V to plate terminal on top of valve V3.

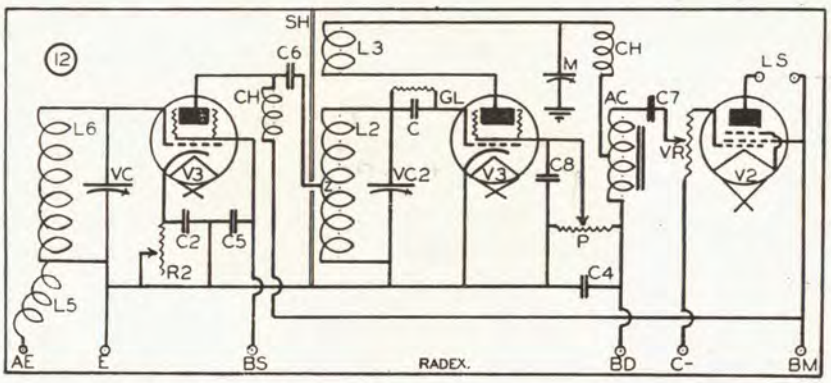
The strongest signals will be obtained when L5 is parallel to L6. Selectivity will be improved (i.e., the tuning will be sharpened) as L5 is pushed out of this parallel. Should it be necessary to enclose Tuner 2 in a coil-can, the number of turns in L6 must be increased to 70.

Set No. 12

This design has about the same degree of selectivity as has No. 11, but the presence of a screen-grid detector (second V3) makes it more sensitive. The screening grid voltage on this detector is critical, and, in order to obtain its accurate value, it is necessary to employ high-resistance potentiometer P, which should be mounted somewhere near the associated socket. This part is set initially (generally with its arm about half-way round) by experiment, and then needs no further attention.

The coupling between the R.F. stage and the detector is choke-capacity in combination with tuner 1 (without L1) and much of the set's ultimate selectivity depends upon the value of C6. In the list of parts this value is given as 0.006 mf, but if this is decreased the tuning will be sharper. In severe circumstances, C6 can be as low as 0.00025 mfd.

Owing to the high impedance of the S.G. detector, the impedance of the coupling to the pentode audio stage must also be as high as possible. In this instance, toward that end, audio frequency choke (centre-tapped) A.C. is employed, and volume is controlled by using a high-resistance potentiometer V.R. as a grid-leak to V2—in-put from condenser C7 being fed to the arm of VR.



Screen-grid valves in both R.F. and detector stages ensure the sensitivity of this 3-valver.

L5-L6 are tuner 2 and its wiring is the same as that detailed for set No. 11. L2-L3 form tuner 1 employed as in set No. 10—the only exception being that end E of coil L2 goes directly to earth. Selectivity is varied with the setting of L5 in a manner similar to that described for set No. 11. While for all the preceding sets a detector voltage of 45 to BD is ample, here between 70 and 90 volts should be applied to BD.

All sets should be laid out with their three valve-sockets running in order from left to right as pictured. Shield SH is erected vertical to the base and at right angles to the instrument panel at such a position that valve V3 (R.F.) condenser VC and its associated coils, and bias resistor R2 are all to its left when the set is viewed from the front.

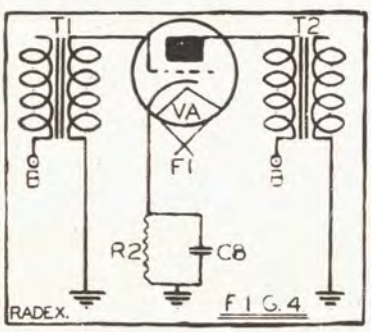
The panel will carry the knobs of variable resistor R2 and midget M and the vernier dials. No. 12 is an exception; here R2 should be mounted close to its associated socket and set initially to give maximum volume. The panel will then carry the two vernier dials and the knobs of midget M and potentiometer VR. It is desirable that coil L4 and tuner 2 should stand on end. With the exception of No. 9 tuners 1 and 3 should be mounted with their axis horizontal, although raised about one inch above the base-board.

If difficulty is experienced in obtaining a centre-tapped audio choke (or impedance) AC in No. 12, this part may be replaced by a fixed carborundum resistor of 100,000 ohms and wired as in set No. 8 of Series 2.

Easy Electric Receivers

Series IV.—POWER PACKS AND FREE BIAS

IN the first article of this Series it was pointed out that A.C. valves, exactly like their battery operated prototypes, require three sources of electric supply for their actuation. These are "A" to heat their filaments or cathodes, "B" to place a high positive potential on their plates or anodes, and "C" to suitably bias the grids of such valves as require that service. The function of a "power-pack" is so to transform or rectify ordinary electric house-supply (when in the form of alternating current) that it will fulfil the duties of A, B, and C simultaneously.



Method of biassing indirectly heated A.C. valve.

The essential components of such a pack are a multi-secondary power transformer, a rectifying valve to convert alternating current into the direct variety, and a smoothing system comprising power chokes and fixed condensers of relatively large capacities. Where a number of radio valves are to be fed from this pack, resistances of predetermined value and sundry fixed condensers of intermediate sizes are adjunctive essentials.

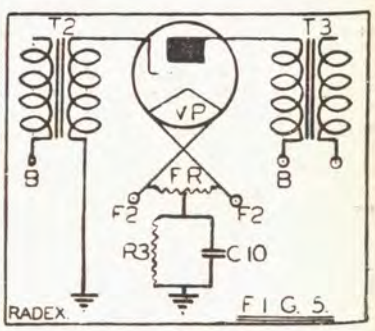
"B" Power Only

In order to avoid clouding the issue it will be necessary to consider each type of supply separately, and in this the logical point of commencement is at the "B." Fig. 1 illustrates the simplest form of B supply, or, as it is often called, "eliminator," and forms the basis of the average so-named commercially-built instrument.

It is not proposed to give a description of how to make such things as power transformers or chokes; the beginner will be better advised to purchase the ready-made article. Our objective is to learn how to assemble a collection of parts so that they will together produce the desired results.

In Fig. 1 are pictured the definite essentials named above. Starting with the power transformer on the left, we see that, for this simple instance only, it has two secondaries giving different voltages. 5V heats the filament of the rectifying tube, RT, while the centre-tapped (CT) secondary, which is rated to deliver 275 volts each side of that centre, impresses its potential on RT's plates.

Avoiding technical—and, therefore, uninteresting—explanation, the result of this combination (when house-supply is fed at AC), is that direct current (sometimes called "rectified" in this application) is delivered to any external circuit, the points of delivery being one end of the 5V winding for the positive,



Method of providing free bias for directly heated power valve.

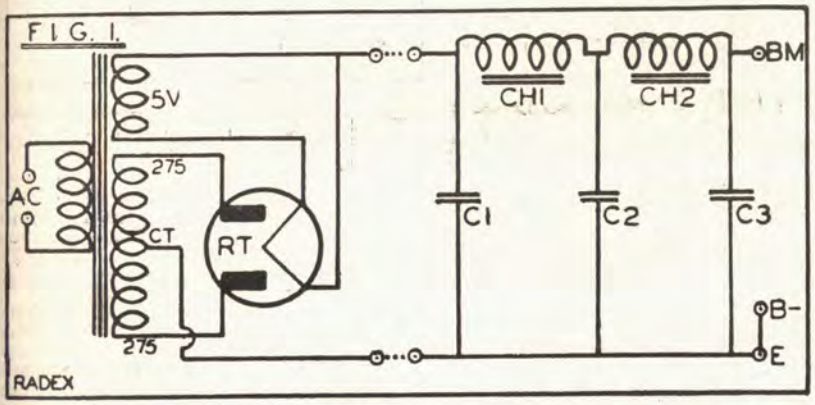
and CT for the negative. Except when an external circuit's special demands forbid, CT is always earthed.

The initial D.C. power output from the combination of such a transformer and rectifying tube would depend for its voltage upon the voltage rating of the power-secondary (275-275 in this case), but is limited by the characteristics of the tube; similarly the current available (always measured in milli-amperes or one-thousandths of an ampere) is proportionate to the gauge of wire used to wind the power secondary but is again limited to the abilities of the tube.

In this article it will be understood that RT is always a type —X280 rectifier which is rated to take up to 350 volts and deliver up to 125 ma.

It has been said that our combination, so far, delivers direct current, but this is only partially correct; more exactly the current is pulsating. True, it is only travelling in one direction, but it is varying between a maximum and nothing at all at a speed of 100 times per second; were this fed to the valves' plates the result would be an unbearable hum from the speaker. To obviate this nuisance it is essential to employ a smoothing system.

FIG. 1.



The simplest form of eliminator. The transformer and rectifier section is on the left and the smoothing system on the right.

Smoothing

Smoothing, as the word truly describes the effect, takes the kinks out of our pulsating current. The smoothing system consists of chokes (CH1 and CH2) of predetermined values and large capacity condensers (C1, C2, and C3) arranged as pictured.

A choke is a piece of electrical apparatus which has a great objection to passing any but perfectly steady currents. It goes even further than that, because it turns fluctuating currents back on themselves. A fixed condenser (such as C1) of large capacity is quite sympathetic to pulsating direct current and—up to its limits—is always willing to harbor it. Let us see how these two opposed abilities do their job.

Pulsating direct current from 5V reaches CH1 by which it is spurned, so it thankfully flows into C1. There it rests for a fraction of a second and, during that period, its brothers follow it into retreat. Finally a time arises when quiescence is reached, the contents of C1 is steady, and so is permitted by CH1 to pass through it without let or hindrance.

Actually this spasmodic charge, but steady discharge, of C1 is going on all the time, but the action of CH1 is not quite perfect, and so some pulsation may exist after the current leaves it. To complete the work—a kind of gleaner following the reaper and binder—come choke CH2 and condenser C2 to do the same job all over again. Finally, we have C3, which functions in a somewhat similar manner but derives its choking effect from the set itself.

Finally, across BM and B—, we obtain true direct current, but its voltage will not be equal to the input (275 volts in this case), because there have been losses in both the chokes and, in addition, no rectifier is 100 per cent. efficient. However, as production becomes nearer perfection, it is usually possible to, having a smoothing system consisting of only one choke and two condensers (say, CH1, C1 and C2) and so minimise the loss.

Differing "B" Voltages

The device shown in Fig. 1 would enforce the use of one plate voltage on all valves, which would be obviously useless, and so means have to be taken to provide lower intermediate values for differing requirements. There are two systems of doing this, the parallel and the series, the latter being the better.

Fig. 2 illustrates the parallel method, and is tantamount to the employment of a multi-tapped potentiometer, which is called a voltage divider (VD) in this application. VD is a high resistance, usually to the order of 15,000 ohms, which is placed directly across BM and B—. Clips can be attached to VD at any point, and the resultant voltage is proportionate to the distance of the clip from B— together with the value of current drawn at the clipping point. Thus there would be a higher voltage at B2 than at B1, but both would be less than BM.

The system has two disadvantages. Firstly it is a source of wastage as it is shunted directly across the mains; secondly, in a multi-valve set it permits feed-backs which create parasite howls and groans. Secondaries F1 and F2 are additional windings on the power transformer which furnish raw A.C. at voltages suitable for filament heating; they form the "A" supply.

Fig. 3 shows the series, or "anode feed" system in laboratory form, and illustrates a general scheme which is invaluable to any home set-builder because of its almost universal adaptability. It is, as a matter of fact, the pack used by the writer, although CH2 and C3 are usually omitted. Its detraction is that it can only be effectively employed in combination with a reliable high resistance voltmeter.

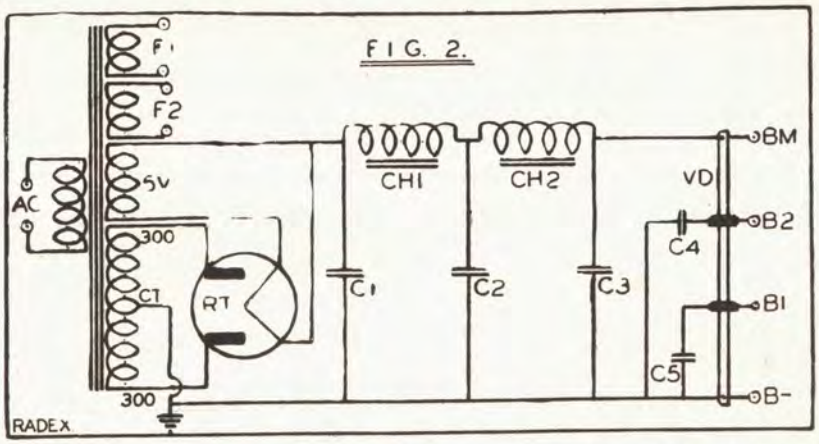
As pictured, the power secondary gives 350 volts each side of the centre-tap and has a current-carrying capacity of 100ma. The choke, or chokes, are capable of carrying the same current at least.

Now it is obviously likely that the maximum available voltage (somewhere in the region of 320) will not always be required. In consequence a master variable resistor MVR is inserted in the main positive leg by which the temporary maximum may be controlled.

Each of the three subsidiary positive delivery points (B3, B2 and B1) is fed through a variable resistor (VR1, VR2 and VR3), and each is shunted with a fixed condenser of 1 MF. The result is that at any of the three points voltages lower than the maximum are easily obtained. Again, there is no constant waste (as in the case of VD in Fig. 2), and a vacant point draws no current. Thus, if only BM, B3 and B1 are wired up, B2 is idle and so non-consumptive.

Certainly this is something of a deluxe method of supply, but the anode-feed system is certainly the better when applied to sets using several valves. In such instances variable resistors are not necessary—although MVR is often useful in cases of miscalculation or over-generosity. Instead, having designed our set, and knowing the plate-current required by each tube, we can replace the VR's by fixed resistors of commensurate

FIG. 2.



Power pack arranged for parallel plate-feed through the agency of a voltage divider.

values, each being shunted to earth by its own 1 MF condenser. An example of such design will be given later.

Voltage Drop

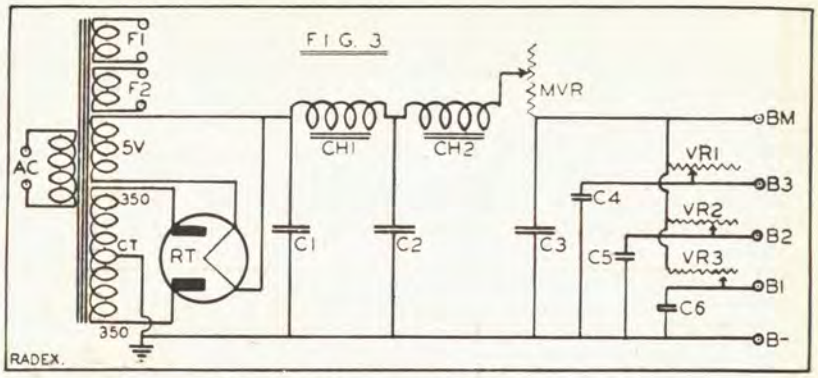
Voltage drop is at once a blessing and a curse. Without it we would not have "free bias," nor would we be able to so divide a maximum "B" voltage value to the lower needs of particular valves; owing to its existence, on the other hand, losses are created which have to be either taken into account or otherwise compensated. When second grade parts are employed such losses can be disproportionately large, and so nullify a host of other benefits.

Further, the whole phenomenon turns on Ohm's Law, which says that in any given electrical circuit the amperes flowing will be equal to the applied voltage divided by the resistance of the circuit in ohms. Extending this law tells us that a circuit's resistance can be found if the applied voltage is divided by the amperes flowing, and that the voltage equals the amperes flowing, multiplied by the circuit's resistance.

Any mention of Ohm's Law always seems to have a paralysing effect upon readers, although it involves only the simplest arithmetic. I have known men who could calculate the most complicated racing odds ("Half up the second, half up the first, win and place!") in their heads, yet they would have expired at the thought of working out the resistance of a circuit in which two amps. were flowing at 10 volts (5 ohms).

Voltage drop simply means the calculated amount of energy consumed in doing a piece of work or in overcoming a certain obstacle of known difficulty. There are dozens of analogies about water-pipes and tanks and men hauling loads of sand up a hill; most of them are merely confusing, and we will be better served by taking a practical example from Fig. 1.

There we have already said that the voltage across BM and B—will be lower than the original 275 because of the drop caused through the chokes; that is to say, the work of passing those chokes has consumed energy—but how much? Mr Ohm tells us definitely. We will say that the circuit connecting BM to B-- is consuming 40 ma.—which is the same as 0.04 ampere—and that the combined



Adjustable series resistors in the plate supplies give this power pack a universal application.

resistance of the chokes is 600 ohms. Working on the third extension of the law given above, we find that 600 multiplied by 0.04 is 24; therefore the drop is 24 volts, and the voltage across BM and B—is 251 volts—near enough to call it 250.

That, of course, is the loss side of the transaction. Now look at voltage drop as a benign entity.

Calculating Resistors

Suppose in Fig. 3 we desire to use a fixed resistor in place of VR1, so that, as nearly as possible, 180 volts will be placed on the plate of a certain valve which consumes 5 MA. The total current consumption of all valves in the receiver is 42 milliamperes and MVR can be so adjusted that there will be exactly 250 volts across BM and B—. What is the new resistor's value in ohms? The answer is obtained in just the reverse way to that of the foregoing teaser; there we wanted to discover how many volts were dropped — here we want to bring 250 down to 180 and so drop 70 volts. To do so we remember that volts divided by amps equals resistance, so we divide 70 by 0.005 amp. (same as 5 ma, of course), and get 14,000. Therefore we want a resistor of 14,000 ohms capable of carrying 5 ma. Resistors are rarely obtainable in such small steps, so we used the nearest higher value, which would be 15,000 ohms.

Bias Voltage Drop

When free grid bias is used it is the outcome of creating a voltage difference across a resistor of calculated value. The method of wiring the resistor varies according to whether the valve to be so treated is indirectly (Fig. 4) or directly heated (Fig. 5). The bias resistors are R2 and R3 respectively, and they should be shunted by 1 MF condensers. Neglecting the resistance of the transformers' secondary, the valves' grids are at earth potential or fully negative.

As there will be a voltage drop across R2, the cathode of valve VA will be positive in respect of earth, and so the grid must be negative in respect of the cathode. The same applies to VP, but there the difference is effected between filament and earth, and, for this purpose, a filament centre-tapped resistor (FR) is necessary.

Incidentally this explains why, when free bias is employed, a directly and an indirectly heated valve cannot be both heated from the same filament-supply secondary. Two such secondaries (F1 and F2) are essential.

The voltage drop required to be furnished by the resistor must be equal to the valve-maker's specification for the valve's bias voltage. Thus, in Fig. 4, we will imagine a UY277 with 180 volts on its plate, a consumption of 5 ma and a demand for a bias of 13.5 volts negative. Resistance equals therefore 13.5 volts divided by 0.005 amp, which gives a resistor of 2700 ohms to carry 5 ma. In the case of R3 the bias required is 50 volts and the current flow is 32 ma; consequently a resistor of 1560 ohms (to carry 50 ma) is required, but 1500 ohms will be near enough.

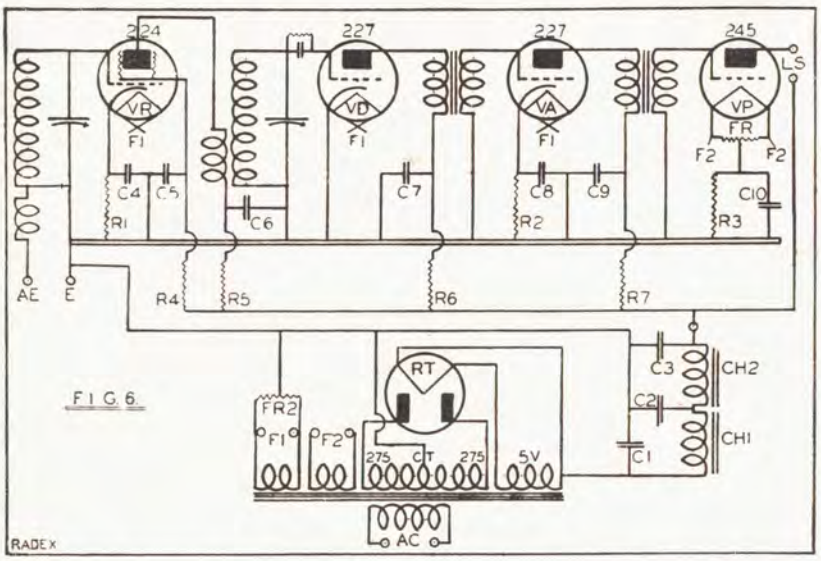
Practical Work

Fig. 6 shows a conventional circuit employing bias resistors R1, R2 and R3, and anode resistors R4, R5, R6 and R7. The voltage available at the receiver side of choke CH2 is exactly 250, and the set's total plate consumption can be taken as 43 ma for example's sake.

The following voltage and current values will apply: VR Plate 4 ma at 180 v; VR screen 1 ma at 90 v; VD 1 ma at 75 v; VA 5 ma at 180 v; and VP 32 ma at 250 v.

From the data and examples already given, see if you can work out the values of the seven fixed resistors used, remembering that VR requires a grid bias of 3 volts negative. Check your results against those below:

R1 .. 750 ohms. R4 .. 160,000 ohms.
R2 .. 2700 ohms. R5 .. 17,500 ohms.
R3 .. 1560 ohms. R6 .. 175,000 ohms.
R7 .. 14,000 ohms.



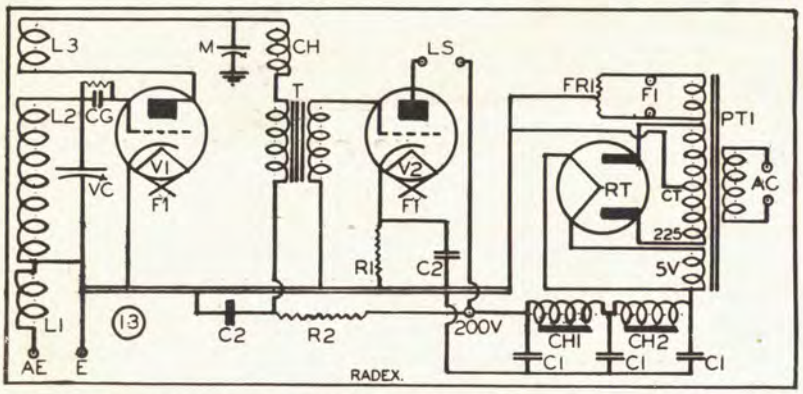
Theoretical circuit of a modern 4-valve A.C. receiver showing the uses of plate resistors, resistors for the production of free bias, and fixed shunt condensers.

Easy Electric Receivers

Series V.—SELF-CONTAINED TWO-VALVERS

A SELF-CONTAINED 2-valver means a receiver, when of the A.C. variety, that includes its own home-built power-pack; thus actually three valves are employed—the third being the rectifier.

As outlined in the preceding article of this series, which dealt with power-packs generally, in the making of an all-electric set, the type of valves selected and the characteristics of the power transformer are factors that are inter-dependent upon each other. Thus, it is useless purchasing a transformer with 2½-volt filament secondaries if it is proposed to employ valves requiring 4 volts on their filaments; similarly it is futile to obtain such a transformer having a power secondary voltage of only 225 if the output valve of the suggested set is designed to deal with 250 volts. Conversely, however, it is not wrong to have a high voltage secondary capable of delivering, say, 100 volts more than are immediately required, because the excess pressure can always be cut down by means of a master variable resistance; an example of this was given in Fig. 3 of Series 4.



Complete circuit of a self-contained 2-valver using indirectly heated tubes in both detector and audio sockets.

In the two-valvers illustrated here Nos. 13, 14 and 15 are presumed to employ A.C. valves of the 4-volt series, while No. 16 definitely uses Radiotron-type tubes (2½ volts). The first three could also, of course, be fitted with 2½-volt tubes, but, in that case, the values of their various fixed resistors would have to be altered from those given in the list of parts. Again, should such a change be made, the output voltage of the transformer's (PT1) power secondary would have to be increased from 225 to at least 275 volts.

Speakers

With any of these sets you may use a magnetic-cone speaker (connected at L.S.) but, in order to protect it against the high voltage applied to the output valve's plate, an output transformer should be interpolated. Do not despise magnetic speakers; they are reliable and economical, and the newer types give excellent reproduction. If a deep tone is desired it can be obtained by shunting a fixed condenser of 0.03mfd. across the L.S. pair of terminals. Dynamic speakers which incorporate their rectifiers and are operated directly from the house-mains (known as A.C. dynamics) are treated in the same manner as magnetics.

The commoner and less expensive type of dynamic which is operated by direct current (D.C. type) requires separate treatment from the A.C. variety; these are energised by the rectified current furnished by RT and the power system generally. If one of high resistance is utilised its field-coil can be connected directly across the pack's maximum voltage point and earth; such maxima points are marked as "200V" and "250V" in the accompanying sketches. This is called parallel wiring and is probably the better for small sets such as these.

Dynamics with low field-coil resistance (e.g., 2500 ohms) have that coil wired in place of smoothing choke—CH1—the latter then being wholely omitted from the circuit. However, as this resistance is at least four or five times greater than that of the discarded choke CH1, if some compensation is not introduced the desired maximum voltage (200V or 250V, as the case may be) will fall far below specification. The compensation is achieved by using a transformer with a secondary voltage approximately 75 volts higher than that marked in the drawings — making PT1 up to 300 and PT2 to 350 volts each side of the centre-tap CT.

We have already said that the valves and power transformer are inter-dependent upon each other. When a D.C. dynamic is employed it is obvious that its requirements must also be taken into consideration.

Valves

The number of A.C. valves of the four-volt filament series that are on the market tends to complicate construction because, although alike in filament requirements, their plate-voltages and current-consumptions and the degree of grid-bias required by each vary very widely. Osram, Marconi, Philips, Cossor, and Mullard makes in this series are all procurable here, and, to be fair, all have their claims. Unfortunately each requires a different bias resistor value (R1 or R3). Within the limits of an article such as this, it is impossible to give a list of values fitted to the positions V2 or V3 and of their correctly valued associated resistors; where desirable, however, a few definite examples will be given.

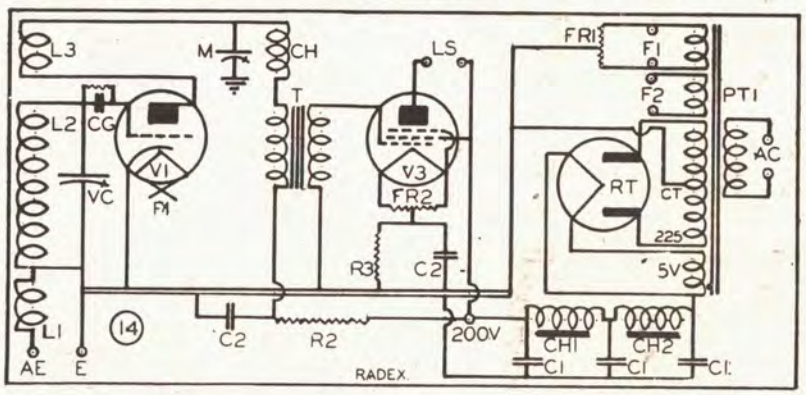
With the 2½-volt filament series the position is more favorable. All such valves are either original Radiotrons or replacements of the same produced by English makers; in consequence, their characteristics are all the same (or so nearly alike that the difference is negligible), and definite values can therefore be assigned to every resistor employed in association with them.

Set No. 13

Owing to the fact that the power-valve (V2) in this set is of the indirectly heated type—as is also the detector, of course—it has two particular claims for attention. It requires only one filament secondary F1 and it is naturally particularly free from hum.

It is extremely easy to build, as there are neither snags nor critical adjustments to be made. Given good parts and the ability to follow the diagram, it will give maximum results as soon as its valves heat up.

For V2 two valves might be suggested. If it is the builder's intention later to convert the set into a 3-valver, he might use an Osram ML4 and then R1 should have a value of 1100 ohms. If not, then a Cossor 41MX would be satisfactory if R1 is valued at 850 ohms. In either case R1 must be wire-wound and capable of carrying 25 ma at least.



The circuit varies from the previous one in the employment of a directly heated pentode as the audio amplifier.

Set No. 14

This is practically a standard two-valve design using a directly heated

pentode as an audio amplifier, the filament of which is fed from secondary F2.

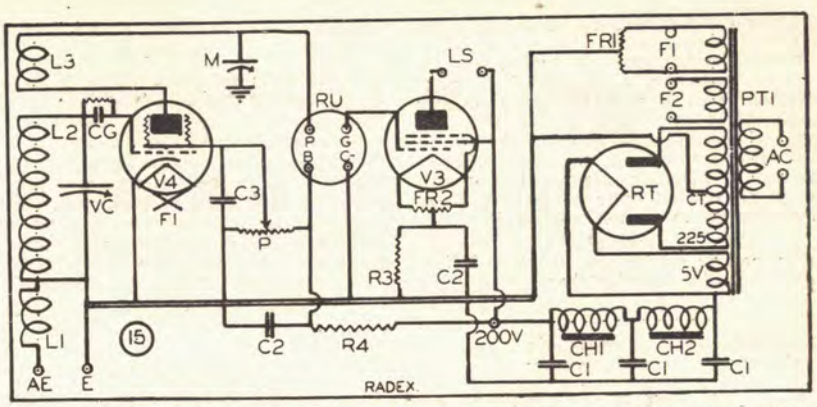
Here again there need be no anticipation of unexpected trouble arising. The only problem lies in the selection of the valve for V3 and the consequent resistor-value for R3.

Three makes are eminently suitable for the position, and they are given herewith, together with the corresponding value for R3:—Osram PT425 and R3 of 500 ohms; Philips C443 and R3 of 1000 ohms; and Cossor 415PT and R3 of 400 ohms. Whatever its value, R3 must be wire-wound to carry 25 ma at least.

Set No. 15

Here the employment of a screen-grid valve as the detector makes a particularly sensitive combination. With it in circuit two other factors must be taken care of.

Firstly, the voltage applied to the detector's screening-grid is critical, and its exact value must be found by actual experiment. To this end we employ high-resistance potentiometer P, which is mounted in the vicinity of socket V4. Initially its arm is set about half-way round, but, after signals have been brought in, this arm is set to a position which gives a combination of the smoothest reaction control with M and the best volume. When this point has been found, P requires no further attention.



Using 4 volt valves a maximum punch can be expected from this design which uses a screen-grid detector, followed by a resistance coupled pentode.

Secondly, in order to suit the characteristics of the valve, the method of effecting the audio coupling must incorporate a relatively high impedance. Here this objective is achieved by the employment of a manufactured resistance-capacity coupling RU.

The remarks covering valve V3 and resistor R3 in Set No. 14 apply equally to the replicas of this design.

Set No. 16

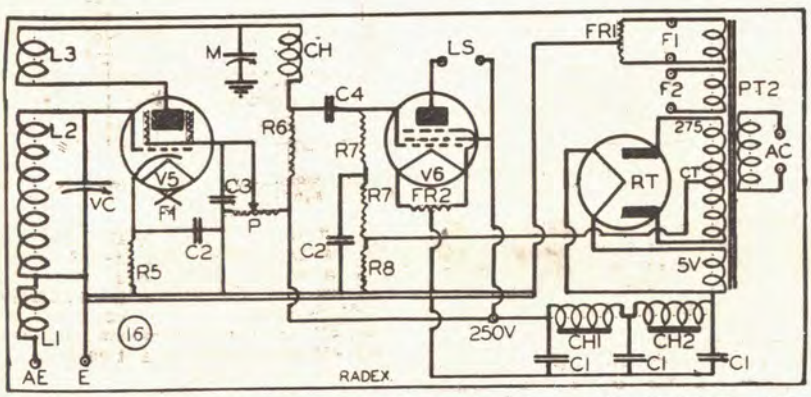
This is one of the most modern and powerful two-valve combinations. It employs a screen-grid detector, followed by a pentode, which are both of the Radiotron type, and it is therefore possible to give values to all the resistors employed—vide the List of Parts.

The S—G detector operates on the anode-band system by virtue of the presence of resistor R5; there is, therefore, no grid-condenser and leak in the circuit. Again, potentiometer P is employed to furnish the most suitable voltage to the screening grid of V5, and the audio coupling is straight resistance-capacity through the agency of R6 and C4.

The method of obtaining grid-bias for the type UY247 at V6 is important and should be followed exactly, is it gives particularly good results with this type of pentode. The centre-tap CT of the power secondary is not directly earthed (as in the three previous instances), but is taken to earth through a fixed resistor R8, while the two half megohm grid-leaks (R7 twice) are connected to the secondary (CT) end of R8. A shunt

KEY TO PARTS EMPLOYED:

AC In-put plug from house power supply.
AE. Aerial terminal.
C1. Fixed condensers of 4MFD. tested to 500 volts.
C2. Fixed condensers of 1MFD. ditto.
C3. Fixed condenser of 0.1 m.f.d.
C4. Fixed condenser of 0.01 m.f.d.
CG. Mica grid condenser of 0.00025 m.f.d. with clips and 2 meg. leak.
CH. Radio frequency choke coil.
CH1 and CH2. Power smoothing chokes each of 30 henries (or 1 centre-tapped 60-henry unit) to carry 50ma.
CT. Centre-tap of transformer's power secondary.
E. Connection to earth and to set's chassis.
F1. Filament secondary for indirectly heated valves.
F2. Filament secondary for directly heated valves.
FR1 and FR2. Centre-tapped filament resistors of 50 ohms.
L1, L2, L3. Tuner coils. (See text.)
LS. Connections for magnetic speaker or for voice-coil of dynamic speaker.
M. Midget reaction control condenser of 22 plates.
P. Potentiometer of 500,000 ohms.
PT1. Power transformer for 4-volt A.C. valves having two secondaries of 4v. (F1 and F2). one of 5v. for rectifier, and power secondary giving 225 volts each side of CT.
PT2. Ditto for Radiotron-type valves, F1 and F2, giving 2½v. each and power secondary giving at least 275 volts each side of CT.
R1. Bias resistor—see text.
R2. Power grid-leak resistor of 80,000 ohms.
R3. Bias resistor—see text.
R4. Resistor of 10,000 ohms.
R5. Resistor of 50,000 ohms.
R6. Resistor of 250,000 ohms.
R7. Resistors (2) of 500,000 ohms. (R4, R5, R6 and R7 all of the power grid-leak type.)
R8. Wire wound resistor of 500 ohms (to carry 50 ma).
RT. Type UX 280 full-wave rectifying tube and UX socket.
RU. Resistance capacity coupling unit—such as Philips 4001.
T. Audio frequency transformer.
VC. Variable condenser of 0.0005 m.f.d. with vernier dial.
V1. Any A.C. tube of the 4-volt series suitable for detection.
V2. Indirectly heated 4-volt power tube (such as Osram ML4 or Cossor 41MXP, etc.).
V3 Pentode 4-volt valve and UX socket.
V4. Any screen-grid valve of the 4-volt series.
V5. Screen-grid valve of the UY224 type.
V6. Pentode of the UY247 type.
5V. Rectifier filament secondary of power transformer.
200V. Smoothed D.C. voltage available from transformer PT1.
250V. Ditto from transformer PT2.



This 2-Valver is definitely designed to utilise only tubes of the Radiotron types UY224-A and UY247, for the latter of whi h a special grid bias system is included.

to ground is provided by C2 at the junction of the two leaks.

Where, with any of these sets, a dynamic speaker is employed in conjunction with a pentode valve of any make, it is important to see that the speaker incorporates a suitably wound input transformer. In other words, when buying a dynamic always be careful to mention what type of output valve you propose to associate with it.

General

The coil combination L1-L2-L3, or "tuner," is the same as that already described in articles Nos. 1 and 2 of this series.

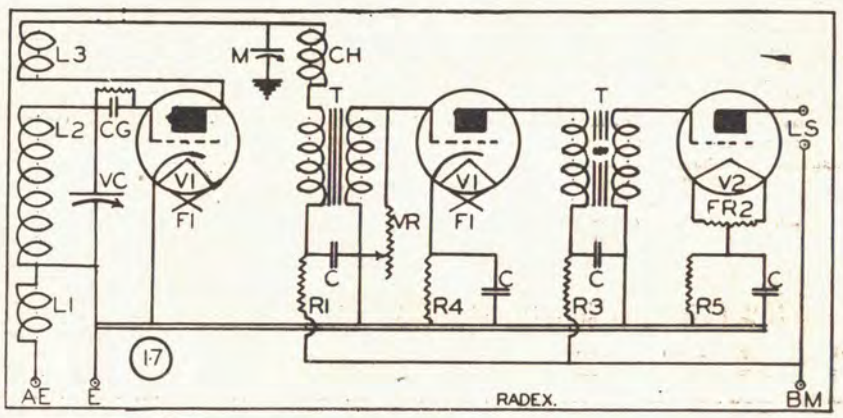
L1 consists of eight turns of No. 30 d.s.c. wire wound on a tube half an inch long and either 1½ or 1¼ inches in diameter. On a tube two inches in diameter and three inches long, and starting half an inch from one end put on 54 turns of No. 30 to Make L2. Leave a gap of three-eighths to half an inch and then lay on a further 20 turns to form L3. All coils are wound in the same direction. When the winding is completed L1 is suspended inside the larger tube by means of a screw and nut which passes through the clear portion above the commencement of L2.

For the external wiring consider the larger tube to be standing on end with L1 uppermost; then wire as follows:—Top of L2 to CG and fixed vanes of VC (in the case of No. 16 this would be to grid of V5 instead of CG); bottom of L2 to earth; top of L3 to fixed vanes of M; bottom of L3 to plate of detector valve. The ends of L1 go, in any order, to aerial and earth.

Easy Electric Receivers

Series VI.—SELF-CONTAINED LOCAL THREE-VALVERS

IN the building of a local all-electric 3-valver, by which is implied a receiver composed of a regenerative detector and two low frequency amplifying stages, it is important to take every precaution to eliminate the intrusion of hum into the final reproduction. Just as two audio stages naturally produce more volume than would one, so will they accentuate any hum that may be present to an extent far more annoying than will a single stage.



The simplest form of all electric three-valve receiver.

Against such an intrusion three precautions should be taken by the novice builder: He should assemble his components on a metal base-plate, running all filament leads thereunder while purely radio connections might be carried out above it; filament leads, tightly twisted together in pairs, should be run as directly as possible; and there should be an almost lavish use of shunt fixed condensers (C and C4) in the accompanying drawings. It is unnecessary to stress the importance of well-soldered joints in A.C. receivers.

The Power Pack

Power-packs in general were discussed in Article No. 4 of this Series, and their relation to the energising of D.C.-operated dynamic speakers was dealt with, together with 2-valvers, in No. 5. The illustration entitled "Power-Pack" may help further to clarify the matter as, if every ounce is to be obtained from a given combination of valves, it is one of considerable importance.

The maximum plate voltage required for Sets Nos. 17 and 19, in which 4-volt valves are catered for, is 200 at BM; sets Nos. 18 and 20 are designed to employ Radiotron-type tubes and therefore BM should be in the vicinity of 250 volts, with a current draw of around 40 ma. The total plate-current draw for the two 4-volters, owing to the variety of such tubes, will vary between 25 and 55 ma.

In these circumstances, and for the sake of simplicity, we might very well decide upon an almost standard type of power transformer PT giving 350 volts (SV) each side of its power-secondary's centre-tap, while filament secondaries F1 and F2 must furnish either 4 or 2½ volts—according to the type of radio valve we decide to install.

For the moment disregarding alternative connections FC-S and FC-P for the field coil of the dynamic speaker, even

A.C.—Connection to house power-point.
AE—Aerial connection.
BM—Maximum voltage from power-pack or into set;
C—Fixed condensers of 1 mf.
C2—Mica condenser of 0.01 mf.
C3—Fixed condenser of 0.1 mf.
C4—Fixed condenser of 4 mf.
C5—Mica consenser of 0.001 mf.
CG—Grid-condenser of 0.00025 with clips and 2-megohm-grid-leak.
CH—Radio frequency choke coil.
CH1 and CH2 — Power smoothing chokes of 30 Henries each to carry 50 ma.
CT—Centre-tap of power secondary of transformer PT.
E—Connection to earth and to chassis of set and power-pack.
FC-P—Dynamic speaker's field coil of 7500 ohms (approx.) wired in parallel with power-pack.
FC-S—Ditto, but of 2500 ohms (approx.), but wired in series with power supply and in place of CH2.

Key To Parts Employed

FR and FR2—Centre-tapped filament resistors of 50 ohms each.
L1-L2-L3—Home-made three-coil
LS — Connection for magnetic or dynamic speaker.
M—Midget reaction control condenser of 22 plates.
MVR—Master variable resistor to pass 69 ma—Clarostat type.
PT—Power transformer having secondaries, F1 and F2 to suit valves' filaments, 5-volt winding for rectifier tube, and centre-tapped secondary for power 350/350v.
R1—Resister of 100,000 ohms.
R2—Resister of 10,000 ohms.
R3—Resister of 5000 ohms to carry 10 ma.
R4 and R5—Resistors—for values see text.
R6—Resistor of 2250 ohms to carry 10 ma.
R7—Resistor of 1500 ohms to carry 50 ma.
R8—Resistor of 250,000 ohms.
R9—Resistor of 200,000 ohms.
R10—Resistor of 50,000 ohms.
RU—Resistance - capacity audio coupling unit.
RT—Type 280 full wave rectifying tube and UX socket.
SV/SV—Secondary voltage of transformers power secondary.
T—Audio frequency transformer.
V1—Any general purpose 4-volt AC valve and UY.
V2—Power out-put valve of the 4-volt series and UX.
V3—Any screen-grid valve of the 4-volt series and UY.
V4—Type UY227 valve and socket.
V5—Type UX245 power tube and socket.
V6—Screen-grid valve type UY224 and socket.
VC—Variable condenser of 0.0005 mf
. R—Potentiometer of 500,000 ohms.
VR2—Potentiometer or variable resistor of 25,000 ohms (such as Electrad Type H).

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Aqueous Type

Guaranteed Maximum Leakage 1 Milliampere after 1 minute at the stated Voltage

Must not be used on Raw A.C.

Container is a Cylindrical Aluminium Pot

Inverted Type

Minimum Capacity	Max D.C. Voltage	Height over Case	Diameter	Height Overall	Price
7 MFDS	500	4½ in.	1⅜ in.	5½ in.	7/
8 MFDS	440	4½ in.	1⅜ in.	5½ in.	7/

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Working Voltage 500 D.C.

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2. That it is tested for at least two hours on 1200 volts D.C. (rectified, but not smoothed).
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.00005 mfd.	.. 1/6	.001 mfd.	.. 2/0
.0001 mfd.		.002 mfd.	
.0002 mfd.		.003 mfd.	
.00025 mfd.		.004 mfd.	.. 2/3
.0003 mfd.	.. 1/7	.005 mfd.	
.0004 mfd.		.006 mfd.	
.0005 mfd.		.007 mfd.	.. 2/6
.0006 mfd.	.. 1/10	.008 mfd.	
.0007 mfd.		.009 mfd.	
.0008 mfd.		.01 mfd.	.. 2/9
.0009 mfd.		.0001 mfd. with .00025 mfd. clips	1/9

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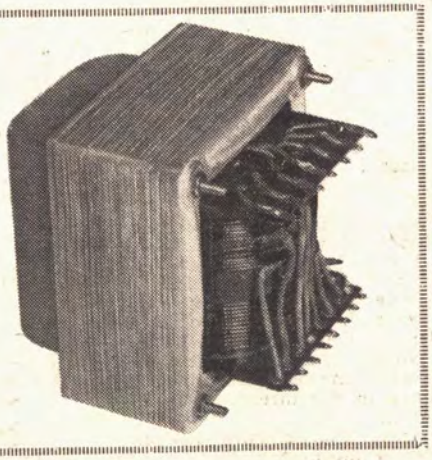

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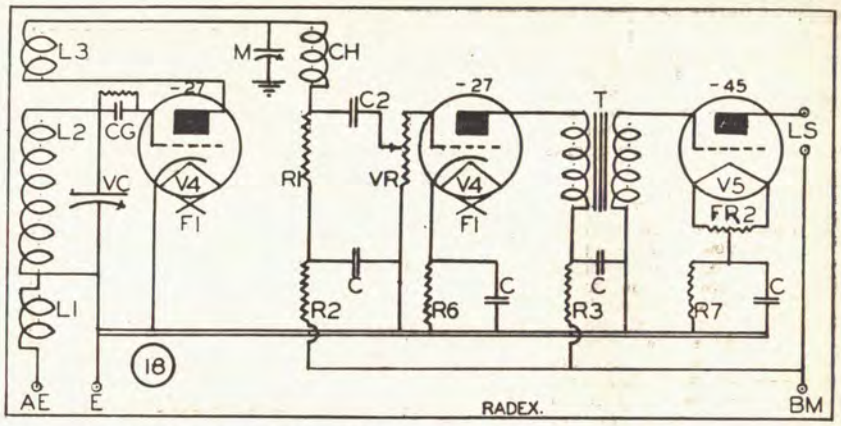
allowing for the voltage drop across smoothing chokes CH1 and CH2, in either case this would produce a greater plate voltage between BM and earth than is required.

In consequence, as a precautionary measure, we insert a master variable resistor (MVR), capable of carrying at least 50ma, between the source of energy and the out-put, BM. When the receiver is completed, MVR is set, through the agency of a high resistance voltmeter, to give the required voltage at BM, and thereafter needs no more attention.

As outlined in the previous article, D.C.-operated dynamic speakers are of two kinds as regards their field coils; those of relatively low resistance (2500 ohms and under), and those of comparatively high resistance (7500 ohms and over). The former variety is wired in series with the main supply, and in place of one of the chokes; thus, in the diagram, FC-S represents such a field-coil, and when it is so connected CH2 is altogether omitted from the circuit. With the latter (FC-P) no alteration to the design is required; both chokes remain, and the coil is wired across BM and earth.

In the instances of the four receivers under consideration, a low resistance field is recommended for Nos. 17 and 19 wired at FC-S; for the other two

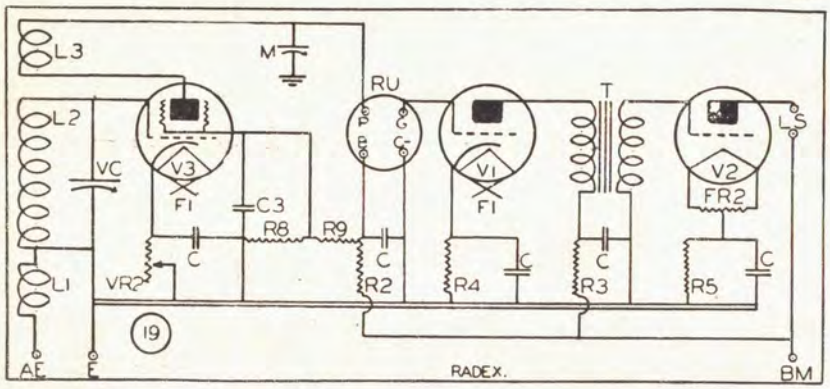


An easily assembled three-valver evaluated for Radiotron valves.

denser; and P to plate terminal of detector valve. The ends of L1 run to aerial AE and earth.

Coil L1 is suspended inside the top of L2 by means of a screw and nut through the hole provided. The further L1 is pushed out of parallel to the turns of L2, the greater will be the set's selectivity—i.e., the greater will be the possibility of avoiding interference.

with transformer couplings. Here, as in the other three of the series, the last tube must be of the power type. Volume is controlled by means of a variable high resistor, VR, across the secondary of the first audio transformer; VR is actually a potentiometer of 500,000 ohms resistance with only the arm and one of its outer terminals connected.



Power local receiver arranged for the employment of tubes of Continental types.

either methods are suitable, but if FC-S is employed, then resistor MVR may be omitted.

Tuning Coils

All four receivers employ the same set of coils, and these are again similar to those used in Nos. 1, 2 and 5 of this series—as shown by the accompanying sketch.

The tuner unit is home-made as follows:—Quarter of an inch from one end of a tube 2 inches in diameter and 3 inches long, drill an eighth inch hole Drill a similar hole in the centre of a piece of 1½ inch diameter tube half an inch in length. On the latter wind eight turns of No. 30 d.s.c. wire, putting four on each side of the hole, and bind them in position with silk thread. This makes coil L1 for the aerial.

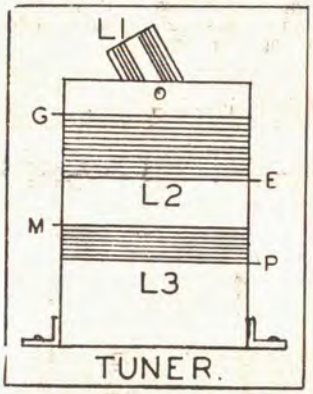
On the larger tube, starting quarter of an inch below the hole, put on 54 turns to make L2. Leave a space of three eighths to quarter of an inch, and then make L3 with 20 more turns.

The order of the connections, as lettered, is as follow: — G to the fixed vanes of VC and to grid condenser CG (in the cases of Nos. 10 and 20 this would be altered to "G to fixed vanes of VC and grid of detector valve"); E to earth; M to fixed vanes of midget reaction con-

Set No. 17

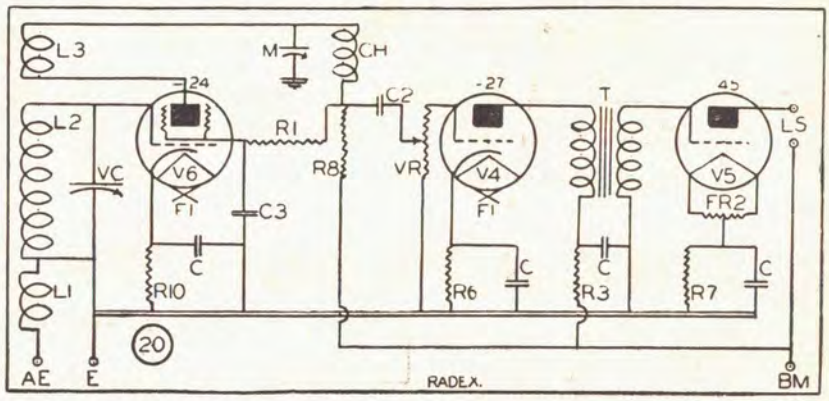
This is the conventional 3—4 valve all electric receiver, of which hundreds have been manufactured and sold in console form. Here its resistors (the nerves of the A.C. system) have been evaluated for 4-volt valves.

Following a regenerative detector, V1, come two stages of audio amplification



This is an extremely easy set to build, and one that contains no pitfalls provided resistors R4 and R5—furnishing bias for audio valves V1 and V2 respectively —are of values suited to those tubes. For these positions many different 4-volt valves can be employed; below are a few suggestions, together with the necessary resistor-values.

In order to be on the safe side, all resistors specified for R4 should be able to carry 25ma, and those for R5 up to 50ma.



Three-valve design including a screen-grid detector of the Radiotron variety

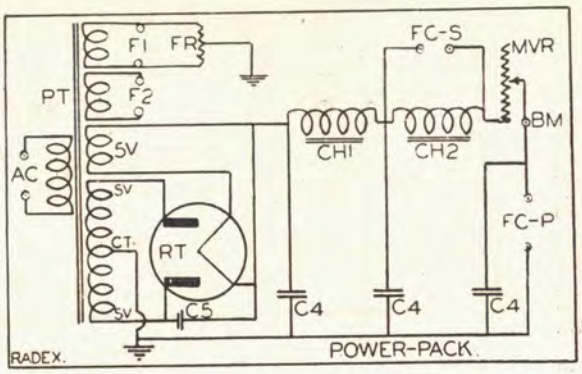
Should it be desired to use Radiotrons in this set it is only necessary to increase BM to 250 volts and to replace resistors R4 and R5 with R6 and R7 respectively—the latter being evaluated in the list of parts. The other components remain unaltered.

Set No. 18

The main difference between this and the foregoing design is that here resistance-capacity coupling of a home-made variety is employed between the detector and first audio and the resistors have values applicable to Radiotron-type valves. All else being equal, this resistance coupling minimises opportunities for distortion due to transformer inter-action and therefore the reproduction is purer.

This coupling consists of resistor R1 and fixed condenser C2. VR is a high resistance potentiometer (used as such in this case) which replaces the conventional shunted grid-leak and so functions as a volume control.

If desired, reversing the former instance, 4-volt valves can be employed in this design. The only change will be to exchange the valves of R6 and R7 for those listed for R4 and R5, and to reduce the plate input to 200 volts.



Basic form of power-pack applicable to the average set.

1st Audio	R4
Osram MHL4	700 ohms
Osram ML4	1100 ohms
Philips E415	1000 ohms
Philips E409	800 ohms
Cossor 41MLF	650 ohms
Cossor MP	750 ohms
2nd Audio	R5
Osram PX4	650 ohms
Philips D404	1000 ohms
Cossor 41XP	850 ohms

Set No. 19

This is a particularly sensitive design owing to its employment of a screen-grid valve as a detector at V3. Its production is of a high order, and this is mainly attributable to the same valve functioning on the anode-bend system of rectification by virtue of the presence of variable resistor VR2

For the values listed 4-volt valves should be employed and VR2 will form the volume control. The drop in voltage for the screening grid of V3 is obtained through the combination of R9 and R8, while the first audio coupling RU is manufactured.

The values for R4 and R5 will be the same as those independently tabulated for Set No. 17.

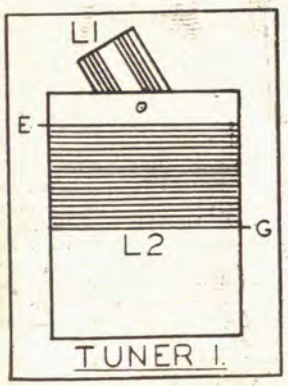
Set No. 20

This is practically the same as the foregoing design, but the resistor values are worked out to suit Radiotron-type valves with 250 volts on BM, while the first valve coupling is home made.

In this instance, however, as we are dealing with a type of valve that has the same characteristics irrespective of its maker, we find it an advantage to use a fixed resistor as a means of bias at R10 and bring the volume control back to VR, as in Set No. 18.

Easy Electric Receivers

Series VII.—SELF-CONTAINED "THREES" FOR RANGE



This tuner uses a variable aerial coil.

IF a three valve receiver is to combine within itself the properties of sensitivity, selectivity and volume, there is only one way in which those valves can be arranged. The first must function as a tuned amplifier at radio frequency and preferably it should be of the screened grid type, the second must be the detector, and to get efficient reproduction from the loud-speaker the last must be either a pentode or a super power tube. All of the four designs presented here are based on these conditions, but for varying uses and varying kinds of valves, they are individually different from each other.

The Power Pack

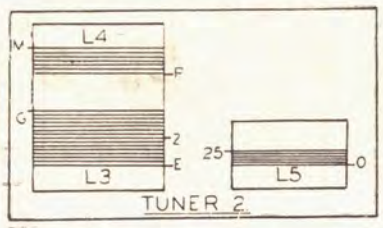
The power supply employed is very similar to that utilised in No. 6 of this series, but the alternatives have been omitted for the sake of clarity. The filament secondaries (F1 and F2) of the power transformer PT can deliver either 4 or 2½ volts—according to the requirements of the valves you propose to use in the receiver proper. Its power secondary gives 350 volts each side of the centre-tap CT and the maximum voltage delivered at BM is adjusted to either 200 or 250 by means of master resistor MVR.

It is suggested that a dynamic speaker having a field coil (FC) of 2500 ohms or less be used, and that there is, therefore, need for only one power choke PCH. The centre one of the three smoothing condensers marked C7 can be omitted if desired—although its presence is always beneficial.

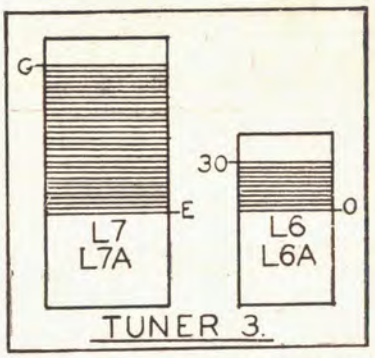
In the list of parts the 350-volt secondary of PT and PCH are both rated to carry no less than 50ma. Both parts will remain cooler if they are rated as capable of carrying anything up to 100ma. —and a cool A.C. set is generally one that is peculiarly free from hum. Nevertheless, with any combination of valves given here the actual draw will not appreciably exceed 50ma.

The Tuners

Each receiver, having two tuned stages, uses two sets of coils or tuners. In order that the directions for their construction may be clear, they are illustrated herewith. With the exception of L5 (which calls for No. 36 or 38 gauge enamel-covered wire) all are wound with No. 30 d.s.c.



Tuner 2 consists of only L3 and L4, the latter being a fixed tickler.

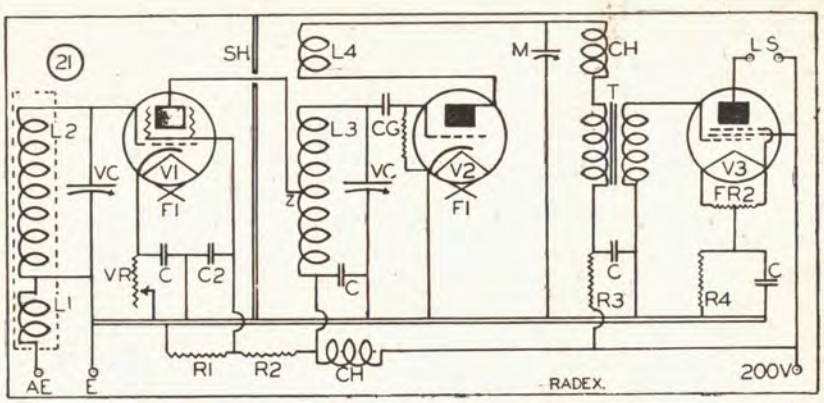


The above details should be studied before constructing the receiver marked 24.

Tuner 1 is a variable aerial to R.F. grid coupler and is wound on two tubes, one 2 inches diameter and 2½ inches long, and the other 1¼ inches diameter and half an inch long. The latter is suspended (after being wound) at the top of the former by means of a single eighth-inch screw, nut and washers. L1 consists of eight turns on the smaller tube. L2, on the larger, has 70 turns. When completed the unit is mounted on end and is to be totally enclosed in a 3-inch diameter coil-can. The ends of L1 go to aerial and earth. The E end of L2 is also earthed, while G goes to the grid of the R.F. S-G valve and the fixed vanes of the first variable condenser VC.

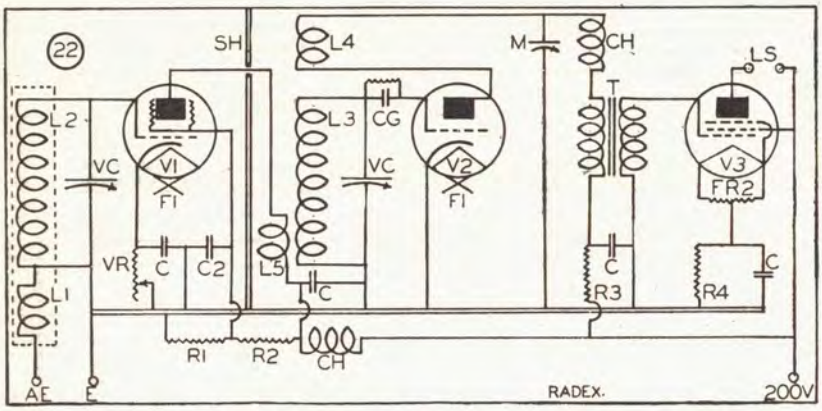
Tuner 2, as used in Sets Nos. 21 and 23, consists of only coils L3 and L4—the latter being a fixed tickler—and is wound on a 2-inch diameter tube 2½ inches in length. L3 has 52 turns with a centre-tap at Z, while L4 contains 20 turns with a space of half an inch between it and L3. In every set in which this combination is used M goes to the fixed vanes of the midget condenser M. P is taken to the plate of the detector valve, and G goes to the fixed vanes of the second tuning condenser VC and also to one side of condenser CG. In the case of No. 21, Z is taken to the plate of valve V1, while E goes to one side of condenser C and an RF choke CH; but in No. 23 goes to one side of condenser C3, while E is earthed.

L5 coil of this tuner is only used in No. 22 and is made by putting 25 turns of No. 38 gauge enamel-covered wire on a 1¾-inch diameter tube one inch long. When completed L5 is pushed inside L3 until its zero turn is approximately under the "E" end turn of the latter. The connections now are:—25 of L5 to plate of V1, 0 of L5 to condenser and choke (C and CH) and E of L3 to earth, while Z is blank. Naturally all coils must be wound in the same direction in order to make good these wiring directions.



Three valve-circuit which will supply plenty of volume. The degree of selectivity is not very high.

panel valve-sockets should be employed. The power transformer and choke might be placed at the right rear while the valves will run in order from left to right. The shield provided in the List of Parts (SH) is to be bolted at right-angles to the base in such a manner that the S-G RF valves and its associated grid and aerial coils and variable condenser are all to its left. Tuner 2, in whichever form it is used, is to be mounted horizontally, but supported at a height of about one inch above the base.



Another three-valve circuit which has a far higher degree of selectivity than that of 21.

Tuner 3, which is made in duplicate, requires two 1¼-inch diameter tubes 3 inches long and two 1-inch diameter tubes each 1¾ inches long. Starting one inch from the ends of the longer tubes wind 100 turns on each to make L7 and L7A. On the smaller tubes, again starting 1 inch from their ends, put 30 turns to make L6 and L6A. The smaller tubes are now pushed inside the larger ones until end-turn O is under end-turn E. The connections are obvious in this instance, except that it must be remembered to take O of L6A to the plate of S-G valve V7 in No. 24. For reasons to be given later, reaction is not actuated by means of a tickler coil in this design. Each completed unit (L6-L7 and L6A-L7A) must be enclosed in its can.

General Assembly

Broadly speaking, a chassis made from a sheet of No. 16 gauge aluminium measuring 14 to 22 inches will suit all these sets. Pieces two inches square are cut from each corner of the sheet and then the 2-inch wide strips all round are turned down to form a shallow inverted box.

Above this chassis appear the valves, coils, tuning condensers, power transformer and power choke. Everything else is located underneath, and under-

Set No. 21

This set and No. 22 are both designed to operate with A.C. valves of the 4-volt series, and call for a maximum plate voltage of 200.

No. 21 is capable of giving plenty of volume, but notwithstanding the possibility of loosening the aerial coupling with L1, its degree of selectivity is not of a very high order. This failing is due to the method of coupling V1 to V2. Properly viewed, however, this is not a fault, as the set is intended for use outside the "shock" area—say, not less than 25 miles from an A class station.

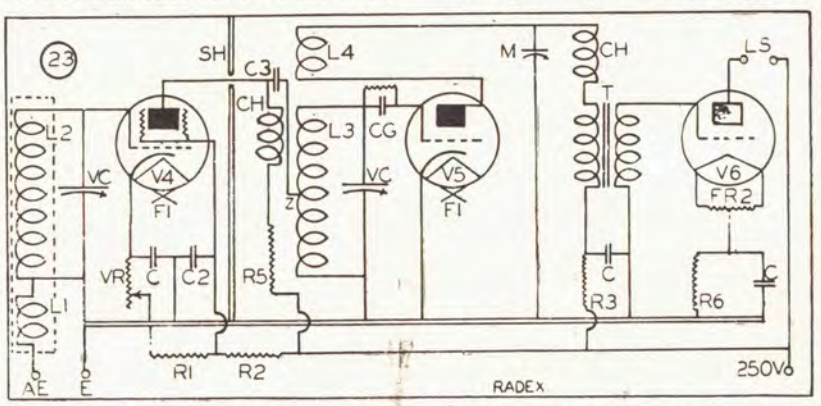
As the plate supply for V1 is fed through a portion of coil L3, it is important to note that the bottom end of that coil does not go to earth but to a fixed condenser C and RF choke CH.

The value of bias resistor R4 will vary with the make of pentode used at V3. Some suggestions are: Osram PT425 and 500 ohms; Cossor 415PT and 400 ohms; Philips C443 and 1000 ohms. In any case R4 must be capable of carrying at least 25ma and a higher carrying capacity is better.

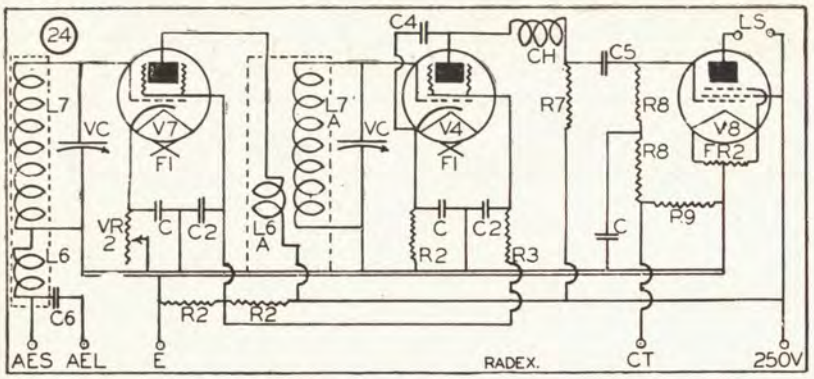
The set gets going without any trouble except that at first the reaction may be either a little fierce or may appear to be on all the time irrespective of the setting of M. In order to account for widely differing types of valves that may be used as detectors at V2 a maximum number of turns has been given to tickler coil L4; in consequence should you encounter excessive reaction the trouble can be removed by taking off a turn or so from the "M" end of that winding.

Set No. 22

This is another 4-volt set, but one with a far higher degree of selectivity. When



This three valve circuit, though more selective than 21, depends largely on the coupling condenser, C3.



A non-renegerative detector employing the anode-end system of detection.

L1 is properly adjusted in conjunction with a moderate aerial—say one not exceeding 40 feet over all—there is silence between 3LO and 3UZ and also between all three of 3DB, 3KZ, and 3AW. In Melbourne, with careful tuning and with reaction at the peak, it will bring in 2BL with only a faint trace of LO while 2NC comes in clear of everything.

BATTERY OPERATION

All sets described in "Easy Electric Receivers" can be taken as alternative battery designs. The change merely entails substitution battery valve-types, the supply of suitable batteries and the erasure of bias resistors, where such are used.

Personally I found this an all-round reliable circuit and one that can be heartily recommended to the listener who requires reasonable volume with freedom from interference. As with other receivers with a final pentode stage, the tone of the dynamic can be varied to suit your own ear by shunting a fixed condenser across the LS terminals. Around 0.01 is an average value, but as the size of the condenser is increased so will the tone be deepened.

The value of R4 should be that listed for various pentodes as in the examples given for No. 21.

Set No. 23

The resistors in this set are given such values as call for the use of Radiotron type 2½-volt valves with a maximum plate voltage of 250.

The over-all selectivity of the set is higher than that of No. 21, but not so good as No. 22, but this is largely dependent upon the value given to coupling condenser C3. As listed it is one of 0.006mf, but if this size is decreased the tuning will sharpen very appreciably; on the other hand, if C3 is made less than 0.001mf. the quality of the reproduction will suffer.

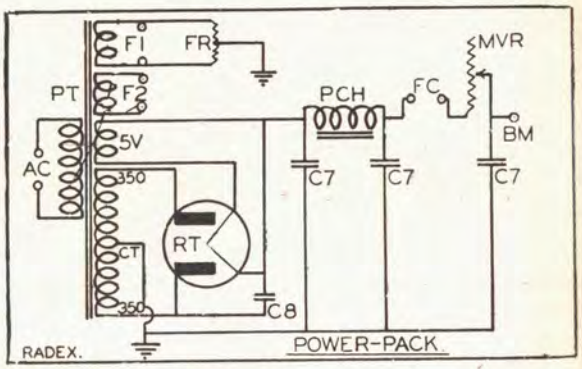
Set No. 24

This design is different to all the others in that the detector is non-regenerative, and functions on the anode-bend system. Owing to the exact similarity of the tuning coils the two variable condensers can be a 2-gang unit—thus affording 1-dial control — but the novice is advised to use separate tuning condensers.

VR2 is at once a volume control, and, past a certain setting, puts valve V7 into such a condition that a partial reaction effect is produced. With the whole of the resistance of VR2 in circuit a minimum of volume is obtained. As the resistance is decreased, so the volume rises until a point is reached when the set bursts into oscillation. Naturally the set is in an extremely sensitive condition, just before this point is reached.

Particular notice should be taken of the method of connecting in R9, which is the bias resistor for pentode V8. The centre-tap (C.T.) of the power transformer is not taken direct to earth—as in the three previous cases — but is wired to the junction of the lower power grid-leak resistor R8 and wire-wound resistor R9, the latter being earthed at its other end.

Alternative aerial connections are offered at points AES and AEL, but these are only necessary should you decide to use ganged tuning condensers at VC. In order to keep the ganging in step, an indoor aerial 10 to 15 feet long could be connected to AES, but if an outdoor catchment is used it would be wired to AEL.



Circuit of the power pack.

Enquiries regarding points that are unclear in any of the sets outlined in this series will be welcomed. Letters should be addressed to The Listener In.

KEY TO PARTS LIST

AC—Connection to house lighting mains.
AE—Aerial connection.
AEL—Connection for long aerial.
AES—Connection for short or indoor aerial.
BM—Maximum plate voltage
C—Fixed condenser of 1 MF.
C2—Fixed condenser of 0.1 mf.
C3—Mica fixed condenser of 0.006 mf.
C4—Mica condenser of 0.0005 mf.
C5—Mica condenser of 0.01 mf.
C6—Mica condenser of 0.0001 mf.
C7—Fixed condensers of 4 MF.
C8—Mica condenser of 0.001 mf.
(All above condensers to be tested to at least 750 volts).
CG—Mica grid-condenser with clips and 2 megohm grid-leak.
CH—Radio frequency choke coils.
E—Connection to earth and chassis.
FC—Series connections for field coil of 2500-ohm dynamic speaker.
FR & FR2—Centre-tapped filament resistors of 50 ohms each.
L1-L2—Coils forming Tuner 1 (see text) and 3-inch diameter coil-can.
L3-L4-L5—Coils forming Tuner 2.
L6-L7—Coils forming Tuner 3 and two 2½-inch diameter cans.
LS—Connections for voice-coil of dynamic speaker.
M—Midget reaction condenser of 22 plates.
MVR—Master variable resistor to carry 50 ma.
PCH—Smoothing choke of 30 Henries to pass at least 50 ma.
PT—Power transformer having secondaries F1 and F2 to suit valves in set; 5-volt secondary for rectifier; and 350/350v. power secondary, to supply at least 50 ma.
R1—Resistor of 60,000 ohms.
R2—Resistor of 50,000 ohms.
R3—Resistor of 100,000 ohms.
R4—Wire-wound resistor—see text.
R5—Resistor of 15,000 ohms.
R6—Wire-wound resistor of 1500 ohms to carry 50 ma.
R7—Resistor of 250,000 ohms.
R8—Two resistors of 500,000 ohms each.
R9—Wire-wound resistor of 400 ohms to carry 50 ma.
SH—Sheet of No. 18 gauge aluminium, measuring approx. 10 x 6 inches as shield between RF stage and remainder of set.
T—Audio frequency transformer.
V1—Screen-grid valve 4-volt series UY and shield.
V2—General purpose valve (detector) 4-volt series UY.
V3—Pentode valve 4-volt series.
V4—Type UY224 valve and shield.
V5—Type UY227 valve.
V6—Type UX245 valve.
V7—Type UY235 valve and shield.
V8—Type UY247 valve.
VC—Variable condensers (2) of 0.0005 mf. and vernier dials.
VR—Variable resistance of zero to 2000 ohms to carry 5 ma.
VR2—Variable resistance of zero to 10,000 ohms to carry 10 ma.
Z—Centre-tap of coil L3, Tuner 2.

General Valve Characteristics

RADIOTRONS AND AMERICAN TUBES

DETECTORS AND AMPLIFIERS

Type	Purpose	Base	Cathode Type	Rating: Filament or Heater Volts	Rating: Filament or Heater Amps.	Rating: Filament or Heater Supply	Rating: Plate Max. Volts	Rating: Screen Max. Volts	Negative Grid Bias Volts: DC on Fil.	Negative Grid Bias Volts: AC on Fil.	Plate Current Milliamp.	AC Plate Resistance Ohms	Mutual Conductance Micromhos	Voltage Amplification Factor	Ohms Load for Stated Power Output	Power Output Milliwatts
55	DET + & AMP	6 pin	heat	2.5	1.0	AC or DC	250	—	20	20	8	7500	1100	8.3	20000	200
56	BIAS ✤ DET	5 pin	heat	2.5	1.0	AC or DC	250	—	20	20	Plate Current to be adjusted to 0.2 ma. with no Input Signal				—	—
56	AMP ✪	5 pin	heat	2.5	1.0	AC or DC	250	—	13.5	13.5	5	9500	1450	13.8	—	—
57	BIAS DET	6 pin	heat	2.5	1.0	AC or DC	250	100	6 approx.	6	Plate current to be adjusted to 0.1 m.a. (approx.) with no Input Signal.				—	—
57	R.F. AMP	6 pin	heat	2.5	1.0	AC or DC	250	100	3 Min.	3 Min.	2	1500000 Min.	1225	1500 Min.	—	—
58	DET SUPER	6 pin	heat	2.5	1.0	AC or DC	250	100	10* Min.	10* Min.	—	—	—	—	—	—
58	R.F AMP	6 pin	heat	2.5	1.0	AC or DC	250	100	3 Min.	3 Min.	8.2	800000	1600	1280	—	—
85	DET+ & AMP	6 pin	heat	6.3	0.3	DC	250	—	20	—	7	8300	1000	8.3	—	—
224A	R.F. AMP	5 pin	heat	2.5	1.75	AC or DC	275	90	3.0	3.0	4.0	600000	1025	615	—	—
224A	BIAS DET	5 pin	heat	2.5	1.75	AC or DC	275	90	5 approx.	5	Plate current to be adjusted to 0.1 ma. with no Input Signal				—	—
224A	A.F. AMP	5 pin	heat	2.5	1.75	AC or DC	275	90	1.0	1.0	0.5	2000000	500	1000	—	—
230	DET✤ or AMP	4 pin	fila	2.0	0.06	DC	90	—	4.5	—	1.8	13000	700	9.3	15000	16
232	R.F. AMP	4 pin	fila	2.0	0.06	DC	150	67.5	3.0	—	1.4	1150000	505	580	—	—
232	BIAS DET	4 pin	fila	2.0	0.06	DC	150	67.5	6 approx.	—	Plate current to be adjusted to 0.2 ma. with no Input Signal				—	—
232	A.F. AMP	4 pin	fila	2.0	0.06	DC	150	67.5	1.0	—	0.25	—	—	—	—	—
234	R.F. AMP	4 pin	fila	2.0	0.06	DC	180	67.5	3.0	—	2.8	1000000	620	620	—	—
235	R.F. AMP	5 pin	heat	2.5	1.75	AC or DC	275	90	3.0	3.0	6.5	350000	1050	370	—	—
236	R.F. AMP	5 pin	heat	6.3	0.3	DC	135	75	1.5	—	3.0	300000	1050	315	—	—
237	DET✤ or AMP	5 pin	heat	6.3	0.3	DC	135	—	9.0	—	4.3	10000	900	9.0	14000	80
239	R.F. AMP	5 pin	heat	6.3	0.3	DC	180	90	3.0	—	4.5	750000	1000	750	—	—

+Duplex-Diode Triode.
✤For Grid-leak Detection—plate volts 45, grid return to + filament or to cathode.
*With 9 volt Oscillator Peak Swing.
✪For Oscillator—plate volts 90, grid volts 0.

POWER AMPLIFIERS

46	A AMP ✪	5 pin	fila	2.5	1.75	AC or DC	250	—	31.5	33	22	2380	2350	5.6	6400	1250
46	B. AMP§	5 pin	fila	2.5	1.75	AC or DC	400	—	—	0	6	—	—	—	1450	16000‡
59	A PWR TRIODE *	7 pin	heat	2.5	2	AC or DC	250	—	28	28	26	2400	2600	6	5000	1250
59	A PENT **	7 pin	heat	2.5	2	AC or DC	250	250 xxxx	18	18	35	40000	2500	100	6000	3000
59	B PWR TRIODE ***	7 pin	heat	2.5	2	AC or DC	400	—	0	0	13	—	—	—	6000	20000
89	A* TRIODE	6 pin	heat	6.3	0.4	DC	180	—	20	—	17	3000	1570	4.7	7000	300
89	A** PENT	6 pin	heat	6.3	0.4	DC	180	180	18	—	20	82500	1635	135	8000	1500
89	B*** AMP	6 pin	heat	6.3	0.4	DC	180	—	0	—	31	—	—	—	2350†	3500‡
210	P. AMP	4 pin	fila	7.5	1.25	AC or DC	425	—	35	39	18	5000	1600	8.0	10200	1600
231	P. AMP	4 pin	fila	2.0	0.13	DC	135	—	22.5	—	6.8	4950	760	3.8	9000	150
233	P. AMP	5 pin	fila	2.0	0.26	DC	135	135x	13.5	—	14.0	50000	1500	75	7000	700

RADIOTRONS AND AMERICAN TUBES—(Continued)

Type	Purpose	Base	Cathode Type	Rating. Filament or Heater Volts	Amps.	Supply	Plate Max. Volts	Screen Max. Volts	Negative Grid Bias Volts D.C. on Fil.	A.C. on Fil.	Plate Current Milliamp.	AC Plate Resistance Ohms	Mutual Conductance Micromhos	Voltage Amplification Factor	Ohms Load for Stated Power Output	Power Output Milliwatts
238	P. AMP	5 pin	heat	6.3	0.3	DC	135	135xx	13.5	—	9.0	102000	975	100	13500	525
245	P. AMP	4 pin	fila	2.5	1.5	AC or DC	275	—	54.5	56.0	36	1670	2100	3.5	4600	2000
247	P. AMP	5 pin	fila	2.5	1.75	AC or DC	250	250 xxx	15.0	16.5	32	35000	2500	90	7000	2500
250	P. AMP	4 pin	fila	7.5	1.25	AC or DC	450	—	80	84	55	1800	2100	3.8	4350	4600

✪Grid adjacent to plate tied to plate.
§Both grids tied together.
†Per Valve.
‡ Two Valves.
*Grids 2 and 3 tied to plate.
**Grid 3 tied to cathode. Grid 2 is Screen.
*** Grid 3 tied to plate.
Grids 1 and 2 tied together.
x Screen Current 3.5 milliamperes.
xx Screen Current 2.5 milliamperes.
xxx Screen Current 7.5 milliamperes.
xxxx Screen Current 9.0 milliamperes.

RECTIFIERS

80	F.W. RECT	4 pin	fila.	5.0	2.0	AC	1 AC Voltage per Plate (Volts RMS) .....350 DC Output Current (Maximum MA).....125 2 AC Voltage per Plate (Maximum Vlts. RMS) 400 DC Output Current (Maximum MA) .....110 3 AC Voltage per Plate (Maximum Volts RMS 550 DC Output Current (Maximum MA) .....135 This rating is permissible only with filter circuits having an input choke of at least 20 H.	
81	H.W. RECT	4 pin	fila.	7.5	1.25	AC	AC Plate Voltage (Maximum Volts RMS.....700 DC Output Current (Maximum MA) 85	
82	F.W. RECT	4 pin	fila.	2.5	3.0	AC	AC Voltage per Plate (Max. Volts RMS) 500 DC Output Current (Continuous) ..... 125-MA Maximum Peak Plate Current 400-MA	Valve Volt. Drop 15V Approx.
83	F.W. RECT	4 pin	fila.	5.0	3.0	AC	AC Voltage per Plate (Max. Volts RMS) 500 DC Output Current (Continuous) .....250-MA Maximum Peak Plate Current 800-MA	Valve Volt. Drop 15V Approx.

PHILIPS VALVES

THE "P.E." 4-VOLT A.C. SERIES

Type	Purpose	Filament Volts	Filament Current (Amps.)	Plate Volts	Plate Current (m/A)	Neg. Grid Bias	Aux. Grid Volts	Aux. Grid Current (m/A)	Mutual Cond.	Amp. Factor	Impedance (Ohms)
E445(M)	Selectode	4	1.1	200	6	-2/-40	100	1.75	1.2	300	250,000
E452T(M)	S.G.	4	1.1	200	3	- 2	100	.5	3	1000	300,000
E442S	S.G.	4	1	200	3	- 3	60	1	1	200	200,000
E442	S.G.	4	1	200	1.5	-1.25	100	.5	1.2	1000	830,000
E424	Spec. Det.	4	1	200	5.5	- 6	—	—	3.5	24	7,000
E409	General	4	1	150	12	- 9	—	—	3	9	3,000
E438(M)	Res. Cap. R.F.	4	1	200	2.5	- 3	—	—	1.5	38	25,300
E444	Binode	4	1	200	0.3-3.2	- 2	25-65	—	3	—	300,000
E455	Selectode	4	1	250	—	- 2	100	—	—	—	—
E499	H.G. Det.	4	1	200	.2	1.6	—	—	4	—	100,000

THE "P.H." 2-VOLT D.C. SERIES

P.H.230	Det.	2	.06	90	1.8	- 4.5	—	—	.7	9.3	13,000
P.H.231	Power	2	.13	135	6.8	-22.5	—	—	.76	3.8	4,950
P.H.232	S.G.	2	.06	135	1.4	- 3	67.5	(A)	.5	580	1,150,000
P.H.233	Penthode	2	.26	135	14	-13.5	135	3.5	1.5	75	50,000
P.H.222	S.G.	3.3	.132	135	3.3	- 1.5	67.5	(A)	.48	290	600,000
234	Var. Mu.	2	.06	135	2.8	3	67.5	—	600	360	600,000
236	R.F. Amp.	6.3	.30	180	3.1	3	90	—	1050	370	350,000
237	G.P.	6.3	.30	180	4.7	13.5	—	—	900	9.0	10,000
238	P. Amp.	6.3	.30	135	9.0	13.5	135	—	975	100	102,000
239	Var. Mu.	6.3	.30	180	4.5	3	90	—	1000	750	750,000
85	Dio Trio	6.3	.30	250	7.0	20	—	—	—	8.3	8,300
89	3 Grid Amp.	6.3	.40	160	17 20 3	20 18 0	— 180 —	— — —	1570 1635 —	9.7 135 —	3,000 82,500 —

PHILIPS VALVES—(Continued)

STANDARD D.C. VALVES

Type	Purpose	Filament Volts	Filament Current (Amps.)	Plate Volts	Plate Current (m/A)	Neg. Grid Bias	Aux. Grid Volts	Aux. Grid Current (m/A)	Mutual Cond.	Amp. Factor	Impedance (Ohms)
A209	General	2	.08	150	4	- 9	—	—	1	9	9,000
A409	General	4	.06	150	3.5	- 9	—	—	1.2	9	7,500
A415	Det.	4	.08	150	3	- 4.5	—	—	2	15	7,500
A425	Res. Cap. R.F.	4	.06	150	.8	- 3	—	—	1.2	25	20,800
A442	S.G.	4	.06	150	2.8	—	75	—	.8	—	—
A609	General	6	.06	150	4	- 9	—	—	1.5	9	6,000
A615	Det.	6	.08	150	4	- 4.5	—	—	2.4	15	6,250
A642	S.G.	6	.06	200	4	—	100	—	.7	—	—

PENTHODE POWER VALVES

B443	Pent. Amp.	4	.15	200	12	-16	150	—	1.5	60	40,000
C443	„	4	.25	300	22	-22	200	—	1.5	60	40,000
E443N	„	4	1	250	48	-39	250	9	2.7	60	22,000
F443	„	4	2	550	45	-39	200	6.5	4	60	15,000
C643	„	6	.25	300	21	-20	200	—	1.5	60	40,000
P.H.247	„	2.5	1.75	250	32	-16.5	250	7.5	2.5	90	35,000
E443H	„	4	1.1	250	36	15	250	—	3.5	130	43,000

STANDARD POWER VALVES

B205	Pwr. Amp.	2	.15	150	7	-18	—	—	1.2	5	4,200
B403	„	4	.15	150	15	-30	—	—	1.5	3	2,000
B405	„	4	.15	150	8	-18	—	—	2	5	2,500
B406	„	4	.1	150	7.5	-15	—	—	1.4	6	4,300
B409	„	4	.15	150	6.5	- 9	—	—	2	9	4,500
E408N	„	4	1	400	30	-34	—	—	4.5	8	1,800
F410	„	4	2	550	45	-36	—	—	8	10	1,250
B605	„	6	.12	150	9	-18	—	—	1.8	5	2,800
C603—(171A)	„	6	.25	180	18	-40	—	—	2	3	1,500
E406	„	4	1	250	48	-24	—	—	6	6	1,000
F704—(UX250)	„	7.5	1.25	450	55	-84	—	—	2.1	3.8	1,800
P.H.245	„	2.5	1.5	250	34	-50	—	—	2	3.5	1,750

THE "P.H." 2.5-VOLT A.C. SERIES

P.H.235	Selectode	2.5	1.75	250	6.5	- 3	90	(A)	1	370	350,000
P.H.224A	S.G.	2.5	1.75	250	4	- 3	90	(A)	1	615	600,000
P.H.227	General	2.5	1.75	180	5	-13.5	—	—	1	9	9,000
P.H.56	Amp. (Cl. A)	2.5	1.0	250	5	-13.5	—	—	1.45	13.8	9,500
	Det.	2.5	1.0	45	—	—	—	—	—	—	—
	Bias Det.	2.5	1.0	250	.2 mean	-20	—	—	—	—	—
	Oscil.	2.5	1.0	90	—	0	—	—	—	—	—
P.H.57	Amp. (Cl. A)	2.5	1.0	250	2.0	- 3	100	1.0	1.2	1,500	1.5 Meg.
(3-Grid)	Bias Det.	2.5	1.0	250	.1 mean	- 6	100	—	—	—	—
P.H.58 (3-Grid Selectode)	Amp. (Cl. A)	2.5	1.0	250	8.2	- 3 min.	100	3.0	1.6	1,280	800,000
P.H.46	Amp. (Cl. A)	2.5	1.75	250	22	-33	—	—	2.3	5.6	2,380
	Amp. (Cl. B)	2.5	1.75	400	6	0	—	—	—	—	—
P.H.59	3-Grid pwr. Amp.	2.5	2	250	30	28	—	—	1200	6	2,500
				250	35	18	250	—	2200	100	45,000
				400	15	0	—	—	—	—	—

RECTIFYING VALVES

Type	Rectification	Filament Volts	Filament Current (Amps.)	Max. A.C. Input Volts	Max. Output in m/A
P.H.281	Full Wave	5	2	400	110
P.H.281	Half Wave	7.5	1.25	750	110
1561	Full Wave	4	2	500	120
373	Half Wave	4	1	220	40
505	Half Wave	4	1	400	60
506	Full Wave	4	1	300	75
P.H.82	Mercury Vapour Rectifier	2.5	3.0	A.C. Volts per plate 500 R.M.S.—D.C. Output 125 m/A.	

COSSOR VALVES

TRIODE POWER VALVES

Type.	Purpose.	Fil. Volts.	Fil. Amps.	Plate Volts.	Plate M/amps.	Screen Volts.	Grid Bias.	Mutual Conductance.	Optimum Load.	Max. Undistorted Output in Watts.	Amplification Factor.	Plate Resistance.
215P	Normal Power	2	.15	150	10.0	—	7.5	2.25	9,000	.150	9	4,000
220PA	Normal Power	2	.20	150	10.0	—	4.5	4.0	9,000	.180	16	4,000
230XP	Extra Power	2	.30	150	22.0	—	18.0	3.0	3,500	.450	4.5	1,500
410P	Normal Power	4	.10	150	11.0	—	9.0	2.0	9,000	.170	8.0	4,000
415XP	Extra Power	4	.15	150	22	—	18	3.0	3,500	.450	4.5	1,500
425XP	Super Power	4	.25	150	20	—	10.5	3.5	5,000	.330	7	2,000
610P	Normal Power	6	.10	150	11	—	7.5	2.28	8,000	.150	8	3,500
610XP	Extra Power	6	.10	150	24	—	15.0	2.5	4,500	.400	5	2,000
625P	Super Power	6	.25	200	25	—	12.0	2.8	6,000	.650	7	2,500

PENTODE AUDIO VALVES

230PT	Battery Operation	2	.30	150	14	150	15	2.0	10,000	.400	—	—
220HPT	Battery Operation	2	.20	150	8	150	4.5	2.5	17,000	.400	—	—
415PT	Battery Operation	4	.15	150	14	150	15	2.0	10,000	.400	—	—
615PT	Battery Operation	6	.15	150	14	150	15	2.0	10,000	.380	—	—
P.T. 41B	Directly Heated Mains	4	1.0	400	30	300	40	2.25	8,000	10,000	—	—
MP/PEN	Indirectly Heated Mains	4	1.0	250	30	200	12	4.0	10,000	2,000	—	—
247/C	American Type	2.5	1.75	250	32	250	16.5	—	7,000	2.500	—	—

BATTERY VALVES

215SG	Screened Grid	2	.15	150	2.5	80	0	1.1	—	—	330	300,000
220VSG	Var. MU Screened Grid	2	.20	150	5.0	+80	0 to 15	1.6	—	—	—	110,000
210RC	R.C.C. or Det.	2	.10	150	.85	—	1.5	.8	—	—	40	50,000
210HF	H.F. Det. or L.F.	2	.10	150	1.6	—	3.0	1.5	—	—	24	15,800
210LF	1st Audio Stage	2	.10	150	4.8	—	4.5	1.4	—	—	14	10,000
210DG	B1-Grid	2	.10	100	—	—	—	0.19	—	—	5.1	27,000
410SG	Screened Grid	4	.10	150	1.2	80	0	1.0	—	—	800	800,000
410RC	R.C.C. or Det.	4	10	150	.6	—	1.5	.8	—	—	40	50,000
410HF	H.F. Det. or L.F.	4	.10	150	1.1	—	3.0	1.1	—	—	22	20,000
410LF	1st Audio Stage	4	.10	150	4.5	—	3.0	1.7	—	—	17	10,000
610SG	Screened Grid	6	.10	150	4.1	80	0	1.0	—	—	200,000	200,000
610RC	R.C.C. or Det.	6	.10	150	.75	—	1.5	.8	—	—	40	50,000
610HF	H.F. Det. or L.F.	6	.10	150	3.0	—	3.0	1.0	—	—	20	20,000
610LF	1st Audio Stage	6	.10	150	6.2	—	3.0	2.0	—	—	15	7,500

ENGLISH A.C. TYPES

41 MSG	Screened Grid	4	1.0	200	0.8	80	1.5	1.6	—	—	4,000	2,500,000
MSG/HA	Screened Grid	4	1.0	200	2.1	100	1.5	2.0	—	—	1,000	500,000
MSG/LA	Screened Grid	4	1.0	200	5.2	100	1.5	3.75	—	—	750	200,000
MVSG	Var-Mu. Screened Grid	4	1.0	200	7.8	100	1.5 to 35	2.5	—	—	—	200,000
M.S/PEA-A	High Freq. Pentode	4	1.0	200	9.0	150	2.5	4.0	—	—	—	—
41MH	Detector	4	1.0	200	2.0	—	2.0	4.0	—	—	72	18,000
41MHL	Det. or H.F.	4	1.0	200	4.0	—	3.0	4.5	—	—	52	11,500
41MRC	R.C.C. and Det.	4	1.0	200	2.7	—	2.0	2.6	—	—	50	19,500
41MHF	H.F. or Det.	4	1.0	200	3.0	—	3.0	2.8	—	—	41	14,500
41MLF	1st Audio Stage	4	1.0	180	9.0	—	5.5	1.9	—	—	15	7,900
41MP	Normal Power	4	1.0	200	24	—	7.5	7.5	3,000	1.250	18.7	2,500
41MXP	Extra Power	4	1.0	200	40	—	12.5	7.5	2,000	2.000	11.2	1,500
41MDG	Double-Grid	4	1.0	200	—	—	—	.25	—	—	10.0	40,000
4XP	Super Power	4	0.6	200	45	—	23	4.0	2,800	1.000	4.8	1,200

AMERICAN TYPE VALVES

46/C	Power Amplifier	2.5	1.0	250	22	—	33	2.3	7,000	1.600	5.6	24,000
57/C	R.F. and Det.	2.5	1.0	250	2.0	100	3.0	1.2	—	—	1,500	1,500,000
58/C	R.F. and Det.	2.5	1.0	250	8.2	100	3.0	1.6	—	—	1,200	800,000
59/C	Indirectly Heated Pentode	2.5	1.0	250	35	250	18.0	2.0	2,500	—	110	55,000
235/C	Var-Mu. Screened Grid	2.5	1.75	250	6.5	90	3.0	1.2	—	—	370	350,000
224 A/C	Screened Grid	2.5	1.75	250	3.5	90	3.0	1.2	—	—	1,000	600,000
227/C	General Purposes	2.5	1.75	180	5.0	—	13.5	1.1	18,700	.165	9	9,000
245/C	Power	2.5	1.50	250	30	—	50	2.0	3,900	1.600	3.5	1,750
247/C	Pentode	2.5	1.75	250	32	250	16.5	2.5	7,000	2.700	95	38,000
171 A/C	Power	5	0.25	180	20	—	40.5	1.6	5.350	.700	3	1,850

COSSOR VALVES—(Continued)

RECTIFIERS

Type	Purpose	Fil. Volts	Fil. Amps.	Max. Plate Volts.	Max. Rect. Current.
280/C	U.S.A.	5	2.0	450	125
442BU	English	4	2.5	350	120
612BU	English	6	.4	250	50

MULLARD VALVES

SCREEN-GRID VALVES

Type	Filament		Max. Anode Voltage	Optimum Screen Voltage	Average Anode Current (mA)	Amplification Factor	A.C. Resistance (ohms)	Mutual Conductance (mA/Volt)	Anode Grid Capacity (mmF)
	Volts	Amps.							
PM 12	2.0	0.1	150	75	2.5	200	180,000	1.1	0.005
PM 14	4.0	0.075	150	75	1.5	200	230,000	0.87	0.005
PM 16	6.0	0.075	150	75	1.75	200	200,000	1.0	0.005
S4VA	4.0	1.0	200	75	0.6	1,500	430,000	3.5	0.0015
S4VB†	4.0	1.0	200	75-100	3.5	900	257,000	3.0	0.0015

†Metallised.

MISCELLANEOUS VALVES

Type	Filament†		At Zero Grid Volts and 100 Volts H.T.			A Max. Anode Volts	B Grid Bias (for A)	Average Anode Current (for A and B) (mA)
	Volts	Amps.	A.C. Resistance (ohms)	Amplification Factor	Mutual Conductance (mA/Volt)			
PM 1A	2.0	0.1	41,600	50.0	1.2	150	1	1.0
PM 1HF	2.0	0.1	22,500	18.0	0.8	150	4½	1.5
PM 1HL	2.0	0.1	14,000	28.0	2.0	150	3	2.0
PM 1LF	2.0	0.1	12,000	11.0	0.9	150	7½	3.4
PM 2DX Detector	2.0	0.1	10,000	19.0	1.9	150	4½	4.0
PM 3A	4.0	0.075	55,000	38.0	0.66	150	1½	0.6
PM 3 General Purpose	4.0	0.075	13,000	14.0	1.05	150	6	2.8
PM 4DX Detector	4.0	0.1	7,500	15.0	2.0	150	6	2.5
PM 5B	6.0	0.075	49,000	40.0	0.85	150	1½	0.7
PM 5D	6.0	0.075	20,000	26.0	1.3	150	3	1.2
PM 5X General Purpose	6.0	0.075	14,700	17.5	1.2	150	4½	2.0
PM 6D Detector	6.0	0.1	9,000	18.0	2.0	150	4½	2.5
PM 1DG†	2.0	0.1	—	—	0.8	80	—	—

†Double Grid Valve. Characteristics taken at Anode Volts = 20, inner Grid Volts = 20, and Control Grid Volts = zero.

INDIRECTLY HEATED A.C. VALVES

904V	4.0	1.0	34,000	75.0	2.2	200	2.0	3.0
354V.	4.0	1.0	10,000	35.0	3.5	200	4.0	4.0
244V.	4.0	1.0	9,000	24.0	2.8	200	5.5	5.0

RECTIFIERS

Type	Filament		Rectification	Maximum Plate Volts R.M.S.	Maximum Output M.A.
	Volts.	Amps.			
DU 10	4.0	1.0	Half Wave	250	75
DU 2	4.0	1.0	Full Wave	250-0-2[illegible]	75
DW 15	7.5	0.6	Full Wave	500-0-500	60
PM280	5.0	2.0	Full Wave	350-0-350	125

MULLARD VALVES—(Continued)

OUTPUT VALVES

Type	Volts	Amps.	At Zero Grid and 100 Volts H.T. A.C. Resistance (ohms)	At Zero Grid and 100 Volts H.T. Mutual Conductance	A Max. Anode Volts	B Grid Bias (for A)	C Average Anode Current (for A and B) (mA)	D Max. Undistorted Output (for A, B, C Milliwatts)	G Optimum Load (for D) (ohms)	Sensitivity (mW per Volt 2 R.M.S.) Input
PM 2	2.0	0.2	4400	1.7	150	12	7	150	9000	2.1
PM 2A	2.0	0.2	3600	3.5	150	6	8	200	8000	11.0
PM 202	2.0	0.2	2000	3.5	150	13	14	350	4000	4.1
PM 252	2.0	0.4	1900	3.7	150	11	17	320	4000	5.3
PM 4	4.0	0.1	4000	2.0	150	8	10	170	9000	5.3
PM 254	4.0	0.2	2150	3.0	200	21	15	400	4000	—
PM 6	6.0	0.1	3550	2.25	150	9	10	150	8000	3.7
PM 256	6.0	0.25	1850	3.25	250	27	20	800	5000	2.2
AC 064	4.0	1.0	2000	3.0	200	21	20	750	4300	3.4
AC 044	4.0	0.7	1150	3.5	200	32	30	1,000	2300	2.0
DO/20	7.5	1.1	2000	2.5	425	66	40	4,000	5000	—
DO/24	4.0	2.0	1670	6.0	400	25	63	5,500	2500	17.0
DO/25	6.0	1.1	800	3.75	400	112	63	5,000	4000	—
DO/60	6.0	4.0	1000	3.5	500	95	120	11,000	1500	2.4
DO/75	10.0	2.0	2000	6.0	1000	55	75	18,000	6000	12.0

INDIRECTLY HEATED A.C. VALVES

164V	4.0	1.0	4850	3.3	200	8½	9	270	13,000	7.5
104V	4.0	1.0	2850	3.5	200	12	17	600	6000	8.3

PENTODE VALVES

Type	Filament Volts	Filament Amps.	Mutual Conductance (mA/Volt)	A Max. Anode Voltage	E Max. Screen Voltage	B Grid Bias (for A and E)	C Average Anode Current for A, B and E) (mA)	F Average Screen Current (for A, B and E) (mA)	D Max. Undistorted Output (for A, B and E) (Milliwatts)	G Optimum Load (for D) (ohms)	Sensitivity (mW per Volt 2 R.M.S Input)
PM 22	2.0	0.3	1.3	150	150	10	15.0	4.0	400	11,000	8.0
PM 24	4.0	0.15	1.75	150	150	12	20.0	5.0	500	10,000	7.0
PM 26	6.0	0.17	2.0	150	150	15	19.0	5.0	750	9,000	6.6
PM 24A	4.0	0.275	2.0	300	200	22	20.0	3.5	1500	8,000	6.2
PM 24B	4.0	1.0	2.1	400	300	40	30.0	7.0	3000	8,000	4.0
PM 24M	4.0	1.0	3.0	250	250	18	30.0	7.5	3000	8,000	—
PM 243	2½	0.6	1.5	300	200	20	25.0	5.0	1500	8,000	—

AMERICAN TYPES

Type	Fil. Volts.	Fil. Amps.	Max. Plate Volts	Grid. Volts.	Screen Volts	Plate m/A.	Amp. Factor	Plate Imp. (Ohms)	Mut. Con.	Undistorted Power Output (m.w.)	Load Imp. (Ohms)	Grid Plate Cap. (u.u.f.)
A.C.3 (226)	1.5	1.05	180	-13.5	—	7.4	8.2	7,000	1170	180	10,500	8.1
A.C.4 (171A)	5.0	.25	180	-40.5	—	20	3	1,850	1620	700	5,350	7.4
PM227	2.5	1.75	250	-21	—	5.2	9	9,250	975	300	34,000	3.3
PM224	2.5	1.75	250	-3	90	4.0	615	600,000	1025	—	—	.010
PM235	2.5	1.75	250	-3	90	6.5	370	350,000	1050	—	—	.010
PM247	2.5	1.75	250	-16.5	250	32	90	35,000	2500	2500	7,000	—
PM245	2.5	1.5	275	-56	—	36.0	3.5	1,670	2100	2000	4,600	8.0
PM56	2.5	1.0	250	-13.5	—	5.0	13.8	9,500	1450	—	—	3.2
PM57	2.5	1.0	250	-3	100	2.0	1500	1,500,000	1225	—	—	.010
PM58	2.5	1.0	250	-3	100	8.0	1280	800,000	1600	—	—	.010

OSRAM VALVES

2.5 VOLT A.C.

Type.	Purpose	Filament Volts	Filament Current	Plate Volts (Max.)	Screen Volts (Max.)	Amplification Factor	Impedance (Ohms)	Slope (m.a./volt)
MY224	S/G	2.5	1.75	180	75	420	400,000	1.05
MY235	S/G. Vari. Mu	2.5	1.75	250	90	370	350,000	—
MY227	G/P	2.5	17.5	180	—	9	9,000	1.0
MX245	Power	2.5	1 35	250	—	3.5	1,900	1.85
MY247	Pentode	2.5	1.5	250	250	95	38,000	2.5

OSRAM VALVES—(Continued)

4 VOLT A.C.

Type	Purpose	Filament Volts	Filament Current	Plate Volts (Max.)	Screen Volts (Max.)	Amplification Factor	Impedance (Ohms)	Slope (m.a.—volt)
MS4B	R.F. S/G	4.0	1.0	200	80	1120	350,000	3.2
MS4	R.F. S/G.	4.0	1.0	200	70	550	500,000	1.1
VMS4	S.G. Var Mu	4.0	1.0	200	60	—	500,000	1.1
MH4	R.F. or Det.	4.0	1.0	200	—	40	11,100	3.6
MHL4	R.F. or A.F. Amp.	4.0	1.0	200	—	20	8,000	2.5
ML4	Small P.	4.0	1.0	200	—	12	2,860	4 2
PX4	Super P.	4.0	1.0	250	—	5	830	6.0
PT4	Pentode	4.0	1.0	200	200	110	50,000	2.2
MPT4	I.H.C. Pent.	4.0	1.0	250	200	100	33,000	3.0
P425	Super P.	4.0	0.25	150	—	4.5	2,300	1.95

D.C. MAINS VALVES

D.S.	H.F. S/G. Amp.	16.0	0.25	200	70	550	500,000	1.1
D.H.	L.F. Amp.	16.0	0.25	200	—	40	10,800	3.7
D.L.	L.F. Amp.	16.0	0.25	200	—	12	2,660	4.5
D.P.T.	Pentode	16.0	0.25	200	200	90	30,000	3.0

2 VOLT BATTERY

S21	R.F. S/G.	2.0	0.1	150	70	220	200,000	1.1
S22	R.F. S/G.	2.0	0.2	150	75	350	200,000	1.75
H2	Det.	2.0	0.1	150	—	35	35,000	1.0
H210	R.C.C.	2.0	0.1	150	—	35	50,000	0.7
HL210	R.F. or Det.	2.0	0.1	150	—	20	23,000	0.87
HL2	Det. and Amp.	2.0	0.1	150	—	27	18,000	1.5
L210	Amplifier	2.0	0.1	150	—	11	12,000	0.92
LP2	Power Amp.	2.0	0.2	150	—	15	3,900	3.85
P2	Power	2.0	0.2	150	—	7.5	2,150	3.5
P215	Small P.	2.0	0.15	150	—	7	5,000	1.4
PT2	Pentode	2.0	0.2	150	150	—	—	2.5
P240	Super P.	2.0	0.4	150	—	4	2,500	1.6
DG2	Freq. Changer for Superhets.	2.0	0.2	100	Inner Grid 20	4.5	3,750	1.2

4 VOLT BATTERY

S410	R.F. S/G.	4.0	0.1	150	90	180	200,000	0.9
H410	R.C.C.	4.0	0.1	150	—	40	60,000	0.67
HL410	R.F. or Det.	4.0	0.1	150	—	25	30,000	0.83
L410	G/P.	4.0	0.1	150	—	15	8,500	1.77
P410	Small P.	4.0	0.1	150	—	7.5	5,000	1.5
P425	Super P.	4.0	0.25	150	—	4.5	2,300	1.95
PT425	Pentode	4.0	0.25	150	150	100	50,000	2.0

6 VOLT BATTERY

S610	S/G.	6.0	0.1	150	90	210	200,000	1.05
H610	R.C.C.	6.0	0.1	150	—	40	60,000	0.67
HL610	R.F. or Det.	6.0	0.1	150	—	30	30,000	1.0
L610	G.P.	6.0	0.1	150	—	15	7,500	2.0
P610	Small P.	6.0	0.1	150	—	8	3,500	2.3

A.C. or D.C. POWER VALVES

P6	Super P.	6.0	0.25	250	—	6	2,400	2.5
P625A	Super P.	6.0	0.25	200	—	3.7	1,600	2.3
T625	Pentode	6.0	0.25	250	200	80	43,000	1.85
PX4	Super P.	4.0	1.0	250	—	5	830	6.0
PT4	Pentode	4.0	1.0	200	200	110	50 000	2.2
MPT4	I.H.C. Pentode	4.0	1.0	250	200	100	33,000	3.0

OSRAM VALVES—(Continued)

SPECIAL VALVES

Type	Purpose	Filament Volts	Filament Current	Plate Volts (Max.)	Screen Volts (Max.)	Amplification Factor	Impedance (Ohms)	Slope (m.a./volt)
	Watts Dissipation							
LS5	10w.	5.25	0.8	400	—	5	5,500	0.83
LS5A	13.5w.	5.25	0.8	400	—	2.5	2,750	0.91
LS5B	—	5.25	0.8	400	—	20	25,000	0.8
LS6A	25w.	6.0	2.0	400	—	3	1,300	2.3

RECTIFIERS

Type	Purpose	Filament Volts	Filament Current	R.M.S. Plate Volts (Max.)			Max. Rectified Current
U8	Full Wave	7.5	2.4	500	+	500	120
U9	Full Wave	4.0	1.0	250	+	250	75
MX280	Full Wave	5.0	2.0	350	+	350	125
				400	+	409	110
GU1	Half Wave	4.0	3.0		1000		250

Table of Characteristics of Standard Gauge Wires with Various Insulations

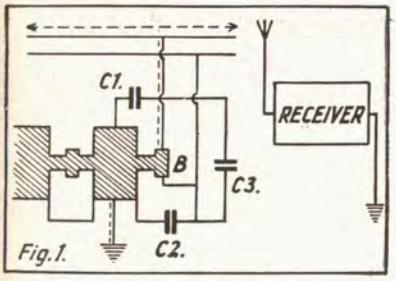
Current carrying and weight tables								Turns per linear inch tables					
Gauge S.W.G.	Diam. Inch	Resistance ohms per 1000 yds	Current rating in amps	S.C.C. lb	D.C.C. lb	S.S.C. lb	D.S.C lb	Enamelled	S.C.C	D.C.C	S.S.C.	D.S.C	Gauge S.W.G.
				Approx. weight per 1000 yds									
10	.128	1.865	12.868	152.32	154.56				7.35	7.04	7.64	7.55	10
11	.116	2.272	10.568	125.44	127.68				8.06	7.69	8.41	8.30	11
12	.104	2.826	8.495	99.80	101.30				8.93	8.48	9.35	9.22	12
13	.092	3.612	6.648	78.30	79.60				10.0	9.43	10.5	10.4	13
14	.080	4.776	5.027	59.40	60.70				11.4	10.6	12.1	11.8	14
15	.072	5.897	4.072	48.30	49.10				12.5	11.6	13.3	13.1	15
16	.064	7.463	3.217	38.40	39.00	37.46	37.66	15.0	14.1	13.2	14.9	14.6	16
17	.056	9.747	2.463	29.20	30.00	28.71	28.89	17.1	15.9	14.7	16.9	16.5	17
18	.048	13.267	1.809	21.00	22.30	21.12	21.28	19.8	18.5	17.2	20.0	19.4	18
19	.040	19.105	1.256	15.10	15.70	14.69	14.85	23.7	21.7	20.0	23.8	23.0	19
20	.036	23.59	1.017	12.34	12.80	11.92	12.07	26.1	25.3	21.7	26.3	26.0	20
21	.032	29.85	.804	9.81	10.20	9.43	9.57	29.4	26.3	23.8	29.4	28.2	21
22	.028	38.99	.615	7.57	8.00	7.24	7.34	33.3	29.4	26.3	33.3	31.8	22
23	.024	53.07	.452	5.56	5.94	5.33	5.38	38.8	38.3	29.4	38.5	36.4	23
24	.022	63.16	.380	4.70	5.07	4.49	4.54	42.1	35.7	31.3	42.1	40.0	24
25	.020	76.42	.314	3.91	4.25	3.72	3.76	46.0	38.5	33.3	46.0	43.5	25
26	.018	94.35	.264	3.19	3.51	3.02	3.06	50.6	41.7	36.7	50.6	47.6	26
27	.016	113.65	.211	2.67	2.83	2.51	2.55	55.9	44.6	37.9	55.1	51.6	27
28	.015	139.55	.172	2.20	2.35	2.06	2.09	61.4	48.1	40.2	60.4	56.2	28
29	.013	165.27	.145	1.87	2.02	1 74	1.77	66.2	51.0	42.4	65.2	60.2	29
30	.012	198.80	.120	1.58	1.71	1.46	1.48	73.3	54.4	44.7	72.0	67.1	30
31	.011	227.2	.105	1.39	1.51	1.27	1.30	77.8	56.8	46.3	76.3	70.9	31
32	.0108	262.1	.091	1.22	1.33	1.11	1.14	83.0	63.3	50.5	81.3	75.2	32
33	.0100	305.7	.078	1.06	1.17	.95	.98	88.9	66.7	52.6	87.0	80.0	33
34	.0092	361.2	.066	.91	1.01	.81	.84	98.0	70.4	54.9	93.4	85.5	34
35	.0084	433.2	.055	.75	.87	.68	.70	106.0	80.6	61.0	101.0	91.8	35
36	.0076	529.2	.045	.63	74	.56	.58	116.0	6.2	64.1	110.0	102.0	36
37	.0068	661.1	.036	.51	.62	45	.47	128.0	2.6	67.6	120.0	110.0	37
38	.0060	849.1	.028	.41	.51	.36	.37	143.0	100.0	71.4	133.0	121.0	38
39	.0052	1130.5	.021	.32	.41	.27	.29	168.0	109.0	75.8	149.0	134.0	39
40	.0048	1326.7	.018	.28	.37	23	.25	180.0	114.0	78.1	159.0	142.0	40

ELIMINATE THAT INTERFERENCE!

In the following article the writer endeavors to throw some light on how to eliminate parasite electrical noises, which are heard frequently on A.C. Receivers.

By P. R. DUNSTONE

HOW frequently do you come across owners of all electric receivers, and find when you ask them how is the wireless, that you receive the answer, "Oh, the wireless is good, but we cannot enjoy it for crackles and other noises." It will be found that, in most cases, these annoying sounds are due to some electrical device which is situated in the vicinity. In a number



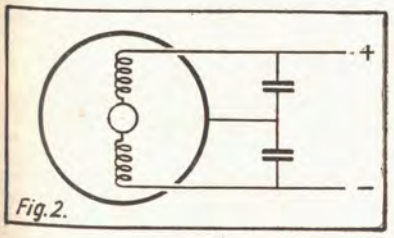
A diagram of a d.c. motor.

of instances the owner may be able to trace the offending instrument, and so solve all the troubles he has been experiencing in the past.

Interference

Interference to radio reception from electrical devices is caused by small sparks produced by the make or break of electrical continuity. As an example, take the switching off or on of the electric light; this will cause a crack in the loud speaker. There are numerous other operations that would result in the same fashion, but to describe them all to you would become tedious.

It probably often has been heard, and, in fact, has quite frequently, appeared in print, that "electrical sparks" produce

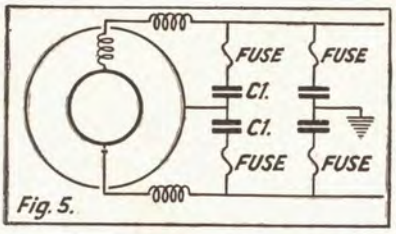


Showing a three wire distribution.

oscillations which radiate into the ether and are picked up by the receiver in the same manner as a radio transmitter radiates its signals. This statement is apt to be misleading, for, in reality, the interference is generally the result of Transient Phonemena, not of regular oscillations.

We will deal with a small D.C. motor which is a prominent offender. On referring to Fig. 1 the reader will note a diagram of a D.C. motor. Let us consider that C1, C2 and C3 are not present for the time being. Between the brush "B" and the commutator imagine a spark appearing. Now, at the very moment the spark appears, two waves of opposite sign are set off in opposite directions.

Assuming that we call one of these waves positive, it will pass on to the corresponding wire of the supply installation as shown by the dotted line in Fig. 1. The negative wave will enter the armature winding, and part of it will reach the armature core eventually, while the other part will continue until it reaches the motor frame. From there it would travel along any conductor to the frame, for instance, the earth lead, which is illustrated with the stippled line in Fig. 1.



Illustrating filters required to eliminate interference on large motors.

The part that reaches the armature core will divide a portion to cross the bearings and reach the motor frame; another portion would reach the pulley or clutch. From this one might think that a section of the negative wave would reach the other brush, and from there follow the other supply wire. But this is usually negligible.

With sparks at the other brush, it would produce a couple of travelling waves, of which one would follow the opposite wire of the installation, whereas the other would follow a similar way, as previously described.

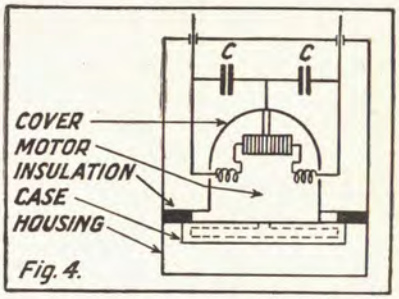
When a positive wave front is passing by the small aerial a disturbance would be caused in the receiver. As definite proof of this, when the supply wire is taken away from the aerial the noise ceases.

In most cases the sum of positive electric charges leaving the motor with the positive wave will be equal to the sum of negative electric charges leaving the motor with the negative waves; thus, if the earth wire is disconnected, the negative wave will be reflected and would carry only the quantity of electricity required for charging the motor as a whole to a certain potential.

Therefore the positive wave will only carry a correspondingly small quantity of positive electricity.

Small D.C. Motor

It will be found then that, when a small motor is being used, the charge

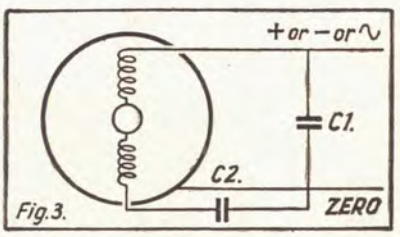


A drawing of the usual type of vacuum cleaner.

will not suffice to disturb the receiver to any extent.

As an example, when the earth connection is interrupted the noise in the speaker will cease. In the case when a person touches the frame of the motor, thus adding to its capacity, the noise will be found to return.

Therefore, to eliminate this disturbance, it will be necessary to unite the two opposite signs by means of condensers connected between each of the wires and motor frame. In Fig. 1 the reader will note condensers C1, C2 and C3. Now, on connecting the earth wire to the motor frame, noise in the loud speaker will be re-established. If C1 and C2 are



A two wire distribution.

connected as shown in Fig 1, the noise will disappear. In C3's case, if connected alone it scarcely diminishes the noise, but when C3 and either C1 or C2 are connected the noise completely disappears.

Unfortunately this practice of connecting condensers is not desirable in some

A WAVE TRAP FOR LISTENERS

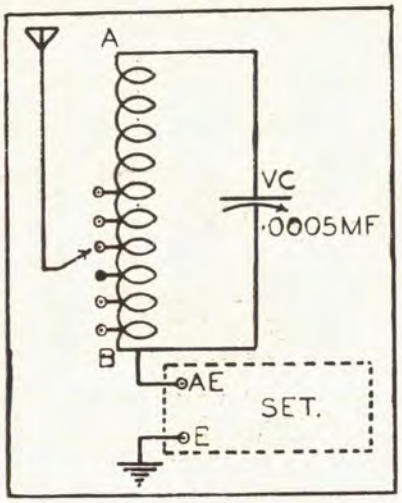
How to add selectivity to an existing receiver.

A WAVE trap is a radio-electrical device that adds to the normal selectivity of any existing receiver. Its own name is its best description: it is designed to entrap unwanted signals (i.e., those tending to cause interference) while, at the same time, permitting the passage of the desired programme. The detraction is that it will only deal with one source of interference at a time.

Owing to the manner in which wave lengths have been assigned to Australian broadcasting media, there is plenty of separation between National Stations. On the other hand, there is a certain amount of congestion amongst those of Class B, and it is to aid their clear reception that this trap has been designed. It is therefore most efficient below the wave of 300 metres.

General Assembly

The coil, AB, consists of 28 turns of 20 gauge D.C.C. copper wire wound on a 3in. diameter tube or former. At one end of the coil the wire is brought to 6 taps or terminals comprising 3 turns per tap. This provision permits the aerial to be adjusted to a position best suited to the conditions of the receiver and will vary with different receivers and types of aerial. The .0005 mfd. variable condenser is connected permanently across the coil AB.



Details of the Trap's design and method of its association with your set.

The position of the wave trap is between the aerial and the aerial terminal of the set. The earth terminal on the receiver is not touched.

In other words, remove the aerial wire from the aerial terminal of the receiver and connect it to one of the taps on the trap (a small battery clip will answer the purpose adequately). Six turns, or the second tap from the wire going to aerial terminal of the receiver, will probably suit average conditions.

Operation

Tune in on your receiver the station you desire to remove by the trap. Having reached the maximum reception position on your receiver, turn the wave trap condenser slowly to a position where the reception is absorbed or reduced to a minimum. This adjustment will be found to be critical. The unit thus being set should be left in this condition and the station wanted may now be tuned in in a normal way.

ELIMINATE THAT INTERFERENCE—(Continued from previous page)

cases, especially in A.C. installations, the reason being that the frame of the motor in some cases is of a different potential from its surroundings. This is when it is not earthed, so causing electrical shocks; secondly, if the frame is earthed, the current to earth through the condensers may give rise to low-frequency telephone disturbances. It will be seen from this that some other form of by-passing will have to be employed, this being shown in Fig. 2 and 3.

When a motor is connected to plus and minus conductors of a three wire distribution system the diagram shown in Fig. 2 should be used.

To eliminate interference to radio only the capacities of the condensers need not be equal.

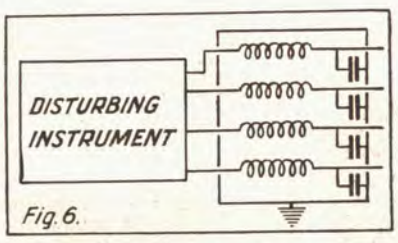
In a two wire installation, where one wire is earthed (zero) conductor, the method shown in Fig. 3 should be adopted.

In Fig. 2 and Fig. 3 series windings are shown connected between the brushes and the line. This is done to emphasise, in this case, that the condensers shall not be connected directly to the brushes, but to the outer terminals to which the supply wires are attached.

Electric Vacuum Cleaner

The Electric Vacuum Cleaner is another electrical device which, provided it is not by-passed, will cause considerable interference while in operation. It will probably be found that, in some cases, if the motor frame does not totally enclose the armature, the surrounding metal parts, which are near the motor, will receive a fraction of the wave entering the armature which is supposed to reach the frame, as shown in Fig. 1, but crosses the air gap and reaches the surrounding foreign metals. It is therefore essential that these metals are electrically connected to the frame, thereby to the condensers.

The particular vacuum cleaner under discussion is illustrated in Fig. 4. It will be seen that the motor and all parts attached to it are insulated from the housing. Secondly, the fan case is electrically connected to the motor, but not to the housing, and the commutator end of the motor carries a metal cover connected and attached to the motor frame. The frame, the fan case, and the cover form a complete electro-static enclosure. In the case of the cover, this may consist of a fine mesh of metal, while in the case of the fan-case it is necessary for openings in it to permit of the passage of the stream air. Therefore, the metal covering must be shaped in such a manner that the electro-static lines of force, issuing from the armature, the shaft and the fan, are not allowed to penetrate the opening and reach the housing, but are picked up by the metal enclosure; in fact, the openings may be covered by netting. There will be no possibility of any interference to telephone or any personal danger, since the housing is insulated from the motor.



This method may be adopted when handling low tension apparatus.

It will probably be wise here to quote a few sizes of condensers that may be used to ensure a practically complete prevention of radio interference. When a small type of motor is employed, a capacity of about 0.1 mfd. may be used. For larger motors, such as 5 to 20 h.p. jobs, condensers should have an approximate capacity of 1 mfd., and for still larger motors it will be found that condensers alone will not stop the noise, and high frequency coils must be inserted in the conductors between the terminals and the point where the condenser connection branches off. The reader will see from Fig. 5 the exact connections for the high frequency coils.

Low Tension Apparatus

The method illustrated in Fig. 6 is applicable in all cases where difficulties have arisen, provided the apparatus is of a low-tension nature. Surround the particular instrument which is causing the disturbance with a metal shield, and then insert high frequency coils in all conductors passing to and from the instrument. Condensers are also used; these are connected between the conductors and earth as shown in Fig. 6.

It is important that the metal shield should not fit too closely around the disturbing apparatus, otherwise the insertion of condensers into the leads and oscillation is generally set up. Care must be taken to prevent electro-magnetic induction between the circuits and the condenser connections.

THE 1933 BATTERY FOUR

An up-to-the-Minute Receiver Specially Designed for Economical Country Operation.

By RADEX

WHEN pentodes are so popular why use two audio stages in a four-valve receiver?

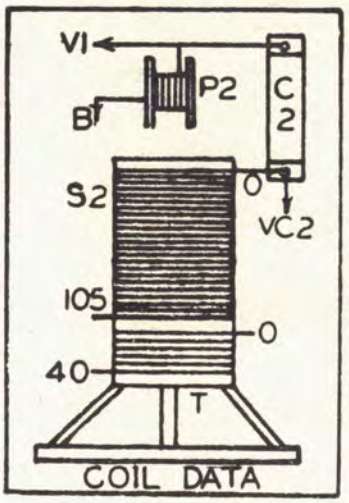
The answer lies in the fact that a properly selected pair of triode audio valves consumes less plate current (meaning that the associated "B" battery is given a greater chance of life) than does a single pentode. Take the instance of this particular design. Using an A409 and a B409 as audio tubes at V3 and V4 respectively, the plate consumption amounts to 10 m.a. The consumption of a pentode would vary between 12 and 20 m.a., according to type.

Admittedly two valves and their associated components, cost more than one pentode, but this initial expense is warranted by the lengthened lives of the B batteries that are always an item of consideration in isolated areas. In the cases of previously published battery circuits, readers frequently inquire if a pentode can be substituted for two audios. Certainly such can be done, but only at the expense of additional (but always limited) B power, and, in this instance, it has been thought advisable to bring the point under direct notice.

What You Can Expect

This battery model has been designed especially for the use of country listeners who, at the most, need fear interference from one station only. In many instances such listeners are well beyond the range of real "interference" as we suburbanites know it.

In consequence, it has been possible to create a cascade in which every stage can deliver its maximum output to its following neighbor. The result is rather surprising. In the city area it was impossible to test on a large aerial of either the indoor or outdoor varieties; the local interference between adjacent stations was too marked. In order to line up the two-gang condenser it was decided to employ just five feet of wire.



The lining up completed, faint signals were noted below 3DB, and the application of reaction proved them to come from 2CH Sydney. With so short a catchment this proved a good performance, so the dial was searched carefully. This resulted in the production of ten interstate transmitters and several country Victorians. Later the set was taken a few miles down the Bay and easily repeated its success with a 40ft. aerial and entire freedom from interference. What it would be like well out on a 60 or 70ft. catchment is best left to your imagination.

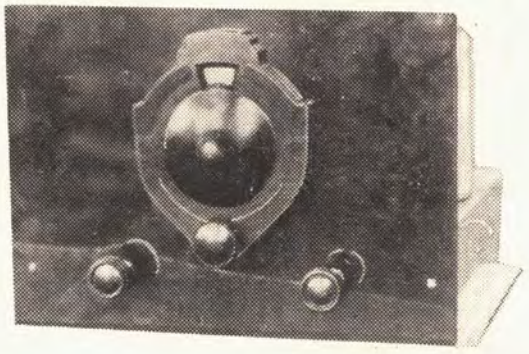
Circuit Details

Tuning is in charge of a 2-gang condenser (VC1 and VC2), which affords single dial control. Owing to the design of the associated circuits, these condensers line up very easily.

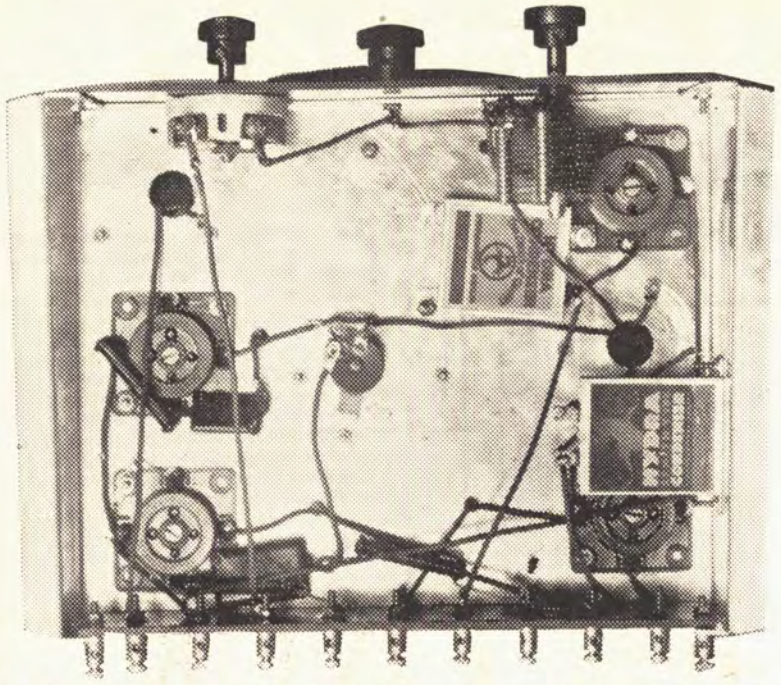
The couplings between aerial and r.f., S/G valve V1 and between V1 and detector V2 are exactly the same, and their particular construction, while requiring a little care in home manufacture, constitutes the reason for the set's punch. In each instance the input (either from the aerial or the plate of V1) is fed to the grid of the following valve through a small fixed condenser (C1 or C2), and simultaneously partially coupled to the corresponding grid-coil (S1 or S2) by means of a special primary (P1 or P2), which is really a form of r.f. choke. The whole assembly comprising fixed condenser, semi-choke, and grid-coil, is enclosed in an ordinary aluminium coil can, as indicated by the dotted lines U1 or U2.

This arrangement is illustrated in more detail in the sketch "Coil Data," which actually shows the contents of Can U2. In this case, however, a tickler coil T, for the detector, is added at the bottom of S2. Adverting to the circuit diagram again, it will be obvious that midget reaction control condenser is not really inside that can.

Generally the novice constructor finds that the canning of coils makes it difficult to maintain the reaction effect throughout the tuning range of the set. In order that possible snags may be entirely removed from the path of the in-



Left: This photo. of coupling unit U2 should be compared carefully with the above sketch of the same component part. The enamel wire tickler is below the silk covered secondary, and comes right down to the coil-former's flair. Right: The set's operating panel is free from complication of controls. Under the vernier dial are the knobs of the rheostat and the reaction condenser, left and right respectively.



The layout and wiring below the chassis. Compare this photo. with the point-to-point directions for making the connections.

PARTS REQUIRED

AFT—Audio transformer, standard ratio (Emmco).
A+A—Accumulator, 4 volts.
B+B—"B" Battery of 120 or 135 volts.
C+C—2—Tapped "C" Battery of at least 9 volts.
C1 and 2.—Fixed condensers of 0.0001 mfd. (T.C.C.).
C3 and 5.—Fixed condensers of 0.01 mfd. (T.C.C.).
C4.—Fixed condensers of 0.00025 mfd. (T.C.C.).
C6.—Fixed condenser of 0.5 or 1 mfd. (Chanex).
CH.—Radio frequency choke (Velco).
LS.—Cone-type magnetic speaker (Del Monte, Mullard, A.W.A.).
M.—Midget 23-plate condenser. (Radiokes).
P, S & T.—See U1 and U2.
R1.—Rheostat of 30 or 60 ohms.
R2.—Grid leak of 2 megohms.
R3.—Resistor of 100,000 ohms.
R4.—Grid leak of 1 megohm. (R2, R3 and R4, all carborundum).
U1 and U2.—Coil material.—2 Marquis 1¼ inch formers and 2½ inch cans, 2 Radiokes bobbins, reel No. 30 d.s.c wire, 1 ounce No. 38 d.s.c. wire, latter in either copper or Eureka.
VC1 & 2.—Two-gang variable condenser and vernier dial (Raycophone or Stromberg Carlson).
Valves.—Philips or equivalents, V1 A442, V2 A425 or A415, V3 A409. V4 B409.
Sundries.—Chassis of No. 16 gauge aluminium 10 by 8 by 2½ inches deep, ebonite panel 10 by 7½ ins., ebonite inset for chassis back and terminal-carrier 9½ by 2 inches, dozen metal terminals, 4 UX Marquis valve sockets, 1 valve-can, rubber-covered wire for connections.

experienced builder, we have made an almost retrograde step in inserting a rheostat R1. This, in its "off" position, functions as a main switch, by which the set's operation is completely stopped. Normally, when receiving, it should be turned full on. However, in order to cover the top of the band efficiently, tickler coil T has been made a little larger than necessary, and in consequence, reaction is a little fierce at the bottom end. Should it, in your case, be too fierce there, it is only necessary to turn back R1 a fraction to regain smooth reaction.

Resistance capacity coupling is very suitable between Detector V2 and the first audio stage V3. With this a type A425 valve is desirable at V2. Should an audio transformer be employed in place of R3-C5-R4, an A415 should be fitted at V2. All subsidiary parts shown are essential to the receiver's successful operation with the exception of condenser C6; this can be omitted although its retention is recommended.

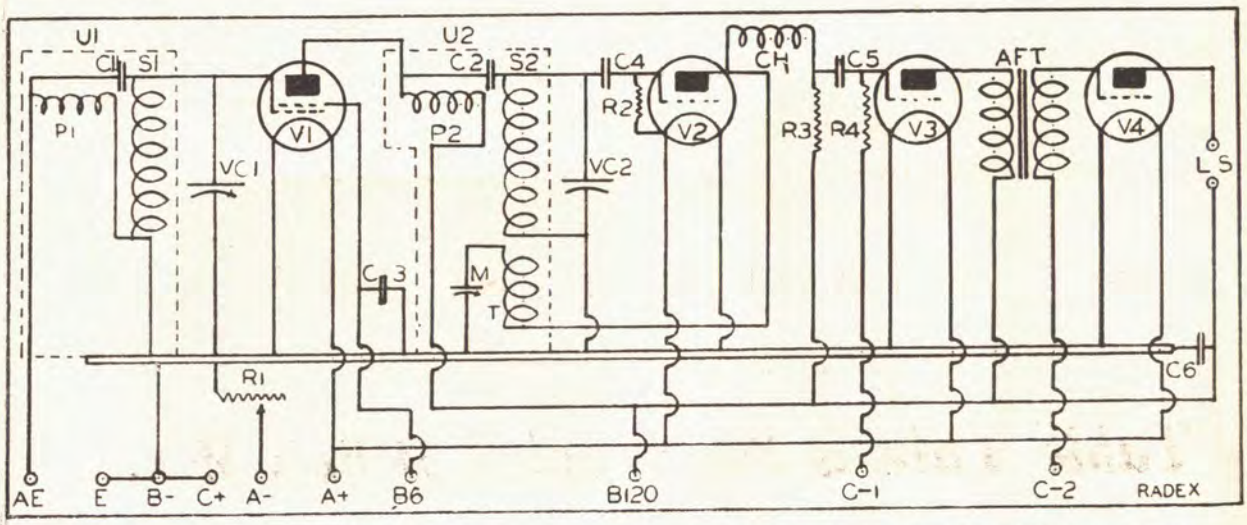
Winding the Coils

The Radiokes bobbins (P1 and P2) each contain three hundred turns of wire jumble wound. For these, No. 38 d.s.c. wire is used, and, in the list of parts, it will be seen that you are given the alternative of either ordinary copper or Eureka resistance wire. The former is quite all right, but the latter is the better, although its cost is an appreciable factor.

Starting one-eighth inch from the top of the Marquis 1¼-inch formers put on 102 turns of No. 30 d.s.c. to form S1. Into the top of this former force one of the bobbins so that its turns are at right angles to those of S1, leaving about half the bobbin (P1) sticking out—vide the photo.

In the case of the second former S2 consists of 105 turns. Below this, winding in the same direction and without any space between, put on a further 40 turns, to make Tickler T. No. 32 enamel is used for this coil. The second bobbin is again forced into the top of S2.

The ends of all coils will come out to the ordinary Marquis clips, which will



Complete diagram of the 1933 Battery Four. Components enclosed in dotted rectangles are fully shielded in cans.

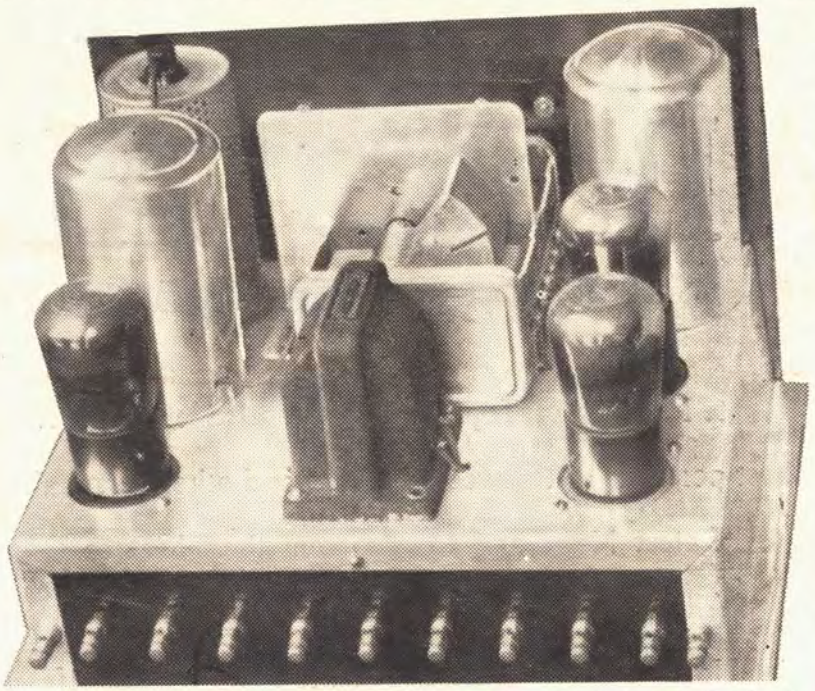
be fitted to the skirt of the former. Arrange yours so that the one carrying the outer end of P2 and the top (or zero) end of S2 are diametrically opposite. A little juggling will allow you to solder the ends of manufacturer's type T.C.C. condenser C2 to these so that the latter will be held across the bottom of the former and between its tripod legs, in about the position now occupied by the letter "T." Condenser C1 and coils P1 and S1 will be connected up in the same way.

The aluminium chassis consists of a sheet of the metal measuring 15 by 8 inches. Two and a half inches from each end of the 15-inch side mark off margins to that width and turn them down. This will result in a flat table-top of 10 by 8 inches. The back of this is filled in with a strip of ebonite to carry the main terminals. The front is covered with the ebonite face-panel, from which, below the chassis, protrude the knobs of reaction condenser M and rheostat R1.

The photos ably illustrate the general disposal of the other components, but these should not all be mounted before wiring commences. On the contrary, fit the valve sockets alone and only add parts, piece by piece, as the wiring actually calls for them.

Large holes in the chassis, for the under-panel valve sockets and the like, should be cut by your metal merchant if possible. Failing this, they can be drilled out by the assistance of a single arm of an ordinary washer cutter or an expansion bit. A liberal use of turpentine as a lubricant will lighten the labor involved. Before fitting, all holes drilled with small bits should be re-touched with an over-size bit to clear away burrs.

In sets of this type the chassis is always earth, and to it such connections are made. To facilitate this operation clamp solder lugs under some of the bolts used for fixing the parts in position. Valve sockets V2 and V3 are on the left of chassis with U1. The other two and U2 are on the right.



Rear view of the chassis. Take particular notice of the ebonite inset to the chassis that carries the main terminals for the batteries, speaker, aerial and earth.

Wiring Details

Earth one filament terminal on each of the four valve sockets. At the rear of the set there are eleven main terminals. Viewed from the rear, and working from right to left, their order is: Earth E, Aerial AE, A+, A—, C—, C—2, B+60, B+120, two LS and one both B— and C+. The first and last of these are connected directly to chassis. From A+ go to the remaining F terminals on V3 and V2 and also to the corresponding points on V4 and V1. At the F+ terminal of socket V2 also attach a tail of resistor R2 (2megohms).

Mount the audio transformer AFT and wire it:—P to the P terminal of V3, G to the G terminal of V4, and C (or F, according to its lettering) to main C—2. Take the P socket V4 to one of the LS pair.

Mount choke CH and complete unit U2. Connect P of socket V2 to one side of CH and continue from thence to end "40" of coil T. Take "O" of T to the fixed vanes of M and earth the latter's moving plates. To the vacant side of CH attach condenser C5 and R3 (100,000 ohms). Attach the other side of C5 and a tail of R4 to G of socket V3 and take R4's other tail to main C—1. From main B+120 go to the remaining tail of R3, point B on AFT, the vacant LS terminal, one side of C6, and the inner end of coil P2. Earth the other side of C6.

From the junction end of "O" of S2 and C2 go to the fixed vanes of VC2 and from the latter go to one side of C4. Connect C4's other side to G of V2 and attach the free tail of R2 to the same point. To the junction of the outer end of P2 and C2 connect a lead up long enough to reach up through the can of unit U2 to the plate terminal on top of valve V1. Earth turn "105" of S2.

Wire the P terminal of socket V1 to one side of C3 and continue to main B+60. Earth C3's other side.

Mount unit U1, and earth end "102" of S1 and also the inner end of P1. Connect the junction of C1 and end "O" of S1 to the fixed vanes of VC1 and thence to G of socket V1. Take the aerial terminal AE to the junction of C1 and the outer end of P1.

Connect main terminal A— to one side of rheostat R1. Earth R1's other terminal.

External Wires

With regard to the external battery leads, connect the positive end of the "C" battery to the negative of the "B" and from that point run a wire to earthed main terminal "B—C+." The B battery should be of at least 120 volts and its full positive goes to main B+120; a tap is taken off at between 60 and 70 volts (the best value is found by experiment when the set is working) and wired to main B+60.

As regards the "C" battery's negative connections, if valves A409 and B409 are used at V3 and V4 respectively, both mains C—1 and C—2 will be given 9 volts negative. Other combinations of valves in the audio stages will probably require different negative biasses, and hence the provision of two main C— terminals. The use of a good earth is essential, while the size of the aerial will depend upon locality.

Operation

Having inserted the valves and completed the battery, speaker and aerial conections, see that M is just slightly in mesh and adjust the trimmers of condensers VC1 and VC2 to an even setting about half-way down. Be careful to have the windings of bobbins P1 and P2 at right angles to those of their associated secondaries. Switch full on with R1.

Rotating the dial through its lower section, look for either 3DB or 3KZ. As soon as one of these test stations is brought to a maximum with the dial, endeavor to augment signals by a re-setting of the variable condenser's trimmers. In general it will be found that during this initial test, VC1 is doing all the really critical tuning, and, therefore, an adjustment (either up or down) of VC2's trimmer will be responsible for an improvement in volume.

Turn now to some station high in the band, such as 3AR or 5CK and note which, if either, trimmer makes an improvement. In doing this be careful to return the trimmer not requiring alteration to its original setting. If, high in the band, one trimmer requires a lot of adjustment, it will mean that the set becomes comparatively insensitive when returning to the lower end.

Should this happen, although it is unlikely, note which is the non-tracking trimmer, and then very slightly turn the bobbin of the corresponding coupling unit toward its associated secondary. For example, suppose it is found that the trimmer of VC2 (after being set previously on 3DB) has to be screwed down to give decent results from 3AR, very slightly incline the turns of P2 toward those of S2. With a little experiment in this direction it will be found that VC2's trimmer will hold good throughout the wave-band with a discrepancy so small that it can be neglected.

The lining up of the variable condensers having been completed, you are at liberty to turn in the reaction condenser M, when a further increase in volume will evidence itself. In order to get the full effect M will have to be almost wholly enmeshed on 3AR. Below 3DB you will probably find that the set will keep on oscillating even though M is entirely out of mesh. Should this happen, very slightly turn back R1 and it will be found that self-oscillation ceases and, in order to regain it, M will have to be re-enmeshed.

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