THE LISTENER IN HANDBOOK No. 8

1/-

ALL RADIO RECEIVERS

A Publication For Both Novice & Expert Set Builders

CONTENTS:

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1 Velco 200 ohm. Bias Resistor ..		1	0
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3 Velco Valve Cans at 1/3 each ..		3	9
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1 Chanex .0001 mfd. Condenser		1	0
1 Chanex .01 mfd. Condenser		1	0
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6 Rubber Mountings for 3-Gang Condensers, at 1d...			6
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1 Radiotron or Ken-Rad 57 Valve ..		15	6
1 Radiotron or Ken-Rad 2A5 Valve ..		17	0
1 Radiotron or Ken-Rad 280 Valve..		12	6

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PARTS REQUIRED

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4 Velco Wire wound Resistors (1-350, 3-400), at 1/	4/
3 Radiokes R.F. Chokes at 2/	6/
2 Solar 8mfd 500V. at 5/	10/
1 T.C.C. .0001 Condensers at 1/7 ..	1/7
4 T.C.C. .01 Condensers at 2/10	11/4
2 T.C.C. .001 Condensers at 2/1	4/2
1 T.C.C .0005 Condenser, at 1/7	1/7
6 Dubilier .1 Condensers at 1/	6/
3 Chanex .5 Condensers at 1/8	5/
1 10 mfd. Dulytic Condenser at 3/ ..	3/
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1 Kenrad 6B7 Valve at	18/
1 Kenrad 41 Valve at	16/
1 Kenrad 80 Valve at	12/6
3 Velco 6 Pin Sockets at 10d.	2/6
2 Velco Small 7 Pin Sockets at 1/	2/
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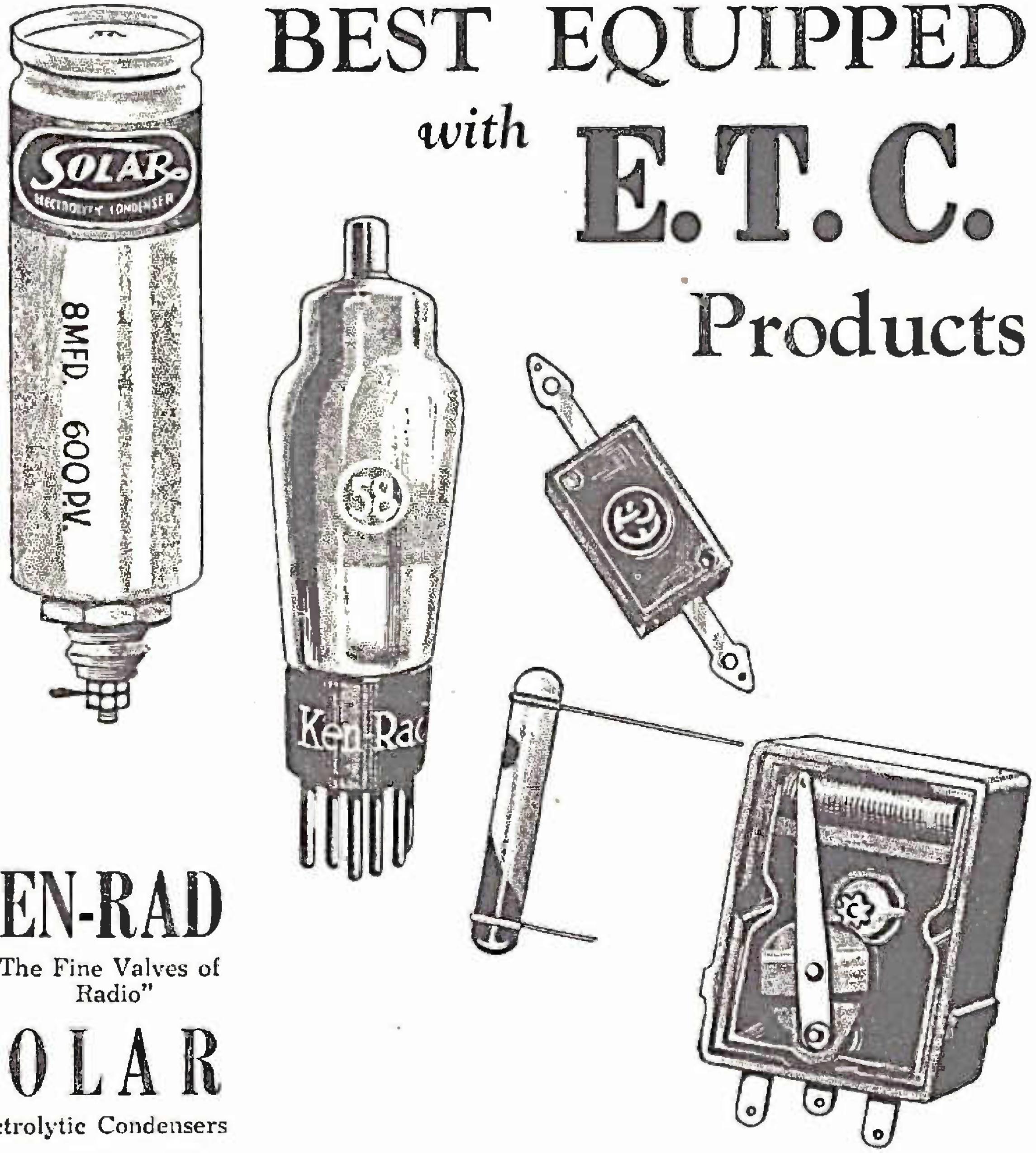

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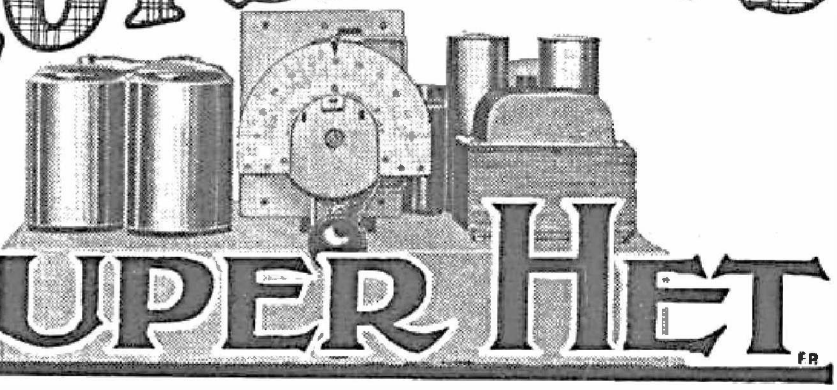
CONTENTS

The SCOTSMAN'S SUPER HET



At Last! A simple super-het. in which the use of the latest valves makes possible extraordinarily good results for a small outlay.

By A. K. BOX

PROVERBIALLY, the Scot has a reputation for "closeness" in money matters, and for turning over in his mind the pros and cons of a purchase before putting his hand in his pocket.

Having the Scot and his frugally-minded Australian associates in view, we set to work to find out how cheaply a really high class modern radio receiver could be built.

As a basis on which to work it was decided that the chief attributes of our low priced receiver should be:—

(1) First class tone quality.
(2) Good selectivity.
(3) Reasonable sensitivity.

The first requirement could quite easily be satisfied by careful design of the audio amplifying stage, but it was evident early in the piece that the super-het type of receiver would be necessary to meet the second and third requirements. This was rather a snag, because it seemed that, if we were to build a worth-while super-het, at least five valves, including the rectifier, would be needed. Fortunately, though, we thought of the recently developed 6F7 valve, which is another of "two in one" valves.

The 6F7 was developed as an alternative to the 6A7 pentagrid converter valve, and basically follows the design of this fairly well known valve. It differs, however, on one important point, inasmuch as the triode section of the valve as electronically screened from the pentode section. This screening is so complete that when the 6F7 is used as a converter valve its triode section, which is used for the oscillator, must be capacitatively or inductively coupled to the pentode section, instead of being electronically coupled as in the 6A7.

Now the 6F7, as is evident from its designation, operates from a 6.3 volt filament supply. In order to standardise the filament voltages in the receiver it was necessary to select other valves having the same rating. For this reason the 6A7 was used as the pentagrid converter, and the type 41 pentode as the power audio valve. The rectifier was a standard 280.

Dual Purpose Valves

A glance at the schematic circuit diagram will show that the 6A7 operates as combined modulator (or first detector if you like) and oscillator. The 6F7 functions as the intermediate frequency amplifier valve, using its pentode section, and as a three-element power grid second detector, using its triode section. The second detector portion of the 6F7 is transformer coupled to the grid of the 3 watt 41 type pentode.

Despite the apparent complexity of the intermediate frequency amplifier-second detector portion, the circuit of the receiver is perfectly straight forward. To make this clear we shall just run through the salient points. Before doing this though it might be as well if we touched upon the subject of the intermediate frequency.

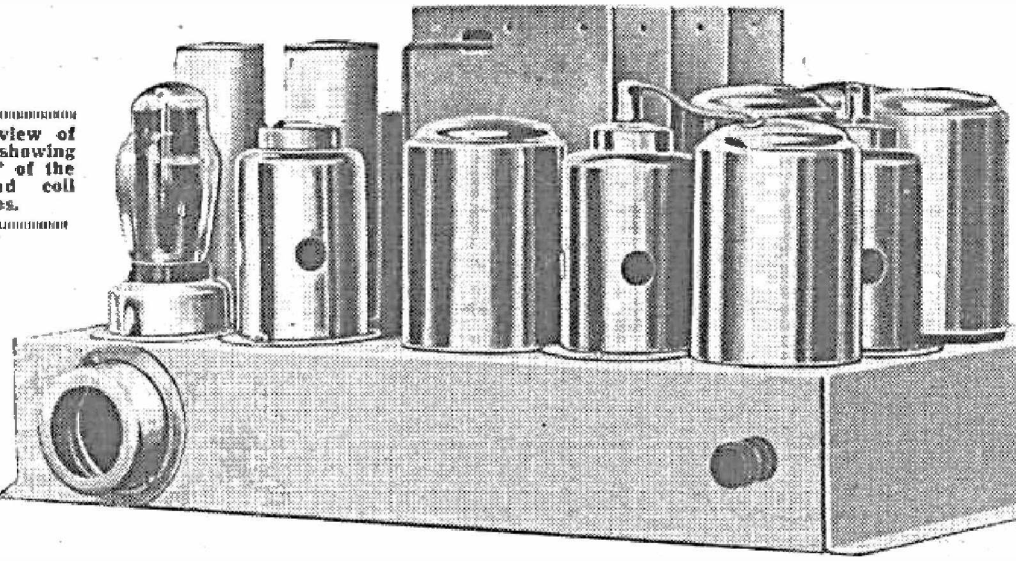
In the original receiver the frequency of the i.f. amplifier was 175 k.c. This low frequency was used simply because we happened to have the necessary i.f. transformers on hand. However, we are inclined towards the belief that the higher frequency of 460 or 465 k.c. would give better results as far as freedom from "image frequency" interference is concerned. The foregoing applies, in the main, to those set builders who live within ten miles radius of the Melbourne stations. Outside this radius it is not likely that the pick-up will be sufficient to produce image interference, i.e., the repeating of such stations as 3AW, 3KZ, 3UZ and 3DB at points on the dial which correspond to their fundamental frequencies, minus 350 k.c. (twice the intermediate frequency).

As with the majority of super-hets., the pick-up from the local stations is likely to produce double hump tuning, but as this is a symptom of second detector overload and occurs only when the set is run "flat out," it can be overcome by judicious use of the volume control.

Circuit Features of the Set

To start the examination of the fundamental features of the receiver we shall deal with the signal tuning system. In this receiver, because no r.f. stage is used in front of the modulator, use has been made of pre-selection to provide sufficient discrimination between the different stations.

The aerial input is transferred through the coil L1 to the tuned circuit C1, L2 which is coupled to the main grid circuit of the modulator through a few turns wound on the bottom end of L3. The grid circuit of the modulator section of V1 is tuned by C2. This section of V1 is operated as a biassed detector or modulator by means of the cathode resistor R2 which is provided with an r.f. by-pass C5.



A back view of the set, showing the "line" of the valves and coil cans.

Note that the final audio tube is provided with a shield to cut out modulation hum.

The oscillator section, which operates on the leaky grid principle, has its frequency controlled by the oscillator grid coil L5 and the C3 section of the gang condenser which is connected in series with the padding condenser PD and L5. L5 is coupled to the oscillator grid through the grid condenser C4.

The plate circuit of the oscillator differs slightly from that usually employed with the 2A7-6A7 type of tube in that the "B" supply potential for the modulator plate and the oscillator plate flows through the oscillator plate coil L6.

The potential for the oscillator anode grid is reduced slightly by means of the 20,000 ohm series resistor R3, which is provided with a radio frequency by-pass condenser C6. The screening grid of V1 is fed to the 100 volt point on the voltage divider R8, and is by-passed to earth with a .5 mfd. condenser C15, connected at the valve socket. The plate of V1 feeds into the first i.f. transformer IF1. The secondary of this transformer connects to the pentode control grid of V2 (top "pip" on valve) and to ground.

The socket connections for V1 and V2 are similar except that instead of reading "oscillator grid" and "anode" grid we read "triode grid" and "triode plate."

The pentode section of V2 is conventional inasmuch as the plate goes off to the second intermediate transformer IF2, and the screening grid is connected to the maximum volt tap on the voltage divider, after being by-passed in the usual manner by a .5 mfd. condenser connected from s.g. to ground at the valve socket.

The Second Detector

Now for the apparently complicated second detector section of V2. The triode grid is connected to the grid side of the second i.f. transformer IF2 through the .00025 mfd. fixed condenser C9. The other side of the secondary of IF2 is connected to ground. The grid leak R4 is connected between the triode grid of V2 and the cathode which is biassed by the usual resistor R5, bypassed by a .5 mfd. condenser, C7.

The triode plate (shown in the schematic circuit diagram as a grid), is connected to the primary of the audio transformer AFT through the .1 mfd. condenser C14. This condenser, and the resistance R9, is used as a shunt feed arrangement to keep the direct current of the plate potential from the transformer primary, and thus to improve the tone quality of the receiver. The "B" supply for the triode plate of V2 is fed through the 100,000 ohm resistor R9. The audio circuit is perfectly straightforward, the usual cathode bias system being used.

Tone compensation for the pentode output is obtained by means of the .006 mfd. condenser C10, and the 10,000 ohm resistor R7 connected in series between plate and screening grid of V1.

One point which requires some explanation here is the volume control VC shown across the secondary of the audio transformer. In view of the fact that it was not practicable, considering that V2 acts as both an r.f. amplifier and a detector, to volume control the i.f. by the usual means. For this reason the volume control was connected in the audio side of the receiver.

A Key Lettered List of Component Parts

1—Super Het. Kit, comprising Aerial, Pre-selector, Oscillator, two I.F.'s and padder. (L1, 2, 3, 4, 5, 6, and I.F.1, I.F.2). (Melbourne, Essanay, Stromberg-Carlson, Velco, Lek-Mek, Paramount, Radiokes, Saxon).

1—Three Gang Tuning Condenser (C1, C2, C3). (Airway, Stromberg-Carlson, Essanay, Raycophone, Precedent).

1—Power Transformer (385-0-385 v. at 80 m.a.; 6.3 v. at 2 a. and 5 v. at 2 a.). (Wendel, Radiokes, Essanay, Velco, Kelvin).

1—.00025 mfd. Fixed Condenser (C9). (T.C.C., Wetless.)

1—.0002 mfd. Fixed Condenser (C4). (T.C.C., Wetless.)

1—.006 mfd. Fixed Condenser (C.10). (T.C.C., Wetless).

5—.5 mfd. Tubular Condensers (C5, C7, C8, C13, C15). (T.C.C., Chanex, Polymet, Concourse).

2—.1 mfd. Tubular Condensers (C6, C14). (T.C.C., Chanex, Polymet, Concourse).

1—250 ohm Wire Wound Resistor, 50 m.a. type, (R2). (M.M., Velco, Radiokes, Saxon, Wendel, Precedent.)

1—400 ohm Wire Wound Resistor, 50 m.a. type (R5). (M.M., Velco, Radiokes, Saxon, Wendel, Precedent.)

1—450 ohm Wire Wound Resistor, 100 m.a. type (R6). (M.M., Velco, Radiokes, Saxon, Wendel, Precedent.)

1—50,000 Ohm Resistor (R1)
1—20,000 Ohm Resistor (R3)
1—500,000 Ohm Resistor (R4)
1—100,000 Ohm Resistor (R9)
(I.R.C., Carborundum, Bradleyohm, Velco, Chanex Silent, Ohmite.)

1—15,000 Ohm Voltage Divider (R8). (Radiokes, M.M., Paramount, Velco, Essanay, Wendel.)

1—Audio Transformer, Ratio 3½-1 (AFT). (Ferranti Wendel, Philips, Essanay, Lissen.)

2—8 mfd. 500 volt Electrolytic Condensers (C11, C12) (Solar, Dulytic, T.C.C., Concourse).

1—25 mfd. 25 volt Electrolytic Condenser (C9). (Dulytic, T.C.C., Concourse.)

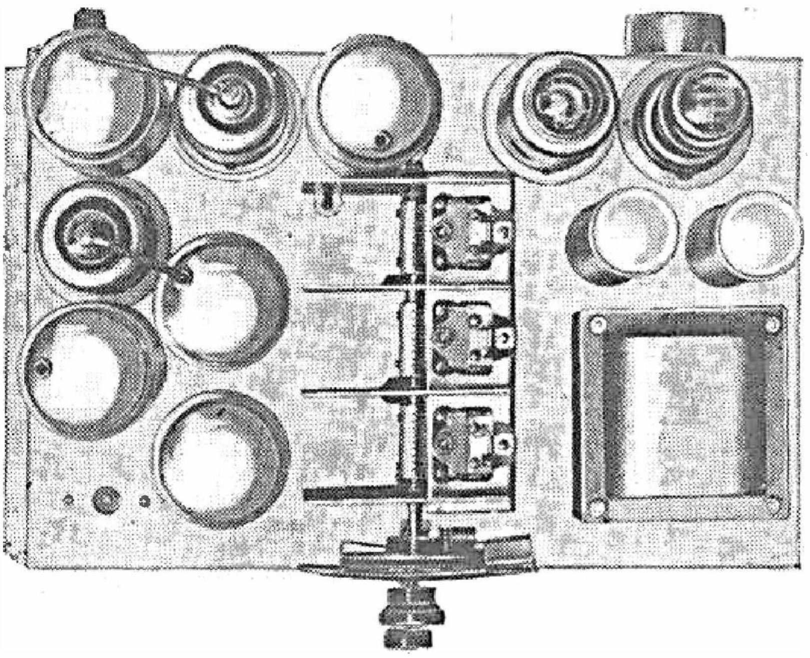
1—5000 Ohm Wire Wound Volume Control. (See text.) (Marquis, Radiokes, M.M.)

1—2500 Ohm. Field Type Speaker, to match 41 valve (Rola, Precedent, Jensen, Saxon, Amplion.)

1—Aluminium Chassis. 15in. x 10in. x 2½in. (George White and Co.)

5—Valve Sockets (Two 7 pin, one 6 pin and two 4 pin.) (Targan, Marquis, Velco, Essanay.)

4—Valves. (One 6A7 (V1); one 6F7 (V2); one 41 (V3); and one 80 (V4). (Radiotron, Ken-Rad, Tungsol, Philips, Speed-J.R.C.)



A photographic plan view of the top chassis which shows clearly the lay-out of the gang condenser, the coil cans and the four valves.

In practice it was found that this method of volume control was not satisfactory, for, while it certainly reduced the output volume, it did not remove the second detector overload. Consequently the control was taken off the audio side and now consists of a 5000 ohm potentiometer connected between the earthed end of V1 and earth. Naturally, the earth shown on R2 in the circuit was removed. This system of control acts quite well and enables the second detector overload to be entirely overcome.

The power pack is quite ordinary, consisting of a standard 385 volt 80 milliampere transformer, which is provided with a 5 volt rectifier winding and a 6.3 volt receiver tube winding. The filter consists of the 2500 ohm loud speaker field and two 2 mfd. electrolytic condensers C11 and C12.

Component Layout Details

The next question for consideration is the lay-out of the receiver. There are many arrangements, each possessing its own advantages, which can be used for the placement of the coil cans and the oscillator tube. The intermediate frequency transformers, the i.f. tube, the second detector, and the audio tube all can be arranged easily, as can the power pack and the filter condensers.

After thinking the matter over for a while we decided to place the tuning coils L1-L2, L3-L4, and L5-L6 as follows:

Looking from the front of the chassis to the back we have in the first can the aerial coils L1 and L2. In the second are the modulator grid coil L3 and the coupling coil L4. At the extreme left, alongside the 6A7 valve is the can containing the oscillator coils L5, L6.

At the back left is the first intermediate frequency transformer I.F.1, while between this unit and the second i.f. transformer I.F.2 is the 6F7 tube. Next to this is the 41 power tube which has been enclosed in an aluminium screen to prevent any modulation hum effects from the rectifier valve on the extreme right.

At the front right of the chassis is the power transformer, and between this and the rectifier the two electrolytic condensers, C11 and C12, are mounted. The padding condenser can be seen in the left-hand front corner of the chassis. The gang condenser is mounted on brackets in the centre of the chassis.

Incidentally this condenser is one of the new "Airway" type which possesses features which should make it of special interest to the home constructor. One of these is the specially-shaped plates which have the effect of opening out the tuning scale in the middle of the wave band. The result is much easier apparent tuning between 3LO and stations down to 3DB. For the super-het constructor it has an even more important advantage in large and easily adjustable trimmers. These trimmers are so shielded that it is possible to adjust them by hand whilst the set is running and yet get accurate results.

The thickness of the rotor and stator plates of the "Airway" removes the possibility of a "modulation zoom" from acoustic feedback from the loud speaker.

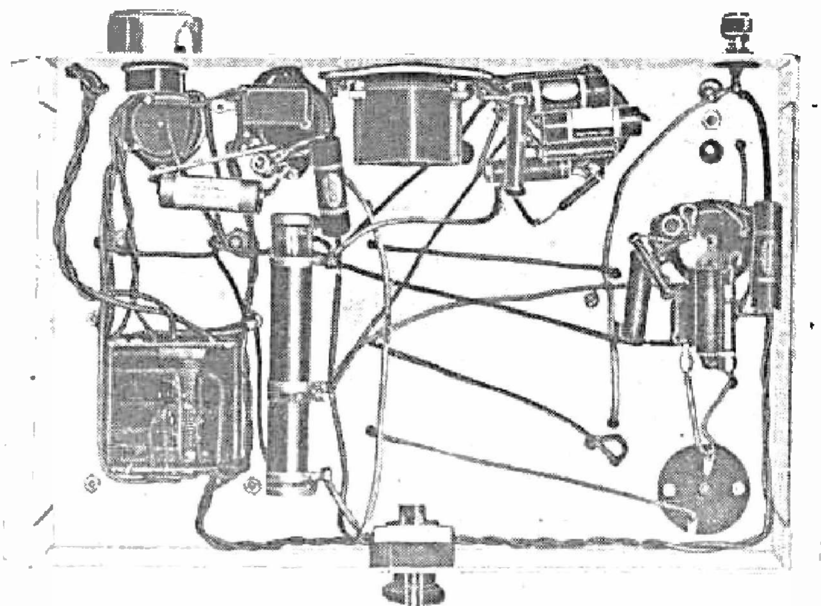
On the front of the chassis is mounted the tuning dial, and below this, underneath the chassis is the volume control. Along the rear side of the chassis a port is cut for the loud speaker socket (back left), and holes are drilled for the rubber grommet, through which the a.c. supply leads pass, and the aerial and earth terminals (back right).

The underneath view of the finished set gives a good idea of the placement of the various components, but some few words of explanation may not be amiss. The photograph of the finished set shows that a shielded cable runs from the volume control to the audio tube. This was used when the volume control was hooked in to the audio circuit, but is not necessary when volume is controlled in the cathode circuit of V1.

Looking at the under-chassis view of the set it can be seen that the by-pass condensers for the first two valves all are connected in circuit as near to their particular socket as possible.

Note that, because of the placement of the aerial coil, the lead to the aerial terminal is carried in a metal braided cable. A point worthy of note is the advantage of earthing one side of the filament line to V1, V2, and V3 to reduce hum.

(Continued on Page 85)

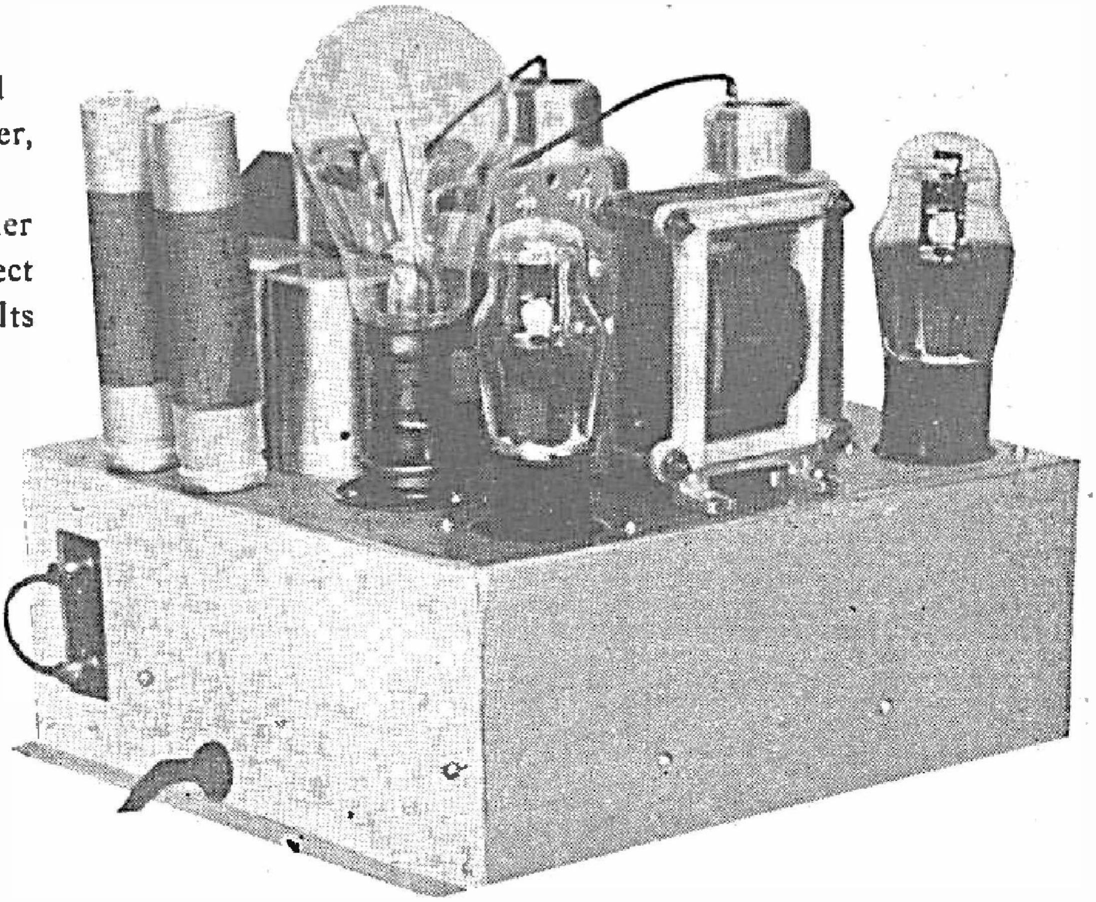


The under chassis view of the finished set, which should be studied in conjunction with the circuit diagram and the list of component parts.

The Universal Three

A midget sized all-electric receiver, designed for operation on either alternating or direct current mains. Its mission is the reproduction of local stations at good loud-speaker volume.

By RADEX



The Universal Three from the right rear with the aerial and earth terminals to the left. The 12Z3 rectifier is in the foreground, with the resistance lamp behind it, and the audio choke to its right.

IT is generally recognised that the most satisfactory radio entertainment is obtained from the local broadcasting stations.

This Universal Three has been designed to meet such a requirement when the owner thereof definitely has no desire to go further afield than his own home town. It incorporates real selectivity in that, operated in the heart of the city of Melbourne, it easily separates all the locals. A single dial station selector, plus a volume control, makes it exceptionally easy to operate. The tone is good, the latest valves being used. The employment of a type 43 tube in the last stage makes available a possible two watts to the speaker, ample volume for all domestic requirements.

Why "Universal"?

"Universal," when applied to a radio set, means that the instrument can be operated equally successfully on either direct or alternating current; and remember that there are still large tracts in this continent still served by the former type of electric supply. Of these the greatest example is Melbourne itself, wherein that populous area bounded by Flinders, Spencer, Lonsdale and Spring Streets is fed solely with direct current. In consequence, for years residents of this huge square have either been limited to the use of antiquated battery sets or have had to install extremely expensive convertor models. As many of them could not afford the latter types, radiographically speaking they have been living in an era some time prior to 1928.

The advent of the robust 6.3-volt type of valve, and advanced specimens in the same series (all having a uniform filament consumption of 0.3 ampere), ameliorates this condition and makes a straight out d.c. set not only possible, but practical. Such a design does not use a power transformer. Instead, its valve's heaters, plus a suitable "breakdown" resistor, are wired in series directly across the mains the latter furnishing the "B" supply, too, after being conveniently smoothed in conventional manner. A purely d.c. model does not demand a rectifier valve, but for reasons that will be given, its inclusion is very desirable.

The Value of the Rectifier

Provided a rectifier valve is included in the circuit, exactly the same valves, in exactly the same manner, may be used in conjunction with alternating current mains and still without a power transformer. In this instance, the rectifier passes the positive half of each cycle while rejecting the negative following it. The result is pulsating d.c. that is smoothed automatically by the corresponding built-in system comprising the usual condensers and choke.

In the case of a.c., the set works at once, no matter how the power plug is inserted in its socket. With d.c., however, the positive lead from the set (i.e., that corresponding normally to "B plus max") must go to "positive line" — although the discovery of this positive merely means a reversal of the plug in its socket until signals come through. Herein lies the value of the inclusion of a rectifier, as follows:—

You will, of course, use electrolytic condensers in the smoothing system. Should you, at the first try out, put the power plug in the wrong way, or should someone else do so at a later date, a negative will be applied to the condensers' positives (and vice-versa), and they will be ruined. The presence of a rectifier tube absolutely precludes this risk, as when the plug is in the wrong way, the valve will not pass any current, and so no strain is placed on the condensers. When the plug is right way round the tube merely idles on the line.

Secondly, with the rectifier in circuit, the full mains voltage only reaches the set through it, and so chances of an accidental shock are reduced to an almost negligible minimum. Thirdly, its inclusion has the already named advantage of permitting the set to be used indiscriminately on either d.c. or a.c. lines. Use it in your office in the city during the day, and take it home to the suburbs at night; it works equally well in either locality.

The Filament Supply

In all universal designs, wherein the valves' heaters are all wired in series (together with "X"), and placed directly across the mains, X, or the breakdown resistor, is the major problem. In the United States, the birthplace of the motor car type of tube employed in these models, the standard is 110 volts average for both a.c. and d.c. This means that X has comparatively little dissipation to do.

Take an example: In the case of the set with which we are dealing, the valves (including rectifier) require 50 volts across them in order that there may be a steady flow of 0.3 ampere. In the U.S.A. X would merely have to get rid of the surplus 60 volts, which corresponds to a dissipation of only 18 watts. Here, with our 230-volt supplies, the surplus is 180 watts, and so X must be able to handle the dissipation of 54 watts, a very different proposition.

In this model, by a careful selection of the valves used, matters have been so arranged that breakdown resistor X takes the form of an ordinary 60-watt house lighting globe. This proves cheap and thoroughly satisfactory, so long as a reliable make of lamp is selected. How the arrangement works will be seen when we investigate the circuit.

Heater Details

Referring to the circuit diagram it will be seen that we have a 3-valve cascade that gives a stage of r.f. amplification, a bias detector and a pentode power output. V1, the r.f. tube, and V2, the detector, both operate on a maximum of 6.3 volts. For V3 pentode 43 was selected; it takes a heater voltage of 25, but, like the other two, has a heater consumption of 0.3 ampere. Its output is to the order of 2 watts when operated with 135 volts (the maximum permissible) on its plate.

V4 is a type 12Z3 half-wave rectifier, the heater of which is wired in series

List of Components and Schematic Circuit

AE.—Aerial condenser.

C1.—Mica condenser of 0.00025 mfd.

C2, 8, 13, 14.—Mica condensers of 0.01 mfd.

C7.—Mica condenser of 0.0001 mfd.

C3, 4, 5, 6.—Tubular condensers of 0.1 mfd.

C10, 11, 12.—Tubular condensers of 0.5 mfd.

C9.—Dry electrolytic condenser of 10 or 25 mfd. tested to 25 volts.

CH.—Audio choke of 500 Henries.

CH2 and 3.—Common 30-Henry power chokes to pass 60 m.a.

E.—Earth connection. See special note in text.

E1 and 2.—Electrolytic condensers of 8 mfd. tested to 450 volts.

G1-2-3.—Triple gang midget tuning condenser with vernier dial.

L1-2, L3 and L4-5.—Midget coil kit in three units. (Saxon, Melbourne, etc.)

LCH.—Special line filter chokes. See text. (Precedent, Firth Bros.)

LP.—Common electric light 60-watt or 200 volts (for 230-volt mains) and bayonet-batten socket.

LS.—Any good magnetic cone speaker or permagnetic. (See text re dynamic.)

R1.—Carborundum type resistor, 10,000 ohms, 1 watt.

R2 and 3.—Carborundum type resistors, 250,000 ohms, 1 watt.

R4.—Wire-wound resistor of 500 ohms to pass 50 m.a.

R5.—Wire-wound resistor of 6000 ohms to pass 50 m.a.

SW.—Main switch, rotary or snap type.

VC.—Volume control, 10,000 ohm potentiometer.

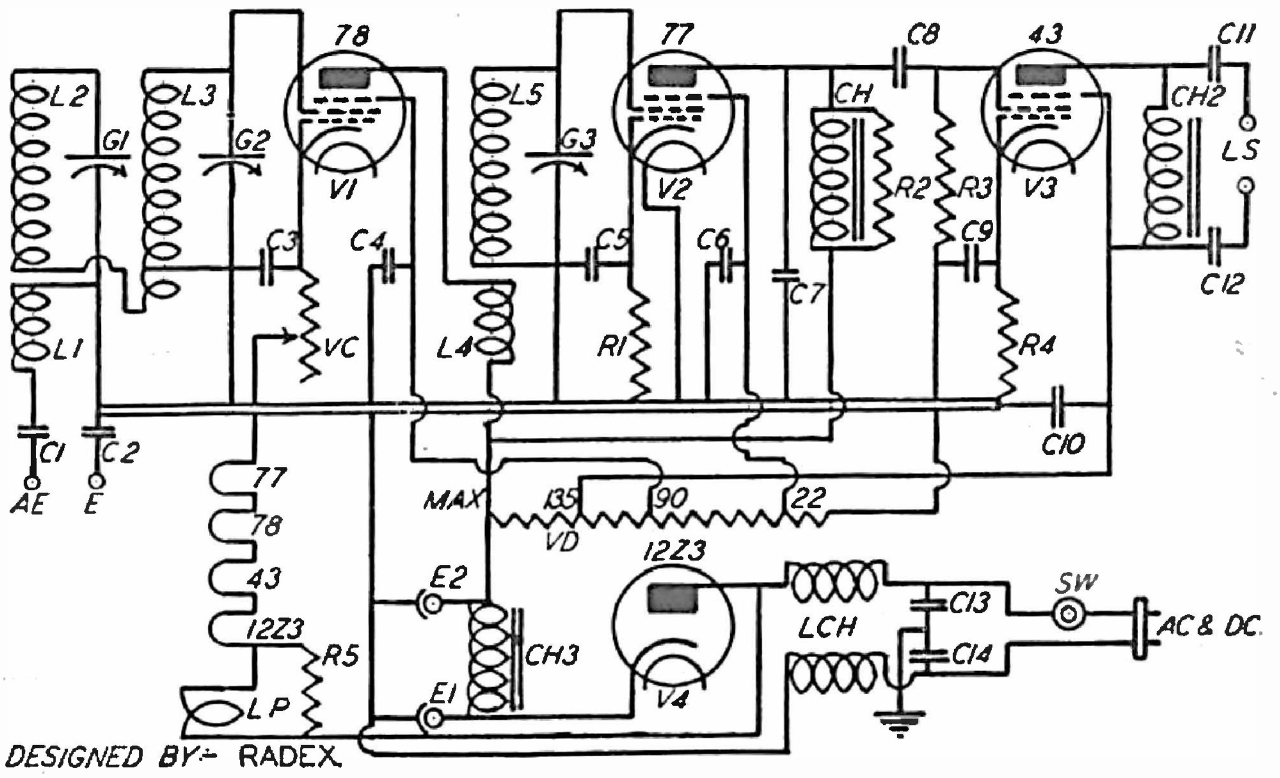
VD.—Tapped voltage divider of 15,000 ohms.

Valves.—One each 78, 77, 43 and 12Z3 with two valve-cans and grid-clips.

Sockets.—Three 6-pin and one 4-pin.

Chassis.—No. 16 gauge aluminium 9 x 8½ by 3¾ inches.

Sundries.—Insulated flexible wire, nuts and machine screws, etc.



with the others. It requires 12.6 volts, and again the consumption is 0.3 ampere.

The full arrangement of the filaments is shown at the drawing's left. Coming directly from the mains, via LCH, the current passes through the breakdown resistor lamp, LP, and then successively through the 12Z3, 43, 78 and 77, and so to chassis, to which latter the other leg of the mains is connected.

On 230-volt supplies a 60-watt lamp at LP is just a tiny shade low; it passes just a fraction too little current to get the full punch from the set, although it takes a critical ear to remark the fact. For those who want to work the set at absolute maximum volume, shunt resistor R5, across LP, is included. It is wire-wound and of 600 ohms; high though it is, it compensates sufficiently to bring the current to exactly 0.3 ampere.

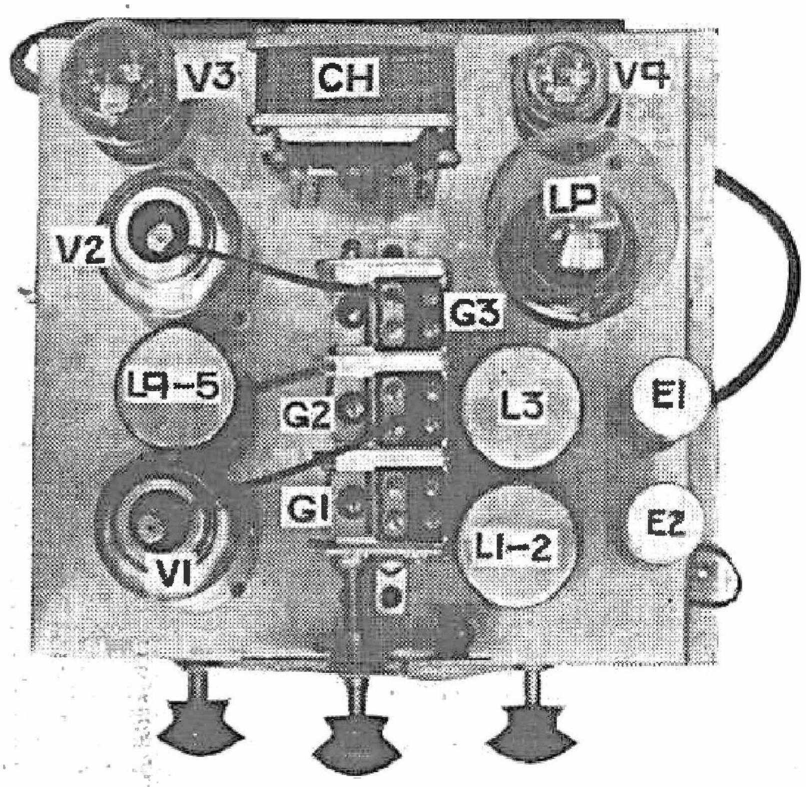
Note that on 230-volt mains LP is only a 200-volt 60-watt lamp. If it is desired to use the model on 200-volt supply then LP must be two lamps wired in parallel; one of these is a 40-watter, and the other a 25, and both are for 200-volts.

The Circuit Design

In order that this model may serve its purpose as a good local receiver, and be immune from interference, the cascade commences with a conventional pre-selector in coils L1-2 and section G1 of the ganged condenser. This is followed naturally by grid input circuit L3 and G2. R.f. transformer L4-5 couples V1 to detector V2, the latter operating on the bias system by virtue of the presence of resistor R1.

Between the detector and output pentode choke-capacity coupling is employed, choke CH being to the order of 500 Henries.

The choke-capacity final output requires a word of explanation. As the arrangement stands it is fitted for the employment of an ordinary magnetic cone or permagnetic speaker. If the volume is cut down even headphones can be connected across LS and with these quite fair interstate reception is possible.



A plan view of the chassis, illustrating the main components keyed to correspond with the list of parts.

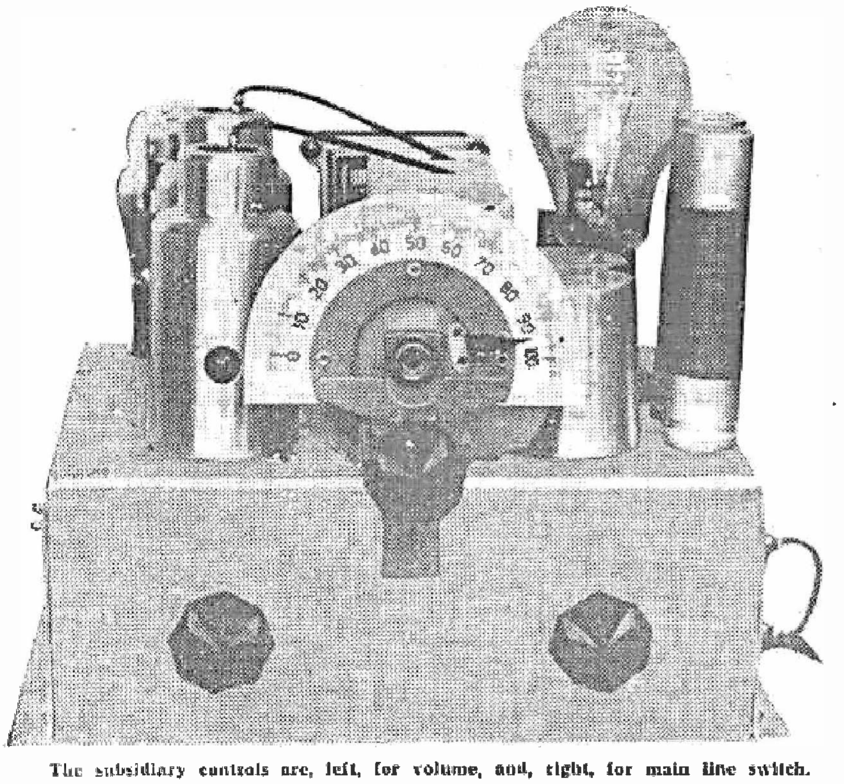
All this notwithstanding, a dynamic speaker can be applied to the circuit with entire satisfaction. If such is used its field must not have a greater resistance than 750 ohms, and that is connected up in place of CH2, the latter being then omitted altogether. In this scheme the plate of the 43 should show a voltage of 135 to cathode.

The set has only one subsidiary control which is for volume. This takes the form of a 10,000-ohm potentiometer and is wired in the cathode of variable-Mu valve 78. All condensers and resistors shown (with the exception of R5 as previously indicated) are necessary to the receiver's operation. The smoothing system is composed of a third choke CH3 and electrolytic condensers E1 and E2.

The Line Filter

Where, as in this case, a power transformer is not used, it becomes necessary to include some means of filtering out line noises, especially those that have something of a radio frequency. Normally these are largely suppressed by the power transformer, but with a universal design we must substitute something to do the same work.

In this instance the line filter is composed of chokes LCH and condensers C13 and C14, all three being enclosed in a small iron box. The complete unit can be purchased from Firth Bros. — Precedent Radio. For those who wish to make it themselves the following details will suffice:—



The subsidiary controls are, left, for volume, and, right, for main line switch.

Obtain a piece of dry wood 1 inch in diameter and 1½ inches long. Three-quarters of an inch apart cut two slots each quarter-inch wide and rather over quarter of an inch deep radially. In each of these slots wind 200 turns of No. 26 enamel wire. Now mount the fixed condensers C13 and C14, one at each end of the wooden cylinders, and wire as in the diagram. The whole is enclosed in an iron box measuring 1¼ to 1½ by 2 inches deep, and the wiring is brought out through holes protected with rubber grommets. Observe that the centre tap, between the two fixed condensers, goes direct to earth.

It is important to note that the set itself is not directly earthed, but is taken thereto through fixed condenser C2. Similarly, to prevent dangerous leakage, it is absolutely essential to insert condenser C1 between the end of L1 and the aerial terminal AE. In effect the mid-tap between C13 and C14 connects direct to E, the latter point going to a good ground connection.

Arranging the Components

The total absence of a bulky power transformer permits of the assembly of a very compact model provided the other components are chosen with a view to their physical sizes.

After a power transformer, probably the next most bulky component in a set is a triple-gang condenser, but today there are several midget types on the market that meet m o d e r n requirements as to limited size. These small condensers also have capacities slightly smaller than normal; therefore, if you purchase one you must see that the coils are so wound as to afford coverage for the complete wave band.

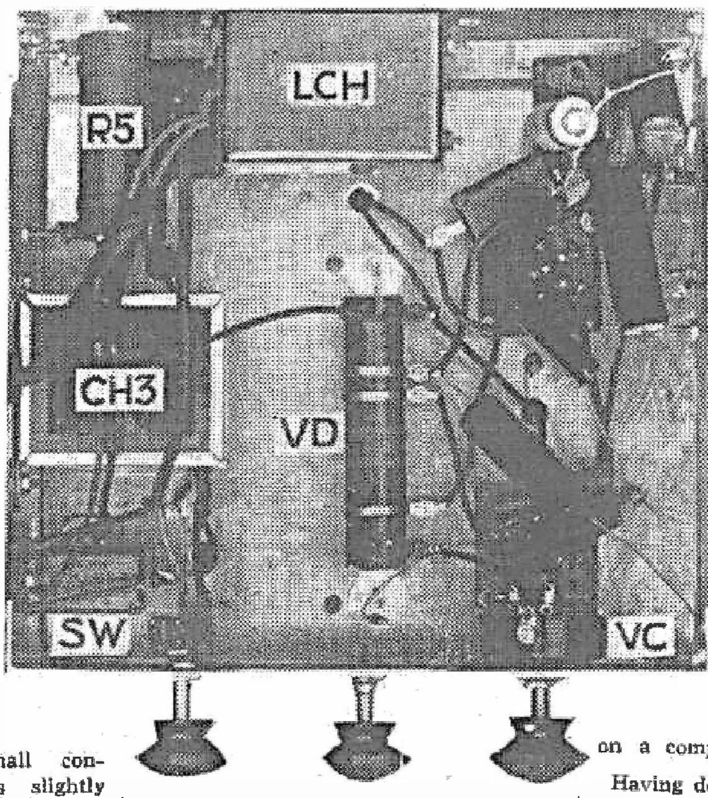
In the original we used a Saxon midget gang and also Saxon midget coils that are designed to work with it. The latter have can diameters of only 1¾ inches and are 2¼ inches in height.

The accompanying photographs will show the general arrangement of the components much better than a possibly confusing description in words. The main thing to be careful about is to see that the LS, AE, and E terminals are thoroughly insulated from the chassis. This is best done by cutting slots in the metal and filling them in with ebonite strip.

It is not necessary to insulate VC, but where the mains supply cable passes through the aluminium it is desirable to insert a rubber grommet to prevent wear. It will be seen, from the underneath view, that choke CH2 is absent. That is because, in its final state, we used the set in conjunction with the type of dynamic speaker already specified.

Wiring Hints

Wiring will commence with the heater circuit after you have gone through the filter system LCH, etc., and the main switch SW. One opposite side of the filter is connected directly to chassis, while the other is taken to both the plate of V4 and the junction of LP and R5. From the other side of the latter go successively through the heaters of V4, V3, V1, and V2—noting that detector V2 is the last in the series, and that, in consequence, one of its heater connections is wired directly to chassis.



This under-chassis picture of the assembled receiver shows that in comparison to its performance the components required for its construction are few. They are key lettered to agree with the list of parts and the wiring instructions. Seen from below, the remaining parts fit easily into position, crowding existing only under the socket of the 43 in the top right corner.

Deal now with the smoothing system, comprising E1, E2 and CH3, and continue to the "Max" end of the voltage divider VD. Between max. and "135" this divider carries a fair current, viz., that for the 43, and for that reason a 15,000 ohm unit is advised because of its usually heavier wire than one of 25,000 ohms.

Clean up the coupling system between V2 and V3, and the output arrangements from V3. The wiring for the screens of all valves can be put in and taken to VD. Fit all bias resistors with their shunts. This just about completes the wiring that is purely below the chassis.

Turning to the top now, it is time to fit and wire the coils and ganged condenser. The former will be suitably lettered and should present no difficulties; in fact, do not purchase a kit that is not so lettered. Connections to the coils are taken from lugs on the gang's lower dimension (i.e., that nearer the chassis), and your work will be infinitely easier if you solder these on before mounting the unit. The final leads are those two running from the tops of sections G2 and G3 of the gang to the grid-pips of valves V1 and V2, respectively.

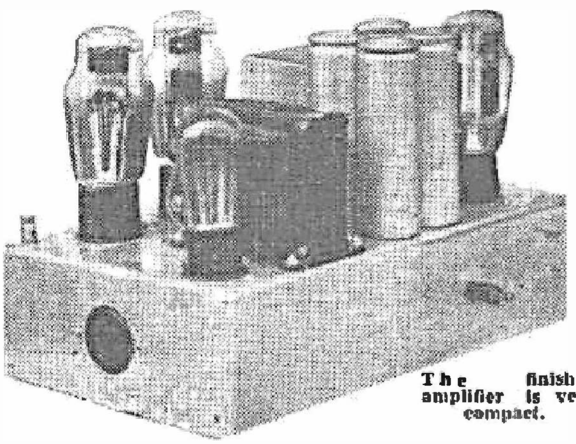
Final Instructions

The series of valves used in this design take a fair time to heat up; they are a little slower, in fact, than those of the 2.5-volt type.

The set lines up very easily. Commence with all trimmers opened about three-quarters of a turn and tune down toward the dial's bottom end. As soon as a station is heard, with the volume control almost fully advanced so that nearly a minimum of its resistance is in circuit, adjust the trimmer of G1 for a further increase in volume. As for the latter rises cut back VC so that you are always working on a comparatively weak signal.

Having done all you can with V1, deal similarly with the trimmer of G3. It will be found that section G2 is the controlling one; that is to say, the circuit composed by L3 and G2 is the one that tunes most sharply, and the other two are really lined to it. In consequence, G2 is the trimmer that has the most effect. G1 is next in order of delicacy, while G3 is relatively coarse and would appear to have little effect on locals. Nevertheless it does a big work and must not be neglected.

As one side of the mains goes through one leg of LCH to chassis, electrically speaking this set is alive. We would interpolate that we have touched the aluminium with impunity, even on d.c. without signs of shock. However, it is always better to be on the safe side, and so it is highly desirable that the entire receiver (less the speaker, of course) be enclosed in a cabinet.



The finished amplifier is very compact.

A Multi-Purpose Power Amplifier

Using 2A3's in push-pull and Twin speakers this modern unit combines clarity of tone with a 10-watt output

By A. K. BOX

THE uses to which a high quality, large output, audio amplifier can be put are many. The possession by the radio experimenter or set builder, of such an amplifier, saves considerable time and trouble, for, in building a new receiver, it is necessary to deal only with the r.f. and detector sections, which are to be connected to the amplifier.

If the audio amplifier has been carefully built in the first place, the experimenter can be sure that any trouble he may encounter with his new receiver will lie in the r.f. circuits, a point which is often of considerable importance when using high gain models. Again, the power amplifier, if its undistorted output is high enough, can be used as a public address system, a talkie amplifier, for picture theatre work, for home recording of gramophone discs, or in conjunction with a high gain input unit, for experiments with light sensitive cells.

There is no doubt at all that the power output of the majority of amplifiers used in broadcast receivers is insufficient. Notwithstanding the fact that a standard pentode of the 2A5 class is capable of an undistorted output of 3 watts, it is the writer's belief that the minimum undistorted power output of an amplifier to be used in the average home should be from 4½ to 6 watts. In making this statement, we realise that there are many who will dismiss it as absurd, but the proof of the contention is a listening test between two well-constructed amplifiers, one having, say, a power of from 1½ to 3 watts, and the other delivering anything above 5 watts. The lack of adequate bass response from the lower powered amplifier will be immediately apparent, as will the tendency for it to "crack up" on loud passages.

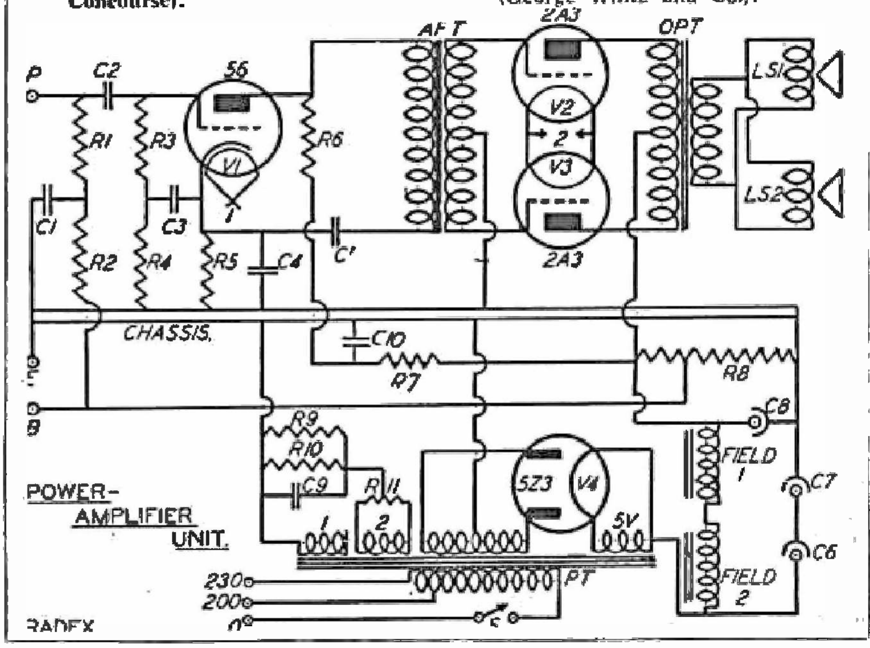
The Reproducer System

The best amplifier is no better than the reproducing system into which it feeds, and it is of little use to go to the trouble of building a first grade unit if it is to drive a loud speaker which is incapable of reasonably faithful reproduction.

The most recent development in reproducing equipment has been the design of loud speakers specially arranged to operate in parallel. The advantage of this use of parallel (or, as they are known, "dual speakers") is that the reproducing end of the amplifier is less liable to overload, resonance peaks are practically eliminated and, provided that a suitable baffling area is employed, there is less attenuation of the frequencies between 100 and 50 cycles than is present when a single loud speaker is employed. The Rola dual speakers used in connection with the tests of the amplifier under review are arranged so that one loud speaker peaks at 100 cycles, and

THE CIRCUIT AND PARTS LIST

1 100,000 Ohm Resist. (2 Watt) (R1).
1 15,000 Ohm Resist. (2 Watt) (R2).
1 250,000 Ohm. Resist. (1 Watt) (R3).
1 100,000 Ohm Resist. (1 Watt) (R4).
2 25,000 Ohm Resist. (2 Watt) (R6, R7).
1 50,000 Ohm Resist. (1 Watt) (R9).
Above are I.R.C., Bradley, Velco, Chanex, Silent or Ohmite.
1 700 Ohm Wire Wound Resistance, 100 m.a. type (R10).
1 2700 Ohm Wire Wound Resistance, 10 m.a. type (R5).
1 15,000 Ohm Voltage Divider (R8).
1 20 Ohm Centre Tap Resist. (R11).
Above are Master Made, Radiokes, Saxon, Velco or R.C.S.
1 3½ to 1 Ratio Push-Pull Audio Transformer (AFT). (Ferranti, Wendel, Saxon, A.W.A.).
4 500 Volt Working 8 mfd. Electrolytic Condensers (C6, C7, C8, C9). (Polymet, Dulytic, T.C.C., Solar, Dubilier, Kelvin).
1 25 mfd. 25 Volt Electrolytic Condenser (C4). (T.C.C., Dulytic, Concourse).
1 1 mfd. Fixed Condenser (C3).
1 4 mfd. Fixed Condenser (C10).
2 2 mfd. Fixed Cond.'s (C3, C5). (T.C.C., Hydra, Chanex, Wetless or Saxon).
1 .01 mfd. Mica Condenser (C2). (T.C.C., Saxon, Wetless).
3 UX Valve Sockets, 2 UY Valve Sockets, (Torgan, Velco, Marquis, Saxon).
1 Power Switch (Alpha, Monarch, Cutler Hammer, Saxon).
1 Pair of Dual Speakers, 1000 ohm fields, and matched to 2A3's in push pull. (Rola, Jensen, Amplion, Saxon, Precedent).
1 Power Transformer, delivering 500-0-500v. at 150 m.a., 2.5 v. at 10 amperes, 2.5 v. at 5 amperes, 5 v. at 3 amperes. (Wendel, Saxon, Radiokes, Aegis, Velco, Kelvin).
1 Aluminium Chassis, 12 inches x 10 inches x 3 inches by 16 gauge. (George White and Co.).



the other at 80 cycles. These are due mainly to the mechanical construction of the speaker, and are to be found at one period or other in any type of speaker.

As the loud speakers are arranged to operate in phase with each other, it follows that when the 80 cycle speaker cuts out at that frequency the 100 cycle one is still delivering its power, the reverse condition taking place at 100 cycles. By reason of the fact that with two speakers we have available twice the diaphragm movement possible with one, the volume of the dual speaker arrangement is greater from a given amplifier than if a single speaker were used. The use of dual speakers calls for extra power for the excitation of the field windings, and when the speaker field coils are used as filter chokes this means that a greater supply voltage must be made available.

The Question of Valves

In building an amplifier such as this we first must decide upon the valves to be used. In the present amplifier use has been made of the newly developed multifilament tube, the 2A3. It is a three-element high vacuum type of power valve, which is capable of delivering an exceptionally large undistorted output. When used as push-pulling class "A" amplifiers, two 2A3's are capable of supplying 15 watts of undistorted output power if operated at a plate potential of 300 volts.

The design features of the 2A3 which are responsible for its remarkable performance, include a very high mutual conductance, 5500 micro-ohms, and a highly efficient emitting system, composed of a large number of coated filaments arranged in series-parallel. This emitter arrangement provides a very large effective cathode area.

On this page are the characteristics of the 2A3 when used in push-pull connection.

We find from the table that the peak signal input to the grids of our 2A3's needs to be 124 volts (twice the bias voltage) to load the tubes fully. Now if the audio transformer used to couple the grids of the push-pull tubes to the plate of the preceding amplifier has a step up ratio of 3½ to 1, we shall require a voltage of 124 divided by 3½, or 35.4 volts, to the input side of this transformer. If we use a 56 as driver we find that the rated amplification factor of this tube is 13.8. To be on the safe side we shall assume that the working amplification factor is 10, with the result that 35.4 divided by 10, or 3.54 volts, is required on the grid of the 56 to load up the last stage tubes.

So far so good, for if the characteristics of the 56 are examined it will be found that the tube will handle a peak grid voltage of 9 volts to load it fully. This is rather important; for we must make sure that the driver stage will not overload before the final stage valves are delivering their full output. Such is the case with the present arrangement, for a 9-volt signal to the driver 56 would result in an input signal to the grids of the 2A3's of 315 volts, which would hopelessly overload the tubes, and so volume must be controlled before the 56's grid.

The next point for consideration is the provision of the 3½ volt input signal to the 56. If the amplifier is to be connected to a radio receiver there should be plenty of signal voltage available. In practice it has been found that a single r.f. stage feeding into a mildly regenerative detector will provide more than sufficient output to load the last stage tubes. But for pick-up work it is necessary either to connect a 3½ to 1 ratio transformer between the pick-up and the grid of the 56 (thus disregarding the resistance coupling arrangement shown in the schematic diagram), or to hook in a second 56 which is resistance coupled to the existing tube and connect the pick-up to the grid and cathode of that tube. In any case this problem can best be overcome by the individual experimenter, the main object of the fundamental amplifier being to provide a source of high audio output power.

Consumption Calculations

Now, to come back to our figuring, we have decided to build an amplifier having a single 56 tube driving a pair of 2A3's, and utilising the dual loud speakers in which the field windings are to do duty as filter chokes in the power pack. An examination of the characteristics of the 2A3's shows that a total plate current of 80 milliamperes is required for their operation. The single 56 will take a plate current of around 3 milliamperes at the voltage at which it will be operated, and if we use a voltage divider of 15,000 ohms resistance we shall have a current 24 milliamperes flowing through it.

To make this clear we must recapitulate a little. First the 2A3's are to be supplied with 300 volts. The required bias at this potential is 62 volts, so that the potential difference between the positive and earth ends of the voltage divider is 362 volts. The divider has a resistance of 15,000 ohms, so by Ohm's law: C equals E over R the current flowing through it is 24 m.a.

2A3 Characteristics

	Fixed Bias	Self Bias	
Fil. volts	2.5	2.5	Volts
Fil. current	2.5	2.5	Amps
Plate volts	300	300	Volts
Grid volts	—62	—62	Volts
Tube Ma's	40	40	Ma.ea.
Load resistance (plate to plate)	3000	5000	Ohms
Power output	15	10	Watts

We now can add our currents as follows:—80 m.a. for the two 2A3's, 3 m.a. for the 56 and 24 m.a. through the voltage divider, a total of 107 m.a. Each of the loud speaker fields has a resistance of 1000 ohms, so, again by Ohm's law, this time E equals C x R we find that the voltage drop across each field shall be 107 volts. For the watt excitation of each field we multiply the current flowing through the field by the voltage drop across it, which means that we have 107 volts multiplied by .107 amperes or 107 m.a. The result is an excitation power of 11.449 watts on each l.s. field, which, although it may seem too high for safety, judged purely from the current load viewpoint is really quite O.K.

The Power Transformer

The next stage in our calculations is to decide upon the output voltage of our power transformer. As we require 362 volts at the positive end of the voltage divider, and 214 volts to take up the 107 volts drop across each of the loud speaker fields, it follows that the power transformer must be able to supply from its high voltage a potential which will result in a rectified voltage of 570 volts. The rectification of such a comparatively high voltage at a current of more than 100 milliamperes requires a heavy-duty rectifier. We must, therefore, select a valve of the 5Z3 class that is capable of handling up to 500 volts per plate at a current of 250 milliamperes.

Used with a condenser input filter having 4 mfds. of capacity, this valve will supply 575 volts rectified A.C. at a current of 110 M.A. when supplied with 500 volts A.C. per plate. Such is the condition under which it is worked in the present amplifier.

It should be remembered that the arrangement of the power supply system of the amplifier is designed to handle only the amplifier itself without alteration of the delivered voltages. If, however, it is desired to power a receiver from the amplifier pack, two courses are open to the set constructor. If a total current of not more than 24 milliamperes is required for the operation of the valves in the radio receiver, the voltage divider can be dispensed with and suitable series resistances inserted in the plate and screening grid supply leads of the receiver valves to reduce the potential of 362 volts to the desired value of 250 or 100 volts.

Another scheme which can be adopted is to reduce the speaker fields to 750 ohms and to arrange matters so that a total current of 142 M.A. flows through them. This makes available a current of 35 M.A. for the receiver, or, if the voltage divider is omitted, a current of nearly 60 M.A., which should be suitable for all reasonable needs. In any case the method followed in the present amplifier, and which was explained in the preceding few paragraphs, can be just as easily applied to any combination of valves and loud speakers desired.

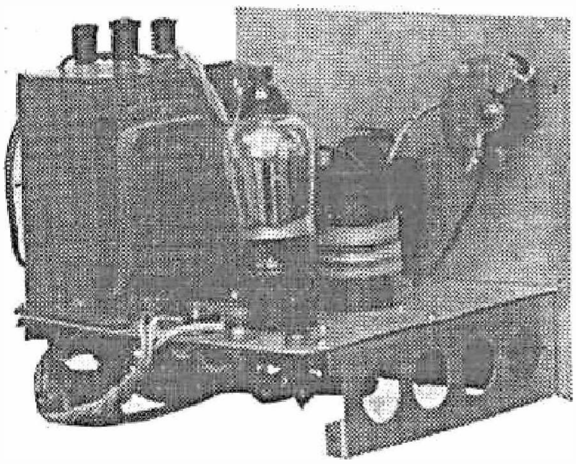
Design of Audio Side

It was explained earlier just how the combination of couplings and driver stages was arrived at, so that all that is necessary now is to touch upon those circuit details which have any bearing upon the performance of the amplifier. First have a good look at the diagram.

It will be seen that the input section of the amplifier has been given special decoupling treatment, that the plate of the driver 56 is shunt fed, and that even this feed arrangement has been decoupled to prevent a.f. instability and oscillation. Other points of exceptional interest are the connection of electrolytic condensers in series on the input side of the filter system and the use of parallel resistances in the 2A3 bias circuit.

In the 56 driver grid circuit it will be seen that the by-pass condenser C3, which provides an audio frequency grid return, and the blocking condenser C5, which serves as the a.f. plate return, are both connected to the cathode of the tube instead of the more usual earth return. This is done to prevent degenerative effects which reduce the low note amplification. The bias condenser C4 on the cathode resistor R5 is a 25 mfd. electrolytic condenser used simply because of the low impedance it offers to the passage of audio frequency currents. The advantage of this high capacity condenser over the more usual 1 or 2 mfd. paper dielectric types can best be appreciated whilst listening to the amplifier render the low note passages of the organ, the 'cello, the bass viol, and similar low pitched instruments.

A 2-Valve S.W. Headphone Set for Beginners



Rear view of the completed chassis, illustrating the filament transformer mounted on the left, with the screen grid detector valve alongside it.

Semi or completely A.C. operated, this little set is extremely powerful, with remarkable distance-getting qualities.

By G. G. THOMPSON

DESPITE the present trend to large and necessarily expensive all-wave superhets, it is recognised by short-wave experimenters that good results can still be obtained with more modest equipment.

Providing that the short-wave listener is prepared to use headphones a simple two-valver will provide excellent reception of the majority of international broadcasters.

This point settled, the next one for consideration is whether the set is to be powered by batteries or by rectified A.C. delivered from a power pack.

Battery supply has advantages, but, from the viewpoint of operation, an all-electric set is to be preferred.

In the design at present under consideration we have steered a middle course and provided for the use of valves whose filaments are lit by raw a.c., but whose plate supply may be furnished either by batteries or from a power pack.

The a.c. or semi a.c. short wave set described here uses a screened-grid detector resistance-capacity, coupled to an amplifier valve, this latter being of a high impedance type which will give greatest magnification of signals from the detector stage. Since, for earphone reception, very little power is required, volume is improved considerably by use of a high impedance type of amplifier valve which gives greatest voltage amplification, and which, due to the low power it is required to handle, will not distort telephony signals as might be thought.

The Variation in Coil Design

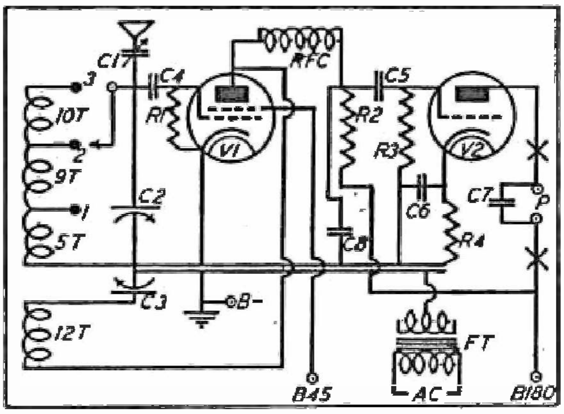
The idea of tapped coils is as old as short wave receivers are themselves, but because technicians have gone to great lengths to explain the "awful" result of "dead end" turns, we find no short wave receivers utilising this method of covering a wide band of frequencies without changing coils.

The writer decided to defy convention and use a tapped grid coil with a fixed reaction coil to cover a band of wave lengths of from 20 to 95 metres.

Firstly, separate coils were made, then a single grid coil of the total number of the grid turns of the three separate coils, and tapped in two places, was wound. After noting the strength of various signals using the single grid + reaction coil combinations, the tapped coil was plugged into position and a comparison made on all wave lengths.

It was found that using the 20 and 40 metre tapping the 'dead end' turns comprising the additional inductance to tune up to 95 metres, did not affect signals to any noticeable extent.

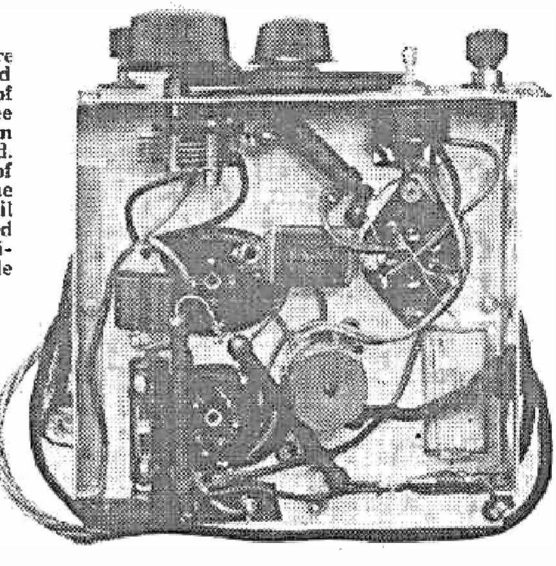
The reaction coil was made just large enough to enable the detector to be brought into oscillation when using the highest tapping and the tuning condenser plates full in mesh. By spacing the reaction coil correctly, smooth oscillation will be obtained over the whole range of wave lengths. Separate coils may be used, however, and the idea of using a tapped grid coil for short wave lengths is merely suggested to those who have been scared off this method by the thought that "dead end" turns may ruin a receiver's performance.



Circuit of the short wave receiver. Note how the grid coil is tapped in order to tune over various bands.

The writer can say with conviction that this little set will satisfy all who may attempt its construction, and provided speaker work is not required, extremely loud signals can be expected. Without noticeable loss of volume as many as half a dozen pairs of earphones may be connected in series to the receiver's terminals. The little set would be of particular value to Morse classes since good automatically sent signals such as are available from most commercial stations are an excellent pattern on which the learner might mould his sending.

When more than one pair of earphones are used an r.f. choke



A sub-chassis view, giving the arrangement of parts and the wiring.

should be connected in each lead to the receiver 'phone terminals as indicated by the points X. This, in conjunction with the .001 mfd capacity mica by-pass condenser connected in this position already, will prevent the complication of tuning due to the detuning effect of moving 'phone cords if this precaution is not taken.

Only Small Power Wanted

Since low voltage only is required for strong earphone reception, plate power consumption is only 5 milliamperes, which means that three 60 volt light duty B batteries of good make could be expected to give 12 months' service with this receiver. However, the two plate voltages of 45 and 180 may be obtained from a standard B power eliminator.

Heater current is available from the secondary of a step down transformer which delivers 4 volts from the a.c. mains. Although this transformer is mounted on the receiver chassis, it is preferable to keep the unit separate from the set unless the original measurements given here are increased to permit of greater spacing between the valves and the transformer. Closeness of the transformer unless it is heavily shielded with iron, may result in induction noises which no amount of filtering or by-passing will remove from the receiver output.

Parts Review in Brief

The metal panel and sub panel material may be treated to produce a neat dull surface appearance by dipping in a solution of hot caustic soda and water. Trial should be made with several scrap pieces of the metal to determine the correct time for treatment. This will only be a matter of seconds however.

Both tuning and reaction condensers should be selected carefully. There should be no trace of side play which would cause the movable plates to move sideways when the shaft is formed. A condenser suffering from this defect would complicate tuning considerably. Similarly, the vernier dial should be a smooth moving type with no traces of "backlash."

On no account should a mains switch be mounted to a metal receiver chassis. The heater switch is optional since switching may be done at the light or power outlet into which the primary wires of the step-down transformer are plugged.

A standard size three plate aerial coupling condenser (C1) will be satisfactory. A 5 plate midget type would also be suitable.

PARTS LIST

Panel 7in. x 7in. gauge 18 aluminium.

Sub panel and brackets 6in. x 7in., or a chassis measuring 2in. deep, gauge 20 material.

One 7 plate midget tuning condenser (C2).

One 9 plate midget reaction condenser (C3).

Slow motion vernier dial.

Heater switch (optional).

1 r.f. choke.

Grid condenser (mica) .00025 mfd capacity (C4).

Grid leak 2 megohms resistance (R1).

Detector plate resistance 250,000 ohms (R2).

3 plate aerial coupling condenser (C1).

Resistance coupling condenser .01 mfd. capacity (mica), C5.

Grid resistance 500,000 ohms (R3).

Amplifier bias resistance 1000 ohms (R4).

Amplifier resistance by-pass condenser, 1 mfd. (C6).

Two UY type valve sockets and one UX type valve socket.

Three battery terminals (B neg., B pos., 45v, B pos. 180v.).

Aerial terminal.

Two phone terminals.

Step down transformer (4 volt secondary to suit British valves of the 4 volt heater type) FT.

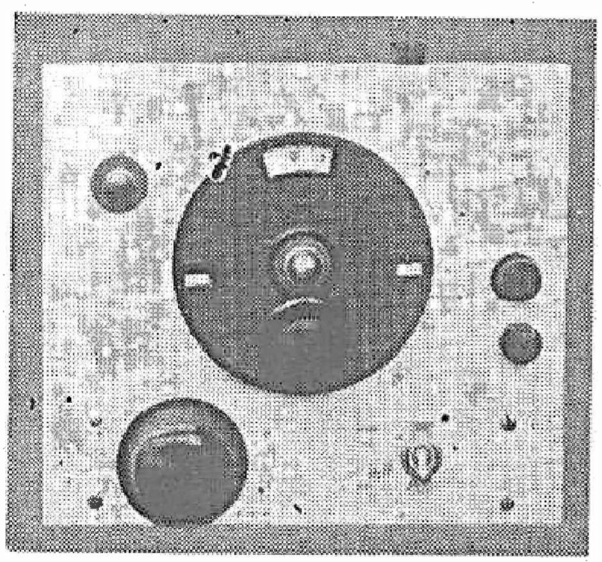
One .001 mfd capacity mica by-pass condenser (C7).

One .0001 mfd capacity mica condenser (C8).

Mounting the Parts

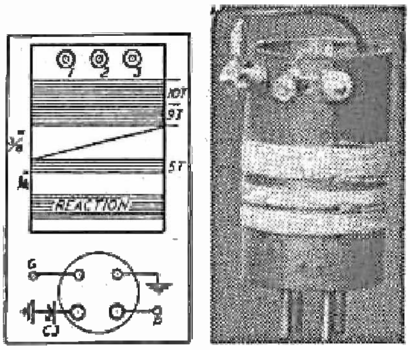
The tuning and reaction condensers are mounted directly to the metal panel. The aerial coupling condenser (C1) and the phone terminals must be bushed from the panel by use of fibre washers. The photograph of the underside of the original receiver will indicate that no particular order in the placement of components of this simple set need be followed.

It will be noted that a plate resistance value of 250,000 ohms has been obtained by connecting two resistances in series.



The U.X. valve socket takes the plug-in coil. It should therefore be of the moulded bakelite type with good spring clips in its construction. The coils are wound on a piece of bakelite former to slip over the end of the standard UX valve base.

Front view of the receiver, demonstrating the relative positions of the controls: Top left, the aerial condenser; bottom left, the reaction control; centre, tuning dial; while below is the switch, and at the extreme right, the two headphone terminals.



Left: A drawing showing how the coil should be wound, while on the right is a photograph of the finished job.

The reaction coil is wound at the bottom of the former of gauge 28 d.s.c. wire, its beginning connected to the filament pin directly (not diagonally) opposite the grid pin of the UX base. The end of the coil connected to the second F pin (directly opposite the plate pin of the base).

The first section of the grid coil consists of 5 turns of gauge 24 d.s.c. wire wound at a distance of between a ¼ and ½ an inch from the reaction coil. A ¼ inch space is left between the 5 turns section and the remaining 9 and 10 turn sections which are wound close together, tapping being brought to three terminals mounted at the top of the former. Connection from the grid pin to the required one of the three terminals is maintained by use of a small flex lead and spade type solder lug.

The beginning of the 5 turn section connects to the plate pin of the coil socket. The end of the grid coil and the two tappings at 5 and 14 turns connect separately to the three terminals. The aerial terminal and the two B positive terminals must be bushed from the chassis in the same fashion as the two headphone terminals.

A wiring in words description is scarcely necessary and the simple following of the circuit should enable anyone to make a successful job of the wiring. This should be done using rubbered flex. Use solder lugs for all joints to terminals or chassis.

The earth connected to the receiver can be made to the centre-tap terminal of the filament transformer secondary or to the B negative terminal.

After wiring has been checked and rechecked to make sure of correctness, switch on primary after having connected B terminals to either B battery or eliminator supply source.

Allowing a minute or two for the cathodes to commence their emission, turn reaction control until a rushing sound to indicate oscillation is heard.

On the first tapping which tunes from about 20 to 35 metres, very little noise will be noticeable, but on the two upper tappings the atmosphere becomes noisy under average unsettled weather conditions. Note whether the detector oscillates satisfactorily on all of the three tappings. If oscillation is fierce reduce screen voltage.

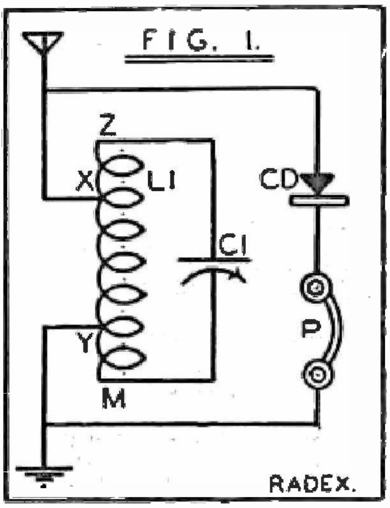
Depending upon the length of the aerial, one or more "dead spots" will be noted. These are points at which the detector will not oscillate. By turning the aerial condenser plates out of mesh this trouble may be avoided with a loss of signal strength and complication of tuning.

Page Eighteen ALL RADIO RECEIVERS

The Super Selective Crystal Receiver

A selective receiver that can be made super-selective by the optional employment of a built-in wave-trap.

By P. R. DUNSTONE



The basic circuit of the crystal set.

DESPITE the fact that they are rapidly being displaced by small valve receivers, the crystal set still has a considerable vogue amongst those who seek the cheapest form of receiver. One of the difficulties of the crystal receiver is its lack of inherent selectivity, so that users of such sets find it almost impossible to separate the various "B" class stations.

The receiver described here is presented in an endeavor to overcome this drawback and to permit the crystal set user to obtain the freedom from station interference enjoyed by his more fortunate valve-set-using colleagues.

The Circuit Design

The circuit design is a very simple and straightforward one, consisting of closed circuit formed by the coil L1 and condenser C1, this making a closed oscillatory path, with the detector, phones, aerial and earth directly coupled to it. In Fig. 3 the same circuit still exists, with an additional trap wired into the circuit. This is used to eliminate any tendency toward interference on the lower wave lengths.

For instance, the trap would hardly be required while tuning in 3LO or 3AR, as there is a fairly great frequency separation between these two stations, but with 3KZ and 3AW it probably would be essential.

The set has been arranged with two aerial terminals, one incorporating the trap, while the other is connected direct to L1.

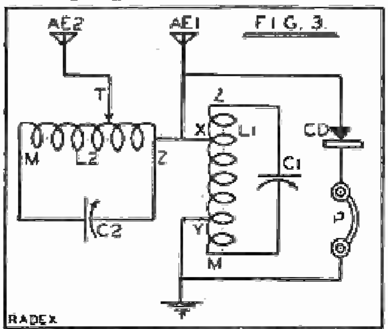
THE LIST OF COMPONENTS REQUIRED

2 .0005 mfd. variable condensers, C1, C2 and two dials.
1 crystal detector, CD.
2 pieces of former (see text).
3 terminals, 2 banana sockets and 1 plug.
Ebonite panel, 10½ x 7½ inches.
Strip of ebonite for terminals.
Some flex, 1 baseboard, 10 x 6 inches, and a few screws.

Winding the Coils

The coils L2 and L1 are wound on 2-inch and 3-inch formers respectively with gauge 26 D.C.C. wire. Commence winding coil L1 an inch from one end. The number of turns required are 48, with tappings at 17(X) and 31(Y).

The L2 coil should be wound with gauge 20 D.C.C. and requires 42 turns to be placed on it with tappings at every sixth turn from zero end. The ends of both these coils should be fastened to soldering lugs screwed to the formers.

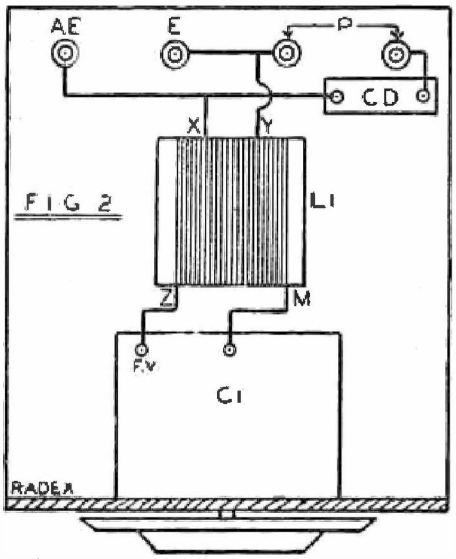


The original crystal hook-up combined with a built-in wave-trap. Normally the aerial is plugged to AE1. In cases of severe interference it is moved to AE2, thereby bringing the trap into operation.

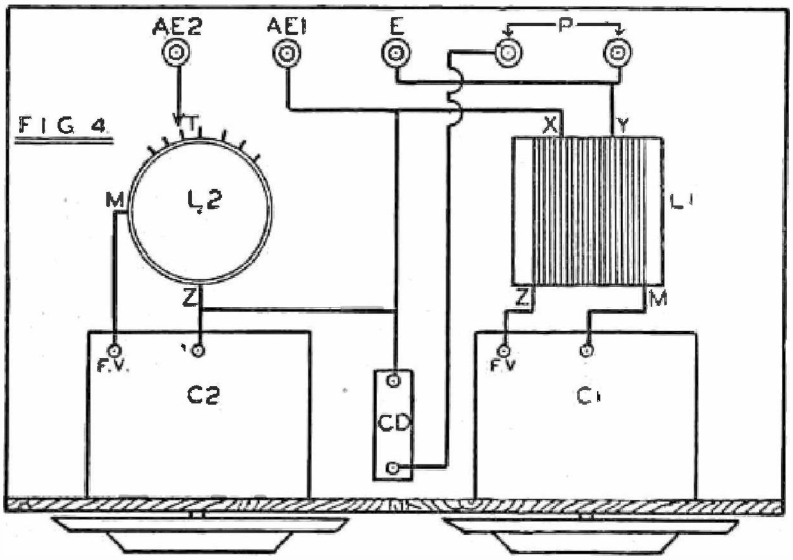
Mounting the Parts

In mounting the parts, the photographs of the original receiver should

(Continued on Page 21).



If circumstances obviate the use of a trap, the layout and wiring of the circuit shown in Fig. 1 are as depicted above.

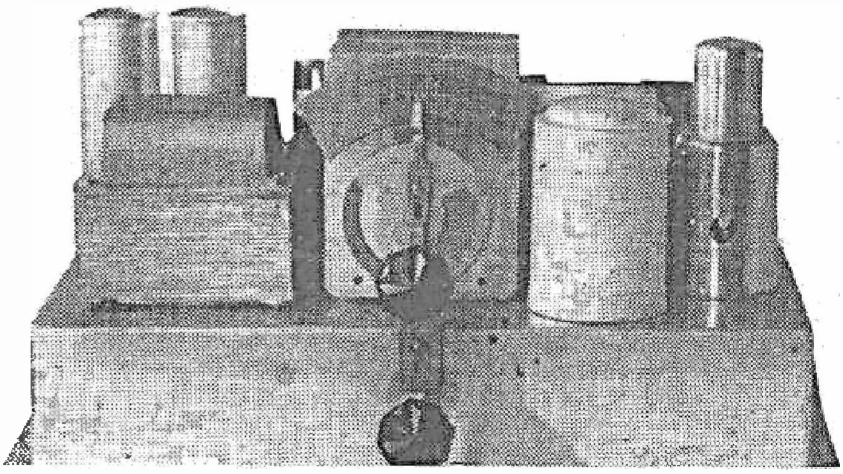


The complete plane view of the layout and wiring of the combined crystal set and wave-trap is shown above. Detector CD actually is mounted on the panel's front, but here its position is varied in order that its wiring may be clear.

The Ultimate A.C. Two

Employment of a dual purpose valve gives this model both punch and selectivity

By RADEX



Controls are limited to two: The upper one is the station selector, while below it is the volume regulator.

THE "Ultimate 2" is the best little a.c. "two" we have turned out to date. Here is the way to build up the design and prove for yourself the truth of our contentions.

Details of the Circuit Design

Regard the 6F7 in Fig. 1 carefully, because around it are built two tuned circuits. Working from its top as drawn are the r.f. plate, screen-grid and control grid. Aerial impulses are fed into the latter of these three through the agency of a tuned circuit composed of L2 and G1. The r.f. plates output feeds through primary L3 into another tuned circuit comprising L4 and 2G, the latter being the second section of the 2-gang condenser.

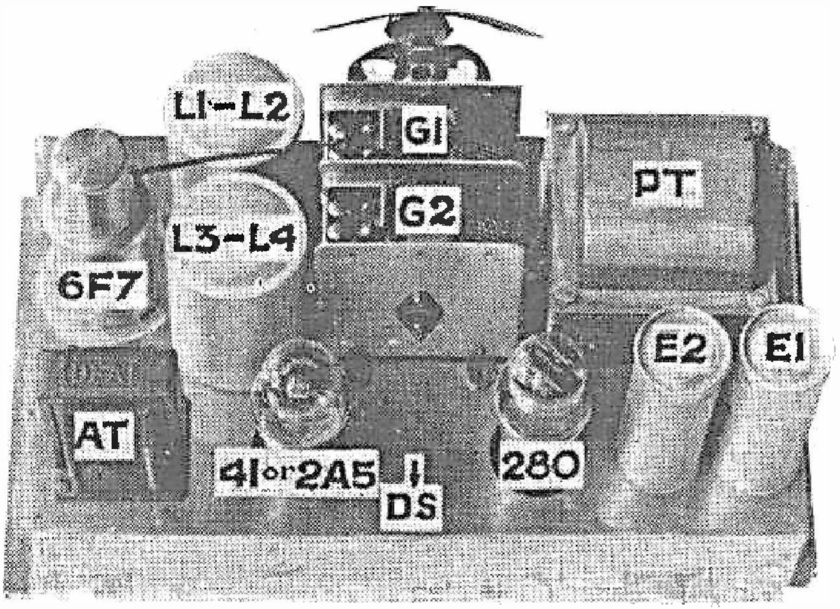
On the leaky-grid system (C3 being the grid condenser and R2 the leak) this second tuned circuit feeds back into the grid of the triode section of the 6F7 (the lower combination), and so actuates the triode plate thereof The latter is fed through the primary of audio transformer AT, and so, very obviously, actuates the control grid of the audio pentode. Nothing could very well be simpler provided the following salient points are rigorously followed:—

In the case of L1-L2, contained in the same can, primary L1 must be very loosely coupled to L2; the former should not exceed 10 per cent. of the turns of the latter, and there should be one-eighth inch (at least) gap between them. The reverse holds good as regards L3-L4. Here the former should be over-wound on the latter, and should contain at least 60 per cent. of its (L4's) turns.

R1 should not exceed a resistance value of 225 ohms. Neither should R2 be more than 500,000 ohms, but C3 must be 0.0001 mfd. The voltage applied to the screen of the 6F7 and also to its triode plate as feed through the audio transformer, should be 100 when measured at the appropriate tap on the voltage divider, VD. Both taking the same tap, one shunt condenser suffices, and that is C2.

Latitude is permissible with regard to the audio pentode, marked tentatively "2A5." Should you already have such a tube by all means use it, and, in that case, only one of your existing transformer's filament secondaries will have to be rewound to 6.3 volts for the 6F7. On the other hand, if you are building an entirely new set, order the power transformer, PT, to the specifications given in the list of parts, use a 41 as an output pentode, and heat both it and the 6F7 from the same 6.3 volt secondary. Either pentode employs the same resistance value at R3, although the undistorted output of the 41 is slightly the higher.

Do not forget that the most successful method of controlling volume is the shunting of audio transformer AT's secondary with a high resistance potentiometer. If a Bradleyohm is employed it does not need insulation from the chassis no matter how it is wired. C5 acts as an efficient tone corrector.



Compare these keyed components with the circuit diagram and list of parts.

Chassis Arrangements

THE accompanying keyed photo of the components' lay-out on top of the chassis affords a concise and easily followed plan. In general the dimensions of the chassis as given in the Parts List (13 by 7½ by 2½ inches) will afford ample room. Height and depth should remain under any circumstances, but were the power transformer PT very far from standard physical size, that factor might cause a variation in length.

Beneath the chassis, vide the corresponding photo, the only real fixtures are valve-sockets, the voltage divider on the extreme left, and the volume control in front. All other minor fitments are of the tailed variety and are soldered into position with the appropriate wiring.

Particularly note the placement of the valve-sockets in relation to their heater connections. These have been so arranged to keep heater-current leads either short or, in the case of the 6F7, as far from r.f. connections as possible. On the extreme lower left will be seen the small piece of ebonite, bolted to side of the chassis, that supports and insulates the aerial terminal.

The wiring order of the 7-pin, 6-pin and 4-pin sockets is shown IN REVERSE in the accompanying Fig. 2. This is how you will see them when wiring is

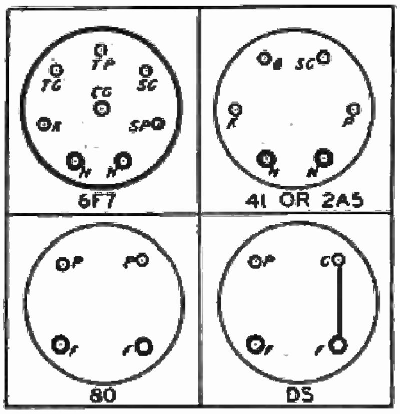


FIG. 2

When wiring refer to these socket-connection indicators. They show the sockets as seen when viewed from below the chassis.

undertaken. "DS" represents the socket let into the back of the chassis into which the speaker is plugged. "P" thereof is wired to the P terminal of the 6-pin (audio pentode) socket, the speaker's field goes across the two F's, while the jumper lead between G and the right-hand F is wired to the high voltage end of the voltage divider and also to SG of the afore-mentioned 6-pin socket.

Wiring Notes

FEW, if any, snags exist in the wiring. As usual, commence by joining up all heaters to the corresponding points on the power transformer and then take the high voltage secondary of the latter to PP of socket 80. Do not omit to earth to chassis one heater connection on both the 6 and 7-pin sockets and then put in the power smoothing system.

Next mount the voltage divider and connect up the four wires of the audio transformer to their appropriate points. The resistors and fixed condensers can

PARTS LIST

C1 and C2.—Tubular condensers of 0.5 mfd. (T.C.C., Chanex, Dubilier, Concourse).

C3.—Mica condenser of 0.001mfd. (T.C.C., Saxon, Wetless, ubilier).

C5.—Mica condenser of 0.006 mfd. (T.C.C., Saxon, Wetless, ubilier).

C4.—Dry electrolytic condenser of 10 or 25 mfd. to withstand 25 volts. (Concourse, T.C.C., Chanex).

DS.—Dynamic Speaker with 2500-ohm field and In-put transformer for either types 2A5 or 41 pentodes, the characteristics of both being practically similar. (Jensen, Jubilee, Saxon, Precedent, A.W.A., Amplion).

E1 and E2.—Electrolytic condensers of 8 mfd. each tested to 450 volts. (Polymet, Dubilier, T.C.C., Dulytic, Concourse, etc.).

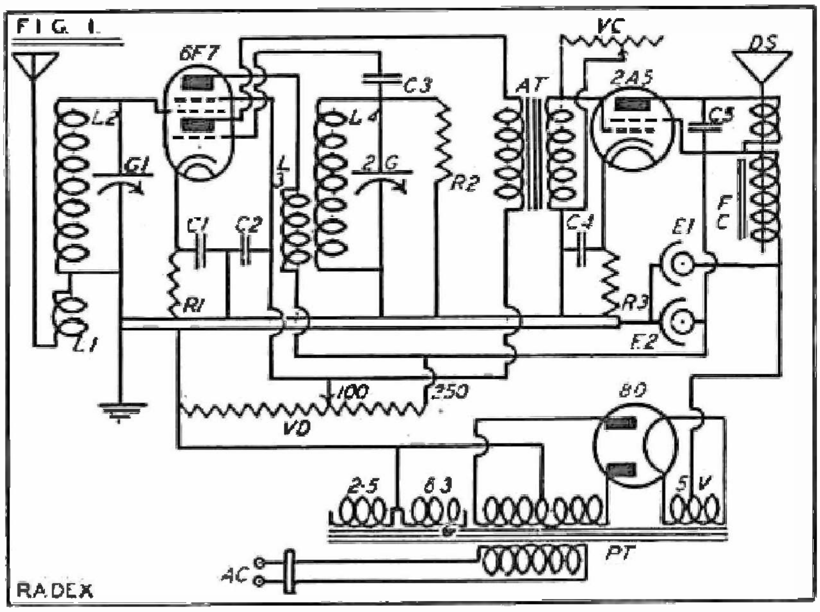
G1 and G2.—Dual gang tuning condenser of standard type. (Stromberg-Carlson, Saxon, Essanay, Raycophone, Airway, Precedent).

L1-L2.—Aerial-input tuning coil. (R.C.S., Essanay, Melbourne, Saxon, Aegis, Paramount). (Shielded, see text).

L3-L4.—Rf.-det. input tuning coil. R.C.S., Essanay, Melbourne, Saxon, Aegis, Paramount). (Shielded, see text).

PT. — Power transformer; main secondary 375-0-375 to 400-0-400, one at 5V. and SA.; one at 6.3V. and 2A., and one at 2.5V. and 2A. optional, vide text. (Radiokes, Saxon, Precedent, Velco, Essanay, Aegis, Wendel, Kelvin, etc.).

R1. — Wire-wound resistor 225 ohms., 15 M.a. (M.M., Velco, Radiokes, R.C.S., Saxon, Precedent, Paramount, Wendel).



The Theoretical Circuit of the Ultimate A.C. Two

R3. — Wire-wound resistor, 410 ohms, 50 M.a. (M.M., Velco, Radiokes, R.C.S., Saxon, Precedent, Paramount, Wendel).

R2. — One-watt G-L resistor 0.5 meg. (Carborundum, I.R.C., Saxon, Chanex-Silent, Stedipower, Ohmite).

T.—Standard ratio audio transformer—preferably manufacturers' type with pendant tails. (A.W.A., Radiokes, Ferranti, Essanay, Precedent, Formo, Velco).

VC. — Potentiometer of 250,000 ohms, volume control. (Bradleyohm).

VD.—Voltage divider, 15,000 ohms tapped. (Radiokes, Paramount, R.C.S., Precedent, Essanay, Saxon, Velco, M.M., Wendel).

Valves.—One each 6F7, 280, and either 2A5 or 41—see text re latter (Radiotron, Ken-Rad, Philips, Mullard, Tung-Sol, Speed-J.R.C.).

Sockets.—Two 4-pin and one each 7-pin and 6-pin. One complete valve shield and one grid-clip.

Sundries.—One illuminated vernier dial to track with movement of tuning condenser unit G1-G2; sundry machine screws and nuts, small; six yards Belden wire for connections and some twin-flex for connections to power-point. Small piece of scrap ebonite and two terminals.

Chassis.—Of No. 16 gauge aluminium bent and drilled as illustrated, measuring 13 x 7½ x 2¼ inches. (Geo. White).

now be fitted and the volume control wired, remembering to earth the latter's centre lug.

Now solder a lead to the UNDERNEATH lugs on the fixed vanes of the 2-gang tuning condenser and then mount it. Fit and connect up coils L3-L4 and L1-2 in that order. The top of L4 goes down to one end of C3 that is already soldered to TG of the 7-pin socket at its other end and the lead pendant already from 2G also goes through the chassis to the same point at the end of C3 (i.e., that NOT attached to TG).

The top of L2 connects to the lead already provided under G1. Fit the 6F7 in its socket and then connect its control grid pip (CG) to the TOP fixed plate connection of G1. Dial light leads, unless carefully placed, sometimes create a mysterious hum, so it is better not to put them in until after the model has had its initial test out.

General Operation

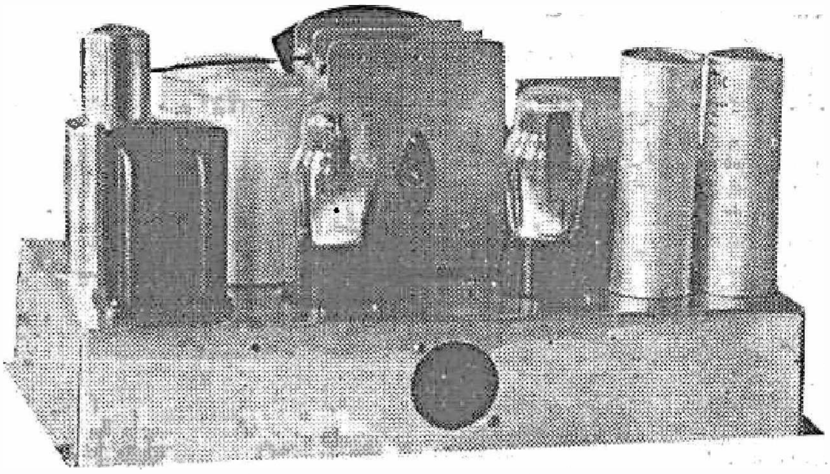
The best results were obtained by omitting the use of any aerial and merely connecting a good earth lead to the set's aerial terminal. Still, as pointed out previously, in very unfavorable receiving areas this might give rise to interference between two stations on closely allied wave-lengths. In the latter instance use a short indoor aerial and NO EARTH.

Ganging the condenser sections is a simple operation, section G1 being the more critical.

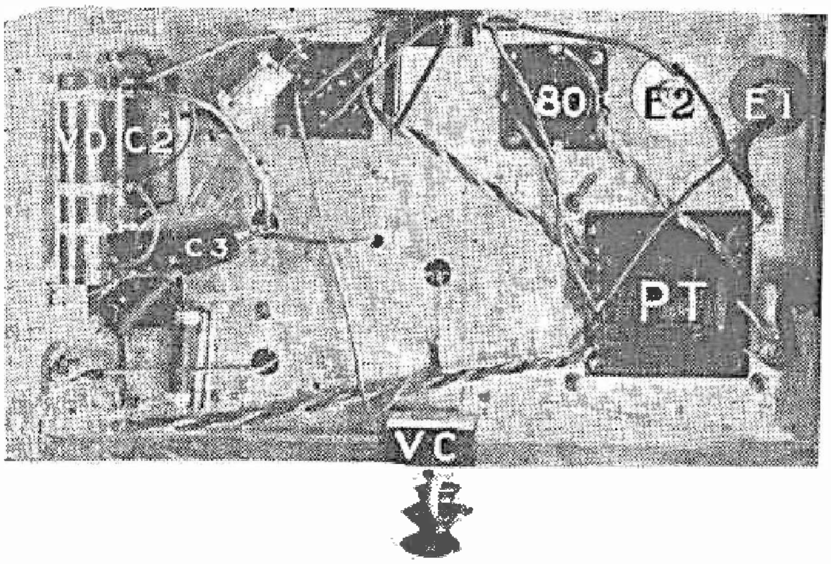
First see that the control VC is set to give maximum volume; that is to say, set its arm so that ALL its resistance is in circuit, and, if in doubt, slip the back off the Bradleyohm to make sure such a condition exists. Open BOTH trimmers about three-quarters of a turn and tune down toward the bottom end of the dial. As soon as a station is heard—and at first it may be weak—work on the trimmer of 2G until a maximum of volume is obtained. As the volume rises cut it back on VC, so that you are always working on a comparatively weak signal.

Unless this ganging, simple though it be, is done thoroughly, not only will you be liable to get unnecessary interference, but definite distortion will appear in the reproduction. The same latter condition will pertain if the volume is cut back too much. Both the 2A5 and the 41 like to be fairly well driven. If you change from an earth as an aerial to an aerial proper, or vice-versa, 2G will have to be re-ganged.

The dial coverage is all that can be desired. In the original model we employed a 2-gang Stromberg-Carlson condenser and R.C.S. coils. With that combination 3AW comes in at 11, while 3AR is heard on 92 dial degrees—the latter being an Effco of the type illustrated.



The rear of the chassis carries the dynamic speaker plug only.



There are few components beneath the chassis, and the wiring is both simple and open.

Super Selective Crystal Receiver

(Continued from Page 18)

be studied. It will be seen that the coils L1 and L2 are placed at right angles. This is most essential, otherwise interaction will be caused between them. The terminal strip should be located at the rear of the set.

The crystal detector can be either the fixed or cat's-whisker type, and is mounted a little above the two condensers C1 and C2.

Wiring

The wiring of this circuit is very simple, and should offer no difficulties to the novice.

Commence by taking a lead from M of L2 to one side of C2. The other side of C2 going to Z and also to aerial terminal 1. An alligator clip is soldered to a piece of flex about 3 inches long, the other end being joined to AE2. The clip is fastened to one of the tappings on L2, the correct point being found by experiment.

That completes the wiring of the trap circuit.

Connect the beginning of the coil L1 (Z) to one side of C1, the other side going to its M end.

Another lead is taken from AE1 to the tapping on the coil known as X. This lead is also joined to one side of the crystal detector CD, while the other side of CD is fastened to one of the phone terminals.

The remaining phone terminal is soldered to earth terminal and also to the remaining tap (Y) on coil L1. This completes the simple connections.

When trying out the receiver plug the aerial into AE1 socket, connect the earth and phones, adjust the crystal and rotate dial C1 until a station is heard, then readjust crystal to its point of greatest sensitivity.

If interference is being experienced on the lower bands, the aerial should be inserted in AE2 socket and C2 adjusted until the offending station is eliminated.

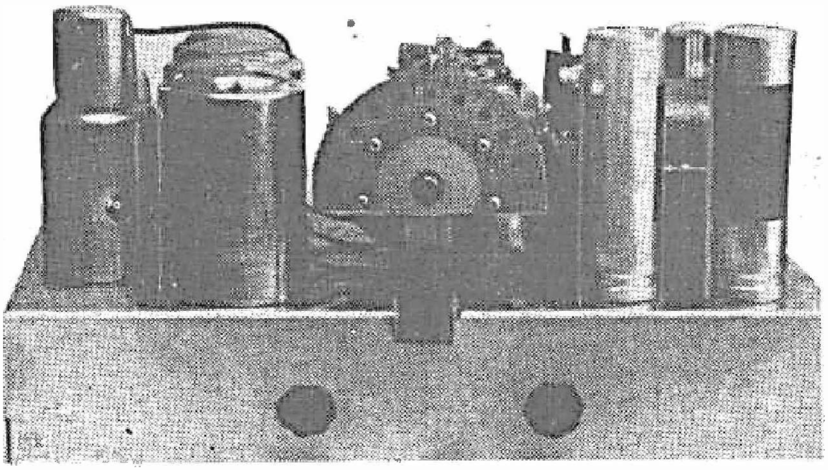
The length of the aerial used on this crystal receiver should not exceed 60 feet for satisfactory results.

The Band-Pass Local 3/4

A Selective and Powerful Receiver With Interstate Possibilities

By A. K. BOX

EVEN in these days of super-sensitive receivers, which make the reception of international broadcasting stations so simple a matter that the non-technical set user can obtain good results, there is a demand for a simple type of set which is capable of reproducing the local broadcasts with clarity of tone and freedom from interference. This is mainly due to the fact that, except for a few dyed-in-the-wool enthusiasts, the pastime of 'D.X.' long-distance listening has palled, and the main requirement is high quality reception free from that accompaniment of high-powered static which is complementary to the 'opening out' of a really sensitive receiver.



This front view of the chassis illustrates its compact construction.

Apart from the question of tone quality, which is fairly easily arranged to satisfy the most critical listener, the chief requirement of the local receiver is selectivity, the capability of separating stations which operate on frequencies separated by only a few kilocycles.

Practical Applications

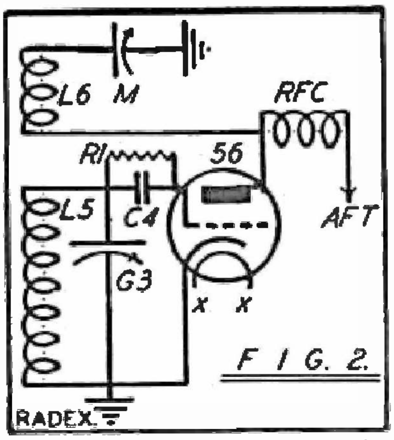
There are two ways in which this desirable feature can be obtained. Either the super-heterodyne principle, in which the incoming signal frequency is mixed with a locally generated frequency to make a third, or the standard multi-tuned circuit system can be used. Both methods are extremely satisfactory, but, where range is not desired, the best type of receiver to build is one which employs ordinary radio frequency amplification and obtains its selectivity by means of circuits tuned to the receiving frequency. For one thing, it is simpler and cheaper to build than the average small superhet, and it is less susceptible to outside noises, such as static and electrical interference.

Recent tests with a receiver of the type mentioned have proved it to be very suitable for use in the metropolitan area, where selectivity is of greater importance than sensitivity. The particular receiver used was one in which a standard 58 radio frequency amplifier preceded a non-regenerative three-element detector which in turn was transformer coupled to a pentode audio amplifier. The necessary selectivity was obtained by the use of a pre-selector stage before the R.F. tuner, with the result that it was possible definitely to separate the various stations even in the most unfavorable localities.

The 56 type of detector was used, because experience has proved that, when transformer coupled to the audio amplifier, this type of detector is capable of a gain equal to that of a resistance coupled screen grid detector besides having a better tone. Further, if in order to increase the sensitivity of the receiver, it is decided to add regeneration, this addition will be more easily carried out.

Notes on the Circuit

Study of the circuit diagram will show that while due attention has been paid to the by-passing of vulnerable supply leads, the number of components used in the receiver has been reduced to a minimum. For the reason that its added current drain increases the field coil excitation on the loud speaker, a voltage divider, VD, has been included instead of the more common series resistor scheme for dropping the supply voltage. Use of this divider is made in the volume control arrangement, which consists of a 10,000 ohm potentiometer connected between the 40 volt positive tap on the divider and ground. The arm terminal on the potentiometer is connected to the cathode of the r.f. valve through a limiting resistance, R4, of 250 ohms. The purpose of this resistance is to ensure that there is always the minimum bias of three volts on the r.f. valve, irrespective of the position of the arm of the potentiometer VC.



Additional details for applying reaction to this receiver.

The condenser, C1, connected between the cathode of the 58 and ground, provides an r.f. by-pass for the resistor R4, and that portion of VC which may happen to be in use. The condenser C3, which is of 1 mfd capacity, was not used in the original receiver, although it may be incorporated in the set with advantage. It acts as an r.f. by-pass and in practice will be found to increase the gain of the r.f. stage. The by-pass C5, which is also of 1 mfd., acts likewise in the audio section of the receiver, deepening the tone and improving the volume. C6 is a standard 10 mfd. 25 volt electrolytic condenser, and R2 is a resistance of 400 ohms. This actually should have a value of 410 ohms, but the small discrepancy will not materially affect the performance of the pentode.

The condenser C7 and the resistor R3 are connected in series between the plate and screening grid of the pentode with the object of flattening the tube's response and cutting down some of the high note amplification which makes the average pentode so "tinny." The audio transformer AFT may be any standard ratio instrument, although, naturally, the better the transformer the better will be the tone of the receiver.

Coil Data

The coils were of standrad Velco make, consisting of an aerial coil (L1, L2), a pre-selector coil L3, and an r.f. coil L4-L5. For the benefit of those who may wish to wind their own coils, the following data is provided. All coils are wound on Marquis 1¼ inch diameter formers. They are screened with 2½-inch diameter cans.

L2 consists of 88 turns of 34 gauge enamel wire, over the filament end of which is wound the aerial winding, L1, of 15 turns of 40 gauge d.s.c. wire tapped at the 10th turn from the bottom of the winding. L3 consists of 90 turns of 34 gauge enamel wire with a separation of 3-16th of an inch and a further six turns. The finish of L3 and the start of the additional six-turn winding are joined together, and, in wiring the set, are connected to earth. L5 will have the same number of turns as L3, whilst L4 will consist of 45 turns of 40 gauge d.s.c. wire wound over the filament end of L5.

Although this coil data has been included, we advise the intending set builder to purchase the coils already wound, as he then need have no qualms about the alignment of the gang condenser when once the set is assembled.

The General Lay-out

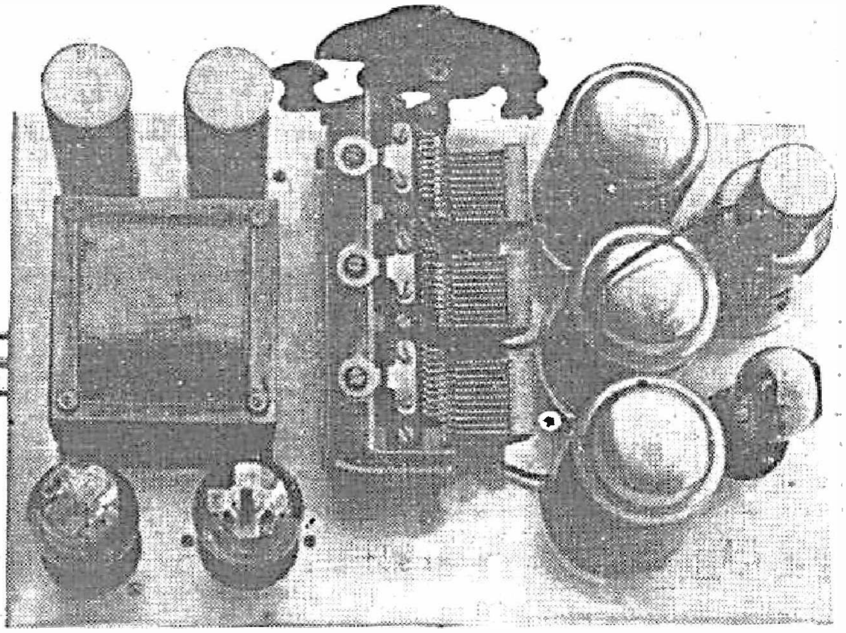
The chassis on which the various components are mounted measures 14 inches in length, nine inches in width, and 2½ inches in depth. As can be seen from pictures of the finished set, this chassis size gives the constructor plenty of room to mount the components and yet permits a compact and efficient lay-out.

Looking at the top view of the chassis the aerial coil in its shield can be seen at the front right of the thereof. Next to this coil is the pre-selector coil, the detector coil being the third. The 58 is mounted at the extreme right of the chassis between the aerial and the pre-selector coil cans. The detector is mounted in a corresponding position between the pre-selector and detector coil cans.

At the left we have, at the front of the chassis, the two electrolytic condensers, E1, E2. The power transformer is mounted between the electrolytics and the rectifier and power tubes which are at the back. The three-gang condenser is mounted in the middle of the chassis. The three-pin power plug is mounted along the left-hand edge of the chassis, the four-pin socket for the loud speaker plug being mounted in the centre of the back of the chassis. The aerial and earth connections are made to terminal strip mounted at the right of the loud speaker socket.

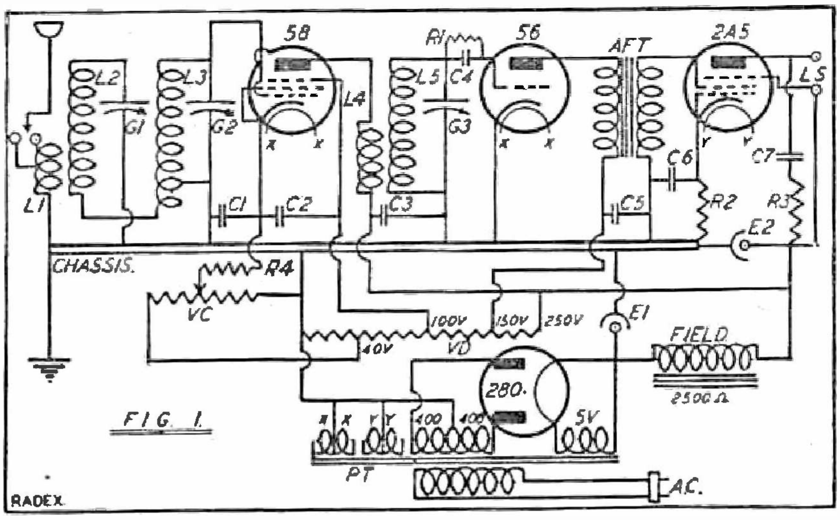
Underneath the chassis we find that, in addition to the valve sockets, the power transformer, and the electrolytic condensers (the connections of which are made under the chassis), we have the voltage divider VD mounted alongside the power transformer, the audio transformer AFT mounted a little in front of the loud speaker plug, and the bias resistor R2 and electrolytic condenser C6 mounted alongside the socket of the 2A5.

Other components include the condenser block, C2, C3 and C5, mounted between the audio transformer and the front of the chassis, the volume con-



A photograph of the top of the chassis illustrating the placement of the three-gang tuning condenser, coils and valve sockets, etc.

CIRCUIT AND LIST OF COMPONENTS



Schematic circuit of the Band-Pass Local 3/4

The Parts Required

1 Kit of Coils (L1, L2, L3, L4, L5) (Velco, Aegis, Radiokes, R.C.S.)

1 Three Gang Tuning Condenser (G1, G2, G3). (Stromberg-Carlson, Saxon, Essanay, Raycophone).

2 Six-pin Valve Sockets; 1 5-pin Valve Socket; 1 4-pin Valve Socket, (Targan, Marquis, Velco, Precedent).

1 15,000 Ohm Voltage Divider (VD). (Master Made, Radiokes, R.C.S., Velco, Saxon, Precedent.)

1 Power Transformer, 400-0-400, 5 v., and two 2.5 v. Windings. (Velco, Kelvin, Radiokes, Wendel, Saxon).

1 2500 Ohm Field Type Dynamic Speaker to match 2A5 valve. (Rola, Jubilee, Amplion, Saxon, Precedent).

1 Audio Transformer (A.F.T.). (Lissen, Philips, A.W.A., Ferranti).

2 8 mfd. 450 volt Electrolytic Condensers (E1, E2). (Polymet, T.C.C., Dulytic, Concourse.)

1 10,000 ohm Potentiometer (VC). (Marquis, Radiokes, Saxon).

1 .00025 mfd. Grid Condenser (C4). (T.C.C., Wetless).

1 .006 mfd. Fixed Condenser (C7). (T.C.C., Wetless).

2 1 mf Fixed Condensers, 300 volts working (C3, C5). (Chanex, Hydra, T.C.C., Concourse).

1 .5 mfd. Fixed Condenser, 300 volts working (C2). (Chanex, Hydra, T.C.C., Concourse).

1 .1 mfd. Fixed Condenser, 300 volts working (C1). (Chanex, Hydra, T.C.C., Concourse).

1 10 mfd. 25 volt working Electrolytic Condenser (C6). (Dulytic, T.C.C., Concourse).

1 250 ohm Resistor, 10 m.a. (R4). (Master Made, Radiokes, Velco, Saxon, R.C.S., Wendel, Paramount).

1 400 ohm Resistor, 50 m.a. (R2). (Master Made, Radiokes, Velco, Saxon, R.C.S., Wendel, Paramount).

1 2 megohm 1 watt type Resistor (R1). (I.R.C., Bradleyohm, Velco, Chanex, Ohmite).

1 10,000 ohm 1 watt type Resistor (R3). (I.R.C., Bradleyohm, Velco, Chanex, Ohmite.)

1 58 Valve; one 56 Valve; one 2A5 Valve; one 80 Valve.—(Radiotron, Kenrad, Philips, Mullard, Speed-J.R.C.).

1 Metal Chassis, 14 inches by 9 inches by 2½ inches. (Geo. White and Co.)

1 Illuminated Vernier Dial. (Efco, Radiokes, Raycophone, Saxon).

trol VC and the a.c. power switch. Both the latter are mounted on the front of the chassis.

Point to Point Wiring

The wiring is best begun by starting from the power pack end and leaving the r.f. and a.f. connections until last.

Begin by connecting the centre solder lug of the a.c. supply strip to the O lug on the primary of the power transformer. The 200 volt lug on the transformer is connected to the right-hand solder lug on the voltage strip, the remaining lug of which is connected to the 230 volt lug on the transformer.

Now connect one of the high voltage secondary lugs to the P lug on the 280 rectifier socket. The G lug is connected to the other high voltage lug. The centre tap lug on the high voltage winding is connected to the chassis, as is the centre tap lug on each of the 2.5 volt filament windings. One lug on the five volt filament winding is connected to one of the F lugs on the 280 socket, the other F lug on this socket being connected to the remaining 5 volt lug, to the positive terminal on the electrolytic condenser E1, and to the lug on the loud speaker socket to which one of the field coil leads later will be connected.

A pair of twisted leads is run from the 2.5 volt 5 ampere winding Y to the F terminals on the 2A5 socket. A similar pair of twisted leads connects the 2.5 volt 10 ampere filament winding X to the F terminals on the 58 and 56 sockets. Another pair of leads from these filament lugs is taken up through the chassis to the dial light if any.

Now from the lug on the loud speaker socket which is to carry the second field lead take a wire to the positive terminal of the second electrolytic condenser E2, to the positive end of the voltage divider VD, and to the lug on the loud speaker socket which is to carry one of the loud speaker voice coil leads. The other end of the voltage divider VD is connected to the chassis.

Complete the wiring of the 2A5 socket by connecting the electrolytic condenser C6 and the 400 ohm resistance R2 in parallel with each other and hooking the negative end of C6 to the nearest convenient earthing point. The positive end of C6 is connected to the C lug on the 2A5 socket. The G lug on the 2A5 socket is connected to the G terminal on the audio transformer AFT. The P lug on the socket is connected to the vacant voice coil lug on the loud speaker socket. The screening grid lug on the 2A5 socket is connected to that voice coil lug on the loud speaker socket to which already is connected the positive end of the voltage divider VD.

The .006 mfd. condenser C7 is connected in series with the 10,000 ohm resistor R3 and the vacant lug on C7 is connected to the P lug on the 2A5 socket. The remaining lead on R3 is connected to the screen grid lug on the same socket. The C minus terminal on AFT is connected to the chassis. The P terminal on AFT is connected to the P lug on the socket of the 56. The B plus terminal on AFT is connected to one lug on the one mfd. condenser C5 and to a point about 2½ inches down from the positive end of the voltage divider. The other lug on C5 is connected to the chassis. The C lug on the 56 socket is connected to the chassis.

The screen grid lug on the 58 socket is connected to a point about two inches up from the negative end of the voltage divider VD and to one lug of the .5 mfd. condenser C2. The other lug on C2 is connected to the C lug on the 58 socket.

One lead of the .1 mfd. condenser C1 is connected to the C lug on the 58 socket, as is one lead of the 250 ohm resistance R4. The other lead on this resistance is connected to the arm terminal of the potentiometer R4. One of the outside terminals on R4 is connected to the chassis, whilst the other is connected to a point about 1½ inches from the negative end of the voltage divider VD.

The other lead on C1 is connected to the chassis. Having completed this stage of the wiring, we now may turn our attention to the connection of the tuning coils and gang condenser.

One of the aerial terminals is connected to the top end of L1, whilst the other aerial terminal is connected to the tap on the coil. The other end of L1 is connected to ground. The top end of L2 is connected to the fixed plate lug on the front section of the gang condenser, whilst the bottom end is connected to the bottom end of L3.

The top end of L3 is connected to the fixed plate lug on the middle section of the gang condenser, whilst the tap point (junction between the main and the small windings) is connected to the chassis. From the top end of L3 a lead also is taken to the grid pip on the top of the 58. The P lug on the socket of the 58 is connected to the top end of L4. The bottom end of this coil is connected to one lug on the 1 mfd. condenser C3 and to the full positive end of the voltage divider VD. The other lug on C3 is connected to ground.

The top end of L5 is connected to one lug on the grid condenser C4, the other lug of which is soldered to the G lug on the 56 socket. The grid leak R1 is connected in parallel with this condenser. Another lead from the top end of L4 is taken to the fixed plate lug on the third section of the gang condenser. This completes the wiring of the receiver, and after the set has been allowed to run for a short period, to warm the valves up properly, we may set about aligning the gang condenser.

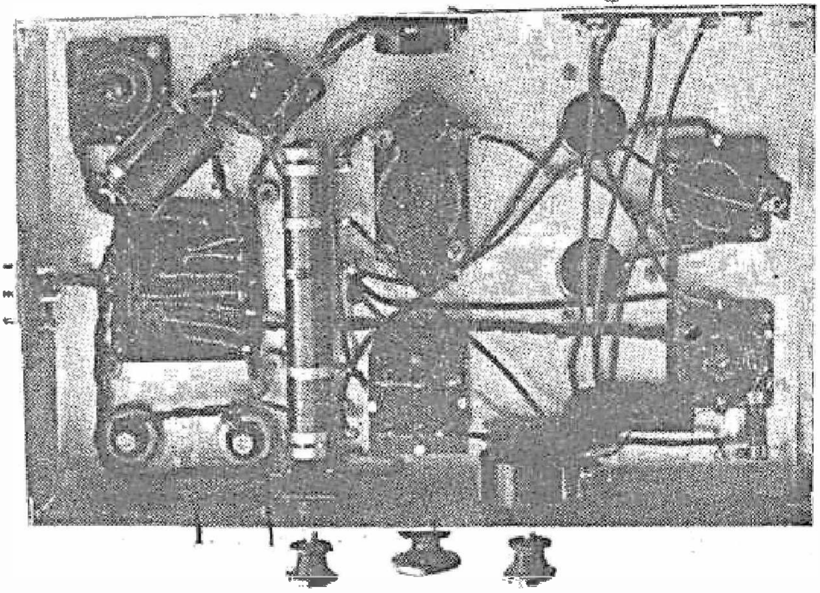
Lining Up the Trimmers

Assuming that the condenser is o.k. start the alignment of the tuner on the high frequency end of the tuning band. In the case of this particular receiver use a short aerial, say about 15 or 20 feet of wire around a picture rail, and tune in 3AW. When the station is tuned in to maximum volume try adjusting the trimmer on the detector section of the gang to improve the strength. A fraction of a turn either way will usually have a considerable effect. With the greatest volume adjustment of the detector stage trimmer and with the set still tuned to 3AW, repeat the procedure with the trimmers on the r.f. and aerial stages in turn.

Increasing Sensitivity

In Fig. 2 will be found schematic details which cover the addition of reaction to the detector valve. While it was not found necessary to use reaction in order to obtain sufficient volume from the original receiver, there is always the possibility that the set constructor may wish to increase the range of the receiver sufficiently to bring in the Interstate stations. The necessary alterations are few, and consist of an additional winding on the coil former which carries L4 and L5, the installation of a 23-plate midget condenser (M), and the connection of a radio frequency choke coil between the plate of the 56 detector and the P terminal on the audio transformer, AFT.

The additional winding, L6, may consist of 20 turns of 40-gauge d.s.c. wire wound in the same direction as L5, and mounted on the top end of the former about quarter of an inch away from L5. The end of the winding nearest to L5 is connected to the P lug on the 56 socket, and the other end goes to the fixed plate terminal of the midget condenser

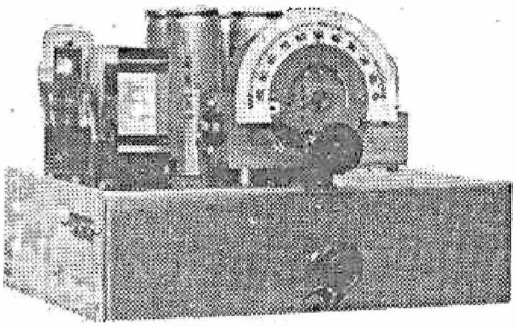


An underneath view will give the builder a good idea of the layout of various components

THE JUNIOR "AIR-RAIDER"

A Simple A.C. All Wave Receiver For The Novice

By C. A. CULLINAN



A front view of this interesting baby "all-waver."

AMONGST the many technical articles in "All Receivers" will be found several descriptions of "all wave" super-heterodynes. This type of receiver represents the latest trend in modern set design, and is capable of remarkable short wave reception.

On the broadcast band it is also a superlative performer showing that the addition of the all wave equipment has not, in any way, impaired its use as a broadcast receiver.

Because of the number of valves employed it is rather a complex receiver to build unless one has had a fair amount of experience in large set building. Furthermore the cost of making it may be excessive to some whose tastes and pockets do not run to large sets.

For these reasons the Air-Raider Junior receiver was designed. It is modest in cost and very simple to build, whilst its performance is fine.

Like its big brothers, it is an all-wave receiver, which means that it can be used for broadcast reception of the local stations as well as receiving the programmes of oversea short wave stations.

Plug-in coils are employed for the reason that this is the most efficient system. In a super-heterodyne receiver the loss occasioned by using a less efficient coil system is usually counteracted by having higher gain in the I.F. system, but in a receiver such as this, where the actual signal is applied to the detector valve, only the most efficient coil system can be considered.

A standard broadcast single gang variable condenser is used for tuning. The capacity of this would be too large for short wave work, so it is reduced by automatically connecting a fixed condenser of 0.0025 mfd. in series with it, when a short wave coil is plugged in.

In the power pack a standard transformer is used, but the filtering system is different from the usual in that a double section filter is employed with plenty of capacity to ensure adequate filtering. For this reason the set should be used with a permanent magnet type dynamic speaker.

Coil Turns and Wave Ranges

Wound on Marquis Ribbed Formers, 1¼in. diam.

Wave band.	L1.	Wire	Space	L2.	Wire.	Space.	L3.	Wire.
19-30	3	22 d.s.c	¼in.	6½	22 d.s.c.	⅛	5	30 d.s.c.
29-50	4	22 d.s.c	¼in.	10	22 d.s.c.	⅛	8	30 d.s.c.
46-80	8	22 d.s.c.	¼in.	14	22 d.s.c.	3-16	11	30 d.s.c.
Broadcast	10	30 d.s.c.	¼in.	115	30 d.s.c	¼	20	30 d.s.c.

No spacing between turns in any windings.

Point to Point Wiring

In wiring the receiver the greatest care should be taken in soldering the various joints, as a single bad connection can produce noises that are very hard to find.

The wiring should be started at the power transformer by connecting the primary leads to the voltage plugs at the back of the chassis.

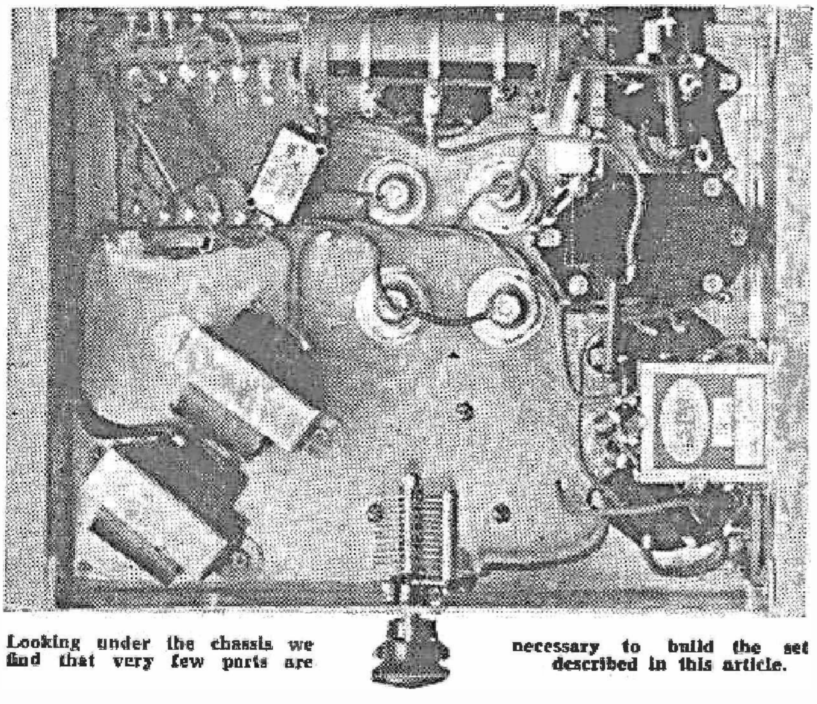
From the two outside 5-volt connections on the power transformer run leads to the filament pins of the rectifier socket (V3). Follow with two leads from the outside H.T. connections on the P.T. to the grid and plate pins of V3. Twist each pair of wires together. Join together the centre taps of both 2.5 volt windings and the H.T., and run this connection to a convenient soldering attached to the chassis.

Connect one side of the 0.01 mfd. condensers, C11, C12, to the chassis and the remaining lug on each to one high voltage side of the H.T. secondary so that any stray radio frequency currents which may be present will be effectively bypassed.

Take a twisted pair of wires and join together one of the 2.5 volt windings on the transformer to the heater-pins on the audio socket, V2, and repeat the operation with the other 2.5 volt winding and the detector socket, V1.

From the 5-volt centre tap connection run a lead to one side of the choke CH1. Join together the remaining lug on choke CH1, and the first lug on choke CH2.

The electrolytic condensers are wired by joining the centre lug of condenser C10 to the rectifier filament winding centre top (5-volt). The lugs on condensers C8 and C9 are linked together and then joined to the connection between the two-power chokes. The remaining condenser, C7, goes to the un-



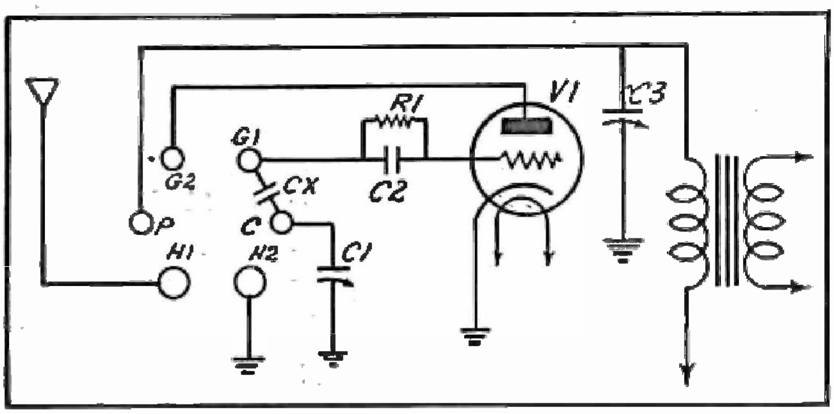
Looking under the chassis we find that very few parts are necessary to build the set described in this article.

connected lug on choke CH2, and to the nearest end of the voltage divider, R5.

The filter thus consists of the chokes CH1 and CH2, with a condenser input of 8 mfd., intermediate capacity of 16 mfd., and an output capacity of 8mfd., which effectively removes all hum from the set.

Earth the free end of the voltage divider.

The audio socket, V2, is the next to receive attention. The grid pin and the grid connection on the audio transformer are joined together, and the plate pin of the speaker socket is wired to the plate pin of V2. The grid pin of the speaker socket is then linked to the screen grid of V2. The tone corrector, comprising condenser C5 and resistor R3, is fitted by joining these two components in series and wiring them across the two speaker pins.



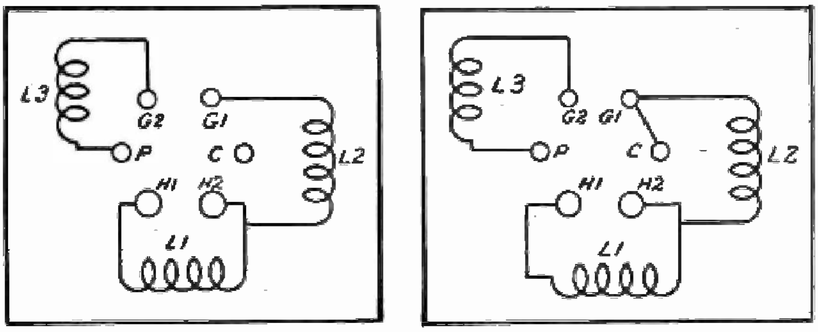
A schematic diagram of the wiring of the coil socket.

Coil Socket Wiring

Bias for the output valve is obtained by the voltage drop across a 450 ohm resistor in the cathode circuit. This resistor is connected across the 25 mfd. electrolytic condenser C6, and the combination wired to the cathode of the 2A5 (V2) socket and the chassis. Care should be taken to see that the positive of the electrolytic condenser is joined to the cathode. Earth the free end of the audio frequency transformer (AFT) secondary.

To the screen grid connection on the audio socket connect a lead which terminates at the junction of the two electrolytic condensers, C8, C9.

Now wire the detector valve socket and the coil socket.



The wiring connections to the pins of the plug in-coils. Left, the short wave coils, and, right, the broadcast coil.

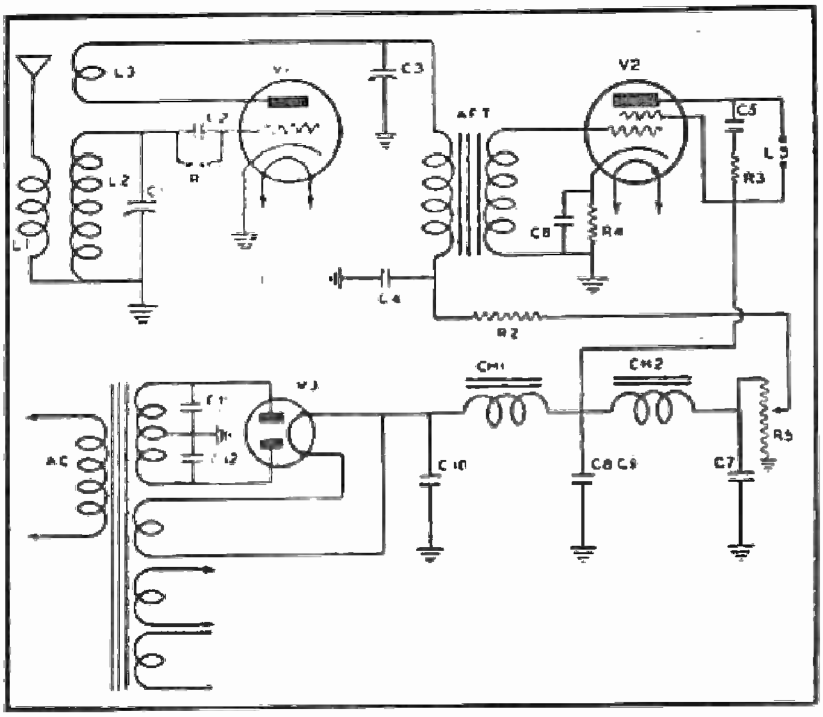
The aerial strip contains three terminals. The one nearest the grid of the socket, V1, is connected directly to the grid (for gramophone pick-up use). The middle one is joined to the H1 lug on the coil socket, and the other is earthed to the chassis. Coil socket lug H2 is also earthed.

The fixed condenser, CX, 0.00025 mfd, has its lugs bent, and is fastened directly to the cathode and G1 lugs of the coil socket. The cathode lug also is wired to the stator plate lug of the variable condenser, C1.

The grid condenser, C2, is fastened directly to the G1 lug of the coil socket and the grid lug of the detector socket. The 5 megohm grid leak is then connected across this condenser, C2.

The G2 lug on the coil socket is joined to the plate lug of the socket V1 and the P coil socket lug to the stator of the midget condenser, C3, and the P terminal of the audio transformer.

The 2 mfd condenser, C4, is fitted into place and one lug wired to the B plus terminal of the audio transformer. A resistor, R2, 15,000 ohms, also is connected to this lug with its other side going to one of the clips on the voltage divider (about 60 volts). Earth the other side of the 2 mfd. condenser. The cathode of the detector socket should then be earthed to complete the wiring.



The schematic circuit of the two-valve all-wave receiver, which should be studied in conjunction with the coil socket wiring diagram.

Coil Winding Details

The diagrams show the connections to both the coil formers and the coil socket from the underneath, and it is important to remember this when connecting the wires to the coil former pins.

In all cases, the reaction coil, L3, is the first to be put on since it is at the bottom of the former.

Drill a 1-16th hole at the bottom of the former, and in line with the G2 pin. Insert the end of the wire and commence to wind on the required turns. When completed, drill another hole in line with the P pin on the former and secure the end of the wire.

For the secondary, L2, measure up the former the specified distance and drill a hole opposite the H2 pin. Wind on the required turns and pass the end through a hole opposite the G1 pin.

The start of the aerial coil, L1, is made opposite the H2 pin, and finished opposite the H1 pin.

(Continued on Page 47)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By RADEX

A Super-Heterodyne four/five valve receiver specially designed to operate with valves of the 4-volt series, and employing a screened-grid diode-triode second detector.

WITH so many super-heterodynes available, either described in these pages, or already on the market, in commercial form another might, at first sight, appear almost superfluous. Against this it must be pointed out that the constant arrivals of new types of tubes necessitate sundry modifications and elaborations of the basic circuits in which they are designed to work.

It is generally believed that certain equine quadrupeds have improved acceleration when asked to display their abilities in particular arenas. The same applies to valves. For example, suppose you own a super-het. in which a 224 is the autodyne detector, and you wish to alter it to a 57. Theoretically the only other change necessary is an alteration in the value of the bias; actually the results will be infinitely better if the constants of the oscillator coil are changed too. Any wireless receiver depends upon its weakest, or least sympathetic, link. And so, while new valves continue to be evolved, new or modified circuits will have to be published in order to give full force to repeated constructional improvements.

Special to Golden

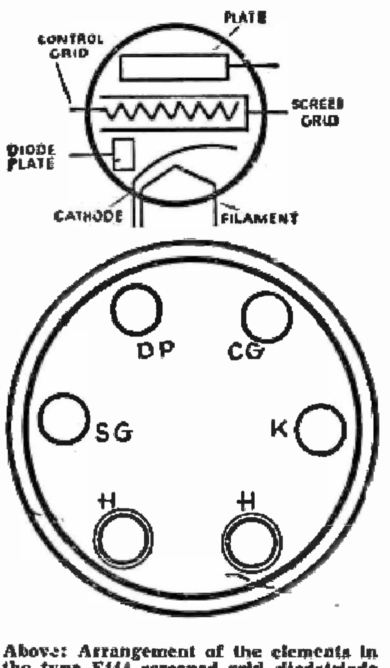
In the Gilded Melbourne Super we deal exclusively with a.c. valves of the 4-volt series and they, naturally, require special treatment in order that they may give of their best. In the original, as pictured on these pages, the Philips Golden Series was employed.

The remarkable feature of The Gilded Super is its intense quietness in operation, i.e., its low noise level. It is no exaggeration to say that I have not previously handled a 4/5-valve super that is so free from parasitic sounds. This is, of course, attributable to the valves.

Its performance is definitely good. Tone and quality are really beyond reproach. Range is all that could be desired. The separation is excellent as the following evidences will show.

Tested in Essendon, under the shadow of 3LO and 3AR, 5CK was absolutely clear of the latter station, while there were three or four degrees between the former and 2BL. Sydney—2CH had no background of 3DB, and three stations (4BH, 2GN and 3GL) came in between 3KZ and 3AW.

The only major station upon which any signs of interference were noted was 2GB, behind which there was a moderate background of 3UZ. However, the former's signals were so strong that this was only perceptible between items.



Above: Arrangement of the elements in the type E444 screened-grid diodetriode second detector. Below: The tube's socket connections viewed from below.

Circuit Details

Treating with the actual valves tried in the original, the E452T (V1) is a screened grid tube that functions as an autodyne first detector in the conventional manner, while the E455 (V2) is of the variable-Mu type, by means of which quality the volume is controlled, and operates as the intermediate frequency amplifier.

For the second detector binode E444 (V3) is employed. This is a screened grid diode, the control grid of which affords an audio lift, and it is much more sensitive, and more capable of a reasonable delivery, than is the common double diode. It feeds the power output pentode E443H (V4) adequately, and the result is sufficient to load up any ordinary 8-inch dynamic speaker. The cascade is completed by a 1561 (V5), a 4-volt filament rectifier.

Repeated tests prove that, for all usual circumstances, one tuned circuit is a sufficiently selective input to the first detector. This is formed by the combination of the secondary coil AER and G1,

THE CIRCUIT AND ITS COMPONENTS

A.C.—In-put power plug 200/230 volts.
C1.—Mica condenser of 0.0015 mfd.
C4, C8.—Mica condensers of 0.01 mfd.
C5.—Mica condenser of 0.00025 mfd.
} T.C.C., Wetless.

C2, C3, C10.—Tubular condensers of 0.1 mfd.
C6, C7, C7A, C9.—Tubular condensers of 0.5 mfd.
} T.C.C., Chanex Dubilier.

E1, E2.—Electrolytic condensers of 8 mfd, 500 volts. Concourse, Dulytic, T.C.C., Polymet, Dubilier.

G1, G2.—Two-gang variable condenser of 0.00043 mfd. Essanay, Stromberg-Carlson, Precedent, Airway.

Kit.—Super-het kit 465 k.c., comprising tapped aerial coil (AER), oscillator coil (OSC), two intermediate frequency transformers (IF.1, IF.2) and padder condenser. Melbourne, Radiokes Midget, Stromberg-Carlson, R.C.S., Paramount.

L.S.—Dynamic speaker with 2500-ohm field with in-put matched to pentode E443H or the like, corresponds to 47. Jensen, Rola, Precedent, Saxon, Jubilee, Amplion.

PT.—Power transformer FOR FOUR VOLT VALVES: Tapped primary, main secondary 400-0-400 volts, and three 4-volt filament secondaries. Radiokes, Hilco, Velco, Aegis, Wendel.

R1, R5.—Wire-wound resistors of 400 ohms to pass 7.5 m.a.
R2.—Wire-wound resistor of 400 ohms to pass 15 m.a.
R11.—Centre - tap filament resistor, 20/30 ohms.
R12.—Wire-wound resistor of 250 ohms to pass 100 m.a.
} Stedipower, R.C.S., Radiokes, Master-Made, Wetless, Velco, Wendel, Precedent.

R3.—Resistor 2 megohms
R4.—Resistor 1 megohm
R6, R8.—Resistors 250,000 ohms
R7.—Resistor 10,000 ohms
R9.—Resistor 500,000 ohms
R10.—Resistor 100,000 ohms
} All power grid-leak types, Carborundum, Silent-Answer, Radiokes, Bradley, I.R.C. Ohmite.

TC.—Tone Control, 10,000 orm potentiometer
VC.—Volume control, 2500 ohm potentiometer
} Marquis, Radiokes, M.M.

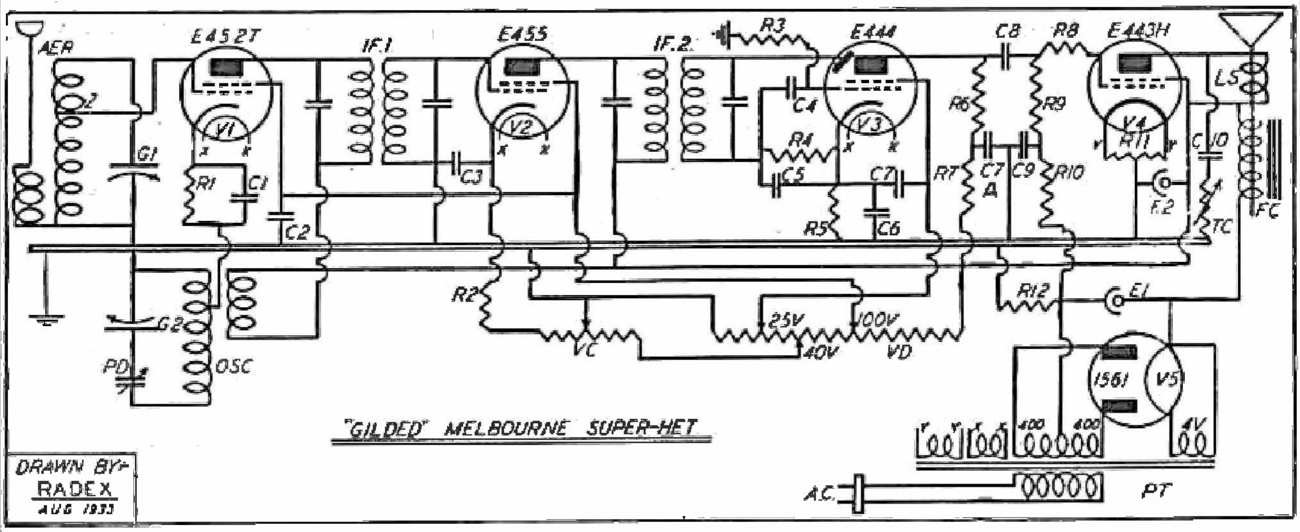
VD.—Voltage divider of 15,000 ohms. Radiokes, Kelvin, Velco, R.C.S., Wetless, Peerless, M.M. Stedipower.

Dial.—Full vision. Radiokes, Aegis, Efco, Raycophone.

Valves.—One each, E452T, E455, E444, E443H and 1561—Philips. Or equivalents by Cossor, Mullard or Osram.

Chassis of pressed steel or aluminium measuring 17 by 9 by 3 inches.

Sundries.—3 5-pin sockets, 2 4-pin sockets, and 1 6-pinner, machine screws, terminals, wire.



Complete circuit of the Gilded Melbourne Super.

which is the first section of a 2-gang variable condenser. However, a marked improvement is achieved by feeding the grid of V1 from a tap, Z, which is taken out one-third from the top of the secondary.

It can be suggested, with truth, that this is a "loser" method, but the subsequent amplification of the circuit is so great that drop of volume is imperceptible, while the gain in selectivity is tremendous. The kit we used had this tap provided, but any home builder can easily apply it to any type of aerial coupling coil.

The makers of the valves used in this design (Philips) suggested to us that, as regards the oscillator circuit, the best results would be obtained by placing the pick-up (the smaller coil of OSC) in the cathode lead, and wiring the closed circuit (comprising G2, PD and the larger coil) in series, with the primary of intermediate frequency transformer, IF.1. We tried this and then tested out the arrangement shown, which is exactly the reverse. On the air our method proved far the better of the two, and so, in spite of the maker's advice, we have no hesitation in recommending it here.

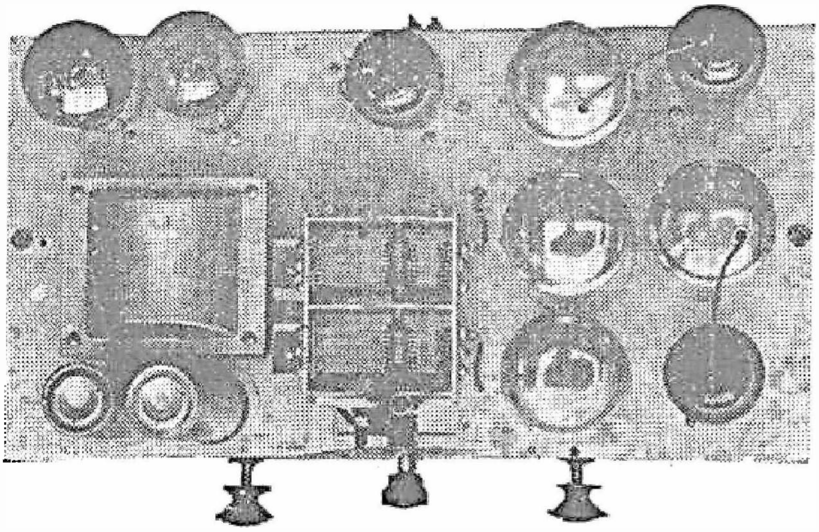
The Oscillator Circuit

We found that, with the aperiodic cathode system, bias resistor R1 became extremely critical and that line-voltage fluctuation (to which everyone is subjected to some extent) was apt to produce dead-spots so far as oscillation was concerned. With the method shown neither of these snags appeared. R1, though naturally critical, is not superlatively so, and the autodyne V1 functions easily and steadily.

It will be noted that the complete outfit calls for the use of only a 2-gang condenser, and four coils (including the two intermediates). Thus, as against a pre-selector circuit, we save one coil and a third section of the ganged condenser. In these days of desirable economy this is a big consideration.

There is no point in taking up space here with a detailed description of the operations involved with binode E444. Suffice it to say that there are no difficulties to be overcome with it, and that its base connections are illustrated here for the benefit of those who have not handled it previously. The only thing at all critical about it is its screen voltage; on the diagram this is shown as 25 (vide VD), but this should be varied initially between 20 and 30 volts until the best output is achieved.

The binode is coupled to pentode E443H (V4) on the resistance-capacity method, and is very fully de-coupled by means of resistors R7 and R10 and condensers C7 and C9. A further precaution lies in suppressor resistor R8; this latter is not absolutely essential, but it is highly

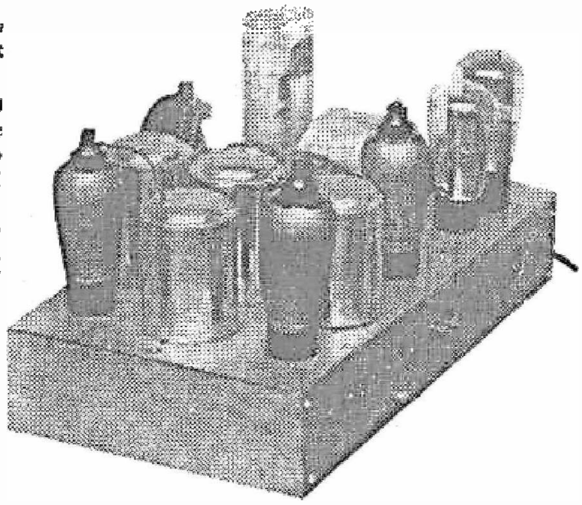


A bird's-eye view of the Gilded chassis. Right and left of the ganged condenser are the volume and tone controls respectively.

beneficial, and the few pence involved make it well worth while.

The combination of C10 and TC clears up the "highs" that are natural to pentode reproduction. If desired TC can be a fixed resistor of 10,000 ohms; we prefer, however, to use a variable potentiometer of the same value and to employ it as an adjustable tone control. R12 provides the bias for V4, and hence electrolytic E1 must be insulated from the chassis.

The only variation from standard in the power-pack is that all filament windings on the transformer PT must give 4 volts. The actual filament consumption is low, YY having to carry 1.1, XX 3, and the rectifier winding; 2, all amperes. It is desirable that XX should be centre-tapped; if it is not then it must be shunted with a centre-tapped filament resistor similar to R11.



A rear view of the chassis, the valve in the foreground being the E455, or intermediate frequency amplifier. The speaker's socket is on the extreme right below the E443H.

Notes on the Parts

The Melbourne Kit, specially made for us by Colonial Radio, and obtainable by that name from most radio dealers, proved entirely satisfactory, and its markings are sufficiently clear to preclude possibility of error in connections. Special tap Z was provided thereon, and extra attention was paid to the constants of the oscillator unit. The intermediaries are standard at 465 k.c.

Bias Condensor C1 is definitely critical in value, and variations from that given will cause worry. In general, values of 0.0015 mfd. can be obtained without trouble, but in cases when they are not available, C1 can be made up by wiring a .001 and a .0005 mfd. in parallel.

Mica Condensers should be used wherever they are specified. Some extra response would be achieved were C8 larger than 0.01 mfd. but, if a higher value is used, it must be either of the mica type, or else be absolutely proof against leakage.

Tubular Condensers are specified at other points because of the ease with which they can be hooked into the wiring. However, this does not mean that the older "bloc" types cannot be employed.

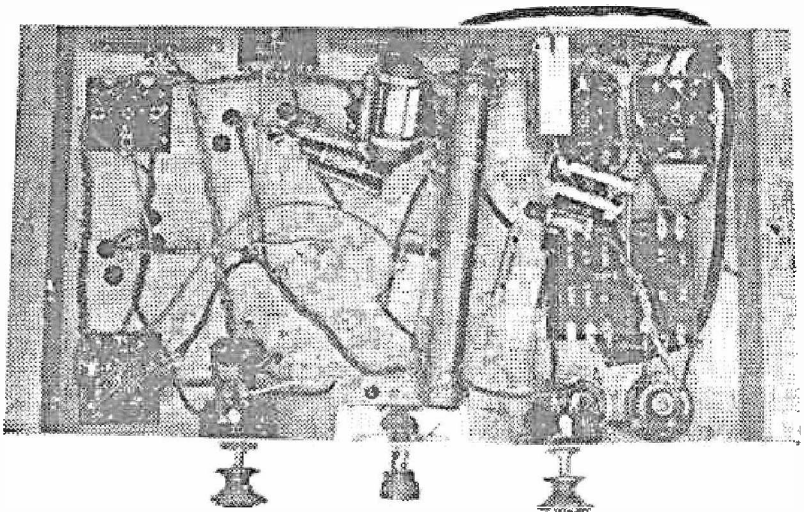
Electrolytics E1 and E2 should be tested to withstand 500 volts. When purchasing them be sure that an insulating mounting washer is included for E1.

Dynamic Speakers, now that they are almost wholly manufactured in Australia, offer a wide choice. The plate impedance of the E443H is so near to that of an American 47 that an in-put transformer already matched to the latter will suit the former admirably. A field resistance of 2500 ohms is essential.

Power Transformer PT's characteristics have already been dealt with. While a power secondary of 400 volts a side is desirable for the supply of full voltage to all tubes, one with 385 volts a side will do. In this respect, builders may be confused by the maker's incomplete specification regarding the plate voltages for valves V1 and V2, which is listed at 200. Actually this applies to straight-out impedance or parallel feeds; on the system employed here it is permissible to supply each plate with a full 250 volts.

Wire-wound Resistors should have the current carrying capacities assigned to them.

Other Resistors should be either color-coded or marked with their values in figures. Without such precautions it is so easy to become confused, to your ultimate sorrow when the set refuses to function properly. All are important in that if they are of poor quality the production will be spoiled by crackles that only complete replacement will eradicate.



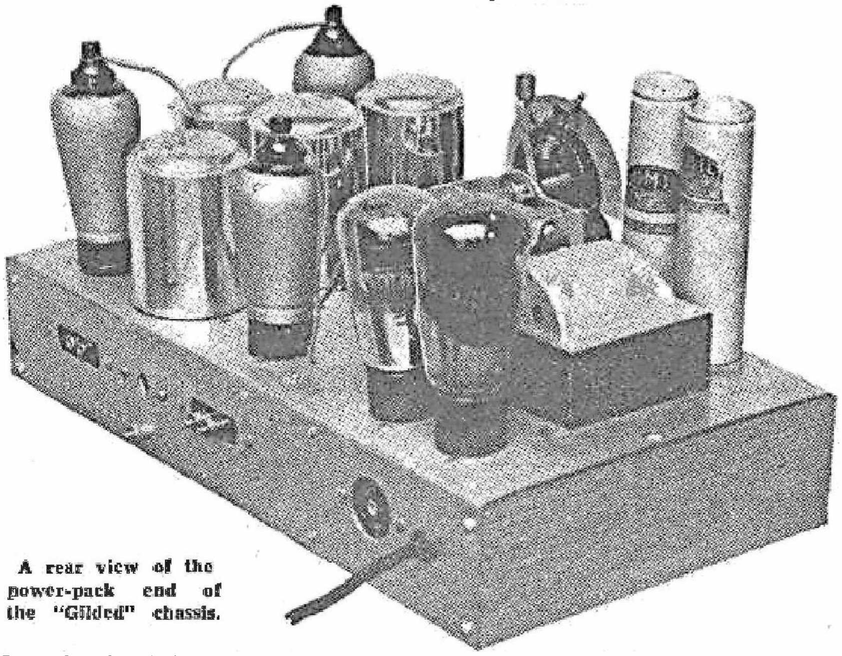
The view of the chassis from underneath gives an impression of the arrangement of the subsidiary components, the under side of the power transformer being on the right.

Advt. of Philips Lamps (A/sia), Ltd. (Radio Dept.), 590 Bourke Street, Melbourne. 4R2

Lay-out Pointers

Although the dimensions of the chassis are given as 17 by 9 by 3 inches, an inspection of the photo will show that this is not all metal. Actually it is made from a sheet of steel measuring 17 by 15 inches, three inches at both extremities of the 15-inch dimension being bent down at right-angles. The ends are then filled in with ¾-inch thick pieces of wood measuring just under 9 by 3 inches.

The top view shows that the components can be laid out without cramping. On the extreme right, and running back in a row, are the E452T, intermediate transformer IF.1 and the E455 in that order. The next row comprises the aerial coil AER, oscillator coil OSC and intermediate IF.2. The padder is let into the back of the chassis just below the last of that three.



A rear view of the power-pack end of the "Gilded" chassis.

Immediately behind the 2-gang condenser (but not too close to it) is binode E444 with its 6-pin base, and to its left are the E443H and rectifier 1561. The placement of the electrolytics and the power transformer is obvious.

Particular attention is directed to the fact that the connections on top of valves V1, V2 and V3 are all to their PLATES. Looking at the sockets of V1 and V2 from the underneath first select the two heater connections, the ones with the large holes. Continue now in clockwise order and you have screen-grid, control grid and cathode. In the case of V4, and going in the same order from the large filament-pin holes, the connections are:—Plate, control grid and screen-grid. The socket wiring of the E444 is illustrated on these pages.

These variations in grid and plate connections naturally mean that PLATE LEADS are the ones that must protrude from the cans of the intermediate frequency transformers, while grid leads will go down, through the chassis, to the associated sockets. The grid-lead from IF.2 is taken to the diode plate point on the 6-pin socket of the E444. Leads do not come out of the tops of the cans for AER and OSC.

Having arranged all these placements and provided the necessary holes (not forgetting one through the chassis for the plate lead to the cap of V3), it will be found that the other minor components will fit in during the course of the wiring. The exception to this is, of course, voltage divider VD, for the fitment of which screw holes should be provided. As wired it is not necessary to insulate either volume control VC or tone control TC from the chassis.

Wiring Notes

In connecting up the heater circuits, which will be your first step in building, allot one 4-volt secondary to the exclusive use of the E443H V4.

Observe that the centre tap of the 400-volt secondary is NOT earthed. Instead it goes to the insulated negative (can) of electrolytic E1 and to the same point are connected ends of resistors R10 and R12, the other end of the latter being earthed.

Field coil FC of the speaker is also the smoothing choke, one end being connected (at the 4-pin socket into which it fits) to both the positive of E1 and the filament of V5 (rectifier). The other end of FC is then taken to one side of the speaker's transformer, the screen of V4, the positive of E2 and then to VD and the general 250-volt supply points.

The intermediate frequency transformers' connections, being all lettered plainly, present no difficulties. The only snag lies in B of IF.1. This does not go directly to full B plus, but to the TOP end of the over-wound small coil of OSC and then the bottom of that same coil does go to full B plus. The TOP of the larger OSC coil is taken to the padder, whose other side returns to the fixed plates of G2.

Again, "F" of IF.2 is NOT earthed (as is the corresponding point on IF.1 transformer), but connects to the binode's network consisting of C4, C5 and R4. Note also that shunt condenser C7 is not directly earthed either; instead it is taken back directly to the cathode of V3.

Operating Hints

Before connecting up the speaker check over its 4-pin plug to see that its wiring corresponds with yours to the associated UX socket. The latter should have been wired with the field (choke) across the filament contacts and the speaker's input transformer across G and P. This is standard, but it may save you a lot of trouble if you satisfy yourself that the maker has followed the same system.

For the results described at the beginning of this article an indoor aerial with a total length of around 20ft. was used, and its response was satisfactory. As already stated, the tests were made under about the worst possible conceivable conditions. If you are away from the shadow of a transmitter there is no reason why a reasonable outdoor aerial should not be employed with naturally enhanced signal volume and range.

ALTERNATIVE VALVE CHART

Valve	Phillips	Cosser	Mullard	Osram
V1	E452H	MSG/HA	S4VV	MS4B
V2	E455	MVSG	VM4V	VMS4
V3	E444	—	—	—
V4	E443H	MP/PEN	PM24M	P425
V5	1561	442BU	DU2	U9

Lining up the condensers is, with only a 2-gang unit, an extremely simple operation. Set tone control TC with all its resistance in circuit. After the valves have had time to warm up (say, between 30 and 45 seconds), cut resistance out of volume control VC until there is a very, very fair plop or something in the tone of the speaker's slight hiss that seems to indicate a change in quality, and then reverse the direction of motion until the normal sound resumes.

Screw both the gang's trimmers full down, and then open them about a quarter of their travel. Screw down the padder and open it again one full turn.

Search for a local station low down on the dial (below 3DB), and, as soon as a faint programme comes through, adjust the padder on G1 for maximum volume. As this rises, keep on cutting it back with VC, so that you are always adjusting on a comparatively weak signal.

When a maximum has been reached at the low end of the dial, turn to the top end (at least 3AR) and similarly adjust the padder. In this case, however, after each small re-setting you must remove the driver from the padder's screw or you will get false results.

By now everything should be in order, and it only remains for you to make a final adjustment at night on some weak (but steady) distant station. Should you find, when this has been completed, that you just cannot reach up to 2CO it will be necessary to screw both trimmers down more and go over the lining up again.

Conversely, should you be unable to get down to 3AK, the reverse will hold good; i.e., open both trimmers and repeat the balancing operation. In any case, as stated above, having only two variables to worry about, lining up is a much simplified operation. This is one of the reasons, among many others, why we can recommend this easy circuit to those who have not previously built a super-heterodyne receiver.

The reduction of the amount of resistance in circuit in TC will lower the tone. However, when "searching" have TC "all in", as at that setting the whole receiver is in a more receptive condition.

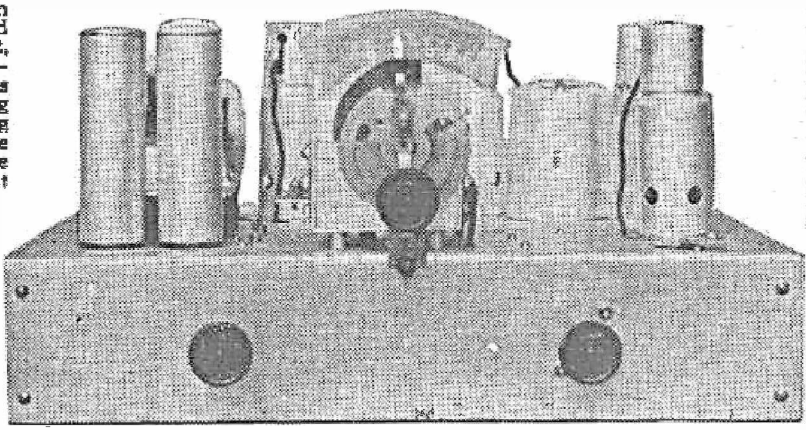
Air-Raider All-Wave Super-Het.

Full constructional details of an outstanding receiver which operates on both broadcast & short wave lengths

By A. K. BOX

ON broadcast wave lengths the cardinal feature of the super-het is its selectivity, although its distance-getting ability also is an attraction to those who wish to "step out" for their radio programmes. On short waves, because of its freedom from the tricky tuning adjustments encountered with a t.r.f. receiver, which employs a regenerative detector, the super-het has an outstanding advantage for the radio novice.

When we combine a dual range coverage with the above - mentioned features of a super-het, we have virtually a deluxe receiver which is capable of a surprising performance on both long and short waves. The inclusion of a suitable switching arrangement overcomes the necessity for the coil changing which in the past has made the operation of short wave receivers more a penance than a pleasure for the average listener, whilst the use of the super-het principle permits the designer more or less to overlook the efficiency of the input tuning system.



A front view of the completed set, showing, at the right, the wave band changing switch, the main tuning dial (centre), and volume control (left).

The receiver we propose to describe has been on the test bench for several weeks. Its evolution has been gradual, and has been attended by considerable difficulties. These have not been in the form of trouble in making the set work—it has been difficult to stop it working—but have been brought about by our aim to produce a really simple receiver which can be duplicated by the average radio set builder and experimenter. Originally it was intended to use a radio frequency stage before the modulator, but experience showed that such a stage unduly complicated the construction of the set and did not give sufficient improvement in performance to warrant the extra constructional trouble.

Interesting Details of Design

The first point of interest in the receiver is the use of the 6.3 volt filament type tubes. The reason for their inclusion is: (1) Robustness of construction; (2) freedom from microphonic troubles; and (3) high efficiency. A glance at the circuit diagram will show that a 6A7 tube is used as the combined oscillator modulator, a pair of 78's as the two intermediate frequency amplifiers, a 6B7 diode pentode as combined second detector tube, first audio amplifier, and automatic volume control tube, and a 41 power pentode as the output valve. The set is powered from a standard 80 rectifier.

An examination of the circuit will show that if we eliminate such items as the coil switching arrangement, the r.f. chokes, and possibly the A.V.C. circuit, we have a perfectly standard broadcast superhet. With this as a basis, it can be realised that the construction of the all-wave receiver has been reduced to its absolutely simplest form.

The wave range of the receiver on short waves lies between 19 and 80 metres, the broadcast band coverage being the usual 1500 to 545 k.c. (200 to 550 metres). The short wave range is divided into two sections—19 to 31 metres, and 31 to 80 metres. This means that there are only three switch settings to be used on the wave changing switch.

Again, looking at the schematic circuit diagram, it will be seen that the aerial and modulator grid coils and the oscillator grid and plate coils all are changed for the various wave bands. At No. 3 position on the wave change switch, the broadcast band, the aerial is fed into a coupling coil. On the two short wave bands the aerial is fed to the grid end of the modulator grid coil through a .0001mfd. fixed condenser.

The oscillator circuit used is the conventional 2A7-6A7 circuit, in which the supply voltage for the oscillator plate is reduced by means of a 25,000 ohm Resistor. Likewise the screen potentials for the 6A7 and the two 78's are obtained through a voltage divided system, consisting of a 15,000 ohm and a 25,000 ohm resistor connected in series between B maximum and earth.

One of the features of the design of this receiver is the use of two intermediate frequency amplifying stages. The first of these stages makes use, between the output of the 6A7 and the input of the first 78, of a high gain sharply tuned transformer. The succeeding i.f. transformers are neither so efficient nor so sharply tuned, but, nevertheless, give an extraordinarily high boost to the output signal from the modulator.

Circuit Filtration

Because of the high overall gain of the i.f. amplifier, and the possibility of trouble when receiving on the high frequency bands, it was decided to filter the plate circuits of the modulator and i.f. amplifiers by means of radio frequency chokes. Each of these chokes is bypassed on its high r.f. potential side with a .1 mfd. fixed condenser.

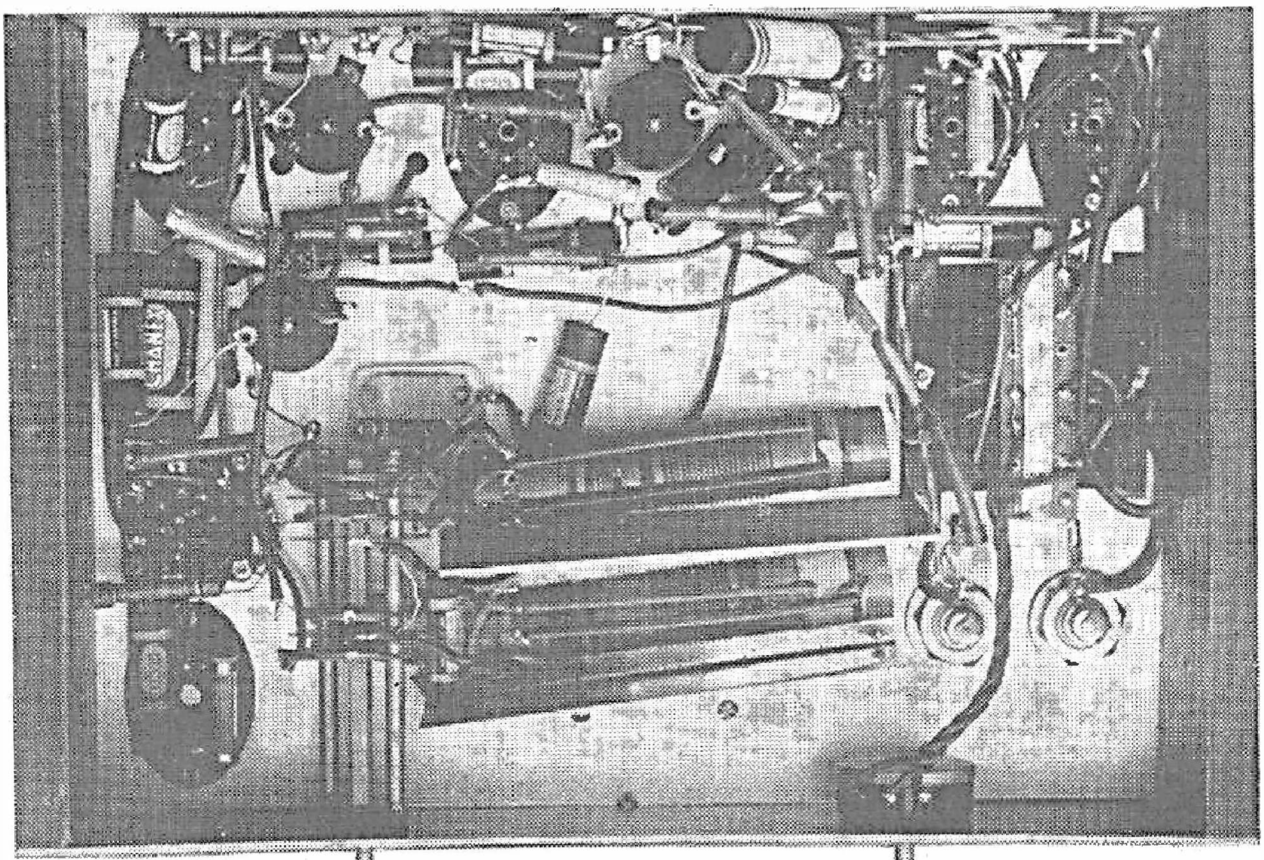
As automatic volume control applied to the grids of the i.f. amplifier tubes is used, it is necessary to isolate the grid returns of the two i.f. transformers. This is done by means of .01 mfd. condensers, the a.v.c. voltage being fed from the diode section of the 6B7 through the filter network provided by the .5 megohm resistor in each grid return lead from the i.f. transformers. The two 78 i.f. tubes are slightly over-biassed in order to keep the i.f. amplifier stable, but this does not affect the gain of the amplifier to any marked degree. The 4 ohm. bias resistor in each 78 cathode is by-passed by a .5 mfd. condenser.

In addition to the automatic volume control incorporated in the receiver a manual control is also used in the grid circuit of the pentode section of the 6B7.

This volume control is not shown in the circuit diagram, but consists of a 250,000 ohm. potentiometer. The arm connection of the potentiometer goes to the grid of the 6B7, one of the outside connections goes to earth ,and the other outside connection goes to the grid side of the .1 meg. resistor, which, of course, is not then connected to the 6B7 pentode grid.

In the plate circuit of the 6B7 a .001 mfd. by-pass condenser returns unwanted r.f. to earth and has the additional function of reducing somewhat the high audio frequency peak encountered with this class of tube. The 250,000 ohm. plate resistor for the 6B7 is de-coupled by means of a 15,000 ohm. resistor in series between it and the maximum "B" supply line. The junction point between these resistors carries one side of the .1 mfd. by-pass condenser. The input and output circuits of the 41 are perfectly standard, and need no comment. Note though that for tone compensation a single .01 mfd. condenser has been connected across the output circuit of the pentode instead of the more usual .006 mfd. condenser in series with a 10,000 resistor.

The field and voice coil connections to the 1300 ohm pentode type dynamic speaker are as shown in the schematic circuit diagram. The power pack arrangement is standard, the transformer having the following windings, 375—0—375 at 80 m.a., 5 volts at 2 amperes, and 6.3 volts at 3 amperes.



This picture of the under side of the "Air Raider" chassis shows that whilst a number of resistors and condensers are used in the receiver, the wiring is not unduly complicated.

The Multi-Wave Band Coils

So much for the general components in the receiver. The next thing for consideration is the coil unit and the selector switch. In this experimental model the two formers which carry the complete range of oscillator and modulator coils are mounted on pillars fastened to the under-side of the chassis.

The switch, a Marquis Multiple All Wave type, is provided with two rotary sections of three contacts. These take care of the three wave band settings on the set. The Essanay Manufacturing Co. manufacture a coil and switch unit which will be contained in the one shield can. Only the leads, which will be color coded to conform with the colors listed in the coil section of the schematic circuit diagram, will extend through the shield can.

Naturally, the coils are the most important part of the receiver. If they are not right, then nothing that is done in other sections of the set will secure for the builder the results which were obtained with the original. Unless he is equipped with a short wave-meter, and is prepared to spend considerable time experimenting with the wave bands the making of the coils by the home constructor is out of the question. For this reason no attempt has been made to give coil winding data.

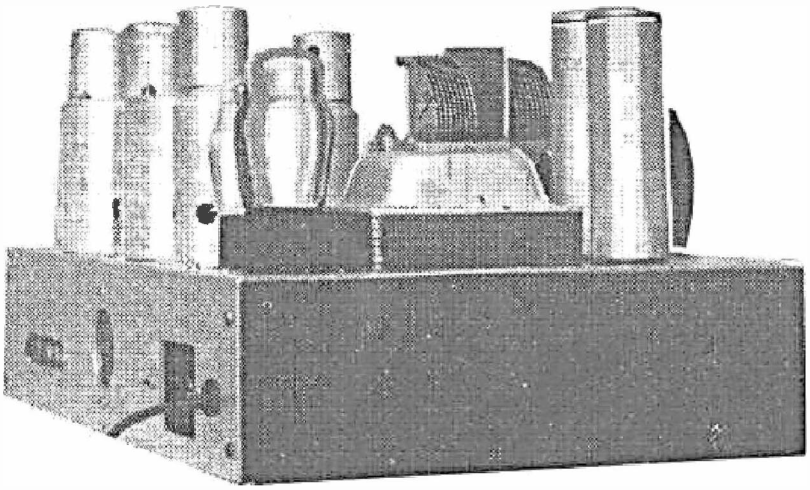
A point of particular interest with this receiver is that the tuning of both the broadcast and short wave bands is carried out with a standard broadcast size gang condenser. The coils have been so proportioned that it is possible to keep the padding condenser PD in circuit throughout the whole tuning range.

The effect of this is to keep the ganging of the two sections of the gang condenser highly accurate on the short wave ranges, as well as the broadcast range, thus ensuring that the efficiency of the short wave tuning circuits is kept as high as is compatible with the coil-condenser ratio used. It must be admitted at the start that the efficiency in the tuned input circuit is not as high on short waves as it might be, because we use a large capacity, and a small inductance. However, as was pointed out at the beginning of this article, the design on an all wave receiver is attended by many compromises, not the least of which is the one between ease of wave length coverage against tuned circuit efficiency.

Component Lay-out

The loss of efficiency on the short wave band, however, is amply compensated for by the high amplification of the intermediate frequency unit with the result that even on the shortest wave-length the receiver is capable of a really outstanding performance.

With such a receiver as this, the layout of the various components is of the



Another picture of the "Air-Raider" which will illustrate salient points of the chassis assembly.

utmost importance, so that it will not be amiss if, at this juncture, we touch upon the salient features of the chassis make-up.

The top chassis view shows, from left to right along the back edge, the 80, the 41, the 2B7, the third intermediate frequency transformer, the second 78, the second i.f. transformer, and the second 78, in that order. Continuing the "line" around the right-hand end of the chassis, we have the first i.f. transformer and the 6A7.

The under-chassis view demonstrates that, in the disposition of the various components attention has been paid to the important question of short leads. Such components as resistors and condensers have been soldered directly to the point in the circuit to which they are to connect and are not provided with long leads which wander around and give rise to instability.

Naturally, with a completely screened coil and switch assembly, some deviation must be made from the under-chassis lay-out of the experimental model, but this variation will not be serious enough to call for a re-design of the general chassis lay-out.

The lining of the all-wave super-het. is quite simple, but, as the broadcast wave length alignment holds good on the two short wave bands, it is to the set builders' advantage to take pains with the adjustment on the broadcast band so that best results will be obtained on the high frequency ranges.

Start the alignment of the receiver in the usual way by tuning the set to 3AW and adjusting the oscillator gang condenser trimmer until 3AW comes in at about 15 on the dial.

The alignment of the set should be carried out with the A.V.C. circuit opened.

Now roughly adjust the modulator section trimmer until the best signal is obtainable from 3AW, and then shift down scale for more definite adjustments on a weaker and lower wave length station. Probably the best station of the lot for Melbourne listeners is 7UV. Note, however, that the fading usually experienced with this station during its night-time transmissions makes it practically impossible to line a super with any degree of accuracy, so that it is necessary to pick a daytime transmission. The midday transmission on Sundays is convenient. Failing 7UV, move up above 3AW and use 3GL.

Having decided on the distant station on which to line the set, tune to it and cut the volume control well back. Without touching the oscillator trimmer, adjust the modulator trimmer until the best signals are obtained. In order to get a definite tuning adjustment on the trimmer keep the volume control shut well back and, as each adjustment brings the volume up compensate for it by re-adjusting the control.

Having lined the set on the low wave length station, tune up to 2CO and, whilst rocking the gang condenser (tuning it back and forth over six or seven degrees), adjust the padder condenser for best signal strength. The same manipulation of the volume control as for the low wave length station also will be necessary.

Be sure to remove the screwdriver from the padder screw after each adjustment, or you will get false results.

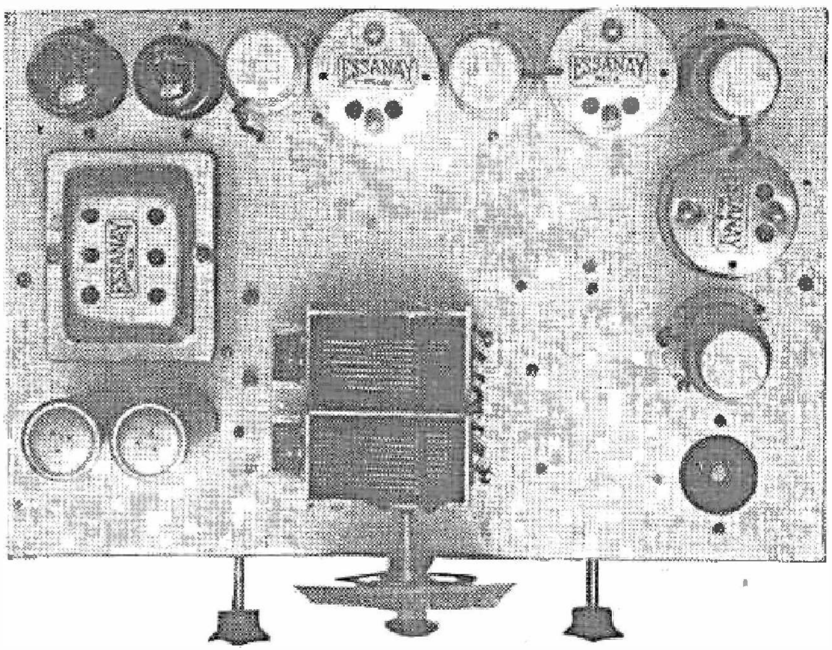
When you are quite sure that the set is padded properly at the top end of the dial, tune again the station on which the low broadcast wave length adjustments were made, and try the effect of a further adjustment of the modulator trimmer. This trimmer may need a fraction of a turn adjustment, but any alteration should be made with the volume control cut well back, so that you can hear exactly what you are doing.

When the set has been lined up we are ready to give it a try out on the short wave bands. Turn the wave changing switch to the No. 1 position (shortest wave length band), and, tuning very slowly, see if you can pick up a broadcasting station. There will be—we are speaking of night-time tests — plenty of code stations transmitting modulated C.W. signals, but what we are looking for is a broadcasting station.

For the benefit of the newcomer to short waves, the following list of stations broadcast and short wave lengths, by received on the receiver is included:—

Wave Length.	Station.	Dial Reading.
Band No. 1		
19.68	FYA, Paris, France	11
19.73	DJB, Zeeson, Germany	11.5
25.28	GSE, London	41
25.57	PHI, Holland	42
30.4	EAQ, Spain	63
31.38	DJA, Zeeson	75
31.45	GSB, London	76
Band No. 2		
31.38	DJA, Zeeson	2
31.45	GSB, London	3
49.6	GSA, London	46
70.2	RV15, Russia	83

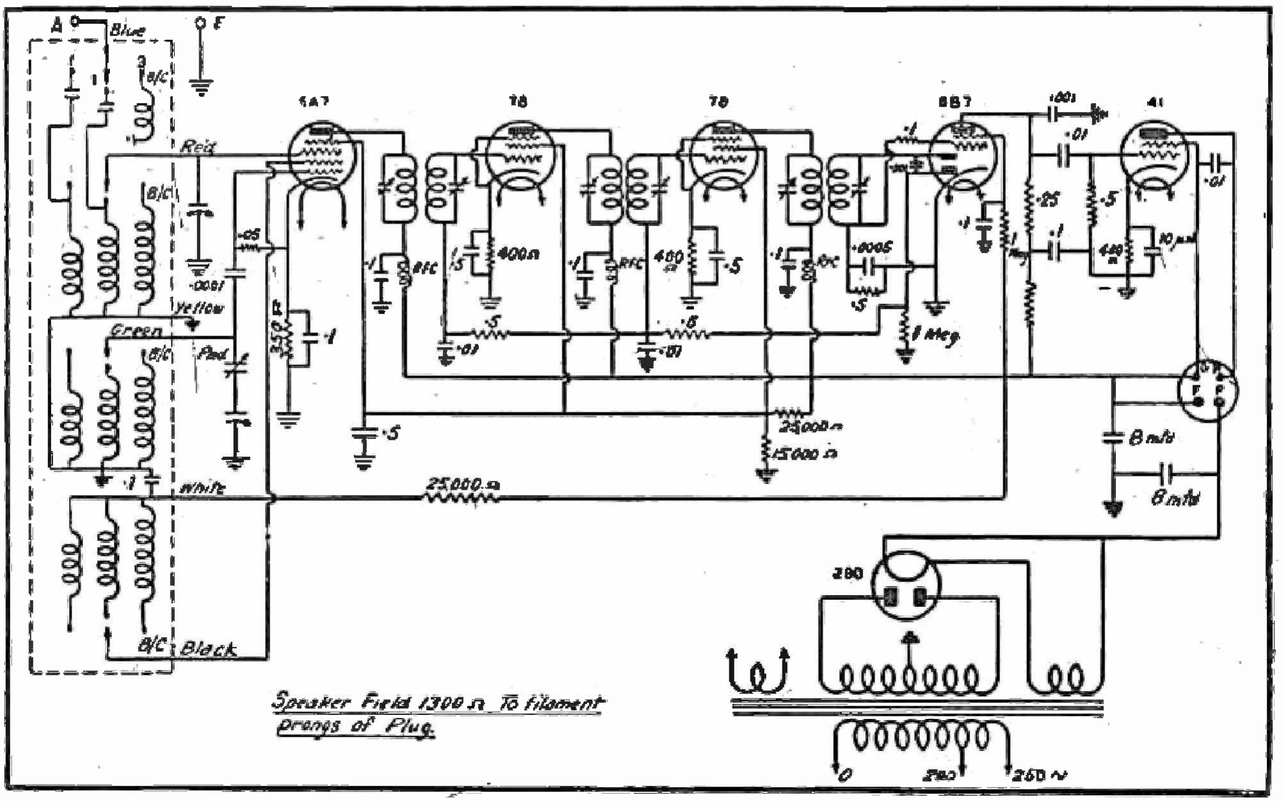
Naturally the dial readings given above do not mean a thing when applied to another set, even if it uses the same type of dial we used with the experimental model. When a different dial is used the comparison becomes even less reliable. However, the readings will give some basis for computation of the possible dial readings at which a given station may be heard.



Looking down on the top of the finished set.

From the viewpoint of performance on the short waves the receiver is a winner. It brings in the Empire stations, notably GSE, GSB and GSA at full loud speaker strength during the peak periods, gives even better results from the German station DJB, and, if that is possible, better results still from FYA. Were it not for the terrific static encountered on the 80 metre band during the summer months, the Soviet station RV15 would also fall into the category of a first-class short wave broadcasting station.

Naturally, with its two intermediate frequency stages the "Air Raider" is an exceptionally sensitive broadcast receiver and no trouble is experienced in bringing in all the Australian stations as well as some of the New Zealanders, a couple of Japs. and Radio Manila. Its ease of operation and the reliability with which it will bring in distant broadcast and short wave stations mark it as an outstanding receiver.



Speaker Field 1300 Ω To filament prongs of Plug.

Parts For The Air-Raider Super-Het.

1 All Wave Coil Unit, with Wave Changing Switch, Aerial Coupling, Condensers and Padding Condenser (Essanay).

1 Two Gang Tuning Condenser (Essanay).

3 460 K.C. Intermediate Frequency Transformers (Essanay).

1 250,000 Ohm Volume Control Potentiometer (Bradleyohm).

2 1 Megohm Resistances.

2 25,000 Ohm Resistances.

4 500,000 Ohm Resistances.

3 250,000 Ohm Resistances.

1 100,000 Ohm Resistance.

1 50,000 Ohm Resistance.

2 15,000 Ohm Resistances.

(Carborundum, I.R.C., Ohiohm, Bradleyohm, Ohmite, Chan:-- Silent, Velco.)

3 Special Radio Frequency Chokes (Essanay).

2 8 Mfd. 500-volt Electrolytic Condensers (Solar, T.C.C., Dulytic, Polymet, Concourse).

1 .0001 Mfd. Mica Condenser.

4 .01 Mfd. Mica Condensers.

2 .0001 Mfd. Mica Condensers.

1 .0005 Mfd. Mica Condenser. (T.C.C., Wetless, Saxon.)

6 .1 Mfd. 1500-volt Test Tubular Condensers.

3 .5 Mfd. 1500-volt Test Tubular Condensers.

1 10 Mfd. 25-volt Electrolytic Condenser. (T.C.C., Chanex, Hydra, Concourse, Dulytic, Saxon.)

1 Power Transformer, 375-0-375 at 80 m.a.; 5 v. at 2 amperes, and 6.3 volts at 3 amperes. (Essanay, Wendel, Radiokes, Hilco, Velco, Saxon, Precedent.)

1 Tuning Dial. ((Efco, Radiokes, Essanay, Precedent, Saxon, Raycophone.)

1 Chassis 16in. x 10in. x 3in. (Essanay, Geo. White and Co.).

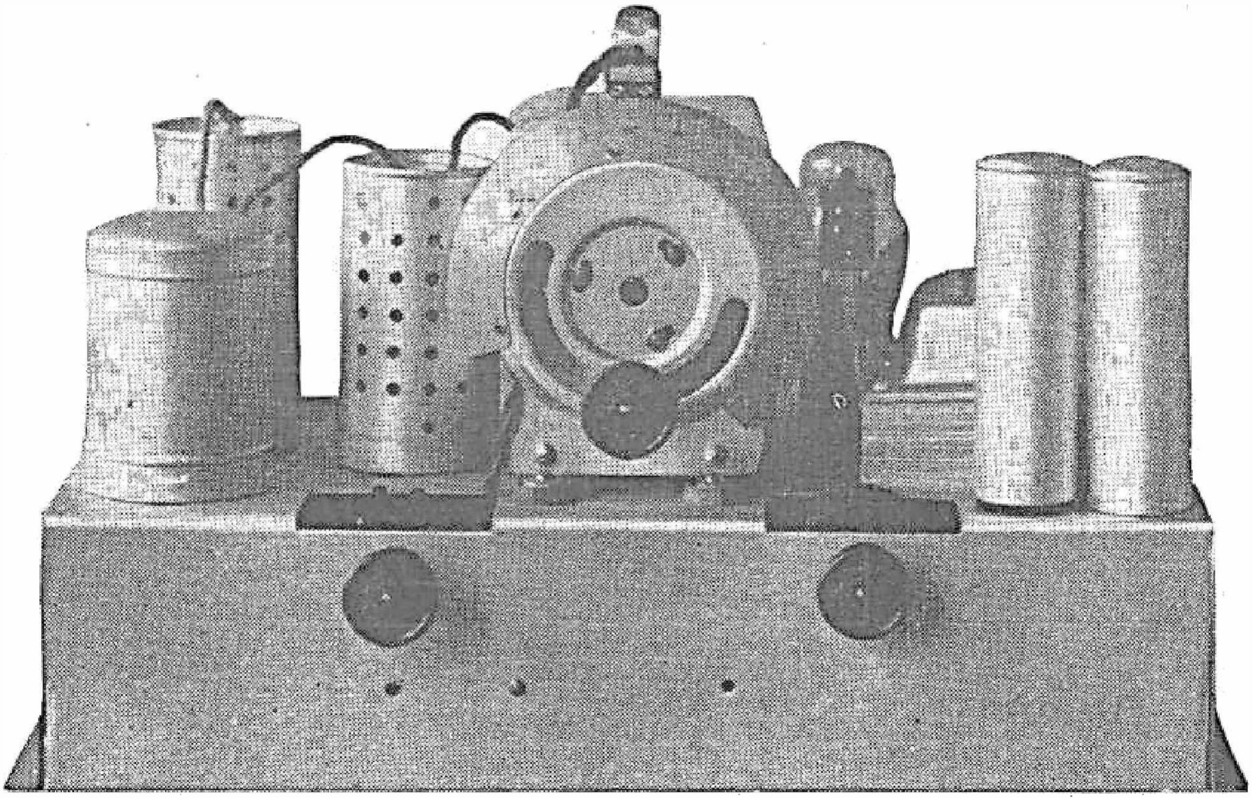
3 Six Pin Valve Sockets.

2 Seven Pin Valve Sockets.

2 Four Pin Valve Sockets. (Essanay,, Velco, Targan, Marquis, Saxon, Precedent.)

1 1300 Ohm Dynamic Speaker to match 41 Type Valve. (Rola, Precedent, Amplion, Saxon, Jubilee, A.W.A.).

Valves:—Two 78's; one each—6A7, 6B7, 41 and 80. (Philips, Radiotron, Speed-J.R.C., Kenrad, Mullard, Tungsol.)



Front finished view of the Centenary Five with the local-distance switch on the left and the volume control on the right. The left-hand electrolytic condenser is insulated from the chassis.

Centenary Super-Het. "5"

Through the agency of pentagrid-converter 2A7, used as a combined first detector and oscillator, this ultra-modern receiver has abilities previously attributable to much larger sets only.

By "RADEX"

IN order that the prospective set-builder may tackle the construction of this astonishing receiver intelligently, it is desirable that he should have some insight into the general application of pentagrid-converter valve 2A7 to the cascade. It is the secret of the design's success, and its function warrants attention.

It is presumed that the average reader, who is interested in A.C. super-heterodynes, is already familiar with the offices of the tubes in a regular 5-valve assembly. In natural sequence they comprise a combined first detector and oscillator (autodyne 57), variable-Mu intermediate frequency amplifier, second detector, audio amplifier, and power rectifier. The 2A7 replaces the autodyne 57.

The First Detector's Importance

When a 57 is employed in the autodyne stage it serves two purposes: (a) it has to operate as a grid-bias detector, and (b) it must be an independent oscillator to create a beat frequency that in turn, when mixed with the incoming signal, will make the intermediate (or constant amplifier) frequency by subtraction. In these dual objectives there is an inherent trouble. If we so bias the 57 that it is at its most sensitive condition for detection, we can rarely (if ever) make it oscillate throughout the required frequency band; and, of course, without such oscillation the whole system stultifies itself. Accordingly, self-oscillation being of primary importance, irrespective of sensitivity, the bias has to be varied until that essential condition is achieved. Obviously, such action desensitises the valve's detector function, but, under the circumstances, and bad though it is heretofore, that could not be helped.

In this relation it may be pointed out here that a super-het. with the above-named specifications is nothing more than a non-regenerative single-valve receiver so far as initial sensitivity is concerned. Its ultimate voluminous output is produced by the amplification powers of the intermediate stages, but such are released, in the first place, by the unaided action of a common bias detector tube. In other words, were it possible to make a sufficiently delicate piece of electro-mechanical recording apparatus, all the stations received by a 5-valve super would be brought in on a straight one-valve set, but at minute volume. The stumbling block lies in the fact that all such recording devices have ponderous inertia. But, compared with that immobility, an electronic stream stands in the same relationship as does a ton of lead to a hair.

This means that while a tiny signal would have no effect upon a recording device such as a pair of headphones, it is yet perfectly capable of registering itself when brought into contact with another radio frequency stream. The popular idea is that the super-heterodyne design acquires its sensitivity from its intermediate stages, but this is only partially correct. Were the first detector's output not recorded on its locally generated frequency, the I.F. sections might be as delicate as is conceivable, but there would be nothing for them to do.

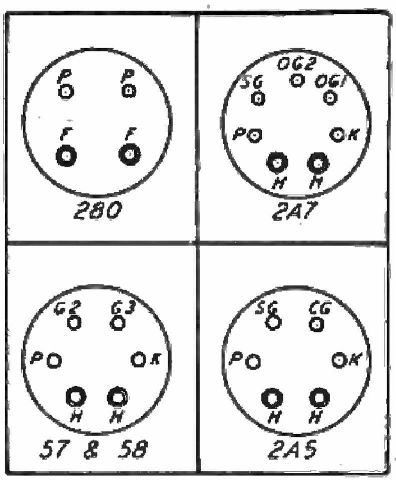
Functions of the 2A7

Adverting to the question of an autodyne first detector, in the pentagrid convertor 2A7, we are offered a tube that has been specially designed for the position and so allows of its detective function being carried on at the peak of efficiency. Actually, it is two complete valves in one envelope, the connections being made by seven base-pins and a top grid-pip.

Inspection of V1 in the circuit diagram will clarify the situation. The bulb enclosed one ordinary screen-grid and one triode combination, and is indirectly heated. In the order of the drawing come the plate, the screening grid and the control grid of the S/G section. Below again (and what appears to be another grid) is the anode grid, and then the grid of the triode section with a common cathode for both.

Considering these divisions externally; in the triode section R3 is a specially evaluated grid-leak while C2 is the grid condenser and links to a tuned circuit comprising padder PD, section G3 of the ganged condenser, and the larger winding of OSC. The other winding of OSC is the plate OG2 (anode-grid) feed-back (or tickler) coil which is supplied with the maximum "B" voltage available. Obviously, with R3 returning directly to cathode, here we have an independent oscillatory circuit, free from metallic association with the tube's other elements, the sole function of which is to generate the required beat frequency.

In the S/G section is offered a combination similar to the 24 or 57 types, that operates as a detector on the anode-bend system, the necessary bias being obtained through the agency of bias resistor R2 shunted by non-critical



Valve sockets used in the Centenary viewed from below. The letters indicate: —F, filament; P, plate; SG and G2, screened-grid; K, cathode; H, heater; CG, control grid; G3, suppressor grid; OG1, triode grid; OG2, anode-grid. Control grids of 2A7, 57 and 58 are on top of the envelopes.

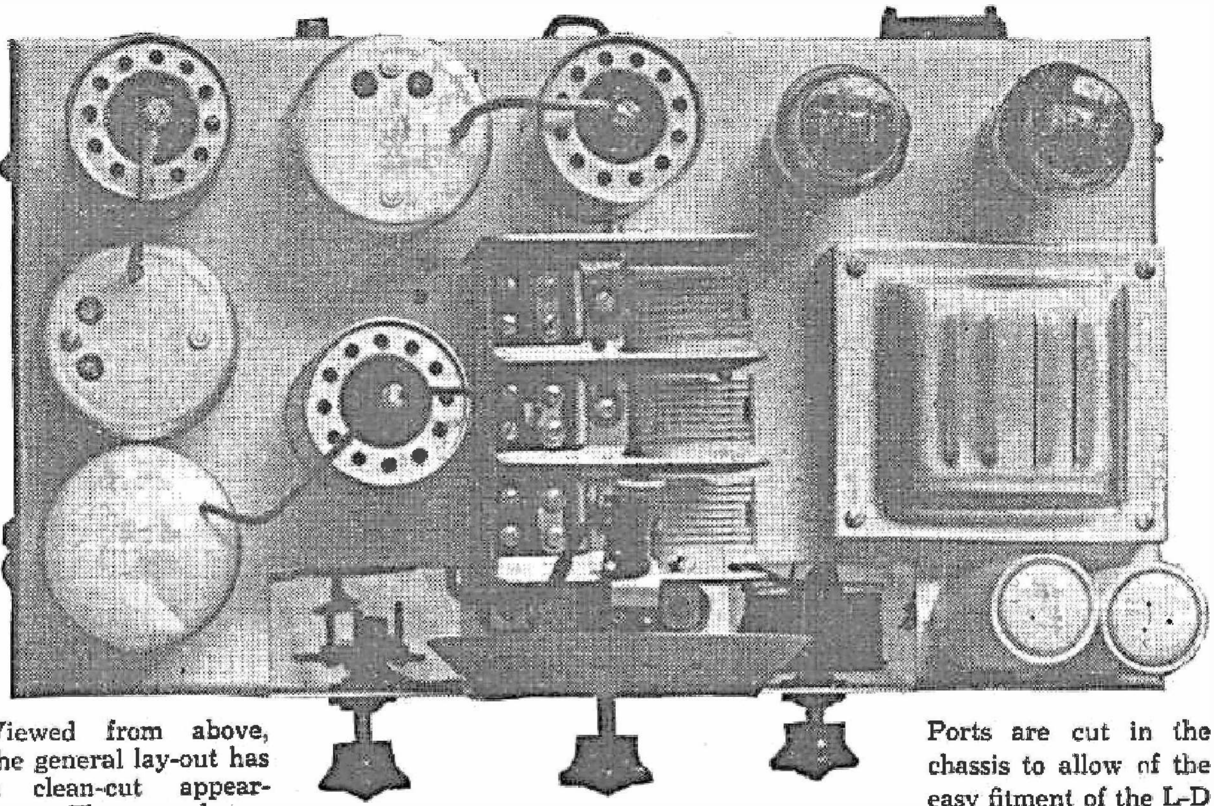
capacity C1. But the difference between the 57 and the 2A7 lies in the important fact that, having independent sections, we can bias the S/G portion until we reach that point on its characteristic curve at which the utmost detective efficiency is attained, and yet the oscillator portion carries on uninterruptedly.

Just how the actual mixing of the two frequencies (that of the in-coming signal with that of the oscillator working constantly at a 175 k.c. difference from the former) is done, would need an explanation too lengthy for the available space. Condensing the matter, and glossing over technicalities, it will be seen that the same cathode forms the return for both the true plate and the anode-grid. Accordingly both delicate electronic streams mix and combine to form a third, viz., the intermediate frequency.

Some Illustrative Results

As outlined in the paragraphs covering the importance of the first detector, the 2A7 fits this position admirably because its assigned section has been designed to give individually high efficiency there. In consequence the overall results of this Centenary Five are better than those of an ordinary Super-Het Six, and often favorably comparable with those of a Seven.

A fortnight's nightly test in Melbourne has, in the first place, brought in 2YA, Wellington every night at genuine entertainment value, with only one exception, when static was severe. From about 9 p.m. onward until closing, 6WF has behaved similarly. KZRM—Manila was always there with the set opened out, but static prevented pleasant reception on all but six occasions. Perth and Wellington came in so comfortably because it was possible to cut down the volume on them (thereby reducing the noise level) without unduly weakening their signal. Several Japs have been logged for dial settings, but not always identified.



Viewed from above, the general lay-out has a clean-cut appearance. The ganged condenser is isolated on rubber.

Ports are cut in the chassis to allow of the easy fitment of the L-D switch and volume control, left and right.

LIST OF COMPONENTS

KIT.—Comprises Aerial, Pre-Selector and Oscillator coils, two 175 k.c. intermediate frequency transformers and padder condenser with shunt (all Saxon).

A.C.S.—Three-point in-put a.c. voltage adjuster, not illustrated (Saxon).

C1, C3, C6, C8.—Tubular condensers of 0.1 mfd., 400 volts.
C4.—Tubular condenser of 0.5 mfd., 400 volts.
} Chanex, Dubilier, T.C.C. Concourse.

C2.—Mica condenser of 0.0001 mfd.
C5.—Mica condenser of 0.001 mfd.
C7.—Mica condenser of 0.03 mfd.
C9.—Mica condenser of 0.01 mfd.
} Saxon, T.C.C., Wetless.

E1, E2.—Electrolytic condensers of 8mfd., 500 volts. T.C.C., Solar, Dulytic, Polymet, Dubilier, Concourse.

G1, G2, G3.—Triple gang variable condenser with trimmers (Saxon).

PT.—Power transformer with 200, 230 and 250 volt. a.c. in-put, out-put 380-0-380, 110 m.a., 1 5-volt secondary and two 2.5 volters (Saxon).

R.3.—Resistor 50,000 ohms.
R7.—Resistor 25,000 ohms.
R8, R9, R10. — Resistors 500,000 ohms.
R11. — Resistor 250,000 ohms.
} ALL POWER GRID-LEAK TYPES. Saxon, Carborundum, Radiokes, Bradley, I.R.C., Raycophone, R.C.S., Chanex-Silent, Ohmite.

R1.—Wire-wound resistor, 90 ohms.
R2.—Wire-wound resistor, 450 ohms 25 m.a.
R4.—Wire-wound resistor, 200 ohms 15 m.a.
R5.—Wire-wound resistor, 8000 ohms, 15 m.a.
R6.—Wire-wound resistor, 12,000 ohms, 15 m.a.
R12. — Wire-wound resistor, 420 ohms, 100 m.a.
} Saxon, Stedipower, R.C.S., Radiokes, Master-Made, Wetless, Velco, Aegis, Raycophone.

RFC.—Radio frequency choke. (Radiokes, Saxon, Velco, Aegis, Raycophone, Paramount).

S.—Two-way local distance switch. (Saxon, Velco, Radiokes.)

VC.—Volume control 500 ohms. (Saxon, Marquis, Radiokes, Master-Made, Raycophone, Bradleyohm).

LS.—Dynamic speaker with 2500 field, and in-put for 2A5 type (Saxon, Jensen, Rola, Jubilee, Amplion, Precedent).

Valves.—One each 2A7, 58, 57, 2A5 and 280 (Radiotron, Tung-Sol, Ken-Rad, National, Mullard, Philips, Speed-J.R.C., etc.).

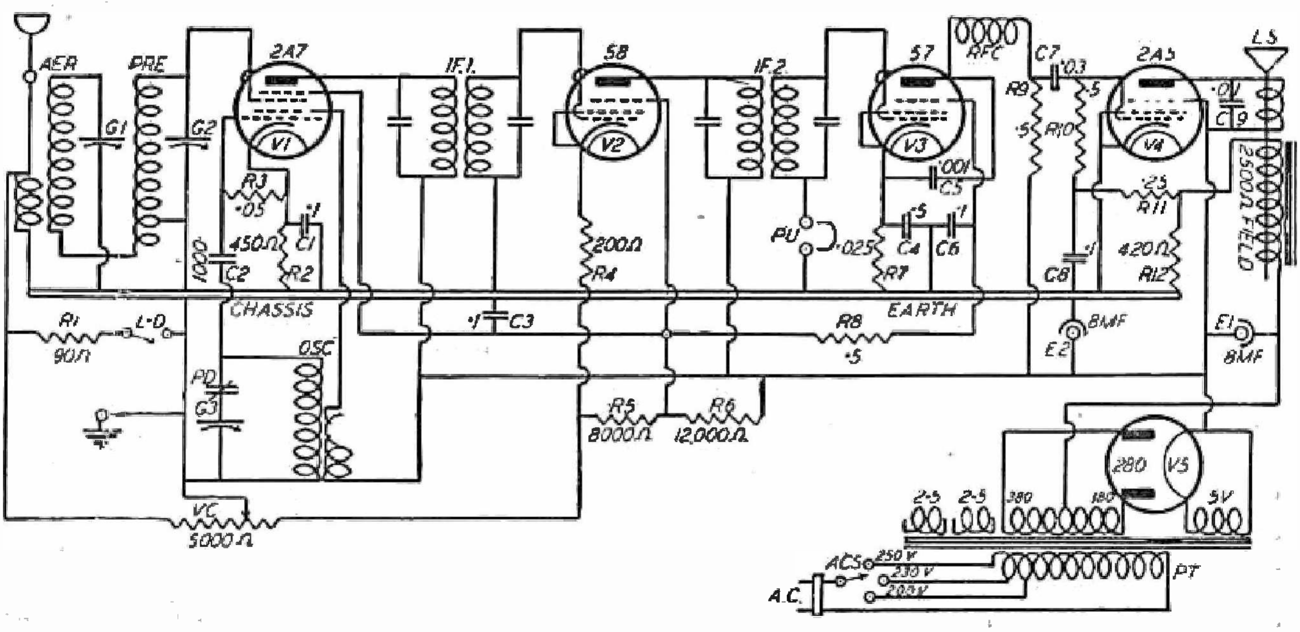
Sockets.—Three 6-pin, one small 7-pin and two 4-pin, one of latter being for speaker. (Saxon, Marquis, Targan, Velco, A.G.N., Raycophone.)

Chassis.—Pressed steel measuring 15 x 8½ x 3½ inches.
Sundries. — Three valve-cans, bushings, rubber and wiring flex.

Dial.—Illuminated vernier (Saxon).

THE SCHEMATIC CIRCUIT

Pentagrid Converter 2A7 Makes New Circuit



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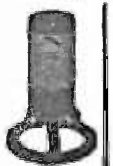
Essanay Matched Coils



Aerial
R.F.
R.F. with reaction
I.F's.
Preselector
Oscillator.
In Cans. Ea. (q). **4/3**

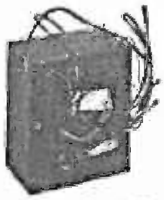
Sonotron 280 Valves

8/6 (F.)

PAN Full Vision Dials

5/6 (F)

Power Transformers



2.5 Alpha Type.
2.5 Volt
2.5 Volt
5 volt. 385 volts.
100 Mills. **12/6**

Radiokes Voltage Dividers

25,000, 4/6 (T.).
15,000 ohms, 3/6 (T.)

RADIOTRON VALVES

57,58 Type ..	15/6 (T).	1-A6 Type ..	18/ (T).
2a5 Type .. .	17/ (T).	31, 30 Type ..	14/ (T).
280 Type .. .	12/6 (T).	32 Type .. .	16/ (T).
247 Type .. .	15/6 (T).	33 Type	17/ (T).
2a3 Type .. .	32/ (T).	55 Type	15/6 (T).
2a7 Type .. .	18/6 (T).	77 Type .. .	16/6 (T).
2B7 Type .. .	18/ (T).	5Z3 Type	18/ (T).
2a6 Type .. .	17/6 (T).		

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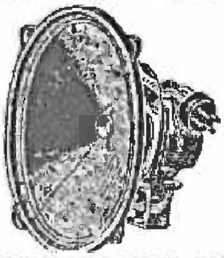
2500 Ohms Penthode 8in. Cone



18/6 (Y) ea.

10in. Cone 21/- (Y.)

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Strange though it may seem to some, none of these results was obtained with an aerial. Instead, a good earth connection was attached to the set's aerial terminal while the earth terminal was left blank. Signals were not so loud when an aerial was connected up in the regular manner.

The Circuit Generally

As usual with a super-het cascade that begins at the first detector V1., the circuit commences with an ordinary type of inductively coupled pre-selector. This is utilised to sharpen tuning and to obviate double spotting, both of which objectives it achieves satisfactorily. The small aerial coil of unit AER is shunted to earth through 90-ohm resistor R1 and switch L-D. When the latter is closed R1 shunts a portion of an over-strong local signal to earth and thereby eliminates possibilities of blasting. As a matter of fact, even with L-D closed, many interstaters came in well, and it would seem, therefore, that R1 could be reduced safely to even 30 ohms and still give powerful local reception.

With the intricacies of the 2A7 we have already dealt in detail, and it will be obvious that G1-G2-G3 is the triple-gang condenser that tunes with the larger windings of coils AER, PRE and OSC. As C1, in this design, has no real effect upon the oscillatory circuit, its value is not critical, as is usual with autodyne models.

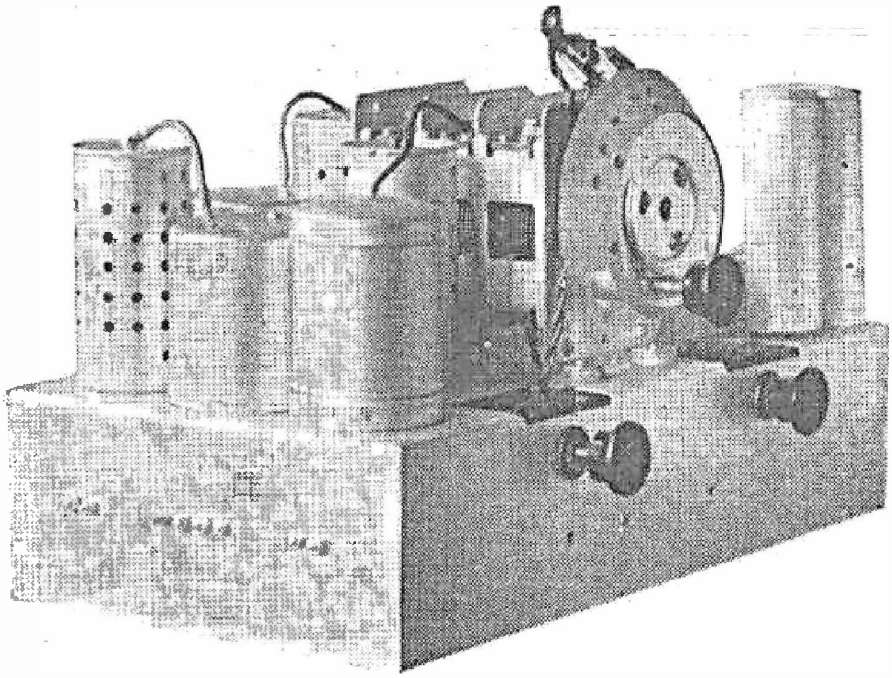
V1 feeds the intermediate frequency through the usual cascade, incorporating r.f. transformers IF1 and IF2, tuned to 175 k.c.) and variable-Mu tube 58, to second detector V3. Volume is controlled by VC, placed in the cathode lead of V2 and limited in action by R4.

The final output comprises a type 2A5 pentode capable of delivering up to 3000 milliwatts, back-biassed and well de-coupled, besides being shunted by C9 for purposes of "highs" reduction. The whole is fed from a more or less standardised power-pack, in which the dynamic speaker's 2500 ohm field operates as the smoothing choke. Resistors R5, R6 and R8 break down the maximum "B" voltage to the valves' individual needs. If desired, a pick-up can be inserted in the otherwise earthed secondary lead of transformer IF.2. All components listed and pictured are essential to the design's satisfactory operation.

Arrangement of Parts

The specified chassis is of either steel or No. 16 gauge aluminium, and its depth of 3½ inches is necessary to accommodate the components that fit under it. The photo. of its top view shows that ports are cut to allow of the fitment of the local-distance switch and the volume control without risk of them coming into contact with "live" points, etc. Immediately below PRE and IF.1, bolted to the left hang-over of the chassis, are AER and OSC, the former being that nearer to the L-D switch, A.

With the exception of large components, such as the power transformer, coils AER and OSC, combined resistor R5-R6 (seen near the top end of OSC) and the valve-sockets, there is very little fitting to be done under the chassis. Inspection will show that the majority of the resistors and fixed condensers, being of the tail-type, fit obviously into the wiring scheme. Chassis is, of course, earth, and in the majority of instances one tail of such components is permanently anchored thereto, thus providing stability.



In the left foreground, working backwards, are coil "PRE," the first intermediate frequency transformer and its type 58 valve.

Notes on the Wiring

It is practically axiomatic that if a prospective builder of a super-heterodyne circuit cannot make the assembly from the circuit diagrams, photos of the original model and sundry essential tips, it will be unwise to make an attempt. If you feel, therefore, that you require point-to-point wiring directions, your safer plan will be to get your radio dealer to do the assembly for you.

Having drilled all required holes and seen that everything will drop into its place when needed, fit the power transformer and valve sockets and wire up the heater circuits. The 5-volt secondary supplies only the rectifier's FF terminals on V5; the 2.5 volt winding marked to carry the heavier amperage feeds V1, X2 and V3, while the other 2.5 secondary runs only to V4's heater.

If the 2.5 volt coils carry a centre-tap each, these should be earthed; if they do not, then each must be shunted by a filament resistor and its centre earthed.

The outers of the 380-0-380 volts power winding are now run to the PP terminals of socket V5, while its zero tap goes to the can of electrolytic E1 and an F point on the UX socket into which the speaker is plugged. The other F is taken only to ends of resistors R11 and R12, the other end of the latter being earthed. In connecting up the power transformer's primary, be careful to take its variously valued voltage taps to corresponding points on voltage switch ACS.

At this stage you can arrange the feeds of the B supply to the screens of valves V1, V2 and V3 through the agency of resistors, R5, R6 and R8, together with their by-pass condensers C3 and C6. Follow this by putting in the bias arrangements of the same valves and the coupling and de-coupling devices between V3 and V4

Kit Connections

On the whole you will find it simplest to work through the installation of the kit backwards, i.e., commence with IF2 and finish at AER. The clearly marked connections to these units are as follow:

The coil kit proper consists of three coils: aerial (AER), pre-selector or band-pass (PRE) and oscillator (OSC). The aerial coil is lettered A for aerial, E for earth, S for the end of the larger coil that goes to the fixed plates of G1 and X for later attachment to a corresponding point on PRE.

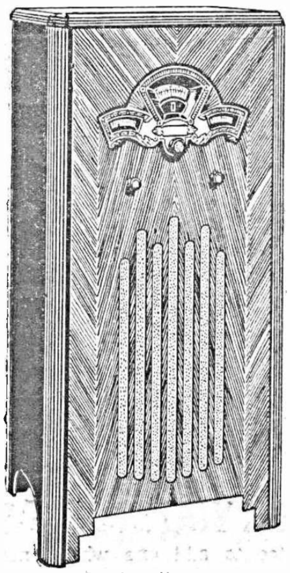
Coil PRE has three connections: G goes to the grid-pip of valve V1 and the fixed plate of G2, E is a tap near the bottom that is connected to chassis and X (the bottom) is taken back to X on AER.

On the oscillator coil there are only four connections (not five as in the case of a 6-pin autodyne design). They are: E to earth, G to one side of the padder and one end of C2, P to connection OG2 on the socket of the 2A7 (vide sketch of socket connections in reverse) and B to the main full positive supply.

The 175 k.c. intermediate frequency transformers are marked alike, and their lettering is very obvious. The indications are: P to plate of preceding valve, B to full positive of plate supply, G to the grid-pip on top of the following valve and E to chassis (earth). The exception, in the case of IF.2 is that if a gramo-pick-up is included, E of the transformer must be taken to an insulated terminal for that purpose. For the pick-up return another terminal is screwed into the chassis itself, and these two connecting points must always be short-circuited when the instrument is being used for radio reception.

Lining up the Ganged Condenser

For the initial test use a small aerial (one indoors around the picture rail is quite sufficient), about 30 or 40 feet in length, and an earth may be attached to the corresponding terminal on the chassis. Later, you may (or may not) find that you do better without any earth, or with the earth on the aerial terminal, but, for a start, it is wiser to be orthodox



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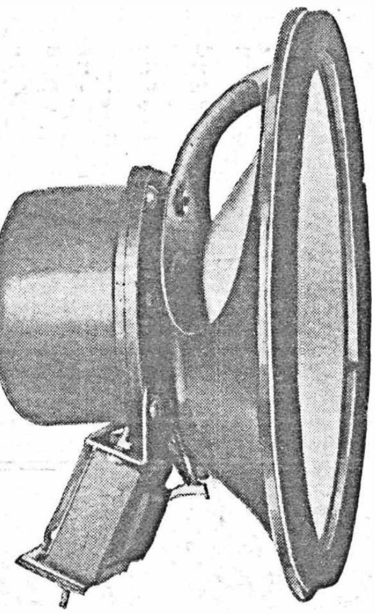

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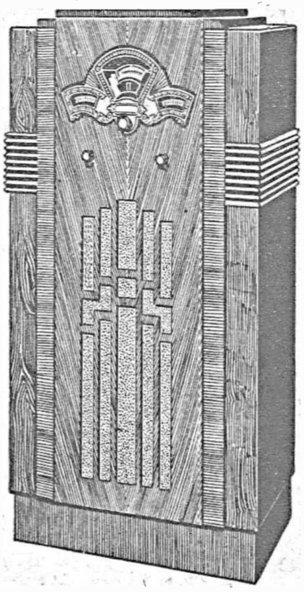

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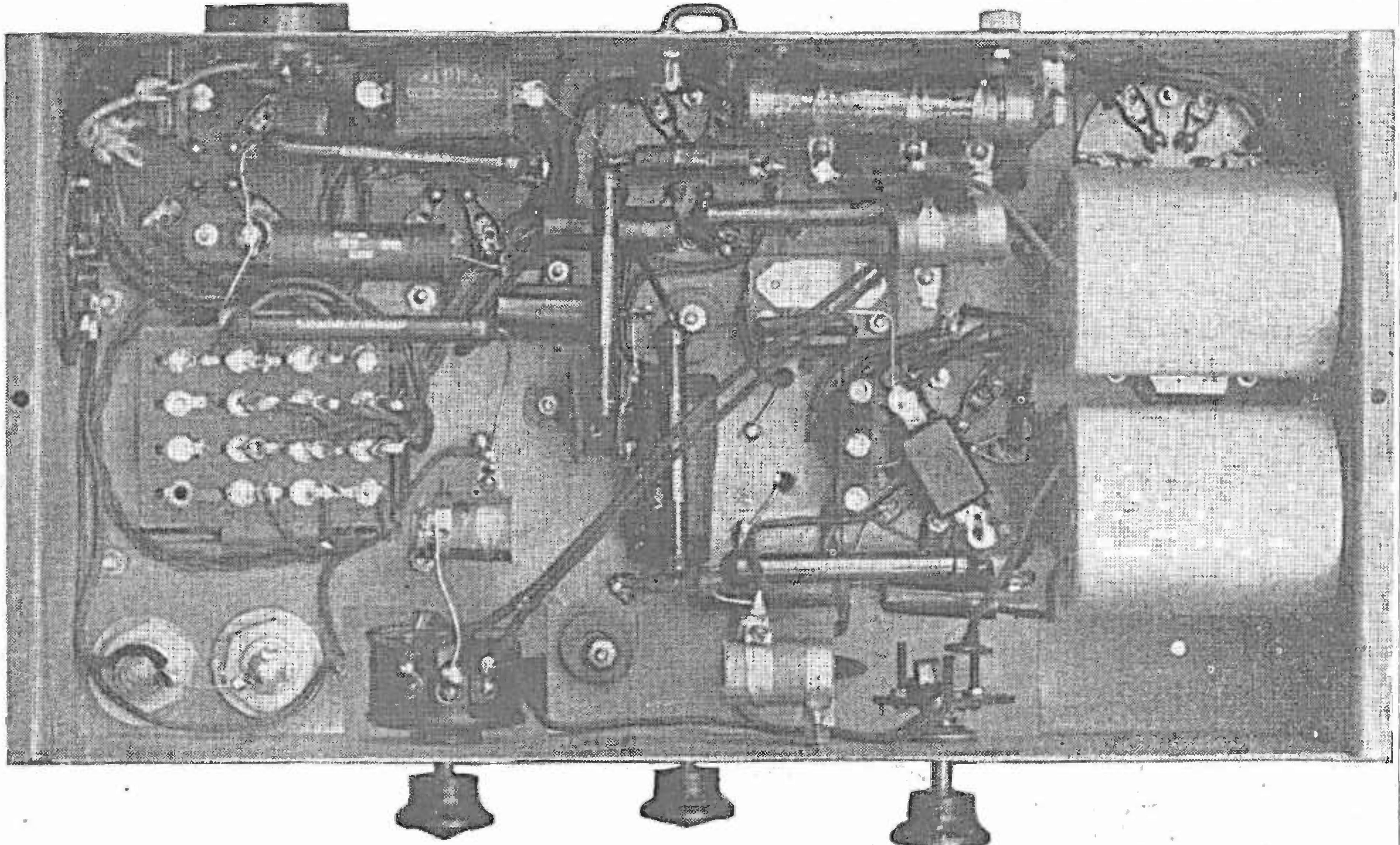
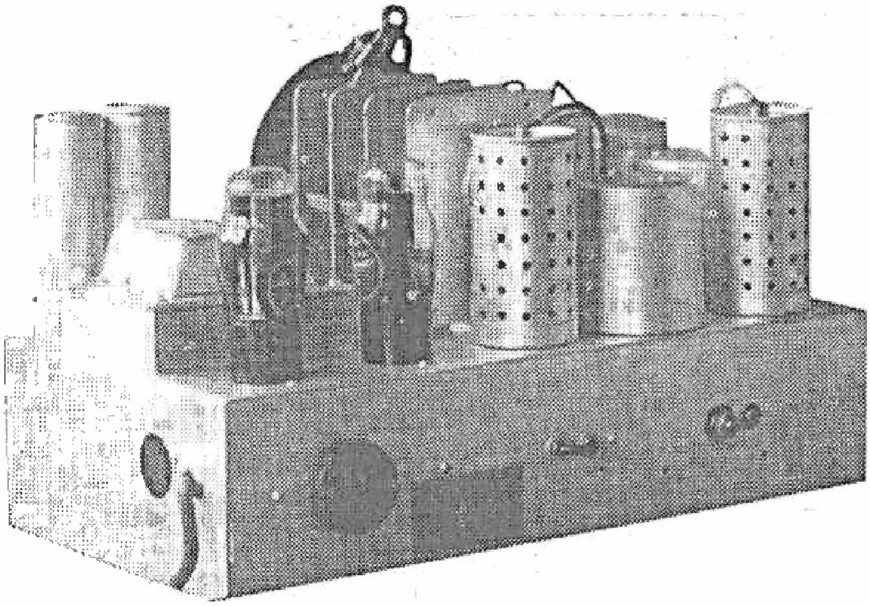


There is ample space for all subsidiary components below the chassis provided their fitment is carried out in logical order. To do this all heater and power-pack wiring should be completed before connections to coils, condensers and resistors are undertaken. Of the two coil-cans on the right that nearer the front is "AER," while "OSC" is next to it. Obviously the leads to can "PRE" and sockets V1 and V2 should be made before these cans are bolted into position.



At the rear of the chassis, from the left, are the in-put voltage adjusting switch, the short-circuited gramophone pick-up points, and the earth and aerial terminals. The speaker's plug is at the extreme left, just past the power leads.

Now, screw the padder all the way down (by inserting a screwdriver through the hole provided in the chassis) and then loosen it about one turn.

Swing the dial to some local station with a wave low down in the broadcast band, and adjust the trimmer on section G3 of the ganged condenser for best interim volume. In this it will be found that section G2 is the controlling one of the gang, and that you will be tuning G3 (by means of its trimmer) to the optimum setting selected by G2.

When everything possible has been done with G3, move over to G1 and turn it either way for a further increase. Being satisfied that a maximum has been attained (always keeping the volume down with the control, so that fine differences of output may be detected aurally), run over all three trimmers again, but, in so doing, be prepared to make infinitely small movements of the screws.

Now turn the dial to the other end of the scale, and select a station as high as possible. If the padder is nearly right you may fluke 2CO at once, but in any case you will be sure of getting 3AR, 5CK or 2FC, according to your geographical position. On the longest available station, AND WITHOUT TOUCHING THE TRIMMERS IN ANY WAY, adjust the padder for maximum volume, removing the screwdriver after each small re-setting. If this is not done you will get a false result, and, when the driver is removed for good, signals will drop in strength. The final adjustment of the padder must be made on 2CO, and, during the process, the main condenser must be rocked gently backwards and forwards to make sure you are on the signal's peak.

The condensers inside the intermediate frequency transformers, the screws of which are visible through holes in their cans, need no attention. They are accurately peaked at 175 k.c. before leaving the factory, and you will do well to let them severely alone. After the padder has proved itself satisfactory on 2CO, run over the trimmers again on some station between 3KZ and 3AW—say, 3GL or 2GN.

Operating Hints

Certain types of wire-wound resistors are available on which the clip at one end can be loosened and slid down so as to decrease the value. If possible limiting resistor R4 should be of this type, as it permits you to get the most from the volume control and yet does not allow less than the necessary bias on V2.

To adjust R4, when of this type, set the volume control hard over to its maximum setting. Now, by means of the slider, reduce the amount of resistance in R4 until a point is reached when the 58 paralyses, then increase until signals come back to the fullest volume again and screw the slider tight at that. Almost needless to say, before making this setting the condenser dial should be turned to the lowest station in the band (3AK).

Similar action can be taken in respect of R1, if locals come in too strongly. The value 90 ohms is an optimum one to suit all conditions. Under actual test it was found that ample volume was obtainable with R1 of only 30 ohms, and this had the added attraction of calling for but a small movement of the volume control when changing from distance to local reception.

Junior "Air-Raider"

(Continued from page 26)

To complete the coil the ends of the wires should be passed through the correct pins and soldered. Remember that the H2 pin carries two wires, these being the low potential ends of L1 and L2.

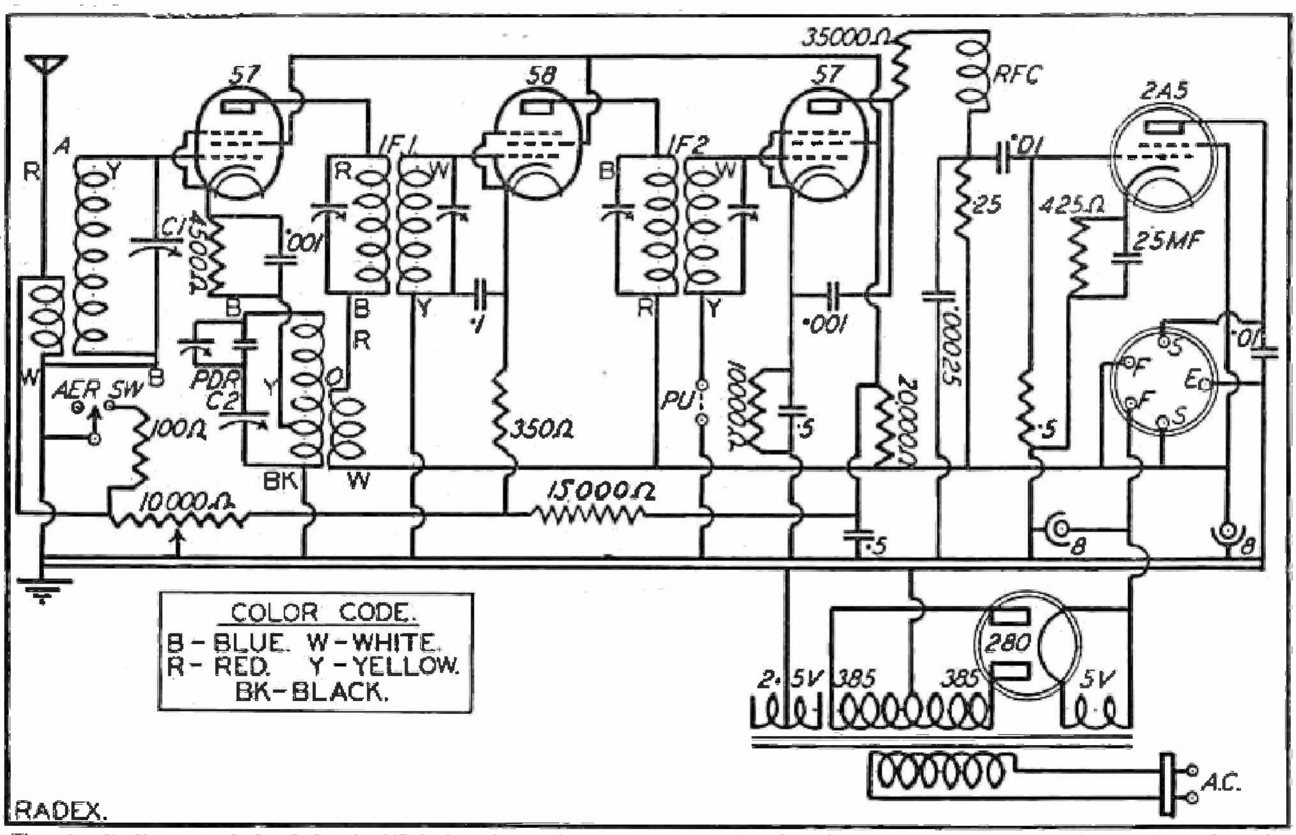
For the broadcast coil join the pins C and G1 together. When this coil is inserted into the coil socket this bridging piece will short circuit the condenser CX, so that the normal range of the variable condenser C1 will be available. On the short waves this bridge is not used.

There are several factors in all wave receiver design which may cause the

(Continued on page 70)

Parts For The Junior Air Raider

1—Single-gang variable condenser (C1.) (Essanay, Stromberg Carlson).
1—Vernier Dial (Radiokes, Efco .
1—23-plate midget condenser (C3.) (Radiokes, Essanay).
1—Power transformer. Specifications: H.T., 375 to 385 volts per side; filaments, 1 5-volt for 80 valve; 1 2.5-volt up to 8 amps. (Radiokes, Hilco, Velco, Essanay, Wendel).
2—30 Henry Filter Chokes (CH1, CH2). (Radiokes, Saxon, Wendel).
1—Audio frequency transformer. (AFT.) (Essanay, Wendel, Velco).
2—Six-pin, 1 five-pin and 2 four-pin sockets (Marquis, Targan, Velco, Essanay).
1—5-megohm resistor, (R1.)
1—15,000-ohm resistor, 1 watt (R2).
1—10,000-ohm resistor, 1 watt (R3). (I.R.C., Continental, Ohmite).
1—15,000-ohm voltage divider (R5). (Radiokes, Velco, Wendel).
1—450-ohm wire wound resistor (R4). (Radiokes, Velco, Wendel).
1—0.0001 mfd. mica condenser (C2).
1—0.00025 mfd. mica condenser (CX).
1—.006 mfd. mica condenser (C5)
2—.01 mfd. mica condensers (C11 C12). (T.C.C.).
1—2.0 mfd. fixed condenser (C4). (Chanex, Hydra).
4—8 mfd. electrolytic condensers, 500 V. (C7, C8, C9, C10). (Solar, Polymet, T.C.C., Dulytic, Concourse).
1—25 mfd. electrolytic condenser (C6). (Dulytic, T.C.C.).
4—Six-pin short wave coil formers. (Marquis.)
1—56 Valve, 1 2A5 Valve, and 1 80 Valve (Ken-Rad, Radiotron, Philips, Speed-J.R.C.).
1—Chassis.



The circuit diagram of the Lekmek 4/5 is key lettered to agree with the list of parts, and the wiring instructions given in the article.

The Lekmek 4/5 Super Het.

A highly efficient manufacturer's type super-het, this model should have a wide appeal to set constructors who require something a little out of the ordinary.

THE modern trend of super - heterodyne design is all towards circuit simplification. Despite the fact the larger and more sensitive receivers are being built, designers are learning now to obtain really satisfactory operation with a minimum of apparatus. This is all right for the commercial set builder, for each factory has its own particular methods of obtaining simplicity of construction, but for the home set builder who must to a large extent use his own judgment in the lay-out and general arrangement of a receiver, attempts at circuit simplification usually end in trouble.

For this reason, if for no other, the receiver we propose to describe should be of interest.

Although in every sense of the word it is a modern superheterodyne, arranged to give the maximum results with the minimum of gear, it can be easily duplicated with readily available standard parts. A study of the schematic circuit diagram will show that the receiver employs a total of five valves, of which one is the rectifier. The mixer tube is a 57, the i.f. amplifier tube a 58, the second detector a 57, and the audio tube a 2A5.

It may be wondered why a 57 has been used as a mixer instead of the electron coupled 2A7 type tube. The experience of super - het designers, both in Australia and abroad tends towards the opinion

List of Parts for Lekmek 4/5 Super Het.

1 Lekmek Kit Type 345D.
1 Power Transformer, type 42T Lekmek
1 Vernier Dial (Efco, Radiokes, Precedent, Saxon, Essanay)
2 8 mfd. Electrolytic Condensers (Solar, Dulytic, Concourse, T.C.C.).
1 10,000 ohm Potentiometer, W.W. (Marquis, Radiokes, Paramount, M.M.)
1 Single Circuit Switch.
1 Chassis — 14½in. x 8¾in. x 2¾in. (Lekmek, Geo. White and Co.)
1 .00025 mfd. Condenser
2 .0001 mfd. Condensers
2 .01 mfd Condensers } T.C.C., Wetless, etc.
2 .5 mfd. Tubular Condensers
1 .1 mfd. Tubular Condenser } (Concourse, T.C.C., Wetless, Chanex, Hydra, Dubilier)
1 25 mfd. Dry Electrolytic Condenser (T.C.C., Concourse, Dulytic).
1 10,000 ohm. Resistor
1 15,000 ohm. Resistor
1 20,000 ohm Resistor
1 35,000 ohm Resistor
1 250,000 ohm Resistor
1 500,000 ohm Resistor } (I.R.C., Carbon, Ohmite, Bradleyohm, Carborundum, Velco)
1 100 ohm 25 M.A. W.W. Resistor
1 350 ohm 50 M.A. W.W. Resistor
1 425 ohm 50 M.A. W.W. Resistor
1 4500 ohm 20 M.A. W.W. Resistor } (Paramount, Lekmek, Radiokes, M.M., Velco, Precedent, Wendel)
2 57 Valves, 1 58 Valve, 1 2A5 Valve, 1 80 Valve (Philips, Kenrad, Speed-J.R.C., Radiotron, Tungsol.
4 6 Pin, 1 5 Pin, 1 4 Pin Valve Sockets (Lekmek, Targan, Marquis, Velco)
3 Valve Shields and Bases
Power Flex and Adaptor
4 Terminals and Sundry Screws, etc.
1 Speaker, 2500 ohm Field Single 2A5 Input Transformer (Rola, Precedent, Saxon, Amplion)

that, despite their undoubted efficiency, tubes of the electron coupled mixer type are broader in their tuning than autodyne mixers of the 57 class. From the viewpoint of component costs the 57 mixer is just as cheap to use in a circuit as a 2A7, so that the argument boils down to that of the relative efficiency of the two tubes.

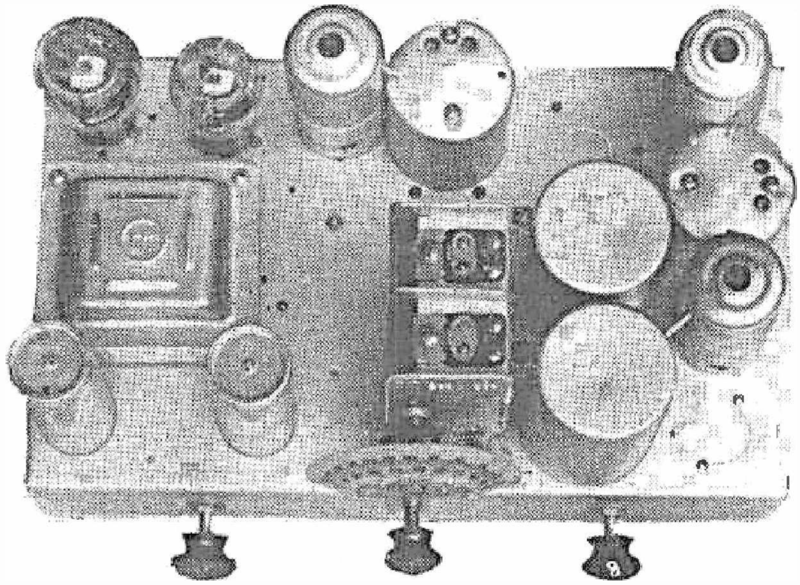
Effective Control of Volume

It will be noticed that no pre-selector stage has been used with this super-het, because the intermediate frequency, 460 k.c., permits adequate signal selectivity in the input tuning circuit. The modulator circuit of the receiver is perfectly straight forward, and requires no comment. The provision of a "Local-distance" switch, which, on the "local" position cuts in a 100 ohm resistor in parallel with the aerial coil and the wiring of the volume control resistance so that increased bias on the intermediate frequency tube and a reduction of the resistance across the aerial coil are simultaneously obtained, makes the control of the receiver exceptionally smooth. As is usual with autodyne mixer tubes, the oscillator grid coil connects to the cathode of the tube through a tap at the low potential end.

The 57 is biassed by means of the 4500 ohm resistor in its cathode circuit. The resistor is provided with a radio frequency by-pass of .001 mfd.

The padding condenser PD is made up of a conventional compression type padder in parallel with a small fixed condenser of .0002 mfd. Tuning of the modulator and oscillator circuits, of course, is carried out by C1 and C2 sections of the gang condenser respectively. The coupling coil for the oscillator section feeds directly to the low potential end of the primary of the first i.f. transformer I.F.1.

The screens for the 58 and the two 57's are fed from a single voltage source



Ease of wiring, one of the salient constructional features of the receiver, has been obtained by suitable placing of the components.

which consists of a 20,000 ohm resistor in series, with the main positive supply, and bled to ground through a 15,000 ohm resistor and the volume control. A further step in the direction of simplicity is the use of a single large by-pass condenser across this common screen supply lead. In the cathode of the 58 is a 350 ohm resistor by-passed to earth through a .1 mfd. condenser. This ensures that the i.f. tube shall have its minimum bias of three volts irrespective of the position of the volume control. The plate supply for the 57 mixer and the 58 is drawn direct from the B plus line, as is the plate supply for the pentode audio tube.

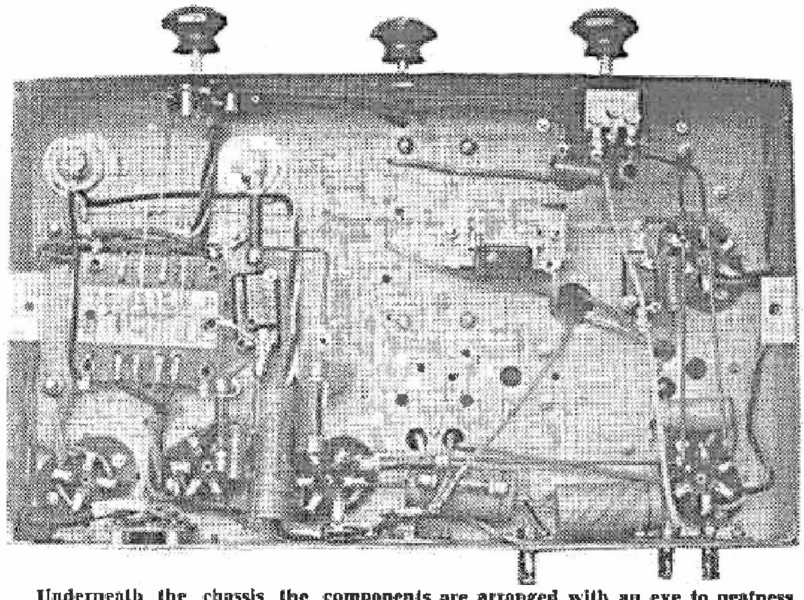
R.F. Filtration

In the grounded side of the secondary of the second i.f. transformer I.F.2. provision is made for the connection of a gramo pick-up to the second detector if required. A 10,000 ohm, resistor in the cathode circuit of the second detector provides the bias necessary for the tube to act as a plate detector. Its value is calculated to permit sufficient audio output to load up the 2A5 with a very small r.f. input to the grid of the 57 detector.

Despite the aim for simplicity the designers of the Lekmek 4/5 have spared no pains to ensure that unwanted radio frequency currents are kept from the grid circuit of the audio tube. To this end a filter network consisting of a 35,000 ohm resistor in series with an R.F. choke has been included between the plate of the 57 detector and the coupling condenser between this tube and the 2A5. The 57 plate side of this network is by-passed to ground through a .001 mfd. condenser, while the coupling condenser side carries a .00025 mfd. by-pass. The plate resistor of 250,000 ohms, the coupling condenser of .01 mfd., and the grid resistor of .5 megohm have been selected as ideal values for this particular hook-up.

In view of the R.F. filtering which exists in the second detector plate circuit no decoupling of the plate or grid resistors has been found necessary. Bias for the 2A5 is obtained in the conventional manner by means of a 425 ohm resistor connected between the tubes cathode and ground. This resistor is by-passed by a 25 mfd. electrolytic condenser. Tone compensation is obtained by means of a .01 mfd. fixed condenser connected between the plate of the 2A5 and ground.

The rectifier and filament supply circuit is standard, and should not need



Underneath the chassis the components are arranged with an eye to neatness as well as accessibility.

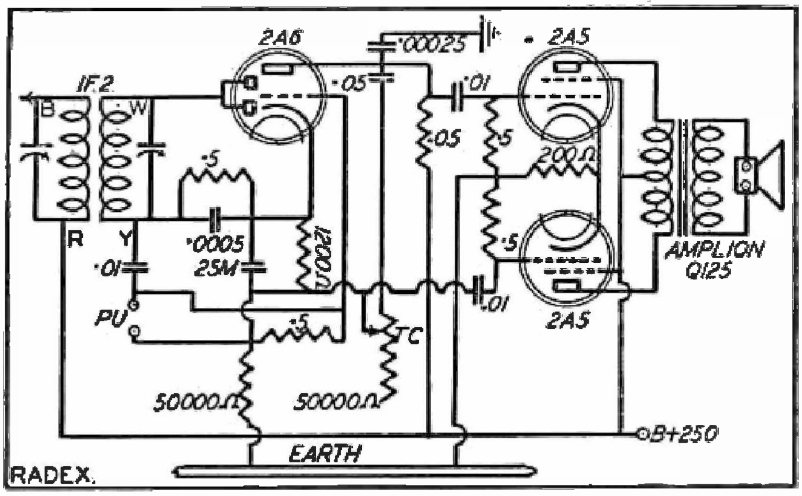
comment here. Note, on the circuit diagram the coded connections to the loud speaker socket and the color code for the coil and I.F. transformer connections.

Component Layout

Having outlined the salient features of the receiver we now will take up the question of construction. So simply is the Lekmek designed that it does not seem possible that anyone could have trouble with it. The receiver is quite compact, being built upon a chassis measuring only 14½in. x 8¾in. x 2 5-8in. In spite of the apparently small chassis used there is no need, as the various illustrations show, to cramp any of the components. Looking down on the top of the chassis from the front the two gang tuning condenser can be seen in the middle.

To the right of this condenser are two cans containing the modulator and oscillator coils, the first-named being to the front of the chassis. The mixer valve is mounted at the right hand end of the chassis to the right of the two tuning coil units. Between this valve and the 51 I.F. amplifier, which is mounted in the rear right hand corner is the first intermediate frequency transformer IF1. The second I.F. transformer IF2 is mounted behind the gang condenser. To the left of this transformer is the can containing the 57 second detector tube. The 2A5 audio tube and the 80 rectifier come next in line along the back edge of the chassis.

Along the left hand side of the chassis is mounted the power transformer. The two electrolytic condensers can be seen at the front left. The right hand control is the volume control, the centre one the main tuning control, and the left hand one the "local-distance" switch. Underneath the receiver practically every component, including the various resistors and condensers, is soldered into place during



An alternative circuit employs the new 2A6 tube as second detector to drive a pair of push-pulling 2A5's. The additional components necessary for this modification can be gauged from a study of the diagram above.

the wiring of the receiver. A study of the under chassis view of the set will show the intending builder practically everything he wants to know about the wiring of the set and the placement of parts. Note that the filament leads are kept to the sides of the chassis well out of harms way. Note also that a bus-bar has been used to join up those points of the circuit which are to be earthed, and that a lead is run from this bus-bar to the earth terminal on the chassis.

The .001 mfd. condenser used as the cathode by-pass for the 57 is mounted on a small machine screw over which has been fitted a collar which permits the condenser to be kept well clear of the chassis and holds it firmly enough to allow the bias resistor to be soldered direct to the condenser lugs. Near the power transformer the two .01 mfd. condensers, and the .00025 mfd. condenser used as the r.f. choke by-pass, are stacked together and bolted to the chassis. Near this pile of condensers the r.f. choke is similarly bolted to the chassis.

In addition to the socket for the l.s. outlet and the strips which carry the a.c. input leads, the aerial and earth terminals and the pick-up terminals, the padding condenser is bolted to the under side of the chassis between the oscillator and modulator coils. It is held off the chassis by means of distance pieces. All other fixed condensers and resistance are wired directly into circuit.

Wiring Hints

In wiring the receiver rubber covered flex is used for most of the connections, although for such leads as that from the 350 ohm 58 cathode resistor, which is soldered on the volume control, to the cathode of the 58, spaghetti sleeved stiff wire is employed. The screening grids of the three tubes are similarly joined with spaghetti sleeved wire.

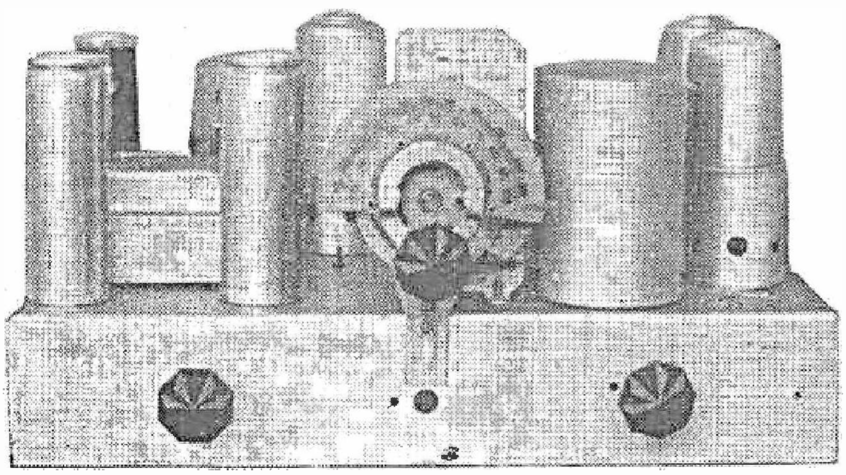
For the lead from the oscillator coupling coil to the primary of the first intermediate frequency transformer shielded cable is used to prevent unwanted radiatio.

When completed it is an easy matter to line up this receiver, for there are only three major adjustments to be made. After plugging in the valves, speaker and aerial and earth, and connecting the set to the a.c. line, tune down to 3AW or some similar wave length station. Adjust the trimmer on the oscillator condenser so that the station comes in at about 14 on the dial.

With the volume control set well back adjust the trimmer on the modulator section of the gang until best results are obtained, and then tune the set up to 2CO and adjust the padding condenser until greatest volume is obtained from this station. After each readjustment of the padder rock the dial back and forward over three or four degrees until the correct padding condenser setting has been found.

When this point in the alignment has been reached tune back to the lower end of the dial and bring in 3GL. Readjust the modulator trimmer if necessary, but on no account touch the oscillator. This completes the alignment of the receiver, and, judging by the results we had with the original, the builder should be proud of his job.

Selectivity, sensitivity and tone are all that could be desired, whilst the power output is more than sufficient for normal needs.

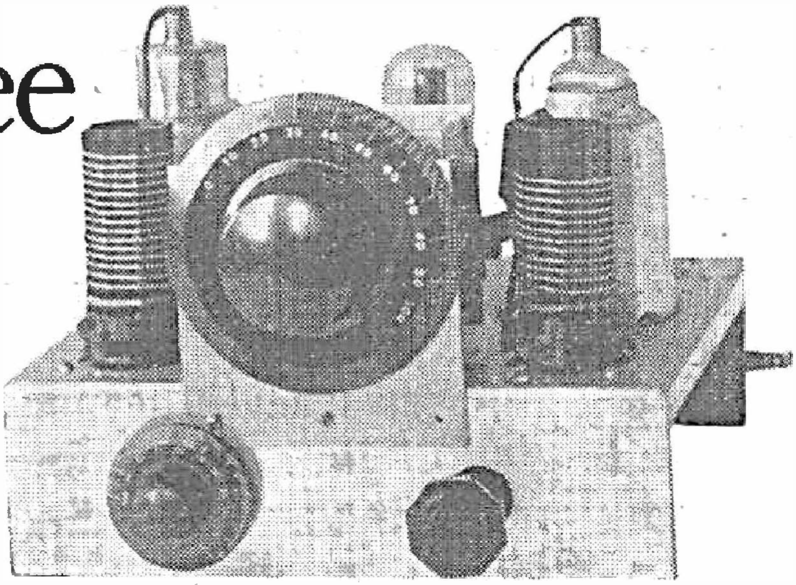


The front view of the completed receiver shows that, contrary to usual custom, the power pack equipment is mounted at the left-hand side of the chassis.

The Trans-Oceanic A.C. Three

Short-wave broadcast or Morse reception brought to its simplest forms in both construction and operation.

By RADEX



General appearance of the Trans-Oceanic Reaction Control is on the lower right, while the main dial is a Velvet Vernier, or some type free from back-lash.

HERE is a simple little three-valve short-wave receiver, of the self-contained type, that I built up for myself over a week-end not very long ago. In it are used all sorts of scrap parts, and it was assembled on a chassis from which an old testing model had been stripped. The framework just happened to fit and holes that at first appeared to have no immediate use came in very handily at the finish.

All those who have built sets to cover from, say, 14 to 90 metres, will agree that they are finicky things. Occasionally a model will come out as a winner: more frequently dull mediocrity is the result. The trans-Oceanic definitely comes into the former class. It is sensitive, it tunes very simply, it is absolutely free from fringe-howl or any signs of instability, and—most telling point of all—a carrier wave can be picked up and resolved into a broadcast programme merely by an adjustment of the conductively-coupled reaction control and without any alteration of the tuning condensers' settings.

Enthusiasts who have chased an elusive carrier half-way round the dial, only to discover it to be a local harmonic at the end, will give the final recommendation a very hearty welcome.

Apologies will not be made for the comparatively rough appearance of this model, as evidenced by the accompanying photos. Just as it was built, here it appears, and so it will remain. Certainly I made one small addition, to which reference will be made later, but it effected no real improvement. Furthermore, building from scrap lead to an interesting tuning combination which provides true overlapping band-coverage with a minimum of coils; this also will be dealt with in its proper place.

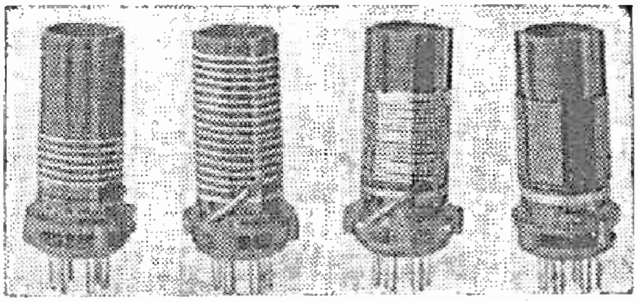
The Circuit Described

The design comprises a stage of tuned r.f. amplification, a regenerative screen grid detector operating on the conductively-coupled system, and controlled through the screen's voltage, and a resistance coupled audio stage for headphone reception. For these operations are employed two 58's and one 56, and here it may be remarked that a 58 proved a far better detector in every respect than a 57.

The variable-Mu characteristic of the first 58 is not employed; it is biased fixedly by R1. In the photos. appears a potentiometer on the left side of the chassis. This was tried in place of R1 in order to control volume, but, in practice, it proved a nuisance, as any alteration to it had an influence on tuning, even though it was well shunted by C1.

The r.f. transformer L3—L4 serves to couple the radio stage to the detector, and, associated with L3, the inclusion of shunt C3 and choke RFC1 is distinctly advantageous.

The detector functions on the leaky-grid system, and for purposes of regeneration its cathode is not earthed, but is taken to a pre-determined tapping point on L4. So far as the reaction effect is concerned, L4 now becomes an auto-transformer, that portion between tap X and earth serving as the primary and carrying the valve's full plate current to earth or B negative. Now it is obvious, or it should be so from your experience, that the degree of plate current in a screen-grid valve circuit is governed by the voltage on that screen. If, therefore, we provide means to vary the latter we automatically control the former.



Right: Completed coils Nos. 2, 5, 6, and 8. Below: The Coil Winding Table which should be followed in detail.

COIL WINDING DATA

No.	Turns Pri.	Detail	Turns Sec	Detail	Tapped at turn.
1	2⅛	No. 30 d.s.c.	3⅛	No. 20 tinned copper, spaced ⅛in.	⅜
2	3⅛	No. 30 d.s.c.	6⅛	Ditto.	½
3	5⅛	No. 32 d.s.c.	9⅛	Ditto.	¾
4	6⅛	No. 32 d.s.c.	12⅛	Ditto.	⅞
5	8⅛	No. 32 d.s.c.	15⅛	Ditto.	1
6	10⅛	No. 32 d.s.c.	20⅛	No. 29 tinned copper, spaced 1-16in.	1⅛
7	16⅛	No. 34 d.s.c.	30⅛	No. 20 enamel, close wound	1½
8	22⅛	No. 34 d.s.c.	45⅛	Ditto.	2¼
9	30⅛	No. 34 d.s.c.	60⅛	No. 22 Enamel, close wound	3

How Reaction is Obtained

This, boiled down, means that when the setting of the screen's voltage is such that a particular current value flows in the detector's plate-cathode-L4-earth circuit, that value can be sufficient to make the valve oscillate. The screen voltage is governed by high resistance potentiometer RC, across which are 100 volts. If we now move the arm of RC gradually nearer its earthed end, the screen voltage will be decreased and, in consequence, the current flow in the plate circuit will fall. Gradually, by this means, we will reach a condition when the detector will be at its most sensitive condition just below the point of oscillation. It will be noted that, in all of this, nothing effecting either the capacity or inductance of tuned circuit L4-VC2 has been done, therefore re-setting of VC2 for the two conditions (oscillating and non-oscillating) is obviated.

Tap X on L4 might be termed critical and this applies especially to coils used on the very short waves—say between 30 and 14 metres. If the tap is too far up from the coil's earthed end reaction will be too fierce unless the screen voltage is brought down to so low a value that the 58 is incapable of giving effective detection. Conversely, if it is too low down, for the same reason the screen voltage will have to be made too high before the value of the plate current will reach up to the point of oscillation. However, to within an eighth of a turn, all these tapping points have been worked out and are given in the coil data.

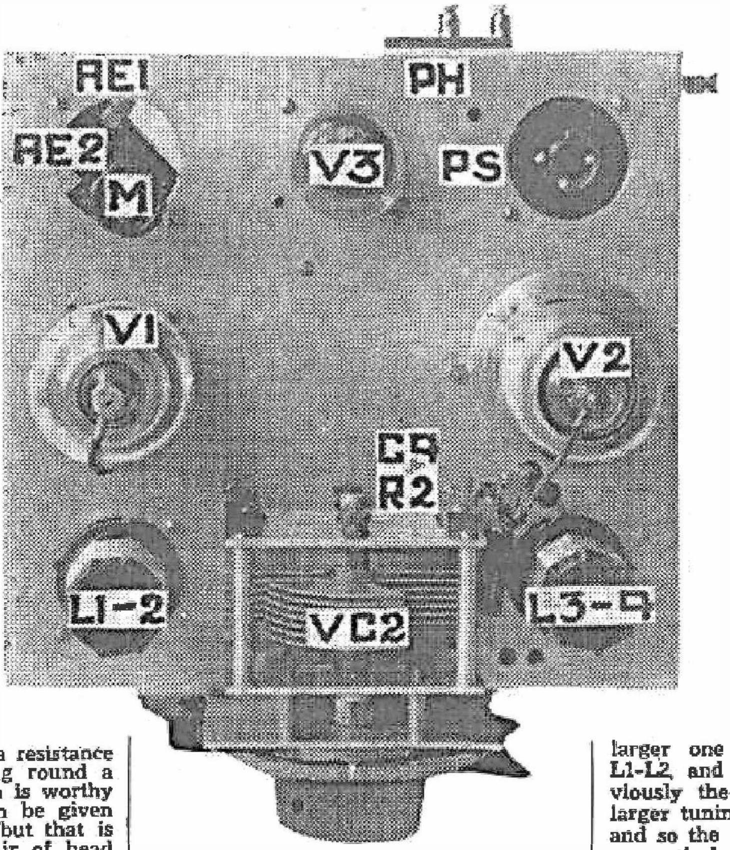
The circuit concludes with a resistance coupled audio stage centering round a 56. In this the output system is worthy of consideration. The 56 can be given up to 250 volts on its plate, but that is quite enough to wreck a pair of head phones. In consequence the valve is fed through resistance R8 and the phones are capacitatively coupled by means of C8. This arrangement has the additional advantage of permitting the S/W set to be coupled safely to an existing B/C receiver for loud-speaker reproduction; for that purpose it is only necessary to remove the phones, connect the upper phone terminal directly to the grid-pin of the B/C's final power valve and use a common earth for both instruments.

The Power Supply

IN the original, having one handy, the trans-Oceanic was fed from a power-pack built on a separate chassis. This, as illustrated, was taken by four wires (one Bx250, one earth and B—, and a 2.5-volt heater pair) by a UX plug to a 4-pin socket mounted in the right rear corner of the set chassis. In this arrangement C9 functions as the final by-pass condenser while a single tap on the voltage divider, at around 100 volts, feeds the screen of both 58's—that of V2 circulating via RC.

The average builder of this short-wave model will naturally desire to draw power supplies from the existing B/C set and this can be done quite easily provided a little common sense is used. As a start only three wires will be run to the 4-pin plug; the earth lead is the one dropped and, instead of it, the two chassis are to be connected together by an independent wire. It can be attached most easily to the B/C earth terminal.

Remove the B/C detector from its socket and leave the latter vacant. Now, if your B/C is either a straight T.R.F. or a super-het with a stage of radio before the mixer, remove its first radio valve and fit a 5 or 6 pin socket (as the case may be) in its place. From this take leads ONLY from the plate pin and the two heaters. These three wires will terminate, as before, in a 4-pin plug to fit into the short-wave set.



Plan view of the chassis with major components keyed to agree with the List of Parts.

In the case of a super-het that commences with the mixer, remove both the second detector and intermediate frequency amplifier valve and plug into the latter to pick up power supplies. The object of removing the second detector is to prevent the speaker howling, and also to limit heater current drain on the main power transformer.

Coil Construction and Tuning Overlaps

Except on the very short wave lengths the action of condenser VC1 is comparatively broad, whereas VC2 is always very sharp indeed. In consequence it is only necessary to employ a vernier dial in conjunction with the latter.

Again, with the exception of tap X on L4, L2 corresponds to L4 when similarly valued variable condensers are used at both VC1 and VC2. Further, for any given joint values of L2 and L4, L1 and L3 can also be the same. This similarity of the pairs of coil units for any given band gives rise to an interesting innovation in winding arrangements if we make VC1 and VC2 of different sizes.

To go back; suppose that those condensers were alike. We would then require, say, four pairs of coil units to cover from 14 to 90 or 100 metres, or eight in all. Experiment shows that if we use a 0.0001 midget 23-plate condenser at VC1, and one of 0.00014 or .00015 at VC2, we can not only go very much higher in the wave-band (which is not of much real use), but we also get a far more valuable over-lap of coverage between coil and coil. Under the old system it was often common to get a particular station low on VC2 (below 15 degrees) with one particular coil, and everyone who has used a S/W set knows that it is always a noisy position. Under the system employed every station can be heard on at least two coils, and, for at least one of these, the setting will be somewhere near the middle of the dial.

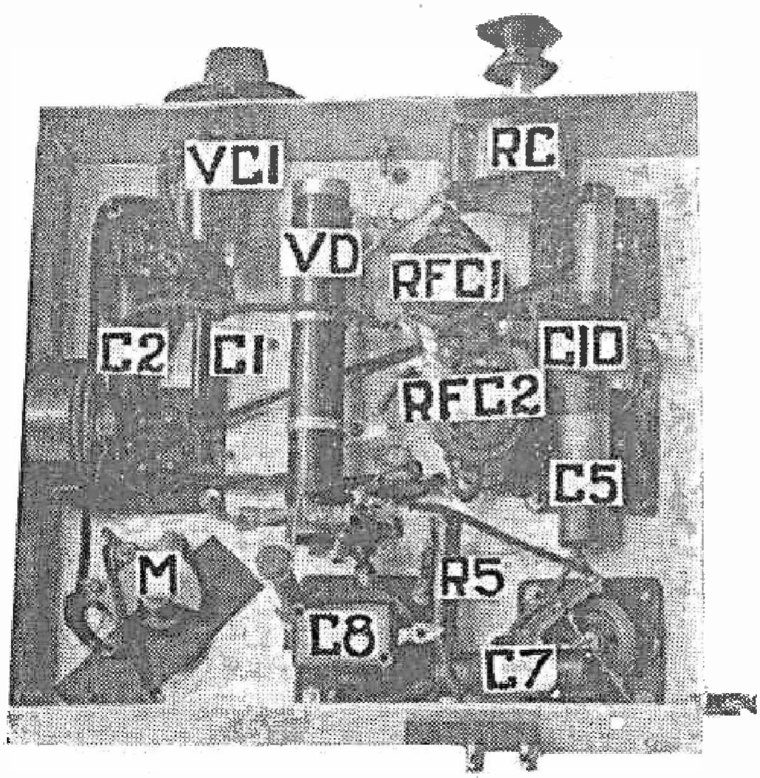
Reference to the Table of Winding Data will illustrate how this objective is achieved. Regarding the secondaries only, it will be seen that instead of having four similar pairs we have nine different coils progressively increasing in their number of turns from three to 60, and all are tapped at predetermined points X. Primaries also rise in the same manner.

Example of Coverage

In practice, two adjacent coils in the scale are employed together, the larger one being placed in position L1-L2, and the smaller in L3-L4. Obviously the smaller secondary gets the larger tuning condenser, and vice-versa, and so the balance is maintained. Take a practical example with GSB on 31.545 metres as the test station.

GSB can be brought in with 4 as L1-L2, and 3 as L3-L4, and both condensers nearly fully meshed. It will come in again with 5 at L1-L2 and 4 in L3-L4, and about two-thirds of both condensers. It can be heard with 6 in L1-L2, and 5 at L3-L4, and both variables at around 40 degrees. It even can be tuned with 7 and 6 in L1-L2 and L3-L4 respectively, and the condensers nearly all out, but in this instance the noise level is particularly high. Of course, owing to GSB's position in the band, this is an extraordinary example, but it is sufficiently illustrative for our purpose. Purists may say that there is too much over-lap, but it is easily found that certain combinations suit particular stations, and, after all, the system calls for only one more unit than the fully paired method.

If the wiring diagram of the coil-to-plug connections is inspected it will be easy to see how the units are interchangeable, even though L3-L4 has five connections, and L1-L2 only four. In both positions the coils plug into 5-pin sockets. In the instance of that for L1-L2, K is left vacant (unwired below



Looking into the under chassis arrangements. The text deals with these very fully.

chassis) and H1 and P are connected together, and to earth. In the socket for L3-L4 K is wired to the cathode pin of V2 and individual leads are taken from all five socket contacts.

All coils are wound on 5-pin Marquis 8-ribbed formers, and it is for this reason that eighths are included in the winding data. Primaries are started as near the formers' bases as possible. An eighth inch separates all primaries and secondaries. While the wire for tap X from pin K must come up through that pin, it should not go inside the tube; instead, it must be brought outside, so that it can be externally soldered to its specified point. This makes an alteration to its point of contact—perhaps an eighth of a turn either way—an easy matter. Where spaced winding is indicated, the measurement of the gap is taken as between centres of successive turns. All primaries are close wound.

While considerable latitude is permissible at the rear of the chassis, the illustrated arrangement of the front portion, vide the photographs, should be followed as nearly as possible. The physical size of VC2 affords sufficient shielding between the two coil units when it is placed between them. The dimensions of the original chassis are given as 9 wide and deep by 2¼ in height, all inches because that happened to be available with the holes already made for sockets. Provided the relative situations of L1-L2, VC2, L3-L4, V1 and V2 are maintained, the locations for M, V3 and the in-put power plug are of no particular importance; depth could be saved as regards their placements.

In case of misunderstanding, it should be explained that VC2 in the photos is a variable of 0.00035 mfd, with a fixed condenser of 0.00025 mfd in series with it, and operated by an old N-U velvet vernier dial. This was tried as a substitute for a straight 0.00015 mfd variable to see if there was any loss in signal volume. There was not, so you can use that combination, if you like, or a variable of 0.0005 mfd with a fixed condenser of 0.0002 mfd in series. The first arrangement results in a capacity maximum of 0.000146 mfd, and the second of 0.000143 mfd.

It is imperative that RC (reaction control potentiometer) should have a vernier movement and be insulated from the chassis; for this reason, a Marquis type is nominated in the Parts List. A 2-inch dial is quite sufficient for the rotation of VC1: its action is not critical. Place the 6-pin sockets for V1 and V2 and the two 5-pin sockets for the two coil units in such a manner that their heater connections are those furthest away from the front of the chassis.

By twisted pairs of leads connect the two heater contacts on the 4-pin power in-put socket to similar points on the sockets of V1, V2 and V3. Attach the G of the same 4-pin unit to chassis and leave P to take the B + in-put.

The most important thing in the wiring is to avoid trusting to the aluminium chassis for a negative return and earth. Instead, using No. 20 tinned copper wire, see that all returns from every source are eventually taken to G of the 4-pin power socket. Even in doing this certain of the bare leads must be kept very short. Thus you will so join up one H and P of L1-L2, C1, the moving vanes of VC1 as directly as possible, the other tail of C1 going right onto K of socket V1. Similarly the moving plates of VC2 will be wired actually to the same H of L3-L4.

Again, RFC2 should be close to P of V2. Note also that while the cathode of V2 goes to the X tap on L3 (K of that coil's socket) the same tube's suppressor grid is earthed; this is important.

The alternative aerial connections are not necessary unless your aerial is long —say over 80ft. over-all. For all ordinary aerials use AE1 only and omit AE2 and midget M altogether. Do not forget that the K contact of the socket for L1-L2 remains vacant.

Nothing is more true about a short-wave receiver than that its successful operation depends purely on patience, experience, and a lot of common sense. A couple of evenings' intensive searching together with notes of dial settings and coils' combinations therewith, will be more illuminating than reams of written directions. The secret of the whole thing lies in keeping the detector weakly oscillating while searching.

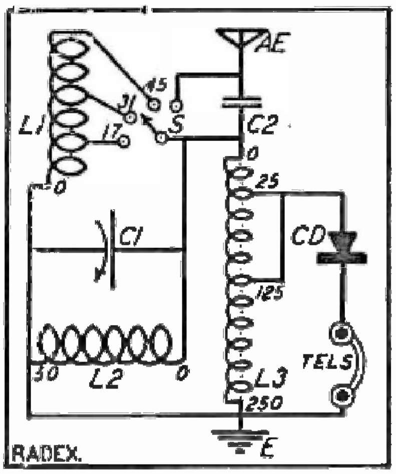
Commence by plugging Coil 4 into position L1-L2 and Coil 3 into the other socket. Turn the arm of RC hard over towards its earthed end. Set VC1's plates about half in and VC2 at around 85 on a 100-degree scale. Now slowly turn up the arm of RC. As you commence to do this you should notice a certain faint "liveliness" in the phones, and then a point will be reached when the sound becomes a definite rush—indicating an oscillatory condition of the detector V2.

To prove this reverse the direction of motion of RC until the rush is just there and then swing VC1 to either of its extremes; generally, going one way or the other, the rush will cease with a faint —very, very faint—"plop," indicating a stoppage of oscillation. Somewhere a

(Continued on Page 85)

LIST OF COMPONENTS

- AE1—Ordinary aerial connection.
- AE2—Long aerial connection.
- C1, C6, C8, C9—Mica condensers of 0.01 mfd.
- C4 and C10—Mica condensers of 0.0001 mfd.
- C2, C3, C7—Tubular condensers of 0.1 mfd.
- C5—Tubular condensers of 0.5 mfd.
- L1-2, L3-4—Special plug-in coils—vide text.
- M—Three-plate midget condenser.
- PH—Phones.
- PS—Power in-put socket—4-pin.
- RC—Potentiometer, 10,000 ohms, with vernier movement (Marquis).
- RFC1 and 2—Duffy S/W Chokes, Type D.
- R1—Wire resistors of 200 ohms.
- R5—Wire resistor of 2500 ohms.
- R2—Fixed resistor of 3 megs.
- R3—Fixed resistor of ¼ meg.
- R4—Fixed resistor of ½ meg.
- R6—Fixed resistor of 50,000 ohms.
- VC1—Midget variable condenser of 0.0001 mfd. and small dial.
- VC2—Variable condenser of 0.00015 mfd. with vernier dial (see text).
- VD—Voltage divider, 25,000 ohms.
- Valves—Two 58's and one 56, with two valve shields.
- Sockets—Two 6-pin and three 5-pin.
- Chassis of No. 16 gauge aluminium; for dimensions, see text.
- Sundries—Flex wire for connections, machine screws and nuts, some scrap ebonite for bushings.



Circuit of the Crystal Set.

Country Crystal Set

This simple crystal receiver is the one which has recently picked up a great number of local and interstate stations. City listeners are warned, however, that the design is not very selective and is mainly adapted to bush work.

By J. MYERS

ALMOST every crystal circuit will operate satisfactorily down to 3DB, but the other two stations, 3KZ and 3AW, come in very faintly in country districts. It is often the two latter that are desired with good phone strength. This circuit will give real results on 3KZ, 3AW, 3DB and exceptional results on 3UZ, 3LO and 3AR. It will also bring in interstate programmes when some of the larger transmitters are not working.

The idea of this design is to use as long an aerial as possible and yet retain a fair amount of selectivity.

The set contains three coils; L1 is of 45 turns, being tapped at the 17th and 31st turns, and is used to alter the setting of the condenser or reduce the tuned wave length. The other tuning coil, L2, has 50 turns, and is tuned by the variable condenser, C1, L1 and L2 are in parallel.

The remaining coil, L3, consists of 250 turns, and is used to alter the setting. The aerial is coupled through fixed condenser C2 except when shorted to receive 3AR.

Constructional Details

The panel and base board can be of any convenient size, about 6 x 8 inches will be found suitable with holes drilled to take the variable condenser C1, the detector CD and the four terminals. The panel should be screwed to the base of the same proportion as the panel.

The Coils

The formers should be placed in the oven for about 5 minutes to free them of moisture and then be given a coat of shellac varnish. When the varnish is dry the coils should be ready for winding.

Commence with L1 on the two inch former half an inch from the end. Wind on 17 turns and make a tap by twisting the wire in the form of a loop. Wind on 14 turns and make another tap. Then wind on the remaining 14 turns.

To make L2 take the second 2in. former and wind in the same way 50 turns without taking any taps. On the remaining former of 1¼ inch diameter another coil of 250 turns of the fine wire (No. 36) must be wound, taking taps at the 25th and 125th turn.

The Assembly

Having wound the coils the next step is to mount the components. The condenser C1 and the detector CD are mounted in their respective locations on the panel and the terminals screwed into their places.

LIST OF COMPONENTS

1 variable condenser of .0005 (C1) mfd and dial.
2 2-inch diameter pieces of former 2 inches in length.
1 1¼ inch diameter piece of former 6 inches long.
1 reel of 30 gauge S.C.C. copper wire for L1 and L2.
1 reel of 36 gauge S.C.C. copper wire for L3.
1 fixed condenser of .001 mfd. C2.
1 catswhisker type, crystal detector, CD.
4 terminals, wire for connections, screws, etc.
1 4 point switch, S.

The large coil L3 is fastened horizontally behind the condenser C1, L2 and L3 are placed vertically further behind. The fixed condenser C2 is screwed in position on the base under the aerial terminal.

Wiring Up

The aerial terminal is connected to one side of fixed condenser C2 and to one stud of the switch. The other side of C2 is taken to the starts of L2 and L3, to the fixed of C1, and to the arm of switch S. The moving vanes of C1 are joined to the finish of L2, to the start of L1, and the finish of L3.

The two taps on L3 are joined and fastened to one side of the detector CD, and the other side of CD is connected to the first phone terminal The other phone terminal is joined to the earth terminal, which is also wired to the finish of L3.

The aerial should be as long as possible for the distance from town. About 150 feet gives good results 40 miles from Melbourne. It may be increased or decreased as distance from Melbourne varies, and should be of 7/20 copper if possible. This may be obtained from almost any power station for about 2/ a length, or second hand.

Tuning In

The operation is very simple. Turn the switch on to the first stud at the catswhisker and tune the condenser. With this setting of the selector 3AR will be received loudly. The receiving wave length is decreased as the switch is altered to the other studs. With the switch off the studs it is not quite so selective.

To obtain the best results tune out a station until it can just be heard, then adjust the catswhisker. With this hook up surprising results may be obtained in the country, and for such areas it can be recommended. City listeners will find it lacking in selectivity and to them its value will be very questionable.

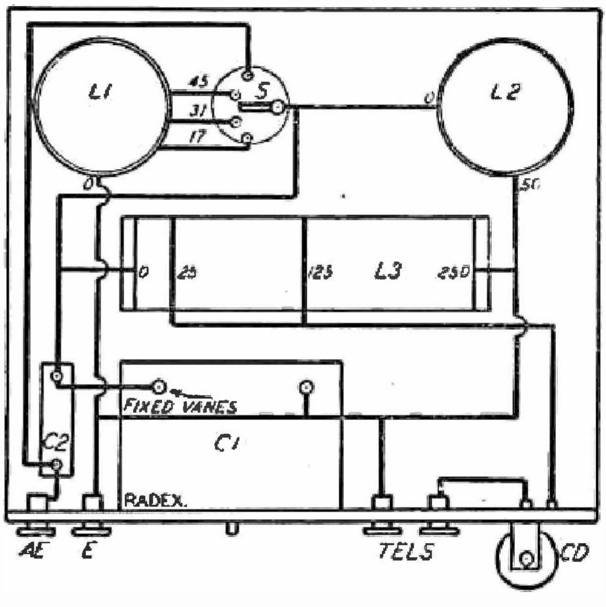
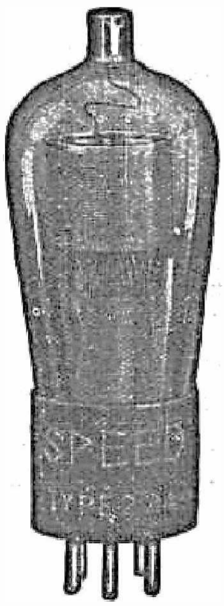


Diagram illustrating the layout of the parts

SPEED J.R.C. Radio Valves



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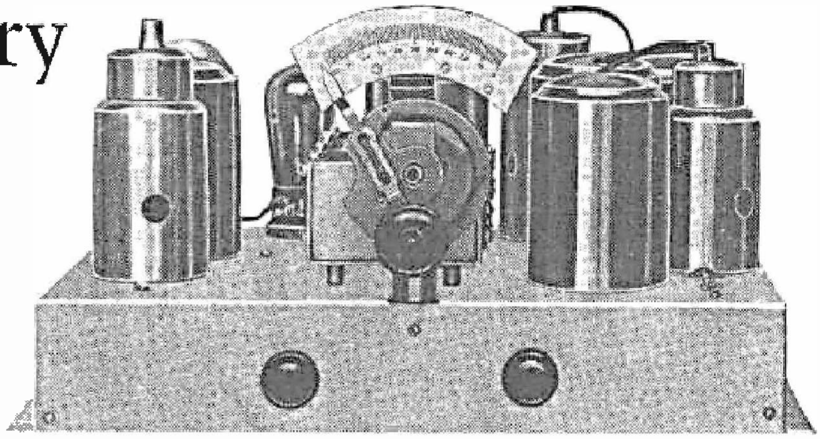
The Centenary Battery Super-Het. 5



This front view of the finished receiver illustrates its simplicity of construction.

An economical, battery superheterodyne for satisfactory reception in country areas.

By A. K. BOX

TEST cricket descriptions, broadcasts of the Centenary celebrations, the Davis Cup tennis matches, and a hundred and one interesting items make it more important than ever for the country listener to have a first-class radio receiver for 1934. The fact that interesting sporting broadcasts from 3DB and other B class broadcasting stations are transmitted during daylight hours makes it imperative for a sensitive receiver to be employed if full use is to be made of the entertainmnt possibilities of the 1934 radio receiver.

As usual, however, we are up against the old difficulty of "B" battery consumption, for the more valves we include in the receiver the greater the drain on both "A" and "B" batteries. The design of a suitable receiver comes down to a compromise between sensitivity and battery consumption, and the greatest use has to be made of modern developments in order to keep the sensitivity of the set high and yet use as few valves as possible.

Seeing that we wish to have a modern receiver, it is desirable — even necessary — to employ the superheterodyne circuit which permits us to get the greatest overall gain for the smallest number of valves.

During the last year or so there have been many versions of battery super - heterodyne receivers, but, despite the claims in some quarters that the valve is not satisfactory, it is the writer's opinion that best results can be obtained from a battery super-het which employs the 1A6 pentagrid converter valve. The main trouble with the battery super-het is not only the difficulty of getting sufficient amplification in the i.f. stage, but in feeding a sufficiently strong signal to the input circuit of the converter valve. This trouble, experienced so often during our city tests of battery operated receivers, is aggravated when the receiver is used in districts where because of the distances from the transmitting stations the signal voltage available at the aerial is very low. The consequence is that the receiver will not respond properly to the more distant stations and can be depended on to give results only from the powerful A class broadcasters.

Personally we have experienced difficulties such as these even with supposedly sensitive battery receivers which have employed either a two stage r.f. amplifier ahead of the converter tube or have used a two stage i.f. amplifier after it. Despite the fact that these receivers have given good results—two of the sets we have in mind are at the present moment performing very satisfactorily in areas well away from broadcasting stations—we have had a haunting suspicion that things were not right and that better valve for valve results should be obtained from the battery super-het.

In this spirit of humility we tackled the construction of the Centenary Battery Super-het with the determination to improve matters if it was humanly possible.

Salient Features of New Design

The first step in the design considerations of the new receiver was to keep the number of valves to a minimum. Having in mind our past experiences, we decided to be a little more modest in power output requirements and eschew Class "B" audio, to limit the i.f. amplifier to a single stage, and to concentrate upon a receiver which would function well when powered with a 90-volt "B" battery in addition to giving excellent results (at heavily increased plate current consumption) from the normally used 135 volt supply.

In order to keep the number of valves at a minimum and yet maintain the set's performance in remote districts, it was decided to precede the 1A6 mixer tube with a single radio frequency amplifier and to follow it with a single intermediate frequency stage; a grid leak detector and a transformer coupled pentode power tube. It is possible to reduce the number of tubes to absolute minimum by scrapping the r.f. stage, but in light of our experiments with our own and commercial four-valve battery super-hets, this does not appear wise.

Starting from the basis set out above, we built up a five-valve, employing fundamentally the same circuit as that shown for the final

LIST OF PARTS FOR CENTENARY BATTERY SUPER-HET. 5

1 Coil Kit, comprising aerial, r.f., 2 465 k.c. i.fs., oscillator, and padding condenser (L1, L2, L3, L4, L5, IF1, IF2 and PD) (Melbourne).
1 3 Gang .0005 mfd. Condenser, to suit coil kit (G1, G2, G3) (Essanay, Stromberg Carlson, Airway, Precedent, Saxon).
7 .1 mfd. Tubular Condensers (C1, C2, C3, C5, C6, C7, C8) (T.C.C., Concourse, Dulytic, Polymet, Saxon, Wetless).
1 .0002 mfd. Mica Condenser (C4)
1 .0001 mfd. Mica Condenser (C9)
1 .001 mfd. Mica Condenser (C10)
1 .006 mfd. Mica Condenser (C13) } (T.C.C., Wetless, etc.).
5 .1 megohm Resistances (R1, R2, R3, R4, R7)
1 1 Megohm Resistance (R5)
1 50,000 ohm Resistance (R6)
1 10,000 ohm Resistance (R8) } (I.R.C., Ohmite, Velco, Carbon, Chanex-Silent, Bradleyohm, etc.)
1 500,000 ohm Potentiometer (VC) (Bradleyohm)
1 Double Pole Single Throw Toggle Switch (SW1, SW2)
2 2 mfd. 250v. Test Fixed Condensers (C11, C12) (T.C.C., Chanex, Hydra, Wetless)
1 Aluminium Chassis, 15½ in. x 10¼ in. x 2½ in. (Geo. White and Co.)
1 3½-1 Ratio Audio Transformer (AFT) (Lissen, Philips, A.W.A. Ferranti)
3 4 Pin Valve Sockets (for V1, V3 and V4)
1 5 Pin Valve Socket (for V5)
1 6 Pin Valve Socket (for V2) } (Targan, Velco, Marquis, Precedent, Essanay, Eclipse, etc.)
1 Aerial Earth Strip.
1 4 Pin Loud Speaker Socket (LS)
1 Tuning Dial (Efco, Radiokes, Essanay, Saxon, Precedent, etc.)
1 Set of Valves:—1 Type 32, 1 Type 1A6, 1 Type 34, 1 Type 30, and 1 Type 33 (Ken-Rad, Philips, Radiotron, Speed-J.R.C., etc.)
3 45 Volt Heavy Duty "B" Batteries, (Diamond, Ever-Ready, Impex)
1 2 Volt Accumulator Type "A" Battery (Century).
1 15 Volt "C" Battery (Diamond, Ever-Ready, Impex)
Wire, Battery Cable, Nuts, Bolts, etc.

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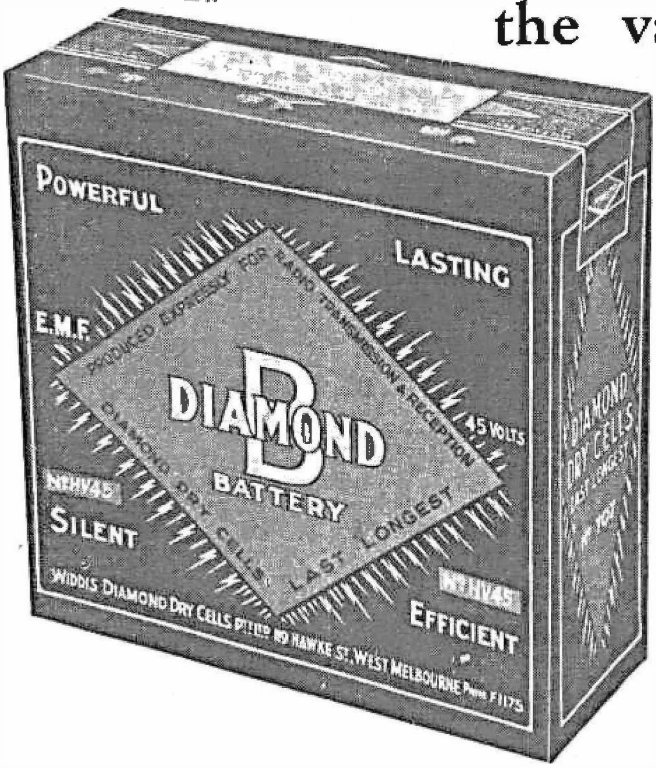

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SOLD AND RECOMMENDED BY ALL RELIABLE COUNTRY & CITY DEALERS receiver. The results, although a marked improvement on the four-valve models, were still not satisfactory, indicating that nothing like maximum performance was being obtained.

The first step was to juggle with the i.f. stage, experimenting with plate and screen voltages on the 34, and with different intermediate frequencies. Finally, through the collaboration of the engineers of Colonial Radio, we were able to get an i.f. transformer which improved matters tremendously. This was a special close coupled 465 k.c. transformer, which replaced the 175 k.c. ones we previously were using.

Although, for a given coupling between the primary and secondary windings, it is generally considered that the low frequency transformer has a higher gain than the 465 or similar frequency types, the fact that very close coupling was used in an endeavor to lift the i.f. stage gain made it advisable to lighten the job of the r.f. signal selecting stages by using the higher intermediate frequency.

The experimental i.f. transformers were provided with movable primary windings, so that the coupling between primary and secondary could be readily varied. As a matter of fact our experiments in this direction ended by setting the windings at a point of maximum coupling (about 5-16in. apart). This very close coupling broadened the tuning of the receiver to some extent, but this disadvantage was offset by the fact that the stage gain was increased markedly.

R.F. Coupling is Important

Even at this stage in the experiments, the receiver, although giving first-class response from powerful stations, did not display that "alive-ness" which is the characteristic of a really sensitive receiver. The next point for improvement then was the coupling between the r.f. and mixer valves.

In the original coil kit the r.f. plate coil L2 consisted of about 60 turns of fine gauge wire wound at the bottom end of L3, but separated from it by about quarter of an inch. Previous experience with r.f. couplings for battery receivers had shown that in single stage r.f. amplifiers the design and arrangement of the r.f. plate coil could make or mar the set, so we decided to graft some of our ideas for "straight" battery receivers on to this new superhet.

The existing plate coil was replaced with a high efficiency primary wound with 60 turns of fine wire on a close fitting former which would slide over the modulator grid coil L3. Some adjustments to the number of turns were necessary before we could get the optimum coupling point for L2 (above the middle of L3) without introducing r.f. instability, but when these details were cleared up it was found that a really important improvement had been made.

Carrying our ideas to their logical conclusion we worked on the input stage and replaced the small and loosely coupled aerial winding with two tapping points on the r.f. valve grid coil L1. These taps were empirically taken out at the 5th and 15th turns. The tryout after this last adjustment was eminently satisfactory. The receiver now had all the "pep" we required — in fact it had been "hotted up" to the limit and any further fiddling would be likely to give rise to either r.f. or i.f. instability.

Some Test Results

As an example of what these improvements had done it might be mentioned that our test stations 7UV and 2AY on the lower range could be brought in only at medium loud speaker strength when an outdoor aerial was used with the receiver before we experimented with the r.f. and i.f. stages. The top wave length test stations 2CO and 5CK, although good speaker strength performers on an outdoor aerial, had no entertainment value when an indoor aerial was used. When we had finished our alterations it was found possible to bring in 2AY and 7UV at full speaker strength with the set depending on its battery leads and wiring for pick-up whilst the top wave length test stations were sufficiently loud to overload the last stage valve. Naturally the middle wave length stations were improved to a like degree.

The thing we next went into was the battery consumption for the receiver. With the use of 135 volt potential on the plate of the pentode V5, 135 volts through 15,000 ohms on the plate of the detector V3, 135 volts on the plate of the i.f. valve V2 and 67½ volts on its screen, 135 volts on the modulator, and oscillator plates of the mixer tube V2, and 45 volts on this tube's screen, and 135 volts plate and 67½ volts screen on the r.f. valve V1, we were horror stricken to find that the set's plate consumption was 30 m.a. —a figure which exceeded even our most pessimistic imaginings.

A check-up of the various tubes showed that the pentode V5, despite the fact that it was biassed to the tune of 15 volts negative, was taking 17½ m.a. or nearly 60 per cent of the total plate consumption. The detector V4 also was a nasty shock, for it was drawing 4 m.a. On the other hand the 34, V3, was taking only 3 m.a. and—greatest surprise of all —the 1A6, V2, required the modest current of only 3 ma. The 32, V1, draw 2 m.a.

The most interesting thing about this examination was that by using a screen voltage of onl·: 45 we were able to cut down the plate current of the 1A6 materially without affecting the tube's performance.

As for the pentode—well, obviously, for the man who must depend upon dry batteries for plate supply the thing is hopeless.

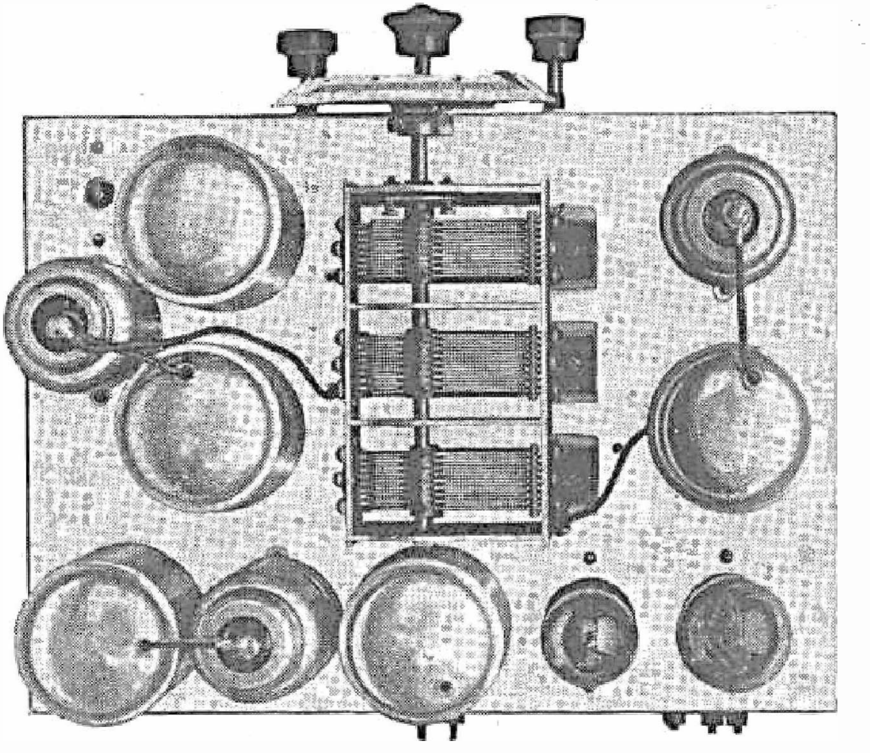
Incidentally, in making our original calculations we slipped badly as far as the second detector was concerned. The maker's instructions for this tube specify that when used as a leaky grid detector its rated plate potential should not exceed 45 volts, in which case it would raw a maximum plate current of 1 m.a. As a matter of fact, with a 2 megohm grid leak and 45 volts on its plate the 30 draws only half a milliampere, but allowance must be made for the fact that with the lower value grid leak, we have used 1 megohm, the plate current will be greater.

The point at which we are driving is that R6, instead of being 15,000 ohms, should be roughly 100,000 ohms when the receiver is to be used from 135 volts supply of 50,000 ohms when a 90 volt plate potential is available. Alternatively, keep to the 15,000 ohm resistor, which is necessary for de-coupling purposes and tap the supply for V3 from the 67½ volt point on the "B" battery.

Economical Operation Possible

Having painted the doleful side of the set's maintenance let us see what happens when we reduce the maximum plate voltage to 90. Although the undistorted power output of the receiver is reduced, its sensitivity does not appear to be greatly affected. Economy of operation, as is evident from the following figures, is made practical, and the receiver becomes a real proposition for the country listener.

With a 90 volt plate supply the set's consumption is as fol-



A photographic plan view of the top of the set shows that, whilst simplicity of wiring has been given primary consideration, the component layout is pleasing to the eye.

lows:—Plate and screen of V1. 1 m.a.; both plates and the screen of V2, 1½ m.a. plate and screen of V3, 1½ m.a.; V4, 2 m.a., and V5, 8 m.a. — a total of 14 milliamperes, which is well within the working capacity of any good heavy duty "B" battery. The remarks anent the plate potential on V4 apply here, too, so that with correct operation it should be possible to save at least another milliampere.

The foundation unit is an aluminium chassis measuring 15½ inches in length, 10½ inches in width, and 2½ inches in depth. Looking from the front of the set, we see in the left-hand corner the r.f. valve V1. Next to this is the aerial coil can containing L1. Still in line with this but in the back left-hand corner is the pentode valve V5, and alongside it the second detector valve V4. Directly behind the gang condenser is the second i.f. transformer, IF2. The intermediate frequency amplifier tube V3 is at the right of this "can" between it and the first i.f. transformer IF1, which is mounted in the back right-hand corner of the chassis.

The oscillator coil can containing L4 and L5 is at the front of the chassis to the right of the gang condenser. The modulator coil unit comprising L2 and L3 is between this "can" and the back of the chassis, whilst the 1A6 mixer tube is mounted on the right-hand end of the chassis midway between these two coil cans. The padder condenser adjusting screw can be seen to the right of the oscillator coil can. Note that the connections to the gang condenser are such that the back section tunes L1, the centre section tunes L3, and the front section tunes L4.

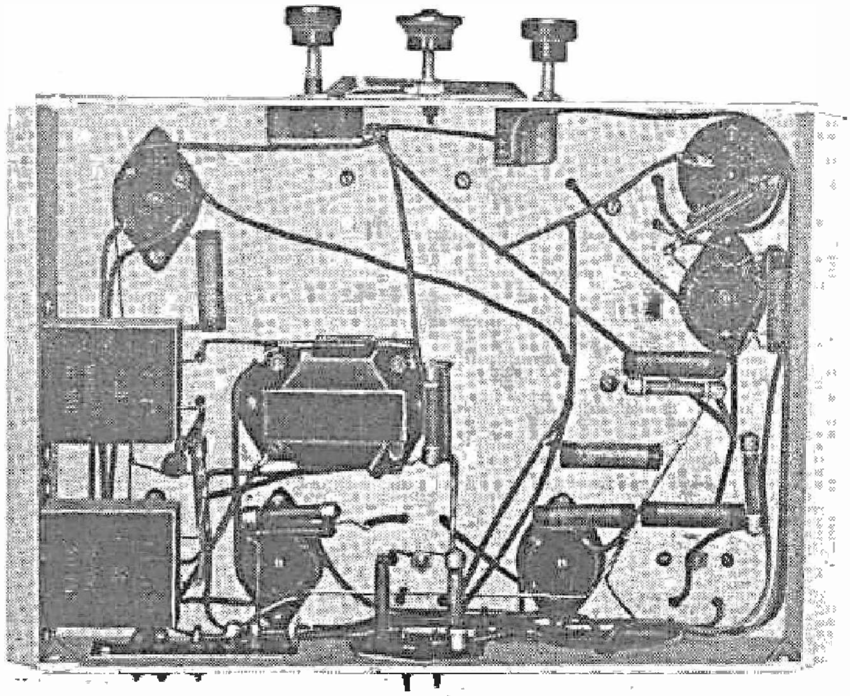
Note the under chassis layout which tends to easy wiring.

Looking towards the front of the set (upside down, of course), it will be seen that the padding condenser PD is mounted in the extreme right-hand corner, alongside the socket for V2. The by-pass condenser C5 is to be seen between the socket for V2 and the side of the chassis. The grid leak, R3, and the fixed condenser C4 are suspended above PD. The condenser C3 and the decoupling resistance R2 are mounted together in front of the socket for V2. In the back right hand corner are the fixed condenser C7 and the resistance R4 for decoupling the grid circuit of V3. To the left of these can be seen two fixed condensers. The one nearest the back is C8, whilst the front one is C6. The resistances mounted by the audio transformer, AFT, are the decoupling resistors R6 and R7. C10 is mounted alongside the audio transformer.

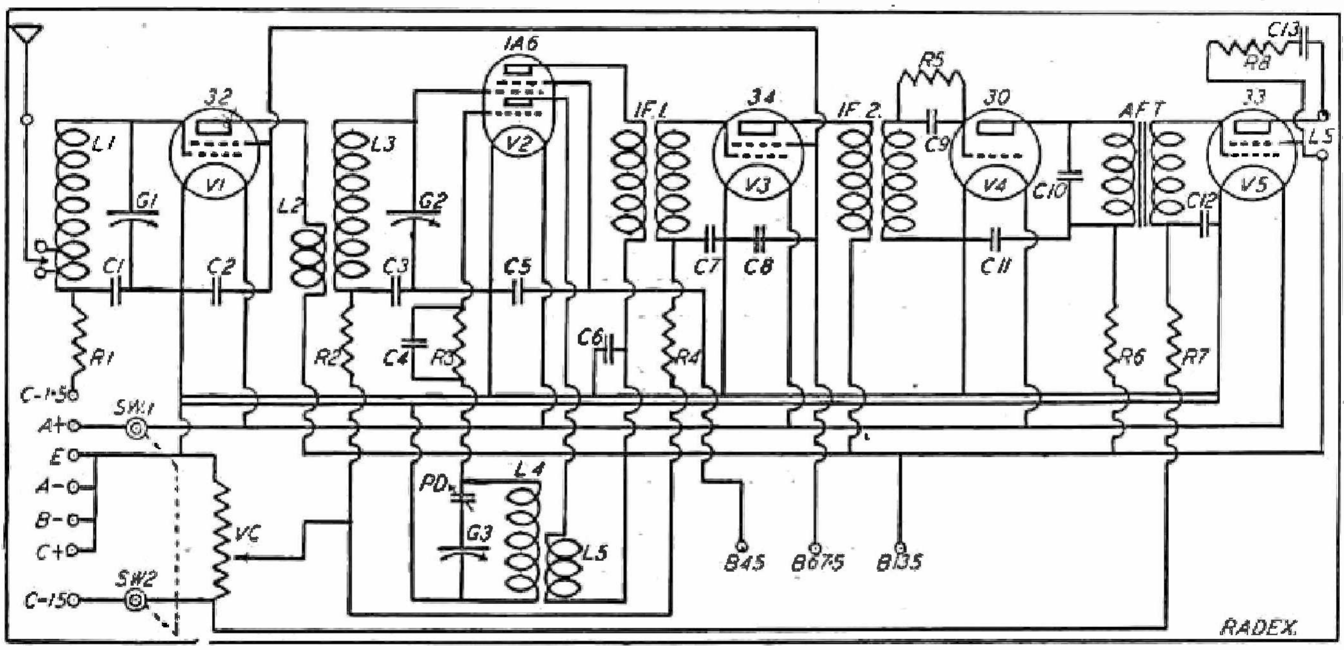
The resistor and the condenser seen protruding from the l.s. socket (back middle of the chassis) comprise the tone unit made up of R8 and C13. In the front left hand corner can be seen the socket for V1 and the screen grid by-pass C2. The two large fixed condensers at the left hand end of the chassis are C11 and C12. Just in front of the aerial-earth terminal strip (back left of the chassis) can be seen the second detector socket for V3, with the grid leak R5 and grid condenser C9 mounted alongside.

In the wiring maze between C11 and C12 is hidden the decoupling resistor R1 and by-pass condenser C1 for the r.f. valve V1. The controls on the front of the receiver are (left) the 500,000 ohm volume control, the tuning dial shaft (centre) and the double circuit switch (right). As can be understood from these pictures of the completed set, its construction and wiring are a comparatively simple matter.

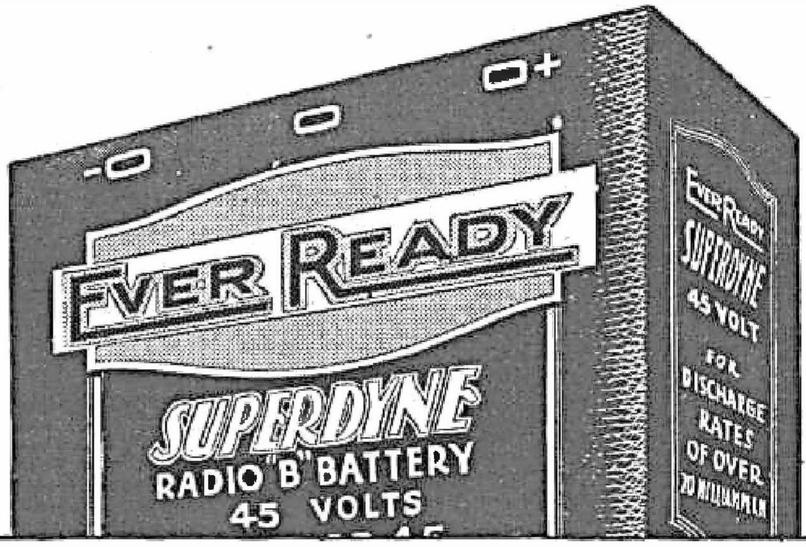
The only point to watch from the mechanical aspect of wiring is that the connections to the sockets of V1 and V5 (the latter being hidden under C12) must be completed before the 2 mfd. condensers C11 and C12 are bolted into place.

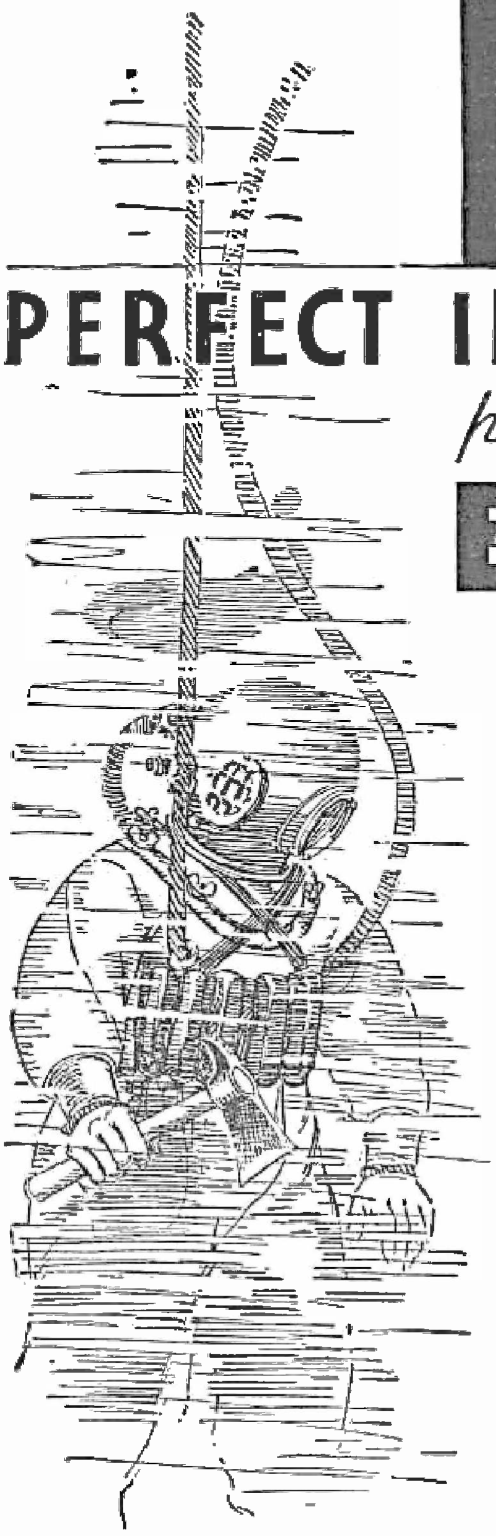


Study this under-chassis illustration of the completed set in conjunction with the constructional details and the schematic circuit diagram.



The schematic circuit diagram of the Centenary Battery Super-Het 5 is key lettered to agree with the list of component parts and the assembly instructions provided in this article.





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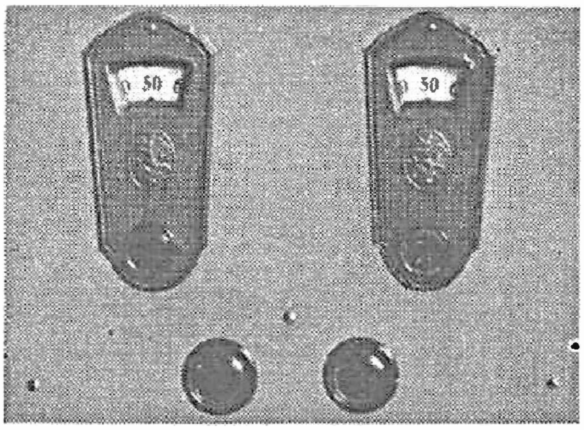


Front view of the finished assembly. The controls are:—Left, vernier for tuning the radio frequency stage, and the right for the detector, whilst below the left knob is the battery switch and the right reaction control.

An ideal set for Country Listeners who reside in areas not supplied with A.C.

By
P. R. DUNSTONE

The Constant Gain "Three"

THIS article deals with a new system of coupling the radio frequency valve to the detector by which the gain can be made equal at the two end frequencies and only slightly less at the geometric mean frequency.

To obtain this end in practice it is necessary to combine the mutual-inductive and capacitive coupling. By proportioning the two so that at any two extreme frequencies the coupling is the same we reach our goal. The system can be seen in the schematic circuit accompanying this article. Here the coupling is the sum of that of the condenser C3 and of the two coils L3 and L4.

There is one trouble which confronts the experimenter when using this system, and that is the difficulty of making the two tuning condensers track.

The Question of Ganging

Since the coupling condenser C3 is in the tuned circuit, or in other words in series with VC2, it will naturally affect the frequency or resonance a little. Owing to the large capacity of C3 the tuning condenser VC2 will, however, alone determine the frequency. Nevertheless this extra capacity in the tuned circuit is enough to upset the business insofar as using a two-ganged variable tuning condenser.

Looking from another point of view—although I have not yet experimented with it—should the aerial and grid coils L1 and L2 be coupled in the same manner as L3 and L4 it may be possible for the receiver to use a gang condenser. The greatest effect of the coupling condenser occurs when the tuning condenser has the largest value, that is, at 540 k.c. Therefore, should the first series of coils be coupled the same as the r.f. it should be possible to make the two condensers track evenly over the complete scale.

The features of the constant gain coupler are that it serves two purposes. First, it increases the coupling at the low frequency end of the tuning range, and, second, it decreases it at the high frequency end. Such a coupler is very useful in straight-out radio frequency circuits but less so in superheterodynes, where most of the amplification is done at a uniform frequency.

The model described in this article uses a PM12A in the radio frequency stage, a PM1HL in the detector, which is transformer coupled to a PM22A. It can be seen that with the inclusion of these valves the total consumption is low, making it an ideal set for use in country districts not favored with electricity.

Parts List

2 Variable tuning condensers .00043mfd. VC1, VC2.
3 Valve sockets, sub panel mount; 2 UX and one UY.
Coil Kit: One aerial and one radio frequency.
1 Midget condenser 23 plates M.
1 Switch SW.
2 .003mfd. C3, C5.
2 .01 mfd. C1, C2.
1 .0025mfd. C4.
1 .5mfd. C6. } **(T.C.C., Chanex or Saxon)**
1 Carbon resistor 2 megohms R1.
2 Radio frequency chokes RFC1, RFC2.
1 Audio frequency transformer T.
1 Five-way battery cable, 6 feet length.
Terminals, wire, etc.
1 Aluminium Chassis.
Valves: 1 PM12A, 1 PM1HL, 1 PM22A.
1 2-volt Century Accumulator Battery.
1 B Battery (60 volts).

Although this receiver should have 130 to 150 volts applied to the plate of the output valve, it will operate quite effectively with only 60 volts throughout. From this it is seen that these battery-operated valves are very elastic and can be employed on any voltage ranging from 60 to 150.

The whole receiver is built on an aluminium chassis giving it a neat finish and at the same time eliminating a considerable amount of the wiring. Where, in the older models of battery-operated sets, it was essential for all the earth leads to be taken to an earth terminal mounted at the rear of the baseboard, it is now only necessary for these leads to be taken direct to chassis.

Keep Leads Short

The accompanying photographs will show the builder the layout adopted in this model. These illustrations should be closely followed since the arrangement of components permits the connections being made as short as possible. When there is a radio frequency stage on the same chassis as the rest of the receiver, it is best to keep all leads short, thus preventing any tendency for feed-backs or adverse couplings of any description.

A battery cable is used in place of the conventional terminal strip mounted at the rear of the chassis. This is a much more practical method of connecting the various battery leads to the receiver, since they are soldered direct to their respective components in the circuit, eliminating all troubles due to faulty connections at terminals.

Reaction has been included in the detector circuit to give the little extra lift that is required in most country districts. Provided the builder follows the coil winding details given in a later paragraph, no trouble should be experienced from this source.

The receiver is reasonably sharp in its tuning, permitting an aerial of 50 to 75 feet being used. This should be erected in a position clear from any shielding properties and should be raised as high as possible.

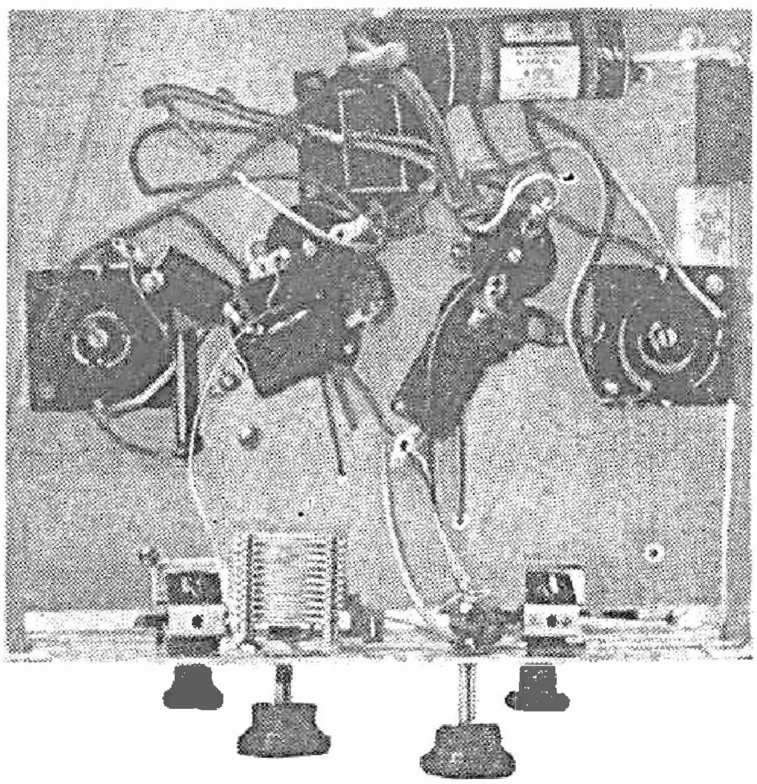
It is essential in all battery-operated receivers that a good earth be used, therefore particular attention should be paid in the making of one to a water pipe or a rod driven well into the ground, preferably where the earth is damp.

Reviewing the Components

The variable tuning condenser VC1 and VC2 should have a capacity of .00043 mfd. each, and be of solid construction. In the case of VC2 the capacity could be .0005 mfd. and VC1 .00043 mfd., the former having the effect of compensating for the series capacity of C3, although the use of two condensers with the same capacity gave reasonable tracking.

The valve sockets are of the sub-panel type—two UX and one UY will be required. It is essential that the contacts on these be rigid, otherwise foreign noises due to poor contacts will be noticed, which, in time, will completely spoil a radio programme.

The audio transformer T is the usual 3 to 1 ratio type. It is desirable to have this component shielded, so preventing any coupling, or feed back, due to interaction of the windings of the transformer and some other part of the circuit.



Sub-chassis picture demonstrating the wiring and placement of parts.

The radio frequency chokes should be of a type with at least 500 turns wound on them. Should the builder be desirous of winding his own chokes, the following data will probably be of assistance to him:—The sides of the bobbin should be made from a piece of fibre about the size of a penny. Two pieces are locked together with about a quarter inch ebonite washer between them. Then commence winding with gauge 35 to 40 wire until the bobbin is filled.

When the winding is completed it may be advisable to drop the whole job in a tin of hot paraffin wax, which will seal the windings together. Two of these chokes will be required in the construction of the set.

The midget condenser M is used for controlling the regeneration of the detector valve and should have 23 plates. It is not essential for this number of plates to be used. Provided the builder makes the necessary adjustments to L5 coil, a smaller midget will be satisfactory.

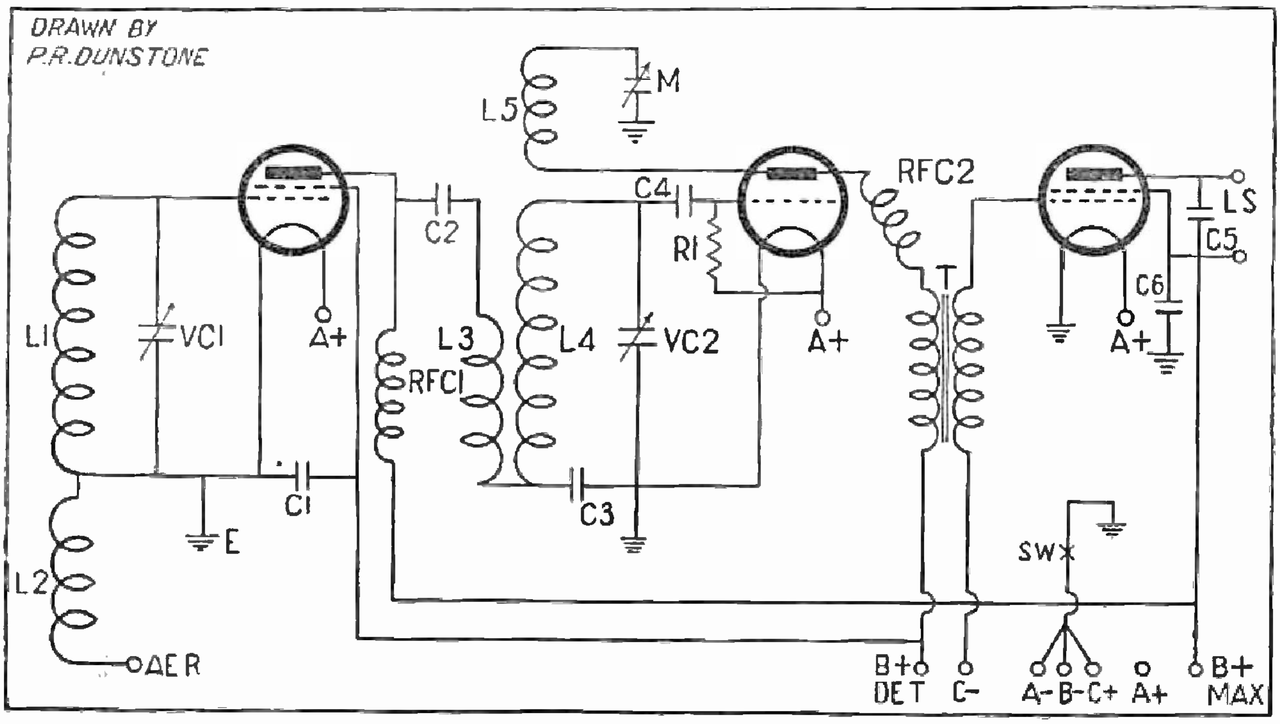
The coils used in this model consist of the standard R.C.S. aerial and radio frequency units. In addition to these, a coil consisting of 30 turns No. 30 D.S.C. wound on a 1in. diameter former should be made up. This is placed inside the R.F. coil former and is used for reaction. It is not necessary to use R.C.S. coils so long as types similar to these are employed.

The valves used in this model are of the modern battery variety and are PM12A and PM1HL and a pentode PM22A. On referring to the characteristics of these valves, shown here, the builder will see how little A and B battery consumption they have:—

The Mullard PM12A Characteristics

The P.M.12A is a 2-volt screen grid valve specially suitable for use where low consumption is desired.

Schematic Circuit of the Constant Gain "Three"



Filament voltage 2.0
Filament current .. .. 0.18 amp.
Max. plate voltage 150
Max. screen voltage 90
Plate current .. .. 1.25 Ma.
Screen current .. .. .8 Ma

These currents hold when the valve has volt bias applied to the grid. When used without grid bias the valve will handle a maximum input signal of 0.1V (peak) without distortion. With optimun plate and screen voltage, and assuming an output coupling having a dynamic impedance of 100,000 ohms, a stage gain of approximately 133 can be obtained. The maximum voltage for 0.1V (peak) input would therefore be 13.3V (peak).

Note.—The stage gain figures given above, assume an anode coupling of 100,000 ohms dynamic impedance, since this is a value easily obtainable in practice with reasonably good coils. Where more efficient couplings are used, however, considerably higher stage gains can be obtained.

P.M.1HL Characteristics

The P.M.1HL is a medium impedance 2 volt detector and general purpose valve. The characteristics for this tube are:—

Filament voltage 2.0
Filament current 0.1
Max. plate voltage 150

Used as a leaky grid detector with the usual .00025 mfd condenser and 2 megohms grid leak, the PM1HL will operate only 20 volts applied to the plate. When used under these conditions the steady plate current is 0.4 m/a and this should not be depressed below .03 m/a by a signal.

An input voltage of 0.19 V.R.M.S. can be handled without distortion and, when coupled by a 3/1 ratio transformer, the PM1HL will deliver a peak voltage of 6.5 volts to the succeeding stage, assuming 80 per cent. modulation.

Mullard PM22A Characteristics

The PM22A is a 2-volt pentode output valve specially suitable where H.T. current is of vital importance. The operating data is as follows:—

Filament voltage 2.0
Filament current ... .. 0.2 amp.
Max. Plate Voltage 150
Max. Aux. Grid Voltage ... 150
Recommended load .. . . 15,000 ohms

When this valve is operated with 150 volts on both the plate and auxiliary grid the plate current is approximately 15 m/a with a negative grid bias of 4.5 volts. With the recommended load of 15,000 ohms the undistorted output is 425 milliwatts. Should this valve be used under conditions where the plate and auxiliary potential is 100 volts the plate current is only 4.5 m/a with a negative grid bias of 3 volts.

From this data it can be seen that for the little extra output it will be advisable to operate the valve on the lower voltage, thus reducing the current drain to half its normal amount.

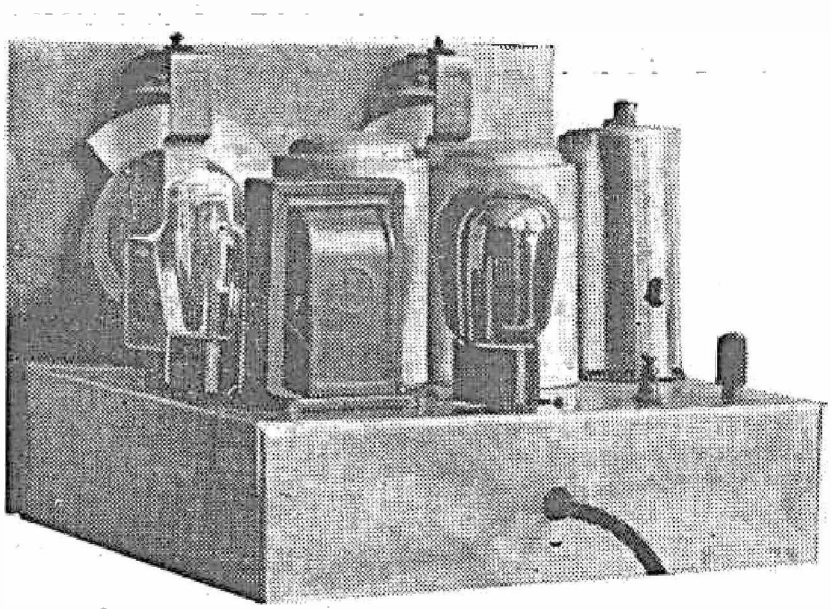
Only the important parts of the circuit have been reviewed and the remaining components will be left to the discretion of the builder.

Mounting the Components

The 32 valve socket should be mounted as near the tuning condenser VC1 as possible so as to permit a short lead to be taken from the grid on top of the valve to the fixed plates of VC1. Alongside this valve socket the coils L1 and L2 are mounted which actually places the radio frequency stage free from any other section of the circuit. The remaining parts, that are mounted on top of the chassis, are shown in the photographs, and should not offer any difficulty to the builder.

There is one important thing to keep in mind when mounting these components; see that they are so arranged as to allow the shortest leads possible. The aerial terminal should be bushed from chassis. In the original set the loud speaker was wired direct into the set. However, if the builder is desirous of mounting terminals for the speaker it will also be necessary to bush these from the frame.

Below the chassis the two radio frequency chokes are the only parts fastened to the frame. The condensers and resistors are wired direct into circuit, there being no necessity for them to be made fixtures.



Photograph showing how the battery cable is taken out at the rear of the chassis.

Wiring in Words

Commence the wiring by taking a lead from the beginning of L1 coil to the fixed plates of VC1 and to the grid of the PM12A valve. The other end of this coil is taken to earth. The start of L2 is soldered to the aerial terminal mounted at the rear of the chassis, the remaining end of this coil is fastened to the chassis.

The plate terminal of the PM12A valve is joined to one side of R.F.C.1 and C2. The other side of C2 is then taken to the top of L3 coil. The top of L4 coil is connected to the fixed plates of VC2 and to one side of C4.

The two remaining ends on coils L3 and L4 are soldered together and joined to one side of C3, the other side of this condenser is taken direct to chassis.

The other end of C4 is fastened to one end of R1 and to the grid of the detector valve. The resistor R1 is then connected to the A positive terminal of the PM1HL valve socket.

The plate terminal of the detector valve socket is joined to the top of L5, the other end of L5 is fastened to the fixed plates of the reaction condenser M. The movable plates of this condenser are automatically connected to chassis through the medium of its frame.

Another lead is taken from the plate terminal of the PM1HL valve socket, which is connected to R.F.C.2, the other end of this choke is joined to the P terminal of the audio transformer T. The G terminal of this transformer is soldered to the grid terminal of the PM22A valve socket. The P terminal of this valve socket is taken to a terminal mounted at the rear of the chassis for the loud speaker, while the screen of the PM22A is connected to the remaining loud speaker terminal.

The condenser C5 is soldered across these two loud speaker terminals, while another condenser C6 is joined from the screen terminal of the PM22A to chassis.

The screen terminal of the 32 valve socket is by-passed to earth by C1 and is also connected to the B terminal of the audio frequency transformer T. This leaves the battery cable to be wired into the circuit.

One lead is soldered to the B terminal of T and serves for the B positive detector voltage. Another lead is taken to the C or F terminal of T, which is used for C negative lead. A lead from the cable is joined to the loud speaker terminal that is connected to the screen of the PM22A valve socket, this is also taken to the remaining end of R.F.C.1, and serves the purpose of B positive maximum.

Of the two remaining wires inside the cable one is fastened to the switch mounted on the front panel while the other side of the switch is taken to chassis. The lead connected to the switch is used for A and B negative and C positive. The remaining lead is connected to all the A positive terminals of the three valve sockets. The A negative terminals on these sockets are taken direct to chassis.

Operation

Having connected the aerial-earth and all leads to their respective batteries, switch the receiver on. Rotate VC1 and VC2 until a station is heard, then adjust M until greatest volume is received. Should the receiver not oscillate when adjustment to M is made it may be that you have L5 wrongly connected, so first try a reversal of its two leads.

If neither method of wiring L5 gives a reactive effect of M, it is an indication firstly that the detector plate voltage requires to be higher, or, alternatively, that L5 wants more turns.

The Lekmek Short Wave Convertor

Details of a Super-heterodyne short wave convertor unit which is both cheap and simple to build.

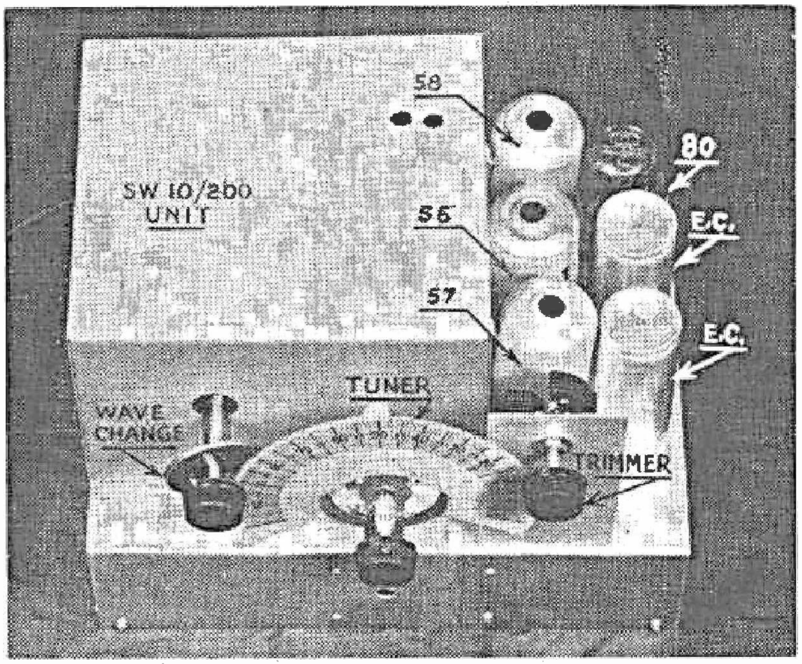
By A. K. BOX

IT is generally recognised that its high sensitivity and ease of control make the super-heterodyne particularly suitable for short wave reception. However, not every set builder can afford the expense and trouble of a special short wave super-heterodyne, and is forced to look round for a cheaper and simpler method of embodying the advantages of the s.w. super-het. in an existing receiver. For this individual the separate super-het. convertor offers the greatest possibilities.

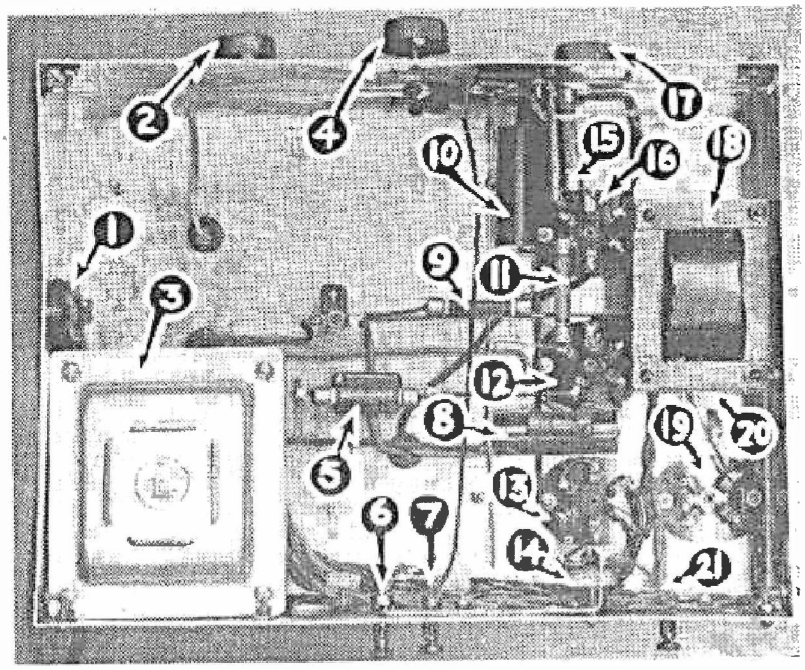
A super-het. convertor consists of a suitable modulator, or first detector tube, combined with a heterodyne oscillator, and arranged to convert the incoming signal to a pre-determined intermediate frequency. In other words, it consists of the first part of a super-het. circuit—that part before the i.f. amplifier.

This convertor is connected to a broadcast receiver, either of the tuned radio frequency or the super-heterodyne type, which is tuned to a pre-determined frequency and acts as the i.f. amplifier, second detector, and audio stage of the short wave super-heterodyne. In the case of the Lekmek short wave convertor, the mixer circuit is designed to deliver a frequency of 585 kilocycles to the intermediate frequency amplifier which, as explained above, consists of a broadcast receiver employing either a super-heterodyne circuit, or having one or more stages of radio frequency amplification. Naturally, the more sensitive the broadcast receiver the better will be the results obtained from the convertor.

In the Lekmek convertor kit an additional refinement, in the form of continuous wave band switching, has been incorporated. This makes it possible to



This "keyed" illustration of the short wave convertor shows that simplicity is the key-note of its design.



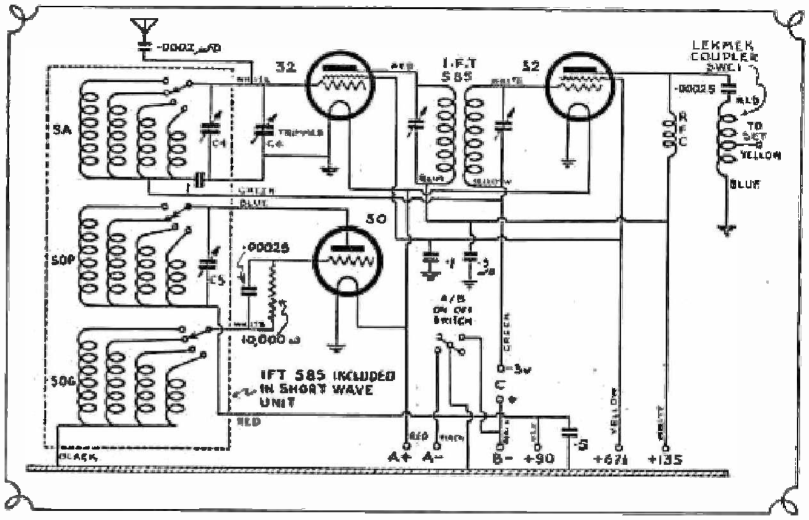
Key to numbered components in this under-chassis view:—1. 240 V. Outlet Panel. 2. Wave Change Switch. 3. Power Transformer. 4. Short-wave Tuner. 5. 10,000 ohm. Resistor and .00025 by-pass Condenser. 6. Earth Terminal. 7. Aerial Terminal. 8. 350 ohm. Bias Resistor, Wire-wound, with .5 m.f. by-pass Condenser. 9. 20,000 ohm. Resistor. 10. .5 m.f. by-pass Condenser. 11. 35,000 ohm. Resistor. 12. Valve Socket 56 type Valve. 13. Valve Socket 58 type Valve. 14. Short-Wave Coupler S.W.C.I. 15. 10,000 ohm. Resistor with .5 mfd. by-pass Condenser. 16. Valve Socket 57 type Valve. 17. Trimmer Condenser. 18. Filter Choke. 19. 280 Rectifier Socket. 20. Electrolytic Condenser. 21. Terminal to A Terminal of Set.

LIST OF PARTS FOR ELECTRIC CONVERTOR

- 1 Kit, Lekmek S.W. 10/200.
- 1 Chassis, 11½in. x 9½in. x 3½in.
- 1 Power Transformer—275—o—275 v. at 50 mills., 2.5 volts at 6 amps., 5 volts at 2 amps., Lekmek type 42-TC.
- 1 Vernier Dial.
- 1 Filter Choke, 30 Henries, 75 mills., Lekmek type 30/75.
- 1 R.F. Choke.
- 3 .5 mfd. By-pass Condensers.
- 2 .00025 mfd. Condensers.
- 1 .0001 mfd. Condenser.
- 2 8 mfd. Electrolytic Condensers.
- 2 10,000 ohm. Resistors.
- 1 20,000 ohm. Resistor.
- 1 35,000 ohm. Resistor.
- 1 350 ohm. W.W. Resistor.
- 1 58 valve, 1 57 valve, 1 56 valve, 1 280 valve.
- 3 Valve Shields.
- 4 Sockets: 1/4, 1/5, 2/6 pin.
- Nuts, bolts, 3 terminals, hook-up wire, etc.

select the 10-20 metre, 20-40 metre, 40-80 metre, or 80-200 metre wave bands simply by rotating the wave change switch to the correct position. There are no plug in coils.

As can be seen from the list of parts and the illustrations of the finished receiver (a.c. model only), few parts are required, and the assembly and wiring is a simple job. T he sockets, electrolytic condensers, and the bracket for holding the trimmer condenser, should be mounted on the chassis. The terminals are mounted on an insulating strip, and screwed to the back of the chassis. The short wave unit S.W. 10/200 is placed in position, and the wires put through the holes provided in the chassis. The power transformer and filter choke is not fitted until the wiring is almost completed. The short wave coupler and r.f. choke should be firmly screwed to the chassis, which is now ready for wiring.



The schematic circuit diagram of the battery operated model.

LIST OF PARTS FOR BATTERY CONVERTOR

1 Kit, Lekmek, S.W. 10/200 B.
1 Chassis, 8¾in. x 10in. x 2½.
1 3 volt C Battery.
1 Filament Switch.
1 Vernier Dial.
1 10,000 ohm Resistor.
1 R.F. Choke.
2 .5 mfd. By-pass Condensers.
2 .1 mfd. By-pass Condensers.
1 .0002 mfd. Fixed Condenser.
2 .00025 mfd. Fixed Condensers.
3 Valve Shields.
3 Sockets, 4-pin.
1 Socket, 5-pin (for Battery Outlet).
2 32 valves, 1 30 valve.
Nuts, bolts, terminals, etc.

Wiring Details

The filaments and dial light require first attention. The filament wires may be twisted together and run neatly round the chassis, being connected as shown in the circuit diagram. All earth connections should be connected by means of a common bus-bar run through the centre of the chassis. After the screens and cathodes are connected to their respective points in the circuit wire the S.W. 10/200 unit, but be careful to follow the color code shown in Fig. 1.

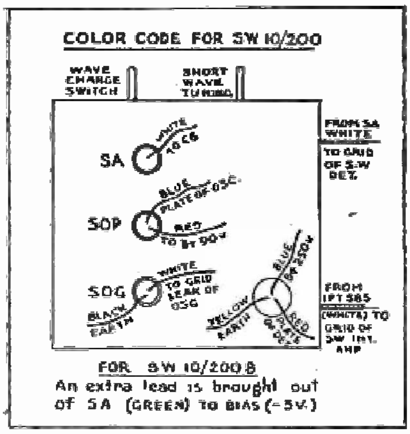


Fig. 1 shows the color code for connections to the coil unit.

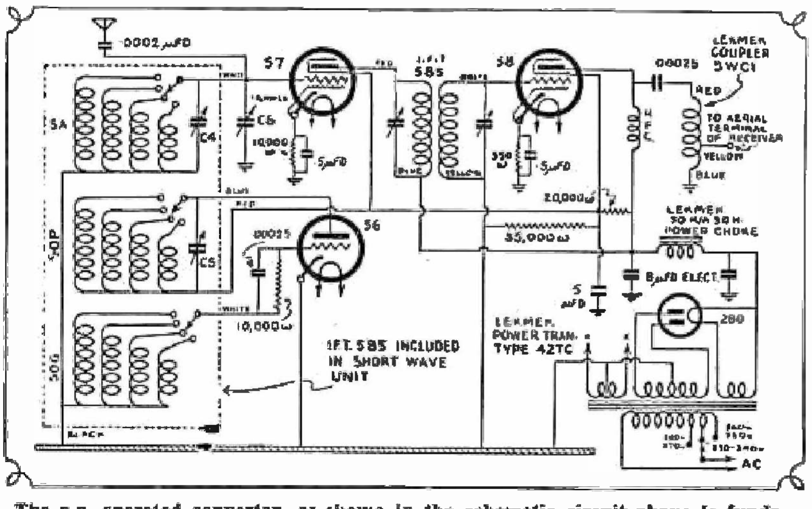
Before mounting the filament choke it is advisable to connect two wires each about six inches in length to each of the electrolytics, as they are inaccessible when once the choke is mounted. Before mounting the power transformer feed the power flex through the rubber bushed hole in the back of the chassis. The terminal strip is used for the leads from the power transformer. When wiring the trimmer condenser on the top of the chassis make sure that it does not foul the valve shield.

The method of wiring the battery model is similar to that described for the electric model, although of course the power transformer filter choke, rectifier valve, and electrolytic condensers are omitted. Although the battery model chassis is smaller than that used for the a.c. job the general lay-out is similar.

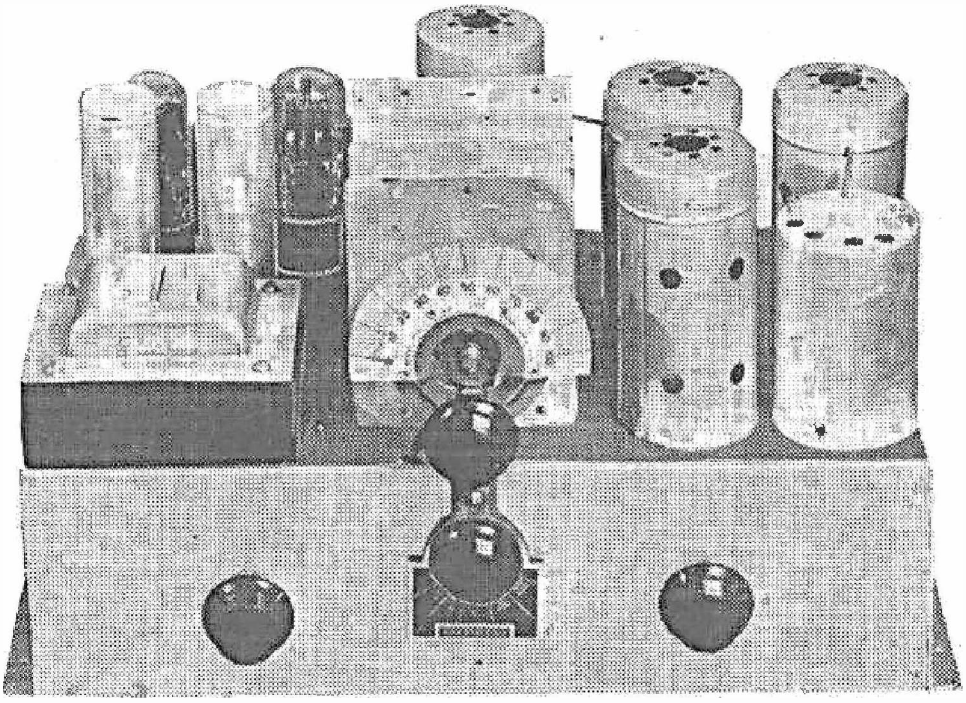
Operation of the Convertor

The unit is provided with three terminals. Two are for the aerial and earth leads, and the third is for a wire to connect the output of the converter to the nect the output of the convertor to the aerial terminal of the broadcast receiver. No lining up of the convertor tuning unit is necessary, as this has already been carried out in the manufacturers' laboratories. To operate the convertor after the valves have been placed in their sockets the power (either a.c. or batteries) has been supplied to the plates and filaments of the tubes, connect the aerial and earth and connect the convertor to the broadcast receiver, which should be tuned to 585 k.c. (511 metres) or just above 3AR.

The results which can be obtained with the convertor are subject to the particular receiving area conditions and to the inherent sensitivity of the broadcast receiver. However, on a reasonably good broadcast receiver, in a normal receiving area some exceptionally good results are obtainable, the majority of the well-known international broadcasts in England, Europe and America being heard at full loud speaker strength. The tuning, although sharp, is easily carried out, the final adjustments, by means of the trimming condenser, usually being responsible for a big increase in "kick."



The a.c. operated convertor, as shown in the schematic circuit above is fundamentally the same as the battery powered model.



Front view of the completed assembly, showing the arrangement of controls

An All-Wave Super-Het

A Kit-type of 5/6 valve receiver designed to cover the entire wave band between 10 and 550 metres

By "FREQUENCY"

THE radio set user is ever in search of fresh worlds to conquer. No sooner were his yearnings for long distance broadcast reception met by the development of high gain r.f. amplifiers than he immediately turned his attention to the mysterious short waves.

A few years of international reception attended by the various problems of building and operating short wave receivers were sufficient to swing the explorer back to the fold of broadcast listeners. The wonder is not that short waves did not have sufficient attraction to hold him indefinitely, but that their interest was such as to keep him quiet for so long.

In broadcast reception he soon decided that a greater degree of selectivity was necessary and that ease of control should come before all things. The result was the development of the superhet.

Now we see the stage reached when it would seem that set design has reached the uttermost pinnacle and we find the thoughts of the experimenter turning again to a newer and more interesting problem — the evolution of a receiver which will combine all the advantages of the modern broadcast receiver with the thrill-giving qualities of a good shortwave receiver.

The Advent of "All Wavers"

There have been many attempts to design such "All Wave" receivers, but until the last few months, in Australia at least, little success seems to have been achieved. It was possible to make receivers which would cover both long and short wave bands, but they invariably were tuned by two or more separate condensers and required a similar number of coils for each stage for each wave band. This meant that the user might have 10 coils for a two stage receiver or 15 for a three stage one. Naturally, such a state of affairs could be tolerated only by the dyed-in-the-wool experimenter whose enthusiasm overshadowed his sense of the fitness of things.

The ideal all wave receiver was one which did not compromise between ease of control and efficiency, which operated as well on either broadcast or short wave bands as the best of the single purpose receivers, had an automatic wave band selection device and yet embodied the advantages of sensitivity, selectivity and ease of tuning.

The super-het type of receiver has always been an attraction to short wave experimenters. Its sensitivity and ease of handling have made it the short wave receiver de luxe. For somewhat similar reasons the super-het possesses another advantage in that its high sensitivity permits us to compromise somewhat on the efficiency of the tuning stages without seriously affecting the performance of the receiver. This is an important matter, for unless involved, expensive and sometimes constructionally unsatisfactory methods are employed we cannot use the most suitable capacity tuning condenser for the short wave range and at the same time get an easy coverage of the broadcast band.

Details of the Kit

The coil kit around which this receiver has been designed is the one made by the Paramount Radio Manufacturing Co., of Sydney. This kit consists of three coils, aerial, r.f. and oscillator, for broadcast wave lengths and four sets of two coils, aerial and oscillator for short wave lengths. In all, five sets of coils are used to cover the wave range between 10 and 550 metres.

The switching of the coils is so arranged that when changing over from the broadcast to any of the short wave bands the r.f. valve and its associate coil are disconnected from the circuit. The aerial is fed direct to the grid of the modulator section of the 2A7 through a small capacity fixed condenser C4 which is incorporated in the kit.

The use of a standard size tuning condenser for the broadcast wave lengths made it necessary for the kit designers to employ some means of broadening the tuning on the higher frequency ranges, particularly on the two covering the wave band between 10 and 30 metres. This is done by means of band spreading fixed condensers connected in the oscillator and aerial coils which cover this tuning range, with the result that even on the highest frequencies to which the set will respond the tuning is not too sharp for comfortable operation.

An even more important advantage from the viewpoint of efficient operation is that the inductance-capacity ratio has been made favorable for the frequency covered, i.e., there is not too great a capacity or too small an inductance in circuit.

The needs of the home constructor have been borne in mind by the kit manufacturers, who have provided the coil assembly and switch gear totally enclosed i.. an aluminium can and fitted with color coded leads of ,ust sufficient length to get to the desired connecting points. This means that it is impossible for the set builder to depart from the manufacturer's idea of connecting the coil unit, a point which is too important to permit the leaving of even the smallest loophole.

The Circuit Described

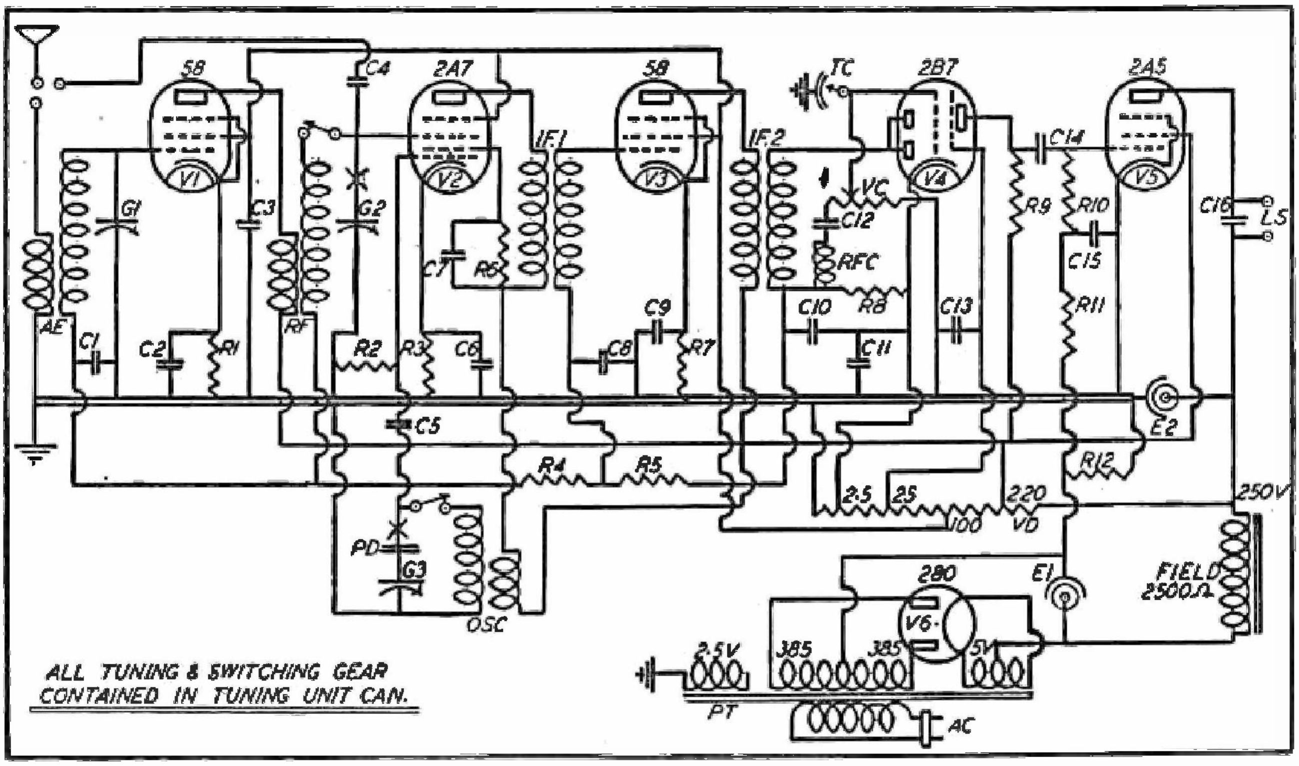
Referring to the schematic circuit diagram it will be seen that he set employs five valves and a rectifier, or six tubes in all. The first V1, is a standard 58 tube used as an r.f. amplifier on broadcast wave lengths. The 2A7 pentagrid tube V2 combines the function of detector, or modulator, and oscillator on all wave lengths. V3 is the second 58 tube which functions in this case as an intermediate frequency amplifier, whilst the 2B7, a duplex diode pentode, combines the functions of second detector, first stage audio amplifier, and automatic volume control tube. The output of the pentode section of V4 is fed to the grid of the indirectly heated 2A5 pentode V5.

The power supply for the receiver is furnished from a standard power transformer delivering 385 volts on each side of its centre tap and provided with the necessary low voltage windings for the rectifier filament and the receiver tube heaters. The 80 rectifier V6 provides the rectified output from the pack and this is filtered and smoothed by the electrolytic condensers E1 and E2 and the choke coil provided by the field winding of the loud speaker.

It will be noticed that, whilst throughout the receiver every effort has been made to keep the number of components at a minimum, care has been taken to

LIST OF COMPONENTS AND SCHEMATIC CIRCUIT

AE—Aerial coil included in can unit. (Paramount).
C1, 3, 8, 11—Tubular condensers of 0.5 mfd.
C17—Tubular condenser 0.5 mfd. (see text).
C13 and 15—Tubular condensers of 0.1 mfd.
C2, 6, 7, 9, 12, 14, 16—Condensers of 0.01 mfd.
C5—Condenser of 0.0001 mfd. } All these
C10—Condenser of 0.0005 mfd. } are mica.
C4—Included in can unit. (Paramount).
E1, E2—Electrolytic condensers of 8 mfd. tested to 450 volts.
G1-2-3—Triple gang standard type tuning condensers with vernier dial (Effco).
IF1, IF2—Intermediate frequency transformers with air di-electric condensers tuned to 410 k.c. (Paramount).
LS—Dynamic speaker with 2500-ohm field and input for 2A5 pentode.
PD—Padder condenser (Paramount).
PT—Power transformer with 385-0-385 main secondary, one of 5V-2A and one of 2.5V-8A.
RF—Radio frequency coupling coil included in can unit (Paramount).
RFC—Radio frequency choke.
R12—Resistor of 480 ohms to pass 100 m.a. } Wire-
R1, 3, 7—Resistors of 200 ohms to pass 15 m.a. } wound
R4, 5, 8, 10, 11—Resistors of ½ megohm each.
R2—Resistor of 10,000 ohms.
R6—Resistor of 25,000 ohms.
R9—Resistor of 250,000 ohms.
All power-grid-leaks are carbon types, to carry at least 1 watt.
TC—Tone control, see text.
VC—Carbon-strip type potentiometer volume control of 500,000 ohms.
VD—Tapped voltage divider of 15,000 ohms.
Valves—Two 58's, one each 2A7, 2B7, 2A5 and 280, together with 4 valve cans and 4 grid clips.
Sockets—Three 6-pin, two 7-pin and two 4-pin.
Chassis—Steel or aluminium, 16 by 10 by 4½ inches.



ensure full by-passing of all circuits which would be likely to give rise to instability. The resistors R1, R3 and R7 are standard 200 ohm 15 m.a. types to provide the necessary cathode bias on the r.f. tube, the converter tube, and the i.f. tube. These bias resistors in turn are by-passed by the .01 mfd. condensers C2, C6 and C9, which provide a low resistance path for the flow of r.f. potentials.

Special Oscillator Wiring

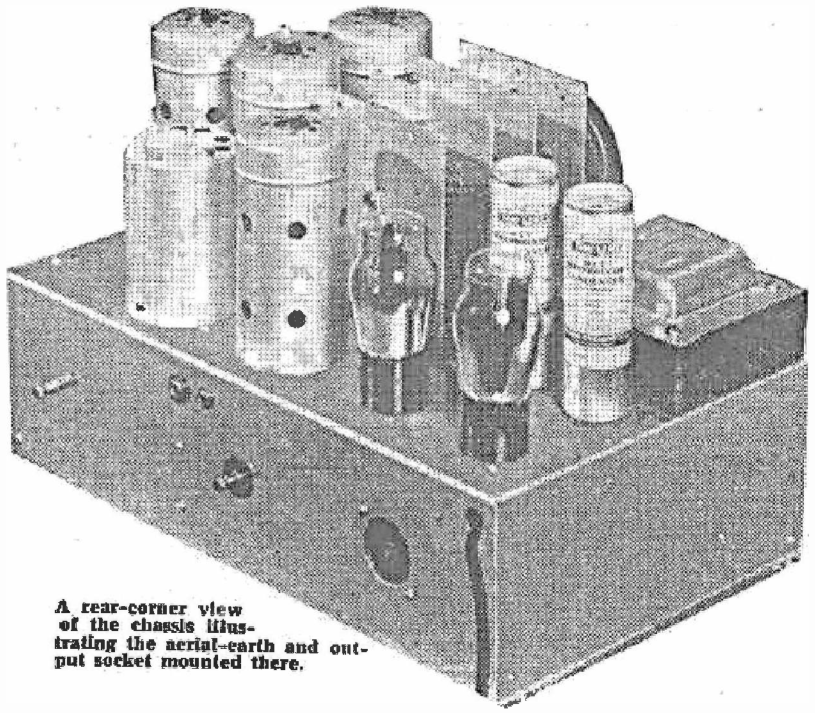
In the plate circuit of the oscillator section of V2 it will be seen that a slight change from the commonly used arrangement has been made. The "B" supply for the plate of the modulator section and the oscillator grid (or plate) is taken through the feed back coil and the necessary reduction in voltage to the oscillator grid is obtained by means of the 25,000 ohm resistor R6. In order to overcome the r.f. blocking effect of R6 this resistor is by-passed by the .01 mfd. condenser C7.

The screen potentials for the first three tubes, V1, V2 and V3, are the same, i.e., 100 volts, whilst the plate potentials for V1, V2, V3 and V4 (pentode plate) and the screening grid of V5 are taken to the 220 volt tap on the divider. The screening grid of V4 is supplied with a positive potential of 25 volts. The plate of V5 goes to the full output, whilst the cathode of the diode 2B7 is connected to a 2½-volt positive point on the divider VD.

Need for Time Lag

The purpose of this fixed bias is to introduce some small time lag in the action of the automatic volume control used in the diode rectifier circuit and operating through the resistor network R4, R5 and R8 on the grids of V1, V2 and V3. If this "delay" were not arranged, signal strength on even the weakest of receptions would automatically be reduced.

Coming to the audio side of the receiver we find that the grid circuit



A rear-corner view of the chassis illustrating the aerial-earth and output socket mounted there.

of the 2A5 is de-coupled and that back bias has been used in an endeavor to obtain first class tone quality and a freedom from hum. This necessitates the insulation from the chassis of the can of the electrolytic condenser E1.

Referring again to the 2B7, it will be noticed that both tone and volume control are carried out on the pentode section of the tube. The volume control consists merely of a 500,000 ohm potentiometer VC, the extremes of which are connected between ground and one side of the .01 mfd. coupling condenser C12. The arm of VC goes to the pentode grid.

The tone control used in the original receiver was a commercially manufactured one known as the "Octave." As it is somewhat difficult to obtain this control in Melbourne, it may be replaced with a 10,000 ohm variable resistance connected in series with the .01 mfd. condenser already shown in circuit across the loud speaker output.

Although not shown in the schematic circuit diagram, a .5 mfd. condenser C17, should be wired between the B+ side of oscillator plate coil and chassis.

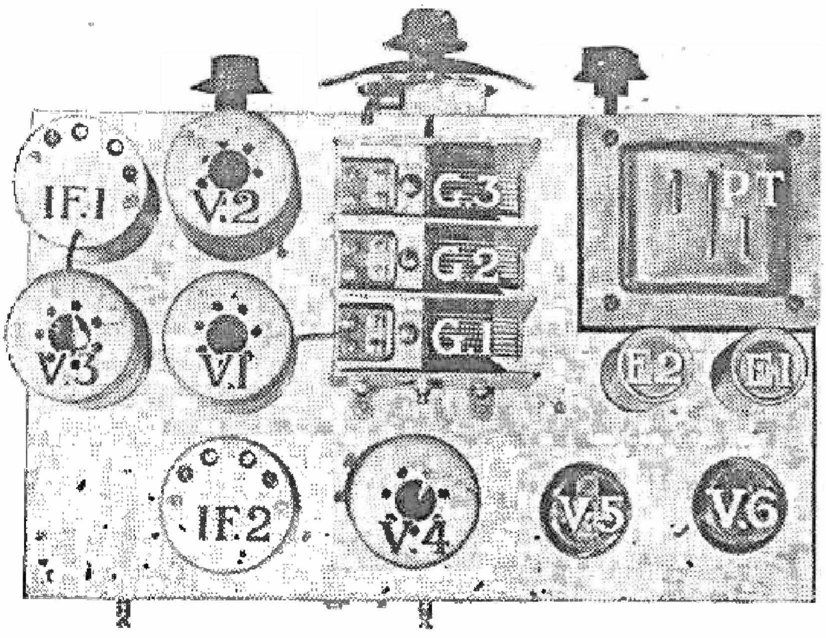
Illustrations Clarify Building

The pictures of the original receiver illustrate clearly the salient features of its construction, but for the benefit of those who have not had previous experience in constructing all-wave receivers, the following pointers are provided. Looking down on the top of the chassis we find that the power transformer, electrolytic condensers, rectifier and power valve occupy the space to the left of the gang condenser. To the right are the 2A7 and the r.f. 58, the first-named being nearest to the front of the chassis.

Alongside the 2A7 is the first intermediate frequency transformer IF1 and behind this transformer is the i.f. 58, V3. Immediately behind the gang condenser is the Duplex diode pentode 2B7, whilst to the right of this tube is the second i.f. transformer IF2.

On the front of the chassis we have at the right the volume control and, at the left, the tone control. The wave change switch is the lower of the two central controls.

Along the back of the chassis, in a position relative to the 280 and 2A5, is the loud speaker outlet socket. The aerial terminal is in the centre and the earth at the extreme left along this side of the chassis. The pick-up points can be seen near the aerial terminal, the pick-up being connected between



Looking down on top of the chassis. All components have been tabulated to correspond with the list of parts.

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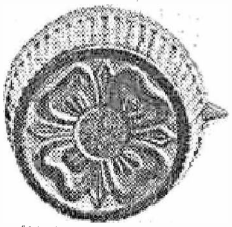
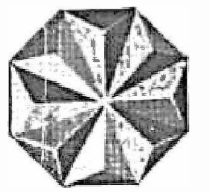


MFK 7/P Index Knob with pointer Each 9d.



MOK 4/M Small Oct. Prism Knob Each 7d.

Marquis Standard Range of Moulded Knobs, fitted with hardened grub screw are all made to go over ¼-inch shaft. The wide range offers a choice to harmonise with various styles of cabinets and escutcheon plates, and the selection of the right types will definitely enhance the appearance of your radio cabinet.

Latest additions to the range are illustrated here. In Black, Black and Brown, and Walnut Finish. Other finishes to special order.

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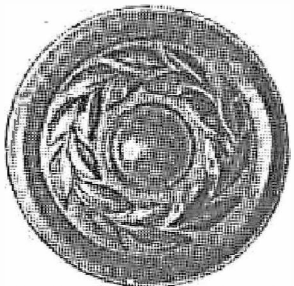

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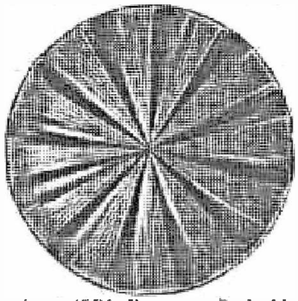

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This product has been developed to meet the latest practice in modern chassis design, which demands a perfect safety device for the power inlet. Moulded of the best quality Bakelite, its insulating and protective properties are of the highest quality. Heavy metal parts ensure easy connection and perfect contact. Two hole mounting and rectangular design of male portion makes for rigidity when fitted to chassis. MCP1. Retail Price, 1/9 each.

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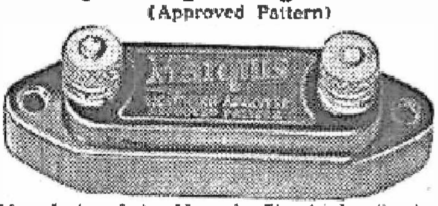
(Approved Pattern)



Manufactured to Marquis Standard. Particularly suitable for use in tropical regions. A definite safeguard for your valves. Totally enclosed and weatherproof. MLA1. In Carton, with two fixing wood screws. Retail Price 1/9.

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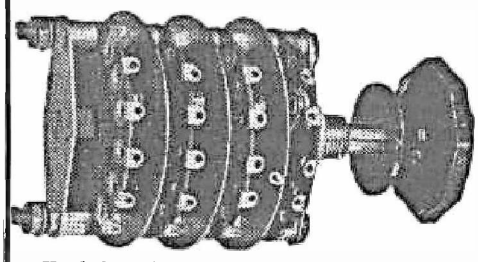

Used by all leading manufacturers of All-Wave Receivers and S.W. Converters. Wide Range and complete insulation. Absolutely rigid when in operation.

- **PERFECT METALLIC CONTACT.**—Rotating arm seats under pressure half ball constant ensuring perfect point conductivity.
- **NO PIGTAIL CONNECTIONS.** — On the rotor section, contact is made on high pressure wiper system.
- **COMPLETE EARTH RETURN.** — Earthing connections on frame of switch make shielding between each set of circuits fully effective.
- **LOSSES ELIMINATED.**—Extraneous matter cannot get between contact points.
- **COMPACT SIZE.**—Standard MAW4 is 2½ by 2 ins. overall. MAW 1½ with one to eight banks, each with 6 contacts.

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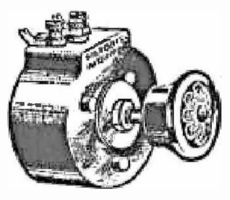

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ROLLING CONTACT ensures noiseless action . . . no pressure on winding wires . . . cannot wear or break wires . . . no moving metal parts to get out of alignment or adjustment . . . hair line control . . . finer adjustment . . . all resistances from 400 to 20,000 ohms.

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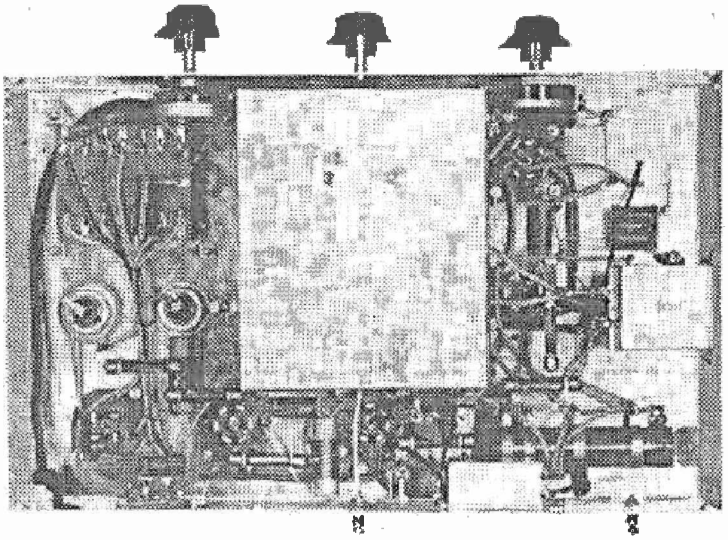
the pentode grid of the 2B7 and ground.

Provided that a certain amount of common sense is used, the set builder should not strike any trouble in assembling or wiring the receiver. Start the assembly by securing everything that goes on the top of the chassis, and then, turning your attention to the underneath, attach the loud speaker socket, aerial, earth and pick-up terminals, and the tone and volume controls. At this juncture it probably will be found best to start the wiring of the receiver, hooking into place the various resistors and condensers. When all the wiring, except the connections to the coils, has been completed, mount the coil unit can and hook up the various leads according to the color code which is provided with the kit.



An underneath view of the chassis, showing the wiring and placement of parts. The section covered by the shield contains the marquis switching device and band coils.

Trimming Up the Set

The alignment of the receiver, contrary to what might be expected, is an extremely simple job. One of the reasons for this is that provision has been made in the modulator tuning coil section of the coil unit to take care of the fine tuning of this stage, with the result that very little difference will be noted as the modulator gang condenser trimmer, G2, is altered. The critical trimmers for broadcast tuning are those of the r.f. and oscillator sections, which should be adjusted by the method usually used in lining a super-het.

First tune the set to the lower end of the broadcast band and, with it operating satisfactorily, adjust the oscillator trimmer so that 3AW will come in at about 5 to 7 on the dial. Now adjust the r.f. trimmer until maximum signal strength is obtained. During this and subsequent adjustments, for greatest sensitivity work with the volume control turned well back so that small changes in overall amplification can quickly be noticed.

With the set lined at the bottom end, tune up to 2CO and by means of the padder, which is mounted inside the coil unit can, adjust for greatest signal strength on the high wave band. Be sure to rock the gang condenser back and forward over two or three degrees after each adjustment. When the maximum response has been obtained on the top end of the band return again to 3AW and try the effect of a very slight readjustment of the r.f. trimmer. Don't touch the oscillator trimmer or you'll have all your work over again.

Some Delicate Work

When you are convinced that the set is lined to the best of your ability, tune to a distant station which operates at the low frequency end of the dial and is reasonably steady, and try the effect of adjusting each i.f. trimmer. Work from the second detector grid circuit to the modulator plate circuit in that order.

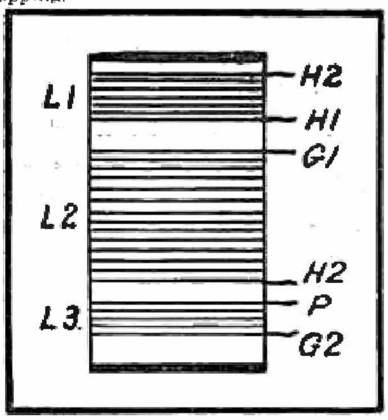
Actually it is not wise to monkey around with the modulator plate circuit of the i.f. transformer too much, as you are likely to end up by throwing the whole cascade out of line. However, a little judicious readjustment of the other trimmers in the i.f. transformers is often beneficial.

It will be found that in operation the receiver is exceptionally quiet. This is particularly noticeable on the short waves, where it often is necessary to listen hard to make sure the set is working. However, when a station is tuned in you'll soon know about it, because on short as well as broadcast wave lengths the receiver is a good performer.

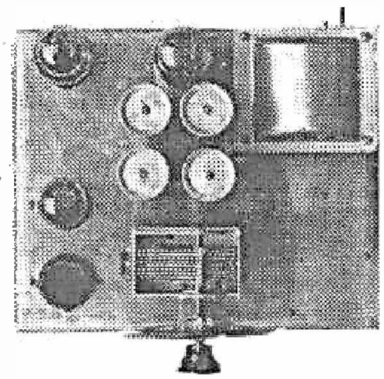
JUNIOR "AIR-RAIDER"

(Continued from page 47)

above coils to be slightly out, and for this reason the grid coils, L2, should have their turns adjusted to give the best coverage without too much overlapping.



This diagram shows the connections of the various leads from the coil on the former.



A top chassis view of the Junior Air-Raider.

Operation of the Receiver

The voltage applied to the plate of the power valve (2A5) will be about 250 volts, and that to the plate of the detector valve (type 56) about 60 volts.

The set must not be switched on without a speaker, as this will quickly ruin the output valve.

Plug in the broadcast coil and tune the set. Turns should be added to or subtracted from the grid coil, L2, until 2CO comes in at about 98 on the dial. If this is done the condenser will cover the widest possible wave range. It may also be necessary to increase the reaction turns to make the set oscillate, and the addition of a radio frequency choke may also be called for, although none was needed in the original receiver. Insert the choke in the lead from the P of the audio transformer to the stator of the midget condenser.

With a short wave coil in place and the set just oscillating, the dial should be rotated very slowly until signals are heard. Then adjust the reaction coil and the detector voltage until the reaction is quite smooth. Repeat on all coils, the main aim being to have them so adjusted that any coil can be plugged in without requiring alterations to the detector plate voltage.

Remember that short wave tuning is very fine, and it is quite possible to pass completely over a station without noticing it. The reaction should be adjusted so that the set just oscillates over the whole wave range of a given coil, as in this condition the receiver is most sensitive.

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(NEAR CITY BATHS)

International Calls

AUSTRALIAN BROADCASTING STATIONS

Frequency	Wave Length	Call Sign	Name and Address	Aerial Power K.W.
560	535.7	2CO	National Broadcasting Station, Corowa, N.S.W.	7.5
580	517	7ZL	National Broadcasting Station, Hobart, Tas.	1.0
610	492	3AR	National Broadcasting Station, Melbourne, Vic.	4.5
635	472	5CK	National Broadcasting Station, Crystal Brook, S.A.	7.5
665	451	2FC	National Broadcasting Station, Sydney, N.S.W.	2.5
690	435	6WF	National Broadcasting Station, Perth, W.A.	3.5
730	411	5CL	National Broadcasting Station, Adelaide, S.A.	2.0
760	395	4QG	National Broadcasting Station, Brisbane, Q'ld.	2.5
800	375	3LO	National Broadcasting Station, Melbourne, Vic.	3.5
855	351	2BL	National Broadcasting Station, Sydney, N.S.W.	3.0
880	341	6PR	Nicholson's Ltd., Perth, W.A.	0.5
890	337	7HO	Commercial Broadcasters Pty. Ltd., Hobart, Tas.	0.05
900	333	3MA	Sunraysia Broadcasters Pty. Ltd., Mildura, Vic.	0.05
910	330	4RK	National Broadcasting Station, Rockhampton, Q'ld.	2.0
930	326	3UZ	Nilsens Broadcasting Services Pty. Ltd., Melbourne	0.4
950	316	2GB	Theosophical Broadcasting Station, Sydney, N.S.W.	1.0
960	312	5DN	Hume Broadcasters Ltd., Adelaide, S.A.	0.3
970	309	3BO	Amalgamated Wireless (A'sia) Ltd., Bendigo, Vic.	0.2
980	306	6BY	Bunbury Broadcasters Pty. Ltd., Bunbury, W.A.	0.05
1000	300	4GR	Gold Radio Service Ltd., Toowoomba, Q'ld.	0.05
1010	297	3HA	Western Province Radio Pty. Ltd., Hamilton, Vic.	0.2
1025	293	2UE	Electrical Utilities Supply Co., Sydney, N.S.W.	1.0
1041	288	5PI	Midlands Broadcasting Services Ltd., Port Pirie, S.A.	0.05
1050	286	2CA	A. J. Ryan Broadcasters Ltd., Canberra, F.C.T.	0.05
1060	283	4MB	Maryborough Broadcasting Co. Ltd., Maryborough, Q'ld.	0.05
1070	280	2KY	Trades Labor Council, Sydney, N.S.W.	1.0
1080	277.8	3SH	Swan Hill Broadcasting Co., Swan Hill, Vic.	0.05
1100	273	7LA	Findlay & Wills Broadcasters Pty. Ltd., Launceston, Tas.	0.3
1110	270	2HD	Airsales Broadcasting Co., Newcastle, N.S.W.	0.5
1125	267	2UW	Radio Broadcasting Ltd., Sydney, N.S.W.	1.0
1135	264	6MI	Musgroves Ltd., Perth, W.A.	0.3
1145	262	3YB	Mobile Broadcasting Service, Melbourne	0.05
1145	262	4BC	J. B. Chandler & Co., Brisbane, Q'sld.	0.75
1155	260	2WG	Wollongong Broadcasting Co., Wollongong, N.S.W.	0.05
1170	256.4	4TO	Amalgamated Wireless (A'sia) Ltd., Townsville, Q'ld.	0.2
1180	254	3DB	3DB Broadcasting Station Pty. Ltd., Melbourne, Vic.	0.4
1190	252	4MK	Mackay Broadcasting Service, Mackay, Q'sld.	0.1
1200	250	5KA	Sport Radio Broadcasting Ltd., Adelaide, S.A.	0.3
1210	248	2CH	N.S.W. Council of Churches, Sydney, N.S.W.	1.0
1220	246	6KG	Goldfields Broadcasters Ltd., Kalgoorlie, W.A.	0.1
1245	241	2NC	National Broadcasting Station, Newcastle, N.S.W.	2.0
1260	238	3WR	Wangaratta Broadcasting Pty. Ltd., Wangaratta, Vic.	0.05
1270	236.1	2SM	Catholic Broadcasting Co., Sydney, N.S.W.	1.0
1280	234	3TR	Gippsland Publicity Pty. Ltd., Sale, Vic.	0.05
1290	233	4BK	Brisbane Broadcasting Co. Ltd., Brisbane, Q'sld.	0.2

Australian Broadcasting Stations—*Continued*

Frequency	Wave Length	Call Sign	Name and Address	Aerial Power K.W.
1300	230.8	3BA	Ballarat Broadcasters Pty. Ltd., Ballarat, Vic.	0.05
1310	229	5AD	Advertiser Newspapers Ltd, Adelaide, S.A.	0.3
1320	227	2MO	M. J. Oliver, Gunnedah, N.S.W.	0.05
1330	225.56	4RO	Rockhampton Broadcasting Co. Ltd., Rockhampton, Q'sld.	0.05
1340	224	2XN	G. W. Exton, Lismore, N.S.W.	0.05
1350	222	3KZ	Industrial Printing & Publicity Co., Melbourne, Vic.	0.4
1370	218.9	3HS	Wimmera Broadcasters, Horsham, Vic.	0.05
1380	217.3	4BH	Broadcasters (Australia) Ltd., Brisbane, Q'sld.	0.6
1390	216	2GN	Goulburn Broadcasting Co. Ltd., Goulburn, N.S.W.	0.1
1400	214	3GL	Geelong Broadcasters Pty. Ltd., Geelong, Vic.	0.05
1415	212	2KO	Newcastle Broadcasting Co. Ltd., Newcastle, N.S.W.	0.5
1425	210.5	3AW	The Vogue Broadcasting Co. Pty. Ltd., Melbourne, Vic.	0.4
1435	209.06	2WL	Wollongong Broadcasting Co., Wollongong, N.S.W.	0.05
1460	205.5	7UV	N.W. Tasmanian Broadcasters Ltd., Ulverstone, Tas.	0.25
1480	203	2AY	Amalgamated Wireless (A'sia) Ltd., Albury, N.S.W.	0.05
1500	200	3AK	Akron Broadcasting Co. Pty. Ltd., Melbourne, Vic.	0.05

NEW ZEALAND BROADCASTING STATIONS

Frequency	Wave Length	Call Sign	Name and Address	Aerial Power K.W.
630	476.2	1ZH	G. S. Anchor, Hamilton	0.045
650	461.5	4YA	N.Z. Broadcasting Board, Dunedin	0.5
720	416.7	2YA	N.Z. Broadcasting Board, Wellington	5.0
820	365.9	1YA	N.Z. Broadcasting Board, Auckland	0.5
900	333.3	2ZP	E. A. Perry, Wairoa	0.105
980	306.1	3YA	N.Z. Broadcasting Board, Christchurch	0.5
1010	297	2YC	N.Z. Broadcasting Board, Wellington	0.2
1050	285.7	2ZO	J. V. Kyle, Palmerston North	0.2
1050	285.7	2ZF	Manawatu Radio Club, Palmerston North	0.15
1080	277.8	4ZB	Otago Radio Association, Dunedin	0.02
1080	277.8	4ZO	Barnett's Radio Supplies, Dunedin	0.04
1080	277.8	4ZM	McCracken & Walls, Dunedin	0.045
1080	277.8	4ZW	4ZW Broadcast Service, Dunedin	0.03
1090	275.2	1ZR	Lewis, Eady Ltd., Auckland	0.08
1120	267.9	2ZW	2ZW Broadcasting Service Ltd., Wellington	0.4
1150	260.9	2ZJ	C.T.C. Hands, Gisborne	0.25
1150	260.9	2ZM	Atwater Kent Radio Service Ltd., Gisborne	0.16
1160	258 6	4ZP	R. T. Parsons, Invercargill	0.125
1180	254.2	2ZD	W. D. Ansell, Masterton	0.005
1200	250	3ZC	N.Z. Farmers Co.-op. Association, Christchurch	0.25
1220	245.9	4ZL	Radio Service Ltd., Dunedin	0.1
1220	245.9	4ZF	Laidlaw & Gray Dunedin	0.01
1230	243.9	2YB	Nth Taranaki Radio Society, New Plymouth	0.1
1250	238.1	1ZM	W. W. Rodgers, Manurewa	0.015
1260	234.4	4ZC	John I, Bilton, Cromwell	0.02
1290	233.6	2ZH	C. B. Hansen & Co. Ltd., Napier	0.065
1300	230.8	3ZE	Schaef's Ltd., Greymouth	0.045
1300	230 8	3ZR	West Coast Radio Society Greymouth	0.08
1320	227.3	1ZJ	Messrs Johns Ltd., Auckland	0.026
1340	233.9	4ZR	Messrs B. R. Renton and C. G. Clark, Balclutha	0.005
1360	220.6	2ZR	2ZR Radio Club, Nelson	0.05
1400	214.3	2ZL	John Holden, Hastings	0.02
1420	211.3	1ZB	The La Gloria Gramophones Ltd., Auckland	0.02
1420	211.3	1ZS	McCabe's Radios, Auckland	0.05
1450	206.9	3ZM	W. J. Green and J. Sanger, Christchurch	0.1

CHINA, JAPAN, INDIA AND SIAM

Frequency	Wave Length	Call Sign	Name and Address	Aerial Power K.W.
590	508	JOAK	Nippon Hoso Kyokai, Tokio, Japan	10.0
618.5	485	KZRM	Erlanger & Galinger (Inc.), Manila	5.0
618.5	485	KZEG	Erlanger & Galinger (Inc.), Manila	—
625	480	JOTK	Nippon Hoso Kyokai, Matsuye, Japan	0.5
645	465	JOUK	Nippon Hoso Kyokai, Akita, Japan	0.3
660	454	XGOA	Administration of Central Broadcasting Stations, Nanking, China	75.0
670	448	JFAK	Taiwan Sotokufu Kotsokyoku Taikoku, Japan	10.0
674	445	—	N.E. Telephone, Telegraph and Radio Admin., Harbin, China	—
680	441	JOLK	Nippon Hoso Kyokai, Fukuoka, Japan	0.5
680	441	JOVK	Nippon Hoso Kyokai, Hakodate, Japan	0.5
681.4	440	XGOA	Administration of Central Broadcasting Stns., Nanking, China	75.0
682	440	XGOK	Canton Municipal Govt., Canton, China	1.0
690	435	JODK	Keijo Hoso Kyoka, Keijo, Japan	1.0
700	429	JOKK	Nippon Hoso, Okayama, Japan	0.5
700	429	—	Government of Ceylon, Colombo	1.06
710	423	JOJK	Nippon Hoso Kyokai, Kanazawa, Japan	3.0
720	417	JORK	Nippon Hoso Kyoehi, Kochi, Japan	0.5
720	417	JFBK	Taiwan Sotokufu Kotsukyoku, Tainan, Japan	1.0
731	410.?	XGOA	Administration of Central Broadcasting Stns., Nanking, China	75.0
731.3	410	—	N.E. Telegraph, Telephone and Radio Admin., Moukden, China	—
750	400	JOBK	Nippon Hoso Kyokai, Osaka, Japan	10.0
750	400	KGU	Advertiser Publishing Co. (Ltd.), Honolulu, Hawaii Islands	2.5
750	400	HS7PJ	Posts and Telegraph Dept. Radio, Salading, Bangkok, Siam	10.0
760	395	JQAK	Kantoshu Teishinkyoku, Dairen, Japan	0.5
769	390	VUM	Corporation of Madras, Madras, British India	0.2
770	390	JOHK	Nippon Hoso Kyokai, Sendai, Japan	10.0
780	385	JOPK	Nippon Hoso Kyokai, Shizuoka, Japan	0.5
790	380	JOGK	Nippon Hoso Kyokai, Kumamoto, Japan	10.0
809.9	370.4	VUC	Indian State Broadcasting Service, Calcutta, India	2.0
810	370	JOCK	Nippon Hoso Kyokai, Nagoya, Japan	10.0
821	365	HS7PJ	Post and Telegraph Dept., Salading, Bangkok, Siam	10.0
830	361	JOIK	Nippon Hoso Kyokai, Sapporo, Japan	10.0
840	357.1	VUB	Indian State Broadcasting Service, Bombay, India	2.0
845	355	ZBW	Colonial Government, Hong Kong, Hong Kong	2.0
857.1	350	HSP1	Post and Telegraph Dept. Radio, Bangkok, Siam	2.5
870	345	JOAK	Nippon Hoso Kyokai, Tokio, Japan	10.0
882	340	VUL	Y.M.C.A. Radio Club, Lahore, India	0.1
882	339.8	XGOB	Administration of Central Broadcasting Stns., Loyang, China	1.0
900	333	KZIB	I. Beck (Inc.), Manila, Philippine Islands	1.0
937	319.99	XGOB	Administration of Central Broadcasting Stns., Loyang, China	1.0
940	319	JONK	Nippon Hoso Kyokai, Nagano, Japan	0.5
952.3	315	XOPP	Ministry of Communications, Peiping	100.0
960	313	JOOK	Nippon Hoso Kyokai, Kyoto, Japan	0.3
974	308	XGOD	Chekiang Provincial Government, Chekiang, China	1.0
1000	299.82	XGOB	Administration of Central Broadcasting Stns., Loyang, China	1.0

HIGH POWERED WORLD BROADCASTERS

545	550.5	HAL	Budapest VIII., Sandor, u.7, Hungary	20
545	550.5	HAL2	Budapest VIII., Sandor, u.7, Hungary	120
554	541.5	RW34	Stalingrad, U.S.S.R.	10

High Powered World Broadcasters—*Continued*

Frequency	Wave Length	Call Sign	Name and Address	Aerial Power K.W.
563	532.9	—	Deutsche Reichsport, Munchen, Germany	60
571	525.4	RW80	Magnitogorsk, U.S.S.R.	10
572	524.5	—	Egyptian State Radio and Telephones, Cairo, Egypt	20
580	517.3	—	Oesterr. Radioverkehrs A.G. Wien-B'samberg, Austria	120
585	512.8	XEPN	Cia. Radiodif de Piedras Negras, S.A. Coahuila, Mexico	100
589	509.3	RW35	Astrakhan, U.S.S.R.	10
589	509.3	—	I.N.R., Brussels, Belgium	15
598	501.7	RW42	Gorkii, U.S.S.R.	10
598	501.7	1FI	E.I.A.R., Firenze, Italy	20
617	486.2	RW22	Oufa, U.S.S.R.	10
625	480	North Regional	British Broadcasting Corporation, London, England	50
625	480	RW31	Ivanovo, U.S.S.R.	10
635	472.4	—	Langenberg, Rheinland, Germany	60
640	469	KFI	Earle C. Anthony (Inc.), Buena Park, California, U.S.A.	50
644	465.8	RW17	Kazan, U.S.S.R.	10
644	465.8	—	Administration des P.T.T., Lyon La-Dona, France	15
645	465.1	ZTJ	African Broadcasting Co., Johannesburg, South Africa	15
650	462	WSM	National Life Insurance Co., Franklin, Tennessee, U.S.A.	50
653	459	RW46	Karaganda, U.S.S.R.	10
660	455	WEAF	National Broadcasting Co. (Inc.), Bellmore, N.Y., U.S.A.	50
660	454.5	XEM	G. Lizarraga, Matamoros de Tamaulipas, Mexico	500
662	453.2	—	Postes et Telegraphes, Riga, Latvia	20
665	451.1	XER	Cia. Radiodif. de Acuna, S.A., Coahuila, Mexico	500
662	453.2	RW36	Arkhangelsk, U.S.S.R.	10
662	453.2	RW13	Odessa, U.S.S.R.	10
680	441	KPO	National Broadcasting Co., Belmont, California, U.S.A.	50
680	441.4	IRO	E.I.A.R., Roma-S. Palomba, Italy	50
690	435	NAA	United States Navy, Arlington, Virginia, U.S.A.	17
700	429	WLW	The Crossley Radio Corporation, Mason, Ohio, U.S.A.	500
707	424.3	RW39	Moskva-Noginsk Imeni Stalina, Moscow, U.S.S.R.	100
720	417	WGN	W.G.N. (Inc.), Elgin, Illinois, U.S.A.	25
720	417	WLIB	W.G.N. (Inc.) Elgin, Illinois, U.S.A.	25
725	413.8	RW28	Vladivostock, U.S.S.R.	10
725	413.8	RW73	Simferpol, U.S.S.R.	10
725	413.8	—	Dept. of Posts and Telegraphs, Athlone, Irish Free State	60
735	408.1	XEF	Cia. Radiodif. de Acuna, S.A., Coahuila, Mexico	500
743	403.8	RW79	Mourmansh, U.S.S.R.	10
750	400	WJR	W.J.R. (Inc.), Sylvan Lake Village, Michigan, U.S.A.	10
752	399	—	British Broadcasting Corporation, London, England	25
760	395	WJZ	National Broadcasting Corp (Inc.), Bound Brook, N.J., U.S.A.	30
761	394.2	—	Finmark, Norway	10
770	390	—	Leipzig Germany	120
770	390	WJBT WBBM	WBBM Broadcasting Corp., Glen View, Illinois, U.S.A.	25
779	385.1	RW26	Stalino, U.S.S.R.	10
790	380	WGY	General Electric Co., Sth. Schenectady, N.Y., U.S.A.	50
797	376.4	Scottish Regional	British Broadcasting Corporation, London, England	50
800	375	WBAP	Carter Publications (Inc.), Grape Vine, Texas, U.S.A.	50
800	375	WFAA	Dallas News and Dallas Journal, Grape Vine, Texas, U.S.A.	50
810	370	WCCO	North-Western Broadcasting (Inc.) Anoka, Minnesota, U.S.A.	50
815	368.1	OFA	Postes et Telegraphes, Helsinke, Finland	10

THE SCOTSMAN'S SUPERHET

Continued from Page 9

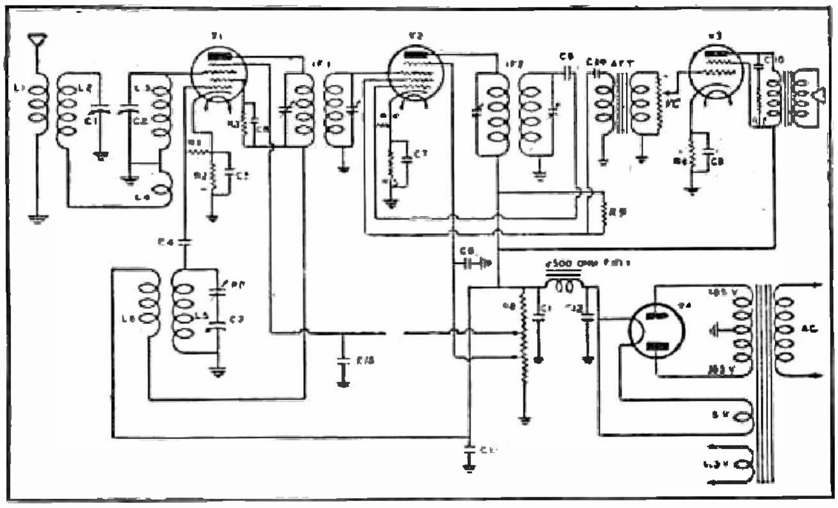
Aligning and Testing the Set

When the receiver has been completed, the valves and loud speaker plugged into the respective sockets, and the aerial, earth and power supply leads connected, we can set about the preliminary adjustments.

The alignment of this super-het is carried out in the conventional manner by setting the oscillator trimmer (front section of the gang), so that 3AW comes in at about 10 to 12 on the dial. Next adjust the modulator grid section of the gang (back section) until best signals are received, and repeat the procedure with the aerial trimmer (middel section).

After this rough alignment has been completed tune up a couple of degrees to 3GL, and, with the volume control cut well back, carefully adjust both the aerial and modulator grid sections of the gang for best signals. On no account touch the oscillator trimmer after the initial setting.

Having satisfied yourself that the set is properly lined on the low wave lengths, tune up scale to 2CO, Corowa, or 5CK, Crystal Brook, it doesn't much matter which, and, with the volume control cut well back, try adjusting the padding condenser. After each small adjustment of the padder, remove the screw driver from the adjusting screw and rock the gang condenser back and forth over a few degrees. When the best setting for the padder has been found, return to the lower end of the dial and try the effect of slight readjustments of the aerial and modulator trimmers.



The schematic circuit diagram of "The Scotsman's Superhet" shows that the receiver has many interesting features.

Results Are Excellent

When the receiver has been properly lined it will be found to be a wonderful little performer.

We were particularly impressed with its sensitivity and selectivity at the bottom end of the dial, where it brought in four of the five available stations between 3AW and 3KZ without the slightest trace of splash. On this end of the dial we are able to bring in 7UV at good speaker strength in daylight, a feat which in our locality is no mean criterion of the efficiency of many larger super-hets.

With the use of a shunt fed transformer and proper tone compensation on the pentode, the quality of output is very fine, whilst the 41's three watt output is ample for all normal needs.

It may be a Scotsman in price, but it certainly is not economical in the results it delivers!

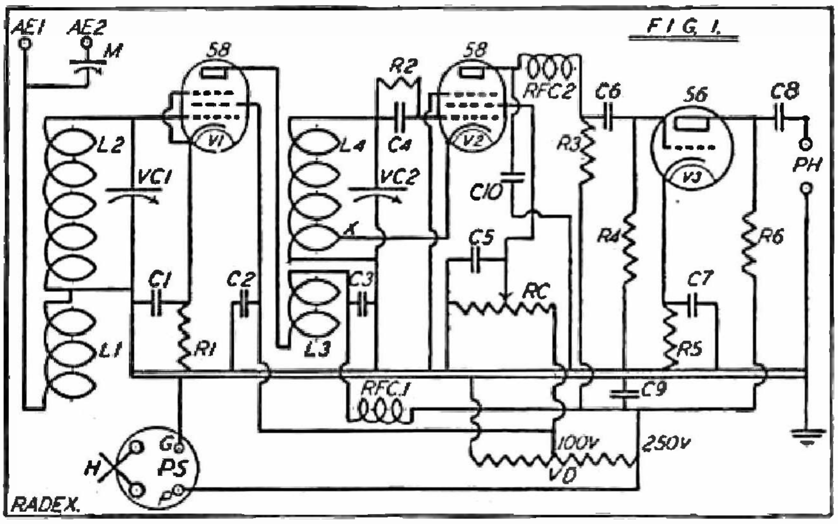
The Trans-Oceanic A.C. Three

(Continued From Page 51)

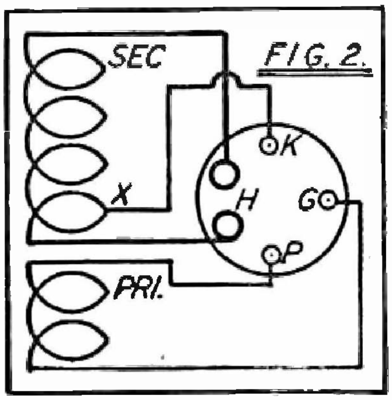
few degrees either side of that setting of VC2 come in all the short-wave broadcasters around 31 metres, GSB being especially good in the early mornings and late evenings. Referring to VC 2 only the same band will appear with Coil 4 and 52 degrees, Coil 5 and 36 degrees, and sometimes Coil 6 and 11 degrees—the size larger coil being in L1-L2 in each case and the dial settings being approximate only.

For any combination of coils VC1 has to be increased with VC2 (and vice-versa), though not necessarily in step, and in any case very roughly. In other words, set RC so that V2 is just oscillating, and then, as VC2 is moved, maintain that condition by the gradual concurrent rotation of VC1.

Having got a carrier wave (distinguished by a steady whistle as against the jerky morse of the hundreds of telegraph stations coming in all over the dial with every coil combination), set both VC1 and VC2 for its maximum volume. Now very gradually cut back RC until oscillation, and the programme (if such the carrier really is) should appear. Increase in signal strength can often be obtained by slightly reducing the setting of VC1, but this will recommence oscillation and return the whistle; stop that again by another reduction of RC.



The key-lettered circuit diagram of the Trans-Oceanic A.C.3.



Method of connecting coils to the Marquis former's five pins. L1-L2 and L3-L4 are identical, but K idles in the case of the former pair.

High Powered World Broadcasters—*Continued*

Frequency	Wave Length	Call Sign	Name and Address	Power Aerial K.W.
820	366	WHAS	Courier Journal Co., Jefferstown, Kentucky, U.S.A.	25
825	363.7	—	Radio Alger, Algeria	15
830	361	LR5	Alfredo B. Dougall, Monte Grande, Argentine Republic	12
830	361	KOA	National Broadcasting Corp., Denver, Colorado, U.S.A.	12.5
832	360.6	—	Muhlacker, Germany	60
838	358	RW57	Tiraspol, U.S.S.R.	10
842	356	London Regional	British Broadcasting Corporation, London, England	50
845	355	XETM	M. Muzquiz, Matamoros de Tamaulipas, Mexico	500
850	353	WWL	Loyola University, Kenner, Louisiana, U.S.A.	10
850	353	KWKH	Hello World B'casting Corp., Kennonwood, Louisiana, U.S.A.	10
860	348.8	WABC WBOQ	Atlantic Broadcasting Corp., Wayne, New Jersey, U.S.A.	50
860	348.8	RW70	Leningrad, U.S.S.R.	10
869	345.2	—	Administration de P.T.T., Strasbourg, France	17
870	345	WBCN	National Broadcasting Co., Downers Grove, Illinois, U.S.A.	50
870	345	WENR	National Broadcasting Co., Downers Grove, Illinois, U.S.A.	50
870	345	WLS	Agricultural Broadcasting Co., Downers Grove, Ill., U.S.A.	50
888	337.8	—	Brussels, Belgium	15
905	331.4	1MI	E.I.A.R., Milan, Italy	50
914	328.2	—	Poste Parisien, Paris, France	60
923	325	—	Breslau, Germany	60
932	321.9	SBB	Goteberg, Sweden	10
950	315.8	LR3	Buenos Aires, Argentine Republic	12
959	312.8	1GE	Genoa, Italy	10
965	310.8	XEAW	Tamaulipas, Mexico	10
968	309.9	RW75	Vinnitsa, U.S.S.R.	10
980	306	KDKA	Westinghouse Electric and Mfg. Co., Saxonburg, Penn., U.S.A.	50
986	304.3	—	Administration de P.T.T., Bordeaux, France	20
990	303	WBZ	Westinghouse Co., Millis Township, Mass., U.S.A.	25
990	303	LR4	Antonio C. Devoto Rividavia, Buenos Aires, Argentine	12
995	301.5	N. Regional	British Broadcasting Corporation, London, England	50
1004	298.8	—	Hilversum, Holland	25
1004	298.8	—	Tallinn, Esthonia	15
1010	297	CX24	Monte Video, Uruguay	10
1020	294.1	KFKX	Westinghouse Co., Bloomingdale Township, Illinois, U.S.A.	10
1020	294.1	KYW	Westinghouse Co., Bloomingdale Township, Illinois, U.S.A.	10
1030	291.2	XEB	El Bueno Tono S.A., Federal District, Mexico	10
1031	291	OFH	Viipuri, Finland	10
1040	288.5	Scot. Reg.	British Broadcasting Corporation, London, England	50
1040	288.5	KRLD	KRLD Radio Corp., Dallas, Texas, U.S.A.	10
1040	288.5	KTHS	Hot Springs National Park, Arkansas, U.S.A.	10
1050	285.7	KNX	Western Broadcasting Co., Los Angeles, Cal., U.S.A.	25
1060	283	WTIC	Travellers Broadcasting Service, Avon, Conn., U.S.A.	50
1060	283	WBAL	Glen Morris, Maryland, U.S.A.	10
1070	280.4	WTAM	N.B.C., Brecksville Village, Ohio, U.S.A.	50
1080	277.8	WBT	W.B.T. (Inc.), Charlotte, North Carolina, U.S.A.	25
1085	276.5	—	Heilsberg Ermland, Germany	60
1090	275.2	KMOX	Voice of St. Louis (Inc.), St. Louis, Missouri, U.S.A.	50
1112	269.8	1BA	E.I.A.R., Bari, Italy	10
1130	265.5	WJJD	WJJD (Inc.), Mooseheart, Illinois, U.S.A.	20
1130	265.5	KSL	Radio Service Co. of Utah, Saltair, Utah, U.S.A.	50

Standard American Valve Bases

Keep this sheet for reference: it shows bases in reverse for wiring

01A, 10, 12A, 20, 26, 30, 31 — 45, 50, 71A, 99, 864, 2A3

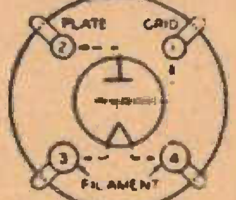


FIG. 1

80, 82, 83, 5Z3

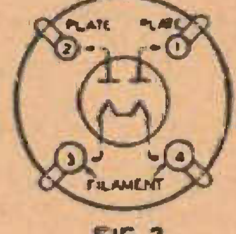


FIG. 2

81

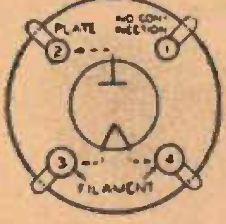


FIG. 3

22, 32

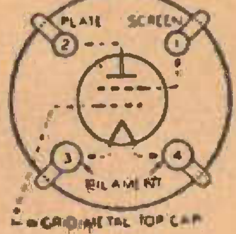


FIG. 4

34

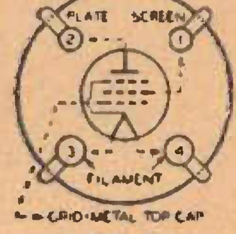


FIG. 4A

25Z5

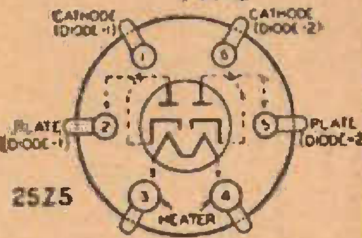


FIG. 5

33, 47, 6A4

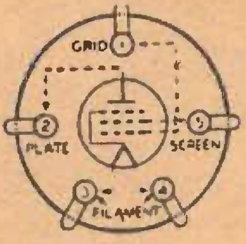


FIG. 6

46, 49

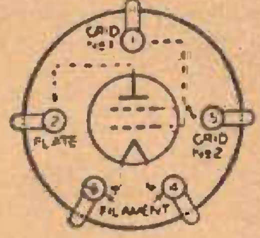


FIG. 7

27, 37, 56

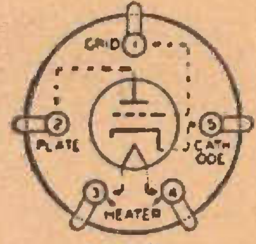


FIG. 8

24A, 35, 36

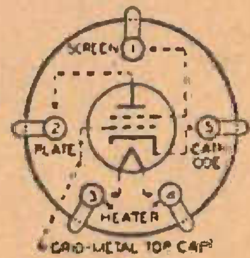


FIG. 9

38, 39, 44

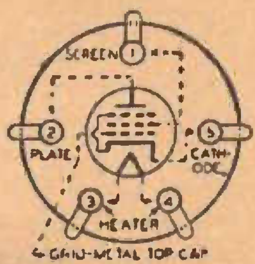


FIG. 9A

1A6

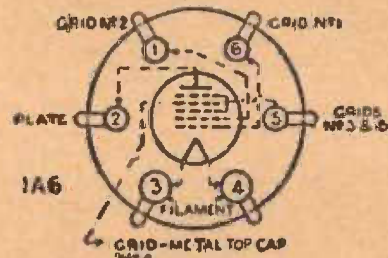


FIG. 10

57, 58, 77, 78

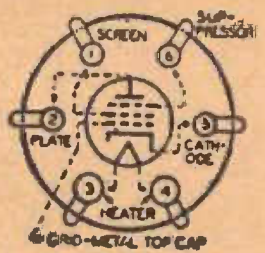


FIG. 11

19

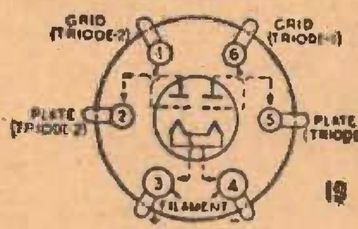


FIG. 12

55, 75, 85, 2A6

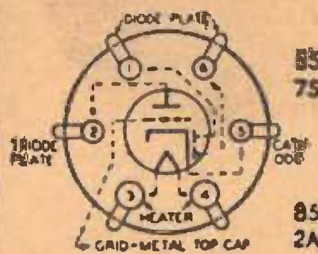


FIG. 13

89

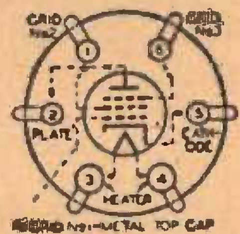


FIG. 14

48

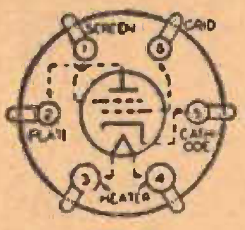


FIG. 15

41, 42, 43, 2A5

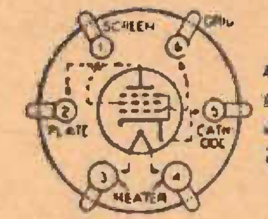


FIG. 15A

866

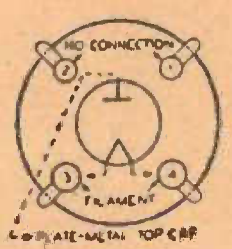


FIG. 16

53

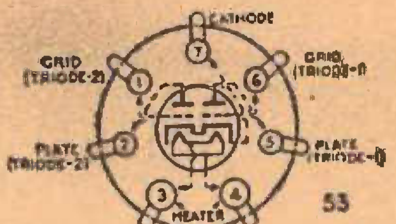


FIG. 17

59

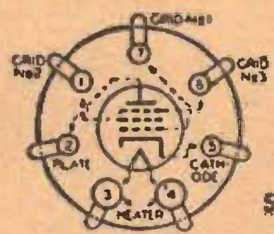


FIG. 18

79

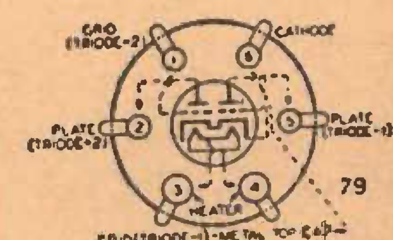


FIG. 19

2A7, 6A7

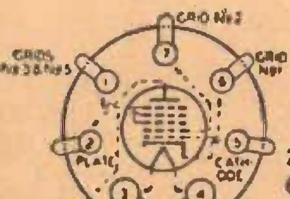


FIG. 20

2B7, 6B7

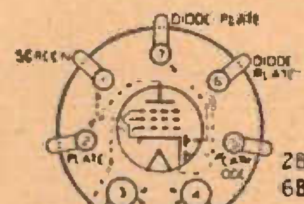


FIG. 21

1V, 12Z3

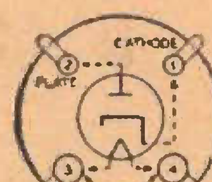


FIG. 22

84

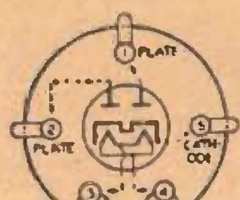


FIG. 23

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