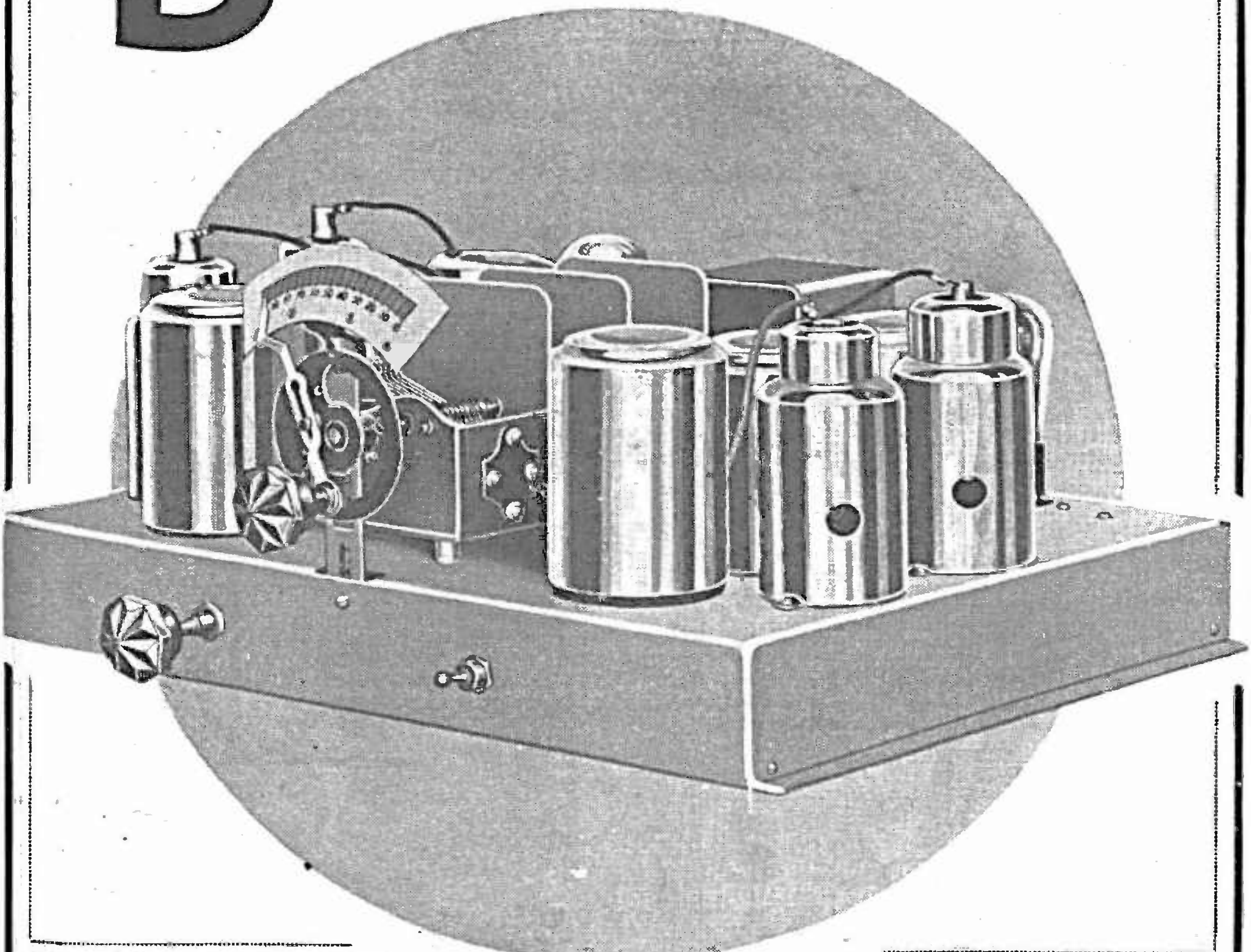
Handbook No. 7

6D

The Listener In

Battery Sets



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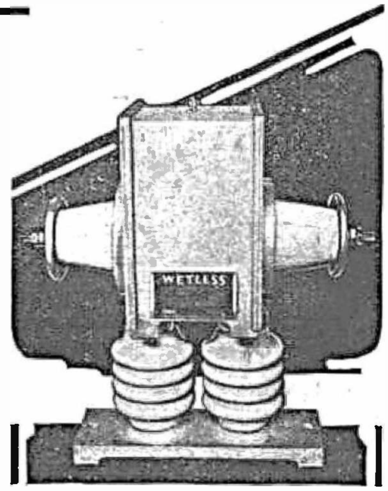

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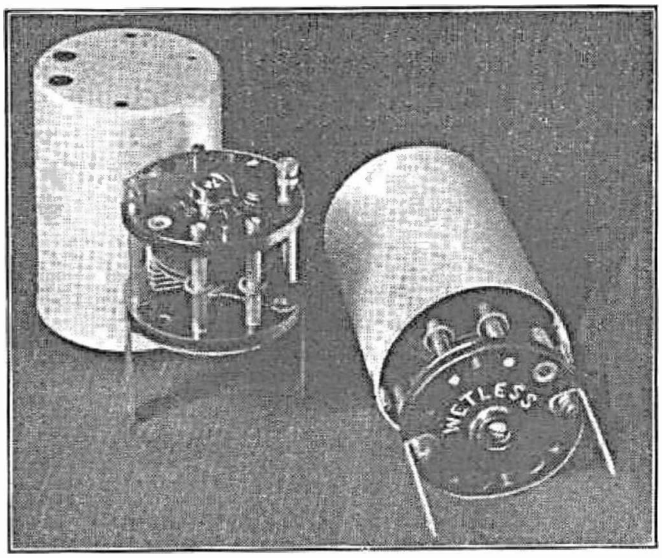

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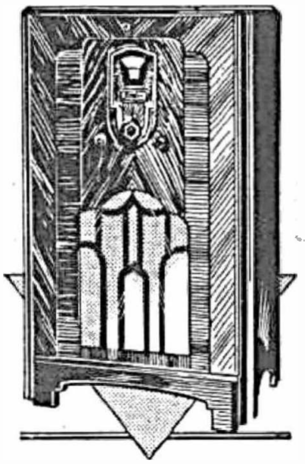

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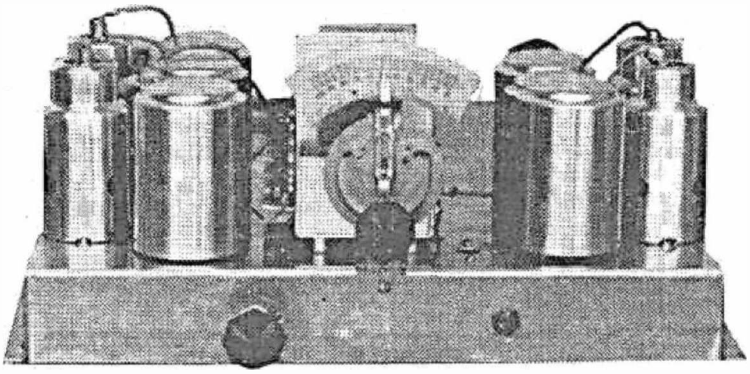

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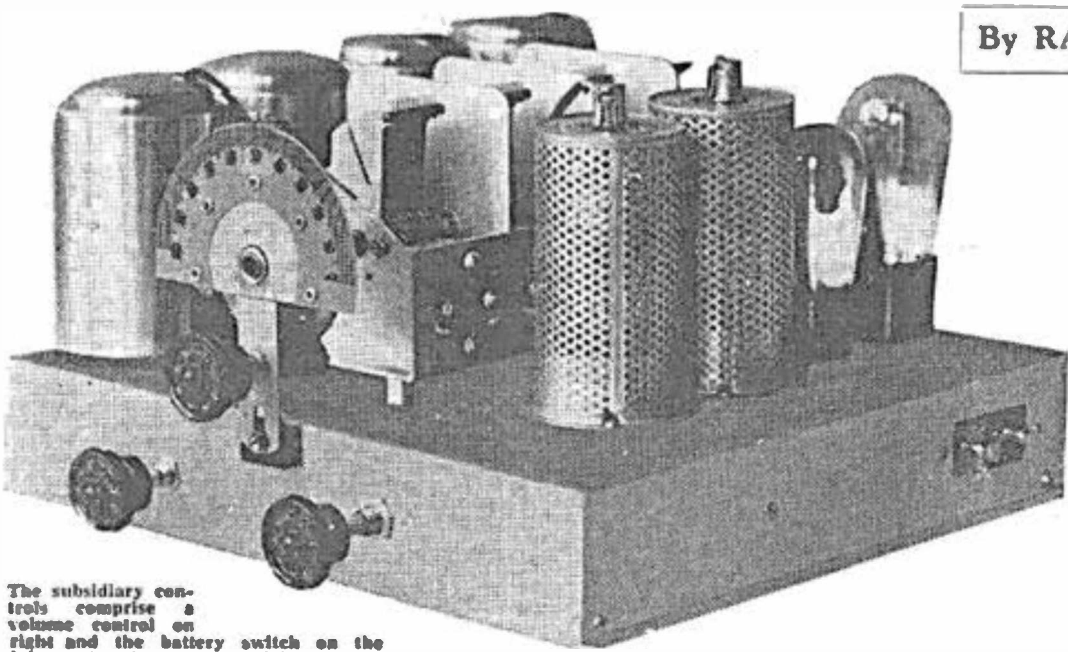
The Economic Four



The subsidiary controls comprise a volume control on right and the battery switch on the left. On the extreme right are the speaker's terminals.

By RADEX

A Battery receiver that is really selective, well capable of interstate reception, reasonable volume yet having a B Battery consumption of only 12 milliamperes at the most.

THE Economic Four has been specially designed to meet the conditions experienced by country listeners, particularly those who reside in districts where station interference is prevalent.

Valves that would give a reasonable response with a minimum of consumption naturally meant the selection of the 2-volt filament series, and the characteristics of all such were compared very carefully. In this it was noted that the variable-Mu type of r.f. amplifiers invariably showed a higher plate battery drain than the older, but equally sensitive, straight out screened-grids. As every means of achieving economy in a country battery set is permissible, and in view of the fact that the ultimate instrument would be more likely to run flat out most of its time, it was decided to employ the latter. Volume can be controlled easily at the audio end.

Two types of circuits were debated. One, a 3-valver, would have included a stage of r.f., a regenerative detector, and a pentode audio; this required a reaction control that would be a critical setting on weak signals. The other, that illustrated here, required two r.f. stages, a pure detector without reaction, and an audio pentode again. The extra r.f. valve's plate current is very small, and its presence eliminates the need for reaction, thereby simplifying tuning and making station selection a positive operation that involves the rotation of but one knob.

Now, if you consult data sheets covering the 2-volt series and having special reference to types 30 (detector), 32 (r.f.'s) and 33 (audio pentode), you will find that when such a 4-tube combination is empowered from a 135-volt B battery its total current is in the region of 23 m.a. As a matter of fact, using Philips in the original, the meter showed the passage of 25.2 m.a., when all valves were correctly biassed. However, do not be worried by those figures.

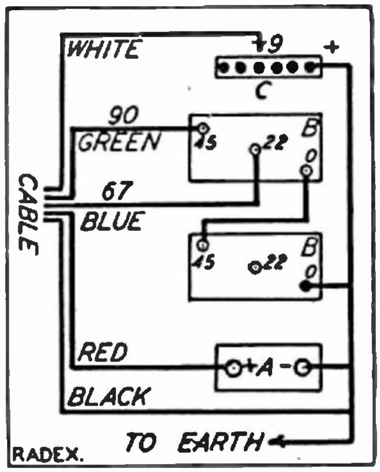
When the plate supply was reduced to 90 volts, with 67.5 volts on the screens of the two 32's, the consumption dropped at once to 11.75 m.a. The result was certainly a slight reduction of the volume from strong stations, but distant programmes came in just as well, because the reduced potential did not decrease the set's sensitivity perceptibly. The draw on the "A" battery accumulator is to the order of only 0.44 ampere.

The Circuit in Theory

The range, the sensitivity of this model is governed to a very large extent by the winding ratios of the coils. It is essential that the inter-valve r.f. transformers L4-L5 and L6-L7 make possible a big transference of energy from plate to following grid. To this end it was specified that these transformers should have a primary to secondary ratio of not less than as 3 is to 5, the former being of very fine wire wound either over the secondary's earthed end or just below that point.

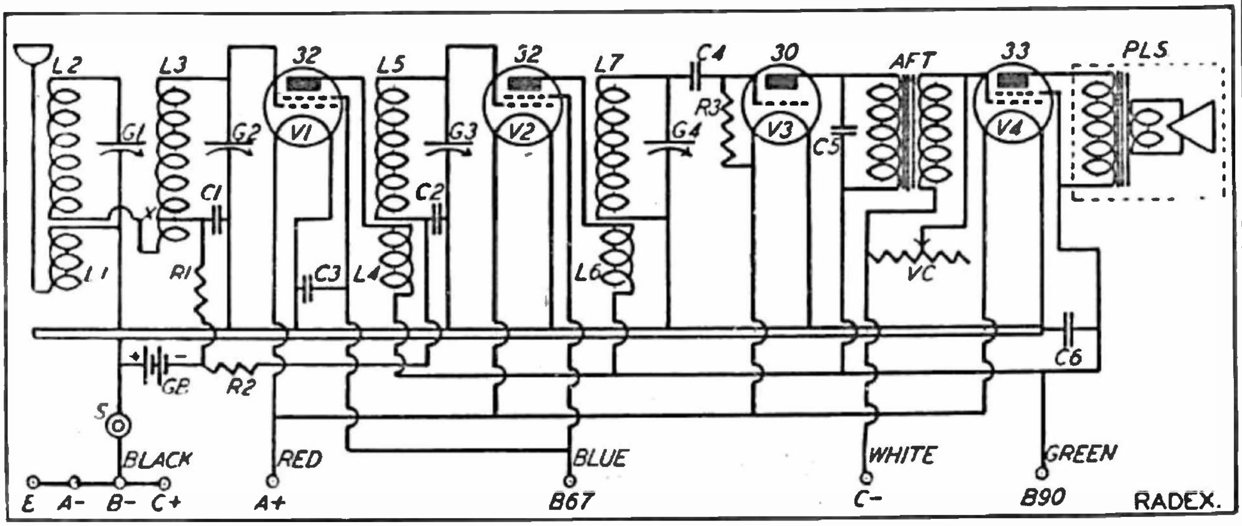
While such a formula affords a high gain per stage, it has the natural fault of making for broad, or unselective, tuning, and that is one of the troubles that we must avoid. Fortunately, that is an easy matter and the required degree of selectivity is attainable by the insertion of a pre-selector stage before the first r.f. tube, V1. This stage is composed of coil L3 (tapped at a point X three turns from its lower end) and section G2 of a 4-gang variable condenser. L1-L2, the latter tuned by section G1 of the same gang, form an ordinary aerial coil unit, but the bottom of L2, instead of being earthed, connects to the bottom of L3—that coil taking its earth at X. Obviously, the three turns between X and the bottom of L3 form the only means of coupling (energy transfer) between aerial input and the grid of V1 and the result is knife-edge selectivity even under the worst of conditions.

I am quite prepared to admit that this model has not been actually tested out under country conditions, but here in Essendon, it has had to put up with a lot of powerful local interference, and I think it has come through quite well. It separates 5CK from 3AR with ease; 2CO is clear, too, but the same cannot be said of 7ZL. Sydney-2BL is free from both 3LO and 3UZ, but the latter washes over a little on to 2GB, although



Method of connecting the 5-channel cable between chassis and batteries

LIST OF COMPONENTS AND SCHEMATIC PARTS



A.—2-volt Accumulator, anything over 40 ampere-hour capacity.

B.—Two 45 volt heavy or triple duty "B" Batteries.

C.—Tapped 15-volt "C" Battery.

AFT.—Audio Transformer, 3/1 ratio at least, but preferably 6/1. (A.W.A., Essanay, Radiokes, Wendel.)

C1, 2, 3.—Tubular Fixed Condensers of 0.1 mfd. (T.C.C., Chanex, Concourse.)

C6.—Fixed Condenser of 1 mfd. (T.C.C., Chanex, Concourse.)

C4, 5.—Mica Condensers of 0.00025 mfd. (T.C.C., Wetless, Saxon.)

E.—Earth Terminal.

G1, 2, 3, 4.—Four-gang Tuning Condenser. (Essanay, Stromberg-Carlson, Saxon, Airway.)

GB.—Three-volt R.F. Grid Bias Battery. (Everready 1678).

L1, 2.—Shielded Aerial Coils. (Melbourne, Essanay, Saxon, R.C.S., Radiokes, Aegis.)

L3.—Shielded Pre-selector Coil. (Melbourne, Essanay, Saxon, R.C.S., Radiokes, Aegis.)

L4-5 and L6-7.—Shielded R.F. Coils. (Melbourne, Essanay, Saxon, R.C.S., Radiokes, Aegis.)

PLS.—Preferably Permagnetic Speaker with input transformer to match 233 pentode, but ordinary magnetic cone will do. (Rola, Philips, Del Monte, A.W.A., etc.)

R1, 2.—Resistors of 100,000 ohms. (Carborundum, I.R.C., Silent Answer, Bradley, Stedipower).

R3.—Resistor of 2 megohms. (Carborundum, I.R.C., Silent Answer, Bradley, Stedipower).

S.—Rotary or Snap Battery Switch.

VC.—Potentiometer of 500,000 ohms. (Bradley.)

V1 and 2.—S/G Valves, type 32. (Philips, Radiotron, Ken-Rad, Mullard, Cossor, Osram, Speed.)

V3.—Triode, type 30. (Philips, Radiotron, Ken-Rad, Mullard, Cossor, Osram, Speed.)

V4.—Pentode, type 33. (Philips, Radiotron, Ken-Rad, Mullard, Cossor, Osram, Speed.)

Four valve sockets, three UX and one UY; two valve-shields, and two grid-pip clips. Three terminals and some scrap ebonite. Two yards 5-channel battery cable. Aluminium No. 16 gauge chassis 11 by 10½ inches by 2¼ inches. Sundry nuts and bolts.

3BO is quite uninterrupted. The Herald's 3DB does not trouble 2CH, but only 4BH has been heard between 3KZ and 3AW. In comparing these results it should be remembered that all these locals are within five miles, while both 3AR and 3LO are little more than a mile distant.

Going further afield and coming to sections of the tuning dial in which Melbourne stations have no scope, that crowded area that includes 2KY, 3SH, 7LA, 2HD, 2UW and 4BC shows up well, as all six were clearly cut off from each other. The same applies to the section that starts with 2NC and goes down to 5AD. In its Sunday noon to 2 p.m. session 3BA Ballarat came in quite nicely in daylight, while 7UV Ulverstone has an entertainment value in the early mornings.

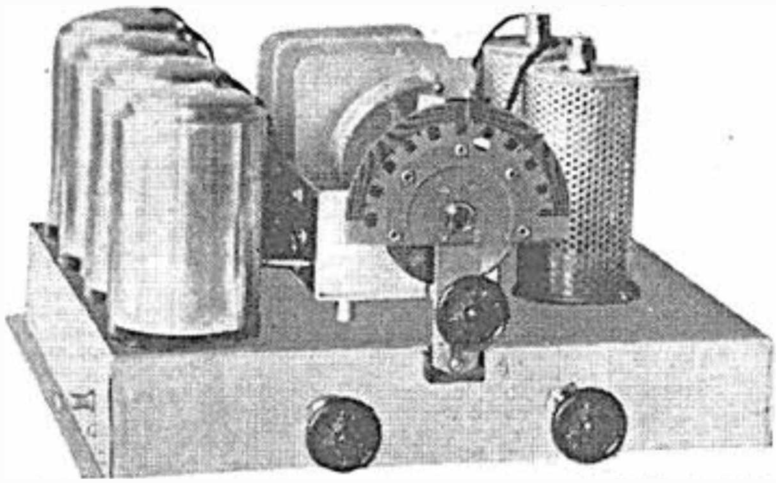
The Audio End

Triode 30 was chosen as a grid-leak type of detector valve in preference to one of the screened-grid type. Its use permits of it being followed by an audio transformer for coupling purposes, and avoids the critical screen voltage of the S/G detector. Shunt condenser C5 cleans up signals while volume is governed by high resistance potentiometer across the secondary of AFT.

Pentode 33 can be followed by an ordinary 2000 ohm resistance magnetic cone speaker. Better results will be obtained from the employment of a permagnetic type of reproducer, but such must be mounted on a baffle-board measuring about 24 by 30 inches and include a built-in in-put transformer to match the 33. Main by-pass condenser C6 should not be omitted; its presence is always beneficial to reproduction, and it flattens the crackles so often natural to an ageing B battery.

The Importance of Bias

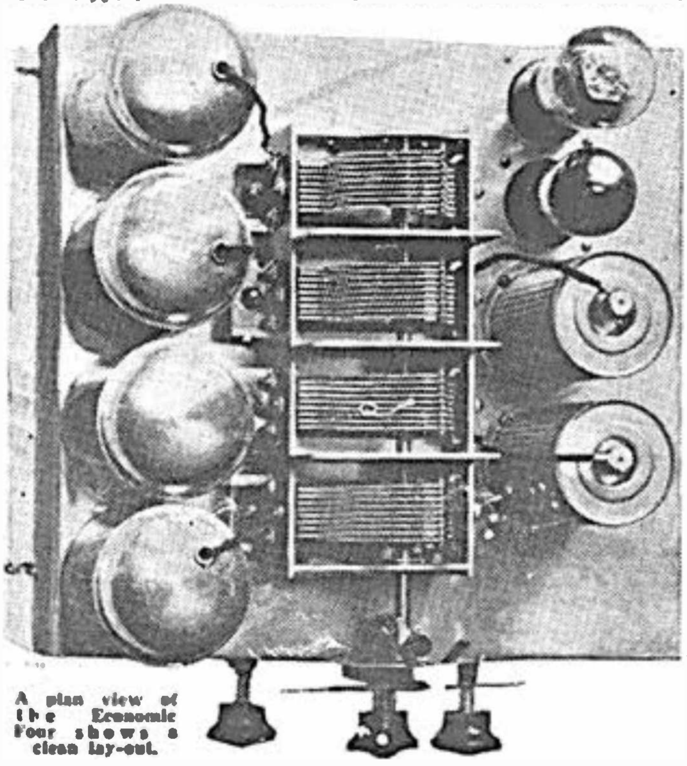
This receiver employs two separate "C," or bias, batteries. One, the larger, of 15 volts tapped, connects across mains C plus and C — and serves the final pentode only. With a 90 volt B supply C— should get at least 10½ volts negative; below that the plate consumption will rise very rapidly, above it there will be a slight decrease in volume (and possibly of quality also to critical ears), but the B battery's life will be even more lengthened.



The cell cans to the left of the ganged condenser occupy the full depth of the chassis, 10½ inches.

The other bias is GB, and takes the form of a very small 3-volt cell such as is used as a re-fill for flat, vest-pocket torches. Its life will be long, and so it is fitted in under the chassis (vide photo) and permanently wired into the circuit. With this device de-coupling is absolutely essential; in the case of V1 this takes the form of resister R1 and by-pass condenser C1. R2 and C2 perform a similar office in respect of valve V2. When the set is switched off drain on GB ceases automatically.

Many quite earnest experimenters have pointed out to us that they cannot notice any alteration in signal volume when the r.f. bias battery is alternatively connected and disconnected in a battery model. That is quite right; it takes an exceptionally sharp ear to detect any change in either quality or sensitivity. A milliampere-meter in the B negative lead tells a different story and, in this particular instance, the removal of GB puts the total consumption up by nearly 2.5 m.a. In other words the drain of the two r.f. valves is just about doubled, and hence the need of bias.



A plan view of the Economic Four shows a clean lay-out.

Battery Connections

Good five-channel, color-coded cable is inexpensive and lightens the constructor's labor considerably. It permits of the employment of an aluminium chassis without the trouble of making large insets of ebonite to provide insulation for terminals.

Procure a small strip of ebonite about 2½ inches long and ½ inch wide and drill it with seven 1-8in. diameter holes. Using small screws and nuts, fix double ended solder lugs to the centre five holes; the other two, in conjunction with slightly longer screws, are used to make fast the strip to a convenient side of the chassis while holding it away from the metal for the avoidance of short-circuits to earth.

The double-ended lugs permit of two connections being made easily at each point and correspond to B90, C—, B67, A+ and the common return formed of C+B—A—E. One such connection, in each case, goes to appropriate points in the set, the other takes the correspondingly colored lead of the cable. Note that some makes of cable substitute a yellow for a white in the combination.

Externally the three batteries are grouped together as shown in a separate drawing. Four of the leads go to obvious points therein. The fifth, the black, should terminate at the negative of the 2-volt accumulator and from there should be carried on by other wires to the full negative of B, the positive of C, and a good damp earth.

General Construction

Do not attempt to make your own coils. The chances against ultimate satisfaction are very high, while the possibility of your ever being able to line up the 4-gang tuning condenser is positively remote. Ours were made to specification by Colonial Radio, of Melbourne, and the details were: A standard aerial coupling unit (L1-L2), a pre-selector with a 3-turn in-put (L3), and two r.f. transformers (L4-L5 and L6-L7), with a 3 to 5 primary to secondary ratio, the former being of No. 40 (or finer) d.s.c. wound either on or below the secondary's earthed end. Each unit is wound on a 1¼in. diameter former and enclosed in a 2½in. aluminium can.

Everything fits comfortably on a chassis measuring 11 by 10½ inches. The depth is governed by the size of the audio transformer, which fits in underneath and below the G4 section of the condenser gang. In our case 2¼in. was enough, but a more bulky transformer would increase that dimension.

The photographs clearly show the general lay-out. On top of the chassis, and to the left of the condenser gang, the four canned coils run backward in the order of the diagram, L1-L2 being nearest the front and L6-L7 at the rear. Also, in natural order, the valves are arranged on the other side of the gang, and are so close together that V1 is exactly level with section G2. Place the gang so that the extreme end of its shaft just comes flush with the front edge of the chassis.

Underneath the main fixtures are the battery connections strip, transformer AFT, cells GB, and block condenser C6. The other components work into position in the course of the wiring.

Wiring in Words

As shown in the photos., cut two ports in the chassis and fill them in with suitably sized pieces of ebonite. That towards the front of the left side carries the aerial terminal; the other, to the rear of the right side, takes the two terminals for the loud-speaker leads. Mark the five now vacant contacts on the battery strip with their ultimate denominations, "B90," "C—," etc. Similarly, letter the wiring points on the valve sockets, remembering you are working in reverse.

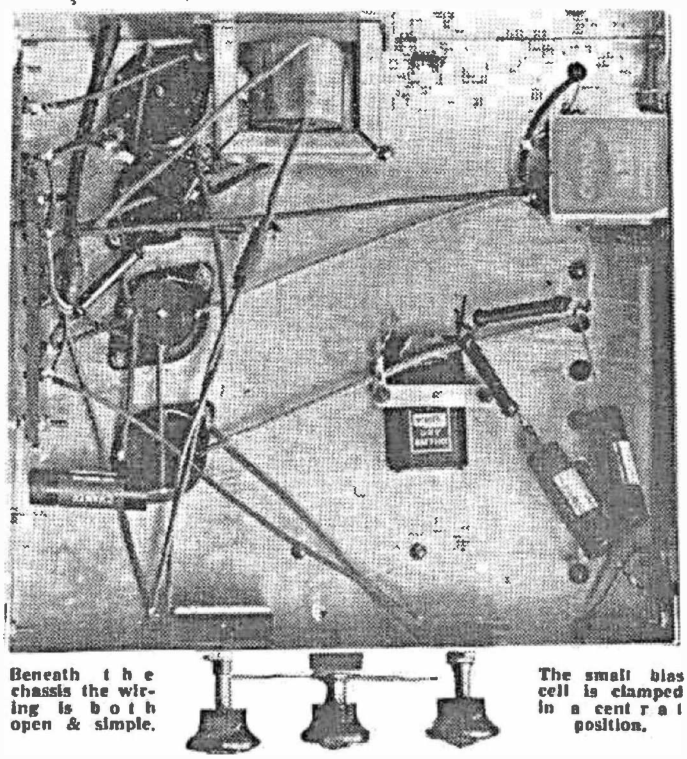
Wire together one F on each socket and continue to main "A plus." Connect the single main "G B—A—E" to one side of switch S. From the other side of S go successively to the remaining vacant F on each socket, and continue to a lug bolted right to the metal of the chassis.

Connect P of UY socket V4 to one speaker terminal. Starting at one side of C6 go to the B terminal (or lead) of AFT, the remaining speaker terminal, the screen on socket V4, and finish at main "B90."

Take the grid connection of V4 to the arm contact of VC. One outer of this control goes only to G of AFT; the other outer is taken to P of AFT, and thence to main "C—." Take P of the same transformer to P of socket V3 and connect C5 across P and B of AFT.

Solder ends of C4 and R3 directly to the G of socket V3 and connect the other tail of R3 to filament-positive on that socket. From main "B67" go successively to the screen contacts on sockets V2 and V1, and then wire C3 between the latter point and earth (chassis). Solder a tail of both resistors, R1 and R2, to the negative side of GB, and then earth its positive.

We now come to coil wiring, and these should be mounted as the directions call for them, starting with the two r.f. transformers together. The ganged condenser must be fitted last of all in order that it may be protected from all chances of damage—bent plates and the like. If the coils' connections are made from contacts in their bases and brought under the chassis through the suitable holes bored in it, such contacts will be invisible after mounting. In order to avoid error the necessary tails should be differently colored and a note made accordingly. All grid leads (even that of L7) come out of the tops of their cans, as does also the top of L2.



Beneath the chassis the wiring is both open & simple.

The small bias cell is clamped in a central position.

Connecting the Coils

Take the bottom ends of L4 and L6 to the lug on C6 already wired to main "B90," and earth the other side of C6. Take the tops of those primaries L4 and L6 to the plates of V1 and V2 respectively. Note carefully that these directions only hold good when primaries are wound over the earthed ends of their secondaries; when they are wound below the order is reversed, i.e., tops go to B and bottoms to P.

Earth the bottom of L7. Take the bottom of L5 to the free end of R2 and one side of C2, earthing the other end of the latter.

In the case of L3, take the tap X, 3 turns up from the bottom, to the free end of R1 and C1 and earth the other side of C1. Connect the bottom of L3 to that of L2. L1 will be wound below L2; take the former's top to earth and its bottom to the aerial terminal.

Now mount the ganged condenser and this will automatically earth its moving plates. The photos show that in three instances connections are made to a given set of fixed plates at both sides, as these directions will specify.

Take the top of L2 only to the fixed plates of G1. Similarly the top of L3 goes to the fixtures of G2, but from the other side of that section a lead (terminating in a grid clip) is taken off going to the grid on top of V1. Again, the top of L5 goes to G3 and the other side of the latter carries another lead to V2. In the case of G4, while it carries the top of L7 on one side, from the other a short wire runs off and THROUGH the chassis to the free end of C4.

It now only remains to solder the 5-channel cable to the battery strip according to its color-code, and then to connect up the batteries and earth as illustrated. In order to "drive" the set a good aerial is desirable. An over-all length of around 80 feet would be useful and as much of that as possible should be vertical.

Operation Notes

Turn the arm of VC so that it is hard over in the direction of its outer that is wired to G of AFT. Switch on and "liveness" should appear in the speaker. If this does not show up at once see that you have not put VC to its minimum volume, instead of the maximum, by mistake.

Open all the trimmers about one-half turn. Having been careful to set the dial so that it reads 100 when all plates are fully meshed, run through scale in search of a station. Go slowly and listen hard; as yet the condensers are unlined and whatever you do get just now will, in all probability, be pretty faint. Try to get something as low down on the scale as possible.

Having got signals, get to work on the trimmers for an increase in volume. In this it will be found that the trimmer of section G2 (the pre-selector) is the most critical; indeed, all other sections set themselves to it. It can, therefore be taken as the master, and the others should be adjusted, either up or down, in the order G1, G3 and G4. Of these, the first and second are about equally critical, while G4 is broad in comparison.

In the course of these operations you may find one trimmer that is still increasing volume when screwed to the limit either up or down. In such a case (for the limit down), open G2 a quarter-turn more, return to the test station by increasing the dial reading by about a degree, and re-line on G1, G2 and G4. For the limit up, the reverse, G2 is closed a little, of course.

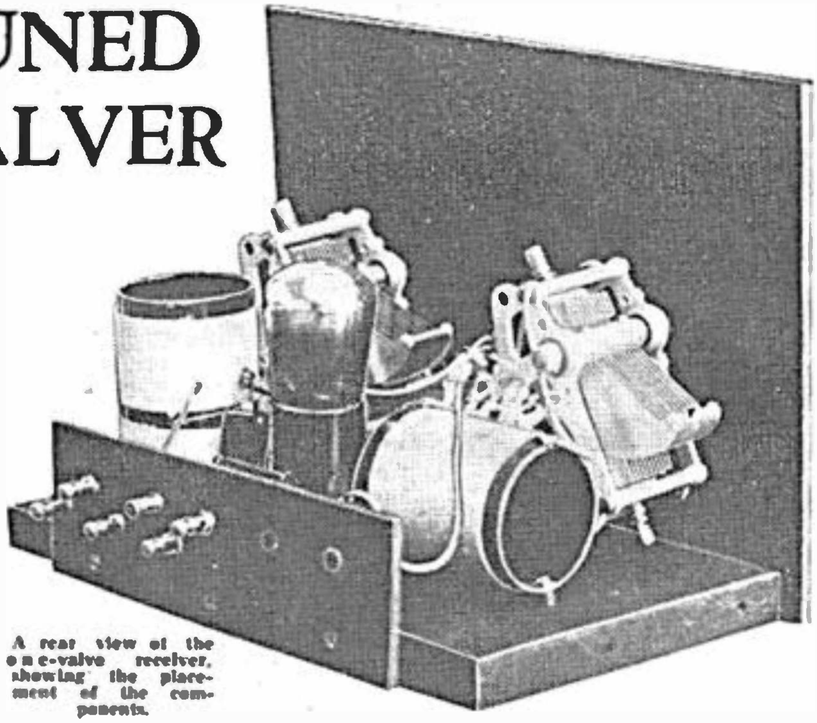
The final lining should be down definitely on some station operating on a

(Continued on Page 28)

A TRAP TUNED ONE-VALVER

A selective receiver that will give good headphone results on all local "A" and "B" class broadcasting stations

By P. R. DUNSTONE



A rear view of the one-valve receiver, showing the placement of the components.

IN this article we propose to describe a one-valve set employing the well-known Reinartz system of regeneration. This outfit will be suitable for anybody who is desirous of obtaining a little more step up than a crystal can give. Provided specifications are closely followed the builder should receive very satisfactory results. It will be seen from the schematical diagram, that a trap has been included. This is inserted in the circuit to prevent any interference which may be on the lower wave-lengths.

A one-valve receiver using this regenerative circuit can be expected to bring in all the local broadcasting stations and most of the amateurs at good headphone strength. The cost of operating a receiver of this type is small.

Then again many listeners have the impression that a crystal receiver gives a more faithful reproduction, and for this reason we sometimes find the crystal detector trying its hardest to handle the output of several RF stages preceding an expensive amplifier system. That the idea is a fallacy is obvious when we consider the fact that signals that they are trying to pick up without distortion by means of a crystal detector have already passed through some dozen thermionic valves in the process of transmission, and yet still retain absolute fidelity.

Therefore why cannot a circuit of this type, having the regeneration correctly applied, still enable distortionless reproduction to be available for headphones, or to be fed into an amplifier system?

Coil Details

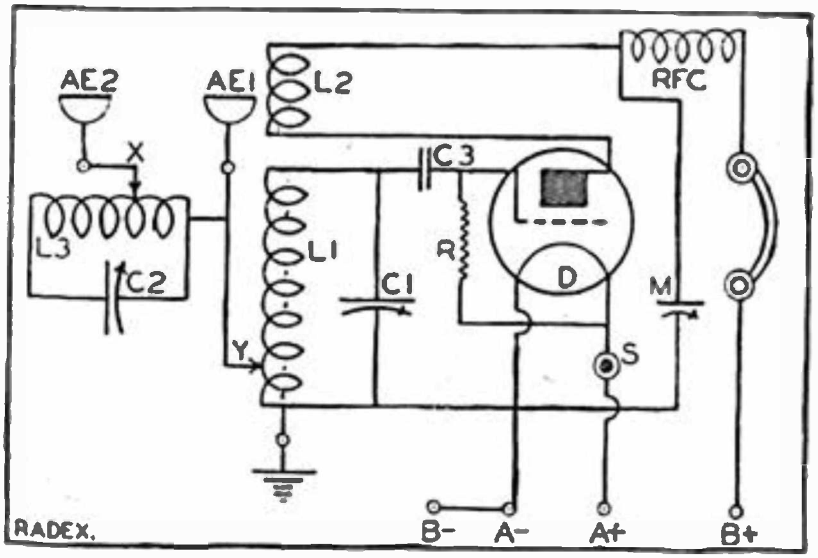
The coils for the trap and detector circuit are both wound on a 2in. former. We will commence winding the L3 trap coil. This requires a piece of 2in. former measuring 2½ inches long. Drill a hole in the wall of the former about a quarter of an inch from one end, then fasten the gauge 20 wire in it and wind 42 turns on taking tappings at every sixth turn. These tappings are used to connect the alligator clip from AE2 terminal, to the most selective tapping.

The grid coil L1 and reaction coil L2 are wound on a separate piece of former 3in. long. Begin the L1 coil a quarter of an inch from one end of the former and wind on 60 turns, making tappings at the 45th, 50th and 55th turns. The reaction coil L2 is wound alongside L1 and will require 30 turns wound in the same direction as the grid coil. The distance of separation between L1 and L2 is about a quarter of an inch. Little difficulty should be experienced while winding these coils, provided the directions are closely followed.

Mounting the Components

The photographs of the original receiver accompanying this article should assist the builder greatly when mounting the parts. However, we will touch on the essential things to simplify it for the beginner. Regarding the two coils:

(Continued on Page 11)

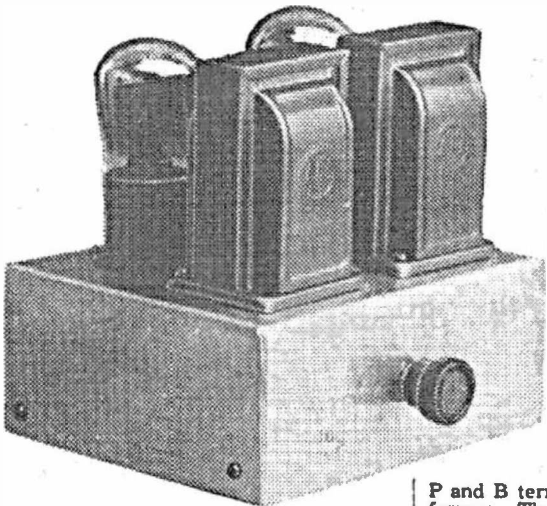


Schematic Diagram of the Reinartz One-Valve Receiver.

TWO-STAGE AUDIO AMPLIFIER

A signal magnifier that will be suitable for attaching to a detector for loud speaker results.

By P. R. DUNSTONE



A front-corner view of the amplifier showing the volume control knob mounted below the transformers.

THIS two-stage audio amplifier is suitable for coupling to the crystal or one-valve circuits.

Amplification is executed at low frequency (otherwise audio) after detection has been carried out by means of a crystal or valve (the latter being more extensively used), and is usually adopted when desired to operate a loud speaker.

Mainly we are describing this amplifier for those who have constructed the one-valve receiver, although it would work quite satisfactorily with the crystal.

An audio frequency amplifier does, in fact, slightly increase the range of reception, inasmuch, that it magnifies signals just audible on headphones to a much greater volume. Nevertheless, it is a good working rule that amplification at high frequency increases the range, while amplification at low frequencies merely increases the strength of signals already discernible.

To introduce an audio amplifier it is only necessary to remove the headphones from the plate lead of the detector valve, and to substitute the primary (i.e., P and B terminals), winding of the transformer. The additional valves are operated from the same A and B supply as used for the detector valve. For the bias it will be necessary to incorporate another battery, its voltage depending upon the particular types of valves utilised. Without this additional batery to supply a steady potential to the grids of the valves, distortion would be experienced on all signals and B battery wastage would accrue.

It may be advisable to hesitate here, and give a brief run over what part the C battery plays in the actual circuit. It is essential that the grid of an amplifying valve remain negative so as to operate it on the straight sloping part of its characteristic curve and so avoid distortion. It, therefore, becomes necessary to make sure that the grid is given the requisite negative bias through the medium of batteries. (Other methods of obtaining bias will be described at a later date).

From this you will see the important part a C battery plays, when faithful reproduction is called for.

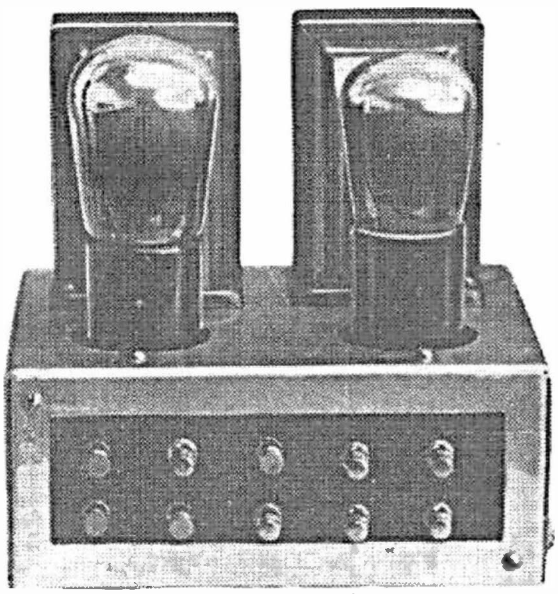
However, this is not the only place that distortion can be introduced into a circuit. Another is the design of the transformer used. In some cases where inferior types are used, they will be found to pass certain note frequencies better than others, and that uneven amplification is bound to result, although sometimes not noticeable to the non critical ear. The resultant distortion may be minimised by shunting the transformer secondaries with high resistances, to the order of 0.5 megohms. The usual pig-tail type can easily be fitted to the transformer. This method of loading the transformer to remove resonant note frequencies is not advisable, as, in the majority of cases, it will be observed to reduce the volume of the amplifier.

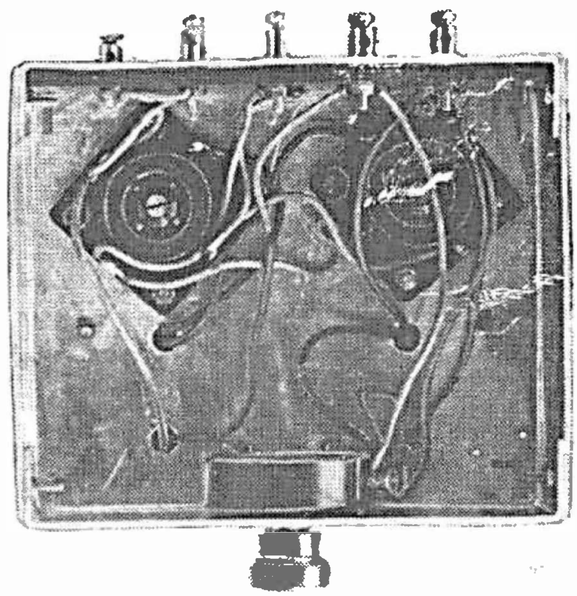
The amplifier described in this article is mounted on an aluminium chassis with the valves and transformers on top, giving an attractive appearance when finished. The actual size of the chassis measures 6¼ long by 5¼ wide by 2½ inches deep, and is made with gauge 16 aluminium.

Reviewing the Parts

The audio frequency transformers should be of a reputable make, and have a ratio of 3-1. If cheap transformers are purchased the builder cannot hope to obtain life-like results.

The volume control is a variable re-





Rear view of the amplifier, showing the terminal strip. Right: An underneath view of the finished amplifier, showing the placement of the valve sockets.

sistance with a value of 0-50,000 ohms. This may be the wire wound or carbon type.

Valve sockets in the majority of cases are largely to blame for troubles in receivers. Therefore, it is absolutely essential that a type with solid contacts be used for satisfactory results over any period of time. The UX sub-panel type is used in this outfit.

Chassis Construction

Take a sheet of gauge 16 aluminium, measuring 11¼ by 10¼ inches. Cut 2½ inch squares from each corner, then bend aluminium into the form of a chassis.

Parts Required

- 2 Audio frequency transformers, 3-1 ratio (T1, T2).
- 2 UX sub-panel valve sockets (V1, V2).
- 1 Variable resistance .0-50,000 ohms (R).
- 10 Terminals.
- 1 Chassis (see text).
- 2 Valves.
- 1 Strip of ebonite.
- Some flex and machine screws.

The back is then cut away to permit a piece of ebonite to be fastened, this serving as the terminal strip.

Two valve holes are cut 1½ inches from the rear corners, vide the original photographs. Having finished this, the sides of the chassis should be fastened by means of brackets. This completes its construction.

Mounting the Components

Provided the transformers are of the shielded type, it will not be necessary to mount them at right angles to each other. These are spaced evenly over the remaining surface of the chassis.

The variable resistance is mounted at the front. It may be necessary to bush this control, depending on the particular type used.

Ten terminals are mounted on the piece of ebonite at the rear of the chassis for input and output purposes.

Wiring in Words

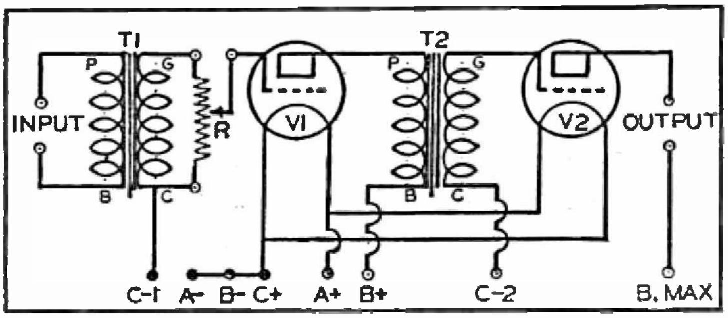
Having mounted the components, it only leaves the wiring to complete the amplifier. The P and B terminals on the transformer T1 are connected direct to two terminals on the strip respectively (known as "input"). The secondary of this transformer has the variable resistance R wired across the G and C terminals. Another lead is also taken from the C terminal to a terminal of the strip to serve the place of C negative 1. The G terminual of T1 is joined to the G terminal of V1.

The P terminal of V1 is taken to the P terminal on T2, while the B terminal of this transformer is soldered through the medium of a piece of flex to another terminal on the strip, serving the B positive connection. The G terminal of T2 is connected to the G terminal on V2, while the P terminal of V2 is taken to one of the output terminals on the ebonite strip. The other output terminal is soldered to a terminal which is used for B positive max.

A lead is taken from the terminal strip to the C terminal on T2 and is used for C negative 2. The filament terminals on V1 and V2 are wired in parallel and connected to the two remaining terminals on the strip, one of the terminals serving the place of A positive, while the other is used for A and B negative and C positive connections. This completes the wiring.

Operation

There is little to say regarding the operation of this amplifier, other than a warning to pay strict attention to the voltages applied to the valves. These voltages may be learned when purchasing the valves, combined with the right potential to apply to the grids of the valves in the form of C bias. The variable resistance R has been included in the circuit to control the volume.



Circuit of the audio frequency amplifier

A Trap Tuned One-Valver—

(Continued from Page 9)

these should be mounted as in the original photograph, viz., at right angles, otherwise interaction will be caused between them, probably resulting in inferior reception.

The grid leak and condenser may be mounted directly to the G terminal of the valve socket D. It is not essential that the two vernier dials specified in the list of parts be used. We will leave the type of dial optional to the builder.

Wiring in Words

Commence by wiring the trap. The beginning of coil L3 is connected to one side of the tuning condenser C2, while the other side of this coil is taken to the remaining end of L3. This latter is also fastened to AE1 terminal. An alligator clip is fastened to AE2 terminal through the medium of a piece of flex, and clipped to one of the tappings on L3, the correct one being found by experiment.

The beginning of L1 coil is taken to the fixed plates of the tuning condenser and to one side of condenser C3, the other side of the coil going to one side of R1 and to the G terminal of the valve socket D. The remaining end of L1 is connected to earth, to the movable plates of the two variable condensers C1, M, and to the negative side of the filaments.

The fixed plates of condenser M are connected to the beginning of L2. The other end of L2 goes to the P terminal of the valve socket and to one side of the R.F.C. The other side of this choke goes to one of the phone terminals. The remaining phone terminal is joined to the B positive terminal on the terminal strip.

The remaining end of R is connected to the positive side of the filaments. The F terminal on the valve socket is also joined through the medium of a switch to the A positive terminal on the strip. The other F terminal goes to a terminal on the strip for A negative, and continues to a further terminal for B negative. A lead is taken from AE1 to a tapping of L1, the correct one being found by experiment.

List of Parts

- Two .0005 mfd. variable condensers, C1, C2.
- One 23-plate midget condenser M.
- Six terminals, two banana sockets, one plug, and one alligator clip.
- One grid leak and condenser 2 Mgs. and .00025 mfd respectively.
- One reel of 20 gauge D.C.C. wire and one of No. 30.
- Two pieces of former (see text).
- One radio frequency choke (R.F.C.)
- One switch (S.).
- Some flex and screws.
- One valve A415 type and UX socket.
- Two vernier dials.
- One panel measuring 10½ x 7½ inches, and one base board 10 x 6 inches.

Operation

A four-volt accumulator or three 1½ dry cells will be required to supply he filament of the valve, while a 60-volt B battery will furnish the plate supply.

Having checked the wiring over with the schematical sketch, the earth, phones, and batteries should be connected. The aerial is connected to AE1 terminal for a start. Rotate C1 condenser until a station is heard, then slowly adjust condenser M until maximum volume is obtained.

If interference is experienced on the lower wave-lengths the aerial should be changed over to AE2. The offending station should be tuned in until maximum volume is received, then C2 should be adjusted so that the station is reduced to the minimum volume. It will be found on rotating C1 t the other stations that no interference is experienced.

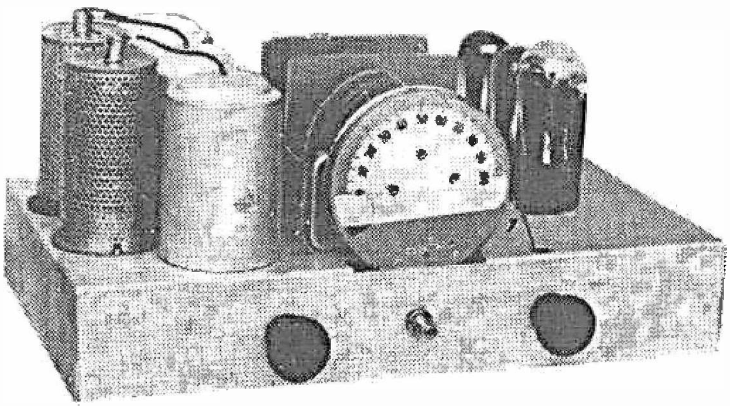
The T.R.F. Battery Five Valver

Full constructional details of how to build a sensitive receiver employing two stages of radio frequency, detector and two stages of audio amplification are given below

IN designing a modern battery receiver such as is required for present-day radio receiving conditions, there are five fundamental points to keep in mind. These are:—

(1) Sensitivity.
(2) Stability.
(3) Selectivity.
(4) Tone Quality.
(5) "A" and "B" Battery Consumption.

Without placing these requirements in their true order of precedence. which. frankly, would be rather difficult, we shall go on to discuss the various factors which contribute to 100 per cent. results in all sections of the receiver. Naturally to the above list we should add "case of control," but with modern design methods, including the use of ganged tuning condensers, this latter requirement is the most easily met of all.



Front view of the finished chassis, showing the relative position of the controls and switch.

Sensitivity

Broadly speaking, the sensitivity of a receiver is governed by the number of valves it employs. When, as is the case in most modern sets, this amplification is carried out at radio frequencies, before the incoming signal is demodulated or "detected," it is possible to obtain terrific amplifications of weak signals without running into trouble.

In a well-designed two-stage radio-frequency amplifier it is not uncommon to find a signal amplification of 1600 taking place whilst in laboratory models the amplification of such a combination may exceed 3600. As far as we are concerned in the present case we employ both radio and audio frequency amplification in order to get sufficient response from distant stations to provide a good loud speaker strength signal.

Stability

As the amplification of a receiver is increased so is there a falling off in its stability. This is evidenced by howls, whistles, and squeals of the types so familiar to most radio enthusiasts. In using high gain radio frequency amplifiers care has to be taken to screen the input and the output circuits, and to separate electro-magnetically the associated equipment. For this reason the valves and coils are heavily screened and attention is paid to the disposition of all leads which carry high frequency currents.

The same thing holds good in a high gain audio amplifier where unwanted feedbacks will cause endless trouble. Filter circuits of various kinds are used in the endeavor to overcome this instability, for a comparatively sensitive set which is stable in operation is much to be preferred to the extremely sensitive but untamable type of receivr.

Selectivity

With the large number of broadcasting stations now on the air in Australia it has become imperative for the listener to use a receiver which is capable of separating one from the other. In this respect the country listener is a little better off than his city brother, for whilst he must use a more sensitive but more expensive type of receiver to provide him with worth-while reception, the inherent design of the receiver is such that he usually has very few worries on the score of selectivity.

There is always the danger, however, that in carrying the amplification of a receiver too for the selectivity will suffer. This is particularly true of receivers in which two or three tuned circuits are used to select the desired signal.

Tone Quality

As ever, tonal quality is one of the most important attributes of a radio receiver. It is of little use having a set which is capable of extremely long distance reception, is very stable to operate and is highly selective if after all this the signal delivered to the loud speaker is so bad as to make listening a penance.

There are as many variations in the available tone quality of receivers as there are in the capabilities of listeners to appreciate it. What may to one listener sound like the very outpourings of Orpheus himself will to another be reminiscent of his nursery escapades with drum and tin whistle.

The chief difficulty under which the designer of a battery receiver labors is that in order to get real tone quality it is necessary to have a high power output in the audio system. This would be easy to obtain if operating costs were not so big a factor, but, as things are, the audio system of the modern battery set cannot be anything but a compromise between fidelity of reproduction and economy of operating costs. The developments in reproducing equipment which, temporarily at least, have culminated in the permanent magnet type of dynamic loud speaker, have smoothed the designer's path considerably, and by careful arrangement it is possible for the 1933 battery receiver to have quite good tonal qualities.

Battery Consumption

Like the car owner who said that his expense only started after he bought his first car, the radio set owner will always find that he must face upkeep costs. Although the incidentals of valve replacements and similar maintenance have to be met by the battery set owner, his most important consideration is that of battery replacements. This is not altogether because of the cost of such replacements, although in these times even that is a big factor, but rather to the inconvenience which these replenishments of the set's motive power entail.

In passing it is interesting to note that among the models available during the present radio season country listeners are offered an alleged "battery" receiver which requires an "A" battery current of 1.2 amperes each hour it is used. Such a state of affairs cannot be tolerated, for it means that even with a large accumulator, which is correspondingly awkward to transport, the average useful life of the "A" battery would be one month per charge.

The "B" battery consumption is perhaps more important than that of the "A" battery, for while 3/6 may settle the charging bill for a large six volt accumulator, the replacement of a 90 volt heavy duty "B" battery, involves the spending of 30/. If this latter cost is repeated every four to six months, as is the case with some of the older types of sets, the receiver becomes more of a liability than an asset. This should not be the case for, by careful design, the battery consumption of even a large receiver can be kept within reasonable limits without impairing the performance of the set in any way.

So much for a general review of the situation. We have had quite a lot to say about badly designed battery receivers, so let us attempt to justify our criticisms. We started out to design the receiver which now is to be described with the points outlined at the start of this article well in mind.

The Circuit Scheme

For reasons of sensitivity and selectivity it was decided to employ two tuned r.f. stages before a non-regenerative detector and a two stage audio amplifier.

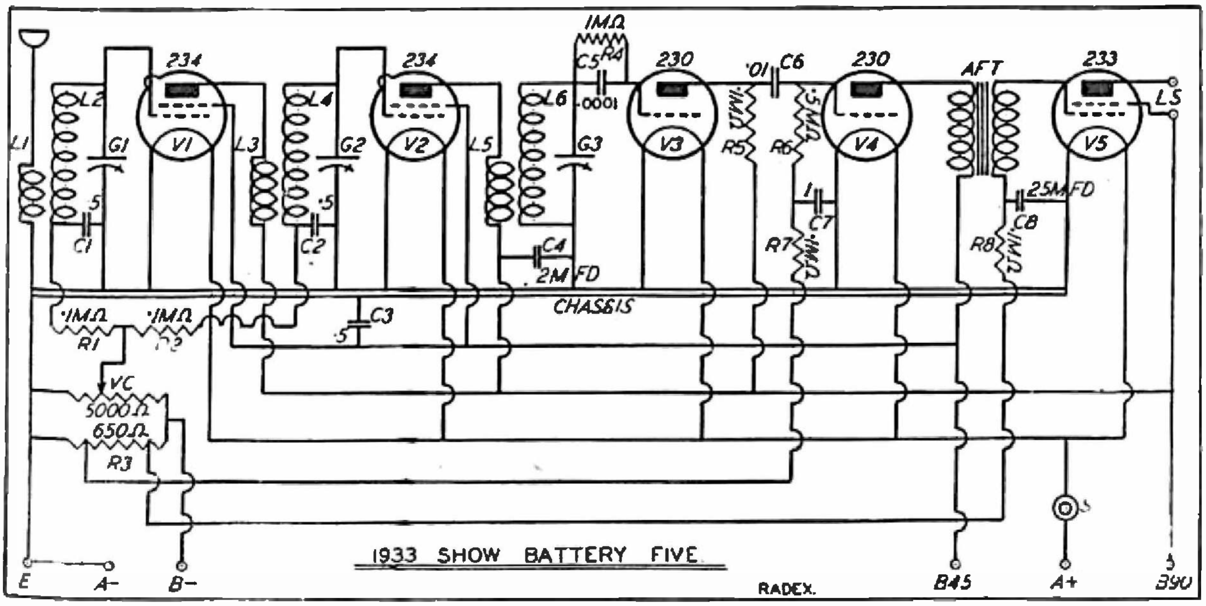
A glance at the schematic diagram will show that the two r.f. valves are of the two-volt variable-Mu type. Advantage was taken of the variable-Mu characteristic of the r.f. tubes to install the conventional r.f. type of volume control, in which volume is reduced by increasing the negative bias on the r.f. valve grids. The resistors R1 and R2 are used merely as de-couplers to prevent unwanted r.f. from getting into the grid circuits of either stage.

The detector tube is arranged to act as a semi-power detector, and for this reason the grid condenser and leak have a much lower value than normal. However, if for reasons of sensitivity, it is desired to operate V3 as a weak signal detector, the normal values of .00025 mfd. for C5 and 2 megohms for R4 may be used.

The detector is resistance coupled to the first a.f. stage, which, in turn, is transformer coupled to the pentode output tube. This audio amplifier system was used with great success in the "Music Master Battery Four", but in this five valve receiver, because automatic "C" bias is used, it is necessary to take special precautions in order to keep the a.f. amplifier stable. For this reason

SCHEMATIC CIRCUIT AND COMPONENTS

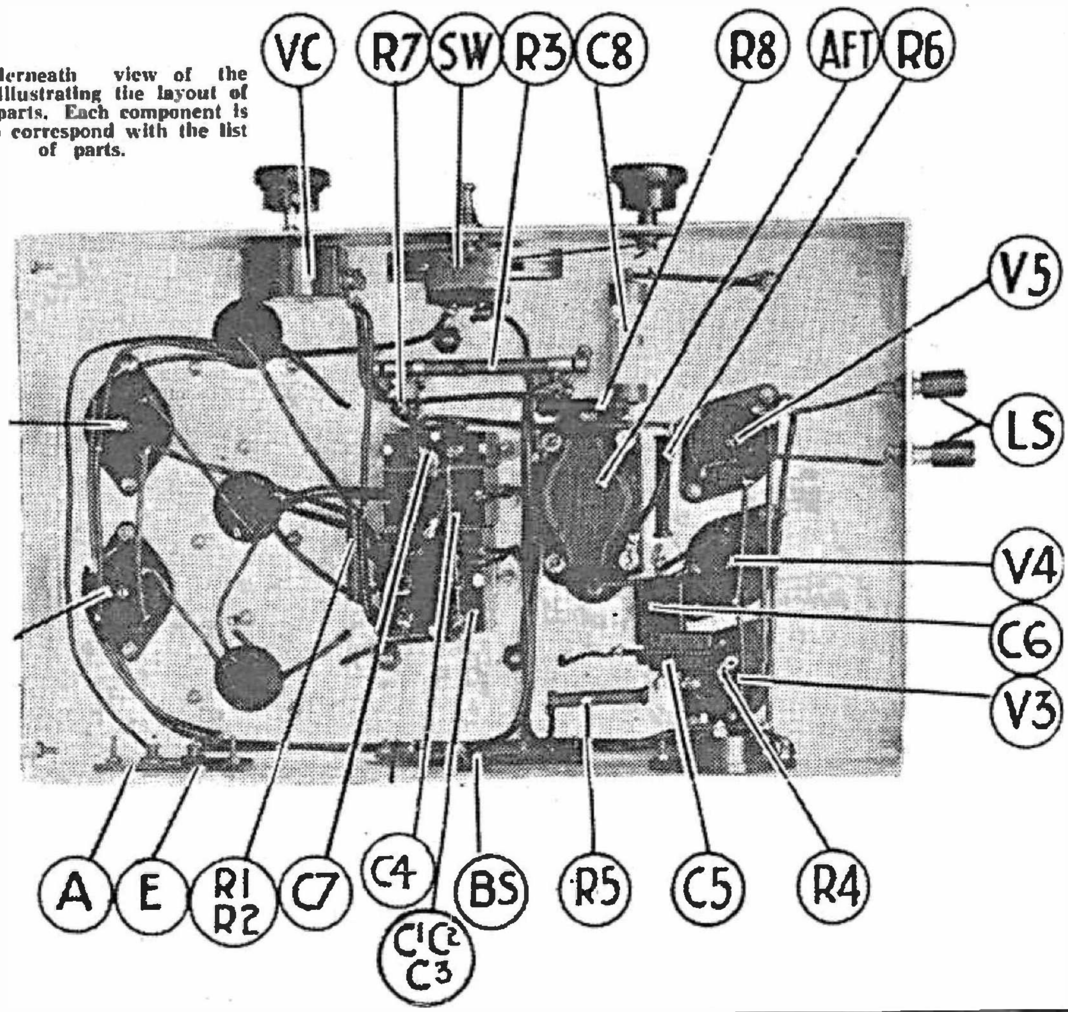
- 1 Three Gang .0005 mfd. variable condenser (G1, G2, G3) (Stromberg-Carlton, Raycophone, Essanay, Saxon).
- 4 UX Valve Sockets (for V1, V2, V3, V4) and one UY for V5 (Targan, H.C.R., Velco, Marquis).
- 1 Coil Kit, comprising aerial and two r.f. stages (L1, L2, L3, L4, L5, L6) (R.C.S., Aegis, Velco, Melbourne).
- 5 100,000 ohm Carborundum Resistors (R1, R2, R5, R7, R8) (Bradleyohm, Velco, Silent Answer, I.R.C.).
- 1 500,000 ohm Carborundum Resistor (R6) (Bradleyohm, Velco, Silent Answer, I.R.C.).
- 1 1 megohm Carborundum Resistor (R4) (Bradleyohm, Velco, Silent Answer, I.R.C.).
- 1 Special 650 ohm 25 m.a. wire wound resistor (R3) (Mastermade).
- 1 5000 ohm Potentiometer (VC) (Marquis, Chancery, Radiokes, Saxon).
- 1 3½ to 1 Ratio Audio Transformer (AFT) (Philips, Lissen, A.W.A., Wendel).
- 3 .5 mfd. Fixed Condensers (C1, C2, C3) (Hydra, Chanex, T.C.C.).
- 1 1 mfd. Fixed Condenser (C7) (Chanex, Hydra, T.C.C.).
- 1 2 mfd. Fixed Condenser (C4), Chanex, Hydra, T.C.C.).
- 1 .0001 mfd. Fixed Condenser (C5) (T.C.C., Saxon).
- 1 .01 mfd. Fixed Condenser (C6) (T.C.C., Saxon).
- 1 25 mfd. 25 volt Electrolytic Condenser (C8) (T.C.C., Dulytic, Concourse).
- 1 Battery Switch (S) (Alpha, Monarch, Cutler Hammer).
- 2 234 Valves (V1, V2) (Ken-Rad, Radiotron, National Union, Philips).
- 2 230 Valves (V3, V4) (Ken-Rad, Radiotron, National Union, Philips).
- 1 233 Valve (V5) (Ken-Rad, Radiotron, National Union, Philips).
- 1 Chassis, 15in. x 9in. x 2½in., in 16 gauge aluminium (Geo. White and Co.).



Circuit of the T.R.F. Battery Five Valve Receiver.

A PEEP BELOW THE CHASSIS

An underneath view of the chassis, illustrating the layout of various parts. Each component is keyed to correspond with the list of parts.



the grid circuits of V4 and V5 are decoupled by means of the series resistors R7 and R8 and the by-pass condensers C7 and C8.

The means by which automatic "C" bias was obtained without interfering with the normal operation of the volume control, is interesting. The idea is that we shall, at 90 volts, require a bias of about 10½ volts on the pentode audio tube, a bias of 3 volts on the 230 valve V4, and a readily variable bias of from 0 to 10 volts on the r.f. valves V1 and V2. We would of course use a standard 1000 ohm potentiometer and tap the various voltages from it by soldering the grid return leads from V4 and V5 to it. This is rather an awkward way to go about the job, so it was decided to connect a fixed resistance of suitable value in parallel with the volume control potentiometer.

The exact value of R3 was worked out by first calculating the actual resistance it should have to give 10½ volts bias at a current drain of 18.2 milliamperes, which is the rated consumption of this receiver. This value works out at 577 ohms. However, when we parallel one resistance with another the result is a resistance having a lower value than either of the two which were paralleled. In this case our parallel resistance are 5000 ohms and 650 ohms, the resultant value coming out at 575 ohms, which is near enough to the required value as to make no difference to the set's performance.

The use of this particular automatic bias arrangement dispenses with the necessity for a "C" battery with its attendant connecting leads (in this case there would be four) saves the fitting of a switch which would be necessary if the volume control VC were connected across the battery and lengthens the working life of the "B" battery because the bias voltage is automatically reduced to correspond with the falling "B" battery potential.

Although, because they sometimes introduce instability in a receiver, automatic bias systems are not popular with some experimenters, no fear that this decoupled audio and radio frequency bias system will "play up" need be entertained. One of the largest contributions towards stability is the connection of a low voltage, high capacity electrolytic condenser between the low potential end of the audio transformer secondary and ground. This by-passes to earth all circulating a.f. and r.f. currents besides providing a first-class return path for the audio frequency currents in the last valve.

The General Arrangement

Turning now to the illustrations of the finished receiver, it can be seen that the lay-out has been reduced to the simplest level. Although no real attempt was made to build a "pretty" set, the result has a neat and workmanlike appearance, to which is coupled high technical efficiency because of the disposition of the various components. Glance at the illustration showing the top view of the receiver whilst we explain the salient features of the top chassis layout.

Looking from the front to the back of the receiver, we see, at the left, the first and second r.f. valves V1 and V2 in that order. Alongside them are the aerial and first grid coils L1 and L2 in the first can, L3 the plate for coil for V1 and L4 the grid coil for V2 in the second can, and the plate coil L5 for V2 and the grid coil L6 for V3 in the third can. Next is the gang tuning condenser G1, G2 and G3 being the order of the sections from front to back. At the right of the gang condenser are the three valves, V5 being nearest to the front of the set, V4 in the middle and V3 at the back. The two knobs on the front of the chassis are the tunning dial control knob (right) and the volume control knob (left). The filament switch, S, is mounted in the centre.

From the key-lettered picture of the underneath of the chassis the position of the various components can be clearly fixed. Note that the fixed condensers C1, C2 and C3 are, in the case of this set, contained in a single block. There is no reason, however, why the set builder should not make use of three separate .5 mfd. condensers.

Another point worthy of note is that in the original receiver a valve socket can be seen mounted on the back of the chassis. This was originally used as the loud speaker connection point, but it was found that the plate lead from V5 travelling down past the first audio and detector valves introduced audio frequency feedback, which manifested itself in the form of a high-pitched whistle. Neither filtering nor by-passing of the various audio circuits would cure the trouble, and it finally was necessary to take the loud speaker connections to two terminals on the side of the chassis.

A further point is the "cleanness" of the wiring at the r.f. end of the chassis. The filament leads to the r.f. valves are taken around on the outside, i.e., nearest to the walls of the chassis, whilst the plate leads for the two r.f. valves and the grid leads to the gang condenser are well separated. This arrangement of the r.f. wiring results in a particularly stable receiver and permits the greatest gain being obtained from the radio frequency valves without instability.

The five battery leads are soldered to a small terminal strip inside the chassis and are taken out through a hole which has been bushed with a rubber grommet.

This method of attaching the battery leads is mechanically strong, and, because no screw type terminals are used, there is little fear of short circuits being caused by leads breaking loose.

The Wiring Details

Despite the size of the receiver, the wiring will be found quite simple, the lay-out of the various parts being such as to make soldering easy.

Begin the wiring by joining a lead from the A plus point on the battery strip to one terminal on the filament switch S. From the other terminal on this switch run a lead to the A plus lug on each of the valve sockets, starting with the first r.f. valve and working around the chassis in an anti-clockwise direction to the last stage tube. Now run a wire from the A negative lug on the first r.f. tube to the A negative lug on each of the remaining sockets. This wire should be run similarly to the A plus wire. Connect the A negative lug on each socket to the nearest socket securing bolt so that the filament negative is earthed to the chassis at each valve.

Having done this, forget about the r.f. end of the set for a while and hook up the detector and audio valve circuits. Start this second phase of the wiring by connecting the P lug on the five-pin socket for V5 to one of the l.s. terminals. The other L.S. terminal carries a lead which comes from the C lug on the five-pin socket and continues to the B plus 90 point on the terminal strip.

The G terminal on the audio transformer AFT is joined to the G lug on the socket for V5, whilst the C terminal on the transformer is connected to the negative terminal on the 25 mfd. electrolytic condenser C8 and to one lead of the 100,000 ohm resistance R8. The other lead on R8 goes to the B negative end of the fixed resistance R3. From this point on R3 a lead is taken to the B minus point on the terminal strip. Another lead from this end of R3 joins to one of the outside terminals on the 5000 ohm volume control VC. The other end of R3 is connected to the second outside terminal on VC, and to earth which can be the nearest chassis bolt.

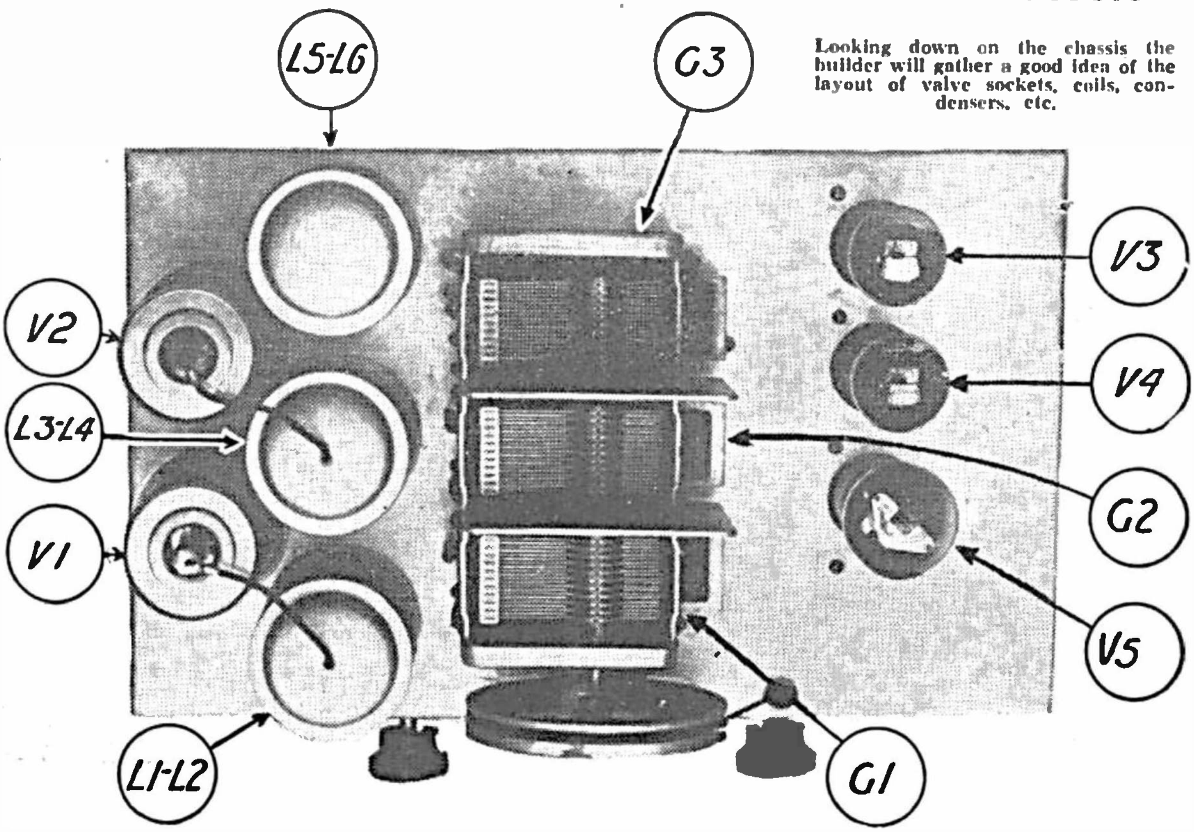
The P terminal on the audio transformer AFT is wired to the P lug on the socket for V4. The B plus terminal on this socket joins to the B plus 45 volt point on the battery strip. One lug on the .01 mfd. condenser C6 and one lead on the 500,000 ohm resistance R6 are soldered to the G lug on the socket for V4. The other lead on R6 and one lead on the 100,000 ohm resistance R7 are soldered to one lug on the 1 mfd. fixed condenser C7. The other lead on R7 is connected to a tap about half an inch up from the earthed end of R3.

The other lug on C6 and one lead of the 100,000 ohm resistance R5 are soldered to the P lug on the detector valve socket V3. The other end of R5 goes to the B plus 90 point on the battery strip. One lug on the .0001 mfd. condenser C5 and one lead on the 1 megohm resistance R4 are soldered to the G lug on the socket for V3. Now

(Continued on page 44)

A KEYED PHOTOGRAPH OF TOP OF CHASSIS

Looking down on the chassis the builder will gather a good idea of the layout of valve sockets, coils, condensers, etc.



A Good Two-Valve Short-Wave Headphone Receiver

The simple two-valve regenerative detector-amplifier combination is generally selected by newcomers as the ideal set with which to commence their interest in short-wave activities.

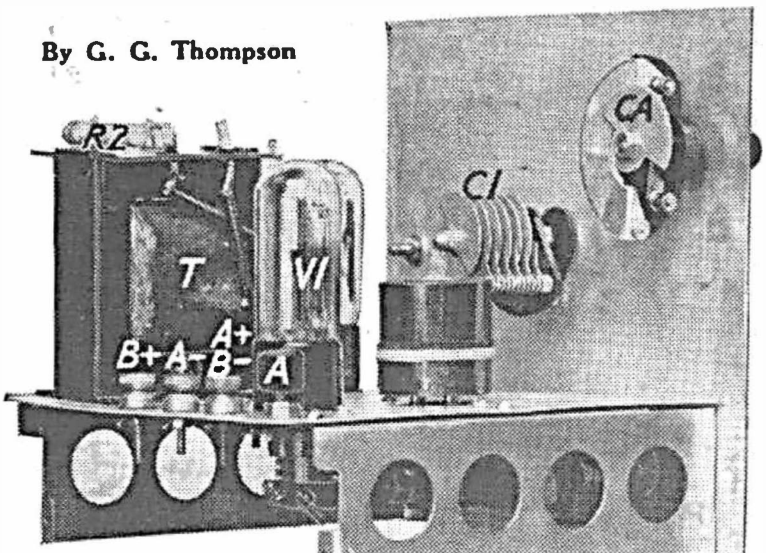
By G. G. Thompson

THE main question upon the minds of those who will consider building this simple battery operated set will be, "Can it receive short - wave transmissions from all over the world, or, because of its size, will reception with this receiver be limited to a range of a few thousand miles?"

The answer is that the simple two-valve reaction set, on short-wave lengths, can be expected to receive stations at the most distant points of the earth PROVIDED THE CONDITIONS ARE AT THEIR BEST.

The fact that this simple set was one of the two or three sets in Victoria which were successful in picking up the British transmission when high-powered screened grid sets failed, indicates that, where headphones can be used, nothing is impossible on short - wave lengths with the simple regenerative set.

Short wave reception is in no way similar to broadcast reception, which is regular and always there. The seasons of the year, the prevailing weather conditions at both transmitting and receiving ends all have their peculiar effects upon high frequency (short wave) signals.



Rear view of the finished chassis.

The Receiver

Photographs have been taken of the unwired receiver to show to best advantage the placement of the parts.

The circuit comprises an ordinary three-element detector valve, such as a 201A or a 199 (in the battery circuit), feedback to obtain oscillation in the detector stage being obtained through a reaction coil L2 and midget condenser C2. The detector is coupled through a high ratio audio frequency transformer to a similar valve which operates as an amplifier. Bias for the amplifier is obtained by use of a small torch battery of the required voltage. In the original receiver a valve of fairly high impedance was used in the amplifier stage. At a plate voltage of 90, a bias voltage of 1½ was needed. This voltage was obtained from a single cell cut from a flat torch battery and fastened under the chassis as shown in the photograph.

Use of a high ratio audio frequency transformer will result in maximum output from the set. A transformer having a ratio of 1-5 was used in the original. There is nothing to prevent the use of ratios down to 1-2, however.

Parts Review

In order that the components purchased be suitable, the writer has always deemed the inclusion of a components review to be advisable.

The Midget Tuning Condenser normally will be a 7 plate type. However, in most makes of midget condenser, slight play within the fitting of the movable plates spindle results in slight side movement of the movable plates, causing "backlash" and complicated tuning. When purchasing midget condensers for short wave work, inspect all types and makes until components in which this fault is not apparent or if evident, in only a slight degree, are found.

While not apparent upon broadcast wavelengths use of a vernier movement dial in which backlash is evident might prevent completely the satisfactory operation of a short wave receiver.

The reaction condenser C2 should be selected to have no possibility of its plates touching. Touching plates in this component may damage the audio frequency transformer, besides endangering valve filaments and running down the plate supply batteries. In order to preclude the possibility of damage through accidental shorting within this component, a fixed mica condenser of .004 mfd. may be connected in series with it.

The mica-dielectric grid condenser C3 is an important component. One of good make should be selected.

The Midget aerial coupling condenser CA is a very small capacity. Originally, this condenser was made from two discs the size of pennies. The discs could be made of copper, brass or aluminium, and were usually fitted so that the distance between the discs could be varied.

However, the two or three plate midget condenser fitted to the panel (insulated from metal) with a controlling knob, will be found most convenient.

The small bias battery CB is best fitted underneath the chassis. For average battery valves a voltage of between 1½ and 4½ will be found satisfactory depending upon the plate voltage used, and the actual type of valve installed.

The grid leak resistance B1 should be of good make. The large 3 watt type 2 and 3 megohm, manufacturers' resistance, although bulky, is ideal for this position. When a detector valve is oscillating, grid current may amount to as much as 1½ milliamps, this current being sufficient to cause noise in carbon or graphite deposit types.

The resistance R2 will eliminate the annoying effect known as "fringe howl."

The audio frequency transformer T should have a good solid core. The weight of an audio frequency transformer is an indication of its efficiency.

The Detector Valve V1 should be a normal type. R.C.A. 230 low voltage low filament consumption valves for dry cell battery operation were used in the original receiver.

The R.F. Choke R.F.C. is easily made. Four 1in. diameter discs of fibre are bolted together with ⅛in. spacing washers, the resultant former being filled with gauge 34 or thereabouts d.s.c. wire, care being taken to wind each section in the same direction.

The Panel is of gauge 16 aluminium. **The Sub Panel** is of gauge 18 aluminium. The panel may be of any convenient size. The original receiver was built with one 7in. high by 8in. long, the sub-panel being 7in. x 7in., and fastened into position by a pair of stamped out metal brackets 2in. high. These brackets are available from almost any radio store.

Mounting the Parts

The tuning condenser, C1, is mounted in the centre of the panel, the vernier dial being fitted with extreme care to obtain a nice even movement of the condenser plates without undue stiffness.

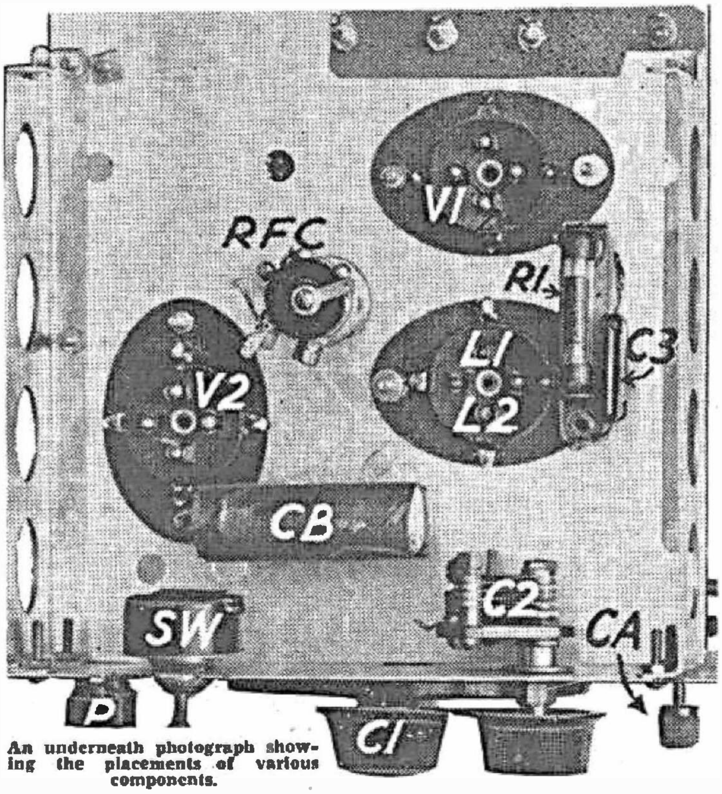
In the top left-hand corner of the panel is fitted the aerial coupling condenser, CA. This should be mounted so that neither fixed nor movable plates connect to the panel. This can be accomplished by use of thin sheet fibre washers cut to prevent the metal mounting fittings of the condenser from touching the panel.

On the right of the panel are mounted the two headphone terminals, both of which must be insulated from the metal.

In the bottom right-hand corner is the filament switch. In the average switch, the mount- may be made directly to the panel metal, but in some makes bushing will be necessary to prevent one side of the switch from touching the chassis.

On the left-hand side, opposite the filament switch and in a corresponding position is the reaction condenser C2. The mounting may be made directly to the panel (as with the tuning condenser C1) since the movable plates of both these condensers connect to earth.

In the original receiver manufacturers' type valve sockets were used. If available, the writer recommends porcelain type sockets, since these generally are made of better insulating material. Three sockets are necessary.



An underneath photograph showing the placements of various components.

Four terminals for battery and aerial connections are needed. On the extreme left is the ebonite aerial terminal. Next is the A positive terminal, then the A negative—B negative terminal and finally the B positive 60 volts terminal. A terminal to allow the connection of a higher voltage to the amplifier stage as shown in the circuit may be used, in addition to the three shown, but generally it will be found that both stages will operate satisfactorily for headphone reception at 60 volts derived from a medium duty B battery of this voltage.

All terminals must be bushed from the panel. Great care must be taken to see that there is no possibility of terminals or battery leads touching the chassis.

Wiring in Words

Aerial terminal to one side of aerial condenser CA (movable plates). Other side of aerial condenser CA to G terminal of detector coil socket, fixed plates of tuning condenser C1, and one side of grid condenser C3. Other side of grid condenser C3 to grid terminal of detector valve socket and one side of grid leak R1. Other side of R1 to chassis.

P terminal of coil socket to chassis. Plate terminal of detector valve socket to one side of r.f. choke and F2 terminal of coil socket (F terminal opposite plate terminal), F1 terminal of coil socket to fixed plates of reaction condenser C2. Other side of r.f. choke to P terminal of primary of transformer T.

B terminal of transformer to B positive terminal and to one headphone terminal. G terminal of transformer secondary to one side of resistance R2 and grid terminal of amplifier valve socket. F terminal of transformer secondary to other side of resistance R2 and negative of C battery. Positive of C battery to one F terminal of detector and amplifier valve sockets, and A negative terminal on chassis.

One side of filament switch to A positive—B negative terminal on chassis. Other side of filament switch to remaining F terminal of detector and amplifier valve sockets and to chassis. The earth connection to the receiver is made to either side of the A battery or to the chassis.

Coil Construction

Tuning coils are wound on valve bases to which have been fitted sections of 1½in. fibre former. The outside diameter of the former is exactly 1½ inches.

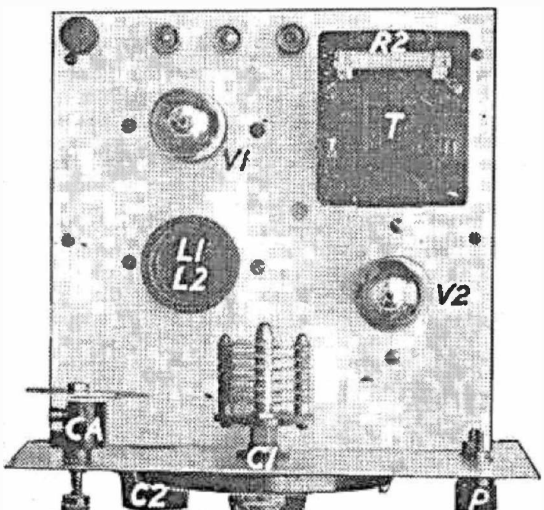
In all coils leave a space of about 1-8in. between tuning and reaction coils.

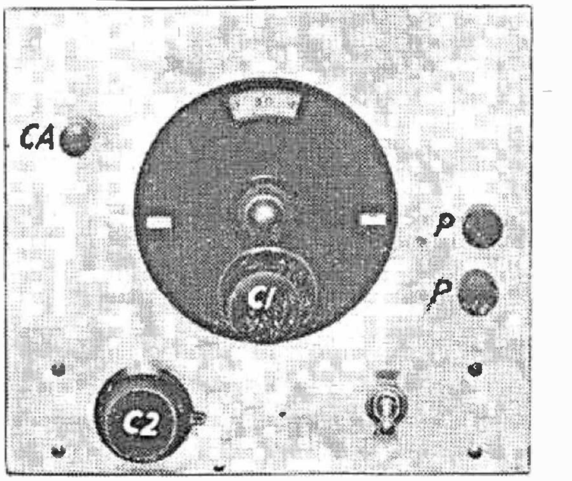
Connections should be made to the pins of the valve base as follows: Beginning of tuning coil L1 to G pin of valve base. End of tuning coil to P pin of valve base. Beginning of reaction coil L2 to F1 pin of valve base (pin opposite G pin). End of reaction coil to F2 pin of valve base (pin opposite P pin of base).

COIL DATA

Waveband (metres)	Grid coil L1	Reaction coil L2	Wire gauge d.s.c.
12-21	3	3	22
20-31	4½	7	22
30-52	9	[illegible]	24
49-81	18	[illegible]	24
80-152	35	15	26

(Continued on page 42)



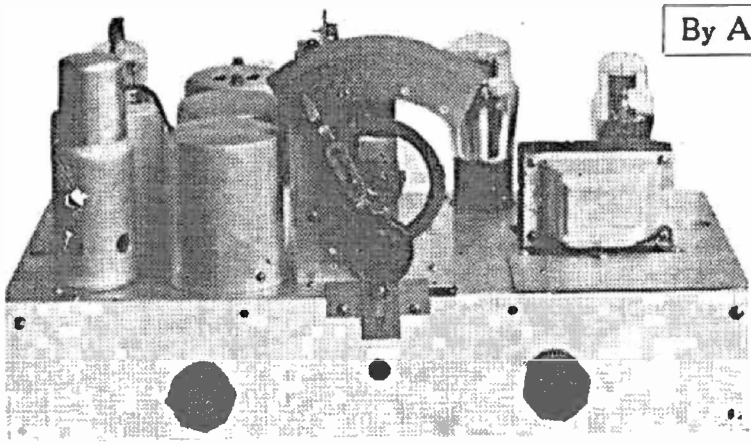


Left: Looking down on top of the chassis will show the builder the particular layout required. Right: Front view of the panel.

The Pentagrid Battery Five

By A. K. BOX

A front view of the finished chassis illustrates the cleanliness of the set's construction. Class B Transformer is to the right.



Not the least of the receiver's attractions for the set builder and user is its simplicity of operation, there being only two controls.

Something new in battery superheterodynes, this interesting receiver employs the latest 2 volt American Pentagrid convertor tube 1A6 and a class "B" audio system capable of delivering as much audio output as is obtained from the average A.C. receiver.

BECAUSE of its selectivity and the ease with which a high degree of sensitivity can be obtained, the super-heterodyne type of receiver has practically swept the board in the field of a.c. set design. As far as battery receivers have been concerned, the position has been quite different, for, owing mainly to the difficulty of obtaining suitable valves, the tuned radio frequency type of receiver has been more generally used than the super-het.

There have been several attempts to evolve a satisfactory battery super-het, but the design of battery valves, which all have directly heated filaments, does not lend itself to the circuit arrangements of the modern super het which depends for its efficiency upon a non-resonant oscillator coupling circuit. Included in the compromises made necessary by lack of suitable valves, were the use of filament coupling from the oscillator to the modulator and the departure from true battery set operation by the use of the indirectly heated 6.3 volt automobile series of tubes.

The first scheme was rarely satisfactory and was used chiefly in an experimental way. The second was quite sound from the performance viewpoint, but the heavy "A" battery drain made the 6.3 volt receiver practicable only for those who had ready access to battery charging facilities.

The Matter of Power

Another equally important drawback to the design of an up-to-date battery super-het has been the difficulty of obtaining reasonably high undistorted audio frequency power output without a corresponding increase in "B" battery consumption. The sensitivity of the average super-het is such that the audio stage will be overloaded on even the reasonably powerful distant stations unless a power tube capable of handling real audio output is used. Fortunately for the countryman, who must depend on battery-operated receivers for his radio reception, both these disabilities have been overcome by the development of new valves.

The problem of the oscillator-modulator tube has been solved by the manufacture of a pentagrid converter similar to the 2A7 and the 6A7, but operating with a directly heated filament and from a two-volt battery supply. Class "B" audio amplification solves the power output difficulty, and for this purpose the type 19 valve has been developed. This is a dual valve combining the equivalent of a complete push-pull, or to be more correct, "push-push," output stage in a single envelope.

A Twin Valve

The type 19 is capable, under ideal circumstances, of delivering an audio power output of 2-5 watts but this high output is attended by a rather high "B" battery drain, so it will pay the average set-builder to be more modest in high power requirements and to operate the final tube at a lower output level. Later, in dealing with the construction of the receiver we shall touch further upon the question of the final stage tube.

To go on with the story of the receiver: as arranged the battery super-het is capable of extremely fine performance and compares quite favorably with the average a.c. super-het. In addition it is, considering the number of tubes used, quite economical in battery requirements and, of course, is practically fool proof in operation.

Turning to the schematic diagram it will be noted that of the five tubes used, three are entirely new types. The 1A6 valve, V1, is an electron coupled modulator oscillator, the 49, V4 is a high impedance pentode tube used in this case as the driver for the Class

"B" 10. The other two tubes are the variable mu 34 and the triode 30, both of which are old friends to battery set builders.

All valves are arranged for two volt operation, the total filament current being only .56 amperes, which means that something like 100 hours service will be obtained from each charge of a 50 ampere hour accumulator. The total "B" battery current at no signal is 16 milliamperes maximum, which also is reasonable when it is remembered that five valves are employed.

Naturally this plate current rises greatly when the Class "B" stage is driven by the incoming signal. At peaks the total plate current may reach 45 to 50 m.a. This does not mean, however, that the set user will need to establish his own "B" battery plant for, provided that "B" batteries of sufficient capacity are utilised, these momentary current surges will not reflect unduly on the life of the battery and its service life can be estimated on a basis of about 20 milliamperes drain. To be on the safe side, it is advisable to use triple duty batteries not so much because of any expectation that the figures given above will be exceeded, but simply because this capacity battery will give most economical service with the receiver.

The Circuit's Theory

Now, before touching on the construction of the receiver, we will run briefly through the schematic diagram and explain the functioning of the receiver.

The incoming signal is transferred from the aerial through the coupling coil L1 to the grid coil of the modulator section of the 1A6. The control grid of this section of the tube is variably biassed by means of the potentiometer VC connected across the 15 volt "C" battery. The by-pass condenser C1 isolates the grid coil electrically, and prevents a short circuit of the "C" battery through the chassis. The resistor R1 is merely a decoupling resistor to prevent undesirable feedbacks.

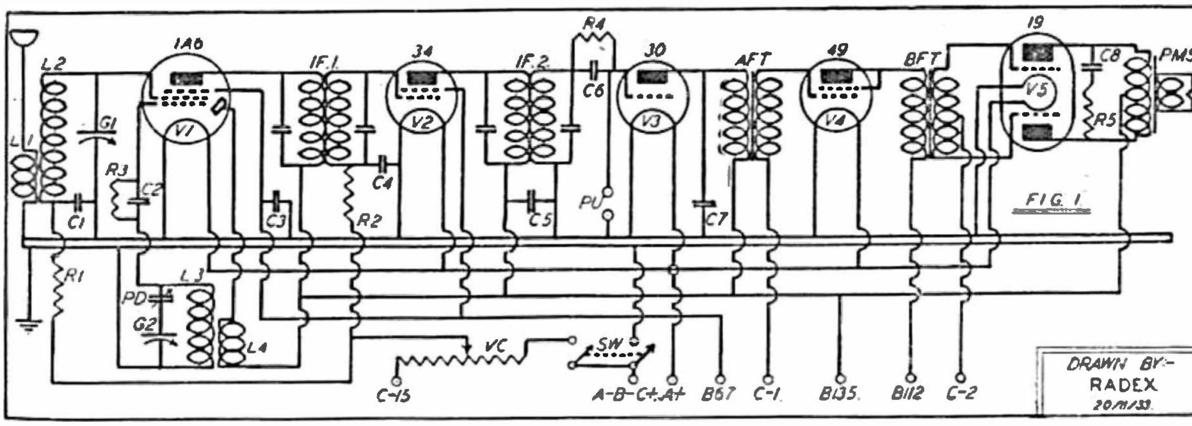
A locally generated signal is provided through the oscillator section of V1. This section consists of the oscillator grid, known as Grid No. 1, to which is connected the oscillator grid coil L3 through the grid leak R3 and the grid condenser C2. The anode grid, or possibly more clearly the oscillator plate which is known as Grid No. 2, carries the feedback coil L4, which functions as an ordinary reaction coil.

This coil provides the necessary feedback of energy to throw the oscillator section of V1 into a state of oscillation, the frequency of which is controlled by the grid circuit of G2, PD and L3. The mixing of the local oscillations with the incoming signal is carried out electronically, the chain consisting of the electron circuit between the filament and the control grid of the modulator section.

Beat Frequency's Work

The difference between the incoming signal frequency and the locally generated one fixes the resultant output fre-

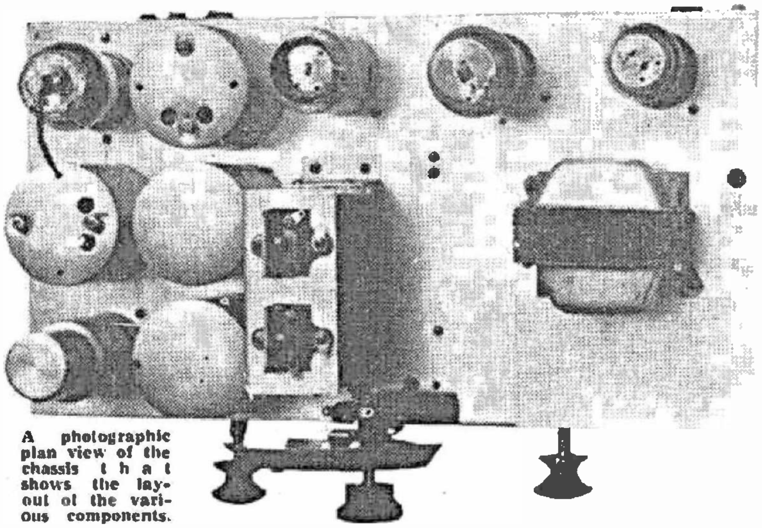
LIST OF COMPONENTS AND SCHEMATIC CIRCUIT



The schematic diagram of the Pentagrid Battery Five is key-lettered to agree with the list of components and the point to point wiring instructions.

LIST OF PARTS

- 1 Two Gang Tuning Condenser (G1, G2) (Essanay, Stromberg-Carlson, Raycophone, Saxon).
- 1 Battery Super Het. Kit, aerial, oscillator and two 465 k.c. i.f. (Essanay, Saxon, Radiokes, Stromberg-Carlson, Paramount, R.C.S., Melbourne) (L1, L2, L3, L4, IF1, and IF2).
- 2 Six Pin Sockets (V1 and V5).
- 1 Five Pin Socket (V4).
- 3 Four Pin Sockets (V2, V3 and L.S.).
  (Essanay, Marquis, Velco, Saxon, Targan).
- 1 Class "B" Audio Transformer (BFT) (Radiokes, or to specifications).
- 1 Class "A" Audio Transformer, 3½ to 1 (AFT) (Essanay, Saxon, A.W.A., Lissen Ferranti).
- 3 .1 mfd. Fixed Condensers (C1, C3, C4) (Chanex, T.C.C., Polymet, Saxon).
- 1 .5 mfd. Fixed Condenser (C5) (Chanex, T.C.C., Polymet, Saxon).
- 2 .0001 mfd. Mica Dielectric Condensers (C2, C6) (T.C.C., Wetless, Saxon).
- 1 .001 mfd. Condenser (C7) (Chanex, T.C.C., Polymet, Saxon, Wetless).
- 1 .02 Mica Dielectric Condenser (C8) (T.C.C., Wetless, Saxon).
- 2 .1 megohm Resistors (R1, R2) (Bradleyohm, Carborundum, I.R.C., Silent Answer, Velco, Paramount).
- 1 1 megohm Resistor (R4) (Bradleyohm, Carborundum, I.R.C., Silent Answer, Velco).
- 1 50,000 ohm. do. (R3) (Do., do., do.).
- 1 500,000 ohm. Volume Control (VC) (Bradleyohm, Chanex).
- 1 Double Circuit Filament Switch (SW) (Velco, Alpha).
- 1 Aerial, earth and pick-up strip.
- 1 Set of Valves:—1A6, 34, 30, 49, 19 (Radiotron, Ken-Rad, Tungsol, Philips).
- 1 Aluminium Chassis, 15in. x 8in. x 3in. (George White and Co.).
- 1 Permanent Magnet Dynamic Speaker to match 19 value. (Rola, Saxon, Aegis.)



A photographic plan view of the chassis that shows the layout of the various components.

quency from the plate of V1. This is the one to which the intermediate frequency transformers IF1 and IF2 are resonated. The intermediate frequency is first amplified by the I.F. amplifier V2, which is a variable mu r.f. Pentode, and then is handed on to the detector V3 for demodulation in the ordinary way.

Because of the relatively high signal voltages which are available in the grid circuit of the detector, which is a standard three element 30 type tube, it is necessary to operate this tube as a power detector. By reason of the slightly higher sensitivity which is possible, it was decided in this case to operate the tube in that manner.

The out-put of the 30 is fed through a 3½ to one ratio audio transformer to the grid of the dual grid power amplifier 49, which acts as the driver for the final stage. As the tube is operated as a Class "A" driver, it is connected with Grid No. 2 wired to the plate. The coupling transformer between the 49 and the Class "B" 19 tube is a special step down type, about which we shall have more to say later.

The 19 feeds into a push pull type permanent magnet dynamic speaker having an input load resistance of 10,000 ohms from plate to plate. Across this transformer is connected an equaliser network consisting of a 10,000 ohm resistor R5 and a .02 mfd fixed condenser C8.

Variable-Mu Valves

The volume control VC consists of a 500,000 ohm potentiometer shunted across the "C" battery. Its arm is connected to the 100,000 ohm de-coupling resistors in the grid circuits of the modulator section of V1 and the control grid of V2, thus allowing a bias of from zero to 15 volts to be applied to these tubes. Actually the bias voltage could have a higher maximum for complete volume control when the receiver is used near to a powerful station, but in most country districts the 15-volt maximum will be found sufficient to give a complete wipe out of signals.

In operating the receiver it will be found that greatest sensitivity and consequently volume is obtained when the arm is just back from the zero voltage point. This is due to the fact that both V1 and V2 are designed to operate at maximum with a 3-volt negative bias. Naturally, even if the VC is high, there is a constant current drain across the "C" battery as long as the volume control is in circuit. For this reason a double circuit toggle switch has been used so that both the "A" battery and the "C" battery circuits can be independently broken.

Few Minor Parts

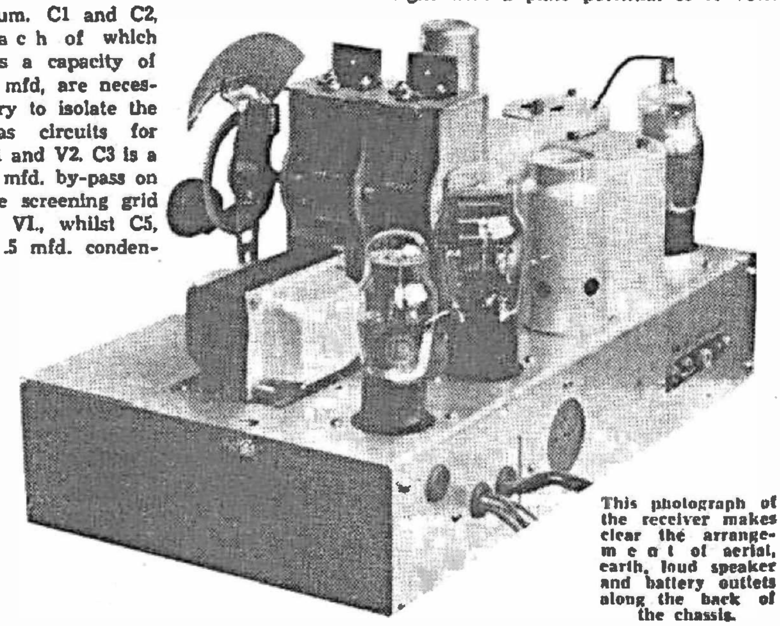
The number of by-pass condensers in the circuit has been reduced to a minimum. C1 and C2, each of which has a capacity of .1 mfd, are necessary to isolate the bias circuits for V1 and V2. C3 is a .1 mfd. by-pass on the screening grid of V1., whilst C5, a .5 mfd. condenses, serves as an r.f. by-pass for the B+ maximum supply line. The condenser C7 is a .001 mfd. mica dielectric type used as an r.f. by-pass and an aid to complete detection.

To do any good with the receiver it is necessary to have a maximum potential of at least 135 volts available. Less will be useless for the distortion level of the class "B" audio stage will rise to unbearable limits. Lest this comment on the maximum supply voltage be thought needless, we might mention some of the random enquiries received anent battery operated receivers by the technical staff handling "Trouble Corner" enquiries. One set builder wrote in for information on the building of a five-valve r.f. receiver which would operate from a 60-volt "B" battery; another wanted a public address amplifier which would give good results from a 90-volt battery; a third wanted to use screen grid and pentode valves but would not consider more than 45 volts "B" battery, whilst the fourth wished to have a battery Loftin White work from 60 volts supply.

Keep Down Voltage

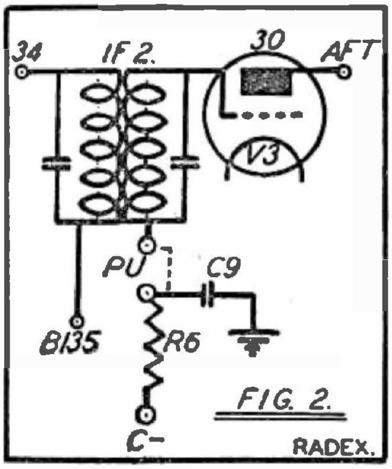
It should be understood that, when dealing with battery receivers, technical men do not advise more voltage than necessary. They usually strive to hit the mean between first class operation and economy of upkeep. For this reason do not attempt to build this receiver unless you are prepared to supply it with not less than 135 volts, on the plates. The plate of the modulator section of the 1A6, the plate of the 34 and the plates of the 19 must have those 135 volts. Some compromise may be made with the other tubes, but it is not advisable to spoil the ship for the ha'porth of tar.

For example, the 30 will function all right with a plate potential of 90 volts



This photograph of the receiver makes clear the arrangement of aerial, earth, loud speaker and battery outlets along the back of the chassis.

—until you hear it working with 135. The 49 can be worked at 90 volts, but there then is practically no margin of audio power over that required to operate the 19, and the possibility of overload of the 49 or starving of the 19 always exists. In the original receiver we compromised on this plate potential and used 112½ volts on the tube.



An alternative arrangement for the 30 detector tube that gives it improved fidelity and greater power handling capabilities.

The plate of the 30 was operated at 135 volts, as was the anode grid of the 1A6. This grid, despite the warning of the valve people, will function when tied to the 67½ volt screen lead, but the tube does not give as high a signal output nor is it as sensitive to weak signals as when the full 135 volts are used. The screening grid of the 1A6 and the 34 both can be operated at 67½ volts; indeed there seems no advantage to be obtained by increasing the potential of these elements.

Bias Voltages Vary

The "C" voltages for V1 and V2 are, as was explained before, variable. The negative voltage for V4 will be 15 at a plate potential of 112½, and 20 at a plate potential of 135. This brings us to the Class "B" stage, which is probably the most critical in the whole receiver. First let us explain briefly the difference between Class "A" and Class "B" audio.

In Class "A" audio the grid of the valve is maintained negative with respect to the filament by such an amount that plate current is flowing at all times even though no signal is being fed to the grid of the valve. This operating condition is obtained by adjusting the negative bias so that the grid of the tube draws no current even at the most positive swing of the signal voltage, and so that there is no reduction in plate current during the most negative signal swing. Actually the maximum plate circuit efficiency of a valve operating as a Class "A" amplifier is 20 per cent. for a triode and 40 per cent. for a pentode.

The features of this class of amplifier operation are that no appreciable power is required by the grid and that an essentially undistorted output power may be obtained either with a single valve or with two tubes operating in push-pull.

In the case of Class "B" amplifiers the valve is operated so that the plate current is practically zero with no input grid signal. This plate current by the way is referred to as the "static" current. The negative bias is so high that when a signal is applied to the grid there is no plate current flow during the greater part of the negative half cycle but an increasing flow from the zero point up to the most positive part of the positive half cycle. Thus to all intents and purposes the valve only operates during each half cycle. For this reason it is necessary to use two valves connected in a push pull arrangement so that whilst one is idle the other is in operation.

Inverse Bias

In class "B" services it is possible to drive the grids of the amplifiers positive to a certain extent and still get a reasonably undistorted output. However, for this purpose we first must have a class "A" driver stage which is capable of supplying sufficient input audio power and, secondly, we must have a transformer capable of transferring this power from the plate of the driver to the grids of the class "B" tubes. This transformer must be carefully designed for efficient working and, because a definite current (in the case of the 19 about 10 milliamperes) flows in the grid circuit at the positive peaks, it must have a low secondary resistance.

Although we obtained fairly good results from a standard Radiokes Class "B" transformer which happened to be on hand, the ratio between primary and secondary turns was not correct, and better results could have been obtained from a specially designed transformer. For this we are providing the design data for transformers suitable for two combinations of Class "B" and driver tubes. The first is a 49 driver operating with 112½ volts on its plate and 15 volts negative bias. The second is for a 30 driver with 135 volts on its plate and a negative bias of 9 volts. For the purposes of calculation we have assumed the core material to be standard grade silicon steel. Following is the data required:—Type 30 Driver and Type 19 as the Class "B" tube:—Transformer Specifications:—Primary Inductance at 3 m.a. d.c. 50 henries: Ratio of Primary turns to one-half of secondary 1.75-1: Core cross section 1 inch. Window area ½ inch: Primary Winding 5000 turns of 40 gauge S.W.G. enamel: Secondary Winding 5700 turns of 38 gauge S.W.G. enamel tapped at 2850 turns.

The Primary resistance is 2500 ohms, and that of the Secondary 1400 ohms.

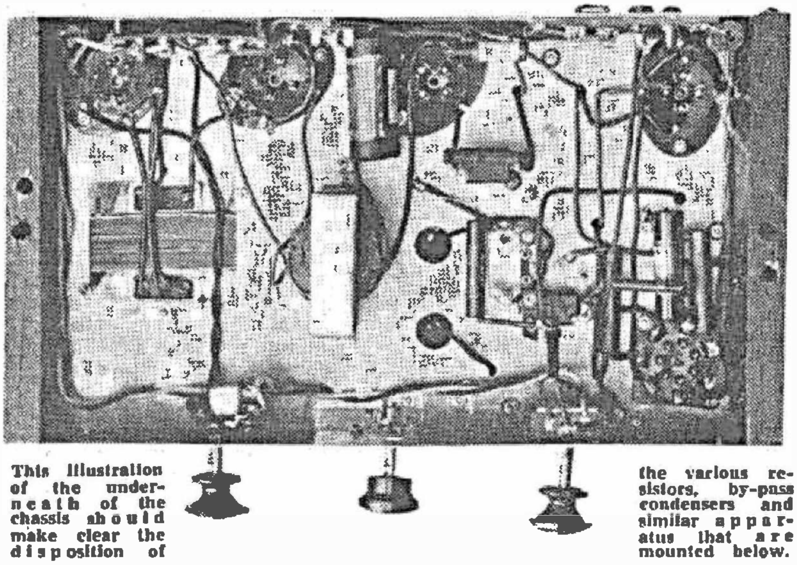
Special Transformer . .

With Type 49 Driver and Type 19 as Class "B" Tube, use the same core and Primary winding Specifications, but now the Turns Ratio Primary to ½ Secondary becomes 1.4 to 1. Although perhaps the more skilled set builders will have little difficulty in making their own transformers to the specification provided, we would advise all but those equipped with a good workshop and provided with a knowledge of transformer manufacture to have the component constructed for them by an expert.

Having dealt with the various design points of the receiver we now will take up the question of its construction. The actual receiver was built up on a steel chassis measuring 15 inches in length, 8 inches in breadth, and 3 inches in depth. On the top of the chassis were mounted the valves, coils, gang condensers, and class "B" audio transformer, whilst the various by-pass condensers, resistors and the driver transformer were mounted underneath. The pictures of the receiver should make the lay-out of the components fairly clear, but to save trouble we will touch briefly upon the various salient points.

Looking at the chassis from the front we find that on the top, from front to back are, at the extreme left, the socket for V1, the first intermediate frequency transformer IF1, and the intermediate frequency amplifying tube V2. Again from front to back we find to the right of the first line the aerial coil, the oscillator coil, and the second intermediate frequency transformer in that order. Next comes the two gang condenser with the detector valve V3 mounted directly behind it on the back top edge of the chassis. Next to V3 is the 49 driver tube V4, and next to this again is the dual valve, the Class "B" 19. Between these two valves and the front of the chassis is the Class "B" transformer BFT.

On the front of the chassis are the volume control at the left, the tuning control, centre, and the double circuit filament switch, right. A back view of the chassis shows the aerial, earth, and pick-up sockets at the right, the four-pin loud speaker socket in the

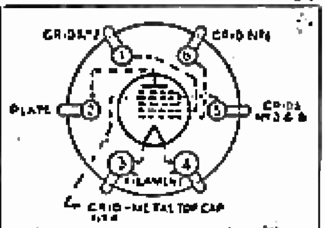


This illustration of the underneath of the chassis should make clear the disposition of the various resistors, by-pass condensers and similar apparatus that are mounted below.

middle, and the two grommets through which the various battery leads are taken.

Below the Chassis

The underneath view of the chassis shows clearly the degree to which the receiver has been simplified. Working from right we find in the extreme corner

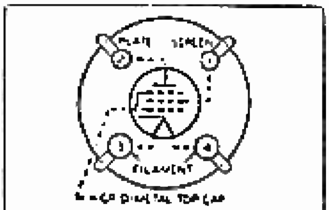


Wiring of the socket of the 1A6 Mixer.

the six-pin socket for the 1A6. (Actually when this picture was taken a seven-pin socket was used because we then were experimenting with a 6A7 tube, whilst waiting for samples of the 1A6. This also explains the extra bias resistor and by-pass condenser shown in the under chassis view.)

Between that socket and the volume control mounted on the front of the chassis, is one of the 100,000 ohm resistors (R1). The other is between the volume control and the grid condenser C2, which is shunted by a 50,000 ohm resistance R3. Alongside this combination is the padding condenser PD, the adjusting screw of which registers with a hole in the top of the chassis. To the right of the padder is the .1 mfd. by-pass condenser C1, whilst to its left is the corresponding capacity C4. To the left of the padder again is the audio transformer AFT.

Along the back of the chassis from right to left we find the .1 mfd. condenser C3 jammed right into the corner near the aerial-earth and pick-up strip, the four-pin socket for V2 being mounted in this corner. Incidentally, the sockets for V1 and V2 are mounted so that their filament terminals face the right hand end of the chassis. The next



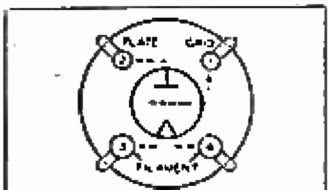
Connections for the 34 I.F. Amplifier.

socket along the back of the chassis is that of the detector. It and the remaining two for V4 and V5 are mounted so that their filament terminals face the back of the chassis. Alongside the socket for V3 is the .001 mfd. condenser C7, whilst between it and the padding condenser is the .001 mfd. condenser C6 and the 1 megohm grid leak R4. To the left of the socket for V3 is the .5 mfd. condenser C5.

The next two sockets are the five-pin socket for V4 and the six-pin socket for V5 respectively. A terminal strip consisting of solder eyelets mounted on a fibre strip can be seen attached to the back of the chassis between, but above, the sockets for V4 and V5. The only component not accounted for is the filament switch which can be seen in front of the audio transformer AFT.

Wiring in Words

As arranged the chassis will be quite simple to wire and there will be no long leads that are likely to cause unstable operation. A start can best be made by running a filament lead to one filament terminal on each socket and thence to the A plus solder lug on the battery cable strip. Another wire is run from one of the outside lugs on the double circuit switch to the A minus lug on the battery strip. The other outside lug on the filament switch carries a lead which connects to the C plus solder point on the battery strip. The two centre lugs in the switch are joined together. One lead is taken from this point to the remaining filament lug on each of the five sockets and another joins to one of the outside lugs on the volume control VC.



Scheme of the 30. Second Detector. All socket connections shown on this page illustrate the holders as seen when viewed BELOW the chassis.

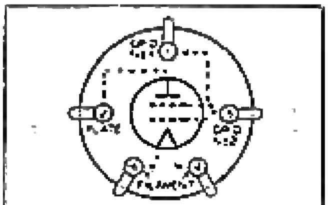
From the other outside lug on the volume control VC take a lead to the C minus 15 volt lug on the battery strip. Solder one lead on both R1 and R2 to the centre contact on the volume control and join the other lead on R1 to one lead on the .1 mfd. condenser C1 and to the earth end of the modulator grid coil L2. Whilst we are about it, connect the aerial end of L1 to the aerial socket on the strip and the earth end to a convenient earthing point on the chassis. To this earthing point also connect the vacant lead on C1.

Take a lead from the grid end of L2 down under the chassis and up to connect to the fixed plate lug on the first section of the gang condenser G1, G2, and take another lead from this point on L2 through a hole in the top of the coil can to the grid pip on V1.

Watch Socket Connections Carefully

Now, studying the socket connections for the 1A6, join the oscillator grid No. 1 to one lug of the .0001 mfd. condenser C2. The other lug on this condenser is connected to the fixed plate lug on the padder condenser PD and the 50,000 ohm resistor R3 is paralleled across C2. The fixed plate lug on PD carries a lead from the grid (top) end of the oscillator coil L3. The bottom end of this coil goes to the chassis. The moving plate section of PD is wired to the fixed plate lug on the G2 section of the gang condenser G1, G2. The bottom end of L4 (nearest to the earthed end of L3) joins to the anode grid No. 2 on the socket of V1, the other end carrying a lead which is soldered to the B plus maximum lug on the loud speaker socket.

The screen grid, Grids Nos. 3 and 4 on the socket of the 1A6, has soldered to it a lead which joins to the screen



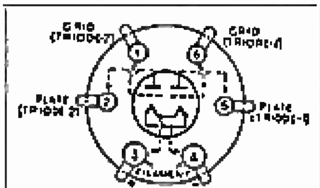
The 49 driver uses a 5-pin socket.

grid lug on the socket of V2, and proceeds to connect to the B plus 67½ volt solder lug on the battery cable strip. One lead of the .1 mfd. by-pass condenser C3 is soldered to the screen grid lug on the socket for V2, and the other lead of this condenser is soldered to one of the bolts which secure the aerial-earth strip to the chassis.

The plate lug on the socket for V1 carries a lead which goes to the plate connection on the first intermediate frequency transformer IF1. The B plus connection on this transformer is taken to the B plus connection on the second I.F. transformer, and then to the maximum B plus lug on the loud speaker socket. The grid connection on the first I.F. transformer carries a lead which terminates at the grid clip of the 34 valve V2. The earth, or "C" minus connection on this transformer has soldered to it one lead from the .1 mfd by-pass condenser C4, and the remaining lead on R2. The other lead on C4 is earthed to the chassis.

The Second I.F. Stage

The plate lug on the socket for V2 carries a lead which goes to the plate connection on the second I.F. transformer



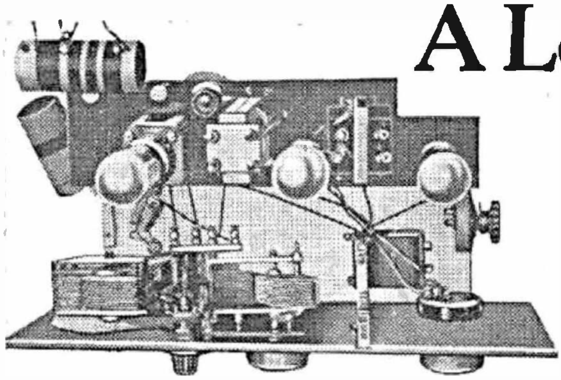
The final Class B stage employs a 19, a twin tube in the one envelope.

The grid connection on this transformer is joined to one lug on the .0001 mfd. condenser C5, and to one lead on the 1 megohm resistance R4. The vacant connections on C6 and R4 are joined together and soldered to the grid lug on the socket of the 30 valve V3. The earth, or "C" minus, end of the second I.F. transformer is connected to the chassis.

A lead is taken from the grid lug on the socket of V3 to one of the pick up

(Continued on page 42)

A Long Wave Receiver



Looking down on the completed chassis, it will be seen that it is constructed largely from that accumulation of junk usually stored away by the average experimenter.

With a Wave Length Range of from 150 to 3000 metres.

By C. E. LINDBERG

A LONG WAVE receiver is very useful in any ham station. On the bands around 1000 meters steady code signals may always be heard. The signals have a leisurely, consistent character and there is little fading or interference. Many stations send for hours at constant speeds varying from 10 to 60 words per minutes. These transmissions make ideal code practice. Then there are the foreign broadcast programmes, aeronautical and trans-Atlantic phone stations, as well as the press and weather reports.

LONG WAVE STATIONS

Wave Length.	Name of Station	Power Kilo-Watts.
167	Helsinki, Finland	40
174	Paris, France	75
183.5	Berlin, Germany	60
193	London, England	30
202.5	Moscow, U.S.S.R.	500
207.5	Paris, France	13
212.5	Warsaw, Poland	120
217.5	Novosibirsk, U.S.S.R.	100
221.5	Motala, Sweden	30
230	Moscow, U.S.S.R.	100
250	Reykjavik, Iceland	21
256	Tashent, U.S.S.R.	25
260	Copenhagen, Denmark	75
260	Monte Cerini, Switzerland	20
268.5	Moscow, U.S.S.R.	40
277	Oslo, Norway	60
280	Tiflis, U.S.S.R.	35
290	Kiev, U.S.S.R.	36
300	Moscow, U.S.S.R.	100
320	Kharkov, U.S.S.R.	20
350	Leningrad, U.S.S.R.	100
357	Budapest, Hungary	185
363.6	Sverdlovsk, U.S.S.R.	50

The receiver described was built with the idea of avoiding the usual array of plug-in coils. An old inductance switch was mounted on the panel and arranged so as to connect three fixed condensers, either singly or in combination, in parallel with the tuning condenser. This arrangement provides an unbroken secondary capacity range of zero to .0035 microfarads. Only two plug-in coils are necessary to tune from 150 to about 3000 metres.

The construction of the receiver is already shown in the photograph. The vernier dial controls the tuning condenser C1, the centre dial C2 and the right hand dial, the potentiometer R2. The vernier dial was used because it was handy. It is not needed, but it is convenient for DX or phone stations.

The tubes, transformers and the detector rheostat are mounted on the bakelite subpanel at the rear of the set. The AF rheostat and the by-pass condenser are placed on the baseboard. Two lamp cord sections, six feet long, are used as a battery cable. They are brought out at one side. Three grid-leak condensers are mounted side by side and provided with short leads so that the capacity may be adjusted if desired. A single condenser of .001 mf. size may be used. A small sheet of aluminium mounted between the panel and the tuning condenser effectively eliminates hand capacity effects.

The coils are provided with pieces of bus-bar and plug into the binding post strip mounted between condensers C1 and C2.

Both coils are wound on cardboard forms of 1¾ inches outside diameter. The smaller coil has 35 turns of No. 26 D.C.C. wire for L1. It is wound in scramble fashion in two layers. The tickler L2 has 55 turns of No. 36 S.S.C wound in one layer.

The larger coil has a secondary of 225 turns of No. 36 S.S.C., bunch-wound in three sections. The tickler has 200 turns of the same size wire, bunch-wound in three layers. The space between L1 and L2 is about ⅜-inch in both coils. Larger coils for higher wave-lengths may be wound. A comparatively small number will cover all the long wave bands.

The receiver was tested with 201A tubes and gave excellent results. Of course, other tubes such as the new, low-drain tubes, can be used.

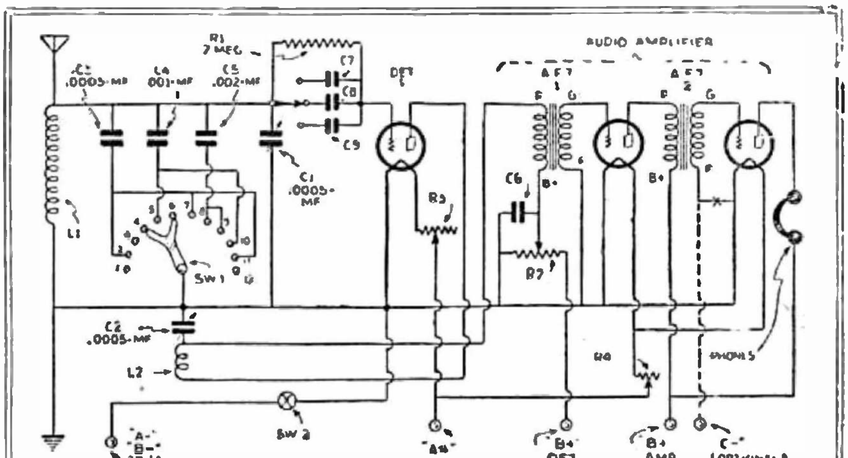
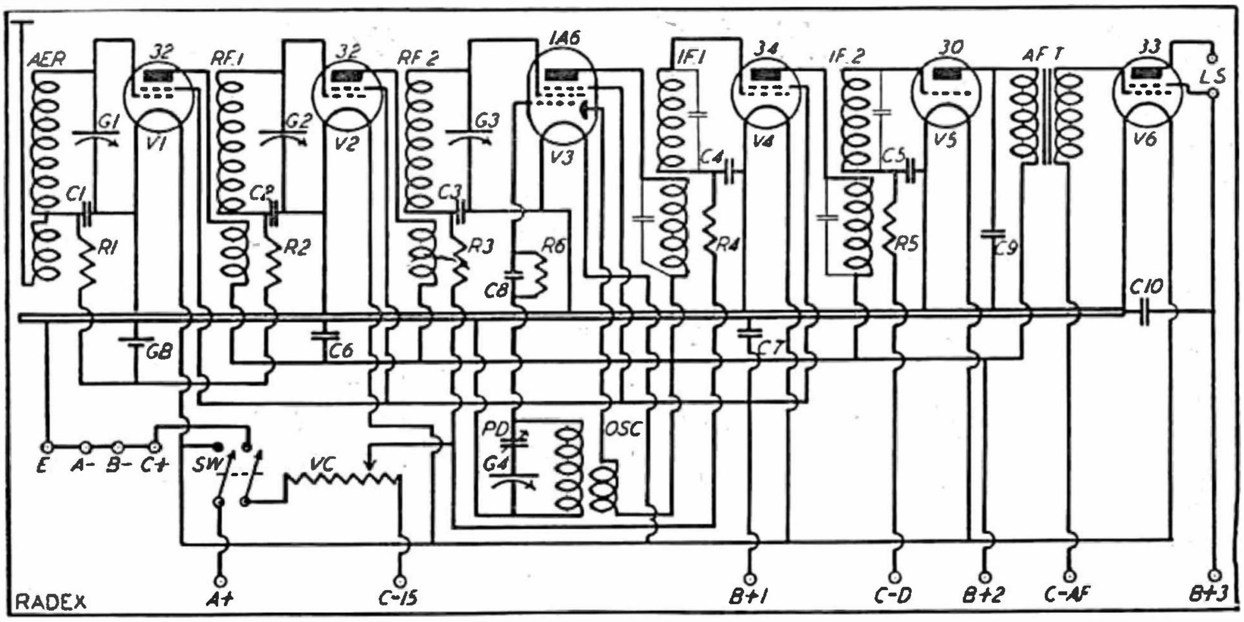


Diagram showing ingenious condenser switching scheme for tuning to waves 150 to 3000 metres in length.

LIST OF PARTS FOR LONG WAVE RECEIVER

1 Bakelite panel, 7 x 18 inches.
1 Bakelite subpanel, 4 x 15 inches.
1 Wood baseboard, 6 x 14 inches.
2 Variable condensers, .0005mf. (C1, C2).
3 Dials, 4-inch.
1 I.d. switch with dial, 12-point (SW1).
2 Rheostats, 20 ohms (R3, R4).
2 A.F. transformers, 5-to-1 ratio.
1 50,000 ohm potentiometer (R2).
1 By-pass condenser, 1 mf. (C6).
1 Open-circuit jack.
3 Fixed condensers, .0005mf. (C3), .001mf. (C4), .002mf. (C5).
3 Grid Condensers, .0005mf. (C7), .001mf. (C2), .001mf. (C9).
1 Filament switch (SW2).
6 Terminals.
1 Grid leak, 7 megohms (R1).
2 Subpanel brackets.
2 Coil forms, 1¾ inches O.D. (outside diameter). Wire, hardware, etc.



The schematic circuit diagram of the Battery Super Six is key lettered to agree with the component list of the constructional details which are provided in the article below.

A BATTERY SUPER SIX

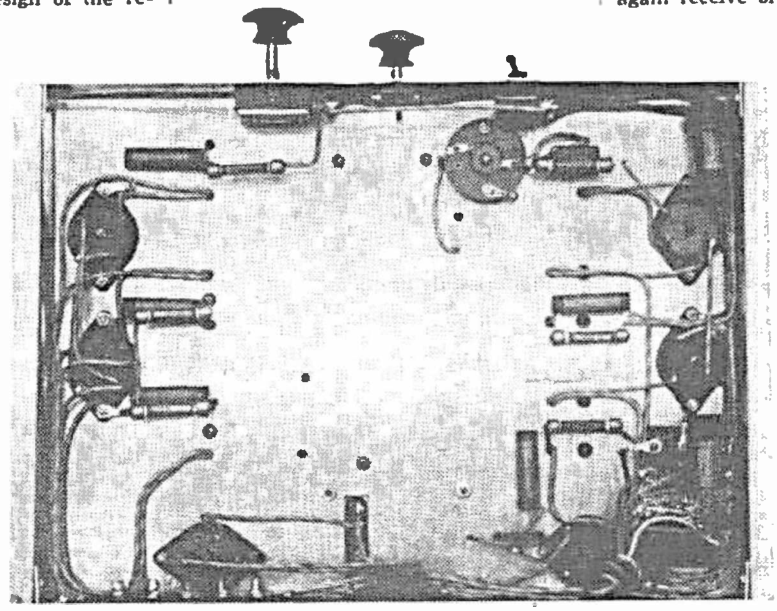
An interesting and amazingly sensitive battery Super-Het. which combines tone quality with operating economy.

By A. K. BOX

IN designing any type of superheterodyne receiver the first question which crops up is that of the frequency upon which the i.f. amplifier is to work. The two generally used intermediate frequencies, 175 and 465 k.c., each have their own particular advantages, so that the decision really boils down to the ultimate design of the receiver.

The high intermediate frequency of 465 k.c. has particular advantages in small receivers where the modulator is not preceded by more than one tuning stage. As a matter of fact, it is necessary with most a.c. super-hets which are to be used in the metropolitan area to add a second tuning stage to the input circuit, even when a high i.f. is used. The reason for this is that even the best of super-hets is only as selective as its input tuning system. If this is flat in its response (i.e., is capable of accepting a signal frequency so far off tune as to give the second position in the oscillator beat) this signal will be mixed, amplified and fed to the speaker in the form of a repeat point for a given station.

For example, let us take the case of a 465 k.c. super-het which has a modulator tuning range of 545 k.c. to 1500 k.c. In this case the oscillator will tune from 1010 k.c. to 1965 k.c. Now, in these circumstances 3AW on 1425 k.c. will come in at an oscillator frequency setting of 1890 k.c. (station frequency plus intermediate frequency equals oscillator frequency). However, if the input circuit is broad in tuning it will be found that on tuning the oscillator to 960 k.c. we again receive 3AW. This is due to the fact that, either because of proximity of the transmitter where shock excitation is responsible for the signal breaking through or to a very broadly tuning input circuit, we get the second position of the station.



An under-chassis view of the finished set shows how simple its construction can be made.

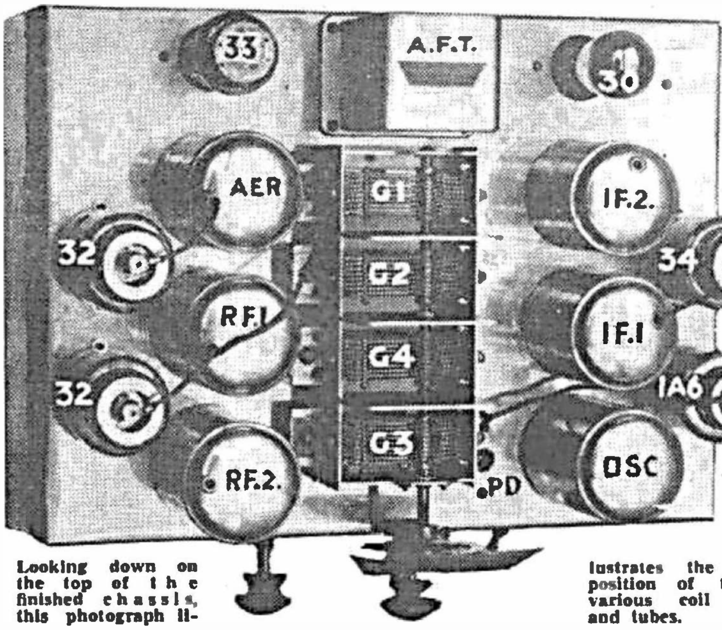
This example represents the extreme, but is sometimes encountered by metropolitan users of super-hets. The remedy of course is to add additional input tuning stages either in the form of r.f. amplifiers or as straight pre-selector circuits.

This trouble of second spotting is far more prevalent with the 175 k.c. type of super - het because naturally the separation between the top and bottom oscillator positions is much smaller. For example.

with a 175 k.c. superhet the second position of 3AW would be at an oscillator setting of 1250 k.c.

The point of these remarks is that as far as the country user of a super-het is concerned a 465 k.c. intermediate frequency will be satisfactory if only one tuned stage is used in front of the input. If the 175 k.c. intermediate frequency is used it will be necessary to use either pre-selection or r.f. tuning stages.

One important advantage which the low intermediate frequency has over the high one is its increased gain. This is set off by the need for additional signal filtering in the form of tuned stages, but in certain circumstances, such as those with which we now shall deal, the low frequency intermediate is the better proposition.



Looking down on the top of the finished chassis, this photograph illustrates the disposition of the various coil cans and tubes.

One of the points which is sometimes overlooked by the designer of a sensitive super-heterodyne type of receiver is that irrespective of the amount of i.f. and a.f. amplification which follows the first detector or modulator, the performance of the receiver as far as the reception of weak signals is concerned depends solely upon the sensitivity of the modulator. The writer is of the opinion that the average high impedance tube is not particularly sensitive to weak signals, although it will give excellent ouput from medium and good signals. This lack of weak signal sensitivity is particularly noticeable with the 1A6, the modulator section of which is normally operated with a negative bias of 3 volts. For this reason it was decided to add r.f. stages to the modulator input so as to put the maximum signal on to the grid of this tube.

Such being the arrangement in mind, the problem of the i.f. solved itself for naturally with sufficient signal reflection in front of the modulator it was an advantage to use the high gain of the 175 k.c. intermediate frequency. After a few experiments the circuit was boiled down to that shown in the schematic circuit diagram.

A study of this will show that two r.f. amplified tubes V1 and V2 precede the electron coupled 1A6, which combines the function of modulator and oscillator. The output of the modulator section of V3 feeds into the first i.f. transformer IF1 to which is coupled the 34 i.f. amplifier V4. The second i.f. transformer, I.F.2 couples this tube to the 30 detector which in turn is transformer coupled to the 33 pentode which feeds the loud speaker.

The first point of interest in the circuit is the arrangement of the various negative bias voltages. The two 32's require a maximum bias of 3 volts and a normal one of 1½. The 1A6 and the 34 requires a normal bias of 3 volts and, for volume control purposes, a maximum of up to 22½ volts. The 30 detector is operated as a plate detector and requires a negative bias of 6 to 9 volts whilst the 33 audio amplifier requires from 10½ to 15 volts depending upon the plate voltage which is applied. These potentials are supplied from a 15 volt "C" battery across which is connected the 500,000 ohm potentiometer which acts as volume control.

Actually for complete volume control on both the 1A6 and the 34 we should have 22½ volts bias available but in general it will be found that it is possible to cut out all but the most powerful stations when a 15-volt negative bias is applied to the grids of V3 and V4. The "C" bias for V1 and V2 is supplied from the 1½ or 3-volt taps on the "C" battery, but the resistors R1 and R2 are necessary in order to de-couple the r.f. circuits and prevent interaction. The condensers C1 and C2 provide a passage for the r.f. currents and an insulation against short circuit of the "C" battery.

The same method of de-coupling is used in the bias circuit of the 30 detector which is supplied with a negative potential of 6 volts through R5. No de-coupling will be found necessary in the grid circuit of the 33 which receives its bias direct from the 10½-volt tap on the "C" battery.

It should be pointed out at this juncture that the main idea behind the design of this particular receiver has been to obtain the maximum of sensitivity and power output with a minimum of "B" battery consumption. For this reason it was decided to use the 32 in the r.f. stages in preference to the 34. The latter tube, although possessing the desirable characteristics of high gain and ease of control (by means of a variable bias) has the disadvantage that it requires a greater plate current than the 32.

The 32 takes a plate and screen current of only 2.1 milliamperes whilst the 34 requires 3.8 m.a. These figures are taken at 135 volts plate potential, but at 90 volts the comparison still holds good. With a saving of 3.4 m.a. for the two tubes it was decided that the 32 offered sufficient advantages from the

A KEY-LETTERED LIST OF COMPONENT PARTS

1/175 K.C. Coil Kit, consisting of aerial, two R.F.'s, oscillator, two I.F.'s and padder. (Aer., RF1, RF2, oscs., IF1, IF2, and PD) (Melbourne).

5 4-Pin Valve Sockets (V1, V2, V4, V5 and L.S.).
1 5-Pin Socket (V6).
1 6-Pin Socket (V3).
} Targan, Velco, Marquis, Saxon.

1 4 Gang Condenser (G1, G2, G3, G4) (Essanay, Stromberg-Carlson, Raycophone, Saxon, Airway).

5 100,000 ohm Resistances, R1, R2, R3, R4, R5).
1 50,000 ohm Resistance (R6).
} I.R.C., Velco, Bradleyohm, Saxon, Silent Answer.

1 500,000 ohm Volume Control (VC) (Bradleyohm).

5 .1 mfd. Tubular Fixed Condensers (C1, C2, C3, C4, C5).
2 .1 mfd. Tubular Fixed Condensers (C6, C7).
1 2 mfd. Fixed Condenser (C10).
} T.C.C., Chanex, Polymet, Wetless, Saxon, Dulytic.

1 .00025 mfd. Mica Fixed Condenser (C8).
1 .001 mfd. Mica Fixed Condenser (C9).
} T.C.C., Wetless, Saxon.

1 Double Circuit Toggle Switch (SW) (Alpha).

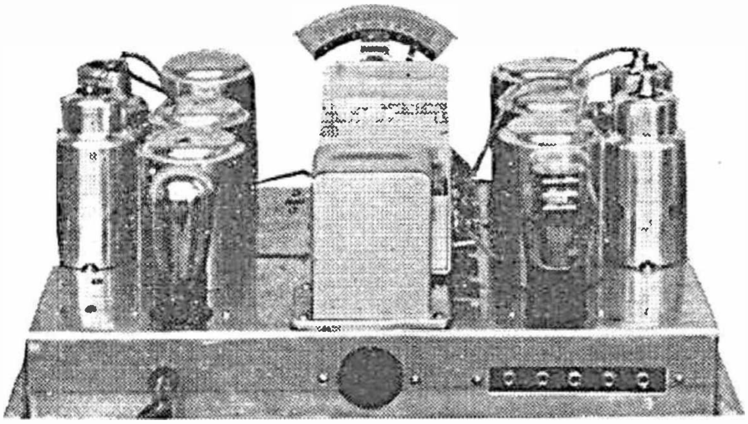
1 Aerial, Earth and Pick-up Strip.

1 Full Vision Dial (Efco, Radiokes, Saxon).

1 3½ to 1 ratio Audio Transformer (Wendel, Philips, Ferrant, A.W.A.).

1 Aluminium Chassis, 15½in. x 10½in. x 2in. (Geo. White and Co.).

2 32 Valves (V1, V2).
1 1A6 Valve (V3).
1 34 Valve (V4).
1 30 Valve (V5).
1 33 Valve (V6).
} Radiotron, Ken-Rad, Philips, etc.

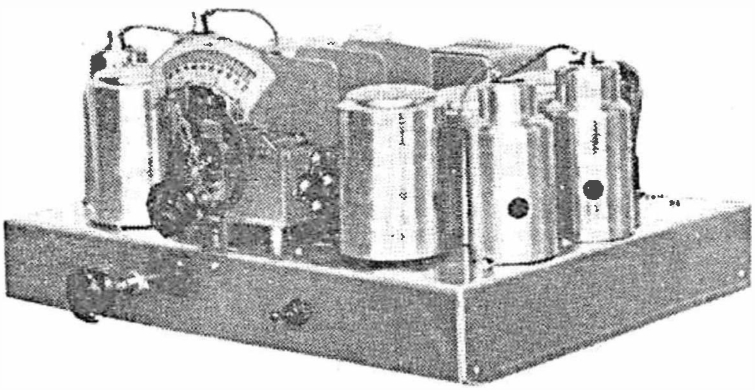


The arrangement of the outlets at the back of the chassis.

viewpoint of economy to offset those of lack of controllability.

For this reason the volume control was arranged to operate on the 1A6 and the 34. The latter tube was used in the intermediate frequency stage because, with a high gain intermediate coupling there is a tendency for battery tubes to oscillate readily. This state of affairs could be brought under control by means of a variable bias voltage, a thing which would not be possible with the 32 without introducing distortion.

Now the overall amplification of the two r.f. stages, the modulator, and the high gain intermediate frequency stage is such that a fairly large voltage is handed to the grid of the detector when the set is tuned to any reasonably powerful station. The 30, despite its advantage of economy is not capable of handling large signal voltages when used as a leaky grid detector. Consequently it was arranged as a plate or anode-bend detector and negatively biased to a suitable potential. This has the effect of reducing the plate current still further, and at the some time permitting the handling of fairly large signal potentials.



The oscillator and R.F. end of the chassis is clearly shown in this picture.

Incidentally it was decided fairly early in the piece that a triode was better as second detector than a screen grid tube despite the higher amplification of the latter. The difficulty of obtaining suitable screen potential and the fact that the tone quality from the tetrode was not of the best ruled the latter out of our calculations.

In the original design we provided for a high ratio coupling transformer in the belief that the detector output when the set was tuned to a weak station would not be sufficient to load up the power tube. In practice, however, it was found that the high ratio transformer was quite unnecessary because it resulted in last stage valve overload and distorted tone. As a matter of fact it is possible to get quite good results from the audio end, we are speaking from the viewpoint of power output, from a resistance coupled stage.

In view of the expressed intention of designing an economical receiver it may be wondered why a pentode was used in the last stage in preference to a Class "B" output system. The reason for the pentode is that with a plate potential of 90 volts the tube requires a plate current of about 8½ milliamperes and delivers something like 400 milliwatts undistorted output.

Naturally this is not to be compared to the power output of a modern a.c. receiver or even of a battery operated Class "B" amplifier. However, it does show a substantial saving in "B" battery current and really delivers quite a respectable loud speaker strength signal.

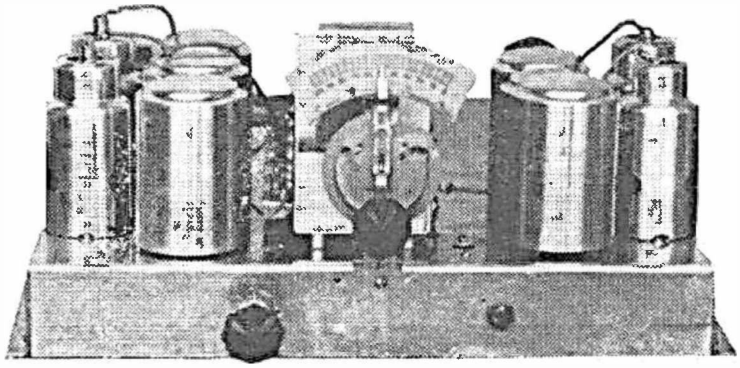
From experiments with tubes of the 19 Class we are inclined to think that a class "B" amplifier, unless the input transformer is very carefully designed, must be operated with practically a zero bias to obtain decent tone quality. In these circumstances the quiescent, or no signal, plate current is in the vicinity of 10 milliamperes and to this must be added the plate current of the driver stage, which will amount to between 2 and 5 milliamperes. On these figures the class "B" amplifier would not appear to be as good as a battery saver as a study of its characteristics might lead us to assume.

One point in favor of the pentode is that up to the overload point the plate current remains at the fixed value of 8½ m.a., whilst with the class "B" amplifier at zero bias the plate current will vary between 10 and over 30 m.a.

Before we leave this consideration of the receiver for practical information on its construction and operation it would be as well to examine its power requirements. It should be noted that the set is designed to operate at 90 volts maximum potential, although if desired there is no reason why 135 or even 180 volts should not be applied to the plates of the various tubes. However, at the latter voltages the consumption will rise considerably, and it will no longer be economical to operate the receiver from non-rechargeable "B" batteries.

As an example of the current consumption of the various tubes the following figures have been taken at 90 volts, with no signal being fed to the input. V1 and V2 2 ma. each (plate and screen), V3 5.25 m.a., V 4 4.25 m.a., V5 .5m.a., and V6 6 m.a. These currents are drawn when the screen potential is 67½ volts, and the plate potential to all tubes including the oscilator grid of V3 is 90 volts.

At a sacrifice of a certain amount of sensitivity and gain, which incidentally should not be very serious when the set is used in any normal country district, the screen potential can be reduced to 45



A front-on view of the finished set, showing the tuning and volume control gear.

with a marked saving in "B" battery current. With a 45 volt screen potential the readings come out as follow:—V1 and V2, .3 m.a. each (a saving of 1.4 m.a. total); Vs. 2.25 m.a.; V4, 2 m.a.; V5, .5 m.a., and V6, 5.5 m.a., or a total of 10.85 m.a. The total current drain at full signal strength under the conditions is in the vicinity of 12.5 m.a., while the range and selectivity is, of course, all that could be desired.

The bias conditions under which these measurements have been made are:—V1 and V2, 3 volts negative; V3 and V4, 3 volts negative; V5, 6 volts negative; and V6, 10½ volts negative. If the set user is prepared to make another sacrifice, this time in connection with the audio end, he can reduce the plate and screen current of V5 to 4½ m.a. by increasing the bias on this tube to 15 volts. The effect of the higher bias is to thin the tone, and to reduce the undistorted power output to some extent, but in circumstances where "B" battery consumption is of paramount importance the compromise is well worth while.

No figures were taken at a plate potential higher than 90 volts, because it then would have been necessary to keep the screens at 67½ volts, and, frankly, we lacked the courage to check the consumption at these values. As it it, with the high gain r.f.'s and intermediates we are using, 135 volts on the plate causes some instability, which, failing extra filtering and possibly a reduction in the efficiencies of the r.f. and i.f. transformers, can only be controlled by increased biassing, which, of course, puts us back where we started as far as sensitivity is concerned.

The "A" battery consumption of the receiver is, considering the number of valves used, exceptionally modest, being only .56 of an ampere, so that the average accumulator will give considerable service with each charge.

The only other point which need be touched on before we deal with the construction of the receiver is that of the loud speaker. It is impossible to do the receiver justice with a magnetic type of speaker, and for this reason one of the permanent magnet type dynamics should be used. This loud speaker should be fitted with an input transformer of suitable design to provide the impedance match between the 33 pentode and the voice coil of the speaker.

The pictures of the completed receiver show fairly well the disposition of the various components, although there are certain points with which it is necessary to deal more fully. The key-lettered top chassis view shows that the r.f. section of the receiver is to the left of the gang condenser, while the oscillator and i.f. components are at the right. The detector and audio tubes, with the associated coupling transformer, are mounted on the back edge. Note that the oscillator tuning section of the gang condenser (G4) is between the r.f. and modulator sections so that there is no possibility of hand capacity effects causing any drift in the oscillator tuning when the receiver is being operated.

The leads of the modulator coil, RF2, are taken to the left-hand side of the gang condenser, while the connection to the modulator grid of the 1A6 is picked up from the right-hand side of the condenser. This obviates a long grid lead under the chassis where it might cause instability.

The controls on the front of the chassis are the left, the dial drive, centre, and the double circuit toggle switch at the right. This switch, it should be explained, has two entirely independent circuits and may be compared electrically to two separate toggle switches. In addition to the customary function of making or breaking the "A" battery circuit, it also breaks the potentiometer circuit across the "C" battery. If this was not done the small but constant drain of the short circuit volume control resistance would exhaust the "C" battery in a few weeks. The chief advantage of the independent circuit arrangement of the double circuit toggle switch is that it permits us to break the "C" battery circuit separately from the "A" battery circuit, so that the switch for the filament supply can be connected in the "A" (plus) line, a much safer arrangement than in the negative line as would be necessary if the toggle had a common circuit.

A glance at the under chassis view of the finished set will show that an attempt has been made to keep the wiring as "clean" as possible. With the exception of the leads to the control grids of V1, V2, V3 and V4, all the wiring is carried out in tinned copper wire sleeved with spaghetti insulation. The wiring object has been to take all filament, plate and screen grid leads that are not carrying r.f. currents around the sides of the chassis. The various decoupling resistors and condensers are mounted as near to the coils to which they are connected as is possible.

The negative filament leg of each valve socket is earthed to the chassis by means of a jumper to a solder lug held down by one of the socket securing bolts and a common negative busbar connects the sockets in the usual manner. These precautions have been taken to prevent instability which might arise from r.f. loops in the filament circuits.

The various "A," "B," and "C" battery connections are brought to a small terminal strip made up from a scrap of bakelite, some solder lugs and some machine screws. The external battery cables are connected to the respective lugs on the terminal strip. This strip can be seen in the right-hand back corner of the chassis. The by-pass condenser C6 is connected between B (plus) and ground at the terminal strip, whilst the screen grid by-pass C7 is connected from the screen grid of the 1A6 to ground.

It will be noted that a 2 mfd. condenser, C10, is shown in the schematic diagram, but does not appear in the photographs of the finished receiver. This is because the condenser was added as an afterthought as a straight audio frequency return for the pentode. It is certainly an advantage from the viewpoint of tone and can be mounted conveniently near the socket of V6.

Likewise it was decided after the receiver had been photographed to hook a 1½-volt torch cell into the grid circuits of V1 and V2 instead of taking a long bias lead around to the battery strip and thence through the cable to the 1½-volt tap on the "C" battery. This built-in "C" battery can be secured to the chassis by means of a little aluminium clamp near to the sockets of V1 and V2.

To place the receiver into operation after hooking up the batteries, speaker, aerial and earth, and applying the various plate screen grid and bias voltages, set out earlier in the article, the following procedure may be adopted:—

Screw the padding condenser, PD, hard down and then slack it off about 1½ turns. Next tune the receiver to the low end of the scale, and bring in a station such as 3AW, 2AY or 7UV. The oscillator trimmer should be screwed three-quarters down so that 3AW comes in at about 17 and 2AY or 7UV three or four degrees below. Adjust the trimmer on the modulator section of the gang (G3) until the loudest signals are obtained, at the same time progressively reducing the volume by means of the volume control, so as to get a definite point of adjustment. Then adjust the trimmer on G2, and finally the trimmer on G1.

It may happen that because G1, G2 and G3 are badly out of step it will not be possible to tune in a station. In this case the procedure is to remove V2 from its socket and push the aerial lead into the plate contact of the socket. After adjusting G3 and G4 plug in V2 and remove V1. Plug the aerial into the plate contact of V1's socket and adjust the trimmer on G2. Then replace V1 and connect the aerial to the aerial terminals and adjust G1. Any small discrepancies may be taken up by reverting to the original method of alignment.

When the set is lined on the bottom end of the band tune up to 95 where 2CO should be found. Now rocking the gang condenser back and forwards over two or three degrees adjust the trimmer until loudest signals are obtained. A final slight re-adjustment on the lower end should now result in the receiver functioning properly and being in line over the whole wave band.

THE ECONOMIC FOUR

(Continued from page 8).

wave length between those of 3KZ and 3AW inclusive. When this has been completed it will be found that all sections will track equally well at the longer wave end of the dial.

As a guide and as an indication of the set's wave-band coverage, the dial setting of 3AW is 15 degrees, while that of 2CO is 97 degrees.

A Useful Dodge

If you live in a bad receiving area, of which many are scattered about, it is possible that an added punch will be desirable in order to equalise conditions, at the expense of a little quality that can be obtained through the employment of one r.f. choke and one of the old neutrodyne type of micro condensers to be found in most junk piles.

First discard condenser C5, and then insert the choke between P of V3 and the P connection of AFT. Connect one lug of the neutralising condenser also to P of V3. From its other side run a lead to the wire that already joins the bottoms of coils L2 and L3. The neutcondenser should be set to its minimum capacity.

Now tune in to some station low on the band—say, 3AW or below. Turn in the little condenser until the set howls, and then turn it back until the howl ceases. If you fail to get a howl it means that the little variable is not quite big enough. Once set on a low station, the addition needs no further attention.

This device boosts many stations, but it decreases quality. It is better out than in circuit, but then necessity knows no law.

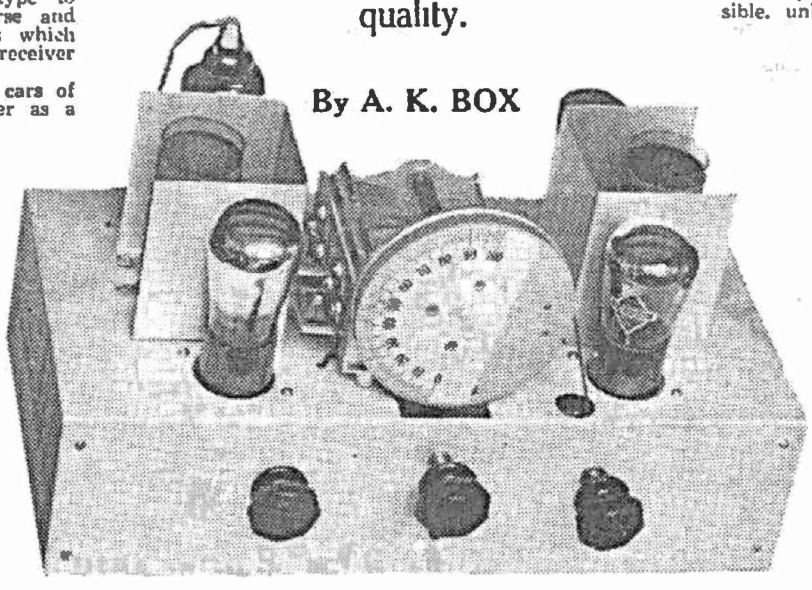
The Music Master Battery Four Valver

An efficient four valve receiver that has a remarkable low battery consumption combined with range and quality.

By A. K. BOX

IT is generally realised by set builders that the radio set's performance is analogous to that of the motor car. The one, two and three-valve receivers fall into the light car class, the four-valves into the medium car class, with the five, six and seven-valve, tuned r.f. receivers and super-hets., as the "go-every-where-do-every-thing" type. Similarly to the motor car, we select the particular type to suit our individual purse and to perform those jobs which we feel that our ideal receiver should.

Talking of the light cars of radio, we may consider as a suitable example a modern three valve receiver which obtains the greater part of its efficiency from the use of modern valves in conjunction with well designed aerial and r.f coils. In such a receiver, which would employ a screen grid radio frequency amplifying stage, a regenerative detector and a transformer coupled pentode audio amplifier, we have all the pep we expect from the light car. A three-valver built along lines similar to these, provided that care is taken in its construction, can be depended upon to give reliable reception over reasonable distances day in and day out, much in the same way as we should expect our light car to take us backwards and forwards over the average roads without trouble.



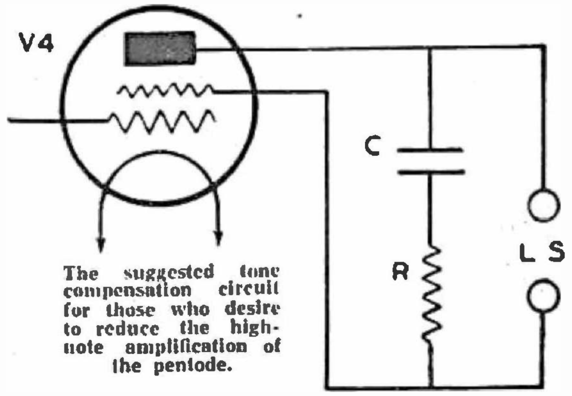
Front view of the finished chassis with the valves inserted.

Sometimes, atmospheric and other conditions being favorable, we are able to turn off into the by-ways—to bring in inter-state and international stations at good strength and clarity. However, there is the "if," and, as the object of the true seeker after international reception is to remove such "ifs," it stands to reason he must have a much bigger receiver. Such a state of affairs can be easily remedied if he has a sufficiently deep pocket and is able to use an all electric receiver but for the country user the possession of a really large set brings in its train a completely new set of problems, not the least of which is the provision of battery power for the receiver. This means then that the average country radio user, even should he be desirous of really reliable distant reception, must confine himself to as small an instrument as possible, unless he wishes to be bankrupted with "B" battery bills.

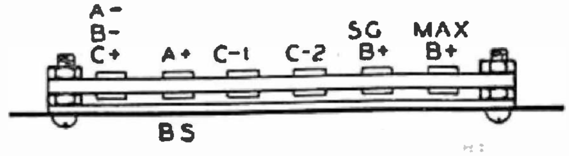
This is where the present model comes in. We claim that, valve for valve, it is capable of a sensitivity equal to that of the average two-stage r.f. design, although figures would seem to prove that its sensitivity is only half that of the former. Further, it is much more simple to build and to get going than the two stage job, and, thirdly, it is possible to load up the audio stage quite easily on weak signals, a thing which is not possible with the two-stage r.f. receiver without grave overload of the detector valve. Note that these remarks are made on the assumption that we are discussing a battery receiver which uses a triode of the 2-volt class as an ordinary leaky grid detector.

Anyway, theory or no theory, we have built up a set on the lines discussed above and have proved, beyond shadow of doubt, that it functions excellently, and that it out-performs the average four-valver that uses two r.f. stages.

Naturally, in using the low consumption 2-volt valves, to which we personally are wedded, we had to give some little



The suggested tone compensation circuit for those who desire to reduce the high-note amplification of the pentode.



The arrangement of the six-point battery strip that is used in preference to terminals. The various battery leads are soldered direct to the points on this strip. These points may consist of small brass bolts.

thought to the audio amplifier, making sure that it would not be possible to blast the screening grid off the pentode when an ordinarily loud signal was being received. How this was done will be explained now when we discuss briefly the technical side of the receiver's design.

The Circuit's Details

First, glance at the schematic circuit diagram. It will be seen that the receiver employs a transformer coupled screen grid r.f. stage, a regenerative detector, a resistance coupled audio stage and a transformer coupled pentode output tube.

The following are some of the salient features of the receiver. The aerial is connected to the grid circuit of the radio frequency valve V1 by means of suitably arranged taps. It has been found that this method of aerial connection gives greater signal input for a given degree of selectivity than does the normally used separate aerial coil.

Although the average gang condenser used with the receiver is provided with trimmers which permit of accurate adjustment of each section of the gang condenser throughout the broadcast wave band, this adjustment is sometimes a little difficult for the novice. In order to get over this difficulty a five-plate midget condenser has been connected in parallel with the radio frequency tuning section of the gang condenser, to equalise any discrepancies in capacity between the two tuning sections.

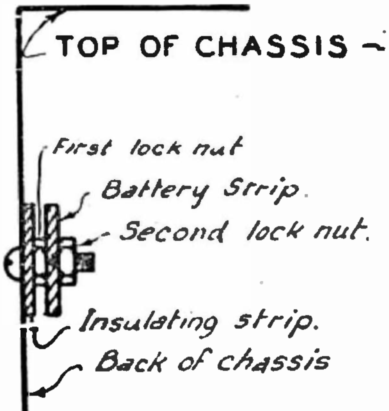
The radio frequency transformer L2, L3, L4 is of the special high impedance type which permits of maximum amplification being obtained from the screen grid valve without trouble from lack of selectivity or stability.

In considering the audio stage of this receiver we were faced with two problems. The first was that of limiting the "B" battery consumption, whilst the second was the necessity for a reasonably high undistorted output. There were three ways in which the audio stage could have been arranged. We could have a single pentode audio tube, transformer coupled to the detector (and thus make a three-valve receiver); we could employ two transformer-coupled stages and use a low impedance power valve in the last stage; or we could resistance-couple the first audio stage and employ a transformer-coupled pentode in the last stage.

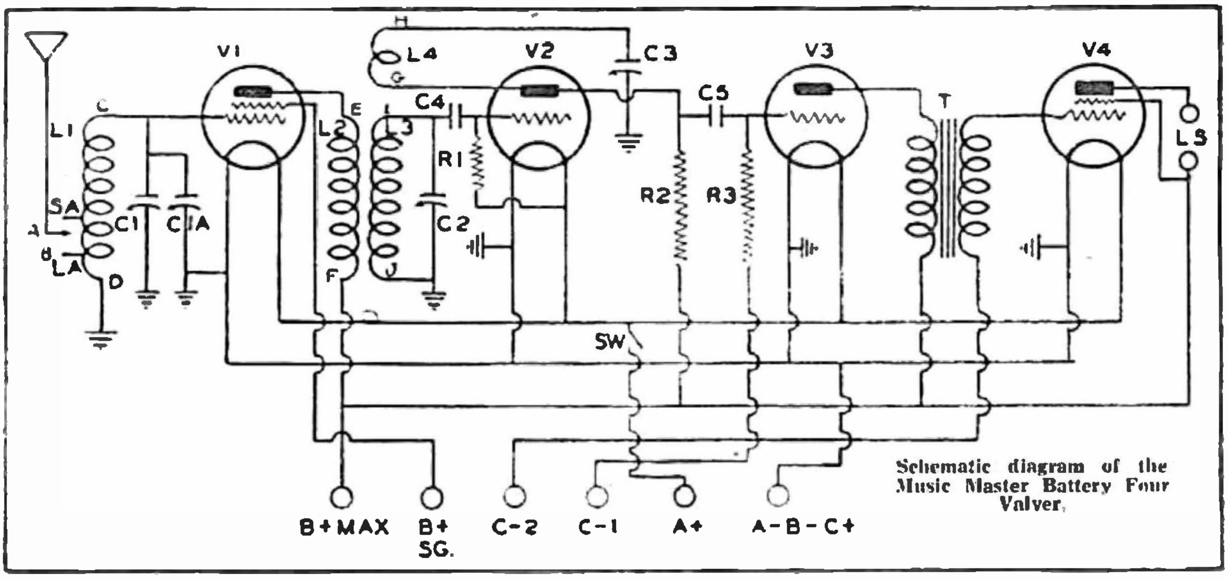
Reasons for the Audio System

The use of a single transformer-coupled audio stage employing a pentode would fail because it would not give us sufficient output from weak and distant stations. The use of two transformer-coupled stages, employing three element valves, would fail because a power output of only about 150 milliwatts would be available. The natural thing to do then was to employ a two-stage amplifier with a pentode in the last stage.

Now the over-all amplification of this combination, were two transformers employed and the audio valves operated from 90 volts, would be such as seriously to overload the pentode. In order to cut the over-all amplification down to a reasonable point and, at the same time retain tone and clarity, it was necessary to resistance-couple the first stage. This really had two advantages, for, besides allowing us to load the pentode to its full output (about 350 milliwatts at 90 volts plate potential), the extra "B" battery consumption of the first audio valve was kept to a minimum. As a matter of fact, the total plate consumption of the receiver is around 11 milli-amperes for normal operation, a figure seldom reached in the average four-valve battery receiver.



Details of the arrangement of the battery strip, its insulating strip and its method by which it is secured to the chassis.



Schematic diagram of the Music Master Battery Four Valver.

List of Parts Required

- 1 2-Gang .0005 mfd. Variable Condenser (C1, C2).
- 1 13-plate Midget Condenser (C3).
- 1 5-plate Midget Condenser (C1a).
- 1 Audio Transformer (T).
- 3 UX Sockets (V1, V2, and V3).
- 1 UY Socket (V4).
- 1 Filament Switch (SW).
- 1 R.F. Coil (L1).
- 1 Detector Coil (L2, L3, L4).
- 1 Drilled Chassis and End Blocks.
- 2 Coil Screens.
- 1 Tuning Dial, complete with Cord Drive and Dial Drive Spindle.
- 1 Three-socket Aerial Strip.
- 1 Two-socket Loud Speaker Strip.
- 1 6-Point Battery Strip and Insulating Strip.
- 1 .00025mfd. Grid Condenser (C4).
- 1 .006 mfd Fixed Condenser (C5).
- 1 .2 Megohm Resistance (R1).
- 1 .5 Megohm Resistance (R3).
- 1 100,000 ohm resistance (R2).
- 1 Set of Battery Leads.
- 24 ½in. x ⅛in. Nickel Plated Machine Screws.
- 2 ½in. x ⅛in. Nickel Plated Machine Screws.
- 24 Nuts.
- 8 Nickel Plated Wood Screws.
- 5 Lengths Spaghetti Sleeving.
- 1 Roll Tinned Copper Connecting Wire.
- 3 Tuning Knobs.
- 1 Length Resin Cored Solder.
- 1 Cossor 215 S.G. Valve (V1).
- 2 Cossor 210 L.F. Valves (V2 and V3).
- 1 Cossor 220 H.P.T. Valve (V3).

The proper loading of the pentode results in really good tone quality being obtained, although, of course, the advantage of this is not appreciated unless one of the permanent magnet type of dynamic loud speakers is employed.

Chassis Design and Lay-out

The receiver is built up on a chassis measuring 14 inches in length, 7 in width, and 3½ in depth. This chassis may be of 16 gauge aluminium or of 22 gauge motor steel, the latter for preference, because of its better shielding characteristics.

As will be seen from the pictures of the finished model, the coils are fitted into three-sided metal screens. These are made up either of aluminium or motor steel and are 3¼ inches in height and 2¾ inches wide on each side. They are provided with a half-inch right angle bend on the bottom edge to facilitate mounting on the chassis.

In addition to the holes for the mounting of the four-valve sockets and for the tuning condenser dial drive, the reaction condenser, and the midget trimmer condenser on the front of the chassis, two "ports" are cut out of the back of the chassis to take the aerial, earth, and loud speaker terminal strips.

The under chassis view of the finished receiver shows that very few components are employed and that the wiring of the receiver is extremely simple. Besides the valve sockets, the aerial and loud speaker strips, the five-plate and 13-plate midget condensers and the dial drive spindle, the only components to be seen underneath are the audio transformer, the grid condenser, the coupling condenser, the plate and grid resistances and the grid leak.

This particular model of the set had incorporated in it a tone compensating network as shown in Fig. 2. This arrangement is not absolutely necessary, but it is a distinct advantage, inasmuch as it suppresses the undesirable high note amplification of the pentode. The necessary condenser and resistance are shown (in the picture) connected to the loud speaker output terminals.

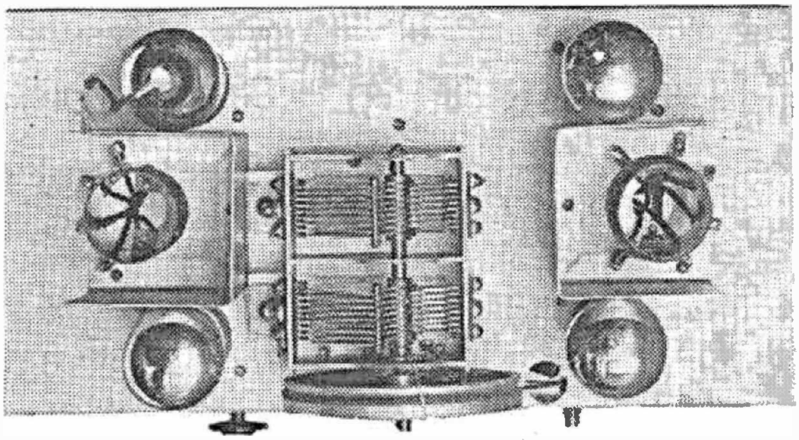
The various battery leads are taken to a small six-pin strip which is mounted to the chassis by means of machine screws, but is insulated from it.

The Wiring in Detail

This is fairly straighforward and, beyond the usual care necessary when making soldered joints, should not give rise to troubles even for the novice.

The wiring is begun by connecting one of the aerial terminals to the first tap on the aerial coil L1 and the second aerial terminal to the second tap on L1. The earth end of L1 (nearest to the taps) is connected to the earth terminal. The remaining lead on L1 is connected to the G lug on the socket V1, to the fixed plate lug on the C1 section of the gang condenser C1-C2, and to the fixed plate terminal on the 5-plate midget condenser C1a.

From the earth terminal on the aerial-earth strip a lead is taken to the F minus lug on each of the four valve sockets, V1, V2, V3 and V4. This lug on each socket is also connected by means of a soldered wire to one of the socket securing bolts.



Looking down on top of the chassis, the builder gets a good idea of the layout of the components.

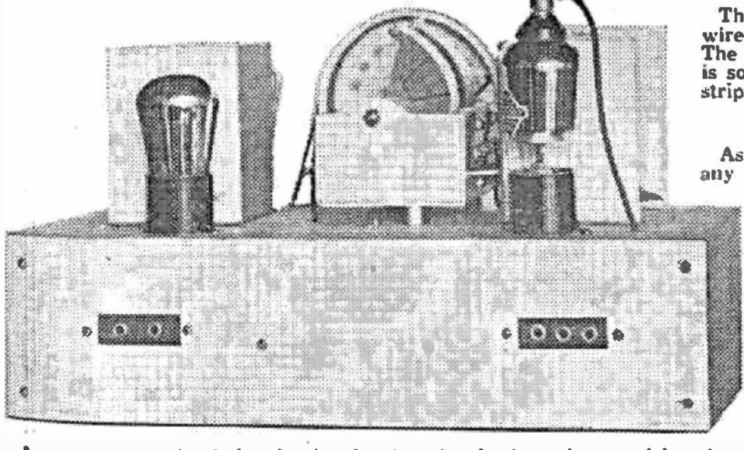
This is done to earth possible r.f. potentials which may develop in the filament wiring and thus spoil the stability of the receiver.

The A minus lug on the socket V3 carries a third wire which is soldered to an A minus battery strip solder point. The A plus lugs on each of the four sockets are joined together by means of a wire which continues to one lug on the filament switch. The other lug on the filament switch is connected to the A+ solder point on the battery strip. The P lug on the r.f. valve socket V1 is connected to the B+ S.G. solder point on the battery strip. The top (plate terminal) on the r.f. valve V1 is connected to the top end of the r.f. primary winding L2. The bottom end of L2 is connected to the B+ Max. solder point on the battery strip. The top of the grid coil L3 is connected to one lug on the grid condenser C4 and to the fixed plate lug on the C2 section of the gang condenser C1, C2. The other end of L3 is connected to earth.

The vacant lug on C4 is soldered to the G lug on the detector socket V2 as is one lead of the 2 megohm grid leak R1. The other lead on R1 is connected to the A+ lug on the socket V2. The P lug on V2 is connected to the top lead of the reaction winding L4, whilst the other lead on L4 is soldered to the fixed plate lug on the 13-plate midget condenser C3. To the P lug on the socket V2 solder one lead of the 100,000 ohm resistance R2 and one lug of the .006 mfd. condenser C5. The other lug on C5 is soldered to the G lug on the socket V3, to which lug also is soldered one lead of the 500,000 ohm resistance R3.

The P lug on V3 is connected to the P lead on the audio transformer T and G lead on this transformer is connected to the G lug on the pentode valve socket V4. The P lug on this socket is wired to one of the loud speaker output terminals. The other l.s. terminal is connected to the terminal on the side of the pentode valve itself. The C— terminal on the audio transformer is connected to the C—2 solder point on the battery strip. The B+ terminal on the transformer is connected to the B+ max. solder point, as is the lead from the l.s. terminal, to which the screening grid of the pentode was connected.

The remaining lead on the 500,000 ohm resistance B3 is wired to the C—1 solder point on the battery strip. The remaining lead on the 100,000 ohm resistance R2 is soldered to the B+ max. solder point on the battery strip. This completes the wiring of the receiver.



A rear photograph of the chassis, showing the loud speaker, aerial and earth connections.

Adjustments and Tuning

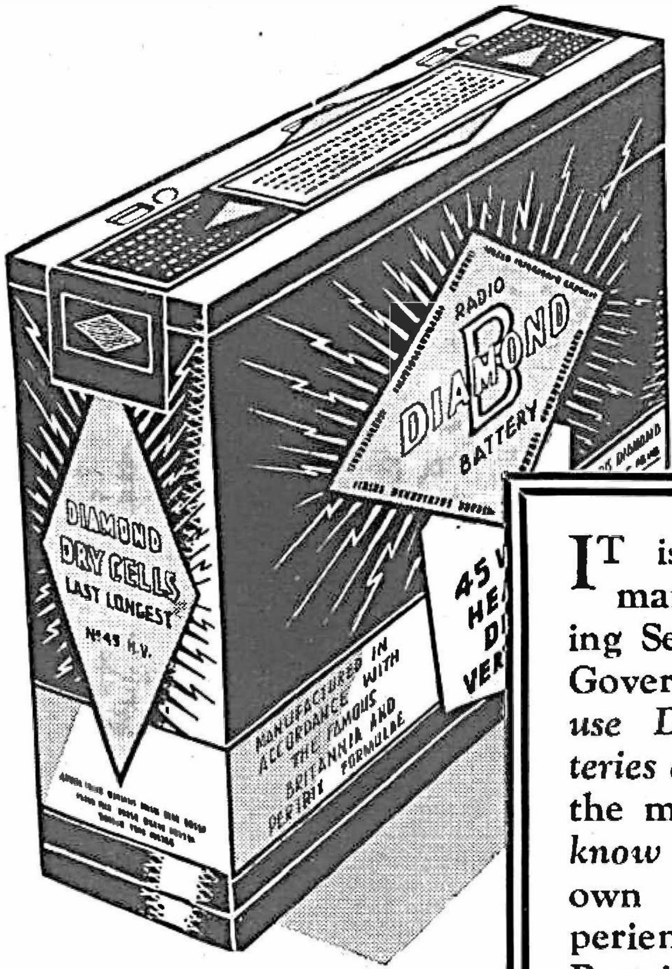
As designed, "The Music Master" does not require any adjustment whatsoever when once it has been built up in accordance with the foregoing instructions. The tuning of the receiver is simple, and is carried out as follows:—

To tune in a station, rotate the gang condenser C1, C2 until a whistle is heard. Then rotate the control knob on the 13-plate midget condenser C3 (which previously should have been in the "all in" position) until the whistle disappears and the speech or music is heard clearly. A further increase in volume and clarity can be obtained now by adjusting the "trimmer" condenser C1a. This procedure is followed in tuning to any station within the tuning range of the receiver. No qualms that the receiver will

(Continued on page 41)

LIST OF 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	6ML	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'ld.	0.75
1155	260	2WG	Wollongong Broadcasting Co., Wollongong, N.S.W.	0.05
1170	256.4	4TO	Amalgamated Wireless (A'sia) Ltd., Townsville, Qld.	0.2
1180	254	3DB	3DB Broadcasting Station Pty. Ltd., Melbourne, Vic	0.4
1190	252	4MK	Mackay Broadcasting Service, Mackay, Q'ld.	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'ld.	0.2
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'ld.	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'ld	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. Ulverston, Tas.	0.25
1470	204	6IX	West'n Australian Newspapers Ltd. St. George's Ter. Perth, W.A.	0.3
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



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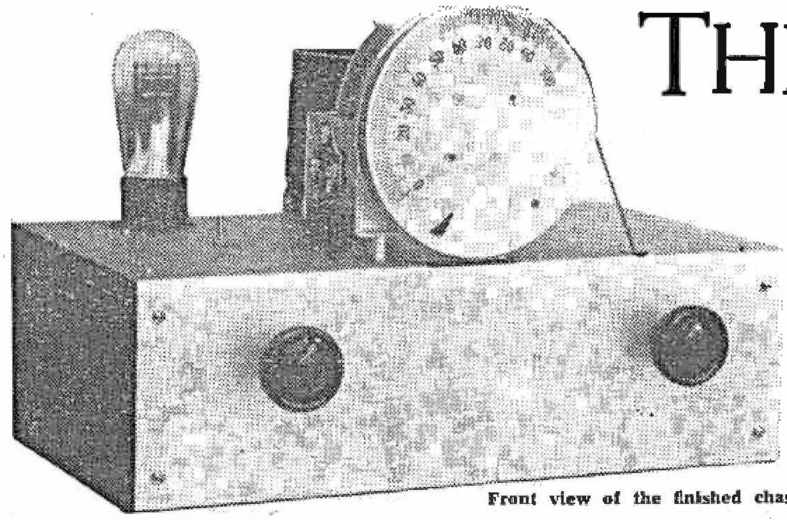
THREE GOOD BATTERY SETS

By
A. K. BOX

Some Standard Circuits of Modern Design



Front view of the finished chassis.

DESPITE the undoubted interest taken by experimenters and home set builders in elaborate types of battery receivers, the fundamental one and two valve receivers still are in favor by many. During the last few months The Listener In technical mail has contained numerous requests for simple one, two and three-valve battery receivers, which could be built up cheaply, with a minimum of apparatus, and at the lowest possible costs. Other enquirers have requested details of battery receiver circuits which employed modern multi-element valves, such as the screen grid and pentode tubes, in order that they could convert their standard receivers to use these more efficient types of valves. In the following summary of the position of the small battery receiver, both types of enquiries are catered for, and complete constructional details have been provided on three standard battery circuits of modern design.

Before attempting to deal with the constructional side of a receiver which may embody any one of these circuits, we first will review each circuit, point out its advantages and disadvantages, and compare it with the other two.

To start with we will take the simplest circuit of them all, that of Fig. 1, in which a standard three element detector is transformer coupled to a second three element valve. The idea we have in mind in regard to this circuit is the use of two general purpose type valves such as the Mullard P.M.1HL, which, operating on a 60 or 90 volts plate potential, will deliver sufficiently good headphone or even weak loud speaker strength signals from the majority of the "A" class stations (we are considering the use of these receivers in the average country reception area when forecasting the probable results), with a real economy of "B" and "A" battery consumption.

For example, with the two Mullard valves mentioned the "A" battery consumption will be 2 volts at .2 amperes, which means that the average 20 ampere hour "A" battery will give something in excess of 200 hours' service without recharging. The "B" battery consumption will be even more economical, for at 90 volts the total current drain when the audio valve is operated with a negative "C" bias of 1½ volts, will be not more than 1½ milliamperes. This means that even the light duty type of "B" battery can be depended upon to give from six to nine months' service.

Technically this type of receiver (Fig. 1) is the very simplest it is possible to build. The use of the three element detector makes it an easy matter to obtain suitable control over regeneration; there are no snags likely to develop from the view point of stability; and the total cost of the set is extremely low.

Using a Pentode

The next stage of radio development with the two valver is the use of a pentode audio valve instead of the general purpose type valve. This change has several distinct advantages. First it allows us to increase the volume of the receiver because the pentode has an amplification factor of from 60 to 90 against the 28 of the P.M.1HL. It has another even more important advantage in that it is capable of delivering a far greater undistorted power output than the general purpose valve.

The general purpose valve has an undistorted output of only 11 milliwatts at 90 volts, whilst at the same plate potential the pentode has an undistorted output of 150 milliwatts, which means, in effect, that we shall be able to deliver more power to the loud speaker without valve overload taking place. This question of undistorted output is one of the most difficult to solve with the battery receiver, for, with every increase in output power, we are faced with a more than parallel increase in the "B" battery voltage and current required. Furthermore, in the case of the three element power valve, we have to provide additional audio frequency amplifying stages in order to put a sufficiently strong signal on the grid of the power valve to operate it at full output.

There is no doubt whatever that when it comes to the question of output power versus battery power the pentode type of valve shows up very strongly against the three element or triode type of valve. In the case of the circuit we are now considering valves of the class of the Mullard P.M.1HL and the Mullard P.M.22a should be used. The former will operate as the detector and will take a plate current of not more than half a milliampere, whilst the pentode valve, operated with a plate potential of 90 volts, will require a total plate and

The Parts Required

1 Aluminium Chassis, 12in. x 6in. x 3in. (with wooden end blocks).
2 UX Valve Sockets (one UY in some cases. See text).
1 .0005 mfd. Variable Condenser (C1).
1 23-Plate Midget Condenser (C3).
1 Audio Transformer, 5-1 or 3½-1 ratio (T.).
1 .00025 mfd. Grid Condenser (C2).
1 2-Megohm Grid Leak (R.).
1 Tuning Coil (see text), (L1, L2, L3).
1 Tuning Dial.
1 Radio Frequency Choke Coil.
Battery Cable, Connecting Wires, Machine Screws, etc.

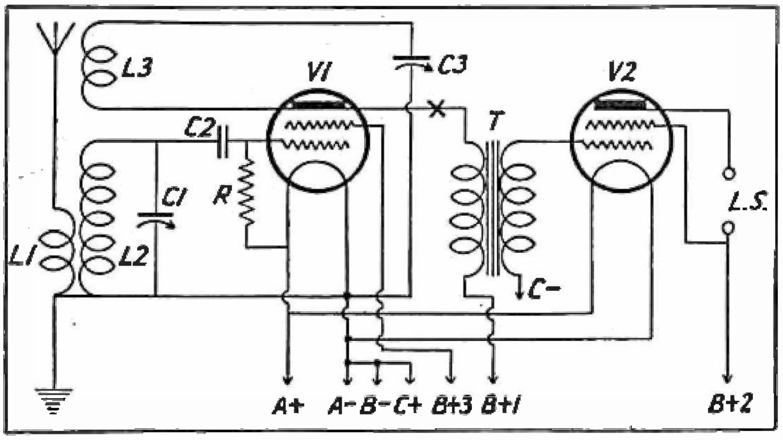
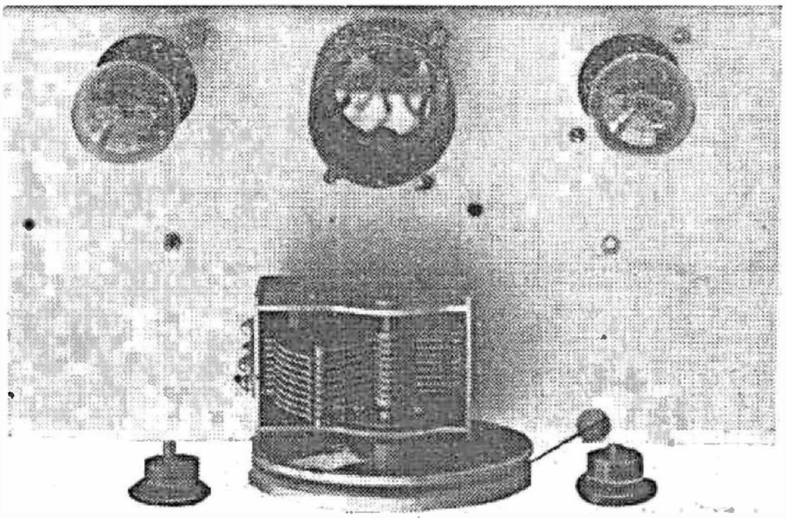


Fig. 1 shows a standard three-element detector transformer coupled to a second three-element valve.



Looking down on top of chassis, the layout of coil, valves and condenser can be seen.

screening grid current of about six milliamperes.

This means then that to obtain our increased power output of 150 milliwatts we have increased the plate current requirements of our receiver from 1½ milliamperes to 6½ milliamperes. Further, as the "A" battery current for the pentode is .2 amperes we have reduced the useful life of our accumulator "A" battery from 200 hours per charge to around 70 hours per charge.

Naturally, because of the increased current drain, we shall find it more economical to use the heavy duty type of "B" battery and because of the use of a pentode we shall require a "B" battery voltage of not less than 90. On the surface it would seem that the pentode valve has thrown our "B" battery set from the high pinnacle of economical operation which it enjoyed into the pit of high operating costs and has not compensated for the change by any substantial advantages. This is not really the case as the following exposition is intended to show.

In the first place, with small receivers such as these we require every bit of amplification we can obtain, and the use of the pentode certainly increases the useful range of the receiver by boosting the strength of stations which normally would not be receivable. Secondly, the day of the headphone receiver has definitely passed, and in order to obtain reasonable tone quality and sufficient output from the loud speaker we must employ a valve which is capable of delivering a reasonable power.

As previously pointed out the pentode does this more efficiently than the triode valve, and enables us to obtain the best results with a reasonably economical "B" battery consumption. Definitely the second circuit (Fig. 2) is a distinct advance on the first. From the constructional viewpoint, it is no more difficult than the straight two valve receiver, although the increased cost of the pentode and the necessity for heavy duty type "B" batteries will call for a greater cash outlay.

Screen Grid Detectors

The third circuit (Fig. 3) shows the use of a screen grid detector valve in place of the three element tube, and retains the pentode as an audio frequency amplifier. For the sake of clarity we have retained the transformer method of coupling these two valves, although better tone quality will be obtained from the use of resistance coupling. The screen grid detector is generally known to be more sensitive to weak signals than is the triode, and for this reason is used to increase the useful range of the receiver.

However, because for tone reasons we are compelled to use resistance or some similar form of coupling between the detector and the audio valves, the actual amplification of the two valves is no greater than that of the three element detector and the pentode. The reason for this is that whilst the average audio frequency transformer has a step up ratio of 3½ to 5 the resistance coupling stage has at best only a step up ratio of 1, and generally has a step down ratio of 1 to ¾.

Another nasty complication which occurs with the screen grid valve when used as a detector is the difficulty of obtaining a reliable control of oscillation. If the reaction coil is connected in the plate circuit a careful adjustment of the screening grid potential is necessary to get smooth control of oscillation, and even then the disturbing phenomenon of "fringe howl" often makes its appearance and spoils results. If the reaction coil is connected in the screening grid circuit there is always the liability of upsetting the stability of the valve by the sudden potential changes which take place during the change from a non-oscillating to an oscillating condition.

The plate current consumption of the screen grid detector valve is about the same as that of the three element valve, so that this point does not come into our consideration of the advantages and disadvantages of the screen grid tube as a detector.

To sum up, we may say that where extreme sensitivity is required from a two-valve receiver the screen grid detector is a decided advantage. The disadvantages are those of obtaining stable operation.

Having dealt with the theoretical side of the problem, we now shall set out the constructional points which should be followed in building a receiver which employs any of the three circuits dealt with. The main point to bear in mind is that the circuits have been so arranged that it is possible to change over from one to another merely by using the required valves.

The design of the receiver follows modern practice in that an aluminium chassis is used on which to mount the various parts. This chassis is made deep enough to permit the audio transformer to be mounted underneath and thus to confine all the wiring (except the two leads to the tuning condenser) to a place where it will be out of sight. The result is an exceptionally "clean" looking receiver, in which only the tuning condenser, the tuning coil, and the two valves are visible on the top of the chassis. This chassis form of construction has another advantage in that it simplifies the wiring and keeps all vulnerable parts away from dust and moisture.

Making the Chassis

The chassis itself is made from a sheet of 16 gauge aluminium measuring 12 inches in length and 12 inches in width. It is bent on each of two sides to provide the three inch side of the chassis. The result is a chassis measuring 12 inches in length, three inches in height, and six inches in width. The open ends are closed by means of two wood blocks measuring 3¼ inches in height, 6 inches in length and ⅝ inches in thickness, which are secured to the chassis by means of wood screws.

The tuning coil should be made by the set builder to the following specifications:—The former is of two inches in diameter and 4½ inches in length. Starting at a point about quarter of an inch from one end, a winding of 25 turns of 26 gauge d.s.c. wire is laid on. Separated

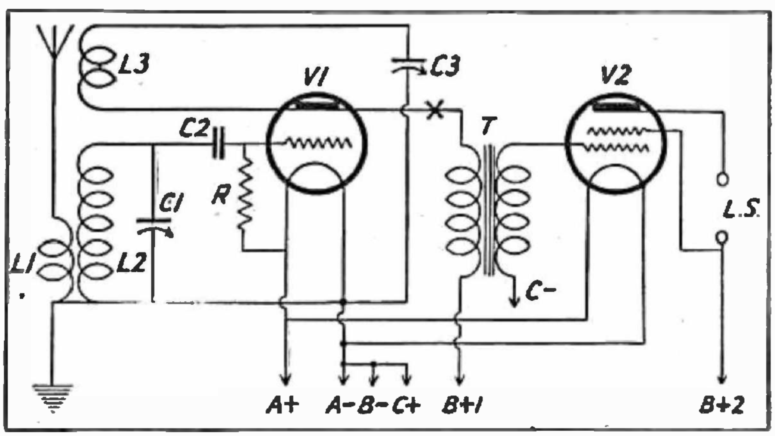
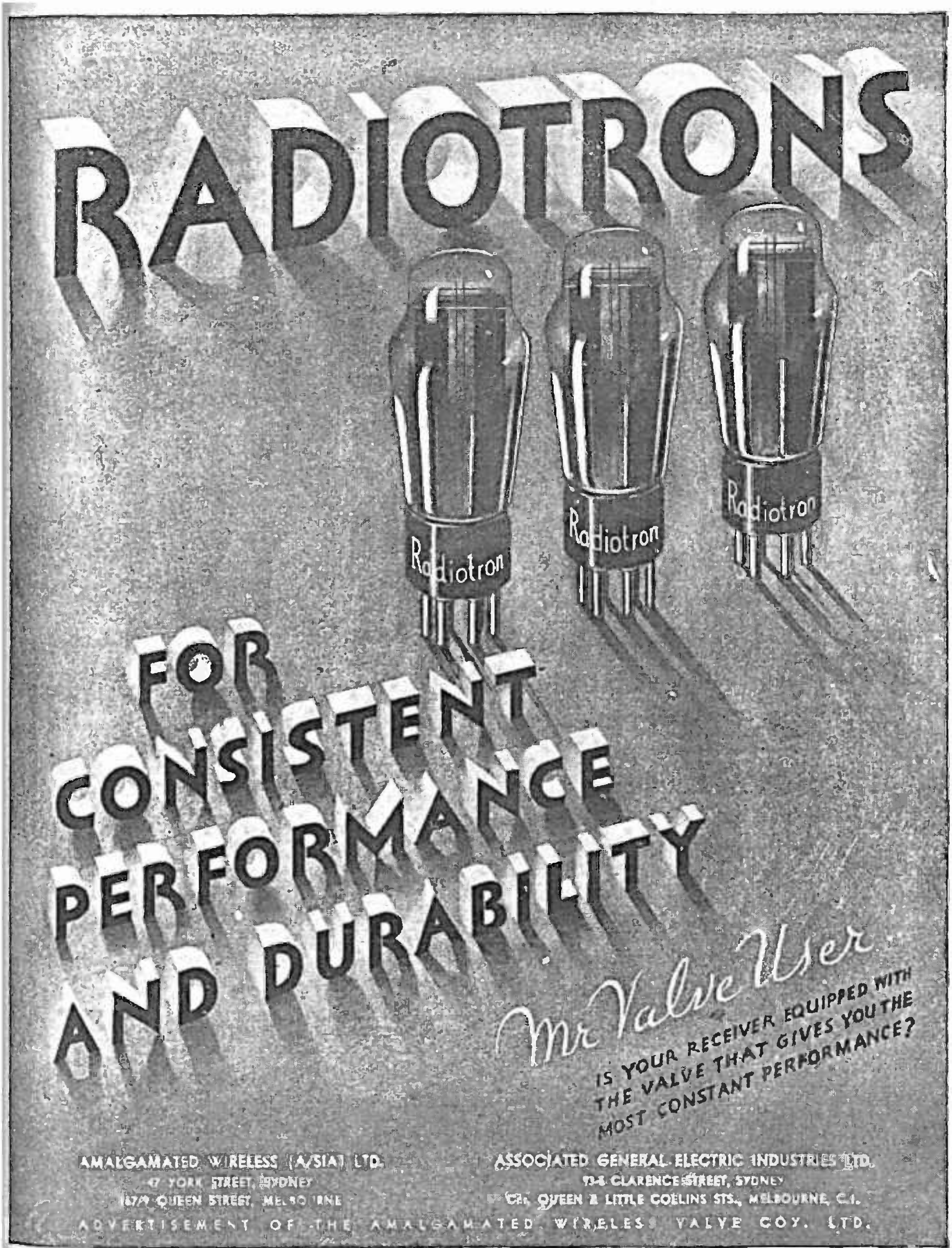


Fig. 2 shows a two-valve circuit, using a pentode in the audio stage.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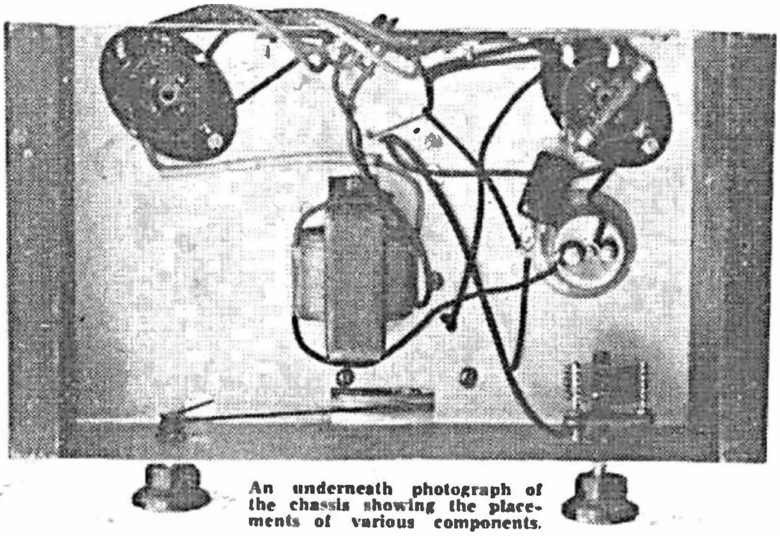

An underneath photograph of the chassis showing the placements of various components.

from this winding by quarter of an inch is the grid winding (L2) of 65 turns of 26 gauge d.s.c. wire. Separated from the end of L2 by a further quarter of an inch, the reaction winding L3, consisting of 25 turns, is laid on. The coil is then provided with a pair of brass or aluminium brackets attached to the bottom (reaction coil) end of the former to permit it to be mounted to the chassis. The leads from the coil are taken down inside it, through a suitable hole in the chassis, where they are connected to the various parts of the circuit.

Referring to the circuit diagrams it will be noticed that a point marked X is included in each of the plate leads to the audio frequency transformer. This is to indicate a radio frequency choke coil, which may or may not be necessary. With the particular transformer we employed in the original receiver a choke was necessary, and it can be seen in the under chassis view of the finished set mounted between the detector valve socket and the midget reaction condenser C3.

Wiring Details

Now that the constructional points of the receiver have been dealt with, we shall detail the wiring of the receiver. For this purpose we take the simplest of the three circuits (Fig. 1) and later make the necessary amendments which will permit the set builder to use the circuits of Figs. 2 and 3.

Before dealing with the wiring it would be as well if we explained the connections on the tuning coil L1, L2, and L3. The top winding of 15 turns is L1 and the start of this winding shall be known as the E lead. The end of this winding is to be known as the A lead. The 65 turn winding L2 is the grid winding. The end of L2 nearest to L1 is to be known as the G lead. The other end of L2 is to be known as the F lead. The third winding, L3, is the reaction winding. The end which is nearer to L2 is to be known as the B+ lead, and the other end of L3 is to be known as the P lead.

Start the wiring of the receiver by connecting the A lead on L1 to the aerial terminal on the receiver. The E lead is connected to the earth terminal. The G lead on L2 is connected to one lug of the grid condenser C2 and to the fixed plate terminal on the tuning condenser, C2. The other lug on the grid condenser C2 is connected to the G lug on the socket V1. From this point on the socket of V1 a lead is taken to one side of the grid leak R.

The P lug on the socket of V1 is connected to the P lead on the reaction winding, L3. The B+ lead on this winding is connected to the fixed plate terminal on the 23 plate midget condenser, C3. The moving plate terminal on this condenser and the moving plate terminal on the tuning condenser, C1, both are connected to the earth terminal, as is the F lead on the coil L2.

From the P lug on the socket of V1 connect a wire to the P terminal on the audio transformer T. The G. terminal on this transformer is connected to the G lug on the socket V2. The P lug on this socket is connected to one of the loud speaker terminals. The other loud speaker terminal carries the B+2 battery lead. The B+ terminal on the audio transformer T carries the B+1 battery lead.

A wire is soldered to the A plus lug on the socket V2, and is connected to the corresponding lug on the socket V1. To this same lug on V1 is connected the remaining terminal on the grid leak R. The A battery positive lead is soldered to the A+ lug on the socket of V1. From the A— lug on V1 a lead is taken to the earth terminal on the receiver. Another lead is taken from this lug to the A— lug on the socket V2. The common lead to which are connected the A—, B—, and C+ battery terminals is soldered to the A— lug on V1. The lead which connects to the C battery negative is attached to the C— terminal on the audio transformer T.

If a radio frequency choke is necessary, in order to make the receiver oscillate easily over the whole tuning range, it should be connected between the P lug on the socket V1 and the P terminal on the transformer T. These two points are at present connected by a wire.

Pentode and Screen Variations

So much for circuit No. 1. If it is desired to employ a pentode valve in the audio frequency stage we have only one wiring alteration to make. That is the connection necessary between the loud speaker terminal which connects to B+2 and the screening grid of the pentode valve.

The valve may have the screening grid connection on the side of the socket in which the change will be easy. On the other hand it may be fitted with a five pin base, in which case we must change the socket of V2 to a UY socket and connect as follows:—A + and A — to the two F, Filament, or Heater lugs; the G terminal of the audio transformer T to the G lug; the plate lead to the L.S. terminal to the P lug; and the B+2 lead to the L.S. terminal to the C lug on the socket as well as to the l.s. terminal.

The further alterations necessary if a screen grid detector is employed are governed by the type of valve used. If the s.g. tube is of British or Continental manufacture its plate terminal will be on the top and the only alteration necessary will be to connect the P lead from L3 and the P terminal of T to the plate terminal on top of the valve instead of to the P lug on the socket of V1. The P lug on V1 will now carry the B+3 lead for the screening grid supply voltage.

If the s.g. valve is an American type the grid terminal will be the "pip" on the top of the valve. To this must be connected the lug of C2 and the terminal of R which previously were connected to the G lug on the socket V1. This G lug now will carry the B+3 lead.

Any, or all of these three circuits given above can be depended upon to give first-class results, and require the minimum in "A," "B" and "C" battery power. Although Mullard 2-volt valves have been used as the basis of calculation, it is possible to substitute with either four or six volt Cossor, Mullard, Osram or Philips valves.

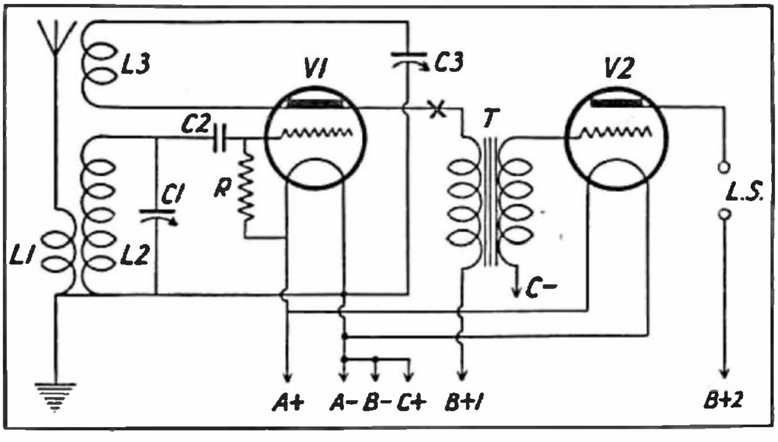

Fig. 3 incorporates a screen grid detector in conjunction with a pentode output.


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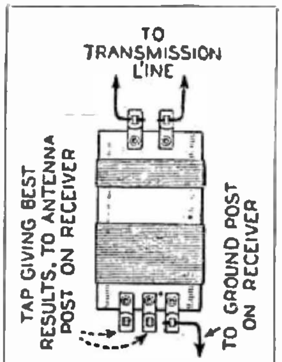

Method of wiring aerial to grid coupler with a transposed system.

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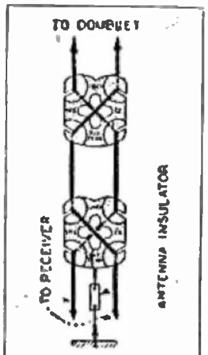


System employed to give insulated cross-overs.

WHILE considerable attention has been given to the design and installation of the short wave receiver, most experimenters have been satisfied with aerials of contrastingly low efficiency. It was with this purpose in mind that engineers have designed a transposed antenna system to overcome this inadequacy. They attacked the problem from three different angles. First, the use of better aerial wire; second, the design of a pickup system favorable to the short waves, and, third, the elimination of noise pickup by the lead-in, thus improving the signal-to-noise ratio.

While this system was designed primarily for short wave reception, its noise reduction properties are effective on the broadcast frequencies and will provide usual reception where ordinarily the signal would be lost in a barrage of man-made static.

Two hundred feet of antenna are sufficient for a doublet or any modified doublet of average dimensions. The exact dimensions can best be determined by the space available and the direction of reception desired.

Reception Is Directional

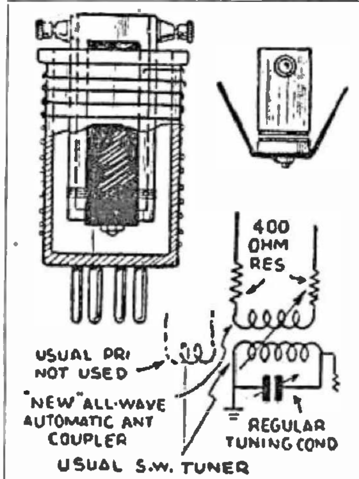
The horizontal doublet receives best from the two directions at right angles to the direction in which the wire is stretched. If the wire runs north and south, signals will be received best from the west and east. When the antenna is tilted the directional preference is "bent" toward the lower end.

The doublet antenna provides signal response on signals of a wave length which has a certain relationship to the length of the top portion of the antenna. This characteristic is practically unaffected by the transposed transmission line lead-in. For best results on a given wave-length the lengths of the two tops of the aerial should be one-quarter of the wave length one desires to listen-in on. Thus, for the 80 meter band the double portion of the antenna will have overall dimensions of approximately 125 feet and a 40 meter band about 63 feet. However, the 80 meter band will provide excellent reception on the 40 and 20 meter bands due to harmonic conditions. However, the reverse is not true. A doublet tuned to 20 meters will not show peaks at 40 or 80 meters.

The main points to be carried in mind in erecting a modified or folded doublet are that the space partially enclosed by the two sides of the antenna system is noise free, and the transposed lead-in be connected as high as possible. Remember, the principle involved is to erect the antenna pickup system in a noise-free area and connect to the receiver, by means of transposed transmission line, which has no pickup and which, therefore, can be run through the noise areas.

If metal masts are used, the insulators should at least be 20 feet from the pulleys.

It also must be remembered that the transposed transmission line should not be twisted. Except, in the case of turning corners it should remain in one plane. No shielded wire should be used in the transmission line, and the distance between the lower end of the transmission line and the antenna-ground earth on the receiver should not be longer than eight feet. The shorter this distance the better.



Practical and diagrammatic in-put circuits.

Coupling to the Receiver

The simplest method of coupling, and one which will be effective on many short wave receivers is to connect the transmission line to the antenna and ground terminals of the set. The use of a ground is not needed.

Where operation without a ground results in lack of stability, this can usually be corrected by lowering the screen and plate voltage of the set slightly. When this is not practical or effective, and in cases where hum is introduced by the removal of the ground connection, resort is made to other methods of coupling. The simplest of these employs the doublet coupler. Such a coupler is mounted inside the receiver close to the antenna and ground posts. In this case the ground post on the receiver is grounded.

The effectiveness of the antenna lead-in and input system as a whole can be increased by "impedance matching" or changing the values of the resistors for different frequencies. The following values indicate the best resistance under average condition: — For a wave length of 40 metres the resistance should be 150 ohms in each leg, for 80 metres 200 ohms, and for general coverage about 300 ohms.

Best to Use Coupler

In some instances best operation is obtained when the transposed transmission line is coupled to the set by means of a special coupler and connected to the lead-in by means of a flexible twisted pair and inserted inside the first grid coil where it functions as the antenna primary. The ground remains connected to the receiver ground post, and not to the transposed lead-in or new primary.

It will be observed that the principle involved in the various methods of coupling with receivers requiring a ground connection for stability or hum reduction, is to isolate the antenna coil or circuit from the ground, yet leaving the ground connected to the rest of the receiver. In many instances it will be possible to wind a separate primary over the secondary, using the same number of turns as the original primary or to break the connection between the grounded end of the primary and the ground post or any other grounded portion of the receiver. No other connection to the ground should be broken. The transmission lead-in is then connected to the antenna post and the free end of the primary coil. The ground is connected, as usual, to the ground post on the set.

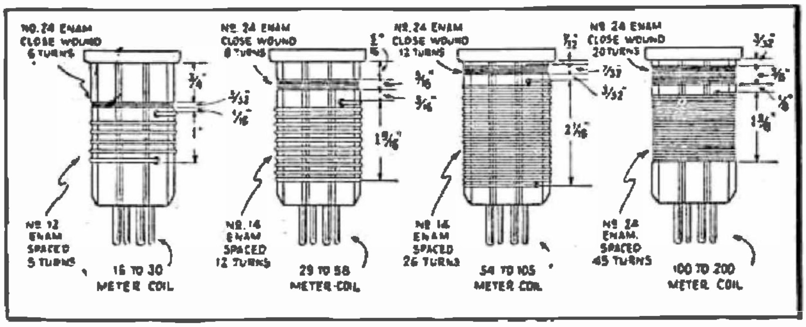
Some short wave receivers have special aerial input circuits, so they may be used with an ordinary aerial or the highly effective doublet, merely by changing the position of the primary lead.

Short Wave Coil Data

Particulars of tuning condenser capacities and coil winding details which will help you to get the most from your S.W. set.

NOT the least of the troubles encountered by newcomers to the fascinating realm of short wave reception is the selection of suitable tuning condensers and coils to cover the various wave bands. Although it is possible to tune a short wave receiver with a standard .0005 mfd. capacity condenser, it is generally accepted that such a tuning condenser cramps the tuning (because a large frequency change takes place for a small dial movement of the condenser), and lowers the efficiency of the receiver tremendously. Actually the very smallest tuning condensers, midgets having a maximum capacity of about .0005 mfds. (50 micro-micro-farads), give best results.

The drawback to the use of such tiny condensers is the small wave range covered with each coil so that seven or even ten coils may be required to cover the wave band between 15 and 90 metres.



Full coil details for the various wave bands are given in this drawing, which also shows the degree of spacing between each winding.

The generally used tuning condenser capacity is .00015 or .00016 mfds., which permits the tuning range to be covered with a maximum of four coils and at the same time makes tuning easy and keeps the efficiency of the tuning circuits high.

In the past valve base coils have been extremely popular, but, with the manufacture of cheap and efficient formers of special type, these makeshifts have disappeared, and the majority of short wave coils are today wound on ribbed bakelite formers of the type shown in the accompanying illustration.

The diagram also gives coil winding data for the complete wave band from 16 to 200 metres, and provides a generous overlap between each coil so that no stations are likely to be missed.

The MUSIC MASTER BATTERY FOUR

(Continued from page 31)

interfere with neighboring sets when it is made to oscillate need be entertained.

The use of a radio frequency amplifying valve V1 effectively prevents the receiver from radiating the local oscillations which are generated when the plates of C3 are brought fully into mesh. As a guiding rule, when once the station has been tuned in, rotate the plates of C3 as nearly towards the "full out" position as possible, in order to get the greatest clarity of reception.

Battery Requirements

"The Music Master" requires for its operation two 45-volt "B" batteries, which are connected in series. A 15-volt "C" battery and a 2-volt "A" battery are also required. The "B" batteries should be of the heavy duty type, or even of the triple capacity type.

The advantage of using high capacity "B" batteries is that they last more than proportionately longer than the light duty, small capacity batteries. The "A" battery may consist of a 2-volt 20 ampere hour accumulator, or, if the difficulties of battery recharging are too great, may be made up of two 1½-volt dry cells connected in series. As these cells will deliver 3 volts, it will be necessary to connect a fixed resistance of 2¼ ohms in series between the "A" negative battery lead and the negative terminal of the "A" battery.

The "C" battery should have the C—1 lead connected to its 3-volt negative terminal, and the C—2 lead connected to its 10½-volt negative terminal.

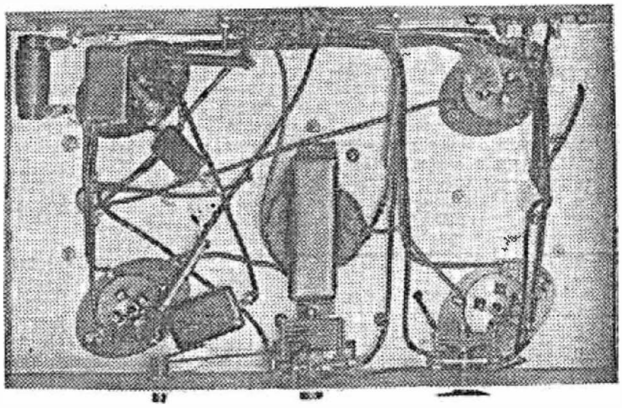
When using the receiver, always be sure to use these "C" battery voltages when a 90-volt "B" battery is used.

In view of the comparatively high cost of battery power it is imperative for the set owner to watch carefully the consumption of his receiver. Always be sure to switch the receiver off when not in use. Another important saving in battery consumption is achieved by always keeping the volume of the receiver down to reasonable limits. As the power output (volume) is increased, so is the battery current drain.

The moral, of course, is always to keep the volume of output within reasonable limits, and thus obtain the best service from your "B" batteries.

What "The Music Master" Has Done

The results obtained with this receiver have been remarkable. A series of tests, on all types of aerials, and under all kinds of receiving conditions, have proved that the set is capable of consistent loud-speaker strength daylight reception



An underneath view of the Music Master Battery Four illustrates the various positions of valve sockets, etc.

over distances exceeding 300 miles. At night the range is Australia-wide, even the Western Australian "A" and "B" class stations being tuned in at full speaker strength.

The night range of the set is really remarkable, for, in addition to regular reception of the majority of Australian "A" and "B" class stations, such internationals as JOAK, JODK, JOCK and JOGK (to mention some of the identifiable Japanese broadcasters), KZRM, Manila, and (more weakly) the Indian broadcasters, have been consistently received.

Used under the average country conditions, the receiver is highly selective, and withal easy to tune. Its tone quality, considering the limited power available, is excellent.

The Coils

Although the other components play an important part in this receiver the tuning coils are the key stone on which its performance rests. If these coils are not properly made all the good work in other directions of the set's construction will go for naught.

The main coils L1 and L3 each consist of 100 turns of 26 gauge d.s.c. wire wound on a 1½ inch diameter former. Each winding is spaced so that 44 turns of wire go to each inch of winding length. L1 is tapped at the 85th and 95th turns from the start of the winding. Over the earth end of L3 a sheet of paper or other insulating material is wrapped, and over this is wound 30 turns of 26 gauge d.s.c. wire to form L4. Note that L4 is close wound and in the reverse direction to L1, L2, and L3. The r.f. primary L2 consists of 60 turns of 26 gauge d.s.c. wire close wound on a 1¾ inch diameter former which slips over L3.

The Pentagrid Battery Five

(Continued from Page 22)

pin jacks. The other pick up pin jack is earthed to the chassis. The plate connection on the audio transformer AFT is soldered to the plate lug on the socket of V3, as is one lead of the .001 mfd. condenser C7. The other lead on C7 is earthed to the chassis. The B plus connection of AFT goes to the B plus maximum lug on the loud speaker socket, to which, also, is soldered one lead from the .5 mfd. condenser C5. The other lead on C5 is connected to the chassis. The grid connection on AFT is taken to the grid lug on the socket for V4.

The plate and cathode lugs on V4 are joined together and connect to the plug on the class "B" transformer BFT. The C minus connection on AFT is soldered to the C minus 1 lug on the battery cable strip. The B plus connection on the class "B" transformer BFT is taken to the B plus 112½ volt lug on the battery cable strip. Join one G lug on BFT to No. 1 grid lug on the socket for V5. Grid No. 2 lug on this socket carries the other G lead to the transformer. The C lug on BFT is taken to the C minus 2 lug on the battery cable strip.

From plate No. 1 lug on the socket for V5 run a lead to the P lug on the loud speaker socket and connect the G lug on this socket to Plate No. 2 lug on V5. Join the two filament lugs (one of which is carrying the B plus max. lead from the anode grid, modulator plate, intermediate plate and detector plate) and take a lead from them to the B plus maximum lug on the battery cable strip. It is necessary now only to attach the necessary battery leads to the solder lugs on the battery strip to complete the wiring of the receiver.

The First Try-Out

For the initial test of the receiver attach the aerial and earth leads and plug in the loud speaker, and the valves. Attach the grid clips on V1 and V2. Next hook up the "A" and "B" batteries, the various leads for the latter being connected in accordance with the voltages shown in the schematic diagram. Connect the C minus and C plus leads to the "C" battery and also take the C minus 1 lead to the 15 volt negative tap on the "C" battery. For initial tests we can connect the C minus 2 lead to the positive terminal on the "C" battery.

On switching on the receiver all the usual symptoms of "alive-ness" should be evident. If not either a mistake has been made in the connection of the batteries or loud speaker, or the receiver is wrongly wired.

Assuming that the set appears to be operating correctly, rotate the tuning dial until a low wave length station such as 3AW or 7UV can be heard. 3AW should come in at about 10 on the dial, when the trimmer on the oscillator section of the gang condenser (G2) is screwed about half in. If the station comes in at a higher dial reading than this, reduce the capacity of G2 by unscrewing the trimmer.

With 3AW at 10 adjust the trimmer on the G1 section of the gang condenser until loudest signals are obtained. This adjustment is best carried out by reducing the sensitivity of the receiver by means of the volume control as each fraction of a turn of the trimmer increases the volume from its original level. The idea is of course that it is easier to get a definite adjustment on a weak signal than on a very loud one. Do not do as one misguided enthusiast did and attempt to reduce the volume by moving the tuning condenser plates whilst he was attempting to line the receiver.

Lining Up On the Padder Condenser

When once you are satisfied that the peak has been reached on the lowest wave length on which a reasonably powerful station can be received (incidentally try and pick a station which does not fade too much), tune up to 2CO and adjust the padder condenser. This operation is carried out by first screwing the padder hard down and then slacking it off for about 2½ turns. With a long-handled screwdriver try increasing or decreasing the capacity of the padder by a fraction of a turn at a time, at the same time rocking the gang condenser by turning it back and forward over a few degrees for each adjustment of the padder. A point will be found at which loudest signals are received, and when this is definitely discovered by a further check with reduced volume we can consider the set to be lined on the top of the band.

During this check of the padding condenser adjustment, be sure to remove the screw driver, after each alteration of the condenser's capacity or false results will be obtained.

After the padder has been satisfactorily adjusted, tune again to the bottom end of the dial to 3AW, or the lowest wave-length station on which the set was first lined, and readjust the trimmer on the G1 section of the gang. Do not on any account touch the oscillator tuning adjustment at this stage.

The alignment of the receiver should not take even the novice more than about half an hour. It is worth while taking time with this job, for on it will depend to a large extent the successful operation of the receiver.

Operation of Class B Audio Amplifier

Now the next point for consideration is that of the Class "B" stage. If the 19 is operated with zero bias the tube will take a static plate current of 10 milliamperes total. If it is operated with 4½ volts negative bias this current will fall to 1.3 milliamperes. The saving is important, but the set user will have to decide for himself whether the increased distortion at the low signal levels which takes place when the tube is negatively biassed is offset by the saving in "B" battery consumption.

Another thing is the type of aerial required with the receiver. As this superhet employs no r.f. stage and depends for its signal pick-up on the sensitivity of the modulator, it is necessary to feed as much signal into the first tube as possible if we are to provide sufficient power to drive the Class "B" output stage. As a matter of fact we discovered in our tests in a Melbourne suburb that because of the relative inefficiency of our aerial system we were unable to get anything like sufficient punch from 6WF to kick the Class "B" tube over.

In these circumstances we suggest a good long aerial, one perhaps up to 100 or 150 feet in length, and coupled to the receiver through a .00025 mfd. condenser. As long as the signals get into the set they will soon advertise their presence. This brings up another point.

Alternative Detector

With a long aerial, and consequently greater signal input, it becomes possible to overload the 30 detector. For this reason in Fig. 2 we have shown the circuit modifications necessary for converting the 30 to a plate detector. The grid lead and condenser are removed and the pick-up is changed over to feed through the secondary of IF2. Naturally the pick-up points must be bridged when the set is operating on radio. The series resistance is a 100,000 ohm. one, and by-pass condenser C9 may be .1 mfd. The C minus lead connects to either 6 or 9 volts negative.

This arrangement gives better tone but lower detector sensitivity. However, it is particularly useful in localities where the signal inputs are likely to be large.

The performance of the receiver, considering the economy of tubes, is remarkably good. All the national stations except 6WF were brought in at full speaker strength on a short indoor aerial, the selectivity was of a high order, and the tone at the high volume levels was better than that of many a.c. receivers with which we have come in contact.

Two-Valve Short Wave

(Continued from Page 17)

After winding, the coils should be dipped in a pan of hot paraffin wax which, besides holding the windings in position, will prevent the access of moisture to the windings. The use of double silk covered wire is to be recommended if the coils are not dipped, as cotton covering tends to absorb moisture, the resultant loss often becoming considerable, particularly in humid atmosphere.

Components

C1. Midget tuning condenser. 7 plates or 23 plate double spaced
C2. Midget reaction condenser, 9 plates.
C3. Mica dielectric grid condenser, .00015 mfd capacity.
CA. Two or three plate midget aerial coupling condenser.
CB. Small Torch Type bias battery.
R1. Grid leak resistance 3 meghoms.
R2. fringe howl resistance 200,000 ohms.
T. Audio Frequency Transformer
SW. filament switch.
V1. detector valve.
V2. amplifier valve.
RFC radio frequency choke.

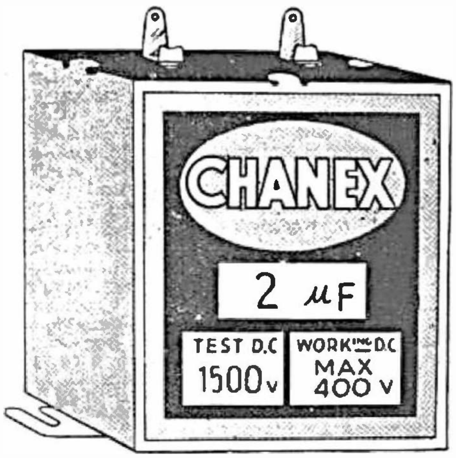
Operating the Set

Connect the A battery of a voltage suitable for the type of valves used in the set, and 60 volts positive from a B battery, or to the 60 volts terminal of a B eliminator which is known to give good silent output. B negative connects to the A negative terminal.

Connect a good aerial to the aerial terminal of the set, and the earth lead to either A battery terminal. Very often an earth lead will be unnecessary, particularly when using A and B batteries.

(Continued on page 41)

Use Only PROVED Components in Your Battery Set!



Chanex Can type and Pigtail Condensers have definitely established a preference with set manufacturers, radio technicians and experimenters throughout Australia—a preference based on the results of actual performance. Use "Chanex" wherever condensers are specified, and be certain of absolute efficiency.

At All Radio Dealers

CHANEX (Metallized) SILENT RESISTORS
are also fully recommended for constancy of value and noiseless operation under all working conditions.

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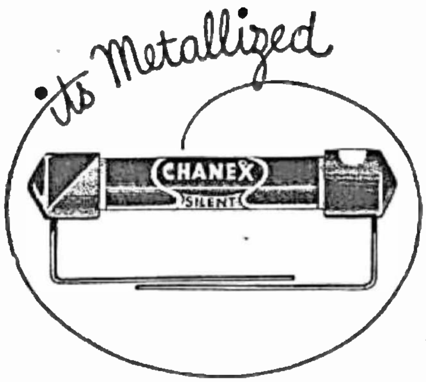
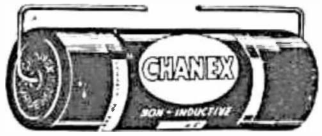
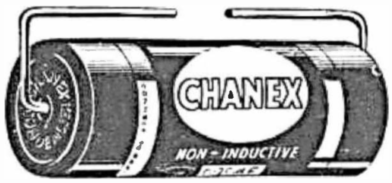
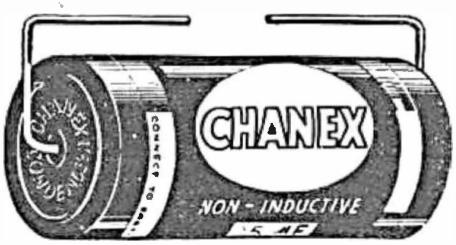


CHANEX
FIXED CONDENSER







Factory Reps.: H. HECHT & CO., Melbourne and Sydney.

These goods are obtainable from all leading distributors of radio parts.
Interstate Distributors:
SOUTH AUSTRALIA: WM. T. MATTHEW, 95 Grenfell St., Adelaide.
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QUEENSLAND: P. H. PHILLIPS, Clock House, Brisbane.
TASMANIA: W. and G. GENDERS Pty. Ltd., 69 Liverpool St., Hobart, and 53 Cameron St., Launceston.

The T.R.F. Battery Five-Valver—

(Continued from Page 13)

join one lug on each of the fixed condensers C1, C2, C3, C4 and C7 by means of a wire which continues to an earthing point on the chassis.

The remaining lead on R4 is soldered to the vacant lug on C5, and a lead is taken from this lug up through the chassis to connect to the fixed plate lug on the G3 section of the gang condenser. Note that this particular connection to the gang condenser is made to the trimmer side of the condenser whilst all the others are taken to the conventional solder lugs on the opposite side of the condenser.

We now can carry on with the last phase of the wiring which embraces the connection of the r.f. tuning stages and their associate circuits. Start by running a lead from the aerial end of the aerial coil L1 to the aerial terminal on the receiver. The earth terminal is connected to the nearest earth point on the chassis as is the earth end of the aerial coil.

The grid end of L2 carries two leads. One of these is that which carries the grid clip for the s.g. valve V1, and which is taken through a hole drilled in the top of the coil can, whilst the other is taken out through the bottom of the chassis, and then passes through a hole drilled near the G1 section of the gang condenser to solder to the fixed plate lug on this section. The earth end of L2 is soldered to the vacant lug on the .5 mfd. condenser C1, to which also is soldered one lead of the 100,000 ohm resistance R1.

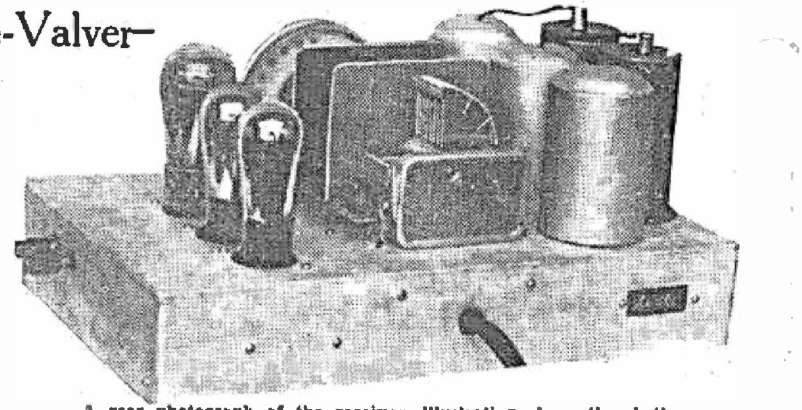
The G lugs on each of the r.f. sockets V1 and V2 are joined together and a wire is taken from them to the vacant lug on the .5 mfd. condenser C3, thence to the B+45 volt point on the battery strip. The plate end of L3 is connected to the P lug on the socket of V1, the B plus end of this coil being joined to the vacant lug on the 2 mfd. condenser C4. From this point on C4 a wire is run to the B+ end of L5. Another wire from the same point on C4 connects to the B+90 volt point on the battery strip.

The plate end of L5 is connected to the P lug on the socket for V2. The grid end of L4 carries two leads. One of these connects to the grid clip for V2, and is taken through the top of the can in a similar manner to the grid clip lead for V1. The other lead travels through the bottom of the chassis across, and up through a hole drilled near the G2 section of the gang condenser, and is soldered to the fixed plate lug on this section. The earth end of L4 is joined to the vacant lug on C5, to which is soldered one lead of the 100,000 ohm resistance R2. The vacant leads on R1 and R2 are soldered together, and connected to the centre terminal on the volume control VC.

The grid end of L6 carries a wire which travels under the chassis and up through a hole near G3, when it is soldered to the fixed plate lug on this section of the gang condenser. The earth end of L6 is soldered to the nearest earthing point.

The Initial Test

Except for the soldering of the battery leads to their respective points on the battery strip, the wiring of the receiver is completed and everything is set for the initial try-out. After attaching the "A" and "B" batteries, plugging in valves, speaker, aerial and earth, switch the set on and tune down to a low wave length station such as 3AW.



A rear photograph of the receiver illustrating how the battery cable and aerial-earth terminals are arranged.

With the volume control almost at the full on position (i.e., as far as it will go without setting up instability), adjust the trimmers on G3, G2 and G1 in that order until maximum strength signals are being received. If possible, conduct this line up in day time, when the strength of the stations is weakest.

When once the line up has been completed on the lowest wave length station it should not be necessary to touch the gang condenser trimmers again, the tuning being in line from the lowest to the highest wave length stations. Due to the fact that the design of the r.f. transformers is such that greatest amplification is obtained between 4QG and 3AR, it probably will be found necessary to cut back the volume control when tuning over this portion of the wave band or the receiver will break into oscillation. If a volt meter is handy it is an assistance to be able to check the bias voltages on V4 and V5, but the approximate settings of the clips on R3 will be found to be fairly right for best reproduction and lowest "B" battery consumption.

The results obtained with the original receiver were excellent, and not the slightest difficulty was experienced in Melbourne in tuning in all the "A" class stations and most of the "B's" that were on the air. The signal strength obtained when using only a 15ft. length of indoor aerial was far too loud for comfortable reception, and some of the more powerful "A" class stations, notably 2CO, 5CK, and, later at night, 6WF, actually overloaded both the audio stages and the loud speaker.

The selectivity is of a high order, although not as good as that of a modern super-het. but still should be more than sufficient for most country areas. Taken all round, the "T.R.F. Battery Five" is a first-class set which is simple to build, economical in operation, and capable of good tone quality and range.

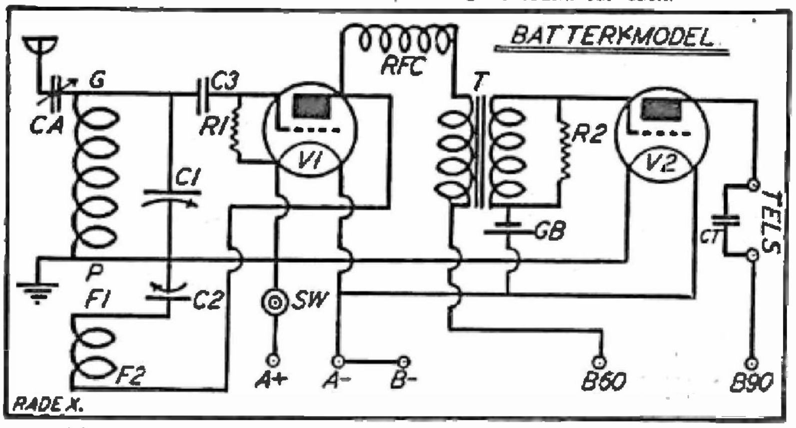
Two-Valve Short-Wave—

(Continued from Page 42)

The use of an eliminator, however, generally requires the use of a good earth.

With the aerial condenser CA about an eighth of the way in, turn the reaction condenser plates gradually into mesh until a rushing sound (indicating detector stage oscillation) is heard. Keeping the detector at the point where it just oscillates, commence rotating the tuning condenser until carrier waves are heard. A continuous carrier wave will indicate a telephony transmission, while code signals will be heard in the form of ripples with occasional breaks in the case of high speed automatic sending, or the characteristic hand-sent morse signals heard from most code stations.

Telephony transmissions are best received, once they have been found with the detector oscillating, at the point just before oscillation commences, when they will be loudest. Having received a telephony transmission or a modulation code signal, gradually turn the condenser CA into mesh, following the station down the dial as this is done. Alteration to the position of the condenser CA will change the dial readings of received transmissions so that a definite position at which oscillation over the whole band with each tuning coil should be found for each.



Schematical diagram of the battery version of the two-valve short-wave headphone receiver.

Countryman's Head-phone 2

A cheap battery operated receiver, using the latest type of 2 volt valves, that can be used by the farmer to keep in touch with current topics. Its consumption is remarkably low.

By P. R. DUNSTONE

THIS simple, but effective, two-valve battery-operated receiver will be found suitable for the average country resident, who is desirous of keeping in touch with the news and sports, and at the same time derive a certain amount of entertainment at a low cost.

When designing a circuit for such, it is essential to keep in mind that they depend upon batteries as the source of supply for their receivers, therefore a screen grid 215SG and a 210HF type of valves were decided upon. These valves are not only far more sensitive than the older types, but are also very low in battery consumption.

The circuit described in this article is a straight-forward radio-frequency stage, fed into a regenerative detector, which, in turn, excites a pair of headphones. The aerial has been tapped directly to the grid coil of the radio frequency stage, giving it an additional boost that would be lost if an aerial coil were incorporated.

At this point it may be questioned "Why use a radio frequency stage in preference to an audio stage?" The answer is that amplification at high frequency is introduced into receiving sets for the purpose of increasing the receiving range. At short range, or when reception is from a powerful station, very little is gained by R.F. amplification; but when signals are weak, or fail by reason of the transmitter and receiver working at extreme range, then a suitable R.F. amplifying stage must be added. And since the model has been designed for use in the out-back, it is desirable to add an R.F. stage here, in preference to an audio.

Reasons For Shielding

This R.F. stage should be shielded from the detector by means of a piece of aluminium, fastened on the chassis separating one stage from the other. In the event of neglecting this shield, a feed-back or coupling effect will be experienced, resulting in poor reception.

It is also essential to see that all plate and grid leads are kept as short as possible, otherwise the receiver will perform in the same manner as if the shield was not in position.

In the radio frequency stage, all components are carrying a high frequency current, therefore every part in this stage is surrounded by an intensive field. If these are placed so as to oppose each other, it is obvious that consequent loss of efficiency will r[illegible]

The better the insulating qualities of the material the more readily will the fields penetrate the substance. Radio frequency currents behave in the opposite manner to that of direct current. where it is possible to confine D.C. within conductors, high frequency will travel through almost any insulating medium. Therefore, it is necessary to place a piece of metal (such as copper or aluminium) within the field causing the energy to dissipate itself in the metal in the form of eddy currents.

It may be of interest to the reader to learn that a field surrounding an inductance coil will extend several inches in a receiving set, and as much as several feet in a transmitting circuit.

From the previous paragraphs the importance of shielding will be seen and, when constructing this hook-up, the accomplishment of shielding should be kept in mind.

The most suitable metals for shielding are copper, aluminium and brass. Foil or lead sheets are not suitable for shielding materials.

The List of Parts:

- 2 .0005 mfd variable condensers, C1 and C2. (Pilot, A.W.A., Velco).
- 2 UX sub-panel valve sockets, V1 and V2. (Marquis, A.G.N. Targan, Velco).
- 1 23-plate midget condenser, C3. (Radiokes, Velco).
- 2 1 mfd fixed condensers, C5 and C6. (Chanex, T.C.C. Dubilier).
- 2 .00025 mfd fixed condensers, C4 and C7. (T.C.C. Simplex, Ulsa, Wetless).
- 1 Switch (H. and H).
- 5 Terminals.
- 1 Grid leak, 2 megohms R. (Carborundum (I.R.C. Silent - Answer, Velco).
- 1 Radio frequency choke RC. (Velco Radiokes).
- 2 Pieces of former 2 inches in diameter, 3 inches long.
- 1 Alligator clip.
- 1 Reel of gauge 30 D.S.C. wire.
- Some flex.
- 1 Chassis, size depending on parts purchased.
- Machine screws.

The following valves will be suitable for this circuit:—

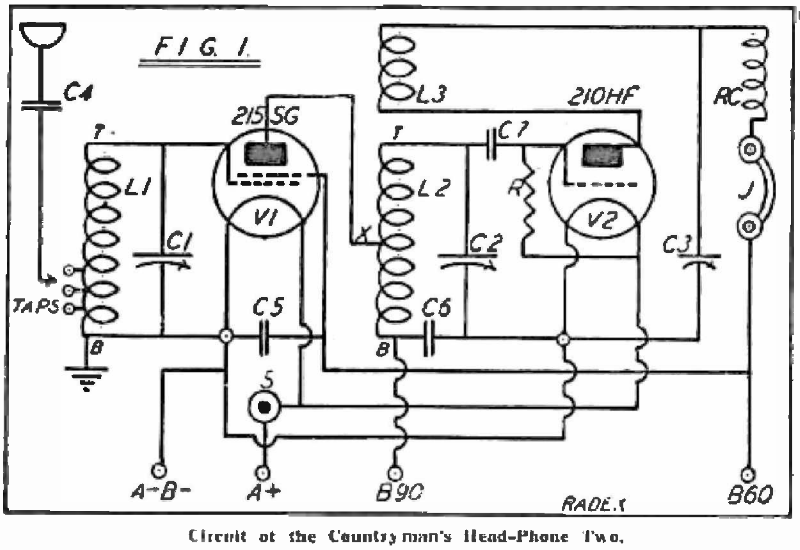
	RF.	Det.
Cossor	215.S.G.	210 HF.
Mullard	PM 12 A	PM 1 HL
Osram	S 21	HL 210
Philips	PH 232	PH 230
R.C.A.	UY 232	UX 230

Winding the Coils

In winding the coils, two pieces of former will be required, having a diameter of 2 inches and measuring 3 inches long.

One piece of former will be used for winding the grid coil L1 for the radio frequency stage, while the other is for the radio frequency transformer. This coil is used for coupling the R.F. stage to the detector stage.

Commence winding coil L1 about one inch from the end of the former. This is the T end. Put on 66 turns taking tappings at the 50th, 55th, and 60th turns, as illustrated in diagram accompanying this article. The T and B ends of the coil should be taken to soldering lugs fastened at one end of the former.



Circuit of the Countryman's Head-Phone Two.

The coils L2 and L3 are wound on the remaining piece of former. L3 should be commenced about ¾in. from one end thereof, and has 25 to 30 turns wound on it. This coil will need experimenting with, to obtain smooth oscillation. In the event of having placed 30 turns on the former for this coil, and it is found that the receiver will not oscillate, it will be necessary to add more turns to L3, or alternatively increase the voltage on the plate of the detector valve

The last coil to be wound is L2. This should be started about ¼in. away from L3. and will require 70 turns, with a tap (X) taken at the 35th turn. This tap is used for coupling the radio frequency stage to the detector circuit.

Take the four loose leads of this coil to soldering lugs at one end of the former in the same fashion as was done on the preceding coil, L1.

This completes the winding of the coils. Attention is drawn to the fact that, when wiring these coils into circuit, they are wired to have all coils running in the same direction, otherwise weak reception will only be obtained, and, in the case of L3, no oscillation.

Reviewing the Components

The two variable tuning condensers, C1 and C2, should have a capacity of .0005 mfd. These can be of any make provided they are of a solid construction.

The valve sockets are of the UX subpanel type. Care should be taken when purchasing these to see that the valve prongs make good contact to the socket, otherwise trouble will be experienced from foreign noises, etc.

The radio frequency chokes may be of the purchased type, or can be made by the builder. If the builder is desirous of making his own R.F.C., the following information will probably be of assistance. The parts required are a piece of fibre large enough to cut out two round pieces, about the size of a penny, one ebonite washer about 3-16th of an inch thick, and one bolt. Now clamp a piece of fibre on either side of the ebonite washer by means of the bolt, and then begin by drilling a small hole near the centre to take the beginning of the wire through. Continue winding on the wire until you have filled the reel. Fasten the end in the same fashion as the beginning. The gauge of wire used is approximately 38 to 40 gauge D.S.C. Having finished this, fit a brass bracket on the side of the choke, which is used for mounting it to the chassis.

The midget condenser, which is used to control the oscillation in the detector circuit, should have 23 plates. If a condenser with less plates is used, it will be essential to add more turns to L3 coil to compensate for the loss of capacity.

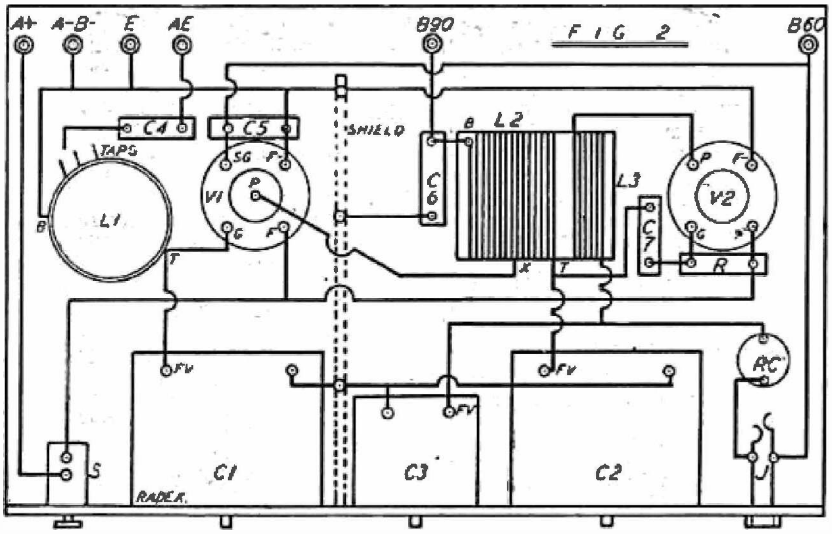
When mounting the parts on the chassis care should be taken to see that the A positive, aerial, B positive 90, and B positive 60 terminals are bushed from it. The A and B negative and earth terminals can be fastened direct to the chassis.

Wiring in Words

Commence by taking a lead from the aerial terminal that is bushed to one side of C4. The other side of this condenser C4 is joined to a piece of flex and an alligator clip. This clip is connected to one of the tappings on L1 coil. The correct one will be determined when the receiver is put into operation.

The beginning of L1 coil is taken to the grid terminal of V1, and to the fixed plates of C1. The other end of L1 is taken direct to earth.

The movable plates of C1 are connected to earth through the medium of the chassis.



Wiring sketch and layout of components in the Countryman's Headphone Two.

The screen grid lead of V1 is soldered to the B positive 60 side of the headphone terminals. This lead is also bypassed to earth by C5. The P connection, which is on top of the valve, is joined to the centre tap X of L2 coil.

A lead is taken from the T end of L2 to the fixed plates of C2 and to one side of C7. The other side of C7 is soldered to one side of R and to the grid terminal of V2. The remaining side of R is joined to the A positive side of the filament circuit.

The B end of L2 coil is soldered to one side of C6 and to a bushed terminal at the rear of the chassis. This terminal is used for the B positive 90 volt connection to the B battery.

The other side of C6 is taken direct to earth. The movable plates of C2 are connected to earth through the medium of the aluminium chassis.

The end of L3 coil nearest the T end of L2 coil is connected to the P terminal of the detector valve socket V2. The remaining end of this coil is joined to the fixed plates of C3 and to one side of RC. The other side of RC is soldered on to one side of the phone jack. The remaining terminal on the phone jack is joined to the terminal mounted at the rear of the chassis for B positive 60.

If the builder is not desirous of using a single circuit jack it will be quite in order to use two terminals in its place.

The movable plates of C3 are connected to earth through the chassis. This leaves only the filament circuit to be wired, to complete the wiring.

The A negative filament terminals of V1 and V2 are taken direct to the chassis, while the A positive sides of these two valve sockets are joined to one side of the switch S. The other side of this switch is connected to another terminal at the rear of the chassis and is used for the A positive battery connection. The remaining terminal that is mounted direct to the aluminium chassis is used for the A and B negative battery connections.

Operation

To put this model into operation two 45 volt B batteries and one 2 volt A battery will be required. Connect the batteries as shown in the schematic diagram. The aerial, earth and headphones should be joined to their respective terminals on the receiver.

Connect the alligator clip to the tapping nearest the T end of L1. This tapping will do for a start. It may be necessary afterwards to alter this clip to one of the other two tappings, the correct tapping being found by experiment.

Switch the set on. Rotate C3 control and see if the receiver can be made to oscillate. Having seen that the receiver will oscillate, rotate C1 and C2 controls until a station is heard, then adjust C3 until the greatest volume is received.

EARTH EVERYTHING

WHEN wiring a receiver, it is almost always wise to "earth" all large metal objects wherever possible. Although complete observance of these precautions may often be neglected with impunity, occasions sometimes arise where R.F. potentials are conveyed from one circuit to another in a most puzzling and obscure manner by "free" masses of metal; the resulting lack of stability is most difficult to trace.

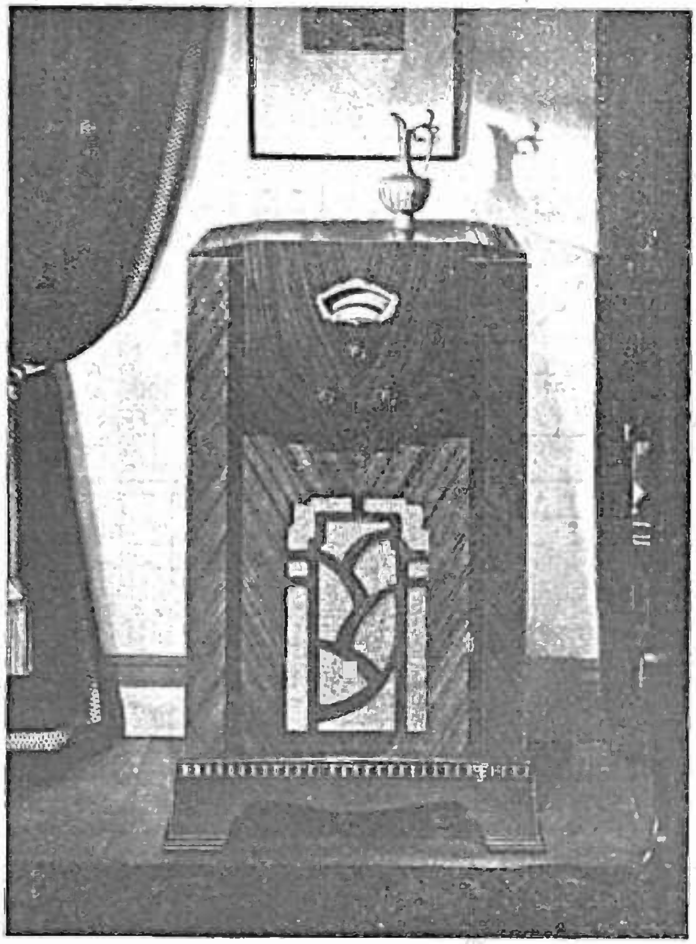
It is unnecessary to emphasise the need for "tying down" such components as inter-stage screens, but the reader's attention may be drawn to the fact that several other components may be responsible for trouble. In particular, metal rods used as a link between wave-range switches should always be carefully earthed, not merely at one point but between each stage.

TRIMMING CONDENSER ADJUSTMENT

THE trimming condenser of a receiver with ganged tuning should always be set at the lowest possible capacity value; otherwise, the tuning range of the receiver will be restricted to an unnecessary extent.

It is often convenient to make the initial adjustment more or less at random, and, when everything else is working properly, to return to the trimmers, reducing the capacity of each of them slightly in steps and "re-ganging" at each position. The reason for this progressive method is that it is possible to reduce capacity to too great an extent, with the result that one, or perhaps even more, of the circuits is not correctly tuned.

As a rule, it is hardly safe to assume that matching of the circuits is perfect if any one of the trimmers is at its maximum or minimum setting.



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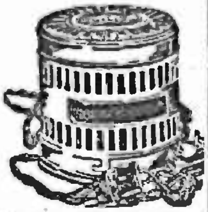

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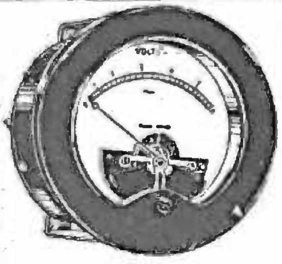

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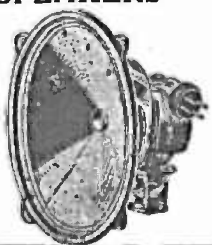

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