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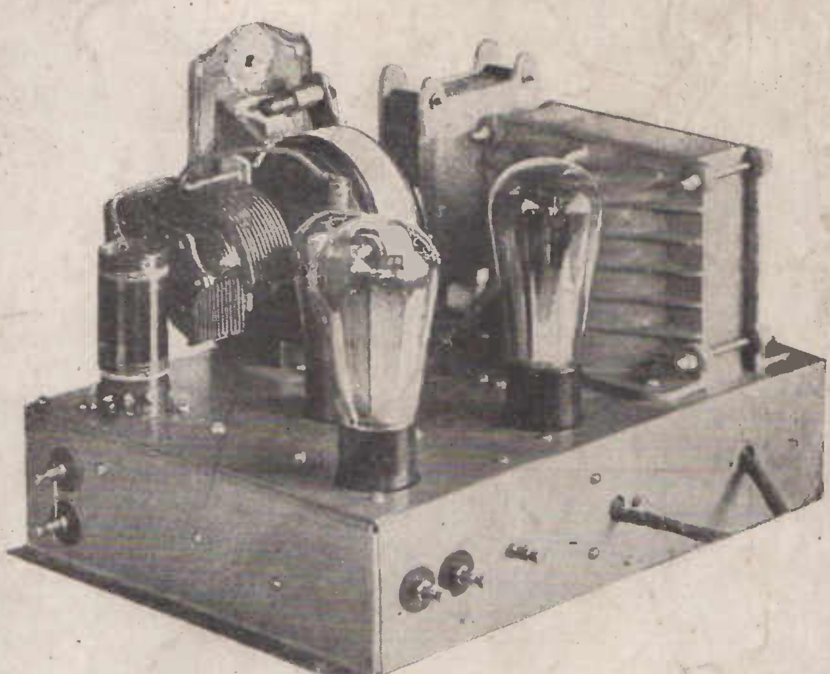
January 7, 1933

MODERN SETS

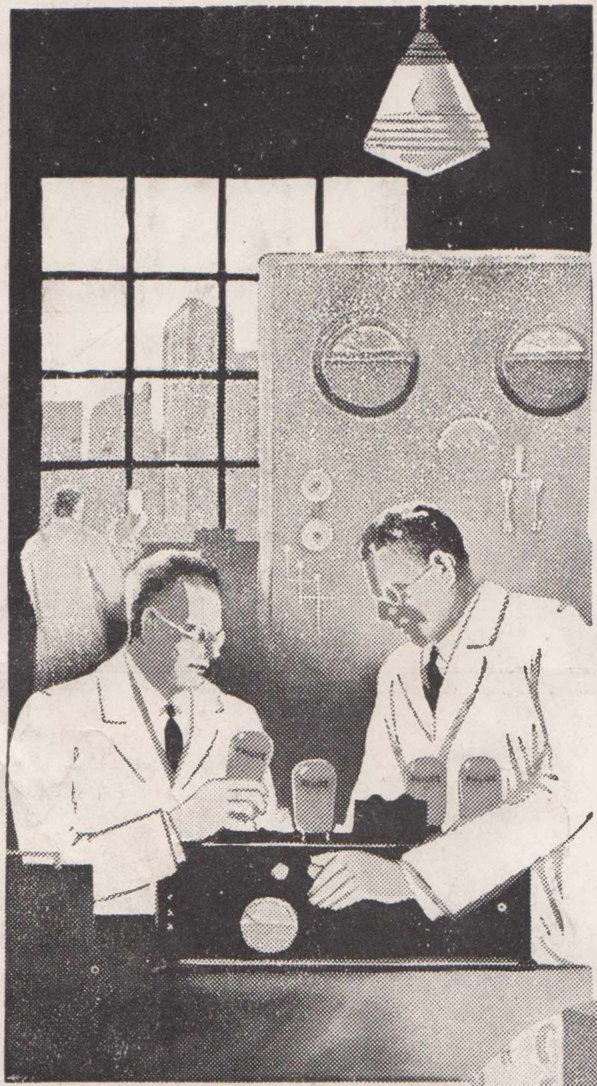
MONTHLY

JAN 1933



Build this Cheap and Reliable A.C. Two

PRICE 9D



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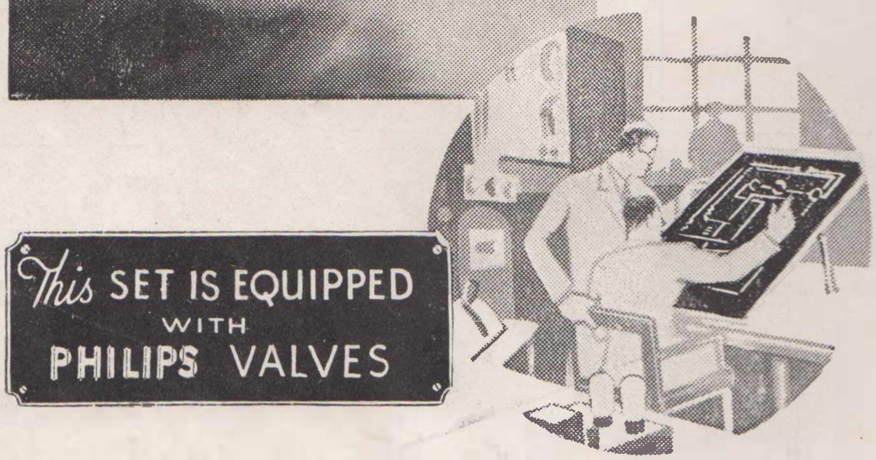

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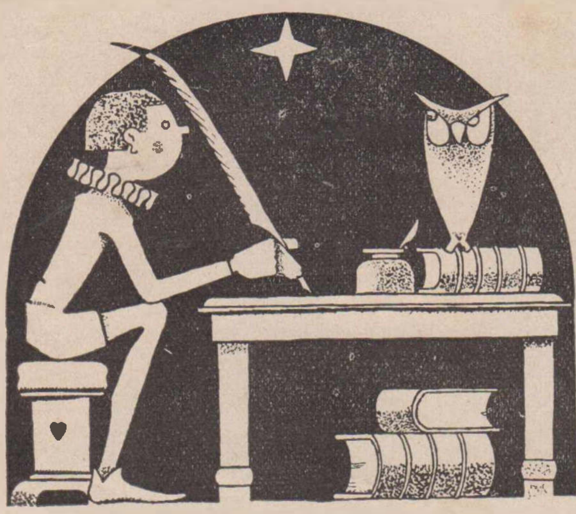


EDITORIAL

As we promised last year, we have constructed an additional stage of R.F. for the famous little "Test All Wave Set" featured in our October issue. The same success has attended all experiments of this additional piece of apparatus. We do not hesitate to urge those of our readers who are building up this receiver step by step to complete it with an additional R.F. Stage.

* * *

Although this issue has been produced during the holidays, which rendered it impossible to give the same amount of pages as last issue, we think we have contrived to keep faith in producing this month as usual a wireless magazine which gives more actual "meat" than any of its contemporaries in Australia.

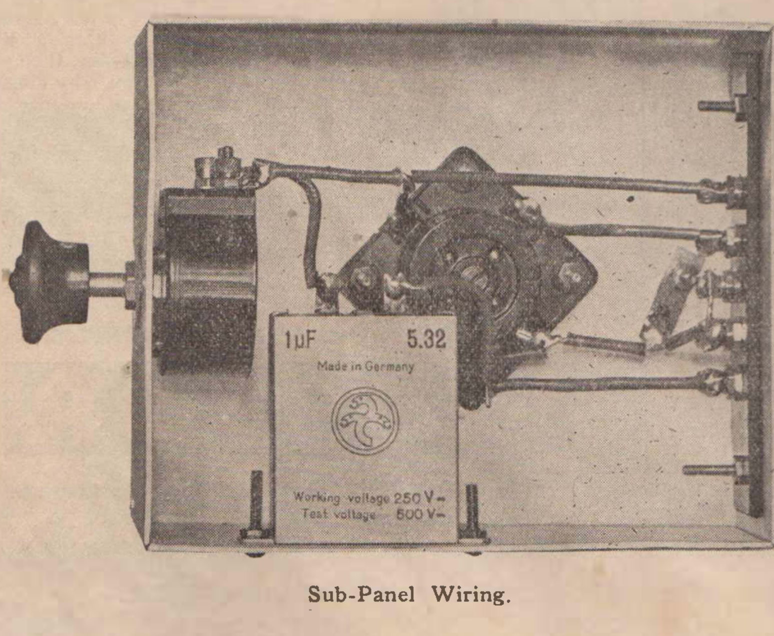
* * *

Full constructional details are given for four up-to-date receivers. When it is realised that each of these sets has to be designed, built up, and thoroughly tested before they can be described, it may well be imagined that our staff has been pretty busy. In conclusion, we shall wish all our readers a most happy and prosperous New Year.

The Three Stages Joined Together.

Adding a Stage of R.F. Amplification to the Test All Wave One

By CHARLES M. SCOTT.
(V.K. 3CS.)



Sub-Panel Wiring.

STILL another unit to add to the "Test All Wave Battery One," this time a stage of radio frequency amplification using the Philips A442 screen grid valve.

Now that the audio frequency amplifier is working well, how about building this unit? The increase in strength will not be very great, but it will increase the range of the detector on the broadcast band.

On the short-waves the amplification is very low, but it is here that the screen grid is used as a stabiliser rather than an amplifier. Any instability in the detector circuit caused by body capacity effects with the aerial, or swinging aerial wires in the wind, etc., will be eliminated by the introduction of the screen grid tube. The screen grid stage lifts the aerial load from the detector, and thus removes all resonance effects commonly known as dead sports; the result will be much smoother reaction control and greater ease in tuning.

Tuned anode or direct coupling has been adopted because of its simplicity between the R.F. stage and the detector. It will be noticed that the radio frequency stage is untuned; this is quite O.K. where a battery screen grid valve is employed, as the gain is so low on the short waves a tuned circuit is not warranted, it would only add to the controls and complicate tuning.

When this stage is added it may be necessary to take off a few reaction coil turns, otherwise the detector will oscillate too fiercely; this is due to the aerial load being lifted.

The Components and Their Uses.

Before going ahead with the detailed construction it might be as well as we did in the preceding articles, to discuss the uses of the various components.

R2 is a Marquis 10,000 ohm. wire wound variable resistance connected between the aerial and the earth.

As R2 is variable, the volume and selectivity can be adjusted by altering its resistance value. C6 is the by-pass condenser for the screen grid, its purpose being to by-pass feed-back currents to earth. L1 is the grid coil of the detector unit which is tuned by C3.

Now C7 is a 0.01 mfd. blocking condenser which is used to isolate the lower end of L1 from earth, as the high tension supply for the plate of V3 must pass through L1.

Now that the various components have been discussed, we are ready to go ahead with the actual construction of the unit.

The stage is built up on a 16 gauge metal chassis measuring 6½ in. x 5 in. x 2 in. The valve V3 is the only component that appears on the top of the chassis, whilst underneath are mounted the variable resistance R2 and the bypass condenser C6. The aerial and battery banana sockets are mounted on a small bakelite strip, and screwed behind a rectangular slot cut in the rear of the chassis.

Point to Point Wiring.

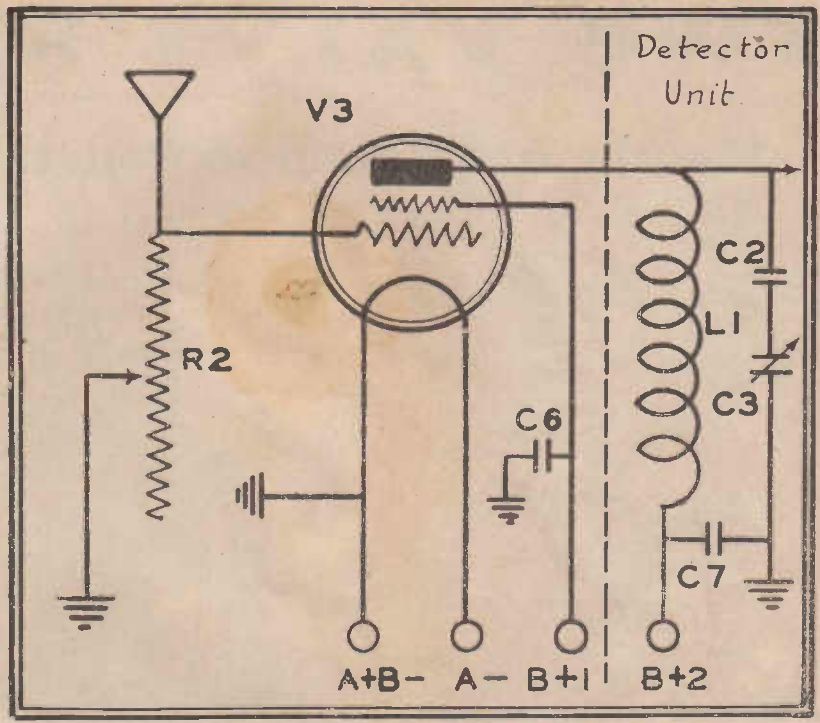
The wiring of this small unit is fairly simple but care should be taken to keep all leads as short as possible.

Starting at the aerial socket A, a wire is run to the G terminal of the valve socket V3, and to one of the outside terminals of the variable resistance R2; the other outside terminal is left free.

Now, from the centre terminal of R2, which is the moving arm, run a wire to earth, this completes the aerial circuit. From the S.G. terminal on the socket V3 connect a wire to one lug of the by-pass condenser C6. and also to the banana socket marked B + 1; the remaining lug on C6 is now joined to earth.

The plate terminal on top of the valve V3 is connected across to one side of the aerial condenser C1.

From the F + terminal on the socket V3 take a wire to the banana socket marked A + B — and to earth. From the F — terminal on V3 connect a wire directly to the banana socket marked A —.



Circuit.

THE PARTS THAT ARE NEEDED.

1 Philips valve A442 screen grid (V3).
1 Marquis UX valve socket (V3).
1 Mraquis 10,000 ohm. variable resistance (C6).
1 1 mfd. Chanex fixed condenser (C6).
1 0.01 mfd HCR fixed condenser (C7).
5 Banana sockets.
5 Banana plugs.
1 16 gauge metal chassis, 6½ in. x 5 in. x 2 in., 1/8 in. nuts and bolts, spaghetti wire, etc.

This completes the actual wiring of the unit, but before coupling up an alteration will have to be made in the detector unit, the earthed end of L1 will have to be broken, and the blocking condenser C7 inserted between the lower end of L1 and earth. From the lug of the condenser C7, which is joined to L1, a lead must now be taken to the high tension maximum.

In coupling, the plate terminal on top of the screen grid is connected to the terminal marked T on the aerial coupling condenser C1, this will complete the high tension circuit. To enable the valve V3 to be switched off with the others the A— lead is brought round and soldered directly to the F— terminal on the socket V1.

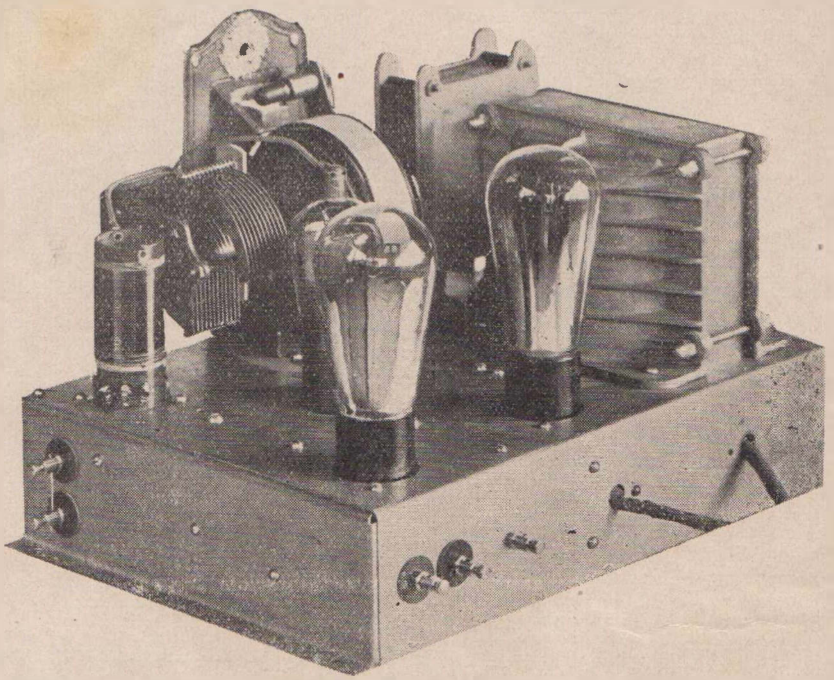
The A442 screen grid was found to work quite well with a plate potential of 90 volts and 45 volts on the screen.

TWO VALVE RECEIVER

Simple and Cheap to Construct, Good Tone

By C. A. Cullinan.

OF late we have had a number of inquiries from readers for detailed instructions for the construction of a cheap two valve receiver having good tone quality, and that is easy to make. Since quite a number of receivers using pentode valves have been described, we decided to describe one using a 245 valve in the audio stage, for there is no doubt that this valve gives better quality than the pentode. The only trouble with the 245 valve is that it takes far more driving than the pentode, but by using direct coupling this is readily overcome. Direct coupled receivers were in great demand among home constructors some twelve months ago, but have given way to the resistance coupled pentode, although the modern trend is to return to the triode due to the better quality obtained. Direct coupling has always been considered to be tricky in operation, no doubt due to lack of knowledge of it, the experience of the writer being that, with properly selected components, there is no trouble worth speaking about.

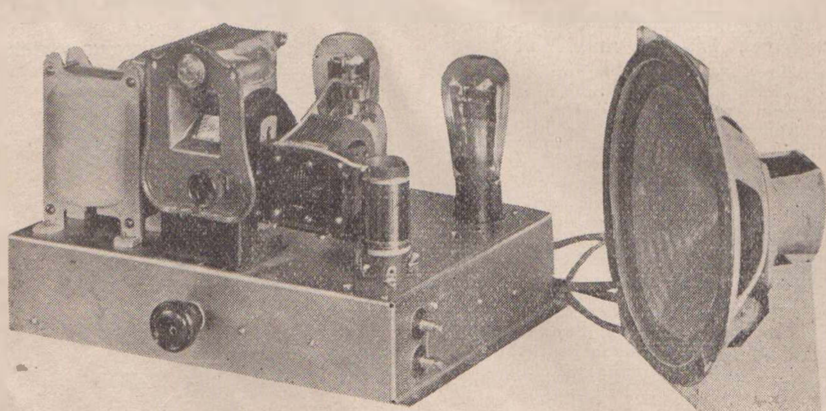


The Chassis complete.

The receiver to be described uses a simple form of direct coupling and actually was placed on the market in kit form about a year ago, by Messrs. Firth Bros. Slight modifications have been made but fundamentally it remains the same.

An examination of the circuit shows that the grid of the 245 and the plate of the 244 are tied together, through an RF choke, voltage for the plate of the 224 being obtained through the resistor R3.

Now, if we allow a total voltage of 500 volts between plate and earth and insert a resistance of about 8000 ohms between the filament of the 245 and earth, we will get 250 volts between plate and filament, and 250 between filament and earth at a plate current of 32 milliamps. Thus, in respect to earth the filament of the 245 is 250 volts positive, and the plate is 500 volts positive. Now the plate current of the 224 is very small, and by using a coupling resistor, R3 of one megohm 300 volts will be lost across it with the result that the plate of the 224 is 200 volts positive in respect to earth. Therefore, since the grid of the 245 is connected to the plate of the 224 it follows that the grid of the triode must also be 200 volts positive in respect to earth. We therefore have the condition in which the plate filament voltage of 245 is 250 volts, and the filament is 50 volts more positive in respect to earth than the grid. In other words there is a bias (negative) of 50 volts between the grid and filament of the valve which is the correct bias for this type of tube, the grid return for the 245 being through the 224 tube, and its associated bias resistor. The resistor R2 is connected to the filament of the 245, and provides the necessary voltage for the screen of the 224 The condenser C5 is most important and can be of any capacity between 1 and 4 mfds. the size playing a great part in the tone of the set. The remainder of the set is straightforward except the method of applying the gramophone pick which is connected in the earthed end of the grid coil, being shorted out when not in use. In this manner the phono voltage is applied to the grid of the 224, whilst maintaining freedom from those bad effects which are always associated with long leads attached directly to the grid when the set is being used for radio operation.



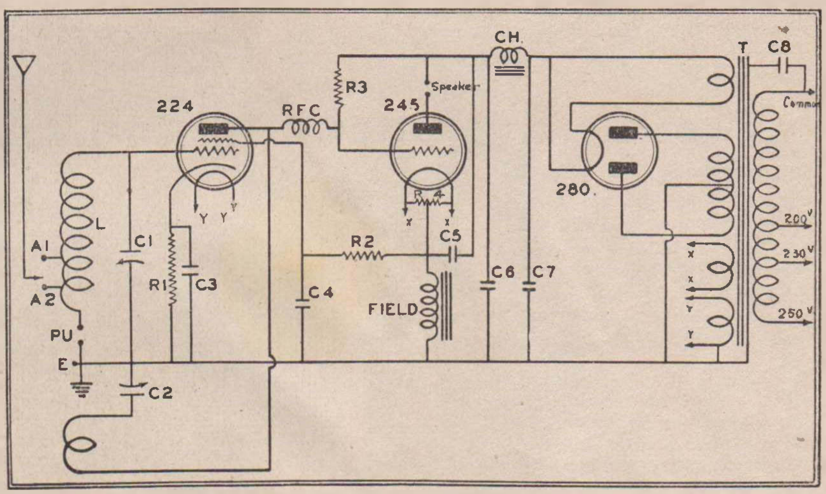
Front view and Speaker.

Due to the gramo connection, the earth end of the grid coil is not connected directly to earth, but to an insulated terminal. Taps are taken on the grid coil for the aerial, and the usual reaction system is employed. The power pack is familiar to all and need not be described here.

The arrangement of the parts is clearly shown in the photographs, so will not need much comment. Of course, a drum dial need not be used while the two filter condensers can be located elsewhere if desired. In this instance they are held in place by means of a small brass strap, and fit in quite nicely. It will be seen that the layout allows good suspension of the carbon resistances, but this layout need not be followed at all. In another receiver using the same circuit, the writer placed all the valves in a row along the back of the chassis with the detector at one end and the rectifier at the other, the spacing between valves being about 1 inch measured at the widest part of the tubes. No necessity has been found to shield the detector tube, and the set is quite hum free, more so, in fact, than many pentode sets on the market.

In view of the excellence of the photographs, a detailed description of the wiring need not be given. Care should be taken with it, and only the best quality wire used. It will be noticed that the filament, high tension, and several other leads have been cabled to make for neatness in wiring, and that all other leads are as short and direct as possible.

The wiring of the speaker is quite simple. The two field connections go to the centre tap resistance across the 245 filament and the chassis respectively, while the output transformer connects to the high tension maximum and the 245 plate. The position of the 4 mfd. tone condenser helps considerably in this, as both the centre tap and the high tension connect to it while the plate is only an inch or so away.



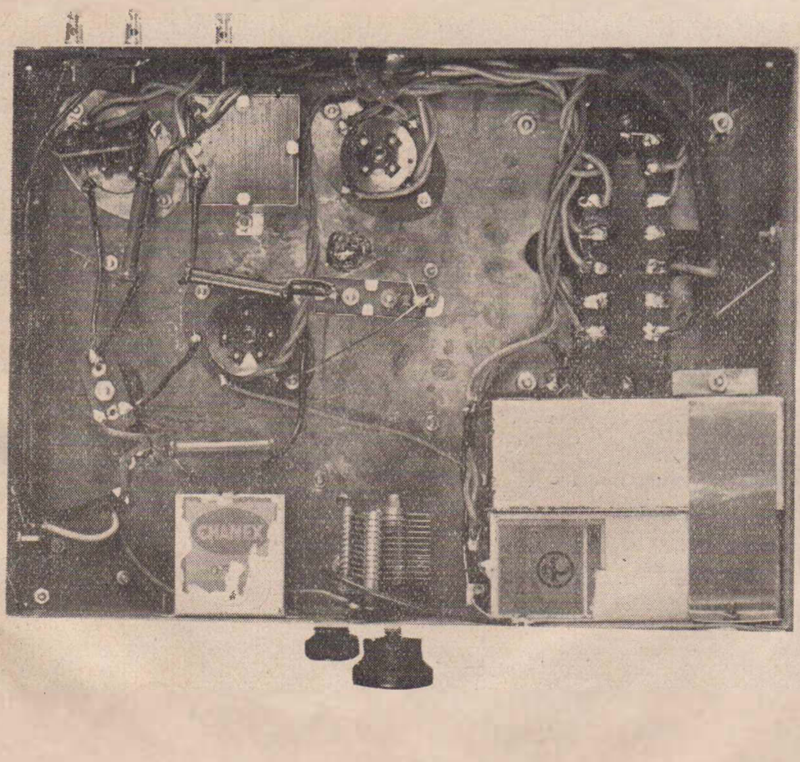
Testing: Short the phono terminals with a piece of wire or else connect a gramo pick up to them. Insert the 224 and then connect the set to the mains. The 224 should light up, after which the 245 can be inserted. This also should light up to a dull red. Now insert the 280 into the rectifier socket and set the gramo going. If everything has been wired correctly music will be heard. Lacking the gramo turn the variable condenser until a station is heard, the aerial being connected to the A1 tapping. If the reaction condenser is turned too far the set may howl even if a station is not tuned in. This cannot always be overcome, although loosening the reaction coupling will often help, although it may then be necessary to increase the number of turns to make it oscillate at all.

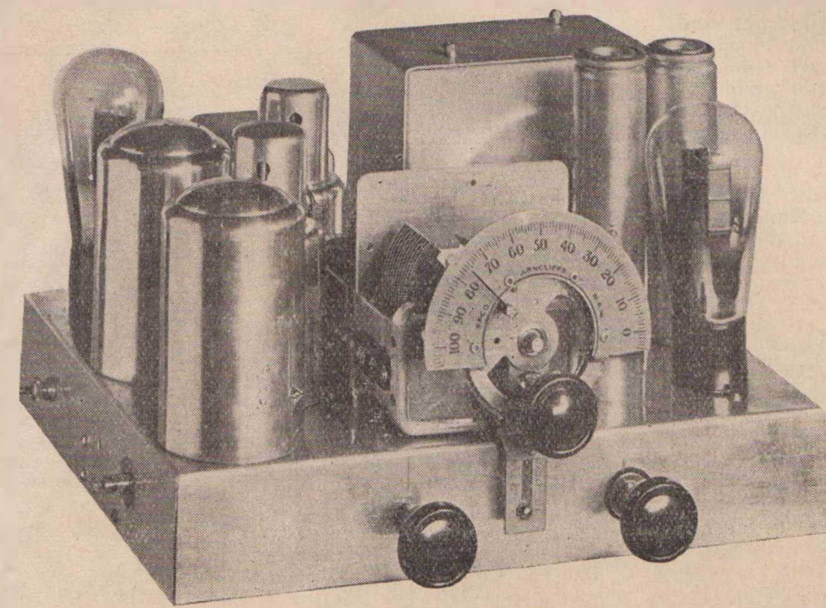
If a voltmeter is available the voltage from plate to filament will be about 250, but such measurements should not be made until the set has been running for about half an hour to allow the speaker field to warm up and remain at a constant resistance. If the voltages appear to be much out, the coupling resistor can be changed for another, and finally the value of the screen resistor should be altered. In one set the writer had to use 2½ megohms.

(Continued on page 27.)

LIST OF PARTS.

L—Coil, as described.
C1—Variable condenser, .0005 mfd.
C2—Midget condenser, .0001 mfd.
C3—Fixed condenser, .1 mfd.
C4—Fixed condenser, .1 mfd.
C5—Fixed condenser, 4 mfd.
C6—Fixed condenser, 4 mfd.
C7—Fixed condenser, 4 mfd.
C8—Fixed condenser, .01 mfd.
R1—Carbon resistor, 15,000 ohms 1 watt.
R2—Carbon resistor, 2 megohms 1 watt.
R3—Carbon resistor, 1 megohm 1 watt.
R4—20 ohm centre tap.
RFC—R.F. choke.
CH—30 Henry Power choke.
T—Transformer.
FIELD—7000 ohm speaker field.





Note compact arrangements of components.

The Simplex Six Pin Four

By W. B. GRIMWOOD.

IN this article we propose to describe a receiver of outstanding performance for its size, using the much-discussed 57 and 58 six pin valves, and the KR25, which is a new indirectly heated pentode.

Operated in the suburbs and near country districts, this outfit will separate and bring in all the local broadcasters at full speaker strength. The best of the inter-State stations can also be heard at good speaker strength.

If located in the country, the set will definitely receive all A class stations at good speaker strength if an efficient aerial is used.

The KR25 is an entirely new tube which offers great possibilities. The advantages gained by using an indirectly heated pentode output valve are many.

Indirect filament heating assures absolute freedom from hum, which is sometimes noticed when listening to a weak signal.

This tube is extremely stable in operation, and has much better characteristics than the ordinary type of direct heated pentode.

The characteristics of the KR25 are as follows:—

Filament volts, 2.5; filament amps., 1.75

Grid bias, 16.5 volts; plate potential, 250 volts; plate current, 34 mills.; screen voltage, 250; screen current, 6.5 mills.; amplification factor, 220; impedance (plate), 100,000 ohms; and an undistorted power output of 3 watts.

Readers may wonder why reaction has been employed in such a modern receiver.

Well, to get maximum efficiency from three tubes it is almost essential

LIST OF PARTS.

- 1 Velco aerial coil.
- 1 Velco R.F. coil, with reaction.
- 1 Stromberg-Carlson 2-gang.
- 3 Hydra .5 mfd. 500 volt test.
- 1 Radiokes 10,000 ohm pot.
- 1 Radiokes 250 ohm resistor.
- 1 Radiokes 450 ohm bias resistor.
- 1 Carbon ½ meg. 1 watt leak.
- 1 T.C.C. .0001 grid condenser.
- 1 23 plate midget reaction condenser.
- 1 Radenc R.F. choke.
- 1 Velco tapped impedance.
- 1 H.C.R. .01 coupling condenser.
- 1 Carbon 1 meg. 2 watt resistor.
- 1 Concourse 10 mfd. by-pass for bias.
- 3 6-pin Sockets, H.C.R.
- 2 UX Sockets.
- 1 T.C.C. .01 mfd. mica condenser, 1500 v. test.
- 1 UX speaker plug, Marquis.
- 2 30 ohm C.T. resistors.
- 1 Radiokes 15,000 ohm divider.
- 1 Efco full vision dial.
- 2 Polymet 500 v. electrolytic condenser.
- 1 E.V. 6 power transformer and shield.
- 1 Ken Rad KR25.
- 1 Ken Rad KR57.
- 1 Ken Rad KR58.
- 1 Ken Rad UX280.
- 1 Chassis, 18 gauge, 12in. x 10in. x 2in.
- 2 Valve shields.
- 2 Terminals, flex, etc.
- ½in. x ⅛in. nickel nuts and bolts.

that reaction be used to boost up the signals before they leave the detector circuit.

The increase in signal strength gained by the use of reaction on the detector is easily equivalent to an additional stage of radio frequency amplification.

Provided that reaction is applied within reason no noticeable distortion will result. Of course, if the detector is forced too much, the quality will certainly suffer.

In the Velco Coil Kit, which, by the way, was used in this set, the reaction coil has been so arranged that it has little influence on the grid coil, consequently the ganging of the two tuning circuits is not effected in any way.

In designing a circuit, the question always arises: Where shall the volume control be connected?

Most of us know that it is bad practice to shunt an audio frequency inductance with a resistance.

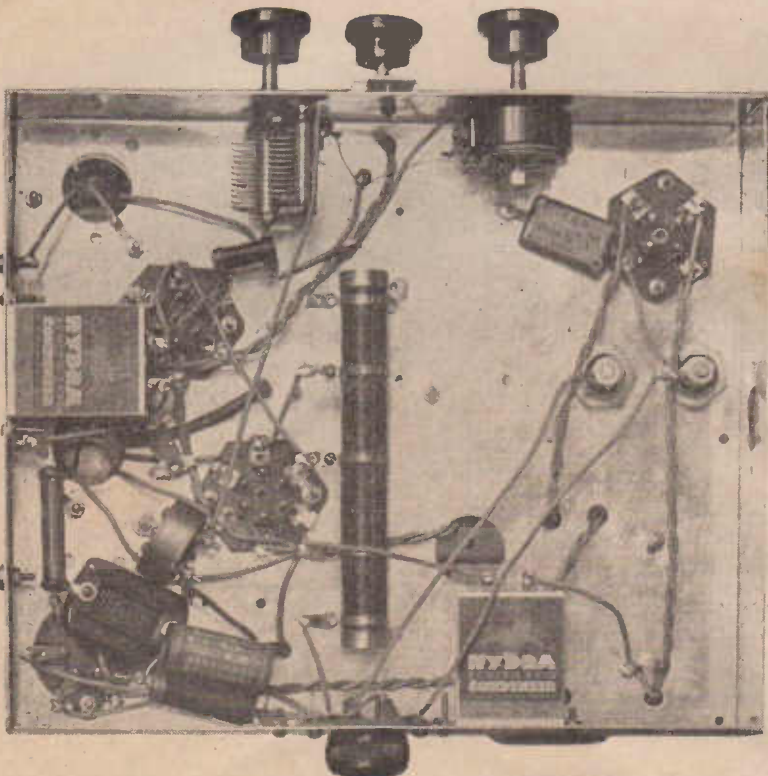
For instance, if the volume control were connected across or in shunt with the audio frequency coupling choke it would certainly control the volume, but as the volume is reduced by lowering the value of the resistance, the amount of distortion introduced will become more noticeable.

This is due to saturation of the core on which the inductance is wound.

The partial shorting of the inductive winding increases the current flow through the windings, causing a more intense magnetic field.

We, therefore finally decided to connect it between the aerial and earth, —i.e., across or in shunt with the aerial coil. This method is most efficient, and does not affect the quality or tone.

The shielding used is of particular interest, particularly the special shields used for the 57 and 58. You will notice that these differ from the ordin-



The sub-panel wiring is extremely simple.

ary 57 and 58 shields in that an additional small can has been fitted over the grid pin on top of the valves.

Trouble has arisen in some cases from instability due to the top of the can being open, so precaution has been taken in this receiver to prevent any such feed back troubles.

This additional little can is truly something out of the box, for this is the first time it has appeared in Australia.

Note how compact the set really is; every available space has been utilised, yet no trouble was experienced from feed back, which shows what shielding can do when effectively applied.

General Discussion of the Components.

The 10,000 ohm variable resistance shown connected between the aerial and earth is the volume control. The moving arm of which is connected to one side of the 250 ohm bias resistor.

This bias resistor is by-passed by a .5 mfd. condenser.

The screen grid of the 58, which is by-passed to earth by a .5 mfd. condenser, is connected to a tapping on the voltage divider, giving approximately 60 volts.

The high tension supply for the plate of this tube comes from the 180 volt tap on the divider. This lead is by-passed near the B + end of the primary winding by a .5 mfd. condenser.

Now, in the detector circuit the 57 is used as a power grid detector, necessitating a .0001 mfd. grid condenser in conjunction with a grid leak having a value between ½ and 1 megohm. Several values should be tried, and the best selected.

Regeneration in this circuit is obtained by the coil R.R. and controlled by the 23 plate midget condenser.

The plate supply for the 57 comes from the 180 volt tap on the divider via the audio and radio frequency chokes. The screen grid of this valve is connected to the 35 volt tap.

The audio frequency choke is one of the high impedance type, and is centre tapped, the plate of the 57 being connected to the centre tap.

Connected to the B + side of the audio frequency choke, a 1 mfd. condenser is shown dotted in; this is not essential, but should any undesirable hum be present the inclusion of this condenser will fix things up.

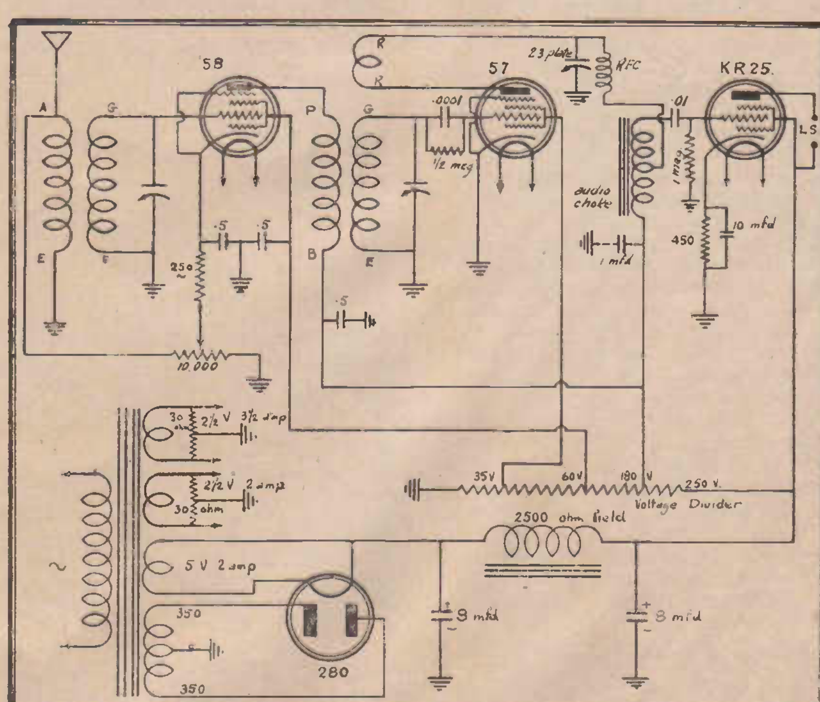
The feed condenser which couples the audio frequency choke to the grid of the KR25 is of 0.01 mfd. capacity.

Bias for the KR25 is obtained by means of a 450 ohm resistor inserted between the cathode and the earth. The auxiliary grid and the plate of the KR25 tube are both connected to the B maximum tap on the divider.

To keep to standard practice we have used the 2500 ohm field of the dynamic speaker as the power choke in the filter system.

In the power pack the standard 280 has been used in full wave rectification, the output from which is

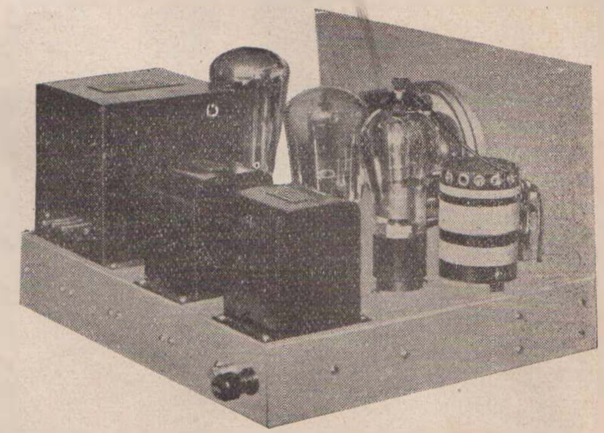
(Continued on page 27.)



Circuit of the Simplex Four.

The Local A. C. Two

Full Details of an amazingly Efficient, yet Economical, A.C. Two-Valver



A view of the completed receiver.

THE steady improvement in both components and circuit design which has taken place during the past twelve months has made it possible for the radio experimenter to obtain some really remarkable results from small sets. Nowadays, for the man who is content with full loud speaker strength reception of the local broadcasters and home reproduction of gramophone records, there is no need for a larger set than a two-valver.

Besides lowering the initial outlay such a receiver possesses several distinct advantages. First, because it employs but one audio amplifying stage, audio distortion is practically eliminated, or, at most, limited to that existing in the detector stage. Secondly, although the high amplification of the modern detector valve also brings about certain troubles, there is not the same difficulty with a.c. hum as is experienced in multi-stage receivers.

Another interesting point is that in a set of this type it is much easier to control the volume than is the case with a multi stage t.r.f. receiver.

In the receiver we propose to describe several interesting features have been incorporated. It may be mentioned in passing that the set originally was designed for an invalid, and so was built into a cabinet only 24 inches in height. The top of this cabinet thus served as a bed-side table, and, in addition, was provided with an ash tray and match holder. The top section of the cabinet housed the receiver, whilst the lower section contained the dynamic loud speaker, for which the cabinet acted as a baffle board.

Technical Details of the Set.

Now for technical details of the receiver. A glance at the schematic diagram will show that the set employs a screen grid detector which is impedance coupled to an indirectly heated power tube. The field winding of the dynamic speaker is used to provide additional filtering of the power supply. The various "B" and "C" voltages for the detector and audio valves are obtained from a single voltage divider. As an extra safeguard against hum troubles, which are likely to develop in a high quality receiver such as this one, a .1 mfd. "buffer" condenser has been connected between the centre tap and outside winding of the plate transformer. In addition, one side of the detector-audio valve filament has been grounded.

The aerial is loosely coupled to the grid coil L2, and regeneration is obtained by the Weagant system, which utilises the winding L3 and the midget condenser C2. The high impedance choke AFC couples the high impedance screen grid valve V1 to the audio tube through the condenser C5 and the resistance R2. It will be noticed that this resistance is of the variable potentiometer type, which, besides acting as a coupling resistance, also provides a smooth and satisfactory volume control.

WHAT YOU NEED TO BUILD THIS SET.

1 metal chassis, 12 in. x 10 in. x 2 in.
1 front panel, 12 in. x 7 in.
1 Essanay tuning unit (C1, C2).
1 Essanay power transformer.
1 Essanay screen grid choke (AFC).
1 Chanex 500,000 ohm. potentiometer. (R2).
1 Essanay 12,000 ohm. voltage divider (R3).
2 Chanex 4 mfd. 1500 volt condensers (C7, C9).
1 Chanex 2 mfd. condenser (C8).
3 Chanex .1 mfd. condensers (C4, C5).
2 Marquis UY sockets (V1 and V2).
1 Marquis UX sockets (V3).
1 Essanay filter choke (CH).
1 Cossor MSG-LA valve (V1).
1 Cossor 41 MP valve (V2).
1 Ken Rad UX280 valve (V3).
1 2 meg. grid leak (R1).
1 T.C.C. .00025 mfd. grid condenser (C3).
1 coil former.
2 ozs. 34 gauge d.s.c. wire.
6 lengths sphagetti.
3 doz. machine screws.
2 terminals.

The Valves.

The whole success of this particular receiver hinges upon the use of the Cossor four volt a.c. valves.

The detector is the Cossor MSG LA This valve is a remarkably efficient one, for it possesses all the advantages of the high-gain tube, but none of those of the medium impedance screen grid valve. Although its rated screen grid potential is 75 volts, we found it impossible to utilise all the gain of the tube, and were compelled to reduce this potential to between 55 and 65 volts.

The audio valve is another eye-opener. Like the screen grid tube it is a Cossor. It possesses the very desirable feature of being indirectly heated. Besides reducing much of the hum which is encountered with directly heated audio tubes the isolation of the filament supply from the plate makes it possible absolutely to eliminate hum by earthing the filament.

The combination of these two tubes and one of the new dynamic loud speakers makes it possible to build up a receiver which is capable of reproduction equal to that of the famous Loftin-White. In addition to this the arrangement shown is absolutely stable in operation, and is not likely to alter as the various components "age."

How the Plate Voltages are Obtained.

The plate supply is furnished by means of an Essanay transformer, which delivers 375 volts on either side of the centre tap. This means that something like 400 volts will be delivered at the rectifier side of the choke. Aided by the current drain across the voltage divider, R3, the total voltage drop in the filter choke CH will be about 45 volts, and, in the speaker field, about 115 volts, with the result that around 200 volts is applied to the plate of V2, and 30 volts bias is provided.

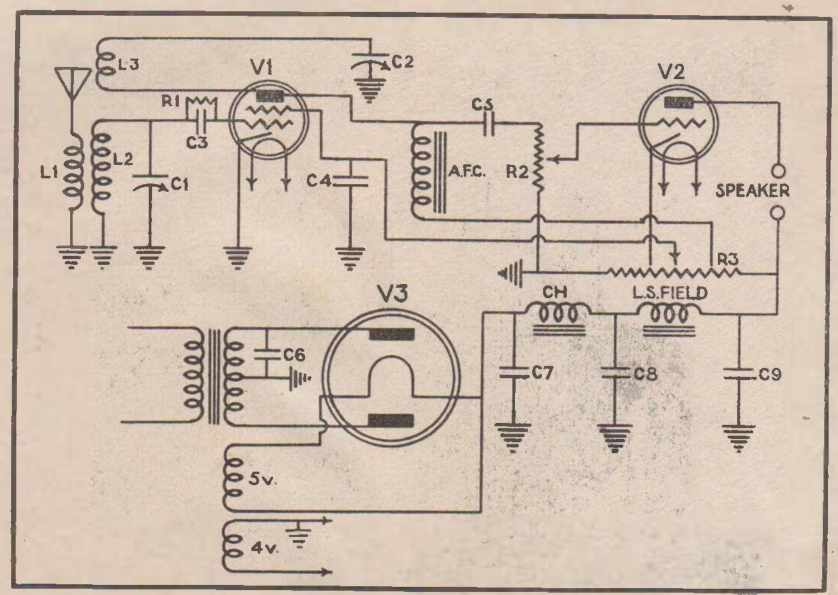
The total current drain on the rectifier is kept low, there being a total of about 50 m.a., so that there is absolutely no danger of overloading the rectifier. On the other hand, the voltage, 350, permits absolutely full excitation of the dynamic speaker field, so that the maximum efficiency can be obtained from this component.

The impedance coupling arrangement is of particular value, for, in addition to giving very high amplification, it also permits faithful reproduction of speech and music. This is a very important matter, for the usual coupling systems are not at all suited to use with high impedance tubes of the screen grid class.

Coil Details.

Coil details are as follow:—All three coils are wound with 34 gauge d.s.c. wire on a two-inch bakelite or treated cardboard former. The aerial winding L1 consists of 20 turns wound at the top end of the coil. The grid winding of 52 turns is separated from the aerial by a quarter of an inch. The third winding L3 is for the reaction, and consists of 35 turns separated half an inch from the other end of the grid winding L2.

Remember when winding the coil to leave sufficient length of wire at the start and finish of each winding to permit connections to be made, through the hole drilled in the chassis at the point where the coil is mounted, to the various components.



The schematic diagram of this interesting a.c. receiver is key-lettered to correspond with the text and with other pictures of the completed set.

Point to Point Wiring.

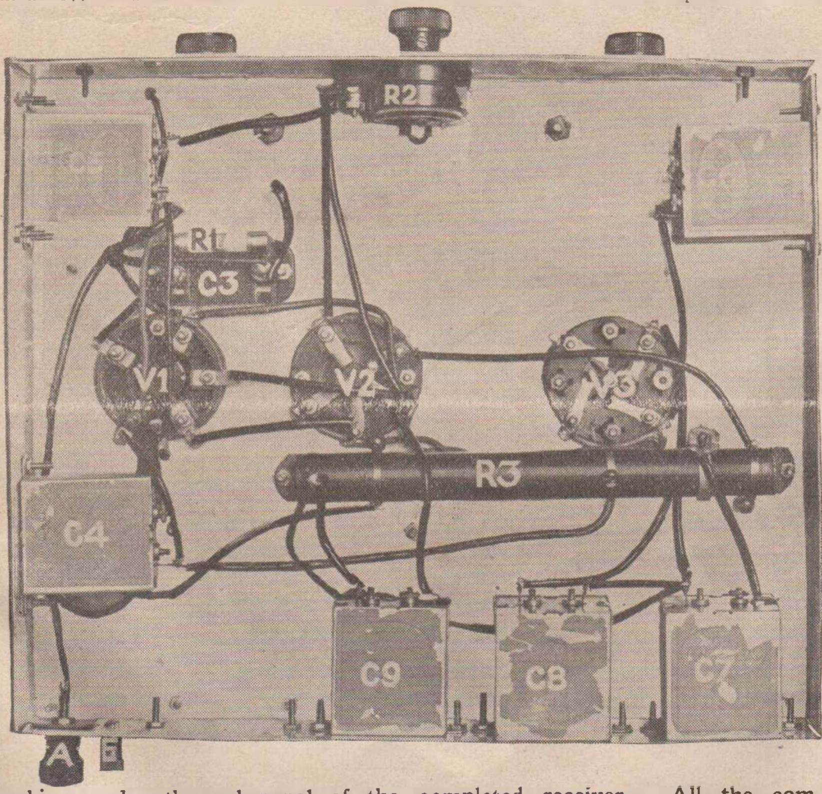
Now for the point to point wiring connections.

Start the wiring of the receiver by connecting the moving plate terminal on each of the condensers C1 and C2 (variable), and one terminal on C4, C6, C7, C8, and C9 to the metal chassis. The best way to make this connection as far as the fixed condensers C4, C6, C7, C8, and C9 are concerned is to bend over one of the connecting lugs and solder it to the case of the condenser. The other earth connections are the top (outside lead) of L1, the bottom (nearest L3) winding of L2, the cathode terminal on V1, one end of the variable resistance R2, one end of the voltage divider R3, the centre tap of the high voltage secondary, and one of the leads on the four-volt filament winding.

The remaining lead on L1 is wired to the aerial terminal on the chassis. The vacant lead on L2 is taken to one terminal on the grid leak and condenser mount and to the fixed plates of the .0005 mfd. variable condenser C1. The other side of the grid leak and condenser mount is wired to the G terminal on the socket of V1. The plate (top) terminal on V1 connects to the outside (nearest to chassis) lead on L3. The other lead on this coil connects to the fixed plate terminal on the midget reaction condenser C2. From that lead on L3 which connects to the plate (top) terminal on V1, a second lead goes under the chassis to connect to the black lead on the Essanay coupling choke, and to one terminal on the .1 mfd. condenser C5.

Disregarding the green lead on the Essanay choke A.F.C., connect the blue lead to a point about one inch up from the positive (unearthed) end of the voltage divider R3. The P terminal on the socket of V1 is wired to the vacant lug on C4 and to a point about three inches up from the earth end of the voltage divider R3.

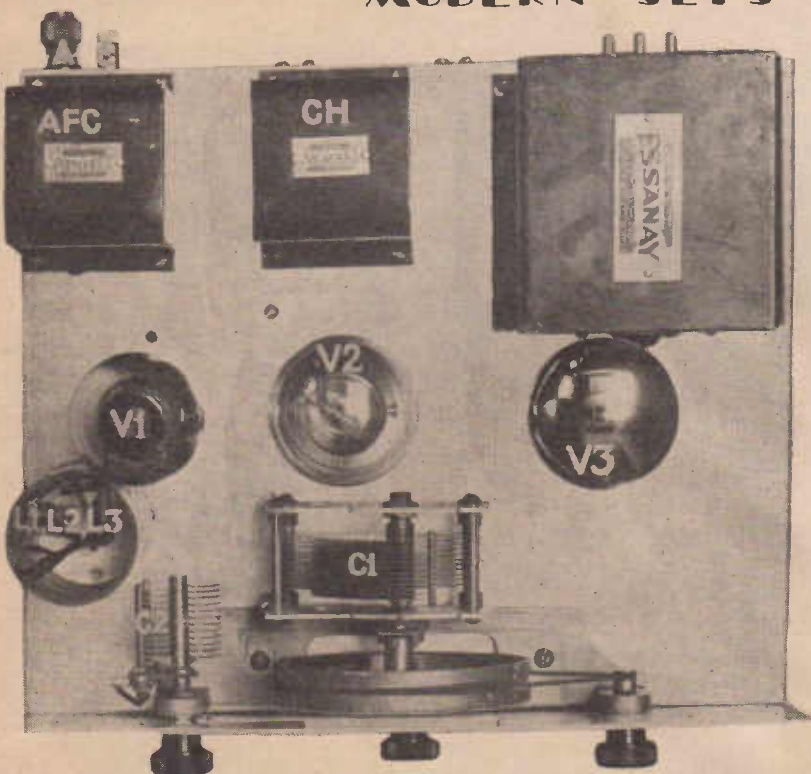
The other side of C5 goes to the remaining outside terminal on the volume control R5. The centre terminal on R5 is wired to the G terminal on the socket V2.



Looking under the sub-panel of the completed receiver. All the components shown are key-lettered in accordance with the schematic diagram and the list of parts.

Dynamic Speaker Connections

The P terminal on this socket carries one of the input leads to the dynamic speaker, and may, if desired,



The top view of the receiver showing the simple arrangement of the components on the top of the sub-panel. The use of sub-panel construction makes for a "clean" and efficient receiver.

be taken to one of two extra terminals mounted on the chassis, but insulated from it. The C (cathode) terminal on V2 is wired to a point about one inch up from the earthed end of the divider R3. The opposite end of R3 is wired to the vacant terminal on the 4 mfd. condenser C9. Note that this terminal on C9 also carries one of the field coil leads for the 2500 ohm. dynamic speaker. The vacant terminal on C8 is wired to one side of the filter choke CH.

This terminal also will carry the second field coil lead for the dynamic. The other lead on CH is connected to the vacant terminal on C7, and to one of the filament terminals on the rectifier socket V3. One of the five volt filament winding leads is taken to this terminal on V3, and the other lead from the five-volt winding goes to the second filament terminal. One of the high voltage secondary leads is taken to the G terminal on V3, and to the vacant terminal on C6. The other high voltage secondary lead connects to the P terminal on V3.

All that remains to be done is to connect the four-volt filament winding leads to the filament (F or H) terminals on V1 and V2. When this is done the wiring of the set is completed, and, after the voice coil leads of the dynamic are connected to the P terminal of V2 and the positive side of the divider R3, and the field leads to the unearthed terminals on C8 and C9, the valves may be placed in their sockets and the set given a try-out.

Tests and Adjustments.

The tuning of this receiver is the same as that of any standard regenerative detector. The main points to watch during the preliminary tryout are the adjustments of the voltage divider clips which carry the leads from the G terminal on V1, the lead from AFC, and the lead from the C terminal on V2.

The last named regulates the bias on V2. For best results the bias on this valve should be 30 volts. The use of a 1000 ohm per volt meter to check up this bias voltage will prove of great assistance, although the actual position of the clip given in the wiring details is approximately correct.

As mentioned before, this little receiver proved an eye-opener when judged from the viewpoints of tone and volume.

Although it possesses all the desirable features of the Loftin-White type of amplifier it has none of the drawbacks, and can be depended on to give long and trouble-free service.

THE DECIBEL (Continued)

By C. A. CULLINAN.

LAST month it was shown that the number of decibels that one power is greater than another is expressed by the 9 equation.

$$\text{Decibels} = 10 \log_{10} \frac{\text{Output power}}{\text{Input power}}$$

whilst for voltage we have

$$\text{Decibels} = 20 \log_{10} \frac{\text{Output voltage}}{\text{Input voltage}}$$

and for current

$$\text{Decibels} = 20 \log_{10} \frac{\text{Output current}}{\text{Input current}}$$

and that the usual reference level is .006 watts, this being virtually the power dissipated by II (3.1416) milliamperes flowing through a resistance of 600 ohms.

As intense interest has been aroused over this discussion we are giving here some applications of its use, together with a small list showing the relationship between decibels and current, voltage and power.

To take an easy example, we find on measuring the input power to an amplifier, and then its output power, that the ratio output power/input power equals 100. Looking down the column Pa/Pb, we find that a power ratio of 100 is equal to a gain of 20 decibels.

Now, let us imagine that a fault develops in the amplifier, and on measuring again we find that the ratio of output power/input power is now .01, we now find that we have a loss of 20 decibels, which gives us a rule that if the ratio output power/input power is less than 1, find the number of decibels for the reciprocal of Pa/Pb, and prefix a negative sign. Thus, the number of DB corresponding to a ratio of .01 = —20 DB since the number of DB corresponding to 1/.01 = 100 = 20 DB, to which is prefixed the negative sign as ruled above.

If an amplifier has a gain of 26 DB and an input of 10 milliwatts, what is the output power? The logarithm of the power ratio is 1-10th of 26 = 2.6, and from our discussion on logs, we find that .6 is the mantissa of the logarithm of 2, but as .6 is not shown in a table of logarithms we will take .5999, which is quite near enough for our purpose.

This mantissa then gives us the three figures 398, and since the characteristic of our logarithm is 2, there will be 3 figures before the decimal point in our answer, which then becomes 398.0. Thus, to solve our problem we merely multiply this power ratio by the input power—398.0 × 10 = 3980 milliwatts.

Just in case someone does not believe us when we say that the difference through using the slightly incorrect mantissa is small, we will make amends. The difference between the two mantissas 6000 and 5999 is 1, and on looking further into the table of logs, we get the figures 3981, the required antilog then being 398.1, and the corrected answer 398.1 × 10 = 3981 milliwatts, or a difference of 1 milliwatt in nearly 4000.

And now for a simple one.

What is the DB gain of a voltage amplifier with a voltage gain of 100? Yes, this is a mental question, since 20 × log. 100 = 20 × 2 = 40 DB.

In our discussion of the decibel we have shown its relationship to electrical power only, but it applies equally to the power of sound waves, irrespective if such power is measured in watts or ergs. Usually, however, sound power is measured in millibars, which is analogous to voltage in electrical circuits. Therefore, if the ratio between two sound powers is expressed in millibars it is necessary to multiply the logarithm by 20 to get decibels, which means that an increase of sound power of 1000 times equals a gain of 60 DB.

Since we have a reference level in electrical work, it is just as necessary to have one in sound work. This is now, more or less, accepted as 1 millibar.

In the first part we mentioned the existence of the Najeuom system of logarithms, which gives us a unit known as the "nefer."

$$\text{Therefore nefers (N)} = \log_{2.71828} \frac{\text{Output voltage}}{\text{Input voltage}}$$

$$\frac{\text{Output voltage}}{\text{Input voltage}} = 2.71828^{N}$$

which corresponds to the equation for decibels.

$$\frac{\text{Output voltage}}{\text{Input voltage}} = 10^{\frac{DB}{20}}$$

from which is seen that

$$2.71828^{N} = 10^{\frac{DB}{20}}$$

and by taking the common logarithm of both sides of the equation we have

$$N \log_{10} 2.71828 = \frac{DB}{20}$$

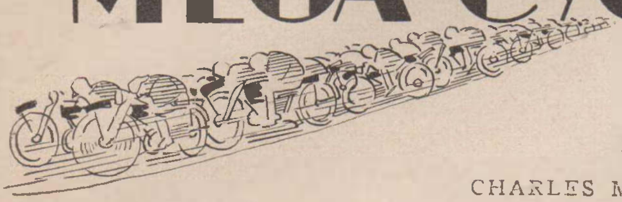
$$= DB = (20N \log_{10} 2.71828) N$$
$$= 20 \times .434N$$
$$= 8.68N$$

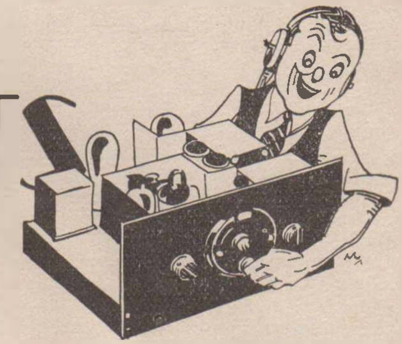
Therefore one nefer equals 8.68 decibels.

In these discussions on the decibel the writer has not had an opportunity of correcting the proofs and should any mistakes be found he would be pleased to hear of them so that corrections can be made.

Decibels	1a/1b or Va/Vb	Pa/Pb	1b/1a or Vb/Va	Pb/Pa
.1	1.012	1.023	.9886	.9772
.2	1.023	1.047	.9772	.9550
.3	1.035	1.072	.9661	.9333
.4	1.047	1.096	.9550	.9120
.5	1.059	1.122	.9441	.8913
.6	1.072	1.148	.9333	.8710
.7	1.084	1.175	.9226	.8511
.8	1.096	1.202	.912	.8318
.9	1.109	1.230	.9016	.8128
1	1.122	1.259	.8913	.7943
1.1	1.35	1.288	.8811	.7763
1.2	1.48	1.318	.8710	.7586
1.3	1.162	1.349	.8610	.7413
1.4	1.175	1.380	.8511	.7244
1.5	1.189	1.412	.8414	.7080
1.6	1.202	1.445	.8318	.6918
1.7	1.216	1.479	.8222	.6761
1.8	1.230	1.514	.8128	.6607
1.9	1.245	1.549	.8035	.6457
2	1.259	1.585	.7943	.6310
2.1	1.274	1.622	.7852	.6166
2.2	1.288	1.660	.7763	.6026
2.3	1.303	1.698	.7674	.5888
2.4	1.318	1.738	.7586	.5754
2.5	1.334	1.778	.7499	.5623
2.6	1.349	1.820	.7413	.5495
2.7	1.365	1.862	.7328	.5370
2.8	1.380	1.906	.7244	.5248
2.9	1.396	1.950	.7161	.5128
3.0	1.413	1.995	.7080	.5012
3.1	1.429	2.042	.6998	.4898
3.2	1.445	2.089	.6918	.4786
3.3	1.462	2.138	.6839	.4677
3.4	1.479	2.188	.6761	.4571
3.5	1.496	2.239	.6683	.4467
3.6	1.514	2.291	.6607	.4365
3.7	1.531	2.344	.6531	.4266
3.8	1.549	2.399	.6457	.4169
3.9	1.567	2.455	.6383	4074
4.0	1.585	2.512	.6310	.3981
4.1	1.603	2.570	.6237	.3891
4.2	1.622	2.630	.6166	.3802
4.3	1.641	2.692	.6095	.3715
4.4	1.660	2.754	.6026	.3631
4.5	1.679	2.818	.5957	.3548
4.6	1.698	2.884	.5888	.3467
4.7	1.718	2.951	.5821	.3388
4.8	1.738	3.020	.5754	3311
4.9	1.758	3.090	.5689	3236
5	1.778	3.162	.5623	3162
6	1.995	3.981	.5012	2512
7	2.239	5.012	.4467	.1995
8	2.512	6.31	.3981	1585
9	2.818	7.943	.3548	1259
10	3.162	10.0000	.3162	.10000
11	3.548	12.59	.2818	.07943
12	3.981	15.85	.2512	.06310
13	4.467	19.95	.2239	.05012
14	5.012	25.12	.1995	.03981
15	5.623	31.62	.1778	.03162
16	6.310	39.81	.1585	02512
17	7.080	50.12	.1412	.01995
18	7.943	63.10	.1259	.01585
19	8.913	79.43	.1122	.01259
20	10.0000	100.0000	.10000	.010000

WITH THE MEGA-CYCLISTS





Conducted by

CHARLES M. SCOTT (VK3CS).

Direct Short Wave Reception Brings New Entertainment to the Parlour and a New Thrill to the Hobbyist

THE era of international broadcasting has definitely arrived. The repeated appearances of Ramsay MacDonald in England, Cosgrave in Ireland, Mussolini and the Pope in Rome, before the international microphone, and the almost universal rebroadcast on long waves, have stimulated the interest of the average broadcast enthusiast in the high-frequency impulses that carry their voices across the oceans.

It is almost paradoxical that the quite excellent reception of the long-wave broadcasts on standard receivers should result in the desire to receive such programmes on the more direct original waves. And, aside from the intriguing element of direct contact, it is occasionally possible to secure better reception from a foreign short-wave station than from a semi-local rebroadcasting the programme.

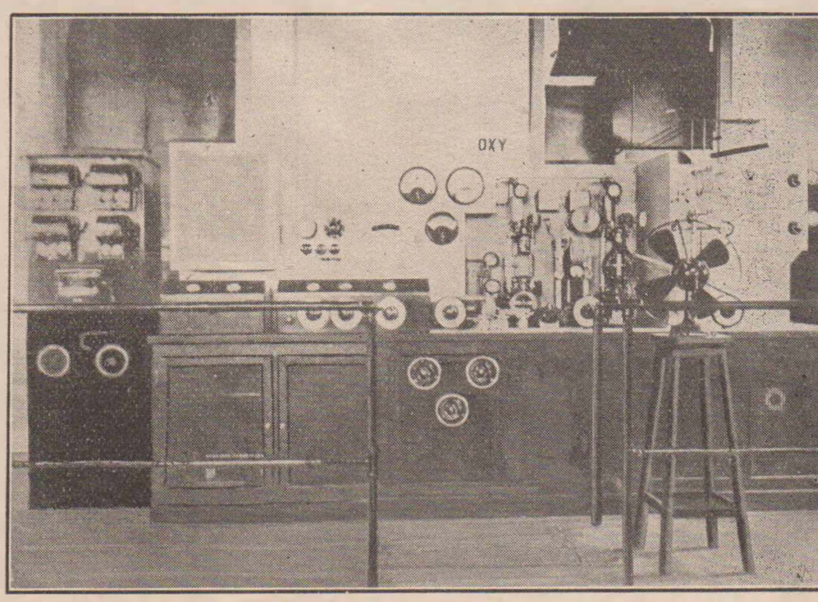
Also, many interesting programmes are being broadcast by short-wave stations which may be received with fairly consistent excellence, and the short-wave receiver thus contributes to the possible sources of radio entertainment. In rural communities, isolated from long-wave coverage, the s.w. receiver often provides the only reliable reception.

At this juncture it might be as well to mention some of the stations which are used as a sole means of entertainment.

Radio Saigon, whom we believe will be back on the air shortly, was listened to regularly by broadcast listeners in Indo-China, Siam, Singapore, Malay States, and Java. In Singapore Radio Saigon was the only reliable and regular station that could be heard without bad atmospheric interference.

Although the short-wave receiver has not been really commercialised in Australia, great development has taken place overseas.

In Java the stations are not concentrated between 200 and 550 metres, but are scattered all over the place, down to as low as 25.00 metres.



General view of transmitter, OXY.

Unlike most Governments, the Dutch Government has encouraged amateur radio in the Dutch East Indies, consequently amateur societies have been formed and short-wave broadcasting stations built for reception in Java and Sumatra.

The short-wave receiver has definitely emerged from the laboratory. In simplicity, reliability, battery of light socket convenience, and appearance it compares favourably with the conventional broadcast apparatus. It may take its place in the parlour with the long-wave receiver, or in the "short-wave nook," where its offerings are reserved for the privileged ears of the real radio fans of the family, and where one can concentrate on its operation and programmes without parlour distractions.

The expression "short waves," offhand, is self-explanatory, but, on further thought, requires qualification. After all, the term is relative. Two hundred metres was a short-wave length ten years ago. Indeed, it was considered just about the lowest limit available for practical communication purposes.

To-day 100 metres is hardly among the conventional short-wave bands, which, in general parlance, include the wave-lengths between ten and seventy metres.

The larger part of short-wave communication is carried on at present between 14 and 55 metres, but successful experimental work has established two-way communication over short distances on wave lengths 50 centimetres long.

The wave-length with which the broadcast listener is most familiar are those that bring to him his daily entertainment, generally comprising musical arguments for the purchase of some commodity. These wave-lengths are between 200 and 550 metres.

Wave-length is a physical conception, by means of which we are quite successful in representing how a signal travels along its route from the transmitting station to your receiver. A wave form is assumed, because a recording instrument placed anywhere within the influence of the signal would show a wavy line on the recording paper or tape. Such an instrument would show that the signal, starting at zero, would attain a certain maximum, positive strength, then slowly decrease to zero again, to build up on the negative side to a similar maximum, again dropping to zero to recommence the "cycle." This cycle occupies a certain definite time, which may be measured directly or indirectly. Also, radio waves travel from the transmitting antenna to the receiving antenna with a speed of about 300,000,000 metres a second.

One of the principal advantages of short-wave communication lies in the multiplicity of available radio channels as contrasted to the congested conditions existing above 200 metres.

High frequencies are characterised by an uncanny power, low powers on low wave-lengths transmitting over distances that could be spanned on long waves only by the expenditure of hundreds of times the same power.

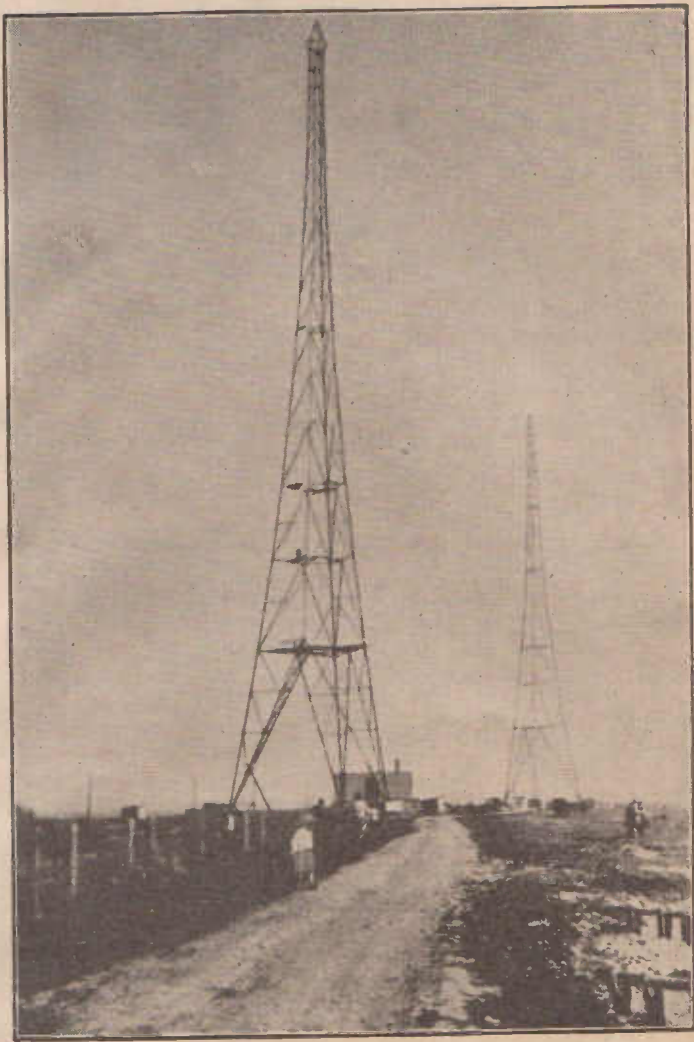
Short-wave signals suffer from peculiar fading and absorption effects, from which long-wave signals are relatively free. The most unusual of these is, perhaps, the so-called "skip distance" effect.

For instance, the direct wave from a 50 watt transmitter operating on 7500 kc/s may be attenuated at a receiving station 500 miles away by absorption or deflection due to terrestrial conditions that the signal is entirely lost. However, another portion of the signal, travelling more directly upwards, collides with the somewhat problematical Kennelly - Heaviside layer—a stratum of ionised gases high above the earth's atmosphere—and is refracted and reflected to the earth thousands of miles from the transmitter.

Thus, a receiver in Australia might hear a transmitter in New York, the signal from which is inaudible in New Orleans or Panama.

The tricks played by high frequencies vary with atmospheric conditions. the time of the day, and the frequency employed.

But it is almost always possible, by making a shift in frequency, to pick out a short-wave length satisfactory for the communication desired. For instance, for trans-oceanic telephone communication three frequencies are always available, approximately 20, 15 and 10 megacycles. During the day the 20-megacycle frequency is generally used, shifting to 15 megacycles in the evening and to 10 at night.



The Antenna System at OXY.

A Short Outline of the Story of the Danish State Broadcasting

THE first actual broadcasting took place on October 29, 1922. It was an experiment for which an old ship's wireless was used as transmitter, while a receiving apparatus was placed in a lecture hall in Copenhagen. The results of this experiment, however, were far from satisfactory.

During 1923 and 1924 a series of transmissions were organised on private initiative, at first by aid of the Poulsen arch transmitter, which the Government had built at Lyngby (suburb of Copenhagen) for commercial purposes; later some private firms established a valve transmitter in the heart of the town (Yorcks Passage), and the exploitation of this station was granted to an association of listeners. The necessary means for the remuneration of the artistic assistance, etc., were procured by private collections.

About this time another association of listeners obtained permission to use a military valve transmitter which had just been built at Ryvangen.

These broadcasts, organised by two rival associations, gave rise to several disputes, and the listeners still more and more energetically claimed a fixed organisation the Parliament sanctioned in March, 1925—that the Board of Telegraphs in Denmark, by way of experiment, should take over the organisation of the wireless transmissions for a year. At the same time, it was ordered that every listener should pay a licence fee of 15 kr. for a valve receiver and of 10 kr. for a crystal receiver.

The management of the transmissions was placed in the hands of a council—the Radio Council—established for this purpose, and consisting of 38 members.

During the time of the experiment in 1925 the number of listeners amounted to 28,140.

On the suggestion of the majority of the Radio Council, it was ordered by an Act of Parliament on broadcasting that the Danish broadcasting should be a State institution, and not, as desired by the Association of Listeners, a private institution with franchise.

The Present Organisation.

A Radio Council of fifteen members shall have the paramount authority. The council, which holds immediately of the Ministry of Public Labours, is composed of two representatives of the Ministry of Public Labours, one representative of the Board of Education, two representatives of the Press, four representatives of Parliament, and six representatives of the Associations of Listeners.

The Radio Council has established three sub-committees—viz.: (1) The business committee; (2) the programme committee; (3) the legal committee.

Dependent of these three sub-committees are two departments—(a) The administration and bookkeeping department; (b) the programme department.

Since 1925 the number of licences have been steadily increasing, the total at the end of 1932 being 500,000, or 13.4 per cent. of the population.

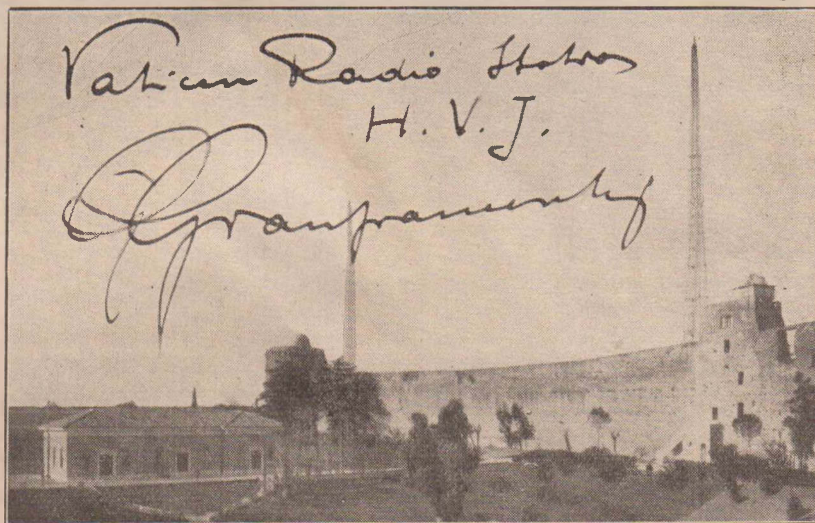
The broadcasting stations in use at the present are:—OXQ, Copenhagen, 281.2 metres, 1067 kc/s, 10 kilowatts; OXP, Kalundborg, 1153.8 metres, 260 kc/s, 60 kilowatts; OXY, Skamlebaek, 31.51 metres, 9520 kc/s, 0.5 kilowatts; OXO, Skamlebaek, 1153.8 metres, 260 kc/s (reserve station for Kalundborg). The call, Kobenhavn—Kalundborg, OG Danmarks Kortbolgesender.

Normal schedule for OXY daily except Monday, 5.00 a.m. to 10.30 a.m., Melbourne time.

SHORT WAVES UNDERSEAS.

ON September 22 a new story was written in short-wave history.

On the afternoon of this day Dr. Beebe, an eminent scientist, took a microphone with him underseas to a depth of 2200 feet, and from there broadcast a programme which was relayed over a chain of stations numbering nearly seventy stations. Dr. Beebe's underseas tour made a new record in deep-sea diving, and also a new one in short-wave broadcasting. From the microphone in the "Bathosphere," as the steel ball which was used is called, lines were run to a small portable transmitter on board a ship which was used to lower the ball into the waters. This ship was anchored off the coast of Bermuda, and the voice of Dr. Beebe was picked up and relayed by the short-wave 'phone station ZFA at Hamilton, Bermuda, and picked up and relayed again in the United States. The short-wave station W3XL, Boundbrook, New Jersey, kept the ship informed as to the progress of the programme.



Keep a Watch for this Station

THE Italian ship Conteraggo, travelling from Trieste to Pekin, is now outfitted with a telephone station, which operates on 17.05 and 22.68 metres between 9.00 and 11.00 p.m., 2.0 a.m. and 4.00 a.m. Eastern time. (1100 to 1300 and 1600 and 1800 G.M.T.). They oftimes broadcast musical programmes of the ship orchestra.

Schedule of Radio Vaticano Programmes Radiated by H.V.J.

Monday.—8.00-8.15 p.m., 15,123 kc/s (19.84 metres), 10 kw.: Lecture of letters from missions in Italian.

Tuesday.—5.00-5.15 a.m., 5969 kc/s (50.26 metres), 10 kw.: Vatican's information and notices in Italian. 8.00-8.15 p.m., 15.123 kc/s (19.84 metres), 10 kw.: Lecture of letters from missions in English.

Wednesday.—5.00-5.15 a.m., 5969 kc/s (50.26 metres), 10 kw.: Vatican's information and notices in Italian. 8.00-8.15 p.m., 15.123 kc/s (19.84 metres), 10 kw.: Lecture of letters from missions in Spanish.

Thursday.—5.00-5.15 a.m., 5969 kc/s (50.26 metres), 10 kw.: Vatican's information and notices in Italian. 8.00-8.15 p.m., 15.123 kc/s (19.84 metres), 10 kw.: Lecture of letters from missions in French.

Friday.—5.00-5.15 a.m., 5969 kc/s (50.26 metres), 10 kw.: Vatican's information and notices in Italian. 8.00-8.15 p.m., 15.123 kc/s (19.84 metres), 10 kw.: Lecture of letters from missions in German.

Saturday.—5.00-5.15 a.m., 5969 kc/s (50.26 metres), 10 kw.: Vatican's information and notices in Italian. 8.00-8.15 p.m., 15.123 kc/s (50.26 metres), 10 kw.: Lecture of letters from missions in Italian.

Sunday and Every Feast Day—5.00-5.15 a.m., 5969 kc/s (50.26 metres), 10 kw.: Vatican's information and notices in Italian and Latin. 8.00-8.15 p.m., 5969 kc/s (50.26 metres), 10 kw.: Liturgic and spiritual lectures for sick people, in Latin, French, Italian, and sacred music.

Special speeches from personalities or special programmes will be announced in advance.

It is easy to recognise the station by the clock's ticks in the studio.

HVJ absorbs 80 kw. from the 125 volt D.C. main central supply of the Vatican City.

It is interesting to learn that during the opening of the Vatican radio station the best reception was had in Australia.

Occasionally the transmissions are extended for an extra fifteen minutes.

ULTRA-SHORT WAVES.

THE first of the projected post office wire'ess telephone links using ultra-short waves will probably be established in the near future between South Wales and the West of England. We understand that 5-metre transmitters and receivers of the type exhibited at Radiolympia are being used at Lavernock, on the Glamorgan side of the Bristol Channel, and at Brean Down, on the Somerset side.

NEW ITALIAN STATION.

IAC, Coltana, Italy.

A LETTER confirming the reception of IAC has been received from Direzione, Centro Coltano Radio, Piza, Italy, with the following information enclosed. IAC is a Government-owned station, working commercially with ships on wave-lengths of 23.45 and 45.1 metres. Lately it has been testing with ships of the Italian Navy, with the Conte Rossi, which is found on 23.35 and 17.03 metres.

The Latest World Time Chart

WORLD TIME CHART

(*M.N.—Midnight).

Sweden, Italy Germany Switzerland	Petrograd Constantinople Capetown	Bagdad, Persia	India	Borneo, Java, Dutch E. Indies	Philippine Is. China West. Australia	Tokio Cent. Australia	***** Sydney Melbourne East. Australia	Auckland New Zealand	Samoa	Hawaiian Islands	America. Pacific	Mountain	Central	Eastern Standard	Halifax Buenos Aires N.Y. Daylight Sav	Rio de Janeiro Brazil	London, Paris Madrid	G. M. T. or G. C. T.
1.00	2.00	3.00	5.00	6.00	8.00	9.00	10.00	11.30	Noon	1.30	4.00	5.00	6.00	7.00	8.00	9.00	*M.N.	0000
2.00	3.00	4.00	6.00	7.00	9.00	10.00	11.00	12.30	1.00	2.30	5.00	6.00	7.00	8.00	9.00	10.00	1.00	0100
3.00	4.00	5.00	7.00	8.00	10.00	11.00	Noon	1.30	2.00	3.30	6.00	7.00	8.00	9.00	10.00	11.00	2.00	0200
4.00	5.00	6.00	8.00	9.00	11.00	Noon	1.00	2.30	3.00	4.30	7.00	8.00	9.00	10.00	11.00	*M.N.	3.00	0300
5.00	6.00	7.00	9.00	10.00	Noon	1.00	2.00	3.30	4.00	5.30	8.00	9.00	10.00	11.00	*M.N.	1.00	4.00	0400
6.00	7.00	8.00	10.00	11.00	1.00	2.00	3.00	4.30	5.00	6.30	9.00	10.00	11.00	*M.N.	1.00	2.00	5.00	0500
7.00	8.00	9.00	11.00	Noon	2.00	3.00	4.00	5.30	6.00	7.30	10.00	11.00	*M.N.	1.00	2.00	3.00	6.00	0600
8.00	9.00	10.00	Noon	1.00	3.00	4.00	5.00	6.30	7.00	8.30	11.00	*M.N.	1.00	2.00	3.00	4.00	7.00	0700
9.00	10.00	11.00	1.00	2.00	4.00	5.00	6.00	7.30	8.00	9.30	*M.N.	1.00	2.00	3.00	4.00	5.00	8.00	0800
10.00	11.00	Noon	2.00	3.00	5.00	6.00	7.00	8.30	9.00	10.30	1.00	2.00	3.00	4.00	5.00	6.00	9.00	0900
11.00	Noon	1.00	3.00	4.00	6.00	7.00	8.00	9.30	10.00	11.30	2.00	3.00	4.00	5.00	6.00	7.00	10.00	1000
Noon	1.00	2.00	4.00	5.00	7.00	8.00	9.00	10.30	11.00	12.30	3.00	4.00	5.00	6.00	7.00	8.00	11.00	1100
1.00	2.00	3.00	5.00	6.00	8.00	9.00	10.00	11.30	*M.N.	1.30	4.00	5.00	6.00	7.00	8.00	9.00	Noon	1200
2.00	3.00	4.00	6.00	7.00	9.00	10.00	11.00	12.30	1.00	2.30	5.00	6.00	7.00	8.00	9.00	10.00	1.00	1300
3.00	1.00	5.00	7.00	8.00	10.00	11.00	*M.N.	1.30	2.00	3.30	6.00	7.00	8.00	9.00	10.00	11.00	2.00	1400
4.00	5.00	6.00	8.00	9.00	11.00	*M.N.	1.00	2.30	3.00	4.30	7.00	8.00	9.00	10.00	11.00	Noon	3.00	1500
5.00	6.00	7.00	9.00	10.00	*M.N.	1.00	2.00	3.30	4.00	5.30	8.00	9.00	10.00	11.00	Noon	1.00	4.00	1600
6.00	7.00	8.00	10.00	11.00	1.00	2.00	3.00	4.30	5.00	6.30	9.00	10.00	11.00	Noon	1.00	2.00	5.00	1700
7.00	8.00	9.00	11.00	*N.M.	2.00	3.00	4.00	5.30	6.00	7.30	10.00	11.00	Noon	1.00	2.00	3.00	6.00	1800
8.00	9.00	10.00	*M.N.	1.00	3.00	4.00	5.00	6.30	7.00	8.30	11.00	Noon	1.00	2.00	3.00	4.00	7.00	1900
9.00	10.00	11.00	1.00	2.00	4.00	5.00	6.00	7.30	8.00	9.30	Noon	1.00	2.00	3.00	1.00	5.00	8.00	2000
10.00	11.00	*M.N.	2.00	3.00	5.00	6.00	7.00	8.30	9.00	10.30	1.00	2.00	3.00	4.00	5.00	6.00	9.00	2100
11.00	*M.N.	1.00	3.00	4.00	6.00	7.00	8.00	9.30	10.00	11.30	2.00	3.00	4.00	5.00	6.00	7.00	10.00	2200
*M.N.	1.00	2.00	4.00	5.00	7.00	8.00	9.00	10.30	11.00	12.30	3.00	4.00	5.00	6.00	7.00	8.00	11.00	2300

INSTRUCTION FOR USING THE WORLD TIME CHART.

THIS World Time Chart is a valuable adjunct to any short wave list. Because of the world-wide range of short wave receivers and the difference in time in different cities of the world. it is difficult to compare transmitting times without the aid of such a chart. The time given in our magazine is Eastern Standard Time, which is the eighth column from the left.

This is the column marked *****. Listeners in any part of the world need only compare these times with their own to show when a station is operating in their particular time.

Note.—Crossing from dark to light area at midnight indicates the following day. Crossing from light to dark area indicates preceding day.

Port Said Memorial

GREAT OVERSEAS BROADCAST 15,000 MILES BY A.W.A. RADIO-PHONE.

EACH year's advance in radio science brings the world nearer—or, at least, thousands more of its inhabitants nearer—to Australia. The ceremony of the unveiling of the Anzac Memorial at Port Said on November 23 was a triumph for the radio-telephone.

The voices of the speakers, the chief of whom was the Right Hon. W. M. Hughes, and the music of the bands and bugles were heard throughout Australia and New Zealand.

The important part played by the A.W.A. radio-telephone is evidenced by the fact that approximately 15,000 miles of the link-up were covered by this service.

The broadcast was taken from Port Said, relayed to Cairo by land-line, thence it was transmitted by the A.W.A. radio-telephone circuit via London to the receiving station of Amalgamated Wireless at La Perouse, from whence it was passed on by land-line to 2FC studio. It was relayed throughout Australia by 2FC and the national broadcasting stations, and also to New Zealand by the A.W.A. radio-telephone channel, and from there to the N.Z. stations.

The authorities who co-operated in the broadcast were the Postal Administration of Egypt, the P.M.G.'s departments of Australia and New Zealand, Amalgamated Wireless (A'sia) Ltd., and the National Broadcasting Services of Australia and New Zealand.

Ultra Short Waves

MARCONI'S LATEST SUCCESS ON 57 CENTIMETRES.

INFORMATION of the success of remarkable experiments in ultra short-wave wireless has been received by Amalgamated Wireless (A'sia) Ltd. from the Marconi Co. of England.

The Marchese Marconi has developed a new system for the transmission and reception of wireless signals on wave-lengths of less than 1 metre over distances exceeding the optical range (which is limited by the curve of the earth). Using his own improved system with a wave-length of 57 centimetres, Marconi succeeded in sending clear telegraphic telephone messages from Rocca di Papa, near Rome, to Cape Figari, Sardinia, a distance of 168 statute miles (270 kilometres). With the same apparatus two-way wireless telephone communication of commercial quality was maintained between Marconi's yacht Elettra and Rocca di Papa up to a distance of 80 miles, and Morse messages were received up to a distance of 150 miles.

"Marchese Marconi's latest development demonstrates that these waves can be used over distances exceeding the optical range," said Mr. Fisk, managing director of A.W.A., "and can overcome the supposed obstacle of the curvature of the earth."

A.W.A.'s New Short Wave Programme from VK2ME

VK2ME (Sydney), Sunday

January.—1: 4 p.m.-6 p.m. (Sydney time), 0600-0800 (GMT). 2 and 3: 8 p.m.-mdt., 1000-1400. 4: Mdt.-2 a.m., 1400-1600.

February.—1: 4 p.m.-6 p.m., 0600-0800. 2 and 3: 8 p.m.-mdt., 1000-1400. 4: Mdt.-2 a.m., 1400-1600.

March.—1: 4 p.m.-6 p.m., 0600-0800. 2 and 3: 8 p.m.-mdt., 1000-1400. 4: 12.30 a.m.-2.30 a.m., 1430-1630.

April.—1: 4 p.m.-6 p.m., 0600-0800. 2 and 3: 8 p.m.-mdt., 1000-1400. 4: 12.30 a.m.-2.30 a.m., 1430-1630.

May.—1: 4 p.m.-6 p.m., 0600-0800. 2 and 3: 8 p.m.-mdt., 1000-1400. 4: 1.30 a.m.-3.30 a.m., 1530-1730.

June.—1: 3 p.m.-5 p.m., 0500-0700. 2 and 3: 8 p.m-mdt., 1000-1400. 4: 2.30 a.m.-4.30 a.m., 1630-1830.

July.—1: 3 p.m.-5 p.m., 0500-0700. 2 and 3: 7.30 p.m.-11.30 p.m., 0930-1330. 4: 2.30 a.m.-4.30 a.m., 1630-1830.

August.—1: 3 p.m.-5 p.m., 0500-0700. 2 and 3: 7.30 p.m.-11.30 p.m., 0930-1330. 4: 1.30 a.m.-3.30 a.m., 1530-1730.

September.—1: 3.30 p.m.-5.30 p.m., 0530-0730. 2 and 3: 7.30 p.m.-11.30 p.m., 0930-1330. 4: 12.30 a.m.-2.30 a.m., 1430-1630.

October.—1: 3.30 p.m.-5.30 p.m., 0530-0730. 2 and 3: 7.30 p.m.-11.30 p.m., 0930-1330. 4: 12.30 a.m.-2.30 a.m., 1430-1630.

November.—1: 4 p.m.-6 p.m., 0600-0800. 2 and 3: 7.30 p.m.-11.30 p.m., 0930-1330. 4: Mdt.-2 a.m., 1400-1600.

December.—1: 4 p.m.-6 p.m., 0600-0800. 2 and 3: 8 p.m.-mdt., 1000-1330. 4: Mdt.-2 a.m., 1400-1600.

VK3ME (Melbourne).

Wednesday.—8 p.m.-9.30 p.m. (Sydney time), 1000-1130 (GHT).

Saturday.—8 p.m.-10 p.m., 1000-1200.

THE MOSCOW COMINTERN PROGRAMME.

Beginning of Their Broadcasts.
(1000 and 50 metres.)

German, Dutch, Czecho-Slovakian.—5.00 to 6.00 a.m. (Melbourne time). Eng'ish, French.—6.00 to 7.00 a.m. Swedish, Hungarian, Spanish.—7.00 to 8.00 a.m.

At the end of the English transmissions they give "Five minutes of latest news items."

Days of Transmission.

German.—Monday, Thursday, Friday, Saturday, Sunday.

Dutch.—Tuesday.

Czecho-Slovakian.—Wednesday.

English.—Monday, Wednesday, Friday, Sunday (twice).

French.—Tuesday, Thursday, Saturday.

Swedish.—Thursday, Sunday.

Hungarian.—Tuesday.

Spanish.—Saturday.

Station address.—Trade Union Radio Station, Palace of Labour, Solianka 12, Moscow, USS.R.

ULTRA SHORT WAVE BROADCASTING

Details of the Experimental 7.5 Metre Transmitter Now Installed at Broadcasting House

IN collaboration with Marconi's Wireless Telegraph Company Ltd., the B.B.C. has installed in Broadcasting House an experimental broadcasting transmitter capable of working on the "ultra-short" waveband between wavelength limits of 6 and 8.5 metres. The purpose of this apparatus is to determine whether ultra-short waves are suitable for providing a broadcasting service in big cities.

Some of the properties of ultra-short waves are already known. Experimental work has been carried out in America, Germany, and Holland, but insufficient research has yet been done to determine fully the behaviour of such transmissions and the requirements at the receiving end. Enough has been accomplished, however, to show some of the limitations.

There is no doubt that ultra-short waves will never replace medium or long waves for broadcasting purposes, principally owing to the fact that the range of a station working on ultra-short waves is for all practical purposes limited almost to an optical range, that is to say, the transmitter is not generally receivable beyond the horizon. These waves may, however, well perform a useful function by providing a service over small distances in densely-populated areas.

Another serious difficulty is that at present it is not easy to receive such short waves on receivers capable of being handled by non-technical listeners. Necessity, however, is the mother of invention, and doubtless if the need arises manufacturers will produce receivers as simple in operation as modern mains-driven apparatus. Experimental work already carried out seems to show that the simplest solution may lie in the provision of a small attachment which can be connected to an ordinary broadcasting receiver, by which the latter is converted either to a super-regenerative or to a superheterodyne receiver for ultra-short waves.

An important point yet to be investigated more fully is the question of what interference may be expected. It is already known that the ignition systems of motor cars may cause serious interference, but whether this is due to a high level interference or a low level of required signal has yet to be determined. Practically no absolute measurements of field strength on these waves have yet been made, although relative measurements in arbitrary units have been made at the National Physical Laboratory.

It has been said that the range obtainable is strictly limited; moreover, screening due to high buildings or local topography has more effect on ultra-short waves than on medium or long waves. It may be that this screening effect will be so marked in a large city full of steel-framed buildings as to cause the strength of reception to become extremely patchy and unreliable. These limitations and many others have to be examined in detail and this work will form the basis of the experiments.

Before describing the installation at Broadcasting House, let us consider some of the possible advantages which the use of ultra short waves may bring. First, previous experiments seem to indicate that waves of a length below the order of 8 metres are not reflected by the Kennelly-Heaviside layer. Thus, the indirect ray is entirely absent. This means that outside the reception limit of the direct ray no interference would be caused to another transmitter on an adjacent channel, or even on the same channel. In practice, this would result in the possibility of the establishment of several ultra short wave transmitters at distances of, say, about 100 miles apart all using the same wave-length. Secondly, there is a large number of channels available, for instance, between 6 and 8.5 metres there are approximately 14,700 kilocycles, a band nearly fifteen times as large as the present medium-wave broadcasting band of 200 to 545 metres. Finally,

(Continued on page 27.)

BALTIC RADIO.

THE one and only broadcasting station in Latvia, erected at Riga, will shortly have its aerial power increased from 15 to 50 k.w. At the same time, we learn that the new station will work on the 600 m. wavelength. The new building and the aerial poles are ready, and it is hoped that test-transmissions can be started within a few months. The station will announce itself by its new name "Madona."

The Lithuanian station at Kowno, which, with its 1935 m. wavelength, heads the list of the broadcasting stations, also intends working in future with an increased power.

SPANISH TRANSMITTER.

THE short-wave station designed to popularise Spanish culture, particularly in the South American countries, started its transmissions recently. The transmitter is erected at Aranjuez, near Madrid, and is identified by the following letters: "EAQ." It has a power of 20 k.w., whereas the wavelengths lie between 15 and 20 m. or between 30 and 35 m., according to the time of day. The aerial system is so installed that it can easily serve other purposes. It can also be turned into any direction. From time to time, programmes will be broadcast destined for Europe.

REORGANISATION OR DISORGANISATION?

THE strong measures taken for the reorganisation of the German broadcasting, which became effective as from October 1st, have until now shown little improvement. On the contrary, chaos seems to be the only result, and already rumours are afloat saying that the old system will be maintained until the end of the year. According to others, it appears that there seems to be some confusion as to the appointing of the staff. Moreover, the reorganisation would mean such high expenses that the old regime will be continued at least in part. It is hoped, for the listeners' sake, that some light will soon pierce this inextricable situation, as this quandary of the German broadcasting has its inevitable repercussion on the composing of the programmes.

RADIO-NICE.

THE transmitter for the French Riviera, included in General Ferrie's plan, is to be constructed at Biot, quite near the Mediterranean Coast. The station will announce itself as: "Radio-Nice." The plans comprise three studios, i.e., one at Nice, another at Cannes, and the third one at Monte Carlo; they will be connected to each other by means of special cables. The energy of the new station will be of at least 60 k.w.

SPANISH CONTEST.

THE Spanish Broadcasting "Union Radio" at Madrid has organised an international contest for symphonic works. This contest calls for an overture for a large orchestra which must last not less than 10 minutes and not more than 20 minutes. The first prize amounts to 3000 pesetas, the second one to 1500 pesetas. Crowned compositions remain the property of the composer.

SCHOOL RADIO IN AUSTRIA.

ON Monday, October 3rd, the new School Broadcasting Year was officially inaugurated. The Vienna Symphony Orchestra played before the microphone, and the Austrian Minister of the PTT, as well as the Director of the Austrian Broadcasting Companies, made speeches. This was followed by a lecture entitled "Before the Transmission."

FRENCH RADIO TAX.

THE project of the French Minister of the PTT, Mr. Queille, which consists in levying a tax on the radio listeners, has apparently not been well hailed by the future victims. It has given rise to a storm of protests, and a French newspaper even predicts that the Minister will not find one Deputy to support his proposition.

OPERAS FROM MILAN.

THE negotiations between the Scala Theatre at Milan and the Italian Broadcasting Association concerning the payment of a contribution by the Broadcasting Association, have apparently been satisfactorily settled. As it is, we learn that the broadcasting association will, once a week, broadcast an opera played in the Scala at Milan. Moreover, Toscanini will conduct a series of concerts to be played before the microphone of the EIAR.

For the winter season, 1932-1933, the Hungarian Broadcasting Association has also come to an agreement with the Budapest Opera according to which ten of the operas played during these months are to be broadcast.

4600 K.W. IN THE ETHER.

AT the end of last year, Europe counted 250 stations with a total power of 4600 k.w.—an average of 18 k.w. per station. The 600 American stations total only 1400 k.w., viz., 2.3 k.w. per station. If, in another few years, all the broadcasting projects of the various countries are carried out, the total power flung into the European ether, at every second of the greater part of the day, will be not less than about 6000 k.w.

Making Your Own Records

A new series of Articles which will tell you about this Fascinating Hobby

PART II.

MICROPHONES.

CHOICE OF MICROPHONES.

In the selection of the microphone, one has a choice of several types. The single-button carbon, the two-button carbon, the condenser microphone, and the dynamic microphone are all readily adaptable to home recording.

An average single-button carbon microphone has the characteristic shown in Fig. 3. It is noted that the characteristic rises rapidly from 100 to 500 cycles, then flattens out up to about 2800 cycles, and from that point falls off very sharply. In other words, there is a variation of 8 DB between 100 and 2800 cycles. In any electro-acoustical device, the maximum allowable difference in level over the entire range is between 2 and 3 DB, and it is readily seen that this type of microphone is not suitable for recording if good results are desired.

While voice may be recognisable through this instrument, the sharp cut-off around 2800 cycles makes it absolutely useless for any musical work. The carbon hiss is another objectionable characteristic—because it makes the letter "s" very hard to reproduce, giving the effect that everyone talking through it has a lisp.

The double-button carbon microphone is the type best suited for home recording. Fig. 5 shows a simple circuit using this instrument. It is easily seen that, as the diaphragm is actuated by the voice waves making it move in either direction, the current through one side of the transformer will increase while the current through the reverse side will decrease.

This effect contributes to the elimination of the microphone hiss caused by the normal current flowing through the carbon granules, as well as eliminating distortion caused by even harmonics. It also eliminates any effect of the microphone current upon the transformer, since the battery current flowing through the microphone transformer creates opposing magnetic fields, and therefore is balanced out. (This is similar to the action taking place in the primary of the output transformer in a push-pull amplifier.) A well constructed two-button microphone has a characteristic as shown in Fig. 4. The curve is flat, within 3DB, from 30 to 6000 cycles, and this is more than enough to reproduce all of the frequencies necessary for good recording. No frequency above 6000 cycles is ever put on the air from a broadcast studio.

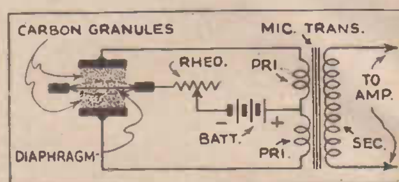


Fig. 5.—Connections of a two-button microphone.

The condenser type of microphone, no doubt, is the instrument for perfect recordings, but its high cost and the extreme care required in its use make it impractical for the average home-recording enthusiast. Its characteristic is very flat from the lowest audio frequency to well above 7000 cycles. It has no internal noise, and there is no danger of any trouble, such as packing, developing during recording.

The microphone consists in its essentials of nothing but two metal plates. One is a flat brass disc, called the "back plate," and the other is an extremely thin, tightly stretched circular sheet of duralumin, called the diaphragm. This diaphragm is spaced .001 to .002-in. from the back plate and well insulated from it. These plates together form a small condenser, from which the microphone derives its name. Sound waves striking the diaphragm cause it to move slightly toward or away from the back plate, and thus vary slightly the capacity of the condenser.

Fig. 6 shows a circuit of this microphone with its associated amplifier. Since the capacity of the condenser transmitter is very small, the capacity between the leads from it to the grid of the first amplifying tube must also be kept very small, and that is the reason that the amplifier and transmitter are always built as a unit.

A more recent development in microphones is the dynamic microphone. It is a well known fact that ordinary loudspeakers and headphones can be used as microphones.

The dynamic speaker owes its high efficiency to the dynamic principle, in that a moving coil actuated by voice frequencies is arranged to float in a magnetic field. This magnetic field may take the form of an electro magnet or a permanent magnet. The dynamic microphone operates on the same principle as the dynamic speaker.

Essentially it is composed of a diaphragm D supporting a voice-coil of fine aluminium ribbon, wound edgewise in the field of a permanent magnet M. as shown in the cross-section view. Fig. 7. When sound waves impinge on the diaphragm, the coil (to which it is rigidly attached) vibrates with a plunger-like motion, cutting the lines of force, and thus generating across two terminals a potential which is substantially constant from about 35 to 10,000 cycles. The use of the permanent magnet obviates the necessity of utilising any exciting batteries; and since the impedance of the voice coil is only 25 ohms, that of the line load also is low. These factors combine to eliminate the batteries and the local amplifier.

The diaphragm is made of duralumin .0011 in. thick, and has a dome-shaped centre portion which extends to the inner edge of the moving coil. This type of construction stiffens the centre so that the diaphragm has a plunger action throughout the entire audio frequency range.

The advantages of the dynamic microphone are as follows:—

It may be placed at a considerable distance from the pre-amplifier;

It is adapted to use in localities indoors or out, where there exists wind or other extraneous noises;

Simple and rugged in design;

Frequency response graph practically uniform;

Unaffected by atmospheric conditions;

Conveniently located and mounted, and does not require spring mountings.

High sensitivity, occasionally precluding the need of a pre-amplifier;

Does not require an exciter battery;

Is insensitive to ordinary vibration.

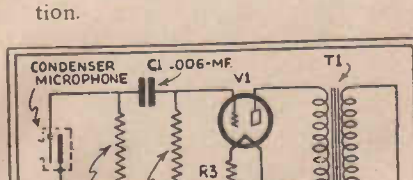


Fig. 6—Connections of a condenser microphone to its associated amplifier.

There is no doubt that this type of microphone is the ideal for instantaneous recording, but again its high cost makes it prohibitive to the average amateur. It must be borne in mind that the output impedance of the

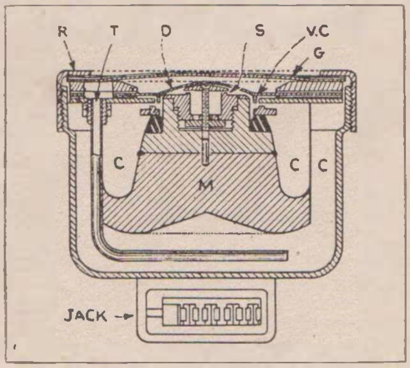


Fig. 8.—Cross section of the dynamic microphone, in which the letters have the following meanings:—R, clamping ring; T, pressure equalising tube; D, diaphragm; S, air gap; VC, voice coil; G, protective grille; M, permanent magnet; C, cavities.

"mike" is 25 ohms, and consequently the conventional 200 ohm input transformer is useless.

Microphone Technique.

Too many records are spoiled by incorrect use of the microphone. Fig. 9 is the schematic diagram of a single-button microphone circuit, and Fig. 10 that of a two-button microphone hookup. In Fig. 9 the milliammeter is placed in series with one leg, and the microphone current is varied by means of the potentiometer "P"; the values of this current is determined by the type of microphone used, and this information is usually supplied with the instrument.

If a two-button microphone is used, jacks in each button leg, as shown in Fig. 10 will be necessary. Some people connect the meter permanently in the centre leg, to read the sum of the two currents, but this is a risky procedure. If the microphone is rated at 20 mils per button, the middle leg will carry 40 mils. With the meter in the centre leg reading 40 mils, one button may be packed and carrying 30 mils, while the other carries only 10 mils. The result will be that the button carrying the 30 mils will pit and burn out. For the same reason it is inadvisable that the meter should be placed permanently in either leg. The ideal way of keeping close watch on the current is to have a meter in each leg, but this means added cost.

If the speaker, or singer, stands too close to the microphone the reproduced record will be loud and possibly distorted; even if there is no distortion, the quality will be poor. The effect will be "tubby" and stifled, as when talking into a partly filled barrel. On the other hand, if the distance from the microphone is too great, the volume of the record will be low. It is best to stand about 10 inches from the microphone, and the voice directed into it. If it is necessary to stand closer to the microphone, the person should face the instrument and direct his voice past it. At no time during the recording should the current be changed by the operator; otherwise a crackling noise will be registered.

If the current should suddenly rise, it is an indication that the microphone is packed; this usually happens on particularly loud notes. The pressure causes consequent lowering of the resistance. The microphone should then be tapped lightly, to spread the granules.

When starting to record, the full microphone voltage should never be ap-

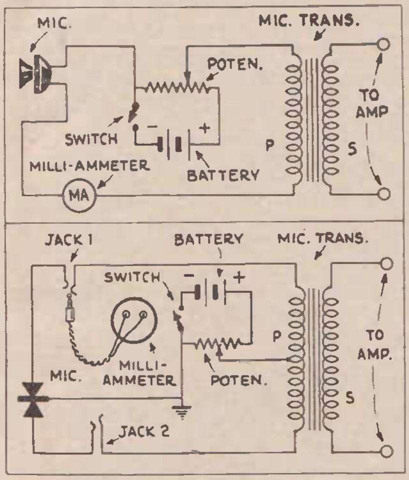


Fig. 9.—Above, connections for the adjustment of current in a single-button microphone.

plied suddenly, but should be brought up gradually until the milliammeter reads the normal current. A little time may elapse, while the microphone is warming up, before the button current readings stabilise.

It will be found that the use of a two-button microphone will result in much better recordings than by the use of a single button type. At best, the single button will not pass frequencies higher than 2500 cycles; while the two button will easily pass 5000—6000 cycles. If the recording system is to be used for voice only, then a single-button microphone will be sufficient.

The carbon microphone while the least expensive of all the types is nevertheless a very delicate instrument and extreme care should be used in handling it. The microphone should be used always in a vertical position and should be preferably mounted in a ring from which it is suspended by springs. Some people use rubber bands, but these are unreliable because the rubber deteriorates. The purpose of the springs or rubber is to prevent any vibrations from being transmitted to the instrument, and as a result being recorded. One disadvantage of using springs is that they have a natural frequency of their own, and if the vibrations are of this frequency the springs will emphasise this particular vibration to the extent that it will be recorded. Rubber bands do not have this disadvantage.

Carbon microphones should never be exposed to moisture, but should always be stored in a dry place. Moisture causes the buttons to pack. A heavy note or shouting also causes the buttons to pack. In either case the microphone should be tapped lightly with the hand to loosen the granules. Revolving the unit might also help considerably. Do not hit the microphone with any instrument as damage might result. Under no condition should the microphone be tapped or shaken when the current is turned on. Batteries are recommended for the microphone supply, but a well filtered low voltage power supply is quite suitable.

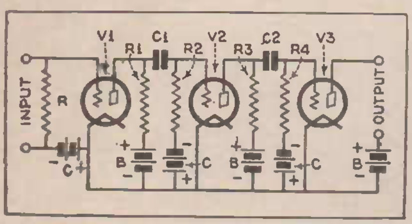
AMPLIFIERS.

The advisability of using high gain, quality audio amplifiers is absolutely necessary for the insurance of good records.

The recording level required for instantaneous or "home" recording is much higher than that required for commercial wax recording; the cutting stylus in the latter case having very little mechanical work to do against the wax disc and, consequently the required level is only about +3DB. In making instantaneous records, however, the cutting stylus, besides modulating the track, must compress the material of which the record is made. This compression must be effected by weighting the cutting head with a fairly heavy weight, and naturally the modulating action of the stylus is retarded considerably. As a result, the gain of the amplifier feeding the cutting stylus has to be quite high if a loud record is desired.

Aluminium records are made at a level of between +15 to +20 DB, and since the output level of a carbon microphone is about —36 DB, the gain of the recording amplifier must be at least +51 DB. Ungrooved celluloid records, due to their greater hardness, require a higher recording volume level than aluminium records, or about +25 to +30 D B. It is obvious, therefore, that the amplifier gain should be at least +61 DB. The recording level for pre-grooved celluloid or aluminium records is the same.

It is desirable for two reasons that the amplifier have more gain than is really needed. First, high gain affords extreme freedom of position about the microphone; that is, the person or persons being recorded may be located at a greater distance from the microphone than ordinarily, and still obtain a good recording. Secondly, high gain makes it unnecessary that the microphone, in order to increase its sensitivity, be ope-



rated at the high current value, which results in strong background noise.

The "direct-coupled" amplifier is considered one of the most faithful from the point of view of frequency response, and it makes an excellent amplifier for use with pre-grooved celluloid or aluminium records.

The disadvantage is that the gain with respect to the microphone is comparatively low. There is very little mobility allowed around the microphone, and since the latter thus has to be operated at full current value, to increase its sensitivity, the chances of microphone noise are increased.

Fig. 11 shows a schematic of a resistance coupled amplifier. The variation of the plate current in the resistance R1 produces across it a varying voltage drop which actuates the grid of the next tube V2. The blocking condenser C1 is for the purpose of preventing the plate voltage from being impressed on the grid of the tube. This blocking condenser must be small in order that rapid voice variations may be reproduced. A large capacity may result in blocking. When a signal is impressed on the input the condenser becomes charged, and it requires a certain amount of time to discharge. This time required depends on the time constant of the condenser, and this is equal to the product of the grid leak resistance and the condenser capacity. It is therefore obvious that these two factors must be properly proportioned to each other to keep this time constant small.

Resistance coupling does not give as much amplification as other types because the only amplification is that due to the mu of the tube, and at best only 75 per cent. of this is available. The high mu tube can be used to bring up the amplification per stage so that it is about equal to that of a transformer stage.

The main advantages of resistance coupled amplifiers are (a) flat frequency characteristics over the entire audible range, (b) absence of all resonance peaks, and (c) compactness and low cost of amplifier units.

One of the most important objections to this system is the excessive plate battery voltages that are necessary. The plate voltage on the tube is not the plate voltage at the supply, but this voltage minus the voltage drop in the plate resistor. The latter is usually very high, from 50,000 to 100,000 ohms, and as a result the voltage drop is very high. These excessive plate voltages require a bulky and heavy power supply and sometimes this is quite an objection, especially where space requirements are a determining factor. The voltages are high enough to be dangerous and great care must be exercised in handling the supply.

The impedance coupled amplifier is very similar to the resistance coupled one of Fig. 11. Instead of the plate, and grid resistors, chokes are used. In this method of coupling, as in the preceding, the amplification in one stage cannot be greater than that of the vacuum tube itself. It has the advantage that the d. c. resistance of the choke is very small and as a result the voltage drop is reduced. This means that the plate supply is low, and the apparatus is more compact and lighter than the resistance coupled supply. High mu tubes can be used to increase the gain per stage, but this involves more care in design. At low frequencies the impedance of the choke is very low as compared to the high internal resistance of the tube and this results in a loss of amplification at the lower frequencies. This type of tube has a high effective input capacity, and this is the cause of resonant points and even oscillations, at frequencies lower than 400 cycles. The high capacity also causes a pronounced drop in response at the higher frequencies. For best results the high-mu tube is recommended only with resistance coupled amplifiers.

In Fig. 12, is shown a circuit of a transformer coupled amplifier. For a given investment this style of coupling gives the most amplification per stage. Besides the mu of the tube being utilised, the transformer ratio also adds to the gain. The B supply requirements are comparatively small and the amplifier is much more stable. The only real objection offered to this method of amplification is that the frequeucy response is not very flat. There is usually a resonant peak around 5000 cycles. This is due to the distributed capacity of the transformer combined

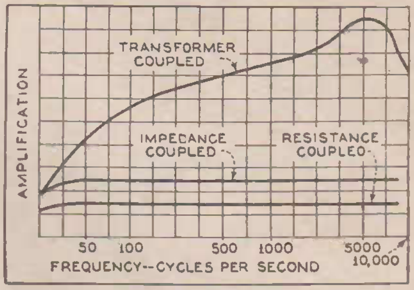


Fig. 14A.—Characteristics of the basic circuits for amplifiers.

with the input capacity of the tube, connected across the secondary terminals. To avoid this resonant condition the secondary winding is usually divided into two sections with a space between the sections.

Another way of flattening out the frequency characteristic is by using a

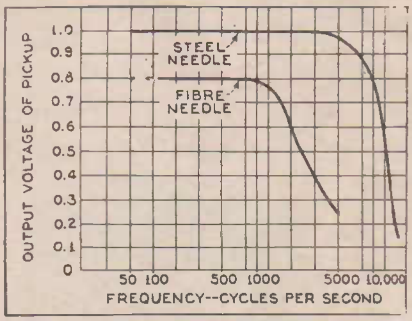


Fig. 15.—Frequency characteristic of fibre needle against steel needle.

resistance across its secondary winding. This resistance should be variable from 5000 to 1,000,000 ohms. When the resistance is decreased the amplification is lessened, and the quality improved. In this way it is possible to approach the characteristic of the impedance coupled amplifier.

In some transformer coupled amplifiers where more than two stages of amplification are used, the transformers are so chosen that resonant peaks

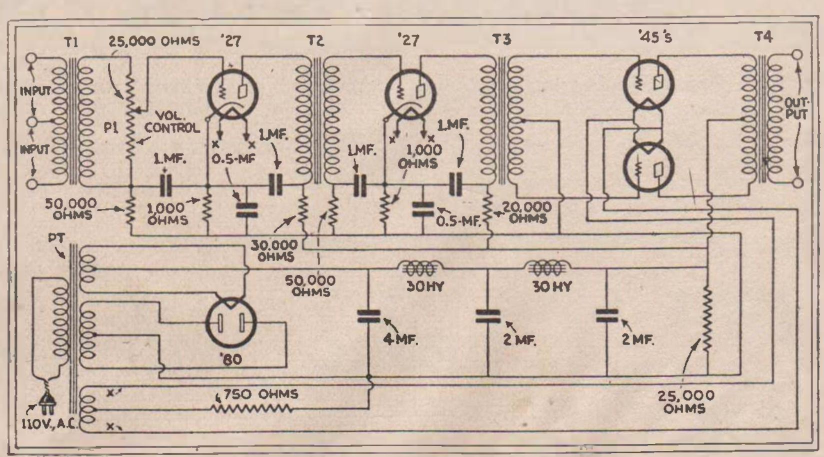


Fig. 12.—Three-stage transformer coupled amplifier, suitable for recording. The very thorough bypassing makes for extreme stability of operation.

occur at different frequencies over the entire range. This gives an approximation of the ideal equal amplification.

In the past year and a half the screen grid has come into use in amplifiers. The screen-grid tube, due to its high amplification factor is particularly advantageous where a great deal of voltage amplification is necessary. If the ordinary 3 element tubes are used in this case many stages in cascade would have to be used, and this is cumbersome and costly.

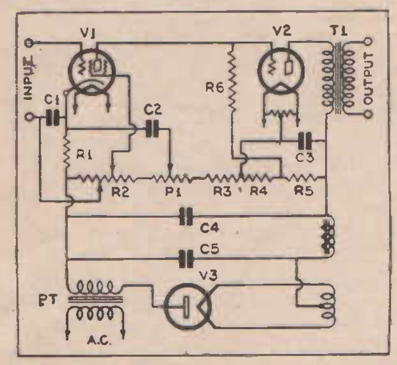


Fig. 13.—Directly-coupled screen-grid amplifier.

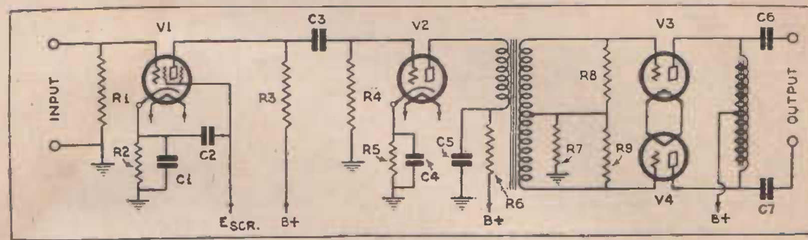


Fig. 14.—Three-stage amplifier utilising screen-grid tube in first stage.

In Fig. 13, the tube is shown in its simplest circuit. This is the familiar direct coupled amplifier as developed by Loftin White.

Fig. 14, shows the circuit of a more elaborate amplifier using the screen grid tube. This circuit is a good example of how the different types of amplifying systems are utilised. The first and second stages are resistance coupled, while the last stage is transformer coupled. When the screen-grid tube is coupled by the conventional resistor-condenser combination to the power stage, it should be remembered that because of the high internal impedance of the tube, high impedance coupling units must be used to obtain sufficient voltage amplification.

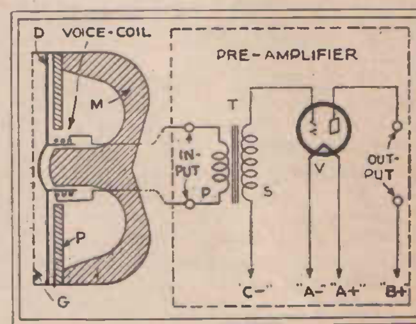


Fig. 7.—Connections of a dynamic microphone and remote pre-amplifier.

AERIALS AND EARTHS FOR SHORT WAVE RECEPTION

THE question is very often asked nowadays as to whether there is any particular type of aerial which is best for short-wave reception, and whether, in fact, a short-wave receiver really requires a special type of aerial or not. There is no doubt that a well-designed aerial and earth system will really improve short-wave reception, although it is not possible to lay down any hard and fast rule as to exactly what type of aerial will give the best results in all cases.

The average short-wave listener requires that his receiver shall be sensitive over the whole of the short-wave bands, and he also requires that his receiver shall be as sensitive as possible to signals originating from all directions (in relation to the receiver). Thus it is not generally possible for the average short-wave listener to make use of any of the special types of directional aerials which can sometimes be used for producing a maximum degree of sensitivity on certain wavelengths, and to signals originating from a certain direction.

We turn now to some practical considerations of aerial and earth systems for general short-wave reception. As a rule, it can be said that any aerial which will give good results on an ordinary receiver will give some results with a short-wave receiver, but efforts spent in designing and erecting an aerial system for use particularly on the short waves will be well repaid.

Indocr Aerials.

The point is often raised regarding the use of an indoor aerial for short-wave reception. Sometimes one sees advice given that results will not be worth while. and that an indoor aerial for short-wave reception is not a practical proposition. Suffice it to say that quite reasonably good results can be achieved with an indoor aerial if sufficient attention is paid to one or two small points.

Firstly, let it be said that, as a rule, an indoor aerial will be more sensitive to certain forms of "man-made" interference than other types, owing to its close proximity to electric light wires, bell wires, etc., and a loud click will probably be heard every time any light in the house is switched on or off, or if a bell is rung, etc. These effects can be minimised when erecting the aerial by ensuring that the wire does not run parallel with any supply wires, and that it does not come into close proximity with any piece of electrical apparatus, apart from the receiver. The aerial should be coupled to the receiver as "loosely" as possible, otherwise very troublesome "body-capacity" effects will probably be noticed if the aerial is situated where it can be approached closely by persons moving about the room.

Outdoor Aerials.

Outdoor aerials for short-wave reception need not be very long, nor is any great height essential. Rather, it is more important to pay attention to such details as electrical contact, insulation, etc. The writer generally prefers to use a covered wire, rather than a bare or merely enamelled wire, owing to the fact that single strands of the wire seem less likely to break when protected by a cover over the whole of the strands. A single broken strand may cause some very annoying effects, and if the aerial is inclined to sway slightly in a wind. tuning may become so difficult that it is almost impossible to "hold" a station.

For the highest efficiency, the aerial should be all in one piece, from the far end of the aerial wire to the actual terminal on the receiver, or, at any rate, as far as the earthing switch. This ideal can be achieved by removing the brass rod from the lead-in tube and taking the wire straight through the ebonite tube into the house in one piece. The reason for this is that a connection made outside will very soon become dirty and corroded, resulting first in poor electrical contact, and finally, in the wire itself breaking at the point of contact.

For general short-wave use, the usual single wire forms perhaps the best type of aerial, fastened at the house end to some point on the roof, or if the receiver is installed on a second or third floor room, the wire can be taken direct to the window. If the reader intends to explore the ultra-short wave-lengths below 10 metres, a very short aerial will have to be erected, about ten or twelve feet long. Here, however, the type of the aerial depends very greatly on the actual waveband used, and no general notes need be given here.

If the aerial is coupled directly to the detector valve, care will have to be taken to see that it is kept taut, as any movement of the aerial relative to nearby objects will cause considerable changes in the tuning. If a screened-grid stage is used ahead of the detector, however, this effect will hardly exist at all. See that the earthing switch or lightning arrestor is kept very clean, as any dirt or corrosion here will permit a leakage to earth.

Earth Connections.

Sometimes the receiver will be found to work just as well, or even better with no earth at all. In any case, the experiment should be made, in order to ascertain whether an earth connection is an improvement in each particular case. In the case of mains-operated receivers, either A.C. or D.C., the earth connection will generally make a very appreciable difference in the amount of hum present, and a really good "earth" is essential here. The well-worn advice—do not use a gas pipe for an earth connection—may well be repeated. A water pipe or deeply-buried metal tube or plate still forms the best type of "earth" for short-wave or any other radio use. Counterpoises, very popular some years ago, are definitely not in fashion now with the average listener, and, for short-wave reception, they may be regarded as unnecessary. Finally, some listeners who do not object to a certain amount of trouble, may care to experiment with short-wave frame aerials, with which some very interesting results can sometimes be achieved.

ULTRA SHORT-WAVE BROADCASTING.—(Continued from p. 19.)

evidence would seem to show that there are practically no atmospherics on these short waves.

The power which it is necessary to radiate from an ultra-short-wave transmitter to provide a reasonable field strength over, say, five to ten miles to a large city, if, indeed, it is possible to do it at all, has not yet been determined. For these experiments a transmitter with an input of 1.2 kW to the final amplifier stage has been installed. At these high frequencies it is not easy to obtain a true measurement of the high-frequency power supplied to the aerial by this stage, but it is estimated to be of the order of 300 watts.

The transmitter at Broadcasting House is installed on the seventh floor, in the room immediately behind the clock tower. It is a Marconi type S.W.B. 4 transmitter, consisting of four units, the main rectifier unit, the auxiliary rectifier unit, the modulator unit and the oscillator unit.

Power is taken from the supply mains at 415 volts, 3 phase, 50 cycles, and after stepping up the voltage by means of a transformer, rectification is carried out by three air-cooled diode rectifiers, type M.R.7.A. The D.C. power output from the main rectifier unit after smoothing is approximately 1200 milliamps at 4000 volts. Voltage regulation is obtained by means of an induction regulator.

The auxiliary rectifier unit provides the various D.C. voltages for the early stages of the transmitter. Power for heating the filaments of the high-frequency amplifier and modulator valves is obtained from a motor generator set of 30 kW, running at 470 r.p.m. This machine is mounted on anti-vibration pads to avoid vibration being transmitted to offices below. The filaments of the drive valves are heated from a 6-volt accumulator.

The modulator unit comprises three stages, a sub-sub-modulator type M.T.4.B., a sub-modulator type, M.T.6.B., and the main modulator consisting of four valves type M.T.9.L., in parallel. Modulation takes place by choke control at high power, and the modulator system is, in many respects, quite conventional and representative of modern technique. The frequency characteristic of the modulator system is sensibly flat between 30 and 9,500 cycles, and amplitude distortion is practically non-existent up to 80 per cent. modulation and is negligible up to 90 per cent.

Perhaps the most interesting part of the transmitter is the high frequency side, which contains nine stages in all. The frequency of the carrier wave is determined by a Franklin master oscillator, working on 2,150.54 kc/s (139.5 metres). This is followed by the master oscillator amplifier containing five stages, the first and third of which triple the frequency by selecting the third harmonic, the second, fourth and fifth being amplifying stages. Thus, the frequency of 2,150.54 kc/s is transformed successively to 6,451.52 kc/s (46.5 metres) and 19,354.86 kc's (15.5 metres).

The output of the master oscillator amplifier is applied to the first high-power amplifier, the output of which is connected to a frequency-doubling stage giving the final carrier frequency of 38,709.72 kc/s (7.75 metres), which is applied to the final high-frequency amplifier consisting of two M.T.9.F. valves in parallel. At this level, modulation takes place.

The above figures indicate a typical adjustment of the transmitter. If a different emitted frequency is required, then, of course, the master oscillator frequency must be altered accordingly.

The output of the final high-frequency amplifier is connected to a concentric tubular feeder, which is carried outside the building to a coupling box situated on the roof immediately underneath the aerial. The latter is suspended from a triatic between two of the lattice steel towers, each 35 feet high, and is of the Franklin type, consisting of two half-wave aerials with phasing device.

One has but to stand at the base of the masts on the roof of Broadcasting House, 112 feet above street level, to realise what a large part of London is within optical range—from Hampstead in the north to Crystal Palace in the south; and from beyond the Tower of London in the east to beyond Kensington in the west. At least the roofs of a very large number of houses in this area are visible. Receivers are not generally installed on the roofs of houses, but it may be that the experiment will show the desirability of installing an aerial on the roof of a high building with a high-frequency transmission line running down the side of the building, a number of receivers being connected to the line.

TWO-VALVE RECEIVER.

(Continued from page 7.)

It will be noticed that a small condenser is connected from one side of the primary to earth, this being used to cut out modulation hum; and, since it will pass a certain amount of 50 cycle current, don't be alarmed if you get a slight shock from the chassis, just reverse the main plugs.

THE SIMPLEX SIX-PIN FOUR.

(Continued from page 9.)

smoothed by the aid of two 8 mfd. electrolytic condensers, one on each side of the speaker field.

When connecting up the electrolytics, make sure that you have the polarity correct—that is, the positive terminals connected to the choke and the negative earthed.

However there will be new electrolytic condensers on the market shortly which will have no polarity, and, therefore, can be connected into the circuit in any way.

Each filament winding is shunted by a 30 ohm resistor, the centre tap of which is earthed.

Take special note of the leads from the audio frequency choke. The blue lead connects to the B +, the black lead to the plate, and the green lead to the .01 mfd. coupling condenser.

As for quality and tone, nothing more could be desired, thanks to the splendid characteristics of the Velco high impedance choke, which is one of the main features of the audio system.

Power-Grid Detection

Cossor Technical Service Department Correct a Prevalent and Erroneous Impression

POWER-GRID detection is too often considered to be something entirely different from leaky-grid detection, and as a method that is entirely superior for all purposes. Both these ideas are erroneous. In the first case, where does power-grid start and leaky-grid end?

Power-grid detection can be aptly described as "optimum leaky grid" detection, because it differs only inasmuch as the operating conditions are definitely chosen from a consideration of the valve rectification characteristics for minimum distortion with but little regard for sensitivity.

A Question of Input.

The operating conditions of a leaky-grid detector are selected for maximum sensitivity, but there is one point that should not be overlooked, and that is that these values may be the best possible for obtaining the best reproduction if the signal input is small enough. In other words, the values chosen for detector are to some extent dependent upon the expected input voltage.

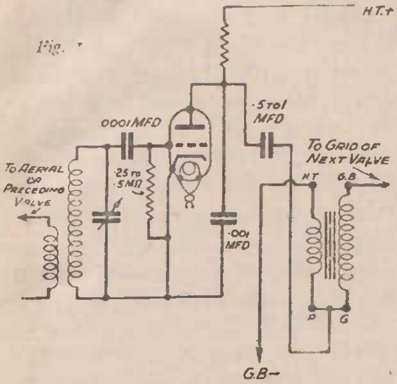
In a multi-valve receiver the detector would be designed so that when loaded with the optimum input the output valve is adequately loaded. Assuming that two screened grid stages, variable mu or otherwise, are used, there should not be any difficulty in obtaining the optimum input on a wide choice of stations; rather the problem will be to have suitable means of decreasing the input, unless, of course, variable mu valves are used, when the difficulty is solved that is experienced with all other valves.

When two screened grid stages are used, it will often be found that the "local" appears to have a tuning "hump," giving, perhaps, the impression that ganging is at fault, whereas this is not so, the effect being produced by the detector being so overloaded when the station is in "dead tune" that the volume can be raised by lowering this input. This state of affairs will result if the station is detuned either up or down and gives the hump effect.

Correct Grid Leak and Condenser.

Turning our attention to the practical aspect of power-grid detection there is a common fallacy that the grid leak must be .25 megohms, but there is no justification for this other than the crude one that it is an average value fairly suitable for mains triodes in general. The optimum grid leak for both Cossor 41 M.H.L. and 41 M.H. is .5 megohms, assuming an anode voltage of 150. The grid condenser is flexible within certain limits. If it is too large, a loss of high notes will result, also danger of motor-boating; and, if it is too low, a loss of efficiency will result. Generally speaking, .0001 is a good average value, but if there is danger of hum being passed from the screened grid stage or stages this value can be reduced with advantage, often down to .000025. Such a step, however, should be approached with caution and comparison made with a .0001 condenser on a station on the top of the long wave dial to make sure that no sensitivity is lost.

Fig.



Obtaining High Stage Gain.

The 41 M.H. possesses a relatively high impedance and a very high slope It is, therefore, very suitable as a power-grid detector. The grid current characteristic is such that distortionless rectification can be obtained up to a high percentage modulation while high stage gain, due to its high slope, is easily obtainable! For convenience and for the sake of completeness, the circuit is shown at Fig. I the actual arrangement being an auto coupling.

The 41 M.H.L. can be treated in exactly the same manner, and differs only inasmuch as the optimum input is higher.

In exceptional cases where it is decided to load up a really large output valve without a separate low frequency stage, the Cossor 41 M.P. can be used as a power-grid detector, providing, of course, the amplitude of the input can be raised to the necessary figure.

The Cossor MS/Pen A is an extremely interesting valve when looked upon as a power-grid detector (see Fig. II.), when, in addition to offering a remarkable stage gain, it has the advantage of lowering the anode current damping.

For Battery Operation.

Power-grid detection with battery valves is a perfectly practical proposition, especially if an eliminator is used. The circuit is shown at Fig III. Suitable valves are the Cossor 210 L.F., 215 P., or 220 P.A., the value of R. being 30,000, 15,000 and 15,000 ohms respectively. The 220 P.A. is strongly recommended as being the best battery valve for power-grid detection.

Fig. 2

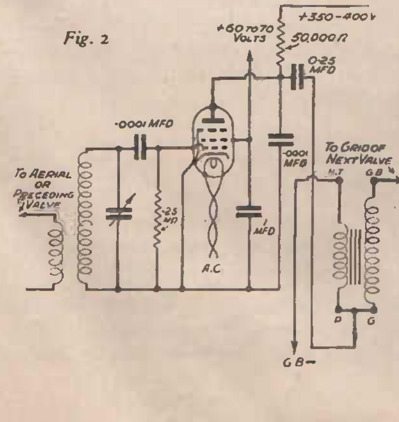
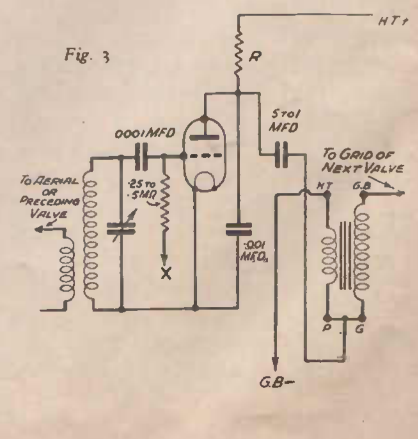
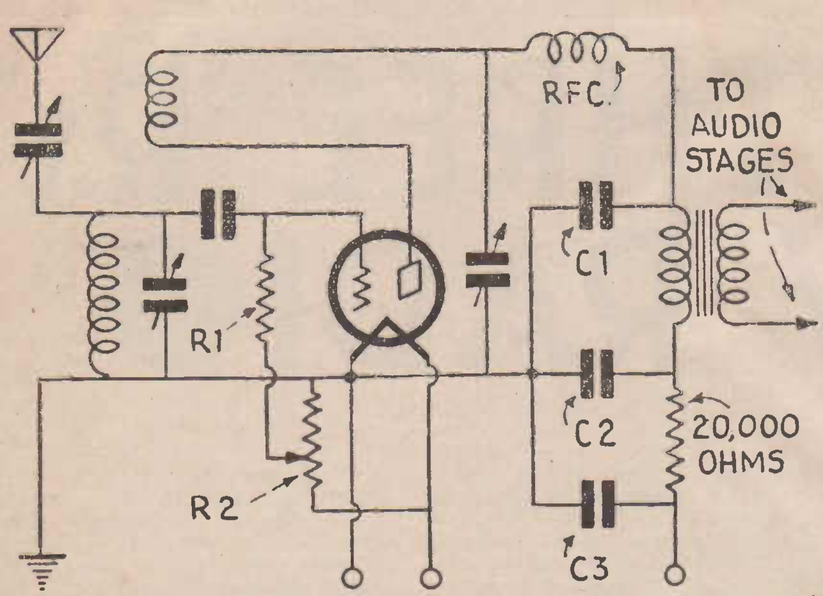


Fig. 3





A unique arrangement of bypass condensers are used in this regenerative detector receiving circuit.

HOW TO GAIN DETECTOR SENSITIVITY

WITH due respect to all the other parts which go to make up the average short-wave receiver, it can truthfully be said that the detector tube and its component parts, are the most important parts of any short-wave receiver and should, therefore, receive first attention. We are all acquainted with the old "bloopers," and fully know that they relied solely upon the smooth working of the regenerative control and the general sensitivity of the detector tube for their reaching out powers. Well, it is practically the same even to-day with the short-wave receiver. Ordinary broadcast receivers can use two or three stages of R.F. amplification and, with the modern screen-grid tubes, they get an extraordinarily high amount of amplification out of these pre-detector stages, and, therefore, extreme sensitivity of the detector circuit and its component parts is not an essential.

The really modern short-wave receiver certainly employs a stage or two of R.F. amplification, but these stages cannot be made to amplify very much—nowhere near as much as if they were being used in an ordinary broadcast receiver—and therefore, we must again fall back on the detector tube to do practically all the work. Again, the short-wave receiver has to make use of a regeneration control—the average broadcast receiver has none—and, therefore, we have to set about making this control as easy and smooth working as possible:—not always quite so easy as it sounds.

When somebody will design a short-wave R.F. amplifier with, say, three stages which will give as much amplification if they were being used on the ordinary broadcast band, then there will be not so much need to worry about extreme detector sensitivity as far as the short-waver is concerned. Nobody, however, seems to have done this yet, and we must devote our attention to the detector stage and spend much time and temper trying to make it perk.

At some time or other, practically every short-wave fan has met the receiver which stops oscillating at, say, 50 degrees on the regeneration dial (most modern short-wavers don't have the regeneration dial marked in degrees, but, for the sake of argument, we'll assume that they have, and then starts again at about 40. Well, it's absolutely hopeless trying to get China or Europe on a set that plays like that! So, if your own short-waver shows signs of this trouble, get down to it at once and see what can be done about it.

Grid Leak Value a Compromise.

The commonest cause of trouble in this direction is the grid leak. Some short-wave fans prefer low resistance such as 2 megohms; while others always support the use of a much higher value, such as a 10 megohm leak. It is certainly true that the high value will practically always give you a smooth regeneration control; but at the same time it results in a general loss of detector sensitivity and will be found that the reproduction is not so clear-cut, because the higher notes of the musical range will be missing. The use of a 2 megohm leak cures this, but, at the same time, very often introduces unstable regeneration effects. An excellent compromise between these two effects (or defects), is to use a low value (2 megs.), of grid leak and, instead of connecting it directly to "A—" or "A+" (according to the type of detector used), connect it direct to the moving arm of a 200-ohm potentiometer R2, the two remaining terminals of which are then connected across the "A" supply. The grid potential is then adjusted so as to coincide with the smoothest regeneration effects. The potentiometer may be of the baseboard-mounting type because, when the best adjustment has been found, it need not be altered very often. Thus, it does not mean an extra panel control, and the symmetrical appearance of the panel dials will not be upset.

Other Problems of Regeneration Control.

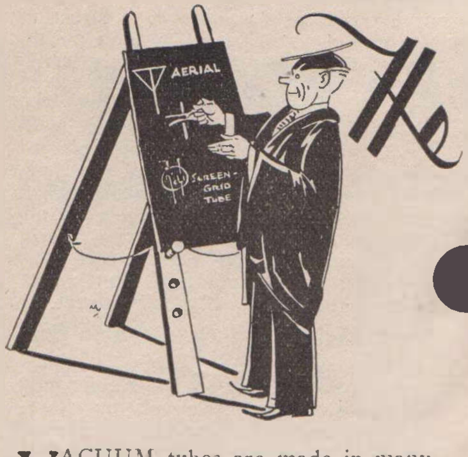
Too many turns on the tickler coil will cause unsteady regeneration effects and "regeneration-tuning" also: i.e., a small adjustment of the regeneration control will cause a large change in wavelength, and this effect is not wanted in short-wavers!

Too much "B" supply on the detector tube will also prove a ready culprit. In this case, the remedy is obvious, plus a consequent saving in battery costs.

"Threshold howling" is generally prevalent in receivers which use one or more audio stages, if certain points are not observed. Frequently, this fault is produced in the audio stages themselves, but sometimes it can be caused solely in the detector stage. A receiver which suffers from this fault is not much use at all, as the howl generally only occurs near the point of oscillation when the receiver is in its most sensitive condition. The usual cure for this fault is to connect a high resistance across the secondary of the first audio transformer; but sometimes this resistance has to be of a fairly low value before the howl stops and this, of course, cuts down volume.

"Threshold howling" occurs sometimes in the detector stage when the antenna is too tightly coupled. Always have the antenna as loosely coupled as may be consistent with good results. This will also help to smooth out "dead spots" in the tuning, which are caused by the natural wavelength of the antenna. This trouble, of course, does not appear in receivers using a screen-grid tube in front of the detector.

In the accompanying diagram is shown a super-sensitive detector circuit in which every effort has been made to make it as smooth working as possible. R1 is a 2 meg. grid leak, and R2 is the 200-ohm potentiometer. C1 is a small by-pass condenser, about .0002-mfd.; a larger capacity would possibly by-pass R.F. currents better, but would cause a cut-off in the notes of the higher musical scale. C2 is a 2-mfd. condenser, and this, together with the 20,000-ohm. resistor, effectively decouples the detector circuit from the other audio and R.F. stages. C3 is merely for R.F. by-passing purposes, and must be kept very small —.0002-mfd. will do again here. This must be kept very small or otherwise it would tend to cancel out the effects of C2. Both R.F. and A.F. stages may, of course, be added to this detector circuit as required.



The THREE "R's" of RADIO

VACUUM tubes are made in many forms with electrodes of various sizes, shapes and arrangement. The filaments may be designed to be operated from dry cells, storage batteries or raw alternating current. The tubes can be constructed to handle from one to two milliwatts to several thousand milliwatts of power. The filaments may be either of the thoriated tungsten type or coated with the oxides of barium of calcium to increase the electron emission for a given temperature. They may be made in the form of round wires or flat ribbons; arranged in the form of a straight wire, an inverted V, a double V, etc.

The plates are usually plain, box shaped, or nearly cylindrical, with the grids corresponding. The relative spacing of grid, filament, and plate, as well as the fineness of the mesh in the grid, also varies in the different tubes. Some tubes have been designed with a multiplicity of filaments, grid and plates. In Europe, some tubes have been designed with multiple elements so as to contain within the glass bulk all the necessary parts for one or two amplifier stages. These have not attained great popularity in the United States.

Type of Tube	Emission Test: Fil. Volts	Emission Test: Plate Volts	Emission Test: Minimum Emission Allowable	Reactivation Process: Flashing: Fil Volts	Reactivation Process: Flashing: Time	Reactivation Process: Ageing: Fil. Volts	Reactivation Process: Ageing: Time
WD-11 WX-12 C-11 CX-12	1.1	50	6 M.A.	Cannot be reactivated			
UX-199 CX-299	3.3	50	6 MA	12	10-15 Sec.	4	30 Min.
UX-120 CX-320	3.3	50	15 M.A.	12	10-15 Sec.	4	30 Min.
UX-201A CX-301A	5.0	50	20 M.A.	16	10-15 Sec.	7	30 Min.
UX-200A CX-300A	5.0	50	14 MA	16	10-15 Sec.	7	30 Min.
UX-240 CX-340	5.0	50	14 M.A.	16	10-15 Sec.	7	30 Min.
UX-112A CX-112A	Emission reading cannot be taken			Cannot be reactivated			
UX-171A CX-371A	5.0	50	50 M.A.				
UX-210 CX-310	6.0	100	85 MA	No flashing		9	30 Min.
UX-226 CX-326	1.5	50	35 M.A.	Cannot be reactivated			
UX-227 CX-327	2.5	50	35 MA				
UX-216B CX-316B	6.0	125	85 M.A.	No flashing		9	30 Min.
UX-280 CX-380	5.0	80	100 M.A.	Cannot be reactivated			
UX-281 CX-381	7.5	150	200 MA				
UX-250 CX-350	7.5	250	560 MA				

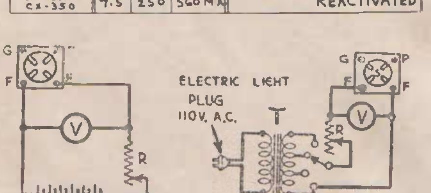


Fig. 61 (top) gives the values necessary for proper reactivation of valves which have lost their emission. Fig. 62 (bottom) shows, at the right, the connections for d.c. work, and, at the left, the corresponding hook-up for a.c. reactivation.

The relations of parts and construction of a 201A type vacuum tube are as follow: We have first of all the filament or electron-emitter, surrounded by the grid or controller, and this in turn surrounded by the plate. The entire assembly is mounted on a glass flare through which the connecting wires are sealed, and from which a hollow tube extends at the bottom. The flare is then joined to the outside glass bulb, making an upright assembly. The long tube is attached to a vacuum pump, and the air is drawn out. To insure a perfect vacuum the tube elements are heated by an induction furnace to release any entrapped bubbles of air from the pores of the metal and the glass surfaces. At this point, a small piece of magnesium (same as ordinary flashlight powder), which has previously been welded on to the plate of the tube (or to a separate little cup), is flashed by raising the temperature by the induction furnace, and the vapour or gas produced enters a vigorous chemical combustion with any remaining oxygen in the tube. The vapour instantly condenses or deposits itself on the inside of the glass bulk, and imparts to it the familiar silver-like look or mirror appearance.

The reddish and oil-film effects on some tubes is the resultant of some similar process in which phosphorus as well as magnesium is used.

The presence of the silver coating is thus seen to be merely incidental to the course of manufacture of the tube. The glass stem is then sealed off near the base of the flare. The bulb is mounted in a Bakelite insulating base with prongs for external connection. The prongs are made of hollow brass tubing, and copper lead-in wires from the tube elements run through them and are soldered at the tips. There are two prongs for the filament connections, one for the grid and one for the plate. The latter two are smaller in diameter than those of the filament, so that the tube can be inserted only one way in the standard UX type socket. This eliminates the possibility of inserting a tube in a socket in the wrong way.

There are at present three popular classes of vacuum tubes—namely, the dry cell type, the storage battery type and the A.C. type, all deriving their names from the current supply used to heat the filament.

Since the function of the filament is to give off electrons, it is evident that it is desirable, in battery operated tubes, at least, to coax out a maximum number of electrons with the minimum filament temperature. By decreasing the necessary temperature of the filament, the amount of electrical power used to heat it is reduced, thus resulting in longer life of batteries, lower operating cost, etc.

As explained at the beginning of Lesson 5, some substances give off electrons readily at low temperatures while most give off very few even though heated to extremely high temperature. Among the former are the oxides of the rare metals thorium, barium and calcium.

The electron emission from a large number of materials has been studied and it has been found that a tungsten filament with a layer of thorium on its surface gives about 130,000 times more electrons at a temperature of 1500 degrees Centigrade absolute than a plain tungsten filament of the same dimensions. Other materials, such as calcium oxide, barium oxide, and strontium also produce increased emission. Lately the thoriated and oxide coated filaments have been developed, and they are now used almost entirely.

Filament Construction.

At the present time practically all of the commercial D.C. type tubes use a thoriated tungsten filament. This is really a tungsten filament having thorium distributed throughout its mass, and a very thin layer of the metal thorium on its surface. The tungsten serves merely to heat the thorium and to renew the thorium layer as it is used up, the electron emission coming wholly from the thorium layer.

The raw filament wire is made of tungsten impregnated with from one-half to one per cent. of thorium oxide and some carbon. (Tungsten is the metal used for the filaments of incandescent lamp bulbs because of its ability to withstand high temperature without melting.)

When such a filament is heated, two important actions take place. As the temperature is increased to about 2500 degrees Centigrade, some of the thorium oxide is reduced to metallic thorium, and then this gradually works its way to the surface of the filament. At this temperature, the thorium which diffuses to the surface of the filament vaporises immediately, leaving only pure tungsten at the surface. If the temperature is then lowered to about 800 degrees Centigrade for a few minutes, the thorium wanders or diffuses through the filament, and when it reaches the surface (provided the vacuum is about perfect) remains there and gradually forms a layer of metallic thorium atoms which never exceeds a single atom in depth. It is this almost inconceivably thin layer which increases the emission over a hundred thousand times. When more thorium atoms work their way to the surface and come up under other thorium atoms already there, the latter at once evaporate, thus maintaining the layer only one atom thick. If the temperature is raised a few hundred degrees the metallic thorium is formed from the oxide more rapidly and comes to the surface more abundantly, but it does not stay on the surface. It evaporates at once, leaving a tungsten surface.

This film is very sensitive and must not be heated to too high a temperature, or it will evaporate. It is necessary to operate such a filament within a narrow range of temperature close to 1700 degrees Centigrade, where the ratio of evaporation is small and the temperature is high enough for the thorium to diffuse gradually to the surface and continually replenish the layer as it is used up by the normal operation of the tube. In the UX-201A tube this condition obtains approximately when five volts is applied to the filament, sending a current of 0.25 amperes through it.

A large proportion of the vacuum tubes used at the present time have thoriated filaments.

The electron emission of these tubes depends upon the presence of a thin layer of thorium atoms on the outer surface of the filament. During the normal operation of the tubes, the thorium on the outer surface of the filament gradually evaporates. This is constantly replenished by diffusion of the thorium from the inside of the filament. As long as the filament voltage is normal and is not raised over ten per cent. above the rated value, the evaporation and replenishing continues at an equilibrium rate so that a constant layer of thorium is maintained on the surface.

If too high a filament voltage is used, the rate of evaporation of thorium is increased more rapidly than the rate of diffusion of the thorium to the surface, the thorium surface layer is partially or totally destroyed, and the emission drops to that of pure tungsten (which is practically zero at these temperatures) and the tube operation is impaired. If the tubes are operated at very low voltages the filament temperature is so low that the process of boiling out the thorium from the interior of the filament becomes abnormally retarded, and the layer is slowly used up.

The great majority of thoriated tubes die a natural death, in that their life continues until all of the thorium in the filament is used up. Obviously nothing further can be done with them. Tubes which decrease in operating efficiency after having suffered some of the abuses mentioned above can usually have their thorium layer and full efficiency restored by the simple process of "reactivation" or "rejuvenation." Reactivation consists of cleaning the surface and reducing some of the thorium oxide in the wire to metallic thorium by heating the filament of the tube (with plate and grid circuit disconnected) to a higher temperature than normal, for a short time, by the application of specified high voltages. This is known as "flashing." Then it is operated for a longer time at a lower temperature. This boils out additional thorium atoms from the interior of the filament and a new active layer is formed on the surface. This is known as "aging." The plate and grid circuits are left disconnected to prevent them from attracting the thorium electrons to themselves during the process.

Before reactivating a suspected tube the condition of its filament should be tested by testing its electron emission to see if it is actually below normal This is done by connecting the grid and plate together as in Fig. 60, and connecting them to the plus terminal of a "B" battery through a milliammeter of suitable range (see Fig. 61). The remaining connections are shown in Fig. 60. The voltage across the filament, read on V, should first be adjusted to the values specified in Fig. 61 for the particular type tube being tested. This also gives the proper "B" voltage to use. Close the switch just long enough to obtain a reading of the emission current on MA. If the reading is less than that specified in the table the tube can usually be improved by reactivation. If the emission is above the minimum specified, the tube is in good condition, and does not need reactivation.

(Continued in our next issue.)

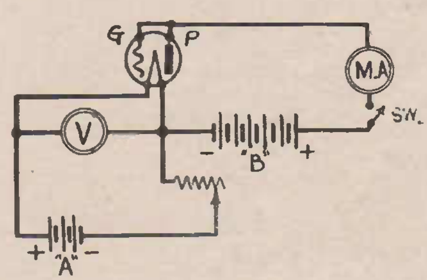
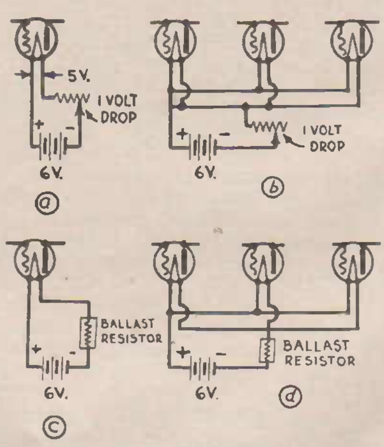


Fig. 60 gives details of the emission testing circuit used for checking up old valves.



RHEOSTAT SIZES RECOMMENDED								
Nº OF TUBES IN PARALLEL→	1	2	3	4	5	6	7	8
TYPE OF TUBES	RHEOSTAT RESISTANCE IN OHMS							
112-A, 171-A, 201-A WITH 6V. SUPPLY	20	10	6	6	3	3	2	2
171, 172 WITH 6V. SUPPLY	10	6	3	2				
199 WITH 4.5 V. SUPPLY	30	20	10	10	6	6	3	3
199 WITH 6 V. SUPPLY	100	60	40	30	25	20	15	10
120, 222 WITH 4.5 V SUPPLY	20	10	6	6				
120, 222 WITH 6V. SUPPLY	50	30	20	15				
11, 12 WITH 1.5 V. SUPPLY	10	6	6	6	3	2	2	2
11, 12 WITH 2V. SUPPLY	10	10	6	6	6	3	3	3
VT-2, 216-A WITH 6V. SUPPLY	3	2						

Fig. 64 (left) shows standard filament voltage control circuits, whilst the right-hand table, Fig. 65, gives details of the filament resistances required by different valves, and with different voltage "A" supplies.

HINTS AND TIPS

HIGH-FREQUENCY STABILITY.

ONE occasionally experiences difficulty in making a set stable, particularly where an efficient high-frequency valve is being used. Sometimes, although the coils are screened and the circuit layout appears perfectly satisfactory, one finds that instability sets in towards the bottom of the tuning scale.

Sometimes this is found to be due to the reaction circuit and one of the first tests to be applied is to disconnect the reaction condenser altogether. If the condenser is of the differential type it is only necessary to disconnect the lead between the reaction coil and the condenser, leaving the remainder of the condenser still connected in circuit.

If this does not cure the fault, then the difficulty is probably due to the layout. Try connecting the wiring differently. Connections to low-tension negative, for example, can often be made in various ways, and in some cases the current may have to go quite a long way round to get to its ultimate point. While this does not matter with direct currents, it is very important for high-frequency currents.

"Close" Connections.

Generally speaking, connections to low-tension negative or high-tension negative, or the connections of by-pass condensers, should be taken as close as possible to the apparatus with which they are associated. Often the disconnection of a lead from one point and its reconnection to another which is apparently the same and is, in fact, connected to the first point by a fairly long length of wire, will make all the difference to the stability of the set.

FILLING YOUR ACCUMULATOR.

PERIODICALLY one's low-tension accumulator should be "topped up." This is done by adding a little distilled water or, if this is not available, boiled water may be used.

The purpose of this is to allow for the evaporation of water due to atmospheric changes and also partly due to charging of the cells.

Distilled or boiled water is used because tap water usually contains a certain percentage of lime or similar salt, and these are affected by the acid in the electrolyte of the accumulator, causing a white deposit to be formed on the plates and thus preventing their proper working.

This deposit must not be confused with the very tenacious deposit known as sulphate, which sets in all over the surface of the plates if the accumulator is allowed to run down too far. When the accumulator is fully discharged it is in a very weak state and the material of the plates is attacked by the acid with the formation of white sulphate.

Therefore, one should be careful not to allow the accumulator to remain in a run-down condition for long.

Acid should not be used when topping up a battery, as it is only the water which evaporates and therefore water only should be added in order to bring up the level to the required value.

SOLDERING TIPS.

CONNECTIONS between wires and conductors in radio and electrical work should be protected with solder if highest efficiency is desired. To insure a sound and permanent electrical connection between two wires, they should first be cleaned thoroughly, then joined so that a connection that is electrically conductive and mechanically secure is formed, and then the connection should be covered with solder to keep it in that condition. The coating of solder not only prevents vibration and the constant expansion and contraction of the metal caused by temperature changes from loosening the connections; but it also prevents the formation of metallic oxides that would introduce a high resistance at the connection. The solder forms a coating that is flexible and lasting, and one that will not lose its conductivity with age.

A SUPPLEMENTARY H.T. BATTERY.

BATTERY users are now paying greater attention to the efficiency of their receivers, and particularly to quality of reproduction. But there is one point that seems to be generally neglected: it is not always realised that there will be a gradual falling-off in the voltage of a dry-cell H.T. battery. The purpose of this note is to stress the desirability of buying a battery of rather higher initial voltage than is needed, or, alternatively, of obtaining a "booster" battery after the main battery has been in use for a few weeks.

The latter plan is perhaps the best and most economical, as the auxiliary cells, which will eventually be used as a supplementary source of voltage, may deteriorate slightly before occasion arises to put them into service. A 50-volt battery will be suitable in most cases, and it is not essential that it should have quite as high a capacity as that of the main battery. Perhaps this question of capacity is not of great importance, but a fairly good case can be made out for the use of the next smaller size of cell.

All battery valves are now rated to work at 150 volts, and so those who are desirous of obtaining the maximum sensitivity and volume will normally start with a 100-cell battery, which gives approximately that initial voltage. After fifty or sixty working hours the voltage of such a battery will probably fall to 1.25 volt per cell, or a total of 125 volts; at this juncture 25 volts from the "booster" battery may be added in series. As the modern H.T. cell maintains its voltage at roughly 1.25 volts for a considerable period, it is unlikely that any further addition will be necessary for some considerable time. After, perhaps, a total of 150 working hours it may be necessary to add the remaining 25 volts of the auxiliary battery in order to restore pressure to the original value of 150 volts.

This method of boosting would have been condemned at one time, as a falling-off in battery voltage is always accompanied by an increase in internal resistance. But nowadays, thanks to the general use of decoupling, a fairly high internal resistance may be tolerated.

UNWANTED COUPLINGS.

INSTABILITY in an H.F. amplifier is made evident by the fact that the valve (or valves) tend to oscillate uncontrollably when the various circuits are brought into tune with each other. This state of affairs should never be tolerated, even though, with the modern method of volume control by means of a grid potentiometer, it may be possible to attain stability by applying a suitable value of negative bias. But, when stabilised in this way, the sensitivity of the amplifier, even when operated close to the point of self-oscillation, will not often be so great as that obtainable when it is in a state of complete stability.

Instability is almost always due to spurious couplings, and much space has been devoted in these columns to the nature of these couplings, as well as to the appropriate steps to be taken for their removal. It is sometimes forgotten that a metallic rod, when used as a mechanical link between the various switches of a ganged wave-change system, will often act as a medium for the transference of energy between grid and plate circuits. Most manufacturers who produce matched coil assemblies nowadays take precautions against this trouble either by breaking electrical continuity in the rod by the insertion of insulating pieces between the various coils, or by making provision to earth the rod at corresponding points. A low-resistance earth connection between each section will almost always prove efficacious, and is often arranged by fitting a light metal spring in such a way that it acts as a brush, making continuous contact with the rod as it is rotated. Another method of earthing, which may be more convenient to the amateur who has traced the cause of instability to this source, is, instead of a spring, a "pigtail" of flexible wire used to tie down the rod electrically, either to a metal chassis, or to the earth line of the receiver.

Unshielded wires in grid circuits are well-known causes of instability and care should consequently be taken both with regard to their position and to reduce their length. The fact that many ganged tuning condensers are fitted with duplicated terminals or soldering tags for each stator section often enables us to reduce the unshielded length of such leads.

It is a common practice to mount the valve on one side of the condenser and the coil on the other, and it is a good plan in such cases to make use of both connection points.

H.F. CHOKE EFFICIENCY.

WHEN several H.F. chokes are available it is wise to choose the best and most efficient specimen for insertion in the anode circuit of an H.F. valve which precedes a parallel-fed tuned inter-valve coupling. An ineffective choke used in this position, will appreciably reduce the amount of H.F. amplification, and if it has a very high self-capacity will also tend to restrict the wave-range of the circuit.

A choke of poor design will often serve well enough as a deflector of H.F. energy in a detector anode circuit. This choke, of course, is used in connection with reaction control, and even if it be hopelessly ineffective the basic qualities of the receiver will not be impaired, and in any case there will be a clear indication of what is wrong. Inefficiencies in the H.F. coupling, on the other hand, are more insidious, and it may be difficult to discover the cause of a poor performance.

A BATTERY AUDIO AMPLIFIER

AN audio amplifier must, if it is to be used with a short-wave tuner, possess as many as possible of the following features: A really high step-up gain and positively no audio fringe howl; it should be as compact as possible, and should have a really flat amplification curve over the whole audio frequencies. In my favourite audio amplifier, which is used in conjunction with a regenerative detector, an attempt has been made to make it conform to the above ideals as closely as possible. The circuit diagram is shown in Fig. 1. The amplifier, itself, of course, comprises only V2 and V3, but, because the first audio tube is resistance-capacitively coupled, a screen grid detector is used, as shown by V1.

By analysing the above features set out for our ideal audio amplifier of a short-wave receiver we find that this amplifier has a relatively high gain, considering the small number of tubes used. V1 with the resistance-capacity coupling units R1-C2 and R3 produces a high gain—higher than that obtained with an ordinary tube as detector, of course — and a high-ratio transformer (7:1), can be used between V2 and V3 without detrimental effects on quality. The step-up gain, then, is possibly higher than it would have been if two transformer stages had been used, and the quality is better.

Battery coupling in an audio amplifier can be very annoying and cause motor-boating, as well as fringe-howl effects. So that battery coupling shall not take place between the detector and the audio amplifiers, the detector plate supply is decoupled from the rest of the circuit by means of R2 and C1. R2 has a value of about 20,000 ohms, and C1 about 2 mfd.

The plate resistance R1 is about 80,000 ohms, or higher, but if a higher value is used it must not be forgotten that R2 is also in series with it, and this will help to lower the plate voltage so that a higher plate potential than usual will be necessary.

RFC, of course, is an ordinary short-wave R.F. choke. C2 has a value of .004 mfd., which is not too large and not too small to pass audio currents. R3 is about 0.5 megohm, but the resistance is not very important and a 2 megohm leak will do, if one is on hand. C3 helps to smooth over noisy batteries, and also keeps R.F. currents out of the batteries; it has a value of 2 mfd. C4 keeps R.F. currents out of the output leads; its value is .001 mfd. A larger condenser would tend to cut off the higher audio notes.

The tubes, of course, are all battery tubes, V1 being a screen grid tube, V2 a general-purpose tube, and V3 a small power tube. This amplifier, is, of course, built in a metal case along with the tuner.

In practice it will be found that this amplifier actually does fill most of the ideals set out, and is certainly a very useful audio channel for use with any type of short-wave tuner.

"SERVICE PLEASE"

A Department to Help Solve the Various Technical Problems Which are Encountered by the Radio Set Builder and Experimenter.

Is it possible to insert a current-indicating instrument in series with the detector anode when diode rectification is employed?—R. J., Camberwell, Vic.

The usual plan of inserting a current-indicating instrument in series with the detector anode is almost impracticable when diode rectification is employed. As the current flowing in the output circuit of the valve amounts merely to micro amperes, an extremely sensitive and consequently a very expensive meter would be necessary.

Fortunately for those who like to have some visual indication of what is happening in the preceding tuned circuits and in the detector itself, there is a simple and quite permissible little trick which enables us to overcome this disability.

As has already been pointed out in these pages, a milliammeter of ordinary sensitivity may be joined in series with the anode of the low frequency valve which immediately succeeds the diode, and the readings of this instrument will serve as a useful index to the functioning of the entire tuning system and of the detector.

The meter moves in a downward direction when a strong signal is tuned in.

The rectified current from the diode builds up a voltage across the load resistance which is in parallel with the low frequency valve grid circuit, and this voltage is of such polarity that the grid of the valve is made more negative. As a consequence, anode current is reduced. If this were not so, we could not depend on the rectified carrier wave to provide negative bias automatically.

It will be appreciated that maximum downward deflection of the meter needle is an indication of maximum output from the detector.

Thus the instrument will serve as a visual guide to the trimming of the tuned circuits, and generally to the effectiveness of adjustments made to the high frequency side of the receiver.

Would you be good enough to answer the following questions in connection with the "Test All Wave One." (1) How would a 30 ohm rheostat do in place of the filament switch? (2) Must the A415 have the full 60 volts? (3) How would a very small variable 3-plate condenser, 2 fixed plates, do in place of the one published in the article?—P.K., Laverton, Victoria.

(1) A 30 ohm rheostat will be quite satisfactory in place of the switch.

(2) The A415 need not necessarily have 60 volts on the plate, but a reduction in plate voltage will mean a slight loss in signal strength.

Provided two or three more reaction coil turns are added, the detector will work fairly well with voltages between 35 and 45 volts.

(3) The small 3-plate condenser would work, but not nearly so well as the type described.

The success that constructors have had with the "Test All Wave Battery One" is principally due to the special construction of the aerial coupling condenser.

It is so constructed that the losses are reduced to a minimum.

This Free Technical Information Service is Open to All "Modern Sets" Readers. When Forwarding Your Question Be Sure to Give Every Detail Possible Regarding the Type of Receiver, Make and Type of Valves and Speaker, and All Details Which You Consider May Help Us to Solve Your Trouble. Only in Special Circumstances Can We Answer Enquiries by Post.

Can I use my battery charger employing a dry metal rectifier as an "A" battery eliminator? — "Interested," South Melbourne.

Yes, you can use your battery charger as an "A" battery eliminator, provided its output is suitably smoothed, and that supply is carefully governed by means of a 60 or 70 ohm rheostat and a voltmeter connected in shunt.

The smoothing system will consist of two 1500 mfd. electrolytic condensers and two low frequency chokes. Both the rheostat and voltmeter are extremely important because, as you will be under-loading the rectifier, its uncontrolled voltage would tend to fly up well above 8 volts, with disastrous results to the valves' filaments.

However, while stressing the necessity for great care on this point, the system is quite satisfactory.

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