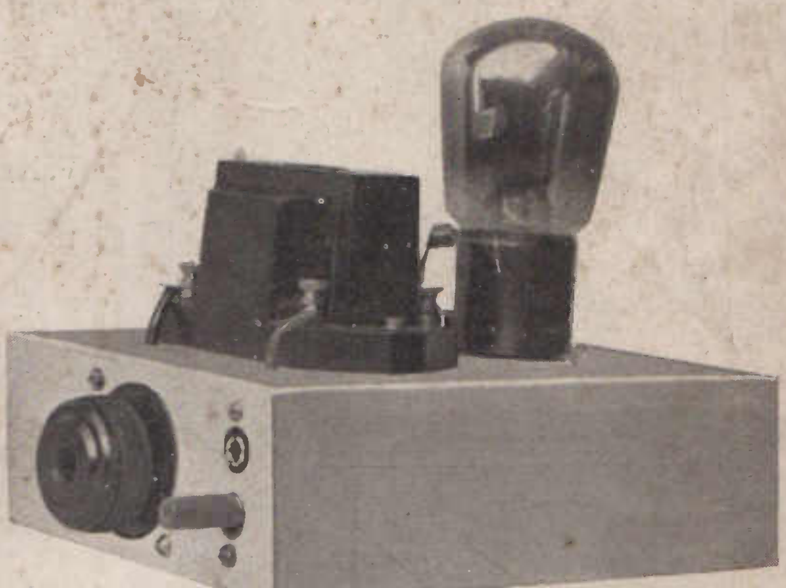
MODERN SETS

MONTHLY

DEC 1932



Now build this Amplifier for the "Test All Wave One" and get all the loud speaker results you want

PRICE 9d

EDITORIAL

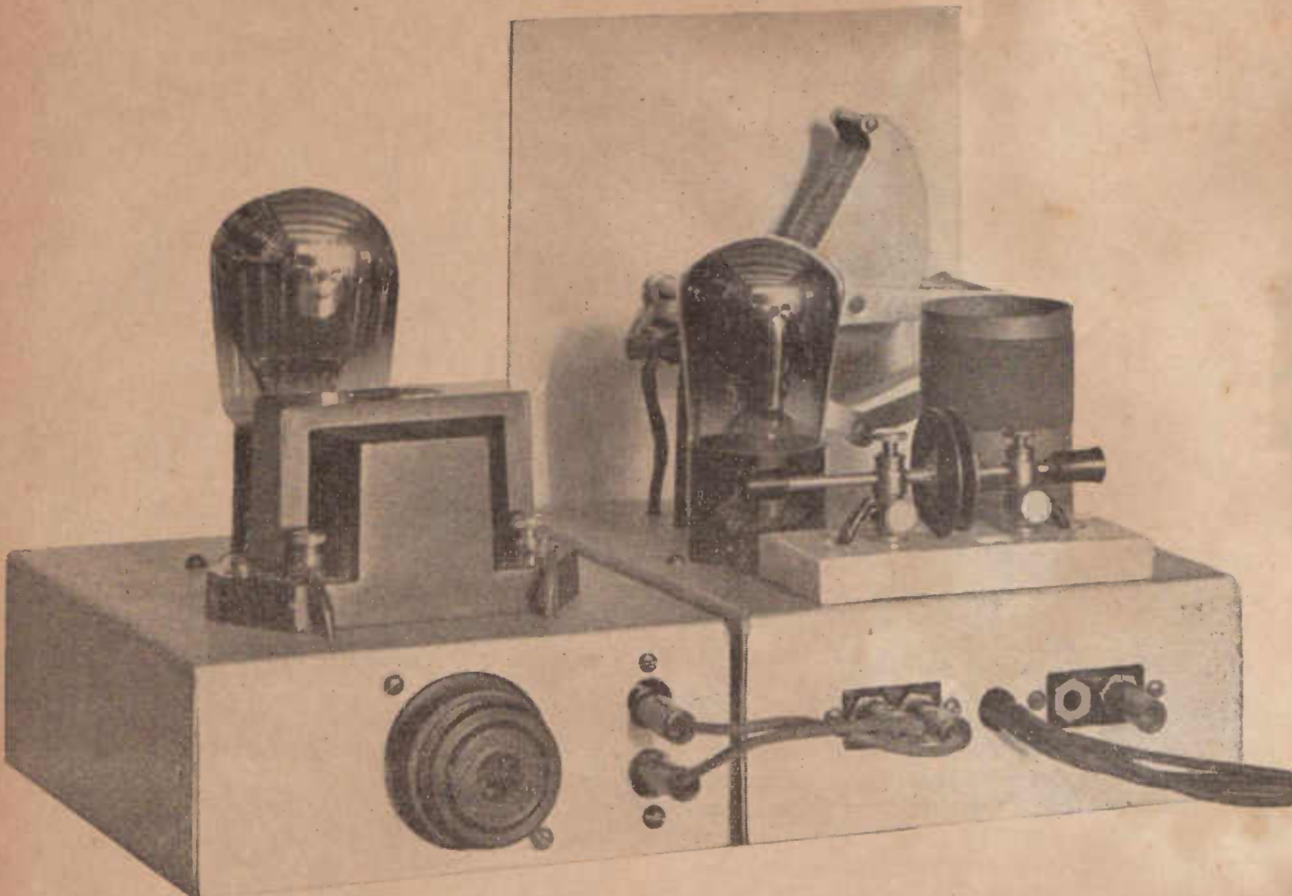
LAST month we burbled enthusiastically about the "Test All Wave Receiver." It was not long before we found our readers endorsed our opinions, as the set soon made many friends. In this connection we would dearly like to hear from readers interesting reports on their experiences with the Receiver. These letters will be published.

Well, we have taken the Test Set a stage further. This month we show you how to build up, with the utmost simplicity and at an extremely low price, a one stage audio amplifier which, when coupled to the set, will produce marvellous results. The member of our staff who designed and built it brought in all the locals with all the volume wanted. Some of them, indeed, could be made to rattle the dynamic speaker, and several of the inter-State stations were received on speaker without interference. The quality, too, was all that could be desired.

On a dynamic speaker a very good register was made of the highs and the bass.

To make the best "All Wave One," the last word in battery-operated receivers, we propose next month (January) to show you how to build an additional stage of R.F. But of this more anon.

Talking about money—who isn't these days?—we have hit on a scheme whereby readers of our journal may turn their spare time profitably to account. It isn't taking samples from a bank, or tips for winners, or anything romantic like that. It is a simple workable scheme requiring little effort. If you are interested, write to the manager of the magazine. Adieu!



Showing method of linking the set with the amplifier.— For permanent use a complete front panel can be fitted.

Now Build an A. F. Amplifier for the "TEST" ALL WAVE ONE

By CHARLES M. SCOTT. (VK.3CS.)

IN our last issue readers will, no doubt, remember the article describing the Test All Wave Battery One. For this little distance-getter we have designed and built up a one-stage transformer coupled audio frequency amplifier, to enable constructors to get good louder speaker strength on the local stations within about thirty miles or even further, from the local broadcast stations.

This little amplifier will also boost up the short wave signals, and even bring in some of the more powerful of these stations on the speaker.

Transformer coupling has been adopted because of the greater voltage amplification possible with this system.

The output of the audio frequency transformer swings the grid of a Philips Pentode, the B443, which gives a far greater amplification than any three element battery output valve.

Bias is obtained for this tube from a small dry battery.

Although designed for a working plate potential of 150 volts the B443 works surprisingly well with only 60 volts on the plate and screen grid.

At this plate voltage an ordinary flat type 4.5 volt. torch battery will be quite sufficient for bias.

However, the greater the plate potential the better the volume and quality will become.

Ninety volts were found to give excellent all-round results for both volume and economy. At this potential the anode current is much lower than at 150 volts, consequently achieving a big saving in "B" battery consumption. The best bias at this potential will be round about 7 or 8 volts.

Assembling the Components.

The amplifier is built up on a 16 gauge aluminium chassis measuring only 6½ in. x 5 in. x 2 in. deep.

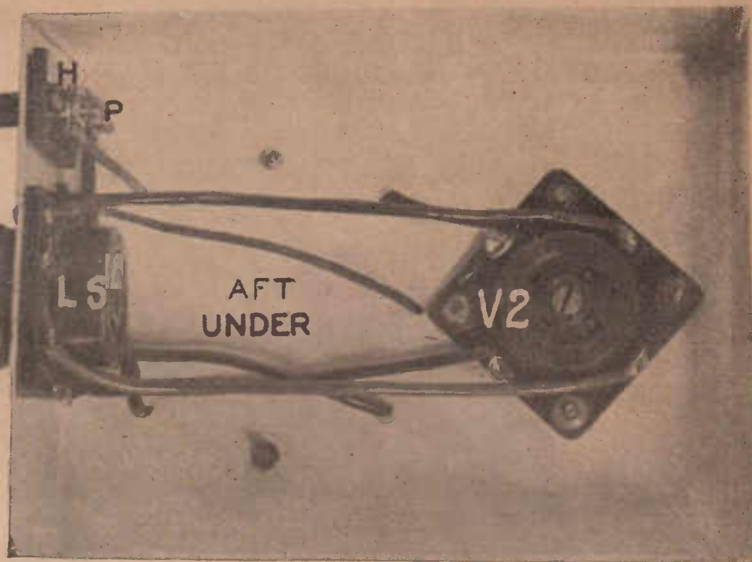
The valve socket, V2, is mounted centrally, but towards one end of the chassis, whilst at the other end is mounted the audio frequency transformer, AFT.

Underneath and at the transformer end of the chassis is mounted the five pin socket, LS, which takes a Marquis five pin plug to which is attached the battery and speaker leads. Next to the socket, LS, are mounted the banana sockets, P and H, which are the input terminals of the amplifier.

MANY PEOPLE BUILT UP THE "TEST" ALL-WAVE ONE.

THEIR RESULTS HAVE BEEN REMARKABLE.

NOW WE SHOW YOU HOW TO GET GOOD LOUD SPEAKER STRENGTH FROM THIS FAMOUS DISTANCE GETTER.



Simplicity itself—a few neat connections and the amplifier works.

These banana sockets are mounted on a strip of bakelite, which is screwed to the chassis. To insulate the sockets from the chassis two 3/8 diam. holes have been drilled to allow plenty of clearance.

Point to Point Wiring.

The wiring of this small outfit is fairly simple, but care must be taken to see that no shorts to the chassis occur.

Starting at the input banana socket H, a wire is run to the terminal marked P on the audio frequency transformer AFT. From the other input banana socket P a wire is taken to the HT + terminal on the transformer AFT.

Now the G terminal on the transformer AFT is connected to the G terminal on the four pin valve socket V2, the remaining terminal GB on AFT is joined to the G terminal on the five — X pin socket LS.

The F— terminal on the valve socket V2 connects across to the F terminal on the socket LS, whilst the F + terminal on the socket V2 connects across to the other F terminal on the socket LS.

The P terminal on the valve socket, V2, is now connected to the C terminal on the socket, LS.

The remaining terminal P on the socket LS is connected directly to the screen grid terminal on the side of the pentode valve.

This completes the actual wiring of the amplifier unit.

Now for the connections to the plug.

To this five pin plug are connected the battery and speaker leads.

The C — battery lead is connected to the G pin, the two filament leads to the two F pins, the high tension B + and one terminal of the loud speaker or phones to the P pin and the remaining speaker lead goes to the C pin.

The C + is connected to the A + either at the battery or at the pin.

To switch the amplifier off you simply pull out the plug. If desired the switch on the detector unit can be used to cut off the filament current of the amplifier. This is done by connecting the A — lead of the amplifier directly to the F — terminal on the valve socket VI instead of taking it direct to the battery.

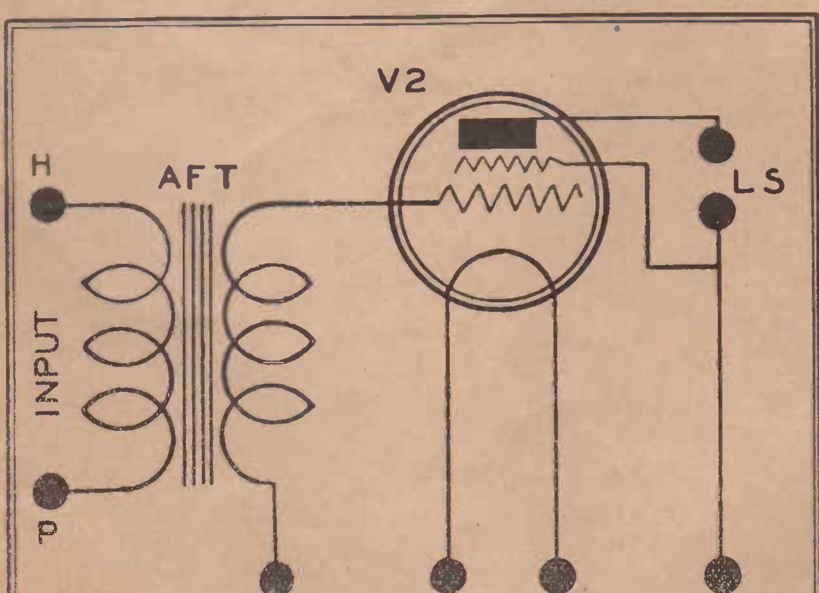
The filament current to both units must then pass through the switch S1.

This outfit could also be used to increase the strength of your crystal re-

(Continued on page 36.)

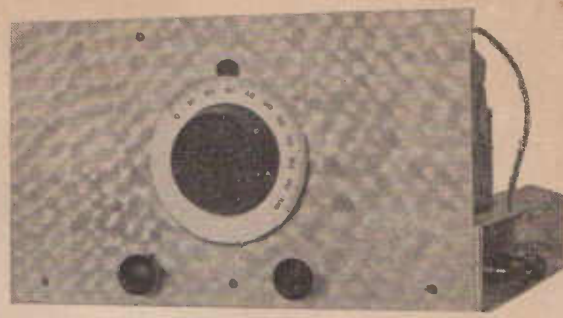
THE PARTS THAT ARE NEEDED.

1. Philips Valve B443, V2.
1 UX Marquis valve socket, V2.
1 UY five pin Marquis valve socket, LS.
1 Lissen audio frequency transformer, AFT.
2 banana sockets.
4 banana plugs.
1. 16 gauge aluminium chassis, 6½in. x 5in. x 2in.
1 dozen 1/8in. nuts and bolts, a few lengths of wire and sleeving.



The circuit of the amplifier. Note the B— lead is not shown; this is already connected to the detector unit.

The "Cockie's" Battery Operated Three



A laboratory sample of the completed receiver.

THE trouble which most battery set users are encountering at present is the failure of Australian technical writers to realise their need for modern sets.

All the experimental work is towards the improvement of the all-electric set. So great have been the improvements in batteries and valves that it now is possible to develop battery-operated receivers which, valve for valve, are more efficient than their a.c. replicas. Another important point, too, is that the building of a good battery-operated set is much less expensive than that of an a.c. set, and, for the novice, certainly offers less difficulty.

This set is capable of exceptionally good results. In the main, though, it is intended to be used as a "local" receiver, that is to say, it has a reliable receiving range of about 150 miles. The next step was to build up a real distance getter. This is the class under which the set we presently will describe will fall. Using, as it does, a screen grid r.f. valve, a screen grid regenerator detector, and a pentode audio amplifier, it is, without doubt, the most sensitive three-valve combination which possibly could be evolved.

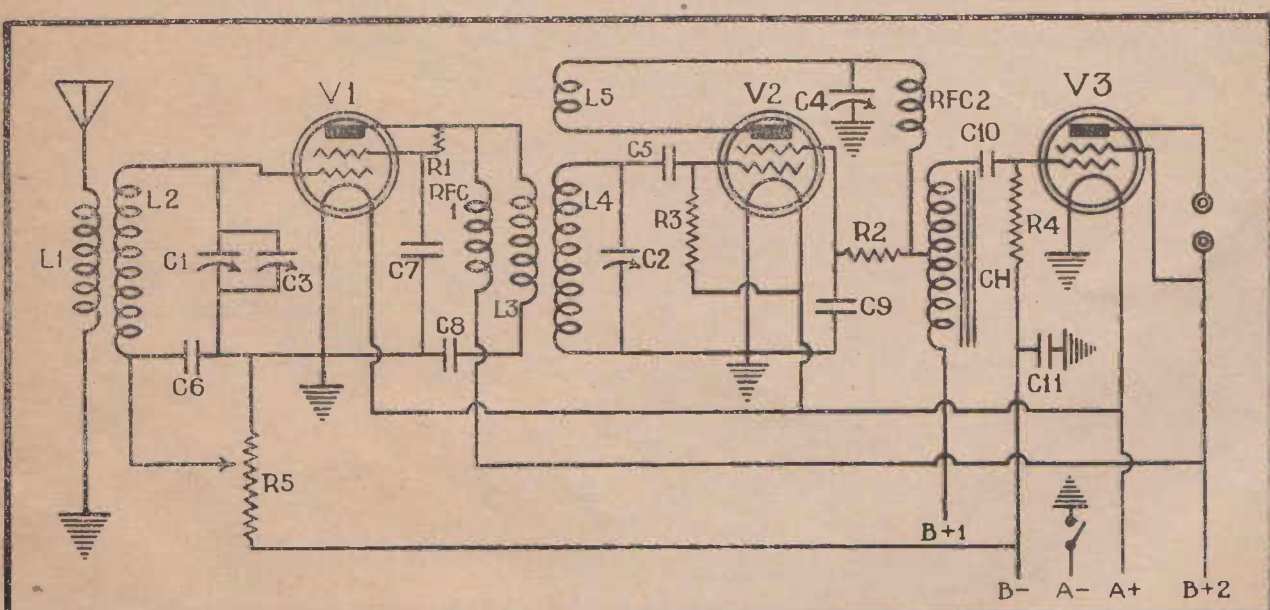
Its other "high lights" include the use of gang controlled tuning, which eliminates the need for two main tuning dials; the inclusion of automatic "C" bias which improves the tone quality of the set, and makes the "B" batteries last longer; the famous Velco choke coupling audio system which has already given such fine results in the various Loftin-White a.c. sets; and the fact that it is phenomenally light on "B" batteries.

Although we say it as shouldn't, we believe this receiver to be the best engineered three-valver which has yet been brought to the notice of the set building public. Before we go on with the actual constructional details, it would be as well to go over the schematic diagram and to deal with each stage of the receiver.

Technical Description.

The R.F. Stage: As will be seen from the diagram, the aerial is loosely coupled to the r.f. grid coil by means of the coil L1. The grid coil L2 is a standard type of coil, details of which will be provided later. This coil is tuned by the .0005 mfd. condenser, C1, which is part of the two gang tuning condenser. Any inequalities in the "ganging" of the two-tuned stages are made up by the "trimmer" condenser C3. The .1 mfd. fixed condenser C6 is used to isolate the grid from the filament circuit in V1, so that bias may be applied to the grid through the resistor R5. The plate circuit of the r.f. stage is especially interesting, for it employs a system which has never really been exploited in Australia.

Developed by a well-known engineer, this r.f. coupling system is characterised by an extremely high gain and a great degree of stability. Its operation is as follows:—The plate supply for the r.f. valve V1 is fed through the radio frequency choke RFC1 to the tube. The



The schematic diagram of the three valve battery operated set will convey to the technically minded reader every "high light" of this remarkable receiver. Note that all components are key-lettered to correspond with the various photographs.

r.f. output of this tube cannot pass through the r.f. choke, and thus is forced into the primary winding L3, which is coupled inductively to the detector grid coil L4. In order to provide a true oscillatory circuit for the r.f. tube, the other end of the L3 is coupled through a .1 mfd. fixed condenser to the filament of V1. The resistance R1 is used to drop the plate voltage for V1 to a value sufficient for the screen grid of this tube. The screen grid is by-passed to earth through the fixed condenser C7 in order to prevent any undesirable feedbacks.

The Detector Stage: In this stage the grid coil L4 is tuned by the .0005 mfd. condenser C2, which is the second section of the gang condenser. C5 is the grid condenser and R3 the grid leak. The detector valve V2 is another screen grid tube. Its already high sensitivity is further increased by the use of regeneration applied through the coil L5 and the midget condenser C4. The r.f. choke RFC2 is used to prevent radio frequency currents from entering the audio amplifier. Again, the screen grid voltage is automatically regulated by a resistor connected between the plate and screen grid of V1. The screen grid again is connected to earth through a fixed condenser.

The Audio Stage: The high impedance detector valve is coupled to the audio stage by means of a special high impedance Velco choke coil, which ensures that both high amplification and good quality reproduction will be obtained. Because of the difficulty of providing sufficient voltage for Loftin-White amplification, the detector valve is choke coupled to the audio tube by means of the choke CH, the fixed condenser C10, and the resistor R4. The audio valve itself is a high gain pentode.

The fixed condenser C11 is used to shunt the bias resistor and thus prevent instability.

WHAT YOU WILL NEED.

Having dealt with the technical features of the receiver, we now can take up the question of construction. To build the receiver the following parts will be needed:—

1 2 gang .0005 mfd. variable condenser (C1, C2).
2 A.W.A. UX sub-panel sockets for V1 and V2.
1 A.W.A. UY sub-panel socket for V3.
2 2¾ inch diameter formers, each 2½ inches long.
1 Velco high impedance choke (CH).
5 Chanex .1 mfd. fixed condensers (C6, 7, 8, 9, 10).
1 Chanex 4 mfd. fixed condenser (C11).
2 Radiokes R.F. chokes (RFC1 and 2).
1 Radiokes 5 plate midget (C3).
1 Radiokes 23 plate midget (C4).
4 Insulated terminals.
1 .00025 mfd. grid condenser (C5).
1 2 meg. grid leak (R3) and mount.
2 .1 meg. resistors and mounts (R1 and R2).
1 Dubilier .25 meg. grid leak (R4).
1 Velco 1000 ohm resistor (R5).
1 Vernier dial.
1 Metal chassis and front panel.
2 Valve screens.
2 Dividing screens.
2 Osram S.410 valves (V1 and V2).
1 Osram P.T. 425 valve (V3).
4 doz. machine screws.
6 lengths spaghetti.
10 feet rubber covered flex.

It will be noted that much of the material listed above is definitely specified, whilst the selection of other apparatus has been left to the set builder. The reason for this is that the apparatus we definitely have mentioned is, in our opinion, necessary to the success of the receiver. Other equipment may be substituted by the experienced builder, but the novice is advised to stick closely to the list specified.

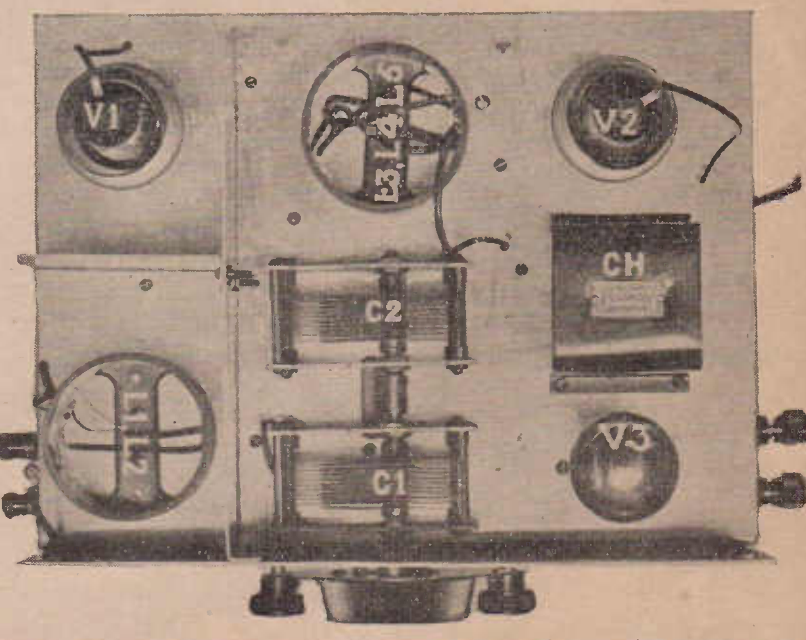
This is particularly important with regard to the Osram valves, and the Velco choke. In the case of the first-named the internal capacity is so low that a high degree of amplification can be obtained without any trouble from instability. Other screen grid valves have a greater internal capacity, so that the amount of signal amplification that can be obtained without trouble is seriously limited. In the case of the Velco choke the position is just as serious. There is no choke on the market to the writer's knowledge which matches the plate impedance of the screen grid tube as well as the Velco. Any failing in this direction will result in lowered amplification and a reduction in tone quality.

Now for the constructional details.

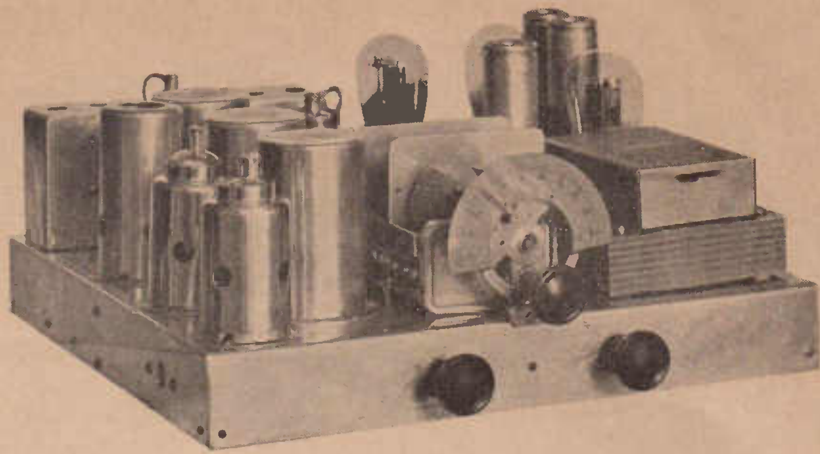
Building the Set: The metal chassis upon which the set is built measures 12 inches in length, 9 inches in width, and 2 inches in depth. The front panel which, as can be seen from the illustrations, is nicely mottled, measures 12 inches by 7 inches. The main dividing screen between the r.f. and detector compartments measures 8¾ inches by 4¾ inches, and, in addition, is provided with half-inch angles, so that it can be bolted to the chassis and the front panel. The secondary screen between the r.f. valve and the tuning coil measures 4¾ inches in height, and 3¼ inches in width. Like the main screen it is provided with two half-inch angles to facilitate its mounting to the chassis and the main screen. The valve screens are more involved, and consist of two sections. The bottom, which can be compared to the lid of a cocoa tin, measures 2 inches in diameter, and is provided with "lip" half an inch in depth. In the centre of this cup a hole of 1¼ inches in diameter is cut to fit the portion of the A.W.A. socket which protrudes through the chassis. The top portion of the valve screen consists of a 2 inch diameter tube open at one end, and with a hole 1½ inches in diameter cut in the top end. It is 2¼ inches high. Two valve screens are wanted.

When once the problem of the screens has been overcome, the actual assembly of the receiver may be started. Do this by drilling the front panel to take the gang condenser, the two midget condensers and the machine screws which are to hold the front panel to the chassis. Drilling points are as follows:—

(Continued on page 43.)



This photographic plan view is keyed in accordance with the text, and should make the building of the set exceptionally easy.



An Improved Modern Penthode Superheterodyne

Using the New 57, 58, 56, 55 and 47's in Push-Pull

(A NEW SUPER. THAT OFFERS AUTOMATIC VOLUME CONTROL, TAKES FULL ADVANTAGE OF THE NEW 57 AND 58 R.F. PENTHODES, AND ALSO PENTHODES IN PUSH-PULL.)

By W. G. GREENWOOD.

WITH the introduction of the new six-pin valves, Nos. 57 and 58, which are variable mu radio frequency penthodes, we decided to see how much better they were than the 224's and 235's, so well known to us, and also to see what the 55 diode detector had to offer. Briefly, we can assure you the improvement was manifest in the forms of finer tone quality, with an incomparable gain of a far better signal to noise ratio, absolute 10 K.C. selectivity, freedom from oscillator radiation, and the complete elimination of cross-talk or cross-modulation.

The 55 is a very good detector, which lends itself to adaptation of either full or half wave rectification. With full wave rectification the carrier frequency is balanced out, and is not supplied to the grid of the amplifier; with half-wave rectification the two diode plates are connected together, carrier frequency filtering is necessary, but approximately twice the signal output and A.V.C. voltage is generated, as compared with the full wave connection.

We adopted the half-wave connection, two of our reasons being at present unable to obtain centre-tapped intermediate frequency transformers, and we wanted a good signal output to fully operate satisfactorily the 247's connected in push-pull in our output stage.

The 55 lends itself to connection for automatic volume control, one benefit of the A.V.C. being the ability to tune over the whole dial without any noticeable extra volume or blasting, etc., from the more powerful local stations. The method of A.V.C. we adopted worked quite well, the only noticeable difference being a little more noise, etc., between stations: but.

(Continued on page 11.)

WHAT YOU WILL NEED.

- 1 Kriesler 460 kc Super Het Kit, complete with variable condensers and padder.
- 1 Power Transformer, Grand Opera.
- 1 Marquis UX Socket.
- 3 Marquis UY Sockets.
- 4 Marquis 6 pin Sockets.
- 3 Polymet 8 mfd. 500-volt Electrolytic Condensers.
- 5 Valve Shields.
- 1 15,000 ohm Divider.
- 1 10,000 ohm Potentiometer, wire wound.
- 1 50,000 ohm Potentiometer for Tone Control.
- 1 .006 mfd. Condenser, for Tone Control.
- 1 Full Vision Dial.
- 1 250 ohm 100MA Bias Resistor.
- 1 250 ohm 50MA Bias Resistor.
- 1 Hydra 3 x .5 Condenser, 700 V. Test.
- 1 Polymet .1 Condenser, 700 V. Test.
- 1 Alum. Chassis, 16in. x 15in. x 2½in.
- 1 Power Choke 30 H. 100 mills.
- 2 30 ohm C.T. Resistors.
- 1 Push Pull Input Transformer, A.W.A. Ideal.
- 1 .5 mfd. 70 V. Test Coupling Condenser.
- 2 50,000 ohm 2 Watt Carbon Resistors.
- 1 10,000 ohm 2 Watt Carbon Resistor.
- 1 100,000 ohm 2 Watt Carbon Resistor.
- 1 .1 mfd. 700 Volt Condenser.
- 1 .001 mfd. Mica Condenser.
- 1 mfd. By-Pass Condenser.
- 1 2 megohm 2 Watt Carbon Resistor.
- 1 500,000 2 Watt Carbon Resistor.
- 2 .00025 T.C. By-Pass Condensers.
- 1 .01 T.C.C. By-Pass Condenser.
- 1 R.F. Choke, shielded if possible.
- 1 Pea Lamp and Socket for Fuse. Flex for wiring and connections to A.C., nuts and bolts, solder and terminals.
- 1 Speaker Outlet Plug and Socket, 5 pin.
- 1 Dynamic Speaker, 2500 ohm Field matched for Push Pull Penthodes.
- 1 Yard of Braided Flex (metal braid covering).
- 1 Ken Rad 55 Valve.
- 1 Ken Rad 56 Valve.
- 1 Ken Rad 57 Valve.
- 2 Ken Rad 58 Valves.
- 2 Ken Rad 247 Valves.
- 1 Ken Rad 280 Valve.

(Continued from page 9.)
despite that, we think it worthy of adaptation. However, if you do not want to use the A.V.C., simply run the sec. return ends of aerial and first I.F.T. coil to earth and don't connect in the .01 by-pass condenser and 2 meg leak to grid of 55.

The circuit and kit used is the one developed in the Kriesler factory, the only addition being the connection of the 55 as second detector, and using a push-pull audio stage, and consists of eight valves, including the rectifier.

Probably you wonder why we use eight valves, but we can assure you you will be well repaid, getting better volume and fidelity when listening to either local or distant stations; further, we recommend the use of push-pull audio, as the result is better bass reproduction and an all-round improvement in quality reproduction, with none of the overloading that a single penthode would give were you to turn up your volume control on a local or powerful station.

In practice, a single 47 will give the same voltage amplification as does a 227 first audio stage and a 245 power output stage; we might therefore say a 47 penthode is equal to two ordinary stages—i.e., a 227 and 245; but actually this is a conservative statement, since the undistorted output of a 47 is from 2½ to 3 watts, or far greater than a 245 power valve. However, in order to get good quality reproduction we decided to use two 47's, connected in push-pull, and the results obtained were a good 4-5 watts output from local stations. Naturally, two 47's will give us from 6-7 watts if boosted by a previous audio stage, but considering the point that, naturally, greater amplification means more noise and louder static, etc., we decided to use one audio stage consisting of two 247's connected in an auto-transformer arrangement, and, despite the fact that penthodes are howled down a great deal by many on account of tube noises and tinny reproduction, etc., we state that, if used properly, they will give really good quality reproduction, and with little or no trouble.

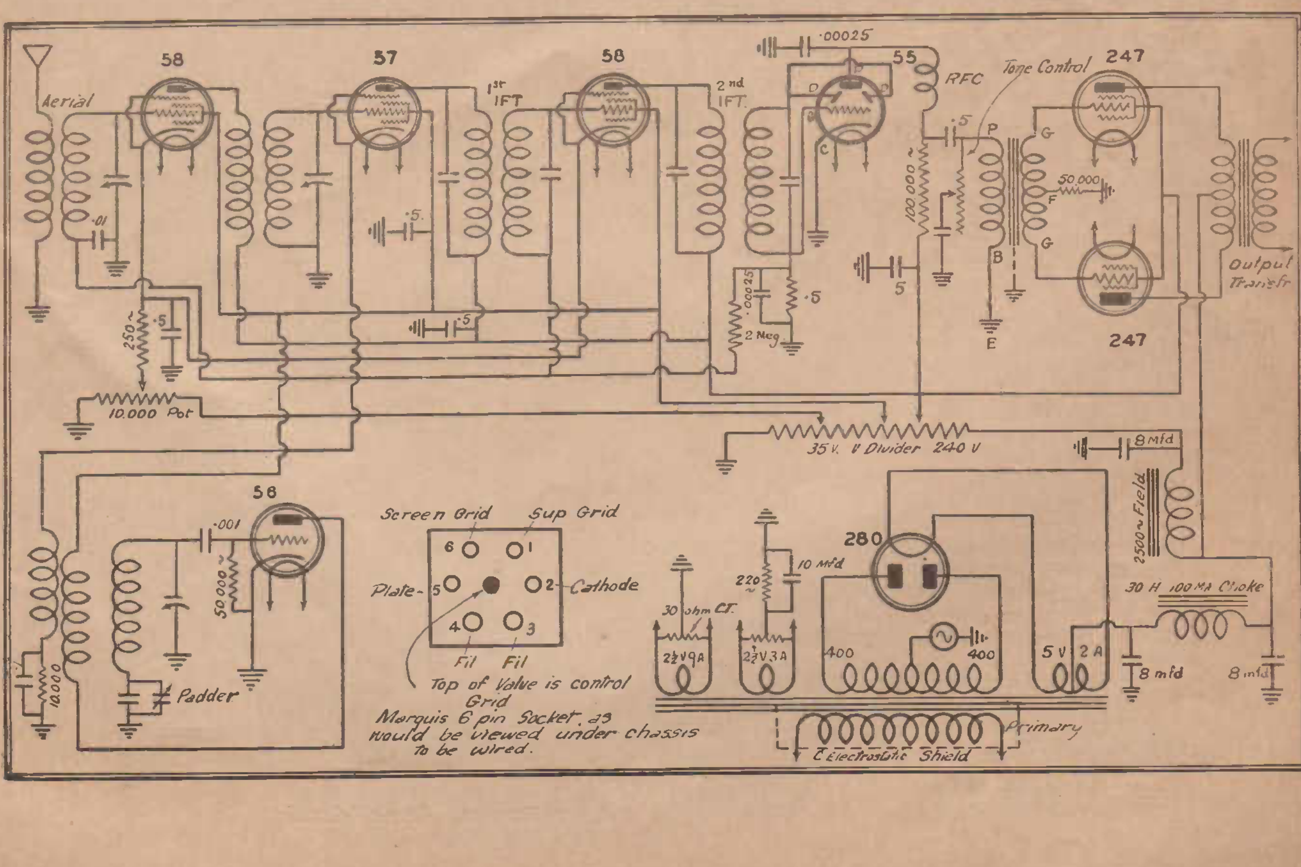
In the set described we used a .5 coupling condenser to the push-pull transformer primary, and we attribute a great deal of our bass reproduction to that. Naturally, we advise a good quality transformer. If you have a Ferranti AF5C, we advise you to use it; if you happen to have an A.F.5 which is not centre-tapped on the secondary you could use that by connecting two 250,000 ohm resistors in series across the secondary, taking the centre connection of the resistors to earth; by this means you obtain a fairly good electrical centre-tap, and results are quite good.

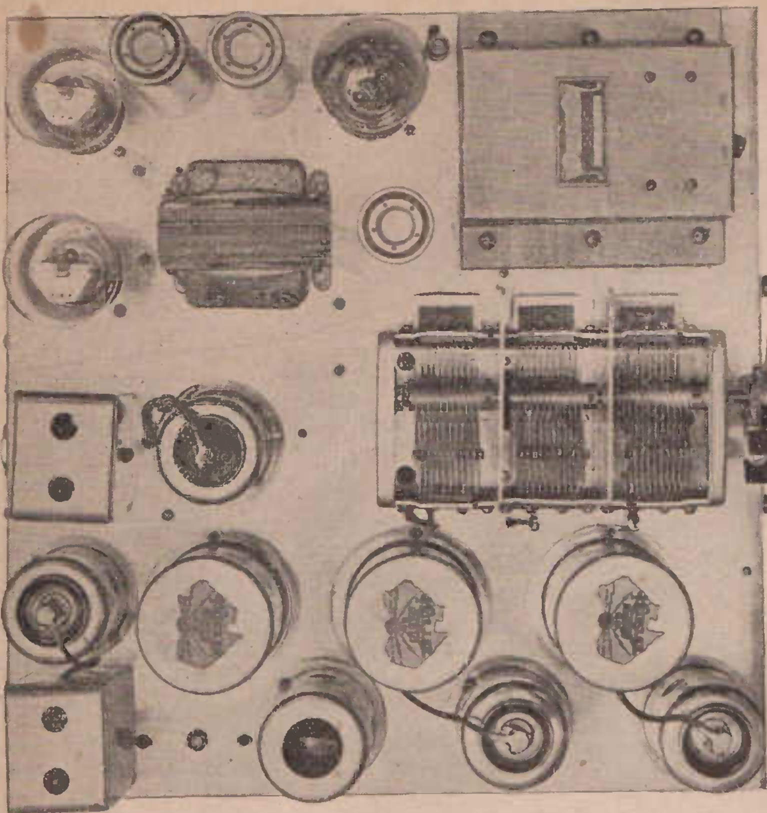
However, so much for the audio system. We do not think it necessary to give a point to point wiring description, as the man who tackles a super will have had some experience with electric sets and be quite able to follow the circuit as shown in Fig. 1. We used a new Kriesler superhet. kit, made for the new valves, but if you happen to have one of the other kits it can be used quite satisfactorily, and will give you good results. And, although we have not used the new Radiokes or Lek-Mek kits, we feel certain that they would give you equal results and would be adaptable to the circuit described, which, like nearly all the new super kits, has its intermedite transformers tuned to 460 k.c. instead of the earlier 175 k.c. So far we have not found any great advantage with the former, excepting a lower noise level and freedom from harmonics. However, quite probably there are other advantages.

The layout of the set is probably a little wide for many who have cabinets, the chassis being 16 x 15, with a 2½ in. bend all round, and is made of 16 gauge aluminium. However, this could be modified to suit, bearing in mind the necessity of short grid, plate and oscillator leads. You will notice we have used a quantity of metal braided flex, the object of this being to stay interaction from surrounding wires and components. The metal braid must be earthed to chassis, otherwise it would be of little benefit. In the original we shielded the cathode connection from the 57 to oscillator coil, return of secondary of the aerial coil and first intermediate secondary to 2 meg. bias resistor coupling to return of second intermediate secondary for A.V.C. control, and also aerial connection to coil.

The Power Transformer.

The power transformer must have a secondary winding of 400-425 volts each side, and must be capable of supplying 100 milliamps; 2-2½ volt





Top view of chassis, showing layout of components.

filament windings, one of 3 amps, and the other of 9 or 10 amps; one 5 volt, 2 amp for the rectifier, and, if possible, one with an electrostatic shield. The advantage of this shield is to stop a lot of power-line noise, and will help to minimise stations' modulation hum. However, if you do not use a transformer with electrostatic shield, you will need to use a .01 condenser tested to 1500 or 2000 volts from the B+ output supply from the 280 to one side of the 400 volt secondary winding, or from B+ output supply from 280 to earth.

In the original we used a Grand Opera universal transformer, and no fault could be found, it being exceptionally well made, with a 120 milliamp secondary, an electrostatic shield and very good regulation, also being made to fit into the chassis, an added advantage for wiring.

Condensers and Resistors.

Three 8 mfd. electrolytic condensers of 500 volt test should be used to give good filtration; other by-pass condensers can be from .1 to .5, or even 1 mfd., and tested to work on 200 volts; other condensers, of the smaller type, should be of mica for preference. Carborundum 2 watt resistors are alright for plate resistors, etc.; bias resistors are wire wound, and the 250 volt capable of standing 50 mills.; the bias resistor for the penthodes, from 220 to 250 ohms, and able to stand up to 70 mills. The voltage divider can be of either 15,000 or 25,000 ohms.

The filter choke should be 30 henries at 100 milliamperes.

The speaker should have a field winding of 2500 ohms, and must be matched with an output transformer to suit push-pull penthodes, otherwise tonal quality will be impaired. Wiring will be carried out in the normal wire, with good quality flex, etc.

Adjustment on Completion of Wiring.

Check up and make sure all connections are well soldered and making good contact, and that correct voltages are getting to all valves. When this is done, tune in to a strong local station, adjust trimmers roughly until you are receiving station fairly good; next adjust padding condenser two-thirds of the way in, then turn to 3KZ or 3AW and adjust again with trimmers until you are able to get good selectivity and volume; now turn to 3AR or 2FC or 2CO.

Now you will adjust the padding condenser only. Don't adjust the trimmers at all in this setting. During the adjustment of the padder, turn dial to and fro a few degrees until you obtain a setting of the trimmer where you get the greatest volume, this being the correct setting. Any further adjustment to trimmers should be effected on the lower wave-length stations below 3UZ.

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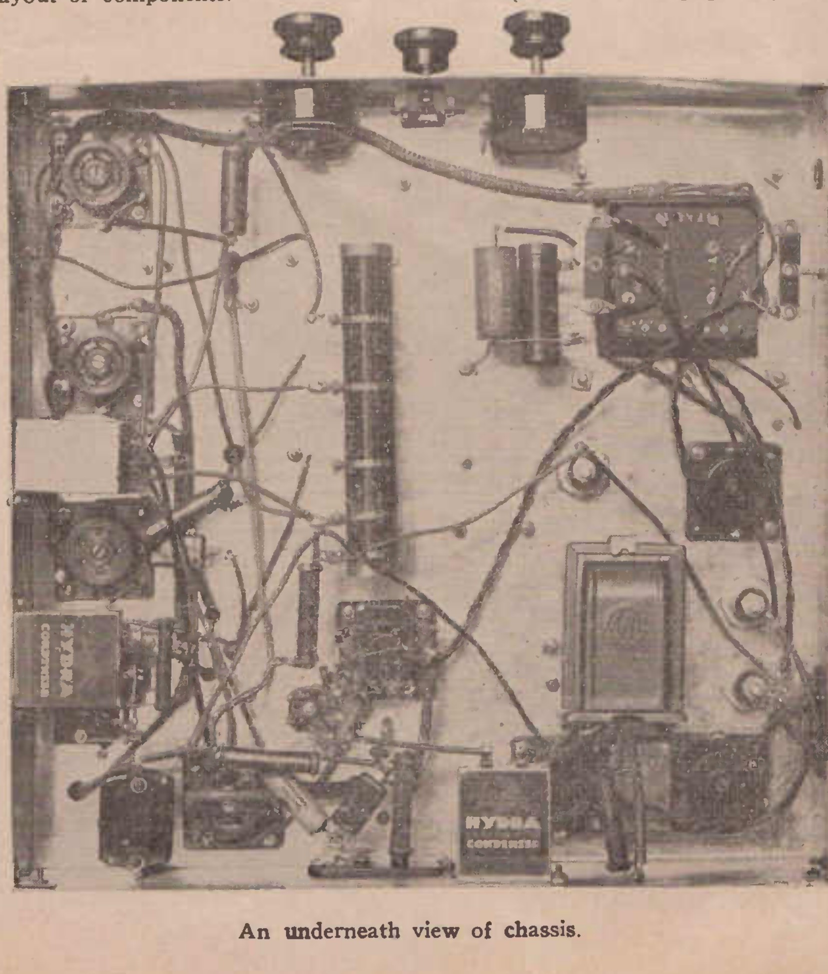
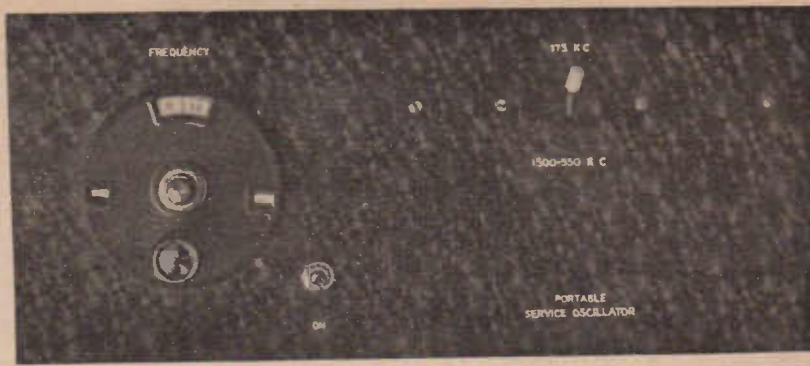


An underneath view of chassis.



Front Panel View Section.

A Portable Service Oscillator

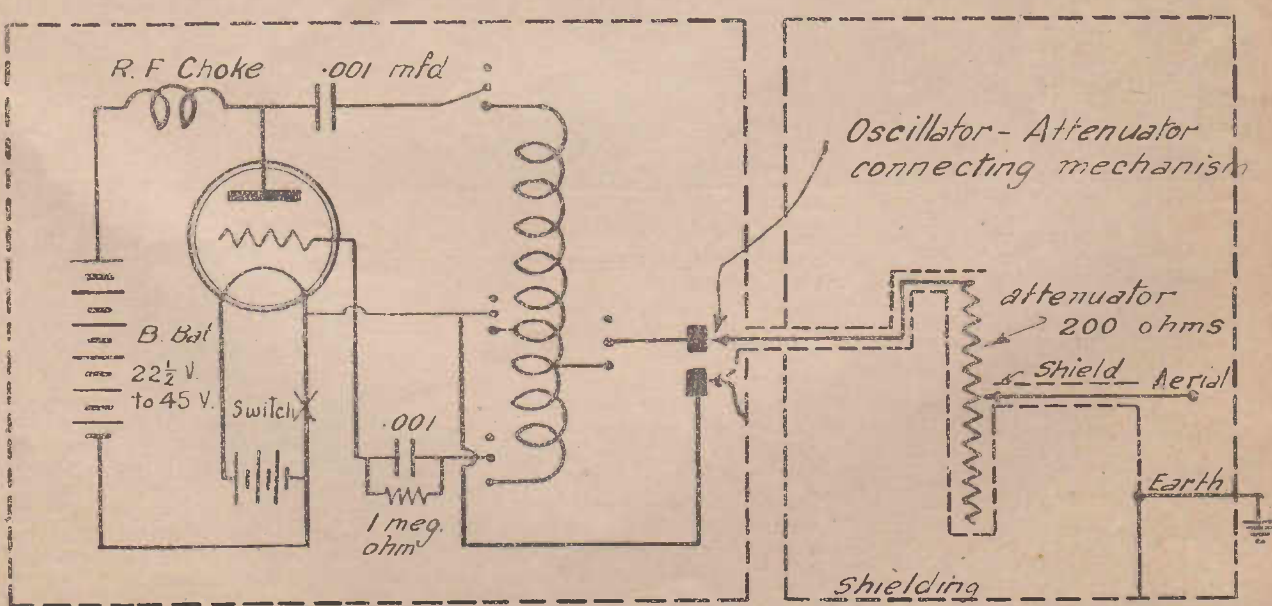
By "Service."

MODERN servicing calls for a great deal more instruments than of yore, for the days of the service man who carried a screwdriver, and perhaps a voltmeter, are gone. To-day's receivers, with their multi-tuned circuits all ganged together, call for far different equipment if satisfactory service is to be done, and with more stations on the air the days of aligning sets by tuning in a weak station are also gone, for sets aligned in such a manner are never very sharp in their tuning, which brings up the subject of oscillators. Various types of oscillators have been described from time to time in technical radio papers, but the writer has seen few which are really suitable for the service man.

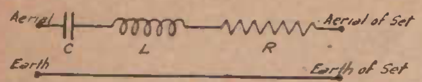
For his own convenience, the writer built up the service unit shown in the photographs, the main considerations being that of size and weight, together with an electrical circuit that would take care of all servicing needs, including supers.

The instrument is contained in a copper-lined, two-section box, actually there are two separate copper boxes, and it is entirely self-contained, since a light duty 45-volt B battery supplies the plate voltage and a standard 4½ volt C battery does nicely for the filament of the tube, which is a 409.

By examining the circuit, it will be seen that a single tube is used in this oscillator, and is of the blocked grid type in which the grid condenser and grid leak values are so chosen that the oscillator tube blocks up at audio frequencies and is, therefore, modulated at these frequencies. Of course, modulation is necessary because nothing would be heard of the oscillator on a non-regenerative receiver were it not modulated. This system has one fault in that it is inherently broad, due to the method of modulation, but this is not a bar to good work if its output is kept down to a reasonable level, whereas oscillators having a separate modulator tube are a bit difficult for the average service man to build and adjust; and, anyhow, require more battery power and mean heavier weight. In order to cover both the broadcast band and the intermediate frequencies, for super-het work, two coils are required, the change from one to the other being made by means of a four-pole two-way anti-capacity switch. Only one coil is shown in the diagram for the sake of simplicity. Tuning is done by means of a single variable condenser for both coils. The output from



It may be necessary to connect the shielding on the wire to the attenuator shield, where it comes through the shield.



L = 28 turns of 30 B & S wire, space wound on a 1¼" former, to occupy 1" length.
R = 25 ohms.
C = .0002 mfd.

the oscillator is obtained by tapping off a part of the grid coil and feeding the voltage developed across this section into an attenuator consisting of a potentiometer of two to four hundred ohms.

To keep leakage to a minimum, it is necessary that the whole system be thoroughly shielded, and that the attenuator be shielded from the rest of the apparatus. We have provided, therefore, a box divided into two parts, and each part being lined with thin copper foil, the dividing piece in the box keeping the two copper shields well apart (¼ inch). It should be borne in mind that the outer container must be of wood or some insulating material, so that the two copper sections can be kept isolated from each other.

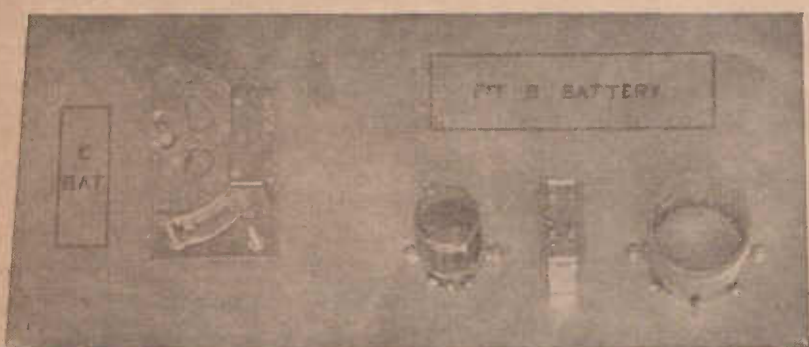
The construction is very simple, the main parts to watch being that the variable condenser bust be insulated from the copper shielding on the back of the panel (both panels are backed with copper to complete the shielding), and that none of the components make contact to it. This also applies to the attenuator (which is mounted on a panel separate to that of the oscillator) and great care taken to allow a fair copper compartments in such a position that the springy brass pieces will make contact with them. One of each of these flat pieces is connected to the copper by as short a lead as possible, and becomes the earth point for the oscillator.

In wiring, use bus bar throughout, and keep all leads as short as is convenient, and do not earth any of them. Those about the switch should be kept well apart, and the lead from the "earth" clip of the panel is connected directly to the leaf of the filament section of the switch.

The centre leaf of the tap section of the switch is connected to the aerial section of the contact system by means of a shielded lead, the shield being connected to the earth section as shown in the diagram.

To join up the attenuator, a shielded lead is taken from the arm of the potentiometer, the shield being connected directly to the earth terminal at one end, and one of the outer terminals of the potentiometer at the other end. The free end of the potentiometer is then connected to the attenuator section of the connecting mechanism by means of another shielded piece of wire, the shielding in this case connecting to the earthed end of the potentiometer and to the other plate of the connecting system.

It will be seen, therefore, that the only earth connection between the oscillator and the earth terminal is that provided by the shielding around the wires. In use an earth is connected to the Earth terminal only this system

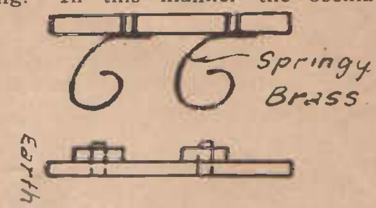


A rear view of the oscillator section partly assembled.

margin of space around the "Aerial" terminal. The earth terminal should be screwed down hard on the copper to make a good contact. All of the components, including the batteries, are mounted on the panels, so that is is only necessary to remove either panel for inspection of the whole of the works without disturbing the shielding in any way. In order to make connection from the oscillator to the attenuator, two pieces of springy brass are mounted on a piece of good bakelite which is screwed to the back of the panel, taking care that the brass pieces do not earth to the shielding. Two flat pieces of brass are then mounted on another piece of bakelite, and this is screwed to the dividing wall between the two helping to reduce leakage to a minimum.

Adjustments are simple, since the instrument will oscillate first shot if the apparatus is in good order. Have a receiver going, and connect it to the oscillator. Set the switch to the broadcast band, and turn the dial until the oscillator is heard, having the attenuator turned to the full on position. Adjusting the attenuator will then reduce the signal if everything has been done properly, after which the grid leak and condenser combination can be altered until a satisfactory note is obtained, and one which does not change much as the dial is turned from one end of the band to the other.

The frequency of the oscillator can be calibrated by beating it with the signals from broadcast stations of known frequency until zero beat is obtained. The output should be kept to a reasonable level when doing this to ensure accuracy. The 175 KC calibration can be obtained in a somewhat similar matter. A receiver is again required, and after setting the switch for the intermediate band, tune in a station, and then tune the oscillator so that one of its harmonics beats with the BC signal. Adjust for zero beat, and note the exact frequency. Now do the same with an adjacent harmonic. Keep on doing this until you obtain settings for two consecutive harmonics, which are exactly 175 KC apart, for harmonics are merely multiples of the fundamental, so the difference between any adjacent harmonics will be the frequency at which the oscillator is working. In this manner the oscillator



Connecting Mechanism.

can be calibrated for several IF positions.

The dummy aerial takes the place of the usual aerial for test purposes, and is connected between the oscillator and the receiver. The specifications are given in the drawing, and need not be repeated here.

To use the oscillator, the dummy aerial is connected between the oscillator and the receiver, and the earth terminal of the latter earthed. With the oscillator switched on and the attenuator at the maximum position, the signal is tuned in, and then the output adjusted to a reasonable level by means of the attenuator. The receiver can now be aligned according to the manufacturers' instructions. If possible, an output meter should be used instead of relying on the ear. This, preferably, should be an AC voltmeter of the copper oxide type, and should be connected across the primary of the speaker input transformer through a 2 mfd. fixed condenser, the purpose of the latter being to prevent the DC component from flowing through the rectifier. The standard output is 50 milliwatts, and the input should be varied to obtain this value.

Coil Data.

The coil for the broadcast band consists of 90 turns of 33 B and S enamel closely wound on a one-inch former, while that for the intermediate frequencies has 190 turns of the same wire, wound on a two-inch former.

A lay for the filament is taken at the centre of each coil, and the output tap for the broadcast coil two turns along the grid coil from the filament tap.

For the IF coil the lay is taken at four turns.

The Variable Mu

How to Reduce Valve Noises

IT is possible to vary the H.F. input and cause a deterioration in selectivity, or even alter tuning. A variable resistance in parallel with a tuned grid circuit would do this.

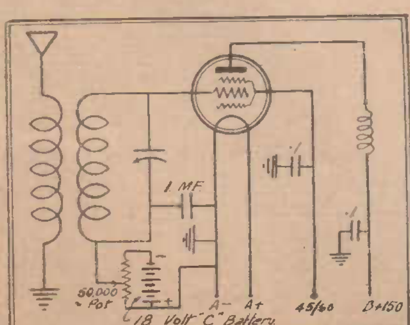
But even if we choose a different method of cutting down the input, the H.F. valve (an S.G. valve in these days) will retain its full amplifying power even though that power is not used. The result is that "valve noises" (due to irregularities in filament emission, etc.) remain, and are more noticeable because the desired signals have been toned down.

The valve noises can be cut down by reducing the amplification, and many sets provide a means for reducing both H.F. inputs and amplification.

It may well be asked: "Why not just reduce the amplification?" The retort to that is: "Because if you do, the strong signals—being applied to a valve specially adjusted to operate inefficiently—will become distorted and, moreover, cross modulation will result."

This answer requires further explanation, but the question was an extremely sensible one—so sensible, in fact, that someone decided that reducing amplification was the only logical and seemly way to go about the job, but that a special valve would be needed. That valve was the variable-mu. With this valve one is able to vary its mutual conductance. (The mutual conductance, of course, is the change in anode current in milliamps, produced by one volt change on the grid.)

With S.G. valves, I explained that an S.G. valve had a grid-volts-anode-current curve no different from that of an ordinary 3-electrode valve.



Battery Circuit.

At a certain negative potential on the control grid the anode current is zero; as we make the grid less negative the anode current rises slowly at first, and then—at what we call the "bottom bend"—rises rapidly.

The S.G. curve in the diagram is a sample S.G. valve curve showing what happens to the anode current as we vary the grid potential. (We are not concerned as to what happens when the grid is given high positive potentials, because this never happens in practice.) The normal "operating point" is probably R (—1½ volts), although the value varies with different S.G. valves.

Steep and Straight.

At this point the curve is steep and straight and the maximum amplification is obtained. But if we gave the control grid of our S.G. valve a "bias" of —4 volts we should be working near the point Q. We should suffer three main disadvantages by operating at this bend.

(1) The H.F. amplification given by the valve would be decreased as the "slope" is flatter. For every volt on the grid there would be less change of anode current, and therefore lower output volts to be passed on to the detector.

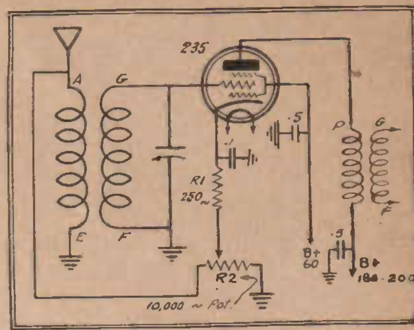
(2) The H.F. would undergo rectification, and this would result to some extent in distortion. For example, large positive grid swings caused by incoming broadcast signals would get on to a steeper part of the curve, and would be amplified more than the small E.M.F.'s occurring at other parts of the stream of modulated oscillations.

(3) Cross-modulation would occur, impairing selectivity. This will be explained later.

Very Small Input.

The objections to the ordinary S.G. valve are, however, numerous.

For one thing, the change in amplification would not be gradual. It will also only handle very small input voltages. If these are exceeded you run into grid current on the positive side and into the bottom bend on the other. You are between the devil and the deep sea!



Circuit for A.C.

With a strong station coming in you are bound to get rectification, with resultant percentage-modulation change, and interference due to cross-modulation.

"Hum modulation" experienced on sets worked from the mains, or where A.C. hum is picked up by the aerial of a battery set, is a similar phenomenon. You only hear the hum when the set is tuned in to a station and when rectification in the S.G. valve is occurring.

The stray A.C. on the grid modulates the stations carrier-wave, and these modulated signals are amplified and detected together with the wanted ones. You thus get an unpleasant hum in the speaker; if you detune, this kind of hum disappears, because no signal is being received.

To avoid cross-modulation, two methods of attack should be employed.

One is to decrease as much as possible the voltage applied to the grid by interfering signals; in other words, we should increase the selectivity as much as possible before the S.G. valve.

The second is to avoid rectification at all costs in the S.G. valve.

Unfortunately, the ordinary S.G. valve is very prone to rectification. It does so on the slightest pretext, and if we start controlling its amplifying powers (e.g., by varying the grid or screen potentials) we are asking for trouble. Hence the development of the variable-mu valve.

There are one or two points that may be mentioned before summarising the merits of the valve. One is that by increasing the negative potential on the grid, the screen-grid current will be reduced.

Screened-Grid Changes.

Since we do not "use" this current in an outside circuit this does not matter. When the screened-grid is connected directly to a point on a high-tension battery a change in screen-grid current will not affect the screen-grid voltage.

But if the screened-grid derives its potential from a potentiometer, or otherwise through a resistance, the change in screened-grid current (due to varying the grid bias) will alter the screened-grid voltage.

To keep the latter steady, in the case of indirectly-heated valves, the screened-grid is connected to a fixed point on a potentiometer across the H.T. supply, while the cathode is connected to a slider working near the negative end of the potentiometer. Moving the slider so that the grid becomes more negative tends simultaneously to reduce the screened-grid voltage, while the fall in screened-grid current tends to increase the screened-grid voltage.

An advantage of the variable-mu valve is that it is possible to have the volume-control potentiometer (for varying the negative grid bias) any distance from the set. Remote control of volume from an armchair is thus very simply carried out.

Automatic volume control, which is popular in America and which brings in all stations at substantially the same strength, is easily arranged with the variable-mu valve.

We arrange that any tendency to very loud signals automatically "pushes back" the voltage on the grid of the variable-mu, thereby cutting down signal strength.

The amount of negative bias required to control the amplification of a variable-mu valve will depend upon the type of valve. As much as forty or fifty volts may be necessary in the case of an A.C. valve, but an 18-volt grid-bias battery is used in conjunction with say, a 50,000-ohm potentiometer when battery valves are used.

ADVANTAGES OF THE VARIABLE-MU VALVE.

1. It provides a very simple form of volume control.
2. Cross-modulation is reduced.
3. Distortion due to rectification is avoided.
4. Wide variations in input may be handled without grid current or "bottom bend" rectification.
5. Absence of grid current ensures constant selectivity of input circuit.
6. Volume control does not affect tuning.
7. Hence volume control does not upset ganging in ganged circuits.
8. Absence of rectification largely prevents hum and "motor-boating" caused by modulation of incoming signal.
9. Background noises in general are reduced.
10. Valve noises are reduced as signal volume is cut down.
11. Remote volume control is a simple matter.
12. The valve lends itself to automatic volume control.
13. Two or more H.F. valves may be controlled at the same time.
14. As most listening is probably done on the more powerful stations, high negative bias will normally be used, thus saving H.T. current.

Making Your Own Records

A New Series of Articles which will tell you about this Fascinating Hobby

CHAPTER I.

THE theory of sound was first perceived scientifically by the ancient Greeks. They were the first to analyse the origin of sound and come to the conclusion that sound as heard by the ear was the result of disturbances in the air. They knew that vibratory objects were the source of sound, but it was not until 1857, only 75 years ago, that Leon Scott patented in France an instrument which he called the phonautograph. Scott's machine utilised a piece of smoked paper attached to the cylindrical surface of a drum, so mounted that when rotated by hand it moved forward at the same time. A stylus was attached to the centre of a diaphragm through a system of levers in such a manner that if moved laterally along the surface of the cylinder when the doaphragm vibrated. Over the diaphragm was placed a barrel shaped mouthpiece. When the drum was rotated, words spoken into the mouthpiece caused the stylus to trace a wavy line upon the smoked paper. This wavy line was the first known record of sound vibrations. Unfortunately, Scott did not go any further in his experiments. He was unable to reproduce his sound, and, as a result, his machine had no practical value. It was Thomas Edison, in 1877, or twenty years later, who came out with his famous phonograph. His machine was very similar to Scott's phonautograph, except that it differed in two very important details. The first was that the smoked paper was replaced by a sheet of tinfoil, and second, the stylus was attached directly to the diaphragm so that it traced an impression of variable depth as the diaphragm vibrated, instead of a wavy line as with the phonautograph. After such a record had been made, the drum was returned to the starting point, and, with the stylus in place, again rotated as before. The recorded sound was then intelligibly reproduced. Thus, Edison gave us the first phonograph and also the first instantaneous record.

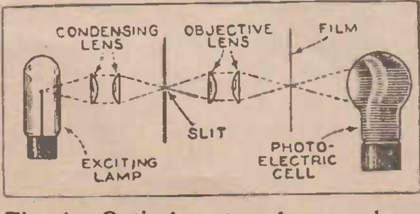


Fig. 1.—Optical system for sound on film reproduction.

In subsequent models the tin foil was replaced by a wax cylinder. For many years the wax record, either in cylinder or disc form, was used almost exclusively for the recording and reproducing of sound. As a matter of fact, the first phonographs by Edison were instantaneous recording machines. The owner had his own choice of either playing back commercial records or making his own.

The records used were of cylindrical wax, and the machine was provided with a shaving device so that the records could be shaved and new ones made. The present day dictating machine is nothing more than the old Edison phonograph, with a few improvements.

At the present there are four methods of sound recording. The first two are very similar, in that both use a flat disc for the sound record. The hill and dale method, as developed by Edison, utilises a constant width groove. The depth is varied according to the sound impressions. The reproducer is then varied in a vertical motion as the needle point moves up and down, within the sound track.

The lateral cut method utilises a groove constant in depth, but variable in width; that is, the needle moves from side to side according to the sound impressions. This method has been in wide commercial use for years, and it seemed, for a while, that the hill and dale method was to become obsolete. Lately, however, vast progress has been made in adapting the variable depth method to electrical recording. This method possesses many advantages over the variable width. In the first place, more sound can be put on a record of given diameter. Since the grooves are of a constant width, up to 150 lines per inch can be put on the disc as against 96 or 100 that are the limits with the variable width. The other advantage is the frequency response is much better. Deeper bass notes can be recorded without any danger of over cutting. As it is now, with the variable width, if very low bass notes are to be recorded, the grooves must be cut further apart and consequently they are of shorter duration. The higher frequencies can be recorded and reproduced more easily, because the reproducer is more sensitive to the finer modulations. Unfortunately for the home recordist, this method has not been developed, up to the present time, for instantaneous recording, so until

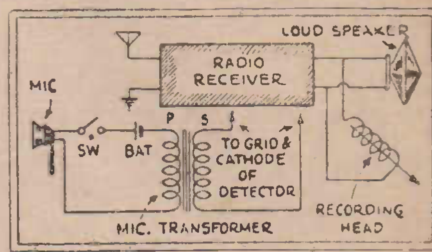


Fig. 2. The general arrangement of the standard voice and radio recording reproducing equipment.

this development takes place, the amateur must content himself with the variable width method which has proved to be very satisfactory.

The third method of recording is the photographic one, which is used in the talking movie field. The simplest system is where a flashing lamp is used. The output of the amplifier is fed to this lamp, and the glow is alternately increased and decreased following the modulating current in frequency and depending in degree upon its strength. This light shines through a slit and optical system that brings it to focus on the film as a fine line running cross-wise of the sound track. There is then produced in the developed film a series of alternate light and dark lines whose spacing and contrast depend on the frequency and intensity of the modulated current applied to the lamp. A low note corresponds to a slow frequency of sound vibration, and results in a wide spacing of lines on the film. A high note, corresponding to rapid frequency sound vibrations, results in a close spacing of the lines.

In reproduction, the positive film is run through a standard projector which is modified by the addition of an attachment for reproducing the sound known as the sound head which is located below the mechanism of the head.

The beam from a small, high intensity electric light is concentrated by an optical system containing a slit and brought to focus as a fine line across the sound track of the film as it passes through a sound gate. See Fig. 1. The film at this point moves uniformly, and at the same speed as used in recording. On the side of the sound gate opposite the light is a protoelectric cell, which responds to variation in the amount of light striking it by

(Continued on page 45.)

letting pass a varying electric current. The more light, the more current, and it responds practically without lag to the fluctuations of the light received. The density of each particular line of the sound record as it passes through the beam in the sound gate, determines the amount of light passing through the film into the light sensitive cell, and the current through the cell is therefore modulated according to the sound record. There is 14½ ins. of film between the picture gate and sound gate, but since the sound record is displaced on the film the same distance in advance of the picture the two reach their respective gates at the same time. The sound and picture are always in this same relation, and they are therefore always properly synchronised without attention.

The output of the photo-cell is strengthened by a small amplifier built into the sound attachment and is then fed to the regular amplifiers.

Needless to say, such a recording system is out of question for instantaneous recording. The cost of the apparatus would be prohibitive to the amateur, even if the theory was practicable, and unfortunately, at the present time he has no means whereby he can make his own home talkies on film. Some day such a system will be developed, and until that day arrives, we must be content with the reliable disc method.

The fourth method of recording is known as magnetic recording. A steel wire is passed between the pole pieces of a magnet which is energised by a solenoid, which, in turn, is energised by the conventional microphone and amplifier. The steel wire then retains a magnetic record which is reproduced when the wire is passed again through the pole pieces. These pole pieces have coils of wire on them. The output of these coils is then fed through an amplifying system.

On the surface this method of recording seems ideally suited for the amateur. The first difficulty is that this apparatus has never been developed for commercial use. All of the work has been done in the laboratory, and the results have never been any too satisfactory. The main objection is that the magnetic impressions begin to spread, especially the higher frequencies. In a short time the record is practically useless. The high frequencies are practically gone and only the lows are present.

From the foregoing apparently, the only practical method available to the layman is the disc method of variable width. The apparatus for this has been so highly developed that the amateur has hardly any more work to do than in operating the kodak camera.

The uses to which this instantaneous recording can be put are varied and many; and the profits to be realised therefrom will be proportional to the foresight and ability of the salesman who puts across the idea and makes the installation. Every home that has a radio receiver, every music school, music store, amusement park, department store, club, and broadcast station is a good live prospect. In short, the field of application for this method of making records is unlimited; and it remains only for the energetic salesman to familiarise himself with the technique of obtaining good results, then to go out and demonstrate. The idea sells itself.

Orchestras and bands are now being recorded, so that their technique may be studied carefully and improved upon. Singers, instrumental artists and music students everywhere are making this recording a regular part of their course; since they can thus watch their progress and note their improvement. Students of elocution can record their talks and study their delivery. Records of broadcasts can be made, and, if necessary, encore programmes can then be broadcast. Likewise, anyone who broadcasts can have his selections recorded for his personal file.

Vaudeville singers or musical acts will find this new art very much to their advantage; for they can use these records for advertising purposes and auditions at distant points. Another novel application of this instantaneous recording is in the making of "sound effects" for amateur theatricals. The ambitious producer can, after patient experimenting with the recording of different sounds, electrically reproduce them whenever desired; thus giving his presentation the realism of the professional theatre.

Portable Recording.

One of the most common uses of the portable recording machine is to take it into the home to record the voices of the different members of the family and to form a voice album similar to the picture album. If the family has young ones, then periodic visits can be made, so that the voices of the children at different stages of their growth are preserved. Some might argue that the studio can easily render this service, but it must not be forgotten that the photographer who takes his photographs in the home has always been successful, and always will be, so why can't the professional recordist do the same thing? Individuals are much more at ease in their own homes with familiar surroundings than in the studio, and this in itself is a tremendous factor in overcoming microphone fright, with the result that better records are made. The potential possibilities in this field are quite apparent when it is observed that every single family is a good live prospect, not for just one call but for repeated calls.

At parties, portable recording has proved itself to be a great source of entertainment and, at the same time, a big money-maker for the person making the recordings. In the past, it has been the custom for the host or hostess to buy souvenirs to give their guests as mementos of the occasion, but now portable recording steps in to give the guests the thrill of hearing their voices as others hear them, and, at the same time, gives them a living record of the occasion. Appropriate labels for the records can be made for the party souvenirs, which will give them a sort of exclusiveness so that the host will feel that he is giving his guests something personal rather than just a disc.

At banquets, speeches can be recorded for the speakers themselves, or for the guests, while at church fairs and bazaars recording booths can be set up and business solicited in much the same manner as at studios. Students of music, who in the past have been reluctant to go to the studio for recording on account of the inconvenience of carrying their instruments, are excellent prospects, because the studio can now be easily brought right into their own homes with no inconvenience to them. It is readily seen that visits of this nature can become a regular part of the student's courses.

One of the most unique applications of the portable service is the recording of wedding ceremonies. By the use of a double turntable the complete ceremony can be easily recorded and the writer has been informed by one firm that is doing this sort of work that not one single bridal couple approached has refused to have their ceremony recorded.

Recording Systems.

Whether the recording equipment is utilised in commercial enterprises or for home use, the apparatus in either case is substantially the same. For home use the audio amplifier of the radio receiver, used in conjunction with an ordinary magnetic phonograph pickup and a microphone makes a simple but efficient and practical recording system. (See Fig. 2.)

This system makes use of pre-grooved records, which are now available at all music and radio stores. The pre-grooved record, which is made up on either a metal or celluloid disc, has a blank groove already cut into the surface; and this groove serves the same purpose as the feed screw used in recording on blank uncut discs—namely, to guide the recording head across the face of the record. The microphone transformer, being of the step-up type, amplifies the audio frequency voltages; and this gain, combined with the mu or amplification factor of the detector tube, really adds a transformer-coupled stage to the audio amplifier.

A weight (about 10 oz.) should be attached to the recording head to prevent the needle from jumping the groove, as it tends to do when modulated. The weight also serves the purpose of pushing the needle deep into the groove, thus making available more

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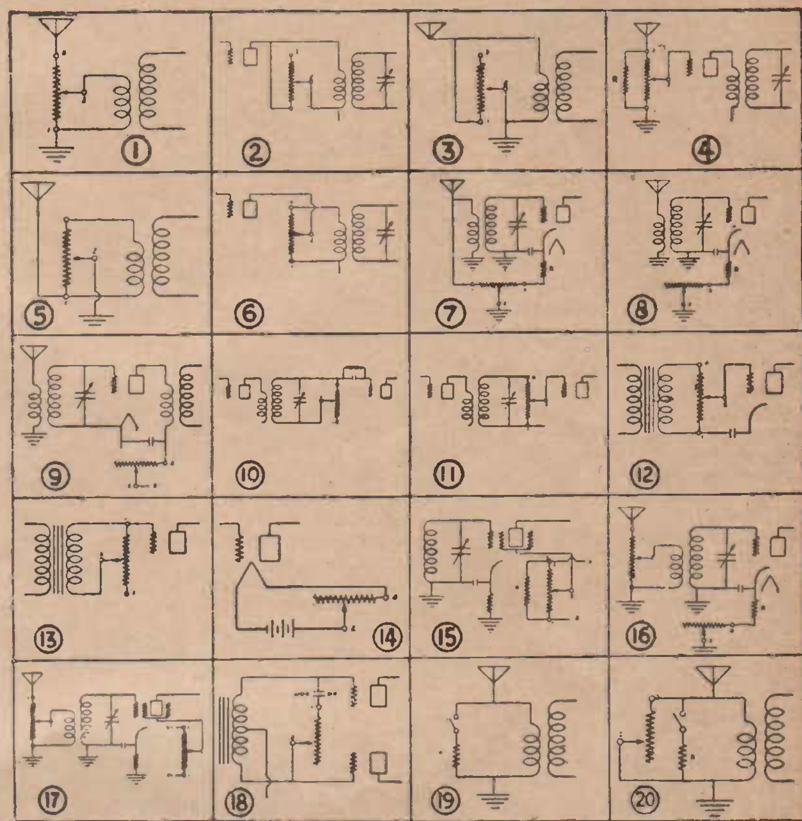
Circuits of Practically all Types of Volume Control



Circuits 1 to 7 inclusive offer the prize example of standardisation advantage, for all seven can be satisfied with the single type of volume control, one of 15,000 ohms built to give the practical equivalent of a logarithmic resistance curve (R against rotation angle). This is the so-called "tapered" volume-control. Designed to produce increased volume as its arm is rotated to the right, this control hits about 3000 ohms in centre position; it has 13,000 ohms on the right half of the turn, 2000 on the left.

Circuits 1, 3, 5 and 7 can be installed in most receivers. The best circuit is 7, but 5, 3 and 1 are sometimes a necessity. 7 carries the same defect as 3 and 1 in that any of these three circuits results in a shorted antenna winding, with the consequence of detuning of the first tuned-circuit at low volumes on strong stations. If the town is filled with locals this tuned circuit should be aligned while the volume control is set as near the short-circuit (lowest volume) position as possible. The receiver will be "out" for DX, but the local selectivity, which is usually most important in such cases, will be high. Use your own judgment, accept no rules save those dictated by your observation of your customers' wants. Always install circuit 7 if possible, as it reduces tube sensitivity along with antenna input, the overall result being much quieter reception.

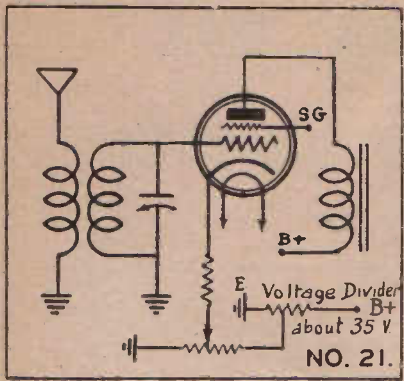
All these circuits must be wired correctly to have them control locals properly. Notice Fig. 2A: here the wire lengths A and B are interposed between the volume control resistance and the antenna coil. When the control is set for lowest sensitivity (volume), and the antenna coil seems to be short circuited, they can represent more than enough ohmage (reactance) to allow a 50 kilowatt station to have full volume for any average living room if the receiver has about 20 microvolts sensitivity. But in 2B the antenna is shorted through the arm of the volume-control, the lowest reactance that can be got. Control is adequate. To use circuit 2B it may be necessary to disconnect the regular antenna-coil ground from the chassis so that the circuit gets to chassis only at the volume control.

A final precaution regarding these circuits: In Fig. 2B the placement of the receiver coil and antenna terminal are frequently such, in relation to the volume-control, that both the leads from the control to the coil and from the control to the antenna will be long and nearly parallel. If so, capacity transfer will produce an effect that 2B wiring cannot overcome. In this case both the antenna lead and the coil lead may have to be run through grounded metal braid. Act according to results.

Circuit 5 avoids the shorting of the antenna coil and consequent broadness of input circuit tuning when the control is set for low sensitivity. However, the end 3 of the antenna coil is left ungrounded by the control and some signal will get to it by capacity effect from the antenna lead. In a sensitive set with partial shielding this permits signals to leak through. This may be stopped by stopping the capacity effect—which is done by putting metal braid (grounded to chassis at both ends) over that part of the antenna lead which is inside the set. With this circuit the receiver should be aligned with the volume control set for ¾ full volume.

The chief and important point is that circuits 1, 3 and 5 can be, to the advantage of the receiver and its owner, installed in dozens of receivers now containing more complicated controls. In fact some receivers will not reduce volume to a suitable point without disconnecting the antenna, whereas the installation of an antenna volume-control such as has been described is sufficient of a change to eliminate this inconvenience. I recommend unreservedly that receivers equipped with only screen-grid voltage control of volume be changed to antenna circuit volume-control forthwith, wherever a strong local station is proving the former method inadequate.

Some receivers are designed to use antenna potentiometers of 2000 to 10,000 ohms. A good universal potentiometer for this use is the Marquis, which has 100 ohms in the left third and 10,000 in the remainder of the travel of the slider.



There is one exception to all this. Some receivers have large antenna coils built honeycomb style and designed to resonate below 700 kc. This is in order to raise the low-frequency sensitivity of the receiver. Here the antenna potentiometer resistance can spoil the effect of the resonance bump. In such sets stick to the volume control devised by the manufacturer unless the lower broadcast frequencies are of little importance to the set owner. The manufacturer ought to have used sense enough to do his "bumping" elsewhere in the receiver—but who are we to argue?

Control by Change of D-C Voltage.

Voltage-governing controls operate by changing, (1) screen voltage, (2) cathode bias, (3) plate voltage, (4) filament voltage. This may be done automatically or manually. The automatic volume controls will be left for a later paper.

1—Screen-voltage control, whether used alone as in circuit 15 of Fig. 1, or in combination with an antenna-input control as in 17 is seldom satisfactory against strong signals because of screen-overloading and cross-talk, and should be replaced by circuits 1, 3, 4 and 5. If this is done as explained before, the original control is left at maximum. If the screen control cannot be replaced because of instability or a trick antenna circuit replace the old control with an equal or higher resistance, which may be nearly anything from 5000 to 50,000 ohms, depending on the arrangement of the B supply. It is simple to find out whether a high-resistance voltmeter shows the proper range of screen voltage.

2—Cathode bias control is shown in its simplest form in circuit 6 and in combination with antenna-input controls in circuits 7 and 16. The 75,000 ohm regular taper potentiometer is correct for one tube and may be used for several. In manufactured sets one finds scores of kinds which give no better control—better senseless originality than no originality at all! It takes about 13 volts cathode bias to cut off a '24 tube. This can (almost) be provided by a high cathode resistor, but the 30 volts required to cut off '35 and '51 tubes is hardly obtainable in this way. A much better scheme is that of Fig. 3, which raises the voltage across the control resistor by putting through it some current directly from the B supply. Suppose that we intend to use a 5000 ohm control and to take the current from an 80 volt point on the B supply. To produce 13 volts across a 5000 ohm control we must put about 2.6 Ma. through it. At 80 volts this requires a total resistance of 30,000 ohms, and as we already have 5000 in the control R1 must be 25,000 ohms. Similarly it is easy to calculate the series resistance needed to draw enough current through a 7500, 10,000 or 15,000 ohm control so as to produce 30 volts across it. Usually the supply will need to be taken from some point in the B system which is at 140 to 250 volts "above chassis." The current which is "bled" through the control should be either considerably larger (3 times or so) than the plate current or else much smaller (¼ as much).

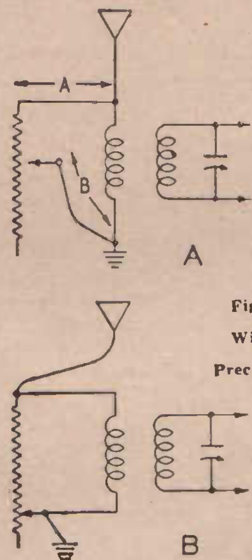


Fig. 2 Wiring Precautions.

There must be a provision in all cathode controls to prevent reducing the bias to zero when turning the control to "full on." This is done by the resistance R2 in Figs. 3 and 4. In Fig. 3 it should be about 250-350 ohms for one tube and half as much for two. In Fig. 4 use whatever value is needed to produce 1½ volts across it (use high resistance voltmeter) when the control is turned to full on.

3—Plate voltage control (circuit 9 of Fig. 1) is inexcusable with modern tubes. The circuit of diagram 6, though not controlling d-c. voltage, can also be condemned, as it ruins the selectivity of the associated tuned circuit, which can also be said of circuits 6, 10 and 11. They should be replaced by the circuits discussed in Part 1, which at least protect the first tube from overload. Study the wiring before cutting into it—nothing should be changed in some sets, such as the Fada 70.

Twin volume controls (as in circuits 16 and 17) were born of the easy overloading of the '24 tube—and of inadequate care in wiring layout, as mentioned in Part 1. The general data of Fig. 1 fit most receivers, but there are exceptions, such as the Victor 32, which requires abnormally low resistances, and the Radiola 48, which requires such high resistances that there must be a metal static shield between! Infrequently one meets a combination of an antenna control and an audio-shunt control (combine circuit 12 with 1, 2, 4, 5 or 7). The antenna control is usually sufficient.

4—Filament control of volume went out with the 201A tube. That's that.

Other Types of Controls.

Audio controls such as 12 and 13 appear in modern receivers with automatic volume control. The correct control is specified in Fig. 1, but lower resistance values may be used in emergency. Circuits 19 and 20 represent one type of local-distant switching circuit, but the result depends on the input transformer and the wiring layout. One must cut and try. Other local switches simply disconnect the antenna, allowing some signal to get in through

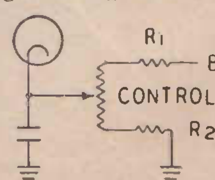


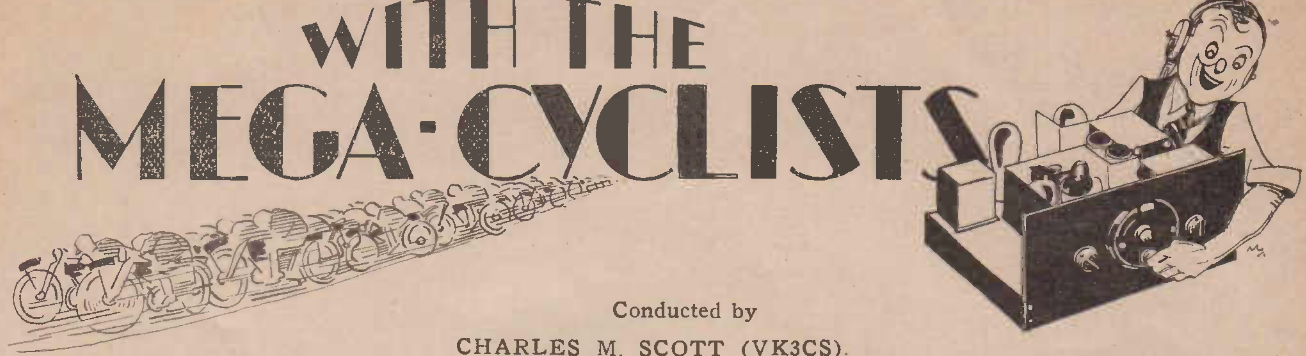
Fig 4

the switch capacity, or a shunt consisting of two wires twisted together. In a few cases a tuned circuit is opened to reduce efficiency.

Circuit 18 is the best form of tone control. The proper capacity will be found to lie between .0025 and .01, while the resistor may be between 500,000 and 1,500,000 ohms maximum.

The main point of all this talk is that a stock of just 6 volume controls will fit every job of the experimenter and will satisfy 9 out of 10 of the repairman's customers—only the 10th man is forced to say that you delayed him—the rest build business.

WITH THE MEGA-CYCLIST



Conducted by
CHARLES M. SCOTT (VK3CS).

The Empire Broadcasting Station

By NOEL ASHBRIDGE, Chief Engineer, B.B.C.

THE technical requirements for an Empire Station are most interesting, chiefly because they are complex and difficult. The first consideration must be the wavelengths which are available for such a service, and it has already been stated that at least one wave in each of the Washington short-wave bands will be employed. In two of the bands it may be necessary at certain times to use two wavelengths, and the actual waves notified to Berne for the Empire transmitters are as follows:—

6050	kc/s	(49.586 metres)
9510	,,	(31.545 ,,)
9585	,,	(31.297 ,,)
11,750	,,	(25.532 ,,)
11,865	,,	(25.284 ,,)
15,140	,,	(19.815 ,,)
17,770	,,	(16.88 ,,)
21,470	,,	(13.97 ,,)

When the transmitters are put into service they will work in the first instance on these waves, but practical experience of reception in various parts of the Empire may make it necessary for slight alterations to be made at a later date, consequent on reports of interference during reception.

Having decided on the wavelengths to be used, the next question which naturally arises is, can effective use be made of directional aerials? If one examines a globe map of the world, it immediately becomes obvious that the extreme limits of the Empire subtend a very wide angle at this country and, therefore, the use of one single directional aerial is obviously out of the question. In any case, a directional short-wave aerial is normally designed for one particular wavelength and, therefore, at least eight such aerials would be required. Subsequent examination of the map, however, showed that from the technical point of view, the Empire could be divided into five zones, the boundaries of these zones being determined by three factors: (a) time of transmission; (b) direction of transmission; (c) the distance of the point of reception from this country.

The five zones decided on are as follow:

Zone 1: Australia and New Zealand, and the Pacific Islands.

Zone 2: India, Burma, and the Malay States.

Zone 3: Iraq, Egypt, East Africa, and South Africa.

Zone 4: West Africa, including Nigeria and the Gold Coast, and the Atlantic Islands (Tristan da Cunha and the Falkland Islands).

Zone 5: Canada, West Indies, Trinidad, British Guiana, and the Pacific Islands.

It will be seen that all these zones do not subtend the same angle at this country, and arrangements will therefore be made for the angle of the transmitted beam to be different in the different cases. The narrower the beam, of course, the greater the gain in using a directional aerial. It is perhaps, of interest to note, in passing, that in the most advantageous condition to be met with in this system, the theoretical gain in field strength at the point of reception, by using a direction aerial, will be of the order of four times compared with the field strength at the point of reception if an omni-directional aerial were used. This, it may be noted, is equivalent to a sixteen-fold increase in transmitting power.

The allocation of the wavelengths to the various zones will provisionally be as follows:—

Zone 1 will require only one wavelength, since the only wave band likely to be of use is that in the neighbourhood of 25 metres, and thus only one aerial is required for this zone.

Zone 2 will require three wavelengths and three aerials, one each in the 17, 25 and 32-metre bands.

Zone 3 will have two wavelengths and two aerials, viz., 14 and 32 metres, but the latter of these aerials will be arranged to cover both zones 4 and 5.

Zone 5 will require three wavelengths and three aerials, viz., 19, 32, and 48 metres respectively.

It will be noted that certain wavelengths, viz., 25 and 32 metres, are common to more than one zone, and as in some cases the time difference between the two zones in question may not be great, it may become necessary to serve two such zones at the same time. It is not, however, possible in practice to use exactly the same wavelength for each transmitter, and, thus, the reason for the use of two wavelengths in the 25 and 32 metre bands becomes obvious.

The above choice of wavelengths and zones is on the basis of providing the best possible reception in the various parts of the Empire at some period between the hours of 6 p.m. and midnight local time. Occasionally, however, transmissions may be required at other times, and in order to cover this point six omni-directional aerials (one for each waveband) will be erected in addition to the directional ones. In all there will be seventeen aerials.

In designing a system which relies for its success on the use of short waves, it is very desirable to make this system as flexible as possible, since the best wavelength for a given time of the day and a given season is not definitely fixed. If possible, therefore, the aerial systems should be simple and economical from the point of view of first cost. Accordingly, the aerials which will be used are simple in construction, supported by masts 80 feet in height.

Having considered the wavelengths and the aerial systems to be used, the next question of importance is that of the type and number of transmitters necessary to feed these aerials. If it were necessary to transmit to the five zones simultaneously, it would obviously be necessary to have five separate transmitters, but a consideration of the time difference between the various parts of the Empire shows that it is not likely to be necessary to serve more than two zones at one and the same time. It therefore follows that two transmitters will suffice. If at any time in the future the hours of transmission were considerably extended, or if for any reason it became necessary to serve all the zones simultaneously, then, of course, additional transmitters would have to be added.

Having decided on the number of transmitters, one must next consider the type of transmitter, firstly its power and, secondly, its general characteristics. Experience of shortwave working over many years has shown that an aerial power of the order of 15 to 20 kW. is a reasonable figure to adopt, and the Empire transmitters will therefore be built for this power. As far as the high-frequency characteristics of the transmitter are concerned, it is obviously desirable that the stability of wavelength should be high, and in this respect the transmitters which are being supplied by Standard Telephones and Cables Ltd. will conform to the recommendations of the International Technical Consulting Committee for Radio Services—i.e., an error not exceeding plus or minus one part in 10,000. Actually, quartz-crystal drives will be used, giving a better performance than this (viz., one part in 25.000), and in order to permit the necessary flexibility of operation of the two transmitters on eight wavelengths some eighteen separate crystals are being provided.

As far as modulation characteristics of the transmitters are concerned, it might seem at first sight that an exacting specification for frequency characteristic would not be necessary, since conditions of shortwave reception, particularly during times of differential fading, are generally against the reproduction of very high musical quality. However, in order to allow the best results to be obtained from the quality point of view when reception conditions are good, these transmitters will have a very good overall frequency characteristic. In fact, it will be similar to that of modern medium-wave broadcasting transmitters.

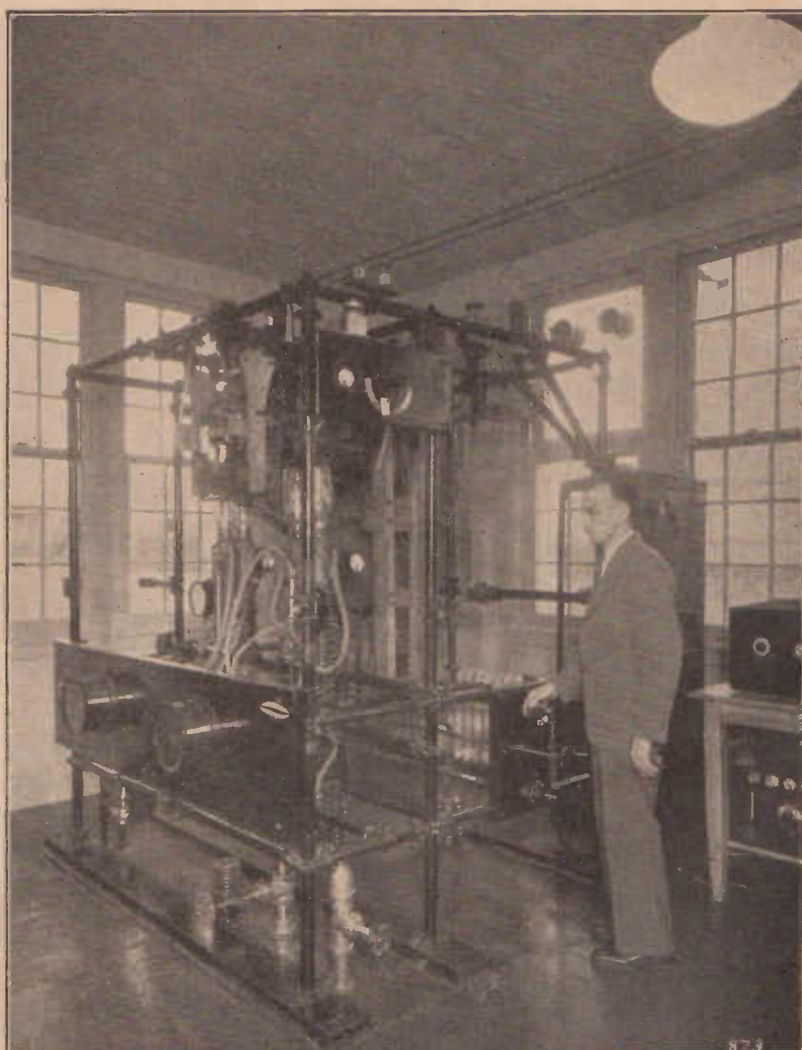
As far as the depth of modulation is concerned, it is most important that a high mean degree of modulation should be employed, in order to give the best possible chances of reception, and the transmitters are being designed to be capable of a high peak modulation without distortion.

It is necessary here, however, to add a warning as to the service to be expected from a shortwave system. It must be realised that it is impossible to supply a service by short waves which can be comparable in reliability, strength, and technical quality of reproduction with that which can be given in the service area of a medium-wave broadcast transmitter—e.g., within the service areas of the London, Northern, or Scottish Regional transmitters. In fact the service will not usually be as good as the service available in those parts of the British Isles where the reception of our National stations is at its worst. The aim therefore is to set up a station which will provide at least intelligible reception in those regions which it is intended to serve. Musical quality of a high artistic value is normally out of the question, and for this reason the transmission of large symphony orchestras and of the higher forms of music will not generally be undertaken. Lighter music, however, will provide acceptable material.

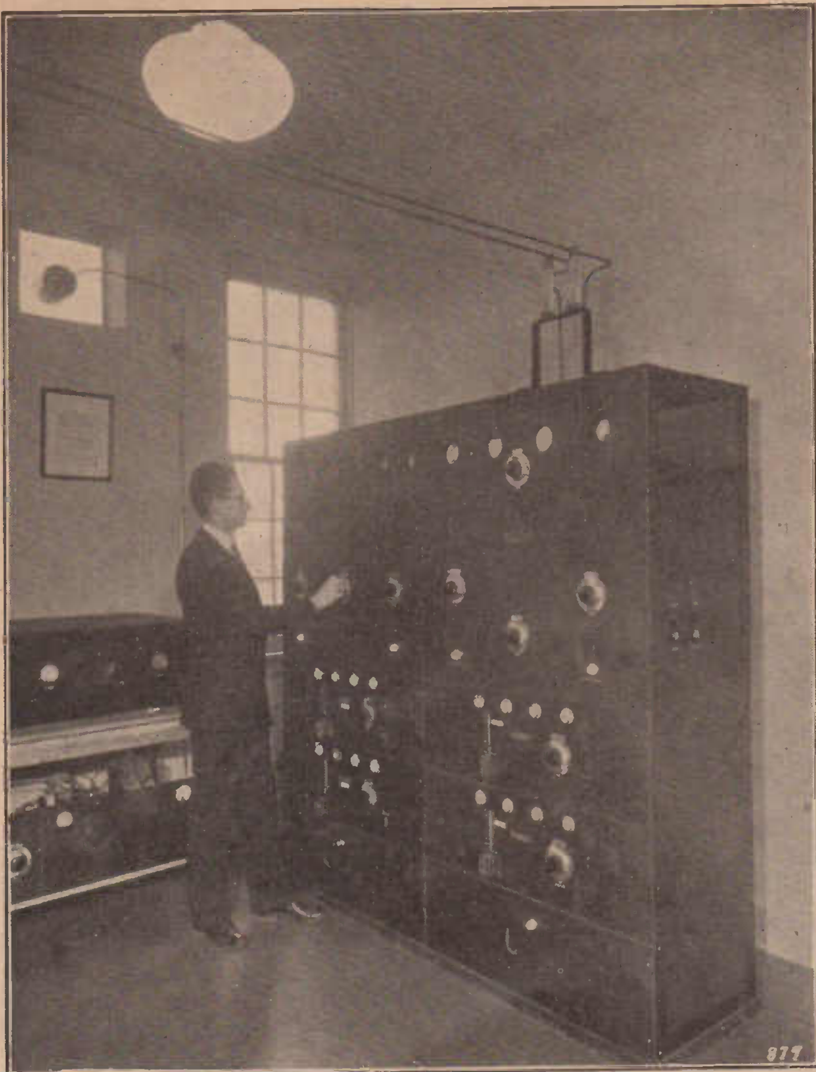
As has already been stated, the station is to be erected at Daventry, and the building is already practically complete. The transmitters are nearing completion at the manufacturers' works, and the erection and installation at Daventry will begin very shortly. There is every reason to expect, therefore, that the original estimate for the time of completion of the station—i.e., by the end of this year—will be adhered to. The transmissions will at first be entirely experimental, and it is anticipated that it will take some months to determine the best wavelength for each zone under the various different conditions. A comprehensive system for collecting data is already being worked out. Co-operation of the various authorities in different parts of the Empire is being freely offered, and most readily accepted.

Description of Short-Wave Transmitter, W3XAL, Bound Brook, New Jersey

THIS short-wave broadcast transmitter is operated and owned by the National Broadcasting Company, Inc., 711 Fifth Avenue, New York City. It is located in the same building as transmitter WJZ, at Bound Brook, New Jersey, about thirty-five miles from New York.



D. N. Stair, engineer in charge of WJZ-W3XAL-W3XL-W3XAK, adjusting W3XAL. This station and W3XL are known all over the world, since they are two of the most widely-heard short-wave high-power installations in use.



Radio frequency exciter equipment, recently remodelled for W3XL-W3XAL. Carl Dietsch at controls.

The frequencies assigned are 6100 kilocycles (49.18 metres wavelength), and 17,780 kilocycles (16.87 metres wavelength). The transmitter at present transmits from 4 p.m., E.S.T., on Saturday afternoon until 1 a.m., E.S.T., on Sunday morning on the 6100 kilocycle frequency and transmits from 8 a.m. until 4 p.m. daily on the 17,780 kilocycle frequency.

The antenna for the 6100 kilocycle frequency consists of a half-wave radiator approximately 90 feet above the earth. This is fed by a two-wire transmission line about 700 feet long. The antenna for the 17,780 kilocycle frequency consists of a horizontal half-wave radiator approximately 200 feet above earth and located several hundred feet from the transmitter.

The transmitter is crystal controlled, having a complete spare crystal unit for each frequency. By means of a number of multiplier stages the crystal frequencies are transformed to either 6100 kilocycles or 17,780 kilocycles. Of these two, the particular frequency used is amplified through two intermediate stages which in turn drive a power amplifier consisting of four type UV 207 water cooled tubes.

The carrier output on the 6100 kilocycle frequency ranges from 25 to 30 kilowatts in the antenna, while on the 17,780 kilocycle frequency, the carrier power sent to the antenna ranges from 12 to 15 kilowatts.

Modulation of the transmitter is accomplished by the constant current method employing in the modulator a bank of 12 water cooled tubes which are used to modulate the water cooled tubes of the power amplifier. The percentage of modulation normally is about 75 per cent. The National Broadcasting Company receives thousands of letters from short-wave broadcast listeners throughout the world every year, an indication that this transmitter has a tremendous coverage area on both frequencies.

Latest "Dope" of the British Stations

BROADCAST.

G5SW—11,750 kc., Chelmsford, 12 kilowatts. Programmes: 12. 30 to 13-30 GMT and 18-45 to 24-00 GMT. News: 12.30 to 12.45 GMT and at 24.00 GMT.

Transmits every day except Sunday.

COMMERCIALS.

Telephone Transmitters at Rugby.

Call	Frequency	Works to
GAS	18,310	New York
GBS	12,150	New York
GCS	9,020	New York
GDS	6,905	New York
GAW	18,200	New York
GBW	14,440	New York
GCW	9,790	New York
GAU	18.620	New York
GBU	12,290	New York
GCU	9,950	New York
GBB	13,585	Egypt & Canada
GCB	9,280	Egypt & Canada
GBC	4,975	Ships at Sea
GBC	8,680	Ships at Sea
GBC	12,780	Ships at Sea
GBC	17,080	Ships at Sea
GBP	10.770	Australia
GAA	20,380	Buenos Aires, Monte Grande
GCA	9,710	Buenos Aires, Monte Grande
GAG	18.970	South Africa

Telegraph Transmitters at Oxford.

Call	Frequency	Works to
GIA	19,640	Europe: sends press at 12, 14, 17 GMT
GIC	8,640	Europe: sends press at 19, 20, 23.30 GMT.
GID	13,555	Europe
GIF	9,220	Europe
GIH	10,650	Europe
GIK	5,325	Europe

Beam System Telegraph Transmitters.

Call	Frequency	Location	Works to
GMI	18,500	Grimsby	India
GOI	8,780	Grimsby	India
GNH	11,585	Grimsby	Australia
GMJ	18,580	Bodmin	Sth. Africa
GOJ	8,820	Bodmin	Sth. Africa
GMK	18,100	Bodmin	Canada
GOK	9,260	Bodmin	Canada

Ships Equipped With Telephone Transmitters that Work With BGC.

GDLQ	S.S. Homeric
GFWV	S.S. Majestic
GLSQ	S.S. Olympic
GMBJ	S.S. Empress of Britain
GMJQ	S.S. Belgenland

Frequencies Common to All the Ships.

4,430	12,380	16,440
8,860	13,320	17,550

SHORT WAVES

Notes and News

RADIO ROMA.

A VERIFICATION received last month from Radio Roma, whose address is Ente Italiano Audizioni Radiofoniche, via Asiago N.10, Roma, states that both short-wave stations I2RO relay the programme of the 441.1 metre transmitter I1RO, on 25.4 metres 11,810 KC, and 80 metres 3,750 K C.

Transmissions are conducted daily from 2.00 a.m. to 3.30 a.m., and 5.30 a.m. to 8.30 a.m.

RADIO COLONIALE, PARIS.

RADIO Paris, which is now well-known to listeners all over the world, is a crystal controlled S.F.R. type transmitter, employing 12 kilowatts in the aerial, which is a single wire, Oriented East and West.

The station was opened during the International Colonial Exposition at Paris on May 5, 1931.

The wavelengths and transmitting schedules are as follows:—

19.68 metres, 10.30 p.m. to 2.00 a.m.
25.20 metres, 3.00 a.m. to 6.00 a.m.
25.60 metres, 7.00 a.m. to 10.00 a.m.

INTERESTING SHORT-WAVE EXPERIMENT.

DURING October last a very interesting experiment was carried out by 2UW, Sydney.

On this day, Hospital Sunday in Sydney, a small portable, transmitter was installed on the Dutch liner Nieuw Holland, for the purpose of broadcasting some special activities on board.

The portable station on 42 metres was heard very clearly at 4.50 p.m. at R6Q5.

ZSB, CAPETOWN, HEARD.

ZSB, Capetown, South Africa, working on 15.9 metres, was heard in contact with GAA, London, and VLK, Sydney, at excellent strength.

ZSB was not heard direct but through the England-Australia phone circuit, via GBP, on 28 metres.

MOSCOW TELEPHONE.

THE new station, believed to be a Russian telephone station at Moscow, heard recently on 20.8 metres, working with RAU, Tashkent, Turkestan, 19.85 metres, is now upon 40.00 metres after midnight, working with RAU on 39 metres.

Another new station on 27 metres has also been heard calling "Moscow" at 8.00 p.m. in English.

THE PICK OF THE OVERSEAS PROGRAMMES.

MOSCOW.

THE English session from Moscow on 50 metres is now from 6 a.m. to 7 a.m., Melbourne time, each Monday, Tuesday, Thursday and Saturday, and on Sunday evening from 8 to 9 o'clock.

G5SW, LONDON.

LISTEN to the Empire news session from London daily, except Sundays, between 10.30 p.m. and 10.45 p.m., also the musical programme, which continues till 11.30 p.m. week days and till midnight on Saturdays.

The signal strength of this station is steadily increasing.

RADIO COLONIALE, PARIS.

WATCH for the English news session from this station on 19.68 metres each day, either at 11.30 p.m. or 11.45 p.m. This news is preceded by a musical programme, which starts round about 10.30 p.m.

BANDOENG STATIONS.

PLF usually plays a number of selected recordings on 29.25 metres before meeting Sydney at 8.30 p.m.

PLE and PMC can also be heard at times with music on their carriers between 7.15 p.m. and 9 p.m.

PMY, BANDOENG.

PMY broadcasts an excellent musical programme daily between 9.40 p.m. and 12.40 a.m., excepting Saturdays, when the programme of dance music from the Hotel Preanger is broadcast till 1.40 a.m.

Towards midnight the station begins to rise out of the static, and reception is often very good at this late hour.

GBP, RUGBY, LONDON.

GBP, 28.00 metres, which can now be heard at excellent strength, often broadcasts items of international interest after midnight. Keep a watch for this station.

J1AA, TOKIO, JAPAN, ON REGULAR SCHEDULE.

A LETTER received from the chief engineer, Hidewo Kikutani, of J1AA, Tokio, states that J1AA has a regular schedule from 1000 GMT to 1245 GMT, or 8 p.m. to 10.45 p.m. daily.

The station relays JOAK programmes from Tokio to Manchuria on a wavelength of 30.4 metres.

CHANGE IN TIME.

RECENTLY a number of nations went back to standard time after having been on daylight saving during our winter.

Among these stations are all those in America, England, France and many other places. Remember all these stations, like G5SW, Radio Paris, W8XK, etc., will be heard on the air an hour later, than we have been hearing them during the winter.

ULTRA SHORT-WAVE BROADCASTING.

DURING the past three months the engineers of Amalgamated Wireless (A'asia) Ltd., under the direction of Mr. E. T. Fisk, have been carrying out a series of experiments on the ultra short wave-length of 7 metres, and, although a power of only 10/15 watts is used in the aerial, very satisfactory results have been obtained, reception being effected in many of the suburbs of Sydney and in one instance at Springwood, on the Blue Mountains, about thirty miles air line from Sydney.

The transmitter is located at Wireless House, the vertical aerial being attached to the flagpole on the roof. The radio frequency energy is conveyed to the aerial by means of two feeder wires. The frequency of the carrier wave is maintained constant by means of a crystal oscillating on a wavelength of 112 metres. This frequency is multiplied by means of frequency doublers until the desired wave-length is reached—namely, 7 metres. The valves used are the same as those used in public address amplifiers, enabling the house service mains to be used for the H.T. supply.

The object of the tests is to determine the usefulness of ultra short wave-lengths for giving a broadcast service over a restricted area without causing any appreciable interference outside a comparatively limited range. If this proves possible, a number of local broadcasting services could be carried out on a common wave-length without mutual interference—a development of great importance and utility.

STUNT BROADCASTING.

RECENTLY the Coney Island Amusement Park, N.Y., was burnt down with a loss estimated at some three millions of dollars.

The Colombian Broadcasting System put a portable station on the ship Resolute and broadcast a description of the fire as seen from the ship.

The station was WIEK and the wavelength used 112.00 metres.

ANOTHER stunt where short-waves were used recently was when Gertrude Ederle, the world-famous swimmer, with a new type lapel button microphone fastened to her swimming suit, broadcasted her reactions to an aquaplane ride behind a power boat. A short wave transmitter was placed on the power boat and a wire run to microphone.

Travelling at a high speed, Miss Ederle took a spill into the briny deep, microphone and all, just to give the radio public a thrill.

A TELEPHONE company in Connecticut, U.S.A., has now made it possible for a housewife or merchant to call up any of the fishing schooners on the telephone while they are getting their fishing done.

Imagine ordering your lobster before it is caught and giving your order to the ship's captain by telephone. Well, that's how they do it in the United States.

THE Rev. J. N. Martin, of Ditton-avenue, Auckland Park, Johannesburg, a 73-year-old minister, has recently opened a new short wave broadcasting station on 42.5 metres. This station has been testing with the United States, Poland, India and Brazil.

COMMUNITY RADIO.

Short Waves in India.

A SCHEME has been drafted by the wireless consultant to the Government of India for the installation of radio in villages in the Bombay Presidency. Indian gentlemen have undertaken to provide receiving sets, and a European business man has promised to pay a substantial donation to defray part of the cost.

It is proposed to choose villages in the centre of well-populated areas and establish listening posts in them.

A listening post will consist of a reinforced concrete cubical about eight feet high with a loud speaker in the roof.

The receiving set in each post will be of the superheterodyne seven valve type, and entirely automatic, so that when the operator of the transmitter at Poona switches off, the receiving set will be automatically switched off, and vice versa.

Transmission will be carried out on a wavelength of 49.00 metres.

SHORT WAVES IN HUNGARY.

IT is reported that a new transmitter at Stuhlweissenburg, Hungary, has been built and will operate on six different waves between 17.51 and 55.56 metres. The power is 8000 watts, and it is said that programmes will be broadcast on 21.92 metres during the day and 43.83 metres at night. The report states that the station is already completed.

A CORRECTION.

WE wish to correct a portion of a paragraph which appeared under the title of "Characteristic Signals" in the last issue. This

(Continued on page 26.)

IDENTIFYING STATIONS

HERE are a few tips on identifying stations that may be heard on a short wave receiver. The call letters of each station are given, then the identification signal.

PLE announces in English, Dutch and French as "Bandoeng Radio." Radio Coloniale Paris. Plays "La Marseillaise" at start and close of programme.

DJA and DJB announces all stations in chain broadcast like "Berlin, Dresden, Hamburg, Stuttgart."

HVJ announces "Hello, Hello, Radio Vaticano."

Rabat announces "Radio Rabat." Uses beat of Metronome.

I2RO, lady announcer, "Radio Roma Napoli."

G5SW announces, "London Calling" or "G5SW Chelmsford."

EAQ announces "Hello, Ay ah, coo. Transradio, Madrid."

T14—NRH, Bugle Call or TIC—TAC between selections.

VK2ME, laughing notes of Kookaburra open and close programmes.

CTIAA, six Cuckoo calls between selections. Announces as "Radio Coloniale."

VK3ME broadcasts 10 o'clock chimes.

OXY broadcasts midnight chimes at 9 a.m.

HSP2 strikes six notes between selections.

F3ICD, one stroke of a gong between selections. "Allo, Allo, ici Radio Saigon."

LSG calls "Allo, allo, Paree; ici Buenos Aires."

Geneva announces in English and French.

HSJ calls "Hello, Hello, Berlin; here is Bangkok."

PMC calls "Hello, Berlin or Amsterdam; here is Bandoeng calling."

FZS, "Hello, hello, hello, Peree; ici Saigon."

Moscow announces in English three or four times a week.

American Stations identified by the station they relay.

JIAA, call given periodically in English.

XGO, call given periodically in English.

Most telephone stations can be identified by the station or city they are heard calling, and judging the wavelength it is heard on. When one 'phone station is heard, tune round for the other and try to log it also. In most cases you will find that both stations are working on wavelengths very close to each other.

How to Keep a Log Book and Prepare Reports

"KEEP a Log Book." This advice is given to every owner of a short wave receiver. But what form is the log to take?

Probably the cheapest, simplest and best log book is an ordinary stiff-covered school notebook, measuring about 7 by 9 inches, with the pages ruled horizontally. A good book of this type can be bought for ten cents in any stationery store.

Divide the book into as many sections as you have ranges on your set, and cut away the edges of the pages for a distance of about one-quarter inch to form a convenient thumb index. Mark the tops of the pages with the respective identifying colours of your plug-in coils, and also indicate the wavelength or frequency range. Then simply rule off five vertical sections. Date, station call, dial setting, and time are all you will want to record, along with a few remarks about the programme.

For those who are more deeply interested a log similar to the suggested type of report shown will be much more useful. A report giving little information just the time, wavelength, etc., is of practically no use to the station engineers.

If a verification is desired care must be taken to see that everything it is possible to observe should be included in the report.

Fifteen minute observations taken over the period at which the station is audible, is of much more value than just a single one.

The suggested type of report given here, will, no doubt, be of interest to those just starting in the game.

SUGGESTED TYPE OF REPORT.

Report on Transmission.

Radio Station....................

Date of Reception................

Address..........................

Weather..........................

Temperature......................

Modulation.......................

Understandability Q.S.A..........

Volume R.........................

Fading...........................

Interference.....................

Type of Receiver Used............

Atmospheric Conditions...........

Details of Programme Received.....

....

Time: From.......................

to..........(Eastern Standard Time).

should have read as follows:—

Sydney, VK2ME (New South Wales): Opening signal, Laughs of the Kookaburras (gramophone recording). Announcement, "VK2ME, Sydney, the Voice of Australia, broadcasting simultaneously on 31.28 and 7.0014 metres." Closing down with the laughs of the kookaburras and one stanza of "God Save the King."

The rest of the information contained in the paragraph is correct.

The Amalgamated Wireless has sent us a copy of the regular hours of broadcasting by stations VK2ME, Sydney, and VK3ME, Melbourne. This schedule will be included in these columns next month.

NEW EMPIRE STATION HEARD.

THE new British Empire Station has been heard on 25.53 metres between 9.30 p.m. and midnight.

The signal strength on some occasions was rather disappointing, and the carrier appeared to be R.A.C.

Some of the trouble has been caused by a heterodyne from one of the Japanese Amateur Society stations, believed to be at Sourabaya.

It has been arranged by B.B.C. to send out Empire greetings on its new short wave system. Australia is known as Zone No. 1, and the track over which the short-wave message will come will be through Siberia and Manchuria, to the west of Fremantle and to the east of New Zealand. The B.B.C. is concentrating on all-Empire programmes, which will be put over the air as soon as the new station is ready, about December 19.

J1AA, Japan, has also been heard again on 38.07 metres, broadcasting to Manchuria. A news service in English is sometimes given at 9.30 p.m. At 9.45 p.m. the same service is given in Russian.

BROADCAST TO TASMANIA.

THE speech of the Prime Minister, Mr. Lyons, as well as the speeches of Sir Henry Braddon and Sir John Butters, at the annual reunion of the Tasmanian Association, held at the Dungowan Restaurant, Sydney, on Saturday night, was broadcast by Amalgamated Wireless to Tasmania.

The speeches were transmitted by land line to the Amalgamated Wireless short wave station, 3ME, Melbourne, which transmitted them on short waves to Broadcast Stations 7ZL, Hobart, and 7LA, Launceston, from which stations the speeches were rebroadcast and quite clearly heard by Tasmanian listeners.

On this occasion a wavelength of 74 metres was used.

Although static is usually bad on these longer waves, they are particularly useful for night work over comparatively short distances, and as long as the signal is well over the background noise level, excellent reception can be had.

MICROPHONIC FEED-BACK PHENOMENA

Amplitude and Frequency Modulation in a Receiver

HITHERTO little information has been available on the subject of microphonic feed-back phenomena as applied to radio receivers, in particular those originating in the high-frequency portion of the instrument. It has been known for a long time that such a feed-back occurs between the first valve of a multi-stage L.F. amplifier and the loud-speaker it drives, if sound waves from the latter impinge on the first valve or if the speaker vibrations are mechanically transmitted.

With the advent of self-contained receivers, such as radio-gramophones, midget sets, console and portable receivers, several difficulties have been encountered in connection with microphonic effects. The first difficulty to make itself known is a plain audio-frequency feed-back between the detector and loud-speaker. This can only be effectively overcome by suitable design of the detector valve electrodes. The second difficulty is due to what may be called amplitude modulation of a radio-frequency signal in the receiver itself. This occurs usually in the first stage of the H.F. portion of a self-contained receiver. If the electrodes of the first valve in particular are not mounted on supports which damp their natural vibrations they will vibrate, causing a periodic variation in the amplification factor of the valve at the natural frequency of either the grid or the cathode systems, or both together, thus producing amplitude modulation at these frequencies of any signal being received. The result is a sustained note emitted from the speaker, if the low-frequency gain of the receiver be sufficiently high to overcome existing damping.

Frequency Modulation.

The energy fed back will, of course, build up until limited by the maximum power output of the receiver. The remedy lies in a suitable design of the valve-electrode supports, as the valves and the speaker must of necessity be mounted in the same cabinet. Since this feed-back is both mechanical and acoustic, it is of very little assistance to employ sprung valve-holders alone, which only eliminate the transmission of mechanical vibrations to the valves.

The third problem occurs in the case of the superheterodyne receiver, and is due to frequency modulation of the oscillator. The effect is very pronounced in this type of receiver if properly designed electrically for high adjacent-channel selectivity, since the narrow frequency band-width of the intermediate-frequency amplifier is between the oscillator and the audio detector. The frequency modulation of the oscillator is the result of tuning-capacity changes caused by variable-condenser vibrations. These vibrations can be classified into two kinds, namely, "reed" or "diaphragm" vibrations of the rotor and/or stator end vanes and transverse vibration of the rotor gang structure. The second kind of vibration is usually the most troublesome, as this generally causes a greater change in capacity for a given amount of displacement of the parts concerned.

Condenser Vibration.

If the rotor structure consists of a number of gangs resulting in a spindle more than about ten times its diameter in length, it should be supported in more than two bearings, or else definite means should be employed at points along its length for damping out transverse vibrations. If it is impossible for any reason to make the condenser-rotor assembly not subject to resonant vibrations, the amount of feed-back, which in this case is mechanical between the speaker and the condenser, must be reduced. This may be achieved by mounting the radio-receiver chassis on soft rubber blocks, thus introducing resistance to mechanical transmission between the speaker and the condenser.

The "reed" or "diaphragm" vibrations of the vanes are usually produced by acoustic feed-back from the speaker, but as this feed-back is less than the former, sufficient damping is usually obtained by bracing the vanes where possible. It should be realised that all these effects are independent of H.F. and I.F. gain, and depend entirely on L.F. gain and the amount of feed-back present.

It may be worthy of note that the L.F. gain of a radio set varies with the R.F. or I.F. input to the detector in accordance with the law of rectification, and therefore, the feed-back effect depends also on the condition that the H.F. or I.F. input to the detector shall be great enough to cause the L.F. gain to be sufficient for the effect to build up. In the case of the first and sceond problems, the only possible solution lies in a suitable design of valve-electrode supports, since it is very difficult to reduce the amount of acoustic feed-back in so confined a space.

These problems present many interesting difficulties, which, as has been stated, may be overcome by careful attention to the considerations of design already enumerated.

Radio and Traffic.

INFORMATION given by radio concerning the closing of streets to traffic has proved of great assistance on the Continent. One example in this connection is the traffic-broadcast emitted daily immediately following the weather forecast by the Leipzig-Dresden stations. At the end of the week the Swedish transmitters always give information concerning the state and practicability of the various important roads of communication, which information is then worked out by the Royal Swedish Automobile Club at Stockholm. Naturally, such a broadcast is most efficient if it is carried out daily at the same hour.

A Broadcasting Film.

Some time ago, a German film producing company, the Emelka, started a sound film of the Bavarian station at Munich during its operation. The film will faithfully reproduce a broadcasting day in the offices and the studios of a station, and what happens near the transmitter. The filming will be done within the buildings, and the "actors" will be the daily employes of the Bavarian broadcast station. Some time ago scenes were filmed in the large broadcasting studio which preliminarily had been turned into a real film studio. The sound was not recorded on the spot, but carried for recording by means of leads to the studios of the film producers.

The B.B.C. Winter Programme.

On October 19th the well-known "B.B.C. Symphony Concerts" were again resumed. It is known that these concerts are not only broadcast, but are also accessible to the public. The recapitulation of the collaborators to these concerts represents a most imposing mass of famous names. Amongst others, the microphone will have the honour of broadcasting the pianists Harriet Cohen, Alfred Cortet, Myra Hess, Frederic Lamond and Arthur Schnabel; that of the violinists Hubermann, Busch, and Micha Elmon; the violin-'cellist Casals, and further of many great singers. A number of set-owners in Europe are undoubtedly looking forward to these very promising artistic evenings which the winter is bringing them.

The Radio-Sphinx.

Radio Morocco has planned a novelty for their listeners. This is the radio-sphinx. This sphinx is a young lady with an extraordinarily sweet voice, and at specific hours of the day will throw out a few incoherent words through the microphone. If the listener-in is very attentive, he will be able to build a sentence with these words, such as, for instance, a motto or a well-known saying. The listeners-in of Radio-Morocco are hard at work to solve the riddles, and their wits are undoubtedly sharpened by the not unimportant money prizes which are granted to the correct solutions.

Radio in Italy.

Within a few months Italy will introduce radio schools. The president of the Italian Broadcasting Company has drawn up a plan which has been discussed by various experts, and it is now to be submitted for approval to the Italian Parliament. This new department of the broadcasting will be entrusted to the care of a new organisation which will be known as the "Radio-Rurale," and will be dependent on the Government. A series of sets have been developed especially for the schools, one of the principal characteristics being their inexpensiveness. Each school in Italy will be equipped with a receiving set.

Radio in Scandinavia.

Denmark is the most radio-loving country in Europe, and in August had 488,832 listeners-in; this represents an increase of 12,000 for one month. 19,300 Danish listeners have been exempted from radio subscription and delays of payment have been granted to 17,000 others; these latest figures give an idea of the present situation due to the economical crisis. The number of listeners-in in Norway has slightly decreased. On August 1 it amounted to 108,886, as compared to 108,997 on July 1.

New Freiburg Transmitter.

Numerous measurings of the field strength in the range of the new broadcasting station, Freiburg, led to the decision to choose a neighbouring plot lying more than 3 k.m. from the centre of the town. The transmitter will have a power of 5 k.w., and will work with the Frankfurt, Cassel and Trier stations on the 259.3 m. wavelength. The construction was started recently, and it is hoped that the station will be in working condition at the end of next spring.

On Records—B.B.C. Programmes.

Australian listeners may shortly hear programmes of the British Broadcasting Company from the local stations. Philips Radio have received information that the B.B.C. will make available to broadcasting stations within the Empire records of special Empire programmes, so that they may be broadcast in the Dominions.

In this way a complete B.B.C. programme can be transmitted by an Australian station from a number of discs similar to the ordinary gramophone record. This should have a great bearing upon the standard of programmes in Australia, giving opportunity for vast improvement.

Broadcasting in Canada.

At the end of the last fiscal year (March 31), Canada counted 598.358 listeners; this shows an increase of 75,258 in one year. The largest number of receiving sets is found in the province of Ontario—285.048. In the N.W. territory 183 sets have been registered. Toronto owns 68.454 sets for a population of 631,207, whilst Montreal has a population of 818.577 inhabitants and 76.160 sets.

ULTRA SHORT WAVE.

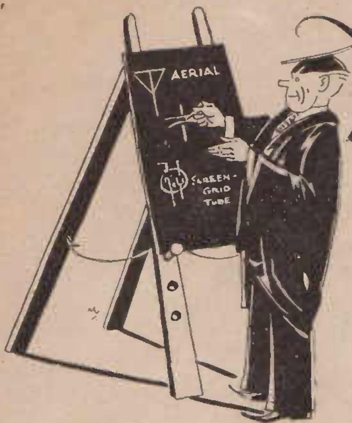
Experimental Broadcasts.

AMALGAMATED WIRELESS (Australasia) LTD. is exploring the very short wireless wavelengths around seven metres. Little is known of the qualities and peculiarities of these low waves, which differ enormously from those of the band between 200 and 575 metres on which the usual broadcasts take place. They are also quite distinct in their action from the ordinary short waves of 20 to 80 metres on which long distance communication is usually conducted.

Every Sunday Amalgamated Wireless broadcasts from Pennant Hills on a wavelength of 28.5 metres programmes for reception in countries all over the world. These programmes are now being radiated also on 7 metres and A.W.A. is studying the characteristics of such transmission. The desire is to determine the range of these broadcasts. It may be found that they are only effective within the comparatively limited range of about 200 miles.

It has been noticed that transmissions on 7 metres are peculiarly free of the effect of static and there is little or no fading in the signals.

The suggestion has been made that these ultra short waves may prove useful for purely local broadcast services for listeners within a limited range. Although the whole matter is speculative, A.W.A. hopes to secure information of a highly interesting nature from this latest series of experiments.



The THREE 'R's' of RADIO

PRESENT-DAY vacuum tubes operate on the principles discussed in previous chapters. Their design and construction are being constantly refined, and practically a perfect vacuum is now being obtained in the millions of tubes being manufactured yearly. Filaments have been improved with a view towards longer useful life and greater efficiency.

Experience has shown that one particular type of tube cannot be used for all purposes for best results. There are special tubes for radio frequency amplification, special detectors, and special audio frequency amplifiers of various capacities for handling various amounts of power. We have tubes designed to have their filaments heated by dry batteries, types for use on storage batteries, and the more recent ones which use raw alternating current from the house electric light lines. Though most of them look quite the same externally, they vary in size, shape and spacing of the internal elements, giving rise to different characteristics.

A knowledge of some of the more commonly used terms regarding vacuum tube performance is essential not alone for its general educational value, but also because it tends to promote a better and practical understanding of the theoretical action of the vacuum tube.

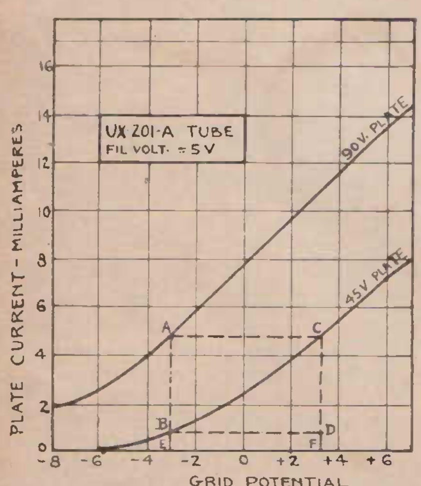


Fig. 55.—Here is shown a typical characteristic curve and the method used to find the amplification factor of the tube.

Characteristic curves of ordinary 3-electrode tubes can be compiled from measurements made with the apparatus connected as shown in Fig. 54. The chart of Fig. 54 shows the characteristics of various types of tubes commonly used. It will be discussed later.

With a fixed value of filament current, the plate current of a 3-electrode vacuum tube can be varied either by varying the grid potential or varying the plate potential. However, it can be shown experimentally that a small change in grid potential by a few units (unit equals, say, one volt) causes as great a change of plate current as would a much greater change of plate potential. This property is employed in radio receiving sets where the weak incoming signal potentials are applied to the grid circuit and made to produce large changes in plate current; or, in other words, the changes are "amplified." The ratio of the change in the plate potential required to vary the plate current a given amount to the change in grid potential required to produce the same variation in plate current is called the "Voltage Amplification Factor" or "constant" of the tube, and is commonly called MU.

To show the method employed for finding the amplification factor from the usual characteristic curves of a tube, consider the curves in Fig. 55. These are for a UX-201A tube at plate potentials of 45 volts and 90 volts. Selecting any point B on the straight portion of the 45-volt curve, draw a perpendicular A B E through this point. Draw horizontal lines A C through point A to the 45-volt curve, and B D through B. Drop a perpendicular line from C to F. Now consider the tube operating at a plate potential of 45 volts, and grid potential equivalent to point B on its characteristic curve.

If the grid potential is increased an amount equal to E F (or B D) units, the plate current increases an amount C D. This same increase C D in plate current could also be obtained by

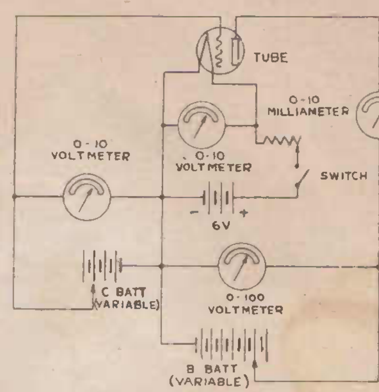


Fig.

Fig. 54 shows the connection of the measuring apparatus necessary to plot characteristic curves of radio valves.

keeping the grid potential at E and increasing the plate potential from 45 to 90 volts (point A). Therefore, an increase of E F units of grid potential has the same effect on the plate current as an increase of 45 volts in plate potential. From the foregoing definition of amplification factor, then the mu of this tube is 90 volts minus 45 volts divided by E F (6.3 volts), or mu=7.1. That is, the grid exerts 7.1 times as much influence upon the plate current as does the plate voltage itself at the particular point B on the characteristic.

Amplification Factor Variations.

The mu is not constant for a given tube, but varies slightly with the plate and grid potentials, as shown in Fig. 56. For accurate work it is necessary to determine it at the particular values of grid and plate potentials at which the tube is operating, the filament, of course, being operated at the normal current and temperature for which the tube is designed.

The value of an amplifying tube depends, to a large extent, upon its amplification factor. This increases as the grid wires are arranged closer together, making a finer mesh, and increasing its effective area, thus giving the grid more control on the plate current; and increases as the ratio between the plate-filament and grid-filament distances increase, since the closer the grid is to the filament, the smaller the potential required to set up a field around the filament equivalent to that of the plate. A UX-201A tube has a mu of about 8.5. The UX-240 high mu tube has a value of 30. The UX-224 screen-grid tube has a value of about 400, although only a fraction of this latter value can be obtained in a practical amplifier. By using very fine-meshed grids mounted at a small distance from the filament, as compared to the distance of the plate to the filament, amplification factors of several hundreds have been obtained in some experimental tubes. It must be remembered, however, that changing the mesh and spacing of the grid and plate also changes other important characteristics of the tube, so that, while high amplification factor might be desired, its attainment may so change these other characteristics that the tube is worthless as a practical amplifier when used in certain positions in a radio receiving set.

Also there are practical mechanical considerations to be taken into account, since if grid and filament, or grid and plate are mounted too close together there is danger of them touching together, causing a short circuit; and small mechanical vibrations will produce a proportionately larger change of relative spacing between the elements, resulting in strongly microphonic tubes. For instance, as will be explained later, high mu tubes having a value of 20 or 30 are very valuable for use in resistance and impedance coupled audio amplifiers, but the types available at present are unsuited for transformer-coupled amplifiers because of their high plate impedance, which is about 40,000 ohms, as compared to 12,000 ohms for a 201A type of tube. The screen-grid tube suffers from the same handicap.

When a difference of potential is applied between the plate and filament of a vacuum tube it causes a current to flow through the "B" battery circuit, and across the space between the plate and the filament in the tube. The amount of current flowing for a given filament temperature depends not only on the plate voltage, but also on the grid potential. The tube can thus be thought of as a variable resistance, whose value depends on the grid potential. The lower the grid potential, the higher is the plate circuit resistance, and the higher the grid potential the lower is the plate resistance and the larger the plate current. This is sometimes known as the "internal resistance" of the tube.

Since the plate and the filament in the tube are both made of metal, and insulated from each other, they really form a condenser of small capacity, with the filament as one plate, the plate of the tube as the other plate, and the space between as the dielectric. When a varying potential is impressed on the grid, a pulsating current flows in the plate circuit, and if the frequency is very high, the small plate-filament capacity cannot be neglected. The tube then acts as a variable resistance equal to the internal plate resistance of the tube, shunted by a condenser having a capacity of the plate to the filament. Their combined effect, for alternating current work, is known as the "plate impedance" Rp of the tube. As the plate filament capacity is very small (about six micro-microfarads for a 201A type tube), its effect is practically nil except at very high frequencies, and for most tube discussions the internal plate resistance is taken as the plate impedance.

The plate or output impedance is defined as the change in plate potential in volts divided by the change of plate current in amperes which it produces. Using the values ascertained for calculating the amplification constant in Fig. 55, the plate impedance of the tube is $Rp = \frac{90-45}{.004} = 11,250$ ohms.

Plate Impedance and Mutual Conductance.

As the plate impedance varies with each change in plate and grid voltage, it shou'd be considered only for small changes and at the point on the characteristic curves where the tube is actually operating in a radio set. The plate impedance depends on the plate-filament spacing and the plate voltage used, the grid voltage, the fineness of the grid mesh, and to a small extent the distance between the grid and plate. The plate must be designed so its temperature is kept relatively low under operating conditions, for if it gets very hot it will emit electrons as does the filament, and hence interfere with the operation of the tube.

The essential function of an amplifying tube is to produce a large undistorted change in plate current for a small change of grid potential. As this important quality of the tube therefore depends upon the ratio of the change in grid voltage to the corresponding change in plate current which it produces, by comparing these values we obtain a figure which is usually known as the "mutual conductance," represented by "Gm". (The conductance of a conductor in "mhos" is defined as the reciprocal of its resistance in ohms.)

The mutual conductance of a three-electrode vacuum tube can be found by taking the amount of "slope" or slant at a point on the characteristic curve. As the curve is not straight, the mutual conductance (slope), changes somewhat for different values of grid potential and plate voltage, so that it should be taken at the point on the curve corresponding to the conditions under which the tube is to work.

The plate current-grid potential characteristic curve of a UX-201A tube with 90 volts on the plate, assuming that the grid return is connected to a "C" battery of —4½ volts as is commonly done, thereby setting the normal grid potential at —4½ volts. The operating point is then point A on the curve. First, to take the slope of the curve at this point, lay a straight edge tangent to the curve at the point A, and draw tangent line B C so it cuts the horizontal axis. At any point C draw the perpendicular line C D; now measure the ordinate C D of the point of intersection (say 11.6 milliamperes). Also measure the horizontal distance B D from this latter point to the point where the tangent line intersects the horizontal axis. (Say a total of 15.3 volts.) Dividing the former distance 11.6 M. A. by the latter 15.3 volts gives the slope of the curve or the mutual conductance at point A, which in this case is 0.76 millimhos.

The unit of conductance ordinarily used in vacuum tube work is not the milimho, but the "micro-mho" (millionths of a mho.) To change to micro-mhos we multiply by 1000, which gives 760 Mmhos. The mutual conductance of a tube varies with changes in grid potential and plate voltage.

The mutual conductance can also be found from the relation between amplification constant and plate impedance.

$$\text{Mutual conductance} = \frac{\text{Amplification constant}}{\text{plate impedance}}$$

$$\text{or GM} = \frac{\text{Mu}}{\text{Rp}}$$

As a general rule, the best type of amplifying tube is one with a high value of mutual conductance. Of course, other considerations, such as filament current consumption, necessary plate voltage, capacity between tube elements, etc., may determine the selection of the type of tube for a given use, but between several tubes, any of which are suitable, the one with the highest value of mutual conductance will be found to be superior for amplification.

The exact voltages to be used on the plate and filament of a vacuum tube, for best results in a particular radio set, can be determined only by experiment, for it is evident that it is impossible to make duplicate tubes in every respect, although tube manufacturers are doing marvellously well in this matter. The degree of vacuum to which the tubes are pumped, the sizes and shapes of grids and plates, the distances of each from the filament and from each other, all cause the characteristics to vary slightly from the average values.

Features of Power Tubes.

It should be remembered that the amplification constant of a tube refers to its voltage amplifying characteristics only; it says nothing about its power-handling ability. A tube whose output goes to a loud speaker is called upon to deliver actual electrical power to it, to set the air in motion for the production of sound waves. The plate impedance of such a tube should be kept low so that the power supplied to the plate circuit will not all be wasted in the tube itself. The more voltage it takes, inside the tube, to overcome the plate impedance, the less there is left for use outside of the tube. If the plate load impedance is equal to the plate impedance, the maximum transfer of energy will take place, and as the load impedance becomes less, the energy transfer becomes proportionately smaller, as we shall see later.

Usual types of power tubes have a low output impedance and consequently also a low amplification factor.

High mu tubes have a very high plate impedance, and are used primarily for resistance and impedance coupled audio amplifiers. The mutual conductance, which expresses both of these factors at once, is a good characteristic to take as a figure of merit of an amplifying tube.

The expression "Figure of Merit Factor" generally is used as a measure of the performance of a tube instead of the rather technical term "mutual conductance" where

$$\text{FM} = \frac{\text{Mu}}{\text{Rp}}$$

Mu is the voltage amplification factor and Rp is the plate impedance of the tube when operated at normal plate and filament voltages. The figure of merit factor obviously considers both characteristics.

Three electrode tubes are used either as detectors, amplifiers, modulators or oscillators. In each case we are interested in producing changes in the steady plate current by variations in grid potential. The plate current-grid voltage characteristic of the tube is, therefore one of the most important.

Fig. 58 shows the relation for various tubes, between grid voltage and plate current, at the same plate voltage, the filament in each case being operated at normal current. The curves are all of the same general form. The current first increases gradually as the grid voltage increases, then more rapidly and finally more and more slowly as saturation is approached. This last condition is met only with high positive grid biases, and should not be approached durng the normal operation of a receiver.

The slopes of these curves indicate the degree of amplification obtainable, a steep slope indicating a high amplification constant.

(Continued in next issue.)

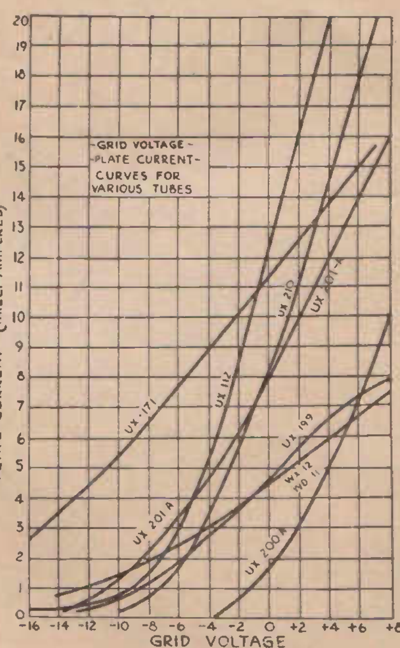


Fig. 58.—The grid-plate characteristics of various American battery type valves.

Practical Hints and Tips

TESTING BY SUBSTITUTION.

IT is often recommended that stage-by-stage tests of a receiver should be carried out by temporarily eliminating the H.F. stage or stages. To do this the aerial is joined to the anode lead of the last H.F. valve through a very small condenser, and the set should then work as a simple detector-L.F. combination. If it does so, conclusive proof is afforded that any defect that may exist is in the H.F. amplifier or the input circuits.

When it is suspected that the coils used in an input band-pass filter are defective, the correctness or otherwise of this diagnosis may almost invariably be checked by carrying this test a stage farther and substituting each individual coil in turn for the tuned winding which precedes the detector. From this point of view it is fortunate that all the tuned windings in a modern set are usually identical; the various coil assemblies differ only with regard to such additions as aerial coupling coils, filter coupling coils, and the positions of tappings, etc.

WITHOUT AN EARTH.

IT is sometimes forgotten that every D.C. mains-operated set is automatically "earthed" by its connection to the supply system. Admittedly, this form of earth connection is often lacking in efficiency from the H.F. point of view, but when an unduly noisy background of hum is present it is at least worth while to try the effect of taking off the normal earth wire.

When a marked improvement is noticeable as a result of working with a "mains earth" only, it will generally be found that there is an appreciable difference of potential between the "set earth" and the "mains earth." This provides a clue as to how disturbing hum voltages are introduced into the receiver.

IS FIELD CURRENT EVER "FREE"?

THE unfortunate use of the word "free" in connection with grid bias and the field current of moving-coil loud speakers has, in the past, misled many people into imagining that the laws of nature could be successfully circumvented by the wireless engineer. It has long ago been made clear that "free" grid bias volts are merely filched from the H.T. voltage, which has to be correspondingly increased in order to make good the deficit; many people are, however, still somewhat hazy concerning the question of field current supply in the case of a moving-coil loud speaker, which is certainly more entitled to the term "free" than any system of obtaining grid bias.

An "energised" type of loud speaker requires a certain value of current to pass through its field winding before it will function properly, and a certain number of volts—usually in the neighbourhood of 100—are needed to overcome the resistance of the winding and force the current through.

The plate current of a modern mains receiver is usually sufficient for the purpose, but if the field winding is connected in the common H.T. positive supply lead it will at once, according to its resistance value, appropriate a certain number of the volts which rightly belong to the anodes of the valves in the receiver. The net result is that neither valves nor loud speaker are adequately provided for. Fortunately, the loud speaker field serves as an excellent smoothing choke, and can be substituted in place of an ordinary inductance, and the volts hitherto absorbed by the latter will be available for loud speaker and set.

The voltage demand of the field winding, however, is usually in excess of that absorbed by any ordinary smoothing choke, and the deficit will therefore have to be made up by increasing the voltage of the H.T. supply. However, the modern tendency to use a generous output valve which usually requires a much greater anode voltage than preceding valves in the set does enable the loud speaker winding to be used to absorb the excess voltage, which normally would have to be wasted in a resistor. In this latter case, therefore, the field current is really free, apart from the fact that its winding serves also as a smoothing choke.

CATHODE CIRCUIT MEASUREMENTS.

IT is usual, when making a measurement of anode current, to insert the milliammeter at any accessible point between the plate terminal of the valve concerned and the positive terminal of the source of H.T. supply. But when it is more convenient to do so, there is not the slightest objection, on technical grounds, to connecting the instrument in the cathode lead of an indirectly heated three-electrode valve. The resistance of the meter will usually be negligibly low in comparison with that of the bias resistor which is customarily included in the cathode circuit.

The anode current of a directly-heated output valve, of which the filament is supplied with A.C. from a step-down transformer, may be ascertained in a similar manner by inserting the milliammeter in the lead which joins the L.T. transformer secondary to earth—generally through a self-bias resistor.

This method offers the slight advantage of additional safety; no considerable voltage difference exists between the meter leads and the metal chassis of the set, and so the result of an accidental short-circuit is not likely to be serious.

When dealing with a screen-grid or pentode valve in this manner it should be remembered that the meter will indicate the sum of anode and screen currents, also possibly that consumed by the feed potentiometer.

SPINDLE CONNECTIONS.

THE electrical connection between the rotary contact brush of a potentiometer and terminal is a fairly common source of background noises; these do not of necessity occur only when the knob is being turned.

Although many potentiometers are cleverly designed to ensure good and consistent electrical continuity throughout, some of them depend on contact between a spindle and bush designed entirely from the mechanical point of view. Even when a spring contact is fitted, its functioning may be impaired, in the course of time, by an accumulation of dust or dirt between the contacting surfaces.

A temporary "pigtail" connection of flexible wire, made directly between the rotary brush and the terminal, will soon show whether background noises are due to this cause. If they are, a cure may generally be effected by cleaning the bush and spindle, etc. Better still, recurrence of the trouble may be avoided by fitting a permanent "pigtail," so that it will no longer be necessary to depend on rubbing contacts.

DIODE RECTIFICATION AND BIAS.

AN appreciable D.C. voltage is built up, by the action of rectification of the carrier wave, across the coupling resistance of a diode detector. When this coupling resistance is directly connected to the grid of a succeeding L.F. amplifying valve, voltage thus developed is effectively in series with any grid-bias voltage that may be applied from normal sources. Unless this point is borne in mind there is a real risk that the valve will be over-biased under working conditions.

The general rule to apply in these circumstances is that a battery valve will not need any additional bias. A mains-operated triode, in which grid current generally starts "early," should have a standing bias of about 1 volt or slightly more.

TESTING FOR "SOFTNESS."

IT is not always realised that the decoupling resistance used in conjunction with an automatic bias scheme offers a ready means of testing the valve in whose grid circuit it is connected for "softness," or deficient vacuum. If anode current is changed to any appreciable extent as a result of short-circuiting this resistance, it can almost invariably be assumed that the valve is soft; the extent of change in current is more or less a measure of the degree of softness, although the magnification factor of the valve concerned must always be taken into account. Current variations are always greatest when dealing with high-magnification valves.

MAKING HASTE SLOWLY.

WHEN starting to build a new set there is a very natural tendency to waste no time over apparently unproductive preliminaries, but to begin operations by removing the components from their boxes and mounting them forthwith in their final positions. It is urged with some confidence that it is a far better plan to make a start by devoting half an hour to a thorough examination of all the parts, and even to carrying out rough electrical tests, before they are finally screwed down. If a defective piece of apparatus happens to have escaped the vigilance of the manufacturers' test department, it is much easier to detect a fault, whether it be electrical or mechanical, while the component is freely accessible, and while the work of testing is unhampered by interconnecting leads. In addition, a single faulty part may be responsible for damage to other components when first switching on the finished set.

Experience shows that attention may most usefully be devoted to the points mentioned in the following list:—

It is worth while to go over the valve-holders very carefully with a pair of pliers, and to make sure that all the contact springs or sockets are properly fixed in position and are in firm electrical contact with the terminals. A valve may then be inserted in the holder to assure oneself that each of the pins is a good fit in its corresponding socket. Almost all modern valve-holders are cleverly designed and well made, but one cannot expect these components, which obviously represent very good value at their present low prices, to have been subjected to exhaustive electrical and mechanical tests after assembly.

Even if a couple of dozen fixed condensers are to be included in the set, it will not take many minutes to test them roughly, and by doing so the possibility of an expensive short-circuit will be largely avoided.

Built-in trimmers on ganged condensers may be examined in order to make sure that the adjustment works properly, and that the thin sheet of dielectric which is usually included is in its correct position.

It is hardly necessary to test modern tuning coils electrically, but if they include built-in wave-change switches it is wise to make an examination, and even an electrical test, of the switch contacts. Indeed, all switches to be included in the set may well be tested, as these components are susceptible to damage, and are not generally given an electrical test by their makers.

Any mechanical moving parts that will be inaccessible after assembly should be examined, adjusted if necessary, and even lubricated, if it seems likely that they will benefit from this attention.

Although not directly connected with our present subject, it may be pointed out that solder does not take kindly to nickel-plating, and so it is worth while to file away the external coating from soldering tags that have been treated in this way.

HOW TO USE ELECTROLYTIC CONDENSERS.

A CONDENSER, in order to be suitable for amateur transmitters and large power amplifier filter circuits, should be capable of withstanding the operating voltages without any spluttering, buzzing, or similar phenomena.

Since for the present, the available electrolytic condensers are limited to a working voltage of 450 volts, it is obvious that two or more units must be wired in series to stand the necessary working voltage.

Also in series operation of condensers having equal capacity the effective capacity is represented by the capacity of a single unit divided by the number of units in series.

Thus with 3-500 volt peak 8 mfd. units in series to operate on a voltage of 850 to 1200 volts rectifier circuit, the total capacity is 1/3 of 8 mfd.—that is, 2.6 mfds.

Correct Working Voltages.

Maximum D.C. Volts	No. of units in series 500 volt peak type.	Capacity using 8 mfd. units.
600—800	2	4
850—1200	3	2.6
1250—1600	4	2.0
1700—2000	5	1.6
2100—2500	6	1.3

In conclusion, we might add a standard 8 mfd. 500 volt peak condenser when used on voltages less than 450 volts, the capacity increases slightly.

In a good electrolytic condenser, the current leakage is approximately ½ milliamp per mfd., viz. 8 mfd=4 mills.

A Giant Voice Heard Over the Harbour

A.W.A.'S LOUDSPEAKER.

PERSONS in the vicinity of the Sydney Harbour foreshores one day this week were startled by the sound of a stentorian voice proceeding from the excursion steamer Kirrule.

As the steamer drew out of Circular Quay for her weekly tourist trip, the voice of a lecturer describing the progress of radio science could be heard for a distance of perhaps two miles. This was followed by music which was still audible to people on Kirribilli Point when the steamer passed out of sight proceeding up the Parramatta River.

The tremendous amplifying effect was produced by the most powerful speaker ever seen or heard in the world. It was manufactured for Amalgamated Wireless by the Marconiphone Company and the weight is 3½ cwt. The speaker was mounted on the top of the tourist steamer, where it was operated by a huge amplifier manufactured in the Radio-Electric Works of Amalgamated Wireless (Australasia) Ltd., at Ashfield. It is fitted into a 36 inch searchlight cowling, and it bears the appearance of a searchlight or trench mortar. The speaker uses 120 watts of electric power for its operation, as compared with two watts used by the standard speaker of a high power radio receiver.

The speaker throws the sound in a broad beam almost on the principle of the searchlight. Its power is astonishing. Beside or behind it there is little sound. To stand in front the listener feels the strong pulsing of its air waves and is almost deafened. Although it is full throated its reproduction of music is perfect. It could thunder directly to airmen flying near the clouds or speak to the crowd on scattered harbour craft and on the foreshores on Regatta Day.

The speaker is too big for ordinary amplifying work. It is reserved by A.W.A. for special outdoor occasions, such as Head of the River boat races, Showground or Aerodrome gatherings, and, perhaps, for controlling street crowds of the magnitude of those seen when the Harbour Bridge was opened.

"SERVICE PLEASE"

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

Some advice was published recently on the subject of charging an L.T. cell from a motor car battery. What is the reason for showing a current limiting resistance connected in the positive lead of the charging battery?—R. L. Leach (Brighton, Vic.).

This is a matter of very small importance, and, of course, from the theoretical aspect, it is quite immaterial whether the limiting resistance be inserted in the positive or negative leads.

But, as the negative pole of the grid battery will probably be permanently "earthed" to the frame, the risk of damage to the car battery, due to an accidental short circuit from the charging leads, etc., to any earthed metal work will be slightly reduced by adopting the method of connection given.

Having purchased a commercially made power transformer, I find that my receiver is only drawing a load of about one-half of the manufacturer's rating.—C.R.S. (Ivanhoe, Vic.).

It should be remembered that this is a matter of little importance provided that the transformer is designed on reasonably generous lines, its voltage regulation should be good enough to cope with small discrepancies. In other words, the voltage should not rise by more than a few per cent. when the load is well below the normal rating; similarly, it should be maintained at sensibly the full value when maximum current—or even a little more—is taken from the windings.

Several questions dealing with this subject have lately been received, and one correspondent appears to be doubtful whether it would be safe to wire two indirectly heated A.C. valves (consuming a total of 2 amperes) across a winding rated at 4 amperes. In this case, the transformer secondary will be delivering one-half of the full-rated current, and even a badly regulated component should do this without an appreciable voltage rise.

Can the detuning effect in a receiver be used as a volume control?—Mug (Melbourne, Vic.).

Although the practice of detuning a receiver in order to reduce an over strong signal to a suitable level is generally deprecated, this crude method of volume control has its uses.

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.

But it should be emphasised that unless the receiver be detuned to a considerable extent—by more than say 5 per cent.—a peculiar form of distortion is likely to be introduced as a result of mis-tuning.

The rule then emerges that the set must either be detuned very considerably from the wavelength of the transmitting station, or that it must be exactly in tune.

The latter point is perhaps not sufficiently appreciated, especially when receiving a near-by station from which there is no difficulty in obtaining signals of more than sufficient loudness.

With many modern sets, and particularly with superheterodynes, it pays to take meticulous care to see that the circuits are exactly in resonance.

From this it logically follows that a satisfactory form of volume control is an essential part of almost every modern set.

Having obtained a highly accurate A.C. meter, I wish to test my power transformer under working conditions. How could I calculate the value of the artificial loads which will be connected across the L.T. secondaries?—"A.J.C." (Surrey Hills, Victoria.)

Although this is quite a simple matter in theory, we are inclined to suggest that you would do better to take the measurements with a natural load, i.e., that of the valve heaters, etc., which will ultimately be connected across the various transformer windings.

The reason is that we doubt if you will have access to fixed resistors of suitably low value, combined with adequate current-carrying capacity.

The calculation in question is easily made by dividing "rated voltage" by "current to be consumed" (in amps.). For example, a 4 volt secondary, which will be required to give 2 amperes, should be shunted by a resistance of 2 ohms. The measured R.M.S. voltage across the winding should then be 4 volts.

It may be added that, strictly speaking, measurement should only be made when all the secondary windings are delivering their normal outputs, as a reduction in the total load imposed on the transformer will introduce a rise of voltage, even across those secondary windings that are fully loaded.

The extent of this change will depend on the design of the transformer.

Enclosed is a 4 valve circuit I am using at present, and you will note that it is rather similar to the "World Short-Wave Four," (Mod. Sets, Aug. edition), with the exception of (1) different valves, (2). detector plate connection; (3) variable condensers; (4) A+ goes to earth instead of A—. Could I make it into an "All Waver" set by changing the variable condensers for smaller capacities, say .00015, .00025 or even .0001 mfd.?

Are the midget condensers as efficient as the others—i.e, being comprised of semi-circular plates? Will they tend to bunch stations? — B. A. Harris, "Kippilaw," Goulburn, N.S.W.

The circuit you enclose will be quite O.K. for short-wave reception, the only alterations necessary will be the values of some of the components. However, I suggest you try the effect of a few alterations when down on the short waves.

In the detector circuit, because of the fact that the grid coil is not earthed, the charge leaking away through the grid leak will have to travel through the B battery to the filament.

To avoid this, connect the grid leak directly to earth. The reason why better results are obtained when the A+ lead and the grid leak return are connected to one another, is due to a more correct value of bias.

A detector valve requires a certain amount of bias to enable it to work on the correct portion of its curve, the general efficiency depending therefore on the value of the leak.

If the values of the condensers are changed for short-wave work, two or more coils will be required to cover the broadcast band.

Suggest you use your present condensers as they are for broadcast work, but on short-wave connect a fixed condenser in series with the tuning condenser.

This has the effect of reducing the total capacity across the coil.

Where the tuning condenser has a capacity of .0005 mfd., if a .00025 mfd. fixed condenser is connected in series with it, the resulting capacity will be .000166 mfd.

The switching-in of this series condenser can be done automatically by having two pins on the five pin valve base coil, bridged with a piece of wire.

For full details refer to the "Test All-Wave Battery One" described in the November issue.

Midget condensers are quite as efficient as some of the larger type, but having semi-circular plates, they do tend to bunch stations at one end of the dial.

The bias connections for the S.G. valve are quite O.K., you might find that the battery screen grid valve will work just as well without bias, on the short-waves.

Answers to queries will be sent free by post provided a stamped envelope is enclosed.

The paper usually comes out on the first of the month.

In the case where a five plate aerial condenser is specified, a thirteen plate would probably do, but the adjustment would be very critical on short-waves, if the detector was coupled to the aerial.

The coil data you require will be found in the Test All-Wave Battery One article.

What appears to be the best way of winding valve base coils is to wind the grid coil on top, and the reaction coil below, taking the first top turn to the grid, and the last bottom turn of the reaction coil to the plate.

Does a D.C. mains receiver cost more to run than an A.C. mains set?—D.C. (Melbourne).

As a considerable amount of energy has to be dissipated in the form of heat in the mains resistance of a set operated from a D.C. supply, it follows that these receivers are somewhat more costly to operate than those designed for A.C. systems. Fortunately the matter is not serious; as a set with say ¼ amp. indirectly heated valves consumes practically the same current as the type of lamp in most general use for illuminating purposes.

As D.C. sets have this not altogether merited reputation for extravagance, it is not surprising to find that certain misconceptions have arisen with regard to cost: buyers of sets—and even builders of them—sometimes seem to be under the impression that, as the current consumed will be considerable, it follows that a special effort should be made to restrict the total number of valves in a receiver.

This is totally wrong. Practically speaking, it costs the same to run a single valve D.C. set as one with four valves.

Of course, the multi-valve set will consume rather more anode current, but this will be quite negligible in comparison with that required for feeding the heater circuits.

Is it possible to cure the extremely broad tuning of the super-regenerative circuit? Could a stage of R.F. be added to increase selectivity? Also, when winding coils, what spacing should be used between tickler and secondary or grid coil.—C.R. (Blackburn, Vic.).

Broad tuning is a characteristic of super-regenerative circuits. This is one of the reasons they are used on the very short waves, where ordinary short-wave sets are too critical for operating convenience.

An R.F. stage can easily be added, but even this does not increase selectivity to any great extent.

The spacing will depend upon the detector plate voltage, the value of the grid leak and condenser, the number of tickler turns and the tube. Approximately 1/16 to 1/8 inch will generally be sufficient for short wave coils.

The spacing and number of tickler turns should be proportioned so that the tube will just oscillate at the high end of the tuning scale, with the regeneration control set at maximum. When this is done regeneration will be very smooth with a minimum of fringe howl and other noises.

Could you tell me the best type of antenna for short-wave use?—A. W. Smith (Bendigo, Vic.).

There is no "best" antenna for short-waves unless you desire reception from one direction only, in which case a dipole is recommended. A single wire between 10 and 60 feet long is generally O.K.

I have built a one-tube super-regenerative set. Signals are strong, but always accompanied with a loud "mushing" noise. Is there any cure for this? Could I add automatic volume control to a receiver having low R.F. gain?—A. J. White (Bondi, N.S.W.).

A variable grid leak and variable grid condenser will be helpful in reducing this noise to a minimum. An increase in the variation frequency will also help.

Automatic volume control could not be added since the R.F. gain necessary must be quite high.

Would grounding the far end of a 125 foot single wire antenna through a 10,000 ohm resistor, as was done in the old Beverage antenna, cause it to be directional?—R. V. Crosby (Hamilton).

It is doubtful if the directional effect would be sufficient with such a short length.

If you could increase the length to 400 or 500 feet, and place it not more than 8 feet above the ground, with the far end in the direction of the desired station, the directional effect would be worth while.

I am desirous of building the "Test All Wave Battery One," described in the November issue.

As I have recently built up a midget four valver I would like to use your one valve set as a short wave adaptor.

As the detector valve is a screen grid (A442) I would like to know how to couple the two together.—K.R. (Tooronga-road, Glen Iris, Vic.).

Using the Test All Wave Battery one as an adaptor for your broadcast re-

(Continued on page 35.)

ceiver, only the audio stages of the set will be used.

The method of coupling the A442 to the first audio will be quite O.K. for the A415, excepting that a lower voltage will be required on the plate of this tube.

To connect the short wave detector unit or adaptor, use an old valve base as a plug, to which must be soldered the two filament and the plate leads.

In the case where an ordinary three element detector is being employed, the valve base could be plugged directly into the detector socket of the broadcast set.

But in your case the plate is on top of the valve, so the only way to overcome the trouble would be to mount another four pin valve socket alongside the existing detector socket, and plug the adaptor into here.

The plate lead of the broadcast detector could be permanently connected to the normal plate terminal of this socket, and the filaments to the corresponding filament terminals.

Care should be taken to see that if an earth wire is brought to the adaptor as well as the existing set, the "A" battery is not short-circuited.

This will happen if the "A" — lead on the present set is earthed.

I have constructed a short wave receiver which will work one night but not the next. I have rebuilt it many times, but with the same results. Can you suggest what is wrong?—"Worried," (Footscray, Vic.).

You may possibly be in a poor location, and, again, something may be wrong with your set.

First go over the aerial and earth and see that the connections are all O.K. If this is not the cause examine both valve sockets and coil sockets, especially the latter.

It frequently happens that the constant removal of valves or coils loosens the contacts, thereby resulting in an open circuit.

I have bought a power transformer rated to deliver 375 volts on each side of the centre tap. I am using it with a UX280 rectifier, yet when I connect a voltmeter across the output of the 280 the meter shows that only 225 volts are delivered. Could you tell me what the trouble is?—R.C.M. (Mont Albert, Vic.).

If the rectifier valve is new and the power transformer is at all efficiently built, your volt-meter should read at least 375 v. when connected between the centre tap of the high voltage transformer and the rectifier filament.

Possibly, you are using a low resistance meter. In this case your measurements would be all out. For the measurement of the DC output of power packs, it is necessary that the voltmeter be of the high resistance type.

There are many small, cheap voltmeters on the market which are sold for work of this kind, but unless they are plainly labelled as having a resistance of 750 or 1000 ohms per volt. they are worse than useless. They will give readings, but these will be false and misleading.

Low resistance voltmeters draw an appreciable amount of current for their own operation; because of the characteristics of most "B" supply circuits, this load causes the output voltage to drop appreciably, and the meter reading then means nothing, because the actual voltage will be different when the meter is disconnected.

I am constructing the All Wave Battery One, which, by the way, seems a great little set. Is it possible to use this set as an adaptor for my three-valve electric receiver? — "Battery One" (Carnegie, Vic.).

Provided your power supply is sufficiently filtered, the All Wave Battery One should work as an adaptor.

However, it will be rather difficult to connect it up.

In the first place, the voltage available for the 224 will be too high for the detector in the adaptor.

A dropping resistor would, therefore, be necessary to reduce the detector plate voltage.

Secondly, a battery would be necessary to light the filament of A415.

The 224 tube in your electric receiver is probably resistance coupled to the 247. If this is so, the gain will not be very high when the A415 is used as a detector.

We would suggest you to build up the one-valve amplifier described in this issue, and use batteries for both plate and filament supply.

E. S. Jones, Deniliquin.

We mentioned last month that Gheradi's Radio Course, in one volume, was not obtainable in Australia.

This course can be obtained from McGill's Agency, 183 Elizabeth-street, Melbourne.

I am desirous of building the screen grid detector portion of the circuit of the Diamond All Wave Battery Two, as described in the August issue of "Modern Sets."

Could I use a .00035 variable condenser in series with the main tuning condenser C2, for spreading any portion of the broadcast band?—H.J.H. (Stony Creek, South Gippsland).

Yes, you can use a .00035 variable condenser in series with C2 for spreading on the broadcast band.

Band spreading will not increase the selectivity of the detector circuit, but will enable you to tune right on the centre of the carrier and make tuning much easier.

The correct capacity of a Stromberg-Carlson variable condenser is .00043 mfd.

This is the capacity required.

When the .00035 condenser is connected in series with the .00043 condenser, the total tuning capacity will be reduced to .0002 mfd, which will only tune across half the band.

However, the series condenser need only be used when receiving 4BC and 2WG; in this case no alteration would be made to the coil.

Using 45 volts on the plate, it would be advisable to add another two or three turns to L2.

MAKING YOUR OWN RECORDS.

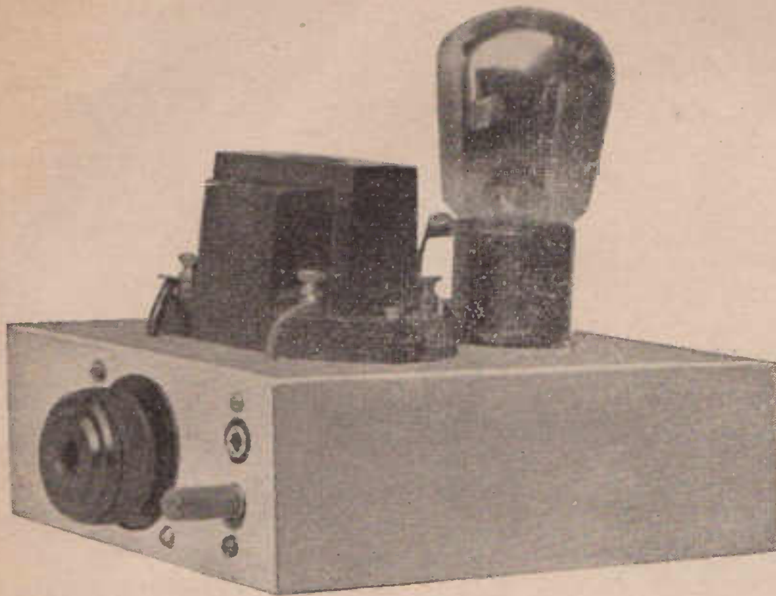
(Continued from page 18.)

mass to work against; with the subsequent result of more volume in the produced record.

Only home-recording needles should be used for recording and playback. These needles, which have a relatively dull point, with a red shank to differentiate them from regular phonograph needles can be obtained at all radio and music stores.

In recording from the microphone, the switch "Sw." is closed, and the volume control of the radio set is turned away down; and vice versa when records are to be made from the air. With a little patience and experimenting the home recordist can achieve results that will be almost on a par with commercially-pressed records.

WE SHALL BE PLEASED TO WRITE PERSONALLY TO THOSE OF OUR READERS WHO REQUIRE A WORTHY, LENGTHY ANSWER TO THEIR PROBLEMS, THAN SPACE ALLOWS IN THESE COLUMNS. SEND 1/- IN POSTAL NOTES OR STAMPS TO COVER NECESSARY EXPENSES.



(Continued from page 5.)

ce.ver by connecting two wires from the 'phone terminals on the set to the sockets P and H on the amplifier.

After both units have been constructed they can be firmly bolted together, side by side, and a new metal panel to cover both chasses fitted in front.

For those who want still more volume and greater stability on short waves a radio frequency amplifier unit will be described in the next issue of "Modern Sets."

NEXT MONTH

January Issue

We will show you how to

Add One Stage R. F. Amplification

to the

"Test" All Wave Battery One

(Continued from page 12.)

A.W.A. push-pull transformers suitable for penthode valves will soon be available.

Results.

In conclusion, we can recommend this set to anyone requiring distance, selectivity, quality and good volume, it being capable of good tonal reproduction without distortion. As a test of distance abilities we have tuned in every Australian "A" and "B" class station at loud speaker strength, also New Zealand and Japanese stations at good strength, but with too much static for comfortable listening. The set was tested at North Brighton, Victoria, on an aerial 60 feet long and 10 feet high.

Should a slight whistle or growl be noticed, and adjustments fail to eliminate it, try a 25,000 ohm resistor as the grid leak for the .56 oscillator, instead of the 50,000 ohm.


Ken-Rad

What the Decibel Means to Radio

By C. A. CULLINAN.

FOR some considerable time now a new term has been becoming prominent in radio circles under the name of the decibel, and, although it is new enough to be uncommon, we will, no doubt, soon consider this abstract term as a reality, as we do the volt, ampere, and the ohm.

The ohm is, of course, based on nothing more than a mathematical ratio between volts and amperes, and our friend the decibel is also a mathematical expression based upon power ratios; and, since it is logarithmic, it has a physical meaning not possessed by other electrical expressions, because it brings power ratios and sound sensation, as heard by the ear, to a common plane.

Our ears do not hear equal steps of loudness for equal steps of sound power, but hear equal steps in loudness more nearly as equal steps in a logarithmic scale of sound power.

In the first days of the telephone it became obvious to the telephone engineers that a definite relationship between sound power and sound sensation was necessary, and eventually they derived a unit known as the "standard mile of cable." This power ratio unit was equal to the loss of power which occurred in one mile of standard No. 19 telephone cable with a resistance of 88 ohms per loop mile and a capacity of 0.054 mfd. Of course, the engineers did not carry about with them a mile of cable, but an artificial cable having the same electrical characteristics. In recent years, however, it became necessary to revise this unit of power ratio, so the decibel came into being. It was not developed by the more or less haphazard methods of the "standard mile," in which, by the way, the transmission loss practically represented the smallest loss in loudness that the ear could register, but was evolved mathematically.

To explain this it would be best, perhaps, to take an example, and we will suppose that we have a transmission line of X miles in length. Now, we put into this line a definite power, which we will designate as IP, and the output power as OP. The ratio, R, of the two powers (any point at which we measure) is OP/IP, and if we measure at different points—say, one mile apart—the successive power ratios would be R2, R3, etc.; so that at the end of the line the ratio is RX. Since the power ratio is an expotential function of the length of the transmission circuit, we can put the power ratio in the form of an equation, RX=OP/IP.

Now, what we want to know is the value of X, so we bring in the logarithmic business and put our equation into this form:

$$X = \text{Log } R \frac{OP}{IP}$$

To get any further we must now obtain a numerical value for R, and, if we remember correctly, there are two systems of logarithms in use—the Naperian, in which the base is taken as 2.71828, and the Briggs, in which the base is 10. Now, both of these can be used, the first giving us "Nepers" and the latter "Bel," and, since the decibel is one-tenth of a bel, the base 10 is the one that we use.

We can now rewrite our equation, which then looks like this—

$$X = \text{Log}_{10} \frac{OP}{IP} \text{ bels}$$

and in order to bring it to decibels it is only necessary to divide the right-hand side of this equation as follows:

$$X = 10 \text{ Log}_{10} \frac{OP}{IP} \text{ decibels}$$

Very often it is impossible to measure the power directly, and since the power is proportional to the square of the voltage or current when the impedance is the same, our equation becomes slightly more formidable as—

$$X = 10 \text{ Log}_{10} \frac{OI^2 r}{II^2 r} \text{ decibels}$$

$$X = 20 \text{ Log}_{10} \frac{OI}{II} \text{ decibels}$$

or for voltage

$$X = 20 \text{ Log}_{10} \frac{OE}{IE} \text{ decibels}$$

where OI is the output current, II the input current, R the resistance, OE the output voltage and IE he input voltage. In discussing power it is customary to refer to a power as so many DB (decibels) up or down, depending upon gain or loss, and for this purpose a standard reference level of 6 milliwatts is used.

In order to eliminate a low of unnecessary mathematics, the following figures are presented so that readers can draw curves for themselves.

Semi-logarithmic graph paper is required, the ordinates forming a geometrical progression, and the abscissae forming an arithmetical progression. The ratios are marked out on the lorgarithmic scales and the decibel values on the horizontal scales, the resultant curves being straight lines. It will be found that the scales will run from ratios of 1 to 1000, and 1000 to 1 million, so that two scales will be required. Since the loss section will deal with ratios which are fractions, it will be as well to make four separate charts, two for Gain and two for Loss, and if both power ratios and current and voltage ratios are placed together, that two sets of figures will be required on the horizontal line.

Ratio (Power, current or voltage)	Gain in DB (power)	Gain in DB (voltage or current)
1	0	0
10	10	20
100	20	40
1000	30	60
10,000	40	80
100,000	50	100
1,000,000	60	120

	Loss in DB (power)	Loss in DB (voltage or current)
1.0	0	0
0.1	—10	—20
0.01	—20	—40
0.001	—30	—60
0.0001	—40	—80
0.00001	—50	—100
0.000001	—60	—120

Calculations involving logarithms are liable to be confusing to those who have forgotten their school day mathematics, so we propose here to say a few words regarding them.

Logarithms assist one to snmplify calculations in arithmetic, in multiplication, division, root extraction, and in raising numbers to powers, and are most useful in dealing with numbers of several figures, and, in fact, frequently allow the finding of roots and powers which cannot be obtained by ordinary arithmetic.

In order to study logarithms it is necessary to review a little of our arithmetic. We all know that 2^2 is the same as 2 × 2, and that 2^6 is the same as 2 × 32, since both equal 64, because each successive power of 2 is obtained simply by doubling the previous one. In the same way, each successive power of 10 is found by multiplying the previous one by 10, as can be shown by $10^2 = 10 \times 10 = 100$, $10^3 = 10 \times 10 \times 10^2 = 100 \times 10 = 1000$ and so on. Similarly the powers for any number can be found in this manner, and by making up a table of the successive powers of different numbers. these tables can be of great assistance in simplifying calculations. Suppose that we want to multiply 2048 by 512, and by direct multiplication we find that the answer is 1,048,576. However, by referring to a table of the successive powers of 2 we find that 2048 is the 11th power of 2 and 512 is the 9th power of 2, while the answer, 1,048,576, is the 20th power of 2. This then suggests that an easy way of making this calculation is to add the exponents 11 and 9 and find the number corresponding to this exponent, 1E $2048 \times 512 = 2^{11} \times 2^9 = 2^{20} =$ 1,048,576. Similarly, 16 multiplied by 65536 = 1048576, or $16 = 2^4$ and $65536 = 2^{16} = 2^4 \times 2^{16} = 2^{20} = 1048576$, which gives us the rule that if any power of a number is multiplied by any other power of the same number, the answer will be a power of that number, the exponent of which is the sum of the exponents.

Since division is the inverse of multiplication, it is only necessary to subtract the exponents instead of adding them. In the same way, the extraction of a root is carried out by dividing the exponent of the number by the index of the root, while to raise a number to any power its exponent is multiplied by the exponent of the stated power.

When we raise a number to any power, we involve a base number and the exponent, such as $5^2 = 25$, wherein 5 is the base and ^{2} is the exponent. However, we can consider this in a different manner, when we take $5^2 = 25$ in which the 2 indicates a definite operation to produce 25. Thus $10^4 =$ 10,000, the 4 can be related to the 10,000 in the same manner, in which case it is seen that it is the relationship between the exponent and the product (answer); which is of importance:

Thus, taking $2^{10} = 1024$ it is said that in expressing the relationship of the 10 to the 1024, that the 10 is the logarithm of 1024 to the base 2.

Thus $2^{10} = 1024$, 10 is the exponent of 2, and the logarithmic of 1024, and is generally written $10 = \log_2 1024$. the 2 indicating the base number. $2^{10} = 1024$; $10 = \log_2 1024$. Considering our other example, $5_2 = 25$, also $2 = \log_5 25$ and $10_4 = 10{,}000$, $4 = \log_{10} 10.000$, or as is more often written $\log_{10}$, $10{,}000 = 4$.

Since any number can be used as a base to produce any number as a power the base is not very important, the important consideration being the logarithm (exponent of the base number). Thus in our first examples it was the exponents of the 2 (base number), (or the logarithms of the numbers) which so greatly assisted us.

When a certain base number is understood to be used it is not necessary to write it so we can prepare a table showing directly the product and its logarithm, such as

Number	Logarithm.
1	0
2	1
4	2
8	3
16	4
32	5
64	6
128	7
256	8
512	9
1024	10
1048576	20

and from this we can read immediately that $\log_2 1024 = 10$; $\log_2 1048576 = 20$ and so on; which show that for—

Multiplication of numbers we add the logs.

Division of numbers, we subtract the logs.

Powers of numbers we multiply the logs.

Roots of numbers we divide the logs.

Thus to multiply 512×2048 we find $\log_2 512 = 9$, and $\log_2 2048 = 11$, and log, answer $= 9 \times 11 =$ logarithm, which from the table corresponds to 1048576, which is jolly easier than direct multiplication.

Generally the base number 10 is used in logarithms because of its importance in decimals, and usually it is not shown when writing logarithms, being taken for granted.

In writing decimal fractions use is made of the negative sign, so that 0.1 can be written 10^{-1}, since 0.1 is one-tenth of 1, and so on, so that logarithms of decimal fractions are written in this manner:—

Log. 0.1 = —1, etc.

Now the numbers between 1 and 10, 100 and 1000, etc., are not exact powers of 10, so that their logarithms will not be whole numbers because log. 100 = 2 and log. 1000 = 3. Therefore the logs. of numbers between 100 and 1000 will lie between 2 and 3, or, in other words, will be 2 and a fraction. This, of course, applies to other numbers as well, the 100 and 1000 being given only as examples.

Now a name is given to the whole number of such a logarithm, and another name to the fraction, these being the characteristic and mantissa respectively.

As an example, let us take the number 5555, which lies between 1000 and 10,000, and, therefore, its logarithm lies between 3 and 4. Actually, it is 3.7447, to four decimal places.

Therefore log. 5555 = 3.7447, the characteristic being 3, and the mantissa .7447.

In the same way—

Log. 5555 = 3.7447
Log. 555.5 = 2.7447
Log. 55.55 = 1.7447
Log. 5.555 = 0.7447
Log. .5555 = —1.7447
Log. .05555 = —2.7447

and so on.

from which is seen that the characteristic of any number is found by noting if the number is between 1 and 10, 100 and 1000, etc., but the mantissa depends only on the sequence of the figures in the number, as can be seen from the previous table.

Tables have been prepared on numerous occasions showing the various mantissas since the characteristics can be readily found by inspection, as has been shown. Such tables are found in many textbooks, etc., and it is hoped that this discussion on logarithms will be of assistance to those who have forgotten them or have never had the opportunity of learning them, for they sure make arithmetic easy.

Unfortunately space doesn't permit of examples of the use of the decibel being given, but if desired by our readers, we will give detailed examples next issue, so let us know your wishes early.

Push-Pull Detection on Your Super-Het.

THERE is no doubt that Super-Hets. will supplant all other circuits, due to their distance and selectivity abilities; and with push-pull amplification they will represent a very fine musical instrument.

At the present time, fortunately, due to the activities and efforts of Mr. A. Hull, of Sydney, we in Australia are well advanced in our Super Heterodynes.

However, this article is written for the experimenter, and it possesses really good possibilities and advantages.

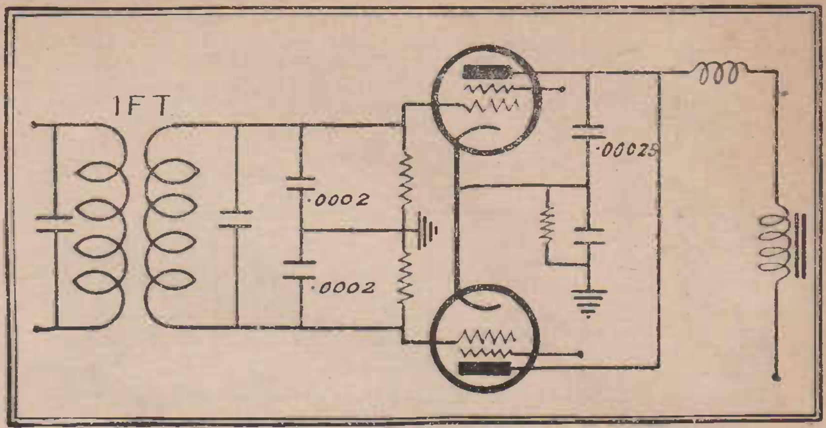
Push-pull detection is certainly by no means new, but a fresh aspect of it has cropped up in connection with a recent patent that concerns a unique scheme for obtaining selectivity. This selectivity scheme has nothing whatever to do with what I am going to write about, but the fresh aspect of push-pull detection has.

So it will be taking things in the correct order if I describe the fresh aspect first. Perhaps it is not entirely new, but it certainly has not been brought out so definitely previously.

Just a word or two to start with on the subject of push-pull in general. The principle is briefly this.

Currents Out of Phase.

In Fig. 1 the opposite ends of the coil that is supplying H.F. to the grids of the two detector valves are out of phase at any moment of time. When the top end is positive, the lower end is negative, and vice versa.



Screen Grid Detectors in Push-Pull.

The result, so far as the H.F. component in the anode current is concerned, is that when the current increases from one valve it decreases in the other. If the two anodes were joined to the ends of a centre-tapped primary of an H.F. transformer they would act on the secondary in the same direction, thus producing a double effect.

If, on the other hand, the anodes are joined in parallel as in the diagram, then the H.F. components will oppose one another the whole time. The result so far as H.F. is concerned will then be nil in the anode circuit, the H.F. component being cancelled out due to the push-pull input, but parallel output circuits.

H.F. Cancelled Out.

Now for the interesting point. Since the valves are wired up as grid detectors, the low-frequency modulations on the H.F. will also be applied to the grids of the two detector valves.

But so far as these low-frequency currents are concerned, the valves are not provided with push-pull input circuits, but with a parallel input scheme. This is because, so far as L.F. is concerned, the inductance coil is a dead short, and so the two grids are to all intents and purposes in parallel.

When we come to the output circuit the valves are still in parallel, so far as L.F. is concerned, and, since the L.F. is applied in phase to the grids of the valves, it does not cancel itself out in the anode circuit like the H.F. We therefore have low-frequency currents after detection that have no high-frequency component on them. This would naturally not be very helpful where ordinary circuits were concerned, because in nearly all such cases reaction is obtained by feeding back H.F. from the anode circuit of the detector.

The Second Detector.

But when we come to consider the detector (usually termed second detector) of a super-het., we have a different proposition. We do not want to get reaction, rather we want to be completely rid of H.F. after the detector. The H.F. in this case being, of course, the intermediate frequency of our "super."

As a matter of fact, in many of the modern super-hets. special H.F. stopping devices and by-pass schemes have to be incorporated to keep this H.F. out of the L.F. stages. Also, it is quite often noticed that output valves do not seem to handle so much power in a super-het. before they overload as they do in a straight circuit.

It is quite feasible that this is due to the loading produced by H.F. getting to the grid of the output valve. With the aid of the circuits shown it should be quite an easy matter for anyone with a super-het. to experiment with a push-pull detection.

Not everyone will be able to try it though, because it requires a centre-tapped secondary to the intermediate transformer, and I do not know of an intermediate on the market with such a tap. Some may care to take a transformer to pieces and try making a tap, but this would certainly be a doubtful proposition.

(Continued on page 45.)

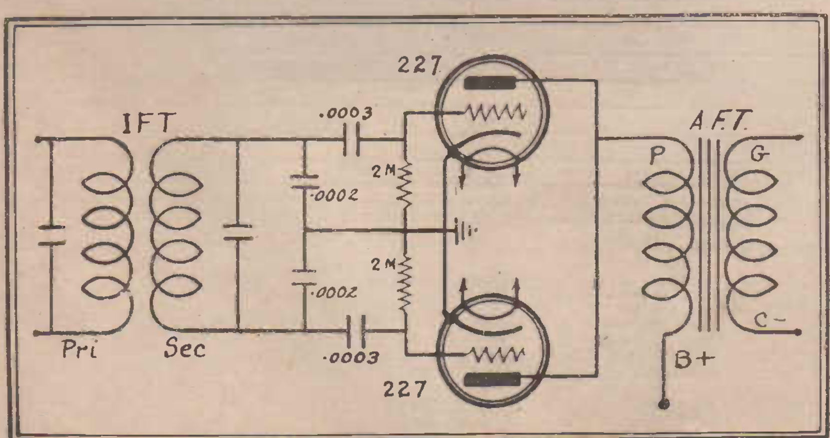


Fig. 1.

SPEED

TUBES AND CONCOURSE CONDENSERS ARE THE BASIS OF THE

"SPEED-ALL-WAVE-2"

described in this issue

SOME ENGINEERING DATA OF THESE WONDERFUL TUBES.

Type	Purpose	Filament Volts	Filament Amperes	Maximum Plate Volts	Grid Volts	Screen Volts	Plate M. A.	Amplification Factor	Plate Impedance (Ohms)	Mutual Conductance	Undistorted Power Output (M W.)	Load Impedance (Ohms)	Grid Plate Capacity (u. u. f.)
WD-11	D. C. General Purpose.......	1.1	.25	135	−10.5		3.0	6.6	15000	440	35	18000	3.3
WD-12	D. C. General Purpose.......	1.1	.25	135	−10.5		3.0	6 6	15000	440	35	18000	3.3
226	A. C. Amplifier	1.5	1.05	180	** −13.5		7.4	8.2	7000	1170	180	10500	8.1
230	Low Wattage General Purpose	2.0	.06	90	− 4.5		1.8	9.3	13000	700	16	15000	6.4
231	Low Wattage Output.........	2.0	.13	135	−22.5		6.8	3.8	4950	760	150	9000	5.9
232	Low Wattage Screen Grid.....	2.0	.06	135	− 3.0	67.5	1.4	580	1150000	505	—	—	*.020
233	Low Wattage Pentode........	2.0	.26	135	−13.5	135	14.5	70	50000	1350	650	7000	0.9
234	Low Watt. Vari-Mu RF Pent.	2.0	.06	135	− 3	67.5	2.8	360	600000	600	—	—	*.020
224	A. C. Screen Grid............	2.5	1.75	250	− 3	90	4.0	615	600000	1025	—	—	*.010
227	A. C. General Purpose........	2.5	1.75	250	−21		5.2	9	9250	975	300	34000	3.3
235	A. C. Vari-Mu Screen Grid...	2.5	1.75	250	− 3.0	90	6.5	370	350000	1050	—	—	*.010
551	A. C. Vari-Mu Screen Grid...	2.5	1.75	180	− 3.0	90	5.5	420	400000	1050	—	—	*.010
245	A. C. Output................	2.5	1.50	275	** −56		36.0	3.5	1670	2100	2000	4600	8.0
247	A. C. Pentode...............	2.5	1.75	250	** −16.5	250	32.0	90	35000	2500	2500	7000	—
256	A. C. General Purpose........	2.5	1.0	250	−13.5	—	5.0	13 8	9500	1450	—	—	3.2
257	A. C. Radio Frequency Pent..	2.5	1.0	250	− 3	100	2.0	1500	1500000	1225	—	—	*.010
258	A. C. Vari-Mu RF Pentode...	2.5	1.0	250	− 3	100	8.0	1280	800000	1600	—	—	*.010
295	A. C. Triple-Twin Output.....	2.5	4.0	250	*** −14 −3	—	52	187	3000	4350	4500	4000	—
S-85	A. C. General Purpose........	3.0	1.40	150	− 7.5		8	12.5	8600	1450	—	18000	3.3
120	D. C. Output................	3.3	.132	135	−22.5		6.5	3.3	6300	525	110	6500	4.1
199	D. C. General Purpose.......	3.3	.063	90	− 4.5		2.5	6.6	15500	425	7	15500	3.3
222	D. C. Screen Grid............	3.3	132	135	− 1.5	67.5	3.3	290	600000	480	—	—	*.025
S-82-B	A. C. Special Output.........	5.0	1.25	200	** −29.0		18	5	3600	1400	—	7500	8.0
S-83	A. C. Special Output.........	5.0	1.25	250	** −65.0		26	3	1500	2000	—	3600	—
112-A	D. C. General Purpose.......	5.0	.25	180	−13.5		7.6	8.5	5000	1700	260	10800	8.1
140	D. C. Hy Mu General Purpose	5.0	.25	180	− 3.0		.6	30	150000	200	—	250000	8 8
171-A	Output......................	5.0	.25	180	−40.5		20	3	1850	1620	700	5350	7.4
171-AC	A. C. Output................	5.0	.50	180	−40.5		20	3	1850	1620	700	5350	7.4
200-A	D. C. Special Detector.......	5.0	.25	135	2–5 meg.		1.5	20	—	800	—	—	8.5
201-A	D. C. General Purpose.......	5.0	.25	135	− 9.0		3	8	10000	800	55	20000	8.1
236	Automobile Screen Grid......	6.3	.30	180	− 3.0	90	3 1	370	350000	1050	—	—	0.01
237	Automobile General Purpose..	6.3	.30	180	−13.5		4.7	9.0	10000	900	175	20000	2.1
238	Automobile Pentode..........	6.3	.30	135	−13.5	135	9 0	100	102000	975	525	13500	0.3
239	Automobile Vari-Mu RF Pent.	6.3	.30	180	− 3.0	90	4 5	750	750000	1000	—	—	.007
293	Auto. Triple-Twin Output....	6.3	.60	180	− 7.5	—	17.5	—	7000	—	1250	8000	—
210-A	Power Amplifier.............	7.5	1.25	425	** 39		18.0	8 0	5000	1600	1600	10200	8.0
250	A. C. Output................	7.5	1.25	450	** −84.0		55	3 8	1800	2100	4600	4350	9.0
280	A. C. Full Wave Rectifier.....	5.0	2.0	†400 RMS			110						
281	A. C. Half Wave Rectifier....	7.5	1.25	700 RMS			85						
282	Full Wave Mercury Rectifier..	2.5	3.0	475 RMS			125		††10–15				
291	D. C. Triple-Twin Output....	12.6	0.3	††† 120	−11	—	30	—	3000	—	1250	3000	—

* Maximum. ** Grid volts measured from mid-point of filament. *** Input Section. † A maximum A. C. (RMS) Voltage per plate of 550 Volts with an output current of 135 M. A. may be used providing the filter circuit is equipped with an input choke of at least 20 Henries. ††Volts drop between filament and plate. ††† Line Voltage (D. C.).

(Note: Types S-85, S-82-B and S-83 are designed for Sparton Receivers.)

Form C-25M. 3-25-32. SRB.

SOLE AUSTRALIAN AGENTS:

HENRY G. SMALL & CO.

74 POST OFFICE PLACE

BETWEEN ELIZABETH & QUEEN STREETS, MELBOURNE. Central 11455.

(Continued from page 7.)

Main tuning condenser, 3½ inches up from the bottom, and 6 inches in from one end.

Midget condensers, 4 inches from either end, and 1 inch up from the bottom.

Securing bolts, ½ inch up from the bottom, and at points 1 inch in from either end, and 6 inches in from one end.

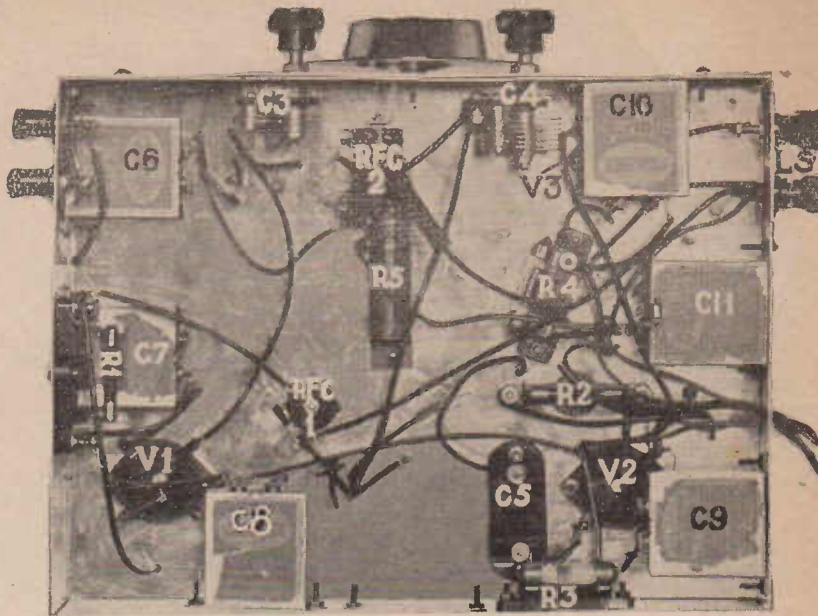
The drilling and mounting of the vernier dial naturally will depend upon the type of dial used. One word in season. Don't attempt to use a Radiokes or similar type of back panel mounting vernier dial unless you extend the size of the chassis about one inch, and cut out a section 1 in. x 4 in. long with a cold chisel, so that the bottom of the dial can be fitted in place.

The front panel type of dial such as the Emmco De Luxe, the De Jur, or the Pilot, will give satisfactory results, and will be easy to mount. The next job in construction involves the fitting of the front panel to the chassis and the arrangement of the various components on the top of the chassis as shown in the pictures of the completed receiver. One hole is drilled at a point 3½ inches from the left hand end (facing the front panel) of the front panel to carry the retaining bolt which holds the main dividing screen. This hole is drilled half an inch down from the top edge of the front panel. Two holes in the other angle of the main dividing screen serve to secure it to the chassis. The secondary screen is drilled and bolted to the main screen at a point four inches in from the back edge of the main screen. One machine screw will hold this screen to the chassis.

At a point 1¾ inches in from the back left-hand end of the chassis and 2 inches in from the back edge, describe a 1¼ inch circle which is to be cut out to take the A.W.A. UX socket. The same distance in from the back, but 2¾ inches in from the right hand end of the chassis cut out another 1¼ inch hole for the second A.W.A. UX socket. The same distance in from the right-hand end of the set as the UX socket was mounted and 1⅞ inches in from the front edge of the chassis cut out a third 1¼ inch hole for the A.W.A. UY socket, which is to take the Cossor pentode.

Coil Details.

Between these last two sockets the Velco choke is mounted so that one edge is 1 inch in from the right-hand end of the chassis. Two little angle brackets serve to hold the gang condenser firmly to the chassis. The next job is the winding of the coils. The first one is the r.f. coil (L1 and L2). L1 consists of 20 turns of 32 gauge d.s.c. wire separated from the grid winding of 46 turns of 26 gauge d.s.c. wire by quarter of an inch. Both windings are laid on in the same direction, of course.



A plan view of the set looking down on the top of the chassis. The various components are key-lettered to agree with the schematic diagram.

The second former carries three windings—L3, L4 and L5. Start off by winding 30 turns of 32 gauge d.s.c. wire on one end of the former. Separated from this winding (L5) by ⅛th inch, the grid winding, L2, of 45 turns is started. When this winding has been completed, we are ready to lay on the primary L3, which consists of 30 turns of 32 gauge d.s.c. wire.

This is laid on so that the final turn of the winding is right hard up against the first turn of the 45 turn grid winding. Note particularly that this primary winding L3 is laid on between the reaction coil and the grid coil, and is not wound over the grid coil. Possibly the best way to start this winding is to reverse the direction of winding and wind from the grid coil outwards to the reaction coil. Be sure, though, that when you have finished, that all three coils are wound in the same direction—i.e., either clock-wise or anti-clock-wise.

When the coils have been completed fit them with small angle brackets and mount them in place. The r.f. coil L1 and L2 is arranged so that the aerial, smallest, winding is furthest from the metal chassis.

The second coil also is mounted vertically, but so that the reaction winding, the smallest outside winding, is nearest to the chassis. Now start work on the chassis by drilling four holes for the aerial, earth, and two loud speaker terminals. The actual position of these does not matter, although the writer found it most convenient to mount the aerial and earth terminals at the front left-hand end and the two speaker terminals in a corresponding position at the right-hand end. Be sure, though, to insulate these terminals carefully, the earth terminal excepted, of course, from the chassis.

The six large fixed condensers all are mounted underneath the chassis by means of machine screws passing through the sides. The position of these condensers can plainly be seen from the illustrations, so we will not confuse the builder by attempting to describe their position. Note that in the case of condenser C10 that countersunk head screws are placed in the sides of the chassis, so that the front panel can be screwed into place afterwards, and an unbalanced machine screw prevented from marring the clear appearance of the panel.

It is understood, of course, that during the process of construction it will be necessary to fit various sections of the screening, and then remove them to facilitate wiring and assembly.

Seeing that a lettered plan photographic view of the chassis has been provided, it hardly seems necessary to complicate the issue by explaining the position of the various components underneath the chassis.

We will content ourselves by proceeding with the wiring of the set.

Point to Point Wiring.

A point to point description of this is as follows:—

Start by connecting the lead on L1 which is nearest to the grid winding L2 to the aerial terminal on the chassis. The other end of L1 is connected to the earth terminal. The end of L2, which is nearest to L1, is wired to the G terminal on the socket V1, and to the fixed plate terminal on that section of the gang condenser C1, C2, which is nearest to the front panel.

From this terminal on C1, C2, a lead is taken to the fixed plate terminal on the 5 plate midget condenser C2, which should be mounted at the left of the tuning dial.

The remaining lead on L2 is taken to one terminal on C6, and to the contact on the resistor R5, which is nearest to one end. This end of R5 is connected to the metal chassis, and to the other terminal on C6. The A plus terminal on each of the UX sockets, and one of the F terminals on the UY socket, are wired together. The other filament terminal on all three sockets is connected to the chassis. From the P terminal on V1, a lead is taken to the .1 meg. resistor R1, and to one lug on condenser C7. The other lug on C7 is connected to the chassis.

The other lead on R1 is connected to one terminal on RFC1. From this same terminal on RFC1 a lead is taken to that end of the primary winding L3, which is nearest to the grid winding L4. A lead from the same terminal RFC1 goes to the top (plate) terminal on the screen grid valve V1.

From the top end of the grid winding L4—i.e., the one furthest away from the other windings, a lead goes to one terminal on the grid condenser C5, and to the fixed plate terminal on the remaining section of the two gang tuning condenser (C1, C2). The other lead on L3 is connected to the metal chassis through the .1 mfd. fixed condenser C8. The remaining terminal on C5 is connected to the G terminal on the socket of V2, and to one lead on the mount which carries the 2 meg. grid leak R3. The other terminal on this grid leak mount is connected to the positive filament terminal on the socket of V2. The P terminal on this socket is wired to one lead on the second .1 meg. resistance R2, and to one lug on the .1 mfd. fixed condenser C9. The other lug on this condenser is connected to the metal chassis.

The black lead from the Velco choke CH is wired to one terminal on the second radio frequency choke RFC2, and to the same terminal on this choke is connected the remaining lead on R2. The vacant terminal on RFC2 is wired to the fixed plate terminal on the midget condenser C4, and to the inside lead—i.e., the one furthest from the chassis, on the reaction winding L5. The remaining lead on this winding connects to the plate (top) terminal on the valve itself. The green lead on the Velco choke coil CH is wired to one lug on the .1 mfd. condenser C10.

The other lug on this condenser connects to one terminal on the mount which holds the .25 meg. grid leak, R4, and to the G terminal on the UY socket of V3. The P terminal on this socket is wired to one of the speaker terminals, and the C terminal connects to the other terminal. From this terminal a piece of flex wire carries the maximum B plus supply from the batteries.

A further connection to the B plus maximum terminal is made from the vacant terminal on the radio frequency choke RFC1. One lug on the 4 mfd. condenser C11 is wired to the chassis, and the other lug is connected to the vacant terminal on the mount which carries the resistance R4. From this lug a second lead is taken to the vacant lug on the resistance R5, and a piece of rubber-covered flex attached to carry the B minus lead to the batteries. The blue lead on the Velco choke CH is extended by means of a piece of rubber-covered flex, to carry the detector plate supply from the batteries.

From the A plus terminal on one of the valve sockets a piece of rubber-covered flex goes off to the "A" battery. Although we have not incorporated one in the original receiver, a filament switch is a decided advantage. One may be incorporated by connecting the "A" minus battery lead to one side of the switch and connecting the other side of the switch to the metal chassis.

Testing and Operating.

This completes the wiring of the receiver, and all now is ready for the tests. For the "A" battery either three 1½ volt dry cells or a standard four-volt accumulator may be used. The "B" battery should consist of either three or four Heavy Duty Diamond "B" batteries. Naturally, the higher voltage 180 volts which the four batteries will give will result in an increase in efficiency and a decided gain in volume. The new Diamond Batteries should be used, for they will give greatest service. Actually, something like 375 to 400 hours' service can be expected from these batteries, because this particular set requires a plate current of only 14 milliamperes.

The connection of the batteries is simple. They are wired in series, and the B negative lead taken to the full negative. The B plus 1 lead from the detector plate choke goes to 67½ or 90 volts, and the lead from the loud speaker terminal to either 135 or 180 volts, depending upon the number of batteries used.

The insertion of the two screen grid valves into their respective sockets, and the plugging of the pentode into the last stage socket, makes the set ready for test as soon as aerial, earth and loud speaker are connected. With a plate potential of 150 volts the bias required by the Osram P.T. 425 is 12 volts, which means that a resistance of 820 ohms will be wanted.

This can be adjusted on R5 either by placing a high resistance volt meter and adjusting the clip which carries the lead from R4 until 12 volts is registered between this clip and the earthed end of R5, or it can be judged roughly by measuring the resistance and sliding the clip down towards the earth end until best results are obtained. Our resistor in the original happened to be a 2500 ohm one, so adjustment was slightly more difficult. The bias on the r.f. valve wants to be between ½ and 1½ volts, the latter figure requiring 125 ohms resistance. These adjustments are best carried out whilst the set is being operated.

Set is Sensitive.

Now for the results of our tests. Although the set in its present form was built in a hurry, not the slightest trouble was experienced in getting it to function perfectly. The sensitivity and selectivity was all that could be desired, whilst the tone quality certainly was the best which we previously were able to obtain from a pentode. On the score of range, not the slightest difficulty was experienced in bringing in every Australian broadcasting station at full loud speaker strength. The New Zealanders also could be received when the set was tested at Diggers' Rest, but we are not prepared to guarantee this when the set is used in the metropolitan area.

Suffice it to say that in the opinion of all who have heard it, "The 1931 Battery Special" has been declared the finest example of a high efficiency d.c. receiver ever seen. Readers who follow the instructions set out above should have absolutely no difficulty in duplicating the excellent results which we have obtained, because the set is simple as well as efficient.

LIST OF STATIONS RECEIVED ON THE "COCKIE'S THREE."

Dial Reading	Station.		Reception Strength
92	7ZL	Hobart	M.L.S.
83	3AR	Melbourne	F.L.S.
78	4YA	Dunedin, N.Z.	W.L.S.
76	2FC	Sydney	F.L.S.
73	6WF	Perth	W.L.S.
68	5CL	Adelaide	G.L.S.
65	4QG	Brisbane	G.L.S.
61	3LO	Melbourne	F.L.S.
55	2BL	Sydney	F.L.S.
50	3UZ	Melbourne	F.L.S.
48	2GB	Sydney	F.L.S.
46	5DN	Adelaide	M.L.S.

Dial Reading	Station.		Reception Strength
44	3YA	Christchurch, N.Z.	W.L.S.
42	2UE	Sydney	M.L.S.
40	2KY	Sydney	M.L.S.
37	7LA	Launceston	G.L.S.
36	2UW	Sydney	G.L.S.
35	4BC	Brisbane	G.L.S.
34	3DB	Melbourne	F.L.S.
32	5KA	Adelaide	M.L.S.
26	3BA	Ballarat	M.L.S.
25	5AD	Adelaide	W.L.S.
23	2AY	Albury	G.L.S.
20	3KZ	Melbourne	F.L.S.
18	3GL	Geelong	G.L.S.

(Continued from page 41.)

Fig. 1 shows the theoretically best way to go about the matter. Here the H.F. potentials from the secondary circuit are applied across two fixed condensers in series, a centre-tapped potentiometer effect thus being obtained. The value indicated for these condensers should be about right, but remember that, like the remainder of the scheme, anything may prove to be the case, because it is entirely experimental. But it shows a lot of promise!

A NEW POWER TRANSFORMER.

OWING to the heavy currents demanded by A.C. valves, modern radio receivers require power transformers rated at somewhere round 90 to 100 watts to insure good regulation, otherwise there will be an appreciable voltage drop under heavy loads, causing irregular performance.

The Wendel Electric Company Pty. Ltd. has designed and manufactured a highly efficient heavy duty, self shielded power transformer, which maintains a very constant voltage under all loads.

An electrostatic shield is fitted to the outside of the primary winding, and the whole job is completely shielded in a handsome metal case, the whole being rigidly bolted together to prevent any mechanical vibration. An outstanding feature of the transformer is the exceptionally large core, which gives a voltage regulation under load of 94 per cent.

They are available in different types for mounting, and capacities to suit any kind of receiver.

The high tension voltages range from 350 to 400 volts aside, and currents from 85 to 150 milliamps.

All filament windings are of extra heavy gauge wire, and are each centre tapped. They are designed with voltages and currents to suit any kind of valve.

On actual test the transformer gave an excellent performance, being absolutely free from hum, and no heating under the rated output load. Each model carries a twelve months' guarantee.

For the Sake of Your Radio Replace Your Valves

TALES of the radio set owner often rival those of the enthusiastic angler for unrestricted play of the imagination. The reception of a weak signal which cannot be deciphered often reoccurs the next day as the basis of small-talk in the bar parlour, when it is related how an American broadcasting station came in at great strength about 15 p.m.

Then there are the radio enthusiasts who openly boast of the number of years for which their valves have been working in their receiver. It appears to be a matter of great satisfaction that they are years old, yet still alive. If these people were to try a new set of valves in place of the veteran survivors they now use, in ninety-nine out of a hundred cases they would toss out the old chaps and wonder how they had ever put up with mediocre radio when amazingly better results were possible.

It is a fact that valves deteriorate appreciably after twelve to eighteen months' use. This degeneration is a gradual process, however, and is not noticeable on that account. It is only when new valves are fitted that the huge difference is apparent.

To avoid buying new valves when not actually required it is the wisest plan to take or send valves, after twelve months' use, for regular testing by the nearest dealer. He will be able to advise you as to their condition. Usually the emission becomes low, thereby throwing the function of the valves out of the correct alignment.

Using your radio with valves which are too old is depriving yourself of the full enjoyment which your set can provide, yet only when you hear your set in operation with good valves can you appreciate this fact.

Apart from the deterioration factor, which is by far the greatest consideration, there is also the fact that years old valves are out of date compared with the modern types. The latter will give you much finer reproduction and greater all-round efficiency.

Perhaps you will be in a quandary as to which types to use when replacing for better results. Here your dealer can advise you when the type of set you are using is explained to him.

Don't tell fish tales about your valves, however, otherwise you may be informed that valves were not intended to ever grow beards.

Next Month's Star

Adding One Stage of R.F. Amplification to the "Test All-WAVE Battery One."

SIX GOOD CRYSTAL CIRCUITS

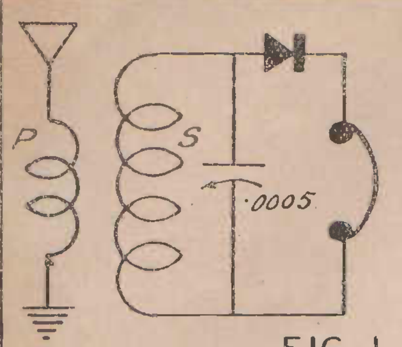


FIG. 1

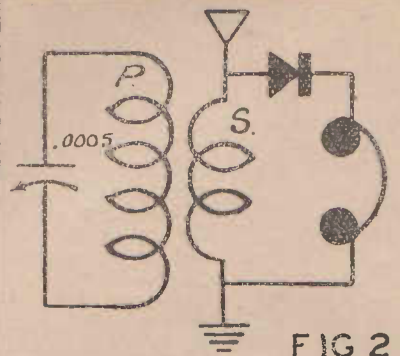


FIG 2

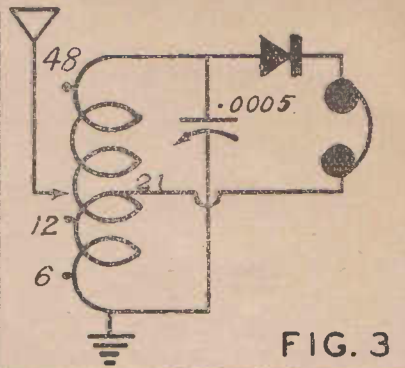


FIG. 3

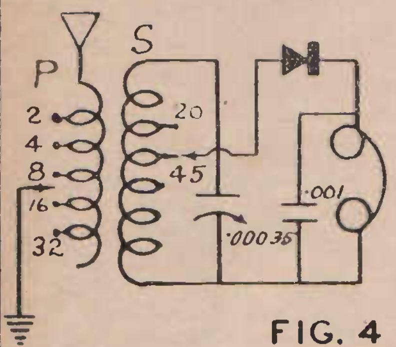


FIG. 4

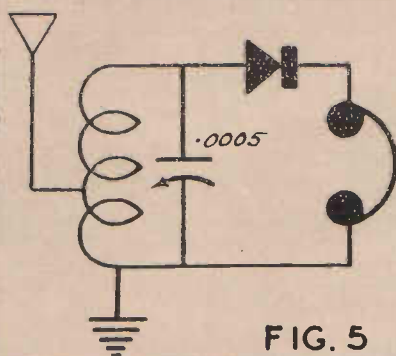


FIG. 5

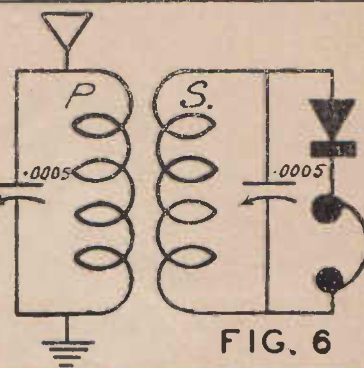


FIG. 6

Fig. 1.—P = 12 turns 22 dcc. on 3" diam. former. S = 55 turns 22 dcc. on same former coupling ¼ inch.

Fig. 2.—P = 55 turns 24 dcc. on 3" diam. former. S = 15 turns 24 dcc. wound in the centre and over the top of P. Insulate S from P with a layer of paper.

Fig. 3.—48 turns 22 dcc. tapped at the 6th, 12th, and 21st, turn on 3" diam. former 4 in. long.

Fig. 4.—P = 32 turns 28 dcc. on 2" diam, former, tapped at 2, 4, 8, and 16 turns. S = 90 turns 28 dcc. on same former, but ⅛ inch away from P tapped at 20th and 45th turn.

Fig. 5.—50 turns 24 dcc. tapped at the 12th turn on 3" diam. former.

Fig. 6.—P = 30 turns 24 dcc. on 3" diam. former. S = 55 turns 24 dcc. on same former, ¼ to ⅜ inch coupling between coils.

Blazing the Trail Through Mexico

"CQ . . . CQ . . . CQ," sang the tiny radio set. Its operator, huddled close in a large overcoat, frowned.

"IPH calling. CQ . . . CQ . . . CQ."

Five hundred miles south of Mexico City, atop a wind-swept mountain, the operator sat by his radio, calling. At last an amateur in Illinois heard the weak signals and answered. Then, field station IPH told how three small American automobiles and their crews of six had progressed three miles during the day up steep mountainsides, en route from Nogales, 2844 miles, to San Salvador, surveying a route for the 12,000-miles highway to connect all the nations of North and South America, from Fairbanks, Alaska, to Buenos Aires.

Across the dreaded Barrancas, the deep gorges of North Jalisco, the party had pushed its way south; down through the bad lands and treacherous canyons south of Mexico City and across high mountain ranges and through burning jungles to San Salvador, the explorers and road mappers crawled, until, at last, in the late spring, they had driven their automobiles entirely through Mexico, the one country that presents the biggest problem in the continuity of the highway.

The survey party—a chief engineer, a doctor, radio operator, interpreter and two drivers—"attacked" Mexico twice before finally being the first to traverse the country from north to south in automobiles. Last year, they drove from Los Angeles along the west coast of Mexico and on to Mexico City. Even on that journey, sometimes two yokes of oxen helped pull the cars up steep grades, and occasionally blocks and tackles and racing engines assisted the oxen. The difficulties of that trip were hardly an indication of the troubles that would beset them on the journey recently completed, of the mechanical ingenuity to be developed in rounding narrow mountain burro trails with heavily loaded automobiles, of recrossing one narrow river eighty-eight times in a seventeen and one-half mile drive.

Each car was fitted with a steel compartment to carry guns, ammunition, tools and supplies. The radio instruments were conveniently located on the sides of one truck, and could go on the air without further preparation than to deposit a one-cylinder engine on the ground and start it. As the cars bounced down stream beds, over rough cobblestones that lined village streets, and around fallen trees, the radio set never broke loose from its moorings, and over it the party was in daily touch with the United States through amateur stations scattered from Maine to California.

When E. E. East, chief engineer for the Auto Club of Southern California, turned the lead car south from Mexico City on the journey that was to bring many hardships in a primitive land, he led the caravan along an improved road to Puebla, eighty-two miles distant. At that point, having traversed the beautiful valley of Mexico and crossed the surrounding two-mile-high rim, the party left improved highways and embarked on the ancient Spanish trail, used only by ox teams, for Suchite, a populous community on Mexico's southernmost border. Even the primitive trail soon disappeared, however, and the three drivers turned their cars into a wild country where the natives never before had seen "devil waggons," as they called the little automobiles.

"Leaving Puebla," East explained, "was much like breaking down a fence and walking from a clearing into a primitive forest. We knew that until we should reach Guatemala we could expect no help, that we would have to blaze nearly all our own trails and create our roadways as we went.

"Once the grade pointed up at such a sharp angle that the cars would not move until twenty men assisted the racing engines by pulling on a rope tied to the front axle. Going downgrade was no easier. Engine compression, four-wheel brakes, and the score of Indians holding back on the rope were all that saved the cars from pitching to the bottom.

"We were warned about the difficulties that lay ahead, but we had no alternative, even though we might have wished to retrace our steps. We never could have forded the Rio Tehauntepec upstream. Just outside Nejapa, we climbed four mountain summits, widening a pack trail as we climbed, blasting boulders out of the path, building retaining walls, and, at one sharp turn in the solid rock, constructing a bridge. Here we were, at an elevation of a mile, felling trees and lacing them together at a dizzy height over a canyon so our cars could crawl around the bend.

"At Rio Tequisitlan, after a fifty-mile road so rough all the equipment was packed on burros, we came upon the so-called 'cerreta' roads. The cerreta is a two-wheeled ox-cart. Its tread is six inches narrower than an automobile tread, so we were constantly breaking trail through the decomposed sandstone for one side of the cars. These trails became trenches, which were cut sometimes to a depth of ten feet, and as we threaded our way down them, the tyres would ride on side slopes and wear away, as though they were turning against emery paper."

Aerial surveys of routes have been completed in British Columbia and Alaska for roads that will cost £1,500,000. Governors of the several Mexican States met in Los Angeles several months ago to prepare plans for their sections. Even in South America the route down the Pacific coast is being mapped. Already tourist travel along one highway into Mexico has increased from two cars weekly to fourteen daily, due to the impetus of the trail blazers.

Factors Governing Radio Reception

THERE are three main factors governing the distance that can be satisfactorily covered between a given transmitting station and a given receiving set. These can be stated as follows:—

1. The amount of interference.

2. The inverse distance effect. As the radio waves spread out in all directions from the transmitting station their strength naturally decreases. At twice the distance, their amplitude is halved; at four times the distance, it is only one quarter, etc. This same fact could also be expressed by saying that the strength of the signals is inversely proportional to the distance. A curve illustrating this is shown in the accompanying diagram. The curve is based on ideal conditions, and neglects absorption by buildings, fading, etc.

3. The attenuation, which is quite a different thing. It acts simultaneously with the inverse distance effect to reduce the amplitude of the waves. Attenuation of the waves is due to their being dissipated in the form of heat. Whenever the waves strike any object in which they can produce electric currents, the currents are produced at the expense of the energy of the waves and heat up to a minute degree, the material in which they flow. In the case of ordinary telephony over land wires, the attenuation is such that the current is about one-third, at the end of every ten miles, of what it was at the beginning of those ten miles, and a little calculation shows that to talk across the Continent without any amplifiers inserted along the line would require an immense amount of power. Yet, by the insertion of fifteen amplifiers or relay stations along the line, the attenuation law is prevented from "getting under way," and a ridiculously small power is enough for proper Transcontinental line telephony.

How the Electrolytic Condenser Works

INTERESTING "DOPE" ON THE OPERATION OF THE LATEST TYPE OF FILTER CONDENSER.

MOST radio beginners are familiar with the paper condensers used to filter out the pulsations in "B" eliminator circuits. They consist of sheets of tin foil or aluminium foil separated by thin sheets of specially prepared paper. The capacity of such a condenser depends on the area of the metallic foil and the thickness of the paper placed between the sheets of foil.

For two reasons the size of a paper condenser is governed by its capacity and its rated working voltage. Obviously, more foil and paper must be used to get greater capacity, and the higher the rated working voltage, which, of course, is the highest voltage that the condenser will stand in regular use, the thicker must be the insulating paper.

Knowing these facts, the modern electrolytic condenser appears to be a queer piece of apparatus that does not conform to the usual rules. That is because of the principle on which the electrolytic condenser operates. Instead of paper, the insulation in an electrolytic condenser is a microscopically thin layer of aluminium oxide, which forms on the surface of the aluminium electrode.

The plates of the condenser are, therefore, the aluminium electrode and the solution. Contact with the solution is obtained by way of the metallic can which holds the solution and the electrode.

High Capacity Feature.

Enormous capacity in a small space is possible in the electrolytic condenser because of the thinness of the oxide film. The capacity of any condenser is in proportion to the spacing of the plates, and the aluminium oxide film is many times thinner than the thinnest paper used in the ordinary foil condenser.

Early types of electrolytic condensers had many disadvantages. They often leaked solution, and their rated working voltage was not high. Now, electrolytic condensers have been improved so greatly that it seems likely that more and more manufacturers will use the electrolytic type in place of paper condensers in the filter circuits of the future sets.

One special advantage of the electrolytic condenser lies in the fact that it is self-healing. If, by any chance, it is subjected to excessive voltage, a breakdown will occur as with the paper condenser, and as long as the high voltage is maintained the condenser will be out of commission. However, as soon as the excessive voltage is cut off the insulating film is restored.

The capacity of the latest type of unit electrolytic condenser is eight microfarads at a peak voltage of 430 D.C. Units of this size sell for about 7/-, and are useful to substitute for a blown-out section of a paper condenser block. The bottom of the metal can is threaded, and screws into a thin brass socket, which can be screwed or riveted to the metal chassis.

Electrolytic condensers can be used only on pulsating direct current. This is because the electrolytic condenser is a "one-way" outfit. The oxide coating forms only when the current is flowing in one direction. If high voltage is applied in the other direction, the film breaks down and there is a heavy flow of current.

Electrolytic condensers are, therefore, only useful as filter condensers in "B" eliminator circuits of a radio set or in other commercial uses where the conditions are substantially the same.

SIMPLE TEST TRICKS.

MOST experimenters know how to use test points connected to a voltmeter to find out if the voltages developed at various points in the circuit are correct. The same principle can be used in other ways. When the set is not working right you can connect the test points to the terminals of a variable resistance and use the combination to reveal several kinds of trouble.

Assume, for instance, that the resistance can be varied from approximately zero to, say, ten thousand ohms. Suppose that your voltage tests indicate that one of the resistance units in the set has burned out. You can set the variable resistance to about the value of the suspected unit and touch the test points to each end of it.

If your surmise is correct, the current which cannot flow through the burned out unit will pass, by way of the test prongs, through the variable resistance, and the set will resume normal operation. If, on the other hand, providing another path for the current in this way produces no noticeable effect, you can be sure that the suspected unit in the set is in working order.

The same general method of substitution can be used in testing the various fixed condensers in the set. Condensers, however, are not quite so simple to test as resistors. A condenser may become either open circuited or short circuited. An open circuited condenser is one in which an internal connection has opened. This has the same effect as disconnecting the condenser from the circuit.

In the case of a short circuit, the insulation between the layers of metal foil that give the condenser its capacity may give out, and the current then flows across from one layer of foil to the other. The effect on the circuit is the same as though you connected a piece of wire directly across the terminals of the condenser.

Obviously, if you connect a spare condenser to the test prongs and touch the prongs to the terminals of an open circuited condenser the spare condenser will function in place of the one in the set.

If the condenser is shorted, try disconnecting one terminal, then touch the disconnected wire with one prong and the terminal with the other. This puts the test condenser in series, and the set will work. If the suspected condenser is in good order, both these tests will give virtually negative results.

In making such tests it is wise to use as a test condenser a unit having a high voltage rating. A small, low voltage condenser will short-circuit if you attempt to substitute it, even for a few seconds' test, in place of one of the filter condensers.

A SIMPLE DRY CELL SWITCH.

Very often it is not convenient for the radio enthusiast who uses a battery receiver, particularly if it be of the portable type, to mount the filament switch on the panel of the set. A very easy solution to the difficulty is that pictured, where a piece of sheet brass or copper, a little strip of bakelite, a terminal, and a toggle switch can be combined to form a filament switch which is mounted directly on one of the cells.

A distinct advantage of this scheme is that the switch can be changed over when it becomes necessary to replace the cells.

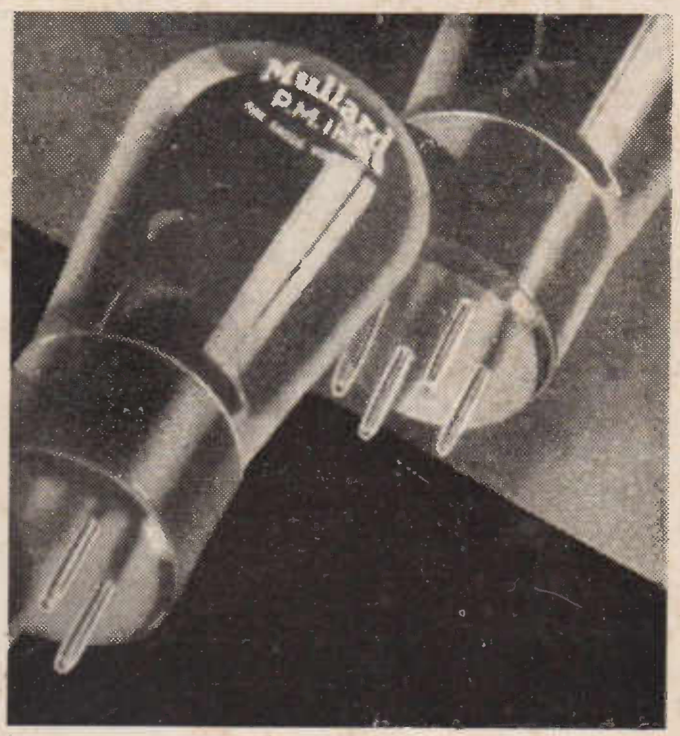
THE TECHNICAL EDITOR CHOOSES THIS IDEAL 2-VALVE BATTERY COMBINATION

Here is a 2-valve combination for a battery operated set, which for efficiency cannot be equalled. It is composed of two famous valves — the very latest additions to the Mullard 2-volt range — the P.M. I HL, detector, and the P.M. 2A, power output valve. Two new economical triodes, as modern as this morning, definitely non-microphonic. Dwarfs in battery consumption, but giants in performance.

P.M.1HL
P.M.2A

P.M.1HL
Operating Data
Filament Voltage 2.0
Filament Current 0.1
Max. Anode Voltage.... 150
CHARACTERISTICS
(At Anode Volts 100, Grid Volts zero)
Anode Impedance, 20,000 ohms
Amplification Factor 28
Mutual Conductance.... 1.4 mA/V

P.M. 2A
Sensitivity (mW per Volt [2] R.M.S. input) 11
Average Plate Current, 8mA
Impedance ...... 3,600 ohms
Slope .... 3.5 mA/V

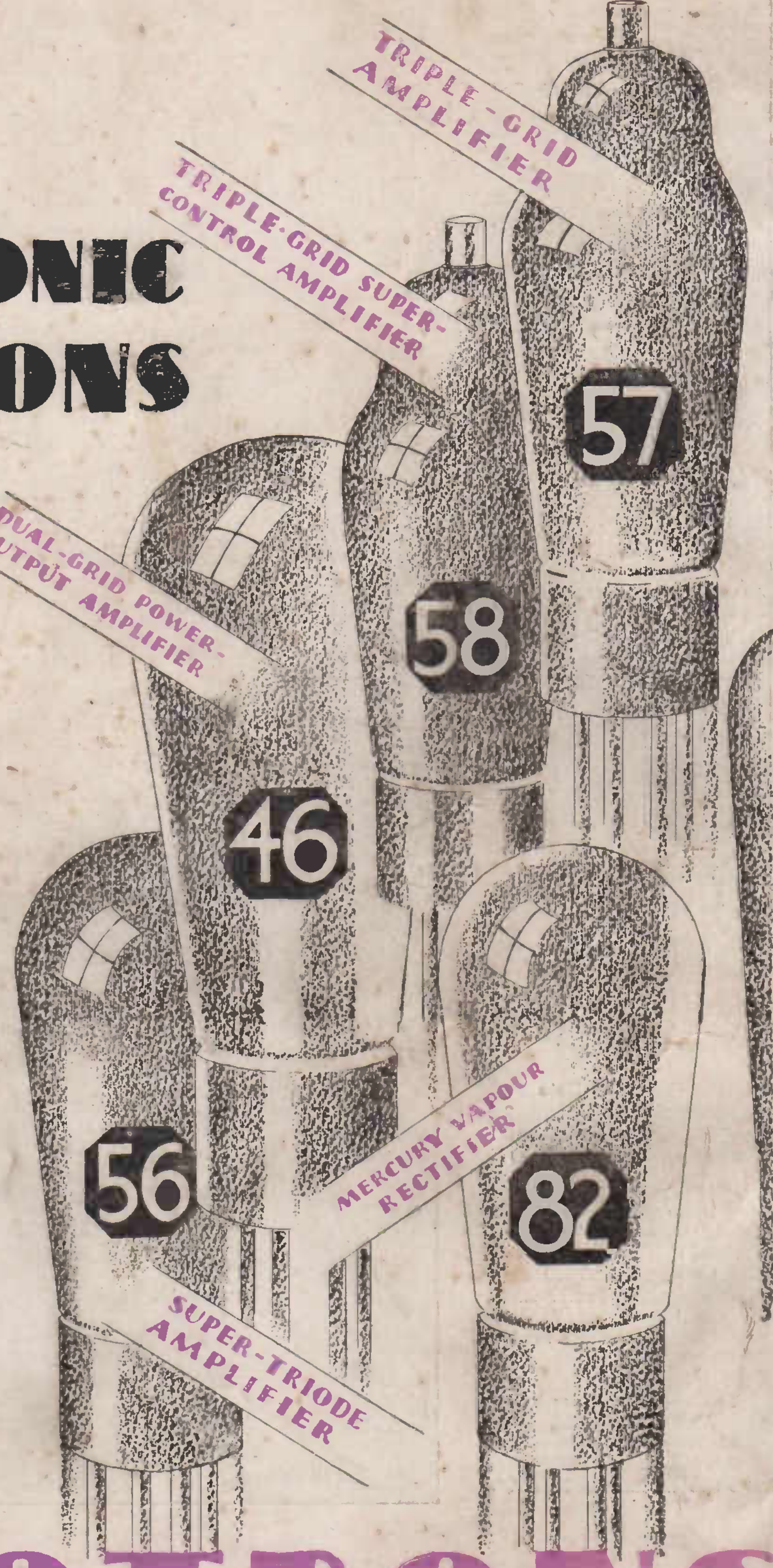


MADE IN ENGLAND

The Mullard Radio Company (Australia) Limited. Head Office: 35 Clarence St.,

THE NEW SUPER-PHONIC RADIOTRONS

AWA



Radiotrons 46, 56, 57, 58 and 82, featuring Dual Grid, Super Triode, Triple Grid, and Super-Control Triple Grid Amplification, with Mercury Vapor Rectification — create new and outstanding valve performance.

The types 56, 57 and 58, in the "radio frequency system," offer the last word in selectivity, sensitivity, volume control and quietness of operation.

Types 46 and 82 give unexcelled audio-frequency performance, resulting in outstanding tone quality and fidelity of reproduction.

These Radiotrons give greater output per valve with same signal input.

Obtainable from Radio Dealers Everywhere

RADIOTRONS

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