The Wireless Constructor

6D MONTHLY

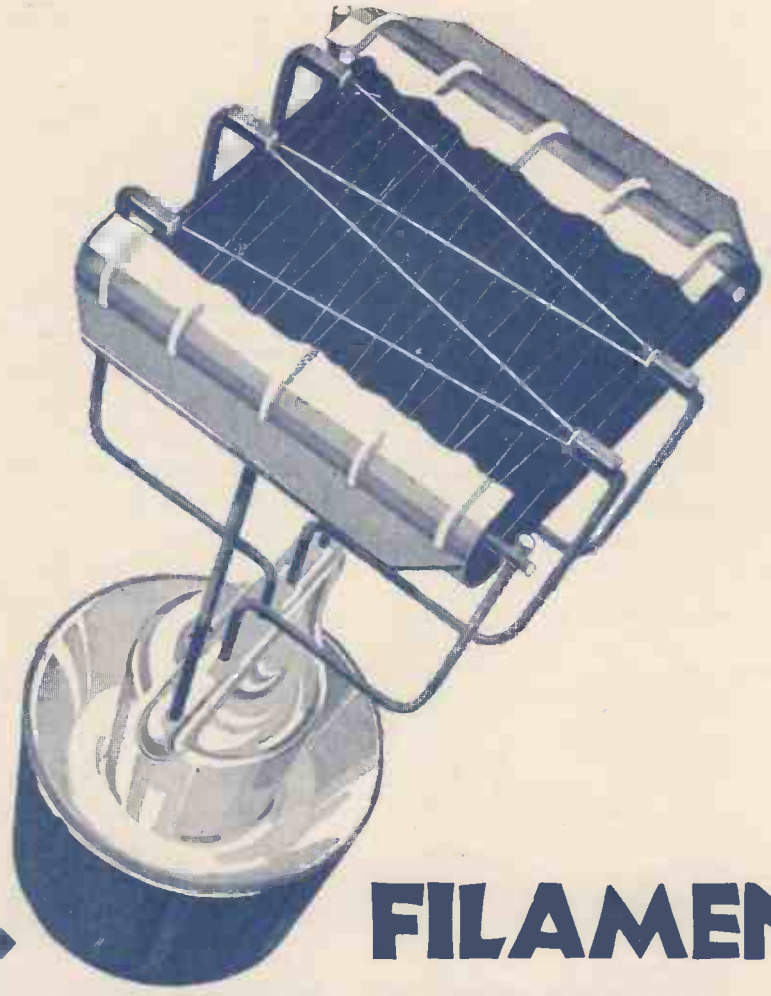
EDITED BY
PERCY W. HARRIS. M.I.R.E.

VOL. IV. SEPTEMBER, 1927 No. II

IN THIS ISSUE

HOW TO BUILD THE "RADIANO" H.F. UNIT

Note the generous and robust construction of the wonderful Mullard P. M. Filament shown in the sectional view of the P.M. 5X. This is the construction that brings improved results from any radio receiver.



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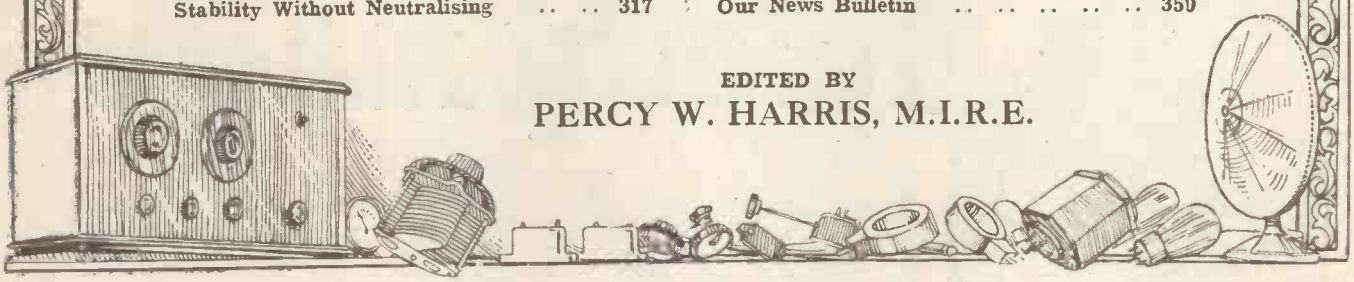

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The WIRELESS CONSTRUCTOR

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THE EDITOR'S CHAT

Percy W. Harris, M.I.R.E., the Editor of the "Wireless Constructor," has something to say about the "Radiano H.F. Unit," and other matters of importance and interest.

IT is more than pleasing to find that readers all over the British Isles, and, indeed, in many foreign countries, are finding the Radiano Three such a useful, reliable, and powerful receiver. A selection from the numerous letters received has already appeared in this journal, and almost daily further communications in similar strain are pouring into the Editorial Offices. The Radiano Short-Wave Receiver, too, has gained a large circle of friends, for the interest in short-wave reception is increasing daily.

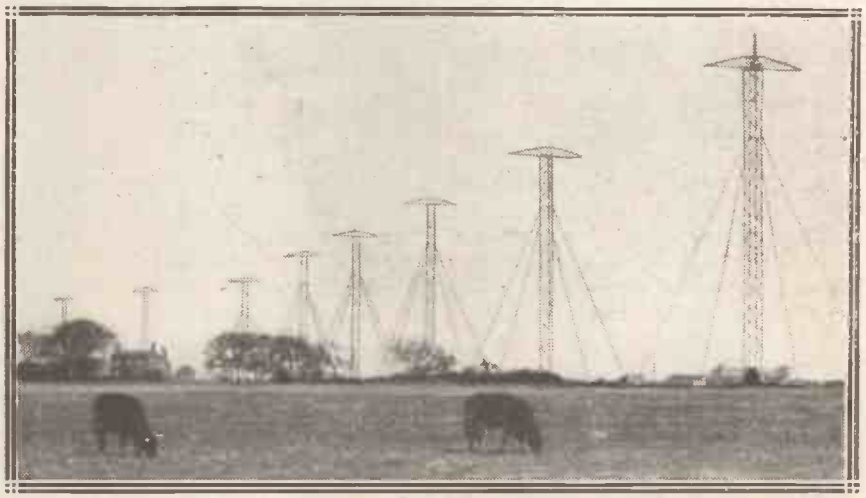
An Adaptable Unit

A large number of letters of appreciation have asked that a design for an H.F. stage to precede the Radiano Three should be published, and we are pleased to be able to accede to these requests in the current issue. Not only will the "Radiano H.F. Unit" fill the bill in regard to the Radiano Three, but it will also serve as an H.F. unit to precede practically any type of receiver which the reader now possesses.

The circuit, you will notice, is rather unusual and does *not* employ the conventional neutralised circuit. The "neutrodyne" or its many modifications, although highly efficient when properly handled, is not by any means an ideal method of H.F. amplification for the beginner—indeed, experience is showing that neutralising methods have certain distinct disadvantages as well as advantages. The circuit used in the Radiano H.F. Unit is one readily adaptable to 2-, 4- and 6-volt valves, and is extremely simple to adjust, while its efficiency on test has been shown to come very close to the best neutralised method which could be employed for such a unit.

Stability Without Neutralising

Within the last twelve months there have been a number of attempts—and many of them very successful attempts—to obtain stability in H.F. amplifiers without recourse to the neutralising methods, and at the same time without reverting to the old and very inefficient ways which preceded the neutrodyne. The Loftin-White circuit, referred to in a previous issue, is one method, and another of very great interest, also hailing from America, is described in the current issue. Readers of the WIRELESS CONSTRUCTOR are well acquainted with the fact that new methods are tested out in our laboratory under English conditions, before being described, and in this way a sane and just appraisement of their value can be obtained. Differences of opinion may exist as to just *why* such schemes work in the way they do, and on theoretical grounds debate can proceed with great vigour for months, but what the practical man wants to know is what kind of *results* are obtained with the various methods, and this it is always our endeavour to show.



The eight masts of the Skegness Beam Station are 400 ft. apart, each being nearly 300 ft. high.

Another article published in response to readers' requests is the description of a simple valve tester, by means of which readers can check their valves from time to time to see whether they have lost emission. Overseas readers who have to obtain their valves from

SUPPORTING LARGE PANELS.

LIKE many other wireless enthusiasts I cannot refrain from gazing at the sets and components displayed in the windows of wireless dealers. One thing has struck me very forcibly, however, as a result of this habit, and that is the way in which the average ebonite panel is apt to become distorted.

During the past few weeks I have seen literally dozens of very misshapen panels displayed in different shops. At first I was inclined to think that the summer sun might be responsible, but we have seen so little of that heavenly body recently that I have come to the conclusion that ebonite is peculiarly apt to warp. Few things are more annoying than a bent panel. It looks unsightly, and it makes the nice adjustment of condenser dials almost impossible.

Use of Extra Brackets

I have considered possible solutions. First, the use of good panel brackets is essential on all but very small panels. But where the panel is long a single pair of brackets will not prove sufficient. If possible, another pair should be fixed nearer to the middle of the panel. Where this is not possible an excellent solution lies in making a long brass girder bracket somewhat like those found in Meccano sets, and screwing this along the top edge of the panel.

Another method is to fix a bar of wood along the front of the cabinet against which the panel presses. Should the panel show any tendency to warp it may be screwed to the bar by means of small brass screws, or a wood bar may be arranged in front of the panel to hold it in place. Such a bar may easily be removed should it prove necessary to remove the set from the cabinet.

Personally, I dislike ebonite panels. They are expensive and they are seldom beautiful, and many amateurs find them none too easy to work.

Plate-glass panels are very efficient, but I do not like to see the "innards" of a set at all times. Moreover, plate glass is expensive and very difficult to work. I have found that oak three-ply wood can be bought of the same thickness as ebonite, namely one-quarter inch. If now it is necessary to mount condensers whose spindles are not at earth potential, small pieces of ebonite may be "let in" to the wood. The ebonite should be cut to the right size, and any holes required should be drilled.

Then the ebonite should be put on the wood in the exact position and marked round with a sharp scriber.

Economising Ebonite

The wood may now be cut out with a fretsaw or a keyhole saw and the ebonite fixed in place by the help of small flat brass plates, bolted to the ebonite with 6 B.A. bolts and fixed to the wood by similar means or by short stout screws. Terminals may be mounted on ebonite washers.

In this way the amount of ebonite used is small, and the risk of bending is eliminated. The appearance of a well-polished oak panel is excellent—the small pieces of ebonite, countersunk as described above for the mounting of condensers, are hidden behind the dials, and if in working a small piece of ebonite becomes damaged it is an easy matter to replace it.

Metal twist drills will be found to give best results as oak three-ply is exceptionally strong; it does not warp, and is easy to work. By its use much needless expense and difficult work can be saved. H. P. W.

Correspondence from Readers.

Owing to readers' complaints that undesirable touting and similar queries have followed the publication of letters addressed to the "Wireless Constructor," we have decided to discontinue giving the full postal addresses of our correspondents.

Relevant queries arising from such correspondence are always welcomed for publication. We cannot accept any responsibility for the views expressed by readers in their letters.

THE EDITOR.

THE EDITOR'S CHAT

—continued

long distances will find the unit particularly valuable. Often experience has shown that the trouble in sets attributed to the valve has really arisen in quite a different part of the set. A quick test with the unit described will settle once and for all whether the valve is "up to scratch." The unit has many other uses and will also enable the reader to keep a close check on the state of his H.T. and L.T. batteries.

The growing demand for simply handled "local" receivers is steadily increasing. The serious experimenter, however fond he is of searching for distant stations, fully appreciates the nearest and best station, and the desire of the family to listen to the whole of the programme. But the receiver which serves the needs of the "distance hunter" is not generally suitable for operation by the unskilled. Next month, in "Foolproof Radio," a description will be given of a pure reproduction receiver designed for local work alone. Tuning is effected once and for all when the set is installed, so that not even a dial appears on the face of the instrument. Even the conventional on-and-off switch has been dispensed with, for the mere process of plugging-in one or other of the jacks automatically switches on all valves, while the withdrawal of the plug "turns" them off. As a second receiver in the experimenter's house, the "Knobless Three" will find a welcome all over the country.

"Making Light of It."

In appearance the unit matches the set.

BUILD THE "RADIANO" H.F. UNIT

A simple amplifier that can be added to any receiver.

by Percy W. Harris M.I.R.E.

"I AM so pleased with the Radiano Three and its distance-getting properties," writes a reader from Birmingham, "that I am anxiously looking forward to the Radiano Four, in which one high-frequency stage is incorporated." Many other readers have written in a similar strain, and the design for the Radiano Four is now under consideration. Meanwhile, however, it is a very simple matter to build the Radiano High-Frequency Unit, which can be "hooked up" in front of the Radiano Three and without any alteration of the original set will give all the benefits of high-frequency amplification preceding the detector. This means, of course, that distant stations which now require the use of considerable reaction to bring them up to an appreciable volume, can be brought in at the same volume with very little reaction and the corresponding increase in purity of reproduction, or at a much greater volume than before with no sacrifice of quality. In addition to this, many stations which were previously quite inaudible will be brought in at fair strength.

Suitable for Any Set

Another way of considering it is that the addition of a high-frequency valve means that the same results as before can be obtained with a smaller aerial.

In addition to being very useful to every owner of the Radiano Three, the Radiano High-Frequency Unit can be made to precede practically any existing receiver. Its appearance is neat and simple, the space it occupies is small, and the cost of construction relatively low. No additional batteries are needed, as the high-frequency unit utilises the existing batteries, while the additional load on the accumulator imposed by a single high-frequency valve is so small as to make very little difference to the time one charge will last.

YOUR "SHOPPING LIST."

- Ebonite panel, 8 in. × 6 in.
- 1 cabinet for same to take 7 in. baseboard. (Note, the cabinet is identical with that used for the Radiano Silencer.)
- Baseboard for same.
- 1 ·0005 mfd. variable condenser. (Square law or stralght-line frequency,)
- 1 potentiometer.
- 1 on-and-off switch.
- 1 radio-frequency choke.
- 1 anti-phonic valve holder.
- Fixed or variable baseboard resistor to suit valve.
- 1 fixed condenser, ·002 mfd.
- 1 baseboard-mounting coil socket.
- 2 small strips of ebonite, each 2 in. long by 1 in. wide, fitted each with 2 terminals.
- Rubber-covered wire for leads.
- 3 dozen Radiano pinch-on brass tags.

A good deal of thought and experiment was given to the circuit to be used, particularly as it was desired to arrange the unit to be applicable to practically any set. The first experiments were conducted with a unit utilising one of the several possible neutralised circuits, but experience has shown that a large number of readers find difficulty in accurate neutralisation and the adjustment of such a set is by no means simple for the uninitiated.

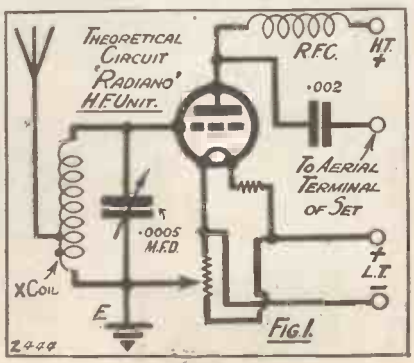


FIG. I.

Stability and Sharp Tuning

By using the "parallel-feed" method the tendency to self-oscillation—one of the bugbears to be faced in a high-frequency unit—is considerably reduced, so much so that a very slight positive bias on the grid of the high-frequency valve—scarcely sufficient to reduce its efficiency—is quite enough to give stability, with the additional advantage that a little reaction can be left in the circuit, sharpening the tuning and adding to its sensitivity. On test this high-frequency unit has proved extremely simple to handle, quite sharp in tuning, and very sensitive. So far as the last quality is concerned, I doubt whether it could be beaten by a neutralised high-frequency unit unless this were skilfully handled. As it is, anyone can get very sensitive results with the greatest of ease.

Efficient Amplification

Examining the circuit in detail you will see that the aerial is coupled through the now popular X type of coil to the first grid circuit, the grid return being taken not directly to the negative filament but to the slider of a potentiometer. When the slider is fully over to one side the steady voltage applied to the grid is the same as that of the negative end of the filament. When the slider is full over on the positive side the grid will be as many volts positive as the voltage of the accumulator you are using. Between these points the voltage of the grid can be continuously varied and the more positive it

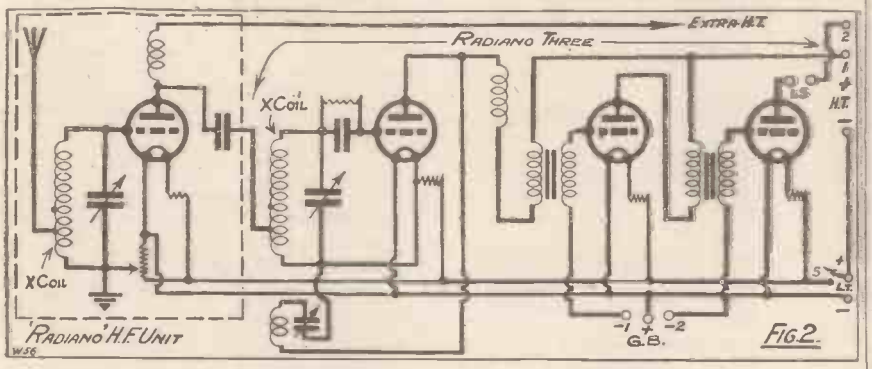
Build the "Radiano" H.F. Unit—*continued*

becomes the greater the damping introduced by the grid current set up. You need not worry about the theory of this, but simply consider the practical side, remembering that if the set starts oscillating, a touch more positive will "hold it down." If the arrangements were such that a good deal of positive bias were required to stop the set oscillating, then the unit would be inefficient. This is guarded against, however, in this design and in the way in which the unit is connected up. I will tell you more of this later.

When the grid circuit is tuned to the incoming signals, the differences of voltage applied to the grid set up differences of voltage between the plate and the filament. The plate is connected through a fixed condenser to the aerial terminal of the set to which the high-frequency unit is attached. The earth terminal on the receiver is left free, the return path for the high-frequency currents from the plate through the condenser being via the common battery lead.

How the Unit Works

When the receiver is used without the high-frequency unit oscillations pass from the aerial terminal through whatever form of coupling is used to earth. When the set is used *with* the high-frequency unit, the oscillations which normally would pass to the aerial terminal of the set, and thus to earth, now pass through the aerial and earth connection of the high-frequency unit, and similar oscillations, but of intensified form, are repeated in the receiver. The purpose of the radio-frequency choke is to allow the H.T. current to reach the plate of the valve, at the same time preventing the high-frequency currents from passing to earth through the H.T. battery, instead of through the path chosen for them, i.e. through the aerial terminal of the receiver. The fixed condenser, by the way, is necessary to prevent the H.T. battery from being shorted through the aerial coupling of the receiver. This condenser offers very little opposition to the passage of radio-frequency currents, but is an effective barrier to the direct current from the H.T. battery.



Separate H.T. Supply

Fig. 1 shows the theoretical diagram and Fig 2 shows the complete circuit when the high-frequency unit is made to precede the Radiano Three. For simplicity's sake the switch is omitted. The dotted line surrounds the portion contained within the cabinet of the high-frequency unit. You will see that the same accumulator supplies both the high-frequency valve and the rest of the set, while the H.T. battery is tapped off by a special lead connected to the radio-frequency choke. In this way you can choose the best voltage for the high-frequency valve irrespective of the adjustments you have made to the Radiano Three itself.

The Method of Coupling

You will see that as the high-frequency current from the first valve passes through only a portion of the grid coil of the second (detector) valve, a kind of auto-transformer coupling is used with the Radiano Three. If, however, you are using the Radiano High-Frequency Unit with another circuit which employs an untuned aerial coil, inductively coupled to a tuned grid circuit, this aerial coil will form the primary of the high-frequency transformer and the grid coil the secondary. If, again, this unit is being used with a receiver which has direct aerial coupling (rather unusual in a modern set) then the grid circuit of the detector valve acts also as the

As this photograph shows, the H.F. unit is extremely simple to construct.

The parts given in the list of components are shown here mounted in position ready for wiring.

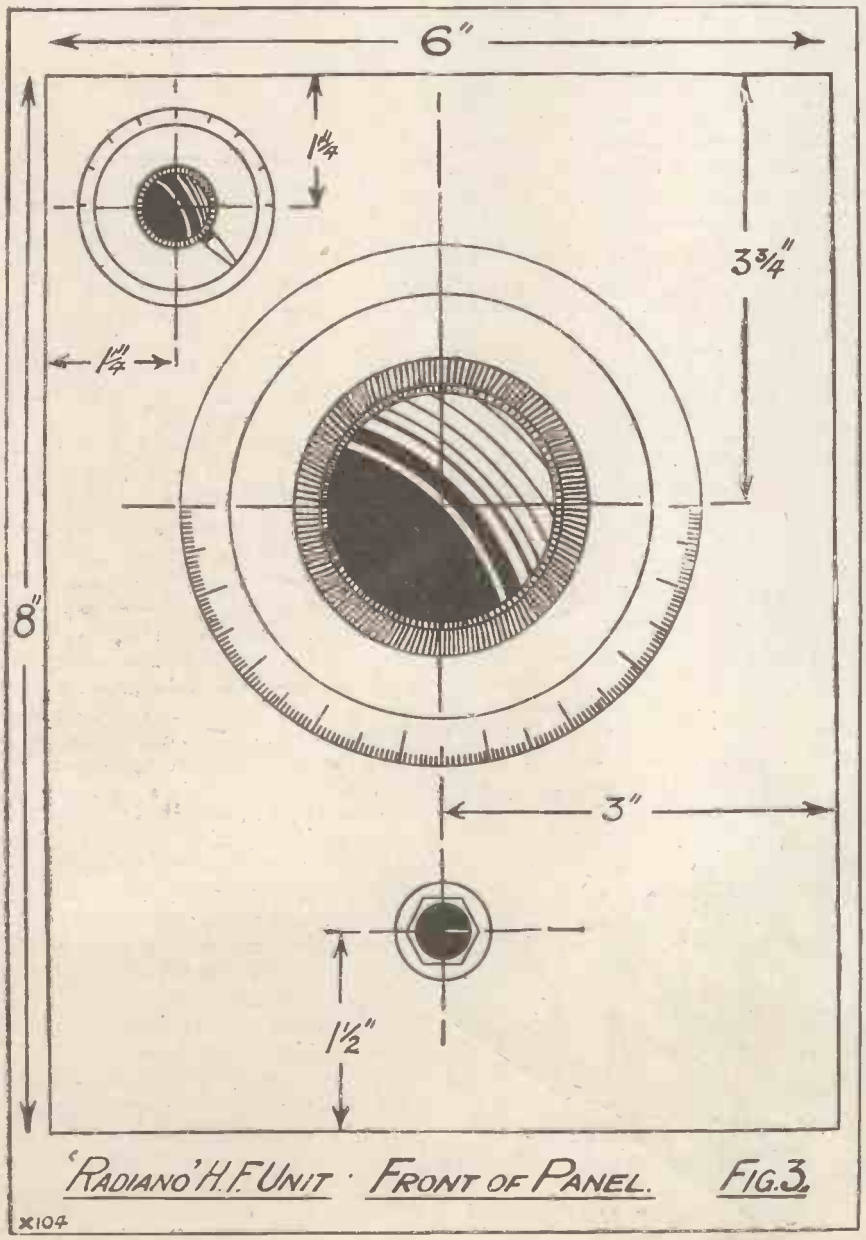
Build the "Radiano" H.F. Unit—*continued*

tuned anode circuit of the high-frequency valve.

I am dealing with some of the simpler theoretical aspects of the Radiano High-Frequency Unit as many readers will like to study them, but it is by no means essential that you should understand them thoroughly in order to build and use the unit. Readers who are not interested in the theoretical side can, if they please, skip the next few paragraphs and continue their reading where the constructional details begin. Having built and tried the set they should then certainly study the theoretical side, as it will help them to understand a great deal about the design of high-frequency amplifiers.

Feed-Back

If a circuit connected to the grid of a valve is tuned to a given frequency, and a similar circuit in the plate lead of the valve is tuned to the same frequency, this latter circuit will carry oscillations of greater strength than those in the grid circuit, and some of this energy will be fed back into the grid circuit, thus taking the place of the losses. As a matter of fact, it is easy to pass back more than sufficient to make up losses, and then the currents of the grid circuit are steadily built up until the grid and plate circuits are in a state of persistent oscillation. The causes of the feed-back sufficient to produce this state are many, the most important being stray fields from the coils, capacity between wires, and the capacity between the electrodes of the valve itself. Even if you guard against all other strays, the valve capacity is often quite sufficient to feed back enough energy to make up the losses in the grid circuit, and for this reason it has been found necessary to devise some means of preventing this continuous oscillation. Obviously, if we can neutralise the feed-back caused by the inter-electrode capacity of the valve itself, this will do much to stop the trouble, and such methods are used in many neutrodyne circuits devised and developed during the last few years.



'RADIANO' H.F. UNIT · FRONT OF PANEL. FIG. 3.

x104

An Analogy

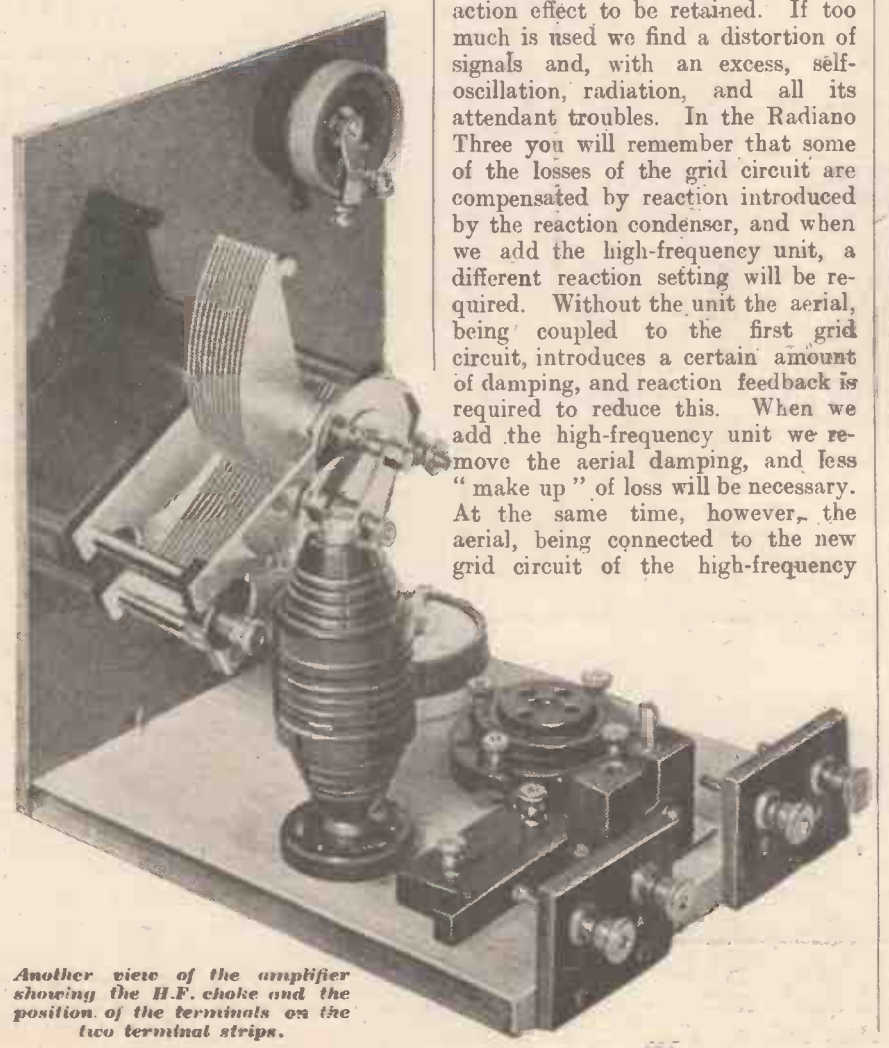
Another method is to introduce just sufficient loss into the grid circuit or the plate circuit so that the amount of energy fed back is only just sufficient to keep the valve in a sensitive condition without oscillation. We can explain the neutralising and the losser methods quite simply by analogy. Let us consider a cistern of water with a tap which can be adjusted so that a certain amount of water flows out of it. Let us imagine, too, that a constant stream of water is poured into this tank by means of a pump and that the amount flowing into the tank is greater than that which the tap will carry off. Obviously, then, there will be an overflow. How can we prevent this overflow? Two methods are available. Firstly, we can diminish the energy of the pump and, secondly, we can insert a second tap or increase the size of the first tap, and adjust it so that just as much flows out as goes in.

Neutralising

In the neutralised methods, the capacitative coupling gives a series of pulses, one for each oscillation, thus feeding back energy from the plate to the grid circuit, or from the supply tank into the cistern. By an arrangement of coil and small condensers, these pulses of capacity coupling are more or less neutralised by other equal

Build the "Radiano" H.F. Unit—*continued*

and opposite pulses. This is the equivalent of inserting another pump to work in opposition to the one which is filling the cistern. If the pumps are of exactly equal strength, then there will be no overflow into the tank. If one is slightly stronger than the other then there will be a little flow, but not sufficient to run over. The second method—that of introducing losses into one or the other circuits—is the equivalent of putting an extra tap in the cistern and adjusting it so that you can just compensate for the amount of water coming in, over and above that which is carried away by the first tap. If we place an equal and opposite pump to prevent too much flow, we do not waste any water, but if we provide for an additional tap we lose just that amount of water which is necessary to compensate for the overflow. For this reason the method of introducing losses into a circuit to produce stability is often called the "losser" method. If badly designed and carried out, it may quite easily waste as much signal strength as you gain by the introduction of a high-frequency stage. Properly carried out, however, the losses need be only quite small and will not appreciably reduce the efficiency. The neutralising method, while, theoretically, more efficient, gives much more difficulty in practice, as very careful layout of wiring is needed, and the adjustment to get the perfect balance is by no means simple, being often quite beyond the skill of the beginner.



Another view of the amplifier showing the H.F. choke and the position of the terminals on the two terminal strips.

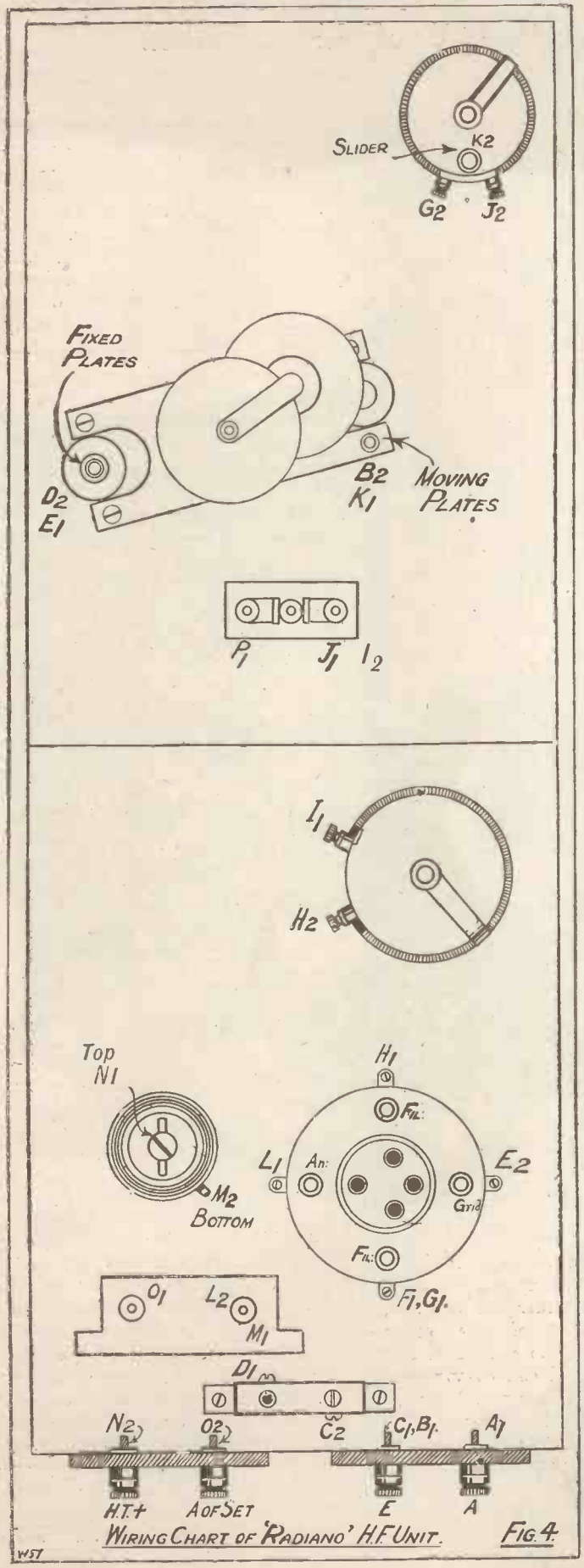
Reaction Effects

It is neither necessary nor desirable to eliminate *all* feed-back in such an arrangement as that we have been discussing, for signal strength and selectivity can be considerably increased when we allow a little reaction effect to be retained. If too much is used we find a distortion of signals and, with an excess, self-oscillation, radiation, and all its attendant troubles. In the Radiano Three you will remember that some of the losses of the grid circuit are compensated by reaction introduced by the reaction condenser, and when we add the high-frequency unit, a different reaction setting will be required. Without the unit the aerial, being coupled to the first grid circuit, introduces a certain amount of damping, and reaction feedback is required to reduce this. When we add the high-frequency unit we remove the aerial damping, and less "make up" of loss will be necessary. At the same time, however, the aerial, being connected to the new grid circuit of the high-frequency valve, will introduce damping there, and we must decide the best way of reducing this. We can, on the one hand, use a good deal of reaction in the Radiano Three and then introduce losses into the first grid circuit, or we can do much better and reduce the amount of reaction used in the Radiano Three (which, in turn, will reduce the tendency to oscillation over the whole arrangement), and then we shall need fewer losses in the first grid circuit to "hold it down." The fewer the losses introduced the higher the efficiency, so that when you try the receiver, as I will explain later, you should endeavour to arrange the stability with a minimum of loss in the first circuit.

Having perhaps bored you by going into such theoretical details, let us now see how the set is built.

The Components

You have a wide choice of components for this set, the only general specification being that all components should be fitted either with terminals or with screws and nuts so that the Radiano tags can be connected without soldering. As there is not a great deal of room on the front panel, care must be exercised in choosing the variable condenser and potentiometer. The potentiometer used in the set illustrated is a C.E. Precision, which is smaller than the average. If a larger size potentiometer is used, make sure that the condenser vanes will clear it at all positions. There are a number of good radio-frequency chokes now available, all fitted with terminals, such as the R.I.-Varley, McMichael, Lissen, Wearite, etc. Similarly, there are a number of baseboard-mounting resistors with terminals. Provided it is chosen to be of the correct value for the valve to be used, this resistor can be any of the leading makes. Baseboard-mounting coil holders are not all provided with terminals or adequate screw connections. The particular holder used in the set illustrated is a Wearite and happens to suit the Radiano scheme excellently, as there is no danger of the brass tag fouling any metalwork. Furthermore, the terminals are placed on opposite sides. In connection with this coil holder, note particularly the position of the pin and the socket respectively. *You must get these positions correct,*



WIRING CHART OF 'RADIANO' H.F. UNIT. FIG. 4.

W57

Build the "Radiano" H.F. Unit — *continued*

The wiring connections can be easily understood by reference to this diagram and the chart on another page. Each lead is marked so that no mistakes are possible. Thus the lead marked A_1—$_2$ on the chart is connected between the point marked A_1 in the above diagram, that is, between the aerial terminal, and a tapping on the coil; B_1—B_2 are connected by means of the lead B_1—$_2$, while C_1—$_2$ connects together the plug of the aerial coil holder and the earth terminal, which latter is also marked B_1 and is thus connected to the moving vanes of the variable condenser, B_2. The whole of the wiring is carried out in this way, using all the leads from A to P.

otherwise the X coil will be connected the wrong way round. Make sure that the earth connection is taken to the pin of the coil holder.

Assembly

There are only five holes to be drilled in the front panel, three of $\frac{3}{8}$-in. diameter to take the potentiometer, variable condenser, and on-and-off switch respectively, and two small ones for the securing screws which hold the bottom of the panel to the baseboard. In a small job such as this there is no need to use panel brackets.

Secure the three components mentioned in place and lay the panel aside. Remember, of course, that the position of the hole on the drilling diagram of the front panel is correct only for the particular potentiometer shown in this diagram. If one of larger diameter is used the hole must be set in a little more accordingly (see note above regarding sizes of variable condenser and potentiometer).

Now screw the five baseboard-mounting components into position, and the two terminal strips to the back. A continuous terminal strip is not used, as space is required for the screwdriver blade to reach the screw on the coil holder when securing the Radiano leads in place. Before you actually fix the securing screws, hold the front panel in position against the baseboard to see that the condenser clears all parts. If the components illustrated are used there will be ample clearance, but if you use different shapes and types they may require a little readjustment of position.

The Leads

The next step is to make the Radiano leads, of which there are sixteen. The process is very simple and has been explained in previous Radiano articles, but, for the benefit of those who have not yet tried the scheme, I will repeat the process. On the Radiano chart you will find straight lines of the exact length required for the particular leads. Take your reel of rubber-covered flexible wire and measure off a length against lead A. Cut the wire to the exact length, bare each end for about $\frac{1}{4}$ in., and take one of the little brass pinch-on tags, and lay the bared wire in the groove. With a pair of pliers pinch over the little projecting fingers on

Build the "Radiano" H.F. Unit—*continued*

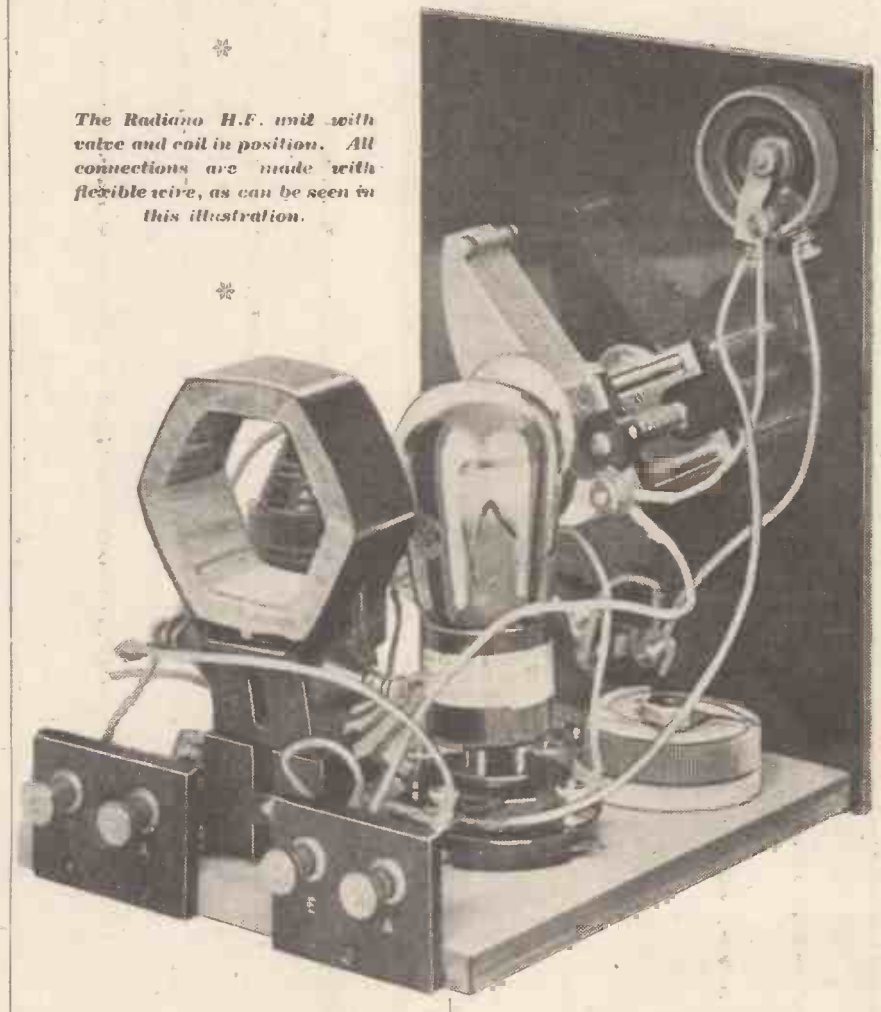
each side until they grip the wire tightly. Fix one of these tags to each end. Now proceed to cut lead B, and so on. Note that in one or two cases (as marked) the leads are left with plain ends, without tags. This is to allow of the wire being passed under small terminals where the spade would be a little too large for convenience.

When all the leads are made, connecting up is the simplest possible matter. Every terminal on the diagram is marked with a letter and a number, as is every lead. To connect up the set it is only necessary to screw the lettered and numbered tag under the terminal of the corresponding letter and number. Thus, to connect between points C_1 and C_2, you take lead C and screw tag C_1 under terminal C_1 and its tag C_2 under terminal C_2. The lengths of the wires have been adjusted to suit. There are, however, two exceptions to this statement, that of the length of the leads lettered F and P. These are the two L.T. leads, one going from the valve socket and the other from the on-and-off switch. These are not taken to terminals on the high-frequency unit, but through the back of the cabinet to the low-tension terminals on your Radiano or other set. Obviously, the length of these will depend upon the actual distance of these terminals from the high-frequency unit, and you must measure them off yourself with the particular set to be used.

A Battery Point

You may be puzzled why there is no H.T. negative lead in this high-frequency unit. The reason is that, as it uses the same L.T. accumulator and H.T. battery as the main set, the H.T. negative is already connected in the main set to the L.T. positive, so that we do not need to duplicate the process in our unit.

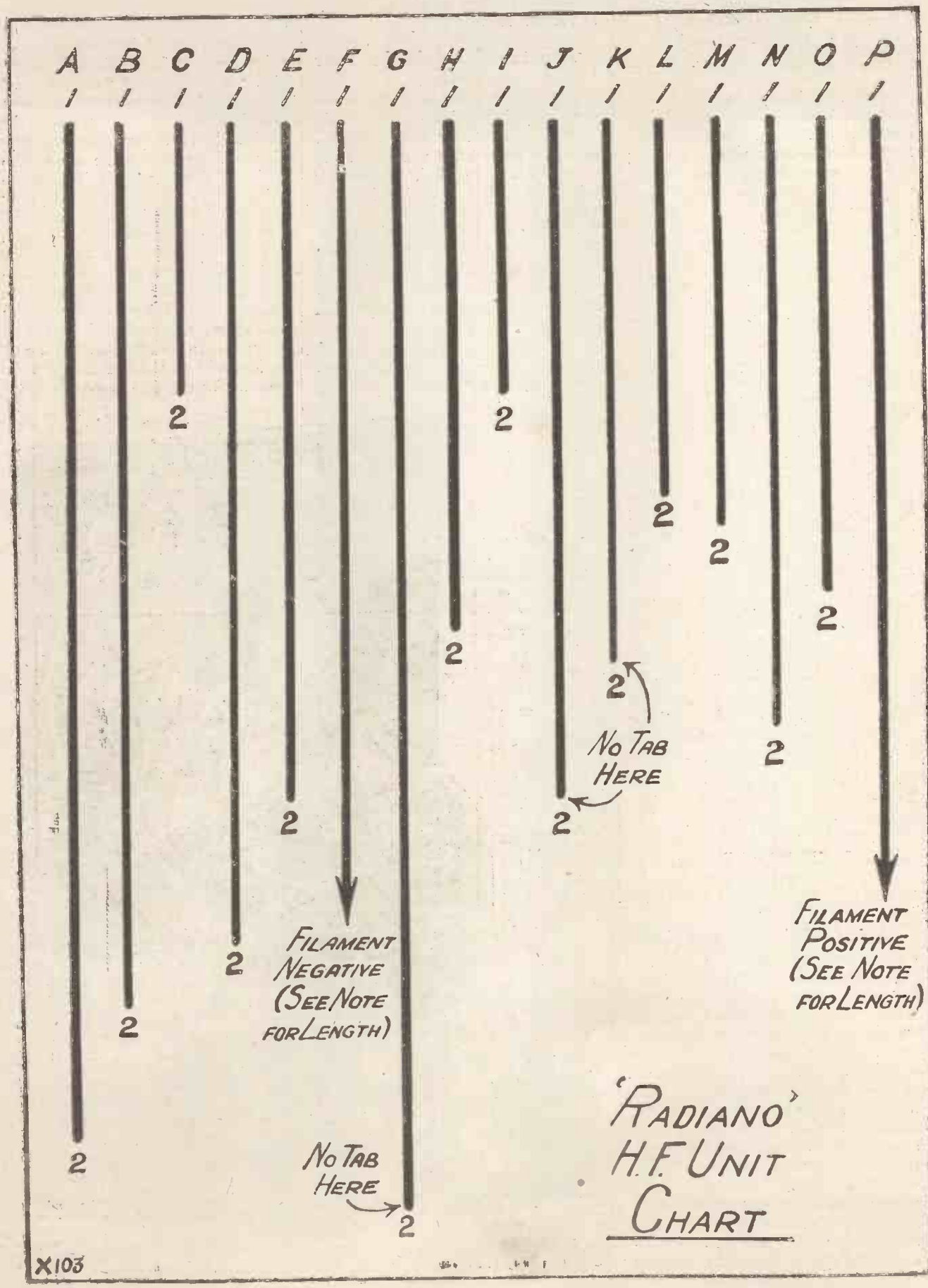
When everything is wired up, you are ready to try out the unit with your present receiving set. To do this tune in your Radiano Three to some station (not the local, as this will be much too loud), and then, leaving the tuning positions as they are, remove the aerial and earth terminals from the Radiano Three. Now place the unit alongside the Radiano Three and connect the aerial and earth wires to the aerial and earth terminals on the unit. Take a lead from the terminal on the unit marked "A of set" to the aerial terminal on the Radiano Three, and a lead from the H.T. positive on the unit to about a 30- or 36-volt tapping on your H.T. battery. Leads must also be taken from the unit to the L.T. terminals on your set as already explained. Alternatively, if it is convenient the two L.T. leads can be taken to the accumulator direct.



The Radiano H.F. unit with valve and coil in position. All connections are made with flexible wire, as can be seen in this illustration.

Now insert in the socket of the high-frequency unit any standard high-frequency valve, either 2, 4 or 6 volt, according to the type of valve you are using in the Radiano set. Insert in the socket a 60 X coil of any good make. Gambrell, Lissen, and Raymond all make X coils suitable for this set. The X coil has two terminals in addition to its plug and socket. Take the flexible lead from the aerial terminal of the high-frequency unit and join it to the larger number of turns on the X coil, leaving the other terminal free. These two terminals are for different tappings, and you use one or the other according to your requirements. To start it is best to use the larger number of turns.

Before switching on turn the reaction condenser of your Radiano Three to zero and the slider of the potentiometer on the high-frequency unit as far over to the negative side as it will go. This means that the slider should be turned so that it is as near as possible to the terminal which is connected to the valve socket. Now switch on and, without altering the tuning on the Radiano set, vary the tuning condenser on the high-frequency unit and try to pick up the station to which the main Radiano set is tuned. One of two or three things may happen when you do this. First of all, you may be able to pick up a station easily; secondly, you may have to make a slight


A B C D E F G H I J K L M N O P
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
FILAMENT NEGATIVE (SEE NOTE FOR LENGTH)
NO TAB HERE
NO TAB HERE
FILAMENT POSITIVE (SEE NOTE FOR LENGTH)
'RADIANO' H.F. UNIT CHART
X103

BUILD THE "RADIANO" H.F. UNIT—*continued*

readjustment of the Radiano tuning condenser before you can pick up a station if it is weak; thirdly, the set may possibly oscillate when the tuning condensers are brought into resonance, and, fourthly, you may find that a little reaction must be used on the Radiano set before you can pick up the station you want. I mention these different states of affairs so that you may know what is likely to happen, with almost any make of high-frequency valve and with almost any aerial. If you pick up the station easily and the set does not oscillate, then you can bring up the strength by using the reaction condenser on the Radiano Three. When doing this a slight readjustment of the tuning position on the Radiano Three will be necessary. Secondly, if, as happens with some aerials, retuning of the Radiano set is necessary for picking up, it may take you a little longer to find the station you want. The process is not difficult, and, having searched with the first condenser and found nothing, search again with a slight alteration on the Radiano Three condenser. A few trials will soon find the station.

If without any reaction being used on the Radiano Three the set oscillates, move the slider of the potentiometer a little towards the positive side until the set just stops oscillating.

The rest of the searching is plain sailing.

THREE PRACTICAL TIPS

Charging H.T. Accumulators

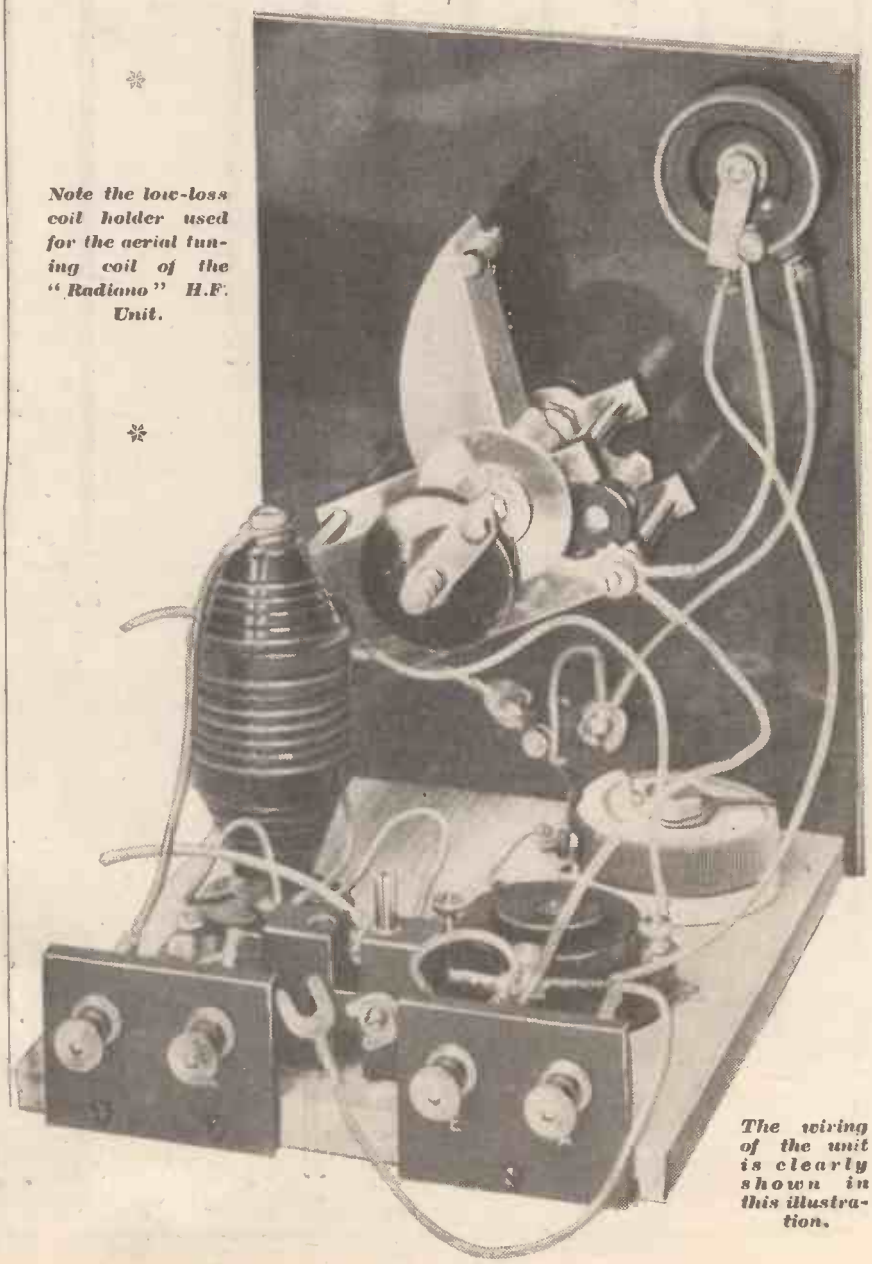
THE best way to keep your H.T. accumulators in good trim is to charge them, or to have them charged, at certain regular intervals whether you use them or not. It is quite a mistake to imagine that the battery does not need a charge until you have taken out of it the ampere-hour discharge for which it is rated. The average H.T. accumulator will gradually lose its charge whether it is used or not, and a partially discharged battery sulphates very easily. At holiday times it is just as well to have your H.T. accumulator charged right up immediately before leaving home. In any case, it is a good plan to charge once a month, and this treatment will add to the life of the battery.

Watch the Celluloid in Your Set!

QUITE a number of components are being finished with a thin layer of coloured or clear celluloid, either to protect the windings or to cover up a loose label. Remember this when soldering, for if a hot iron comes into contact with the celluloid it may set it alight and ruin a perfectly good component—if not, indeed, the whole set! It is as well to keep a wet cloth handy, so that if you should have any trouble in this way you can extinguish the small flame at once.

A Valve Warning

ALTHOUGH most valves nowadays have far more robust filaments than their earlier brethren, it does not mean that they are immune from all shocks. A frequent source of valve breakage is the tight fit of the pins in some makes of "anti-phonic" sockets. When withdrawing the valve considerable force may have to be used, and as a consequence you may hit the valve against the side of the cabinet. Another point is that the valve bulbs themselves are only cemented into the insulated base, and if you pull on the glass rather than on the base you may loosen this cement, and, indeed, you may even rip the bulb and its connecting wires clean away from the insulating base. For this reason valves should always be removed from their sockets by taking hold of the base and not the bulb itself.



Note the low-loss coil holder used for the aerial tuning coil of the "Radiano" H.F. Unit.

The wiring of the unit is clearly shown in this illustration.

Savoy Hill Happenings

By OUR SPECIAL COMMISSIONER

Progress with Alternative Programmes—The Claims of Ulster—Sir John Reith and America—The Sunday Problem—5 X X and 5 G B : A Warning.

Progress with Alternative Programmes

THERE is at long last some real progress to report in connection with the new plan of technical distribution. The committee of consultants under the chairmanship of Dr. Eccles, which the B.B.C. called in June last, has sacrificed its normal holidays in an exhaustive examination of all aspects of the proposals brought forward by Captain Eckersley. Already test transmissions from 5 G B have been of great assistance to this committee in clearing up practical points at issue.

I am told on the best authority that as soon as the Post Office agrees the report of the Eccles Committee will be published as a parliamentary paper, and work will proceed. And as the Post Office has an engineer on the committee there should not be very much delay. The chief advantage to listeners of the results of the deliberations of the Eccles Committee is that instead of a gradual station-by-station building programme the work will be put in hand much more expeditiously.

Not Enough Wave-lengths

If there had been no independent committee the B.B.C would naturally have been more cautious, and would have proceeded slowly in order that mistakes of conception might be put right before there was any very large financial commitment. As things stand, however, the Eccles Committee are satisfied that the scheme as now evolved is quite sound, and should be undertaken in generous instalments. The decision, therefore, is to put in hand simultaneously and at once the double transmitters for London, the West Country, and the Pennines.

These should be completed by the middle of next year, so that listeners in the south, west, and middle of England should have their full-fledged alternatives at the beginning of the season of 1928–29. So far so good. But I understand that the real difficulty rests with the other transmitters. There are not enough exclusive wave-lengths to go round.

If Northern Ireland were left out all would be well. But the B.B.C. is in honour bound to treat Ulster well. Therefore, some part of the United Kingdom will ultimately have an inferior service, unless something quite unexpected happens meanwhile. But the B.B.C. is wise to concentrate meanwhile on the construction of the stations where the most people are waiting adequate service.

Sir John Reith and America

The National Broadcasting Company of the United States has officially invited Sir John Reith to be present at the inauguration of their great building in New York in September. There had been rumours about this for some time, and some unfair attacks in certain newspapers. It was suggested that it would be improper for Sir John to go to the States on such a mission.

In point of fact, it would be improper for Sir John not to make every possible effort so to arrange his affairs that he might accept. The B.B.C. should be in much closer contact with American broadcasting than it is. Then, again, there are many things which the B.B.C. might learn from America. There is also the consideration of Anglo-American

Rear-Admiral W. H. G. Bullard, America's Radio Chairman, tuning in at Washington.

Savoy Hill Happenings—*continued*

relations, which might well be improved and consolidated by a wise co-ordination of radio. On all counts, the case for acceptance is almost irresistible.

The Sunday Problem

Although it is true that the B.B.C. puts out eight years of programme time annually, there is still a good deal of grumbling about the silent periods on Sundays. The very success of the transmission from Menin Gate on July 24th called particular attention to the problem. Then there is Saturday morning, when even Daventry is silent. But the Sunday periods are of greater importance.

The Listeners' Committee has been hammering away at the matter; but apparently without result. Lord Drogheda is particularly keen on changing the normal time of religious transmission to church hour in the morning, thus liberating the whole of the Sunday evening period for entertainment. Here is a case in which the B.B.C. have failed to assess correctly the strength of public opinion. Savoy Hill will be forced to move ultimately; they had better move soon with good grace. Both Saturday and Sunday mornings must have broadcasting, and the Sunday evening transmissions must be entertainment and not half ethical or religious instruction.

The Troubles of Scotland

It is an unusually strange paradox that, while Scotland has given the B.B.C., in Sir John Reith, one of the greatest organisers in the United Kingdom, the B.B.C. seems unable to avoid turmoil in Scotland. Public irritation with Scottish stations, and particularly with Glasgow, has become chronic. The B.B.C. tried numerous experiments in the hope of placating the local irritation. Officials were removed; others were switched round; there were several close inquisitions and reorganisations. But apparently the trouble is as acute as ever. Or, rather, the manifestations are as vindictive and extreme as ever.

An independent critic has given it as his considered opinion that if the B.B.C. had never paid the slightest attention to the Glasgow outbursts these would have subsided long ago, and all would be calm by now. There may be something in the view that frequent changes designed as heroic curatives of ill-defined troubles have only exacerbated the infection. I have been going into the matter carefully, and have evolved a solution which I am sure would be efficacious. Let the B.B.C. give Scotland more autonomy—both in fact and in name. Let the official at the head of B.B.C. affairs in Scotland set up a national committee to advise him. Let him also arrange for a full and regular service of local news from Glasgow, Edinburgh, Dundee, and Aberdeen. And, finally, why not let the B.B.C. change their headquarters for Scotland from Glasgow to Edinburgh?

The Listeners' Committee

While officially the relations of the Wireless Organisation Advisory Committee with the B.B.C. appear to be good, there are so many rumours of dissatisfaction and trouble that there must be something wrong. This rift in the lute is all the more regrettable in view of the valuable work the committee has been doing since it came into being at the beginning of the year.

It appears that some members of the committee are disappointed at the lack of publicity attending their work. It was, of course, quite wrong to expect publicity. It would be true to say that the value of their work is in inverse proportion to the publicity it receives. In other words, as long as there is no publicity they can be as rude as they like to the B.B.C., and secure reforms in various directions; but with publicity they would not have half the chance to get things done, for the reason that they would no longer have access to confidential information. Despite some unpleasant aspects of the recent flare-up it is probable that the Savoy Hill people will succeed in tranquillising the position. They must call up their not inconsiderable reserves of tact and forbearance.

5 G B and 5 X X: A Warning

5 G B is providing a fairly acceptable contrast programme in the Daventry service area. But the tendency to "dump" is now noticeable in the case of 5 X X. I had expected it with the new station; but Savoy Hill evaded this danger only to get entangled in another. The practice of dumping undesirable or unworthy programme material lifted its head first of all at Chelmsford. There were signs of it later at Daventry. But each time the vigilance of listeners was quick to "raise Cain." The same process should begin again. Listeners must insist on the absolute application of the principle that unsuitable material should not be accepted for any wave-length, long or short.

More About Screened Coils

An article of interest to all constructors.

By A. JOHNSON-RANDALL.

MR. THOMAS in the last issue of this journal gave a full description of the standard screened coils. This article was called for by the very large number of readers who wish to wind their own coils for use with the standard screens.

Screening

There are many, however, who may also desire to wind coils for smaller sets, such as those employing a single stage of H.F., or for single-valve receivers in which it is undesirable to use screens. It is generally understood that in order to obtain freedom from magnetic interaction between the coils in a receiver utilising two or more H.F. stages some form of screening is practically essential. It was for this reason that a radio engineer devised the well-known scheme of surrounding the H.F. transformer or aerial inductance with a metal screen. I am afraid that many readers do not fully appreciate the fact that in order to achieve the purpose for which the screens were designed it was necessary to sacrifice to a small extent the efficiency of the coil. This loss in a well-designed coil wound with Litz wire and inside the screen is probably not more than ten per cent, and is more than compensated for by the gain in stability and ease of operation when two or more H.F. stages are used. In fact, without these screens or some other device it is probable that such a receiver would be unworkable.

Alteration in Wave band

With smaller sets, however, the loss becomes appreciable, and there is little point in using this form of screening. In these circumstances it is a good plan to utilise the standard-type coils in conjunction with an ordinary 6-pin base, since they have the advantage of being both compact and easily interchangeable. I have carried out experiments with the standard coils, and I find, as one would expect, that when the screen is removed the wave-band over which the coil will tune is altered. Hence, instead of the coil tuning from, say, 250-550 metres with a given condenser, the removal of the screen may change the wave-band to 300-600 metres, thus making it necessary to strip off a few turns in order to get down to a minimum of 250 metres. This is owing to the fact that the use of a screen lowers the effective inductance of the coil and more turns are necessary in order to cover a given wave-band.

Adjusting the Turns

For instance, the standard split-primary coil has 90 turns on the secondary winding, and I have found

A compact portable receiver made by Leslie McMichael, Ltd.

it desirable to strip off about 20 turns when the inductance is to be used without the screen. The Daventry coil has a secondary of 300 turns, and here again, if one is to tune down to Hilversum, it becomes desirable to strip off about 50 turns. In the case of the split-secondary coil, the removal of about 25 turns from each half of the winding is an advantage. These coils were primarily designed for use with split condensers having a total capacity of ·00025, the two halves being in series, and if ·0005 single condensers are employed across the whole winding fewer turns are necessary. This is, of course, quite apart from the fact that the removal of the screen also alters the effective inductance.

Some readers may be in possession of formers which have a slightly larger diameter than two inches. Although these are quite suitable for use with the ordinary six-pin bases it is inadvisable to employ them in conjunction with the standard screens, unless these are larger in diameter than the minimum specified. To increase the diameter of the coils is to increase the losses.

The screen should clear the coil by at least half an inch all round; and this should be increased top and bottom, if possible.

Reaction Winding

The primary and neutralising windings are placed in the centre of the secondary winding, inside the 2-in. former. A 1⅝-in. tube is about the right size, but this may be increased to 1¾in. in some cases. In the split-primary type the neutralising winding is wound on first, then a layer of Empire tape, and lastly the primary winding. Both windings are in the same direction. The reaction winding is wound on a similar tube and is inserted near the end of the secondary winding remote from the grid of the valve—that is to say near the end of the winding which goes to terminal No. 2. This winding is really a continuation of the secondary winding, and is wound in the same direction. The free end is taken to terminal No. 6.

(*Continued on page 356.*)

THE EVOLUTION OF A "GLORY HOLE"

Are Super-Power Valves Worth While?

By KEITH D. ROGERS.

An article of value to all users of loud speakers or multi-valve receivers.

I WONDER how many readers have debated the question set forth above, and how many have merely contented themselves with a shrug of the shoulders and the remark "They are and they're not, because of the H.T. bother. If it wasn't for that——" Yes, I admit the H.T. bother is a real one, and is, indeed, a problem which needs some solving, but on the whole I think you will admit that super-power valves are worth the extra trouble and cost.

If the super-power valve did *not* consume so much H.T. current I feel sure everyone would employ this type in the last stage of their sets, if anything like good volume was being obtained.

After all, it is entirely a matter for the individual to answer. I cannot say here, dogmatically, that the super-power valve *is* worth while. It depends. It depends on many factors, chief of which are the facilities of the owner of the set in which the valve is to be used to provide anode current and plenty of potential, and also upon the amount of noise, or, putting it more politely, music he wants from his loud speaker. It would be ridiculous for a man employing headphones only to use a super-power valve. But for the man who wants plenty of volume this valve is an essential if pure results are to be obtained.

A Definite Drop

Now, do not assume from the foregoing that "plenty of volume" is a sine qua non where a super-power valve is concerned. Far from it. The amplification factor of a super-power valve is much below that of the ordinary power valve, and so *less* amplification is obtained. This amplification loss is not proportional to the difference in amplification factors of the two valves, for various reasons, but there *is* a drop, a definite drop.

Why, then, it is often queried, is the valve called a *super-power* valve? This is not because it provides super power "on its own," but because it can deal with a more powerful input than can other valves, and so enable more powerful results to be obtained without distortion. Also it very often improves the tone of the reproduction when substituted for a valve of the ordinary power type.

For Even Amplification

This improvement is evident, because for even amplification of all musical frequencies (and such amplification is essential if purity is to be obtained) it is necessary for the valve impedance to be considerably less than the impedance of the outside circuit. That is, in most cases, the impedance of the last valve has to be greatly exceeded by the impedance of the loud-speaker windings.

Now, as a rule these windings are of low impedance, somewhere about 5,000 to 7,000 ohms being the figure, which, by the way, is *not* stated by the makers. (Do not confuse impedance with resistance.) So, to utilise this advantageously, a super-power valve with a value of about 2,500 to 3,500 ohms should be used. It is better still to use this type of valve and also an output transformer or choke system having a suitable impedance value—say 25 to 30 henries.

Handling Greater Volume

Thus we see that one very definite improvement in reception can be obtained by the use of the super-power valve, besides the fact that greater volume can be "handled."

In a set of this description (Det. and two stages of L.F.) it is essential that a correct choice of valves be made, and if full loud-speaker strength without distortion is required the last valve should be of super-power type.

Are Super-Power Valves Worth While?—*continued*

This latter point is the real purpose for which such valves were designed. Their characteristic curves are such that as a rule twice the voltage variations can be handled when compared with those with which the ordinary power valve can deal.

Comparative Grid Swings

For instance, an ordinary power valve, though it may have an amplification factor of about six or seven, and will theoretically give louder signals, can only handle at the most about six volts each way on the grid, even when most carefully biased. Then, as its impedance is so high the impedance of the output circuit has to be high if pure reproduction is to be maintained and anything like a reasonable degree of amplification obtained, and this at once cuts down the power available for any specified H.T. voltage, and this voltage must not be too high.

With the super-power valve we can use a high value of H.T., giving greater electron flow and greater power. A smaller output impedance allows the same thing without loss of quality, and the valve will handle about fourteen volts input on either side of the centre biasing point on the characteristic curve.

Not for Nothing

But we certainly do not get these advantages for nothing. Unfortunately, high H.T. voltages and low impedance mean heavy H.T. current consumption, and so if we use a super-power valve we find the H.T. current for that valve goes up to about twelve to eighteen milliamps instead of the six or seven that are often the maximum required when an ordinary power valve is in use.

That H.T. business is not now the drawback that it was because mains units have become more efficient and reliable, and in very many cases enable a very cheap and plentiful supply of anode current to be obtained. Where batteries have to be used, however, the H.T. accumulator is about the best, followed closely by the wet Leclanché type or the super dry battery.

But if you determine to use a super-power valve I want to make it clear that this H.T. consumption must be expected and that you will only spoil results if you cut down the H.T. voltage or increase the grid bias voltage beyond certain limits, and poor tone will be experienced.

Keep the H.T. above 120 volts if best results are to be obtained, but don't use a super-power valve unless somewhere near this voltage can be supplied.

Use Plenty of H.T.

If less than the required voltage is employed you will get results far from the best that can be obtained when the valve is given its requisite voltage, and in such circumstances the answer to the question is that it is certainly *not* worth while.

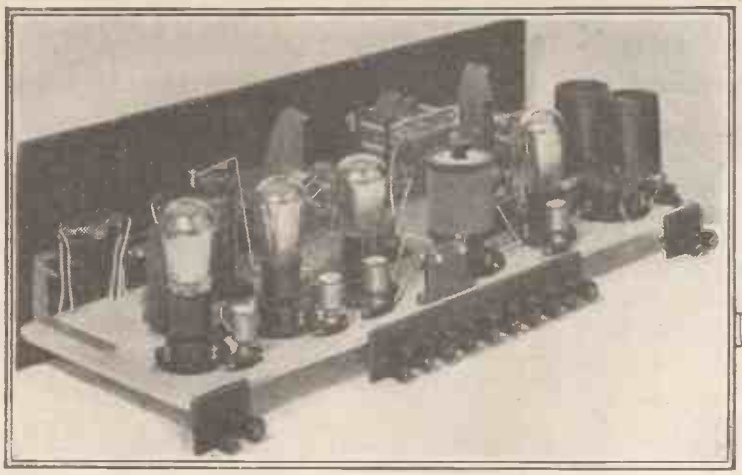
If a valve is used properly, and is of good manufacture, then it is a very good investment, and this applies to the super-power valve as well as to other types, but where some valves will show no decided loss when mishandled, or rather, I should say, misused, the super-power shows a marked falling off of efficiency when wrongly used. Give it plenty of H.T., plenty of grid bias, a pure input, and an output circuit of suitable impedance, and it will well repay you by giving pure reproduction with a volume absolutely unapproachable with the ordinary power valve.

If you can supply the necessary H.T. and want good volume, then the super-power valve is the valve, and a super-power you must have—paralleling the other types will not help much, for it does not allow a greater grid input unless push-pull amplification is employed.

The Output Circuit

There is a final point about super-power valves which should not be forgotten, and that concerns the matching of the impedance of the output circuit with the impedance of the valve itself. In order to obtain full amplification the impedance of the loud speaker (or whatever form of output circuit is employed) should be at least three times that of the valve itself, though the D.C. resistance should not be any higher than can be helped. The question of suitable impedance—seeing that most loud speakers have low impedances—is one of the reasons why many set designers advocate a transformer or choke output circuit. In this way the impedance in the anode circuit of the valve can be arranged as desired, and any loud speaker may be used without the balance being affected. The cheapest and easiest method is to employ the choke and condenser type of output (a "filter" it is often called), and this is an eminently satisfactory form.

To the man who wants his local station at moderate volume only the super-power valve is hardly worth the extra upkeep expense. So that it all boils down to this: If you want moderate strength the ordinary power valve will do the job, but if you want full, not necessarily loud, volume, you must have a super-power, and it will amply repay you.

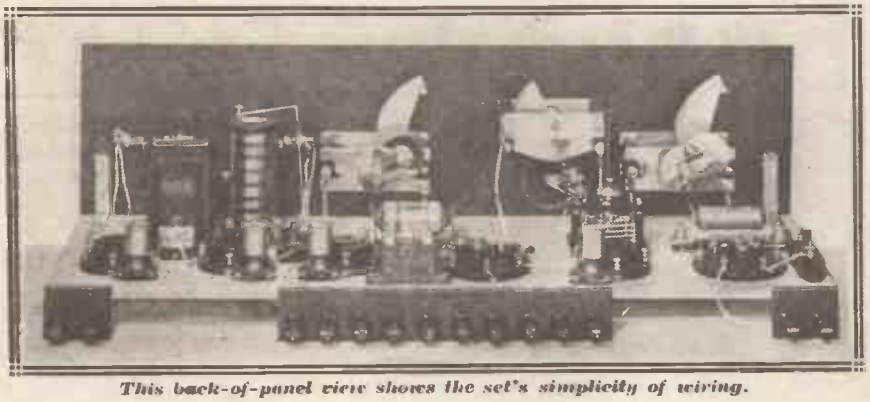


The "New Family Four" at Home

BY PERCY W. HARRIS M.I.R.E.

Practical hints enabling constructors to get maximum results from this already popular receiver.

IF, as I expect is the case, you have now finished the constructional work of the "New Family Four," you will be anxious to know how to get the best from it and how to make the necessary adjustments. Fortunately, these are simple and very easily carried out.



This back-of-panel view shows the set's simplicity of wiring.

First, a word as to the valves used. These may be 6, 4 or 2 volt, according to taste. Generally speaking, the 6-volt are slightly more efficient than the 4-volt, and the 4 slightly more so than the 2-volt; but the set works well with all three varieties. While I am writing the set is giving adequate loud-speaker reproduction from Langenberg (Germany) at 11.30 in the morning, using 2-volt valves throughout, the programme, incidentally, consisting of gramophone records of "Rose Marie."

The H.T. Tappings

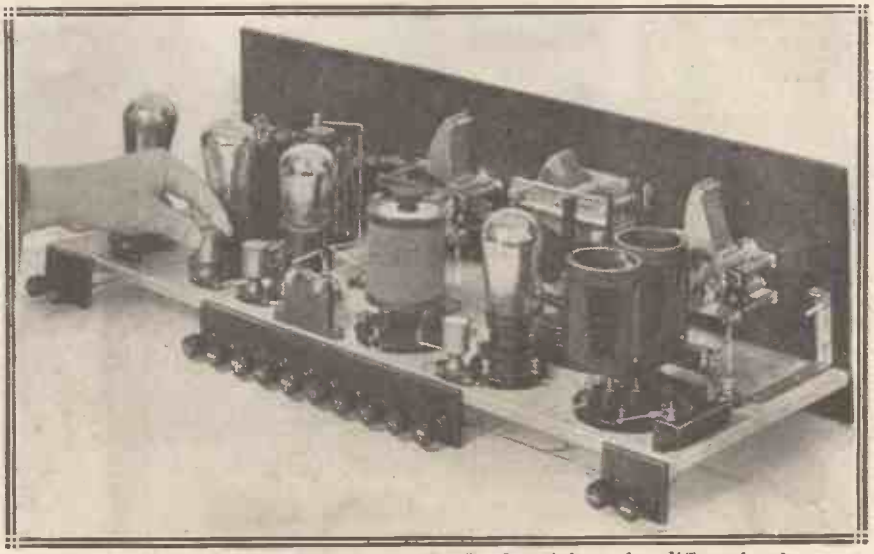
Whatever voltage valves you use, remember that the first must be an "H.F." type, the second an "R.C." type, the third an "L.F." type or small power valve, and the fourth either another of the same type or, still better, one of the kinds specially designed as output valves for loud-speaker work.

There are four "H.T. positive" tappings on this set. H.T. positive one is for the detector; H.T. positive two for the high-frequency valve; H.T. positive three for the first note magnifier, and H.T. positive four for the second note magnifier. H.T. positive one should be fairly high, and, in fact, it is not a bad plan to join H.T. positive one, H.T. positive three and H.T. positive four together, and to connect them to 100 or 120 volts if you have them available. If your H.T. battery is not of such a high value, then join these three to the maximum voltage you can give.

H.T. positive two need not be so high, and it is here that I suggest you make a few tests to obtain the best voltage to suit your conditions. Much depends upon the make of valve you are using. Try 60 volts to begin with. It may be necessary to vary this voltage a little in certain conditions, which I will explain in a few moments.

Grid-Bias Adjustments

With regard to grid bias, only one grid-bias battery is necessary, and grid-bias positive is connected to the positive terminal of this battery. Grid-bias negative one will have a value which will depend upon the particular type of low-frequency valve you use in the first note-magnifying stage, and the H.T. voltage you



It takes but a moment to change the fixed resistors, for different valves.

The "New Family Four" at Home—*continued*

give it. The maker's instructions will give the value for the particular valve you use. Grid-bias negative two will depend upon the make of the last valve and the voltage, and here again the maker's instructions should be taken as a guide. L.T. negative and L.T. positive will, of course, be joined to your accumulator, the voltage of which will depend upon the filament voltage of the valves you use.

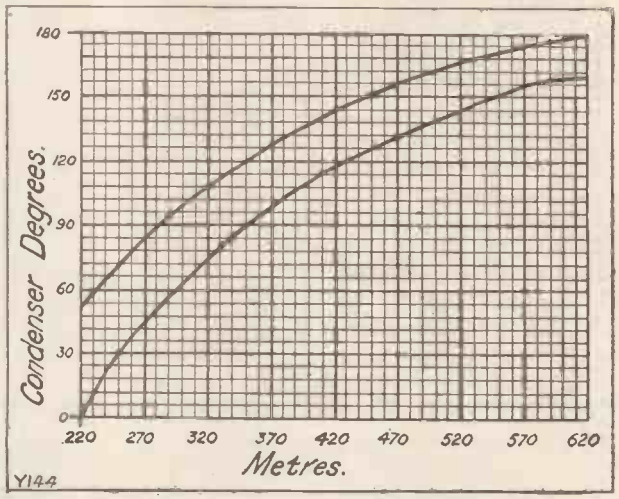
How to Neutralise

Remember that two tappings are provided on the base of the second high-frequency transformer for the primary connection. Two-volt valves should be used with the tapping on the point marked "3," and 4- and 6-volt on the tapping marked "4."

For the preliminary testing, the variable filament resistance, which is situated immediately under the reaction knob, should be put at the full "on" position. You will not hurt your high-frequency valve by doing this, as you will remember that there is a fixed resistor permanently in series with the filament.

The next step is to neutralise the receiver. As there is only one high-frequency stage in the "New Family Four," this is a comparatively simple matter, and is most easily carried out when you have a station within fifteen or twenty miles. First of all, set your neutralising condenser so that the plates are "all out." Now tune in your nearest station. Do not tune it in at full strength, as if you do so when the set is unneutralised you may cause bad oscillation. Tune the first circuit approximately and then tune on your second (right-hand) dial until you find the position of maximum strength. If signals are very strong detune on the first condenser until they come down to a reasonable strength, and then find the best position on your second condenser.

Now quickly tune the first condenser to maximum volume and without any delay unscrew or remove the first fixed resistor. During these tests the reaction condenser should be set at zero, or with the plates all out. Listen on the loud speaker or telephones and you will probably hear your nearest station at medium strength. Now turn your neutralising condenser slowly towards the maximum position. The signals from the local station will now probably disappear. At this point make quite sure that you are accurately tuned on the first condenser by readjusting this, but do not touch the second. Carry on with your movement of the neutralising condenser and it is probable that you will begin to hear the local station again. Turn back again and leave the neutralising condenser at the point where you hear no signals at all from the local station.



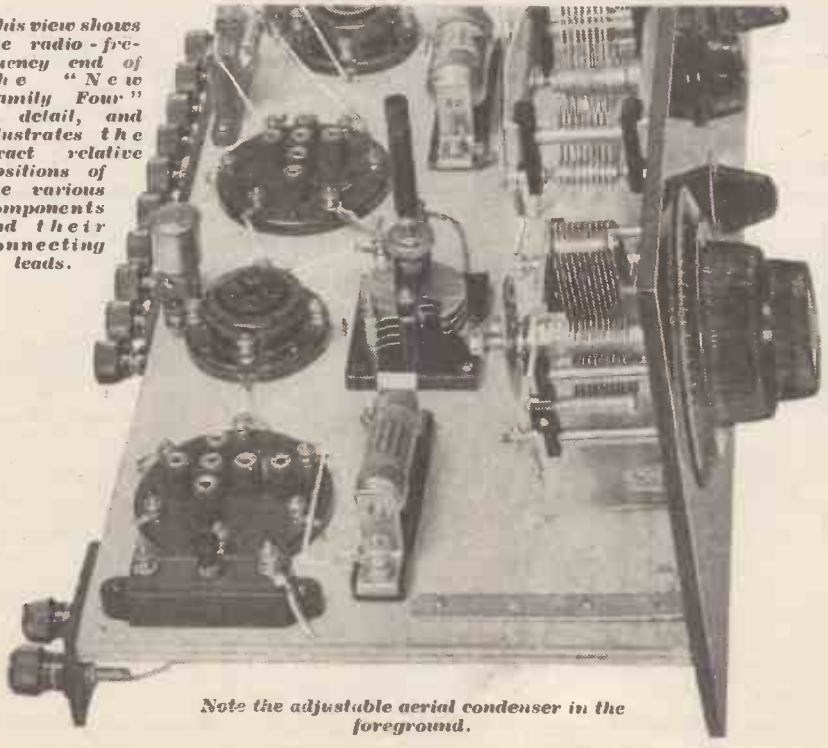
A specimen chart of the tuning-condenser curves. This is intended as a guide only, as the curves for any particular set will depend upon its own coils and condensers.

The Silent Point

When you have found this silent position, the neutralising condenser can be left as set and need not be touched again until you change the valves. Replace the fixed resistor, and the set will be ready for work. The simplest method of searching is to move the second condenser a degree or two at a time and move the first condenser backwards and forwards till you pick up a station.

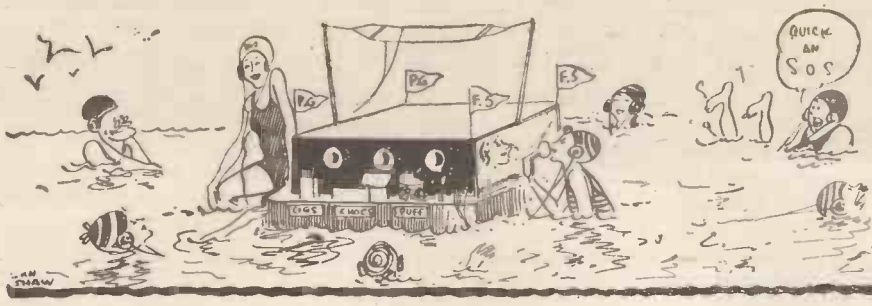
The tendency to oscillate will be considerably greater with the 6- and 4-volt valves than with the 2-volt, and the point of neutralisation will be

(Continued on page 358.)



This view shows the radio-frequency end of the "New Family Four" in detail, and illustrates the exact relative positions of the various components and their connecting leads.

Note the adjustable aerial condenser in the foreground.



IN LIGHTER VEIN

By WIRELESS WAYFARER

"So far as I can see——" remarked Professor Goop. We were walking down the High Street at the time, and he was so excited about an inspiration which had just come to him that he placed himself face to face with me in order to be better able to conduct his explanation. This, of course, meant that he was walking backwards. He had just unburdened himself of the words, "So far as I can see," when he collided, with a certain amount of violence, with the Rev. Aloysius Tosher, who was standing passing the time of day with Miss Worple.

"It would appear," said Aloysius, rather acidly, after retrieving the

A passing van-horse had been wearing his hat as a kind of cuff.

remains of his wideawake hat (which a passing van-horse had been wearing for some moments on one foreleg as a kind of cuff), "it would appear, if I may be permitted to say so, that you cannot see very far, particularly out of the back of your head. Why any man in his senses should perambulate the High Street backwards I do not know. Things are coming to a pretty pass in Mudbury Wallow when one cannot stop to speak to a friend without being knocked down by some elderly maniac."

A War Begins

Professor Goop's reply was to borrow Miss Worple's umbrella and to break it over the head of Aloysius. For answer, Aloysius extracted one of the hatpins from the lady's headgear and jabbed the professor in a fleshy part. Quick as lightning, and with a polite "Allow me," the professor granted himself the loan of the heavy parcel which she was carrying under her arm and flung it, well and truly aimed, at his adversary.

Glancing round in quest of a further weapon or missile Aloysius caught sight of her handbag, which he grabbed and used flailwise with considerable effect until the handle came away. In springing back, so as to be out of the battle, Miss Worple, who was playing to perfection the part of a neutral by supplying munitions to both belligerents, was unlucky enough to step on a banana skin, which caused her to sit down a little hastily upon the pavement.

Repairing the Damage

In a flash the professor had whipped off both her shoes—Miss Worple affects a stout "sensible'" type of footwear—and was chasing Aloysius down the street, hurling his latest, and most effective, projectiles at the retreating enemy.

Flushed with victory, he returned, like the perfect gentleman that he is, to the assistance of Miss Worple. Since one of her shoes had landed in the dustcart, whose horse, taking fright at the sight of the fleeing Aloysius, had promptly bolted, and since he deemed it for the moment inadvisable to retrieve the other, which had somehow found its way through Mr. Snoopham's plate-glass window, he immediately doffed the one gym shoe and one elastic-sided boot that he was wearing, and insisted upon her making temporary use of them.

End of the Scene

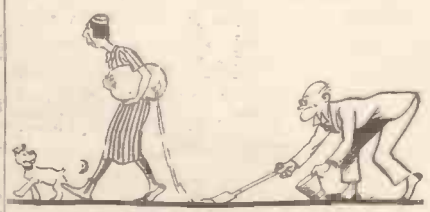
As her hat, no longer safely anchored after Aloysius's base removal of its pin, had been carried by a sudden gust of wind on to the weathercock of the Town Hall, he made good the deficiency by lending her the Old Borstalian cricket cap that he was himself wearing. The handbag he promised to replace after his very next visit to Woolworth's. The parcel, which contained seven pounds of flour, was practically intact, save that there were one or two holes to be seen in its wrappings, after the professor had rescued it from a large puddle, into which it had fallen.

He placed it under her arm, telling her how glad he was to be able to restore all her possessions, or at all events to replace them by something just as good. "Except, of course, the umbrella," he said, "but nobody could possibly need an umbrella on so fine a day as this, and in any case it is sheer folly for so sweet a flower as yourself to carry one; all flowers require rain for their well-being, and an umbrella in your case is therefore positively unhygienic."

Too stunned for words, Miss Worple waddled off, leaving in her wake a trail of flour. Professor Goop, having borrowed from outside a toyshop a child's bucket and spade, followed her, retrieving the flour, which he afterwards assured her upon the word of a scientist was of exactly the right colour to make the most health-giving standard bread. Poor Miss Worple was sadly shaken by the affair. When I called round to inquire on the following day, she told me how relieved she felt, on thinking it over, that the battle did not last any longer.

The Professor Resumes

After leaving her I went round to see the professor, whom I told that I was still in suspense as regards his latest discovery. He had got, I reminded him, no further than the



. . . . Waddled off, leaving a trail of flour.

words "So far as I can see," and I felt sure that there was something big to come. Nor was I mistaken.

I have been privileged in the past to take part in the development of not a few of the professor's discoveries, but none of these, I feel, was of the same epoch-making importance as that which he proceeded to unfold.

"So far as I can see," he resumed, glancing somewhat apprehensively, I thought, behind him, "the needs of

In Lighter Vein—*continued*

the great wireless public have been pretty well met by designers, except in one most important respect.

"We have had sets for the flat-dweller and sets for the sharp tuner; sets for the long-distance man, and sets for the truthful; sets with two knobs for the two-handed, with no knobs for the handless, and with from three to twenty knobs for the multi-handed; as regards portables, Mr. Hercy Parris designed, if I remember aright, "Samson" for powerful twins.

The New Invention

"That eminent authority Marcel has given us permanent-wave sets which require no tuning; Heinz has produced no less than fifty-seven varieties; the Beecham crystal set is worth a guinea a box; the world-famed Dr. Williams has given us his pink sets for pale listeners; in the Doan Televisor every picture tells a story; the Insupportable is probably the last word in self-contained receivers.

"But there is one clear omission from the list of sets intended for special purposes. Has it ever occurred to you that we have at present no receiving

. . . . Showed me his original model . . . .

set intended particularly for the use of bathers? They cannot plant a portable set at the water's edge and turn on its loud speaker in order to be able to revel in the sweet strains of the broadcast music, for the authorities will not permit loud speakers upon the beach.

"It would, of course, be possible for them to use telephone cords fifty or a hundred yards in length, but I foresee certain difficulties should two or three thousand bathers thus equipped enter the sea from the same comparatively small beach. My solution of this pressing problem I intend to give to the world in the form of the "Goop Floatable Five," which will undoubtedly serve to cheer up the sad sea wave all round our coasts this summer.

"I propose to use on the H.F. side the circuit due to Freeman, Hardy and Willis, in conjunction with the Knockspotsoff anode-kink method of rectification. For my note-magnifiers I shall employ the highly ingenious arrangement evolved by Edison, Swan, and Edgar.

Extra Refinements

"So much for the internal arrangements of the apparatus. The cabinet will be made entirely of plate glass silvered upon its inner surface in order that feminine bathers shall not be deprived of their mirrors whilst taking their dip. It will be mounted upon a neat raft made on the widely-used Tate Cube principle. This raft will support the aerial masts, from which flags, pennants, and so on, may be flown. And a cheerful display of bunting from four or five hundred of my Floatable Fives will add greatly to the festive appearance of any bathing beach. The earth wire is replaced by a chain, and instead of an earth plate we have a stout anchor which prevents the Floatable Five from being carried out to sea.

"In suitable positions upon the raft are receptacles containing cigarettes, matches, chocolates, powder puffs, and lipsticks. I am also thinking of designing a *de luxe* model incorporating a tea urn and an ice-cream freezer.

"These instruments will be known as Sea Lyons. Either type will be furnished with one dozen of my patent Mermaid bathing caps with built-in 'phone receivers. These are connected to the set by means of flex leads, so that all the broadcatching bather has to do after donning his or her Mermaid cap is to tread water and listen."

Seizing me by the arm the professor hurried me off to his workshop, where he displayed to me with pardonable pride the original model of his Floatable Five.

The Test Arranged

"To-morrow morning," he cried, "you and I, assisted by our good friends Captain Buckett, Primpleson, and Tootle, will test out and demonstrate this glorious piece of apparatus."

"But," I said, "there is no sea at Mudbury Wallow."

The professor retorted that there was, at any rate, a canal which would answer excellently for the purpose. He bade me tell the others of the great honour that was about to be conferred upon them, and instruct them to turn up, without fail, clad in bathing garments, at noon on the following day, by the bridge which spans the canal in the middle of the town.

Tootle, I am sorry to say, cried off, saying that he never bathed in fresh water. I told him that the canal water was distinctly on the stale side, but this left him unmoved. The others, however, were most enthusiastic. They presented themselves punctually at the rendezvous, as did

. . . . A barge arrived in the nick of time . . . .

practically the entire population of the town.

The professor and I put out in a boat, conveying the Floatable Five to mid-stream. Arrived there, the professor gave the word to launch, and we committed it to the waters. It was a pity that the professor should have chosen for flinging out the anchor just the moment when I was engaged in catching a crab. The resulting slight lurch imparted to the boat caused him to go in with the anchor clasped to his bosom.

A Disastrous Ending

Apparently it did not occur to him to let go and, for what seemed like hours, he remained head downwards with only his feet showing above the surface.

"Man overboard!" I yelled. Two simultaneous splashes announced the entry into the water of Captain Buckett and Primpleson bent on heroic rescue work.

The noble fellows had dived off the bridge, not realising that the canal was but four feet deep. There were now three sets of feet visible above the surface, for Captain Buckett and Primpleson were as firmly planted in the mud at the bottom as flowers in a garden border. Luckily a barge arrived in the nick of time, and by means of some strenuous work with boathooks all three were rescued.

In the excitement of the moment the Floatable Five was unfortunately rammed and sunk by the barge, but the professor is undaunted.

TEST YOUR OWN VALVES

by the Editor

A description of an extremely useful instrument.

THERE is no need to have a great knowledge of valves or valve theory in order to "test your own," and it is a great help and, indeed, often an economy to be able to do so. The simple valve tester described in this article has been designed and built in response to a number of requests from readers—many of them living overseas—who sometimes have sent long distances for new valves only to find that the trouble they had attributed to this part of the apparatus was really located elsewhere.

The Filament's Function

Before telling you how to build the tester, I shall ask your indulgence while we discuss a few fundamental points regarding valves and just what we want and expect them to do. We shall then be able to see how to make the best use of the tester, as well as how to use our valves to the best advantage.

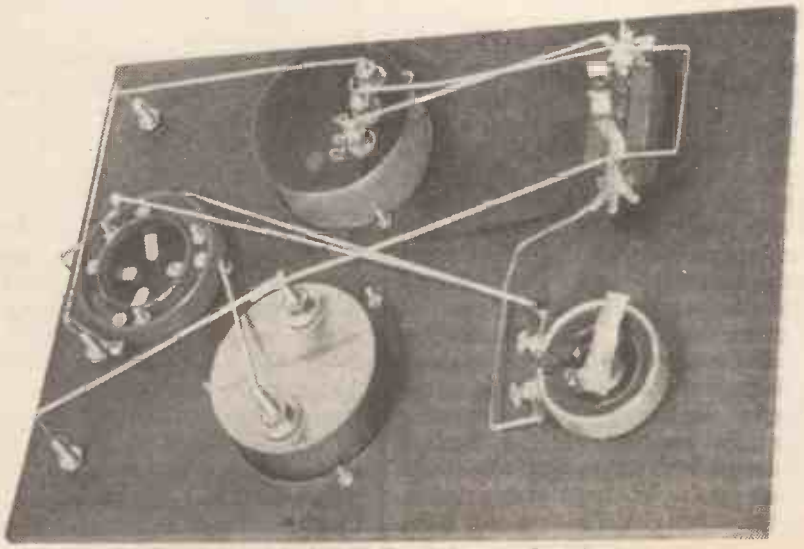
Although it is almost magical in its power to perform wonderful deeds, the valve is really quite a simple device at heart. It has three parts, the functions of which are the same in practically all valves, although the mechanical design may be vastly different. Let us see what they are.

The first is the source of electron supply. It is something which, placed in the highest possible vacuum and heated by an electric current, will send off a uniform spray of electrons into the surrounding space. We call it the filament because it generally consists of a metallic thread, but sometimes it is quite thick or even in the form of a flat metal strip coated with metallic oxide. When it takes this form, the word filament, which really means a thread, is quite incorrect. If you want to understand a valve clearly, bear in mind that what we call the filament is there merely to supply the spray of electrons. It is only for purposes of convenience that we use the electric current to heat it, and, if there were some convenient way of using it, heat derived from a gas flame could be used. It would even be possible to heat it by concentrating the rays of the sun by a magnifying glass upon it. Provided the necessary heat were obtained by some means or other, the electron spray would be produced.

Now this filament, in the early valve, was just a thread of carbon similar to those used in the original electric lamps. It had to be made very hot by an electric current to give even the meagre "emission," or spray of electrons, with which we had to do our work in those days. A little later it was found that a tungsten wire heated to white heat gave much improved results, but the mere fact that it was burnt so brilliantly made the life comparatively short. As the efficiency of a filament can be measured in its power to emit electron spray, and as the spray was quite a poor affair compared with the copious emission of a modern valve, we must rate the old bright emitter valve as inefficient to a high degree.

Improvements in Emission

Later it was discovered that by using certain admixtures of metals a filament could be produced that would give a copious spray of electrons at a much lower temperature. The term "dull emitter" was given to valves using such filaments, and perhaps one day we shall get a filament or source of electron spray



A general view of the under-panel wiring.

Test Your Own Valves—*continued*

(it need not necessarily be a wire) which will operate quite effectively without any heat at all. Modern valves use a tough wire filament of special metal which will give very high emission at a relatively low temperature. The current required to provide the heat to give such emission is only a fraction of that which we had to use in the early days. I have some early valves in my laboratory which require no less than an ampere and a half of filament current! And I have some modern valves which will give a much greater emission using just one-fifteenth of that current!

Where 6-Volters Score

If we have a length of filament through which we want to pass certain current, a certain voltage will be required to pass this current. The filament has, we say, a certain resistance, and we know from Ohm's law that to pass a given current through a given resistance a certain definite voltage is required. The makers when manufacturing valve filaments tell us the voltage to apply to the filament terminals in order to pass the current for which the valve is designed. We have two-, four-, and six-volt valves, which means that, approximately, two, four, or six volts are required in order to pass the current necessary to heat the filament to the required degree. For a given thickness of filament wire, and a given current, the longer the wire the greater the total emission. If the filament is designed to operate most effectively when passing one-tenth of an ampere, a two-volt valve filament will have a certain length, a four-volt valve will have twice that length, and a six-volt valve three times that length. Other things being equal, a four-volt valve will have twice the emission of a two-volt, and a six-volt three times that figure. In order to get high emission on some modern two-volt valves two filaments are placed in parallel and this gives twice the emission of a single filament, but in any case where the highest possible emission is required, such as in super-power valves, six-volt valves always give a better emission than four-volt, and four-volt a better emission than two-volt. In certain valves used for H.F. and detection efficient emission for all practical purposes can be obtained with two- or four-volt filaments, but for the output stage of a loud-speaker set I have yet to find a valve with two- or four-volt filament which will equal those of the six-volt series.

COMPONENTS REQUIRED.

- 1 ebonite panel, 10 in. × 7 in. (Any standard make.)
- 1 convenient cabinet. (That shown was made by Camco.)
- 4 terminals marked respectively: L.T.−, L.T.+, H.T.−, H.T.+. (Belling Lee.)
- 1 valve socket. (Bowyer-Lowe.)
- 1 double-range voltmeter, 6 and 120 volts. (Sifam.)
- 1 milliammeter, 0 to 15 milliamps. (Sifam.)
- 1 variable filament resistance, 30 ohms. (Lissen, "C.E. Precision," "Peerless," Igranic, etc.)
- 1 double-pole double-throw jack switch. (Lotus.)
- Wire for wiring-up.

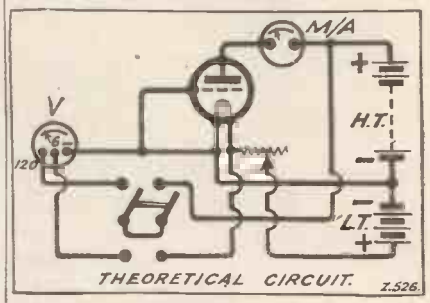
The Filament Voltage

Remember, it is not so much the voltage applied to the valve as the current flowing in the filament which is the determining factor. The valve makers, who have taken great pains to produce good valves, mark on their boxes or on the slips accompanying the valves the correct voltage to apply to the filament in order to obtain the current required. If we apply a higher voltage than that stated by the maker we shall reduce both the life of the valve and its efficiency, and if a lower voltage is used insufficient current will flow and we shall not get the emission for which the valve is designed. A filament resistance, whether fixed or variable, is merely a device to cut down the current flowing in the valve filament when the voltage of the battery is greater than the voltage at which the valve should work.

For Accurate Adjustment

Remember that the valve filament has a certain resistance and when the full accumulator voltage is applied to it, this may pass a greater current than that for which the valve is designed. By adding the extra resistance of the filament resistance, the current flowing through the whole circuit can be adjusted to be correct.

The valve tester contains a variable filament resistance connected in series with the valve filament and the accumulator. It also contains a voltmeter connected across the filament legs of the valve (not across the accumulator terminals). The introduction of the filament resistance has the effect of reducing the voltage applied to the



valve, and if when the valve is placed in the tester socket we turn the knob of the variable resistance, we can adjust the voltage across the valve to exactly that for which it is designed. We are then operating the valve at exactly the voltage specified by the maker.

The second element in the valve is the "grid." The grid design varies tremendously in different types of valves, as does the space separating it from the filament. The exact dimensions and form of the grid are determined by the valve maker when he designs the valve, and nothing you can do when using the valve will alter this. The *way* the grid is used, however, will have a vital effect upon the operation of the valve.

The Electron Stream

The third element in the valve is called the plate or anode. Both the grid and the plate have their separate terminals or pins. If we connect a second battery between the filament of the valve and the plate, so that the plate is the positive terminal and the filament the negative, then the electron spray will pass towards this plate and be, so to speak, absorbed by it. This electron flow is really a current across the vacuous space between the filament and the plate, or anode, of the valve and a current will flow (depending upon the voltage applied and also the emission of the filament) in the circuit formed by the filament, the H.T. battery, the plate, and the vacuous space of the valve. If we maintain the voltage at the same figure we can say that the greater the emission of the valve the greater will be the flow of current. The maker

Test Your Own Valves—*continued*

of the valve tells us the voltage we should apply to the plate of the valve, and therefore, in the tester, a means is provided of measuring this. In order that the current may flow across this space it is only necessary that there should be a filament emitting electrons and a plate with a positive potential on it. We can ignore the grid for the moment. Indeed, valves are made without any grid for the purpose of utilising this electron flow (which, by the way, is in one direction only). Such valves are called "rectifiers," and are used in battery eliminators for converting an ordinary current into uni-directional current.

The Control Grid

Now, returning to the grid—this plays a very important part in the function of the valve. If we insert the grid between the plate and the filament, and do not connect any lead to it, nothing particular happens, unless the grid is so fine that it effectively shields the filament entirely. If, however, we make this grid positive in respect to the filament it will act as if it were a plate and will draw electrons to it. In this way a current will flow from the filament across the vacuous space to the grid and back to the filament. As the grid usually consists of some form of mesh of wires, some electrons will pass through it and reach the plate, but the effect of a grid with a positive potential upon it is to reduce the electrons flowing across the vacuous space to the plate.

As this does not pretend to be an article explaining all the functions of the valve, but only the reasons for the tests we are about to apply, we must leave the subject at this point. It must suffice at the moment to state that if the grid is connected to the negative leg of the valve filament it is at what we call "zero potential." We very rarely work a valve with the grid positive, and indeed in note magnifiers we make it negative by means of a special "grid-bias" battery.

Loss of Emission

There are two main causes of valve failure. The first is obvious and the second by no means so. The first is, of course, fracture or burning out of the valve filament. In the old bright-emitter days, this was a very obvious fault. During operations our valves would all be glowing brightly and then suddenly a valve filament would "go." The particular valve would immediately "go out." The modern valve, however, has a filament which, firstly, shows barely any glow, and secondly, is enclosed within a bulb the inner surface of which is almost entirely covered by silvery coating. We therefore cannot see whether the filament is alight, and very often, particularly in a multi-valve set, the cause of failure may be nothing more than the burning out or the failure of the filament itself. The valve tester will show at once whether the filament is burnt out, as will be explained in a few moments.

The tester in its completed form.

The second cause of failure is much more puzzling. It is called "loss of emission." Some valve filaments are very sensitive to the temperature at which they are run. Run them at the temperature for which they are designed and they will have a long life, but "overrun" them and they may suddenly lose their emission. This means that while the valve filament glows as usual, it ceases to spray off the electrons upon which, as I have already explained, the whole functioning of the valve depends. Again, it may partially lose its emission, and there may not be a strong enough electron stream to enable the signals to be produced without distortion. How can we find whether this is so? Only by measuring the electron flow to find whether it is up to normal.

The valve tester, which I shall now describe, consists simply of a valve socket, a variable filament resistance, a milliammeter to measure the current flowing in the plate circuit (or in other words, the emission for a given set of conditions), a means of measuring the actual filament voltage, and a means of measuring the plate voltage. Every valve-maker supplies either in the box or on application a little chart showing the plate current which will flow with various plate voltages, when the filament is at the correct voltage. This is generally in the form of a graph which plots out as a curve the current which will flow at a given plate voltage with various values of grid voltage. In the present tester the grid is arranged to be always at a zero voltage, so that if you look at your chart all you have to do is to see the plate current flowing at zero voltage, with the particular H.T. voltage.

Mounting the Meters

For convenience the voltmeter is of the double variety, with a switch, so that in one position it measures the filament voltage and in the other the plate voltage. The circuit is shown in the figure, while a practical wiring diagram is also given, together with photographs. The components required are listed separately.

Everything, as you will see, is carried on the one panel. The most difficult task will be to cut the two large holes to take the meters, but this is a fairly simple matter if you mark off the correct size first of all on the ebonite and cut them out with a fretsaw. If you have not such a saw handy, drill a series of holes round the circumference of the circle, knock out the disc, and then file the hole reasonably smooth. So long as the meter will pass through the hole, and the hole is not so big that you cannot drill holes for the securing screws in the ebonite, the actual finish of the hole need not be very smooth, as the flange of the instrument will cover it.

The Switch Wiring

The Bowyer-Lowe Antipong valve holder is easily mounted so that the sockets themselves project through the panel. A template is given with the holder which explains exactly how to mount it. The Lotus D.P.D.T.

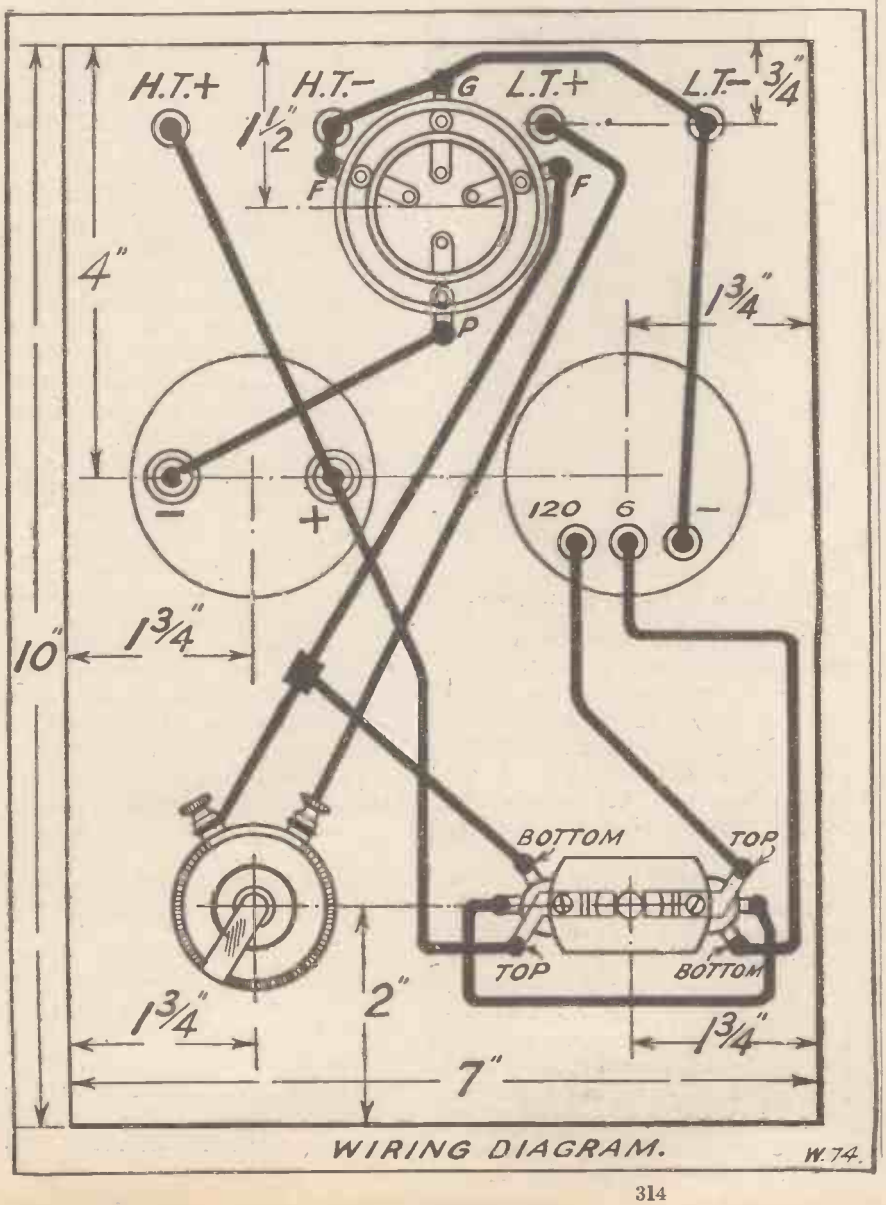
Test Your Own Valves—*continued*

switch is of the single-hole-mounting variety, as is the filament resistance. The only precautions to take in wiring up are to see that these wires are clear of one another and to see that you solder the wires to the correct lugs of the push-pull double-pole double-throw switch.

How to Test Valves

The method of using the instrument is as follows. Connect up your accumulator to the L.T. terminals and set the jack switch at the out position (pulled out from the panel). Do not yet connect up the H.T. battery. Put the filament resistance at the "off" position. Now insert your valve to be tested in the socket and gradually turn the filament resistance towards the "on" position. As you do so you will find the voltage reading on the voltmeter gradually increase until you reach the voltage specified by the maker for this valve. Notice the exact position on the filament resistance for this particular voltage, so that you can return to the setting again quite conveniently. Now turn your valve off.

Next connect up your H.T. battery and push the D.P.D.T. switch in. This automatically switches the voltmeter on to the high-reading scale.



You will now see the actual voltage of your H.T. battery. By altering the plugs, adjust the voltage until it is exactly one of those noted by the maker on his chart. For example, you may have curves for 40, 60, 80, and 100 volts. Pick the voltage nearest that at which you generally work the valve, say 80 for example, and adjust the correct voltage on the meter by varying the H.T. plug. Now turn your filament resistance slowly "on" until you come to the point which you have previously found to give the correct filament voltage. The needle of the milliammeter will now creep up and will give you the milliamps the valve is passing. This figure should be approximately that specified by the maker.

Checking the Figures

There are, of course, slight differences between individual valves in manufacture, and the figures the maker gives are a general average. Sometimes the figure may be slightly more and at others it may be slightly less, but if it is very near to the maker's figure it should be quite satisfactory. If the valve is a power valve, then the current taken from the H.T. battery may bring the voltage down a little. You must watch the H.T. voltage to see whether this is so or not. If there is a drop below the figure to which the battery had previously been set, readjust your plugs so that when the current is flowing the voltage is that which you aim to have. Leaving all other adjustments as they are, recheck your filament voltage by pulling out the jack switch. If there is a slight change readjust your filament resistance.

H.T. and L.T. Voltages

If you get no reading whatever on the milliammeter one of two things has happened. Either the valve has lost its emission or the filament has gone. If the latter is the trouble the voltmeter will give the full voltage reading of your *accumulator* so long as the filament resistance is at any on position, and variations of this filament resistance will not make the slightest difference to this reading. If the filament is intact any variation of the filament resistance will vary the reading of the voltmeter.

It is not intended that this instrument should be used for plotting valve

HOW GEORGE DID IT

The Story of a Damaged Accumulator.

CORROSION was the cause of it, and carelessness had been the cause of the corrosion, but when one of the terminals of my accumulator broke off short I forgot my own shortcomings and invented quite a lot of new names for that battery. Nothing for it but to fix up a new terminal. This, however, was a lot easier said than done!

With a small hand brace and a $\frac{5}{32}$ in. drill I attempted to drill out the broken stump of 2 B.A. rod that had originally been the shank of the terminal, and which was now flush with the top of the lead lug. The drill, however, persisted in running off the comparatively hard brass into the soft lead, no matter how careful I was, and after an hour's sweating work I gave in, and decided to call up George for his opinion. What George doesn't know about fitter's work isn't worth knowing.

George Grunts

He came round the following evening, and after explaining to him what I had attempted to do, I gave him the battery. He examined my handiwork and grunted.

"Got a file?" he asked. With this he filed the top of the lead lug nearly flush with the rubber collar, obliterating my miniature "no-man's-land." Then he centre-popped the middle of the 2 B.A. rod and drilled a $\frac{1}{16}$ in. hole $\frac{3}{8}$ in. deep in it. The $\frac{1}{16}$ in. drill he replaced with a $\frac{5}{32}$ in., and enlarged the hole to this diameter, and finally with the $\frac{5}{32}$ in. drill, with which I had made my vain efforts to clear away the stump, George neatly drilled away the last of the brass.

Bad? Yes. But are yours all clean? Have a look to-night!

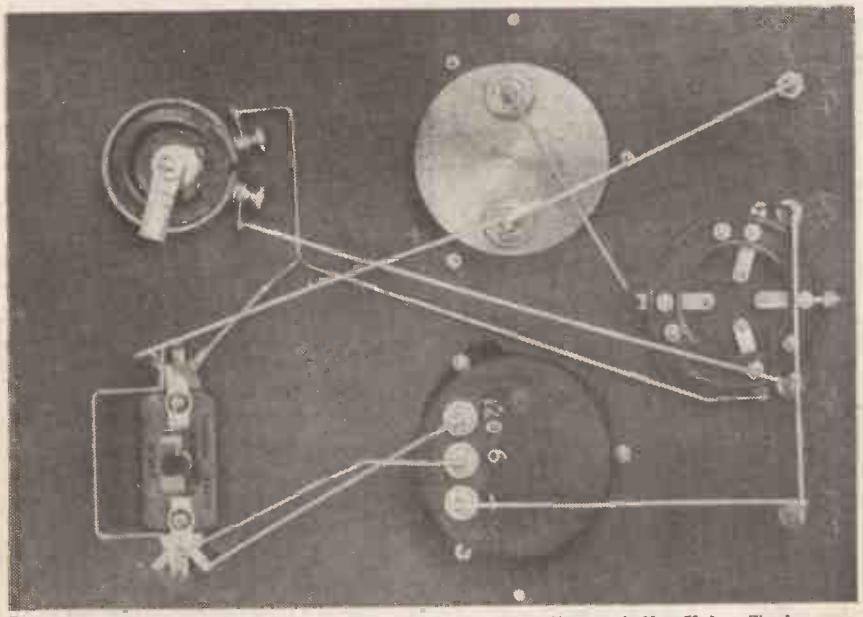
"Quite easy," he said, "if you only drill a 'leading' hole first. Now I want a couple of inches of 2 B.A. rod, two nuts, and some flux."

First locking the two nuts on to the rod in order to get a grip on it without damaging the threads, George proceeded to screw it straight into the hole he had drilled, having first well smeared it over with flux. The hard brass, apparently, cut its own thread in the soft lead as it went in.

George smiled, and said: "Now we've come to the dangerous part of the job. Watch how I do it!"

He cut a piece of three-ply wood about two inches longer on each side than the full size of the battery top, drilled a $\frac{1}{4}$ in. hole near one corner, took out the three vents from the accumulator, then slipped the shank of the new terminal through the hole in the wood, completely screening the whole battery except for about half an inch of the brass rod.

In a few minutes I saw the use of this screen, for George proceeded to heat the tip of the terminal red-hot with the blow-lamp, and, considering that there was a celluloid battery beneath the wooden screen, I no longer marvelled at his precautionary move. The heat naturally travelled down the terminal shank, which in less than a minute had sweated itself firmly into the battery lug. George allowed it to get cool, wiped off the surplus flux with a rag, slipped the indicating disc over the terminal, fastened it down with a lock-nut, put on the nut, and the job was done.



The double-pole, jack-type switch and the connections of the Valve Tester can clearly be seen in this illustration.

TEST YOUR OWN VALVES

—continued

characteristics, as the greatest simplicity has been aimed at. If your valve has its normal emission at zero grid voltage it will in practically all cases work satisfactorily.

A Final Word of Warning

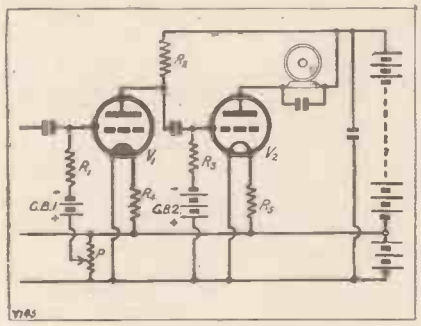
After you have wired up the set, and before you connect any batteries, examine the push-pull switch carefully to see that the blades are out of contact with one set *before* they make contact with the other. The switch will normally be like this, but if it has been dropped or otherwise slightly damaged it may be that contact is made with one set of blades before the others are released. Correct this, or you may do some damage to your voltmeter.

GRID-BIASING HIGH "MU" VALVES

From a Correspondent.

For satisfactory operation it is essential that all L.F. valves should have the correct negative grid potentials applied to them, and, though they do not need such large voltages, high-magnification valves are not exceptions to this rule.

WHEN high-magnification valves, specially designed for resistance-capacity coupling, are used as first-stage amplifiers on the note-magnifying side of the receiving set a little difficulty arises about the matter of proper grid bias. An examination of the characteristic curves of such valves will show that the useful straight portion is in many cases extremely short, the maximum amount of negative grid bias permissible being often as little as one volt



or even rather less where a very high anode voltage is not used. In actual working the straight portion of the characteristic curve may be a little longer than that which appears in the static curve, but the fact remains that the grid bias required is usually quite small. Now, for perfect working grid bias is essential with any valve doing duty as an L.F. amplifier. There are certain types of valves in which grid current does not start to flow until the grid is made slightly positive. Good results may be obtained with these without grid bias so long as the grid swings are tiny; but where H.F. amplification is used before the rectifier, or when a near-by station is being received, the grid swings of the first note-magnifier are nearly always so big that distortionless reproduction cannot be obtained with any kind of valve unless its grid is given a proper negative bias.

Minute Variations

The trouble is that no dry-cell grid battery allows steps of less than 1½ volts to be obtained, whilst with an accumulator grid battery we have nothing smaller than 2-volt steps. A handy method of getting over the difficulty and of giving first-stage resistance-coupled note-magnifiers of the high μ class exactly the grid bias that best suits them is shown in the accompanying diagram, which includes only the note-magnifying valves of a resistance-coupled receiving set. Of these, V_1 is a high μ valve and V_2 the power or super-power valve necessary for working a loud speaker. The first grid battery consists of a pocket flashlamp refill or refills. With 4- and 6-volt accumulators a 3-volt refill can be used. With a 2-volt accumulator either a refill of the same size or a single cell is employed; if the grid bias required exceeds 1½ volts a two-cell refill is necessary, but if it is less than this a single cell must be used. The lower end of R_1 is connected to the negative end of G.B.1, the positive end of the battery being taken to the slider of the potentiometer P. It will be seen that when the slider is at the negative end of its travel the accumulator and G.B.1. are in series, the grid bias of V_1—remember that the grid bias is always calculated with respect to the negative leg of the filament—being equal to the voltage of the grid battery. When, however, the slider is moved right over to the positive end the two batteries are in opposition, and the grid bias is the difference between their E.M.F.'s.

Thus, with a 6-volt accumulator and a 3-volt grid battery, the grid bias with the potentiometer at the positive end of its travel is—3+6 or 3 volts positive, and as the slider is moved any biasing voltage between this and 3 volts negative can be obtained and minute adjustments of the grid potential are possible.

Potentiometer Reading	L.T.B.6v	L.T.B.4v	L.T.B. 2v	
	G.B. 3v	G.B. 3v	G.B. 3v	G.B. 1·5v
0	−3·0	−3·0	−3·0	−1·5
1	−2·4	−2·6	−2·8	−1·3
2	−1·8	−2·2	−2·6	−1·1
3	−1·2	−1·8	−2·4	−0·9
4	−0·6	−1·4	−2·2	−0·7
5	±0·0	−1·0	−2·0	−0·5
6	+0·6	−0·6	−1·8	−0·3
7	+1·2	−0·2	−1·6	−0·1
8	+1·8	+0·2	−1·4	+0·1
9	+2·4	+0·6	−1·2	+0·3
10	+3·0	+1·0	−1·0	+0·5

The potentiometer scale should be divided into 10 equal sections. (See table.)

Stability Without Neutralising

Details of an interesting device.
By HARRY P. WOOTTON.

BEFORE high-frequency transformers were really efficient, and when we but dimly understood the causes of the various losses in wireless circuits, two- and even three-stage high-frequency amplifiers were built up and operated without special precautions to obtain stability. Every tuned high-frequency amplifier has a tendency to oscillate, and if the energy fed back into the grid circuit from the plate circuit exceeds the amount that is being lost in the grid circuit, then the set will oscillate at once. If the design of the high-frequency transformer is so poor, or other components are so inferior, that high losses are set up it is quite easily possible that this feed-back is not sufficient to create oscillation.

Fitted in a Few Minutes

On the other hand, if we choose our components carefully, use a good layout and a really well-designed high-frequency transformer, the losses are far less than the energy fed back, so that if we want to avoid oscillation we must take special precautions. For the last year or two the neutralising method has largely occupied our attention, and by balancing out the feed-back potentials by equal and opposite potentials we have got rid of most of our trouble without serious loss. At the same time the neutralising methods have their own disadvantages, and the correct neutralisation of a receiver requires more skill and experience than many amateurs possess. Consequently, inventors have been continually experimenting to see if other stabilising means can be found. The little device called the "Phasatrol" which is the subject of this short article, has been largely sold to home constructors in America during the last six months or more. As it appeared to be very simple to fix and operate, and as, moreover, it takes but a few minutes to introduce it into any existing receiver, it was decided to obtain specimens for test in the WIRELESS CONSTRUCTOR laboratory. These tests have now been completed, and the results are available for WIRELESS CONSTRUCTOR readers.

Circuit Connections

"The Phasatrol" itself consists of a small insulated casing, with three projecting soldering lugs and a central recess in which can be seen an ordinary slotted screw-head. The casing encloses a fixed condenser (connected between two of the lugs) and a variable high resistance, the value of which can be varied by turning the screw-head. The actual connections are shown in the accompanying figure.

One Phasatrol is used for each stage of high-frequency amplification. If an ordinary high-frequency circuit without any stabilising device be rigged up, the Phasatrol can be

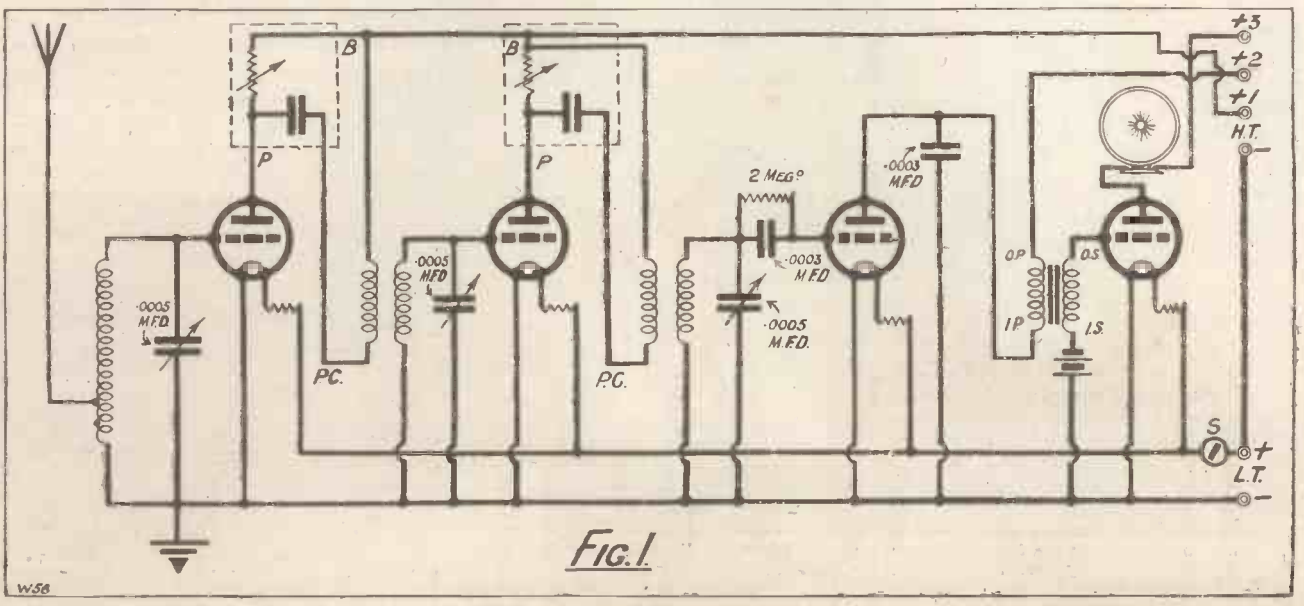


FIG. 1

Stability Without Neutralising—*continued*

tested quite easily. Let us imagine we have a circuit, consisting of the ordinary tuned grid coupled to the aerial in some conventional manner, with the primary of a high-frequency transformer in the plate circuit. The secondary of this transformer is connected in the conventional manner to the grid of the next valve which, in its plate circuit, carries again the primary of another high-frequency transformer. This second transformer is connected as before to the grid of the next valve, and as this is a detector a grid leak and condenser are inserted for rectification purpoess.

Alternative H.F. Paths

Now every experimenter knows that such an arrangement will oscillate violently unless the coupling in the high-frequency transformers is so weak as to make the set very inefficient. The Phasatrol provides stability in such a receiver, and is fitted by simply cutting the lead going from the plate of each valve to the primary of the high-frequency transformer and connecting the Phasatrol there. (The terminal on the Phasatrol connected to the plate of the valve is joined to both one side of the fixed condenser and one end of the variable resistance. The other end of this latter is joined directly to the H.T. positive lead of the high-frequency transformer.)

We thus have an arrangement in which the high-frequency pulsations from the plate can pass through the fixed condenser (which is of a relatively high value) and through the high resistance. The direct current from the plate supply, however, has but one path—through the high resistance, the value of which is apparently about 3,500 ohms maximum. The capacity of the fixed condenser appears to be about ·006 mfd.

The operation of the device is as follows: First of all, the screw-head is turned in a clockwise direction as far as it will go without using force, and the circuits tuned to any available signal.

In these circumstances the set will oscillate violently. With the aid of a screwdriver the screw-head is turned in an anti-clockwise direction and a further trial made. The set will now be found to oscillate less readily. Further adjustments are now carefully made till a point is found when the set just ceases to oscillate. Where two stages of high frequency are used and two Phasatrols are in action, these adjustments are made simultaneously on each, and it is a very simple matter to obtain stability. However, our tests showed that, as would be expected, such a receiver is more sensitive on the lower wave-band than on the upper, as the Phasatrol allows a controllable amount of reaction in each circuit. For example, when the set was stabilised at the upper end of the condenser scale, giving excellent sensitivity, turning to the lower end of the scale brought about self-oscillation. The amount of reaction permissible on the upper range is too great for the lower. When stability was once obtained by adjustment on the lower end one naturally lost sensitivity on the upper, although it must be stated

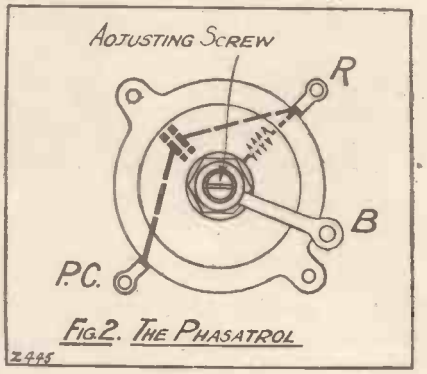


FIG. 2. THE PHASATROL

that a good general position could be found at which the set remained quite reasonably sensitive over the whole scale from about 250 to 600 metres.

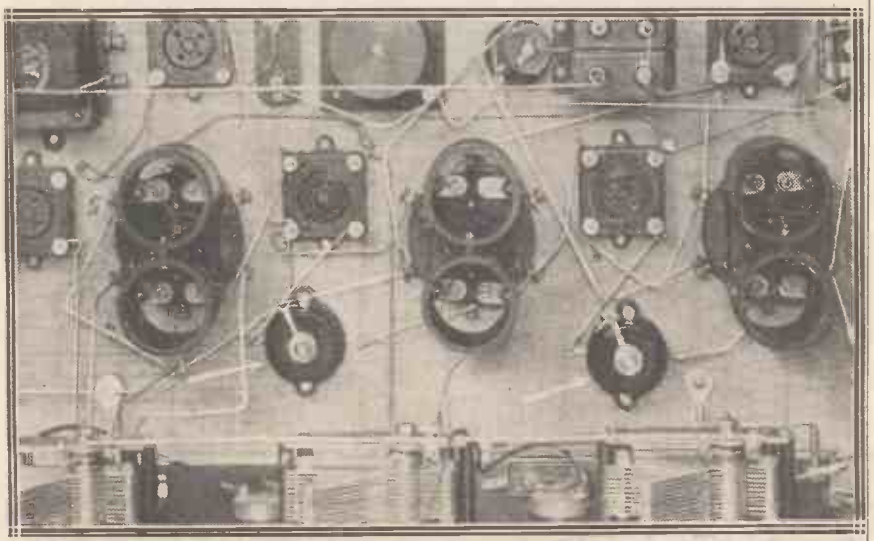
Effect of the Resistance

The actual manner in which this device functions theoretically is debatable. In one way it seems related to the kind of device used by Messrs. Loftin and White in their constant coupling circuits, and the condenser would appear to put the feed-back currents out of phase with the grid currents in the previous valve. At the same time we must consider the presence of the high resistance which forms an alternative path for the high-frequency oscillations. It might be thought that as this high resistance is in series with the plate it would reduce the plate voltage, and thus be a kind of plate "losser" device, but it must be remembered that the value of the resistance is not very high and is only about a half of the A.C. resistance of the American valves with which it is designed to work, so that the plate voltage would not be very greatly reduced in this way.

Valves for Best Results

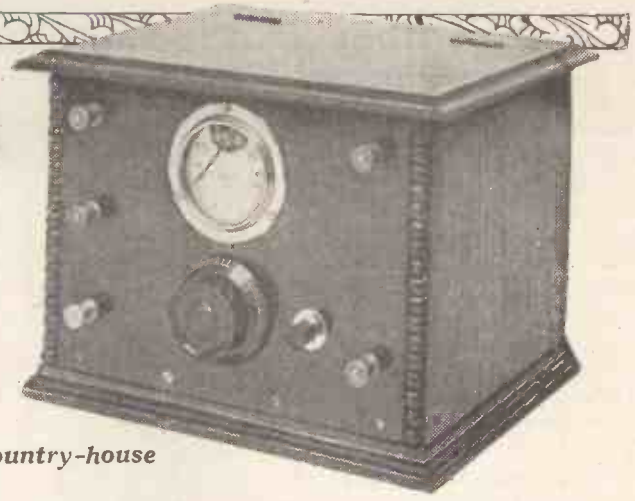
There is no question, however, that the device works best with valves of round about 8,000 to 10,000 ohms impedance, although we have worked it quite successfully with valves of up to 20,000 ohms impedance.

The photograph shows the set in which the WIRELESS CONSTRUCTOR tests were carried out. It consists of a five-valve receiver with three binocular coils, the circuit being that already referred to.


A multi-valver made up by the author. Two "Phasatrol" units were employed, together with binocular H.F. transformers.

Radio from House-Lighting Accumulators

by A.V.D.Hort B.Sc..



Constructional details of an H.T. unit for use with country-house electrical supply.

THE country districts of the United Kingdom will before many years have passed, it is to be hoped, be served by generating stations with electricity for lighting and power supplies. At present, however, it is the exception rather than the rule to find a public electricity supply service in the smaller towns and villages of this country.

The convenience of electricity for many purposes is so generally recognised nowadays that the owners of houses in the country, where there is no access to a public supply, have found it worth their while to equip their property with its own private lighting plant.

COMPONENTS REQUIRED.

- 1 "Ebonart" panel, 8 in. × 6 in. ¼ × in., or similar high-grade brand.
- 1 cabinet for above, with loose base-board, 7 in. deep (Artcraft).
- 1 potentiometer (McMichael).
- 1 moving-coil voltmeter, 0–10, 0–15, or 0–30 (Sifam).
- 1 on-and-off switch, panel mounting (Lissen, Igranic, Rothermel, etc.).
- 1 fixed condenser, Mansbridge type, 4 mfd. (or two 2-mfd.) (T.C.C., Lissen, Dubilier).
- 5 terminals.
- 1 electric-lamp standard-pattern batten holder.
- Strip of ⅜-in. ebonite, 17 in. long, by 1½ in. wide (or other dimensions to suit resistance required for potentiometer).
- About 10 in. of 2 B.A. studding, with nuts, 6 B.A. bolts, and soldering tags, wire for connections, wood-screws, etc.
- Eureka resistance wire, length and gauge as required.

Accumulator Supply

The apparatus installed most commonly consists of a bank of accumulators charged periodically by means of an internal combustion engine and dynamo. Current is supplied by the accumulators at a pressure of 25, 50, or 100 volts.

It will readily be appreciated that a 50- or 100-volt supply of this kind is practically ideal for running a wireless receiver. A 25-volt supply

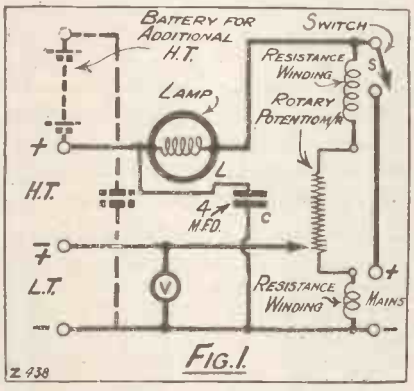


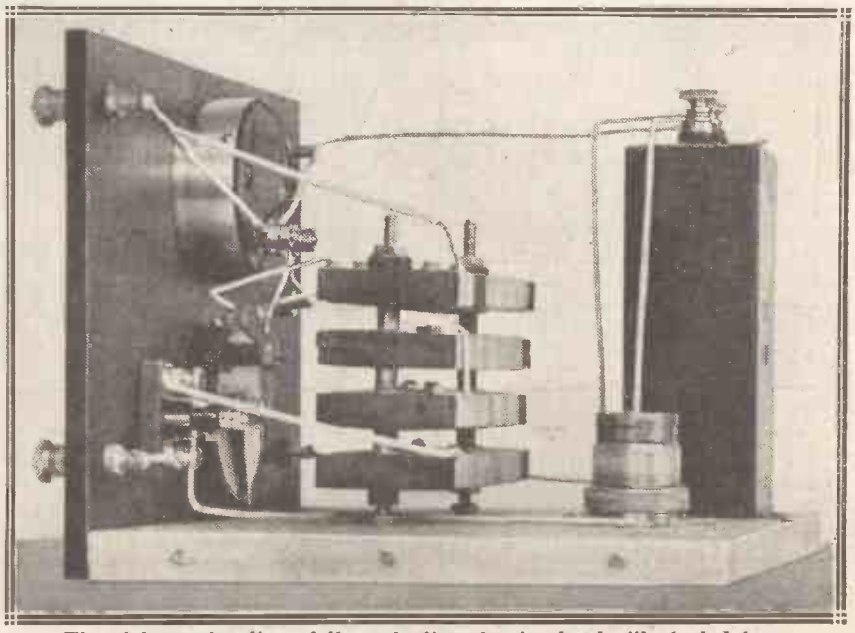
FIG. 1.

may quite well be used for filament heating, and as part of the H.T. battery, though it is hardly worth while with this low voltage to worry about using it for H.T. The 50- and 100-volt supplies, on the other hand, are admirable for both filament heating and H.T. supply, additional batteries being needed in the former case in order to obtain a high enough voltage for the last valves of the receiver.

Easily Modified

The unit described in these pages is designed for use on a 50-volt supply. With slight modifications it is suitable for 100 volts. An attractive feature of the unit is its simplicity, since it is unnecessary to make much provision for smoothing the supply. As will be pointed out later, the receiver should not be used while the charging plant is running, so that there are no fluctuations, such as those caused by the dynamo commutator on a public supply, to be smoothed out.

The circuit of the unit is given in Fig. 1, and from this it will be seen



The slab construction of the potentiometer is clearly illustrated here.

Radio from House-Lighting Accumulators—*continued*

that the potentiometer method of obtaining the correct voltage for the filaments is used. A voltage of 2, 4, or 6 volts, as required by the valves chosen, is tapped off on the resistance wire of the potentiometer, the end of the potentiometer closest to this tapping being connected to the negative of the supply. A voltmeter across the L.T. terminals of the unit gives accurate information for the correct adjustment of the filaments.

Theoretical Considerations

The other end of the potentiometer is connected to the positive of the mains. In the 50-volt unit a further connection goes from this point to the anode of the detector valve, and must also be connected to the negative terminal of the additional H.T. battery for the subsequent valves. If the unit is to be used on a 100-volt supply, suitable voltage tappings for the valves in use may be taken off on the potentiometer between the filament tapping and the positive end.

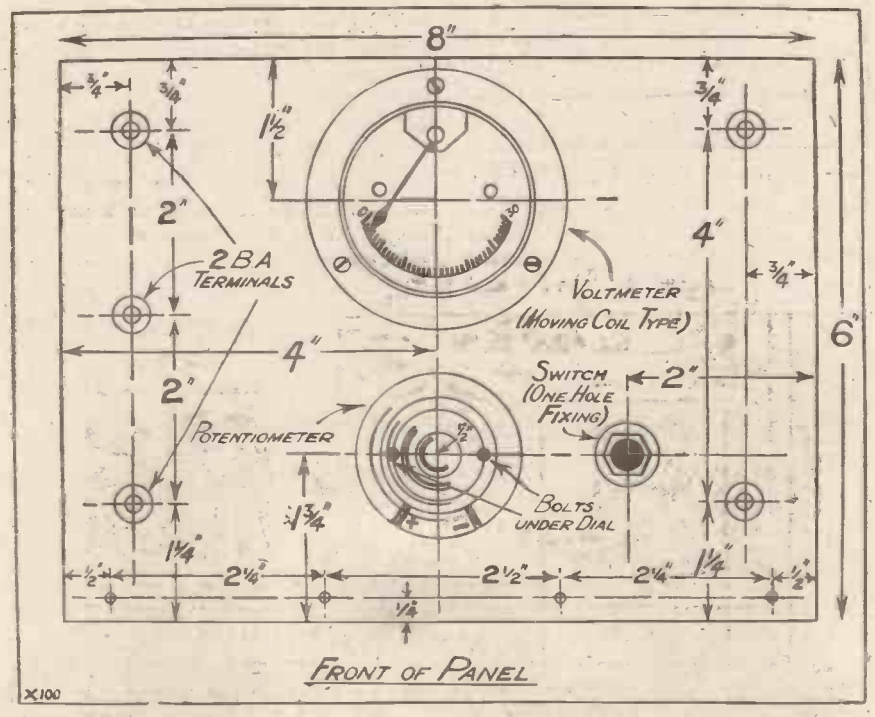
produce unwanted coupling effects, owing to the fact that it is included in the anode circuits of the valves. Between the positive end of the potentiometer and the H.T. positive terminal of the receiver is inserted a lamp. The purpose of this is merely to act as a safeguard against accidental short-circuiting of the mains from contact between the H.T. positive and the L.T. terminals.

In the event of such a contact, this lamp will limit the amount of current which can pass.

A 5-watt lamp should be placed in the holder. Then even if the H.T. positive lead touches the L.T. positive lead, no harm will result to the valves, provided that their total filament consumption is not below 0·1 ampere.

Current	Eureka	Actual capacity	Res. of winding	Res. per yd.	Length reqd.	Tapping from neg. end. Valves. 2-volt.	4-volt.	6-volt.
Amps.	S.W.G.	Amps.	Ohms.	Ohms.	Yds.	Yds.	Yds.	Yds.
0·1	32	0·15	500	7·35	68	3	5·5	8
0·2	28	0·25	250	3·91	64	2·5	5	7·5
0·3	26	0·5	167	2·65	63	2·5	5	7·5
0·4	26	0·5	125	2·63	47	1·75	3·75	5·5
0·5	24	1·0	100	1·77	57	2·25	4·5	6·75
0·6	24	1·0	84	1·77	47	1·75	3·75	5·5
0·7	24	1·0	71	1·77	40	1·5	3	4·75
0·8	24	1·0	63	1·77	36	1·5	2·75	4·25
0·9	22	1·5	56	1·10	51	2	4·5	7
1·0	22	1·5	50	1·10	45	1·75	3·5	5·5

The tapping-point is given to the nearest 0·25 yd.



Coming now to the practical details of the construction of the unit, it will be seen that this is built in compact form in a cabinet with a vertical panel. The filament voltmeter appears on this panel, the on-and-off switch, and also the knob of the potentiometer controlling the filament supply. It is inadvisable to fit a 6-volt meter, especially if 6-volt valves are to be used, since it will be only too easy to damage the voltmeter by applying too high a voltage when first switching on. The meter incorporated in the unit shown reads from 0 to 30 volts. It is of the moving-coil type, so that accurate readings at the lower end of the scale are obtained. A meter reading up to 10 or 15 volts would be quite satisfactory.

Commencing Construction.

The first operation is to mark out the panel in accordance with the figure. The hole for the voltmeter may be cut out either with a special cutting tool held in the drill brace, or by drilling a series of holes round the circumference of the scribed circle, breaking out the centre, and smoothing the edges of the hole with a half-round file.

In the construction of the potentiometer itself a "slab" system of winding has been employed.

The advantage of this system is its flexibility, the potentiometer winding being made up of a number of sections, the actual number used in any instrument depending on the gauge of the

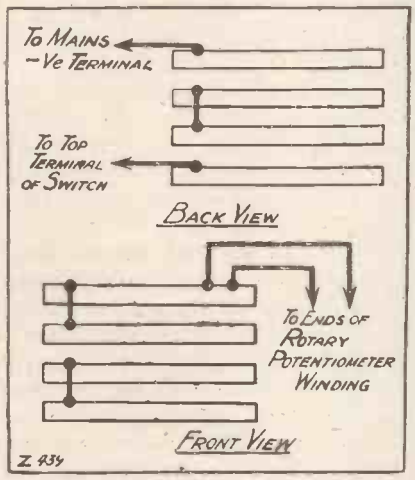
No additional batteries are then needed, unless a voltage in excess of 100 is required.

The inclusion of the 4-mfd. shunting condenser across the potentiometer is most important. If this component is omitted, the winding of the potentiometer is almost certain to

Radio from House-Lighting Accumulators—*continued*

wire and the ohmic resistance required. In addition to the slabs, a few yards of the wire are wound on a rotary potentiometer. This variable portion of the winding is placed in circuit at the correct point, and provides the necessary means of adjusting the filaments of the valves, allowing variations of a few volts on either side of the optimum setting.

Before winding the potentiometer we must decide what current we are going to require, and the voltage



rating of the valves to be employed. The accompanying table gives the necessary details for the winding, these figures being worked out for a 50-volt supply. Let us take one example, the figures used for the unit described. Suppose that we are going to use three valves, each rated at 0·1 ampere at 6 volts. We shall need rather more than the 0·3 amperes taken by the valve filaments, for the operation of the voltmeter and for the anode current. Looking, therefore, at the 0·4 ampere line in the table, we find that 47 yards of No. 26 S.W.G. Eureka wire will be needed.

The Tapping-Point

The actual tapping-point for the filaments will be located at about 5·5 yards from the negative end of the potentiometer, so that we must allow a certain amount of wire on each side of this point to obtain the requisite variation of resistance for the final adjustment of the voltage required. The main portion of the winding must therefore consist of 39 yards of the wire; 4 or 5 yards will be put on the rotary section, and the remainder will form a separate section of the main winding.

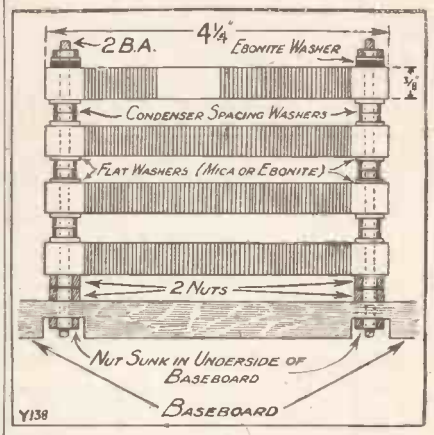
The rotary potentiometer should be dealt with first. For this a standard McMichael potentiometer is used. The two screws holding the fibre strip are removed, the strip is taken off, and the fine wire is unwound or cut off.

Winding the Potentiometer

The new winding, of No. 26 S.W.G. wire, is then put on as tightly and neatly as possible, and the strip is replaced in position. If bare Eureka wire is used, give it a good coat of enamel to prevent contact between the turns, and subsequently scrape off the enamel round the edge of the strip, for contact with the rotary arm.

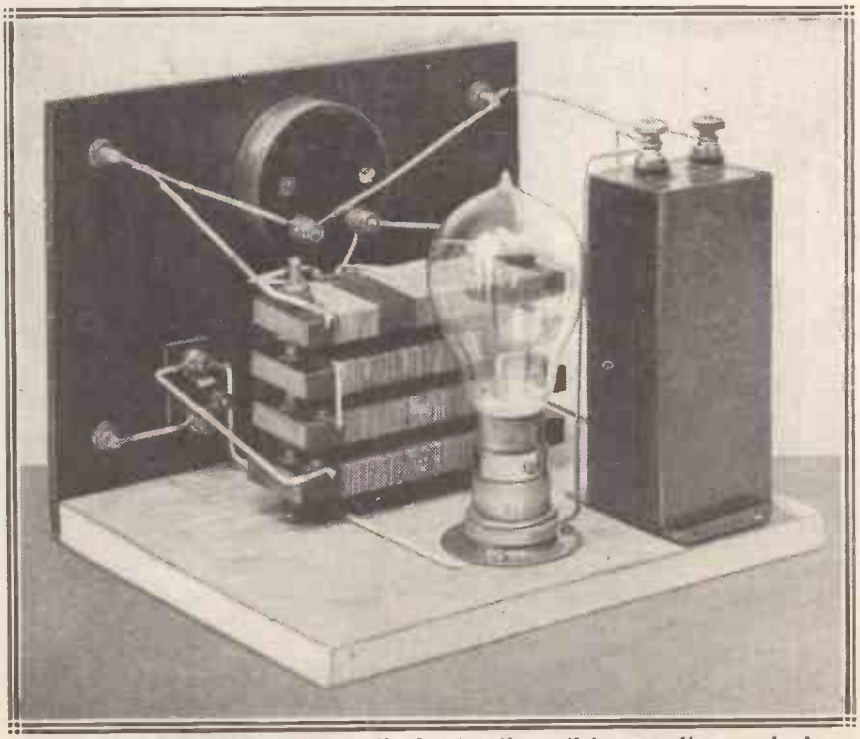
For the main winding strips of $\frac{3}{8}$-in. ebonite are employed, cut to the dimensions given. Alternatively, strips of $\frac{3}{16}$-in. ebonite may be clamped together in pairs, the winding afterwards keeping them together. Holes for 6 B.A. bolts are drilled and tapped near the ends of the strips, to hold the soldering tags for subsequent interconnection of the strips.

The resistance wire is wound tightly on each strip, turns not quite touching. If any difficulty is experienced in spacing the turns, a stout thread should be run on parallel with the wire and stripped off when the winding is completed. The whole of the winding is then given a coat of enamel, to prevent contact between the turns.



This precaution may, of course, be dispensed with if the wire is obtained ready enamelled or otherwise insulated.

Winding in this way, the 39 yards of wire will fill three strips and about 2½ in. of the fourth, a bolt and soldering tag being placed at the finishing point. A gap of ¼ in. or so is left, and the remainder of the wire is wound on up to the end of the strip. If the wire has not been wound closely enough it may happen that it will not fit into the four strips.



Another view of the back of the unit, showing the switch connections, and a lamp inserted in the holder.

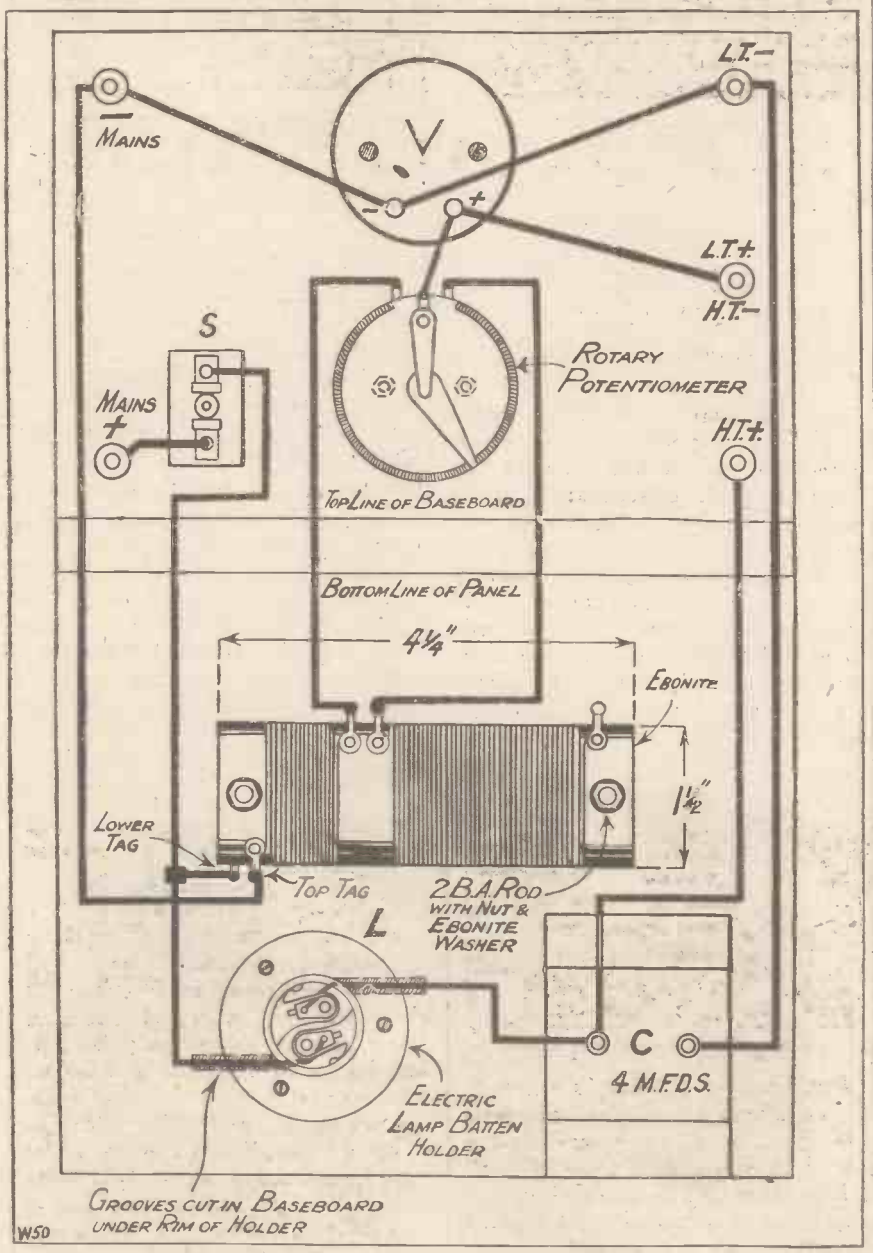
Radio from House-Lighting Accumulators—*continued*

In this case a fifth will be needed, constructed in the same way as the others.

The completed strips are mounted on two 2 B.A. rods, themselves secured with nuts to the baseboard. In assembling the strips on the rods, arrange them so that the soldering tags at the "gap" in the winding face towards the panel, in order to keep the leads to the rotary potentiometer short. The strips are connected together in series, short connecting wires being soldered to the tags. The wiring of the unit is straightforward and should present no difficulties.

To test the unit, place the 5-watt lamp in the holder, see that the switch is open, connect the terminals on the left side (looking from the front) to the set, and those on the right side to the mains. Do not put any valves in the set. Now momentarily close the switch. If the voltmeter needle moves the correct way and gives a reading, the mains are correctly connected. If, on the other hand, the needle tries to move the wrong way, against the end stop, the leads from the mains must be reversed.

When the mains are right, close the switch, and adjust the rotary potentiometer till the lowest possible reading is obtained. If this is little higher than the rated voltage of the valves it is of no importance, since the only load on the circuit is that imposed by the voltmeter, which takes a very small current. Open the switch, insert the valves in their holders, and close the switch again. The voltage recorded on the meter will now be found to be much below that required, somewhere about 1 or 2 volts. Slowly turn the knob of the potentiometer till the correct voltage is shown.



"End Cells"

In order to compensate for the drop in voltage between charges of the accumulators used for house lighting installations, "end cells" are usually provided. Immediately after charging, the ordinary group of 25 cells supplies the necessary voltage, but towards the end of the discharge period it is sometimes necessary to bring into use one or more of the spare cells. The effect of this on the set will be that a slight fall in the valve voltage will occur, rising perhaps slightly above the normal when the end cells are brought into circuit.

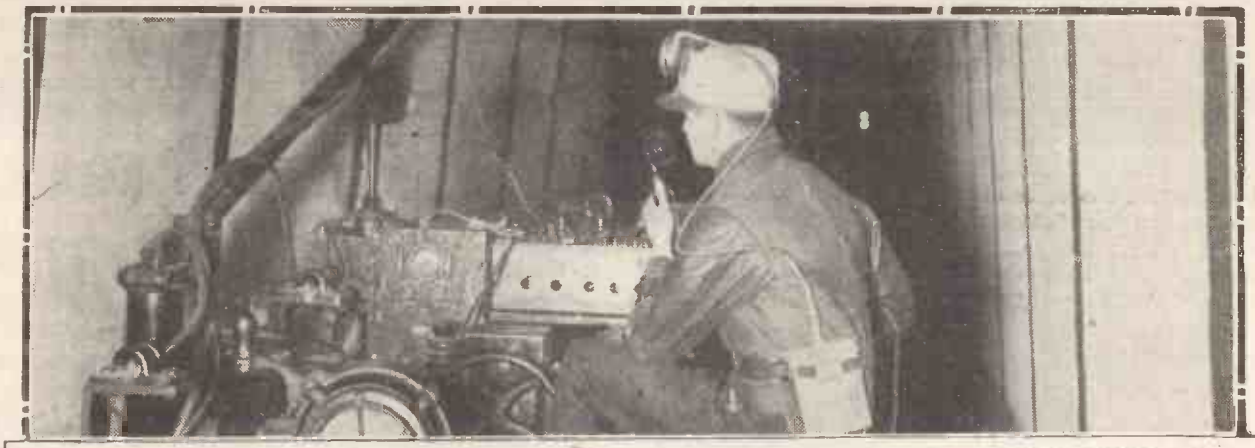
It is advisable, therefore, to set the potentiometer so that a voltage slightly below the full rating is provided, in order to avoid overrunning the valves when the end cells are brought in. Occasional readjustment may be needed as the supply voltage falls off.

When the charging dynamo is running the set should not be used, since the voltage at the supply terminals will be somewhat above the normal. In addition to this, the fixed condenser in the unit will be quite inadequate to eliminate the hum produced by the commutator.

Extra H.T.

The method of connecting extra H.T. batteries, in order to obtain a voltage above 50, will be clear from the circuit diagram, Fig. 1. Note also that an additional fixed condenser will be required in this case, connected between the common negative terminal and H.T. plus 2.

[EDITOR'S NOTE.—As one side of the mains supply is sometimes "earthed," a 1- or 2-microfarad Mansbridge-type condenser should always be inserted between the earth terminal of the set and the actual earth wire, when using this unit.]



A THERMIONIC WIZARD

The Story of the Wireless Valve as "Jack of All Trades."

By SEXTON O'CONNOR.

THE thermionic valve has been aptly christened the Aladdin's lamp of modern science. Possibly the term was originally devised to indicate the almost magic nature of the electron stream flowing inside the bulb. Whether this be so or not, recent developments have given the term an even truer and wider significance. Day by day the valve is demonstrating its marvellous qualities in an ever-increasing field of specialised application.

In the first place, the valve is admittedly the most delicate and sensitive relay at present known. Its pre-eminence in this respect is due to the fact that the "working principle"—the electron stream—possesses no appreciable inertia, and therefore responds freely and instantaneously to the slightest applied impulse, without lag or any perceptible loss of energy.

In Medical Science

In the second place, it is also unique as a generator of high-frequency oscillations. There is no other source of high-frequency energy so dependable in output or so elastic in operation. It is equally steady and reliable when handling the 20 watts of a small transmitting set as when generating the thousands of watts radiated from the huge Rugby station.

Possessing these remarkable qualities it is only to be expected that inventors should seize upon the valve and develop its potentialities in a variety of fields extending far outside that of wireless for which it was originally devised.

Medicine is one instance in point. The virtues of electricity have long been recognised by medical science, both as a curative agent and as a means for alleviating pain.

In particular, the use of high-frequency currents—a specialised branch of therapeutics known as diathermy—is at present rapidly growing in favour amongst medical practitioners.

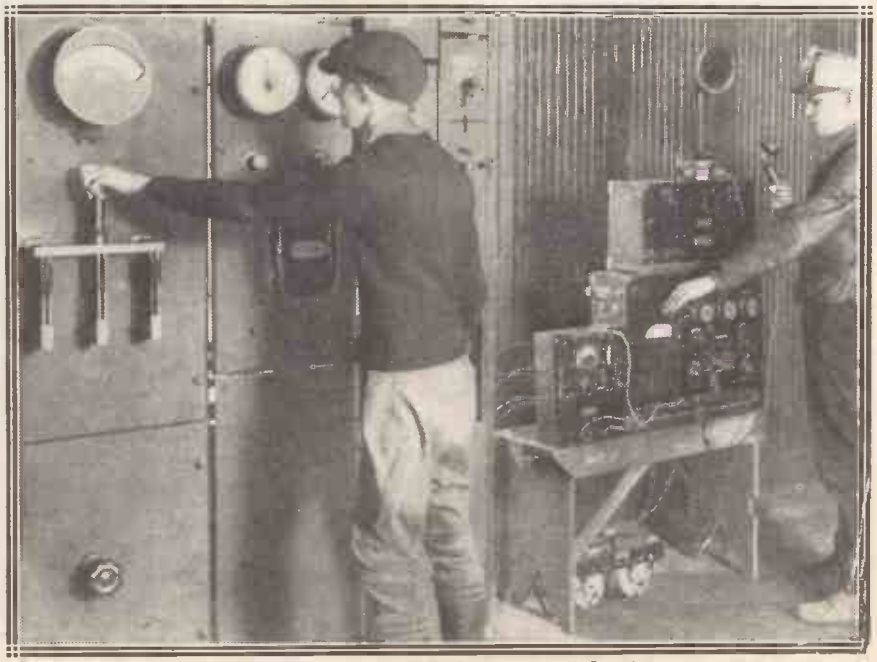
The application of heat is usually a sure means of alleviating pain, as witness the universal use of the old-fashioned poultice. If the source of pain lies somewhere near the surface of the body this is an easy matter, but it is a very different thing when the trouble is due to one of the deep-seated organs.

It is then that diathermy comes to the rescue. High-frequency currents differ from ordinary direct current in that they are able to pass through the skin and tissues without creating any burn or other painful effect. In that passage they set up a pleasant warmth which tends to alleviate pain and is otherwise beneficial.

Treatment by Diathermy

Formerly the high-frequency currents used in diathermy were generated by spark and induction-coil apparatus somewhat similar to that used in early times for wireless transmission.

In modern practice the thermionic valve generator gives much better results. Not only is it more reliable in action and free from sudden fluctuations liable to alarm the patient, but the output is easier to control and to



Wireless in use at an American pit-head.

A Thermionic Wizard—*continued*

adjust in accordance with the varying requirements of different diseases.

In operation the valve oscillator is connected to a pair of electrodes which are laid against the patient's body, front and rear of the internal source of pain, so that the current passes completely through the body, warming the organs in its passage without burning the sensitive skin.

The Stethophone

The stethophone is a further illustration of the use of the valve in medical science. In this instrument, an ordinary stethoscope, such as is used by the family practitioner in "sounding" the heart or lungs, is combined with a multi-stage valve amplifier.

As a result, the normally faint internal "murmurs and wheezes" are magnified up to a tremendous extent, allowing the physician clearly to identify and distinguish sounds which would otherwise remain obscure and possibly unidentified. In this way the stethophone represents a most valuable asset in the modern art of diagnosis.

The same instrument has found another useful application in the hospital theatre or lecture-room. Stethoscope readings from a patient under examination can be amplified and communicated simultaneously through earphones to a large audience, thus giving each student an opportunity of sharing the personal experience of the chief surgeon or operator.

High-Frequency Bloodless Surgery

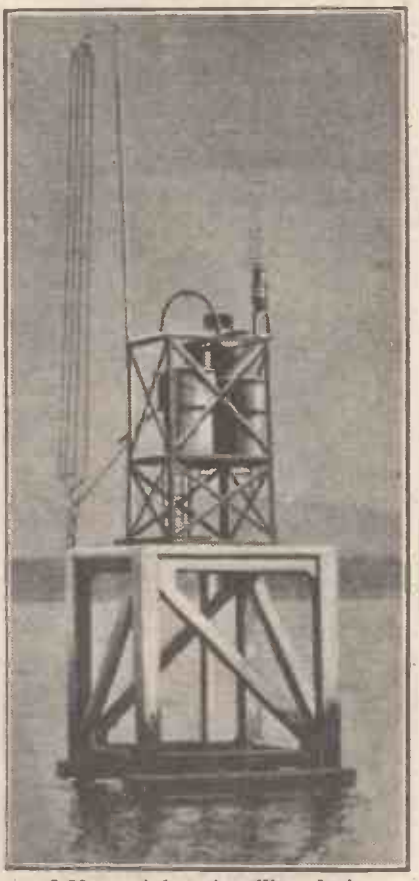
Finally, high-frequency currents produced by valve generators are now being employed for cauterising purposes as well as for actual surgical operations. By using currents of radio frequency of from ·25 to 2 amps. in strength it is possible to cut through bone and tissue in an absolutely aseptic manner and without loss of blood.

"Trigger" Valves

Most listeners are well aware of the extreme sensitivity of a valve to any change in external circuit conditions, especially when set on the "threshold" of oscillation. If, for instance, the reaction coil of a valve receiver is set just short of the oscillating-point, the set can be made to "howl" simply by moving the hand to and fro near the coils.

The same effect is produced by passing a pocket-knife, a metal pencil, or other similar object through the open core of one of the inductance coils.

In the first case the "howl" is due to the change in capacity caused by the approach of the hand, whilst in the second case the introduction of a metal object alters the effective inductance of the coil by creating induced currents and a corresponding out-of-phase magnetic field.



A Marconi fog-signalling device.

Both these effects have been utilised in a variety of ingenious ways to give warning of the approach, say, of an unauthorised person, or an automatic indication of the presence of an unsuspected substance.

Burglar Alarms

A burglar alarm, for instance, can be actuated by locating a coil, forming part of the plate circuit of a "trigger" valve, near a safe or around the door or window of the house to be protected.

The approach of a burglar detunes the plate circuit sufficiently to set the trigger valve into self-oscillation. This in turn causes the plate current to alter suddenly, thereby energising a contact which closes a local relay containing a warning bell.

The bell may be arranged at any suitable place, say in the bedroom of a private house, or in the caretaker's room of a warehouse. Or it might be wired up to some more distant place, such as the local police-station or telephone exchange.

Detecting Theft

In a certain German factory the pilfering of valuable metal by workmen has been detected by means of a very similar "trap" circuit arranged around a special exit door through which each workman passes on his way home.

The door windings are connected to a superheterodyne receiver, which is sufficiently sensitive to indicate the presence of any metal hidden in the pockets or about the person, by giving rise to an alteration of the normal tuning note in the 'phones as the culprit passes through.

Prospecting With a Super-Het

A similar principle underlies the arrangement used by Dr. Lowy in prospecting for the presence of metals. Here a part of the detector circuit is slung in the form of a Hertzian oscillator below the fuselage of an aeroplane which flies over the area to be explored.

The presence of metal or mineral deposits below the surface of the ground exercises a "damping" effect upon the search coil or oscillator. This creates a change in the characteristic beat-note of a supersonic receiver and so gives a positive indication to the prospecting aviator.

The combination of a selenium or photo-electric cell with a thermionic amplifier has also been used to give warning of the unauthorised opening of a safe or strong-room. The change in the normal lighting conditions, caused by the opening of the door, alters the resistance of the optical cell, which in turn sets a trigger valve into oscillation, and so rings an alarm.

A Thermionic Wizard—*continued*

Miners in a distant working are kept in touch with the surface by wireless.

Fog Warnings

A very similar combination has been used for some time in Dublin Harbour to give an automatic indication of the appoach of fog.

A ray of light is steadily focussed from a distance upon the optical cell, the circuits of an associated valve being so set that nothing happens so long as atmospheric conditions are normal.

Should fog set in, however, the atmosphere between the source of light and the beacon station gradually thickens and cuts off some of the light. When the strength of the ray of light falls below a certain critical value, a relay is actuated and automatically brings the harbour fog signal into operation.

Preventing Atmospheric Pollution

It is sometimes necessary, in order to comply with local regulations, to arrange that the smoke emitted by a factory does not contain more than a certain low percentage of soot or other impurities. This is usually ensured by special systems of smoke combustion or purification. It may, however, happen that the precautions normally taken will suddenly fail. In such a case, a similar arrangement to that in use at Dublin can be employed to give an automatic alarm.

A lamp and lens are mounted at one side of the chimney stack, so as to focus a ray of light on an optical cell arranged inside the opposite wall of the stack.

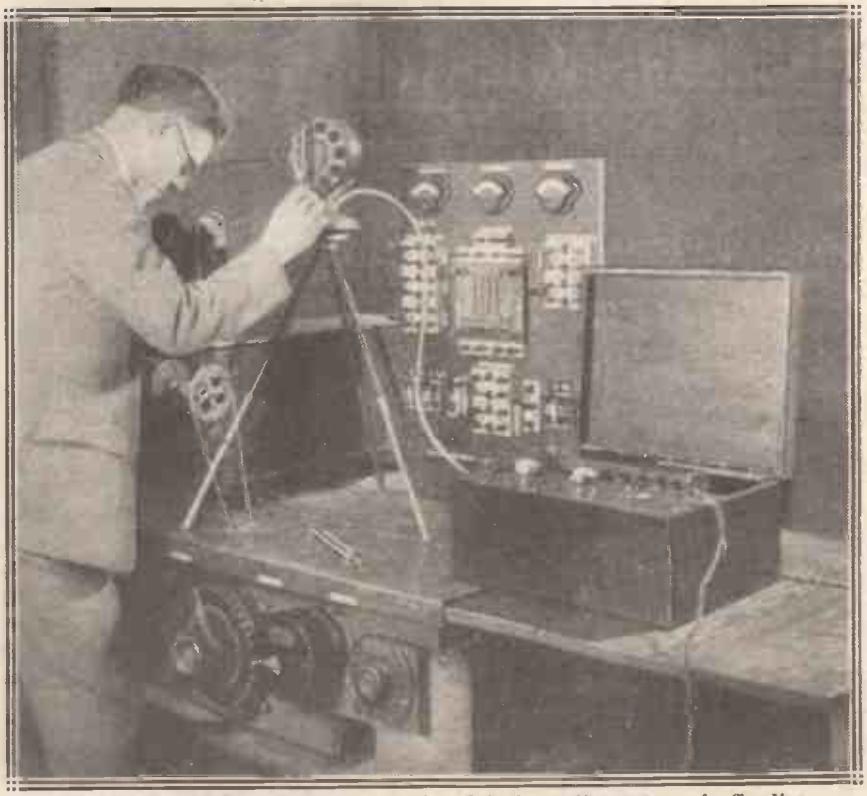
If the passing smoke grows too dirty, the ray of light is dimmed proportionately, until a stage is reached when a valve relay is operated to warn those responsible of what is happening.

Railway Signalling

Amongst other applications, outside the field of wireless, mention may be made of railway signalling systems in which trap or loop circuits laid on the permanent way co-operate with valve amplifiers mounted in the locomotive and automatically give audible or visible signals of track conditions ahead as the train passes by.

Saving Life Underground

A valve has also been used most ingeniously to give an audible warning of the accumulation of choke damp or other dangerous gases in a coalmine. The operation in this case depends upon the change in "tuning note" of a pipe resonator, the fundamental frequency of which is determined by the density of the contained column of air. The intrusion of noxious gas alters the original density of the air column in the pipe and so actuates a local alarm.



This "wireless" equipment is designed to trace the source of offending noises on motor-car engines.

FROM AN AMATEUR'S NOTEBOOK

A frank review of Radio Topics of To-day.

By a Correspondent.

IT has often been said that this country is the stronghold of the crystal-set user, and last year there was probably a good deal of truth in the estimate that at least seventy-five per cent of listeners were crystal-set users. But recently the B.B.C. appealed to listeners to send in postcards stating what sort of set they used, and what station they usually listened to. In reply the B.B.C. had something like 100,000 to 200,000 answers, and an examination of these answers shows that to-day fifty per cent of the B.B.C.'s correspondents are crystal-set users and fifty per cent valve-set users.

The Morning Concerts

This radical change in the proportion may have an important effect on the B.B.C.'s plans for a regional scheme. Daventry, too, has always been regarded as the station most in favour for crystal-set users, but of the listeners who gave 5 X X as their regular station only 10 per cent were users of crystal sets, while the proportion of 2 L O listeners who used crystal sets was 30 per cent.

It must be borne in mind that the percentage of replies is, in comparison, very small with the number of actual licence holders—the number to-day is something like 2¾ million—but nevertheless the figures are illuminating.

Another significant development in broadcasting is the B.B.C.'s decision to cut down morning transmissions. Daventry, in future, will continue to give the time signal and weather forecast at 10.30 a.m., but the usual morning concert is to begin at noon instead of 11 o'clock, although London will begin transmitting at 12 noon, an hour earlier than has hitherto been the case.

Loud-Speaker Popularity

Provincial stations will transmit on Mondays, Wednesdays, and Fridays from 11 a.m. to 1 p.m. except in the case of Manchester, which will broadcast on Thursdays instead of Fridays at the hour named; Sheffield, which will broadcast from 11.30 to 12.30 on Mondays, Wednesdays, and Fridays; and Nottingham, which will broadcast on Mondays, Wednesdays, and Saturdays.

In the majority of cases the programmes will consist of a relay of Daventry's programmes. The B.B.C. point out that in cutting down the morning transmissions they will be able to devote some of the money saved to improving the evening programmes. This would seem to be a sound move.

The growing increase in the number of valve users, as indicated by the B.B.C.'s request for reports from

A telephone attachment for hearing broadcasting without an aerial or set.

listeners, would probably be accentuated if, as is expected, valves are reduced in price in the early autumn. With the growth in the development and the popularity of H.T. mains units and the increasing reliability of valve sets, the crystal set will probably die out in favour just as it has died out in America; and so, probably, will the telephone method of reception fall lower and lower in public favour as loud speakers are improved and the quality of reproduction made easier of attainment by the average listener.

There is, and always will be, that large section of the public which is primarily interested in circuits and in the experimenting side of wireless. It would be difficult to estimate the numbers of circuits which have been developed since broadcasting began. Certainly a good number of original and first-class circuits have appeared for the first time in this journal. And whatever the merits of a circuit, when a new one is developed it is always interesting to analyse it and try it out.

The Strobodyne

The latest circuit which seems to have attracted some attention comes from France. It is called the "Strobodyne," and it is the invention of a Frenchman, M. Lucien Chretein. The "Strobodyne" gets its name from an optical illusion known as Stroboscopic phenomena. It really means the "twisting of vision." For example, this may be noticed in the cinema, where wheels on the screen seem to rotate backwards or at varying rates of speed compared with the real motion. Or, put in this way: Think of a white disc on which has been drawn a black line.

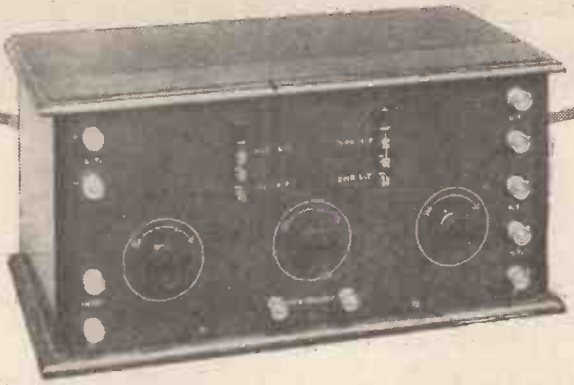
If the disc revolves at the rate of 1,500 times a minute the line becomes invisible, and if a spark lights up the disc at the rate of 1,499 times a minute, then the line will be seen revolving apparently at the rate of once a minute. And if the speed of the spark is increased the line will appear to rotate backwards. Therefore, if the frequency of the rotation of the disc we have in mind is 1,500 a minute, and the frequency of the spark is 1,499, the resulting frequency is one—i.e. 1,500 minus 1,499.

Easy and Efficient

The electrical principle of the Strobodyne is analagous to the optical principle, in this sense: that it obtains a change in radio frequency. Details to hand at the moment are not very clear, but it appears the set does not use a grid leak or a grid condenser and the valve which changes the frequency also amplifies with an increase in sensitivity, while the whole combination results in a set of extraordinary sensitivity and selectivity. The circuit devised by M. Chretien uses eight valves, and only a few feet of wire as an aerial is required to bring in distant stations at great strength and purity.

The Strobodyne is something like the super-heterodyne inasmuch as it is a frequency-changing circuit. It brings about a similar change but in a different way, which is more efficient and more easy as regards operation. We shall undoubtedly hear more about this very interesting French circuit in the near future.

WHICH L.F. CIRCUIT?



All prospective constructors of wireless receivers should read this article.

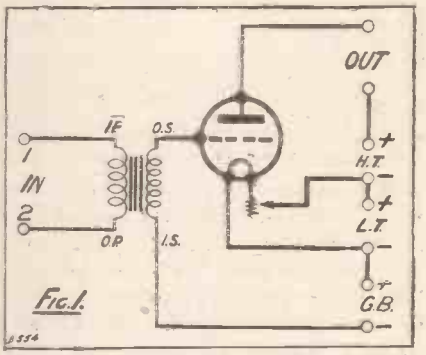
By G. P. KENDALL, B.Sc.

ONE so often hears arguments as to "the best L.F. circuit" that it seems likely that a discussion of the "pros and cons" of some of the more useful types of L.F. coupling would be helpful. Such arguments indicate clearly a lack of understanding of a quite important fact, namely, that the different circuits possess special characteristics which often render them useful in different ways.

Thus, in many actual cases there is really no definite answer to the question "Which is the best L.F. circuit?" since it is rather a matter of suiting the particular conditions of that actual case, and I propose to begin by taking some examples to make this point clear and so assist my readers to make a correct choice for themselves in any given circumstances. Now, L.F. amplification is commonly used for two distinct purposes, and these should be considered separately. First, it may be employed to bring signals up to adequate strength for *'phone* reception, and here there is a wide choice of methods. In general, only one stage will be needed, and the type of coupling to adopt can soon be decided after a little consideration of the particular case.

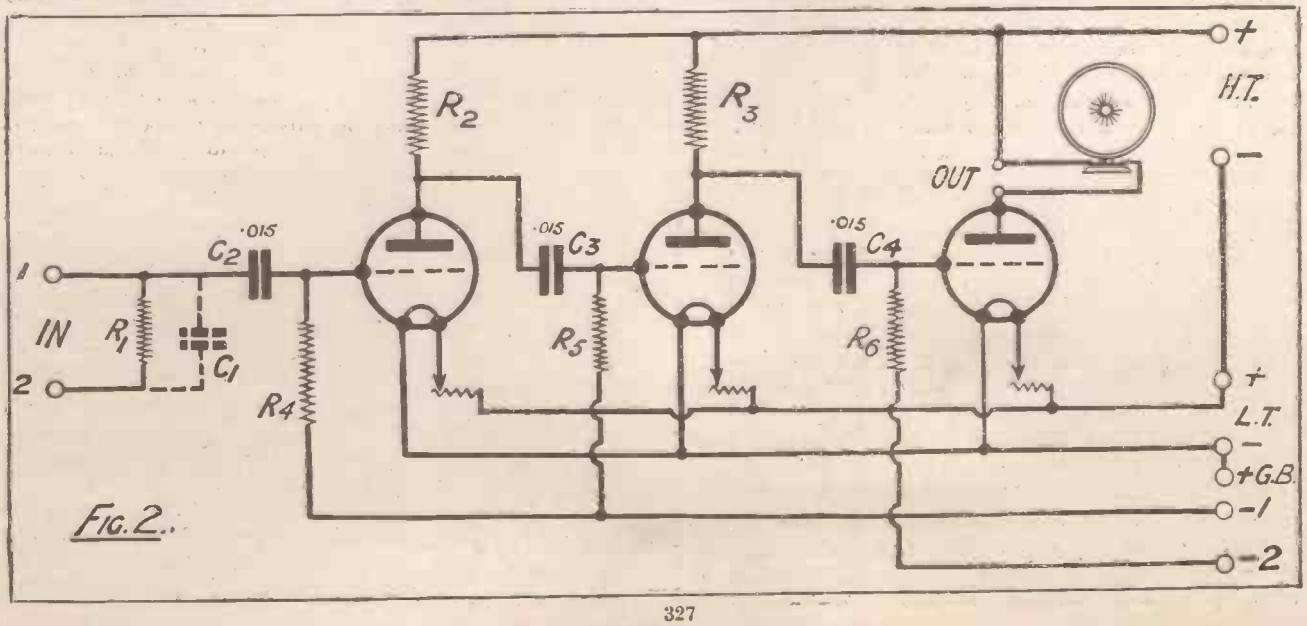
Transformer Coupling

As a rule, the single stage which we are discussing will follow a valve detector, and the first point to be settled is the probable effect of the various systems of L.F. coupling upon the *preceding* circuits. Now, if no reaction is used, as in a number of sets incorporating two stages of H.F., there is little difficulty, since the addition of any type of L.F. stage will have little or no effect on the functioning of the set when proper precautions are taken. Transformer coupling is, of course, the simplest way of adding our single L.F. valve, and it has the possible merit that it enables us to use a wider variety of types of valve in the detector position than most other kinds of coupling. So long as the detector valve is not of too high an impedance it can be chosen chiefly on its merits as a rectifier when transformer coupling is used, and a good standard of performance will be obtained from the L.F. stage.



For a single stage transformer coupling is very useful.

A low-ratio transformer should always be used after the detector—say, two or three to one ratio—in order that it may have a large enough primary to suit the rather high impedance of some of the valves likely to be used as detectors, and so



Which L.F. Circuit?—*continued*

give the greatest possible amplification of the lower notes. Provided that this is attended to, and a really good make of transformer is used, the quality obtainable from a single stage is good, assuming a power valve with proper H.T. and grid bias in the last socket, and for 'phone work I should generally choose this coupling where reaction is used. It is true that, even with the very best of the leading makes of transformer, there is theoretically a deficiency in the amplification of the lower notes, but this is not noticeable with the average pair of 'phones, which are themselves not above suspicion in this respect.

The essential feature which makes transformer coupling so useful in a case like this is that it permits reaction to be obtained and controlled just as easily as if only a pair of 'phones were connected in the anode circuit of the detector valve. This is important in simple circuits where reaction finely adjusted is relied upon for good results, and provides a ready answer to the question "Which is the best L.F. circuit?" in such cases, especially if reception is on 'phones only.

A Difficult Case

Where there is no reaction, but where a single stage of L.F. is still being used to produce headphone signals only, however, the choice is not so easy. Perhaps it would be more correct to say that there is less difference between the three principal types of coupling (transformer, resistance, and choke) as regards their *suitability*, so that the decision must be made upon their *intrinsic* qualities. The main points to be considered are these: transformer coupling is desirable if the detector valve is likely to be of a medium- or low-impedance type, and will permit a great variety of types to be used. Most of the newer kinds of quite high-impedance valves, however, are very good detectors, and so this point has lost most of its importance, and is merely mentioned for the guidance of those who have certain definite types actually in their possession which they intend to use.

When the likeliest valve is one of the high-impedance type (25,000 ohms and upwards) it is advisable in the interests of good reproduction to use either resistance or choke coupling, and, of the two, resistance is more commonly employed. For 'phone reception in particular, however, there is little indeed to choose between them provided that the choke is a really good one of high value (100 henries, or more), and choke coupling has the advantage that it renders it a much easier matter to apply a known H.T. voltage to the detector valve. It can be assumed that there is only a very small voltage drop in the choke, and hence whatever voltage the detector H.T. lead receives from the battery can be regarded as reaching the anode. Where a resistance is included in the anode circuit, however, conditions are quite otherwise, and of the H.T. voltage applied only perhaps a quarter may actually reach the anode of the valve, according to the ratio of the resistance of the valve to that of the coupling resistance. This must, of course, be remembered in adjusting the H.T. to the detector, and is perhaps rather a minor point.

When one stage of transformer coupling and one of resistance is employed, the transformer is usually placed first, as shown here, if the amplifier follows a crystal detector, while with a valve detector it is usua to place the resistance first.

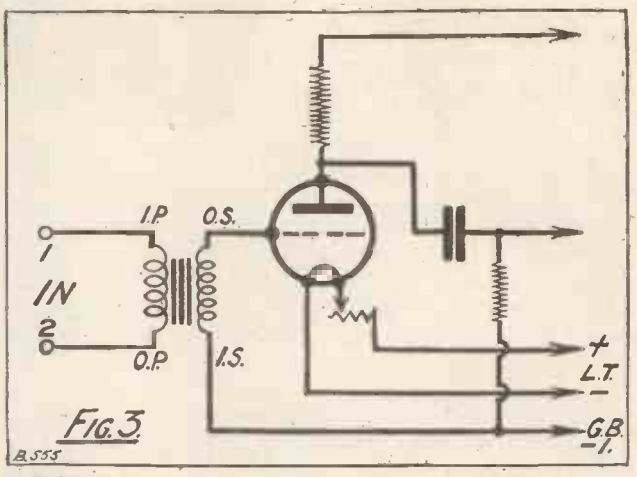


FIG. 3.

The Choke

A more important matter concerns the quality of the L.F. choke, if one is used. A choke of high inductance and with a properly wound low-capacity coil is essential for good amplification and quality of reproduction. If you do not feel that your experience is great enough to choose such a choke, then by all means use a resistance, which, after all, is the smaller and lighter component to mount in your set.

It must be mentioned at this point that all the preceding discussion has assumed that grid-leak and condenser rectification is used. If "anode-bend" rectification is the method employed, choke or resistance coupling is regarded as essential.

The reader will now, I think, have realised that the object of this article is not to attempt to cover every possible case and tell him exactly what to choose, but rather to show how a choice can be made in any given

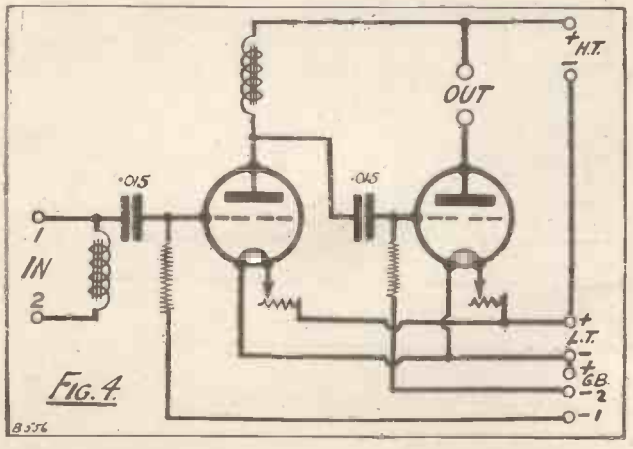


FIG. 4.

Choke coupling has the advantage that fair results can be obtained with lower H.T. valves, although the usual high voltage is desirable for really good quality.

Which L.F. Circuit?—*continued*

circumstances when once the conditions are known. When the factors governing the choice are understood, it becomes fairly simple to make a decision in each set of circumstances.

Loud-Speaker Work

We can now turn our attention to the other main type of case in which a decision may be required, namely, that in which reception will be upon a loud speaker, and here we shall usually find that two stages are used. Now, there have been notable improvements in loud-speaker design of late, and there are now a number on the market (the various conical diaphragm models, for example) which give a much more even rendering of high and low notes than has previously been the case. These instruments will go down to quite low frequencies, and it becomes important to see that our L.F. amplifying circuits will do the same.

One definite rule can be laid down at the outset, and will simplify matters somewhat: two transformer-coupled stages are now very rarely used in ordinary sets, since it has been found more difficult to obtain really good reproduction in this way than by means of some of the alternatives.

The choice evidently rests, then, between two stages of resistance or choke coupling, and a stage of transformer coupling with a stage of resistance or choke. Now, it is probably easiest to secure fairly even amplification of practically the whole scale of musical frequencies by means of resistance coupling, and this method has become very popular, especially since special valves have been introduced which provide quite a high degree of amplification in a resistance amplifier.

Choke Advantages

Choke coupling is also capable in theory of producing almost equal amplification over the main frequency range, but to do so perfect chokes of very high inductance are needed, and this condition is not very easy to satisfy. Consequently, many choke amplifiers show more falling off on certain notes than do resistance amplifiers. One advantage of the choke amplifier, of which rather a point is sometimes made, is that it will amplify fairly well with lower values of H.T. than the resistance type.

Since, however, good reproduction demands that a fairly high voltage be applied to the last stage, there seems little force in the argument, in that a high-voltage battery is needed in any case. As regards actual economy in current consumption, the resistance coupling shows a decided superiority.

A Combination

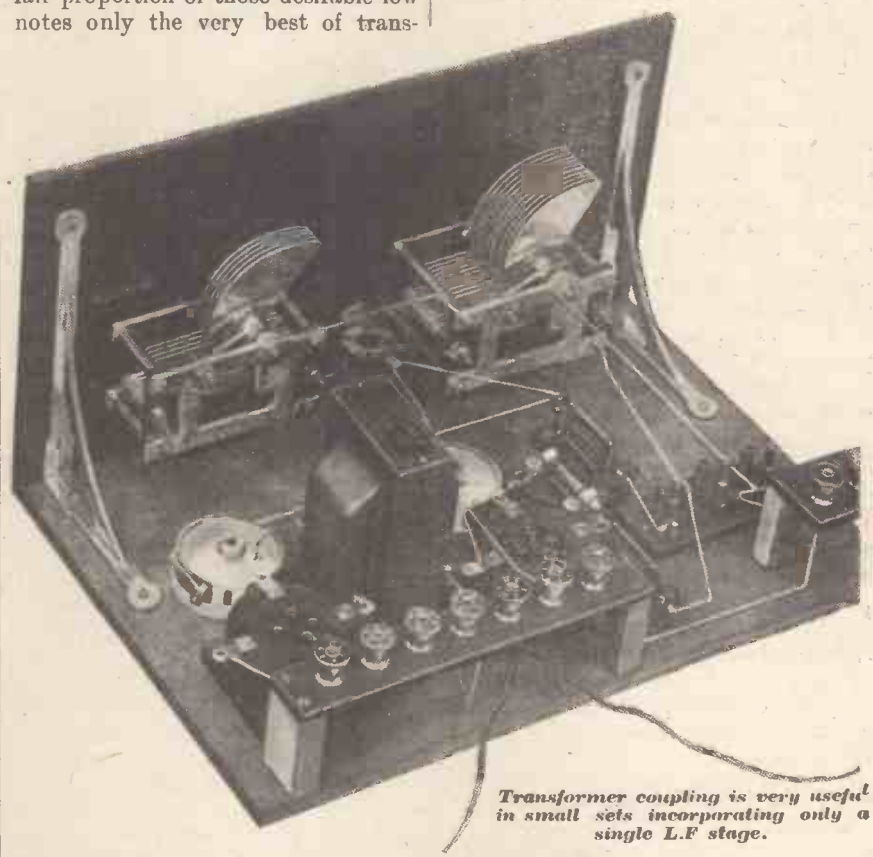
We now come to the one remaining method, namely, one transformer and one resistance (or choke) stage, and here the first point is that to get a fair proportion of those desirable low notes only the very best of transformers should be used. A rather low ratio is desirable, and the *preceding* valve should not be of too high an impedance (remember, we are now dealing with the production of quality fit for one of the latest types of loud speakers).

When these conditions are satisfied the combination is an extremely good one, and is preferred by many authorities to a pure resistance amplifier. It does not give such theoretically even amplification over the musical scale, but such evenness is not perhaps quite what we want. The loud speaker is still not perfect, and the particular kind of unevenness given by the type of amplifier now being considered apparently helps to conceal the imperfections of the speaker.

Granted, then, that the combination is a desirable one, the question arises as to the order in which the transformer and resistance stage should be arranged.

The desirable arrangement is to have the primary of the L.F. transformer in the anode circuit of a valve of as low impedance as is practicable, and for this reason it is usually placed in the second stage, where it will be following a power or L.F. valve. The resistance coupling will then be in the anode of the detector valve.

This is now practically a standard arrangement, and should only be departed from in cases where the detector is a low impedance type (for example, where it is a crystal).



Transformer coupling is very useful in small sets incorporating only a single L.F stage.

Improving Your Metal-Work

This article contains many valuable and unusual hints, particularly helpful to the man who desires a good finish on a repaired job.

By ELECTROGRAPHER.

MANY amateurs can fit up their own wireless work quite satisfactorily, but are conscious that compared with that of the professional it comes considerably behind in respect of finish. Often the final presentment of the work leaves much to be desired, and is a cause of grievous dissatisfaction to those who take any pride in their task. It is, therefore, proposed to give here a few hints and wrinkles on the subject, founded on many years' practical experience, that will be helpful to every amateur wireless constructor.

Firm Fixing Essential

One of the chief causes of dissatisfaction arises from inability to solder up a joint properly. There are several reasons for this; one of the chief and most frequent being the lack of care in fixing up the two pieces of metal to be joined. Amateurs never seem to realise the pains the professional worker takes to ensure as perfect and as rigid setting for the two pieces to be joined as possible.

Very much of the success necessarily depends on this, as it is quite impossible to make a presentable job if either of the pieces moves at all during the process of soldering. While there is no royal road to success in this, either for professional or amateur, the difference in the result is the realisation by the former how much depends on this point. Both will find, in most cases, that any means that will bind the two pieces together effectually are permissible practice, and may be adopted if they secure good results.

How Solder Can Be Coloured

Especially needful is careful adjustment and secure fixing before hard soldering is undertaken. The force of the gas blast will sometimes move a light metal part, and before it can be readjusted the solder may have run, and, becoming hard on removal of the gas jet, makes further effort of no avail.

Hard soldering is never an easy job for the amateur; at the worst it is a nightmare. Frequently, when a good strong joint has, at last, been secured, an examination finds it full of holes or irregularities. A judicious use of the file will remedy the trouble arising from the latter.

When the joint is then smoothed down all over the holes may be filled with soft solder, which is easier to apply. This can only be done, of course, when paint or some other coating will hide the difference in colour of the two metals; but it is better than the amateur again risking the effect of the gas blast in trying to remedy the defects with hard solder—an attempt that may bring disaster to a joint that may be passably satisfactory otherwise.

An Accumulator Hint: Terminals should be cleaned and coated with a little vaseline or petroleum jelly to avoid corrosion.

Many letters reach the writer from time to time asking how solder can be coloured to match the surrounding metal. This depends, of course, on what the latter is. If of copper and the hard solder shows a yellow streak against it, or soft solder disfigures it, the following is the best way out of the trouble. Dissolve two ounces of sulphate of copper in a pint of warm water, then add about a couple of teaspoonfuls of sulphuric acid or vitriol, stirring well in.

Clean the seam of solder free from all grease by means of strong soda-water—not with soap, or your labour will be in vain. Then apply a little of the copper solution and rub over the seam with a piece of clean iron or steel, such as the back of an old blade of a penknife, or a screwdriver. The iron will copper first in all probability, but after a time the hard or soft solder will assume the same hue if the rubbing over is continued with a little patience. The solution should then be rinsed off thoroughly and the metal dried.

A Good Grease Remover

A good way to cover the solder joints in the case of iron is to coat over with aluminium paint that may be brought to the required tone of greyness by mixing a little lampblack with it. If the whole surface of the iron is lightly touched over with fine emery cloth the part that has been camouflaged will be less noticeable. As with the method previously described, it is necessary completely to remove all grease before applying the paint.

The trouble amateur workers experience in getting a good finish to their job arises, most frequently, from the presence of grease. No paint, and few other coating materials, will overcome the effects of oil or grease.

There are two good methods of thoroughly clearing grease from metal. The first is by means of petrol well brushed over, and the second is by boiling in potash water. About a quarter of a pound of potash to a quart of water makes a powerful grease remover. It is essential that the latter be all thoroughly rinsed off before any paint is applied, or it saponifies the oil and prevents drying.

Before any coating of paint or lacquer is applied the surface of the metal requires to be brought to an even surface by smoothing over with fine emery cloth, finishing with the finest grade.

Painting Metal-Work

There is a little wrinkle to be learned by most amateurs in painting metal-work, and here it is. In using a tin of ordinary ready-made paint, contrary to the directions given thereon, do not shake up the can. Open it as it is, when the pigment will be found settled at the bottom.

Take some of this out on a knife or chisel and put it in another vessel. Thin it down to working consistency with turpentine and gold size only. Give the metal a first coat of this, which will dry hard and quickly. The second coat should be of similarly

(*Continued on page* 356.)

A HOME-MADE CONE LOUDSPEAKER

Full constructional details of an efficient hornless loud speaker.

By A. V. D. HORT, B.A.

ALTHOUGH there are large numbers of loud speakers on the market, ranging in price from the small instrument with a horn to a high-priced moving-coil speaker beyond the means of the average listener, there is a considerable attraction about building one's own loud speaker and adapting it to the conditions under which it is to be used.

The problem of perfection in loud-speaker reproduction is not easy to solve, and it is not claimed that the instrument described in these pages is ideal. In many ways, however, it will be found superior to those loud speakers which possess an individual tone of their own. This tone, whether due to a wooden or metal horn, or to other features in the design, tends to reduce the reproduction to a sort of monotone, while certain portions of the acoustical scale will be unduly pronounced.

Ease of Construction

The paper-diaphragm loud speaker gets over this trouble to a certain extent, but again it often falls short of expectations, as it is difficult to place it correctly in the room. Sound waves are sent out from both sides of the diaphragm, and those behind are reflected from the walls of the room, eventually reaching the ear out of phase with the waves from the front surface of the diaphragm, so tending to blur reproduction.

LISTS OF PARTS REQUIRED.

1 loud-speaker unit, with reed. (Lissenola.)
2 pieces 3-ply wood, 15 in. square.
1 baseboard, 15 in. × 6½ in. × ½ in.
Various pieces of wood, as detailed; also a piece of linen or oiled silk, wood-screws, 6 B.A. bolts and nuts, wood for box, etc.

In the experiments which led to the construction of the present loud speaker, a cone was decided upon for the diaphragm, rather than a disc of pleated paper, mainly because of the greater ease of construction and handling of the former. First of all, the cone was fixed rigidly in a wooden frame. This was not found satisfactory, because the "monotone" effect of the wood was immediately noticeable. Leaving the edge of the cone completely free allowed chatter of the operating mechanism to take place readily, a Lissenola loud-speaking unit with reed being used. The cone is therefore held all round its circumference by a linen ring, not stretched too tightly, so that the cone has ample freedom for the reproduction of the bass notes without being loose or unsupported.

The linen is clamped between two sheets of plywood, which are in turn secured in a vertical position at right angles to a baseboard. At the back of this baseboard are rigid supports for the operating unit, the centre of the cone being secured to the reed. If this represented the complete instrument, it would possess no advantages over the open type of paper-diaphragm loud speaker; the blurring of music and speech, which has already been mentioned, will, in fact, be observed if the loud speaker is tested while in this state.

The Cone Support

To get rid of this blurring the whole of the back of the cone is enclosed, boards of a generous thickness being used, in order to subdue possible resonance effects. An aperture is provided at the back, in order to permit of access to the adjusting screw of the operating unit.

For the construction of the loud speaker the parts given in the accompanying list will be required. The first operation is to cut the circles out of the two pieces of three-plywood. Clamp the two pieces together, with the surface grain of one running at right angles to that of the other (this makes for greater rigidity when they are bolted together), mark out the circle

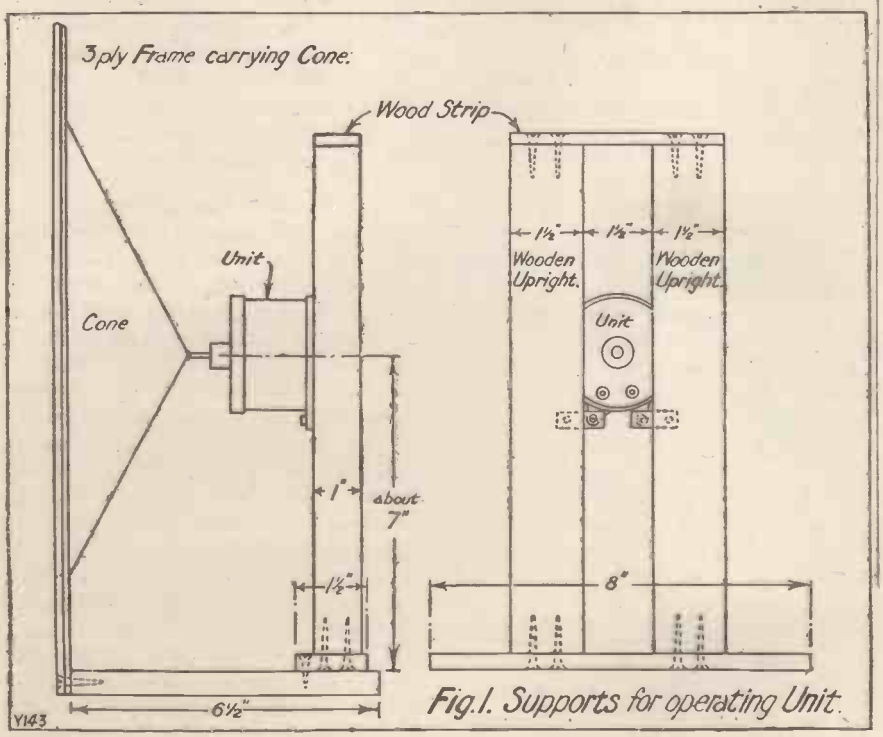


Fig. 1. Supports for operating Unit.

A Home-Made Cone Loudspeaker—*continued*

with a pair of compasses and cut it out with a fretsaw. (See Fig. 2.)

Before separating the two sheets, mark the positions for the clamping bolts and drill clearance holes, which may be either 4 B.A. or 6 B.A. Then mark the two pieces so that they can be put together in the same positions again later, and take them apart.

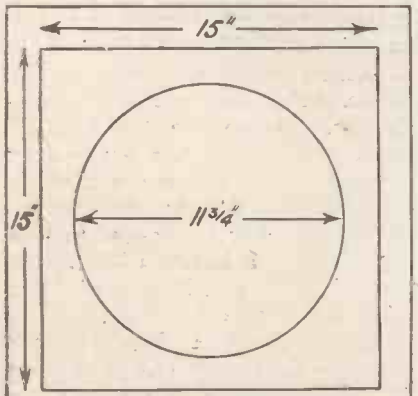


FIG. 2. TWO PIECES OF 3-PLY WOOD OF ABOVE DIMENSIONS. Z460

The support of the cone may consist either of linen or of oiled silk, the former material being quite good so long as it is fairly closely woven and not too heavy. A handkerchief of good quality will be suitable. Coat the inner surface of one of the sheets of wood with glue or seccotine, spread out the linen, which should not be less than 15 in. square, on the wood, and stretch it pretty tightly in every direction, though taking care not to pull it out of shape. Give the other sheet a coating of glue, place it in its correct position, push a spike through two or three of the bolt-holes to pierce the linen, insert the bolts and tighten them up with their nuts.

Construction of the Cone

As you pierce each of the remaining holes and insert the bolts, pull the edge of the linen which projects beyond the wood, so that when all the bolts are in the linen is stretched tightly across the cut-out circle in the centre. Tighten up all the nuts and put the frame aside for some hours to dry.

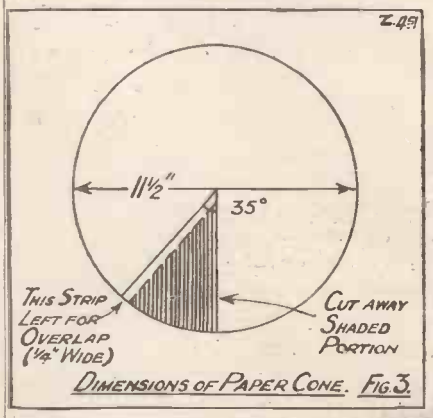
For the cone good-quality drawing paper or "parchment" paper will be suitable. Cartridge paper is mostly too soft for the purpose and will not make a rigid job. Describe a circle 5¾ in. diameter, and from its centre as apex mark off an angle of 35 degrees. Leave an extra ¼ in. of paper inside this angle on one side for the overlap, and cut away the remainder of the paper bounded by the lines drawn. The overlapping edges are drawn together with seccotine. When it is dry, make a hole with a stout needle at the exact centre of the cone.

Fixing to the Frame

To secure the cone to its frame, lay the latter inner side upwards on a flat surface, smear a band half an inch wide round the inner edge of the cone with seccotine, and place the cone with this edge on the linen and as nearly as possible central in the frame. Keeping the cone in this position, turn the whole assembly over the other way, and press the linen down on to the gummed edge as far as it will go. It will not be possible to secure much of it in this way, owing to the tension of the linen, but enough can be done to locate the correct position for the cone. Now, with a razor-blade or a sharp pair of scissors cut round the linen, leaving ¼ in. to ½ in. to gum to the cone. Work this edge down over the edge of the cone with the fingers, keeping the cone central and stretching the linen quite tightly. It will "give" again sufficiently when the adhesive is dry.

Substantial Supports

Attention may next be given to the support for the operating mechanism. This is made substantial and rigid, in order to obviate any vibration of the unit itself. Fig. 1 gives the dimensions of the supports in the instrument described. There is no need to adhere to these, the most important points being to use stout uprights. It will be noted that the uprights are mounted on a subsidiary base, which is in turn secured to the baseboard which carries the frame of the cone. This may appear to be a complicated method of construction, but actually it renders considerably simpler the fitting together of the various parts, and particularly the correct alignment of the reed and the cone.



DIMENSIONS OF PAPER CONE. FIG. 3.

A back view of the speaker, showing the actuating mechanism.

The operating unit is fixed to the uprights with two brass strips, the dimensions of which are given in Fig. 5. Great care should be observed in drilling the holes through the lugs on the unit, or the moulding will be broken. For this reason it is advisable to make these holes larger than 6 B.A. clearance.

Fitting the Drive

When the frame of the cone has been secured to its base, place the supports of the operating unit in position behind the cone, and locate the holes for the screws to fix the unit to the uprights. The tip of the rod on the reed should project about ⅛ in. through a small hole punched in the centre of the cone. Fasten the unit to the uprights, set it in position, and secure its base to the other baseboard with stout screws.

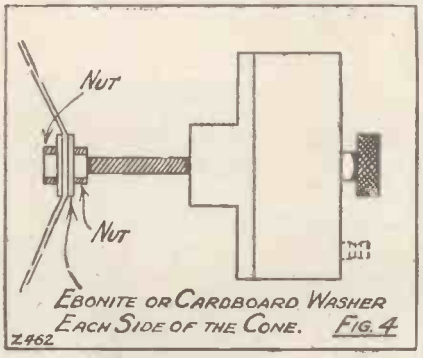
A single nut and washer should previously have been placed on the rod, and these may now be moved up to the back of the cone. A nut and washer are put on the front of the cone to clamp it to the rod. Do not use metal washers, as these will cut the paper of the cone. Ebonite

A HOME-MADE CONE LOUDSPEAKER

—continued

will do, and cardboard is better still. Adjust the nuts so that the cone is firmly gripped without damage to the centre.

The construction of the box which encloses the whole instrument does not merit a detailed description. It is best to use fairly thick wood in order to reduce the possibility of resonance effects occurring. In this instrument ¾-in. deal was used. A gap is left at



the back, opposite to the gap between the two uprights of the unit supports, and a hinged flap covers this, allowing access to the adjusting screw and terminals of the unit. The leads are brought out through a hole in the back of the box, and tied securely to an eyelet, so that an accidental jerk on them will not pull them away from the terminals. Four rubber feet on the bottom of the box prevent damage to polished surfaces, while for convenience in moving the instrument a carrying strap is secured to the top.

If a pronounced hollowness of tone is noticeable when the loud speaker is tested, this will probably be due to undue vibration of the containing box. An improvement may then be effected by lining the inside of the box with felt, allowing the felt to come in between the pieces of wood at the joints. The parts of the box must be firmly screwed or glued together, or chattering noises will be heard when loud signals are coming through.

A BATTERY-CHARGING TIP

Most of the home chargers for L.T. accumulators are designed to give a charge of two, two and a half, or three amperes to six-volt accumulators. If a two-volt accumulator is charged without any added resistance the charging current will be too heavy, and will probably blow the fuse in the charger. For this reason experimenters sometimes wait until they have two or three two-volt cells to charge, or else they place them in series with an already charged accumulator.

Where two-, four-, and six-volt accumulators are charged regularly from such a charger it is worth while purchasing one of the old-fashioned variable resistances consisting of a straight former on which the resistance wire is wound, the slider being carried on a square-section rod. These resistances can be ordered through any electrician, and should carry three amperes and have a total resistance of about eight ohms. (A very good resistance of this kind is made by the Zenith Manufacturing Co., Ltd., of Willesden, N.W.) When placed in series with a two-volt accumulator it can be adjusted to pass from about three-quarters of an ampere up to the full rate of the charger. An ammeter should be used to measure the current, but this need only be a cheap instrument.

DON'T OVERDO THE BASS

Since, owing to the queer ways of English spelling, the title might mislead some readers, I had better explain at once that this note

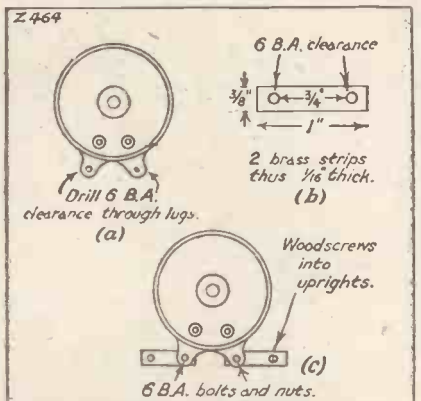


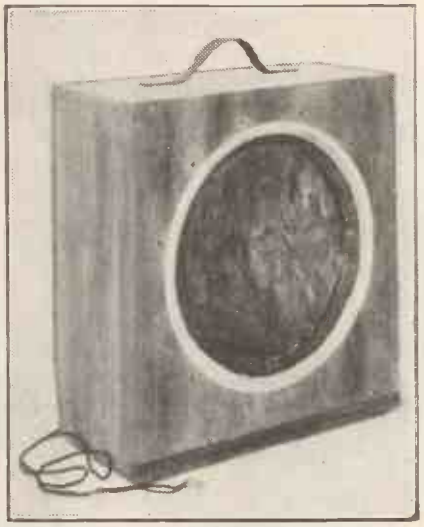
Fig. 5. Attachment of Operating Unit.

More constructional details of the cone loud speaker.

is concerned not with froth-blowing but with wireless reproduction!

Improvements made during the last year or two in transmitting appliances have made it possible for the frequencies due to very deep notes such as those produced by the drum, the bassoon, or the pedals of an organ to play their proper part in modulating the carrier wave, a thing which was quite impossible in the early days of broadcasting.

Since the bass notes are now included in the transmission the wireless receiving set should now be able to reproduce them with their full value. When it was first realised that this could be done many people rather overdid their enthusiasm for the deep tones, and this attitude still persists



The completed cone speaker, and its wooden case.

to some extent. Many a time, in fact, I have come across a receiving set completely ruined by misguided efforts to make it "bring out the bass."

What happens is this. An "expert" friend comes round to hear the set, and after a few moments says: "The reproduction is very poor; you are hearing nothing of the bass. Now let me show you——" Under his guidance the owner of the set proceeds to shunt the loud speaker and the low-frequency transformers with large fixed condensers, which certainly have the effect of lowering the tone somewhat. But they do this simply by cutting down the high frequencies, or in other words at the expense of the upper notes and the higher harmonics.

Where proper components are used the receiving set should be capable of reproducing the bass without this wholesale shunting; if the set will not do it otherwise it is often better to leave well (or middling well) alone, for the last state may be very much worse than the first, speech in particular being woolly and muffled, and music sounding rather as though those producing it had a thick heavy curtain between them and the microphone.

CHATS AT THE WORK-TABLE

An article of particular interest to the practical amateur.

By R. W. HALLOWS, M.A.

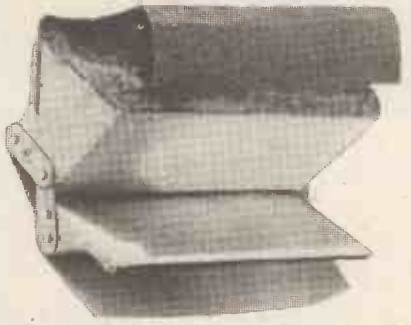
EVERY wireless constructor knows how quickly emery cloth or sandpaper wears out and becomes useless if the material is simply folded several times and used as a pad. Some months ago I described in these notes how a holder could be made which led to distinct economies, and lately I have come across the simplest and most satisfactory holder that I have ever used. It is by no means an expensive tool, costing as it does only a few pence at Woolworth's. The device is illustrated in one of the accompanying photographs. It consists of a small block of wood with sloping sides, to the bottom of which is glued a pad of felt. Hinged to the top of the block are side flaps. A piece of emery cloth or glasspaper is folded over the felt pad so that it projects half an inch or a little less on either side. The flaps are now closed and the grip of one's fingers suffices to keep the abrasive in position. This holder makes easy such jobs as rubbing down panels, and with it a single small sheet of emery seems to suffice for quite big tasks, and to last very much longer than it would if used in the ordinary way.

For Scratched Panels

Those who buy their panels ready drilled may not have much occasion for rubbing down. The constructor, however, who does his own drilling, as so many do, and anyone who makes alterations to an existing receiving set, is pretty certain to find that the panel is disfigured, however careful one may be, by small scratches or tool marks. In such cases rubbing down will effect a cure, as it will also where old panels are used which have lost their original blackness owing to long exposure to the effects of light. The process is not a lengthy one, and if you set about it methodically a beautiful finish is obtainable. The best way is to lay the panel on an old newspaper placed on a flat table and to fix it firmly by means of small stops placed at either end and at the sides. Suitable stops can be made from little pieces of wood about $\frac{3}{16}$ in. thick fastened to the top of the table by means of short nails. Work always in straight lines, using the finest obtainable emery cloth, and give a last rub over with old glasspaper of the finest grade as used by cabinet makers. This having been done, polish over with a selvyt cloth, and then apply a little turpentine. The result is a semi-matt finish of deep black hue.

Cutting Fin-Formers

Ebonite formers of the finned type, which are now very popular for making coils for both the medium and the short wave-lengths, are not as a rule obtainable in lengths less than 3 in. For aerial coils, the primaries of H.F. transformers, and so on, one often wants something shorter than this, lengths of $1\frac{1}{2}$ or 2 in. being required. Several constructors that I have met lately have told me that they find a considerable difficulty in making a neat job of cutting formers of this kind. As a matter of fact, the job is quite a simple one if it is tackled in the right way. On one of the fins of the former to be operated on measure off from one end the length required and make a scriber mark. Proceed right round the former, making a mark on each fin. This having been done, a straight edge should be laid across two of the marks and a line scribed down the sloping sides of the fins and across the body of the former. The former is now turned so that the next pair of fins comes uppermost, and the scribing is continued. At the end of this process you have a scribed line running "up hill and down dale" right round the former at the correct distance from one end. The next step is to nail a small piece of wood to the top of your work-table to act as a stop in the way shown in Fig. 1. Push the former firmly against this and hold it there with the left hand. Take a small, stiff-backed saw and with it make a shallow cut on the scribed marks in the two fins that come uppermost. These are shown numbered 1 and 2 in the drawing.

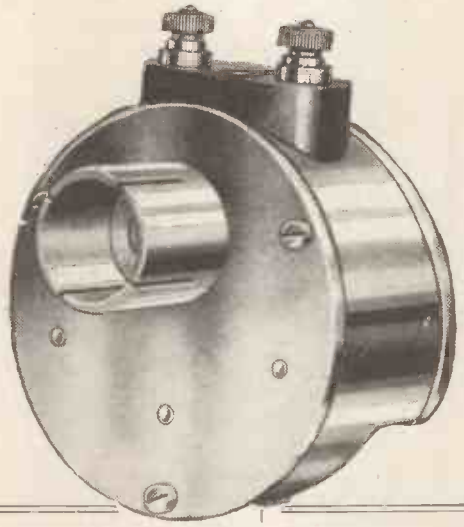


An ingenious and useful holder for emery cloth, which can be made at the cost of only a few pence.

Guiding the Saw

Now turn the former so that 2 and 3 are at the top. Put the blade of the saw into the nick cut in fin No. 2 and make a similar cut in No. 3. Deal next with fins 3 and 4, and so on until you have a made a small cut in each of the six. Now go round again making a deeper cut. You can hardly go wrong now, since you have guides everywhere for the saw. Always cut into *two* fins at once and keep turning after you have gone down a little way. When the cuts are so deep that the edge of the saw shows through on the inside of the former between the fins, you are ready to undertake the final operation of parting. There is now no need to turn the former, provided, of course, that the blade of the saw is deep enough to allow it to go right through. Cut straight down from the top. The saw will guide itself in the cuts already made. Working in this way any length may be cut off as neatly as could be desired. When cutting has been done fasten a sheet of emery cloth with a piece

Electrify your Gramophone!



GRAMOPHONE results never before obtainable are now made possible by the Brown Electrical Pick-up. 'Wonderful reproduction' was the description given by the "Wireless Constructor" last month. No need now to buy a new gramophone to appreciate fully the new standard of reproduction set by the electrical record. Just electrify your present gramophone by fitting a Brown Electrical Pick-up in place of the sound box and connecting to an amplifier and loud speaker. The result will be an entirely new pitch of tone perfection that will command instant admiration. Reproduction will be infinitely purer; the lower notes with equal fidelity to the high notes.

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Reduced needle scratch.
Controllable volume.
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ELECTRICAL PICK-UP

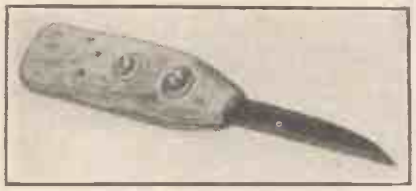
Puts Life into your Gramophone

Chats at the Work-Table—*continued*

of folded newspaper underneath it to the table by means of four tin-tacks or drawing-pins, lay the face of the cut-off piece on it and rub it over the abrasive with a circular motion. This will soon remove all tool marks, and this face of the former will be as smooth as the other.

Big Drills in Short Sizes

For a long time past I have bewailed the fact that, unless one wanted to buy a complete set of drills, it seemed to be impossible to purchase such a thing as a $\frac{3}{8}$-in. drill less than 5 or 6 in. in length. In wireless work one seldom has to drill through a greater thickness than $\frac{1}{2}$ in. at the outside, and big drills of such length are most unwieldly tools in the brace



A handy keyhole saw, made from an old hacksaw blade.

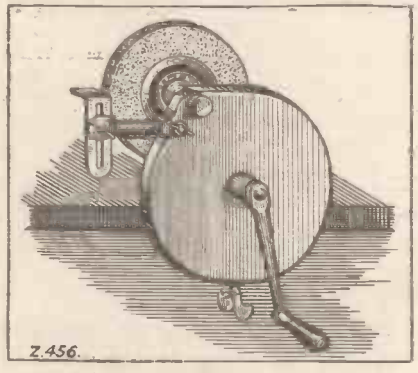
or hand drill. In many bench drills it is impossible to use them, since there is not sufficient clearance between the chuck and the table. Recently, I am glad to say, I have found a toolshop at which $\frac{3}{8}$-in. drills, 2 in. in length, can be obtained. One of these is illustrated alongside a section of a foot rule in one of the photographs, and its handiness will be appreciated by most constructors. The $\frac{3}{8}$-in. drill is used a great deal, since holes of this size are required, as a rule, for the bushes of variable condensers as well as for those of potentiometers, rheostats, push-pull switches and many other components. A tool that I very much hope to see available before long is a short $\frac{3}{8}$-in. drill with a $\frac{1}{4}$-in. shank. I am quite sure that if any tool merchant would put one on the market he would have a very large sale for it, since so many constructors possess hand drills whose chucks will take nothing of greater diameter than $\frac{1}{4}$-in.

An Emergency Tip

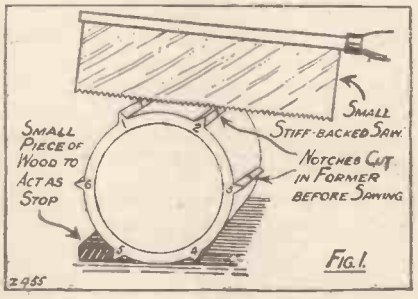
If, by the way, you have a hand drill of this type and require to use it in an emergency for making holes bigger than $\frac{1}{4}$ in., here is a tip that will be found useful. Make the hole, in the first instance, with the biggest drill that you can use. Next take an old half-round file whose end will enter the hole so made, and fit its tang into the chuck of your drill. If care is exercised it will be found that the file makes quite a good D-bit, reamering out the hole until it is of the size required. This tip is also useful when one undertakes the job of mounting jacks on the panel, for many types require holes bigger than $\frac{3}{8}$ in., and the constructor may not possess a drill of greater diameter or a chuck that would take it if he had one. With the file $\frac{3}{8}$-in. holes can be enlarged until they just fit the jacks nicely.

A Home-Made Keyhole Saw

The photograph shown illustrates a most useful little tool, which I made up the other day for a job of work which not infrequently comes the constructor's way. This is a keyhole saw, intended for cutting large holes in ebonite, though it will answer equally well for metal if required to do so. Little saws of this kind are quite easy to make, and many readers will doubtless like to add them to their workshop equipment. Look through your stock of hacksaw blades until you find one that is soft at the ends. You can easily select a suitable one by trying a number with a file. If the file cuts into the metal fairly easily, then the blade is suitable for the present purpose. Break the blade in



two and make use of the end which will give you a cut on the thrust, and not on the draw, when the saw is used—the end, that is to say, whose teeth point away from and not towards the hole already existing in it. About an inch away from this hole make a punch-mark and drill through with a No. 26 drill to make a 4 B.A. clearance hole. Now grind off the other end of the blade to a point, as shown in the photograph. Cut out two pieces of $\frac{1}{2}$-in. thick wood about 4 in. in length by 1 in. in width. Clamp them together in the vice and shape them off so as to form a suitable handle for the saw. Through them drill two 4 B.A. clearance holes with the same spacing as those in the saw blade. In the tool seen in the photograph round-headed 4 B.A., screws



and nuts were used for clamping purposes, a washer being placed beneath the head of each screw and under each nut. Neither the screw heads nor the nuts were sunk into the wood of the handle, for if the ends of the screws are trimmed off with a file, and the nuts slightly rounded, the protusions do not seem to get in the way of one's hand at all. If desired, however, hollows may be made in the handle so that both the heads of the screws and the nuts are sunk. When the blade has been tightly clamped into this holder the tool is ready for use. The front portion of the handle where it meets the blade may be tapered off by whittling with a sharp knife and afterwards smoothing with glasspaper. This little saw has done excellent service since it was made, having cut out dozens of pieces of ebonite from 1 in. to 2 in. square. The best way of using it is to mark out the hole that is to be made and to drill at each corner a $\frac{1}{4}$ in. or larger hole. One then inserts the point of the saw, working carefully until the cut is deep enough to allow the whole of the blade to enter. Cutting can now proceed quite rapidly. Care must, of course, be taken to hold the saw straight or the blade may buckle during the thrust and break. It is as well to make a spare blade so that it may be available should such a casualty occur; a change can then be made in a couple of minutes.

For the Workshop Outfit

One of the best additions that the wireless constructor can make to his

Chats at the Work-Table—*continued*

stock of tools is a small geared emery grinder of the kind shown.

These are quite inexpensive, useful little wheels, being obtainable at prices as low as five or six shillings. The cheaper grinders are generally fitted with wheels made of a rather soft composition. Whilst these are quite useful for light work I would recommend the spending of a few shillings more in order to obtain a rather more durable wheel if the grinder is to be used much for jobs upon hard metal. The simplest grinder contains an abrasive wheel actuated by a crank through the medium of gear-wheels. By turning the crank a very high rate of speed is obtainable and jobs that would take a long time with a file are quickly accomplished. The main drawback to the use of a hand-driven wheel is that since one hand is required for turning the crank, only one is available for holding the work. It is a convenience, therefore, to have a foot-driven grinder. Not a bad tip, if you do not care about going right away to the expense of such a tool, is to purchase a hand wheel in the first instance, making sure at the time by inquiry that it is of a type for which a treadle drive can be obtained.

Uses For the Grinder

Later on, the foot motor may be fitted by simply removing the crank handle and bolting on the strip of metal that forms the connection between the crank and the treadle. With the grinder screwdrivers, brad-awls, scribers, centre-punches, and other tools can always be kept in perfect condition. Should the edge of a screwdriver become rounded it is literally a matter of seconds to grind the blade straight and true again. A blunt scriber can be repointed in double quick time, whilst a centre-punch whose point has become blunted or burred after long use is easily set to rights. And there are hundreds of other uses for the grinder which will suggest themselves to the reader. With it old files are easily ground into scrapers, D-bits, and other handy tools. The shaping of small brass parts can often be accomplished roughly on the wheel with an immense saving of time and labour, the finishing touches being given with a file. The saving in time thus effected is enormous.

Those who contemplate acquiring grinders, and possibly not a few of those who already possess them, may not realise that there are many other uses than those already suggested for them. A drill-grinding attachment can, for example, be obtained for many types of wheel. The possessor of such an attachment will find that it soon pays for itself owing to the state of perfection in which it enables one to keep one's drills. Nothing blunts them so rapidly as ebonite.

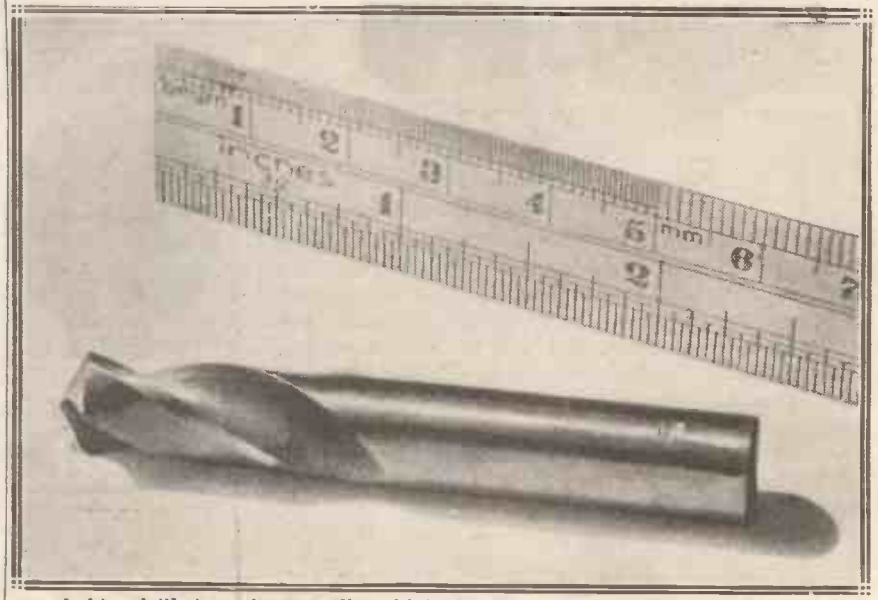
Sawing Made Easy

When a drill which has been used much for work upon this material is called upon to drill a hole in brass one usually finds that the job is, to say the least of it, somewhat laborious. A touch on the emery wheel with the help of the drill guide will make it as keen as it ever was. Experienced workshop hands are often able to grind drills on the wheel without the use of a guide, but I would strongly recommend that this should not be attempted by the inexperienced, or weird results may follow. Another attachment that one can obtain for the grinder is a small circular saw, most useful for cutting ebonite in sheet, rod, or tube form. When you are buying a circular saw make sure first of all of the diameter of the spindle of your grinder, for it is most important that the saw should be a good fit. When the saw is to be brought into action the grinding wheel is removed and the toothed disc clamped on. A small sawing table must be made, which can be fitted over the circular saw so that only a small portion of its circumference protrudes through a slot. With a small circular saw long pieces of strip ebonite can be cut off perfectly straight.

For Stripped Threads

Despite the rapidity with which it wears away steel tools, ebonite is a soft material, and threads cut in it are very liable to strip if any force is used, especially in holes of small size, such as those required for 4 B.A. and 6 B.A. screws. When a component has been fixed to a panel or some other piece of ebonite by means of screws it is distinctly annoying to find that one or more of these will not hold firmly. One way of dealing with the matter is to rethread the holes with a larger tap. Thus, if a 6 B.A. hole contains a stripped thread a No. 33 drill may be passed through it, followed by a 4 B.A. tap, in which case, of course, a screw of appropriate size must be used.

In some cases it is impossible, or, at any rate, undesirable, to use a screw of larger size. In such circumstances I have found the following "botching" method very useful. Warm the screw a little, and smear its threads with Chatterton's compound. Now drive it in, using just sufficient force to get it reasonably tight. In an hour or two's time, when the compound is hard, the screw will be found to be quite firmly fixed.



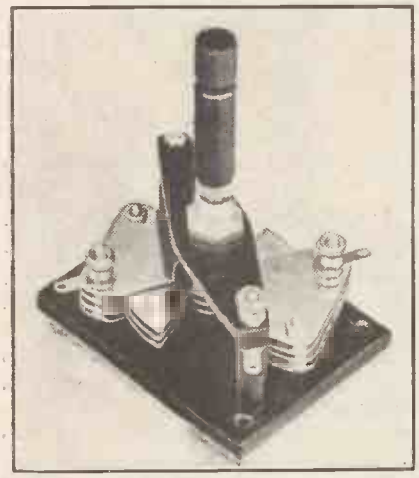
A big drill is not generally obtainable in a short and handy length.

A MONTHLY REVIEW OF TESTED APPARATUS.

(NOTE: All apparatus reviewed in this section each month has been tested in the Editor's private laboratory, under his own personal supervision.)

A Convenient Balancing Condenser

THE "Lisenin" balancing condenser illustrated herewith is a simple little device consisting of three sets of condenser plates. Two of the sets are fixed and the third moving. As will be seen from the photograph, turning the adjusting knob causes the moving plates to interleave with the two sets of fixed plates. Each set of plates has a terminal, so that by connecting one lead to the moving plates and the other to one set of fixed plates we have a small variable condenser completely adjustable throughout its range. As



The Lisenin balancing condenser.

an alternative arrangement the two ends of the circuit may be connected to the two sets of *fixed* plates, whereupon we have a continuously variable condenser with a maximum capacity only half that of the former arrangement, for the two side condensers are now in series. The device is made for either baseboard or panel mounting, the one-hole-fixing method being adopted in the latter case. This condenser should have a variety of uses in modern sets.

Useful Condenser Clip

From the Telegraph Condenser Co., manufacturers of the well-known T.C.C.-type Mansbridge condensers, used by experimenters for shunting H.T. batteries, we have received specimens of their new clips designed to enable the conventional Mansbridge condensers to be attached horizontally instead of vertically to a panel. This is of great use in the "underboard" method of wiring now becoming popular, or further saving of space in a set can be effected by screwing the Mansbridge condensers to the side of the cabinet by means of these clips.

The clips are made in several sizes to accommodate the various thicknesses of condensers sold by this firm.

A Radio-Frequency Measuring Instrument

The more advanced experimenter who is keen on making actual measurements in his set will be interested in the Weston Radio-Frequency Thermo Galvanometer illustrated in the accompanying picture. Unlike most measuring instruments with which the experimenter is acquainted, this can be placed directly in a radio-frequency circuit and used to measure the current flowing there. The full scale reading is equal to 115 milliamperes.

The most important uses of this instrument are in wavemeters and instruments designed to measure radio-frequency resistances. If, for example, a circuit is set up consisting of a coil and condenser and this instrument, and a current induced

The H.F. Thermo Galvanometer (Weston Electrical Inst. Co.).

into this circuit from an oscillator, the difference of reading caused by the insertion of a known resistance into this circuit (all other constants being kept the same) may be used to calculate the high-frequency resistance of the whole.

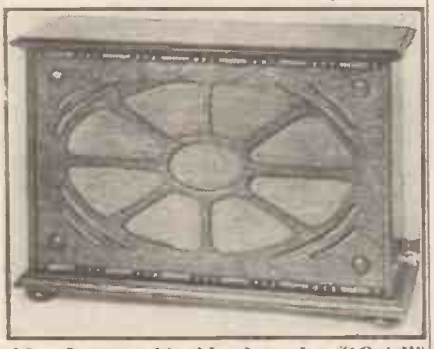
Instruments of this type are in regular use in the WIRELESS CONSTRUCTOR laboratory, in apparatus designed for testing high-frequency resistances and high-frequency losses. Like all Weston instruments the Thermo Galvanometer is beautifully made. When inserted in a radio-frequency circuit it acts as a pure resistance and not as an inductance. The high-frequency resistance is approximately four and a half ohms.

The T.C.C. clip for fixing condensers horizontally.

What's New—*continued*

The "Oriel" Loud Speaker

A cabinet loud speaker which is both handsome and of good tone quality is the "Oriel" illustrated in the accompanying photograph and submitted for test by The London Radio Mfg. Co., Ltd. It consists of a polished cabinet about 16 in. long by 10 in. high, the sound aperture



A handsome cabinet loud speaker ("Oriel")

being covered by a kind of gilt gauze, which certainly enhances the appearance. The diaphragm adjustment is made by means of a knurled nut concealed beneath the base, and terminals for attaching to the set are provided on the right-hand side, positive and negative terminals being clearly marked in red and black. In both tone and sound efficiency (i.e., strength of reproduction for a given input) the instrument proved quite satisfactory on test, with a decidedly better tone than many loud speakers of higher price.

An Efficient R.C. Unit

A handsome and efficient new R.C. unit has recently been produced by the R.I.-Varley Company and has been submitted for test to this journal. Unlike several of the cheap R.C. units which contain high resistances of very poor material, the R. I.-Varley unit contains this company's well-known wire-wound resistance in which every turn of wire is separated from the other by silk. This resistance, together with a high-grade mica insulated condenser and a suitable leak, is contained in a handsome moulded case, provided with four terminals for plate, H.T. positive, grid, and grid bias respectively. The makers have wisely produced two types, type A being suitable for valves with an impedance from 15,000 to 40,000 ohms, and type B for valves with an impedance from 30,000 to 100,000 ohms. On practical tests these couplers proved to be of the high efficiency one has come to associate with the names of R. I. and Varley, and they work, unlike some R.C. units we have tested, with a perfectly silent background. The unit can be thoroughly recommended to all readers of this journal.

The R.I.-Varley's new R.C. Unit.

New Neutralising Condenser

When neutralised circuits began to be popular one of the first efficient small condensers to be produced was the "Polar." The makers have now produced a greatly improved model, illustrated herewith, in which all possibility of short-circuit between plates has been removed. The condenser can be used for either baseboard or panel mounting, and in the latter style one-hole fixing has been adopted. A locking screw is provided to maintain the best adjustment once it has been found. When the locking screw is loosened the plunger can be pulled up and down for rapid variations of capacity, and a slight rotation gives a still finer adjustment. Tested in a standard type of neutralised circuit the condenser was found to function excellently and to fulfil all the requirements of this circuit. It can therefore be recommended with confidence.

An improved form of the "Polar" neutralising condenser, with which there is no possibility of a short-circuit between the plates.

A Useful Condenser and Dial

Messrs. Ripault's have just submitted the latest specimen of their lateral action variable condenser. This gives 360 degrees as against the 180 degrees tuning, with a low-loss construction

A front view of the new Ripault's variable condenser.

quite different from the usual pattern. The general form of this condenser will be well known to readers, as it was used in "Samson—The Powerful Twin." The new pattern has several minor modifications, the chief of which is the addition of a handsome vernier dial suitable for a 360-degree rotation, and divided into

The plates of the Ripault's condenser have a lateral action.

What's New—*continued*

200 instead of 100 degrees. The dial utilises the now popular friction drive, a small disc bearing against a larger, which carries the markings.

A Filter Unit

The growing use of super-power valves and the necessity of by-passing the comparatively heavy plate current has turned the attention of many

The McMichael filter unit.

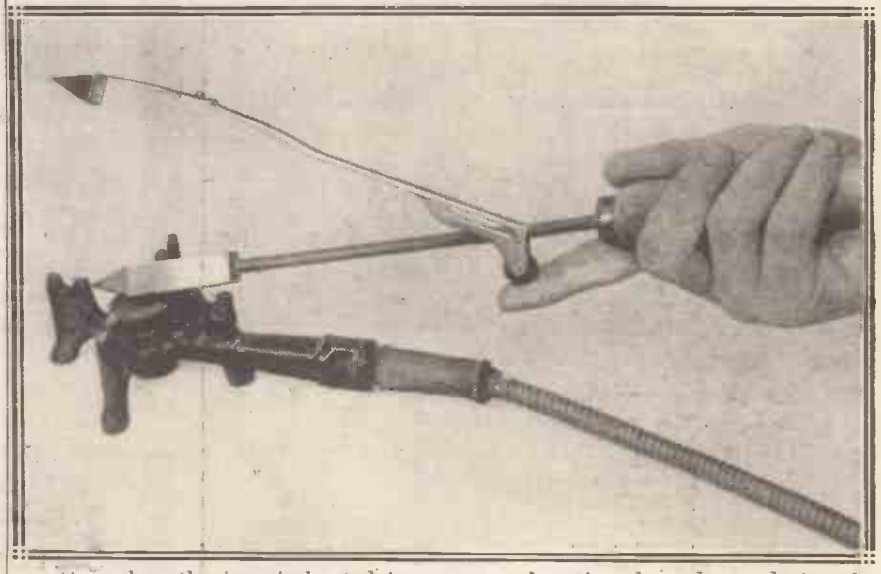
home constructors to filters. While a filter unit can readily be made up from components by the average constructor, many will care to purchase the device ready made. Such a filter in convenient form is that supplied by Messrs. McMichael, Ltd., and illustrated herewith. It consists of a wooden box with an ebonite top, carrying four terminals suitably marked, and two pairs of clips. These clips enable shunting condensers to be placed across either the input or the output side, or both, the well-known clip-in condensers manufactured by this firm being used for the purpose. The box itself contains a choke and a large condenser, this latter being mica insulated—a good point. For all save the very heaviest loads this filter should fulfil all requirements.

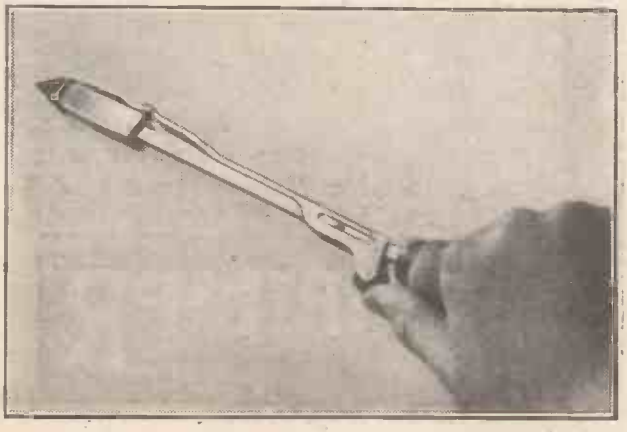
Novel Soldering Iron

A novel and very practical soldering iron which should prove a great boon to home constructors is illustrated in the accompanying photographs. It is called the "Junit," and consists of a soldering bit and handle of conventional form, together with a special attachment which places a thin copper cap over the end of the iron, or removes it with equal facility. The idea, of course, is to make sure that the soldering tip is always clean—ordinarily a difficult matter when the iron is heated in a fire or gas flame.

To use the iron the thin tip is removed and the bit placed in the gas ring or other flame. When it is sufficiently hot the thin copper cap is slipped over the end, whereupon the heat of the main bit is immediately transmitted to the thin metal, which can be tinned and used in the customary way. There is, of course, a slight loss of heat due to placing the metal cap over the soldering bit, but this is negligible in practice, and in any case the iron can easily be made a little hotter to allow for this loss. The pleasure of having a perfectly clean, well-tinned tip available at a moment's notice must be experienced to be believed. It is a very useful and practical component, and can be fully recommended.

A novel centre-tapped coil ("Lewcos").



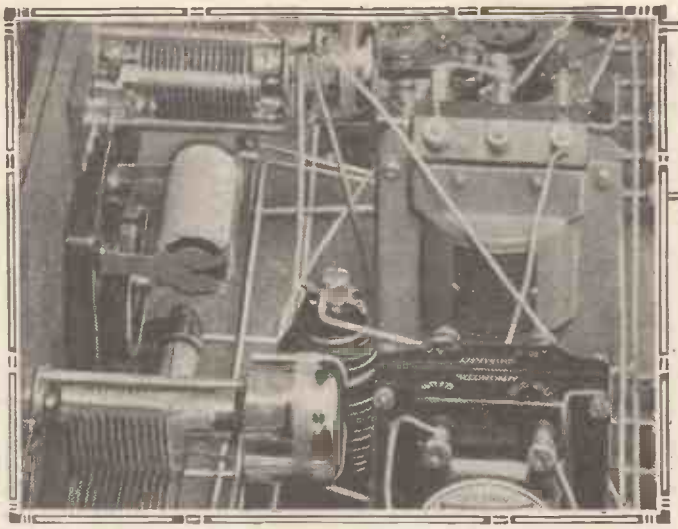


This photograph and the one above show the "Junit" soldering iron with the ingenious attachment which keeps the tip clean and ready for use at all times.

A New Plug-In Coil

The London Electric Wire Co., Ltd., makers of the well-known Lewcos coils, have now produced a centre-tapped coil in two sizes, one for the

(*Continued on page* 352.)

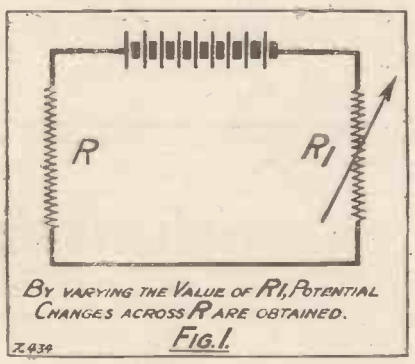


Difficulties with L.F.

This article deals in an eminently helpful manner with those practical points that puzzle the constructor in his quest for quality of reproduction.

From a Correspondent.

THE developments in the department of high-frequency amplification which have taken place recently have been of such absorbing interest that the low-frequency amplifier has perhaps received less than its fair share of attention. Yet its importance is enormous, and there are some very pretty problems connected with the design and the operation of note-magnifying stages.



BY VARYING THE VALUE OF R1, POTENTIAL CHANGES ACROSS R ARE OBTAINED.
Z 434 FIG. 1.

Fundamental Differences

We can probably obtain the best grasp of the fundamental problems of note-magnification if we remember that many of the most important requirements are the exact opposite of those connected with high-frequency amplification. In the high-frequency stages we are dealing with tiny grid swings whose frequencies may range up to a million a second; with note-magnifiers we are concerned with audio-frequency grid swings, which in a powerful set may have in the last stage values of from 10 to 30 or 40 volts.

The high-frequency amplifier must be capable of sharp tuning—that is to say, there must be a very definite resonance point and the response to frequencies other than that to which the circuit is tuned must be of the weakest; the note-magnifier, if distortion is to be avoided, must have no marked resonance point within the limits of audible frequencies—ideally, it should respond equally to all audio-frequencies. To put it in another way the high-frequency amplifier must be sharply tuned, and the low-frequency amplifier must favour no particular frequency.

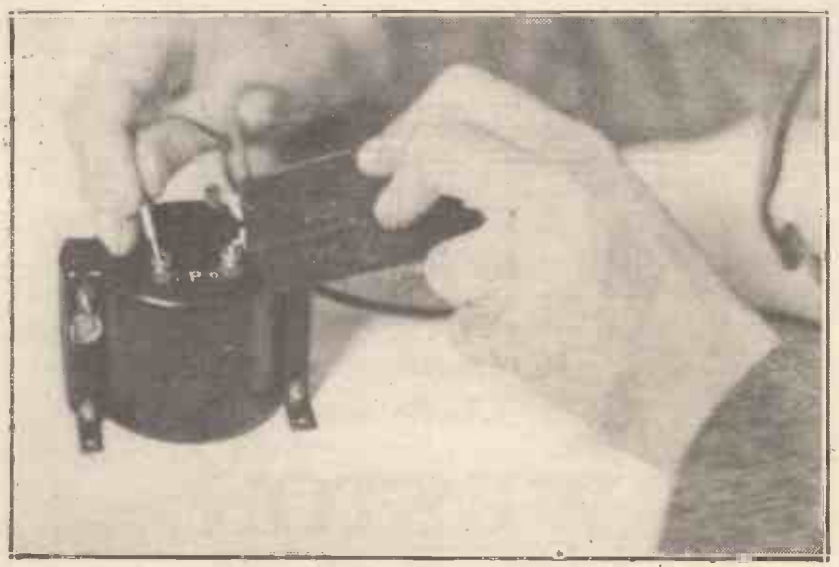
The difficulty about obtaining this equal response to all audio-frequencies in note-magnifiers is bound up mainly with the quality known as impedance, which for our present purposes we may take as being to alternating or oscillating currents practically what resistance is to direct currents.

Control of Potential

In Fig. 1 is seen a simple D.C. circuit incorporating a fixed resistance R and a varying resistance R_1. Of the total potential drop round the circuit part takes place across R and part across R_1. If we reduce R_1 to zero the whole potential drop will take place across R. On the other hand, the greater the value of R_1 the bigger will be the potential drop across it and the smaller that across R. Hence, by varying the resistance of R_1 we can vary the potentials set up across R.

R. C. Coupling

Fig. 2 shows a similar circuit, but instead of the battery we have a generator supplying alternating current, and the resistances are replaced by impedances Z and Z_1. At a given frequency the potentials across Z can be varied by altering the impedance of Z_1. This is very much the state of affairs which would prevail in the ideal note-magnifier. Here the valve itself represents the variable impedance



Testing a transformer with a battery and phones in series.

Difficulties with L.F.—*continued*

and the transformer primary or choke coil or resistance unit in the plate circuit the fixed impedance.

It is unfortunate for wireless purposes that such a thing as a fixed impedance is a practical impossibility, for the value of any given impedance depends not only upon resistance, capacity, and inductance, but also upon the frequency. If we could make an anode-circuit impedance consisting of resistance only, its value would remain constant, for it would be independent of the frequency. Actually there must always be inductance and capacity, not only in the resistance itself but also in the holder and in the leads which connect it to other components.

Resistance-capacity coupling seems to open a promising field, for with the proper precautions both capacity and inductance can be kept low and something like a constant value for the impedance in the plate circuit is obtainable. However, though it has been hailed by many as the cure for all note-magnification evils, resistance-capacity amplification contains a great many often unsuspected imperfections.

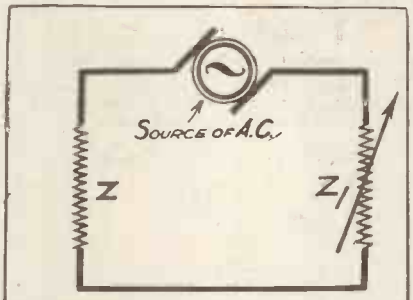
The Amplification Obtained

In order to obtain a reasonable amount of amplification from any valve coupled by the resistance-capacity method, it is essential that the resistance in the anode circuit should possess a high value. The *theoretical* amplification obtainable is found by dividing the external resistance in ohms by the external resistance added to the valve impedance and multiplying the amplification factor by the result.

Thus, if we take a typical valve designed for resistance-capacity coupling with an amplification factor of 50 and an impedance of 80,000 ohms, and propose to use an anode resistance of 500,000 ohms, the calculation is:

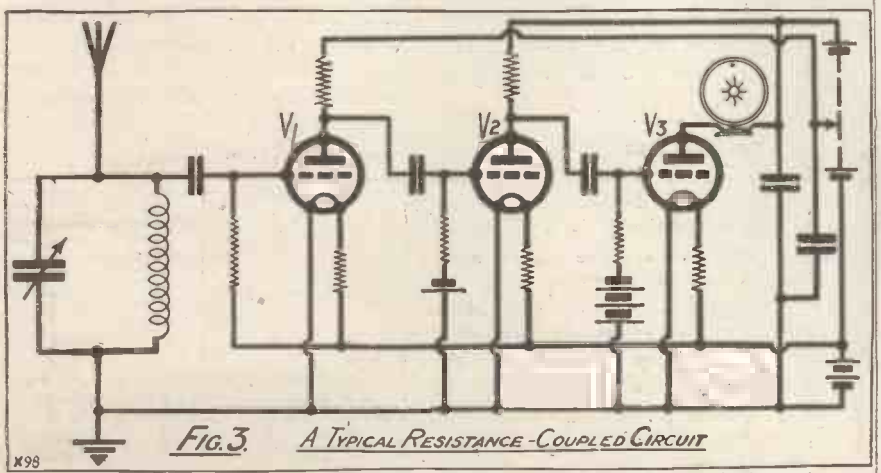
$$\frac{500{,}000}{500{,}000+80{,}000}\times 50$$

or approximately 43.



VARIATIONS IN THE IMPEDANCE, Z_1, WILL CAUSE POTENTIALS ACROSS Z TO VARY.
Z433 FIG. 2.

By raising the resistance to a million ohms we obtain a theoretical amplification of 46. In practice, the amplification obtainable is considerably less. We see, however, that the higher the resistance in the plate circuit the more nearly does the amplification obtainable approach the figure of the amplification factor of the valve.



X98 FIG. 3. A TYPICAL RESISTANCE-COUPLED CIRCUIT

It must be remembered that in the plate circuit of the valve we are concerned not only with oscillating potentials, but also with the normal positive potential applied to the plate. Now the use of a very high resistance in the plate circuit means that the potential drop outside the valve is large, and therefore that the plate potential is comparatively small. This condition leads to a rather unsatisfactory state of affairs. Unless the positive plate potential is kept fairly high, grid current tends to flow even when the grid is slightly negative. Thus the positive half of an oscillation of moderately large amplitude may suffer a certain amount of distortion. Further, the presence of a very high resistance in the plate circuit of a valve in whose grid circuit there is a grid condenser and grid leak is bound to cause rectification to result to a greater or less extent.

Effect of Grid Current

Take the case of V_2 in the circuit shown in Fig. 3. A little consideration will show that the only important difference between its circuits and those of V_1, which is intended to rectify, is that V_1's grid leak is connected to L.T. positive, whilst V_2's is given a small negative bias. The bias cannot be a large one, since V_2 is supposed to be one of the high-magnification valves specially designed for resistance-capacity coupling. I have before me as I write a book published five or six years ago which contains the still generally accepted explanation of leaky-grid condenser rectification. The circuit diagram which accompanies this explanation is reproduced in Fig. 4.

It will be seen that the grid leak is here in parallel with the grid condenser, and that, as the return is taken to L.T. negative, the grid is set at zero potential. This was the custom in those days, and anyone who cares to make the experiment will find that a valve such as V_1 in Fig. 3 will rectify with a fair amount of efficiency if its grid leak is connected to L.T. negative, or even if it is given a slight negative bias. In point of fact, the accepted explanation of grid leak and condenser rectification is every bit as true for a valve with circuit such as V_2 in Fig. 3 as for a valve arranged like V_1, unless the negative bias on the grid of V_2 is such that no positive half-cycle can cause any flow of grid current. You cannot have it both ways!

If we accept the explanation that a valve whose grid is partially insulated by a leaky condenser accumulates a slight surplus of electrons (negative charges) on its

Difficulties with L.F.—*continued*

grid at the end of a complete cycle, then that valve must rectify. We can reduce the rectifying effect to some extent by means of negative grid bias, but the fall in the positive plate potential, which takes place as the arrival on the grid of a positive half-cycle reduces the internal resistance of the valve and is often sufficient to set up a flow of grid current.

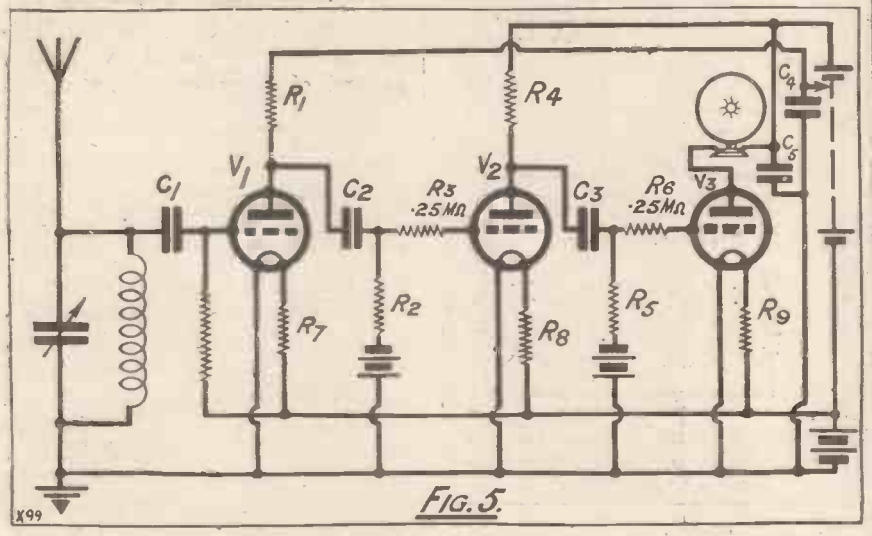


FIG. 5.

A Simple Experiment

Now if an L.F. valve such as V_2 does rectify at all, the result is bound to be that a certain amount of distortion occurs, for the essence of grid leak and condenser rectification consists in the suppression, partial or complete, of positive half-cycles.

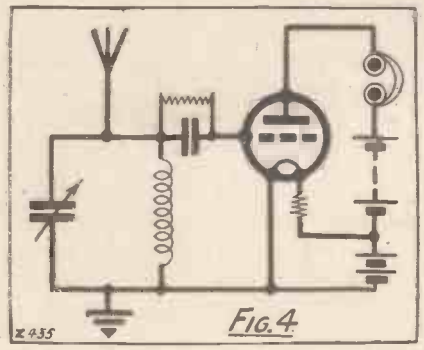


FIG. 4.

And there is another point which is not always realised. Anode-bend rectification to a greater or less degree frequently occurs in a resistance-coupled amplifier. A very simple experiment will show that this is the case. Hook up an anode-bend rectifier followed by one or more stages of resistance-capacity-coupled note magnification. In theory the negative potential on the grid of the rectifier which will cause detection to take place should be quite critical; it should be that amount which brings the working point just to the top of the lower bend in the characteristic curve. But is it? A trial will show that a valve so coupled will rectify with fair efficiency with its grid at any potential from zero to several volts negative; nor, if a potentiometer is used, will there generally be anything like the sharp, definite setting that one might expect. Instead, you will frequently find that a volt or more either way makes very little difference indeed to the working of the rectifier.

The Process Reversed

The explanation of this curious behaviour may be discovered by actually taking the grid-volts-anode-current curve of a valve with a high resistance in its plate circuit. It will be found that no sharp bend exists in most cases, but that (though a straight line may be drawn passing near many of the dots that one puts in to indicate the readings obtained) the greater part of the graph that lies to the left of the zero line is really not a straight line at all, but a very gentle curve. Now, the slightest curvature in the characteristic means that some kind of rectification must take place.

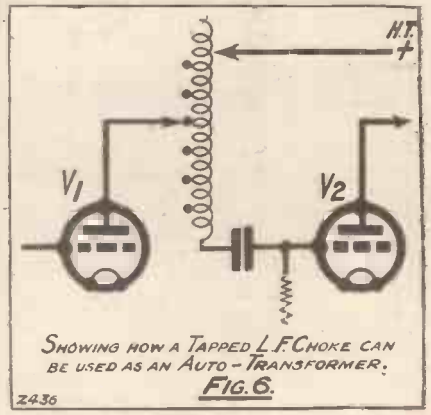
Unhappily, the two kinds of rectification which are liable to occur in a resistance-coupled amplifier—that due to the leaky-grid condenser and that caused by the slight curvature of the characteristic—do not cancel out. In complete grid leak and condenser rectification there is a suppression of the positive half-cycles; the plate current falls owing to the building up of negative charges on the grid.

In anode-bend rectification, however, the process is reversed, a suppression of the negative half-cycles taking place. The resistance-coupled amplifier, therefore, is liable to cause distortion by mutilating both halves of the wave forms. Actually the distortion produced is very slight in a well-designed amplifier of this kind; so slight, in fact, as to be almost unnoticeable.

Milliammeter Tests

Still, when a sensitive milliammeter with a very lightly damped needle is placed in the common positive lead which serves the two low-frequency valves in the Fig. 3 circuit, it may be found almost impossible so to arrange matters that the needle remains perfectly steady when signals of good strength are coming in. Clearly, then, resistance-capacity amplification is not quite above criticism.

And there are other difficulties in connection with resistance amplifiers. Not the least of these is a tendency to howl, which is due to the presence of unwanted high-frequency impulses in the low-frequency circuits. In a recent article in the WIRELESS CONSTRUCTOR Captain Round showed a way of overcoming this by using a resistance of about 250,000 ohms in the position shown in Fig. 5.



SHOWING HOW A TAPPED L.F. CHOKE CAN BE USED AS AN AUTO-TRANSFORMER.
FIG. 6.

This is a first-rate tip, and it is most effective provided that you obtain a proper balance between the resistance values of R_2 and R_3, and

(*Continued on page 357*)

OUR NEWS BULLETIN

Some of the More Interesting Happenings in the Radio World this Month

Indian Broadcasting Stations

Who will be the first British listener to pick up the new Indian broadcasting stations? In case you would like to have a shot at this difficult feat (and if it's not been done by the time these lines appear!) the call signs and wave-lengths are given below:

Bombay: Call sign 7 B Y, wave-length 357·1 metres.

Calcutta: Call sign 7 C A, wave-length 370·4 metres.

A Wireless Wife

"Say, 'Rastus, why do you call your old woman 'Radio'?"

"Well, Bo, it's like this. Befo' I bring her home I have to get a licence, and then I find she picks up all the local news, and she talks and talks, and if I lay a finger on her dial she howls—and so I ses to myself, I ses, 'Rastus, you sho' got a Radio'!"

Ultra Short-Wave Work

Amazing as it may seem to short-wave workers, an account has just been received of reception on *ultra*-short waves, using an ordinary four-pin three-electrode valve. The experimenter concerned has actually been down as low as 7 *metres*, the valve employed being an ordinary 4-volt Cossor!

F.F.B. & Co. to Retire?

Is wireless photography going to make the Morse code unnecessary? Will telegrams and messages of the future be *photographed* across space, instead of being laboriously spelt out letter by letter?

They say that Mr. G. M. Wright, of the Marconi Co.—well known as a research worker and radio dark horse—is tackling the whole problem of picture transmission from a new angle at the Chelmsford laboratory. Should he succeed there will be an unparalleled and sensational clearing-up of the ether, for spark jamming will be a thing of the past. Good luck to you, Mr. Wright!

Aerial for Panel Mounting

According to a report from Paris the outside aerial is doomed. An engineer claims to have invented a gadget with a silvered copper wire, inside a sealed glass tube, that picks up broadcasting as effectively as an outdoor aerial.

Something of the kind was on sale about a couple of years ago, but in that instance purchasers found that the instrument had one great drawback—it wouldn't work!

A 20-Metre Mystery

Rumours that the B.B.C. had installed a 20-metre try-out transmitter sent a good many listeners searching down on low waves recently. But all they could find were the usual harmonics and a mysterious Frenchman, whose numerical conversation suggested that he employed his whole time in counting sheep going through a gate! (Evidently not a B.B.C. station, for no soporific of that type is needed on *this* side of the Channel.)

(*Continued on page* 355.)

WHAT'S NEW

—*continued from page* 344

lower broadcast band and the other for the upper band. The conventional plug and socket mount is used, the centre tap being taken by means of a pin terminal into a socket at the centre of a moulded case. Readers who are acquainted with the high efficiency of the standard Lewcos coils will be glad to welcome this new addition to the family.

An Interesting Accumulator Preparation

Messrs. D. A. R., Ltd., of Australia House, London, W.C.2, have submitted to us for test a substance known as "D. A. R.," which is guaranteed to "desulphate a sulphated battery provided the plates are mechanically sound and the battery not otherwise defective." As any substance which will really fulfil this claim is of great use to the wireless experimenter, careful tests were undertaken.

D. A. R. is a liquid which is sold in 6-oz. blue glass bottles. It is colourless, transparent, and odourless. The instructions on the bottle are that the old acid should be emptied from the cell to be treated and the cell thoroughly washed with distilled water, after which it is refilled with a fresh solution of electrolyte to which 1 oz. of D. A. R. to each pint has been added. The battery is then charged in the usual way.

It so happens that in an odd corner of the laboratory stood two 2-volt 10-amp.-hour accumulators in celluloid cases. They had been so badly sulphated that they were abandoned over a year ago, since when they have been untouched, and, as a matter of fact, the electrolyte had evaporated down to half the normal level. The cells in question had been forgotten, or they would have been thrown in the dustbin long ago. They were therefore chosen for the test and incidentally were in a far worse condition than any cell the average amateur is likely to want to treat with the substance.

First of all, the cells were washed out and some new electrolyte of standard specific gravity for these cells poured into a jug, a pint being used. One ounce of D. A. R. was added and the cells filled up.

In the first five or ten minutes there was no obvious change, but after that time the sulphate did appear to be reduced. The battery was now on charge at one and a half amperes, which is the standard rate for these cells, and after an hour both cells were quite hot, showing a high internal resistance. Observation after an hour or two showed a slight further reduction in the visible sulphate. These cells take a very small amount of electrolyte, and for this reason it was thought that possibly the active material in the solution had been exhausted. For this reason the electrolyte was twice emptied and both cells were filled up again with new acid and D. A. R. A further diminution of sulphate took place fairly rapidly.

Exit the Sulphate

After twenty-four hours' charging practically all the sulphate had disappeared, and the cells were put on discharge at one ampere at 1.30 p.m., the voltage on discharge of the two cells being four volts. At 3 p.m. the internal voltage was 3·85, at 3.30 p.m. it was 3·8, at 5.30 p.m. it was 3·6, and 6.20 p.m. 3·5. Individual tests showed that one cell showed 1·8 volts and the other 1·7.

The cells were now charged again for another twenty-four hours, the

(*Continued on page* 354.)

Invaluable to every Amateur and Constructor

The "POPULAR WIRELESS" BLUE PRINTS

of Tested Circuits

The following is a *complete* list of the "P.W." 6d. Blue Prints for Constructors, showing the different circuits available.

P.W. BLUE PRINT Number

1. DETECTOR VALVE WITH REACTION.
2. UNIDYNE DETECTOR VALVE WITH REACTION.
3. 1-VALVE L.F. AMPLIFIER.
4. CRYSTAL DETECTOR WITH L.F. AMPLIFIER.
5. H.F. (Tuned Anode) AND CRYSTAL, WITH REACTION.
6. H.F. AND CRYSTAL (Transformer Coupled, without Reaction).
7. 1-VALVE REFLEX WITH CRYSTAL DETECTOR (Tuned Anode).
8. 1-VALVE REFLEX AND CRYSTAL DETECTOR (Employing H.F. Transformer, without Reaction).
9. H.F. AND DETECTOR (Tuned Anode Coupling with Reaction on Anode).
10. H.F. AND DETECTOR (Transformer Coupled, with Reaction).
11. DETECTOR AND L.F. (With Switch to Cut Out L.F. Valve).
12. DETECTOR AND L.F. UNIDYNE (With Switch to Cut Out L.F. Valve).
13. 2-VALVE REFLEX (Employing Valve Detector).
14. 2-VALVE L.F. AMPLIFIER (Transformer Coupled, with Switch to Cut Out Last Valve).
15. 2-VALVE L.F. AMPLIFIER (Transformer-Resistance Coupled, with Switch for Cutting Out Last Valve).

P.W. BLUE PRINT Number

16. H.F. (Tuned Anode), CRYSTAL DETECTOR AND L.F. (With Switch for Last Valve).
17. CRYSTAL DETECTOR WITH TWO L.F. AMPLIFIERS (With Switching).
18. 1-VALVE REFLEX AND CRYSTAL DETECTOR, with 1-VALVE L.F. AMPLIFIER, Controlled by Switch.
19. H.F. DETECTOR AND L.F. (With Switch to Cut Out the Last Valve).
20. DETECTOR AND 2 L.F. AMPLIFIERS (With Switches for 1, 2, or 3 Valves).
21. THE 2-VALVE LODGE "N."
22. "THE GUARANTEED REFLEX."
23. THE 1-VALVE "CHITOS."
24. THE "SPANSPACE THREE." Three-Valve Receiver employing 1 Neutralised H.F. Valve, Detector with Non-Radiating Reaction Control, and 1 L.F. Valve.
25. 2-VALVE REINARTZ (Det. and L.F.).
26. A "STRAIGHT" 4-VALVER (H.F., Det., and 2 L.F. with Switching).
27. A "MODERN WIRELESS" 4-VALVER (2 H.F., Det., and L.F.).
28. A "MODERN WIRELESS" 5-VALVER (H.F., Det., and 3 L.F.).

ALL "POPULAR WIRELESS" BLUE PRINTS 6d. EACH

All orders for these Blue Prints should be sent direct to the "Popular Wireless" Queries Department, Fleetway House, Farringdon Street, London, E.C.4, enclosing a stamped addressed envelope and a postal order for 6d. for each Blue Print ordered.

WHAT'S NEW

—continued from page 352

acid being changed after about six hours. The second charge effected a very considerable improvement in the colour of the plates, and at the end of the second twenty-four hours all plates looked very healthy, the negatives being light grey and the positives dark brown. The negative plates were quite clean and the positives almost so, with a trace of sulphate here and there. There was still a little visible sulphate left on some of the wood separators.

One of the cells was now taken to pieces and the plates removed. It was noted with satisfaction that there had been no appreciable shedding of the active material, the plates being strong, and what little visible sulphate remained could be wiped off with the finger. The plates were washed, put back in the cell, and given a further charge of two or three hours. After two hours at a two-ampere rate there was no appreciable rise in temperature.

The Discharge Test

By this time both cells appeared to be in quite excellent condition, and on being taken off charge and stood aside for three hours they showed at the end of this time 2·2 volts per cell (open circuit). One of the cells was put by and used for several practical tests at various reasonable discharges, and stood up well. In all appearance it is now quite a healthy cell. The other was put on a proper discharge test to see to what extent its capacity had been affected.

The discharge at one ampere was begun at 9.30 a.m. At the beginning of the discharge the voltage of the cell on discharge was 2·1. After an hour this figure had fallen to 2. Hourly tests up to 2.30 p.m. showed that the voltage was maintained at 2, and at 3.30 the voltage had dropped to 1·9. By 5.30 the voltage had dropped to 1·85, at which point useful discharge was considered finished.

It will thus be seen that out of a battery retrieved from the scrap-heap it was possible to make a useful cell, having a capacity of about seventy-five per cent of its rating when new—no mean achievement.

So far as our tests have been conducted the makers' claims appear to be borne out in practice, and we shall watch further tests with interest.

OUR NEWS BULLETIN

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Bound to Keep

Readers who bind their volumes of the WIRELESS CONSTRUCTOR have inquired how the numbering of future volumes will be carried out, and how many issues will be in one volume.

In future a new volume will be commenced every six numbers. But the numbers of the monthly issues will run consecutively, and will not revert to 1 at the commencement of every new volume.

Broadcasting Incognito

Announcers who marvel at the long-distance records set up by some broadcasting stations should listen-in to P C J J if they wish to learn the secret of such success. It is not only the wave-length, the degree of modulation, the wonderful technical excellence that does the trick—but the simple, artless, honest-to-goodness habit of announcing the call sign clearly, at frequent intervals!

P C J J does it in Dutch, in English, in French, and in German. And if only other stations would copy his example, the DX listener would be a happier—and more truthful!—man!

Low-Power Legerdemain

I see that G 5 K L has been talking to a Canadian ether-pal of his on 45 metres. The remarkable part of this performance was that, although the stations were 2,500 miles apart, G 5 K L was only putting 925 watts into his Mullard transmitting valve.

It just shows what one one-watt-er will do!

Szigetszentmiklos

I hear that the Austrians are going to put up a regular whale of a station near Budapest. The actual site is to be at a place called Szigetszentmiklos.

For the poor announcer's sake it is to be hoped that they decide to call this the "Budapest" station, and not Sziget-and-the-rest-of-it.

Turkey Talking

Several readers have informed me that they have picked up Stamboul, the new Turkish station that has been on the air only a month or so. Personally, I have not heard a sound of this Young Turk, though he is said to be "quite strong" on an H.F., Det. and L.F. set, when the conditions on 1,200 metres are good.

MORE ABOUT SCREENED COILS

—continued from page 303

This reaction winding is included in all the standard coils, but is only used in the stage preceding the detector valve.

In the remaining stages the terminal No. 6 is left blank, since the extra winding is not required.

Reaction Condenser

These coils are therefore interchangeable, but it is dangerous to place the aerial coil for use with split-primary transformers in any of the H.F. transformer bases. The aerial coils have tappings Nos. 3 and 4 connected to the secondary winding, and if the coils are inserted accidentally into an H.F. transformer base the H.T. battery will be short-circuited through the coil.

The constructor may be a little hazy as regards the correct size reaction condenser to use with split-primary transformers. This should be fairly large if the screens are used. ·0002–·0003 is about right, and it is quite easy to bring down the capacity by placing a ·0003 fixed condenser in series. A neutralising condenser is not large enough if the H.F. valves are correctly neutralised.

The best valves to use with the standard H.F. transformers are those having an impedance of 20–30,000 ohms and an amplification factor of 20 or more if possible. If the impedance is greater than this value it is necessary to increase the number of turns on the primary and neutralising windings. When not neutralised the H. F. valves ought to oscillate freely when the circuits are brought into tune. If self-oscillation does not occur it is useless to expect to obtain maximum efficiency, but in some cases an increase in the H.T. voltage to about 90 helps matters.

Avoiding Hand Capacity

When split-secondary transformers are employed, hand-capacity effects are sometimes rather troublesome if the set is critically adjusted. It is important to connect the fixed vanes of the variable condensers to the grids of the valves, and it is inadvisable to employ metal screens between the condenser dials and the plates. If slow-motion dials are desired, choose those which are constructed of bakelite or a similar non-metallic substance.

The reaction condenser used in conjunction with the split-secondary type of coil should be very small, and those of the neutralising type are usually suitable. The reason for this is that instead of a small winding as in the split-primary transformers the reaction winding is virtually half of the secondary coil, hence it is very easy to produce oscillation.

When Screens Are Essential

With sets employing two H.F. stages the split-primary transformers will give excellent results, but if three stages are desired I would recommend the use of the split-secondary type. Whenever more than one stage is employed screening is essential, but for a simple detector valve, or with one H.F. stage, better signal strength will be obtained without the screens. Choose your valves carefully and use ample H.T.

IMPROVING YOUR METAL-WORK

—continued from page 330

prepared paint, only a little linseed oil may be added instead of so much of the other ingredients.

This may take longer to dry, but when quite hard shake up the original paint in the tin and give a final coating of that. Brush on all the coatings very thinly in preference to giving fewer thick ones. Four thin coatings gives greater protection than two thick ones on metal.

An excellent way of getting a good even finish on any metal-work is by means of bronze paints, of which there is now considerable variety of colour. Copper, brass, gold, silver, can all be imitated by this means, and when neatly done few things look better. The important point is to obtain only a good quality of bronze powder. There are special mediums for fixing the powder, but a good colourless celluloid lacquer answers admirably. This may be mixed with the bronze powder to form a liquid paint, or the powder may be applied by means of a sprayer on the surface previously prepared by coating with the lacquer. A glossier finish is then obtained by coating the powder over with a spray of lacquer.

A Shot-Silk Finish

The preparation of the metal surface is of even greater importance for this finish than for paint. Every part must be clean and smooth. Some fine effects can be got by mixing certain

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IMPROVING YOUR METAL-WORK

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pigments with the powder in specific proportions. Black in small quantities with a copper-bronze powder gives a dark bronzed shade, and a little indigo blue with a gold-coloured powder gives a fine shot-silk appearance.

Some of this bronze powder can be bought of a bright green tint. This, in given proportions with a copper powder, gives another kind of shot-silk finish, but the secret lies in the proper proportioning and thorough mixing to which attention must be paid. Loud-speaker horns finished in this style look well and always last a long time.

DIFFICULTIES WITH L.F.

—*continued from page* 348

R_5 and R_6. Failure to do so will mean a distinct loss in signal strength. The values of R_2 and R_5 are to no small extent fixed by those of R_1 and R_4. It must not be forgotten that in the plate circuit of V_1, R_2 must be regarded, so far as oscillating currents are concerned, as in parallel with R_1.

There are two alternative paths to earth for these. The first is via R_1 and C_4, the second via C_2 and R_2. When two impedances of different values are placed in parallel the total impedance is less than that of the smaller, and in any case the total impedance of the circuit is reduced. Unless, therefore, we keep R_2 up to a fairly high value with respect to R_1 we undoubtedly reduce the impedance in the plate circuit of V_1, and therefore obtain less amplification than should come our way.

A Fact to Face

As an alternative to resistance-capacity coupling transformer coupling has both advantages and disadvantages. On the one hand it gives a respectable voltage step-up in the transformer itself, owing to the ratio between primary and secondary turns. On the other we are faced by the fact that the total number of turns in both windings of the transformer is definitely limited by certain considerations. A big step-up can in fact be obtained only at the expense of primary turns, and therefore of primary inductance. Now, unless the

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THE "NEW FAMILY FOUR" AT HOME

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sharper. There is a slight advantage in using a higher voltage than 60 on the H.F. valve (H.T. positive two), but if this interferes with the stability and you cannot obtain a proper neutralisation, due to your valves being very "lively," a reduction of the H.T. positive two voltage will make the set stable again. In most cases 60 volts will give full stability.

If your nearest station is some distance away, another method of neutralising must be used.

Another Neutralising Method

Start with the neutralising condenser plates all out and the reaction condenser at zero, and then place the second condenser at 0° and turn the first condenser backwards and forwards, noting whether oscillation occurs at any point. If so, enmesh the neutralising plates a little and repeat at every five degrees.

One other matter regarding valves requires mention. There are one or two makes of R.C. valves with a very high internal impedance, such as the B.T.H. B8 in the 2-volt series. With these there is great difficulty in obtaining reaction, and these particular valves, although excellent when used in certain circuits, are not advised for use as a detector with reaction. Two-volt R.C. valves which work excellently in this set are the Cossor R.C., Mullard P.M.1a, Electron S.S.2, R.C., Cosmos S.P.18B. A safe guide in the 2-, 4-, or 6-volt series is to use an R.C. valve which has an impedance of not more than about 80,000 ohms.

Getting a Graph

Owing to the two coils tuned by the two variable condensers being of different types you will not get identical readings on both dials. For this reason, and as the set is very sharp in tuning, it is as well to note the readings and wave-lengths of the stations as you pick them up, and then, when you have gathered up quite a number, to plot a chart similar to that shown above, joining the various points by a continuous line. In this way

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THE "NEW FAMILY FOUR" AT HOME

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you will get a "graph" by which you will be able to read off the approximate position of any station you have not so far picked up, by looking at its wave-length on one scale and reading off on the other scale the condenser degrees for the two variable condensers. The graph illustrated is that of the original set.

Reaction control is very simple, and when the set is neutralised there should be no "backlash" whatever. You should be able to pick up quite a number of stations without altering the reaction setting. When hunting for very distant stations, or when you want to get a higher degree of selectivity, a little reaction control is a very great help.

Saving Filament Current

When you have your set going well it is not a bad plan to turn the variable filament resistance towards the "off" position as far as it will go without reducing the efficiency of the set. On 6-volt ·1 amp. valves you will be able to turn the knob nearly to the "off" position, i.e., you will be able to use practically all the resistance in series with the filament without noticing any drop in efficiency. When you do this, of course, you are running the valve at a lower temperature than normal and its life should be appreciably increased.

COILS FOR THE "NEW FAMILY FOUR."

In the list of components given last month it will be noticed that split-primary Reinartz transformers were specified. These transformers are, of course, ordinary *standard* split-primary H.F. transformers (which include a "Reinartz" winding) and must not be confused with the standard Reinartz coils of the type described on page 239 of the same issue.

On quarter-ampere valves, or on any of the 2-volt series, you will find that the variable filament resistance acts an as excellent volume control, reducing the strength of the output without introducing distortion. It can also be used occasionally on all makes of valves as a very delicate reaction control.

Automatic Switching

Whether you use a plug or the terminals for connection to your loud speaker is a matter for your own

(*Continued on page 360.*)

DIFFICULTIES WITH L.F.

—continued from page 357

primary inductance has a high value we find ourselves up against a very serious cause of distortion.

Owing to the fact that it contains inductance, the impedance of the transformer primary varies continually with the frequency. To oscillating impulses corresponding to a very high note the impedance will be large; to those corresponding to a low note it will be comparatively small. Hence, with a transformer of small primary inductance value there will be an over-emphasis of the higher notes and a suppression of the lower.

Primary Impedance

This suppression can be avoided only by making the primary impedance considerably greater *at all frequencies* than the valve impedance. Hence with a valve of comparatively high impedance we must use a transformer whose primary has a big inductance value, though with a valve whose impedance is low a much smaller impedance for the transformer primary will suffice. In practice, excellent reproduction can be obtained with transformers so long as the primary impedance at the lowest audible frequency is four or five times that of the valve.

Screened Transformers

In any amplifier containing two transformers the Round quarter-megohm resistance should certainly be used between the grid of the first valve and OS of the transformer, and it frequently pays to employ the same system in the grid circuit of the second note-amplifier. Screened transformers should be used, and their screens should be earthed.

THE "NEW FAMILY FOUR" AT HOME

—continued from page 359

choice. The advantage of using the terminals and permanently connecting the loud speaker to them is that if you listen on the telephones on either three or four valves, withdrawing the plug automatically switches on the loud speaker with all four valves. On the other hand, if you wish to compare loud speakers it is very convenient to have a plug connected to each of the loud speakers to be tested. You can then plug in one or the other very rapidly.

If you are working on the local programme from a station not more than ten or fifteen miles away, a considerable economy can be effected by tuning in the station in the usual way and then withdrawing the H.F. valve from the first socket without altering the neutralising condenser setting.

Filament Connections

If you are twenty or thirty miles away from the station, and this method reduces signal strength too much, leave the H.F. valve in circuit, connect your loud speaker to a plug, and plug it into the first jack.

You will then be able to economise the filament current of the last valve, by removing the filament resister from its holder. The valve itself can remain in its holder, in this case.

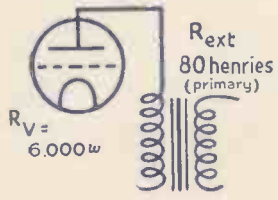
A final point regarding the filament wiring. On the wiring diagram on page 228, it should have been made clear that the top-of-baseboard connection from 2 and 43 to the fixed resistor should also have made contact with its adjacent filament contact on the valve holder.

INDEX TO ADVERTISERS

To True Radio Reproduction

The Wrong Way

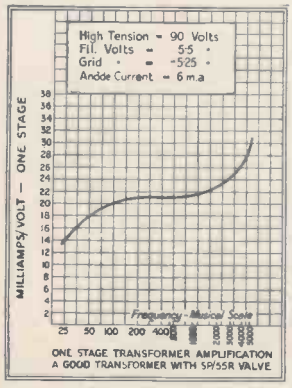
Transformer Coupled



Primary ...	80 henries
Ratio	3 : 1
Voltage Factor ...	10
Valve Impedance ...	6000 ω

Resulting Magnification

25 cycles	20·2
50 „	24·2
100 „	26·8
400 „	29·2
1600 „	29·8



SOME THEORETICAL AND PRACTICAL CONSIDERATIONS

Poor reproduction is nearly always attributable to the irregular or faulty amplification due to L.F. Transformers. The considerations outlined below make theoretical and practical comparisons between L.F. Transformer (or choke) and Resistance coupled circuits.

THEORETICAL

The impedance of a resistance is constant at all frequencies, while that of a transformer primary (or choke) varies directly with the frequency. Consider the circuits represented by the adjoining diagrams, bearing in mind the formula:—

$$\text{MAGNIFICATION OF A VALVE AND COUPLING} = \frac{\text{Imp. of Circuit} \times \text{V.F.} \times \text{Ratio}}{\text{Imp. of Circuit} + \text{Imp. of Valve}}$$

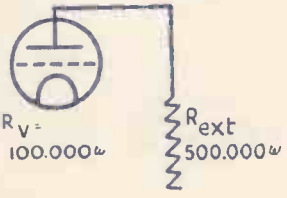
The results as tabulated show that whereas with L. F. transformer coupling the magnification will vary with the frequency, it will be constant with resistance coupling.

PRACTICAL

The curves reproduced make the practical comparison of actual results for one stage of L.F. amplification. The curves for two stages are even more striking. With Transformer Coupling distortion at high frequencies is due to resonance in the windings and at lower frequencies to insufficient primary inductance. With Resistance Coupling the slight distortion at higher frequency is reduced to the small value shown, by the avoidance of a too high value of anode resistance. The form of coupling used is the "Cosmos" Resistance Coupling Unit, which comprises a correctly proportioned condenser with an anode resistance and a grid leak, and the unit is guaranteed.

The Right Way

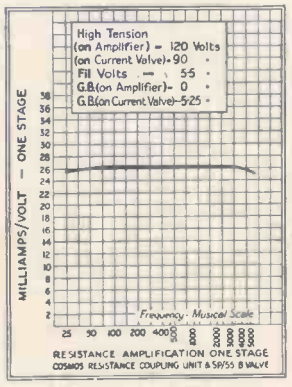
Resistance Coupled



Resistance ...	500,000 ω
Ratio	1 : 1
Voltage Factor ...	35
Valve Impedance	100,000 ω

Resulting Magnification

25 cycles	29
50 „	29
100 „	29
400 „	29
1600 „	29



You'll get good reproduction when you use

Cosmos

RESISTANCE CAPACITY COUPLING UNIT

Advert. of Metro-Vick Supplies Ltd. 155 Charing Cross Road, London, W.C

New Improvements ~ New Additions

BI-DUPLEX WIRE WOUND

TAPPED RESISTANCES

These new components mark a still further advance over our original Bi-Duplex wire-wound Tapped Resistances. The general design has been improved, and our latest models are supplied with both terminals and sweating tags. Supplied in three different sizes.

Note Reduced Prices

10,000 ohms 4 Tappings 12/6

60,000 ohms 6 Tappings 15/-

150,000 ohms 6 Tappings 17/6

UNIVERSAL HOLDER HORIZONTAL MOUNTING

We have now designed a UNIVERSAL HOLDER for our well-known Bi-duplex wire-wound anode resistances. This new holder is a very neat job, takes up remarkably little space, and is beautifully finished. It can be fixed either horizontally or vertically, and constructors will appreciate the remarkable degree of latitude in set building which this new holder allows.

The Resistances themselves remain unchanged — they are wire wound on the famous Bi-duplex system and ensure the same degree of reliability, efficiency, and purity of tone, as of old.

Made in a complete range of sizes up to 500,000 ohms.

Prices complete with UNIVERSAL HOLDER (no increase).

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Power type *from* 8/6 to 20/6

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