ANOTHER FREE GIFT STEEL WIRELESS SPANNER WITH THIS ISSUE!

Practical Wireless

3D.

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THE LEADING HOME CONSTRUCTORS' WEEKLY!

Practical Wireless

EDITOR:
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ROUND *the* WORLD *of* WIRELESS

Swiss Radiodiffusion Services

THE relay services by which subscribers in many Swiss cities are given the broadcasting programmes *via* the telephone system have been so arranged that the intervals in the Swiss studio programmes are filled by taking entertainments from neighbouring countries. Such cities as Berne, Basle, St. Gall, and Lausanne at odd times relay concerts and other radio programmes from Bremen, Leipzig, Frankfort, Stuttgart, Lugano, and Milan. In this manner the subscriber has music on "tap" throughout the day and evening hours.

Would You Recognize Your Voice?

IT has been the experience of many broadcasting artists and speakers to be told by acquaintances who have listened to them that their voices were not recognizable on the air. But how many people would recognize their own talking voice as reproduced on a gramophone record? In experiments recently made at the Physiological Institute at Berlin, "phonograms" of a number of students were made, and it was found although production was as nearly perfect as possible, the original speaker was seldom able to pick out his own record. Similar tests were made with dogs, by playing a record of their master's voice; in each case the animal showed recognition, but a reproduction of his own bark merely raised the idea that a strange dog was in the room!

New High-Power Romanian Station

BOD (Brenndorf), some seven miles distant from Brasov, is the site chosen for the new high-power Romanian station destined to take over the Bucarest transmissions. According to the new Lucerne Plan the exclusive wavelength of 1,875 metres (160 kc/s) was allotted to Romania with freedom to use in that channel up to 150 kilowatts. It is hardly likely that plant of such energy will be installed, but as the wavelength is one which Holland is not likely to relinquish, it is expected that another position in the waveband will be sought. The sharing of such a channel with the Kootwijk (Holland) station would be out of the question.

Jubilee of the Accumulator

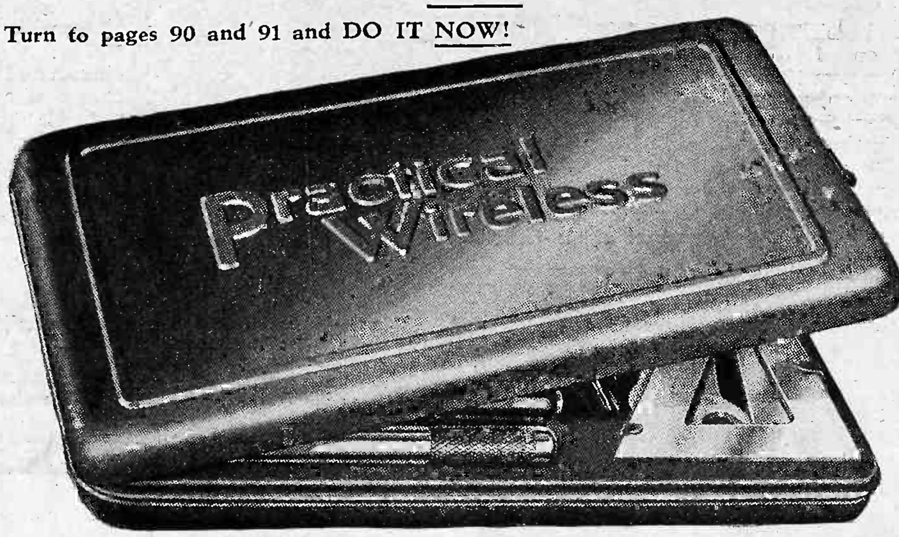
AN International Committee has been formed in France to arrange for centenary celebrations, in 1934, of the birthday of the French scientist, Gaston Planté, the inventor of the electrical accumulator. Devised by him in 1859, it was originally made up of two sheets of lead separated by rubber strips and rolled in spiral form. It was the forerunner of the low-tension accumulator as used to-day.

The Amateur Transmitter's Paradise

APPARENTLY Brazil fulfils these conditions, for according to a recent report radio fans wishing to install transmitting stations may do so "without let or hindrance." The annual subscription is a small one and the limit of power allowed 1 kilowatt!

HAVE YOU RESERVED YOUR POCKET TOOL KIT?

Turn to pages 90 and 91 and DO IT NOW!



THE HANDIEST POCKET KIT OF TOOLS

This illustration shows the handy size and form of our Birthday Offer Tool Kit. It contains one four-inch Chesterman rule; one steel pocket scriber with chuck; one accurate 50-degree steel set square; a pair of ebonite test prods; one reflecting mirror for viewing obscure parts of the set; one set of trammels, with heads, for scribing, cutting holes in ebonite, etc.; one steel centre punch, and one handled screwdriver. The case is of metal finished in blue, and is especially reinforced with a metal-recessed bed into which the tools snugly fit. Owing to the extreme care used in manufacture and the length of time taken to produce these Kits, *it is necessary for every reader to reserve without delay, as the offer is only available for a short time. Turn to pages 90 and 91 and comply with the conditions now!*

Listen to the News Reel

EVERY Saturday evening between October 14th and December 30th, the B.B.C. will broadcast a news reel consisting of a summary of the outstanding events of the day, followed by a reproduction of the details of the events. These will include such items as eye-witness accounts.

Muhlacker Temporarily Closing Down

IN order to permit the erection of new aerial masts, the Muhlacker 60 kilowatt station will temporarily suspend its broadcasts; the programmes will be put out by the older 1½ kilowatt plant. Later, Muhlacker, of which the power is to be increased to 100 kilowatts, will exchange wavelengths with Munich.

An Expensive Toy!

ACCORDING to the French newspaper *L'Antenne*, the price paid by the French Ministry of Posts and Telegraphs for the new Radio-Paris transmitter, which is being taken over by the State in November, is some twelve million francs. At to-day's rate of exchange this works out at roughly £150,000. Yet if rumour is to be believed, the Paris P.T.T. contemplates erecting another high-power station in the neighbourhood of the French capital.

ROUND *the* WORLD *of* WIRELESS *(Continued)*

Radio-Paris P.T.T.

FROM November 1st, the high-power transmitter erected for Radio-Paris at Remy St. Honoré near the French capital will be taken over by the State authorities, and from that date will act as a unit of the P.T.T. network. It has not yet been decided whether and when the entertainment broadcasts from the Eiffel Tower are to be suspended, but if and when this takes place the station will solely carry out its official telegraphy and telephony transmissions.

The Freedom of the Ether !

WITH the launching on the German market of the *Volksempfaenger* (People's Receiver), which the wireless industry in that country has been required to produce at a low price, steps are to be taken by the authorities to prohibit owners of other types of multivalve sets from listening to foreign broadcasts. The VE 301 (People's Receiver) is a two-valve battery or mains set designed to permit its owner to listen *only* to the *Deutschlandsender*, and to his local transmitter. Every effort is to be made to bring this set into general use in Germany. Persons convicted of listening to foreign anti-Nazi broadcasts are liable to a heavy fine, imprisonment, and to immediate confiscation of their wireless receivers !

Interference

THE transmitter from which occasional broadcasts are to be heard in the background of the Hilversum programmes on 1,875 metres, is Moscow (RCZ), a new 100 kilowatt station used for telephonic communication with other Soviet cities. Another station in the Russian capital, RAX, on 1,760 metres, with a power of 30 kilowatts, may sometimes be tuned in when Radio-Paris is silent. During the past few months the Soviet authorities have added many new stations, working on both medium and short waves, to their ever-increasing radio system.

Late Night Special

FOR the benefit of British listeners to the night concerts of Radio Normandie, the Fécamp studio now broadcasts a special news bulletin in the English language between midnight and 12.15 a.m., B.S.T.; it is followed an hour later by a French transmission of news from Paris.

A Weekly Ether Tour

IF, on occasion, you should pick up an English or foreign programme on a wavelength immediately below that of Scottish Regional make a note that it may emanate from Radio Lyons (France) which as a weekly "treat" takes its local listeners for a tour through the European ether. The foreign broadcasts are captured by the Radio Club of Lyons, and passed over by land-line to its more powerful colleague. In this call the announcer will refer to the city as *Lee-yon*, and not *Lyons* as we know it on this side.

Anti-Propaganda Measures

FOLLOWING steps taken by the governments of Czechoslovakia and Lithuania against the public broadcasts of propaganda talks adverse to their respective countries, Austria has also passed a similar law prohibiting its nationals from listening to foreign transmissions of that nature. In the last country, where conviction is obtained, the culprit may be condemned to three months' imprisonment.

A Popular Relay

ON September 30th, the B.B.C. will place its microphones at the Sadler's Wells Theatre (Islington) for the relay of Act I of Gounod's opera *Faust*, for the benefit of listeners to the National programme.

Japan's Broadcasters

THE number of registered listeners in Japan has already reached 1,470,000, the majority of licensees using crystal or small two-valve receivers. Eight of the bigger stations in daily operation are: JOAK, Tokio (345 m.); JOHK, Sendai (394.7 m.); JOIK, Sapporo (361 m.); JOBQ, Osaka (400 m.); JOCK, Nagoya (370.3 m.); JOGK, Kumamoto (380 m.); JOFK, Hiroshima (353 m.); and JODK, Keijyo (435 m.); with the exception of the last transmitter all are rated at 10 kilowatts. In view of the great success achieved by the broadcasting system, the authorities are considering the installation of a 150 kilowatt station in the neighbourhood of the capital. Without doubt, on favourable nights broadcasts at such power would be heard in Europe.

Entertaining the Troops

IN Italy, a special radio-cinema motor lorry has been attached to the Army during the summer manœuvres. It is fully equipped with electrical turntable, pick-up, and amplifiers, as well as with a talkie projector and wireless receiving apparatus. The entire installation is worked by a picked staff of engineers. The lorry follows the troops on the march, providing them with martial music en route, and in the evenings furnishes both cinema and radio entertainments. By means of a public address system of multiple loud-speakers entertainments, including broadcasts of news bulletins, are given to a very large military audience.

Vaudeville and Revue

FOR the autumn and winter months the B.B.C. announces great plans for the development of the lighter kind of entertainment. From the end of September under the title of *First Time Here*, a vaudeville matinee will be broadcast every Saturday afternoon to which will contribute a number of artists appearing for the first time before the microphone. Billy Merson will appear in and present his own revue, and Elsie and Doris Waters will take the principal parts in a new show written by Ashley Sterne. *The Follies of the Air*, in future a regular feature, is a new concert party working on the lines of performances devised by the producers of *Songs from the Shows* and *The White Coons*. Musical plays, such as the great Drury Lane success *The Desert Song*, will also be adapted for ether transmission, and Kalmann's operetta, *The Circus Princess*, will be heard for the first time in English during the same month. The main item of the Christmas entertainment will be a grand pantomime, of which the subject is still being kept a secret.

Austria's Fifth Relay

CONTRARY to the original plan, the Ravag will build in the neighbourhood of Bregenz, on Lake Constance, a 2 kilowatt relay station, as the Vorarlberg district appears to be beyond the range of the Innsbruck broadcasts.

THE LATEST RADIOGRAM

A piano-shaped radio-gramophone, priced at £110.10.0, shown at the recent Radio Show at Olympia.

SOLVE THIS!

Problem No. 54.

Whitaker decided that he would build up a three-valve mains receiver, and accordingly wound a mains transformer and choke, using data obtained from our data sheets. He decided to use a Mullard V.P.4 for the H.F. stage, an Osram M.H.4 for the detector and a Mazda A.C. Pen. for the output stage. All these valves are rated at 200 volts maximum H.T., and he accordingly wound his transformer to suit the Westinghouse H.T. 7. All his figures and workings were correct; and when the receiver was finished and checked it was found to be perfectly O.K. Results were, however, very disappointing, volume being sadly lacking and quality very poor. All good components were employed and all were tested and found in order. What was wrong? Three books will be awarded for the first three correct solutions opened. Address your envelopes to The Editor, PRACTICAL WIRELESS, Geo. Newnes, Ltd., 8-11, Southampton Street, Strand, London, W.C.2, and post to reach here not later than October 2nd. Mark your envelopes Problem No. 54.

SOLUTION TO PROBLEM No. 53.

Blenkinsop made a mistake in the formula, which requires that the nominator of the equation should be the optimum valve load, and not its impedance.

The following three readers received books in connection with Problem No. 52.

F. Rooke, "Clyvdene," Bramstan Gardens, Bramley, Leeds; H. A. White, 39, Royston Avenue, Wallington, Surrey; A. E. Boozer, 125, Butt Rd., Colchester, Essex.

ARE MULTI-ELECTRODE DETECTORS Worth While?

A Practical Article Dealing with the Possibilities of the Different Types

By PERCY RAY

THE last twelve months have seen an increasing tendency towards the use of multi-electrode detectors, and a review of the receivers employing this form of rectification suggests that 50 per cent. of them would work far better with an ordinary 3-electrode valve, while a large percentage of the remainder fail to justify the extra expense involved. There are a few commercial receivers employing such an arrangement, but in all the cases that have come to the writer's notice there is reasonable justification for such a procedure.

Before going into the matter farther, the advantages and alleged disadvantages of multi-electrode detectors will require considerable investigation.

There are only three possible advantages:

(1) Greater gain.

(2) Superior quality of reproduction, and

(3) Less damping on the tuned circuit immediately preceding the detector valve.

Take first of all the question of gain, where the greatest justification for this form of detection has been found. A valve such as the Cossor MS/Pen-A has considerable possibilities. Readers will probably be aware that this valve is classed as a high-frequency pentode, although a far better idea of the valve can be conveyed by describing it as a screened-grid valve with an extra grid interposed between outer grid and anode to straighten out the kink in the characteristic, which is inevitable with the ordinary screened-grid valve. This valve will give 29 volts output when .55 volts are applied between grid and cathode. This represents a stage gain of just over fifty-four times, or, assuming a 3 to 1 transformer, a total gain of over 160.

It is difficult to see how such a gain could be obtained by the use of any 3-electrode valve, and where the number of valves is of paramount importance this valve might appear to be a candidate for the detector position. On the other hand, these valves, having practically no Miller effect, the damping on the preceding tuning circuit will be small.

The Miller Effect

At this juncture it will be as well to explain exactly what is meant by the Miller effect. Fig. 2 shows a triode valve with its preceding tuning circuit and succeeding coupling in the form of a 50,000 ohm resistance. The condenser shown in dotted lines is representative of the capacity existing between anode and grid, and it will be seen that a path can be traced through the condenser, through the resistance, through the H.T. battery or power pack to the other end of the tuned circuit. Consequently, the capacity and resistance in question are in parallel with the coil,

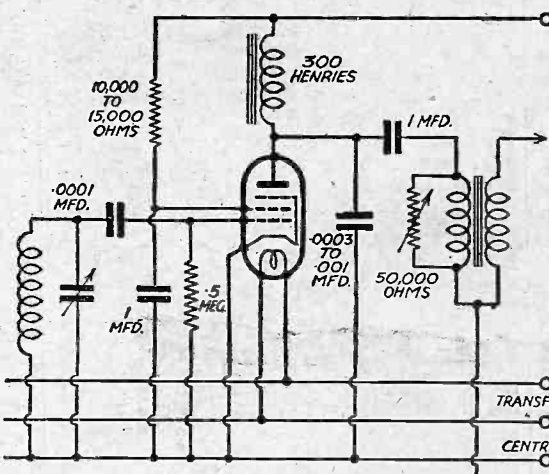


Fig. 1.—Circuit diagram showing a Cossor MS/Pen-A used as a power grid detector. This arrangement was employed in the A.C. Twin.

and will reduce the efficiency and selectivity considerably.

With a screened-grid valve the capacity between grid and anode is very small; consequently this effect is proportionately immaterial.

This explanation of the Miller effect would seem to indicate that the high-frequency pentode had the advantages of gain and extra efficiency, but unfortunately this extra efficiency is often a serious disadvantage, because modern components force the constructor to use everything screened except the short wires between one terminal and another. When the pre-detector coil is heavily damped by the detector valve, everything is all right, but when this damping is removed the average set becomes hopelessly unstable.

To achieve stability with such a valve extravagant screening is necessary, and infinite care must be bestowed on the actual layout of the chassis. Furthermore, if the set is to be used with reaction, the Miller effect is of no consequence, as the reaction will more than overcome the damping arising from this source.

This valve either requires an external anode voltage of 400 or else the inter-valve transformer must be choke-fed, and the total cost of the stage will be about equal to the cost of an ordinary detector, plus an L.F. stage with R.C. coupling between them, which would give greater gain than the high-frequency pentode by itself.

Summing up the high-frequency pentode within the meaning of the word at the time of writing, it would appear that although it probably represents one of if not the most advanced form of power-grid detector technique, it is doubtful if its presence is desirable under normal circumstances.

Following the lines of thought that we have just explored, the possibility suggests itself of using an ordinary pentode valve as a power grid detector, but much the same arguments can be applied, particularly in the case of a battery set where the relatively high cost of a pentode valve makes the use of two stages a definite economy; and furthermore, the difficulties of straightening out the peak in the middle of the speech band of frequencies practically throws away anything that may have been gained.

Screened-Grid Valves

The next multi-electrode detector that presents itself is an ordinary screened-grid valve, which automatically branches into two classes, the use of a high impedance or low-impedance type.

The high-impedance type offers remarkable gain and has great possibilities in receivers not employing any high-frequency stages; but when one or more such stages are used a high-impedance S.G. detector valve will overload far too easily.

(Continued on page 116)

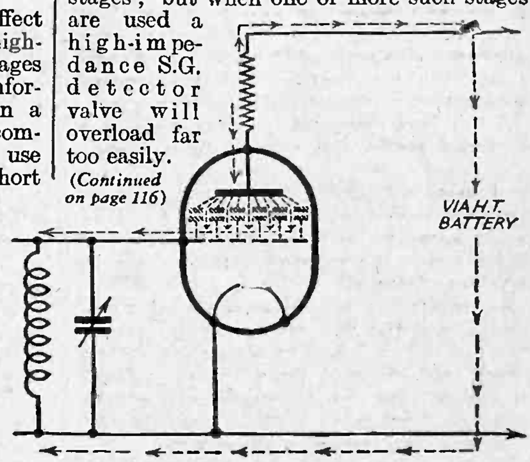
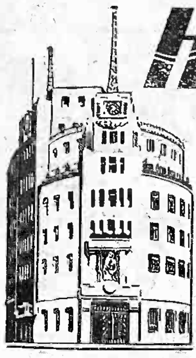
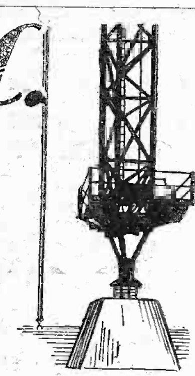


Fig. 2.—Showing how the component in the anode circuit is in parallel with the preceding tuned circuit via the grid to anode capacity of the valve. (Represented by ghost condensers). This condition is known as the "Miller Effect."



How the B.B.C. Does It



An Informative Article by our B.B.C. Correspondent on the Way in which the B.B.C. Experts Design and Operate their Receivers and Amplifiers. This Article will help you in Designing your own Apparatus

YOU can learn much from B.B.C. receivers and amplifiers, and many of the circuit arrangements used and component values chosen are a help when you come to designing apparatus for yourself. Examine the circuit diagram of the check receivers used at Broadcasting House and you will see what I mean.

These receivers are, of course, a little more elaborate than you would use for ordinary B.B.C. reception, as they are real quality jobs, and no expense is spared nor economy in valves studied. But they are planned for a rather special job, namely, the reception of local transmission with knife-edge selectivity and the best possible quality.

After all, this is what is wanted in any receiver.

In the case of the B.B.C. receivers at Broadcasting House, there are three. Each is tuned definitely to one station. Thus there is one for Daventry, one for London Regional, and one for London National. The tuning circuits are pre-set, and the adjustments checked over every morning. The sets themselves consist of a screen-grid H.F. stage and push-pull detectors. The output is coupled to an ordinary low-frequency amplifier to bring the volume up to loud-speaker level. However, each of the B.B.C. loud-speakers is fitted with a two-stage mains driven L.F. amplifier in addition.

H.F. and Detector Stages

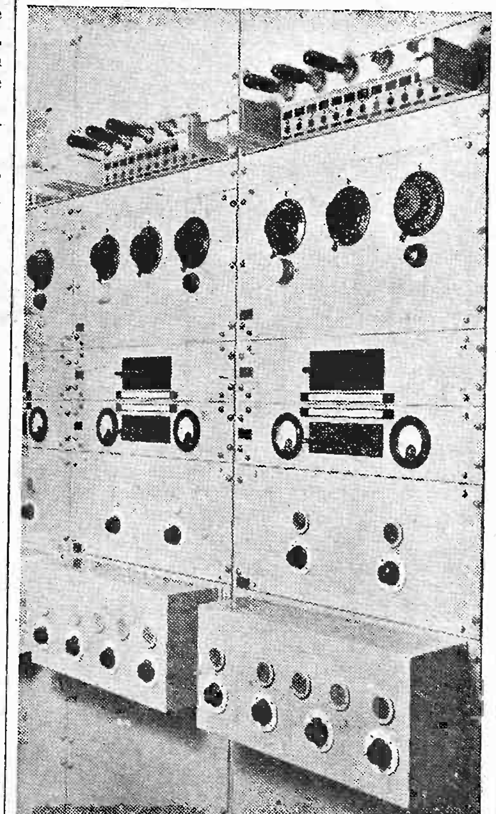
We will first concern ourselves with the H.F. and detector stages of the check receivers. The tuning circuit is normal. There is a tuning condenser of .0005 microfarads and a series condenser of .0002 microfarads. The tuning condenser is not directly in parallel with the coil, but there is a fixed resistance in series with the coil as part of the tuning circuit. The value of this resistance depends on the wavelength to which the set is tuned and is not the same in both the Daventry National and London National receivers.

A hundred thousand ohm potentiometer is placed across the whole tuning circuit as a pre-detector volume control. This is used to adjust the rectified current output from the detector and is always adjusted to the same value for all the receivers, so that there is the same output to the L.F. amplifiers from all of them.

An indirectly heated screen grid valve is used, and the bias on its normal grid is obtained by a 1.5 ohm resistance in the heater lead shunted by a .01 microfarad condenser. In the anode circuit of the screen grid valve is an H.F. choke and a by-pass condenser of 1 microfarad.

There is a common high-tension supply of 300 volts to all stages of the check receiver. There is a 20,000 ohm resistance in series with the screen grid valves to cut down the voltage for the anode.

A split primary H.F. transformer coupled between the screen grid valve and the push-pull detector stage. The coupling between the two primary sections and the secondary section of this H.F. transformer is variable, and both the primary and secondary are tuned. There is a .0003 microfarad condenser across the primary and a .0005 across the secondary. Incidentally the screening grid voltage for the screen grid valve is obtained by dropping resistances. There is a 35,000 ohm resistance between the main high-tension terminal and the screening grid itself.



Two of the check receivers at Broadcasting House.

Ordinary triode valves are used as push-pull detectors, and as there is a common 6-volt low-tension supply to the valves in the check receivers, 35 ohm resistances are placed in the filament leads to cut down the voltage. Half megohm grid leaks are used in both grid circuits of the push-pull detectors. A by-pass condenser of .0001 microfarads is used and there is resistance and condenser output to the L.F. amplifier line.

The mounting and arrangement of these check receivers is on conventional lines. The controls are carried on metal panels at the front and the main components are on brackets at right angles, but actually these panels are mounted in the control room racks at Broadcasting House. There are three tuning controls and a volume control on one panel, and the loud-speaker output arrangement and switches are on a separate panel beneath.

The output of each of these check receivers is taken to two separate L.F. amplifiers, one feeds the local headphones used for quality checking, and the other goes to the mains operated amplifiers installed in the engineers' listening rooms and in other points of the building. The purpose of the check 'phone amplifier is to prevent any feed back between the 'phones and the H.F. side of the circuit. As there is an intermediary L.F. amplifier the 'phones can be cut in or out of circuit as required without causing clicks to be heard on the loud-speaker line.

However, I do not want to take up too much space with a description of the way in which the B.B.C. uses its apparatus, but rather I want to show you how this apparatus is constructed.

L.F. Amplifiers

Now let us consider one of the ordinary low-frequency amplifiers which the B.B.C. engineers use for microphone and gramophone pick-up amplification. These are what is known as the "A" type amplifiers and are for the first stages of amplification. Power amplifiers, known as "B" amplifiers, are used for the later stages.

There are three stages in each "A" amplifier, but four valves. This is in order to suit the rather special B.B.C. needs of two separate outputs from each amplifier, and so there are two separate output valves, each with its own output transformer. Although the coupling between the valves and the amplifiers is by means of resistances, the coupling to the amplifiers in the first place is by means of an iron-cored transformer shunted with resistances.

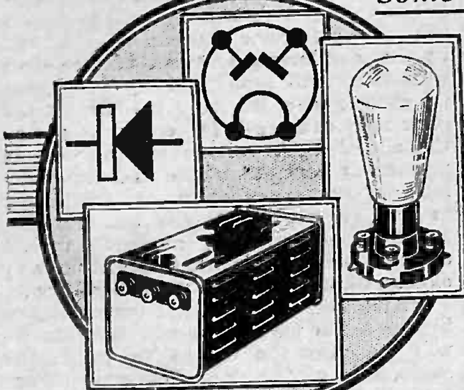
The iron-cored input transformer to the "A" amplifiers is shunted on the primary side by a 374 ohm resistance and on the secondary side by a .25 megohm resistance. There is a 10,000 ohm resistance in series with the slider of the potentiometer connected across the secondary side of the transformer. This potentiometer, of course, acts as a volume control.

All the four valves in the "A" amplifier are of the indirectly heated type and are triodes. Each valve is separately decoupled, and, of course, there are in addition the ordinary resistances of the resistance coupling. The anode resistance of the first stage has a value of 25,000 ohms and the decoupling resistance is 20,000 ohms. The decoupling condensers in both cases have a value of 2 microfarads and the coupling condenser between the first and second valves has a value of .5 microfarads. There is a .5 megohm grid leak and, of course, the usual automatic bias resistances. There are separate grid bias supplies of 2, 12 and 24 volts. The anode resistance in the second stage has a value again of 25,000 ohms, but this time the decoupling resistance has a value of only 10,000 ohms. The coupling condenser to both the output valves again has a value of .5 microfarads, and in the anode of each of the output valves there is a 6-microfarad condenser coupling an iron-cored choke to the output transformer for each stage; in series with the iron-cored choke in each anode circuit there is a 1,200 ohm resistance.

A 4-volt supply is given to the heaters

(*Continued on page 116*)

Some Interesting Points Concerning A.C. Mains Rectifying Valves



The RECTIFIER — and its Peculiarities

By H. J. BARTON CHAPPLE,
Wh.Sch., B.Sc., A.M.I.E.E.

EVERY owner of an A.C. mains set realizes that one of the most important elements in his equipment is the rectifier, the duty of which is to convert a portion of the alternating current supply to a uni-directional current so that, after it has been smoothed, it will serve as high-tension current for the various receiving valves.

Two types of rectifier unit are available, the electrolytic or metal rectifier and the two electrode valve rectifier. Both operate on the same principle, namely, that both pieces of apparatus will permit a current to pass in one direction but not in the reverse direction. Thus, if an alternating (that is, rapidly reversing) voltage as Fig. 1 is applied to a single rectifier, the actual current passing through the rectifier will consist of a number of impulses all in one direction, separated by quiescent periods corresponding to the negative halves of the A.C. cycles (Fig. 2). By a modified arrangement, using two or more rectifying units, the gaps between the half-wave impulses can be filled up as in Fig. 3. This method is known as full-wave rectification and is almost universally employed in modern A.C. receivers.

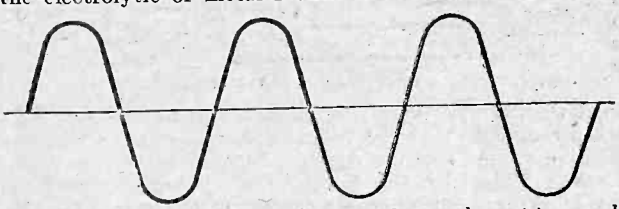


Fig. 1.—An alternating voltage with equal positive and negative pulsations.

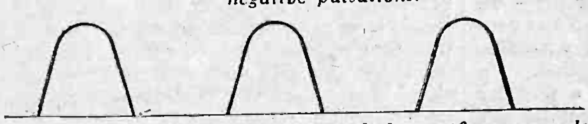


Fig. 2.—The resultant current through the rectifier as a result of applying the voltage of Fig. 1.

Rectifier Operation

Although both metal and valve rectifiers operate on the same principle, namely, that of unilateral conductivity, or, in simple English—one-way traffic, this property is due to vastly different reasons. The metal rectifier consists essentially of metal plates, usually copper, one side of each being covered by a very thin film of copper oxide, arranged alternately with plates of lead.

I do not know if any satisfactory scientific explanation of the process has yet been found, but, at any rate, the fact remains that such an arrangement has the property of permitting current to pass in one direction but not in the other.

The valve rectifier, however, operates on the well-known principle that a heated filament emits electrons, these electrons being attracted across the vacuum in the valve by a positive charge on a metal plate or anode. In the half-wave rectifier valve, the filament or cathode is heated by a four-volt A.C. supply taken from a separate low tension winding on the power transformer, while the A.C. high-tension voltage is applied between the filament and the anode. During positive half-cycles, when the anode has a positive potential, electrons will pass through the valve from filament to anode; thus, as far as the output is concerned, the filament will be the positive side of the high-tension supply and the anode the negative side. During negative half-cycles, of course, no current will pass through the valve because the anode, being negative, will not attract the electrons emitted by the filament.

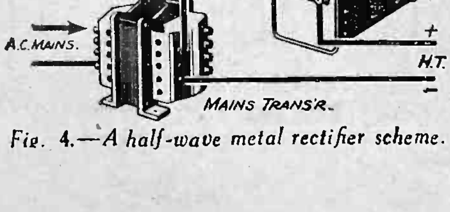


Fig. 4.—A half-wave metal rectifier scheme.

Circuit Connections

Figs. 4 and 5 give the circuits of simple half-wave metal and valve rectifiers, respectively. For full-wave rectification the usual circuit for metal rectifiers is that known as the voltage doubling arrangement (Fig. 6). Here, during positive half-cycles, the circuit is from the top of the transformer winding, through rectifier A to the H.T. positive terminal, through the receiving valves, etc., and back to the H.T. negative terminal and thence through the condenser C_2 to the bottom end of the transformer winding. During the negative half-cycles the circuit is from the bottom end of the transformer winding, through condenser C_1 to the H.T. positive terminal, through the load (valves, etc.), and back to the H.T. negative, then *via* rectifier B to the top end of the transformer winding.

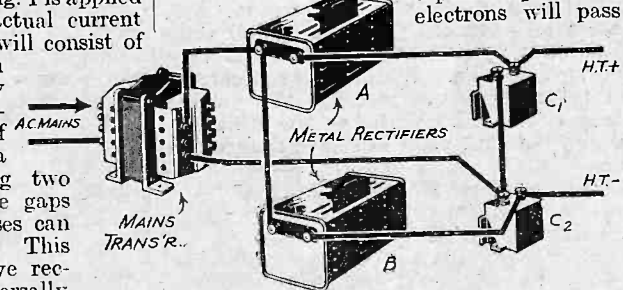


Fig. 6.—Using a voltage doubler circuit for full-wave rectification with metal rectifiers.

In the case of the full-wave valve rectifier, it is usual to employ a valve having a single filament but two anodes, connected as shown in Fig. 7. The H.T. winding of the transformer is centre tapped, and the transformer is so designed that the voltage developed across the whole of the high-tension secondary is twice the voltage it is intended to apply to each anode. It will be seen from the connections in Fig. 7, that while one anode, say A, is being fed with a positive half-cycle, a negative half-cycle is applied to anode B, and *vice versa*. It follows, therefore, that a load, such as the anode circuits of the various receiving valves, is connected between the filament of the rectifier and the centre tap of the high-tension winding, and high-tension current will flow from the filament connection (H.T. positive), through the load, and back to the centre tap (H.T. negative) through each rectifier anode in turn.

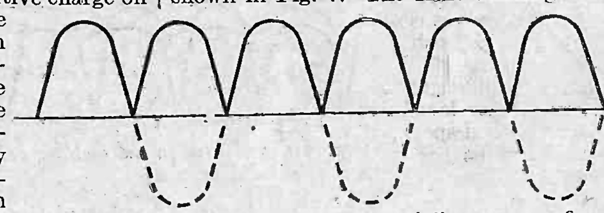


Fig. 3.—Resultant current in a full-wave rectifier arrangement.

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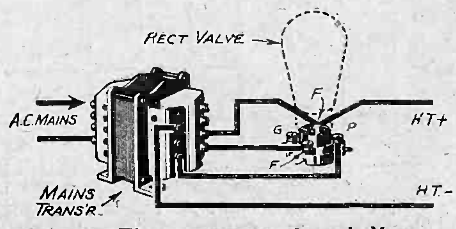

Fig. 5.—The arrangement for a half-wave valve rectifier.

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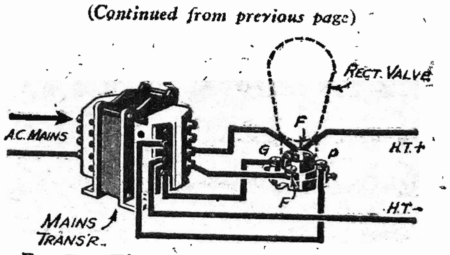

Fig. 7.—The connections for a full-wave rectifier.

Some Interesting Points

Now there are several interesting points about this full-wave rectifier system which, although well known, are not generally realized to the full. In the first place, it must be clearly understood that the rectifier does not supply a direct current. Uni-directional current, yes, but a steady direct current, certainly not. The output from such a rectifier is of the general form shown in Fig. 3—a series of impulses, all in the same direction, but dying down to zero every one hundredth of a second (for a standard 50 cycle supply). In this form, the rectifier output is quite unsuitable for high-tension supply in a broadcasting set, and its use would only result in an intolerable hum.

Fortunately, however, there are simple means available for improving matters, namely, the use of a smoothing circuit. This is, in essence, an arrangement of condensers and chokes, and its action may best be studied by examining the result of connecting a fairly large condenser of at least 4 microfarads across the rectifier output, as C_1 in Fig. 8. What happens is this: As the rectified voltage grows (a-b in Fig. 9) the condenser begins to charge up, resulting in a slowing up of the rise in voltage (a-c). Then, when the rectified voltage begins to fall off, *i.e.*, as soon as it becomes less than the maximum, the condenser commences to discharge and supplies energy to the circuit, thus partially making up for the reduction in rectifier output (c-d). During the next impulse from the rectifier the charge on the condenser is replenished, and the cycle of operation commences again. It will be seen from Fig. 9 that the voltage from a combination of full-wave rectifier and "reservoir condenser," as it is called, is definitely more uniform than that from a rectifier by itself. Moreover, the average value of the voltage is definitely higher than the effective mean in the case of the rectifier alone. The relation between the effective voltage of a full-wave rectifier and the voltage from a rectifier plus condenser is given in the curve reproduced in Fig. 10—which shows, incidentally, that little improvement is obtained by increasing the value of the reservoir condenser above 4 microfarads.

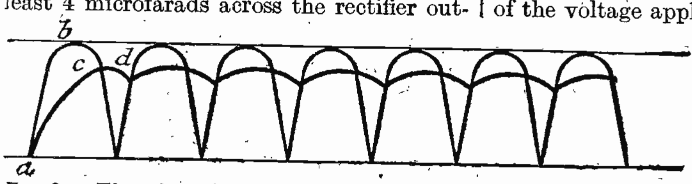

Fig. 9.—The effect of the reservoir condenser on the rectifier voltage is illustrated here.

Further Smoothing

But the smoothing provided by a single condenser is not sufficient to give a satisfactory high-tension supply, so the smoothing circuit is completed by the inclusion of the iron-cored choke in series with the load, and a further condenser as indicated in Fig. 8. The effect of the choke is to oppose changes in current—it may be considered as forcing back the peaks still existing in the output, and causing them to be dealt with more fully by the reservoir condenser; the second smoothing condenser plays a similar part to that of the first, but of course it has to deal with very much smaller variations, which may be described as mere ripples.

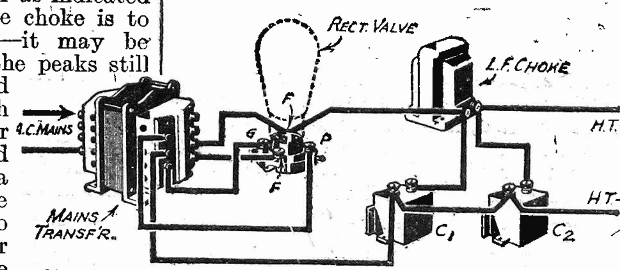

Fig. 8.—Add a smoothing circuit to a full-wave rectifier.

It has already been explained that the voltage obtained from a smoothed rectified supply is greater than the effective value of the voltage applied to each anode of the rectifier. It must not be thought, however, that a rectifier gives an absolutely constant H.T. voltage whatever the load applied. On open circuit, a rectifier will give a direct current voltage substantially greater than the R.M.S. value of the alternating voltage applied to each anode. By the way, in case any reader has forgotten, R.M.S. stands for "root mean square," and is the effective value of an A.C. voltage.

Thus, the open circuit voltage of the usual type of 250 volt milliamp. rectifier, when an alternating voltage of 250 volts R.M.S. is applied to each anode, is very nearly 350 volts. When, however, current is taken from the rectifier, the voltage begins to fall. With a 15 milliamp. drain, the D.C. volts will have dropped to about 300; at 35 milliamps to about 275 volts, while when the valve is giving its rated output of 60 milliamps, the voltage will have fallen to the rated value of 250 volts.

Performance

The performance of a typical full-wave rectifier valve is given in the graph reproduced in Fig. 11 which gives the output voltage corresponding to various output currents for different values of anode voltage. This falling off of voltage as the drain on the rectifier increases is, of course, due to the fact that the rectifier valve itself has a definite resistance, and the fall in voltage is in fact the voltage drop in the valve resistance and can be calculated by the well-known formula, voltage drop equals current multiplied by resistance. Of course, in a receiving set the output current is substantially constant, so that the actual H.T. voltage will also be of practically constant value, and the valve makers' curves, similar to that reproduced in Fig. 11, will enable any listener, once he has measured the amount of H.T. current taken by his set, to ascertain very closely what H.T. voltage he is getting.

I have said that the H.T. current taken by the set is practically constant, but we will see now the extent to which the *modulation* of the anode currents in the various valves affect the performance of the rectifier and, through the rectifier, of the whole set.

At the beginning of this article I explained that the output voltage available from the rectifier depended upon the current taken by the receiving set. As, however, the mean anode current of the valves remains substantially constant all the time the receiver is in operation, the actual high-tension voltage is also to all intents and purposes constant, as, of course, it should be, if the set is to give satisfactory operation. I qualified this statement, however, by saying that there were certain cases in which the high-tension voltage was caused to vary, and I want now to deal with these special cases. The first instance to be discussed is that in which a variable-mu high-frequency stage is incorporated in the receiver. It will be clear that when the grid bias of this valve is increased for volume control purposes, the anode current of the valve will be decreased, and as the anode current of the variable valve forms a part of the output taken from the rectifier, the actual output will increase, and this will mean a rise in the high-tension voltage.

(To be continued)

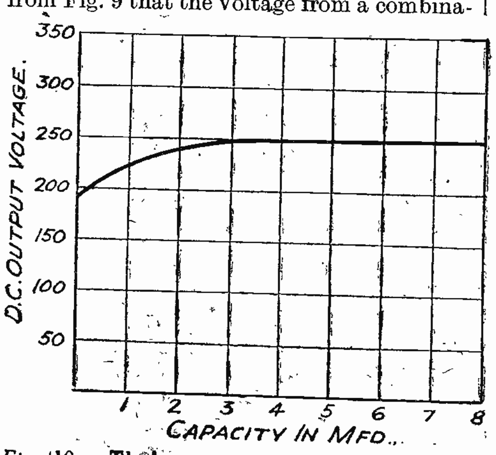

Fig. 10.—The variation in output voltage with reservoir condenser capacity.

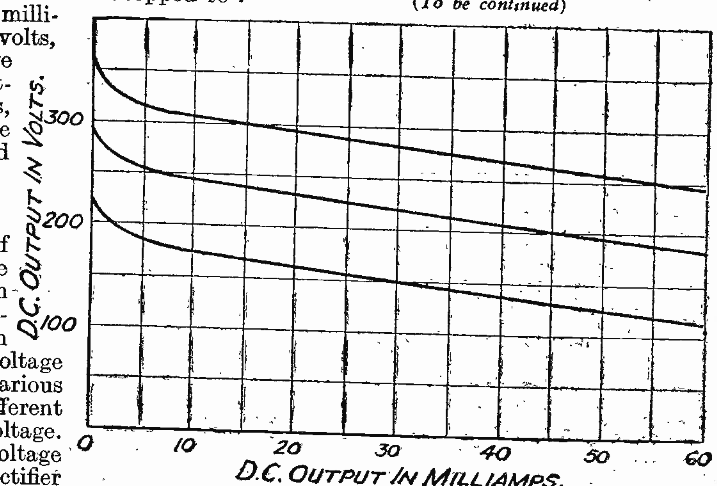

Fig. 11.—The variation in D.C. output voltage of a typical rectifier at various loads and for various anode voltages.

SOME JUGGLES WITH JUNK

An Article describing how Several Useful Components can be Made with Scrap Materials

By ALFRED J. POTTS

A TYPE of indoor aerial popular at the moment is that which has some sort of foil as a conductor. A very good aerial of this type can be made from something that is usually found in every constructor's junk-box. A fairly large Mansbridge condenser, of 1 mfd. or even

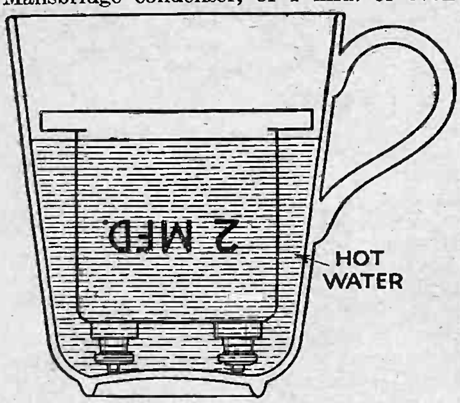

Fig. 1.—Softening the pitch in an old condenser.

.5 mfd. capacity, would do fairly well. As readers are no doubt aware, the Mansbridge type of fixed condenser consists of two long strips of metal foil insulated from each other by a thin greasy-looking kind of paper. If, therefore, we get these long strips out of the case without unduly damaging them we have the very thing required. It does not matter even if the condenser is burnt out or shorted in any other way; unless the damage is exceptionally bad, it will work just as well.

Uses for an Old Condenser

The easiest way to get the condenser out of its case is to stand it upside down in a cup of boiling water for a few minutes, when it should be possible to get it out without trouble. It is sometimes easier to chip the pitch out first and then use the hot water to melt the wax inside. If this is done, do not let the water get into the condenser if it can be helped, but have the water only as high as indicated in Fig. 1.

Having got the condenser out we find the foil is in the form of a closely packed roll. Find the end and unroll carefully, taking care not to tear it. If it should be badly burnt out in any part, so that it is in two pieces, or nearly broken, cut the bad part out and join the ends together, making sure, of course, that metal touches metal. If this strip is attached by drawing-pins or, if preferred, glued to a picture rail, it will result in quite an efficient aerial, owing to the fact that the surface of pickup area is large and that H.F. currents travel on the surface of a conductor. So much for the internals of that old condenser. Now what's to be done with the case?

Many listeners have a tone control, for compensating a pentode valve, already in their sets and consisting of a resistance and condenser wired as shown in Fig. 2. Surely it would be more convenient if this were one self-contained unit? Very well then. Disconnect them from the set and then connect them together inside the condenser case, as in Fig. 3. Practically any size of condenser case will be large enough to take these two small components. Seal up the bottom with a little pitch and you have a neat, self-contained tone-compensating control-unit ready to be reconnected in the set. Another use for the

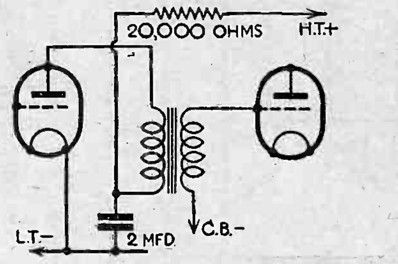

Fig. 4.—Circuit diagram showing connections for decoupling components.

condenser case is to mount two fairly large terminals in the top, or more if desired, to act as a terminal mount. There are several other uses for these old condenser cases, many of which depend on special individual circumstances.

Old coil holders are useful in many ways as plugs and sockets for extensions to loud-speakers, etc., and have one very important advantage over other forms of extension plugs and sockets. This advantage is that they are all standardized and, therefore, no difficulty is experienced in changing over from one connection to another.

Many amateurs, no doubt, have by them an old type transformer, and no self-respecting radio amateur needs to be told what the wire can be used for. The bobbins and laminations are not particularly useful things but they can, in certain circumstances, be found to be of use to the experimenter.

For instance, the case has many uses. The components of an R.C.C. stage can easily be accommodated inside and the connections can be brought out to the terminals which were previously used for the connections to the transformer. Or a complete decoupling device can be equally well accommodated in most ordinary transformer cases, and can conveniently consist of a 2 mfd. condenser and a 20,000 ohms resistance with the connections brought out to the H.T. and plate and earth terminals. A diagram of the connections is given in Fig. 4 for those who are not sure of them. This by no means completes the possibilities of using the old transformer case, but it is not difficult to adapt these suggestions to suit your own requirements.

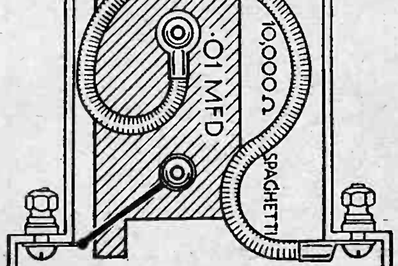

Fig. 3.—A simple tone control unit.

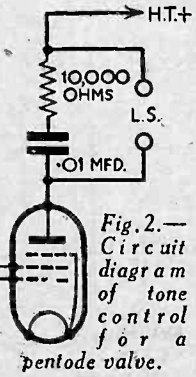

Fig. 2.—Circuit diagram of tone control for a pentode valve.

Coil Formers from Old Ebonite

Old ebonite panels are probably the most persistent hangers on in the junk line. Uses for them are often rather lacking. If not in too bad a condition the holes can be filled up with Chatterton's compound, cobblers' wax or in some cases even pitch. Or they can be cut into useful terminal strips and insulating strips by carefully missing the holes. A rather good use, however, is to cut two pieces shaped as shown in Fig. 5, remembering that the central slots must be the same thickness of the ebonite used. The slot A must be in the position shown by the dotted lines marked B in the second piece. In all other respects both pieces are alike. The two parts are pressed into each other, as depicted, and attached by four small screws to a base of the same ebonite measuring about 4in. by 3in. If this former is wound with the requisite amount of wire a low-loss coil will result owing to the liberal quantity of air spacing and very little insulating material being close to the wires. The deeper slots can contain the long-wave winding and the shallow one the short and reaction windings. The design can be altered to suit any particular type of coil required.

Useful Fitments made from Metal Panels

Old or damaged metal panels and screens, if unsuitable for their proper purpose, will provide the material for a strong pair

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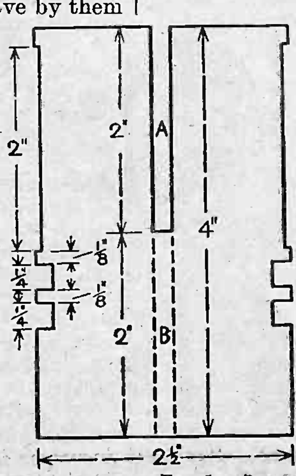


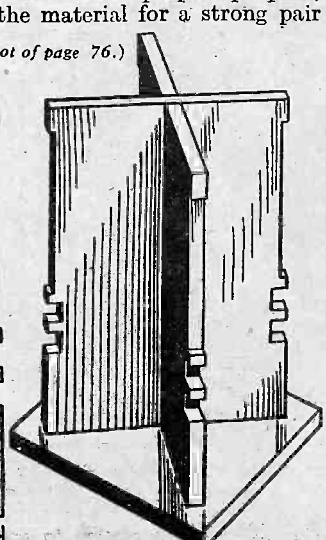
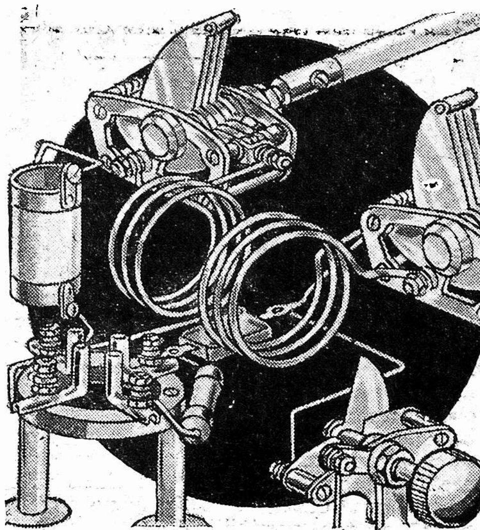


Fig. 5—Details of coil formers.

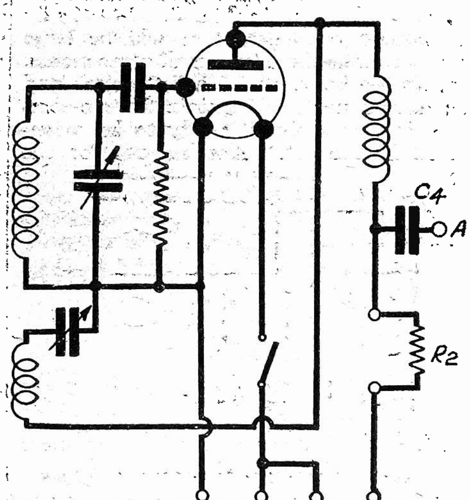


Short Wave Section

Further Practical Points on the Technical Side

By MANDER BARNETT

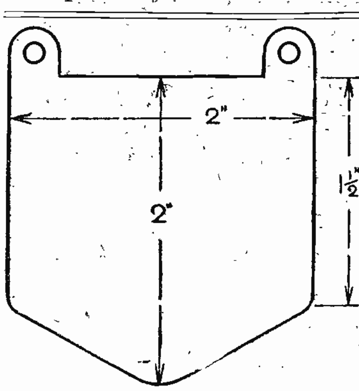
THE short-wave oscillator described in these notes recently can very easily and efficiently be put to a number of uses other than that of a mere test oscillator. With very little alteration we can bring it into service either as a one-valve short-wave receiver, a one-valve "straight" adaptor, or a one-valve super-heterodyne converter. The diagram on this page shows how the unit can be used in the latter manner, the only extra component necessary being a spaghetti or flexible resistance (R_2) of about 30,000 ohms. Alternatively, a high-frequency choke (not a short-wave type) can be used here, but the resistance is very effective in this instance. The condenser C_4, instead of being earthed on one side, as in the original diagram, is brought out to an extra terminal (A). From this point a wire is taken to the aerial terminal on the receiver and the result is now a complete short-wave superheterodyne outfit. Enough has already been said concerning this type of adaptor, so that it is unnecessary for me to go into the details of operation here. Suffice it to say that the receiver must be tuned to as high a wave-length as possible for satisfactory reception on the converter. This unit is easily used as an adaptor of the "straight" type, merely by omitting the high-tension battery, and taking a wire from the H.T. plus terminal to the plate socket of the detector socket in the receiver. Two stages of L.F. are required to operate a speaker with the arrangement so that this method of wiring will prove the most satisfactory with receivers of the detector and L.F. amplifier type. If the receiver itself has a screened-grid stage, however, we can make full use of the amplifying properties by wiring up the unit as in the circuit herewith.



This circuit shows how the oscillator described can be used as a short-wave converter

Short Waves and Interference

The fact that the short waves, at any rate, those below about fifty metres, are scarcely subject to atmospheric disturbance is very little consolation for the fact that these waves are very much more subject to interference by "man-made" sources—a fact which the newcomer to short waves will very soon discover for himself. It is certainly rather puzzling, and not a little exasperating, to find that reception is liable to be spoilt at intervals by a series of noises mildly resembling machine-gun fire, until one realizes that such interference happens just when a motor-car passes the house! The difference between operating a short-wave receiver in the middle of a busy town and then out in the open country is really amazing, reception in the country making one realize that short waves *can* provide a really very quiet background! There is, unfortunately, really very little that the amateur can do to reduce the noise level in a location where such noise is produced mainly by local interference. Here, of course, I am referring strictly to short-wave reception—on the medium bands, by careful attention to certain aerial and other details, the noise level can be very materially reduced. With a short-wave receiver it is sometimes possible to use a very short aerial, and this can sometimes be shortened to such a point where the amount of signal strength picked up is still quite reasonable, but the local interference is very much reduced. When using a super-heterodyne type of short-wave adaptor with a powerful receiver, it is very advisable to use only a very short length of wire connecting the adaptor to the receiver, otherwise, if this wire is too long, the receiver itself will start picking up outside noises on the long waves—the intermediate frequency amplifier in this case—and thus the background level would be unnecessarily increased. Probably the worst type of interference on the short waves comes from various types of motor-cars, and where one is unfortunate enough to live very close to a main road the problem becomes rather acute. Probably the best procedure is to install the whole of the apparatus, including the aerial itself, as far away from the road as possible and then hope for the best!



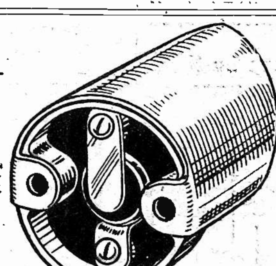


Fig. 8.—A reflector for a fuse bulb.

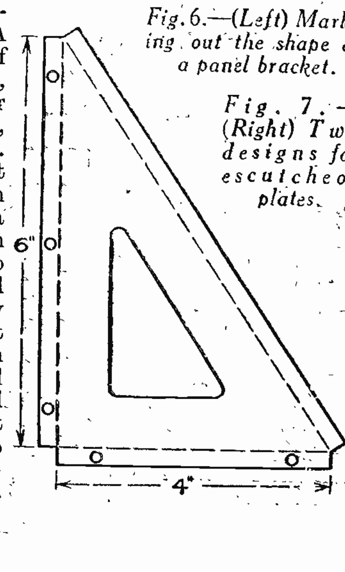


Fig. 6.—(Left) Marking out the shape of a panel bracket.

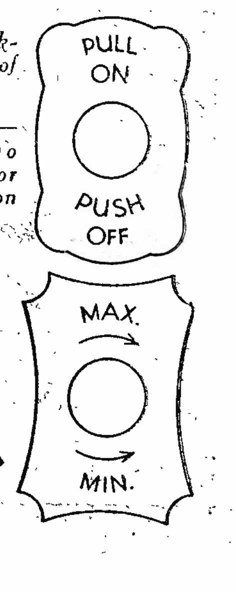


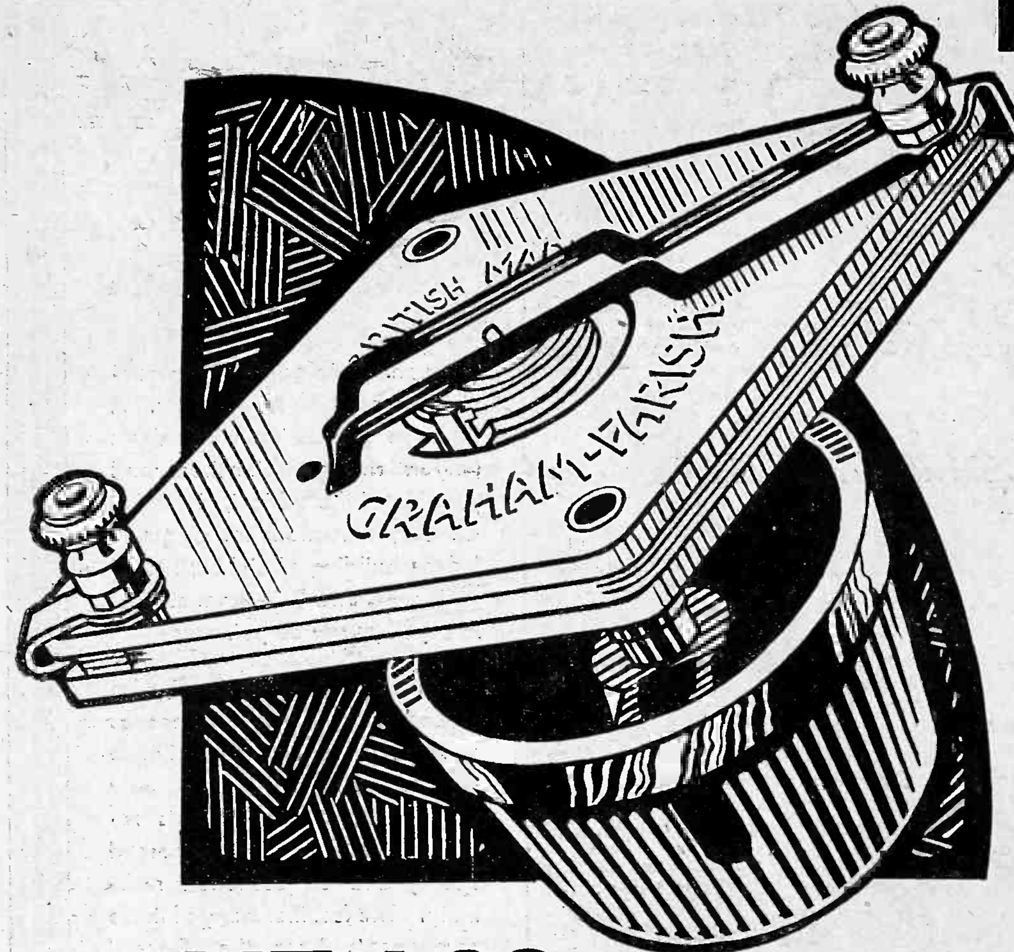
Fig. 7.—(Right) Two designs for escutcheon plates.

SOME JUGGLES WITH JUNK

(*Continued from previous page*)

of panel brackets by cutting them to the shape shown in Fig. 6 and bending over the flanges at right angles on the dotted lines. A circular plate cut from an old screen, and having a hole in the centre, will make a very neat escutcheon plate for switches, volume controls, etc. A pair of good examples of simple yet neat designs, which can be used for these escutcheon plates, are shown in Fig. 7. A very simple yet neat shield and reflector can be made for use with a bakelite or porcelain fuse bulb-holder, so that when mounted it will throw a very useful light over the set so that adjustments can be made with ease. The shape for cutting the metal and diagram showing how the finished reflector is fixed are given in Fig. 8. It should be noted that the two woodscrews which fix the bulb-holder in place also hold the reflector.

Preferred and praised by every Expert



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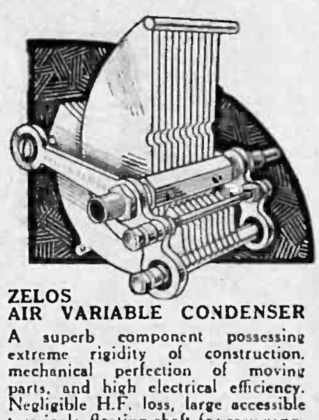

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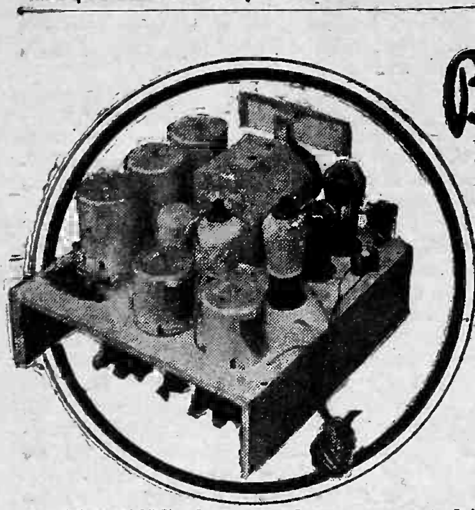
Building the PREMIER SUPER



CONVERTING THE "PREMIER SUPER" TO A BATTERY RADIO-GRAM.

and Full Particulars Regarding the Adjustment and Operation of this Efficient Receiver.

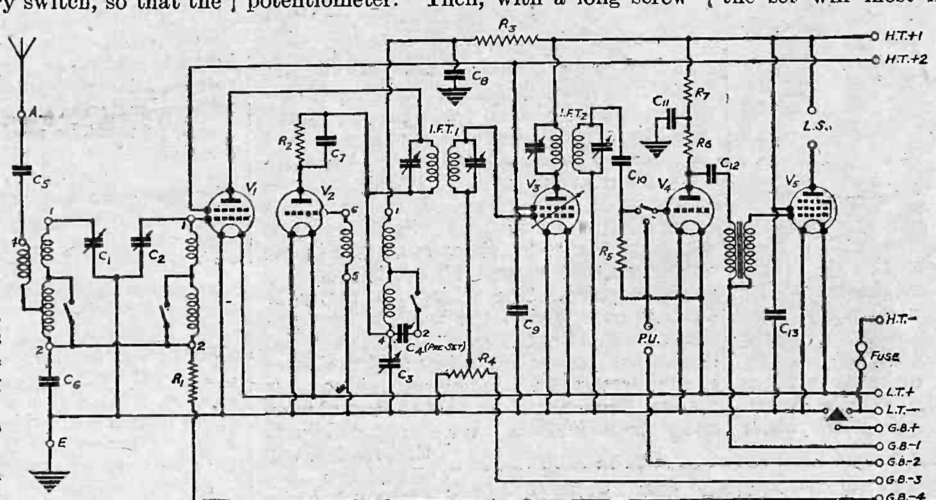
By The Technical Staff.

ASSUMING that you have connected up the batteries as explained last week, the next thing is to attach the loud-speaker. This is fitted with a multi-ratio output transformer with tappings brought out to a rotary switch, so that the correct ratio can be obtained immediately by rotating two switch contact arms. When the two outside (black) terminals are joined to the receiver the proper ratio will be secured by putting the two arms on contacts marked "B" and "F" respectively. Should you desire, however, it is not a bad plan to try various ratios by moving the two arms, finally using the one which produces what appear to be the best results.

The aerial and earth must, of course, be connected to their respective terminals, and it has been found in experimenting with this receiver that the earth connection is very important and has a great influence on the results to be obtained. The aerial is not so important, and may consist of any arrangement from a thirty-foot length of wire round the picture moulding of the room to an efficient outside aerial such as will be produced by using the "Aeroficient" kit specified.

"Trimming" the Three-gang Condenser

When all the necessary connections have been made, set the wavechange switch (on right of set) to the long (anti-clockwise) or medium-wave (clockwise) position, turn the volume control knob to its maximum (clockwise) setting and slowly rotate the tuning knob. We would emphasize that word "slowly," since tuning is extremely sharp, and it is thus quite easy to miss even the local station completely if the knob is turned too quickly. It will probably be found that a number of different stations can be received without difficulty, although, on the other hand, it is not very unlikely that the first attempt at tuning will seem rather unsuccessful. It is all a matter of having the three-gang condenser accurately "trimmed." In any case, a station on about 300 metres should be carefully tuned in and its volume reduced to bare audibility by means of the variable-mu potentiometer. Then, with a long screw-driver, try adjusting the trimmer on that section of the condenser remote from the panel—this is the aerial tuning section —until signal strength attains a maximum. Slightly alter the main tuning control, if necessary, and then set the trimmer on the middle condenser section. Lastly, do the same with the trimmer for the oscillator section; this is by far the most critical and should be done with extreme care.



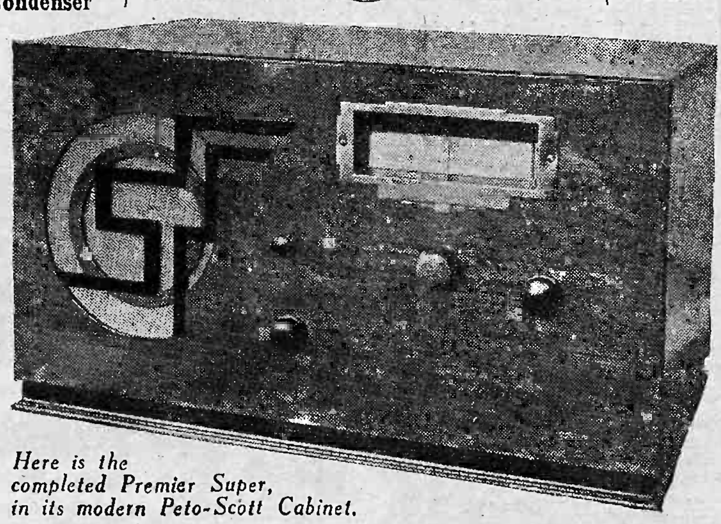
Theoretical circuit of the Premier Super.

Long-wave "Tracking"

After these adjustments have been made, the set will most likely operate perfectly well on the medium-wave band, but a further setting must be made before it can function at maximum efficiency on the long waves. We refer to the .002 mfd. pre-set "tracking" condenser, which must be set to its correct capacity after tuning in a long-wave station. Use a long screwdriver again to vary the capacity, and slowly screw down the adjusting screw. You will find that a very pronounced "peak" occurs at one particular setting; this is when the screw is turned almost to the end of its travel. When this optimum position has been found the locking nut should be tightened so that the capacity will remain constant.

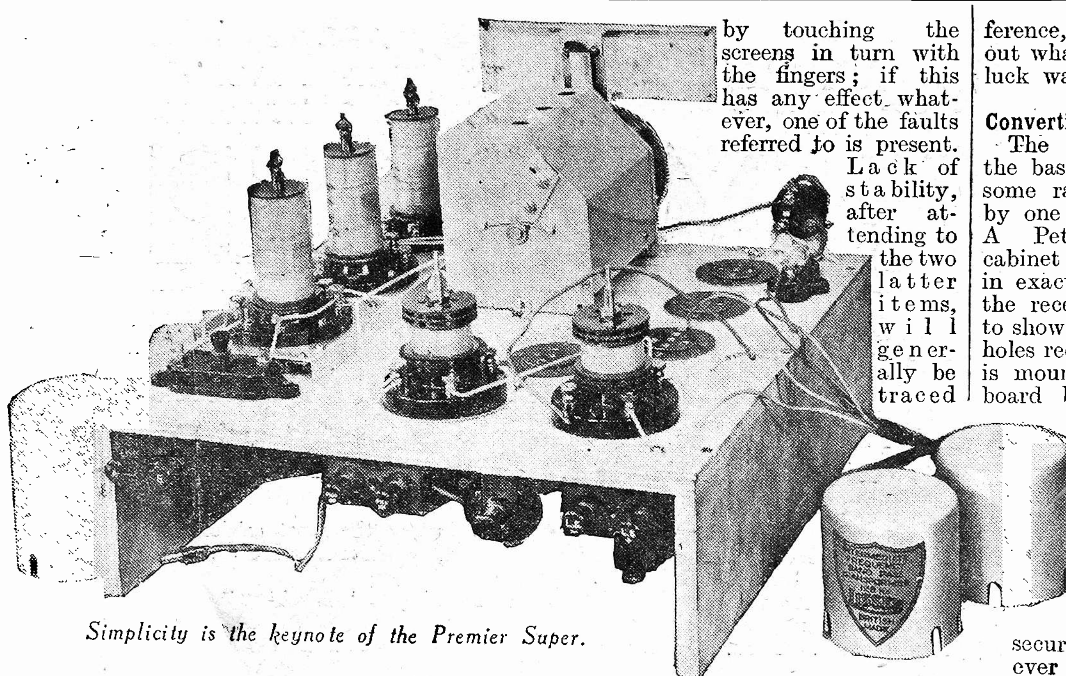
That completes all the preliminary adjustments and the set should now be ready to tune in almost any station required. All that the operator has to do is to turn the wave-change switch to the wave-band required, set the volume control to maximum and slowly rotate the tuning knob.

There are no "snags" or difficulties in either building or using the "Premier Super," but there is one little point which might have been mentioned last week. One reader found that the coils which he had bought were arranged in a different order to that indicated in the wiring plan, and thought that perhaps he had been given a wrong component. As a matter of fact, the coils, when obtained, are not in the correct positions for this set; it is, however, only necessary to reverse the positions of the two end ones (aerial and oscillator), and this can be done in a few seconds by removing the two screws which hold the coils to the aluminium baseplate. The method is also



Here is the completed Premier Super, in its modern Peto-Scott Cabinet.

(Continued overleaf)



Simplicity is the keynote of the Premier Super.

(*Continued from previous page*)

explained on the instruction sheet supplied with the coils by Messrs. Lissen, so no difficulty can occur here.

In Case of Trouble—!

So that you may be "forewarned"—if that is necessary—we might just mention one or two minor troubles which may possibly be encountered. For instance, if it is found that the set seems to be prone to oscillation it is a sure sign that either one of the coil screens is not properly screwed down to make contact with the base, or that one of the connecting wires is short-circuiting to the screen cover. You can easily check both these points by touching the screens in turn with the fingers; if this has any effect whatever, one of the faults referred to is present. Lack of stability, after attending to the two latter items, will generally be traced to a bad contact between some component and the metallized chassis. Remember that the chassis carries all the "earth return" leads and, therefore, connections to it must be sound. This also means that the components must be screwed down firmly to ensure that good electrical connection is secured. Should the fuse bulb "blow" you will know that either there is a make in the wiring, or that a short circuit is occurring at some point. The wiring can easily be checked over, whilst the most likely location of a short is between the coil cans and one of the connecting wires; if the wires are not arranged with some care it is possible for the screen to rub against them and wear away the insulation. We do not anticipate that readers will experience any of the difficulties to which we have made reference, but we thought it wise to point out what *might* happen, especially if one's luck was out.

Converting the Set to a Radio-Gram.

The "Premier Super" can be made the basis of a really excellent and handsome radio-gramophone, as you can see by one of the accompanying illustrations. A Peto-Scott "Premier-Adaptagram" cabinet is used and the front of this is drilled in exactly the same way as the front of the receiver cabinet—a drawing is given to show the exact location and sizes of the holes required. The Garrard spring motor is mounted in the centre of the motor-board by making use of the template supplied with it. The B.T.H. "Minor" pick-up, which is complete with track arm and volume control, is also attached to the motor-board by means of the three screws which are included. Its exact position is very important, since correct "tracking" is essential if good reproduction and minimum record wear are to be secured. This offers no difficulty whatever because the thick cardboard base to which the pick-up is attached when bought serves as an accurate template so that the exact position for the pick-up may be located in a few seconds.

A hole must be made in the motor-board directly below the pick-up flange, and the screened leads are passed through this. It will be found that there are three leads, although only two pick-up terminals are provided on the receiver; the third lead is merely connected to the screening braid and to the metal parts of the pick-up, and should be joined to the earth terminal. Take care that the leads are kept fairly clear of the receiver components and that the metal braiding cannot possibly make contact with the anode terminal on the screen grid or variable-mu valve, since if it were to touch either of these the H.T. battery would be short circuited.

Of the three terminals on the radio-gram. switch mounted on the back of the chassis, that in contact with the longest

(*Continued on page 114*)

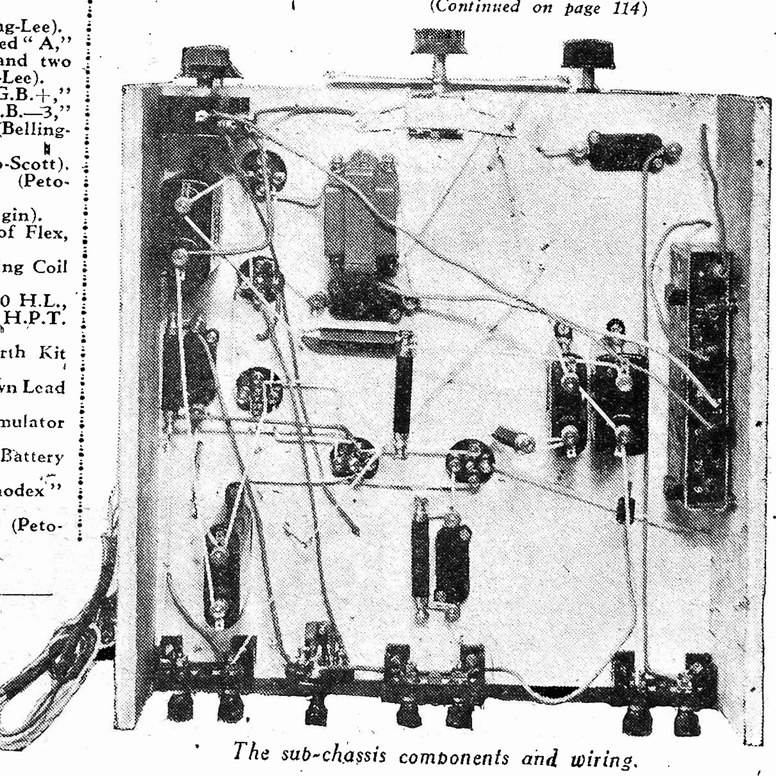
LIST OF PARTS FOR THE PREMIER SUPER.

Don't depart from these specially selected components.

- One Superhet 3-gang Midget Variable Condenser, Type 693, with Straight Line Dial (British Radiophone).
- One Set Matched Superheterodyne Coils (2 Bandpass and Oscillator) (Lissen).
- Two Intermediate Frequency Transformers (Lissen).
- One 50,000 ohm Volume Control Potentiometer, Type V.C.36 (Bulgin).
- One 3-point Switch, Type 48 (British Radiogram).
- One Push-Pull Radio-Gram. Switch, Type 50 (British Radiogram).
- Three Chassis Brackets, Type 21 (British Radiogram).
- One "Pip" 3/1 L.F. Transformer (Graham Farish).
- Six "Ohmite" Resistances—2,000 ohms, 10,000 ohms, 20,000 ohms, 30,000 ohms, 100,000 ohms, and 2 megohms (Graham Farish).
- Two .1 mfd. Condensers, Type B.B. (Dubilier).
- Two 2 mfd. Condensers, Type B.B. (Dubilier).
- One .0001 mfd. Condenser, Type 670 (Dubilier).
- One .0002 mfd. Condenser, Type 670 (Dubilier).
- Two .01 mfd. Condensers, Type 670 (Dubilier).
- One .002 mfd. Pre-Set Condenser (Polar).
- Four 4-pin Chassis Mounting Valve-holders (Clix).
- One 5-pin Chassis Mounting Valve-holder (Clix).
- Three Terminal Mounts (Belling-Lee).
- Six Terminals, Type "R," marked "A," "E," "L.S.—," "L.S.+," and two marked "Pick Up" (Belling-Lee).
- Six Wander Plugs (marked "G.B.+," "G.B.—1," "G.B.—2," "G.B.—3," "G.B.—4," and "G.B.—5" (Belling-Lee).
- One "Metaplex" Chassis (Peto-Scott).
- One Premier Super Cabinet (Peto-Scott).
- One Fuse Holder and Fuse (Bulgin).
- Two Coils Quickwire, length of Flex, Screws, etc. (Bulgin).
- One P.M.6 "Microlode" Moving Coil Speaker (W.B.).
- Five Valves Types 215 S.G., 210 H.L., 220 V.S., 210 Det., and 220 H.P.T. (Cossor).
- One "Aeroficient" Aerial Earth Kit (Graham Farish).
- One Length Metal Screened Down Lead (Goltone).
- One 2-volt 40 amp. Accumulator (Smiths).
- One 9-volt G.B. "Anodex" Battery (Smiths).
- One 120-volt Triple "Anodex" H.T. Battery (Smiths).
- One Baffle Baseboard Assembly (Peto-Scott).

LIST OF ADDITIONAL PARTS REQUIRED FOR THE RADIO-GRAM. CONVERSION.

- One Peto-Scott "Premier-Adaptogram" Cabinet
- One B.T.H. "Minor" Pick-up with Track Arm.
- One Garrard Spring Motor, Type 20.
- One length "Goltone" Screening Braid (if R.-G. switch is to be mounted on motor board).



The sub-chassis components and wiring.

Wherever wireless terms are understood "Ohmite" means "The Best Resistance"

"Better than wire wound."

OHMITE RESISTANCES

The most popular and efficient type of fixed resistance for all general purposes. "Better than wire wound." All values, 50 ohms to 5 megohms.

1/6

HEAVY DUTY TYPE 2/3

Safe maximum current carrying capacity of "Ohmites."

100° F Temperature Rise

Ohms.	Milliamps.	Ohms.	Milliamps.
1,000	40	20,000	8
2,000	35	30,000	6·75
3,000	29	40,000	6
4,000	24	50,000	5·5
5,000	20·25	60,000	5
10,000	12	80,000	4·24
Other values pro rata		100,000	3·5

Safe maximum current carrying capacity of "Ohmites" Heavy Duty Type.

100° F Temperature Rise

Ohms.	Milliamps.	Ohms.	Milliamps.
1,000	80	20,000	16
2,000	70	30,000	13·5
3,000	58	40,000	12
4,000	48	50,000	11
5,000	40·5	60,000	10
10,000	24	80,000	8·48
Other values pro rata.		100,000	7

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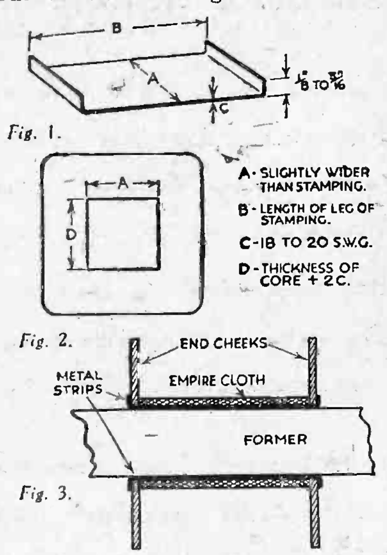
READERS' WRINKLES — The HALF-GUINEA Page

Making Transformer Bobbins

A DIFFICULTY often experienced when wishing to wind a transformer or choke is that of obtaining a suitable bobbin. I have on several occasions used a bobbin made up in the following manner. A wooden former is planed up, about double the length and the same



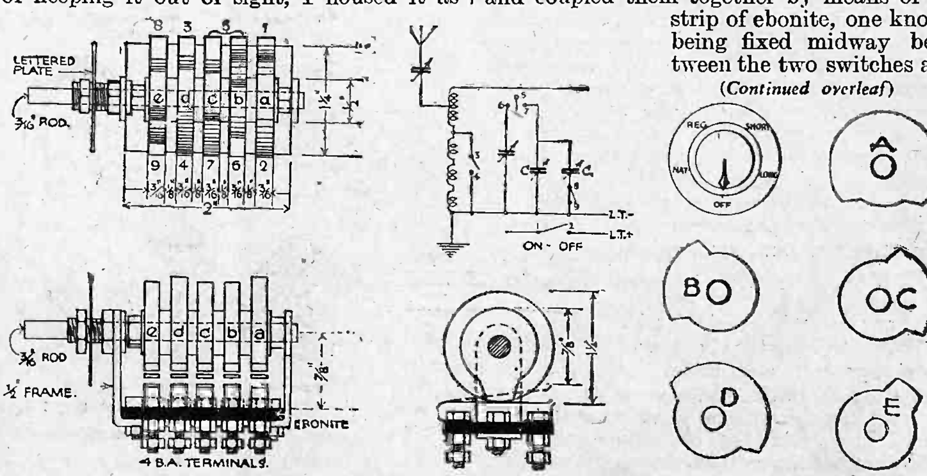
Details of cheeks for making transformer bobbins.

size as the core. Two pieces of brass or soft iron are made as in Fig. 1, and two cheeks are cut from stiff card, or bakelite sheet, and core holes fretted as in Fig. 2. The two metal strips (Fig. 1) are warmed and a little Chatterton's compound rubbed on the flanges. They are then inserted in the cheeks, drawn apart, and slid on to the former. The cheeks are then drawn well apart, metal strips dabbed with Chatterton's compound, and space wound with empire cloth or insulating tape to a thickness of about 3/32in. as in Fig. 3. Winding then proceeds, and on completion the bobbin is gently withdrawn and the core built in. —L. W. BONES (Crayford).

A Multiple Switch

THE switch illustrated was designed for a family set to save time and patience when returning to the local stations. With the only addition of two pre-set condensers a turn of the switch brings in either of the two locals, and also acts as wave-change and on-off switch. The bed of the switch is a piece of 2in. by 1¼in. ebonite or fibre, and to this the U-shaped frame of 4⅝in. by ½in. brass is bolted. The contacts are of springy brass, 3/16in. wide, fixed to the ebonite at 5/16in. centres by means of bolts and nuts which serve as terminals. These contacts are closed by cam-shaped pieces of ebonite or wood 3/16in. thick, spaced ⅛in. apart by washers, glued, and tightly clamped with nuts and washers on a 3/16in. screwed rod. Care should be taken that these are shaped and placed as in drawing. After these have been mounted on the frame, as shown, the switch is fixed to the panel and a lettered plate and knob fitted.

The only other components required are two .0003 pre-set condensers of reputable make, and wiring to these and the switch will be easily followed from the circuit diagram. An extension rod might, in many cases, shorten the wiring, and if so, this could easily be arranged. Checking up of the positions of the cams and adjusting should be carried out as follows. With switch knob in position 1 (off) all contacts should be open. In position 2 (Nat.) contacts 1 and 2, 3 and 4, and 5 and 7 should be closed and pre-set condenser C screwed up until the shorter wave local is tuned. In position 3 (Reg.) contacts 1 and 2, 3 and 4, 5 and 7, and 8 and 9 should be closed and condenser C_1 screwed up until the longer wave local is tuned in. Medium-wave stations can be tuned in on the dial in the normal manner with switch in position 4 (Short), when contacts 1 and 2, 3 and 4, and 5 and 6 should be closed, and in the same manner long-wave stations can be tuned with the switch in position 5 when contacts 1 and 2, and 5 and 6 are closed. If the set employs two tuned circuits a larger switch, with all contacts except 1 and 2 doubled or two switches as described ganged together, should be used.—WILLIAM MUIRHEAD (Falkirk).



Two views of a multiple switch and details of operating cams.

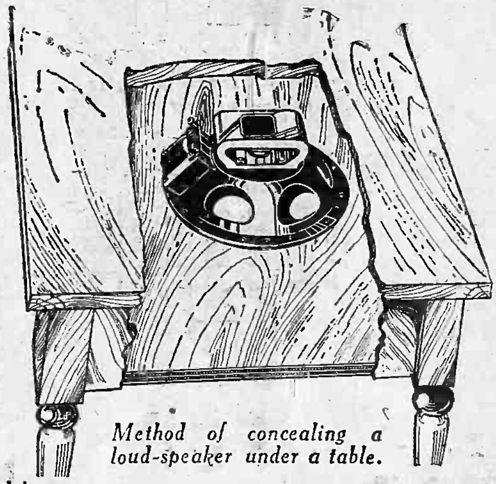
THAT DODGE OF YOURS!

Every reader of "PRACTICAL WIRELESS" must have originated some little dodge which would interest other readers. Why not pass it on to us? We pay £1-10-0 for the best wrinkle submitted, and for every other item published on this page we will pay half-a-guinea. Turn that idea of yours to account by sending it in to us addressed to the Editor, "PRACTICAL WIRELESS," George Newnes, Ltd., 8-11, Southampton Street, Strand, W.C.2. Put your name and address on every item. Please note that every notion sent in must be *original*. Mark envelopes "Radio Wrinkles." Do NOT enclose Queries with your Wrinkle.

Concealing a Speaker

POSSESSING a speaker unit on a baffle board 2ft. square, and being desirous of keeping it out of sight, I housed it as shown in the accompanying sketch: most kitchen tables have an underneath depth of 4 to 6ins., which is sufficient space for a speaker cone and unit. The baffle board faces the floor, and is fixed to the side framework of the table.

This arrangement gives excellent results, especially when the table is against the wall so that the table acts as a kind of sound box. This method is definitely superior to using the table-top as a baffle board with the cone facing upwards. No trouble was experienced with the drawer, which clears the unit.—ARTHUR GRIFFITHS (Blackwood, Mon.).



Method of concealing a loud-speaker under a table.

A Combined L.T. and H.T. Trickle Charger for Use on D.C. Mains

THE following details apply to a charger that was operated on supply mains of 220 volts D.C.

The components required are two double-pole change-over switches (suitable for high voltage), two lampholders (batten type), eight insulated terminals, and a wood block, approx. 12in. by 9in. The parts are placed on the wood block and the holes marked and drilled for receiving the insulated wire. In my case I used two D.P.C.O. switches mounted on porcelain and coupled them together by means of a strip of ebonite, one knob being fixed midway between the two switches as

(Continued overleaf)

RADIO WRINKLES

(Continued from previous page)

in Fig. 2, and the other discarded. If this type of switch is used a cover should be made for each one, as shown in Fig. 1. The switches and lampholders are fixed to the block and wired as in Fig. 4. The lamp used for the resistance for the H.T. side is an ordinary 220 volt, 15 watt lamp, and for the L.T. a 60 watt, 220 volt. These give charging rates of approx. 60 milliamps for H.T., and .27 amps. for L.T. These rates

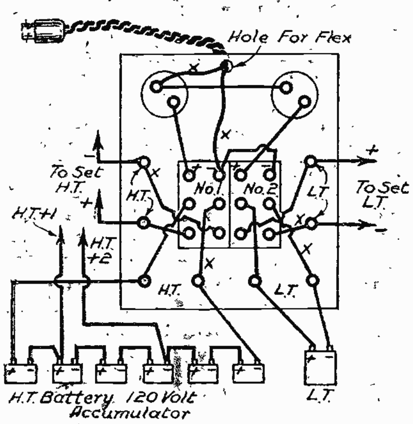


Fig. 4.—Diagram of connections for a D.C. trickle charger.

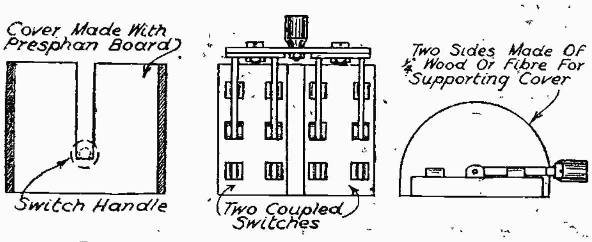


Fig. 1. Fig. 2. Fig. 3.

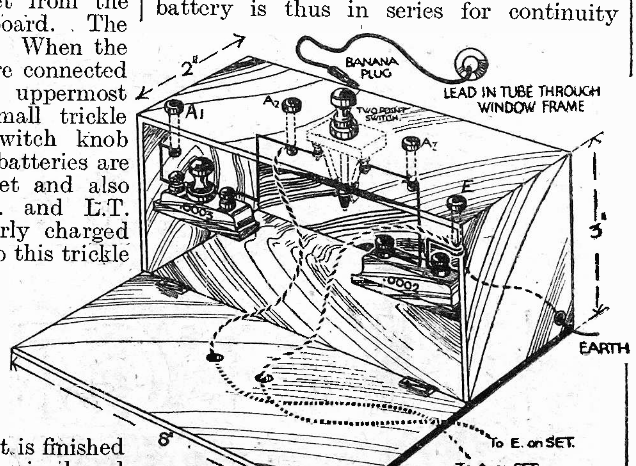
Details of switch and cover for a D.C. trickle charger.

can be increased by putting in larger lamps or, of course, reduced by fitting smaller ones.

It would be best if the finding of the polarity of the main fuses is left until the board is fixed in position, and the adaptor or plug put in the socket and the supply switched on. Now, with the lamps in place, first dip into a jar of diluted acid the two wires connected to the left-hand terminals, or H.T. charging terminals, and mark the terminals with the plus and minus signs as they are ascertained. Next do the same with the low-tension leads and mark the terminals. The accumulators are then connected to their respective terminals and wires are run to the set from the terminals on the charging board. The charger is now ready for use. When the switch is down the batteries are connected to the set, and when in the uppermost position they are given a small trickle charge. Of course, if the switch knob is left in midway position the batteries are disconnected both from the set and also the charger. Both the H.T. and L.T. accumulators should be properly charged up before they are connected to this trickle charging system. It is only necessary to top up the batteries with distilled water at very long intervals, and it is best to keep the charging rate very low and make a practice of always changing over to charge position after set is finished with. I might add that if the charging board is fitted near the set the change-over switch can be used to switch the set on and off. It should be noted that if you are connected on the positive live side of the main, this arrangement can be carried out with only one D.P.C.O. switch, provided that H.T.— is connected to L.T.— on the set in use. In this case all wires marked x would be joined together and the three wires on the positive side of Switch No. 2 are transferred to the right-hand contacts of switch No. 1. It is important also to note that when lampholder adaptor or two-pin plugs are used to obtain the supply, they must be left in position, or care taken to see that they are not put in the reverse way round after tests for polarity have been carried out.—C. T. COOPER (Barwell).

A Range-increasing Device

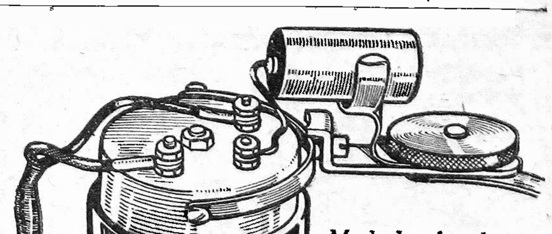
ON installing my set (a commercial one) I found I was unable to tune as low as Fecamp or as high as Radio-Paris, and evolved the attached gadget which might be of use to other readers. The box, which stands on the window ledge inside the room, is made of ordinary thin wood, the top being a piece of ebonite strip in which are fixed four sockets. A banana plug is attached to the aerial lead-in, and when plugged into socket A1, the preset is brought into use enabling me to tune lower. A2 gives the usual tuning, and A3, with the two-point switch closed, enables me to reach above Radio-Paris. When plugged into E the aerial is earthed. The gadget has been in use for some time now and answers the purpose very satisfactorily.—EDWARD JEFFERSON (St. Boswells).



A range-increasing device.

A Simple Tester

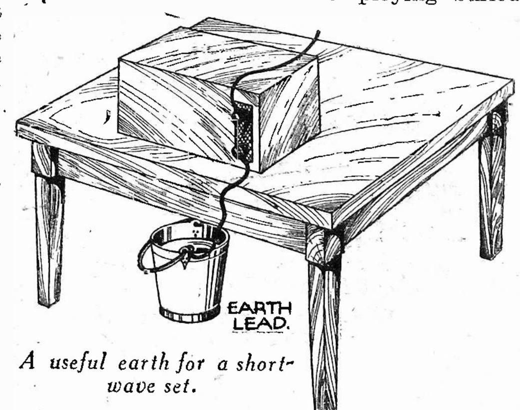
ALTHOUGH this neat little device will prove invaluable to the service engineer, the amateur constructor will also find it extremely useful when carrying out various circuit tests. As may be seen from the illustration, an ordinary telephone headpiece is adapted to accommodate a small 1.5 volt cell. An extra hole is drilled in the metal 'phone case, and a small terminal or nut and bolt fitted into this hole. One lead from the 'phone bobbins is left in position, but the other is removed and wired to one of the battery terminals, the return being made by means of the zinc container of the battery and its contact with the metal frame of the 'phones. The battery is thus in series for continuity tests, and the lead may be removed and replaced in its original position to enable the 'phones to be used in the ordinary way. The illustration should make the arrangement quite clear.—R. CRICHTON (Glasgow).



Method of adapting 'phones for a useful testing device.

Earthing a Short-wave Set

ADVANCED short-wave practice condemns the use of long, straggling earth leads. Annoying hand-capacity and general instability, even in elaborate and well-designed receivers, may be directly traced to this source. Removing the earth lead entirely may sometimes render the exasperating "signal-shifting" a little less acute, but a short, direct earth connection is usually a complete cure. In instances where it is impossible to provide an ideal earth, an ordinary household bucket, partially filled with water and placed directly under the receiver, will answer the purpose admirably. When used on the ground floor, results are equal, if not superior, to those obtained with short-connection earths employing buried tubes; this applies to short-wave reception only. Connecting lead is taken to the bucket handle-hole, previously scraped bright.—F. J. GOUGH (Ellesmere).

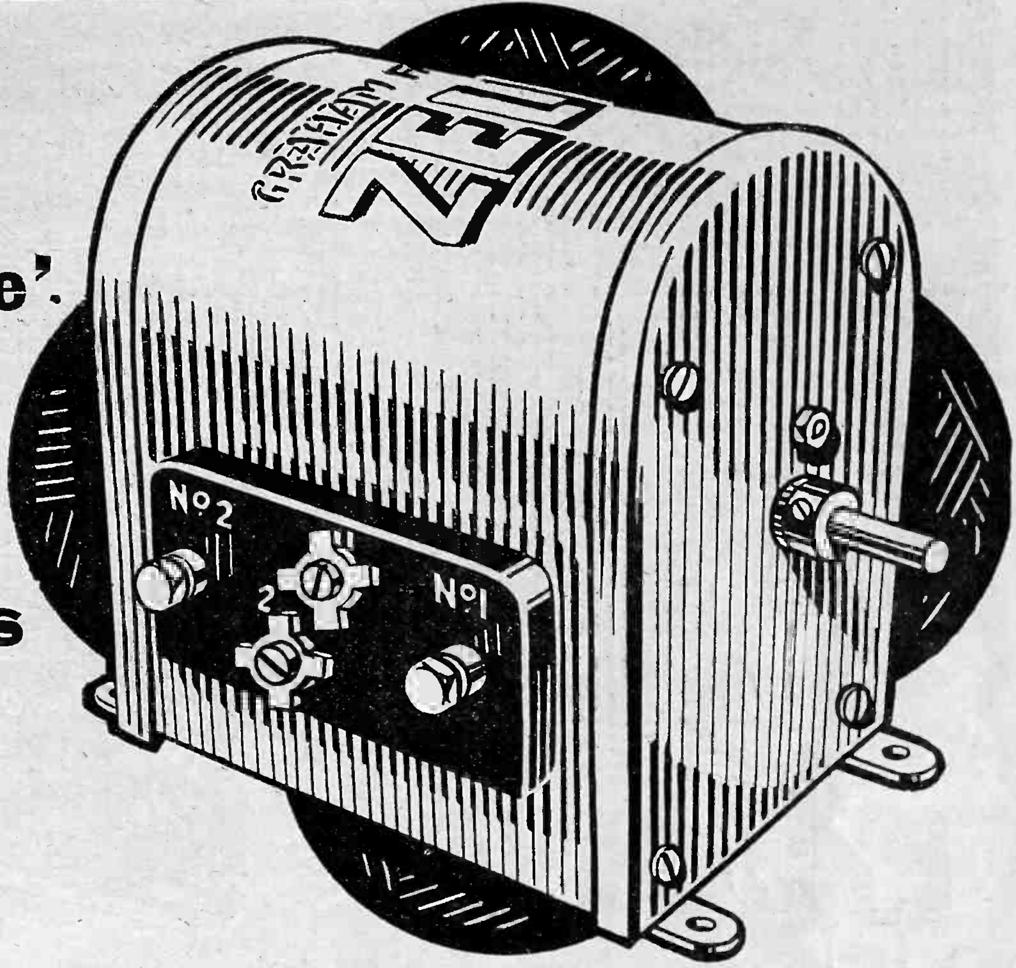


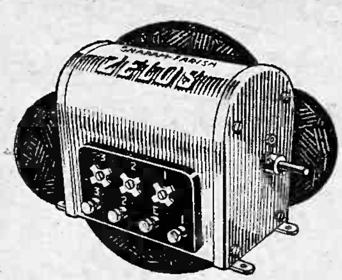
A useful earth for a short-wave set.

A Pick-up Hint

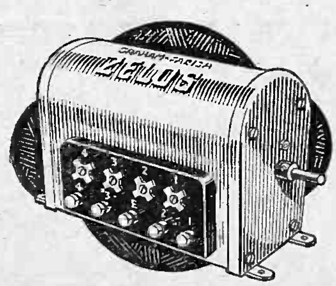
WHEN connecting a pick-up to a set having two L.F. stages, many amateurs simply mount two extra terminals on the terminal strip, connecting one to the grid of the first L.F. valve and the second to the 1½ volt tapping on the G.B. battery. In most cases it will be found that about 4½ volts G.B. are already applied to this valve through the transformer secondary. In this way, when the pick-up is connected, the 1½ volt tapping is connected to the 4½ volt tapping through the pick-up and transformer secondary, even although the set is switched off. The two cells thus shorted become exhausted, the total voltage of the G.B. battery falls and distortion is caused through the valves being insufficiently biased. As long as the pick-up is connected, therefore, the G.B. plug connected to the transformer secondary should be pulled out from the battery. Of course, if a proper radio-gram. switch is used this point does not arise.—J. J. SCULLION (Glasgow).

The 'Rolls Royce'. of Condensers





ZELOS THREE-GANGED CONDENSER - - 19/6



ZELOS FOUR-GANGED CONDENSER - - 27/6

Ensure a safe and efficient Aerial and Earth. The new **AEROFICIENT KIT** provides all you need.

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The Condenser supreme for the modern Receiver, giving precise and simultaneous tuning for two circuits. Accurately spaced, carefully matched and efficiently screened. Fitted with low-loss trimming Condenser and star-wheel adjustment. Each set of fixed vanes attached to its own terminal, moving vanes connected to terminal on case. Rigid frame. Beautifully finished in frosted aluminium.

2-GANGED **14/6**

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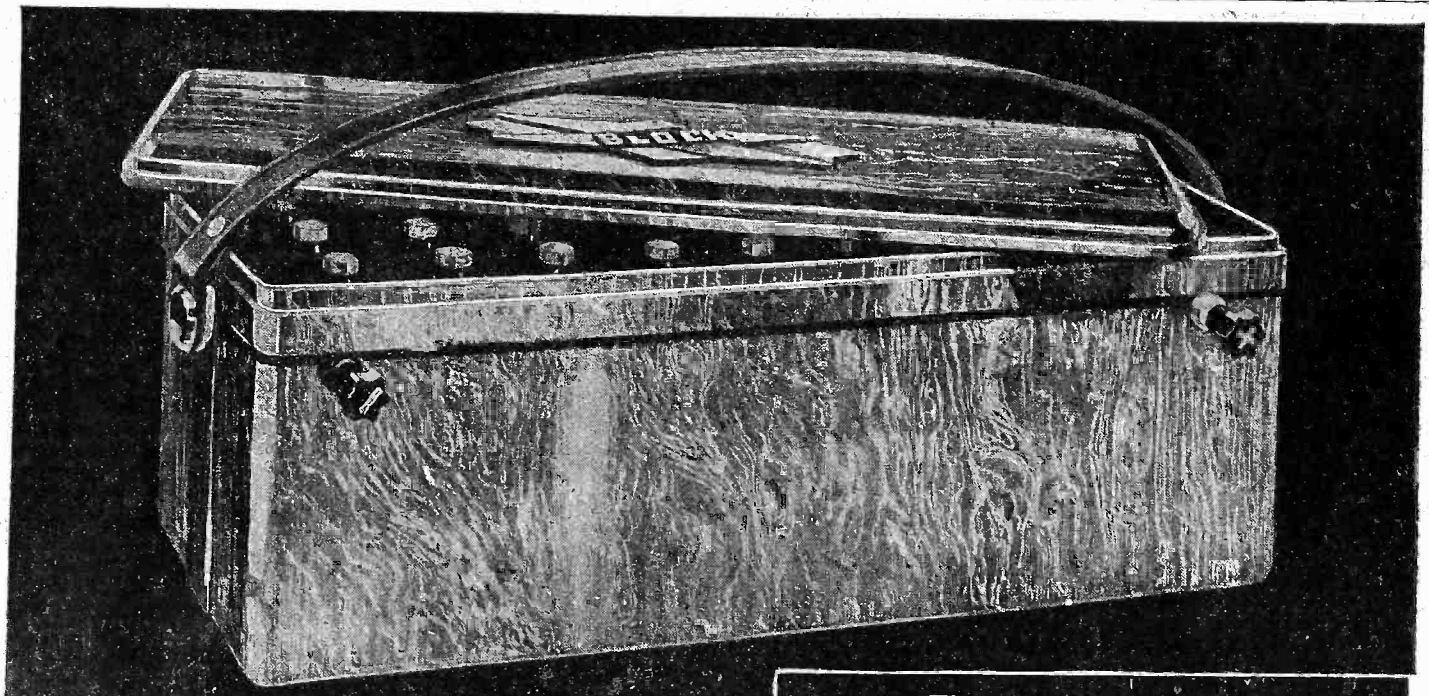


TELE-TALKIE TOPICS

By H. J. BARTON CHAPPLE, Wh.Sch., B.Sc. (Hons.), A.C.G.I., D.I.C., A.M.I.E.E

WHILE I appreciate that the prime interest of PRACTICAL WIRELESS readers is in the constructional or practical side of television, from time to time it will be necessary to place on record certain developments which may have a far reaching effect on the science itself. An occasion of that character has just transpired at the British Association Meeting, held at Leicester, where demonstrations were given daily of 120-line cathode ray tube television. In PRACTICAL WIRELESS dated 19th August, I dealt at length with the problems associated with cathode ray television, and interested readers should refer to that article for further details.

Fig. 2.

A special large ended cathode ray tube, developed in the Baird laboratories and giving a 9-inch image without lens magnification.

Previous Demonstrations

Television demonstrations have been staged at four previous British Association meetings, namely, Leeds—1927, Glasgow—1928, South Africa—1929, London—1931. At each of these a very definite stage in the progress of Mr. J. L. Baird's work was seen. Simple disc equipment formed the basis in 1927, while in 1928 both colour and stereoscopic images were shown. Images on a large screen, showing for the first time a modulated arc, were featured in 1931, and now, in 1933, a big step forward is portrayed, namely, a 120-line image scanned mechanically at the transmitting end by means of a rapidly rotating disc, but shown at the receiving end on a cathode ray tube.

It may not be known generally, but on April 6th, 1933, the first demonstration of *true* television on the cathode ray tube was given to the Press in the Baird laboratories. Hitherto, the demonstrations of cathode ray television had been confined to the transmission and reception of cinema films, but on the day referred to, not only were cinema films shown on the cathode ray tube's fluorescent screen, but also actual living persons.

Apparatus Details

Regarding the actual apparatus used for the Leicester television demonstration, this is shown in simple schematic form in Fig. 1, and it may be stated briefly that a standard film projector was employed with the Maltese Cross removed. An image of the pictures on the film was thrown on to a disc revolving at the high speed of 3,000 revolutions per minute, and as one picture on the film is scanned by two revolutions of the disc, it will be seen that the combination gives twenty-five pictures per second. Instead of the disc having the more usual spiral of holes, the scanning apertures, which total sixty in number, are set round the periphery of a circle, and in this way it was possible to obtain a 120-line picture with horizontal scanning.

Located behind the disc was a single photo electric cell, the light variations passing through the disc holes being changed to equivalent voltage variations according to the normal functioning of this device. After amplification through the "A" and "B" amplifiers, the signal was fed to the cathode ray tube.

These demonstrations created an enormous amount of interest at the British Association meeting, a variety of well-known cinema films forming the subjects for transmission purposes. Referring to Fig. 2, we see the special large-ended cathode ray tube which has been developed, having a fluorescent screen size of one foot diameter and giving a nine inch image without lens magnification, and having an image area ratio of approximately six horizontal to five vertical. One important feature of this tube is the pleasing sepia colour of the image. Hitherto, cathode ray television images have been blue or green in colour, and somewhat unpleasant to the eyes, but with this new tube the cream high lights and the soft sepia half-tones are a delight to watch.

The Ultra-Short Waves

It is very important to note that the television images demonstrated revealed a whole wealth of detail and were almost flickerless. To the uninitiated it may seem strange, therefore, that a television service embodying all these improvements is not yet available to the public. The problem is to find a medium whereby the signals can be transmitted. The employment of ultra-short waves appears to be the most natural solution, but at the moment the difficulties associated with any form of *service* through this radio channel are considerable. First of all, we have the restrictions connected with the area of reception due to the fact that these waves, at least as far as can be ascertained with present knowledge, travel in straight lines, and are somewhat like a searchlight beam, inasmuch that obstacles in the wave path screen the radio receiver.

On top of this we have the deleterious effects of outside interference, which badly impair the received image. Then again, the amplifiers have to be designed to cover a frequency range of at least a hundred kilocycles, while phase changes are another item which has to be guarded against.

Naturally, intensive research technique is being applied towards a solution of these problems, which it should be noted are *radio* and not television difficulties, but it is likely to be some time before the full fruits of this work are made known. The Baird Company, fully cognisant of this, are pursuing a bold policy, and have rented one of the high towers at the Crystal Palace for a period of four years, so that they can conduct independent ultra-short-wave experiments. A special experimental licence has been granted by the Postmaster-General for this purpose, and every advantage will be taken of the valuable height given by this unique situation for an experimental transmitting station, and in due course it is hoped to supply readers with fuller details. In the meantime, there is the established thirty-line B.B.C. television service, and the fullest advantage should be taken by readers of these transmissions to gain an insight into television reception, as it is unlikely to be superseded by ultra-short waves for an indefinite time. It is more than probable that eventually the two services will be supplementary to one another, owing primarily to the limited range of the transmissions in the case of the ultra-short waves.

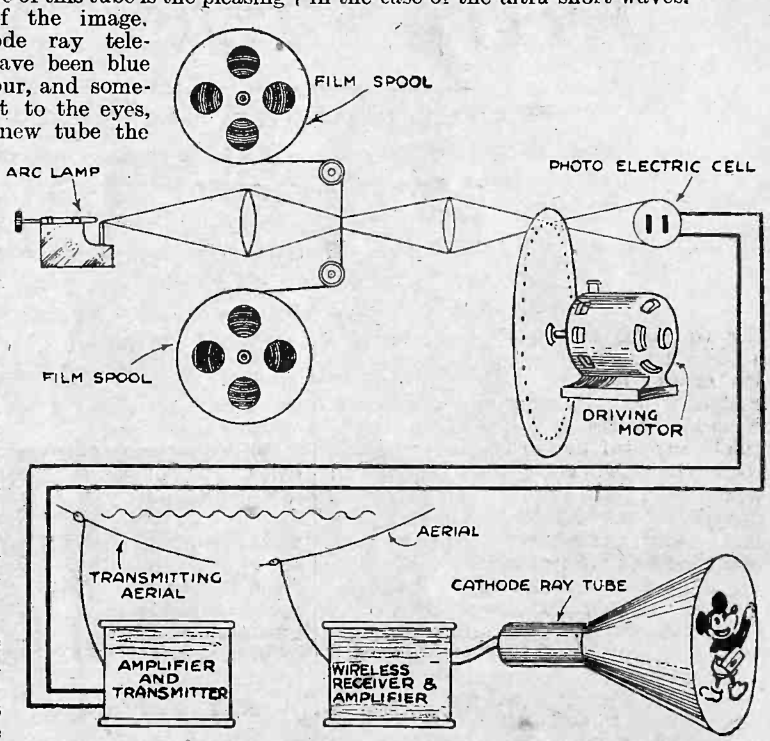


Fig. 1.—A simple schematic diagram showing how a 120-line mechanical tele-cine transmitter works, and employing cathode ray tube reception.

THE FILAMENT CIRCUIT IN D.C. MAINS SETS

By H. T. GODLEY, A.Rad.A.

It may be thought that the much-spoken-of "grid-system" of A.C. distribution, which was to supply alternating current to everyone all over the country within a few months, has rendered the design of D.C. receivers of little importance, and, in fact, I think it may be said that the design of this type of set has, in consequence, been allowed to stagnate to some extent. Unfortunately, perhaps, the "grid-system" has not proceeded quite so rapidly as was

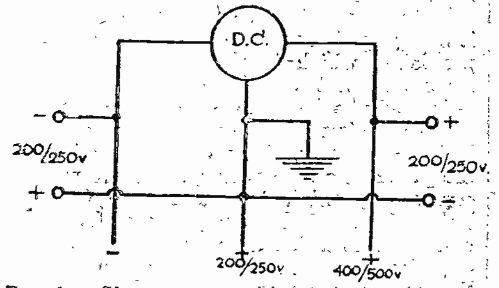


Fig. 1.—Showing the arrangement of the three-wire supply system.

at first anticipated, with the result that a very considerable number of amateur constructors now on D.C. mains are likely to remain restricted to a couple of hundred volts or so for some time yet. Actually, this restriction in available voltage is the only real grouse of the D.C. user, as generally speaking the construction of a D.C. set is less expensive and, to some extent, less complicated than its A.C. counterpart, as, in any event, a simple mains resistance takes the place of the expensive mains transformer and rectifiers essential in an A.C. set. Furthermore, if a large, undistorted output is required, the lack of available high-plate voltages can be overcome by using two pentodes in parallel, by which means an output of some two watts can be obtained with high-tension voltages of only 180 volts or so.

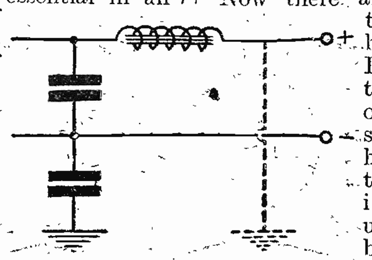


Fig. 2.—If the smoothing choke is in the earthed mains lead its efficiency is reduced.

D.C. Distribution

The title of this article should restrict me entirely to filament and heater circuits, but in order to make the later text clear, I am obliged to enter into a short explanation of the method in general use of distributing D.C. Current is generated by the power station at twice the potential actually supplied to the consumer (*i.e.*, if your input is 230 volts, then the current is generated at 460 volts). This generated output is separated into two branches by what is known as the "three-wire" system, the method being shown clearly in Fig. 1.

It will be seen that one side of the mains is always earthed, *but not necessarily the negative side*. Usually, on one side of the street, the negative leg is earthed, and on the other side, the positive. It will be clear from Fig. 2, that if the smoothing choke happens to be in the earthed mains lead (whichever side it may be), then the smoothing efficiency is being seriously reduced owing to the fact that the choke is being partially short-circuited by the smoothing-condenser and the earth condenser, which are in series! Therefore, when designing a set or mains-unit for use on D.C. mains it is essential first to ascertain which side of the main is earthed, and then take care to see that the smoothing choke is in the other lead. If you omit to take this precaution, the chances are that you will hear practically nothing but hum!

In commercially-designed D.C. receivers, it is, of course, necessary to provide for adequate smoothing regardless of which side of the main is earthed, and consequently, it is the usual practice to insert a choke in each side, with a 4 mfd. condenser shunted across before the chokes. In this way, smoothing efficiency is assured, as, of course, one of the chokes must be doing its job properly even if the other is partially short-circuited.

Types of D.C. Valves

Now there are three types of valves which can be used in an "all-mains D.C. set," as the manufacturers put it! Firstly, the ordinary battery valves, secondly, the indirectly-heated D.C. valve, and thirdly, the recently-introduced Ostar-Ganz universal valve, which can be used on either D.C. or A.C.

I will deal firstly with a three-valve set designed for D.C. mains using ordinary battery valves, S.G. Det. and Power. Assuming that the first two valves are two-volters, and the last one a six-volter, we must first decide by what means we can obtain filament current at the correct voltages.

As we cannot step-down the voltage by means of a mains-transformer, as we would in an A.C. set, all we can do is to dissipate the unwanted two hundred volts or so in the form of heat through a suitable resistance. Reference to Fig. 3 will show that the filaments are wired *in series* and not in parallel as in a battery-driven set. The valve-filaments possess, of course, ohmic resistance, and being in series with the smoothing chokes and the mains-resistance, form part of what is virtually a "potential-divider" across the mains. This is clearly shown in Fig. 4, this circuit merely being that in Fig. 3 drawn in another way.

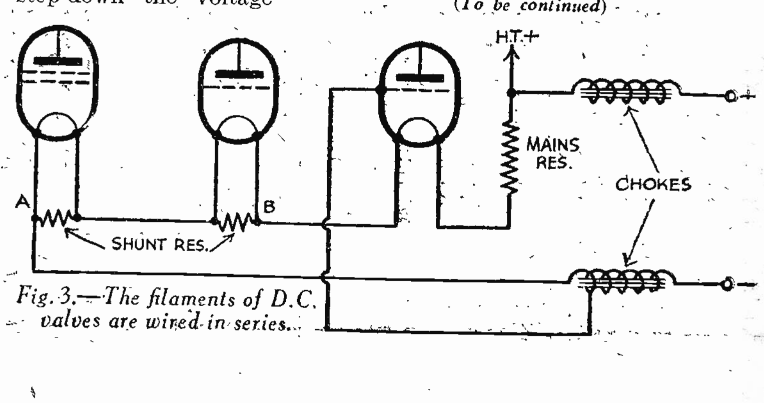


Fig. 3.—The filaments of D.C. valves are wired in series.

Mains Resistance

The mains-resistance must, of course, be of such a value that it will allow only the required filament current to pass, no more and no less. (Incidentally, as the filaments are wired in series, the voltage ratings are of no importance except for calculating resistance values, but in order to avoid excessive use of shunt resistances, they should all require the same filament current.) Assuming, for our set, the valves are rated at .1 amp., then in order to pass this current from 250-volt mains, we should have to use a resistance having a value of 2,500 ohms $\left(R = \frac{\text{Voltage}}{\text{Amps}}\right)$, but as the filaments and chokes have ohmic resistance, we must decide what actual total resistance they have and deduct it from our required total resistance of 2,500. The manufacturers of the choke will, of course, advise you of the choke resistance, or it can be determined by a suitable measuring instrument, such as the "Avometer"—they may very probably have a resistance of 200 ohms each, which we will assume is the case. Now for the resistance of the filaments. We use for this purpose the Ohms Law formula already given, *i.e.*, $\text{Res.} = \frac{\text{Voltage}}{\text{Current}}$, which, in the case of a 2 volts .1 amp valve, becomes $\text{Res} = \frac{2}{.1} = 20$ ohms. Equally, the six-volt filament resistance will be 60 ohms. Therefore, the total filament resistance is 100 ohms, plus the total choke resistance of 400 ohms, being 500 ohms, which we must deduct from the total resistance of 2,500 ohms.

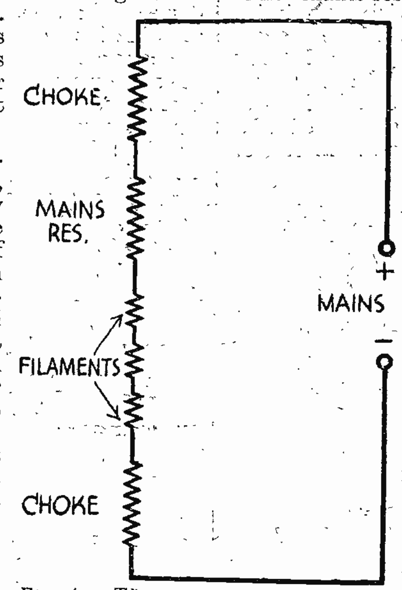
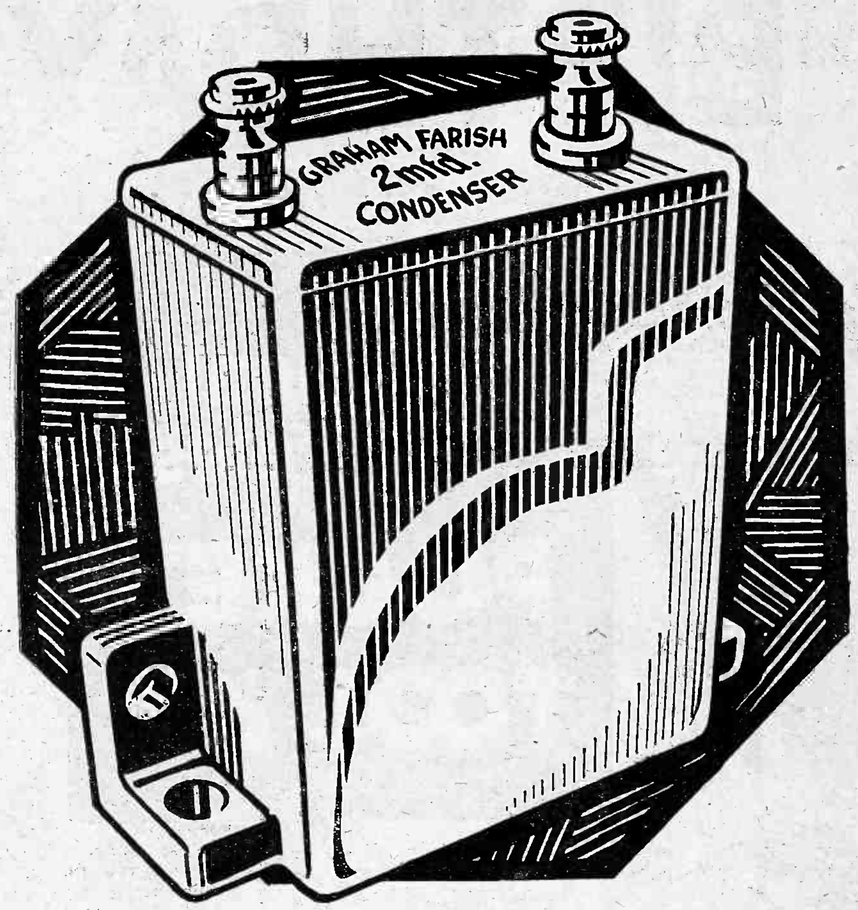


Fig. 4.—The circuit given in Fig. 3 is here shown in simplified form.

(To be continued)



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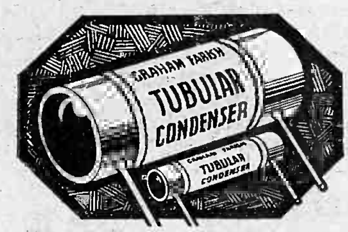

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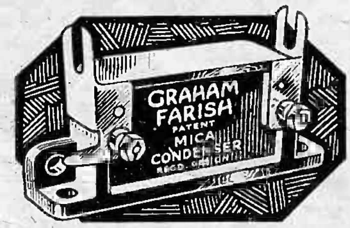

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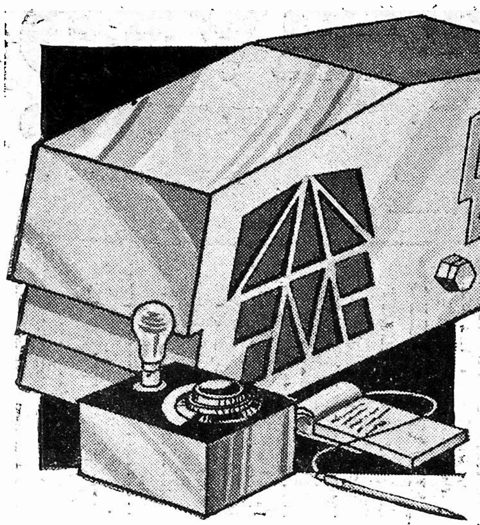


OUR VIEWS ON RECEIVERS

THE COSSOR ALL-MAINS RECEIVER MODEL 3468.

RECEIVERS naturally drop into various classes, but this compact set stands more or less alone, as it provides a Console receiver using a modest number of valves, and priced at an equally modest figure.

Generally speaking, the man who wants a Console must have five or more valves whether he wants them or not, which is not always desirable to those who want a set of normal proportions, but prefer it to stand on its own legs as a complete unit.

The Cossor Model 3468 exactly fulfils these requirements, and the excellence of the general design will be more readily understood if the internal arrangements are touched upon.

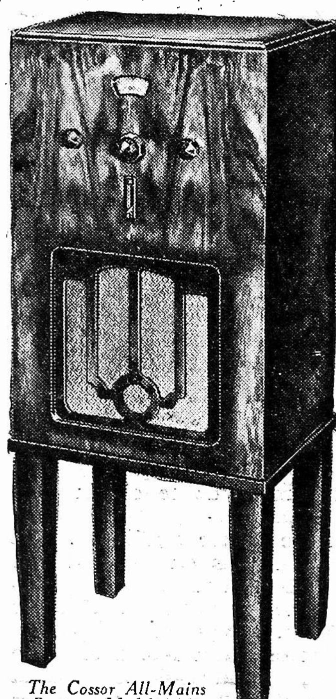
It comprises a three-valve receiver built on an all-metal one-piece gun-finished chassis, and represents the latest manufacturing principles.

The first valve is a metallized Cossor MVSG variable-mu screened-grid valve, equipped with the usual bias volume-control upon which this type of valve depends if its advantages over the ordinary screened grid are to be realized. Coupling between this valve and the detector takes the form of a tapped auto-transformer, the coupling condenser being abnormally low—.000025, which is presumably used to avoid risk of stray hum reaching the detector grid from the S.G. anode. The fact that volume at the top of the long-wave dial is fully up to standard, notwithstanding this very low coupling condenser, is a great tribute to the efficiency of the coil.

The detector valve is the Cossor 41 MH, working with a grid-leak that would normally be associated with a leaky grid detector, but the anode voltage is higher than normal, resulting in rectification somewhere midway between leaky grid and power grid, which is probably the very best compromise between quality and sensitivity when preceded by only one screened-grid stage.

The output is taken care of by the Cossor 41 MP which, though classed as an ordinary power valve, is capable of an output of over 1 watt, and with the abnormal slope of 7.5 mA/V it possesses sensitivity equal to, if not greater than, that of an indirectly heated pentode.

The power pack is built round the Cossor 442 BU, a rectifying valve of exceptionally robust construction that will give abnormally long service. The smoothing associated with it is heavy, incorporating the field coil of the loud-speaker as the smoothing choke with generous smoothing condensers. The mains transformer is a particularly massive construction, and among other advantages it enjoys that of an earth shield between the primary and secondary windings to prevent modulation hum.



The Cossor All-Mains Receiver Model 3468.

The exterior of the set is both pleasing and simple, of walnut clear finish with a very slight matt, the main part of the cabinet being supported on four short legs. The total height is 2ft. 11in. The general proportions and appearance of the cabinet may be readily seen in the accompanying illustration.

The controls are those normally associated with a three-valve variable-mu set, and include one-knob tuning, combined L.T. switch and volume and reaction controls.

The wave-change switch is delightfully light in action, and the wave bands, when checked with a heterodyne wave-meter, extended from 200 metres to rather more than 230 metres on the medium waves, and from rather less than 900 metres to 2,000 metres on the long-wave band.

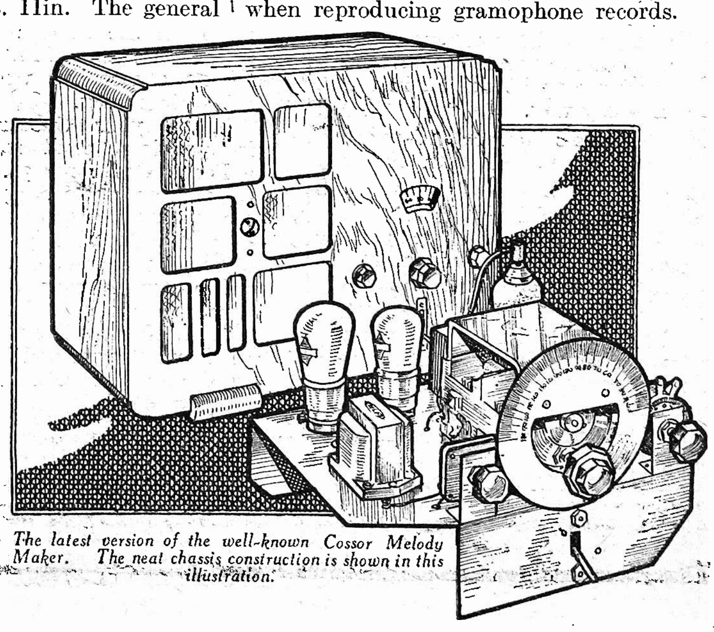
Refinements include combined on-off switch and volume control, one-knob tuning with dial light, and provision for gramophone pick-up. An outstanding feature is the mains energized moving-coil loud-speaker, which is naturally more sensitive than a permanent magnet type could be, in addition to superior tonal qualities.

On test the receiver was found to be simple to use and came fully up to expectations, providing a wide choice of European stations. No difficulty was experienced in getting below Fécamp. An imposing list of stations received could be easily given, but owing to the variation between one locality and another it would mean very little; but it may be mentioned that at twenty-two miles from Brookmans Park all the usual worth-while European stations were received at excellent strength, and with more than pleasing quality and entirely without any trace of objectionable mains hum. On the long waves Radio-Paris was easily cleared from 5XX, and with careful adjustment Königswusterhausen could be almost entirely cleared from the former stations.

The selectivity is of a high order, and the variable-mu gives the perfect control of volume with which it is identified.

Mains consumption was measured and found to be 45 watts, which means that the set may be run for twenty-two hours for one unit of electricity, which is a little more than seven hours for 1d., assuming the electric current to cost 3d. per unit. The transformer is tapped to accommodate mains voltages from 200 to 250 alternating current only (40 to 100 cycles), and the receiver represents unique value at the modest price of £10 15s.

Using the gramophone, the receiver was found to give good quality with a somewhat brilliant top register, which is also true when working on radio. Owing to the sensitivity of the 41 MH it is essential that the pick-up be fitted with a volume control, the volume control on the receiver being out of use when reproducing gramophone records.



The latest version of the well-known Cossor Melody Maker. The neat chassis construction is shown in this illustration.

THE BEGINNER'S SUPPLEMENT

HOW YOUR RECEIVER WORKS.—IV

In this Instalment the Author Explains the Function of a Detector Valve and Deals with the Principles of Reaction Control.

(Continued from page 50, Sept. 23 issue)

OUR detector valve is connected to the tuned grid circuit as shown in Fig. 15, and the fluctuating signal voltages supplied to it can be represented graphically in the manner shown in Fig. 16. These voltages are of precisely the same nature as those which we previously saw were applied to the aerial circuit, but are of greater amplitude. Now as they are applied to the grid of the detector valve, they will cause more or less current to pass from the filament to the anode; at any moment when the grid receives a positive voltage more anode current will flow, and when the voltage is negative, the current will be reduced. So far, then, the detector performs in exactly the same manner as our H.F. valve. *But*—when the grid becomes positive it will attract a certain amount of the anode current (some of the electrons emitted by the filament) to itself. When this occurs that current, being of a negative character, will flow through the grid-leak back to the filament from whence it came. And whenever current is passed through a resistance a "voltage drop" occurs between the ends of the latter component. This fact is made use of in obtaining automatic grid-bias and might be more readily appreciated by making reference to that excellent stand-by, Ohm's law, which states that the voltage drop across a resistance is equal to the product of the current and the ohmic value of the resistance. It can thus be seen that if the latter remains constant the V.D. is proportional to the current flowing.

We can now understand that the flow of current through the grid-leak causes one end to become negative in respect to the other. This negative potential is applied to the grid in the form of grid-bias, the actual value of the latter being dependent upon the current flowing and thus, in turn, upon the "strength" of the signal voltages causing it. This grid-bias voltage quickly attains a steady value, and although it is always very small (since the grid current never exceeds a few millionths of an ampere), it is sufficient to serve a very useful purpose.

The steady grid-bias voltage is "added" to the fluctuating signal voltages, with a result that the positive half-cycles are reduced in amplitude, and the negative half-cycles are increased. The net effect of this is that the mean or average value of the signal voltages is caused to fluctuate in sympathy with the variations in amplitude, as shown in Fig. 17. The latter fluctuation is, therefore, applied to the grid and produces corresponding variations in anode current. In other words, the anode circuit of the detector valve will contain not only the current fluctuations caused by the carrier wave (called high frequencies), but also others corresponding to the modulation and known as low or audio frequencies. It is the latter which we require to operate our loud-speaker after they have been amplified sufficiently for that purpose.

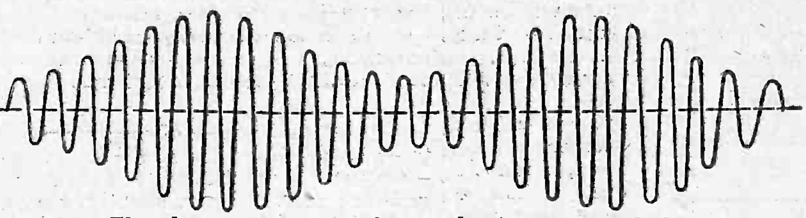


Fig. 16.—This diagram represents the signal voltages as applied to the grid circuit of the detector.

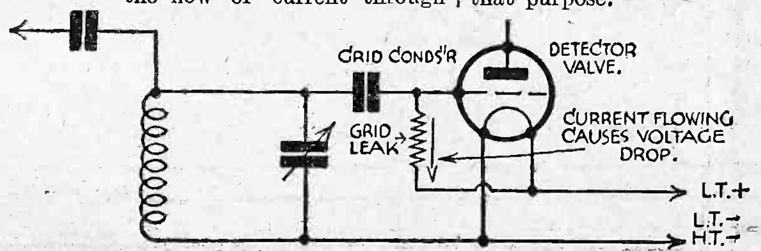


Fig. 15.—The principal connections of a leaky-grid detector.

Throwing Away the H.F. Component

The high-frequency "component" is no longer required, so our first object must be to "throw it away" and prevent it from reaching the L.F. amplifier, where it could do no useful work and would be a nuisance. But how ? There are two ways; one is to feed it back to the filament circuit by means of a condenser (C) connected as shown in Fig. 18. Here it should be noted that a condenser has the interesting property of passing high-frequency currents much more easily than those of low frequency, and if a suitable capacity is chosen for C, it will allow easy passage of all H.F. without having any effect whatever on the audio frequencies. By calculation we can find that the most suitable capacity lies between about .0001 mfd. and .001 mfd. Incidentally, if the capacity

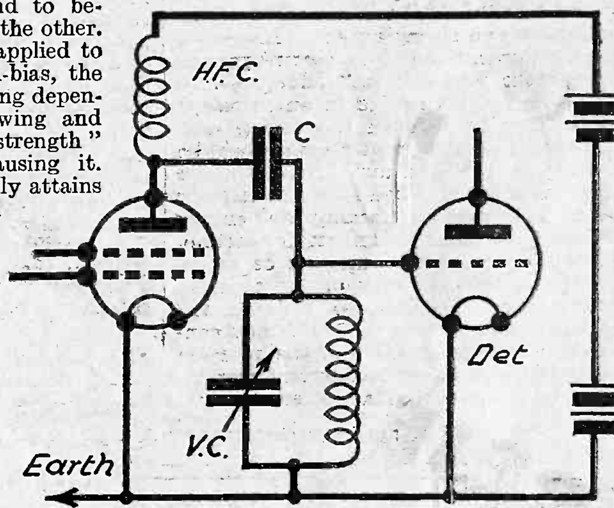


Fig. 14 (b).—The tuned grid circuit, which is really a modification of the circuit shown in Fig. 14 (a).

were greater than this it would allow some of the higher audio frequencies to leak away and would consequently reduce the strength of the higher musical notes and thus spoil the "quality" of loud-speaker reproduction.

Reaction

In the method of "throwing away" the high frequencies which we have discussed, those currents are literally wasted, but we can put them to valuable use by feeding them back to the filament by the path

(Continued overleaf)

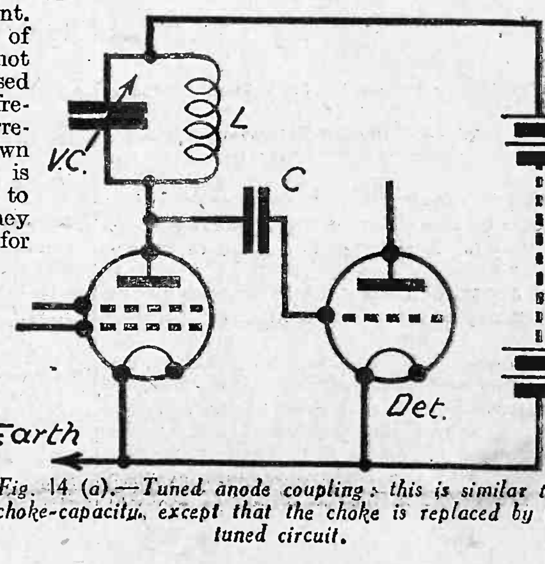


Fig. 14 (a).—Tuned anode coupling: this is similar to choke-capacity, except that the choke is replaced by a tuned circuit.

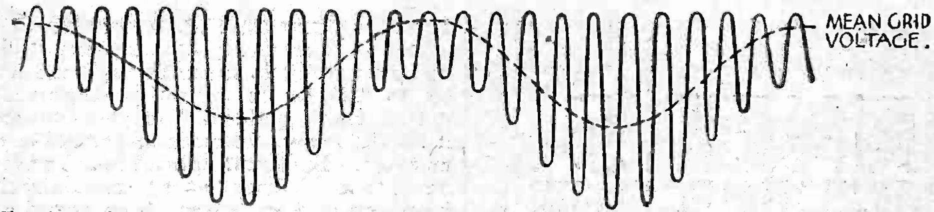


Fig. 17.—A diagrammatical representation of the combined signal voltages and steady bias voltage supplied by the grid leak.

THE BEGINNER'S SUPPLEMENT

(*Continued from previous page*)

illustrated in Fig. 19. They are now sent through a variable condenser and a coil which is situated close to the tuned-grid coil. The currents are still returned to the filament circuit, but in passing through the coil they cause a magnetic field to be set up and this "links" with the field of the tuning coil and strengthens it. Expressed in other words, some of the current passing through the first coil is "induced" into the second. This results in an increased current flowing through the tuning coil, which means that a greater voltage will be applied to the grid and hence a larger signal output is obtained from the detector valve. The process of feeding back energy into the grid circuit is known as reaction, and the degree of feed-back can be varied by altering the capacity of the reaction condenser or the distance between the reaction and tuned-grid coils. It is most convenient to fix the position of the reaction coil and vary the amount of current passed into it by means of the reaction condenser, and although there are several variants of this method they all depend upon the same principle.

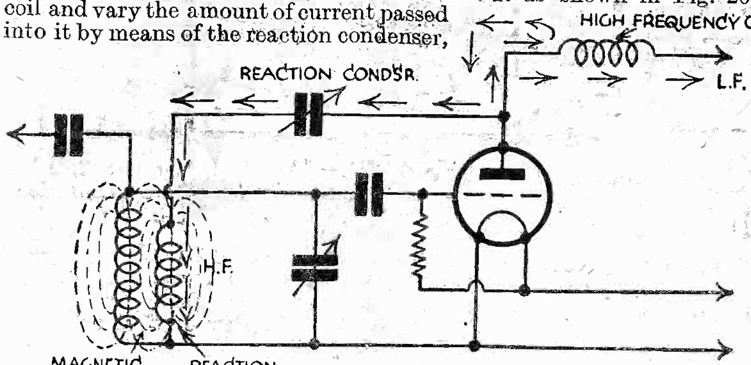


Fig. 19.—This circuit shows how the H.F. currents are made to do useful work by passing them through a reaction coil. Also notice the effect of the H.F. choke.

The High-frequency Choke

Although we have provided an easy leakage path for the H.F. currents, there is still nothing to prevent their passage into the L.F. amplifier, so we must fix some kind of "barrier" past which they cannot escape. Our barrier consists of a high-frequency choke connected in the position shown in Fig. 19, between the anode of the detector valve and the L.F. amplifier. The choke is a form of inductance coil, which behaves in precisely the opposite manner to a condenser. In other words it does not restrict the passage of low so much as it does the high frequencies. By choosing a suitable value of inductance we can almost entirely prevent the passage of H.F. currents without offering any appreciable restriction to the audio impulses. By calculation it is not difficult to find that the best value of inductance for the choke is in the region of 200,000 microhenries.

L.F. Amplification

We can now revert to the audio-frequency component again and see what is to happen to that. In all probability it will require to be amplified (or increased in amplitude) before it is capable of operating the loud-speaker, so another valve will be required for this purpose. Our first problem is to devise a means of feeding the low-frequency currents into the next valve. As a matter of fact, there are three available methods which are not unlike those we considered for passing the amplified signal voltages from the H.F. to the detector valve.

Inter-valve Coupling

Let us make a start by using a resistance R as shown in Fig. 20 and passing the L.F. voltages developed across it to the grid of the amplifying valve through condenser C. As we saw in respect to the H.F. valve, a higher voltage will be developed across R as its resistance is increased, and it would therefore appear that best results would be obtained by making R of, say, 1 megohm. This would not work out in practice, though, because the resistance has to carry the steady high-tension current to the detector valve as well as the audio frequencies; thus, if its value were so high as the figure mentioned a high-tension battery of unduly high voltage would be required to supply a working voltage to the anode of the detector valve. Moreover, it is found that the improvement effected by increasing the resistance beyond a certain value is so slight as to be of no consequence. That value is from two to three times the impedance of the detector valve. Thus, if we were using a detector valve having an impedance of 10,000 ohms, R should have a resistance of between 20,000 and 30,000 ohms. It is not difficult to prove by calculation that an efficiency of some ninety per cent. is obtained by employing a resistance whose value lies between the two limits quoted.

Choke Coupling

But whatever value of resistance is employed it will of necessity cause some drop in high tension voltage, and so unless there is a fair amount of "reserve" in the H.T. supply, the detector valve will be prevented from functioning efficiently. We can, however, replace the resistance by a low-frequency iron-cored choke which will offer the necessary resistance (or more correctly, impedance) to low-frequency currents whilst at the same time having only a small resistance to steady direct current.

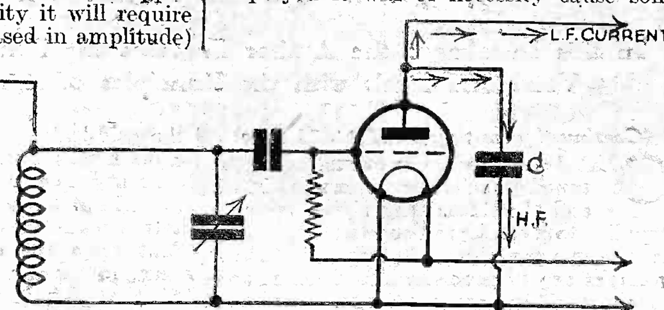


Fig. 18.—H.F. currents in the anode circuit of the detector are fed back to the filament through a condenser.

We have not yet said very much about the coupling condenser marked C. This has to pass low-frequency currents without hindrance, and so must have a capacity of from about .005 mfd. upwards.

The L.F. Grid-leak

Both of the methods of coupling referred to—resistance capacity and choke capacity—are used in practice, and in each case a grid-leak must be connected between the grid of the L.F. valve and a grid-bias battery. The purpose of the grid-leak is to apply a steady negative voltage to the grid of the valve. We will leave an explanation of the reason for applying grid-bias until next article, when we study the action of the L.F. valve, and dismiss the matter for the present by saying that the leak should have an ohmic value of about four times that of the resistance R, or of the impedance of the L.F. choke.

(*To be continued*)

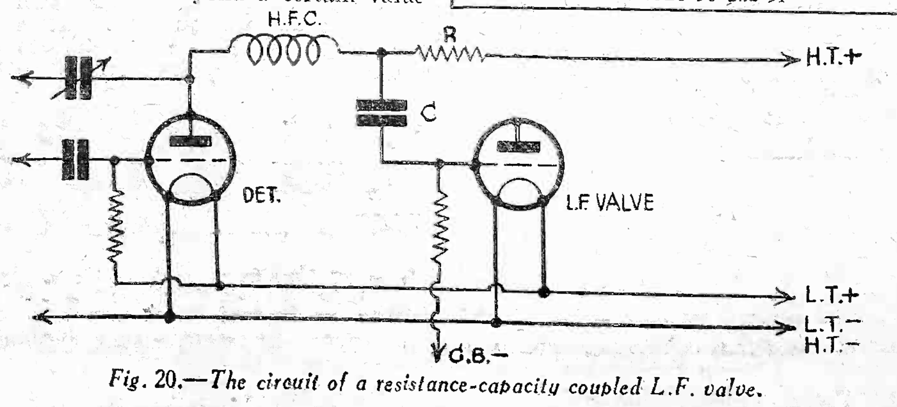


Fig. 20.—The circuit of a resistance-capacity coupled L.F. valve.

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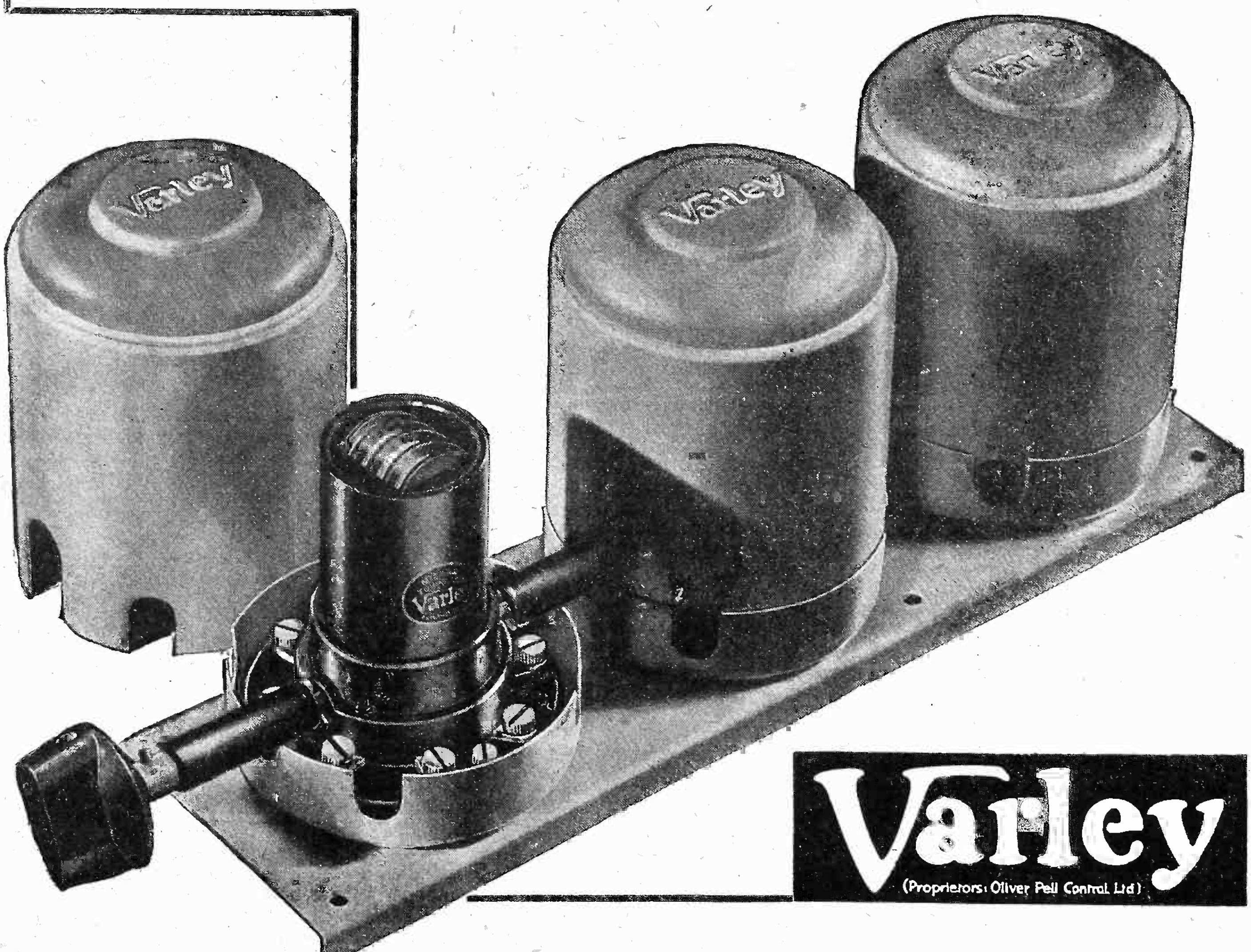

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L.C.R. and L.S.D.

Notes on Power Requirements for All-Mains Working

By H. BEAT HEAVYCHURCH

THE title which I have chosen for this article may at first sight seem rather peculiar, but I want if possible to try and show how we can arrive at an approximate cost (L.S.D.) for running our wireless sets (L.C.R.) from the mains. Almost daily I am confronted by some worried listener who feels that his electricity bill is going to soar in leaps and bounds because he has built or bought a radio receiver which is to derive its power from the mains. Although after a time it is possible to convince each individual that this is entirely a wrong impression I feel that the subject is of sufficient interest to readers of PRACTICAL WIRELESS to warrant an explanation of the items which are involved.

Unfortunately, actual cost figures cannot be given as the various electricity supply companies upon whom we are dependent for our lighting and power requirements are singularly lacking in uniformity in their tariff charges. In some districts the cost per "unit" of electricity rules high, while in others the reverse is the case, but no doubt when the "Grid" scheme comes into full operation we shall all be able to obtain electricity at quite moderate charges.

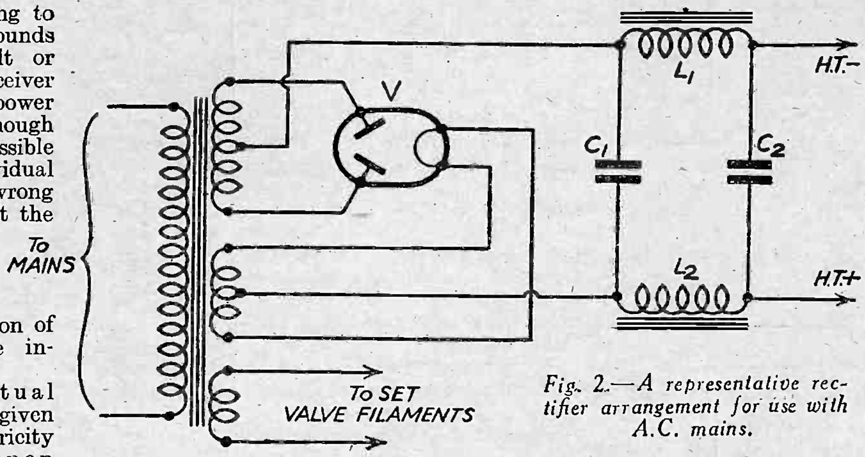


Fig. 2.—A representative rectifier arrangement for use with A.C. mains.

The B.T.U.

Irrespective of whether the supply is direct or alternating in character, the charge is so much per "unit," that is, per kilowatt hour. Here is the first difficulty, what is meant by a kilowatt hour? It is the legal unit of electrical energy fixed by the Board of Trade (hence we sometimes speak of the kilowatt hour as the B.T.U.) for public supply services, and is the quantity of energy supplied in one hour by a current of electricity at such a pressure that the product of volts, amperes and hours equals one thousand. Thus, supposing we worked a piece of domestic apparatus which consumed a current of 2 amperes at a pressure of 250 volts for 6 hours, we should have a total consumption of:—

$\frac{2 \times 250 \times 6}{1{,}000} = 3$ kilowatt hours or three units in that time. This statement is strictly true when we are dealing with direct current, but, as will be shown later, needs to be qualified when we come to alternating current.

D.C. Sets

When the individual is using D.C. mains, and has instruments at his disposal he can very accurately measure the consumption of his radio set, and then calculate his running costs. This is shown in Fig. 1, and consists in connecting a voltmeter *of the high resistance type*, and an ammeter between the mains supply and the input to the set, and noting their readings. By multiplying these two figures together we obtain the power in watts and can then calculate how long the set may be run in order to consume one unit. For example, the voltmeter V may read 240, and the ammeter A say, 0.3 amp. The wattage is, therefore, 240 × 0.3 = 72 watts, which gives us nearly 14 hours radio for one unit consumed, and knowing the cost per unit in your own district the running costs per hour is only a matter of simple division.

In the absence of any meters, then a knowledge of the characteristics of the valves employed is called for, so that the figure for the current consumption may be computed, the mains voltage itself being stated on the supply meter. Generally, the bulk of the current drawn from the mains is used to supply the valve filaments which are wired in series. These may be of the 0.1 amp., 0.18 amp., 0.25 amp., etc., class, but a reference to the data sheet found in the valve cartons will soon settle this point. To this filament current must be *added* the *total* anode current drawn from the mains by the valves.

For example, we may have a three-valver with a high-frequency pentode or screened-grid valve taking 5 milliamps, a detector valve adding another 4 milliamps with a pentode taking a further 25 milliamps, thus giving a total of 34 milliamps. Adding this to the filament current of say 0.18 amp., we have a total current of 0.214 amp. If, for the sake of illustration we take a mains voltage of 200 volts the watts consumed are 42.8, giving just over twenty-three hours use before one unit is registered on the supply meter.

Readers will learn from this, therefore, that as far as D.C. mains working is concerned, the relation between L.S.D. and L.C.R. is a very simple one, but when we come to alternating current mains matters are a trifle more involved.

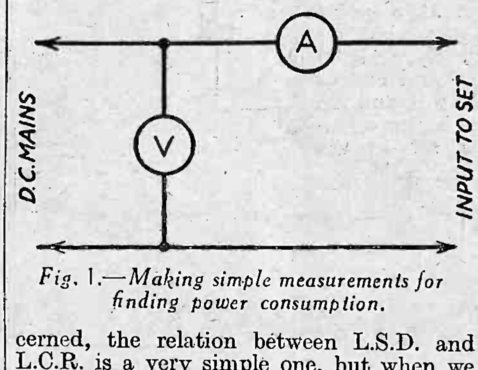


Fig. 1.—Making simple measurements for finding power consumption.

The Problems of A.C.

First of all, owing to the very nature of the electricity supply, that is alternating, the current pulsates first in a positive direction and then in a negative direction, maintaining this double positive and negative effect (called a complete cycle) indefinitely. As it stands, this is useless for feeding our mains receiver so recourse is made to some means for rectifying the current or making it unidirectional, and we then proceed to smooth it by means of inductances and condensers before passing it to the valve anodes. Added to this we have to supply the valve filaments, generally of the indirectly-heated cathode type, and included in the combined power unit or power pack which is required for A.C. mains sets we have a transformer acting as the intermediary link between the unit and and mains.

Looked at as a whole this seems somewhat complicated, and before we can begin to talk of running costs we shall have to analyse the scheme, and then the method of computation will follow automatically. First of all, then, can we multiply amperes, volts and hours together to obtain our kilowatt hours as we did in the case of D.C.? The answer is No! To attempt to give a full explanation of this interesting phenomena would take too much space here so I must try and deal with it briefly.

The Importance of "Phase"

If we take an alternating current supply and place across it separately a pure resistance load, a pure inductive load and, finally, a pure capacitative load, three different effects will take place. This arises from the fact that with alternating current we have to take account of the difference in *phase* between the voltage and current, both of which are pulsating. In the case of a pure resistance load both current and voltage are in phase, and the numerical value of both the current and the voltage can be multiplied together to give the power. With a pure inductive load, however, the current lags behind the voltage by 90 degrees, and for a pure capacitative load the current leads the voltage by 90 degrees. Here, then, we have our phase difference creeping in and when a complicated load is made up from a combination of resistance, inductance and capacity the phase difference between current and voltage will vary according to the values of each item.

Now when we speak of the *power* in an alternating current circuit, without in any way qualifying the expression, we understand by this term the *mean value* of the power over a complete period. Mathematically, it can be shown that the power is not simply equal to the product of voltage and current, but that it is equal to the product multiplied by a factor which is dependent on the phase difference which has just been mentioned. Actually, the multiplier which converts *volt-amperes* or *apparent power* into watts or *true power* is termed the *power factor* of the circuit.

(To be concluded next week.—Editor.)

Artificial Aerial Transmitting

By D. P. TAYLOR

In a recent article published in PRACTICAL WIRELESS it was stated that a beginner applying for a transmitting licence is usually allotted a licence to transmit with "Artificial Aerial" only for a probationary period, and the purpose of this article is to describe some experiments which can be done with an artificial aerial transmitter.

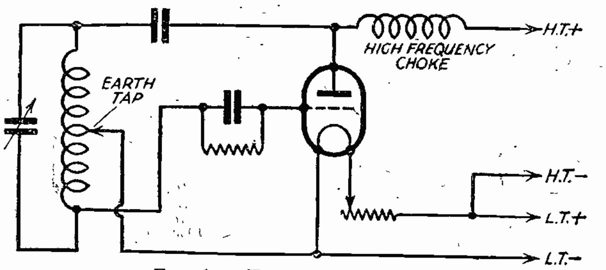


Fig. 1.—The Hartley circuit.

First, let us consider the term artificial aerial. It is defined by the Postmaster-General as "A closed, non-earthed oscillatory circuit, possessing inductance, capacity, and resistance, and functioning in the place of the usual aerial-earth system." It must be as nearly non-radiating as possible.

The inductance must be of one piece, and of small dimensions—as distinct from an inductance of large dimensions such as a frame aerial—the maximum area formed by the turns of the inductance not exceeding three square feet.

The artificial aerial should have the same values of inductance, capacity, and resistance as the aerial for which the transmitter is intended for use on, when the transmitter will function in exactly the same way as if it were coupled to the aerial.

In practice it is difficult for the amateur to measure these constants, but if experiments are to be performed on the short waves (below 100 metres) suitable values are—inductance 10 microhenries, capacity .0003 mfd. variable, and resistance 15 ohms.

By the choice of these values the aerial circuit can be brought into resonance, although, if it is desired to work mostly on waves lower than 50 metres the values of inductance and capacity could be reduced somewhat.

Instruments Required

In series with the closed oscillatory circuit is connected a hot-wire ammeter to measure the current passing through the artificial aerial. The other pieces which are essential for experiments are—wavemeter, milliammeter, voltmeter, and listening device or monitor.

The wavemeter can conveniently be one of the absorption type consisting of a coil shunted with a variable condenser, and this is calibrated on the receiver from known stations and a graph plotted of wavelength, or frequency against condenser dial readings.

A lamp of the flash-lamp variety is included in the wavemeter circuit for the purpose of detecting resonance with the transmitter, or alternatively, resonance can be detected by the flick of the milliammeter needle in the anode circuit of the transmitter valve when the condenser dial is rotated with the wavemeter coil held in coupling with the coil in the transmitter.

A milliammeter is an essential piece of apparatus, and a good value for use with low power transmitters is 0.25 m/A. and is used for reading the anode current of the oscillator valve.

A voltmeter is also a useful piece of apparatus for use with the milliammeter in measuring the power input to the transmitter.

A monitor is required for the purpose of listening to the transmissions, and this can consist of a small single valve receiver, using a pair of grid-bias batteries as high tension, alternatively a screened receiver could be used with the aerial disconnected, and if the received signals are too powerful such as to overload the detector valve the harmonics of the transmitter should be tuned in.

Hartley and Armstrong Circuits

Two of the most useful circuits of the self-oscillator variety are shown in Figs. 1 and 2. They are the Hartley and Armstrong or tuned-plate, tuned-grid respectively.

In the Hartley circuit the chief merit lies in the fact that there is only one tuned circuit, but it suffers from the disadvantage that both sides of the tuning condenser are at high-frequency potential above earth. In this circuit the amount of coupling between the anode and grid circuits is varied by altering the position of the earth clip on the coil.

The two fixed condensers have values of .001 mfd. and should be of the mica dielectric type in the interests of safety, whilst the grid leak can be a 50,000 ohm volume control type variable resistance.

The high-frequency choke in the anode circuit of the valve is a component of some considerable importance, and experiments should be made to determine the best value for this component starting with a single layer winding of 200 turns on a one-inch former of 30 S.W.G.

The adjustment of the Hartley transmitter is as follows:—

The earth clip on the inductance should be set at a point approximately one-third from the grid end of the coil, and the tuning condenser set to the required wavelength, this being measured by means of the wavemeter.

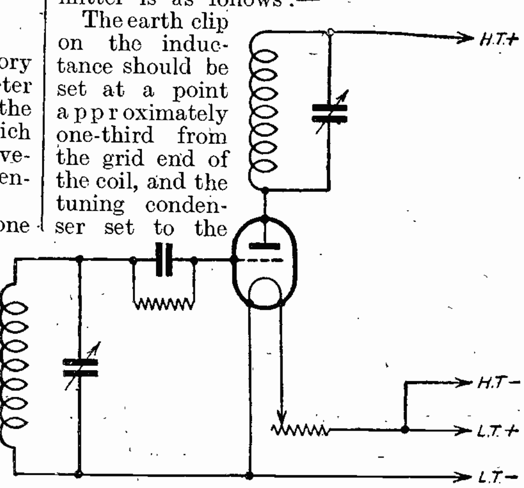


Fig. 2.—The Armstrong circuit.

The exact position of the earth clip can now be located, and circuit adjustments such as the value of the grid resistance made, the object being to obtain the greatest efficiency.

The Armstrong Circuit

The circuit shown in Fig. 2 is the Armstrong or tuned-plate tuned-grid, this circuit depends upon the inter-electrode capacity of the valve for the coupling between the grid and anode circuits. Similar values of components can be used in this circuit as described for use in the Hartley circuit.

The adjustment of the Armstrong circuit is as follows:—

The grid tuning condenser is set at approximately the required value and the anode condenser rotated, noting at the same time the anode current as shown by the milliammeter.

As the two circuits come into resonance it will be found that the anode current "dips" sharply and falls to a small value at exact resonance, the correct operating point being where the anode current is about 10 per cent. higher than the minimum value.

The wavelength is now measured, and, if necessary, readjustments of the condensers made to tune the circuit to the exact wavelength required. The artificial aerial circuit can now be coupled and the current in this circuit noted and adjustments made to obtain the greatest possible efficiency without imparing the stability or purity of tone of the transmitter.

It is essential that in the two transmitters described that the tuned circuits should be of a rigid and low-loss construction, as large circulating currents will flow around this circuit, even in low-power transmitters this current may be as large as an ampere.

The use of low-loss well-built condensers together with coils rigidly built and using heavy-gauge wire is necessary.

Suitable Valves

Suitable for use with the previously described circuits are small power receiving valves and particular mention might be made of the LS5 type of valve for powers up to 10 watts. The anode supply can in the case of low power transmitters conveniently be either dry batteries, or high-tension accumulators, but those having the facilities to do so are advised to use the electric supply mains. A further useful addition which can be produced cheaply is a small flash-lamp bulb having its terminals bridged with a loop of say 6in. diameter, this is used for detecting oscillations and is brought into proximity with the transmitter coils, when the power induced into the loop causes the lamp to glow.

Keeping a Log

It is required by the Postmaster-General that a log shall be kept of all transmissions which take place, and in this log should be entered a record of the power used, wavelength, circuit details, etc. The experimenter is advised to enter the fullest possible details of all experiments in the log, which will be found of great use when the radiating licence is granted. This is by no means the limit of the experiments which can be performed with an artificial aerial transmitter; many more could be described using transmitters of the crystal control type, of the master-oscillator type, or the use of telephony, but this is beyond the scope of this article.

YOUR SET'S POWER

Some Useful Advice for the Beginner on L.T., H.T., and G.B.

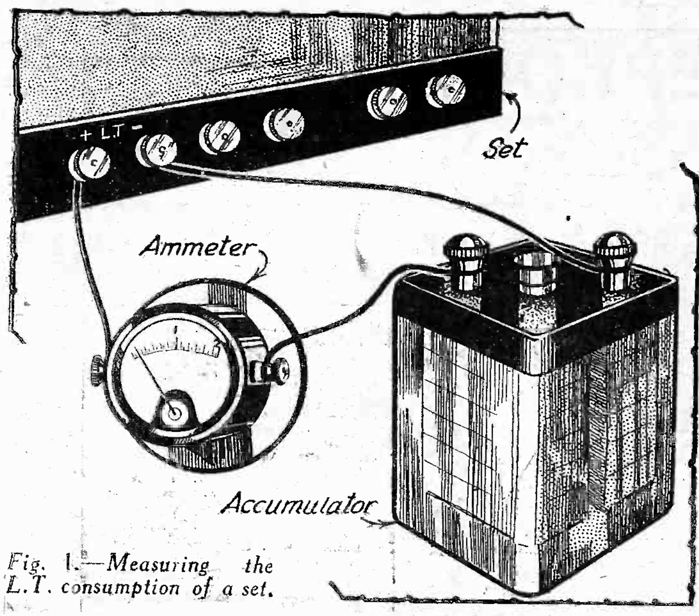


Fig. 1.—Measuring the L.T. consumption of a set.

THE correct choice and maintenance of a set's power supply—by which I refer to the low tension, high-tension, and grid bias—is of far more importance than most amateurs believe, and the exercise of a little thought on this matter can easily be the means not only of improving the performance of the set, but also of effecting an appreciable saving of hard cash in the way of running expenses. By way of amplifying and proving the latter statement let us consider the matter in detail by examining the three main voltage sources.

Low Tension

The object of the low-tension supply is, of course, to heat the valve filaments, and for this purpose we generally use a 2 volt accumulator of some particular " capacity." We can take it that by capacity we mean the amount of electricity which the accumulator will " hold." This is not scientifically correct, because an accumulator does not really hold electricity, but by applying a voltage to its terminals (charging) a certain chemical action takes place within; afterwards, when the accumulator is connected in an electrical circuit (such as to the L.T. terminals of a wireless set), the chemical action is reversed and the accumulator generates electricity. But to return to the subject of capacity; the accumulator is said to be of so many ampere-hours, for example, 30 a.-h. Broadly speaking a 30 a.-h. accumulator will deliver a current of 1 ampere for 30 hours or of 3 amperes for 10 hours. Theoretically it should also be capable of giving 30 amperes for 1 hour, but in practice it is known to be harmful to discharge or charge an accumulator at any current in excess of one tenth its ampere-hour rating. Thus, the maximum current which should be taken from a 30 a.-h. accumulator is 3 amperes. With any receiver having up to six or seven modern valves there is very little likelihood of our putting too heavy a current load on our accumulator unless it is also being used to supply high tension through one of those excellent Battery Superseders now on the market, or to charge a high-tension accumulator of the well-known type made by Milnes Radio Co. But the ampere-hour capacity also determines the number of hours of service that can be obtained per charge, so we must take full account of it even if our set is of the smallest type, consuming only a fraction of an ampere of low-tension current.

Let us see how we can determine the number of hours that an accumulator will " last " on any particular set. First we must find out how much low-tension current our valves consume; this can be done by connecting an ammeter as shown in Fig. 1, or by adding together the current ratings of every valve in use. In the former case the ammeter should have a full scale reading of no more than 2 amperes or else an accurate result will be well nigh impossible. The latter method is just as good when the valves are of reliable British make, but should not be relied upon when foreign valves are employed, for they frequently consume far more than their rated current. (I hope no readers of PRACTICAL WIRELESS use foreign valves, because they are dear at any price.) The L.T. current consumption is given on the makers' instruction sheets and is also used as a " code figure " in the valve's designation. For example, an S.G. 215 valve requires a filament voltage of two and a current of .15 ampere, an H.L.210 requires the same voltage at a current of .1 ampere, whilst a 230 pen. takes .3 of an ampere. If the latter valves were used in a three valve S.G.—Det.—Pen. receiver their total consumption of low-tension current would be .55 (or rather more than half) ampere. When a 30 a.-h. accumulator was used, the number of hours it would last per charge is found by dividing .55 into 30; thus it works out at about 54 hours. In the same way it can be deduced that a 40 a.-h. accumulator would operate the set for approximately 73 hours.

The " Economical " Accumulator Capacity

Following the same line of reasoning it would appear that a 100 a.-h. accumulator could be used to drive the set for over 180 hours, but this is where we meet our first " snag." An accumulator should regularly be recharged at periods of no more than six weeks if it is to be kept in good condition, and it is actually rather better to reduce the time between charging to four or five weeks. It can be seen that if the latter accumulator were to be exhausted in six weeks the set would have to be in use for 30 hours a week or over four hours per day, whereas I daresay the average daily use of most receivers is not much more than two hours. Of course, it does not harm an accumulator to be recharged before it is completely run down, but there are very few of us who like to pay for anything we do not get. Consequently it is the most satisfactory policy to choose an accumulator of such a capacity that it will just drive the set for upwards of a month on one charge. One should not be " penny wise " in this respect, because an accumulator is damaged more by running it for *three days* in an almost completely exhausted state than by *three years* of normal use.

Whilst it is uneconomical to use a battery of too large a capacity, it is still more wasteful to buy one which is too small and which will only last for a fortnight or so, because the cost of recharging is only slightly more for the larger one and there is not a great difference in initial cost.

Care of the Accumulator

Having decided on the most suitable capacity for the accumulator, let us form a few rules regarding its correct use. At this point it should be emphasised that a good accumulator properly cared for should have a life of at least five years, although I could recite innumerable cases where batteries have been ruined in less than half that time. The most important rule of all has already been dealt with, namely, recharge at regular intervals of not more than six weeks *whether the battery is running down or not.* Another rule is that the accumulator should be disconnected from the set immediately its voltage begins to fall, as indicated by a drop in volume or the necessity for the application of more reaction. After switching off the set the accumulator tends to recuperate to a cer-

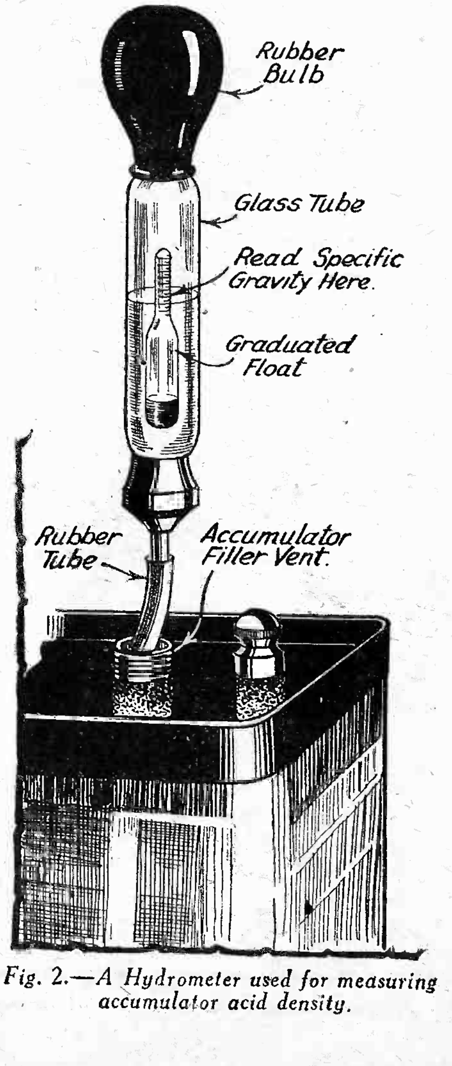


Fig. 2.—A Hydrometer used for measuring accumulator acid density.

SUPPLY

By FRANK PRESTON, F.R.A.

the Choice and Maintenance of the Supplies

tain extent and there is a most foolish practice on the part of some people to use it again after such recuperation. This is distinctly wrong and might result in irreparable damage.

It is not always appreciated that an accumulator can seriously be damaged by allowing it to stand in an uncharged state If it is not required for some months, it is much better to lend it to a friend who can use it, or otherwise to have it fully charged and then to pour out all the acid. After the acid had been emptied, the plates and inside of the case should be washed out with a small quantity of distilled water; the water must not be left in the case, but should be taken out after washing. When an accumulator runs down more quickly than it should, a fairly serious fault is indicated. The cause might be incorrect charging or careless discharging, but prompt attention is necessary. If the battery is fairly new a cure might be effected by having it charged slowly by a competent electrician, but with an old battery it is probable that the plates are being short-circuited by sediment which has collected in the bottom of the case. It is possible to remove the plates and wash out the sediment, but with modern accumulators this will be of little avail, because they are so designed that when the space below the plates becomes filled with sediment, which drops from the plates, the latter are of no further use.

The above rules apply to the user of the accumulator but there are others which concern the person who charges it. Many amateurs now charge their own from the mains, so a few pointers for them will not be out of place. It is vital to the accumulator that the plates should always be covered with acid and it is usual to maintain the acid level at least ⅜in. above that of the top of the plates. The fall in level whilst the battery is in use is due to the evaporation of *water* in the acid and not of the acid itself. Consequently any drop should be made up with distilled water, which may be obtained cheaply from a chemist. On the other hand, if any acid is spilt, the level should be made up with more acid of correct specific gravity or density. The correct density (often indicated by the letters S.G.) is always stated on the accumulator and should accurately be maintained. It varies from about 1,300 to 1,200, and is measured by means of a hydrometer like that shown in Fig. 2. New acid should be added only when the battery is fully charged, because the S.G. specified by the makers does not apply under any other circumstances. It is usual to buy pure sulphuric acid of full strength (about 1,800 S.G.) and to let it down with distilled water, although it is possible to obtain battery acid of correct density from most accumulator service stations. If you mix your own, remember that the acid should slowly be added to the water, and not *vice versa*, because chemical action between the acid and water results in the generation of great heat which might be sufficient to crack the container if the proportion of acid to water were too great. This does not apply when adding water to the accumulator, because the acid inside the latter is already diluted.

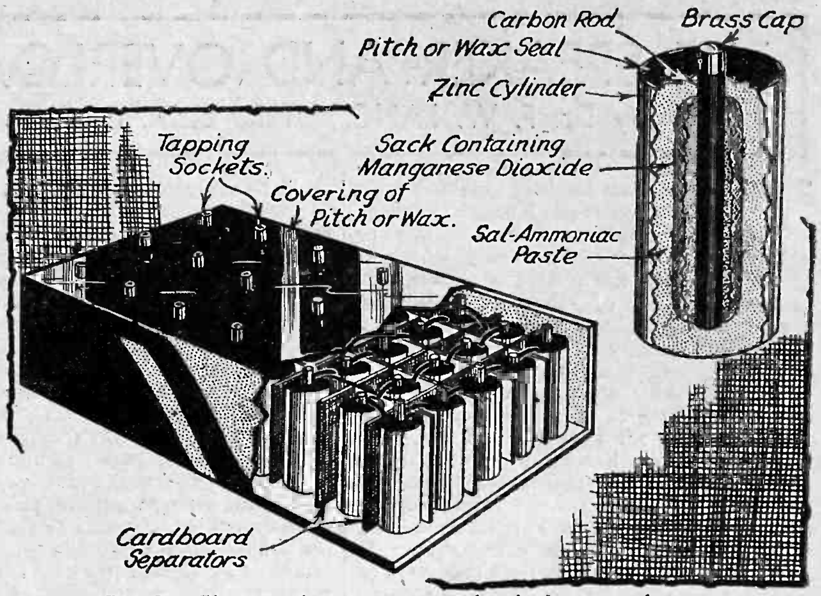


Fig. 3.—Showing the construction of a high-tension battery.

A voltmeter is practically useless as a means of discovering whether or not the accumulator is fully charged; the only satisfactory test is to measure the acid density by means of a hydrometer. Provided the acid was originally of correct density the hydrometer test will give a true indication of the accumulator's condition.

How Long Shall I Charge?

The length of time for which an accumulator must be charged is found in exactly the same way as the hours of discharge, that is by dividing the charging current into the ampere-hour capacity. For example, if the charger gives a current of .5 ampere it must be kept in circuit with a 30 a.-h. accumulator for 60 hours. This assumes an efficiency of 100 per cent., so it is best to add about 10 per cent. to the calculated figure to ensure a full charge.

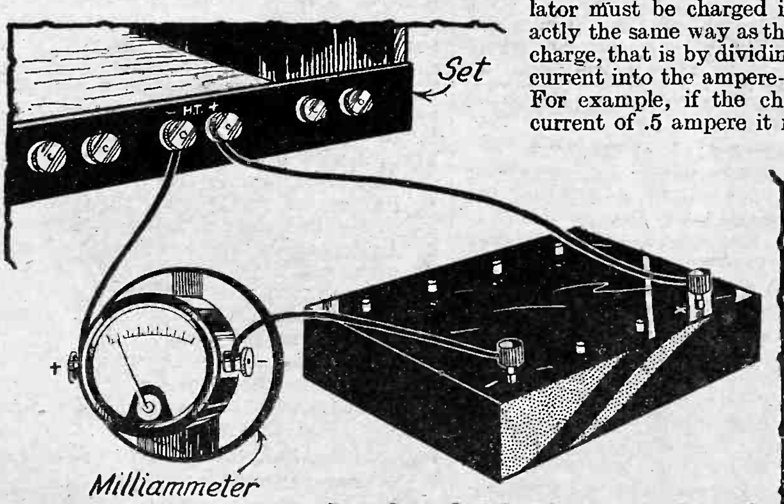


Fig. 4.—Finding how much high-tension current your set consumes.

The latter calculation takes it for granted that the battery has been completely run down, but actually this should never be the case when a trickle charger is employed. It is better in every way to charge the accumulator overnight once or twice a week, putting just as much current into it as has been used by the set. As an example let us suppose that we have in use a receiver employing the valves referred to above, and that we keep it going for an average of 2½ hours per day or 17½ hours per week. Since the current consumption is .55 ampere we shall use 17½ multiplied by .55, or nearly 10 ampere-hours, and to replace this we must charge at, say, .5 ampere for 20 hours or at .25 ampere for 40 hours. As explained, the charging may be done at a stretch once weekly or for half the length of time twice a week, whichever is more convenient.

Safety First

Just three safety-first rules about charging: (1) Stand the accumulator on a sheet of zinc, rubber, glass or porcelain when on charge, and keep it well away from fabrics, etc., which might be damaged by the fine spray given off when the battery approaches "full charge"; (2) Keep naked lights away from the accumulator, which gives off inflammable (not explosive or harmful) gas; (3) Carefully wipe the accumulator after charging to avoid acid stains in the receiver cabinet.

High Tension—Dry Batteries

Probably 70 per cent. of set users derive their H.T. supply from dry batteries, so we will consider these first. That we may better understand later remarks in respect to dry batteries let us first get some idea as to how they are made and how they work. The sketch of Fig. 3 will simplify the explanation. The battery consists of a number of cylindrical cells, each giving 1.5 volts, connected in series and thus providing a total voltage equal to one-and-a-half times the number of cells in use. Each cell is made up of a central rod of carbon (fitted with a brass connecting cap) surrounded by a quantity of manganese dioxide contained in a small linen sack or bag. This fits in the middle of a cylindrical zinc container holding a paste made up of sal-ammoniac. The carbon rod forms the positive pole and the zinc cylinder the negative pole when the cell is in use.

(To be continued)

THE SPEAKER AND OVERLOAD

By Dr. F. W. LANCHESTER, LL.D., F.R.S.

THERE are two kinds of overload with which listeners are familiar, namely, the overloading of the amplifier or set by the speaker and the overloading of the speaker by the set. The latter, the true overloading of the speaker, is very rare indeed, the reason being that any decent moving-coil speaker, even a miniature, will take, under normal conditions, anything up to a ½ watt or 1 watt undistorted output at middle frequencies, whereas there are a vast number of sets, including all dry battery sets, which will not give more than 200 milliwatts undistorted output. The overloading of the set or amplifier is a subject which I propose to discuss in a later article; it will suffice to state here that this class of overload usually arises in the power stage, though it may come through from the detector. Such overload may cause the most distressing symptoms in the speaker; one of these is the well-known "rattle" that sounds as if it *must* be of mechanical origin, but which actually is not. In this, in my early acquaintance with radio, I have been deceived myself, and the general public can only be made to realize the truth by the most rigid demonstration; it is not unnatural: the ugly noise comes from the speaker, and the speaker is blamed. It is the same with a man who swears and blasphemes: people say he is "foul tongued," when it is his mind (or brain) that is at fault!

In the present article I shall confine myself to the real overloading of the speaker such as is liable to occur when the amplifier output amounts to several watts; such amplifiers are being marketed to-day up to 5 and 10 A.C. output, and there are few speakers competent to handle so great a load. Furthermore, as I shall demonstrate, to ask, or to state, the power that a speaker will receive without some added qualification is to put a question (or make an assertion) in a form that cannot be regarded as having any exact meaning.

Factors Relating to Overloading

There are, in any type of speaker and in any individual example, two limitations or two factors that limit the capacity and determine the condition of overload. These are the *maximum amplitude* and the *maximum mechanical force* the diaphragm or cone will stand without ultimate disruption. And both these are related to the acoustical emission. Another factor is the C^2R loss in the speech coil, which might come into the picture as related to the input; this is the part of the accepted input which is *not* represented by work done. If this were to come in as a limiting factor it would mean that the speech coil would be distorted by heat or burnt out; I have never heard of such an incident being reported.

The watts energy accepted by the speaker is disposed of in overcoming the impedance of same, which comprises the ohmic resistance of the speech coil (to which reference has just been made) and the motional impedance of the diaphragm or cone. The latter, in turn, may be considered as divided into the impedance due to acoustical emission and that due to a dissipation of energy in the cone and its mounting; much of this latter is absorbed in the fabric or leather peripheral surround. The mass of the diaphragm introduces an impedance of a different character; inertia forces due to its motion are controlled by currents in the speech coil, but these are wattless currents; there are also other wattless components introduced from another cause. For our present discussion these wattless currents may be disregarded.

The motional impedance due to acoustical emission (with which we may lump that due to damping losses without serious objection) is of the same character as ohmic loss; that is to say, the maximum volts and the maximum current are in phase; this is counterpart to the fact that in the generation (or propagation) of an acoustical wave the phase of maximum pressure is also that of maximum forward velocity. Consequently we may treat the impedance as made up of two parts, the pure resistances whose algebraic sum gives the total resistance:—

$$R=R_1+R_2$$

where R_1 is the ohmic resistance and R_2 the motional impedance. Furthermore, if W=total watts input, and W_1=watts dissipated in C^2R losses, and W_2=watts output: $W=W_1+W_2$, and the efficiency (we might say the mechanical efficiency) is given by the expression:—

$$\frac{W_2}{W}=\frac{R_2}{R}$$

In view of the fact that the word *sensitivity* is used in this connection where efficiency would be more appropriate, we might term $\frac{R_2}{R}$ the "sensitivity factor."

Wattage "Acceptance" of Speaker

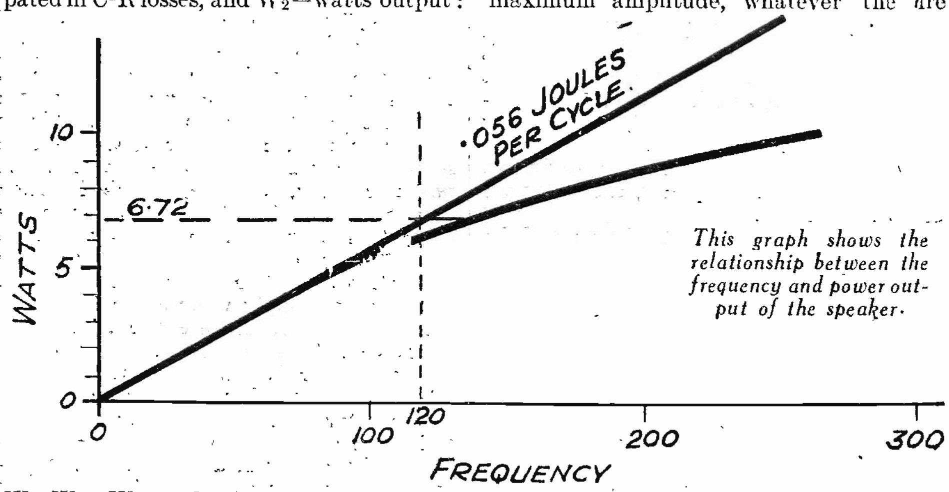
The above is a necessary preliminary to what follows, for the overloading of the speaker is governed by considerations of watts acoustical emission or output, namely W_2, whereas the usual form of expression is "how much power (watts or milliwatts) will the speaker accept or handle without overload," which is W and includes W_1, the watts lost in the ohmic resistance of the speech coil. Obviously, a speaker with a low efficiency or sensitivity factor would, other things being equal, "accept" more watts than one whose efficiency was high, so that really it is not the acceptance, but the acoustical output which should be specified. The acceptance of watts to be converted into heat in the speech coil is no good whatever, and a speaker that has a good acceptance in this sense only has nothing to commend it.

So we are led to concentrate our attention on the *acoustical output*, and here we have to take into account the effect of frequency. In this connection it is best to consider the diaphragm as an incident in the transmission of an acoustical wave; we could regard the wave as traversing a tube and postulate a weightless diaphragm or piston moving with the air disturbance as the wave progresses and exercising no restraint on same. The diaphragm will transmit movements and forces from the air column (in the tube) on the one side to that on the other; then if the frequency vary, but the energy transmitted remain constant, it is easy to demonstrate that the *amplitude* × *frequency* is a constant. Also the *force* (across the diaphragm) for given power transmitted is constant (we are not here dealing with inertia forces due to the mass of the diaphragm, only the forces due to the acoustical output). Thus there is no power limit imposed by high acoustic frequencies; the force transmitted to the air, or force reaction on the diaphragm for a given power output, is independent of the frequency—it is only the amplitude we have to consider.

Maximum Amplitude

Now in every actual speaker there is a maximum amplitude, whatever the frequency that must not be exceeded; a point is reached when the diaphragm (or cone) reaches its limit of movement, whether this limit is imposed by the surround or centring device does not matter—there must be a limit. Sometimes the limit is signalled by the speech coil being blown out of the gap, or conversely it may be sucked in. And since *amplitude* × *frequency* is constant for any given power output, a maximum value of amplitude means (for that output) a minimum value of frequency. Thus, if with 1 watt acoustical output the diaphragm amplitude reach its maximum at 100 cycles per second, then for any frequency less than 100 the speaker will not be capable of giving as much as 1 watt. So we appreciate that when the wattage output or input is stated, the lowest frequency at which this applies should be given in the same breath.

But we can go further; we can express the acceptance or output of the speaker (as the case may be) in terms of the frequency since the amplitude is definitely limited; in brief, the maximum amplitude is the constant of the speaker. Or, $\frac{\text{watts}}{\text{frequency}}$ =constant. If we take the inverse of the



This graph shows the relationship between the frequency and power output of the speaker.

(Continued on opposite page)

THE SPEAKER AND OVERLOAD

(Continued from previous page)

frequency, namely, the *time* required to execute one complete cycle, and call this t, then (W_2=watts) we have: $W_2 \times t = k$ where k is the constant, and k gives the speaker power output. Thus, if the limiting output of a speaker be two watts at 100 frequency, $t = .01$ and $W_2 = 2$ $W_2 t = .02$ or $W_2 = k/t = .02/.01$. And for any other value of frequency, say 50; and $W_2 = .02/.02 = 1$ watt, and so for any other low frequency; the constant k defines the output or the acceptance as the case may be, and takes cognisance of the relation of power (watts) to frequency. The question naturally arises: "What is k; is it merely a numeral, constant, or is it a physical reality?" Now a *watt* is a measure of power just as a *joule* is a measure of energy; in fact, a watt is one *joule* (work done) per second, $W = J/t$, and since $k = W \times t$ we have $k = J$ or k is actually the *joules per cycle.*

Acoustic Output

We have seen that it is more scientific to specify acoustical output rather than acceptance, which latter relates to the electrical A.C. output of the amplifier, because a low efficiency or sensitivity factor would be a help to the acceptance, and tend to make a poor speaker look like a good one; but it is not always practicable to specify acoustic output. Authorities are not in very close agreement as to the proportion of energy supplied actually delivered as sound. Hence the assumption is made that the sensitivity in different speakers is up to a certain level, which, owing to commercial competition, is more nearly true than might be expected. This being so, the acceptance in *joules per cycle* may be allowed as a measure of the *acceptance* power capacity of the speaker. We then have W, the watts supplied in place of W_2, the watts output; the expression is the same form as before, but the value of k will be greater for W than for W_2.

In order to make sure that the meaning is understood, we will take a further example. A speaker accepting 2.8 watts is found to be just within its permissible amplitude at 50 cycles, the test being made at mains frequency. Then

$$k = W \times t = 2.8 \times .02 = .056.$$

That is to say, the speaker will accept .056 joules per cycle. We require to know how many watts it will accept at, say, 120 frequency, $W = k/t = .056 \times 120 = 6.72$ watts.

It must not be thought that if an amplifier has an output of 6.72 watts, the speaker will be limited to 120 as its lowest frequency; all that is implied is that for frequencies below 120 in the example given the amplifier must have a falling characteristic, such that the A.C. output does not exceed .056 joule per cycle. Referring to Fig. 1, the acceptance graph of the speaker is a straight inclined line which at 6.72 watts cuts the 120 frequency ordinate. Theory requires that the output characteristic of the set does not at any point rise above the acceptance curve.

Frequency and Impedance

The common or popular method of giving the acceptance of a speaker in watts without specifying the frequency, we have seen cannot be justified. But if we were dealing with some particular kind of music in which the lowest frequency can be inferred without

(Continued on page 109)

FROM THE FLASH LAMP

"TUNING COILS." By "Photon"

PRIOR to the introduction of the iron-powder core the practice with regard to tuning coils had become standardized on the basis of a single layer solenoid winding for the medium waveband, and, generally speaking, bunch winding subdivided and accommodated in two or three slots for the long-wave band.

Confining our attention to the medium waveband solenoid winding, many formulas have been given at different times for the calculation of inductance, but such formulas only apply strictly when the winding is well clear of screening or other conductor capable of reacting on the winding by induction. The theoretical basis is that the coil is *in the open* far removed from any conducting body. In the case of potted coils this condition is violated to such an extent that the ordinary equation or formula is no longer applicable.

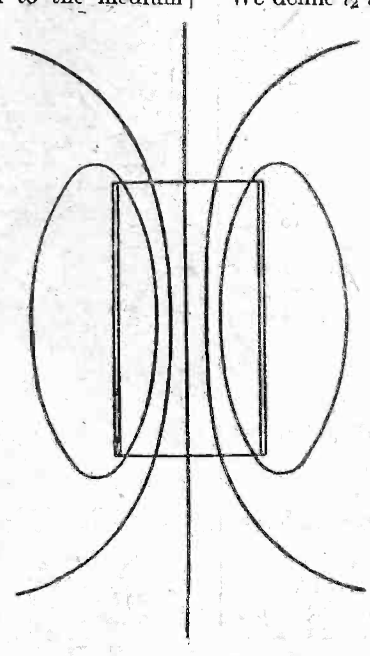


Fig. 1.—Diagram illustrating the magnetic field set up by a solenoid winding.

The writer always prefers to apply fundamental principles rather than employ a cut and dried formula, and in the first section of this article the subject dealt with is the solenoid winding under ideal conditions, that is, in the open.

The essential, which it is necessary to calculate, is the inductance; in the first place we go over old ground. The inductance of any given coil is the product of the number of turns, and the number of lines of force threading or interlacing same for one ampere current flowing in the winding. To give the inductance in henries, this must be divided by 10^8, or in microhenries, by 10^2. The problem centres itself round the calculation of the number of lines of force in question, that is to say, the flux.

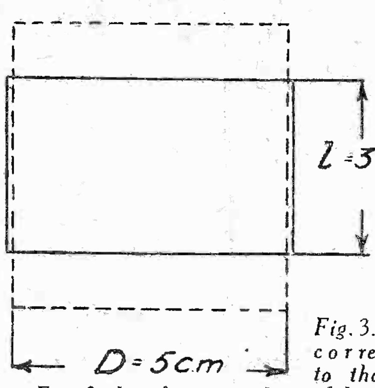


Fig. 3.—A field corresponding to that shown in Fig. 2, but for a winding of less relative length.

If N=the number of turns, then with one ampere flowing N=the ampere turns and the measure of this in gilberts is 0.4π N. If the whole of the reluctance of the magnetic circuit were in the core of the solenoid all we should have to do to obtain the lines of force per cm² would be to divide 0.4π N by the length of the winding in centimetres. But part of the reluctance of the magnetic circuit is in the external field, and we must measure this or assess it on some basis. It is here that the complications of the usual formula come in. We find some constant has to be applied which is tabulated and has a different value for every diameter/length ratio. The writer's method avoids this, if a length equal to 0.45 of the coil diameter be added to l, the actual length of the winding, it exactly (within 1 per cent.) accounts for the reluctance of the external field. So we proceed as follows:—

We define l_2 as equal to $l+0.45$ D, l and D being in centimetres. Then the lines of force per square centimetre within the winding will be $.04\pi\ \text{N}\div l_2$ and total flux$=\frac{0.4\pi\ \text{N}}{l_2}$ multiplied by the area $\frac{\pi \text{D}^2}{4}=\frac{0.1\times\pi^2\text{N}\ \text{D}^2}{l_2}$ so that the inductance$=$

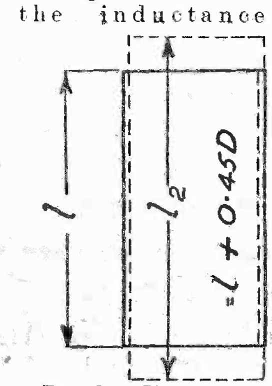


Fig. 2.—Showing the equivalent field according to the "Photon" rule.

$\frac{0.1\pi^2\ \text{N}^2\ \text{D}^2}{l_2\times 10^8}$ henries, or approximately $\frac{\text{N}^2\ \text{D}^2}{l_2\times 10^8}$

In microhenries$=\frac{\text{N}^2\ \text{D}^2}{l_2\times 10^2}$

The writer does not consider any formula is properly presented to the practical man unless accompanied by one or more examples. In Fig. 1 we have a graphic representation of the magnetic field set up by a solenoid winding. Fig. 2 represents the equivalent field according to the "Photon" rule, namely, $l_2=l+0.45$ D. Fig. 3 is a figure corresponding to Fig. 2 for a winding of less relative length, and Fig. 4

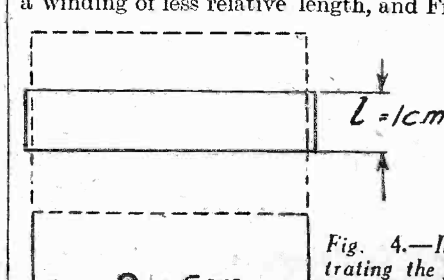


Fig. 4.—Illustrating the field for a winding having a diameter five times its length.

shows a similar diagram for a short winding whose diameter is five times its length. About this point the "Photon" rule begins

(Continued on page 109)

RADIO RAMBLINGS

By JACE

Jottings from my Notebook

Condenser Drives

EVEN the best variable condenser cannot give satisfactory service if it is not fitted with suitable means of operation. Tuning is so extremely sharp and critical on short waves that the "spread" of a station on 30 metres is only about a third of a degree on the dial of a .0001 mfd. condenser, so some form of reduction drive is a practical essential. There is a good deal of disparity, both inside the trade and elsewhere, regarding the most suitable form of reduction drive and the mechanical principle upon which it should operate. Some manufacturers prefer a 100 to 1 reduction, and others favour a ratio of only 10 to 1; some say a positive gear drive is essential, and others swear by the frictional method.

I am of the personal opinion that a ratio somewhere between the two is most pleasing from the point of view of ease of operation. A high ratio allows of accurate tuning, but I find it very irksome to have to rotate the tuning knob through fifty whole revolutions to get from zero to 180 degrees on the tuning dial. On the other hand, a ratio of 10 to 1 is not quite sufficient to permit of really accurate tuning, although it does allow "searching" to be carried out more rapidly. A well-made drive, giving a reduction ratio of about 25 to 1 and having a *good-sized operating knob,* seems to be just about right. I don't think it matters whether the operating mechanism employs gears or friction discs, so long as it is really well made and is entirely free from back-lash.

The Reaction Condenser

AS to the reaction condenser, the capacity must depend entirely upon the size of the reaction winding. Here again opinions differ, for some designers prefer a small condenser and a large reaction winding, and vice versa. I always prefer to use the smallest winding possible, and this entails the use of a larger condenser. As a general rule, I employ about two-thirds as many turns for reaction as for tuning purposes, and this involves the use of a reaction condenser having a capacity of from .0002 mfd. to .0001 mfd. When the reaction winding has more turns than the tuned winding it is liable to be tuned (by the series-connected condenser) to the same wavelength as the tuned circuit, and this can cause all kinds of queer effects. Not least of these is a complete "dead spot" on the tuning dial, over which it is quite impossible to obtain reaction.

Aerial-Earth Systems

ALTHOUGH surprisingly good short-wave reception is often obtained on what appears to be the worst possible aerial, it is worth while to give close attention to this item if maximum efficiency is to result. When it can be erected, a short vertical wire about 20ft. long is best, but it should be kept as far away from earthed objects as the situation permits. If the normal "broadcast" aerial *must* be used, a small series condenser is essential, and the longer the aerial the smaller should the capacity of this be. It is often found that a short indoor aerial gives better results than a long outside one: such an aerial is certainly worth a trial when the outside one is long or has a high capacity.

The earth lead should either be a first-rate one, or should be discarded entirely. Most short-wave sets will give better results without an earth than with a poor one, but the absence of an earth almost invariably makes hand capacity more troublesome. The ideal is one consisting of a similar wire to the aerial and erected below and parallel to the latter. This is called a counterpoise earth, and although it is not commonly used by amateurs for receiving, it is very popular with transmitters. The wire should be insulated in the same way as the aerial and erected from 6 to 8ft. above the ground. A counterpoise earth has a very low resistance, and therefore does not add to the damping of the tuned circuit.

New Polish Stations

POLAND, one of the countries which did not agree to the findings of the Lucerne Conference, is adding two more transmitters to her wireless net. The Poznan 2 kilowatt transmitter will be dismantled and re-erected at Torun (Thorn) at no great distance from Danzig. It will work on a common wavelength with Cracow, in 1934, on 219.6 metres. Poznan, in compensation, will be endowed with a 20 kilowatt station. Work is being hurried forward, and tests may be made before the end of this year.

Cutting Down Broadcasts

IN consequence of a "cut" in its revenue, the I.N.R. responsible for radio transmissions from the two Brussels stations has been compelled to curtail its programmes. In future there will be only two broadcasts daily, namely, from midday to 2 p.m. (week-days), or 10 a.m. to 2 p.m. (Sundays) and from 5 to 10 p.m. daily.

Alternative Channels

IT is often very difficult to pick up transmissions from such stations as Belgrade and Ljubljana, and so far for these programmes no alternative channel has been available to the foreign listener. In future, Czechoslovakia and Yugoslavia will exchange a series of evening entertainments and in this manner the latter's best programmes will frequently be heard through Prague. This station is one of the most powerful in Europe as its 120 kilowatt broadcasts are easily receivable on almost any evening.

THE SPEAKER AND OVERLOAD

(*Continued from page 105*)

being stated—for example, a string quartet in which the lowest tone is approximately sixty-six, the open C string of the 'cello; or if concerned only with the spoken voice, as in public address, in which case the lowest tone is in the region of 100 or 120—then in either case it would be legitimate to talk in watts acceptance, but only so on account of the fact that the lowest tone is understood without being expressed. If, however, forgetting this limitation, the speaker be called upon to receive its declared watts from organ music at a frequency of, say, 30 cycles, it will immediately be found to be overloaded and the diaphragm will be overswinging with the emission of anything from a few unauthorized harmonics to a regular concatenation. Moreover, a speaker treated in this way will sooner or later show signs of disintegration.

The relation of the total watts supplied, W to the watts dissipated in the winding W_1, and the watts emitted acoustically, W_2, depends upon the value of B, the number of turns in the field, and the ohmic resistance of the winding; these relations will be discussed in a later article. It may be stated here that the *theoretical* value of W_2 in terms of W, which is the same as the motional impedance in terms of the total impedance, is commonly in the region of 33 per cent. to 50 per cent., and this (if the theory were complete) would represent the mechanical efficiency of the speaker, or otherwise express its sensitivity factor. But authorities, generally speaking, give a very much lower figure as based on acoustical measurements. This is in part due to the damping losses and in part due to the "back-wash," *i.e.*, the energy given out from the back of the diaphragm; this latter may easily represent nearly half of the motional impedance of the speech coil and watts sound emission of the diaphragm. It is not actually lost, or not wholly lost, in a speaker as used, but it is not recorded in the measurements made by the microphone in a padded room. There is also the question of the wattless component or components of the working current; it is difficult to say how much this may invalidate the conclusions drawn from the elementary theory.

FROM THE FLASHLAMP

(*Continued from page 106*)

to break down; with a coil whose diameter is eight to ten times its length, the addendum to be added to the length l is about 10 per cent. lower, namely, .040 D.

Numerical Example:

Let $N=65$ turns; $N^2=4{,}200$.
Let $D=5$ cm.; $D^2=25$.
Let $l=3$ cm.;
Then $l_2=3+(0.45\times5)$.
$=3+2.25=5.25$.
Let L=inductance in μh.
Then:

$$L_1=\frac{4{,}200\times25}{5.25\times10^2}=200 \text{ microhenries.}$$

The reader is invited to work out examples and compare results with those obtained from other published formulas.

Some formulas give the inductance in *centimetres*. To those not accustomed to absolute units, or c.g.s. units, this is mystifying. All that is necessary is to remember that 1,000 cm. go to the microhenry, or one microhenry=ten metres.

THE SUN AND WIRELESS SIGNALS

(Concluded from page 24, September 23rd issue)

FOR example, if reception conditions were good in 1917 and 1928 they will again be good in 1939, and during no year between those dates will the general level of conditions rise as high as it does in 1917, 1928 and 1939. Conversely, there will be years when the general level of conditions is bad; 1923 was the last of such, so that we may expect bad conditions again in 1934. It must be realized that since regular observations were only begun in 1915 the existence of this cycle cannot be regarded as proved beyond all doubt, but it has appeared quite regularly since 1915, and the interesting thing about it is that this cycle of variations follows very closely the sunspot cycle of the sun. Sunspots are believed to be cyclonic whirlwinds on the sun that show up black against its disc, and these have the interesting property that the number appearing in a year follows a definite cycle of eleven years; if a maximum number of sports is observed in 1917, the next maximum will appear in 1928, and a minimum in 1923 will be repeated in 1934. It has been found that over the period of time investigated the sunspot cycle is accompanied by a parallel variation in radio conditions on the earth, being at their best at sunspot maxima and worst at sunspot minima. It is believed that sunspots cause a great increase in the corpuscular radiation from the sun and hence increase the ionization of the Heaviside and Appleton layers. There is experimental evidence to show that the ionization at sunspot maximum is about 60 per cent. greater than that at sunspot minimum. The effect of such an increase in ionization on wireless signals depends on the wavelength. Short-wave signals will generally be stronger because, owing to the increased ionization, a greater part of the radiation from a station will be returned to the earth by the Appleton layer than is the case at times of low ionization. At the other end of the wireless spectrum Dr. L. W. Austin showed that very long wave signals also increased in strength at sunspot maximum. Both long and short waves therefore give louder signals at sunspot maximum and their eleven year period is parallel to the sunspot period. The medium-wave band between 150 and 400 metres, however, behaves in an opposite fashion, giving loudest signals at times of lowest ionization, *i.e.*, at sunspot minima. This is because these wavelengths, known as "critical wavelengths," are much more strongly absorbed in the Heaviside layer than waves either above or below them, and this absorption increases with increased electron density and therefore ionization. Consequently at times of sunspot maximum medium-wave signals will be weak.

Reflection from the Appleton Layer

In years of sunspot minimum ionization falls off with the result that short waves are not completely refracted, a higher percentage escaping from the Appleton layer and consequently the range and signal strength will be reduced. Medium waves, on the other hand, may give stronger signals partly because attenuation is reduced and partly because they may pass through the lower layer, since it is much less ionized, and be reflected at the upper layer, with the result that the range is greater since the height of the reflecting layer is greater. Also it must be remembered that the earth acts as a not-very-efficient reflector, so that a signal on a wavelength, coming from the reflecting layer, may strike the earth and be returned once more to the layer whence the wave is again reflected to the earth, and a signal may make several hops of this kind, following a path such as TABCR in Figure 1. Clearly the longer the hop the less the attenuation, and reflection at the Appleton layer necessarily results in a greater hop than from the Heaviside layer; the path TPR in Figure 1 illustrates this point. This then is a possible reason for improved conditions on medium waves at times of sunspot minima and would explain the unusually good reception from North America during the past winter, which is near a sunspot minimum.

Another periodic change in conditions has been shown to exist by Dr. G. W. Pickard in some observations on medium-wave broadcast stations. In this case a cyclic change from good to poor conditions every fifteen months was noticed, and it was found that this cycle corresponded very closely with what is called the subsidiary sunspot cycle, a period of fifteen months during which sunspot numbers fluctuate from a minimum to a maximum, about the average value for the year in the eleven-year cycle. It is important to notice that during this fifteen-month cycle the best conditions for reception were found to coincide with sunspot minima. From the discussion of the behaviour of medium waves during the eleven-year cycle, this inverse relationship for the fifteen-month cycle is to be expected, since observations were made on medium-wave stations only; it is probable that the reverse effect would be observed on short and very long waves.

There is another important terrestrial phenomenon whose variations follow a cycle parallel to that of the sun's spottedness, and that is what is called the earth's magnetic activity. This refers to changes that occur in the normally steady magnetic field, changes which are called magnetic storms and are detected as violent perturbations of sensitive magnetic needles on the earth's surface. They are believed to arise from a great increase of ionization in the upper atmosphere, causing large electric currents to flow which disturb the magnetic field, but what causes the increased ionization is not clear. The cycle of magnetic activity is very closely parallel to that of the sun's spots and, consequently, a magnetic storm generally accompanies the appearance of a sunspot, but they do not necessarily appear together, and so it is becoming customary now to describe magnetic storms as arising from what are vaguely called M-regions of the sun.

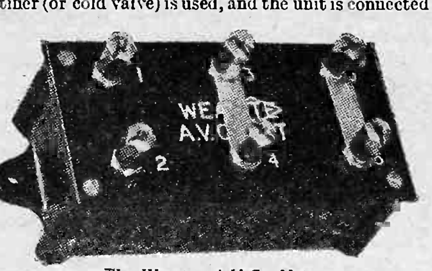
Facts and Figures

Components Tested in our Laboratory

BY THE PRACTICAL WIRELESS TECHNICAL STAFF

WEARITE A.V.C. UNIT

THIS is a very neat component designed for inclusion in a powerful receiver employing H.F. stages for the purpose of removing the troubles caused by fading. It is, of course, an additional requirement to the normal manual or hand-operated volume control, but enables the output of the receiver to be kept at a more or less constant level. It measures approximately 3in. long by 1½in. wide and is just over 1in. deep. Six terminals are provided, together with two small shorting straps. The usual circuit arrangement employing a resistance, condensers and metal rectifier (or cold valve) is used, and the unit is connected in the anode circuit of the detector valve. Naturally, best results are obtained when two good H.F. stages are fitted, and under correct operating conditions a distant station may be received with a constant volume level irrespective of any fading troubles. The price is 10s. 6d., and the makers are Messrs. Wright and Weaire, Ltd.



The Wearite A.V.C. Unit.

MILLGATE H.T. BATTERY

THE principal feature of the Millgate battery is the inclusion of a fuse in the actual battery. The normal negative socket is connected, therefore, to the first cell of the battery *via* a screwed socket into which fits a neat fuse, rated in the model supplied for test at 150 m/A. There is no necessity, therefore, to use special battery cords, or to include a fuse in the receiver, as the entire circuit is safeguarded at the source. The battery supplied for test was rated at 60 volts, and when received the measured voltage was slightly in excess of this value. A shelf-life test was arranged, and the battery was stood by, without any precautions for protection, etc., for three months. At the end of this period the voltage was again measured and found to be just over 59 volts. In view of the fact that the position chosen for storage received quite a large proportion of direct sunlight during the period this is very good indeed. A discharge test was then arranged and the battery was short-circuited for a few minutes. The results of all our tests confirm that this is a splendid battery for normal use, and will be found to give adequate service and protection. The fuse is, of course, replaceable.

GRAHAM-FARISH "PIP" TRANSFORMER

THIS is probably one of the smallest L.F. transformers we have received for test, although as is usual with modern wireless components, the size gives no indication of performance. In spite of its size this transformer employs quite substantial windings, the D.C. resistance of the primary being of the order of 500 ohms. Two ratios are obtainable, 3 to 1 and 5 to 1, and the instrument was tested in a simple two valver in order to obtain some idea of its quality-giving properties. We were agreeably surprised at the overall response, which seemed to extend much farther into the lower region than one would expect from such a component. In a three-valver, two of these transformers were used without ill-effects, and for all normal requirements, where expense is a consideration we have no hesitation in recommending the use of this component. The price is 6s. 6d., and the makers Graham Farish, Ltd.

FORBAT DOUBLE CHOKE

THERE are a number of circuits where it is desirable to employ a smoothing choke having two separate windings wound over one core. Some types of Universal circuit, for instance, work better with one choke in each mains lead, a common iron core being included in both chokes. A neat component of this type has been received from Eugen Forbat, and employs a core ⅝in. thick, with the two windings arranged on a former which is provided with a central distance piece. The ends of the windings are brought out to four terminals mounted on a paxolin strip and they are numbered from 1 to 4. The resistance of each choke is approximately 500 ohms, and the inductance of each choke is sufficiently large to provide adequate smoothing at quite high currents. The price is 12s. 6d.

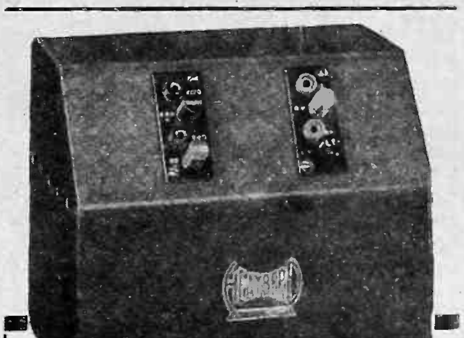
B.R.G. MINOR BINOCULAR CHOKE

A VERY neat and compact H.F. choke of the binocular type is manufactured by the British Radiogram Company, and costs 3s. 6d. Two small ebonite pillars are grooved to accommodate the windings which are carried out in enamel covered wire, and terminals are fitted to the tops of the pillars for connection. A small base of rectangular shape is provided and the component is mounted on the baseboard with two wood-screws. The D.C. resistance of the choke is only 150 ohms, so that it may be safely included in the anode circuit of a detector valve which is used alternatively as an L.F. valve with a gramophone pick-up, without undue voltage drop taking place. A larger type of choke is also obtainable and bears the name Major, at a cost of 4s. 6d. It is built up on similar lines but has a much larger winding and slightly greater D.C. resistance.

EELEX MODULATED OSCILLATOR

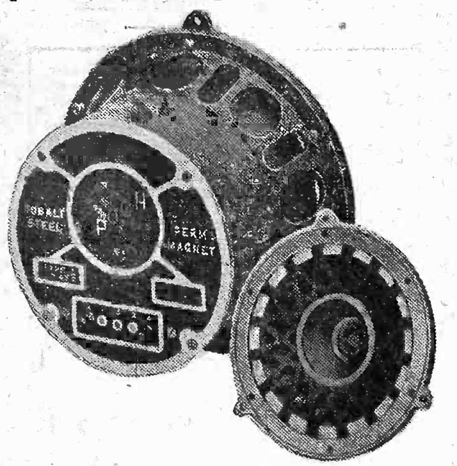
ALTHOUGH primarily designed for testing purposes, this ingenious oscillator, an illustration of which appears below, will be found a most useful piece of apparatus for the amateur. It consists, as may be seen, of a neat case very much resembling a portable gramophone. A good clockwork motor and a pick-up of sound design is fitted, and beneath the motor-board is arranged the necessary electrical equipment. This consists of a single valve unit, coils, etc., arranged to provide a modulated circuit. The normal method of using the outfit is to connect a 60-volt H.T. battery and a 2-volt accumulator to the requisite leads and place a gramophone record on the turntable. When switched on the unit radiates the music with quite a good strength over a fair distance. If, therefore, the tuning scale on the oscillator is adjusted, say, to 250 metres, when the tuning dial of a receiver situated near to it is also adjusted to 250 metres, the music from the oscillator will be picked up by the receiver and reproduced from the loud-speaker. It thus offers a novel method of utilizing the radio-gramophone feature, without the necessity of building a large radiogram cabinet, and has the added advantage that needle scratch, etc., is removed in the oscillator. Furthermore, for test purposes, the oscillator may be adjusted to any frequency over the normal broadcast band, and the receiver under test then tuned to the same frequency in order to pick up the radiated oscillations. It is not necessary, therefore, to wait for a transmission in order to test some particular receiver. It is altogether a most valuable piece of apparatus. With valve complete the cost is £2 15s., and a De Luxe model is available in oak cabinet for £6 15s. The makers are J. J. Eastick and Sons.

Eelex Modulated Oscillator



A MOST INTERESTING RANGE OF LOUD-SPEAKERS

IT was with profound interest that we recently took the opportunity of examining what must surely be the widest range of moving-coil speakers made by any British manufacturer. These speakers are made by the well-known firm of Messrs. Epoch Manufacturing Co., Ltd., Exmouth



One of the larger Epoch P.M. moving-coil speakers, the type "A2½ P.M."

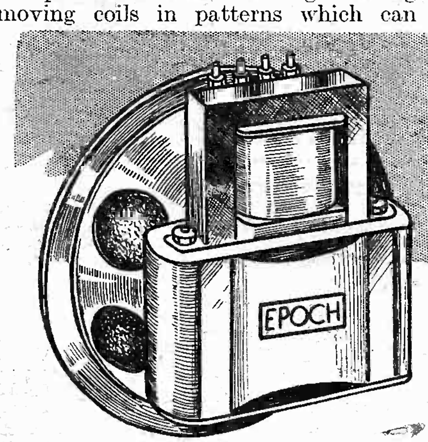
Street, London, and vary in type from a "Super-Dwarf" permanent magnet model with 5-ratio transformer and selling at the attractive price of 23s. 6d. to the large "Super Cinema" model of the mains energized pattern listed at £14 10s. for D.C., or £17 10s. for A.C. The smallest speaker is of particular interest at the present time, due to the immense amount of interest which is being shown in miniature receivers for both car and domestic use. It has a diaphragm of only 5in. diameter and yet is well able to handle as much as two watts of signal output. Additionally, it is extremely sensitive for this type of instrument and will work perfectly on an input so low as one-quarter of a watt. An extremely interesting modification of the "Super-Dwarf" is a dual pair of accurately matched speakers mounted together on a small baffle board. This pair gives almost perfect response to the complete range of musical frequencies, and at the price of £2 7s. represents almost unprecedented value.

Excellent Magnet System

Other popular speakers in the Epoch range include the "Twentieth Century" permanent magnet model at £1 15s., the "Eleven-Inch Super" at £2 5s., the "Type A2½ P.M." at £3 3s., the "Super Junior" at £1 10s., the "B.5 P.M." at £4 4s., and the "Type D.2.S.P.M." at £4 11s. 6d. All the latter are of the permanent magnet type and are fitted with excellent 9 per cent. cobalt steel magnets which make them equal to the very best value in the trade. All can be obtained with a special multi-ratio output transformer by means of which they can be correctly matched to any power or pentode valve, or with a well-designed Class B transformer; the price is just the same in either case.

Energized Types

Messrs. Epoch, although they were the pioneers of permanent magnet moving-coil speakers and produced the first efficient instrument of this kind in Great Britain (some eight or nine years ago, by the way), also produce an extensive range of energized moving coils in patterns which can do

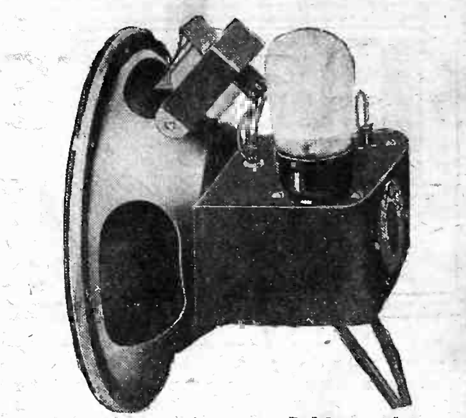


A new speaker of the "midget" type, the "Super-Dwarf."

justice to signal outputs up to 25 watts. The energized models are, of course, of chief value for public address and auditorium work, but they are also of particular interest to the amateur who requires a large output of really perfect quality. All of them can be obtained for either D.C. or A.C. operation or for use with an accumulator as field energizer.

A Combination Class "B" Speaker

A really ingenious and beautifully turned out instrument which Messrs. Epoch



A very neat combination P.M. speaker and Class B amplifier made by Messrs. Epoch.

have introduced quite recently is the "Class B Combination Speaker." As the name implies, this is a combined permanent magnet speaker and most efficient Class B amplifier. The complete unit is extremely compact and of excellent appearance.

It would, of course, be quite impossible to give anything like full details of each type of Epoch speaker which is available, but the above notes will show very clearly that there is without question a type for every conceivable purpose and at a price which bears no comparison with the obviously high quality and well-made instruments.

The names and prices mentioned above refer to the actual units which can be fitted into any cabinet which might be to hand, but it is also interesting to note that any one can be supplied in a cabinet designed on the best acoustic principles and made from selected timber, beautifully polished.

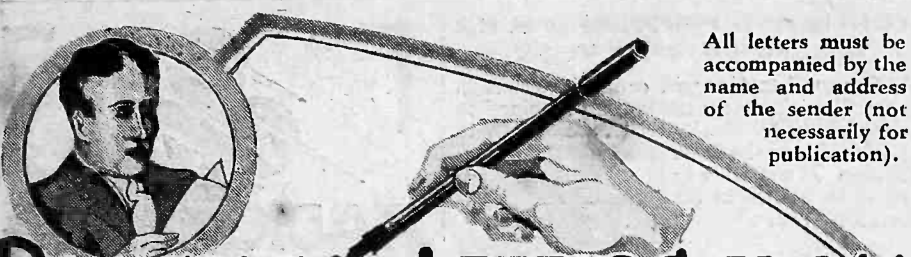
Matched Pairs for Perfect Reproduction

A further advantage in these days when perfect reproduction is more nearly possible than ever before is that nearly all the smaller speakers can be purchased in matched and balanced pairs. The two units are so chosen that between them they give a practically uniform response to notes of all frequencies from the lowest to the highest. In view of their low prices these dual speakers should find a very wide application in conjunction with modern efficient receivers.

We can only conclude by saying that any reader who is considering the purchase of a new speaker should at least examine the Epoch range before making a final choice.

THE IMPORTANCE OF A GOOD EARTH

SOME weeks ago I referred to the better earthing properties some soils had over others as regards wireless communication, and I mentioned the work that was being done by the National Physical Laboratory in this connection. You will probably remember that the conclusion was reached that soils consisting of the most part of clay made better "earths" than those whose chief constituent was sand, or similar material. On January 19th a paper was read before the Royal Society by Dr. R. L. Smith-Rose of the N.P.L., in which he described some investigations on the electrical properties of soil which have been carried out at the Laboratory on behalf of the Radio Research Board of the Department of Scientific and Industrial Research. The experiments consisted of the measuring of the electrical resistance of samples of soil from different localities under conditions met with in radio communication. The results of the experiments showed that while dry soil is a poor conductor, the conducting power is increased by more than *one thousand* times when water is added to bring its moisture content up to the value commonly met with in garden soil. The soil that was taken from different sites was studied and it was shown that its properties varied to a considerable extent, and it is obvious that a knowledge of these properties is important in connection with the location of a wireless transmitting station. At the same time most broadcast listeners are familiar with the function which the earth connection plays in reception. Unless the receiver is of the portable type, it is essential that the earth connection should have a low electrical resistance. The earth plays another and more important part, however, in wireless communication, particularly in the distribution of broadcasting programmes, for at moderate distances of up to 50 or 100 miles the waves from the transmitting station travel along the earth's surface, and some of their energy is lost in setting up electrical currents which have to overcome the resistance of the earth. If the earth is a good conductor this energy loss is reduced to a minimum and thus the field strength of the waves is maintained to a considerable distance, and good reception results. If the ground is a poor conductor the waves lose their energy rapidly and poor or indifferent reception is obtained. It is because the sea is a good conductor that signals received over an all-sea path are much stronger that those received under similar conditions over land.



All letters must be accompanied by the name and address of the sender (not necessarily for publication).

PRACTICAL LETTERS FROM READERS

The Editor does not necessarily agree with opinions expressed by his correspondents.

The "Selectone Three"

SIR,—I have built the "Selectone" from the particulars published in PRACTICAL WIRELESS and have had it in operation for some months. It is a first-class job and I am very satisfied with the set; a few of my friends who have heard it were greatly impressed with its performance. Many thanks to Mr. Preston and the rest of your technical staff.—A. J. ONIONS (Oldbury).

A Barnsley Reader's Thanks

SIR,—I thank you very much for the Wireless Encyclopædia just received. I consider the book one of the most interesting and helpful that I have ever read, and it compares with books far more expensive. I had your paper recommended to me about three months ago, and have enjoyed reading each number ever since, many of your articles being a great help to amateurs like myself wishing to improve their knowledge of wireless. Wishing your paper every success.—G. F. EASTWOOD (Barnsley).

Birthday Congratulations

SIR,—May I take this opportunity to congratulate you and your staff on the completion of your first year's work with PRACTICAL WIRELESS.

The production is worthy of all praise and a credit to the House of Newnes.—H. H. THOMSON (Glasgow).

From a Barmouth Reader

SIR,—I received "The Wireless Constructor's Encyclopædia" safely, for which please accept my sincerest thanks. Mr. F. J. Camm is certainly to be congratulated for compiling this excellent work, which has already cleared the air that surrounded many obscure problems. He has also afforded the beginner a good chance of getting a sound working knowledge of wireless by providing him with ample scope for experimenting, and also with plenty of diagrams and illustrations to assist him in making his own components—R. W. HUGHES (Barmouth).

"Readers' Service"

SIR,—I duly received your answer to my inquiry, and have carefully noted all your remarks. Since sending my inquiry *re* modifications to the original "Selectone 3" I have noted the resemblance of the "Auto-B Three" to my suggested conversion to Ferrocart tuning, so your recommendation to that circuit has already been considered. I would like here to state my appreciation of the detailed study of my diagram which has obviously been taken, to say nothing of your very helpful notes on the circuit values, etc. You can be assured that the trouble you have taken over what must be, after all, a hackneyed and unsatisfying type of query is much appreciated, and cannot help being a real recommendation in any discussion on wireless matters with wireless "fans." I shall make it my business to mention it at our works.—C. J. CROSS (Bristol).

A Really Wonderful Volume

SIR,—I have just received my copy of the "Wireless Constructors' Encyclopædia" and wish to express my thanks. It is a really wonderful volume. With best wishes for the future of PRACTICAL WIRELESS.—R. V. LISTER (Heworth).

A Storehouse of Information

SIR,—I have received my copy of the "Wireless Encyclopædia" all right, for which many thanks. It is indeed a storehouse of information. I might add that Wednesday has become quite an important day for me, as I eagerly await my copy of PRACTICAL WIRELESS. Again thanking you.—J. LAWSON (Walton).

CUT THIS OUT EACH WEEK

DO YOU KNOW?

—THAT valves are obtainable which operate with the full mains voltage (200 to 250 volts) on the heaters.

—THAT special short-wave systems are being experimented with in which no present-day practices are carried out.

—THAT as a result of research [on the above lines, some novel medical uses have been found for the short-wave radiations.

—THAT great care should be exercised when using headphones on a mains-operated receiver.

—THAT the reactance of a condenser varies with the frequency.

—THAT an H.F. decoupling condenser should be chosen with the above fact in mind.

—THAT tone control devices only operate on frequencies which are present—in other words you cannot put anything back which has already been lost.

—THAT peak values must always be considered when deciding upon the rating of a condenser.

—THAT a separate additional tapping may be fitted to an eliminator by means of a pair of resistances and a condenser joined across an existing tapping point.

NOTICE.

The Editor will be pleased to consider articles of a practical nature suitable for publication in PRACTICAL WIRELESS. *Such articles should be written on one side of the paper only, and should contain the name and address of the sender. Whilst the Editor does not hold himself responsible for manuscripts, every effort will be made to return them if a stamped addressed envelope is enclosed. All correspondence intended for the Editor should be addressed: The Editor,* PRACTICAL WIRELESS, *Geo. Newnes, Ltd., 8-11, Southampton Street, Strand, W.C.2.*

Owing to the rapid progress in the design of wireless apparatus and to our efforts to keep our readers in touch with the latest developments, we give no warranty that apparatus described in our columns is not the subject of letters patent.

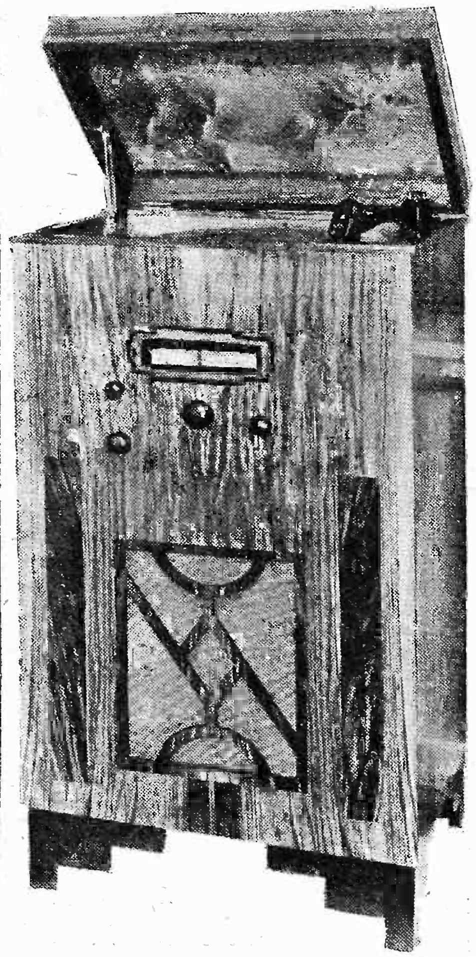
CONVERTING THE PREMIER SUPER

(Continued from page 80)

spring goes to the grid condenser, that in contact with the shortest spring is joined to the pick-up terminal, and the third goes to the grid terminal on the detector valve-holder. It will thus be seen that the switch must be pushed in for "gram." and pulled out for "radio."

A More Convenient Position for the R.-G. Switch

For those who wish to use the gramophone side of the equipment fairly often, it will seem a little inconvenient to have to operate the switch through the back of the cabinet, but the particular position was chosen from the point of view of efficiency. At the same time, the switch can be mounted



The Premier Super fitted into the handsome and reasonably priced Peto-Scott Adaptagram Cabinet.

in a more accessible position on the motor board if care is taken to keep the connections to it as short and direct as possible. The leads should also be screened by fitting lengths of "Goltone" screening braid over them. The braid should, of course, be earth connected by means of lengths of thin wire bound round them tightly and joined to the most convenient earthing point—the terminal on top of one of the coil screens.

Gramophone reproduction is particularly good and ample volume is obtainable. A wide control of volume is possible by means of the knob fitted to the pick-up, however, and this enables the sound intensity to be reduced to a mere whisper if desired.

You will find the "Premier Super," in either "radio" or "radio-gram." form, a particularly economical and likeable instrument.

RADIO CLUBS AND SOCIETIES

Club Reports should not exceed 200 words in length and should be received First Post each Monday morning for publication in the following week's issue.

THE CROYDON RADIO SOCIETY

The Society has not been idle during the summer, as informal meetings have taken place whereat plans for the ensuing season have been discussed. Indeed, the Society's tireless chairman, Mr. F. Nightingale, gave his committee no rest until his forceful views were ventilated. As a result, programmes are nearly complete. The Session starts on Tuesday, October 3rd, 1933, with a lecture-demonstration by the President, Mr. H. R. Rivers-Moore, B.Sc., on his unique amplifier. Mystery is attached to it, as three hefty members will be needed to carry it to the Society's transport vehicle en route to headquarters. Also, it will guide the destinies of four giant loud-speakers! Other events will be a monthly night organized by the short-wave section, and, of course, the Society's loud-speaker and gramophone pick-up nights appear in the syllabus with members' demonstrations meetings.

Better accommodation is obtained in the new headquarters at St. Peter's Hall, Ledbury Road, South Croydon. Meetings will be held weekly on Tuesdays, and PRACTICAL WIRELESS readers are welcome, to whom a fixture card will gladly be sent by the Hon. Secretary, E. L. Cumbers, Maycourt, Campden Road, South Croydon.

INTERNATIONAL SHORT WAVE CLUB, LONDON

One of the biggest attractions ever arranged by the London Chapter was given before a great gathering of short-wave listeners at the R.A.C.S. Hall, Wandsworth Road, S.W.8, on Friday, September 15th, when Mr. P. H. Spagnoletti, B.A., gave a lecture on the British Empire Broadcasting Station transmitters at Daventry. Mr. Spagnoletti was the engineer in charge of the installation of these transmitters and his lecture was illustrated by slides. His lecture dealt with every aspect of the transmitters, the lay-out of the station, and the aerials, etc. He preceded this lecture with a short talk on the propagation of short waves, a subject which always arouses keen interest at these meetings. The evening closed with an exhibition of over fifty photographs of the Empire Station at Daventry.—A. E. Bear, Secretary, 10, St. Mary's Place, Rotherhithe, London, S.E.16.

BURTON-UPON-TRENT AMATEUR RADIO SOCIETY

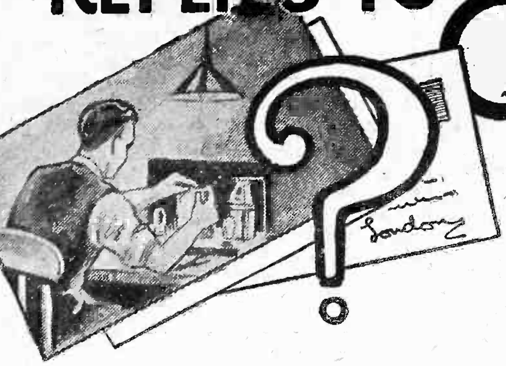
The above Society opened its winter season on Tuesday, August 5th, at the Wheatsheaf Hotel, Station Street, when Mr. F. Youle, B.Sc., gave a lecture on catkin valves, illustrated by lantern slides. In view of the fact that this was the first meeting of the season, the Society was honoured by the presence in the chair of its President, Councillor W. Hutson, J.P., Mayor of Burton. Mr. Youle outlined the various advantages of the catkin valve over the more familiar glass valve; these included mechanical strength, freedom from microphony due to double-ended suspension of electrodes, cooler running owing to circulation of air round the anode, and finally, uniformity of characteristics due to rigid construction. At the conclusion of the lecture various points were raised by members, and they were answered in a very lucid manner by Mr. Youle. The Society holds its meetings on the first and third Tuesdays of the month at the above address, and a cordial welcome is extended to anyone who cares to come along. Particulars of membership, and fixture lists for the season can be obtained on application to the Hon. Sec., W. A. Mead (G5YY), 189, Burton Road, Burton-on-Trent.

SLADE RADIO

A lecture on "Catkins, etc.," was given by Mr. F. Youle, B.Sc., at the meeting held last week. After giving details of the various steps in the assembly of the catkin he went on to describe the virtues and the many points of interest. This portion of the lecture was illustrated by a series of slides, which included an X-ray photo of a catkin and also the transmitting valve from which the former was developed. Details were then given of the new B21 and L21 valves, also the general working of Class B valves was explained in detail. The lecture proved to be one of considerable interest and was thoroughly enjoyed by those present. Details of the Society and its activities may be obtained on request from the Hon. Sec., 110, Hillaries Road, Gravelly Hill, Birmingham.

LET OUR TECHNICAL STAFF SOLVE YOUR PROBLEMS

REPLIES TO QUERIES and ENQUIRIES by Our Technical Staff



The coupon on this page must be attached to every query.

If a postal reply is desired, a stamped addressed envelope must be enclosed. Every query and drawing which is sent must bear the name and address of the sender. Send your queries to the Editor, PRACTICAL WIRELESS, Geo. Newnes, Ltd., 8-11, Southampton St., Strand, London, W.C.2.

SPECIAL NOTE

We wish to draw the reader's attention to the fact that the Queries Service is intended only for the solution of problems or difficulties arising from the construction of receivers described in our pages, from articles appearing in our pages, or on general wireless matters. We regret that we cannot, for obvious reasons—

(1) Supply circuit diagrams of complete multi-valve receivers.

(2) Suggest alterations or modifications of receivers described in our contemporaries.

(3) Suggest alterations or modifications to commercial receivers.

(4) Answer queries over the telephone.

Please note also, that all sketches and drawings which are sent to us should bear the name and address of the sender.

REPLACING OLD VALVES

"As a result of my visit to the recent Exhibition I have decided to replace all my old four-year-old valves with the latest ones, and I was told on one of the valve stands that this could be done with practically any set without any trouble and with a big increase in efficiency. Before I risk the outlay I should like you to confirm that I may do this without any risks, and to let me know whether you advise the change."—Y. S. (Glasgow).

It is certainly true that the majority of receivers may be vastly improved by replacing the old valves with those of more recent design, but in some cases instability will undoubtedly result, due to the inefficient wiring or layout of the receiver. If, for instance, your set employs an H.F. stage, it would be advisable to examine this carefully and make certain that no screening or alteration of the wiring is necessary. The detector and L.F. valves are, in most cases, free from trouble, except in so far as decoupling is concerned. You must remember that the modern valve is much more efficient than the older pattern and this may lead to instability. Each case must, therefore, be judged on its merit, but it should not be difficult to stabilise a receiver if it is found that the new valves introduce any troubles.

CALCULATING RESISTANCE VALUES

"Although I know that you will tell me that Ohm's law will help me, I should like you to show me how to use it in the calculation of the decoupling resistances for my set. I wish to fit the resistances in the anode leads, and I see that they are obtainable in 1 watt, 2 watt, and so on. I am not sure, either, how to find the exact value, and should be glad if you could explain it simply to me."—W. D. (Willesden, N.W.).

We will assume that the detector valve in a mains receiver needs decoupling. The H.T. line will no doubt be of the order of 250 volts, and the detector will pass a normal current of, say, 1 milliamp. The normal H.T. is given as 150 volts. We, therefore, have 100 volts excess voltage, which must be dropped through the decoupling resistance, and accordingly the value of this resistance is found from the formula $R=\frac{E}{I}$, which is 100 divided by .001. This gives us 10,000 ohms. The wattage is obtained from the formula $W=I^2\times R$, which gives us .001 × .001 × 10,000, or in other words .1 watts. From these figures we have therefore found that we require a 10,000 ohms resistance which may be of the 1 watt type. The same method of calculation applies, of course, to biasing resistances, etc.

HOME-MADE TUNING COIL

"As I am making a neat dual-range tuning coil I should like to have your opinions regarding the various methods of aerial coupling which I can include in the circuit. I do not know which to choose between an ordinary tapping on the coil, or a loose coupled aerial coil. Which is most suitable for modern conditions?"—L. F. (Holloway).

If you intend to tap the aerial into the coil you must remember that this tapping will be at the top end of the coil when you switch over to long waves, and this will result in decreased selectivity. On the other hand, a separate aerial coil will enable you to wind a value of inductance which will give best results from the selectivity point of view on both bands. In the first case, a separate tapping will have to be made in the long-wave winding, and this will mean that the switching device will have to be arranged to transfer the aerial lead from the medium to the long-wave coil, and in the second case you will have to use a double switch so that the long-wave aerial coil may be short-circuited, as well as the grid coil, when listening on the medium waves. As regards the actual merits of the two systems, the tapped coil may prove as good as the separate coil if the tapping is made at the correct position, and a little experiment should enable you to decide this point to suit your own local conditions.

DATA SHEET No. 53

Cut this out each week and paste it in a notebook.

STANDARD ABBREVIATIONS.

AMPERE	A
FARAD	F
HENRY	H
IMPEDANCE	Z
KILO-	k (One thousand)
MEG(A)-	M (One million)
MICRO-	μ (One millionth)
MICRO-MICRO-	μμ (One billionth)
MILLI-	m (One thousandth)
π	3.1416
OHM	Ω
VOLT	V
WATT	W
WAVELENGTH	λ
ω	2πf

CORRESPONDENCE COURSE WANTED

"I have sent you my six months subscription and hope you will continue on the good lines already started. Will you please let me know whether there are any institutions which deal in correspondence courses for wireless. I wish to get a diploma or a certificate, as I am in the electrical line and have got a good elementary knowledge, and would like to proceed for advancement."—V. P. K. (Aurangabad, Dn., India).

We would advise you to communicate with either of the following: International Correspondence Schools, Ltd., Dept. 94, International Buildings, Kingsway, London, W.C.2, or British Institute of Engineering Technology, 396, Shakespeare House, 29/31, Oxford Street, London, W.

DEAF AID

"I am in the unfortunate position of being fairly deaf, and I find it a trifle difficult at meal times to hear the conversations which go on around me. I can hear the wireless quite well, as we have a fairly good set, but I should like to know whether I can make up a suitable apparatus to help me to join in the table conversations and other normal domestic discussions. I am handy with tools, and have made one or two sets quite successfully. What can you advise?"—V. B. N. E. (Harrow).

One of the simplest devices would be to purchase one of the new home microphones, and connect this to the pick-up terminals of your wireless set. The microphone could be stood on the table and the volume adjusted to produce good signals from the loud-speaker, or, alternatively, a pair of headphones could be fitted in a suitable part of the circuit and worn by you to avoid inconveniencing others by the magnified conversations.

TONE-CONTROL AND CLASS B

"I have purchased a Class B unit and have added this to my set, but am not pleased with the reproduction. My set is S.G. Detector and Pentode, and I had no troubles before installing the new unit. How would you advise me to alter the pitch to sound more natural? I had no control before, and do not wish to interfere with the unit, as at present it is only on appro."—G. S. (Norwich).

It would be quite simple to fit a tone control in the input side of the Class B unit, and this should give perfect control over the tone of reproduction. We would recommend a Bulgin Controlatone, as this necessitates only two connections and contains both the condenser and the necessary resistance. These should be joined to the loud-speaker terminals on your original receiver, and you will then find that rotation of the control will vary the tone through quite an appreciable range.

MEASURING ANODE CURRENT

"I have repeatedly tried to measure the anode current of my mains variable-mu valve, but without success. The meter is one of the best, and I have tried it with a condenser across it and without. In every case, as soon as the valve begins to heat up, the set goes into oscillation. I have tried using long leads, and moving these about, and also short leads, but I cannot stop the trouble, and, consequently, cannot obtain an accurate measurement. Can you suggest some way of doing this, please?"—D. N. E. (Edgware).

The trouble is very often experienced in making measurements of the kind you refer to, and, generally speaking, the only way of overcoming the oscillation is to short-circuit either the grid or the anode coils. You will find that this will cure the oscillation, but there may be some inaccuracies in your reading due to the variation of bias or other alteration in the circuit, so that you must first of all examine the circuit wiring and make certain what will happen when the short-circuit is introduced. It should only be necessary to short one inductance, and generally this should be the one included in the grid circuit.

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COUPON

This coupon is available until October 7th, 1933, and must be attached to all letters containing queries.

PRACTICAL WIRELESS, 30/9/33.

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WAVEMETER COMPONENTS

IN a neat folder issued by Webb Condenser Co., Ltd., a range of well-finished condensers and knobs is given. Included in the list are midget log condensers, universal log slow- and fast-motion condensers, and solid di-electric two and three-gang condensers. There are also air-spaced and solid di-electric slow-motion condensers with ivorine scales, moulded escutcheon plates and lampholders. Another neat component, listed at 3s., is a slow-motion disc drive, having an escutcheon plate with indicating hair-line, lampholder and bracket, and suitable for panel or baseboard mounting. The address is 42, Hatton Garden, London, E.C.1.

THE BOOK OF IGRANIC

IN the making of a high-class receiver constructors must accept many of its components on the reputation of their makers—and Igranic radio components need no recommendation to those who know. Those who do not know would be well advised to obtain a copy of this handy book, which contains full descriptions and prices of every component likely to be required for the building of a modern receiver. Particulars of the new "Igranicor" coils are, of course, included, together with screened dual-wave super-het. coils and the "Igranipak" tuning unit. H.F. chokes, fixed and variable condensers, slow-motion dials, transformers for all purposes, wire-wound volume controls and potentiometers, switches and terminals are amongst the other components listed. There is also the Igranic short-wave adaptor which has a wave-length range of 14.8 to 78 metres, and is available in two models—for battery and A.C. mains operation. Copies of this useful handbook can be obtained from Igranic Electric Co., Ltd., 149, Queen Victoria Street, London, E.C.

HELLESEN'S BATTERIES

WITH a reputation of over forty years behind them Hellesen's Batteries are too well known to need introducing to our readers. In the Hi-Life range of H.T. batteries prices have been reduced to the lowest possible level, consistent with a high standard of performance and long life. In the "Super" Range, a new patented cell gives greatly increased capacity while in no way increasing the size or weight of the batteries. Also listed are a range of Hellesen's dry cells for flash lamps, bells, cycle lamps and other purposes. Copies of a folder, containing full particulars of these batteries can be obtained from Hellesens Ltd., Hellesen Works, Morden Road, South Wimbledon, London, S.W.19.

SOVEREIGN COMPONENTS

CONSTRUCTORS desirous of being up to date with their receivers will find much to interest them in a new booklet just issued by the Sovereign people. Amongst the outstanding items in the new range of Sovereign components is a Permeability tuner, which gives great selectivity and volume and tunes over both medium and long waves perfectly. This compact unit, which is arranged for one-hole panel fixing, is priced at 15s., complete with slow-motion tuning-dial; escutcheon and blue print. Another noteworthy component is an iron-cored coil which sells at 7s. 6d. In addition, there are condensers of various types, dual-range coils, chokes, transformers, resistances, volume controls, and a three-point miniature toggle-switch, a sturdy little component which will safely carry 3 amps. At the end of the booklet an electrical section is given in which are listed such handy parts as 5-amp. two-pin plugs, bayonet adaptors, bell pushes, ceiling roses and tumbler switches. These parts, although made of best moulded brown bakelite, with first quality metal fittings, are particularly low in price. The Sovereign electric iron, for ordinary domestic use, suitable for A.C. or D.C. mains, is also shown in the booklet, copies of which may be obtained from Sovereign Products, Ltd., 57, James Street, Camden Town, N.W.1.

Replies to Broadcast Queries

R. X. (Port Glasgow): G5AP portable call of G5NW; E. J. Allen, 8, Westfield Place, Dundee, Angus, Scotland. G6JZ; C. Fenton, 18, Hill Top Road, Kells, Whitehaven, Cumberland. G5US: J. Croysdale, "Reamsley," Carlton Drive, Gatley, Cheadle, Cheshire. G2IM: E. R. Radford, 33, Whitehall Park, Upper Holloway, N.19. G2NY: H. Littley, "Radiohm," Bridgnorth Road, Stourton, Stourbridge, Worcestershire. G5CY: J. E. Cory, "Dallington," High Street, Sutton-on-Sea, Lincolnshire. G6PL: F. J. Popplewell, "Hollin' Bank," White Lee, Heckmondwike, Yorkshire. G6JG: C. W. Jennings, 150, Longmead Avenue, Bishopston, Bristol, Glos. G2LU: Alderman's Green, Coventry. G6BT: C. A. Jamblin, 121, Queen's Road, Bury St. Edmunds, Suffolk.
BARBER (Blackpool): The calls we can trace are the following: G6IF, M. E. Tapson, 115, Hadleigh Road, Leigh, Essex; G6JZ, C. J. H. Joyce, 9, Campbell Street, London, W.2; G6KA, Keith F. Hardie, 66, Ulverston Road, Walthamstow, E.17; G5GR, L. W. Gardner, 40, Medina Road, Coventry; G5ID, P. D. Coates, 55, Ennismore Street, Burnley, Lancs.; G5NR, E. G. Nurse, 1, Cambridge Road, London, W.6; G5RX, S. Newell, 9, Moor View, Rakehead, Stacksteads, Bacup, Lancs.; G5XF, J. Butterworth, 1088, Manchester Road, Castleton, Rochdale, Lancs.; G5YV, H. Beaumont, 14, Halliley Street, Dewsbury, Yorks; G2AP, F. Adams, "Newhouses," Girnigoe Street, Wick, Caithness, N.B.; G2CJ, S. Townsend, 115, Erlham Road, Norwich; G2GA, T. C. Platt, 70, Fieldhead Avenue, Elton, Bury, Lancs.; F8DS, J. Lory, 38, Rue Michel-Ange, Paris (16), France; F8LA, G. Barba, 140, Avenue du Roule, Neuilly-Sur-Seine, France; F8PR, Pierre Roy, 48, Rue Ph-Delasalle, Lyons, France; F8PV, Georges Vuillemot, 45, Rue de la Recette, Creteil, Seine, France.

ARE MULTI-ELECTRODE VALVES WORTH WHILE?

(*Continued from page 71*)

The low-impedance screened-grid valve as a detector presents problems of stability on similar lines to those already touched upon, and difficulties regarding its coupling to the following valves.

If resistance coupling is to be used, the H.T. voltage will have to be somewhat high, to allow for the voltage drop in the anode resistance, and the gain of the stage will be disappointing, as the customary transformer step-up will be missing.

If a resistance-fed transformer is used, some difficulty will be experienced in getting a sufficiently high load for satisfactory working. In the first place, the impedance of the transformer must be very high; so high, in fact, that there are only about two suitable transformers on the market, and as the primary and resistance will be in parallel with each other (*via* the coupling condenser), the latter will have to be somewhat higher than if the resistance were used alone, which means that extra anode voltage will be required.

Broadly speaking, a screened-grid valve is better than a triode, provided that the obstacles can be overcome, but when fixing attention on battery receivers only, a triode detector and L.F. valve would be more efficient and less costly.

Many readers may be slightly acquainted with some of the very new multi-electrode detectors, such as the double-diode-triode and the double-diode-tetrode, but these constitute three valves in one bulb and are intended for automatic volume control.

HOW THE B.B.C. DOES IT

(*Continued from page 72*)

of the valves, of course, and the cathodes are connected to the frame of the amplifier and to the metal panel front.

From the circuit arrangement and component values of an amplifier like this we can learn much in the design of a power amplifier for ordinary amateur radiogram use. I have not complicated the description by giving details of the special switching arrangement which the engineers have for listening on the amplifier circuits, and for the output arrangements. It is interesting to note that in Broadcasting House, London, alone there are 31 of these "A" amplifiers. They are arranged in racks with the four valves on metal brackets on the front of the panel and with the volume control potentiometer projecting. The components at the back are mainly the wire-wound resistances and the heavier components such as the iron-cored transformers and chokes.

In addition to these amplifiers there are the mains operated loud-speaker amplifiers which are installed in each of the moving-coil speaker cabinets in the studios, control rooms, listening rooms, press-listening room, and so on. These are complete units, and in fact are portable, being fitted with carrying handles. They are two stage amplifiers with the valves mounted on a little platform inside the box, and the couplings, components, iron-cored transformers, and so on, underneath. There is an on-off switch on the panel, a wire-wound volume control, and separate jack sockets for external speakers or listening head-phones.

Although the B.B.C. engineers use a large amount of apparatus which is quite different from that which ordinary listeners could use, the check receivers, "A" amplifiers, and loud-speaker amplifiers are typical of amateur practice. Yes, you can learn much from the way the B.B.C. does it!

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