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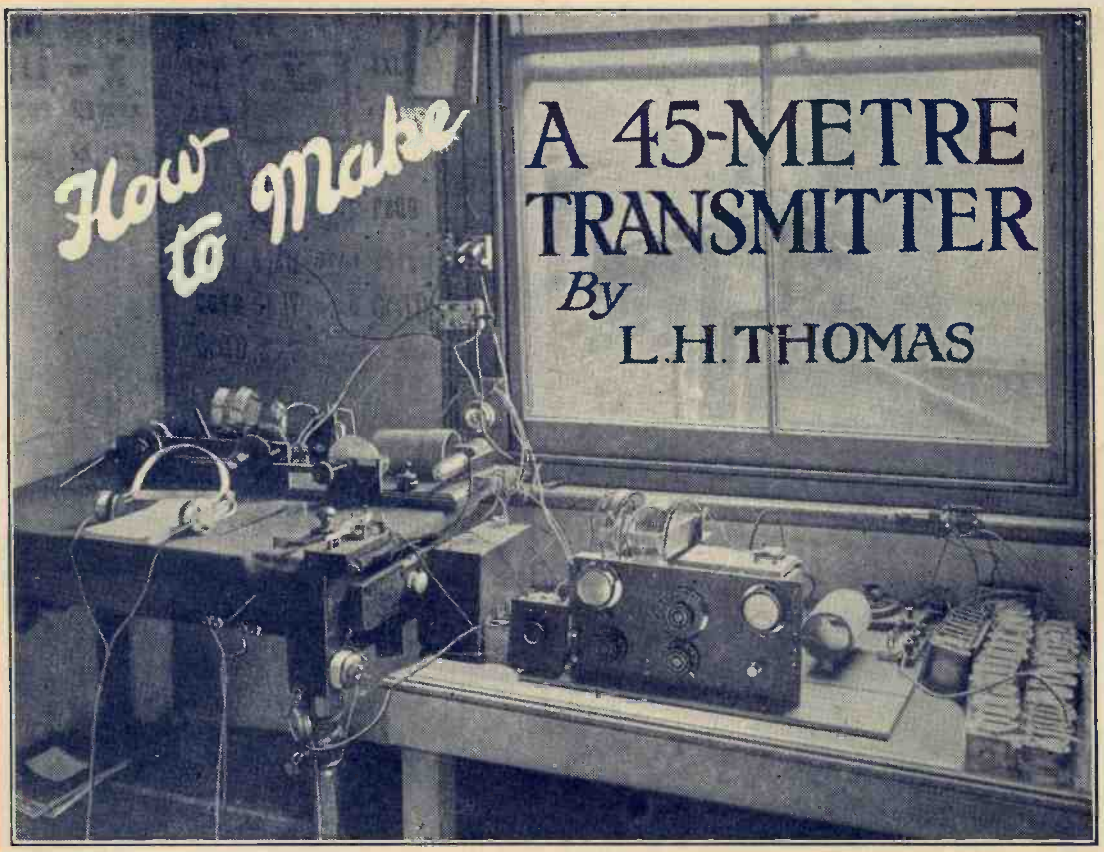
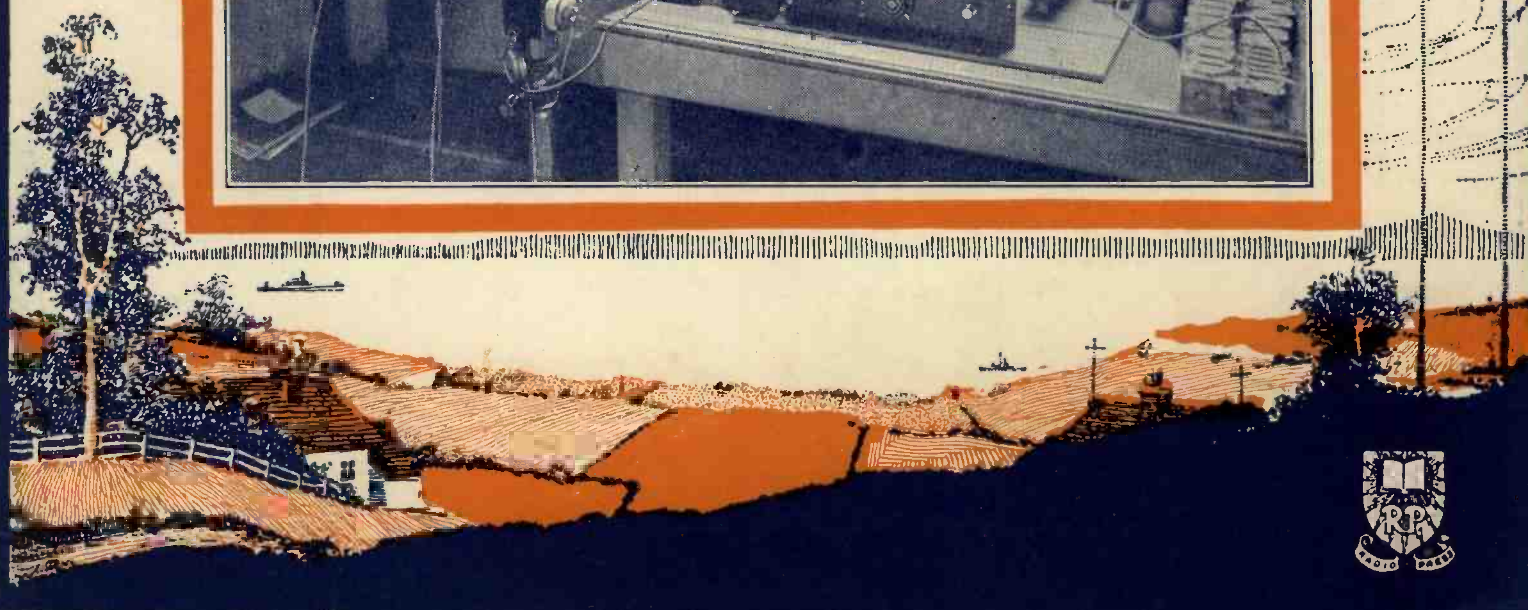
Wireless Weekly

Vol. 7. No. 7.

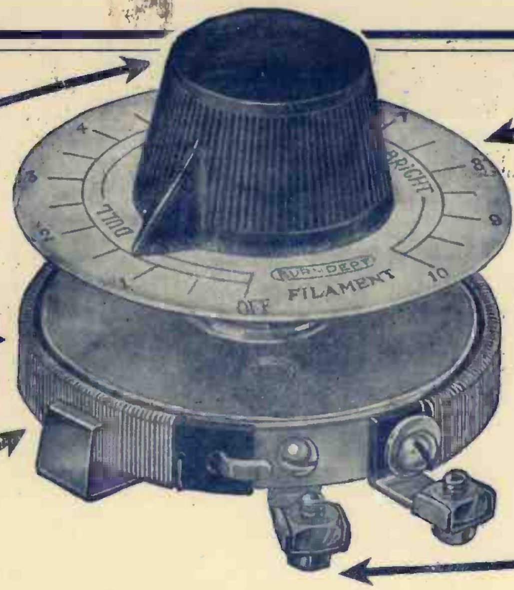




The Burndept method of one-hole fixing is unusual in that the pointer-knob will remain flush with any panel from ⅛ to ½ an inch in thickness. There is only one hole to drill and one nut to tighten.

The element is wound with thick wire, having high current-carrying capacity.

The brush moves over a flat surface with a very smooth movement and cannot work loose. The contact resistance is low.



This neat scale saves one the trouble of engraving the panel. It is interesting to note that either the scale or knob will cover holes previously drilled for our old rheostats.

As these rheostats are made almost entirely of metal, the heat dissipation is increased. On account of this and the fact that there is ample air-space between element and panel the ebonite cannot be damaged by heat.

Large-headed screws are provided for connecting wires.

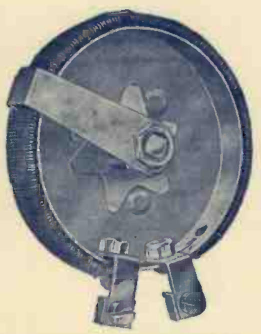
New Burndept Rheostats—better than ever

THOSE who already know of the Burndept reputation in the production of rheostats will take special interest in the new models which are constructed almost entirely of metal. They are a distinct advance both in appearance, efficiency and durability and are very easy to fit.

The movement is perfectly smooth and absolutely noiseless. Each rheostat is supplied with a scaled aluminium plate and a neat pointer-knob, ready for mounting on any panel from ⅛ to ½ an inch in thickness.

The well-known Dual Rheostat, illustrated in its new form above, was first introduced by Burndept in December, 1923. We have gone a step further in this direction by producing a Super-Dual Rheostat, which enables one to use **any** valve, bright or dull-emitter, with **any** battery up to 6 volts! It may truly be described as the "universal" rheostat.

Two Burndept Potentiometers are now obtainable, with 250 and 500 ohm windings, the latter type being particularly suitable for use with dry batteries.



The special contactor-spring between spindle and body ensures perfect contact and complete absence of "frying noises".

That these new Rheostats will meet with general approval cannot be doubted. In price, performance and appearance, they have no equal. Send the coupon below for Publication 281, giving full particulars of the various types, and a free copy of the Burndept Components Catalogue. Here are brief details of the eight models:

Price list of New Rheostats, supplied complete with Scale and Pointer-knob, ready for mounting on any panel.

No. 754.	Power Rheostats, 2 ohms, 3 amps. ..	5/-
No. 756.	Standard Single-Valve Rheostat, 7 ohms, 1½ amp.	5/-
No. 757.	Medium Rheostat, 15 ohms, 1 amp.	5/-
No. 758	H.R. Rheostat, 30 ohms, 0.5 amp.	5/-
No. 743.	Dual Rheostat, 5-30 ohms ..	6/-
No. 744.	Super-Dual Rheostat, 10-60 ohms	7/6
No. 760.	Standard Potentiometer, 250 ohms, 0.1 amp.	6/-
No. 759.	H.R. Potentiometer, 500 ohms, 0.05 amp.	7/6

The Burndept Range includes everything for radio reception from components to complete installations.

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Wireless Weekly, 4-11-'25

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Thank You!

NOW that we have had time to read through carefully and analyse the mass of replies to our form, "We Ask for Your Criticism," which appeared in *Wireless Weekly* for October 7, we should be guilty of gross ingratitude if we did not immediately express our sincere thanks to our readers for the trouble they have taken to express their ideas.

As regular readers know, we have published a form of this type on a previous occasion, when we also received a remarkable response, but in the present case the replies, in the great majority of cases, have been fuller and more detailed than we had even dared to hope. More than anything else, we appreciate the frankness with which the views have been expressed, and in hundreds of cases the forms have contained valuable ideas and suggestions for articles which, with the facilities now available at the Radio Press Laboratories at Elstree, we can immediately put in hand.

Wireless Weekly, as our regular readers know, has for some time past been paying particular attention to the reception of short waves. Our readers' views, as expressed in the criticism form, have proved to us the wisdom of this policy, and have indicated that throughout the length and breadth of the country the interest in short-wave reception and transmission is exceedingly high. We propose in future to devote still more space to short-wave work, and, in fact, we have already started a section which will contain up-to-date news items based on direct observations and tests by our own staff. In addition to this, there are many problems confronting the short-wave enthusiast which he is unable, through lack of precision apparatus, to solve for himself; such problems are being tackled immediately by our Elstree laboratories. On this we shall have more to say at a later date.

A study of the question forms has not been without its humorous aspect. We found, for example, that numbers of readers expressed considerable feeling in their replies to the question No. 10—"Do you wish the humorous feature to be continued?" "I can stand it," said one man. "Yes! A thousand times yes!" says another, while immediately following this we came across a form in which "No! No!! No!!!" was inscribed in large block letters. Perhaps the most interesting reply of all was, "I do not understand to which article you refer." The majority of our readers like the feature, however, and it will certainly be continued.

A particular word of thanks is due to those readers (and they are many) who, in addition to filling in the question form in great detail, sent to us expression of their views in the form of letters. We especially desire to thank correspondents at Westcliff-on-Sea, Oxford, Southampton, Earl's Court, Altrincham and Bracknell, whose letters we have found particularly helpful. Once more, THANK YOU!

CONTENTS.

Edited by
JOHN SCOTT-TAGGART,
F. Inst. P., A.M.I.E.E.
November 4, Vol. 7, No. 7.

What Controls the Characteristics of Valves?

By CAPTAIN H. L. CROWTHER, M.Sc., Deputy Director of Research to Radio Press Ltd.

The correct design of valves for specific purposes can nowadays be accurately determined without the assistance of experimental work. Capt. Crowther discusses here the principal factors which affect the characteristics of valves intended for different functions.

THE characteristics, constants, and possible performance of a valve entirely depend on the size and disposition of its electrodes. In the early days of valves the effect of altering the design of the electrodes was only known in a general kind of way, with the result that valves at that time were made rather by a trial and error method than by actual design. At the present time a large collection of data and formulæ are available, by which practically any ordinary type of valve can be designed from beginning to end without the assistance of experimental work. The actual mathematical treatment of the problem is complicated, and would not be of interest here. Unless actually interested in valve manufacture, all one requires is a general idea of the function of each of the electrodes, and how they affect the working of the valve.

The Valve Filament

The filament is the primary source of the electrons which are required for the operation of any type of valve. In the soft valve, of course, electrons are also obtained by the ionisation of the gas present. Also, in the dynatron type of valve, secondary electron emission is obtained by bombardment of the anode. Both these types of valves, however, are primarily dependent on a supply of electrons from the filament.

Filament Emission and Battery Power

The emission from the filament is directly proportional to the area of its heated surface, and also to its temperature. It also depends on the type and composition of the filament.

As economy in battery power to heat the filament is usually very important, the next question is how emission depends on the filament current and voltage. The most economical valve from this point of view is one which has a high filament efficiency or high total emission per filament watt consumed. As the filament efficiency depends on the temperature of the filament, and consequently on the life of the valve, it is essential to consider filament efficiency in conjunction with a satisfactory life. With bright-emitter valves the filament efficiency may be from about 2 milliamps. per watt to about 15 milliamps. per watt.

Life of Valve Filament

Receiving valves, in which long life is essential, are usually designed

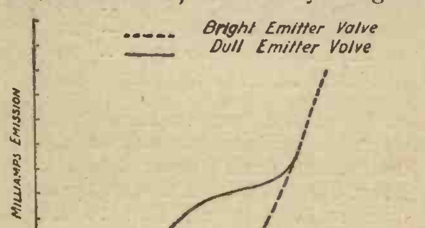


Fig. 1.—Illustrating the comparative emission of bright- and dull-emitter valves at different filament temperatures.

for operation at about the lower figure, whereas transmitting valves may be designed for operation at any value up to 15 milliamps. per watt, depending on whether life or economy in filament batteries is the more important. In aircraft, for instance, the life of the valve is sacrificed in order to cut down the power required for the filament, and valves are used with an emission as high as 10 or 12 milliamps. per filament watt. The life of bright-

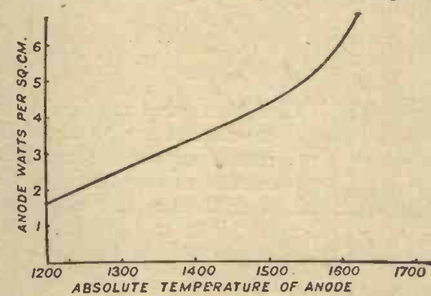


Fig. 2.—A curve showing the relationship between the temperature of the anode of a valve and the energy dissipated.

emitter valves under these conditions is necessarily very short.

Dull-emitter valves, on the other hand, have emissions of the order of 20 to 30 milliamps. per watt, and at this value the life is probably as long as a bright-emitter with only an efficiency of 1 or 2 milliamps. per watt.

Temperature and Efficiency

An interesting point in connection with dull-emitter filaments of the thoriated type is that the filament efficiency may actually fall as the temperature of the filament is increased above a certain value. There is, therefore, an economical temperature at which a dull-emitter filament should be designed to operate. In the case of the bright-emitter the filament efficiency always increases rapidly with increasing temperature.

Diameter and Length of Filament

The efficiency of the filament also depends to some extent on the relative diameter and length of filament. With a short, thick filament the cooling at the ends may be considerable, and a certain amount of power may be consumed which does not assist in the electron emission. Thus a long, thin filament of the same surface area would consume less watts for the same emission and the same temperature. On the other hand, the life of a filament at any given temperature is proportional to the

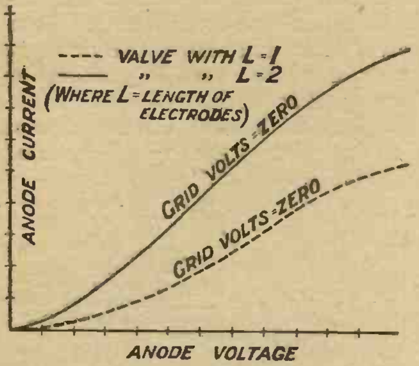


Fig. 3.—The anode voltage-anode current curves of valves with long and short anodes.

diameter. A thick filament can, therefore, be run at a higher temperature for a given life.

All these factors, together with the general design of the other electrodes, and also the available power supply for the filament, must be taken into consideration in the design of the filament.

The Size and Shape of the Anode

As ordinary receiving valves are not required to dissipate much power, the actual surface area of the anode can be made as small as convenient to suit other considerations. In the case of power amplifying valves for large loud-speaker work, the anode must be large enough to dissipate several watts without overheating. In trans-

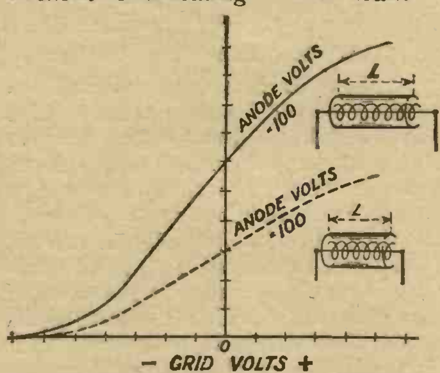


Fig. 4.—The more commonly used grid volts-anode current curves corresponding to those given in Fig. 3.

mitting valves, however, the size of the anode governs the power of the valve. In fact, the usual rating of a transmitting valve is the amount of energy that can be safely dissipated at the anode.

Surface Area

The actual surface area of the anode required to dissipate a given number of watts depends on the metal used. Nickel and molybdenum are the two chief metals used for transmitting valve anodes, and in each case there is an accepted figure for the safe dissipation per square centimetre of surface. A molybdenum anode can dissipate two or three times the power that can be dissipated by a nickel anode of the same size.

Anode Shape and Impedance

The shape of the anode bears an important relation to the characteristics and constants of the valve. For instance, a valve with a long anode can be made of lower impedance for any given amplification ratio than a valve with a short anode. An oval-shaped anode with a loop filament also has similar advantages. The oval anode is also more convenient from the structural point of view, as it offers

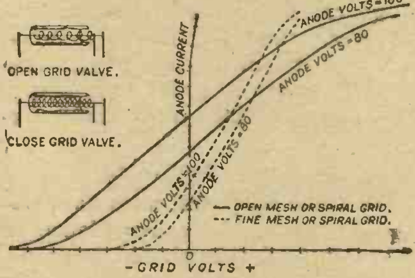


Fig. 5.—Characteristic curves of valves with open and close mesh grids.

better facilities for supporting the grid and filament. The diameter of the anode and the distance from the filament affects the working voltage of the valve. The greater the distance of the anode from the filament the larger will be the working voltage required. Thus a valve for operation on a low anode voltage should have an anode as close as possible to the filament.

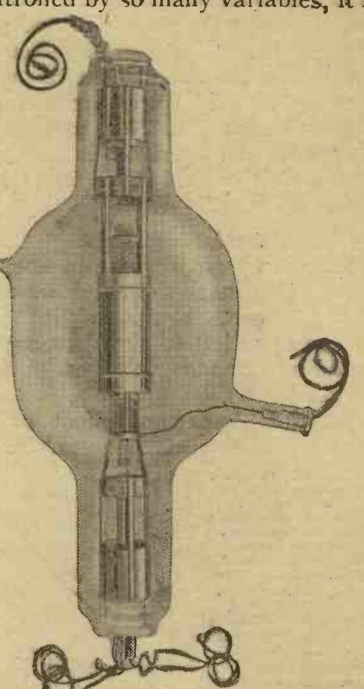
Grid Diameter and Mesh

The mechanical construction and disposition of the grid or control electrode probably has more bearing on the actual characteristics of the valves than either of the other electrodes, and its dimensions are very critical.

Amplification Ratio

The amplification ratio of the valve is the ratio of the slope of the anode current-grid voltage characteristic to the slope of the anode current-anode voltage characteristic, the slope in each case being that at the point representing the particular adjustment under consideration. This factor is chiefly controlled by the diameter and mesh of the grid.

As this amplification ratio " m " is controlled by so many variables, it is



A modern high-power transmitting valve.

best expressed by the following formula, which holds good generally for valves with cylindrical anodes and helical grids :—

$$m \quad \frac{\pi \ Dg \ N \log\left(\frac{Da}{Dg}\right)}{\log\left(\frac{1}{\pi \ d \ N}\right)}$$

Where Dg = diameter of grid.
Da = diameter of anode.
d = diameter of grid wire.
N = grid mesh in turns per Cm.

An Example

For example, if diameter of grid spiral Dg = 1.5 cms., diameter of

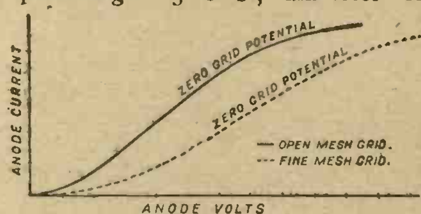


Fig. 6.—The anode voltage-anode current curves of the valves whose other characteristics are shown in Fig. 5.

anode Da = 5 cms., turns per cm. of grid N = 5 turns per cm., diameter of grid wire d = .021, the amplification ratio " m " as given by the above formula is equal to about 15.

Since " m " is proportional to $Dg \times \log\left(\frac{Da}{Dg}\right)$ it can be seen that there is a best grid diameter for any given anode which gives a maximum value for "m"—assuming, of course, that the mesh is not altered. It can also be seen from the formula that the finer the mesh of the grid the greater will be the amplification ratio. For instance, if the turns per cm. in the grid spiral are doubled, the value of "m" is more than doubled. An increase in the diameter of the grid wire itself also increases "m."

Fine Mesh Grid

Again, by an increase in fineness of the grid mesh the anode current-grid voltage characteristics are moved from left to right for corresponding anode voltages. (See curves.)

Another important effect of increasing the turns per cm. in the

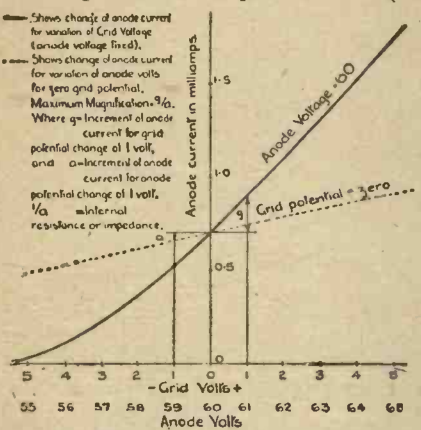


Fig. 7.—Showing how the amplification ratio and impedance of a valve may be obtained from the characteristics. The lower horizontal scale refers to the dotted curve.

grid spiral is to crease the steepness of the anode current-grid voltage and anode current—anode voltage characteristics.

For anode rectification and cumulative grid rectification, the steepness of these curves is of considerable importance for sensitivity.

Valve Impedance

This is not simply the resistance of the valve as obtained by dividing the value of the high-tension voltage applied to the anode by the anode current. It is obtained by finding the change in anode current produced by a small change in the anode potential, and dividing the change of anode volts by the change in anode current. For example, if a valve at zero grid potential gives 10 milliamps anode current at 90 volts and 12 milliamps at 110 volts on the anode, then the impedance of the valve at zero grid volts and a mean anode voltage of 100, is equal to

$$\frac{110-90}{2/1000} = 10{,}000 \text{ ohms}$$

Impedance and Amplification Ratio

The impedance of a three-electrode valve and its amplification ratio are very closely related. A valve with a high "m" always has a high impedance, and a low impedance necessarily means a low "m." The ideal

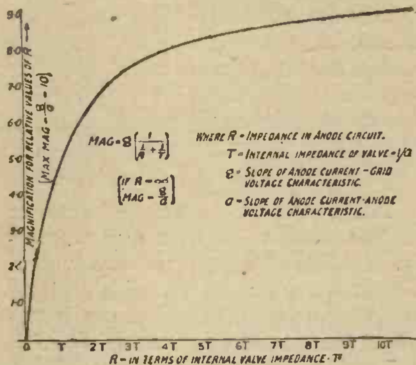


Fig. 8.—A curve showing the magnification factor of a valve for different values of impedance.

valve for most purposes would have a low impedance and a high amplification ratio. These characteristics however, cannot be obtained in practice, and it is necessary to sacrifice low impedance in order to obtain a high amplification ratio and *vice versa.*

Loud-speaker Work

For some purposes, such as loud-speaker work, a low impedance is essential, and this should be com-

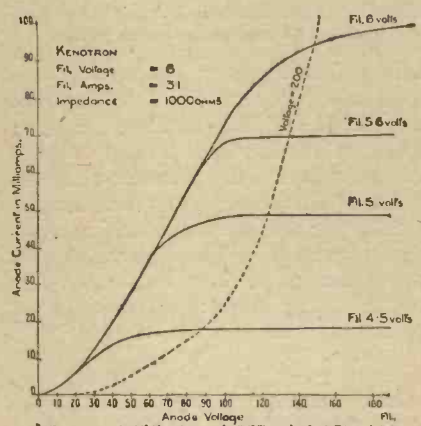


Fig. 9.—The characteristics of a two-electrode valve showing its low impedance.

bined with the highest possible value of "m." The ratio of "m" to impedance is chiefly controlled by the length of the electrodes. This is equivalent to running two or more similar valves in parallel. If this is done, it can easily be seen that the slopes of the anode current—grid voltage characteristic and the anode current—anode voltage characteristic are proportional to the number of valves used. Thus the amplification ratio remains constant, but as the slope of the anode current—anode voltage characteristic is proportional to the number of valves, the impedance is inversely proportional to the number of valves. Thus with two valves in parallel the impedance is one-half that of one valve. For this reason two or more valves are often used in parallel for loud-speaker work.

Valves with oval electrodes can also be designed with a high ratio of impedance to "m."

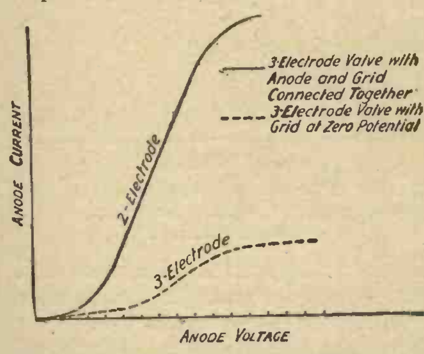


Fig. 10.—Illustrating the difference in impedance between a two- and a three-electrode valve.

Impedance of Two-Electrode Valve

The impedance of a two-electrode rectifying type of valve is much lower than that which can be obtained with the three-electrode valve. The insertion of a grid of any description between the anode and filament increases its impedance to a very large extent. If the grid and anode of an ordinary three-electrode valve are joined together, the impedance of the valve probably falls to less than one-tenth its original value when the valve was used as a three-electrode type.

Valve Impedance and Output

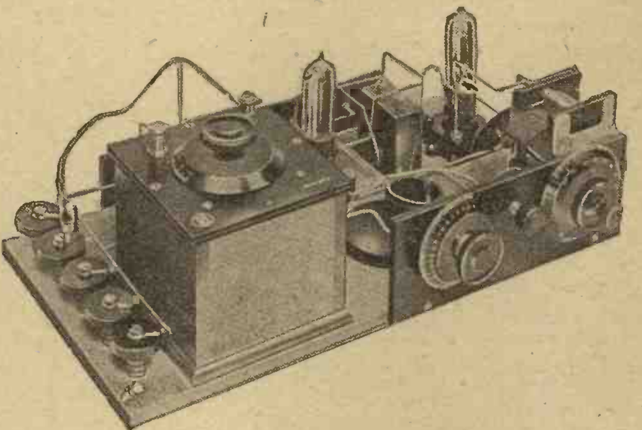
When valves are required to supply power for the operation of a loud-speaker, the impedance is of great importance. For any given anode voltage the maximum energy that can be obtained from a valve is limited by its impedance. This assumes, of course, that good quality is required, and that the valve is only operated with a negative grid.

Ordinary receiving valves with impedances of the order of 20,000 to 30,000 ohms are only capable of supplying a small fraction of a watt to a loud-speaker with voltages of between 100 and 200 volts. As a loud-speaker giving good strength probably delivers the order of one watt in the form of sound energy, it is important that a special type of valve be used for this purpose.

Check Your Own Tuning Circuits

By J. H. REYNER, B.Sc. (Hons.), A.C.G.I., D.I.C.,
Staff Editor.

Some details of a simple testing set whereby the high-frequency resistance, inductance and capacity of any particular circuit may readily be checked.



The components of the Auto-Resonator are mounted on a board, adequate spacing being a desirable feature.

IN my article last week I indicated that I should shortly describe a simple testing set which would enable the serious experimenter to make measurements for himself of the high-frequency resistance of any particular coil. The instrument described in this article is the outcome of experiments which I have recently conducted, and I have made it in such a form that it can be used for a variety of other purposes.

The Auto-Resonator

The principle of the device is as follows :—There is first of all a local oscillator, which generates a high-frequency current of the particular frequency at which the measurements are to be carried out. A small pick-up coil is provided, which is coupled to this oscillator, and so induces currents into the particular circuit under test. The test circuit is then tuned by means of a suitable calibrated condenser, the resonance point being indicated by means of a valve connected across the condenser.

This valve is arranged to measure the voltage developed across the condenser, and thus give an indication of resonance. The unit has been made up as a self-contained piece of apparatus with the exception of the necessary batteries—that is to say, it contains its own source of supply, and the necessary device for detecting the condition of resonance in the tested circuit. For this reason I have called it the Auto-Resonator.

Circuit Diagram

The diagram of the circuit finally employed is shown in Fig. 1. It will be seen that the oscillator is comparatively straightforward, consisting of a tuned coil in the anode circuit, with a reaction coil in the grid circuit. The two coils were both wound on the same former, details of which are given in Fig. 2. This form of oscillator is essential for reasons which will be apparent later.

The Detector Valve

It will be seen from Fig. 1 that a small quantity of energy is picked up by the coupling coil, and introduced into a circuit containing the coil under test, which is tuned with a variable condenser. The voltage across this condenser is applied across the grid and filament of the detector valve.

This valve is arranged to rectify on the anode rectification principle. That is to say, the anode current is reduced to a small value by the application of a suitable negative grid bias voltage, and the application of the voltages across the grid and filament then causes an increase in the mean anode current. The anode current is measured in this case by a milliammeter inserted in the anode circuit. This instrument need not be very expensive, and I myself employ an instrument giving a full-scale deflection for a current of about 3 milliamperes.

Anode rectification is employed in preference to the usual grid condenser and leak method, because this latter method introduces considerable damping into the circuit. The effective resistance of a tuned circuit may be increased by as much as 20 to 40 ohms if the detector valve is arranged to operate with the usual

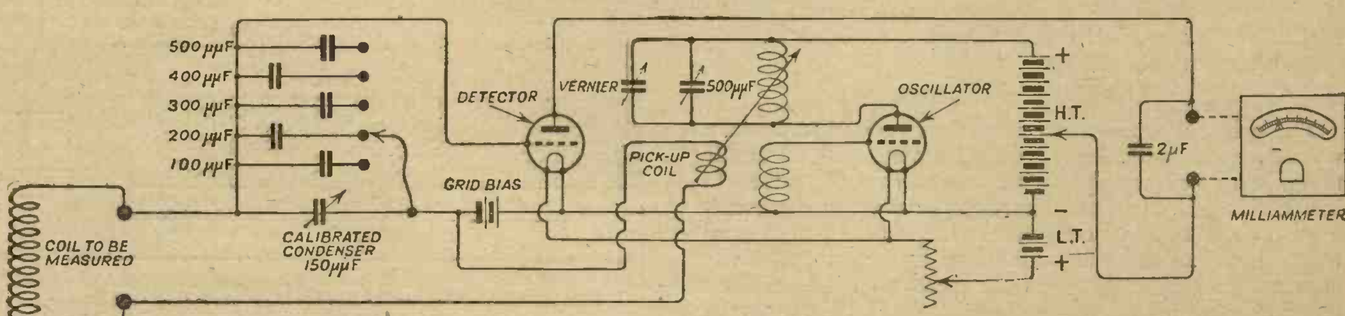
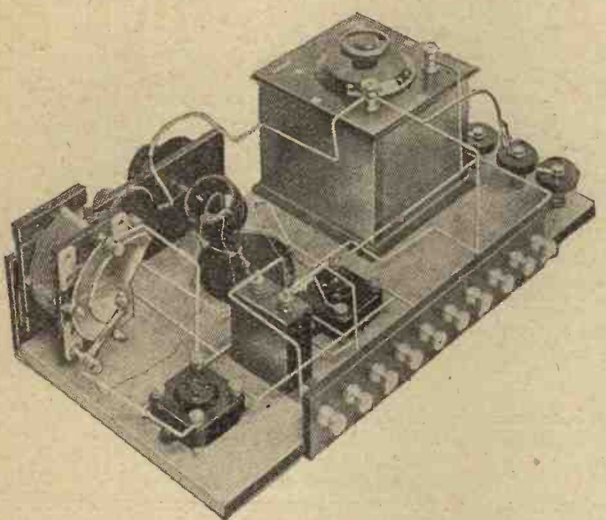


Fig. 1.—The circuit diagram of the Auto-Resonator. Note that the negative of the H.T. battery is connected to L.T. negative.

condenser and leak connection. With the provision of a separate local oscillator, as in this instrument, sufficient current can be induced into the tuned circuit to make anode rectification perfectly satisfactory, and the damping in this case is negligibly small.

Constancy of Input

It is absolutely essential in many types of measurements, particularly in the methods employed for



This view shows the oscillator coils and the pick-up coil quite clearly.

measuring high-frequency resistance, that the input from the oscillator to the tuned circuit shall be approximately constant, irrespective of the tune of the secondary circuit. Now it is found that if the coupling between the pick-up coil and the oscillator is strong then this condition of constant input does not apply. Further, if a tight coupling is employed, the frequency of the source of supply will vary as the tested circuit is brought into tune, and the magnitude of this variation may be as much as 10 per cent. or more.

Variation of Frequency

It is obviously impossible to carry out any reliable measurements if such a state of affairs prevails. Consequently it is most important to have a very weak coupling between the oscillator and the tuned circuit. In testing this particular instrument I arranged to pick up the oscillations generated by the local oscillator on a heterodyne wavemeter, and listened to the heterodyne note as the test circuit was brought into and out of tune.

Oscillator Coupling

The original oscillator consisted of two 25-turn coils, wound on a 3-in. cylindrical former, and a small 1¼-in. diameter coupling coil was arranged to rotate inside this coil. It was found that even when the winding on this coupling coil was reduced to a single turn only, the coupling was much too tight, except when the coil was practically in the zero position. When the coil was placed at an angle of 45 degrees, the heterodyne note would vary right out of audibility, a change, at broadcast frequencies, of over 10 per cent. Further experiment showed that this type of oscillator coupling was quite unsuitable for this instrument, and the oscillator coils were therefore wound on a flat disc type of former, as shown in Fig. 2.

The pick-up coil consisted of 6½ turns on a 1¼-in. diameter former as before, but this was arranged as indicated in Fig. 3. It will be seen that the centre of the pick-up coil is vertically over the middle of the actual winding of the oscillator coil, in which position the coupling is practically zero. With this arrangement the pick-up coil in the maximum position will still be found to give an appreciable deflection of the milliammeter of the detector valve, but the change in strength and in frequency of the oscillator current is very slight.

This is the portion of the whole apparatus which requires particular care, as, unless this coupling is arranged in this manner, so that the actual coupling is very weak indeed, the results obtained may be hopelessly incorrect. If the constructional details, as indicated in Fig. 3, however, are followed reasonably closely, there will be no difficulty in obtaining satisfactory results.

Calibrated Condenser

For measurements of high-frequency resistance, and also for certain other measurements which can be made with the Auto-Resonator, it is necessary to know the actual capacity in the circuit. It is, however, quite easy to obtain a calibrated variable condenser from a maker of high-class instruments. I found, on experiment, that as the variations in capacity which had to be measured were sometimes quite small, it was advisable to use a comparatively small variable condenser with a suitable size of fixed condenser in parallel.

I therefore used a variable condenser having a maximum capacity of .00015 μF, and placed in parallel with it suitable fixed condensers.

The variable condenser was a standard Radio Instruments semi-circular plate type of instrument, rated at .0001 μF capacity, which can be obtained with a calibration chart on request. The fixed condensers were of the Dorwood Precision type, which were employed because in construction they are actually adjusted to the rated capacity on a capacity bridge.

Components

The principal components which were utilised in the manufacture of the set were :—

One .0001 μF semi-circular plate condenser with calibration (R.I., Ltd.).

One .0005 μF variable condenser, with vernier (Ormond) for the oscillator. A vernier adjustment is advisable in synchronising the frequency to that of the local station, a process which will be described later

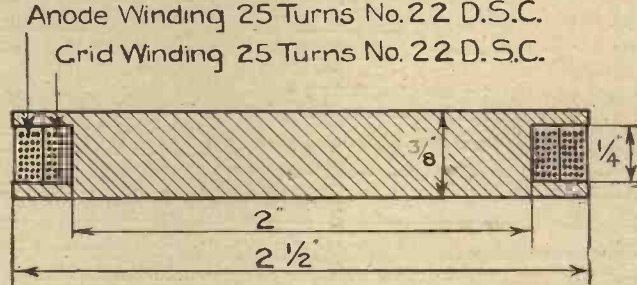


Fig. 2.—Dimensions of the former carrying the oscillator coils.

Five fixed condensers—.0001, .0002, .0003, .0004 and .0005 μF (Dorwood).

The particular capacity required is connected in parallel with the calibrated condenser by means of the clip shown in the photographs.

Two anti-vibration valve holders (Benjamin Electric, Ltd.), One 2 μF condenser—connected across milliammeter terminals (T.C.C.).

One clip.

One terminal strip, having 10 terminals (Burne-Jones & Co., Ltd.).

The construction of the set will present no difficulty, as the layout can readily be seen from the photographs.

Use of Resonator.

We may now consider how this Auto-Resonator may be used for a variety of measurements. The most important of these is that of the actual high-frequency resistance of any particular circuit. I explained last week that the resistance may readily be obtained by what is known as the "Reactance Variation Method." This method consists in tuning the test circuit to the frequency of the supply and noting the current obtained. The circuit is then mistuned by a certain amount and the current again is noted. The resistance is then given by the expression

$$R = \frac{C - C_1}{\omega C C_1} \sqrt{\frac{I_1^2}{I^2 - I_1^2}}$$

where I and I_1 are the currents at resonance and in the mistuned condition; C and C_1 are the capacities at resonance and in the mistuned condition; $\omega = 2\pi \times$ frequency.

Measurement of Resistance

Now in actual practice this expression may be considerably simplified. In this particular case we are not measuring the actual current, but we are measuring the rectified current produced in the anode circuit of the detector valve. This current is proportional to the square of the voltage applied across the grid and filament, and since this voltage, which is that developed across the condenser in the test circuit, is directly proportional to the current in the test circuit, we can say that the current through the milliammeter is proportional to the square of the actual current flowing in the test circuit.

Thus instead of I^2 we may write D, where D is the deflection of the milliammeter. The expression for the resistance then reduces to $R = \frac{C - C_1}{\omega C C_1} \sqrt{\frac{D_1}{D - D_1}}$ and it will readily be seen that if we make the second deflection, that is in the mistuned condition, equal to half the resonant value, then the expression under the root sign reduces to unity, and we have the resistance simply given by $R = \frac{C - C_1}{\omega C C_1}$

Frequency of Oscillator

As I explained last week, it is necessary to know

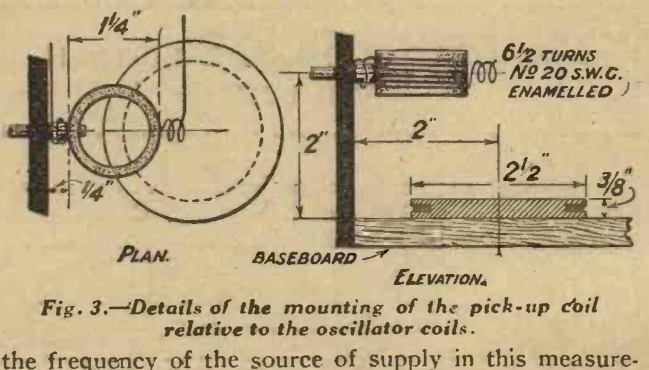
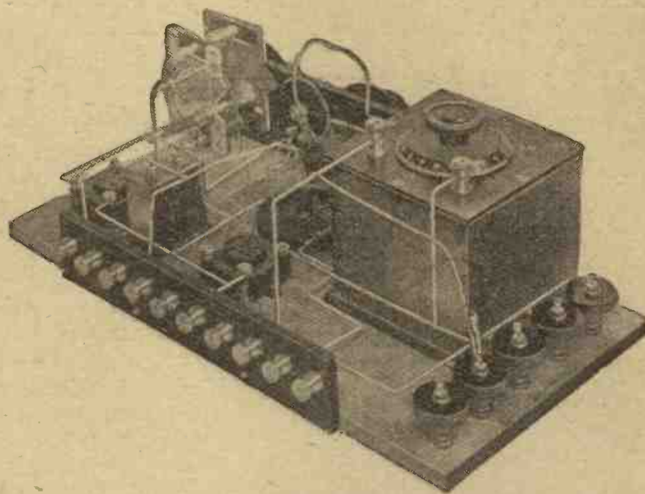


Fig. 3.—Details of the mounting of the pick-up coil relative to the oscillator coils.

the frequency of the source of supply in this measurement. This may readily be obtained by checking up against the frequency of the local station, which may be done with the assistance of an ordinary broadcast receiver. Tune in the receiver to the local station, and then switch on the Auto-Resonator. As the condenser of the oscillator is rotated, so the frequency of the oscillations will be varied, until these oscillations begin to heterodyne the carrier wave of the local station, and the note or whistle will be heard in the telephones.



The fixed condensers on the right are connected in parallel with the variable condenser by means of the clip shown.

Adjust the oscillator condenser until the whistle is zero, when the frequency of the oscillator will be approximately that of the local station. The frequency of the local station can be obtained from the accurate figures which are published from time to time in the columns of this journal.

Checking with a Wavemeter

This method will not cause any appreciable interference because the actual oscillation does not get on to the aerial circuit, so that the presence of this whistle need not be viewed with alarm. As has been stated, the synchronisation of the two frequencies is a business which requires a vernier control of the oscillator condenser. Alternatively, if a wavemeter is available, of course, the frequency of the oscillator may be definitely determined by this means.

Method of Operating

The procedure, therefore, in making a measurement is as follows :—Apply a suitable negative grid bias to the detector valve until the current is reduced to a small value (about 0.1 or 0.2 milliamp.). The grid bias should not be so large as to reduce the current actually to zero. Having calibrated the local oscillator by the method just described, connect the coil to be measured across the test terminals, and place the pick-up coil at about the mid-way position (45 deg.). Adjust the variable condenser with a suitable fixed condenser in parallel, until the circuit tunes to the frequency of the local oscillator. When this is the case the deflection of the milliammeter will suddenly increase.

Weak Coupling

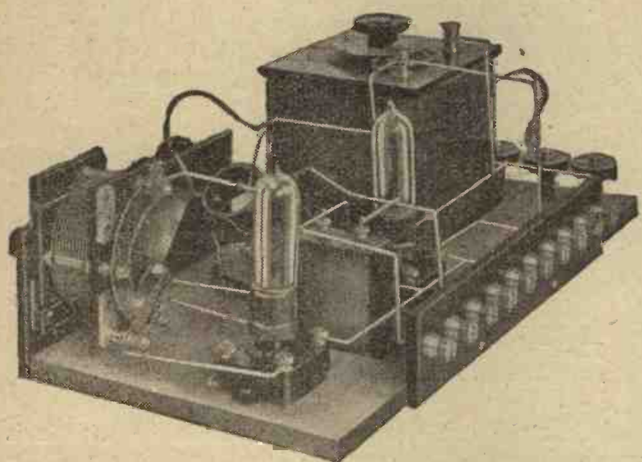
Note the exact readings both on the milliammeter and the condenser at the maximum deflection. The value of the pick-up coil should be adjusted until a suitable indication on the milliammeter has been obtained. It should be remembered that the smaller the coupling the greater is the accuracy of the method.

Thus it is desirable to work the pick-up coil towards the zero position. The current indicated by the milliammeter at the resonance point should be about 10 times that shown under normal conditions.

Then reduce the condenser until the deflection on the milliammeter in the anode circuit is one-half of the previous value. Again note the reading on the calibrated condenser. The resistance may then be calculated directly from the formula,

$$R = \frac{C - C_1}{2\pi CC_1 \times \text{frequency}}.$$

in which all the necessary terms are now known.



If 60-milliampere valves are used the instrument is quite economical to run.

Circuit Resistances

The simple method of connecting a suitable coil across the test terminals and measuring the resistance, as just described, suffers from one disadvantage. In the resistance which is obtained the result includes not only the resistance of the coil, but also the resistance of the calibrated condenser and the various leads, including the coupling coil. The best method to adopt, therefore, is to wind a small standard coil having a comparatively small inductance, and to place this across the test terminals first of all. The resistance of the circuit with this coil joined up may then be obtained, after which the circuit may be opened, and the particular coil whose resistance is to be measured inserted.

Preliminary Measurement

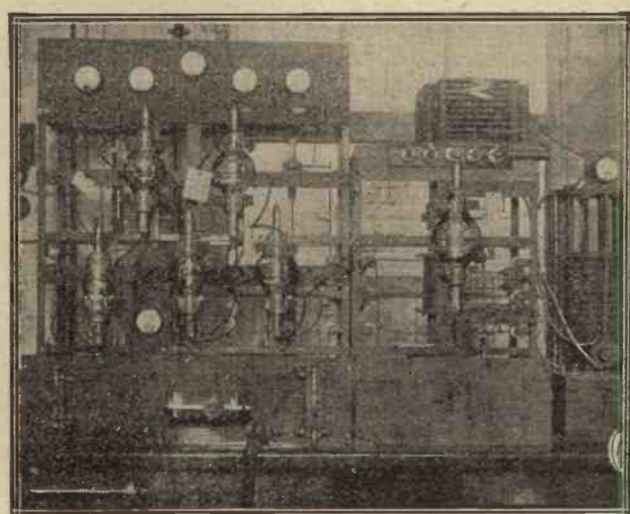
If the resistance of the circuit is then measured, the increase is due to the additional coil which has been added. With my particular instrument the resistance of the circuit and coupling coil and variable condenser, with such fixed condensers in parallel as are necessary, is of the order of 1 ohm, so that this precaution is desirable if reasonably accurate results are required. A suitable coil for the preliminary measurement would be one having about 20 turns on a 1½ in. diameter former, but any small inductance coil may be used for the purpose. The inductance should be kept small, particularly if the inductance of the coil being measured is fairly large, as otherwise the capacity required to tune it will be very small. In such a case the variations of capacity required to produce the necessary change of current would be so small as to render the results inaccurate.

Precautions Necessary

It will usually be found, however, that with the circuit arranged as laid out in this article, the variations of capacity extend over 10 or 20 deg. of the calibrated condenser, so that reasonable accuracy may be obtained. There are, however, certain precautions which have to be taken when the instrument is first constructed. It is advisable to check the values of the fixed condensers, which are placed in parallel with the standard; the circuit capacity itself also affects the readings. These points I shall refer to in future articles, which will also show how this Auto-Resonator may be used for measuring inductance and capacity at radio frequencies, and how it may be utilised to measure the resistance of a complete circuit, that is to say, a coil complete with its correct tuning condensers.

A Useful Instrument

Those experimenters who would like to obtain more definite data concerning their apparatus, therefore, will find this instrument of particular value, and, in view of the amount of information which can be obtained at such a comparatively low cost, it is an instrument which well repays the trouble involved in making it up.



The transmitting valve panel at the Nottingham Broadcasting Station.

The Institution of Electrical Engineers

A meeting of the Wireless Section of the above Institution will be held on Wednesday, November 4, at 6 p.m., when an Inaugural Address will be delivered by the Chairman, Major B. Binyon, O.B.E., M.A.

An Ordinary Meeting will take place in the Lecture Theatre of the Institution on Thursday, November 5, at 6 p.m., when Mr. P. Dunsheath, O.B.E., M.A., B.Sc., will read a paper on "Dielectric Problems in High-voltage Cables."

SHORT-WAVE NOTES AND NEWS

IN view of the fast-increasing number of countries entering the field of amateur transmission, there is a heavy demand for new "intermediates" (i.e., prefix letters indicating the nationality of a station). Herewith is given a complete list of intermediates up to date:—

A : Australia
B : Belgium.
BE : Bermuda.
BZ : Brazil.
C : Canada.
CH : Chili.
CR : Costa Rica
CS : Czecho-Slovakia.
D : Denmark.
E : Spain.
F : France.
G : Great Britain & Northern Ireland.
H : Switzerland.
HU : Hawaii.
I : Italy.
IR : Irish Free State.
J : Japan.
K : Germany.
L : Luxembourg.
LA : Norway.
M : Mexico.
N : Holland.
O : South Africa.
P : Portugal.
PI : Philippine Islands.
PR : Porto Rico.
Q : Cuba.
R : Argentina.
S : Scandinavia (Iceland, Sweden, Finland).
U :United States.
X : Ships and various portable stations.
Y : Jugo-Slavia.
Z : New Zealand.

Post-Office Research

The call-sign 5DH, apparently heard in all five continents, emanates from the G.P.O. Radio Research Station at Dollis Hill, near Wembley. 5DH transmits automatic Morse on 6,000 kc. (50 metres), and may be heard almost every evening working with Cairo. We are informed that, as soon as these experiments are completed, the Northolt station will commence work at this frequency on a commercial basis. One of the many advantages of these frequencies is that the local high-power stations are no stronger than other stations at much greater distances employing much less power. We seem to be approaching a solution of the "local interference" problem at last.

The Antipodes

The "A's" and "Z's" may be heard at about 08.00 G.M.T. every day now on about 7,500 kc. (40 metres). They are considerably stronger than the Americans, but no scientific reason has yet been found to account for this. Prominent among the New Zealand stations heard in this country are 2AC, 2AQ, 2XA, 4AL and 4AR. Two of these have been heard by the writer when their inputs were less than 5 watts. Reception conditions are also good, the nearest source of outside interference being Australia, 1,300 miles distant. New Zealand is divided into districts, like the United States, all stations whose calls begin with 1 or 2 being in North Island, and the 3's and 4's in South Island. Australia also follows this plan, there being at present six districts. The most prominent Australian station here is that of Mr. MacClurcan, A-2CM. Any readers hearing A-6AG are asked to communicate with Mr. W. E. Coxon, 5th Avenue, Inglewood, Western Australia.

The transmitting equipment at the station operated by Il Radiogiornale (1RG) at Milan. Telegraphy and telephony are transmitted at 7,895 and 16,667 kc. (38 and 18 metres).

South America

The South American stations are now mostly to be found between 8,333 and 10,000 kc. (36 and 30 metres). Brazil's best representative during the past few weeks has been BZ-1AB of Nichtheroy, near Rio de Janeiro. Readers should experience no difficulty in finding this station any evening after 22.30 with an ordinary "low-loss" single-valve receiver. A very active Chilian station is that owned by Major L. Raven-Hart, and working with the call-sign CH-9TC. The Argentine stations are also very active. Their calls consist of two letters followed by a figure, and those most frequently heard are CB8, DA8 and FB5.

Our Own Efforts

Many British stations have now established consistent communication with America, and may be heard on 6,667 kc. almost every evening after 22.00 G.M.T. It seems to be accepted as a matter of course that, with 100 watts or even less, one can "raise a Yank" almost at the first attempt. This is all the more creditable in view of the enormous number of stations working simultaneously in America, and the resulting interference.

As usual, the British stations doing the most work are 2KF, 2NM, 2OD, and 5LF. Our friends in the north, however, including 5MO, 5KO, and 2CC, do not seem to care very much for sleep, judging by the regularity with which they appear "on the ether."

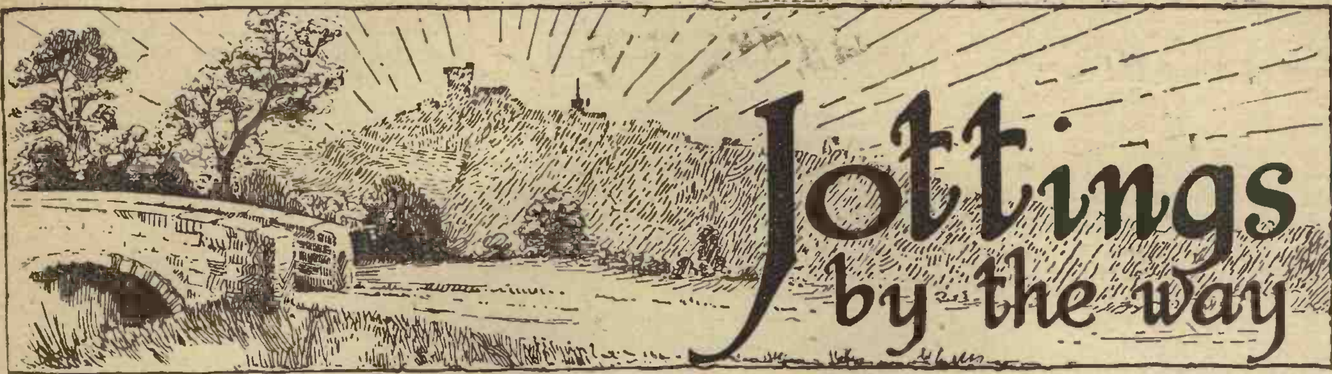
2SZ has worked two American amateurs in the sixth district (on the Pacific Coast), and he and 2NM have also worked HBK, in India. Other stations that have been heard in India are 2DX, 2LZ, 2KF, 2XY, 5LF and 2FM.

Germany

Several German stations have been audible during the past few days. Their intermediate, K, is incorporated in their actual call-sign (viz., KY4, KL4, etc.). It is interesting to note that in Germany the receiving stations are allotted identification numbers. These numbers must apparently be mentioned in all communications relating to radio, and are of the form DE0023, DE0038, etc. The receiving experimenters are thus not tempted to use their "identification number" as a call-sign!

Spain and Portugal

Signs of activity in Portugal have appeared at last. The writer heard a station signing "P1AB" on 5,263 kc. (57 metres) on October 25 at 23.00 G.M.T. The Spanish amateurs have, however, been in evidence ever since last winter. They are nearly all very strong on a single valve, and mostly work on 7,500 kc. (40 metres). Their calls are E-AR1, AR2, etc.



Slow Progress

OUR work at the magnificent laboratories of the *Little Puddleton Gazette* has not progressed of late quite so quickly as we would have liked. So long as the weather remained moderately dry, the line of duckboards that had been installed made it possible for us to reach both the house on wheels, which is the headquarters of the Professor and myself, and the hen house, in which Poddleby is supposed to carry out his tests. When, however, the heavens opened and rain descended upon us last week, progress to and fro became rather difficult. On the first occasion we were unluckily caught by the rising waters whilst we were at work. At the close of our day's labours, when it was time to go home, Professor Goop stepped from the wheeled house and disappeared from sight at the bottom of the little mound upon which the research laboratories stand. I dashed back to find something that would do duty as a lifebuoy, and the only thing that I could lay my hand upon was the five-valve receiver that Gubbsworthy had sent round to be tested. This I flung after the struggling Professor, who

. . . We hauled him ashore . . .

grasped it as drowning men grasp straws. They sank together, but the Professor's head presently emerged above the waters, and he shouted that I had saved his life, since by standing on the set he was just within his depth. When I told Gubbsworthy what a noble part he had played indirectly, the fellow was, if you will believe me, quite nasty about it. Some people have no finer feelings.

A Difficult Situation

The Professor, I must say, took things very calmly. In fact, once he had got his head out he quite forgot about his predicament and started to wax enthusiastic over the wonderful reception that we might expect, owing to the dampness of the soil surrounding our station. Not for some minutes was I able to make him realise that he was standing in mud and water up to his neck, and that the best thing that he could do was to get out of it as quickly as possible. I called Poddleby, who emerged from his henhouse and came to my side. My plan was an excellent one. I wanted Poddleby to lie on his face and to crawl forwards towards the edge of the mud whilst I held his feet. By stretching out his arms he would then be able to reach the Professor, who could climb over him to safety. But Poddleby, I regret to say, refused point-blank to play a man's part. I was almost at my wit's end when I remembered that several pairs of telephones had been sent in for test. By tearing the cords from these and knotting them together I managed to make a rope which I flung out to the Professor. The pair of us then hauled him ashore.

S.O.S.

The next problem before us was to devise some means of getting back to Little Puddleton. My own idea was that in the manner of Noah of old we should send out not a dove, but Poddleby, which was the nearest thing that we had. "But I can't fly," said Poddleby. "No," I said, "but you can swim." Poddleby, however, declined, and matters began to look serious. "The first thing," I said, as we formed an impromptu council of war, "is to make a careful inventory of our food supply. We must then live on strict rations." "Food?" shouted Poddleby and the Professor in chorus, "we have not got any food." I smiled. "This," I said, "is where the resourceful mind comes in. How many high-tension batteries have we?" Investigation showed that there were eight of 66 volts apiece. "Four of these," I

. . . If we consume one H.T. battery a day . .

explained to my somewhat sceptical audience, "are covered with wax, and if we consume one high-tension battery a day—that is 22 volts apiece—we shall be able to last out until help arrives. As you have doubtless observed, there is no lack of water."

Unselfishness

I have always stoutly maintained that wireless people are an unselfish crowd, and nowhere have I seen a finer example of altruism. Each one of us was insistent that the other two should share his ration between them, maintaining that he was better able than they to bear the hardships of hunger. "If only," said the Professor, "we had a transmitting set." This remark set me thinking furiously. "Poddleby," I asked, "have you not got Snaggsby's receiving set that was sent round for test some days ago?" Poddleby replied that he had. "Snaggsby," I said, "is the worst howler in Little Puddleton, and any receiving set that he makes is really a transmitter. Let us yoke up Snaggsby's box of tricks to our aerial and see what we can do with it."

Beset by Difficulties

"But," exclaimed the Professor, "we have not got an aerial. You forget that it is to be erected next week." This, however, was a small matter, and we easily improvised something suitable by unwinding some of the coils that the General had sent round to be calibrated, and suspending the wire obtained from them between the wheeled house and Poddleby's hen roost. As we had luckily not begun to eat our high-tension batteries, plenty of anode voltage was available.

Help at Hand

We then rigged up Snaggsby's set, and as the time when the club

. . . *With a sickening crash she grounded* . . .

would be meeting was approaching, we tuned in 2LO. Though we had no tapping key, we found that we should have little difficulty in sending out our message by means of the anode tuning condenser. On the stroke of eight Poddleby, who had been appointed wireless operator, got to work. "S.O.S." he waggled out in squeals: "*Little Puddleton Gazette* Research Laboratories calling! Professor Goop, Wayfarer, and Poddleby marooned in the laboratory by floods. No food available. The flood is rising. Send help at once. *Little Puddleton Gazette* Research Laboratories over to Little Puddleton Wireless Club." This message we sent out again and again, hoping to get through, though we were badly jammed by interference. Several people kept on sending out "Shut up!" using the method of transmission that we were employing, whilst Snaggsby, whom we knew was due to try out still another new set that evening, was at his very worst. At long last, though, we heard the welcome "wheeeeeeoooooo," which betokened that the club's generator was getting under way. In a few moments we heard the Admiral's cheery bark as transmitted by the microphone. "Help will be sent at once," he said. "Give us your exact latitude and longitude."

The Rescue

Having a six-inch ordnance map upon our walls, we were able to supply the required information, and on switching over we received cheery messages from members of the club, all of whom assured us one after the other that no stone would be left unturned to effect our rescue. "Don't worry about turning stones. Get a boat!" we replied. As Little Puddleton is about as far from the sea as it could be, and as the Pud can hardly be classed as a navigable river, boats are somewhat scarce in our locality. Still, we hoped for the best. Within half an hour we observed a considerable number of lights flashing upon the hillside above the sewage farm. All of them were sending messages in Morse at once, which made it a little difficult for us to read their purport. Still, we gathered that we were to bear up and not to give way in despair. Nearer and nearer the bearers of the lights came, until they got so close that we could hear the splashes whenever one of their number fell in. "Have you got a boat?" we shouted. "No," came the reply, "but cheer up, we will soon reach you." Presently we heard a super splash, followed by a roar from the General, who appeared to be praying Bumpleby Brown to refrain from standing upon his face. More noises of a mixed nature followed, and presently we saw a light approaching us over the watery waste.

Land Once More

"Ship ahoy!" I bellowed, carried away by excitement. "Hullo, there!" came the answering hail. "Is that the crew of the *Gazette* Research Laboratories?" "Yes, yes," I bellowed. "Come quickly, for we are nearly at the last gasp." I begged Poddleby to give me his shirt in order that I might wave it so as to attract the attention of the rescue party, but once again the man failed us. The rescue craft approached. Presently we could hear those on board it talking. "Keep your pole out of my eye, you ass." "That's not my pole, you idiot; it's the Admiral's telescope." Slowly the craft drew nearer, and we saw that it consisted of the bodies of two farm wagons lashed together and punted by the stalwart members of the club. Then, with a sickening, horrid crash she grounded, and to judge by the splashes that followed, the wallowings and the gurglings, most of her crew were thrown overboard by the shock. They seemed to scramble back somehow, but to our horror we found that they were still some fifty yards from us.

The Plunge

As I suffer agonies from chilblains I begged Poddleby to carry me out upon his shoulders, but he replied that it was now a case of every man for himself. As he appeared reluctant to make the plunge I pushed him in enthusiastically, and he struck out for the rescue vessel. Bringing a torch along to find the best take-off place for the Professor and myself I was amazed to find that the floods had subsided sufficiently to bring the duckboards once more into view. The Professor and I therefore tripped lightheartedly and dry-footedly to land, waving our hands as we passed, both to the struggling Poddleby and to the crew of the rescue ship. Once back in safety, my thoughts turned naturally to our brave would-be rescuers, who were thus placed in peril. The only means of reaching them appeared to be by rocket apparatus, and at this season of the year rockets are abundant. The first one that we fired, borrowed from Edward Bugsnipp, took the Admiral squarely in the brisket, whereupon the shipwrecked crew signalled urgently to us to desist. There was therefore nothing for it but to leave them to their fate, and this we did. The next morning they were able to wade ashore, and considering the jolly night of excitement that they had had, it was curious to notice that they were not in the best of tempers. The two wagons have been left in the midst of the field, and we propose shortly to roof them over and to convert

. . . *Tripped lightheartedly to land* . . .

them into an office for the assistant supervisor. Meantime I am rather annoyed with P.C. Bottlesworth, who has served upon the Professor, Poddleby, and myself summonses to appear before the court on a charge of transmitting without the necessary licence. It has often been observed that initiative is not encouraged in this country.

WIRELESS WAYFARER.

HOME-MADE NEUTRODYNE UNITS

By DONALD STRAKER.

In a previous article in "Wireless Weekly," Vol. 5, Nos. 8 and 9, Mr. Straker described the construction of a type of H.F. Transformer modelled on the "X" former devised by Percy W. Harris, M.I.R.E. Details are given here of an extension of this method to the construction of Neutrodyne units, with some practical notes on their incorporation in receiving apparatus.

NEUTRODYNED high-frequency stages are deservedly popular, for by no other simple means is it possible to gain so much amplification while having self-oscillation under good control. Since Mr. Percy W. Harris, M.I.R.E., introduced his arrangement in which plug-in transformers are used for the anode and neutrodyne coils, a very large number of such receivers have been built, and although in theory the ordinary commercial neutrodyne unit may appear to violate many of the principles of low-loss, it is nevertheless exceedingly compact and convenient, and in practice gives good average results.

Varying Conditions

It is obvious that the tendency to self-oscillation must vary within wide limits in different receivers and associated aerial-earth systems, and the commercial unit must be a compromise to function reasonably well under widely different conditions. It may be used in a receiver, which by efficient design is very prone to self-oscillate, with an aerial in which damping has been reduced to a minimum. At the other extreme it may be used in a flat-tuning receiver with a high-resistance aerial. Some receivers, too, employ slow motion neutrodyne condensers of a minute capacity, while others have capacities of 30 $\mu\mu$F or more. It is hardly surprising, therefore, that one hears of cases in which difficulty is experienced in finding the neutral point within the limits of the neutrodyne condenser in use.

Disadvantages

These neutrodyned circuits have also been criticised on account of the difficulty of "logging" distant stations by the condenser readings. As the neutrodyne circuit is so closely associated with the aerial circuit,

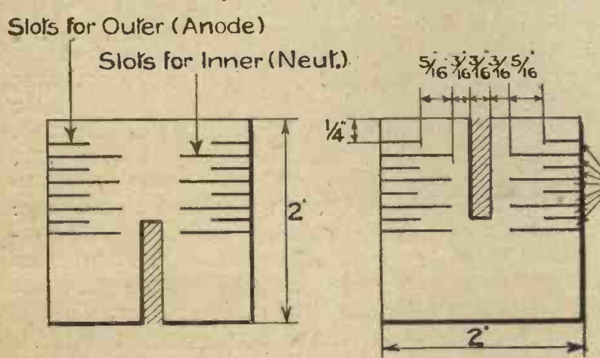


Fig. 1—All necessary dimensions for constructing the former are given in the above diagram.

adjustments to the neutrodyne condenser have an effect on the setting of the grid circuit condenser, and a still larger effect on the anode condenser, and the difficulty is increased where an additional variable is introduced in the shape of a separate reaction coil.

The "Reception Peak"

In long-distance reception there is a certain set of conditions which unfortunately is nameless, but which is recognised by all serious experimenters. For want of a better name this shall be called the "reception peak." It occurs when all circuits are perfectly tuned and the amount of reaction is just sufficient to give the very best *pure* signal strength. Short of this "peak" signal

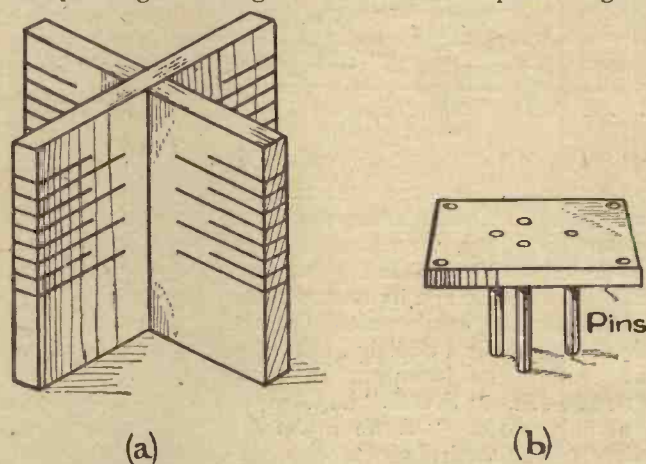


Fig. 2.—The assembled former is shown at (a), while (b) shows the base upon which this is mounted.

strength is needlessly sacrificed, beyond it one gets an unnatural *timbre*, distortion, and ultimately self-oscillation. It would appear to be immaterial whether this happy amount of reaction is introduced magnetically by means of the usual coil coupled to the aerial circuit, or by means of the inter-electrode capacities of the actual valve; but if it is possible to use the latter in a convenient form, there is a great saving in stray capacity in the set, owing to the elimination of the separate coil and its connections, as well as other advantages which will be appreciated in actual use.

Experiments

Some time ago the writer was experimenting with a neutrodyne receiver in which it was hoped to increase selectivity by the use of coils with opposed magnetic fields, and since it was not advisable to use magnetic reaction with a separate coil, the neutrodyne condenser alone was used to give reaction effects. Up to a point this was thoroughly satisfactory, but it was found that when various experimental aerials were used, the ordinary type of neutrodyne unit failed to give the desirable reception peak within the limits of the neutrodyne condenser.

Complete Oscillation Control

It was therefore decided to construct special units to suit the individual receiver, so that it would be possible

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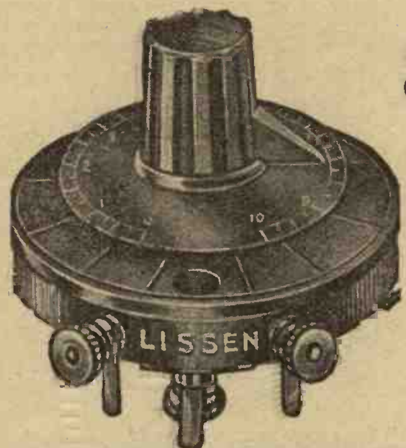
You will make a quick decision—



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Turn them up—try the contact—note how firmly and surely the brush moves, yet how pleasant it feels. Try and move the turns of wire and make them short—you can't. Note the heat resisting former, the solid, robust construction of everything, promising extremely long life. See how the combined knob and pointer will fit flush with the dial when mounted. And *lastly* NOTE THE PRICE.

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No drain on the L.T. Accumulator

LISSEN WIRE POTENTIOMETER (pat. pending) —does not wastefully consume current, 400 ohms **4/6**

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LISSEN WIRE DUAL RHEOSTAT (pat. pending) —gives a rotary movement equal to two separate rheostats—a thing no other dual does - - **6/-**

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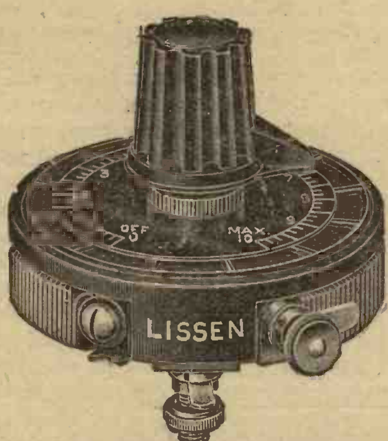

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to introduce any desired amount of reaction up to the point of self-oscillation by the progressive setting of the neutrodyne condenser alone, whether used for long or short waves or with all sorts of aerial-earth conditions. The minimum reaction requirement was when using a short aerial and counterpoise earth, with constant aerial tuning and the aerial condenser towards its zero end. The maximum requirement was when using the standard large aerial, water-pipe earth, parallel tuning and the aerial condenser turned towards its maximum end.

The Harris " X " Coil

The type of former adopted for these units is similar to that described by the writer some time ago in an article on home-made transformers (*Wireless Weekly*, December 10 and 17, 1924). This form of construction, which is really based on the Harris " X " coil, possesses considerably less self-capacity than the usual unit in which the windings are nearly buried in solid dielectric. This is very evident in practice by an appreciable gain in volume, sharp tuning and its consequent selectivity. The writer finds that a Bowyer-Lowe square-law condenser with five moving plates (.00015 μF nominal) is more than sufficient to tune one of these units over the B.B.C. (1,000 to 600 kc.) band, and even with this small capacity condenser some form of slow motion device on the dial is acceptable.

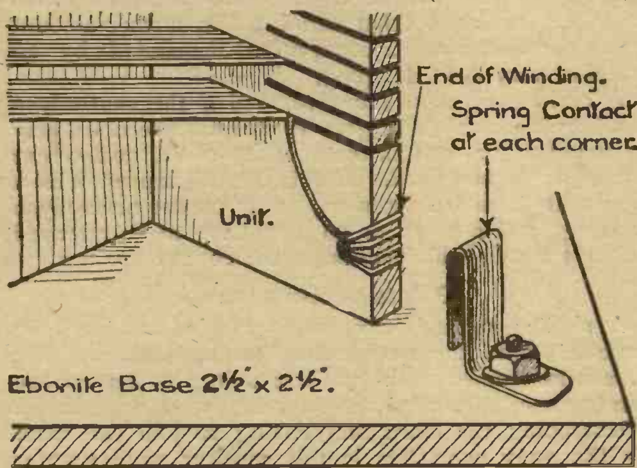


Fig. 3.—Showing the construction for a " plug-in " method of connecting the transformers in circuit.

Ebonite Formers

Fig. 1 shows the two halves of the ebonite former. The writer uses " Paragon " panels 4 in. by 4 in. by 3/16 in., as they are very handy for making two units when quartered. The secret of making them easily lies in careful measurement and accurate work with the square and scriber point when marking out the ebonite. As most constructors will probably cut the wire slots with the saw they happen to have by them, it is not of much use to specify the cutting of slots 1/64 in. wide. For the higher frequencies, however, the ideal to aim at is to have the slots just wide enough to take a single turn of wire, and at the higher frequencies this ideal is quite attainable.

Mounting the Unit

There are many simple ways of mounting these units. If ordinary valve holders are in use in the set it is best to fit four valve pins to a small square of ebonite, about 2 in. by 2 in., which is fixed to the bottom of the former by small brass wood screws (⅜ in. by No. 3) (Fig. 2). Shouldered valve-pins and back nuts will get over the difficulty of tapping the ebonite for the pins, but in that case the holes for the pins should be arranged so that the projecting nuts come in the spaces between the arms of the former.

A very good method of mounting is shown in Fig. 3. The contacts are made of springy brass or phosphor bronze fixed to a square of ebonite with 4B.A. screws and nuts, which also form the connections with the set. The ends of the windings are bared and passed a few times through small holes at the edges of the arms of the former. These turns should be lightly tinned with a hot soldering iron to give a good clean contact with the springs on the holder. In this way the parallel capacities of the usual valve holder are avoided and the wiring spread out somewhat.

The Windings

Before commencing the winding, study the connections shown in Fig. 4. This is the standard connection in commercial units when viewed with the pins turned towards the eye. It will be noticed that the ends of the inner (neutrodyne) coil are taken to the " filament " pins, while those of the outer (anode) coil go to the " grid " and " anode " pins. Further notice that the beginning of the inner coil connects with the left hand filament pin while the beginning of the outer coil connects to the grid pin and both coils are wound in the same direction.

Number of Turns

It might here be remarked that it is not really necessary to follow the dimensions given in Fig. 1. When once the general principle underlying the construction of units in this manner is thoroughly grasped, similar results can be obtained with formers of different sizes and shapes or with wire of a different gauge, and as the idea is to wind the units to suit individual receivers, it is, of course, impossible to specify the exact number of turns for each winding. The general principle to follow is to put on too much wire at first and to reduce the windings progressively and intelligently on trial under actual receiving conditions, until the unit tunes over the required range and gives exactly the required

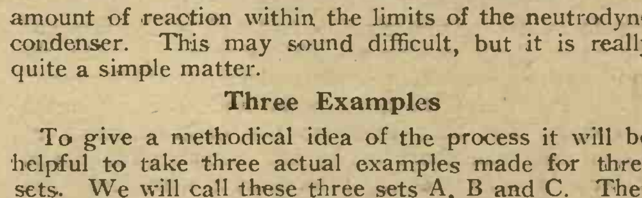


Fig. 4.—When the pins are pointing towards you, the standard method of connection is as shown here.

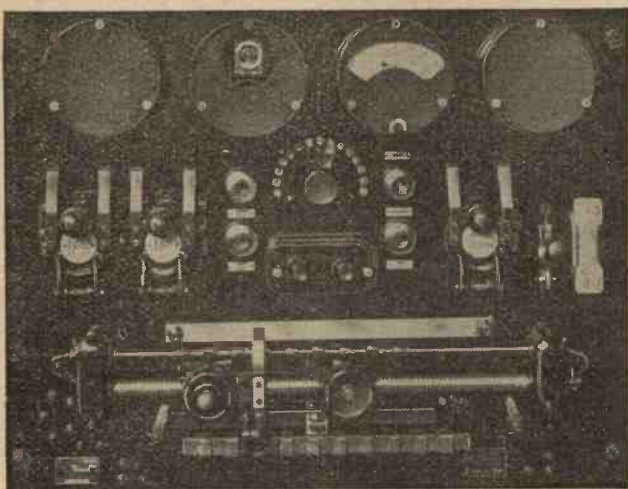
amount of reaction within the limits of the neutrodyne condenser. This may sound difficult, but it is really quite a simple matter.

Three Examples

To give a methodical idea of the process it will be helpful to take three actual examples made for three sets. We will call these three sets A, B and C. They are all enclosed in teak cases, " American " fashion, with controls on a vertical panel and valves, etc., on a wooden baseboard. Harris X coils are used for aerial tuning with condensers of .0003 μF capacity and separate " Colvern " verniers. The anode condensers are of .0002 μF capacity, and Polar micro-condensers are used for neutrodyning. No reaction coils are fitted. A is a straightforward three valve with a single H.F. stage (HF-Det.-LF). B has an additional H.F. stage, both stages being tuned by a double condenser (2 H.F.-Det.-L.F.). C also has two H.F. stages, but each is tuned with a separate condenser, and it also has two stages of low-frequency (2 H.F.-Det.-2 L.F.).

Testing the Windings

Using No. 30 gauge s.s.c. wire, the unit for A was first tried with 25 turns per slot (total 100) for the inner (neutrodyne) winding and 36 per slot (total 144) for the outer (anode) winding. A "Buzzerdyne" wavemeter was then set for 857 kc. (350 metres), the minimum required, and the receiver connected up as for reception with the large aerial and water main earth. Constant aerial tuning was used invariably at the higher frequencies. As the unit would not tune down low enough nor permit self-oscillation, even with the neutrodyne condenser right "out," a few turns were stripped off both windings progressively, careful notes being made of the effect of each alteration, until the Buzzerdyne would tune in with the anode condenser set to about 5 deg. A small margin is convenient,



This automatic switchboard, of the type used at the Post Office Station at Burnham, is operated by a motor behind the panel.

because as more reaction is used the anode condenser requires to be turned back slightly to compensate for the coupling.

Final Adjustments

The neutrodyne winding was then still further reduced, until the set would oscillate freely with the neutrodyne condenser about one quarter "in." At this stage the anode winding had 138 total turns and the neutrodyne 75 turns. This was correct for the conditions of maximum reaction demand which accompanied the use of the large aerial and ordinary earth. A change was then made to the other extreme by substituting the short aerial and counterpoise earth. It was at once seen that too much wire had been removed from the neutrodyne winding, as the set oscillated even with the neutrodyne condenser set at its maximum. Five turns were therefore *added* to the winding, and this brought the reception "peak" just inside the maximum setting of the neutrodyne condenser. With the large aerial connected, the "peak" could still be passed and the set made to oscillate before the neutrodyne condenser reached its minimum setting. As the addition of the five turns to the neutrodyne winding had increased the capacity of the anode winding, so that the anode condenser required to be turned back uncomfortably close to zero to tune in to 857 kc., two more anode turns were removed to give the working margin on 857 kc. (350 metres). The final windings were therefore—anode 136 turns, neutrodyne 80 turns, and in this state the reception "peak" was readily found within the limits of the Polar neutrodyne condenser, no matter what aerial was employed.

A Peculiar Effect

It will be seen from this description that the neutrodyne coil of itself is made just too small to stabilise the set when used on the aerial with maximum damping. The small amount of additional capacity then supplied by means of the neutrodyne condenser gives complete stability on that aerial, and a further amount gives the additional neutralisation demanded by an aerial of very light damping.

A curious effect may be observed if the neutrodyne winding is much too large. In this case reaction may be found to increase as the capacity of the neutrodyne condenser is *increased.* If this should happen it is a sign that there are too many turns on the neutrodyne winding, and a score or so may have to be removed before the unit will function in the correct manner.

Points to Observe

A similar method was employed in making the matched units for receiver B, but remembering the experience gained with the first unit, the neutrodyne windings were reduced more gradually, so as to avoid overstepping the mark and having to join the wire. As the stray capacities in this receiver were greater than those in A, these units required only 130 anode turns, but, as the tendency to self-oscillation was greater, 90 turns were found necessary for the neutrodynes. The two units were then very carefully matched in receiver A, turns and even half-turns being removed until both units would tune and permit self-oscillation with identical condenser settings. When doing this it should be noted that any alteration in one of the windings has a corresponding effect on the other winding owing to the close coupling, and this should be considered and kept clearly in mind when estimating the probable effect of each progressive alteration.

Matched Units

As each stage in receiver C had its own tuning condenser, it was not really necessary to match the units, but it is of interest to note that when a matched pair was used the second condenser had to be turned up about 15 deg. above the first. For convenience in use more anode turns were used in the second unit to bring the condenser readings approximately equal.

Units for Daventry

For the units for 5XX the slots in the formers were cut with a rather thicker saw to accommodate the larger number of turns. At this frequency the benefits of the single layer are not so apparent, and as No. 40 s.s.c. wire is used the turns tend to bank up side by side in the slots. For the first trial it is well to wind on about 400 turns for the neutrodyne and 550 turns for the anode. Here again the neutrodyne winding should be adjusted until the reception "peak" is obtainable within the limits of the neutrodyne condenser. As parallel tuning is generally used on this wave, the task is less exacting, since the extremes of reaction demand are much narrower.

(*Continued on page 237*)

The Elimination of "Atmospherics" from Wireless Receivers

By Major JAMES ROBINSON, D.Sc., Ph.D., F.Inst.P., Director of Research to Radio Press, Ltd.

In his previous article in this series, Major Robinson indicated the nature and sources of atmospheric disturbances. After some further notes on the same subject, he proceeds to discuss some of the methods suggested for combating their interference with reception.

A CONSIDERABLE number of observations have been made of the relation between atmospherics and the Aurora Borealis and the Aurora Australis. There is undoubtedly some connection, and the general view is that there is a source of atmospherics in the upper regions of the atmosphere. These are supposed to be produced by a form of dust which comes from sources external to the earth, striking the upper layers of the atmosphere, and thus disturbing the electrical equilibrium of these higher regions. These higher regions of the atmosphere are supposed to be very conductive, the conduction being obtained by ionisation produced by the strong ultra-violet light of the sun. Whenever such layers of dust pass through these ionised layers there is a change in the general electrification, and we can expect changes of potential and consequent discharges between various layers to equalise the potential again. The view has been expressed that, as the sun's light is most intense over the tropics, we thus obtain the most violent atmospherics in the regions of the tropics.

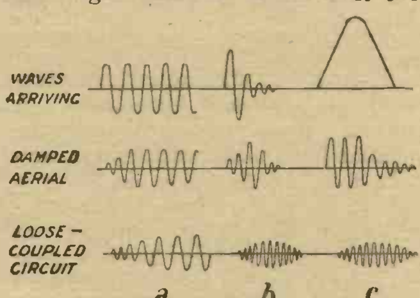


Fig. 1.—Showing the effect of different types of aerial systems on (a) undamped waves, (b) damped waves, and (c) atmospherics.

Atmospheric Electricity

Meteorological conditions are bound up very considerably with the state of electrification of the atmosphere. The study of atmospheric electricity is very old, and is still being pursued very assiduously. No more can be given here than a review of the chief facts of the subject. It is found that normally there is near the surface of the earth a potential gradient of 300 volts per metre, which diminishes gradually as we ascend. Actually at a height of 1,000 metres the normal potential difference is about 100 volts per metre. At 5 kilometres it is about 30, and at 10 kilometres it is estimated that it should be non-existent. This gradient is of such a direction as to lead to the conclusion that the earth is negatively charged, with a surface charge equal to 10^{-13} coulombs per square centimetre, corresponding to a total charge on the earth equal to half a million coulombs. The potential gradient is very variable, and it can change from 300 volts per metre in very fine weather to 10,000 volts per metre in the slightest mist or rain.

Potential Differences

Normally we would have a potential difference between a point 1,000 metres high and the surface of the earth of about 200,000 volts, and in such circumstances there would be equilibrium. As, however, mist and rain and other factors can change this potential, in certain circumstances we might have a large difference of potential of millions of volts between a spot 1,000 metres high and the earth. It is thus seen why we might get lightning. Again it is easy to see that there might be large differences of potential between two clouds, thus again acting as a source of lightning.

Explanation of Crashes

De Bellescize makes use of atmospheric electricity to explain why we get atmospherics lasting for some seconds. Over any particular region of the atmosphere we may at times have very variable temperature conditions, thus making the distribution of atmospheric potential very variable. One discharge may take place between two points, thus equalising the potential between those two points. This, however, will affect the equilibrium between one of these points and another point, thus producing a second discharge immediately afterwards, and so on from point to point, thus producing a series of discharges one after another.

Lightning Discharges

Although each single discharge only lasts for a very short time, it is easy to see how a series of such discharges may last for a few seconds. These discharges may be visible, in the form of lightning, or they may be dark discharges, these latter being much slower than lightning, but yet quick enough to account for electro-magnetic waves being sent out.

Hisses

The explanation of hisses now becomes apparent. These are due to actual discharges of the aerial itself, and are not due to distant atmospherics. If we have the atmospheric potential at the earth's surface in the neighbourhood of the aerial changing constantly, the top of the aerial finds itself at a different potential, and thus it discharges, producing a disturbance like an atmospheric.

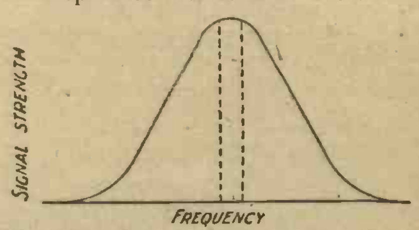
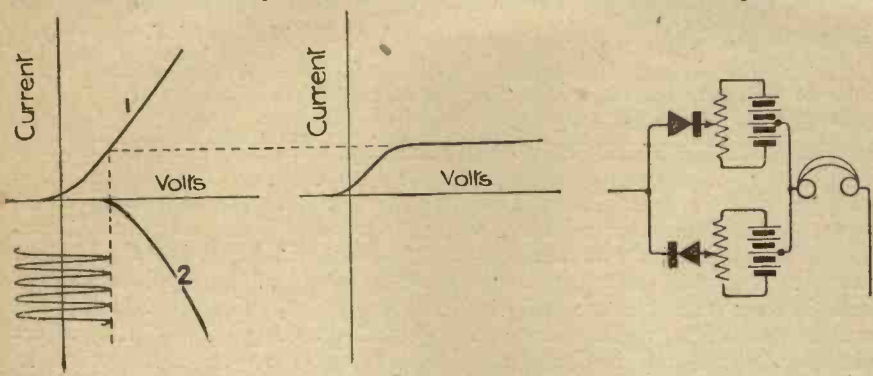


Fig. 2.— The flat-topped resonance curve of the highly damped aerial system referred to in connection with Fig. 1.

Interference with Reception

From the foregoing description of the characteristics of atmospherics, it is obvious that unless something is done towards eliminating them from wireless receivers, or towards cutting down their effect, wireless communication will be seriously interfered with.

Actually the interference with communication from this cause is a very serious matter, and it is not unknown for certain stations to shut down for two or three hours owing to the fact that atmospherics are so bad. Such closing down of wireless stations occurs most frequently in the tropical regions, but even in higher latitudes the interference with communication is sometimes very serious. It causes the necessity for repetition of signals, involving delay and inefficiency.



a b c

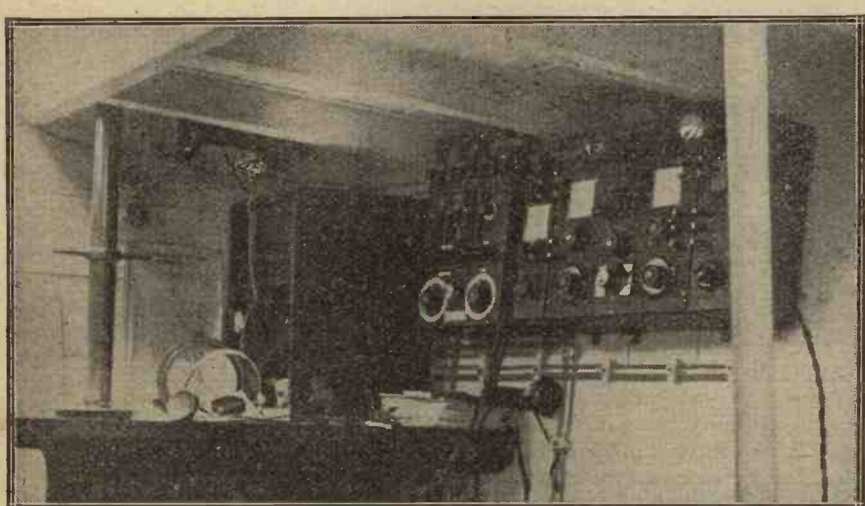
Fig. 3.—A "limiting method" suggested for elimination of atmospherics uses two crystal detectors connected in opposition.

Frequency and Atmospherics

We have seen that atmospherics appear at all frequencies and that they are usually worse at the lower frequencies. This effect has had an appreciable influence on the design of transmitting and receiving stations. There is an optimum frequency for communication over any given distance for the longer waves, the optimum frequency decreasing according to the Austin Cohen formula as the distance increases. This formula, however, actually accounts for too small a value for the optimum frequency, but in addition the fact that atmospherics are worse on the lower frequencies has meant that the frequencies chosen for long-distance communication are higher than they would otherwise have been. For instance, for a distance of 4,000 kilometres the optimum frequency calculated is 33 kc. (9,091 metres), whereas actually it is found to be better to use a frequency of about 100 kc. (3,000 metres).

Shock Excitation of Aerial

Another fact which has appeared from the foregoing description is that a single atmospheric produces at a receiving station an electrostatic field which may be 1,000 times greater than that required for good, strong signals. It is thus obvious that if there is a constant stream of atmospherics it is utterly impossible to receive even strong signals which are seen to be of a strength of such a small magnitude in comparison. It has also been brought out that atmospherics as a rule are not usually oscillatory, but that they are more of the nature of a pulse. Being of such large magnitude, they are equivalent to a blow or a shock. An analogy is the striking of a tuning fork by a single blow. Any tuning fork, no matter what its frequency, will be set into oscillation by such a blow. The analogy can be carried still further: the amplitude of the vibrations that can be produced in tuning forks depends upon the frequency of the fork, being greatest for the lowest frequencies and smallest for the highest frequencies. This is then equivalent to what happens when an atmospheric strikes an aerial—the lower the frequency, the more freely is it set into oscillation at its own frequency.



The wireless apparatus on the lifeboat "Elizabeth and Blanche," which is leaving on a long cruise to make practical tests of a life-boat's equipment.

Elimination

The problem of eliminating atmospherics is of the utmost importance, and many attempts have been made to try to eliminate them completely in wireless reception. A number of very ingenious suggestions have been put forward, and it is well worth while devoting a little time to some of these suggestions. A large amount of imagination must have been used on some of these suggested ideas, and although the problem of the elimination of atmospherics has not yet been completely solved, a study of the methods that have already been tried may lead to a final suggestion which will enable communication to be carried on completely and independently of atmospherics. It will be impossible to describe or even to refer to all the suggestions which have been put forward, in this article, and we will restrict ourselves to a few of the more typical ideas.

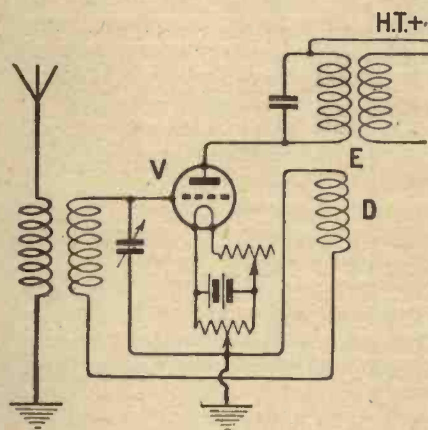


Fig. 4.—Another "limiting circuit" in which the valve filament is run dim.

Heterodyne Reception

The type of reception which is being used has very little to do with whether atmospherics are present or not. It was at one time thought that when using continuous waves the heterodyne method of reception gave a certain amount of freedom from the disturbance. This, however, is not the case, but it is possible with the heterodyne method to work more freely through atmospherics. The reason for this is that it is possible to change the pitch of the note received by the heterodyne method, and this enables one to distinguish signals from the atmospherics, whose disturbance is usually very rough, the average pitch of the noise which is heard being usually comparatively low. By adjusting one's heterodyne note to be fairly high, it is often possible to carry on quite good reception through bad atmospherics.

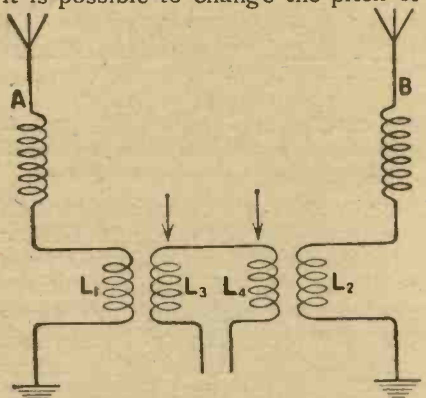


Fig. 5.—The aerials A and B in this circuit for balancing out atmospheric disturbances are spaced half a wave-length apart.

Can We Tune Out Atmospherics ?

We have just seen that, when an atmospheric strikes a simple resonant circuit, it acts just like a blow and starts this resonant circuit in vibration. The problem would therefore seem to be hopeless, of attempting to get rid of atmospherics by using very highly selective circuits. However, this is not absolutely the case. It is possible by adjusting successive circuits to cut down the effect of atmospherics somewhat. We will examine the case where we have a highly-damped circuit, followed by a circuit with comparatively little damping in it and loosely coupled to the highly-damped circuit. We shall for convenience consider the highly-damped circuit to be the aerial circuit, which may even be of the nature of an aperiodic aerial. The effect of damped and undamped waves on such a system is well worth studying.

Continuous Waves

In Fig. 1 the cases are shown for damped and undamped waves and an atmospheric striking such a system. The series of curves (*a*) shows what happens when continuous waves strike this system. The top line shows the wave arriving at the aerial. The waves cause the damped aerial to oscillate at the same frequency.

Damped Waves

There is usually another vibration present in such a forced system, but we can afford to neglect this. The loosely coupled circuit in the lower line, being in tune with the arriving wave, receives these waves completely. The series of curves (*b*) shows the same series of events for a damped wave. It is seen that the aerial in this case repeats the form of wave as it arrives at the aerial.

Atmospheric Pulses

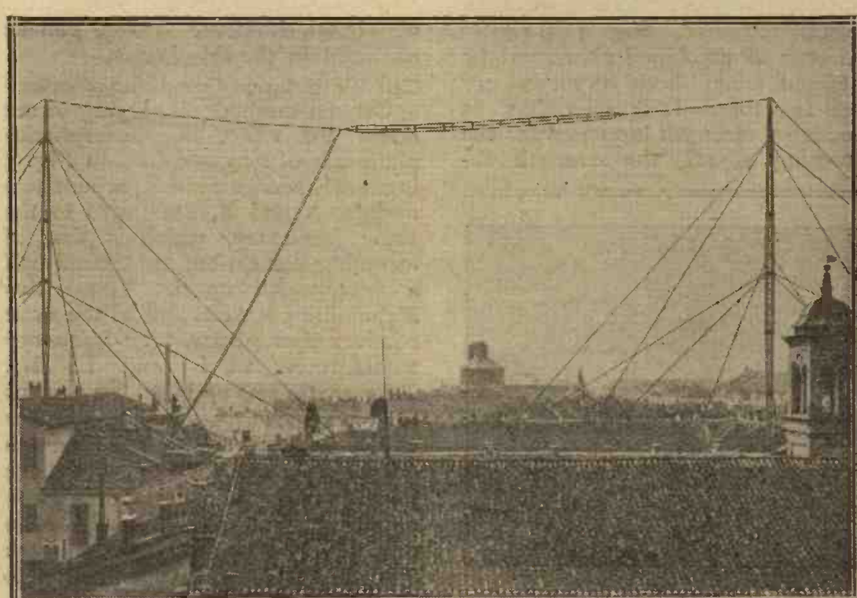
Now such a highly damped system has a resonance curve as shown in Fig. 2, which means that it has really a number of frequencies, or that its energy is spread over quite a band of frequencies. The loosely coupled circuit tends to pick up only the energy which is in tune with it, and we get a result as shown in the lower line of Fig. 1. The effect of the atmospheric is shown in the curves (*c*). The top line shows an atmospheric in the nature of a pulse, which starts the damped aerial oscillating, and it is seen that this oscillation is very much of the same nature as a spark train. Thus in the loosely coupled circuit we again pick up a relatively small amount of energy.

Disadvantages

These curves thus show that, by using coupled circuits and highly-selective circuits, it is possible to cut down the effect of atmospherics to some extent. One might feel inclined to carry this process to a logical issue, and use a loosely-coupled circuit with exceedingly small damping in it. However, when this happens, we should get a very objectionable feature, that when such a system is struck by a shock it commences to oscillate and will continue to oscillate. In other words it will " ring," which is very objectionable, and in order to reproduce signals accurately a certain amount of damping must be retained in these various circuits.

Degree of Damping

By coupled circuits we can hope to obtain some alleviation of the disturbance from atmospherics, but it is not possible by coupling to eliminate atmospherics completely. One feature will be noted from the curves in Fig. 1, however, and that is, that the effects of damping in the various receivers cause the signal and the atmospheric to have different effects. The ratio of atmospheric to signal can be altered by altering the damping in the receiver. This feature is of importance and lies at the basis of some very successful means of cutting down the effect of atmo-



The aerial system of the Milan broadcasting station, from which test transmissions are now being carried out at 890 kc. (337 metres).

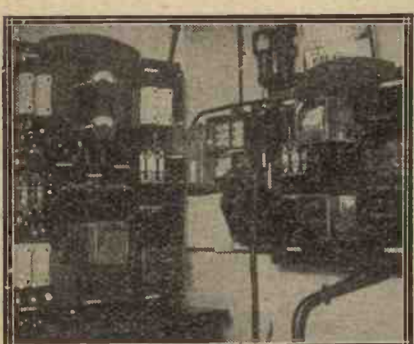
spherics, which will be described more fully later.

Filter Circuits

A number of ingenious filter devices have been suggested for trying to eliminate atmospherics. Such devices are designed to allow only one frequency or a narrow band of frequencies to pass through to the receiver. From the description of the effect of atmospherics on coupled circuits it appears that filter circuits cannot give any more freedom from disturbance of atmospherics than that which is obtained by the use of coupled circuits.

Limiting Methods

A number of methods have been proposed from time to time, based on the assumption that it is not possible to eliminate atmospherics altogether, but it would be highly desirable to cut down the disturbance due to them, so that its strength is not greater than the strength of the incoming signal. Such methods are called "limiting methods." The earliest suggestion of this type was to use two crystals, one being sensitive and the other insensitive. These crystals are connected in opposition, as shown in Fig. 3 (c). The characteristics of the two crystals are shown in Fig. 3 (a). Weak signals will act on the crystal with characteristic 1, but they will not act on the crystal whose characteristic is 2. Strong signals, however, will act on both crystals together. Fig. 3 (b) shows the type of combined characteristic obtained when both crystals are used together. It is seen that, as the signal strength increases for the incoming signal, the strength obtained in the telephones rises to a maximum. Thus, weak signals will be heard, and the signal strength can never rise above a certain value. Very strong signals, such as atmospherics, will also give the same maximum strength.



Part of the switchboard at the Nottingham broadcasting station.

Valve Circuits

The same idea has been applied to valve circuits, one of them being arranged to be sensitive, and the other insensitive. Weak signals act on the sensitive valve, and atmospherics act on both valves at the same time, and as these valves are arranged in opposition it is possible to cut down the effect of atmospherics so that they are no stronger than the average signal which arrives. Such methods are useful up to a point.

Another Device

Another method of a somewhat similar nature is shown in diagrammatic form in Fig. 4. This suggestion was put forward by Mr. Wright, of the Marconi Co. The valve V is arranged to have its filament dimmed, so that the signals heard in the telephones will never be very strong. This is because the weak signal will cause the valve to be used to its full extent, and a strong signal cannot give any greater effect than this; the valve thus acts as a limiter. It is essential, however, to eliminate further any direct effect of the atmospheric through the capacity of the valve. This is provided for by coupling the grid circuit to the anode coil E by a special coupling coil D, the coupling being so arranged that when the filaments are not lighted no signal, however strong, can be obtained in the telephones.

Can We Balance Out Atmospherics?

Certain methods for trying to cut down the effect of atmospherics make use of two aerials. In Fig. 5 is shown such a system, where two aerials, A and B, are tuned to the same frequency, which is that of incoming waves, but are spaced half a wavelength apart. These two aerials are both coupled to the same receiver through the high-frequency transformers L1 L3 and L2 L4. They are joined up in such a way as to oppose each other. For waves which are arriving in the direction AB or BA, the fact that we have joined up the two aerials so as to oppose each other will really mean that the effects will assist each other in this case, because owing to the fact that they are spaced half a wavelength apart, the received waves are of opposite phase in the two aerials. Any other waves which arrive from other directions will strike the aerial more or less equally, and because the aerials are joined up so as to oppose each other such effects should balance out. This would apply to atmospherics which would most frequently arrive from other directions than that of the line joining the two aerials.

Balanced Aerials

Other systems using two aerials act on a somewhat different principle, by having one aerial tuned to the incoming wave, and the other aerial detuned from this, or even aperiodic. In this case the aerials need not be spaced half a wavelength apart. Atmospherics would then affect the two aerials more or less equally, whereas signals would affect the tuned aerial very much more than they would the aperiodic aerial. Again, the two aerials are coupled to the receiver, so that the effects received in them tend to neutralise each other.

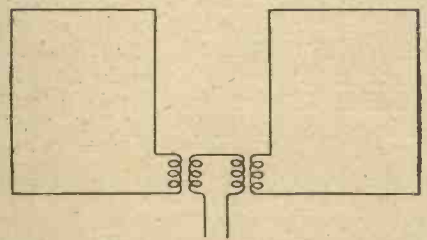


Fig. 6.—The Weagant method of balancing two loops has been employed with a certain amount of success.

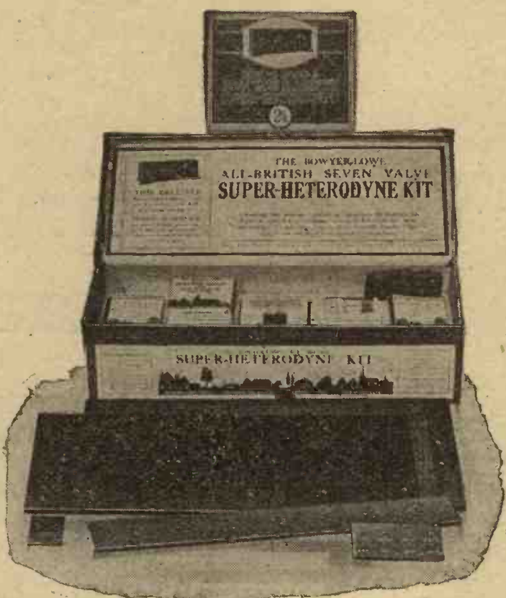
Directional Effects

Such systems do in effect tend to cut down disturbance due to atmospherics. When the aerials are spaced half a wavelength apart this obviously tends to make the receiver directional, and such a system is suitable only for point-to-point work, and not for receiving in any direction.

Weagant Loop System

This type of system has also been used with loops, and quite successful results have been obtained by the use of two such loops. The name associated with the balancing of two loops in this way is Weagant. The loops are placed with their planes both pointing towards the incoming signal, and thus again they are useful for point-to-point work only. The loops are placed one behind the other, both in the same plane, being spaced with their centres of the order of half a wavelength apart. As the loops are joined in opposition to the receiver, signals arriving along the line of the loops in a horizontal direction will be received owing to the phase difference in the two aerials, but atmospherics arriving in any other direction, even from vertical directions, will tend to be balanced out.

30 STATIONS ON LOUD-SPEAKER



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Wireless News in Brief.

Prince to Broadcast. On November 10 the Prince of Wales will broadcast from his study in York House, St. James's Palace, a message on behalf of Earl Haig's British Legion Fund. All stations will broadcast this talk simultaneously.

* * *

Northolt Interference. The G.P.O. station at Northolt appears to have become more of a nuisance to listeners than ever just recently. Several owners of really selective receivers have reported the impossibility of listening to distant stations owing to the harmonics and mush of Northolt.

The Leafield station was once noted for giving rise to similar interference, but this was improved by the efforts of G.P.O. engineers. The G.P.O. promised to take steps towards improving matters in connection with the Northolt station, but the actual result appears to be an increase instead of decrease in interference.

* * *

Mr. R. M. Ford At Marlborough Street Police Court last week Mr. R. M. Ford was summoned at the instance of the Postmaster-General for unlawfully establishing a wireless telegraph station, and for working wireless apparatus without the necessary licence.

Mr. Ford said he had a statement that would take considerable time, as there were many considerations involved. The case was thereupon adjourned until November 12.

* * *

The Venezuelan Government have imposed a temporary ban on the importing of receiving sets, owing to the fact that they consider that wireless is responsible for keeping people from their work.

It is stated that the Commissariat of Posts and Telegraphs proposes to construct over 40 wireless stations in Russia during the coming year.

* * *

Wireless and Lifeboats. The converted Royal National Life Boat *Elizabeth and Blanchè*, at present lying off the Embankment, London, will shortly be leaving for a round-the-world cruise in order to test the utility of wireless receiving and transmitting apparatus on such a small craft, and also in order to ascertain the essential foods and clothing, etc., for a long journey in a small boat.

The input power of the transmitter is ¼ kilowatt, the generator being driven by the boat's petrol engine, and the receiving equipment includes direction-finding apparatus.

* * *

Broadcasting a Tattoo. The broadcasting of various "effects" by the British Broadcasting Co. having resulted in a fair measure of success, a more ambitious scheme is shortly to be attempted. This will be an imitation of the Wembley Tattoo, consisting of sounds resembling galloping horses, marching troops, aeroplanes, tanks, etc., by means of ingenious mechanical devices.

Music will be supplied by the 2LO military band, the fifes, drums, bugles and pipes of the 2nd Scots Guards, and Trumpeters of the Life Guards.

* * *

Round-the-World Relays. Some very interesting experiments have been carried out recently in connection with the relaying of messages right round the world, first in one direction and then in the other.

The first message was transmitted from Columbus, Ohio, on 15,000 kc. (20 metres), and picked up in England by H. S. Nichols, of Stocksfield-on-Tyne. It was passed on to Mr. E. J. Simmonds, of Bucks, who then transmitted it to Sydney, Australia. From Australia the message was passed on to Wittier, California, and was subsequently forwarded to the A.R.R.L. headquarters at Hartford, Connecticut, its final destination.

A further experimental relay round the world in the reverse direction also met with success, a specially meritorious performance being the relaying of the message by Mr. Evan O'Meara, of New Zealand, to a station in France.

* * *

Wireless Prosecutions. Following the recent prosecutions of listeners for installing and working wireless receivers without licences, there has been quite a rush by "pirates" to procure licences for their installations.

In the first case, Mr. Harold Pearse, for the Postmaster-General, said the recent Act dealing with wireless licences made it clear that the word "transmitting" included the reception as well as the sending of wireless messages, and that anyone having a set for receiving only must take out a licence.

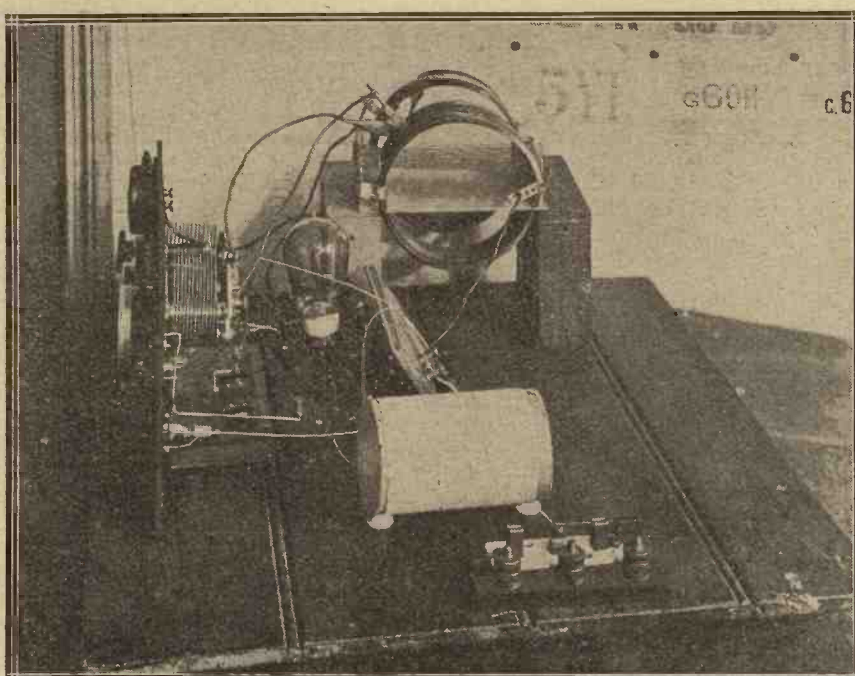
* * *

Short-Wave Success. At a meeting at the Central Hall, Westminster, recently, Senatore Marconi disclosed some of the latest results of radio research. He stated that during the past week or two experiments had been carried out by some of his staff between Buenos Aires and Chelmsford, a distance of 6,000 miles, a frequency of 20,000 kc. (15 metres) being employed. Using this frequency, it had been found easy to communicate by means of telegraphy during the hours of daylight, but not at night-time.

HOW TO MAKE A 45-

By L. H. TH

Experimenters who are inte mission at high frequencies that is of interest and assis



A side view of the transmitter with the grid-leak removed. The coil in the fore-ground is one of the radio-frequency chokes. The method of making connections to the coils with spring-clips may be clearly seen, and also the method of supporting the coils.

EFFECTIVE transmission at a frequency of 6,667 k.c. (45 m.) may be accomplished by two methods, viz., using a small aerial with a natural frequency slightly higher (wavelength slightly lower) than that which it is desired to use, or using an ordinary "P.M.G. aerial" and tuning it to an exact sub-multiple of the frequency (*i.e.*, multiple of the wavelength) at which it is to be used.

In actual practice the writer has found the first method the more satisfactory, and a short description of his own apparatus and experiences may be of use to those readers who are interested in low-power transmission at these frequencies.

Care in Lay-Out

First, various special precautions must be taken in laying out the apparatus. These are as follows :—

(i) All the components in the high-frequency section of the apparatus must not only be very well insulated from earth, but must also be exceedingly well spaced from earth and from each other. Readers would do well to read Mr. Kendall's article in *Wireless Weekly* for October 21, on "Laying-out a Short-Wave Set."

(ii) All leads should consist of good rigid wire (*e.g.*, No. 14 gauge enamelled), and be fixed so that they cannot vibrate, as even a slight vibration of a lead at frequencies such as this will give rise to violent fluctuations in the emitted wave, sometimes rendering it quite unreadable.

(iii) Good-quality components are more than ever a necessity, and all coils and condensers should be of a well-known "low-loss" make. For powers up to ten watts good receiving apparatus is perfectly suitable, but the writer recommends the use of coils wound with copper ribbon or copper strip, as described later in this article.

Choice of a Circuit

Most of the usual transmitting circuits require various small modifications before they may be used efficiently on 6,667 kc. (45 m.). Fig. 1 shows an excellent circuit to commence with, the actual dimensions of coils and capacities of condensers being discussed in this article.

The writer has used this for some time and has found it very stable in operation, all adjustments being perfectly straight-forward.

Coils

On his own transmitter for 6,667 kc. (45 metres) the writer uses special coils, the scheme of construction being illustrated in the photograph on page 230. The material used is "edgewise-wound" copper strip, which, when bought, is coiled up tightly like a flat spring. The coils are simply pulled apart, and glass photographic plates are

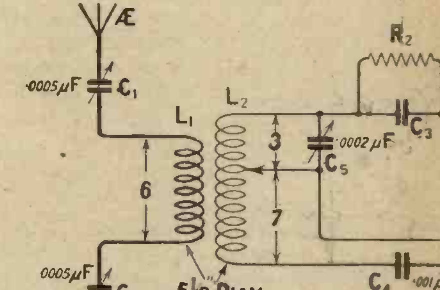


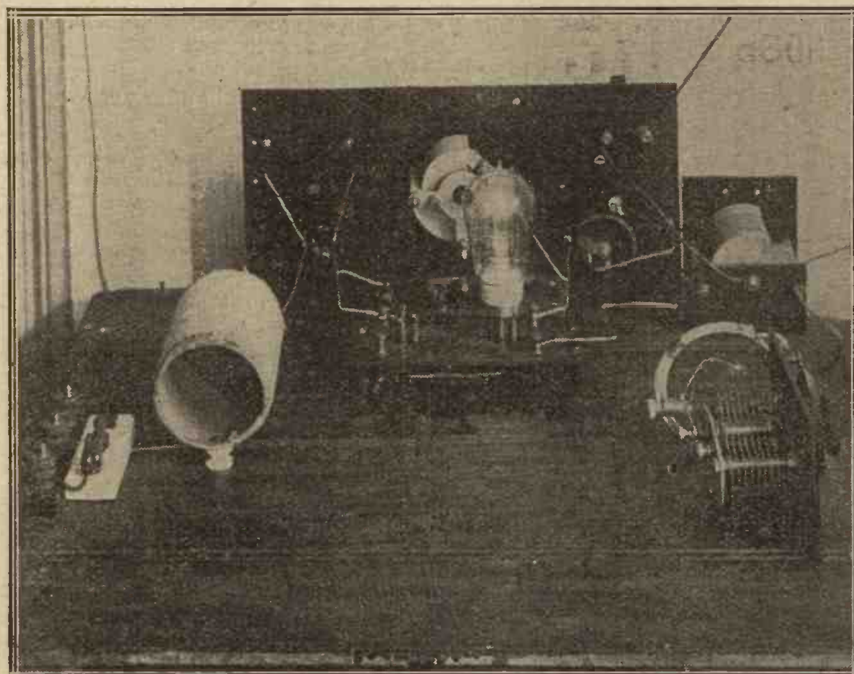
Fig. 1.—The complete circuit diagr the chokes in the L.T. battery lea the

inserted between the turns, these plates being slightly greater in length than the diameter of the coil. They are then bound together at

METRE TRANSMITTER

OMAS (6QB).

nding to commence trans- this winter will find much tance to them in this article.



A rear view of the transmitter, with the grid-leak and coils removed to show the method of wiring. The piece of apparatus in the right foreground is an absorption wavemeter with a small flash-lamp bulb in series with the coil.

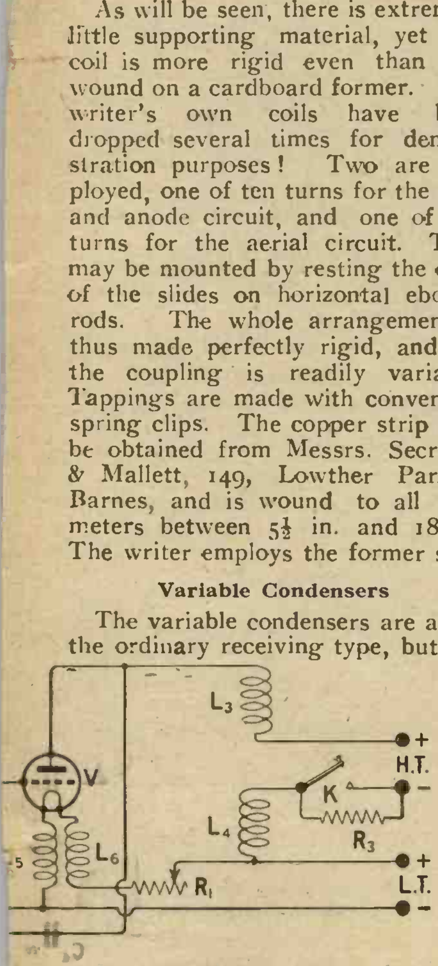
each end by elastic bands or rubber tape.

Turn Numbers

As will be seen, there is extremely little supporting material, yet the coil is more rigid even than one wound on a cardboard former. The writer's own coils have been dropped several times for demonstration purposes! Two are employed, one of ten turns for the grid and anode circuit, and one of six turns for the aerial circuit. They may be mounted by resting the ends of the slides on horizontal ebonite rods. The whole arrangement is thus made perfectly rigid, and yet the coupling is readily variable. Tappings are made with convenient spring clips. The copper strip may be obtained from Messrs. Secretan & Mallett, 149, Lowther Parade, Barnes, and is wound to all diameters between $5\frac{1}{2}$ in. and 18 in. The writer employs the former size.

Variable Condensers

The variable condensers are all of the ordinary receiving type, but are



am of the writer's transmitter. Note ds and also the resistance R3 across key.

being replaced by "low-loss" condensers at the earliest opportunity. Fixed condensers should preferably be of the air-dielectric type, but any mica condenser of repute will answer quite well.

One feature worthy of note is that radio-frequency chokes are inserted in *both* the high-tension and *both* the low-tension leads. The latter chokes (not shown in the photographs) are wound with 20 turns of No. 16 gauge d.c.c. on opposite ends of a $3\frac{1}{2}$-in. cardboard former. Both chokes in the high-tension leads consist of 100 turns of 24 gauge d.c.c. on $1\frac{1}{2}$-in. formers.

Valves

Though fairly good results have been obtained with valves of the D.E.R. type, as described in my article in last week's *Wireless Weekly*, their use is not recommended for work on these higher frequencies. The chief reason is that when the key is pressed, and the load put on the valves, the filaments "dim" quite considerably, causing a "chirpy" note. Excellent results are obtained with power valves of the 6 volt .25 amp. type (e.g., B.T.H. B4, Marconi D.E.5, Mullard D.F.A.1, etc.). An excellent valve to use, however, is, in the writer's opinion, a Marconi L.S.5. This consumes .8 amps at 4.5 volts, and will, if run at 5 volts, dissipate 10 watts with ease. With 200 volts on the anode, and the filament running at its normal brilliancy, an anode current of 25 milliamperes is obtained. The writer never uses more than 5 watts, and the voltage necessary for this is quite convenient. For smaller powers, however, almost any make of receiving valve functions satisfactorily.

Keying

The key is used in the high-tension negative lead, with a resistance of about 10,000 ohms shunted across its contacts. This just allows sufficient current to pass to keep the valve oscillating. A faint "spacing wave " results, and key-clicks are thereby eliminated, enabling the set to be operated during broadcast hours without evoking the wrath of the neighbours. The resistance should be adjusted so that the aerial current obtained when the key is up

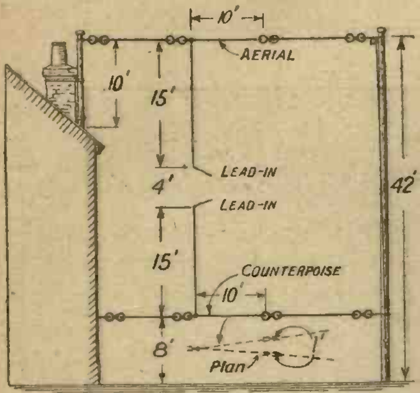


Fig. 2.—Symmetry is aimed at in the arrangement of the aerial and counterpoise.

is about a tenth of the total figure obtained with the key down. An alternative arrangement was shown in my previous article, but I consider the method just described to be the more satisfactory. It is also advisable to key the *negative* high-tension lead, particularly if the key is of the metal variety.

The Radiating System

The present radiating system used by the writer is shown in Fig. 2. The vertical leads to aerial and counterpoise are arranged to be as nearly identical as possible. If a higher aerial is used, thereby allowing the use of longer vertical leads, the "flat top" may be dispensed with altogether. As mentioned before, the writer has obtained better results with this arrangement than with a larger aerial tuned to a harmonic. This arrangement also does not seem to possess directional properties to any appreciable extent.

Operation

As short-wave licences for transmission generally specify a fixed wave of 45 metres, the apparatus should be adjusted as follows :—

(i.) Using an accurate wavemeter, tune the receiver to 6,667 kc. (45 metres).

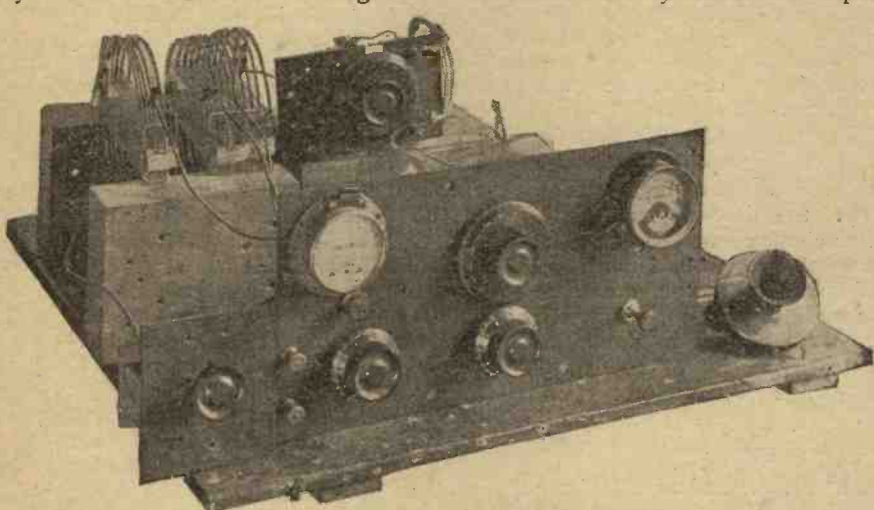
(ii.) Switch the aerial and counterpoise over to the transmitter.

(iii.) Couple the A.T.I. on the receiver as closely as possible to the secondary (i.e., aerial circuit) coil on the transmitter.

(iv.) Then, by adjusting the number of turns and the two series condensers, tune the transmitting coil to 6,667 kc. (When the tuning coincides with that of the receiver, the latter will stop oscillating, just as in the operation of an "absorption" wavemeter.)

(v.) Place the filament tap 3 turns from the grid end of the coil (see Fig. 1), the grid and anode taps being at the ends.

(vi.) Now switch on the valve, press the key and slowly rotate the grid circuit condenser C5, looking out for a "kick" on the needle of the hot-wire meter. A large aerial current must not be expected—the writer obtains only about 0.08 amps. with 5 watts input. Having obtained this indication of resonance, the anode tap may be brought down nearer to the filament tap. It must, however, be borne in mind that the fewer the anode circuit turns (compared with the grid circuit turns) the higher is the input, and it is essential to keep one eye on the milliammeter when "juggling" with the anode tap. It is therefore far from economical to use fewer turns in the anode circuit for the sake of obtaining a slightly higher aerial current.



The assembly of the various instruments is quite compact. The box on the right of the coils on which the wavemeter is standing, contains the water grid-leak.

Remarks

It will be found that the best results are obtained when the condensers C1 and C2 (Fig. 1) are set at approximately the same reading. With the aerial arrangement shown, both these .0005 μF condensers are used "all in" with six turns of the inductance in circuit. The writer invariably uses three turns in the grid circuit and seven in the anode. This gives freedom from "overlap," and

The turns of the coils are separated with glass plates.

seems to secure maximum efficiency generally. The adjustments will, however, be altered by different circumstances.

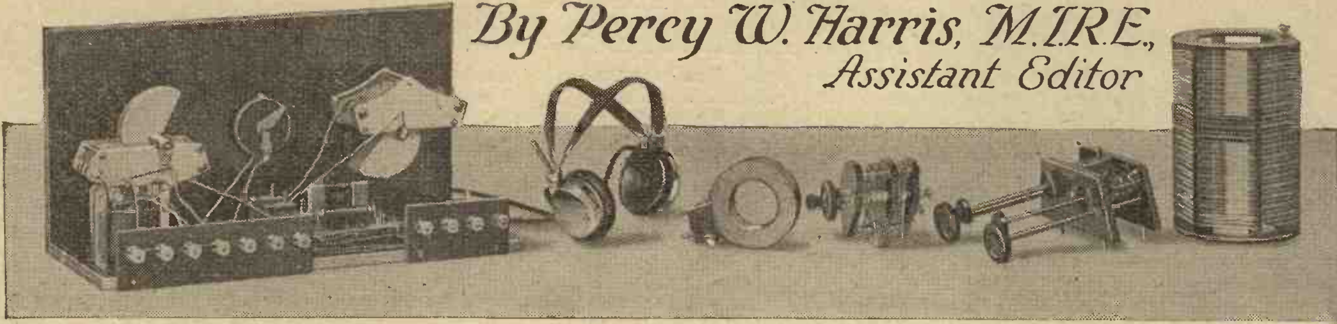
Sharp Tuning

The golden rule appears to be to keep the resistance of every part of the circuit as low as possible. No circuit of high resistance can tune sharply, and sharp tuning is very highly desirable from every point of view. Do not be afraid of seeming unduly fastidious in such matters as the spacing of components, the gauge of wire adopted for the leads, and the insulation used for all the apparatus, including the aerial and counterpoise. It is hardly more difficult to make a transmitter function efficiently than it is to get the best from a receiver. Experience in operation of receivers is therefore valuable to the amateur who wishes to attempt transmission.

Telephony

For telephony a P.O. microphone is placed across a single turn of No. 12 bare copper wire, which is very loosely coupled to the aerial coil.

Random Technicalities



By Percy W. Harris, M.I.R.E., Assistant Editor

QUITE an interesting way of spending a quarter of an hour in these days is to take an atlas and examine the map from the point of view of broadcasting distances. I have done this on a number of occasions since returning from the United States, in the hope of finding some solution of the mystery of long-distance reception of the broadcasting stations of that country. The claims one so frequently sees in American radio magazines that this or that set will bring in dozens of stations more than a thousand miles away—fantastic as they may seem to British readers—are unquestionably true.

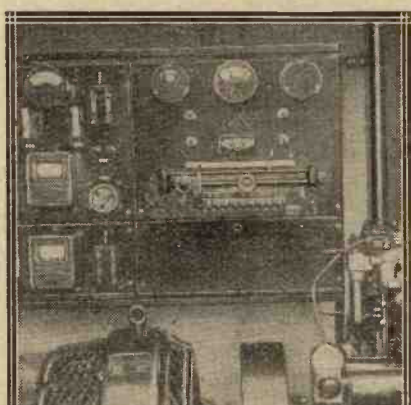
* * *

In England the ether seems "dead" so far as the reception of our own stations is concerned, and anyone who has done consistent listening for a number of consecutive nights in spring, summer, autumn and winter will agree with me that, save in an exceptionally favourable location, one cannot guarantee to receive on any set all of the B.B.C. main stations every night.

* * *

At the same time we must not ignore the remarkable way in which Madrid, and, more recently, that interesting new arrival in the etheric chorus, Radio-Toulouse, come in! Listen to Munich, Breslau, and a lot more of the German school. In those dim and distant pre-war days we used to be much annoyed by German bands—now our chief annoyance would appear to be German side-bands, for any night you can hear dozens of German stations heterodyning with British and Continental stations in the most carefree way.

In New York it seems the easiest thing in the world to receive Chicago stations after nightfall. If you turn to the map you will see that the distance between London and Madrid is somewhere about the same as the distance between New York and Chicago, while Rome, which seems to come in extremely well, is about equal in distance from London to several other stations which are heard very well in New York. When I discussed the matter with Captain Round the other day he ventured the opinion that closer examination of the phenomena would show that the nearer American stations come in very little better than the nearer British, and that it is only when one deals with distances comparable with that between London and Madrid or London and Toulouse that long-distance reception at night becomes an easy matter.



One of the 3 kw. generators in the Post Office Wireless Station at Burnham.

* * *

There seems to be a great deal in this theory, although I do not believe it explains all the problems relating to American long-distance reception.

* * *

I wonder who is responsible for telling the Postmaster-General that the interference from Leafield and Northolt has largely disappeared? While Leafield does not seem to be much of a bother, the mush from Northolt is at the present time worse than ever. When Northolt is operating, the mush completely blots out (so far as I am concerned) the relay station band, although I have several receivers quite capable of bringing in the relay stations at loud-speaker strength after dark.

* * *

One day somebody might present a paper to the Radio Society of Great Britain or the Wireless Section of the Institution of Electrical Engineers dealing with the whole question of mush. There is, for example, the kind of mush which, when heterodyned, can be read as either a marking or a spacing wave of a C.W. station. I am not, of course, referring to pure C.W. harmonics, which frequently heterodyne broadcasting stations, superimposing their Morse upon the musical transmissions. Then there is another kind of mush which, when heterodyned, gives nothing but a steady roar, in which no signals whatever can be distinguished. Northolt is emitting this kind of mush at the present moment.

AERIALS AND EARTHS FOR SHORT-WAVE RECEPTION

By G. P. KENDALL, B.Sc., Staff Editor.

An aerial and earth system which gives good results at the broadcast frequencies may prove quite unsuitable for use at higher frequencies. Mr. Kendall indicates in this article the desirable features of an efficient system for the latter purpose.

GRANTED a set has been laid out in accordance with the rules which were considered in my article in *Wireless Weekly*, Vol. 7, No. 5, and incorporates a suitable circuit, there yet remains one condition which must be fulfilled before good results will be obtained: the aerial and earth arrangements must be suitable for short-wave work.

Direct Earth or Counterpoise?

Whether to use a counterpoise earth or not will depend largely upon the quality of the direct earth

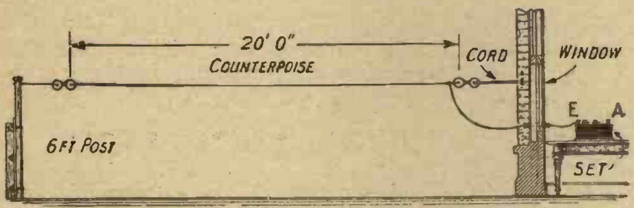


Fig. 1.—The counterpoise should be well insulated and placed in as isolated a position as possible.

which is available, and this point is best settled by actual comparison. In most cases it is not at all necessary to use a counterpoise, and a direct earth is to be preferred if it is of reasonably low resistance.

Tests by Comparison

An ordinary direct earth will serve for the first trial, and it is to be noted that with the circuit chosen in the first of this series of articles (*Wireless Weekly*, Vol. 7, No. 4) a bad earth will not, as a rule, affect the ease or otherwise with which the set will oscillate; it merely makes all signals abnormally weak.

The obvious course to adopt, therefore, is to get the set working properly upon the ordinary earth, tune in a fairly weak signal, and change over to an improvised counterpoise earth connection. After retuning there should be little or no difference in the strength of the signal; if it is noticeably stronger on the counterpoise the direct earth would appear to be condemned, and it will be advisable to install a permanent counterpoise.

Series of Tests

It is wise to repeat this simple test on the signals of several stations before coming to a definite conclusion; if possible make sure, if there is any serious difference between the direct and counterpoise earths, that the effect is not a directional one, *i.e.*, that it is always present, whatever the direction of the transmitting station.

Also repeat the experiment on a variety of different frequencies, for you may find that although the direct earth appears to be perfectly satisfactory on a frequency of 3,000 kc. (100 metres), yet when the frequency rises to 15,000 kc. (20 metres), there may be an advantage to be gained by the use of a counterpoise.

Insulation of Counterpoise

The type of counterpoise to use must obviously depend almost entirely upon local conditions. The ideal at which to aim is a single wire suspended beneath the aerial, perhaps six feet above the ground, and entirely isolated from trees, buildings, etc.

The wire should, of course, be insulated just as carefully as an aerial, and the same pains should be taken to lead it in through a good porcelain tube, without approaching walls or other earth-connected bodies. A short, straight, isolated lead from the lead-in point to the earth terminal of the set is also to be desired.

Length of Counterpoise

To most city dwellers I am afraid all this must sound impossibly idealistic, but when it is remembered that for work on the higher frequencies, say, above 3,000 kc. (below 100 metres), the counterpoise need only be a few yards long, it will be seen that the problem is one not incapable of solution in the average suburban back garden.

When it is found that the best direct earth which can be made is seriously inefficient on the higher frequencies, probably the best thing to do is to install quite a small counterpoise, say, twenty feet long, making the best job one can of it, and to use this for frequencies above about 6,000 kc. (waves below 50

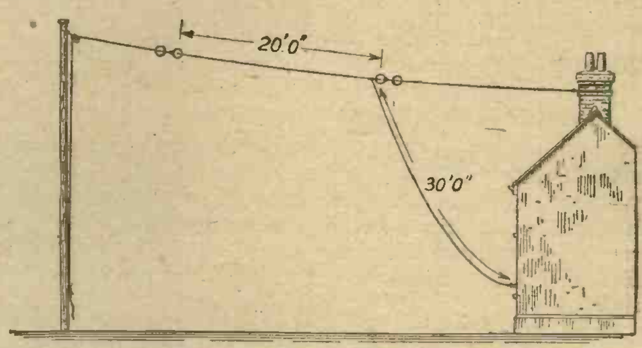


Fig. 2.—A short single-wire aerial is recommended, as nearly vertical as can conveniently be arranged.

metres). On all lower frequencies (longer waves) the ordinary direct earth will probably serve perfectly well, unless it is a most exceptionally bad one, in which case it can probably be improved.

A Substitute Indoors

Such an elaborate counterpoise as I have described is not necessary, of course, for the comparative test which was mentioned. For that purpose all that is required is a length of rubber-covered flex, stretched out in a straight line on the floor, preferably well away from the walls of the room.

Three or four yards will suffice, and if it is impossible to put up a proper outdoor counterpoise this crude

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alternative may well be made permanent. It is decidedly less efficient than a properly-arranged counterpoise, but it is much better than a bad direct earth.

The Aerial

As regards the aerial itself, there is little to be said which has not already been said in connection with aerials for broadcast frequencies; all those things which make an aerial inefficient for broadcast reception operate with even greater force to make it inefficient for short-wave work.

Since probably very few readers will be prepared to erect a special aerial for their short-wave work, I would suggest that the first thing which the beginner at short-wave work should do is to take a good look at his existing aerial.

Points to Note

Does it violate many of the rules of good aerial design? Is it well isolated from earth-connected bodies (wells, fall-pipes, etc.)? Is it well insulated? Does the lead-in approach unduly close to the wall before passing through? Is the lead from the insulator to the set itself as short and isolated as possible? All these questions should be considered, and if the answers to some of them are not entirely satisfactory steps should obviously be taken to amend matters. At this point I can imagine readers with experience of short-wave work making facetious comments, having discovered for themselves that almost any sort of aerial will give good results on the really high frequencies, and the feeling that "any old thing will do" is comprehensible.

Efficiency

As a matter of fact, however, those who make this assumption are really confusing the factors of size and actual efficiency: a large aerial is neither necessary nor advantageous for short-wave reception, unless special methods are adopted, and quite a small one is all that is needed.

The true efficiency of the aerial, on the other hand, as distinct from its size, does affect results seriously, and is worth taking into account if real long-distance reception is the aim.

The Ideal Aerial

If the reader is so fortunate as to be able to erect a special aerial for use with his short-wave receiver, he should remember all those points raised above in the form of questions, and at the same time should consider whether he cannot obtain an aerial in the form of a single wire (much to be preferred), arranged vertically, or nearly so. Such an aerial, incorporating, say, forty or fifty feet of wire, is probably as near the ideal for the more commonly used frequencies as amateur conditions will permit.

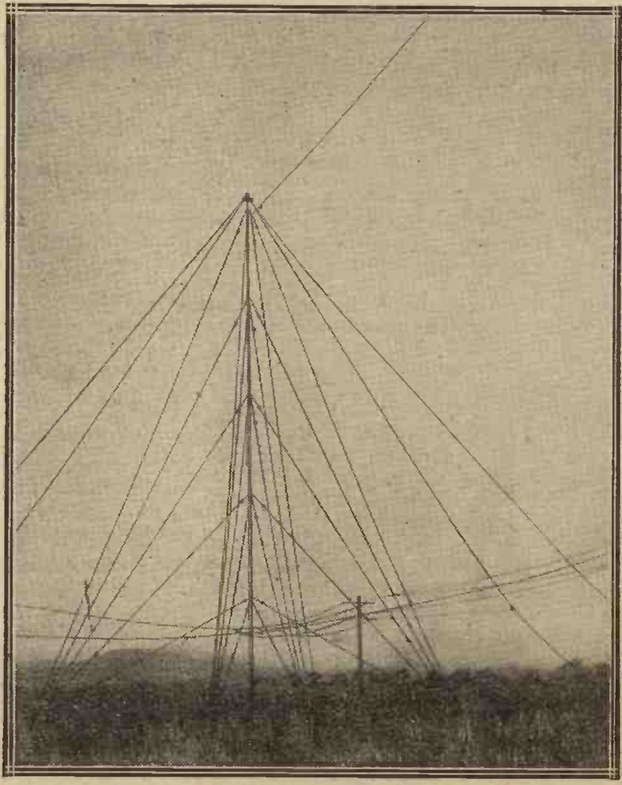
R.S.G.B. (T. AND R. SECTION) MEETING.

At a meeting of the Transmitter and Relay Section of the Radio Society of Great Britain, at 6.30 p.m. on Friday, October 23, at the Institute of Electrical Engineers, Mr. Alfred D. Gay (6NF) opened a discussion on "The Lay-out of Short-wave Transmitters."

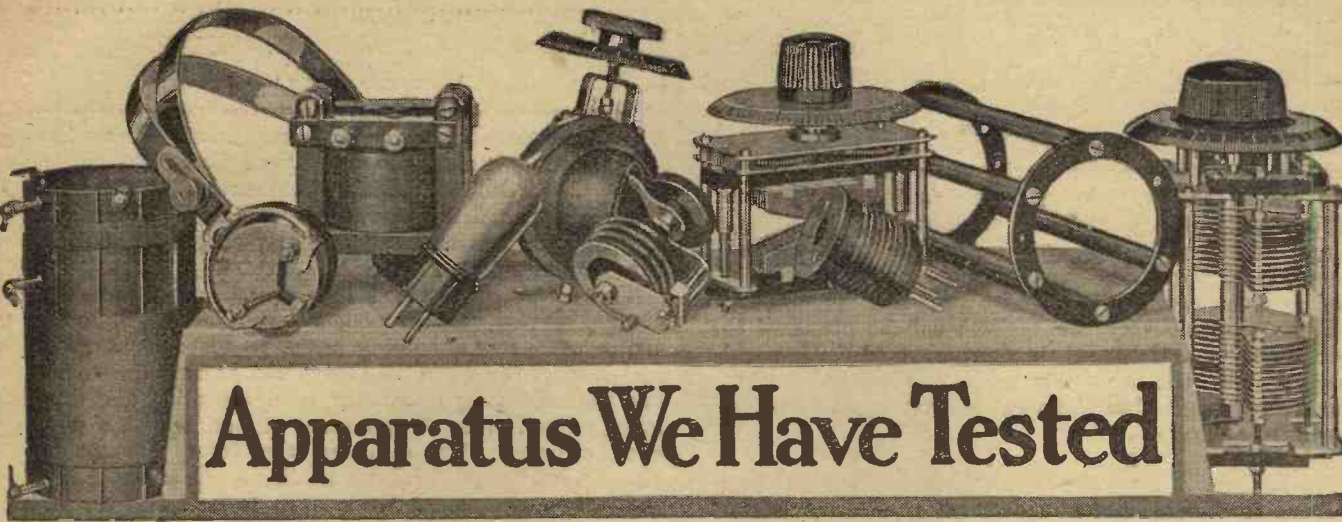
The lecturer described his own arrangement, consisting of two vertical panels seven feet high, in the centre of a room, leaving space to walk right round and inspect the wiring. One panel is used for mounting the rectifying apparatus, and the other the oscillator. Each piece of apparatus is mounted on a small ebonite panel, thus reducing the total amount of ebonite necessary. All connections are made behind the panels, and where leads have to be taken through to the front, this is done through short lengths of glass tubing. Some ingenious relays for switching and keying were described.

Several prominent members spoke on the subject, and described their own methods of laying-out transmitting apparatus. Opinion seemed in favour of the "bread-board" type rather than the vertical panel, as leads could be kept shorter, and this was always a desirable feature with short-wave apparatus. Some amusing descriptions of the disastrous results of untidiness were given, several members speaking from bitter experience.

The Chairman, Mr. Maurice Child, closed the meeting by making by making a few remarks on his own lay-out, and a hearty vote of thanks was proposed to Mr. Gay for opening a discussion on so important a subject.



One of the masts at the Post Office Station at Burnham, the receiving and control station for the ship traffic previously handled by Devizes only.



Conducted by Radio Press Laboratories, Elstree.

"Aermonic" Valve Holder

This valve holder has been sent for test by Messrs. Christie & Hodgson, Ltd. The holder is arch-shaped, with the composition insulating material flanged at the base to permit two screw holes to be provided. It is designed to enable valves to be mounted behind a panel without the necessity for bridges or brackets, use being made of the two screw holes previously mentioned. The grid and anode sockets are marked on the upper surface of the holder by "G" and "A" respectively, and soldering tags are screwed to the outside of the insulating material, the screws making contact with the base of the sockets. All four wiring points are thus very accessible when the holder is in position. A vertical brass strip screwed to the side projects about ½ in. above the top of the holder. This is apparently to grip the side of the valve base when the valve is in position, but since the spring is somewhat weak, its utilitarian value is nullified. The valve sockets are sufficiently sunk into the body of the holder to make it impossible to insert a valve incorrectly, but the fit of most valves into the sockets was poor. The insulation resistance was quite good and the holder was of a robust character.

Telephone Magnetiser

Messrs. Kenyon & Torrance, Ltd., have submitted for test a K. & T. Telephone Magnetiser. The instrument is of particularly robust construction. An electro-magnet is mounted on a heavy bedplate provided with screw holes for screwing to a baseboard. The electro-magnet has semi-circular shaped pole pieces so as to accommodate the earpiece of the telephone conveniently. Terminals are provided for connecting to a 6-volt accumulator, and an "on-and-off" switch allows the battery to be put on and off at will. The battery can be connected to the terminals either way round, the polarity of the poles being identified with the aid of a compass supplied with the instrument. Having unscrewed the earcap from the 'phones, it is necessary to test the polarity of the telephone magnets to ensure that the south pole of the remagnetiser coincides with the north pole of the telephone magnets when the 'phone is placed on the poles. If this is not done the magnetiser will obviously demagnetise the 'phones. Full instructions, however, are given on the base of the instrument.

A bad pair of telephones was dismantled and placed on the pole pieces, the current being switched on for about 30 seconds as recommended by the makers, the battery contact being occasionally broken during the process. This length of time was found to be insufficient, for on re-test the telephones only showed a small improvement. On repeating the process for over a minute, a marked improvement resulted in the amount of magnetisation, and when used in the usual wireless receivers the telephones were about 50 per cent. better. During the process of remagnetisation the winding on the electro magnet became rather hot and required a long time to cool. The current taken from the 6-volt accumulator was six amperes, which is rather heavy for small batteries. The instrument is convenient for intermittent use, but some provision appears to be necessary to allow the magnet windings to dissipate the heat generated during remagnetisation. The instrument is well made mechanically, with a smart blue enamel finish.

Three-coil Micrometer Holder

Messrs. Ward & Goldstone have submitted a three-coil micrometer holder for test. The three-coil holders are mounted between two semi-circular bridges made of moulded insulating material, the centre holder being the fixed one. The whole component is supported on a rectangular moulded base provided with two screw holes for mounting in a receiving set. Two metallic pillars are screwed into the base, one on either side of the bridges, and these carry two screwed metallic rods. The rods are provided with metallic balls at one end and 1¼ in. diameter milled knobs at the other. Each ball end of the rods engages with a metallic cam, and by turning the milled knob the movable holder is slowly rotated through 90 degrees. Steel springs keep the ball and cam engaged, but these springs are liable to rust readily in a damp situation, and then quickly become useless. The control arms are long, no doubt with a view to eliminate hand-capacity effects, but the metal of the arm considerably neutralises this advantage. In addition, the length of the arm tends to make the control somewhat weak, unless the screwed portion fits tight into the pillar; in the component tested one arm was quite loose. The large milled knob is to allow slow movement of the coil, but the impossibility of a quick adjustment is a distinct disadvantage. Several coils were tried in the holders, and a good fit was possible after the holder pins had been opened out. The appearance of the holder is quite good, although the moulded insulation appears somewhat coarse. The insulation resistance was infinity.

Two-coil Micrometer Holder

We have received from Messrs. Ward & Goldstone, Ltd., a two-coil micrometer holder for test in our laboratories. The construction is somewhat similar to that described in the report of a three-coil micrometer holder made by the same firm, except that only one extension arm is provided to operate the single movable coil holder. In addition the screwed arm passes through the centre of the fixed coil and the ball end engages in a slotted metal frame. The micrometer control of this component was better than in the case of the three-coil holder, but, as before, rapid movement of the coil's position is not possible. All the features pointed out in the report of the three-coil holder are present in this holder, but the finish is somewhat better.

"QSB"?

In radio communication, the letters "QSB" followed by an interrogation mark mean "Is my tone bad?" If such is the case the station in reply sends "QSB." "Your tone is bad" (no interrogation mark).

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THE "TRANSATLANTIC FOUR"

SIR,—Having read in your magazines at different times that you are always interested to hear from readers as regards results obtained with various sets that have been described, I should like to mention I have constructed and carried out various tests with the "Transatlantic Four" described by Percy W. Harris, M.I.R.E., in last November's issue of *Modern Wireless*, during a voyage out East.

In conjunction with this set I was using the tuner unit mentioned in *The Wireless Constructor* of the same month, and also described by Mr. Harris.

The results were very good indeed. 5XX was received the whole way out to Port Said, at excellent strength on the loud-speaker for the greater part of the journey, except in one or two spots where it was somewhat screened. It is interesting to note that several of the B.B.C. stations of the lower wavelength band were heard exceptionally well off Algiers, Bournemouth and Manchester being exceptionally loud.

I find this type of receiver very good indeed for long-distance reception, though somewhat difficult to handle at first.

When used with the Tuner Unit and loose coupling, it possesses a great degree of selectivity, but does not appear to have quite the range as when used with direct coupling.

I should like to mention that if one is apt to use different makes of British H.F. transformers the various connections often require to be altered to obtain the best results, and it is rather unfortunate they are not all standardised.

Wishing your journals every success.—Yours faithfully,

P. LUND.

s.s. *Makalla*,
Liverpool.

A READER'S RESULTS IN SOUTH AFRICA

SIR,—As a matter of interest to readers of your paper I include details of crystal long-distance reception at my address, which is about 40 miles north of Bulawayo.

Three South African stations have been heard, and any amount of morse comes in on the 600-metre band.

The tuner employs a variometer used with a galena crystal. A very thin copper wire (about 40 S.W.G.) is used as the catwhisker. I found that of all the important parts in the set that required special attention the earth was the most important. Many will not believe that I can get these stations on a simple crystal set. Then there are some that say that it is radiation from another set that is installed about 500 yards away. So one night, by special request, the valve set was not used, and still the signals came through on my set. Lately the valve set has been out of commission, and I have been getting splendid results from the crystal set.

Just a list of stations heard on the crystal:—Durban, 750 miles; Johannesburg (JB), 450 miles; Capetown, 1,250 miles; Delagoa Bay and Beira, Portuguese East Africa, and several other stations in Portuguese East Africa.

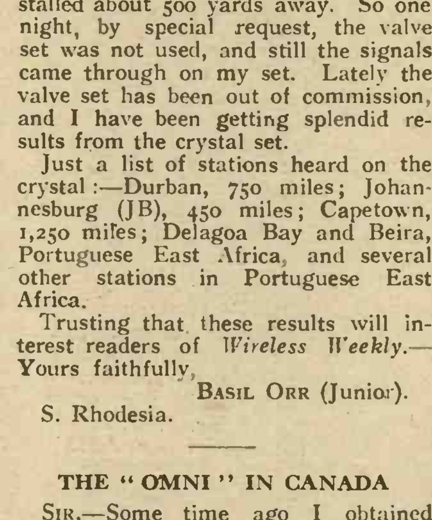
Trusting that these results will interest readers of *Wireless Weekly*.—Yours faithfully,

BASIL ORR (Junior).

S. Rhodesia.

THE "OMNI" IN CANADA

SIR,—Some time ago I obtained Envelope No. 5 and constructed the "Omni" Receiver, of which I enclose a photograph. I have added a fourth tube and have fitted an extra



The "Omni" Receiver built by Mr. J. B. Richardson in Canada.

.0005 μF variable condenser, with which I can have a .0005 μF fixed condenser in series, using a single-pole double-throw switch. The switch (push-pull) beyond the crystal is for batteries off and on. Rheostat controls are between the tubes.

After testing ST100 and several other circuits I hooked up ST100 + H.F. as described by John Scott-Taggart, F.Inst.P., A.M.I.E.E., in *Modern Wireless* of June, 1924.

Results have been so good with this, using a small loud-speaker (by the way, I have not yet purchased a set of head 'phones), that though I have tried other hook-ups since with good results, I have returned to it. I have heard a large number of stations at really loud strength. One or two of the stations are 700 miles away. My aerial is single ribbon 100 ft., unfortunately only 50 yards from and at an angle of 30 deg. to Cataract power lines carrying 40,000 volts. I also use a frame aerial 22 in. sq. with 12 turns 22 enamelled wire with a braided covering and get a good many of the stations, but of course at reduced strength.—Yours faithfully,

JOHN B. RICHARDSON.

Burlington, Ontario.

A "TWO-VALVE DOUBLE REACTION" RECEIVER

SIR,—Perhaps it will be of interest to you to hear some results obtained with the "Two-Valve Double Reaction" Receiver, described by Stanley G. Rattee, M.I.R.E., in *The Wireless Constructor*, August issue. I have made up the receiver for a friend of mine, but I have added one stage of note magnification and a switch for series and parallel tuning, and I have omitted the potentiometer. The condensers of our set are: Aerial .00075 μF, and anode .0005 μF higher values than described. First we got Hilversum (about 25 miles away) at excellent loud-speaker strength, and Daventry the same. Then we tuned to the lower waves and got many stations, but as it was already very late in the evening we noted the principal among them, and heard "Achtung, Herren und Damen, hier Münster auf Welle 410." The music was heard all over the room, and the speech was very good on the loud-speaker.

The results were remarkable, and so I wish to congratulate Mr. Rattee for the fine circuit and the simple explanation of the set. I am only seventeen years old, and I did not know much of wireless before I bought your journals.

Wishing you and your papers all success and prosperity.—Yours faithfully.

JAC. WIGMAN.

Amsterdam, Holland.

SHORT-WAVE RECEPTION

SIR,—I am very glad to see a "Short-Wave Notes and News" page in last week's issue of *Wireless Weekly*. I hope it will be approved by many other readers and be a permanent feature.

It may interest readers to know that, with reference to page 176 in last week's issue on "Long Distance Amateur Communication," where SMTN communicated with A2BK, using 4.5 watts, I think I know of a record which equals if not beats that. It also concerns a Swedish station, Radio SMUI, Mr. C. Aulin, of Humlegatan 19, Malmö, Sweden. I sent him a report a short time ago, and had a card to the effect that, as his transmitting valves were both blown out, he rigged up a dull emitter receiving valve with 40 volts on the anode for the transmitter. I heard him about R4, and he has just received a card from U9ASY, Iowa, U.S.A., who heard him calling.

My receiver is an all-wave 12-2,000 metre modified Reinartz. The circuit is similar to that given by Mr. W. K. Alford in *Wireless Weekly*, Vol. 6, No. 15, with some minor alterations. I have three L.F. amplifiers on it. The first L.F. is choke-capacity coupled and the second and third are resistance-capacity coupled; wire wound anode resistances are used. It is fitted with plugs and jacks for one, two, three or four valves, although the last is never used except on long-distance stations for the loud-speaker.

I am only 17 years of age, but I have made several sets, including the "Transatlantic V," described by Percy W. Harris, M.I.R.E., in *Modern Wireless* for June, 1924. Best success to Radio Press.—Yours faithfully,

R. C. BRADLEY.

Reading.

ENVELOPE NO. 4

SIR,—Having lately made the "All-Concert de Luxe" (Radio Press Envelope No. 4), I thought I would—as you invite correspondence—let you know the results obtained.

With plug-in coils, 35, 75, 50, Manchester very good; 35, 100, 75, Birmingham very good; 35, 75, 50, Liverpool very good; Glasgow comes through very fair. All these on a large loud-speaker.

I am splendidly satisfied with the set, and I think with more experience shall get more stations.

Market Drayton is situated some 50 miles roughly from Manchester, Liverpool and Birmingham. I have a twin aerial (outside), of 100 ft. roughly all in.—Yours faithfully,

F. E. BRADLE.

Market Drayton.

A COURSE OF POPULAR LECTURES ON WIRELESS

SIR,—I enclose herewith particulars of a course of lectures to be given at the Norwood Technical Institute. For various reasons the course was not started on the date originally fixed, but it is hoped to start on Friday, November 20. I should be grateful if you could include a paragraph in *Wireless Weekly* calling attention to these lectures.—Yours faithfully,

J. F. STANLEY.

A course of ten lectures on wireless telephony, with special reference to the reception of broadcast programmes, will be given at the Norwood Technical Institute on Friday evenings, commencing at 8 p.m., by Mr. J. F. Stanley, B.Sc. (Hons.), Eng., London, A.C.G.I.

The first lecture of the series will take place on Friday, November 20, 1925.

At the conclusion of each lecture, half an hour will be set apart for practical experiments, and students will be invited to discuss their own constructional problems.

Fees: For students resident in the administrative counties of London, Kent or Middlesex—first lecture free; single lectures, 1s.; for the complete course, 8s.; for students not resident in the administrative counties of London, Kent or Middlesex, additional fees will be payable.

Applications for admission should be made to the Principal, Norwood Technical Institute, Knight's Hill, West Norwood, S.E.27.

Special Note:—It is proposed to form a West Norwood branch of the Radio Society of Great Britain. Arrangements will be made for members to experiment and test out their apparatus in the Laboratory, provided such members are students of the Institute.

HILVERSUM BROADCASTING STATION

SIR, — Our principals, Messrs. Philips Glowlampworks, Ltd., of Eindhoven, Holland, who take great interest in the Hilversum (Holland) broadcasting station (call sign HDO), inform us that in future every Thursday night a concert will be broadcast from Hilversum by the world-famous orchestra of the "Concertgebouw," Amsterdam.

We should feel appreciative if you would be good enough to let your readers know this item of news, and also if you would ask any wireless amateurs who may pick up this musical programme if they would communicate direct with our principals at the address given below, who, we know, would be interested to learn that the transmission is being successfully received in England. — Yours faithfully,

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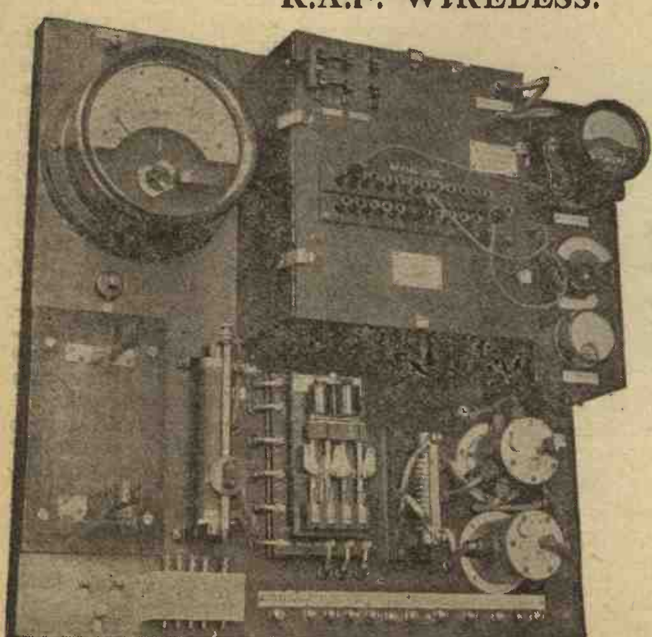


The 250-watt transmitter used on aircraft by the R.A.F. The clips for the transmitting valve can be seen on the left.

ERRATUM

On page 177 of our last week's issue the kilocycle equivalent of the Bournemouth wavelength on October 16 is given as 772.2. This is incorrect, and should read 777.2 kilocycles.

IMPORTANT NOTICE

Owing to the numerous applications from our readers for back numbers of our publications, we have decided to make no extra charge on any of our periodicals for issues published within six months. The charge for back issues prior to six months will be as in the past.

Home-made Neutrodyne Units

(*Continued from page 222*)

It is, of course, well known that a tuned anode is most efficient when the tuning capacity shunted across it is as small as possible, and for this reason it generally pays to make two units for the B.B.C. higher-frequency band. Whether anything of the sort holds good in the case of the neutrodyne winding or not is a point which might receive the attention of those who possess patience and the necessary measuring instruments. It might be found that there is an optimum inductance-capacity ratio even in a neutrodyne coil!

A Winder

Winding 5XX units by hand is a most tedious business, and it is well worth while making a rough winder such as that illustrated in Fig. 5. The centres are made of pieces of 2 B.A. studding pointed at the tips. A small wooden crank is clamped on the right hand one by nuts and washers. Shallow centre holes are drilled in each end of the former, and a piece of busbar wire bent up into the shape of a driving dog imparts the motion to the former. With this appliance the lower-frequency units can be wound in a very few minutes. As the fine wire is easily broken, the mouths of the slots should be splayed out with a small triangular file to form an easy entrance for the wire in winding.

Care in Handling

When using matched units of this construction, care should be taken to grasp them by the ebonite only when inserting them in the receiver. If the turns of wire are handled and displaced to any appreciable extent, the capacity may be altered, and this, of course, will mean re-matching. If the units are handled with reasonable care, and kept in a rack when not in use, no trouble will occur on this account.

Reception at Lower Frequencies

The lower frequency units will, of course, be mostly used for receiving 5XX or Radio-Paris, and with those strong transmissions two stages of high-frequency are hardly necessary. The receiver A mentioned above

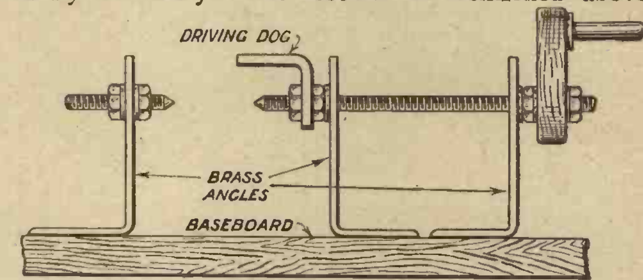
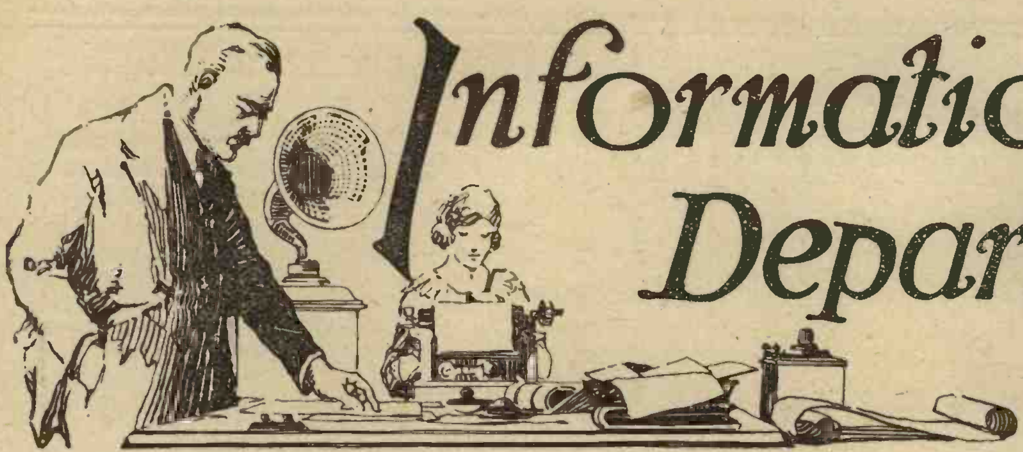


Fig. 5.—A winder for the lower-frequency units can easily be constructed on the lines indicated.

brings in 5XX at 150 miles with great volume on almost anything in the form of an aerial. Receiver B gives good volume on 5XX with a short length of flex thrown down on the floor and no earth, and the purity or reproduction shows that the reception "peak" has not been overstepped. The writer considers that two neutrodyned stages constructed in this manner are equal to three ordinary unit stages. They are also more selective and infinitely easier to handle.



Information Department.

W. M. (STIRLING) asks how he can charge his 4-volt 40 ampere (actual) accumulator together with his house battery. This latter battery is rated for 32 volts 20 amperes and is charged by a petrol driven charging set.

It is obvious that our correspondent's small accumulator cannot be charged in series with the house lighting battery, since the charging current in this case would be excessive and would ruin the small battery. Arrangements must therefore be made so that it can be charged at a suitable rate. Although charging rates vary with different makes of accumulators, it is fairly safe to assume that a charging current of 3 to 4 amperes will be satisfactory. The 4-volt accumulator should be connected in series with a variable resistance and a low reading ammeter across the main battery terminals. The series resistance should be capable of carrying the charging current for the small battery without undue heating, and one of 10 ohms will allow the battery to be charged at 3 amperes or more as desired. A range of 0 to 5 or 10 amperes would be a suitable one for the ammeter.

L. B. (HASTINGS) asks for a simple method of comparing signal strength.

Probably the simplest method our correspondent can adopt for his purpose is to shunt the telephones with a variable resistance. This should be adjusted until signals become just inaudible and the reading of the variable resistance should be noted. Let this reading be R_1 and, for example, the resistance of the telephones 2,000 ohms. If now signals are tuned in from another station, and a second reading of the variable resistance taken under similar conditions, which reading we will call R_2, the ratio of the two signal strengths is as $2{,}000 + R_2$ is to $2{,}000 + R_1$.

G. M. (IPSWICH) has constructed the 2-valve Amplifier de Luxe, described in Radio Press Envelope No. 7, to add to his single-valve set, which is of commercial design. He states that all goes well in cross-

connecting the batteries until a connection is made to the high-tension negative terminal of the amplifier. When touching this terminal with the appropriate lead, sparks are obtained and the wire gets hot. He asks our advice as to the cause of the trouble.

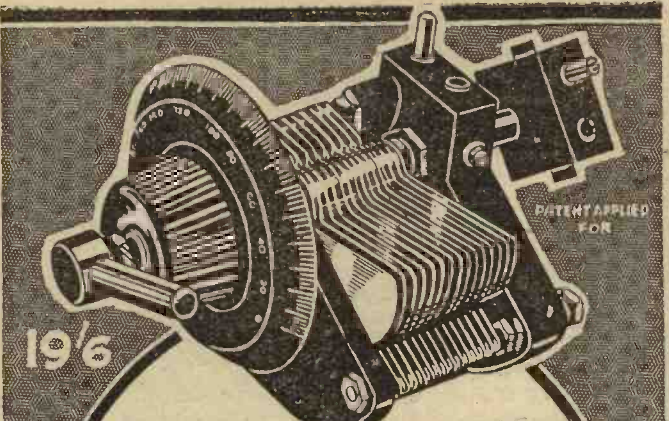
It would seem evident from our correspondent's letter that his single-valve receiver has H.T. negative and L.T. negative joined together internally, whilst the 2-valve Amplifier de Luxe has H.T. negative and L.T. positive common. With a receiver and an amplifier with connections as given above when the instruments are connected in the normal manner, it results in shorting the low-tension battery. The trouble in our correspondent's case can be overcome easily by making one slight alteration to the wiring of the two-valve amplifier. Referring to the blue print given in Radio Press Envelope No. 7, it will be seen that H.T. negative and L.T. positive terminals are joined together and a lead is taken from these two points to the left-hand filament legs of the two valves. The lead between these two terminals should be removed, and that from the two filament legs of the valves should be joined to L.T. positive. The high-tension negative terminal should now be connected to L.T. negative, when the amplifier should function in a satisfactory manner when employed with the single-valve receiver.

T. H. J. (BERLIN) states that he is employing a set consisting of a valve detector, with reaction, followed by three transformer coupled stages of low-frequency amplification in order to listen to the British stations. Living in a flat he is forced to employ a small indoor aerial. He asks a number of questions on how he can improve his detection, or obtain a signal reasonably large compared with the carrier wave.

In reply to our reader's query, we would advise him to cut out one of the low-frequency amplifiers and use a stage of high-frequency amplification instead. Seldom in practice do three transformer-coupled stages of low-frequency amplification work well together, as there is usually a pronounced tendency towards self-oscillation. This may be overcome, to a certain extent, in many cases by connecting resistances across the secondary windings of the L.F. transformers, values of ½ or ¼ megohm being suitable for this purpose, and also by trying the effect of reversing the connections to certain of the windings. We would, however, advise our correspondent that the percentage modulation on a carrier wave is fixed at the transmitting station, and therefore at the receiving end there is no method of varying the ratios between the carrier wave strength and that of the superimposed telephony. Under the circumstances, therefore, as mentioned above, a high-frequency stage should be used when the percentage modulation is not sufficiently great to allow proper detection with the set employed.

Our correspondent also complains that reaction control is very floppy, but it is improved by connecting the grid leak to L.T. minus, although signal strength is not so good. Generally it is found preferable in practice to connect the grid leak to L.T. positive for best detection, and this connection should be made, or alternatively a potentiometer may be connected across the L.T. battery and the grid leak connection taken to the slider. This will give a certain amount of added control, but in many cases it is doubtful whether the extra complication is worth while. To improve reaction control, the by-pass condenser across the primary of the first L.F. transformer should receive attention, various values being tried; various sizes of reaction coils should also be used, and the smallest that will give satisfactory oscillation should be employed. The effect of varying the value of the grid leak and of the high-tension voltage applied to the anode of the detector valve should be noted.

Another point raised by our correspondent is how to cut out hum from the alternating current mains in the building. Dealing with this latter subject we would advise the employment of a counterpoise, which may consist of a length of wire taken through our reader's flat on the floor rather than to earth to a waterpipe, which, he states, goes to earth one floor below. The employment of a loosely-coupled circuit may also be found helpful and should be tried.



Brilliant Reception

The final adjustment of a reaction coil upsets tuning and necessitates a reduction in the value of the tuning condenser across to the second coil. With

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the operation is simplified. Referring to the illustration, it will be seen that an increase of reaction and a compensating reduction of capacity can be accomplished by one hand in a fraction of the usual time. To all who habitually tune in distant stations this advantage is obvious.

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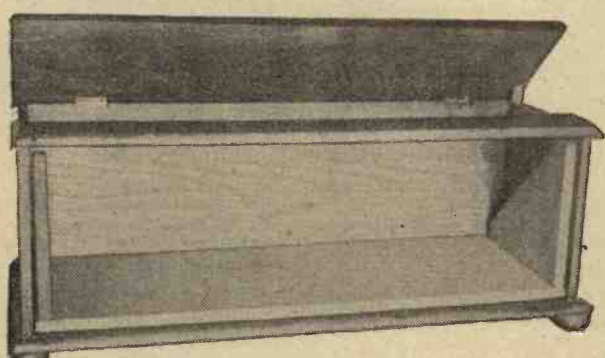

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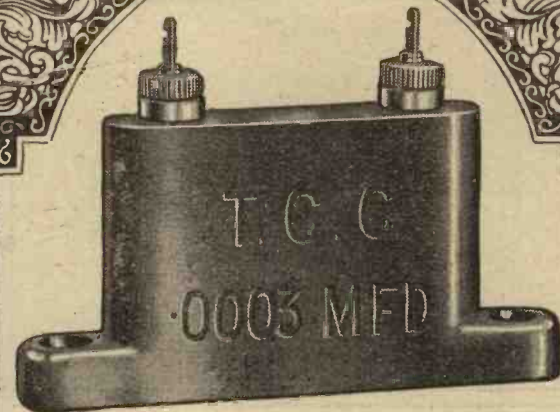

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Here is the latest T.C.C. production—an accurate mica Condenser in a green moulded case with duplex terminals. Owing to its convenient shape it takes up very little room on the panel, and because it is sealed from below instead of from above it is proof against the heat of the soldering iron. For those who do not wish to solder their connections, a convenient milled head is provided to ensure a perfect electrical contact.

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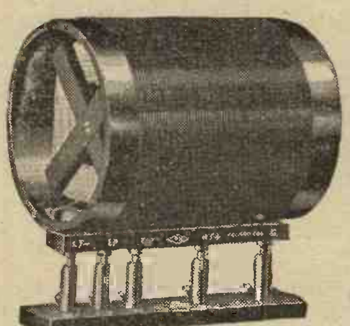

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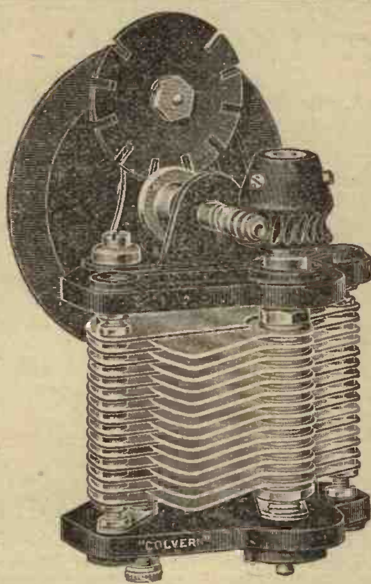

Little experience is necessary upon any such super-sensitive circuits as the short wave side of the Super-Heterodyne or capacity-reaction circuits to self-demonstrate that distant work is an impossible pastime without a mechanical fine tuning device operating on the condenser.

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WIRELESS WEEKLY. Vol. 7. No. 7. November 4, 1925.

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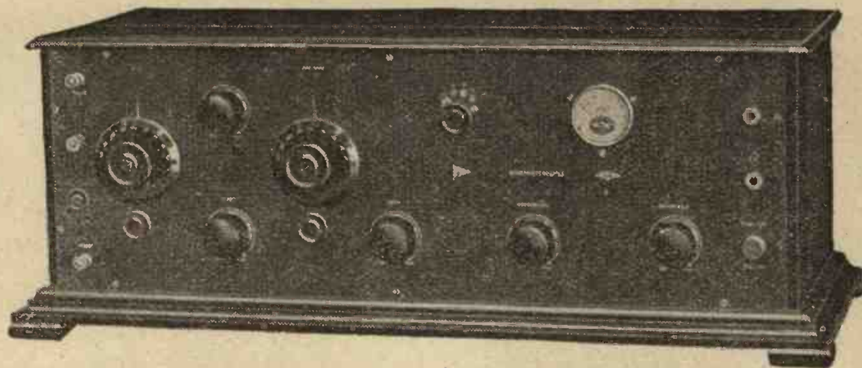

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Barclays Advt.

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HERE ARE A FEW OF THE

CONTENTS.

Modern Wireless

Barclays Ad.

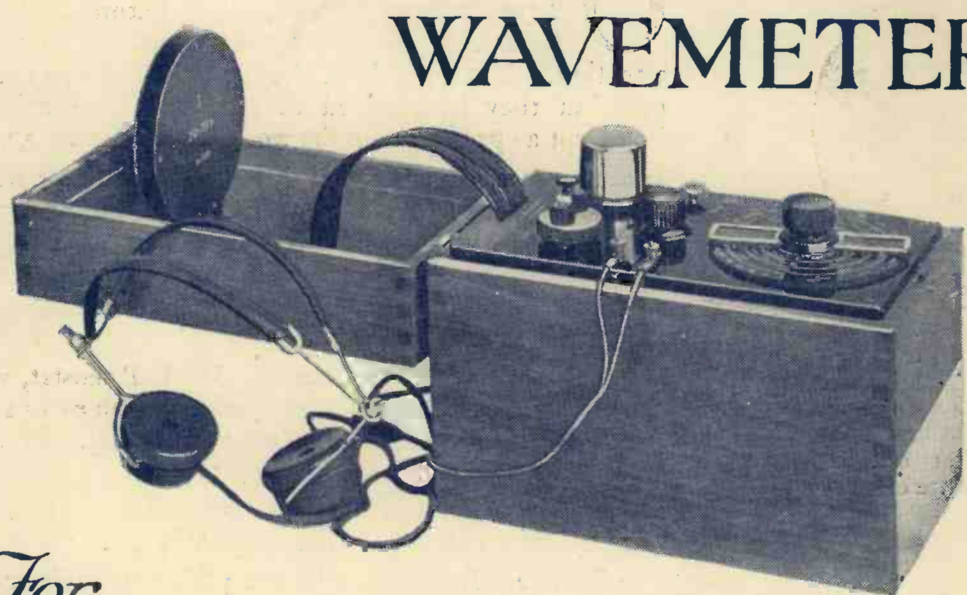
Published by the Proprietors, RADIO PRESS, LTD., Bush House, Strand, London, W.C.2, on Wednesday of each week, and printed for them by THE AVENUE PRESS (L. Upcott Gill & Son, Ltd.), 55-57, Drury Lane, W.C.2. Address for Subscriptions and Editorial Communications:—Bush House, Strand, London, W.C.2. Advertisement Managers:—BARCLAYS ADVERTISING, LTD., Bush House, Strand, London, W.C.2. Registered as a newspaper and for transmission by Canadian Magazine Post. Subscription rates:—32/6 per annum, 16/3 for six months, post free. Sole Agents for Australasia:—GORDON & GOTCH (Australasia), LTD. For Canada:—IMPERIAL NEWS, LTD. For South Africa:—CENTRAL NEWS AGENCY, LTD. For Japan:—SALE & FRAZAR, LTD.

Wireless Weekly, 6d. Net. Wednesday November 11th, 1925

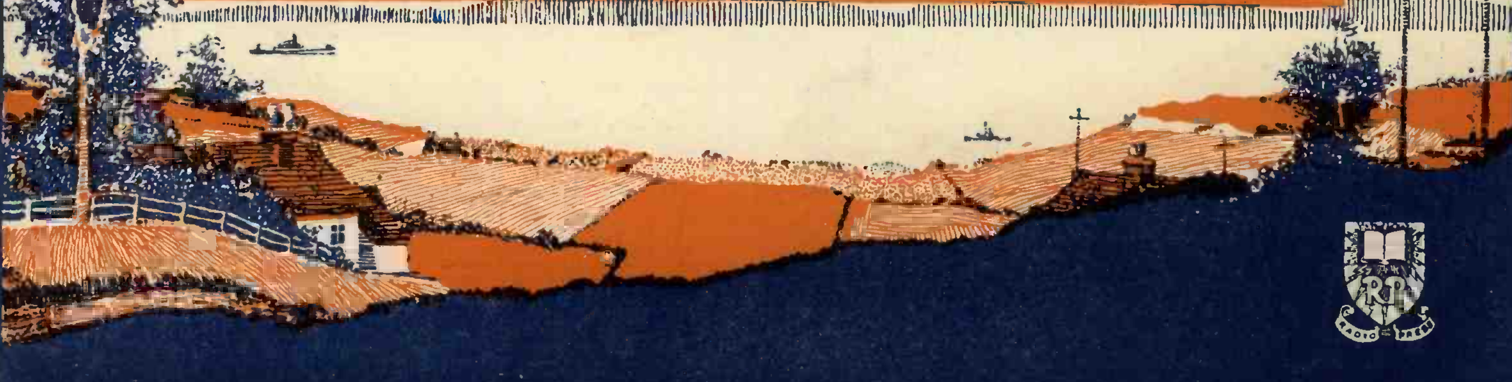
Wireless Weekly

Vol. 7. No. 8.

An INTERESTING WAVEMETER



For DAMPED or UNDAMPED WAVES



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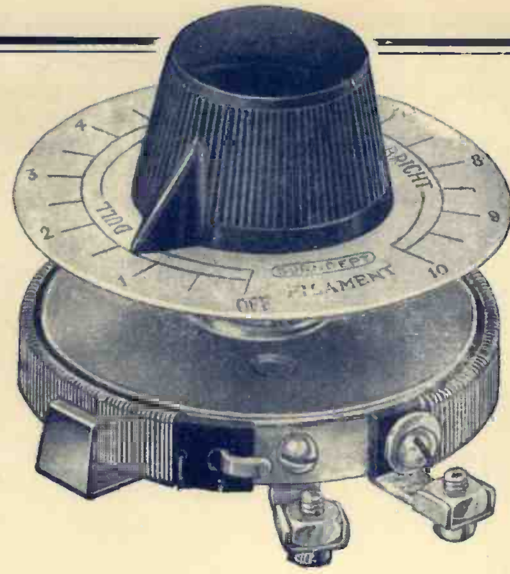

Burndept Rheostats quickly become popular

An important feature of the new Burndept Rheostat is the special contactor-spring between spindle and body. It ensures perfect contact and complete absence of "frying" noises.

ON account of the Burndept reputation as makers of "quality" components, it was natural that the new Burndept Rheostats should attract considerable attention. Not only have they found favour in the public eye, but they have added to the reputation enjoyed by Burndept as producers of the world's best wireless apparatus.

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More About a Single Exhibition

IN *Wireless Weekly* for October 28 we expressed our views on the urgent necessity of holding one Wireless Exhibition only in London next year. Our readers will remember that in the issue in question we reprinted a letter addressed by the Editor of this journal to the wireless trade. The immediate effect of this letter and the editorial in question was to bring overwhelming evidence of support from all branches of the industry and from the public, who, of course, are the chief supporters of an exhibition. In view of the success which has attended our efforts to arouse the trade and the public generally to the importance of holding one exhibition, it is amusing to see that in certain quarters our attitude in the matter has been, perhaps deliberately, misunderstood.

It should be obvious to every reader of the letter in question that our main object is to assist in the establishment of *one* exhibition, and whatever really representative organisation succeeds in establishing such an exhibition will receive the fullest support from Radio Press, Ltd. This should have been sufficiently clear from the letter, in which we stated, speaking of Radio Press, Ltd., that "if by its influence it is possible to persuade exhibitors of both exhibitions to come together to a single roof of their own accord, so much the better. Preparations, however, are going forward to run a single exhibition, so that, *if it becomes necessary*, an organisation will exist to provide the public and the trade with what it wants."

Of course, we did not imagine for a moment that a straight talk on the subject of one exhibition would please everybody. Obviously if everyone thought the same as we do, then a single exhibition would have been established long ere this. We are very pleased to see, however, that the "Wireless Trader," in an Editorial published in their issue of October 28, are in full agreement with the policy of one exhibition, and refer to the fact that in the summer of 1924 they disagreed with the policy of the N.A.R.M.A.T. in excluding non-association exhibitors. In the "Radio Trade Journal" (the official organ of the N.A.R.M.A.T.) for November 7, the Editor expresses his views on the subject of trade exhibitions. "It would be very foolish on our part," says he, "to oppose a single exhibition, but we are strongly opposed to any such exhibition being held other than under the auspices of the N.A.R.M.A.T."

Let the N.A.R.M.A.T., then, show its goodwill by throwing open its exhibition to the whole trade, and Radio Press, Ltd. will give such an exhibition full support. We cannot fail to be amused, however, by a statement made in the same Editorial that "the matter has not been made any easier by the fact that the proprietors of a group of journals connected with Wireless have suggested running a *third* show next year." (The italics are ours.)

What has really made the position difficult is that, so far, the N.A.R.M.A.T. has given no indication that it is likely to allow non-association firms to exhibit. By adopting a "die-hard" attitude the N.A.R.M.A.T. will injure itself and the trade generally. If the association maintains its old attitude of requiring firms to join it before they are allowed to exhibit, and if it prohibits its members from exhibiting elsewhere, then the position will remain precisely as it is as present. Our proposal to run an exhibition ourselves *if necessary* is based on the reasons given in the letter of October 16, and no good is done by misreading or distorting its meaning.

CONTENTS.

Edited by
JOHN SCOTT-TAGGART,
F. Inst. P., A.M.I.E.E.
November 11, Vol. 7, No. 8.

Calibrating an Oscillating Valve Wavemeter

By Captain H. L. CROWTHER, M.Sc., Deputy Director of Research to Radio Press, Ltd.

An easy method is described by which a valve wavemeter can be completely and accurately calibrated from an oscillation of one known frequency.

THE question of the calibration of an oscillating valve wavemeter from one or two waves of known frequencies often occurs in wireless work. If a calibrated standard wavemeter is available, the calibration of our own wavemeter is perfectly straightforward. It is not generally realised, however, how easy it is to calibrate accurately an oscillating wavemeter over its entire scale, if the wavelength or frequency of any one continuous wave or telephony transmitting station which can be easily received is accurately known. A number of stations are now sending out either waves of standard frequency or waves whose frequency is fairly accurately known. The method that will be described is a simple and interesting one, and will strongly appeal to the wireless experimenter.

Harmonics of Oscillating Valve Circuits

The method to be described depends on the well - known phenomena of harmonics. An oscillating valve circuit does not oscillate at just the one fundamental frequency, but also at a number of other frequencies which are exact multiples of the fundamental. For instance, an oscillating circuit whose fundamental frequency is 1,000 kilocycles, also has a frequency of 2,000 kilocycles, 3,000 kilocycles, 4,000 kilocycles, etc. These higher frequencies are called the 2nd, 3rd, 4th, etc., harmonics respectively.

Strong and Weak Harmonics

This is due to the fact that the anode current impulse through the valve is not anything like a pure sine wave form. It is practically impossible to adjust an oscillating valve circuit so that it is free from these higher frequencies or harmonics. The comparative strength of these harmonics depends on the circuit and its adjustments. Generally speaking, the strength of the harmonics falls off as the relative frequency increases. It very often happens, however, that some harmonics predominate and may be considerably stronger than those of a lower order, that is, a 5th harmonic may be found to be stronger than either the 2nd or 3rd harmonic.

Calibration in Wavelength or Frequency

Wavemeters in general can be calibrated either in metres or kilocycles, depending on which is considered the most useful. The method to be adopted in the calibration, however, differs to some extent for the two cases. Since the tendency nowadays is to speak of wireless waves in terms of frequency rather than wavelength, the following article will be limited to the calibration of valve wavemeters in frequency.

Range of Wavemeter and Accuracy

A wavemeter may be designed to cover the largest possible range of frequency by variation of the condenser or variometer alone. For example, an oscillating wavemeter can easily be designed to cover a frequency range of 500 kilocycles to 1,500 kilocycles (200 to 600 metres). That is, the frequency at the top and bottom of the scale is in the ratio of 3 to 1. Such a wavemeter, of course, cannot be very accurate, unless it is very specially designed with micrometer adjustment of the condenser and a special scale.

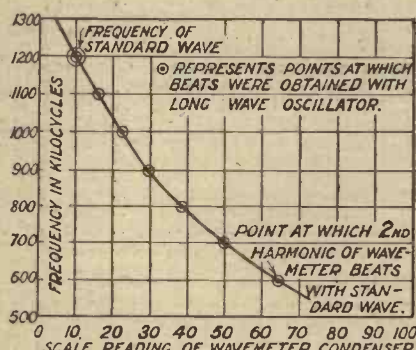

Fig. 1.—The calibration curve of the wavemeter, showing the division of the scale into equal steps of frequency.

Open Scale Desirable

Normally, the whole scale of frequency has to be cramped into a length of about 6 in., so that the least change in the capacity is liable to alter the frequency considerably. Such a wavemeter, although not accurate to 1 or 2 per cent. is often very convenient, as a large scale of frequencies can be covered with just one sweep of the variable condenser. If the wavemeter is to be reasonably accurate the variable condenser should not vary the frequency to anything like the extent of a 3 to 1 ratio. Obviously, the smaller this ratio the more accurate can the wavemeter be made.

An Easy Method of Calibration

The actual method of calibration depends to a certain extent on the range of frequencies covered by the variable condenser, and also whether the frequency of the standard wave is included in this frequency range. For the simplest and most straightforward calibration, it is necessary that the wavemeter easily cover a 2 to 1 ratio of frequency, and that the frequency of the standard wave be at approximately the highest frequency of the wavemeter. The calibration of such a wavemeter will be described first, so as to give a clear idea of the principle of the general method of calibration.

Practical Details

For example, suppose the wavemeter to be calibrated roughly covers an approximate range of frequency from, say, 500 kilocycles to 1,300 kilocycles (230 to 600 metres), and the standard wave which can be received has a frequency of exactly 1,200 kilocycles (250 metres). The standard wave is received on any ordinary non-oscillating receiver which can be tuned to the frequency of the standard wave. The wavemeter is loosely coupled to the aerial and adjusted to the exact frequency of the standard wave. This is easily done by adjusting the wavemeter until the nil point of the beat note is obtained. This point is noted exactly. The frequency of the wavemeter is now reduced, until the second harmonic of the wavemeter gives a beat with the standard signal. Thus two points are found on the wavemeter which are exactly 1,200 kilocycles (250 metres) and 600 kilocycles (500 metres).

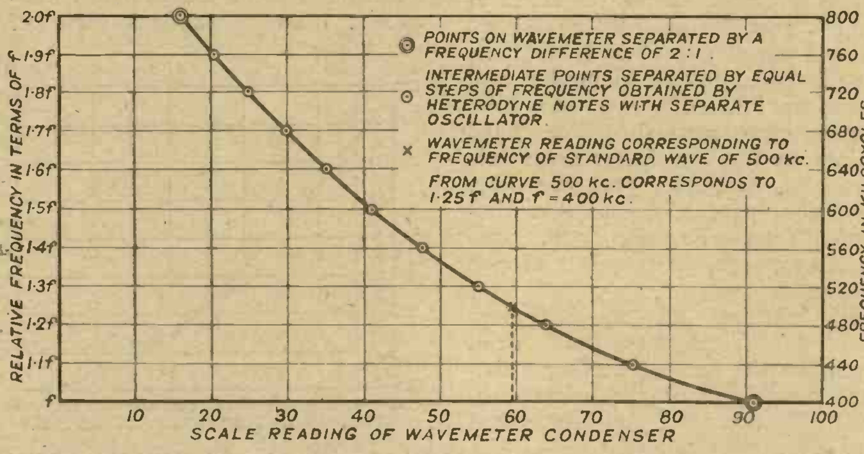

Fig. 2.—Showing the division of the wavemeter scale into ten equal steps of frequency.

Division of Scale into Equal Steps of Frequency

The next operation is to divide this scale between the two points just obtained into a number of equal steps of frequency. In this case steps of 100 kilocycles would be suitable. For this purpose a power oscillator of variable wavelength is required, with, say, 100 to 200 volts on the anode. It should be suitably designed for frequencies from about 1,000 kilocycles downwards (300 metres upwards). The problem now is to obtain beats between the oscillator and the wavemeter. An independent receiver is probably the most satisfactory method to receive these beats, although they

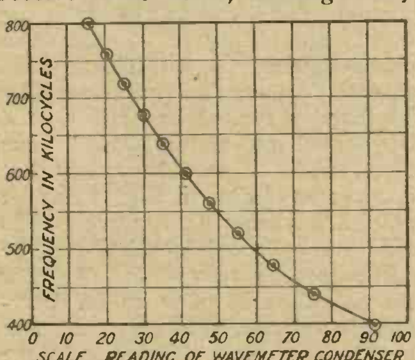

Fig. 3.—The curve of Fig. 2 plotted to a more convenient scale of frequency.

can generally be heard by inserting a pair of telephones in the oscillator itself. The telephones can also be used in the wavemeter, but as they are liable to alter the calibration slightly, it is not usually advisable.

The oscillator is set to give a beat note with the wavemeter, the latter being set to 600 kilocycles (500 metres). By increasing the frequency of the wavemeter, beats will be heard at various points on the scale. These beats will be separated by a frequency difference equal to that of the oscillator.

Obtaining Further Points

Since the two known points on the wavemeter have frequencies in the ratio of 2 to 1, it is obvious that if the oscillator is adjusted to give a harmonic equal to the low frequency on the wavemeter, then a harmonic will also coincide with the higher frequency point on the wavemeter. Taking actual figures, suppose the 6th harmonic of the oscillator coincides with the 600-kilocycle (500-metre) point on the wavemeter, then the 12th harmonic of the oscillator will coincide with the 1,200-kilocycle (250-metre) point on the wavemeter, and there will be five intermediate points at which beats will occur, and these will be equally spaced, as far as frequency is concerned, between 600 and 1,200 kilocycles (500 and 250 metres). That is, points will now have been obtained on the wavemeter at 600, 700, 800, 900, 1,000, 1,100 and 1,200 kilocycles (500, 430, 370, 330, 300, 270 and 250 metres).

Calibration Curve

If these points are plotted against the scale reading on the condenser a complete calibration curve of the wavemeter can be obtained. If the 100-kilocycle points are considered too far apart, all one has to do is to increase the wavelength of the oscillator until a convenient number of intermediate points has been obtained. If necessary, the frequency of the oscillator can be reduced so that points could be obtained at every 10 kilocycles.

Another Case

If the standard frequency happens to be at the lower-frequency end of the wavemeter, i.e., at about 600 kilocycles (500 metres) in the example given above, then the second point at 1,200 kilocycles (250 metres) can be found by means of the separate oscillator, by tuning it accurately to the 600-kilocycle (500-metre) point, and then increasing the frequency of the wavemeter until a beat note is obtained with the 2nd harmonic of the oscillator. The intermediate points can then be found as above.

Standard Frequency Outside Wavemeter Range

We next come to the method of calibration, when the standard frequency is not at one or other end

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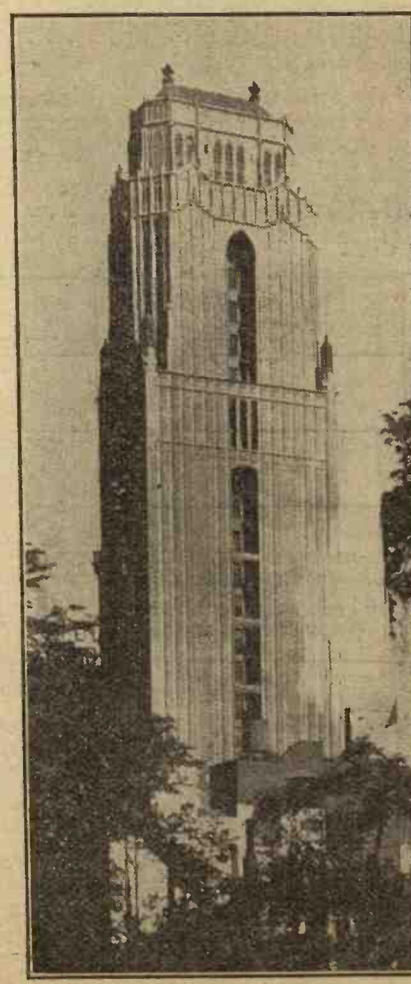


The Bush Building in New York, in which the offices of Radio Press, Ltd., American house are situated.

of the wavemeter scale. This forms an interesting application of the method, but it is not quite so straightforward as the previous case. By means of the independent oscillator two points can easily be found on the wavemeter which are in a frequency ratio of two to one. This is done by setting the oscillator at a frequency corresponding to a point conveniently near the high frequency end of the wavemeter. On reducing the frequency of the wavemeter, a second point is found which gives a beat note with the oscillator. This point will correspond to just half the frequency of the oscillator. Thus two points are obtained having frequencies which we can represent by f and 2f kilocycles.

Scale Divisions

The division of the scale between these two points into, say, ten equal steps of frequency can be carried out in exactly the same way as described in the previous example. Points on the wavemeter are now obtained at frequencies of

$f; (f+\frac{1}{10}f); (f+\frac{1}{5}f); (f+\frac{3}{10}f) \ldots\ldots (f+\frac{9}{10}f)$ and 2f.

If the scale was only divided into, say, seven equal steps of frequency, then the points would be represented by

$f;\ (f+\frac{1}{7}f);\ (f+\frac{2}{7}f);\ (f+\frac{3}{7}f) \ldots\ldots (f+\frac{6}{7}f)$ and 2f.

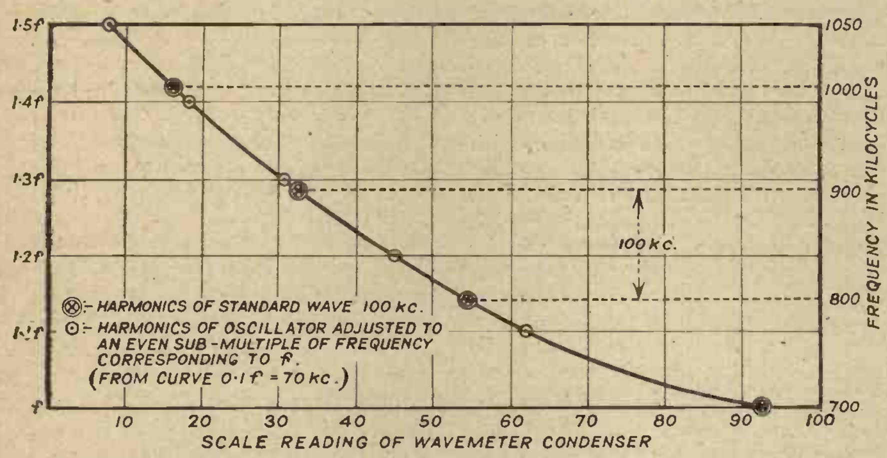


Fig. 4.—The calibration curve of a wavemeter covering a narrow band of frequencies, the standard wave being outside the wavemeter range.

Determination of "f"

If we can determine f, the calibration of the instrument can be completed. A curve can be plotted showing the relative values of f for different condenser scale readings, as shown in Fig. 2. The point on the wavemeter corresponding to the standard frequency is now determined.

An Example

By way of example, let the standard frequency of, say, 500 kilocycles (600 metres) correspond to a condenser reading on the wavemeter of 59.50. From the curve of Fig. 2 this is found to correspond to a frequency of 1.25 f, that is, 1.25 is equal to 500 kilocycles, and therefore f is equal to 400 kilocycles (750 metres). The fixed points on the wavemeter are therefore 400, 440, 480, 520, 560, 600, 640, 680, 720, 760, and 800 kilocycles (750, 680, 620, 570, 540, 500, 470, 440, 420, 390 and 370 metres).

By plotting on a convenient scale the frequencies thus found against the corresponding condenser readings on the wavemeter, the calibration can be completed (see Fig. 3).

A Further Problem

Up to the present we have only dealt with wavemeters whose highest and lowest frequencies have been in the ratio of at least two to one. It has been pointed out above that an ordinary type of wavemeter covering such a large range with the variable condenser alone cannot be very accurate. For instance, suppose the condenser is divided into 100 small divisions, and that it is possible to read accurately to within half a division. If the condenser is designed so that the frequency of the wavemeter is approximately proportional to the condenser readings, then the maximum accuracy at the low frequency end will be to within 0.5 per cent., and at the high-frequency end to within 1.0 per cent. Also in the previous cases we have assumed that the frequency of the standard came within the range of the wavemeter.

Wavemeter for Narrow Band of Frequencies

We will now consider the case of the calibration of a wavemeter, covering an approximate range of frequencies from 700 to 1,100 kilocycles, from a standard wave of 100 kilocycles.

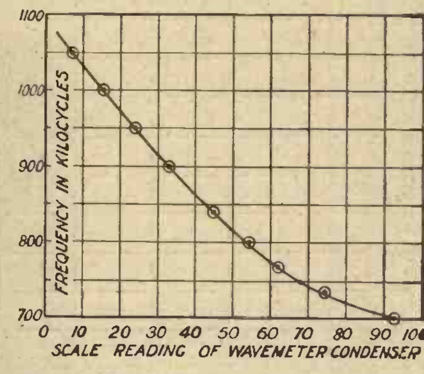


Fig. 5.—The curve of Fig. 4 plotted to a more convenient scale of frequency.

Method of Calibration

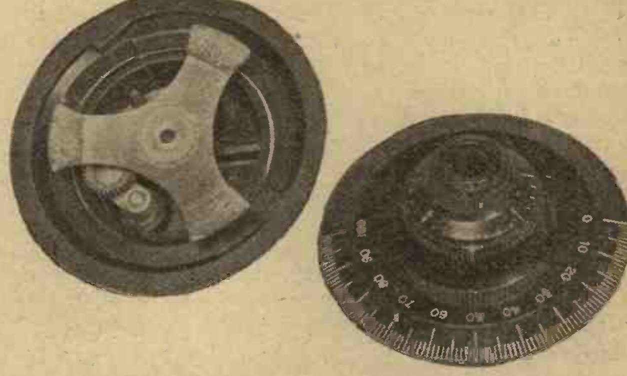
Set the independent oscillator to exactly the frequency of the standard wave, and then find points on the wavemeter at which heterodyne notes are obtained. These points will be separated by 100 kilocycles, but their actual frequency will not be known. Let the frequency of the wavemeter of these points be represented by f; f + 100; f + 200; etc. The separate oscillator is now tuned to exactly 0.5f, that is, to a frequency whose second harmonic is equal to f. The point on the wavemeter which corresponds to its third harmonic, or 1.5f, can easily be found. In order to divide the scale into equal steps of frequency, a wave must be chosen which has a frequency corresponding to an exact sub-multiple of 0.5f. This means that only the even sub-multiples of f will also coincide with 1.5 f. These even sub-multiples can easily be found by trial and error. The scale should be divided into at least four or five equal steps of frequency, so that a curve as shown in Fig. 4 can be plotted. From this curve points differing by 100 kilocycles can be determined in terms of f, so that the actual value of f can be determined. From the curve it was found that 100 kilocycles were equivalent to .14f approximately, that is, f must be equal to exactly 700 kilocycles (430 metres) and 1.5f to 1,050 kilocycles (290 metres). By taking readings from the curve as shown in Fig. 4 a new curve giving the complete calibration can

(*Continued on page 271.*)

How to Operate a Short-Wave Set

By G. P. KENDALL, B.Sc., Staff Editor.

In this, the concluding article of his series on "Practical Short-Wave Reception," Mr. Kendall indicates the special points to which attention should be paid by the beginner in operating a short-wave receiver.



Slow-motion dials on the variable condensers of a short-wave set may prove of considerable assistance in tuning.

ONE of the reasons for the common belief that short-wave reception is a task of great difficulty is probably to be found in the fact that the whole technique of operating a short-wave set is different from that required in handling a receiver upon the broadcast frequencies. The experimenter with experience upon the really high frequencies, however, will agree that the operation of a set in this region is not in reality so very much more difficult, but rather *different*, and until the differences of behaviour, indications, etc., are grasped, the business will be a little puzzling.

The Main Difficulty

In concluding this series of articles, in which I have endeavoured to cover the ground in such a way that a beginner will be able to make a start in short-wave reception with a good prospect of success, it seems desirable to give some general instructions upon the operation of the set, and to explain the special points of difficulty which may be encountered. These difficulties are really more a matter of the different behaviour of the set upon the higher frequencies, and since it may safely be assumed that the reader is fairly proficient in operating receivers upon the ordinary broadcast frequencies, these points of difference can be quite briefly covered.

Two Main Controls

In the typical simple circuit which we have chosen and which has formed the basis of all our considerations, there are two principal controls which must be manipulated in searching for signals, namely, the tuning control and the reaction adjustment. Both of these are furnished by variable condensers, and it is in the skilful manipulation of these that the experience of the old hand betrays itself.

Reaction Adjustment

These two adjustments can quite well be considered separately, and we will take first the reaction control. As in all receivers employing a circuit of this general type, regardless of the frequencies upon which they are operating, it is essential to secure the correct working conditions for the detector valve, in order that the reaction control may be possessed of certain characteristics. In particular, the end at which to aim should be a condition in which it is possible to secure a really smooth passage from the non-oscillating to the oscillating state, and this question is closely bound up with that of the choice of a detector valve and the adjustment of the working conditions of that valve.

Choice of Valve

Upon the higher frequencies it is of the greatest importance that a suitable valve should be employed in the detector socket, and my own personal preference is always for one of the small power valves of the dull-emitter type, or for one of the valves specially intended for resistance-capacity low-frequency amplification.

High-tension Voltage

These valves all oscillate readily in the circuit which we are considering, and with very little adjustment of the high-tension voltage and filament current can be persuaded to give the required smooth passage into oscillation. They possess the considerable advantage, also, that the filament current for the desired effect is by no means critical, and very little adjustment of the filament rheostat is needed. So long as anything like the required voltage is applied across the filament (as specified by the makers of the valve), all necessary adjustment can be done by means of the high-tension wander plug. As a rule, with one of these valves about 40 volts high-tension will be correct.

Smooth Reaction Control

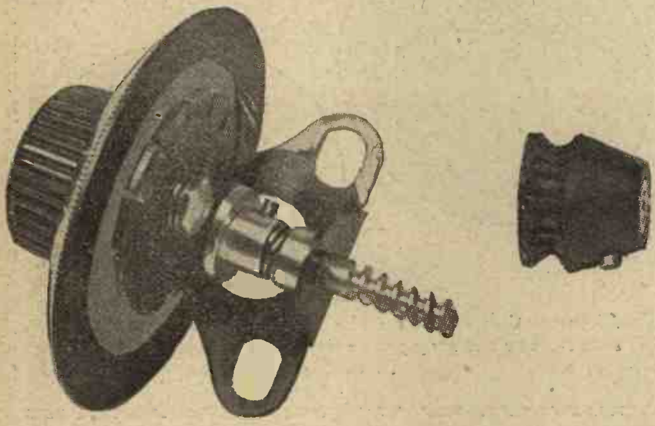
The first thing to do, then, is to set the tuning condenser to a reading somewhere near the middle of its scale, having inserted the necessary coils, the two valves, and connected up the various batteries, etc., is to adjust the high-tension voltage until upon increasing the capacity of the reaction condenser the set is found to pass smoothly into oscillation without any noticeable click as the threshold of oscillation is passed.

Testing for Oscillation

It will probably be observed that when the correct adjustment has been found, it is quite difficult to decide when the set starts to oscillate, especially if the aerial coil is only rather loosely coupled to the grid coil. The usual finger test upon the grid of the detector valve, or rather, the side of the grid condenser which is connected to the tuning circuit, or any point upon the tuned circuit which is connected to the side of the grid condenser in question, will serve.

Hand-capacity Effects

A warning must be given, however, with regard to this test, that its behaviour is very different upon the really high frequencies from that to which the user of broadcast receivers will have been accustomed. It is often found that the set ceases to oscillate as the hand is brought anywhere near one of the points upon which the test is being made, and it is therefore necessary to listen for a click or a slight change in the sound of atmospherics and other small noises, as the hand actually approaches the point upon which the test is to be made.



In this slow-motion device the ebonite bevel pinion on the right, which is secured to the condenser spindle, is rotated by the worm on the dial spindle.

Careful Observation Necessary

As a rule, the click will be heard when the finger is still about half-inch or so away from the point which it is intended to touch. Upon actually touching the test point, therefore, it is probable that the actual oscillation click will not be heard. Bearing this in mind, the test can be carried out quite easily as the reading of the reaction condenser is gradually increased.

So much for the method of testing to determine whether the set is in the oscillating or non-oscillating condition. The actual adjustment of the set during reception as regards the reaction control is, it must be admitted, somewhat more difficult than the same process in the case of a broadcast receiver.

Tuning and Reaction Controls

The difficulty arises from the fact that if the receiver is adjusted to the desired condition, say just below the self-oscillation point, at one end of the tuning condenser scale, by the time this condenser has been revolved to the other end the set is likely either to have stopped oscillating altogether or to have started to oscillate so strongly that practically no signals can be heard. In other words, the set does not hold its reaction adjustment over the tuning range nearly so well as does an instrument designed for, say, broadcast reception.

Size of Reaction Coil

Very careful adjustment of the number of turns of the reaction winding will do something to secure an adjustment which is held over a wider range of tuning, but it must be accepted as a general rule that upon the really high frequencies, say those in the neighbourhood of 15,000 kilocycles (20 metres), fairly constant readjustment of the reaction control will be needed as tuning proceeds.

Simultaneous Adjustments

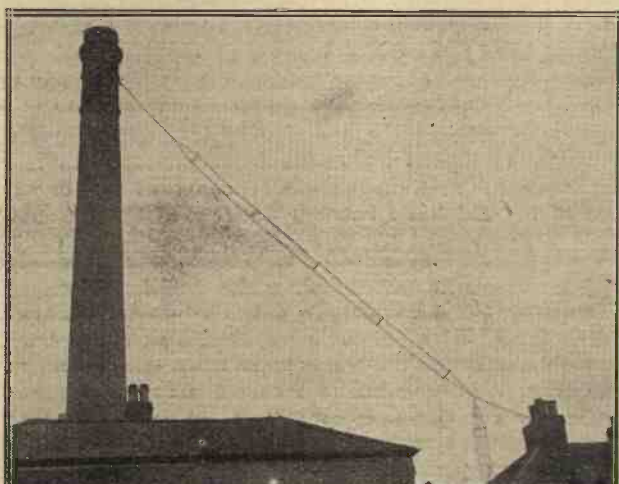
Since this readjustment must be so constant during the process of searching for signals, it is advisable to learn to recognise the signs of self-oscillation in the form of the slight rustle which is usually heard so long as the set is oscillating, rather than to depend upon the finger test. In this way both hands can be kept free for the controls, one being used to operate the tuning condenser and the other the reaction condenser, and as the one is revolved, so the other is readjusted to suit

When the beginner has grasped these various points with regard to reaction control and has learned to keep the set adjusted to any desired state of oscillation or non-oscillation as he varies his tuning control, he will find that the difficulties of short-wave reception have vanished to a very large extent. The main difficulty undoubtedly is to maintain the set in the desired condition as searching proceeds, since it is usually found that the reaction control is decidedly sensitive to changes of tuning; in fact, a change of only a portion of the tuning condenser scale may carry the set from the correct "just-oscillating" condition to one in which the circuit is oscillating so strongly that practically no signals can be heard. This seems to be characteristic of a receiver operating upon the higher frequencies.

An Audible Indication

For reception of Morse signals, of course, it is desired to keep the set only just freely oscillating. It is fairly easy to keep the set in this condition, once it has been discovered that there is a fairly clear audible indication of which advantage can be taken. When the set is not oscillating, of course, only an occasional atmospheric is heard under normal conditions, and, as a rule, quite faintly. As soon as the set starts to oscillate, a faint continuous rustling and crackling will be heard, which is composed partly of small atmospherics and partly of battery and other local noises, while if this point is passed and the receiver put into really strong oscillation, the whole circuit seems to go dead, and practically nothing will be heard.

AT THE NOTTINGHAM STATION



A four-wire cage-type aerial is employed at the Nottingham Broadcasting Station.

Tuning In

So far as the actual process of tuning-in a signal is concerned, there is, I think, very little to be said, but a good deal to be discovered by actual experiment. So long as the old "waveband" of 150-200 metres was in use, all that was required was a delicate touch upon the tuning dial, and a tuning condenser of not too large a capacity. Since so many very much higher frequencies are now in use, ordinary methods of direct tuning by means of the fingers upon a condenser dial are really not to be recommended. The process becomes highly critical and is more likely to lead to exasperation than success.

Use of Slow Motions

I would therefore strongly advise that some means of obtaining a vernier, or, rather, slow-motion drive for the tuning condenser be adopted, rather than the use of the primitive long handle arrangement.

Hand-capacity effects may sometimes necessitate the use of an extension handle, but they can generally be reduced to small proportions by keeping all wires away from the front of the set and connecting the moving plates to the earth or low potential side of the circuit.

In choosing some form of vernier drive for the condensers, preference should be given to one which is continuous in its action—that is to say, which permits the condenser to be turned through its whole travel by means of the vernier device alone. This is desirable because on the very high frequencies all searching must be done by means of the slow-motion drive, since if the condenser is turned direct, no matter how carefully, it is quite likely that signals will be missed entirely because they "flash past," as it were, so extremely rapidly.

Reduction Ratio

A slow-motion drive, to be effective upon the high frequencies, should have a considerable reduction ratio, I think, not coarser than 5 to 1, and should preferably be more of the order of 20 to 1, assuming a tuning condenser of something like .0003 μF capacity. In selecting such a device, great care should be taken to see that it is reasonably free from "backlash." (By backlash is meant the presence of slackness in any gearing which is employed, which results in an appreciable degree of free travel of the knob without a corresponding motion of the condenser spindle.) Any appreciable amount of backlash in one of these devices renders it practically useless for short-wave work.

Since it is desirable to be able to perform the whole of one's searching by means of the slow-motion drive, it will be realised that the old-fashioned separate vernier condenser will not serve the desired purpose, nor is it desirable from other points of view.

Searching

To sum up, then, the beginner should observe the following points in searching for short-wave Morse signals: learn how to adjust the set so that it is only just oscillating, noting the indication in the telephones of this condition, and try to keep it so adjusted as the tuning control is varied. Revolve the tuning condenser as slowly as your vernier drive device permits, listening very closely and carefully for the first indications of a signal, however weak. If you are searching for telephony, of course, you should endeavour to keep the set just *below* the point of self-oscillation as you tune; if the signals prove so weak that they cannot be found in this way, you may have to search for the carrier wave with the set oscillating, bringing it off the oscillation point directly the carrier is found. (Remember the neighbours!)

"Dead Spots"

Finally, if you find that there are one or more points on the tuning condenser dial at which the set refuses to oscillate, try a different size aerial coil or insert a loading coil (about 20 turns in a hank of any available gauge of wire between 20 and 30 s.w.g.).

The operator in the transmitting room at WJZ, Newark, New Jersey, who keeps a continuous watch on 500 kc. (600 metres) for distress calls from ships at sea, so that broadcasting can be stopped, if necessary, to avoid interference.

Two-Way Communication with South Africa

We hear that Mr. F. A. Mayer (2LZ), of Wickford, Essex, has established two-way communication with o.A4Z, owned by Mr. J. S. Streeter, of Johannesburg, South Africa. This is the first two-way communication between Great Britain and South Africa, although each country has been heard by the other on several occasions.

* * *

Several amateurs in this country are now conducting experimental transmissions on 60,000 kc. (5 metres), the greatest distance yet covered being five miles. This was accomplished by Mr. C. W. Goyder (2SZ), of Mill Hill, who was heard by Mr. E. H. Robinson (2VW), of Hampstead.

Lists of addresses of all United States amateur transmitters may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D.C. The price is 25 cents.

Allotment of Call Sign

We are informed by Mr. J. L. Wood, of Stanhurst, Burntisland, Fife, that the call sign G5JD has been allotted to him.

Mr. Wood is now working (C.W. and telephony) on the 2,000-1,500-kc. (150-200 metre) band, and occasionally on 682 kc. (440 metres). He will be glad to receive reports on his transmissions, which are normally carried out on 1,714 kc. (175 metres).

SOME DEVICES FOR "ATMOSPHERIC" ELIMINATION

A buried aerial has been found fairly effective in reducing the amount of atmospheric interference in the receiver.

By Major JAMES ROBINSON, D.Sc., Ph.D., F.Inst.P., Director of Research to Radio Press, Ltd.

Some further notes on the various methods suggested for the elimination of atmospheric disturbances from wireless receivers are given here by Dr. Robinson.

WE shall now describe one of the simplest methods for cutting down the effect of atmospherics, and a method which is used very largely for this purpose. This method is one which makes use of the directional properties of certain forms of aerials. We have already seen that atmospherics come on occasions from very definite directions, and thus if we can use a receiver which can have its plane of direction altered, we are able on occasions to cut down the effect of atmospherics very considerably. The chief occasion on which this does not give very satisfactory results is in the case where the direction of the prevalent atmospherics happens to coincide with the direction from which signals are being received. Many well-known types of directional receiver can be made use of. In general a rotating loop is employed, and this applies to most of the big receiving stations, that is, stations which are receiving from long distances. In some cases, however, the Bellini Tosi type of apparatus is employed.

Loop and Vertical Aerial

It is very often advisable to use the uni-directional properties of loops instead of the ordinary bilateral directional properties. This can be obtained by combining a loop with a vertical aerial by methods which have already been described in *Wireless Weekly*, Vol. 6, No. 20, and it is not necessary to describe them in detail here.

It must be understood, however, that this directional method does not cut out atmospherics altogether, because a loop, when adjusted for its minimum, cuts out only from a direction which is perpendicular to the plane of that loop.

Properties of a Loop

To understand the meaning of this more thoroughly we shall refer to Fig. 1. The loop is shown as A B C D in the form of a square, and at the centre point O we have drawn a line ZOZ1 and another line YOY1 in the plane of this loop, and perpendicular to these two lines ZOZ1 and YOY1 we have drawn a line XO, this line XO thus being perpendicular to the plane of the loop. The direction XO is the only direction in which waves can arrive at the loop to give zero effect in the loop. If waves arrive in the direction ZO the maximum effect will be heard. Again, if the waves arrive in the direction YO the maximum effect will be heard.

Direction of Waves

Usually the assumption is made for directional work that waves always travel along the surface of the earth, that is, in the horizontal direction, but in dealing with atmospherics we have seen that the waves may arrive in any direction, and that they may even come vertically downwards; or, again, they may come obliquely from the upper atmosphere. Any other direction of arrival of waves or of atmospherics than XO will give a response in the receiver. A line SO is shown which is in the horizontal plane XOZ, and again a line TO is shown which is an oblique direction from the upper atmosphere. These and all other directions, except XO, will give a response in a loop.

In spite of the fact that a loop only gives a minimum effect for one direction of the waves in space, it does give a considerable freedom from the effect of atmospherics, as it can be rotated at will, until the atmospherics are weakest.

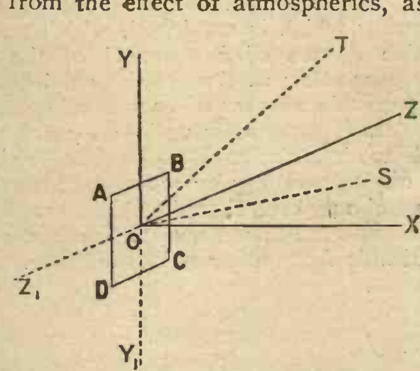


Fig. 1.—A loop will respond to waves arriving from any direction except XO, perpendicular to the plane of the loop.

Use of Two Different Aerial Systems

Some of the most successful methods of cutting down the disturbance of atmospherics depend upon the fact which has already been pointed out, that atmospherics have different effects on aerial systems with different amounts of damping in them. In addition to this there is a peculiar fact about aerials which are laid along the ground, or even buried (in the latter case obviously the aerial would be insulated before being buried). In this case the aerials are usually of some considerable length, and may be buried at a depth of two or three feet below the surface of the ground.

Buried "Aerials"

A horizontal aerial above ground or buried is naturally directive, and, in fact, it has been reported by a number of experimenters that atmospherics are cut out on such aerials to a very large extent. Obviously as such aerial systems do receive wireless waves, they will also receive atmospherics of some types. For instance, atmospherics which arrive vertically will be picked up by the horizontal or the buried system.

Reduced Signal Strength

The principle of the systems which employ two aerial systems of

Aircraft in flight between Croydon and the Continent are kept in touch with Croydon by wireless telephony, their positions at any moment being plotted on a map.

different effective dampings is that the ratio of the signal strength to atmospheric strength is different for different forms of aerial systems. If we employ two entirely different aerial systems, we can balance out the atmospheric and leave a small proportion of the signal. Obviously we can adjust the aerial systems so that we obtain atmospheric disturbances of the same value, and in doing so it is obvious that we shall cut down the resultant signal strength.

Balancing Adjustments

But in such a case, even if we have only a weak signal left, there is a tremendous advantage if we have completely eliminated the atmospheric. The installation of such a system is not altogether easy, because we have to balance out high-frequency effects, and thus it is essential not merely to adjust the intensities to be equal, but we must also adjust the phases of the disturbance and of the signals.

Hoyt Taylor's System

One of the best methods for this form of atmospheric eliminator is due to Hoyt Taylor. A diagram of this system is shown in Fig. 2. The two aerial systems are shown as M, which is a loop, and T which is a horizontal aerial. The system is earthed at the loop, and also at the near end of the horizontal aerial T, in this case through the resistance R_1.

Operation

The loop is joined to the horizontal aerial through an inductance L_1, a condenser C_1, and a resistance R. Another earth is provided from a variable tapping of this resistance R. This earth is provided through a variable condenser C_2 and an inductance L_2. An inductance L_3 is employed coupled to L_2 to lead to the amplifier. By adjustment of L_1 C_1 and the variable tapping of R, and by the adjustment of R_1, the balance of the atmospheric can be obtained, and we are left with a

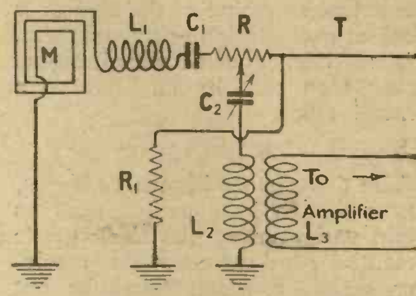


Fig. 2.—The atmospheric eliminator devised by Dr. Hoyt Taylor.

resultant signal which can be amplified as much as we require.

Advantages Claimed

Such a system has enabled point to point stations to extend the time of operation of long-distance communication for many more hours per day, and the atmospheric disturbance is cut down very considerably. With regard to buried aerials, it has been reported that if the complete receiving apparatus is underground, atmospherics are less disturbing in relation to signals.

Effect of Local Conditions

None of the systems described so far gives complete freedom from atmospheric disturbances. One form of atmospheric disturbance which it is almost impossible to eliminate is that caused by local thunderstorms. We have seen that the effect as regards atmospheric disturbance of local thunderstorms does not reach to a very great distance. An atmospheric due to a single lightning discharge is usually not heard at a distance greater than a few hundred miles. For point to point working, in order to guarantee communication when there is a local thunderstorm, it has been proposed that two such systems as that described by Hoyt Taylor should be installed at a distance apart of about 100 miles. Each system would be similar, and one station would act merely as a stand-by for the other station.

Continuous Communication

It would generally be possible to carry on communication at one of these stations throughout almost the whole of the twenty-four hours of the day, except when there happened to be a local thunderstorm. In such a case the reception would be handed over to the other station which is about 100 miles away, which would not normally be suffering from the effects of the same thunderstorm. Such a system of using two stations for reception of long-distance signals is possible, as the actual reception of the signals is done at each station or one of them, the rectified and amplified signal being then sent by land-line to a central office.

Shielding

The disturbance known as hisses, being due to local causes such as rapid variations of the electrostatic potential gradient near the receiving aerial, can sometimes be cut down in intensity by surrounding the receiving aerial with an electrostatic shield, which consists of a number of wires connected through resistances to earth. Such shields or cages have been proposed by De Groot and by Dieckmann.

The Kallirotron

Limiting devices have been proposed which have the characteristic that as the incoming signal increases in strength the response in the receiver rises at first and then falls off. One such system is called the Kallirotron, and is due to L. B. Turner. Another system was proposed by Capt. Crowther and the author. These devices have not so far been seriously applied. They would not account for complete elimination of the atmospherics, but they would cut down the disturbing effect.

Automatic Frequency Variation

Other proposals of a different character have been made to make a strong highly-damped wave automatically alter the frequency of the aerial. A continuous wave signal or a uniform signal would thus maintain a constant frequency of the aerial system, and would be passed on to the receiver. An atmospheric would, however, vary the frequency over a considerable band, and only when the aerial frequency happens to agree with that of the secondary circuit of the receiver, which would be only for a very short interval, would energy be transferred. Thus the effect of the atmospheric would be cut down.

Disadvantages

Such a system, however, would prevent a continuous wave also from being received during the time that the atmospheric was effective; but even so it would be useful. Such systems have been proposed by De Bellescize, by the well-known German wireless engineer Zenneck, and again by Capt. Crowther and the author.

Acoustical Tuning

Other methods for telegraphic communication employ elaborate acoustical tuning at the receiving station. The received note can be adjusted to be of a different pitch from the average noise of the atmospheric. As in the high-frequency coupling methods, however, we cannot have the acoustical selectivity too great or ringing will commence and the signals will be distorted. Most receiving stations use some form of acoustical or note tuning, and thereby achieve some freedom from the disturbance of atmospherics.

A Further Method

Another proposal which appears to be hopeful is to use two aerials tuned to different wavelengths and to use a local oscillator to enable the efforts of both aerials to be combined to give a resultant effect either at an audible or a supersonic frequency.

Investigation Needed

These last few methods have been merely briefly referred to in the hope that the principles involved may cause someone to devote further ingenuity to this most vital problem. Various methods have been described or briefly referred to, and some of them enable the disturbance due to atmospherics to be cut down. In designing receiving stations, a number of the devices can be used, and, in fact, are often used in combination. They will be described in greater detail at a later date.

A New Metre-Kilocycle Conversion Table

FOR some time now we have been referring to frequencies (in kilocycles) in preference to wavelengths (in metres). For reasons of convenience we recently discarded the accurate conversion formula in favour of a simpler approximation in round figures. A table of metres and the corresponding kilocycles is given below. Higher and lower values than those actually given can readily be deduced from this table, while intermediate values may be interpolated with the assistance of the formula given.

Metres to Kilocycles, or Kilocycles to Metres.

$$\text{Frequency (kc.)} = \frac{300{,}000}{\text{wavelength (metres)}}$$

Correct to 0.1 kilocycle.

Metres	Kilocycles	Metres	Kilocycles	Metres	Kilocycles	Metres	Kilocycles	Metres	Kilocycles	Metres	Kilocycles	Metres	Kilocycles
10	30000.0	23	13043.5	36	8333.3	49	6122.4	62	4838.7	75	4000.0	88	3409.1
11	27272.7	24	12500.0	37	8108.1	**50**	6000.0	63	4761.9	76	3947.4	89	3370.8
12	25000.0	25	12000.0	38	7894.7	51	5882.4	64	4687.5	77	3896.1	**90**	3333.3
13	23076.9	26	11538.5	39	7692.3	52	5769.2	65	4615.4	78	3846.2	91	3296.7
14	21428.6	27	11111.1	**40**	7500.0	53	5660.4	66	4545.5	79	3797.5	92	3260.9
15	20000.0	28	10714.3	41	7317.1	54	5555.6	67	4477.6	**80**	3750.0	93	3225.8
16	18750.0	29	10344.8	42	7142.9	55	5454.5	68	4411.8	81	3703.7	94	3191.5
17	17647.1	**30**	10000.0	43	6976.7	56	5357.1	69	4347.8	82	3658.5	95	3157.9
18	16666.7	31	9677.4	44	6818.2	57	5263.2	**70**	4285.7	83	3614.5	96	3125.0
19	15789.5	32	9375.0	45	6666.7	58	5172.4	71	4225.4	84	3571.4	97	3092.8
20	15000.0	33	9090.9	46	6521.8	59	5084.7	72	4166.7	85	3529.4	98	3061.2
21	12485.7	34	8823.5	47	6383.0	**60**	5000.0	73	4109.6	86	3488.4	99	3030.3
22	13636.4	35	8571.4	48	6250.0	61	4918.0	74	4054.1	87	3448.3	**100**	3000.0

A Compact Short-Wave Coil

By H. BRAMFORD.

For reasons of economy in space, coils of flat spiral form are sometimes preferred to cylindrical coils. The coil described here is practically wound "on air" and will be found simple to construct.

A SHORT-WAVE coil constructed on the lines to be described will be found simple and efficient, and also neat in appearance. The completed coil is shown in the photograph, and a diagram showing the principle of construction is shown in Fig. 1. The

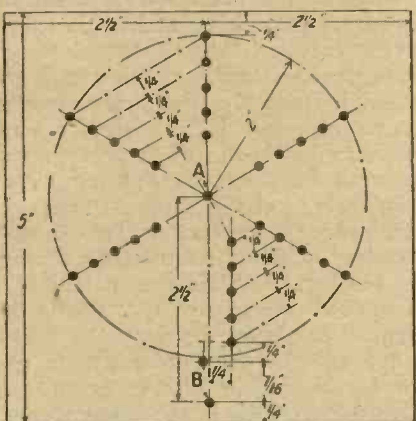


***Fig. 1.**—The dimensions for laying out the winding former may be obtained from this diagram.*

coil, which is of rather a frail nature, by reason of the fact that it is almost entirely self-supporting, should be handled with care when completed. The ebonite adaptor provides a good handling piece, as the winding once set should not be touched or interfered with.

Materials Required

The materials which will be required for the construction are as follows:—

For the coil:

One piece of ebonite measuring $3\frac{1}{2}$ in. by 1 in. by 3/16 in.

Two terminals.

Small quantity of No. 12, 14, or 16 S.W.G. bare copper wire.

For the former:

One piece of wood measuring 5 in. by 5 in. by $\frac{3}{8}$ in.

Thirty-three valve pins.

Winding Former

Before proceeding to make the coil itself, it will be necessary to construct a winding former as shown in Fig. 1. First cut a piece of wood 5 in. square. A suitable thickness of wood to use is $\frac{3}{8}$ in. Any kind of wood is suitable, common deal being quite good enough for the purpose. Drill 33 holes in the positions indicated, which take the form of a hexagon. These drillings should be made with a 5 B.A. tapping drill. To finish the former, screw a valve pin into each of the holes just made. It will be found that the valve pins will cut their own threads into the wood. The slotted part of the valve pins answers a similar purpose to the slot in the head of a screw. When all the valve pins are inserted the slots of each pin should be so arranged as to be at right angles in each case to the radial lines of the hexagon, for a purpose which will be explained.

Winding the Coil

For winding the coil, No. 12, 14, or 16 S.W.G. soft, bare copper wire may be used. The coil shown in the photograph was wound with No. 16, but the stouter the wire used the better, chiefly owing to

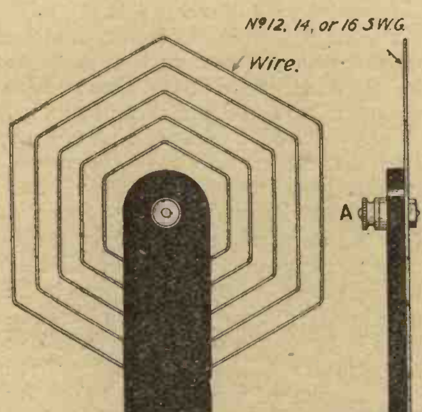
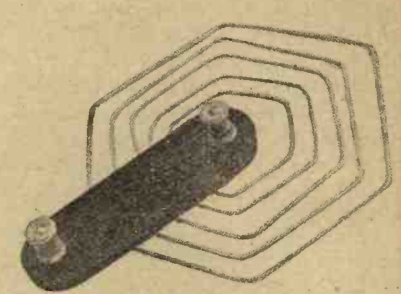


***Fig. 2.**—By means of the terminal B the coil may be mounted on an angle bracket on the panel or baseboard.*

the fact that it shapes up much more easily, and is more rigid. Commence the winding by securing



The completed coil is practically self-supporting.

one end of the wire to the centre pin A, and travel round the pins anti-clockwise, keeping the wire taut and straight all the time. Finish by securing to the last pin B. Lift the finished winding thus made carefully off the pins, and it is now ready for securing to the ebonite adaptor.

Ebonite Adaptor

The ebonite adaptor is made from a piece of ebonite measuring $3\frac{1}{2}$ in. by 1 in. by 3/16 in., as shown in Fig. 3. Drill two 4 B.A. clearing holes and round off each end of the ebonite to give a neat finish.

Assembly

For details of assembly refer to Fig. 2. The beginning of the coil is secured by means of a nut, to terminal A, which passes through

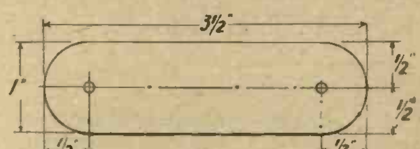
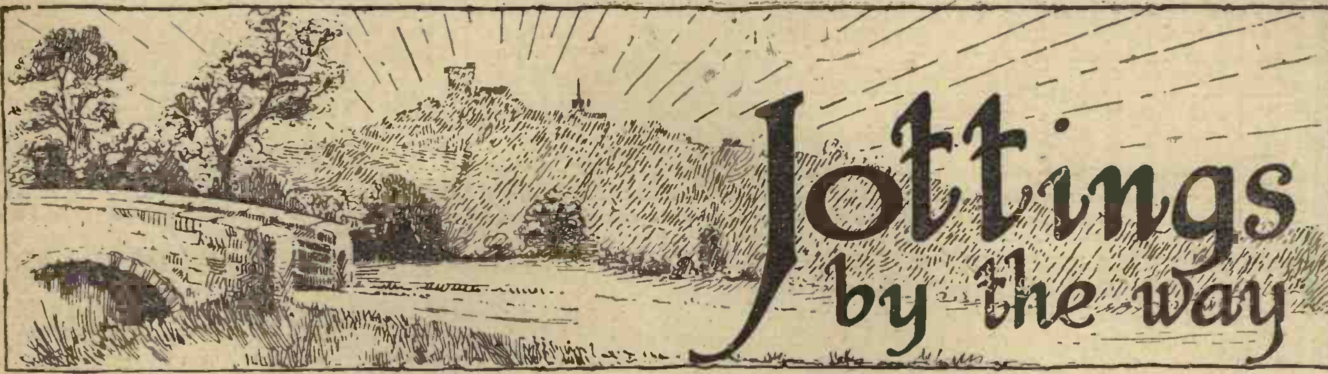


***Fig. 3.**—Holes may be drilled if desired in the ebonite adaptor, to reduce the amount of solid dielectric present.*

the adaptor. The end is secured likewise to terminal B. Having done this, shape the coil as nicely as possible and tighten up the contact nuts. Next secure each turn in its true form by pouring Chatterton's compound over the portions of the wires which lie on the back of the ebonite adaptor. During this process each turn of the coil should be held true in position. When the compound sets, the coil will be firmly held in its correct form.

Copper Ribbon

A similar coil may be made from stout soft copper ribbon $\frac{1}{4}$ in. wide. In this case the winding is made upon the same former as before, but the ribbon is laid in the slots of the valve pins, instead of around them.



I DO not think that in the ordinary way I covet my neighbour's goods and chattels. I do not go about the place wishing that I had a hat like Poddleby's—in fact, I thank heaven many times a day that I have not. I have no desire to possess Mr. Bendall's knowledge of coil winding; so long as he makes the coils and I use them I am perfectly content. No, on the whole, I go contentedly through life, for if I have not much money I have a certain persuasiveness, which enables me in the ordinary way to provide myself with such wireless goods as I need by borrowing them from my friends and neighbours. Sometimes I think that I would like to be a financial magnate and smoke cigars and ride about in a Rolls-Royce; but

. . . Better with gaspers and a push-bike . . .

when I remind myself that financial magnates have to work at times, I decide that I am better as I am with gaspers and a push-bike.

You might think that the last implied a certain amount of work, but as I use it it does not. On it I free-wheel gaily in the mornings from my abode to the station, the road being entirely down hill. Later in the day one of my young hopefuls calls at the station and takes it home. That is the way to enjoy bicycling to the utmost.

Snaggsby's Windfall

Well, as I was saying, I am not as a rule at all a covetous person. The other day, however, I found myself fairly wallowing in the mire of envy. It happened in this way. Snaggsby, who has recently come into money in some mysterious (and probably, between ourselves, nefarious) way—before we go any further I must ask you to promise me that you will not let that remark in brackets go any further, though it is probably quite true, for Snaggsby is a nasty vindictive kind of person who might easily take out a writ of a priori or *petitio principii* or something of the kind, and run me into goodness knows what in the way of costs and damages.

A Demonstration

Snaggsby then has come into money and seems to be doing himself pretty well. The other night he asked me round to hear the performances of the very last word in receiving sets. Having been present at many such side-splitting exhibitions, I hastened to accept, and I must confess that I was influenced not a little by the thought that Snaggsby would now probably offer his guests Corona Coronas, instead of the ghastly toofers that used to be handed round to those who dropped in to see him of an evening. Being a prudent person, I placed my two largest cigar cases (borrowed originally from Poddleby and Bumpleby Brown) in my pockets. I found on reaching Snaggsby's den that he had possibly expected this move on my part, for though he produced a magnificently embellished box of a really excellent brand, it contained only three cigars, one of which was taken by Poddleby, one by myself and the last by our host. Some people do not quite understand the obligations that the possession of wealth imposes upon them.

The Super Set

Though slightly embittered by this display of meanness on Snaggsby's part my normal sunny temper quickly returned when my eye fell upon the receiving set which reposed upon a carved table in a corner of the room. The cabinet was one of the most beautiful things that I have ever beheld, a poem in wonderfully polished mahogany so perfectly designed that one felt a thrill of pleasure in looking at it. So shiny was the panel that one could easily have used it as a shaving mirror, though possibly Snaggsby would have objected if his guests had produced brush and razor and started to do so. Glorious large dials were to be seen upon the panel, with nice fat knobs that one can get hold of without contracting cramp in the hand. "Did you make it?" I asked Snaggsby. "No," he replied in a superior way. "I really have not the time nowadays to go in for these big bits of work. I bought it. This is the Supersonora ten-valve supersonic super-hetero-

. . . Could use it as a shaving mirror . . .

dyne." "Super, super, super," I murmured. "Well it certainly looks like it. Let's hear what it can do."

Envy

With a little superior smile (super again) Snaggsby switched on. In came 2LO at wonderful strength and with perfect purity. A tiny tweak of the knobs and Cardiff was entertaining us. From Cardiff we passed to Manchester. (Can you pass from Cardiff to Manchester? I can't.) We went on to Bournemouth, to Newcastle, to Madrid, to all over the place. Every station came in to perfection. I went home filled with envy, hatred and uncharitableness. I could, of course, make a similar set, but that would

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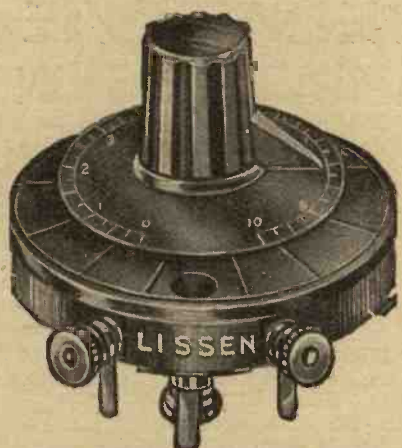

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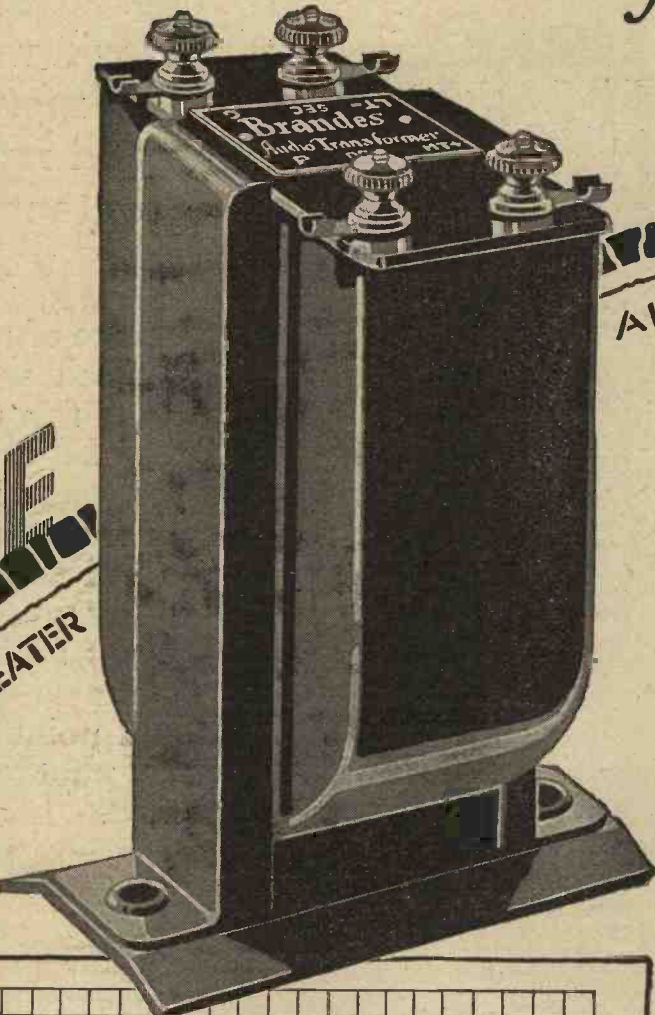

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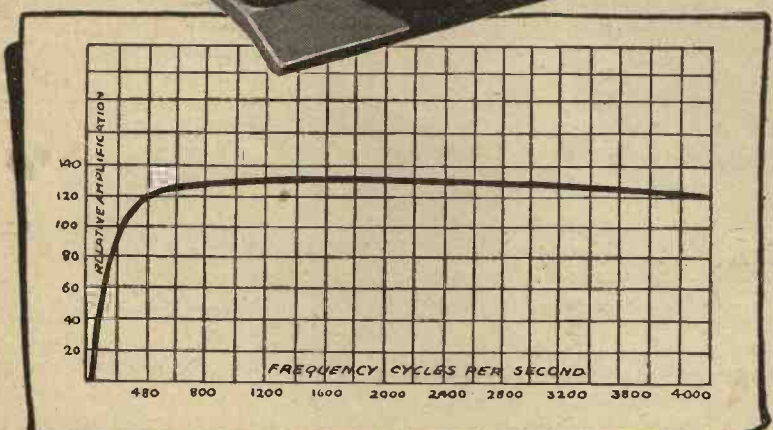

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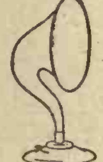

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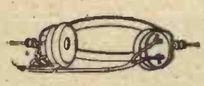

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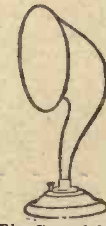

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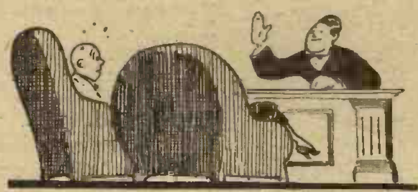
demand work, and work, if it does not fill me with envy and uncharitableness, fills me always with hatred. Why should a fellow like Snaggsby be able to have such a set? I sat down before the fire to brood over it. . . . .

The Enchanted Palace

My wife and I found ourselves in the most wonderful of showrooms. Upon tables, upon shelves, upon counters and upon stands were sets and sets and sets and sets. They ranged from tiny crystal things to the vastest of valve receivers. Under the guidance of the most obliging and delightful salesman that I have ever come across we roamed amongst them whilst he was ever ready to discuss their points or to demonstrate their good qualities by yoking now this and now that to an aerial and making it bring in broadcast transmissions from all over the place. We wandered through the showroom liking all that we saw, yet not seeing at first just what we wanted. At last we came upon it. There on a special table was the Supersonora, almost as big as a grand piano and glistening as only a Supersonora can glisten. My wife clutched my arm. "Look!" she whispered. "I am looking," I whispered. "I wish," she breathed. "So do I," I re-breathed. "Can we?" she gasped. "No, no," I groaned, "that is to say, yes, yes. We can, at all events, have a shot." "I notice," smiled the demonstrator, washing his hands with invisible soap, "that you have made your selection. Allow me to felicitate you upon your choice. You could not have chosen a finer set. Let me conduct you to the sanctum of Mr. Savit Sage."

The Interview

He conducted. We followed. We found ourselves in the presence of one even more delightful than the demonstrator. "Good morning, Mr. Everybody," he said, with a welcoming smile. "Er—" I put in, "my name is—er, that is to say—our name is Wayfarer." "Never mind about that," said Mr. Sage. "To me all my patrons—I hate the word customer, don't you?—are Mr. and Mrs. Everybody. I am quite sure that neither you nor Mrs. Wayfarer will object to my addressing you in this way?" "Not in the least," I replied, "if it means that we get better terms." "Terms?" cried Mr. Sage. "What are terms? It is quite against my principles to make terms with anybody. The word savours too much of commercialism, an idea that I abhor." "Hear, hear," I said heartily. "I beg to second that motion. If only you could see the bills that I get daily from commercially-minded people . . ." "Bills?" shouted Mr. Sage. "Disgusting. I cannot think how reputable firms can do it." I would have seconded

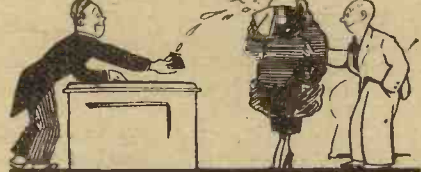


. . . Terms? What are terms? . . .

that motion too, but Mr. Sage went on talking. "And now," he said, "how can I be of service to you and to Mrs. Everybody?"

So Simple

"Mrs. Everybody and I," I said, falling into his mood, "have spent a most pleasant morning in your beautiful showrooms, and we have selected a Supersonora ten-valve supersonic super-heterodyne." "You do not superise me," cooed Mr. Sage. "It is quite obvious that Mrs. Everybody and your good self are connoisseurs for whom, if I may say so, the best is good enough. The set that you have chosen will help to brighten the little nest that you have built for yourselves. I am charmed and delighted to hear of your discriminating choice." "How nice of you," cried my wife. "The only thing that is worrying us is to know your



. . . Weeping tears into Mr. Sage's inkpot . . .

ter . . ." Mr. Sage held up a protesting hand. "That horrid word! You almost said it, Mrs. Everybody, did you not?" "Ha, ha!" cried I, digging him in the ribs. "He, he!" said he, returning the compliment. "I scored off your good lady, did I not?" "Well, Mr. Sage," I murmured at length, "leaving out all such horrid words as terms, what are we going to do about it? What?" "No, no," said Mr. Sage, "it is not for me to tell you, it is for you to tell me."

Generosity

I felt in my pockets. "Would 2s. 4d. down and eighteen-pence a month do?" I faltered. Mr. Sage's smile broadened. I observed that his glance was directed towards the floor. "If you will forgive me for saying so, Mr. Everybody," he smiled, "I observe that your boots are in need of repair. It is quite obvious to me that eighteen-pence a month will be a heavy drain upon your resources. Will you favour me by sending your footwear to our Gent.'s Boot Department, to be renovated at my expense? And shall we call it 1s. 3d. a month?" Tears welled to my eyes. Asking in a stifled voice if I might send Mrs. Everybody's shoes as well, I clasped him by the hand, speechless with emotion.

Better and Better

Mrs. Everybody, in the meantime, was weeping tears of pure joy into Mr. Sage's inkpot. Hastily closing the lid, he pushed an ash-tray to the proper spot, and patted her paternally upon the shoulder. "One of my greatest joys in life," he observed, "is that I sign my agreements not in ink, but in the tears of grateful clients. However, that inkpot is full, so you will forgive me if I provide you with an ash tray instead. In case you and Mrs. Everybody do not know it, our men will install the set free of charge, and bring it down in a plain van that even the most gossipy of your neighbours cannot mistake for a Black Maria. Our free insurance policy covers you against bankruptcy, foot and mouth disease, and twins. Under these terms you are entitled at no cost to have your accumulators charged for life, and to have all defective valves replaced for the next five years. Should circumstances make it impossible for you to pay your instalments, we will pay them for you." With a lump that felt like a doughnut in my throat, I shook him once more by the hand, unable owing to stress of emotion to utter a syllable. "As you are rather fatigued," said Mr. Sage, "my chauffeur shall take you home in my own Rolls-Royce."

The Morning After

And then I woke up.

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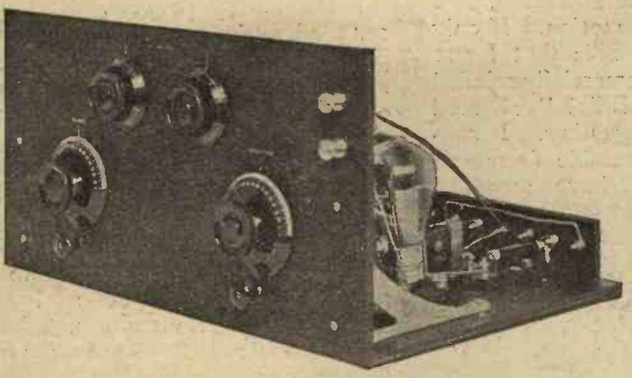


The tuning controls are placed in positions which make for ease of handling.

By L. H. THOMAS (6QB.)

The receiver described here is intended for use in conjunction with the 45-metre transmitter described in our last week's issue, and the design incorporates features which are desirable for this purpose.

THE receiver described in this article has been constructed primarily for use with the 45-metre transmitter described last week. The writer has, therefore, aimed at obtaining the greatest possible efficiency over the range of frequencies between 10,000 and 5,000 kc. (30 and 60 metres), and has not attempted to make the receiver ultra-efficient on the very high frequencies (15,000 kc. and over). It was also designed with a view to eliminating, as far as possible, all the very troublesome noises and "mush" usually associated with transformer-coupled L.F. amplification. A single resistance-coupled L.F. valve has been added to the detector in order to give reasonable signal-strength on distant stations, combined with noiseless operation.

Essential Features

Now, from the transmitting amateur's point of view, the essential points in his receiver must be:—

(i) Facilities for extremely quick searching over the entire range on which any station is likely to reply to his call.

(ii) Extreme reliability—a breakdown in the middle of a reply from a distant station is exceedingly annoying to both operators.

(iii) Ability to cover a fairly large range, in case the station with whom he is working should wish to carry out experiments on a different wavelength.

Aerial Circuit

To satisfy condition (i), it is necessary to employ as simple a reaction control as possible, and for this reason the writer has chosen a modified form of Reinartz circuit. The aerial is coupled directly on to the main coil, but should the reader wish to employ a loose-coupled aerial circuit, only the very slightest modifications are necessary. The reason for this is that the writer considers an untuned aerial circuit to be less efficient than the arrangement in use when it is necessary to cover a wide range, whereas, to tune the aerial circuit makes the operation rather more difficult, and quick search is no longer possible.

Selectivity

If a separate tapping is provided for the aerial, selectivity may be improved according to circumstances (e.g., local interference, etc.) by moving it nearer to the earth clip. An ordinary auto-coupling effect is obtained. Fig. 1 shows the theoretical circuit diagram. C2 is the reaction condenser, and C3 is a fixed condenser of .001 μF capacity inserted to protect the high-tension battery in the event of an accidental short-circuit occurring across the plates of C2. If any "overlap" should occur, however, the grid-leak R3 may be connected to L.T. negative instead of L.T. positive. The circumstances will, of course, vary with different types of valve.

High-Tension Voltages

A B4 or similar small power-valve is used as a rectifier, with a filament voltage of about 5. This is an excellent rectifier, and 60 volts plate potential suffices, in spite of the 100,000-ohm resistance in the plate circuit. Sixty volts is also sufficient for the note-magnifier, but the use of 75 or 90 volts gives a considerable increase in signal-strength. As regards grid-bias, with the full anode potential of 90 volts, 4½ volts is found to be sufficient. This is provided from the high-tension battery itself.

Valves

The valve used in the L.F. stage is actually another B.T.H. B4, but an Ediswan A.R.06 is found to give almost as good results, and, of course, a D.E.5B or

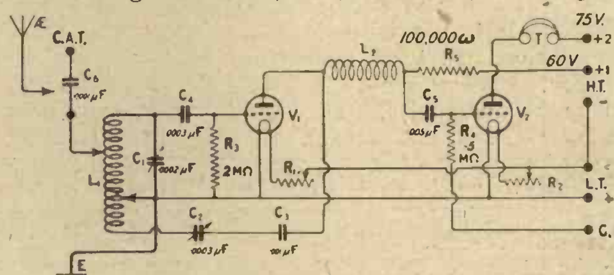


Fig. 1.—If the receiver refuses to oscillate over a band of frequencies, bringing the aerial series condenser into circuit may effect a cure.

D.F.A.4 or similar valve would be quite suitable. The amplification obtained from this single resistance-coupled stage is surprising when all adjustments of grid and plate potentials have been carefully made. The most noticeable effect, is, of course, that for which the set was expressly designed, namely, the absence of practically all "mush." It is quite refreshing to have to tap the aerial terminal before one can tell whether the set is oscillating or not!

Reducing Atmospheric Disturbances

A rather curious effect is observed when atmospherics are severe, namely, that their strength is considerably reduced by attaching the aerial on the grid side of the filament tapping on the coil, instead of employing the more usual connection on the anode side. Signal-strength is reduced by about 20 per cent., but "atmospheric strength" by something approaching 50 per cent. It is a great advantage to have a receiver that can be adapted to the particular conditions prevailing when it is used.

The Coil

The actual coil consists of twelve turns of No. 18 gauge tinned copper wire wound on a skeleton-type low-loss former. The winding is spaced equally between the ends, and only every third slot is employed for carrying the wire, i.e., the turns are all treble-spaced. The grid (through the grid-leak and condenser) is permanently connected to one end, and the aerial, earth and anode connections are all made by means of spring clips. Another refinement to facilitate experimenting is the use of clip-in condensers, so that they may be readily interchanged and the most suitable values found.

Components Used

The following is a list of the components needed for the construction of a receiver on the lines indicated in this article:—

Two "Clearer-Tone" valve holders (Benjamin Electric).

One grid-leak and condenser fitting (Dorwood).

One ebonite panel, 16 in. by 8 in. by $\frac{1}{4}$ in. (Paragon).

One baseboard, 16 in. by 11 in. by $\frac{3}{8}$ in. (Carrington Manufacturing Co.).

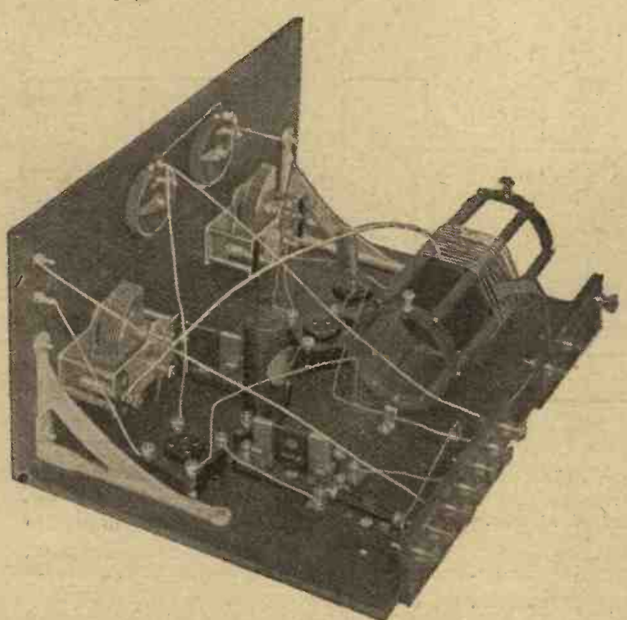
One .0002 μF variable condenser (geared) (Jackson Bros.).

One .0003 μF variable condenser (geared) (Jackson Bros.).

Two dual rheostats (McMichael).

One .001 μF fixed condenser and base (McMichael).

One .005 μF fixed condenser and base.



The arrangement of the wiring will be clear from this photograph. Note that the coil is placed well away from other components.

One 100,000-ohm fixed resistance and base (McMichael).

One .5 megohm fixed resistance and base.

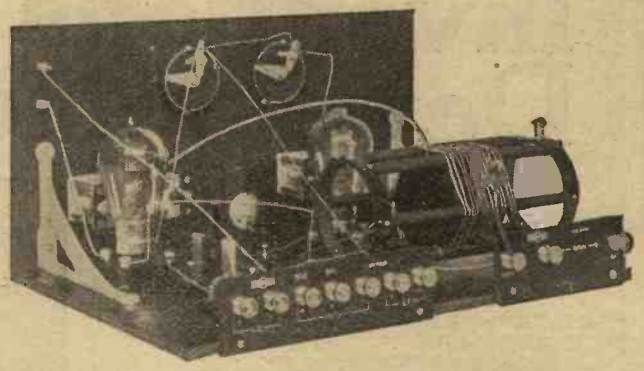
One 2-megohm grid-leak (Dubilier).

One low-loss coil former (Peto Scott).

One high-frequency choke (Lissen).

Two aluminium right-angled brackets.

One No. 1 terminal strip.



In order to facilitate adjustments the receiver is not enclosed in a cabinet.

One No. 2 terminal strip.

Two spring clips.

All wiring has been carried out by means of No. 16 gauge tinned copper wire. Square wire may equally well be used, however.

Geared Condensers

Geared condensers are almost a necessity in a receiver intended to operate on such high frequencies, and it is also desirable to use a condenser in which provision is made for direct rotation of the spindle carrying the moving plates, independently of the gearing arrangement. Those actually used employ a 60:1 gear, operating through a friction bearing, so that the main knob will rotate quite as freely and smoothly as that of an ordinary condenser.

Results Obtained

No actual constructional details are given, as no doubt many small alterations and refinements will suggest themselves to readers. The arrangement of the components and wiring will be clear from the photographs. The fact that the actual receiver described was constructed primarily to function in co-operation with a 45-metre transmitter need not, of course, deter the reader who does not possess a licence for transmission from building a similar receiver. It is an extremely useful "all purpose" short-wave receiver; telephony from WGY, KDKA and various amateurs has been very well received. In this connection the following test report may be of interest. The dates and times are all given:—

Date.	Time, G.M.T.	Call heard.	Location.	Strength *
Oct. 30	2255	PR–4JE	Porto Rico ..	R 5.8
	2256	U–8BGN	Michigan, U.S.A.	R 5.8
	2300	U–2AX	Brooklyn, U.S.A.	R 4.8
	2302	U–4WE	Georgia, U.S.A.	R 5.7
Oct. 31	2300	S–5NF	Finland ..	R 4.5
	2310	U–2BEE	New York ..	R 8.9
Nov. 1	0712	BZ–1AB	Brazil	R 5.8
	0717	U–3CDV	Philadelphia ..	R 4.6
	0720	U–9CCM	Illinois, U.S.A. ..	R 3.6
	0721	Z–2XA	New Zealand ..	R 5.8
	0725	CH–2LD	Chile	R 5.7
	1009	G–2GY	Bristol ..	R 6.9
	1045	H–9AD	Switzerland ..	R 7.9
	2208	KDKA	Pittsburg ..	R 4.5

* For meaning of second figure see "Short-Wave Notes and News" this week.

Inventions and Developments

UNDER THIS HEADING MR. J. H. REYNER, B.Sc. (Hons), A.C.G.I., D.I.C., OF THE RADIO PRESS LABORATORIES, WILL REVIEW FROM TIME TO TIME THE LATEST DEVELOPMENTS IN THE RADIO WORLD.

H.F. Amplification

IT is usually found in high-frequency amplifiers that the overall amplification falls off as the number of stages is increased. The first stage may have a voltage amplification of, say, 7. The first two stages, assuming them to be similar, should then give an amplification of 49.

Decrease in Amplification per Stage

In practice this true "cascade" amplification is rarely obtained, the amplification on the second and subsequent stages falling off very rapidly.

The factors which militate against true cascading are:—

(1) Capacity regeneration in one of the valves of the chain.

(2) Capacity regeneration between two circuits, not associated with the same valve.

(3) Magnetic intercircuit reaction effects.

True Cascade Amplification

An amplifier has been produced in America in which these defects have been overcome and the amplification really obeys a true cascade law.

The circuit is shown in the accompanying figure, which will be seen to be reasonably straightforward. The main features are:—

(1) All intervalve filter units are screened.

(2) Reverse reaction is incorporated on the H.F. stages instead of neutrodyning.

(3) Real low-loss transformers are used having H.F. resistances of less than 5 ohms.

Control of Reaction

It is found that reaction effects in *one valve only* may be permitted without spoiling the cascade effect, but if more than two circuits are permitted to oscillate the overall amplification immediately falls off. A certain feedback therefore is provided for in the second valve, which is not counter-reacted. Reaction effects are controlled by a variable resistance in the oscillatory circuit itself, this adjustment serving as a volume control.

Practical Results

It is claimed that this amplifier has proved very efficient in practice, and the principles involved should provide interesting material for experimenters in this country.

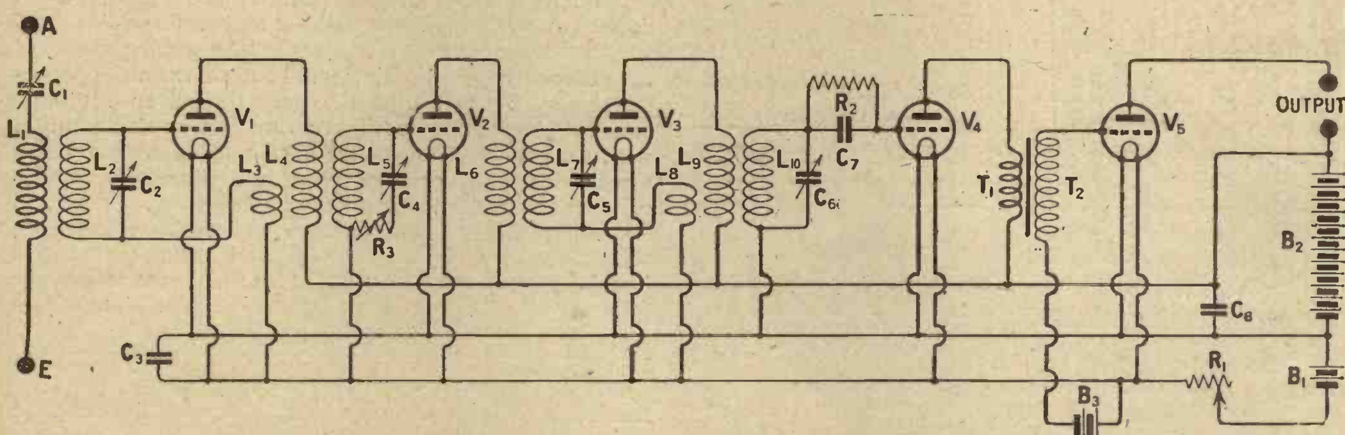


Fig. 1.—When the couplings between the various coils have been adjusted to the correct values they are left fixed. Low resistance windings are provided in the H.F. transformers, stabilisation being obtained by coils L3 and L8 providing reversed reaction effects.

An Interesting Wavemeter for Damped or Undamped Waves

By PERCY W. HARRIS, M.I.R.E., Assistant Editor.

Buzzer wavemeters normally exhibit somewhat flat tuning properties. The instrument described here is remarkable, among other interesting features, for its extreme sharpness of tuning over a wide range of frequencies.

THE progress of radio research work is intimately connected with the development of accurate measuring instruments, and the ever-increasing use of the high frequencies for transmission has made the measurement of frequencies a matter of great moment to every experienced experimenter. Wavemeters, or as we should perhaps call them frequency meters, are in the simpler and less accurate form easy instruments to construct: but if really good precision work is to be done, the problems of wavemeter construction are quite formidable.

Difficulties of Constant Calibration

For example, there are comparatively few variable condensers available at reasonable prices which can be relied upon to maintain constancy in calibration, while the inductance coil across which the variable condenser is shunted must for its part maintain calibration accurately—an acquirement which not all plug-in coils are found to fulfil! Wavemeters using oscillating valves—generally called heterodyne wavemeters—are exceedingly useful, but on the higher frequencies are particularly susceptible to changes in valves, so that the owner is liable to experience extreme annoyance on finding that immediately after he has accurately calibrated his instrument it has to be re-calibrated, because the original valve has burnt out.

Buzzer Wavemeters

I have often heard it stated that buzzer wavemeters cannot be accurate or sharp in tuning. Such a view is only correct when it relates to a wavemeter of the more conventional design, where the buzzer is shunted across the whole of the inductance. The wavemeter which I have been using with success for some time for general measurement work has a number of points of interest which I think are little known, for which reason it occurred to me that a short description of it might be of value to *Wireless Weekly* readers.

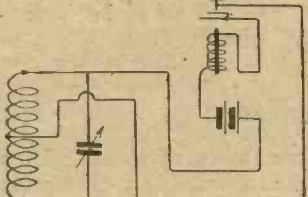
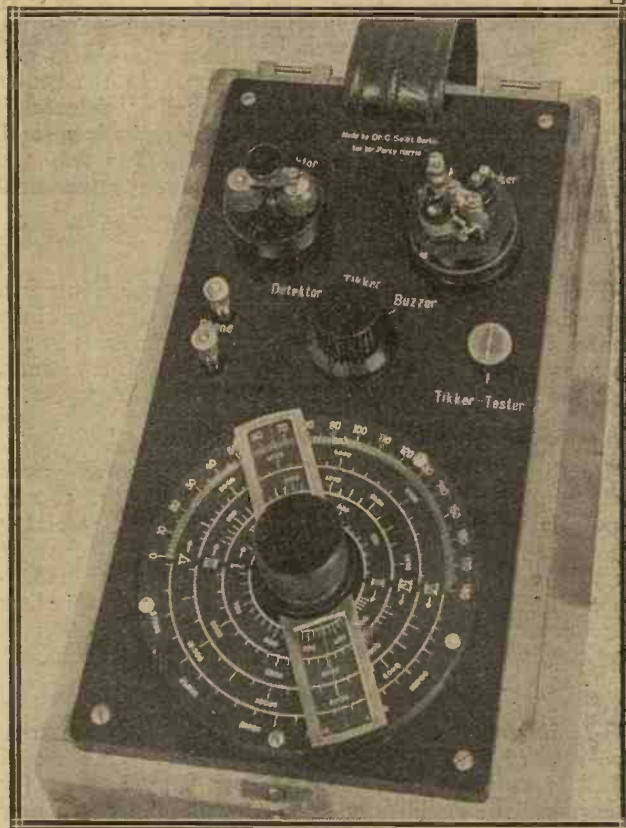


Fig. 1.—The buzzer is connected across about one-third of the tuning coil.



The scale of the dial is graduated to read either in degrees, or directly in metres, over the six ranges provided.

A Special Instrument

It was built and calibrated for me by Dr. G. Seibt, of Berlin, who specialises in instruments of extreme precision. Dr. Seibt is known by name to all advanced radio workers, and has made many valuable contributions to the art. His experience of radio work dates back for many years, for he was the first chief engineer of the Telefunken Company in Germany. Seibt Precision variable condensers are probably used in every wireless laboratory of note throughout the world.

Engraved Scales

The instrument is extremely neat and compact, measuring $10\frac{3}{4}$ in. × 6 in. and $8\frac{1}{2}$ in. deep, enclosed. There are two closed compartments, one at each end of the box. One contains the dry cells, and the other forms a container for the special plug-in coils used to cover the frequency range of the instrument. The frequency range is from 10 to 7,500 kilocycles (40 to 29,000 metres), and the instrument gives direct readings from 3,333 kc. (90 metres) downwards. For the most accurate work one reads in degrees on the upper part of the scale, which can be seen in the photograph accompanying this article. The 180 degrees scale is divided into single degrees, accurate reading to a quarter of a degree being easily possible by means of the cursor line in glass which runs over the scale.

Change-Over Switch

The arrangement of the parts is also clearly indicated in the photograph. A special combined buzzer and ticker in a metal case is seen at the right, while on the left is a crystal detector, so made that any part of the crystal surface can be brought into action by means of a swing movement on the contact arm and an eccentric motion of the crystal cup. In the centre is seen a three-way switch marked "detector," "ticker" and "buzzer," while on the right is a small press button marked "ticker tester." The two terminals on the left-hand side are for the attachment of telephone headpieces.

Coils

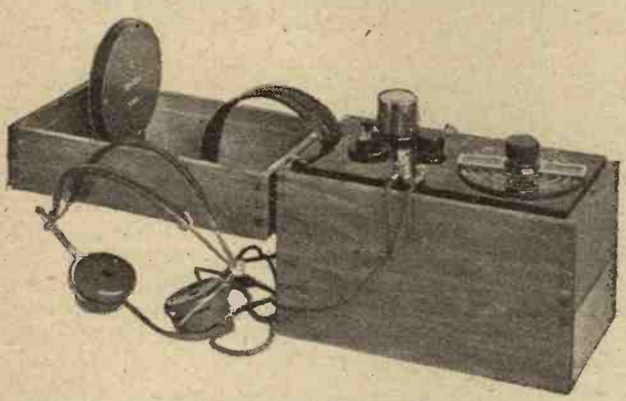
The special plug-in coils are of particular interest. For the higher frequencies the coils are carefully space wound, while for the lower frequencies they are spiral wound. All coils are wound with Litzendraht, and the ends are brought out to three contact pins.

Circuit Arrangement

By this arrangement the buzzer is connected across only a portion of the inductance, as in Fig. 1, and similarly when the instrument is used as a receiving wavemeter, the crystal detector is shunted across a portion only. The very low high-frequency resistance of the coils, and this arrangement of shunting the buzzer and the detector across only a portion of the inductance, makes for extremely sharp tuning.

The Buzzer and Ticker

The buzzer is of rather a special type, and carries two sets of contacts on its moving arm. One set of contacts operates in the usual way as a buzzer, for energising the oscillatory circuit, while the other pair is insulated from the buzzer itself and serves to make and break the current from one dry cell as a ticker.



The three leads to the coils, which are made to plug in, are enclosed in a leather band.

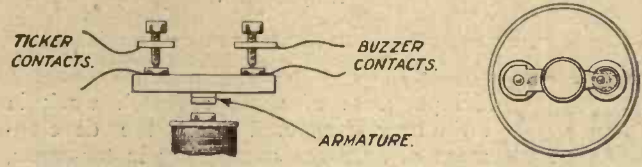
When the change-over switch is placed at the detector side, a pair of telephones can be connected, and if the wavemeter coil is brought within a foot or two of a crystal receiver connected to aerial and earth, exceedingly sharp frequency readings can be obtained. By going on to the ticker adjustment, similarly accurate readings can be made of continuous wave signals, such as the carrier waves of broadcasting stations, when no modulation is superimposed on them.

Sharp Tuning at Low Frequencies

Such is the sharpness of tuning with this instrument that at the lowest frequency the movement of a degree or two on either side of the tuning point will completely lose the signal. This point will be appreciated only by those who have attempted to do low-frequency measurement work with a buzzer wavemeter. The tuning of an ordinary buzzer wavemeter is exceedingly flat at low frequencies, and indeed on many types it is almost impossible to get a reading of any accuracy.

Connection to the Coil

It will be noticed that a flexible lead in the form of a band extends from the instrument to the coil. This



Figs. 2 and 3.—Showing (left) the arrangement of the ticker contacts on the buzzer, and (right) the detector with an eccentrically mounted rotatable crystal cup.

band terminates in an ebonite block with three spaced sockets for the pins of the plug-in coils. The band is made of leather and carries flexible leads from the wavemeter to the coil, the spacing between these leads being kept constant by their being sewn into the leather band itself. In this way the coil does not come too near the hand of the operator, and calibration is not upset by reasonable movements of the coil.

The Tuning Condenser

Both the buzzer ticker and the crystal detector are interchangeable, if necessary, and the dry cells (two for the buzzer and one for the ticker) can be replaced in a few moments, if necessary. The variable condenser is a very pleasing piece of work, both fixed and moving plates being milled out of solid blocks of metal, thus ensuring constancy of capacity and doing away with all troubles that may arise through imperfect contact between plates and spacing washers.

Calibration Charts

The whole instrument is provided with calibration curves as well as with direct readings on the dial, as indicated. Instruments of this kind, of course, are not cheap, and indeed are only made to order. I am given to understand that the calibration of my own instrument occupied two or three days, so that it is not surprising that the price is considerably nearer £40 than £4. Its use, however, is a sheer delight, and in many of the experiments which I have been conducting since my return from America it has been of inestimable value.

Developments

I am pleased to see that a number of British firms are now making good, sound and reliable wavemeters at quite a reasonable price. Such an instrument should be in the hands of every experimenter, whether he builds it himself or purchases it. The usual trouble with the home-built wavemeter is, of course, the calibration. Readers of *Wireless Weekly* will be interested to hear that shortly we shall be making an announcement of considerable importance on this subject.

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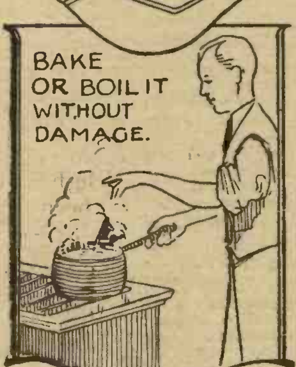

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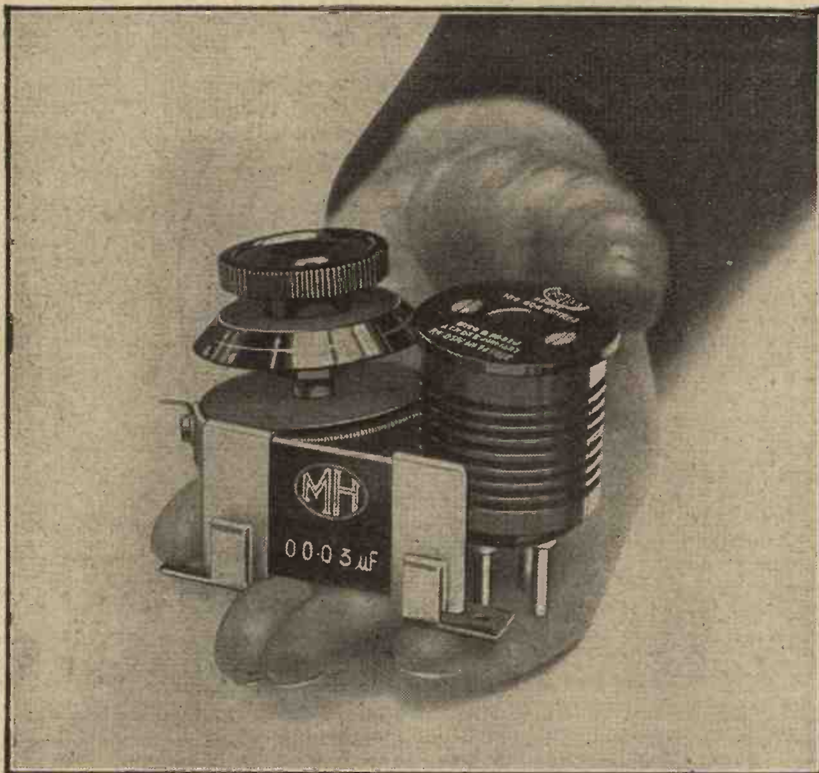
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Wireless News in Brief.

Wireless in Canada. A Canadian Government wireless station has been opened at Aklavik, in the delta of the Mackenzie River, within 60 miles of the Arctic Ocean. This station maintains direct communication with Edmonton, capital city of Alberta, across a distance of over 1,700 miles.

Aklavik constitutes the fourth station of a chain, the first link of which was opened at Edmonton last year. The first station to bridge the gap between civilisation and the Arctic region was opened at Fort Simpson, on the Mackenzie River, a year ago. But for the wrecking of the Hudson's Bay Company's steamer *Lady Kindersley* off Behring Strait last year, with the entire equipment for the Aklavik station on board, this station would have been completed some months ago.

A fourth station is in operation at Fort Smith, on the Slave River, and this forms the half-way link between Edmonton and the Arctic Ocean.

* * *

Strike of Marconi Operators. A strike took place last week of Marconi wireless operators employed on the Transoceanic and Continental services. The transmission and reception of messages by the Marconi Company from America, France, Switzerland, Spain, and other places on the Continent was affected. The strike was settled on November 4.

* * *

From Burma, 7,000 miles away, comes a report of reception of Daventry, 5XX, on August 29. A three-valve receiver was employed, and Sydney, Australia, has been heard on the same set.

* * *

Wireless at Sea. In his inaugural address to the members of the Wireless Section at the Institute of Electrical Engineers, Major B. Binyon, O.B.E., M.A., the newly elected Chairman, gave interesting demonstrations of an automatic calling device at sea and of a new direction-finding system.

On the subject of the equipment of ships' lifeboats with wireless apparatus, Major Binyon said that it had not yet been ascertained definitely whether a petrol engine or storage battery was preferable as a source of power.

The automatic calling device is capable of ringing a bell on the bridge or elsewhere on receipt of a distress signal without a human intermediary, and will work through heavy jamming. A further interesting experiment was shown, which indicated the possibility of producing a device which would automatically point to a transmitter whose signals were being received.

* * *

B.B.C. "Round Europe" Test. In the second "Round Europe" test by the British Broadcasting Company, seventeen stations were tuned in with varying success. Unfortunately, severe spark jamming, and in some cases heterodyne notes, marred the effect as a whole.

The amateur who co-operated in friendly rivalry with the B.B.C. engineers achieved some amount of success, but difficulties were encountered, it appears, when switching over from his receiver to the amplifying gear.

* * *

Licences in S. Africa. Owing to the non-payment of wireless licence fees, we understand that the three broadcasting stations in the Union of South Africa are in financial difficulties. The Government is now being pressed to introduce legislation to make the payment of fees compulsory.

Wireless Transmission of Pictures. Before the Royal Photographic Society, Mr. Thorne Baker recently claimed that it was possible to broadcast pictures in the same way that music is broadcast.

In a demonstration a portable wireless transmitter was placed at one end of the room, with an attachment in the shape of an old-fashioned cylinder phonograph. At the other end of the room was installed a valve receiver with an attachment of similar appearance to that on the transmitter. With this arrangement a picture of the King and Queen seated in a carriage was transmitted, and was reproduced completely by the receiver in a period of three and a half minutes.

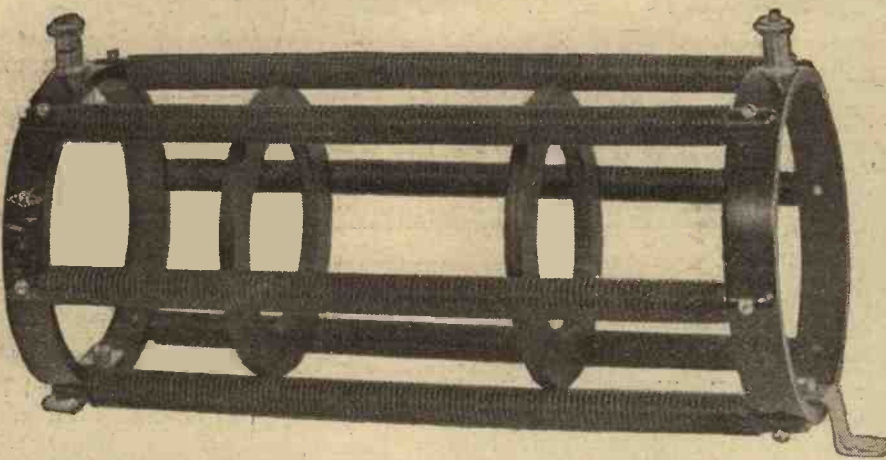
* * *

Large Coils for Rugby. Nine tuning coils, each seventeen feet high, have been made for the Government high-power station at Rugby. These had to be taken through an eighteen feet high slot made for the purpose in the wall of the North Woolwich factory in which they were manufactured.

As the railways were unable to handle these coils, owing to their size, they had to be conveyed to their destination by road. Even then the route had to be carefully examined in order to ensure that the special lorries which conveyed the coils could pass safely under bridges and beyond other obstacles.

* * *

The Dublin Station. It is hoped that the first broadcasting station in the Irish Free State will be in operation within the next two months. Its actual situation will be on the outskirts of Dublin. The power of the station will be $1\frac{1}{2}$ kilowatts, and it is announced that the frequency to be used is 770 kc. (390 metres). A station is also to be built at Cork, its main function being to relay the Dublin programmes.



The H.F. resistance of windings of fairly stout gauge wire on a former of this type are compared with windings of the kind shown opposite.

THE question of the high-frequency resistance of coils is one which has considerable bearing on the design of wireless apparatus. It has become the practice to construct coils having reasonably low resistance, as practical experience seems to indicate that better results are obtained by using such low-loss coils.

Bulky "Low-loss" Coils

In this quest for low-loss construction various types of spaced windings have come into use, and the majority of the sets nowadays which have any claim to selectivity are usually provided with these low-loss coils.

There is no doubt, however, that the construction of these coils is accompanied by certain disadvantages, which arise from the bulky nature and the fairly large stray field of such coils. Moreover, certain experimenters have expressed considerable doubt as to whether these low-loss coils really are any better than the ordinary type of coil.

The Auto-Resonator

I propose in this article to give a few preliminary results which have been obtained on the Auto-Resonator (described in last week's issue) which certainly throw considerable light on this interesting problem. As I have previously pointed out, however, the important factor in a coil is not so much the actual resistance as the ratio of the resistance to the inductance of the coil. There are also other factors which have to be considered, and it does not necessarily follow that the coil which has the best ratio of resistance to inductance would be the most suitable coil to employ in a wireless circuit.

The absurdity of this, of course, is apparent if we consider the case of a coil having a single turn only, when the ratio of resistance to inductance might conceivably be very low, but the tuning capacity required with such a coil would be so large that the voltage developed

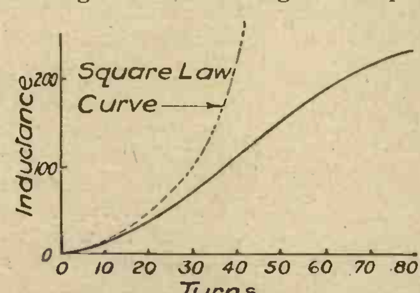


Fig. 1.—The dotted curve shows the graph obtained from the usual formula. The actual relationship for a single layer air-spaced coil is given by the full-line curve.

across it would be almost negligibly small.

Comparisons of Coils

Some interesting comparisons, however, can be arrived at if we compare coils having the same, or approximately the same, inductance, this inductance being such as can be tuned to ordinary broadcasting frequencies with a reasonable value of condenser. The first experiment, therefore, was to com-

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By J. H. REYNER, B.S
A.M.I.E.E.

In this article the auth which he has obtained q resistance of coi

pare several such coils, all of which were adjusted to tune on the Auto-Resonator with approximately the same value of capacity.

Coils Compared

Four coils were actually compared in this way. The first of these was a coil wound on a 3-in. diameter low-loss former with 22 gauge enamelled wire, the turns being spaced 1-16 in. apart. This is a typical form of "low-loss" construction. The coil, which had 44 turns, tuned to a frequency of 825 kilocycles with a capacity of 300 $\mu\mu$F. The second coil was wound with the same gauge of enamelled wire, the winding in this case consisting of 35 turns unspaced on a plain 3-in. ebonite former.

Fine Gauge Wire

The third coil was a simple hank wound coil, wound round the end of an ordinary tumbler, again with the 22-gauge enamelled wire. The outside diameter of this coil was only 2½ inches. Finally a coil was wound on a 3-in. former with 35 turns of 30-gauge double silk-covered wire. It will be remembered that, as I pointed out last week, as the size of wire was reduced, so the skin effect was also reduced, and also that more turns to the inch could be obtained. I suggested, therefore, that it was conceivable that a coil might not have an appreciably greater resistance if wound with a finer gauge of wire, and the results below will show that this anticipation was justified.

Some Results

The actual resistances of the four coils were as follows :—

Low-loss coil 10 ohms.

3 in. dia., 22 gauge, 14.1 ohms.

NG COILS MED?

:. (Hons.), A.C.G.I., D.I.C., , Staff Editor.

or discusses some results : the actual high-frequency :s of various shapes.

The H.F. resistance of fine wire windings of the types illustrated may be quite low so long as the coil is correctly proportioned.

Hank-wound coil, 10.5 ohms.
3 in. dia., 30 gauge, 9 ohms.

These results are particularly interesting. It will be seen, first of all, that there is a definite advantage obtained by spacing the winding. The coil wound on the low-loss former with only 16 turns to the inch has a resistance 4 ohms lower, i.e., about 30 per cent. better, than the plain winding.

On the other hand, the hank-wound coil, which is, of course, a multi-layer coil without any spacing, is only half an ohm higher in resistance; that is, only 5 per cent. It should also be remembered that this hank-wound coil was wound on a $2\frac{1}{2}$-in. former, and not a 3-in. former, as the other coils were, and it is conceivable that if the coil had been of 3 in. diameter the resistance would have been no worse, and possibly even a little better.

An Unexpected Result

The most surprising result of all, however, in view of our accepted ideas, is that the coil wound with the finer gauge of wire should actually have a less resistance than the low-loss coil. This amply bears out the suggestion that was made last week, that it does not necessarily follow that thick wire gives the best results.

Isolated results, however, are not conclusive. It is necessary to examine the subject in considerably greater detail before definite conclusions can be arrived at. It is interesting to consider, however, what reasons may be adduced for the increase in efficiency of the fine wire coil.

Shorter Winding

The principal reason is undoubtedly the fact that the coil is shorter. That is to say the actual length occupied by the winding is much smaller for the fine wire coil than in the case of the low-loss coil. The diameters of the two coils were approximately the same, but the low-loss coil winding was nearly 3 in. in length, whereas the fine wire winding was only just a little over $\frac{1}{2}$ in.

Now it is a fact which is not always recognised that with a single layer coil the shorter the coil is the more efficient does it become from the point of view of induct-

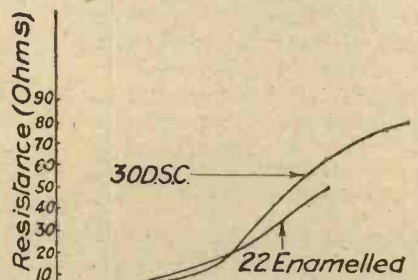


Fig. 2.—Illustrating the comparative resistance-inductance ratios of the two principal types of coils dealt with.

ance. This point of view is very well demonstrated by a simple inductance formula which I devised some time ago.

A Useful Formula

The ordinary inductance formulæ involve the use of correction curves to account for the variations set up due to the different shapes of the coils. It is possible, however, to devise a formula which will take into account the effect of the shape of the coil without the use of correction curves. The particular formula referred to is correct within about 2 per cent. for all ordinary coils, and will therefore serve to illustrate my present point admirably.

The inductance L is given by

$$L = 0.2 \left[\frac{N^2 D^2}{3.5D + 8l} \right] \mu H$$

where N = number of turns
D = diameter of coil
l = length of winding } inches.

This equation can be re-written

$$L = \frac{k_1 N^2 D}{1 + k_2 \frac{l}{D}}$$

where k_1 and k_2 are constants.

Length-Diameter Ratio

From this formula it will readily be seen that as the ratio of l/D is reduced so the inductance for a given number of turns increases. Conversely, if we require a particular inductance, then the number of turns required to obtain this inductance will be less with a short fat coil than with a long thin coil. With the thinner gauge of wire it is possible to obtain a greater number of turns to the inch, so that the coil becomes shorter, with the result that the actual number of turns required is smaller.

Efficiency of Short Coils

In the case we have just considered, only 35 turns of the fine wire were required, as against 44 on the low-loss former. We can develop this point a little farther.

Fig. 1 shows the relationship between the number of turns on a low-loss former, having a winding of 16 turns to the inch, and the actual inductance obtained. It will be seen that the inductance is by no means proportional to the square of the number of turns, as is sometimes assumed for rough calculations, due to the increase in the ratio of l/D. There is thus every reason for making coils short and fat, if efficient types of inductances are required.

Multi-layer Coils

I am, of course, referring in the present article only to single-layer coils. The question of multi-layer coils involves other considerations which I hope to discuss in future articles. For the present, however, attention is confined to single-layer coils entirely.

Measurements

With a view to investigating this question of ratio of length to diameter rather more closely a series of readings were taken on two coils. The first coil was wound with 22-gauge wire on the low-loss former of 3 in. diameter previously referred to, and the number of turns was gradually reduced from a maximum of 82 down to a minimum of 12. In the second case, a coil was wound with 85 turns of 30-gauge D.S.C. wire, and the turns were gradually reduced down to a minimum of 20. The actual values of the resistances obtained are given in the accompanying table. The inductances were measured as well as the resistance at each point, and Fig. 2 shows the variation of the resistance, in terms of the inductance of the coil.

"Low-Loss" Coil No. 22 Gauge Enamelled

No. of turns.	Inductance (μH)	Resistance (ohms).
12	20	0.9
24	58	4.5
34	80	6.0
44	120	10
54	160	13.7
65	210	22
82	240	36

No. 30 Gauge D.S.C. Coil

No. of turns.	Inductance (μH)	Resistance (ohms).
20	60	5.25
30	95	6.1
35	155	9
40	215	24
65	425	82
85	750	219

A Critical Point

It will be seen that up to a certain point the resistance increases only comparatively slowly as the inductance is increased, but after a certain point the curve of resistance begins to rise more rapidly. This indicates, therefore, that with a coil having too high an inductance, the resistance may be very large, but on the other hand, if the inductance is reduced to too small

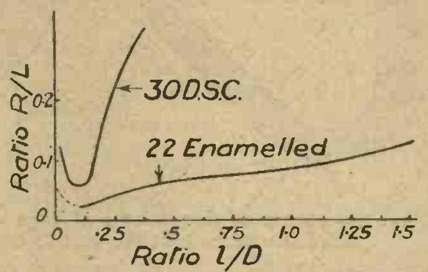


Fig. 3.—The resistance of the fine wire coil after a certain point increases rapidly with an increase in the length of the winding for a constant diameter.

a value, the resistance does not fall off in the same proportion, and the coil therefore again becomes inefficient.

Resistance and Coil Shapes

The best point to work the coil is obviously one round about the point where the curves are beginning to rise. More information is obtained, however, from the curves of Fig. 3, which gives the ratio of resistance to inductance in terms of the ratio of length of winding to diameter. Here it will be seen that as the ratio of l/D is decreased, so the ratio of resistance to inductance falls off, until a minimum point is reached when the length of the coil is about one-eighth of the diameter.

Turn Numbers and Resistance

The minimum in the case of the finer wire coils is much more pronounced, and the rise of the ratio

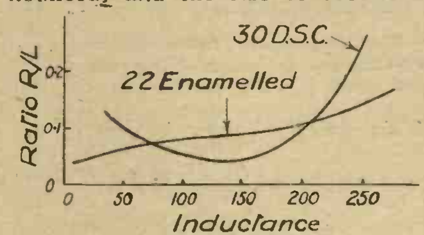


Fig. 4.—The advantages of the fine wire coil will be apparent from these curves.

of resistance to inductance is much more marked. Moreover, the actual minimum is appreciably lower in the case of the coil wound with the thicker wire. This is, of course, what one would expect, because there is no doubt that a given length of wire of a thicker gauge must of necessity have a lower resistance.

Superiority of Fine Wire

What these curves do not emphasise, however, is that the fine wire coil has a much higher inductance for the same length of wire. Fig. 4 is a curve showing the ratio of resistance to inductance, plotted against the actual inductance of the coil itself, and here the advantage of the fine wire coil is at once apparent. It will be seen that as the inductance of the coil is increased, so the ratio of resistance to inductance also gradually increases in the case of the thick wire coil. The coil wound with 30-gauge wire, however, shows a distinct minimum in the neighbourhood of 130-140 μH inductance. Moreover, the actual ratio of resistance to inductance over a range of from 75 μH to 200 μH is definitely less than in the case of the thick wire coil.

Inductance and Gauge of Wire

Outside these ranges the thin wire coil is appreciably and increasingly worse than the thick wire coil. In such a case, however, one would obviously use a different gauge of wire, and one would expect to obtain a series of curves, all of them efficient over a certain band of inductance, and the suitable coil to use would depend upon the actual inductance values employed. I hope to investigate the point in more detail shortly.

Conclusions

These results, therefore, indicate first of all that the low-loss type of construction is not by any means the best that can be obtained. Secondly, that the use of a thinner wire is capable of giving quite appreciably better results under certain conditions. The results open up lines of investigation for the serious experimenter. One of the next things to try is that of winding coils of fine wire, but spacing the windings. In the present case a comparison has been made between a spaced winding of fairly thick wire and an ordinary close winding of thin wire, which is, of course, hardly a fair comparison in some respects. The results, however, are not intended to be anything more than preliminary, and will simply serve to indicate that our present ideas on the subject of what constitutes a good low-loss coil are by no means necessarily correct.

SHORT-WAVE *Notes & News*

WITH the rapidly-improving reception conditions every possessor of an efficient receiver will experience little difficulty in tuning in stations in all five continents. It will therefore be necessary to keep as complete a log as possible, and for this the following scheme for recording signal strength has been suggested. Instead of logging a station as "R6," "R9," etc., the letter R is followed by *two* figures, the first representing the actual signal strength, on a scale ranging from 0 to 9, and the second what may be termed the "interference ratio."

A Double "R" Scale

For instance, if an extremely strong (R9) signal is heard, but is only half readable on account of severe jamming, the station would be reported as "R95," i.e., R9, 50 per cent. readable. The second figures represent the following: 9—100 per cent. (or 90 per cent.) readable, 8—80 per cent., and so on. Thus one would know, on looking through the log, that although one signal might be very weak (R28), yet it was more easily readable than another much stronger signal (R53), as it was subject to less interference.

Conditions Improving

During the last week conditions have been extremely favourable for the reception of signals from distances greater than 3,000 miles. Although the nearer American amateurs have not been even moderately strong, the South American and Australasian signals have been quite exceptional.

Some Stations Heard

On a two-valve receiver (detector and one resistance-coupled L.F.) the following stations were heard after 6.30 a.m. on the morning of November 1:—Brazilian, 1AB, 1AP, 1IA; Chilian, 2LD; New Zealand, 2AQ, 2XA, 4AR; Australian, 2CM, 3BD. We shall soon be able to decide whether 6,667 kc. (45 m.) signals are going to improve as winter progresses, or whether they are at their best now, and are about to fall off towards mid-winter, rising to another "peak" in the early spring.

15,000 Kc.

To those who are unable to receive good signals on 15,000 kc. (20 m.) the following may be of interest. Until quite recently the writer had a receiver which was perfectly efficient on frequencies in the neighbourhood of 10,000 kc. (30 m.), but, although it would oscillate on 15,000 kc. and above, refused to receive any readable signals. It seemed altogether dead, until the writer remembered that it was in a room with a large lead roof. Earthing the latter improved signal strength considerably, while using it as an aerial effected a further improvement. (There was, of course, no insulation except the brickwork, but in spite of this it functioned quite satisfactorily.) Large conducting masses have a considerable screening effect on all frequencies, but it increases enormously as one approaches such frequencies as 15,000 kc. This roof must have had a tremendous effect to "blanket" out signals almost completely.

Mr. W. E. F. Corsham (G2UV), who has worked telephony with 7XX of Yugo-Slavia.

Europe

Some new European countries are now entering the field of amateur transmission. P1AB (Portugal) has been heard on 5,000 kc. (60 m.), and GHA, of Malta, is in evidence on 6,667 kc. (45 m.). Russia is also represented by NRL, RDW and NCRL, all call-signs of radio laboratories. The Balkans seem to be the most backward part of Europe at the present time.

Our Own Work

Our own stations continue to do good work, both local in daylight and distant at night. In the early evenings, and throughout the week-ends, on a receiver in London, all the northern British transmitters seem to be tremendously strong. G6OH, of Stafford, is generally about R69, although his input is 2½ watts to an A.R.D.E. valve! 5SI also is extremely consistent, although he employs very low powers. We hear that he has worked New Zealand with 12 watts and Porto Rico with ½ watt. We shall soon have to mention our inputs in milliwatts! G5RZ has also worked Porto Rico with less than 20 watts input on 6,667 kc. (45 m.).

G2KF has worked Canadian 1AR throughout the twelve hours from 2 p.m. to 2 a.m. G.M.T. (i.e., 9 a.m. to 9 p.m. at the Canadian's station). This work was done on 15,000 kc. (20 m.).

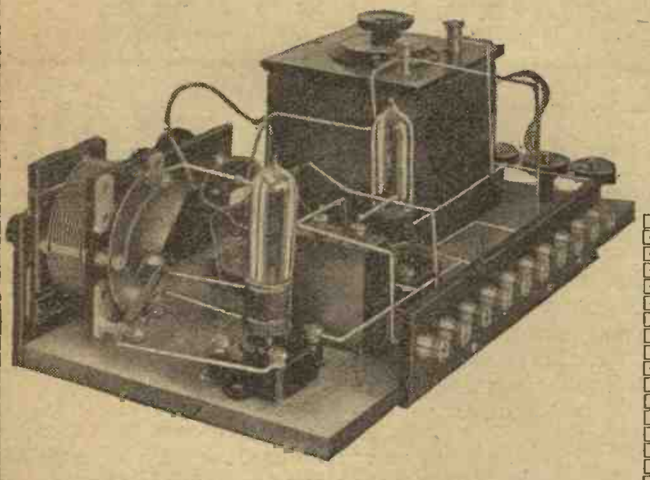
Telephony

The higher frequencies are rather disappointing in connection with telephony. "Night distortion" and "distance distortion" both mar the quality seriously, but perhaps the worst bugbear is the very rapid fading that often occurs. WGY (2XK) and KDKA, however, are both well worth listening to.

Some Further Notes on the Auto-Resonator

By J. H. REYNER, B.Sc. (Hons.), A.C.G.I., D.I.C., A.M.I.E.E., Staff Editor.

In this article the author gives details of certain calibrations and checkings which have to be carried out when the Auto-Resonator is first constructed, and also gives details of other measurements which may be carried out with this instrument.



The Auto-Resonator, which was fully described in our last week's issue.

When the Auto-Resonator is first constructed, there are one or two measurements which have to be made in order to determine certain constants of the instrument before it can be used for actual measurements. The most important of these is the calibration of the fixed condensers which are placed in parallel with the variable condenser, as required. These condensers may, of course, be purchased from the makers with a definite calibration, but even so an additional check is valuable.

Testing Clip-in Condensers

The actual capacities may be tested very simply by means of the following method. With no added capacity in circuit, connect a coil across the test terminals, and adjust the frequency of the oscillator so that the coil tunes with the variable condenser nearly at the top of the scale (*i.e.*, with a capacity of about .00012 μF). Now clip in the .0001 μF fixed condenser and re-tune on the variable condenser. It will be found, of course, that the variable condenser has to be reduced to a value in the neighbourhood of .00002 μF only. The actual difference between the two readings is equal to the capacity of the condenser which has been clipped in.

Higher Values

To calibrate the .0002 μF and higher values of parallel capacity, the circuit should first be tuned with the .0001 μF condenser in parallel, and the variable condenser towards the top of the scale as before. The frequency of the oscillator will, of course, have to be re-adjusted. Then, by clipping in the .0002 μF condenser, and again reducing the value of the variable condenser, the difference in the two readings will give the increase of capacity obtained by changing from the .0001 μF to the .0002 μF.

An Example

For example, if the .0001 μF condenser actually works out at .000097 μF, and the increase is found to be .000094 μF, then the actual value of the .0002 μF condenser would be the sum of these two values, that is to say, .000191 μF.

In a similar manner the values of all five parallel capacities may rapidly be checked up. It is desirable to take a certain amount of trouble with this measurement, and to take several readings, until the same result is obtained each time, because the accuracy of all the measurements carried out with this instrument depends upon accurate knowledge of the capacity in circuit.

Circuit Capacity

There is another point which requires calibration once and for all when the instrument is first constructed, and that is the capacity of the various leads, the valve holder, and the valve, which are connected in parallel with the actual tuning capacity. This capacity is usually quite small, in my own instrument it is only about 10 μμF, but in cases where the test coil is tuned with a small condenser only, this additional capacity may affect the results obtained.

A Further Example

It will be remembered that the formula for the resistance is

$$R = \frac{C-C_1}{\omega CC_1}$$

Now it will be seen that if there is a small parallel capacity added across the calibrated condenser, the difference between the two readings C and C_1 will remain the same, but the actual values C and C_1 will be slightly increased. Since both C and C_1 occur in the denominator of the expression, this variation of capacity will cause an appreciable alteration in the result. For example, suppose that the difference in capacity were 3 μμF, and the actual capacity values were 50 μμF and 58 μμF respectively. Then at a frequency of 825 kilocycles, this would give a resistance of 250 ohms. If there were, however, a parallel capacity of 10 μμF in parallel with the variable condenser, the expression would become

$$\frac{3\times 10^{12}}{2\pi\times 60\times 68\times 825\times 10^{3}}=142 \text{ ohms}$$

thus giving a reduction in the resistance of nearly 100 per cent.

Method of Estimating Stray Capacity

It is desirable, therefore, to be able to estimate the stray circuit capacity with a reasonable degree of accuracy, and this fortunately may be done comparatively simply. It will be remembered that the local oscillator was synchronised with the local broadcast station by listening on an ordinary receiving set, and varying the frequency of the local oscillator until a heterodyne note was heard.

A wonderful achievement

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now at a price within the reach of all

IT is doubtful if there is a single wireless enthusiast who has not heard of Brown A-type Headphones. Not everyone, however, who has coveted them has been able to buy them—in fact, owing to their comparative high price, only a small proportion have been able to enjoy their advantages.

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Now this heterodyne note can be heard not only when the local oscillator is tuned approximately to the same frequency as the local broadcast station, but also a very faint oscillation can be heard when the local oscillator is tuned to a frequency of twice that of the local station. This phenomenon may therefore be employed in the calibration of the Auto-Resonator.

Details

First of all tune in the oscillator to the local broadcast station. Connect a suitable coil across the test terminals of the set, and adjust the value of this coil so that the set tunes towards the bottom of the scale of the calibrated condenser. Note the reading of the condenser (C_1) at the point where the heterodyne whistle is zero, as described last week. Now tune the local oscillator to double its original frequency, detecting the actual tuning point by the heterodyne method just described, and re-tune the test circuit until the milliammeter again indicates resonance. Note once more the reading of the calibrated condenser (C_2).

A Necessary Measurement

The total capacity in the circuit, including such stray circuit capacities as may be present, must now be four times what it was in the original case. This, therefore, enables us to determine the stray capacity in the circuit directly from the expression

$$\text{Stray Capacity} = \frac{C_2 - 4C_1}{3}$$

It will be thought possibly that all this is a rather troublesome and complicated process, and it must be admitted that there is a certain amount of trouble attaching to the initial calibration of the apparatus. It should be borne in mind, however, that these adjustments have to be made once and for all, and when they are done they will not require to be repeated.

Value of Careful Checking

Some little trouble should be taken, therefore, to carry out these tests so as to provide a reliable calibration of the instrument, because, as has been indicated previously, the uses to which the instrument can be put are very numerous, once it has been satisfactorily constructed and calibrated. In my own instrument the stray circuit capacity is 10 $\mu\mu$F, and this value must be added to all the readings of capacity which are taken.

A Practical Case

An example will probably serve to make this point clear. The local oscillator was adjusted to resonance with the frequency of 2LO, which was 824.6 kilocycles. (For the purposes of this measurement the figure is taken as 825, because the experimental error in the instrument is not less than 1 per cent. The local station may also vary in frequency to a small extent.) With a particular coil in circuit, the capacity when the circuit was in resonance was 346 $\mu\mu$F, and when the circuit was mis-tuned to give a half deflection the capacity was 357 $\mu\mu$F.

Some Interesting Results

Both these capacities have to be increased by 10 $\mu\mu$F to allow for the stray circuit capacity, so that the resistance of the coil is given by

$$R = \frac{11 \times 10^{-12}}{2\pi \times 825000 \times 356 \times 10^{-12} \times 367 \times 10^{-12}} = 16{\cdot}3 \text{ ohms.}$$

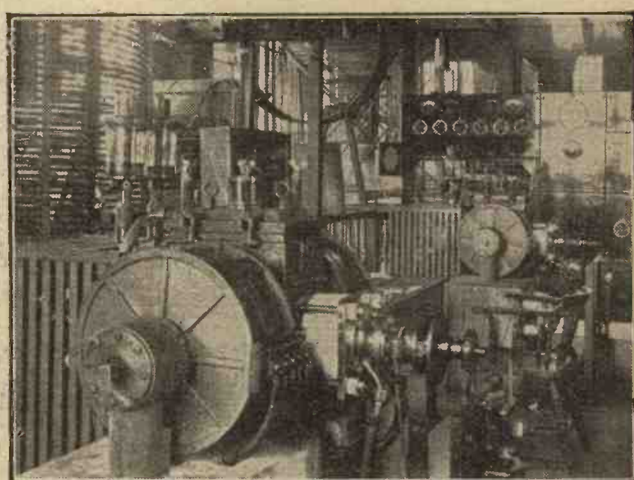
On another page of this issue some actual results taken on tuning coils of various forms are given, and the results are so interesting that the value of this instrument will readily be seen.

Measurement of Capacity

The Auto-Resonator may readily be used for the measurement of capacities. All that is necessary is that the particular condenser to be measured shall be connected in parallel with the variable condenser. This latter instrument should be placed at some definite reading, towards the bottom of the scale, say, at 10 degrees, and the local oscillator is then adjusted until the milliammeter gives an indication of resonance. The test condenser is then removed and the circuit re-tuned by clipping in a suitable parallel capacity, and re-tuning on the standard variable condenser. The difference between the readings on the standard condenser in the two cases (making due allowance for the added capacity in the latter case) will then be equal to the condenser of which the capacity is required.

Measurement of Inductance

Inductances may also be measured by means of this instrument. It is necessary in this case to synchronise the oscillator with the frequency of the local station, after which the test coil is tuned to resonance with this frequency. Then, knowing both the value of the tuning capacity and the frequency to which it is tuned, the inductance may readily be obtained from the expression :—

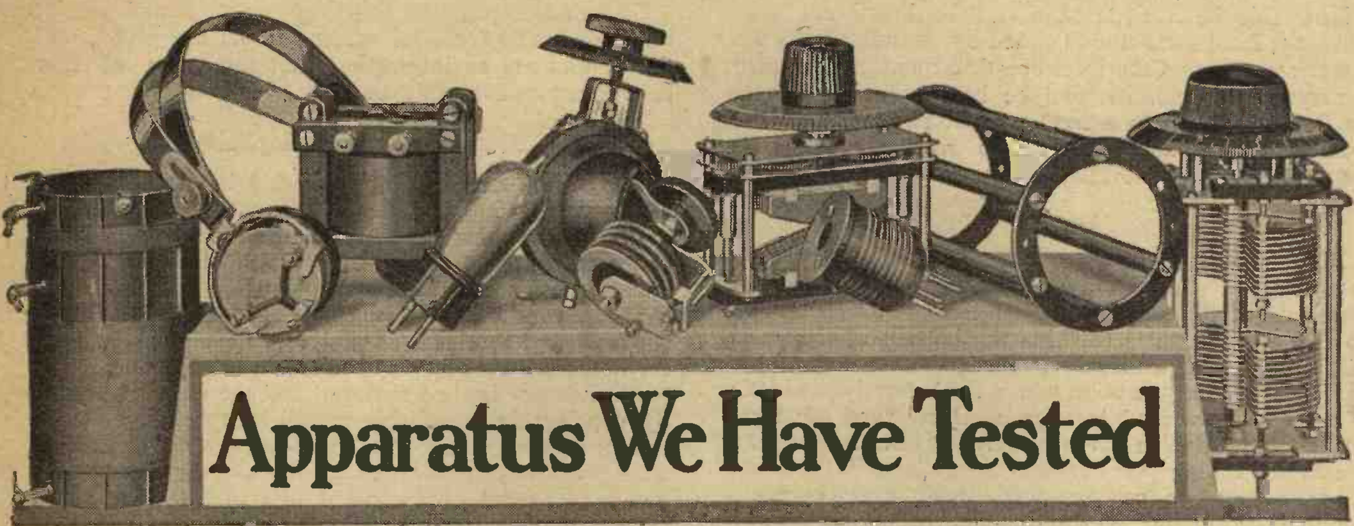


A view in the Post Office Wireless Station at Northolt, showing the arcs.

$$L = \frac{2.54 \times 10^{10}}{f \times C} \mu H$$

where f = frequency in kilocycles/sec.
C = capacity in $\mu\mu$F.

It will thus be seen that this instrument, once it has been properly adjusted and calibrated, is capable of supplying a variety of information concerning tuning circuits, so that the design of sets and apparatus is very considerably simplified.



Apparatus We Have Tested

Conducted by Radio Press Laboratories, Elstree.

Vernier Basket Coil Holder

Messrs. Harding, Holland & Fry, Ltd., have submitted to us for test their "Harko" basket coil holder with vernier attachment. The basis of this is a strip of insulating material 5 in. × $1\frac{1}{2}$ in. rectangular in shape, except for a curve which rounds off its upper end. A longitudinal slot extends from the top to two-thirds of the way down the strip. The provision for fixing the coil consists of another strip 3 in. × $\frac{3}{8}$ in., which can be fastened at right-angles to the former main strip by a nut and bolt passing through the slot. The coil is fixed between the two strips mentioned, and thus by loosening the nut it can be moved up and down the holder, and if necessary completely removed from the end.

The plug and socket are not fitted directly into the main strip, but into a block of insulating material $1\frac{1}{8}$ in. square by $\frac{3}{8}$ in. thick. This carries four brass pins projecting normally about $\frac{3}{8}$ in. from the four corners of its face. Four holes are drilled in the end of the main strip to correspond with these. Thus the pins act as guides for a $\frac{1}{4}$-in. motion of the coil. The motion is controlled by a brass screw, which passes through a nut embedded in the centre of the face of the insulating block, and a corresponding hole in the main strip. A nut on either side of the latter secures it in position, so that as the screw rotates the main strip moves backwards and forwards in relation to the block. The rotation of the screw is controlled by a knob of moulded material. The screw does not screw directly into this, but into a nut embedded within it. A locknut is also provided. It was found that about ten revolutions of the knob were required to move the coil through its maximum distance. The terminals are fixed on the insulating block on the same face as the knob, which is on the opposite face to that on which the main strip is fixed. The terminals screw right into the brass sockets, so that the contact should be satisfactory. It is unfortunate, however, that no washers are provided for the terminals, as the ends of the coils can only be secured between the terminals and the insulating material of the block.

Two sockets are provided, and the plug can be withdrawn from one and inserted in the other. This is necessary if coil holders of this type are to be used on both sides of a three-way coil holder.

The finish of the specimen submitted is quite good, but adjusting the vernier involves a motion which is somewhat erratic. This is sufficient largely to reduce the benefit of the fine adjustment. Another drawback is that the vernier knob is very stiff to turn, so that there is a danger of altering the coarse adjustment provided.

Double Eccentric Crystal Detector

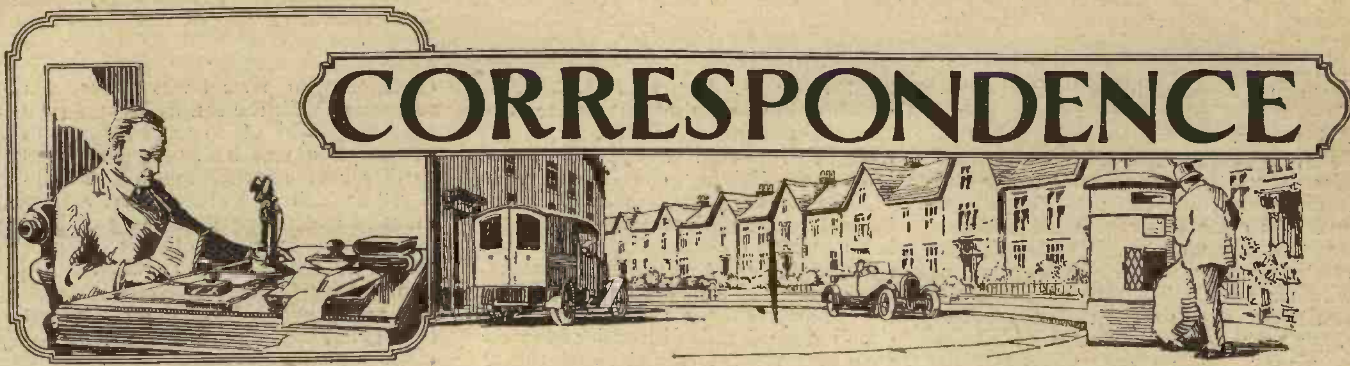
Messrs. Auto Equipments have submitted to us for test their "Double Eccentric Crystal Detector." This detector is a very compact affair, being only about 2 in long by $\frac{1}{2}$ in. wide, while when mounted its height above the panel is not more than $\frac{3}{4}$ in. The Perikon crystal combination, i.e., zincite and bornite, is employed, and is enclosed in a glass case of the horizontal type. The ends of the case have plated metal caps stamped in the centre so as to form circular bosses, and these fit into corresponding holes in the angle brackets, which support the glass case. The brackets are fastened down to the ebonite strip provided by screws and nuts. Each screw is provided with two nuts and a washer, and serves as a terminal.

The crystal cup containing the zincite is mounted eccentrically, and can be rotated by a small revolving knob. It is held in position by a spring, but unfortunately this is of steel and in the specimen examined had rusted. The crystal cup containing the bornite is not eccentric, but the crystal itself, which is in the form of a pointed chip, is mounted eccentrically. The cup containing it can be rotated in the same way as the cup containing the zincite, but has also a longitudinal motion controlled by a spring. Both the crystals are mounted in Wood's metal.

It was found on test that all except a very small area at the centre of the flat surface of the zincite could be explored by the point of the bornite crystal. Adjustment was very easy, but the spring alone did not produce a firm enough contact, and it was necessary to grind the two surfaces together slightly. A stronger spring would also be an advantage in that it would increase the stability of the detector. On test it was found extremely difficult to spoil a contact entirely by banging the table on which the detector was laying, but it was, however, not very difficult to alter the rectified current by about 10 per cent. by this means.

Although the Perikon type of detector is advantageous where stability is required, the specimen submitted was found to have fewer sensitive points than an average specimen of galena, and the sensitve spots, when found, also gave smaller rectified currents than galena. Thus on London about 18 microamps were obtained, whereas an average crystal will give between 25 to 30 microamps on the same aerial. It was found difficult to obtain Daventry at all, whereas generally a crystal will render speech just readable at our laboratories and on the particular aerial employed.

In cases where stability is more important than signal strength this detector will be found useful, and if it is desired to use a double crystal combination, then this type of detector can be recommended.



THE "TWIN-VALVE" RECEIVER

SIR,—I have recently constructed the "Twin-Valve" Receiver described by John Scott-Taggart, F.Inst.P., A.M.I.E.E., in No. 3 issue (January) of *The Wireless Constructor*, and in Radio Press Envelope No. 10, and have been getting splendid results with same, the signals being very pure.

The following are the stations received with the "Twin-Valve" up to the present: — Aberdeen, Cardiff, Bournemouth, Birmingham, and Radio Paris.—Very strong 'phone strength. Newcastle, Petit-Parisien and one Continental station (no call-sign).—Tuned in on L.S. fair strength. London (with or without reaction coil). —Audible on L.S. all over the house. Daventry.—Not quite such good strength as London.

I am about three miles (direct) from 2LO, and without any wave-trap can tune this station out and receive Birmingham and a Continental station (which I have not yet been able to identify) at very strong 'phone strength.

The valves I am using are Cossor-Wuncell W2 as the "Dual," and Cossor-Wuncell W1 as the detector. Voltage H.T. 1, 104, H.T. 2, 68; grid bias, 3 volts. Coils.—Aerial 60, reaction 35. For Daventry I use 150 and 200, which I made from the particulars given in the article "Easily Made Plug-in Coils for 5XX," which appeared in the November, 1924, issue of *The Wireless Constructor*. The panel lay-out is exactly as per original design, except that I have incorporated an on-and-off switch for the filaments. The cabinet I made according to the details given, with the exception that I have made a hinged back instead of a hinged top.

I much appreciate the arrangement of the battery leads, and although I am using an accumulator instead of dry cells, I have taken the leads through the panel as in the original receiver and down into the lower cabinet which contains the high-and-low-tension batteries.

I have made up several of your sets, but the "Twin-Valve" is, in my opinion, the best two-valve receiver yet designed, and I wish to thank you for giving such a splendid circuit.

Upon my recommendation, two of my friends are making up the receiver from Radio Press Envelope No. 10, and will, no doubt, be writing you their results later on.

Wishing you every success.—Yours faithfully,

B. W. PATTEN.

London, S.E.15.

THE T.A.T. IN SOUTH AFRICA

SIR,—You will be interested in results obtained with the T.A.T. system (described by John Scott-Taggart, F.Inst.P., A.M.I.E.E., in the November, 1924, *Modern Wireless*) in South Africa.

I should imagine that no two countries put together have such terrible atmospherics as we have. One good night per month is about the average for nine months in the year. For this reason I decided to use an indoor aerial with multi-stage H.F. amplification. After reading your article I tried out the T.A.T. system with one alteration. In place of using tapped coils I used 150 coils and damping plates. Using four H.F. valves, the results are remarkable, Durban, 400 miles, Capetown, 750 miles, coming in at full loud-speaker strength on an indoor aerial 80 ft. long, run under an iron roof. The best result obtained in so far as elimination of atmospherics is concerned was by using a "Human Aerial," four people joining hands, the first touching aerial terminal. Durban came in at moderate loud-speaker strength and atmospherics were practically eliminated. I have not yet patented this aerial!

On outdoor aerial signals are too powerful when the four H.F. valves are used, and I cut down to two tuned anodes. Strongest results on indoor aerial are obtained on first valve 150 coil, the remaining three H.F. tuned anode checked by potentiometer. Valves used: First two H.F., "R.," second two H.F., D.E.3, detector and first L.F., D.E.3, second L.F., D.E.4.

I have several times picked up Bournemouth, London and Madrid, but using four H.F. valves results in a roar similar to a barrage, and I have to come down to two H.F. valves; even then the noise is usually deafening. KDKA and Buenos Aires come in without any disturbance, the former being very powerful. Unfortunately I cannot use four H.F. valves for KDKA, as I have not the necessary coils, and in any case I am afraid that tuning would prove almost impossible.

Trusting you will find this information of some interest.—Yours faithfully, REGULAR READER.

THE "FIVE-CIRCUIT ONE-VALVE" RECEIVER

SIR, — Several months ago my brother and I decided to make a single-valve receiver. We searched through a few dozen wireless magazines and decided to construct the "Five-Circuit One-Valve" Receiver described in *Modern Wireless*, April, 1924, by E. H. Chapman, M.A., D.Sc.

We had had no experience with valve sets before this, and felt like the "Innocents Abroad." However, from the excellent photographs and diagrams, we constructed the set, and have received the following telephony stations (all call signs received):—

British.—All B.B.C. main stations; eight amateurs, including 2BB (53 miles), and Croydon Aerodrome.

Foreign.—FL, SFR, Radiophone du Midi, Toulouse, EAJ13, Munster, Konigswüsterhausen, Hilversum, Rome and Vienna.

Also many other unidentified stations.—Yours faithfully,

C. J. OUGH.

London, N.19.

THE ACCEPTOR WAVE-TRAP

SIR,—I should like to express my great appreciation and thanks for the best wave-trap which has yet appeared in the pages of your journals. I refer to the Acceptor Wave-Trap described by Mr. G. P. Kendall, B.Sc., in the October, 1925, issue of *Modern Wireless*, which I made up a few days ago, after having tried all others which have appeared in *Modern Wireless* and *The Wireless Constructor*. For the first time I have been able to cut out my local station completely when receiving London or Bournemouth, without any detectable loss in signal strength. I was astonished and delighted on a recent afternoon in full daylight to be able to separate Stoke-on-Trent from Bradford, a difference of only four metres in wavelength, getting each station without a trace of the other, by means of the trap, a thing I have never been able to do before. In my opinion this trap has a great future so long as the ether is so congested.

May I also express to Mr. Percy W. Harris my congratulations on the Anglo-American Six (*The Wirsless Constructor* for January), which I have used for about six months and which I built for long-distance work. It is a wonderful set, and the purity with which long-distance stations come in when the conditions are favourable must be heard to be realised. All B.B.C. main stations and some relays come in well in addition to most Continental stations, when all are going full power. Apart from B.B.C. stations, I enjoy best Hilversum and Koenigswüsterhausen, which can be heard beautifully on most evenings, and it is often difficult to tell without knowing the wavelength to which the set is tuned or hearing the announcer, whether one is listening to the local station or not, so quiet is the background when there is no morse.

It may be an encouragement to others to say that I am quite a novice at radio science, commencing twelve months ago with a high-class commercial two-valve set, and the Anglo-American Six is the first radio set I have made. Carefully following the detailed instructions given in *The Wireless Constructor*, it presented no difficulty whatever, and its manipulation is easy after a week's practice.

As excuse for my letter I may say that I think it is the duty of those who take advantage of the information you are spreading in your excellent journals at such a small cost to the public, to acknowledge the pleasure derived from a Radio Press set. Wishing you continued success.—Yours faithfully,

E. N. Ramsbottom,
M.A., M.D. (Lond.), B.Sc., D.P.H.

Manchester.

D.C. MAINS FOR FILAMENT HEATING

Sir,—Having urgent need of an accumulator one night to work my wireless set (one taken from *The Wireless Constructor* for August, a Two-Valve Double Reaction Receiver, by Stanley G. Rattee, M.I.R.E., of which I have nothing but praise, due thanks to your excellent book), I thought I would utilise the house D.C. 100v. lighting circuit by means of the existing switch and lampholder, so I just replaced the lamp with one of higher voltage suitable for *twice* the amperage of one valve of the set, and found the polarity of the switch terminals, simply pushed ends of length of flexible wire into these terminals, and thence on to set L.T. + and – terminals. I then adjusted the filaments by means of the existing rheostats, but was careful to keep both simultaneously adjusted, owing to their parallel wiring. The light switch is kept in the " off " position, the amperage of the lamp thus flowing through the valve filaments. Reception perfect. Thinking there are many who will be interested, I respectfully submit this tip.—Yours faithfully,

T. C. Swain.

Wickham Market.

[Editor's Note: We do not recommend the scheme suggested by our correspondent, since in many cases it may cause damage to the lighting installation.]

ENVELOPE NO. 3

Sir,—Having decided a few months ago to attempt making the " Simplicity " three-valve set, described by G. P. Kendall, B.Sc., in Radio Press Envelope No. 3, I thought you would like to hear my experience.

In the first place I knew nothing whatever regarding wireless apparatus, and when I went to a local " radio engineer " for parts I was advised not to proceed with the set, as he said such a set would be of no use in Cornwall as reception was bad. He even went further and showed me a " Simplicity " which had been partly dismantled and scrapped as being useless.

However, in spite of this, I proceeded to make the set, and am delighted with the result.

I am using home-made coils, and can get Daventry with 150 and 200 coils.

I have not troubled about the low wavelength stations, but have received the following :—Plymouth, London, Bournemouth, Cardiff, Manchester, Newcastle, Paris and a German station.

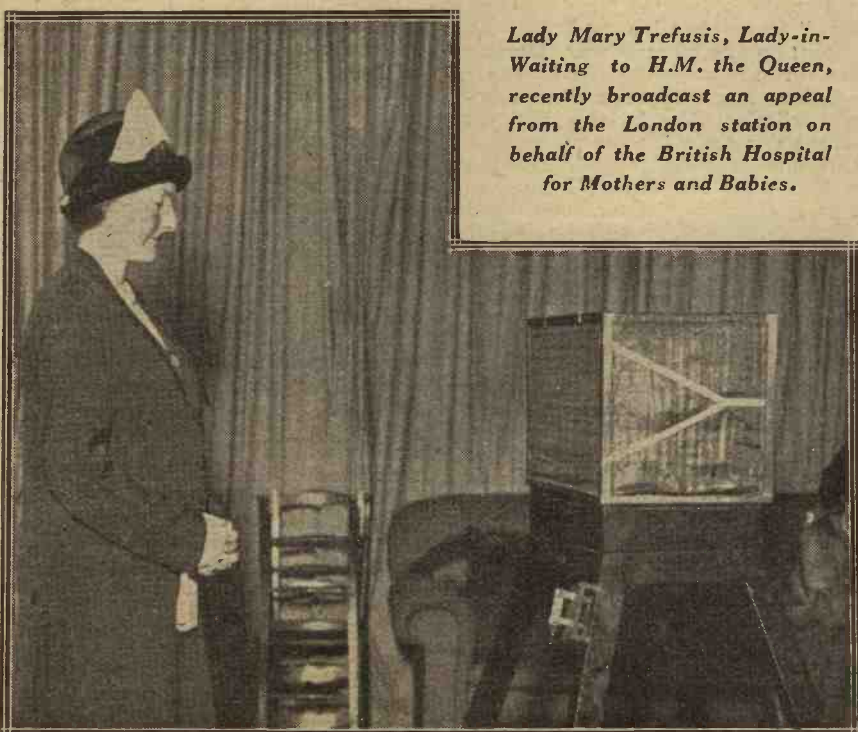
My friends who have heard the set working say that it is the clearest reception they have ever heard.

I have not tried a loud-speaker, but prefer to keep to the headphones, and can bring home Daventry quite clearly with 30 volts high tension. I am using Cossor-Wuncell valves.

I am now making another " Simplicity." Best wishes.—Yours faithfully,

Leslie Champion.

Probus, Cornwall.



Lady Mary Trefusis, Lady-in-Waiting to H.M. the Queen, recently broadcast an appeal from the London station on behalf of the British Hospital for Mothers and Babies.

R.S.G.B. SCHOOLS COMPETITION

Sir,—The following announcement regarding a competition which is being organised by the Schools Radio Section of the Radio Society of Great Britain may be of interest to your readers.—Yours faithfully,

H. A. Rock.
For Hon. Secretary.

The Schools Radio Section of the Radio Society of Great Britain is offering a prize of £5 to the school boy or girl who submits before November 28, 1925, the best essay on " The Value of Broadcast Lessons." The competition is open to any school boy or girl throughout the country, and there is no entrance fee, the only conditions being that :—

1. The essay must be certified by head teacher or parent that it is the unaided effort of the scholar.
2. The essay must not contain more than 200 words.
3. The name and age of the scholar must be given in full.
4. The name of the school and the town in which it is situated must be stated.
5. All competitors must accept the decision of the judges as final.
6. All essays must be written on foolscap.
7. All entries must reach Mr. R. J. Hibberd, St. Paul's School, Dorking, by November 28, 1925.

The winning scholar will have the opportunity of broadcasting his or her essay from 2LO and 5XX.

THE LONDON ESPERANTO CLUB

Sir,—The Committee of this Club feel that the enclosed Press notice may

be of interest to many of your readers.
—Yours faithfully,

L. N. NEWELL,
Hon. Secretary.

The London Esperanto Club, which for over twenty years has been the central organisation for the study and practice of the international language in the Metropolis, has just started its autumn season at St. Bride's Institute, Ludgate Circus, where classes and meetings are held every Friday evening from 6.30 to 10 p.m. An attractive programme of lectures and social functions has been arranged, and the Hon. Secretary (Mr. L. N. Newell, of 166, Brixton Road, S.W.9) will be glad to give particulars to any inquirer. Visitors are heartily welcomed, and recruits for a new class for beginners are now being enrolled. It may be added that a number of Esperanto classes are also starting in the L.C.C. Evening Institutes; particulars of these can also be had from Mr. Newell or from the British Esperanto Association at 17, Hart Street, W.C.1.

IMPORTANT NOTICE

Owing to the numerous applications from our readers for back numbers of our publications, we have decided to make no extra charge on any of our periodicals for issues published within six months. The charge for back issues prior to six months will be as in the past.

Calibrating an Oscillating Valve Wavemeter

(Continued from page 246.)

be plotted with a more convenient scale of frequencies as shown in Fig. 5.

A Warning

It can be seen from the above examples that any oscillating wavemeter can be calibrated from a single wave of known frequency. In actually carrying out the calibration many difficulties will probably arise, but sufficient details have been given to enable the keen experimenter to give the method a trial. In this connection, however, one point might be mentioned. It has rather been assumed with regard to harmonics that heterodyne notes will only be obtained between the fundamental of one oscillator and the harmonics of the second oscillator.

Other Beat Notes

Heterodyne notes can be obtained between harmonics of both the oscillators. For instance, if the oscillators are set to 400 kilocycles (750 metres) and 600 kilocycles (500 metres), beats can be obtained, although one of the frequencies is not equal to a harmonic of the other. It will be seen, however, that the third harmonic of 400 kilocycles (750 metres) is equal to the second harmonic of 600 kilocycles (500 metres), and it is the combination of these two harmonics that produces the beat.

Confusion Unlikely

It might appear that this might cause very serious confusion in the calibration, but with a little practice, and the use of reasonably loose coupling between the oscillators, the main harmonics can easily be picked out by their strength alone. There are also other features which distinguish the main harmonic beats from the beats obtained between harmonics of both oscillators, but it will be left to the experimenter to discover these.

RS1. M. (Mahogany) Model at 8 guineas.
Other designs from £4 15s.

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Real Music Enters Every Home

with a RADIOLUX AMPLION Loud Speaker, for its performance is the nearest approach to the ever-present ideal—perfection in Wireless Reception.

The art of furniture design also is blended with this achievement of science; the cabinets possess that beauty of form and superlative finish which denote the *masterpiece*.

The Radiolux Amplion Series

For Better Radio Reproduction

All those inclined towards "horn" Loud Speakers can also have the choice of the popular ***Dragon*** and ***Swan Neck*** models at prices from 25/-.

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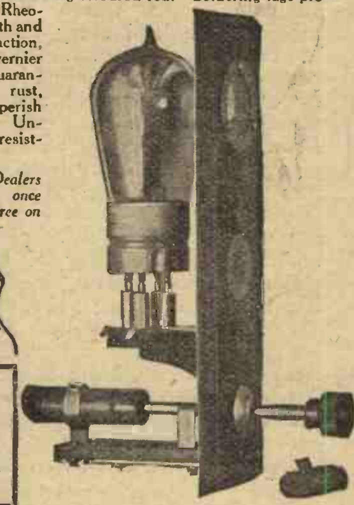
L & P Valve Unit

(As flatteringly commented on in the Radio Press publications).

Provides the constructor with a simple NUCLEUS around which to build an American Type valve set. Valve holder, rheostat, panel and window all in a handy unit. Only hole for window and hole for Rheostat to be drilled. The demand to-day is for easy-to-fix units.

The Valve Holder is of low capacity. Each leg separately insulated. Anode leg coloured red. Soldering tags provided. The Rheostat is smooth and velvety in action, and gives vernier control. Guaranteed not to rust, get brittle or perish with heat. Unalterable in resistance.

From Good Dealers or write at once for list. Free on request.



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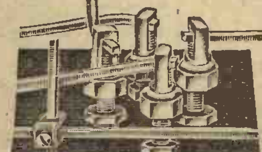

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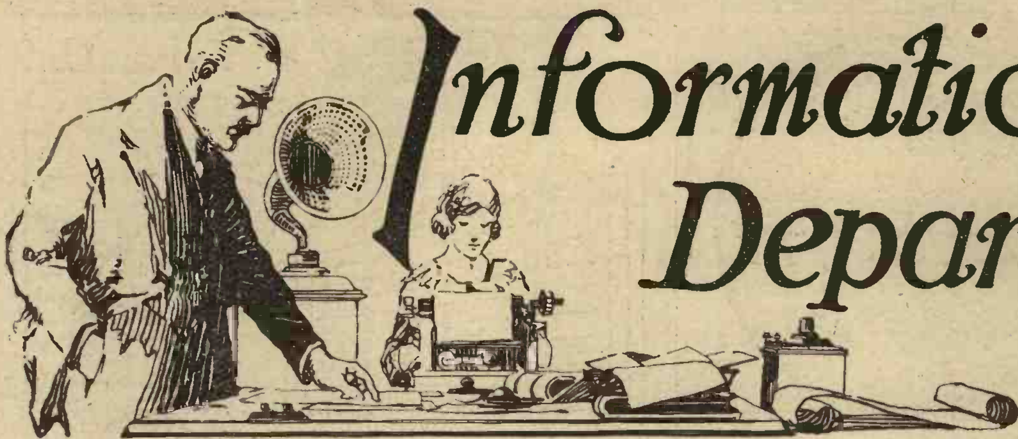

Information Department.

L. L. R. (BIRMINGHAM) has constructed the "Harmony Four" receiver, which works fairly satisfactorily, excepting for a curious failure to oscillate. Using constant aerial tuning it can be made to oscillate, and also slightly when all the condensers are in tune and the neutrodyne condensers are set in a certain manner.

In reply to our correspondent, we would state that when a neutrodyne set of this type does not oscillate, it is often found in practice that the lack of a by-pass condenser across the primary winding of the L.F. transformer is responsible. If, therefore, none is present, the effect of employing a condenser in this position should be tried, and the grid condenser between the first and second high-frequency amplifying valves should be changed if necessary. If this condenser tends to be leaky, it results in the grid of the second valve receiving a considerable positive bias from the H.T. battery, which will make the set behave in too stable a manner.

E.W. (DULWICH) wishes to alter "A Single-valve Broadcast Receiver" described by Mr. Redpath in the issue of "WIRELESS WEEKLY" for Jan. 2nd, 1924, to receive Daventry.

The conversion of this receiver for the reception of Daventry is not a very easy matter, since it is necessary to add certain components outside the set. For example, a variable condenser is necessary for tuning purposes, and this is best placed beside the set, one of the boxed-in type being required, for which a suitable value is .0005 μF. Connect it in parallel with the aerial and earth terminals of the set, taking care to set the switch S to the position which cuts out the small fixed series condenser. To one side of the box of the receiver attach an ordinary two-coil holder, whose sockets should be wired into circuit as follows: Break the connection between the telephone terminal and the reaction winding in the set and take the two wires thus formed to the moving socket. Break the aerial circuit of the receiver at any convenient point, such as at the connection between the rotary and fixed

coils, and take the two ends thus formed to the fixed socket of the coil-holder.

To use the set for Daventry it will then be necessary to insert a No. 150 coil in the fixed socket, and a No. 150 or 200 in the moving socket. To obtain reaction effects bring the moving coil towards the fixed one, if necessary reversing the connections to the moving socket. When employing the receiver on the broadcast band, set the variable condenser to the zero position, and insert short-circuiting plugs in both sockets of the two-coil holder.

J.C.W. (GLASGOW) asks us what alterations are necessary to the wiring of the original "All Concert Receiver," described in "TWELVE TESTED WIRELESS SETS" by Mr. Percy W. Harris, to employ separate high tension on individual valves and grid bias on the low-frequency amplifier.

To meet our correspondent's requirements considerable alterations are necessary to the wiring of this set, and referring to the practical wiring diagram on page 72, these are as follow:—

First remove the short lead between the right-hand contact of the .01 μF fixed condenser and the upper terminal of the .0005 μF variable condenser which tunes the anode coil. The original H.T. positive terminal now serves to supply the low-frequency amplifier only. Two new terminals will be necessary for the tappings for the high-frequency and detector valves respectively, and these should be placed adjacent to the present H.T. positive terminal. Again referring to the diagram, a further lead will be seen connected between the previously mentioned terminal of the anode condenser and the IP terminal of the low-frequency transformer. This lead should be removed. Now connect the IP terminal of the low-frequency transformer to one of the two new terminals, which will now serve for the H.T. tapping to the detector valve. For the high-tension positive supply to the high-frequency amplifier connect the remaining new high-tension positive terminal to the upper contact of the .0005 μF variable condenser tuning the anode coil, from which the two leads previously mentioned have been removed.

Provision for the employment of a grid-biasing battery is made by severing the lead between the IS terminal of the low-frequency transformer and L.T. negative, close to the latter terminal. The lead from IS should now be joined to a further new terminal placed near to L.T. negative. This serves for the grid-bias negative terminal, whilst grid-bias positive is taken to the L.T. negative terminal.

W.C. (BRISTOL) has been working between 15,000 and 6,000 k.c. (20 and 50 metres), and finds his short-wave receiver refuses to oscillate on certain frequencies, which seem to change from time to time.

When working at the very high frequencies, effects such as our correspondent mentions are very often noticed. In certain cases the trouble has been traced to the presence of other receivers in the same room, or even somewhat more distant from the set, to coils of wire and even to the presence of metal objects near the receiver. If other receivers are present in the room, therefore, the effect of altering the settings of the tuning controls should be noted, coils of wire should be shifted to a remote part of the house, and if a wavemeter is near the effect of altering its condenser reading should be tried. Where a long earth lead is employed, which may work perfectly satisfactorily on the ordinary broadcast band, it should be disconnected, as in some cases short-wave receivers will work better with no earth connection at all. In other cases, it is found beneficial to connect the earth wire directly to the low-tension positive terminal of the accumulator rather than to the normal earth terminal on the receiver.

In other cases the refusal of the set to oscillate may be due to the aerial, oscillation ceasing when the grid circuit is tuned to the fundamental frequency of the aerial, and the employment of a series condenser or a loading coil in the aerial circuit usually overcomes this difficulty. A metal roof or pipes in the house may be responsible for poor results, and it is possible in some cases to utilise these as aerial or earth, especially at very high frequencies, thus obtaining some improvement.

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VARIABLE GRID LEAK
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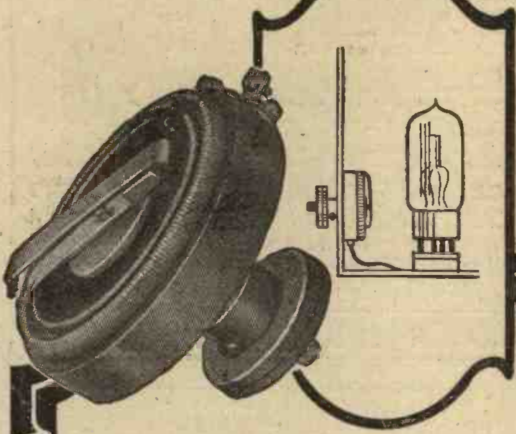

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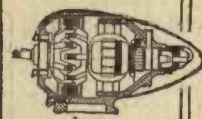

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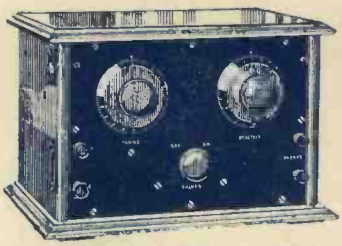

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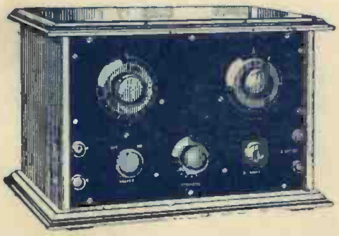

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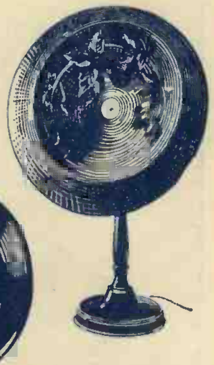

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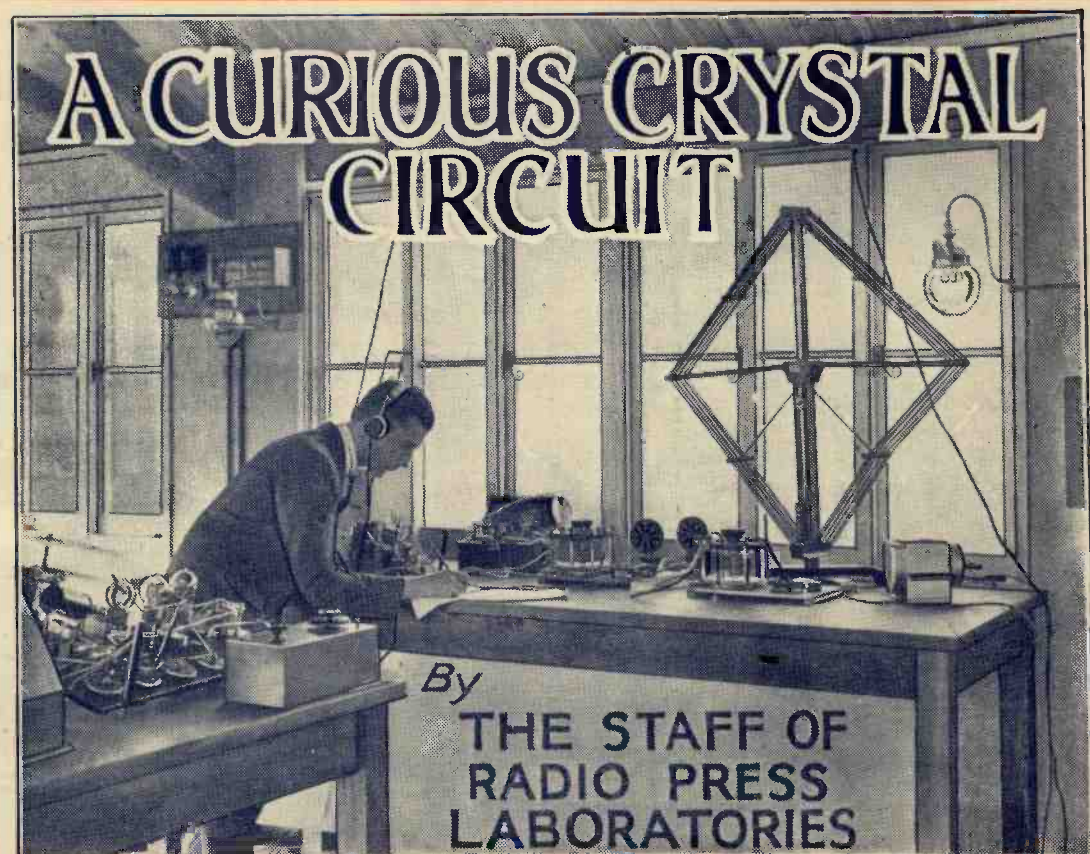

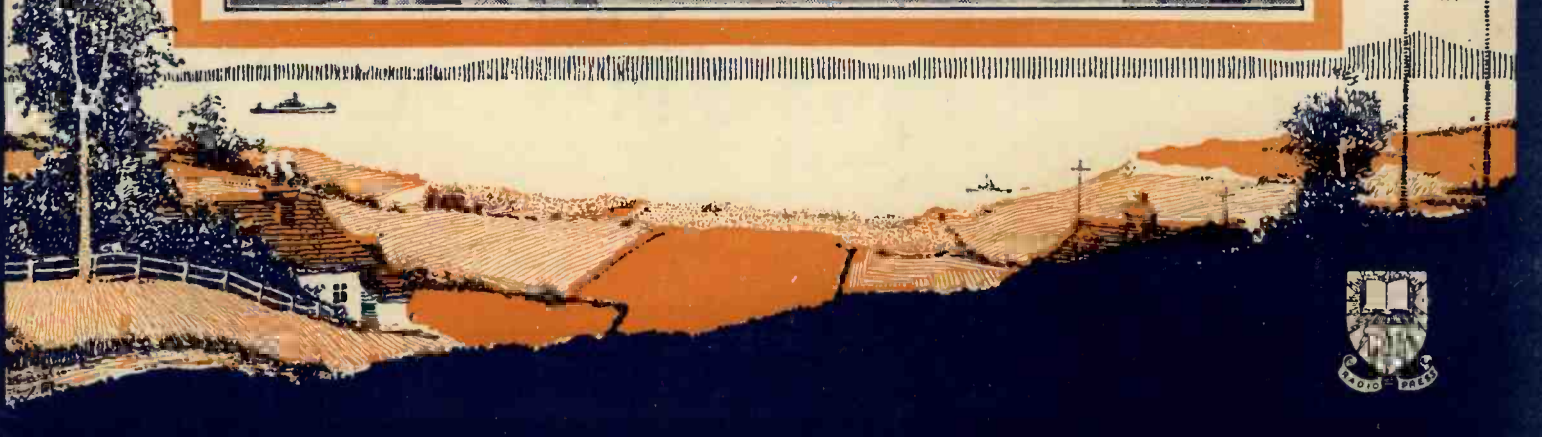

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A Calibration Service for "Wireless Weekly" Readers

WITH the rapid approach of the best season of the year for long-distance wireless reception, experimenters throughout the country are now actively engaged in building new instruments or improving their older models, in preparation for excelling their previous feats of reception of signals from distant parts of the world. In particular, signals from across the Atlantic will be sought more actively than ever this coming winter, and if we are to avoid the acute annoyance which was caused last year by oscillating receivers, proper calibration of both wavemeters and receivers will be essential.

An accurately calibrated wavemeter is by no means a cheap instrument, and although the home construction of wavemeters is an easy matter, their calibration is generally a matter of far greater difficulty. Radio Press, Ltd., with the aid of their Elstree laboratories and highly skilled technical staff, have now devised an exceedingly simple scheme by which all readers of this journal will be able to calibrate their receivers with a far greater accuracy than has hitherto been possible, and without cost to themselves. Full particulars of the new method of calibration will be published in next week's *Wireless Weekly*, but meanwhile we can indicate the main outlines. Briefly, they are as follows: On a given day at a stated time, shortly to be published, Radio Press, Ltd., will arrange to make measurements with great accuracy of the frequencies of some of the leading broadcasting stations. Readers can then listen-in to these stations and note their own dial readings. In a subsequent issue the actual frequencies will be published, so that from these figures the reader will be able to calibrate his own instrument with an accuracy which has not hitherto been possible.

It is unnecessary to emphasise the many advantages which will accrue from a method of this kind. The British Broadcasting Company have already announced that from time to time it has been found necessary to change the frequency of their stations to avoid interference. Whatever views may be held by experimenters upon the advisability of these changes, the fact remains that they *are* made, and that the figures published are not necessarily those which are used on any given night. In the Radio Press scheme, however, whatever the frequencies may be of any particular stations on the particular night and at the hour mentioned, they will be published, and any doubt of the exact figures will be dispelled. Further elaborations of this scheme are now in active preparation, and an announcement regarding them will be made in an early issue.

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Edited by
JOHN SCOTT-TAGGART,
F. Inst. P., A.M.I.E.E.
November 18, Vol. 7, No. 9.

SOME FURTHER NOTES ON INTER-VALVE CONNECTIONS

By Captain H. J. ROUND, M.I.E.E.

A previous article by Captain Round on this subject appeared in "Wireless Weekly" for October 21. Here the methods of coupling H.F. valves with a view to maximum efficiency are discussed, and practical examples are given.

MAKERS now give us the characteristics of the valves they sell, certainly only approximately, but sufficiently accurate to be of considerable use. But what a lot of other valuable data is missing which might help us work out our circuits a little less empirically. Inductance coils are very bad offenders. If a little of the attention that has been paid to condenser gadgets and losses had been put into coils so as to give us—even if no improvement—some figures to work on, it would be better for the art. "We cannot improve the coil, but we can improve the look of it," seems to be the only motto, but it is not enough.

H.F. Resistance of Coils

Give us coils with a stated accuracy, marked in micro-henries, and give us some figures on H.F. resistance and, to a minor extent, self-capacity. If I were to publish the high-frequency resistance of some of the coils on the market it might result in a libel action. The trouble is that high-frequency measurements are, more or less, beyond the ordinary amateur at the moment, on account of the expense of the apparatus; but the makers could do it, and absolute accuracy does not matter so very much.

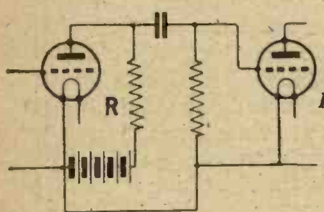


Fig. 1.—An example of resistance-capacity coupling.

Measurements Required

If they published their coil resistances it would undoubtedly result in better coils. In high-frequency circuits things are difficult enough, with reaction adding and subtracting ohms in an elusive way. Even condenser losses should be stated, but I have never seen such a statement, except in the case of certain high-class mica condensers. Elstree will be invaluable.

This is a preliminary to a discussion on the calculation of tuned circuits and transformers for coupling valves at high frequency, and for this purpose I shall have to state some probable values of coils such as can be bought on the market, or wound with ordinary solid wire in flat cylindrical form.

Approximate Calculations

With all high-frequency valve work calculation can only be considered as being approximate, and continual checks must be made by measurement, so that the following should be taken as a way of guiding measurements and of checking serious discrepancies in the measurements.

Resistance Coupling

In a resistance-coupled circuit as shown in Fig. 1, if the grid-leak is made of sufficiently high resistance and there is no loss in the second valve grid circuit, the resistance of the first valve and the resistance R control the magnification. We can say that if "M" is the magnification constant of the valve, "M" is divided proportionately between Ra, the resistance of the valve, and R, the static resistance. So, with a valve of published characteristics on medium or low frequencies, this magnification can be quite easily worked out. As valve characteristics are always curved, and in effect the internal resistance of the valve Ra decreases with increase of milliamperes, account must be taken of the working position. Regulators which work on filament current also tend in effect to alter the value of Ra. Dimming a filament in general increases Ra.

Stray Capacities

On short-wave H.F. work, such as the broadcast range, we are to some extent beaten in this calculation by the capacities of valves and resistances, but as these capacities are negligible compared with that of the condenser in a tuned anode circuit, and as I am only using this resistance amplification to explain the tuned anode circuit, we can neglect them.

A Simplification

For simplicity, leave the grid-leak of the second valve out, and across R put a tuned circuit LC (Fig. 2) stipulated as having no loss at all, and put in a blocking condenser K of a very large value, so as to have no high-frequency effect, but to prevent a D.C. change in the circuit.

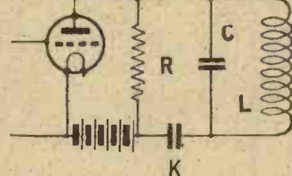


Fig. 2.—It is assumed that the circuit LC has no losses, while the value of K is large.

We know that if we applied an E.M.F. in resonance with LC across LC by itself, no feed current would flow. It is a perfect rejector, so that if we apply a similar E.M.F. to the valve grid our circuit acts as though L and C were not there, the only feed current from the valve flowing into R, and we can calculate as for a resistance amplifier.

Calculating the Magnification

Now LC with R in shunt can be made the exact equivalent for H.F. to a coil and condenser containing all sorts of losses. In the very simple case where the resistance of the coil ρ is the whole resistance, an equivalent R is given by the formula,

$$\frac{\frac{1}{R}}{C} = \frac{\rho}{L}$$

which is a symmetrical formula if $\frac{1}{R}$ is called a conductivity and labelled in mho's. Thus, given the effective resistance of a circuit, by converting to an equivalent shunt resistance, we at once know the maximum magnification at the "in tune" portion.

Shape of Resonance Curve

The magnification will fall off on either side of the tune, but we can obtain the shape of the curve in a very simple manner, which is, however, a bit laborious arithmetically.

We could consider the valve resistance Ra, in series with R, C, and L, in parallel with one another. Work out the voltage drops at any frequency and split the M value of the valve accordingly. But another way which actually comes to the same thing is to consider

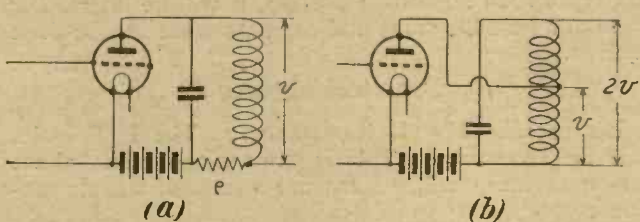


Fig. 3.—An R valve across the whole coil, as shown at (a) will give the same tuning curve as a D.E.5 type of valve across half the coil (b), but we obtain twice the voltage magnification.

the valve resistance Ra in parallel with R, C, and L, and these fed with constant current at various values of frequency.

Effect of Valve Resistance

The voltage across Ra, R, C and L connected in parallel is given by the formula,

$$V = \frac{1}{\sqrt{\left(\frac{1}{R_a} + \frac{1}{R}\right)^2 + \left[2\pi n c - \frac{1}{2\pi n L}\right]^2}}$$

By plotting this at various values of n, we get the shape of the tuning curve given by such a plate circuit, and, as we know the maximum magnification, we have all the data desired. The reason why I have taken this way of considering the valve in parallel with L, C and R is because it draws attention clearly to the effect of the resistance of different valves on the tuning curve.

Optimum Conditions

A tuning curve will be at its best when Ra is very large and bad when Ra is very small.

If with some particular valves Ra is much less than R, the magnification is approaching M, but the tuning is bad. If Ra is much more than R, the magnification is much reduced, but the tuning is improved. Without working it out, it is easy to see that an approximate best balance of the two factors, magnification and tuning, will be obtained round the portion where R=Ra.

An Example

I propose to leave till later serious consideration of these tuning curves, as it is necessary to consider what we require to do with the tuning before laying down what tuning to calculate for. We will merely consider the general effect of certain changes here.

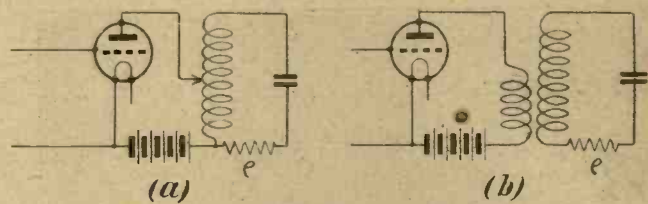


Fig. 4.—Here the methods of connection (a) and (b) are equivalent for magnification and tuning, but (b) has some circuit advantages.

In a concrete case L=200 μH.
C=.00013 μF.
Series ρ =12 ohms.

A valve with a magnification constant of 8 and a resistance of 8,000 ohms is shunted across this. The average practical coil is of about this value of ρ. By our first formula,

$$\frac{12}{200} = \frac{\frac{1}{R}}{.00013}$$

or the equivalent shunt resistance to represent the circuit losses is,

R = 130,000 ohms,

so that if the valve resistance is only 8,000 ohms we shall get a magnification of

$$8 \times \frac{130,000}{138,000}$$

very nearly the full magnification of the valve, and without any calculation we can see that if 130,000 ohms in shunt is equivalent to a resistance of 12 ohms, then 8,000 ohms across the circuit is going to give very poor tuning.

Improvements

We have bad tuning and not very good amplification, and we are nowhere near where Ra=R. Let us consider various steps we can take to improve both tuning and amplification.

1. *Altering the Valve.*

If we take any type of valve and keep the mechanical dimensions the same, except that we alter the grid mesh, then, as we make the latter closer and closer, the "M" value goes up and the Ra value goes up in the same proportion. This rule, although not absolute, is very nearly true; but it must be noted that the same position on the characteristic is called for. That is, the same grid bias; but the H.T. is raised until the milliamperes are the same.

Increase in Valve Resistance

Suppose we raise the Ra value of a valve such as we have used to 130,000 ohms, then the "M" value will have gone to

$$8 \times \frac{130}{8} = 130$$

and with such a circuit we should have a resonance magnification of $\frac{M}{2} = 65$. We have the condition here that Ra = R.

Large High-Tension Voltage

Practical difficulties lie in the way of using this arrangement, as the minimum suitable high-tension volts would be well above 600, possible to those with A.C. rectification, but not for anyone else but the experimenter. The magnification and resonance have been improved greatly by this scheme. It is not much good raising the "M" value further in this case, as the best possible resonance, of course, is that of the circuit without the valve, and, after increasing Ra to the point where R=Ra, going further reduces the active proportion of the "M" value rather rapidly.

Major B. Binyon, O.B.E., M.A., demonstrating an automatic direction finder in his lecture on Marine Wireless at the Institution of Electrical Engineers.

Reducing Coil Resistance

2. *Altering the Coil.*

We can gain by lowering the resistance of the coil. The lowest practical value of a coil of 200 microhenries inductance is about 3 ohms (there are none sold as good as that), and this is equivalent to a shunt value of 420,000 ohms, which, if we could obtain a valve for the purpose, would bring our possible magnification up to 260 for one valve, but with an uncomfortably high high-tension voltage of 2,500 volts. Incidentally, as we must keep our current the same as on the low "M" valve tube, the energy required has gone up considerably. Some difficulties connected with electrode capacities would undoubtedly upset any such arrangements. With such a coil shunted by the valve with the M = 8 and Ra = 8,000, we shall not gain at all, so that we must consider how we can use a low-resistance coil effectively with a normal valve.

3. *Auto-transformers.*

A resistance of 130,000 ohms across a whole coil is equivalent in energy loss $\left(\frac{V^2}{R}\right)$ to $\frac{130{,}000}{4}$ (=32.200 ohms) across half the coil, because the voltage is half, or to $\frac{130{,}000}{16}$ (=8,000 ohms approximately) across a quarter of the coil (note Fig. 3). We can assume that the same idea applies for a valve, and, taking a coil of 12 ohms resistance, or R = 130,000 ohms shunt equivalent, and attempting to match this with our 8,000-ohm valve, we see that we must put the valve across a quarter of the coil.

Effect of Tappings

This gives us only $\frac{M}{2}$, or 4, across the tapped position, because Ra=R effectively; but, as we are getting a $\frac{4}{1}$ ratio up to the condenser terminals, our actual available voltage magnification is 4×4=16. It is interesting to note that the magnification will not vary very much for some considerable alteration of tapping position, but the tuning will steadily improve as one taps downwards. If you are using stranded wire coils, sticking pins in makes ample contact for the purpose of finding the best tap positions, contact with any one strand being ample for the feed circuit.

H.F. Valves Available

With a low-resistance coil of 3 ohms, theoretically we could tap down to 1-16th of the coil and obtain a magnification of 32.

As we could afford to have a higher voltage and "M" value than this value M=8, Ra=8,000, and manufacturers are now putting on the market such valves as H.F. valves, although, perhaps, the Ra is not quite such a good proportion, it will be interesting to take a possible valve and estimate what can be done with it.

Practical Figures

Let us take M=16, Ra=16,000. The H.T. volts will be about 150. Taking R=130,000 ohms shunt for an ordinary coil, we can use a ratio of transformation of

$$\sqrt{\frac{130{,}000}{16{,}000}}=2.8 \text{ (approximately)}$$

so that we can get a magnification with an ordinary coil of

$$2.8 \times 8 = 22.4$$

or, with the better 3-ohm coil, of 45. All the time I have neglected the load of the rectifier on the circuit, and this will reduce the magnification considerably. In fact, it will probably give an average best result if we give equal losses to the rectifier, the valve and the coil.

Transformers

We have considered tapping down a coil, and making an auto-transformer of it. The best transformer will be obtained by putting a winding as close as possible over this tapped section with the same pitch as the main winding, wound in the same direction.

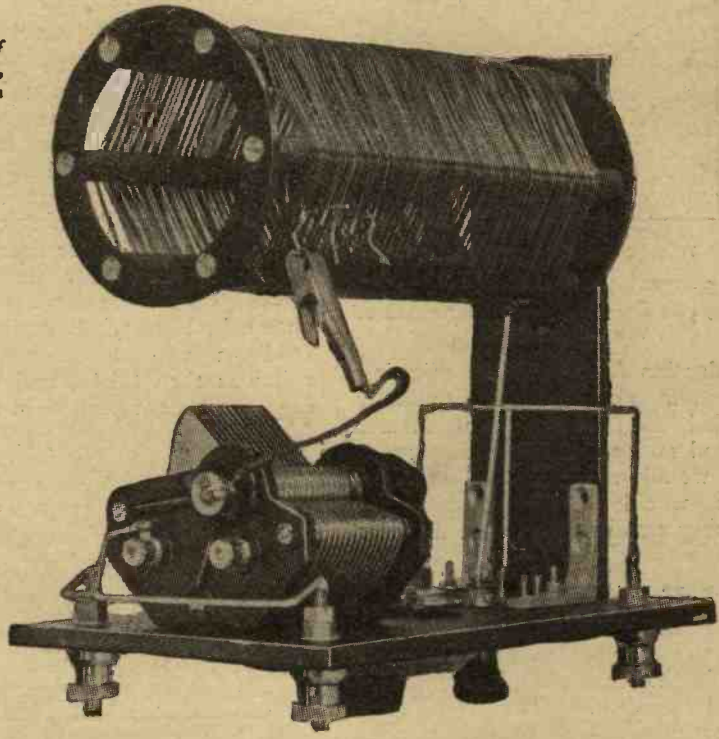
No capacity currents will then result to upset the tuning, and we shall not have to consider the effect of leakage inductances in the plate circuit of the first valve, which would result from loose coupling and which would reduce the magnification available.

Fig. 4 shows the equivalent auto-transformer and two-winding transformer arrangements.

What is the Best Wave-Trap to Use?

By C. P. ALLINSON (6YF).

The five most commonly employed types of wave-traps are here discussed and compared, details of comparative measurements being given



An acceptor wave-trap of this type, described by G. P. Kendall, B.Sc., in "Modern Wireless" for October, is best used with an untuned aerial circuit.

THERE are broadly six different types or forms of wave-trap that can be used in the aerial circuit for helping to eliminate interference. Of these types, five are used for cutting out an unwanted signal and one for cutting out all signals but the wanted one. As the wireless amateur's problem is usually the elimination of a local broadcast station so as to be able to receive a distant one, the first five are the most usually known. The last one in particular needs to be adjusted for every station it is desired to receive, thus complicating the handling of a receiver with which it is used.

Types Discussed

To name the more commonly used ones, these are the series rejector, the acceptor, the loose-coupled absorption trap, another form of the loose-coupled absorption trap, and the auto-coupled absorption trap. These circuits are shown in Fig. 1.

These circuits are probably well known to most readers, so that an indication merely of the values of the trap coils and condensers will suffice, namely, that the coil L1 will be one of 50 to 75 turns, while C1 will be about .0005 μF. L2 or L3 and C2 will be the usual tuning circuits.

Comparative Merits

The writer had found in the course of various experiments with these traps that they varied greatly in their action, and he had never been able to get satisfactory results on distant stations when using the (*a*) type of trap, as all stations working on frequencies anywhere near to that on which interference was being eliminated were barely audible. The (*b*) type of trap he found to be better, the (*c*) type next, then the (*d*) type next, and best of all the (*e*) type.

This was found to be the case on two different aerials of totally different characteristics, and therefore it was decided to make some investigation into the resonance curves of these various traps.

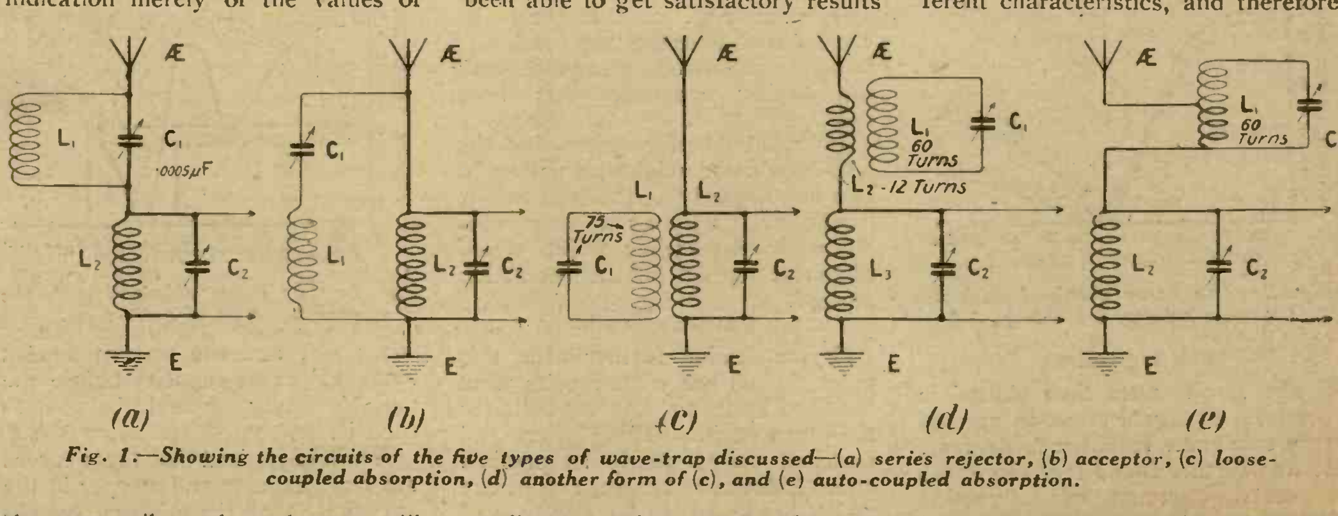


Fig. 1.—Showing the circuits of the five types of wave-trap discussed—(a) series rejector, (b) acceptor, (c) loose-coupled absorption, (d) another form of (c), and (e) auto-coupled absorption.

Moullin Voltmeter

For this purpose a Moullin voltmeter was used, consisting of a valve using a leaky grid condenser, and though it might be argued that this would impose a heavier load than a voltmeter using lower bend

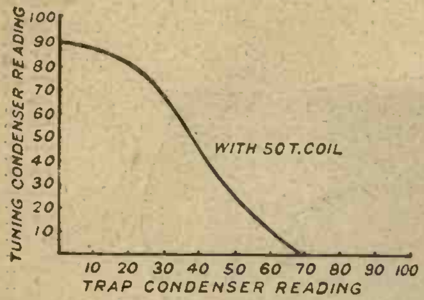


Fig. 2.—Showing the variation in the tuning circuit caused by adjustments of the trap circuit.

rectification (thus possibly affecting the readings obtained), it was finally decided to employ the former method so that the resulting readings would approximate more to what would be expected under working conditions when a detector valve was being used.

Method of Measuring

The method employed was to tune the receiver to the local station, in this case 2LO, and note the signal strength. The trap condenser was then turned a few degrees at a time, retuning when necessary on the receiver tuning condenser, so as to get the maximum reading; this being carried right through the point at which the signal strength recorded from 2LO fell to zero and on again till the maximum reading of the trap condenser was attained.

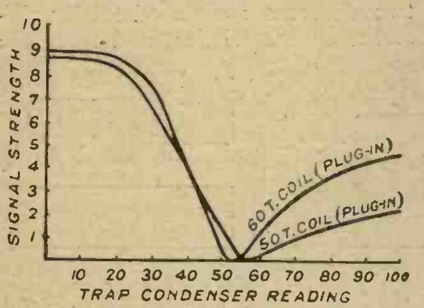


Fig. 3.—The curve obtained with the series rejector wave-trap.

Plotting Curves

The results were then plotted in the form of signal strength against trap condenser readings in degrees. It was further found that there was a certain amount of interaction between the trap and tuning circuits, and therefore the tuning condenser readings were also taken and plotted against the trap condenser readings, where this interaction was sufficiently great, as an indication as to what might be occurring in the circuits.

In all these readings loose-coupled tuning was used, with the primary or aerial coil tuned as well as the secondary.

Series Rejector

The first circuit to be investigated was the series rejector (*a*) circuit. This was done first with a 50-turn plug-in coil for L1 and a .0005 μF variable condenser for C1, and it was found, apart from the fact that the aerial tuning condenser had to be varied after every setting of the trap condenser, that a rather broad curve resulted. This is shown in Fig. 3. A further set of readings with a 60-turn plug-in coil was then taken, and the readings are shown plotted in the same figure.

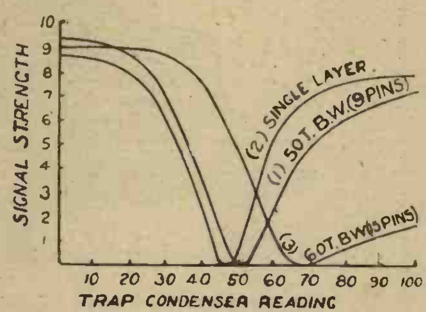


Fig. 4.—Showing the variations obtained by using different coils for the wave-trap.

Retuning Adjustments

While taking these readings it was found that the variation of the tuning condenser with adjustments of the trap condenser was so great that a curve was drawn, this being shown in Fig. 2. It will be noticed that after the trap condenser has been increased up to 70 degrees the tuning condenser has been reduced to zero.

It would therefore seem that the trap condenser might be acting in two ways, partly as the trap tuning condenser, partly as a series condenser in the aerial; which would of course account for the interaction noticed.

Wave-trap Coils

Before dealing further with this point, let us see what results were obtained by using different coils for the trap coil. These were all matched up as nearly as possible on an inductance bridge, except one which happened to be handy and was not far out in value.

Coils Used

The coils used were: (i) A tightly bound basket weave coil of 50 turns on a former 3 in. in diameter; (ii) a single layer solenoid of 60 turns on a $3\frac{1}{2}$-in. ebonite tube; and (iii) a 60-turn basket weave on a former $3\frac{1}{2}$ in. diameter, using a different

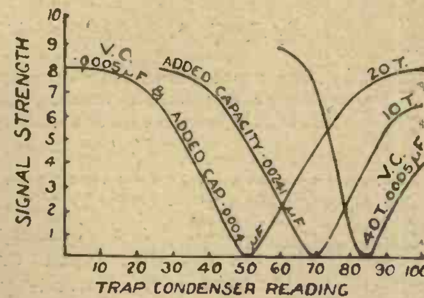


Fig. 5.—Smaller coils for the wave-trap, with consequently increased tuning capacities, gave curves as shown here.

type of weave, and only bound loosely, so as to reduce its self-capacity. The resulting curves are shown in Fig. 4 at 1, 2 and 3, and serve to illustrate how great a variation is obtained by using different inductances.

Tuning Variations

With regard to the interaction between the two circuits, the obvious solution was to make the trap condenser so large (and therefore the inductance so small) that the variation necessary to tune the trap would in no way affect the tuning of the receiver. It was therefore decided to take curves with smaller and smaller sizes of trap coil. The coils used consisted of 40, 20 and 10 turns. The 40-turn coil was tunable with the .0005 μF variable condenser in use. The 20-turn required an added capacity of about

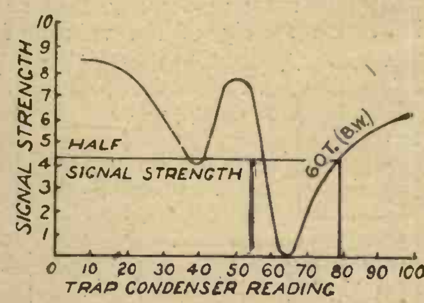


Fig. 6.—The curve obtained with the acceptor type of wave-trap.

.0004 μF, and the 10-turn needed .0024 μF extra capacity before the variable condenser could be used to tune it.

It will be noticed that these curves are more regular and steeper in the aggregate than the other curves obtained with the series rejector.

Inductance-capacity Ratio

The use of the 20-turn coil enabled the trap to be tuned with very little interaction between the trap condenser and the tuning condenser, and when the 10-turn coil was used, no such effects were obtained at all.

It is interesting to note here a point that the writer has seldom seen mentioned, but which was

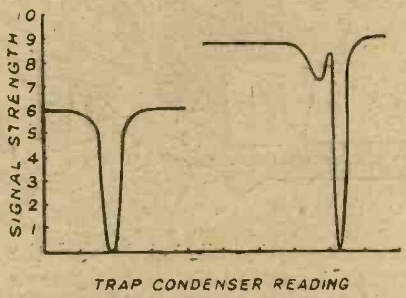


Fig. 7.—The two types of loose-coupled absorption wave-traps gave the curves shown here, the (c) type being on the left and the (d) on the right.

made full use of in the Naval type rejector used in the Navy before and during the Great War. That is, that in a rejector circuit the inductance should be very small, in order to allow of a very large capacity being used, so as to reduce the losses in the rejector as far as possible and thus sharpen its tuning.

H.F. Resistance

Recent readings obtained by Mr. J. H. Reyner, B.Sc. (Hons.), A.C.G.I., D.I.C., A.M.I.E.E., go to show that even a low-loss coil has an H.F. resistance of the order of 5 to 10 ohms, while the resistance of a good condenser may be as low as 0.1 ohm, or even less. It is therefore far easier to obtain a sharp tuning rejector by using a large condenser and a small inductance. The Naval rejector, in fact, used a total inductance of about 4.5 to 12 microhenries, the final adjustment being made by means of a sliding contact on a three-quarter circle of thick copper bar.

Acceptor

The next trap to be tried was the acceptor trap, as shown at (*b*) in Fig. 1. The results obtained are shown in the Fig. 6 curve, and it will be seen that this is much sharper, but shows a curious dip at a point about 25 degrees before the zero point, which, should it coincide with the frequency of a station to be received while the trap was in use, would seriously cut down its signal strength.

Better Results

Although this curve is steeper than all but one of those obtained with the series rejector circuit, we find nevertheless that a considerable reduction in signal strength would appear to result with stations whose frequencies fall approximately between the two points projected in the figure. If, therefore, it is desired to receive stations working at frequencies close to that of the interfering station, it is necessary to use a trap with a far sharper and steeper curve than those so far tried; and, a further important point, this should preferably be more symmetrical about the zero point.

Loose-coupled Absorption

The next trap to be tried was (*c*), the coupled absorption type. This gave a far more satisfactory curve, as shown in Fig. 7. A No. 75 plug-in coil was used, and here we find that only over a narrow band of frequencies either side of the resonant frequency of the trap will signal strength be cut down. Yet even this does not seem quite as good as it might be.

Reduced Interaction

Let us, then, see what we get with another form of loose-coupled absorption trap, as shown at (*d*) in Fig. 1. The resulting curve is given in Fig. 7, which, it will be seen, gives the same preliminary dip as the Fig. 6 (acceptor) curve, but not nearly so pronounced. Further, it was found that the trap condenser and the tuning condenser hardly had any interaction effects at all.

Auto-Coupling

The next two curves (Fig. 8) were taken with an auto-coupled absorption trap, as shown at (*e*), Fig. 1. The curve marked 1 was taken with 22 turns of the trap coil common to the aerial circuit, and that marked 2 with only 16 turns. It will be seen that the curves are identical, except for the fact that curve 1 is a little less steep than 2.

A comparison of one curve of Fig. 7 and the two of Fig. 8 shows that they are almost the same. If the Fig. 8 curve is a little steeper, the Fig. 7 curve does not show such a large preliminary dip.

Practical Use.

In actual practice the writer has found that there is very little to choose between the two; if anything, the auto-coupled trap has proved the more satisfactory of the two, and it was, in fact, incorporated by the writer in the "Stable Three-Valve Receiver" in *Wireless Weekly*, Vol. 5, No. 11, with which it was found possible to receive 2ZY without interference from 2LO while the latter station was working.

This type of trap was further adapted for use in a type of selective circuit described by the writer

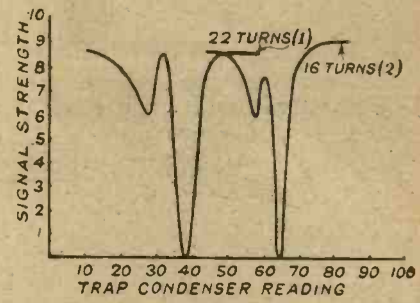


Fig. 8.—Different turn numbers in the aerial coil gave these curves with the auto-coupled wave-trap.

in the October 28 issue of *Wireless Weekly*, and here again it proved the most satisfactory method to employ, if the maximum selectivity was to be obtained.

Wave-traps and Aerial Circuits

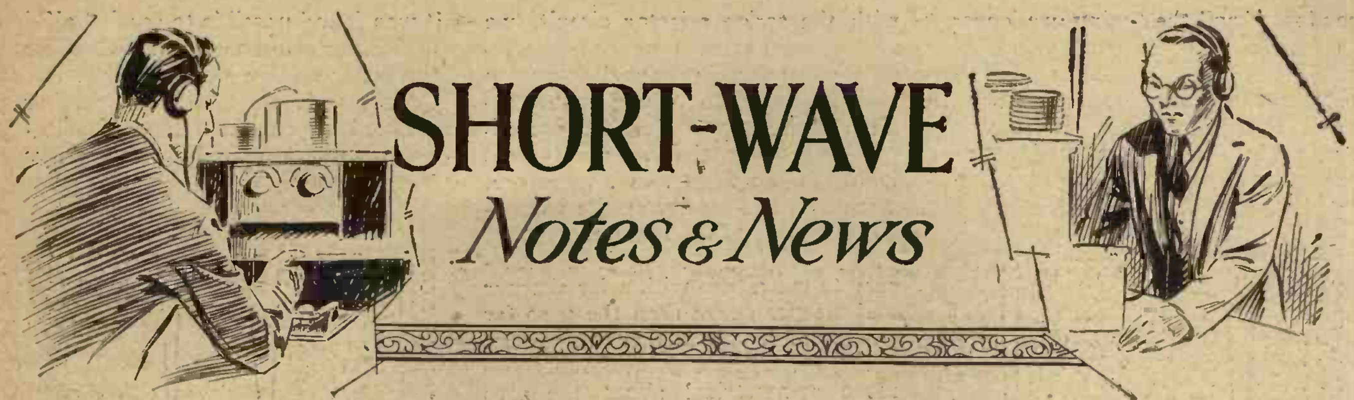
It should be remembered in considering what wavetrap to use that its action is most probably influenced by the type of tuning circuit with which it is used. Thus the acceptor circuit is most suited for use with an untuned aerial coil. The application to this method was first described by Mr. A. D. Cowper, M.Sc., in the Vol. 6, No. 7 issue of *Wireless Weekly*. Similarly different traps may work better with different aerials, and this must be so in view of favourable reports received from various readers with regard to a type of trap that the writer has never been able to use on his aerial with any degree of success.

Conclusions

In conclusion, the writer would state that all these readings were taken on a small aerial about 20 ft. long, although the practical reception results obtained, which favour the auto-coupled trap, were also observed on an aerial of average size.

METRE-KILOCYCLE CONVERSION TABLE

Owing to a printer's error on page 252 of *Wireless Weekly* for November 11, the kilocycle equivalent of 21 metres was given as 12485.7 kc. This should read 14285.7 kc.



WE hear from Mr. C. W. Ashton (G5CW) that he has received signals from Australian 6AG, the station mentioned in these columns a fortnight ago. This is, as far as we know, the first reception of A6AG in this country. He also suspects that the intermediate " R " is being unofficially used by the Russian amateurs.

Telephony

A fair number of British stations now seem to be taking a rest from the ultra-high frequencies, and are working on telephony on 3,000 kc. and under (100 m. and over). The most active are 5IS, 6JB, 2ON, 2KT, 5BY and 2ZB. The latter is struggling with the problem of modulating an input from one flash-lamp battery by means of the grid-control system. 6QB is breaking all " miles-per-watt " records by working telephony with 2ZB (200 yards away) with an input that cannot be measured. His " high "-tension supply for these tests consists of one 1½-volt dry cell!

Long Distance Working

We have little doubt that " fone " will meet with increasing popularity as the winter progresses, particularly on account of the difficulty in transmitting really good telephony on the very high frequencies. Several of the well-known British stations having succeeded in working the Antipodes on telephony, one wonders what there is left for them to do in the " DX " field of radio.

2LZ's telephony on 6,667 kc. (45 m.) is received R9 in South London during daylight, and is actually too weak to be understood during the evening. This is, of course, explained by the fact that his distance is only about 50 miles.

He has also established two-way communication with a U.S. Government station at Manila, Philippine Islands, using C.W. on 6,667 kc.

France

We have never yet heard a really good telephony transmission from a French amateur, but whether this is really because they are not so expert in these matters as the British stations, or whether they all delight in a badly-smoothed A.C. note, is difficult to decide. For sheer power and noise, however, France stands first! Practically all the active French stations work the Antipodes regularly.

South America

A new country is represented in South America, namely, Bolivia, using the intermediate " BO." The only active station as yet is BO-A9, in Oruro. The Brazilians are increasing in numbers, and we hope a complete list of their addresses will soon be available.

Atmospheric Interference

Readers using high-frequency amplification for short-wave work may find the following a helpful hint for reducing the strength of atmospherics: instead of connecting the aerial to the primary coil in the usual way, connect it directly to the anode of the detector. It is then coupled to the input to the H.F. valve by means of the reaction coil. Atmospherics certainly are reduced in strength, but it is rather difficult to decide whether the signal-atmospheric ratio is altered very much. Perhaps readers will let us know their opinions on this subject.

Parasitic Noises

Another useful idea for minimising the parasitic noises often alluded to as " mush," in a receiver using L.F. amplification, is to place a high resistance across the secondary of the first L.F. transformer. A large condenser across the high-tension battery is, of course, a necessity, but it often improves results to connect the condenser across the low-tension battery as well as the high-tension.

Transmissions from Nauen

The following calls, often heard on the higher frequencies at very great strength, all belong to the German Experimental and Research Station at Nauen: AGA, AGC, POF, POW, POX, POY, POZ. The frequencies of these transmitters do not seem to be fixed, but they all work between 15,000 and 7,500 kc. (20 and 40 metres).

Switzerland

All Swiss amateurs may be reached now via " Le Journal de Radio," Lausanne. Communications should be sent under cover, as only one licence has, as yet, been issued for transmission in Switzerland. The fortunate one owns the call-sign H-9XB.

A Round-the-World Relay

A message that a Washington transmitter was recently unable to transmit to Georgia (500 miles distant) was overhead and relayed by a Californian amateur. His message was overheard by a New Zealander, who relayed it to Australia, whence it was sent direct to London, and delivered across the Atlantic to Georgia! In other words, a message that could not be sent 500 miles direct reached its destination by travelling right round the world, a practically " all-red " route being used.

This illustrates in a striking manner the extraordinary carrying power of the high frequencies over long distances, while they are still inaudible over shorter spans.

A New Intermediate

We have particulars of one more officially recognised " intermediate," namely, " SR," for the Salvador Republic. It should be noticed that, in the case of intermediates comprising two letters, they are always " grouped " in the transmission to avoid any ambiguity. For instance, America 4IO calling Salvador 2CH would not send simply " 2CH SRU 4IO," but " 2CH SR U 4IO." The advisability of this will at once be seen.

Choosing Valves to Suit Your Circuit

By D. J. S. HARTT, B.Sc.

The choice of suitable types of valve for various functions in a receiver is a matter of considerable importance for efficiency. In view of the large number of valve types now available, these notes should be of value to the experimenter.

IF anyone takes the trouble to prepare a list of the receiving valves available on the British market, together with their more important characteristics, such as

The Ediswan P.V.5 D.E. is representative of the 5-volt dull-emitter type of small power valve.

filament voltage, filament current, suitable high-tension voltages, internal impedance and theoretical amplification factor, he will realise what a large selection there is to choose from for the various purposes for which we use valves in a receiving set.

Confusing Nomenclature

With such a large selection of valves available, it is not surprising that beginners in wireless, and often more advanced amateurs too, find themselves in doubt as to which valves will suit their particular requirements best. Despite the fact that practically all the manufacturers now specify for which purposes each of their particular valves is best suited, there is still some confusion which is certainly not lessened by the varieties of systems of nomenclature now in existence.

Under such circumstances a few general hints on the selection of valves for particular purposes, with a mention of representative types for guidance, may be of help.

General Classification

As a sort of general classification, receiving valves can be allocated positions in one of the three groups:

(i) Valves for high-frequency amplification.

(ii) Valves for low-frequency amplification.

(iii) General purpose valves.

Few manufacturers have produced valves specified particularly for use as detectors.

Filament Voltage

There are a few general considerations to be taken into account which will govern your selection. First, if you are using a multi-valve set, you will choose for convenience valves which require the same filament voltage. You need not do this, of course, for provision can be made for the use of valves of different filament voltage in the same set, but this is rarely necessary, except in special cases. However, if valves requiring the same filament voltage are used, and the filaments are run in parallel in the usual way, it is often possible to dispense with some of the filament resistances.

An Osram low-consumption 2-volt valve designed for H.F. amplification and rectification.

Valves rated at 6 volts or 5.6 to 6 volts can be run quite safely in this way from a 6-volt accumulator, and similarly we can in some cases dispense with resistances when using valves rated at 3.8 to 4 volts, and

Two Cleartron valves of the small power class.

2 volts, and, under some conditions, when using 3-volt valves, by a suitable choice of low-tension supply.

Filament Current

Secondly, we must consider the question of total filament current consumption, and make sure that this is sufficiently within the limits of our low-tension supply to give a reasonable number of hours of service for each charge if an accumulator is being used. This will not, of course, greatly concern those who have good charging facilities.

Low Consumption Valves

However, for those who can use only dry batteries, the question of filament current consumption is of importance, and the valves will have to be carefully selected if satisfactory service is to be obtained from the dry batteries. Now the types of valves which can be used satisfactorily with dry batteries are those such as the Wecovalve, which takes .25 amperes at .8 to 1.1 volts; the 2-volt valves such as the Burndept H.L.213, Cosmos D.E.11 and S.P.18, the Marconi and Osram D.E.2 valves, the Cleartron C.T.15, and some other types, also the 3-volt valves such as the B.T.H. B5, the Mullard D.06's, Marconi and Osram D.E.3 and D.E.3B, Ediswan A.R.06, which are all of the .06 amp. class, and such valves as the C.T.08, Mullard P.M.4, and others.

Dry Batteries

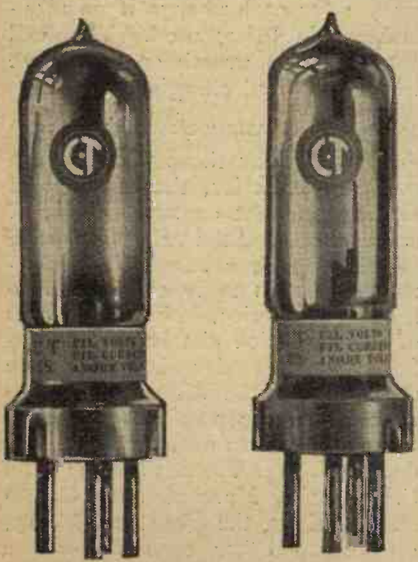
In any case, it is unwise to use dry cells when the total filament current consumption is more than about .25 to .3 amps., and for current consumption of this order only the largest sizes of dry batteries specially made for the purpose by reputable manufacturers should be used, or a suitable number of the smaller dry batteries for L.T. supply run in parallel. This, therefore, places a limitation upon the number and types of valves which can be run satisfactorily from dry cells.

H.F. Amplification

I will next deal generally with the types of valves suitable for various purposes, taking in the first place valves for high-frequency amplification. Many people are content to use general purpose, bright- or dull-emitter valves for the purpose; others prefer some of the more special types of valve. It is all largely a question of the type of H.F. circuit employed. The majority of the special H.F. valves have high theoretical amplification factors, with correspondingly high values of internal impedance.

High Impedance Valves

I refer to such types as the Mullard D.06 (60,000 ohms, 17), Burndept H.310 (75,000 ohms, 15), Marconi and Osram QX valves (80,000 ohms, 25), etc. These are best suited for high-frequency circuits



A pair of general purpose 2- and 3-volt dull-emitter Cleartron valves.

where the external impedance in the anode circuit is high, such as is the case with the tuned anode coupling, for then the actual amplification obtainable more nearly approaches that indicated by the theoretical amplification factor. Under these conditions we have to contend with the question of stability, and some form of stabilisation is in many cases required. This matter, however, has been dealt with by other writers in this journal. In some H.F. circuits, where the external impedance in the anode circuit is small, we may even get better amplification by using a low-impedance valve of the small power type having a moderate amplification factor than by employing a high μ valve of high impedance.

Amongst the special H.F. valves, in addition to the type referred to above, may be mentioned the Marconi and Osram D.E.8H.F. (25,000 ohms, 16), the Cosmos S.P.18, Green Spot (17,000 ohms, 15), Mullard H.F., Red Ring (40,000 ohms, 9.8), and Ediswan A.R.D.E. Red Line (40,000 ohms, 9.5), and Burndept H.512 (45,000 ohms, 18), and Cossor P2 (40,000 ohms, 10).

Detector Valves

As far as valves for use as detectors are concerned, apart from the more commonly used general-purpose valves. I might mention the suitability of some of the valves with a high value of μo, such as the special H.F. valves or those designed particularly for resistance - capacity amplification, such as the D.F.A.4, D.E.5B, D.E.3B, S6, and C.T.25B. These latter valves all have theoretical amplification factors of the order of 20.

Low-Frequency Amplification

For low-frequency amplification there is a very wide choice of valves; in fact, the array of L.F. valves may make the beginner's choice rather a perplexing matter. If, however, you are using a multivalve set, and you decide on your H.F. valves and detector first, it will be an easier matter to select the L.F. valve or valves, for your selection will then be made presumably from one of the 2-, 3-, 4- or 6-volt sub-groups. The first L.F. valve should have a moderately low impedance, and if only one stage of low-frequency amplification is being used for moderate signals a valve having an internal impedance of around 8,000 ohms will be suitable.

Transformer Ratios

The choice of L.F. valves, if transformer coupling is used, is, of course, bound up with the type of transformers in use and their ratios, the primary impedance being an important factor, so a few hints on these points may not be out of place.

If a general-purpose valve of impedance around 30,000 ohms is used for the detector, a transformer of ratio 4 to 1 will be suitable for the first transformer, or a 2.5 to 1 if a valve of high impedance, such as the D.E.3B type, or one of the special high-impedance H.F. valves, is used for the detector. If a valve of impedance 6,000 to 8,000 ohms is used for the first L.F. valve, a good transformer of 4 to 1 ratio may be used in its anode circuit, with a valve of lower impedance still, such as the D.E.5A, for the last valve.

The Marconi D.E.8 H.F. type of valve has an impedance of 25,000 ohms and an amplification factor of 16.

A good 6 to 1 ratio transformer is suitable for use in the last stage in the anode circuit of a valve having an impedance of about 6,000 ohms or less.

These are general indications which will influence your choice of L.F. valves, but they are not infallible, since the ratio of a transformer means nothing unless the primary impedance is adequate.

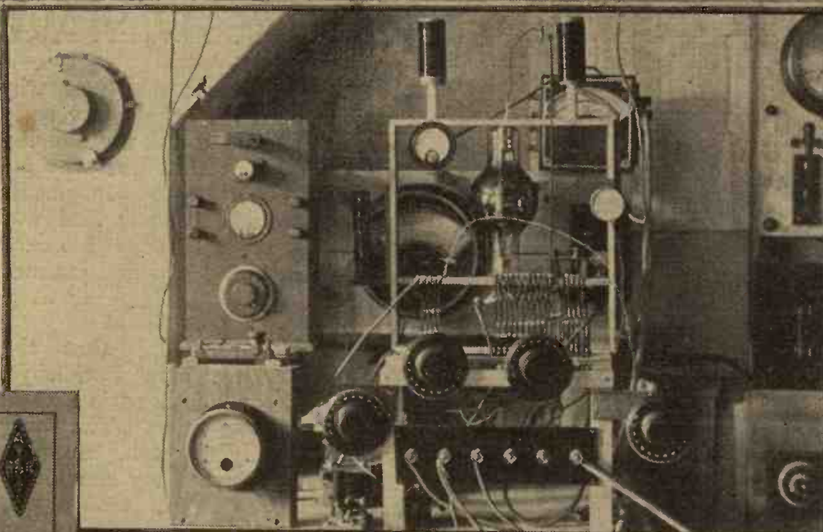
Resistance-Capacity Amplification

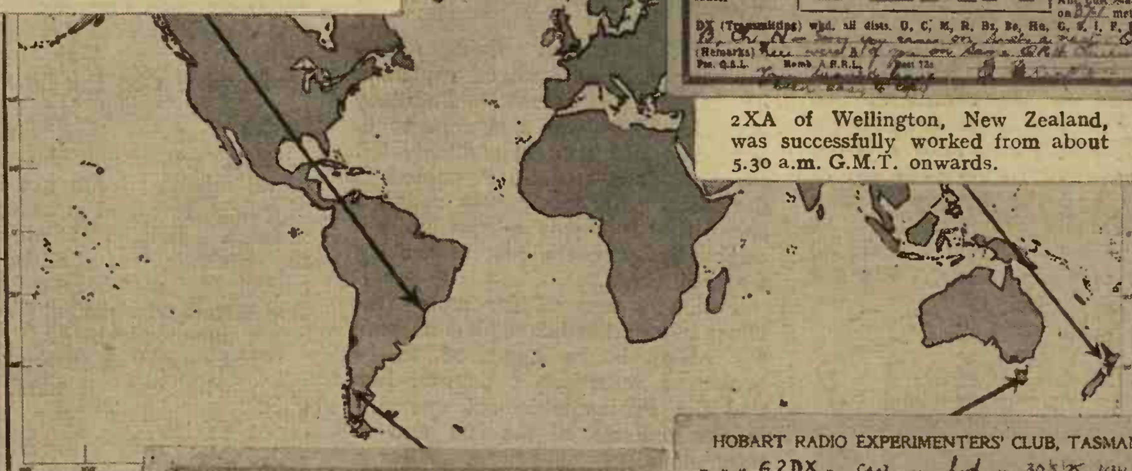
For resistance-capacity low-frequency amplification, using anode resistances of about 100,000 ohms, it is desirable to use valves of the special resistance capacity type mentioned previously. With such high value anode resistances the impedance of the valves may be fairly high, and special valves of high amplification factor have been developed. For the last valve in a resistance capacity L.F. amplifier, a low-impedance power valve should be used.

It must be realised that in this short article all the various makes cannot be referred to, and omission to mention particular valves of some makes should not, therefore, be taken to be a reflection on their capabilities.

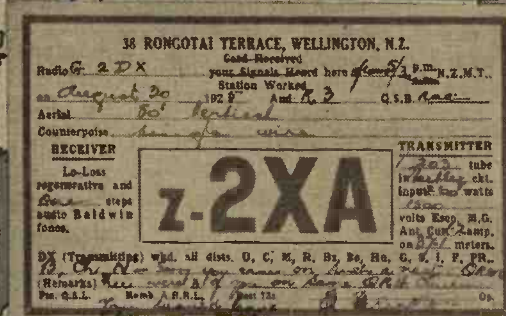
ROUND THE WORLD IN ONE NIGHT

During the night of August 29-30 signals from 2DX, Mr. W. K. Alford's station at Camberley, were heard by the stations whose QSL cards are reproduced below. This occurrence is of peculiar interest, since it would seem to show that waves of the high-frequency used (6667 kc.) travel equally well in a South-Easterly or South-Westerly direction.



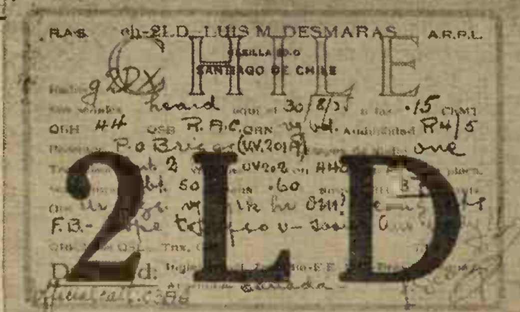


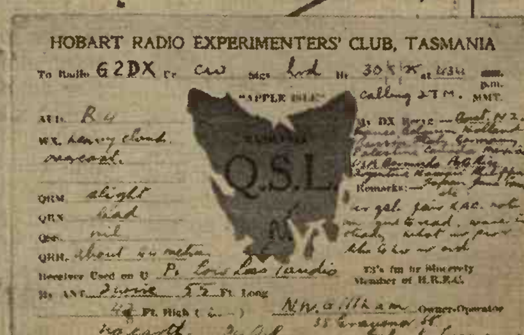
Brazilian 1AF is operated by J. Cardoso de Almeida at Rio de Janeiro.



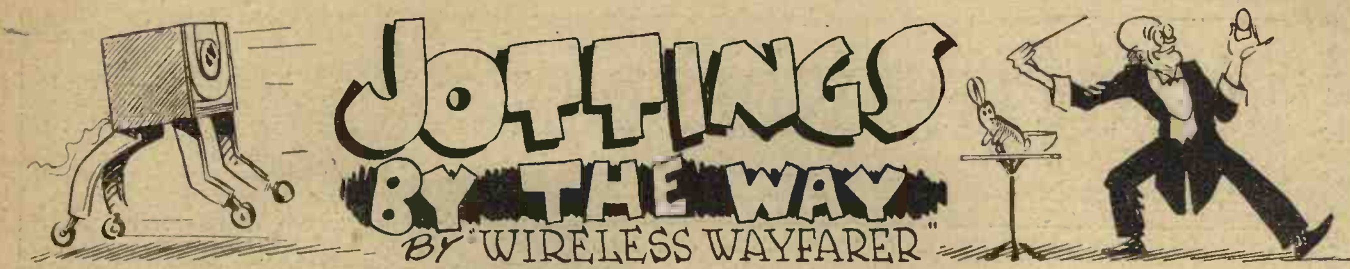
2XA of Wellington, New Zealand, was successfully worked from about 5.30 a.m. G.M.T. onwards.

M. Luis Desmaras of Chilian 2LD reported that the signals from 2DX were of good strength.





A report card sent by a listener with a 2-valve receiver in Tasmania.



The "Gazette" Again

YOU will have gathered from the vivid accounts that you have had from my able pen of the inauguration of its special wireless features and articles that the *Little Puddleton Gazette* has adopted a distinctly progressive policy with regard to wireless. Only a short time ago it might have been said with some justice that the Editor was the kind of person who lets the grass grow under his feet; now that he has got under way, however, his progress is as rapid as that of the proverbial rolling stone, which, as you know, never becomes moss-grown. Only the other day Poddleby, Professor Goop and I received another communication from him bidding us attend at once, or rather earlier if convenient to us, at his office.

More Haste . . .

On that particular morning, I remember, I was feeling a little tired after a heavy spell of work on the previous day, and it was quite on the cards that I should have economised to the extent of two meals, by making breakfast coincide with tea, had I not been aroused by the entrance to my bedroom of Poddleby and the Professor, who were obviously very excited. As they were both talking at once at the tops of their voices, I did not at first gather what it was all about. Poddleby, however, handed me a note that the morning's post had left at my house and signed to me to open it.

. . . Taking my bath while wearing shirt and trousers . . .

It was then that I read for the first time the momentous summons that I have just been telling you about. Having to hurry always rather disconcerts me. That I suppose was why I found myself taking my bath whilst wearing my shirt and trousers; that was why I shaved with the help of my early morning tea and drank my shaving water at a gulp; that was why my bootlaces flew into fragments directly I touched them; that was why being at last ready I seized the first hat that I saw and jammed it on.

. . . Less Speed

It was unfortunate that the hat should have been Poddleby's bowler and that his head is several sizes larger than mine. The thing went on easily enough, stopping only when it touched my shoulders; the trouble was to get it off again. Poddleby and the Professor rushed to my help, but as each pulled in a different direction, the net result of their efforts was nearly to wring my neck. Poddleby at last persuaded the Professor to desist and himself took charge of the salvage operations. Directing me to lie down he placed his feet upon my shoulders and his hands upon the brim of the hat. "Are you ready?" he called. Being necessarily speechless I raised my hand in token of assent. Poddleby heaved. There was a strange rending noise and his feet suddenly left my shoulders. I still remained in darkness. Feeling gently round I found that though the brim had undoubtedly gone the rest of the hat was still there.

Poddleby was all for trying the effect of another heave, but as both my collar bones appeared to be broken I refused. I begged him and the Professor to cut eye slits in the remains of the hat and to take me along as I was. After a few further efforts at removing it, they took this course, and we proceeded down the High Street. I like to think that the greater part of the laughter that I heard was caused by Poddleby's appearance, for he was wearing one of my hats balanced precariously upon his round, bald head.

The Proposal

When we reached the office of the *Gazette*, the reporter-sub-editor-compositor-chauffeur gave one wild shriek of "Ku Klux Klan!" and hastily left the building. We made our way to the editorial sanctum, where the Editor, having got over his first surprise, produced a pair of scissors and freed me from my visor, removing only a small portion of one ear in the process. "And now," he said, when we were all once more composed, "let me tell you why I asked you to wait upon me. You have probably noticed that some papers less well known than the *Gazette* have been providing broadcast programmes at their own expense. The *Daily Lyre*, for example, has given one, so has the *Splash*, and a week or two ago the *Evening Scream* entertained us with evening screams. Once more I do

. . . we proceeded down the High Street . . .

not propose that the *Little Puddleton Gazette* shall lag behind. I intend that we shall give a programme which will outclass those of all others. I am not in favour of going far afield in search of star artistes. Briefly, I propose that the entertainment shall be provided entirely by members of the Little Puddleton wireless club. Can I count upon your help?"

"I for one," cried the Professor, "am with you. I shall be most happy to lecture upon mysteresis losses in metaprocataleptic circuits. I use the term mysteresis because nobody, myself included, understands what they are." "And I," said Poddleby, "will lecture with the utmost willingness upon the Heaviside layer." "I, too," I exclaimed, "will lecture, and so I am sure will Snaggsby and Bumpleby Brown and General Blood Thunderby and the Admiral and Gubbsworthy and Dippleswade and . . . . ."

Variety

"But you can't all lecture," said the Editor. "That's just what we

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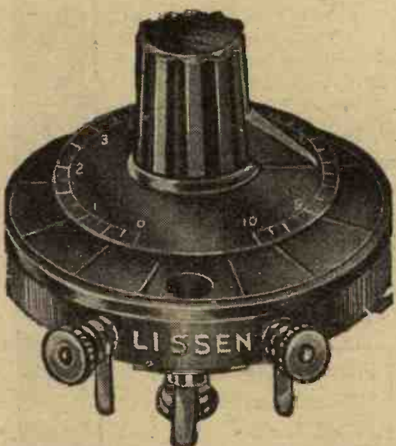

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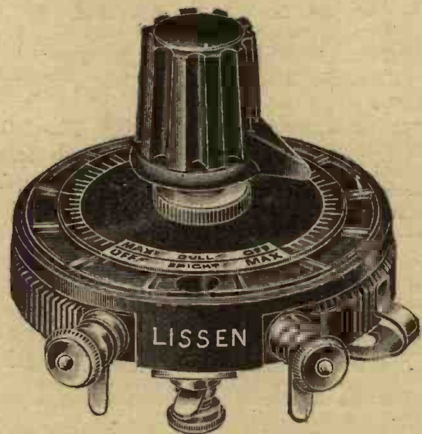

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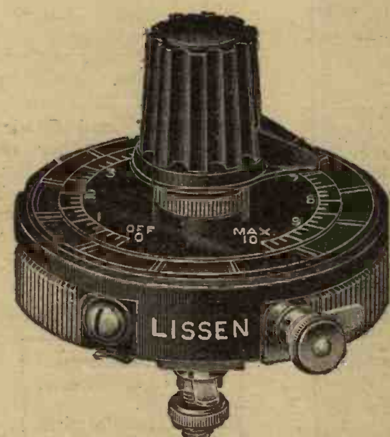

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all want to do," we chanted in chorus. "Now I," said the Professor, "have some entirely new ideas." "So have I," said Poddleby. "And mine are newer than any of them," I shouted above the din. "No, no," said the Editor kindly; "you shall all do your bit, but I am afraid that you cannot all lecture." We looked rather glum on hearing this, but as each of us was ready to sacrifice himself to the cause we surrendered without a murmur. The programme was roughly outlined within the next half-hour, and at the meeting of the wireless club that same night the various items were fixed up, all members being sworn to the most complete secrecy.

. . . collaring the instrument low . . .

The Programme

When we arrived at 2LO in a body we were all of us, I think, feeling a little nervous. We stipulated that we should be allowed to enter the padded cell in a body, so that the person performing at the microphone might have a sympathetic audience. It was agreed, too, that the announcer, having once introduced us to the world, should depart and leave us to carry out the programme. We took our seats round the room, and, as the hands of the clock moved to the fatal hour of eight, all of us found it rather hard to sit still. The first item was "Home, Sweet Home," sung by the Professor, accompanied at the piano by Mrs. Bumpleby Brown. To say that this brought tears to every eye in the studio is to put it mildly. Poddleby followed with a banjo solo, which was stated to be "Last Night on the Back Porch," but sounded much more like midnight on the garden wall, owing to the breaking of three out of the four strings whilst he was engaged in whacking them.

Misunderstood

My turn came next. For some reason that I do not quite understand it was entitled "A Humorous Monologue by Mr. Wayfarer." I have always failed to comprehend why people fail to take seriously the articles that my pen produces. Only one reader out of many thousands appreciated me at my true worth in responding to the questionnaire which appeared in *Wireless Weekly* a short time ago, when asked "Do you wish the humorous feature to be continued?" He replied, "I do not understand to which article you refer." He alone has seen the real worth of my writings; he alone has made up, I have no doubt, the Goop-Wayfarer receiving sets, and has profited thereby; he alone knows what is what. He is a man and a brother. If he will let me know who he is, he shall dine with me, and dine royally—that is, if I can touch Bumpleby Brown for a fiver in the meantime. Anyhow, there it was: "A Humorous Monologue."

My Appeal

Rising from my chair, I pulled down my waistcoat, and made a theoretical step towards the microphone. I say theoretical, because Poddleby's large feet intervened, and actually I made several steps, and was only brought up short by collaring the instrument low and bringing it down with a crash to earth. Forgetting all their instructions, the studio audience cheered. You have probably noticed that the great British public never laughs so heartily as when somebody falls on his ear. Picking myself up, I gathered together the bits and pieces of the microphone, replacing them as well as I could. I then proceeded to deliver a straight-from-the-shoulder talk upon the brotherhood of wireless, in the course of which I made a strong point of the fact that many of the greatest brains are handicapped by the lack of the necessary cash to provide themselves with apparatus. I appealed to all and sundry to lend their wireless apparatus to weaker brothers in straitened circumstances, and I gave my own address as one of the straitest of the strait.

The General

The General's conjuring turn was, I thought, extremely good. His *pièce de resistance* was the Indian rope trick, which, as he explained to the audience, no one has ever seen. Never have I more regretted that television is not an accomplished fact. Had the great army of listeners been able to see Admiral Whiskerton Cuttle going hand over hand up a rope that was not there they would have enjoyed one of the thrills of the century. The General then borrowed a watch from a gentleman in Balham, a tall hat from a listener in Wigan, and a match from an enthusiast at Inverness. He then proceeded to make an omelette, at the end of which he returned all the borrowed articles intact to their owners. Snaggsby next sang "Annie Laurie" with a Little Puddleton-Scots accent, and after him came Dippleswade with "Robin Adair." Dippleswade was unfortunately so nervous that no accent at all was discernible. Admiral Whiskerton Cuttle obliged with some sea shanties, and Gubbsworthy followed with a pathetic rendering of "Swanee River." Gubbsworthy claims to have a tenor voice, but all his friends call it adenoids.

The Star Turn

The real star turn of the evening now came on. Professor Goop and myself, using the very latest of the Goop-Wayfarer receiving circuits, took listeners for a little trip round the world on the magic carpet of wireless. Our first item was mush from Northolt; so was our second, and so was our third. Our fourth was atmospherics from the Atlantic, and our fifth heterodynes from Rome and surrounding districts. All of these came through magnificently. We next put on Radio Iberica during a thunderstorm, Oslo S.B. with Stuttgart, and Radio Paris with an obligato from Daventry. Never have I known a more satisfactory "Round the stations" trip than this.

. . . "There was a tiny mishap" . . .

Sad

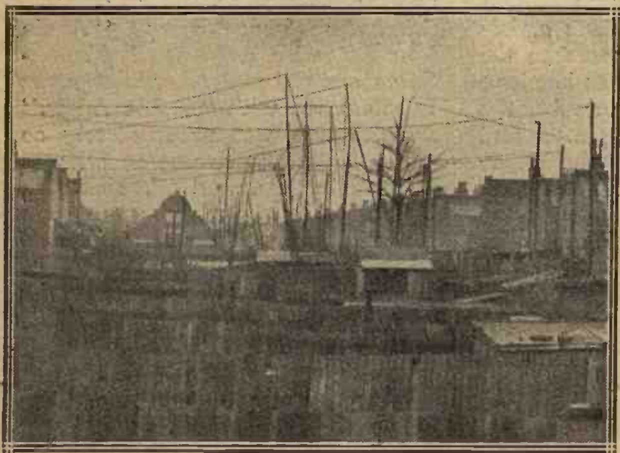
When we had all done our turns the General tiptoed to the door, opened it, and signed to the announcer that he might enter once more. Bland and smiling, the official came in and made a little speech. "I want," said he, "to thank everyone here for his and her splendid efforts. You have surpassed yourselves, if I may say so. Unfortunately there was a tiny mishap. Just as you started a microphone broke down, and during your hour we have been relaying dance music from the Savoy." So now you know just what you missed.

WIRELESS WAYFARER.

Does an "Aperiodic" Aerial Radiate?

By G. P. KENDALL, B.Sc.

Many experimenters are under the impression that the use of an "aperiodic" aerial circuit is practically a cure for the radiation of oscillations. Mr. Kendall here discloses the true facts of the case.



The question of re-radiation is likely to be of considerable importance in localities where there are numerous aerials in a small area.

PERHAPS one of the most useful devices originated of recent years in America is that arrangement of tightly-coupled primary and secondary windings with a variable condenser across the secondary only, which for some reason was christened the "aperiodic aerial" circuit. One of the claims originally made for this circuit was that it was practically non-radiating, in the sense that when a receiver employing such an arrangement was allowed to oscillate, there was little or no interference with neighbouring receivers.

A Doubtful Claim

The arrangement undoubtedly does possess very considerable advantages from the point of view of selectivity and comparative constancy of tuning adjustment over considerable variations of aerial capacity, but this particular claim has always seemed to me a doubtful one, particularly so in the light of certain experiments which I have described in the November issue of *Modern Wireless*, which most readers of *Wireless Weekly* will no doubt have seen.

Comparative Tests

Being in possession of two suitable adjacent aerials, I recently carried out some tests upon the relative radiating powers of an oscillating circuit employing the ordinary tuned aerial circuit, and one of the tightly-coupled tuned-secondary variety, and possibly the quantitative results obtained will prove of interest. The two aerials in question are both supported at one end from a 50-ft. lattice mast, but whereas one is held at the other extremity by a short pole on the gable end of the house and led down to a front window, the other diverges at an angle from the first, and is led down to a workshop which is situated some thirty yards away from the down lead of the first-mentioned aerial. The arrangement is very much what occurs under normal crowded suburban conditions, and serves quite well for such experiments as these.

The Oscillating Receiver

Upon the workshop aerial a receiver was arranged, consisting of an experimental tuner and a detector valve panel, so that it was quite easy to change over from the ordinary direct-coupled arrangement with reaction to the tight-coupled scheme with tuned secondary, again with reaction. For the tests a single-valve reaction circuit was used, the valve being a small power valve (a P.M.4) with 72-volts high tension, and a milliammeter was included in the anode circuit, for reasons which will be seen in a moment.

Measurement of Signal Strength

This set was thrown into continuous oscillation by tightening the reaction coupling, and the effect upon the other aerial was measured by tuning it to the frequency of the oscillating set, and connecting a Moullin voltmeter across the tuned circuit. The signal strength so obtained was measured and then a change was made in the circuit of the oscillating set from the direct-coupled to the inductively coupled arrangement, and signal strength once more measured.

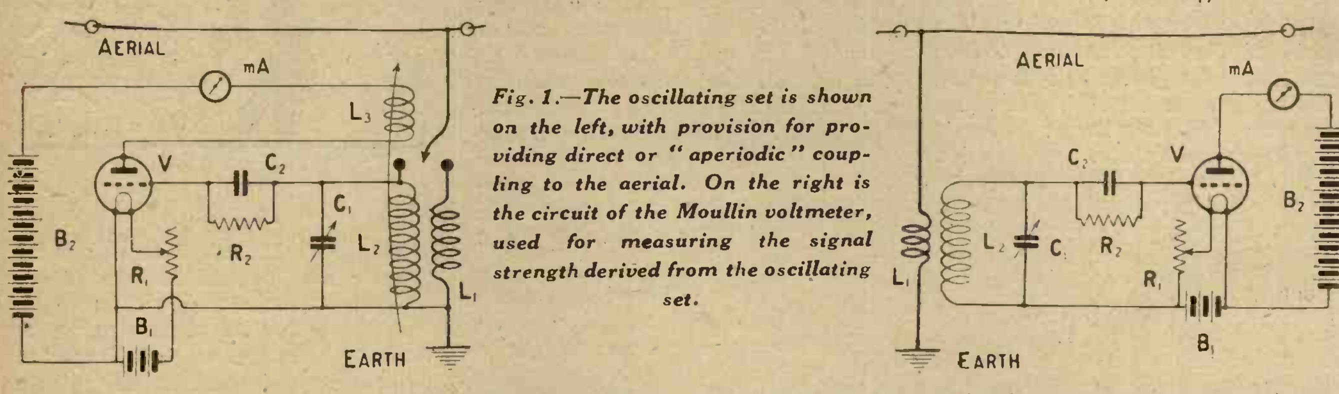


Fig. 1.—The oscillating set is shown on the left, with provision for providing direct or "aperiodic" coupling to the aerial. On the right is the circuit of the Moullin voltmeter, used for measuring the signal strength derived from the oscillating set.

Ensuring Constant Conditions

If it can be assumed that the radiating set was in each case in a similar state of oscillation, the signal strength recorded upon the second aerial may be taken as a measure of the relative harmfulness of the arrangement. It is, of course, somewhat difficult to arrange a constant output from the oscillating circuits, and two different methods were tried. In the first, it was decided that the set should be made to oscillate fairly strongly, and the method adopted was to note the reduction in the anode current of the valve as the reaction coupling was tightened. When the anode current had dropped to 2 milliamperes, it was assumed that suitable conditions had been obtained and the signal strength on the distant aerial was measured.

Measurement with Direct Coupling

Upon changing over to the different circuit, the reaction coupling was again tightened until the anode current dropped to 2 milliamperes, and the measurement of signal strength was once more carried out. In this way a figure of 12 was obtained upon the distant aerial for the signal strength given by the oscillating set with a direct-coupled circuit and a parallel tuning condenser. With a series condenser the figure of 10.5 was obtained.

The " Aperiodic " System

Changing over to the so-called aperiodic aerial arrangement was done by tying to the side of the plug-in tuning coil which was to form the secondary winding a hand coil of No. 22 d.c.c. wire, of either 15 or 20 turns, whose ends were of course connected to aerial and earth. It should be noted that the aerial upon which the experiments were being done was of somewhat small capacity, and hence the rather large size for the aerial winding. These turn numbers are the actual ones found most suitable in practice upon this aerial for general reception upon frequencies similar to that of 2LO.

Aerial Coil

The 20-turn primary is of approximately the correct size for the greater part of the broadcast band for the best signal strength with a reasonable amount of selectivity. The 15-turn coil would be used when a higher degree of selectivity is required at some sacrifice of signal strength.

Preliminary Results

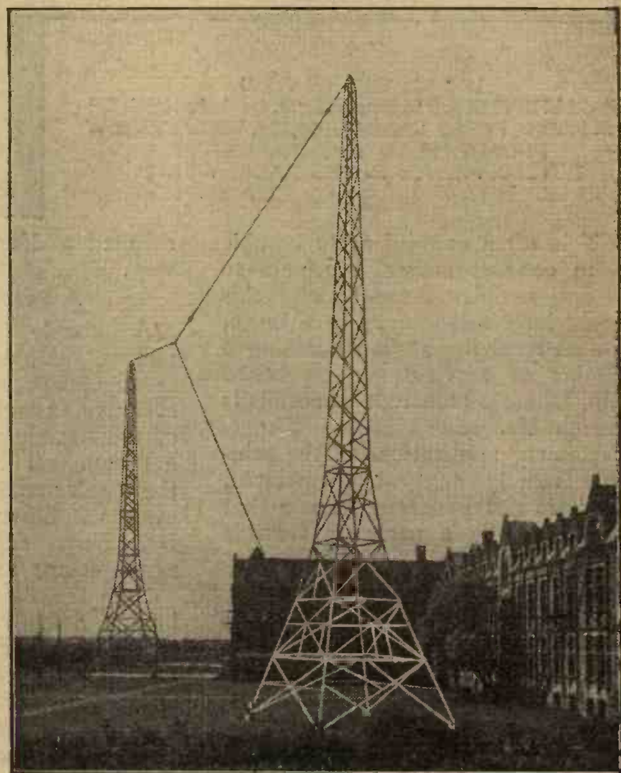
The results obtained were, in the case of the 20-turn primary, a signal strength of 8.5 upon the distant aerial, and in the case of the 15-turn primary, a signal strength of 6. These figures, of course, suggest a distinct reduction in the amount of radiation, but nothing to justify the assumption that the " aperiodic " aerial circuit is by any means an effective one for the reduction of interference.

Further Tests

A further series of tests was then carried out, adjusting the oscillating set to slightly different conditions. The method of obtaining uniform conditions in this case was to increase the reaction coupling gradually until the valve was just and only just maintained in the oscillating condition. This method approximates to the conditions existing where a set is being used to search for distant stations in the oscillating condition.

Results Obtained

The results obtained in this way were as follows. With the direct-coupled arrangement with parallel condenser the figure of 7 was obtained upon the distant aerial, and with a series condenser the figure 6 was recorded. With the tightly-coupled arrangement, using the 20-turn primary, the signal strength was 5, while with the 15-turn primary it fell to only 2.3, again showing a quite useful reduction in interference producing power, but nevertheless not such a one as to justify anyone feeling that in the aperiodic aerial arrangement is to be found a " safe " circuit.



The aerial of the Canadian National Railways Broadcasting Station, from which the special programmes for reception in this country were sent out.

German Amateur Transmission

KXH is the call-sign of a well-known German experimenter in Heidelberg. We have no details regarding the power used, but signals from this station are heard strongly in England, on frequencies of 6,000 and 3,000 kc. (50 and 100 m.). We are unable to publish the full address of this station, but all correspondence may be sent via Captain E. H. Robinson (5YM), " Langmead," Pirbright, Surrey, who will be pleased to forward it.

* * *

Another call-sign frequently audible in this country is NUMM, which belongs to the U.S.S. *Litchfield*, one of the vessels taking part in the United States Navy manœuvres in the Pacific Ocean. Reports on reception of NUMM will be welcomed, and should be addressed to " The Wireless Operator, U.S.S. *Litchfield*, c/o Postmaster, San Francisco, U.S.A." The transmissions take place at various frequencies between 7,500 and 15,000 kc. (20 and 40 metres).

Inventions and Developments

UNDER THIS HEADING MR. J. H. REYNER, B.Sc. (Hons), A.C.G.I., D.I.C., A.M.I.E.E., OF THE RADIO PRESS LABORATORIES, WILL REVIEW FROM TIME TO TIME THE LATEST DEVELOPMENTS IN THE RADIO WORLD.

IT is often convenient to be able to connect several receivers to one aerial. Commercially this would have advantages in a large, central receiving station handling a number of services, or on board ship, where a multitude of aerials is undesirable.

Amateur applications of the principle readily suggest themselves, but it is not generally known that the system is a perfectly feasible one.

Theory of Operation

The essence of the arrangement consists in the insertion of a high resistance, of the order of 10,000 to 50,000 ohms, in the aerial circuit. The currents of various frequencies flowing in this resistance produce voltages across it. For each receiver a valve is tapped across a suitable portion of the resistance, so that amplified currents from all the stations within range are obtained. By the use of suitable tuned circuits, the particular station required may be selected and amplified in the usual way.

A Practical Method

A simple and readily-applied method employs a tuned anode arrangement, but this is not always selective enough. Dr. Hoyt Taylor, of the American Navy, has devised a system of filters which gives all the selectivity required. This system is illustrated in Fig. 1, and Dr. Hoyt Taylor describes the arrangement as follows:—

" In the figure A is an aerial having a high resistance in series therewith. The thermionic valve V has its grid circuit connected between two points in this resistance. The plate circuit of this valve contains the tunable high-frequency circuit having inductance L1 and variable capacity C1 in parallel relation. I find it preferable to make the ratio of inductance to capacity in this circuit large. There is also included in this circuit a device J, which I term a rejector. It comprises a very low inductance element having very low resistance, usually being one or more turns of very heavy copper strip or wire, and a large capacity condenser constructed to have small resistance, the condenser being made variable in order to permit of tuning the rejector element to the desired frequency. Shunted around the rejector is a tunable circuit containing inductance L2 and variable capacity C2 in series. A receiver is associated with this last-named circuit usually through a tunable circuit containing inductance L3 and variable condenser C3 with leads to a detecting device or to an amplifier and detector as desired.

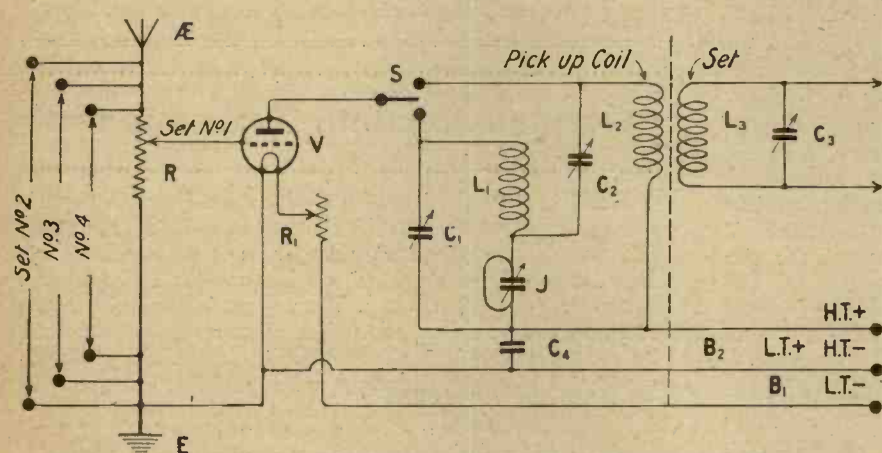


Fig. 1.—The receivers to be connected to the aerial are tapped across suitable portions of the resistance R.

Batteries

" B1 is a source of current for heating the filament of valve V, and B2 is a source of current for the plate circuit of this valve. These same sources may be used in connection with the amplifier and detector if valves are used in connection therewith. The capacity C4 is preferably large, and is introduced mainly for the purpose of preventing a short-circuit of battery B2. The aerial may be tuned, but this is not essential, as the high resistance R in series therewith renders it aperiodic.

" Any number of receivers may be connected with the aerial through similar valves and circuits as described above through additional leads connected between points in the resistance R, as illustrated.

" I term the valve V a coupling valve because it couples the collector to the selective circuits and receiver, as illustrated, and at the same time prevents a reaction caused by variations in these circuits on other circuits connected to the collector.

(Continued on page 309)

SOME FURTHER NOTES ON COIL RESISTANCES

By J. H. REYNER, B.Sc. (Hons.), A.C.G.I., D.I.C., A.M.I.E.E.

In last week's issue Mr. Reyner gave some most interesting results of measurements with the Auto-Resonator of the H.F. resistance of different types of coils. Some additional information on the same subject is given here, further coils having been subjected to tests, and certain preliminary conclusions are reached.

I HAVE been following up my investigations on the subject of the resistance of tuning coils, with results which are both interesting and at the same time somewhat disconcerting.

Further Investigations

In an attempt to find the effect of using different gauges of wire, a large number of coils have been wound and the results compared. It will be remembered that last week the preliminary results indicated that over a certain range of inductance in the region of 100-150 microhenries, the resistance of a coil wound with 30-gauge wire was actually lower than that of a well-spaced winding of 22-gauge wire.

Different Gauges of Wire

The next step in the investigations was obviously to wind a series of coils all on the same former, but using different gauges of wire, and this was actually carried out. Coils were wound on a plain 3-in. ebonite tube, with 22-, 28-, 30- and 36-gauge wires, the windings in all cases being straightforward unspaced windings. Double silk-covered wire was employed, so that there was a very slight spacing due to the insulation; this spacing also increases slightly as the finer gauges of wire are employed, owing to the slightly thicker covering in proportion on the finer gauges. The spacing, however, was so small that the windings could reasonably be considered to be unspaced.

Curves Obtained

Now the remarkable thing about the results obtained is that all the resistances lie practically on the same curve over a certain range of inductance. Fig. 1

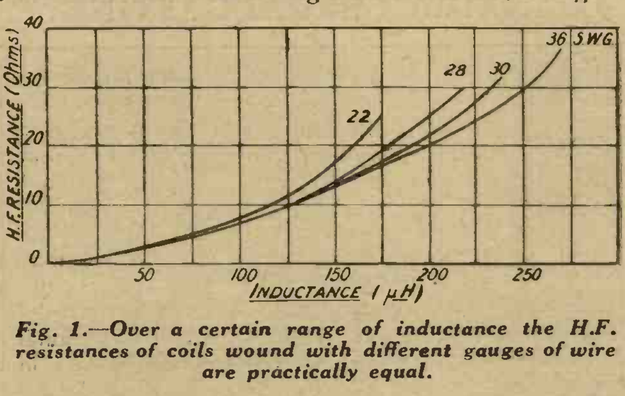


Fig. 1.—Over a certain range of inductance the H.F. resistances of coils wound with different gauges of wire are practically equal.

shows the curves which were obtained for the various coils, and it will be seen that they all overlap over the range from 75 to 150 microhenries.

A Critical Point

As soon as the inductance is increased beyond about 150 microhenries, then there is a considerable discrepancy between the curves and the resistance rises somewhat rapidly with the finer gauges of wire.

For the lower inductances, however, the resistance for a given inductance is almost the same, irrespective of the size of wire employed for the coil. We can thus draw a representative curve for the particular diameter of former, such as is shown in Fig. 2, showing the resistance which may be expected for a given inductance.

Various Diameters

For other diameters of former, the representative curve will, of course, be different. In Fig. 2 I have

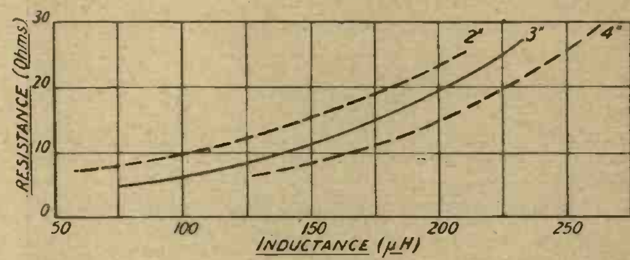


Fig. 2.—Changes in the diameter of the winding former produce the variations of resistance shown by these curves.

shown, in dotted lines, the curves for a 2-in. and a 4-in. former. These curves are only intended to indicate the nature of the variation produced in the resistance by a change in the diameter of the former. I have not yet taken an adequate series of readings to enable a definite curve to be given, as in the case of the 3-in. former.

Slight Influence of Diameter

The different effect of the different diameters of former is really a comparatively small one, until one reaches the smaller inductances, where the difference becomes considerable. Another interesting point, arising from the 3-in. curve in particular, is that the actual resistances for a given inductance are of the same order as those obtained for a well-spaced winding of thick wire on a "low-loss" former, as was shown last week.

The "Low-Loss" Coil

Over the range of inductance under consideration, therefore, up to about 200 μH, there is little or no advantage in using one of the present types of low-loss coil. Whether, in view of these results, we shall be able to produce a really low-loss coil, remains to be seen, although I have little doubt that we shall ultimately succeed in doing so.

Conditions for Low Resistance

Another important point is that, as the higher inductances are attained, the lowest resistance is obtained with the finer wires, the 22 s.w.g. coil being particularly bad. It should be remembered that these results apply only to close windings. The conditions which obtain with spaced windings are somewhat different, and here the thicker wire shows up to better advantage, although, as we have seen, the actual resistances are no less than can be obtained with an equivalent close-wound coil of finer gauge wire.

A Practical Instance

This is a remarkable result, and at first sight one is inclined to doubt the accuracy of the measurements. It is interesting to note, however, that Mr. D. J. S. Hartt, B.Sc., has recently completed a five-valve set, having two high-frequency stages incorporating filters made up on 3-in. formers wound with 28-gauge d.s.c. wire, and has found the tuning very sharp.

The Rt. Hon. Philip Snowden, M.P., who recently broadcast a talk from the London Station.

Replacing one of the coils with a spaced winding coil of the "low-loss" type wound with 22-gauge wire resulted in noticeably inferior results. This receiver, which is called the "DX Five," is being described in the December issue of *Modern Wireless*, so that it will be seen that the conclusions drawn from these resistance measurements are borne out in practice.

Small Inductance Values

Considering next the actual values of the resistances, it will be seen that we do not reduce the resistance down to the 5 ohms limit until the inductance falls as low as 75 microhenries. This is a comparatively small inductance, and tunes to the ordinary broadcast frequencies with a much larger condenser than is usually employed. A coil of this inductance would actually require about 450 $\mu\mu$F in parallel, to tune to 825 kilocycles.

Inductance-Capacity Ratio

It is a more or less accepted fact that, in order to obtain the best results from a particular circuit, it is necessary to employ a large coil and a small condenser, so that we cannot consider that a coil such as this really satisfies our requirements. What is required is a coil having a resistance of about 5 ohms with an inductance of about 200 microhenries or more.

Some Unexpected Results

In passing I may mention that the question of the best ratio of inductance to capacity to employ in a circuit is one which is interesting to investigate, and I am actually engaged upon this problem at the present time. The results are very curious, and I hope to be in a position to report upon them shortly.

Theoretical Requirements

In order to comply with the requirement specified above, we require a coil having an R/L ratio of 0.025 ohms per mic. The best I have come across so far is 0.07 ohms, which is about the figure obtained at the optimum point on the coils wound on 3-in. formers. Various attempts were made to obtain a coil having a lower ratio than this, and still having a fairly high inductance, but so far the attempt has not been successful with single-layer windings.

Multilayer Windings

If multilayer windings are employed, the problem is considerably complicated. It is well known that the resistance of a coil increases rapidly as the number of layers on the winding is increased, and, unfortunately, increases more rapidly than the inductance, so that the use of multilayer coils would not appear to offer much prospect of a solution.

Plug-in Coils

Most of the commercial plug-in coils are of the multilayer type, and, as is well known, vary widely in efficiency. Some coils I have measured have had resistances as low as 12 ohms, giving an R/L ratio of about 0.095, whereas other coils of equivalent inductance have had resistances as high as 70 ohms.

Single-Layer Coils Best

I do not propose, however, to say much about multilayer coils at present, because the subject is one which requires careful and somewhat lengthy investigation. It is interesting to note, however, that, as far as I have found at present, the single-layer coils have the lowest resistance.

CANADIAN BROADCASTING.

The walls of the studio at CNRA, the Canadian National Railways broadcasting station, are not heavily draped. The microphone can be seen on a pedestal close to the piano.

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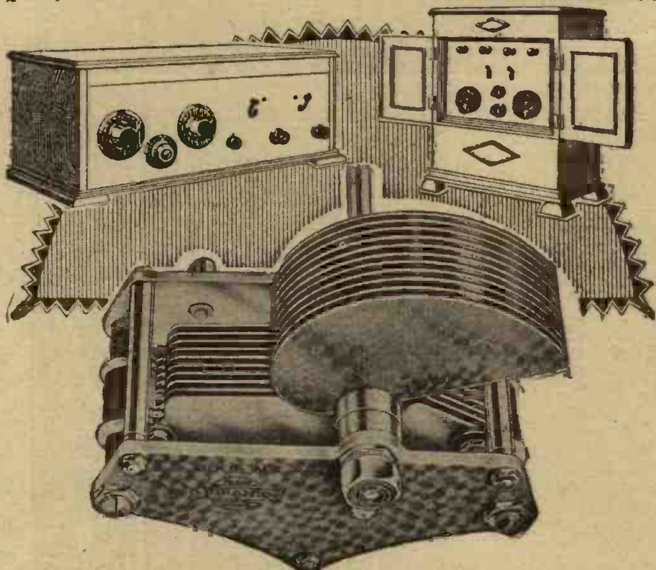

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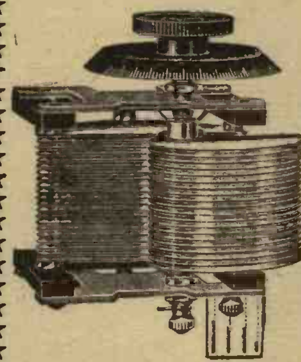

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BRITISH Brown THROUGHOUT

Gilbert Ad. 3985

Wireless News in Brief.

The Northolt Station. We hear that, following the recent agitation in regard to the bad interference caused by mush from the Post Office station at Northolt, alterations have been made to some of the transmitting gear with a view to lessening this interference. The situation, however, is as yet by no means perfect, particularly in the north-west area of London.

An official of the General Post Office has stated that the engineers are taking all possible steps, but that it is not an easy matter to rectify the trouble.

* * *

American Broadcasting. From the following extract from a well-known American wireless journal it would appear that some efforts are likely to be made to raise the standard of the average broadcast transmissions: "An impartial critic must admit that we have but thirty-five or possibly forty broadcasting stations out of a total of about five hundred that are trying to lift broadcasting to the plane of a decent source of American entertainment."

* * *

Daventry Heard in Tasmania. Music broadcast from Daventry has been heard by a wireless amateur in Hobart, Tasmania — more than 12,000 miles away.

An English amateur helped to accomplish this record, but it was not until he heard by post from the Tasmanian listener—Mr. N. W. Gillham, of 38, Grosvenor Street, Hobart—that he knew it had been done.

The amateur is Mr. F. A. Mayer, of Wickford, Essex, who was picking up Daventry on the night of September 12, and re-transmitting the programme on a low wavelength.

The subject of night-distortion of the Daventry station is shortly to be investigated thoroughly by fifty amateur transmitters and fifty listeners who are regular correspondents of the British Broadcasting Company. The reports will be passed on to scientists, who will aid the B.B.C. in analysing the reports received and in suggesting explanations of the phenomena observed.

* * *

A Wireless Fatality. The theory has been put forward that the fire which caused the death of a woman at Mersham, near Ashford, Kent, last month, was occasioned by the short-circuiting of the accumulator belonging to a wireless receiver. It was shown that a wire short-circuiting the terminals of an accumulator may, due to the heavy current, become red hot and thus set fire to the celluloid container. An additional danger, under the circumstances, it was stated, lay in the production of dangerous fumes which would render a person unconscious.

* * *

Reception of CNRA. The transmissions of the station CNRA at Moncton, Canada, were recently picked up successfully in this country by the office of the Canadian National Railway Company, Cockspur Street, London, the company to which the station belongs. Reception of this station was also reported from Southampton and Worsley, near Manchester, and other parts of the country.

Despite unfavourable atmospherical conditions good results were obtained, a listener at Southampton reporting clear reception on a three-valve set. In London, a noteworthy achievement at the Cockspur Street office was loud-speaker reception of CNRA, using a frame aerial and a seven-valve super-heterodyne receiver.

Transatlantic Telephony. The British Broadcasting Company announce that a series of tests especially arranged for amateurs on both sides of the Atlantic will take place at the end of January, 1926. It is said that there is a possibility of the Rugby station taking part in the tests, and, of course, if this proves to be the case, much interest and value will be added to the experiments.

* * *

Hospital Wireless. We are informed that the Hounslow and District Wireless Society are installing wireless receiving apparatus at the Hounslow Hospital, for which a "Hospital Wireless Fund" has been started in the district.

* * *

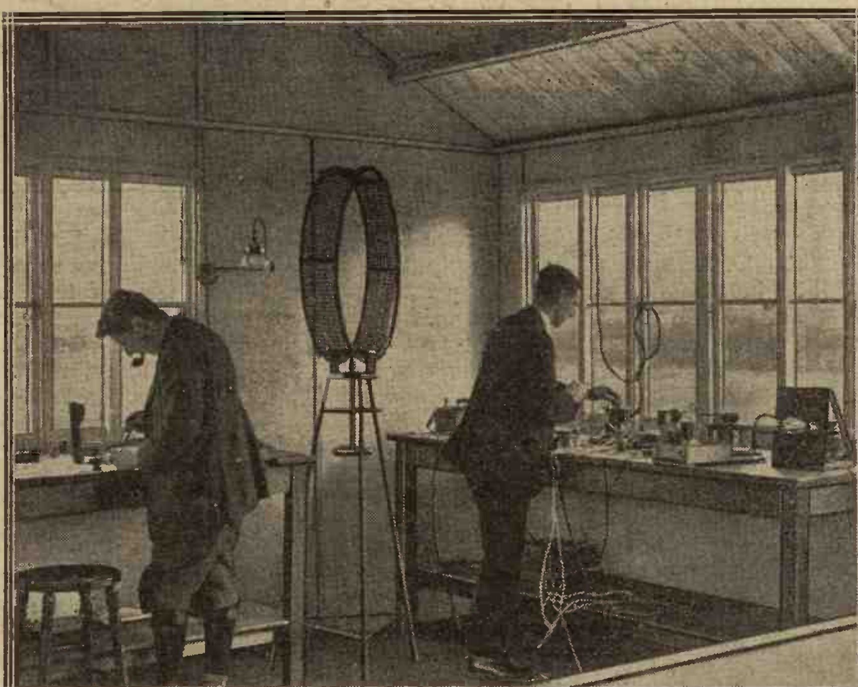
Mr. R. M. Ford. Mr. Robert Moffat Ford, of East Lodge, Park Row, Albert Gate, S.W., appeared before Mr. Mead at Marlborough Street Police Court last Thursday on an adjourned summons, at the instance of the Postmaster-General, for—"That he, between August 7 and September 7 last, at East Lodge, unlawfully established a wireless telephone station, and further installed and worked a wireless apparatus without the necessary licence." Mr. Ford pleaded "Not guilty" to the three charges of establishing a station, installing a wireless apparatus, and working it.

Mr. Percival Clarke, prosecuting on behalf of the Postmaster-General, stated that, under section 7 of the Wireless Telegraphy Act of 1904, the defendant would be liable to a penalty of £10 if the charges were proved. The whole apparatus, save the telephones of a wireless listening-in set, had been tested since the search, and was found to be in working order and capable of receiving.

A CURIOUS CRY

By the Staff of the Radi

The account given here of tes circuit submitted to us by interest to those who hav mysterious phenomen



A corner of the Research Building at the Radio Press Laboratories at Elstree.

EVERY wireless experimenter knows that a circuit, which on paper appears to be capable of giving good results, may in practice turn out to be a dismal failure. Occasionally the reverse occurs and a circuit of no apparent theoretical value will give astonishingly good reception. In such a case it is always worth while to follow the matter up and to try to discover to what factor or

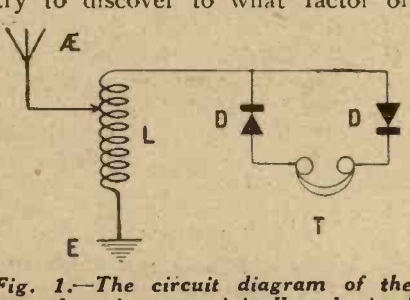


Fig. 1.—The circuit diagram of the crystal receiver as originally submitted for test.

factors the unexpected results are due.

A Puzzling Circuit.

The circuit shown in Fig. 1 was recently submitted to Radio Press by a reader who, quite naturally, was puzzled by the good results he obtained with it. It may be said at once that if the diagram represented the whole of the circuit, no reception would be possible. The effect of oscillations in the aerial would be to cause the potentials set up across the telephones and across both crystals to rise and fall simultaneously. Thus there would be no potential drop across either crystal, no rectification would take place, and no signals would be heard.

A Capacity Connection

The secret lies in the capacity of the telephones and wiring to earth. Since the former are always shunted by their self-capacity and the capacity between their leads, it does not matter whether we suppose the middle, or either end of them, to be connected through a capacity to earth.

Tuning Components

We may thus draw the circuit again as in Fig. 2, the condenser C, shown dotted, representing the capacity of the telephones to earth. The particular tuning arrangement employed is immaterial, and it may equally well be a plug-in coil, tuned with either a series or parallel tuning condenser, or a plain coil with a sliding tapping arrangement, as shown in the diagrams.

Test Measurements

This circuit has been tried on two different aerials, respectively at distances of four and of thirteen miles from 2LO. Tests were also made on the lower frequency of Daventry. In the case of 2LO at a distance of 13 miles the measured rectified current varied between twenty and thirty microamperes, while an orthodox circuit gave about forty microamperes. The other aerial closer

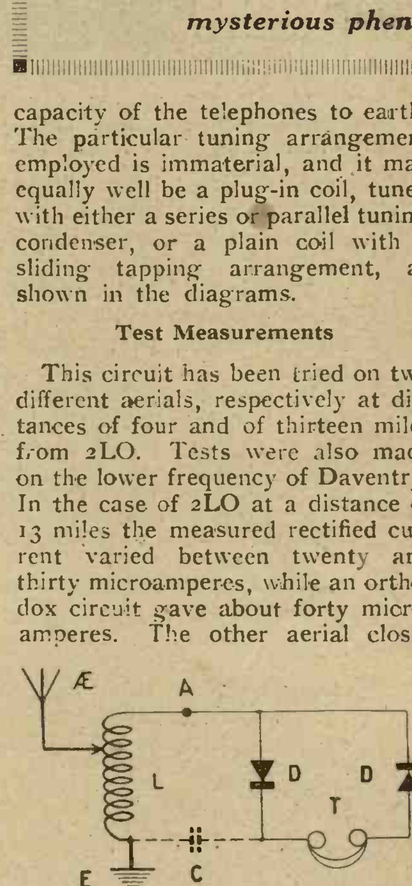


Fig. 2.—Here the condenser C represents the capacity connection between the telephones and earth.

to 2LO gave similar results, but unfortunately no microammeter was available in this case to enable exact measurements to be made.

Reduction of Body Capacity

In an endeavour to elucidate the action of the circuit, the first thing done was to attempt to reduce the stray capacity C (Fig. 2). For this purpose a small loud-speaker was substituted for the telephones, in order to eliminate the capacity of the latter to the experimenter's head, and thence to earth. The whole of the apparatus was then re-

YSTAL CIRCUIT

'o Press Laboratories.

ts carried out on a crystal a reader should prove of encountered apparently of a similar nature.

moved towards the centre of the room. In spite of these precautions, no reduction in signal strength could be detected.

Value of Stray Capacity

The stray capacity C was then augmented by a variable condenser, but an increase of its capacity to .0005 μF caused no appreciable increase in signal strength. Finally this condenser was removed and another variable condenser was inserted at A in Fig. 2. In order to cause the signal strength to decrease by about one-half, it was found necessary to reduce the capacity of this condenser to about .000012 μF. Now the capacity C of the telephones and wiring to earth is in series with this capacity, and increasing C to a large value causes

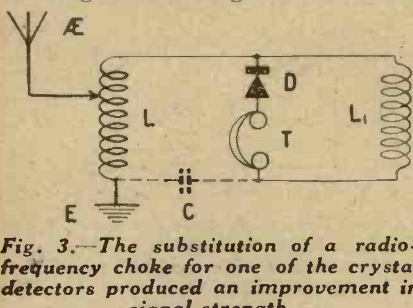


Fig. 3.—The substitution of a radio-frequency choke for one of the crystal detectors produced an improvement in signal strength.

no appreciable increase in signal strength. Thus we may reasonably deduce from these data that the stray capacity of the telephones to earth is greater than .000012 μF.

One Detector Only

Connecting the telephones to earth generally, but not always, resulted in a slight increase of signal strength. If, however, the appropriate crystal was now removed from the circuit, thus converting it into a circuit of ordinary type, signals were, as stated above, invariably louder.

Apparatus submitted to Radio Press for test is seen here, together with part of the general stores.

Choke and Tuned Circuit

Attention was next turned to the crystals, and it was found that a greater signal strength resulted if one of the crystals was replaced by a radio-frequency choke. Alternatively a circuit tuned to the incoming frequency was substituted for the choke, when equally good results were obtained. The corresponding circuits are shown in Figs. 3 and 4.

Action of Tuned Circuit

The action of the tuned circuit is, of course, similar to that of the choke, as it imposes a very large impedance in the path of high-frequency currents, while the rectified low-frequency currents pass without difficulty. It must be emphasised that in all of these experiments the apparatus was well insulated from earth.

The Explanation

We may therefore explain the circuit (Fig. 1) submitted to us as follows. The high-frequency current flows from the aerial, through the crystals, and via the stray capacity C to earth. It is rectified by both crystals, and flows through the telephones in the ordinary way. We thus have a kind of double rectification effect, but, as often happens in such a case, this is more than counterbalanced by the additional damping introduced, so that any gain which might be expected from the arrangement is neutralised.

Conclusions

Although the circuit appears to have no advantage over the more

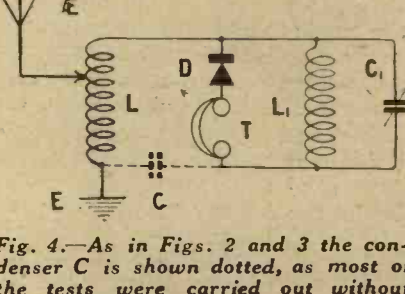


Fig. 4.—As in Figs. 2 and 3 the condenser C is shown dotted, as most of the tests were carried out without an actual condenser here.

orthodox type, yet it is interesting as emphasising the importance of stray capacities to earth.

Filament Chokes in Transmitting Circuits

By L. H. THOMAS (6QB).

In his article on "How to Make a 45-metre Transmitter" in the issue of "Wireless Weekly" for November 4, Mr. Thomas recommended the employment of chokes of a certain type in the filament circuit of the transmitter. A certain amount of controversy having arisen as a result of this recommendation, Mr. Thomas has since carried out experiments with various methods of connecting such choke coils, and the results of these are detailed in the accompanying article.

IN the article on "A 45-Metre Transmitter," which appeared in *Wireless Weekly* for November 4, the filament chokes L_5 and L_6 were placed as shown in Fig. 1, which represents part of Fig. 1 of the above article, connected directly to the filament legs of the valve. A certain number of queries about the efficacy of such chokes in the position shown having been received, the writer has subsequently made several variations in the positions and sizes of these chokes. and some of the results are appended here.

A Criticism

One criticism of the circuit of Fig. 1 which was offered was that the choke L_5 being in the grid-filament circuit, the valve could not possibly be made to oscillate, unless the choke were so inefficient that its self-capacity acted as a by-pass for the H.F. energy. The circuit, so it was stated, should be re-drawn with the lead from the coil taken to the point B instead of A, *i.e.*, the chokes should be in the battery leads, as distinct from the filament leads.

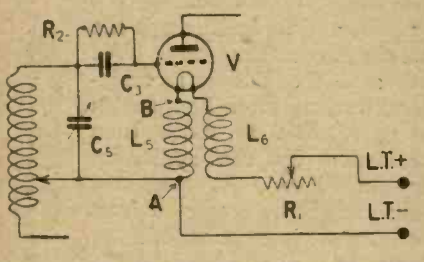


Fig. 1.—Part of the Fig. 1 circuit of the previous article, reproduced to show the positions of the choke coils L5 and L6.

New Choke Coils

The writer, therefore, first did all that seemed necessary to render the chokes efficient. They were wound with bare wire on a low-loss "skeleton" former, and the turns were spaced, the number of turns being increased from 20 to 25 to keep the natural wavelength unchanged. The transmitter was then put into operation and adjusted to the normal frequency, 6,667 kc. An aerial current of .12 amps. was obtained, the anode current being 22 milliamps. at 200 volts.

No change

The original chokes, wound on a cardboard former, were replaced, and, with no alteration whatever in tuning, exactly the same aerial current and anode current were obtained. Obviously the self-capacity of the choke had little or no effect, since, even by retuning the circuit, no greater aerial current and no less anode current could be observed.

Another Test

Both chokes were then removed and placed next to the accumulator, *i.e.*, one end of each of the chokes was attached directly to each of the accumulator terminals. The aerial current and anode current still remained the same as before, but it was found necessary to vary the setting of C_5 very slightly. This, of course, is quite understandable, since the accumulator was about a yard from the transmitter itself. This state of affairs is represented by Fig. 2.

Tuned Choke

The next test consisted in replacing the chokes as they were originally and *tuning* L_5 by means of a variable condenser of .00025 μF capacity. The results of this experiment were distinctly interesting, the aerial current being found to fall off gradually as the condenser approached a certain setting, at which the circuit ceased to oscillate. This point was found, by coupling the coil to the receiver, to occur when L_5 was tuned to 3,333 kc. (90 metres), *i.e.*, the second harmonic of the frequency at which the rest of the circuit was functioning. A larger condenser, capable of tuning the coil to 2,222 kc. (135 metres), was substituted, and, although the transmitter did not stop osciliating, the aerial current fell off considerably at this point.

A Further Precaution

With the chokes connected directly in the battery leads, as in Fig. 2, tuning one of them had no effect whatever.

The coils were now raised some six inches above the baseboard of the transmitter, in case their capacity to earth had been responsible for any by-passing effect of the H.F. currents. Still no difference whatever was noticed. Care had, of course, been taken to place the coils so that their field was as clear as possible of any solid objects, so that this latter test had not been expected to have very much effect.

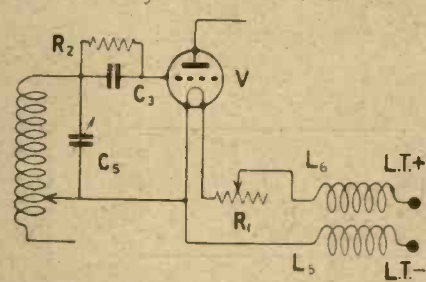


Fig. 2.—This method of connecting the choke coils in circuit was tried, with the effect of altering the necessavy setting of C5.

Effect of Removing Chokes

Lastly, the chokes were removed altogether. The aerial current was reduced to 0.1 amp. and the anode current increased somewhat. By no amount of retuning could the conditions be brought back to normal.

Conclusions

The inference drawn from the above observations is that the chokes, as shown originally, were functioning quite satisfactorily. Results, though not apparently improved, were not hindered by removing the chokes to the battery leads, and the chokes were definitely found to be necessary in this particular case.

Is Your Coupling Tight or Loose?

By SYLVAN HARRIS.

It is quite likely that many experimenters have no very clear idea of what really is "tight" and what is "loose" coupling. In the following article Mr. Sylvan Harris gives details of experiments he has carried out to ascertain the actual co-efficient of coupling between coils of varying turn numbers and diameters.

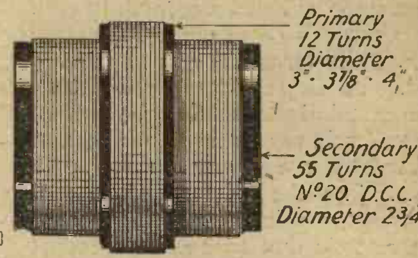


***Fig. 1.**—This illustration shows the coils used during the experiments. As indicated, primaries of different diameters were employed, with similar turn numbers.*

THE question has often arisen as to whether the coupling in a tuning unit is loose or close, and most people who dabble in radio have some qualitative idea of what loose and tight coupling mean. But there are very few, even among the "experts," who could answer with any degree of accuracy the question as to what is the *value* of the coupling co-efficient. In fact, there are very few who have the slightest idea as to how tight "tight" coupling is, or as to how loose "loose" coupling is. Generally they think that if there

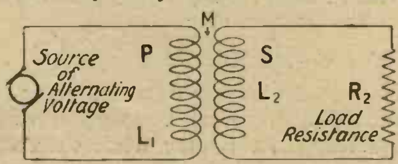


***Fig. 2.**—A very simple form of coupled circuit, having a pure resistance load on the secondary.*

are but few turns on the primary of the aerial circuit tuner, considering now the aperiodic or untuned primary, that the coupling is loose; this in total disregard of the other constants of the circuits and of the relative spacing and geometrical configurations of the coupling coils.

A Few Examples

To bring the importance of the whole matter clearly to the mind of the reader we may ask him a very simple question: What, does he think, is the co-efficient of coupling in a unit having the following dimensions?

Secondary—55 turns
- No. 20 d.c.c. wire
- 2¾ in. in diameter
- Self-inductance, 164 micro-henries.

Primary—12 turns
- No. 20 d.c.c. wire
- 3 in. in diameter
- Self-inductance, 18 micro-henries.

The primary coil is placed directly at the middle of the secondary coil. One might be tempted to think that the coupling is very loose. As a matter of fact, if the co-efficient of coupling were calculated by means of the formulæ given by the Bureau of Standards, it would be found to be about 66 per cent.

Large Primary

Now suppose we consider a unit with the secondary coil at the middle of the primary of the following dimensions:—

Primary—34 turns
- No. 20 d.c.c. wire
- 2¾ in. in diameter.

Secondary—32 turns
- No. 20 d.c.c. wire
- 3½ in. in diameter.

One would suppose that, because there is a large number of turns on the primary winding, the co-efficient of coupling would be tighter than for the coils above. On the contrary: the co-efficient of coupling of the latter is slightly less—it is about 60 per cent.

Effect of Position

To show further how poor our qualitative ideas on coupling happen to be, let us consider again the first described coupling unit. If the primary coil is placed directly at the centre of the secondary coil, the coupling is 66 per cent., whereas if the primary coil is moved out to either end of the secondary coil, the co-efficient of coupling may drop as low as 25 or 30 per cent.

The writer has recently conducted in his laboratories a study of this question, part of the results of which are included in this article.

Coupling Co-efficient

We shall first try to obtain a physical conception of the ideas of coupling and the co-efficient of coupling. Suppose we consider a circuit such as is shown in Fig. 2. This diagram shows a source of alternating voltage connected to a transformer, across the secondary of which is connected a resistance. If the equations for the currents in the primary and secondary circuits be worked out, it will be found that the current in the primary circuit will be the same as that in a simple circuit whose inductance is

$$L_r - \frac{4\pi^2M^2L_2f^2}{Z_2}$$

in which M is the mutual inductance between the primary and secondary in henries, L_1 and L_2 are the self-inductances of the primary and secondary coils in henries, and f is the frequency of the impressed voltage in cycles per second and Z_2 is the impedance of the secondary in ohms.

In other words, the effective inductance of the primary has been decreased by the effect of the secondary coil. If the resistance of

***Fig. 3.**—The magnetic field may be resolved into primary and secondary leakage fluxes and the mutual flux.*

the secondary L_2 be neglected in the second expression it will reduce to

$$L_1\left(1-\frac{M^2}{L_1L_2}\right)=\sigma L_1$$

The second quantity in the bracket is called the co-efficient of coupling, and the quantity σ (the Greek letter sigma) is called the leakage factor.

A Practical Example

Now let us see what these various terms mean. Fig. 3 shows a coupling arrangement consisting of a primary coil and a secondary coil. An alternating voltage is impressed across the terminals of the primary coil. To fix our ideas, let us think of a certain instant when the current in the primary is in the direction shown by the arrow on the wire going into the primary. The current in the primary winding causes a magnetic flux to be set up, part of which threads the secondary winding and part of which does not thread the secondary at all. The first part is called the mutual flux, and the latter the primary leakage flux.

Mutual and Leakage Flux

The mutual flux is utilised in inducing electromotive forces in the secondary winding and, in considering the transformer action only, is the only part of the flux that is useful in transferring energy from the primary to the secondary windings. The instantaneous direction of the E.M.F. induced in the secondary is indicated by the arrow on one of the secondary leads.

This secondary voltage causes a current to flow in the secondary winding which, in turn, causes another magnetic field, having a polarity opposed to that of the primary, to be set up. Part of this secondary flux is opposed by the mutual flux coming from the primary, and in this way energy is transferred from the primary to the secondary. Another part of the secondary flux links only the secondary turns, and is known as the secondary leakage flux.

Leakage Factor

We can now begin to understand the meanings of the terms co-efficient of coupling and leakage factor. The total flux which is available for transferring energy from the primary to the secondary windings is that set up by the current in the primary, and is represented by the self-inductance of the primary winding. But not all of this flux is utilised. Part of it goes to waste as leakage flux. The co-efficient of coupling, therefore, represents the percentage of the total primary flux that is utilised in the transference of energy. This subtracted from unity gives the percentage of the total primary flux which goes to waste, viz., the leakage factor.

Tuned Transformer

Thus far we have considered an untuned circuit—that is, a circuit in which no condensers appear. If the circuits are tuned by condensers, the simple transformer becomes a resonance transformer; similar ideas hold true for the resonance transformer, but the expressions become more complicated. For the sake of mathematical convenience, however, the simple form of the expression for co-efficient of coupling is still preserved, viz. :—

$$k = \frac{M}{\sqrt{L_1 L_2}} \times 100$$

in which k is the co-efficient of coupling in per cent., M is the mutual inductance existing between the two circuits coupled together, L_1 and L_2 are the *total* self-inductances in the primary and secondary circuits, respectively.

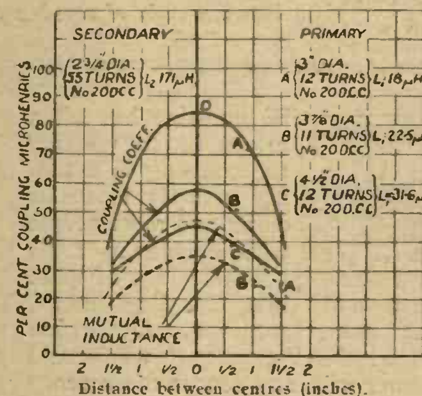


Fig. 4.—These curves show actual values obtained by measurements made on ordinary aerial coupling.

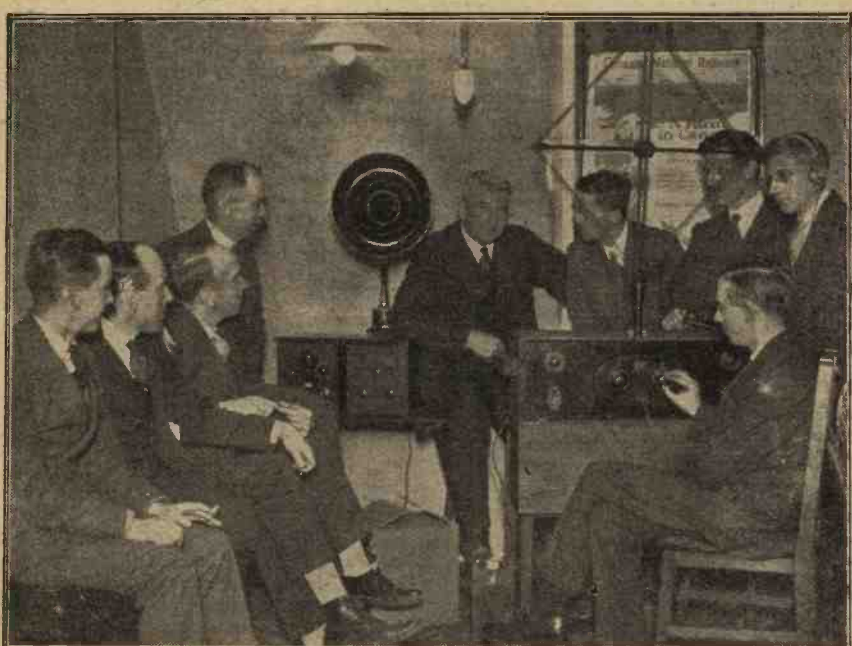
The Co-efficients of Coupling

Now that we have obtained somewhat of a physical conception of these ideas, let us see what values the co-efficient of coupling may have in our radio tuning units. An ordinary aerial coupling coil was constructed, as shown in Fig. 1. The mutual inductance between the primary and secondary was measured for various positions of the primary on the secondary. The self-inductances of the two coils were also measured and, by means of the formula given above, the co-efficient of coupling was calculated. The chart in Fig. 4 shows plainly the results obtained.

When the primary was directly at the centre of the secondary, the mutual inductance and the co-efficient of coupling were greatest. As the primary was moved away from the centre toward the ends of the secondary, these dropped off rapidly, as indicated by the increasing slopes of the curves.

Increased Diameter

Another set of coils was measured, using the same secondary, but having a larger diameter for the primary coil. The same number of turns was used on the primary. The effect of the in-

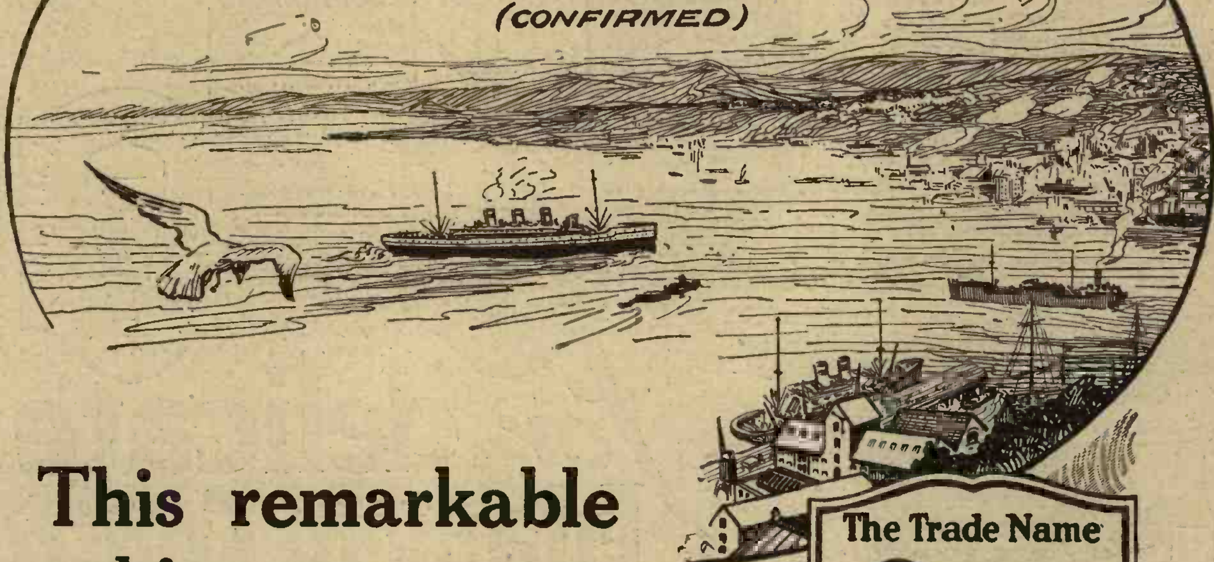


A party of Canadians listening at the Cockspur Street Office of the Canadian National Railway Company to CNRA, Moncton, Canada, the Company's station, on the occasion of its first anniversary.

Long Distance Record

2-WAY COMMUNICATION WITH TASMANIA

(CONFIRMED)



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creased diameter can also be seen in Fig. 4. The effect of the increased diameter is to lower considerably the mutual inductance and co-efficient of coupling.

To investigate further the effect of the primary diameter on the coupling, the curves shown in Fig. 5 were computed. The same secondary coil as used in obtaining Fig. 4 was assumed, having a self-inductance of 164.2 microhenries, and calculations were performed, various primary coils of different diameters but of the same number of turns being assumed.

Relative Diameters

In these curves (Fig. 5) the primary coil was always at the centre of the secondary, that is, their centre lines coincided. The calculations were started with the assumption that the primary coil was always to have 12 turns of 20-gauge d.c.c. wire on it. The diameter of the primary was taken as small at first and gradually increased. The line AB in Fig. 5 indicates a case where the primary has the same diameter as the secondary. Of course, this is physically impossible, but the point is indicated to show where the maximum value of mutual inductance and co-efficient of coupling are obtained.

To the left of the line AB the primary diameter is smaller than that of the secondary, and to the right of AB it is greater. It will be seen that as the diameter is increased, the self-inductance in-

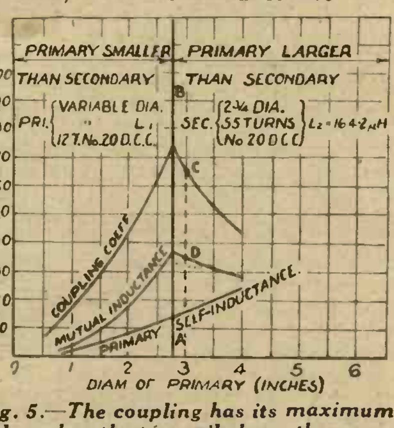


Fig. 5.—The coupling has its maximum value when the two coils have the same diameter.

creases at a nearly constant rate. At the same time, the mutual inductance and the co-efficient of coupling increase steadily, until the maximum values are obtained when the two diameters are equal.

A Discrepancy

As the diameter of the primary becomes greater than that of the secondary, the mutual inductance and co-efficient of coupling drop off almost as rapidly as they increased before, while the self-inductance continues to increase steadily.

There is a discrepancy between the curves in Figs. 4 and 5 which I would next like to point out, and which is very important in the design of coupling coils. To illustrate the point, let us consider the

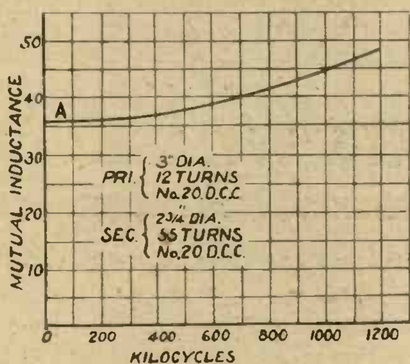


Fig. 6.—The point A, at zero frequency, agrees with the calculated point D of Fig. 4. Note that M increases with the frequency.

curve marked A in Fig. 4 and the curve marked C in Fig. 5. The first of these curves was found experimentally, and the second was calculated. The secondary coil was the same for each of these curves. The primary coil for curve A, Fig. 4, was 3 in. in diameter, and was placed at the centre of the secondary.

A Large Error

The curves in Fig. 5 assumed the primary always at the centre of the secondary. Therefore, it will be seen, by following the dotted line vertically in Fig. 5, that for a primary diameter of 3 in. the co-efficient of coupling obtained from the curve is 65.5 per cent. This is indicated at the point C in Fig. 5. The measured value of the coupling, obtained from the point D in Fig. 4, is 84 per cent. There is a considerable difference between these two values, which must be due to the capacity of the coils and the capacity between the two coils.

Capacity Coupling

In other words, there is not only the magnetic coupling between the primary and secondary coils, as we have pictured it in Fig. 2, but there is also capacity coupling between them. It can easily be understood that the winding of each coil closely resembles a metallic cylinder, so that we have something which acts like two coaxial cylinders, that is, one cylinder within another.

The Mathematical Analysis

The mathematical analysis of the problem is an exceedingly difficult one, since the capacity is distributed throughout the windings of the coil, and we do not know exactly how it is distributed. The measurement of this capacity is also a troublesome job—at least, to obtain any degree of accuracy, since the value obtained will depend a great deal upon how connections are made to the coils. To obtain an approximate idea of the capacity between the coils, however, one coil was regarded as one plate of a condenser, and the other coil as the other plate of the condenser, and the capacity between the two was determined by a method of substitution. It was found to be about 42 $\mu\mu$F.

Reason for Error

This surprisingly great coil capacity no doubt accounts for the discrepancy existing between the measured and computed values of the coupling co-efficient as described above. To investigate the problem further, the mutual inductance was measured at various frequencies, and the curve shown in Fig. 6 was obtained. If the coils had no capacity, the mutual inductance should remain constant in value, and the curve should be flat. That is, there should be no variation of mutual inductance with frequency.

However, the mutual inductance does not remain constant, as Fig. 6 indicates, since the curve turns upward. The "apparent" (or

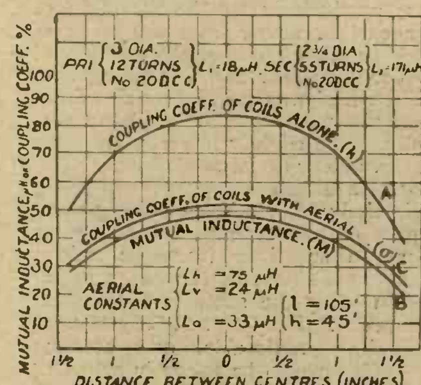
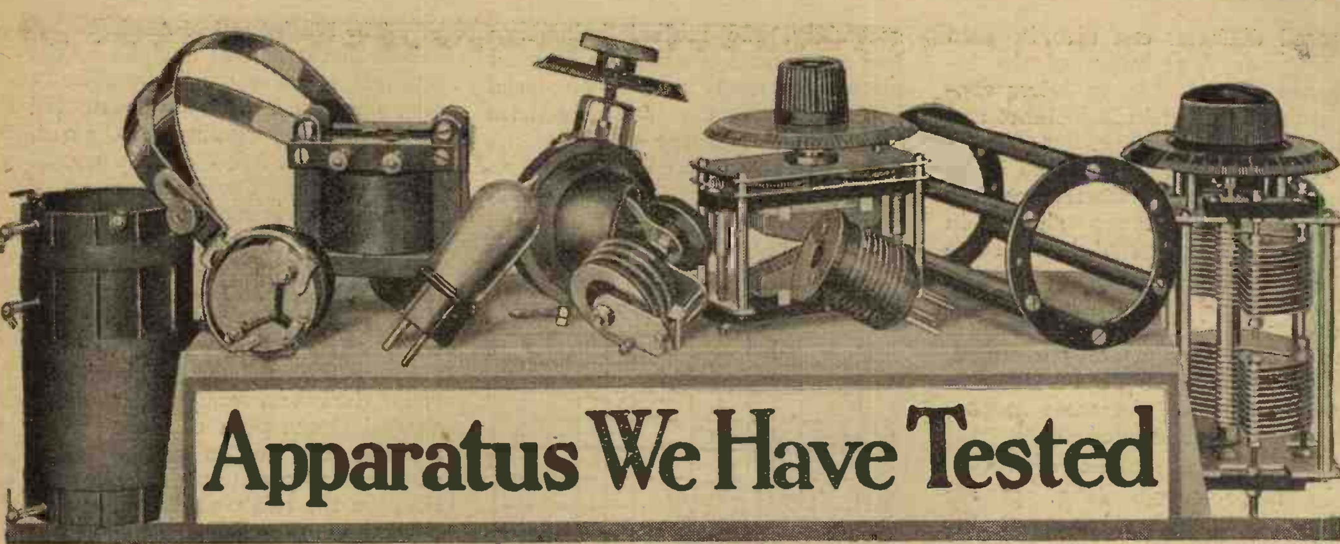


Fig. 7.—The effect of the aerial on the co-efficient of coupling is clearly shown in this diagram.

measured) value of the mutual inductance increases steadily as the frequency increases. The measurements were made over a range extending from 200 kilocycles (1,500 metres) to 1,200 kilocycles (250 metres) and extended at the left end until it intersected the vertical axis, which represents zero frequency.

(*Continued on page* 304.)



Conducted by Radio Press Laboratories, Elstree.

Area Aerial

Mr. T. C. Round has submitted an aerial for test in our Laboratories at Elstree. The aerial, of which he is the patentee, is of a novel construction, consisting of a metallic foil plate about 8 ft. by 2 ft. fixed between two layers of brown paper. Semi-cylindrical wooden rods grip the paper and foil at each end, and at one end a metal strip makes contact with the metal foil. Two terminals are mounted on this strip, one at each end, and connection is made to these two terminals from the aerial terminal of the set. The aerial can be conveniently hung by means of cords, and may be employed for decorative and advertisement purposes by painting on the paper surface, or, failing this, can be rolled up when not in use. It is designed more particularly for the reception of broadcasting when, from the want of space or other reasons, the erection of the usual outdoor aerial is impossible.

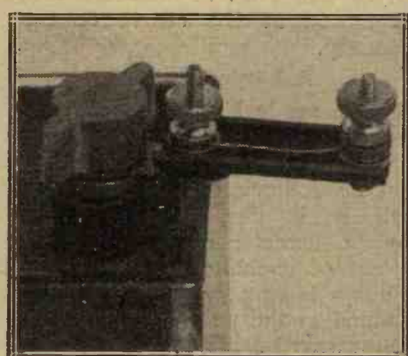
The aerial was tested 13 miles from 2LO, and was found, when hung vertically, to be slightly less efficient than a 25-ft. indoor aerial made from single-strand insulated wire. When hung horizontally 8 ft. from the ground signals of about 30 per cent. greater volume than those from the indoor aerial were obtained, the range of reception being the same as for the indoor aerial. Body-capacity effects were particularly noticeable, and extreme care will have to be taken in choosing a suitable location for the aerial to minimise this effect, suspension away from a damp wall being also necessary. The body-capacity effects were more conspicuous when the aerial was used in conjunction with a valve receiving set, owing to the fact that a valve set is more selective. The aerial should be a boon to those people who object to seeing wires about the room.

"Protex" Accumulator Safety Device

Messrs. Ward & Goldstone have submitted to us for test their "Protex" Accumulator Safety Device.

The "Protex" is a neat attachment capable of being fitted in a few seconds. It acts as a safety fuse in the case of a short circuit, and thus eliminates the danger of fire. It also prevents the accumulator from being charged at an excessive rate. The "Protex" will also save valves and damage to apparatus caused by wrong connections. An ample supply of fuse wire is provided.

The "Protex" Accumulator Safety Device consists of about an inch of fuse wire made of soft metal. This is connected between two nickel-plated terminals, mounted on a trough-



The "Protex" Accumulator Safety Device consists of a fuse which may be attached to a terminal of the filament battery.

shaped piece of insulating material about an inch long. One of these terminals is double, so that a connecting wire or spade terminal can be attached to it. Connection with the terminal of the accumulator is made by a short plated strip of metal. A slot in this enables it to be secured beneath the screw head of the appropriate terminal shank, while the other end is cut like the end of a spade terminal so as to fit into the accumulator terminal.

Laboratory Tests.

The resistance of the fuse wire was found to be of the order of 1/100 ohm. On gradually increasing the current the fuse went at about 12 amperes. Of course, shorting the accumulator blew the fuse immediately.

The component is sufficiently strong mechanically to withstand any strain likely to be imposed upon it.

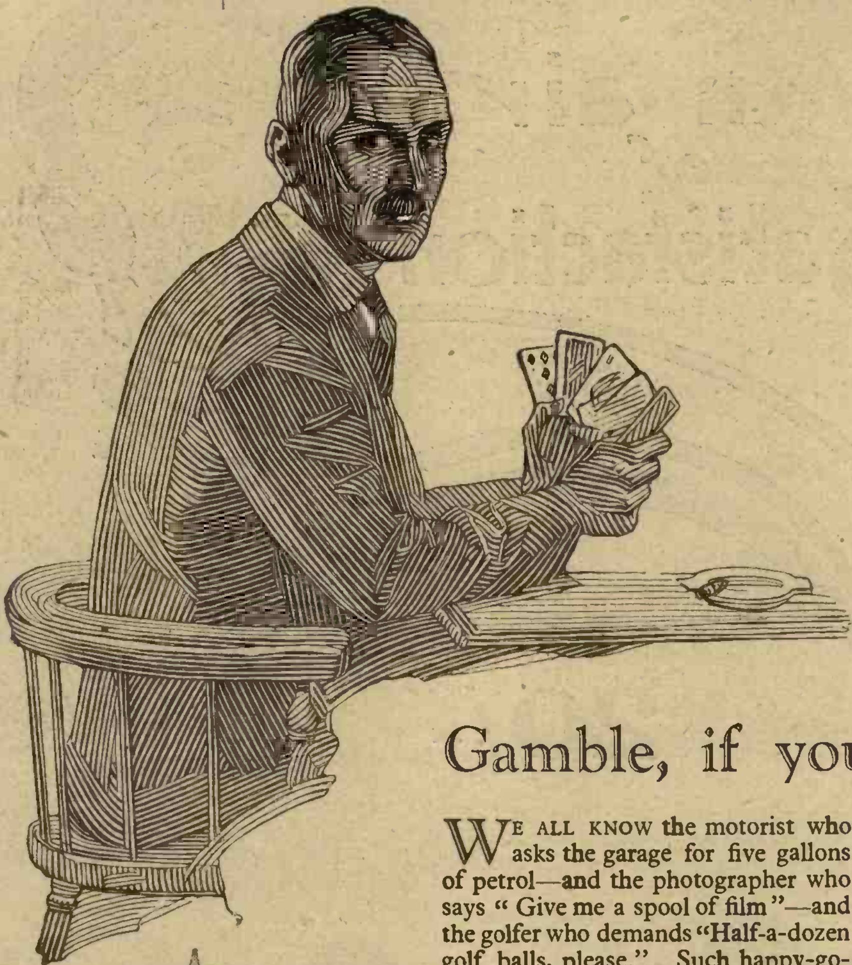
The "Protex" is certainly a very useful attachment for any accumulator both when on charge and in ordinary use.

"Fortevox" Variable Grid Leak

A sample of their new "Fortevox" Variable Grid Leak has been submitted by Messrs. Fraser & Glass.

The resistance element consists of an inch or so of tape which is presumably impregnated to render it of the correct resistance. The tape is wound once round a short brass barrel, $\frac{1}{4}$ in. long and of $\frac{1}{4}$ in. radius, and is held taut by a brass spring. This spring also serves to make connection with one terminal. The tape is secured to the brass barrel by being tightly fixed in a slot. This barrel is capable of rotation through nearly a complete turn, and varies the leak by shorting that part of the tape which is wound upon it. The centre of the lower flat face of the barrel is provided with a depression into which presses the point of the screw shank of the appropriate terminal. The barrel itself is held in position by a stiff bronze spring. That part of the tape not wound upon the barrel presses upon the inner face of an annular space in the case. This case is of a short, cylindrical form, being about 1 in. in diameter and $\frac{1}{2}$ in. in height. One terminal is fixed to its circumference, while the other, which makes connection to the brass barrel, passes through the centre of its bottom face. Both terminals are provided with soldering tags, and rather small double nuts, between which the connecting wire can be fixed. The soldering tags could with advantage be longer, but as they are fixed between the double nuts, the lower nuts are sufficient to prevent heat from the soldering iron reaching the insulation

(*Continued on page 305.*)



Gamble, if you will, but . . .

WE ALL KNOW the motorist who asks the garage for five gallons of petrol—and the photographer who says " Give me a spool of film "—and the golfer who demands "Half-a-dozen golf balls, please." Such happy-go-lucky buying is bound to have unfortunate results. The first finds his engine losing power on hills. The second detects an irritating inconsistency in his picture-making records. While the third discovers, to his chagrin, that he has lost his usual form.

Now had these three exercised a considered judgment in making their purchases all would have been well. It is just the same in Radio. Don't go into a shop and say, "I want a Dull Emitter Valve," and expect to obtain the most suitable one for your Set. Exercise some discrimination. Ask your friends which they find most satisfactory for long life, economy of operation and sensitiveness. You'll probably find that the majority favour the Wuncell—the Cossor Dull Emitter.

Its extraordinary popularity is due to its unique filament and its original design. While most Dull Emitters use a thoriated filament, the Cossor Wuncell makes use of one embodying entirely new principles. It is a filament built up *layer upon layer* until its diameter approximates that used in a standard bright emitter. But in addition to stoutness the Wuncell filament possesses one other special feature. Its intense emission is such that it can function at the exceptionally low temperature of 800° C. So low in fact is its working temperature that the glow in daylight is practically invisible. At such a low temperature the Wuncell filament suffers no harm from the stretching and contracting inevitable when electric current is switched on and off. In other words, the Wuncell filament is one of the greatest contributions made by Science in the unceasing search for an "everlasting" valve.

The Wuncell Dull Emitter

Voltage 1·8 volts. Consumption ·3 amp.
*W1 for Detector and L.F. 14/-
*W2 for H.F. amplification. 14/-

The Cossor Loud Speaker Valve W3

Voltage 1·8 volts. Consumption ·5 amp.
Price 18/6

* Also in WR Series, with special switch and resistance in base to enable Valve being used with 2-, 4-, or 6-volt Accumulator.

WR1 for Detector and L.F. 16/-
WR2 for H.F. amplification 16/-

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PORTUGUESE AMATEUR STATIONS

SIR,—The many experimenters in this country who are devoting their attention to the ever-increasing interest in short-wave work may like to know that several Portuguese amateurs are to be heard on about 50/60 metres.

The pioneer Portuguese amateur station P1AB, reported in *Wireless Weekly*, Vol. 7, No. 7, page 217, as having been logged in England on 5,263 kc. (57 metres) on October 25, at 23.00 G.M.T., is operated by Mr. Alvaro Contreiras, Editor of *T.S.F. em Portugal*, 50-60, Rua do Seculo, Lisbon, who will be pleased to receive direct, or through myself, QSL cards or reports as to his QST transmitted between 23.45 and 01.00 G.M.T., on the 9th/10th inst.

As the call "QST de P1AB," sent at regular intervals, was to be followed by two words, probably expressive of greetings, in the Portuguese language, I should be extremely glad to know whether any English amateur has succeeded in logging same, even in a mutilated condition, in which case I should like to have details as to the strength of signals received, etc.

The writer would be equally interested to know whether any other Portuguese amateur stations, such as P1AA, P1AC, P1AE, P8AM, etc., have recently been heard or recorded in this country.

As it is invariably impossible to advise the technical Press in time for publication of any intended calls to be made by the Portuguese transmitting stations, the writer will be happy to forward details of such transmissions, as soon as received from Portugal, to any interested amateur who will kindly send a stamped envelope to the address hereunder.

Requesting you to accept and to convey to your readers the heartfelt greetings from the amateurs of the "oldest Ally of England," I wish your invaluable publication every success, and remain, Sir,—Very sincerely yours,

A. C. M. DE CARVALHO.
(Representative of *T.S.F. em Portugal*.)

NEWCASTLE-ON-TYNE RADIO SOCIETY

SIR,—It may be of interest to your readers to know that the annual general meeting of the above Society was held in the Club Rooms, 5, Charlotte Square, Newcastle-on-Tyne, at 7.30 p.m., on November 9. New officers were elected for the coming year, and a very hearty vote of thanks was passed to the retiring officers and committee.

We would also draw attention to the fact that the Society caters for all classes of persons interested in wireless, and is not run solely for the benefit of the more advanced experimenter. Meetings are held every Monday at 7.30 p.m., notices of the agenda of each meeting being broadcast from 5NO on the previous Sunday. Any who are interested are cordially invited to attend a meeting as visitors.—Yours faithfully,

N. HENDRY (G6FG),
Hon. Secretary.

Hertford House,
Sanderson Road,
Newcastle-on-Tyne.

PRESTON AND DISTRICT RADIO RESEARCH SOCIETY

DEAR SIR,—I beg to submit particulars of this Society in the hope that they will be of interest to your readers.

J. B. COOKSON, Hon. Sec.

14, Lune Street, Preston.

This Society had a membership of 76 last year, and would undoubtedly have had more, but for the fact that it had no permanent headquarters. It has now a permanent room in Tommony's Yard, off Friargate, Preston, which will be open nightly on and after November 9, from 7.30 p.m. to 10.15 p.m. Members have thus the opportunity of building their sets in comfort at the Society's room under the able guidance of various members of the committee (if required). Lectures and demonstrations are to be held about once per week. It has been suggested that the room should be open to the general public on Sunday afternoons on payment of a small entrance fee, when members of the Society would give lessons in the construction of sets. If those interested will write to me, the matter will be further considered, if there is sufficient support.

The committee are only too willing to elucidate defects in sets if members will bring them to the room. The entrance fee to this Society is low (2s. 6d.), and the annual subscription is 5s. New members are cordially invited, and should write for entrance form from the Secretary, 14, Lune Street, Preston.

AMATEUR TRANSMISSION

SIR,—I am now active on 45 metres (6667 kc.), call sign G6YV, input 5 watts.

I should be very pleased to receive reports on my signals from any distance.—Yours faithfully,

STANLEY F. EVANS.

3, Clarence Crescent,
Whitley Bay, Northumberland.

THE "SIMPLE SELECTIVE SET"

SIR,—I am writing to report results with the "Simple Selective Set" described in the April, 1925, issue of *Modern Wireless* by A. D. Cowper, M.Sc. I made this up in desperation as an attempt to get smooth reaction control. I will never go back to the swinging coil method again. As this is one of the few detector circuits I have tried, I can only compare it with previous HF circuits I have made up, and it is as good as any, except your modification of the neutrodyne, and is much easier to handle. I am so pleased with it that I have made up a 3-valve embodying this set, with the addition of the "2-valve Power Amplifier" described by C. P. Allinson in the November, 1925, issue. Using a DE3 and two Mullard power valves, the strength and purity of reception is remarkable. I can get all British and Continental stations, and, besides the local station, the Scottish relays, Edinburgh and Dundee, come in well on the loud-speaker. The reaction control is splendid, but I find a variable grid leak a useful addition, as there is a slight tendency to develop a grid-leak howl on some frequencies and the variable feature cures this. The selectivity is excellent, but, of course, 5SC at five miles swamps badly. I also get full loud-speaker strength on a frame merely plugged across the ten turns of the aerial inductance, with extreme selectivity. My usual aerial is a 50-ft. single wire in the attic 25 ft. above the set; earth to water main. This is an improvement on my outside aerial, which was very low and screened. Wishing you continued success,—Yours faithfully,

R. E. FISHER.

Glasgow.

THE "HARMONY FOUR"

SIR,—I have constructed the "Harmony Four" as described by Mr. Percy W. Harris, M.I.R.E. in the September, 1925, issue of *Modern Wireless.*

The ease, strength and purity with which distant stations can be tuned-in is truly remarkable, B.B.C. and Continental stations being received at excellent loud-speaker strength.

I have had experience with various sets described in *Modern Wireless*, but for purity and volume on distant stations the "Harmony Four" is easily the finest circuit I have tried, and must be at least as good as the wonderful American circuits we hear so much about.

The first evening the set was constructed Ecole Superieure, Paris, was tuned in on the loud-speaker without the slightest trace of 2LO, four miles distant and for strength was comparable with the latter station on D and power L.F. and with a remarkably silent background.

I might add that I have experimentally fitted an additional stage of L.F., resistance coupled, which can be switched on when desired, and also a switch on the terminal principle to cut out the two H.F. stages, as I find D and one L.F. ample for the local station.

The set was originally constructed from components I already had, but I have substituted a .0005 μF variable condenser, as recommended, in place of the .001 μF.

I must congratulate you on designing a really efficient method of H.F. amplification. I am sure this circuit will meet with approval from all amateurs who desire to select their evening's programme from the various British and Continental stations without having to rely on "S.B."—Yours faithfully,

A. W. KELLY.

S.W.17.

THE TRANSATLANTIC V

SIR,—It may interest you to know that, having built the Transatlantic V as described in the June, 1924, number of *Modern Wireless*, by Percy W. Harris, M.I.R.E., I have had splendid results from it, and the set has certainly range and volume as truly described. I should like to thank Mr. Harris for giving us a circuit which is far in advance of anything I have yet seen. The purity and volume of sound were quite a revelation to me. I have built several sets previously, including a five-valve set, which I thought was very good, but the Transatlantic V is ever so much better; the reception of speech or music is very powerful and distortionless and most enjoyable. I hear Radio Iberica (Madrid) quite well on loud-speaker, also some station in Austria which always concludes by playing the Austrian National Anthem. Bournemouth, Paris, Cardiff, etc., come through magnificently, and it is really a first-class set.

I use two Cossor red-top valves for H.F., one Cossor detector and two B.T.H.4 power valves. The results are extraordinary, and reception is very clear. With many thanks.—Yours truly,

J. B. COLE.

Jersey.

M. Chaliapin, the famous Russian bass, recently broadcast for the first time from the London station

IS YOUR COUPLING TIGHT OR LOOSE?

(Continued from page 301.)

Zero Frequency

This zero value of frequency corresponds to direct or constant current. The mutual inductance at zero frequency is the true mutual inductance, for at zero frequency the effect of the capacity between the coils is *nil*. The agreement between the value indicated by the point A in Fig. 6 (the mutual inductance at zero frequency) and the calculated value indicated by the point D of Fig. 5 is very good. The curves of Fig. 5 were calculated without including the capacity of the coils.

Apparent and Actual Coupling

From the values of the co-efficient of coupling shown on the various curves, the reader may be led to believe that the coupling in his radio receiver is much tighter than it really is. To tell the truth, the values on the curves apply only to the coils themselves, without considering the circuits to which they may be connected in a receiver. In the formula given above, L_1 and L_2, it must not be forgotten, are the *total* inductances in the primary and secondary circuits.

Thus, if the primary inductance L_1 is connected in series with the inductance of the antenna, the denominator of the fraction above will be $\sqrt{(L_1 + L_2)\, L_1}$, and the value of the co-efficient of coupling k will be much less. This is shown graphically in Fig. 7. The curve A in this figure has been reproduced from Fig. 4, and represents the co-efficient of coupling between the primary and secondary coils alone. The curve B represents the corresponding value of the mutual inductance.

Effect of Aerial

Let us assume the primary coil connected to a single-wire aerial 105 ft. long and 45 ft. high. This aerial has an inductance of approximately 33 microhenries. When the correction explained in the preceding paragraph is made, the curve of co-efficient of coupling drops considerably—to the position shown in Fig. 7 by the curve C. Therefore, if the primary coil is assumed to be at the centre of the secondary, whereas the value of k for the coils alone is about 83 per cent., it drops to about 53 per cent. when the aerial and earth are connected.

Apparatus We Have Tested
(Continued from page 302)

material. The knob, which is moulded, screws on to the top of a brass spindle, the other end of which is fixed to the brass barrel. Unfortunately the spindle screws directly into the material of the knob itself, a practice which is not to be recommended. A lock-nut is, however, provided.

Laboratory Tests.

On test it was found that the resistance was capable of variation from a minimum of $\frac{3}{4}$ megohm to a maximum of about $4\frac{1}{2}$ megohms. When tested in a receiving set the grid leak was found to have an extremely smooth movement, while parasitic noises were completely absent. In a receiving set which was critically adjusted, a small movement of the control knob was found to produce a large variation in signal strength.

From the above it would appear that a finer movement is desirable. This could readily be achieved by the provision of a large knob. The article is particularly well finished, and makes use of a rather novel principle to achieve its good results. The minimum resistance value could with advantage have been made $\frac{1}{2}$ megohm and not $\frac{3}{4}$ megohm.

Cable 2-Valve Receiving Set

Messrs. Cables & Electrical Supplies have sent us for test a Cable V2E set.

The set is mounted in a cabinet with double doors, by opening which access is obtained to the ebonite panel carrying the controls. Aerial and earth plugs and sockets are provided, and a shorting plug to be used in conjunction with high and low wavelength plug and socket. This is in addition to the usual telephone terminals, while at the back of the set are neatly arranged terminals for the L.T. and H.T. battery leads. The circuit consists of one H.F. valve and a detector valve, the high wave coil being direct wound on a former coupled to the reaction coil, thereby introducing reaction without the aid of a separate coil. A stud switch is provided for varying the tappings to the high wavelength coil. It is necessary to insert the shorting plug into the socket marked for the particular wavelengths to be received, *i.e.*, low or high wavelengths.

Variometers are used both for the tuning and reaction, and earthed metal plates are placed under these controls to eliminate hand-capacity effects. A valve port and two filament rheostat knobs indicating on or off positions complete the panel.

Laboratory Tests.

The set was tested on a single wire 80-ft. aerial, 35 ft. high and about 13 miles from 2LO. One Ediswan AR and one Marconi DE5 valves were employed with 80 volts high tension and 4 volts grid bias. Both 2LO and 5XX were received at good loud-speaker strength, and Bournemouth on the telephones. The signals were particularly clear, hand-capacity effects were absent, and the set was fairly easy to tune.

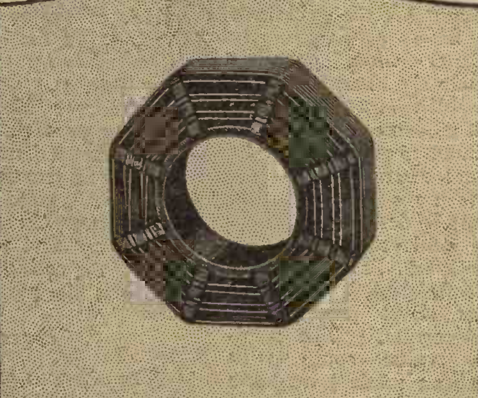
The set has an extremely neat appearance, but the stud switch should be labelled to indicate its purpose. This switch unfortunately is of a very flimsy character, and calls for a redesign, as it fails to make a satisfactory contact, any vibration or jolting throwing the switch out of position. The wiring behind the panel could be improved upon, but the soldered joints are quite good, and the wires are covered with systoflex to overcome the possibility of shorting. The method of coupling the high-wave coil to the aerial is efficient for Daventry, but although shorted when not in use on the lower wavelength, it introduces a damping effect, and reduces the distance of reception possible.

The Secret of Selectivity

The SLEKTUN (TRADE MARK) Inductance Coil.

MACADIE PATENT No. 241383.

COIL COMPLETE IN EBONITE CASE



METHOD OF WINDING & AIR SPACING

The Windings of the SLEKTUN INDUCTANCE COIL are spaced and separated in the most scientific manner, giving the **Lowest Distributed Capacity with High Inductance.**

COIL OF 200 TURNS **INDUCTANCE: 1770 MICRO-HENRIES** **SELF-CAPACITY: 3 MICRO-MICROFARADS**

(THESE ARE N.P.L. FIGURES)

The Windings of the SLEKTUN COIL have tapered Ebonite Separators of the finest quality and the convolutions do not touch at any point, therefore the highest insulation is ensured.

The Coils are wound with heavy gauge wire, which gives them a very low effective resistance.

The SLEKTUN COILS are completely enclosed in polished Ebonite cases, thus giving protection from dust, damp and damage and permitting the insertion and withdrawal of a Coil from the Holder without any possibility of damage.

ALL CASES ARE ONE SIZE 3½" IN DIAMETER AND 1¼" IN DEPTH.

SLEKTUN COILS ARE THE MOST SELECTIVE AND EFFICIENT ON THE MARKET

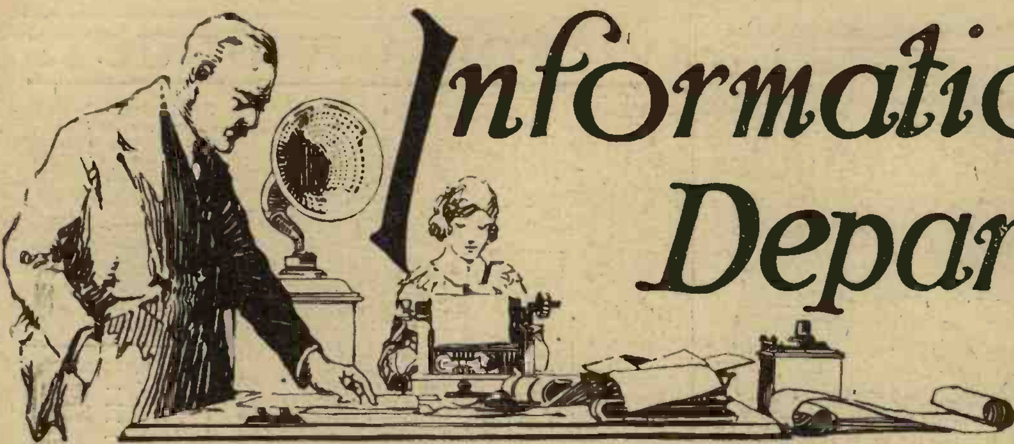
No. of Coil.	Wave length range when in circuit with standard P.O. aerial, .001 MF. in series.		.001 MF. in parallel.		Wave length range when used in anode or Secondary circuits. .001 MF. in parallel.		Price per COIL.
	Min.*	Max.	Min.	Max.*	Min.	Max.*	
25	85	170	190	390	105	350	5/6d.
35	130	260	283	580	156	510	5/6d.
50	190	380	422	850	232	750	6/-
60	220	440	483	1000	265	870	6/-
75	240	480	535	1100	295	1000	6/-
100	290	580	649	1300	360	1200	7/-
150	480	960	1055	2200	595	2000	8/-
200	600	1200	1323	2800	733	2500	8/6d.
250	675	1350	1486	3200	836	3000	9/-

EVERY SLEKTUN COIL IS TESTED AND GUARANTEED AND IS MADE IN ENGLAND.

* In view of the fact that some loss in efficiency is occasioned when using very small capacity in series, and very large capacity in parallel with the Coils, it is recommended that purchasers should order such sizes which will tune well inside the above mentioned figures.

If you experience any difficulty in obtaining SLEKTUN COILS order direct from the makers:

THE AUTOMATIC COIL WINDER & ELECTRICAL EQUIPMENT CO., LTD., DEPT. C.
"WELLINGTON HOUSE," BUCKINGHAM GATE - - LONDON, S.W. 1.



Information Department.

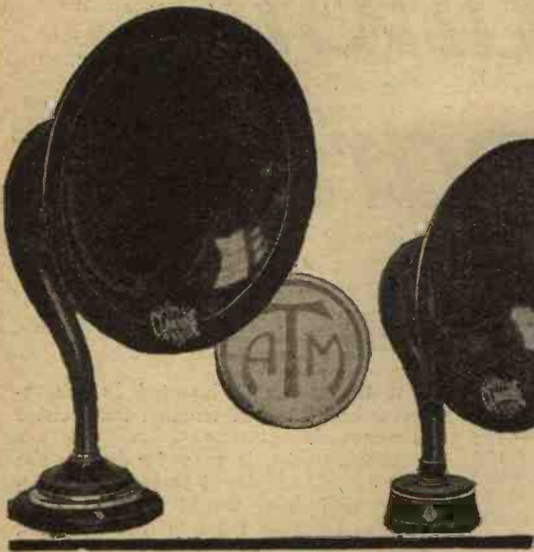
D. J. (SWANSEA) wishes to construct a variometer for the broadcast band of 1,000 to 600 kc. (300—500 metres), employing ebonite tubes for rotor and stator. He asks for the necessary turn numbers.

We would suggest that tubing of 3-in. diameter be employed for the rotor and 4-in. diameter for the stator. The winding of the rotor should consist of 36 turns of No. 24 gauge wire, and that of the stator should consist of thirty turns of the same gauge.

G. G. M. (LEWES) is employing an "Anglo-American-Six" Receiver, constructed from the design given in THE WIRELESS CONSTRUCTOR, Vol. 1, Nos. 3 and 4. He is getting excellent results from the receiver, but finds that two settings of all neutrodyne condensers are necessary to keep the set stable over the whole broadcast band. One setting holds from approximately 1,000 to 750 kc. (300 to 400 metres) and the other from 750 to 600 kc. (400 to 500 metres). He asks our advice.

Generally most troubles of the type that our correspondent is experiencing are due to the neutrodyne units, although it is impossible to state definitely whether this is so, in the present case, without an instrument test. If, therefore, it is possible to borrow other neutrodyne units, for the same frequency range, we would suggest that these be inserted in the receiver and it noted whether the trouble is removed.

Alternatively, it may be due to the type of coil employed in the aerial circuit, and we would suggest that various coils be tried in this position, more especially if two are necessary at present to cover the whole broadcast frequency band. An interesting experiment to carry out in this case would be the effect of employing a coil which covers the whole of the broadcast frequency band. We would suggest that one of the numbered type be inserted, of 50 or 60 turns, and a semi-aperiodic arrangement be tried, so that there is no necessity to change the



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LOUD SPEAKERS

enable you to appreciate the pleasure of perfect reception and to obtain that sweet purity of tone so dear to all music lovers. They stand unequalled in quality and service, and are recognised as a true example of faithful sound reproducers.

Senior Model Claritone

2000 ohms—W290. 120 ohms—W291.

£5 : 0 : 0

Junior Model Claritone

2000 ohms—W295.
120 ohms—W296.

£2 : 15 : 0

CLARITONE HEADPHONES 20/-
W216.

Supplied by all reputable dealers.

Sole Agents :

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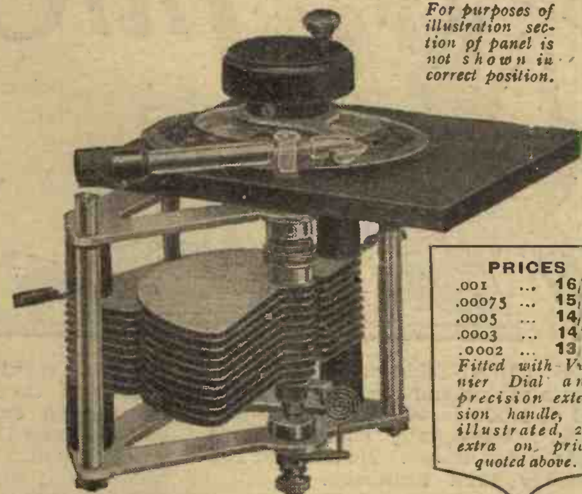
69, Renshaw St., Liverpool

Telephone 4628 Royal. *Telegrams : Rotary, Liverpool.*

VICTORIA PRODUCTS



For purposes of illustration section of panel is not shown in correct position.

PRICES

.001 ...	16/-.
.00075 ...	15/6.
.0005 ...	14/9.
.0003 ...	14/-.
.0002 ...	13/6.

Fitted with Vernier Dial and precision extension handle, as illustrated, 2/6 extra on prices quoted above.

The VICTORIA Low-Loss Condenser for *better* Tuning Efficiency

THE successful reception of any station, particularly a distant station, depends primarily upon your tuning in of the weak radio frequency oscillations.

Any ordinary condenser can probably tune in a station more or less satisfactorily—but for tuning in with the absolute maximum of signal strength you need to use a condenser that is extremely efficient. Such a condenser is the Victoria Low-Loss. Its unquestionable efficiency of performance is the result of long and specialised experience in the design and manufacture of radio condensers. Incorporate the Victoria Low-Loss Condenser in your receiver. You'll be delighted at the wonderful improvement and ease in your tuning in of both distant and local stations.

OBSERVE THESE POINTS OF SUPERIORITY.

Fixed and moving vanes designed to give perfect square law reading. Ball bearings. Vanes insulated by ebonite supports outside the electro-static field. Sturdily constructed, yet presenting a pleasing appearance with highly finished aluminium end plates, nickelled supports and brass vanes. A really first-class condenser, particularly ideal for short wavelengths.

THE VICTORIA VERNIER DIAL.

You can obtain a micrometer variation of the whole condenser by using the "VICTORIA" VERNIER DIAL, which has a ratio of 300 to 1, obtained by a precision screw motion. No gears, therefore no back lash. Coarse and fine tuning provided for. Suitable for use with any standard condenser or variometer.

Price - 4/9.

VICTORIA ELECTRICAL (Manchester) Ltd.
Victoria Works, Oakfield Rd., Altrincham, Cheshire.

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aerial coil. For this purpose a coil of the same diameter as the aerial coil should be wound of 10 or 15 turns of 24-gauge D.C.C. wire. Instead of connecting the aerial to the normal aerial terminal, it should be connected to one end of this coil, which should be tied to the aerial coil, and the free end of the coil should be connected to the earth terminal and to earth in the normal manner. If with this arrangement one setting of the neutrodyne condenser holds for the whole broadcast band, this clearly indicates that the type of aerial coil is responsible, and we would suggest that the semi-aperiodic arrangement suggested be employed.

RADIO PRESS TEST DEPARTMENT.

IMPORTANT NOTICE

Readers availing themselves of our Test Service are asked, when forwarding sets for test, to enclose with the receiver full particulars of the behaviour of the set and of the valves and batteries employed. Coils, H.F. transformers, and neutrodyne units should always be included with the set. Valves, if sent, should be forwarded under separate cover.

Where sets are despatched by rail or post they should be addressed to :—

The Radio Press Service Department, Ltd. (Test Department), Shenley Road, Elstree, Herts., Elstree Station, L.M.S. Railway.

By carrying out these instructions readers will facilitate the testing and return of their sets.

INVENTIONS AND DEVELOPMENTS

(*Continued from page 292.*)

How the System Works

"The operation of the system is as follows: Assuming that a number of signals of different frequencies are being collected on the aerial A, the desired signal is selected by tuning the inductance L1 and C1 to this frequency, which admits this particular signal to the circuit containing these elements. However, as other signals cannot be entirely excluded from this circuit, the tuning of the rejector J to the frequency of the desired signal permits further selectivity, the desired signals being accepted by the rejector, and all other signals being rejected or by-passed by the low inductance element of this device. The desired signals are then passed on to the receiver through the tuned circuit containing inductance L2 and Capacity C2, any residual undesired signal being excluded from this circuit through being out of tune with it.

Use of the Switch

"To aid in picking up signals, I provide the switch S, which in its up position elminates the intermediate selective circuits, connecting the coupling valve directly to the circuit containing inductance L2 and capacity C2. This arrangement, not being very selective, permits of the signals being picked up properly and adjusting the receiver containing inductance L3 and capacity C3 to the desired frequency.

"When the desired signal has been found and the receiving circuits adjusted, the switch S is thrown to the down position connecting in the intermediate selective circuits, and these are then tuned until the desired signal is brought in and the undesired signals excluded. As was previously mentioned, each receiver is provided with a coupling valve and the necessary filter circuits, the input being tapped across a suitable portion of the resistance."

Now, *heigh-ho* for a real Super-Het.!

related by
A. W. Pyrke

I have been wanting to build a good Super-Heterodyne for months past. Several designs have appeared in the various wireless papers, but they all, without exception, have possessed disadvantages which render them unsuitable. Take, for instance, wave-length range. Not one of them went higher than 600 metres. Now this is a point which may be important as time goes on. With the new Geneva regulations allotting new wave-lengths, it is quite possible that there will be more high wave-length stations used on the Continent. So what is the use of building a set suitable only for a comparatively narrow band of wave-lengths?

Then, again, there's the matter of the intermediate transformers. Many of the sets described use American ones. No doubt they were very good in their way, but it seems to me that transformers should be designed to suit the valves with which they are going to be used. English valves are very different to American valves, so it doesn't seem reasonable to expect American parts to give perfect results with English valves.

So this was how I had been looking at the Super-Heterodyne situation until, by chance, I happened to come across a little book called "Keystone Super-Heterodynes." * "Ah," said I, "here's just the little book I've been wanting." More than forty pages it contained—and lots of illustrations showing how to build them up. But the most useful part of the book, in my opinion, was the explanation as to how a Super-Heterodyne works. To tell the truth, I've worried my head scores of times trying to discover why a Super-Het. has *two* detectors when any respectable Set only needs one.

I've made up my mind to build a Keystone Super-Heterodyne because it conforms nearest to my ideal. It has an interchangeable oscillator coupler which will permit any required wave-length range. It works from a frame aerial. But what I like about the Keystone idea best of all is its convenience and economy. For instance, I already own a four-valve set and naturally was rather loth to discard it completely. So I wrote to Peto-Scott's and asked them if I could use any of the parts in building up a Keystone Super-Het. A reply came by return telling me that I could use all my own parts except the panel and the coils, and giving me a list of the extra parts I should need. And a reasonable list it was too. Only £11 the lot including a panel 24 inches long, drilled, tapped, and engraved. So this morning I sent along my cheque and in a day or two's time I shall be well on the job. By the way, I forgot to tell you that they have promised me the help of their Service Department experts for quite a nominal sum if I don't get good results straight away.

**A limited number of these books will be distributed free. Clip the coupon below at once.*

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2-VALVE Amplifier, 35/-, use one or two valves; also 1-Valve Amplifier, 20/-, both perfect, as new. Valves, 4/6 each. Smart Headphones, 8/6 pair. New 4-volt Accumulator, celluloid case, 13/-. New Dura 66-volt H.T. Battery, guaranteed, 7/-. 2-Valve All-Station Set, works speaker, £4. Approval willingly.—W. TAYLOR, 57, Studley Road, Stockwell, London.

HEADPHONE REPAIRS.—Re-wound, re-magnetised, readjusted. Lowest price quoted on receipt of telephones. Delivered three days. Est. 26 years.—Varley Magnet Co., London, S.E.18.

CABINETS with baseboard for vertical panel. Direct from makers. In stock solid Light or Dark oak or mahogany finish. Overall 10¼ × 6 × 6¼ for 9 × 5¼ × ¼ panel. 10/6 post free. Paragon panel fitted 3/3 extra. Satisfaction guaranteed. Lucas & North, Handsworth, Sheffield.

EXPERIMENTER, good knowledge Wireless, Engineering and business experience, wishes to enter reputable Radio firm in or near London. Manufacturer Preferred. Willing to invest £400. Write Box, A.38, Barclays Advertising Ltd., Bush House, W.C.2.

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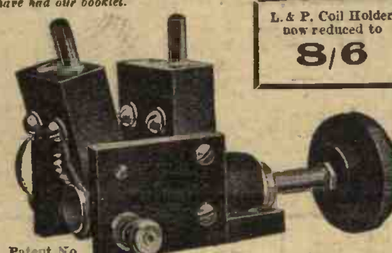
Whatever design of set you are making the L. & P. Coil Holder with its wonderfully smooth movement can be fitted. (See illustration at foot.) You can mount it at side of set—one hole fixing for coils back of panel—or any way to suit your set.

The L. & P. is the only *true* Vernier because it works on worm and pinion principle and has a compensating spring that makes backlash impossible.

Don't buy a coil holder of any kind until you have had our booklet.

L. & P. Coil Holder now reduced to **8/6**



Patent No. 241614.

From all Good Dealers or write at once for the Sent free on request.

London & Provincial Radio Co., Ltd., 30, Colne Lane, Colne, Lancs.
Other leading "Ellanpee" Lines.—L. & P. Valve Windows enhance the appearance of any set. Small size 2½d. each. Large Size 3½d. each. L. & P. Miniature Switches, D.P.D.T. 1/6 each. L. & P. Pull and Push Switch—positive action, positive satisfaction—only 2/- each.

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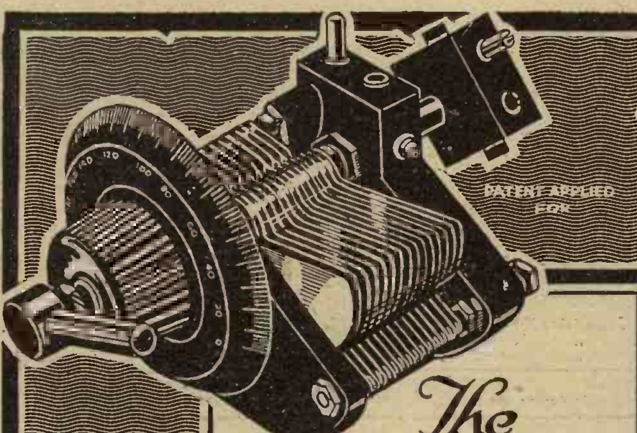
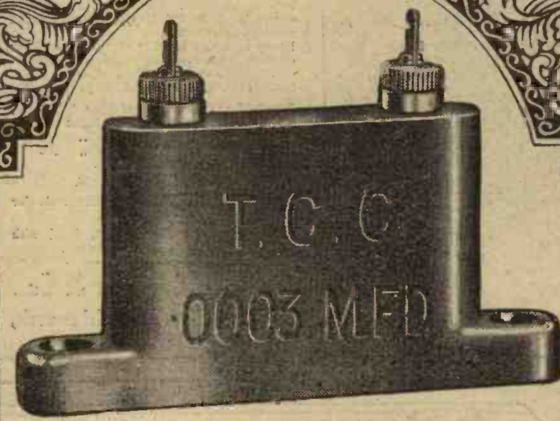


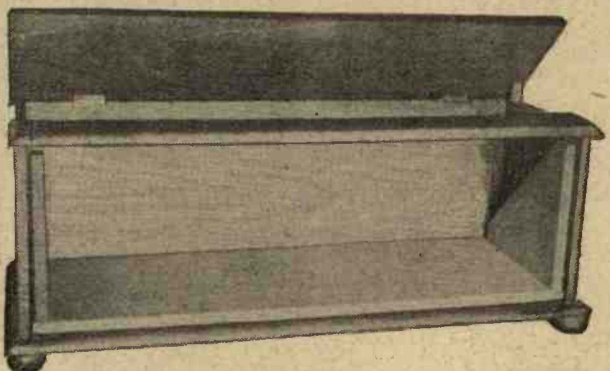
PATENT APPLIED FOR



T.C.C
.0003 MFD

CAXTON 4-VALVE CABINET

Made for Editor of Wireless Magazine for Set "As good as money can buy" described in issue February, 1925.



Cash with Order. Fumed Oak	...	£1 5 0
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With detachable recess fitted Base Board to mount 21 in. by 7 in. panel to slide out of Cabinet front.

Extra 10/- with two beaded front doors totally enclosing fitted panel.

Cabinet overall length 22½ ins. Width 8½ ins. Height 9 ins.

Polished with the new enamel that gives a glass hard surface that cannot be soiled or scratched.

SENT FREE.—Catalogue of standard Wireless Cabinets in various sizes and woods. Special Cabinets made to customer's orders.

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For GREATER SELECTIVITY *and* LESS INTERFERENCE

The CLEAR-SPEAKER Aperiodic Coil is notable for the greater selectivity it provides. Others of its outstanding advantages are :—

(1) *Reduction of interference from Ships and Spark Stations.*

(2) *Cutting out of local Broadcast Stations.*

(3) *Wider tuning range, viz.: Approx.* 250—500 *metres with* ·0003 *m.f. condenser.*

The CLEAR-SPEAKER may be used in any receiver employing the standard coil holder, with no alteration of the set. It means greater efficiency and wider selection.

Price 7/6 Retail

The **CLEAR-SPEAKER APERIODIC COIL**

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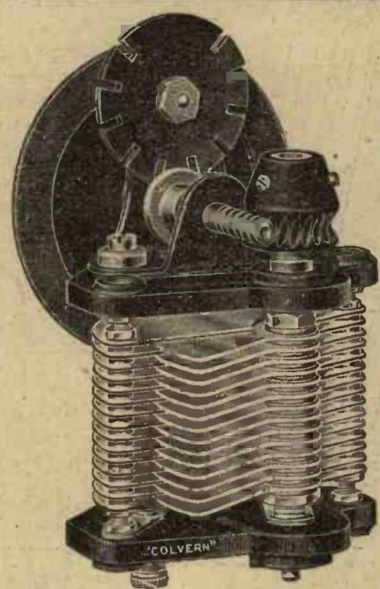
CLEAR - HOOTERS LTD., Hooterland, Highgate Square, BIRMINGHAM.



Little experience is necessary upon any such super-sensitive circuits as the short wave side of the Super-Heterodyne or capacity-reaction circuits to self-demonstrate that distant work is an impossible pastime without a mechanical fine tuning device operating on the condenser.

It's when you want to calibrate—

your receiver to dead accuracy that the Colvern Selector proves its superiority as a fine tuning device.

Every other Vernier device can only be calibrated with certainty to a degree interval. Obviously, any smaller interval must be imaginary and its relocation arbitrary.

Home Constructors are aware that a Vernier knob provides only slow motion—the dial or indicator continuing to travel at the same rate as the moving vanes.

The Colvern Selector is a geared Condenser and embodies a system of fine tuning control which permits the definite and accurate location of any pre-determined calibration. The dial is divided over the full circle and provides 360 degrees value for each rotation of the index.

By this system ten complete turns of the dial reduces a one degree interval to the equivalent of 1/3600th part of the variable capacity.

In point of fact, the Colvern enables you to tune to a degree of accuracy that is 20 times greater than ordinary vernier adjustment. It is an instrument which will give the precise tuning essential to perfect reception, whether of local broadcast or weak distant transmission.

The Colvern Selector Low Loss :—
Reading to 1/3600th of capacity

Capacity .0005 mfd.	£1 1 0	
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Type F without gear attachment—

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One hole fixing. Other capacities if required.

Descriptive Folder upon request.

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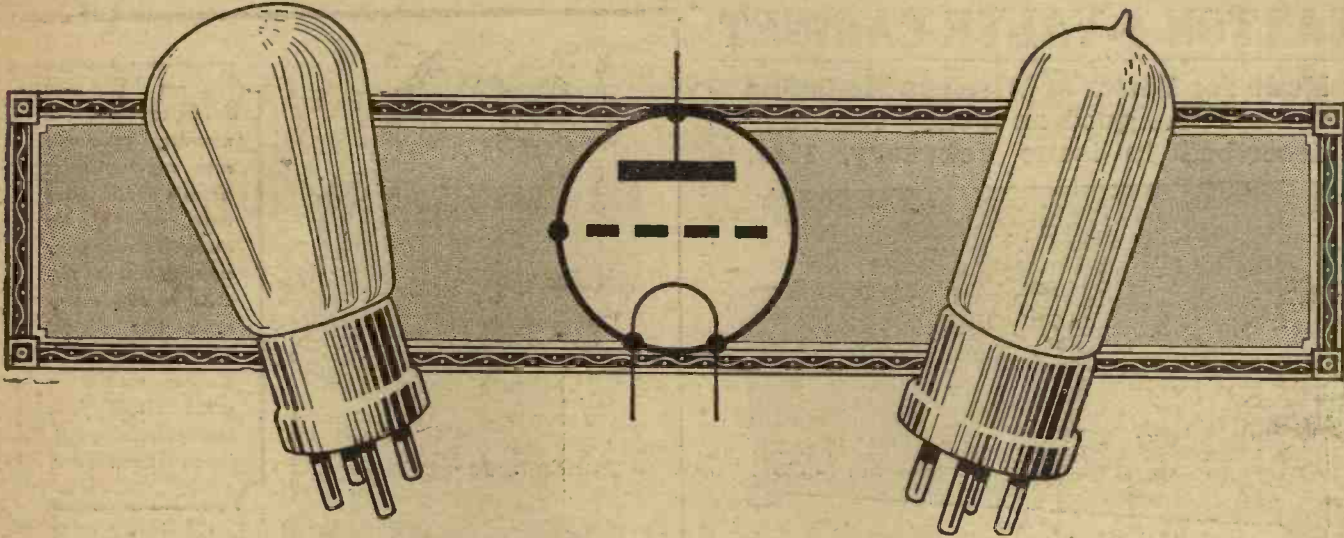

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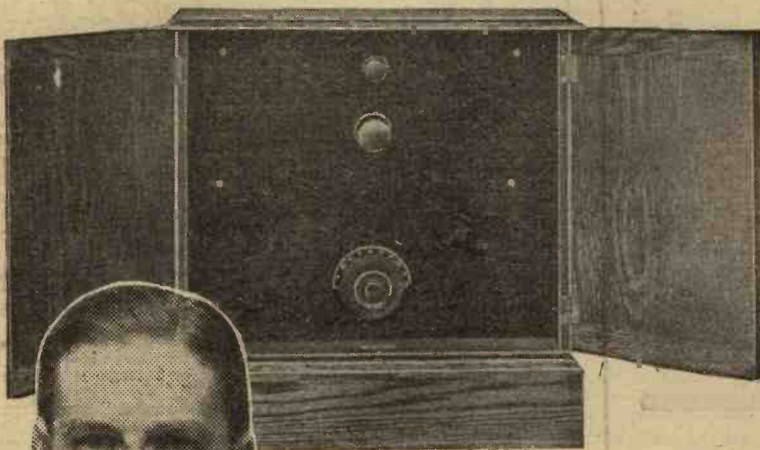
"My Own" Local Receiver

By

PERCY W. HARRIS,

M.I.R.E.



PERCY W HARRIS,
M.I.R.E.
Editor of THE WIRELESS CONSTRUCTOR.

Principal Contents:

Safe and Efficient!!!

IN this issue, the Editor, Percy W. Harris, has given to the public just the set that all experimenters would recommend and build for the use of the family.

"My Own" Local Receiver is a powerful 3-Valve and Crystal Set which any member of the family can control by one knob only.

This set gives the highest quality reproduction from the local station, and will also give one Daventry 5XX.

Full and lucid instructions are given so that anyone of average intelligence can successfully construct it at home.

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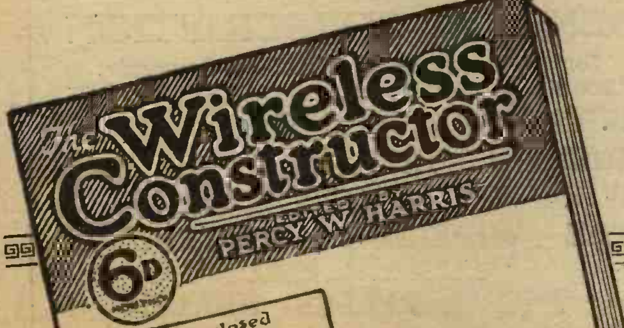

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This book is the third of a series planned and edited by Mr. E. B. Wedmore, M.I.E.E., F.Inst.P., Director of the British Electrical and Allied Industries Research Association.

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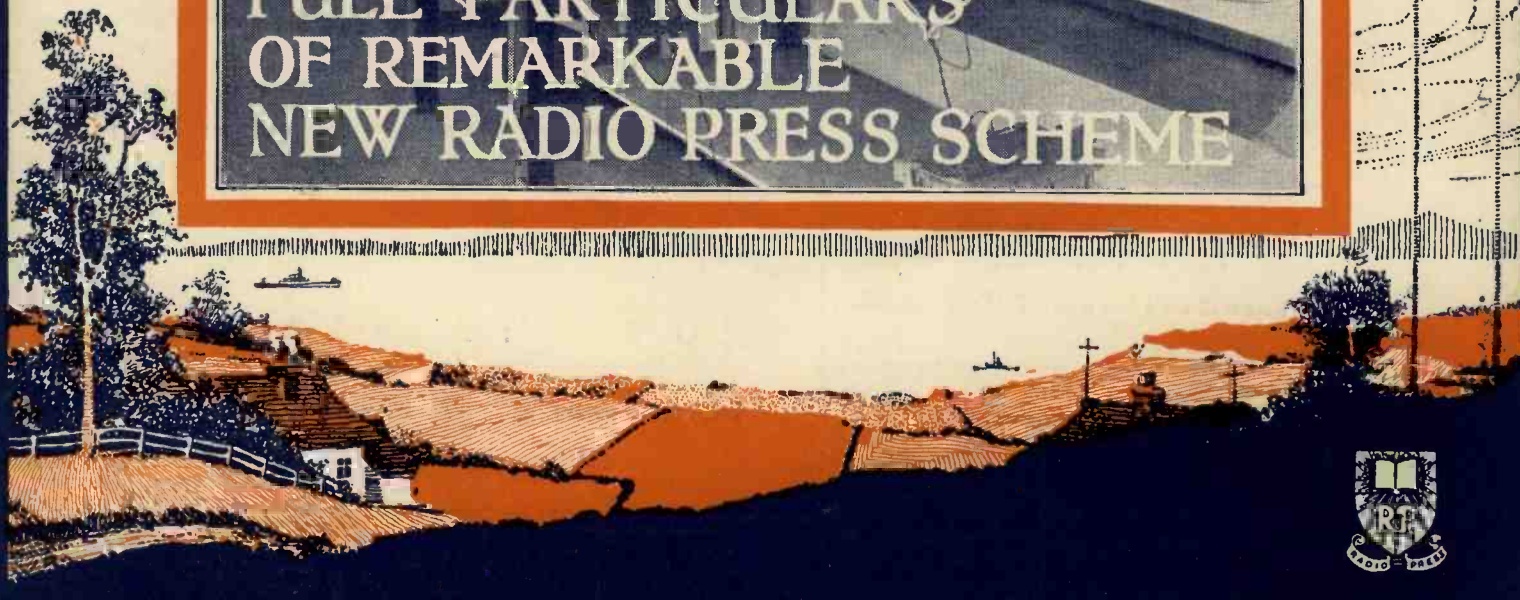

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Next Year's Transatlantic Broadcasting Tests

THE friendly relations between the United States of America and Europe will be still further enhanced this winter by another attempt at the interchange of broadcast programmes across the Atlantic. The tests will take place between January 25 and February 1, when special programmes will be sent out from a number of American broadcasting stations with greetings to European listeners. Similarly, British and Continental stations will send special programmes to America, the times of transmission being suitably adjusted.

It must be borne in mind that there is a minimum difference of five hours in time between the United States and England. The United States is divided into Time Zones, and Chicago time, for example, differs from ours by six hours. Programmes from this side will be sent between the hours of 4 a.m. and 5 a.m. The British Broadcasting Company and the organisation controlling a number of Continental broadcasting stations have already promised their support by undertaking to give special programmes, and there is every indication that the tests this year will be a very great success.

In the United States of America arrangements are being made with the greatest enthusiasm, and already the different organisations controlling the broadcasting stations have promised to keep silent nights to enable listeners to receive European broadcasting stations without interference from those listening to America. The significance of this agreement can scarcely be realised by those who are not acquainted with the American broadcasting situation, for there are roughly five hundred licensed stations, one or two hundred of which are in regular operation every night. For all these stations to forego their broadcasting on certain evenings is a powerful indication of the interest taken in, and the importance placed upon, the International Broadcasting tests.

The arrangement of the tests in the United States is in the hands of our contemporary, *Radio Broadcast*, and on this side of the water Radio Press, Ltd., are acting as organisers. In order that British listeners may participate fully in these interesting tests, full technical details of how to adjust receivers for American broadcasting, what kind of sets to use, and full details of the arrangements will be given in *Wireless Weekly* and other Radio Press publications. Special calibrations will also be given by Radio Press laboratories, so as to avoid the totally unnecessary howling that so frequently upset previous tests.

Full details of arrangements to date will appear in our next issue.

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Director of Research: Major JAMES ROBINSON, D.Sc., Ph.D., F.Inst.P.
Deputy Director of Research: Capt. H. L. CROWTHER, M.Sc.
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November 25, Vol. 7, No. 10.

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Prof. C. L. FORTESCUE, M.A., M.I.E.E.

Calibrate Your Own Receiver!

By the Staff of the Radio Press Laboratories.

We announced in our last week's issue that Radio Press, Ltd. will shortly be inaugurating a calibration service, to enable readers to calibrate their wavemeters and receivers in a simple manner. Further details of this scheme are given here, together with some notes on methods of calibration recommended.

The Buzzerdyne wavemeter, which was described by Mr. Percy Harris in a previous issue of "Wireless Weekly."

AN announcement was made last week in *Wireless Weekly* that the Radio Press proposed to give a service of standard frequencies for our readers. The method proposed is that on a particular day the frequency of some of the B.B.C. stations will be measured accurately at the Radio Press Laboratories at Elstree, at definite times according to a programme which will be published beforehand.

Publication of Frequencies

At the earliest possible opportunity afterwards, these results will be published, and thus any reader who makes observations at the same time will be able to check his wavemeter very accurately on a number of points.

Sufficient frequencies will be given to cover the whole of the B.B.C. frequency band from 1,000 kilocycles to 600 kilocycles (300 to 500 metres). We shall restrict ourselves to this band of frequencies for the first observations, but later it is possible we shall extend the band to include other frequencies.

Stations to be Checked

The B.B.C. stations which will be observed and recorded at Elstree will be chosen at first from the following:—

Sheffield.	London.
Leeds.	Manchester.
Liverpool.	Bournemouth.
Nottingham.	Newcastle.
Hull.	Glasgow.
Plymouth.	Belfast.
Bradford.	Birmingham.
Cardiff.	Aberdeen.

The First Test

It will be noticed that if a reader obtains a considerable proportion of these he will be able to calibrate his receiver completely over the B.B.C. band of frequencies. It is proposed to carry out our first calibration in the second week of December. On our first test for calibration purposes we shall take a certain length of time for each station, and we shall aim at calibrating eight stations per hour. In case this is too rapid or too slow for readers, we shall be very pleased to have comments after the first test. The actual programme will be published in the first week of December in the issue of *Wireless Weekly* of December 2.

Identification of Stations

It will be essential for anyone who makes use of this calibration to identify the particular station with which he is working. For this purpose it will be necessary for him either to hear the announcer of that station stating the station which is calling, or, failing this, to identify from the *Radio Times* the actual programme which is being transmitted. The question of identification will be difficult unless one hears the actual name of the station announced, so that for this calibration purpose it will be essential to choose a night when S.B. is not being used.

How to Use the Calibrations

The obvious suggestion that will occur to most people who use these calibrations will be to note the receiver adjustments accurately at the time of observation. For instance, supposing it is stated that Newcastle will be observed between 7.15 p.m. and 7.22 p.m. on a particular evening, then during that period the observer should adjust his receiver accurately and note the adjustments. Having noted the adjustments a rough value for the setting of the receiver will be obtained, but it must not be considered that an accurate setting is thus obtained.

Accuracy

With most receivers the adjustment of the condenser or variometer will not be anything like accurate. Normally, it will not be possible to obtain an accuracy greater than one per cent. by this method. With receivers there are so many factors which may alter the adjustments from time to time. We have first of all

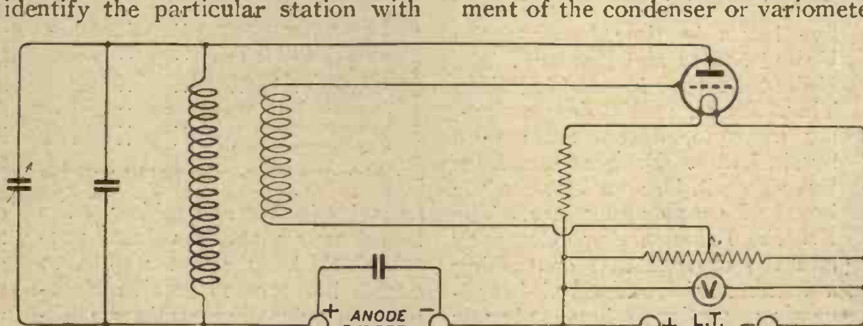


Fig. 1.—The circuit diagram of a heterodyne wavemeter. The anode and grid coils are in a position of rigidly fixed coupling, and the elimination of the anode battery is advisable, if possible, in order to secure greater constancy of calibration.

the aerial capacity which might alter, then, again, the amount of reaction that is used, then again the anode voltage, and the filament current, to say nothing of the grid bias. All of these factors will vary the frequency for a particular setting of the condenser or the variometer. Although a certain amount of good will be done by observing the setting of the actual receiver, and noting the actual calibrations of these settings, this method is not to be recommended for very accurate work.

Buzzer Wavemeters

It is absolutely necessary for accuracy to use a frequency meter or wavemeter. In the case of a buzzer wavemeter, the method of use is as follows: At the appointed time for the calibration of a particular station, the receiver will be accurately adjusted on that station. Then the wavemeter will be brought into action, being arranged with the coupling between the wavemeter and the receiver no tighter than is actually necessary to receive signals, and the frequency of the wavemeter altered until a maximum response is obtained in the receiver. When this happens the reading of the wavemeter should be noted. For a description of a buzzer wavemeter, and, in fact, other wavemeters, the reader is referred to *Wireless Weekly*, Vol. 4, No. 17, of August 27, 1924.

Absorption Wavemeters

Another type of wavemeter which might be used with advantage and which will give an accuracy probably a little greater than that obtained with the buzzer wavemeter, is called the absorption wavemeter. This consists merely of a condenser and a tuning coil joined in parallel. In actual use this wavemeter is brought near to the receiver when signals are being received from the particular station under investigation.

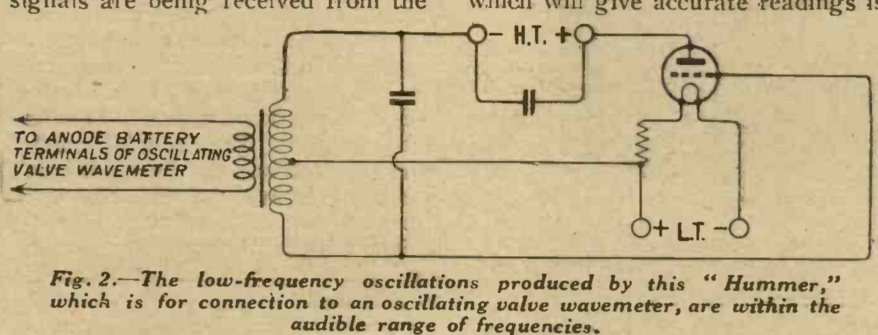
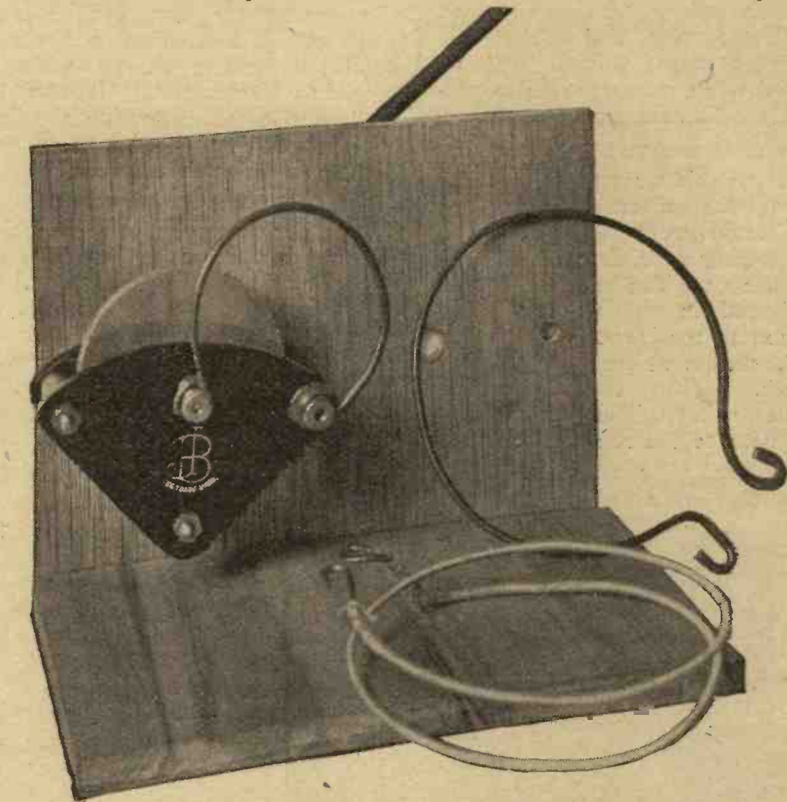


Fig. 2.—The low-frequency oscillations produced by this "Hummer," which is for connection to an oscillating valve wavemeter, are within the audible range of frequencies.

Method of Operation

The absorption wavemeter is then adjusted until it comes into tune with the transmitting station, when it will be found that it will absorb energy from the receiver, and the observation will be made by noting the point on the wavemeter at which the energy is absorbed from the receiver, that is, when the signals are weakened. A description of this type of wavemeter was given in *Wireless Weekly*, Vol. 7, No. 2, of September 30, 1925, although the instrument described there was for higher frequencies than the frequency band at present under consideration.



This absorption form of wavemeter has the merit of being extremely simple to construct. This actual instrument is, of course, provided with coils for much higher frequencies than those used for broadcasting.

Heterodyne Wavemeter

Another form of wavemeter which will give accurate readings is the heterodyne wavemeter. Such a wavemeter consists of a simple oscillating circuit using the reaction principle, arranged so that the whole range of frequencies which are under investigation can be obtained. A diagram of such a wavemeter is shown in Fig. 1. If the reaction effect is big enough, it will be possible to cut down the size of the anode battery very considerably, and in fact in certain cases it is possible to abolish this battery altogether. It is advisable to do so when possible for the following reasons:—

The frequency of such a wavemeter depends upon the capacity and inductance in the circuit, also on the amount of reaction, the emission from the valve filament, and on the anode voltage and grid tapping. Thus in a wavemeter it is essential to fix as many of these as possible. A fixed reaction coupling should be employed, and a fixed grid tapping, both of which are shown in Fig. 1. It is thus advisable to abolish the anode battery, whose voltage might vary from day to day, and thus would cause the frequency to alter. In any case, if an anode battery is employed, it is essential to adjust it to give the same anode voltage whenever a measurement is made.

Necessary Precautions

As regards the emission, it is essential to guarantee that the filament current is the same from day to day, and for this purpose a filament ammeter should be employed, or alternatively a filament voltmeter, so as to guarantee that the voltage supplied to the filament remains absolutely constant. If we can abolish the anode battery, then all that is required is the filament voltmeter. From this description it becomes obvious that the calibration of the wavemeter depends upon a particular valve, and in case this valve gets burnt out, it will be essential when it is replaced to perform the calibrations once again.

Use of Heterodyne Wavemeter

In using this wavemeter in order to set up the calibrations according to the Radio Press calibration tests, the following procedure should be made use of. The receiver should be adjusted in the *non-oscillating* condition to receive the particular B.B.C. station at the best possible strength. Then the heterodyne wavemeter should be adjusted somewhere near to the receiver, but not too close, so that beats are produced between its oscillations and those of the carrier wave of the B.B.C. station. The heterodyne wavemeter should then be adjusted until zero beats are obtained. Then the reading of the wavemeter should be noted.

A calibrated commercial type of buzzer wavemeter.

Calibration Chart

In this way all the B.B.C. stations should be recorded. As soon as the accurate wavelengths are published in *Wireless Weekly* a curve can be drawn showing the actual setting of the wavemeter for definite frequencies. The wavemeter is now in condition for use as an accurate receiving wavemeter. It can be made use of to determine the frequency of any station which is picked up on one's receiver.

A Further Requirement

It is not, however, in a condition to use for adjusting one's own receiver to any wavelength. For this purpose it will be essential to convert the wavemeter so that it uses modulated continuous waves instead of continuous waves. For this purpose the reader is again referred to *Wireless Weekly*, Vol. 4, No. 17, where two methods are shown for converting heterodyne wavemeters to modulated continuous wave wavemeters.

The Buzzerdyne

One of these methods makes use of what is called the "Hummer" type, and a diagram of this is shown here in Fig. 2. This consists of a low-frequency oscillating circuit impressed on the high-frequency oscillating circuit, the low frequency being within the audible range. The other type of wavemeter is called the Buzzerdyne. This again interrupts the continuous waves by means of the grid-leak and grid condenser circuit. This also gives an audible note.

Such modulated continuous wave wavemeters can be used in a similar manner to buzzer wavemeters, while giving greater accuracy than the latter.

OBITUARY

We regret to announce the death of Brigadier-General R. Marr-Johnson, C.M.G., D.S.O., which occurred on November 15, after a serious illness following an operation.

General Johnson was a Director and Deputy-Chairman of Messrs. Radio Communication Co., Ltd., having joined the Board of that company after the completion of a brilliant military career in the Royal Regiment of Artillery.

General Johnson was engaged in the Boxer campaign in 1900, and altogether did fourteen years' duty in the Far East. During the first year of the Great War, General Johnson controlled all the railway transport in the British forward zone in France. In August, 1915, he took over command of a Field Artillery Brigade, with which he went through the Battle of Loos. In January, 1916, he became G.S.O.1. to the 19th Division under General Sir T. Bridges, now Governor of South Australia. In the autumn of that year he returned to France and became C.R.A. of the 29th Division. He had already been awarded the D.S.O. for gallantry in the Somme Battle in July, 1916, and his excellent work during the final advance in 1918 brought the C.M.G. and the French Croix de Guerre. He remained with the Army of Occupation until May, 1919, when he returned to England.

In 1920 he took over the International Volunteer Corps at Shanghai, which he reorganised and re-equipped, and shortly after his retirement from the Army, Radio Communication Co., Ltd., were fortunate in securing his services.

SHORT-WAVE Notes & News

A Great Achievement

MR. F. A. MAYER (G-2LZ), of Wickford, Essex, was recently experimenting on telephony (on 6,667 kc.) with 1DH of Mosul. He asked the latter to stand by while he re-transmitted the broadcast programme from 5XX; 1DH reported good reception, and G-2LZ received a card from an amateur in Tasmania reporting excellent signals. British broadcasting has at last been heard round the world, but after having passed through an amateur's station *en route!* 2LZ has also worked Chile, Mexico, the Philippines, and the U.S.S. *Seattle* when at the Antipodes.

Pacific Islands

Readers who have heard PI-1HR and wish to send reports to him should write to Signal Officer Hayden P. Roberts, Fort McKinley, Manila, Philippine Islands. Several other stations in the Philippines and Hawaii (Intermediate "HU") are now active just above 7,500 kc. (below 40 m.), and are at their maximum strength in the afternoon, at about 3.30 p.m.

Early Morning Working

The Australasian stations are now at their best between 7.30 and 8.30 p.m., when they are generally in great demand by our own stations. Unfortunately there are not enough of them to share round! They have, however, excellent receivers, and many British stations have now been heard "across the world" when using 15 watts and less. This work is also carried on in the mornings. Incidentally, short-wave enthusiasts who do not like to sit up late at night will be amply repaid if they get up at about 5.30 a.m. one morning. WGY is then working on about 7,500 kc. (40 metres), and large numbers of American amateurs may be heard. The writer has heard 170 in one period of just over two hours. After 6.30 a.m. the New Zealanders and Australians begin to come in.

Calibration

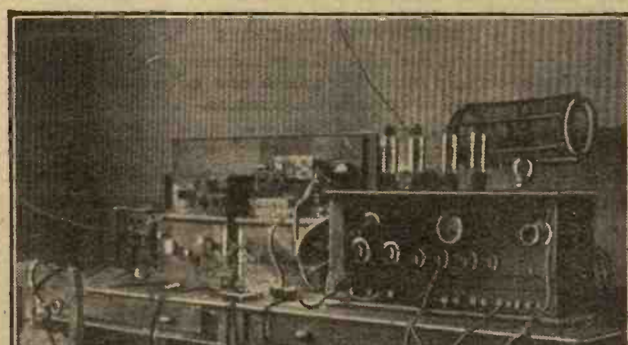
For those who wish to keep their receivers fairly reliably calibrated, GCS, the G.P.O. station at Caister-on-Sea, Norfolk, is a useful guide. He works on 10,000 kc. (30 m.) and 7,143 kc. (42 m.), and is strongly heard all over the United Kingdom. He is often to be heard asking for reports between 2.0 p.m. and 2.30 p.m. on Saturdays and Sundays. G-5DH, the Post Office station at Dollis Hill, has been mentioned previously, but he seems to vary between 6,000 kc. (50 m.) and 6,250 kc. (48 m.).

with an input of 3 watts, and G-2VX, of Aberdeen (500 miles), with .3 watt.

The American OWLS

The American Radio Relay League has provided an excellent method of calibrating short-wave sets by its system of OWLS (Official Wave-Length Stations). These stations do *not* transmit calibration waves, but simply give their wavelength before "signing off." Naturally, only the extremely reliable stations are granted this privilege, and the method of procedure is simply to send, at the end of each message, ". . . . ar 2OD GU 9ZT 41 K," or a similar phrase. There are about a hundred of these stations, the majority being American. G-2NM, 2OD, and a few "Zs" are included, however, so they may be of service to British listeners.

Some American stations may also be heard sending "RCC" when signing off. These are the members of the "Rag-Chewers' Club," an association for promoting more "chattiness" in radio, and not merely strings of "QRM, QSS, QRZ," etc.



The transmitting and receiving equipment of Belgian 4C2, near Brussels. Note the tubular transmitting valves employed.

Europe

NTT, the U.S.S. *Scorpion*, is cruising the Mediterranean and Black Sea waters. This ship often works traffic with European amateurs, but reception is very irregular, no doubt on account of constant experiments and alterations.

Our remarks on the "noise" turned out by the French amateurs have called forth a note to the effect that F-8UT has worked U-1CMX

STANDARD RESISTANCES FOR HIGH-FREQUENCY MEASUREMENTS

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

In experiments involving accurate measurement of H.F. resistance it is important to have a standard resistance for purposes of comparison. The simple method given here of constructing such a resistance should present no difficulties to the experimenter.

IN view of the interest which is now being created in high-frequency resistance measurements, owing to their great importance to the wireless experimenter, the question arises: "How can the measurements be checked against a reasonably accurate standard to ensure that all the experimental results are not fallacious?" Naturally the only satisfactory answer will be found in the adoption of a piece of apparatus which can be constructed readily from inexpensive material, and yet remain unaltered in value within the usual experimental limits of measurement.

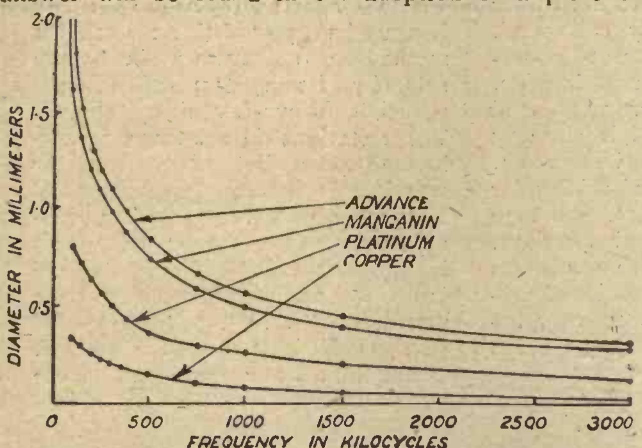


Fig. 1.—These curves show the maximum diameters of wires of certain materials which can efficiently be used at various frequencies.

Skin Effect

Now it has been pointed out by J. H. Reyner, B.Sc. (Hons.), A.C.G.I., D.I.C., A.M.I.E.E., in *Wireless Weekly*, Vol. 7, No. 6, that at radio frequencies the current does not flow uniformly through a conductor, but tends to confine itself to the outer surface, due to the appreciable effects of the magnetic field produced within the wire itself. The theory of this problem does not lend itself to an elementary treatment, but it can be shown that the depth of penetration of the current into the conductor itself remains approximately constant irrespective of the size of the wire, or, in other words, the thin skin representing the boundaries of current flow has a constant depth. This leads to the conclusion that there is an optimum gauge of wire where the high-frequency resistance does not differ from the normal and direct current resistance by more than 1 per cent.

Complicated Formulæ

These facts only have direct application to a straight uniform conductor, and an exact analysis of the whole problem would show that the ratio of the alternating current resistance to the direct current resistance would involve an expression, with an infinite number of terms, containing such constants of the wire as diameter, permeability, resistivity, and the frequency at which it is used. Consequently, if a straight wire is chosen with a very small diameter, we shall find that the ratio of H.F. resistance to D.C. resistance will not exceed 1.01, and since the D.C. resistance is a quantity which can be measured or calculated with a high degree of accuracy, it follows that the H.F. resistance will be known almost within the same limits.

A Useful Table

It thus becomes necessary to find how large a wire can be employed without having its high-frequency resistance exceeding the direct current resistance by more than a specified amount. In the previously-mentioned issue of *Wireless Weekly* a table was published, showing the limiting diameters of four metals to fulfil this condition, at five different frequencies, measured in kilocycles. The accompanying table, prepared by L. W. Austin, is somewhat fuller, and should prove very handy to use in conjunction with the one already published. To find intermediate values curves should be drawn with frequency and diameters as abscissae and ordinates.

Wire Diameters in Millimetres.

Largest *straight* wire which can be used without the H.F. resistance exceeding the D.C. resistance by more than 1 per cent.

Frequency (kc.)	*Advance.*	*Manganin.*	*Platinum.*	*Copper.*
3,000	0.30	0.29	0.13	0.006
1,500	0.46	0.40	0.20	0.045
1,000	0.57	0.50	0.27	0.09
750	0.66	0.60	0.30	0.10
500	0.83	0.75	0.37	0.15
375	0.98	0.88	0.42	0.20
300	1.10	0.99	0.50	0.21
250	1.20	1.10	0.57	0.22
200	1.30	1.21	0.63	0.26
150	1.52	1.38	0.73	0.30
100	1.82	1.62	0.80	0.33

A further table gives the equivalent diameters in millimetres of the range of standard wire gauges covered by the first table. The two tables may therefore be used in conjunction with each other.

Millimetres correct to .01	*S.W.G.*	*Millimetres correct to .01*	*S.W.G.*	*Millimetres correct to .01*	*S.W.G.*
0.07	45	0.23	34	0.61	23
0.08	44	0.25	33	0.71	22
0.09	43	0.27	32	0.81	21
0.10	42	0.29	31	0.91	20
0.11	41	0.32	30	1.02	19
0.12	40	0.35	29	1.22	18
0.13	39	0.38	28	1.42	17
0.15	38	0.42	27	1.63	16
0.17	37	0.46	26	1.83	15
0.19	36	0.51	25	2.03	14
0.21	35	0.56	24	2.34	13

Fig. 1 shows the shapes of the curves for the metals mentioned in the above table, so that the maximum diameter for any particular frequency can be read off from the graphs. If a wire is required to cover a range of frequencies, the size of the wire should be determined from the maximum desired frequency, and not the minimum.

Fine Gauge Wire Required

Now it is clear from the above figures that the wire to be employed must be very fine, *e.g.*, at a maximum frequency of 1,000 kc., 43-gauge copper wire would almost conform to the necessary diameter. Experimenters will thus appreciate that the conditions imposed call for a certain amount of skill in handling, without damage, the requisite fine wire, and it now becomes necessary to devise a suitable mode of mounting the resistance wire to minimise, and almost eliminate, all possibilities of breakage.

Constructing the Standard Resistance

Since the wire must be kept straight in order to adhere to the aforementioned conditions, it appears that one way to meet the circumstances easily is to have a length of the wire freely suspended in space from a support, with a small weight attached to one end. If this were done without any precautions the wire would most likely break under the tension produced by the weight, but this weight is necessary to keep the wire straight, with this particular form of the resistance.

A Simple Method

So it becomes necessary to adopt the following simple scheme. Two pieces of 18-gauge bare copper wire, about 2 in. long, should be procured, and shaped as at A and B in Fig. 2, the circular portion merely being a loop about ½ in. in diameter in the centre of each wire. The two ends of the resistance wire should be wound two or three times round these thicker copper pieces, which will then form the extremities of the resistance. Of course, if the length of resistance wire is covered with insulation, it should be bared at

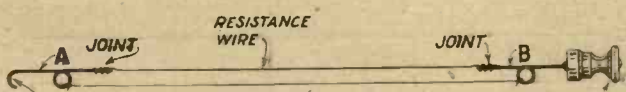


Fig. 2.—This type of standard resistance may be suspended vertically by means of the hook shown.

these points, and then, to ensure good electrical contact, the joints should be carefully soldered.

Cotton Support

To one of the copper ends an ordinary terminal should now be sweated to enable external connections to be made, and, incidentally, this will act as a weight to keep the wire straight. The hook at the end A is for the purpose of suspension. A piece of cotton or very fine string, which must be quite dry, should now be tied between the two wire loops, and made just slightly shorter than the length of the resistance wire. If the wire is now suspended from the top hook, it will hang straight, with the thread and wire parallel, and if extreme care is exercised in adjusting the length of the cotton support, it will take all the weight due to the terminal, and the wire can be regarded as straight for all practical purposes.

Measuring the Resistance

The resistance of the wire can be conveniently measured on an ordinary resistance "bridge" by direct current methods, or if this piece of apparatus is not available the value may be calculated from the diameter and length of the wire (the latter quantity being the distance between the junctions of the thick and thin wires), and the "specific resistance," which is given in most wire tables or reference books.

If two or three of these resistances are made as described, in lengths varying between 1 ft. and 2 ft. 6 in., they can be used as standards for calibrating or testing high-frequency resistance measurement apparatus. It is necessary to ensure that no kinks appear in the wire during the process of construction or subsequent use, as naturally the resistance would

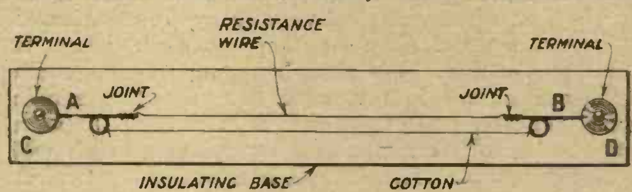


Fig. 3.—An alternative method of constructing the standard resistance is to mount it horizontally on an insulating base.

then become inaccurate and consequently useless for standardising purposes.

Another Form of Mounting

For those experimenters who object to this particular form of apparatus for general use, on the grounds of inconvenience in connecting to the required apparatus, it is quite possible to modify the design so as to produce a more rigid mode of support. This is brought about by obtaining a piece of ebonite, or good-quality insulating material, with high insulation resistance, about 1½ in. wide, ¼ in. thick, and 2 or 3 in. longer than the resistance wire itself. The thick copper wires A and B should be made with the circular loops, and their ends shaped so as to mount under the bosses of terminals.

Adjusting Length of Wire

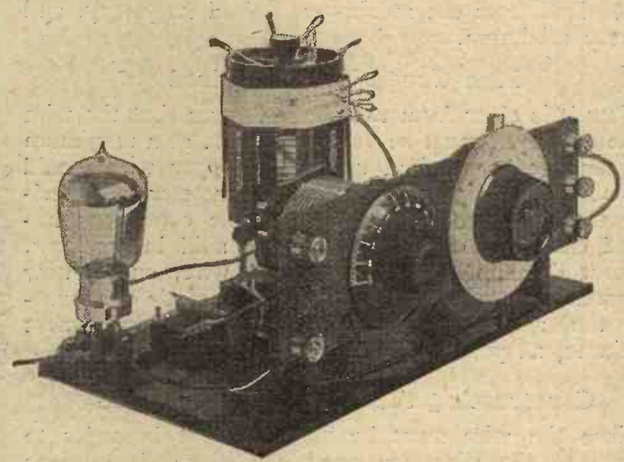
The cotton should be adjusted to the required length, and then the resistance wire with its thick copper ends and cotton distance piece can be placed on the insulating base. With a slight tension applied to the ends A and B, the terminal positions can be accurately marked on the base. Now mount the terminals C and D of Fig. 3 and insert the resistance in place as shown, taking care to have the wire supported at least 2 in. above the base to reduce any dielectric losses. If desired, the cotton can be removed after this has been completed, as it will have fulfilled its purpose of taking any strain imposed between A and B during the process of construction.

The construction of these resistances will amply repay the experimenter for his trouble, while the cost incurred is very small.

Selectivity and the Tight-Coupled Aerial

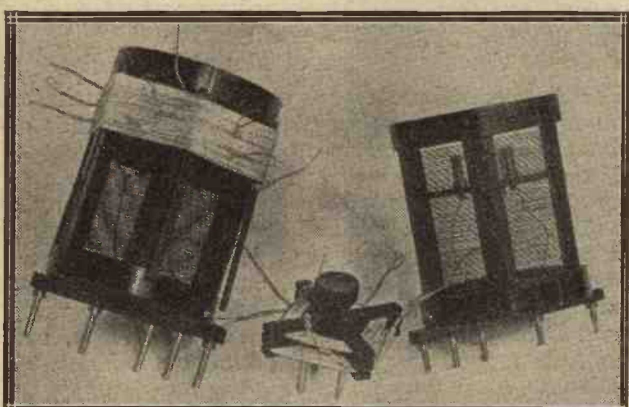
By G. P. KENDALL, B.Sc.

This article is introductory to a series by Mr. Kendall, who has been investigating the type of aerial circuit commonly known as "aperiodic," with a view to discovering exactly how this circuit functions in practice.



The set which was improvised for the author's experiments. The milliammeter was not built into the set itself.

IN commencing this article, which is intended to be the first of several dealing with a recent series of experiments, I should perhaps explain what is meant by the title. We shall be actually dealing with the device known to the reader as the "aperiodic aerial" circuit, and in the title it is referred to as a "tight-coupled" aerial circuit for reasons which will become apparent. The name is not, perhaps, a perfect one, but it seems more appropriate than the term "aperiodic aerial" circuit, since there would seem little doubt that the aerial circuit is by no means aperiodic, but is rather a flatly-tuned circuit, which can be made, under suitable conditions, to respond with a practical degree of uniformity over a fair band of frequencies.



Two of the special coil units. That on the left has an overwound primary winding, while on the right and in the centre respectively are the secondary and detachable primary of another type of unit.

The Functioning of the "Aperiodic Aerial"

This point as to the actual functioning of what we have been accustomed to call an "aperiodic aerial" circuit was dealt with in an article in the November issue of *Modern Wireless,* in which I described a series of experiments intended to elucidate the question, which strongly suggest that the arrangement is simply an over-tightly-coupled primary and secondary circuit, which conforms exactly to the normal behaviour of such an arrangement. Briefly, the chief experiment described in the article in question was to vary the number of turns in the aerial circuit, tuning the secondary in each case to the local station's frequency, and noting the signal strength of that station with various numbers of turns included in the primary winding.

In order to make certain that the increase of turns in the aerial circuit did not function merely by increasing the tightness of coupling between primary and secondary, the experiment was done in one case by keeping the number of coupling turns fixed and inserting a tapped loading coil which was kept separate from the secondary winding, so that no direct variation of coupling was produced by increasing the number of turns.

The Curve Obtained

The signal strength across the secondary winding was then plotted against the number of turns included in the aerial circuit, and a curve of the form illustrated in Fig. 1 was obtained. It will be seen at once that this is simply the typical double-humped

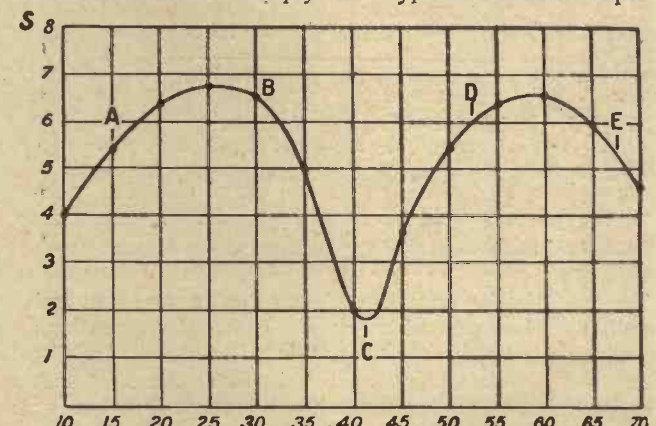
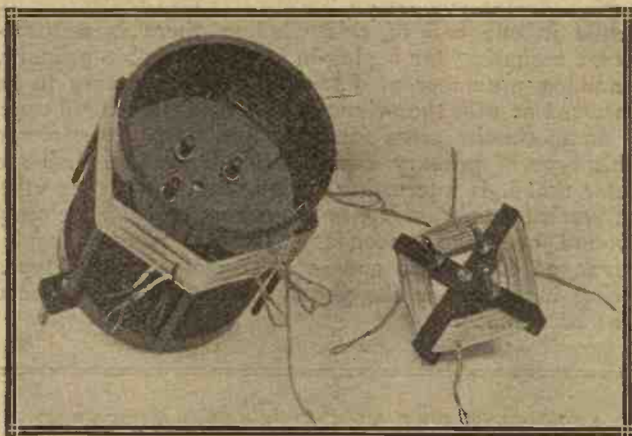


Fig. 1.—The curve obtained with a coil wound on a "three-step" former with an overwound primary. The usual working point on this curve would be in the neighbourhood of the points A and B, with 15 to 30 turns in the primary winding.

resonance curve produced when the coupling between primary and secondary is too tight in the ordinary arrangement of fully-tuned primary and secondary circuits. The "notch" between the two humps was the natural result of the over-tight coupling, and corresponds to the condition of the aerial circuit being fully tuned to the received wavelength. Very poor signal strength and also very flat tuning are to be observed at this point in the secondary circuit when this condition obtains.



Showing how the primary of the coil units is arranged to plug inside the secondary winding.

Variations of Coupling

Experiments on variations of the tightness of coupling were also tried, variations of the turn numbers of the loading coil being made in each case. It was found that the tighter the coupling the deeper was the notch between the humps, and the flatter the peaks of the humps themselves. It was thus seen that the tighter the coupling the wider the band of frequencies which can be covered by one of the humps, and it is interesting to note that in practice we had been in the habit of working upon, or endeavouring to work upon, that portion of the first hump indicated by the portion A-B in Fig. 1.

Meaning of the Curve

In the neighbourhood of A it will be found that there is a slight loss of signal strength as compared with the top of the hump, but that tuning is exceedingly sharp, and therefore selectivity is good. At B, on the other hand, signal strength may perhaps be greater, but tuning has become very much flatter, and, as one progresses down the slope of the notch to C, tuning becomes flatter and flatter, until the bottom of the notch is passed, whereupon it tends to sharpen again.

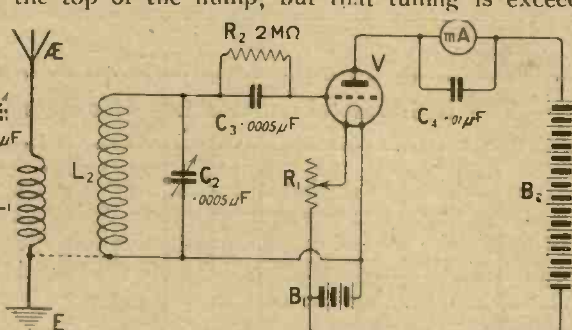


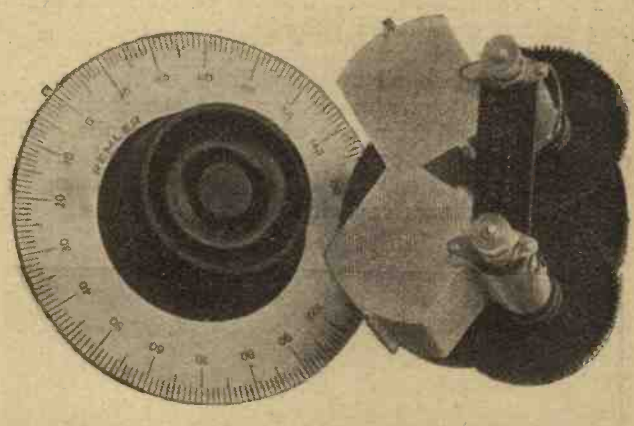
Fig. 2.—The circuit of the measuring set employed. The condenser C1, shown dotted, may be connected in the aerial circuit for certain experiments, while the inclusion of C4, shunted across the milliammeter, will usually be found essential.

"Three-Step" Coil

Fig. 1 is actually the curve obtained by the use of a coil of the skeleton-former, spaced-winding type—in actual fact a "three-step" inductance. The turns which are plotted horizontally as being included in the primary winding were actually wound tightly on top of the secondary winding. The result is very nearly the same as that obtained when a separate loading coil was used. It will be seen that the useful part of the first hump is present between the points A and B, where there were 15 turns and 30 turns in the aerial circuit respectively.

Method Employed

There are quite a number of interesting points which require elucidation concerning the behaviour of this valuable arrangement, and I have recently carried out a series of experiments designed to clear up some of these questions. In order that the reader may fully appreciate the results, it will be desirable to give a brief description of the methods employed, and also of the apparatus used. All the experiments involved the measurement of signal strength across the secondary winding, and for this purpose the familiar Moullin voltmeter was used.



The Remler variable condenser used in the set has a reduction gearing ratio of 2 to 1.

The Moullin Voltmeter

The reader will probably remember that the Moullin voltmeter is an instrument for measuring signal strength which is dependent upon the employment of an ordinary valve detector in whose anode circuit is placed a milliammeter or suitable galvanometer, which records the change in anode current when a signal is applied across the grid and filament of the valve. The amount of the change in anode current may be taken as a measure of signal strength applied across the grid and filament, and this provides a very simple but highly effective method of measuring, or, at least, of comparing, signal strength. The arrangement is, in fact, a high-frequency voltmeter.

The Measuring Set

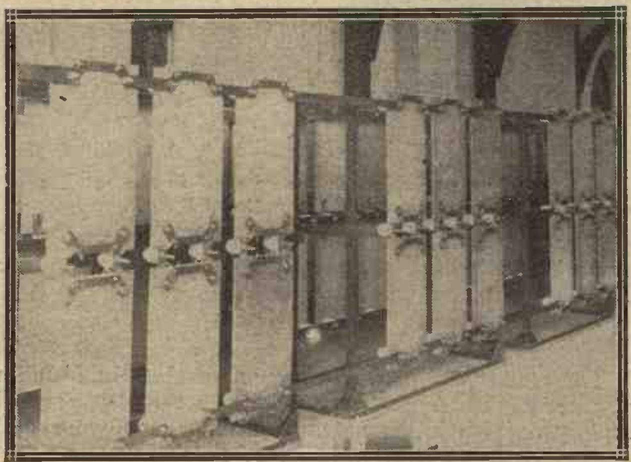
In order to carry out this particular series of experiments with facility, I improvised a unit composed chiefly of parts from the scrap-heap, which is illustrated in one of the photographs on these pages. It will be seen that it consists of a small wood baseboard, with a front panel carrying a pair of variable condensers, upon the baseboard being mounted a valve socket with a grid-leak and condenser for rectification purposes, a filament rheostat and a socket for a plug-in coil unit. The milliammeter is, of course, placed separately.

Circuit

The complete circuit arrangement is shown in Fig. 2, and in this diagram readers who have any intention of carrying out similar measurements should notice the provision of a large-capacity shunt across the milliammeter, which is, in most cases, absolutely essential, in order to eliminate reaction effects resulting from the fact that the milliammeter has windings whose natural period may fall upon the broadcast band.

Geared Controls

The two condensers visible upon the upright panel are provided for the purpose of tuning the secondary winding, and of enabling one to insert fixed values of capacity in series with the aerial lead. The right-hand condenser is the one which is used for actual tuning purposes across the secondary winding, and this is a very interesting American component, which possesses a 2 to 1 reduction gearing, and is actually one of the few geared condensers suitable for use in circuits where it is vital that the dial readings shall remain reasonably unchanged by possibilities of backlash. It is actually a Remler condenser, and the details of it will be gathered from one of the photographs. This condenser is of .0005 μF total capacity, and gives a square-law variation, the other condenser being of .0003 μF maximum capacity.



The absorption resistances used at the Hillmorton Station are enclosed in panels of insulating material, arranged in groups of three, as shown.

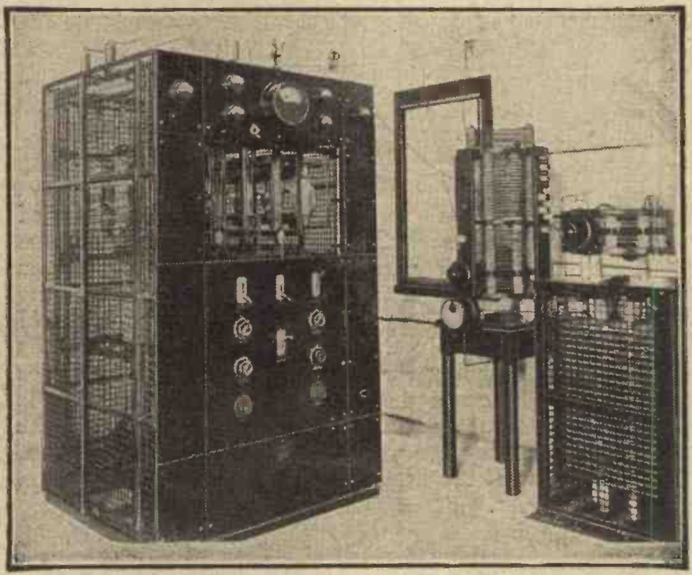
Special Coil Units

A socket is provided upon the baseboard for the insertion of special coil units comprising the secondary and primary windings, these being made up specially for the purpose by a wireless firm, the general arrangement being very similar to that of the high-frequency transformers used by Mr. Percy W. Harris in the "Special Five" receiver, which he has described in the November issue of *Modern Wireless*.

Construction of Coils

A photograph appears of two of these units, showing that there is a large cylindrical winding comprising the secondary, whose ends are brought out to two pins, which make contact with the sockets on the baseboard, while in one end of this winding there is a three-point mounting for a plug-in interchangeable primary, enabling a number of different sizes of primary to be inserted at will, the primary itself being arranged upon a small ebonite cross former. For many experiments this type of primary has been used, but we shall see later that it is interesting to investigate the properties of various different types of primaries, some closely wound over the secondary, others placed inside, arranged end to end and so on, certain of these types being illustrated in the photograph to which reference has been made.

AUSTRALIAN BROADCASTING.



The transmitting equipment at 3LO, the broadcasting station in Melbourne, Australia.

The R.S.G.B.—Forthcoming Meetings

We are informed that the following meetings of the Radio Society of Great Britain have been arranged, and will take place at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, W.C.2, at 6 p.m. on the dates specified :—

November 25, 1925.—Ordinary Meeting. "A Review of Short-Wave Developments," by Capt. W. G. H. Miles, R.M.

December 9, 1925.—Informal Meeting. Talk on "The Acoustics of the Headphone and Loud-speaker," by Mr. A. E. Bawtree, F.R.P.S.

December 16, 1925.—Annual General Meeting. "Some Facts and Notions about Short Waves," by Mr. Duncan Sinclair.

The "Princeps" Wireless Concert Receiver

Tested by the Radio Press Laboratories.

The circuit employed in the receiver shown here is that suggested by Major Prince to Mr. G. C. Beddington, who recently described the arrangement in " Wireless Weekly," under the title of " A New Loud-Speaker Circuit."

For adjusting the frequency of reception a single control is provided.

THE " Princeps " four-valve receiver has been tested at the Elstree Laboratories. It is a very interesting set, and quite recently the principle employed has been described in *Wireless Weekly* and in *Wireless*. Reference should be made to *Wireless Weekly*, Volume 6, Nos. 22 and 24, where the principle was described by G. C. Beddington, and also to Volume 1, No. 5, of *Wireless*, where a " Two-Valve Loud-Speaker Receiver for the Local Station," employing this principle, was described by D. J. S. Hartt, B.Sc. Major Prince, the designer of this four-valve receiver, is actually responsible for the original suggestion of the principle to Mr. Beddington.

The anode and grid batteries are placed inside the cabinet.

The four valves consist of a high-frequency valve, two valves for the trigger circuit, and a low-frequency valve.

Maker's Claims

The claims for this receiver agree with those made in the articles already published in *Wireless* and in *Wireless Weekly*, in that it gives good loud-speaker work on the local station and on the high-power station, combining quality, power and ease of control. Our tests confirm all these claims. The ease of control is particularly noticeable, so that it should be a very good receiver for people who have little knowledge of wireless.

Distortionless Amplification

There is no doubt that the receiver is as free from distortion as any we have tested. The receiver was tested with a number of different loud - speakers, excellent results being obtained with each of them. Reference has already been made in the Journals referred to, that this trigger circuit gives amplification with freedom from distortion. The introduction of an iron core transformer would appear to tend to spoil this good effect, but Major Prince points out that this should not occur in this particular case, and the results certainly seem to indicate that this is so, and that the iron core transformer does not introduce distortion. In any case the distortion is not appreciable.

Valves Recommended

Definite valves are recommended for use in this receiver, the valves being different for each position. The valves recommended are certain of the D.F.A. series of the Mullard Radio Valve Co., Ltd. Tests were made with other valves, and it was not difficult to find other combinations of valves of different makers which would operate in this receiver.

Ease of Control

The appearance of the receiver is excellent, all accessories being arranged behind the receiver. The only things external to the receiver are the aerial and earth, the accumulator and the loud-speaker. The method of switching from the local station to the high-power station is very good, there being a small push-pull switch, very little tuning adjustment being required in either position, the tuning being somewhat flat. A double plug is provided for reversing the loud-speaker connections, which is very useful.

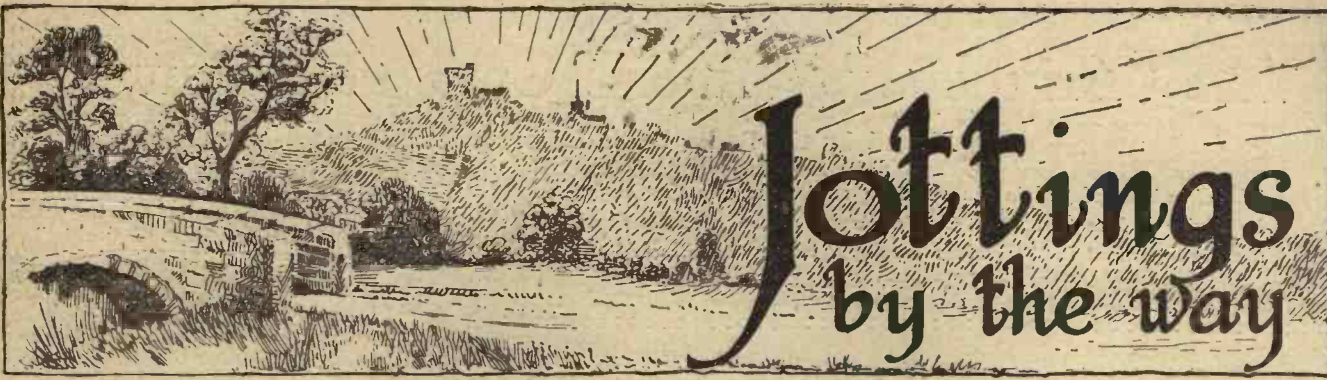
Oscillation

In the pamphlet definite anode voltages are recommended, and by using these there is no tendency for the set to oscillate at all, although, by using the incorrect anode voltages, it is possible to make the receiver oscillate. A tone control is provided, and by means of this it is possible to obtain exceptionally loud signals, which can be regulated as much as required, the quality being particularly good throughout, except, of course, when the signals are too loud.

Distant Reception

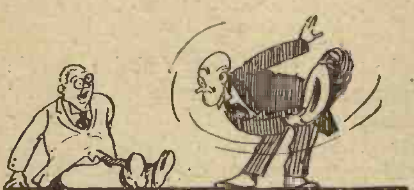
It is possible by careful adjustment to obtain distant broadcasting stations, but under these circumstances hand-capacity effects are rather marked.

Major Prince's idea in providing a receiver which will give good quality, good volume, and ease of control for the local and the high-power station should meet with commendation from a large number of users.



The Bee-Line

TURNING into the High Street of Little Puddleton the other day I caught sight of Professor Goop, who was obviously in a state of considerable excitement, for he was running rapidly along the pavement on the far side, cannoning at frequent intervals into other pedestrians. Whenever he did so he apologised profusely, sweeping off with a flourish of old-world courtesy one of Mrs. Goop's hats which he was wearing, having apparently mistaken it for his own in the hurry of his departure from home. I must say that its curling feather suited him rather well. Presently he caught sight of me and made a bee-line across the road, looking neither to the right nor to the left.. I have always been rather



. . . With a flourish of old-world courtesy . . .

puzzled over that expression "bee-line," which, I take it, is intended to signify that the line is straight.

No bee that I have ever observed, and I once spent a whole month investigating this particular problem, ever travels in anything approaching a straight line.

Safety Last

Now when I say a bee-line, I mean the kind of line that bees take. This describes precisely Professor Goop's course across the High Street. His first two steps forward brought him into contact with a Ford van, from which he rebounded on to the pavement. His next attempt caused a collision between two cyclists proceeding in opposite directions, owing to their efforts to avoid him. He slipped rather neatly between them, and they made a head-on. This brought him face to face with the Bilgewater Magna bus. With immense presence of mind he held up his hand, whereupon with a fearful grinding of brakes the bus stopped. The Professor leapt aboard, paid his penny, and asked to be set down on the opposite side of the road. This splendid idea was denied fruition, since the sudden stoppage appeared to have disorganised the internal arrangements of the bus, which remained stationary in the middle of the street. Luckily, at this moment, a man in blue, in the person of P.C. Bottlesworth, arrived, who, seeing the immobilised bus and the pitched battle that was proceeding between the infuriated participants of the cycling accident, promptly held up all traffic in both directions, thus allowing the Professor to pass in safety. "Good morning, Harold Lloyd," I said, taking him by the hand. The Professor smiled. "Crossing streets has become very perilous these days," he remarked, "but once my anti-crash pneumatic suit is perfected, pedestrians will have little to fear. The thing is covered with steel spikes, guaranteed to puncture the stoutest tyre, so that when wearing it the pedestrian becomes a terror to the motorist."

A Circuit Diagram

At this moment Mrs. Goop appeared on the scene, and had a few words to say. Tactfully I retired into Mr. Muggs's emporium, leaving them at it. Presently the Professor followed me in, hatless now, but as excited as ever. "My friend," he cried, "you are the very person that I was looking for. I have just completed one of my very finest circuits; in fact, I may say the finest of all my circuits. Let me explain. Here" (and he picked up a sausage, which he placed in the middle of the counter) "is my aerial tuning inductance. This" (he put a tin of sardines opposite the sausage) "is the aerial tuning condenser." In a few moments the whole circuit was laid out, with the help of five Dutch cheeses, representing valves, vast numbers of sausages and sardine tins, and yards of macaroni to show the wiring.

Volume

"It is the most wonderful thing that you can imagine," he cried. "There is simply no station that it will not get. Its range is unlimited. Selectivity is such that you can separate Northolt from 2LO, and as for its signal strength—well, when I tell you that there is hardly a whole pane of glass left at the Microfarads, or indeed in the neighbouring houses, you will understand what I mean. Let me see, to-day is Saturday, and there is, if I remember aright, no meeting of the wireless club. Will you come round to hear it? I am asking you alone, because we have been the co-authors of so many triumphs that it is only fair that we should share the first fruits of this one

. . . "Here is my aerial tuning inductance" . . .

together. The *séance* may be rather a long one, since I propose to conduct you round all the broadcasting stations, both British and foreign; but we will have a little supper together before we retire to bed."

Secrecy

Naturally I accepted with enthusiasm, and promised that I would not say a word to a soul. Leaving Mr. Muggs to tidy up his scattered

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Won't warp, won't twist, won't bend—

No chance of this with a LISSEN Wire Wound Rheostat or Potentiometer - - - no shorted turns - - - no development of faults in use - - - no chance of arcing, noise or flickering. Every contact brush of every LISSEN Wire Wound Rheostat and Potentiometer GRIPS ITS WAY ALONG THE WIRE, yet never too harshly.

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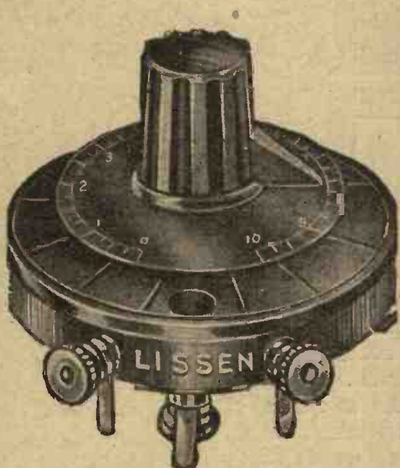

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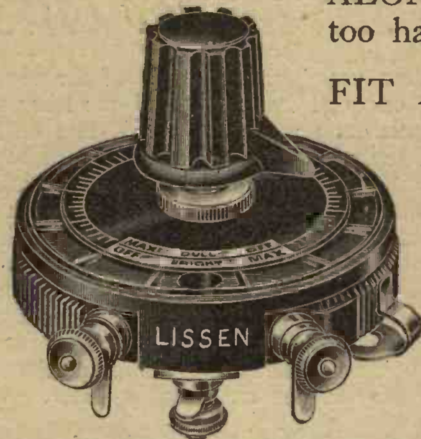

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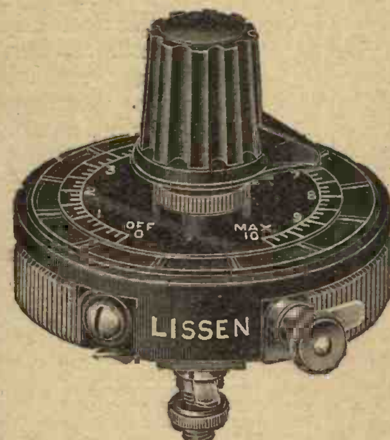

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A coil-mount with holes in it

We have let daylight into this new LISSEN COIL-MOUNT, the mount that is now being fitted to all LISSENAGON COILS, making the Coils still better than they were. You can buy this new LISSEN COIL-MOUNT separately - - - fit it to your existing coils, or any coils you wind yourself, or others you may buy.

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THE TABLE-TALKER

The new goose-neck design is the result of research in radio acoustics, which definitely establishes its value in relation to the diaphragm fitted. Patent material used in the construction of the horn eliminates metallic harshness. Volume and sensitivity controlled with small lever located at the rear of the base. Elegantly shaped, tasteful neutral brown finish, felt-padded base. Height 18 ins., bell 10 ins.

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MATCHED TONE HEADPHONES

The whole secret of Matched Tone is that one receiver refuses to have any quarrel with its twin. Ably schooled in these generous sentiments by our specially erected Matched Tone apparatus, their synchronised effort discovers greater sensitivity and volume and truer tone. There is no possibility of the sound from one earpiece being half a tone lower than its mate.

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Ratio 1 to 5. The main objects in view are high amplification of applied voltage, together with a straight line amplification-frequency curve. That is to say, for a given input voltage, the amplification is constant over a wide band of frequencies, thus eliminating resonance. Mechanically protected and shielded so that the transformers may be placed close together without interaction.

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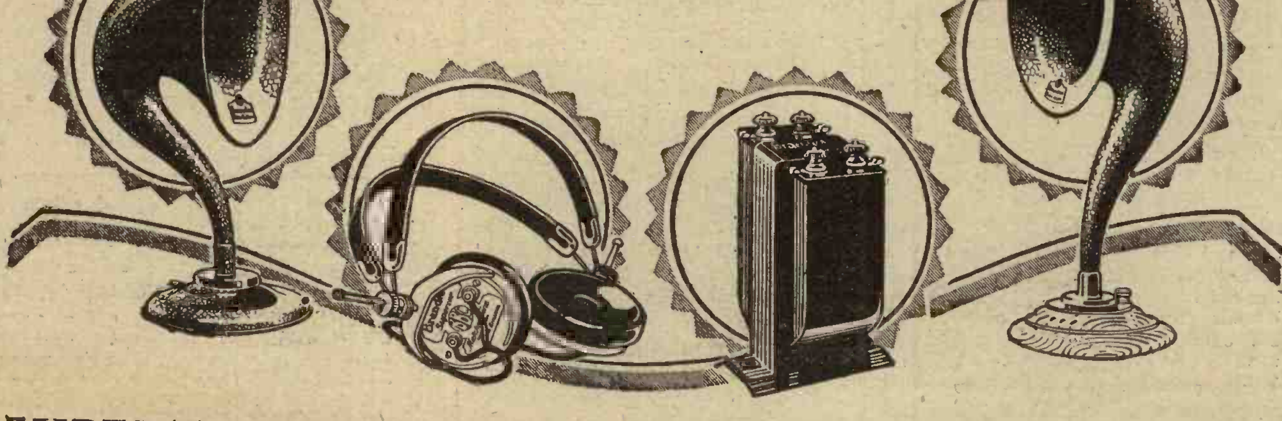


EXPERTS IN RADIO ACOUSTICS SINCE 1908

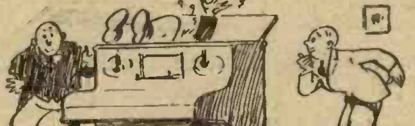
29/233

Service Advertising

components, we parted, I going my way and he his. But a few yards along the pavement I met Poddleby. " Any news? " he inquired. " There certainly is news," I said, " but I am afraid that I cannot tell you anything about it. All that I can say is—and this is in the strictest confidence—that the Professor has invented a perfectly marvellous new circuit and he is going to demonstrate it to-night at the Microfarads. Promise that you won't say a word to a soul." Poddleby duly promised and passed on. The General, when I met him, was just as easily sworn to secrecy, and so were Bumpleby Brown and Admiral Whiskerton Cuttle. A little later on I passed Poddleby in conversation with Snaggsby and heard the words, " Promise that you won't say a word to a soul." Though naturally a trusting person, these words made me wonder.

Visitors

That night at half-past eight I was ushered into the Professor's den. Hardly had we exchanged greetings when there was a ring at the front-door bell, and the next moment the maid announced General Blood Thunderby and Mr. Dippleswade, who explained that having nothing to do at home he had just dropped in for a chat with the Professor. " I trust," said the General, " that we are not intru——" " Mr. Snaggsby and Mr. Bumpleby Brown," announced the maid. " Well, well, my dear fellows," said the Professor, " it is a great pleasure for me to see you all, particularly as I was just about to demonstrate the new set to my friend and helper, Wayfarer. There are just enough chairs, I think, to go round. Please sit down." We were doing so when the maid ushered in Poddleby and Winklesworth. They were followed in rapid succession by Admiral Whiskerton Cuttle, Gubbsworthy, Mr. Montmorency-Marjoribanks (né Moses Aaronstein) from the Hall, the Editor of the *Gazette*, and, in fact,



. . *Bumpleby Brown fell in* . .

by all the wireless enthusiasts of Little Puddleton, which means practically the entire male population of the town.

An Accident

Giving up our chairs politely to the newcomers, Poddleby, Bumpleby Brown and I seated ourselves on top of the piano. By a stroke of ill luck we failed to notice that the lid thing was open, and Bumpleby Brown fell in. I begged him to stay where he was for a moment, and to open the proceedings with a harp solo on the strings; but the fellow refused, demanding instant rescue. Being unsuccessful in our efforts to haul him out through the top we removed the bottom panel, and by strenuous foot-work from above pushed him out below the keyboard. Owing to Bumpleby Brown's struggles Professor Goop is now, I believe, the first person in the world to possess a wireless piano. Part of the company distributed itself upon the floor; others occupied tables, the coalscuttle, the mantelpiece and the book-shelves. Four enterprising souls bore in a step-ladder, placing themselves in cascade upon its rungs.

The Repast

Of the set and its performances I shall not speak in detail now; that must come later. It will suffice to say that we had a wonderful evening, in the course of which the Professor scored a notable triumph. It was nearly midnight when the demonstration came to an end. " And now, my friends," said the Professor, " I am sure that you must be hungry, and I insist that you stay to supper with me. I must say that I did not expect so many guests; in fact, the cold meal that has been prepared is for two only. However, we will forage in the larder and see what we can do." Bumpleby Brown, General Blood Thunderby, Poddleby and myself were told off as foragers. The larder appeared to contain all the ingredients necessary for quite a satisfactory supper. There was a ham, there were a dozen eggs. These Poddleby, unfortunately, made into an omelet by slipping on the backstairs, up which he was bearing them to the dining-room. There was also a complete leg of mutton and three loaves of bread. The General, having been appointed cook, proceeded to cut both ham and mutton into slices, in order to produce, with the aid of a frying-pan, what he assured us was a delicious Indian dish. Meantime, I cut up the three loaves and spread upon the slices the pound of butter that I had found upon a shelf. I do not think that General Blood Thunderby would earn a large salary as a chef; still, we were all very hungry, and we kept him slicing and frying away until nothing was left but bones. The supper was on the whole an immense success, and everyone told the Professor that it had been a wonderful evening.

Light Fare

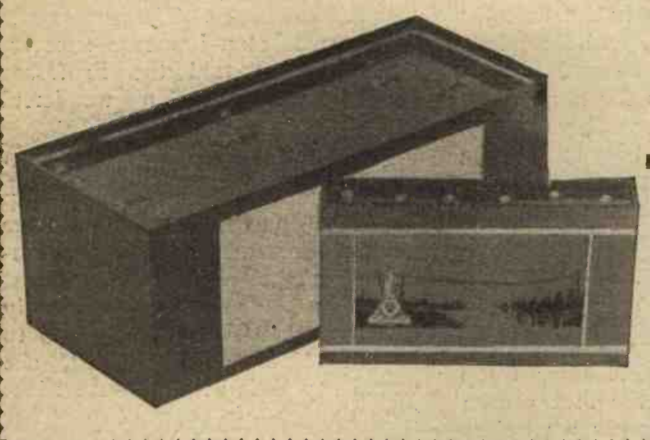
Next morning I met Mrs. Goop in the High Street coming from church. Instead of her usual beaming smile she gave me the curtest of nods accompanied by a perfectly frozen stare. When I hastened to inquire what had happened, she would say little at first, but at last the dammed-up torrent of her speech poured forth. Did I realise that yesterday was Saturday? I did. And that to-day was Sunday? Certainly. Had it occurred to me that I and my low friends had eaten or thrown about the staircase the breakfast, the dinner, the tea and the supper of the entire Goop household? Would I have liked to have breakfasted off coffee and sardines with no bread? Would I care to

. . . *Gave me the curtest of nods* . . .

be going home to a luncheon off Brussels sprouts and water? And so on and so on. It was, you will admit, a most awkward position, especially as I recollected that upon the previous day the Professor had asked me to lunch with him on the Sunday, so that we might talk over the results of the demonstration. As my wife and family were away, I knew that nothing awaited me at home. The situation was saved by my catching sight of General Blood Thunderby, up to whom I rushed with my tale of woe. By working upon his finer feelings I secured an invitation to lunch with him, not only for myself but also for the Goop family. No one could accommodate the whole family for supper, but they were billeted out singly that evening upon various members of the club. On the whole, I think that I will not trust Poddleby with any further confidences.

WIRELESS WAYFARER.

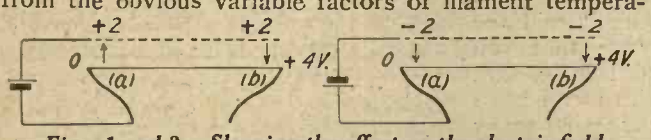
Grid Bias—Its Necessity and Application



For the efficient operation of a valve receiver, it is essential that the correct potentials be applied to the electrodes of the valves. Readers will find much useful information in the accompanying notes on the various methods of applying the required potentials to the grid.

IT is sometimes found that commercial sets compare unfavourably with those constructed by the amateur, and the reason for this may be found in the fact that, in an endeavour to reduce the multiplicity of controls, due provision is not made for varying factors, which have a marked bearing on successful reception. In this connection one particular aspect has been here singled out for further explanation, so that experimenters who do not labour under the obligation of reducing controls may provide themselves with a means of conveniently varying grid bias.

With so many different makes of valves on the market it is difficult to design a set which will function equally well with the same connections, so that apart from the obvious variable factors of filament temperature and anode voltage, provision should be made for adjusting the grid voltage.



Figs. 1 and 2.—Showing the effect on the electric field between grid and filament of the voltage drop across the filament, with positive and negative bias applied to the grid.

Necessity for Grid Bias

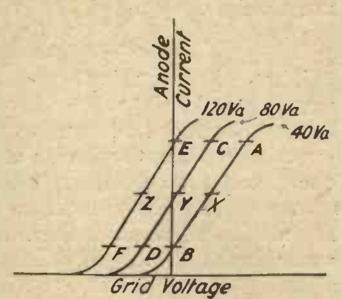
As a result of a number of tests on broadcast receiving sets the writer is led to the conclusion that many experimenters have only a vague idea of the real function of grid bias; so for the benefit of those readers who are a little in doubt let us very briefly review the facts of the case.

The operating characteristic of a three-electrode thermionic valve is the relation between the anode current and the grid voltage relative to the negative end of the filament. This end of the filament is always called the "zero point," and it is from here that we reckon positive or negative grid potential. This is present day accepted practice, and is probably due to the fact that this end of the filament is the point of lowest potential in the filament-anode circuit.

Effect of Filament Potential

It is interesting at this juncture to examine the effect of the fall in volts across the filament itself. Assuming, for purposes of discussion, that there is a 4-volt potential drop along the filament, and neglecting, for the moment, the effect of the anode voltage, we see from Fig. 1 that if the grid is made 2 volts positive along its whole length, with reference to the negative end of the filament, at the end (*a*) of the filament there is a 2-volt field producing upward attraction on the electrons (filament horizontal), while at (*b*) the filament end is 2 volts above the grid potential, hence there is a 2-volt field producing downward attraction on the electrons. At the middle point of the filament

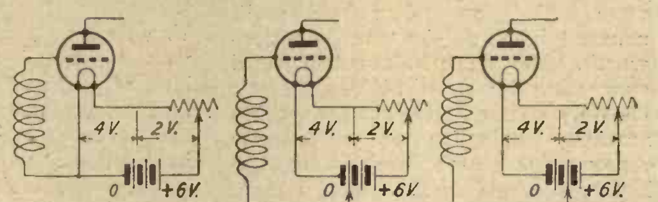
Fig. 3.—For distortionless L.F. amplification, a characteristic such as that marked EF should be used, the working point being Z.



there is zero attraction, since the grid and this point are at the same potential. Thus we have a varying electric field of attraction and repulsion between the grid and filament throughout the lengths of these two electrodes.

Addition of Grid Bias

On the other hand, if the grid is given a conventional 2-volts negative bias with reference to the zero point (*a*), the field is wholly repulsive, being 2 volts at (*a*) and 6 volts at (*b*) (see Fig. 2), so that if the velocity of the electrons should be of such a magnitude as to cause a grid current to flow under these conditions, it



Figs. 4, 5 and 6.—Showing the conditions for zero, 2 volts positive and 4 volts positive grid potential.

would do so across the field of lowest value, *i.e.*, between (*a*) and the grid.

Distribution of Potential

The points just enumerated are often lost sight of when considering the action of the valve, and in order to overcome the effect of this fall of voltage across the filament, it would be necessary to raise the filament to incandescence by some other external means, and make this electrode in the form of a plate, similar to the anode, but smaller in diameter.

In spite of this, however, it is clear that electrons will reach the anode when a certain anode voltage is applied, but the electron stream through the grid mesh is not uniformly distributed throughout the length of the grid electrode, more electrons passing through one end than the other.

Further Considerations

If we examine some typical valve characteristic curves, such as the three examples shown in Fig. 3, it is clear that if we require the variations of current in the anode circuit to be proportional to the signal-voltage variations applied to the grid from the aerial, we must work on the steep straight portions of the curves, *i.e.*, between A and B, C and D, E and F. Now in order to take the fullest advantage of the valve, the grid voltage should be such as to allow normal working to take place half way up the curve, indicated by X, Y, Z.

Correcting Distortion

Assuming that the variation in voltage applied to the grid is not sufficient to bring the representative point into the top and bottom bends of the characteristic, it would appear immaterial whether the working point was X, Y, or Z. However, if a positive voltage is applied to the grid, a grid current will flow, and energy is consequently expended without necessarily doing use-

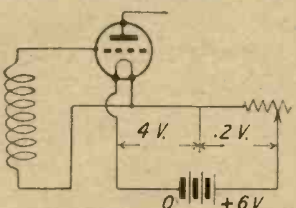


Fig. 7.—Variations in the filament resistance will change the positive potential applied to the grid.

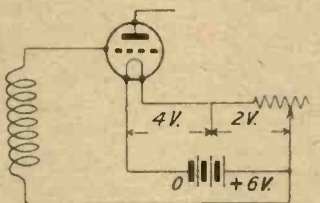


Fig. 8.—Here a 6-volt positive potential is applied to the grid.

ful work. In addition, this effect is accompanied by distortion of the signals in L.F. working, so that to overcome this defect it will be necessary to apply a small negative voltage to the grid and to increase the anode voltage, so that the working point is now located at Z, on a new characteristic. Grid current will now cease to flow, and an improvement in the audio-frequency amplification will immediately result.

Positive Grid Potentials

Now positive grid potentials find their application in rectifiers when employing grid condenser rectification, especially when using British valves. This is due to the particular form of the grid current—grid voltage characteristic curve. Again, a positive voltage is often found useful in high-frequency amplifiers for stabilising the receiver. This is brought about by causing grid current to flow, and thus introducing a damping effect which will prevent the set from oscillating too readily.

We thus see that we must bear in mind to apply a negative grid bias for low-frequency working, and zero or a positive grid bias in all other cases, with, of course, suitable anode voltages.

Applying Positive Grid Potentials

Figs. 4 to 9 show how the positive bias may be easily applied, while the variation in the resistance of the filament rheostat will naturally give a variation in this voltage in the circuit of Fig. 7.

To secure the best advantage from these methods, it is seen that a 6-volt accumulator is recommended, but care should be exercised to prevent the valve filaments from being overheated through an excess of current. The figures indicate that the valves are functioning with four volts across the filament, thus leaving a further 2-volts fall in potential across the rheostat, but this latter figure is open to alteration, according to the filament rating of the valve employed.

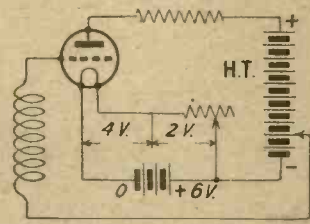


Fig. 9.—This arrangement applies a high positive potential to the grid.

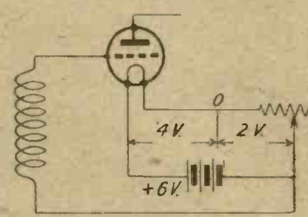


Fig. 10.—Showing how 2 volts negative bias may be applied without a separate grid battery.

Only a coil is shown connected between grid and filament, and in view of the high internal impedance between those two electrodes compared with that of the coil, any pressure utilised in forcing current through this coil will be a negligible factor. With a grid-leak substituted, however, it must be borne in mind that a fair proportion of this available voltage will now be lost in the leak, so that the actual positive voltage of the grid will be considerably reduced. To secure a high positive grid bias, advantage will have to be taken of the high-tension battery, as illustrated in Fig. 9, although this case seldom arises in practice.

Applying Negative Grid Potentials

It will be seen in Fig. 10 that the filament rheostat has now been placed in the negative side of the low-tension battery, thus giving the benefit of a 2-volt negative grid bias, without the addition of grid bias batteries. This value will often have to be exceeded in the last low-frequency stage for power amplification, and recourse may then be had to extra batteries, which, however, need only be dry cells. The connection to give this large negative grid potential is indicated in Fig. 11.

Reference to Fig. 12 brings us to an interesting method for obtaining negative grid bias. Between the negative of the low-tension battery, and the negative of the high-tension battery is located a high-resistance potentiometer. Since an electron current is flowing through the anode circuit of the valve and through the valve itself from H.T. positive to H.T. negative, it

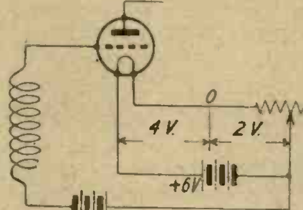


Fig. 11.—The usual method of applying a high negative potential to the grid.

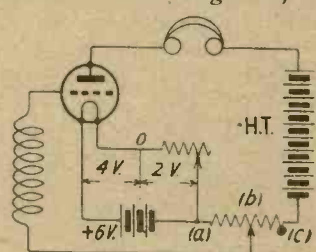


Fig. 12. — An alternative method, which makes use of the voltage drop across a resistance placed in the negative H.T. lead.

follows that the point (*a*) must be at a higher potential than (*b*) or (*c*); but (*a*) is already at −2 volts with reference to the zero point of the filament, and thus the point (*b*), which is the movable connection of the potentiometer, can be moved to the right or left so as to give a variable negative bias to the grid of the valve.

Random Technicalities

By Percy W. Harris, M.I.R.E., Assistant Editor

I HAVE just added to my laboratory equipment a new instrument which enables me to plot the grid volts-anode current characteristics of a valve very rapidly and easily. It has connected to it an accumulator which can be rapidly adjusted to 2, 4 or 6 volts, a high-tension battery up to 120 volts, and a 20-volt high-tension accumulator, tapped in the centre, so that any grid voltage up to 10, positive or negative, can be applied to the grid of the valve to be tested. There are grid and filament voltmeters, filament ammeter, anode milliammeter, and anode voltmeter, while a filament resistance of the dual type, and a potentiometer, control the filament current and grid voltage respectively. The valve socket is of the ordinary British type, but I have an attachment which enables me to test valves on American bases.

A Useful Instrument

While there is not a single measurement possible with this instrument that I was not able to make before, yet the combination of all the facilities in one piece of apparatus is a great advantage, and it has led me to perform many experiments which, to be quite frank, I would not have troubled to perform before. It is so refreshingly easy to run through one's stock of valves, to check up their emission, compare their characteristics, and see how they stood up to hard work. For example, quite recently I picked out of my collection some dull emitter valves which have been in use for well over two years. So far as I can remember I bought a batch of half a dozen, three going to one of my relations and two to another. In the case of the three, they were given almost continuous use for a long period, and went temporarily out of commission when, one night, the set caught fire (I think a short across the high-tension battery must have been the cause). When the trouble was discovered in the middle of the night, half the cabinet was burnt away, and some of the parts were red hot. I have seen a mess made of my set designs, but never anything to equal the condition of that "All Concert" receiver when I saw it next! The valves were handed to me "in case they might be of any use," and it was only after obtaining the new instrument that I thought I would try them again, to see just how they had stood up to the ordeal of fire.

The artistes about to enter the aeroplane at Croydon on the recent occasion when a programme was successfully broadcast from the air.

Long Life of Filaments

You can guess my surprise when I found they were just as good as they ever were, and in fact are considerably better than many valves now sold. They are now working merrily again, and I shall not be surprised if they last another year.

Two others have also lasted very well, and in fact have outlived a number of other valves used with them. Probably one of the reasons for their long life is that they are 2-volt valves, used with a 2-volt accumulator, and for this reason cannot be accidentally overrun.

Filament Emission

Among my stock of .06 ampere valves I found one which gives a most astonishing fluctuation of anode current, which shows itself as a continuous flickering of the anode milliammeter needle. Two 0.25 ampere valves of the same make, which I thought were fairly well matched, showed an enormous variation in their emission, one having twice the emission of the other. Other valves showed quite considerable variations between specimens of the same type, whilst French dull emitters showed practically no emission until the filament voltage was brought practically up to 4, although according to the makers' indications, 3 volts was the correct figure.

The .06 Ampere Valve

One or two dull emitters had entirely lost their emission, although

(*Continued on page* 337.)

60,000 KILOCYCLE TRANSMISSION AND RECEPTION

By R. E. KOLO, U8CAU.

This article, by the operator of an American amateur transmitting station, gives interesting practical details of the construction and operation of a transmitter and receiver for 60,000 kilocycles (5 metres).

TRANSMISSION and reception at 60,000 kc. (five metres) have been greatly limited, because of the difficulty of securing the proper circuit relations. The troubles encountered in adjusting very small capacities and inductances are such as to discourage experiment on this frequency. While it is possible to use standard circuits on 60,000 kc., it is very difficult, in most cases, to maintain steady oscillations. It is, however, useless to go into the numerous difficulties that arise in experimental work along such lines, for the object of this article is to describe and illustrate a circuit and set in which but little trouble was experienced in obtaining the required frequency.

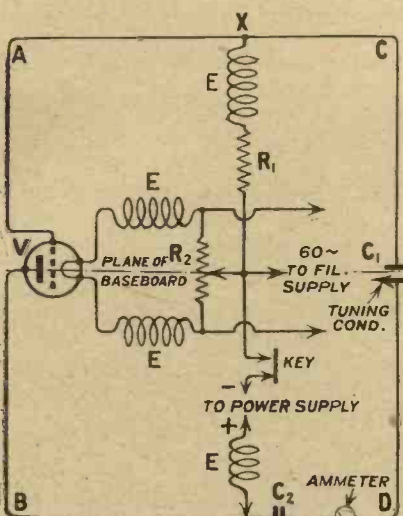


Fig. 1.—The circuit may be set up so that the sides AC and BD of the loop are symmetrically arranged above and below the baseboard of the transmitter.

The circuit is essentially a series circuit, for all condensers and inductances are in series with the valve capacity. This reduces critical adjustments to a very helpful extent. The wiring of the circuit is the inductance and, in one case, also the loop aerial.

Circuit Arrangement

The theoretical diagrams illustrate the circuit far better than a lengthy discussion, so reference will be made according to the lettering of the drawings. The oscillatory circuit ABCD is made in the form of a loop, as shown in Fig. 1. The size of this loop will vary according to the use for which the oscillator is intended. For a loop transmitter the inductance, that is, the wiring, should be as large as possible. Where the circuit is coupled to some sort of radiating system it is not so important that the loop be large. On a fifty-watt set the loop was rectangular in shape and made of ¼-in. copper tubing. The sides AXC and BYD were 30 in. long, and sides AB and CD 18 in. long. The loop of a five-watt set was 16½ by 13½ in. Of course, these sizes can be changed to suit any conditions, provided the condenser capacity C1 is varied accordingly.

The Condensers

Almost any sort of small variable condenser will do for C1 so long as the capacity is somewhere near that of the valve V. Two plates widely spaced in an ordinary receiving condenser will serve the purpose very nicely. Alternatively mount two small sheets of brass or copper on insulating supports, so that one plate is movable. The condenser C1 in the fifty-watt set was made of two copper sheet plates 2 in. in diameter, supported on glass rods. A separation of 2½ to 3½ in. was necessary to cover the range of 62,500 to 50,000 kc. (4.8 to 6 metres). For the five-watt set an ordinary condenser was reduced to two plates, separated by ½ in.

Position of Loop

The side AC of the loop is made horizontal or vertical in accordance with the plans as to the method of transmitting. A Hertzian oscillator placed parallel to AC should fundamentally be vertical. However, a horizontal mounting is far easier to support. The better arrangement of the two remains to be determined.

Choke Coils

The choke coils E are most necessary and should be placed in the

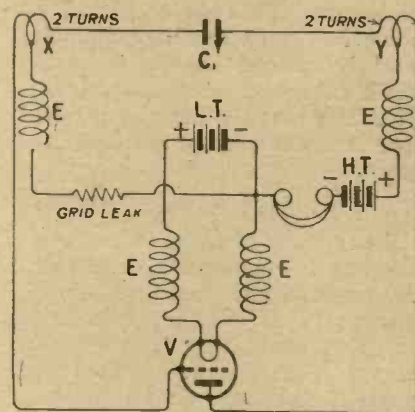


Fig. 2.—With slight modifications the circuit of the transmitter may be used for reception.

circuit as shown. The portion of the circuit included between the points X and Y is not part of the radio-frequency circuit, and care should be taken that it be isolated by means of the chokes. The coils were wound with 25 turns of No. 24-gauge d.c.c., basket-weave fashion, on a ¾-in. mean diameter former. This makes a convenient self-supporting coil.

Other Components

The resistance R1 is an ordinary grid leak. The usual transmitting leak of 5,000 ohms was used in both sets. The resistance R2 is for the purpose of getting a centre tap to the filament with the A.C. supply used. Twenty ohms tapped in the middle is sufficient. The stopping condenser C2 is to protect the tube in case of failure of C1. A .002 μF 6,000-volt condenser was used for the fifty- and a .002 μF condenser for the five-watt set. The radio-frequency indicating device may be an ammeter or a flashlight bulb. The voltage and current will vary in value from point to point throughout the circuit, so that the ammeter or bulb must be located near a point of maximum current in order to be of use. The correct position will be near the voltage nodes, which can be found at the points X and Y. The meter could

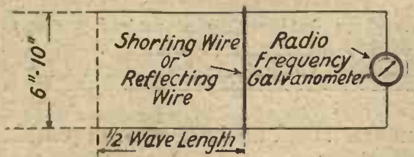


Fig. 3.—The arrangement of the Lecher wires for calibrating the transmitter is shown here.

be placed near either point, but in order that the side VAXCC1 be continuous it is best placed as shown. A very sensitive ammeter could be placed anywhere in the circuit except at V and C1, but it is obvious that the most convenient place is at the current anti-node, as shown.

The Receiver

The receiver uses the same circuit with but few changes. The stopping condenser C2 can be removed, since the H.T. battery voltage is not great enough to flash over in the valve, as in the case of the transmitter, should C1 be shorted. A grid leak of about two megohms is substituted in place of R1. The sides VXC1 and VYC1 are made of two turns of heavy wire or tubing. The choke coils are the same as those used in the transmitter. It is possible to make one set do for both transmitter and receiver. In fact, the five-watt transmitter was used as a receiver with no changes except the placing of lower voltages, 'phones and a receiving valve in the circuit. The construction is so very simple that the illustrations give sufficient information for anyone.

Valves

The selection of the valves to be used is largely dependent upon "local" conditions. A hard valve will work best. Slightly soft valves suitable for 15,000 kc. (20-metre) work will not function at 60,000 kc. The five-watt valves worked very well and no trouble was experienced in any of the five tried. The fifty-watters presented a few difficulties—gaseous valves, faulty internal construction, etc.—but it was possible to put two of them in parallel and operate them. When the valves were finally made to oscillate, perfectly steady operation followed.

Adjustments

Oscillation in the receiver is controlled by the grid leak only, but, if desired, a potentiometer could be placed in the circuit. It is advisable to use a vernier dial on the receiving condenser. The receiver needs no critical adjustments, the connections being made as shown in the wiring diagram.

Location of Power Supply Leads

The only adjustment on the transmitter is the locating of the voltage nodes, X and Y. The easiest way is to vary the leads until maximum current is indicated in the ammeter. Maximum efficiency is obtained when the power leads (the leads included between X and Y) are at zero potential with respect to radio-frequency. It should be possible to touch the loop at these points without affecting the oscillator. So it is important that these points be properly located. The radio-frequency chokes should be given close attention, and put in the circuit at the *points shown.*

Range Obtained

The fifty-watt set was coupled to an aerial having a fundamental near 1,200 kc. (250 metres). With about 1.5 amps. in the oscillator, .3 amp. was pushed into this big aerial. The maximum range during local tests was five miles. In this set the receiver was used without aerial or earth. Tests are now going on to determine the best manner in which to work the set. Three methods are in use, namely, a loop transmitter, coupling to a very large aerial, and coupling to a "Hertzian" oscillator.

Measuring the Voltage Wave

The method of calibration is somewhat different from the usual one employed, and it is illustrated in Fig. 3. Two "Lecher" wires are stretched parallel and a galvanometer or thermocouple placed across their ends. A shorting plate or wire is moved along the system until a maximum deflection is noted on the meter. The distance between two such points represents half a wave-length. The method is extremely accurate, and is so sensitive that a movement of two or three centimetres of the shorting or reflecting wire will change the meter deflection more than 50 per cent. of the scale reading.

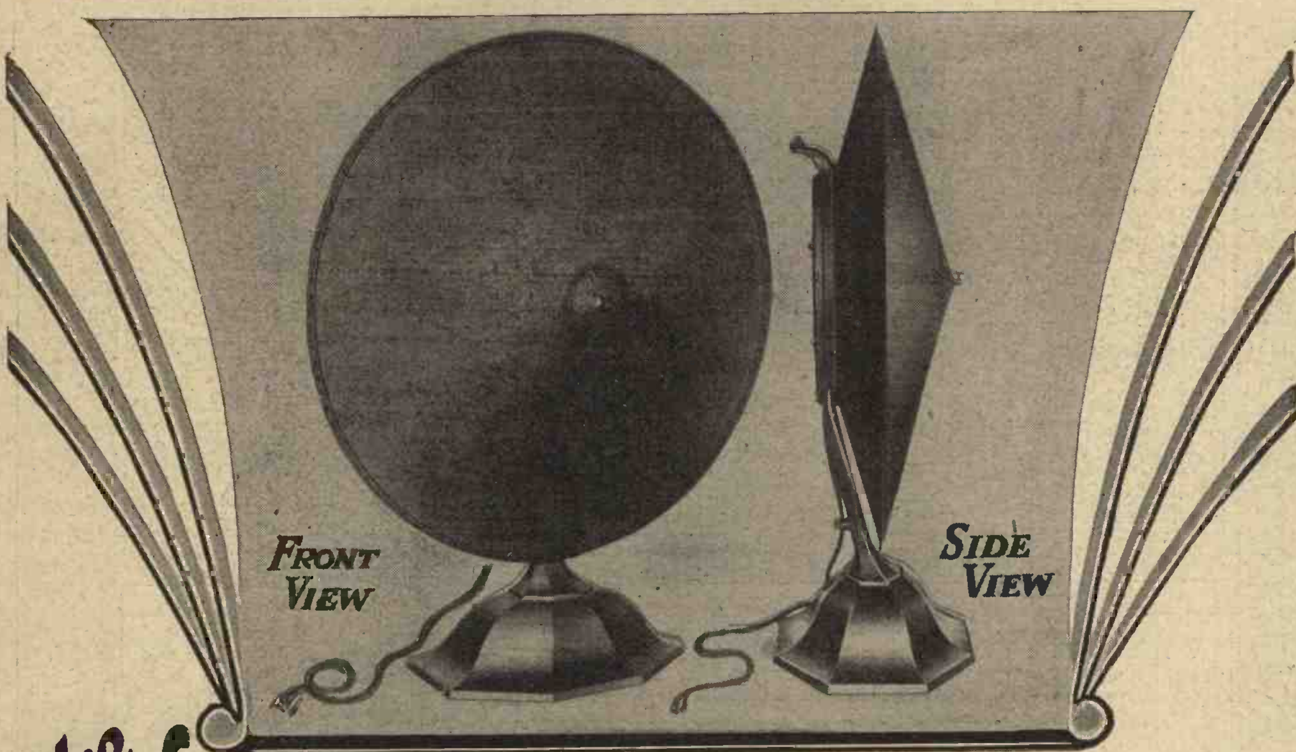
Resonance Indications

The oscillator is coupled to the "Lecher" wires at the meter end by bringing the side AC near to them. It is not advisable to couple too closely, since the interaction between the wires and the transmitter may change the frequency. If sufficient power is used, it is possible to use a flashlight bulb in place of the meter. The receiver, with the valve in, but the filament not lighted, was used as a wave-meter. To find the frequency it was only necessary to bring the wave-meter near the transmitter and note the sharp drop in the circuit current of the transmitter.

The illustrations and diagrams will convey the simplicity of 60,000 kc. (five-metre) work and perhaps encourage some experiment in a more determined manner in the near future.

Taping the ends of the inductance windings at the Post Office Wireless Station at Hillmorton.

The rejuvenation of wireless!



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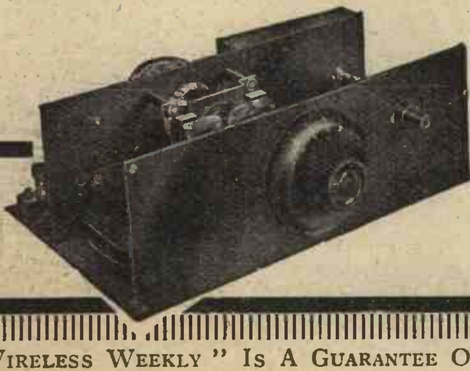

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Wireless News in Brief.

B.B.C. "Round-Europe" Tests. The third official "Round-Europe" test on November 13 was of short duration, but the results were encouraging. Four stations were tuned in successfully, these being Hilversum, Radio-Paris, Brussels and Munster.

* * *

On the following evening Captain Eckersley spoke from the Brussels station, his speech being picked up and re-broadcast successfully in this country. A few words were lost, due to fading and some periods of spark interference, but, regarded as a whole, the experiment was successful.

* * *

Wireless Telegraphy on Aircraft. Owing to the increase of air traffic, it is being found that the one frequency of 337 kc. (900 metres) allotted for wireless communication between aircraft and land stations is inadequate. The situation bids fair to become far more acute when, as has been proposed, air passengers are allowed to send private messages whilst travelling. As a partial solution to the traffic problem, a scheme is to be tried out shortly in which an operator will be carried on the larger machines to handle all the traffic, which will consist of telegraphy instead of telephony. It is also probable that a band of higher frequencies (lower wavelengths) will be sought as a solution to the problem, since it will then be possible to work with greater freedom from jamming within a given waveband.

* * *

Broadcasting from the Air. The recent experiment by the British Broadcasting Company of broadcasting music by members of the Savoy Band while travelling in an aeroplane provided widespread interest. There was a certain amount of engine noise, but results were otherwise fairly good. The aeroplane cruised in the neighbourhood of Croydon Aerodrome during the transmission, the concert being picked up at Keston and thence relayed by land-line to London and re-transmitted.

* * *

The new switchboard which has been installed at the headquarters of the B.B.C. at 2, Savoy Hill, W.C.2, to control the new system of simultaneous transmission, is now complete and is undergoing final tests. It will be recalled that under the new system all the Northern stations will be linked up by land-line with Leeds instead of direct with London, and it is expected that transmission to distant stations will thereby be improved.

* * *

Wireless in India. Experiments have been in progress for some time at the Colombo station, where up-to-date C.W. plant is in use, to decide whether it is possible to establish regular direct wireless communication with Perth, in Western Australia. Communication has been established with ease, and the experiments are being continued to ascertain whether regular communication at all times is possible. It is expected that this will prove to be the case.

* * *

The Colombo station will also commence broadcasting later on, using a frequency of 375 kc. (800 metres), and should be audible not only throughout Ceylon, but also over a large portion of Southern India.

* * *

We are informed that an Englishman staying in Jodhpur, in Central India, while experimenting on a long-range six-valve set, picked up on 350 metres or thereabouts a concert in full swing from 10.30 p.m. (Indian time) to close upon 1 o'clock. It was evidently a European station. He was listening to broadcasting between 5.30 and 8 p.m. (European time). He heard solos, duets, and music, both instrumental and vocal, at very good strength, but, strange to say, on no occasion was a call sign announcement heard. Between October 24 and 31 there have been many such reports received in Bombay. There is some idea that it was an Italian station which was heard.

* * *

High-Power Broadcasting Stations. One of the American stations most frequently received in this country, WGY, Schenectady, New York, has increased its power to fifty kilowatts, and extensive tests are being conducted. Another fifty kilowatt station is in course of erection at Boundbrook, New Jersey, the call sign of this station being WJZ. The frequency to be used is 659 kc. (455 metres).

* * *

Two other stations which will outpower Daventry, 5XX, are those of Germany, at Koenigswusterhausen, and at Hergostrand, Bavaria. The first of these is designed to work with fifty kilowatts, and the second with not less than one hundred.

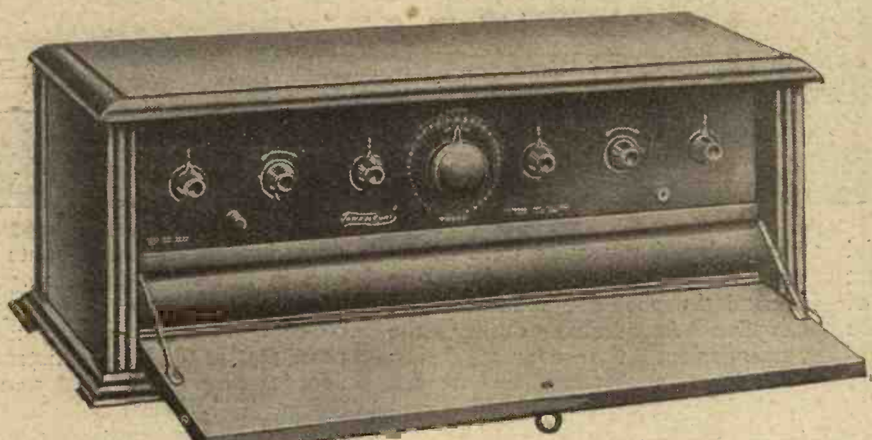
* * *

Exhibition at Olympia. The wireless apparatus shown by the Marconi International Marine Communication Co., Ltd., at the Shipping, Engineering and Machinery Exhibition, Olympia, includes eight pieces of apparatus for a variety of purposes, namely, to provide communications at sea, to increase the safety of life, to assist navigation, and to provide entertainment on board ship.

American Radio Sets from

By PERCY W. HARRIS, M

While much has been writ methods of high-frequency c details of American wireles little attention has been dir view. Ultimately this has of design. The article whi this week will be found to st direct



An American six-valve receiver with a single tuning control—the Thermodyne.

I HAVE in front of me, as I write, a copy of an American publication dated November, 1922, which was published at a time when American radio manufacturers were becoming worried as to the effect of the constantly increasing number of broadcasting stations on the design of radio receivers.

The Armstrong Circuit

A glance through the advertisements of wireless sets shows that the majority of instruments incorporated what was called the Armstrong regenerative circuit—a practical interpretation of this being a grid circuit variably coupled to an aerial, tuning of this grid circuit being effected by means of either a variometer or a condenser shunted across the coupling inductance. In the plate circuit of the valve was a variometer of sufficient size to tune the anode circuit to the same wavelength as the grid circuit.

Skilful Handling Needed

Owing to the fact that the grid circuit was loosely coupled to the aerial, the damping of this latter was not impressed too strongly upon the grid, and, as a consequence, when both anode and grid circuits were in tune, self-oscillation occurred. By detuning the anode circuit, a point could be reached where oscillation ceased, and on this "fringe" a maximum regenerative action without self-oscillation was introduced. Such a circuit in skilled hands (for it must be remembered that aerial, grid and plate circuits all had to be adjusted) was capable of giving extraordinarily good results, both in regard to sensitivity and selectivity.

Many Controls

Fully conscious of his lack of skill, the average broadcast listener in those days fought shy of what were known as "Three-Circuit Regenerative Receivers," and contented himself with a single-valve reaction circuit, or, in those cases where it was possible, a crystal receiver. Receivers were still in the "knobby" stage, with all kinds of knobs, dials, switch points, indicators, and a wealth of panel engraving. Long-distance reception was a feat of skill, and extreme ranges were only obtained at the expense of tonal quality, for to get them it was necessary to work the valves very close to the oscillation point. A similar state of affairs

A cabinet form of the Zenith Receiver.

A very popular three-dial receiver—the Fada Neutrodyne.

the User's Point of View

.R.E., Assistant Editor.

en on American circuits, upling and other technical receivers, comparatively ted to the user's point of nuch to do with the trend ch Mr. Harris has written imulate thought in several ions.

exists in many British receivers to-day.

Variometer Anode Tuning

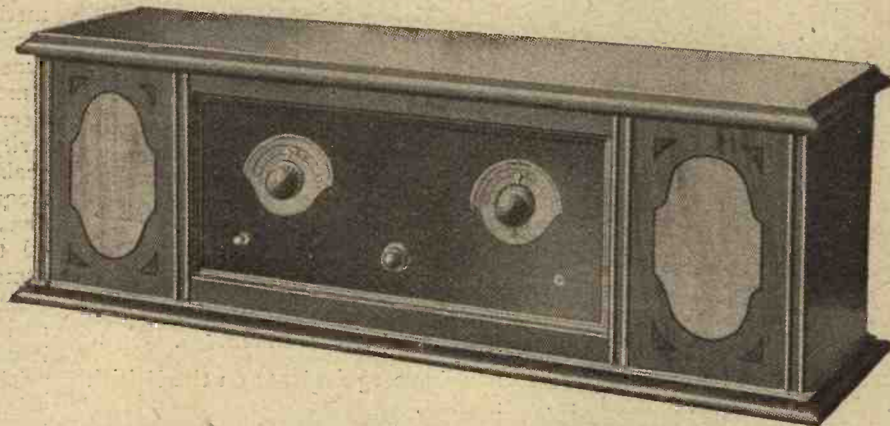
It is not always realised to what an extent the American had developed the single-valve reaction circuit at this time. Loose-coupling was the rule in all good receivers, and no one expected to get a fine control of reaction with an accompanying maximum of amplification with a direct-coupled circuit. The variometer tuning of the anode circuit gave an extremely delicate

A handsome single tuning control set—the Kolster.

build up of reaction effect, and in a number of the best designs it was quite impossible to find the exact point at which the set went into oscillation, save by the distortion of signals which occurred.

Tuned H.F. Stages

In England we were beginning to make use of tuned anode circuits at this time, obtaining considerable improvement in the range of our receivers thereby. American experimenters found that the introduction of a stage of tuned radio-frequency in front of a detector prevented them from making full use of the regenerative effect of their detector



The "All-American," a five-valve U.S.A. product, with two tuning controls.

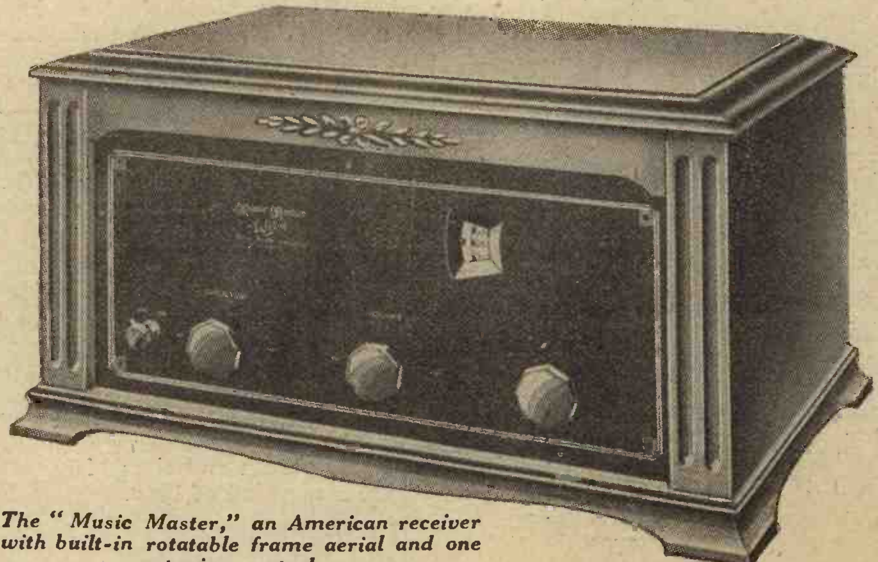
valves, and many opinions were published to the effect that radio-frequency amplification did not increase the range of a set for this reason.

Stable H.F. Amplification

Nevertheless, numerous experiments were being carried out to find some means of obtaining stable radio-frequency amplification, and for a time a considerable popularity was gained by iron core radio-frequency transformers—instruments which never obtained any hold in this country. While very slight amplifications were obtained, such transformers had the advantage that they were sufficiently broadly tuned to enable reception to be carried out over a wide band of frequencies. Stability was also gained quite easily. Quite a number of commercial receivers were built, containing these semi-aperiodic iron-cored radio-frequency transformers, and the unskilled user in the United States was able to buy a receiver which gave him moderately good long-distance effects without skilful handling.

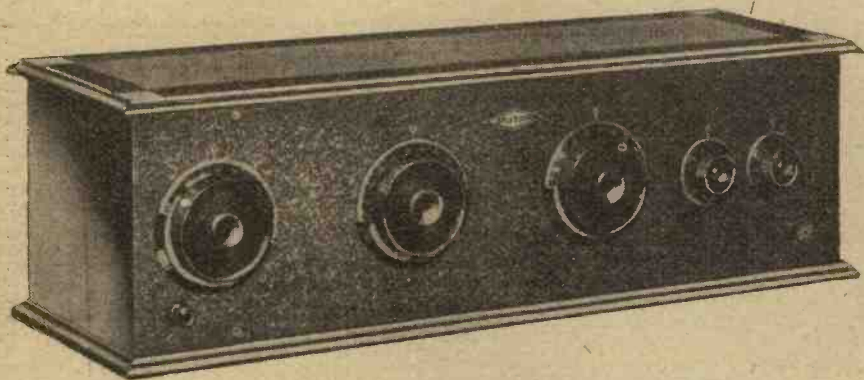
Neutrodyne Receivers

The next big step forward was the development of the neutrodyne receiver, by the use of which it was



The "Music Master," an American receiver with built-in rotatable frame aerial and one tuning control.

found possible to build tuned radio-frequency amplifiers in which stability was obtained without any loss of sensitivity. Two stages of neutralised high-frequency preceded a non-regenerative detector valve, and were found to give just as good results as the best adjusted regenerative detector valve. This meant, put in another way, that a three-valve set on the neutrodyne principle would give in unskilled hands just as good results as a single-valve detector in the hands of an expert.



The "Splitdorf," a five-valve, three-dial receiver of sound design.

Long Distance Reception

As remarkably long ranges could be obtained with a properly handled single-valve regenerative receiver, and as, furthermore, the quality obtainable with a neutrodyne receiver (owing to the fact that it was not worked near the edge of oscillation) was distinctly superior to that obtained with a regenerative detector on the edge of oscillation, the art could be said to have developed up to the point when the ordinary user could obtain a set capable of long-distance reception with headphones, with three valves, or on a loud-speaker with five. Three tuning controls were necessary on such instruments, one for the first grid circuit (the aerial circuit was made semi-aperiodic), one for the second grid circuit, and a third for the detector valve grid circuit.

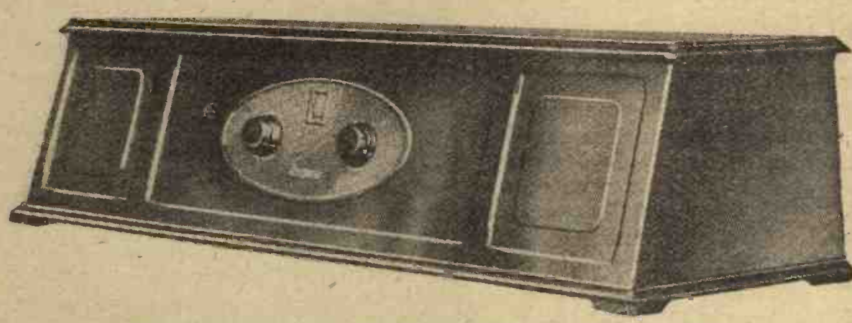
Simplifying Controls

All three dials could be made to read to approximately the same figure for the same frequency. Station hunting was thus brought down to a very simple procedure. Attempts which were made to combine all three dials by means of pulley gears, or other similar arrangements, did not prove very successful, however, as it was not found practicable to match all three circuits perfectly. At this stage of progress bright emitter valves were rapidly passing out, and all the new receivers were designed to take either the .06 ampere type of valve or the 0.25 ampere small power-valve, of both of which types we now have equivalents on the British market.

American Valves

All commercial neutrodyne receivers are designed for particular kinds of valves, and are balanced at the factory. In America the 0.25 ampere type of valve has a different base from that used on a .06 ampere type, so that it is impossible to interchange them. All commercial receivers in the States are designed for one or the other kind of valve and the position is quite different from that in this country, where we have all kinds, shapes and sizes of valve on the same kind of base.

One central dial controls this set—the "Murad."



A distinctive and very simply operated set—the "Ferguson."

Low-loss Features

Accompanying this article are a number of illustrations showing well-known American receivers in their present form. The success which attended the neutrodyne receiver drew the attention of Radio Manufacturers to the advantages of tuned radio-frequency amplification of a stable kind, and before long many methods were found of obtaining stability without necessarily using the Haseltine pattern. The method of obtaining stability by introducing losses into one of the tuned circuits is now dead in America, for the "Losser" method decreases both sensitivity and selectivity to an extent not generally realised in this country. Radio-frequency transformers and condensers are carefully designed to be of the low-loss variety, and the utmost care is taken to reduce capacity coupling between primary and secondary transformers to the lowest practical limit. It is surprising how great an increase in selectivity can be obtained by looking after the question of capacity coupling between two windings of a radio-frequency transformer.

Double Range Tuning

I have already described in these pages the Grebe synchrophase receiver, as an instrument representative of the best modern American practice in radio-frequency design. In the latest model, just placed on the market, two important improvements have been introduced. The dials are to be brought up to the 180 degree mark, start again at zero, and run through a further range of frequencies. On passing the 180 degree mark a switch is operated to bring into action a different winding. The second big improvement is the linking of the three dials so that single-control operation is now possible.

Filament Resistances

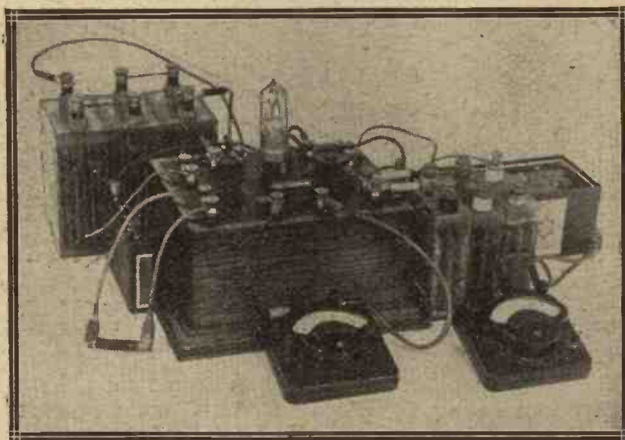
In all recent American receivers the practice of fitting separate filament resistances for each valve has been abandoned; in fact, switching of all kinds has been reduced to

(Continued on page 341.)

The Measurement of High Resistances

By C. P. ALLINSON (6YF).

Describing a simple method of measuring the resistance value of such components as grid-leaks without the use of elaborate instruments.



The calibrated grid-leak is shown in the clips on the left. The accumulator in the background should preferably be an 8-volt one.

MOST of us have wondered at some time or another exactly what resistance grid-leak we were using, especially in cases where a variable leak was being used, and it was found that its value in a particular circuit was somewhat critical for maximum signal strength.

The method evolved by the writer is suitable for measuring grid-leaks between .25 and about 10 megohms with a fair degree of accuracy. The extreme values should be within 10 per cent., and values between 1 and 6 megohms may be within 2 or 3 per cent.

Instruments Required

The only special instruments required are an accurate voltmeter, which must be a high-resistance instrument, a milliammeter (this need not actually be calibrated exactly, a home-made instrument with an approximate range of 0 to 3 or 4 milliamps. being suitable), and one calibrated grid-leak of, say, 2 megohms resistance.

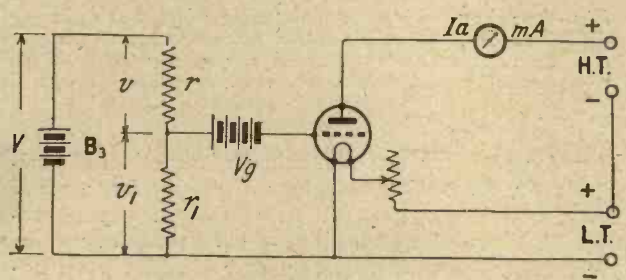


Fig. 1.—In this circuit r is a known resistance and r_1 is the unknown to be measured.

The theoretical circuit showing the method of measurement employed is given in Fig. 1. In this the known grid-leak is shown at "r," the unknown one being connected in series with it across a battery having a voltage V.

Theoretical Determination

A current I will flow in the circuit, and if "v" be the voltage drop across "r" and "v_1" the drop across "r_1" (which is the unknown resistance), then

$$v = Ir \quad \ldots\ldots (1)$$

$$\text{and } v_1 = Ir_1 \quad \ldots\ldots (2)$$

$$\text{dividing } \frac{v}{v_1} = \frac{r}{r_1}$$

$$\text{therefore } r_1 = \frac{r\,v_1}{v}$$

$$\text{but } \quad v = V - v_1 \text{ (since } V = v + v_1\text{)}$$

$$\text{so that } r_1 = \frac{r\,v_1}{V - v_1} \quad \ldots\ldots (3)$$

High-resistance Voltmeter

We know r and we can measure V, so that it only remains to find some method of measuring v_1 to be able to solve the equation so as to obtain the value of the unknown grid-leak (r_1). Now to measure the voltage drop across a high resistance requires a voltmeter itself having a resistance many times that to be measured, and the wireless amateur has an easy solution in the shape of a valve. With this he can not only measure a voltage, but he can do so accurately, owing to the amplification given by the valve.

In order, however, that the valve shall have a really high resistance or impedance, it should be used with a negative grid bias. Further, if this is not done and the grid becomes positive, grid current will flow, and thus introduce a source of error.

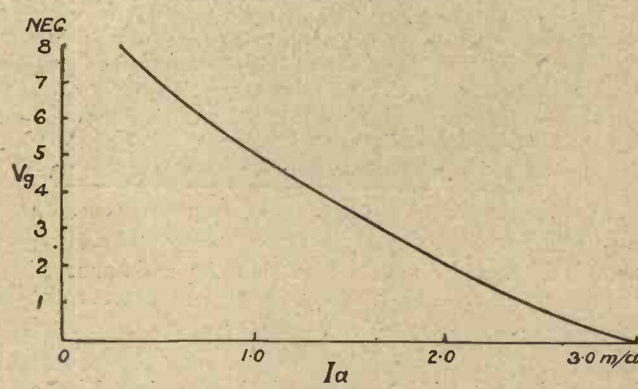


Fig. 2.—The curve obtained by plotting grid volts against anode current.

Circuit of Measuring Set

The theoretical scheme of connections used is shown in Fig. 1. Vg may be a grid battery of 6 to 8 volts, while the source of potential across the two resistances can be a 6-volt battery (B_3). If, now, we have a curve showing grid volts against plate current, we are in a position to determine the voltage drop "v_1" across

r_1. As B3 is connected so that its positive pole goes toward the grid through the resistance r, and we always work with an initial large negative bias on the grid, it follows that when V is put into circuit the plate current will rise, and the bigger the resistance of r_1 the greater will v_1 be, and as this will be + ve, the greater will the plate current be. We can thus draw a curve calibrating the plate current directly against the resistance of r_1 for any given value of r.

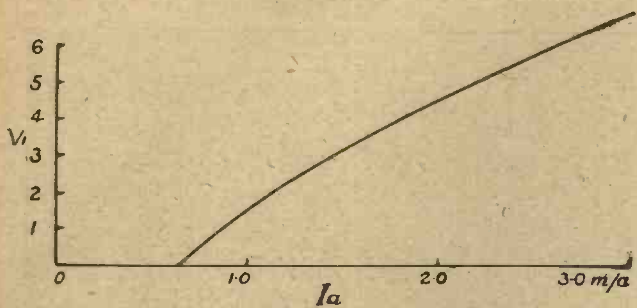


Fig. 3.—The curve of Fig. 2 reversed, so that v_1 can be read off direct for different values of anode current.

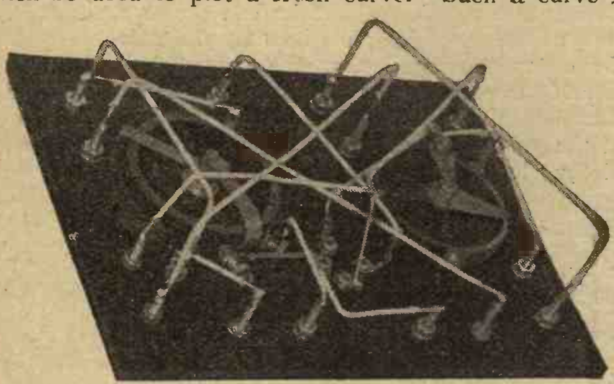
Data for Plotting Curves

To do this we solve

$$r_1 = \frac{r\ v_1}{V - v_1}$$

for various values of v_1, which we assume conveniently according to our Vg/Ia curve. (Fig. 2.)

We obtain different values of r_1 corresponding to various values of v_1. Now from Fig. 3 we can read off the plate current Ia for these varying values of v_1, and so we shall now have a set of readings for Ia corresponding to various values of r_1. These can then be used to plot a fresh curve. Such a curve is shown in Fig. 4, by means of which the resistance of the leak can be read off directly when the plate current Ia is known.



The arrangement of the wiring of the instrument can be clearly seen in this photograph.

An Example

Let us illustrate this by a practical example. Fig. 2 shows a Vg/Ia curve obtained with a given plate voltage up to a maximum negative grid bias of 8 volts. Actually it is intended to work from 6 volts. Let us reverse this curve as in Fig. 3 (taking −6 volts as our zero), so that the plate current reading will give us v_1 direct; for if we start with an initial negative bias of 6 volts which is then opposed by a voltage of 1.5 (*i.e.*, v_1) across the resistance r_1, then the plate current reading will give us a grid voltage of −4.5 from the Fig. 2 curve. This has now to be subtracted from 6 to give us v_1. Thus, by reversing the curve, this will be read off direct.

Constants Necessary

Suppose we have a calibrated grid-leak, the value of which is 2.1 megohms, and that we use a battery (for B3) of exactly 6 volts. Then :—

$$r_1 = \frac{2.1\ v_1}{6 - v_1}$$

So that, by assuming different values for v_1, we get different values for r_1. If $v_1=2$, then $r_1=1.05$; but when $v_1=2$, we find from Fig. 3 that Ia=1.22, and so we plot $r_1=1.05$, Ia=1.22 on a fresh curve. When $v_1=3$, then $r_1=2.1$ and Ia=1.5, and we get another point. We finally obtain the curve shown in Fig. 4.

It should be remembered, however, that this curve holds good only for one particular value each for plate voltage, filament voltage, grid voltage, supply voltage (B3), and known leak resistance. These, however, are easily kept constant.

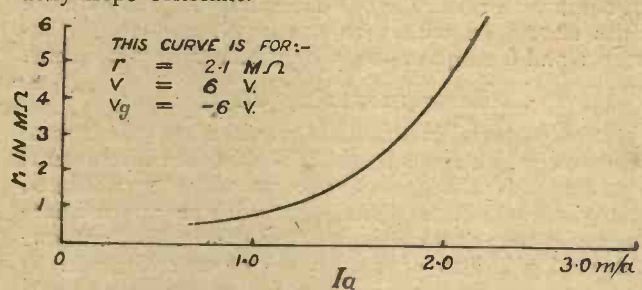


Fig. 4.—From this curve, actually plotted for the values shown, the value of the unknown resistance can be read off, according to the anode current reading recorded by the milliammeter.

The Test Panel

In order to carry out a number of practical experiments in the measuring of values of grid-leaks, a small test panel was constructed, as shown in the photograph. This is built on a piece of ebonite, 8 in. x 6 in. x ¼ in., and consists merely of a valve holder, potentiometer, and a filament resistance. Various terminals are provided for connecting the necessary batteries and meters, while two grid-leak clips allow a calibrated leak to be slipped into position when taking readings. The circuit diagram of this panel is shown in Fig. 5.

Use of Potentiometer

The reason for placing a potentiometer as shown in the grid circuit, instead of connecting the grid battery direct, is that it gives us a means of adjusting the grid potential to the exact value with which we wish to work.

An 8-volt accumulator might be used with this, but a voltmeter might actually show it to be only 7.8 volts, and therefore if we assumed in the first place that its value was actually 8 volts, a considerable error would be introduced.

The first point to decide is what grid bias we are going to use. This should be greater, of course, than the voltage of the battery providing the source of potential across the resistances. If, therefore, we use a 6-volt battery for B3, the grid battery should be a nominal 8 volts. We can then, by means of the potentiometer, apply exactly 6 or 7 volts to the grid of the valve, the actual value used by the writer being 6 volts.

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The Wuncell Dull Emitter

Voltage 1·8 volts. Consumption ·3 amp.
*W1 for Detector and L.F. 14/-
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5/6, 9/- and 13/6 each.

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Plotting the First Curve

Having decided this point, the next thing is to obtain the Vg/Ia curve. To do this, connect the two terminals T1, T2 together, the H.T. and L.T. batteries to the valve, and an 8-volt battery to the terminals G.B. + and G.B. –. A high-resistance voltmeter is connected across the two terminals Grid V, and a milliammeter across the two terminals provided. This gives us the circuit shown in Fig. 6. A curve may now be plotted showing the variations of anode current against grid voltage. A curve of this description is that shown in Fig. 2.

Having done this, carefully set the grid voltage at the particular value from which it is determined to work, which we will assume is exactly 6 volts negative. Make a careful note of the anode current flowing, and of the anode voltage, so that the conditions obtaining may be exactly duplicated at any future date, when it is desired to take another reading. (Note that it is preferable that the valves be left switched on with the H.T. battery connected for about a quarter of an hour before starting to take any readings, so that the whole arrangement may settle down.)

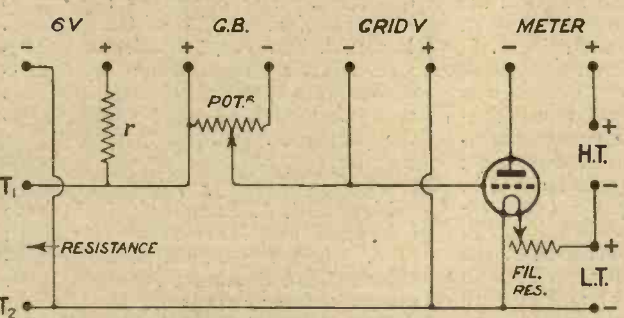


Fig. 5.—The circuit diagram of the test panel, showing how the external apparatus is connected.

The Next Operation

Now reverse the grid volt-anode current curve, taking the point which corresponds to the 6-volt negative as the new zero point; then the –5 point will become +1, –4 = +2, and so on. This will give us the Fig. 3 curve, and will enable us to read the voltage v_1 across the unknown resistance, r_1, directly from the value of plate current given by the milliammeter in the plate circuit.

Obtaining the Result

Now connect a 6-volt battery across the two terminals marked. The voltage of this should be accurately measured, as it will give the value of V in our equation. Next connect the grid-leak to be measured across the two terminals T1 and T2, and read the plate current. Suppose this is 1.8 milliamps., on consulting the curve (Fig. 3), we can obtain from this the voltage v_1 across the resistance r_1, which in this case is equivalent to 3.1 volts. We now have the following known quantities in our equation :—

$$r_1 = \frac{r\ v_1}{V - v_1} \quad \ldots \quad (3)$$

v = 6 volts

v_1 = 3.1 volts

r = 2.1 megohms.

It can therefore be solved to give us r_1. An alternative method is that previously mentioned, namely, to assume various values for v_1, and plot the Fig. 4 curve. It is then a simple matter, on obtaining plate current readings, to determine the value of the grid-leak which is being measured.

Good Insulation Essential

Care must be taken in the construction of the test panel, needless to say, to see that the insulation of all grid connections and terminals or clips to which the grid-leaks are attached is of a very high order, otherwise errors will be introduced into the readings.

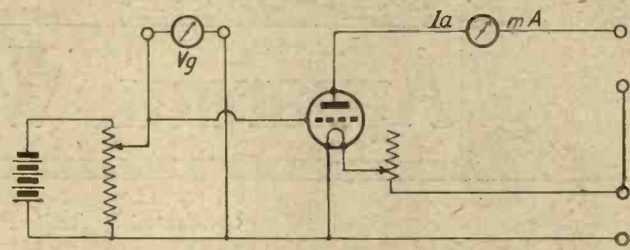
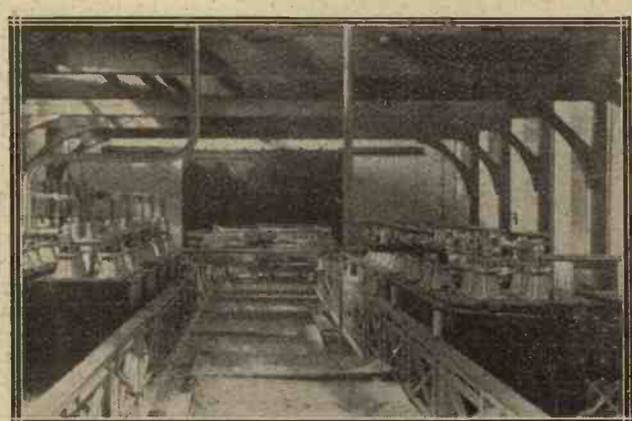


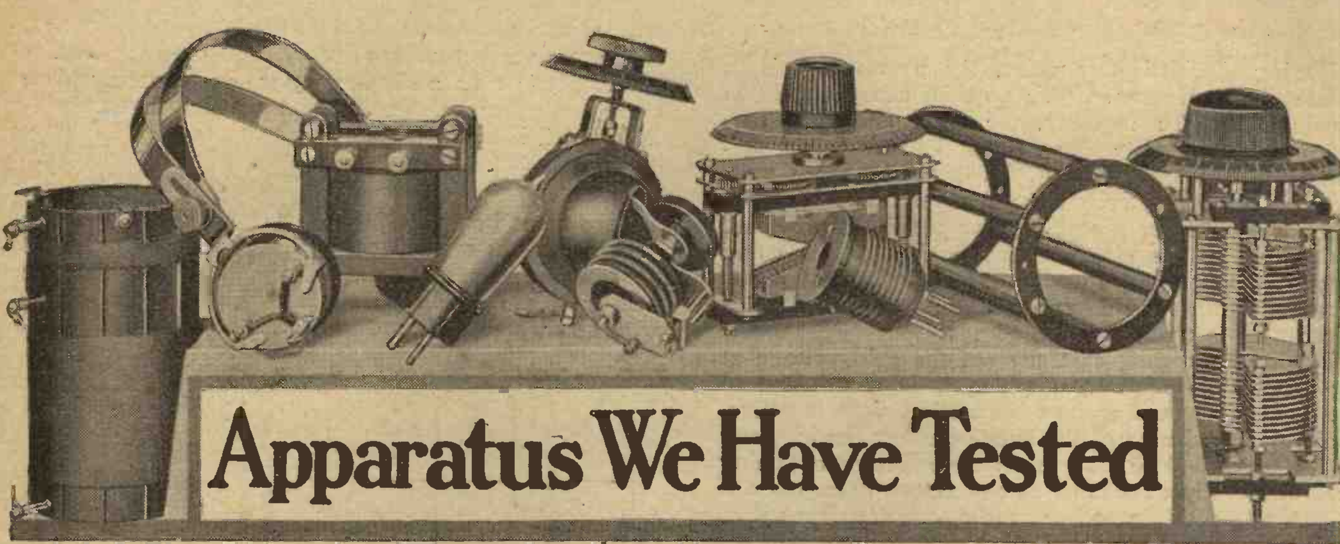
Fig. 6.—The preliminary circuit arrangement for obtaining the grid volts-anode current curve (Fig. 1).

The test panel described was checked upon a number of calibrated grid-leaks which the writer had in his possession, and it was found that readings could be obtained of quite a fair order of accuracy, especially in view of the high resistance values being measured. With different values of leaks for the known resistance r, a greater range of unknown resistances can be measured. If it is desired to measure anode resistances of the order of 100,000 ohms, the known resistance should have a value approximating to this, which will enable readings to be obtained fairly accurately between 20,000 and 500,000 ohms.

As a matter of interest a number of grid-leaks were tested on this panel, and the difference between their true and their nominal resistances was somewhat surprising, especially among the lower values, such as .25 and .5 MΩ. Variations of over 80 per cent. were noted in many cases, and not more than half-a-dozen out of about thirty were within 10 per cent. of their rated values.



A view in the Hillmorton wireless station, showing the banks of condensers. Note the thickness of the pair of conductors in the foreground.



Apparatus We Have Tested

Conducted by Radio Press Laboratories, Elstree.

Filament Rheostat for Dull Emitter Valves

Messrs. Lamplugh, Ltd., have submitted to us for test a filament rheostat designed for dull emitter valves.

It is claimed that as this rheostat, which is of 30 ohms resistance, is fitted with a special buffer contact, smooth and silent working is assured. Strong terminals and good winding are provided, together with a highly polished knob to match the Lamplugh dial.

Description of Component. — The resistance element of this rheostat is of wire, and is wound on a fibre former. This former consists of a strip $\frac{5}{8}$ in. in width and $\frac{1}{8}$ in. in thickness, bent in a circular form $1\frac{3}{4}$ in. in diameter. The terminals, which are fairly large and have milled heads, are mounted on the ends of the strip and are thus fairly close together. The shanks of these terminals carry soldering tags, and are provided with screw heads, and they are securely fixed with the aid of round nuts. The latter also serve to fix the fibre strip to the framework of the rheostat. This framework is roughly triangular in shape, its base being a chord of the circle formed by the fibre former, while its apex expands into a small disc which carries the spindle of the rheostat. The spindle in turn carries the knob and contact arm. The latter bears upon the inside of the resistance winding, and is of rather a novel type. It consists of a short, thick brass rod about $\frac{1}{2}$ in. long, with a cap, also of brass, which slides on the rod like a sleeve. A spring is contained in the hollow of the cap and presses the latter against the resistance winding. The brass rod screws at right angles to the spindle and is further secured by a lock-nut. The upper end of the spindle screws into a brass nut embedded in the black moulded material of the knob. A stout pointer fits on the spindle, so that when the knob is screwed up it is held fast between the knob and a collar on the spindle. The collar presses hard against the top of the screwed sleeve provided for one-hole fixing. This pressure is imposed by a spring washer on the spindle between the frame of the rheostat and that end of the contact arm which screws on to the spindle.

Laboratory Tests.

The resistance of the rheostat was found to be nearly 40 ohms, and is considerably higher than the rated resistance of 30 ohms. Connected in a set it was found to be easy and silent in operation, and was capable of carrying .25 amp. without undue heating, which is enough for four valves of the dull emitter .06 class, for which it is intended. All connections and moving parts were found to be in good condition, and not readily susceptible to mechanical damage. The soldering tags are in such a position that there is no fear of damaging the rheostat through applying the soldering iron carelessly.

This rheostat has a well-finished appearance, and is mechanically sound, and fulfils the maker's claim except for its high resistance value.

Fixed Condenser

Messrs. Ward & Goldstone have submitted to us for test a fixed condenser of rated capacity .001 μF.

Description of Component.—This condenser consists of a case of black insulating material $2\frac{1}{4}$ in. long by 1 in. wide, the base being sealed off by means of a black waxy material. Two nickel-plated terminals are provided, together with washers on top of the condensers. The terminal shanks are fitted to the case of the condenser by small nuts. At each end of the condenser a shoulder projects, through which a $\frac{1}{8}$-in. hole is drilled, and this enables the condenser to be fixed to the panel or baseboard as required.

Laboratory Tests.

On test, the rated capacity of the condenser was found to be correct, *i.e.*, .001 μF, while its insulation resistance was infinite. In order to test the effect of exposure, the condenser was left in damp grass for two days. The capacity was not found to have altered, and the insulation resistance had not decreased. The condenser appears to be mechanically and electrically sound. It would, however, be desirable to provide soldering tags, while if the condenser were stamped with the maker's name it would be some guarantee to the purchaser.

Engraved Dial

Messrs. S. A. Lamplugh, Ltd., have submitted to us for test their Lamplugh Dial. The large knurled flange provides a fine adjustment for condensers, variometers or reaction control.

Description of Component.—The dial is made from well-polished hard black insulating material. It is 3 in. in diameter and its rim, which is bevelled, is graduated for 180 degrees. The knob is much larger than usual, being nearly two-thirds of the diameter of the dial. It is milled and slightly tapered, so as to form an easy grip for the fingers, and is also slightly concave, which seems to improve its appearance. From the underside it can be seen that the knob is really hollow, while in the centre is a pillar in which a very thick 2 B.A. brass nut is embedded. This is intended to screw on to the condenser shaft. The makers also supply dials with a 3/16-in. plain shaft hole and grub screw.

Laboratory Tests.

On test, the dial was found to be without wobble, and enabled a fine and positive motion of the moving vanes of the condenser to be obtained. This dial has a well-finished appearance and is mechanically sound.

Seven-Way Leads

A sample of their seven-way Easifix Loom has been submitted to us for test by Messrs. Ward & Goldstone, Ltd.

Description of Component.—These seven-way leads are intended for connecting low-tension, high-tension and grid-bias batteries to sets. In the sample submitted three H.T. leads and two grid-bias leads, as well as a pair of accumulator leads, are provided. We understand, however, that looms are also made containing different numbers of leads. The leads submitted are composed of stranded wire, there being seven strands of No. 32 gauge copper wire for all leads except those for the accumulator, which contain 16 strands of No. 30 gauge wire. All the wires are rubber-covered, and above the rubber is a woven cotton covering of different colours for different leads. At one end of the leads spade terminals are provided, while at the other spade terminals are used only for accumulator connections. The accumulator leads are covered with thick rubber on the outside for ¾ in. to protect the cotton covering from corrosion. Plug-in terminals are provided for both high-tension and grid-bias batteries. These have spring plugs, so that they fit tightly into the battery sockets, and they are coloured red and black to indicate their polarity. The leads are bound together by a black loosely-woven cotton covering in the middle, for a length of about 10 in., and project from this, at the ends remote from the set, to different lengths. Thus the accumulator leads are longest, being 5 ft. 3 in. in length. These are bound together up to a distance of 5 in. from the accumulator terminals. The high-tension leads are shorter, while the grid-bias leads are shortest of all.

Laboratory Tests.

The resistance of the leads was found to be satisfactorily small, being less than 1/30 ohm in each case. The insulation resistance was found to be infinity, and even when the leads were thoroughly wet the insulation resistance did not decrease. All terminals were found to be in good condition, but it would be advantageous if the spade terminals for the accumulator were a little thicker, as this is where corrosion generally sets in. The leads are, of course, quite flexible, and are also mechanically strong.

Experimenters who wish to avoid the unsightly tangle of wires which often mars the otherwise pleasing appearance of a set will probably find that the seven-way Easifix Loom will meet their requirements.

On page 293 of *Wireless Weekly* for November 18, in the last line of column 1, the word "finer" should read "heavier."

Random Technicalities

(Continued from page 326)

the filaments were intact. In these cases I had no trace in my records of their having been mis-handled either by applying excessive filament voltage or an unduly high anode voltage. If one fact more than another stood out in my valve tests, it was that there is a lack of uniformity in the .06 ampere type, and that .06 ampere is a minimum and not a maximum current taken by these valves. In most cases, too, makers' characteristics are "idealised."

Dual Filament Resistances

I wonder why there are so few dual filament resistances on the market which are capable of being used with a 6-volt accumulator and a .06 ampere type of valve. Practically all the dual resistances now sold are made to work with a 4-volt accumulator, which means that special wiring must be introduced into the set if it is desired to use, say, a .06 ampere type of valve in the first socket, and a 0.25 ampere at the audio-frequency end.

Bypass Condensers

As a bypass condenser across the primary of an L.F. transformer, it is customary to use either .001 μF or .002 μF. Lately I have been using .0003 μF for this purpose, and have found that, so far as I can trace, there is no need to use anything bigger. The idea of shunting a fixed condenser across the primary of a transformer never appeals to me, particularly when the transformer has been carefully designed to give the maximum purity of results.

A Good Move

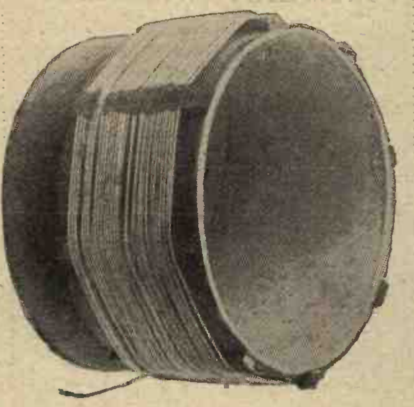
Congratulations to Messrs. Fuller's, makers of the Sparta loud-speaker, upon the way in which they are now marketing their loud-speakers. There has been a convention to make loud-speakers of 4,000 ohms resistance, ignoring the fact that resistance and impedance are not the same, and that, to give the best results, the impedance of the loud-speaker winding must be made to suit the valve with which it is used. Messrs. Fuller's are now selling their loud-speakers with an indication of the type of valve with which they are to be used. There is no attempt to give the loud-speaker an arbitrary resistance of 4,000 ohms. I do not know what the D.C. resistances of these instruments are, and I am not a bit interested in those figures, but I do appreciate the fact that they are matched up with particular valves, a method which should be used with every loud-speaker. Of course, it does not follow that because a loud-speaker is designed to work with certain types of valves it will not give results with other kinds. Many loud-speakers, I am afraid, are not matched with any valves.

Mr. Albert Sammons, the famous violinist, whose playing was broadcast from the London Station recently.

"LOW-LOSS" COILS

SIR,—I have very been very much interested in the series of articles in *Wireless Weekly* on low-loss coils, culminating in the article in the issue for November 11, entitled "Are Long Coils Doomed?" In his article Mr. Reyner gives experimental proof of a theory I put forward before the R.S.G.B. in January, 1924. In this I pointed out that, starting with a coil of 22 S.W.G. d.c.c., if others were wound of decreasing diameters of wire, *but maintaining the same pitch*, viz., $\frac{1}{25}$ in., there would be at first an increase of efficiency up to a certain maximum, after which this would fall off, and I estimate the maximum at about 32 S.W.G.

Hence my particular interest in Mr. Reyner's 3-in. coil of 30 S.W.G. with turns touching, and I think he will get even better results if he spaces the turns.



The special coil with spaced turns submitted by Mr. J. H. Reeves for measurement.

In a subsequent article I showed that, provided the D/l ratio is kept constant, the diameters of coils can be calculated by the formula

$$\frac{D}{D_0} = \left\{\frac{\lambda m d}{\lambda_0 m_0 d_0}\right\}^{\frac{2}{3}}$$

where λ is wavelength, d the diameter of wire used, and the pitch = m times d. Using this, I have estimated that the coil required to be equal to Mr. Reyner's, with pitch 3 diameters of No. 30 S.W.G., requires to be 3¾ in. diameter with 29 turns. I enclose such a coil, with three extra turns thrown in. I think Mr. Reyner will be interested to measure this and report. I have a number of other coils of great interest.—Yours faithfully,

J. H. REEVES.

SIR,—I should like to express my thanks to Mr. J. H. Reeves for sending his coil for measurement. I am at present carrying out further investigations along the lines indicated in my series of articles published already in *Wireless Weekly*, and I shall be pleased to subject Mr. Reeves' coil to test and measurement, with due attention to the special points mentioned in his letter.—Yours faithfully,

J. H. REYNER.

"AN EASILY-CONSTRUCTED TWO-VALVE SET"

SIR,—In *Wireless Weekly* dated September 10, 1924, was described "An Easily Constructed Two-Valve Set," by Stanley G. Rattee, M.I.R.E. I made this set on the lines given.

I am situated about 17 miles from 5SC, and the results which I have received from this circuit may be interesting to you. On one valve I can tune in all the B.B.C. main stations at quite a nice strength, and Glasgow comes in on the loud-speaker. Those signals on one valve are quite strong. On two valves I can put all the stations on the loud-speaker to be heard very well in a room. I have also picked up a great number of European stations.—Yours faithfully,

W. M. FREW.

Larkhall, N.B.

"AN IMPROVED TWO-VALVE RECEIVER"

SIR,—It is perhaps a little late in the day to write you about the excellent set ("An Improved Two-Valve Receiver") described by Stanley G. Rattee, M.I.R.E., in the January issue of *Modern Wireless*.

In my opinion, it is the best two-valve set I have yet seen described in *Modern Wireless*, and I have had every issue since the first.

I am looking forward to a description of the same circuit, with a further stage of L.F. amplification, either resistance coupled or transformer coupled.

In conclusion, a few of the results. Loud-speaker: Bournemouth and Plymouth. 'Phones: Manchester, Newcastle, Glasgow and several Continental stations.

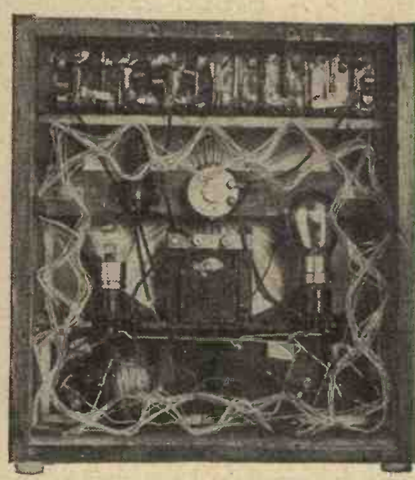
Wishing you every success.—Yours faithfully,

W. GUY.

Paignton.

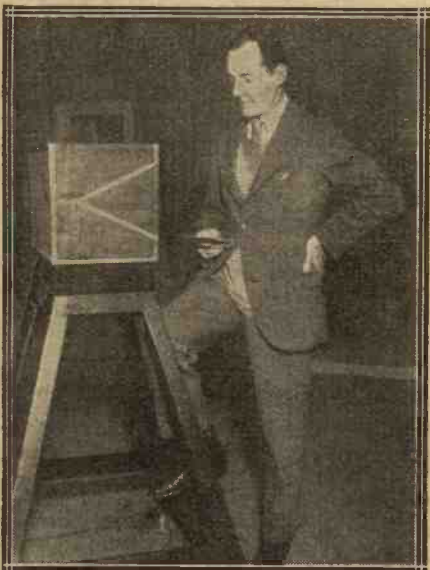
THE "THREE-VALVE DUAL"

SIR,—I feel I must let you know the results I am obtaining with your "Simplified Three-Valve Dual" circuit, described by John Scott-Taggart, F.Inst.P., A.M.I.E.E., in the March, 1925, issue of *Modern Wireless*. I have built the receiver in the American style, with components on a baseboard behind the panel. A fixed resistance of 100,000 ohms has been used, and the grid leak is variable. The first two valves are Mullard .06, and the third is a Mullard D.F.A.o power valve.



A portable receiver employing circuit ST99, built by a North London reader, all accessories, including loud-speaker and loop aerial, being contained within the case.

Five minutes after completion of the wiring Daventry was heard all through the house on a small loud-speaker, and on changing coils and transformer (H.F.) four of the lower wavelength stations were tuned in on the speaker at excellent strength without making use of the telephones., As the Savoy Bands were on at the time, it was not possible to identify these stations, but on the next evening (Sunday, November 8) I gave the receiver a further test, with the result that Manchester (about 70 miles) was loud and clear in the loud-speaker, as were also Birmingham (60 miles) and London 2LO (about 150 miles). Glasgow, Newcastle, Bournemouth, Radio-Paris, Radio Toulouse, Madrid, Barcelona, Munster and several other stations I could not identify were of moderate loud-speaker strength.



Mr. Donald Calthrop, the actor manager, has joined the staff of the B.B.C. He will help in developing the lighter side of the programmes, both dramatic and musical.

The majority of the above stations were clearly heard on an indoor aerial consisting of about 12 ft. of twin flex slung across the room on the ground floor.

The receiver is very selective and as stable as a rock. Considering that these results were all obtained within two days of completing the set, I am greatly looking forward to the results I am confident of getting during the coming winter. I may say that last winter, using the "All Concert" Receiver, described by Percy W. Harris, M.I.R.E., in Radio Press Envelope No. 4, I received several of the American broadcasting stations, some of which confirmed their programmes on request.

Thanking you very much for such a fine circuit as the "Three-Valve Dual," and wishing your publications the success they so richly deserve.—Yours faithfully,

OWEN H. OWEN.

Oswestry.

"TWIN-VALVE" RECEIVER

SIR,—We, the undersigned, having made up the "Twin-Valve" Receiver described by John Scott-Taggart, F.Inst.P., A.M.I.E.E., in Radio Press Envelope No. 10, feel compelled to write offering our best thanks for being enabled to avail ourselves of something well worth having. Both our sets are working large loud-speakers perfectly, one within half a mile of the local station, the other about three miles distant. Daventry high-power station comes in splendidly on the loud-speaker, and Radio-Paris, several other Continental stations and most B.B.C. stations, including some relay stations, at good 'phone strength. We also have no difficulty in tuning Daventry on the speaker and Radio-Paris on the 'phones while the local station is on, the set operating three miles distant without a murmur of the local station, and in the case of the set half a mile distant, the local station *very faint*. Again thanking you.—Yours faithfully,

W. S. W. TUZARD.

Bournemouth.

H. BRIGHTWELL.

Winton.

THE "HARMONY FOUR"

SIR,—You may be interested in the following report of the "Harmony Four" Receiver, described by Mr. Percy W. Harris, M.I.R.E., in the September issue of *Modern Wireless.*

I have to use a transformer in the place of a neutrodyne unit, as this has not arrived yet. Birmingham, 35 miles away, and Manchester, about 60 miles, come in too loud on the loud-speaker. I get Bournemouth, Glasgow, Newcastle, Cardiff at fair loud-speaker strength. Aberdeen comes in at very good 'phone strength. I can get numerous Continental stations. Madrid comes in at very good 'phone to weak loud-speaker strength, and many German stations which I cannot identify are received very loudly. The French stations are not quite so good, except Radio Toulouse, which is the loudest Continental station I get. It comes in well on the loud-speaker.

Daventry comes in at terrific strength, and Radio-Paris comes in very well. I have a very short and screened aerial about 60 ft. long, including lead-in. As I am only thirteen I consider the results very good. I have had four other Radio Press sets, the "Three-Valve Transatlantic" Receiver, the "All-Concert de Luxe" and two crystal sets.

Wishing *Wireless Weekly, Modern Wireless, The Wireless Constructor* and *Wireless* the greatest of success.—Yours faithfully,

Stafford. GEORGE WOOLLEY.

ENVELOPE NO. 2

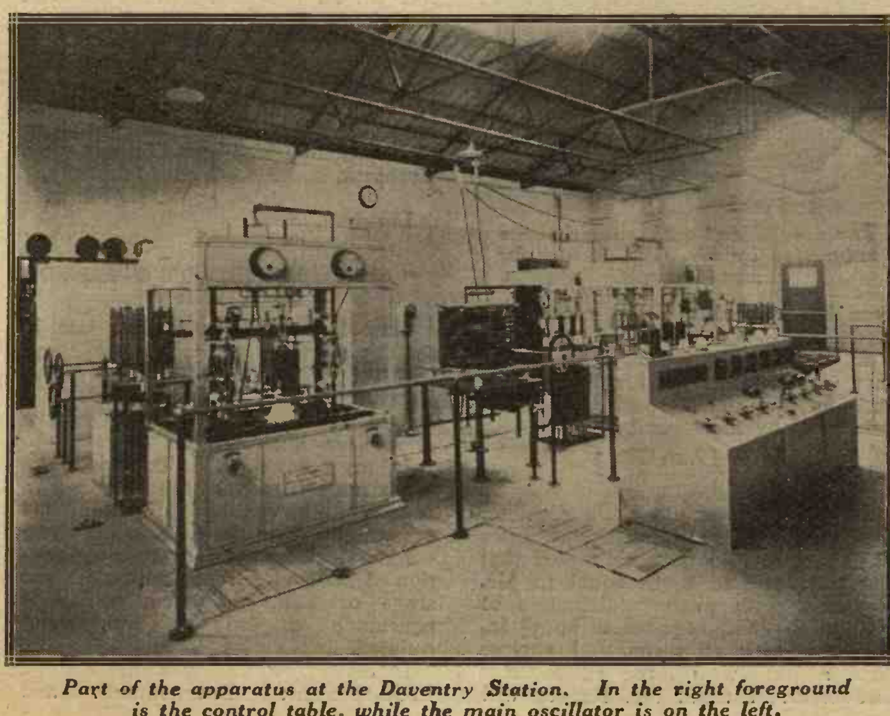
SIR,—Just a line to say how pleased I am with the "Family Four-Valve" Receiver, described by Mr. Percy W. Harris, M.I.R.E., in Radio Press Envelope No. 2. It is really wonderful. The local station, Manchester, five miles away, is cut out at will and might not exist. I have enclosed the set in an oak cabinet, with drawers serving to house everything.

Stations, British and Continental, come in on the loud-speaker with beautiful sweetness and volume. The set was made on the kitchen table, and presents no difficulty to the average constructor.

Wishing your papers every success.—Yours faithfully,

H. W. DOUGHTY.

Stockport.



Part of the apparatus at the Daventry Station. In the right foreground is the control table, while the main oscillator is on the left.

American Radio Sets from the User's Point of View
(*Continued from page 332*)

its lowest proportion. One knob controls the filament current of all the valves, while in most cases one other knob serves as a volume control in which the volume of signals on a loud-speaker is altered without affecting the tuning control. This is generally done by a variable resistance between the grid and the filament of one of the amplifying valves, or else across the primary of one of the intervalve low-frequency transformers.

Single-Control Receivers

This season a number of single-control instruments have been placed on the market, and in some cases dials have been discarded in favour of indicators which are actually engraved either with wavelengths, or frequencies, or with the actual call signs of stations which can be heard. An examination of the interior of the instruments shows that in practically all cases there are three tuned circuits, and by careful balancing and design the three circuits have been so matched as to make possible the gearing of their controls to one knob. In the Zenith receiver, which I have also described recently in these pages, there are two instead of three controls, two of them being linked together by a small belt arrangement. A large number of receivers still retain the three dials, while others have one tuning knob with "verniers," which are used to bring up signals to the best point after a general control of the three circuits has been obtained on the one knob. Single-knob tuners with three verniers are, however, a compromise, and it is doubtful whether they present advantages over the three dials already mentioned.

Current from A.C. Mains

This year, then, American receivers have been brought up to a point where first-class results can be obtained on the day of purchase by the customer who has never previously handled a radio set. In almost all cases American homes are equipped with 110 volts, 50-cycle, alternating current, and this has made possible the commercial success of "feed battery eliminators," or, as we should call them, "high-tension battery eliminators." These can be attached directly to the set and supplied with current from the main. Indeed, there are several receivers in which both high-tension and low-tension supplies are obtainable from the mains, thus dispensing with all battery troubles and their attendant mess and deterioration.

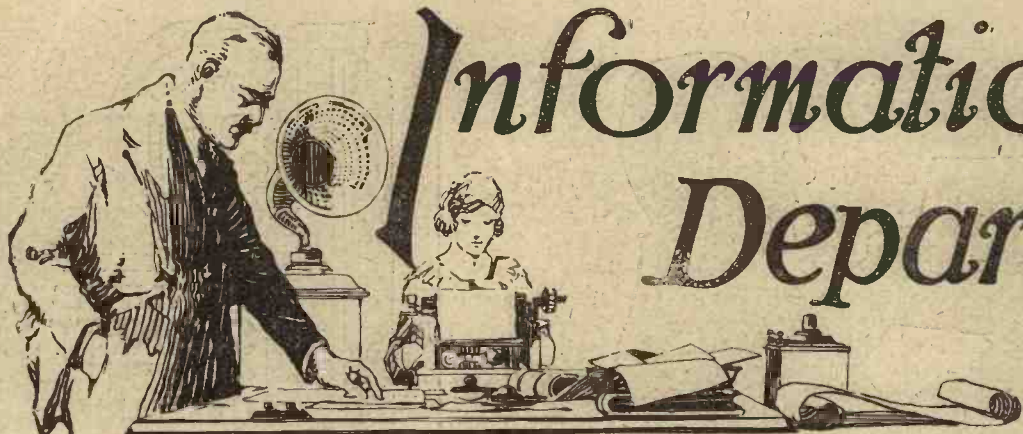
Loud-Speakers

Having obtained sensitivity, selectivity and simplicity of control, the American manufacturer is now turning his attention to the improvement of the audio-frequency side of his apparatus, which, on the whole, is distinctly below the level obtained in this country. Similarly loud-speakers are being improved quite rapidly. The Western Electric Kone, for example, is a loud-speaker of great merit, and is now also manufactured in this country.

No Howling

British manufacturers do not yet realise what an immense fillip will be given to the industry when radio receivers are produced which can be operated at once with full satisfaction by the inexperienced user. None of the American neutralised receivers can be made to radiate, even when very badly handled, and as a consequence our Transatlantic cousins enjoy delightful immunity from squeaks and howls. Practically all our sets radiate badly, and you know the results!

Information Department.

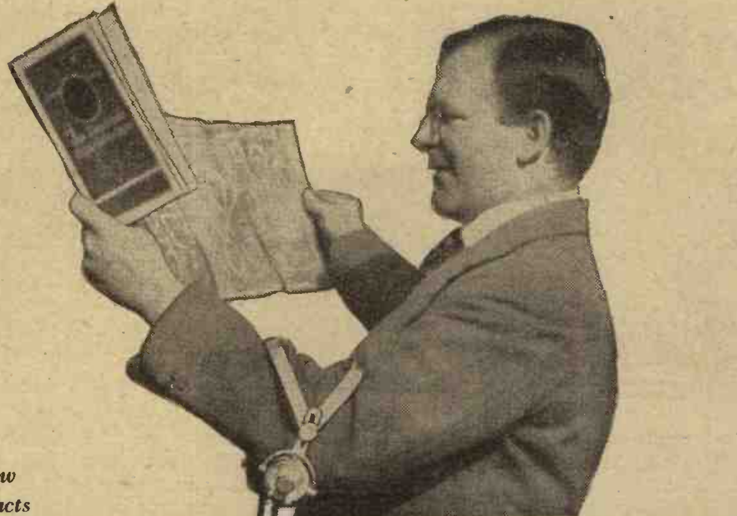


C. B. F. (AMPTHILL) states that when employing a straightforward high-frequency, detector and low-frequency 3-valve receiver he can obtain 5XX at good loud-speaker strength, with a No. 150 coil in the aerial socket, a No. 200 for reaction and a No. 250 for the tuned anode coil. When, however, he inserts a No. 35 coil in the aerial circuit, a No. 50 in the anode and a further No. 50 for reaction, only a jumble of low-frequency C.W. stations can be heard.

From our correspondent's letter it is obvious that the aerial and earth system, the batteries, valves and loud-speaker are not responsible for the fault, and we should, at once, from the symptoms given, suspect the aerial coil, which in our correspondent's case is a No. 35.

The most simple test to see whether this is responsible is to replace it with the No. 50 coil used at present in the reaction socket, whilst shorting this latter socket. Now, with the receiver arranged for series tuning it should be possible to tune in 2LO at quite good telephone strength. By the above test we think it more than likely that our correspondent will locate the cause of trouble to his No. 35 coil, which in all probability has a break in the winding or at the point where the ends of the winding are connected to the plug.

Recourse to the simple telephones and dry cell test will soon show whether our diagnosis is correct. To carry out this test join one tag of a pair of telephones to one side of a small dry battery, such as that used in an ordinary flash lamp, and the free side of the battery to the plug of the coil, whilst tapping the metal of the socket with the free telephone tag. If loud plonks are *not* heard in the telephones, it may be taken that the coil is broken down internally, and it should be removed from the coil block, since faults of this type are usually found where the ends of the coil are soldered to the metal of the plug or socket fittings.



An Interview based on facts

With blue prints like these I couldn't possibly go wrong

YES! That's the great point about the Keystone idea—you need not be an expert wireless man to build a first-class Super Heterodyne. Look at my experience, for instance. I have only made one other Set in my life, yet I built this Keystone 7-Valve Super Heterodyne in my spare hours in less than a week. And the very first time I connected up the batteries the Set worked. Luck? No, not a bit of it!—just common-sense and following the directions in the book.*

Look at these blue prints, for example. See how the exact position of every component is carefully marked. Note that the wiring is shown full size so that a mistake is almost impossible. What's that? Simple wiring—rather. That's because the Keystone Intermediate Transformers contain their own valve holders. The valve is actually plugged into the top of the transformer. This ingenious method eliminates a large number of connections and prevents the possibility of mistakes. So far as I know, no other Intermediate Transformer uses this idea. Then look here, too, at the Oscillator Coupler. Notice how I can vary it and improve my selectivity if I'm troubled with interference at any time. And if I want to go to higher wave-lengths above the ordinary B.B.C. band, I can change the coupler for a larger one. That's a brainy idea, isn't it? The cost? Oh, absurdly low. The biggest item is the kit of transformers and they only amount to £6 : 0 : 0. If you have a good three valve Set you can strip down, it should not cost you more than about £10 in addition. But send for a copy of the Keystone Book. You'll find it set out in detail with full constructional details and diagrams. If you take my advice you'll invest in a Keystone Super Heterodyne—they're just wonderful, a little frame aerial, two condenser dials to control, and you can choose your programme from Aberdeen to Seville.

**He is referring to the Keystone Book—a copy of which will be despatched to any reader sending three penny stamps and this coupon*

PETO-SCOTT CO., LTD.
77 CITY ROAD, E.C.1
BRANCHES; 62 High Holborn, London, W.C.1. Walthamstow; 230 Wood Street. Plymouth; 4 Bank of England Place. Liverpool; 4 Manchester Street.

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The Keystone Super Heterodyne

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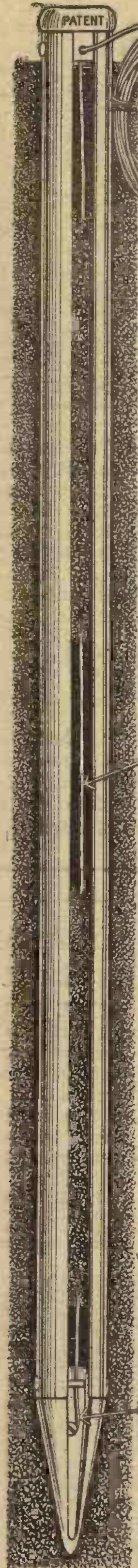

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W. J. (HAVERFORDWEST) has read an article "For best reception watch your meters," and he asks us how to include a volt-meter and a milliammeter in the 8-valve Supersonic-heterodyne receiver described in the September, 1925, issue of "MODERN WIRELESS."

Although suitable meters throw considerable light on the functioning of valve receivers, we do not advise our correspondent to alter the set he mentions in order to place two instruments on the panel. To carry out this project would necessitate considerable alterations in the wiring if useful readings were to be obtained easily.

We would make the suggestion, therefore, that a double range voltmeter be obtained, one reading from 0 to 10 and 0 to 100 volts, for example, and also a milliammeter reading from 0 to 20 milliamperes. These instruments are best used outside the set. A high-resistance voltmeter should be obtained, as otherwise undue strain will be placed upon the batteries, and in the case of the high-tension battery, the current taken may be sufficiently high to cause a drop in the voltage and give inaccurate readings.

If a suitable double range voltmeter is obtained, it may be used to measure the voltage of the low-tension battery, the voltage across the filaments of the valves, by measuring across the filament legs of individual valves, and also the voltage of the grid-bias battery. By measuring between H.T. negative and the five positive tappings to the high-tension battery useful indications may be obtained of the voltages applied to the various valves or groups of valves. By placing the milliammeter between the H.T. negative terminal of the set and that of the high-tension battery, the anode current taken by all the valves may be measured, whilst by connecting the instrument between any high-tension positive terminal and the appropriate point on the H.T. battery the current taken by an individual valve or group of valves may be read.

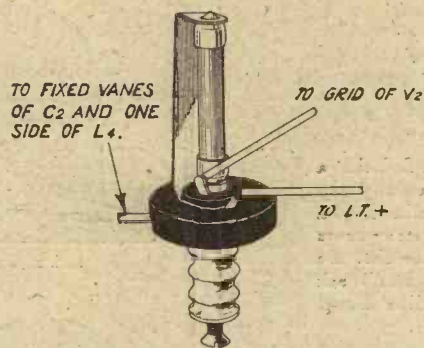

Fig. 1.—Illustrating the correct method of making connections to the Dorwood grid condenser and leak (C. G. V., Chislehurst).

C. G. V. (CHISLEHURST) has constructed the "DX Four" described by Mr. D. J. S. Hartt, B.Sc., in the October, 1925, issue of "MODERN WIRELESS" and can only obtain his local station, 2LO, at fair telephone strength on four valves. He states that he has carefully checked the wiring, but is not quite certain of the connections to the Dorwood grid condenser and grid leak.

The fact that our correspondent states in his letter that his "DX Four" will not oscillate under any conditions, and that only telephone strength is obtained from the local station, at once gives a clue to the fault. It would appear likely that a mistake has been made in wiring the Dorwood grid condenser and leak into circuit.

We give in Fig. 1 a pictorial diagram showing how this unit should be wired. It will be seen that there are two contacts, which go respectively to the grid of V2 and to low-tension positive. If these two connections are accidentally reversed in wiring, it will result in the grid leak being wired in series with the grid, and one side of the grid condenser being wired directly to L.T. positive. This, in practice, will give rise to the symptoms observed by our correspondent. We think, therefore, that if the unit is connected as shown in Fig. 1, the set should function in the normal way.

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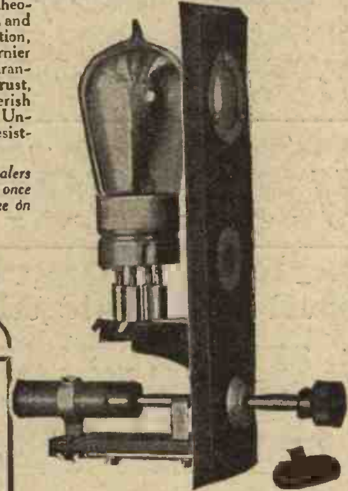

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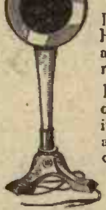

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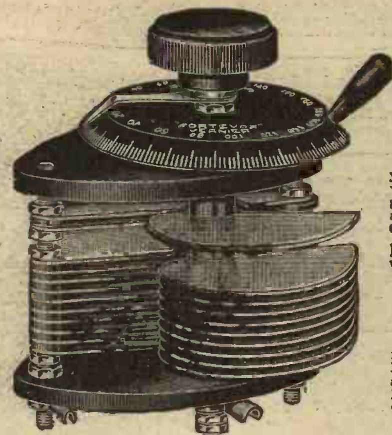

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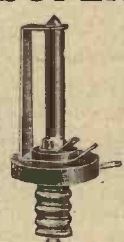

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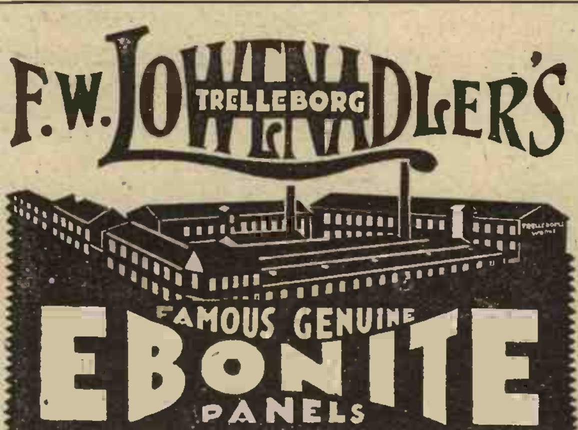

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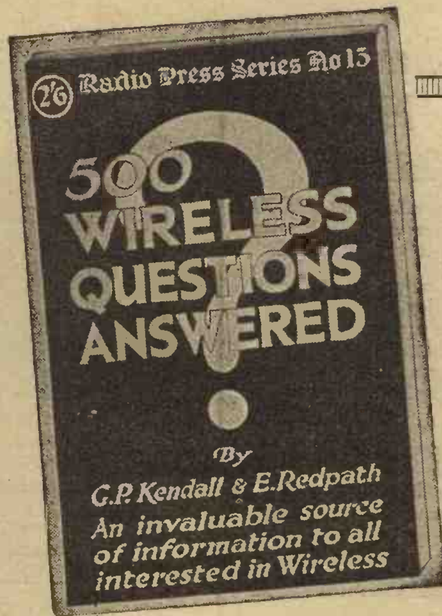

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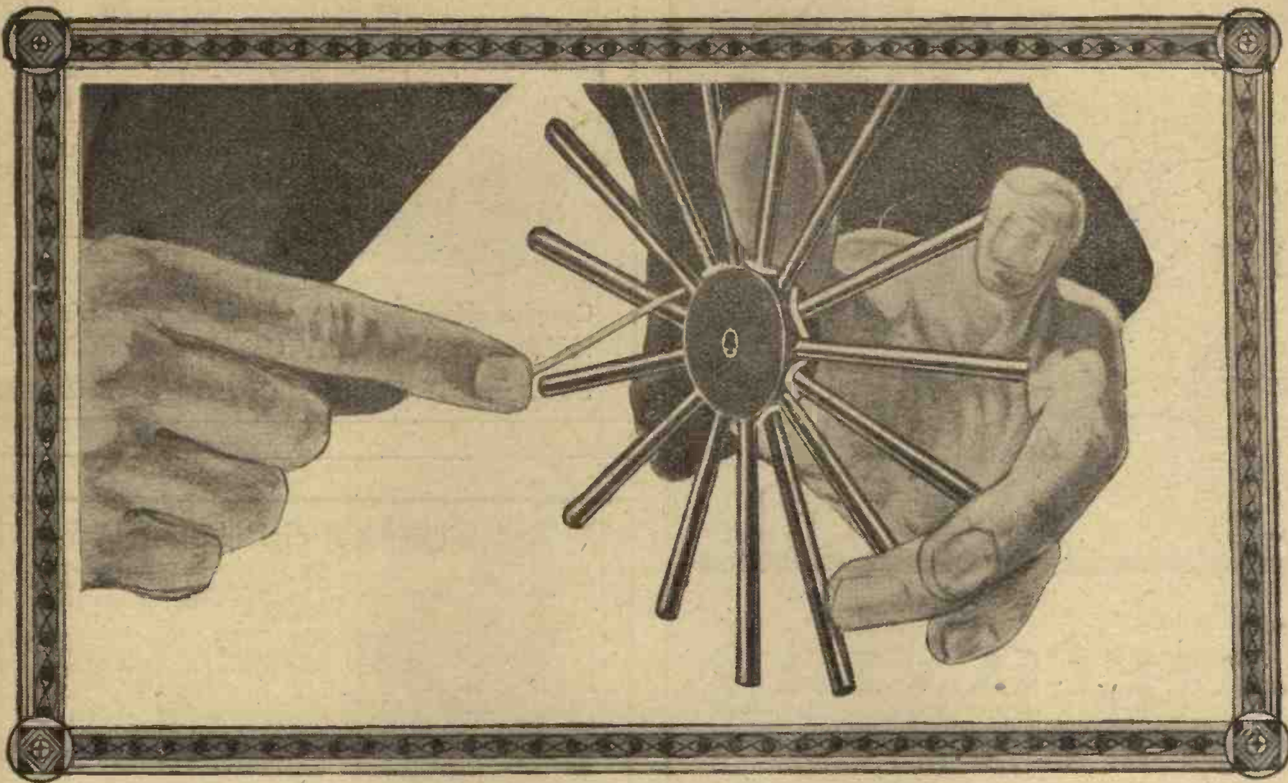

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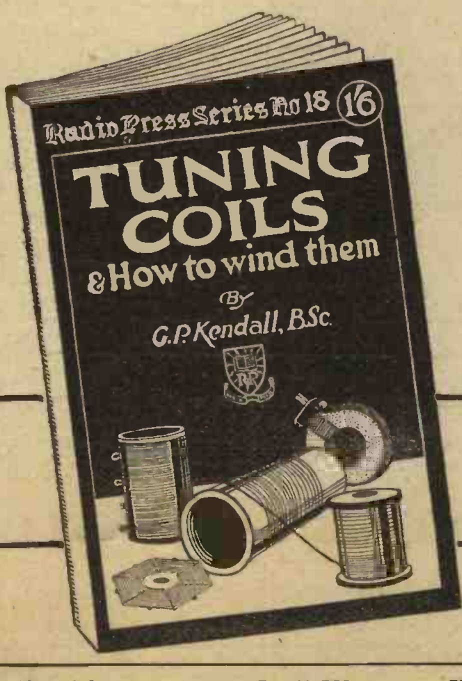

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